Highlights of the ING-IABSE Workshop on "Design, Construction and Maintenance of Steel Bridges" held at Dehradun, Uttarakhand on 19-20 October 2024

The Indian National Group of the IABSE, Ministry of Road Transport & Highways and Public Works Department-Uttarakhand, jointly organized a workshop on "**Design, Construction and Maintenance of Steel Bridges"** on 19th and 20th October 2024 at Dehradun.

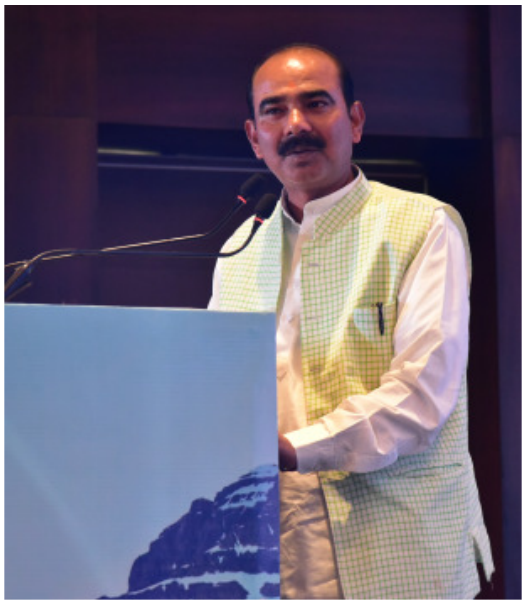
At Inaugural Session the dignitaries sitting on the dais in center Shri Ajay Tamta, Hon'ble Union Minister of State for Road Transport and Highways in his right Shri Satpal Maharaj, Hon'ble PWD Minister, Uttarakhand State; Shri Dharmananda Sarangi, Chairman, ING-IABSE & DG(RD) & SS, MoRTH; Shri Deepak Kumar Yadav, EnC, PWD, Uttarakhand; Dr Harshavardhan Subbarao, Chairman, Scientific Committee, President-Elect, IABSE; Shri BK Sinha, Secretary, ING-IABSE and ADG, MoRTH; Shri Sudip Chaudhury, ADG, MoRTH and Shri Daya Nand, CE(NH), PWD, Uttarakhand

Shri Ajay Tamta, Hon'ble Union Minister of State for Road Transport and Highways and Shri Satpal Maharaj, Hon'ble Minister, PWD, Uttarakhand lighting the lamp

The Workshop was inaugurated by **Shri Ajay Tamta**, Hon'ble Union Minister of State for Road Transport and Highways and Shri Satpal Maharaj, Hon'ble Minister, PWD, Uttarakhand by lighting of lamp.

Hon'ble Union Minister of State Shri Ajay Tamta highlighted the road and bridge construction related schemes being run in the state with the support of the Government of India and congratulated ING-IABSE, Ministry of Road Transport & Highways, Government of India and Public Works Department, Government of Uttarakhand for organizing the Workshop in Dehradun.

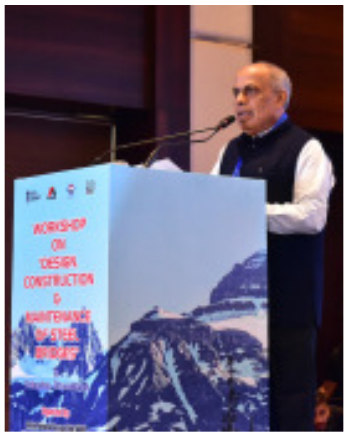
Hon'ble Shri Ajay Tamta stated that the Central Government is working on the improvement of all the National Highways of the state including the Delhi-Dehradun Expressway. Along with this, focus is also being laid on the projects of building ring roads in the cities of the state. He said that the work of No Objection Certificate from The Ministry of Environment, Forest and Climate Change (MoEFCC) is going on for the 52 km long ring road in Dehradun, while the NOCs have been received for by-passes in many cities of the state including Rishikesh. The construction of Rishikesh by-pass from Nepali Farm will provide great relief to the Chardham pilgrims along with Garhwal and Kumaon. He said that efforts are on to improve connectivity to Kund-Guptkashi by-pass, Kathgodam-Nainital double lane road, double lane road from Jyolikot to Garhwal via Ranikhet, Charchung, Jauljibi along with the road from Ramnagar to Ranikhet.



