Central Road Research Institute, New Delhi

S. Gangopadhyay and U. K. Guru Vittal*

Central Road Research Institute, New Delhi 110 025, India

Road transport is the most prevalent mode of transport in our country. However, large sections of our roads still suffer from congestion, inadequate pavement thickness and road safety hazards. Significant segments of population in hilly and tribal areas do not have all weather road accessibility. CSIR-Central Road Research Institute (CRRI), New Delhi has a crucial role to play in the road development programmes being undertaken by the government. Over the years, CRRI has developed many new techniques and solutions to problems affecting road sector. Notable achievements include urban road traffic and air pollution study, techniques for usage of waste materials, safety audits for various sections of national highways, traffic and transportation studies of metropolitan cities, bridge design and rating, providing solutions to premature pavement failures across the country, ground improvement, landslide problem mitigation, etc. The present article provides a glimpse of activities of CRRI and summarizes significant achievements during 2013–14.

Keywords: Erosion control, driver behaviour, pot hole repair, road transport, warm-mix asphalt.

A good road transport system is one of the best indicators of the economic and industrial development of a country and its growth. The road network in India has grown from 400,000 km in 1951 to about 4.7 million km at present. Also, India has the second largest road network in the world, next to USA. This network transports more than 60% of all goods in the country and 85% of India's total passenger traffic. Today, road transport is by far the most prevalent mode of transport, because of its flexibility, accessibility to remote areas and adaptability to changes for achieving the desired objective of connectivity. Providing road accessibility in under-developed areas is an important means of achieving inclusive growth in a developing country like India. The Government of India (GoI) has set aside 20% of the investment of US$ 1 trillion reserved for infrastructure during the 12th Five-Year Plan (2012–2017) to develop the country's roads.

Thanks to great visionaries like Kenneth Mitchell, S. S. Bhatnagar, G. M. McKelvie, R. K. N. Iyengar and many others, the GoI set up the 'Central Road Research Institute' at New Delhi, as a constituent laboratory of the Council for Scientific and Industrial Research (CSIR), more than 62 years ago to serve the highway engineering profession. Ernst Zipkes, an eminent road engineer from Switzerland was appointed as the first Director of CRRI. The Inauguration was by Jawaharalal Nehru, then Prime Minister of India and the President, CSIR on 16 July 1952. Presently, CSIR-CRRI is the pioneering organization in India providing high-quality and globally acceptable R&D and consultancy services in the area of road and transportation sector (Figure 1). The major activities of the Institute encompass road pavement design and performance, road condition monitoring, pavement deterioration modelling, landslide management and hazard mitigation, improved transportation planning for emerging urban needs, road safety and environment issues, bridges and culverts, etc.

Recent R&D achievements

Over the years, CSIR-CRRI has been carrying out pioneering R&D and consultancy work to solve various problems associated with road construction in our country. Some of the notable R&D achievements in recent years are given below:

- The first road user cost study (RUCS) was conducted by CSIR-CRRI in 1980s. The objective was to establish accurate relationships between various components of vehicle operating cost, value of travel time and accident cost with the geometry of the road, surface characteristics and environmental conditions. An update of RUCS was carried out in 2001.

Figure 1. Central Road Research Institute, New Delhi.

*For correspondence. (e-mail: vittal.crri@gmail.com)

- The Institute has carried out R&D work on industrial waste materials like fly ash, different types of slags, kimberlite tailings, Jarofix, etc. Novel designs and methodologies for usage of such materials in road embankment and pavement construction were devised and successfully implemented at many locations in the country.
- To assess, travel demands and expected air pollution from automobile exhaust emission, a study was taken up in 2001–2002 in eight metropolitan cities. Based on classified traffic volumes, the quantity of air pollutants was estimated. This data generated helped in understanding the quantum of emission from different types of vehicles, vehicular pollution scenario in different Indian cities and provided inputs for auto fuel policy formulation.
- Inputs towards formulation of 'Pradhan Mantri Gram Sadak Yojna' (PMGSY) scheme, preparation of rural roads manual and MoRD guidelines for rural road planning at district level, carrying out many training programmes for rural works engineers, etc.
- GIS-based highway information system to build a unique data bank of our national highways covering about 50,000 km of the national highway network. The system is capable of storing and providing data pertaining to pavement and road geometrics-related data for any location in the network.
- Use of waste plastic in bituminous roads – laboratory evaluation and field demonstrations.
- Novel techniques for rigid pavement construction – ultra thin white topping, roller compacted concrete, high performance concrete, interlocking concrete block pavement (ICBP) for desert and snow-bound areas, high volume fly ash concrete, etc.
- Introduction of new technologies like reinforced earth construction using fly ash as fill material; usage of geotextiles (polymeric as well as agro-based) for road works.
- Carrying out road safety audit exercise for several segments of our national highway network leading to preparation of 'Road Safety Audit Manual'. Preparation of 'Manual for Safety in Road Design' in collaboration with TRL, UK.
- Ground improvement solutions for soft subsoils at several locations like Mumbai, Kandla, Visakhapatnam, Kakinada, Chennai, Rann of Kutch, etc.
- Landslide investigation and disaster mitigation techniques for hill roads in various locations in the Himalaya, North East India, Bhutan, Eastern and Western Ghats.
- Instrumentation and performance monitoring/health assessment of many road bridges as well as a number of railway bridges, load testing for several bridges, etc.
- Greenhouse gas (GHG) emission inventory for transport sector in India – comprehensive GHG emission database for different modes of transportation, viz. roads, railways, aviation and marine navigation.
- Airfield pavement evaluation studies for several airfields for determination of PCN, design of overlay requirements, for future operation of bigger aircraft, etc.
- EIA studies for Delhi metro rail; noise and vibration studies for Kolkata metro.

