CRRI

ANNUAL REPORT

2011-12

सी एस आई आर-केन्द्रीय सड़क अनुसंधान संस्थान

CSIR-CENTRAL ROAD RESEARCH INSTITUTE

New Delhi

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Director

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सीएसआईआर–केन्द्रीय सड़क अनुसंधान संस्थान
नई दिल्ली (भारत)

CSIR-Central Road Research Institute
New Delhi (India)

CRRI Annual Report 2011-12

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From Director's Desk

It is my proud privilege to present the CSIR-CRRI Annual Report 2011-12. The previous year was not just another year gone by, it marked a special milestone in the history of CSIR-CRRI, the beginning of Diamond Jubilee year. The Diamond Jubilee of the Institute is the best time to look back with pride at achievements and contributions made for the industry, society and the academia over past sixty years and look forward with renewed dedication to the national cause. Thanks to great visionaries like Sir Kenneth Mitchell, Sir S.S. Bhatnagar, Mr. G.M. Mckelvie, Dr. R.K.N. Iyengar and many others, the Govt. Of India set up Central Road Research Institute at New Delhi, sixty years ago to serve the Highway Engineering profession. The inauguration was carried out by Pt. Jawarhar Lal Nehru, Hon'ble Prime Minister of India and President CSIR, on July 16, 1952. The Institute has marked this occasion with a year long programmes featuring National and International Conferences/Workshops in the niche areas of road and road transportation.

During the year, CSIR-CRRI has embarked on several important projects. Some of these projects are highly inter-disciplinary in nature requiring expertise drawn from multiple discipline within Institute to work together as a team. Some of the significant studies are use of Plastic Waste in Road Construction – A Pilot study; Design, Construction and Performance Evaluation of New Materials and Mixes towards Development and Upgradation of Standards / Specifications; Evaluation and Monitoring of Rohari Steel Bridge for Increased Axle Load of Freight Wagons; Traffic Management and Design of Selected twenty Intersection of Allahabad City. Traffic and Transportation Study for Port Blair City. Micro-simulation based Driving Cycle in Delhi City for Sustainable Transport System, Evaluation of Operational Efficiency of Highway Network using Travel Time Reliability Measures; Development of Microscopic Traffic Simulation Model using VISSIM and PARAMICS to Develop Speed-Flow Equations and Roadway Capacity for High Speed Corridors; Evaluation of Jute Geotextile for Retardation and Reflection Cracking in Bituminous Pavements; and Economic Evaluation of Road Blockade due to Kaliasaur Landslide.

Work has been completed on preparation of Guidelines for Construction of Roads, Culverts and Bridges in Cyclone Prone Areas.

Under a study sponsored by MORTH on Creation of Complete Range of Independent Facility for Testing of Expansion Joint, test facility for testing of raw materials used in expansion joint have been created. Further work on testing and operation of the APTF facilities acquired earlier has been carried out.

For better data management system, a Data Information Management System (DIMS) has been installed which consists Storage Area Network (SAN), Servers, Computational and backup software along with other required infrastructure. CSIR-CRRI and AIMIL have jointly fabricated large size Pullout Test Apparatus recently which is very useful in determining the interface friction coefficient between Geosynthetic / GI strips with different backfill materials.

As a part of Diamond Jubilee Anniversary celebrations, several events were organized during the year. This included workshop as Indo-highway Capacity Manual; Issues and Strategies for Non-motorized Transport Mode. A National Get-together on Road Research and its Utilization (NGT-2012) was organized which was inaugurated by Sh. C. Kandasamy, Director-General, RD, MORTH while Lt. Gen. R. Ravi Shankar, PVSM, VSM, DG(BRO) was the Guest of Honour. The interactions between the road researchers and user agencies resulted into a number of priority R&D areas pertaining to road and road transportation.

For North-east Regions, a one day workshop on Sustainable Technologies for Road Construction in North-East was organized which was inaugurated by Sh. M.C. Bora, Commissioner and Special Secretary, Govt. of Assam.

In its endeavour for effective technology transfer and building a close linkage with user organizations, the Institute handled a large number of consultancy assignments and earned a sizeable cash resource. The Institute also continued with its year round activities of conducting refresher course/training programme in the field of highway and bridge engineering, traffic engineering, quality control, construction techniques and other related aspects. An International training course on Highway Management and Development (HDM-4) was also organized. In addition, several customized training programmes were also organized for RCD Patna, NRRDA, Ministry of Environment, Iraq.

Under HRD Programme of the Institute, many Scientists have been deputed for studies to acquire higher academic qualification. Besides, staff members were deputed to receive training in the area of their expertise to cope up with the challenging assignments. Further, several Students (B.Tech, M.Tech, MCA) from different academic Institutions / Universities were provided guidance and training for accomplishing their summer project / training and thesis / dissertation work etc. Some of our Scientists received excellence award for their contribution in the Highway Sector.

I take this opportunity to thank all my colleagues and user organisation for their support and look forward to their continued participation in the times to come.

Dr. S. Gangopadhyay
Director

Objectives

The scientific & technical objectives of CRRI are :

- To develop specifications and manuals for construction of low cost roads for different regions of the country.
- To carry out applied research for investigation, construction and maintenance of different types of roads and runway including studies on related materials such as aggregates, bitumen, cement, etc. with a view to effecting economy and achieving greater serviceability.
- To develop appropriate tools, machinery, equipment and instruments for adapting technologies as related to highway engineering and relevant to the country for indigenous use.
- To carry out research and development activities in all aspects of roads under varying climatic and traffic conditions.
- To carry out research and development in all aspects of road traffic and transportation engineering, including study of accidents, development of road safety measure, psychology of road users and transportation economics in relation to different forms of transport.
- To render technical advice and consultancy services to various organisation in roads and related fields to avoid import of foreign expertise.
- To train engineers through refresher courses, workshops and training programmes for wider application of indigenously developed technologies.
- To create and establish all the needed infrastructure, both equipment and expertise, in the various facets of highway and transportation engineering for investigation, planning, design, construction and maintenance as well as to achieve judicious solutions for special problems.
- To collaborate with other institutions for R&D studies concerning roads, road transportation and related practices particularly on regional problems.
- Publication of scientific and technical findings in journals, symposia, conferences, etc. devoted to research and development in related areas of highway engineering.
- Generation of intellectual property and its commercialization through technology transfer.

सीएसआईआर- केंद्रीय सड़क अनुसंधान संस्थान, नई दिल्ली

गुणवत्ता नीति

सीएसआईआर- केंद्रीय सड़क अनुसंधान संस्थान (सी एस आई आर-सी आर आर आई) सड़क व सड़क परिवहन के क्षेत्र में व्यवसायिक उत्कृष्टता का विकास करने तथा व्यवसाय के समक्ष उपस्थित विविध तकनीकी समस्याओं का उपयुक्त समाधान प्रस्तुत करने के लिए अनुसंधान एवं विकास कार्यक्रमों, परामर्श सेवाओं एवं मानव संसाधन विकास कार्यक्रमों को संपन्न करने हेतु कटिबद्ध है।

Quality Policy

The CSIR-Central Road Research Institute (CSIR-CRRI) endeavors to develop Professional Excellence in the area of Roads and Road Transport and to undertake Research & Development (R&D) Programmes, Consultancy Services and HRD Programmes to evolve appropriate solutions to the diverse technical problems faced by the profession.

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Geotechnical Engineering



CSIR-CENTRAL ROAD RESEARCH INSTITUTE

Engineering of Structures against Natural & Other Disasters – Network Project

Under the network project, two landslides namely, Patalganga and Kaliasaur landslides had been selected for study.

(i) Kaliasaur Landslide

Kaliasaur landslide (Fig. 1) is a complex slope failure case having more than one mode of sliding that has been creating crisis at Kilometer-147 on the strategic National Highway-58 of Garhwal region of Uttarakhand state, for last five decades. It has repeatedly activated many times (1952, 1963, 1969, 1972, 1984, 1985 and most recent in 2010). Severity of failure of Kaliasaur Landslide during monsoon time which also coincides with the peak tourism period impedes transportation for several days thereby affecting basic amenities and infrastructural facilities in the region.

Fig. 1 Kaliasaur landslide

Work done on Kaliasaur landslide :

- ***Base Map Preparation*** – A total 231.49 Ha area was covered for the topographical survey with scale of 1:500 (Fig. 2). The topographic base map which was produced with the help of high precision total station and the DGPS was used to develop a Digital terrain model (DTM) and its derivatives maps such as slope and aspects. The DTM and its derivatives give opportunity of logical thinking about the possible influence and activities on the basis of visual observation on the ground.

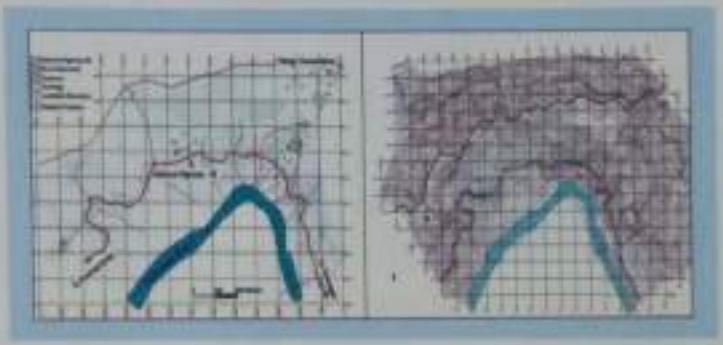


Fig. 2 (a) Contour map of initial stage (b) Final contour map

- ***Geomorphological Assessment*** – Geomorphological studies of the area have been carried out on the base map of the 1:500 scale. The morphology of slide has changed regularly since the slide first appeared. Repeated sliding of minor magnitude have been occurring from the main scarp of the slide making the slide retrogressively moved because the surface of rupture was extending in the direction opposite the movement of the displaced material. However, at a later date the surface of rupture started extending at the lateral margin as well widening the slide making it advancing in nature. The cliff, the steep rupture surface of the top has got enlarged by 40m since 1984. In 2010 alone it has got enlarged by 20 m during one event of

sliding (Fig. 3). The cliff between the crown and displaced material become irregular because of the numerous gullies. There are many cracks above the crown part. There are a few minor scarp developed below the main scarp indicating successive sliding.

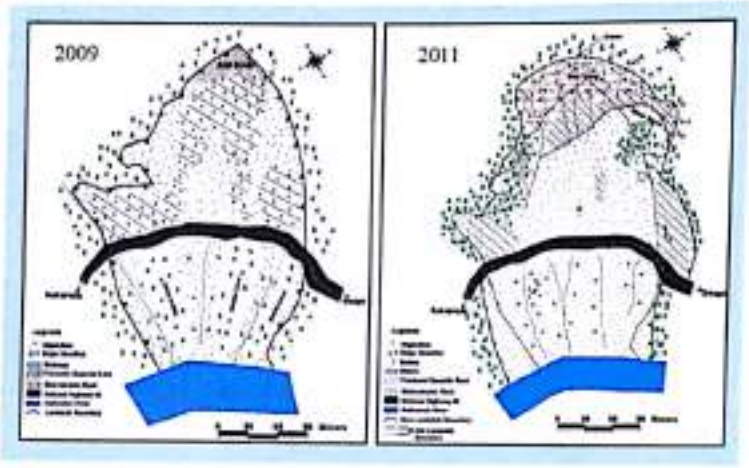


Fig. 3 Geomorphic features of Kaliasaur landslide area

- **Role of Geology in Slope Instability –** Detailed geological map (Fig. 4) of the area was prepared to find out the role played by lithology and structures to affect the slope stability. The independent geology and structural mapping revealed the fact that structures are formed by tectonic deformations in past geological times. The detailed study of major and minor structures was carried out with an intention of figuring out their role in inducing instability and causing the slope failures in the area. In the area of study it has been observed that contacts between two litho-units (e.g. pink and white quartzite) are often a fault, i.e. their contact surface is actually faulted. Prominent foliation of the area shows that the strata are folded synclinally and anticlinally. The crest portion of the anticline houses the maximum stress and to accommodate the same, it eventually gets fragmented due to development of fractures. The displacement observed in the immediate vicinity of the volcanic intrusions suggests faulting associated with the time of intrusion, i.e., displacement might have taken place on account of the intrusion. Slicken-sided surfaces are well exposed in the area further verifying the fault presence. Geological cross sections (Fig. 5) of the study area have been prepared to analyze the geometrical relations of the structures present in the rocks. Folding observed in the quartzite has been associated with the displacement at places. Fall of rock blocks due to intersection of discontinuities is very common and occasionally causes damage to the retaining wall. Fractured condition of quartzite generated small to medium

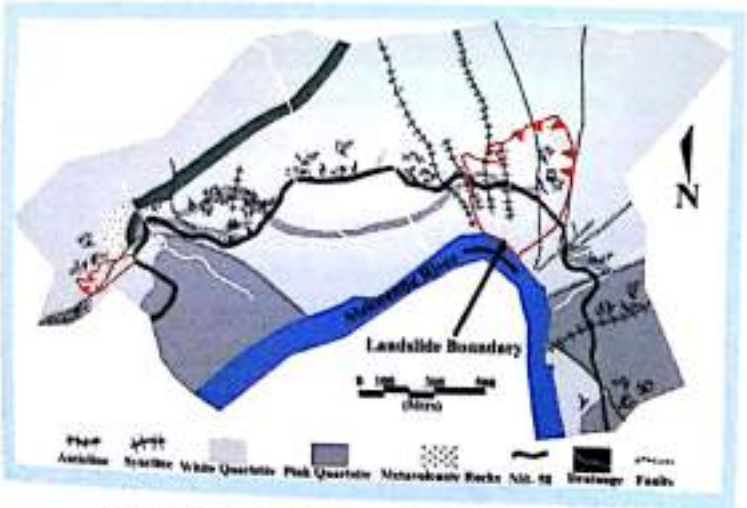


Fig. 4 Detailed geological map of Kaliasaur landslide area

sized blocks that keeps on getting deposited on the side trench of the highway. This causes chocking of the trench and surface run-off is re-directed on the highway. Main landslide scar has lithological contacts among pink, white quartzite and metavolcanic rocks. Contact between metavolcanic and quartzite is very distinct at the crown part. Wedge failure is the most common mode of failure in highly jointed quartzite rock in this area.

In a similar manner, Micro-Zonation Analysis based on Rock Mass Rating (RMR) and Slope Mass Rating (SMR), Kinematic Slope Stability Analysis, Microhazard evaluation have been carried out for this slide. For the first time CRRI has estimated indirect landslide losses due to reactivation of Kaliasaur landslide using unit cost estimation method.

Detour cost – (Extra operating costs in detouring + Extra fuel used*Fuel price)*Number of travelers affected.

The estimation was based on the detouring due to blockage of National Highway – 58. The total detouring cost for 45 days during September-October, 2010 has been estimated to be about Rs. 25 million (approx).

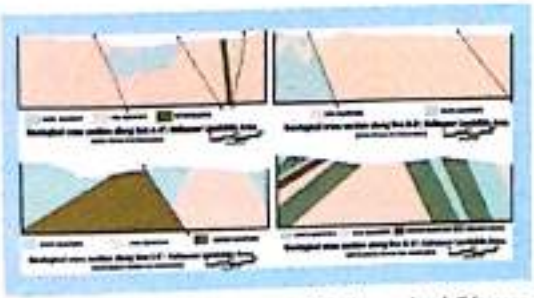


Fig. 5 Geological cross section of Kaliasaur landslide area

Patalganga Landslide

Patalganga landslide (Fig. 6) is located at km 257 on NH-58 at latitude 30°29' and corresponding longitude 79°29' at the mouth of Patalganga River, was once heavily damaged due to devastating landslides in 1970. Since then the valley has become the place of attraction to the geo-environmentalists but much has not been achieved in preventing the denudation of the valley. The mouth of the basin is crossed by the life line (National Highway-58) over a narrow gorge which connects the area with rest of the country. The bridge over the narrow gorge has been washed away thrice and repeatedly shifted up. If the bridge goes away anymore, there is no suitable space to reconnect the highway from both sides.

Fig. 6 Patalganga landslide

Work done on Patalganga landslide:

Base Map Development — The topographic map in the scale of 1:500 with a contour interval of 1 meter with the help of high precision EDM (Total Station) Survey was prepared in 2002-2005 during implementation of DST sponsored project (Fig. 7) the same process has been repeated again & the new map was produced in 2008 to find the

changes occurred during the gap of 4 to 5 years (Fig. 8). A reference datum (of known coordinates and height) was setup in the area using differential GPS of sub-mm accuracy. The most difficult topography of the terrain forces the surveying team to shift base stations of the instrument 16 times, within and outside the slide body, so that its finer details may be mapped. The base map

Fig. 7 Base map of Patalganga basin

prepared was intended to be used not only for the current mapping but also for the continuous monitoring of the Patalganga landslide after every monsoon season.

Fig. 8 Topographic map of Patalganga landslide

Geomorphological Studies – Geomorphological mapping of Patalganga slide was carried out on the base map of the scale 1:500 in the year 2002-2005 and has been repeated in 2009 & 2011 (Fig. 9). The study indicates the changes recurred for last 4 to 5 years. The salient geomorphological features of the landslide are as follows:

Fig. 9 Geomorphological map of Patalganga basin

- Patalganga landslide which extended for about 390 m in length and 320 m in width covering an area of 79,370 m² in the year 2005 has advanced to 457 m in length, 338 m in width and in area 1, 09, 121 m².
- The toe of the slide starts at elevation of 1340 m whereas the crown of the slide attains a height of 1504 m.
- The slide had five prominent streamlets formed on the slope in addition to number of deep gullies and rills in 2005, but at present instead of five streamlets there are only four and the gullies have been also reduced because of the fresh sliding and erosion.
- The slide has steep scarps made out of differential erosion mainly due to rain.

- The toe part initially (1999) had convex slope having average slope angle of about 20 to 250 at the meandering of the river Patalganga. Both side of this convex part concavity was distinct. The toe part however, kept on shifting due to continuous toe cutting during every rainy season. The convexity was converted to convexo-concave with a few gravitational cracks parallel to the riverbank in the year 2005. However, at present the overall slope form indicate towards concavity having segments with convexo-concave slopes.

In a similar manner, geology of area, Landslide Susceptibility Potential Analysis, geotechnical investigations and monitoring of slope movement using pedestals were carried out at this slide area.

Development of Non-Destructive Equipment for Determination of Dry Density of Compacted Soils

Soil density and moisture content are two essential properties in the quality control and quality assurance of projects that involve soil compaction. However, current field practices either are destructive and time consuming (Core cutter and sand replacement methods) or include hazardous substances that require special handling and operating procedures (Nuclear density gauge). Therefore, new robust reliable and non nuclear techniques for the determination of in situ density and moisture content would assist in quality control and quality assurance processes and would allow more measurements to be performed in a shorter time. A study has been taken up to develop a non destructive, non nuclear, mechanical density gauge which works on the principle of variation of penetration resistance with the variation of different levels of soil compaction. A model equipment has been fabricated and calibration curves are being developed. The repeatability of results is being investigated.

Guidelines on Landslide Management on Indian Roads and Highways

The guidelines on "Landslide Management on Indian Roads and Highways" are being developed in collaboration with Indian Roads Congress. According to the flexible Term of References, the following chapters are to be included in the guidelines.

- Case Records of Some Major Landslides and Identification of Areas of Concern
- Landslide Hazard Mapping, Vulnerability and Risk Assessment
- Scientific Investigation of Slopes and Landslides
- Landslide Instrumentation, Monitoring, Prediction, Forecasting and Early Warning
- Landslide Risk Reduction through Improved Planning, Design and Construction Practices
- Technology for Landslide Prevention and Remediation

These guidelines will be prepared for usage by usage by State Public Works Departments,

specially with regard to road infrastructure. The preparation of guideline is in progress. The first chapter of the Guidelines will be Introduction to landslide hazard involving road infrastructure, International and Indian scenario. The other chapters include Terminology and Classification of Mass Movements, Landslide Hazard Mapping, Vulnerability and Risk Assessment

Consultancy Assignments

Preparation of Guidelines for Construction of Roads, Culverts and Bridges in Cyclone Prone Areas

In continuation of the work reported earlier on **Guidelines for Construction of Roads, Culverts and Bridges in Cyclone Prone Areas,** two workshops were organized at Bhubaneswar (Orissa) and Visakhapatnam (Andhra Pradesh) (Fig. 10). Engineers from state PWD and Rural Works Department entrusted with the task of road works in cyclone prone areas (Fig. 11) participated in the workshop. Salient features of

Fig. 10 Workshop organised at Visakhapatnam for dissemination of guidelines

Fig. 11 Protection works against sea erosion at Puri Konark Road

the Guidelines were presented in the workshop and CRRI faculty interacted with engineers to get firsthand knowledge about problems associated with road works in cyclone prone areas. Field visits for the road works constructed in these areas was also undertaken. Based on these visits, Guidelines have been modified.

Design and Construction of Embankment and Pavement Layers using Copper Slag

The construction of experimental test section using copper slag was carried out as per the method statement developed by the Institute. The embankment was constructed in the bridge approaches of Madurai-Tuticorin Highway (NH-45B). The approaches towards Madurai (200m on both lanes) were constructed with copper slag while the approach towards Tuticorin (200m) was constructed with soil. The maximum height of copper slag embankment was 4m. As the construction of 100 per cent copper slag was not practically feasibile, the material was mixed with locally available pond ash by 50 per cent. Copper slag which was found suitable as a replacement of fine aggregates in bituminous construction was tried for its field feasibility, by constructing a 350m experimental Bituminous concrete

Fig. 12 Deflection and roughness observations of copper slag embankment

Fig. 13 Bituminous cores from experimental test track

layer at Ettaipuram, towards Madurai. The first performance observation of experimental test section of copper slag embankment and bituminous concrete layer has been evaluated. Roughness, settlement and deflection of the test track were investigated using different equipments viz. Benkelman beam, Dipstick and Total station (Fig. 12). Bituminous core was taken from the surface layer of bituminous concrete constructed by using copper slag to evaluate its in-situ density (Fig. 13). It was observed that both deflection and roughness characteristics of copper slag embankment was comparable to soil embankment. This study was sponsored by Sterlite Industry Pvt. Ltd.

Feasibility Studies on Vedanta IPP Coal Ash Samples for Road & Embankment Construction

The Vedanta Independent Power Plant 4 × 600 MW (IPP) is located at Jharsuguda in Odisha, India. Situated about 5 km away from the bustling town of Jharsuguda, this coal-based thermal power plant of Vedanta Group has been built alongside one of India's largest deposit of coal at IB Valley and Asia's largest non-brackish reservoir – 'Hirakud Reservoir'. Commissioned in July 2008, this plant has four units of coal-fired turbine generators of 600 MW each. Ash is the major by-product of the plant. The fly ash is periodically removed from the collection hoppers

below the precipitators and is pneumatically transported to storage silos. Here, fly ash is given to cement manufacturers for reutilisation. Balance remaining ash is mixed with optimum quantity of water to be transported to the ash pond through high concentration slurry disposal. To this slurry, bottom ash collected through clinker grinders is also mixed in slurry form. Present production of ash from the Vedanta IPP is about 16,000 tons per day. The Vedanta IPP authorities are keen to utilise ash in value added products. Huge amount of pond ash getting accumulated near the power plant needs to be utilised. To evolve more avenues for bulk utilisation of pond ash, especially in the area of road construction, CSIR-Central Road Research Institute (CRRI), New Delhi was requested to carry out 'Characterisation on different types of ash samples produced at Vedanta IPP'. Under this project, characterisation of fly ash, bottom ash and pond ash samples to determine their suitability for road and embankment construction was carried out and suggestions/recommendations regarding their usage in road construction works was provided to them.

Design of Road Embankment in Submerged/Flood Affected Border Areas of Bhuj, Gujarat

As reported earlier, this project was sponsored by National Buildings Construction Corporation Ltd (NBCC) who has been entrusted the responsibility of constructing 'Border Fencing and Border Roads' along a part of our country's International border in Gujarat. India's International border in Gujarat is situated in Rann of Kutch where Arabian Sea water transgresses and regresses frequently leaving

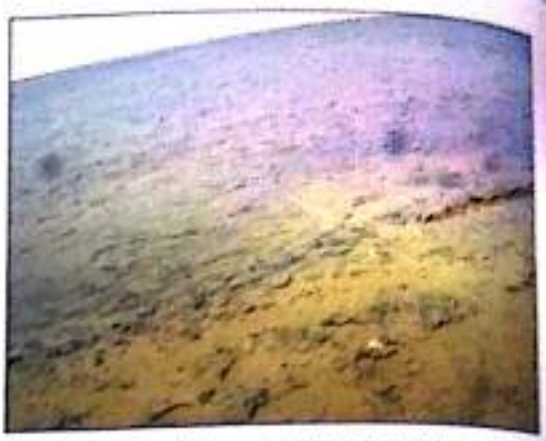


Fig. 14 A view of the proposed road stretch inundated by tidal waters

inland marshy and swampy, dotted with small to very large salt water bodies (Fig 14). During the year, embankment design for construction of road stretch in tidal area adjacent to sea, technical advice on road construction in waterlogged area and bituminous overlay design for roads in service were carried out.

Feasibility Study of JGRS Soil Stabilizer

The feasibility study of JGRS Soil Stabiliser was entrusted to Central Road Research Institute by M/s Jindal Steel and Power Limited, Raigarh. A laboratory study had been taken up to investigate the efficacy of JGRS soil stabiliser for soil stabilization of different types of soils for use in road construction. To carry out the study, four types of soils coarse grained soils (Badarpur sand and Granular sub base soil) and fined grained soils (Delhi silt and Clayey soil) were chosen.

In order to assess the efficacy of JGRS via-a-vis Cement (a conventional soil stabilizer); the coarse grained soils (Badarpur sand and Granular sub base soil) and fined grained soils

(Delhi silt and Clayey soil) have been stabilized both with cement and JGRS soil stabilizer separately. Strength gain was determined in terms of Unconfined compressive strength and CBR. The durability tests were also conducted to assess the performance of stabilized soils under the wetting and drying cycles which simulate the environment condition in field.

Based on laboratory data, it was found that the unconfined compressive strength of soil stabilized with 2, 4 & 6 per cent cement gives higher strength as compared to with 2, 4 & 6 per cent JGRS for 7,14 & 28 days curing period. The increase in soaked CBR value with 2, 4 and 6 per cent cement & JGRS was also evaluated. It was found that CBR values increase significantly with the addition of both cement as well as JGRS. From durability test, it was concluded that silty soil sample stabilized with 2 per cent cement as well as JGRS failed in durability test. However, with 4 & 6 per cent cement and JGRS soil stabilizer could pass the durability test. The samples made with 4 & 6 per cent cement and JGRS have satisfied the criterion as stipulated in ASTM D559 and prescribed by IRC:SP:98-2010 . In case of Badarpur sand samples stabilized with 2&4 per cent cement and 2, 4 & 6 per cent JGRS failed in durability test. However, soil sample with 6per cent cement could pass the durability test. The samples made with 6 per cent cement only have satisfied the criterion as stipulated in ASTM D559 and prescribed by IRC :SP:98-2010. In case of clayey soil the samples made with cement as well as JGRS could not satisfy the criterion as stipulated in ASTM D559 and prescribed by IRC:SP:98-2010 .However in case of granular soil it was concluded that soil sample stabilized with 2, 4 & 6 per cent cement as well as 2, 4 & 6 per cent JGRS could pass the durability test (Table 1). The samples of granular materials made with cement as well as JGRS have satisfied the criterion as stipulated in ASTM D559 and prescribed by IRC:SP:98-2010.

Table 1 Results of Durability Test of Stabilised Granular Soil

Durability Test				
Soil – stabilizer Mix	Soil- Cement loss (per cent) of stabilized samples			Permissible Soil-Cement loss (per cent)
	Soil + 2 per cent stabiliser	Soil + 4 per cent stabiliser	Soil + 6 per cent stabiliser	
Granular Soil + cement	3.875	0.6	1.57	Maximum permissible loss 10 per cent.
Granular Soil + JGRS	6.97	4.2	1.57	Maximum permissible loss 10 per cent.

Based on laboratory studies, it is concluded that Delhi silt treated with both 4 & 6 per cent cement as well as JGRS soil stabilizer, Badarpur sand with 6 per cent cement only and granular soil with 2 per cent, 4 per cent & 6 per cent cement as well as JGRS soil stabilizer, can be considered for its use for subgrade improvement as well as in sub-base layer of a road pavement. However, before recommending for large scale application, an experimental section be constructed and monitored over a period of time to assess the performance of road.

Feasibility Study on Utilisation of Phosphogypsum as Road Construction Material

The study on Feasibility Study of Utilisation of Phosphogypsum as Road Construction Material was entrusted to Central Road Research Institute by M/s Paradeep Phosphates Ltd., Orissa, India. In order to assess its suitability as a road construction material, a laboratory study has been taken up. The broad scope of work is as follows;

- Characterization of Phosphogypsum
- Characterization of Soil /Flyash
- Use of Phosphogypsum in concrete roads
- Use of Phosphogypsum in Bituminous mixes of flexible pavements.

The chemical composition of phosphogypsum is given in Table 2.

To carry out the study, locally available soil from the plant campus was collected. The soil selected for the study is fine grained soil and clayey in nature. In order to use phosphogypsum with flyash, which is available in abundance near the plant, a study was also proposed to assess the strength characteristics of flyash with addition of phosphogypsum. Phosphogypsum and soil samples were characterized in detail as per BIS standards. The characteristics include the physical characteristics such as specific gravity, particle size distribution, consistency limits such as Liquid limit & Plastic limit, natural moisture content etc. In addition to the above, the optimum moisture content (OMC) at which the soil can be compacted to its maximum dry density (MDD) were also evaluated for further casting of samples for strength determination. The strength and engineering characteristics of phosphogypsum alone and in combination with local soil, lime and flyash etc were determined in terms of its Shear strength (c, ϕ); Unconfined compressive strength and California Bearing Ratio (CBR). In order to assess the efficacy of phosphogypsum for the purpose of stabilisation, the soil was stabilized with phosphogypsum and phosphogypsum+ lime separately. Strength gain was determined in terms of Unconfined Compressive Strength and California Bearing Ratio (CBR). The durability tests were also conducted to assess the performance of stabilized soils when subjected to wetting and drying for simulating water logging and flooding situation at site.

Based on laboratory data, it was found that phosphogypsum as such when compacted at

OMC & MDD, yield very high strength. The unconfined compressive strength (UCS) was good enough for its use in different pavement layers. However when this sample was soaked in water for the purpose of durability, it was found to lose some strength but still it has sufficient strength for use in sub base layer or as a capping layer (Table 3). The local soil was also stabilized with different percentages of phosphogypsum up to 50 per cent. It was found that with the addition of phosphogypsum, the UCS increased but only upto 20 per cent phosphogypsum. When the quantity of phosphogypsum was increased beyond 20 per cent, the strength decreased afterwards. However, when the mixes of soil and phosphogypsum, were subjected to durability tests none of the samples could withstand the durability test criteria.

During the determination of unconfined compressive strength, it was observed that compacted specimen of phosphogypsum behaved like a semi rigid material. It is evident from the fact that when the compacted mass of the same was subjected to loading in increment it behaved like a brittle material at its ultimate strength. Based on laboratory studies, it is concluded that phosphogypsum as such can be used as a fill material and in sub-grade/sub-base layer of a road pavement. However, before recommending for large scale application, an experimental section be constructed and monitored over a period of time to assess the performance of road. Further work is under progress.

Table 2 Chemical Composition of Phosphogypsum

Compound name	Concentration (per cent)
F	0.234
Na_2O	0.112
SiO_2	0.54
P_2O_5	1.06
SO_3	76.259
CaO	21.755
Fe_2O_3	0.012
SrO	0.021
Y_2O_3	0.007

Table 3 Unconfined Compressive Strength of Phosphogypsum after Different Curing Periods and Durability Test

Material	UCS ,Kg/cm2
PG One Day Curing	46.0
PG 3 Day Curing	46.0
PG 7 Day Curing	53.5
PG 14 Day Curing	53.2
7days curing +7 days in water	31.6

Experimental Test Track Construction Using Jarofix Waste Material

As reported earlier (Annual Report 2010-11), the feasibility study of Jarofix waste material in the construction of embankment and sub grade was sponsored by Hindustan Zinc Ltd. Chanderia, Chittorgarh, Rajasthan. Jarofix

waste material samples were collected from Hindustan Zinc Ltd. (HZL) Chanderia, Chittorgarh and Debari, Udaipur, Rajasthan separately. After finding its suitability in embankment construction, experimental test tracks were constructed to study its behaviour under actual traffic and environmental conditions. Pavement performance study of the experimental test section was evaluated by visual condition survey, deflection study by Benkelman beam, roughness observation by dipstick, (Fig. 15 & 16) and auto level observation for predicting the surface settlement. First set of performance study was carried out on all four sections of the experimental test sections. The performance of Jarofix/Jarofix-soil sections is compared with that of conventional soil section. Following conclusions are drawn.

- Overall condition of the embankment test sections constructed using Jarofix waste material is comparable to that section constructed with conventional soil.
- It was observed that rebound deflections values of sections with Jarofix and mix of Jarofix:soil material (0.49–0.66 mm) are comparable to that obtained for conventional section (0.61 mm).
- The values of IRI (m/km) for Jarofix and mix of Jarofix:soil (3.96 - 5.90) are comparable to conventional soil (5.09) pavement section.
- It is concluded that performance of Jarofix and mix of Jarofix:soil embankment and sub grade is comparable to conventional soil construction.

Fig. 15 Roughness measurement by using dipstick

Fig. 16 Deflection measurement by using Benkelman beam

Feasibility Study on Usage of Super Fine Copper Slag in Land Filling and Road Construction

This feasibility study of super fine copper slag waste material in land filling and road construction is sponsored by M/S Hindalco Industries Limited, Dahej, Gujrat. Super fine copper slag is a waste material produced during extraction of copper concentrate from high copper ore by floatation and filtration processes. At present, the accumulated super fine copper slag is about 2 lac MT, while its annual production is about 1.5 lac MT per year at Hindalco Industries Limited, Dahej, Gujrat. After investigating its feasibility for construction of road embankment, laboratory studies were also carried out for evaluating the suitability of material as a replacement

of fine aggregates in various bituminous mixes. The feasibility of its utilization was tried in different bituminous mixes viz. Dense Bituminous Macadam (DBM), Grade 2 and Bituminous Concrete (BC), Grade 2. The study indicated that 10-15 per cent of fine aggregate can be replaced by super fine slag. The optimum bitumen content was obtained as 4.8 per cent and 5.5 per cent respectively for DBM and BC mixes. The bituminous samples with superfine copper slag satisfied the design requirements as per MORTH specifications.

Feasibility Study of Cinder Waste Material for Road Construction

Cinder is a waste material produced at Tata Steel Limited, Jamshedpur, Jharkhand. A study has been taken up to study its feasibility for use in embankment and sub base, base and bituminous layers of road pavement. Cinder, WRP (Waste Recycled Product), local soil and their various mixes in different proportions are being studied for their use in different layers of road construction. These materials are being studied whether they will satisfy the criteria laid down by MORTH & MOST specifications. The study is in progress and these materials have been found granular in nature having good drainage properties, high angle of friction. A combination of WRP and cinder can satisfy density requirements of the materials for the embankment construction.

Geotechnical Study of Jugsalai Cinder Dump Area for Building Construction

Cinder dump area which is about 50m height is lying unused for the last 30 years

Fig. 17 A pictorial view of cinder dump

(Fig. 17). The dump would be investigated for its feasibility for building construction. Different field tests viz. SPT, DCPT and Plate load tests would be conducted and data would be analysed to arrive at some conclusions. The project is presently under progress.

Design of Remedial Measures at Lukhbir Slide on NH – 31 A

National Highway 31A (NH–31A) links Gangtok to Sevoke. NH–31A runs along the banks of the Teesta River. It takes four hour to reach Gangtok from Bagdogra Airport. The swift Teesta clears her serpentine track through slopes of bamboo and wild banana trees that rise to conifers towering like cathedral pillars and orchids.

Lukhbir slide is located at km 26.8 on NH 31- A (Fig. 18). This Landslide is active since 1968. Several agencies like GSI, CRRI & CWPRS carried studies on this landslide and suggested some of the remedial measures like benching of slopes, ceiling of cracks, retaining walls and

Fig. 18 View of the landslide portion

Brest wall. Border Roads Organisation has sponsored this study to CSIR-CRRI.

The rocks are of highly weathered condition. Although these rocks dip away into the hills from the roadway, at an angle of nearly 40 to 45°, due to highly weathered conditions they are vulnerable to fail. Sometimes, rocks are found in the form of powder due to excess overburden pressure and availability of moisture. They are of very thin layered form but seem to be compacted probably again due to the overburden. Though high amount of weathering has taken place and schist is a weak rock but the slope is still quite stable due to the vegetation cover over it. There are traces of fractures on the weathered surface in different directions. The slope has plenty of seepage water which makes the slope vulnerable to fail. For stabilising the downhill slope, the following remedial measures were designed:

- Design of gabion wall on downhill slope
- Design of 15m high cantilever wall on downhill slope
- Design of 10m high cantilever wall with cladding
- Design of cladding on downhill slope
- Design of cladding with anchors on downhill slope

Site Stabilisation for Platform at Diglipur (North Andaman)

The area under the study falls in the Northern Part of North Andaman Island. Digilipur, the main township of the Island, is about 325 km from Port Blair. Aerial Bay is connected to Port Blair by 350 km long bituminous road. Most of the hill ranges show a parallel trend to each other. The Platform was constructed after cutting two adjoin hillocks. The hilltop is at an elevation of 148m from mean sea level. The terrain is fully covered with vegetation. Nearly 3.5 lakhs cubic meters of earth was excavated to create important structure and other facilities. Debris excavated from that area was loosely dumped on side slopes. Berms were provided on the slope. Heavy rainfall during monsoon creates large slope stability problems in this area. The first landslide was observed in the revenue side during September 2008 (Fig. 19). Two slides were observed in this area. Military Engineering Services requested CRRI for stabilisation of platform and design of remedial measures to stabilise the landslides. Field investigation has been

Fig. 19 Front view of the landslide at Diglipur, North Andaman

carried out. Design of remedial measures is under progress.

Suitability of Granular Materials for Capillary Cutoff

The project was sponsored by Jhajjar PWD, Haryana to study the suitability of granular material for capillary cutoff. The traffic on NH-71 and two other State Highways is plying on a diversion road of length 4.2 km causing heavy traffic congestion. At this location, a canal is flowing parallel to the road saturating the sub grade layer by capillary rise. As a result, diversion road is frequently getting damaged. To rectify this problem, it was decided that the height of embankment be raised and a capillary cutoff layer may be provided. For this, suitability locally available materials commonly known as Tibba sand, granular material-I passing 13.2 mm and granular material-II passing 4.75 mm were investigated for the construction of embankment, sub grade and capillary cutoff. It was observed that Tibba sand may be used for the construction of embankment and a mix of Tibba sand and good earth for sub grade construction. It was suggested that either the proposed soil be replaced with better soil or the same be mixed in suitable proportion with other soil, so as to achieve the minimum dry density of the order of 17.5 kN/m3. Both granular materials did not satisfy the required filter/drainage specifications for capillary cutoff. However, these materials may be used as a capillary cut off with a geotextile layer.

Design of Filter Material for Capillary Cutoff and Assessment of Suitability of Soil for Embankment /Sub-grade

The project was sponsored by Fatehabad PWD, Haryana. A bypass road at Fatehabad is proposed to be constructed parallel to existing canal in the district Fatehabad, Haryana. The highest flood level (HFL) at site was observed as 200.220 m. The proposed formation level

(top of sub grade) is at a height of 0.99 m above HFL. Locally available soil was proposed to be used as a fill material and a 100 mm thick capillary cutoff was proposed at a height of 0.29 m from HFL. To investigate the suitability of proposed soil for earth work and suggest the requirement of capillary cutoff under the present site conditions, a study was carried out. For sub grade soil, it was suggested that either the proposed soil be replaced with better soil or the same be mixed in suitable proportion with other soil, so as to achieve the minimum dry density of the order of 17.5 kN/m^3. Advice regarding design of capillary cut-off material was also provided.

Feasibility Study of 'Stabilig' as a Soil Stabilising Agent

The project was sponsored by M/s Stabilig Road Solution to study the feasibility of 'Stabilig' as soil stabilizer. It is planned to study the effect of Stabilig/soil stabilizer on strength of different type of soil viz. Gravely soil, Sandy soil, Silty soil and Clayey soil. All four type of soil have been characterized for their Geotechnical/Engineering properties. The unconfined compressive strength test and California bearing ratio test are being performed on soils after treating with different percentage of Stablig. Further work is under progress.

Annual Rreport 2011-12

Pavement Engineering and Materials

Flexible Pavements
Rigid Pavements
Pavement Evaluation



CSIR-CENTRAL ROAD RESEARCH INSTITUTE

CSIR CRRI

Development of Composite from Fly Ash and Plastic Waste for Bituminous Road Construction

The objective of this study is to develop a composite by blending fly ash and plastic waste for its use as filler in bituminous road construction. Stone Matrix Asphalt (SMA) requires 8 to 10 per cent filler and offers improved functional as well as structural characteristics over traditional bituminous concrete mixes. In the present study, the laboratory performance characteristics of SMA mixture containing fly ash and composite have been investigated by various laboratory tests such as indirect tensile strength, indirect tensile strength ratio, static creep at different temperatures, resilient modulus at different temperatures and rutting resistance by wheel tracking test. Laboratory tests indicate increased resistance to moisture sensitivity of SMA mixture containing composite as filler. The values of resilient modulus of the SMA mixture containing composite are fairly high compared to SMA mixture with plain fly ash as filler indicating potential of such SMA mixes for better pavement performance. The rutting in SMA mixture containing composite is reduced to 1.75 mm as compared to 2.3 mm in SMA with plain fly ash. The values of creep modulus of SMA mixture containing composite are higher compared to mixture of plain fly ash filler. The results of mechanistic analysis indicate significant increase in allowable number of traffic on use of composite as filler in SMA mixture. These findings indicate that SMA containing composite is an acceptable material for bituminous road construction.

Results of rut depth studies and resilient modulus studies are shown in Figs. 20 and 21.

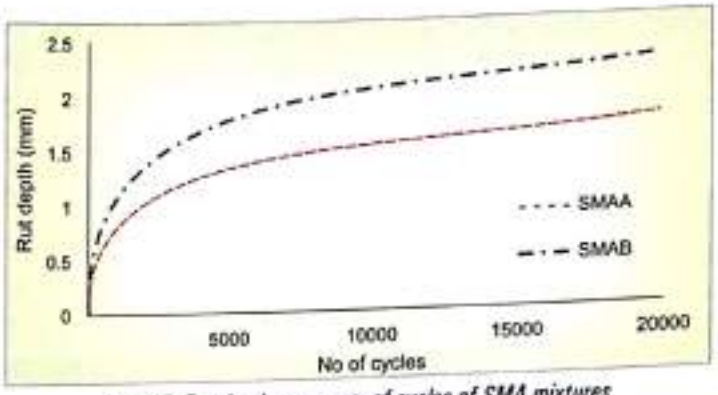


Fig. 20 Rut depth versus no. of cycles of SMA mixtures

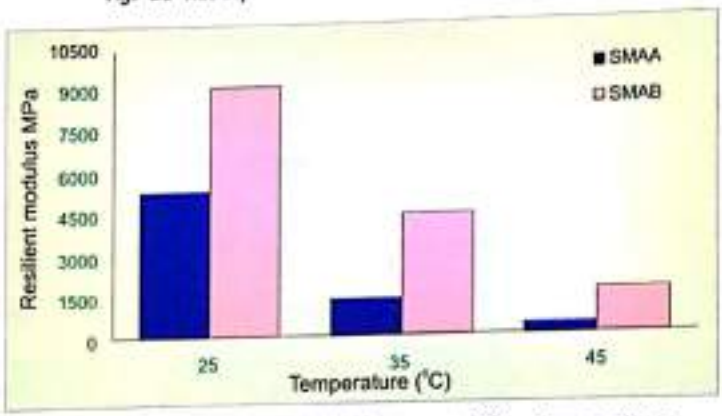


Fig. 21 Resilient modulus of SMA mixtures at different temperatures

Development of Polymer Modified Binder with Improve Compatibility

The world is facing a waste disposal crisis from the most problematic plastic produced today i.e. Poly Vinyl Chloride (PVC). The products made up of PVC are reported to be causes of dioxin pollution during incinerations. In this study, PVC pipe waste has been used as a modifier up to a level of 3 per cent and 5 per cent to made bituminous products for paving applications. PVC is not compatible with bitumen, therefore to make homogeneous blend of PVC with bitumen, waste PVC was

treated with a chemical followed by blending with bitumen. The visco-elastic property of the bitumen-PVC blends such as storage modulus, loss modulus and phase angle were determined and compared with values of unmodified bitumen. The performance characteristics of bituminous mixes made up of these PVC modified binders were also investigated and compared with those of conventional bituminous mixes. The results indicate that PVC pipe waste can be used in bituminous road construction. Strength and stability of the mixes increase by the incorporation of PVC pipe waste. It was also observed that addition of PVC pipe waste in bitumen showed increased resistance to permanent deformation.

Development of Technology to Produce and Lay Down the Modified Bituminous Mixtures at Lower Temperatures

Warm Mix Asphalt (WMA) mixes are produced at lower temperature, while maintaining key advantage of hot mixes. The aim of the present study is to investigate mechanistic properties of polymer modified warm mix asphalt (PMWMA) for reduction of mixing, laying and rolling temperature. The optimum dose of additive for reduction of operational temperatures is determined by viscosity-temperature relationship and performance properties of PMWMA. Laboratory performance properties of traditional PMB mix and PMWMA such as Marshall stability, retained stability, indirect tensile strength ratio, Marshall quotient, ITS, creep and resilient modulus at different temperatures, fatigue life and rutting are investigated. Results reveal that optimum dose of organic surfactant additive (warm mix) lies in the range of 1.5 to 2.0 per cent by weight of PMB to achieve lower mixing, laying and rolling temperature. The reduction in temperatures by a factor of 30 to 40°C is achieved. Values of creep modulus and resilient modulus of PMWMA are found superior at different temperatures, indicating better performance. Rutting is also found lower compared to traditional PMB mix. Fatigue life of PMWMA mixes determined by 4 point bending beam fatigue test is observed higher than conventional PMB mix. The better indirect tensile strength ratio values indicate potential of PMWMA towards prevention of moisture damage even after compaction at lower temperature. Improved performance of PMWMA alleviate compaction problem of traditional hot PMB mixes at lower temperature. The clean and safe environment due to reduction in production temperature besides better road performance under heavy traffic and extreme climatic condition is expected to enhance the use of warm PMB mixes in bituminous road construction in place of traditional PMB mixes.

Effect of Higher Axle Weight and Moduli Variation of Pavement Materials on Fatigue and Rutting Life of Flexible Pavement

To find out the impact of increased axle weight and moduli variation on fatigue and rutting life of bituminous pavement, an in-house study is under progress. Resilient modulus of bituminous mix at different temperature

has been determined to carry out further mechanistic analysis.

Performance Evaluation of Test Section Laid with Stone Matrix Asphalt (SMA) Surfacing in NDMC Area

The performance of SMA test section laid at Zakir Husain Road in NDMC area was done. The data of deflection by Benkelman beam, roughness and distress have been collected for final observation. The surface of test section is observed satisfactory.

Mechanistic Evaluation of Warm Asphalt Mixture Containing Crumb Rubber Modified Bitumen

Crumb Rubber Modified Bitumen (CRMB) is a popular binder in India due to its better performance compared to traditional paving grade bitumens. The drawbacks of these high energy CRMB mixes over traditional bituminous mixes are requirement of higher mixing, laying and rolling temperatures. New moderated temperature mixing technologies are graining attention due to stricter environmental restrictions. Warm Mix Asphalt (WAM) technology, reduces the production and application temperatures of bituminous mixes during construction. Therefore, an attempt is made in this study to develop a method to reduce mixing and compaction temperature of CRMB mixes for safer working, retention of improved properties, save fuel and reduce green house gas emissions in road construction. The optimum dose of additive for reduction of operational temperatures is determined based on viscosity-temperature relationship of CRMB and additive blends as well as mechanistic properties of modified CRMB mixes. The laboratory performance of warm asphalt mixture containing CRMB is found comparable or superior to traditional CRMB mixes in terms of Indirect Tensile Strength (ITS), ITS ratio, resilient modulus, deformation, rutting and fatigue. Results reveal that optimum dose of organic surfactant additive is found 2.0 per cent by weight of crumb rubber modified bitumen to lower mixing, laying and rolling temperatures by 30°C to reduce requirement of fuel.

Development of Suitable Methodology in terms of Repair Treatment of Defence Runway in Emergency

Damages caused due to bombing by enemy's air actions develop in the form of craters which are of different magnitude in terms of shape and dimensions. It is absolutely essential to continue to operate airfield pavements damaged by air bombing and by other similar weapons. Therefore, the repair essentially must be completed immediately and rapidly after the attack so as to allow the launching and recovery of combat aircrafts. New developments in the weapon technology with deep strikes and increased demands in aircraft operations make existing crater repair procedures complex, inadequate and unsuitable. The cold mixes of bituminous concrete have been developed for better load dissipation. The results are given in Table 4.

Table 4 Values Obtained at Optimum Emulsion Content (OEC) for Cold BC-II Mix

Parameter	Obtained values at Optimum emulsion content 10.0 per cent
Marshall stability (kN at 60°C)	9.24
Flow mm	5.10
Percent air voids	7.24
Percent voids in mineral aggregate (VMA)	20.86
Percent voids filled with bitumen (VFB)	65.28

Study on Validation of IRC Pavement Design Method Using Heavy Vehicle Simulator (HVS)

After the successful completion of stipulated 'Site Acceptance Test (SAT)' of APTF, an in-house project entitled 'Study on Validation of IRC Pavement Design Method Using Heavy Vehicle Simulator (HVS-APTF)' was initiated. The main objective of the study includes:

- Construction of a Test Strip within CRRI with specifications conforming to MoRT&H
- Verify the 'Design Life' as envisaged
- Attempt to validate IRC design method

The pavement structure and associated instrumentation involved in this study are shown in Figs. 22 and 23.

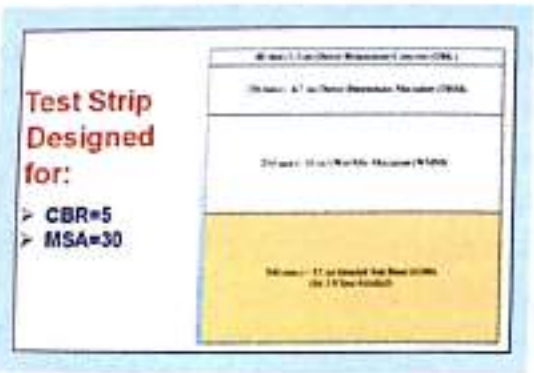


Fig. 22 Pavement section

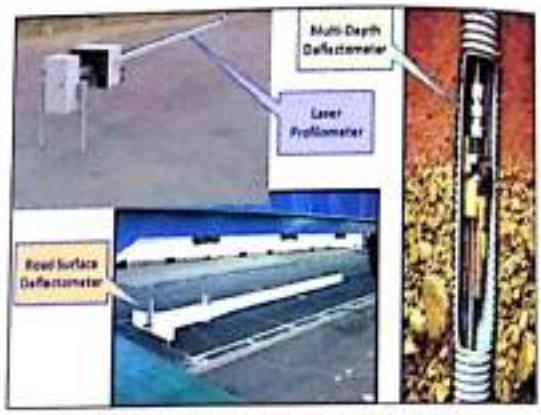


Fig. 23 Associated monitoring instrumentation

Evaluation of Jute Geo-textile for Retardation of Reflection Cracking in Bituminous Pavements

This project has been sponsored by Institute of Jute Technology, Kolkata, with the following objectives:

- Characterization of various physical properties of jute fabrics supplied by IJT
- Laboratory evaluation of selected jute fabrics supplied by IJT in terms of performance related parameters of bituminous mixes
- Analysis of test results
- Submission of reports along with recommendation on the final fabric to be used for field trials

The following conclusions were drawn from the study:

(a) Jute was found to be effective in increasing the fatigue life of bituminous mixes.

(b) Jute impregnated with 60/70 bitumen was found to have an average Effectiveness Factor (EF) of 2.72, i.e., it increases the fatigue life by 172 per cent compared to samples where no jute was used.

(c) Jute impregnated with PMB-40 bitumen was found to have an average Effectiveness Factor (EF) of 4.17, i.e., it increases the fatigue life by 317 per cent compared to samples where no jute was used.

(d) Jute impregnated with 80/100 bitumen was found to have an average Effectiveness Factor (EF) of 2.53, i.e., it increases the fatigue life by 153 per cent compared to samples where no jute was used.

(e) A higher value of Effectiveness Factor (EF) indicates higher potential for delaying the development/propagation of cracks.

Figures 24 and 25 shows the beam fatigue testing and flexure beam fatigue test set up used in the study.

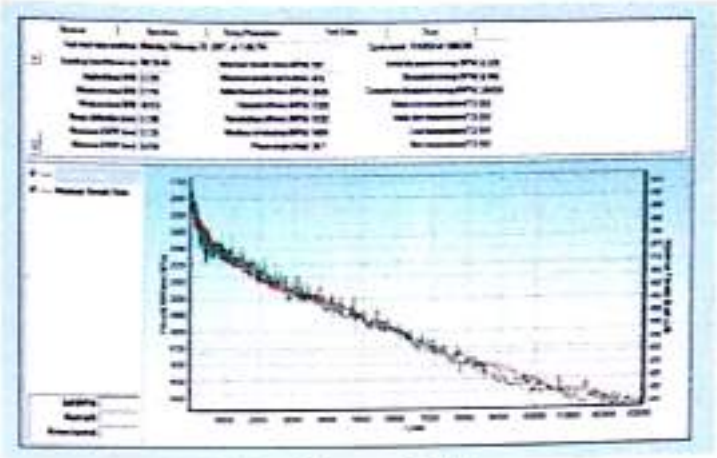


Fig. 24 Beam fatigue testing in Progress

Fig. 25 Flexure beam fatigue test setup used in the study

Field Performance on Warm Mix Technology Using Bitumen Emulsion in Gujarat

Recently, environmental criteria in bituminous road construction has become stricter and stricter resulting to development of new moderated temperature of mixing and compaction technologies such as warm or half-warm (less than 100°C). M/s Elsamax India Pvt. Ltd. sponsored a study to Institute for design of half warm mix using cationic bitumen emulsion and supervises construction of experimental section at km 160.000 to 160.850 of NH-27 in Rajkot District of Gujarat followed by observation of performance. The optimum bitumen emulsion content was found 9.5 per cent by wt. of aggregate or 8.71 per cent by wt. of mix. The optimum bitumen content was found 6.0 per cent by wt. of aggregates or 5.7 per cent by wt. of mix. The emulsion based warm mixture process is considered a promising

method to produce bituminous mixtures at significantly lower temperatures in which good balance can be obtained between a low viscosity binder in emulsion. The reduction of operating temperatures will contribute positively to reduction of emissions (fume, dust and CO_2) and energy savings. A view of surface is given in Fig 26 and 27. The properties of designed warm mix using cationic bitumen emulsion are given in Table 5.

Figs. 26 & 27 Production and laying of emulsion based half warm mix at NH-8B in Gujarat

Table 5 Properties of Designed Warm Mix using Cationic Bitumen Emulsion

Properties	Test Value	Requirement
Bulk Density, g/cc	2.413	-
Stability at 60°C, kN	10.57	8
Flow, mm	5.0	3-6
Voids, per cent	6.3	5-7
Voids, filled by bitumen, per cent	66	65-75

Use of Plastic Waste in Road Construction – A Pilot Study

On request of Haryana Public Works Department, Institute supervised laying of test section as a part of pilot study for demonstration of plastic waste modified mix technology for implementation on roads under jurisdiction of Haryana PWD (B&R). Specifications and mix design was done and experimental section was laid at km 97 to 98 of Rothak-Bhiwani Road. A typical static creep curve is shown in Fig. 28 and a view of road is shown in Figs 29 and 30.

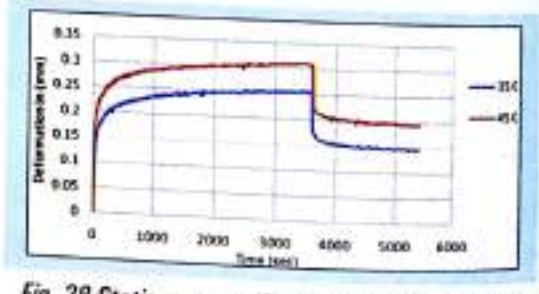


Fig. 28 Static creep studies on cores from test track

Fig. 29 Laying of plastic waste modified mix at Rohtak–Bhiwani road

Fig. 30 Finished surface of plastic waste modified mix at Rohtak – Bhiwani road

Recommendations for Maintenance Treatments for a Section of Flexible Pavement of Jetpur-Rajkot on NH-27

The state of Gujarat has got National Highways running through it as arterial corridors, of which NH-8 and NH-27 (Formerly NH-8B) prominently. NH-27 connecting Rajkot to Porbandar is an important link of the state's efficient road network. The section between Rajkot-Jetpur being under concession agreement, the operation & maintenance needs to be taken care by the concessionaire as per the stipulated terms/norms in the concession agreement. Proposing micro surfacing for the surface during the present periodic renewal cycle, the concessionaire referred the matter to the Institute for the purpose of verification of the appropriateness of the proposal. The verification was subjected to the pavement condition evaluation data as provided and a site inspection for appropriate remedial recommendations. A view of surface is shown in Figs 31 (a & b).

(a)

(b)

Figs 31 (a & b) A view of surface recommended for micro surfacing treatment

A field work for the physical observation of existing flexible pavement section was undertaken by CRRI team in January, 2012.

The scope of work under the project includes the following major activities / tasks:

- To assess the site condition by inspection
- To verify the condition data acquired by the client
- Make suitable recommendations

A visual inspection in a slow moving vehicle was made during the field visit, while a get-down-and-view approach was followed at some locations. The overall surface condition of the pavement in the section appeared to be fairly good with the deflection and unevenness data provided by the concessionaire corroborating the same. The recommendations covered maintenance/ rehabilitation measures based on the field observations and the data/information provided by the concessionaire.

Consultancy Assignments

Investigation for Flexible Pavement Design for Construction of Bituminous Road from Live Stock Market to NHF–24 via Existing Approach Road of SLF Site, Ghazipur

Project is sponsored by Municipal Corporation of Delhi. The main objective of the study is to carry out the field investigations for flexible pavement design to construct bituminous road from live stock market to NH-24 via existing approach road of Sanetary Land Fill (SLF) site, Ghazipur. A view of site is shown in Fig. 32.

Fig. 32 Actual site view showing that the landfill has been deposited in layers

The study has been completed. The recommendations emerged from the study are given as under:

(a) Excavate the landfill material upto 1.5 m depth. It should be properly leveled and compacted with a suitable coarse sand or screenings; Type B material conforming to MoRT&H Specifications, 2001.

(b) Place a surcharge loading of granular layers upto WMM layer only (including the blanket course) for 1 to 2 years for causing the further settlement of the material. The surcharge material may be provided with a bituminous premix carpet for smooth movement of trucks.

(c) During initial period of 1 to 2 year of surcharge loading, it might be possible that the surface may undergo differential settlements causing undulations, which may be aggravated due to the movement of trucks. So, the leveling of the undulations of the surcharge roadbed would probably be necessary at regular intervals. Therefore, it is suggested that the maintenance, filling and leveling of any settlement or depression should be carried out at regular intervals.

(d) Special care is to be taken for the movement of trucks during the rainy season. It is probable that due to the penetration of rain water in the lower layers, large differential settlements may occur. So, it is suggested that during the rainy season, truck movement should not be allowed on the surcharge roadbed. This control would only be required during the

initial 1 to 2 years of surcharge loading. Once the bituminous road is constructed after the surcharge loading period, such problems would be minimized.

(e) After the completion of the period of surcharging, the bituminous layers (BC + DBM) may be provided of thickness as specified in section 4.0, after providing a profile corrective course of Dense Bituminous Macadam (DBM).

(f) Strict quality control measures shall be exercised during all stages of construction.

(g) All works must conform to the relevant clauses of Ministry's Specifications for Road and Bridge Works, 2001, (Fourth Edition).

Side drains are to be provided on either side of the road to carry off the excess water during the rainy season and should be cleaned regularly.

Evaluation of Inssta Pattch (A Pressure Sensitive Compound for Instant Repair of Potholes)

The project was sponsored by M/s Akshay Innovations Pvt. Ltd., Nagpur. The main objective of the study is to evaluate performance of Inssta Pattch pressure sensitive cold mix compound for filling of the pot holes and minor repairs. Project has been completed. The conclusions of the study are given as under:

- Inssta Pattch pressure sensitive cold mix compound is found suitable for repair and maintenance of bituminous roads specially for filling of potholes and utility cuts, as the various properties of the mix such as stability, bond strength, moisture susceptibility and retained stability have been found acceptable. The results of field study also indicate acceptable performance. The Inssta Pattch ready-mix is, therefore, recommended for repair of potholes, ravelled surface and utility cuts in roads.
- Inssta Pattch pressure sensitive cold mix compound can be used for timely repair of potholes, ravelled surface and utility cuts on roads, thereby preventing further damage to roads and savings in huge recurring repair costs.
- Inssta Pattch ready-mix can be applied for repair of roads using just 2 to 3 labours and in a short time causing minimum disruption to traffic.

