

MESSAGE FROM THE PRESIDENT



Dear Friends,

Greetings!!

Hope you are doing good. You shall be happy to know that IAStructE is very actively engaged in routine technical lectures, webinars, publication of newsletters, CROSSFAL & Structural Engineering Digest. All these activities have rich technical contents & are being appreciated by the fraternity. You may find details of such activities & publications in this newsletter and on our website. Our committee members & chairpersons are putting in their best efforts for the betterment of the profession. It is also heartening to note that we are continuously getting good applications for the membership, which promises a good future of IAStructE. Recently we organised a symposium in association with VanRo on 11th November in Delhi in Hybrid mode to celebrate the work & life of our founder President Mr. Mahendra Raj. All deliberations & Panel discussions were very lively, interesting & insightful. Each year 11th November shall be celebrated as 'Structural Engineers Day' throughout India.

Our students Chapters are quite active, and I appreciate their efforts in organising technical events in their Institutions. As you know we have launched an annual award scheme for best student chapter. I hope it will further encourage them to do better.

From January 2023 IAStructE is starting a new program of accreditation of engineers as 'Chartered Structural Engineer IAStructE'. It will be open to all structural engineers having 5 years of experience with minimum bachelor's degree in Civil engineering. It will be on voluntary basis but membership of IAStructE shall be mandatory to get this accreditation. It will be two stage process. Initial Professional development (IPD) assessment interview followed by a written examination of actual problem solving. It will be mandatory to clear both the stages. This accreditation shall be renewed every 5 years based on CPD. It is an extremely ambitious program. Details of this program shall be posted on website and on social media platforms on January 1, 2023.

I encourage you to send your feedback on our activities and suggestions for further improvements.

Best regards,



Manoj Kumar Mittal
President-IAStructE

FROM THE EDITOR'S DESK



November 2022

This issue of the newsletter provides details of EGM conducted to adopt the new clause in the bye laws, the first ever structural Engineers Day celebrations along with other regular knowledge sharing activities conducted at head office and at the student's chapters. The organization feels extremely proud to share the achievement of one of its members Dr. P. Pravin Kumar Venkat Rao faculty advisor of IAStructE - IIIT Hyderabad Student's Chapter, who has been awarded the "ISET D. K. Paul Research Award for best Ph.D. thesis in Earthquake Risk Reduction in India" for the year 2022. An article on Morbi bridge collapse would be worth reading for our reader's. Do encourage us by following the organization on all social media platforms.

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Thanks & Regards,



Dr. Visalakshi Talakokula

Extraordinary General Meeting (EGM):

An Online Extraordinary General Meeting (EGM) was organized on 17 November 2022 through zoom platform, in which a new clause “3.6 - Chartered Structural Engineer – IAStructE: Accreditation” program was adopted in the bye laws and approved by all members. The adopted clause is given below:

3.6 Chartered Structural Engineer-IAStructE Accreditation

“A Structural Engineer with at least Bachelor’s Degree in Civil Engineering or equivalent as approved by the Governing Council, with minimum 5 years of professional experience in Structural Engineering can opt for this accreditation. The applicant shall be required to undergo Initial Professional Development (IPD) assessment interview as well as written examination as prescribed by the Committee appointed by the governing Council for this purpose. Accreditation shall be valid for a period of five years which shall be renewed periodically as per the procedures laid down by the Governing Council. The Governing Council shall have the mandate to develop any other systems & procedures for operating this clause, including the validity period of accreditation, the procedure for renewal and the associated fees to be charged to applicants. This provision shall be open to all Fellows/Members & Associate Members of the Association on a voluntary basis subject to fulfilling the eligibility requirements. It will be mandatory for a non-member applicant, qualifying for this accreditation to become a member of the association, in appropriate grade, as per the provisions of the Byelaws. Continuance of membership of the association shall be mandatory for the validity of the accreditation.”



Fig. 1. Glimpses from EGM

Symposium on Works of Mahendra Raj:

On the occasion of 98th Birthday of Shri Mahendra Raj, Founder President, IAStructE and a legendary structural engineer, IAStructE has decided to celebrate this day 11th November 2022, every year as “Structural Engineers Day” throughout India. In this 1st Structural Engineers Day a Symposium was organized jointly with Studio VanRO Foundation titled “Mahendra Raj - Honoring a Legacy in Structural Engineering and Architecture in India” at India International Centre, New Delhi to celebrate his life and his contribution to the Society and engineering profession. IAStructE has decided to celebrate 11th November 2022 as Structural Engineers Day every year throughout India.

During the inaugural session, Mr. Manoj Mittal, President IAStructE gave his welcome address. Mr. Rohit Raj Mehndiratta and Ms. Vandini Mehta made their presentation on “The Structure: Works of Mahendra Raj”.

Session 1 was based on “Mahendra Raj through decades: Work Ethics, Technical Innovation – through Stories, Anecdotes” the following speakers have shared their vivid experiences and journey with Shri Mahendra Raj:

- Dr. Vasudev Nori, Chairman, Shirish Patel Associates Consultants Pvt. Ltd.
- Mr. Ganesh Juneja, Managing Director, Juneja Techno Consultants Pvt. Ltd.
- Prof. V. K. Dogra, Associate Professor, Shri Mata Vaishno Devi University
- Mr. S. S. Mann, Director, Mahendra Raj Consultants Pvt. Ltd.

