FOUNDED 1999

Meeting Agenda

IABMAS Technical Committee on Bridge Load Testing

Room VS213

Tuesday July 12th 2022, 3 pm – 4:30 pm CET (Central European)

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 code-prescribed 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.
- 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
Jesse Grimson
Mitsuyoshi Akiyama
Sreenivas Alampalli
Fabio Biondini
Alok Bhowmick
Jonathan Bonifaz
Anders Carolin
Dave Cousins
Dan Frangopol
Boulent Imam
David Jauregui
Ho-Kyung Kim
David Kosnik
Marcelo Marquez
Johannio Marulanda
Piotr Olaszek
Joan Ramon Casas
Pavel Ryjacek
Marek Salamak
Gabriel Sas
Gregor Schacht
Jacob Schmidt
Tomoki Shiotani
Matias Valenzuela
Esteban Villalobos Vega
David Yang

Attendees in the room

Eva Lantsoght
Fernando Moreu
Piotr Olaszek
Sreenivas Alampalli
Gabriel Sas
Matias Valenzuela
Jacob Schmidt
Yuguang Yang
Fabio Biondini

Iman Boulent
Monique Head
Robby Caspeele
Rein de Vries
Christian Christensen

Attendees online
Alok Bhowmick
Beatrice Belletti
David Jauregui
David Kosnik
Marcelo Marquez Marambio
Francisca
Marek Salamak
Kamyab Zandi

Meeting minutes prepared by Fernando Moreu.

1. Administrative

1.1. Welcome and introduction

The meeting was called to order at 3:05 pm CEDT. All those present in the room and online introduced themselves.

1.2. Review and approval of agenda

The agenda was approved unanimously.

2. Strategic Planning and Discussion

2.1. Membership

Welcome of the new committee members. Welcome suggestions for potential members from the bridge owner side. The chair emphasized the opportunity of new people to join the membership, with an emphasis on industry and government. Comments from members interested to join from various countries: Chile, Norway.

2.2. Website

On the IABMAS website, the committee information is included. The website includes the information on the members, mission and goals of the committee, as well as the minutes of meetings.

2.3. Review of mission

The committee reviewed the mission on the screen, both in the room and in Teams. The goals were also reviewed.

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The committee reviewed the goals on the screen, both in the room and in Teams. The goals were also reviewed. The discussion also focused on outlining the next priorities of the committee. Dave Kosnik asked where the research topics would be disseminated, and this was related to the next point on the agenda.

3. New Business

3.1. Research updates

There were three short research updates:

1. 3:25-3:45pm: The possibilities of using a set of two Interferometric radars during dynamic tests of railway bridges – Piotr Olaszek (This presentation sparked a lively discussion with several questions)
2. 3:50- 4:05pm: Laboratory proof loading of trough bridges to fatigue and dynamic behavior - Gabriel Sas
3. 4:05-4:15pm: In-situ proof loading of four railway: plans and future developments - Gabriel Sas

3.2. New research topics

The chair opened the floor to bring up new research topics that this committee could support or carry out. This topic immediately followed the discussion on collaboration with *fib*.

3.3. Opportunities for collaboration

[4:15-4:25pm] Fib TG 3.2: general update from Kamyab Zandi (structures and activities). The main idea is to coordinate collaboration with FIB. The committee had about 32 people with 15 actively participating and contributing. Dario Coronelli chairs the committee.

[4:25-4:30pm] Collaboration on proof load testing report update from Yuguang Yang. Yuguang explained the updates of 2022 and their ongoing plans on proof loading in the Netherlands. He explained the interest to transform the following procedures: probabilistic tools, stop criteria, typology approach are some of them. The proposal is to work to together on a bulletin on proof load testing of concrete bridges.

3.4. Upcoming conferences and events

Information on upcoming conferences and events will be shared by email with the committee membership.

4. Adjournment

The next meeting will be in virtual format – tentatively in October 2022.

Chair Lantsoght adjourned the meeting at 4:40 pm CEDT.

IABMAS Technical Committee on Bridge Load Testing

The possibilities of using a set of two Interferometric radars during dynamic tests of railway bridges

Piotr Olaszek

Road and Bridge Research Institute, Warsaw, Poland

The possibilities of using a set of two Interferometric radars during dynamic tests of railway bridges

The application of a set of two Interferometric radars:

- makes possible to remote measurement of lateral displacements;
- increases the accuracy of remote measurement of vertical displacements (especially when accompanied by horizontal displacements transverse to the axis of view)

The possibilities of using a set of two Interferometric radars during dynamic tests of railway bridges

Interferometric radar has high accuracy when measuring displacement in the direction of its target axis.

Then, the range direction will be vertical and measured displacements will be determined directly.

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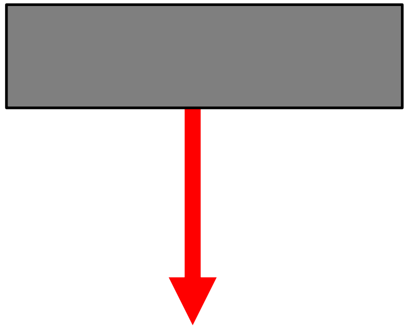
The possibilities of using a set of two Interferometric radars during dynamic tests of railway bridges



In the case of when we do not have access to the area under the tested point of the structure,
we have to set the range direction at an angle
to the measured vertical displacements.

