



## MESSAGE FROM THE PRESIDENT



Dear Members,

Greetings!!

Last two months were probably the most devastating months in the recent history of India. There is generally a feeling of sadness & frustration around us. However, encouraging news is that second wave of Covid is now on declining trend. Vaccination is best hope we have. We must take the vaccine whenever possible and must follow covid appropriate behaviour at home, workplace and in public spaces. These are trying times for all our members as they

have to work from constraint resources while making extra efforts in procuring & implementing projects amidst slowing pace of economy.

Your association is doing its best by way of organising useful technical events and addressing professional issues as and when they arise. This monthly newsletter is medium to keep you updated on such matter. Recently we concluded a phenomenally successful refresher course on 'Prestressed Concrete for Bridges & Buildings'. I would like to express my sincere thanks to the course coordinator Mr. V N Heggade & all speakers for conducting this wonderful course. Next course on 'Design & Construction of Steel Bridges' is starting from 17th July 2021. You must be aware that results of 2020 IAStructE awards have been announced and award ceremony will be on 10th July at 5.00 PM. Recently we wrote a letter to government regarding our apprehensions on the proposed amendments in architects act 1972 as being suggested by Council of Architects. Proposed amendments are profoundly serious in nature and will have far reaching adverse consequences on the civil/structural engineering profession. Contents of our letter have been published in this newsletter. I must also thank Dr. N Subramanian who is regularly contributing scholarly papers/articles in the Newsletter and our journal SED.

Committees of IAStructE have started their activities. Many of them have prepared very ambitious plans. We will announce many new initiatives soon. Your active support, suggestions & feedback on our activities is very vital for the growth of the association.

Best regards

Manoj Kumar Mittal  
President-IAStructE

## FROM THE EDITOR'S DESK



Warm greetings to all the readers!!

This month issue highlights are the action initiated by the organization regarding proposed amendments in Architects act, Mokshagundam Visvesvaraya Award 2021 award received by our honorary fellow Mr. Amitabh Ghosal and an article by Prof. Subramanian listing the various

probable causes of failure of the Mexico city metro overpass. Further, National awards 2020 for different categories are announced.

Members are encouraged to submit their achievements and articles which could benefit fellow readers.

Thanks & Regards,

Dr. Visalakshi Talakokula

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### **CONCLUSION OF ONLINE REFRESHER COURSE**

Online Refresher Course on “Pre-Stressed Concrete for Bridges and Buildings”, which was launched on 20<sup>th</sup> March 2021 has concluded on 01 May 2021. The lectures were organized on every Saturday from 02:30 PM to 06:30 PM (IST). Mr. V. N. Heggade, Fellow IAStructE and CEO, STUP Consultants Pvt Ltd was the Course Coordinator. The Course was Sponsored by VSL India Pvt Ltd, Tata Steel Ltd, CSI Engineering Software Pvt Ltd, Dextra India Pvt Ltd, Dynamic Prestress India Pvt Ltd, Midas Research and Development Centre India Private Limited, S. P. Singla Construction Pvt. Ltd and Dhirendra Group of Company. The course was attended by 170 participants. The presentations were made by the following eminent speakers.

- Dr Harshavardhan Subbarao, CMD, Construma Consultancy Pvt Ltd
- Mr. Vipul Ahuja, VP (N) IAStructE & Director & CEO, Ahuja Consultants Pvt Ltd
- Mr Vinay Gupta, Director & CEO, Tandon Consultants Pvt Ltd
- Mr Umesh Rajeshirke, VP(W), IAStructE & MD – Spectrum Techno Consultants Pvt Ltd
- Mr V. N. Heggade, CEO, STUP Consultants Pvt Ltd
- Mr. Max Meyer, Principal Consultant, Rui-Feng International Pte Ltd, Singapore
- Prof. Mahesh Tandon, Managing Director, Tandon Consultants Pvt Ltd
- Mr. Alok Bhowmick, Managing Director, B&S Engineering Consultants Pvt Ltd
- Dr. Satish Jain, Managing Director, Satish Jain Consulting Engineers Pvt. Ltd.
- Mr Jatinder Pahuja, Managing Director, Paragon Consultants Pvt Ltd
- Mr Anirban Sengupta, CTO, STUP Consultants Pvt Ltd
- Mr Sanjay Kumar Jain, CEO, B&S Engineering Consultants Pvt Ltd
- Mr Harpreet Singh, Sr. Project Manager, B&S Engineering Consultants Pvt Ltd
- Mr. P. Y. Manjure, Director, The Freyssinet Prestressed Concrete Company Limited
- Mr. Sandeep Pattiwar, Managing Director, Tangent Technical Solutions

### **STUDENT CHAPTER ACTIVITY**

Student Chapter at DTU in association with S&S Consultants organized Webinar on Building Information Modelling (BIM) by Mr Navneet Vaish, BIM Expert, Ercom Engineers Pvt Ltd on 30<sup>th</sup> May 2021.