Performance Evaluation of Stabilized Layer

The project has been sponsored by M/s Soma Enterprises Ltd., Gurgoan. The objective of the study is to carry out one-time performance evaluation of stabilized layers on NH-1. The testing of surface is in progress at project site as shown in Fig. 33.

Fig. 33 Roughness measurements using Dipstick in progress on reach 3 on NH-1

Project has been completed and the final report has been submitted. The conclusions of the study are as under:

- There is an improvement in the in-situ CBR of the local soil after treatment with the stabilizer.
- The roughness condition of the road sections was found to be within the specified limits.
- The deflection measurements indicate that the alternate design proposed by M/s IPPL, Delhi is not sufficient to cater to the anticipated future traffic during the design life and an overlay is required.

Investigation for Causes of Distress and Providing Remedial Measures on the Main Runway of Flexible Pavement at NSCBI Airport, Kolkata

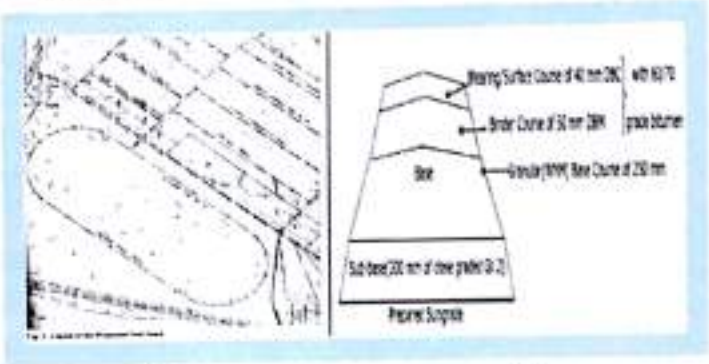
This study is sponsored by Airport Authority of India. The Netaji Subhash Chandra Bose International Airport (NSCBIA) of Kolkata is an important international air transport hub serving the eastern part of the country. Many domestic and international carriers operate from this airport serving the passenger and freight air traffic. The airport has two runways, namely main runway(old) and the second runway. The main runway was reported to have distress developed in different portions and the airport authorities referred the matter to the Institute for the purpose of evaluation of the runway condition to provide appropriate remedial recommendations. The task was taken up with an aim to determine (i) the condition of main runway pavement and the likely causes of distresses (ii) the Pavement Classification Number (PCN) and, (iii) the required remedial/ corrective actions in order to bring out the runway for use by operations of indicated critical Aircrafts vis-à-vis the specified PCN requirement of the main runway. Some typical views are shown in Fig. 34 (a-d).

Fig. 34 Typical views of NSCBI Airport

Necessary field work for the evaluation of existing airfield pavement was undertaken. The investigations carried out include general appraisal of the airfield pavement condition, pavement deflection measurements by Falling Heavy Weight Deflectometer, extraction of cores and test pits observations etc. A draft report was submitted to the sponsorer which includes the salient data/results and key observations made based on the field studies and laboratory investigations; the probable causes of distress/defects encountered on the runway and recommendations with needed remedial/rehabilitation measures to correct the defects in order to improve the condition of affected sections of the runway.

Verification of Design of Flexible Pavement for Vehicle Dynamics Test Track at VRDE, Ahmednagar

This study is sponsored by Center for Vehicle Research and Development Establishment (VRDE). VRDE carries out extensive testing of the military vehicles for their dynamic behaviour and performance. For this reason, it gets test tracks designed and built in its establishment for the specific requirements, executed by Military Engineering Services (MES), and then tests the designated vehicles over the tracks. Different types of pavement structures are used in these test tracks built as per design considerations. In the process of adding another test track, with the absence of the design input parameters considered by the consultant, it was required to verify the design with known input parameters. A request was made for the same with the Institute by the concerned GE. Based on these, the verification of design of flexible pavement was taken up. Recommended cross section of the pavement studies is shown in Fig. 35 (a & b).



(a) (b)

Fig. 35 (a & b) Recommended cross-section of the pavement structure

During the field observations, the site was jointly visited and the location of the proposed test track was seen. It was learnt that the pavement structure will be brought out in 'cutting' in order to get full lateral confinement by natural ground only.

There was no much documented record available on the earlier design and specifications of the flexible pavement of the proposed test track. In the absence of the design parameters considered in the original flexible pavement design, based on the available information and test results of soil samples, the design was revisited using the California Bearing Ratio (CBR) values and

the traffic (load and repetitions) information provided by the concerned officials.

Also, the information obtained on heavy vehicles to be used on the test track was an input on the loads exerted on the pavement structure.

Laboratory Evaluation of Trindad Lake Asphalt (TLA) in Bituminous Mixes

Trinidad lake asphalt is well known natural bitumen which occurs naturally in lakes Trindad as semi solid bituminous material. The objective of the study is to evaluate the feasibility of the use of the TLA in bituminous road construction. Various performance tests on the mixes such retained stability, tensile strength ratio, rutting, beam fatigue have been conducted. The addition of TLA pellets to the bitumen has significantly affected properties of bitumen and its mixes. Considerable reduction in rutting is observed. Tensile Strength Ratio (TSR) is also high for TLA mixes indicating its ability for better resistance towards moisture sensitivity. The beam fatigue test results showed that addition of TLA pellets increased the fatigue life of bituminous mixes

Laboratory and Field Evaluation of Shell Thiopave

Shell Thiopave is a product developed by Shell Sulphur Solutions for use in bituminous paving mixture. Project is sponsored by M/s Shell India Market Pvt. Limited. The Thiopave helps in replacing bitumen by 15 to 20 per cent in a bituminous mixture. The interim conclusions drawn from performance are given as under:

- From the visual observations, the trial sections; Thiopave – (DBM) + Thiopave (BC), Thiopave (DBM) + Conventional (BC) and Conventional (DBM) + Conventional (BC) are in good conditions except raveling at some locations.
- The Benkelman beam deflection values showed that the Thiopave + Thiopave section had the least deflection value (0.636 mm) when compared with the other two sections, showing better structural adequacy of pavement. The deflection value was decreased by 12.1 per cent with Thiopave in two layers of DBM (120 mm) when compared with two layers of conventional DBM (120 mm). Similarly, the deflection values were decreased by 11.8 per cent with Thiopave in one DBM layer (60 mm) and one layer of conventional DBM (60 mm) when compared with two layers of conventional DBM (120 mm)
- The data have shown that the roughness along the section remains similar in all the sections (1390 to 1398 mm/km) and this may be due to the effect of surface layer alone. Further evaluation studies on the trial section, will provide sufficient data for predicting the effect of DBM layers on the surface unevenness.
- Second round of pavement evaluation has shown encouraging results with Thiopave as a bituminous mixture modifier in DBM layers. Further, structural and functional evaluation studies will provides sufficient data in predicting the advantage of Thiopave in DBM over the conventional mixtures.

Feasibility Study on Use of RoadCem for Use In-Situ Stabilization of Soil

This project in sponsored by M/s PowerCem Technologies. The conclusion of the study based on the results of UCS, CBR and ITS tests, the feasibility of RoadCem as soil stabilizer for use in different layers of road pavement viz. Sub grade, Sub base and base is evaluated. The following conclusions are drawn based on the tests carried out on stabilized soil.

- The soil is stabilized with 10 per cent cement and 0.1 per cent Roadcem by weight of soil as requested by technical expert of the client.
- The CBR values of untreated soil sample after 4days and 7 days soaking period are found to be 7.2 and 7 per cent respectively.
- The soil stabilized with 10 per cent cement and 0.1 per cent Roadcem by weight of soil gives 7 and 28 days curing CBR value of 126.4 and 203.7 per cent respectively as compared to 122.8 and 202.4 per cent CBR value for cement stabilized soil without Roadcem indicating improvement.
- The UCS of untreated soil after 7 days curing is found to be1.07 kg/cm^2.
- The soil stabilized with 10 per cent cement and 0.1 per cent Roadcem gives 28 days curing UCS value of 26.1kg/cm^2 as compared to 25.6 kg/cm^2 UCS value for cement stabilized soil without Roadcem.
- The addition of cement (10 per cent) and Roadcem (0.1 per cent) lead to increase in CBR as well as UCS value of soil
- From durability test, it was observed that the resistance to the effect of water on strength for soil treated with 10 per cent cement and 0.1 per cent Roadcem is 92 per cent and as compared to 78 per cent of cement stabilized soil. Therefore RoadCem stabilization is durable toward resistance to the effect of water.
- Cement and Roadcem stabilized soil may be used in Sub-base layers as stabilization is effective and durable.
- Due to higher strength and bearing capacity of soil stabilized by Roadcem, the thickness of pavement may be reduced.

Investigation for Pavement Design of Sohna Road (Strengthening Measures) and Service Lane (Pavement Crust) of Sohna Road

Haryana Urban Development Authority, Gurgaon requested the Institute to undertake investigation study of Gurgaon-Sohna Road (5 km road stretch) to recommend strengthening requirements to improve its condition and also design for service road.

Based on the Benkelman beam deflection data, it is recommended that an overlay of 50 mm Dense Bituminous Macadam (DBM) + 50 mm Stone Matrix Asphalt (SMA) may be provided on Gurgaon-Sohna carriageway and 100 mm Dense Bituminous Macadam (DBM) + 50 mm Stone Matrix Asphalt (SMA) for design life of 5 years.

Investigation for the Causes of Distresses Developed on Delhi-Jaipur NH-8 between km 144.770 to 181.330 and Suggestions for Remedial Measures (Approx. 15 km Length, One Carriageway)

The bituminous surface under the wheel path developed rutting under heavy axle. The study was undertaken for investigating the causes of rutting. Various field tests were conducted such as Benkelman Beam deflection study, Axle load, visual assessment and test pits were dug on selected locations. Further work is in progress.

Evaluation of Microsurfacing Treatment on NH-10 (Delhi-Rohtak) between Punjabi Bagh and Mundka in Delhi

The bituminous surface under the metro rail developed distress due to fall of water on the surface from metro track. To prevent development of distress, slurry sealing and microsurfacing treatment was recommended. Further evaluation of treatment provided by Delhi PWD was undertaken and the report submitted to Delhi PWD.

Investigation for Flexible Pavement Design of (i) Road Surface in Khan Market Area, (ii) Road of B.K. Dutt Colony, Aliganj Colony and Back Lane of Jor Bagh Colony, Other Colony Service Roads in Sub Division

Field investigation of above mentioned project roads was carried out in Sept. Oct. 2011 to understand the causes of distress. Laboratory evaluation of existing crust material collected through test is completed. Interim recommendation for strengthening work has been submitted to sponsors

Investigation for the Causes of PrematureFailure of Khar-Banur Road (km 0.00 to 22.00)

This study is sponsored by Central Works Division, Mohali, Punjab. Project road developed distress prematurely in the form of cracking and potholes (Fig. 36 (a & b)). It is observed that characteristic deflection value exceeded permissible limits. Recommendations have been given for improvement of pavement and surface condition based upon analysis of pavement data, axle load and traffic studies. Micro surfacing treatment is also recommended as premature maintenance treatment.

(a)

(b)

Fig. 36 (a & b) A view of distress (Pothole and cracking)

Laboratory Evaluation of Emulsion Samples (MS, RS-I)

The project is sponsored by Pratap Petro Products Pvt. Ltd. Samples of emulsions of different grades were evaluated and found in conformity to IS: 8887 specifications.

Investigation for Premature Failures of Wazirpur - Farukhnagar Road (km 0.600 to 2.500) and Suggestions for Remedial Measures

The study is sponsored by Haryana State Roads & Bridges Development Corporation Ltd. The final report of project has been submitted to the client. Based on the results obtained through field and laboratory investigations, the following major conclusion can be drawn regarding causes of pavement failure on Wazirpur-Farrukhnagar road:

- The projected traffic considered in the pavement design for 10 years design life was 30 million standard axles (msa) but the projected traffic based on the actual axle load survey is worked to be 70 msa for 10 years design life.
- The increased msa on this road was due to movement of heavily loaded vehicles and the calculated maximum Vehicle Damage Factor (VDF) was 11.8. The movement of the mix occurs due to the heavy axle load.

Profile Correction (Camber Correction) on Outer Ring Road From IIT to Modi Mill

Recommendation for Modi Mill to IIT Gate Side Road

A profile correction layer of Dense Bituminous Macadam is to be provided on those sections where undulations/unevenness is observed. This is followed by 50 mm thick layer of Dense Bituminous Macadam with VG-30 grade of bitumen and followed by a wearing course of 40 mm thick Bituminous Concrete with PMB-40 binder. It is recommended to provide 40 mm mastic asphalt as per IS: 5317-2002 after providing required profile corrective course and 50 mm thick Dense Bituminous Macadam layer at major Junctions/Intersections/Existing Mastic Surface which are subjected to acceleration and decelerations.

Recommendation for IIT Gate to Modi Mill Side Road

A profile corrective layer of Dense Bituminous Macadam is to be provided on those section where undulations/unevenness is observed. This is followed by 50 mm thick layer of Dense Bituminous Macadam with VG-30 grade of bitumen and followed by a wearing course of 40 mm thick Bituminous Concrete with PMB-40 binder. It is recommended to provide 40 mm thick mastic asphalt as per IS 5317-2002 after providing required profile corrective course and 50 mm thick Dense Bituminous Macadam layer at major junctions/intersections/existing mastic surface which are subjected to acceleration and decelerations.

Investigations for Causes of Stagnation of Water near Sewage Treatment Plant Channel for Remedial Measures

The proposed road has alignment from Dwarka to NH-8 through a road stretch from km 9.500 to 10.500 near Sewage Treatment Plant (STP) channel in water logging area where water stagnate with full of vegetation, bushes, organic matter and humus

The scope and objectives of the study are:

- To determine the construction techniques for improved road in water logging area
- To collect soil sample from different strata of alignment for filling embankment
- Laboratory evaluation of in situ subgrade soils and other pavement materials
- To suggest remedial measures for improvement and strengthening of road
- To suggest / recommend suitable measures for soil treatments for strengthening / improvement.

Following recommendations are made:

(i) *Removal of Upper Layer of Clayey Soil– Existing* poor soil up to the depth of 50 cm shall be replaced by sand as per Grading given in Table 6.

Table 6 Grading Requirement of Sand-Type B Screening

Sieve size, mm	% Passing
11.2	100
5.6	90-100
0.180	15-35

(ii) *Raising of Embankment for Road Section km 9.500 to 10.500* – Fill the entire road width of 12 m and 3m wide berm on either side of Central Verge up to 1.0 m high embankment by borrow soil with compaction in the range 1.791 to 1.883 gm/cc with optimum moisture content 10 to 12 per cent.

(iii) *Sub Grade of Pavement* – The 50 cm subgrade shall be made up of good non plastic soil (CBR > 4) compacted to the 97 per cent density of the Modified Proctor Density.

(iv) *Sand Blanket* – 15 cm thick course of Sand Blanket or Inverted Choke (clause 404.3.2) as per MORT&H Specification for Roads & Bridge Work. The resultant sand blanket may act to cut of capillary water to above pavement structure.

(v) *Drainage Along with Pavement* – The drain shall be designed on the principles given in IRC: SP: 42. The drain shall be 30 cm deeper from the bottom of crust of the pavement.

(vi) *Camber* – The camber of the shoulder shall be kept 4 per cent and the camber of the bituminous surface shall be kept 2.5 per cent.

(vii) *Crust Thickness of Pavement* – It is advised that the crust of the pavement shall be GSB Grade 1 (Coarse Graded, Clause 401 of MoRT&H Specification Grading Table I Table 400.2). Base Course of Wet Mix Macadam + DBM of Modified Bitumen + 40 mm wearing coat of Stone Matrix Asphalt (SMA), conforming to IRC SP-79-2008. The thickness of pavement layers shall be designed for projected traffic as per IRC-37.

Field Evaluation of Evotherm WMA Technology in Godhara–Gujarat and Delhi

This project is sponsored by M/s MeadWestvaco India Pvt. Ltd. The first trial is conducted under the project entitled "Dense Bituminous Work on Master Plan, Sector & Cluster Roads including part development of Master Plan Road No. 2, Relocation Industries Project, Udyog Vihar, Bawana". From the visual observations, the trial sections, Evotherm and Control are in good conditions. It was observed during construction of test section, the production temperature of Evotherm Warm Mix was 30 to 35 °C lower than the production temperature of conventional. The Benkelman beam deflection values showed that the Evotherm section had the least deflection value (1.04 mm) when compared with the control section (1.08 mm), showing better structural adequacy of pavement. The deflection value was decreased by 3.8 per cent with Evotherm.

Design Validation for Constructed Tar Roads at Multi-Commodity Pack House Facility of National Agriculture Cooperative Marketing Federation of India Ltd. Chhindwara, M.P.

Design validation of bituminous pavement constructed in & around the Multi commodity pack house facility was carried out in Feb. 2012 to find out its suitability for ongoing commercial traffic. Final report has been submitted to the client.

Vetting of Pavement Design using RBI-81 for DLF Mullanpur Project

This project is sponsored by M/s Alchemist Touchnology Limited. The developed horizontal and vertical micro strain values, obtained using F Pave software are less than limiting horizontal and vertical micro strain values, obtained using equations for fatigue and rutting criteria.

Evaluation and Periodic Monitoring during Hot Recycling and Analysis of Cores for Mix Design

The project is sponsored by M/s Writgen India Pvt. Ltd. The main objective of the study is to carry out evaluation and periodic monitoring during hot recycling and provide the mix design for recycling work. To fulfill the above objective, the scope included the site visits, mix design based on results of cores of existing pavement, collection of limited mix samples during construction, field and laboratory evaluation, analysis of field and laboratory results, Preparation of report and submission of report.

Investigation of the Causes and Extent of Failures of Dsc Road to Noida for Strengthening and Improvement

DSC Road to Keshar Garden Road of Noida between Sectors 42 to 43 and 47 to 48 is an important link road, under the jurisdiction of Noida Authority. The length of road is about 2.5 km, which is a four lane divided carriageway. The road under investigation caters local traffic primarily DSC Road residential societies and shopping complexes. Noida Authority requested CRRI to undertake study to recommend strengthening requirements to improve its condition. Field investigations were carried

out and road samples were collected for laboratory investigation. This report contains data of field investigation, laboratory investigation, data analysis, inference drawn and recommendations.

The crust composition of the pavement structure observed from the two test pits is given in Table 7.

Based on the field and laboratory data/results, it is recommended that an overlay of 80 mm Dense Bituminous Macadam (DBM) plus 50 mm Bituminous Concrete (BC) mixes may be provided on both carriageways for strengthening of road in order to provide additional structural strength to the pavement to enable it to carry the present and anticipated future traffic volume and loads in the next 10 years.

Table 7 Composition of Crust Thickness of DSC Road to Keshar Garden Road between Sectors 42 to 43 and 47 to 48

Layer Specification	Pavement Crust Thickness in different Pit , mm					
	Pit No. 1 (Up-Direction) 190m (LHS)	Pit No. 2 (Up Direction) 1245m (LHS)	Pit No.3 (Up Direction) 2225m (LHS)	Pit No.4 (Down Direction) 1900m (RHS)	Pit No. 5 (Down Direction) 1300m (RHS)	Pit No. 6 (Down Direction) 475m (RHS)
Black-Top (Bituminous)	111	113	94	124	100	160
WBM(Grade-II & III)	274	350	372	291	313	305
Total	385	463	466	415	413	465

Transfer of Cold Mix Technology for North East Region

The construction of roads with hot mix involving use of bitumen is associated with environment pollution, higher energy consumption and hazardous to labour force due to higher temperature applications. A higher temperature range is required for different applications in hot mix conventional road construction. Therefore, bituminous roads construction with conventional hot mixes is sometimes not feasible or even not desirable in high rainfall areas due to intermittent rains throughout the year which affect the production and laying of hot mixes. At high altitude or in snow-bound areas, hot bitumen gets solidified quickly and looses its binding property, when it comes in contact with existing cold pavement surface. Cutback bitumen is, therefore, specified to overcome such problems but requires little heating. The heating leads to emission of solvents used as cutter stock, which create environmental problems. The use of bitumen emulsion eliminates the heating of binder and aggregate and thus prevents the degradation of environment and conserves the energy.

Effect of Bottom Ash/ Pond Ash as Replacement of Fine Aggregate in Concrete

As reported earlier, a study on Bottom ash/Pond ash as partial replacement of fine aggregate in cement concrete has been taken up. Studies on strength development i.e. compressive strength, flexural strength and split tensile strength; durability studies such as abrasion resistance, Sulphate attack, chloride ion penetration, drying shrinkage etc. and on green concrete such as compacting factor, slump etc. were carried out. A comparative study with plain cement concrete was also carried.

Samples with 0,10,20,30,40,50,60 and 70 per cent replacement of fine aggregate by bottom ash/pond ash were prepared and the properties were compared. The results indicate that the workability of concrete decreased with increase in bottom ash/pond ash content. The compressive strength, flexural strength and split tensile strength which were initially lower up to 28 days when compared with control specimen became less distinct after 28 days. On durability study, it is observed that specimen prepared with bottom ash is comparable with control specimens. It is concluded that bottom ash up to 30 per cent replacement of fine aggregate can be used in cement concrete. The strength results are given in Figs. 37 & 38.

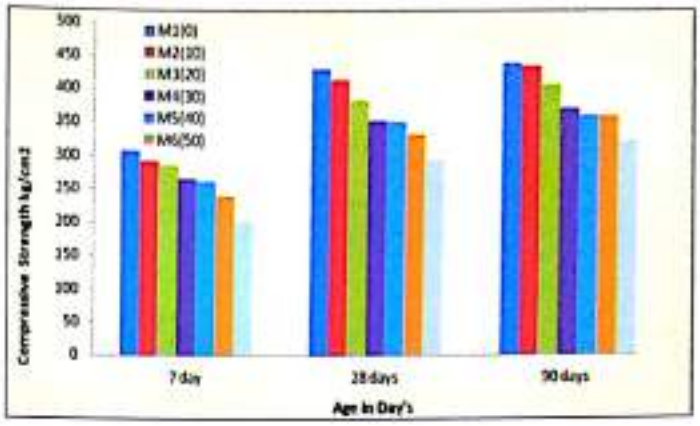


Fig. 37 Compressive strength of concrete for various mixes (0 to 60 per cent bottom ash/pond ash as replacement of fine aggregate)

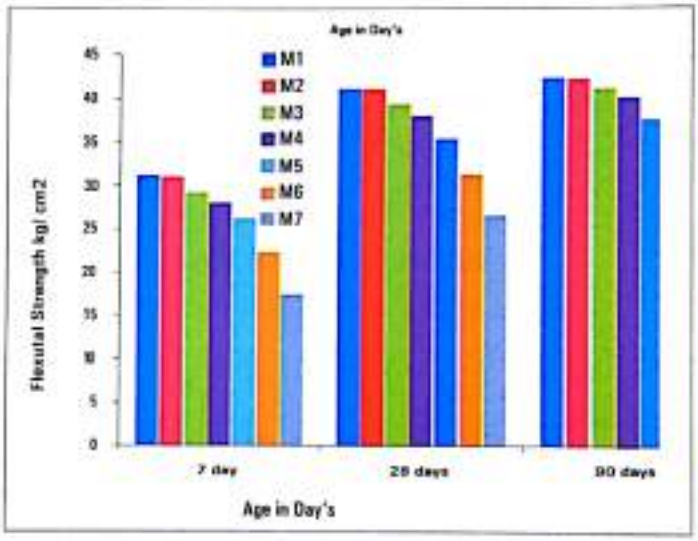


Fig. 38 Flexural strength of concrete for various mixes (0 to 60 per cent bottom ash/pond ash as replacement of fine aggregate)

R & D Studies on Performance Evaluation of Rigid Pavements on High Density Traffic Corridors using Instrumentation Supported by Laboratory Tests

The project was sponsored by Ministry of Road Transport and Highways, Govt. of India with the objective to validate and verify the actual relationships between various design parameters assumed in theoretical design and those actually observed under the rigid pavements. The results of the study are to be used for furthering the actual design consideration and incorporating modifications in the design methodology to be used in future.

Under this research project, response of concrete pavement slabs to environmental and traffic loadings has been captured through instrumentation at Allahabad by-pass on NH-2; Kota, Rajasthan, on NH-76 and Siliguri, West Bengal, on NH-3. The sensors, embedded into the concrete pavement slabs during construction (Fig. 39), included Vibrating Wire (VW) type temperature sensors and strain gages, VW joint meters, and resistance type dynamic strain gages. VW temperature sensors measured temperature within the concrete slabs at various depths. VW strain gages measured the strain induced at different depths due to the temperature. Joint meters installed at transverse joints measured the amount of movement due to expansion and contraction at joints. Resistance type strain gages measured the strains induced within the concrete due to vehicle axle loads under dynamic conditions. Tests were conducted under road traffic to measure the strains induced at non-tied and tied edges at different speed of trucks with different axle loads (Fig. 40). The analysis of the data led to the following major conclusions:

Fig. 39 Sensors embedded in concrete pavement

Fig. 40 Load testing of instrumented pavement

- Measured curling stresses significantly less than the theoretical stresses
- Load induced edge stresses much less than the theoretically calculated stresses
- Tied shoulders and tie bars at longitudinal joint reduces edge load stresses considerably

Consultancy Assignments

Design of Concrete Pavement for SLF Site at Ghazipur, Delhi

Municipal Corporation of Delhi (MCD) is maintaining a Sanitary Land Fill (SLF) site

for disposal of Municipal Solid Wastes near Ghazipur dairy farms located at NH-24. MCD has proposed to construct a road from Live Stock Market of Slaughter House to NH-24. The total length of the road is approximately 1.5 km, out of which nearly 400 m portion is to be constructed as concrete road. The width of the proposed concrete road is 25 m. MCD sponsored the project to Institute for providing design of concrete pavement for the proposed road (Figs. 41 & 42).

Fig. 41 Site for proposed CC road

Fig. 42 Existing area filled with cow dung

The suggested design for the Jointed Plain Concrete Pavement included 220 mm thick Pavement Quality Concrete slabs of size 3.6m x 4.5m, 125 micron thick Polythene Sheet as separation layer between PQC and DLC, 100 mm thick Dry Lean Concrete layer to be provided over 150 mm Granular Sub-base.

Fig. 43 Construction of Ultra Thin White Topping in progress

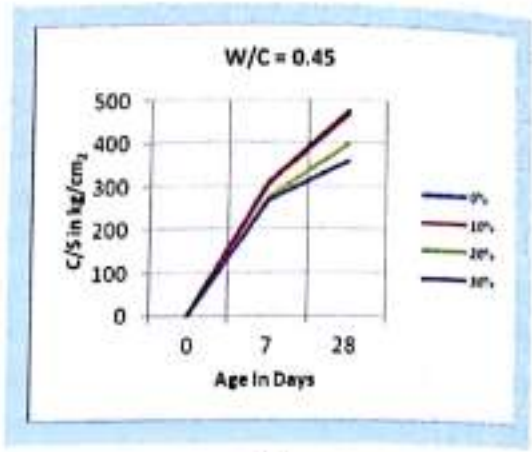
Design and Construction of Cement Concrete Pavement i.e. Concrete Overlay on Internal Lanes of NDMC Colonies at Gole Market New Delhi Areas

This study was sponsored by New Delhi Municipal Corporation with the objectives to design cement concrete overlay on the existing bituminous roads as well as on unpaved portion and to provide concrete mix design containing fly ash for PQC and lean concrete.

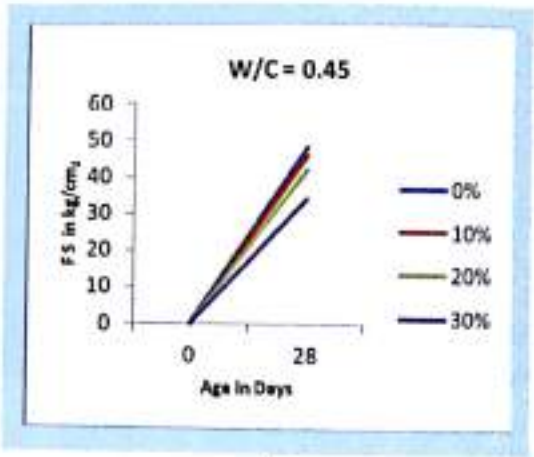
The suggested ultra thin white topping designed for 20 years consisted of 100 mm thick lean concrete leveling layer and 100 mm thick PQC of M-40. The suggested PQC panel size is 1.2m × 1.2m. Figure 43 shows construction of ultra thin white topping concrete at NDMC colonies, Gole Market New Delhi.

Use of Phosphogypsum as a Partial Replacement of Cement in Cement Concrete

To assess the suitability of Phosphogypsum in cement concrete, a study was sponsored by M/s Paradeep Phosphate Ltd. Orissa. An experimental investigation is conducted to study the effect of phosphogypsum in the development of strength by partial replacement of cement in cement concrete. Absolute volume method is used in the present investigation. The test programme consisted of carrying out compressive strength test



(a)



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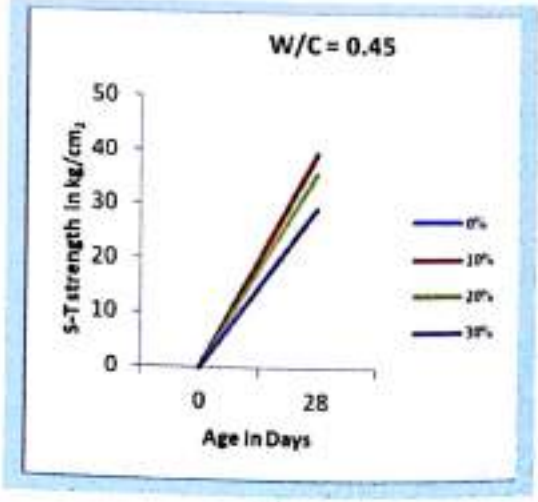


(c)

Fig. 44 (a-c) Compressive strength, flexural strength & split tensile strength at various ages in days using different percentage replacement of phosphogypsum

on cubes, split-tensile strength on cylinders and flexural strength on beams. The cement replaced by phosphogypsum is 0, 10, 20 and 30 per cent. The study conducted at 0.40, 0.45, 0.50 and 0.55 water binder ratio. The results with water binder ratio 0.45 are given in Fig. 44 (a-c).

Third Party Quality Control/Assurance of the Concrete Road Work Related to the Improvement and Strengthening of Dhansa Road from Najafgarh Town to Dhansa Border

Municipal Corporation of Delhi, New Delhi entrusted CSIR-CRRI for the third party quality control/assurance of the concrete road work related to the improvement and strengthening of Dhansa road from Najafgarh town to Dhansa border. The road at present is having different levels of distresses including large size potholes, exposed WBM layer, ravelling, alligator cracks etc. To avoid further damage and as a measure for a long-term solution along with meeting today's traffic needs, MCD has decided to convert the existing bituminous roads into a cement concrete road as a measure of improvement and strengthening. The work is in full progress with the technical and professional advices of CRRI as a result of which an excellent quality road is being constructed. An improved and strengthened view of a portion of the road is shown in Fig. 45.

Re-Design & Upgradation of Internal Sector Road of Sector 1 to 11, Industrial Area, Noida

CSIR-CRRI New Delhi, was entrusted for redesign and up-gradation of internal sector roads from sector 1 to 11, of the Noida Industrial Area. The roads at present are having different types of distresses including

Fig. 45 An improved and strengthened view of road

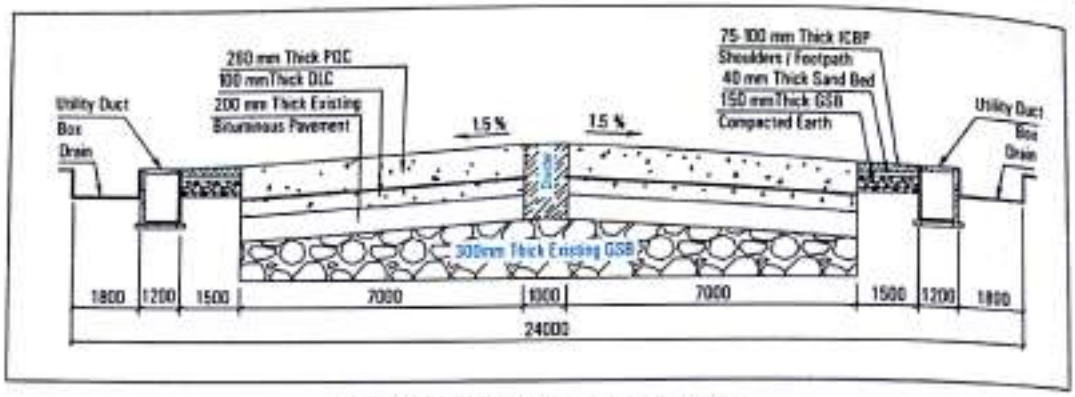


Fig. 46 Cross-section of proposed CC road

large size potholes, totally failed portions, ravelling etc. To avoid further damage and as a measure for a long-term solution along with meeting today's traffic needs, Noida Authority has decided to convert the existing bituminous roads into cement concrete roads. The authority has further decided to widen the existing roads.

The major objectives of the study are:

1. To provide concrete pavement design for the up-gradation of the internal roads from Sector 1 to 11 of Noida Industrial Area.
2. To provide pavement widening scheme with concrete pavement in those sections where earthen shoulders are wide enough to construct new pavement
3. To provide utility ducts
4. To provide interconnected paving blocks scheme for shoulders
5. To suggest guidelines for the construction of concrete roads

A typical Cross-Section of one of the proposed Cement Concrete Road for ROW 24.0 m (with DLC) is shown in Fig. 46.

Design, Construction and Performance Evaluation of New Materials and Mixes toward Development and Upgradation of Standards / Specifications

As reported earlier (Annual Report 2010-11), this study includes new materials and mixes viz. Stone Matrix Asphalt (SMA), Microsurfacing and Hot Asphalt Mixes using waste plastic, which have been laid on actual sites, for performance monitoring, towards development and upgradation of Standards / Specifications. Second series of performance observations were undertaken over the road sections selected in and around Delhi. Performance observations taken for time series data include the following:

a) Assessment of pavement surface distress by visual observation

b) Measurement of pavement surface roughness by using Roughometer-II

c) Deflection measurements by using Benkelman Beam method

d) Traffic volume survey, 24 hours round the clock

Further work with regard to processing / analysis of 2nd series of performance data is in progress. Third series of periodic observations are being planned to be undertaken in the month of November-December 2012. Shown in Figs 47, 48 & 49 are the road sections laid with Stone Matrix Asphalt (SMA), Hot Mix Asphalt mixes using Waste Plastic and Micro-surfacing respectively.

Fig. 47 Road section laid with stone matrix asphalt (SMA)

Fig. 48 Road Section laid with hot mix asphalt mixes using waste plastic

Fig. 49 Road section laid with microsurfacing

Development of Management System for Maintenance Planning and Budgeting of High Speed Road Corridors - Supra Institutional Project

In continuation of the earlier report (Annual Report 2010-11), 1st series of performance observations on the road sections identified in different states have been completed. Second series of performance observations are in progress.

Performance observations being undertaken for these sections include the following:

a. Pavement's Structural Details - Pavement type and crust composition (Once)

b. Pavement's Structural Condition – Deflection measurements by Benkelman Beam Method and Falling Weight Deflectometer (Periodic)

c. Pavement's Functional Condition – Pavement roughness measurements (Periodic)

d. Pavement Surface Distress – Types, extent and severity of distress / defects (Periodic)

e. Pavement Construction and Maintenance History (Once)

f. Vehicle Information Details (Once)

g. Axle Load Spectrum and Classified Traffic Volume Data for 48 hours round the clock (Periodic)

h. Road Inventory Details and Road Geometrics (Once)

i. Environmental Conditions (Periodic)

Fig. 50 Measurement of pavement surface roughness using Automated Road Survey System (ARSS)

Fig. 51 A close view showing deflection measurements using Falling Weight Deflectometer

Shown in Fig. 50 & 51 are various activities / observations being conducted on the selected road sections.

Data management for 1st series of performance observations is in progress and calibration factors for pavement deterioration models of HDM-4 are being attempted.

Consultancy Assignments

Road Inventorisation and Pavement Condition Survey on the Selected Road Stretches using Vehicle Mounted Digital Video Imaging System Integrated with GPS

This was taken up at the request of M/s RITES Limited, for road inventory and pavement condition survey under Road Safety Audit project activity of NHAI for a total length of about 1238 kms covering eight National Highways.

National Highways Authority of India (NHAI) initiated Road Safety Audit of National Highways which is being widened from two to four lanes and four lanes to six lanes etc. As a part of this activity, it was desired that the information on road inventory and condition data of the project highways is collected using Vehicle Mounted Digital Video System Integrated with GPS.

Two equipments namely Automated Road Survey System (ARSS) and Network Survey Vehicle (NSV) have been used for Road Inventory and Pavement Condition Survey. The field work for collection of road inventory and pavement condition data was started in the month of February 2012. Figure 52 shows a typical layout of map generated using Vehicle Mounted Digital Video System, integrated with GPS on NH-3. Figure 53 and 54 shows the field measurements being taken using ARSS and NSV systems respectively on NH-12.

Fig. 52 A typical layout of map generated using ARSS on NH-03

Fig. 53 Automated road survey system for measurement of pavement surface roughness

Fig. 54 Measurements using NSV in progress

The project report includes data on road inventory and pavement condition as per the Road Information System (RIS) format

of National Highways Authority of India. Information on GPS coordinates, average survey vehicle speed, travel time based on survey vehicle speed has been worked out for both Up and Down directions of travel.

Functional and Structural Evaluations of DND Flyway and Mayur Vihar Link Road towards Determining the Maintenance and Strengthening Requirements

This assignment was taken up at the instance of Noida Toll Bridge Company Limited (NTBCL), Noida for evaluating functional and structural DND Flyway and Mayur Vihar Link Road towards determining the maintenance and strengthening requirements.

DND Flyway is an important corridor connecting Delhi and Noida. The DND Flyway is an 8 lane dual carriageway which starts from Delhi (Ashram) side at km 0.200 and ends at km 5.800 towards Noida side. The road passes through the plain terrain for its entire length. The main DND flyway is also connected by several Ramps viz. Ramp (A + B), Ramp C and Ramp E at Delhi side; and Ramp A, Ramp B, Ramp C and Ramp D at Noida side. All these ramps are two lane undivided carriageway. The total length of Ramps at Delhi side is 2.4 kms while it is 1.65 kms on Noida side. DND Flyway also has an exclusive road called Mayur Vihar Link Road. The length of Mayur Vihar Link Road is 1.6 kms (which is a 4 lane dual carriageway).

A layout plan showing DND Flyway, Mayur Vihar Link Road and Delhi Side and Noida Side Ramps is given in Fig. 55.

Fig. 55 A layout plan showing DND Flyway, Mayur Vihar link road and Delhi side and Noida side ramps

Field investigation undertaken for DND Flyway included assessment of pavement surface condition, pavement deflections using Benkelman Beam, traffic volume and axle load surveys and roughness measurements using Automated Road Survey System. Shown in Figs. 56 and 57 (a-b) are the pavement surface conditions of DND Flyway (Delhi to Noida) and Mayur Vihar Link Road (Mayur Vihar to DND Flyway).

Fig. 56 View of transverse cracking and crack sealing on the main carriageway of DND Flyway (Delhi to Noida)

(a)

(b)

Fig. 57 (a-b) Severe alligator cracking with deep settlements on Mayur Vihar link road (Mayur Vihar to DND Flyway)

The final report submitted included the methodology adopted for conducting various field studies/surveys, data / results obtained from functional and structural evaluations, traffic volume and axle loads for DND Flyway and Mayur Vihar link road. Based on the data analyses and findings, recommendations on maintenance and strengthening requirements required for improvement of DND Flyway, Mayur Vihar link road and Delhi side and Noida side ramps were suggested.

Performance Evaluation of Rhinophalt Preservative in Rajasthan and Gujarat States

In continuation of the earlier Annual Report (2010-11), the product rhinophalt preservative is being evaluated for Indian condition for assessing its suitability in increasing the life of pavements and ensure improved performance on large term basis. Performance observations to be undertaken on three selected road sections / stretches for a period of three years include the following:

- Assessment of pavement surface condition by visual inspection
- Benkelman Beam Deflection measurements
- Pavement surface roughness measurements
- Traffic volume and axle load surveys
- Test pit observations
- Skid resistance
- Laboratory evaluation of cores retrieved from bituminous layers

The first series of performance observations has been completed. Second series of observations are planned to be undertaken during October / November 2012.

Evaluation of 130mt. ROW Road in Greater Noida and Recommending its Rehabilitation / Crust Design

The assignment was awarded by Noida authority for carrying out a detailed

investigation of road connecting NOIDA border at Hindon River and Kasna Road, for determining the likely causes of distress/ defects developed on the road and suggest rehabilitation / crust design needed to overcome the problem. The road connecting NOIDA border at Hindon River and Kasna Road is about 28.8 km. long and is a six lane dual carriageway with bituminous pavement and earthen shoulders on both sides. Some sections of the road are currently under construction and some sections are yet to be constructed (missing link). The project road has been constructed with 5 layers of WBM (100mm WBM Gr. I + 250mm WBM Gr. II + 75mm WBM Gr. III) with 25mm Mix Seal Surfacing (MSS) as the wearing course.

Based on the current status/ situation, the entire project road has been divided into five different sections for each of the two carriageways (Table 8).

Table 8 Division of Sections on the Project Road

Carriageway	Section No.	Chainage (Km.)		Description
Noida to Greater Noida Direction (LHS)	LHS - I	0.000	10.300	MSS Section (Phase - I) / Under Construction
	LHS - II	10.300	15.800	Missing Link (Under Construction)
	LHS - III	15.800	21.800	BM + BC Section (Phase - II)
	LHS - IV	21.800	25.800	MSS Section (Phase - I)
	LHS - V	25.800	28.800	Missing Link (Yet to be Constructed)
Greater Noida to Noida Direction (RHS)	RHS – I	0.000	10.300	MSS Section (Phase - I)
	RHS - II	10.300	15.800	Missing Link (Under Construction)
	RHS - III	15.800	21.800	BM + BC Section (Phase - II)
	RHS - IV	21.800	25.800	MSS Section (Phase - I)
	RHS - V	25.800	28.800	Missing Link (Yet to be Constructed)

Notes:

1) LHS : Left Hand Side
2) RHS : Right Hand Side
3) MSS : Mix Seal Surfacing
4) BM : Bituminous Macadam
5) BC : Bituminous Concrete
6) The road section from km. 0 to 6 on LHS is currently under construction

Large amount of pavement surface defects / distress, in terms of slippage, cracking and potholes have now developed on the road making the pavement surface uneven, making the road bumpy thus offering poor riding quality (in the Phase-I construction area).

The major objectives of the study are:

- To evaluate 130 Mt. ROW Road in Greater Noida towards determining the likely causes of distress developed on the road.
- To suggest rehabilitation/ crust design needed for improving the condition of road.

The scope of work included the following major activities:

(a) Field investigations

- Traffic Volume surveys at four representative / strategic locations on project road and / or on those nearby/ surrounding major roads which may influence on traffic flow pattern of the project road.
- Assessment of pavement surface condition through visual surveys on the entire length of project road, to find out the extent and severity of various distress types.
- Benkelman beam deflection measurements on each carriageway.
- Test pits investigation on representative sections having variation in surface condition.
- Axle Load survey on random sampling basis.
- Roughness measurements using Laser based Profilometre, on each lanes of both the carriageways for the entire length of project road.

(b) Laboratory investigations by determining the engineering properties of materials, retrieved from subgrade layer of the existing pavement structure.

The major findings, based on the data / results obtained from field investigations and laboratory evaluation of road building materials collected from the field are summarized as under:

- The total surface distress in one km section (worst section) is maximum 60 to 70 per cent. The major types of surface distress/defects developed on the project road are settlement, cracking, potholes, patching and raveling.
- Both carriageways of the project road are used by substantial number of heavy commercial vehicles, which are of the order of 3482 and 3266 CVPD in RHS and LHS directions respectively.
- The characteristic deflections for the project road are 1.21 mm and 1.21 mm in LHS and RHS carriageways respectively which is high. Such high values of deflections obtained for both carriageways of the project road clearly indicate that the project road is structurally unsound and is grossly inadequate to be able to bear the anticipated traffic loads (stresses)

for the current and projected traffic loading.

- Based on the characteristic deflections data and cumulative number of standard axles worked out for the project road, it becomes clear that the existing road is grossly structurally inadequate and it is not able to cope up with the expected traffic loads. Consequently, the road is in dire need of immediate rehabilitation/ strengthening to augment its structural capacity so as to improve its load carrying/ bearing capacity.

- The relative compaction of subgrade soil varies from 84.1 to 94.8 percent. The soils in pit numbers 3 and pit 4 are non-plastic (PI $\leq$ 6) while the soils in pit numbers 1 and pit 2 are plastic in nature (PI > 6). CBR of these soils ranges from 4.7 to 11.5 per cent. The quality of aggregates used in all the three layers of WBM appears to be reasonably good. The PI of filler is found to be 10 at pit Nos. 1 & 2 while it is Non- Plastic at pit ($\leq$6) Nos. 3 & 4.

- The characteristic of subgrade soil obtained show that the relative compaction of subgrade is somewhat lower than the specified requirement (of minimum 97 per cent), which may be responsible for development of distress.

- The results of granular layers (WBM) show that while the quality of aggregates used in these layers are reasonable, locally available earth has been used as the filler material. However, the gradations of materials (coarse aggregates) in all the three layers are completely outside the grading envelop on many sieves, which can be considered as the contributing factors for distress due to poor mechanical interlocking and large voids.

- The thicknesses of structural overlay for 5 years and 10 years design life for both carriageways of the project road as worked out for LHS I, LHS IV, RHS I & RHS IV are given as under:

Recommended overlay thickness for 5 years Design Life, for sections Under LHS I, LHS IV, RHS I and RHS IV are as given below:

50 mm thick Dense Bituminous Macadam (DBM)

+

40 mm thick Bituminous Concrete (BC)

Recommended overlay thickness for 10 years Design Life, for sections Under LHS I, LHS IV, RHS I and RHS IV are as given below:

100 mm thick Dense Bituminous Macadam (DBM) in two Layersof 50mm each

+

40 mm thick Bituminous Concrete (BC)

Major Recommendations based on the findings are given as under:

1. Keeping in view the heavy traffic volume and higher axle loads (which is causing faster development of the project road), it is expected that the project road would be subjected to severe loading in years to come i.e. soon after the missing links are constructed

and the road is fully developed and opened to traffic. This road would generate lot of traffic from the UPSIDC area as well as it is expected to receive diverted traffic from other surrounding roads. Therefore, it is advised that rehabilitation/ crust design recommended for 10 years life may be adopted for improvement of this road, with regard to augmentation of structural adequacy.

2. There is also a need to maintain proper camber / profile / shape of the existing pavement surface which is currently uneven and irregular at many locations. Therefore, before implementing the bituminous overlays, a profile correction course (PCC) using DBM may be provided to correct undulation, deformation (ruts) and settlement/ depression etc. in the existing surface, wherever required. PCC may also be done at isolated locations, wherever required. Polymer Modified Bitumen (PMB – 40) may be used in wearing course (i.e. in Bituminous Concrete), since it has higher stiffness, higher resistance to deformation and is not susceptible to water induced damage which is found/ learnt to be a common cause for failure of road in the project area.

3. It was also observed during the course of field investigation/ inspection that the existing road has several rotaries at many locations along the project road. It is recommended that 40 mm thick Mastic Asphalt layer may be laid over Dense Bituminous Macadam, on all arms of the junctions for upto about 25 to 30 m in length including rotaries to resist heavy traffic loads (which are causing damage to the road), due to creep speed and static loading at such locations.

Evaluation of Roads in NDMC Area (R-III Division) to Suggest Remedial Measures

This consultancy assignment was referred to CRRI by New Delhi Municipal Council (NDMC), R-III Division with the aim to assess the existing condition of twenty two numbers of roads, scattered in NDMC area, so as to suggest / recommend resurfacing / strengthening treatments needed to improve upon the current condition of these roads. Most of the roads, scattered in NDMC areas viz. (i) North West Moti Bagh, (ii) Sarojini Nagar, (iii) Laxmi Bai Nagar and (iv) West & East Kidwai Nagar, are main colony roads and connecting / link roads. Lengths of various roads undertaken for the study ranged from 14.70 to 498 m while pavement widths were varying from 2.80 to15.50 metres. Traffic plying on these roads comprises of cars, three wheelers, pick-up vans, two wheelers, cycles and more often very less numbers of NDMC heavy vehicles / trucks for servicing / maintenance of colony / service roads.

A variety of activities / tasks were carried out under the field investigations with a view to assess the present structural and functional conditions of existing roads, in order to recommend suitable remedial treatments /

corrective measures for improving upon the present condition of roads. Field investigations undertaken included (i) Assessment of pavement surface condition by visual inspection of all the roads to find out the extent and severity of various distress types developed (ii) Measurement of pavement surface roughness (iii) Benkelman Beam deflection measurements (iv) Classified Traffic volume surveys at few selected locations (v) Laboratory evaluation of road materials retrieved through test pits in order to find out the subgrade characteristics and (vi) Analysis of data / results to make recommendations on resurfacing / remedial treatments.

Data through field and laboratory investigations were collected for the twenty two NDMC roads undertaken for the evaluation. The data was processed, analyzed and used in bringing out the recommendations towards remedial/corrective treatments for improving upon the current condition of the roads. The requirements of structural overlay have been worked out based on characteristic deflection of roads for which Benkelman Beam Deflection measurements were made, considering the projected loading traffic (i.e. cumulative standard axles) for design life of 10 years.

The major findings revealed from the analyzed data are given as under:

a. The distress levels on different roads generally vary from good to fair to poor. During the visual inspection, it was concluded that, in general, predominant distress types encountered on the pavement surface are loss of fines, ravelling, isolated pot holes and cracking. Total distressed area for twenty two roads under evaluation is found to be in the range of minimum 5 per cent to maximum 40 per cent.

b. The traffic volume survey indicates that major proportions of the total traffic are cars as well three wheeler scooters / motor cycles. It was seen that the number of commercial / heavy vehicles is very less. It was assumed that in the worst scenario, a maximum of about 100 Commercial Vehicles Per Day (CVPD) would ply on each of these colony roads and connecting / link roads. Therefore, Vehicle Damage Factor (VDF) has been taken as 2.0 for calculating Cumulative numbers of Standard Axles (CSAs), during the design life of 10 years.

c. The measurements of pavement surface roughness, done on all the twenty two roads, indicate that pavement surface roughness for majority of the roads is in average and poor condition. Average roughness values for various colony roads and connecting roads are in the range of 2723 to 3552 mm /km. It can also be inferred from this that while about 72 per cent of the roads are having roughness values less than 3000 mm/km (average rating), the remaining 28 per cent roads lie within the roughness range of 3000 to 4000 mm/km (poor rating).

General trends of roughness data obtained show that the roughness values are somewhat higher than the desired level of serviceability (< 2000 mm/km). This may probably be due to the raveled and cracked surface as well as due to settlement / undulation etc.

d. Projected traffic loading, in terms of cumulative number of standard axles, has, therefore, been arrived at for traffic of maximum 100 CVPD for future design life of 10 years for the purpose of assessing the resurfacing/strengthening requirements (if any). The traffic loading in terms of cumulative standard axles has been worked out for all the roads for design life of 10 years, assuming an annual traffic growth rate of 5.5 per cent. The Vehicle Damage Factor (VDF) is assumed to be 2.0, for the purpose of calculating the cumulative standard axles for the design life.

e. Analysis of deflections data clearly bring out the fact that none of the roads under evaluation are structurally inadequate and thus no structural overlay / strengthening is needed for any of the twenty two roads. In order to provide maintenance treatments (resurfacing), criterion based on pavement distress and roughness has, therefore, been formulated and given in Table 9. Based on the salient criterion and major considerations, the maintenance (resurfacing) treatments were recommended for the twenty two roads.

Table 9 Salient Criterion and Major Considerations Adopted While Making Recommendations

Condition Rating Classification	Total Surface Distress (%)	Roughness (mm/km)	Recommended / Resurfacing Treatment (mm)
1	≤25	≤3000	30 Bituminous Concrete (BC) / 30 Mastic Asphalt
2	≤25	>3000	35 Bituminous Concrete (BC)
3	>25	≤3000	40 Bituminous Concrete (BC)
4	>25	>3000	50 Dense Bituminous Macadam (DBM) + 30 Bituminous Concrete (BC)

Note: Mastic Asphalt (MA) has been suggested as an alternate option for treatment on those roads which are situated in the thick residential areas, are of narrow width, are very small in length and are always congested / occupied due to parking of vehicles etc.

Investigation of the Old Main Runway Pavement at Kolkata Airport for Suggesting Remedial / Corrective Actions

This assignment was taken up at the instance of Joint General Manager, Engg. (C), Kolkata Airport Project, Kolkata, Airports Authority of India (AAI) with an aim to determine (i) the likely causes of distresses developed on the runway pavement (ii) Pavement Classification Number (PCN) for the old main runway pavement at Kolkata Airport and, (iii) suggest the remedial / corrective actions in order to find out the suitability of the runway for use by operations of critical Aircrafts vis-à-vis the specified PCN requirement of the main runway. Design PCN, based on A-380 type of aircraft and as reported by AAI, was taken as 116/F/D/W/T and 94/R/D/W/T, depending on whether it is a flexible or rigid pavement.

The scope of work under the project includes the following major activities / tasks:

- Measurement of pavement deflections on different sections of the runway, at pre-determined loads, by using Falling Weight Deflectometer (FWD)
- Assessment of pavement surface condition through visual inspections
- Extraction of 4" diameter cylindrical cores
- Measurement of layer thicknesses in the pavement structure
- Test pits observations and collection of subgrade soils and other road building materials used for construction of runway pavement
- Laboratory evaluation of in-situ materials and mixes retrieved from the existing pavement structures for ascertaining the construction quality of pavement component layers
- Analysis of data / results to determine the probable causes for the development of distresses, PCN value of main runway pavement
- Recommend remedial measures to improve the current condition of main old runway pavement so as to make the runway suitable for the anticipated proposed aircraft operations.

The field investigations of the main runway at Kolkata Airport undertaken included general appraisal of surface condition to assess the likely causes of distresses developed. Pavement construction details with regard to pavement's structural composition i.e. layer thicknesses and their specifications etc. were also collated from the concerned AAI officials / test pits observations. The pavement surface of runway was closely examined through visual survey for evidence of distress / deterioration. Based on the general appraisal of the pavement surface condition, representative locations for taking 4" (10 cm) diameter cylindrical cores were marked / identified. Cores were also taken

for determining the layer thicknesses and for evaluating the construction quality of asphalt mixes. Concrete cores were also recovered from the runway end.

In order to collect detailed information regarding the depth of different pavement layers, their composition and field densities etc., three test pits, of size 1.25 x 1.25m, on / near the edge of pavement were cut open. The construction materials from different component layers in the pavement structure were also collected for laboratory evaluation. Samples of sub grade soil from the representative locations were also collected from the runway pavement for detailed laboratory investigations.

Pavement deflection measurements, by using FWD, were undertaken on runway pavement and rigid end. The FWD system was applied on several sections of the airfield pavement with known cross sectional details obtained from the records / test pits. Pavement surface condition of various test points / locations, as observed during the measurements through visual observations, was noticed to be good except for some rubber deposits occurring along the most widely used section of runway by aircrafts during takeoff and landing operations.

Measurements by FWD (Fig. 58) were undertaken on the main runway at an interval of about 100 metres in staggered position and on all the lanes on both sides of the central line. Similarly, FWD deflection measurements were taken on runway ends / turning pads also at representative locations well spread over the paved area.

Fig. 58 FWD deflection measurements on the airfield pavement

Data collected from FWD was used for determination of Pavement Classification Number (PCN) and in deciding upon the strengthening / rehabilitation measures needed to meet the air traffic requirements. Data on deflections obtained through FWD in conjunction with field and laboratory data viz. crust composition, subgrade strength and flexural strength of concrete etc, have been analysed using a standard software to determine PCN and the strengthening / overlay requirements for the main runway pavement. Presented in Table 10 are the PCN values as determined and the strengthening / overlay requirements for the main runway pavement.

Software program available with KUAB FWD system, deployed under this project, has been used for analyzing pavement deflections obtained in the field towards determining PCN values of the runway. Based on the pavement's structural composition (layer thicknesses), flexural strength of concrete, subgrade strength etc, for the airfield pavement, configurations / features of aircrafts (ACN values, tyre pressures, loads, size and movements of various aircrafts) operating / using the airfield pavement, the deflections data obtained from FWD system were analyzed for determining the PCN of the runway pavement and runway end / turning pad.

Table 10 Pavement Classification Number (PCN) and Strengthening / Overlay Requirements for Different Sections of the Main Runway at Kolkata Airport

S.No.	Runway Pavement Section	Type of Pavement	Computed PCN	Overlayrequirements for Design PCN of *116 / 94 (mm)	Overlayrequirements for Design PCN of *105/88 (mm)
1	19L- Alpha Taxi	Flexible	74/F/D/W/T	150mm DBM + 50 mm BC	100mm DBM + 50 mm BC
2	Alpha Taxi – Fire Station Road	Flexible	82/F/D/W/T	150mm DBM + 50 mm BC	100mm DBM + 50 mm BC
3	Fire Station Road - 01R	Flexible	72/F/D/W/T	150mm DBM + 50 mm BC	100mm DBM + 50 mm BC
4	01R Runway END	Rigid	72/R/D/W/T	130 mm Bonded Concrete Overlay	130 mm Bonded Concrete Overlay

* 116/94 means Design Aircraft (A-380) ACN values for Flexible/Rigid Pavement
105/88 means Design Aircraft (B-747) ACN values for Flexible/Rigid Pavement
LHS (Towards 01R END)
RHS (Towards 19L END)
CL (Central Line of the Runway)

Annual Rreport 2011-12

Bridges & Structures

CSIR-CENTRAL ROAD RESEARCH INSTITUTE

CSIR CRRI

Behaviour of Shear Deficient Beams Strengthened by Externally Embedded Reinforcement

In continuation of the work reported earlier (Annual Report 2010-11) rectangular reinforced concrete beams of size 150x250x2000 mm were cast in the laboratory with different deficiency in shear capacity. The shear deficient beam were strengthened by using near surface mounted reinforcement such as steel strips and Carbon FRP strips at an inclination of about 45 degree to the longitudinal axis of the beam. The strips were embedded after carving out grooves on the both vertical face of the beam in shear region. The minimum groove width of the groove was kept 3 times the thickness of the strip and depth about 1.5 times the depth of the strip. The specimens were instrumented for strain measurements and deflection during the testing. Specimens were tested under three-point loading which was applied through hydraulic jack.

The typical failure mode of shear deficient beam specimen using different type of material i.e., steel, carbon FRP is shown in Fig. 59.

Based on the study it was observed that strengthening of structures with NSM FRP / steel reinforcement is an economical and feasible technique. It reduces the risk of debonding in comparison to externally bonded technique due to better bond. From this experimental study, it is observed that the rehabilitation of concrete structure using externally embedded reinforcement in the concrete cover (NSM) technique is quite effective for shear deficient elements. The carbon FRP strips did not rupture as the recorded strain was less than the effective strain. The ratio V_{fe}test / V_{fe}thry of NSM strips obtained was more than one (safety condition) in all the specimens. The same is the case on considering the ratio of $V_s$test and $V_s$thry. The contribution of FRP for shear strengthening was comparable with the specimen with internal shear stirrups.

Fig. 59 Failure modes of tested specimens

The technique is helpful for the field engineers in the rehabilitation of concrete structures.

Experimental Study of RC Beams Strengthened with CFRP Fabric under Pure Torsion

This study was carried out to understand the behaviour of torsion deficient RC rectangular beam specimens strengthened using carbon fabric in relation to the reference beam. Also, in this study attempts were made to understand the complexity of twist angle, torque and ductility of strengthened beams.

Torsional failure is an undesirable brittle failure. In the past only very few research were carried out to find the full sectional capacity of the RCC beams strengthened with FRP.

In this study, two specimens were tested, PTR-1 (reference beam designed for torsion) and PTT-1 (Beam deficient in torsion) as shown in Fig. 60 (a & b). The span and size of the both the beams were 1.79m and 150 x 250 mm respectively. The beam- PTT-1 was strengthened using CFRP fabric strip (400 g/m^2 - Unidirectional, thickness 0.234mm) of U-shaped 50 mm wide with spacing of 75 mm c/c. Electrical strain gauges (120 ± 0.4 Ω) were provided at quarter, middle and three quarter span of the beam, on top and bottom of the longitudinal reinforcement, at the centre of vertical stirrups and on CFRP-Fabric to measure the strains during testing of the beam as shown in Fig. 61. Typical failure modes of both the beams were shown in Figs. 62 and 63 (a-b).