The actual vertical displacement will be calculated based on the geometry of the system and assuming zero horizontal displacement.

Remote measurement of lateral displacements

The length of span is 93.00 m

The rail-way track is curved

with a radius of R = 2600 m

Steel free-end framework with parallel chords

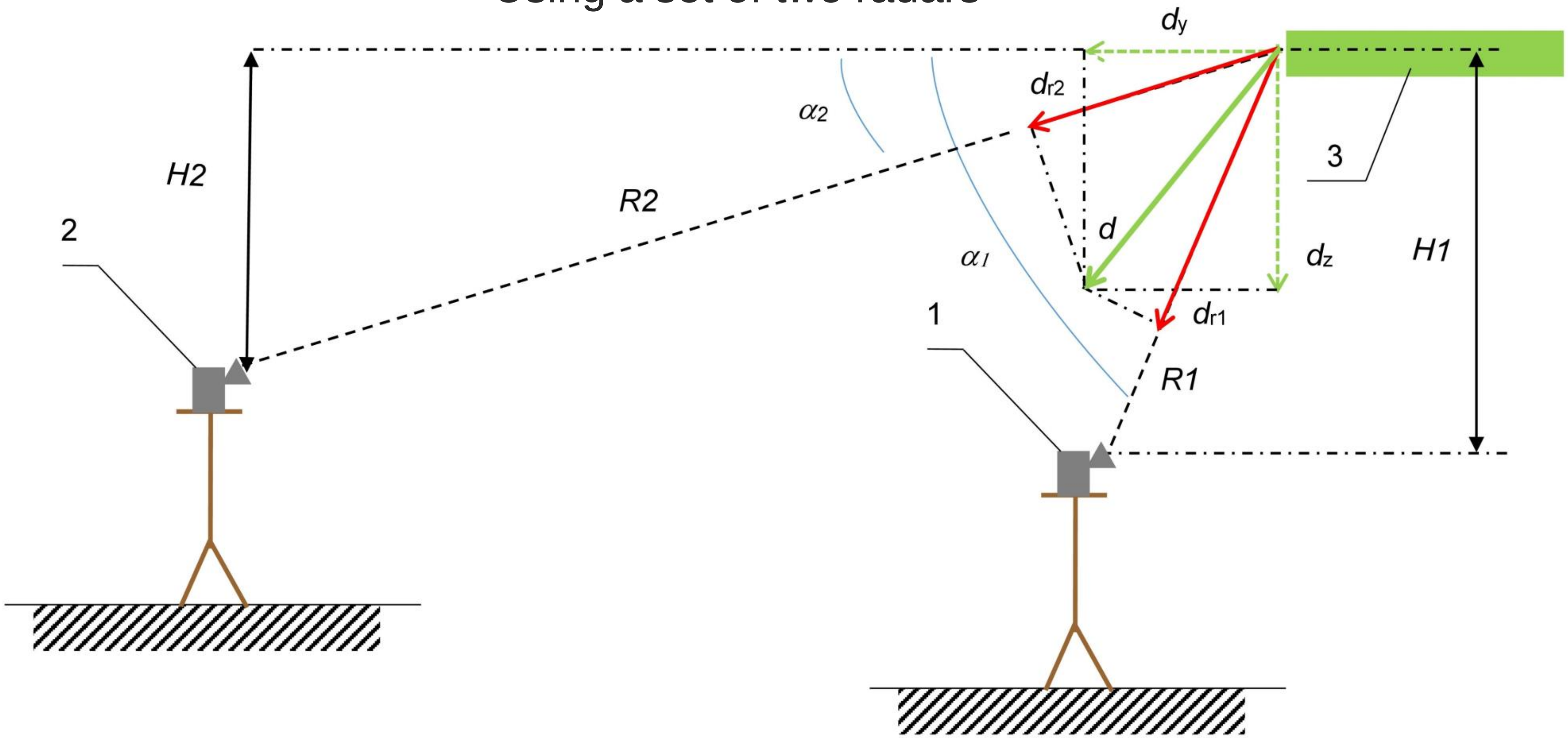
Remote measurement of lateral displacements

An attempt to solve the presented task of measuring two-way vibrations is simultaneous use of two interference radars

Measurement of lateral displacement of upper chords of the truss using a set of two interferometric radars:

