IABMAS

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Meeting Minutes

IABMAS Technical Committee on Bridge Load Testing

Zoom: https://usfq.zoom.us/j/88195686101

Monday November 20th, 08:30 – 10:00 EST, 14:30 – 16:00 CEDT

Mission: *Bridge Load Testing is a field testing technique that can be used to obtain more information about the performance of bridges. In particular, diagnostic load tests can be used to quantify elements of structural performance such as transverse distribution, unintended composite action, repair effectiveness, etc. and the information of a diagnostic load test can serve to develop field-validated models of existing bridges that can be used to develop a more accurate assessment of the bridge's performance. Proof load testing can be used to demonstrate directly that a bridge can carry a load that is representative of the live load, provided that the bridge does not show signs of distress. Other types of load testing include testing for dynamic properties, and parameter-specific tests. Load test data as well as the analytical assessment of the data can be used to make more informed decisions and manage the life-cycle performance and maintenance of bridges.*

Aspects of bridge load testing that are of particular interest to bridge owners are having an overview of the typical uses for bridge load tests, the decision on when to load test or not, which information to obtain from the load test, and how this information can be used to reduce the uncertainties regarding the tested bridge. This committee is eager to learn about and disseminate the potential for applying new technologies for bridge load testing through learning from technologies used in other industries.

Associated with bridge load testing, the following topics are also of importance to this committee: instrumentation used during load testing and the interpretation of the obtained measurements during the load test, determination of required load, method of load application, methods of updating assessments using collected field data, the link between load testing and structural health monitoring, the uncertainties (probabilistic aspects as well as risks during test execution) associated with load testing, the interpretation of load test results, laboratory testing of bridge components to improve assessment methods in the field, and optimization of related costs keeping adequate reliability to spread their use worldwide.

The IABMAS Bridge Load Testing Committee aims to be an international committee of participants from academia, industry, and bridge owners, which provides a forum for the exchange of ideas on bridge load testing. Best practices as well as the insights from the development of national codes and guidelines will *be exchanged among participants from countries that use load testing for the assessment of their existing bridges, those who are exploring the possibilities of this method, and those who are in the process of standardizing the procedures or developing guidelines.*

Goals:

- *Organize dedicated sessions to the topic of load testing at IABMAS conferences.*
- *Develop national IABMAS group events on the topic of load testing.*
- *Exchange information on the use of load testing in different countries.*
- *Exchange lessons learned and best practices.*
- *Inform about case studies of bridge load testing.*
- *Communicate load testing guides or standards that have been developed.*
- *Unify terminology and definitions associated directly with load testing of bridges.*
- *Provide a forum for new ideas and applications of technology.*
- *Identify potential research topics.*
- *Establish international collaborations.*
- *Liaise with relevant committees internationally outside of IABMAS and liaise with the national IABMAS groups.*

Committee Members

Eva Lantsoght	David Jauregui
Jesse Grimson	Ho-Kyung Kim
Mitsuyoshi Akiyama	David Kosnik (TRB AKB40 liaison)
Sreenivas Alampalli	Shane Kuhlman
Numa Bertola	**Marcelo Marquez**
Fabio Biondini	**Johannio Marulanda**
Tulio Bittencourt	**Piotr Olaszek**
Alok Bhowmick	**Pavel Ryjacek**
Jonathan Bonifaz	Marek Salamak
Matteo Breveglieri	Gabriel Sas
Anders Carolin	Gregor Schacht
Hermes Carvalho	**Jacob Schmidt**
Joan Ramon Casas	Tomoki Shiotani
Rolando Chacon	**Matias Valenzuela**
Dave Cousins	**Michal Venglar**
Dan Frangopol	**Esteban Villalobos Vega**
Monique Head	David Yang
Robert Heywood	**Yuguang Yang (fib TG 3.2 liaison)**
Boulent Imam	Ales Znidaric

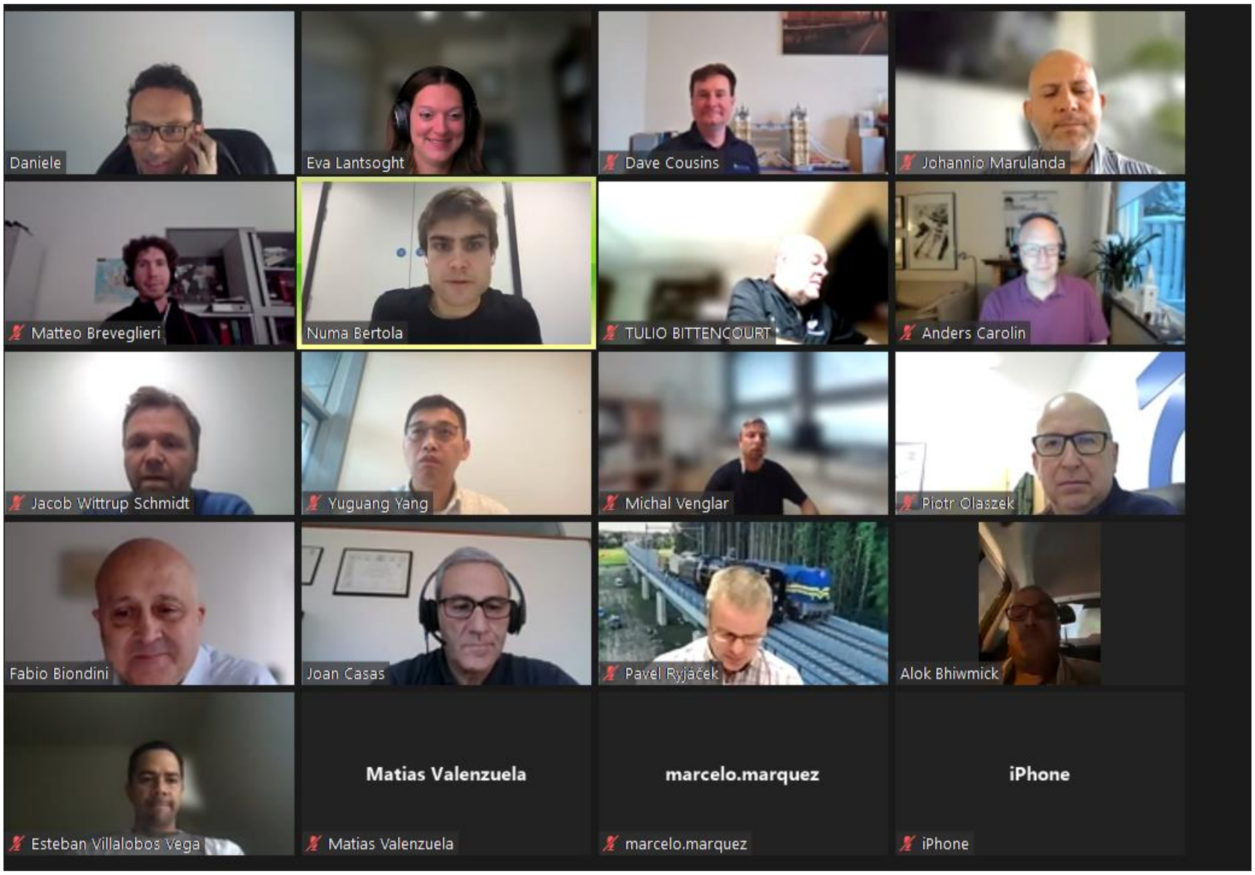
Regrets: Boulent Imam, Ales Znidaric, David Yang, David Jauregui
Guests: Daniele Losanno

1. Administrative

Eva called the meeting to order at 8:34 am EST. Eva asked for permission to use Zoom AI's assistant for the summary of the meeting to assist with writing the minutes. Unfortunately, Zoom was unable to generate a summary of the meeting.

1.1. Welcome and introduction

All 20 participants introduced themselves with their name, affiliation and relevant load testing experience.



1.2. Review and approval of agenda

The agenda was approved as is.

2. Strategic Planning and Discussion

2.1. Membership

There are no new members. Guest Daniele Losanno had expressed interest in joining the committee.

2.2. Website

On the IABMAS website, the committee information is updated.

Dave C. suggested making a map of the members and their role (academia/industry/asset owners) for the website. He volunteered to take on this task.