### **FORTHCOMING EVENTS**

Event	Topic	Speaker	Date & Timing
Webinar	Conceptual Design	Mr. V. N. Heggade, Fellow IAStructE & CEO, STUP Consultants Pvt Ltd	25 <sup>th</sup> June 2021 at 04:00 PM
Online Refresher Course	Design & Construction of Steel Bridges	Eminent Experts are being invited	17 <sup>th</sup> July to 28 <sup>th</sup> August 2021 (every Saturday from 02:30 PM to 06:30 PM)
Felicitation & Award Ceremony	Felicitation ceremony of Prof. Sudhir Jain & awards ceremony for winners of IAStructE National Awards 2020 Competition	-	10 <sup>th</sup> July 2021 at 05:00 PM

The complete details of the above events shall be sent shortly.

### **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/UCvv7ojXO9Dxq1WtP\\_yHZTKw](https://www.youtube.com/channel/UCvv7ojXO9Dxq1WtP_yHZTKw)

### **STATE CENTRES**

Gujarat State Centre: - In order to increase the visibility and to organize the technical events, the governing council appointed Dr. Anal Sheth, Life Member IAStructE & Head- R&D, Fuji Silvertch Concrete Ltd as the Chairperson of the Centre.

### **IAStructE NATIONAL AWARDS Winners 2020**

The following entries have been declared winner in the different categories for the National Awards 2020. To felicitate the winners virtual award ceremony will be organized on 10<sup>th</sup> July 2021 at 05:00 PM in which all the members are cordially invited to attend the ceremony. The details of the ceremony and the program shall be sent shortly

1. **Outstanding Structure Awards (2 nos.)**
  - i) Buildings including, residential & commercial buildings, hospitals, schools etc.  
– **Embassy Lake Terraces by Innotech Engineering Consult Private Limited, Bengaluru**
  - ii) Other than Buildings such as, Bridges; Large span space structures for sports, exhibitions; industrial structures, monuments  
– **Statue of Unity by Larsen & Toubro Limited, Chennai**
2. **Outstanding Structural Engineer Award (2 nos)**

**Dr. Arjun Sil**, Assistant Professor (Gr-I), Department of Civil Engineering, National Institute of Technology Silchar

**Mr. Anal Naresh Shah**, Partner, N. K. Shah Consulting Engineers LLP, Ahmedabad
3. **Outstanding Woman Structural Engineer Award (2 nos)**

**Ms. Amutha R.**, Senior Engineering Manager, EDRC - L & T Construction, Chennai

**Dr. A. P. Shashikala**, Professor (HAG), National Institute of Technology, Calicut
4. **Promising Young Structural Engineer Award (3 nos)**

**Dr. P. Pravin Kumar Venkat Rao**, Assistant Professor, EQ. Engg. Research centre, IIIT Hyderabad

**Dr. Mohammad Adil Dar**, Postdoctoral Research Fellow at the National University of Singapore

**Dr. Satadru Das Adhikary**, Assistant Professor, Department of Civil Engineering, IIT (ISM) Dhanbad
5. **Best M. Tech Thesis Award 2020 (1 no.)** – The commendation certificate is awarded to **Mr. Tapas Tripura**, Indian Institute of Technology, Guwahati

**MEMBERS ACHIEVEMENT**



Mr. Amitabha Ghoshal, Honorary Fellow IAStructE received an Overseas Prize – Mokshagundam Visvesvaraya Award 2021 from The Institution of Civil Engineers, UK for his paper on “Howrah Bridge: Icon of a 330-year-old city in India – Part 1: History, Planning and Design. The article can be read at the following link: <https://doi.org/10.1680/jenhh.19.00017>

**NEW MEMBERS**

“Fellow” Grade

<i>M/S No</i>	<i>Name</i>	<i>Designation, Organization</i>	<i>City</i>
F-474	Dr. Arul Jayachandran S.	Professor, Civil Engineering Department, IIT Madras	Chennai
F-475	Mr. Francis Xavier Santiago	Principal, Francis Santiago & Associates,	Chennai
F-476	Dr. Vijaykumar R. Panchal	Professor, M.S. Patel Dept. of Civil Engg., CHARUSAT	Gujarat

“Member” Grade

M-300	Mr. E. Ganapathisubramanian	Proprietor, Ganapathi Associates,	Kovilpatti
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“Associate Member” Grade

AM-329	Mr. Kunj Jagdish Patel	Proprietor, Kunj Consulting Engineers	Ahmedabad
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**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:

**April - June 2021 issue:**

**Guest Editor-Dr K G Bhatia**

**Theme: Machine Foundation**

Interested professionals may send the full paper along with brief resume and photograph by 15<sup>th</sup> June 2021.