During the testing, it was seen that the failure was due to crushing of concrete and yielding tension steel in PTR-1. The specimen PTT-1 failed due to failure of anchorage, debonding of the CFRP fabric Strips, yielding of reinforcement provided in compression zone at mid span and finally due to crushing of the concrete. The torsional capacity based on the strain recorded in the CFRP fabric during the experiment shows the good agreement with the theoretical values. The significant increase of twist angle of 151 and 44 per cent was observed corresponding to cracking torque and ultimate torque respectively. The internal longitudinal steel was observed to be yielded to both the cases. The torsional capacity of the PTT-1 exhibited 58 per cent enhancement of torsional capacity with the application of CFRP fabric for strengthening.

Based on the study it was concluded that the carbon FRP wrap could be used for the strengthening of RCC beams deficient in torsion after exercising proper care in the design of the rehabilitation scheme.

(a) PTR-1 (b) PTT 1

Fig. 60 Experimental setup of beam

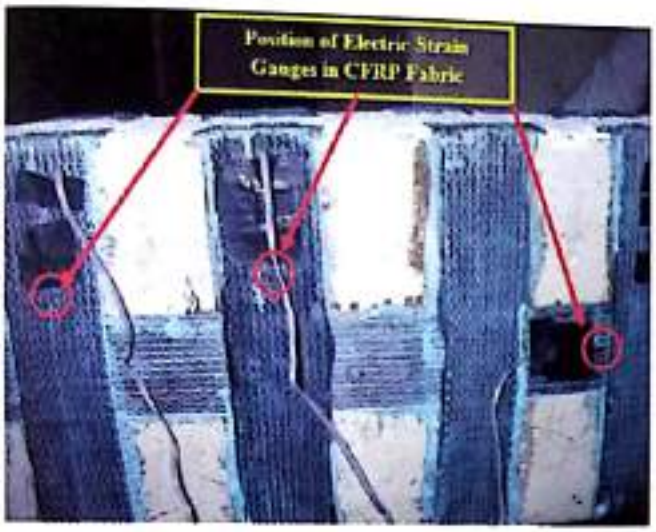
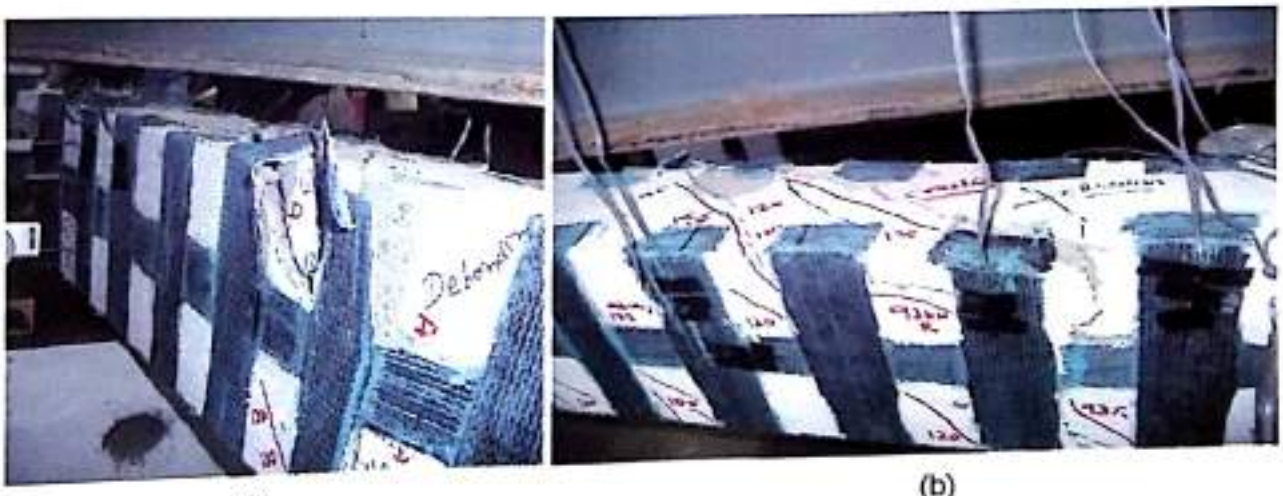


Fig. 61 Position of electric strain gauges on surface of CFRP fabric

Fig. 62 Failure of PTR-1 at ultimate torque 14.14 kNm



(a) (b)

Fig. 63 (a-b) Crushing failure of concrete and debonding of CFRP fabric strips of PTT-1

Field Investigations of Concrete Bridges in Coastal Environment for Corrosion Susceptibility

Two bridges namely, (i) Puduponnani Bridge and (ii) Chetuva bridge on NH-17 in Kerala have been identified for field testing through consultation with the Kerala P.W.D. Figures 64 and 65 show the Puduponnani and Chetuva bridges, respectively.

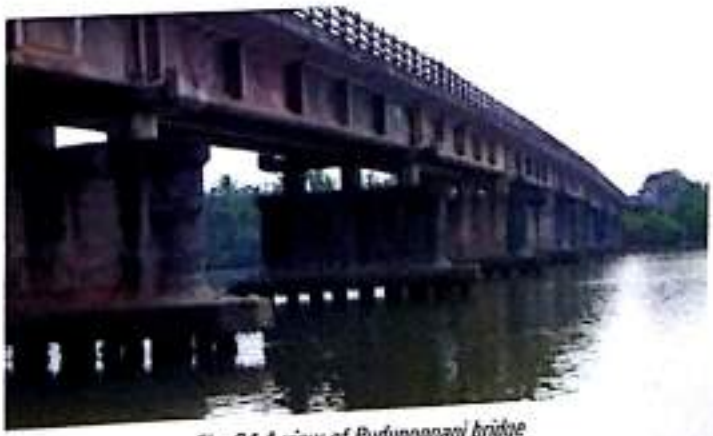


Fig. 64 A view of Puduponnani bridge

Fig. 65 A view of Chetuva bridge

Visual inspection of bridges was carried out first and the types of distresses on various bridge components were noted. It was observed that some of the RCC piles of Puduponnani bridge have been deteriorated due to corrosion. There was local exposure of reinforcement and corrosion of the same.

Subsequently, NDT tests and tests to determine corrosion susceptibility (Fig. 66 (a-d)) such as carbonation test, concrete resistivity test, chloride profile at different depths of concrete cover etc. were carried out.

(a) Concrete cover testing

(b) Concrete resistivity test

(c) Corrosion testing

(d) Concrete powder extraction for determination of chloride

Fig. 66 NDT tests to determine corrosion susceptibility

The test results of NDT, concrete cores and concrete powder extracted from different components of these two bridges were analysed using the prevailing codal specifications and generally accepted criteria. Based on the test results, it has been concluded that the concrete material is good and the concrete cover was generally high. There was no corrosion of reinforcement or carbonation, except at few locations where concrete cover is shallow or due to exposure of reinforcement.

Creation of Complete Range of Independent Facility for Testing of Expansion Joints at CRRI

The expansion joints are used to accommodate allow expansion/contraction of the bridge deck due to temperature changes, creep and shrinkage of concrete, imposition of live load, earthquake, shrinkage etc. These joints are provided to protect the edges of concrete deck from vertical wheel loads and to seal the joint opening. Depending upon the initiation factor, there may be longitudinal, transverse movement or rotation about a longitudinal or transverse axis. The superstructure moves longitudinally in relation to the abutments as a result of thermal movements, and due to vehicular braking/tractive effort etc. Expansion joints are among the smaller elements of the bridge structure, but when they fail to function properly, create problems out of proportion to their size. Therefore, the need to create test facility is very important.

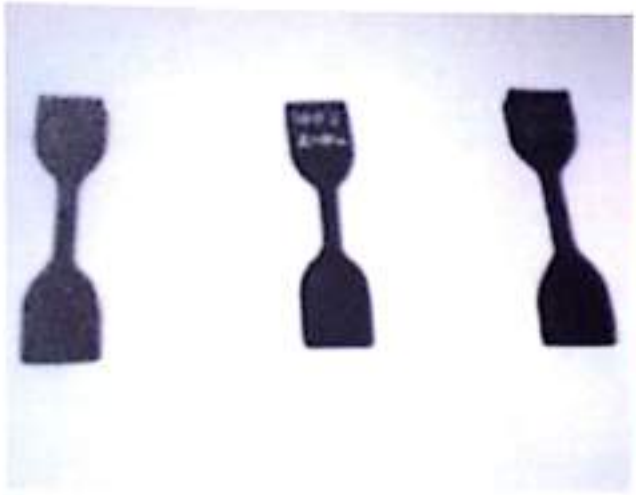
Fig. 67 Equipments used for testing of row materials used in expansion joints

Ministry of Shipping, Road Transport & Highways has sponsored this study with the objective to establish the complete test facilities for testing of different types of expansion joints widely used in bridges as well modular joints, such as:

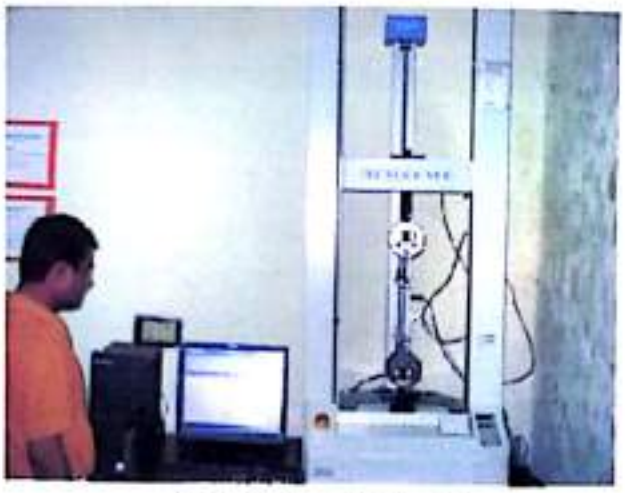
(i) Testing of raw materials used in the fabrication of expansion joints such as chloroprene and steel

(ii) Performance evaluation of expansion joints by (a) cyclic motion test (ii) debris expulsion test, (iii)Pullout test (iv) Opening movement vibration test (v) fatigue test and (vi) seal push out test

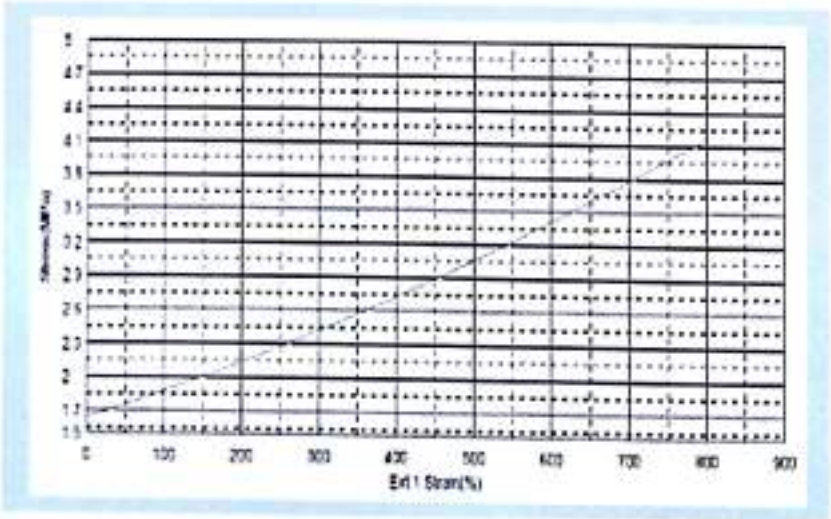
During the reporting period, the facilities created for testing of raw materials used in the fabrication of expansion joints are enlisted in Table 11 and some of them are shown in Fig. 67. The tensile test of strip seal material is shown in Fig. 68 (a-c). The physical properties of tested specimens were meeting most of the limiting values given in IRC: SP:69 (2011).



(a) Dumb bell shaped specimen



(b) Tensile testing of strip seal



(c) Stress –strain graph of strip seal

Fig. 68 Tensile test of strip seal

Table 11 Test Facilities Created for Testing Raw Materials used in Expansion Joints

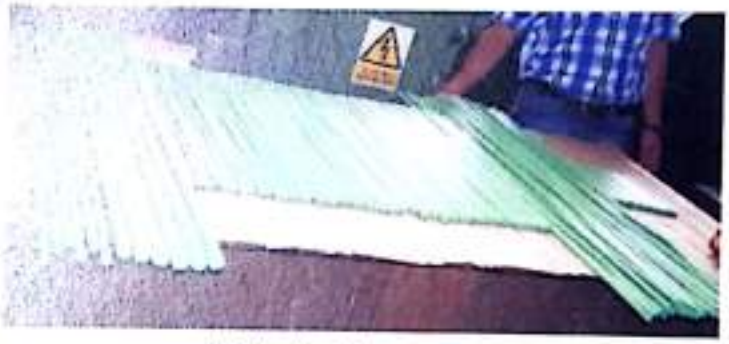
S. No.	Type of Material	Type of Property to Evaluate	Name of Standard
A.	Chloroprene Seal	Hardness	ASTM D2240
		Tensile Strength	ASTM D412
		Elongation of Fracture	ASTM D412
		Tear Propagation Strength	ASTM D 624 C
		Shock Elasticity	ASTM D 7121/DIN 53512
		Abrasion	ASTM D 5963/DIN 53516
		Residual Compression Strain	ASTM D 395, Method B
		Ageing in hot air	
		Change in hardness	ASTM D 573-04/DIN 53508
		Change in tensile strength	
		Change in elongation	
		Ageing in Ozone	ASTM D 1149/DIN 53509
		Swelling behaviour in oil	
		(ASTM Oil No. 1)	DIN 53509
		Change in Volume	
		Change in hardness	
		Cold Hardening Point	ASTM D1043
		Adhesion Strength	IS:3400 Part 14
		Polymer Identification test	ASTM D 3677
B.	Edge Beam (Steel)	Mechanical Properties	IS: 2062, Grade B
		Tensile Strength	
		Elongation at fracture	
		Impact	
		Thickness of Paint Coating	
		Inspection of Weld Joints	
		Inspection of Flaws in the material	

Study of Corrosion Susceptibility of Steel Reinforcement Protected with Anti-Corrosive Coatings / Special Treatments in Ordinary and High Performance Concretes

As reported earlier (Annual Report 2010-11), the scope of the project sponsored by MORTH is to study the corrosion susceptibility of fusion bonded epoxy coated reinforcement (FBECR), hot dip galvanized (HDG) bars, and thermo mechanically treated (TMT) bars, embedded in the ordinary concrete with a 28 day compressive strength of 35 and 40 MPa, and the high performance concrete (HPC), of similar strength ranges, embedded with un-coated reinforcement bar. An RCPT value of 800 coulombs and 1200 coulombs has been chosen as requirement for HPC. For the HPC mixes the following combinations (i) GGBFS + Silica fume, (ii) Fly ash + Silica fume, (iii) GGBFS + Fly ash + Silica fume have been selected.

The material properties of epoxy coated rebars, hot dip galvanized bars as shown in Fig. 69 (a-b) and TMT bars were evaluated prior to their use for casting of various test specimens. Further work is in progress.

(a) Hot dipped galvanized bars



(b) Fusion bonded epoxy coated bars

Fig. 69 (a-b) Epoxy coated rebars and Hot Dip galvanised Bars

Bridge selected for the present study

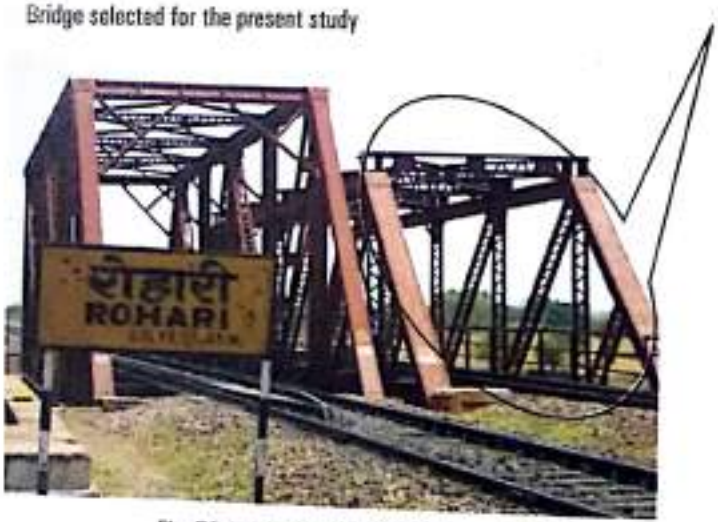


Fig. 70 A view showing two bridges at Rohari

Evaluation and Monitoring of Rohari Steel Bridge in Katni-Manikpur Section of Jabalpur Division for Increased Axle Load of Freight Wagons

West Central Railway (WCR), Jabalpur approached CRRI for evaluation of Rohari bridge, Katni-Manikpur section of Jabalpur division, West Central Railway due to increase in axle load of freight wagons. The typical view of the Rohari bridge is shown in Fig.70. This bridge has one 33.45m long span of steel through truss type.

The first, second and third round of field monitoring of the Rohari bridge was carried out in 2008, 2010 and 2011 respectively. The total scheme of instrumentation was designed to measure the following parameters:

- Wheel loads and longitudinal forces in rails
- Performance parameters for the superstructure
- Settlement and tilting of abutment
- Stresses near the base of abutment
- Dynamic characteristics of superstructure

Strain, deflections, temperature, accelerations etc. were monitored at critical locations by fixing several sensors in rails, couplers, superstructure, bearings and abutments of the bridge as shown in Fig. 71.

Intelliducer for surface strain measurement in rail

Intelliducer for axial strain in truss member

Sensor for dynamic strain measurement

Intolliduers for surface strain of Pier

LVDT for displacement measurement

Vibrating Wire type temperature sensor

Acceleromertres for vibration

Fig. 71 Typical view of various sensors installed in the bridge

After the installation of sensors, continuous monitoring was done (Fig. 72) by extending the cables of the various sensors up to the data acquisition systems. WCR has arranged a test train for the study Fig.73 shows the different views of Test train during testing of the bridge. The bridge was tested under various loadings cases of Test train as well as prevailing trains.

Fig.72 A set up of automatic datalogging station

Fig. 73 Test train over the bridge under various loading conditions

Theoretical analysis of the steel truss bridge superstructure was carried out using FEM based software RM2006. Dimensions and sectional details of the various members of the truss were taken from the drawings/details supplied by WCR officials. The 3-D model of the superstructure is shown in Fig.74. Structural analysis was carried out for the vertical as well as longitudinal loads due to the various loadings viz. HML, MBG, BGML, CC+8+2,and actual test train used for testing as specified by the Railways.

Based on the theoretical analysis, data collected during the monitoring of the Rohari Bridge and interpretation of the data, the following observations are made:

- The measured peak vertical deflection at mid-span of bridge due to passage of test train is found to be 15.3mm which is lower than the permissible value (i.e. span/800). The measured peak lateral deflection at mid-span of bridge due to passage of test train is found to be 2mm.
- The measured maximum stresses in critical members of U/s and D/s truss of this bridge due to passage of test trains at different speeds are comparable with the corresponding theoretically computed axial stresses for the respective members. Also, it is inferred that maximum observed compressive and tensile stresses are quite lower than the permissible stresses.
- The measured local peak dynamic stress in critical members of this bridge due

Fig.74 Three-dimensional modelling of superstructure of the bridge

to passage of some of the goods train/ passenger train are lower than the corresponding theoretically computed axial stress for all the loadings.

- Measured dynamic characteristics of the bridge are found to be comparable with the theoretical ones. This indicates the acceptance of theoretical model.
- Results of Fatigue study show that bridge is made of low carbon steel. Endurance limit of steel is found to be 2400 kg/cm^2. As per theoretical analysis, the maximum stress in any member of U/s and D/s truss of the bridge is found to be of 1265 kg/ cm^2 under HML loading. During test train/ prevailing trains, this maximum stress is found to be further reduced to 740 kg/ cm^2.

From this study, it has been inferred that the bridge is presently safe under increased axle loads of freight wagons i.e. CC+8+2 loading.

Consultancy Assignments

Repair and Rehabilitation of Old ITO Bridge over River Yamuna (Delhi) - 3rd Party Random Quality Check and Inspection

The old ITO Bridge known as barrage -cum-bridge built in the late sixties has 27 simply supported spans with twin carriageways caters to the east-west traffic across the river Yamuna. The two carriageways are of width 7.5 m each and are separated by a 1.2 m wide median and have 2.5 m wide footpath on either side (Fig. 75). Presently this bridge is used for plying of west-east traffic only and a new bridge is used for east-west traffic.

Repair and rehabilitation of this old bridge is in progress in two phases and the 3rd party

Fig. 75 General view of the rehabilitated bridge

Fig. 76 Replacement of roller bearings

quality control inspection of the work has been entrusted to the Institute by PWD. In the first phase of the project, replacement of expansion joints was completed and the report has been submitted to the client.

In Phase-II, the repair activities comprises of replacement of the steel rocker/roller bearings, construction of seismic restrainers and other miscellaneous repairs. A typical view of replacement of bearing is shown in Fig. 76.

Fig. 77 Reinforcement of seismic restrainer

Fig. 78 Neoprene pads provided in seismic restrainers

Seismic restrainers both in longitudinal and transverse direction have been constructed after considering the expansion gap on the pier cap by embedding the reinforcement as shown in Fig. 77. Also, Neoprene bearing pads have been provided inside the seismic restrainers for load transfer from the girders as shown in Fig. 78.

Distress Diagnosis and Rehabilitation of a PSC Girder Bridge on Maskararo River, Chilkana- Gandved Route Near Saharanpur (UP)

This study has been sponsored by UPPWD. The objective of the study is the distress diagnosis and prescribing the rehabilitation scheme of a PSC girder bridge.

This 2-lane bridge of 7.5m wide carriageway was built by M/s Uttar Pradesh Bridge Corporation in 1973-74 and opened to the traffic around that time. The total length of this bridge is about 120 m arranged in a four span configuration of 29.0, 28.25, 28.25 and 29 m length (approx) resting on three piers and two abutments, through steel roller-rocker type bearings and separated by expansion joints. The general view of the bridge is shown in Fig.79.

The investigation highlights identification of causes of distresses in the girders,

Fig. 79 General view of the bridge

assessment of quality of in-situ concrete in different components of the bridge through NDT, and load testing of one span of the bridge. Based on the investigations it is observed that the bridge is deficient in load carrying capacity and suitable scheme for rehabilitation and strengthening of the bridge has been proposed.

Assessment of Noise and Vibrations Induced by Movement of Heavy Vehicular Traffic on the Munirka Flyover on Outer Ring Road, Delhi

The three-lane flyover at Munirka as shown in Fig. 80, with a carriageway width of 9 m and was opened to the traffic in December 2009. This flyover has a composite superstructure, i.e., concrete deck over four numbers of steel girders. Some of the residents residing buildings on both the sides of the flyover felt severe noise and vibration problems during the movement of vehicular traffic. Therefore, PWD Delhi requested CSIR-CRRI to carry out the study of noise and vibrations due to movement of heavy vehicular traffic on the Munirka Flyover, its impact on the buildings in its vicinity and suggesting remedial measures for reduction of noise and vibration levels.

During the study, various parameters such as noise levels, acceleration and velocity in X, Y & Z directions at various locations of the flyover and nearby residential buildings and displacement of the fly over superstructure during the movement of vehicles were measured using Soundbook, NVH software, accelerometers, vibration analyser etc.

Fig. 80 Munirka flyover on outer ring road, New Delhi

The measured noise levels (Fig. 81) at many residential buildings on both sides of the flyover are found to be high in night time compared to recommended value of 45 dB by CPCB (Table 12) as the existing noise barriers was not fully effective in eliminating the airborne noise/vibrations therefore, suggestions have been given to modify these noise barriers.

Based on the instrumentation and monitoring of the flyover and the surrounding buildings

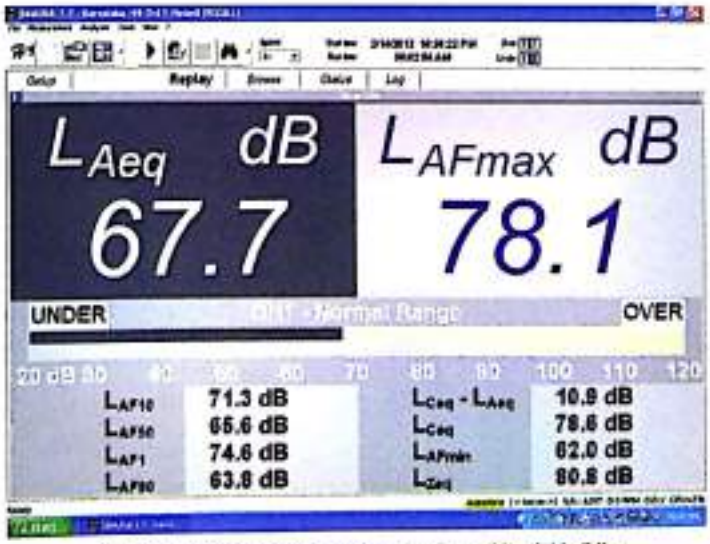


Fig. 81 Measured noise levels in a nearby residential building

Table 12 Limiting Noise Levels Prescribed in CPCB Guidelines

Category of Area	Limit in dB(A) L_{eq}	
	Day time	Night time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

it has been observed that the frequencies of vibration of the flyover were quite close to the surrounding buildings (Fig. 82) which may cause enhancement of the vibratory response of the buildings particularly in night. However, the buildings were found to be safe due to traffic induced vibrations since these are RCC framed buildings. The measured displacements of bridge superstructure were found to be within the prescribed limits as per IRC guidelines.

Several measures have been proposed to reduce the noise and vibration levels felt at the nearby buildings due to the movement of vehicular traffic.

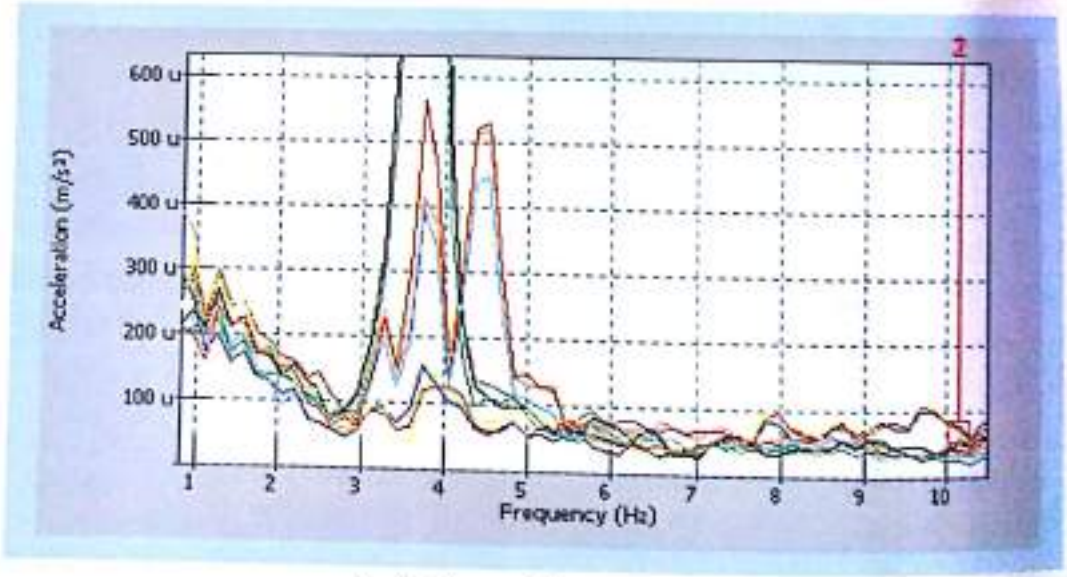


Fig. 82 Spectra of vibration of buildings

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Instrumentation

CSIR-CENTRAL ROAD RESEARCH INSTITUTE

Development of GIS based National Highway Management System

Ministry of Shipping, Road Transport & Highways has sponsored a project titled "Development of GIS Based National Highway Management System" for effective and efficient management of primary road network of the country. Under this project Instrumentation Division has procured an advanced Network Survey Vehicle (NSV) from ARRB, Australia, for generation of data base on road conditions and inventory of road for National Highway network in the country (about 50,000 km).

During this year, collection of primary road condition and road inventorisation data through NSV utilizing Laser, Global positioning system and Video image processing tools etc. on National Highways including Himalyan region of J&K, Himachal Pradesh, Uttrakhand, Chatisgarh, Orissa, West Bengal, Jharkhand, UP and Bihar has been completed Fig. 83 (a & b). The inventory data collected through advance data processing & reporting software include measurement of gradient (Rise & fall), Horizontal curvature, Pavement Surface Condition (distress), Roughness, and GPS Co-ordinates (X, Y, Z) viz. longitude, latitude & altitude etc. The report of the data has been submitted to Ministry.

(a)

(b)

Fig.83 (a&b) Data collection on hill roads in progress

Calibration of Automatic Road Unevenness Recorder (ARUR)

Automatic Road Unevenness Recorder (ARUR) units, comprising both Car Axle Mounted Bump Integrator and Fifth Wheel Bump Integrators, received from different manufacturers and user agencies, were calibrated using Dipstick, Class I equipment (Fig. 84). Roughness measurements, using Dipstick and the response type roughness measuring device, were undertaken on a number of selected test sections having varying roughness levels (excellent to very poor). Calibration equation between the observed roughness and the standard roughness is developed to determine the corrected / calibrated roughness. Calibration certificate is issued to these agencies.

Fig. 84. Calibration of ARUR in progress

Repair & Maintenance Work:

During the year, operation, repair & maintenance of various types of R & D equipments as well as infrastructure equipments including EPABX system, Audio / Video system, UPS systems, stabilizers, power supplies and other equipments upto component level of the Institute has been carried out. The calibration of various R&D equipments was also carried out as per the ISO requirement of different divisions.

Consultancy Assignments

Consultancy Services for Conducting Road Safety Audit For PPP Projects on DBFO Basis

Primary road condition and road inventorisation data through NSV utilizing Laser, Global positioning system and Video image processing tools etc has been carried out on NH-72 Muzaffarnagar-Haridwar-Dehradun and NH-15 Amritsar-Patankot sections.

Road Inventorization and Pavement Condition Survey on the Selected Road Stretches

Under this study, Primary road condition and road inventorisation data through NSV utilizing Laser, Global positioning system and Video image processing tools etc has been carried out on NH-1A, Jalandhar-Panipat and NH-2 : Delhi-Agra section.

Development of Management System for Maintenance Planning and Budgeting of High Speed Road Corridor – Super Institutional Project

Under this study, Primary road condition and road inventorisation data through NSV utilizing Laser, Global positioning system and Video image processing tools etc. has been carried out on NH-1A Jhalandhar-Bhogpur section.

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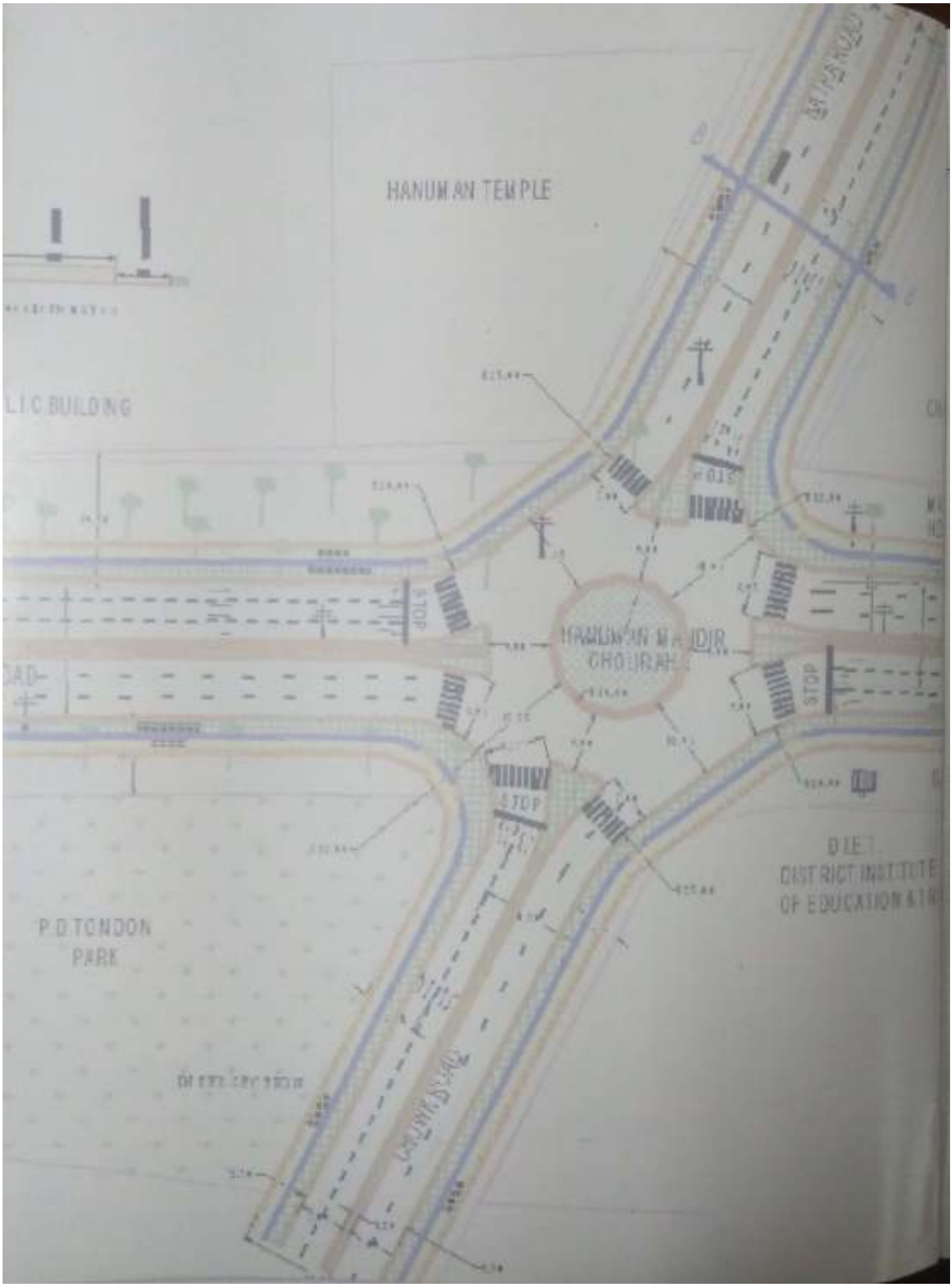
Traffic & Transportation Planning

Traffic Engineering and Road Safety
Transport Planning and Environment

CSIR-CENTRAL ROAD RESEARCH INSTITUTE



Adequacy of Traffic Signal Timings for Pedestrians Intersections

Crosswalks are the critical links in a connected pedestrian network, and crossing the street is by far the most dangerous aspect of being a pedestrian. The risk of injury or death while crossing the street falls disproportionately on pedestrians with disabilities, older pedestrians, children and women. In India, where pedestrian fatalities constitute around 50 to 60 per cent of the total fatalities and 30 to 40 per cent of all reported road accidents on National Highways occur at intersections, this research work was undertaken to find out adequacy of traffic signal timings for pedestrian facilities provided at urban intersections. The objectives and scope of the study are :

- To find out the adequacy of signal timing for pedestrian safety
- To study the effect of inadequate traffic signal timing for pedestrian safety in particular and road safety in general.

The five most accident prone intersections based on the maximum number of pedestrian fatalities (Delhi Traffic Police Accident Data Report) were selected. These are (i) Ashram Intersection (ii) Sarai Kale Khan Intersection, (iii) Buradi Intersection, (iv) Dhaula Kuan Intersection and (v) Shastri Park Intersection.

Various data such as intersection turning movements, pedestrian volumes, signal timings, intersection geometry etc. were collected to identify the pedestrian problems particularly adequacy of crossing time. Pedestrian opinion surveys were also collected at these locations as shown in Fig. 85.

The collected data was analysed aimed at identifying the pedestrian problems and to suggest policy measures at different places and is presented in the Table 13. PV^2 index values were calculated to examine whether grade separated facilities are necessary or not. Adequacy of effective signal timings for pedestrians was calculated. Opinion of the pedestrians was analysed.

Recommendations and conclusions which are general for all the five intersections studied are as under :

(i) PV^2 index values are more than 3×10^8 at most of the intersections which is a standard value decided to provide grade separated facility and indicates the requirement of grade separated pedestrian facilities. However, grade separated facilities are not provided in the above selected intersections.

(ii) At these junctions in the absence of grade separated facilities and exclusive pedestrian phase signal, pedestrians cross when there is red signal for the vehicles. It was observed that 8 to 40 per cent allotted time is wasted due to traffic violations i.e. motorists especially two-wheeler riders and cyclists do not stop even when it is red light. So effective time left for pedestrians to cross is not sufficient.

Table 13 Pedestrian Signal Timings Provided for Different Approach Crossings at Burari Intersection

Approach	Direction	Time available for pedestrian crossings (sec)	Time Wasted due to traffic violation (sec)	Effective Time available for crossing (sec)	Width of road to Cross (m)	Required Pedestrian walking speed (Kmph)
ISBT	UP	90	10	80	37.8	1.701
	Down					
Modal Town	UP	70	13	57	25.2	1.59
	Down					
Karnal	UP	25	13	12	39	11.70
	Down					
Burari	UP	65	12	53	33.9	2.30
	Down					

Fig. 85 Pedestrian opinion survey at intersection

(iii) At many locations required walking speed to cross was as high as 11 km per hour which is impossible even for the able bodied pedestrians not to speak of the elderly, women and disabled population.

(iv) At many locations, free left turns and U-turns are provided and so the pedestrians do not find any exclusive and safe time and are forced to cross in between the moving traffic. This makes the crossing activity very hazardous for the pedestrians especially to elderly women and disabled pedestrians.

Results of Opinion Survey

- Opinion survey was conducted at different intersections in which the sample size was comprised of 100 pedestrians, out of which 66 per cent were the males and 34 per cent were the females. Age wise

23 per cent of them were 15 to 25 year, 30 per cent from 25 to 35 year, 25 per cent from 35 to 50 year, 22 per cent from 50 to 60 year age group.

- Around 59 per cent of the surveyed pedestrians stated that they have to cross the road more than thrice daily.
- Around 22 per cent pedestrians stated that they have to face "Always" difficulties, 29 per cent pedestrians said that they "Often" faced difficulties and 34 per cent of them expressed that faced difficulty "Sometimes" while crossing the road. Hence the findings of opinion survey highlight that mostly pedestrians were facing difficulty in crossing the road.
- Around 50 per cent of them stated that traffic in front of them don't allow to cross the road even when traffic light is red while 33 per cent said that red signal timings are inappropriate because it turns green while they were in middle of the road i.e. the allotted time is not sufficient and because of free left turns allowed they hardly find any safe time to cross. Rest of them felt both kinds of above mentioned problem (Fig.86).
- The opinion of pedestrians clearly states that 95 per cent of the interviewed pedestrians were facing problems while crossing. Majority of them stated (35 per cent) that with children and luggage had to cross with free left turns provided and no exclusive pedestrians phase.

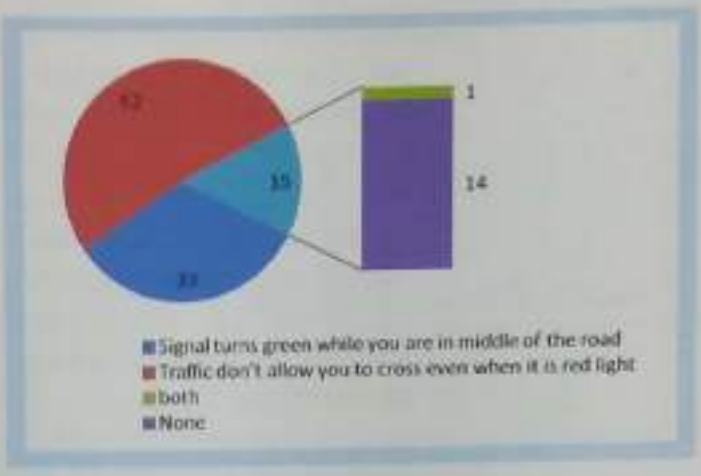


Fig. 86 Types of conflicts pedestrians faced while road crossing

Also around 26 per cent expressed their physical problems

- 58 per cent of the respondents felt that the allotted time is not sufficient while only 38 per cent pedestrians showed that allotted time was sufficient. It shows that allotted time is not sufficient and they want more time for crossing the road.

Fig. 87 Road is too wide to cross

- Eleven per cent pedestrians replied that road is too wide due to which they were not able to cross the road in the allotted time while 46.0 per cent stated that motorist's don't stop even after red-light & allotted time is wasted due to violations while 43 per cent pedestrians were uncertain i.e. could not provide reasons for the insufficient pedestrian crossing time (Fig. 87).
- Ninety per cent pedestrians felt quite unsafe and they gave various reasons for that e.g. the allotted time is less (15 per cent pedestrians felt) , the speed of vehicle is too high (24 per cent stated), motorists don't stop and do not give way to pedestrians (50 per cent pedestrians stated) and none of the above causes (10 per cent)

Assessment of Drivers' Driving Characteristics using Advance Driving Simulator

The purpose of this study was to explore the interrelationship between driver distraction and characteristics of driver behaviour associated. Research on the three-phase traffic theory on behavioural driving suggests that a number of characteristics associated with efficient traffic flow may be affected by driver distraction. Previous studies have been limited, however, by the fact that researchers typically do not allow participants to change lanes, nor do they account for the impact of varying traffic states on driving performance (in realistic settings). So in simulated driving conditions these situations could be easily measured.

This study has been divided into two parts. In the first part, the study analyzed the nature and severity of different risk taking practices e.g. near crash or crash tendency in a simulated driving environment. The participants data was obtained on the behaviours and parameters associated with above mentioned behaviour, such as data on the frequency duration, urgency, and severity of lane changes in regard to manoeuvre type, direction, and other classification variables. A sub set of the full data set was then analyzed in greater depth, with variables such as crashing behaviour, lane changing, traffic signal violation etc. The second part of this study analyzes the driver behaviour in simulated driving environment under different distraction exposure to identify the major sources of distraction that contribute to traffic accidents or near accident situations and developing taxonomy of the most identified distractions. This study also determined the frequency of various distractions under simulated driving condition and thus investigated the effect of various driver distractions on driving performance. Based on clinical approach the crash data driver behaviour and conditions were analyzed. Further, the impact and frequency of crash factor was analyzed when the driver was involved in the secondary task i.e. talking in the cell phone, doing SMS in cell phone while driving.

From the present data analysis this is amply clear that 63 per cent drivers did not crash their simulated vehicle with any kinetic or static stimuli on simulated road environment while 37 per cent drivers were not safe as they crashed their simulated vehicle shown in the Fig. 88. Further, it has been found that two percent drivers crashed their simulated vehicle with

other objects (static and kinetic) 10 times to 20 times which is showing aggressive driving attitude among drivers. Moreover, 28 per cent of the drivers showed somewhat aggressive driving attitude by crashing their simulated vehicle 1 to 5 times in their total driving hours. 15 per cent drivers drove their vehicle out of the road.13 per cent drivers drove their vehicle one time to five times out of the road while 2 per cent drivers were more reckless in driving as it was found that more than five times the vehicle has gone off the travelled way as presented in the Fig. 89.

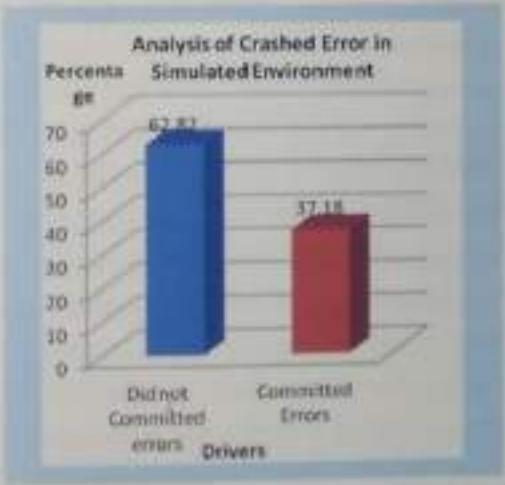
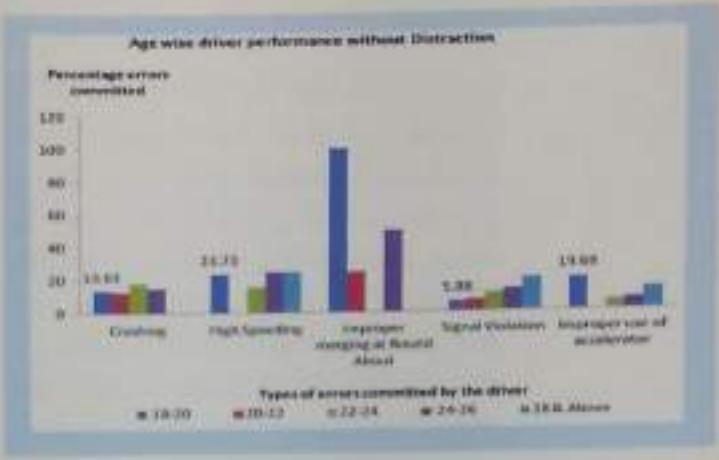


Fig. 88

Fig. 89



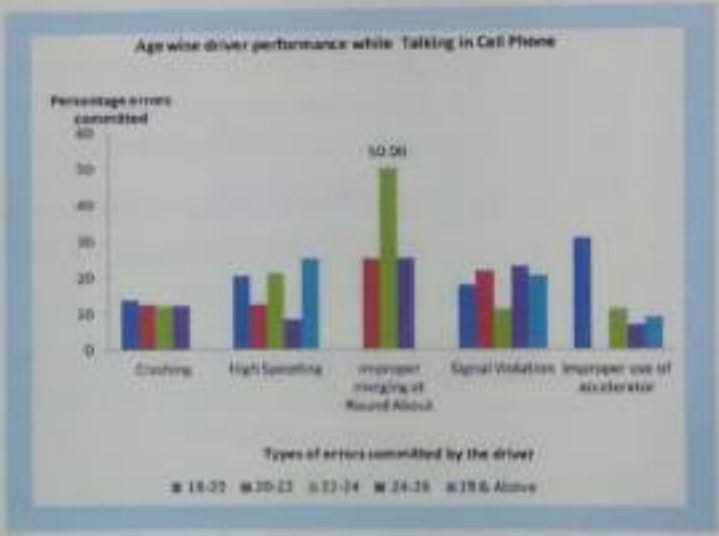


Fig. 90 Age wise driver performace without distraction and while talking in cell phone

The analysis shows that the percentage of crashing, high speeding, Improper merging at roundabout, signal violation and improper use of accelerator errors while talking to cell phone condition were made by participants. The percentage of errors increases the driver does text messaging while driving. Figure 90 show the agewise driver performance without distraction and while taking in cell phone.

Conclusions and Recommendations

From the following research work it can be inferred that drivers in simulated driving environment generally show same type of psychomotor performances as in real life driving situation. Drivers who has generally the tendency of higher speeding on road side environment were also found high speeding at the simulated driving situation. Drivers have shown following risk taking behaviour in the simulated driving environment:

(i) 37 per cent drivers were frequently showing aggressive driving behaviour as they were crashing their vehicle with some (static or dynamic) objects.

(ii) 29 per cent drivers were not adhering to correct lane and were showing frequently lane changing behaviour

(iii) 81 per cent drivers were not giving right indicators or not at all giving any indicator while turning

(iv) 62 per cent drivers overtook from wrong side

(v) 26 per cent drivers have shown specially over speeding behaviour and speeded their vehicle over the stipulated speed

(vi) 78 per cent drivers had shown stalling errors

(vii) 10 per cent drivers jumped red light and disobeyed the traffic signal.

Thus through this research work future directions for research in terms of the effectiveness of driver training under the standardized set of safety related performance criteria against which performance and training effectiveness can be effectively and objectively measured, as well as the standardization of evaluation procedures and criteria could be initiated.

Effect of Vibration and Noise on Human Performance

Driving is a complex task which needs multiple manoeuvring and mental activities which sometimes accompanied with stress may be due to work which is a relatively new phenomenon of modern lifestyles. Some review of the related literature highlight that the drivers who are exposed to the high noise level and vibration more than tolerance threshold generally suffer with multiple problems. But such type of drivers are generally engaged in long driving hours more than 8 hours (as per MVA 1988) and dealing with heavy trucks and manually control manoeuvring machineries. These kinds of behaviour and psychophysical problems are not commonly faced by other types of commercial drivers. Factory and mine workers who are generally engaged in drilling activities generally face these kinds of problems.

Therefore, the present study was conducted to analyse the relationship between visual fatigue , blood pressure with driving hours, also it was analysed that in case of predisposition of mental load whether visual fatigue incur and increases.

The objective of this study module II was to test the drivers' physiological state before and after exposure in real traffic environment.

Initially 15 drivers were tested for this study which after applied on 56 drivers including the previous group of the drivers. The drivers were administered Blood Pressure measurement and Visual fatigue test before starting the driving test in the field and after coming from field testing (without resting).

Pre-Trip Session

All the drivers were between 26 to 36 year age group .Drivers were showing excessive high blood pressure before going to field test. 16 per cent drivers were having above 160 and 13 per cent drivers were having above 150 to 160 mmhg, 27 per cent were having 140 to 150 mmhg and 27 per cent driver were having 130 to 140 mmhg.Thus these drivers were showing very high BP before going to field test. This may be due to the pre stress condition effects on the physiological state of the drivers (Fig. 91 and 92).

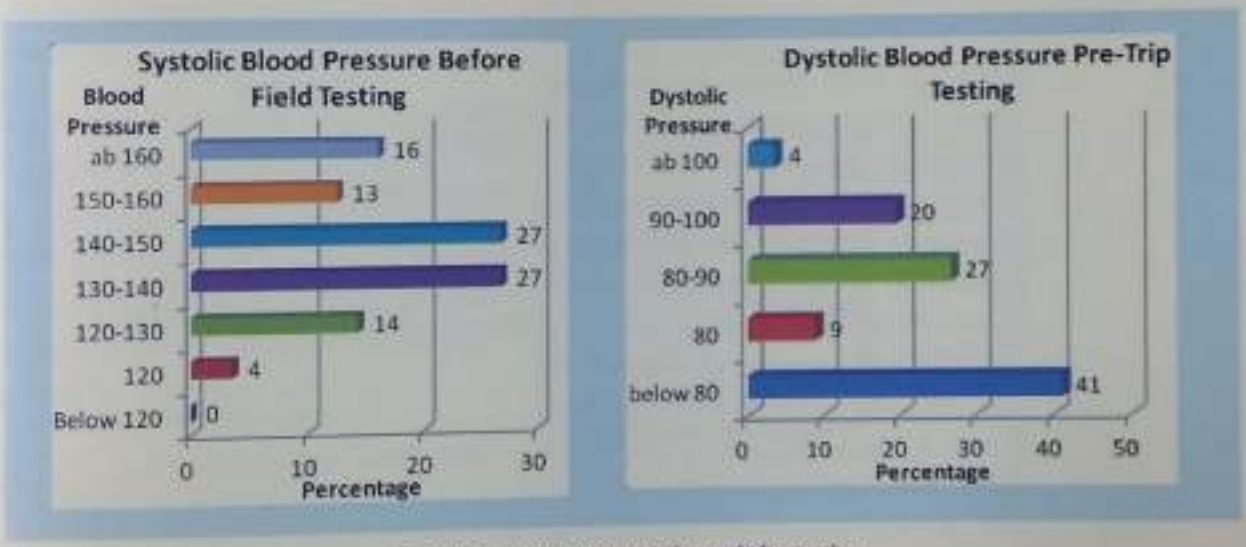


Fig. 91 Test result of drivers before and after testing

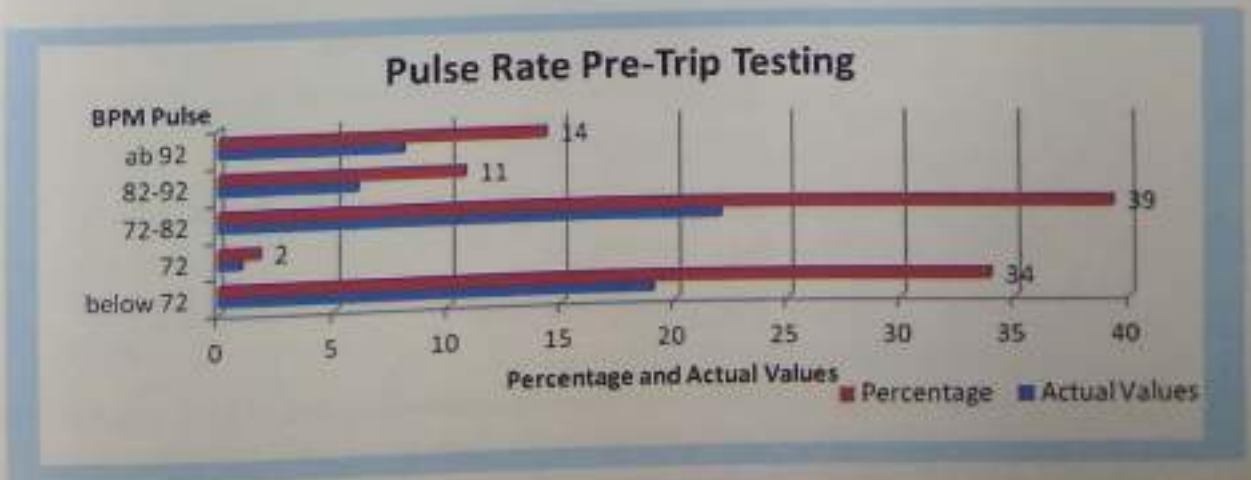


Fig. 92 Test result of tested drivers

Analysis of the probable Causes of Hypertension among Drivers

Current sample of the drivers were coming from different states from India. As per their demographic records they were generally from rural or suburban areas and they were provided very high risk taking jobs with very little livelihood ,they were from Central Reserve Police Force, Shasathra Sena Vahini, Border Security Force, and BPR&D groups. Some of them were also having family problems. Personal Interviews with the Drivers were conducted to assure them best assistance in case of any difficulty.

Post Trip Session

The data highlighted that the majority of the drivers were still having high systolic blood pressure as 26 per cent drivers were having above150 mmhg.

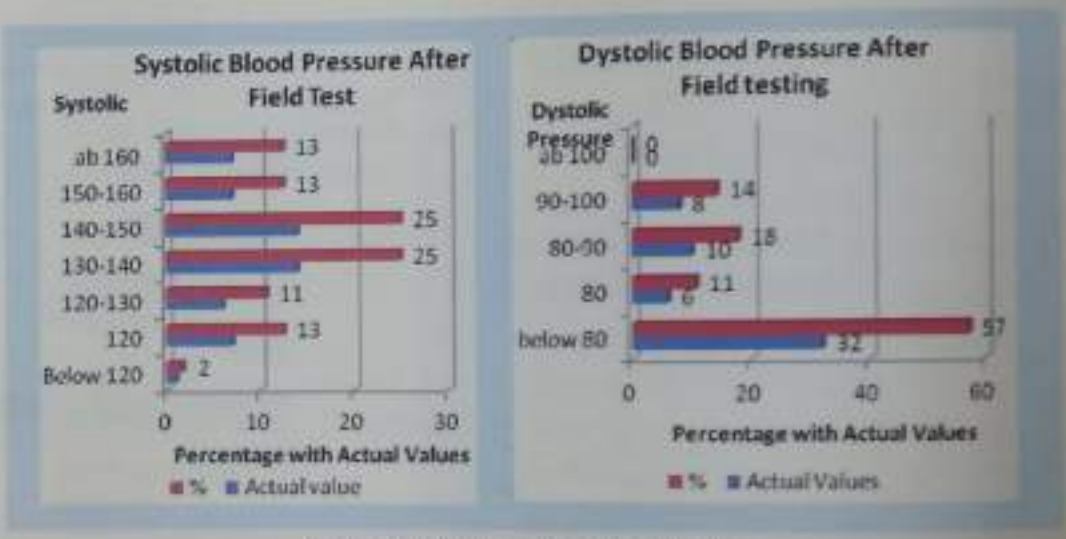


Fig. 93 (a & b) Test results showing BP of drivers

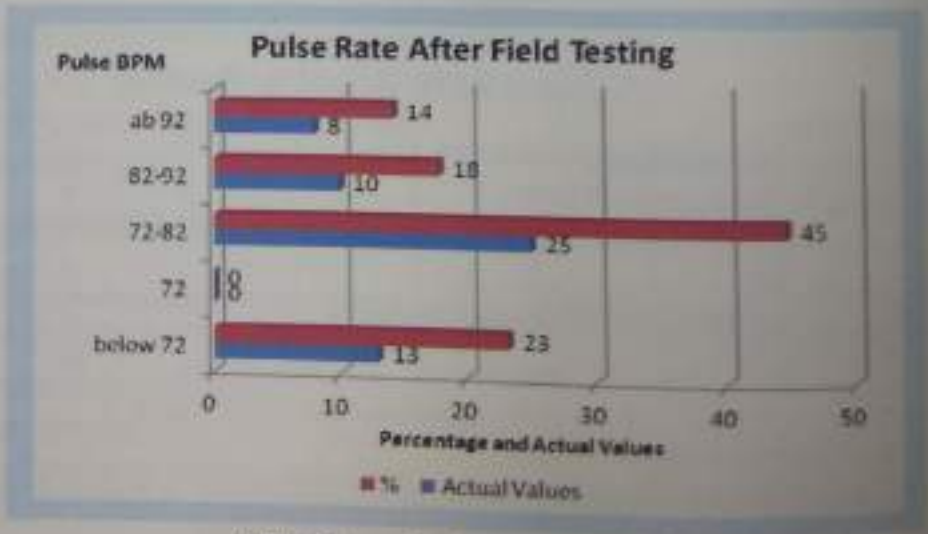


Fig. 94 Test results showing pulse rate of drivers

Analysis of the data showed that diastolic blood pressure of the drivers were quite low after the post trip session showing less anxiety after the field test. 68 per cent driver was having 80 mmhg or below diastolic blood pressure level which is showing a good sign of mental relaxation Fig. 93 (a & b) Only 14 per cent of the drivers were showing above 92 BPM which is a positive sign towards normal pulse rating (Fig. 94).

Visual Fatigue Testing During Pre & Post Phases

Fatigue has major implications in road fatalities and is believed to present a major hazard in the transportation industry. Grandjean (1979, 1988) defined fatigue as a state marked by reduced efficiency and a general unwillingness to work. The environmental causes of visual fatigue are divided into two groups:

(i) Those arise out of the visual task itself, and

(ii) Those arise out of the visual environment in which the task is performed.

From the present study, the following inferences can be drawn:

(i) Systolic Blood Pressure of the drivers was found higher during pre-field test period as compared to post test period.

(ii) Diastolic Blood Pressure of the drivers was found higher during pre-test period as compared to post test period.

(iii) Pulse rate of the drivers was found higher during pre-test period as compared to the post period

(iv) Visual Fatigue values of the drivers were found higher during pre-test period as compared to the post test period.

(v) it was analysed that in case of predisposition of mental load, visual fatigue incur and increases

Recommendations

Though the present study does not find any significant impact of field exposure i.e. exposure in traffic environment on psychophysical health effect of the drivers as the drivers were already facing several psycho-social problems and its related health effect but the health of professional drivers is an important issue in public health, occupational health, transport policy and employment conditions. This is an area of neglect that needs urgent attention. Measures to protect and improve the health of drivers should be pursued in a way that maximizes gains to all sectors of society.

Consultancy Assignments

Road Safety Audit during Development and Construction Phases of 4-laning of National Highways under PPP on DBFO basis

As reported earlier, NHAI has sponsored a study to conduct the Road Safety Audit at design and construction stages for 12 packages (1200 km) spread over four states namely, UP, Punjab,

Fig. 95

Uttrakhand and A.P spanning a period of 30 months (Fig. 95).

During the year, the inception reports of each package (i.e. 12 in number) were submitted to NHAI which consisted of Introduction, Field Appreciation, Approach and Methodology to be adopted at Design Stage Audit as well as Construction Stage Audit. Three Workshops at Delhi, Hyderabad and Lucknow were held aimed at finalising the methodology to be adopted inviting the NHAI professionals coupled with representatives of Concessionaire and Independent Engineers.

As part of the project, the traffic studies were conducted at all the project stretches which contained traffic volume composition and speed and delay studies. The typical traffic hourly variation and traffic volume for NH-18 is given in Fig. 96.