2.3. Review of mission

2.4. Review of goals

New goal as suggested by Dave C.: bring the standards and the terminology used for load testing into alignment internationally. Formulated as:

- To unify terminology and definitions associated directly with load testing of bridges

There was a discussion on using terms between supplementary and proving load testing in the UK, and diagnostic and proof load testing in the MBE. Yuguang also pointed out that the requirements for proof load testing differ across countries and standards.

Eva also brought up the topic of a non-uniform translation of terms to Spanish. Joan mentioned that in Spain, pruebas de recepcion is used for diagnostic load tests prior to opening new bridges. Eva indicated that pruebas de carga are used for all types of load tests in Ecuador.

Daniele and Fabio indicated that in Italy the term acceptance tests (diagnostic load tests prior to opening) is used.

Yuguang suggested to include information on this topic in the bulletin: collect different terminologies, have a chapter 2 on terminologies, collect different practices.

Eva will send the updated goals to webmaster Akiyama.

3. New Business

3.1. Research updates

Presentation by Daniele Losanno – Bridge load testing research in Italy. The slides of this presentation are added to the minutes.

Comment from Fabio: Full-scale load tests are important to inform about the interaction among different components in bridges. Recent full scale-load tests on PC bridge deck beams showed that failure can start at the interface between the PC beam and the top RC slab, leading to internal stress redistribution and brittle failure.
There was a follow-up question from Yuguang to clarify the failure sequence in bridge decks. Fabio indicated that this failure sequence was observed for the assembly of a single beam with top slab from a dismantled bridge. For grillage decks, the failure mode may start from the top slab, but it is expected that the brittle failure sequence observed for individual beams will be mitigated by the internal redundancy of the grillage.

Yuguang: for the prestressed girder, does the girder have shear reinforcement. Daniele: ϕ8 – 200 mm, very low shear reinforcement. Yuguang asked about how it relates to the Eurocode ρ_{wmin}.

Dave asked about the cyclic loading protocol, and how the time necessary in the field can be reduced. Daniele indicated that the goal is to optimize this.

3.2. Development of joint bulletin of proof load testing of concrete structures with fib TG 3.2

Eva gave an update on the current status of document and planning. The working group met on October 12th. The working group is working on the extended outlines for the chapters. Some chapters for the beginning and end of the document will be developed later. The goal is to have the extended outlines ready by the next meeting (March 2024) and develop the chapters over the next 1.5 years.

Yuguang commented on the collaboration between fib and IABMAS (coordination between fib presidium and IABMAS ExC) that is ongoing to ultimately publish the document as a *fib* bulletin.

Eva commented that Dan Frangopol suggested an SIE paper to accompany the bulletin. Eva's first idea for contents is to focus on recent research advances, mostly probabilistic advances, and introducing efforts on joint bulletin.

New volunteers from the IABMAS side are: Fabio, Tulio, Daniele.

3.3. Collaboration with other IABMAS TCs

Eva reported on the collaboration with the other IABMAS TCs. There are IABMAS committees on SHM and Bridge Management. We have the plan for workshop at IABMAS 2026 (postponed from 2024) on digital twins. Eva called for volunteers from the BLT committee to comment on one-pager under development, and to participate in this workshop.

The following members volunteered: Dave, Numa, Tulio, Joan

Dave asked if the TC chairs are aware of ISO 19650: standard for Building Information Modeling based on UK BIM framework https://www.bsigroup.com/en-GB/iso-19650-BIM/

3.4. Upcoming conferences and events

1. SYMPOSIUM ON STEEL BRIDGES 2024. 11. - 13. September. OREA Hotel Pyramida Praha. Czech Republic. https://steelbridges2024.com/
2. 20th WCNDT in Incheon, Korea, 27-31 May 2024 Special Session: AE and relevant Technologies to assess infrastructures https://20thwcndt.com/data/20th%20WCNDT_Call%20for%20Papers%20(August%202023).pdf
3. 19th Structural Faults + Repair Conference Royal Society of Edinburgh, George Street, Edinburgh, UK, 11-13 June 2024 https://www.structuralfaultsandrepair.com/
4. 36th EWGAE, Potsdam, Germany, 18-20 September, 2024 https://www.ewgae2024.com/frontend/index.php
5. 4th IIIAE Nagoya, ICAE 10, IAES 26, Nagoya, Japan, Fall, 2025.
6. SMAR Conference 2024 (INTERNATIONAL CONFERENCE ON SMART MONITORING, ASSESSMENT AND REHABILITATION OF CIVIL STRUCTURES), Salerno, Italy (September 4-6, 2024). https://www.smar2024.org/
7. 18th World Conference on Earthquake Engineering, https://www.wcee2024.it/, Milan, Italy; June 30-July 5, 2024
8. TRB Annual Meeting 2024, https://www.trb.org/AnnualMeeting/Registration.aspx Washington DC, 2024, January 7-11
9. IABMAS 2024, June 24th – 28th, Copenhagen https://iabmas2024.dk/

10. IALCCE 2025 July 15-19, 2025 Melbourne, Australia (Note that the call for abstracts will come soon) www.ialcce2025.org
11. Symposium in India on December 11th, Structural health monitoring in India
12. Conference in Czech Republic on Railways in 2024 RAILWAYS 2024: “The Sixth International Conference on Railway Technology: Research, Development and Maintenance”, in this edition also incorporating STECH 2024: “The 10th International Symposium on Speed-up and Sustainable Technology for Railway and Maglev Systems”, will take place in Prague, Czech Republic, 1st - 5th September 2024. For further details please check: https://www.civil-comp.info/2024/rl/
13. IABSE Symposium Manchester 2024, 10-12th April 2024 in Manchester UK https://iabse.org/Manchester2024
14. IABSE Congress 2024, 25th – 27th of September 2024 in San Jose, Costa Rica https://iabse.org/Sanjose2024

4. Adjournment

Next meeting – Spring 2024, online

A Symposium on

Structural Health Monitoring of Bridges in India

– A Way Forward

11 December 2023
Central Lecture Theatre
Humanities and Social Sciences Block
Indian Institute of Technology Madras

About the Symposium

Infrastructure boom in India has resulted in the construction of several road bridges. In addition, over 400,000 bridges are more than 50 years old, and many of them even 100 years. Periodic inspection of these bridges is critical to ensure their safe operations. Currently, inspection is carried out predominantly by visual inspections, and only when sought explicitly instrumented inspection is performed. Also, some of the bridges are being instrumented and monitored due to contractual obligations without any actionable outcomes. Clearly, "where to instrument" and "how to interpret the sensed values" has been an intense area of study. In fact, "which parameters determine the state of the bridge" also is under debate. With **structural health monitoring** being mandated in infrastructure contracts in India, guidelines on **where** and **how** to instrument and interpret the data is the need of the hour in the country. Formal guidelines are needed to instrument the structures, and to handle, process and interpret the data collected during monitoring.

This symposium will deliberate on the current good practices in instrumentation and data interpretation practiced in USA and India through the prism of completed and ongoing structural health monitoring projects. Challenges in ambient **vibration**-based condition assessment as well as **strain**-based monitoring will be discussed. Also, in view of the recent bridge failures, the symposium will explore how technology can be leveraged to assist in safe operations of bridges.

Participants

Technocrats, practicing engineers, researchers, academics and students, who are actively interested in Bridge Safety and Management will benefit by attending the symposium to learn the big picture of Structural Health Monitoring.

Register

https://sites.google.com/smail.iitm.ac.in/shmiitm/home

Registration Fee
Delegates ₹1,000 (+ GST)   Students ₹500 (+ GST)

Scan to Register

Lecture Titles

Lakshmy Parameswaran
Structural Health Monitoring of Highway Bridges in INDIA

Sreenivas Alampalli
Structural Health Monitoring for Asset Management of Bridges in USA

Harshavardhan Subbarao
Structural Health Monitoring for Bridges - An Overview and State-of-the-Art

N Anandavalli
Structural Health Monitoring - Future and Challenges

A Rama Mohan Rao
Vibration-based Structural Health Monitoring of Bridges

Inki Choi
Bridge Maintenance & Health Monitoring System in Practice

G D Raju
Data-Responsive Damage Detection of Bridges by Real-time Structural Health Monitoring

U Saravanan
Strain-based Structural Health Monitoring of Railway Bridges

About the Speakers

Sreenivas Alampalli

is Senior Principal in the Transportation Practice at Stantec, New York, focusing on asset management in the Bridge sector, including structural health monitoring and non-destructive evaluation services. He has over 30 years of experience in the field of Asset Management and Structural Health Monitoring.