Major R&D achievements during 2013–2014

Use of recycled concrete aggregates in structural concrete

Recycled concrete aggregates (RCA) required for this work were obtained by crushing concrete cubes/beams which had been tested. Concrete mix was designed for a characteristic compressive strength of 40 MPa and a slump of 50–75 mm. Concrete mixes with freshly crushed hard stone aggregates were prepared for comparison. In the same concrete mixes, freshly crushed hard stone aggregates were replaced by RCA (to the extent of 50%, 75% and 100%) and test specimens were prepared. Different engineering properties of both mixes, namely compressive strength, split tensile strength, flexural strength, elastic modulus, bond strength, chloride penetration, resistivity and structural behaviour (RCC beams) were tested. A marginal decrease in E value and other strength properties of RCA admixed concrete mix was noted. Based on these studies, a modified method for mix proportioning RCA concrete has been formulated.

Development of mobile bridge inspection unit

A mobile bridge inspection unit (MBIU) has been developed jointly with CSIR-Central Mechanical Engineering Research Institute to meet field inspection requirements of bridges constructed on major arterial roads like national highways and state highways. This unit has a maximum horizontal reach of 10 m and lowering depth up to 8 m, when the carrier vehicle is parked over the bridge (Figure 2). Inspection personnel and instruments (maximum load 200 kg) can be lowered for closer examination of the piers, underside of deck slabs, etc. MBIU has now been commercialized and is expected to be available in the market shortly.

Sustainable options – assessment of pollution loads in road run-off

The main objective of this project is to analyse, evaluate and assess the pollution loads of road run-off and to explore and suggest probable mitigation techniques, if run-off water is to be reused. With increasing population

and decreasing sources of freshwater, run-off from roads, highways, bridges, etc. is being considered for usage by humans. However, little data are available on the quality of such run-off and usually it is one of the contributors of pollution in both groundwater and surfacewater. Vehicles emit exhaust, and leave worn tyre, engine parts, brake linings, weathered paint, etc. on the road surface. These pollutants which may be present on road surface, are washed and get collected in run-off water when it rains. Studies carried out showed that concentration of toxic heavy metals is highest in run-off from traffic intersections followed by roads in commercial and residential areas of Delhi.

Stabilizing slope around pile cap and river erosion protection measures for a bridge at Basohli, J&K

A cable stayed bridge is being constructed near Basohli, J&K. One of the pylons for this bridge has been seated on weathered sandstone. Detailed site investigations were undertaken and suitable remedial measures like soil nailing and other necessary erosion preventive measures were designed and suggested.

Use of reclaimed asphalt in bituminous mixes

Recycling of bituminous pavements is a good option for conserving naturally available hard stones. However, when such reclaimed asphalt (RAP) is admixed, there are changes in the strength properties of the mix. R&D work was undertaken to investigate the influence of admixing RAP in bituminous concrete mix. Addition of RAP makes the mix stiffer. Studies showed that optimum benefits of admixing RAP occur at about 60% RAP admixing.

Figure 2. Mobile bridge inspection unit.

Field evaluation of warm-mix technology

Warm-mix asphalt technologies permit lowering the temperatures at which bituminous mixes are prepared and placed on the road. Reductions of 10–35°C are possible using different commercially available technologies developed abroad. Such reductions have the obvious benefits of cutting fuel consumption and decreasing the production of GHGs. In addition, engineering benefits include better compaction of the layer, ability to haul paving mix for longer distances, and extending the paving season by being able to pave at lower temperatures. CRRI carried out field evaluation under Indian conditions for different warm-mix technologies which are now available in the market.

Design and fabrication of pothole repair machine

Prototype of a portable machine capable of producing bituminous emulsion-based cold mix for filling and repairing the potholes has been fabricated (Figure 3). The machine is now being commercialized.

Accelerated strength testing and evaluation of concrete

This project was undertaken to develop correlations between one day and 28 days compressive strength and flexural strength of concrete using accelerated curing method. The specimens were prepared using different types of cement such as OPC, PPC and slag cement. Good correlation between one-day strength of concrete specimens

Figure 3. Portable pothole repair machine.

cured in boiling water for 3.5 h (24 h after casting) and cubes cured in water at room temperature for 28 days was obtained.

Study on driving behaviour of young two-wheeler motorists

It is a common perception that young drivers exhibit tendency towards over-speeding. To evaluate such behaviour among young two-wheeler drivers, a study was taken up. The study sample comprised of 961 two-wheeler riders selected among young men and women in Bengaluru and Delhi. Based on the observations and findings of the surveys conducted during the study, a brief interactive intervention software program (called 'Smart Riders') was developed to promote safe and respectful riding. This software provides an opportunity to the youth to broaden their repertoire of cognitive and behavioural skills for effective management of emotions which influence two-wheeler riding behaviours.

The Institute carried out traffic and transportation studies for improvement of major intersections in Vadodara, and junction improvement plans for Ahmedabad city. The Institute is also presently carrying out three 12th Five-Year Plan projects as a nodal laboratory. They are: (i) Development and application of technologies for sustainable transportation; (ii) Evaluation economic loss due to idling of vehicles at signalized intersection and mitigation measures, and (iii) Indo Highway Capacity Manual. Work on these projects is under progress.