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](mailto:iastructe@gmail.com) regarding i) Broad guidelines on areas of coverage; ii) size of the article; iii) format of paper submission; iv) the dates for submission of the abstract and Full paper.

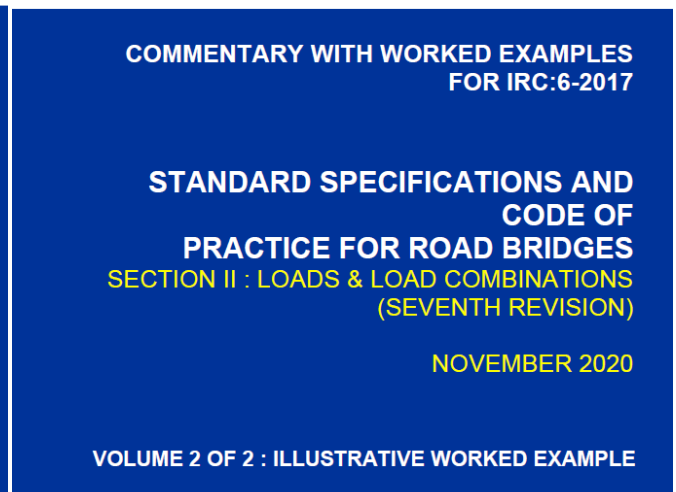
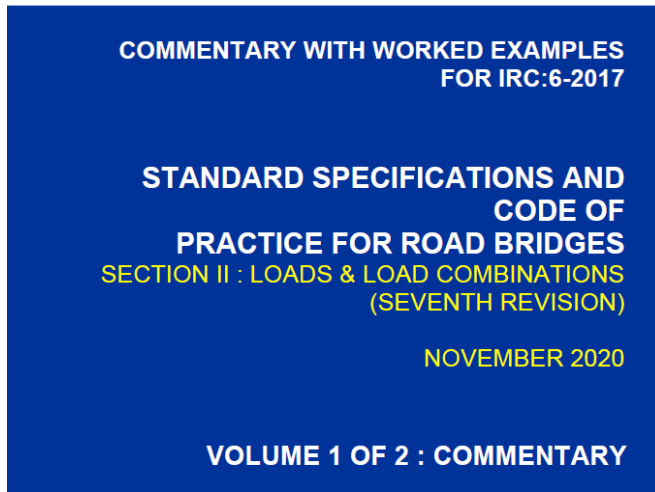
As per the laid down procedures all the papers shall be sent to the referee for review and the comments will be informed to the authors for incorporating the same. Papers shall be published after peer review & approval of SED editorial board.

**IAStructE PUBLICATIONS**

**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/2020/01

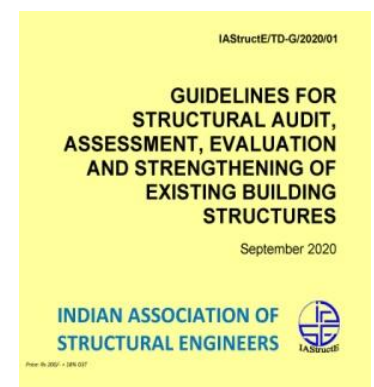
IAStructE/TD-CC/2020/02



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](mailto: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. However one can freely read the document by following the link. <http://www.iastructe.co.in/guidelines-for-structural-audit/>

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](http://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](http://www.iastructe.co.in) under IAStructE Professional Documents. IAStructE member can access this document after login.

## **PROFESSIONAL ISSUES**

### **Action initiated regarding proposed amendments in Architects Act 1972**

Council of Architecture (COA) is proposing amendments to Architects Act 1972, which if enacted will have detrimental effects on Civil Engineering profession. IAStructE and many other associations have already taken initiative at the government level to block these proposals. Recently IAStructE has sent a letter to the Ministry of Education regarding these amendments and its adverse impact on Civil /Structural engineering profession. The gist of the letters sent is given below:

- 1. It has come to our notice that Council of Architecture (COA) in its meeting is actively pursuing certain amendments to Architect's act 1972 which will be sent to Government for getting it passed by Parliament. The proposed amendments (attached as Annex-A) are profoundly serious in nature having adverse impact to the society at large and to the engineering professionals. In fact the amendments proposed defeats the very purpose and objective of this act, and if approved, it will endanger the safety of the built environment. There is anxiety and turmoil in the engineering fraternity. We being the national level apex body of structural engineers in India wish to appraise you about it with a request that such amendments should not be entertained by the Government without taking considerations of the views of engineering fraternity as well as wide-ranging consultations. The proposed amendments are against the original intent/spirit of the Act. They are detrimental not only to the engineering profession but also to public interest.*
- 2. The Statement of Objects & Reasons para 3 of the current Act reads as under:*