During the Session 2, Prof. Arun Menon, Associate Professor (Structural Engineering), IIT Madras made his presentation on “Analysing Mahendra Raj’s Engineering: Sardar Patel Stadium, Ahmedabad”

Session 3 emphasised on “Mahendra Raj’s Contributions - Professional Engineering Associations, his unfulfilled dream – the engineer’s bill & the way forward - a conversation” by Prof. Mahesh Tandon, Managing Director, Tandon Consultants Pvt Ltd, Dr. Uddesh Kohli, Chairman, ECI, and Mr. Sudhir Dhawan, Past President, CEAI shared his dream and efforts for enactment of the structural engineer’s bill.

In the last session Prof. Visalakshi Talakokula, Honorary Secretary, IAStructE, Dr. Narayani Gupta, Retd. Professor of History, Ms. Shiny Varghese, Senior Editor, The Indian Express, Prof. K. T. Ravindran, Retd. Head of Urban Design, SPA, Delhi and Ms. Tanuja Kanvinde, Partner, Kanvinde, Rai & Chowdhury shared their vision of Mr. Mahendra Raj’s work in context to History, Society & Education.

The YouTube link to watch to the symposium is given below:

<https://youtu.be/svOv8TMifwQ>



Fig 2. Glimpses from Symposium

Webinars / Events Conducted:

Online Panel Discussion:

An Online Panel Discussion on "Failure of Morbi Suspension Bridge – Are We Learning Lessons from Such Tragedies?" was organized on 16 November 2022. This session was moderated by Mr. V. N, Heggade, FNAE, Design and Construction Consultant, DECon Complete Solutions & GC member IAStructE. The discussions, learnings and the observations shared by the panelist were highly appreciated by the participants.

The expert panelist include:

- Mr. Amitabha Ghoshal, Advisory Consultant & Honorary Fellow IAStructE
- Prof. Mahesh Tandon FNAE, Int. PE (India) Past President & GC member, IAStructE
- Mr. Alok Bhowmick FNAE, Int. PE (India) Immediate Past President, IAStructE
- Prof. Prem Krishna, Professor-IIT, Roorkee (Retd.) & GC Member IAStructE
- Dr. (Col.) P. Nallathambi, Managing Director, Sakthi Consultancy Pvt. Ltd., Fellow IAStructE

The YouTube link to watch to Panel Discussion is given below: <https://youtu.be/VqNIXeZt334>



Fig. 3. Glimpses from Panel Discussion

Online Lecture:

An Online technical Lecture on "Structure for Underground Metro" by Prof. Mahesh Tandon, Past President & GC member, IAStructE and Managing Director of Tandon Consultants Pvt. Ltd was organized on 25 November 2022. This Lecture was moderated by Prof. Prem Krishna, Professor (Retd.), IIT Roorkee & GC member IAStructE.

The YouTube link to watch the technical lecture is given below: https://youtu.be/4rK_sUqVVC0



Fig 4. Glimpses from technical lecture

IAStructE Student Chapter Activities:

1a. DTU Student Chapter:

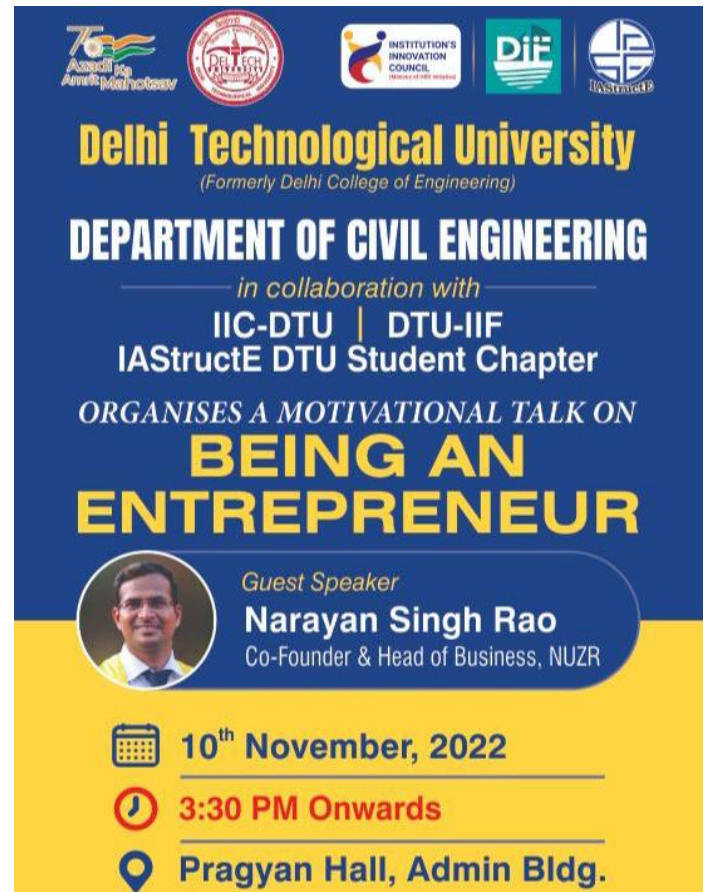
Title of the event: Motivational talk on “Being an Entrepreneur”

Date & Venue: 10 November 2022 at Pragyan Hall

Speaker: Mr. Narayan Singh Rao, Co-Founder & Head of Business, NUZR

Proceedings of the event: Department of Civil Engineering, Delhi Technological University in collaboration with IIC-DTU, DTU-IIF and IAStructE DTU Student Chapter organised a motivational lecture on “Being an Entrepreneur” on 10th November 2022. The event was held at Pragyan Hall Administrative Block, Delhi Technological University. The guest speaker for the event was Mr. Narayan Singh Rao, Co-Founder and Head of Business, NUZR.

