Annual Report
2007 - 08

CENTRAL ROAD RESEARCH INSTITUTE
New Delhi
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CRRI
Annual Report
2007-08

Edited, Compiled & Produced by:
Information, Liaison & Training Divisions

Editing, Compilation & Production:
Sh. T.K. Amla, Scientist & Head
Smt. Anita Arora, Technical Officer,
Sh. P.R.N. Nair, Technical Officer

Assisted by:
Sh. M.K. Meena, Scientist
Sh. Rajbir Singh, STA,

Secretarial Assistance:
Sh. B.S. Batra, Sr. Steno

Overall Supervision:
Sh. T.K. Amla,
Head
Information, Liaison & Training

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It is my privilege to present the Annual Report of the Institute for the year 2007-08 highlighting the major R&D achievements and Consultancy work undertaken. Major thrust on R&D was focused in the areas of Traffic and Transportation Planning; Road Safety and Environment; Road Development Planning and Management; Geo-technical aspects related to Roads (landslide, slope stability, ground improvements etc.); Construction techniques and Evaluation of Materials and Mixes for Rigid and Flexible pavements; Bridge Design, Evaluation and Rehabilitation and Software Development.

Several projects of great importance undertaken / completed by the Institute include: (i) Utilization of Construction and Demolition (C&D) Waste in Road works, (ii) Investigation, Monitoring and Instrumentation of Kalisaur Landslide (iii) Development of emulsion based cold mix technology for structural layers and wearing course of flexible pavement (iv) Marble slurry dust and wollastonite – inert mineral admixture for cement concrete (v) Functional performance of cement concrete pavements in and around Delhi, (vi) Waste plastic in bituminous mixes for road construction, (vii) Evaluation and improvement measures for selected roads of NDMC Phase II, (viii) Pre-
The Institute has signed Memorandum of Understanding with various Zonal Railways for Evaluation and Monitoring of different types of bridges for increased axle load of freight wagons. It consists of theoretical studies, instrumentation and monitoring of ten bridges - two numbers each of South Eastern Railway (SER), Northern Railway (NR), Eastern Railway (ER) and four bridges of West Central Railway (WCR). These bridges are of steel (plate girder, underslung and through girder) masonry arch and composite girder bridge.

Under 11th Five Year Plan of CSIR, a study has been undertaken on “Development of Management System for Maintenance Planning and Budgeting of High Speed Road Corridors. The developed system will assist in reducing of avoidable losses occurring every year on account of poorly maintenance judiciously and in prioritizing the maintenance treatment in view of limited resources.

Design guidelines to optimize the quantity of bitumen for use in construction of wearing course with bitumen emulsion have been developed, which are presently not available in India.

The Institute has procured Portable On-Board Emission Measurement (OEM-2100) System.
first time in India for real world mass exhaust emission monitoring. An acoustic multichannel Universal Real-time Analysis Instrument has also been procured for noise and vibration measurements as well as real-time analysis with sound book, Harmonies and Noise Log along with meteorological and speed measurement.

Two patent application for "Design of Trail Suspension Bridges (TSBD) FOR" – a Computed aided Design which would result in considerable saving of times in addition to the refinement, and economy; and "No Mobile when Mobile" – An educative film showing how use of cell phone can cause unsafe conditions on road, have been filed for getting intellectual property rights.

The Institute continued with its year round regular activities pertaining to imparting training, conducting refresher courses and knowledge dissemination etc. in the various technical areas of the Institute. Besides, six special/customized training programmes were organized on specific requirements of clients. An International training programme tenth in the series on HDM-4 was organized too. Under HRD Programme of the Institute, 54 students (B.Tech, M.Tech, MCA) from different academic Institutions/ Universities etc. were provided guidance and training for accomplishing their summer project/training and thesis/dissertation works etc.

Some of our scientists received excellence awards for their contributions in the highway sector.

I congratulate one and all from CRRRI family for their untiring efforts and contributions in the successful completion of the year and promise that we would continue to serve the profession even better in the years to come.
Quality Policy

The Central Road Research Institute (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.
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.
Summary
of
Progress
Development of Design Guidelines for Trench Drainage System Using Finite Element Analysis

The study deals with the analytical studies on the performance of trench drains in steady state for anisotropic soil media. In a number of instances, landslides occur owing to the development of very high pore water pressure within the soil slope. In order to prevent the occurrence of landslides, trench drains are widely used for the purpose of draining out water from the soil and to reduce the pore water pressure to restore stability of the hill slope. Owing to the complex geometry of slopes, anisotropic and the transient nature of the ground water flow, designing of such drains is an extremely difficult task. Survey of literature indicates that the trench drains being dimensioned on the basis of experience, but not much work has been done so far to provide a suitable design for trench drainage system.

The Finite Element Analysis is required for this problem to investigate the performance of the trench drainage system for incompressible, homogeneous and anisotropic soil media. The project deals with the application of Finite Element Method (FEM) for developing guidelines for designing the trench drainage system. An attempt has been made to determine the geometrical configurations such as depth, width and spacing of the trench drainage system for steady case. Using the developed Flow Chart and Computer Programme in FORTRAN IV for FEM, the unknown pressure head is determined by solving the governing differential equations with the associated boundary conditions.

Based on extensive FEM analysis, various diagrams have been provided from which, the inter-relationship between the optimum spacing $(S/B)_{opt}$, the maximum value of piezometric head and the maximum discharge of water flowing into the drains $(Q'_{max})$ for various values of horizontal to vertical permeability $R_k$ and depth conditions of drains for any drainage system have been determined (Fig. 1).

![Graph showing discharge versus spacing relationship for various values of depth and $R_k$.](image-url)
The present numerical results for isotropic soil medium compare quite favorably with those available from the literature. Comprehensive diagram and mathematical models developed from the finite element solution for maximum quantity of discharge of water are useful for designing trench drainage system.

Waste Materials Information Database for Highway/Geotechnical Engineering-Related Applications

There are a number of waste materials, which can be utilized gainfully in the construction of roads and embankments. Extensive research work has also been done in India as well as abroad and the studies have shown that many such wastes have a great potential for its use in road works. However, they have never been utilized on our roads mainly due to lack of information on the subject. As a result million of tons of waste materials are getting accumulated and causing serious environmental problems.

Keeping the above in view, it is intended to develop database, which contain information for the use of above in highway/geotechnical engineering application. The database would provide the user with both general and detailed engineering and environmental information on different waste materials. The waste materials such as coal fly ash, slags (steel slag & blast furnace slag), municipal waste and mine waste...
Fig. 3 Municipal waste material description screen

Fig. 4 Coal fly ash application screen
(Kimberlite) are included in the database. To develop the database, Visual Basic 6.0 is used which provides the flexibility to edit and update the data to respond to new data inputs. The aim of developing the database is to make the same available to the user at one place in the form of CD which will be Windows based and can be used very easily and conveniently. Individual WRM program files were created for six categories such as general information, production and use, engineering properties and laboratory testing, environmental properties, application and field trials (Figs. 2, 3 & 4).

Effect of Purity of Lime on Strength and Durability of Soil-Lime Mixes

Indian Roads Congress as per IRC: SP 20-2002 and Ministry of Road Transport and Highways Specifications for Road and Bridge Works as per Clause 402.2.2 specifies that lime of 70 per cent purity should be used for soil stabilization to get the desired results i.e., 7 days unconfined compressive strength requirement in case of stabilized sub-base layer should be 17 kg/cm². However, it has been observed that lime of such purities, are generally not available. In case lime of such specifications, are arranged from specific mines, the cost of the same works out to be even more than the ordinary Portland cement, it may make the project cost prohibitively high.

To evaluate the effect of purity of lime on strength and durability characteristics of different soils, three types of soils generally available in the country were chosen. The soils considered for the study are fine grained soils i.e., silty soil, black cotton soil and clayey soil. The study was conducted with laboratory grade lime and commercially available limes from different locations. The purity of laboratory grade lime was 87 per cent and of commercial lime “1” & “2” was 50 and 17 per cent respectively. To assess the strength gain and durability of soil-lime mixes, laboratory experiments were planned to compare the effect of lime of different purities on stabilized soils in terms of unconfined compressive strength and durability.

It was found that in case of silty soil stabilized with 4 per cent laboratory grade lime, 4 per cent commercial grade lime “1” and 6 per cent commercial grade lime “2” satisfies the UCS criteria for use in sub-base/base layer of pavement. However, the black cotton soil stabilized with 6 per cent laboratory grade lime and 6 per cent commercial grade lime “1” satisfies the UCS criteria for use in sub-base/base layer of pavement but failed to satisfy the given criteria with commercial grade lime “2”. It was also found that clayey soil stabilized with 4 per cent laboratory grade lime, 4 per cent commercial grade lime “1” and 6 per cent commercial grade lime “2” satisfies the UCS criteria for use in sub-base/base layer of pavement. However, durability tests carried out on three types of soils stabilized with limes of different purities, indicated that silty soil stabilized with lime of different purities could withstand the durability cycles with certain percentage of lime but clayey soils and black cotton soils stabilized with lime of less purity could not withstand the durability test.

The findings of the project indicate that the criterion of 70 per cent purity of lime can be relaxed for silty type of soil for the purpose of lime stabilization.
Detailed Geological and Geotechnical Investigations, Instrumentation and Monitoring of Amparav Landslide, Uttarakhand State

The project has been sponsored by the Department of Science & Technology (DST) in the field of landslides under the Mission Mode Project Scheme. Amparav landslide is located on the Kathgodam Nainital road, 4 km before Jyolikt on NH-87 in Kumaun Division of Uttarakhand State (Fig. 5). The study area is situated close to the lake city of Nainital and fall under the Survey of India top sheet no. 53 O/7 and O/11. Amparav landslide tragedy took place in the Chopra Gram Sabha on 23rd September, 2004 due to high precipitation (211.33 mm) and followed by the cloud burst. Seven residential and commercial structures were destroyed, 8.9 ha (14.30 per cent) agriculture land of the villagers was lost, 3 people died, and more than 300 m bridle paths and a bridge were destroyed. A part of the NH-87 was also damaged and the traffic was interrupted.

The basic aim of the study is to provide the remedial measures to control the landslide. The study area is covering about 3 sq km areas. The rocks are exposed on high reaches showing two major landslides in the study area and also...
showing the circular failure at lower reaches close to the NH A7, where soil burden is more and the rocks are disintegrated. The two major landslides are the rock slide of plan failure and talus failure in nature. It seems that adjacent area to the main landslide is also susceptible for the failure. It is also found that the area suffered by the many landslides earlier. Geotechnical and geotechnical investigations were carried out. Instrument like rain gauge and the movement gauges were installed. Most of the field tests and other lab tests were done. The further work is under progress.

**Utilisation of Construction & Demolition (C&D) Wastes in Road Works**

As reported earlier (Annual Report 2006-07) construction & demolition (C&D) wastes constitute one of the largest waste streams in the world. C & D wastes consist of the materials generated during the construction, renovation and demolition of buildings and other structures. The management of C&D waste is a major concern due to the increasing quantum of demolition rubble, continuing shortage of dumping sites, increase in transportation and disposal cost and above all growing concern about pollution and environmental deterioration. Delhi city produces about 3000 tonnes of construction and demolition waste every day. Management of such huge quantity of waste puts enormous pressure on solid waste management system. The growing population in the city and requirement of land for other uses has reduced the availability of land for waste disposal. Re-utilization or recycling is an important strategy for management of such waste.

The characterisation work of C&D waste was completed and the report has been submitted to Municipal Corporation of Delhi (MCD), the project sponsor. The study evaluated feasibility of using C&D waste materials for road construction — as fill material, in stabilised form and as a component of concrete and bituminous pavement layers. Some of the outcome of the study are as follows:

- **Use of C&D waste for Embankment Construction:**

  After detailed laboratory investigation it was found out that powdered C&D waste fulfils the criteria specified for soil used for the fill material in embankment construction. C&D waste in dumping yards usually contains particles bigger than the size specified by MoRT&H specifications. Hence C&D waste should be crushed to less than 75 mm size (max) before it can be used for embankment construction. C&D waste is a non-plastic material. Hence the embankments constructed using C&D waste would be prone for erosion. Thus, embankments constructed using C&D waste should be protected against erosion by adopting suitable erosion control measures.

- **Use of C&D Waste for Sub-base and Base Course Construction:**

  Processed C&D waste (after crushing and sieving) can be used as a component material for sub-base construction. Being a free draining material; C&D waste material of proper gradation and CBR value can be used as such (with out any admixture) for sub-base course construction of low volume roads. However since its crushing strength...
not meeting the specification requirements, its usage for roads having high traffic volume, may be restricted to lower half of the sub-base layer. Cement stabilised powdered C&D waste can be used to replace a part of WBM/WMM layers.

- **Use of C&D Waste for Rigid Pavement Construction:**

Admixing C&D waste aggregates in pavement quality concrete (PQC) showed that 28 days compressive strength decreases by about 12 per cent when 60 per cent of C&D waste has been replaced in the conventional hard stone aggregates. The decrease in compressive strength of DLC mix was more; about 50 per cent replacement resulted in 28 per cent decrease in 28 days compressive strength. Hence, proper mix design using the available C&D waste aggregates and conventional hard stone aggregates is to be carried out and replacement of conventional aggregates by C&D waste aggregates may be restricted to about 35 per cent, depending on compressive strength to be achieved.

**Pilot Project for Construction of PMGSY Roads Using Jute Geotextiles**

Under the study supported by Jute Manufacturers Development Council (JMDC), 10 roads are being constructed using jute geo-textile to study its efficacy for drainage, erosion control, capillary cut-off and sub-grade improvement (Fig. 6). The pavement design incorporating jute geo-textiles have been earlier carried out by the Institute and

'Detailed Project Report' for each of the roads was prepared. Some of the road stretches are presently nearing completion while work is under progress in other sites. Due to unprecedented rains in West Bengal previous year, one of the roads, which were nearing completion in that state suffered extensive damages. It is now being repaired as per Institute's advice. Random quality monitoring is being carried out in these demonstration road projects apart from guiding state engineers on aspects related to laying of jute geo-textiles.

**Engineering of Structures against Natural and Other Disasters** (NWP 0039)

Under the CSIR network project coordinated by Structural Engineering Research Centre (SERC), Chennai, the Institute has proposed the studies on effect of landslides and floods on road structure. Patalganga and Kalisaur landslide have been selected as study sites for this project.
Topographical Survey of the Patalganga area has already been completed on a scale of 1:500. Terrain analysis of the data has been generated using GIS (Geographic Information System) ports (Fig. 7). Sixty five nos. of steel GI pipe made pedestals have been installed in the Landslide with their original position fixed by the DGPS (Fig. 8). Collection of the samples has been done for the geo-technical characterization of the rock and soil. The study is currently under progress.

The another part of the study is to assess the damages caused by floods. For this purpose, a field visit was undertaken to flood affected stretch of NH-44 in Assam state near Silchar and held discussions with BRO officials. The BRO have agreed for joint monitoring of efficacy of flood protection measures at this site. Presently flood protection measures are under construction at this site as shown in Figs 9 & 10.
Consultancy Assignments

Landslide/Subsidence Investigations on Aizawl-Lunglei Road (NH-54), Mizoram

The problematic area is situated in the vicinity of Hnahthial town of the Srichip District, Mizoram State and occurrence of slide interrupts the movement on NH-54. The landslide affected area is located at the heart of Hnahthial Bazar Veng at 173.3 km (Fig. 11) and lies in the Survey of India toposheet 84A/6. The road Aizawl-Lunglei as a part of NH-54 was constructed by Border Roads Organization (BRO) under the project ‘Pushpak’ leads to the border area. The main objectives of the study to recommend suitable remedial measures for the slope stability and to get the sufficient road width for the traffic as further winding/cutting of the road was not possible. For this purpose a detailed geological and geotechnical investigations were carried out. Field as well as lab tests were conducted. Factor of safety analysis (FOS) were carried out with and without remedial measures. Suitable remedial measures were suggested along with design parameters. A report was submitted to the client.

Feasibility Study on the Use of Stabilizer Cementation Material in Road Construction

A commercial stabilizer is a powder-based stabilizer composed of natural in-organic material. To investigate the feasibility of this stabilizer in road construction, different type of soils viz. clays, silts, sand and gravel were stabilized with stabilizer in the proportion 2, 4, 6, 8, 10 and 12 per cent. The improvement in strength is evaluated by conducting Unconfined Compressive Strength tests (UCS) and California Bearing Ratio Tests (CBR). The strength is evaluated after curing the stabilized samples for 7 and 28 days. Durability characteristic of stabilized samples

Fig. 11 Landslide at km.173.5 on NH-54

Fig. 12 Stabilizer content versus unconfined compressive strength
value with per cent content of stabilizer for gravel, sand, silt and clay soil. Figure 13 shows the variation of UCS value with curing periods of stabilizer stabilized silt soil. Stabilized gravel and silt soils with stabilizer content of about 5 per cent satisfied the UCS criteria (UCS > 1716 kN/m² as per IRC: 50:1973) after 7 days curing for use in sub base/base layer of road pavement. But the durability criteria for these stabilized soils are satisfied at stabilizer content of 4 per cent for silt and 6 per cent for gravel soils. So considering these values it is recommended that stabilized gravel and silt soils with 6 per cent stabilizer content may be used for construction of sub base layer. It is observed that stabilized sand and clay soils does not satisfy the UCS and durability criteria for use in sub-base/base layers of road pavement.

Fig. 13 Unconfined compressive strength of stabilizer stabilized soil with different curing period

is also evaluated on selected samples after 7 days curing. Based on the results of UCS and CBR values and durability characteristics, its feasibility for use in road construction is evaluated. Fig. 12 shows the variation of UCS

Fig. 14 A typical section of a 5 m height railway pond ash embankment
Design of Railway Embankment Using Coal Ash

This is a collaborative project between RDSO, Lucknow, IIT Mumbai and CRRI. The project is sponsored by NTPC, Noida to study the feasibility of pond ash as a fill material in railway embankment. The study would be carried out by using this waste material in the proposed railway line which shall be constructed within the plant premises of NTPC, Kahalgaon.

Pond ash and local soils were collected and characterized for their geotechnical characteristics. The data of sub soil characteristics of site where the pond ash railway embankment has to be constructed was collected. Using the laboratory data and sub soil data different types of cross sections have been designed. Embankments of different heights viz. 3, 5, 7 and 11 m were designed considering the site conditions. The coal ash railway embankment was designed as a composite structure with coal ash in the core and with good earth as cover on both sides. Stability analysis of embankment was carried out considering saturation/sudden draw down conditions, live load/dead load, and seismic factors. Drainage of railway embankment was also given due consideration during design. The feasibility of using geogrids, geotextiles in railway embankment especially in reinforced earth wall construction is also proposed to be investigated. Instrumentation of the constructed railway track would also be suggested for the long term performance monitoring and final conclusions. Typical cross-section of proposed 5m height railway embankment is shown in Fig. 14. The study is under progress.

Design of Embankment for PMGSY Road in Anjar Taluka, Kutch District, Gujarat

Gujarat R&B (Panchayat Raj) Department entrusted a project on design of road embankment for proposed PMGSY roads in Kutch district. The length of the road investigated is about 11.43 km. The proposed PMGSY road connects fishermen colony and salt workers colony with existing district roads. A part of this road is located adjacent to sea and partly it lies in salt pans (Figs 15&16). The CRRI team undertook field visit in April 2007 to assess the site conditions. Backfill

Fig. 15 PMGSY road enveloped by tidal waters.

Fig. 16 Salt pans adjoining PMGSY road
soil and subgrade soil samples were collected for testing and evaluation. Data regarding soil properties / sub-soil conditions and geometrics of proposed embankment were also collected. After completing laboratory investigations and analysis of data, toe wall design was carried out, so that wave action due to tidal waters does not erode the embankment. In the salt pan areas, embankment side slope protection and toe wall were designed (Fig. 17). Based on the comments received from Gujarat R&B Department, a Project Report has been submitted to Gujarat R&B Department.

Advice Regarding Repair/Preventive Measures for Flood Damages, Indo-Pak Border Roads, Gujarat

The National Buildings Construction Corporation Ltd (NBCC) has been entrusted the responsibility of constructing 'Border Fencing' along our country's borders including Gujarat along selected stretches. India's international border in Gujarat is situated in Rann of Kutch where Arabian Sea water transgresses and regresses frequently leaving inland marshy and swampy, dotted with small to very large salt water bodies. In continuation of the work reported in the previous year, the CRRI team undertook a second visit to flood affected border areas in April 2007 near Bhuj. These areas were inaccessible during the earlier field visit. Detailed discussions were held with engineers of NBCC regarding proposed remedial measures for the eroded border roads and border link roads. The proposed remedial measures were then presented in the meeting of the Empowered committee comprising of Secretary, Union Ministry of Home Affairs, Director General and ADG (CPWD), Executive Director, NBCC, Director General (Border Security Force) and other high ranking officials.
Design and Construction Supervision of Roads and Flyash Embankment at Dwarka

This consultancy work was sponsored to CRRI by the Delhi Development Authority, New Delhi to design and supervise the 30m, 20m and 12m wide roads in sector 24 at Dwarka sub city, Delhi.

The main objective of the project was to characterize the flyash samples and based on the same to suggest a suitable cross-section of flyash embankment. In addition to the above, monitoring and quality control during the construction of embankment and road was also undertaken.

The typical cross-section of road embankment and road pavement structure is shown in Fig. 18 and compaction of flyash during the time of construction is shown in Fig. 19. A report has been prepared and submitted to the client.

Investigation, Monitoring, and Instrumentation of Kalaisaur Landslide on NH-58 and Design of Control Measures for its Long-term Stability

(i) Detailed survey and mapping, (ii) Collection of field data and sampling, (iii) Field and laboratory Tests, (iv) Installation of instruments, (v) Instrumented

Fig. 19 Typical Cross section of 30m ROW road in sector-24, Dwarka, New Delhi
monitoring and analysis of data, (vi) Design of remedial measures and Report preparation are the objectives of study sponsored by Department of Science and Technology. Survey and mapping of the area on a scale of 1:500 has already been completed after which terrain analysis of the area was done for the characterization of the landslide. Rocks of the area were examined using parameters of RMR (Rock Mass Rating) Classification (Fig. 20). To monitor the movement of the slide with maximum possible precision, steel GI pipe made pedestals were installed in the slide body and their position was fixed using DGPS (Differential global Positioning System). Samples from the critical sites have already been collected to test in the laboratory for the evaluation of geo-technical parameters. The slope map of Kaliasaur area is shown in Fig. 21. The study is currently under progress.

Design of Reinforced Earth Wall and Recommendations for Ground Improvement

The project was sponsored jointly by Railways and Tantia Construction Limited for the design of 11m high reinforced earth wall using steel strips and suggestion for ground improvement. A complete design of reinforced earth wall for different heights was provided to the client.

To suggest the ground improvement measures, the data was collected on sub-soil profile and water table fluctuations etc. On the analysis of the subsoil data and considering the load expected due to the construction of reinforced earth wall, it was found that ground improvement measures are essential. After the detailed analysis of bearing capacity calculations, it was suggested that ground improvement by using stone column is required wherever the wall height exceeds 3m.

A complete design of stone column as per the procedure indicated in BIS codes was provided to the client indicating the depth and spacing of the column. The construction procedure for providing the stone column was also indicated in the report. It was also suggested...
to carry out plate load test on the group of stone columns to ascertain the exact height of RE wall to be constructed on the ground improved by providing stone columns. Fig. 22 shows the load test on group of stone column in progress.

Fig. 22 Load test in progress on ground improved with stone column
Performance of PMB-40 (SBS) Modified Bitumen on NH-1 (Outer Ring Road), Delhi

National Highways (NH-1, Km 0 to Km 16) is part of outer ring road, in Delhi and is subjected to heavy commercial traffic from J&K, Punjab, Haryana U.P., Bihar and West Bengal. This road section was widened and strengthened in December, 2005. The reach between Km 9.750 to 16 contains 40 mm BC as wearing course over DBM construction with 60/70 bitumen as well as SBS modified PMB-40. The 1st observations were taken up in April 2006 and 4th observations have been taken up in December 2007. Typical views of test sections are given in Fig 23(a & b). The roughness data at the time of 1st observations and 4th observation is given in Table 1.

The performance of test sections having BC of SBS modified bitumen is found to be better than BC of 60/70 bitumen as total surface distress on all the test sections laid with SBS modified

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<td>10.000 to 10.200</td>
<td>Karnal</td>
<td>1725</td>
</tr>
<tr>
<td>3A (60/70)</td>
<td>11.500 to 11.700</td>
<td>Karnal</td>
<td>1684</td>
</tr>
<tr>
<td>4A (60/70)</td>
<td>13.000 to 13.200</td>
<td>Karnal</td>
<td>1679</td>
</tr>
<tr>
<td>5A (SBS)</td>
<td>14.400 to 14.600</td>
<td>Karnal</td>
<td>1708</td>
</tr>
<tr>
<td>6A (SBS)</td>
<td>15.000 to 15.200</td>
<td>Karnal</td>
<td>1722</td>
</tr>
<tr>
<td>1B (SBS)</td>
<td>9.750 to 9.950</td>
<td>ISBT</td>
<td>1695</td>
</tr>
<tr>
<td>2B (SBS)</td>
<td>10.000 to 10.200</td>
<td>ISBT</td>
<td>1676</td>
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<tr>
<td>3B (60/70)</td>
<td>11.500 to 11.700</td>
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<td>4B (60/70)</td>
<td>13.000 to 13.200</td>
<td>ISBT</td>
<td>1645</td>
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<td>5B (SBS)</td>
<td>14.400 to 14.600</td>
<td>ISBT</td>
<td>1694</td>
</tr>
<tr>
<td>6B (SBS)</td>
<td>15.000 to 15.200</td>
<td>ISBT</td>
<td>1699</td>
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</tbody>
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bitumen, after lapse of 24 months, is less than 0.5 per cent. The layout plan of study sections is given in Fig. 24 and data of rutting behaviour in plotted in Fig. 25.

Fig. 24 A layout Plan showing the number of test sections laid on NH-1

Fig. 25 Rutting of BC mixes with increase in number of cycles
Performance of PMB-40 (HDPE) Modified Bitumen on NH-2 (Durgapur Expressway)

The project is sponsored by M/s. Novaphalt Construction Co Pvt. Ltd. and EMAS Expressway Pvt. Ltd. to develop performance data base on HDPE modified bitumen. Dankuni-Palsit-Panagarh Section of NH-2 is a part of Durgapur Expressway. 50 mm BC on Durgapur bound carriageway as well as on Kolkata bound Carriageway was constructed using HDPE Modified Bitumen and road was opened to traffic in April, 2004. After lapse of 4 years, the condition of road is still very good and roughness is in between 1500 to 2000 mm. There are a total of 16 test sections, on both carriageways. Eighth periodic performance observation (at six months interval) have been completed so far.

**Review of Pavement Designs and Materials Specifications for Construction of Three Border Roads in North Sikkim**

Ministry of Home Affairs has assigned the responsibility to CPWD for development of three...
roads in North Sikkim viz. Dambang-Chaubakha-Gorala (ii) Thangu-Muguthang (Via Lugnak-La) and (iii) Gijang-Karang-ITBP Border outpost roads. CPWD appointed Consultants for preparation of DPRs for the proposed road links (Fig. 26). On request from CPWD, Institute has undertaken “Review of Pavement Designs and Materials Specifications for construction of these three Border Roads in North Sikkim so as to construct long lasting and durable roads since these will operate under very harsh climatic conditions (such as freezing, high attitude, cold and snow bound areas etc. The field work and review of DPRs is currently in progress.

**Laboratory Study to Determine the Suitability of Plastic Waste Modifier in Construction of Bituminous Concrete Mixes Through Dry Process**

Considerable research has been carried out in the past both in India and abroad to determine the suitability of plastic waste modifier in construction of bituminous mixes. It has been well established that the plastic waste modifier can be successfully employed in modification of mixes without compromising on the key properties of these mixes. In fact, a good length of roads has already been constructed in and around Bangalore by incorporating waste plastic modifier in the construction of bituminous mixes. Waste Plastic/Rubber/Polymers can be incorporated in modification of bituminous mixes through anyone of the following two methods:

- **Dry Process:** This method involves direct incorporation of waste plastic/polymer, and substitutes partly the proportion of fine aggregate. The waste rubber/plastic is blended with aggregate, prior to the addition of bitumen, to prepare a waste plastic/polymer modified bituminous concrete mix.

- **Wet Process:** This method involves simultaneous blending of bitumen and waste polymer. The reaction between bitumen and waste polymer is influenced by the temperature at which the blending occurs. Towards this end, the waste plastic modifier was evaluated for its suitability in
particle size of 2 to 3 mm (in diameter). The obtained gradation of waste plastic/polymer is given in Fig. 27. Thermal degradation behavior of waste plastic modifier was also studied on Thermal Gravimetric Analyser (TGA) in nitrogen atmosphere using a sample size of 7.8 mg and a heating rate of 20°C per minute to determine the suitability of incorporating modifier with the hot aggregates. The thermal degradation behavior is shown in Fig. 28. As can be seen, waste plastic/polymer modifier will not pose any problem and will not degrade when blended with the hot aggregates.

Marshall method of mix design was used for determination of Optimum Binder Content (OBC). The gradation curve adopted for the dry BC mix and limits of MoRTH specifications are given in Fig. 29. The optimum binder content for the BC mix was found to be 5.5 per cent (by the weight of aggregate). Further, Marshall samples at optimum binder content (at 5.5 per cent by wt. of aggregate) were cast using 0, 8, 12 and 15 per cent modifier (by weight of bitumen), to determine the bulk density and strength properties.

Rutting potential was studied using Hamburg’s Wheel Tracking Device (HWTD) and the test results are shown in Fig. 30.

Based on the laboratory test results following major conclusions can be drawn:

(i) The significant improvements observed in strength and laboratory performance parameters like Marshall stability, Indirect tensile strength, rutting and retained stability of bituminous concrete mixes clearly demonstrate that waste plastic modified bituminous concrete mixes are

construction of bituminous concrete mixes.

The study is proposed to be implemented in two phases. Phase-I involves laboratory evaluation to determine the suitability of waste plastic in bituminous concrete mixes by using dry process, while Phase-II is again the laboratory evaluation but would be done by employing wet process.

60/70 penetration grade paving bitumen was used under this investigation as the bituminous binder. The modifier used is a mixture of waste plastic/polymer and is in shredded form, having
more durable, less susceptible to moisture and can offer improved performance.

(ii) Hamburg Wheel Tracking test results indicate that the modified mixes, containing waste plastic/polymer modifier, are less susceptible to deformation as compared to conventional bituminous concrete mixes.

(iii) The application/utilization/incorporation of waste plastic/polymer modifier in the construction of bituminous concrete mixes is, therefore, expected to benefit in two major ways i.e. one in improving the overall performance of bituminous mixes and secondly in effective utilization of waste materials, which would ultimately assist in solving the problem of dumping waste plastic/polymer in a big way which are otherwise environmental and health hazards.

(iv) The investigation carried out has brought out very clearly that addition of waste plastic/polymer into bituminous concrete mixes is expected to increase pavement performance and offer durable and long lasting roads in the country, therefore, achieving reduced road maintenance cost.