***“The Legislation protects the title "Architects" but does not make the Design, Supervision and Construction of Buildings as an exclusive responsibility of Architects. Other professions like Engineers will be free to engage themselves in their normal vocation in respect of building construction work provided that they do not style themselves as Architects.”***

*It makes it absolutely clear that Engineers can continue to carry out various design activities and related services for building construction, provided they do not style themselves as 'Architects'. It is further important to mention that the Joint Select Committee of both the houses of the Parliament that was appointed for the purpose added the said para 3 to the Statement of Objects after detailed deliberations on the question of allowing the non-architects/Engineers to render architectural services and the Report of the Joint Select Committee, dated: 28/11/1969 is on record. The Parliament emphatically stated that providing Architectural services is not an exclusive right of Architects and that these services can be rendered by Engineers also. So, in our considered opinion any change in this respect will be against the spirit of the Act.*

- 3. In the past The Council of Architecture (COA) taking advantage of its statutory status spread misinformation about the Act, misled various authorities, created false perception in public, issued unlawful public notices and made frivolous attempts to stop the Civil Engineering professionals from providing Architectural services by filing suits/petitions before the Hon'ble Courts in different states. The issue finally came up before the Hon'ble Supreme Court of India and the Supreme Court in its judgement dated 17-Mar-2020, in Civil Appeal No. 1819 of 2020 arising out of SLP© No. 18752 of 2014, held as follows: -*

*“... For the above reasons, we affirm the decision of the High Court of Allahabad on the first question and hold that section 37 of the Architects Act does not prohibit individuals not registered under the Architects Act from undertaking the practice of Architecture and its cognate activities”.*

*By virtue of the above judgement, it is settled conclusively that Section 37 of the Architects Act does not prohibit individuals, not registered as Architects under Architects Act, from practicing the activities undertaken by Architects, including the Design, Supervision and Construction of buildings.*

- 4. After the judgement of the Hon'ble Supreme Court dated 17-3-2020 the COA has been planning for Amendment to the Architects Act, 1972, in a manner that puts a restriction on Civil Engineers to render Architectural and allied services. The intention of COA appears to be commercial trying to gain exclusive rights over certain services which Civil Engineers have been rendering since centuries. As per the proposed amendments COA is trying to claim exclusive rights over the Architectural Services and terming it illegal if the same is rendered by Civil Engineers. In this regard COA is proposing amendment in section 37(1) of the act. At present this section reads as under:*

*“After the expiry of one year from the date appointed under sub-section (2) of section 24, no person other than a registered architect, or a firm of architects shall use the title and style of architect.”*

*The proposed amendment to this section is as under:*

*“No person other than a registered architect, or a firm of architects shall use the title and style of architect and practice the profession of an architect, including signing of building plans and related documents required for statutory approvals for the construction of any building and its related infrastructure.”*

*As is evident from above quotes the proposed Amendment to Architect Act, 1972 are essentially to prevent civil engineers from rendering architectural & other services and making them subservient to architects. As you will appreciate, this is can not be made acceptable to the engineering fraternity.*

- 5. Civil Engineers are professionally well qualified and are trained professionals who are competent to render comprehensive design, supervision & construction services for all kinds of structures including buildings. Civil Engineers are present across country including small towns. They are built-environment professionals having wider responsibility to the society at large and providing quality services to public in creating safe and affordable buildings and related infrastructure. In the national interest there is need to strengthen & support them rather than restricting their activities, The proposed amendments to the architect's act are only to protect and promote the commercial interest of handful registered architects residing in urban areas while ignoring the interests of other professionals and wellbeing of the public.*

**ARTICLE**

**COLLAPSE OF THE MEXICO CITY METRO OVERPASS**

By

Dr. N. Subramanian, Ph.D., FNAE, F.ASCE  
Consulting Engineer, Gaithersburg, MD 20878, USA

**Abstract**

On 3 May 2021, at 10:25 pm local time, a girder supporting an overpass carrying Line 12 of the Mexico City Metro collapsed, killing 26 and injuring 79 people. This 11.6 km overpass of Mexico Metro system was a part of 24 km long Line 12 and was opened in 2012 at an escalated cost of \$1.7 billion. This ‘Golden Line’ (called due to its color on the Metro system’s map) experienced problems from the start due to design errors, poorly executed construction, lack of maintenance, and negligence. It was also closed several times for repair in 2014 and also after the September 19, 2017 Puebla earthquake of magnitude 7.1. The causes of this Metro's deadliest incident in almost 50 years, is being investigated and the official report is yet to be released. However, the probable causes of failures are provided for the benefit of bridge engineers.