The lecture acquainting the students with the concept of entrepreneurship and instilled in them the spirit of looking beyond the limited scope. It was sort of an interactive session based on the key situations introduced by the speaker. The lecture was attended by 47 students from various courses and branches.



Delhi Technological University
(Formerly Delhi College of Engineering)

DEPARTMENT OF CIVIL ENGINEERING
in collaboration with
IIC-DTU | DTU-IIF
IAStructE DTU Student Chapter

ORGANISES A MOTIVATIONAL TALK ON
BEING AN ENTREPRENEUR

Guest Speaker
Narayan Singh Rao
Co-Founder & Head of Business, NUZR

10th November, 2022
3:30 PM Onwards
Pragyan Hall, Admin Bldg.



Fig 5. Group photos of student from the lecture

1b. Technical Visit:

Department of Civil Engineering, Delhi Technological University in collaboration with IAStructE DTU Student Chapter organised a site visit to Resistoflex Corporate House, A-7, Udhog Marg, A Block, Sector 2, Noida, Uttar Pradesh - 20130 on 17th November 2022. The students were introduced to the concept of the base isolation as solution for earthquake resistant building in aspect of design, benefits and techniques of development through presentation. Then the students were taken through the complete tour of the building demonstrating all the measures taken to make building safe from earthquake. The visit was attended by 43 students of MTech, Structural Engineering and PhD.



Fig 6. Glimpses from Technical Visit

2. CEPT Student Chapter

Title of the event: Webinar on “Data Collection Techniques for Road Asset Management: Recent Trends”

Date & Venue: 18 November 2022 through Zoom

Speaker: Dr. Pradeep Kumar, Senior Principal Scientist CRRRI Delhi

Proceedings of the event: India has the second largest road network in the world, 63, 00,000 km. All roads which are constructed deteriorate with time. The rate of deterioration depends on original condition of road, traffic and loading condition as well as environmental conditions. If the roads are not monitored and maintained, the deterioration causes discomfort and safety risk of people along with financial burden on government. The lecture shared the state of the art technologies to monitor existing roads and how the data collected can be helpful for road asset management system. The records of inventory, pavement condition, roughness, material and construction data, pavement strength are required to take appropriate decisions for maintenance.



18.11.2022 | 5:30 pm IST

Data Collection Techniques for Road Asset Management : Recent Trends



Dr. Pradeep Kumar
Senior Principal Scientist,
CRRRI Delhi

About the Speaker:
Dr. Pradeep Kumar has done Post-graduation in Science (M.Sc.) and Instrumentation Engineering (M.Phil.) and a doctorate (Ph.D.) in Geomatics Engineering. He is the key person for successful implementation of modern pavement evaluation technologies in India mainly the Network Survey Vehicle System, first time in the country for road inventory and pavement condition monitoring of road network.

Session highlights:
The proposed talk strives to share the non-destructive testing techniques for pavement evaluation, road maintenance systems, and management.

For attending this lecture online, click on the registration link:
<https://cept-ac-in.zoom.us/join/register/tZMufu-srD8uE9STJ1HIEcORWEIzWZwtpk>

CEPT UNIVERSITY | FACULTY OF TECHNOLOGY | IAStructE

This expert session is jointly coordinated by Faculty of Technology, IAStructE CEPT student chapter, CEPT University. It is open to all. For any queries, please contact shreshth@cept.ac.in

Members Achievements:

Dr. P. Pravin Kumar Venkat Rao faculty advisor of IAStructE - IIIT Hyderabad Student's Chapter, has been awarded the "ISET D. K. Paul Research Award for best Ph.D. thesis in Earthquake Risk Reduction in India" for the year 2022. This is a national award presented to only a person with an international reputation and excellent standing in the area of expertise. In his doctoral work, he has developed low-cost, innovative, and sustainable strengthening techniques for retrofitting the existing masonry buildings. His developed retrofitting interventions, evaluation procedures, analytical models and design methodologies will be of great interest to the 'Building Construction' and 'Retrofitting Industry' in general and also beneficial to society at large in reducing the risk due to seismic hazards.



Fig 7. Photo of Dr. P. Pravin Kumar Venkat Rao receiving ISET D. K. Paul Research Award for best Ph.D. thesis



IAStructE National Award 2022:

Call for Nominations: Nominations are being called for the IAStructE National Awards 2022 Competition. The nominations forms for various categories can be downloaded from the links given below. The last date for receipt of nomination has been extended till 15th December 2022.