Development of Cold Mix Technology for Structural Layers of Flexible Pavement (CSIR Network Project)

i. Development of Bitumen Emulsions

The bitumen emulsions of different grades such as rapid set, medium set and slow set, have been developed using PMB-Emulsion Plant available at CRRI. The developed emulsions were characterized for their physio-chemical properties, as per IS:8887-2004. The shelf life of slow set emulsion was found to be more than one year.

ii. Development of Design Procedure of Cold Mixes

The design of cold mixes such as SDBC and BM was developed using emulsion and aggregates from Rajasthan, J&K and Mizoram. The procedure adopted for design of cold mix was standard

CRRI New Delhi 21
Marshall equipment. Different sizes of aggregates were blended to achieve the specified gradation of SDBC and BM mixes. 1100 gm graded aggregates were moistened uniformly with optimum water content. Different bitumen emulsion contents viz. 7, 8, 9 and 10 per cent were then added to the wet aggregates and mixed for 2 minutes to achieve uniform binder coating. The cold mix was kept in oven at 60°C for two hours. The cold mix was then transferred into the Marshall mould (with filter paper on base plate) and compacted with 75 blows of Marshall hammer on both faces.

Similarly, the Marshall specimens were prepared with optimum water content and by varying the quantity of bitumen emulsion at 8 and 9 per cent. Marshall specimens were extracted from the mould after 24 hours and were subsequently cured in oven at 40°C for 72 hours before subjecting them to different Marshall tests.

iii. Field Trials for Development of Cold Mix Technology for Structural Layers in Different Climatic Conditions

The test sections with cationic bitumen emulsion were laid using Hot Mix Plant (without heating facility) and Paver at three separate locations falling in different climatic conditions of India i.e. (i) km 57.200 to 57.500 on Dantaur Khajuwala Road (Fig. 31) in desert climate in Rajasthan in April, 2007 (ii) in Alizawl, Mizoram (Figs 32 & 33) in high rainfall area in June, 2007 and (iii) km 213.200-213.450 near Srinagar on Jammu-Srinagar Road (NH 1A) in J&K (Fig. 34) under cold and snow bound areas in September, 2007. The specifications of test sections laid were 50 mm Bituminous Macadam + 25 mm SDBC and 50 mm Bituminous Macadam + 25 mm Mix Seal Surfacing.

The first series of performance monitoring of different test sections has been completed and the test sections are found to be in good to very good condition.

Development of Thin Stone Matrix Asphalt

As part of in-house research project, materials and specifications have been developed for laying 15 mm thick stone matrix asphalt using 6.3 mm and down sized aggregates.
and PMB-40 (SBS Modified). Different compactive efforts were made at 135, 110 and 90°C respectively using warm mix additive and with out warm mix additive. Marshall specimens were prepared and performance characteristics viz. dynamic ITS, dynamic creep and rutting by Wheel Tracking Machine (Coopen’s) were obtained at different testing temperatures. It was observed that warm mix additive when used at the rate 1.5 per cent, can reduce compaction temperature upto 90°C with out compromising on the compaction levels. Rutting data is plotted in Fig. 35.

**Hot In-situ Recycling of Road No. 63 in East Delhi**

This project is sponsored by Delhi PWD. A number of bituminous cores were collected. The oxidised binders and aggregates were extracted for determining their chemical and physical characteristics. Job mix formula was worked out using rejuvenating at the rate of 0.75 per cent for construction using recycling technology.

**Development of Cold Mixed Patching Materials for Instant Repair of Potholes**

CRRI has developed environment friendly and energy efficient emulsion based cold mix technologies for repair of patches and potholes, even in inclement weather. The potholes repair and patch works were carried out on the following locations:

**Fig. 36 Patch repair using cold mix on NH-1A near Srinagar (J&K)**
contains the laboratory evaluation and field performance evaluation of Cold Mix Material applied on a number of locations on different roads in Delhi.

Study on Cement Modified Cold Mixes

This study has been completed, as part of M.Tech. Thesis with an over all objective to develop high strength cold mix SDBC after modification with cement. Based on the laboratory results obtained, it was found that addition of cement enhances the strength of cold mix. The stability of SDBC was determined after different curing periods.

Consultancy Assignments


The project carried out in association with JNTU, Hyderabad and sponsored by Chief Engineer, Greater Hyderabad Municipal Corporation (GHMC) Hyderabad, was a pilot study for implementation of microsurfacing technology the first time in Hyderabad. The scope of work included evaluation of Sardar Patel Road, Minister Road and surfaces of a number flyovers. Quality surveillance of microsurfacing work was undertaken on various flyovers viz. Begumpet flyover, Airport flyover, CTO flyover, Har Har Kala Bhawan flyover, Masab tank flyover, Basheer Bagh flyover, Narayan flyover, Tarnaka flyover and Sardar Patel Road from Paradise junction to Begumpat flyover. The work was executed as per Type

Laboratory and Field Performance Evaluation of Commercially available Cold Mix Material for Instant Repair of Pot Holes

There are a variety of cold mix pot holes materials available in the market now in India. M/s. Pidilite Industries Ltd. (Construction & Chemicals Division) requested the Institute to undertake a study on laboratory and field performance evaluation of Cold Mix Material for Instant Repair of Pot Holes. An interim report was submitted to the firm which
Specification of IRC document. The job mix formula comprises 13 percent emulsion, 1.5 percent cement, 11 percent water and 0.5 percent additive.

Investigation of Road Between Sector 82 and Sector 110 in Noida for Determining the Causes of Failure/Distress and Needed Remedial Measures

This project was sponsored by Project Engineer (Maintenance Unit-III), Noida. A close up view of the slippage developed on road is shown in Fig 38. The probable causes of development of distress/defects, particularly on DSC road bound carriageway have been derived based on the experience gained, observations made during the test pitting and laboratory and field data/results obtained through the investigation done on the project road and can be summarized as follows: (a) Overloading by commercial vehicles (trucks and multi-axles), (b) grossly inadequate structural capacity of the existing road and (c) infiltration of water into the lower layers of pavement structure through central verge as well as from leaked water pipe line. The following recommendations were made for improvement of DSC road bound carriageway : 75 mm BM + 85 mm DBM + 40 mm SMA (where, BM : Bituminous Macadam Gr. 1, DBM: Dense Bituminous Macadam; SMA ; Stone Matrix Asphalt). It is further recommended that the existing waterline under outer lane of the pavement be relocated/shifted to a different location. About 1.5 m side edge of outer lane shall be reconstructed with a total pavement thickness of 650 mm (250 mm GSB + 225 mm CRM + 75 mm BM + 65 mm DBM + 40 mm SMA). Based upon the deflection data and projected traffic loading, a total of 160 mm thick overlay, in terms of BM, for a design life of 10 years is recommended. The provision of 65 mm DBM + 40 mm SMA is also recommended for strengthening of Expressway bound carriageway.

Investigation for Strengthening and Improvement of Existing Approach Road at Mathura Refinery

The study was sponsored by M/s. Indian Oil Corporation (Marketing Division). The main objectives of the study are (i) to evaluate the functional and structural conditions of the approach road (between Gate No. 1 of Mathura Refinery upto the end of LPG Plant) (ii) To determine the probable causes of distress developed, and (iii) to recommend the remedial measures needed for improvement/strengthening of existing road to enable it to cater to present and future traffic loading. A typical view of road condition is given in Figs 39 (a&b). Field investigations have been completed. The data collected indicates that the bituminous surface has developed extensive
distress/defects in terms of alligator cracking, deep and wide potholes, and high unevenness due to the deformation. The data analysis and report preparation is cement in progress.

Providing and Laying Bituminous Concrete on PWD Road no. 43 near Ranibagh with Plastic Waste Additive

This study has been sponsored by Public Work Department. Field trials have recently been carried out in Delhi, using Dry process by
constructing 40mm bituminous concrete overlay on PWD Road No. 43 about 3.5km road stretch. The test section will be monitored for another three years for its performance. The condition of road surface prior to laying of plastic waste additive and after its laying are shown in Figs 40 (a&b) & 41 (a&b).

Investigation for Determining the Causes of Distress/Rutting on Jaipur Bypass (Zones C&D)

National Highway No. 8 (NH-8) is one of the major highway connecting Delhi to Mumbai. The section of highway around Jaipur has been constructed by NHAI as bypass to Jaipur city, which is about 48 km in length and was completed in two different Phases. C-Zone of Jaipur bypass (i.e., Phase-I) is 13.7 km long and was opened to traffic during the year 2000. D-Zone of Jaipur bypass (i.e., Phase-II) is 34.7 km long and was opened to traffic during the year 2005. Sometime after the road was opened to traffic, some sections of Jaipur bypass(NH-8) developed distress. Since then the pavement has deteriorated severely and has started showing signs of pre-mature distress/failure, especially in the form of cracks, settlements/deformation and excessive rutting. Fig. 42 depicts severe settlements and rutting developed on Jaipur bypass.

General Manager (CM), National Highways Authority of India (NHAI), New Delhi requested the Institute to undertake the investigations towards determining the probable causes for development of excessive rutting and cracking on affected road sections and to suggest needed remedial/rehabilitation measures for rectification of the same.

A investigation carried out included both functional and structural evaluation of the road stretch, in a comprehensive manner, to understand the mechanism of distress developed on some sections of the bypass.

The detailed investigations carried out on various affected road sections of Jaipur bypass (zones C & D), included both field studies and
laboratory evaluation, viz., assessment of current pavement surface condition, pavement's structural thickness, traffic volume and axle load surveys, roughness measurements and Benkelman Beam deflection measurements. Vehicle damage factors, determined from the analysis of axle loads data collected through the survey are given in Fig. 43.

In addition, materials used for the construction of road in various layers of the pavement structure were also retrieved from the test pits dug for the purpose for determining their properties in the laboratory.

Keeping in view the current surface condition of existing pavement, traffic loading and damaging factors which are differing significantly on the two carriageways of the byepass, various corrective and rehabilitation measures for the highly affected sections in need of immediate attention based on the extent and severity of distress (rutting), unevenness and deflection have been recommended to NHAI.

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

Stone Matrix Asphalt (SMA) mix follows the 30-20-10 rules, which implies that the gradation should have 30 per cent aggregate passing 4.75 mm sieve, 20 per cent aggregate passing 2.36 mm sieve and 10 per cent passing 0.075 mm sieve. The aggregates on 4.75 mm and 2.36 mm sieves control the degree of gap in the grading and coarse aggregate content, and the materials passing 0.075 mm sieve control the optimum binder content in a SMA mix.
A minimum tensile strength ratio (TSR) of 80 percent, a maximum allowable rut depth of 4 mm at 10,000 passes and 10 mm at 20,000 passes at 45°C are specified in other countries, for design of SMA mixture by Hamburg wheel tracking device, to qualify the rut depth requirements. SMA exhibits superior properties in several key areas when compared with the conventional Bituminous Concrete (BC), such as:

- Resistance to rutting due to slow, heavy and high volume traffic
- Resistance to deformation at high pavement temperatures
- Improved skid resistance
- Noise reduction over conventional alternative pavement surfaces
- Improved resistance to fatigue effects and cracking at low temperatures
- Increased durability
- Reduced permeability and sensitivity to moisture

The reasons for the improved behavior of SMA pavement surface under heavily trafficked conditions can be attributed primarily to its design principles.
A trial section was laid on Dr. Zakir Hussain Marg under NDMC area, New Delhi on November 2007. Every pre monsoon and post monsoon seasons, various performance data like: distress, deflection data, roughness index will be collected and a progress report will be prepared. The different operation made during the preparation of SMA mixture is shown in the Fig. 44. The final surface texture of the SMA mixture is shown in Fig. 45.

*Fig. 45 Final surface texture of the SMA mixture*
An Investigation on the Relationship between Surface to Surface (indirect) and Direct Transmission Mode of Ultrasonic Pulse Velocity through Concrete Member

The main objective of the study is to investigate the results obtained by direct and indirect modes of transmission of the pulses through the concrete members. Laboratory data as well as field data would be used to arrive at the said relationship. This type of relation is seldom available in the literature.

Data was generated on direct and in-direct mode of transmission on various specimens of concrete members, i.e., plain concrete members, reinforced T-beams and from actual site of bridge construction. Several plain concrete members of various strength were cast in the laboratory. The length of the members was 0.75m and 0.5m. In addition to this, RCC T-beams were also used. Further, more data was generated using a plain concrete pedestal.

Actual field data were also collected from bridge being constructed at a Faridabad site. Regress analysis of large data so collected is in progress. Additionally, literature survey and review of related work is in progress.

Evaluation of Recycled Aggregate Concrete for Use in Pavement Construction

As reported earlier, this study has been taken up to explore the use of recycled aggregates in concrete pavements in POC as well in lower layers. Further work is under way on crushing of different grades of original concrete in the laboratory stone crusher to the required aggregate size, evaluation of their mechanical prosperity and study on concrete prepared with Recycled Concrete Aggregate (RCA). Study on use of RCA produced from demolished concrete pavements or structures besides using the concrete of three different grades prepared in the lab for use in concrete road construction will also be carried out in view of conservation of natural material and also from environmental and energy considerations.

Marble Slurry Dust and wollastonite Inert Mineral Admixtures for Cement Concrete

To study the engineering characteristics of concrete mixes incorporating marble slurry dust (MSD- marble waste), wollastonite micro fibres (natural mineral), fly ash and silica fume, further investigations were carried out.

Test results indicated that the workability of the concrete diminishes as the proportion of MSD increases from 30 to 60 per cent as partial replacement of sand, fine aggregate. However, the workable mixes prepared using super plasticizers have highly enhanced compressive strength and improved flexural strength. Further, to such concrete mixes when silica fume is incorporated as partial substitute of cement and wollastonite as that of sand, there is sharp increase in the flexural strength of concrete. Improvement in compressive and splitting tensile strength was also observed. Water absorption, drying shrinkage and abrasion were found to decrease with the addition of these fine mineral admixtures and concrete so prepared remains
unaffected by sulphate waters and alternate freezing and thawing.

From the study following conclusions were drawn:

- Sand can be partially replaced by MSD in making cement concrete mixes.
- Optimum quantity of sand that can be replaced by MSD is 40 per cent.
- Replacement of sand by MSD results in increased water requirement for the desired workability of concrete mix. Keeping same amount of water per cubic meter of concrete, the workability can be achieved by using super plasticizer doses.
- Remarkable improvements in compressive strength can be achieved by substitution of 30 to 40 per cent sand by MSD.
- Incorporation of MSD results in reduction of water absorption and abrasion.
- When 10 per cent cement is replaced by silica fume & 10 per cent fine aggregates (sand and MSD) are replaced by wollastonite, there is vast improvement in the flexural strength of concrete.
- Concrete mixes containing silica fume, wollastonite and MSD are durable against freezing – thawing and sulphate attack.

Based on the study it can be recommended that:

- In the adjoining areas of marble cutting units, natural sand up to 40 per cent should be replaced by MSD in cement concrete works.

- In applications, where high flexural strength is required (roads, airfields etc.) use of wollastonite natural fiber should be encouraged.

**Study on Strength of Concrete Vis-à-vis Grades of Cement Available in Market**

The objective of the project is to study various known brands of cement available in market with respect to the strength development of concrete prepared by their use.

Cements of different grades viz. 43 OPC (IS-8112), 53 MPa (IS-1489, Part-1), Portland Pozzolana cement (fly-ash based) etc. with different brand names are available in the market. However, when tested in the laboratory these cements do not give the strength corresponding to their grades.

By opting the guidelines as per the above mentioned standards, a very good approximation of strength of concrete was possible in past but for last couple of years difficulty is being faced in obtaining the desired strength of concrete with the present day cement. There are cases where cements of certain grades do not give the prescribed strength and also some times 43 grade cement gives 28 day strength matching with 53 grade and when concrete mix is designed, the strength is much lower than the designed strength.

To study the erratic behavior of cement w.r.t. their strength, different brands of cements are under study as per the standard procedure of testing for cement and concrete.
The relative analysis of results of strength of cement (grade as per the label of manufacturer), strength of cement achieved in the laboratory and strength of concrete mixes are in progress.

**Feasibility Study of using Lead Zinc Slag as fine Aggregate for the Construction of Embankments, Granular Sub-base, Cement Concrete and Bituminous Layers**

The study has been sponsored by Hindustan Zinc Limited, Chittorgarh. The scope of work for the study included the following:

- Evaluation of physical and geotechnical properties of Lead Zinc slag
- Evaluation of geotechnical properties of slag and soil mixes for subgrade, embankment, and subbase construction
- Feasibility of slag in Wet Mix Macadam (WMM)
- Feasibility of using slag in cement stabilized sub-base and base courses
- Feasibility of using slag as fine aggregate in bituminous macadam, dense bituminous macadam, semi dense bituminous concrete and bituminous concrete
- Feasibility of using slag as fine aggregate in dry lean concrete and pavement quality concrete

The salient findings of the study are as follows:

1. **ISF slag** is a sand size material having good density, high angle of internal friction and good drainage property. Both these properties indicate its suitability for embankment and subgrade applications. When used in embankment fill applications, ISF slag may have to be used in the core with side soil cover to prevent the erosion of ISF slag due to flow of water.

2. ISF slag and slag-soil mixes satisfied the specified density and plasticity requirements for embankment and subgrade applications as per MDSRTH specifications. Considering the utility of slag and required geotechnical properties, the mixes having 75 per cent ISF slag + 25 per cent soil and 50 per cent ISF slag + 50 per cent soil could be used in embankment and subgrade construction.

3. The mix containing 50 per cent ISF slag and 50 per cent local soil has better CBR and permeability characteristics. This mix has the potential for use in sub base layer of road pavement.

4. The cement stabilised slag-soil mixes satisfied the 7 day unconfined compressive strength requirement as per IRC SP:20.
2002 for use in sub-base layer of road pavement. The optimum cement content for these mixes is in the range of 3.5 to 5.5 per cent.

5. About 15 per cent ISF slag along with 15 per cent stone dust can be mixed with conventional aggregates for its utilisation in Wet Mix Macadam layer.

6. ISF slag has the potential for utilisation in different bituminous mixes like Bituminous Macadam, Dense Bituminous Macadam, Semi Dense Bituminous Concrete, and Bituminous Concrete.

7. About 10 per cent ISF slag along with 5 per cent stone dust can be used to satisfy the gradation requirements for both grades of Bituminous Macadam.

8. About 25 per cent conventional fine aggregate can be replaced with ISF slag in preparation of Dense Bituminous Macadam of Grade I and Grade II.

9. About 15 per cent ISF slag could be used along with 20 per cent stone dust in both Grade I and II SDBC to meet the MOSRTH specifications.

10. It was found that about 20 per cent slag along with 20 per cent stone dust could be used in Grade I BC. In Grade II BC, about 5 per cent slag could be used along with 45 per cent stone dust.

11. The compressive strength of concrete was observed not to be affected adversely even with 100 per cent slag content but bleeding and segregation of the mix was observed at slag content of more than 40 per cent. Therefore, 20 to 40 per cent ISF slag could be used as fine aggregate in preparation of pavement quality concrete mixes. Fig.46 shows the variation of compressive strength of concrete with different slag content.

12. Up to 20 per cent ISF slag may be used in dry lean concrete mixes as fine aggregate in combination with stone dust.

**Demonstration of CRRI Technology for Construction of a Demonstration Test Stretch Road using Marble Slurry Dust (MSD) in District Rajsamand, Rajasthan**

This Study has been sponsored by the Department of Scientific and Industrial Research. To demonstrate the CRRI technology, 150 m length of control sections on either sides of the test sections, 150 m length of embankment in cutting (1m depth and 4m wide) prepared with...
100 per cent MSD and 450m length of sub-grade (0.6m) prepared by mixing in-situ soil and optimum quantity of MSD were constructed in Rajsamand district of Rajasthan in 2006.

To determine the structural strength and roughness of the control and test sections, periodic observations are being made (Figs 47 & 48). The results are encouraging.

**Consultancy Assignments**

**Design of Concrete Pavement in the Premises of School of Planning and Architecture, New Delhi**

The project was sponsored by School of Planning and Architecture, New Delhi, for providing design of concrete pavement in the premises of SPA for Planning and Architecture Buildings, in view of the adherence to the fire safety standards for the proposed road on the basis of soil properties, traffic data and axle loading etc. Existing concrete pavement was abraded and had corner breaks, joint spalling etc (Figs. 49 & 50). It was decided therefore to remove the existing pavement before laying new pavement.

Pits were dug out to measure the crust thickness of the existing pavement. Based upon the soil CBR, traffic data and axle load etc, pavement was designed for 4.5MPa flexural strength of concrete at 28 days. The suggested thickness of pavement quality concrete was 23 cm over 7.5cm thick dry lean concrete sub-base (Fig. 51).
High Volume Fly Ash Concrete Road at Dadri (U.P) and Roller Compacted Concrete Road at Ramagundam, Andhra Pradesh

The study was sponsored by National Thermal Power Corporation Ltd. Two roads of high volume fly ash concrete are to be constructed one at Dadri U.P and the other one at Ramagundam, Andhra Pradesh. The Dadri road of high volume fly ash concrete is to be constructed by conventional method, whereas the Ramagundam road of high volume fly ash concrete is to be constructed by using roller compacted concrete technique. Both the pavement was designed for 4.5 MPa flexural Strength of concrete.

The suggested thickness of pavement quality concrete at Dadri was 30 cm over a 15 cm thick Dry Lean Concrete sub-base Fig. 52 and the designed thickness of roller compacted concrete at Ramagundam was 27 cm over 15 cm thick Dry Lean Concrete sub-base Fig. 53. The minimum quantity of fly ash to be used is 40 to 50 per cent by weight of cement in both the roads.

Fig. 49 A view of existing concrete pavement

Fig. 50 Existing concrete pavement in architecture building

Fig. 51 Cross section of proposed concrete pavement

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Design of Concrete Pavement in Wazirpur Industrial Area, Delhi

All the request of Municipal Corporation of Delhi, the Institute undertook the design of a concrete pavement for the proposed road on the basis of soil properties, traffic data and axle loading etc.

The existing road, with underlying damaged bituminous and WBM layers, was covered completely by soil, debris, and garbage etc. Existing surface of the road was very undulating. It was informed at site that the road gets flooded during rains and acidic effluent of the industries of the area also flows over the road. Soil samples were collected from the pit to find out the CBR in laboratory. The soaked CBR was found to be 3 per cent. Concrete pavement was designed for 4.5 MPa flexural strength of concrete. The designed thickness of concrete pavement was 26 cm to be
Fig. 54 A cross-section of proposed concrete pavement (Not to Scale)

provided over 15 cm thick GSB and 10.0 cm thick dry lean concrete sub-base Fig. 54.

**Third Party Quality Control for the Construction of Internal Roads of Derawal Nagar and Gurjawala Town, Delhi**

This assignment was referred to by Municipal Corporation of Delhi. The scope of work involves site visits to advise on quality control aspects during laying of DLC and pavement quality concrete, checking of cement concrete mix design for required strength and workability, testing of concrete cubes for compressive strength and beams for flexural strength of concrete and submission of report.

Fig. 55 Compaction with screed vibrator
Fig. 66 Texturing with brooming brush

The work included the quality control for the construction of approximately 1.5 km long concrete street roads. The designed 28 days compressive strength of the pavement quality concrete was 25 MPa. Demonstration and instructions were given to staff at site for carrying out the quality construction of concrete roads. The construction was carried out by adopting semi-mechanized methodology using needle and screed vibrators Fig. 55. Transverse joints were cut using joint cutting machine within 24 hours after placement of concrete. Texturing was provided using a long handled brooming brush (Fig. 56).

Third Party Quality Assurance for the Construction of Concrete Road in Block G & H, Sector 16, Rohini, Delhi

At the request of Municipal Corporation of Delhi, this assignment was taken up to carry out quality assurance for the construction of concrete roads in Rohini, Delhi. The scope of work involves site visits to advise on quality control aspects during laying of pavement quality concrete, checking of cement concrete mix design for required strength and workability, testing of concrete cubes for compressive strength and beams for flexural strength of concrete and submission of report.

The work included the quality control for the construction of approximately 700 m long concrete street roads. The thickness of the street roads was 15 cm. The designed 28 days compressive strength of the pavement quality concrete was 20 MPa. Demonstration and instructions were given to staff at site for carrying out the...
quality construction of concrete roads. The construction was carried out by adopting semi-mechanized methodology using needle and screed vibrators Fig. 57. Transverse joints were made using steel strips inserted into green concrete Fig. 58.

Fig. 57 PDC finished with screed vibrator

Fig. 58 Joints formed by steel inserts
Upgradation of Unevenness Indicator: A Low Cost Instrumentation for Standardisation of Automatic Road Unevenness Recorder / Bump Integrator

Speed, comfort and safety are the major factors defining riding quality of a road by the road user. Pavement surface roughness is gaining increasingly importance as an indicator of road condition, both in terms of pavement performance and as a major determinant of road user costs. One of the primary operational characteristics of a road, whether paved or unpaved, is the level of service that it provides to the users. In turn, the variation of level of service with time is a measure of its performance. Road roughness is the distortion to ride quality and is a phenomenon that results from the interaction of the road surface profile and any vehicle that travels over that surface. It is the function of road surface profile and certain parameters of the vehicle including tyre pressure, suspension, body mounts as well as of the sensibilities of the passengers and driver to acceleration and speed.

The object of this In-house project is to upgrade the earlier version of Unevenness Indicator and to digitize the parameters in order to measure the distance travelled and cumulative irregularities observed in a road section length through digital counters on the Panel Board. The existing system had no option to record the road distance travelled corresponding to the irregularities observed over the pavement surface. The cost of the system is very low and it has good repeatability and reproducibility of the data. The important components forming the complete assembly of an existing Unevenness Indicator for measurement of unevenness of pavement surface are as under:

- A wheel of steel hard surface deposit for probing the surface irregularities. The hard surface improves the wear resistance of the wheel and hence its long term accuracy.
- This probing wheel is actuated by strong suspension and is made to follow the surface contour. The up and down movement of the wheel is converted by a linkage mechanism into an angular movement of an anodized pointer over a big dial. Dial is of sufficient radius with markings in inches or mm. The marking is etched for permanency with the help of dial and pointer. It is possible to measure point to point variation of surface level.

The upgraded version of Unevenness Indicator consists of an integrating unit (Fig. 59) which is

![Modified integrating unit](image)

*Fig. 59 Modified integrating unit installed on unevenness indicator for measuring vertical irregularities*
used to measure unidirectional cumulative vertical movements of pavement surface through a Bump Integrator attached over the probing wheel of Unevenness Indicator for recording the vertical movements of probe wheel in up and down directions. The modification in the integrating unit is done by putting auto coupler to sense the electrical pulse through the photo light at an interval of each centimeter irregularity. One photo light auto coupler is attached in front of probe wheel (Fig. 60) to sense the electrical pulse. The provision has been made in the system by providing auto coupler to cut light five times in each revolution of probe wheel and each electrical pulse is generated at an interval of 10 cm distance. The minimum electrical pulse generated through integrated unit is equivalent to one centimeter. The minimum electrical pulse generated through auto coupler attached with probe wheel is equivalent to ten centimeter. The integrator unit is so sensitive that it can activate even a small size of irregularity of magnitude less than 2 mm. The pulses are recorded separately by a recording device through digital counters, as shown in Fig. 61.

**Impact of Automatic Road Unevenness Recorder / Bump Integrator Speed and Tyre Pressure on Roughness Measurements**

Presently, roughness measurements of Indian roads is measured through Automatic Road Unevenness Recorder (ARUR), developed and patented by Central Road Research Institute, New Delhi around eighties, which is almost similar in mechanical functions to the Bump Integrator developed by Transportation Road Research Laboratory (TRRL), UK and BPR Roughometer developed by USA.

Roughness measurements by using Bump Integrator are undertaken at a standard test speed of 30 kmph. However, under special circumstances, like hilly terrains etc., standard test speed cannot be maintained and sometimes it needs to be changed, like on National Highways and Expressways. Tyre pressure
also affects the roughness because of change in its pneumatic behavior over the pavement section. Roughness measurements were, therefore, taken on different road sections by using Automatic Road Unevenness Recorder (ARUR) / Bump Integrator (Fig. 62) to study the effect of different test speeds viz. 10, 20, 30, 40 and 50 km/hr and tyre pressures of 20, 30 and 40 psi on the roughness values.

Some of the salient findings brought out from the study are as under:

- Impact of Automatic Road Unevenness Recorder / Bump Integrator’s test speed and tyre pressure on roughness levels can be seen. There is no definite trend found between the recommended test speed of 30 km/h to other variable speeds i.e. 10, 20, 40 and 50 km/h. Similarly, there is no definite trend found between the recommended tyre pressure of 30 psi to other variable tyre pressures i.e. 20 and 40 psi.

- Though 30 km/h is recommended as the test speed for roughness measurements using Automatic Road Unevenness Recorder (ARUR) / Bump Integrator but circumstances do arise sometimes whereby the recommended test speed can not be maintained in hilly terrain or on very rough roads. Under such situations, correlations developed for 10 and 20 km/h against 30 km/h can be used.

- The correlations developed for higher speeds of 40 and 50 km/h can also be used when road conditions are good.

Study on Functional Performance of Cement Concrete Pavements in and around Delhi

Functional requirements of a road, characterized by its geometric features and surface characteristics are of paramount importance in ensuring road user comfort and safety. The effect of roughness on vehicle operating cost and pavement maintenance costs are well known. Higher pavement roughness reduces vehicle’s speed, increases wear and tear of vehicles, and increases consumption of fuel and lubricants of vehicles. It also increases maintenance cost of vehicles as well as of pavements. Therefore,
the pavement surface roughness is one of the main factors which needs immediate attention of field engineers and planners.

The cement concrete pavements, built with modern construction technology still have low roughness levels as compared to the flexible pavements because of two main reasons: one due to the provision of transverse texturing to ensure adequate pavement skid-resistance for safety of vehicles during driving and another one is frequent transverse joints.

Concrete roads have low maintenance costs during their service life, least pollution during construction and reduced fuel consumption as compared to the bituminous pavements. In India, the construction of cement concrete pavements has recently gained momentum due to the availability of better construction technologies (machineries), good quality of cement and availability of sufficient cement.

The Institute has undertaken the functional evaluation studies on cement concrete pavements from time to time having manual, semi-mechanised and fully mechanized construction.

Study on functional performance of cement concrete pavements, in and around Delhi, is conducted with three different objectives i.e. (i) Performance based on unevenness, (ii) Performance based on skid resistance and texture depth, and (iii) Distresses developed over the cement concrete pavements.

The Institute has undertaken performance evaluation (surface unevenness characteristics) using different evaluation techniques on cement concrete pavements in and around Delhi i.e. on National Highway No. 02 near Palwal, Industrial roads at Kasana and Loni and on NH-02 near Khaga (road sections I & II).

Some of the salient findings emerged are given as follows:

- The standards presently laid down in India on surface unevenness of highway pavements, though are comparable to those prescribed in some other countries, but generally those are not being achieved in practice. The extent of irregularities measured under a 3 m straight edge on Industrial Roads at Kasana and Loni are found to be more than the prescribed values at the time of construction. Unevenness Index were also found to be higher than the prescribed values in the standards.

- Unevenness Index recorded on cement concrete pavements at the interval of two and six years, were not significantly different, which shows that the cement concrete pavements are durable and sustainable for a longer period, as far as its ride ability is concerned.

- The overall riding quality of newly constructed cement concrete pavements, through mechanized means with 8.5 m wide slip form paver being used in NHDP projects, is found to be very satisfactory. The study conducted on two sections near Khaga is found to be having good roughness value.

