IABMAS

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Meeting Minutes

IABMAS Technical Committee on Bridge Load Testing

Zoom: https://usfq.zoom.us/j/83387198267

Tuesday October 11th 2022, 8:00 – 10:00 CDT, 9:00 – 11:00 EDT, 15:00-17:00 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* ***required*** *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.*

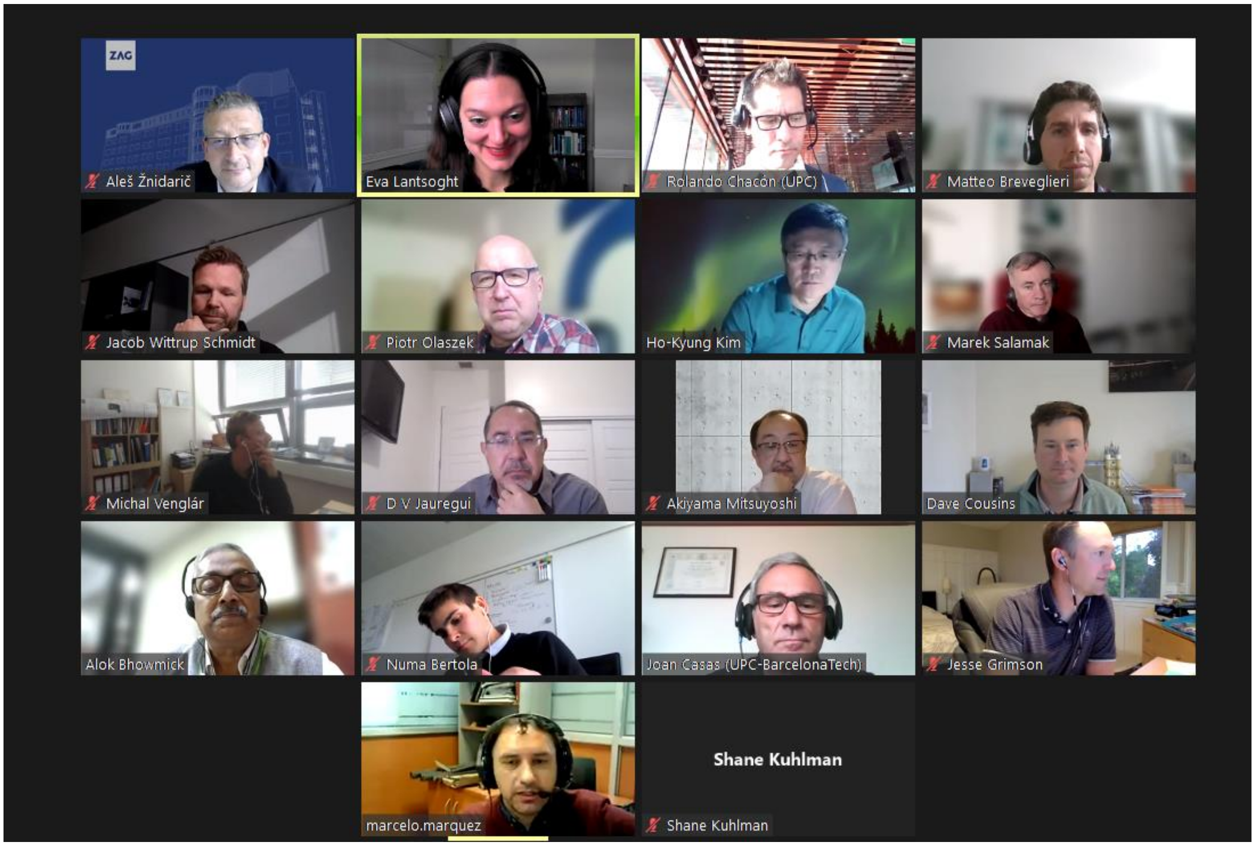
Goals:

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

Regrets: Dave Kosnik, Gabriel Sas, Boulent Imam



1. Administrative

1.1. Welcome and introduction

The meeting was called to order at 8:01 am Quito time by Eva. After having a quick look at the agenda, all participants introduced themselves with name and affiliation.

1.2. Review and approval of agenda

The agenda was reviewed and no objections or additions were raised. The change in time for the presentation by Matias and Marcelo was approved.