Registration Link:

<http://iastructe.co.in/iastructe-national-awards-2022.php>

IAStructE National Awards 2022

IAStructE invites nominations for the following categories of awards
(Instructions & Terms are given in the nomination forms of each category)

1. OUTSTANDING STRUCTURE OF THE YEAR (Two Awards)

- i) Buildings: Residential, Commercial & Industrial buildings, Hospitals, Schools etc.,
- ii) Other structures: Bridges, Large span space structures for sports, exhibitions etc, Industrial structures, Hydraulic Structures, Monuments, Tall towers

2. OUTSTANDING STRUCTURAL ENGINEER AWARD (One Award)

3. OUTSTANDING WOMAN STRUCTURAL ENGINEER AWARD (One Award)

4. PROMISING YOUNG STRUCTURAL ENGINEER AWARD (One Award)

5. BEST MASTER'S THESIS IN STRUCTURAL ENGINEERING (One Award)

(Download nomination forms from the link given below - Kindly read instructions carefully before submission)

<http://iastructe.co.in/iastructe-national-awards-2022.php>

Last date for receipt of nominations has been extended to 15th December, 2022

THE AWARDS

All Awards shall consist of a Plaque along with a Certificate & Citation. The Best Master's Thesis Awardee will get in addition a cash prize of Rs 20,000/-.

The Award Winners can use the IAStructE logo on their print and promotion material by mentioning the year of the award and the name of the Indian Association of Structural Engineers

IAStructE reserves the right to cancel or alter the number of awards stipulated above.

Indian Association of Structural Engineers

K-69 A, Basement, Kalkaji, New Delhi 110019
Tel:(011) 45794829;E-mail: iastructe@gmail.com; Web: www.iastructe.co.in



Fig 8. IAStructE National Award 2022 poster

Call for papers for CROSFALL:

CROSFALL Editorial Board invites reports for the forthcoming issues. Interested candidates can send the reports about structural safety issues related to all types of structures (i.e. buildings, bridges, tunnels, industrial structures etc.) in the built environment. The reporting can be related to:

- Structural failures,
- Poor Design and Detailing, Lack of Seismic Safety in planning
- Safety concerns about high risk erection schemes at Site
- Safety concerns on Temporary Works
- Near misses, or observations relating to procedures followed at site, which may lead to failures or collapses.

Reports do not have to be about current activities so long as they are relevant. Small scale events are equally important - they can be the precursors to more major failures. Report might relate to a specific experience or it could be based on a series of experiences indicating a trend. No concern is too small to be reported and conversely nothing is too large. Reports should aim to include information that will help others to learn from the safety issue identified.

To submit the report please go through the following link: www.iastructe.co.in/crofall.php

Call for papers for the theme based issue of SED journal:

SED Editorial Board invites article contributions for the forthcoming issue of the Structural Engineering Digest on the following theme, which shall be published in e-book format. Details are as under:

October – December 2022 issue: Theme: Structural Fire Safety

Guest Editor: Mr. Manoj Mittal, President IAStructE

Sub – Themes:

- ★ Fire & Life safety in planning & design of structures
- ★ Advances in material science for fire resistant materials for construction
- ★ Fire resistance testing
- ★ Standards for fire resistant design & construction – Prescriptive /PBD
- ★ Fire resistance provisions in structural engineering designs
- ★ Fire resistance provisions in Building Byelaws
- ★ Regulatory & implementation issues
- ★ Firefighting & post fire scenarios
- ★ Fire safety Audits
- ★ Case studies highlighting above issues
- ★ International practices in Structural Fire safety
- ★ Education & training in Structural Fire Safety

Interested professionals may send their full paper along with their photograph and brief resume by end of November 2022 or at the earliest convenience.

Articles are invited from i) Members of IAStructE; ii) Specialists in the field even though they are not members of IAStructE.

Interested authors/contributors may kindly mail to iastructe@gmail.com regarding i) Broad guidelines on areas of coverage; ii) size of the article; iii) format of paper submission. As per the laid down procedures all the papers shall be sent to the referee for review and the comments will be informed to the authors for incorporating the same. Papers shall be published after peer review & approval of SED editorial board.

Advertisement Tariffs:

Structural Engineering Digest (being published in PDF format)

	Rates Per issue	Discounted rate at 20% for 4 consecutive issues	Advertisement Size
Full Page	Rs. 20,000/- + 18% GST	Rs 64,000/- + 18% GST	9.5 inch x 7 inch

IAStructE Monthly Newsletter (being published in PDF format)

	Rates for advertisement	Advertisement Size
Full Page	Rs. 10,000 per issue, 10% rebate for quarterly, 20% rebate for half yearly and 30% rebate for yearly booking	9.5 inch x 7 inch
Half Page	Rs. 7,000/- + 18% GST per issue, 10% rebate for quarterly, 20% rebate for half yearly and 30% rebate for yearly booking.	4.75 inch x 7 inch
1/8th of a Page	Rs. Rs. 2,000/- + 18% GST per issue, 10% rebate for quarterly, 20% rebate for half-yearly, and 30% rebate for yearly bookings. (Only for IAStructE Members)	Standard size of Business Card

IAStructE Publications :