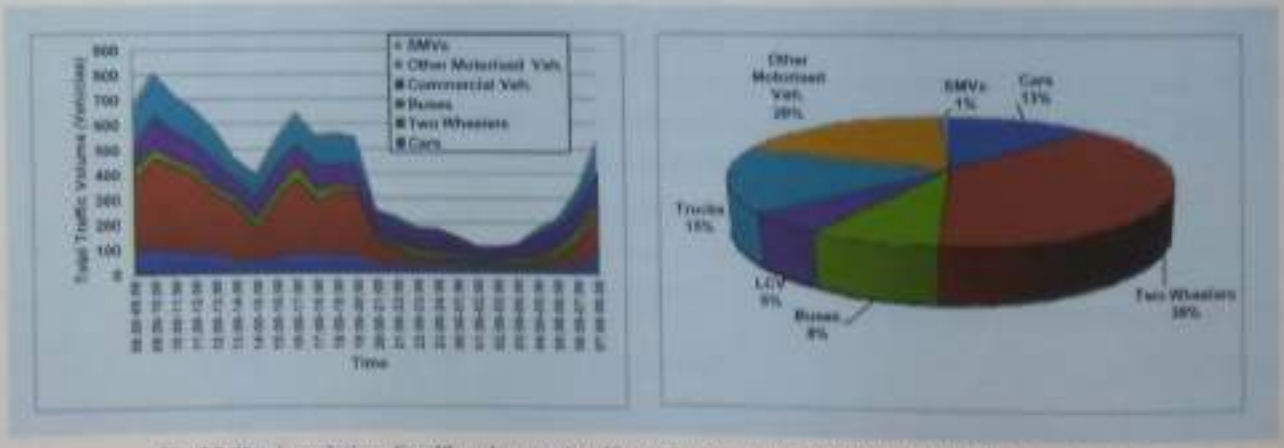


Fig. 96 Hourly variation of traffic volume and traffic composition at km 168.000 of NH-18 (Package No.35)

Further, it can be inferred that the maximum proportion of traffic (36 per cent) is by two wheelers, followed by trucks 20 percent, autos 17 per cent, cars 14 percent and buses 9.5 per cent. With regards to the directional split it was observed that both directions are evenly split to half the total traffic. About 75 per cent of the traffic travelling during day time as compared to 25 per cent of traffic travelling during night time, whereas about 40 per cent of truck traffic was travelling during night time on NH-18 for Package No.35.

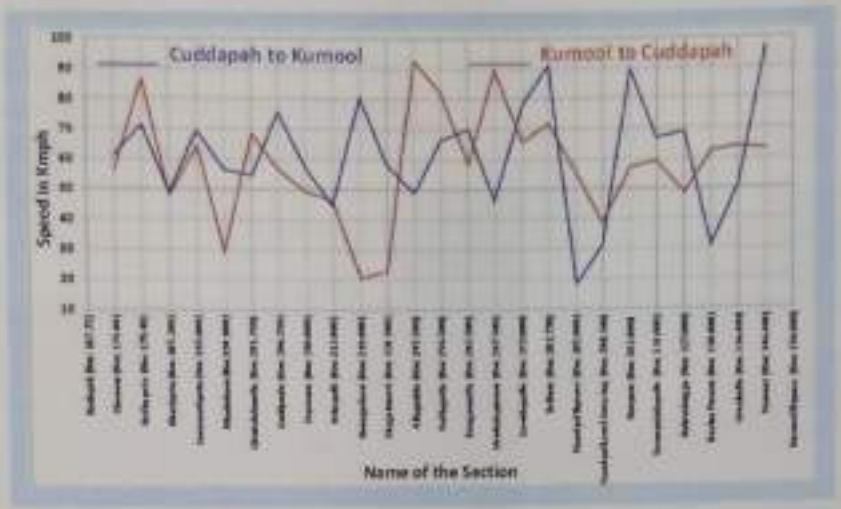


Fig. 97 Speeds on project highway on NH-18 from Cuddapah to Kurnool and Kurnool to Cuddapah

From the Fig. 97, it can be observed that overall average speed observed throughout the project stretch was 60 kmph. However, in the proximity of the urban settlements speeds are gradually reducing to around 19 kmph because of road side friction (i.e. interaction between the local traffic and highway project traffic is very high). To have safer highway speeds, the low height fencing is recommended at urban settlements which is presented in RSA Reports specifying the chainages. The Road Information Survey was conducted at all the 12 project stretches using the Network survey vehicle, typical road sections where inventory and asset updation is given in Table 14.

Table 14 Road Information Survey at Twelve Project Stretching

Chainage (km)	Grade (per cent)	Cross Slope (per cent)	Curvature (deg/km)	RF (m/km)	NUM_RFS (1/km)	Altitude (m)	IRI (m/km)
263	0.01	-3.31	22.93	2.75	13	146.6	2.19
264	-0.48	-3.15	33.82	8.25	14	145.3	5.32
265	0.12	-4.56	32.68	4.48	13	146.2	4.88
266	0	5.04	29.81	3.42	15	145.5	3.54
267	-0.14	-2.77	59.62	3.3	17	144.5	5.38
268	-0.03	-3.41	30.38	3.88	14	145.5	2.34
269	0.04	-5.08	23.50	4.35	17	145.1	2.53
270	-0.02	-1.09	59.62	3.78	15	144.2	5.79
271	-0.18	0.24	98.03	3.32	18	144	5.23
272	-0.14	-3.73	34.39	4.81	14	142.8	2.61
273	0.15	-4.2	34.39	3.55	12	142.5	2.09
274	-0.17	5.02	32.68	3.29	15	142.9	2.02

Package No 10: Moradabad-Bareilly Section on NH-24 from km 148.000 to km 262.000

As part of the safety consultancy, road safety audit during construction stage has been conducted in every three months and some of the audit findings are shown in Figs 98 & 99.

Fig. 98 Damaged crash barrier (w-beam) can be a safety hazard to road user at km 159.760 on Moradabad - Bareilly section of NH-24

Fig. 99 Inadequate barricading and delineation at km 261.000 on Moradabad - Bareilly section of NH-24

The speed and delay study was conducted for both directions of travel on the Moradabad - Bareilly road stretch. The results obtained from speed and delay survey for these directions has been given in Table 15.

The detailed design drawings were obtained from the concessionaire and development stage audits were conducted. The reports commented on the deficiencies from the safety point of view for Plan and Profile, Cross Sections, Junctions, Traffic Control Devices etc. It also provided recommendations to alleviate the safety concerns raised for different parameters.

Typical Cross Section

Safety Issue: This section is proposed for approaches of 25.2m wide VUPs and is expected to have built up area along the approaches. The utility corridor / covered drain of 1.5m width is expected to serve as side walk for pedestrians. The side walk of 1.5m width is not appropriate keeping in view the function of the VUP as interchange point for both vehicles and pedestrians (Fig. 100).

Table 15 Speed & Delay Survey on Moradabad-Bareilly Road Stretch

S. No.	Study Stretch Direction	Distance (Km)	Travel Time (hh:mm:ss)	Average Speed (Kmph)	Delay (hh:mm:ss)	Percentage Delay
1	Moradabad - Bareilly	113	4:04:05	27.75	1:02:29	25.6 per cent
2	Bareilly - Moradabad	114	3:41:47	30.87	0:29:31	13.3 per cent

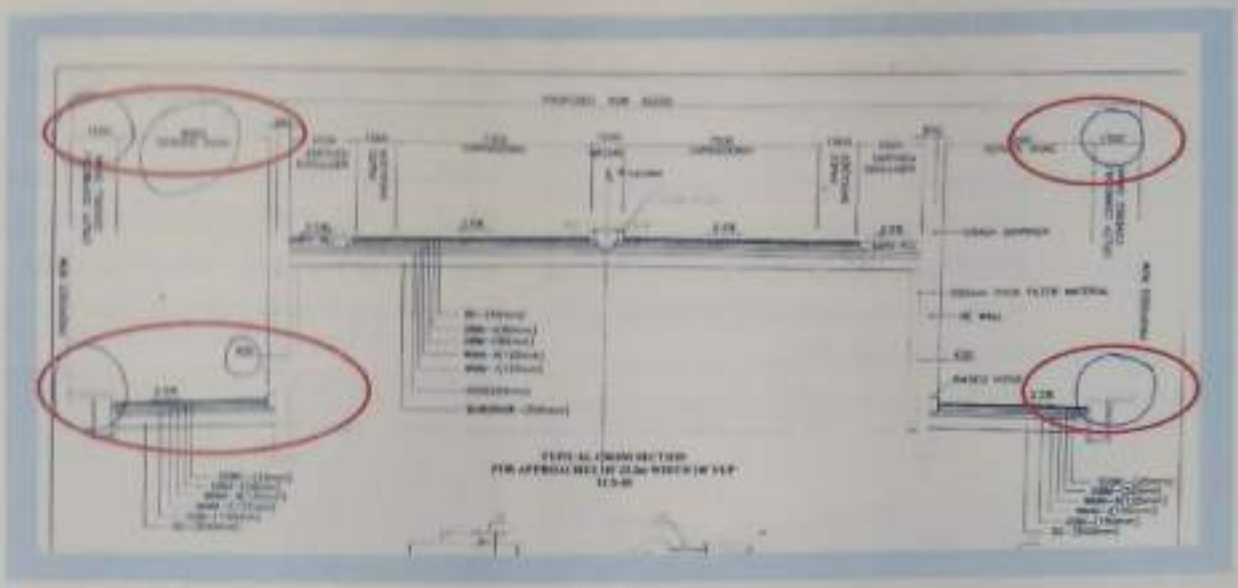


Fig. 100

Recommendations: The covered drain / utility corridor of 2.5 m width may be ensured so that it can function as side walk for safe pedestrian movement. This can be achieved by reducing the width of slip roads from 8.0 to 7.0m without any compromise to vehicular capacity.

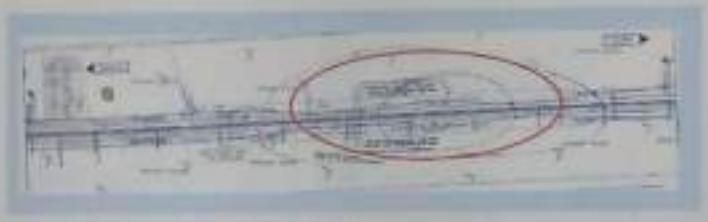


Fig. 101 Service road between chainage 125.321 and 125.900

Discontinuity of Service Road over Small Length / Section

Safety Issue: Service road continuity has been broken for a small length between Chainage 125.321 and Chainage 125.900. Moreover segregated bus bays along both these carriageways have been provided in between i.e. at 125.650 km. This will generate hazardous merging / diverging and weaving movements of traffic at unsafe close intervals and may lead to serious accidents. The site will turn into an accident black spot Fig. 101.

Recommendations: Ensure continuity of service road for an appreciable length and do not provide short breaks in service roads of continuous stretch. Service road may be continued between Ch.125.321 and 125.900 to enhance safety. Access may be provided between main carriageway and service road by providing gap in the divider if required (for long stretches of continuous service roads).

A Typical Junction on One of the Corridors

The intersection is right hand T-junction. The existing acute angle has been aptly changed to near right angle to enhance safety. The junction is deficient in geometric design thus

reducing both safety and efficiency. Though acceleration and deceleration length have been appropriately provided, Zebra crossings for pedestrian crossing have been provided abruptly in unsafe manner without proper refuge area. The service road has been merged with the main carriageway too close to the intersection leading to unsafe traffic movements (Fig. 102).

Fig. 102 Junction on one of the corridors

Recommendations: The intersection may be re-designed with proper channelizing islands and pedestrian crossing features along shortest desire line of flow. The service road may be merged with the main carriageway in such a way that weaving length of 300 m is ensured between right turning from service road and straight movement along main carriageway. Non conflicting straight movements of traffic i.e. Ghaziabad to Aligarh may be segregated with divider at the intersection to reduce number of conflict and conflicting area.

The construction stage audit is being carried out after every three months. For all the packages two times construction stage Audit reports have been prepared and sent to NHAI. The construction stage audit reports contained maintenance of existing roads, construction stage audit, safety of workers, electric safety, medical aid etc.

For Package No.7, Zirakpur to Parwanoo Section on NH-22, final reports have been submitted to the client. Also accident data was collected from the police stations falling

(a)

(b)

(c)

(d)

(e)

Fig. 103 (a-e) Glimpses on typical safety hazards on road section on NH-22

on the project stretches for two years. These FIRs were decoded and accident reports are under preparation. Some of the typical safety hazards observed on the road section during the construction phase are given in Fig. 103 (a-e).

Traffic Management and Design of Selected Twenty Intersections of Allahabad City

The city of Allahabad is amongst the largest cities of Uttar Pradesh and is situated at the confluence of three rivers- Ganga, Yamuna and the invisible Saraswati. The meeting point is known as Triveni and is especially sacred to Hindus. Allahabad is basically an Administrative and Educational city. Keeping in view the forthcoming Kumbh Mela in Allahabad in 2013 and other problems of traffic in the city, Allahabad Development Authority (ADA), Allahabad has requested CSIR-CRRI to prepare Traffic Management Plan and design of selected twenty intersections in the city. Various traffic studies like intersection volume counts, pedestrian volume counts were carried out to assess the existing traffic problems on the selected intersections. Topographic survey drawings of these intersections were provided by ADA. A team of scientists visited all the intersections in order to appreciate the field conditions. From the analyses of classified traffic turning movement data, it was observed that, maximum quantum of traffic is handled at Hanuman Intersection followed by Medical Chowk, Bhairana Chowk and Pani ki Tanki Intersection.

- The proportion of two wheeler traffic dominates on all the intersections
- The share of non motorized traffic especially cyclist traffic is quite high at most of the intersections and it varies from 20 to 30 per cent at different intersections

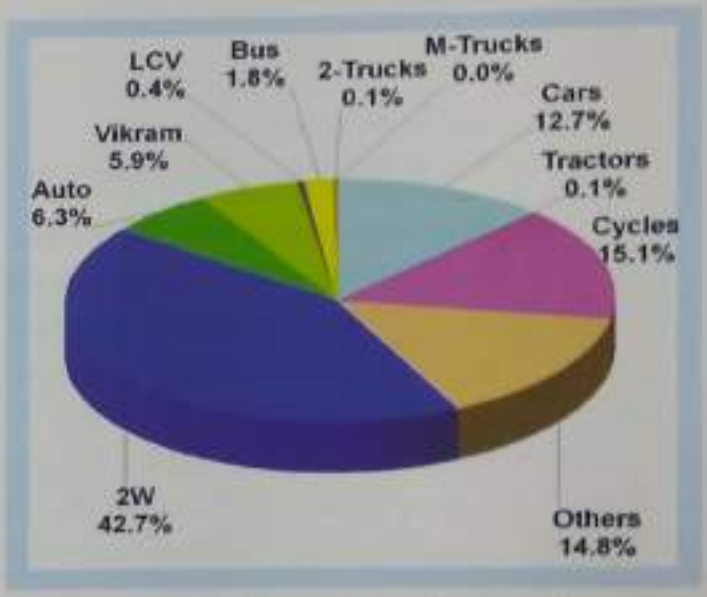


Fig. 104 Traffic composition at Hanuman chowk

The composition of traffic and hourly variation of traffic at a typical intersection (Hanuman intersection) is shown in Fig. 104 & 105.

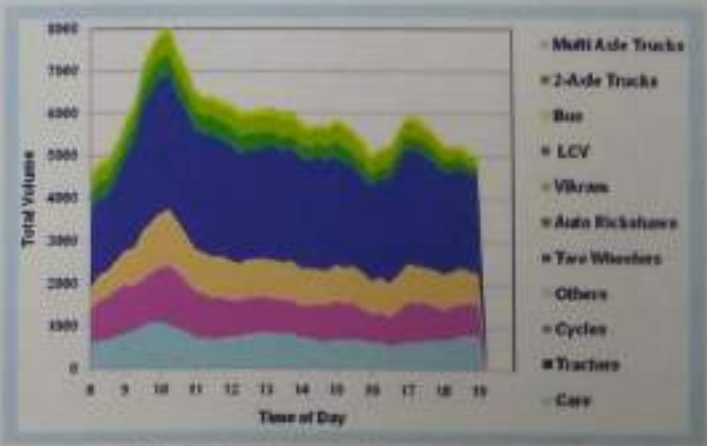


Fig. 105 Hourly variation of traffic flow at Hanuman chowk

Pedestrian counts were also carried out at selected intersections along with traffic volume where sizable quantum of pedestrian movement is witnessed at the intersections during the peak hours to assess the sidewalk requirements and the need for providing controlled pedestrian crossing facilities including pedestrian signals and Foot Over Bridge or Subways.

Traffic Management Plan and Intersection Improvement Plans

Based on the critical analysis of the peak hour traffic flows at these intersections and keeping in view the existing site conditions, the traffic management plans and improvement plans are being developed by providing the appropriate geometric features. Due care is being exercised while redesigning the intersections by providing requisite geometric design elements as per IRC: SP-41 and IRC: 65 without resorting to any major land acquisition. The detailed improvement plans are being developed for all the intersections. Traffic Management Plan and Geometric design done for Hanuman intersection is shown in Fig. 106.

Fig. 106 Traffic management plan and geometric improvement plan for Hanuman chowk

Traffic management plan and intersection designs for ten intersections have already been completed and given to sponsors.

Development of Road Safety Strategy and Generating Awareness on Traffic and Road Safety - Package VII (Phase II)

Punjab Road and Bridges Development Board (PRBDB) has awarded a study on Development of Road Safety Strategy and Generating Awareness on Traffic and Road Safety - Package VII, (Phase II) to CSIR-CRRI for conducting Road Safety Audit study on selected road corridors and to generate awareness generation campaign amongst commuters and communities residing adjacent to the selected road corridors in this study. The main objective is to address road safety issues on selected sections of Up-gradation Roads (UG), Rehabilitation Roads (RG) and some sample sections of road sections under periodic maintenance. The road sections identified for the conduct of the various studies including the road user behaviour surveys and road safety audit studies are shown in Table 16.

A detailed Road Safety Audit was carried out on the above identified road sections to

Table 16 Road Sections for Study

District	Stretch	Code	Length
Mohali, Patiala	Kharar - Banur - Tepla Road	UG 1	39.53
Ludhiana, Sangrur	Ludhiana - Malerkotla - Sangrur	UG 2	71.92
Amritsar	Attari - Chabhal - Taran Tarn	UG 3	40.50
Ferozepur	Ferozepur - Zira Road	RH 1	34.46
Mohali, Fatehgarh Sahib	Chandigarh - Landran - Chunni - Sirhind	RH 2	37.30
Jalandhar, Nawanshehar	Phillaur - Aur - Rahon - Nagar	RH 3	33.51
Kapurthala, Amritsar	Kapurthala - Taran Tarn	RH 4	47.20
Ferozepur	Zira - Dharamkot Road	RH 5	24.70
Patiala , Fatehgarh Sahib	Sirhind – Patiala	RH 6	28.30
Sri Hargobindpura – Batla	Sri Hargobindpura – Batla	PM 1	26.00
Sitoguno – Dabwali	Sitoguno – Dabwali	PM 2	28.38

understand the functional requirements of the project roads and to know the present condition details like available carriageway width, site constraints and thereby decide the locations for conducting the different types of primary traffic surveys.

Further, the Detailed Project Report Drawing supplied by the client was also studied in detail and discussions with PRBDB officials were carried out periodically during the course of the study to understand the Right of Way (RoW) details and issue of congestion problems witnessed due to severe encroachments. The road safety audit, behavioural survey and all other primary surveys were carried out between January 2011 and September 2011 on the locations shown in the Fig. 107 (a-b) through executing the various tasks envisaged in the succeeding.

(a) Study area description

Road Safety Audit

Road Safety Audit *(RSA)* is a formal procedure of assessing the road crash proneness and

(b) Study methodology
Fig. 107

safety insurance of road projects. The road safety audit involves, analyzing the possible hazardous situations during various stages of road projects. The findings of the Road Safety Audit have been clubbed under four headings which are as follows:

- Alignment and cross-section.
- Intersections and their access.
- Road surface and types.
- Various visual aids and crash protective measures.
- Night time audits

The action plans conceived for each of the project road have been recommended and listed in the order of priority. The action plan covered the following aspects:

- Good road surface to enhance safety on the road.
- Measures to enhance the safety on the curves.
- Measures to improve safety on ROB's, minor bridges and culverts.
- Various visual aids to be provided.
- Redesign of the intersections.
- Appropriate design of Informatory signs (Conforming to IRC).

Conclusions and Recommendations Based on RSA Studies

The identified stretches of the Up gradation Roads were critically studied. The detailed design drawings, ongoing site construction as well the existing condition of the Kharar-Banur-Tepla section of UG/1 (ODR), Ludhiana - Malerkotla – Sangrur stretch of SH-11, Attari - Tarn Taran section of MDR-61 stretch vis-à-vis traffic operating conditions were studied. The total length of the up gradation roads audited spans approximately 150 kms. The audit helped in identification of the existing deficiencies in the stretch. Most of the UG roads are catering to higher volume of traffic as compared to RH roads. Major portion of the UG roads are four lane divided carriageways except UG/3. Also, they pass through

densely populated sections. The appropriate corrective measures for improving the safety were suggested to cover the deficiencies. Existing inadequacies in design especially at curves, road signs and markings, roadside activities and development were critically renewed. Based on the study conducted on the above sections, necessary modifications in geometric design such as access control, sight distance improvement, junction improvements, access road junction and median opening designs were suggested.

Further, improvements for pedestrian movement in terms of access control and replacement, installation of new sign boards and markings, chevron markers, delineators and retro-reflective markers for improving the night driving are suggested.

An Action Plan for the audited stretch of Kharar-Banur-Tepla section of UG-1 (ODR-4), Ludhiana-Malerkotla-Sangrur stretch of SH-11, Attari-Tarn Taran section of MDR-61 has also been prepared to enhance the safety situation. The suggested measures are to be implemented in all the study stretches which would help in the mitigation of the road crashes.

Road User Behavioural Analysis

The study of road user behaviour is very important to solve the problems of road safety. The level of literacy and an even poorer knowledge of road safety make the public extremely vulnerable to traffic exposure. Most of the high-speed roads in the country invariably pass through many villages and towns, which obviously cause unsafe frequent exposure of the inhabitants of adjoining villages and towns to the dangers of high-speed traffic. The incorrect behaviour might be either due to lack of knowledge of traffic and general safety rules or to defiant behaviour regarding the rules. Proper road user behavioural analysis can identify all the incorrect behaviors of the road users that are incompatible with modern roads, and they need to be targeted through an effective road safety campaign. Looking into the above important behavioural perspectives of the road users, different behaviour surveys were conducted on all the project corridors.

Attempt was made to collect data from all sections of the road users across age, gender, driving exposure etc. The various parameters of road user behaviour were studied through the conduct of following primary surveys:

- Driver Distraction Survey (for measuring level of distraction while driving).
- Pedestrians Opinion Survey (to understand the perceptions of the road users in terms of assessing their understanding on different parameters like safety aspects, road side assets, visibility of road signs, convenience in walking and crossing time on road and other drivers behaviour towards them).
- Opinion Survey amongst Police Personnel was conducted (to evaluate

their working time and type of duty hours, availability and usage of various safety equipments with maintenance aspects).

- In addition, Road Safety Awareness Survey was conducted amongst the School Children (to elucidate their awareness levels about road safety aspects.

A typical illustration of the type of driver distraction practiced by the drivers while driving is shown in Fig. 108 followed by the Table 17 demonstrating the ranking of the various project roads considering the driving distraction practices data collected on the above roads.

Fig. 108 Type of driver distraction on the project roads

The findings and recommendations emerged from the study during this phase were presented in front of the World Bank Review Team and the same were accepted for implementation on the ground as well as to be appropriately considered during the next phase of the study.

Evaluation and Testing of SPG Drivers (Driver Diagnostics)

This study has been sponsored by the Cabinet Secretariat with the following objectives:

a) To screen and evaluate the driver's performance on the basis of their driving behaviour and habits

b) To increase safety of road environment by screening out drivers having unsafe attitude and having risky practices on road

The drivers from Special Protection Group (SPG) were administered car driving simulation

Table 17 Ranking of Project Roads based on Highest Driver Distraction Practices

Rank	Stretch	Name of the Road Section
1	UG-3	Tarn Taran - Attari section (UG-3)
2	UG-2	Ludhiana-Malerkotla - Sangrur (SH-11)
3	RH-4	Kapurthala - Taran Taran (MDR-61)
4	RH-3	Phillaur-Aur - Rahon - Nagar (ODR)
5	UG-1	Kharat - Banur - Tepla Road (ODR-4)
6	RH-2	Chandigarh - Landran - Chunni - Sirhind (SH-12A)
7	RH-6	Sirhind - Patiala (SH-31)

test, action judgment test, and simple and complex reaction time test, depth perception test (judgment of height, distance and width), night vision and glare test, visual acuity test, driver behaviour rating scale (field testing). Drivers were tested for a number of visual and psychomotor ability tests for in depth analysis and screening.

Results shows only 23 per cent drivers could get overall performances i.e. correct responses to all tests as against 77 per cent drivers who could get only 70 per cent marks for all the tests.

For in depth study following test data was analysed:

(i) ***Driving Simulation Tests:*** Driver Simulation tests were conducted to records different driving errors.

(ii) ***Reactive Capacity (Complex reaction time) Test:*** Reaction time was conducted to measure total time taken by the driver between appearance of the stimuli and reaction over the break. Driving simulation tests were conducted to records different driving errors. In these tests, 73 per cent drivers performed as "Good", 19 per cent as "Very Good" and 8 per cent as "Reasonably Good" and none of the drivers performed excellent or outstanding. This shows that the safety related performance of present sample is 'Good' not 'Very Good' or above (Fig. 109).

(iii) Sensor Motor Coordination Test: This test measures psychomotor functions: precision of motion control, coordination of several limbs, movement orientation time, speed of arm movement speed control, dexterity of the hands and figures, postures consistency of arms and hands etc. The data revealed that only 8 per cent drivers were performed outstanding followed by 15 per cent excellent, 31 per cent very good and 35 per cent good and 66 per cent drivers were between good and very good which also came out in the overall performance report (Fig. 110).

(iv) Driver Behaviour Rating Scale :

This test has been developed by CSIR-CRRI for measuring driver's attitude on the road

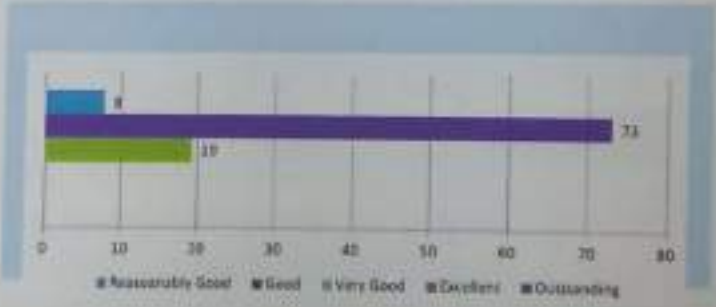


Fig. 109 Performance of decision and reaction test

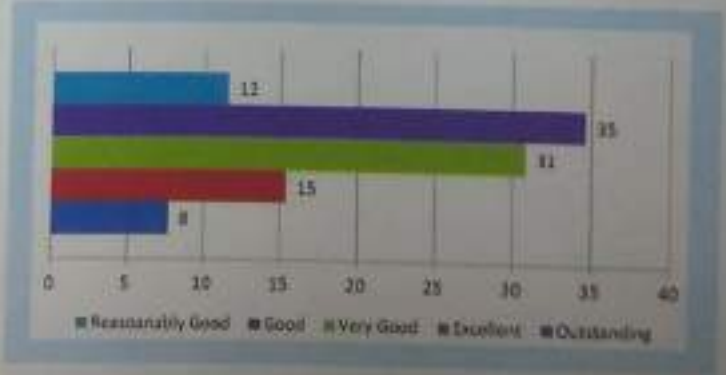


Fig. 110 Per cent performance level of the drivers in sensorimotor test

side infrastructure, pedestrians, road signs and signal, lane discipline and road marking etc. In the present sample 92 per cent drivers performed between Good and Very Good which is highlighting the present sample characteristics, only 8 per cent have shown Reasonably Good performance as shown in Fig. 111.

(v) Hand Grip Test

This test measures hand grip strength of the drivers, this test is important because it helps to predict the driver grip strength on the steering manoeuvring movements as given in Fig. 112.

(vi) Compulsory Tests

Glare recovery test: This test measures how quickly the driver comes out of the glare effect caused by the head lights of oncoming vehicles. This test is being conducted by Porto Clinic Driver testing unit. In the present sample 42 per cent drivers performed "Outstanding" in this test, 38 per cent "Excellent, 4 per cent "Very Good" and 12 per cent "Good".

Fig. 111 Performance levels of the drivers in driver behaviour rating scale

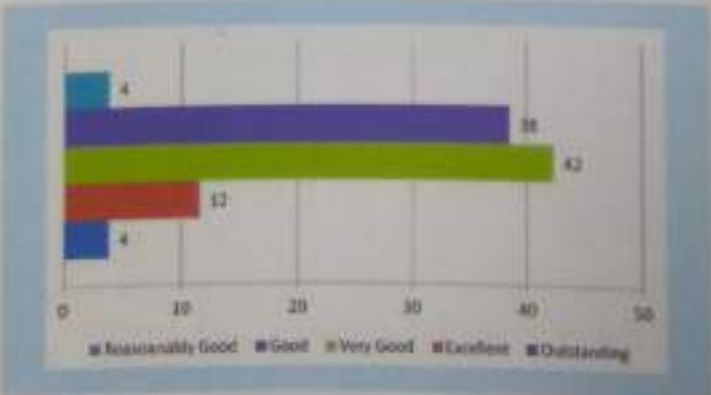


Fig. 112 Per cent performance level of the drivers in hand grip test

Night Vision Test: This test measures driver's ability to see accurately in darkness. This test is being conducted by Porto Clinic. In the present test 81 per cent drivers performed "Outstanding ", 8 per cent "Excellent" 8 per cent "Very Good" and 4 per cent "Good".

Road Tign Test: This test has been developed to measure the awareness level of the drivers related to different mandatory, informatory and warning signs of the road. In this test only 7 per cent performed "Very Good" 12 per cent "Good" and 23 per cent "Reasonably Good" which shows that drivers has to improve in the awareness regarding road signs and road rules.

Visual Acuity Test: This test measures the sharpness of driver's vision which is basic requirement of safe driving. This test has been measured by Driver Vision Screener. (Administration and scoring of the test has been provided in the manual).In the preset sample population 100 per cent was having outstanding vision.

Conclusion

The data reveals that majority of the drivers have performed "Good" and "Very Good" (80 per cent), only 12 per cent are excellent in

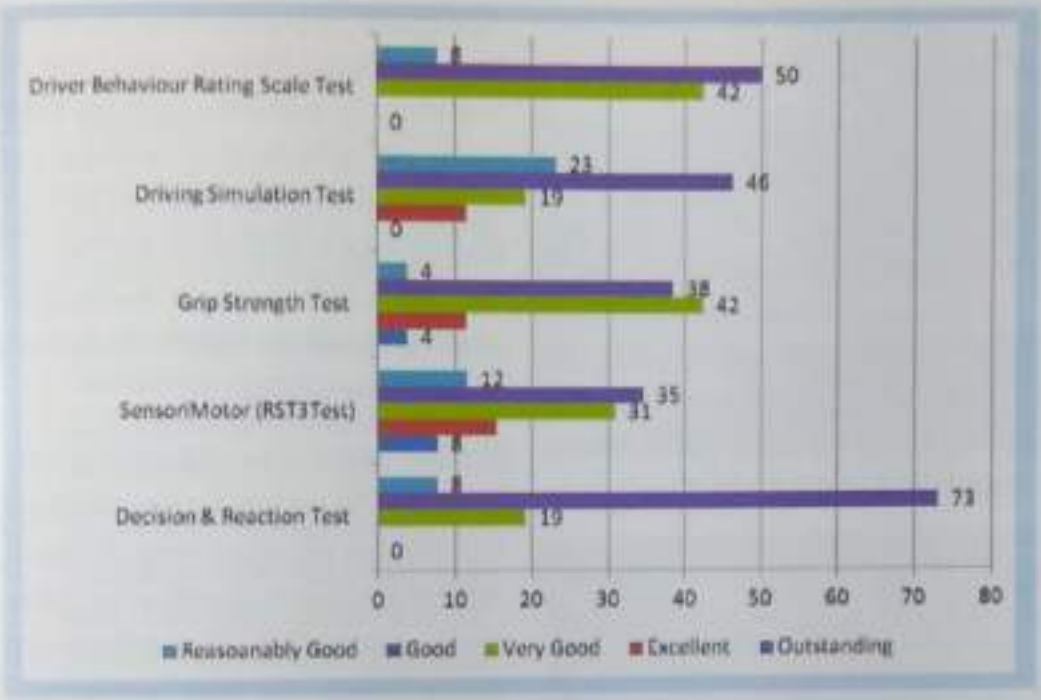


Fig. 113 Overall per cent performance level of the drivers on different evaluation tests

the present sample and rest 4 per cent each performed as Outstanding and Reasonably Good. Overall performance of the drivers reveals that the present sample has been categorized as "good" as their majority in all the performances of all the tests (Fig. 113).

Recommendations

On the basis of the present study, it is recommended that learner drivers' should be compulsorily tested for the basic psychophysical traits or capacities and they should get passing marks before appearing for the learner license. In MVA also, it should be given top priority.

High Security Vehicle Registration Plate System

High Security Vehicle Registration Plate System is being implemented in India. Central Road Research Institute has been notified through gazette as one of the agencies to grant Type Approval Certificate to manufacturers based on the testing of the samples against the specified standards (Fig.114). After start of production of HSRP, the concerned manufacturer has to obtain conformity of production certificate through rigorous procedure of testing of samples from

Fig. 114 A view of laser code number and other security features of HSRP

manufacturing unit as well as embossing stations.

M/S Link Point Infrastructure Pvt. Ltd, New Delhi and M/S Rosmetra Technologies Pvt. Ltd, Gurgaon, Haryana has approached the Institute in this financial year for grant of 'Type Approval Certificate' for manufacturing HSRP. The work in this regard is in progress. Two manufacturers, (M/s Shimnit Utsch Pvt. Ltd., Mumbai and M/s Toonjes Eastern Security Technologies Pvt. Ltd. New Delhi) who have already got 'Type Approval Certificate" have approached CRRI for assessment of conformity of production (COP) of HSRP for second cycle. Team of Scientists has visited the manufacturing units of both the manufacturers at Kala Amb in H.P. (Fig. 115) and Kohima and Dimapur in Nagaland for obtaining the samples of HSRP and the work of testing is in progress.

Fig. 115 Process of fixing hologram at manufacturing unit of M/S Shimnit Utsch at Kala Amb (H.P.)

M/s Real Mazon India Limited, New Delhi who had earlier got Type Approval certificate from CRRI has also started the production of HSRP at Kala Amb in HP and has got tender for fixing of HSRP in UT of Andaman and Nicobar Islands. The manufacturers have approached CRRI for carrying out first COP of HSRP. A Team of scientists has visited their production plant at Kala Amb and collected samples for carrying out COP and work is in progress. The evaluation of HSRP of all the three manufacturers has been initiated and the work is in progress.

Study of Non methane Hydrocarbons in the Atmospheric Environment of Delhi Region

As reported earlier, this study has been sponsored by Department of Science & Technology with the following objectives :

- to do sampling and chemical characterization of ambient / atmospheric (C_2-C_4) non-methane hydrocarbon species in Delhi region
- to identify the sources/strength for the non-methane hydrocarbons in Delhi region and to make source inventories of non-methane hydrocarbons for Delhi region.

Ten sampling sites had been selected in Delhi which were categorised in five different types of areas viz. Traffic Areas (T), Residential Areas (R), Commercial Areas (C), Industrial Areas (I) and Background Area (B). Traffic Area (T) included Ashram (Intersection) (T1) and Dhaula Kuan (Sardar Patel Marg) (T2) (Fig. 116). Residential Area (R) included Maharani Bagh (R1) and Karam Pura (Deen Dayal Upadhaya College) (R2) (Fig. 117). Commercial Area (C) included Lajpat Nagar (Central Market) (C1), Palam (Mehrauli Road Market) (C2) and Nehru Place (C3). Industrial Area (I) included Kirti Nagar (I1) and Mayapuri (I2). Satyam Puram, Jharoda Kalan Border, New Delhi-72 was selected as the background Area (B). The locations of the nine sampling sites are shown in the Fig. 118. Canister Samlper (Model 1800, Entech Instuments Inc.) was used for Field Sampling. The samples were analysed using portable gas chromatograph (GC) system (Fig. 119 to 121).

Fig. 116 Sampling site (T1): Ashram intersection

Fig. 117 Sampling site (R1): Maharani Bagh

Fig. 118 Map showing sample sites

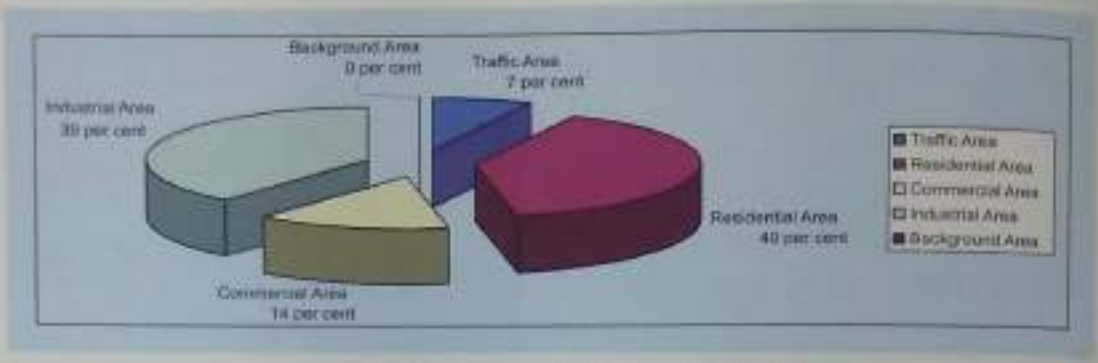


Fig. 119 Distribution of ethane in various areas of Delhi

Fig. 120 Distribution of propane in various areas of Delhi

Fig. 121 Distribution of butane in various areas of Delhi

Conclusions

The maximum contribution of Butane comes from Industrial Areas i.e. 47 per cent and also if individual results for distribution of NMHCs in industrial areas are speculated it was observed that Ethane shows a maximum contribution. This scene could be realized if the various industrial activities like welding, usage of solvents etc. are taken into account.

Satyam Puram, Jharoda Kalan Border which was taken as a background area is nearly undeveloped rural area which has no industrial or commercial activities going on nearby. Only a few numbers of homes are present in that area. Since, it is a

rural area not much traffic activities are existent in the area at present. All these conditions made this zone a completely pollution free area which is reflected in the results thereby proving a very good background.

Consultancy Assignments

Traffic Studies for Junction Improvement on Major Road Corridors in Ahmedabad

Ahmedabad city is the commercial capital of Gujarat and is one of the emerging urban centers in India. With a population of 4.5 million within the municipal area and 5.5 million in the Greater Ahmedabad Urban Agglomeration (GAUA), this city is preparing to face future challenges, more importantly in terms of sustaining its contributions to the growth of Gujarat State. Given these trends, the city is expected to experience rapid growth in population and travel demand. Ahmedabad Municipal Corporation (AMC) initiated a detailed project for developing Bus Rapid Transportation (BRT) plan in the year 2008. This study mainly focused on Integrated Public Transit Plan and BRT plan covering phase wise development of BRT system in Ahmedabad. This study has also suggested to improve some of the major intersections on BRT corridors. Instead of improving major junctions in an isolated manner, a systematic traffic study for improving these junctions on AMC road network is felt essential.

Towards the end, Ahmedabad Municipal Corporation (AMC) entrusted CSIR-Central Road Research Institute (CRRI) to prepare Junctions Improvement Plan for selected junctions on AMCs road network. The objectives of this project are to conduct appropriate traffic studies to quantify the traffic problems and to study traffic characteristics at identified intersections. Estimation of future traffic and its distribution at peak hours for each intersection for the next 10 years and preparation of typical junction improvement plans for identified junctions is the major output. The scope of study is limited to the conduct of traffic surveys and preparation of junction improvement plans for 23 identified intersections based on traffic projections for the next 10 years, as per IRC guidelines.

Various field studies undertaken include road inventory and traffic studies which were carried out to collect primary data to understand the existing problems and to analyze traffic demand. In addition, secondary data information such as vehicle population, land-use data, ongoing and future envisaged developments in the surrounding areas were also collected. This data will be useful in evolving junction improvement plans. Data analysis will be done to find out the estimated base year traffic volume based on traffic volume survey and estimated future demand by considering primary and time series data (secondary data) for next 10 years. Traffic growth was estimated by considering two methods; first one is by considering Net State Domestic Product (NSDP) of Gujarat state and the second one is based on past trends of motor vehicles registered in Gujarat State. Maximum growth rate obtained for each category of vehicle was considered for estimation of traffic in the next 10 years. The projected peak hour traffic volume at the five intersections has been estimated for the horizon year 2017 and 2022 and is presented in Fig. 122.

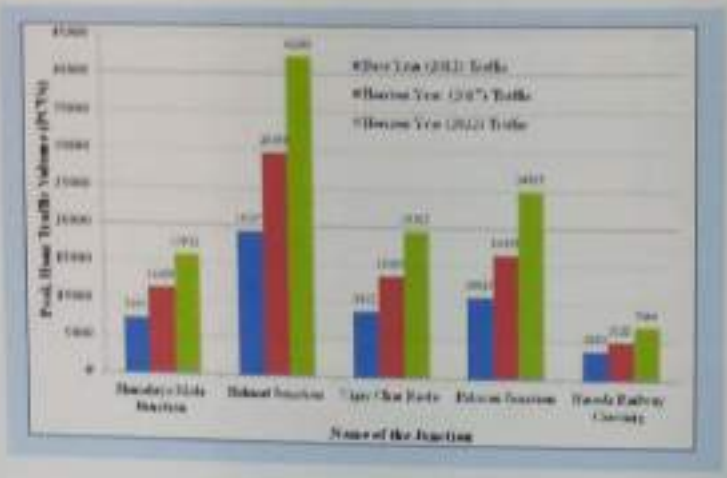


Fig. 122 Year peak hour traffic in base and horizon

Peak hour flow projections in the horizon year were considered for junction improvement plans for the identified five intersections. It can be observed from figure, that the total traffic coming from all the arms of 4 intersections namely Himalaya, Helmet, Vijay Char Rasta and Pakwan exceed 10,000 PCUs per hour by 2017. According to IRC: SP-41 and IRC: 62-1976, it may be recommended that space separated intersections are required besides other signalized facilities at grade junctions to handle traffic flow at these junctions. Therefore, for smooth traffic flow and reduction in delays and traffic congestion, grade separated intersection is essential on major road directions to cater to maximum amount of traffic at all the four intersections.

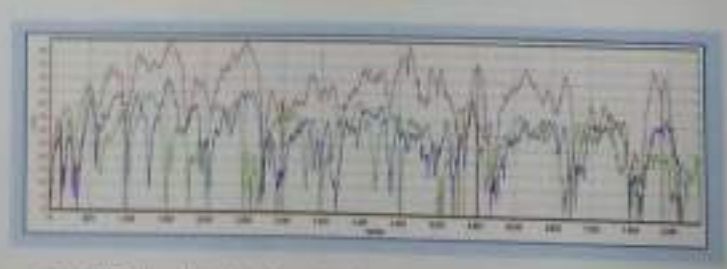


Fig. 123 Speed Profile along the Corridor from Thaltej to Delhi Darwaja

Speed Profiles along the Corridor: The speed profile curve along the corridor was measured through probe vehicle technique (V-Box) as presented in Fig. 123. Red color profile in the figure indicates speed profile along the study corridor (Thaltej to Delhi Darwaja) during early morning hours (6:44AM). Travel time taken for this corridor at this time is about 13 minutes 34 seconds. Similarly, speed profile was measured during morning peak hour (Blue color) and Evening peak hour (Green color). Travel time taken during morning peak hour is about 31 Minutes 8 Seconds while it is about 36 minutes 37 seconds in evening peak hour.

Junction Improvement Plans: Junction improvement plans are proposed to be developed by taking into account results of traffic survey and prevailing site conditions. The main influencing parameters such as traffic volume and composition, turning movements, design speeds and Right of Way (ROW) were considered while developing the conceptual junction improvement drawings. Besides, the frequency of trains and number of gate closures at railway crossings were also considered for recommendations of ROB at Naroda railway crossing. The Junction improvement plans for each junction have been prepared. The conceptual junction improvement drawings for Himalya Mall junction is presented in Fig. 124. Based on the classified traffic volume and turning movements' data, this junction needs at grade improvement and also a grade separation facility for through traffic plying on drive in road. While preparing the improvement plans at this location, the position of Gurukul junction was also considered and it is recommended to extend this grade separated facility up to the end of Gurukul junction.

Fig. 124 Proposed junction improvement plan for Himalaya Mall junction

Steady Speed Fuel Consumption under Controlled Conditions on Mumbai Pune Expressway

The objective of the study is to understand the fuel consumption relating to speed, roughness, gradient, surface type and vehicle type. The study was carried out along Mumbai-Pune Expressway (Fig. 125) using a Tata Sumo (Diesel) vehicle. The data was collected using GPS based V-Box data acquisition system by integrating the distance and fuel flow data (Fig. 126). The gradient on the section varied from 5.3 per cent gradient upward to 4.8 per cent gradient downward. There are totally 25 sections and the section length is up to 1 km. There is discontinuity of data due to tunnel, hill slope, etc and hence section length was effectively reduced up to 300m in many of the test sections. The gradient was calculated by GPS data.

There is a linear relationship between Road Gradient and fuel consumption on both bituminous and concrete surface type. Speed is a dominant factor for determining fuel consumption. The

Fig. 125 Route map of Mumbai-Pune expressway

Fig. 126 In-vehicle test setup of data acquisition system for vehicles

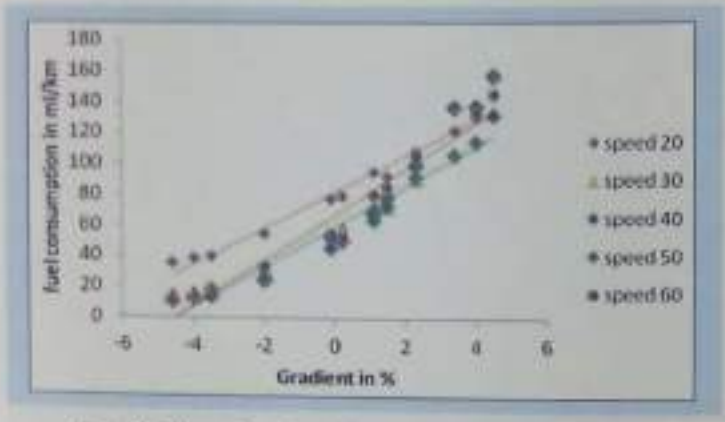


Fig. 127 Effect of gradient in fuel consumption for Tata Sumo on concrete surface

optimum fuel consumption observed in steady speed tests on light vehicles (both petrol and diesel) as well as truck (under different loading conditions) is observed to be between 40 to 50 km/hr. As the road gradient increases the effect of speed in determining fuel consumption decreases Fig.127.

Air Pollution Surveys on Road Network Connecting Darlaghat–Ropar and Darlaghat–Nalagarh

As reported earlier, M/s Ambuja Cements Limited requested CSIR-Central Road Research Institute to carry out air pollution and traffic studies to predict the impact on air quality of the road network in the influence area which are likely to be affected due to the expansion of one of its cement plant at village Rauri, Darlaghat (H.P) (clinker capacity increasing from 1.8 MTPA to 2.6 MTPA) and a new grinding unit at village Panjehra in Nalagarh (H.P) which is situated at a distance of about 20 km from its existing grinding plant at Ropar (Punjab). Air pollution measurement and traffic flow studies were carried out in order to evaluate the influence on air quality, air dispersion modelling (CALINE 4 model) was attempted to obtain the base line information for the same.

The objectives the study included the measurement of roadside (kerb side) air quality at four selected locations; and finding out relationship between vehicular traffic (emissions) and observed roadside air pollution levels. The study also included prediction of CO concentration (CALINE 4) and estimation of vehicular emission load of CO, HC, NO_x and PM at selected locations/sites.

For this purpose, study areas were selected in order to cover the area where the impact was to be evaluated. The four study areas selected/ identified were Darlaghat (HP), Nauni Intersection (HP), Nalagarh Intersection (HP), Kiratpur Intersection (Punjab) (Fig.128).

The comprehensive roadside air pollution measurements with respect to SO_2, CO, NO_x, HC, O_3 and particulate matter (PM_{10}) and classified traffic volume study at these four selected locations were carried out to obtain the baseline information. In addition, micro-meteorological parameters (wind speed, wind direction, temperature and relative humidity) were measured simultaneously.

Continuous measurements were carried out for these air pollutants at each of the selected locations on 24-hr basis by using CRRI's sophisticated state-of-art mobile air pollution laboratory equipped with pollutant-specific automatic analyzers. The monitored pollutant concentrations were compared with air quality standards (NAAQS, 2009) prescribed by CPCB. Further, to predict the CO concentrations

along the road corridor(s), vehicular pollution modelling was carried out using CALINE 4 model. In addition, the vehicular emission load (viz. CO, HC, NO_x and PM) at selected locations (sites) were estimated taking into consideration the emission and deterioration factors specified by ARAI (ARAI, 2008) and CPCB (CPCB, 2000) respectively. The modelling and vehicular load estimations were carried out for base year 2009 and projected year 2012 (considering 5 per cent annual growth over 2009 traffic volume).

Fig. 128 Study areas

Conclusions

Air Quality Assessment

The concentrations of most of the air pollutants at almost all the locations except for CO and PM at Nalagarh (Panjehra) did not exceed the ambient air quality standards as specified by CPCB.

Prediction of CO Concentration using CALINE 4 Model

The CO prediction using CALINE 4 model was carried out for all four pre-identified road corridors. The modelling results indicated that the predicted CO concentrations for the year 2012 were slightly higher as compared to the base year 2009. That was due to natural growth (@5 per cent per annum) in the traffic volume and additional trucks (approximately 300 trucks per day) that have increased after the capacity expansion of the plant were added for the projected year 2012. CO concentrations predicted at the pre-identified locations were found to be below CO standards stipulated by the National Ambient Air Quality Standards (NAAQS, 2009) for 1-hr (4000 $\mu g/m^3$) and 8 hour (2000 $\mu g/m^3$) (for Industrial, Rural and Other Area) for the base year as well as for projected year. Table 18 shows the predicted CO concentration for base year (2009) and projected year (2012) at Nalagarh intersection. Figure 129 shows the prediction of CO concentrations by the CALINE 4 model (Standard Run Condition) at various receptor locations identified along the road corridor at Nalagarh intersection for the year 2012.

Table 18 Comparison of Predicted CO Concentration for Base Year (2009) and Projected Year (2012) at Nalagarh Intersection

Study Location	Nalagarh Intersection					
	1-Hour Values (µg/m³)			8-Hour Values (µg/m³)		
	Standard Run Condition	Worst Run Condition	NAAQS,2009 Standard for CO	Multi Run Condition	Multi Run/ Worst Case Condition	NAAQS,2009 Standard for CO
	CO Concentration Range (µg/m³)					
Base Year 2009						
Site A	228-570	228-684	4000	228-328	242-470	2000
Site B	228-912	228-1140	4000	228-470	228-726	2000
Projected Year 2012						
Site A	228-570	228-798	4000	228-313	242-513	2000
Site B	228-1026	228-1368	4000	228-484	242-798	2000

Fig. 129 Prediction of CO concentrations (18-19 hr) for Nalagarh corridor (2012) (Section of Bharatgarh- Panjehra-Swarghat corridor) (Standard run condition)

Vehicular Emission Load Estimation

Vehicular emission load along the road corridors, likely to be affected by increased vehicular traffic due to proposed expansion activities and new facilities, were calculated for CO, HC, NO_x and PM. Vehicular emission loads were calculated for both the base year (2009) as well as for the projected year 2012. No significant change (± 0-3 per cent) in total emission load and contribution from individual pollutant(s) in the projected year 2012 vis-à-vis base year 2009 was observed. In fact, the total emission load for individual pollutants (viz., CO, HC, NO_x and PM), which would have increased due to natural growth of the vehicles on the road corridor(s) as well as an additional trucks plying on the road corridors due to new/ additional expansion capacity of plant, were compensated by improved engine technology in the vehicles and fuel quality (as indicated by the emission factor for these vehicles) hence, resulting in no significant changes in vehicular pollution load estimations. Table 19 provides summary of estimates total emission and individual pollutants for one of the road corridor (Nalagarh intersection), likely to be affected by the proposed expansion of new facilities, for the projected year 2012 as compared to base year 2009.

Table 19 Comparison of Estimated Vehicular Emission Load (per km) for Base (2009) and Projected Year (2012) at Nalagarh Intersection

Total Emission Load (Kg/ Day)												Total Emission Load (Kg/ Day)		
CO			HC			NO_x			PM					
2009	2012	% Change	2009	2012	% Change	2009	2012	% Change	2009	2012	% Change	2009	2012	% Change
Panjehra- Swarghat corridor														
39	36	-7.69	9	9	0	21	22	4.76	4	4	0	73	70	-4.11
Panjehra- Bharatgarh Corridor														
8.8	10	13.64	2.8	3	-0.55	3.9	5	28.21	1	1	0	16.6	20	20.48
Panjehra- Nalagarh Corridor														
39	36	-7.69	9	9	0	21	22	4.76	4	4	0	73	70	-4.11
Grand Total														
86.8	82	-0.55	20.8	21	0.96	45.9	49	6.75	9	9	0	162.6	160	-1.60

Traffic and Transportation Study for Port Blair City

Port Blair is the capital city of Andaman & Nicobar Islands and the Population of Port Blair was 14,075 in 1961 which was gone up to 99,984 in 2001 with an average annual growth rate of 6.5 per cent. As per the 2011 Census Data, the population of Port Blair is 1, 00,608. Though the resident population has not shown significant growth, the visitor population is becoming significant in Port Blair. In 2008 the visitor population was 1, 36,426 which was more than the resident population. In Andaman & Nicobar Islands, vehicle population has gone up from less than 10,000 in 1991 to around 65,000 in 2010 which has increased at an average of 12 per cent per annum. It is expected that vehicles will be approximately 1.2 lakes by 2015 which is double from the current number. The major share of the vehicles is two wheelers with about 68 per cent followed by cars about 21 per cent. At present Port Blair has 117 km of road length of varying widths which is of very little in terms of supply considering the demand. Moreover, the majority of the traffic ply only on 50 per cent of this road length. This mismatch between supply and demand of infrastructure has culminated in increasing traffic related problems such as congestion, accidents, air pollution etc. Some of the intersections need immediate attention for geometric redesign improvement which requires scientific analysis of traffic operations and designs based on traffic engineering principles and some typical intersections are shown in Fig. 130.

Fig. 130 A view of Bengali club and Chatham junction

The study has been divided into two phases namely short term (Phase I) and long term (Phase II). The objectives of Phase I include:

- To work out a traffic/ transport system management plan to ease the existing traffic problems in Port Blair and to optimize the use of existing infrastructure focusing on short term remedial measures to improve traffic flow conditions considering junctions improvement, area traffic management schemes, parking plans etc.

In Phase I study, short term solutions shall be recommended for about 25 identified junctions on the basis of a set of traffic surveys. In addition to the above road intersections, the design of traffic circulation plans at five given locations in Port Blair city are considered to be developed for smooth movement of traffic at the city centre and market areas

Study Methodology

The study methodology for this study has been devised and presented in the form of flow chart as shown in Fig. 131.

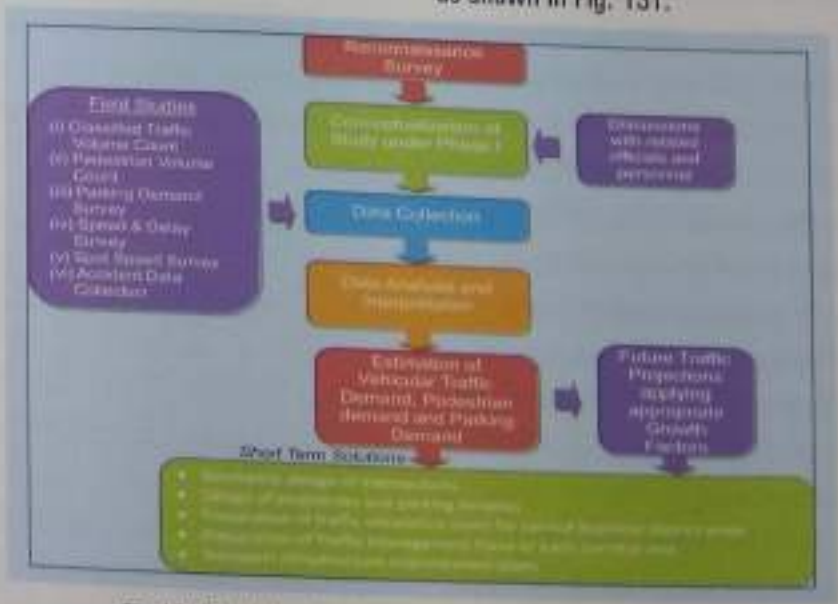
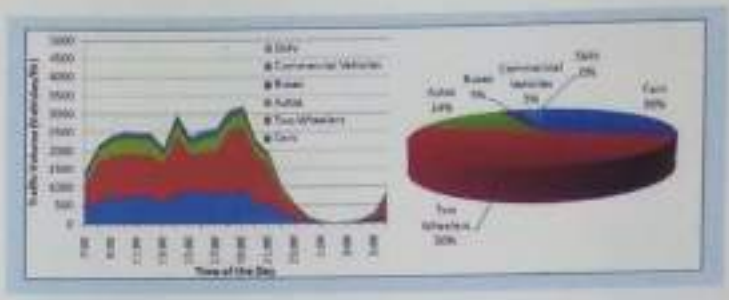


Fig. 131 Devised methodology for the present study under Phase I

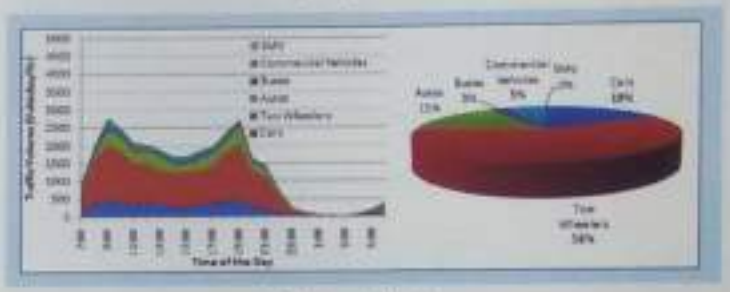
Traffic Data Analysis

The traffic volume count survey has been conducted at 14 intersections and 6 mid blocks. The typical hourly variation of traffic volume and traffic composition is shown in Fig. 132. The fast moving vehicles (FMV) are observed to be have 99 per cent of total traffic and slow moving vehicle (SMV) has very insignificant and negligible. The two wheeler composition is very high and it is varying from about 40 to 55 per cent followed by car of about 15 to 30 per cent at different. Auto rickshaws composition is also varying from 10 to 40 per cent across different intersections. The commercial vehicles include LT, HT and MT and have the composition about 1 to 13 per cent. Bus has a maximum percentage of 5 per cent. The commercial vehicles include LT, HT and MT on mid block has the composition of about 3 to 18 per cent. Bus has a maximum percentage of 11 per cent.

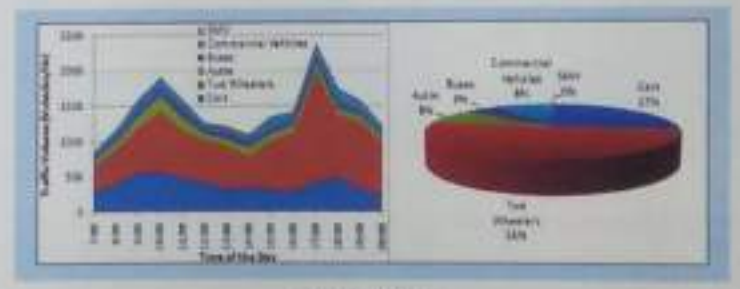
The major road network has been digitized in order to demonstrate the traffic loads on the network. The daily traffic volumes at observed links have been extended to other adjacent links appropriately in order to load the network with traffic loads. The traffic loads of the network are shown in Fig. 133. From the Figure, it can be observed that the links near Clock Tower, Bengali Club, Goal Ghar, Delanipur, Bathu Basti and Hayat Singh Junction area are going to be heavily congested if there are no appropriate traffic management measures taken. Hence, the situation once again highlights that they needs immediate attention to improve the traffic situation.



Hayat Singh Junction



Bathu Basti Junction



School Line Road

Fig. 132 Typical hourly traffic variation and traffic composition

Fig. 133 Projected daily traffic loads on arterial road network of Port Blair city

Speed and delay study has been conducted at 5 road stretches covering most of the arterial road network of Port Blair. The road length covered in this survey is 44.2 Km. The average journey

speeds are ranging from 25 to 35 kmph. The delays are about a maximum of 25 per cent of journey time which can be observed at Delanipur and Hayat Singh Jn Stretch.