The study is based on the limited works carried out by the Institute and there is a need to evaluate more cement concrete pavements for drawing specific conclusions on cement concrete pavements.
Performance Evaluation of Roughometer II Under Indian Conditions

Australian Road Research Board (ARRB) Ltd. has developed Roughometer-II, a high speed road roughness measuring device and donated one unit to CRRI for its evaluation under Indian conditions. This project has been taken up to study (a) Performance evaluation of Roughometer-II, on different roads having varying surface conditions (b) Comparison of data amongst Roughometer-II, Bump Integrator and Dipstick, and (c) Effect of different speeds on roughness index obtained by Roughometer-II.

Various devices used under the study are shown in Fig. 63.

Roughness measurements were undertaken on the selected road sections, with different levels of roughness ranging from excellent to poor (say from about 1500 mm/km to about 10000 mm/km), by using Fifth Wheel Bump Integrator and Dipstick. Roughness measurements were also taken up on the same road sections by using Roughometer-II at different test speeds varying from 30 to 80 km/h.

Data collected from the field is being analyzed and suitable calibrations will be
developed between these devices. The project is currently under advanced stage of progress. The outcome of this research would assist in selecting an appropriate roughness measuring device / system and in deciding upon the suitability of Roughometer – II for Indian conditions.

**Development of GIS Based National Highways Information System**

The project was sponsored to the Institute by MORT&H to develop a GIS based national highways information system for the entire national highways network (excluding NHDP Phase-I and Phase-II). During the period under report, field visits were made in the states of U.P., Haryana, Punjab, Rajasthan and M.P. to collect primary data for different national highways. Data collected included surface roughness, pavement surface condition and road geometrics, by using a sophisticated instrumented vehicle called "Network Survey Vehicle" (NSV). The survey teams also collected other inventory parameters related to the road assets.

Further data collection, both primary and secondary data, for the road network is under progress.

**Consultancy Assignments**

**Economic Benefits of Toll Roads in India**

The project has been entrusted to Central Road Research Institute by M/s IL & FS Consolidated Transportation Networks Limited, Mumbai with an overall aim to assess quantitative and qualitative economic benefits accrued from the following three Toll road projects:

- a) Ahmedabad-Mehsana road project,
- b) Vadodara-Halol road project, and
- c) Belgaum-Maharashtra Border road project

The scope of study includes the following:

- Benkelman Beam deflection studies
- Axle load surveys
- Visual surface condition assessment
- Roughness measurements
- Traffic volume surveys
- O-D surveys
- Speed-flow studies
- Traffic congestion studies, and
- Accident studies

All the field surveys have been conducted and data collected on the existing condition of selected roads. The data is being analysed through HDM-4 software to study / evaluate the likely performance of roads as per projected traffic loading conditions under planned / defined maintenance inputs and for estimation of Vehicle Operation Cost (VOC) and other economic benefits like travel time savings and reduction in accident cost and congestion etc.

Presently, all the needed data has been collated / collected and analysis of data is in progress.

**Improvement of Road Infrastructure in Jawaharlal Nehru Port Trust (JNPT), Mumbai and Needed Remedial Measures**

The assignment was entrusted to Central Road Research Institute, New Delhi to
evaluate / investigate / examine the existing JNPT roads and provide expert opinion / suggestions for rehabilitating / strengthening of these roads. Jawaharlal Nehru Port has emerged as the finest container port in this country and is ranked at 30th position in the world, which is currently handling around 60 percent of the total container traffic of India. Jawaharlal Nehru Port Trust (JNPT) has developed several yards, parking lots and large number of roads for smooth and safe movement of traffic in port area, in the recent past. The port traffic has increased substantially and majority of traffic plying on these roads comprises of multi-axle trailers. Consequently, the port roads are deteriorating at a faster rate under heavy loads coupled with the environmental factors. The JNPT authorities are seriously concerned with the faster deterioration of roads in the port area and have decided to go in for their rehabilitation on priority basis to improve the vital infrastructure facility. The port authorities are looking for optimal solutions and advanced technologies for improvement of existing roads which are sustainable and should provide improved performance levels with minimum maintenance costs during their design life.

In view of the above, CRRI inspected / visited various roads under JNPT network with the following major objectives:

- To recommend long term rehabilitation measures for roads including rigid pavement options, wherever feasible.
- To suggest long term rehabilitation measures for parking bays / yards outside the port area and container yards inside the port area.

Detailed investigations undertaken included the assessment of current road condition, pavement composition, traffic volume, axle load surveys and pavement deflection measurements by using Benkelman Beam Deflection Method. In addition, materials used in various layers of the pavement structure during construction were also retrieved from the test pits dug for the purpose for determining their properties in the laboratory.

Based on the analysis of data / results, obtained through extensive field and laboratory investigations carried out under the project, the recommendations on pavement design and rehabilitation treatments have been made which included the following:

- Design on rehabilitation measures for port roads (inside and outside) with flexible pavement options.
- Design on rehabilitation measures for selected port roads with rigid pavement options.
- Typical designs of parking yards and container yards with Interconnected Concrete Block Pavement (ICBP).

The general recommendations for application of Flexible / Rigid Overlays are also included in the report submitted to JNPT Authorities.

**Strengthening and Resurfacing of Roads in NDMC Area using Microsurfacing - a Cold Mix Technology**

The assignment was entrusted to CRRI by New Delhi Municipal Council (NDMC) towards carrying...
out third party quality checking of twenty one roads in NDMC area. These roads are to be strengthened as per recommendations of CRRI using a combination of Dense Bituminous Macadam (DBM) as a profile correction course, wherever necessary, followed by a Micro-surfacing layer. DBM was constructed using a normal 60/70 paving grade bitumen and Micro-surfacing was laid using polymer modified emulsion and additives, conforming to IS8887: 1995 and ASTM standards. CRRI, as a third party, conducted quality control checks during the execution of work as per scope of work, on random sampling basis. The association of CRRI with this prestigious work has more specifically contributed in the following major ways:

- Providing up-to-date information on the quality requirements through standards and specifications

- On-site training to the concerned NDMC Engineers on testing of materials and evaluation of construction quality of the job executed.

- Calibration of hot mix plant was done prior to the start of DBM work and also periodically checked so as to produce good quality mix as per the laid down standards.

- Calibration of Micro-surfacing laying machine was done before start of work and periodically checked through out till the end of work.

- Periodic supervision of construction activities, by randomly checking the quality of materials and construction, brought out the deficiencies identified which were subsequently got rectified, to the extent feasible.

- The constituent materials like aggregate / bitumen / polymer modified emulsion were checked for their qualities at source / site and materials not meeting the specified requirements got replaced, to the extent feasible.

CRRI’s role as third party quality checking agency helped in improving the quality of construction and also helped the field engineers getting training from CRRI on the actual site situations and many of their day to day doubts were cleared in a big way. The continuous monitoring of works carried out by CRRI teams yielded the following benefits:

- Quality of works for all the twenty one roads covered under the scope of work is rated as “Excellent to Very Good”

- Based on the random / limited material’s testing and quality checking done by CRRI, it can be said that the construction quality achieved and materials used meet the stipulated specifications, in general

- Quality consciousness amongst NDMC staff and officials of construction agency has increased noticeably, which definitely improved the construction quality and will also pay at a later date on other similar projects.
Strengthening and Resurfacing of Roads in NDMC Area under RIP Phase-I using Hot Mix Technology

New Delhi Municipal Council (NDMC) had entrusted CRRI to conduct third party quality checking of forty roads in NDMC area. These roads are to be strengthened (as per recommendation of CRRI), using a combination of Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC) layers. Polymer Modified Bitumen Grade 40, conforming to IRC: SP: 53-2002, has been used by NDMC for the first time, in the wearing course. Limited quality checks, as per the scope of work, during strengthening were done by CRRI, on random sampling basis. The association of CRRI with this prestigious work has specifically contributed in many ways.

Investigation to Determine the Causes of Distress on Mohammadpur-Dohrighat, Mohammadpur-Varanasi and Azamgarh-Ghaziipur Roads and Needed Remedial Measures

This assignment has been taken up at the instance of Chief Engineer, World Bank Projects – Roads, UP PWD for investigating into the causes of distress / pre-mature failure of these roads towards suggesting the needed remedial measures to cater to the existing as well as future traffic. The detailed pavement evaluations such as pavement surface distress surveys, test pit observations and Benkelman Beam deflections on selected sections of three roads have been taken up in first phase of the study. The laboratory testing of in-situ materials collected from different pavement layers and data analysis works is currently in progress.

Under phase II, activities like traffic volume counts, axle loads survey and roughness measurements, on each of the three roads, are proposed to be carried out in April / May, 2008.

Quality Surveillance of Bituminous Works (DBM & BC) on Noida-Greater Noida Expressway (Chainnage: from km 0.000 to km 20.000)

The assignment was taken up at the instance of Project Engineer, Civil Construction Division – 1 (C.C.D), New Okhla Industrial Development Authority (NOIDA) and involved third party quality checking of works planned to be executed. The main objective of the project was to conduct third party quality checking of strengthening/resurfacing works involving of dense bituminous mixes such as Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC), to be executed on Noida – Greater Noida Expressway from Km 0.000 to 20.000, as per the contract specifications. Quality checks for Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC) works have been carried out. Samples of mixes for different pavement layers (DBM & BC layers) and coring of laid DBM & BC layers was done on random sampling basis for detailed laboratory evaluations. Data was analysed and results were communicated to the client from time to time.

It was found that the works have been executed as per the specifications indicated in the contract document and that materials used in different pavement layers (DBM & BC) are generally in
compliance with the laid down specifications. The variations in various properties of different batches of materials are also insignificant.

In addition to the quality checks, the finished roughness levels on Bituminous Concrete (BC) surface for four different packages viz; km 0.000 to km 5.000 (Contract Package – I), km 5.000 to km 10.000 (Contract Package – II), km 10.000 to km 15.000 (Contract Package – III) and km 15.000 to km 20.000 (Contract Package – IV), were also measured using calibrated Fifth Wheel Bump Integrator. The roughness measurements, using duly calibrated fifth

<table>
<thead>
<tr>
<th>Chainage (km)</th>
<th>Measured Roughness (mm/km)</th>
<th>Average for the carriageway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inner lane</td>
<td>Control Lane</td>
</tr>
<tr>
<td><strong>Contract Package – I (km 0.000 to 5.000)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 1</td>
<td>1912</td>
<td>1965</td>
</tr>
<tr>
<td>1 – 2</td>
<td>1938</td>
<td>1918</td>
</tr>
<tr>
<td>2 – 3</td>
<td>1921</td>
<td>1942</td>
</tr>
<tr>
<td>3 – 4</td>
<td>1943</td>
<td>1949</td>
</tr>
<tr>
<td><strong>Contract Package – II (km 5.000 to 10.000)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 – 6</td>
<td>1877</td>
<td>1740</td>
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<tr>
<td>6 – 7</td>
<td>1772</td>
<td>1828</td>
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<tr>
<td>7 – 8</td>
<td>1888</td>
<td>1987</td>
</tr>
<tr>
<td>8 – 9</td>
<td>1876</td>
<td>2000</td>
</tr>
<tr>
<td>9 – 10</td>
<td>1965</td>
<td>1932</td>
</tr>
<tr>
<td><strong>Contract Package – III (km 10.000 to 15.000)</strong></td>
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<td></td>
</tr>
<tr>
<td>12 – 13</td>
<td>1957</td>
<td>1954</td>
</tr>
<tr>
<td>13 – 14</td>
<td>1932</td>
<td>1966</td>
</tr>
<tr>
<td>14 – 15</td>
<td>1880</td>
<td>1932</td>
</tr>
<tr>
<td><strong>Contract Package – IV (km 15.000 to 20.000)</strong></td>
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<td></td>
</tr>
<tr>
<td>15 – 16</td>
<td>1780</td>
<td>1801</td>
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<tr>
<td>16 – 17</td>
<td>1772</td>
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<td>17 – 18</td>
<td>1784</td>
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<td>18 – 19</td>
<td>1900</td>
<td>1998</td>
</tr>
<tr>
<td>19 – 20</td>
<td>1880</td>
<td>1970</td>
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</table>
wheel bump integrator on all the stretches of four packages were undertaken separately for inner, central and outer lanes of Greater Noida bound carriageway (i.e. up direction). The roughness data obtained for the project road is summarized in Table II.

As can be seen from the roughness data given in Table II, no value in any of the three lanes in any of the four contract packages is more than the specified value of 2000 mm / km. The average roughness of the entire carriageway (by combining all the three lanes and all the four contract packages) is 1909 mm / km which is again less than the specified value of 2000 mm / km. Since the average measured roughness values for all the four stretches under contract package – I, II, III and IV are less than the specified value of 2000 mm / km, it is concluded that the BC surface laid falls under the “Good” category, as per IRC: SP-16-2004, implying thereby that the surface finish levels and the riding quality standards achieved for the project road comply with the standards / specifications.

Evaluation of Surface Friction of Airstrip at Lanjigarh (Orissa)

The assignment involving evaluation of surface friction characteristics of the Airstrip at Lanjigarh (Orissa) was taken up at the instance of M/s Vedanta Alumina Refinery Project, Lanjigarh, Kalahandi (Orissa). The main objective of the study was to assess surface friction of airstrip which has recently been constructed, to cater to the aircraft operations from safety considerations.

Necessary field works for determining the surface friction of airfield pavement was carried out during October, 2007. The investigations undertaken included the assessment of pavement surface condition by visual inspection and measurements of skid resistance, using British Portable Skid Resistance Tester (BPT) and surface texture depth using Sand Patch Method on representative / identified spots scattered over the entire length and width of the airstrip. Figs. 64 & 65 show the skid resistance
measurements being taken by BPT and texture depth using Sand Patch Method respectively, on the airstrip.

Data obtained revealed that the average surface friction value under wet condition of the pavement is within the acceptable limits. Similarly, Mean texture depth of 1.07 mm, as calculated for the entire airstrip, is acceptable since it is more than the value of 1.0 mm which is normally considered.

Review of Pavement Design and Quality Checking / Inspection of Construction Works Using Interlocking Concrete Block Paving (ICBP) in Two Villages of Haryana State

This project was entrusted by the Chief Engineer, Panchayati Raj, Public Works, Haryana, Chandigarh, for reviewing the pavement design and carrying out limited quality checking / inspection of construction works using Interconnecting Concrete Block Paving, at two villages i.e. Bahore and Kili in Rohtak District in Haryana. Specifications of Cement Concrete Pavement and paver blocks for streets i.e. Narrow Streets with Light Traffic and Main Streets with Heavy Traffic were provided to the concerned department. During the field visit at Bahore and Kili villages, samples of paver blocks and bedding sand / joint filling sand were also collected for evaluation of their strength and gradation. The quality of paver blocks was found to be meeting the specified requirements of average compressive strength in village Bahore but was not found to be acceptable in Kili village. The overall construction quality for laying of paver blocks was found to be satisfactory. A short term Training Programme for two days was also organized at CRRI for the field engineers from Panchayati Raj, Public Works, Haryana.

Evaluation of SA Road (Maa Anand Mayee Marg) to Determine the Maintenance and Strengthening Requirements

This assignment has been taken up at the instance of Executive Engineer, Delhi PWD for conducting structural and functional evaluations on S.A road towards suggesting the needed maintenance and strengthening requirements. The detailed pavement evaluations such as pavement surface distress survey, test pit observations, Benkelman Beam deflections, axle load survey and roughness survey have been completed.

Laboratory evaluation of materials collected from the test pits and data analysis work is in progress.

Evaluation and Improvement Measures for Selected Roads of NDMC (Phase-II)

The project has been taken up at the request of Executive Engineer, RIP, NDMC, New Delhi for evaluation of selected roads (40 Nos.) in NDMC area under Phase-II towards suggesting improvement measures. The detailed pavement evaluations such as pavement surface distress, Benkelman Beam deflection study and roughness survey have been completed.
Data analysis and report preparation is currently under progress.

Evaluation of Roads in Indirapuram Area and Needed Maintenance and Rehabilitation Measures

The project was taken up at the request of Chief Engineer, Ghaziabad Development Authority (GDA) to evaluate the existing condition of internal roads in Indirapuram and recommend the maintenance and rehabilitation measures viz. resurfacing and overlays etc. needed to improve the present surface conditions of these roads.

In order to arrive at the improvement measures, the following field studies have been conducted:

- Benkelman beam deflection measurements
- Classified traffic volume surveys
- Visual assessment of pavement surface condition
- Roughness measurements using towed 5th Wheel Bump Integrator
- Test Pit observations
- Axle loads study

The different types of distress/defects, as observed on the project roads, were recorded as affected area in terms of percentage of total surface area. The typical surface conditions (good, fair and poor) observed on various project roads are shown in Figs 66, 67 & 68.

Benkelman Beam deflections were taken up on all the project roads as per CGRA procedure, laid
down in IRC: 81-1997. The lowest and highest values of deflections amongst all the project roads are 1.46 and 2.62 mm respectively which show that some of the roads would require strengthening/overlay and some of the roads would require only renewal course.

Roughness measurements were conducted on the project roads using calibrated Fifth Wheel Bump Integrator. The lowest and highest values amongst all the project roads are 2,200 mm/km and 11,219 mm/km respectively. It is observed that most of the roads in the project area have roughness in “average” to “poor” category. Fig. 69 shows the percent road length in different riding quality categories, as per IRC-SP16:2004, for some of the project roads (carriageway-wise).

The requirements of overlay thickness, towards enhancing the structural capacity of existing roads in the project area, have been worked out based on the characteristic deflections and projected / design traffic loading (CSAs), as per IRC: 81 - 1997, “Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Beam Deflection”. The structurally adequate roads have been recommended for resurfacing with 40 mm Bituminous Concrete.

Evaluation of Selected MCD Roads in Division-V Area and Needed Maintenance and Rehabilitation Measures

The project was taken up at the request of Executive Engineer, Municipal Corporation of Delhi (MCD) to evaluate the existing condition of some roads in Division V and recommend the maintenance and rehabilitation measures viz. resurfacing and overlays (both Flexible and Rigid options) etc., needed to improve present surface condition. As per the request of client, all the four roads in Okhla Industrial area were designed for concrete overlay while Lodhi road and Fourth Avenue road were designed for bituminous overlay.

In order to arrive at the improvement measures, the following field studies had been conducted:
- Benkelman beam deflection measurements
- Roughness measurements using towed 5th wheel bump integrator
- Visual assessment of pavement surface condition
- Classified traffic volume surveys
- Collation of axle loads data from Tata Steel Ltd. and Steel Authority of India Ltd.

Fig. 69 Percent road length in different riding quality categories, as per IRC-SP16: 2004 for some of the project roads (Carriageway-wise)
Test pit observations

The different types of distress/defects, as observed on project roads were recorded as affected area in terms of percentage of total surface area. The general views of some of the project roads are illustrated in Figs 70, 71 and 72.

Roughness measurements were also conducted on the project roads using calibrated Fifth Wheel Bump integrator. The roughness data shows that the conditions of roads in Okhla Industrial Area are poor where as the condition of both Lodhi road and Fourth Avenue road is fair to good.

Benkelman Beam deflections were taken up on Lodhi road and Fourth Avenue road, as per CGRA procedure, laid down in IRC: 81-1997. The characteristic deflections obtained on these roads are in between 0.38 to 0.71 mm which show that these roads are structurally adequate and only renewal layer will be enough to improve upon their surface conditions. Hence, 40 mm BC is recommended as the renewal layer.

Based on the traffic data collected, laboratory evaluation of materials and axle loads data collated from steel industries near to the project roads (Tata Steel Ltd. and Steel Authority of India Ltd.) in Okhla Industrial Area, the following concrete overlay, for different categories of roads, has been recommended.

The design details about the Dowel and Tie Bars are also given in the report, as per the site requirement.
**a) Project Roads with 45 feet and 30 feet ROWs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry lean concrete (DLC) as a leveling layer/sub-base</td>
<td>10 cm</td>
</tr>
<tr>
<td>(7 days Compressive strength of 10 MPa)</td>
<td></td>
</tr>
<tr>
<td>Polythene Sheet as a Separation Layer</td>
<td>125 micron thick</td>
</tr>
<tr>
<td>Pavement Quality Concrete (PQC)</td>
<td>20 cm</td>
</tr>
<tr>
<td>(28 days Flexural strength of 4.5 MPa)</td>
<td></td>
</tr>
<tr>
<td>Spacing of contraction joints</td>
<td>4.5 m</td>
</tr>
<tr>
<td>Width of POC slab</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Camber in transverse direction</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

**b) Project Roads with 80 feet and 60 feet ROWs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry lean concrete (DLC) as a leveling layer/sub-base</td>
<td>10 cm</td>
</tr>
<tr>
<td>(7 days Compressive strength of 10 MPa)</td>
<td></td>
</tr>
<tr>
<td>Polythene Sheet as a Separation Layer</td>
<td>125 micron thick</td>
</tr>
<tr>
<td>Pavement Quality Concrete (PQC)</td>
<td>28 cm</td>
</tr>
<tr>
<td>(28 days Flexural strength of 4.5 MPa)</td>
<td></td>
</tr>
<tr>
<td>Spacing of contraction joints</td>
<td>4.5 m</td>
</tr>
<tr>
<td>Width of POC slab</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Camber in transverse direction</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

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**Pavement Evaluation of Road No. 6 from Flex Industries to NH-24 Junction and Needed Remedial Measures**

The project was taken up, at the instance of New Okhla Industrial Development Authority (NOIDA), to carry out a detailed pavement evaluation of main carriageways of Road No. 6 (from Flex Industries to NH-24 Junction) and thereby suggest needed remedial measures to improve upon the condition of existing road. The scope of work included the following major activities:

**a) Field investigations**

- Functional evaluation of pavement through assessment of pavement surface distress by visual observations and taking roughness measurements using calibrated Fifth Wheel Bump Integrator (FWBI).

- Structural evaluation of pavement by Benkelman beam deflection measurements and test pit observations.

- Traffic volume and axle loads survey.

**b) Laboratory investigations by studying the engineering properties of materials retrieved from different layers of the existing pavement structure.**

The different types of distress / defects, as observed on the pavement surface, were recorded as affected area in terms of percentage of total surface area. It was observed that the road surface above and / or near the sewage pipe line below the
inner lane of this road (direction from Flex Industry to NH-24) was worst affected. An opening of sewage pipe line (man-hole) was also observed at about every 40 metre or so for the purpose of undertaking maintenance works which was creating a hump on the road for road users and was responsible for reducing the speed of vehicles and causing poor riding quality.

The typical surface condition in terms of surface defects observed at few selected locations, in both carriageways, is shown in Figs 73 & 74. The overall pavement surface distress was found to be varying from 8 to 40 per cent and 5 to 10 per cent for up and down directions respectively. Types of distresses which were observed to be maximum on the pavement surface were cracking and patch works in up carriageway.

Benkelman Beam deflections were taken in each of the three lanes viz. inner, middle and outer lanes. The deflection measurements were taken as per CGRA procedure, laid down in IRC: 81-1997.

Average roughness values obtained on the project road (km 0 to 4) were found to be varying from 2503 to 4399 mm/km and 2413 to 3685 mm/km for up and down carriageways respectively. Roughness values were found to be more on the central lane on both carriageways.

For the project road, using traffic volume (only Commercial Vehicles Per Day) and Vehicle Damage Factor (VDF) data, Cumulative standard axles (CSAs) expected to ply in the next 10 years design life have been worked out. The traffic growth assumed is 7.5 per cent per year. A lane distribution factor of 0.60 has been considered for taking into account the lateral distribution of traffic over the road. CSAs computed are in the range of 140 to 110 million standard axles (msa) in up and down carriageways respectively.

Based on the conversion factors given in IRC 81-1997 for Dense Bituminous Macadam (DBM) and Bituminous Concrete (BC), the overlay thickness works out to be about 190mm DBM/BC. The total overlay thickness (i.e., 190 mm)
is recommended to be applied in two phases, as given in Table III.

**Table III Recommended Overlay Thickness**

<table>
<thead>
<tr>
<th>Overlay thickness (mm)</th>
<th>First 5 Years (Immediate)</th>
<th>After 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 to 50 DBM (PCC)</td>
<td>75 DBM</td>
<td>40 BC</td>
</tr>
<tr>
<td>50 DBM (PCC, if needed)</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**PCC: Profile Corrective Course**

**Study on Suitability of Operation of Low Floor Buses on Delhi Roads**

The assignment was entrusted by Delhi Transport Corporation (DTC) who decided to carry out a reconnaissance survey, on limited basis, of selected roads / routes with regard to the suitability of operation of newly introduced Low Floor Buses (LFB) on Delhi roads. It was learnt from DTC officials that the bus has not encountered any major problems with regard to its operation and movement on the specific route selected. It was, however, the feeling of DTC that road surface condition on specific / localized places was not desirable which may not make it conducive / safe to the operation of LFB.

In view of the above concerns, the Institute conducted limited trial runs of LFB on some of the typical roads / routes, in association with DTC officials, covering different road geometrics and surface conditions, etc. generally prevailing on Delhi roads. The trial runs were planned in a manner so as to cover manoeuvrability of low floor buses on some of the typical city routes / roads and capture difficult locations such as underpass; horizontal and vertical curves; severely distressed roads; approaches to bridges; steep gradients and cross slopes etc. and examine these situations with respect to their compatibility vis-à-vis bus dimensions and clearances between the road surface and bus body etc.

A number of observations from field surveys have been made (Figs 75, 76, 77 & 78) by sitting inside the LFB and also by follow up vehicles moving behind/in front of LFB which was used to observe the clearance / gaps between the bus body and road surface. A number of important observations have also been made regarding the movement of buses on highly distressed roads, manoeuvring of buses on flyovers and underpasses and around small rotaries / roundabouts. Other important activities such as gap / clearance during the process of puncturing of tyre or tyres in deflated conditions were also covered.

The following major conclusions / inferences have been drawn after conducting the limited trial runs of Low Floor Bus, on some of the typical roads / routes in Delhi:

- No problems were found with regard to the manoeuvring of Low Floor Bus on
two lane roads (7 metre wide, two way traffic) with hard/paved shoulders and having no major surface defects.

Any tyre of Low Floor Bus, if gets entered into a pot hole (which is having depth of about 15 cm and a diameter of about 35 cm), can lead to a situation whereby the bus body may touch the road surface, consequently damaging the bus. This has been observed during the trials when the bus was having no passengers. Further reduction of about 4 to 5 cm in the gap is possible under fully loaded condition which would eventually lead to a situation whereby the bus would probably almost rest on the road surface.

A depression of about 10 to 15 cm on the road surface is highly undesirable and will be the most dangerous situation for movement of bus.

Cracks, bleeding and ravelling on the road surface, without depressions or settlements, would not affect the safety and comfort of buses. It may, however, reduce the long life of Low Floor Bus, increase the wear and tear and may lead to higher maintenance cost of the vehicle due to high roughness values. It is felt that a roughness level of more than 3000 mm/km would not be desirable for safe and comfortable movement of Low Floor Buses on Delhi roads.

It was observed that U-turn under a flyover, with a height less than 4.5 m from the road surface, is not suitable for operation of Low Floor Bus.
Undulated road surface condition is extremely dangerous for Low Floor Bus moving at a speed of even 25 kmph. Bumpy ride of the bus was felt due to the undulations at a speed of about 25 to 30 kmph (which is below normal speed), when passenger occupancy was only 6 to 7 persons. It will still be more dangerous in fully loaded condition.

Non-standard speed breakers which are not as per the design of IRC guidelines may not be suitable and desirable for operation of the fully loaded bus, if the driver of bus does not stop / slows down the bus timely, before the speed breakers.

It was observed that the normal road geometrics viz. gradients (rise and fall), camber (cross slope), superelevation (extra pavement width on curves), steep curves, positive and longitudinal grades at bridges / flyovers are not expected to affect the safe and comfortable movement of Low Floor Bus. It was also observed that the pick up of bus gets reduced drastically on positive grades (up ramps) on flyovers. This phenomenon was observed during the trial runs when the bus was empty which may even become worse under fully loaded condition.

High speed of Low Floor Buses (> 40 kmph) on routes having frequent speed breakers, potholes or depressed / undulated surface can prove to be dangerous owing to the sudden impact by these speed breakers and distressed road condition (if bus is not stopped properly). Proper care will have to be taken by the driver while driving bus under such situations.

It was also observed that while moving around rotaries / roundabouts, the formation of S-curve is not causing any hindrances to other traffic in the stream. The negotiation done by the bus appears to be sufficient enough about the normal sized rotatory(ies) which are commonly found in NDMC area.

The other types of vehicles especially the buses and trucks should not be allowed to overtake Low Floor Buses, though it is impracticable in the actual situations. It is felt desirable that bold signage in red colour on the back of Low Floor Bus may be placed mentioning that no overtaking of Low Floor Buses is permitted specially by other buses and trucks.

**Assessment of Riding Quality (Roughness Index) on DND Flyway**

The assignment, sponsored by ITNL, Noida, Gautam Budh Nagar District, U.P was taken up with the aim to assess the prevailing surface roughness level of DND Flyway (Fig.79). The roughness on DND Flyway, a eight lane divided carriageway, was measured using calibrated Fifth Wheel Bump Integrator (FWBI), lane wise, for both up and down carriageways. Wheel paths were selected at 1.5 m inside the carriageway from the edge of median and at 1.5 m from the edge of pavement for inner and outer lanes respectively. In case of central lanes (two lane) the roughness measurements were taken up in the center of respective lane.
Roughness data collected on 8 lanes DND Flyway and on 2/3 lanes ramps, both in Delhi and Noida bound directions, indicate that the average roughness index on the DND Flyway is in the range of 2024 to 2071 mm/km in Delhi to Noida direction and from 2004 to 2087 mm/km in Noida to Delhi direction.

Calibration of Automatic Road Unevenness Recorders (ARUR) and Road Maintenance Data Acquisition System (ROMDAS)

Standardization of about twenty one (21) units of Automatic Road Unevenness Recorders (ARURs) received from different manufacturers and user’s agencies were undertaken using Dipstick. Surface roughness data was analysed and calibration equations between the observed roughness and the reference / standard roughness were developed, for each of the units, to determine the corrected / calibrated roughness.

Laboratory Evaluation of Polishing Characteristics of Road Aggregates for the Rehabilitation and Upgradation of Different Road Project Works

The assignments were sponsored to the Institute by M/s Leighton Contractors India Pvt. Ltd., M/s Oriental Structural Engineers Pvt. Ltd. (JIV), and M.P.R.R.D.A, PIU- Mauganj, Rewa (MP), for assessing the suitability of aggregates in the wearing course from the consideration of wet surface friction. Laboratory evaluations of polishing characteristics of aggregate samples were undertaken as per the standard test procedures. Mould cast curved
briquette specimens of aggregate samples, as shown in Figs 80 & 81 are prepared, mounted on the road wheel of the Accelerated Polishing Machine and subjected to accelerated polishing using water and standard abrasive material for specified number of revolutions of the wheel and period of testing.

The change in surface texture of aggregate specimens resulting from the action of tyre during accelerated polishing is evaluated in terms of frictional resistance using Portable Skid Resistance Tester and is reported as the Polishing Stone Value (PSV) of the aggregate sample. Comparison of the test results obtained through laboratory evaluation with the specification requirements indicates that the aggregate samples brought from different sources are of fair to good quality, hence their use in the surface layers was recommended only after evaluation of their other characteristics such as strength.
Dynamic Response of Pre-stressed Concrete Bridges

The objective of the study is to develop a realistic modelling of prestressed concrete bridges, which is capable to take into account the time dependent non-linear effect of creep & shrinkage. Based on this modelling, computer software will be developed. Further study, particularly based on dynamic tests in linear / non-linear field is proposed to be carried out to find out the dynamic response of PSC bridges.