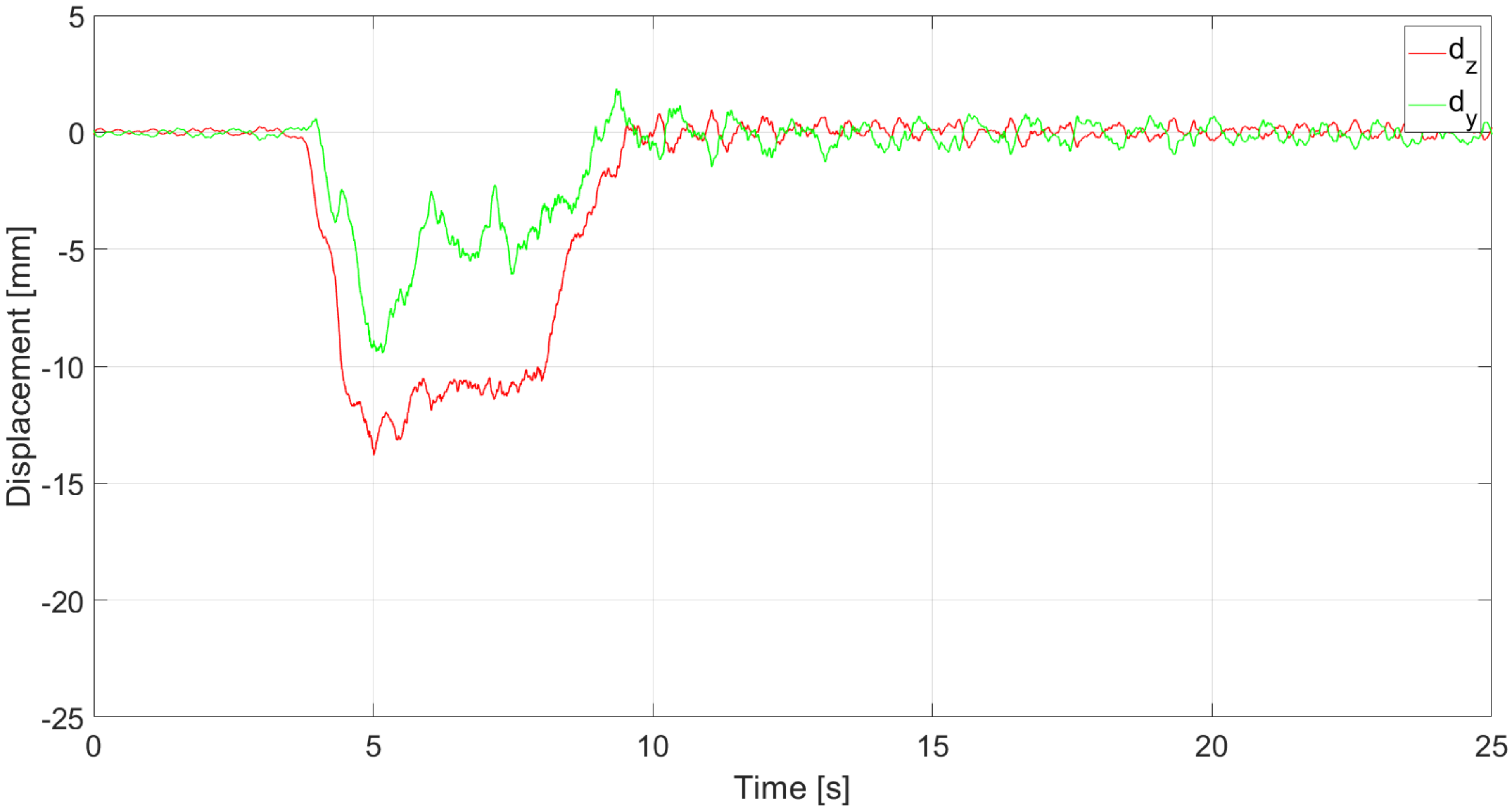
1) The radar No 1 has better orientation towards the measurement of vertical displacements
2) The radar No 2 has better orientation towards the measurement of the lateral displacements.

Using a set of two radars



$$\begin{cases} d_y = \dfrac{-d_{r1} \cdot sin(\alpha_2) + d_{r2} \cdot sin(\alpha_1)}{sin(\alpha_1) \cdot cos(\alpha_2) - sin(\alpha_2) \cdot cos(\alpha_1)} \\ d_z = \dfrac{d_{r2} \cdot cos(\alpha_1) - d_{r1} \cdot cos(\alpha_2)}{- sin(\alpha_1) \cdot cos(\alpha_2) + sin(\alpha_2) \cdot cos(\alpha_1)} \end{cases}$$