2. Strategic Planning and Discussion

2.1. Membership

The new members since last meeting introduced themselves and their previous and current work as it relates to bridge load testing: Numa Bertola, Matteo Breveglieri, Rolando Chacon, Monique Head, Shane Kuhlman, Michal Venglar, Ales Znidaric.

2.2. Website

On the IABMAS website, the committee information is included. The website will be updated with the new members once we have IABMAS membership numbers of all collected. Eva will send this information to Mitsuyoshi.

2.3. Review of mission

Dave Cousins proposed the following change from

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.

to

Proof load testing can be used to demonstrate directly that a bridge can carry a load that is representative of the required live load, provided that the bridge does not show signs of distress.

as he pointed out that proof load testing in the UK is used for a specific load that is not in the code. This change was accepted without objections.

2.4. Review of goals

Monique inquired about the committees with which we currently have a liaison. Eva mentioned TRB AKB40 (liaison is Dave Kosnik), *fib* TG 3.2, ACI 342 (under consideration). Jesse mentioned the suggestion of AASHTO Bridges & Structures, and to include the active liaisons to the website. Eva will follow up with potential liaisons. Jesse suggested that the website include liaison committees and their contacts/website links.

3. New Business

3.1. New research topics

Presentation of Rolando Chacon (collaboration with Stefan Wagmeister from Austrian Standards) on a potential New Work Item Proposal => The role of the load test on the digital birth of railways bridges
Website: www.ashvin.eu https://www.ashvin.eu/
Question from Dave C about monitoring using reflectors: Rolando mentioned that it can be done successfully, but the cost is high.

3.2. Opportunities for collaboration

Discussion of proposal from fib TG 3.2 to collaborate on joint publication on proof load testing of concrete bridges. Volunteers to work on this together with fib TG 3.2 members? Yes, there is interest from our committee. Volunteers: Jacob, Eva, Numa, Dave C, Matteo, Monique, Alok, Piotr.

Questions from Monique on shareable data and key performance indicators of bridges, discussions with Joan and Dave C on generalizability to different bridge types. How can we turn data into information about the bridge? Jesse mentioned the long-term bridge performance program (see: https://highways.dot.gov/research/long-term-infrastructure-performance/ltbp/long-term-bridge-performance), which had as an objective to compile all the information on a general database of the tested and instrumented bridge.

Sreenivas mentioned a project that will serve as a benchmark study of which the information will be available (details will be available early next year). The project will be advertised at ISHMII and TRB conferences.

3.3. Research updates

First presentation was moved up in the agenda right before discussing New Research Topics (3.2).

1. Load Test in Chile. Seminario Bridge experience - Matias Valenzuela and Marcelo Marquez

This presentation came after 2.4 as Matias and Marcelo had a schedule conflict.

Question from Ales regarding the dynamic factor and to confirm if it was indeed around 2? Matias explained that there was a larger than expected deflection caused by direct axle loading over the sensor.

2. The ultimate static and dynamic load tests on the historical steel bridge in Petrov – Pavel Ryjacek

Question from Joan Casas about analytical model of the frequencies. Pavel confirmed they made an analytical model before the test and after the final test. Numa asked about the influence of the asphalt and which temperature the test was carried out. Pavel explained that the zores profile and the gravel came first and then 10-15-20cm of asphalt is placed. All this together is a composite section with the stiff omega profile of the zores and this helps to better distribute the stresses. Under very high loading this may disappear but it functioned under the very high loading in the test. The test was carried out during the summer (July). For the asphalt, only the first mode shape is affected by the viscoelastic properties of the asphalt. Joan asked if the asphalt layer was under tension or compression given the summer temperatures and their effect on the boundary conditions. Pavel mentioned there were tensile stresses on the lower chord of the bridge and that previous measurements showed an effect of fixing the bearings but it could not cause compression on the asphalt layer. There was +- 4mm expansion on the lower chord indicating tension.

Question for Dave Cousins about the use of InSAR data acquisition equipment for deflection under dynamic loading. Pavel confirmed that the equipment can sample up to 200 Hz; however, the hardware is quite expensive and not a feasible option for most load testing applications.