Lakshmy Parameswaran

is Chief Scientist at Bridge Engineering and Structure Divison, Central Road Research Division, Central Road Research Institute, Delhi. With over 30 years of experience as a scientist, she has led and successfully completed over 70 research projects related to repair and rehabilitation, non-destructive evaluation, and analysis and heath assessment of bridges.

Harshavardhan Subbarao

is Chairman and Managing Director of CONSTRUMA Consultancy Private Limited. Also, he is Vice President, IABSE, Zurich, and Member of Technical Committees, such as IRC, BIS, IABSE, *fib,* and Highway Research Board of India. He has over 30 years of experience in bridge projects and played a key role in design of several landmark projects, such as Signature Cable Stayed Bridge in Delhi (India), Rail-Cum-Road Bridge in Patna (India).

N. Anandavalli

is currently Director of CSIR Structural Engineering Research Centre, Chennai. Her research interest includes blast response behaviour of structures, computational methods, sustainable materials and multi-scale modelling of composite materials. She is a Member of the Working Group of Bureau of Indian Standards related to blast resistant design of structures. She is a Fellow of Indian National Academy of Engineering and Institution of Engineers (India).

Inki Choi

is Head, Bridge Design Department, L&T Construction. He has led challenging bridge design projects during his over 28 years of experience. In particular, he steered design of Wando Grand asymmetric cable stayed bridge in Korea, Subiyah Crossing in Kuwait, Mumbai Trans Harbour Link in Mumbai (India), Durgam Cheruvu cable stayed bridge in Hyderabad (India), and Dhubri Phulbari Bridge in Assam (India).

A. Rama Mohan Rao

was formerly Chief Scientist and the Head, Structural Health Monitoring Laboratory, at the CSIR Structural Engineering Research Centre, Chennai. His research interest includes computational structural mechanics, control and health monitoring, high performance computing, and combinatorial optimization.

G. D. Raju

is Head, Geotechnical Department, EDRG, L&T Construction, Chennai. His areas of interest include design of tunnels, caverns, slope stability, structural health monitoring, numerical modelling and experimental rock mechanics. With over 20 years of rich experience in the industry and research, he played a key role in design and real-time monitoring of underground caverns and tunnels for many prestigious hydroelectric projects.

U. Saravanan

is Professor in the Department of Civil Engineering at Indian Institute of Technology Madras. He has monitored continuously railway bridges, such as Scherzer Span of Pamban Bridge, a steel plate girder bridge. He is interested in mechanics-based monitoring strategies for condition assessment of Bridges. Currently, he is the Head, Structural Engineering Laboratory, at IIT Madras, and a recipient of Mathematics Research Impact Centric Award, SERB.

Program

09:00	Registration
09:30	Inauguration

Concepts

10:00	**Sreenivas Alampalli** Structural Health Monitoring for Asset Management of Bridges in USA
10:45	Tea
11:15	**Lakshmy Parameswaran** Structural Health Monitoring of Highway Bridges in India
12:00	**Harshavardhan Subbarao** Structural Health Monitoring for Bridges - An Overview and State-of-the-Art
12:45	**N. Anandavalli** Structural Health Monitoring - Future and Challenges
13:30	Lunch

Practice

14:15	**Inki Choi** Bridge Maintenance & Health Monitoring System in Practice
14:45	**A. Rama Mohan Rao** Vibration-based Structural Health Monitoring of Bridges
15:15	**G. D. Raju** Data-responsive Damage Detection of Bridges by Real-time Structural Health Monitoring
15:45	**U. Saravanan** Strain-based Structural Health Monitoring of Railway Bridges in India
16:15	Tea

Future

16:45	**Panel Discussion** All Speakers
17:30	**Road Ahead** U. Saravanan, IIT Madras
18:00	**Symposium Closure** P. S. Lakshmi Priya, IIT Madras

Contact

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Introduction to Bridge Load Testing in Italy

Daniele Losanno
daniele.losanno@unina.it
Assistant Professor in Structural Engineering

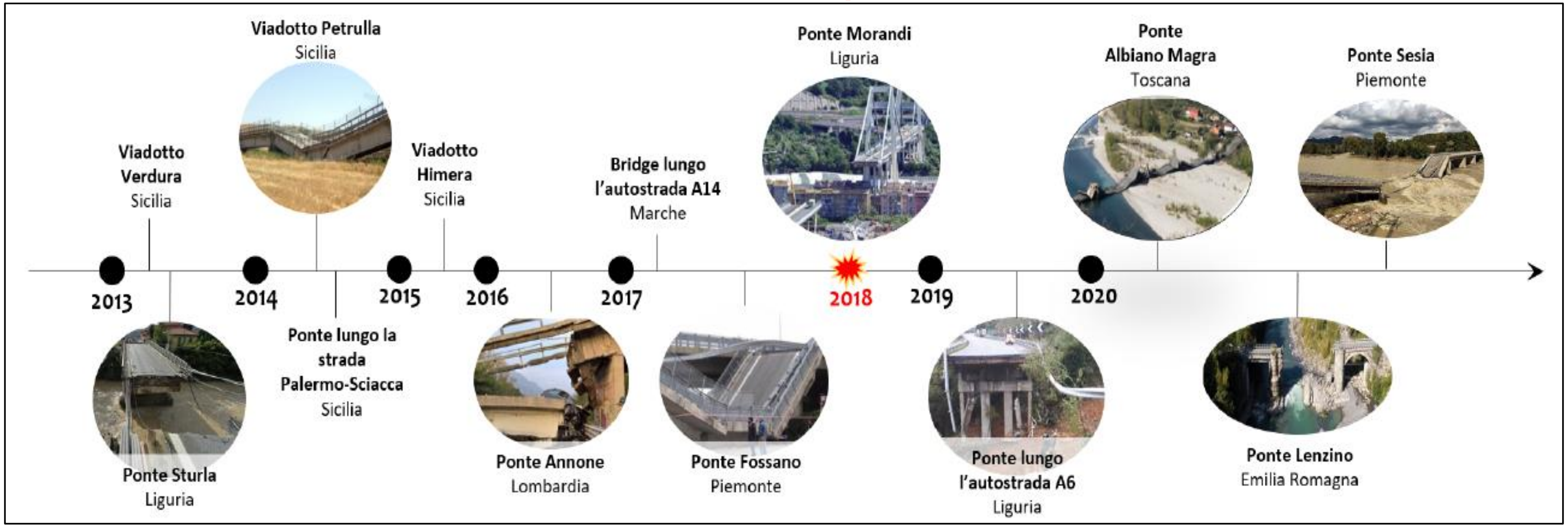
Department of Structures for Engineering and Architecture
Università di Napoli Federico II
Italy

20 November 2023

Motivation

- Many bridges and viaducts have reached a respectable age or show problems
- Large stock of existing bridges demand for safety assessment
- Looking for methods for assessment – i.e. not design
- Lack of information for many bridges
- New Guidelines after the collapse of the Polcevera bridge (designed by R. Morandi) in Genova

Before → ***After***



1. State of the art and code provisions

New Italian Guidelines for Classification and Risk management, safety assessment and structural health monitoring of existing bridges [2020]

Reluis Project

funded by the Italian High Council of Public Works

Task 4.7 – Proof load test for safety assessment of existing bridges

Cosenza and Losanno. (2021). Assessment of existing reinforced-concrete bridges under road-traffic loads according to the new Italian guidelines. Structural Concrete (doi.org/10.1002/suco.202100147)

Multilevel approach

Total number of existing bridges ~ 40.000 – 60.000

- Level 0: overall census of existing bridges to be completed by 2024
- Level 1: visual inspection and report
- Level 2: risk class assessment t.b.d. to be completed by 2026
- Level 3 and 4: safety check