Using a set of two radars



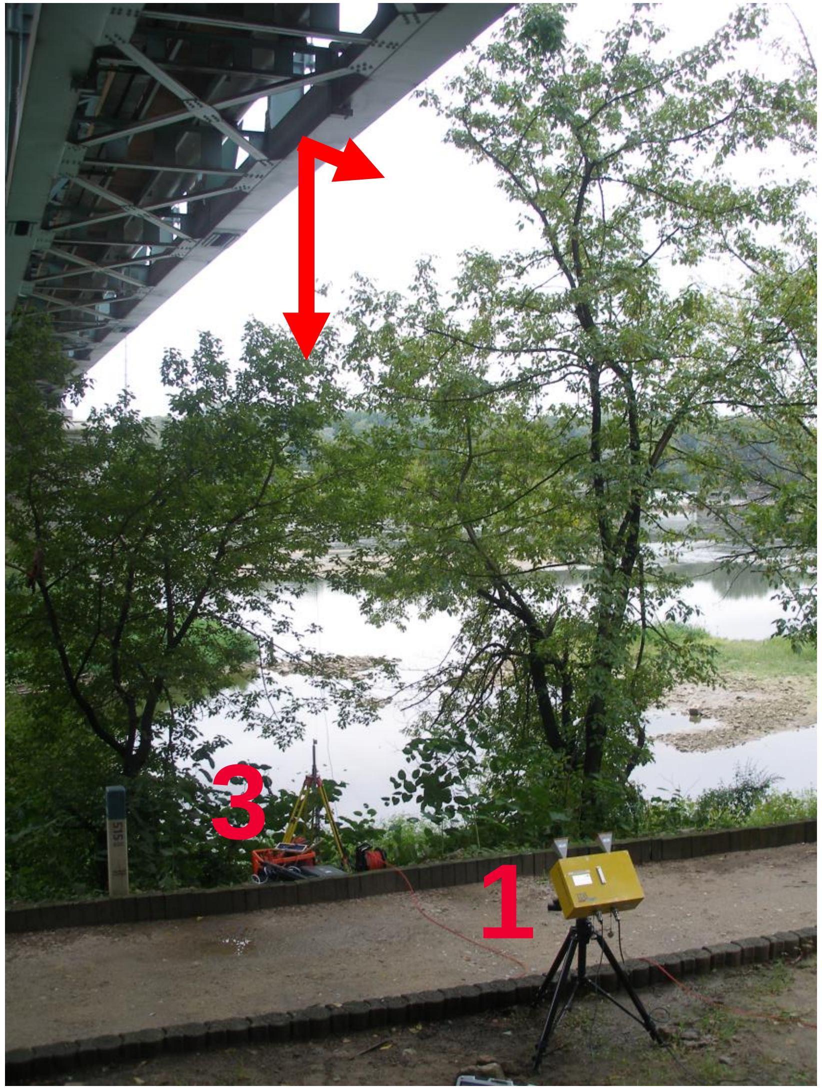
The time history of the determined vertical displacements $d_z(t)$ of the upper chords of the truss and horizontal (lateral) $d_y(t)$ during the passage of the passenger train

Remote measurement of vertical displacements

The bridge consists of two single-track structures,
each with 7 simple-supported spans of 66.00 m length.
They are truss structures with railway at upper truss chord on the bridge sleepers.

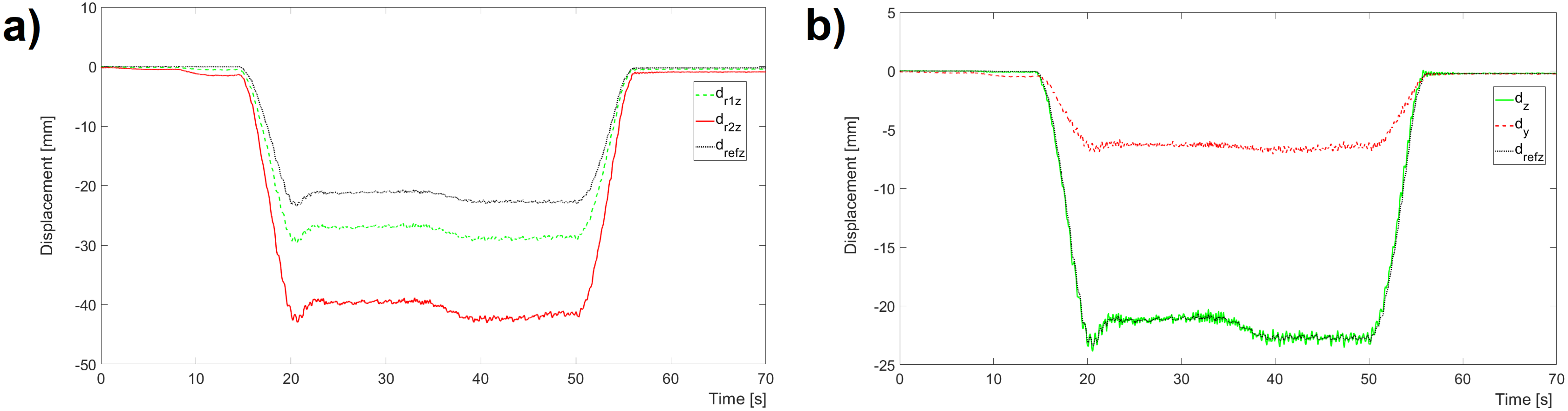
Remote measurement of vertical displacements

The application of a set of two Interferometric radars increases the accuracy of remote measurement of vertical displacements



1 – radar No. 1, 2 – radar No. 2
3 – inductive transducer for the reference measurement

Remote measurement of vertical displacements



An example of an analysis of a cargo train passage,
(a) vertical displacement measured by single radars No. 1 & No. 2 and the reference vertical displacement measurement;
(b) vertical and horizontal displacement calculated based on two radars No. 1 & No. 2 measurements and the reference vertical displacement measurement; scale of the graph a) is two times scale of the graph b).

Conclusions

- In the case of using **one radar**, we have the possibility to perform a detailed vibration analysis only in the direction of the target axis of the radar.
- In the case of the use of **two radar sets**, we have the possibility to conduct a thorough vibration analysis on a plane with both analysed vibration directions.
- It is advisable to **place two radars** so that each of them has a target axis as close as possible to one or the other vibration direction.

Thank you for your attention!

Piotr Olaszek

polaszek@ibdim.edu.pl

Road and Bridge Research Institute, Warsaw, Poland

Olaszek P, Świercz A, Boscagli F.: The Integration of Two Interferometric Radars for Measuring Dynamic Displacement of Bridges. Remote Sensing. 2021; 13(18).