*Fig. 1 Collapsed girder supporting an overpass carrying Line 12 of the Mexico City Metro (Credit: Reuters Photo)*



*Fig. 2 The Overpass before the accident (2019 Photo) (Source: Ref. 6)*

On 3 May 2021, at 22:25 CDT (May 4<sup>th</sup> 8.55 am IST), a girder supporting an overpass carrying Line 12 of the Mexico City Metro collapsed beneath a passing train in the borough of Tláhuac (Fig.1). It resulted in a section of the broken concrete overpass and last two cars of the train falling on the Tláhuac Avenue, near the Olivos station. As per the newspaper reports, 26 people died and 79 injured and hospitalized. It was the Mexico City Metro's deadliest incident in almost 50 years.

**METRO SYSTEM**

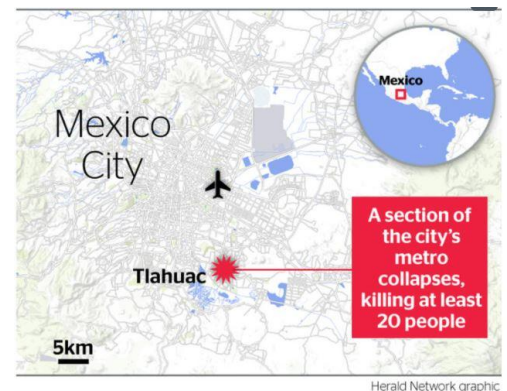
The subway system in the Mexico City, Mexico’s sprawling capital is operated by the *Sistema de Transporte Colectivo* (STC). Starting its operations in 1969, it is one of the busiest in the world, and is second only to New York City’s as the busiest subway system in the Western Hemisphere. Line 12 is 24 km long, with 11.6 km built on a raised platform. 30 metro vehicles run through its 20 stations daily. In 2019, Line 12 carried about 370,000 passengers daily. A 3.5-mile extension is scheduled to open in 2022.

**Construction of Line 12**

Line 12, also called the ‘Golden Line’ due to its color on the Metro system’s map, runs from south-central Mexico City to the semi-rural southeastern borough of Tláhuac. Like many other subway lines in

Mexico, Line 12 runs underground in most of the central areas of the city but is on elevated concrete structure on the outskirts (see Fig. 3 for the location of this collapse).

This newest line on the Metro was built by a construction consortium that included Mexico's Ingenieros Civiles Asociados (ICA) and Carso Infraestructura y Construcción (CICSA), and Alstom Transport of France. Although the construction began in September 2008 it suffered multiple construction delays. The columns supporting the overpass were decorated with Aztec artifacts and Maya-style friezes. Finally, it was opened in October 2012 by the President Mr. Felipe Calderón and the head of government of Mexico City, Mr. Marcelo Ebrard. Mr. Ebrard served as the mayor of Mexico City during 2006- 2012, and this subway line was considered as one of the landmark projects of his administration. The project exceeded the initial cost estimate of US \$1.29 billion and was completed at a cost of \$1.7 billion.



*Fig. 3 Location of Mexico City Metro overpass collapse (Source: [www.nzherald.co.nz](http://www.nzherald.co.nz))*

## INITIAL PROBLEMS

Similar to several Metro's lines, Line 12 runs underground in the central parts of the Mexico city and runs on elevated overpass in the outer areas. From the beginning, Line 12 had problems with trains on its elevated sections, when faults were detected in the tracks, rails and curves. This resulted in reducing speeds as low as 5 km/h on some segments due to the concerns of derailment of coaches. Service on a large part of the elevated overpass was suspended, just 17 months after the \$2 billion line was inaugurated. In March 2014, the 13 km of line running on the overpass, that includes the section where the accident happened, were again closed for 18 months to carry out multiple track and structural repairs and reopened at the end of 2015.

A special commission was created and an independent consulting group SYSTRA was asked to investigate the errors that caused these closures. After reviewing more than 2,900 documents and also after conducting tests on the tracks, SYSTRA came to a conclusion that there were errors during all the stages of the line including the planning, design, construction and operation.

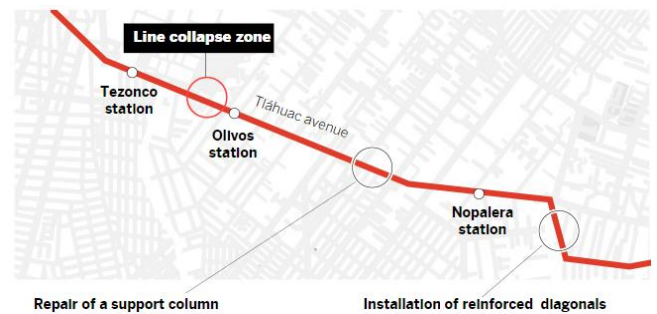
A serious accident occurred on the line in 2015, when two trains collided and injured 12 people. An investigation by Mexico City's comptroller in 2015 identified numerous instances of defective construction materials, questionable project supervision, and compatibility problem between the train wheels and the rails. Enrique Horcasitas, the former head of Proyecto Metro, and several officials of the agency, who oversaw the construction of Line 12, were brought under criminal prosecution. ASF however certified that the operation of trains on the line will be safe, provided the speed is reduced.