1. Commentary with Worked Examples for IRC: 6-2017: It is a document having commentary with worked example on IRC: 6-2017 (The code for Loads & Load Combinations for design of Highway Bridges). This commentary is in two separate volumes. Volume-1 pertains to the Commentary while Volume-2 pertains to Illustrative Worked Examples. It has 48 worked examples demonstrating application of various codal clauses

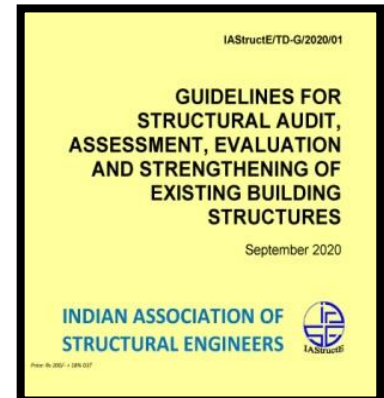
IAStructE/TD-CC/2020/02	IAStructE/TD-CC/2020/01
<p>COMMENTARY WITH WORKED EXAMPLES FOR IRC:6-2017</p> <p>STANDARD SPECIFICATIONS AND CODE OF PRACTICE FOR ROAD BRIDGES SECTION II : LOADS & LOAD COMBINATIONS (SEVENTH REVISION)</p> <p>NOVEMBER 2020</p> <p>VOLUME 2 OF 2 : ILLUSTRATIVE WORKED EXAMPLE</p>	<p>COMMENTARY WITH WORKED EXAMPLES FOR IRC:6-2017</p> <p>STANDARD SPECIFICATIONS AND CODE OF PRACTICE FOR ROAD BRIDGES SECTION II : LOADS & LOAD COMBINATIONS (SEVENTH REVISION)</p> <p>NOVEMBER 2020</p> <p>VOLUME 1 OF 2 : COMMENTARY</p>

It's a priced document and hence not freely downloadable.

The documents are available for sale @ Rs 1200/- for Volume 1, and @ Rs 800/- for Volume II. Members of IAStructE and IRC will be entitled for a discount of 10% on this amount. Interested professionals who wish to purchase the commentary may kindly register with the following link or contact IAStructE Secretariat at iastructe@gmail.com:

Registration link: <http://iastructe.co.in/new-iastructe-publication.php>.

2. Guidelines for Structural Audit, Assessment, Evaluation and Strengthening of Existing buildings Structures: This document will guide structural engineers in proper assessment of building structures before issuing structural stability certificate. These guidelines may be used by IAStructE members, all other structural engineers, house owners, housing society welfare associations, clients and corporation engineers for understanding structural audit of the private and public building structures. The Guideline focuses on the urgent need to strengthen risk resilience of buildings from any kind of risks due to earthquake and other hazards. It is hoped that this document will be useful to ensure that all structures across the country remain safe from any kind of disaster risk.



It's a priced document and hence not freely downloadable.

The price of this e-document is Rs 200/-. Interested professionals, who wish to obtain the soft version of the Guideline in pdf format, may register with the following link. Registration Link: <http://iastructe.co.in/guidelines-for-structural-audit.php>

3. Commentary on IS: 13920: The commentary is available on www.iastructe.co.in under IAStructE Professional Documents. IAStructE member can access this document after login.

4. Commentary on IS: 1893 Part 1: The commentary is available on www.iastructe.co.in under IAStructE Professional Documents. IAStructE member can access this document after login.

Message from IAStructE Social Media & Digitization Committee

Let's get "*****DIGITIZED*****"

With all new look of our website and media handles, please follow us on all major media platforms. For joining us, below mentioned links to be pasted in browser. Let's join hands together to promote the profession of Civil Engineering.

1. **on TWITTER as IAStructE:** - <https://twitter.com/iastructe>
2. **on Facebook as IAStructE:** - <https://www.facebook.com/IAStructE-100114022302316>
3. **on LinkedIn:-** The group is defined as Indian Association of Structural Engineers-IAStructE
<https://www.linkedin.com/groups/6646248/>
4. **on YouTube as IAStructE Webinar:-** Subscribe and press bell icon
https://www.youtube.com/channel/UCvv7ojX09Dxq1WtP_yHZTKw

COLLAPSE OF MORBI SUSPENSION FOOT BRIDGE IN GUJARAT, INDIA



Dr. Colonel. P. Nallathambi,
M/S Sakthi Consultancy Pvt.
Ltd., Chennai 600044

Dr. Colonel. P Nallathambi is the chief of M/S Sakthi Consultancy Pvt. Ltd., Chennai. His company is involved in designing of Government, Public and private buildings all over India. He is a graduate in Civil Engineering, Anna University in 1985 and obtained post graduate degree in Structural Engineering in 1988. He did Ph.D in Earthquake Engineering at Anna University, Chennai in Dec 2017. He also obtained post graduate degree in operational management (MBA) and computer applications (MCA). He joined Indian Army in Jan 1988 and commissioned into Corps of Engineers. After one year of training in Indian Military Academy, Dehradun, he served subsequently in Punjab, J&K, Rajasthan, West Bengal and Assam border areas and took active part in many operations of Indian Army including IPKF in Srilanka. He has vast experience in bridging and combat engineering during his service. He had gained valuable experience in project execution, project management and structural design of various civil works while working in military engineering service for 9 years. He had three years teaching experience 1992-95 in college of military engineering (CME), Pune. After completing 21 years of army service, he has started his own civil and structural consultancy office in 2009. He is a member of many technical institutions and actively participated in all activities of them. He writes articles over seven years on a regular basis in many monthly magazines and shares his valuable experience which he has gained in the construction industry.