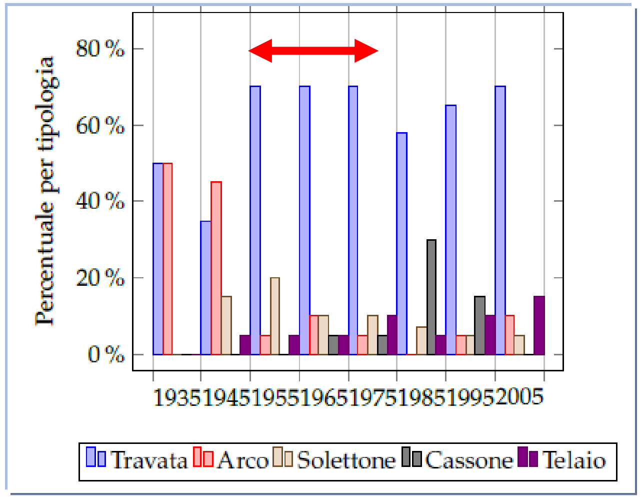
	Livello 0 - Censimento (§ 2)	Livello 2 - Analisi rischi rilevanti e attribuzione classe di attenzione (§ 4)
Concessionarie autostradali	------	entro il 30.06.2023
ANAS S.p.A.	entro il 31.12.2022	entro il 31.12.2023
Regioni, Province, Città Metropolitane	entro il 31.12.2023	entro il 30.06.2025
Comuni con resid. > 15000	entro il 30.06.2024	entro il 30.06.2026
Comuni con resid. ≤ 15000	entro il 30.06.2024	entro il 31.12.2026


Ministero delle Infrastrutture e dei Trasporti
Consiglio Superiore dei Lavori Pubblici

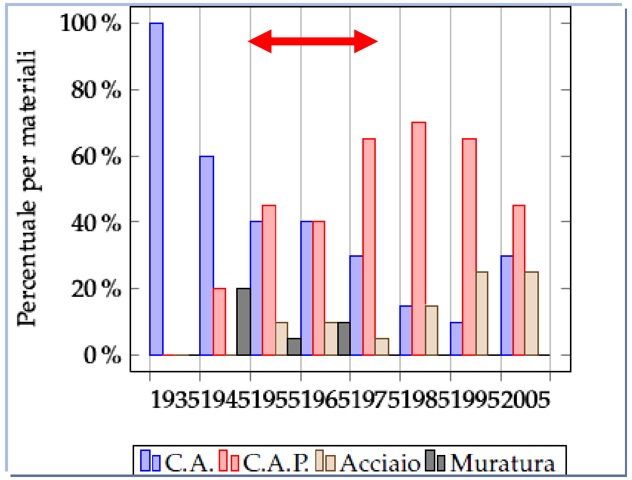
LINEE GUIDA PER
LA CLASSIFICAZIONE E GESTIONE DEL RISCHIO,
LA VALUTAZIONE DELLA SICUREZZA
ED IL MONITORAGGIO DEI PONTI ESISTENTI

Statistics for highway bridges

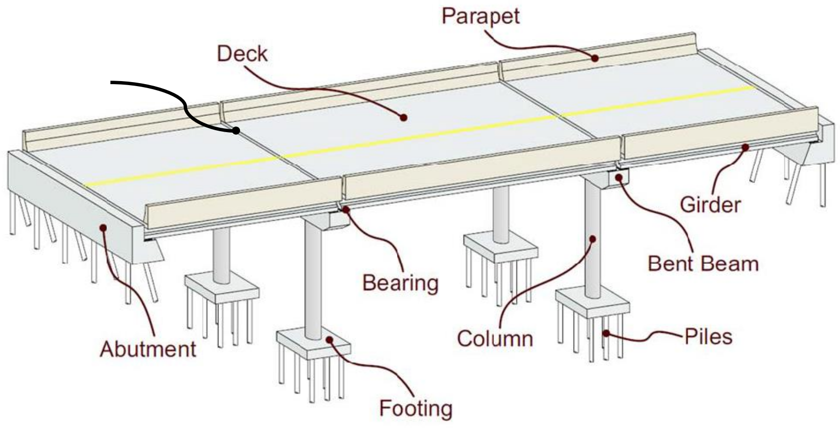
structural type



material type



Beam type PC bridges



1. State of the art and code provisions

New Italian Guidelines for Classification and Risk management, safety assessment and structural health monitoring of existing bridges [2020]

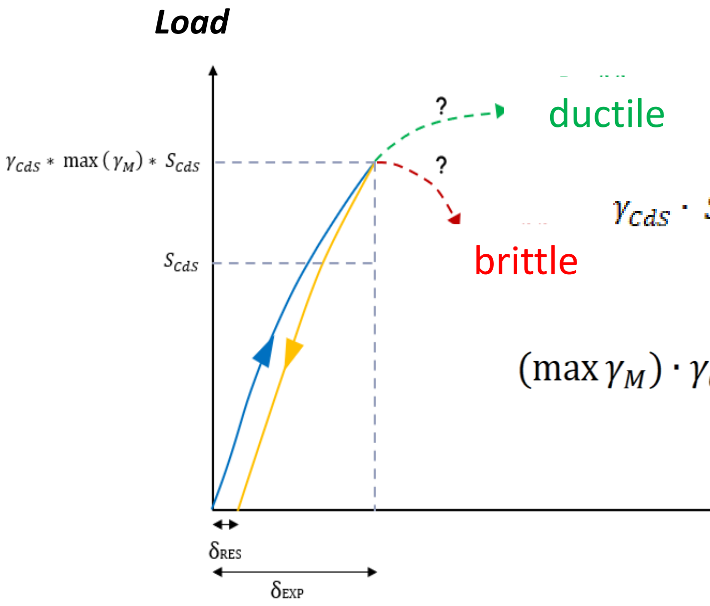
Reluis Project

funded by the Italian High Council of Public Works

Task 4.7 – Proof load test for safety assessment of existing bridges

6.3.5.5 Verifica in sito della sicurezza per transitabilità temporanea

… in special cases to prevent the bridge is closed a proof load test is accepted for no more than 60 days before an analytical safety assessment is conducted…



$$\gamma_{cds} \cdot S_{cds} < \frac{R_{el.exp}}{\max(\gamma_M)}$$

$$(\max \gamma_M) \cdot \gamma_{cds} \cdot q_{cds} \le q_{el}^{SPER}$$

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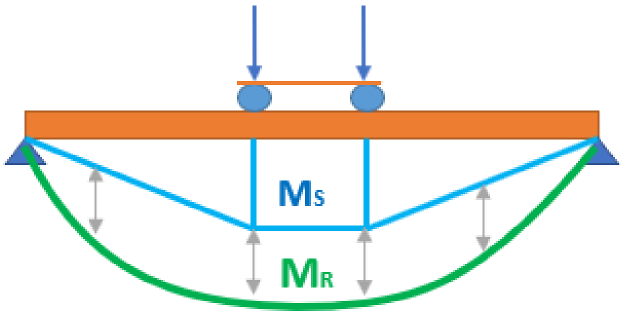
LINEE GUIDA PER
LA CLASSIFICAZIONE E GESTIONE DEL RISCHIO,
LA VALUTAZIONE DELLA SICUREZZA
ED IL MONITORAGGIO DEI PONTI ESISTENTI

PROOF LOAD TEST



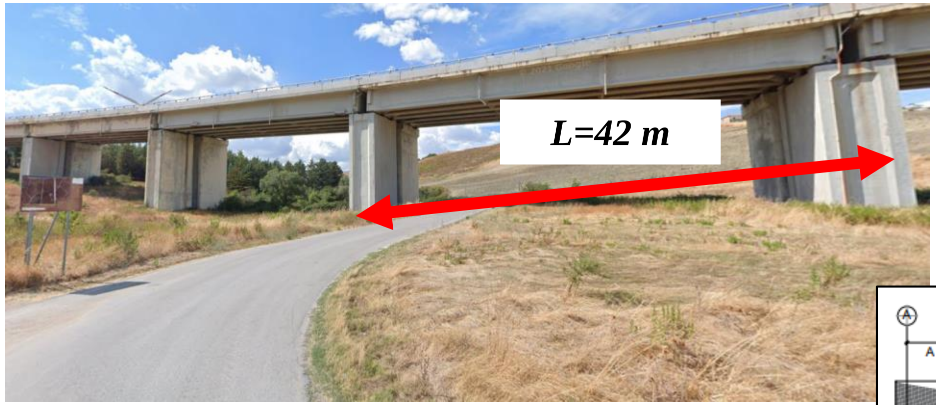
Structural Safety ???