Shri Ajay Tamta, Hon'ble Union Minister of State for Road Transport and Highways delivering Inaugural Speech

Shri Satpal Maharaj, Hon'ble PWD Minister, Uttarakhand delivering his speech

Hon'ble Minister, PWD, **Shri Satpal Maharaj**, during the inaugural session, said that steel bridges are not only lighter but also strong and are more capable of withstanding the fluctuations in the climate. If needed, the parts of the steel bridge can be easily replaced and its maintenance cost is less. He said that during rains and landslides, many times old culverts get damaged; now such durable bridges are being built in its place. He informed that at present there is a huge network of 9192 roads of National Highways, Main District Roads and Rural Roads in 13 districts of the State, with a total length of 46,742 km. A total of 2238 motor bridges, 31 footover bridges, 4 flyovers, 24 road over bridges and 1021 pedestrian bridges have been constructed on these roads, under the supervision of PWD. He assured that along with old steel bridges, new techniques for bridge maintenance will be discussed in the workshop so that the bridges remain safe and useful for a long time.



Shri D. Sarangi, Chairman, ING-IABSE & DG (RD) & SS, MoRTH delivered an Introductory

Shri Deepak Kumar Yadav, EnC, PWD, Uttarakhand delivered a Welcome Address

Dr Harshavardhan Subbarao, President (Elected), IABSE addressing the gathering

Shri BK Sinha, Secretary, ING-IABSE and ADG, MoRTH delivering Vote of Thanks Speech

Shri Dharmananda Sarangi, Chairman, ING-IABSE & DG (RD) & SS, MoRTH delivered an Introductory Address and informed participants about ING-IABSE and its activities in detail. During the address by Dr Harshavardhan Subbarao, Chairman, Scientific Committee, who is also President-Elect, IABSE, he highlighted in detail the objective of this workshop, various topics to be discussed and benefits to the participants. Shri Deepak Kumar Yadav, EnC, PWD, Uttarakhand delivered a Welcome Address and Shri BK Sinha, Secretary, ING-IABSE and ADG, MoRTH gave a Vote of Thanks.

Hon'ble Union Minister of State for Road Transport & Highways, Shri Ajay Tamta presenting the certificate to Dr. Harshavardhan Subbarao on being elected as the President of IABSE

Shri Ajay Tamta, Hon'ble Union State Minister for Road Transport & Highways felicitated Dr. Harshavardhan Subbarao by presenting him a Certificate on being elected as the President of IABSE in the august presence of Shri Satpal Maharaj, Minister, PWD , Uttarakhand.

Saturday, 19th October 2024

Keynote Lecture by Shri Amitabha Ghoshal on Sustainable Usage of Steel in Bridges

Shri Amitabha Ghoshal giving online Keynote Lecture

Shri Amitabha Ghoshal, in his keynote address, explained the need for bridges and the advantages and uses of steel bridges. Shri Ghoshal highlighted the principles of bridge design and how they developed. Benefits of Steel usage. Shri Ghoshal also gave examples of some failures of bridges tell about the learning from the bridge failures.

Session-I – Analysis & Design

Chair: Shri Umesh K. Rajeshirke

[Insert Mr. Rajeshirke's Photo]

Dr. Harshavardhan Subbarao giving a lecture on Analysis & Design of Steel Bridges

After the Inaugural Session and Keynote Lecture, the Technical Session started. Each session had provisions for two lectures from invited speakers. Each session was moderated by Session Chairs. 20 minutes were allotted for question and answer after the end of two lectures.

In the opening session of the Workshop, **Dr Harshavardhan Subbarao** delivered his lecture on Analysis & Design of Steel Bridges. He also gave an overview of Steel Bridges, classification and explain the advantages of steel bridges. He told how to analyse of any steel bridge superstructure and also shows some iconic steel bridges in India. He explained the reasons of failure of a bridge like - corrosion, fatigue, large deformation and human induced vibration. Dr. Subbarao explained how a suitable bridge should be selected. He gave overview, behaviours consideration and analysis methods of truss bridge, steel arch bridge and orthotropic steel deck. He gave references of various codes of IRC for design, drawing erection and fabrication.

Second lecture delivered by *Dr. Sanjeev Kumar Garg* on Design for Fatigue. He emphasised on the fact that fatigue is a long term phenomena governing life and durability of the bridges. In fatigue verification, choosing correct number of design fatigue vehicle passes, selection of appropriate steel according to the location of the bridge, fabrication details & procedures to be used during manufacture and inspection level post construction of the bridge are crucial and should be duly considered.