Dr. N. Subramanian,
Consulting Engineer,
Gaithersburg, MD, USA

Dr. N. Subramanian, Ph.D, FNAE, an award-winning author, consultant, and mentor, now living in Maryland, USA, is the former chief executive of Computer Design Consultants, India. A doctorate from IITM, he also worked for 2 years with the Technical University of Berlin and the Technical University of Bundeswehr, Munich, as Alexander von Humboldt Fellow. He has 45 years of professional experience which includes consultancy, research, and teaching in India and abroad. Dr. Subramanian has authored 25 books and 300 technical papers, published in international/ Indian journals and conferences. He is a Member/Fellow of several professional bodies and a past vice president of the Indian Concrete Institute and the Association of Consulting Civil Engineers (India). He is a recipient of several awards including the ICI - L&T Life-Time Achievement award of the Indian Concrete Institute(2013), Tamil Nadu scientist award (2001), Gourav Award of the ACCE(I)(2021), and the ACCE(I)-Nagadi best book award for three of his books (2000, 2011, 2013). He has also been in the Editorial Board/Review committee of several Indian and international journals.

1.0 INTRODUCTION

The 142-year-old suspension bridge over the Machchhu River in Gujarat's Morbi district is located 300 km from the state capital Gandhinagar. Jhulto Pul (meaning hanging bridge) was a 233m long, 1.25m wide pedestrian suspension bridge, connecting Darbargadh palace and Lakhdhirji engineering college (Ref.1). The bridge was built in the reign of Sir Waghji Ravaji, Thakur Sahib of Morbi (1858-1922), who was responsible for building India's first art-deco palace, which is near the Morbi Bridge. The bridge was built to connect Darbargadh palace with Nazarbarg palace (the residences of the then royalty). The Morbi foot-bridge was first inaugurated on February 20, 1879, by Mumbai governor Richard Temple. All the material (wrought iron) required for the bridge came from England, and was built by Mumbai-based engineering company Richardson and Cruddas. It was completed at a cost of about 3.5 Lakhs in 1880. At that time there was a limit of 15 people on the bridge at any given time, as the narrow structure meant it swayed with any greater weight (Ref.2,3). Information on the design and other details of the bridge are not available. For decades, it's been a popular tourist attraction in the riverside town.

This 142-year-old cable suspension bridge collapsed into the river on Sunday (30.10.2022 at 6:30 pm), sending hundreds plunging about 10m into the water. It had reopened only five days ago after extensive repairs and renovation for seven months. Officials have not yet confirmed how many people were there on the bridge when the tragedy struck, but it is estimated that between 400 and 500 people were there at the time of collapse. Around 600 tickets were sold at 17 per person. According to newspaper reports and police, 141 people are dead so far (including 47 children), while many are missing and more than 180 people have been rescued, thus making it one of the worst tragedies to hit India in recent years (Ref. 2). An investigation panel has been formed, to probe the incident. Besides, ex-gratia of 2 lakhs for the kin of the deceased and 50,000 for the injured have been announced by the Prime Minister.



Figure 1 (a) Gujarat map

(b) Bridge location

(c) Morbi Bridge

(d) Collapsed Morbi Bridge

2.0 THE OREVA GROUP AND BRIDGE MAINTENANCE

The bridge is now owned by Morbi municipality, which had signed a contract with the Morbi-based private trust Oreva for repair of the foot-bridge in March 2022. Oreva's flagship company, Ajanta manufacturing Pvt. Ltd., had also been awarded a 15-year contract for the overall management of the bridge (including maintenance, security, ticketing, cleaning and staff deployment), since 2008. As per times of India, it is not known how the Oreva group managed to get the contract to maintain this 142-year-old bridge, which requires specialized knowledge in bridges and also in its repair and rehabilitation. The Oreva group was founded by Mr. Odhavji R. Patel, about 50 years back,

manufacturing wall clocks under the popular Ajanta and Orpat brands. Mr O.R. Patel was a science teacher at a school, before turning an entrepreneur in 1971 at the age of 45, and passed away earlier in October 2022 at the age of 88 years. This group now has a turnover of about ₹ 800 crores and manufactures wall and digital clocks, electrical appliances, CFL bulbs, calculators, ceramic products, e-bikes, etc. Its manufacturing plant, which is spread over 200 acres of land, is at Samakhiyali, Kutch district, Gujarat. In its profile on its website, the Oreva group claims that it employs over 6,000 people but there is no mention about its construction business.