## Effect of Puebla earthquake

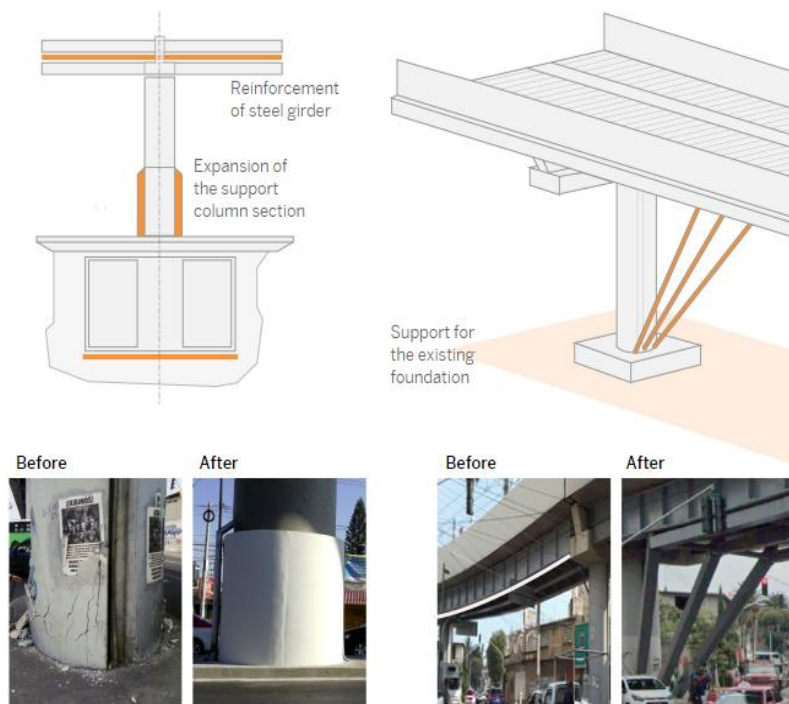
On September 19, 2017, the Puebla earthquake of magnitude 7.1 struck Axochiapan, Morelos state, resulting in 360 fatalities, of which 228 died in the Mexico City. In addition, dozens of homes and buildings collapsed within seconds. The earthquake also damaged line 12's tracks and six Metro stations, from Tezonco and Olivos. Due to this part of Line 12 was temporarily closed to carry out structural repairs. On October 30, 2017, the Government reopened the stations on line 12, which were closed due to the effects of the earthquake.

However, residents in that area complained that the earthquake resulted in visible structural cracks in several columns supporting the elevated section that may cause a future collapse. Based on these complaints, a column between Olivos and Nopalera stations, which had cracks in its base, was repaired by the transport authority in January 2018, at a cost of around \$1 million. Fig. 4 shows the locations on line 12 where the repairs were carried out. Fig. 5 shows the type of repairs that were done. However, residents again complained that the stretch was steep and the girders were bent. Based on this, engineers were supposed to conduct ultrasound tests to check reinforcing bars in 300 columns in the elevated portion of Line 12. In 2019, an engineering company Ingeniería, Servicios y Sistemas Aplicados conducted a study of the structural and geotechnical behavior of the overpass and surprisingly did not indicate any risk to the line's operation.

According to Florencio Serrania, director of the Mexico City Metro, a French company, TCO, had been under contract since 2016 to inspect and maintain the line. As mentioned earlier, the overpass sections of Line 12 had signs of deterioration, showing lack of maintenance. A report issued by the subway system including photos in 2017 revealed cracks in the base of one vertical column supporting the tracks and spalling of concrete, may be due to the provision of inadequate stirrups. In 2017, authorities undertook repairs in the column by injecting resins, wrapping it with carbon fiber, providing additional rebar around the base and pouring concrete around the collar. Authorities also found that one of the horizontal beams had come loose from its support at the top of a vertical column and was sagging - the kind of failure that could have contributed to the current collapse. To rectify the beams, authorities welded steel diagonal braces to the bottom of the beam (see Fig. 2), in addition to chipping out and repairing the fractured concrete elements.