Olaszek, P.: The application of interferometric radar for measuring lateral vibration of bridges. In Bridge Maintenance, Safety, Management, Life-Cycle Sustainability and Innovations. 2021. CRC Press.

Updates on current projects

Gabriel Sas, Chair Professor in Structural Engineering
gabriel.sas@ltu.se

https://www.linkedin.com/company/byggkonstruktion

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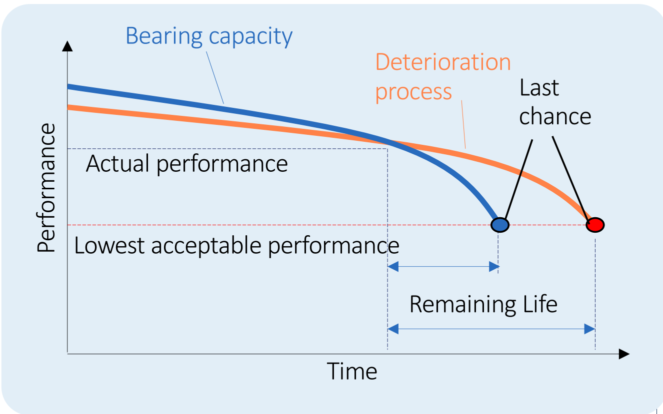
- Born in 1981 in Romania
- MSc: Romania, 2006
- PhD: Luleå University of Technology, 2011
- Researcher: SINTEF, Norway, till 2020
- Chair Professor, LTU since 2020



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Laboratory proof loading of trough bridges to fatigue and dynamic behavior

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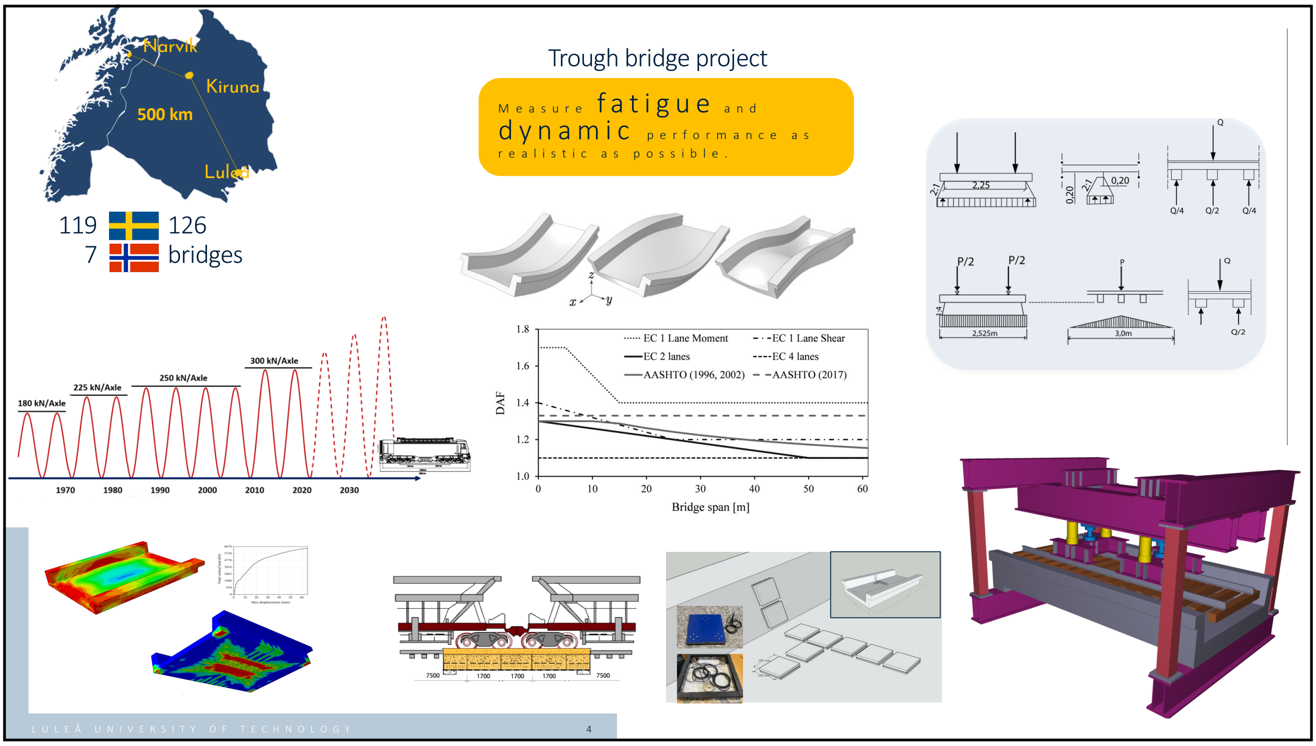

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Research program

- Two real bridges 4x7 m
- pressure distribution between ballast and bridge
- Sensors: Fibre optics, strain gauges, non contact damage detection, scanning, digital twin