According to the Independent dated 1st November 2022, the bridge suffered “extensive damage” in the powerful earthquake that shook Gujarat on 26 January 2001. The 7.7-magnitude quake, whose epicentre was in Gujarat’s Bhuj, killed an estimated 20,000 people and injured more than 150,000 others in north-western India. The Oreva group claimed that it had spent ₹ 2 crores on the Morbi foot-bridge renovation. Some newspaper reports claim that they spent only about ₹ 12 lakhs on the repair. The bridge reopened on 26 October 2022 on the occasion of the Gujarati New Year after being closed for six months. According to the Independent, at the re-opening ceremony, Oreva’s managing director told reporters that people could enjoy a ‘care-free adventure’ and the bridge would not need any major work for another 8-10 years.

Normally when bridges are constructed or renovated, before opening it for public, technical assessment is a must, and the load bearing capacity of the bridge is tested/ accessed. Only after ascertaining the safety, a certificate is issued by the concerned authority for the bridge to be opened for the public. According to some reports, the bridge was reopened ahead of schedule after repairs and without the required fitness certificate from the local civic authorities. The Oreva group was allowed to charge tickets at ₹17 from those who want to visit the foot-bridge. On the fateful day, people were charged up to ₹50 and about 600 tickets were issued, and it is estimated that more than 500 people were there on the foot-bridge, while the estimated capacity was only 125. The chief officer of the municipality, who had given the contract for the repair and rehabilitation of the bridge, after the 2001 earthquake, said that the private firm responsible for the renovations “threw the bridge open to visitors without notifying the municipality, and therefore, the municipality could not get a conduct a safety audit of the bridge”.

3.0 COLLAPSE OF THE BRIDGE

On 30 October 2022, four days after reopening, the bridge collapsed at 6:30 pm, when more than 500 people were celebrating the Diwali and Chhath festivals on the bridge and throwing their offerings to the river below. CCTV footage of the bridge at 6.31pm showed some people taking ‘selfies’ on the packed bridge while others were seen shaking the bridge just before it collapsed. Later footage showed the structure shaking violently and people holding onto cables and fencing on either side of the bridge before the walkway gave way. Further images showed the walkway had separated and collapsed at the mid-point, with some pieces still hanging from snapped cables, during rescue operations (see Fig.2). Another video in the aftermath of the collapse showed people hanging from one side of the bridge as they waited for help. A survivor claimed that there were too many people on the bridge and they could barely move, and that some victims were crushed by pieces of the bridge (Ref. 2). Five teams from the national disaster response force started rescue operations. Later they were joined by army, navy and air force staff. Police, military and disaster response teams were deployed for rescue operations. At

least 141 people were confirmed dead, and more than 180 were rescued, with many still missing. A large number of the victims were teens, women and the elderly. The victims include 47 children.



Fig. 2 Different Views of the Collapse of the Bridge

3.1 Rescuers Searched For Survivors at Night

On Monday (31.10.2022), a dozen boats with members of the national and state disaster response teams searched for survivors while divers from the Indian navy were on standby. Four cranes were deployed to pull out the bridge wreckage and rescuers looked for bodies trapped underneath. Distressed relatives searched for their loved ones and as the hours passed, their desperation grew. After the incident, dozens were seen clinging onto the wreckage as emergency teams attempted to rescue them. Some survivors clambered up the bridge's broken netting, and others managed to swim to the river banks. Early on Monday morning, rescuers made an opening in a small dam on the river, about 500 metres downstream, to reduce the water flow. The bridge above the dam was packed with people, waiting to hear news about their loved ones.

3.2 Action Taken By Police and the Government of Gujarat

The police have arrested nine people in connection with the bridge collapse. According to the police, out of these nine, two worked as managers, while two worked as ticket booking clerks of Oreva, at the bridge site. The other five accused include two people contracted with the repair the structure, as well as security personnel at the bridge. Earlier, it registered an FIR on charges of culpable homicide against agencies given the task of maintenance and operation of the bridge. Morbi superintendent of police (SP) Rahul Tripathi said some people have been called for preliminary questioning after the registration of the fir on Sunday. As per the fir, the incident took place because of the "callous approach" of the agency people. The FIR further stated that persons concerned or agencies did not pay attention to the quality of maintenance as well as repair work of the bridge. There was no immediate response from Oreva to the news of the arrests. A five-member committee was formed by the government of Gujarat to investigate and determine the cause.

4.0 POSSIBLE REASONS OF COLLAPSE

An investigation into the suspension bridge collapse has already begun. The Morbi bridge collapse might have been a result of major lapses by the authorities responsible for the renovation of the 142-year-old bridge. Possible reasons that led to the collapse are:

1. This bridge was built during the British period (already over 140 years old) and was meant for a maximum of 125 people only (it is not clear how this number of 125 was determined). Hence, the bridge has clearly crossed its indented service life and should have been considered as a heritage bridge.