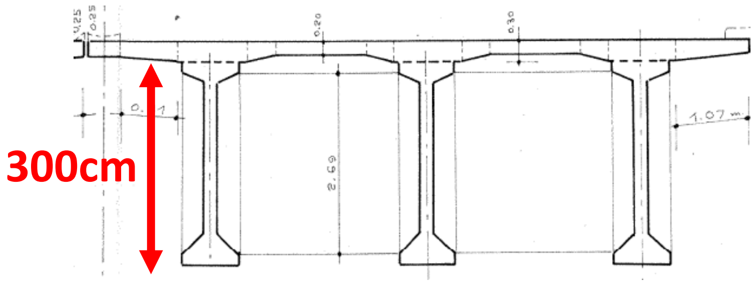
Research objective:

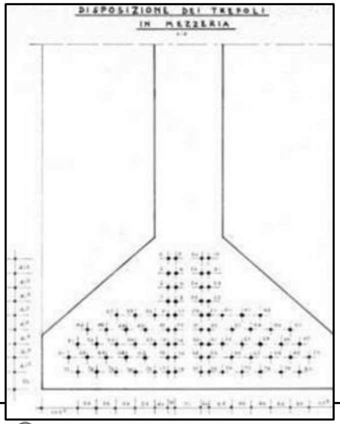
- **Reliability based Proof Load Test** (i.e., for a given β → PLT calibration)

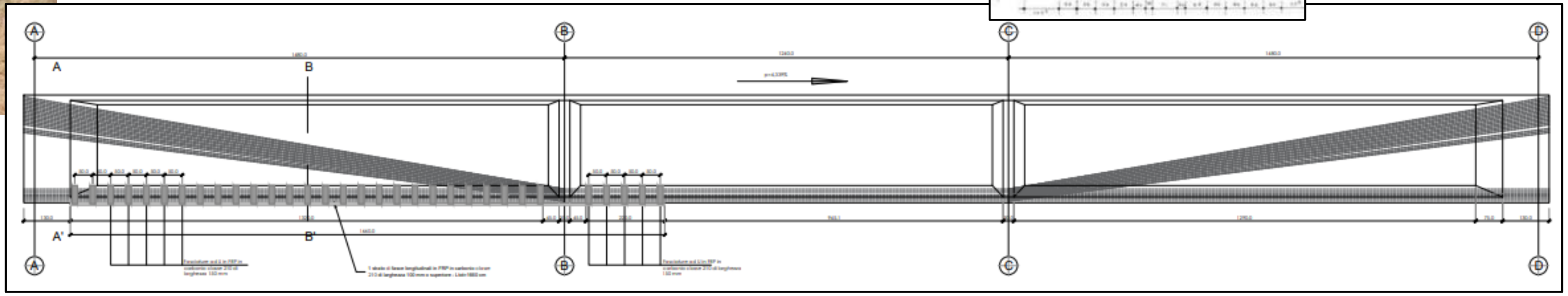
2. Case study PC bridges

Existing highway bridge having beam type pre-tensioned PC girders

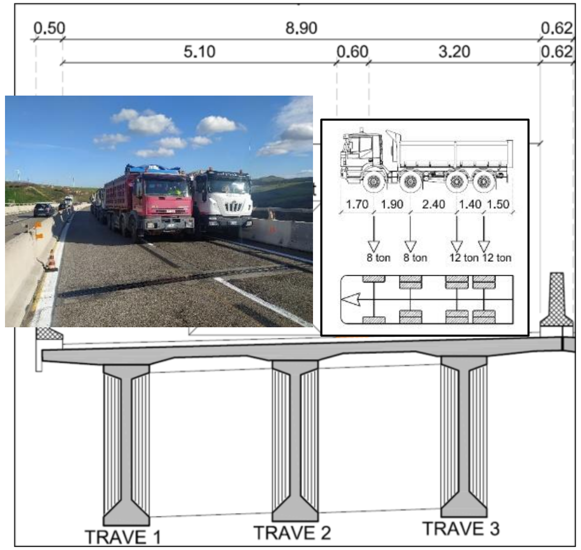






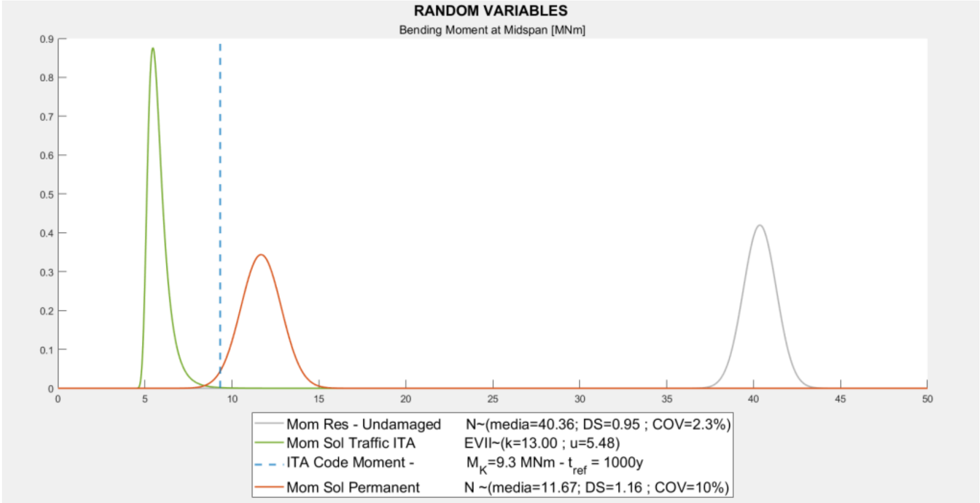


ACCEPTANCE LOAD TEST *(NTC 2018)*



$$M_{PLT} < \quad M_{cr} = \left(\frac{P_t}{A_n} + f_{ct}\right)\frac{I_1}{y_{G,i}} + M_p$$