Various creep and shrinkage prediction models for concrete are available in the literature. Analytical study has been carried out by comparing the results of various creep and shrinkage prediction models with the experimental results. Based on this study, best creep and shrinkage prediction model has been selected. Software has been developed to predict the creep and shrinkage strains in the concrete.

Non-linear material model for concrete, reinforcing steel and pre-stressing tendons have been selected from the literature for incorporation in the computer software. The finite element formulations of three-dimensional isoparametric 20-noded solid element and reinforcing steel are taken from the literature. Pre-stressing tendons are modelled as one-dimensional line element lying inside the solid-element and are represented by 3-noded element. Finite element formulations of pre-stressing tendons, computation of nodal forces due to pre-stressing forces and various types of imposed loading have been developed.

Finite element formulations for defining the geometry (i.e. local coordinates of the various points of cable profile with respect of 20-noded brick element from the global coordinates of the cable profile) of the prestressing cable, computation of the additional stiffness due to the tendon and forces exerted by tendons on the concrete have also been developed. Based on the above formulations, computer software DAPCAS has been developed for three-dimensional finite element analysis of prestressed concrete structures considering the effects of creep and shrinkage and material non-linearities. Validation of the software has been done using the available literature on prestressed concrete beams and bridges.

An existing single cell four lane prestressed concrete bridge which is being monitored for its long term performance monitoring has been analysed to find out its response under the same loading conditions for which field results are available. Analytical results are found to be comparable with the field results. Seismic

![Fig. 82 (a) Mid-span deflection of beam](image-url)
(b) Strains induced in concrete due to effect of creep

(c) Vertical Accelerogram of Uttarkashi earthquake

(d) Earthquake just after construction
analysis of the bridge is carried out for vertical components of acceleration of Uttarkashi earthquake considering the effects of creep and shrinkage for various ages of concrete. Response of prestressed concrete structures is found to be significantly affected by creep, shrinkage and earthquake. This existing bridge is also analysed for seismic loads by scaling up the Uttarkashi earthquake (0.196g PGA) to 0.4g, 0.6g, 0.8g and 1.0g PGA to find the response under different intensity earthquakes Figs. 82 (a,b,c,d,e,f).

**Distress Diagnostics, Performance Evaluation and Bridge Management for Concrete Bridges**

Under this Grant-in-Aid project funded by Department of Science and Technology, a Software entitled “Bridge Distress Diagnostics and Performance Evaluation System” has been developed.

This stand alone software was developed with features for entering and creating database of
DISTRESS DIAGNOSTICS IN RC-TGIRDAR SUPERSTRUCTURE
WITH INSPECTION & NDT/PARTIAL DT DATA

Fig. 83 Flow Diagram for Distress Diagnostics of RC T-Girder Bridge Superstructure
bridge inventory and visual inspection data of bridge superstructure. Based on the inspection data of various components of the bridge, the software suggests the probable cause of distress, evaluates the extent of distress and suggests the different Non-destructive Tests to be performed to confirm the cause of distress. It can further provide information on load carrying capacity, rating factor and remaining life of RC slab and RC T-girder bridges by modeling degradation of material in terms of corrosion of steel in concrete due to chloride attack, carbonation and Alkali Silica Reaction of concrete.

The software comprises of Bridge Inventory Module, Visual Inspection Module, Module for Condition Rating/Extent of Distress, and Module for Data Analysis of NDT Tests, Performance Evaluation Module and Module for Report Generation. These modules are based on the existing guidelines of IRC.

The software is developed using Visual Basic as front end, SQL Server 2000 for database and Crystal Report Software for report generation. The software is interactive and user-friendly and forms a building block of Bridge Management System.

The flow diagram for distress diagnostics of RC T-girder bridge is shown of the software is shown in Fig. 83. The different modules and sub modules of bridge inventory is depicted in Fig. 84.
Consultancy Assignments

Assessment of Quality of Concrete in the Vicinity of End Diaphragm Walls of Box Girder in Span P2-P3 (Outer Carriageway) of Existing 2-Lane Grade Separator on NH 24-A Bypass, Lucknow City

The work of widening and strengthening of existing 2-lane road on NH-24A to 4-lane dual carriageway connecting NH 24 and NH 28 around Lucknow bypass is in progress. A grade-separator having each carriageway of 4 spans of 35 m each (single cell box-girder shape) on NH 24, located at Polytechnic crossing in Lucknow city connecting Sitapur on one side and Faizabad on the other side, is one of the major work of the widening Fig.

85. During construction, honeycombing of concrete was noticed in the vicinity of bearing as well as in the soffit slab in the vicinity of both the end diaphragms of span P2-P3 by the concerned authority which delayed the pre-stressing of the remaining five cables (out of 18 cables).

The aim of the assignment sponsored by Lucknow, PWD was to determine the quality of concrete in the vicinity of two end diaphragm walls on outer carriageway through non-destructive testing before and after the remedial measures and to suggest suitable remedial measures, if required.

Detailed non-destructive investigations of the areas in the vicinity of both the end diaphragm walls of span P2-P3 on Outer carriageway of
Grade separator was carried out in October 2007 and post-repair in December 2007.

After execution of the repair schemes, suggested by CRRI, the remaining five cables of span P2-P3 were pre-stressed successfully to the requisite level of stressing without any failure (no punching of concrete in the anchorage region) and span P2-P3 became self supported after two years of casting.

**Evaluation and Monitoring of Railway Bridges for Increased Axle Load of Freight Wagons**

CRRI has signed Memorandum of Understanding with various Zonal Railways for Evaluation and Monitoring of different types of bridges for Increased Axle Load. It consists of theoretical studies, instrumentation and monitoring of ten bridges—two numbers each of South Eastern Railway (SER), Northern Railway(NR), Eastern Railway(ER) and four bridges of West Central Railway(WCR). These bridges are of steel (plate girder, underslung and through girder) masonry arch and composite girder bridge.

The project has been undertaken with the objective to develop and install appropriate Bridge Condition Monitoring System, to monitor...
the effect of increased axle load and longitudinal loads on various bridge components, to estimate the remaining life of bridge considering the fatigue effect, to assess the distress/deterioration of bridge components and to suggest suitable strengthening measures.

During the year monitoring of seven bridges in Figs. 86 (a & b) of various Railways as shown was undertaken. The methodology adopted in this project include three dimensional modeling of bridge in Figs. 86 (c & d), static analysis of bridge under various loading specified in Bridge Rules in Figs. 86 (e & f), vibration analysis, Instrumentation and monitoring of bridges during the passage of test train and prevailing loads, analysis of field data in Figs. 86 (g & h), comparison of field and theoretical results, material testing at laboratory to develop S-N curve and to assess the condition of bridge for increased axle loads. Based on the studies interim reports were submitted to the Railways.
Fig. 86 (g) Strain variation in mid upper chord member of through bridge of NR during the passage of passenger train.

Fig. 86 (h) Measured vertical deflection at mid span of the composite girder bridge of ER due to test train at 45kmph.
Development of GIS based National Highway Management System

As reported earlier (Annual report 2006-07), the Ministry of Shipping, Road Transport & Highways has sponsored a study on Development of GIS Based National Highway Management System for effective and efficient management of primary road network of the country.

Under this study an advanced Network Survey Vehicle (NSV) has been procured from ARRB, Australia, (Fig. 87) for generation of data base on road conditions and inventory of road for National Highway network in the country (about 50,000 km).

The Network Survey Vehicle (NSV) System is capable of automatic and simultaneous data collection of roughness and rutting using laser profiler beam; pavement distress and roadside furniture using pavement view camera (2 nos); and asset view camera (3 nos); road geometry using GIPSI-TRAC Geometry System; GPS coordinates (x,y,z) using Trimble DGPS; distance and speed using DMI.

Based on the information collected through NSV and using map data, a user friendly GIS based interactive system will be developed. Collection of primary road condition and road inventory data through NSV on National Highways in UP, Rajasthan, M.P has been completed. The information on the National Highway network thus would be available at a common platform, enabling the system to interact with the user and fulfilling his requirement.
The system will be useful for the planners, administrators, policy makers and highway professionals in terms of the road network at a high level of serviceability commensurate with the funds available for highway maintenance work.

Development of Nuclear Gauge for Measurement of Bitumen Content in Bituminous Mixes.

The Nuclear gauges are specifically designed to measure the Asphalt content of asphaltic concrete mixes or other similar materials by the degree of thermalisation of fast neutrons emitted by a radioactive source-usually a radioactive source consisting of Americium – 241 with beryllium target is utilized. In collaboration with ECIL, a study has been undertaken with the objective to develop & commercialize Nuclear Gauge for measurement of Bitumen content of bituminous mixes.

Design parameters has been finalized by CRRI, and a Measuring unit with source holder is completed by (ECIL). Design of amplifier and processing electronics has been completed by (ECIL).

Non-Destructive Testing (Ultrasonic Pulse Velocity Testing etc.) and Core Testing of Cement Concrete Composite Pavement near Boundary Wall of CRRI

Cement concrete pavement near boundary wall from caretaker residence to guest house wing II at CRRI has been laid. It is proposed to conduct Non-destructive Testing (Ultrasonic Pulse Velocity testing etc.) and core testing of the pavement. Nondestructive Testing (Ultrasonic Pulse Velocity testing) results will be correlated with core testing results. Further work in progress.
Environmental Impact Assessment (EIA) for Proposed IT Park, Shastri Park, Delhi

The proposed Block-III project is part of IT Park with having area of 12.12 ha. is being developed by Delhi Metro Rail Corporation (DMRC) Ltd. The proposed building with built up area of approximately 39747 m², will consist of ground and eight (G + 8) floors above two basements for parking. It will have all the modern facilities, specially designed for software development and computer-based services. The total land of the whole IT Park is 12.12 ha. and the same is already in possession of DMRC and construction of the proposed Block –III of IT Park is as per the planned development of Shastri Park area of DMRC.

At present Block-I and Block-II of IT Park has already been constructed. While Block-I is operational and the Block-II is expected to be operational soon. The Block-III is also being proposed at IT Park adjacent to existing Block-I of IT Park (Fig. 88).

The DMRC had requested CRRI to carry out EIA study to enable them to get environmental clearance from the Ministry of Environment & Forests (MoEF), Govt. of India as per the provisions of Revised EIA notification of Sept. 2006. The key objectives of the study included collection of environmental baseline data for various environmental (air, water, noise and solid waste), socioeconomics (public health, education and economics) and traffic parameters, assessment of environmental impacts for various phases of project cycle namely (i) Impacts due to project location (ii) Impacts due to project design & structure (iii) Impacts due to project construction and (iv) Impacts due to project operation and to prepare Environmental Management Plan (EMP) to mitigate the adverse impacts of the most critical areas likely to contribute to the most significant environmental burdens. Further, it was envisaged to work out the cost of environmental mitigation and monitoring requirements and to get environmental clearance from the Ministry of Environment & Forests, Govt. of India before the commencement of actual construction activity at site.

The final report based on the EIA study including EMP has already been submitted to DMRC. It is expected that the environmental clearance from MoEF based on EIA study will be obtained very soon.

Development of Speed Dependent Emission Factors Using On-Board Emission Monitoring System

The study sponsored by Indian Institute of Technology, Mumbai pertains to develop the
speed dependent emission factors for cars and trucks. Thus the model shall be used in quantifying the emission reduction due to network level road capacity expansion. The OEM-2100 (On-Board Mass Exhaust Emissions Monitoring System) for internal combustion engine and for the pollutants such as O₂, HC, CO, CO₂, NOₓ, PM is being used for the study. In this instrument, all pollutants are measured continuously, on a second-by-second basis and the corresponding speeds using the attached GPS instruments. The proposed test plan is to choose a stretch of 2 km and run different vehicles on this stretch with specified speeds. The study is under progress.

Pre-feasibility Study for the Road Connectivity Work of the Proposed Port Facility at Diamond Harbour

Kolkata Port Trust (KPT) has planned to develop a new Port at Diamond Harbour in the southern part of the Kolkata city (Fig. 89). Once the port comes into operation the road traffic at Diamond Harbour road NH-117 will be moving towards various parts of Kolkata and other parts of rest of the country. Presently Diamond Harbour road is the only link which connects the city of Kolkata with Diamond Harbour. A road also exists from Hoatuganj to Sirakol via Usthi which may act as bypass to Diamond Harbour road. Considering the traffic to be generated from proposed port and also the growth of normal traffic on Diamond Harbour Road particularly from Diamond Harbour to Pailan, it is necessary to carry out a pre-feasibility study of the road connectivity between the proposed port facilities with city of Kolkata. Keeping in view of this fact, Kolkata Port Trust has made a request to CRRI to carry out a pre-feasibility study for the above mentioned project.

The objective of this project is to carry out a pre-feasibility study of the road connectivity...
at Daimond Harbour. The scope of the work will include (i) Pre-feasibility study covering the stretch of Diamond Harbour Road (NH-117) from Paian and up to the proposed Port location at the Diamond Harbour & (ii) The existing Bypass connector from Sirakol to Hotugunj and from Hotugunj to the proposed Port location through NH-117.

Classified Traffic Volume count with turning movements at seven locations and origin – destination survey at one location were conducted as shown in the key map (Fig. 90). The peak hour traffic load at various sections has been ascertained and traffic in future years is also extrapolated as per given in Table IV.

On the basis of section load the lane requirement and the geometric design of the intersections, of the study stretch are being worked out.

**Feasibility Study of Replacing Cycle Rickshaw by CNG MINI Buses**

Cycle-rickshaws are operating in various parts of Delhi. It serves the needs of short distance movements of passengers and light goods in residential and commercial pockets. It mostly operates in congested and narrow streets where there is low or no supply of conventional mass transport service. It is highly informal kind of service with virtually no control of its fleet-size and operational aspects. It is said to be poor-driver’s vehicle (mostly unskilled migrants) for rich people (both the passengers and the owners).

Since, the fleet-size and the operation of cycle-rickshaw is informal and un-controlled, it creates hindrance to the smooth flow of normal traffic by taking away almost a lane on either side from the total carriageway. It also creates space problems at their terminal spots by haphazard flocking as no proper designated space is planned or provided. The study has been sponsored by State Transport Authority (STA) Delhi with the following objectives:

- To identify the areas/roads with high concentration of cycle-rickshaw operation interfering the smooth flow of fast moving
traffic, in collaboration with Traffic Police, MCD, NDMC, and other local authorities.

- To study the feasibility of replacing cycle-rickshaw operation with CNG-mini buses or other suitable mode of transport.
- To suggest suitable routes of CNG mini bus operations (not competing with normal bus operation in the area), wherever feasible to replace the cycle-rickshaw operation.

The following are the major conclusions that can be drawn based on the above results:

- Cycle rickshaws are the major cause of congestion in Sadar bazar area.
- Obstacles (Transformers and Kiosks) are further reducing capacity of the carriageway.
Transport Planning and Environment

- Waiting / Parked cycle rickshaws are blocking the carriageway and thus obstruction to the main traffic.
- Rampant misuse of carriageway and sidewalks not only gives a shabby look but also force the pedestrians to use the main carriageway. Thus further obstruction to the main traffic.
- Parking demand is much more than supply. The present parking lots are spilling over with cars and two wheelers.
- About 50,000 passengers need transport facilities in and around Sadar Bazar.
- Appropriate Pedestrian facilities would greatly improve the situation and reduce the vehicular flows.
- Medium capacity system of buses is required as an alternative to the cycle rickshaws.
- Crossing and turning traffic are major problems resulting in congestion and traffic jams.
- Parking is mainly long term and should be provided away from Sadar Bazar.
- Loading and unloading activities are also obstructing the traffic flow. They should be limited to certain hours of the day.

The main objectives of the traffic management plan and replacing the cycle rickshaws by a suitable mode of transport system are to enhance:

a) the accessibility to the markets by public transport as well as foot
b) the traffic circulation during the effective part of the day (shopping time)

c) the quality of environment in Sadar Bazar

The above-mentioned objectives are proposed to be achieved by:

(i) Introducing a new system of Public transport in the form of CNG mini buses to operate in the Sadar Bazar area. Circulation plan of this system is shown in Fig. 91. The buses will operate along Sadar Bazar in two directions in a circular fashion and connect proposed parking lot at ‘MCD’ parking lot.

(ii) To take care of the passenger movement between Sadar Bazar, New Delhi Railway Station and Old Delhi Railway Station, a CNG / Battery Operated mini bus service has been proposed to run in the both directions to cover this area.

(iii) The cycle rickshaw traffic is not to be allowed in Sadar Bazar from 9.00 am to 8.00 pm. They shall be restricted to side roads only. This would minimize the vehicles as well as congestion on Qutub road in Sadar Bazar.

(iv) With the implementation of mini buses, fast moving vehicles like cars, two wheelers might move at controlled speed of 30 kmph however they should not be allowed to park or wait in Sadar Bazar. This has to be followed until the new proposed parking lots at starting of the Qutub road near to New Delhi railway station and Poonamal intersection gets developed.

(v) The above operation would be for the effective part of the day (from 9.00 am...
to 8.00 pm). During the other period of
the day the carriageway can be used by
all vehicles including cycle rickshaws
without any restriction.

(vi) Delivery and pick-up of goods from
Sadar Bazar could be permitted any
time from 8.00 pm to 10.00 pm in the
evening and 6.00 am to 9.00 am in the
mornings using the same tracks as used
by proposed mini buses. These activities
of goods handling will be permitted from
2.00 pm to 4.00 pm in the day time by

(vii) Multi-storey parking facilities
(underground / elevated) are to be built
near the starting of the Qutub road and
New Delhi railway station and also at
Poolmitai intersection with capacity of
3000 cars and 2000 two wheelers. These
facilities can help in taking out vehicular
traffic from Sadar Bazar and enable a
friendly environment for pedestrians. Once
this parking facility is built, the traffic
on Qutub road is expected to be reduced
because the parkers are encouraged to
use this parking lot more conveniently.

(viii) To take care of the parked LCVs and
hand carts out of Sadar bazar separate
parking place may be provided preferably
at besides of 'MCD' parking lot.

(ix) Speed limit signs (30 kmph) and other
regulatory signs clearly indicating
proposed restrictions are to be posted
along Sadar bazar and other adjoining
roads. This must be clearly posted at
entries to Qutub road from all the roads
as per IRC standards.

(x) The road between the 'MCD' parking
lot to Poolmitai intersection could be
made exclusively for pedestrians except
the portion between the MCD parking
to Sadar bazaar intersection where the
CNG Mini buses and private vehicles from
Kharbaoli would be plying until the new
parking facilities are developed.

The salient features of this plan are:

(a) The scheme is totally pedestrian friendly
and visiting Sadar bazar would be an
attractive and joyful event.

(b) Environment friendly buses for passengers
providing access to all sections of
people.

(c) Access to all modes of transport (except
from 9.00 am to 8.00 pm)

(d) Strict adherence to speed limits of 30
kmph. This is proposed to be achieved
by designing the carriageway and
footpaths to give priority to pedestrians
by physically controlling the speeds.

(e) Loading and unloading will be made
during early morning and late evening
periods which would cause no hindrance
to main traffic moving in Sadar Bazar.

(f) No major alteration to the existing
infrastructure is proposed. The side
walks are to be extended by another
4 to 5 metres into the carriageway
and paved with attractive coloured
slabs / interlocking blocks to encourage
pedestrian to walk on them and also to
increase their safety.
(g) Removal of major obstructions in the carriageway. This could be achieved by replacing the electric transformers with new and modern ones and locating them at a height of 2 to 2.5 metres above the side walks to give clear head-room for pedestrians to walk under them.

(h) No parking & No waiting by any vehicle other than mini buses at respective bus stops during 9.00 am to 8.00 pm in Sadar Bazar. On street parking will be strictly prohibited from 9.00 am to 8.00 pm in Sadar Bazar. This will be strictly enforced by the Traffic Police.

(i) Conveniently located bus bays (drop off and pick up points) to pick up and off-load passengers without obstructing the other traffic.

The following actions are required for smooth flow of normal traffic and pedestrians:

(i) Reforming of the Outub road especially at Sadar Bazar carriageway to facilitate better pedestrian movement

(ii) Raising the pavement of the carriageway with interlocking blocks of pleasing colour (Red / Grey) to accommodate pedestrian movements

(iii) Notifying traffic regulations

- Cycle rickshaw movement prohibited between 9.00 am and 8.00 pm (sign to be posted at entries)
- Closure of all the median openings on Sadar Bazar
- Operation of Kharibaoli road as one way towards 'MCD parking.

- Posting speed limit sign of 30 kmph on Outub road entry points and around the Sadar Bazar. Waiting / Parking restrictions of the entire Sadar Bazar for all the period from 9.00 am to 8.00 pm

- Clearing all footpaths / verandah from encroachments and parking

(iv) Introducing CNG mini buses, to start with 30 numbers to operate in and around the Sadar Bazar.

(v) Planning and construction of parking garages at Outub road at the starting and exit points.

(vi) Parking bays for goods vehicles for loading and unloading at side by 'MCD' parking lot.

(vii) Good lighting system for the reformed Sadar Bazar

Furthermore, replacing the cycle rickshaws with a suitable mode of transportation system in the form of CNG / Battery Operated mini bus service at other locations of Delhi would require the study of proper traffic management plan, area needs, socio-economic status of the area and with users characteristics given due consideration.

**Integrated Traffic Circulation Plan Around IGI Airport**

New Delhi being the capital city of India is experiencing a very high growth rate of Population. The city along with towns of National Capital Region (NCR) is experiencing faster growth in terms of population, economic
activities, and vehicle ownership. The improved economic status has culminated in increased mobility by all modes and air travel is no exception to it. Besides economic status the competitive air fares offered by government and private airlines, stimulated fast growth of air traffic. The Delhi airport witnessed a heavy volume of air traffic for both domestic and international passengers and goods movements in the past few years particularly in the year 2005-06. The existing domestic and international airport facilities at Indira Gandhi International Airport (IGIA), New Delhi need modernization to cope up with the present as well as the projected growth of air traffic. The need is further amplified with the upcoming international sports event of Commonwealth Games being organized in New Delhi in 2010 AD.

Besides the modernization of the IGI Airport by Delhi International Airport Limited (DIAL), there are other developmental and large transport projects envisaged by Delhi Development Authority (DDA), Delhi Metro Rail Corporation (DMRC), & Northern Railways (NR) in the vicinity of the Delhi airport. Various other
developmental and transport projects by various agencies in the vicinity (on the west of the airport, i.e. Delhi-Rewari railway line) are:

i. Dwarka Sub-city (DDA),

ii. DMRC Terminal at Dwarka-21 (DMRC),

iii. Integrated Metropolitan Railway Terminal (NRI),

iv. Inter-State Bus Terminal at Dwarka (DoT),

v. Integrated Freight Complex (DSFIDC),

vi. Convention Centre with Hotels (DDA), etc.

All of these envisaged projects will put further traffic-pressure on the already congested transport infrastructure (particularly, the road network) of the city. Delhi Development Authority (DDA) and Delhi International Airport Limited (DIAL) Delhi requested the Institute to critically review / investigate the traffic & transportation scenario in view of the above proposed developments and suggest suitable measures to cope up with the future traffic.

The broad Term of Reference of the study is to suggest an Integrated Optimum Traffic & Transportation Plan (IOT&TP) around Delhi Airport, in view of its up-gradation by DIAL and other planned developments around airport and in Dwarka. The objective and scope of the study includes:

- Connectivity of IGIA
- Review of Plans of various agencies and mutual issues
- Traffic Estimates on NH-8 and road networks around IGIA

The methodology involves a Reconnaissance Survey of the transport network and the existing developments, followed by review of various project reports and collection of secondary data for the proposed developments in the context of airport and city traffic. Observations and findings to be presented and discussed with various stake holders and agencies for sorting out mutual issues and suggest alternative and suitable measures to be considered for optimum traffic circulation plan for Airport-City connectivity and its phasing.

Master plan of the proposed modernisation of Indira Gandhi International Airport (IGIA) is shown in the Fig. 92. The salient features of Master Plan includes the following:

(i) 2+2-parallel runways are proposed instead of existing two runways inclined to one another.

(ii) A Central-Spine for Airport Traffic Circulation within airport

(iii) Connectivity to city thru NH-8 mainly

(iv) The airport spine will require 6+6 lanes by 2025

(v) An under-ground Metro Corridor passing under Central-Spine from Dwarka-21 to New Delhi railway station via Dhaula Kuan

The IGIA Modernization Plan is based on concept of Central-Spine providing the connectivity of various terminals and other infrastructure of the IGIA and the city. The Central-Spine has been planned as a cul-de-sac with an approach from only east side (towards NH-8) interconnecting various terminals and other infrastructure of
the airport. It has been planned with no road connection towards west to avoid the thorough movement of intra-city traffic inside the airport. Even though the airport has two arterial and one sub arterial road running along its east, north and south side boundary, still the connectivity of IGIA to city is primarily dependent on NH-8 (East side).

This study has explored the various developmental project proposals and the
requirements of different stakeholders. These proposals have been discussed and integrated to culminate in mutually acceptable optimum solutions in view of the Master Plan for modernization of IGIA and its impact on the transport infrastructure around it. The conceptual optimum traffic circulation plan has been recommended keeping in view the traffic generated by Airport and other developments in Dwarka. As an alternative to the western entry/exit two access links are provided; one from Dwarka circle and another from Peripheral road (Link Road) to Central Spine. Both of these linkages are having underpasses and provide the connectivity of airport with Dwarka and western Delhi. It will abate the traffic load and dependency on NH-8 (Fig. 93).

The additional projects for Airport connectivity are as:

1. Grade Separation at Dwarka Circle
2. Underpass at the New Northern Junction on NH-8 north of Mahipalpur crossing
3. East West Underpass at Mahipalpur Crossing
4. Access from Southern Side (Dwarka Express Link) to Central Spine
5. Access from Northern Side (Dwarka Circle) to Central Spine

It is recommended to develop new road links to ease the congestion on existing roads around IGIA, particularly NH-8 by 2010. These are:

1. Delhi Peripheral Roads (DDA)
2. NCR Peripheral Expressway (NCR)
   a. Western
3. Three Delhi-Gurgaon Link Roads
   a. Vasant Kunj to DLF-III
   b. Mehrauli to DLF city
   c. Dwarka to Palam Vihar

**Traffic and Transportation Study for Preparation of DPR of Dwarka – Najafgarh Metro Rail Link**

The project sponsored by Delhi Metro Rail Corporation (DMRC) Ltd. has following objectives: (a) Estimation of travel demand estimation of ridership along the proposed metro corridor (b) Economic and sensitivity analysis (c) Testing of alternative alignments. The study included traffic and commuter surveys, traffic assignment, economic analysis and technical report.

The final report of the study has already been submitted to DMRC.

**Traffic and Transportation Study for Ludhiana City**

Delhi Metro Rail Corporation (DMRC) Ltd. has given CRRI the responsibility to identify the best MRTS corridor for Ludhiana City. Hence the objective of the study has been planned to accomplish the task. Although the city has relatively low population compared to other metropolitan cities, an advance planning for a modern transportation system the city shall help it to grow in terms of industrialization and commercialization. Scope of the study is to
estimate present and future passenger transport demand and the supply (MRTS network) to meet the demand for Ludhiana City.

The traffic and Transportation methodology for this work included (a) Collection of socio-economic, land use, traffic and travel survey data from secondary sources as well as conducting limited primary traffic and travel surveys (b) Development of existing road network using map development software (c) Development of zone wise O.D. matrix for base year from HHS and other data and projecting it for different horizon years i.e. 2011, 2021 and 2031. For this trip distribution model will be used (d) Population density the growth rate at zone level was derived from the base year (2001 census). Further, Base year trip rate has been obtained from survey and the growth rate of trip rate will be adopted for different horizon years rationally. These have been used for trip production and estimation. From base year OD, trip attraction factors shall be estimated and future trip attraction ends derived from future land use data (zonal employment etc.) (e) Projected travel demand for the base year 2007 and the horizon year ODs has been assigned on the existing road network and the passenger load as well as volume-capacity ratio on the links obtained from the model will be the key to identify the main corridors of passenger traffic flow.

Further, alternative proposals of underground/elevated rail transport system (metro) is being coded and superimposed on the existing road network and the future travel demand (i.e. passenger OD matrices) will be assigned for selecting the best metro alignment option for the Ludhiana city. Minimum total passenger travel time cost per passenger (which includes the value of the time for making a complete journey, vehicle operating and fuel cost through a congested network) with reference to the base network will be the basis for selecting the best metro alignment option. Detail travel demand assessment such as station location, ridership, link load will then be made. Other requirements which are to be derived are diversion of traffic to metro, road traffic circulation, feeder bus service etc. The field studies related to the project is under progress.

Mobile Combustion: GHG Emission Inventory for Transport Sector in India

This is a part of the project Enabling Activities for Preparation of India’s Second National Communication to United Nations Framework Convention on Climate Change (UNFCCC).

The study sponsored by UNDP, GEF and Ministry of Environment and Forest has two distinct objectives; characterization of road transport vehicles according to their vintage, type and quantity of fuel used by apportioning fuel used in various types of road transport vehicles (improvement in activity data/fuel use) thereby improving the input for greenhouse gas emission estimates for road transport sector; and estimation of greenhouse gas emission inventory for the transport sector road transportation, rail transportation, water borne transportation (national and international marine navigation), and civil aviation (domestic and international aviation) using IPCC 1996/
IPCC 2006/IPCC GPG 2001 guidelines to reduce the level of uncertainty for the period 1995 to 2007 to generate national level GHG emission inventory for transport sector in India.

Data collection from various ministries related to the project is under progress.

**Studies of Non-Methane Hydrocarbons in the Atmospheric Environment of Delhi Region**

Non-methane hydrocarbons in the presence of sunlight and oxides of nitrogen (NOx) in the atmosphere are considered as the precursors for ozone as well as peroxy acyl nitrates (PAN) production at ground level. The elevated concentration of ozone and its precursors i.e. non-methane hydrocarbons at ground level are of particular concern, because of the harm to human health and vegetation due to the carcinogenic nature of these compounds.

As Delhi has extra burden of non-methane hydrocarbons emitted from various industries as well as vehicular exhaust in its atmospheric air, this may affect its surroundings by prevailing winds and affects regionally and ultimately globally. Therefore, the study of non-methane hydrocarbon in the atmospheric environment of Delhi region, could be a significant step to elucidate the relationship between ozone and its precursors like non-methane hydrocarbons. It may help in formulating policy measures to control ozone and its precursors. Experimental work is in progress.
Pedestrian Safety at Urban Intersections in Delhi

As around 25 per cent of the reported accidents occur at or near urban intersections and 45 to 50 per cent of total fatalities occur to pedestrians in Delhi. This study was undertaken to explore the pedestrian facilities near intersections in Delhi. The following surveys were undertaken at Four-arm and T-Intersections.

i) Physical and environmental parameters of pedestrian facilities provided
ii) Observed behavior of pedestrians
iii) Opinion survey of pedestrians
iv) Opinion survey of motorists

Five four arm intersections and six T-intersections were surveyed. Also around 150 to 200 m approach roads to these intersections were surveyed which were 39 in number.