Dr. Sanjeev Kumar Garg giving a lecture on Design for Fatigue

Session-II – Materials, Technology & Structural Detailing

Chair: Shri PVVSS Ravi Prasad

The first speaker in this session was Prof. D.R. Sahoo and he highlighted the benefits of steel as a construction material in the context of sustainability and the life cycle assessment. Some of the measures for sustainable transition were highlighted in his lecture such as adopting clean technologies and briefly discussed other techniques. The potential of steel to mitigate the seismic failure of structures was discussed. Utilizing excellent strength and deformability, structural steel can be used to develop low-cost energy absorbing devices for seismic protection of bridges.

From left Shri PVVSS Ravi Prasad (Session-II Chair) Shri Deepak Yadav (felicitated the Chair & Speakers), Prof DR Sahoo (Speaker) and Shri V Karthik (Speaker)

Shri V Karthik in his lecture discussed Detailing of Steel Connections, Introduction of New IRC Guideline and stated that the IRC:SP:144-2024 gives non-contradictory complementary information for use with IRC:22 "Standard Specifications and Code of Practices for Road Bridges, Section VI – Composite Construction (Limit State Design) Third Revision", IRC:24 "Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridge (Limit State Method), Third Revision" and IRC:SP:104 "Guidelines for Fabrication and Erection of Steel Bridges". This document is to guide on the detailing of typical steel road bridges along with a brief on the force transfer mechanism.

Session-III – Fabrication, Erection and QA/QC for Steel Bridges

Chair: Shri S.K. Puri

Shri Shashank Rajbhoj made a presentation on the Design and Construction Aspects of Chenab Arch Bridge. In his lecture, he described that the Chenab Bridge is currently the world's highest railway bridge, and is a key component of the Udhampur-Srinagar-Baramulla Rail Link (USBRL) project. The bridge is 1315m long, having main arch span of 467m and land pier height 131m, placing of bridge 362m above the river water level. The terrain is most difficult from an engineering design and construction point of view. Shri Rajbhoj also explained the method of construction and stated that the latest and most efficient technology was adopted and also best construction equipment used for construction of the Chenab Bridge.

From left Shri SK Puri (Session-III Chair), Shri PVVSS Ravi Prasad (felicitated the Chair & Speakers), Shri Shashank Rajbhoj (Speaker) and Shri GR Mohanty

Shri G.R. Mohanty explained the guidelines for manufacturing and installation, testing, quality and method of use of materials used in girders. He talked about proper quality materials and methods for welding. He explained as to how the material can be protected from corrosion so that it can last longer and be durable

in different environments. He talked about the selection of different types of cranes, methods of installation and safety measures.

Session-IV – Special Session on Disaster Mitigation, Environmental, Health & Safety Issues

Chair: Shri Deepak Yadav

From left Shri Deepak Yadav (Chair Session-IV), Shri BK Sinha felicitated the Chair & Speakers, Shri Manoj Bisht (Speaker) and Ms Neha Vyas (Speaker)

Shri Manoj Bisht informed that PWD, Uttarakhand recognizing the need for a more systematic approach developed a comprehensive Bridge Inventory and Inspection System to enable structured data collection and analysis. A comprehensive bridge inventory was the first step, capturing detailed information across 60 fields, categorized by aspects like location, design, and structural parameters. Each bridge is assigned a unique ID, with over 3,306 bridges currently documented. To maintain data accuracy, the system features a locking mechanism that prevents unauthorized data alterations, requiring lower-level offices to submit requests for updates when necessary. PWD implemented a Bridge Inspection Module to facilitate regular inspections and detailed ratings. This digital approach addresses numerous PWD needs, including:

- Prioritizing funding based on bridge vulnerability
- Maintaining a historical record of bridge vulnerabilities and interventions
- Grouping of bridges by geographic or structural characteristics for project planning
- Tracking bridge maintenance and intervention history
- Overall, PWD Uttarakhand's transition from manual to digital bridge data collection allows for consistent, validated data, enhancing maintenance decisions and infrastructure planning.

Ms. Neha Vyas from the World Bank talked about the issue of environment, health and safety management during any construction. She explained the main concerns that should be taken into consideration during the design phase - minimize damage to the environment and water bodies, it should not obstruct wildlife movement, minimize the possibility of contact with migratory birds, minimize noise pollution, use modern equipment/ machinery and make the bridge lightweight to reduce carbon footprint. She also stressed the safety of workers and engineers during construction and handling of materials, equipment, etc.

Sunday, 20th October 2024

Session-V – Bowstring Girder Bridge - Construction & Design Challenges

Chair: Shri BK Sinha

Shri V Sadasivam made the presentation on Bowstring Steel Bridges - Construction Challenges. He said that Bowstring steel girder bridges are generally proposed at railway/road crossings for more than 50 m span, location warrants for aesthetic appeal, transportation and

assembly of Steel Bowstring Girder modules is feasible at the project location and limitations on availability of vertical clearance. In his lecture, he talked about the construction of Tallah ROB (Railway Over Bridge) and KMDA ROB and flyover. He explained about Bowstring Girder Bridge - Construction Challenges.