Short Term Traffic Improvement Measures

From data analysis the following short-term traffic improvement measures are emerged:

a) *Geometric Design of Intersections*

b) *Circulation Plans*
- *Around Clock Tower Area (include Clock Tower Jn, Light House Jn, Gandhi Statue Jn, Bengali Club Jn, Model School Jn, IP&T Jn)*
- *Around Dairy Farm Jn and Hayat Singh Jn.*
- *Around Janglighat Area*

c) *Widening of Existing Roads and New Links*
- *Widening of the road from Chatham to Dairy Farm, Chatham to Bengali Club, Marine Gate Jn to Coastal Road Link*
- *Chatham Saw mill junction corner improvements are needed.*
- *Coast road all kinks to be removed and widened to divided two lanes*
- *Cellular jail link connecting to the water sports kink shall be removed to have sufficient turning radius.*
- *Dairy farm to old CCS road needs to be improved/ widened.*

d) *Pedestrian Facilities*

e) *Parking Facilities*

f) *Traffic Signals*

g) *Traffic Signages*

The study is sponsored by Police Department, Port Blair

Comprehensive Traffic and Transportation Study of Goa

Due to intense mining activity and increase mobility in the recent past at some parts of Goa (especially in North and South Goa) as shown in Fig. 134, the heavy truck traffic movement was increased tremendously. The increase in infrastructure development in terms of improvements in road network and intersections could not cope with the increase in heavy traffic in these regions. As a result of this, mix of fast moving heavy trucks with two wheelers and other NMT (Non Motorized Traffic) can be found which is leading to increase in accidents. The hapazard movement of mining trucks without giving any proper care about the people living in these areas resulted in lot of air pollution, noise pollution and also dust pollution. Considering the above problems, the Transport Department, Goa requested CRRI to study the traffic and transportation problem at following mining areas:

South Goa

1. Collamb-Jambauli-Tilamol-Curchorem-Capxem
2. Caurem-Quepem-Tilamol-Curchorem-Capxem

3. Sanguem-Curchprem-Sanvordem Tisk-Capxem
4. Codli-Guddemol-Sanvordem Tisk-Capxem
5. Shigao-Guddemol Junction-NSN Junction-Sanvordem Tisk- Capxem

North Goa

1. Piussurlem-Sonshi-Pali (Vagus)
2. Piussurlem-Honda-Sonshi-Pali (Vagus)
3. Kudnem-Phanaswadi-Naveli (Main Jetty)
4. Kudnem-Khodgiri-Naveli (Main Jetty)

South to North

1. Shigao-Dharbandora - Usgao-Naveli Jetty

The objectives of the present study are:

- To study the traffic and transportation problems at the mining routes and suggest appropriate improvement measures.
- To study the roadway capacities of mining routes and suggest the measures.

Study Methodology

To achieve the above mentioned objectives, the methodology followed for this study was as shown in Fig. 135.

Traffic Surveys

The traffic studies on Classified Traffic Volume Counts of turning movements at the

Fig. 134 Location of mining areas and the effected traffic movement at South Goa as well as North Goa

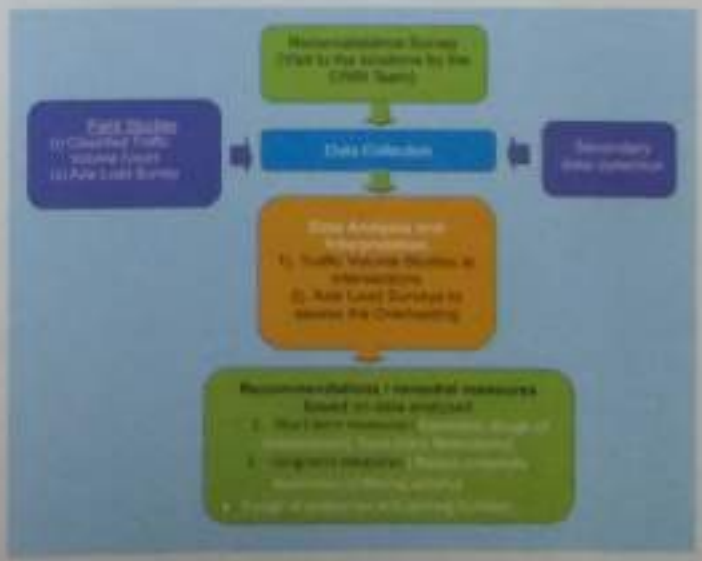


Fig. 135 Study methodology

identified intersections and Axle Load Surveys at Sanvordem–Guddemol Junction at Anatwadi and Usgao – Kotambi (Vagus) have been conducted (Fig. 136).

It can be observed that traffic volume of about 35,776 PCU (12800 vehicles) for 7 hour at Navelium jetty intersection (Fig. 137). The maximum peak hour flow in PCU/hr of about 4,653 was observed at 3 to 4 PM The fast moving vehicles (FMV) are observed to be have 99 per cent of total traffic and slow moving vehicle (SMV) has very insignificant and negligible. The proportion of commercial vehicles includes LT, HT and MT is very high of about 91 per cent, followed by two wheeler of 5 per cent and cars of about 3 per cent.

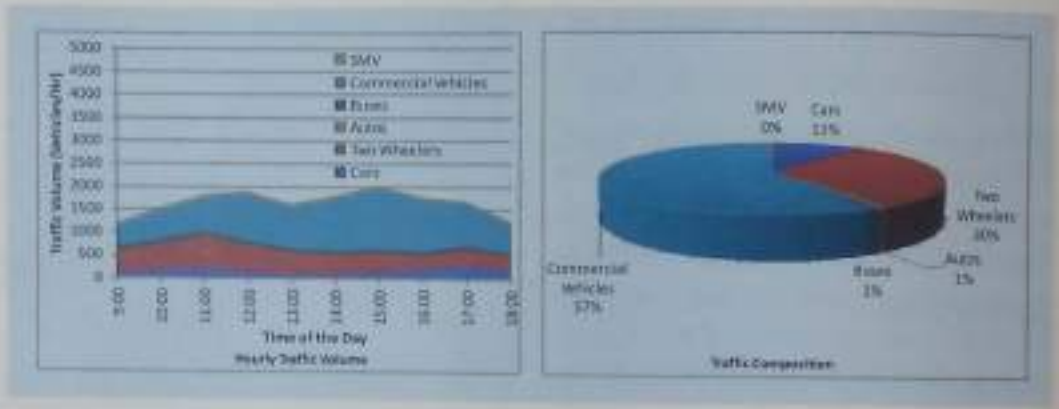


Fig. 136 Hourly traffic variation and composition at Sanvordem intersection at South Goa

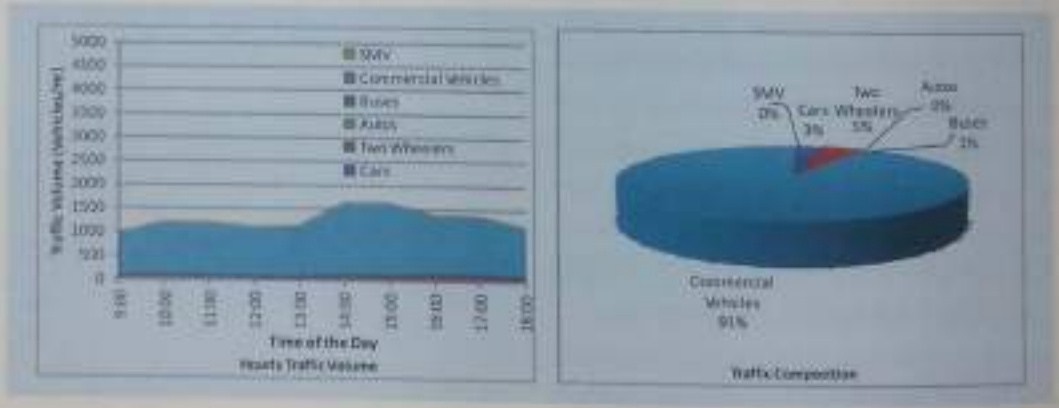


Fig 137 Hourly traffic variation and composition at Navelim intersection at North Goa

Axle Load Surveys

To know the extent of overloading of mining trucks, Axle Load Survey was conducted at one location each in South Goa and North Goa areas as given below:

1. Anatwadi (Sanvordem-Guddemol Junction)
2. Vagus (Usgao-Kotambi (Vagus))

In South Goa at Anatwadi (Sanvordem-Guddemol section), a total of 180 trucks are weighed and

out of these measured trucks, 47 trucks are found to be overloaded which constitute about 26 percentage as shown in Fig. 138. It can be said from this analysis that this 26 percentage of overloaded trucks are adequate enough to damage the road overlays as well as any surface dressing. As a result of this, any overlay or surface dressing would be deteriorated quickly and the pot holes are created along with pavement distress.

In North Goa at Usgao-Kotambi (Vagus) section, a total of 205 trucks are weighed and it was observed that 56 trucks are found be overloaded which constitute about 27 percentage as shown in Fig. 139. This 27 percentage of overloaded trucks are adequate enough to damage the road overlays as well as any surface dressing. As a result of such over loading, pavement surface dressing will deteriorate by creating pot holes and pavement distress.

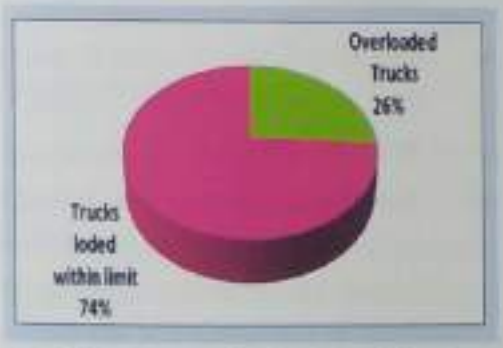


Fig. 138 Percentage of overloaded trucks based on Axle Load Survey at South Goa, Anatwadi (Sanvordem-Guddemol)

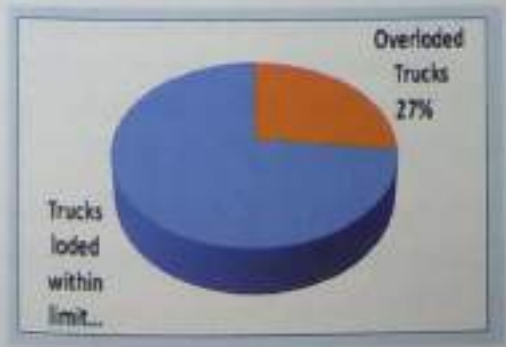


Fig. 139 Percentage of overloaded trucks based on Axle Load Survey at North Goa (Usgao-Kotambi) Vagus

Traffic Improvement Measures

Short-term Solutions

Geometric Design of Intersection

The traffic volume, studies have been conducted at different intersections in order to assess the traffic situation. From the results of these studies it can be understood that some of the intersections need immediate attention for geometric redesign improvement which requires scientific analysis of traffic operations and designs based on traffic engineering principles. The conceptual drawings have been prepared by giving the measurements each for three legged intersection and four legged intersection shown in Fig. 140 and Fig. 141 respectively. Geometry of proposed features is recommended to be adopted for the smooth traffic flow and reduction in accidents at the intersections.

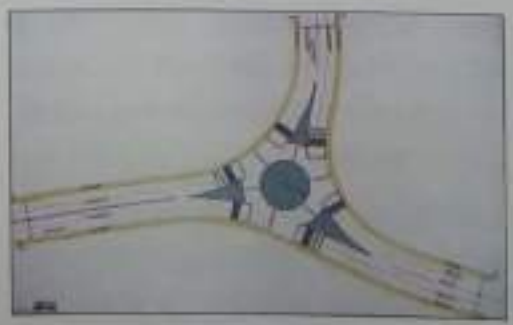


Fig. 140 Three legged intersection conceptual drawing to be adopted for all three legged intersection

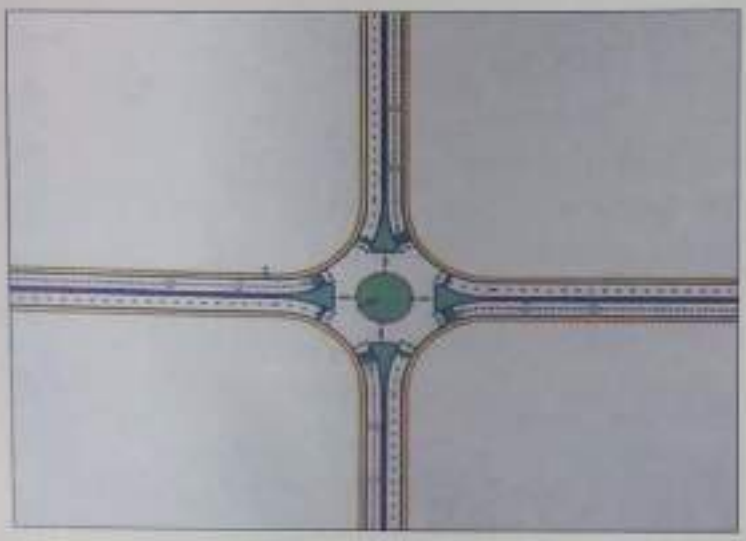


Fig. 141 Four legged intersection conceptual drawing to be adopted for all four legged intersection

Upgradation of Road Sections at Mining areas

From the roadway capacity analysis, the volume to capacity ratios for all the entire roadway sections were exceeding 0.65, hence widening of the above mentioned road sections to four laning shall be taken-up on priority basis.

Other Short-term Measures

In addition to the above measures, following short-term measures are necessary:

- Training of mining truck drivers at regular interval about the safety operations while driving is very important.
- Trucks while leaving the quarry sites are thoroughly cleaned.
- Most of the trucks are covered with teared cloth in dilapidated condition, enough precaution shall be taken and regular replacement of cover is needed.
- At any given point of time no mining trucks shall pass over the bridge continuously.
- Sudden breaks on the bridge sections may lead to collapse of the old bridge on subject of the impact loads; hence sudden breaks on bridge shall be avoided.
- Regular medical check-ups for the mining truck drivers are necessary to check their vision and health conditions.
- Regular sprinkling of water at quarry sites as well as the road sections is very much needed.
- Restriction on number of trips in day by a mining truck shall be imposed. Vehicle log book shall be made available for the concerned authorities for the random checkups.
- Restriction on day operations of truck movement shall be imposed preferably from morning up to afternoon (2:30 PM) these movements shall be restricted. These movements from 2:30 to 7:00 PM can be allowed.
- Speed restrictions (30kmph) on mining trucks within city/ residential areas shall be imposed.
- Proper care shall be taken on the leakage of un-dumped material from

the empty trucks as well as loaded trucks.

- All the mining trucks shall be pasted with retro reflective tapes in the front as well as on the back of trucks, which will enhance the safety while vehicles were passing through the dust.

- Transport Department/ Traffic police shall purchase the portable weighing machines, which are available in the market to check the overloading on these routes at randomly and issue/ withdraw permits if compliance has not met.

Long-term solutions

Considering the impact of mining trucks in these areas there is a lot of dust and smoke coming out of the mining trucks which create many health hazards to the people residing nearby. Though the economic development is taking place, but at the cost of the people who are residing in these areas. Hence to avoid these losses, following measures should be taken:

1. Government shall entrust a study for the feasibility of bypass routes on these mining areas.
2. The new licenses for the mining quarries shall be avoided.
3. The old licenses for the mining quarries gradually scarped.

Noida Se Greater Noida Ko Jodne Wale Yamuna Expressway Par Hone Wali Durghatnaye Evam Unme Vriddhi Dar Ke Mukhya Karno Ki Janch Evam Inke Nivaran Ke Suzhav (Study of Accidents on Yamuna Expressway's section joining Noida and Greater Noida & Suggesting Remedial Measures)

The Yamuna Expressway Project is conceived with the idea to not only reduce the travel time between New Delhi and Agra but also to open up avenue for Industrial and urban development of the region and provide the base for convergence to tourism and other allied industries. The Government of Uttar Pradesh has been working proactively to improve the connectivity of the National Capital Region to improve tourist attraction of Taj Mahal at Agra through the new 6 Lanes (extendable to 8 lanes) Access Controlled Expressway with brand name of Yamuna Expressway. The 23.4 km long section of the Yamuna Expressway joins the Noida and Greater Noida (Fig. 142). The study stretch is 23.4 km long section of Yamuna Expressway which starts from AMITY University at Noida and ends at Pari Chowk in Greater Noida. The road is 6 lanes divided by approximately 3 m wide median and has 1.5 m paved shoulders. Road accidents are one of the most important problems being faced by modern societies. On Yamuna Expressway section joining Noida and Greater Noida, the rate of accidents is much

Fig. 142: Yamuna Expressway joining Noida and Greater Noida (within pink line)

higher than the national average. Degree of fatality is also very high.

To identify the reasons for higher accident rate and to find out probable measures to reduce the rate, a study has been carried out with the objectives:

- To obtain secondary data from concerned police stations regarding road accidents.
- To analyze the secondary data and identify black spots, black sights and dark sights with time, type and causes of accidents.
- To obtain spot speed of the vehicles at identified locations.
- To carry out physical survey on both the sides of the given stretch on Yamuna expressway.
- To carry out road users' opinion survey.
- To suggest measures to reduce accidents and fatalities

In order to access the traffic characteristics and road users' opinion following surveys were carried out.

- Spot Speed Survey
- Classified Traffic Volume Count Survey
- Pedestrian Volume Counts (Across Movement)
- Road Users Opinion Survey

From the study the following conclusions were drawn:

- Traffic volume on the road is in the range of 2000 to 2500 vehicles per hour in most of the day and it is less than 1000 vehicles per hour in night hours in each direction. This is very less than the capacity of a six lane divided highway leading to a freeway condition resulting in high speed driving.
- Major portion of the traffic volume are cars (about 65 per cent) followed by two wheelers (about 20 per cent). About 15 per cent of the vehicles (mainly cars) are running at speed more than 100 kmph and about 5 per cent of the vehicles are running at the speed more than 120 kmph. Two wheelers are second major portion of the traffic running at about 60 kmph average speed. Bus and truck are plying at speed more than 60 kmph. Speed limit of 100 kmph for small vehicles and 60

kmph for big vehicles is not followed at all.

- Road is having developed side lands with residential townships, commercial, educational and industrial complexes. This development is in fast stage and within short time, the road side lands are going to be fully developed which will generate high traffic volume with large amount of cross road movements.
- Due to commercial and educational complexes, cross road movements of pedestrians are very high and Hazard Index near AMITY University and Galgotia University is very high warranting for grade separated road crossing facilities.
- Road is designed as access controlled expressway with concept of road side land development which is contradictory. Instead, the road needs to be designed like urban arterial road with sufficient facilities for cross road movements considering local requirements.
- At present, all slow and fast moving vehicles are allowed generating heterogeneous traffic with different characteristics.
- Passenger vehicles like bus and auto are allowed to ply with local passengers and bus shelters are also provided with unplanned and unsafe gaps in the median without any warning and informatory sign and symbols.
- Rest lane, emergency parking lane, acceleration/deceleration lane are not provided.
- High rate of pedestrian fatalities is due to lack of road crossing facilities (Fig 143).

Fig. 143 Pedestrian crossing the road without any facility

- High rate of rear end collisions and fatalities is due to heterogeneous traffic in freeway with fast and slow moving vehicles plying randomly without specified lanes.

Following recommendations were made:

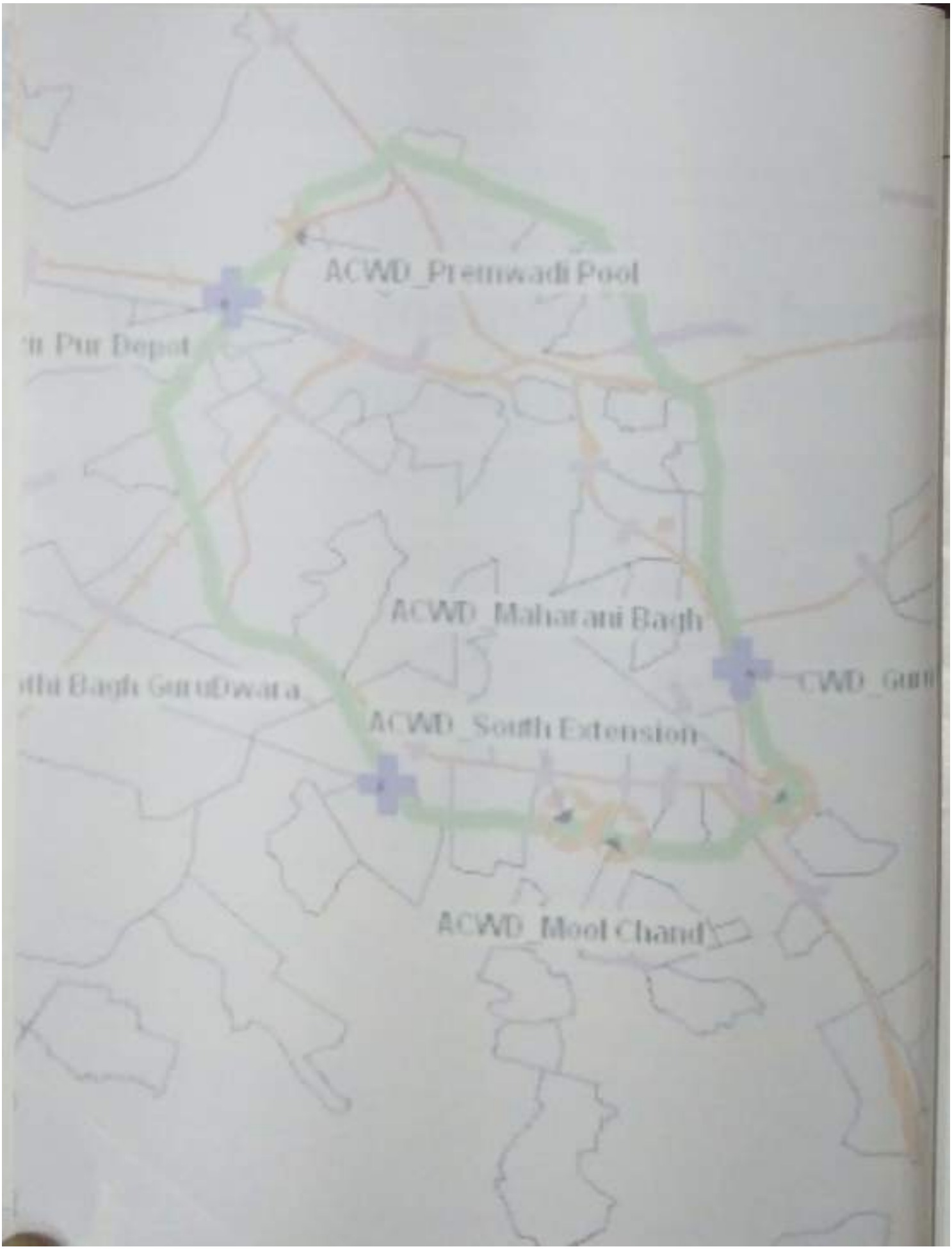
- Provide FOB near AMITY University.
- Provide FOB at Galgotia University and Pari chowk joined by an elevate walkway along the road with stairs and ramps at convenient distance.
- Carry out detailed study and decide locations for road crossing facilities with local public participation at Badauli and Safipur village.
- Provide pedestrian activated stop signals with safety measures and warning signs for road crossing at every bus shelter.
- Establish dedicated staff for traffic discipline enforcement.
- Prohibit or provide separate lane for slow moving vehicles.
- Provide emergency response system for immediate medical treatments.
- As road is functioning like urban road, redesign the road as urban arterial road with lower speed limits.

Annual Rreport 2011-12

Road Development Planning and Management

CSIR-CENTRAL ROAD RESEARCH INSTITUTE

CSIR CRRI



Development of GIS Based National Highway Information System

CRRI has developed a GIS based National Highways Information System (NHIS) under the aegis of Ministry of Road Transport and Highway, Government of India. It proposes to develop comprehensive database for about 50,000 km of National Highways (except the roads under NHDP Phase I & II) in GIS environment. It was implemented in different modules, as a part of the module on GIS applications; software has been developed in a specific GIS environment and database software/hardware. The system enables multi-task operations to enter, upload, store, analysis and retrieve the data base from desktop as well as web based system. The database has been developed using the data collected through the GPS synchronised road network survey vehicle (NSV) and also from secondary sources. The primary data for about 47,000 km national highways has been surveyed using the instrumented vehicle (NSV) and the database was created for the same. A unique km-wise NHID has been created on GIS platform and uploaded all primary as well as the secondary data in the system. The final software with the database has been submitted to the Ministry.

Data Information and Management System (Supra Institutional Project)

The objective of the sub task, under Supra Institutional Project (SIP), is to develop Data Information Management System (DIMS) to manage the data. It mainly consists of Storage Area Network (SAN), servers, computational and backup software along with other required infrastructure. Fig. 144 shows the data center developed for installation of SAN system.

The Storage Area Network (SAN) is a high-speed special-purpose network (or sub network) that interconnects different kinds of data storage devices with associated data servers on behalf of a larger network of users. SAN carries data between servers also known as host and storage devices through fibre channel switches. Fig. 145 shows the SAN storage system, the main benefit of this system is to provide efficient and effective centralised data Information system and computational facilities. The integrated GIS based NHIS with HDM-4 has been loaded in the system to enable the data management. In addition network version of VISSIM software has been loaded for wide usage.

Fig. 144 DIMS/ data center

Fig. 145 Full connectivity DIMS included of SAN storage, servers, tape library and LAN switches

Fig. 146 Monitoring of safety using OSV at Cricket Stadium Metro Station and Dust Monitoring at Central College Station, Bangalore

Evaluation Study on Use of On-Site Visualization and Dust Monitoring System for Safety Management at Construction Site of Bengaluru Metro Rail Corporation (BMRC)

Safety in construction of infrastructure is a matter of concern; therefore, there is a need for innovative engineering techniques to strengthen the safety system during construction. Development and deployment of such techniques in construction is so important that it convey the safety measures to the people involved in and around the construction site. Japan International Cooperation Agency (JICA) implemented Special Assistance project in association, Kobe University and Yamaguchi University Japan to monitor the safety of inclination of the retaining wall through OSV techniques (Fig. 146) and dust density through Mobile phone camera method (Fig. 147). OSV was implemented at underground metro station at Cricket Stadium Station and dust monitoring system at Central College Station of Bangalore Metro Station (BMRC). CSIR-CRRI in association with JICA has evaluated the system acceptability and safety awareness level among various stakeholders at construction site.

Scope of the study includes identification of parameters, to prepare of survey questionnaire on random sample basis of various stakeholders such as workers, site engineers/officers/ scientists, residents of HAL building, road users around the site and conducting survey and analysis.

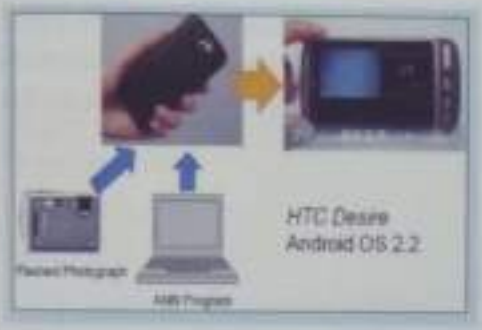


Fig. 147 Dust measuring system by Mobile Phone Camera

Data Analysis has been carried out on various issues such as understand the level safety knowledge, safety experience of workers, engineers, professionals and road users. The use of OSV monitoring and Dust monitoring method also has been examined. The analysis have been carried out in two types (i) grading the opinion in four/three grade point scale and (ii) categorization of the choice of the opinion expressed. Based on the analysis some of the recommendations proposed are as follows:

OSV Monitoring Method

- Location and Number of Sensors: The location and optimum number of sensors required are to be designed/installed based on some relation with construction area and the type of construction.
- Flash Emitting System: There should be flash emitting system when the laser colour changes from one colour to another colour (level of safe to danger: Blue to Green, Green to Yellow and Yellow to Red) to create attention the workers and safety engineers.
- Audio Interface System: The warning system should be interface with audio system which would be beneficial to workers who are busy with their work. The audio would alert all the workers in the site and also beneficial to engineers/ supervisors to manage to evocate the workers from the site.
- Wireless and Centralized Monitoring: The OSV monitoring should be wireless controlled and centralized system to monitor safety of various metro construction sites, will be very useful to large group of the workers working in various sites and as well as centralised safety measurement.

Dust Monitoring Method

Dashboard Display: There should be flash emitting system when the laser colour changes from one colour to another colour (Blue to Green, Green to Yellow and Yellow to Red) to attention the workers and safety engineers so as to take precautions.

Micro Simulation based Driving Cycle in Delhi City for Sustainable Transport System

Micro-simulation is suited to the development of driving cycle, testing and evaluation of various transportation systems. Micro-simulation can be used to develop new systems and optimise their effectiveness in simulating the driving cycle pattern. It can easily estimate the impacts such as energy consumed, amount of pollution emissions, and instantaneous driving cycle, etc.,

which are difficult to measure in the field. A study has been carried out in selected roads in Delhi to stimulate the driving cycle pattern using micro simulation models in VISSIM for a car and a motor cycle.

The important characteristics of the driving cycle obtained through observed (real world survey) and simulated values for cars are presented in Table 20.

Table 20 Comparison of Characteristics of Observed (surveyed) and Simulated Driving Cycles for a Car

Car	Observed value	Simulated values
Average speed (kmph)	19	20
Average running speed (kmph)	27	33
Average acceleration (m/s²)	1.6	0.94
Average deceleration (m/s²)	-1.7	-1.1
Cycle length (seconds)	2029	2030
Percentage time spend in		
Idling (%)	2	37
Accelerating (%)	49	16
Decelerating (%)	46	28
Cruising (%)	3	19

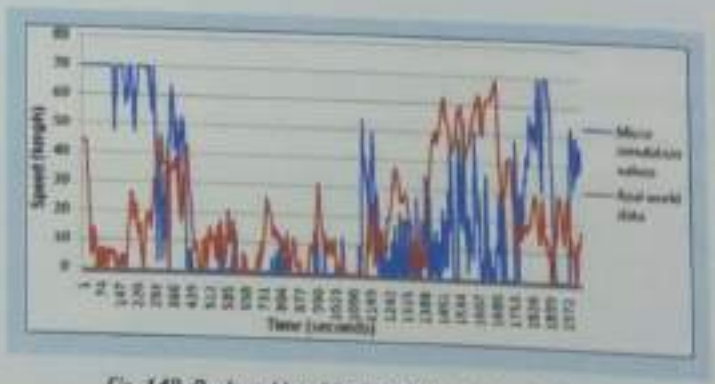


Fig. 148 Real world and Simulated Driving Cycle of a Car

Normally, the main parameter of driving cycle is average speed. Figure 148 represents the driving cycle in terms of speed for car in both with survey data and simulated values. It can be visually verified that profile of the graph match to a great extent in the two cases. This comparison shows 80 percent accuracy for average speed and running speed of both.

The vehicle speed distribution and time spent in different speed ranges at different places of the stretch have little variation except at certain section. The simulated driving cycle was found to be of same cycle length as that of the surveyed driving cycle.

Similarly, the comparison and validation of observed driving cycle and micro simulated driving cycle for a motorcycle has been carried out and the results are presented in Table 21 and Fig. 149.

Comparing the parameters of the driving cycle; average speed and average running speed, it is found that the model has 80 percent accuracy in making the virtual driving cycle for the motorcycle as well. The speed range attained at different parts of the route at different time

Table 21 Comparison of Characteristics of Observed (Surveyed) and Simulated Driving Cycle of a Motorcycle

Motorcycle	Observed values	Simulated values
Average speed (kmph)	31	25
Average running speed (kmph)	32	36
Average acceleration (m/s²)	0.67	0.75
Average deceleration (m/s²)	-0.75	-0.82
Cycle Length (seconds)	1652	1646
Percentage time spend in		
Idling (%)	4	29
Accelerating (%)	48	28
Decelerating (%)	45	33
Cruising (%)	3	9

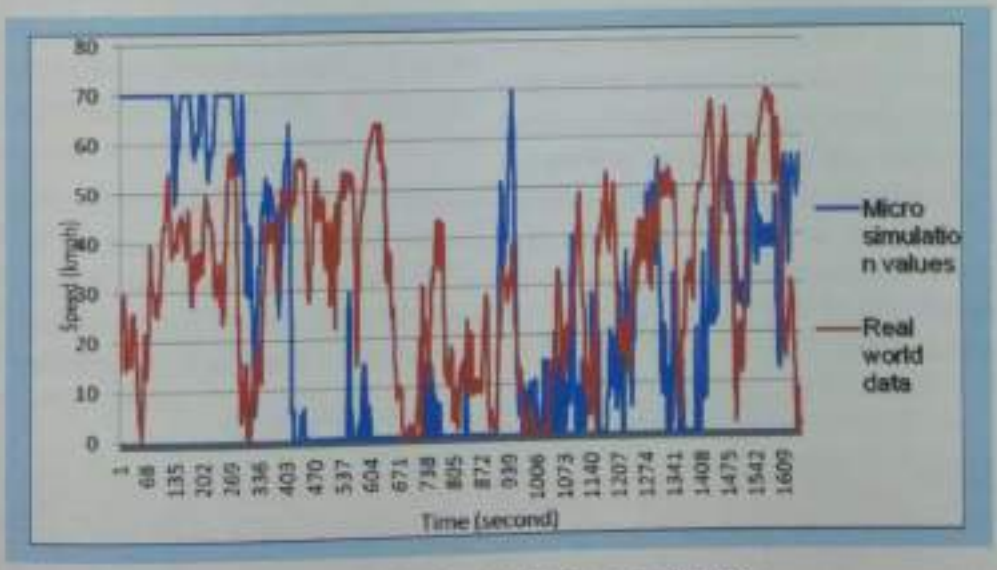


Fig.149 Real world and simulated driving cycle of a motorcycle

intervals does not differ significantly even though the percentages time spent in idling, cruising, accelerating and decelerating time differs greatly. The cycle length of both the driving cycles differs negligibly. The average acceleration and deceleration values have lesser difference than that of a car.

Development of Multimodal Level of Service (MMLoS) Measure for Urban Roads in India

Level of service (LOS) is a term used to qualitatively describe the operating conditions of a roadway based on factors such as speed,

travel time, delay, and safety. The objective of the study is to develop the "Level of Service" (LOS) measure for different modes of travel such as walk, cycle, rickshaw, car, motorised two wheelers, bus on Indian roads. Multimodal Level of Service (MMLOS) for roads has been developed by assigning higher weightages for sustainable modal trips such as walk, cycle, cycle rickshaw and public transport.

The study has been carried out on Aaligoan intersection on National Highway 2 in Delhi. The required data has been collected through Users' opinion survey along with the video data capturing road crossing details of the pedestrians. The data was collected during peak and off-peak hours for 2 hours duration for 5 days. Pedestrians were asked to rate the intersection according to their perspective towards the crossing facility existing at the intersection. Ratings were given between 0 to 10; where 0 means most difficult to cross and 10 means very easy to cross. Table 22 shows the response of pedestrians in terms of ranking given by them for crossing facility at the intersection.

Regarding the initial wait time i.e. wait time before starting to cross the road, hypothesis testing has been done. Results show that there is no significant difference in initial wait time during peak/off peak hours of working/ non-working day. However, in case of non working signal (i.e. condition like unsignalised intersection) initial wait time as well as total crossing time for females is higher compared to the males. Further, it has been observed that with the increased initial wait time, crossing time of the pedestrians' decreases specifically after initial wait time is higher than 50 seconds. Binary logit model developed for male and female show that median wait time is higher for females compared to males. As shown in Table 23, significant variables ($p < 0.05$) are number of conflicts seen with motorised and non-motorised vehicles and the time spend as wait time at median of the road.

Further, conflicts with motorised vehicles while crossing the road is higher for male pedestrians though conflicts with non-motorised vehicles are higher for females. Table 24 presents the results of binary logit model developed to capture the

Table 22 Ratings given by Pedestrians during off-peak and Peak hours

Ranking	0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
Off - peak	17.19	6.59	11.46	14.61	9.46	5.16	8.02	10.89	9.46	3.72	3.44
Peak	18.59	8.16	8.57	10.20	16.73	8.53	8.57	5.31	9.39	3.67	3.27

Table 23 Binary Logit Model Results for Gender based Road Crossing Behaviour

Variables	B	S.E.	Wald	df	Significance	Exp(B)
Conflicts_nonmotorised	.082	.032	6.714	1	.010	1.086
Conflicts_motorised	-.089	.040	5.011	1	.025	.915
Median_wait_time	.004	.002	4.232	1	.040	1.004
Constant	-.879	.093	88.598	1	.000	.415

Table 24 Binary Logit Model Results for Individual and Group Crossings

Variables	B	S.E.	Wald	df	Significance	Exp(B)
Conflicts_pedestrian	0.206	0.052	15.788	1	0	1.229
Conflicts_rickshaw	0.433	0.187	5.356	1	0.021	1.542
Conflicts_car	0.166	0.064	6.698	1	0.01	1.18
Initial_wait_time	0.015	0.002	76.357	1	0	1.015
Median_wait_time	-0.008	0.002	14.072	1	0	0.992
peak_offpeak	1.176	0.128	84.875	1	0	3.243
Constant	-1.314	0.14	87.832	1	0	0.269

differences in behaviour of an individual and group crossing.

The Table indicates that there is a significant difference in number of conflicts made with pedestrians, cycle rickshaws and cars if a pedestrian is crossing the road as an individual or in a group. Present study provides interesting information regarding individual and group crossing behaviour, gender based crossing behaviour and role of different type of conflicts i.e. conflicts with other pedestrians, non-motorised vehicles and motorised vehicle.

Travel Time Related Performance Measures for Evaluation of Sustainable Road Transportation System

In this study, an attempt has been made to investigate travel time based performance measures to evaluate sustainability transportation system. Improving travel time variability would directly improves the economic, environmental and social benefits of the system. Travel time varies mainly due to uncertainties from supply side, demand side and various external factors of the system. As reported earlier (Annual Report 2010-11), the main objective of this study is to analyze variability of performance measures under various uncertainties (from demand side factors and supply side factors) and to evaluate sustainability of road transportation system for current and future transportation system scenarios.

In this study the travel time reliability analysis was performed using VISSIM 5.30 by considering the stochastic traffic simulator. The psycho-physical driver behavior model has been selected as a tool for micro simulation modeling. Traffic volume and speed data was collected from vehicle license plate survey, speed profile survey from VBOX, the spot speed and traffic volume counts are also collected. These data was appropriately analysed to give input to the simulation model. The input parameters namely road network, hourly traffic flow, vehicular characteristics for each vehicle type and driver characteristics have been prepared to give input to develop

microscopic simulation model (Fig. 150). The developed simulation model is validated using the observed travel time data. Further the validated simulation model, estimation of travel time under different cases of uncertainties from demand side (variation of traffic flow) and supply side (variation due to lane closure for road maintenance and addition of extra lane) were carried out.

Fig. 150 Developed road network in VISSIM for study corridor (NH2 in Delhi)

Influence of demand side factors on travel time was examined through validated simulation model. The influence of traffic flow on travel time is estimated for 50 percent increasing and 50 percent decrease to the existing traffic demand. Micro simulation has been carried and estimated travel time obtained by the VISSIM was presented as a cumulative travel time distribution in Fig. 151. It represents the cumulative distribution of travel time under the influence of traffic flow variation. From the figure it can be identified steep gradient of cumulative distribution for the case of 50 percent increment of traffic demand. Further travel time reliability indices such as planning time (PT) and planning time index (PTI) have been estimated for the two cases for various time periods and presented at Table 25.The average PTI for peak hour is about 5.27, this indicates that if 50 percent traffic demand situation arises road users should plan about 5.3 times of travel time as against free flow travel time. If the demand reduced to 50 percent of the flow, the PTI is about 2.2. From the table it can be noticed that higher the PTI value around 7.0 was observed period between 9.45 to 10.00am during the peak hour period. Whereas in the case of 50 percent less demand higher PTI value is 2.4 for the period between 9:00 am to 9:15 am.

The supply variation modeling has been carried out by considering road incident e.g. blockage of a lane. This is defined in the VISSIM as an event that effect or impeded the normal traffic flow at identified location due to this certain length of the section. Due to this incident out of three lane one lane may affect the entire length of approx.200mts. The behavior of the incident has been simulated for morning peak hour and the travel time estimated for the same has been presented in the Fig. 152. From the figure it can be identified steep gradient of cumulative distribution for this case. The average PTI for peak hour is about 5.75, this indicates that if the one lane is blocked for 30 minutes during the peak hour, road users should plan about 6 times of travel time as against free flow travel time. Highest PTI value around 6.4 was observed .

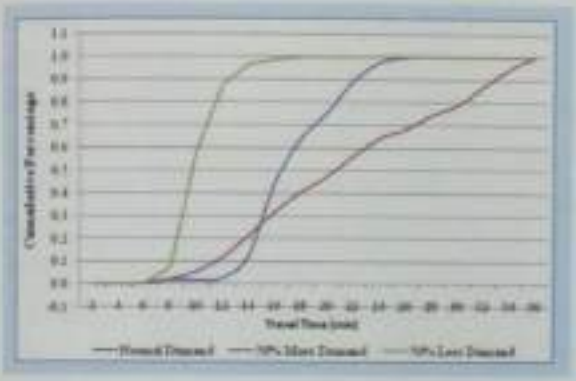


Fig. 151 Cumulative travel time distribution under uncertainties from demand side variation

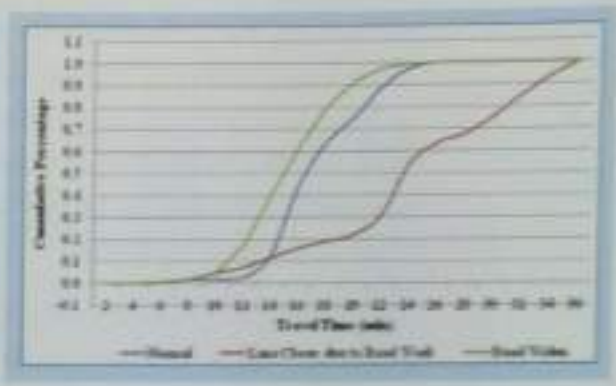


Fig. 152 Cumulative travel time distribution under uncertainties from supply side variation

Table 25 Variance of Travel Time Reliability under the influence of Demand side and Supply Side Variation

	Variance of Reliability measures Due to Demand Side Variation				Variance of Reliability Measures Due to Supply Side Variation			
Time Period	50% Demand Increases		50% Demand Reduces		Lane closer due Road Work		Provision of One extra lane	
	PT (90%)	PTI	PT (90%)	PTI	PT (90%)	PTI	PT (90%)	PTI
8:45-9:00	16	2.7	12	2.0	19	3.2	15	2.5
9:00-9:15	22	3.7	14	2.4	29	4.8	15	2.6
9:15-9:30	29	4.8	13	2.1	36	6.1	17	2.8
9:30-9:45	34	5.6	12	2.0	38	6.4	21	3.6
9:45-10:00	42	7.0	13	2.1	34	5.7	22	3.7
10:00-10:15	40	6.7	12	1.9	28	4.7	19	3.2

Evaluation of Operational Efficiency of Highway Network Using Travel Time Reliability Measures

As reported earlier (Annual Report 2010-11), The main objective of this study is to analyze the stochastic travel time distribution under uncertain factors of traffic volume (demand side factor) and pedestrians crossing at un-signalized location which impedement to traffic flow. Modelling travel time variation under these uncertainties, a stochastic simulation modelling technique has been considered for an evaluation of the effect of these factors on travel time variation.

The travel time variation on each link changes with the flow and therefore the travel time reliability on several of network paths changes as the link flows changes. A stable condition is reached only when no traveller can improve his travel time reliability by unilaterally changes

routes. This is the characterization of the reliability user equilibrium. For each O-D pair, at user RUE, the travel time on all used paths is equal, and (also) less than or equal to the travel time reliability that would be experienced by a single vehicle on any unused path.

The standard Method of Successive Average (MSA) algorithm is modified for solving RUE based traffic assignment problem. The algorithm, when applied to the solution of the Reliability based traffic assignment problem is summarized as follows:

Step 0 : Initialization and generation of a set of link flows (Xa1).

Step 1 : Update the link travel time (Tan) using the derived link flows.

Step 2 : Update the link travel time reliability (Ran) with the link flows.

Step 3 : Direction finding and all-or-nothing assignment based on the current set of travel time reliability, {Ran }. This yields an auxiliary link flow pattern {Yan}.

Step 4 : Move and find the new flow pattern

Step 5 : Check the convergence criterion.

In this study assumed that the link travel time follows Weibull distribution and estimated link travel time reliability. With this initial travel time reliability, all-or-nothing traffic assignment is done. It gives the set of link flows, using which the link travel time and its reliability is estimated. Auxiliary link flow pattern is generated with the current reliability. The new flow pattern is then found by setting Xan+1 = Xan + (1/n) (Yan - Xan). Numbers of iterations were considered as a convergence criteria. This RUE algorithm implemented to simple urban road network. The results and discussion of reliability based traffic assignment is compared with traditional User Equilibrium assignment techniques (Sheffi,Y 1985) in the subsequent sections. To solve the entire procedure a set of programme was developed in MATLAB environment.

Application of RUE algorithm has been carried out. Simple two link road network is considered to illustrate the reliability based traffic assignment technique. For this an urban corridor on National Highway-2 of Delhi-Mathura road and an alternative path connecting the origin (CRRI Signal) and destination (Ashram Intersection) has been considered. Speed and travel time related data is collected using Probe vehicle technique. Traffic volume data from the previous studies were considered. The schematic representation of the study area is shown in Fig. 153.

Fig. 153 Schematic representation of the study area

The network has two links and one O-D pair. For this study purpose considered the link itself is the path and peak hour (9AM to 10 AM) traffic demand of typical day 10,000 vehicles per hour was considered. The results obtained after 50 iterations both in user equilibrium and reliability based user equilibrium are shown in the Fig. 154. A comparison of both the models is made as

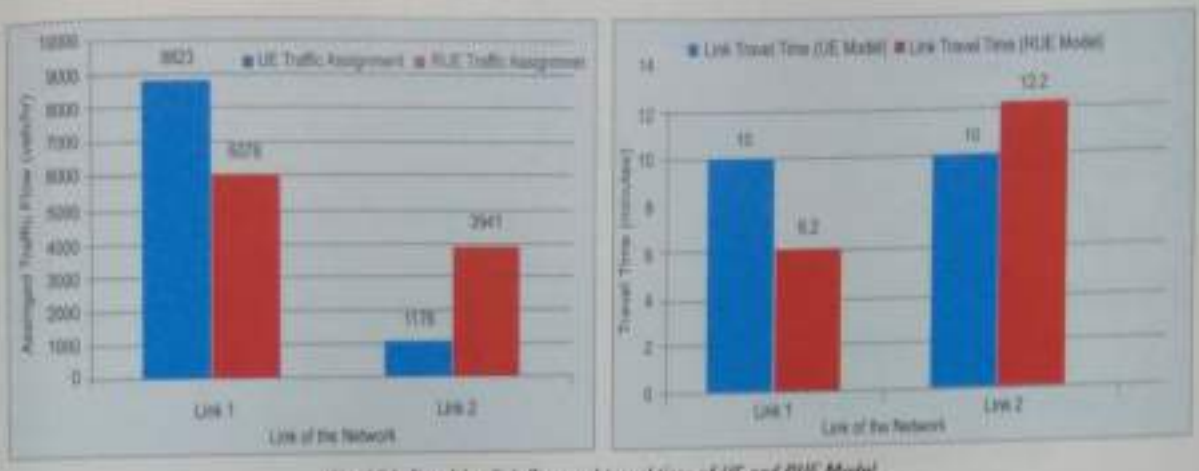


Fig. 154 Resulting link flow and travel time of UE and RUE Model

the basis of the flow pattern at the end of iterations.

From the Figure, it can be observed that assigned traffic flow on Link 1 obtained by UE model is much higher than Link 2 for equal travel time of 10 minutes on each link. The assigned traffic flow by UE model may holds good during uncongested situation. During congested and uncertain traffic conditions road users may use alternative path (Link 2). In this situation instead of travel time, travel time reliability based assignment models may be better to assign traffic flow for real situations. Results from RUE models observed that assigned traffic flow on Link 1 is about 6078 Veh/hr and on Link 2 is about 3941 Vh/hr. This flow is assigned by considering equal travel time reliability on each link and the corresponding travel time on link 1 is about 6 minutes and Link 2 is about 12 minutes. Based on the results it may conclude that analysis of traffic assignment under uncertain conditions reliability based models is better than simple UE model.

When traffic is uncongested motorists choose the path on basis of travel time. But in traffic congestion, motorists might choose the path considering travel time variation due to uncertain from the system. Further, study is required to implement on medium size road network

Accessibility and Mobility Impact on Neighbourhoods due to Expressways/High Speed Corridor

The study which consists of two different sections on National Highway No.8; one with 4 lane wide roads (at village Vav) and other at 6 lane wide road (at village Pipodara) in Surat District, Gujarat, India. The study addresses to certain key issues for the supply of desirable pedestrian crossing services in a village to which people seek access to other side of the highway. Some of the preliminary analysis has been reported earlier, in addition to that, further analysis has been carried out to estimate the neighbourhood accessibility

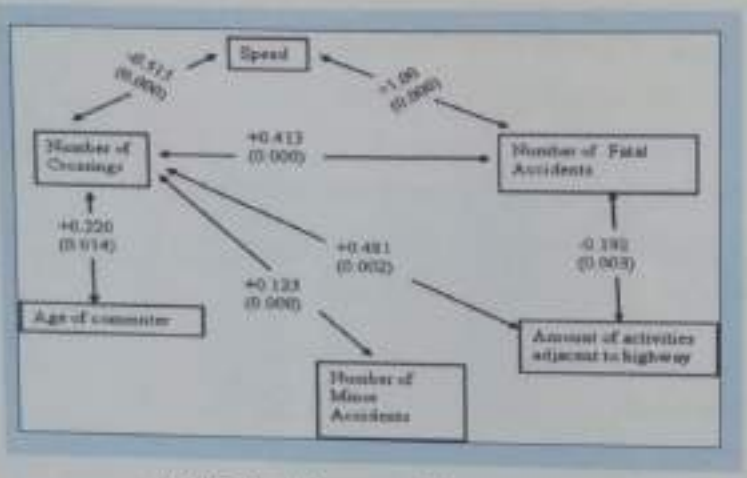


Fig.155: Correlation among different variables

Index. The parameters selected for the analysis are based on the inter-correlation values of various parameters and presented in Fig. 155.

The neighbourhood accessibility index (NAI) has been developed to compare the pedestrian accessibility to the area on the other side of the highway. This index is based on the stated data collected through household survey and pedestrians' survey, traffic volume, speed data and accident data. Based on collected information, an accessibility index has been developed which is based on random utility theory. This measures the accessibility of the area on the other side of the National highway. The utility-based measure is based on an individual's perceived utility for different travel choices. Figure 156 presents the relationship between pedestrian accessibility vs vehicular mobility

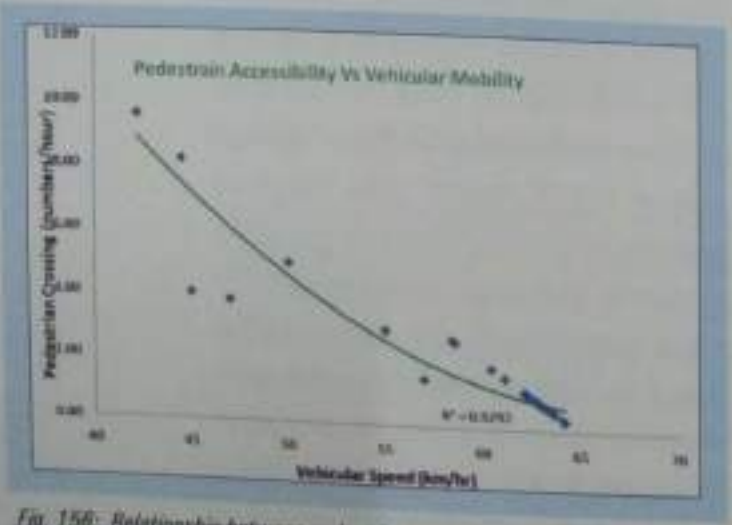


Fig. 156: Relationship between pedestrian accessibility vs vehicular mobility

An increased mobility along the highway section reduces the pedestrians' accessibility. After a peak point, accessibility again starts increasing but with the help of motorised vehicles i.e. an inefficient pedestrian accessibility reduces the pedestrian accessibility but leads to an increase of vehicular accessibility (for crossing the highway) which is basically the mobility. This peak point is of very much importance as this makes a shift from pedestrians' accessibility to motorised accessibility. Therefore, while planning for any infrastructure, it is better to provide good pedestrian facilities to control the motorised mobility for the local access. Increase in motorised local accessibility may create conflict with the mobility on highway thereby increasing chances of risk of safety for the highway users. Therefore, it has been recommended that road passing through habituated area should be treated as an arterial road rather than as a highway if amount of adjacent activities is high. However, if there is very less crossing activities on a stretch of road then that can be treated as a highway with the provision of suitable crossing facilities and/or service

lanes to maintain and improve the accessibility towards neighbourhood area.

Application of Geographical Information System (GIS) in Traffic Congestion Management

The major objective of the study is to develop a methodology for measurement of traffic congestion, quantify the magnitude of the congestion and suggest the measures to mitigate the traffic congestion. This study describes systematic bottleneck identification and analysis for selected urban arterials (Inner Ring Road, Outer Ring Road and one CBD Arterial) of New Delhi city. A detailed analyses of vehicles speed profiles and congestion delays for traffic during peak and off-peak periods is performed based on conducted field surveys. Free speed surveys are conducted at various locations on Inner Ring Road to find out the free speed on the corridor. The collected data is analyzed using Trazer software to find out various traffic characteristics in free speed. The locations of free speed and a screen shot of Trazer software is given in Fig. 157.

Fig. 157 Free speed locations and software analysis

The GPS data collected by probe vehicle are used to identify the accurate location and duration of bottlenecks. A computer programme was developed in Visual Basic Language to identify the bottlenecks. The programme reads the GPS speed data and identifies speed gradient between a pair of GPS data sets. The parameter used to identify the bottleneck is speed drop, because speed changes much more sharply than any other parameter when a bottleneck is activated. It also provides a more sensitive indicator. A micro simulation methodology is developed for mitigation of traffic congestion. VISSIM software is used for formulation of congestion alternatives. Figure 158 shows the Simulation inputs prepared for VISSIM model development

Various alternatives are developed for congestion mitigation. All the alternatives are evaluated using simulation models.

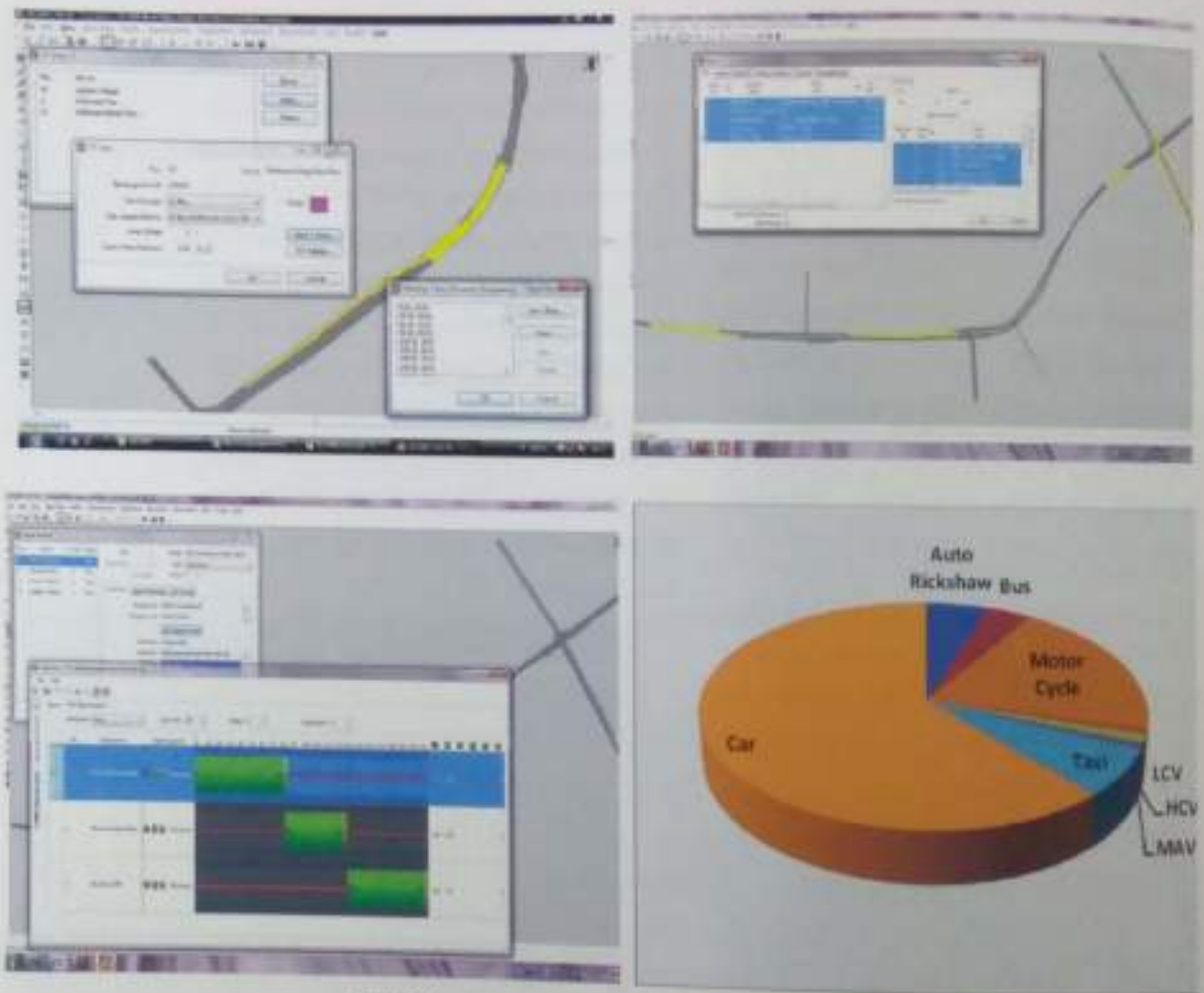


Fig. 158 Imputes preparations for micro simulation models

Modelling of Driving Cycle for Road Network Development Plan in Urban Area and Suburban Area – A Case Study in NCR

In continuation of the work reported earlier, driving cycle data were collected using onboard GPS based Performance Box in Tata Indica Vehicle having diesel engine sizes of 1400cc. Total 609 trips were made during both peak and off peak hours of weekday and week off days in the selected roads of study area. In addition, traffic data, road width and land uses characteristic were collected to investigate the factors associated with different driving condition. A candidate driving cycle was derived for the Delhi, Gurgaon and Ghaziabad, the results of other driving cycles were compared among these cities. Results showing average driving cycle length of Delhi is normally higher than Gurgaon and Ghaziabad city. Normal driving cycle length of city was 525 seconds, 1600 second and 2500 seconds for Ghaziabad.

Gurgaon and Delhi respectively. However, the driving cycle length in week off days were smaller than week days. The average cycle length/trip length was about 9 km for Delhi and Gurgaon, whereas, it is 4.5 km for Ghaziabad city. For Delhi and Gurgaon cities, average cycle speed was lesser than Ghaziabad, whereas, in week off days there is highest cycle speed in Gurgaon, the reason may be that there are many interregional traffic coming for business purpose. In the week off days, speed were quite high and has been observed as 65 km/hr. In weekday speeds were about 21km/hr for both Gurgaon and Delhi where as it is higher for Ghaziabad about 27km/h. Average running speed were higher for week-off days compared to average speed doing week days. Their speeds were about 10 to 20 percent higher. Specially, average running speed was much higher in case of Delhi city as compared to others city contribution. However, overall all cities have higher average running speed approximately about 27 to 37 km in range per hour. Typical comparison of driving cycle is shown in Figs. 159 and 160.