The physical parameters included availability of zebra crossing, footpaths without encroachment, pedestrian signals, pedestrian refuge islands and their width, footbridge / subway, sidewalk width, height. It was also surveyed regarding the provision, visibility, location and illumination aspects of road signs, road markings, guardrail near different intersections, location

<p>| Table V Pedestrian Facility Available at 4-Arm, T-Intersections, Roundabouts and Other Roads |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|</p>
<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Zebra Crossing Availability (per cent)</th>
<th>Footpath without Encroachment (per cent)</th>
<th>Pedestrian Signal (per cent)</th>
<th>Pedestrian Refuge Island (per cent)</th>
<th>Foot Bridge/Subway (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Arms</td>
<td>38</td>
<td>70</td>
<td>5</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>2. T-Intersections</td>
<td>45</td>
<td>69</td>
<td>2</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>3. Roundabout</td>
<td>100</td>
<td>60</td>
<td>0</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>4. Other Roads</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>5. For All 47 roads</td>
<td>45</td>
<td>66</td>
<td>2</td>
<td>21</td>
<td>23</td>
</tr>
</tbody>
</table>

<p>| Table VI Side Walk Availability and Width at 4-Arm, T-Intersections, Roundabouts and Others |
|---------------------------------|----------------|---------------|----------------|----------------|----------------|
| Intersection Type | Side Walk Availability (per cent) | Side Walk width (Left) (per cent) | Side Walk Width (Right) (per cent) |
|-------------------|---------------------------------|----------------|--------------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
<th>&lt; 0.9m</th>
<th>0.9 to 1.8m</th>
<th>1.8 to 2.7m</th>
<th>&gt; 2.7m</th>
<th>&lt; 0.9m</th>
<th>1.8 to 2.7m</th>
<th>&gt; 2.7m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Arms</td>
<td>86</td>
<td>95</td>
<td>11</td>
<td>22</td>
<td>39</td>
<td>28</td>
<td>10</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>2. T-Intersections</td>
<td>87</td>
<td>78</td>
<td>8</td>
<td>33</td>
<td>42</td>
<td>17</td>
<td>21</td>
<td>21</td>
<td>43</td>
</tr>
<tr>
<td>3. Roundabout</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>4. Other Roads</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>5. For All 47 roads</td>
<td>81</td>
<td>91</td>
<td>8</td>
<td>21</td>
<td>42</td>
<td>21</td>
<td>12</td>
<td>19</td>
<td>47</td>
</tr>
</tbody>
</table>
### Table VII Side Walk Height at 4-Arm, T-Intersections, Roundabouts and Other Roads in Delhi

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Side Walk Height (Left) (per cent)</th>
<th>Side Walk Height (Right) (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 15 cm</td>
<td>15 - 22.5 cm</td>
</tr>
<tr>
<td>1. Four Arm Intersection</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>2. T-Intersections</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>3. Roundabout</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. Other Roads</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>5. For All 47 roads</td>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>

### Table VIII Environmental Aspects of Sidewalks at 4-Arm, T-Intersections, Roundabouts and Other Roads

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Aesthetically Pleasing (per cent)</th>
<th>Comfortable To Walk (per cent)</th>
<th>Free of Severe Cracks (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Arm Intersections</td>
<td>85</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>2. T-Intersections</td>
<td>50</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>3. Roundabout</td>
<td>67</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>4. Other Roads</td>
<td>67</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>5. For All roads</td>
<td>72</td>
<td>63</td>
<td>67</td>
</tr>
</tbody>
</table>

### Table IX Road Markings at Different Intersections

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Provision of Stop Line</th>
<th>Zebra Crossing</th>
<th>Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Arm Intersections</td>
<td>33</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>2. T-Intersection</td>
<td>0</td>
<td>45</td>
<td>33</td>
</tr>
<tr>
<td>3. Roundabout</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4. Other Roads</td>
<td>0</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>5. For all 47 roads</td>
<td>28</td>
<td>45</td>
<td>45</td>
</tr>
</tbody>
</table>

### Table X Traffic Signals at Different Intersections

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Visibility</th>
<th>Traffic Signal for Pedestrians</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Arm Intersections</td>
<td>76</td>
<td>10</td>
</tr>
<tr>
<td>2. T-Intersection</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>3. Roundabout</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4. Other Roads</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5. For all 47 roads</td>
<td>66</td>
<td>4</td>
</tr>
</tbody>
</table>
of bus-stops, type of control at different intersections, pedestrian density, vehicle volumes etc. The environmental aspects included whether sidewalks were aesthetically pleasing, comfortable to walk and were free of severe cracks. Results of the study are given in Tables V to X.

The opinion survey of the pedestrians and motorists was also carried out and was analysed gender-wise and age-wise.

The final report is under preparation.

**Safe and Environmentally Pleasing Pedestrian Facilities in and Around Metro Railway Stations**

As the metro rail service is extending in Delhi, a study has been undertaken on safe and environmentally pleasing pedestrian facilities in and around metro railway stations. Preliminary results of the survey indicate that crossing facilities and walking facilities near metro stations are not adequate and also inside, pedestrians face many problems, especially the elderly disabled men and women. The work is in progress.

**Research Study and Pilot Project on Road Safety Aspects & Right of Way for Persons with Disabilities**

The study has been sponsored by National Trust (Ministry of Empowerment and Social Justice) and Samarthya, National Centre for Promotion of Barrier Free Environment for Disabled Persons.

The main thrust of this collaborative project with Samarthya was to take into account all practical means/measures to make external environment and street infrastructure accessible to facilitate safe mobility for all. The immediate concern was to assess and document the present road conditions in the perspective of the user group especially the persons with the diverse disabilities e.g. how to make user friendly road intersections including sidewalks, flyovers and subways etc. with universal design norms. The objectives of the study include:

- Identifying barrier around National Trust office, located at Jeevan Prakash LIC Building, K.G.Marg, Connaught Place, New-Delhi
- Document and record the existing accessibility of the road and street infrastructure.
- Develop cost effective and user friendly solutions for eliminating these barriers.
- Share the project findings with Indian Road Congress, N.D.M.C., M.C.D, TRIPP, I.I.T. Delhi, Delhi Traffic Police, C.P.W.D., P.W.D. and other concerned Ministries and stake holders.

This research study focused on 1 km. radius of street and road infrastructure of National Trust office, located at K.G. Marg, Connaught Place, New-Delhi. The area covered under the research project with appropriate length of each corridor as follows:

- 0.48 km. of K.G.Marg
- 0.39 km of Tolstoy Marg
- 0.39 km of Janpath Lane
• 0.17 km of Connaught Circus

To carry out first two objectives and the necessity to highlight the pedestrian-vehicle conflict total number of vehicles behavior at selected road corridors, Manual Traffic Count (MTC) at each corridor were recorded by trained enumerators on specially designed Performa. Due to time limitation MTC of 15 minutes each (between 11 a.m. to 12 noon) was carried out. Pedestrian crossing behavior and pedestrian count were also observed at four selected road corridors. A video camera was positioned at vantage points of each road and traffic movements for a period of one hour. The following are the observations from the study.

a) Traffic count was observed approximately double at Connaught Circus road stretch and Janpath Marg as compared to the other two road stretches. According to the Delhi Traffic police personnel on the site observed traffic speed is 40 km/hr between 8 am to 11 am due to strict enforcement and after 11 a.m. to 5 p.m. observed traffic speed is 60 km/hr. Due to increase in vehicle speed and risk taking pedestrian behavior like jumping over the median fencing which height was observed 2.35 ft. and found running in front of the speeding vehicles pedestrian vehicle conflicts were found increasing.

b) According to Delhi traffic police personnel daily 30 to 35 challans are made due to over speeding and wrong parking of vehicles on the selected road corridors.

c) Subways are not fully utilized by the
Pedestrians due to saving time and lack of user-friendly environment of subways. Pedestrians were observed running through the busy road at selected Connaught circus road stretch (Fig. 94) and jumping over the median barrier at K.G. Road (Fig. 95). Two or three pedestrians were observed jumping over the median barrier at approximately every 10 to 15 minutes.

To elicit the user group's perspective about the related road stretches following prolonged approaches were adopted:
(a) Questionnaire survey
(b) Interactive discussion
(c) Experiential exercises

The questionnaire survey was carried out on a sample population of 35 persons with diverse disabilities such as Autism, Mental Retardation, Cerebral Palsy, Deaf and Blindness by the research design team for access audit on various aspects related to accessibility of road infrastructures.

It was observed after analyzing survey results of persons with disabilities (PwD) that 69 per cent males and 89 per cent females have expressed difficulties in commuting on road. Twenty three per cent males and 44 per cent females have expressed that they have never got any external help while commuting on road. Sixty seven per cent females (PwD) and 46 per cent male (PwD) have expressed that they "Never" found proper visibility of traffic signals at night time. Fifty eight per cent Male (PwD) and 67 per cent female said "Rarely" road signs are visible. Sixty two per cent males and 56 per cent females expressed "Rarely" and "Never" experienced user-friendly designs of footpaths while walking. Thirty Eight per cent males (PwD) and 44 per cent females (PwD) expressed that they have "always" experienced difficulties in walking on due to encroachment on footpaths by parked vehicles. Seventy seven per cent males (PwD) and 56 per cent females (PwD) commuters expressed "Rarely" have they found any user-friendly subway. Ninety one per cent of the all (PwD) commuters have never seen any audible traffic signal on the road. Sixty two per cent males (PwD) and 33 per cent female (PwD) replied that they have "Never" observed central refuge areas on the road. Accessible toilets on road side was found to be another big problem as 73 per cent male (PwD) and 33 per cent (PwD) replied that they have "Rarely" observed accessible toilets on the road side.

Interactive discussion were held with experts from Autism, Muskaan, Sense international, Future Vision, AADI, Delhi Traffic Police. Apart from these, useful inputs and informations were received from Vidyasagar, Chennai and Spastic Society for Western India at National Trust office. During discussion problems faced by the PwDs were discussed in details.

In the experiential exercise, road users (one from each sample category as mentioned above) covered the selected road stretches around the National Trust and digital photography, video recording and analysis regarding situational access difficulties were done.

Report has been submitted with cost effective and user friendly solutions for eliminating these barriers to the National Trust.
The findings of the project were discussed with N.O.M.C., TRIPP I.I.T. Delhi, Delhi Traffic Police and stake holders at National Trust and following plan of action for accessible road infrastructure were given by the experts of the committee:
(a) No car parking will be entertained on footpaths
(b) Accessible car parking as seen in the report will be planned
(c) Lighting of the subways with proper hand rails at entrances along with the proper visible paints will be done
(d) Height of the footpaths along with the gentle slopes will be planned
(e) Table tops at Zebra crossing will be planned
(f) No free left turn will be encouraged
(g) Proper placement of road signage with proper visibility will be given.
(h) Training of Engineers and traffic police personnel were planned.

**Road Safety Aspects for Vulnerable Group including Children with Disabilities**

Motorized and non-motorized vehicles and pedestrians share same road space. Conflict between the motorized/non-motorized vehicles and pedestrians is common and evident from series of accidents/deaths of school children on the roads. This is not the situation only on the main roads but also on the arterial roads.

No comprehensive data is available to how many children die or are injured on their trip to school. Observing children negotiating through dense traffic and hazardous street infrastructure near their school premises provides sufficient proof of how unsafe trips to schools are.

Preventing road accidents and injuries to the vulnerable group is the most important area that calls for attention of the policy makers/ planners and designers; as it is not only essential for health, social and transportation perspective, but is of utmost importance to ensure the safe mobility perspective of the children including those with disabilities.

Strategic changes in the existing system would help to evolve a better system for future. Sustained, collaborative and concentrated efforts are required. Else, the once considered blessing of technology which has become a necessity today will become an abuse and may lead to unbearable human loss in terms of burden of disability and death due to road traffic crash.

In the wake of above critical issue, it is important to implement strategic interventions by conducting a research study on the “Road Safety Aspects for Vulnerable Group including Children with Disabilities”. The study will also serve as a pilot project to be implemented. The objectives of the study includes the following:
- Identifying barriers to children movement near school premises;
- Documentation & recording the accessibility of the road and street infrastructure;
- Developing solutions for eliminating these barriers;
Providing outlines for the guidelines of safe accessibility of the road for children

Literature review of access standards and guidelines of India and abroad has been completed. The access Audit area included approx. 500 meters approach/around of school premises Blue Bell School and Special School (AADI) Action for Ability Development and Inclusion (AADI), formerly Spastics Society of Northern India, 2, Balbir Saxena Marg, Hauz Khas, New Delhi-110016.

Primarily intervention has conducted through data collection by means of opinion survey. Opinion survey has been conducted on more than 200 students and teachers on selected schools and sample population consisted of able bodied as well as Persons with Disabilities. Access audit of the identified site-roads have been done. Opinion survey has revealed that 82% of the students do not use zebra crossing and 77% school children has replied that there is not adequate footpath facilities near the school.

On the basis of data analysis, following recommendation have been made:

- It is recommended that there is at least one adult for every eight children.
- The bus route will have been determined and risk assessed. The route must be adhered to at all times. Any changes to the route will need to be risk assessed.
- If any part of the pathway cannot be used because of a temporary blockage, e.g. road works or parked vehicles, the adults will need to divert accordingly.

Where possible, the need to cross roads will be kept to a minimum, and use should be made of specific safe crossing places.

Parents are responsible for their children's safety to and from the designated “bus stops” and for seeing their children safely on and off the bus. Drivers and conductors must remain with the group on the authorized route. Both parties must take care when children join and leave the bus.

Parents should have spoken about road safety to their children before permitting them to join the school.

Drivers/conductors must inform newcomers about expected behaviour, reminding children to listen and obey instructions, especially in regard to stopping and crossing.

Children must walk along the footpath away from the kerb, in an orderly manner in pairs when possible allowing other pedestrians to pass.

Everyone should be made aware of the danger when crossing driveways as drivers may not easily notice small children.

When children are ready to cross the road, choose a safe crossing place away from parked cars/corners/functions, etc.

It is not recommended that refuge islands be used with large groups of children if it is not possible to cross the width of the
Development of Reflecting Kerb Stone

During the course of observations made during last twenty years on the performance of types of kerb stones and material used for improving its visibility, the general conclusion was drawn that most of the kerbs were satisfactory when newly painted but all quickly get deteriorated either due to the accumulation of dirt and in some cases the paint get faded drastically and require repainting at least after three months for minimum required visibility of 3 cd/m² at least from 30m distance. All the kerb stones are designed as per IS : 5758-1984 as far as physical dimensions, strength and material to be used in casting the kerb stone is concerned. The standards and the present practice does not case about its visibility from far-off distances which is essential for high speed corridors.

A new design of concrete kerb with reflecting facets formed by the edges of raised and rectangular pad with aluminum sheet having high intensity grade reflecting sheet has been produced in the laboratory by the Institute. The new design of kerb stones improve the visibility level which will enhance the visibility distance. In addition to this, use of reflecting sheet makes the kerb stones free from the problem of early fading of paint as reflecting sheets have durability life of seven years so the kerb stones will not require painting again and again as per the existing practice. The chances of collection of dust are also less as the surface of reflecting sheet is very smooth and slippery in comparison to concrete surface of kerb stone.

road in one go. Large groups of children should be accompanied by two adults, and it is advisable to cross the children in two smaller groups.

When crossing, gather children away from the kerb, until parents have decided it is safe to cross. It may be safer to cross them in a bunch rather than have them stretched out in pairs.

Walk across the road looking and listening. When they have crossed safely the road reform group leaving room for all the children to gather away from the roadside and continue walking.

Children or the parents are not empowered to stop traffic in order to cross. If any school driver stops to allow the group of school children to cross the road it is vital that parents or guardian accompanied should check that other traffic is aware of what is happening and has stopped before children step onto the road.

There is always the danger of other drivers overtaking the stationary vehicle. It is safer to wave the vehicles on and cross when the way is clear.

In bad weather it will take drivers longer to stop and it is more difficult for the children to be seen so that extra care should be taken if children or parents accompanied are wearing a hooded coat or using an umbrella as they can obscure hearing and vision.
The prototype kerb stone consists of a raised pad of size 125 x 75mm at angle of 30° with height of 30mm made out at the centre of the face of kerb stone. A rectangular aluminum sheet is fixed with adhesive on the raised pad.

The following outcomes of the visual effectiveness are basis for recommending the proposed design of kerb stone.

(i) The visibility of the kerb stone on dry nights under headlight beam is improved three times by the contrast in brightness between horizontal surface and raised facets.

(ii) In wet condition at night when the kerb is illuminated by head lamps the width of the bridge angular raised pad is effectively doubled by the addition of image to original reflecting element due to its angularity and lens action of water droplets. The formation of image improves the visibility distance which was almost zero for wet conditions in the case of conventional kerb stones.

(iii) The effectiveness of the reflecting kerb stone in delineating the offside edge at night is improved, when observed during night time.

(iv) In day light also reflecting kerb stone are more visible than the conventional kerb stone

(v) Available reflective markers have been characterized IR-ATR technique for assessment of degradation and its impact over reflectivity.

(vi) Efforts have been made to relate artificial weathering under xenon arc chamber and natural weathering of reflective materials.

The process of standardization is in progress.

Educative film on No Mobile when Mobile

The institute produced an educative film on No Mobile When Mobile of 20 minute duration. The film educates different road users, car drivers, bus drivers, two wheeler riders and pedestrians about the ill effect of using mobile phones while driving or walking. It also provides useful tips to use it wisely. The film is dubbed in Hindi also. The marketing potential of it is to different traffic police organisations in the country, driving schools, TV Channels, schools etc.

Consultancy Assignments

Road Safety Audit for Conversion of Delhi-Gurgaon Section of NH-8 (14.30 km to 42.00 km) into Access-Controlled Highway

This study was sponsored by National Highways Authority of India. As the accidents on this high-speed facility are quite high and this is the first access-controlled urban highway in Delhi, the road safety audit of it was a challenging task. The objectives and scope of the study were:

- To conduct the Road Safety Audit for conversion of Delhi – Gurgaon section (14.30 km to 42.00 km) of NH-8 into Access Controlled Highway at pre-opening stage.

- To provide recommendations to remove operational safety deficiencies on the Access Controlled Highway.
The methodology adopted for the study was:

(i) The Information relating to the design standards adopted for the road project was obtained from NHAI/Consultants.

(ii) Detailed engineering drawings of the road were requested from the NHAI/Consultants in hard as well as soft copies to get an idea of the project from the point of adequacy in design.

(iii) Field visits were made by driving/walking along the project road to appreciate other physical and environmental features that required special attention from the point of view of safety. Some examples are pedestrians, roadside developments, sociological aspects that need special attention and appropriate facilities.

(iv) Help of checklists was taken to ensure that problems and situations that can affect the road safety at the desired stage of road safety audit have been taken into consideration.

The specific safety issues covered on the Access-Controlled highway were as under:

i) Non provision of facilities to non-motorised vehicle users

ii) Cross-sectional design elements which included roadways, shoulders, medians, clear zones, drainage, plantation etc.

iii) Safety issues on service roads which covered aspects like junctions, road widths, roadside fixed objects, shoulders, drainage etc.

iv) Roadside hazard management comprising safety fencing, safety barriers, trees etc.

v) Exit/entry points

vi) Signs, road markings and lighting

vii) Subways

viii) Toll plazas

ix) Emergency response operations

x) Maintenance

xi) Ramps and

xii) Non Engineering issues. (Four photos of (i) Main carriageway (ii) Toll Plaza (iii) Interior of subways (iv) Safety barriers.

For each of these parameters the recommendations were provided. The draft final report was submitted in March, 2008.

Traffic Management Study of the Area around Inland Container Depot, Tughlakabad (ICD, TKD), New Delhi

The objective of the study was to assess the traffic demand and its characteristics on the roads surrounding ICD/TKD and also to assess the traffic and parking demand of ICD, TKD. The study was undertaken to prepare traffic circulation and parking management plan for ICD and to assess the feasibility of providing direct link to ICD/TKD. Figs. 96 (a, b & c) indicates study area location and views of parking and stacking area.

The methodology of the study includes field surveys, data collection, data analysis and interpretation. Evolve appropriate traffic management plan including infrastructure improvement plan, design of approach roads.
approach road intersections and parking facilities.

Traffic Characteristics:

(A) Traffic to/from ICD-TKD:

(i) From the traffic studies carried out at entry/exit points of both the approach roads to ICD-TKD it is found that the total interaction (both way) of traffic between ICD-TKD and surrounding roads is of the order of about 17300 vehicles (30900 PCUs) on a normal working day. Total traffic interaction of traffic from MB Road approach road is about 9000 vehicles (14200 PCUs) and that from Maa Anand Mai Marg approach road is about 8300 vehicles (14500 PCUs) on a normal working day.

(ii) It is observed that on an average about 3390 goods vehicles including trucks, trailers, LCVs etc., are entering or exiting the ICD on a normal working day.

(iii) It is observed that the main entry to ICD for goods traffic is from Maa Anand Mai Marg - ICD approach road. The total goods traffic entering ICD through this road is 2765 vehicles per day and leaving ICD are 411 vehicles per day thus total combined goods traffic volume on Maa Anand Mai Marg - ICD approach road is 3176 vehicles per day.

(iv) The peak hour for goods traffic on Maa Anand Mai Marg - ICD approach road i.e. for goods traffic entering ICD is 5.00 AM to 6.00 AM with traffic volume of 334 goods vehicles.

(v) The main exit of goods traffic from ICD is through MB road. Total goods traffic exiting ICD from this road is 3365 vehicles per day, while goods traffic entering ICD from this road is only 171 vehicles per day thus the combined goods traffic volume on MB road - ICD approach road is 3536 goods vehicles per day.

(vi) The peak hour for goods traffic on MB road - ICD approach road i.e. for goods traffic leaving ICD is 7.00 AM to 8.00 AM with traffic volume of 334 goods vehicles.

Fig. 96 (a & b) Study area location and views of parking and stacking area
Fig. 96 (c) Study area location and views of parking and stacking area
traffic exiting ICD is 3.00 AM to 4.00 AM with traffic volume of 484 goods vehicles.

(vi) The goods traffic movement from/to ICD - TKD is primarily in the night hours (7:00PM to 7:00 AM) and is observed to be about 2/3rd of the total daily goods traffic that enter or exit ICD. Figs. 97 and 98 show hourly variation of traffic and composition on Surajkund Road and MB Road ICD Approach Road.

(b) Traffic on Surrounding Roads

(i) To assess the volume of traffic on the surrounding road network, traffic volume study were conducted on roads and intersections near ICD. Analyses of traffic volume survey at MB road - NH-2 intersection reveals that the total daily (24 hours) traffic volume at this intersection is about 190500 vehicles per day. Fig. 99, shows variation of travel speed around ICD Tughlakabad.

(ii) The morning peak hour at MB road - NH-2 intersection being 9.00 AM to 10.00 AM with traffic volume of about 11,700 vehicles (11,500 PCU's) and evening peak hour is observed from 9.00 PM to 10.00 PM with traffic volume of about 12,300 vehicles (i.e. 18,500 PCU's).

(iii) Total daily (24 hours) traffic volume at MB road – Maa Anand Mai Marg intersection is 1,17,948 vehicles per day (i.e. 124830 PCUs).

(iv) The morning peak hour at MB road – Maa Anand Mai Marg intersection is observed from 9.00 AM to 10.00 AM with traffic volume of about 9,200 vehicles i.e. (7500 PCUs) and evening peak hour is from 6.00 PM to 7.00 PM with traffic volume of about 10,200 vehicles (10,700 PCU's).

(v) It is observed from the analyses that volume to capacity (V/C) ratio on the surrounding roads i.e. on NH-2 is 1.5 to 1.7, on MB road is 1.4 to 1.6 and that on Maa Anand Mai Marg is 1.1 to
1.5. Thus it can be concluded that all the surrounding roads are already catering traffic more than their design capacities and require capacity enhancement through widening.

**Conclusions**

It can be concluded from the traffic data analyses that:

(i) The contribution of traffic due to ICD-TKD to the total traffic of surrounding road network is very meager due to low volumes of daily traffic to/from ICD-TKD as compared to that on surrounding roads.

(ii) The major interaction of goods traffic between ICD and surrounding roads is within the non-peak hours as major goods traffic is carried in the night hours. The peak hours of goods traffic of ICD are not over-lapping with the peak hours of general traffic on surrounding roads. The goods traffic of ICD during general traffic peak hours is negligible and so it
does not contribute in any way to peak hour congestion on surrounding roads.

(iii) The surrounding road network require capacity enhancement through improvement/widening due to high volume of general traffic and not due to the goods traffic of ICD-TKD. Fig.100.

Measures Suggested to Ease Traffic Congestion

Keeping in view the traffic volume, traffic pattern, speed and delays on the surrounding road network, following infrastructure improvement plan has been suggested.

(i) MB road is catering to high traffic volume and the section of MB road between NH-2 intersection & Surajkund intersection is 6 lane divided carriage way. But the section between Surajkund road intersection and Maa Anand Mai intersection is having varying carriageway widths ranging from 6-lane divided to 3-lane undivided and is encroached upon heavily. This section of road needs to be widened to 6-lane divided carriage way.

(ii) Maa Anand Mai Marg is also catering to high traffic volume. This road needs to be provided with exclusive two lane wide service roads on either side of carriage way to be used by goods traffic.

(iii) Mathura road (NH-2) have been developed as 6 lane divided carriage way and a two lane service road is being developed along its both sides by NHAI as corridor improvement plan on NH-2 from Ashram to Badarpur to cater to future needs.

(iv) MB road – ICD approach road intersection (the proposed exit gate for the goods traffic) & Maa Anand Mai Marg – ICD approach road intersection (the proposed entry gate for the goods traffic) have been designed as per proposed traffic circulation plan with geometric
improvements and signal controls (Figs 101 & 102).

(v) Appropriate traffic management plan have been proposed for efficient and safe operation of traffic in the area within and around ICD-TKD.

**Parking Management Plan**

From the analyses of parking data, it is found that the off-street peak parking demand for goods vehicles is 470 vehicles and the on-street peak parking demand of goods vehicle is 70 vehicles. Thus the combined peak goods vehicle parking demand is 540 vehicles (Figs. 103 & 104).

Keeping in view the existing & future parking demand of different vehicles, parking management plan has been prepared along with circulation plan for goods vehicles & passenger vehicles.

(i) For goods vehicle parking, depending upon the functional utility/requirements, the entire area has been divided into six sections (Zone A to E) with total parking space for more than 700 goods vehicles against the peak goods parking demand of 540 vehicles.

(ii) Zone ‘A’ has been proposed on approach road from Maa Anand Mai Marg to ICD-TKD. For providing the parking zone a 45 meter wide land strip is required against the existing 20 meter wide road. Thus additional land strip of approximately 9,000 Sq. meter area is required for parking to develop this parking zone. This land is required to be either acquired and developed into parking area or can be developed by DDA as parking area and can be handed over to CONCOR.

(iii) Zone ‘B’ is proposed at the outlet of ICD towards MB road. This is existing open area being used for parking. However, the area is to be developed as a proper parking zone as suggested.
(iv) Zone ‘C1’ & ‘C2’ are the existing parking areas inside ICD premises. However, in zone ‘C1’ the existing yard has also been considered for parking which is at present used for de-stuffing of import containers.

(v) Zone ‘D’ has been proposed along the exit road from ICD to MB road. At present vehicles are parked in this area but it requires to be redeveloped as a proper parking zone as per suggested parking management plan.

(vi) Zone ‘E’ has been proposed in the area which is being used as an empty container yard for ICD. To develop this zone for parking alternative arrangement has to be planned for stacking of empty containers.

(vii) All the parking areas at different sections are required to be well paved and maintained with proper water drainage system, parking bays of different sections are proposed to be segregated with dividers and channelizing islands. It is suggested that the vehicles may be guided to appropriate parking bays through guiding channelising islands, dividers, signs boards and pavement markings.

(viii) The areas being used for passenger vehicle parking at present is proposed to be developed as organized parking place segregating different modes as per present & future demand.

The proposed parking management plan will address to the existing & future parking
demand of goods vehicles within the ICD/TKD without spill-over of parking to the surrounding roads as on-street parking (Fig.105).

**Future Developments**

It is further observed that there is not much variation in monthly traffic at ICD-TKD. The analyses of last 40 months traffic data shows stagnation in traffic volume of ICD. It can be concluded that ICD/TKD is working to its full capacity & hence it may be concluded that there is no expectation of further increase in traffic in future.

Construction of proposed underpass linking road No.13 and 13A across railway line at Sarita Vihar flyover (linking NH-2 and Maa Anand Mai Marg) will further re-distribute goods and passenger traffic on surrounding road network reducing traffic on NH-2 and MB road. This will further address the need for other alternative links to ICD from NH-2.

The suggested proposals if implemented are expected to reduce congestion, delays and other problems of traffic in and around ICD and will help in smooth, efficient and safe movement of traffic.

Fig.103 Hourly variation of combined parking accumulation of goods vehicles

Fig.104 Cumulative percentage of different vehicles as per parking duration
Development of GIS Based National Highway Information System

This project is sponsored by the Ministry of Shipping, Road Transport and Highways (MOSRTH) to collect and collate the road inventory data of the National Highways for about 50,000 km length (except the roads under NHDP). The main objective of the project is to develop the Geographical Information System (GIS) based Highways Information System for planning and management of the National Highways in India. The data is being collected using a Network Survey Vehicle (NSV) which is synchronized with GPS and also from the secondary sources. The project comprises the following four modules:

Module I: Development of GIS based National Highways Information System Software

This module will be on the development of GIS based software through which data management system can be effected. The software will include various highway information sub-modules such as (i) Locational Referencing, (ii) Pavement Construction and Maintenance History, (iii) Pavement Inventory, (iv) Pavement Condition (v) Pavement Geometry, (vi) Pavement Crust and Strength details (vii) Environmental Condition, (viii) Traffic and Vehicle Information, (ix) Cross-Drainage details and (x) Integration with HDM-4 software. The software to be built on GIS environment will have diversified multi-tasking operations with
computer hardware and software. A prototype system has been developed to demonstrate the query system in GIS. The GPS co-ordinate data collected through the NSV for a section of NH has been analyzed and used for attaching the relevant attribute data to generate the query system. Figure 106 shows the attachment of km-wise attribute data presented in GIS environment for a section of NH-10 collected through NSV.

Module II: Inventorisation of National Highways

This module will cover a comprehensive inventorisation for about 50,000 km length of National Highway network. The inventory data will be collected by running the instrumented vehicle on a single run. The primary data such as roughness, gradient, horizontal curvature, pavement surface distress and various types of events such as junctions, locations will be collected through using the Network Survey Vehicle (NSV). The data is being acquired and processed through Real-time Data Acquisition Software and Office-based Analysis Software (Processing Toolkit) provided with the NSV. Other related data such as details of pavement, cross drainage structures; environmental parameters, etc. will be collected through secondary sources as per the formats devised for the purpose and will form inputs to the system. Using the NSV the primary data for about 12,000 km of National Highway network.
Highways in the states of Haryana, Madhya Pradesh and Uttar Pradesh has been completed and the data is being processed.

Module III: Traffic Volume and Axle Load Surveys

It is proposed that traffic volume data for about 50 representative locations on NHs, continuously for 7 days, shall be collected using Automatic Portable Traffic Classifiers (PTC). The locations for the traffic survey have been finalized and PTC has been procured for the data collection. Figure 107 shows the tentative survey locations for the traffic surveys.