From left Dr Harshavardhan Subbarao (felicitated the Chair & Speakers), Shri V Sadasivam (Speaker), Shri B.K. Sinha (Session-V Chair) and Shri UK Rajeshirke Speakers)

Shri Umesh K Rajeshirke made presentation on Bowstring Girder Bridges - Construction & Design Challenges. While constructing a Bowstring Girder Bridge the main considered points are - an efficient form of the structure, cost effective, aesthetically appealing, clear flow of the forces and the type of bridge has a track record since 1840s. The presentation covered various design challenges such as – buckling, susceptibility to fatigue, design of end joint – local FEM, connections details of hangers – types (steel members, bars, strands), etc.

Session-VI – Repair & Rehabilitation; Inspection, Maintenance & SHM

Chair: Shri Sudip Chaudhury

Dr. Sumantra Sengupta and Shri Jatin Singla made a joint presentation on Repair and Rehabilitation of Old Mokama Bridge over River Ganga, Bihar. They described the philosophy for assessment of the remaining service life of the bridge and highlighted how the working for repair and rehabilitation of Mokama Bridge was a huge learning experience on many counts. Following are some of them:

- Learnt how important it is for Engineers to write articles about the project they are involved in, for the sake of posterity and future repair / rehabilitation / retrofitting.
- Learnt what information should be included in as-built Drawings in a project.

From left Dr GK Sahu (Speaker), Shri Sudip Chaudhury (Session-VI Chair), Shri Jatin Singla (Speaker) and Dr. Sumantra Sengupta (Speaker)

- Huge learning on determination of fatigue service life of elements.

Residual fatigue strength is adequate for all the members except at two locations due to the connection issue where the crack has been observed:

- **Location 1** - Cracks appeared in the weld of the stringer connection at the central cross-girder location of all spans due to fatigue failure. Repair has been proposed
- **Location 2** – Diagonal cracks appeared at web of the shore span 30m stringer near the support. Repair has been proposed

Inclined members of the portal frame have been bent due to the hitting of oversized vehicles. Replacement of the members has been proposed. Height restriction shall be imposed at the road level by ECR, re-laying of the entire deck concrete is being done and bearings are being

replaced for the Main Trussed Bridge. Substructure and foundations are safe with the new loading.

Dr. G.K Sahu made a presentation on Inspection, Maintenance and Structure Health Management. In his lecture he stated that major bridges require Mobile Bridge Inspection Unit (MBIU), Man lifters, Motor Boats and ladders for the detailed inspection and Non-Destructive Testing (NDT) of bridge. The foundations under-water also need scanning through special robots/ divers. The special structures, Suspension Bridges, Cablestayed bridges and Extradosed bridge also needs Drones for visual inspection. The general observations are abutment and pier heads are full of debris, vegetation growth, temporary supports around the bearing not removed, bearings movements are restricted, Expansion joints and drainage spouts are not functioning and Cracks on the girders, bearing pedestals, piers and abutments heads, deck slabs etc. Exposed reinforcement is also seen at several locations on the deck slab. The Condition Assessment of bridges through detailed visual inspection, NDT and core test results or instrumentation data suggest that various strengthening measures be adopted such as Pressure grouting of cracks and honeycombed members, FRP laminates and WRAP, External Prestressing etc.

Session-VII – Temporary Structures & Modular Bridges

Chair: Shri V N Heggade

Shri M V Jatkar gave a lecture on Erection of Steel & Composite Bridge Decks. The features of the presentation are:

From left Shri V.N. Heggade (Session-VII Chair), Shri Alok Bhowmick (Speaker), Shri Daya Nand (felicitated the Chair & Speakers) and Shri M V Jatkar (Speaker)

- Suitable type / configuration, design basis and performance specifications for temporary structures have to be derived from construction methodology.
- Project specific constructability review will help in ensuring the development of cost-effective and constructible designs
- Success of temporary works is not just good design but depends on many aspects such as proper understanding of construction procedure, the need to achieve target time cycles, following relevant procedures at site, safety, cost effectiveness and so on.
- Bridge construction is showing a worrying drop in safety and a consequent increase in the number of serious accidents. Procedural controls have to be established at various stages right from the design of temporary structures to implementation & demobilisation at the site to mitigate the risks involved.
- Serious attention needs to be given to training for developing manpower required for proper construction engineering, design & safe implementation of temporary structures.