Some of the finding are as follows:

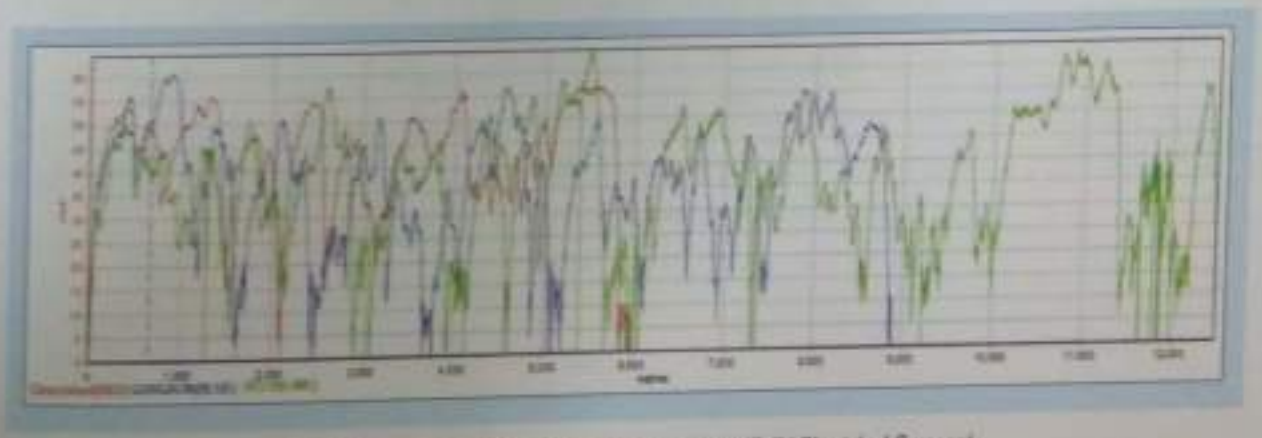


Fig. 159 Comparison of driving cycle for weekdays (Delhi Ghaziabad Gurgaon)

Fig.160 Comparison of driving cycle for week off (Delhi Ghaziabad Gurgaon)

- In Gurgaon city the average congestion time was 4.9 minute where for Delhi it is found to be 2.9 minute and for Ghaziabad it was lowest about 0.2 minutes.
- The rate of average acceleration and deceleration were found to be higher for Delhi city. This shows that Delhi driving is aggressive in spite of heavy congestion. However the same type vehicles were driven in both cities.
- Driving cycle length of Delhi and Gurgaon is higher than Ghaziabad for both week days and week off days. However for week off days, Gurgaon driving cycle length is very near to Delhi driving cycle length. Weekdays Delhi has got highest speed up to 70 km/hr where as in week off highest speed of 70km/hr was observed for Gurgaon city.

Effect of Highway Bypass on Traffic and Habitants

The main objectives of the study is to identify the performance parameters of growth and extent of ribbon sprawl along the National Highway, to understand the traffic characteristics, accessibility parameters and the changes along the corridor due to bypass road with temporal data. This study will bring out the parameters responsible for growth of sprawl taking place over a period of time. Reconnaissance survey has been carried out on the study corridor Further work is in progress selected near the Katholi bye-pass of National Highway. Further work is in progress.

Annual Rreport 2011-12

HRD & Project Management

Planning, Monitoring & Evaluation
Technology Management & Business Development
Information, Liaison & Training



CSIR-CENTRAL ROAD RESEARCH INSTITUTE

CSIR CRRI

R&D management is the main activity of this Division which inter-alia covers Planning, Monitoring & Evaluation of R&D projects, issues concerning Intellectual Property and Business Development, attending to technical queries and technical performance audits and assistance to Director, Management Council (MC) and Research Council (RC) on the project related matters.

Major activities carried out during 2011–2012 are as follows:

Planning Activities

Annual Plan 2012-13

The Annual Plan 2012-13 documents for CRRI contained information related to research work plan to be carried out during the year 2012-13 has been prepared. The financial requirements for these projects were also mentioned.

CRRI Budget

The financial requirements are defined on Plan and Non-Plan basis. Plan items include all research components whereas Non-Plan items cover infrastructural support. The plan requirement of the Institute for the year 2011-12 (Budget Estimate) has been prepared.

Scrutiny & Registration of Project Proposals

Registration of all externally funded projects and allotment of specific identity in terms of a Project No. is effected at PME, soon after the money for the project is received along with In-Principle approval. Registration and Technical scrutiny of in-house R&D projects is also carried out.

Development and Regular Maintenance of Project Database

A Project Database has been developed which is regularly updated incorporating addition of new projects, and modifications during their implementation stage and finally during their completion. The database includes project title, classification and technical & financial details which help in tracking the technical and financial progress of the projects. The division also maintains the cash inflow of all the projects.

Monitoring Activities

Research Utilisation Data (RUD)

Reporting on the performance and the status of various projects was carried out through preparation of Research Utilisation Data (RUD) which contains information related to various projects handled by the Institute.

Quarterly Performance Report (QPR)

Quarterly Performance Report (QPR) contains information about the performance of the Institute on various parameters on quarterly basis. These reports are sent to CSIR for their perusal on quarterly basis. These reports also help the Institute in reviewing its own performance as a monitoring tool.

The Division also calls for progress report of all the on-going projects in the Institute for processing. This exercise is meant to monitor and ascertain the status of each of the projects with respect to adherence to time schedule and other milestones. Any deviation is intimated to the respective project leader and remedial measures are taken to put the project on course. Completed projects, as reported by the respective Project Leaders are processed for closure.

Projects Monitoring

Externally Funded Projects

Externally funded projects were regularly monitored particularly for their adherence to time schedule, amount dues, if any, documentation, closure etc. through divisional review.

In-house Projects

Project Identification and Monitoring Committee monitors the progress of the In-house projects. The committee also reviews the progress of the In-house projects periodically. The new projects are taken up if approved by the Committee after the presentation made by the Project Leader. Similarly at the time of completion of a project, a presentation is made by the Project Leader to incorporate suggestions if any made by the committee members.

External Cash Flow (ECF)

The Institute undertakes projects sponsored by various external agencies such as Ministry of Road Transport & Highways (MORT&H), National Highways Authority of India (NHAI), Department of Science and Technology (DST), etc. The details of External Cash Flow i.e., money received from these agencies to carry out specified task was regularly recorded and monitored vis-à-vis target established by the Institute.

Expenditure Monitoring

Efforts were made to keep track on the expenditure vis-à-vis budgeting allocations/ requirements on the monthly basis so that performance/ working of the Institute could be made more effective.

Evaluation Activities

Activities related to Service Tax Audit and CAG Performance Audit

During 2011-12, both Technical Audit and performance audit were done by CAG for the 10th Five Year Plan Network Project (COR-13). Service Tax Audit was also carried out by Service Tax authorities. The division coordinated these audits for successful completion in time.

CRRI Outstanding Performance Award Scheme

The Institute, in order to appreciate efforts made by a division and also to promote healthy competition amongst various divisions to do better each time, initiated the practice of giving awards in various categories. The activities related

to this scheme have been handled by the division.

RC Secretariat

During the Year, the division has provided various information/ data for Agenda, Information for Action taken Report, Information for Director's Presentation and other related logistics for conducting of meeting.

Miscellaneous

Projects' Summary for Management Council/Research Council

Responsible for preparing the up-to-date Projects' Summary and providing the information on projects that are to be ratified by the Management Council. It also provides the necessary project related information for the Research Council to decide the future programmes of R&D for the Institute.

Management of various Project Proformae

The division designs, maintains, manages and modifies the proformae pertaining to various project related activities as per the need arises from time to time.

Technical Queries from within/or outside CRRI and CSIR

The division handles technical queries pertaining to various projects being handled by the various R&D Divisions of the Institute. These queries are related to CSIR guidelines, technical progress of projects etc. Also interact with various divisions of CSIR particularly PPD regarding the preparation of Annual Plans, Five Year Plans of the Institute, Management of Plan Projects, ECF queries etc.

Service Tax Activity

On receipt of amounts under externally funded projects, Service Tax is paid to the Government. The division regularly prepares the statement on receipts and ensures the payment of Service Tax by accounts section on monthly basis. PME also prepares and files the half yearly returns of Service Tax.

Parliament Queries

The division also handles parliament questions which are technical in nature. During the year, replies to about Thirty one (31) Parliament questions were prepared after collecting, compiling and collating information from various divisions of the Institute.

Considering the need of effective management of technology portfolio of the Institute, TMBD Cell was constituted in 2009-10 and later made a Division in 2011-12. The objectives of the TMBD Division are to:

- document new and emerging technologies that are either developed or being developed by the Institute,
- projecting the good work done by the Institute by implementing the Technology Management Plans,
- integrating technology management aspects including IPR management with R&D and business development,
- safeguarding new intellectual property generated by the Institute and exploiting available IPR portfolio,
- creating high performing network of R&D professionals and organisations,
- ascertaining products development,
- reaching out for the benefit of the North Eastern Region by extending appropriate technological solutions,
- entering into productive partnership through MoU and Agreements,
- enhancing international cooperation,
- interacting with user agencies for identifying challenging technical problems for progressive R&D, and
- ERP implementation.

Major activities carried out during the year are as follows:

I. Technology Management Activities

Technology Management Plans

TECH-D initiative was launched to discover and project technologies out of the work both carried out and being carried out by the Institute. For each technology, a Technology Management Action Plan (TMAP) is proposed for systematic handling of a technological work. Under the initiative, around eight TMAPs were prepared which are under different stages of implementation.

Technology Transfer

A technology on Cold-Mix was transferred to M/s Bitchem Asphalt Ltd. for North-Eastern states on exclusive license basis.

II. Business Development Activities

Interaction for Business Development

Interaction with various agencies was made to communicate the good work done by the Institute and also to trace newer and challenging technical problems for further R&D activities. It made reaching out to our stakeholders and associating them with our activities.

MoU/Agreements Processed

Collaboration is the buzzword in today's globalisation scenario wherein the technology is changing very fast. Only through coming together and harnessing each other capabilities, we can develop newer products and technologies. A well-documented MoU/Agreement is the key for successful collaboration wherein all parties/ stakeholders are in the win-win situation. TMBD Cell processes such documents.

Road Transport R&D Network

At various forums, a need was felt to develop a network of R&D organisations and professionals

A meeting of R&D organisations during IRC Annual Session on Nov. 13, 2010 at Nagpur was also held. It was decided that the network shall be run and managed through a web portal with the following objectives:

- To establish the network of all R&D professionals in the roads and transportation sector
- To establish knowledge sharing mechanism
- To plan future course of action/studies for R&D purposes in the sector
- To derive output to convert into outcome as feeding mechanism for the professionals particularly to different IRC Committees
- To get the information for GRRRI every year
- To be a forum for technology management especially technology commercialization
- To disseminate technical knowledge and R&D findings
- To be a happening and one-stop site for all R&D professionals of the sector

The website has been developed and can be accessed at http://roadresearch.net.

Road Transport R&D Network

Android Application on Google Play

CSIR-CRRI has published an Android application on Google Play. It has probably become the first public funded agency in India to have an Android application. The application serves as a micro-website for the Institute.

III. Intellectual Property Management Related Activities

For any R&D organisation, the most important asset next to human resource is its IPR portfolio. TMBD works to safeguard the intellectual property generated by the Institute through IPMD, CSIR. The related activities involve from sensitising R&D staff to take effective measures to safeguard their intellectual property to processing relevant documents and liaison with IPMD.

IV. North Eastern Region Related Activities

There has been a strong felt need to support North-Eastern Region of our country through appropriate technologies for its overall growth. The region on one hand demands appropriate technological solutions but on other hand provides us with challenging technical problems that need to be solved and demonstrated. CRRI has carried out several studies for the region but there is still significant scope to communicate the available technological solutions and also to arrive at effective solutions for present challenging problems.

Accordingly CRRI interacted with NEIST, Jorhat so that it has a window to communicate with the prospective clients in NE Region. NEIST will work as a CRRI NODE in NER to interact with different road agencies of the region and will be the face of CRRI in NE Region.

V. Course on Project Management for Roads and Transport Sector

CSIR-CRRI has entered into an agreement with Project Management Certifiction Institute (PMCI), and Centre for Excellence in Project Management (CEPM) to organise course on Project Management for roads and transport sector. An online course as Certificate in Project Management with specialisation in Roads and Transportation (CIPM-RT) has been launched and can be accessed at http://www.cepm-csir-crri.org.

VI. ERP Implementation

CSIR has taken a very ambitious project to implement a comprehensive Enterprise Resource Planning (ERP) system. The ERP system is an organizational transformation initiative undertaken by CSIR to focus on building electronic workplaces, nurturing and grooming talent and re-engineering processes for augmented service delivery. The role of TMBD Division is to effectively implement it in CSIR-CRRI.

Regular Training Programme

Imparting training to the engineers of the user agencies is an integral part of the research programme of the Institute. During the year, following refresher courses/training programmes for in-service engineers of the user organizations related to roads and road transportation in the Govt. Public & Private Sectors were organized. Through these programmes, the Institute imparted training to the junior, middle and senior level engineers of the user organizations and acquainted them with the latest research based information on various aspects of road and road transportation.

Special Training Programme

Besides the regular training programmes, the Institute conducted customer oriented programmes to meet the specific training requirements of the user agencies. During the year, the Institute conducted the following customer oriented training programmes:

Design, Construction and Maintenance of Flexible and Rigid Pavement for Rural Roads under PMGSY Scheme

On the request of Rural Engineering Department, Lucknow, a Customized Training Programme was

S. No.	Title of the Course	Duration with Dates
A.	**Pavement Engineering &Materials**	
	• Design, Construction and Maintenance of Flexible Pavements	Sept. 5-8, 2011
	• Rigid Pavements : Design, Construction and Quality Control Aspects	Nov. 14-18, 2011
	• Pavement Evaluation Techniques and their Applications for Maintenance and Rehabilitation	Dec. 12-16, 2011
B.	**Geotechnical Engineering**	
	• Geo-spatial Technology (GIS, GPS, RS etc.) for Roads and Transportation	Feb. 06-08, 2012
C.	**Bridges and Structures**	
	• Bridge Diagnostics, Performance Evaluation and Rehabilitation	May 20-24, 2011
D.	**Traffic & Transportation Planning**	
	• Vibration and Noise Measurement and Analysis	June 06-09, 2011
	• Traffic Engineering and Transportation System Management	July 25-29, 2011
	• Driver Diagnostics & Performance Evaluation and Training	Aug. 1-3, 2011
	• Road Safety Audit	Aug. 8-11, 2011
	• Environmental Impact Assessment (EIA) and Environmental Clearance Process for Road & Highway Project	Dec. 19-21, 2011

organised for the Assistant Engineers, Executive Engineers and Superintending Engineers of RED UP from May 18 – 23, 2011.

Pavement Evaluation Techniques and their Applications for Maintenance and Rehabilitation

A Customized Training Programme was organised for the Engineers of Road Construction Department, Patna from June 30 to July 2, 2011 at Patna.

Road Safety Audit including EIA

A Customized Training Programme on "Road Safety Audit including EIA" at Staff Training College, Gandhinagar was organised from July 18-22, 2011.

Road Safety Audit for NHAI / RITES

The Institute organized a Training-cum-Workshop on "Road Safety Audit" for the Engineers of NHAI /RITES at Jaipur from August 17-20, 2011.

Road Design Standards for Flood Affected Areas

On the request of Road Construction Department, Patna, a customized training programme was organized for the engineers of RCD Patna during September 26-29, 2011 at Patna.

International Course on Dissemination of Highway Development and Management (HDM-4)

A Special Training Programme on HDM-4 was organised from October 10-21, 2011 which was attended by the participants from India and Afghanisthan.

Environmental Pollution and Air Quality Monitoring System for Ministry of Environment, Govt. of IRAQ

A tailor made Training Programme on "Environmental Pollution and Air Quality Monitoring System" was organised for the officials of Ministry of Environment, Govt. of IRAQ from October 16-30, 2011 at CRRI.

Design, Construction and Maintenance of Flexible Pavements for RCD, Bihar

At the request of Road Construction Department, a customized Training Programme on "Design, Construction and Maintenance of Flexible Pavements" was organised at Patna for Engineers of RCD, Bihar from December 7-10, 2011.

Highway Development & Management (HDM-4) for Engineers of RCD, Bihar

A customized Training Programme on "HDM-4" was organised for Engineers of RCD, Bihar at Patna from December 19-24, 2011.

Project Preparation, SBD, Quality Assurance and Maintenance of Rural Roads

On the request of National Rural Roads Development Agencies (NRRDA), CSIR-CRRI organized training programme for the field engineers involved in PMGSY of various state PWDs in 3 batches as per details given below:

i) January 03-07, 2012

ii) January 09-13, 2012

iii) February 06-10, 2012

Material Testing, Laboratory and Quality Control Aspects

On the request of RCD Patna, the Institute organized a customized training programme on 'Material Testing, Laboratory and Quality Control Aspects', for the Assistant Research Officers and Research Assistants from Jan. 30 - Feb. 02, 2012.

Human Resource Development Programme

Human resource development is a philosophy of management and is purported to upgrade the capabilities and professional skills of the personnel working in an organization to match the changing work demands. To enhance the professional capabilities of scientists and scientific staff for undertaking the R&D work in frontline areas of highway engineering and with the urge to develop technologies which have competitive edge and marketable strength, CRRI has been devoted in human resources development. Realizing the need for skill development and capacity building of the human resources, training programmes were selected. Staff members received specialized training in the areas of their expertise to cope up with the challenging assignments. The details of those who attended various training programme and the specialized areas of training are given on page 193-194.

Publications

CRRI Annual Report for the Year 2010-2011

The report is the profile of achievements of the Institute during the year 2010-2011. It also serves as a medium to acquaint the user agencies, clients and the other related organizations in the roads and road transportation research with R&D and other concomitant activities of the Institute. Progress reports of the R&D work and other related activities during the year from the various divisions/sections of the Institute was collected, compiled, edited and brought out as Institute's Annual Report for the year 2010-2011.

General Report on Road Research Work Done in India during 2010-2011

The progress reports on R&D and consultancy projects involving innovative ideas at the highway engineering, research and development and academic institutions from all over the country were received from the Indian Roads Congress for preparation and compilation of the General Report on Road Research work done in India during the year 2010-2011. Based on the input received from organizations including CRRI, the report was compiled in six sections, namely, Highway Planning, Management, Performance Evaluation and Instrumentation; Pavement Engineering and Paving Materials; Geotechnical Engineering; Bridge Engineering; Traffic and Transportation and Research work done in Academic Institutions related to Thesis Work. The suggestions received from the scientists of the various R&D areas were incorporated and the report was finally compiled and edited by CRRI as the General Report on Road Research work done in India which was published as Highway Research Record Number 37 by Indian Roads Congress. The report was presented by CRRI in the 72nd Annual Session of Indian Roads Congress at Lucknow from Nov. 3-6, 2011.

CRRI Newsletter

During the year, three issues of CRRI Newsletter were brought out. The Newsletter contains information related to R&D activities and other general information related to the Institute.

Other Activities

Mailing of Publications

The Institute's R&D publications such as CRRI Annual Report and CRRI Newsletter were sent to highway professionals, engineering & academic organizations in the country and abroad. The publications are meant to disseminate R&D based information to the highway engineering profession.

Technical Queries

Technical queries concerning the R&D activities and technical know-how of the Institute were attended. Information on various technologies developed by the Institute was sent to a number of organizations dealing with databases, technology transfer and consultancy assignments pertaining to roads and road transportation.

Press Publicity

Various local presses approached CRRI for information on research & developments and studies carried out by the Institute on roads, flyovers, bridges etc. The needed information was provided to the press for the purpose of publicity.

Press clippings pertaining to road and road transport in particular and Science and Technology in general were culled out from various National dailies and were brought to the notice of the Director and circulated to staff members for information, if needed. These were also compiled in the form of document.

Publicity through CRRI Advertisement

To popularise the Institute's past R&D achievements and present R&D programmes, capabilities, facilities and expertise, the Institute issued various advertisements at various forums. One such forum was the scientific documents brought out by various organizations on different occasions. The Institute got published its various advertisements in the documents brought out by various organizations on different occasions.

Publication of Research Outputs

Research outputs i.e. Research papers emanating from the R&D work were processed for publication in various National & International Journals/ Conferences through internal review system. Cases pertaining to deputation of CRRI Scientists to attend various Conference/ Symposia were processed and attended.

ISTAG Activities

The scientists of the Institute were deputed abroad under various collaborative, exchange and bilateral programme of CSIR to participate in various conferences/symposia/seminar/study programme and to attend advanced equipment training.

Exhibitions

(a) Intertraffic India Exibition 2011

CRRI participated in Intertraffic India Exhibition 2011 organised by International Road Federation – India Chapter at New Delhi during Oct. 3-5, 2011.

(b) 72nd Annual Session of the Indian Roads Congress and Technical Exhibition

The Institute actively participated in the 72nd Annual Session of the Indian Roads Congress organized at Lucknow from Nov. 3-6, 2011. A Technical Exhibition with special emphasis on Highway Engineering, Bridge Engineering, Traffic and Transportation planning, Road Safety and Environment was displayed, which included Charts and Models and showcased the capability and expertise of CRRI and technologies developed by the Institute.

(C) 2nd African Road Safety Conference cum-Exhibition

CRRI participated in the technical exhibition organised during the 2nd African Road Safety Conference from November 9-11, 2011 at Addis Ababa, Ethiopia. A pavilion showcasing R&D achievements & capabilities of CRRI was setup in the exhibition.

Technology Transfer and Business Development

The division is actively engaged in technology transfer and marketing of Institute's knowledge base through active coordination of promotional activities and professional channels. Scrutinizing proposals of contract research and consultancy assignments of externally funded project as a active member of project scrutiny committee

Visitors

Visits of distinguished professionals and delegates from various organizations related to road transportation from India and abroad to CRRI were organized during the year.

Linkages with Professional Bodies

The Institute is represented as the Institutional Member on the various technical, executive and administrative committees and groups of various National and Foreign Organizations. These organizations maintain their databases including R&D activities, Organizational Heads, etc. of the Member Institutions and regularly seek the updated information. The updated information on CRRI was provided to various organizations and the annual subscriptions were paid to continue the membership. The Institutional membership of the Institute is given on page 211.

Inaugural Session of Training Programme on Driver Diagnostics, Performance Evaluation and Training

Training Programme on Road Safety Audit

Training Programme on Rigid Pavements : Design, Construction and Quality Control

Training Programme on Pavement Evaluation Techniques and their Applications for Maintenance and Rehabilitation

Training Programme on EIA and Environment Clearance Process for Roads and Highways

Training on Road Safety Audit including EIA at Gandhinagar

Participant of International Training Programme on HDM-4 Receiving Certificate

Participants Attending International Course on HDM-4

Inaugural Session of Training Programme on Bridge Diagnostics, Performance Evaluation and Rehabilitation

A view of CRRI Pavilion at Addis Ababa, Ethiopia

CRRI Pavilion during Inter Traffic India Exhibition

CRRI Pavilion during IRC Annual Session at Lucknow

Training Programme for the Engineers of RCD, Bihar at Patna

Training for the field engineers involved in PMGSY

Training Programme on air quality monitoring system for the Officials of Ministry of Environment, Govt. of IRAQ

Customized Training Programme on Rural Roads for NRRDA

Customized Training Programme on HDM-4 at Patna for RCD, Bihar

A view of Inauguration of Regular Training Programme

Prof. S.R. Mehra Library

Prof. S.R. Mehra library provides documentation services to the scientists, engineers, planners and administrators in the field of highways and transportation. The library has a collection of over 89,000 publications including books, reference books, periodicals, conference proceedings, technical reports, standards specifications, microfilms, maps, CD-ROM databases, video cassettes etc.

Bibliographic Services

Literature searches and CD searches carried out and bibliographic service was provided on request to researchers of CRRI on topics related to highway engineering and transportation.

Reference Service

Specific information provided on more than one hundred reference queries.

User Education & Training

User education and training programmes were conducted for refresher courses participants to familiarize the users to the existing information sources & services, information retrieval techniques and technical writing.

Forthcoming Conferences

Information regarding forthcoming conferences in highway & transportation engineering displayed regularly to keep the researchers informed of the new conferences.

Collection Development

Publications like books, periodicals, conference proceedings, technical reports, CD-ROM databases, standards, related to roads, transport and related areas etc were acquired for updating the library collection.

Technical Processing

Publications added to the collection were classified, catalogued, indexed and well maintained for efficient retrieval.

Circulation and Inter-Library Loan

Publications were circulated to the users for reading at their leisure. Publications not available in CRRI library were arranged from other libraries. Publications were also issued to other libraries on inter library loan.

Professional Development

Information on refresher and training courses and workshops etc. available in the field of highway engineering and related areas were recorded and displayed regularly for the benefit of the users.

Access to International and National Databases

Access to national and international databases like TRIS, IRRD, TRANSDOC from TRANSPORT CD, COMPENDEX, PIARC CD ROUTE, and all BIS (Indian) Standards including Civil Engineering were provided through CD ROM databases for quick retrieval of information. Access to all ASTM publications has been provided through ASTM Digital Library.

Access to E-Journals

Access to full text E-Journals is being provided through Internet from various publishers like Elsevier, ASCE, Springer.

Computerisation of Documentation and Library Services

Database is being developed for the publications received in the library. OPAC has been installed on Intranet to search the database of CRRI Library.

E-CART Bulletin - Current Awareness in Roads & Transport

A monthly current awareness service containing scanned content page of the current journals received in the library is e-mailed to individual scientists to make them abreast of latest developments in the field of transportation and highway engineering.

Library Statistics

Books added during the period (01.04.2011-31.03.2012)	310
Total No. of books as on 31.03.2012	55017
Maps	688
Microforms	655
Videocassettes	122
Periodicals titles received regularly	150

LAN Hardware

Local Area Network (LAN) of CRRI uses Central Switch CISCO Catalyst 4507R-E (Layer 3 Redundant Supervisor), CISCO 48 ports 2900 (Layer 2) work group switches, CISCO 2600 Router. CISCO ASA 5520 Firewall , Access Control Server and CISCO Net Manager IP for its functionalities and operations

HP Proliant ML 570 and ML 350 (Xeon Quad Processor) hardware platforms are used for server activities. More than 400 LAN I/O points are operational.

Expansion plan of CRRI LAN with 500+ Nodes which covers entire CRRI campus is being carried-out and under process Figs. 16 and 162

Softwares and IT Services

Intranet service (http://CRRINET) provides Online Library Search (Web OPAC) , BIS Searching facility, Transport Database, Links for E-Journal and Driver Testing Software. The information related with all the division including the equipment list are also available.

Installation and configuration of Scientific Softwares like ARC-GIS , Mx-Road, HDM, NISA, Heads & SPSS also provided.

The newly designed website of CRRI (www.crridom.gov.in) provides information related to CRRI such as scientific, administration, training programmes, events, tenders, history, recruitment and other activities, etc. has been launched and made operational.

E-Mail facility for all the technical and administrative staff of this Institute also available.

Computer facility is provided to all Training programmes & Seminars/ Conferences etc organized at CRRI.

The Trend Micro Corporate Antivirus Solutions is provided to all the servers and nodes.

Storage Area Network (SAN) of scalable capacity 20TB from Fujitsu has been erected in new SAN Room with 5 Nos. of 2-way IBM servers which will be operational soon.

Fig. 161 Newly Installed Central Switch & Firewall Systems

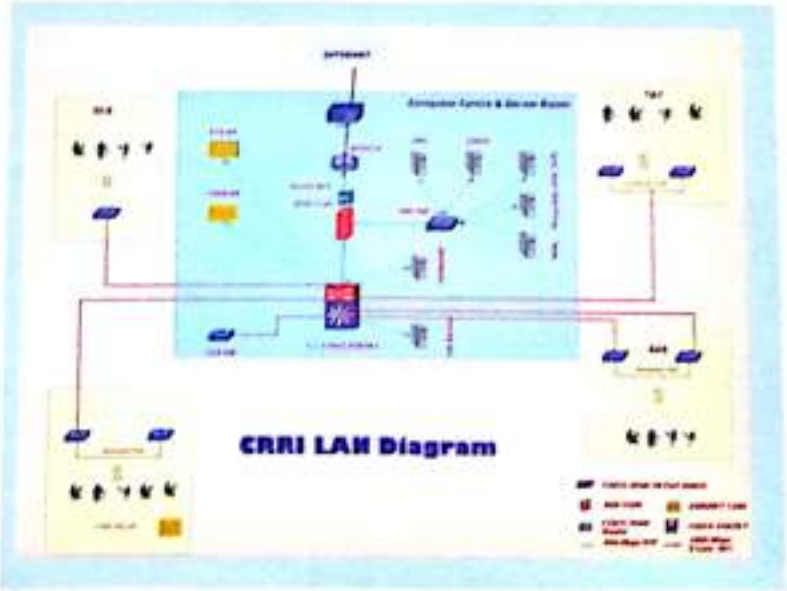


Fig. 162 Schematic CRRI LAN diagram

The Division was responsible for:

- Design and Development of Mechanical Equipment required by R&D divisions for carrying out Sponsored, In-house R&D and Consultancy services.
- Repair and maintenance of R&D equipment (Mechanical & Electrical).
- Air conditioner Repairs and Maintenance
- Operation and maintenance of Air Conditioning Plants
- Repair and Maintenance of Infrastructural Facilities including Furniture
- Book Binding
- Training organised
- Contribution in different R&D and Research Projects
- Participation in Extracurricular Activities

Design and Development

Following equipments were designed and developed during the year.

(a) Change in LVDT Mountings

The dimensions for 50 nos. of the magnetic LVDT mounting were changed to suit the site requirements for BAS division for the project titled "Instrumentation and Evaluation of Bridges on West Central Railway Bridges" Fig. 163.

Fig. 163 LVDT mounting

(b) Fabrication of Helical Springs

(a)

(b)

Fig. 164 Helical Spring

- 25nos of Helical springs were fabricated size 5" Height 5" for BAS Division, These spring are used as reinforcement in casting of cubes used in testing of pull out test for coated bars (Fig. 164 (a&b)).

Repair of R&D and other Equipment

Following equipments were repaired:

1. Automatic Soil Compaction Machine
2. Compression Machine
3. Repair of Gym Equipment
4. Automatic Bitumen Compactors
5. Marshall Hammer
6. Core Cutting Machine
7. Sample Casting Moulds
8. Direct Shear Machine
9. CBR Moulds
10. UTM
11. Rut Depth Measuring Device

Contribution in Different R&D Projects

Contributed substantially in the following projects:

- Fuel Consumption Studies (SIP-30) - Measuring fuel consumption on various vehicle under various load, gradient and roughness conditions.
- Instrumentation and Evaluation of Bridges on West Central Railway Corridor - Designed and fabricated various types of clamps and other facilities to streamline and expedite the testing at site.

Automatic soil compaction machine

Weight lifting

Tread mill

Compression machine

Twister

Paddling machine

Fig. 165 R&D and other equipments

Quality Management Division is responsible to ensure that IS/ISO 9001:2008 Quality Management System operates effectively and efficiently in the Institute. Besides, adopting higher level of quality standards in the working of the Institute is also the mandate of the division. During the year the division was engaged in conducting internal quality audits; discussing the findings of the audit in the management review committee meetings; ensuring the Institute's readiness for the external audits to be conducted by certification agency i.e. Bureau of Indian Standards (BIS) for the surveillance audit for higher level of quality standards in the working of the Institute.

Internal Quality Audits (IQA)

The Internal Quality Audits are systematic and independent examination of the system to determine whether the planned arrangements are implemented effectively and are suitable to achieve the objectives. The audit was carried out by trained and qualified auditors of the Institute with the following objective ;

- To determine the conformity or non-conformity of the quality system elements with specified requirements.
- To determine the effectiveness of the implemented quality system in meeting the specified quality objectives.
- To provide the auditee with an opportunity to improve the quality system
- To meet regulatory requirements.

The non-conformity reports (NCR) and corrective action report (CAR) were communicated to the auditees for ensuring the corrective and preventive actions. The actions taken by the auditees were verified during the subsequent audit and NC's were closed.

Management Review Meeting (MRM)

After the internal quality audits, the findings of the audit and its reports were discussed in detail during the Management Reviewed Committee.

Surveillance Audit

The Surveillance audit of the Institute was carried out during March 5-6, 2012 to check whether the IS/ISO 9001:2008 QMS is effectively and efficiently in place in the Institute. Finally, Certification has been recommended for continuation with the same scope of certification "Research and development in the field of roads and road transportation including design, testing, consultancy services and training in highway, bridge, and transportation engineering".

Modification and Updation of Quality System Procedure (QSPs)

The Quality System Procedures – the procedures (QSPs) of the divisional / sectional activities are in place since February 2003. Since then there have been many changes, addition / deletion in the procedures. In order to make them updated the actions were initiated to modify the existing QSPs.

Rajbhasha Section continued in its endeavor to promote official language in day-to-day work. For this, Official Language Implementation Committee (OLIC) meetings were organized on quarterly basis and follow-up actions were taken on the decision taken in these meetings. Employees doing remarkable work in Hindi were given cash incentives as well as certificates of commendation. Hindi workshops were also organized to encourage staff to start work in Hindi. Hindi Day & Hindi Fortnight were celebrated to enhance official language use in day-to-day work. A large number of staff took participation in different competitions organized during the Hindi Fortnight. Cash prize and certificates were also distributed to the winners.

In accordance with the official language policy of Govt. of India, Rajbhasha section assisted other sections in the translation work of different types of documents. Assistance was offered various areas with respect of Hindi correspondence and preparation of technical reports, abstracts, work report, etc. in Hindi. Scientists were encouraged to write their research papers in Hindi and as an incentive, they were given cash prize and certificates were given their Hindi publications.

Rajbhasha section also helped scientists in preparing lecture/presentations related to their research work in Hindi. A series of Hindi lectures was organized on different topics on monthly basis. Rajbhasha section also continued publishing "Rajbhasha Jagran', the quarterly leaflet in Hindi to promote official Language Policy and to assist employees of the Institute to write and express themselves in Hindi. The eighth issue of the 'Sadak Darpan', the scientific magazine in Hindi has been finalized and is under the process of publication.

Workshop-cum-Training on NHAI's Sponsored Project entitled "Consultancy Services for Conducting Road Safety Audit for PPP Projects on DBFO Basis"

National Highways Authority of India (NHAI) has awarded consultancy service to CRRI for conducting Road Safety Audit for PPP Projects on DBFO Basis. As part of this project, a workshop was organized by CRRI at National Botanical Research Institute (NBRI), Lucknow on 22-23 April, 2011 with the following major objectives.

(i) To train Road Safety Audit Team, Project Directors and Independent Engineers on the whole spectrum of Road Safety Audit Process.

(ii) To finalize the methodology to be adopted at development and construction stage audit.

The workshop was attended by forty two delegates, which included officers from NHAI, Project Directors of the respective contract packages, Independent Engineers and CRRI audit team.

The inaugural session began with welcoming of the dignitaries which included Sh. P.C. Arya, GM, NHAI; Sh. Krishna Murari, DGM, Road Safety Cell, NHAI; and Dr S. M. Sarin, Former Director Grade Scientist of CSIR-CRRI.

Dr. S. Gangopadhyay, Director, CSIR-CRRI, addressed the delegates and explained the importance of this project including timely completion as well as implementation. Dr Nishi Mittal, Head, Traffic Engineering and Safety Division, CSIR-CRRI gave a brief about the project.

The inaugural address was delivered by Shri Krishna Murari on behalf of NHAI (Road Safety Cell). Shri Murari explained about the various activities taken up by NHAI related to road safety all over India. Dr. S. M. Sarin addressed the delegates and highlighted various safety related issues and practical experiences in India and abroad. The inaugural session concluded with Vote of Thanks by Dr. K. Ravinder, Scientist, CSI R-CRRI.

National Technology Day

11th May is observed as National Technology Day every year all over India to commemorate the technological breakthrough made by India. CSIR-CRRI also celebrated National Technology Day on May 11, 2011 by declaring it an open day for the general public to visit CRRI and interact with the scientists of Institute.

Shri T. K. Amla, HOD, ILT gave a brief background of the National Technology Day celebrations. Dr S. Gangopadhyay, Director, CSIR-CRRI delivered the welcome address. He urged CRRI scientists / technologists to develop new technologies which are economically viable for construction of roads. Prof. K. S. Rao, Department of Civil Engineering, Indian Institute of Technology, Delhi graced the occasion as Chief Guest and delivered a lecture on "Static and Dynamic Analyses of Chenab Bridge Abutments Using UNDEC & DEC". The function was concluded with the Vote of Thanks by Shri Sudhir Mathur, HOD, GTE. The programme was also attended by a large member of ex-employees of the Institute.

World Environment Day

The Institute celebrated the World Environment Day on June 6, 2011. As part of this function, Dr S. Gangopadhyay, Director, CSIR-CRRI planted a tree in the CRRI lawn. In this context, a poster on "Reduce Your Carbon Footprints at Workplace" was also released by him for wider circulation/dissemination amongst society at large.

Workshop on Communication and Presentation Skill

A workshop on Communication and Presentation Skill was organised by Hero Mindmine Institute Limited, Gurgaon, for CRRI scientists / Technical officers on June 13, 2011 at CSIR-CRRI. About 25 Scientists / Technical officers took part in the workshop and actively interacted with the faculty member on various issues involved.

Workshop on APTF-Benefits & Opportunities

A workshop on "Accelerated Pavement Testing Facility (APTF) -Benefits and Opportunities" was organised on June 24, 2011 at the Institute with the objective to bring all stakeholders on to one platform to discuss the various related issues.

The Inaugural Session was chaired by Prof. D.V. Singh, Chairman, RC and Mentor-APTF. Dr. S. Gangopadhyay, Director, CSIR-CRRI gave the welcome address followed by addresses by Prof. D.V. Singh and inaugural address by Sh. D.P. Gupta, Retd. DG, MoRTH. The Potentials and benefits were highlighted by both the speakers. A vote of thanks was given by Sh. M.N. Nagabhushana, Scientist and Nodal Officer (APT Group). The one day workshop comprised two technical sessions Technical Session-I: APTF Status, Benefits & Opportunities, Technical Session-II: On site Demonstration of APTF" Which included presentations, floor interventions & live demonstrations of APTF and Panel Discussion-Business Attribute to APTF.

At the end, the recommendations were summarised which mainly includes the coming together of industries & CRRI for effective utilisation of APTF, making a project proposal to DST on utilisation industrial waste material in bituminous mix and formation of a 'Core Group' with members from all major agencies. The workshop concluded with vote of thanks

Diamond Jubilee Celebration

CSIR-CRRI is celebrating year 2011-12 as its Diamond Jubilee Year (60th Anniversary). The opening ceremony of the Diamond Jubilee Celebrations was held on July 16, 2011 and was inaugurated by Prof. Samir K. Brahmachari, DG, CSIR and Secretary, DSIR, Govt. of India. Sh. K.K. Kapila, Chairman, International Road Federation, Geneva, graced the function as the Guest of Honour. On this occasion, a Souvenir containing messages of good wishes from dignitaries and papers of general interest was also released by DG, CSIR. A technical exhibition, displaying the technologies and products developed by CRRI, was inaugurated by Sh. K.K. Kapila, Chairman, IRF, Geneva.

During the inaugural session of opening ceremony of Diamond Jubilee Year, the former Directors of CSIR-CRRI namely, Prof. C.G. Swaminathan, Dr. M.P. Dhir, Prof. D.V. Singh,

Prof. P.K. Sikdar, Dr. P.K. Nanda and Dr. Vikram Kumar presented their reminiscences of CRRI during their tenure.

Besides the inaugural session, a Workshop on "R&D Works in Road Transportation - Way Forward" was organised which was attended by the academicians/scientists and field engineers from different organizations. In the workshop, Area Review presentations were made on Pavement Engineering & Materials by Prof. A. Veeraragavan, IIT-Madras; Traffic & Transportation Engineering by Prof. P.K. Sikdar, former Director, CRRI and on Bridges and Structures by Prof. S.K. Bhattacharya, Director, CSIR-CBRI.

Hindi Pakhwada (Fortnight)

Hindi forthnight was organized from Sept. 14 to 30, 2011. Competitions such as Essay writing, Hindi noting and drafting, Hindi Poster. On the spot Hindi speech and Technical Paper Presentation competitions were organized. About one hundred employees took part in these competitions.

Dr. Deepak Shukla, Director, Pashupawati Singhania Hospital & Research Centre delivered the keynote lecture on "Adhyatmikta aven Samaj Uthaan" on the occasion of Hindi Day, September 14, 2011. Dr. S. Gangopadhyay, Director, CSIR-CRRI presided the inaugural function. He urged all employees and officers to compulsorily make use of Hindi in day to day official work.

Dr. Mahesh Chandra Gupt, Ex-Director, Ministry of Home Affairs, Deptt. of Official Language graced the occasion as Chief Guest on Sept. 30, 2011. Prizes were given to winner of different competitions and also to those employees who have published research papers in Hindi and done commendable work in Hindi.

CSIR Foundation Day

CSIR Foundation Day was celebrated on Sep. 26, 2011. The Institute was kept opened on that day to facilitate visits by General Public and Students. About fifty children of Class 10th &12th visited the Institute. Dr. Geetam Tiwari, TRIPP Chair & Prof. of Civil Engg., Indian Institute of Technology, Delhi was the Chief Guest for the main function who also delivered the Foundation Day Lecture on "Transport Challenges in the 21st Century". In her lecture, Dr. Tiwari mentioned that twenty first century is going to be critical because sizeable population would live in urban area worldwide. India is also expected to have about 40 to 50 percent population living in urban areas by 2050 resulting in nearly doubling the current urban population. Transport Technologies and Solutions of the last century would not serve the purpose and the challenges facing the transport researchers today are to discover accessibility and mobility solutions sooner than later so as to ensure safe accessibility and mobility for all urban residents. Earlier, competitions were organised for the children of employees. Prizes were given away by the Chief Guest to the winners of various competitions. The employees of CRRI, who had completed 25 years of service in CSIR and those who had retired during Aug. 2010 to Sep. 2011, were also honoured and mementoes presented to them by her. The function was graced by the invited guests, fellow scientists, employees and ex-colleagues of CRRI.

Workshop on Sustainable Technologies for Road Construction in North East

A one day national workshop was organized on "Sustainable Technologies for Road Construction in North East" on Sep. 19, 2011, jointly with CSIR-North East Institute of Science and Technology (CSIR-NEIST), Jorhat which was supported by Public Works Department of Govt of Assam.

The workshop is the first of its kind in the region and nearly 175 participants from various organizations in India specifically from the North East Region like Border Roads Organisations; Public Works Department of Government of Assam; Dibrugarh, RR Division; Jorhat (Army); IIT-Guwahati and Private companies from Guwahati participated in the workshop. The workshop was presided over by Dr. S. Gangopadhyay, Director, CSIR-CRRI while Sh. M.C. Boro, Commisioner and Special Secretary, Govt of Assam was the Chief Guest. Dr. P.K. Jain, Chief Scientist and Head, Flexible Pavement Division, CSIR-CRRI was the Convenor of the programme.

Dr. Gangopadhyay, in his presidential address, mentioned that CRRI is extremely happy to work with NEIST with the combined mission to give benefits for the common people of North East. As the poor transportation system leads to poor economy, search for adequate connectivity is vital for the growth of region, for which a modern transportation system is required which has to be sustainable both economically and environmentally. Energy efficient technologies such as Bitumen Additives and Warm Mixes are required to develop eco-friendly roads in the bio-diversity rich states of North East India.

In his welcome address, Dr. P.G. Rao, Director, NEIST mentioned that the region lacks proper transportation system and for that area/site specific technologies need to be developed and practiced. He stated that, already in the 9th and 10th Five year plans, CSIR-NEIST has completed projects on better utilization of bitumen for energy efficient technology for road construction. Towards this end, he said that NEIST can supply the quality material and work together with CRRI on these aspects. Sh. M. C. Boro, Chief Guest of the workshop released the document on "National Workshop on Sustainable Technologies for Road Construction in North East". In his inaugural address, he mentioned that researches, scientists, industries and administration must come together and take challenges to make the green roads accessible to all and develop energy efficient technologies. Cold Mix Technologies for construction of road have already started and in green way, Vetiver grass is being used for slope protection in Assam. Development and implementation of energy efficient technologies for construction of roads would also help to earn carbon credit.

Workshop on Self Development for Women Employees

To motivate the women at workplace, a workshop was organized at CRRI on Oct. 12, 2011 by M/s. Hero Mindmine Institute Limited, Gurgaon. The workshop was attended by 30 women employees of CSIR-CRRI and various issues related to problems of women at the workplace as well as ways to tackle them were discussed.

Vigilance Awareness Week

The Vigilance Awareness Week commended on October 31, 2011 at the Institute's reception Lounge with the pledge ceremony which was administered by Sh. Sudhir Mathur, Senior most Scientist, CSIR-CRRI. Banners and posters regarding observance of "Vigilance Awareness Week" by CSIR-CRRI employee were displayed at prime locations in the Institute premises besides, the Main Gate.

In this series, a Debate competition on "Kya Lokpal Bill Brastachar Virodhi Sabit Hoga?" for CRRI Staff was conducted on November 2, 2011 in the Auditorium of CSIR-CRRI.

In addition to the Debate competition, a Slogan writing competition amongst CRRI staff was also conducted on the issue of "Corruption and its Prevention".

Further, Sh. B.K. Singh, Administrative Officer, CSIR-CRRI delivered a lecture in Hindi on CCS (Conduct) Rules, 1964 for imparting knowledge about the basic provisions specified in the said Rules and the common misconceptions / mistakes committed by the Council Servants in comprehending the Conduct Rules.

The Vigilance Awareness Week closed with a renewed spirit to commit towards the progress of organization by working in a corruption – free environment.

Brain Storming Session on Certified Reference Materials (CRM) for Road Transportation Environment Sector

A half-day brain storming session on Certified Reference Materials was organised at CRRI on 02 Nov 2011 which was attended by the participants from CPCB, Delhi University and CSIR-CRRI. Welcoming the guest, Dr. S. Gangopadhyay, Director, CSIR-CRRI appreciated that this workshop should focus on road transportation planning and environment related issues which is the mandate of CRRI.

Sh. Anil Relia, Director, NABL appreciated the initiatives taken by CRRI, which will help various stakeholders and NABL's accredited testing & calibration laboratories for measuring quality assurance. Association with NPL, New Delhi will help SI traceability in all physical and chemical measurements.

Sh. Prabhat Gupta, HOD, Analytical Chemistry and Scientist G, NPL made presentation on MiCI CRM programme under Advances in Metrology, a CSIR Network project being done in India. He emphasized the importance of CRMs as a link to achieve SI traceability for reliable chemical measurements.

Dr. Abhijit Pathak, Scientist, CPCB presented the research works conducted by CPCB in the field of sampling and analysis of particulates matter.

Dr. Sippy K. Chauhan, Scientist, CSIR-CRRI, presented the progress achieved till now for the dust sample collection efforts and preliminary analysis done besides future planning in CRMs developments for road dust CRMs being done with the cooperation of NPL New Delhi.

The session was concluded with the vote of thanks by Dr. Anuradha Shukla, Scientist, Transport Planning & Environment.

XXXXIII SSBM (Out Door Zonal) Tournament

Institute organised XXXXIII Shanti Swaroop Bhatnagar (Outdoor Zonal) Tournament during November 9-11, 2011, Ten Laboratories of CSIR namely CECRI - Karaikudi; CSMCRI-Bhavnagar; CMERI - Durgapur; IIP - Dehradun; IHBI - Palampur; IIIM - Jammu; IICB - Kolkata; NBRI - Lucknow; NIO - Goa and NIIST - Thiruvananthapuram; participated in the tournament. The tournament was inaugurated by Prof. Samir K. Brahmachari, Director-General, CSIR and Secretary DSIR, Govt of India on Nov. 8, 2011 Prof. Brahmachari, said that the spirit of team in sportsmanship is a good way to come together without hierarchy and the same can also be extended to the work place. Dr. P.G. Rao, Director, NEIST and Chairman, CSIR Sports Promotion Board extended warm welcome to all the players and congratulated them for being chosen to represent their respective labs. He desired that there should be outdoor tournaments for women employees also. Dr. S. Gangopadhyay, Director, CSIR-CRRI welcomed the participants and expressed his happiness for hosting this tournament at Delhi after so many years. Sh. R.S. Bhardwaj, Convenor of the tournament said that it is our proud privilege to host the tournament and thanked all the participants. On this occasion, a Souvenir containing messages from dignitaries and papers of general interest was released by DG CSIR. Sh. Sudhir Mathur, Chief Scientist proposed the vote of thanks.

Cricket and volleyball matches were held between the participating teams. All the teams played true to the spirit of the game. There were some excellent displays of talent and commitment to the games by all the players. Congratulations to the wining team(s).

Seminar on MATLAB Application in Transportation Engineering Problems

As part of Diamond Jubilee Celebrations, CRRI, in association with M/s Math Work India Private limited, Bangalore organised one day Seminar on MATLAB Application in Transportation Engineering Problems, on November 17, 2011 at CSIR-CRRI New Delhi. The main objective of the seminar was to focus on the applications of mathematical modelling and methods in transportation engineering. In his welcome address, Dr. B.Kanagadurai, Head, RDM Division highlighted the importance of software tools and techniques in solving the research problems. The seminar was attended by 25 scientists of various R&D Divisions from CRRI. Dr. S. Gangopadhyay, Director, CSIR-CRRI inaugurated the seminar and emphasised on the necessity of advanced modelling techniques towards solving traffic and transportation related problems. The seminar was organised into three technical sessions. The first two sessions were presented by Professionals from Math Work. The first session was on introduction to mathematical modelling techniques, data processing, data analysis, modelling dynamic systems using MATLAB and various tool boxes. The second session focused on advanced mathematical analysis using Simulink and SimScape tools. The third session was mainly on application of MATLAB in transportation planning and engineering related problems carried out by scientists of CRRI. Sh. A. Mohan Rao, Scientist presented the case study and applications on 'Mode Choice Analysis using

Neural Network Tools' while Dr. Ch.Ravi Sekhar, Scientist presented the works on 'Solving Traffic Assignment Problems using Optimization Tools' and 'Evaluation of Pavement Distress Parameters Using Neural Network Tool Box'.

Workshop on Indo Highway Capacity Manual

A workshop on Indo Highway Capacity Manual (Indo-HCM) was organised on November 24-25, 2011 as part of Diamond Jubilee Celebrations of CSIR-CRRI. The workshop was inaugurated by Shri R. P. Indoria, Director-General (Road Development) and Special Secretary, Ministry of Road Transport and Highways, Government of India. The workshop was attended by a galaxy of transportation professionals representing academic and research organizations including IITs; SPA; NITs; B.E. College of Engineering (Howrah); College of Engineering, Trivandrum; IRC and Consultancy Organizations such as ICT Private Limited; M/s L. R. Kadiyali & Associates; CRAPHTS; Systra Infra Limited etc. The main endeavour of this workshop was primarily to evolve methodology for pursuing the proposed project on 'Indo - HCM' as part of Twelfth Five Year Plan project of CSIR-CRRI which is intended to be accomplished in collaboration with academic institutions.

The workshop was conducted over six technical sessions encompassing presentations on the following theme from the staff of CSIR-CRRI; IIT (Roorkee); College of Engineering (Trivandrum); ICT Private Limited; IIT (Madras); Kadiyali Associates and SPA.

- Capacity Studies on Rural Highways and Expressways
- Capacity and Travel Time Reliability Studies
- Capacity Studies on Two Lane Rural Highways and Pedestrian Studies
- Capacity Studies on Urban Roads
- Methodology for Development of Indo - Highway Capacity Manual

The presentations made the gamut of studies conducted in various parts of the country on each of the above identified themes. During the last session of workshop, deliberations were held in the form of Panel Discussion focusing on the basic theme titled, "Way Forward on Indo-HCM". During the panel discussion, the panelists flagged out various issues which need to be given adequate consideration and also emphasized the need for development of uniform methodology for evolving Indo - HCM.

Road Safety Week

Road Safety Week was observed at CRRI during January 1-7, 2012. On January 4th, a function was held in the Institute. Dr. Geetam Tiwari, TRIPP Chair, Indian Institute of Technology, Delhi delivered a talk on "Road Safety Issues". A debate competition on the "Use of Mobile Phones while Driving": and "Boon or Bane and Pros & Cons of Use of Safety Gadgets (Helmets/ Seat Belt) while Driving", was held amongst the staff.

National Science Day

National Science Day was celebrated on February 28, 2012 to commemorate the great discovery of Raman Effect by Nobel Laureate Prof. C.V. Raman in 1928. The

occasion was marked by the observance of an Open Day when the laboratories of Institute were kept open to general public and school children. Besides, a special function was arranged to pay homage to Nobel Laureate. Dr. Mohit Kumar Ray was the Chief Guest on this occasion who gave a talk on "An Environmental Journey Through Roads".

Road Safety Audit Training for Officials of CRAPHTS Consultants Pvt. Ltd.

A training programme on "Road Safety Audit" was organized at the Institute on February 8-11, 2012. This workshop was conducted for officials involved with seven packages viz. Package # 7 (Punjab); Package # 8 (MP); Package # 22 (MH); Package # 23 to 25 (Orissa) & Package # 26 (RJ). In all, 60 delegates attended this Workshop cum Training. The delegates included officers from NHAI, Project Directors of the respective packages and Independent Engineers. The inaugural session was addressed by high ranking officials which included Mr. R P Khandelwal, CGM (Safety); Dr. Nishi Mittal, Head-TES Division, CSIR-CRRI; and Mr. D. Sanyal, MD, CRAPHTS Consultants Pvt. Ltd.

Workshop on Issues and Strategies for Non-Motorized Transport Mode

As part of Diamond Jubilee Celebrations, a workshop on "Issues and Strategies for Non-Motorized Transport Mode" was held on March 23, 2012. The Chief Guest of the workshop was Mr J B Kshirsagar, Chief Town Planner, Ministry of Urban Development, Govt. of India. About 56 delegates attended the workshop from various organizations like, IIT-Delhi, IIT-Roorkee, School of Planning & Architecture, New Delhi, SVNIT Surat, Local Governments for Sustainability (ICLEI), CRAPHTS consultants, Institute for Transportation and Development Policy (ITDP), Town & Country Planning Organization, Delhi, and Urban Mass Transit Company Limited.

There were four technical sessions covered in the Workshop and included Pedestrians, Barrier Free Mobility, Cycles and Cycle Rickshaws, followed by Way Forward. Shri Satyendra Garg, Joint Commissioner of Police (Traffic) gave an insight into the accident scenario in Delhi including major reasons for accidents, and measures being taken by Delhi Police to abet these accidents.

The major recommendations that emerged out of Workshop deliberations include the following:

(a) Non-motorized transport is required not only for sustainable transport option but also for integrated society building.

(b) Have NMT inclusive planning to focus on movement of people and goods rather than vehicles.

(c) Traffic calming measures in neighborhoods' and shopping/market areas are amongst the most effective indirect planning concepts which can be used for better NMT planning.

(d) An extensive network of streets with proper NMV lanes and footpaths is recommended.

(e) Performance of street design should be reviewed periodically and interventions made to respond to changing conditions.

(f) Develop a balanced multi-modal transport plan on priority with inclusion of all NMT users.

National Get-together on Road Research and its Utilization (NGT-2012), March 1-2, 2012

A National get-together on "Road Research and its Utilization (NGT-2012)" was organised at its premise on March 1-2, 2012. This was done with an aim to provide appropriate forum to highway engineering fraternity – researchers, experts, academicians, consultancy and contracting firms, manufacturers of materials and equipments associated with road development in our country. The main purpose was to hold deliberations on emerging issues related to roads and road transportation for ensuring sustainable development of infrastructure in the country. The get-together was sponsored by 15 organizations and was attended by more than 400 delegates representing DDA, MoRTH, NHAI, State PWDs, various R&D and academic Institutions.

The get-together was inaugurated by Sh. C. Kandasamy, Director-General (RD), MoRTH, while Lt. Gen. R. Ravi Shankar, PVSM, VSM, DG(BRO) was the Guest of Honour. Dr. S. Gangopadhyay, Director, CSIR-CRRI extended a warm welcome to the dignitaries and delegates. In his welcome address, Dr. Gangopadhyay mentioned that NGT-2012 is being organized to provide a forum for interactions between the road researchers and user agencies including in-depth discussions on various measures required to be taken for increased utilization of R&D findings available. He highlighted that issues related with "Energy and Environment", as far as road development activities/policies are concerned would play a key role in years to come. Hence, appropriate technological advancements and innovations in the areas of road building materials and economical designs are essential to achieve sustainable development and to conserve precious and scarce natural resources. Need for undertaking R&D studies towards improving road safety and integration of different modes of transport in order to promote public transport and to provide efficient, effective and economical transportation solutions were also highlighted by him.

Sh. Kandasamy, Director-General (RD), MoRTH, emphasised future transportation needs of the country highlighting the problem of congestion in urban environment. He also stressed the need to use locally available materials, adopt stabilization techniques and different aspects to be considered while planning and designing new expressways and highways.

Lt. Gen. R. Ravi Shankar, PVSM, VSM, DG(BRO) addressed the gathering and stressed the need to develop appropriate technologies for use of local inferior materials, adoption of soil stabilization techniques and materials resource crunch in border areas of the country.

Sh. T.K. Amla, Organizing Secretary, NGT read the messages of good wishes received from VIPs and many important dignitaries for the success of National Get-Together. Sh. Sudhir Mathur, Head, Geotechnical Division proposed the vote of thanks.

During the Get-together, a technical exhibition was also organised in which about 32 agencies/ firms/organisations including CRRI displayed their products. On this occasion, a souvenir containing messages of good wishes from dignitaries and papers/articles of general interest was released by Sh. C. Kandasamy, Director-General (RD), MoRTH.

The two-day meet comprised seven Technical sessions which included Panel discussions and presentations on important themes. The interactions resulted into a number of priority R&D areas pertaining to roads and road transportation, which need to be undertaken in the country.

The salient recommendations of the session on "Way Forward" are:

- Need to develop appropriate framework and policies to implement PPP projects.
- Encourage private investment by providing financial support, long term debt policies.
- Research activities and new technologies to be initiated, developed and imported for implementation in the country.
- Thrust on road safety audit, asset management and sustainable road development.
- Compile research report(s) from India and other developed/developing countries on different thrust areas of research, so as to avoid repetition in research activities and to develop guidelines suited to local environment and traffic conditions.
- Formulate dedicated road safety programmes to avoid accidents.
- Develop adequate policies, strategies and training programmes for proper implementation of road safety audits.

Awards	Awardee
• Dogra Gold Medal for Securing Highest Cumulative Grade Point Average during the Session 2010-11 amongst the M.Tech graduating Students of Construction Engineering and Management of the Civil Engineering Department, IIT, Delhi	Sh. Pankaj Goel
• Bihar PWD Medal by Indian Roads Congress for their research Paper entitled Critical Evaluation of Roadway Capacity of Multilane High Speed Corridors under Heterogeneous Traffic Condition, Through Traditional and Microscopic Simulation Model, Published In IRC Journal Vol.71, No. 3	Dr. S. Velmurugan Dr.E. Madhu Dr. K. Ravinder Sh. K. Sitaramanjaneyulu Dr. S. Gangopadhyay
• Priyankant Divatia Gold Medal for Securing Highest Marks in M.E (civil) of University of Delhi, March 2012.	Pradeep Kumar

Shri Pankaj Goel, Technical Officer Receiving the Award

Dr. S. Velmurugan, Scientist receiving Award during IRC Session

Sh. K. Sitaramanjaneyulu Scientist receiving Award during IRC Session

Dr. K. Ravinder Scientist receiving Award during IRC Session

Inaugural Session of Workshop on Road Safety Audit

Dr. S. Gangopadhyay Director, CSIR-CRRI Addressing the Delegates during the workshop

Dr. S. Gangopadhyay, Director CSIR-CRRI planting a tree on World Environment Day

A view of National Technology Day Celebration

A view of Workshop on Communication and Presentation Skill

Glimpses of Diamond Jubilee Celebration

Glimpses of Diamond Jubilee Celebration

RC Meeting in Progress

Geetam Tiwari, TRIPP Chair & Prof. of Civil Engineering, IIT Delhi Delivering the Foundation Day Lecture

Sh. Abhishek Mittal, Scientist, CRRI explaining the activities of CRRI to students

Shri. R.P. Indoria and Special Secretary, MORTH, during Workshop on Indo Highway Capacity Manual

Welcome Address by Dr. S. Gangopadhyay, Director CSIR-CRRI

A Session on CRM in Progress

Inaugural Session of Workshop on Issues and Strategies for Non-Motorized Transport Mode

Technical Session in Progress

A View of the Inaugural Session of Road Safety Audit Training for Officials of CRAPHTS Consultants Pvt. Ltd.