Module IV: Long Term Maintenance and Rehabilitation Strategies Based on HDM-4 Tool

The complete inventory data of the National Highway, obtained from Module II and traffic volume and axle load data collected from Module III shall be the major input for running the Highway Development and Management (HDM-4) software. Homogeneous sections shall be created from the network data and strategy analysis will be performed to find out the maintenance and rehabilitation alternatives and the required estimated budget. The strategic analysis will be performed only once on the data collected through the proposal study. Preparation of GIS maps and procurement of equipment are under progress.

Road Network Planning Approach for Location of Urban Amenities in Rural Areas- A Case Study of Laksar Block of Hardwar District

As reported earlier, this project has been sponsored by the Department of Science and Technology (DST), Government of India, with an objective to develop a road network planning approach to identify locations of urban facility centers in rural areas of Laksar Block in Hardwar district. The database for study has been built in Geographic Information System (GIS) environment. A block level GIS map has been prepared by referring Survey of India topographs in the scale of 1:50,000 and updated usingPWD road network and census maps. The base map prepared for the analysis is shown in Fig 108. The relevant attribute data on villages and road network details has been incorporated in relevant layers of the map. The centrality score method has been taken to identify the major villages to locate future urban facilities. A road network system has been evolved connecting these centers with major urban areas and villages in the block as well as in the district. Figure 109 shows the proposed location of urban facility centers and the road network system for the block.

Based on the analysis, seven major growth centers are identified namely, Laksar Town, Dausni, Gangauli, Rasi, Nirjanpur, Bikkamur, Joopur and Sultanpur, Adampur by fulfilling the concept of PURA. Using the existing road network system and the geographical location of the growth centers, a ring road connectivity as per the PURA concept has been evolved for the entire Block. It connects all the identified growth centers including Laksar town internally and externally. It connects Roorkee and Hardwar cities. The total length of the proposed ring road is about 65 km. Multiple shortest path method has been used to identify the link roads connecting the remaining villages with the ring road. The proposed ring road system
Fig. 108 Base map of the study area prepared in GIS environment

Fig. 109 Proposed road network system connecting all selected growth centres and villages
directly serves 29 settlements and about 79513 persons in the block. It constitutes more than 55 percent of the total population of the block. It is also proposed that remaining villages are served by the link roads connecting directly to the proposed ring road system and the growth centres.

**Pilot Study on Effect of Overloading on Road Infrastructure**

The study is sponsored by Ministry of Shipping, Road Transport and Highways with an overall objective to develop relationship between the axle load and its effect on total cost to the economy. The scope of the study is to determine the effect of overloading on: (i) pavement (flexible and rigid) deterioration and its service life, (ii) performance of bridges (iii) exhaust emissions (iv) vehicle operating costs, (v) cargo safety and vehicle damage, and also to suggest ways of preventing overloading. An inception report containing the scope and methodology of the study has been prepared and submitted to the Ministry.

**Feasibility Study for the Construction of Elevated Road on New Rohtak Road from Rani Jhansi Road to Jakhera Flyover**

The main objective the project is to study the feasibility in terms of traffic point of view for construction of elevated road along New Rohtak road from Rani Janssi road to Jakhera flyover. The project was sponsored by the Municipal Corporation of Delhi.

The scope of the study is to:
- Identification of critical intersections for monitoring traffic.
- Identifying the method of estimating the consumption of fuel during idling of vehicles at intersections.
- Quantifying the fuel loss at intersections in terms of monetary values.
- Estimation of monetary benefit in terms of savings in fuel by constructing flyovers and/or by implementing other ‘Traffic Management’ measures.

The study involved:
- The classified traffic volume count at selected intersections.
- The delays occurring at selected intersections due to the idling of vehicles during red phase of the signal.
- The estimation of fuel consumption by various types of vehicles plying on Delhi roads.
- Quantification of fuel loss during idling of vehicles at selected intersections.

The study has been carried out and a conceptual plan has been prepared through topographical survey. Fig. 110 shows the study area plan for the proposed corridor on New Rohtak Road from Rani Jhansi Road to Jakhera Flyover has been submitted to Municipal Corporation of Delhi.
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 audit and assistance to Director, Management Council (MC) and Research Council (RC) on project related matters.

Major activities carried out during the year are as follows:

I. Planning Activities

Preparation of Eleventh Plan Proposal

A proposal on “Development of Management System for Maintenance, Planning and Budgeting of High Speed Road Corridor” for Eleventh Five Year Plan Period was prepared. The project is undertaken as Supra-Institutional project.

Annual Plan 2008-09

The Annual Plan 2008-09 document for CRRI which contained information related to research work plan to be carried out during 2008-09 was 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 included all research components whereas Non-Plan item’s cover infrastructural support. Plan requirements for the Institute for the years 2007-08 (Revised Estimate) and 2008-09 (Budget Estimate) have been prepared.

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 by the Division.

Development and Regular Maintenance of Project Database

A project database has been developed which is regularly updated incorporating addition of new projects, modifications during their implementation stage and finally during their completion. The database includes project title, classification and technical and 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.

Internet Site for Information

Developed and hosted a web based (Internet site) “Online Projects Information/ Query System” to facilities the F&A section/Stores and Purchase section and R&D divisions for various purposes.

II. Monitoring Activities

Network Projects

A network project on 'New and Improved Road Technologies’ has been undertaken by CRRI as coordinating lab which is continuing till March 2009. Owing to the size of budget allocation and involvement of national issues and priorities, the
project had significant bearing on the Institute’s functioning.

A national facility Accelerated Pavement-Testing Facility worth Rs. 13 crore is being established under the project.

**Research Utilisation Data (RUD) & Quarterly Performance Report (OPR)**

Reporting on the performance and the status of various projects was carried out through preparation of Research Utilisation Data (RUD) and Quarterly Performance Report (OPR).

Research Utilisation Data (RUD) contains information related to various projects handled by the Institute. Similarly, Quarterly Performance Report (OPR) 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.

PME Division also calls for progress report of all the on-going projects in the Institute for processing. This exercise is meant to monitor & 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 were regularly monitored particularly for their adherence to time schedule, amount dues, if any, documentation etc.

**External Cash Flow**

The institute undertakes projects sponsored by various external agencies such as Ministry of Shipping, Road Transport & Highways (MOSRT&H), National Highway 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 monthly basis so that performance/ working of the Institute could be made more effective.

**III. Evaluation Activities**

**Customer Satisfaction Evaluation (CSE)**

To be in-line with the CSIR CSE system, CRRI also assesses its performance by evaluating the CSE Proforma. The evaluation parameters include usability of the work, adherence to the time schedule, attainment of objectives of the work as stated in agreement and accomplishment of output so as to ascertain the use of the work in the client's business. PME plays an important role in receiving, compiling and analyzing the CSE feedbacks thereby enabling the concerned scientist/project leader for the corrective action to be taken in future for improving Customer Satisfaction.
Issues related to the Technical Audit

Handling of issues related to Technical Audit was another important activity of the Division. It had been instrumental in providing information and necessary support to Audit Team. Annual and Periodical Audit was carried out by CAG and internal Audit Team.

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 awarding ‘Best Performing Division’ each year based on the annual performance from the year 2005-06. The scheme was revised to extend it to incorporate individual team for their meritorious work.

RC Secretariat

PME Division acted as Secretariat to provide full support to RC Secretary in carrying out activities for organizing RC Meeting of the Institute.

IV. Miscellaneous

Projects’ Summary for Management Council/Research Council

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

Management of Various Project Proformae

PME 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

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 interacts with various divisions of CSIR particularly ROPD and TNBDO regarding the preparation of Annual Plans, Five Year Plan of the Institute, Management of Network Projects, ECF queries etc.

Service Tax Payment

On receipt of amounts for externally funded projects, Service Tax is paid to the Government. The Division regularly carries out activities for the payment of Service Tax on monthly basis.

CRRI-IRC Interface

Acted as an interface between CRRI Scientists and IRC so that concerted efforts could be made to incorporate relevant changes due to technological reasons in the prevalent IRC codes and Specifications.

Panel of Experts

Panel of Experts were revised for the assessment purpose of Group IV and III staff. Separate Area-Wise Panels were prepared for Group I & II, III(1) & III (2), III(3) to III(6) and IV staff.
**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, six 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:

**Training Programme on Interlocking Paving Blocks and Cement Concrete Pavements for the Engineers of Panchayati Raj PW, Government of Haryana, Chandigarh**

The Institute organized a training course for the Engineers of Panchayati Raj PW, Government of Haryana, Chandigarh from April 9-10, 2007—Thirty Three participants attended the training programme.

**Training Programme on Good Practices in Highway Construction for the Engineers of M/s Nagarjuna Construction Co. Ltd.**

At the request of M/s Nagarjuna Construction Co. Ltd., a training programme on Good Practices in Highway Construction for the Engineers of M/s Nagarjuna Construction Co. Ltd.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Title of the Course</th>
<th>Duration with Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Pavement Engineering &amp; Materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Design, Construction and Maintenance of Flexible Pavements</td>
<td>August 06-10, 2007</td>
</tr>
<tr>
<td></td>
<td>• Rigid and Composite Pavements: Design, Construction and Quality Control Aspects</td>
<td>September 10-14, 2007</td>
</tr>
<tr>
<td></td>
<td>• Pavement Evaluation Techniques and their Applications for Maintenance and Rehabilitation</td>
<td>November 19-23, 2007</td>
</tr>
<tr>
<td>B.</td>
<td>Planning &amp; Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Highway Development and Management</td>
<td>October 08-18, 2007</td>
</tr>
<tr>
<td></td>
<td>• GIS Application in Planning and Management of Rural Road Network</td>
<td>January 21-24, 2008</td>
</tr>
<tr>
<td>C.</td>
<td>Traffic &amp; Transportation Planning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Aspects of Transportation Planning and Environmental Impact Assessment Studies for Roads</td>
<td>February 11-15, 2008</td>
</tr>
</tbody>
</table>
Practices in Highway Construction was organised for the Engineers of M/s Nagarjuna Construction Co. Ltd. at CRRI from July 03-05, 2007. Twenty Four participants attended the training programme.

**Training Programme on Construction Material, Lab & Quality Control for the Engineers of M/s IRCON International Ltd., New Delhi**

Institute organized a training course on Construction Material, Lab & Quality Control for the Engineers of M/s IRCON International Ltd., New Delhi. on July 24, 2007 Nineteen participants attended the training programme.

**Training Programme on Planning, Design, Construction and Maintenance of Rural Roads for the Engineers of MP Rural Road Development Authority, Bhopal**

At the request of Madhya Pradesh Rural Road Development Agency, Bhopal, a training programme on Planning, Design, Construction and Maintenance of Rural Roads was organised for engineers of Madhya Pradesh Rural Road Development Agency (MP, RRDA) from August 20-24, 2007 at CRRI New Delhi. The programme was attended by 24 engineers from Madhya Pradesh Rural Road Development Agency.

**Training Programme on Highway Development & Management (HDM-4) for the PWD Engineers of Govt. of Karnataka**

On the request of Govt. of Karnataka, a special training programme on HDM-4 was organised for PWD Engineers of Govt. of Karnataka from Sept 22-29 2007 at Bangalore. Twenty participants attended the training programme.

**Training Programme on Quality Assurance and Quality Control Aspects related to the Construction of Rigid / Flexible Pavements for the Engineers of NTPC, Noida**

The Institute organized a training course for the Engineers of National Thermal Power Corporation, Noida from March 24-27, 2008. 25 participants attended the programme.

**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 to 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 150-151.
Student Training

Interfacing with academic institution through liaison and coordinating student training at CRRI. About 60 student trainees were provided facilities for practical training at CRRI each year as part of their dissertation / project work. Details are given in page 153-157.

Publications

CRRI Annual Report for the Year 2006-2007

The report is the profile of achievements of the Institute during the year 2006-2007. 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 2006-2007.

General Report on Road Research Work Done in India during 2006-07

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 2006-07. 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 34 by the Indian Roads Congress. The report was presented by CRRI in the 68th Annual Session of Indian Roads Congress at Jaipur, Rajasthan.

CRRI Newsletter

During the year, two 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 were 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 clipping 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. These were also compiled in the form of document.

Publicity through CRRI Advertisement

To popularise the Institute 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 the various organizations on the 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.

Intellectual Property Management

The division is responsible for drafting, scrutiny and execution of agreements/MoUs for various externally funded projects and cooperation with other organizations for undertaking joint projects. The following agreements/MoUs were signed during the year.

- MoU between CRRI and NTPC Ltd. on Use of High Volume Fly Ash Concrete Road Construction at NTPC Dadri and Roller Compacted Concrete Road at NTPC Ramagundam on Aug.3, 2007

Exhibitions

The Institute participated in the following Technical Exhibitions during the year.

- 68th Annual Session of Indian Roads Congress organized by Public Works Department, Govt. of Rajasthan, Nov. 16-19, 2007 at Jaipur.
- Technical Exhibition MUNICIPALIK 2008 organised by Good Governance
India Foundation at Mumbai from January 31, 2008 to February 2, 2008.

Technology Transfer and Business Development

The division is actively engaged in technology transfer and marketing of institutes knowledge base through active coordination of promotional activities and professional channels.

Scrubinising 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. Details are given in page 141.

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 were provided to various organizations and the annual subscriptions were paid to continue the membership. The Institutional membership of the Institute is given on page 166.

Training Programme on Good Practices in Highway Construction organised for the engineers of M/s Nagarjuna Construction, Hyderabad, July 3-5, 2007
Training Programme on Interlocking Paving Blocks and Cement Concrete Pavements organised for the engineers of Panchayati Raj PW, Government of Haryana, Chandigarh, April 9-10, 2007

International Training Programme on HDM-4, October 8-19, 2007


CRII New Delhi
Training Programme on Design, Construction and Maintenance of Flexible Pavements, August 6-10, 2007

Training Programme on GIS Application in Planning and Management of Rural Road Network, January 21-24, 2008

Training Programme on Quality Assurance and Quality Control Aspects related to the Construction of Rigid/Flexible Pavements for the engineers of NTPC, Noida, March 24-27, 2008
Training Programme on Construction Material, Lab & Quality Control for the engineers of M/s IRCON International Ltd., New Delhi, July 24, 2007

Training Programme on Planning, Design, Construction and Maintenance of Rural Roads for the engineers of MP Rural Road Development Authority, Bhopal, August 20-24, 2007

A view of Training Session in Progress
Participants of Training Programme on International Course on Dissemination of HDM-4, October 8-18, 2007

Participants of Training Programme on Design, Construction and Maintenance of Flexible Pavements, August, 6-10, 2007
CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI

Training Programme on Planning, Design, Construction and Maintenance of Rural Roads
Organised for the Engineers of MP Rural Road Development Authority, Bhopal
August 20 - 24, 2007

Training Programme on
Good Practices in Highway Construction
For the Engineers of M/s Hazari Lala Construction Co. Ltd.
July 09 to 23, 2007
Organised by: Central Road Research Institute, New Delhi
Management Information Division (MIN) is entrusted with office automation programme and data management. It has provided services to the following activities:

**Up-date Computerized Manpower Information**

The day-to-day changes of staff in respect of both quantitative and qualitative is monitored and information is furnished to the top management for decision making. The information is used widely for documentation and projects formulation. The manpower data is transformed to meaningful information for statistical analysis, rations and scientific staff directory.

**Development and Maintenance of Office Automation Software**

- Constant technical support is provided to run the IMPACT and other CSIR software. Over a dozen of software is developed and installed in the office for better and efficient handling of accounts and administrative activities. With the greater availability of computer hardware, more demands of software are meted out. During the year a computerized GPF Accounting System was developed which is implemented fully. An advanced Income Tax modules and e-tax return was also implemented. Reported regularly Project Accounts to the project leaders. Computerised the consumable issue and credited adjustment of sponsored projects issues to the Institute. Developed WEB based information system.

- Assisting Administration, Accounts, Stores and Purchase Division in all crucial information generation and on computerization.

- Interaction with CSIR and DSTP on various manpower data compilation including publication of Directory of Scientific and Technical Personnel by CSIR, publication of CSIR Telephone Directory.

- Modification and standardization of various forms used in the institute from time to time.

- Compilation of internal telephone directory of CRRI and its periodical updation.

- Provided regular training to the administrative staff on computer. Organised training programme for administrative staff in three batches for two days each.

- Supplied charts and graphics for various document.
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 88,500 publications including books, reference books, periodicals, conference proceedings, technical reports, standards specifications, microfilms, maps, CD-ROM databases, video cassettes etc.

Current Awareness & Other Services

CART BULLETIN: Current Awareness in Roads and Transport

It is a monthly documentation service in which content pages of selected periodicals received every month are compiled and displayed in the library to keep scientists abreast of the latest information in their areas of specialisation.

Bibliographic Services

Literature searches and CD searches carried out and bibliographic service was provided on request to researchers of CRIRI 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 familiarise 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 CRIRI 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, IRRO, TRANSDOC from TRANSPORT CD, COMPENDEX, PIARC CD ROUTE, and All BIS (Indian) Standards including Civil Engineering, all ASTM Standards were provided through CD ROM databases for quick retrieval of information. TRANSPORT CD ROM, BIS CD ROM are installed on Intranet.

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. WEB OPAC has been installed on Intranet to search the database of CRRI Library.

Library Statistics

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books added during the period</td>
<td>370</td>
</tr>
<tr>
<td>Total No. of books as on 31.03.2008</td>
<td>53289</td>
</tr>
<tr>
<td>Maps</td>
<td>688</td>
</tr>
<tr>
<td>Microforms</td>
<td>655</td>
</tr>
<tr>
<td>Videocassettes</td>
<td>122</td>
</tr>
<tr>
<td>Periodicals titles received regularly</td>
<td>200</td>
</tr>
</tbody>
</table>
Computer center provides central computer facility and technical services to all the staff of the Institute engaged in R & D, S & T Services and administration.

**Local Area Network (LAN) and Website**

The CRRI campus wide network is operational since 2000 using Cisco 5500 and workgroup switches (2900 Series) and two HP Proliant Server ML 507 with window 2003 Professional Server OS, working as a proxy and Web Server and also one IIP Proliant ML 350 Server with on Redhat Linux Mail Server.

Web based Email services is located at NIC and also the Internet services is being provided by NIC using shared 2 MBPS Leased Line.

The corporate antivirus protection is for all the servers and PCs connected to LAN.

Official website for CRRI is at present located in NIC. New Website is being developed in ASP Framework using SqlServer as Back End and the same will be launched at NIC end soon. Website of CRRI is http://crroidom.gov.in

The process of upgrading LAN will be completed in next quarter. Diagram of proposed expansion of LAN is given in Fig. 111. Expended LAN is expected to be completed this year.

The Procurement of 120 Pentium -IV PC’s with TFT Monitors under process.

64 bit servers are procured and transfer of the services to these servers is under process.

The Center facilitates computer facility to all Training Programs & Seminars/Conferences etc organized at CRRI.
Technical Services

Mechanical Engineering Support Division provides technical services in:
1. Design and development of mechanical equipments required by R&D divisions
2. Repair of mechanical equipments
3. Repair of electrical equipments
4. Repair of temperature controlled equipments
5. Repair of air conditioners

6. Repair of desert coolers
7. Auto fleet management

Apart from the above stated services MES has also
(i) Completed an In house project on "Effects of Mechanical Impact on the shape and size of Aggregates for Road construction”.
(ii) Written technical papers

The MES has developed and fabricated following equipments.

Ponding Cum Debris Expulsion Test Equipment

An application for grant of patent for this equipment has been filed Fig. 112.

The main features of the equipment are:
- Indigenously designed and fabricated in MES division
- Two tests on expansion joints can be carried out in this equipment
- One is Pondind test which requires 25 mm water head to be maintained
- Another is debris expulsion test which requires to & fro movement of expansion joint assembly
- Very versatile equipment and can be used for any type of expansion joint with slight modifications
- Very cost effective equipment

Played a critical role in completion of cor-0022 project

Nuclear Density Gauge Mounting Device

The main features of this equipment are:
- Indigenously designed and fabricated in MES division Fig. 113.
The equipment was developed for continuous monitoring of pavement compaction. It can be mounted on various types/models of road rollers with slight modifications. Easy to handle, easy to assemble and dismantle. Very light and versatile equipment.

The equipment played an important role in completing COR-0013 project.

**LVDT Mounting Equipment**
- This equipment was developed in MES division for measuring pavement deflection on load. Fig. 114.
- The equipment is mounted on a truck for automatic monitoring of pavement.
- Holding assembly for LVDT can be easily inserted between the wheels of truck for taking measurements.
- Light and portable device.

The equipment played an important role in completing COR-0013 project.

**Movement Measuring Equipment for Rock Slide Measurement**
- The main features of this equipment are:
  - This equipment was developed in MES for measuring the movements of rocks in hilly terrains.
  - The gauges are fixed at sight and the measurement is taken after a gap of few months.
  - This gauge can measure lateral as well as angular movements of the rocks.
  - Very versatile and easy to use at site.
  - Very cost effective design.
  - Coated surfaces to avoid rusting.

Several equipment developed and installed at various sites.
Clamps and Supports for Fatigue Testing of Expansion Joint Members

The main features of this equipment are:
- Clamps and supports were designed and fabricated in MES division Fig. 116.
- Designed to withstand load of 20 t
- Sample can be very easily mounted
- Portable

- Developed for COR-0022 project
- Clamps suitable for various types of expansion joints
- Successfully used for creating fatigue testing facility at DHT lab Ghaziabad

The fabrications played critical role in developing the fatigue testing facility and in completion of COR-0022 project.
Quality Management

Quality Management Division was formed with the mandate to ensure that the Quality Management System operates in the Institute effectively and efficiently. Besides, adopting higher level of quality standards in the working of the Institute was also the mandate of the division. This division was responsible for internal quality audits; convening the Management Review Meetings; preparing the Institute for the audits to be conducted by certification agency i.e. Bureau of Indian Standards (BIS) and getting the Institute certified for higher level of quality standards. During the year the division was engaged in the following activities:

Internal Quality Audits (IQA)

The Internal Quality Audits are systematic and independent examination to determine whether the planned arrangements are implemented effectively and are suitable to achieve the objectives. The audits were carried out by trained quality auditors of the Institute with the following purpose:

- 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.

During the year two internal quality audits were carried out. During the audit, two aspects, namely the requirements of the quality management system as defined in the Quality Manual and the Quality System Procedures were given focus.

The non-conformity reports were communicated to the auditees for ensuring the corrective and preventive actions. The actions taken by the auditors are verified subsequently and NC’s were closed.

Renewal Audit:

The Institute’s License for quality management system certification was renewed in December, 2004 which was valid up to December, 2007. Renewal Audit was carried out by the team of auditors from Bureau of Indian Standards (BIS) in November 2007. During the renewal audit all the functional units of the Institute were audited to ensure that Quality Management System is effectively followed in the entire Institute. Based on the recommendations of the BIS audit team, ISO 9000: 2000 Quality Management System Certification was renewed by BIS for next three years which is valid up to December, 2010.

Management Review Meeting:

The Top Management Review’s and discusses the findings of the Internal Quality audits in detail during the Management Review Meeting. Management Review Meeting is chaired by the Director of the Institute and attended by all the Heads of Divisions/Sectional Heads. Besides the finding of the audits grey areas related to the functioning of the Institute are also discussed and resolved to ensure that Institute’s work were does not suffer and is carried out as per the planned arrangements. As a result of the Management Review, Quality Policies and Quality Objectives were reviewed to make them in line with each other keeping in view the mandate of the Institute. The Quality Objectives were modified to make them quantifiable and measurable to meet the system requirement, Institute’s requirements and mandatory requirements.
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 a quarterly basis. 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 was celebrated to enhance official language used in day-to-day work. A large number of staff took part in different competitions. 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 to various areas with respect of Hindi correspondence and preparation of technical reports, abstracts, work report, etc. in Hindi. Scientists actively participated and presented their papers in Hindi at different seminars.

Rajbhasha section also helped scientists in preparing lecture/presentations related to their research work in Hindi. To encourage the staff to do more and more work in Hindi, bilingual dictionaries (English-Hindi & Hindi-English) were made available to all staff members of the Institute. 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.
Workshop on Environmental Impact of Road Transport

A Workshop on Environmental Impact of Road Transport – was organized by CRRI under CSIR Network Project on April 26, 2007. The project has four components i.e. EIA of roads, Vehicular emissions, characterization the emission, atmospheric dispersion model for the heterogeneous mix of traffic on urban corridor in Delhi. These were deliberated in details along with further research needed in the area. About fifty participants from TERI, CPCB, NEERI Nagpur and CRRI Scientists attended the workshop.

National Technology Day

CRRI celebrated National Technology Day on May 11, 2007. As a part of celebration the Institute organized competition for R&D areas on Divisional Display and Up Keeping the R&D Labs. The R&D staff of the Institute actively participated in the competition. Sh S.N. Sharma, Consultant, HRDC, Ghaziabad graced the occasion as a Chief Guest. Sh. T. K. Amla, HOD, IIT gave a brief account of the background of National Technology Day. Dr. S. Gangopadhyay Area Advisor, CRRI, introduced the Chief Guest and gave a brief account of achievement of the Institute. The Chief Guest delivered the Technology Day Lecture. Prizes were given to the winners of the competition held in connection with Technology Day by the Chief Guest. Shri Sudhir Mathur, Area Advisor GTE proposed the vote of Thanks.

Workshop on Identification of R&D Thrust Core Area in Civil Engineering Sub Area Infrastructure Development

One-day workshop on identification of R&D Thrust Core Area in Civil engineering sub

area Infrastructure Development sponsored by DST was organized at CRRI, New Delhi. The deliberation of the workshop was to identify the thrust and core areas in civil engineering including GIS, GPS Surveying and Photogrammetry and Remote Sensing to sponsor R&D activities of national interest. Fifty participants from research institute, professional and CRRI scientists attended the workshop.

CSIR Foundation Day

The Institute celebrated CSIR Foundation Day on Sept. 26, 2007. As a part of CSIR Foundation day celebration, the Institute organized a debate competition on topic ‘Should we have Blue line Bus service in Delhi’ for CRRI staff and various competition for the children of CRRI staff. Around 255 students of 10th and 12th class from Kendriya Vidhyalaya, Jamia Milia Islamia, Laxman Public School and Indian School visited the Institute. The main function was held in the afternoon. Shri Anand Kumar, Director IOC Ltd. (R&D) was the Chief Guest and delivered a Foundation Day Lecture on Energy Challenges and Sustaining Growth. The programme was attended by many old colleagues of CRRI and invitee.

Prizes were also given to R&D Divisions for best divisional display and best performing division during the year. The staff members who have retired during Sept. 2006 to Aug 2007 and those who have completed 25 years of service in CSIR were given mementos by the Chief Guest.

Hindi Pakhwada (Fortnight)

Hindi fortnight was organized from September 03-14, 2007 at CRRI, New Delhi. Competitions
such as essay writing, Hindi noting and drafting, Hindi speech, Quiz & debate competitions were organized during the fortnight. About 150 employees took part in these competitions. Dr. V. Das, Ex-Director, Department of Official Language, Ministry of Home Affairs presided the inaugural function on 3rd September, 2007. Closing ceremony and prize distribution function was organized on 14th September, 2007. Dr. Dhanjai Singh, Editor, Kadamabni graced the occasion as Chief Guest. Prizes were given to winners of different competitions and also to those employees who have published research papers in Hindi and done commendable work in Hindi.

Workshop on Office Procedure and Record Management

To streamline the function of the office, a two-day workshop on office procedure and record management was organized for the administrative staff of the Institute. Shri S.C. Sen, Consultant & Former Deputy Director, Institute of Secretariat Training & Management (Ministry of Home Affairs), New Delhi delivered the lectures. All LDCs, UDCs and assistants of general cadre of the institute attended the workshop.

CRRI-Shell Workshop on Future Technologies in Bituminous Construction for Highways and Airfield Pavements

One-day workshop on Future Technologies in Bituminous Construction for Highways and Airfield Pavements was organized by the Institute in collaboration with M/s SHELL Bitumen on Oct 27th, 2007. The workshop was attended by more than 100 delegates from various organisations in the country. Keynote lecture/presentation were made during the workshop.

National Science Day

To commemorate the discovery of Raman effect by Sir C.V. Raman, the Institute celebrated National Science Day on Feb 28, 2008. Dr. Ilaavazhagan, Director, Defence Institute of Physiology & Allied Services, Delhi graced the occasion and delivered National Science Day lecture on 'Physiology of Stress and its Management'. Welcoming the chief guest, Dr. Sunil Bose, Head, ESS, and Deputy Director highlighted the background of celebration of National Science day. At the outset, Sh. T.K. Amla, Head, Information, Liaison and Training welcomed and introduced the chief guest. Sh. A.N. Ramalingaiah, Deputy Director proposed vote of thanks. He conveyed his thanks to chief guest for sparing his valuable time and also to the Organizing Committee of National Science Day.

Director General, CSIR Visits CRRI

Prof. S K Brahmachari, Director General, CSIR visited CRRI on March 27, 2008. On this occasion, Prof. Brahmachari addressed the staff members of the Institute and had a discussion with Head of the Divisions and Senior Scientists. He also interacted with Young Scientists and Achievers who have contributed in the R&D achievements of the institute significantly. He was shown the facility procured from ARRB Australia for inventorisation of road assets for the entire network in the country-the 'Network Survey Vehicle'.

Prof. Brahmachari enthralled the staff members by his address and shared with them some of
his vision for S&T scenario in the country. He
desired to see CRRI to rise much greater height
and excel its performance. Earlier, Dr. Vikram
Kumar, Director CRRI welcomed the Director
General and informed him about the major
achievements, and future plans of CRRI.

**Hindi Workshops**

Four workshops in Hindi were organized
during the year. About 25 participants
each attended the workshops. Well known
Rajbhasha personnel and seniors officers from
different ministries and departments were
invited to deliver lectures and impart training
to the participants. Lectures related to letter
writing noting and drafting and communication
in Hindi, mechanical facilities and software in
Hindi, Hindi dictation, guidelines for filling up
the Quarterly Hindi Report etc. were delivered
during these workshops.

**Awards / Recognition**

<table>
<thead>
<tr>
<th>Awards / Recognition</th>
<th>Acknowledgement</th>
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<tbody>
<tr>
<td>Elected as Co-chairman and Member respectively of Executive committee of Indian Geo-technical Society-Delhi Chapter.</td>
<td>Shri U.K. Guruvittal, Scientist E-II, Shri Kanwar Singh, Scientist C</td>
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<tr>
<td>Australian Endeavor Fellowships-2008 (For pursuing Post Doctoral Fellowships at University of South Australia from 1st May, 2008 to 31st October, 2008)</td>
<td>Dr. S. Velmurugan, Scientist</td>
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<tr>
<td>First Prize for paper Sadakaon par Vigapanao ka Sadak Suresh a aur Pradosan paar prabhav, published in Vigyan pragati June 2006</td>
<td>Dr. Nishi Mittal, Scientist</td>
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<tr>
<td>WCTR-2007 Fellowship, by World Conference on Transport Research, University of California Berkeley, USA, held in University of California Berkeley in June 24 – June 28th, 2007</td>
<td>Dr. K. Ravinder, Scientist</td>
</tr>
<tr>
<td>Endeavor Research Fellowship Award 2008 to undertake Postdoctoral Research Programme in Australia by Australian Govt Department of Education, Science and Training</td>
<td>Dr. S K Sharma, Technical Officer</td>
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<tr>
<td>ING-IABSE medal for the paper ‘Simplified Method for Pile Foundation Design of Bridges in Liquefiable Soil, New Delhi, Jan 4-6, 2008</td>
<td>Dr. P Lakshmy, Scientist</td>
</tr>
<tr>
<td>Tohoku University, JAPAN Fellowship and made a presentation on research paper at Eastern Asia Society of Transportation (EASTS), International Conference held at Dalian, China, Sept 23rd 30th, 2007</td>
<td>Dr. K. Ravinder, Scientist</td>
</tr>
</tbody>
</table>
Dr. S. Gangopadhyay, AC (TTP) delivering welcome address during National Technology Day, May 11, 2007

Dr. Vikram Kumar, Director addressing CRRRI staff on New Year Day

Dr. Vikram Kumar, Director addressing Heads of Division of CRRRI
Dr. S. Bose, AC (ESS) delivering welcome address during National Science Day Feb. 28, 2008

Dr. Havazhagan, Director, DIPAS delivering National Science Day lecture, Feb. 28, 2008

Dr. S.M. Sarin, ex-acting Director CRRI speaking on the occasion of National Science Day
Other Activities of the Institute Events

Dr. Vikram Kumar, Director CRRI receiving Prof. Brahmachari, DG CSIR

Prof. Brahmachari, DG CSIR addressing the CRRI staff

Annual Report 2007-08
Dr. Vikram Kumar, Director, CRRI giving welcome address during CSIR Foundation Day celebration on Sept. 26, 2007.