Shri Alok Bhowmick delivered his lecture on Prefabricated Modular Bridges and stated that such bridges play a vital role in the immediate restoration of rail/road communication and in developing connectivity to forward areas in new road construction. Modular Bridges are also

very useful as permanent bridges, in remote areas where conventional bridging solutions are not easy due to problems of access, manpower to execute, supervise and maintain.

Session-VIII – Panel Discussion on "Quality of Design and Construction of Steel Bridges

Moderator: Shri Dharmananda Sarangi

Panel Discussion: From left Shri S. Rajbhoj, Shri Daya Nand, Dr. Harshavardhan Subbarao, Shri D. Sarangi (Moderator), Shri SK Puri, Dr. G. Mohanty and Ms. Neha Vyas

A panel discussion was held in one of the sessions, where esteemed panelists highlighted the issues and concerns which is to be addressed by all the stakeholders for improvement in quality of design and construction. Mr D Sarangi, who chaired and initiated the panel discussion, highlighted the Clients perspective and brought out several issues of concerns with respect to quality of design and construction. Dr Harshavardhan Subbarao highlighted the need for independent proof checking by a qualified proof checker having relevant experience. He emphasized that proof checker must be appointed by the Client and not by the Contractor (present practice is that Contractor appoints Proof Checker). He mentioned that the proof checker must not be commercially dependent upon the Contractor. Ms Neha Vyas highlighted the need to focus more on social and environmental aspects during the planning, design, construction and maintenance of the infrastructure. Mr Daya Nand highlighted the current design and construction practices in Uttarakhand and the way quality control / quality assurance measures are undertaken. Shri S K Puri highlighted the lack of competence of field engineers, both amongst the Contractor and the Supervision Consultant which is the root cause of problem of quality. Mr Mohanty highlighted the quality issues in fabrication and erection. From the participants, Mr Alok Bhowmick highlighted the fact that root cause of poor quality of design and construction is the large gap between demand and supply. He emphasized that the country's pace of growth is disproportionate to the existing skill level of engineers and workman. The way forward therefore is to work on two fronts; a) to impart large scale training for engineers and workman in the industry and b) to reduce the pace of growth to a level which is in sync with the capacity. The panel discussion concluded with the moderator, Mr D Sarangi noting down all the action points that will be taken forward and thanking the panelists and the participants for such a lively and fruitful discussion.

Session-IX – Case Studies

Chair: Shri Jatin Singla

Shri VN Heggade made presentation on Forensic Investigation of a Bowstring Girder during Construction. He highlighted the following points:

- During the erection, one of the arch ribs and bottom tie chord of RHS which is towards the median side adjacent to the already commissioned LHS arch bridge was found to be distorted beyond tolerance limits.

From left Shri Jatin Singla (Session-IX Chair), Shri Atul D Bhobe (Speaker) and Shri V N Heggade

- On either side, the approaches were ready for commissioning. Only the deck slab was to be cast on floor beams.
- At the time of the appointment of a forensic expert, the distortion in the arch rib was corrected to a certain extent but the acceptability of the same was in question.

Recommendations

- In a situation like this where the design and construction are not in accordance with the sections of the standard, IRC :24 recommends load testing.
- In this case, the design shows that the structure is safe despite crossing the tolerance limits of 15mm in bottom chord.
- The decision also had to be made keeping in view the ramifications on the other three flyovers which are already in position and impact on sustainability.
- However, as a measure of abundant precaution after the completion of the bridge, load testing as per IRC code was recommended.

Shri Atul D Bhobe presented a case study on Linear Infrastructure through the Forest Area of Construction of six-lane access-controlled highway between Ganeshpur & Dehradun section (NH-72A) for The National Highways Authority of India (NHAI). NHAI is engaged in the development of National Highways and as part of this endeavour, the Authority has decided to undertake the Development of six-lane access-controlled highway from design chainage 0+000 (Ganeshpur) to design chainage 8+130 (near Mohand), and chainage 8+130 (near Mohand) to design chainage 16+380 (Daat kali Tunnel) of Ganeshpur–Dehradun section of NH-72A in the state of Uttar Pradesh under Bharatmala Pariyojana (Package-1) (the "Project") through an Engineering, Procurement and Construction (the "EPC") Contract.

Glimpses of the Event

Shri Alok Bhowmick raised a Question during Q&A time

A view of Question/Answer in a Session

The August Audience at the Workshop	The August Audience at the Workshop
	
The accompanied persons also participated in the function	A view of Cultural Programme