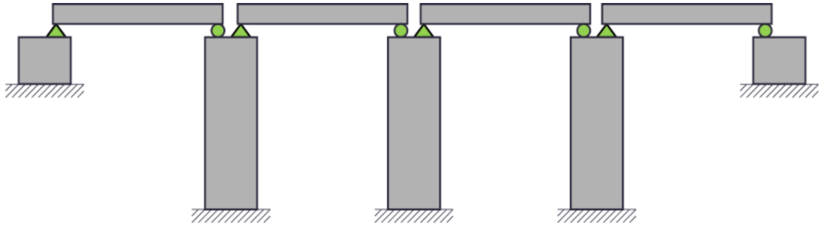
$$\frac{M_{Rd}}{M_{PLT} + M_D} \sim 2$$

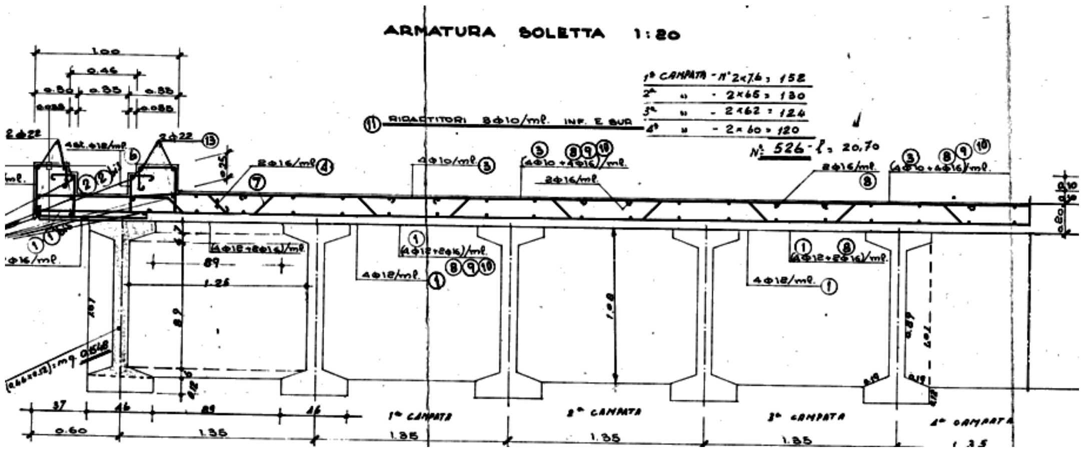


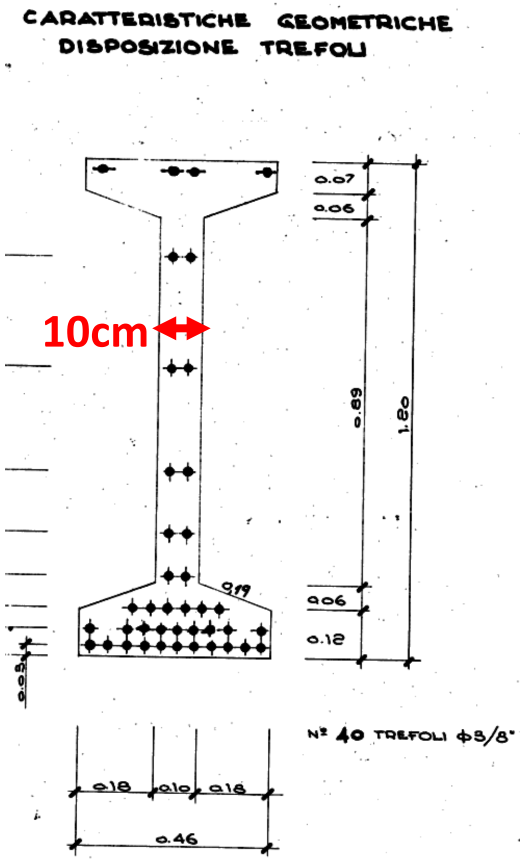
- *Addonizio et al. (2024). Reliability of pre-tensioned PC-I-girder bridge through proof load testing: a preview. IABMAS 2024: 12th International Conference on Bridge Maintenance, Safety and Management*

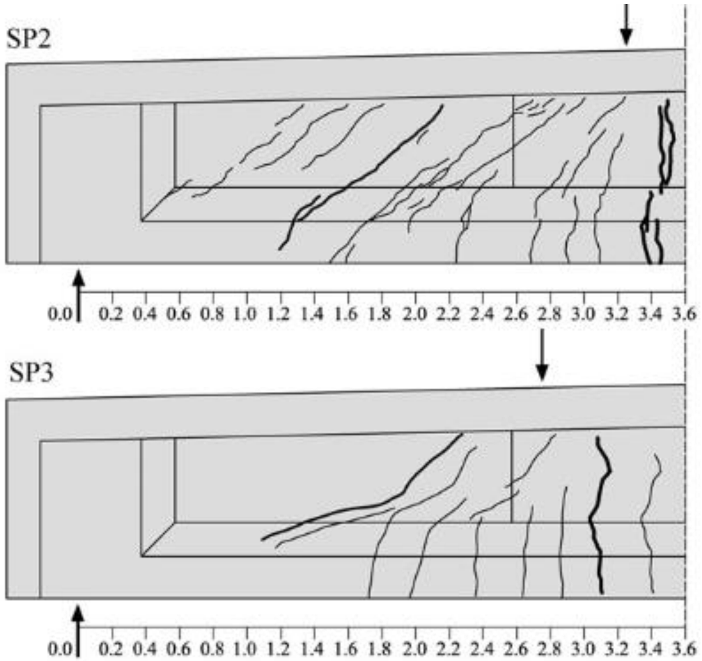
2. Case study PC bridges

Existing highway bridge having beam type pre-tensioned PC girders









Shear tension Model

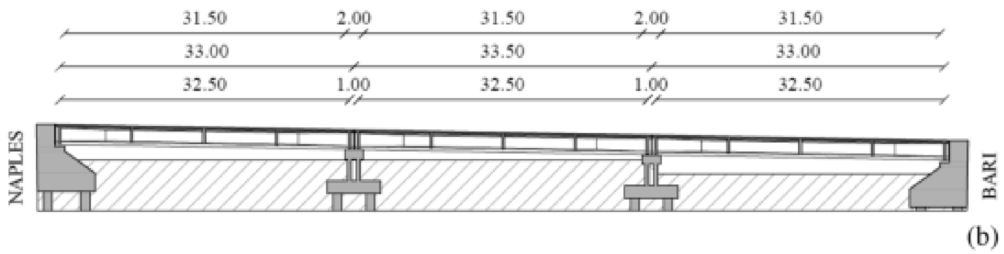
$$V_r = 0.7 \cdot b_w \cdot d(f_{ct}^2 + \sigma_{cp} \cdot f_{ct})^{1/2}$$

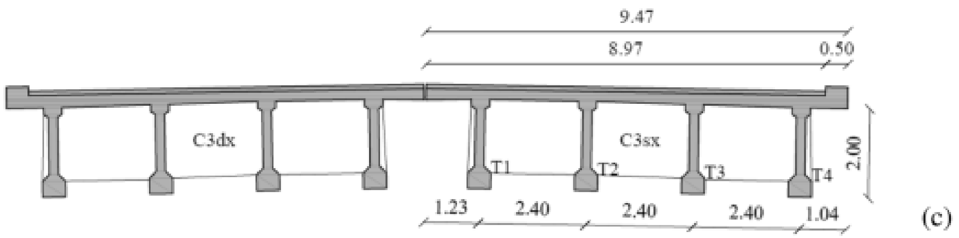
** Picture and drawings from literature*

3. Experimental tests

Experimental tests on post-tensioned bridge girders

Real (decommissioned) bridge

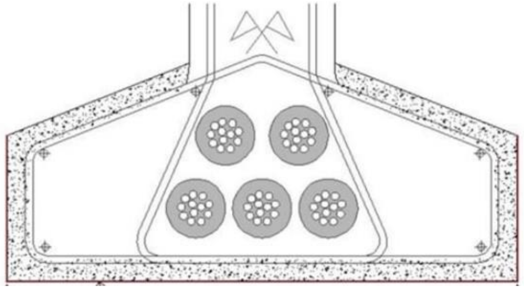




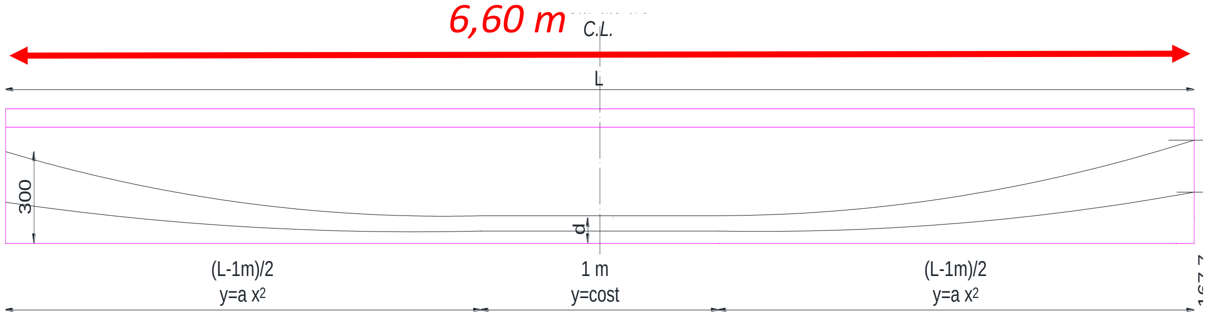
Fully injected duct

Tendon defect

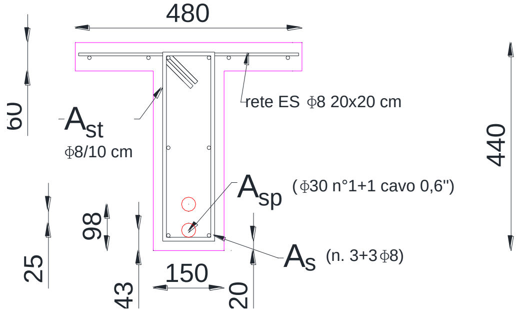
Tendon damage



Experimental programme on 1:5 scaled PC girders



Girder system
(scaled geometry)