Glimpses of NGT 2012

Glimpses of NGT 2012

Celebration of Hindi Pakhwada

Glimpses of XXXXIII SSBM Tournament

Inaugural Session of the Workshop on Sustainable Technology for Road Construction in North Eastern Region at Jorhat

Releasing of Document on the Workshop

Celebration of New Year 2012

Releasing of New Year 2012 Calendar

Dr. Mohit Kumar Ray Speaking on the Occasion of National Science Day

Presentation by Mr. Michael Tan, M/s Akzonobel

Presentation by Prof. S.L. Dhingra, Emeritus Professor, IIT, Mumbai

Presentation by Dr. Sundaram Logras, M/s Akzonobel

S. No	Topic	Place and Date	Presented by
1.	Construction and Maintenance of Concrete Roads	CMA- Ultra Tech. workshop, Goa, June 8, 2011	Binod Kumar
2.	Use of Fly Ash in Cement Concrete Pavement and Comparative Study with Flexible Pavement	NTPC, Noida June 29,2011	J.B. Sen Gupta
3.	Environmental & Forest Clearance Process in India	Indira Gandhi National Forest Research Institute Dehradun, Aug 26,2011	Dr.Niraj Sharma
4.	Design & Construction of Concrete Roads	Engineers Day Celebration, DDA Engineers Welfare Council, Sept. 15, 2011	Binod Kumar
5.	Concrete vis-a-vis Asphalt Road	Workshop on life cycle Assessment for Construction Industry, Delhi, Sep. 20, 2011	Dr. Anuradha Shukla
6.	Environmental Clearance Process in India	Civil Engineer Tech. Festival, SRM University Modinagar, Ghaziabad, September 23,2011	Dr. Niraj Sharma
7.	Design and Construction of Concrete Roads	CMA Workshop, Raipur Sept.24,2011	Binod Kumar
8.	New Technologies used for Road Construction	Cochin Road Conclave, Corporation of Cochin, September 25,2011	K. Sitaramanjaneyulu
9.	Flexible Pavement Design and Construction	NTPC, Noida ,October 10, 2011	K. Sitaramanjaneyulu
10.	Current Road Safety Practices in India	National Safety Council, Oct 20, 2011	Dr. Nishi Mittal
11.	Environmental Clearance Process in India: Some Case Studies	TERI University New Delhi October 31, 2011	Dr.Niraj Sharma
12	Effect of Heavy Commercial Vehicles on Bridges	Engineer-in-Chief Meeting, Lucknow, November 6, 2011	Dr. P. Lakshmy
13.	Design, Planning and Erection of Precast Structure	Indian Academy of Highway Engineers, Nov. 16, 2011	Dr. P.Lakshmy
14.	Delhi Metro : A Sustainable Mass Transport System	UKIERT Stakeholder Workshop on Sustainable Urban Air Quallity Management Strategies in UK and India : Monitoring Modelling and Management (M3), New Castle University (UK) November 29,2011	Dr. Niraj Sharma
15.	High Volume Flyash Concrete for Pavements	National Conference on Flyash, Hyderabad, Dec 5-7,2011	Binod Kumar
16.	Quality Audit and Quality Construction in Pavement Construction	ESCI, Hyderabad, December 09, 2011	K. Sitaramanjaneyulu
17.	Quality Control Aspects for Construction of Cement Concrete Roads	ICI-AICTE Workshop, Gwalior, Dec 10,2011	Binod Kumar
18.	Construction Supervision	Biannual SOSA/SAASO/CE(AF), Vayu Bhawan, December 12,2011	K. Sitaramanjaneyulu
19.	New Technologies	Conference on Operation, Maintenance and Tolling in Road Sector, Indian Infrastructure Publishing Private Limited, December 13,2012	K. Sitaramanjaneyulu
20.	Design, Construction and Maintenance of Concrete Roads	SGSITS, Indore, Dec 24, 2011	Binod Kumar

S. No	Topic	Place and Date	Presented by
21.	Input Data Collection for Road Asset Management & A Decision Support System Software for Road Asset Management : HDM-4	Workshop on Road Asset Management, December 28,2011	Dr. Devesh Tiwari
22.	Construction and Quality Control of Concrete Roads	Ultra Tech- CMA Workshop, New Delhi Jan 7, 2012	Binod Kumar
23.	Design, Construction and Quality Control for Concrete Pavements	Municipal Corporation of Delhi, Jan 7, 2012	Binod Kumar
24.	Design and Construction of Concrete Roads for Mumbai City	Workshop on Sustainable Road Technologies for Mumbai, Mumbai Jan 9-10, 1012	Binod Kumar
25	Load Testing of Concrete Bridges and Case Study	National Council for Cement and Building Materials, Ballabhgarh, January 12, 2012	Dr. P.Lakshmy
26.	Capicity of Multilane Highways and Expressways & Road Safety Audit	College of Engineering, Anna University, Feb, 2012	Dr.S.Velmurugan
27.	Urban Road Transport and Air Pollution in City of Delhi	ORF-RLS Workshop on Transportation Practices in India and The European, New Delhi Feburary 2,2012	Dr. Anuradha Shukla
28.	EIA and Environmental Clearance for Road & Highway Projects	Workshop on Sustainable Road Technologies for North-East, CRRI & Tripura PWD Feb3,2012	Dr. Niraj Sharma
	Use of Locally Available materials and Jute in Road Construction	do	U.K. Guruvittal
29.	Quality Monitoring Process in Construction of Roads	Indian Road Conference, 2012 ASAPP Media Information Group Mumbai Feb 15-16,2012	K. Sitaramanjaneyulu
30.	Accident Data Collection System using ITS for Better Safety and Enforcement	International Conference on Intelligent Transport Systems, Feb 27-28,2012	Dr. Nishi Mittal
	Planning and Designing Functional Aspects of ITS with a Green Mindset	do	Dr. Anuradha Shukla
31.	Quality Control Aspects for Sustainable Flyovers and Bridges and Maintenance Management for Post Construction	Indian Academy of Highway Engineers,Noida, March 20, 2012	Dr. V.V.L.K.Rao
32.	Corrosion of Steel in Concrete	Sharda University, Greater Noida, March 31, 2012	Dr. V.V.L.K.Rao
33.	Design, Planning and Erection of Precast Structures	Training Programme on Highway Construction under India Africa Forum Summit, March 19, 2012	Dr. P. Lakshmy
34.	Current Issues of Accessibility in India	National Symposium on Designing Roads for Disabled Pedestrians in India, New Delhi, March 1-4,2012	Dr. Neelima Chakraboraty
35.	Design and Construction of White Topping	Chandigarh Municipal Department, Chandigarh March 28,2012	Binod Kumar
36.	Highway Planning & Design	School of Planning and Architecture, Delhi	Dr. Devesh Tiwari

CRRI Staff/Scientists Deputed for Training

S.No.	Area of Training	Staff Nominated	Date	Venue
1	Improving Profitability by Cost Reduction through SCM	Sh. Jashwant Singh, Sh. S.S.Chhachia, Sh. K. Bairagi	28-29 April 2011	CII, Pune
2	General Management Programme	Dr. N.K.S. Pundhir	2-13 May, 2011	Administrative Staff College of India, Hyderabad
3	Workshop on Implementation-cum-Internal Audit on IEC/ISO 17025:2005 for NABL	Sh. R.S. Bharadwaj	5-6 May, 2011	IHC, New Delhi
4	High-end Workshop for Transparency Officers / Appellate Authorities and PIOs of CSIR System	Sh. Sudhir Mathur, Sh. Jitender Parasar, Sh. S.P. Pokhriyal	10-12 May,2011	HRDC Ghaziabad
5	Management Development Programmes for Officials of Administration, Financial & Purchase	Sh. B.K. Singh	25-29 July, 2011	HRDC Ghaziabad
6	Research Methodology and Statistical Methods: Designing for Breakthroughs	Dr. Suraj Prakash, Sh. Satish Pandey	16-20 Aug. 2011	HRDC Ghaziabad
7	Earthquake Resistant Design and Construction	Sh. Alok Ranjan	1-3 Sept. 2011	IHC, New Delhi
8	NABL Accreditation Requirement and Internal Quality Audit as per ISO/IEC 17025:2005	Sh. R.S. Bharadwaj, Dr. Neeraj Sharma	14-16 Sept. 2011	Institute of Applied Quality Management, Kolkata
	Profession Skills Development Programme for PS/PA/ Stenographers	Sh. Laliteshwar, Sh. Satish Kumar, Sh. Ashok Kumar, Sh. S.K.Dhingra	28-30 Sept. 2011	HRDC, Ghaziabad
	Project Management with Specialization in Road Transport	Sh. J.K. Goyal	13-14 Oct., 2011	Ramky Infrastructure Pvt. Ltd. Hyderabad
	CSE's Short term Training programme on Social Impact Assessment	Dr. B.K. Durai, Dr. Mukti Advani	9-11 Nov. 2011	Centre for Science and Environment, New Delhi

S.No.	Area of Training	Staff Nominated	Date	Venue
12	Short term Course on Design and Rehabilitation of Highway Pavements	Sh. A.K.Sagar, Sh. Satish Pandey	19-21 Nov. 2011	IIT, Kharagpur
13	DST Sponsored Management Development Programme on Marketing Scientific Research and Innovation in International Business	Sh. A. Saurikhia	28th Nov.-2nd Dec.2011	Indian Institute of Foreign Trade, New Delhi
14	National Convention-2011 (Achieving Inclusive and Sustainable Growth - Role of Supply Chains)	Sh. Kaushal Kishor, Sh. S.S. Chhachhia, Sh. K. Bairagi	2-3 Dec. 2011	Indian Institute of Materials Management, New Delhi
15	Achieving Excellence at Workplace	Dr. V.V.L.K.Rao	29th Jan.-1st Feb. 2012	HRDC, Ghaziabad
16	Management Development Programme for Common Cadre Officers	Sh. B.K. Singh	6-10 Feb. 2012	HRDC, Ghaziabad
17	Hindi Computer Training Programme	Sh. Vijay Kumar, Sh. Surinder Singh	Feb., 13-17, 2012	NPTI, Badarpur, New Delhi

- Dr. Sippy Kalra Chauhan, Sr. Scientist was deputed to visit BAM Federal Institute for Material, Research & Testing, Berlin, Germany as Guest Scientist for trace analysis of road side dust under PTB-MiC programme Material Research & Testing at Germany from May 2 - June 30, 2011
- Dr. Kishor Kumar, Sr. Principal Scientist was deputed to participate & present the paper entitled "Debris flows in North Eastern Region of India – A Case Study" in ISSMGE 14th Asian Regional Conference on Soil Mechnics & Geotechnical Engineering held at Hongkong from May 24-27, 2011
- Dr. Kirti Bhandari, Sr. Scientist was deputed to 9th Eastern Asia Society for Transportation Studies held at Jeju, Korea from June 20-23, 2011 to present papers entitled:
  - Planning and Assessment Framework for Analyzing the Impact of a New Public Transport in a City
  - Carbon footprint: A Tool to Quantify the Impact of Road Construction on the Environment

  Ms. Kamini Gupta, Technical Officer was deputed for oral presentation of the paper entitled "Provision of Sustainable Road Transport Infrastructures – A Urban Corridor in Delhi" in International Conference for "Women Engineers and Scientists (ICWES15) at Adelaide, Australia from July 19-22, 2011.
- Dr. Mukti Advani, Scientist was deputed for oral presentation of the paper entitled "Measuring Safety, Accessibility and Mobility of People Living Adjacent to a National Highway of India in 3rd International Conference on Road Safety and Simulation at Indianapolis, Indiana, USA from Sept. 14-16, 2011.
- Dr E Madhu, Senior Scientist was deputed to attend EITRAIN Meeting on Investigation of the Opportunities for International Cooperation in Transport Research at Brussels, Belgium from Oct. 17–18, 2011.
- Dr Purnima Parida, Principal Scientist was deputed to participate as a speaker in World Congress on Mobility for the Future of Sustainable Cities, Changwon 2011 in South Korea from Oct. 22–24, 2011.
- Shri T K Amla, Sr. Principal Scientist was deputed to setup CRRI Pavilion in the technical exhibition organised during 2nd African Road Safety Conference cum Exhibition at Addis Ababa at Ethiopia from Nov. 9-11, 2011.
- Dr. Niraj Sharma, Principal Scientist was deputed to attend UKIRI stakeholders workshop on Sustainable Air Quality Management Strategies in UK and India: Monitoring, Modelling & Management (m3) at Newcastle University, U.K from Nov. 26,–Dec. 1, 2011.
- Dr. S Velmurugan, Principal Scientist and Sh Binod Kumar, Scientist were deputed to attend 91st Annual Meeting of Transportation Research Board (TRB) and to present the papers at Washington from Jan. 22-26, 2012.
- Dr. S Velmurugan, Principal Scientist was deputed to attend 4th Indo-American Frontiers of Engineers (IAFOE) Symposium held at Bethesda, Maryland, U.S during Feb. 29 – March 3, 2012.

Student Name	Course Being Pursued	Title of the Training / Research Report
ABES Institute of Technology, Ghaziabad		
Ashish Kumar Swami	B.Tech	Electronic Equipment in Highway Engineering
Akshay Jain	B.Tech (CS)	Development of a Matrix Calculator for Transportation Planning
Alfalah School of Engineering and Technology, Faridabad		
Faishal Ahmed Khan	B.Tech (EEE)	Sub-station Desiging & DG set
Abdul Wahab	B.Tech (Mechnical)	Refrigeration and Air Conditioning System
Akmal Siddique	B.Tech (Mechnical)	-do-
Irshad Alam	B.Tech (Mechnical)	-do-
Emran Khan	B.Tech (Mechnical)	-do-
Amity School of Engineering and Technology, Amity University, Noida		
Ananya Bijaya	B.Tech, (Civil)	Modelling Travel Time Reliability of Road Network
Gaurav Gupta	B.Tech, (Civil)	Impact of Varying Driving Behaviour on Fuel Consumption Pattern on Diesel Driven Cars and Critical Comparsion with Steady State Fuel Consumption
Apoorba Bieka	B.Tech, (Civil)	Impact of Varying Driving Behaviour on Fuel Consumption Pattern on Petrol Driven Cars and Critical Comparsion of with Steady State Fuel Consumption
Anna University, Chennai		
Aneeesh R G	M.E	Modelling Travel Time Variations
Banarsidas Chandiwala Institute for Information Technology, (BCIIT), I P University		
Kamal Kishore	MCA	Road Transport R&D Network
Lalit Bhalla	MCA	-do-
Shonbir Singh	MCA	-do-
Yogesh Verma	MCA	-do-
Bengal Engineering and Science University, Howrah		
Yogesh Kr Pandey	B.Tech	Safety audit of the safety provisions for vulnerable road users on a section of NH-2 from CRRI to Appollo Hospital, New Delhi
Debaditya Ghosh	B.Tech	Estimation and modeling density on multi-lane divided expressway for Indian Traffic Conditions

Student Name	Course Being Pursued	Title of the Training / Research Report
Nripojoyti Biswas	B.Tech	Traffic Characteristics at the Okhla Mor Intersection on NH-2
BITS, Pilani		
Manraj Singh	B.E(Hons)Civil Engg	Impact of Varying Traffic Composition on the Roadway Capacity of Four Lane Divided Carriageways
BITS, Sindri		
Mr Ravi Kumar	B.Tech (Civil)	Laboratory & Field Exposure for Concrete Road Construction
Delhi College of Engineering, Delhi		
Anchal Agarwal	ME (Environmental Engg)	Vehicle Pollution Model using (ALIVE-4 model) under Mixed Traffic Condition
Delhi Technological University		
Greesham Anand	B.Tech (Automobile Engg)	Variability in Vehicle Fuel Consumption under controlled conditions for a diesel vehicle (TATA sumo)
Dr Ambedkar Instt of Technology for Handicapped, Kanpur		
Praveen Govind Verma	B.Tech, CSE	Inventory List of Machine
Echlon Institute of Technology, Maharishi Dayanand University		
Aditi Sharma	B.Tech	Electronic Equipment in Highway Engineering
Richa Gupta	B.Tech	-do-
GTBPI		
ogminder Singh	Diploma (Mechnical Engg)	Machine Shop
anish Negi	Diploma (Mechnical Engg)	do
nand Ojha	Diploma (Mechnical Engg)	-do-
ushpendu Mondal	Diploma (Mechnical Engg)	To Study the Refrigeration Machine
Gurgoan Instt of Technology & Management		
Pinky	B.Tech (Electronics & Comm. Engg)	Data Acquisition System Using Labview

Student Name	Course Being Pursued	Title of the Training / Research Report
Guru Govind Singh University		
Nidhi Prabhakar	MSc (Environmental Management)	Variation in particulate levels (PM 10, PM 2.5 and PM 1) in the outdoor and indoor environments of a metro station
Ridhi saluja	MSc (Environmental Management)	Passenger travel behavior and its environmental implications - a case study of Delhi
Manisha Gaur	MSc (Environmental Management)	Real time monitoring of particulate matter and total volatile organic compounds in Indoor environments
Shweta Garg	MSc (Environmental Management)	Monitoring of PM-10 an VOC in hot mix Plant
Guru Tegh Bahadur Institute of Technology		
Nikhal Garg	B.Tech, Information Technolgoy	Computer Networking and Security
H R Institute of Technology, Ghaziabad		
Nikhil Chowdhary	B Tech (EEE)	Electronic devices for measurement of pavement surface condition and road geometrics
Vaibhav Saxena	B Tech (EEE)	-do-
Varun Kumar	B Tech (EEE)	-do-
Deepali Verma	B Tech (EEE)	-do-
Haryana College of Technology & Management		
Vipul Kaushik	B.Tech, Civil	Laboratory Testing of Soils
Indian Institute of Technology, Gwahati		
Divyam Beniwal	B.Tech	Basic Concept of Pavement Evaluation
Indian Institute of Technology, Kharagpur		
Deepak Boora	B.Tech, Civil	Road inventory pavement condition surveying using automated road survey system
Manohar Nandigam	B.Tech	Analysing particulate matter dispersion pattern using air dispersion modeling software (ADMS).
Vijayta Sharma	M.Tech	Refinement of the developed free speed equations for high speed corridor

Student Name	Course Being Pursued	Title of the Training / Research Report
Indira Gandhi National Open University		
Hina	MCA	CRRI website
Priya Sharma	MCA	-do-
Rakhi	MCA	Development of Software for Performance Evaluation
Institute of Instrumentation Engineering, Kurukshetra University		
Sneha Kumari	B.Tech (Instrumentation)	Electronic Equipment in Highway Engineering
International College for Girls, Jaipur		
Priti Saini	M.Sc (Environment Science)	Study of Surface Ozone Conc. in Ambient Air of Delhi
Jagannath International Management School		
Sonali Saxena	BCA	ERP (Enterprise Resource Planning)
Satya Sinha	BCA	-do-
Chetna Bhatla	BCA	-do-
Akansha Sood	BCA	-do-
Jamia Millia Islamia		
Mayank Goyal	B.Tech	Bridges and Structures
JSS Academy of Technical Education		
Saurabh Kumar Gupta	B.Tech (Civil)	Design of Superstructure for a T-Beam Concrete Bridges
Vipin Kumar	B.Tech (Civil)	Study of Prestressed Concrete Girder and its End Anchorage
Kasturba Polytechnic for Women		
Pallvi	Diploma in Civil engineering	Study on possible improvement in the strength properties of soil by using new generation additudes
Neetu	Diploma in Civil engineering	Evaluation of bituminous road construction materials
Bhawna	Diploma in Civil engineering	Evaluation of materials used in road construction
Niharika Sudan	Diploma in Civil engineering	Testing of highway materials and bituminous mix design

Student Name	Course Being Pursued	Title of the Training / Research Report
Krishna Instt of Engineering and Technology, Ghaziabad		
Sarika Awasthi	B.Tech (Civil)	Data acquisition of accelerated pavement testing facilities
Aayush Bhardwaj	B.Tech (Civil)	Analysis of longitudinal profile under heavy loading condition using accelerated pavement testing facitlities
Lingaya's University, Nachauli, Old Faridabad-Jasana Road, Faridabad		
Neha Ranjan	B.Tech (Electronics & Comm. Engg)	Data acquisition systems using Lab View
Nitin Mohan Sharma	B.Tech (Civil)	Various laboratory experiments, procedures and tests related to road building materials.
Akshay Parashar	B.Tech (Civil)	-do-
G Kiran	B.Tech (Civil)	-do-
Kapil Saini	B.Tech (Civil)	-do-
Sonu Panchal	B.Tech (Civil)	-do-
Anubhav Sharma	B.Tech (Civil)	-do-
Lovely Professional University, Phagwara, Punjab		
Saurabh Kumar Sharma	B.Tech (Civil)	Suitability of Geo cells in road pavements
Sagar Dutt	B.Tech, (CSE)	Tools for traffic congestion management and data center development
Isha Sharma	B.Tech, (CSE)	-do-
Varsha Saini	B.Tech, (CSE)	-do-
Preeti Joshi	B.Tech, (CSE)	-do-
Deepshikha	MSc(Chemsitry)	Ground water assessement and its physical and chemical parameter.
Nidhi	MSc(Chemsitry)	Effect of automobile pollution on plants
Renu Pathania	MSc(Chemsitry)	-do-
Ramesh Kumar Janni	MSc(Chemsitry)	Ground water assessement and quality control

Student Name	Course Being Pursued	Title of the Training / Research Report
National Institute of Technology, Calicut		
Susan Thomas	M.Tech (Traffic & Transportation)	Validation of speed-flow relationships and estimation of roadway capacity of four lane divided carriageways across varying terrains
Asnidha V	M.Tech (Traffic & Transportation)	Evaluation of effect of segregation of non motorised traffic at a signalised intersection in Delhi
Anudeva V S	M.Tech (Traffic & Transportation)	Safety implications on helmet usage by two wheeler riders in India
Archana Rajesh	M.Tech (Traffic & Transportation)	Distracted driving in simulated environment: present challenges and mitigation
National Institute of Technology , Hamirpur		
Anupam Singh	B.Tech (Mechnical)	Refrigeration & Air conditioning
National Institute of Technology, Kurukshetra		
Jagmohan Yadav	B.tech, (Civil)	Laboratory evalutaion of recycled bituminous mixes
Vipin Sharma	B.tech, (Civil)	-do-
National Institute of Technology, Patna		
Ankur Agnihotri	B.Tech(Civil)	Testing of Bitumen Emulsion
Gaurav Goyal	B.Tech(Civil)	Laboratory studies on use of warm-mix additive in Bituminous construction
Rahul Kumar	B.Tech(Civil)	-do-
National Institute of Technology, Silchar		
Amit Kumar	B.Tech (Civil)	Driving cycle for car for ring road (Maharani Bagh to Rajouri Garden) in Delhi
Uttam Kr Jha	B.Tech (Civil)	Driving cycle for car for Janak Puri DC to Madhuban Chowk (Outer Ring Road) in Delhi
Abhishek Kumar	B.Tech (Civil)	Driving cycle for car for Ashram to ISBT (Ring Road) and ISBT to Madhuban Chowk (Outer Ring Road) in Delhi

Student Name	Course Being Pursued	Title of the Training / Research Report
National Institute of Technology, Surathkal		
Divia N S	M.Tech	Travel time reliability based traffic assignment model for road network.
Monisha M	M.Tech	Car driving cycle in East Delhi (Yojana Vihar to Karkarduma Via Geeta Colony
Nisha G	M.Tech	Development of multimodal level of service measures for urban roads of India
Athira S S	M.Tech	Value of Travel Time Reliabiligy commuter's route choice behaviour in urban Arterial roads of Delhi- A Case Study
Rahul Sudarsan	M.Tech	Evaluation of roadway capacity for multi-lane highway with microscopic traffic simulation
Divia N S	M.Tech	Travel time reliability based route choice modelling for an urban road network
Liben Varghese Babu	M.Tech	Evaluation of transportation infrastructure improvements along an urban road corridor using VISSIM- A case study of Lucknow City
Devi S	M.Tech (Transportation Systems Engineering)	Micro-Simulationn based driving cycle for sustainable transport system
Sanoop Chandran C	M.Tech	Air pollution modelling using ADMS-Urban
Rahul Sudarsan	M.Tech	Evaluation of roadway capacity for multi-lane high with microscopic traffic simulation
Mr Achutha S	Master in civil Engg	Accessing road compaction impact on life cycle of road projects using HDM-4
National Institute of Technology, Tiruchirappalli		
Avi Garg	B.Tech, (Civil)	State of art of utilisation of waste materials
Nikunj Tomar	B.Tech, (Civil)	-do-
Aditi Rajbansh	B.Tech, (Civil)	Consideration for elderly population transport planning.
Prince Institute of Innovative Technology, Greater Noida		
Mohit Kumar	B.Tech	A study of traffic characteristics of a section of Mathura Road (NH-2) in Delhi

Student Name	Course Being Pursued	Title of the Training / Research Report
RASTA Center for Road Technology		
Niranjan G Hiremath	M.Tech	Driver Psychology & behaviour on roads
Sardar Vallabhbhai National Institute of Technology,Surat		
Mr Krishna Saw	M.Tech	Comparative study of laboratory performance of PMB 40 with warm mix - adhesion promoter in bituminous mixes
Munshi Ramiz Raja	M.Tech	-do-
Vagadia Dinesh	M.Tech	Study of accidents on yamuna expressway joining Noida & Greater Noida
Doshi Parth	M.Tech	-do-
Mansha Swami	M.Tech	Laboratory investigations and performance review of SMA with modiifed binders
Sharda University, School of Engineering and Technology		
Manu Vashist	B.Tech (EC)	Instrumentation technology for field monitoring of bridges
Bhanu Tiwari	B.Tech ECE	Electronic equipment in Highway Engineering
SRM, University		
Adhishree Jain	B.Tech (Civil)	Study on Bridges
Vikash Kumar	B.Tech (Civil)	Study on Bridges
SRMS, Bareilly		
Manish Taishra	MCA	Pavement data management system
Tecnia Instt of Advanced Studies, Guru Govind Singh Indraprastha University		
Neha	MCA	Integration of GPS & GIS data for traffic congestion management
TERI University, Vasant Kunj		
Neeti Suhag	Msc, (Environmental Studies)	Ambient air quality monitoring at roadside corridors
Shikha Jain	Msc, (Environmental Studies)	-do-

Student Name	Course Being Pursued	Title of the Training / Research Report
UIET, Punjab University, Chandigarh		
Sahil	B.E (Computer sciences)	Storage area network and system administration
University School of Environment Management, GGSIU New Delhi		
Pradhat Kashyap	M.SC (Environment Management)	Study of NMHCs (C2-C4) in the ambient air of traffic intersection of Delhi
Anupam Singhal	M.SC (Environment Management)	Carbon Foot Printing
Arunima Arya	M.SC (Environment Management)	Carbon Foot Printing
World college of Technology & Management		
Indrani Parimala	B.Tech, (Civil)	Water proofing including Site visit, Understanding of Specificateions, work measurement , estimation of work etc.
Mohit Yadav	B.Tech, (Civil)	-do-
YMCA Institute of Office Management		
Neelam Negi	Office Management	Secretarial Assistance like file arrangement, typing etc

S.No.	Name of Visitors	Date of Visit	Purpose of Visit
1	A delegation from Netherland	April 1, 2011.	Visited the Institute and held discussion with the Sr. Scientists
2	Dr Colin Franco PE, Chief Engineer of Materials and Research, Rhode Island Department of Transportation, USA	April 8, 2011.	Presentation on Eco Friendly Lasting Pavements
3	Shri C. Ramana Kumar, Sr. Manager, Sitech India North & East Tractor India Pvt. Ltd., Gurgaon	April 5, 2011.	Presentation on Trimble Quantum Alignment Planning System for Roads
4	Dr Abel Gasper Rosas, Technical & Export Sales Director, M/s TA Instrument – Thermal Analysis & Rheology	May 23, 2011.	Technical presentation on Asphalt Rheometer Applications
5	Prof. S. L. Dhingra, Emeritus Professor, IIT Mumbai,	June 17, 2011.	Presentation on Comparative Evaluation of Underground Vs. Elevated Metro Systems
6	Dr Sundaram Logras & Mr Michael Tan, M/s Akzonobel	June 20, 2011.	Presentation on Road Construction Technologies – Warm Mix Technology, Microsurfacing and Chip Seal Application
7	Expert from Quality Council of India-National Accreditation Board for Education and Training (QCI-NABET)	July 6-7 2011	Assessment related to accreditation of CRRI as Environmental Impact Assessment Consulting Organisation
8	Prof. Shinji, Department of Civil Engineering Yama Guchi University, Japan	Aug.5, 2011	Presentation on Dust Measurement and Monitoring by Mobile Phone Camera at Construction Site
9	Dr. Todal Litman, Executive Director, Victoria Transport Policy Institute, Canada	Dec. 8, 2011	Presentation on Transportation Planning
10	Prof. Serji Amir Khanian	Dec. 12, 2011.	Technical presentation on Modified Bitumen
11	Mr. Imad L. Al Quadi, Founder Professor of Engineering, Director ICT and ATREL	Dec. 12, 2011	Presentation on Optimizing Ground Penetrating Data Interpretation for Proper Pavement Assessment
12	Prof. Shrinivas S. Arkatkar, Birla Institute of Technology and Science	January 16, 2012.	Visited the Institute and held discussions with Scientists
13	Dr Umesh Dayal, Senior Lead Engineer, M/s Paul C. Rizzo Associates Inc., Pittsburgh, PA, USA	February 7, 2012.	Presentation on Sustainability and Geotechnical Engineering.
14	Mr. Tal Gryam, Managing Director, TAAL Collaborative Solutions Pvt. Ltd.,	March 19, 2012.	Presentation on Green Geopolymers, Construction Materials for Sustainable Development and Use of 100% Flyash
15	Mr. P. Chris Gibson, Support and Engineering Applications Manager for VTI Instrument, Lake Stevens Instrument Group, Washington	March 22, 2012.	Presentation on Instrumentation for Roads, Bridges and Tunnel & Structural and Model Analysis

Membership of the Staff on Various Technical Committees

Highway Research Board of IRC

S.No.	Committee	Representative's Name	Position held
1.	Highway Research Board	Dr. S. Gangopadhyay	Member
2.	HRB Identification, Monitoring & Research Application Committee	Dr. S. Gangopadhyay Sh. U. K. Guruvittal Dr.Lakshmy P	Convenor Member-Secretary Member
3.	Highway Research Board Core Group	Dr. S. Gangopadhyay	Member
4.	Accreditation of New Materials and Techniques	Dr. S. Gangopadhyay Dr. P. K. Jain Sh. U. K. Guruvittal	Chairman Member Member

Indian Roads Congress, New Delhi

S.No.	Committee	Representative's Name	Position held
1.	Council of Indian Roads Congress	Dr. S. Gangopadhyay Dr. Purnima Parida Dr.Lakshmy P	Member Member Member
2.	H-1 Transportation Planning, Traffic Engg. & Road Safety, Committee	Dr. S. Gangopadhyay Dr. S. Velmurugan Dr. Nishi Mittal	Co-convenor Member-Secretary Member
3.	H-2 Flexible Pavement Committee	Sh.K.Sitaramanjaneyulu Dr.P.K.Jain	Member Member
4.	H-3 Rigid Pavement Committee	Sh.J.B.Sen Gupta Sh.K.Sitaramanjaneyulu	Co-convenor Member
5.	Highway Specifications & Standards Committee	Dr. S. Gangopadhyay	Member
6.	Bridge Specification & Standards Committee	Dr.Lakshmy P	Member
7.	B-2 Load and Stresses Committee	Dr.Lakshmy P	Member-Secretary
8.	Managing Committee of Indian National Group of the International Association of Bridges & Structural Engineering	Dr. Ram Kumar	Member
9.	Chief Engineer Committee	Director	Member
10.	G-2 Human Resource Development	Sh. T.K. Amla	Member
11.	G-3 Reduction of Carbon Footprint in Road Construction and Environment	Dr. Anuradha Shukla	Member
12.	G-4 GSS Committee	D.C.Sharma	Member
13.	G-6 Disaster Mitigation Committee	Dr. Kishor Kumar	Member
14.	G-4 Mechanisation Committee	Dr. Devesh Tiwari Sh.R.S.Bhardwaj	Member Member

S.No.	Committee	Representative's Name	Position held
15.	H-4 Embankment, Ground Improvement and Drainage Committee	Sh. Sudhir Mathur Sh. U. K. Guruvittal	Member-Secretary Member
16.	H-6 Road Maintenance and Asset Management	Dr.P.K.Jain Sh.K.Sitaramanjaneyulu	Member Member-Secretary
17.	H-5 Rural Roads Committee	Dr.P.K.Jain Dr.Lakshmy P	Member Member
18.	H-8 Urban Roads, Streets & Transportation Committee	Dr. S. Gangopadhyay Dr. Purnima Parida	Member Correspondence Member
19.	H-9 Composite Pavement Committee	Sh.K.Sitaramanjaneyulu	Member
20.	B-4 Concrete (Reinforced and Prestressed) Structures	Dr.Lakshmy P Dr. Rajeev Goel	Member Member
21.	B-5 Steel and Composite Structure	Dr.Lakshmy P	Member
22.	B-6 Bearings, Joints & Appurtenances	Dr.Suraj Prakash	Member
23.	B-8 Bridge Maintenance and Rehabilitation Committee	Dr. V. V. L. K. Rao	Member
24.	G-3 Environment Committee	Dr. Anuradha Shukla Dr. Niraj Sharma	Member Corresponding Member
25.	G-5 Instrumentation Committee	Dr.Lakshmy P P. Prasanna Kumar D.C.Sharma Sh.Binod Kumar	Member Co-convenor (upto Oct. 11) Co-convenor wef Nov 11 Member
26.	Form Work and Temporary Structures Committee	J.K.Goyal	Member

Bureau of Indian Standards, New Delhi

S.No.	Committee	Representative's Name	Position held
1.	Civil Engineering Division Council, CED	Director Dr.Lakshmy P	Member Member
2.	Standards Advisory Committee	Director	Member
3.	Executive Council	Director	Member
4.	Cement & Concrete Sectional Committee, CED 2.1	Dr. Ram Kumar	Member
5.	Building Lime & Gypsum Products Sectional Committee, CED4	Sh. Sudhir Mathur	Member
6.	Plain Reinforced and Prestressed Concrete CED 46:P8	Dr. Rajeev Goel	Alternate-Member
7.	Soil Engineering Sectional Committee CED23	Sh. Sudhir Mathur Sh. U.K. Guruvittal	Member Alternate-Member

Membership of the Staff on Various Technical Committees

S.No.	Committee	Representative's Name	Position held
8.	Rock Mechanics Sectional Committee, CED18	Dr. Kishor Kumar Dr. Pankaj Gupta Sh. U.K. Guruvittal	Member Alternate Member Member
9.	Freight Containers Sectional Committee, HMD-12	Dr.S.Gangopadhyay	Member
10.	Soil and Foundation Engineering Sectional Committee, CED-43	Sh. Sudhir Mathur Sh. U.K. Guruvittal	Member Alternate Member
11.	Geo-Synthetics Sectional Committee, CED-45	Sh. Sudhir Mathur Sh. U.K. Guruvittal	Member Alternate Member
12.	Stone Sectional Committee	Sh.K.Sitaramanjaneyulu	Member
13.	Concrete Reinforcement CED54	Dr. Ram Kumar	Member
14	Geotechnical Investigation, Testing and Instrumentation (43.1)	Sh. U.K. Guruvittal	Member
15.	Earthquake Engineering Sectional Committee CED 39 in drafting group PG7	Dr. Ram Kumar	Member
16.	Bitumen, Tar & Their Products Sectional Committee, PCD – 6	Director Dr.P.K,Jain	Convenor Member
17.	Bitumen & Bituminous Product Sub-Committee, PCD 6:2	Dr.P.K,Jain	Member
18.	Hill Area Development Engineering Sub-Committee, PCD-56	Dr. Kishor Kumar Sh. Sudhir Mathur	Member Alternate-Member
19.	Cyclone Resistance Design of Structures, CED-57	Dr. R.K. Garg	Member
20.	Cement Matrix Products CED–53	Dr. Ram Kumar	Member
21.	Environment Protection and Waste Management	Dr. Anil Singh	Member
22.	Special Structures Sectional Committee CED 38	Dr. Ram Kumar Dr. Suraj Prakash	Member Alternate-Member
23.	Expert Group on Modified Bitumen Emulsions	Dr.P.K,Jain	Convenor
24.	BIS-FICCI Task Force to Formulate Specifications for Major Technical Areas of Textiles	Sh. Satish Pandey Sh. U.K. Guruvittal	Member Member
25.	Export Group Specifications for Cold Bituminous Ready Mix for Pavement Maintenance	Dr.P.K Jain	Convenor
26.	Export Group and Round Robin Testing of Modified Binder for Viscosity Test for Modified Bitumen (Revision of IS 15462-2006)	Dr.P.K Jain	Convenor

Membership of the Staff on Various Technical Committees

Ministry of Road Transport & Highways (MoRTH) New Delhi

S.No.	Committee	Representative's Name	Position held
1.	Research Application Committee	Director	Member
2.	Transport Statistics Committee	Dr. S. Gangopadhyay	Member
3.	Committee on Upgradation of NH from 2 lane to 4 lane	Dr. S. Gangopadhyay	Member
4.	Traffic Engineering & Safety Committee	Dr. S. Gangopadhyay	Member
Delhi Traffic Police			
1.	Central Traffic Advisory Committee	Dr. S. Gangopadhyay	Member
New Delhi Municipal Corporation			
1.	Traffic Advisory Committee	Dr. S. Gangopadhyay	Member
Delhi Development Authority			
1.	Sub-group for Examination of various projects in Delhi	Dr. S. Gangopadhyay	Member
Indian Society of Wind Engineering (ICWE)			
1.	Executive Committee	Dr.Lakshmy P	Member
Institution of Engineers, Ghaziabad Local Centre			
1.	Executive Committee	Dr. Rajeev Goel Sh. A. Saurikhia	Member Honorary secretary
Ministry of Rural Development, Govt. of India			
1.	PMGSY Empowered Committee	Director Dr. B. K. Durai	Member Alternate-Member
Central Building Research Institute, Roorkee			
1.	Research Council	Director	Member
School of Planning & Architect, New Delhi			
1.	Review of Project Work of PG Student	Dr. S. Gangopadhyay	Jury Member
MCGB, Mumbai			
1.	MCGB, Mumbai Standing Advisory Committee	Director Sh. UK Guruvittal	Member Member
Delhi Pollution Control Committee for Ambient Air Quality Systems (AAQS)			
1.	Delhi Pollution Specification Committee	Dr. Anil Singh	Member
ICI, Ghaziabad Chapter			
1.	Executive Committee	Dr. Rajeev Goel Dr.Suraj Prakash	Chairman Treasurer
National Institute of Disaster Management			
1.	Committee to Formulate Guidelines for Construction of Saline Embankment	Sh. U.K. Guruvittal	Expert
Advanced Materials and Process Research Insitute, Bhopal			
1.	Management Council	Dr. S. Gangopadhyay	Member
Thana Municipal Corporation			
1.	Science & Technology Advisory Committee	Dr. S. Gangopadhyay	Member
Konkan Railway Corporation			
1.	Technical Advisory Group (TAG)	Dr. S. Gangopadhyay	Member
Centre for Development of Stones (DOS)			
1.	Group on Roads and Mass Concrete Work	Dr. A. K. Misra	Member

Membership of the Staff on Various Technical Committees

National Rural Roads Development Authority (NRRDA)

S.No.	Committee	Representative's Name	Position held
1.	Executive Committee	Dr. S. Gangopadhyay Dr. B. K. Durai	Member Alternate Member
National Highways Authority of India			
1.	Committee to Review of All Toll Related issues	Dr. B. K. Durai	Member
2.	Technical Appraisal and Review Committee for Development of Fibre Reinforced Plastic- Roadside Barriers	Dr. Nishi Mittal	Member
World Bank Aided Project to Uttar Pradesh State Highway Authority (UPSHA)			
1.	Technical Scrutiny	Sh. Sunil Jain Dr. Devesh Tiwari	Member Member
2.	GIS Expert	Sh. Pradeep Kumar Dr. Devesh Tiwari	Member Member
Public Works Department			
1.	Committee on Subway	Sh. Subhash Chand	Technical Member
National Physical Laboratery, New Delhi			
1.	Management Council	Dr. S. Gangopadhyay	Member
National Institute of Science, Technology and Development Studies			
1.	Research Council	Dr. S. Gangopadhyay	Member
Delhi Technical University			
1.	Review Project Work of PG Students	Dr.Lakshmy P	Jury-Member
2.	Review Project Work of UG	Dr.Lakshmy P	Jury-Member
Pune Municipal Corporation			
1.	Standing Technical Advisory Committee(STAC) for Road Development	Dr.P.K.Jain	Member
MOEF, Govt of India.			
1.	Expert Appraisal Committee on CRZ, Infrastructure & Miscellaneous Projects, New Construction and Industrial Estate Project	Dr.Niraj Sharma	Member
Delhi Police			
1.	Technical Committee	P. Prasanna Kumar	Member

- Australian Road Research Board (ARRB)
- Bureau of Indian Standards, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi
- Indian Institute of Bridge Engineers (IIBS), New Delhi
- International Road Federation (IRF) Washington
- Indian Association of Special Libraries and Information Centres, Kakugachi, Kolkata
- Indian National Group of International Society for Rock Mechanics, Central Board of Irrigation and Power, Malcha Marga, Chanakyapuri, New Delhi
- Indian Society of Desert Technology, College of Engineering, Jodhpur, Rajasthan
- Asian Information Centre for Geotechnical Engineering, Bangkok, Thailand
- Permanent International Association of Road Congress, 43, Avenue D4, President Wilson 75116, Paris, France
- Indian Scientific Translators Association, New Delhi
- Transportation Research Board of the National Academy of Science, National Research Council, 2101, Constitution Avenue, Washington DC, USA
- Indian Geotechnical Society, C/o Central Soil and Material Research Station, Olof Palme Marg, Hauz Khas, New Delhi
- Indian Roads Congress, Jamnagar House, Shahjahan Road, New Delhi
- Government of Indian Librarians Association (GILA(Regd.) C/o Planning Commission, Library, Yojna Bhawan, Sansad Marg, New Delhi
- Society for Information Science, NISCAIR Building, Hillside Road, New Delhi
- Indian Group of Geotextiles, Central Board of Irrigation & Power, Malcha Marg, Chanakyapuri, New Delhi
- Institutional Membership of Belgium Road Research Institute, Belgium
- Associate Membership of Current Science Association, Bangalore
- Asian Institute of Transport Development (AITD), New Delhi
- Institutional Membership of Consultancy Development Centre, New Delhi

Marketable Products and Services

Intellectual Property (Patents)

Patented Process Released so far to the Industry

- Bitumastic Joining Composition (Pat. No. 50474)
- Improvement in or relating to Pitch Mastic Composition (two patent No. 92526 and 95305)
- A Process for the Treatment of Styrene Pitch (Pat No. 96710)
- Improvements in or relating to the manufacture of Lime-Surkhi Mixture (Pat No. 90470)
- Improvements in or Relating to the Manufacture of Reactive Surkhi (Pat No. 93276)
- Fatigue Testing Machine (Pat No. 11142)
- Unevenness Indicators (two patent No. 121776 & 121777)
- A Profilograph for Checking Pavement Unevenness (Pat No. 121114)
- Automatic Road Unevenness Recorder (three Pat No. 146517, 146572, 146543)
- Rotiller (developed jointly by MERADO & CRRI)
- Pavement Paint Marking Machine (developed jointly by CMERI Durgapur and CRRI)
- Vertical Profile Meter
- Polymer modified bitumen
- SBS Modified bitumen
- Crum Rubber Modified Bitumen
- Waste Plastic Modified Bitumen
- Axle Mounted System for Measuring Road Roughness
- Impact Tester
- A Device for Sensing and Measuring Moisture in Soil and Other Porous Materials (Pat No. 173089)
- Improved Bullock Cart Technology

Process Ready for Exploitation

- A Process for the Production of Magnesium Phosphate Cement for Emergency Repair of Concrete Pavement
- A New Paving system for desert areas
- Electronic Probe
- Process know-how for Construction of Roads in Sandy Area using Soil Stabilization Technique with Magnesium Oxy-chloride
- Indigenous Weigh-in-Notion and Vehicle Classification System
- Automated Benkleman Beam
- Concrete Abrasion Resistance Tester
- Ready Made Mix for Patch Repair
- Bitumen Emulsion
- Potable Ponding-cum-Debris Expulsion Equipment
- Design of a Mobile Visual Inspection Unit

Marketable Software

- Pavement Deterioration Model (PDM)
- Asphalt Concrete Mix Design (ASCOMID)
- Planning Model for Rural Roads
- Landslide Analysis
- Stability Analysis of Embankments with Stone Columns
- Expert System for Structural Optimisation of Trussed Girder Bridges
- Bridge Deck Analysis (BDAN)
- Software for the Accident Analysis
- Copyright for Software Package for Design of Trail Suspension Bridges
- Software "CRASH" for Prediction of Strains induced in Concrete due to Effects Creep and Shrinkage

Services Offered

Contract Research

- Collaborative Projects
- Sponsored Projects

Consultancy Services

Training Programmes

Testing & Calibration

Training Programmes Organised

For capacity building in human resources in the area of highway engineering to undertake and execute roads and runway projects, CRRI organises following regular training programme each year for the in-service highway, traffic and transportation engineers and planners. The details of the training programme organised are as follows:

TITLE OF THE COURSE	DURATION
A. PAVEMENT ENGINEERING & MATERIALS	
• Design, Construction and Maintenance of Flexible Pavements	(5 days)
• Rigid Pavements: Design, Construction & Quality Control Aspects	(5 days)
• Pavement Evaluation Techniques and their applications for Maintenance and Rehabilitation	(5 days)
B. ROAD DEVELOPMENT PLANNING & MANAGEMENT	
• International Course on Dissemination of HDM-4	(2 weeks)
• Geo-Spatial Technology (GIS, GPS, RS etc) fro Road and Transportation	(5 days)
C. GEOTECHNICAL ENGINEERING	
• Geotechnical and Landslide Investigations for Highway Projects	(5 days)
D. BRIDGES & STRUCTURES	
• Bridge Diagnostics, Performance Evaluation and Rehabilitation	(5 days)
E. TRAFFIC & TRANSPORTATION PLANNING	
• Traffic Engineering and Transportation Planning	(5 days)
• Driver Diagnostics, Performance, Evaluation and Training	(5 days)
• Environmental Impact Assessment (EIA) and Environmental Clearance Process for Road & Highway Projects	(5 days)
• Road Safety Audit	(5 days)
• Vibration and Noise Measurement and Analysis	(5 days)

Customized Tailor Made Programmes:

In addition to the above, CSIR-CRRI also organises customized tailor made programmes as per the clients requirements.

Course Fee: The course fee is payable in advance by crossed bank draft in favour of Director, Central Road Research Institute, New Delhi".

FOR FURTHER INFORMATION & SENDING NOMINATION CONTACT:

Shri T.K. Amla, Head & Course Organiser, Information, Liaison & Training Division, Central Road Research Institute, P.O.CRRI, Delhi-Mathura Road, New Delhi – 110 025 (India). Phone: 91-11-26921939, Fax: 91-11-26845943, 26830480
Telefax: 91-11-26921939, E-mail: tkamla.crri@nic.in, mkmeena.crri@nic.in

S.No.	Topic	Author	Journals
1)	The Shear-friction Aggregate Interlock Resistance across Sliding Planes in Concrete	M. Haskeett D.J Ochler M.S Ali Dr. S K Sharma	Engineering Structures Vol.33 Issue 4, April 2011, pp 1357-1364
2)	Rehabilitation and Replacement of bearings of Balram Bridge on NH-14 of East-West corridor	Atul Kumar J K Goyal Dr. Devesh Tiwari Shankh Das	Indian Highways Vol.4, April 2011
3)	Dispersion of Love Waves in a Composite Layer resting on Monoclinic Half Space	Dr. Sukumar Saha	Applied Mathematics (USA) Vol.721349. do:10.1655/2011/721349
4)	Computation of Pore Water Pressure in Embankment / Slope due to Infiltration through Finite Element Modelling	Dr. Sukumar Saha	International Journal of Applied Mathematics and Mechanics (IJAMM) ISSN0973-0184, Vol.2, N.I.2(2011) pp.67-76
5)	Investigation & Design for Restoration of Hill slopes in Mizoram	R K Panigrahi U K Guruvittal P S Prasad Sudhir Mathur Dr.Pankaj Gupta	Indian Geotechnical Journal, 41(4), 2011 pp 215-225.
6)	R&D in Road Transportation Sector – CSIR-CRRI	Dr. S Gangopadhyay U K Guruvittal	New Building Materials and Construction World, 2011, pp. 25-30
7)	A knowledge based Database on Municipal Waste in Road Construction Applications	Dr. P Pramada Valli Sudhir Mathur	Soft Computing and Engineering, Vol.1, Issue 4, pp. 1-20.
8)	Development of Free Speed Equations for Assessment of Road User Cost on High Speed Multi-lane Carriageways of India on Plain Terrain.	Dr.M Errampalli Dr.S Velmurugan Dr.K Ravinder Dr.J Nataraju	Journal of Current Science, 100(9) pp. 1362-1372
9)	Carbon Footprint: A Tool to Quantify the Impact of Road Construction on the Environment	Dr. Kirti Bhandari , Dr. Anuradha Shukla Dr.S Gangopadhyay	Journal of the Eastern Asian Society for Transportation Studies, Vol.9. 7430-755
10)	Atmospheric Dispersion Modelling of Pollutant at Selected Urban Corridor in Delhi using ADMS.	Dr. S Padma Likith Reddy, Dr. Anuradha Shukla	Indian Journal of Air Pollution Control, Vol. XI No.1.69 – 74, ISSN 0250-5231
11)	Evaluation of Suitability of Oil Well Drill Cuttings for Road Making	Dr. A K Mishra, Dr. Renu Mathur, Pankaj Goel Manoj Kumar Singh	Journal of Scientific and Industrial Res NISCAIR, Vol.69, pp 67-72, April 11.

S.No.	Topic	Author	Journals
12)	Construction of Sustainable Bituminous Roads with Emulsion Based Cold Mix Technology in India	Dr. N K S Pundhir	Construction Business Today, May 2011.
13)	Evaluation of Traffic and Transportation Characteristics of Delhi	Dr.E.Madhu Dr. K Ravinder Dr. S Velmurugan	Institute of Urban Transport Journal, June, 2011.
14)	Mitigation of Rutting in Bituminous Roads by Use of Waste Polymeric Packaging Materials	Dr. P K Jain Shanta Kumar J B Sengupta	Indian Journal of Engineering and Material Science, Vol.18, June, 2011, pp. 233-238
15)	Impact of Road Crasher on the Poor in India	Dr. Nishi Mittal Dr. S Gangopadhyay	Indian Highways, Vol.39, No.6, June, 2011.
16)	Road Rage and Implementation Plan	Dr. Neelima Chakraborty Dr. Nishi Mittal Shalini Sharma	Indian Journal of Scientific and Industrial Research, BVAAP, Vol.19(1), June 2011
17)	Greenhouse Gas Inventory Estimates for India	Dr. S K Sharma ,A Chaudhury P Sarkar, S Biswas Dr. Anil Singh, P K Didhich A K Singh, S Majumdar A Bhata, M Mohini R Kumar, C S Jha M S R Murthy N H Ravindranath J K Bhattacharya M Karthik S Bhattacharya R Chauhan	Current Science, Vol.101, No.3, 405-415, Aug, 2011
18)	Opportunities & Challenge for use of Nanotechnology in Cement Based Materials	Dr. Rakesh Kumar Dr. Renu Mathur Dr. Arun Kumar Misra	New Building Materials and Construction World, New Delhi, Vol.17, Issue 2, pp.170-178, Aug, 2011
19)	Analysis of travel-time variation over multiple sections of Haushin Expressway in Japan	Dr. Ravi Sekhar Dr. B K Durai Dr.E Madhu Dr. S Gangopadhyay	Urban Transport Journal, Vol. 10 No.1, Aug. 2011
20)	Genetic Alogorithm Based Neural Network Model for Mode Choice Analysis	Dr. Ravi Sekhar Dr. B K Durai Dr.E Madhu Dr. S Gangopadhyay	Urban Transport Journal Vol. 10, No.1, Aug 2011

S.No.	Topic	Author	Journals
21)	Systematic Identification of Bottlenecks of Urban Arterials: a Case Study	A. Mohan Rao K. Ramachandra Rao	Urban Transport Journal, Vol.10, No.1 Aug, 2011
22)	A Study of Road Crashes along the High Speed Corridors of India	Dr.S Padma Dr. E Madhu M Shah Pranay Dr. Anuradha Shukla Dr. S Gangopadhyay	Journal of Road Transport No.3, July-Sept, 2011.
23)	Safe and Environmentally Pleasing Pedestrian Facilities In And around Delhi Metro Railway Stations	Dr. Nishi Mittal	Indian Highways, Vol. 39, No.9, Sept, 2011
24)	White topping – an Engineered Economical Long-Lasting solution for Distressed Roads	Dr. Rakesh Kumar Dr. Renu Mathur	New Building Materials and Construction World, New Delhi, Vol.17, Issue 3, pp.244-248, Sept, 2011
25)	Use of Geosynthetic Material for Reinforced Earth Wall Construction	Dr.V G Havanagi A K Sinha Sudhir Mathur	Journal of New Building Materials and Construction World, New Delhi, Vol.17(3), pp. 232-243
26)	New Barge Impact Provision in IRC:6 for Design of Bridges located in Water Ways	Dr. P Lakshmy Alok Bhowmik T. Vishwanathan	Indian Highways, Vol. 39, No.10, pp.17-22, Oct, 2011
27)	Distress in Concrete pavement: A case study Of Delhi-Mathura National Highway	Binod Kumar Dr.S D Sharma Dr. Renu Mathur	Indian Highways, Vol. 39, No.10, Oct, 2011
28)	Design of Sidewalks using Pedestrians Flow Models	Dr. Purnima Parida Dr. M Parida Dr.S Gangopadhyay	Journal of Road Transport, No.4, Oct-Dec, 2011
29)	Driver Training: an effective Tool for Improving Road Safety in India	Dr. Neelima Chakraborty Dr. Anuradha Shukla H Singh Nancy Shokeen	Journal of Engineering and Technology July-Dec, 2011 Vol.1, Issue 2, JET-28-IIR2
30)	Modelling Time Mean Speed and Space Mean Speed for Heterogeneous Traffic Conditions	Dr. S Padma Dr. M Errampalli Dr. S Velmurugan Dr. Anuradha Shukla Dr. S Gangopadhyay	Transportation Planning and Techn Vol.34, No.8, Dec, 2011, 823-838
31)	Influence of types of Coarse Aggregates on the coefficient of Thermal Expansion of Concrete	Tarun R. Naik Rudolph N. Kraus Rakesh Kumar	Journal of Materials in Civil Engineerig, Vo No.1, pp.312-317, 2011

S.No.	Topic	Author	Journals
32)	Recommendations for Driver Licensing and Traffic Law Enforcement in India Aiming to Improve Road safety and mobility	Ashish Verma Dr. S Velmurugan Dr.Neelima Chakraborty Sushma Srinivas	Special Issue on Current Science Journal on Sustainable Transportation System for Utility of Developing countries, Vol.100, pp.1377-1385
33)	Critical Evaluation of Roadway Capacity of Multi-lane High Speed corridors under Heterogeneous Traffic conditions through Traditional and Microscopic simulation Models.	Dr.S Velmurugan Dr. M Errampalli Dr. K Ravinder K Sitaramanjaenyulu Dr. S Gangopadhyay	Indian Roads Congress, Vol. 71(3), pp.235-266
34)	A Laboratory Study on efficacy of Conventional and Modified Bituminous Binders in Construction of Roads	Somna Nishal Dr. Sangita, B M Sharma J B Sengupta	Indian Highways, Vol.40, No.1, pp.13-20, Jan, 2012
35)	Development of High-strength Economical Self compacting concrete	Tarun R. Naik Dr. Rakesh Kumar Bruce W. Ramme Fethullah Canpolat	Construction and Building Materials, Vol.30, pp.463-469
36)	Construction of Embankment and Sub-grade using Jarofix (Zinc Ore Waste) – a Case Study	A K Sinha Dr V G Havangi V K Arora Sudhir Mathur	Civil Engineerig & Construction Review, (CE&CR), Vol.25(3), pp.98-103.
37)	Warm bituminous mixes : the Wave of the Future	Ambika Behl Dr.Sunil Bose Gajender Kumar Girish Sharma	Journal of Indian Road Congress, Vol.72, 2011
38)	Recycling Jarofix waste as a construction material for embankment and subgrade	V G Havangi A K Sinha V K Arora Alok Ranjan Sudhir Mathur	Journal of Solid Waste Technology and Management, USA, 2011
39)	Investigation and remedial measures of Hnathinal Landslide, Mizoram	Dr. V G Havangi A K Sinha V K Arora Alok Ranjan Sudhir Mathur	Journal of National Institute of Disaster Management, New Delhi, 2011
40)	Amending Licensing System for Proper Driver Behaviour	Ashish Verma Dr. S Velmurugan Dr. Neelima Chakraborty	Traffic Infra Technology, Vol.2, Issue 3, Dec 11 – Jan 12 pp. 50-55
41)	Performance of Premix Carpet and Semi-dense Bituminous Concrete laid with Emulsion based Cold Mix Technology	Dr. N K S Pundhir	Journal of Indian Roads Congress, Vol.73-1, March, 2012.