2. The Oreva group, which was awarded the contract to maintain and manage the bridge by the Morbi municipality, reportedly had no experience in the construction business. While the firm specializes in CFL bulbs, wall clocks, and e-bikes, it is unknown how it managed to get the contract to maintain a 142-year-old bridge. It is also not clear what extensive repairs and renovations were done and whether safety checks were carried out before the bridge was reopened to the public. It is learnt that the repair and rehabilitation work was concerned with the floor of the bridge and after the failure the main cables were found to be corroded (reducing its load carrying capacity).
3. The dominant failure modes of the suspension bridge were found to be due to the fracture of suspenders followed by the bending failure of cables/girders (Lu et al., 2020). The degradation of suspenders due to fatigue-corrosion damage has a significant effect on the system reliability of a suspension bridge (Lu et al, 2020). In Morbi Bridge, the suspenders were found to be not straight and also bent (Ref. 5).
4. The bridge was closed for seven months for renovation and was allegedly reopened five months ahead of schedule. How a ₹ 2 crore repair and renovation work was carried out in such a short time was also not known. As per the unconfirmed reports, the contract was awarded to Oreva group on a nomination basis that subcontracted it to a small engineering firm. Only a reputed construction company with a good track record in repairs and rehabilitation should have handled this project.
5. There was no fitness certificate or permission given by the local municipal body to reopen the bridge. It is also not known whether the local municipal body has competent persons to check the strength and stability of a specialized suspension bridge of this nature.
6. Around 600 tickets were sold to enter the bridge. This suggests that the bridge was loaded beyond its capacity, well above the safety limit, which possibly is the main cause of the collapse. Citing a Forensic Science Laboratory (FSL) report, prosecutors told the court that the forensic experts believed that the main cable of the bridge snapped because of the increased weight of the new four-layered aluminium sheets used for the flooring. In addition, it was mentioned by the prosecutors that cables of the bridge were not replaced during the renovation and only the flooring was changed. However, Dr. Manmohan Maniyar showed the following calculations: If the usual live load of 2 kN/m² is considered, the bridge with its dimensions of 233 × 1.25 m. = 291.25 m², should have been able to sustain 291.25 × 2 = 582.5 kN, or 58250 kg which is equivalent to 58250/60 = 970 people. If they were promoting tourism on that bridge attracting crowds, a loading class of 5 kN/m² should have been considered (ideally with dynamic load amplification factor over and above it.). Thus, according to him, the bridge structure could have been deteriorated, under-designed and certainly not fit for nominal loads expected during extended life time and in no way fit for tourist crowd in any sense.
7. In addition the overload on the bridge, some people on the bridge were trying to oscillate it, initiating the collapse.
8. Suspension bridges are not only subjected to dead and live loads but also to the dynamic nature of wind load or people marching on it may create vibration. The latter can create resonance increasing the amplitude of the vibrations and causing it to collapse. (In April 1831, a brigade of soldiers marched in step across England's Broughton Suspension Bridge, causing it to collapse, throwing dozens of men into the water). But, as per Prof. Prem Krishna of IIT Roorkee, in unstiffened single span suspended bridges of this type, failure may not occur due to vibration problems.
9. As per a preliminary probe by the Forensic Science Laboratory (FSL), rusty cables, broken anchor pins, and loose bolts were among the lapses that were not addressed while renovating the bridge.

10. The wind load over the past 142 years could have induced fatigue in the cables and suspenders. The degradation of suspenders due to fatigue-corrosion damage was found to have a significant effect on the system reliability of cable-supported bridges (Lu, et al., 2020).

5.0 SUMMARY

The 142-year-old suspension bridge over the Machchhu River in Gujarat's Morbi district of Gujarat was a 233m long, 1.25m wide pedestrian suspension bridge, connecting Darbargadh palace and Lakhdhirji engineering college. It collapsed on 30th October 2022, killing 141 people, making it one of the worst tragedies to hit India in recent years. The Oreva group, which was awarded the contract to maintain and manage the bridge by the Morbi municipality, reportedly had no experience in the construction business. In addition, the bridge was over-crowded on that fateful day and some people standing on the bridge were trying to oscillate it, thus triggering the collapse.

Indian engineers have built the world's tallest rail bridge over Chenab river in Kashmir as an engineering marvel. However, authorities in Gujarat made a blunder of overloading the heritage Morbi Bridge that resulted in the loss of 141 lives. The possible cause of the failure may be due to the combined effect of corrosion and fatigue in cables and suspenders in addition to overloading. Suspension bridges are considered as fracture critical bridges; in a fracture critical bridge a failure of a tension member leads to the collapse of the entire bridge. In a study of suspension bridges in China it was found that cable replacement should take place after 26 years of service, accounting for the fatigue-corrosion damage of suspenders (Lu et al., 2020).

It is observed that about 633 numbers of more than one hundred year old suspension bridges have been built in India, and it is believed that about 45-50% of them are still in service (Ref.5). Hence, the Indian government should bring in legislation to make bridge management mandatory, similar to the national bridge inventory to monitor the condition of nearly million bridges across United States. It is a database, compiled by the Federal Highway Administration, with information on all bridges and tunnels in the United States that have roads passing above or below them. The data is often used to analyze bridges and to judge their condition. The inventory is developed for the purpose of having a unified database for bridges to ensure the safety of the traveling public, as required by the federal aid highway act of 1968 (Ref. 6). According to Er. Sachidanand Joshi of UBMS research group, India already has a database called IBMS for national highway bridges, and data was collected from 2015 till 2019. But, National Highways in India constitutes a meager 3 percent of India's road network.

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Fig 9. IAStructE Library



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Indian Association of Structural Engineers

K-69A, Basement, Kalkaji, New Delhi 110019

Tel: (011) 45794829; Email: iastructe@gmail.com; Website: www.iastructe.co.in