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The bridges

8

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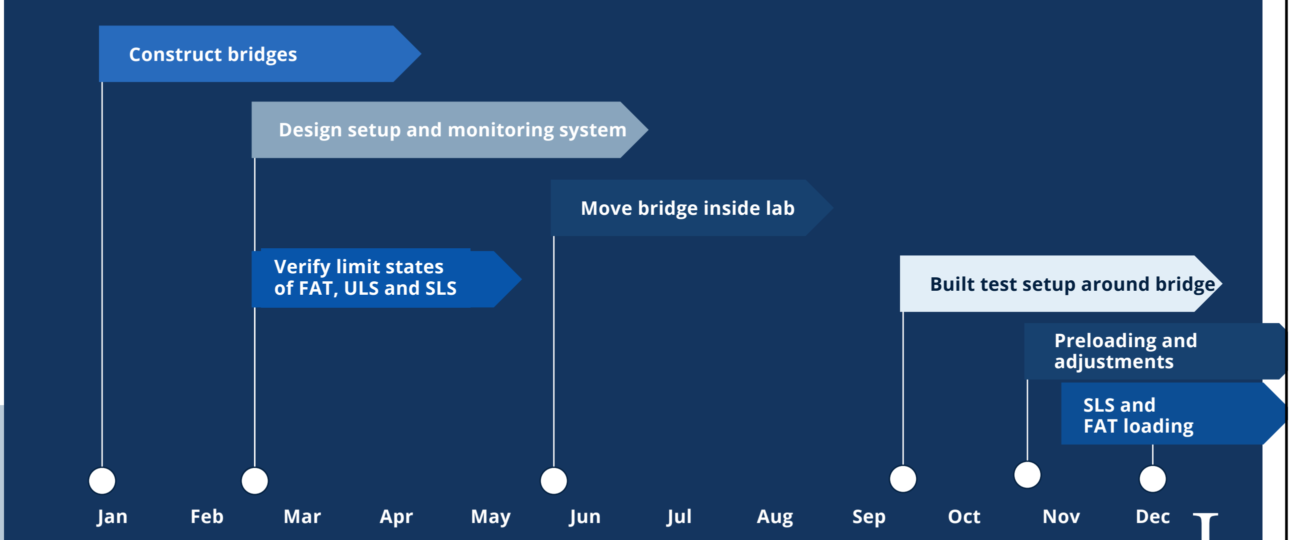
Project plan



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In-situ proof loading of four railway bridges: plans and future developments

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Proof loading and "training" of the Haparanda railway line in Northern Sweden

Project info

Financer: Trafikverket
Lead partner: LTU
Partners:
Start date: 2022-06
End date: 2023-09
Total budget:
LTU budget: 8

LTU team

Gabriel Sas (PL), Chao Wang (M), Jaime Gonzalez (M), Cosmin Daescu (M), Mats Petersson (M), Erik Andersson (M)

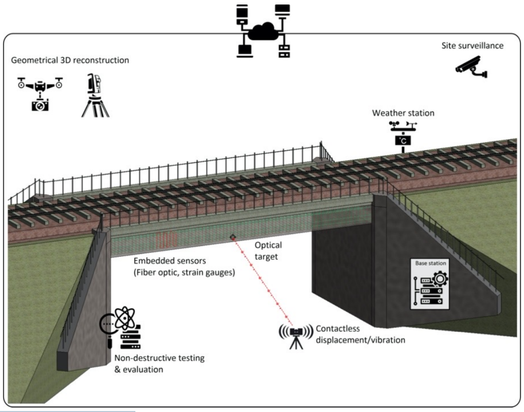
Dissemination

Conferences:
Journals:
Presentations:
Popular science:
Website:

The **aim** of the project is to increase the transport capacity over a rather new railway line.

The **objectives** are to:

1) Proof load to 30 tons axel loads the railway line
2) Monitor the performance of the railway line over a one year period of time



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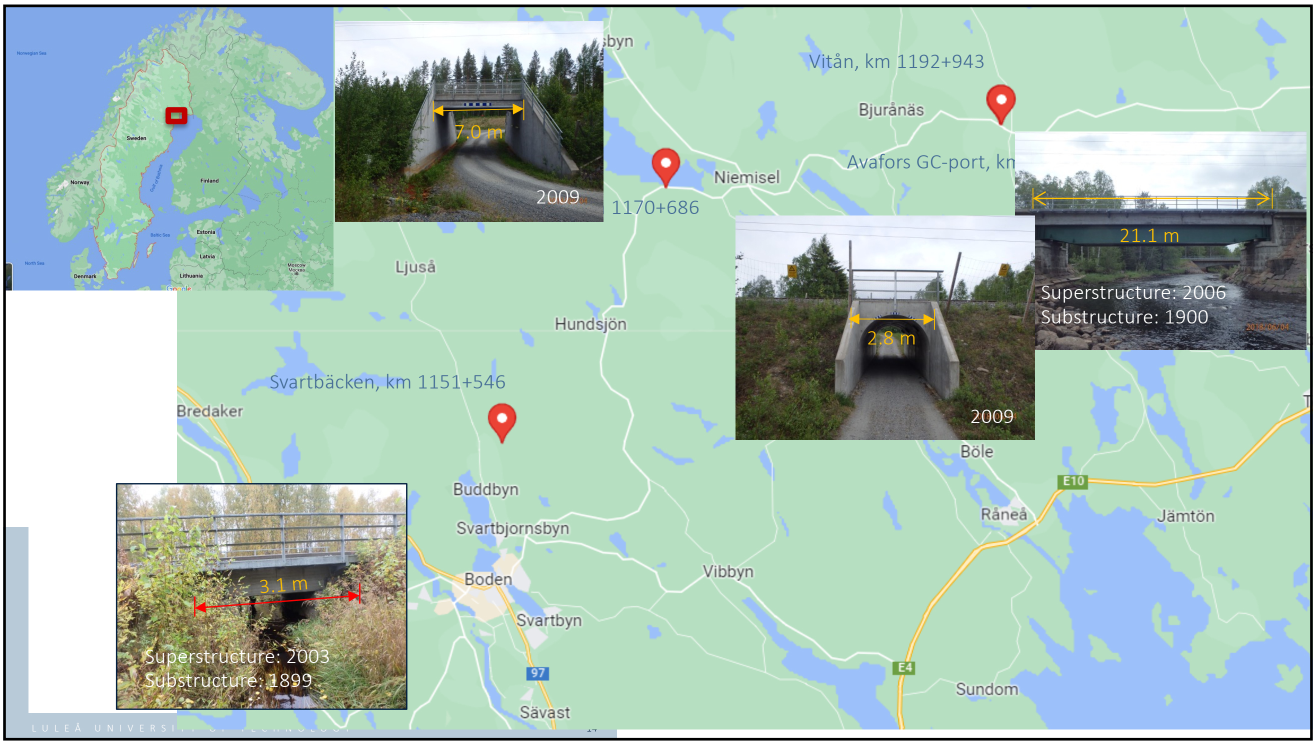