S.No.	Topic	Author	Journals
42)	Effects of Waste Polymer Modifier on the Properties of Bituminous Concrete Mixes	Dr. Sangita Trabrez Alam Khan Sabina D K Sharma	Construction and Building Materials (2011), pp. 3841 - 3848
43)	दिल्ली बस रैपिड (बीआरटी) के वास्तविक ड्राइविंग चक्र का विकास और वायु प्रदूषण परिदृश्य	डा. रवीन्द्र कुमार, कामनी गुप्ता एव डा. बी कनकदुरई	भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका, वर्ष 19 अंक 2 जून 2011
44)	भारत में परिसंकटमय सामग्रियों के सड़क परिवहन के दौरान पर्यावरण संरक्षण, सड़क सुरक्षा मुद्दे एवं संबंधित नियम	डा. नीरज शर्मा, पुष्पिंदर कौर, रजनी भ्यानी, डा. एस. गंगोपाध्याय	-do-
45)	नॉन मिथेन हाइड्रोकार्बन के उत्सर्जन का बाहुल्य क्षेत्र: राजधानी दिल्ली	निधि तारसौलिया, सिप्पी कालरा चौहान, अनुराधा शुक्ला	भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका, वर्ष 19 अंक 2 दिसम्बर 2011
46)	सेतु बीम पर बाहरी ईपोक्सी चिपकी प्लेट द्वारा सुदृढ़ीकरण तकनीक की समस्या	डॉ. एस. के. शर्मा, सुशील कुमार	सड़क दर्पण अंक 8 वर्ष 2012
47)	अपर्याप्त तराई का कंक्रीट की सामर्थ्य और टिकाऊपन पर प्रभाव	डॉ राकेश कुमार, नरेन्द्र कुमार	-do-
48)	स्टोन मास्टिक एस्फाल्ट (एसएमए) का शहरी सड़कों के रखरखाव में उपयोग-एक प्रयोगात्मक अध्ययन	डॉ. पी के जैन, सी. कामराज, बी. एम.शर्मा, बी.एस.निगम	-do-
49)	कंक्रीट सेतु में दरारों की उत्पत्तिकरण एवं समाधान	सुशील कुमार, डॉ. एस के. शर्मा एवं डॉ. लक्ष्मी परमेश्वरन्	-do-
50)	सड़क परिवहन और पर्यावरणीय प्रदूषण	शालिनी शर्मा, सिम्मीदत्ता, अनुराधा शुक्ला, सिप्पी चौहान	-do-
51)	मिट्टी के भू-आभियांत्रिक गुणों के निर्धारण में कण-आकार एवं आकृति का महत्व	आलोक रंजन, यू. के. गुरुविट्ठल एवं सुधीर माथुर	-do-
52)	कंप्यूटर वायरस-एक आतंक	विजय कुमार कौशल	-do-
53)	भू-स्खलन की घटना को रोकने तथा कम करने में सहायक एवं निर्णायक पक्ष	आलोक रंजन एवं आर.के.पाणिग्रही	-do-
54)	सार्वजनिक-निजी भागीदारी परियोजनाओं का वित्तीय विश्लेषण-निर्माण, संचालन और हस्तांतरण (बीओटी) परियोजनाएं	कामनी गुप्ता, ए एम राव, डा. बी के दुरई	-do-
55)	वास्तविक ड्राविंग चक्र का विकास और वायु प्रदूषण उत्सर्जन - परिवहन उद्योग में बस रैपिड ट्रांजिट (बी आर टी) अध्ययन,	डा. रविन्द्र कुमार, कामनी गुप्ता डा. बी के दुराई	सागर बोध अंक 4 वर्ष 2011
56)	विज्ञानमय जन-जीवन	संजय चौधरी	विज्ञान प्रगति निस्केयर 2011
57)	आधुनिक स्वास्थ्य सेवा और पारंपरिक चिकित्सा पद्धतियां	संजय चौधरी	वैज्ञानिक हिन्दी विज्ञान परिषद 2011
58	ग्रामीण सड़कों में अपशिष्ट प्लास्टिक के उपयोग के रूप में कचरे से कंचन	डॉ. संगीता, एम.पी सिंह संजय चौधरी	भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका, जून 2011

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
1	International Conference on Women Issues in Transportation, USA, April 2011	Appreciation of Gender Difference in Development of Qualitative Level of Service for Sidewalks	Dr. Purnima Parida Dr. Parida M	--
2	National Conference on Repair and Rehabilitation of Concrete Structures, Noida, May 6-7 2012	• Study of cracked RCC Beam Strengthened in Shear with CFRP Laminates	Dr. S.K. Sharma Narendra Kumar Sushil Kumar Dr. Lakshmy P.	S.K. Sharma Sushil Kumar Dr. Lakshmy P.
		• Rehabilitation of RC beams using frp – An Overview	Pradeep Kumar Alok Verma	Pradeep Kumar
		• External Prestressing for Rehabilitation of Bridges	J.K. Goyal	J.K. Goyal
		• Cyclic Loading Study of Prestressed Concrete Beam	Dr. Suraj Parkash	Dr. Suraj Parkash
		• Protective Coatings for Ferro Cement Structures	P.C. Sharma Dr. Rajeev Goel	Rajeev Goel
		• A Case Study of Repair and Rehabilitation	S.K. Jain Dr. Rajeev Goel	Binod Kumar
		• Causes and Repair Techniques for Distresses in Concrete Pavement	Binod Kumar Dr. Renu Mathur	
		• Rehabilitation of PSC Bridge – a Case Study	Dr. Rajeev Goel Dr. S.K. Sharma Er. Naveen Kumar Er. Parvez Ahmed	
		• National Highway Information System – Use of Traffic Count cum Classifiers	Neelam J. Gupta Dr. Mukti Advani Dr. B.K. Durai Dr. P.K. Kanchan	
		• Driving Cycle and Sustainability Approach in BRT Corridor – A Case Study	Dr. Ravinder Kumar Kamini Gupta Dr. B.K. Durai	
		• Level of Service for Pedestrians Identification of affecting variables and model development for an intersection	Dr. Mukti Advani	
		• Accessing road compaction impact on life cycle cost of road projector using HDM-4	Achuta A. Mohan Rao B.K. Durai A.V. Ravi Shankar	

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
3	14 th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, Hong Kong, China, May 23-27, 2011.	• Debris flows in North Eastern Region of India – A Case study • Investigation and Monitoring of Historical Landslides in a part of Himalaya • Investigation for Stabilization of Landslides in Bhutan	Dr. Kishor Kumar P. Subramanya Prasad Sudhir Mathur Dr. Kishor Kumar Anil Kathait Inder S. Negi Sudhir Mathur Jai Bhagwan P.S. Prasad Dr. Kishor Kumar Sudhir Mathur	Dr. Kishor Kumar
4	Workshop on Cleaner Liquid Fuels and Improved Vehicle Technologies, New Delhi, May 31, 2011			Dr. Anil Singh
5	9th International Conference of Eastern Asian Society for Transportation Studies, Jeju, South Korea, 20-23 June, 2011	• Development of Vehicle Operating Cost Equations for High Speed Corridors of India • Fuzzy Logic Microscopic Simulation with commuter Mode Choice Model for Evaluation of Public Transport Policy • Modelling Travel Time Reliability of an Urban Corridor using Micro-simulation Techniques • Infrared based Automatic vehicle counters cum classifiers (AVCC) under Indian Traffic conditions • Examining Travel time distribution of Urban and Rural Corridor of National Highway in India • Effect of Driving Cycle and Emission	Dr. Errampalli M Dr. Velmurugan S Dr. Nataraju J Sitaramanjaneyulu K Dr. Errampalli M Okushima M Akiyama T Dr. Ravi Sekhar CH, Dr. Errampalli M Dr. Kanagadurai B Dr. Ravinder K Dr. Errampalli M Dr. Velmurugan S Ch. Ravisekhar Dr. Kanagadurai B Dr. S. Gangopadhyay Dr. Ravindra Kumar Kamini Gupta Dr. B.K. Durai Dr. S. Gangopadhyay	Dr. Neelam J. Gupta A.M. Rao

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
6	International Conference on Advances in Materials and Techniques for Infrastructure Development (AMTID), NIT Calicut, 22-24 June 2011	• Estimation of weights using AHP to prioritize urban road sections for maintenance • Development of Vehicle Operating Cost Models for High Speed Corridors of India • Toll plaza simulation using VISSIM • A Critical Review of Flexible Pavement Performance Prediction Models	C.P. Akash, Dr. Parida M Dr. Tiwari Devesh Solanki M.C Errampalli M Dr. Velmurugan S Vashi B.D. Dhava;, T.B. Dr. Errampalli M Dr. Velmurugan S Deori Sanjay, Chaudhary Rajan Dr. Devesh Tiwari Sharma B.M.	
7.	Seminar on Advanced Instrumentation for Spectroscopy & Elemental Analysis New Delhi, 13 July, 2011		–	Dr. Rakesh Kumar
8.	15th International Conference for Women Engineers and Scientists, Adelaide, Australia, July 19-22, 2011	• Provision of Sustainable Road Transport Infrastructures-Urban Corridor in Delhi	Kamini Gupta Ch. Ravi Sekhar Dr. B.K. Durai Dr. Ravinder Kumar	Kamini Gupta
9.	Diamond Jubilee year CSIR-CRRI Souvenir, July 2011	• Application of Cationic Bitumen Emulsions for Construction of Sustainable Bituminous roads in India	Dr. N.K.S. Pundhir	
		• Sustainable Pavements: A New Look	Ambika Behl Prof. Satish Chandra	
		• National IT Strategy for Transport Infrastructure: CRRI Role & Contribution	J.K. Goyal	
		• Health Monitoring of Civil Structures	Y.C. Tiwari	
		• Development of Bridge Management System in GIS Environment	Dr. Rajeev Goel Dr. P. Lakshmy	

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
		• An Over View of Worldwide C&D Waste Usage Practices	U.K. Guru Vittal Farhat Azad Sudhir Mathur	
		• Roadway Capacity of Multilane High Speed Corridors Through Microscopic Traffic Simulation Models	Dr. E Madhu Dr. S Velmurugan	
		• Efficacy of Infrared based Automatic Vehicle Counters cum Classifiers (AVCC) Under Indian Traffic Conditions	Dr. K Ravinder Dr. S Velmurugan Dr. E Madhu	
		• Carbon Footprint: A Sustainability Indicator	Dr. Kirti Bhandari Dr. Anuradha Shukla	
		• An Innovative Rehabilitation of Distressed Bituminous Wearing Course on Second Vivekananda Bridge	M.N. Nagabhushan Dr. P.K. Jain	
		• Impact of Modeling and Simulation in the Field of Traffic and Transportation Engineering	B. Rajashekar V.K. Kaushal Dr. R.N.Dutta	
		• Potholes- Fast & Environment Friendly Technologies	Dr. P.K. Jain	
		• Agent Based Approach Modeling in Road Transport Network Planning	Dr. Ch. Ravi Sekhar Dr. B.K. Durai	
		• Training for Serving Highway Engineers	T.K. Amla Anita Arora	
10.	SUTRIMS, Surat July 2011	• Feasibility of providing a skywalk for pedestrians in Chandni Chowk, Delhi	Dr. Purnima Parida Shah Jiten	
11.	7th International Conference on Road and Airfield pavement Technology 2011 (ICPT-2011), New Horizon of Pavement Technology, Bangkok, Thailand, 3-4 Aug, 2011	• Prioritization of Maintenance Management decisions for Urban Roads using HDM-4	Dr. Yogesh U. Shah Dr. Parida M Dr. Jain SS Dr. Tiwari Devesh	
12.	Workshop on Promoting Low Carbon Transport in India, Ahmedabad, 29 Aug, 2011			Dr. Kirti Bhandari
13.	Workshop on Indicators for Sustainable Transport, Ahmedabad, 29 Aug, 2011			Dr. Kirti Bhandari

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
14.	National Conference on Emerging trends in Computing and Information Technology, Ghaziabad, 9 Sept, 2011			B. Rajasekhar Vijay Kumar Kaushal
15.	Public Private Partnership in National Highways, Vigyan Bhawan, New Delhi, 12-Sep-2011			Dr. P. Lakshmy Sudhir Mathur Dr. P.K. Jain M.N. Nagabhushan Satish Pandey B.M. Sharma K. Sitaramanjaneyulu Dr. Devesh Tiwari Dr. B.K. Durai A.M. Rao Dr. K. Ravinder Dr. Purnima Parida Dr. E. Madhu Dr. Velmurugan T.K. Amla R.C. Agarwal
16.	World Engineer Convention, Geneva, Sept 2011	• Driving Cycle for Measuring Emission on Road with Bus rapid Transit Corridor in Delhi	Dr. Kumar Ravindra Kamini Gupta Dr. B.K. Durai	
17.	Workshop on Sustainable Technologies for road construction in North East, Jorhat, 19 Sept, 2011	• Cold Bituminous Mix Technologies for Road Construction	Dr. N.K.S. Pundhir	A number of Scienlens
18	Conference on Repair, Restoration and Rehabilitation of Concrete Structures, Chennai, Tamil Nadu, 20 Sep, 2011	• Study on Analytical Models of Reinforced Concrete (RC) Beams Strengthened with FRP under Pure Torsion	Pardeep Kumar Dr. S.K. Sharma Alok Verma Dr. Lakshmy P.	
19	3rd International Conference on Road Safety and Simulation, Indian Polis, USA, 14-16 Sep 2011	• Measuring Safety Accessibility and Mobility of People Living Adjacent to National Highway of India	Dr. Mukti Advani Dr. B.K Durai Dr. S. Gangopadhyay	Dr. Mukti Advani

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
20.	National workshop on Life cycle Assessment for Construction Industry on Concrete vis-a-vis Asphalt Road, New Delhi, 20 Sept, 2011			Dr. Anuradha Shukla
21.	National Workshop on India's second National Communication to UNFCCC, New Delhi, 20 Sept, 2011	• Mobile combustion: GHG Emission Inventory for Transport Sector in India	Dr. Anil Singh	
22.	Workshop on New Technologies used for Road Construction, Cochin, 25 Sept, 2011			Sh. K. Sitaramanjaneyulu
23.	Workshop on Accreditation Scheme for EIA Consultant Organization, New Delhi, 30 Sept 2011			Dr. Niraj Sharma
24.	6th IRF Regional Conference on Road Safety Strategy in India – action plan, New Delhi, 3-5 Oct, 2011			Dr. Nishi Mittal Dr. S. Velmurugan. Dr. Neelima Charaborty Dr. J. Nataraju Dr. K. Ravinder Dr. E. Madhu, T.K. Amla Subhash Chand M.K. Meena Rajan Verma
25.	3rd Indian Rock Conference (INDOROCK-2011) IIT, Roorkee, Oct 13-15, 2011	• Kinematic Slope Stability Analysis of Kaliasaur Landslide on NH-58, Garhwal, Himalaya • Monitoring of Slope Behaviour through Simple and Cost Effective Instrumentation • Probable Causes and Remedial Measures for Amparov Landslide, Nainital, Distt. Uttrakhand	Dr. Kishor Kumar P.S. Prasad Shivashish Kimothi Inder Vir S. Negi Anil Kathait Abhilipsa Dash Sudhir Mathur Dr. Kishor Kumar P.S. Prasad Inder Vir S. Negi Anil Kathait Abhilipsa Dash Sudhir Mathur Dr. Pankaj Gupta	Dr. Pankaj Gupta Inder S. Negi Anil Kathait

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
26.	International Conference on Mobility for the future of sustainable cities, Changwon, Korea, 22-24 Oct, 2011	• Integrating User Perception into Walkability Index – A total to Improve Quality of Pedestrian Infrastructure	Dr. Purnima Parida	
27.	International Conference on Recent Trends in Transportation, Environment & Civil Engineering, TECE, Bangalore Oct 2011	• Application of WS for traffic congestion management • Application of GIS for traffic congestion Management	T. Pratap A. Mohan Rao Dr. B.K. Durai Dr. Lakshmy P. T. Pratap A. Mohan Rao Dr. B.K. Durai Dr. Lakshmy P.	
28.	Seminar on MatLab Applications in Transportation Engineering Problems, Nov 2011	• Traffic Assignment Problem and Development of Relationship Pavement Distress Parameters using Neural Networks • Mode choice Analysis using Neural Networks	Dr. Ravi Sekhar A.M. Rao	
29.	IRC Annual Conference, Lucknow, 3-6 Nov, 2011	• Evaluation of Infrarred based automatic Vehicle counters cum classifiers (AVCC) under Indian Traffic conditions	Dr. S Gangopadhyay Dr. K Ravinder	No. of Scientists
30.	Workshop on Service Life Design of Concrete Structures, India Habitat Centre, New Delhi, 14-15 Nov, 2011			Dr. V.V.L.K. Rao
31.	National seminar on Metro Rail projects – Indian Scenario, New Delhi, 18-19 Nov, 2011			Dr. R.K. Garg Dr. S.K. Sharma Dr. Rajeev Goel J.K. Goyal Dr. Suraj Prakash
32.	Golden Jubilee Seminar on Mining Technology for sustainable development (MINE-TECH-2011), Raipur, 18-19 Nov, 2011	• Hazard estimation for rockslope failure and its remediation – a new method	R.K. Panigarhi Madhusmita Rout	R .K. Panigarhi
33.	National Instrument Technical Symposium, Noida, 21 Nov, 2011			Y.C. Tiwari D.C. Sharma Lalita Renu Chadha

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
34.	17th Technology Summit & Technology Platform, Indo Spanish S&T Cooperation towards win-win partnership at New Delhi, 22-23 Nov, 2011			Dr. Sippy K. Chauhan T.K. Amla R.C. Agarwal
35.	National Workshop on Indo-Highway Capacity Manual, New Delhi, 24-25 Nov, 2011	• Proposed Method Towards the Execution of the Indo-HCM Project under XII Five Year Plan – Pedestrians • Incorporation of Travel Time Reliability in Highway Capacity Manual	Dr. Purnima Parida Dr. Ravi Sekhar	No. of Scientists
36.	Seminar on Cost Effective, Energy Efficient & Ecologically appropriate Building materials & technologies for Housing, Pragati Maidan, New Delhi, 26 Nov, 2011			T.K. Amla J.B. Sengupta R.C. Agarwal
37.	Construction supervision during Bi-Annual SOSA/SAASO/CE(AF) Conference, Vigyan Bhawan, New Delhi, 1 Dec, 2011			K. Sitaramanjaneyulu
38.	Conference-cum-Exhibition on Urban Mobility India-2011, New Delhi 3-6 Dec, 2011			Dr. B.K. Durai Dr. Ravi Sekhar Dr. E. Madhu Dr. K. Ravinder T.K. Amla
39.	Conference-cum-Exhibition on Urban mobility India – 2011, New Delhi, 3-6 Dec, 2011			B.K. Durai Dr. Ravi Sekhar Dr. E. Madhu Dr. K. Ravinder T.K. Amla
40.	Conference-cum-Exhibition on Sustainable Mobility organized by Ministry of Urban Development, New Delhi, 3-6 Dec, 2011	–	–	Dr. B.K. Durai Dr. Ravi Sekhar
41.	Global Symposium for Thinkers and Doers, New Delhi 5-7 Dec, 2011			J.K. Goyal
42.	National Conference on Flyash, Hyderabad, 5-7 Dec, 2011	• Construction of Road Embankment using Flyash in Water Logged Area : A Case Study • High Volume Flyash Concrete for Pavements	U.K. Guru Vittal P.S. Prasad Sudhir Mathur Binod Kumar Dr. Renu Mathur	U.K. Guru Vittal Binod Kumar
43.	12th ESRI India User Conference, New Delhi, 7-8 Dec, 2011	• Landslide Hazard Management on Mountainous Highways – A Critical Need	Dr. Kishor Kumar P.S. Prasad, Anil Kathait Inder S. Negi Sudhir Mathur	

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
44.	International conference of Transportation Research Group of India (CTRG-2011), Bangalore, 7-10 Dec, 2011	• Road Safety Audit of Selected Road sections in Punjab	Dr. Ravinder K Dr. Velemurugan S Dr. Neelima Chakraborty Dr. Nishi Mittal	Dr. S. Velemurugan Dr. Neelima Chakraborty Dr. Neeraj Sharma Dr. Kriti Bhandari Dr. E. Mathu Dr. K. Ravinder Dr. Devesh Tiwari Dr. B.K. Durai Dr. Ravindra Kumar A.M. Rao Dr. Ravi Sekhar
		• Vehicular Pollution Modelling and Estimation of Emission load along a proposed metro rail corridor	Dr. Sharma N Gulia, S, Kaushik C.P. Rajni Dhyani	
		• Environmental impact of different road rehabilitation technologies on the basis of life cycle assessment	Dr. Bhandari K Dr. Tiwari G Aurora, U	
		• Methodology to estimate the carbon footprint of commuting with focus on the role of non-motorised transport	Dr. Sangeeta Dr. Bhandari, K Dr. Advani M Ridhi Saluja	
		• Comparing Direct Assessment and AHP for prioritizing maintenance of Urban Road Network	Akash Prakasan Chavercode Dr. Parida M Dr. Devesh Tiwari	
		• Study on Driver Behaviour and Psychology	Niranjan G. Hirenath G. Kavitha Dr. Neelima Chakraborty	
		• Mobility and Accessibility Problems of the Transport Disabled	Dr. Neelima Chakraborty Dr. Nishi Mittal Dr. Purnima Parida	
		• Use of Travel time reliability for measuring Traffic Congestion Violation	Ch. Ravi Sekhar Dr. B.K. Durai Dr. S. Gangopadhyay	
		• Modelling Travel time Distribution under Uncertainties from Demand and Capacity of System : A case study of Urban Corridor	Ch. Ravi Sekhar Aneesha R.G. Dr. B.K. Durai Dr. P. Lakshmy	
		• Level of service for pedestrians Identification of affecting variables and model development for an intersection	Dr. Mukti Advani	
		• Assessing Road Compaction Impact on Life cycle cost of road projects using HDM-4	Achuta A. Mohan Rao Dr. B.K. Durai A.V. Ravi Shankar Ravinder Kumar Kamini Gupta	
		• Driving cycle and sustainability approach in BRT Corridor – A case study	Dr. Neelima J. Gupta Dr. Mukti Advani Dr. B.K. Durai Dr. P.K. Kanchan	
		• National Highway Information system – use of traffic count cum classifiers		

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
		Comparison of Scheduled and Condition Responsive Maintenance for Urban Road Section	Yogesh U Dr. S.S Jain Dr.M. Parida M.K. Jain Dr. Devesh Tiwari	
45.	Conference on Current Trends in Technology (NUICONE-2011), 8-10 Dec, 2011			Abhishek Mittal
46.	An interactive workshop – Tunnels and underground construction India, New Delhi, 12-14 Dec, 2011			Sudhir Mathur Dr. Kishor Kumar
47.	Conference on Operation Maintenance and Tolling in Road Sector on 13 Dec, 2011			K. Sitaramanjaneyulu
48.	Indian Geotechnical Conference – (IGC-2011: Geochallenger), 2011, Kochi, Kerala, 15-17 Dec, 2011	• Probabalistic Slope Stability Analysis for Slopes along NH-39, Nagaland • Landslide Investigation at Km 221, NH-39, - A Case Study • Feasibility study of Jarofic waste Material for Road Construction • Design and Stability Analysis of Pond Ash Railway Embankment • Low Cost Specifications for the Construction of Low Volume Roads	Dr. Sukumar Saha Dr. Kishor Kumar, P.S. Prasad, J.Ganesh, U.K. Guru vittal, Sudhir Mathur A.K. Sinha Dr. V.G. Havanagi V.K. Arora Alok Ranjan Sudhir Mathur A.K. Sinha Sudhir Mathur V.G. Havangi V.K. Kannaujia R.K. Swami Sudhir Mathur	
49.	26th Indian Engineering Congress Conference, Bangalore, Karnataka, 15-18 Dec, 2011	• FRP's Uses for Torsion capacity Enhancement of Reinforced Concrete Structures	Pradeep Kumar Dr. S.K. Sharma Alok Verma Dr. Lakshmy P	Pradeep Kumar Abhishek Mittal

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
50.	National Conference on Quality Control for Construction of Cement Concrete Roads Organized by ICI and AICTE, Gwalior, 10 Dec, 2011 and Indore, 24 Dec, 2011			Sh. Binod Kumar
51.	National Conference on Bioremediation, New Delhi, 26-28 Dec, 2011	• Preliminary studies on the characterization of non-method hydro-carbons in ambient air of Delhi	Tarsolia Nidhi Dr. Chauhan Sippy K Dr. Shukla Anuradha Gupta, Prabhat K.	
52.	Workshop on Road Asset Management, 28 Dec, 2011			Dr. Devesh Tiwari
53.	International Conference on National Road Safety, Issue in India, SPA, Dec 2011	• Crediability of Speed limit – a Case of Ghaziabad city	Kumar Ravindra Kamini Gupta Dr. B.K. Durai	
54.	International Transport Research Conference 2011, University Sains, Malaysia	• Developing a methodology to evaluate impact of road infrastructures on different model trips – a scenario based study	Dr. Mukti Advani Dr. B.K. Durai	
55.	IRF Seminar on Road Safety Action Plan, New Delhi, 3 Jan 2012			Dr. Nishi Mittal Dr. Neelima Chakraborty Dr. S. Velmurgan Dr. J. Natarajan Niraj Sharma Subhash Chand Dr. Anil Singh Anuradha Shukla Punima Paridha Dr. E. Madhu Sippy K. Chouhan P V Pradeep Kumar Kirti Bhandari Rina Singh T K Amla R C Agarawal
56.	JICA Workshop on On-Site Visualisation and Dust Monitoring, Bangalore, Jan 2012	• Evaluation of Onsite Visualization and Dust Monitoring of Safety Management at Construction Site	Dr. Ravi Sekhar Dr. B. K Durai	Dr. Ravi Sekhar Dr. B. K Durai

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
57.	Seminar on Steel Structure – Design and Fabrication, New Delhi, 6-8 Jan 2012		Dr. P Lakshmy Dr. R. K. Garg Dr. Rajeev Goal	
58.	Workshop on Toll on Highways – Principles and Practices, New Delhi, 9th Jan 2012		Dr. Nishi Mittal Dr. S. Velmurugan Subhash Chand Dr. Niraj Sharma T K Amla R C Agarawal	
59.	Workshop on Enhancing Green house Inventory Management, New Delhi, 20 Jan 2012	• National GHG Emission Inventory for Transport Sector	Dr. Anil Singh	
60.	Workshop on Issues & Strategies for Non-Motorized Transport Modes, 23 Jan 2012	• Accessibility Problems Around Schools – a Case study • Pedestrian and NMT on Rural Highways - Issues and Strategies	Dr. Neelima Chakraborty Dr. Punima Parida Dr. B.K. Durai	No. of Scientists
61.	91st Annual session of Transportation Research Board (TRB), Washington, 20-22 Jan, 2012	• Impact of Vehicular emission norms on vehicular pollution roads in Delhi • Measured Curling Stresses Compared with Theoretical Stresses in joint Plain Cement Pavements • Development of Congestion Cost Equations for Multi-lane Highways in India • Development of Congestion Cost Equations for High Speed Corridors in India	Dr. Ravindra Kumar Dr. M. Errampalli Dr. J. Nataraju Dr. S. Velmurugan Dr. S. Gangopadhyay Binod Kumar Dr. Renu Mathur Dr. S. Velmurugan Dr. S. Velmurugan Dr. S. Velmurugan Dr. M. Errampalli Dr. J. Nataraju Dr. K. Ravinder	Binod Kumar Dr. S. Velmurugan
62.	Workshop on Noise and Vibration Control (WNVC – 2012), NPL, New Delhi, 27 Jan 2012			Neha Dhiman

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
63.	Workshop on Transportation Practices in India and the European Union, New Delhi, 2 Feb 2012	-	-	Dr. Anuradha Shukla
64.	Course and workshop on Conventional and advance NDT Technique for evaluation of reinforced concrete structures, New Delhi, 2-4 Feb, 2012	-	-	Dr. VVLK Rao Dr. Rajeev Goel
65.	Workshop on Sustainable Technologies for North East Region Organized by CSIR-CRRI & CSIR-NEIST, Agartala, 3-5 Feb 2012	-	-	No. of Scientists
66.	Conference on India Geospatial Forum with the theme Geo-Budget: Enabling Sustainable Growth, Gurgaon, 7-9 Feb, 2012	-	-	H. Lokeswar Singh Dr. Anuradha Shukla
67.	1st Indian PTV User Group Meeting, 9-10 Feb, 2012	• Analysis of Travel time reliability of an urban corridor using VISSIM, Micro-Simulation Techniques	Dr. Ch. Ravi Sekhar Dr. E. Madhu	
68.	International summit on Public Private (PPP) in Roads and Highways, New Delhi, 16 Feb, 2012			J.B. Sengupta Dr. Rakesh Kumar Dinesh Ganvir
69.	Workshop in Tunnel Engineering for Highways & Expressways, New Delhi, 10 Feb 2012			Dr. Kishor Kumar D. Mukherjee R.K. Panigarhi Dr. Pankaj Gupta P.S. Prasad
70.	International conference on Green Technologies for Environmental Rehabilitation, Haridwar, Uttarakhand, 11-13 Feb, 2012	• Utilisation of Waste Materials in Road Works –Some Aspects	R. K. Swami Uma Arun	

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
71.	International Conference on Fiber Reinforced Concrete Global Development FIBCON – 2012, Nagpur, Feb 13-14, 2012	• Treatise on Fibre Reinforced Concrete • Use of synthetic and steel fibre as reinforcing admixtures in concrete pavements • Conventional vis-a-vis Synthetic Fiber Reinforced Concrete for construction of Rigid pavements	Dr. Rajeev Goel Dr. Suraj Parkash J.B. Sengupta Dinesh Ganvir Dr. Rakesh Kumar Pankaj Goel Dr. Renu Mathur	Dinesh Ganvir Pankaj Goel Dr. Rakesh Kumar
72.	Quality monitoring Processer in Construction of Roads in India Roads Conference 2012, Mumbai, 15-16 Feb 2012			K. Sitaramanjaneyulu
73.	Workshop on "Artificial Neutral Networks in seismic control of Structure" New Delhi, 17-18 Feb, 2012			Dr. R.K. Garg
74.	Workshop on New and Non-Conventional Materials/ Technologies for Use in Rural Road Construction, NRRDA, New Delhi, 18th Feb 2012	• Lime/Cement Stabilisation for Soil and Granular Materials • Use of Marginal Materials and fly Ash in Road Works • Construction of Rural Road with Cationic Bitumen Emulsion Based Cold mix Technology	Sudhir Mathur R. K. Swami Uma Arun U.K. Guru Vittal Dr. N.K.S. Pundhir	No. of Scientists
75.	Workshop on Handling Customer Complaints dealing with angry and difficult Customer, New Delhi, 18th Feb 2012			R.S. Bhardwaj
76.	Seminar on Challenges in Library management System, Kolkata, 24-25 Feb 2012			Mithali Mohapatra
77.	International Conference on Environmentally Sustainable Urban Eco System (ENSURE-2012), IIT Guwahati, 24-26 Feb 2012	• Urban Roadway Drainage Issues and its Management – A key Component of Urban PMS	Yogesh U Shah S. S. Jain M. K. Jain Dr. Devesh Tiwari	

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
78	2nd Annual ITS India Conference on Planning and Designing the functional Aspects of ITS with a green Mindset, New Delhi 28 Feb, 2012			Dr. Anuradha Shukla
79.	International conference on Intelligent Transport Systems, 27-28 Feb, 2012			Dr. Nishi Mittal
80.	Workshop on CRMS sponsored by PTB Germany and NPLI, New Delhi, 29th Feb 2012			Dr. Sippy K. Chauhan
81.	National Symposium on Designing Roads for disabled Pedestrians in India, New Delhi, 1-4 March, 2012	• Assessibility issues and current practices in India	Neelima Chakraborty	Ms. Neelima Chakraborty
82.	8th international Symposium on Fuels and Lubricants, New Delhi, 5-6 March 2012	• Real World, Drivig cycle, Emission and Fuel economy for Car – A case of East Delhi	Ravindra kumar Kamini Gupta Dr. B.K. Durai	Ravindra kumar
	Indo-US workshop on Global Challenges ; Climate Change, Water and Environment & Society, Gurgoan, 5-6 March 2012			Dr. Sippy K. Chauhan
	27th International Conference on Solid waste Technology and Management, Philadelphia, PA, USA, March 11-14th 2012	• Tanned Bio-waste of leather industry for sustainable flexible pavement Construction	Kamaraj C., Rose C., Mani U., Shukla Anuradha, Dr. Gangopadhyay S. Mandal A. B.	
85.	Seminar on Real Time Emergency Response through Source Identification and 3D Productive Modelling, New Delhi,14 March, 2012			Dr. Anuradha Shukla
86.	National Seminar on Challenges and Issues in Renewable Energy, New Delhi, 15-16 March, 2012			Dr. Anuradha Shukla

S. No.	Name of Seminar/ Conference	Title of paper	Author	Attended by
87.	National Conference on Innovative Challenges in Civil Engineering, Bhatinda, 15-16 March 2012	• Effect of End Restraint of Bearing on Response of PSC Beam	Dr. Suraj Prakash Dr. Rajeev Goel	Dr. Suraj Prakash Dr. Rajeev Goel
88.	Conference on Patinformatics for Research and Business Planning (28th National Convention),			Binod Kumar
89.	National Conference and Field Study on Landslide Management, Nainital, 22-24 March 2012	• Design of tunnel muck yard at Jammu & Kashmir rail link	A. K. Sinha Dr. V.G. Havanagi P.S. Prasad Dr.Kishor Kumar Sudhir Mathur	A.K. Sinha
90.	Seminar on Planning for Pedestrian Mobility and Safety IISc Bangalore, 24 March, 2012	• Accessibility problems of Pedestrians case studies	Dr. Neelima Chakraborty	Dr. Neelima Chakraborty
91.	6th Workshop on Project monitoring Andhra University, Visakhaprtnam, 24 March 2012			Dr. Sippy K. Chauhan
92.	National Conference on Ecotoxicology and Heath Hazand, Hisar, 24 March, 2012			Nasim Akhtar

Staff of the
CSIR-Central Road Research Institute
As on 31st March, 2012

Director

Gangopadhyay S. (Dr.), M.Tech. (Transportation System), M.Sc. (Transportation), Ph.D.

Road Development Planning and Management (RDM)

Kanchan P.K. (Dr.), Ph.D (Maths) Scientist-G (Retired on July, 2011)

Kanaga Durai B., (Dr.), M.A. (Eco), M.R.P. (Regional Planning) Ph.D **(Head)**

Scientists/Technical Officers

Advani Mukti (Dr), M.E. (Transportation Engineering), Ph.D.

Dwivedi S.N., M.A.

Gupta Kamini, M.Tech. (Transportation Engineering)

Gupta S.K. Diploma in Draughtsmanship (Mech.)

Gupta Neelam J. (Dr.), M Sc, M. Phil (Computer Application), Ph.D. (Numerical Analysis)

Poonam Singh, B.E. (Civil), MBEM.

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Ravinder Kumar (Dr.), M.E (Transporation Engineering) Ph.D.

S&T and Supporting Staff

Jeet Ram, Non Matric (Retired on Oct., 2011)

Kumar Ashok, B.A.

Kumar Narendra, Matric

Ram Sagar, Matric

Singh Satyabir, SSC, ITI (Printing)

Bridges & Structures (BAS)

Ram Kumar (Dr.), M.E., Ph.D., **(Area Advisor & Head)** (on Deputation)

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Garg R. K. (Dr.), M.Tech, Ph.D.

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Traffic & Transportation Planning (TTP)

Gangopadhyay S. (Dr.), M.Tech. (Transportation System), M.Sc. (Transportation), Ph.D. **(Area Advisor)**

Traffic Engineering & Road Safety (TES)

Mittal Nishi (Dr.), M.A. (Eco.), Ph.D **(Chief Scientist & Head)**

Scientists/Technical Officers

Biswas S.K., Draughtsman

Chakraborty Neelima (Dr.), M.A., (Psycho.), P.G. Dip. (Environmental Psycho.), Ph.D
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Singh Harcharan, M.A (Eco), B.Ed. (Retired on Jan. 2012)
Subhash Chand, ME (Highways)
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Ummat S.K., B.Com
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Mehto Jag Lal, Non Matric
Mutreja Daleep, B.Com.
Raj Bala, Non Matric
Verma Ranjan

Transport Planning & Environment (TPE)

Shukla Anuradha (Dr.), M.Sc., M.Tech. (Corrosion Science), P.G. Diploma in Ecology & Environment Science, Ph.D (**Head** upto Nov. 30, 2011)
Singh Anil (Dr.), Ph.D. (Environmental Science), (**Head** w.e.f., Dec 1,2011)

Scientists/Technical Officers

Akhtar Nasim, M.Tech. (Environmental Engg.)
Bhandari Kirti (Dr.), M.Sc. (Envirnmental Engg.), Ph.D.
Chauhan Sippy K (Dr.), Ph. D (Chemistry)
Errampalli Madhu (Dr.) M. Tech (Transportation Planning), Ph. D
Padma S, M.Tech. (on Study Leave)
Parida Purnima, (Dr.) M.A. (Economics), M.Tech., Ph.D
Pradeep Kumar P. V, M.E., (Mech.) MBA
Ravinder K., (Dr.), M. Tech. (Transportation Engg.) Ph.D.
Singh Hawa, Matric (Retired on Jan., 2012)
Singh Jagdish, Intermediate
Singh Rina, M.Tech. (on Study Leave)
Sharma Niraj (Dr.), M. Tech., Ph.D.

S&T and Supporting Staff

Chaudhary Neha , Dip in PHE
Daya Ram, B.A.
Dhiman Neha, ITI
Kumar Devender, Matric, ITI (Motor Mech.)
Shakuntla Devi, Non Matric
Sanjay Kumar, M.A. (Pub. Admn.), B.Lib.
Sethi Sarita, B.A.
Singh Brij Mohan, Matric

Pavement Engineering & Materials (PEM)

Flexible Pavement (FP)

Jain P. K. (Dr.) Ph.D (Chemistry) **(Chief Scientist & Head)**

Scientists/Technical Officers

Behl Ambika, M.Tech(Chemical Engineering)
Gajendra Kumar, M.Tech. (Transportation Engg.)
Kamraj C., BE (Civil) (on deputation)
Mittal Abhishek, M.Tech. (Transportation Engg.)
Nagabhushana M.N., M.Sc. (Highway Engg.)
Kumar Narendra, B.A.
Pandey Satish, B.E. (Civil) M.Tech (Transportation Engineering)
Pundhir N. K. S. (Dr.), PhD (Chemistry)
Sangeeta (Dr.), Ph.D. (Polymer Chemistry)
Sharma Girish, M. Tech (Chemical Engineering)
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Raghusaran, Non Matric

Rigid Pavements (RP)

Mathur Renu (Dr.), M.Sc., Ph.D. (Head, upto Nov. 30, 2011)
Sengupta J.B., M.Sc. (Applied Chemistry), **(Head, w.e.f. Dec. 1, 2011)**

Scientists/Technical Officer

Binod Kumar, M.E. (Hill Area Development Engineering)
Dinesh V. Ganvir M.E. (Highways & Transportation)
Goel Pankaj, M.Tech (Const.Engg & Management)
Jain A. K., M.E. Hons. (Transportation Engg.) (on Deputation)
Mishra A. K. (Dr.), M.Sc. (Chemistry), Ph.D. (Retired in June 30, 2011)
Rakesh Kumar (Dr.), M.Tech, PhD (Civil Engg)

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Choudhary Asif Hussain, B.Com
Pant Ashok, Higher Secondary
Saini Karuna, M.A. (Economics)
Singh Balbir, Non Metric
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Singh Nihendra, B.A

Pavement Evaluation (PE)

Sharma B. M., M.E. (Transportation Engg.) **(Chief Scientist & Head upto Oct. 26, 2011)**
Sitaramanjaneyulu K., M.E. (Highway Engg.) **(Head w.e.f. Oct. 27, 2011)**

Scientists/Technical Officers

Dass Shankh, BE, (Civil)
Deori Sanjay, M.Tech., (Transportation Engg.) (Transferred w.e.f. July 12, 2011)
Jain Sunil, M.E. (Transportation Engg.)
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Pokhriyal S. P., M.Sc. (Maths & Statistics)
Pradeep Kumar, M.Sc. (Physics), M. Phil (Instrumentation)
Rampal, B.Sc.
Rao Y. V., M.Sc. (Maths)
Rastogi Sarita, Higher Secondary, Dip. in Commercial Art
Sagar A. K., B.Sc. Engg. (Civil), MBA, M.Tech. (Environmental Engg.)
Singh Ajaypal, Diploma in Civil Engg.
Singh Attar, Diploma in Civil Engineering
Singh Madan Pal, B.Sc.
Singh P. R., B.Sc.
Srivastava R. K., M.Tech.
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Ram Lal, Non Matric
Singh Mahinder Prasad
Singh Pratap , Metric ,ITI
Verma Pushpa, M.A.

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Sudhir Mathur, M.Tech. (SM & FE)
(Chief Scientist & Head)

Scientists/Technical Officers

Arun Uma, M.Sc. (Chemistry)
Beg Raj, B. Sc
Ganesh J. M.Tech.(Geotechnical Engg.)
Goel Nitesh, M.Tech (Transportation) (On Deputation)
Gupta Pankaj, (Dr.), Ph.D (Engg. Geology)
Guruvittal U. K., M.E. (Highway)
Jai Bhagwan, M.Sc. Physics
Kumar Kishor (Dr.), Ph.D. (Geology Engineering)
Mukherjee Deepak, M.Sc. (Applied Geology)
Murugesan.V., SSLC
Panigrahi R. K., M.Sc.Tech. (Applied Geology).
Pramada Valli P. (Dr.), M.Sc. (Applied Geology), Ph.D (Applied Maths)
Prasad Prema, M.A.

Prasad.P. S., M.E. (Geotechnical Engg.).
Ranjan Alok, M.Tech. (Engineering Geology)
Singh Kanwar, M.Tech. (Geotechnical Engg.)
Sinha Anil Kumar, M.Tech. (Geotech. Engg.)
Swami R. K., M. Sc. (Chemistry)
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Kanaujia V. K., B.E. (Civil)

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Jamdar Mehto, Non Matric
Rekha, ITI, BA
Saha Sunil Chander, Matric
Surinder Kumar, Non Matric
Ved Prakash, Inter
Vijay Singh, Non Matric

HRD & Project Management (HRP)

Sudhir Mathur, M.Tech (SM & FE)
(Area Advisor)

Planning Monitoring & Evaluation (PME)

Saurikihia A., M.Sc. (Env. Engg.), PDDPM, AMIE **(Head** upto oct 24,2011)
Dr.Kanaga Durai B (Dr.) PhD. **(Head** w.e.f oct 27,2011)

Scientists/Technical Officers

Aggarwal Nidhi, M.Sc. (Chemistry)
Ravinder D., Diploma in Computer Engg.'A' Level, BCA
Saxena Alind, M.A (Eco), P.G. Diploma in Computer Science, M S (Software System) (Retired on Sep. 30, 2011)
Saxena Anshul M.Tech (IT)

S&T and Supporting Staff

Ashok Kumar
Santosh, Non-matric
Sri Lal, HSC
Sagar Ram

Technology Management & Business Development Cell & ERP Cell

Saurikhia A., M.Sc. (Env. Engg.), PGDPM, AMIE **(In-charge)**

Scientist / Tecnical officer

Khan Farhat Zahoor M.Tech (Geotechnical)
Masih Kamla, MCA

S&T and Supporting Staff

Kapoor Kamalesh, M.A.
Prakash Dinesh, Non-Matric
Sinha Preeti, BCA

Information, Liaison & Training (ILT)

Amla T. K., M.Sc. (Chemistry), Associateship in Information Science, M. Phil. Science Communication & Journalism **(Head)**

Scientists/Technical Officers

Agarwal R. C., B.E. (Mechanical Engg.), AMIE, PG-PDQM (TQM), C. Engr. (I)
Arora Anita, M.Sc. (Chemistry)
Jain Kavita, M.Com
Jeevan Lal, Intermediate (Retired in March, 2012)
Meena M. K., M.Tech. (Civil)
Pal Prityush Kumar, M. Sc. (Computer Science)

S&T and Supporting Staff

Batra Bhupinder Singh, B.Com.
Deep Chand, Non Matric
Khan Amin Ali, M.A (Political Science)
Sumitra Bai, Non.Matric

Photo Section

Kumar Ashok, Certificate Course in Colour Photography
Singh Rajbir, B.A.

Quality Management

Bharadwaj, R. S., M.Sc., Associateship in Information Science, M.Phil (Science Communication & Journalism) **(Head)**

Scientists/Technical Officers
Kannan S., M.Sc.

S&T and Supporting Staff
Kumar Sunil, B.A.

Computer & Networking (CCN)
Dutta R. N., M.Sc. (Operational Research) **(Head)**

Scientists/Technical Officer
Dubey Vivek, MCA, PGDBM
Mariappan S., Diploma in Computer Technology
Rajasekhar B., B.E. (Electronics & Communication)
Rani Reeta, M.Sc. IT, MBA,

S&T and Supporting Staff
Kumar Anil, Intermediate and Computer Course in FC Hardware and Computer Operation
Kaushal Vijay Kumar, MCA
Manpreet, B.Tech.
Shiv Lal, Non-Matric

Instrumentation (INS)
Sharma D. C, B.E. (Elect), M.Tech (Computers) **(Head)**

Scientists/Technical Officers
Chadda Renu, M.Sc. (Botany)
H. Lokeshwar, M.Sc. (Electronics)
Jangpangi Lalita, ME. (Control & Instrumentation)
Meshram P.C., M.Tech. (Digital Communication Engg.)
Prasanna Kumar P., M.Sc. (Physics)
Saini R. P., B.Sc., Diploma in Electronic Engg.
Satish Kumar, Diploma in Electronics & Communication
Sharma V. P., Matric, ITI, Diploma in Electrical Trade (Retired on March 31, 2012)
Subodh Kumar, MS, MBA
Tiwari Y. C., M.Sc. (Physics)

S&T and Supporting Staff
Kapoor K. J. S., B.Com, ITI
Shukla Jai Prakash, Matric
Paswan Bhawesh

Mechanical Engineering Support
Bharadwaj, R. S., M.Sc, Associateship in Information Science, M.Phil (Science Communication & Journalism) **(Head)**

Scientists/Technical Officers
Arora Ashok Kumar, M.A., Dip in Auto Engg.
Gola Kewal Krishan, Post Dip. in R/AC & Mech. Engg.
Harish Kumar, ITI
Sharma N. K, Diploma in Mechanical Engg.
Sharma Ashok Kumar, Inter, ITI (Motor Mech.)
Singh Bir, ITI
Singh Gurdeep, Non-Matric
Singh Bhim, Non-Metric
Singh Satnam, Matric, ITI, National Apprentiship Certificates
Mohd. Irshad, Dip in Draftsmanship (Mech.)

S&T and Supporting Staff
Kishan Swroop, ITI (Electrical/Wireman Course)
Kumar Om, B.A., ITI
Meena Babu Lal, Non Matric
Om Prakash, ITI (Fitting)
Panicker K. R. C, Matric (Retired on July 31, 2011)
Ram Pal, Non Matric
Sachdeva H. L, ME Mech. Engineering
Singh Lakhbinder, H.Sc, ITI (Motor Mech.)
Singh Mohan, Higher Secondary
Sunil Kumar
Sunil Datt, Non Matric

Documentation & Library Services (DLS)
Ashok Kumar, (Dr) MSc, M.L.I.Sc. Ph.D.,
(Area Advisor & Head)

Staff of the CSIR-Central Road Research Institute As on 31st March, 2012

Scientists/Technical Officers

Aggarwal Neera, M.A., B.LI. Sc., Associateship in Information Science
Chhabra Pavan, M.Sc. (Physics), M.LI.Sc
Mohpatra Mitali, DLI.SC POLI.SC. MLI.SC, PGDLAN
Ravinder Kumar, MA (Pub.Adm) Diploma in Offset Print.Tech.

S&T and Supporting Staff

Ching Lydia, BSc MLISC
Rangarajan R, Diploma in Mechanical Engg.
Sharma Dev Dutt, Matric

Post-Graduate Research Programme (PGRP)

Jain P. K. (Dr.), Ph.D. (Chemistry) **(Coordinator)**
Lohani G. C., B.A., LLB

Rajbhasha Unit

Anang Pal Singh (Dr.), M.A. (Hindi), B.Ed., Ph.D. Dip. in Translation **(In-charge)**
Choudhary Sanjay, M.A., B.Ed., Adv. Dip. in Computer
Khuttan Santosh, B.A.
Thapa Tek Chand, B.A.

Estate Services (ESS)

Civil Section

Jai Bhagwan, M.Sc. Physics **(Head** up to 31-08-11)
Goel Rajeev. (Dr.) M.E. (Structural Engineering) Ph.D **(Head** w.ef 1-09-11)

Scientists & Technical Officers

Krishna Kant, Dploma (Civil Engg)
Mukesh Kumar, M.Tech. (Construction Engg. & Management)
Sabharwal, A, BE (Civil) MBA (Marketing)
Tyagi V. K., Dip in Civil Engg

S&T and Supporting Staff

Dass, R. C., Non-Matric (Retired on Jan. 2012)
Gautam Pandey, Non-Matric
Harish Kumar, B.A.
Kailash Kumar, Matric
Manjhi Raja Lal, Non-Matric
Mehto Raj Kishore, Non-Matric (Retired on July, 2011)
Singh Bhanwar, Non-Matric
Varshney Vaibhav, Dip. in Civil Engg.
Vinod Kumar, Non-Matric

Horticulture

Scientists & Technical Officers

Ashok Kumar, M. Sc. (Hort.) (In-charge)

S&T and Supporting Staff

Raj Pal Singh Gautam
Tek Chand

Electrical Section

Sharma D. C. B.E. (Elect), M.Tech (Computers) **(Head)**

Scientists & Technical Officers

Suresh Chandra, B.E (Electrical Engg.) **Incharge**

S&T and Supporting Staff

Mitthan Lal, Non Matric
Sant Ram, B.A.
Satpal Rana, ITI (Retired on April 30, 2011)

Maharani Bagh Staff Quarters (MBSQ)

Sharma, B. M. (M.E. Transportation Engg.) **(Area Advisor)**
Tripathi A. K., Dip.in Civil Engg **(Head)**

Scientists & Technical Officers

Grover Sunil, B.E. (Civil)
Meena Muni Raj, B. Tech (Electrical)
Singh D. V., M.Sc.

S&T and Supporting Staff

Bhatt Pankaj
Mohan Lal, Non Matric.
Prem Chand, Non Matric
Singh Babban, B.A
Shababuddin Khan, Non Matric
Sheonandan Prasad, Matric
Tara Chand, Dip.in Civil Engg.

Vikram Singh, Non Metric

Directorate

Gauba A. K, Intermediate
Jetly Pushpa, B.A.
Singh Kartar, Matric
Singh Madhu Sudan, Non Matric
Saini Sunita, HSc

Administration

Jitender Parasar (Controller of Administration)
Singh B. K., (Administrative Officer)
Behl A.K., (Joined on July 27, 2011)
Kumar Vijay, HSc
Mehto Yoginder, Non Matric
Rakesh Kumar, Intermediate
Ravi Kumar, Non Metric
Sachdeva Priti, B.A. (Hons) & Diploma in Secretarial Practices, **(Receptionist)**
Singh Karam, Matric
Singh Kiran Pal
Thakur Suresh Prasad, Matric

Establishment-I

Chopra Rajeev, Sr. Sec.
Dhingra SK, B.Com
Devi Sumitra, Non Matric
Kaur Satinder, B.A.
Kant Chander
Kumar Anil, B.Com, Diploma in Management(on Deputation)
Mehto Sri Ram, Matric
Nita Kumari, B.A. **(Section Officer)**
Paswan Krishna, Matric (Retired Jan., 2012)
Verma Kamlesh, M.A., Certificate in Library Science
Vinod Kumar, B.A. **(Officiating Section Officer)**

Establishment-II

Kumar Vijay, (Section Officer)
Kumar Anil, B.A.
Desraj
Dinesh Kumar, Non Matric
Madhu Bala, B.Com
Malhotra R. K., HSc
Sharma Ramesh Chand, H.Sc.
Singh Gajai, Non Matric
Singh Narender, M.A.
Talwar Baldev
Verghese Kunjumol, Senior Secondary

Personnel Cell

Bhatia Parveen, B.A., Certificate in Lib. Science
Dharam Pal, Non Matric
Meena Murari Lal, B.A.
Rajan Tirkey, B.A. (Hons.)
Rawat Sanjay, B.A., PGDIRPM **(Section Officer)**

Vigilance Cell

Singh Vandana D., (Section Officer)
Chauhan Purushotam Lal, B.A.
Dhamija Aruna, B.A.
Kurian Sam,SSLC
Singh Hoshiar, Matric (Retired on Dec., 2011)

Cash

Bhambota V.K., Matric
Kishan Ram, Non-Matric

Finance & Account Section

Changloi H., F&AO
Indora Jai Prakash, F & AO
Gurmeet Kaur, SO, F&A
Malik Neelam,Matric
Nagi Vikas Singh
Phool Chandra, M.A.
Sharma Bishan Dass, B.A.
Singh Ajit Kumar, B. A.
Singh Balbir

Singh Bhajan, B.A.
Singh Dheeraj, Section Officer, F&A
Singh Jagdish, Matric
Shiv Narain, Non-Matric

Purchase Section

Rath Debraj (Store and Purchase Officer) (Resigned, Nov. 30, 2011)
Kaushal Kishore, (Dy. Store and Purchase Officer) (Joined on August 4, 2011)
Dussy Virender Kumar
Kumar Vijender, Matric
Chhachhia Sumer Singh
Singh Jai (Transferred)
Shah Ram Badan, Matric
Singh Randhir, Non-Matric
Verma Veena, M.A.
Laliteshwar, Steno
Bairagi K.

Store Section

Kukreti, C.M., HSc
Kumar Bijender
Marwaha Vijay Kumar, B.Com
Paswan Gore Lal, Matric
Singh Jaswant
Verma,S.G. , **SO, Store and Purchase** (Transferred)

Security, Guest House and Canteen

Security

Prakash Om, Non-Matric
Singh Dharam, **(Care Taker)**
Singh Ram, Non-Matric

Guest House (Wing I & II)

Acharya Keshav Ram
Balmiki, Ramsai
Bariya Rajesh
Narayan Chet
Pardesi R.C, BSC (Manager)
Siddiqui Fasih Ahmed (Manager)
Singh Rajbir
Singh Rajpat
Suraj

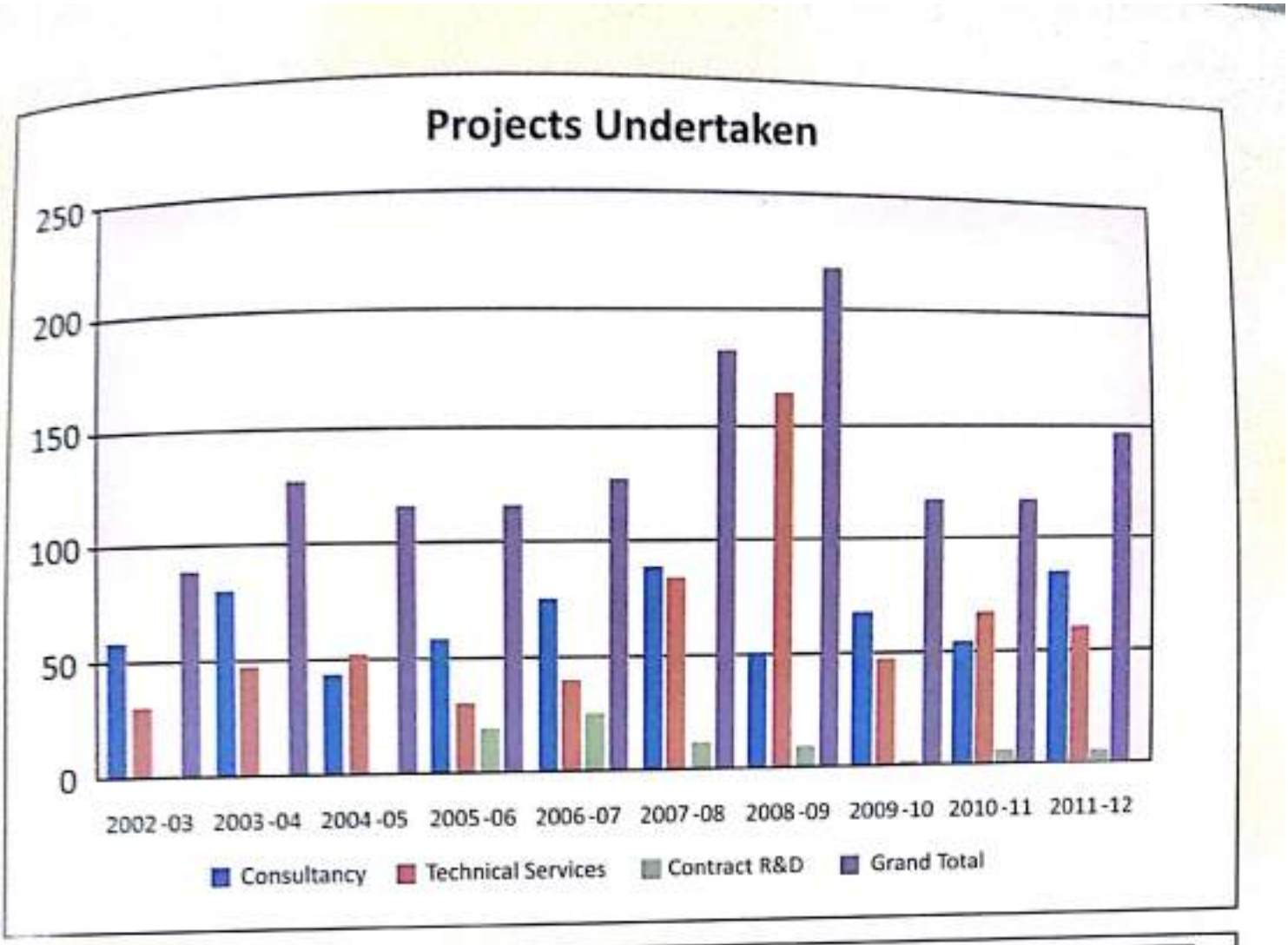
Canteen

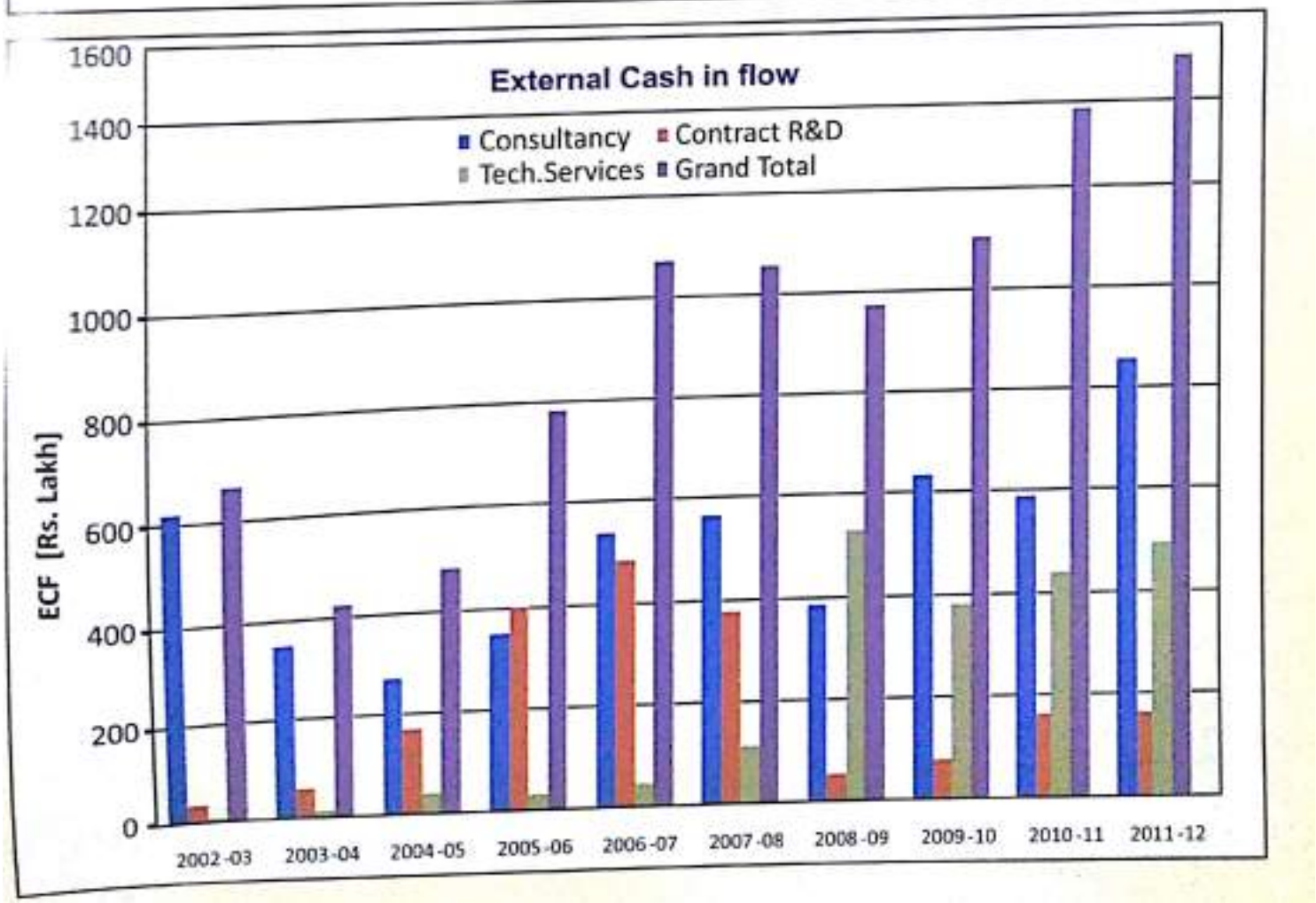
Prakash Braham, Non-Matric **(Manager**
Hem Kumar
Kumari Kamlesh
Kumar Manoj
Rao Ramesh
Singh Balbir
Singh Rajinder
Thapa Prem Bahadur, Non-Matric

Management Council of CRRI

Dr. S. Gangopadhyay Director CSIR-CRRI New Delhi	Chairman
Prof. S.K. Bhattacharya Director CSIR-CBRI Roorkee	Member
Dr. Rajeev Garg Sr. Principal Scientist CSIR-CRRI New Delhi	Member
Dr. Vasant Havanagi Sr. Principal Scientist New Delhi	Member
Dr. K. Ravinder Sr. Scientist (TPE) CSIR-CRRI New Delhi	Member
Ms. Ambika Behl Scientist CSIR-CRRI New Delhi	Member
Ms. Pawan Chabra Principal Technical Officer CSIR-CRRI New Delhi	Member
Dr. B. Kanaga Durai Head (PME) CSIR-CRRI New Delhi	Member
Sh. H. Chongloi Finance & Accounts Officer CSIR-CRRI New Delhi	Member
Sh. Jitender Parasar Controller of Administration CSIR-CRRI New Delhi	Member-Secretary

Prof. D. V. Singh FNAE, FNA, FASc, FNASc, FIE 1002, Sunbreeze Apartments Tower B, Vaishali, Sector V Ghaziabad-201 010	Chairman
Lt. Gen.S. Ravi Shankar, VSM DG, Border Roads and colonel commandant, The Corps of Engineers. (BRO) Seema Sadak Bhawan Ring Road, Delhi Cantt. New Delhi-110 010	Member (External Member)
Shri S. K. Puri Ex. DG (Road Development & Special Secretary MORTH), B-221, Sushant Lok, Phase-I Gurgaon, Haryana	Member (External Member)
Prof. M. R. Madhav Professor "SUTEJA" 159, Road No. 10 Banjara Hills Hyderabad-500 034	Member (External Member)
Prof. B. R. Marwah Executive Director NC College of Engg. & Technology Ishrana, Panipat (Haryana)	Member (External Member)
Dr. L. R. Kadiyali Chief Engineer (Retd.), MoSRTH RZ-44, Bhawani Kunj Behind D-2 Vasant Kunj New Delhi-110 070	Member (External Member)
Shri Kandasamy Director General (Road Dev.) Special Secretary to Govt. of India Ministry of Road, Transport & Highways 1, Parliament Street New Delhi-110 001	Member
Dr. S. Arunachalam Chief Scientist Structural Engineering Research Centre CSIR Campus, TTTI Taramani Post Bag No. 8287 Chennai-600 113	Member (DG's Nominee)
Prof. S. K. Bhattacharya Director Central Building Research Institute Roorkee-247 667	Member
Prof. B.K. Mishra Director Advanced Materials and Processes Research Institute Hoshangabad Road Near Habibganj Naka Bhopal-462 064	Member
Dr. S. Gangopadhyay Director CSIR-CRRI Delhi-Mathura Road, P.O. CRRI New Delhi-110 020	Member (Director, Lab)
Head or His Nominee Planning & Performance Division Council of Scientific & Industrial Research Anusandhan Bhawan 2, Rafi Marg New Delhi-110 001	Member (Permanent Invitee)
Secretary, RC **Dr. P. K. Jain** Scientist "G" & Head PME CSIR-CRRI, New Delhi-110 020 E-mail: pramodj.crri@nic.in Phone: 26921835 (Ext. 223) M: 9910113992	Member





सी एस आई आर-केन्द्रीय सड़क अनुसंधान संस्थान

CSIR-CENTRAL ROAD RESEARCH INSTITUTE

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New Delhi -110 025

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