Influence of *partial bond*, *damage* and *different prestressing levels*

Specimen ID		Grouting condition	Initial prestress force
T1	B-HP	Perfect (B)	150 kN (HP)
T2	U-HP	Lacking (U)	150 kN (HP)
T3	B-LP	Perfect (B)	75 kN (LP)
T4	U-LP	Lacking (U)	75 KN (LP)
T5	PB-M-HP	No grouting across midspan section (PB-M)	150 kN (HP)
T6	PB-L-HP	No grouting across lateral section (PB-L)	150 kN (HP)

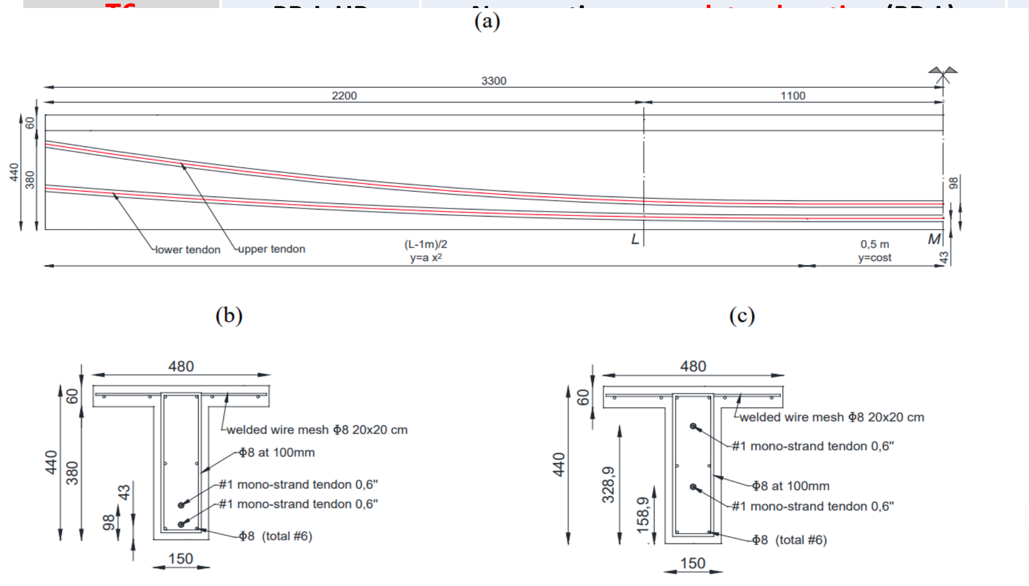
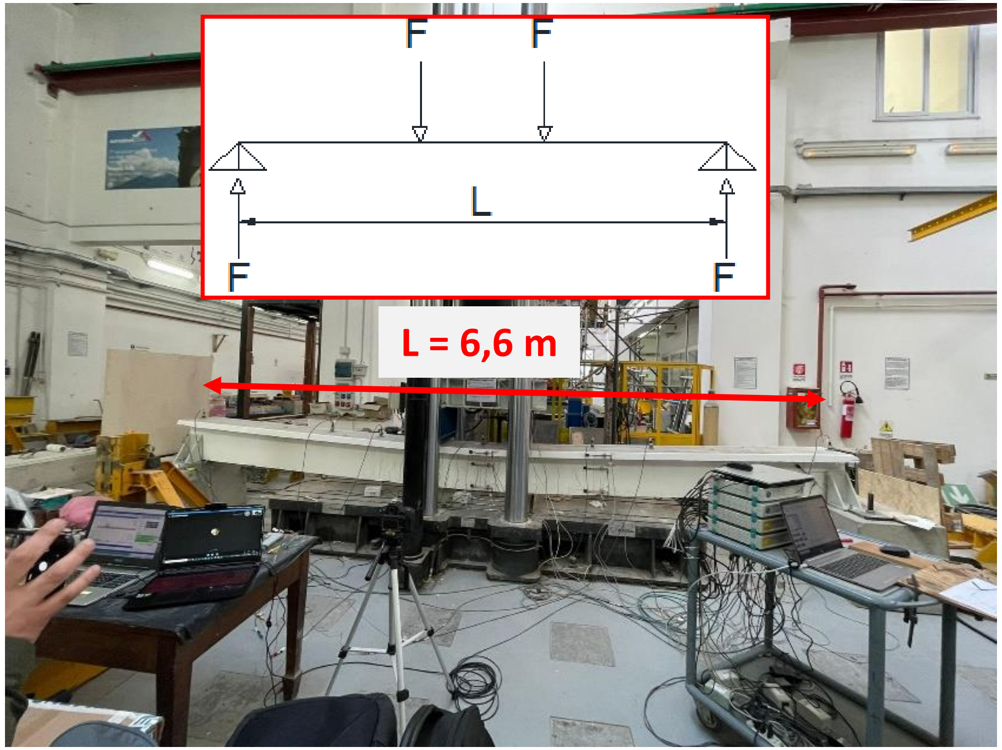
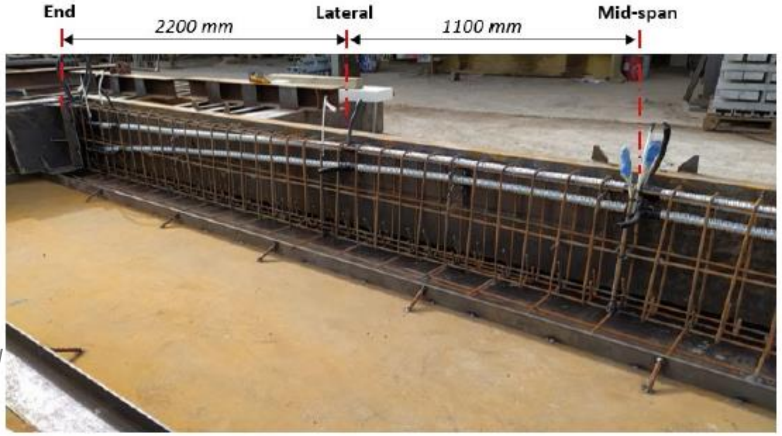
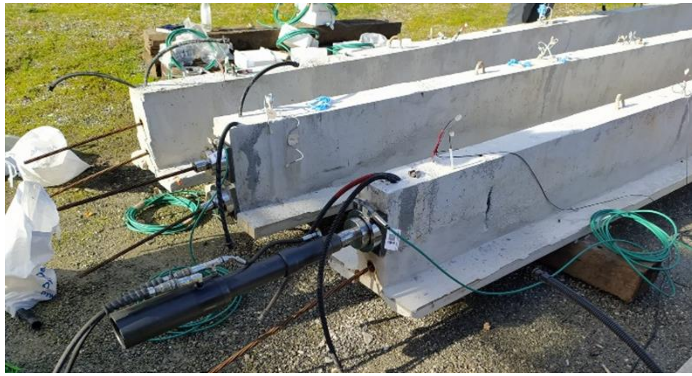


Fig. 2 Lateral view of the half girder scaled by $S_L = 5$ (a); mid-span cross section (b) and end cross section

Losanno et al. (2023). Experimental Investigation on Nonlinear Flexural Behavior of Post-Tensioned Concrete Bridge Girders with Different Grouting Conditions and Prestress Levels. ASCE Journal of Bridge Engineering (accepted for publication - DOI 10.1061/JBENF2/BEENG-6466)