**Fig.4. Locations on line 12 where the repairs were carried out (Source: <https://english.elpais.com/>)**

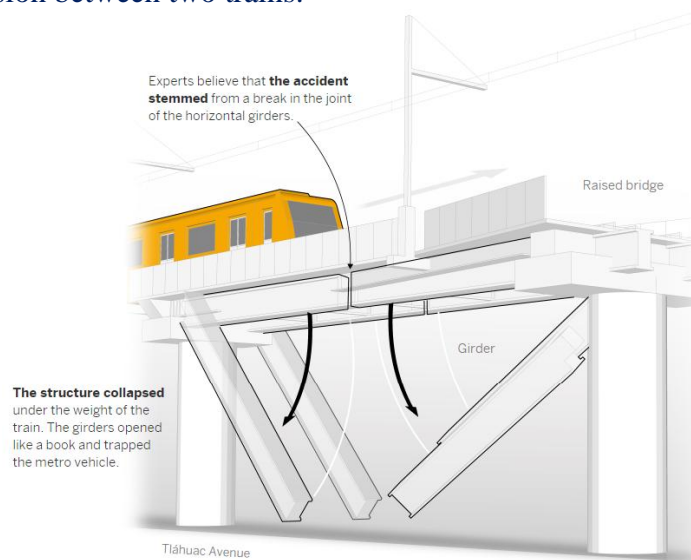


Source: Metro CDMX and OSM.

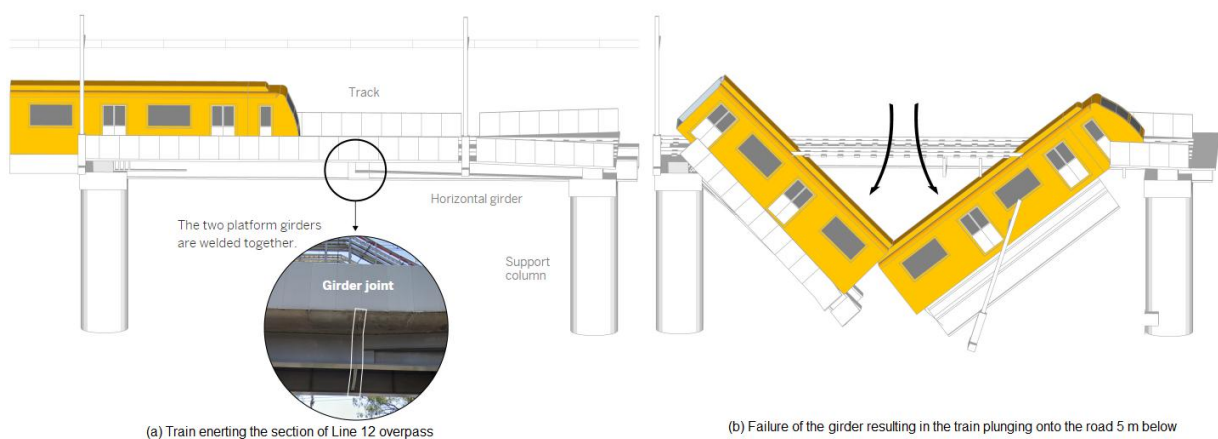
**Fig. 5 Repairs that were carried out on Line 12 supporting columns after the 2017 earthquake (Source: <https://english.elpais.com/>)**

## COLLAPSE

On 3 May 2021 at 10:25 p.m. local time, an eastward-bound train was travelling on the elevated overpass between Olivos and Tezonco stations in Tláhuac. Just 220 m before the Olivos station, a section of the overpass collapsed due to the failure of the girder supporting the tracks, as shown in Figs.6 and 7. This caused the last two train vehicles to fall. The fallen cars were suspended in a V-shape with one train car hitting the ground and the other left dangling, as shown in Fig. 1 and Fig. 7(b). Debris fell onto a car that was traveling on Tláhuac Avenue, and killed the driver and injured his wife. Though the overpass was 5 m above the ground level, a concrete median strip was provided below, which minimized casualties among motorists on the road. As per Newspaper reports, 26 people died and 79 injured and hospitalized, with seven in serious condition. It was the Mexico City Metro's deadliest incident since 1975, when 31 people died due to a collision between two trains.



**Fig.6 Collapse of the supporting girder of the overpass**  
(Source: <https://english.elpais.com/>)



**Fig. 7 The collapse scenario of the overpass of Line 12** (Source: <https://english.elpais.com/>)

## AFTERMATH AND PROBABLE CAUSES OF FAILURE

According to the government sources, the collapse is investigated by the office of the federal Attorney General, its Mexico City counterpart, and DNV, a risk management firm from Norway. Interestingly, the National Regeneration Movement (MORENA), the ruling party of Mexico, voted against creating a special commission to investigate the collapse, because they felt that the incident has no "urgent and obvious resolution".