Shri Anand Kumar, Director, IOC Ltd. (R&D) delivering Foundation Day lecture on Sept. 26, 2007.
Shri P.L. Bongirwar, Chairman, CRRI Research Council giving Best Scientist Award to Dr. K. Ravinder, Scientist CRRI

Shri P.L. Bongirwar, Chairman, CRRI Research Council giving Award to Shri Purshotam Lal, Assistant for the meritorious work

Visit of students at CRRI on the occasion of CSIR Foundation Day on Sept. 26, 2007
Visit of students at CRRI on the occasion of CSIR Foundation Day on Sept. 26, 2007

A view of a Research Council Meeting of CIRRI
Workshop cum-training programme on Office Procedure and Record Management in progress

Inauguration of National Focus Group on Rural Roads Engineering in India at CRRI
Other Activities of the Institute

Events

Workshop on Quality Assurance Handbook (QAHB) for Rural Roads
16th & 17th April, 2007
Organized by National Rural Roads Development Agency (NRRA)
At Central Road Research Institute, New Delhi

A view of inauguration of Workshop on Quality Assurance Handbook for Rural Roads organised by NRRA, New Delhi

A view of special presentation at CRRI
A view of Hindi Pakhwada celebration at CRRI

Prize distribution during Hindi Pakhwada
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Topic</th>
<th>Place</th>
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<tbody>
<tr>
<td>1</td>
<td>Granular Material and Quality Control for Road Construction</td>
<td>NITHE, Noida</td>
<td>Sudhir Mathur</td>
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<td>2</td>
<td>Use of Flyash in Road and Embankment Construction</td>
<td>Consulting Engineering Services, Kolkata</td>
<td>Sudhir Mathur</td>
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<tr>
<td>3</td>
<td>CRRI Experiences on Use of Geotextiles in Road Works</td>
<td>Training Workshop on Non Woven Geotextiles, Ministry of Textiles, Govt. of India, New Delhi</td>
<td>Sudhir Mathur</td>
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<tr>
<td>4</td>
<td>RMC and Mix Design</td>
<td>HRDC, Ghaziabad</td>
<td>Satander Kumar</td>
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<td>5</td>
<td>Aggregate Quality with respect to Elongation and Flakiness Indices</td>
<td>Seminar on Crushing Machinery Units in respect of Aggregate Quality for Road Construction, Staff Training College, Gandhinagar, Gujarat, April 2007</td>
<td>Satander Kumar</td>
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<td>6</td>
<td>Introduction to the Structural Design of Buildings</td>
<td>HRDC, Ghaziabad</td>
<td>S. S. Gaharwar</td>
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<td>7</td>
<td>Erosion Problem of Road Embankment at Rann of Kutch</td>
<td>Seminar on Technologies for River Erosion Control &amp; Use of Gabions / Geosynthetics, BIS &amp; CSMRS, New Delhi, June 2007</td>
<td>U.K. Guruvittal</td>
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<td>8</td>
<td>Testing and Quality Control on Concrete Roads</td>
<td>NCCBHM, Ballabhgarh</td>
<td>Satander Kumar</td>
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<td>9</td>
<td>Roadway Features in Road Accidents</td>
<td>Indo-US Workshop, New Delhi, Aug 29, 2007</td>
<td>Dr. Nishi Mittal</td>
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<tr>
<td>10</td>
<td>Ultra Thin White Topping</td>
<td>Council Meeting, IRC Annual Session, Jaipur, Nov 16, 2007</td>
<td>Satander Kumar</td>
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<td>11</td>
<td>Use of Flyash in Road and Embankment Construction</td>
<td>Training and Awareness Workshop on Utilization of Flyash, Environmental Planning &amp; Coordination Organization, Govt. of MP, Bhopal, Nov, 2007</td>
<td>U.K. Guruvittal</td>
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<tr>
<td>S.No.</td>
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<td>12</td>
<td>Bulk Utilization of Marble Slurry Dust in Roads</td>
<td>Workshop on Bulk Utilization of Marble Slurry Dust, Jaipur</td>
<td>Dr. A.K. Misra</td>
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<td>13</td>
<td>Flyash based Cement Concrete Roads and Roller Compacted Concrete</td>
<td>NTPC, Noida</td>
<td>J.B. Sengupta</td>
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<td>14</td>
<td>Flyash Utilization in Road Works – Prospects and Techniques</td>
<td>Workshop on Utilization of Flyash, Environmental Planning and Coordination Organization, Betul, Feb, 2008</td>
<td>U.K. Guruvittal</td>
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<td>15</td>
<td>Utilization of Fly ash, Bottom ash and Pond ash for Road and Embankment Construction</td>
<td>Workshop on Flyash Utilization in Construction and Materials, NTPC, Vishakhapatnam March 2008</td>
<td>U.K. Guruvittal</td>
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<td>16</td>
<td>Reinforced Earth Walls</td>
<td>Training Workshop on Non Woven Geotextiles, Ministry of Textiles, Govt. of India, Coimbatore, Tamil Nadu, March 2008</td>
<td>P.S. Prasad</td>
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<td>17</td>
<td>CRRI Experiences on Use of Geotextiles in Road Works</td>
<td>Training Workshop on Non Woven Geotextiles, Ministry of Textiles, Govt. of India, Coimbatore, Tamil Nadu, March 2008</td>
<td>U.K. Guruvittal</td>
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<td>18</td>
<td>Fibre Reinforced Concrete</td>
<td>NCCBM, Chandigarh</td>
<td>Satander Kumar</td>
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<td>Awareness workshop on Registration Scheme and New Environment Impact Assessment Notification</td>
<td>Anuradha Shukla, Dr. Neeraj Sharma</td>
<td>April 07, 2007</td>
<td>Quality Council of India, New Delhi</td>
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<td>Arbitration and Dispute Resolution in Construction Contract</td>
<td>K. Sitaramanjanayulu, Binod Kumar</td>
<td>April 6-7, 2007</td>
<td>MODCKDN Engineers, New Delhi</td>
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<td>Services Tax</td>
<td>A. Saunikha, Dheeraj Singh</td>
<td>April 16-17, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Pavement Engineering with Geosynthetics</td>
<td>Dinesh V. Ganvir</td>
<td>April 23-27, 2007</td>
<td>IIT, Delhi</td>
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<td>Geotechnical Investigation in Civil Engineering Project</td>
<td>Kanwar Singh</td>
<td>April 24-27, 2007</td>
<td>IIT, Roorkee</td>
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<td>Advance Training Programme for Assistant (F&amp;A)</td>
<td>B. D. Sharma</td>
<td>May 21 - 26, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Private Secretaries working with Directors</td>
<td>A. K. Gauba</td>
<td>June 14-17, 2007</td>
<td>HRDC, Ghaziabad</td>
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<tr>
<td>Workshop cum Brain Storming of all the Heads of CSIR Knowledge Resource</td>
<td>Dr. Ashok Kumar</td>
<td>July 19-20, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Crafting effective S&amp;T Communications</td>
<td>Dr. Kishore Kumar, M.K. Meena, Sanjay Deori</td>
<td>August 3-4, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Training Programme on Reservation</td>
<td>Ram Swarup, AD</td>
<td>August 9-10, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Quality Control Management</td>
<td>R.S. Bharadwaj</td>
<td>August 07, 2007</td>
<td>ASSOCHAM, New Delhi</td>
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<td>Refresher programme for Section Officers</td>
<td>Vandana D. Singh</td>
<td>Sept. 10-14, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Research Methodology &amp; Statistical Methods</td>
<td>J. Ganesh, Mukti Advani</td>
<td>Sept. 17-20, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Training Programme on SIT Act 2007</td>
<td>R.C. Agrawal, Vandana D Singh</td>
<td>Sept. 24-25, 2007</td>
<td>HRDC, Ghaziabad</td>
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<td>Programme on Official Language</td>
<td>Dr. Anang Pati</td>
<td>Oct. 26, 2007</td>
<td>HRSC, Shillong</td>
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<td>Record Management &amp; RTI Act 2005</td>
<td>Abhishek Mittal</td>
<td>Oct. 29-31, 2007</td>
<td>HRSC, Shillong</td>
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<td>Programme on Leadership Development</td>
<td>Ram Swanup</td>
<td>Nov. 18-30, 2007</td>
<td>HRSC, Shillong</td>
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<td>International Course on Transportation Planning and Road Safety</td>
<td>Dr. Kishore Kumar, R.K. Garg, P.P. Dey</td>
<td>Dec. 16-18, 2007</td>
<td>IIT, Delhi</td>
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<td>Programme on Pensionary Benefits under the old Pension Schemes &amp; Features of new contributory Scheme</td>
<td>Dheeraj Singh</td>
<td>Dec. 27-29, 2007</td>
<td>HRSC, Shillong</td>
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<tr>
<td>Certificate Course in GIS</td>
<td>Pradeep Kumar</td>
<td>Dec. 26, 2007 to Jan. 25, 2008</td>
<td>GIS Institute, NISDA</td>
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<td>Short Term course on Noise and Vibration Measurement and Analysis</td>
<td>Sh Naseem Akhtar</td>
<td>Jan 28-Feb 1st 2008</td>
<td>IIT, Roorkee</td>
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<td>Training Programme on Laboratory Safety</td>
<td>Satish Pandey</td>
<td>Feb 18-20, 2008</td>
<td>Indian Institute of Chemical Laboratory, Hyderabad</td>
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<td>Data Warehousing and Data Mining</td>
<td>Dr. Neelam Jain</td>
<td>Feb 18-22, 2008</td>
<td>ASCL, Hyderabad</td>
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<tr>
<td>CEP Short-term Course on Delivering High Quality Services in Guest House</td>
<td>F.A. Siddique</td>
<td>March 14-15, 2008</td>
<td>IIT Bombay, Mumbai</td>
</tr>
</tbody>
</table>
Dr. Pankaj Gupta, Scientist was deputed to Norway from June 11, 2007 to June 25, 2007 to visit International Center for Geo Hazards, Oslo for carrying out research on Landslide Vulnerability and Risk Assessment as part of the Indo-Norwegian cooperation Programme.

Dr. K. Ravinder, Scientists was deputed to University of Berkeley California, USA from June 24, 2007 to June 28, 2007 to attend Word Conference on Transportation Research (WCTR-2007).

Dr. Kishore Kumar, Scientists was deputed to Bangkok from July 26, 2007 to July 29, 2007 to attend Workshop on Finalizing RCC Guidelines on Mainstreaming of Disaster Risk Reduction into Roads.

Dr. Devesh Tiwari & Sh. R.K. Srivastava, Scientists were deputed to University of Birmingham, UK from Sept 10 to Sept 14, 2007 to attend training course on HDM-4 Version-2.

Ms. Anuradha Shukla, Scientist was deputed to USA to attend the 18th CRC On-Road Vehicle Emissions Workshop, held at San Diego, from March 30th April 2nd 2008.
<table>
<thead>
<tr>
<th>Student Name</th>
<th>Course Being Pursued</th>
<th>Title of the Training/ Research Project</th>
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<tr>
<td>Haryana Engg College, Jagadhri</td>
<td>B.Tech (Electronics)</td>
<td>Electronic Equipment Related to Highway Engineering</td>
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<td>Neha Sharma</td>
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<tr>
<td>NIT, Warangal</td>
<td>M.Tech (Transportation)</td>
<td>Developing of Speed Flow Curves for NH-8</td>
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<tr>
<td>Hari Krishna Gaddam</td>
<td>M.Tech (Transportation)</td>
<td>Study of BRTS Corridor in Delhi</td>
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<td>K B Raghuram</td>
<td>M.Tech (Transportation)</td>
<td>Operational and Performance of BRTS Delhi</td>
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<td>Bhadrabadi Raghu Ram Kadali</td>
<td>M.Tech (Transportation)</td>
<td>Evaluation of Impact of TSM Techniques</td>
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<tr>
<td>Nagavalli M</td>
<td>B.Tech (Civil)</td>
<td>Economic Benefits of Toll Roads in India</td>
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<td>K Lalitha</td>
<td>B.Tech (Civil)</td>
<td>Feasibility Study of using Zinc slag as fine aggregate</td>
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<td>T Archana</td>
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<td>NIT, Tiruchirappalli</td>
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<td>Kolla Kiran Kumar</td>
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<td>Dorangula Venkatarao</td>
<td>M.Tech (Transportation)</td>
<td>Traffic Planning for District Center, Jasola</td>
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<td>K Rahul</td>
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<td>Y Vihakar Reddy</td>
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<td>Optimization of Curing Period of DLC</td>
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<td>Gautam Kumar</td>
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<tr>
<td>Anna University, Chennai</td>
<td>ME (Urban Engg)</td>
<td>Safe &amp; Environmentally Pleasing Pedestrian facilities</td>
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<td>Murugesam M</td>
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<td>Design of Warm Bituminous Concrete Mix</td>
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<td>S Ramalingam</td>
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<td>S Raja Kumar</td>
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<td>C Prabhu</td>
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<tr>
<td>Jiwaji University, Gwalior</td>
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<td>Air Pollution due to Vehicular Traffic</td>
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<td>Subhashree Adhikary</td>
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<td>Environment &amp; Road Safety Consideration during Transport of Hazardous Materials Road</td>
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<td>Sarita Bansal</td>
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<td>IES IPS Academy, Indore</td>
<td>BE (Civil)</td>
<td>Assessment of Traffic Monitoring Techniques for NH</td>
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<td>GIS Based National Highway Inf System</td>
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<td>Characterisation of waste Polymer, bitumen from Plastic waste modified mixes</td>
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<td>Evaluation of Plastic Coated Aggregates</td>
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<td>Akhilesh Kumar Meena</td>
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<td>Use of Cold Mixed Technology in Sub-Based of Flexible Pavement</td>
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<td>Chander Prakash Meena</td>
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<tr>
<td>Monika</td>
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<tr>
<td>Roshmi</td>
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<td>Deepa</td>
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<td>Critical Review of IRC Hill Road Manuals</td>
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<td>Mayank Deepak Bansal</td>
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<td>Raunak Kapoor</td>
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<td>Footpath Characteristics as Related to the Mobility of Pedestrians</td>
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<td>S V S Siddarth</td>
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<tr>
<td>BITS Pilani</td>
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<td>Road Users Behavior and Effects of Delay at signalized Intersections</td>
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<td>Viveka Nalluri</td>
<td>BE (Hons)</td>
<td>Analysis of Traffic Volume and Parking Data</td>
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<td>Economic Benefits of Toll Roads in India</td>
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<td>R Chaitanya Bharathi</td>
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<td>N Rajaganapathy</td>
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<td>MBM Engg College, Jodhpur</td>
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<td>Development of Mix design formulation for Micro Surfacing Under Indian Condition</td>
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<td>Murli Manohar Karwa</td>
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<td>IIT Guwahati</td>
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<td>Design Norms for safe and environmental facilities in Delhi Metro</td>
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<td>Rajnish Kumar</td>
<td>B.Tech (Civil)</td>
<td>Pedestrian Characteristics on the BRTS Corridor</td>
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<td>Estimation of Economic Losses due to Delays at Dhaula Junction</td>
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<td>Devendra Upadhyay</td>
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<td>Evaluation of Bituminous Mixes, Binder in Flexible Pavement</td>
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<td>Ankur Bobbar</td>
<td>BE (Civil)</td>
<td>Study Application of EIA in Construction activities.</td>
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<td>Ramanik Garg</td>
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<td>Prefeasibility Study of Road connectivity at Diamond Harbour</td>
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<td>BE (Civil)</td>
<td>Road Safety Audit for Conversion of Delhi-Gurgaon Highway</td>
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<td>Development of Speed Flow relationship for Toll Road Projects</td>
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<td>Anmol Nagpal</td>
<td>BE (Civil)</td>
<td>GIS Based National Highway Information System</td>
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<td>SVNIT, Surat</td>
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<td>ME (Highway)</td>
<td>High Strength Void less Mixes</td>
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<td>Mohiya Chirag Kumar</td>
<td>ME (Highway)</td>
<td>Use of Geosynthetic Material</td>
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<td>Jigar J Patel</td>
<td>ME (Highway)</td>
<td>Detrain Foot over Bridge</td>
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<td>Vaishakh Iyer</td>
<td>ME (Highway)</td>
<td>Entry Capacity of the Roundabout</td>
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<td>Patel Kapsesh Kumar</td>
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<td>Economic Evaluation of Highway Project</td>
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<td>Vehicular Pollution Modeling through a Highway Corridor</td>
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<td>SGSITS Indore</td>
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<td>Feasibility Study of using Zinc slag as fine aggregate</td>
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<td>An ARRB Delegation led by Mr. Ian Level, Business &amp; Marketing Manager, ARRB Group Ltd.</td>
<td>April 25, 2007</td>
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<td>2</td>
<td>Mr. Tom Meacham, Polyset Company, New York</td>
<td>May 8, 2007</td>
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<td>3</td>
<td>M's WIRTGEN Recycler</td>
<td>June 25, 2007</td>
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<tr>
<td>4</td>
<td>Mr. Allan Archbold, Technical Support Manager &amp; Mr. Matthias Fritz, Sales Manager Paving System, Leick Geo Systems</td>
<td>July 26, 2007</td>
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<td>5</td>
<td>Highway Engineers, Ethiopian Road Authority, Addis Ababa</td>
<td>Jan. 4, 2008</td>
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<td>6</td>
<td>Dr. N.M.D. Hasan, Ex-Sr. Medical Officer, RRL, Jonhat</td>
<td>Jan. 24, 2008</td>
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<td>7</td>
<td>Mr. Barry Baughman, Technical Director ULTRAPAVE Corporation Georgia</td>
<td>March 13, 2008</td>
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<tr>
<td>Committee</td>
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<td>1. PIARC Committee on Surface Characteristics, C-1</td>
<td>Dr. P.K. Nanda</td>
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<td><strong>Highway Research Board of IRC</strong></td>
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<tr>
<td>1. Highway Research Board</td>
<td>Dr. Sunil Bose</td>
<td>Member</td>
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<td>2. HRB Identification, Monitoring &amp; Research Application Committee</td>
<td>Dr. Sunil Bose</td>
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<td>Sh. A. Sauriklia</td>
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<td><strong>Indian Roads Congress, New Delhi</strong></td>
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<td>1. Council of Indian Roads Congress</td>
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<tr>
<td>2. H-1 Transportation Planning Committee</td>
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<td>Sh. Satander Kumar</td>
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<td>4. H-4 Flexible Pavement Committee</td>
<td>Sh. Binod Kumar</td>
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<td>5. H-6 Mechanisation Committee</td>
<td>Dr. Sunil Bose</td>
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<td>6. H-7 Environmental Committee</td>
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<td>Ms. Anuradha Shukla</td>
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<td>8. H-10 Instrumentation Committee</td>
<td>Sh. G. K. Vij</td>
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<tr>
<td>9. IRC Test Track Committee</td>
<td>Dr. P.K. Nanda</td>
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<td>10. H-5 Rural Roads Committee</td>
<td>Dr. P.K. Nanda</td>
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<tr>
<td>11. HSS Highway Specifications &amp; Standards Committee</td>
<td>Dr. P.K. Nanda</td>
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<td>12. Bridge Specification &amp; Standards Committee</td>
<td>Dr. Ram Kumar</td>
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<td>14. B-2 Load and Stresses Committee</td>
<td>Dr. Lakshmy P.</td>
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<td>Dr. Ram Kumar</td>
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<tr>
<td>16. Chief Engineer Committee</td>
<td>Director</td>
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## Membership of the Staff on Various Technical Committees

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<tr>
<th>Committee</th>
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<th>Position held</th>
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<tbody>
<tr>
<td>17. Pavement Drainage</td>
<td>Dr. P.K. Nanda</td>
<td>Member</td>
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<tr>
<td>18. Expert Group for Specification Microsurfacing and Sherry sealing</td>
<td>Dr. P. K. Jain</td>
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<td>19. Surface Characteristics of Roads</td>
<td>Dr. P. K. Nanda</td>
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<td>20. G-1 Project Preparation, Contract Management &amp; Quality Assurance Committee</td>
<td>Dr. P.K. Nanda</td>
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<td>Sh. T.K. Amla</td>
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<td>22. DPC Committee</td>
<td>Dr. P.K. Nanda</td>
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<td>23. Disaster Management Committee</td>
<td>Dr. P.K. Nanda</td>
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<td>24. G-7 Official Language Committee</td>
<td>Dr. S.D. Sharma</td>
<td>Member</td>
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<tr>
<td>25. Disaster Mitigation Committee</td>
<td>Sh. Jai Bhagwan</td>
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<td>26. H-4 Embankment, Ground Improvement and Drainage Committee</td>
<td>Sudhir Methur</td>
<td>Member-Secretary</td>
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<td>27. H-6 Road Maintenance and Asset Management</td>
<td>B. M. Sharma</td>
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<td>Dr. P. K. Jain</td>
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<td>28. B-4 Reinforced, Prestressed and Composite Concrete Committee</td>
<td>Rajeev Goel</td>
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<td>29. B-8 Bridge Bearings &amp; Appurtenances</td>
<td>S. S. Gaharwar</td>
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<td>30. B-8 Maintenance and Rehabilitation Committee</td>
<td>Dr. R. K. Garg</td>
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<td>31. G-5 Instrumentation Committee</td>
<td>Dr. R. K. Garg</td>
<td>Member Secretary</td>
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### Bureau of Indian Standards, New Delhi

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<tr>
<td>1. Civil Engineering Division Council, CED</td>
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<td>2. Standards Advisory Committee</td>
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<tr>
<td>4. Cement &amp; Concrete Sectional Committee, CED2 and sub committee on Concrete CED 2:2</td>
<td>Dr. P. K. Nanda, Sh. Satander Kumar</td>
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<td>5. Cement &amp; Concrete Sectional Committee, CED 2.1</td>
<td>Dr. Ram Kumar, Sh. Satander Kumar</td>
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<td>Sh. T.S. Reddy</td>
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<td>Dr. S. D. Sharma</td>
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<td>Dr. Ram Kumar</td>
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<td>20. Bitumen, Tar &amp; Their Products Sectional Committee, PCD - 6</td>
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<td>Alternate Convener</td>
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<td>Dr. P.K. Jain</td>
<td>Alternate Convener</td>
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<tr>
<td>21. Method of Test for Bitumen, Tar &amp; Their Products Sectional Committee, PCD 6:1</td>
<td>Dr. P.K. Jain</td>
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<tr>
<td>22. Bitumen &amp; Bituminous Product Sub-Committee, PCD 6:2</td>
<td>Dr. Sunil Bose</td>
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<td>Dr. P.K. Jain</td>
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<tr>
<td>23. Hill Area Development Engineering Sub-Committee, PCD-56</td>
<td>Dr. Kishore Kumar</td>
<td>Member</td>
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<td></td>
<td>Sh. Sudhir Mathur</td>
<td>Alternate Member</td>
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### Membership of the Staff on Various Technical Committees

<table>
<thead>
<tr>
<th>Committee</th>
<th>Representative's Name</th>
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<tbody>
<tr>
<td>24. Cement Pozzolana &amp; Cement additives (CED 2.1)</td>
<td>Sh. Satander Kumar Dr. Saroj Gupta</td>
<td>Member Alternate Member</td>
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<tr>
<td>25. Cyclone Resistance Design of Structures, CED - 57</td>
<td>Dr. R.K. Garg</td>
<td>Member</td>
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<tr>
<td>26. Engineering Standards Sectional Committee</td>
<td>Sh. G.K. Vij</td>
<td>Member</td>
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<td>27. Cement Matrix Products CED - 53</td>
<td>Dr. Ram Kumar Dr. Satander Kumar</td>
<td>Member Alternate Member</td>
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<td>28. Expert Group on Modified Bitumen</td>
<td>Dr. P.K. Jain</td>
<td>Convener</td>
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<td>29. Panel for revision of IS: 3370 (part 1 &amp; 2) CED2: 2/P1</td>
<td>Dr. P.K. Nanda Dr. Satander Kumar</td>
<td>Principal Member Alternate Member</td>
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<td>30. Construction Plant and Machinery</td>
<td>Dr. P. K. Nanda</td>
<td>Principal Member</td>
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<td>31. Environment Protection Committee</td>
<td>Anuradha Shukla</td>
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<td>32. Expert Group IS: 8887 Revision</td>
<td>Dr. P. K. Jain</td>
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<td>33. Special Structures Sectional Committee CED 38</td>
<td>Dr. Ram Kumar Dr. Suraj Prakash</td>
<td>Member Alternate Member</td>
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<td>34. BIS Expert Group on Revision of ISO-73-2006</td>
<td>Dr. P. K. Jain</td>
<td>Convener</td>
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<td>35. Expert Group on Readymade Bitumen Material for Patching</td>
<td>Dr. P. K. Jain</td>
<td>Convener</td>
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<tr>
<td>36. Expert Group on Modified Bitumen Emulsions</td>
<td>Dr. P. K. Jain</td>
<td>Convener</td>
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<td>37. BIS-FICCI Task Force to Formulate Specifications for Major Technical Areas of Textiles</td>
<td>Sh. Satish Pandey</td>
<td>Member</td>
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</table>

### Ministry of Shipping, Road Transport & Highways (MoSRTH), New Delhi

1. Action Plan NHDP, MoSRTH, Working Group                                | Dr. P.K. Nanda                 | Member                       |
2. Research Application Committee                                         | Dr. V.K. Sood                  | Director                     |
3. Steering Committee for Development of Pavement Highway under ADB Technical Assistance | Dr. V.K. Sood                  | Member                       |
4. Steering Committee for Development of Pavement Management System in Four State Road Project, World Bank Loan Project | Dr. V.K. Sood                  | Member                       |
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<tr>
<td>5. Subgroup on Maintenance of Urban Roads</td>
<td>Dr. V.K. Sood</td>
<td>Member</td>
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<tr>
<td>6. Transport Statistics Committee</td>
<td>Dr. S. Gangopadhyay</td>
<td>Member</td>
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<tr>
<td>7. Committee on Upgradation of NH from 2 lane to 4 lane</td>
<td>Dr. S. Gangopadhyay</td>
<td>Member</td>
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<tr>
<td>8. Traffic Engineering &amp; Safety Committee</td>
<td>Dr. S. Gangopadhyay</td>
<td>Member</td>
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<tr>
<td>Delhi Traffic Police</td>
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<td>1. Central Traffic Advisory Committee</td>
<td>Dr. S. Gangopadhyay</td>
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<td>Dr. S. Gangopadhyay</td>
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<td>1. Sub group for Examination of various projects in Delhi</td>
<td>Dr. S. Gangopadhyay</td>
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<td>Council of Scientific &amp; Industrial Research</td>
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<td>Dr. P.K. Nanda</td>
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<td>2. Managing Security of CSIR Labs</td>
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<tr>
<td>1. Executive Committee</td>
<td>Dr. Rajeev K. Garg</td>
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<td>Institution of Engineers, Ghaziabad Local Centre</td>
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<tr>
<td>1. Executive Committee</td>
<td>Sh. D. C. Sharma</td>
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<td>1. U.P. State Roads Project Technical Evaluation Committee</td>
<td>Dr. D. Tiwari</td>
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<td>Ministry of Rural Development, Govt. of India</td>
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<td>1. Research Monitoring Committee of NRRDA</td>
<td>Dr. P.K. Nanda</td>
<td>Member</td>
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<td>2. Empanelment of National Quality Monitors of NRRDA</td>
<td>Dr. P.K. Nanda</td>
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<td>Central Building Research Institute, Roorkee</td>
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<td>Vellore Institute of Technology, Vellore</td>
<td>Dr. P.K. Nanda</td>
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<tr>
<td>1. National Advisory Board for Disaster</td>
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<td>Mitigation &amp; Management</td>
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<td>School of Planning &amp; Architect, New Delhi</td>
<td>Dr. P.K. Nanda</td>
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<tr>
<td>1. Board of Studies</td>
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<td>2. Review of Project Work of PG Student</td>
<td>Dr. S. Gangopadhyay</td>
<td>Jury Member</td>
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<td>PWD Sectt., NCT Delhi</td>
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<td>1. Committee on Safety &amp; Quality Forum</td>
<td>Dr. P.K. Nanda</td>
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<td>1. (Ambient Air Quality Systems)</td>
<td>Dr. Anil Singh</td>
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<td>Dr. Ram Kumar</td>
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<td>Construction of Saline Embankment</td>
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<td>1. Committee for Compiling Specifications for</td>
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<td>Dr. S. Gangopadhyay</td>
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<td>1. Task Force on Technical Textiles</td>
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<td>1. Group on Roads and Mass Concrete Work</td>
<td>Dr. A. K. Misra</td>
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<td>National Rural Roads Development Authority (NRIDDA)</td>
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<td>1. Committee for Selection of Quality Monitors (QMs)</td>
<td>Sh. B. M. Sharma</td>
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<td>World Bank Aided Project to Uttar Pradesh State Highway Authority (UPSHPA)</td>
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<td>1. Technical Scrutiny</td>
<td>Sh. Sunit Jain</td>
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<td>Dr. Devesh Tiwari</td>
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<td>Indian National Group of the International Association of Bridges and Structural Engineers</td>
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<td>1. Management Committee</td>
<td>Dr. Ram Kumar</td>
<td>Member</td>
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</table>
- Australian Road Research Board (ARRB)
- Bureau of Indian Standards, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi
- Indian Institute of Bridge Engineers (IIBE), New Delhi
- Indian National Group of the International Associations for Bridge & Structural Engineering, Jamnagar House, Shahjahan Road, 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 Marg, 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 D.C., U.S.A.
- Indian Geotechnical Society, C/o Central Soil and Material Research Station, Olaf 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 of Information Science, NISCOM Building, Hillside Road, New Delhi.
- Indian Group of Geo-textiles, 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.
Intellectual Property (Patents)

Patented Process Released so far to the Industry

- Bitumastic jointing composition (Pat.No. 50474).
- Improvement in or relating to pitch mastic composition (two Patent No. 92526 and 95305).
- Improvements in or relating to the manufacture of lime-Surkhi mixture (Patent no. 90470).
- Improvements in or relating to the manufacture of reactive Surkhi (Patent No. 93278).
- 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).
- Rotiler (developed jointly by MERADO & CRRI).
- Pavement paint marking machine (developed jointly by CMERI Durgapur and CRRI).
- Vehicle Profile Meter.
- Polymer modified bitumen.
- SBS modified bitumen.
- Crumb 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.