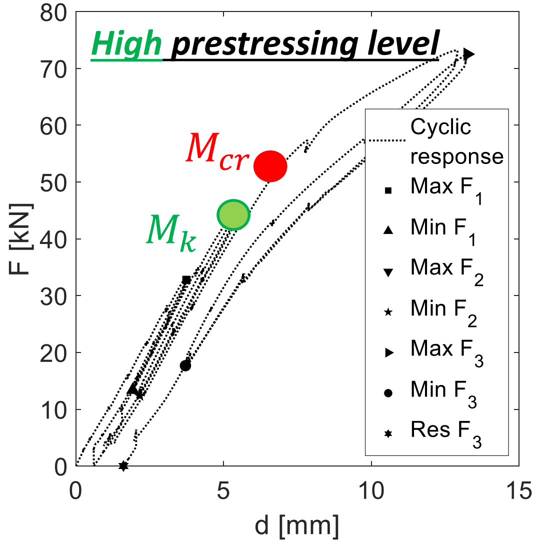


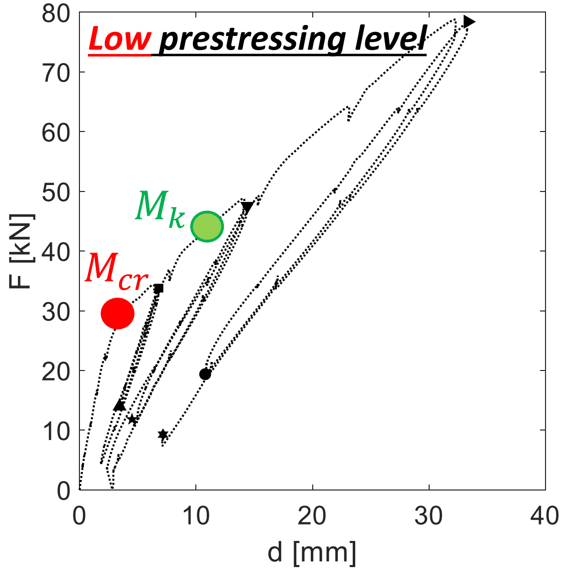




3. Experimental tests

The value of information by monitoring systems





STOP CRITERIA

TABLE 1 | Recommendations for stop criteria for proof load testing (Lantsoght et al., 2018).

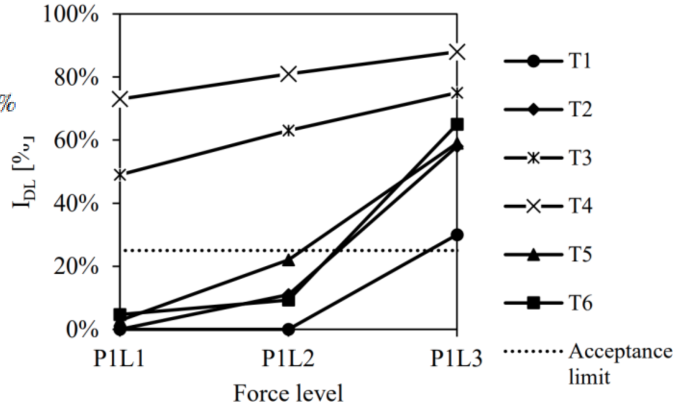
	Cracked in bending or not	
Failure mode	**Not cracked in bending**	**Cracked in bending**
Bending moment	$\varepsilon_c < \varepsilon_{c,lim} - \varepsilon_{c0}$	$\varepsilon_c < \varepsilon_{c,lim} - \varepsilon_{c0}$
	$w_{max} \leq 0.5\ mm$	$w_{max} \leq 0.5\ mm$
	$w_{res} \leq 0.3\ w_{max}$, min $0.05\ mm$	$w_{res} \leq 0.2\ w_{max}$, min $0.05\ mm$
	25% reduction in stiffness	25% reduction in stiffness
	Deformation profiles	Deformation profiles
	Load-deflection diagram	Load-deflection diagram
Shear	$\varepsilon_c < \varepsilon_{c,lim} - \varepsilon_{c0}$	$\varepsilon_c < \varepsilon_{c,lim} - \varepsilon_{c0}$
	$w_{max} \leq 0.3\ mm$	25% reduction in stiffness
	25% reduction in stiffness	Deformation profiles
	Deformation profiles	Load-deflection diagram
	Load-deflection diagram	

PERFORMANCE INDEXES [ACI 437.1R-07]

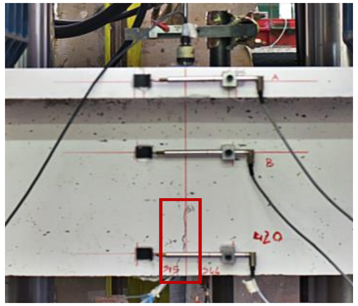
$$I_R = \text{repeatability index} = \frac{\Delta^B_{max} - \Delta^B_r}{\Delta^A_{max} - \Delta^A_r} \times 100\%$$

$$I_P = \text{permanency index} = \frac{\Delta^B_r}{\Delta^B_{max}} \times 100\%$$

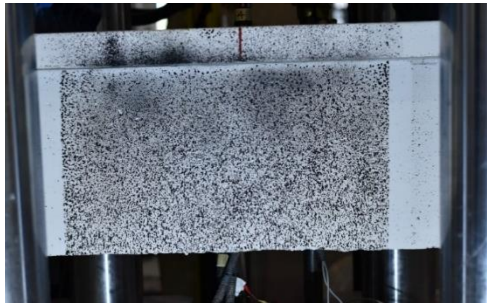
$$\text{Linearity}_i = \frac{\tan(\alpha_i)}{\tan(\alpha_{ref})} \times 100\%$$



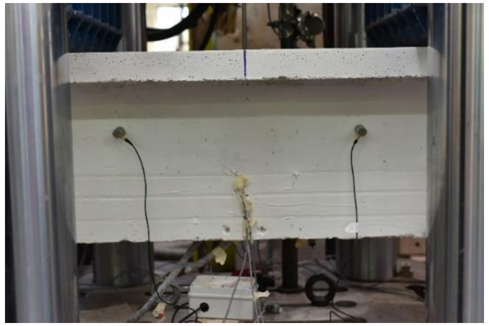
REAL TIME MONITORING



Crack opening



DIC



Acoustic emissions

OMA

3. Experimental tests

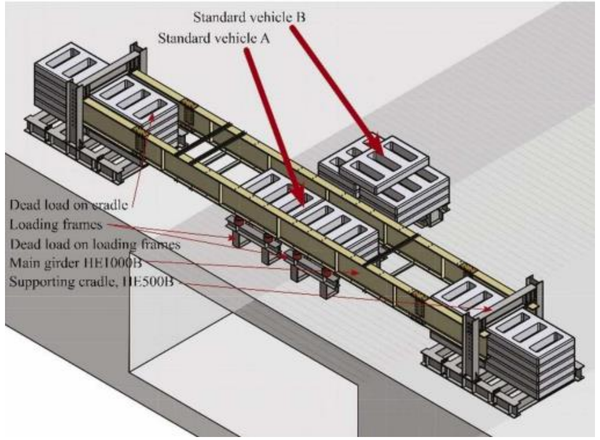
HOW DO WE IMPOSE THE PROOF LOAD?

"Traditional" PLT in Italy

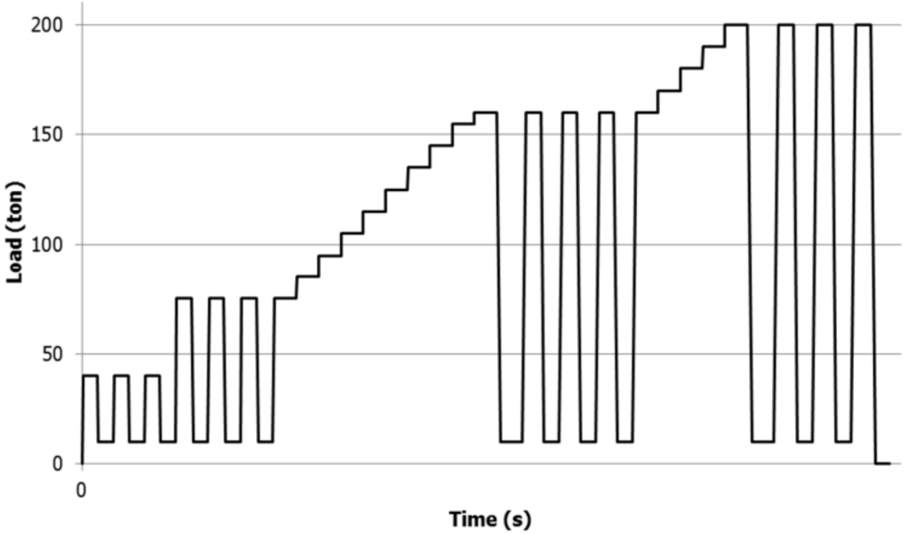
Special vehicles

Fig. 1. L: Crane with 10 Axles and Total Weight of 1100 kN, R: Low-loader with 12 Axle and Total Weight of 1650 kN

"Innovative" PLT



Loading protocol



THANK YOU FOR YOUR ATTENTION

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