According to Francisco García Álvarez, former president of the Mexican Association of Structural Engineering, this collapse can't be attributed to a single factor and the main cause may be due to the construction itself. Having visited the disaster zone at street level, he sees problems in the assembly process rather than in the design or quality of the materials used. According to him the V-shaped failure as shown in Figs. 1 and 7(b) may be due to a problem of welding the steel girders, which might have been shorter than the distance between the bridge columns. García Álvarez rules out the possibility that the collapse was a consequence of the 2017 earthquake while according to Sergio Alcocer, a researcher at the School of Engineering at the National Autonomous University of Mexico, too much time had passed for the earthquake to be a factor, but if that had been the cause, the columns would have collapsed.

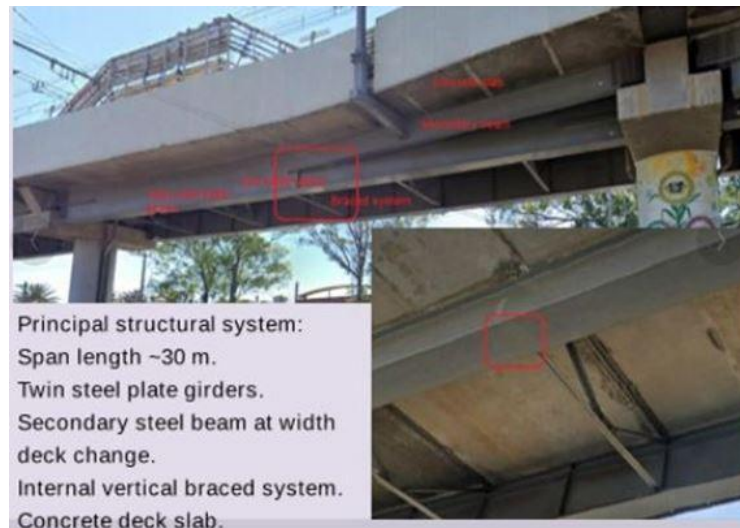
Civil engineer Uriel Perret, from the National Technological University of Argentina, believes that the collapse was caused by a construction defect or fatigue failure – “perhaps the result of negligence and corruption.” Structural engineer Fernando Zamorano of FZB diestra, Diseño Estructural Avanzado, predicts that the errors in the construction process may be the possible culprit, as many recent construction projects undertaken by the Mexican government are poorly executed. Fernando Espino, secretary of the National Union of Workers of the Collective Transportation System, blames the construction materials used as well as the use of heavier and wider metro vehicles than originally planned. However, there is a lack of consensus regarding maintenance, as the structure is relatively new.

According to Prof. Martin Polimeni, Professor at Faculty of Civil Engineering of the University of Buenos Aires and Chair of IABSE Argentinean Group, the following (one or more) may be the causes of the failure (Ref. 5):

1. Defect of a butt weld splice
2. Inconvenient location of the girder's splice.
3. Accumulated damage due to high-cycle fatigue at butt weld
4. A secondary beam is attached to the main plate girder, which could induce cyclic out-of-plane distortion (see Fig. 8). This out-of-plane distortion- might have induced fatigue.
5. Accumulated damage due to ultra-low cycle fatigue because of past seismic action
6. Constraint-induced fracture- Tensile triaxiality also could have happened due to several elements joined at the same location (braced system and secondary beam) as shown in Fig. 9.



*Fig. 8 A secondary beam attached to the main plate girder might have induced failure (Source: Ref.6)*



*Fig. 9 Elements of the structural system of the Metro overpass  
(Source: Ref.5)*

## Summary

On 3 May 2021 night, a section of the overpass carrying Line 12 of the Mexico City Metro collapsed, killing 26 and injuring 79 people. This overpass of Mexico Metro system was constructed between 2008 and 2012 at a cost of \$1.7 billion. This overpass experienced problems from the start due to poorly executed construction, lack of maintenance, and negligence. It was also closed several times for repair in 2014. Several strengthening measures were adopted after the structure was affected by the 2017 Puebla earthquake of magnitude 7.1. Although the official failure investigations have been ordered, the results may be known only after a few months. Several engineers have expressed that the failure is not due to one single cause. It might have collapsed due to design errors, poorly executed construction, lack of maintenance, effect of earthquake induced weakness, accumulated damage due to fatigue at butt welds, and continued negligence.

## Acknowledgements

The author wishes to acknowledge the references cited for the details and figures of the collapse.

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*Dr. N. Subramanian is an award winning author, consultant, researcher, and mentor, currently based at Maryland, USA, with over 45 years of experience in Industry (including consultancy, research and teaching). He is the author of 26 books, including the famous books on Design of Steel Structures, Design of RC Structures, Principles of Space Structures, and Building Materials, Testing and Sustainability.*



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