Processes Ready for Exploitation

- A process for the production of Magnesium Phosphate Cement for emergency repair of concrete pavement.
- A new paving system for desert area.
- Electronic probe.
- Process know-how for construction of Roads in Sandy Area using soil stabilization technique with Magnesium Oxide chloride.
- Indigenous Weigh-in-motion and Vehicle Classification System.
- Automated Benkelman 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.

All the patented and a few other processes of the Institute are being exploited directly by the Institute and the Industries interested in commercial exploitation of these processes may contact Head, Information, Liaison and Training Division of CRRI. (Email: tkamla.crri@nic.in)

 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 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.

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Services Offered

Contract Research
- Collaborative Projects
- Sponsored Projects

Consultancy Services
- Training Programme
- Testing & Calibration

(for further details see website: www.crridom.gov.in)

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:

<table>
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<tr>
<th>TITLE OF THE COURSE</th>
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<tr>
<td>A. PAVEMENT ENGINEERING &amp; MATERIALS</td>
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<tr>
<td>• Design, Construction and Maintenance of Airfield</td>
<td>(5 days)</td>
<td>Rs. 6000/-</td>
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<tr>
<td>• Design, Construction and Maintenance of Flexible Pavements</td>
<td>(5 days)</td>
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<tr>
<td>• Rigid Pavements: Design, Construction &amp; Quality Central Aspects</td>
<td>(5 days)</td>
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<tr>
<td>• Pavement Evaluation Techniques and their applications for Maintenance and Rehabilitation</td>
<td>(5 days)</td>
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<tr>
<td>B. ROAD DEVELOPMENT PLANNING &amp; MANAGEMENT</td>
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<tr>
<td>• International Course on Dissemination of HDM-4</td>
<td>(10 days)</td>
<td>Rs. 25,000/-</td>
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<tr>
<td>• GIS Application in Planning and Management of Rural Road Network</td>
<td>(5 days)</td>
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<td>C. GEOTECHNICAL ENGINEERING</td>
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<td>• Planning, Design, Construction &amp; Maintenance of Rural Roads (PMGSY)</td>
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<tr>
<td>• Geotechnical and Landslide Investigations for Highway Projects</td>
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<td>D. BRIDGES &amp; STRUCTURES</td>
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<td>• Bridge Diagnostics, Performance Evaluation and Rehabilitation</td>
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<td>E. TRAFFIC &amp; TRANSPORTATION PLANNING</td>
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<td>• Traffic Management and Safety</td>
<td>(5 days)</td>
<td>Rs. 6000/-</td>
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<tr>
<td>• Aspects of Transportation Planning and Environmental Impact Assessment Studies for Roads</td>
<td>(5 days)</td>
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Customized Tailor Made Programmes:
In addition to the above, CRRI also organises customized tailor made programmes as per the clients requirements.

Course Fee: The course fee as indicated above 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. Anil, Head & Course Organizer, Information, Liaison & Training Division, Central Road Research Institute, P.O. CRRI, Delhi-Mathura Road, New Delhi – 110 020 (India), Phone: 91-11-26821939, Fax: 91-11-26845943, 26830480, Telex: 91-11-26821939, E-mail: tkanjil.crr@nic.in, mkmneon.crr@nic.in
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Title of the Paper</th>
<th>Author</th>
<th>Journal</th>
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<tbody>
<tr>
<td>1.</td>
<td>Environmental Impact Assessment of Road Projects: Salient Features under Revised</td>
<td>Dr. Niraj Sharma</td>
<td>Journal of Indian Roads Congress, 68(3), PP 253-97</td>
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<td>Notification (Sept 2006)</td>
<td>P. Nair</td>
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<td>Dr. S. Gangopadhyay</td>
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<td>Rishikesh, Garhwal Himalaya</td>
<td>K.K. Chaudhary</td>
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<td>R.K. Garg</td>
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<td>सिंहासन के लिए भारतीय भाषाओं का माध्यम-एक विविध लोगी की प्रनाली</td>
<td>संजय त्रिपाठी</td>
<td>Gyan Garima Sindhu, 11 Aug, 2007</td>
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<td>Dr. N.K.S.Pundhir</td>
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<td>6.</td>
<td>Large Scale Mapping and Monitoring of the Patalganga Landslide</td>
<td>Dr. Kishore Kumar</td>
<td>Transportation Research Record, Jounal of the Transportation Research Board, No.1989, Low-</td>
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<td>7.</td>
<td>Experimental Study on Prestressed Concrete Beams subjected to Cyclic Load to</td>
<td>Dr. Suraj Frakash</td>
<td>Disaster and Development Journal of the National Institute of Disaster Management, Vol. No.2,</td>
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<td>9.</td>
<td>Maturity of Concrete and its Use in Highway Structure</td>
<td>Dr. VV.K. Ras</td>
<td>Bulletin of Material Science, Vol. 30, No.3, pp 239, Indian Academy of Science, June 2007,</td>
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<td>National Workshop on Structural Health Monitoring, Non-destructive Evaluation and Retrofitting of Structures, IIIT, IIT, Delhi, March 7-8, 2008</td>
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<td>Dr. Rakesh Kumar</td>
</tr>
<tr>
<td>63</td>
<td>Workshop on Self Compacting Concrete for Durability, ICI, New Delhi, March 29, 2008</td>
<td></td>
<td>Dr. Rakesh Kumar</td>
</tr>
<tr>
<td>64</td>
<td>National Conference on Showcasing Cutting Edge Science and Technology by Women, New Delhi, March 8, 2008</td>
<td></td>
<td>Dr. Renu Mathur</td>
</tr>
</tbody>
</table>
Director
Nanda P.K. (Dr.), B.Tech (Hons) (Civil), M.Tech. (SM&FE), FIE (India) Ph.D, (Upto June 30, 2007)
Dr Vikram Kumar, Ph.D, (w.e.f. June 2007)

Road Development Planning and Management (RDM)
Nanda P.K. (Dr.), B.Tech (Hons) (Civil), M.Tech. (SM&FE), FIE (India) Ph.D, (Upto June 30, 2007), (Area Advisor)

Scientists/Technical Officers
Advani Mukti, ME
Chander Subhash, M.A (Eco.)
Dwivedi S.N., M.A.
Gupta Kamini, M.E. (Transportation Engineering)
Gupta S.K, Diploma in Draughtsmanship (Mech)
Jain Neelam (Dr.), M.Sc, M. Phil (Computer Application), Ph.D (Numerical Analysis)
Kanaga Durai B., (Dr.) M.A. (Eco), M.R.P. (Regional Planning)
Kanchan P.K. (Dr.), Ph.D (Maths) (Head)
Kumar Shanta, B.Sc, LLB
Poonam Singh, B.E (Civil), MBEM.
Rao A. Mohan, M.Tech (Transportation Engineering)
Ravi Sekhar C., M.E (Transportation Engineering) (On Study Leave)
Ravinder Kumar, M.E (Transportation Engineering) (On Study Leave)

S&T and Supporting Staff
Jeet Ram, Non Matric
Kumar Ashok, B.A.
Kumar Narendra, B.A.
Kumar Naveen.
Singh Satyabir, SSC, ITI (Printing)

Bridges & Structures (BAS)
Ram Kumar (Dr.), M.E., Ph.D., (Area Advisor & Head)

Scientists/Technical Officers
Ali Fariyad, ITI (Retired on Feb 29, 2008)
Dhal A. K., M.Tech. (On Deputation)
Garg R. K., (Dr.), M.Tech, Ph.D.
Gaharwar S. S., B.E., M.E. (Structure)
Goei J. K., M.E. (Civil) Structures
Goei Rajeev, B.E (Civil Engineering), M.E (Structural Engineering)
Kayal Sulata (Dr.), Ph.D (Structural Engg.)
(Retired on Feb 29, 2008)
Kumar Narendra, B.Sc.
Lakshmy P (Dr), M.E, PhD.
Manisekar R., M. Tech (Structural Engg.)
Prakash Suraj (Dr.), M.E. (Earthquake Engineering), Ph.D.
Rao U.S., M.Tech, (Structure)
Rao V.V.L.K. (Dr.), M.Sc., Ph.D.
Saha Sukumar (Dr.), M.Sc, Ph.D (Applied Maths.)
Sahu G.K., M.E. (Structure)
Singh W.P., ITI
Sharma S.K., M.E. (Structure)
Sushil Kumar, B.Sc., Dip. in Civil Engg., AMIE
Yegender K. Singh, Dip. Electronics

S&T and Supporting Staff
Bhushan Kumar Shashi, Diploma in Civil Engg.
Dharam Vir, Non Matric
Pradeep Kumar, Diploma in Civil Engg, A.M.I.E.
Rana, M.S, ITI
Rajveer Singh, Non Matric
Satish Kumar, B.A.

Traffic & Transportation Planning (ITP)
Gangopadhyay S. (Dr.), M.Tech, (Transportation System), M.Sc. (Transportation), Ph.D. (Head & Area Advisor)

Traffic Engineering & Road Safety
Scientists/Technical Officers
Beijai R.K., M.Tech (Transportation System)
Biswas S.K., Draughtman
Chakraborty Neelima (Dr.), M.A., (Psycho.), P.G. Dip. (Environmental Psycho.), Ph.D
Staff of the
Central Road Research Institute
As on 31st March, 2008

Singh Rina, Joined on Oct., 22., 2007
Shukla Anuradha, M.Sc., M.Tech. (Corrosion Science), P.G.
Diploma in Ecology & Environmental Science
Sharma Niranjan (Dr.), M.Tech., Ph.D.
Suthar H.H., B.Sc (Hons.) (Physics)

S&T and Supporting Staff
Daya Ram, B.A.
Kumar Devender, Matric, ITI (Motor Mech.)
Devi Shankuntla, Non Matric
Sethi Sarita, B.A.
Singh Brij Mohan, Matric

Pavement Engineering & Materials (PEM)

Flexible Pavement (FP)

Scientists/Technical Officers
Bahi Ambika, M.Tech (Chemical Engineering)
Gajendra Kumar, Diploma in Civil Engg.
Jiwan Lal, Intermediate
Jain P.K. (Dr.), Ph.D Chemistry
Kamraj C., Diploma in Civil Engg.
Nigam B. S. BA.
Nagabhushana M.N., M.Sc. (Highway Engg.)
Kumar Narendran, B.A.
Pandey Satish, BE(Civil)
Pundhir K.N. K.S. (Dr.), PhD (Chemistry)
Sangeeta (Dr.), Ph.D (Polymer Chemistry)
Sharma B. M., M.E. (Transportation Engg.), (Head)
Sharma Girish, B.E (Civil)
Shukla Manoj, M.E. (Transportation)
Sridhar R., M.E. (Highways) (On Study Leave)
Singh Surender, ITI

S&T and Supporting Staff
Dhingra S.K., B.Com
Rishi S. K., B.Com, Diploma in Book Keeping & Accountancy
Saini Karuna Ma., B.A.
Singh Nihandra, B.A
Rigid Pavement (RP)

Scientists/Technical Officer

Binod Kumar, M.E. (Hill Area Development Engineering)
Dinesh V. Ganvir, (M.E. Highways & Transportation)
Goel Pankaj, Diploma in Civil Engg
Gupta Saroj (Dr.), Ph.D. (Chemistry)
Jain A. K., M.E. (Highway Engg.)
Maheshwari R. K. (Dr.), M.Sc. (Chemistry), PhD
Mathur Renu (Dr.), M.Sc., Ph.D (Head) (w.e.f. Sep 28, 2007)
Pant Ashok, Higher Secondary
Rakesh Kumar (Dr.), M.Tech, PhD (Concrete Technology)
Satander Kumar, M.Sc. (Chemistry), AMIE (Civil)
Sengupta J.B., M.Sc. (Applied Chemistry)
Tike G.K., M.Sc. (Chemistry) (Head) (Up to Sep 27, 2007)

S&T and Supporting Staff

Hussain Asif, B.A.
Lohani G. C., B.A., LLB

Pavement Evaluation (PE)

Scientists/Technical Officers

Chakravarty B. K., HSC, ITI.
Deori Sanjay, B.E. Civil Engg.
Jain Sunil, M.E. (Transportation Engg.)
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
Perdeshi R C, B Sc
Sagar A. K., B.Sc, Engg. (Civil), MBA, M.Tech, (Environmental Engg.)
Sharma B. M., M.E. (Transportation Engg.), (Head)
Sharma S.D. (Dr.), M.Sc, (Chemistry), Ph.D
Singh Ajaypal, Diploma in Civil Engg.
Singh Attar, Diploma in Civil Engineering
Singh Madan Pal, B.Sc.
Singh P. R., B.Sc.
Sitaramanjaneyulu K., M.E. (Highway Engg.)
Sudesh Kumar, M.Sc, (Chemistry)
Tiwari Devesh (Dr.), M.E (Transportation Engg.), Ph.D

S&T and Supporting Staff

Kumar Prashant, Diploma in Civil Engg, AMIE (Civil) (On Study Leave)
Ram Lal, Non Matric
Sharif Md. Ibrahim, Intermediate
Singh Mahinder Prasad
Singh Pratap, Metric. ITI
Verma Pushpa, M.A.

Geotechnical Engineering (GTE)

Sudhir Mathur, M.Tech (SM & FE) (Area Advisor & Head)

Scientists/Technical Officers

Arun Uma, M.Sc. (Chemistry)
Beg Raj, B. Sc
Ganesh J.
Goel Nitesh, M.Tech (Transportation).
Gupta Pankaj, Dr., PhD (Engg. Geology)
Guruvittal U. K., M.E (Highway)
Jai Bhagwan, M Sc Physics
Khan Farhat Zahoor Ms., B.Sc, Engg., M.Tech. (Geo Technical)
Kumar Kishore (Dr.), Ph.D. (Geology Engineering)
Mukherjee Deepak, M.Sc. (Applied Geology)
Murugesan.V., SSLC
Pramada Valli P, (Dr.), M.Sc. (Applied Geology), Ph.D (Applied Maths)
Prasad Prema Ms., M.A.
Prasad P. S, M.E (Geotechnical Engg.).
Ranjan Alok, M. Tech. (Engineering Geology)
Sharma N. K., B.Sc.
Singh Kanwar, B.E. (Civil) (On Study leave)
Sinha Anil Kumar, M.Tech (Geotech. Engg)
Staff of the
Central Road Research Institute
As on 31st March, 2008

Information, Liaison & Training (ILT)
Scientists/Technical Officers
Amla T. K., M.Sc. (Chemistry). Associateship in Information Science, M. Phil. Science Communication & Journalism (Head)
Agarwal R. C., B.E. (Mechanical Enng.), AMIE, PG-PDQM (TDM), C. Engr. (I).
Arora Anita, M.Sc. (Chemistry),
Gupta Honey, B. E., M.B.A.,
Meena M. K., B.Tech. (Civil),
Nair P. R. N., B.A.,
Singh Rajbir, B.A., ITI
Soni A. K., B.FA (Applied Group) (Retired on 31.10.2007)

S&T and Supporting Staff
Batra Bhupinder Singh, B.Com.,
Deep Chand, Non Matric
Khan Amin Ali, M.A. (Political Science)
Singh Bhop, Diploma in Draftsmanship & Commercial Art
Sunita Bai, Non Matric

Photo Section
Kumar Ashok, Certificate Course in Colour Photography
Singh Rajbir, B.A.,

Management Information Network (MIN)
Scientists/Technical Officer
Ghosh B. N., M.Com., M.B.A., CWA (I), Diploma in Computer (Head)
Masih Kamla, MCA

S&T and Supporting Staff
Kapoor Kamalesh, M.A.,
Prakash Dinesh, Non Matric

Quality Management
Bharadwaj, R. S., M.Sc, Associateship in Information Science, M.Phil (Science Communication & Journalism) (Head)
Kannan S., M.Sc.
S&T and Supporting Staff
Kumar Sunil, B.A.

R&D Services (RDS)
Vij G. K., M.Sc. (Physics) (Retired on May 31, 2007)
(Area Advisor)

Computer Centre (CCN)

Scientists/Technical Officer
Dutta R. N., M.Sc. (Operational Research)
Mariappan S., Diploma in Computer Technology
Mishra A. K. (Dr.), M.Sc. (Chemistry), Ph.D (Head)
Raghav T. D., B.Sc., PGDCA
Rajasekhar B., B.E. (Electronics & Communication)
Rani Reeta, Dip. in Computer, MBA, M.Sc. IT

S&T and Supporting Staff
Chinna Reddy, K., Dip in Computer, AMIE (upto w.e.f. May 4, 2007)
Jain Kavita, M.Com.
Kumar Anil, Intermediate and Computer Course in FC Hardware and Computer Operation
Shiv Lal, Non Matric

Instrumentation (INS)

Scientists/Technical Officers
Chadda Renu, M.Sc. (Botany)
Jangpangi Lalita, B.Sc. (Engg.)
Kapoor K. J. S., B.Com, ITI
Meshram P.C., M.Tech. (Digital Communication Engg.)
Prasanna Kumar P., M.Sc. (Physics) (Head)
(w.e.f. June 1, 2007)
Saini R. P., B.Sc., Diploma (Electronic Engg.)
Satish Kumar, Diploma (Electronics & Communication)
Sharma D. C., B.E. (Elect.), M.Tech (Computers)
Sharma V. P., Matric, ITI, Diploma in Electrical Trade
Singh Gurmeet, Matric, ITI and Radio and TV Trade
Tatia Vir Prabha, MSc (Electronics), M.Tech

Tiwari Y. C., M.Sc. (Physics)
Usha Kiran, M. Tech.
Vij G. K., M.Sc. (Physics), (Head) (Retired on May 31, 2007)

S&T and Supporting Staff
Shukla Jai Prakash, Matric
Pawan Bawesh
Singh Lokeshwar, M.Sc. (Electronics)

Mechanical Engineering Support

Scientists/Technical Officers
Arora Ashok Kumar, M.A., Dip in Auto Engg.
Bharadwaj, R. S., M.Sc. Associateship in Information Science, M.Phil (Science Communication & Journalism) (Head) (w.e.f. Nov 2007)
Harish Kumar, ITI
Mohan N. V. R., B.E (Mech) M.E., PGDM (IIMB), MIMA, FIE (Head) (Retired on May 5, 2007)
Sharma N. K., Diploma in Mechanical Engg.
Sharma Ashok Kumar, Inter, ITI (Motor Mech.)
Singh Bir, ITI
Singh Gurdeep, Non Matric
Singh Satnam

S&T and Supporting Staff
Gola Kewal Krishan
Kishan Swaroop, ITI (Electrical/Wireman Course)
Kumar Om, B.A., ITI
Meena Babu Lal, Non Matric
Mehd. Irshad, Dip in Draftsmanship (Mech)
Mehta Bhola, Non Matric
Om Prakash, ITI (Fitting)
Panicker K. R. C., Matric
Ram Pal, Non Matric
Sachdeva H. L., ME (Mechanical Engineering)
Singh Bhim, Non Matric
Singh Lakshmi, H.Sc, ITI (Motor Mech.)
Singh Mohan, Higher Secondary
Sunit Datt, Non Matric
Verm D. P., Non Matric
Staff of the
Central Road Research Institute

As on 31st March, 2008

Documentation & Library Services (DLS)
Ashok Kumar, (Dr) MSc, M.I.I.Sc. Ph.D.,
(Area Advisor & Head)

Scientists/Technical Officers
Aggarwal Neera, B.Sc., M.A., B.I.I.Sc., Associateship in
Information Science
Asha Rani, B. A., M.I.I.S.E.
Chhabra Pavan, M.Sc. (Physics), M.I.I.Sc
Ravinder Kumar, M. A., (Pub. Adm),
Dip. in Offset Print, Tech.

S&T and Supporting Staff
Des Raj, Non-Metric
Gupta Arohi Sen, Matric (Retired on July 1, 2007)
Ishwar Singh, Matric
Sharma Dev Dutta, Matric
Sharma Rashmi, M.A. (Hindi) B.Ed. Dip. in Russian Language

Rajbhasha Unit
Anang Pal Singh, (Dr.), M.A. Hindi, B.Ed., Ph.D. Dip. in
Translation (In-charge)
Giri Hem Kumar
Khutit Santosh, B.A.

Estate Services (ESS)
Base Sunil, (Dr.) M.Tech (Highways), Ph.D.
(Area Coordinator)

Civil Section
Scientist & Technical Officers
Grover Sunil, B.E. (Civil) (On Study Leave)
Krishna Kant, Diploma (Civil Engg)
Mukesh Kumar, B.E. (Civil)
Sabharwal A. K., AMIE, PGDBA (Mktg.) (Head)
Tyagi V. K., Dip in Civil Engg
Yadav Suresh Kumar, Diploma (Civil Engg.)

S&T and Supporting Staff
Dass Shukla, Diploma (Civil Engg)
Dass, R.C., Non-Metric
Gautam Pandey, Non-Metric
Harish Kumar, B.A.
Kumar Kailash, Matric
Manjhi Raja Lal, Non-Metric
Mehta Raj Kishore, Non-Metric
Singh Bhanwar, Non-Metric
Vineet Kumar, Non-Metric

Horticulture
Scientist & Technical Officers
Kumar Ashok, M.Sc. (Hort) (Incharge)

S&T and Supporting Staff
Raj Pal Singh Gautam
Tek Chand

Electrical Section
Sharma D. C., B.E., (Elect), M.Tech
(Computers) (Head)

Scientist & Technical Officers
Suboth Kumar, MS, MBA
Suresh Chandra, B.E. (Electrical Engg.)

S&T and Supporting Staff
Baldev Singh, ITI
Mitthan Lal, Non-Metric
Sant Ram, B.A.
Satpal Rana, ITI

Maharani Bagh Staff Quarter (MBSO)

Sharma, B. M., M.E. Transportation Engg.) (Area Advisor)

Scientist & Technical Officers
Singh D. V., M.Sc.
Tripathi A. K., Dip in Civil Engg. (Head)
S&T and Supporting Staff

Hari Om, Non Matric
Jille Ram, Non Matric
Meena Muni Raj, B.Tech (Electrical)
Mohan Lal, Non Matric
Prem Chand, Non Matric
Singh Babban, B.A
Shahabuddin Khan, Non Matric
Shenb paran Prasad, Matric
Tara Chand, DIP in Civil Engg.
Vikram Singh, Non Matric

Directorate

Gaula A. K., Intermediate (PS)
Jetly Pushpa, B.A.
Singh Kartar, Matric
Singh Narain, Non Matric
Singh Madhu Sudan, Non Matric
Saini Sonita, HSc

Administration

Anil Kumar, B.Sc (Hons), LLB, (Controller of Administration) (upto Sep 24, 2007)

Jitender Parasar,
(Controller of Administration) (W.e.f Sep 5, 2007)
Bhoga Balu, Non Matric
Kumar Vijay, HSc
Mehta Yoginder, Non Matric
Rakesh Kumar, Intermediate

Raman Singh (Administrative Officer) Upto March 17, 2008
Ravi Kumar, Non Matric
Sachdeva Priti, B.A. (Hons) & Diploma in Secretarial Practices, (Receptionist)
Singh Karam, Matric
Singh Kiran Pal
Thakur Suresh Prasad, Matric
Verma Simesh (Administrative Officer)
(w.e.f. March 17, 2008)

Establishment-I

Budhi Singh, Inter
Dev Vi, Non Matric
Joan R.C., M.A. (English) (Section Officer)
Kaur Satinder, B.A.
Kumar Anil, B.Com, Diploma in Management (on Deputation)
Mehta Sri Ram, Matric
Paswan Krishna, Matric
Saini A.K., B.A.
Singh Rajender, M.A.
Verma Kamlesh, M.A., Certificate in Library Science

Establishment-II

Kumar Anil, B.A.
Bhatnagar Jagbir Prasad, Matric
Desraj
Dinesh Kumar, Non-matric
Kant Chander
Kumar Ravi
Madhu Bala, B.Com
Malhotra R.K., HSc
Sharma Ramesh Chand, H.Sc.
Singh Gajaj, Non Matric
Singh Narendra, M.A.
Singh Ravinder Pal, (Section Officer)
(Retired on Feb 29 2008)
Verghese Kunjumol, Senior Secondary

Personnel Cell

Bhatia Parveen, B.A., Certificate in Lib. Science
Chopra Rajeev Kumar, Sr. Sec.
Dharam Pal, Non Matric
Kumari Nita, B.A.
Meena Murari Lal, B.A.
Rajan Tirkey, B.A. (Hons.)
Rawat Sanjay, B.A., PGDIRPM
Singh Vandana D., (Section Officer)
Vigilance Cell
Chandra Prakash Lal, B.A.
Bhamija Aruna, B.A.
Kumar Ram, M.B.G.
Singh Hashiar, Matric.

Cash
Bhamota V.K., Matric.
Kishan Ram, Non-Matric.
Thapa Tush Chaudh

Finance & Account Section
Badalia Raksh, F&A.
Gurminder Kaur, S.O., F&A (Joined on July 26, 2007)
Malk Nalin, Matric.
Naidu K. A., Sr. F & A.O. (Upto June 20, 2007)
Pawan Samir Lakra, B.A., LLB
Phool Chandra, M.A.
Sharma Bishan Dass, B.A.
Sharma Soni Datt, Pre University
Singh Ajit Kumar, B.A.
Singh Bhajan, B.A.
Singh Deora, S.D., F&A
Singh Jagdish, Matric.
Singh Harman, B.A.
Shiv Narain, Non-Matric.

Purchase Section
Julka Vinod Kumar, (Senior Store and Purchase Officer)
(Upto April 30, 2007)
Khanna Sunil, (Dy. SPO) (Upto Nov. 16, 2007)
Kumar Vijender, Matric.
Marwaha Vijay Kumar, B.Com
Singh Jai
Shah Ram Badan, Matric.
Singh Randhir, Non-Matric.
Singh S.P., (Controller of Store and Purchase)
(w.e.f. April 10, 2007)

Verma Veena, M.A.
Lalitshwar, Steno

Store Section
Bairagi K.
Chhachhia Sumant Singh
Kukreji, C.M., HSc
Kumar Bijender
Paswan Gero Lal, Matric.
Singh Jaswant
Verma S.G., S.D., Store and Purchase

Security, Guest House and Canteen

Security
Mani Chinta, Matric.
Prakash Om, Non-Matric.
Singh Dharam, (Care Taker)
Singh Ram, Non-Matric.

Guest House
Achariya Kesavan Ram
Bariya Rajesh
Lal Sohan, Non-Matric.
Narayan Chet
Prakash Braham, Non-Matric.
Siddiqui Fazl Ahmad (Manager), Guest House
Singh Ramesh
Singh Rajpat
Suraj

Canteen
Chand Hari
Kumari Kamlesh
Kumar Manoj
Rao Ramesh
Sharma Girraj
Siddiqui Fazl Ahmad (Manager), Canteen
Singh Balbir
Singh Rajinder
Thapa Prem Bahadur, Non-Matric.
Dr. P.L. Bongiriwar
Ex. Jt. Project Director (MMRDA)
B/1102, Patliputra CHS
Four Bungalow Signal
Andheri (W)
Mumbai – 400 053
M: 09867288464
Email: pplongirwar@rediffmail.com

Shri R. Subramaniam
Engineer-in-Chief
Delhi PWD
MSD Building, I.P. Estate
New Delhi – 110 002

Dr. H.C. Mehendiratta
Former Professor (IIT Roorkee)
50/BA, Bhagirathi Enclave
Balbir Road
Dehradun – 248 001
Ph: 0135-2871035

Dr. K.S. Reddy
Professor
Department of Civil Engineering
Indian Institute of Technology
Kharagpur – 721 302

Shri N.K. Shangari
Scientist G
Central Building Research Institute
Roorkee – 247 667

Shri C. Kandasamy
Member (Technical)
National Highway Authority of India
Plot 5&6, Sector 10, Dwarka
New Delhi – 110 075

Lt. Gen. K.S. Rao
Director-General
Border Roads
Seema Sadak Bhavan,
Ring Road, Delhi Cantt,
Delhi-110 010
Ph: 25686858; Fax: 25686857
Email: bromonitoringcell@gmail.com

Dr. G. Sharan
Director General (Road Development)
Ministry of Shipping, Road Transport & Highways
Transport Bhawan, Sansad Marg
New Delhi – 110 001
Ph: 23718575; Fax: 23715047
Email: dgdrd@nic.in

Dr. N. Lakshmanan
Director
Structural Engineering Research Centre
CSIR Campus, Post Office TTTI
Taramani,
PB No. 8287
Chennai – 600 113
Ph: 044-22542138; Fax: 22541508
Email: director@sercm.csir.res.in ;
director@sercm.org

Dr. Vikram Kumar
Director
Central Road Research Institute
P. O. CRRI, Mathura Road
New Delhi – 110 020

Dr. Naresh Kumar
Head, R&D Planning Division
Council of Scientific & Industrial
Research
Rafi Marg, New Delhi – 110 001
Ph: 23710453 Fax: 23710340
Email: headrdep@csir.res.in
Management Council of CRRI,
(upto 30.06.2007)

Director
CRRI
New Delhi

Chairman

Dr. N.K. Shangari,
Scientist 'G',
CBRI,
Roorkee

Member

Dr. S. Gangopadhyay,
Scientist 'F'
CRRI
New Delhi

Member

Shri B.M. Sharma
Scientist 'F'
CRRI
New Delhi

Member

Dr. S. Velumurugan,
Scientist 'E-I'
CRRI
New Delhi

Member

Dr. Smt. Sangita,
Scientist 'E-II'
CRRI
New Delhi

Member

Shri N.K. Sharma,
Technical Officer
CRRI
New Delhi

Member

Head, RPBD & PME
Sr. CoFA/CoFA/F&AO
Sr. COA/COA/AO

Member
Member
Member-Secretary
Management Council of CRRI,
(from 01.07.2007 to 30.06.2009)

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>CRRI</td>
<td></td>
</tr>
<tr>
<td>Chairman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>New Delhi</td>
<td></td>
</tr>
<tr>
<td>Sh. R.K. Garg.</td>
<td>Scientist 'F', CBRI, Roorkee</td>
<td>Member</td>
</tr>
<tr>
<td>Dr. S. Gangopadhyay</td>
<td>Scientist 'F', CRRI, New Delhi</td>
<td>Member</td>
</tr>
<tr>
<td>Dr. S. Velmurgan</td>
<td>Scientist 'E-I', CRRI, New Delhi</td>
<td>Member</td>
</tr>
<tr>
<td>Dr. Rakesh Kumar</td>
<td>Scientist 'E-I', CRRI, New Delhi</td>
<td>Member</td>
</tr>
<tr>
<td>Sh. Mukesh Kumar Meena</td>
<td>Scientist 'B', CRRI, New Delhi</td>
<td>Member</td>
</tr>
<tr>
<td>Smt. Pawan Chabara</td>
<td>Gr. III(7), CRRI, New Delhi</td>
<td>Member</td>
</tr>
<tr>
<td>Head, RPBD &amp; PME</td>
<td></td>
<td>Member</td>
</tr>
<tr>
<td>Sr. CoFA/CoFA/F&amp;AO</td>
<td></td>
<td>Member</td>
</tr>
<tr>
<td>Sr. COA/COA/AO</td>
<td></td>
<td>Member-Secretary</td>
</tr>
</tbody>
</table>