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Challenges

- Harsh climate
- Swamp
- Stone masonry abutments

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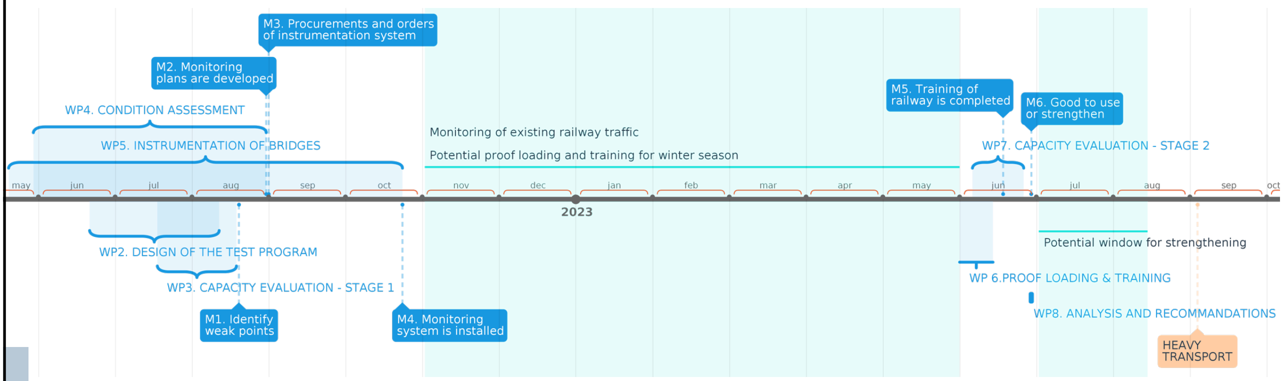

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company/byggkonstruktion

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COM3 TG3.2 – Structure and activities

IABMAS meeting, 12/07/2022

Technical secretariat

Convenor:
Dario Coronelli, Politecnico di Milano, Milano, Italy

Co-Convenor:
Kamyab Zandi, Timezyx, Vancouver, Canada

Technical secretary:
Giuseppe Di Nunzio, Politecnico di Milano, Milano, Italy

TG3.2 report of 2021-2022 activities

2021 spring (May) and fall (Dec.) meetings
2022 spring (July) meeting

Next meeting fall (Nov.) 2022.

CACRCS DAYS 2021 Workshop
(Capacity Assessment of Corroded Reinforced Concrete Structures)

Work Program:

- Assessment of corroded structures
- Proof loading
- Level of approximation

Chapters in MC2020

Materials

Reinforcement cross section

Reinforcement material properties deterioration (pitting)

Bond (with TG25)

Members

Rotation capacity, plastic hinges

Shear

TG3.2 Bulletins Drafts

1. Bearing capacity of concrete structures with corroded reinforcement

2. Improved procedures for proof loading and the interpretation of the results

3. Level-of-Approximation (LoA) Approach for assessing existing structures

Bearing capacity of concrete structures with corroded reinforcement

1.1 **Corrosion and reinforcement properties**

1.2 **Bond and corrosion**

1.3 **Structural models**

1.4 **Models for corrosion**

1.5 **Application**

Improved procedures for proof loading and the interpretation of the results

2.1 **General principles of proof loading**

Definition of target proof load (magnitude, location, loading method) based on probabilistic approach.

Quantification of the uncertainties involved during the proof loading

Extrapolation of the results considering the spatial variability of structures.

2.2 **Stop criteria in proof loading**

Define the general types of failure modes in a proof loading test: bending, shear, and other types.

Provide stop criteria for bending, shear failure of a structural member: deformation and acoustic emission based.

Reliability of measurements during a proof loading test.

2.3 **Considerations of various structural types**

Concrete slabs and beams in buildings, precast prestress girders, concrete slab bridges, other types.

3.1 Quantification of corrosion level and the effects at different LoAs

3.2 Structural analysis for load effects in assessment of corroded structures at different LoAs

3.3 Resistance evaluation

3.4 Decision support framework for the use of more advanced models

3.5 Application examples

GANTT chart of the new bulletins

						2021	2022		2023		2024	
						Fall	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**
Bull 1	1	Reinforcement	Dario	Call for models								
				Reference Tests setup								
				Models verification								
				Writing								
	2	Bond	Dario	Call for models								
				Reference Tests setup								
				Models verification								
				Writing								
	3	Members	Joost	Call for models								
				Reference Tests setup								
				Models verification								
				Writing								
	4	Models for corrosion	Carmen	Call for models								
				Reference Tests setup								
				Models verification								
				Writing								
	5	Application, LoA	Kamyab									

Liasson of fib TG3.2 and IABMAS on proof loading of concrete bridges

Yuguang Yang
Assistant Professor, Delft University of Technology
Email: Yuguang.yang@tudelft.nl

TU Delft

Introduction

- Introduction of fib TG3.2
- Achievement section 7.7 of TG3.2 bulletin
- Further developments

TU Delft

Task Group 3.2: Modelling of structural performance of existing concrete structures

Convener:

Coronelli	Politecnico di Milano	Italy

Secretary:

Di Nunzio	Politecnico di Milano	Italy

COM 3

Members:

Andrade	Instituto Eduardo Torroja	Spain
Belletti	University of Parma	Italy
Chrysostomou	Cyprus University of Technology	Cyprus
De Boer	Mot Infrastructures	Netherlands
Del Zoppo	University of Naples Federico II	Italy
Dieteren	TNO	Netherlands

TU Delft

Fib Bulletin: Modelling of structural performance of existing concrete structures

fib Bulletin ...

Modelling of structural performance of existing concrete structures

State of the Art Report

Task Group 3.2

Final Draft May 20th 2020

1

Objective on proof load testing of concrete structures

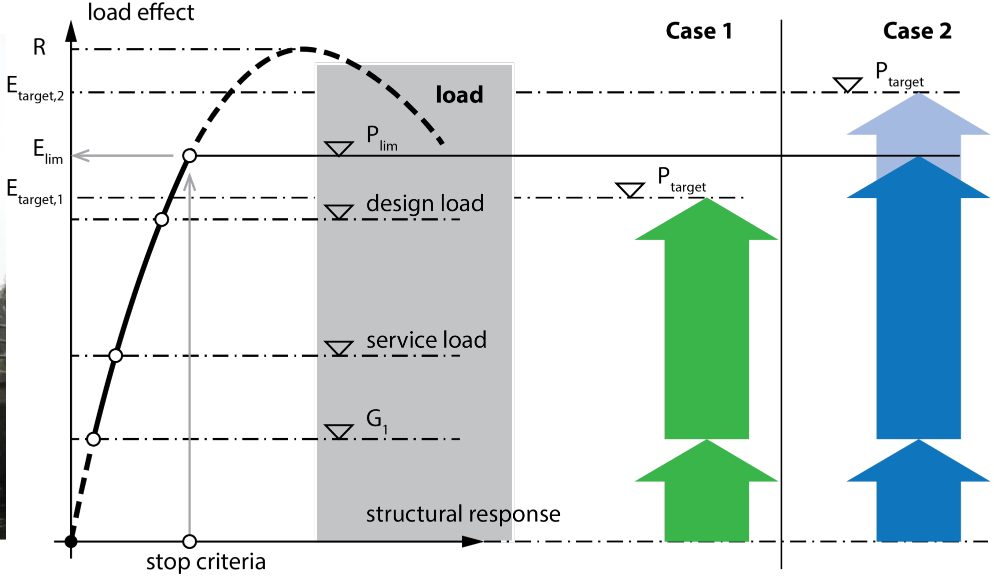
- Bearing capacity of concrete structures with corroded reinforcement
- Development of improved procedures for proof loading and the interpretation of the results
- Use of level of approximation approach for assessment of existing structures.

Introduction of proof loading

For structures that are lack of the following information, proof loading may be considered as alternative assessment tool.

- The analytical system of load transmission through the structure;
- The cooperation of structural elements or parts of the structure;
- The influence of damage on structural safety in the actual situation;
- The critical properties of the structure such as the dimensions, material properties, etc.;
- The effectiveness of previous repair measures.

Introduction of proof loading



Target experiment

reached	not reached
($P_{target} < P_{lim}$)	($P_{target} > P_{lim}$)

Loading procedure

stop at P_{target}	stop at P_{lim}

Section 7.7 in TG 3.2 Bulletin

- Basic principles
  - Conversion of target limit state to proof load
  - Magnitude of proof load at target safety level
  - Effect of spatial variability of structural resistance
- Procedures for proof loading
- Loading protocol
- Stop criteria
- Acceptance criteria

Improvement of proof loading procedure

- Probablistic tools
- Stop criteria
- Typology approach
- Other points that has not yet mentioned

Possible cooperation with IABMAS Bridge Load Testing Committee

- Joint publication/bulletin on proof load testing of concrete bridges.