3.4. Upcoming conferences and events

IABMAS USA committee will have its meeting during TRB.

4. Adjournment

Mitsoyoshi asked Eva to send information for the website.

Dave C mentioned he looked further into the accuracy of the GNSS positioning of the bridge: it is 15 mm in the vertical direction and 10 mm in the horizontal direction. The deformations during the test were +- 120 mm.

The meeting was adjourned at 9:54 am.

Next meeting –Spring 2023, online

Load Test in Chile: Application Seminario Bridge

October 2022

Matías A. Valenzuela
Pontificia Universidad Católica de Valparaíso

Marcelo Márquez M.
Dirección de Vialidad – Ministerio de Obras Públicas

State of Arts in Chile

Apply Spanish guidelines, considering Static and Dynamic Load Test

Load Test mostly applied when:

1. Existing structure to have been rehab: Maintenance
2. Crossing of overweight trucks
3. Observed a damage of a structure: During construction stage
4. In service activities

State of Arts in Chile – Protocols

FECHA:
PUENTE: CANELILLO 2
COMUNA: LOS VILOS

TRAMO	PISTA	VEL.	INSTANTANEA Fi	Fo	FLECHA	DEFORMAC. CALCULADA	OBSERVACIONES
1	CENTRADO	0	1417	1419	2		
	AGUAS ABAJO	0	1417	1422	5		
1	CENTRADO	10	1417	1419	2		
	AGUAS ABAJO	10	1417	1422	5		
1	CENTRADO	20	1417	1418	1		
	AGUAS ABAJO	20	1417	1422	5		
1	CENTRADO	30	1417	1419	2		
	AGUAS ABAJO	30	1417	1422	5		
1	CENTRADO	40	1417	1419	2		
	AGUAS ABAJO	40	1417	1422	5		
1	CENTRADO	50	1417	1418	1		
	AGUAS ABAJO	50	1417	1422	5		

Parameters:

1. Truck Speed
2. Direction
3. Instant Deformations
4. Med term Deformation
5. Calc. deformation
6. Comments

State of Arts in Chile – Protocols

Administration and contractual responsibilities:

Signature and control by:

1. Civil Engineer
2. Chief of the project (rehab or new structure)
3. Administration / Owner inspector: Professional

State of Arts in Chile – Preliminary Activities

Truck process:

Partial and total weigh
Include review per axles

Total Weigh = 45 ton approx.

EJES	PESO TOTAL	PESO PARCIAL
1	6600	6600
2	16520	9920
3	25420	8900
4	35080	9660
5	44870	9790

State of Arts in Chile – Load Test

Measurements of deformation using topographic equipment

Truck Pass:

- Central
- Lateral

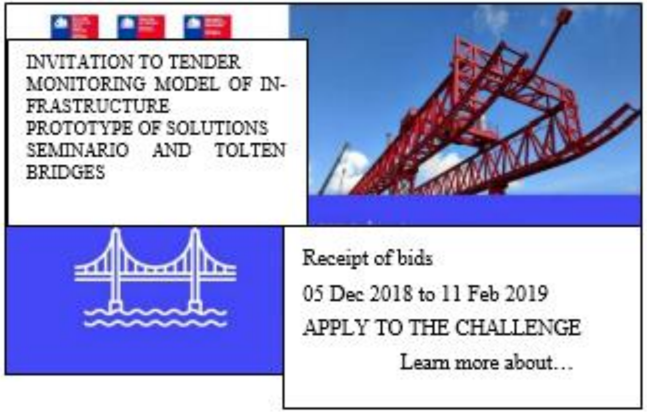
Video – Load Test

Pupio Bridge and Canelillo 2 Bridge

Infrastructure Monitoring Program

The General Directorate of Public Works (DGOP), through the Executive Secretariat of Technological Innovation (SEIT), proposed the challenge of implementing an infrastructure monitoring program, by way of prototypes.

A total of 59 interested parties (companies, private persons and universities), downloaded the bidding conditions, and, by the end, 21 of them submitted proposals to the MOP.



Working Method

The work method was that the companies had to submit a prototype for monitoring of the two bridges chosen by the Highways Board: Seminario Bridge, located in the Region of Valparaíso, and Toltén Bridge, located in the Region of Araucanía. The bridges monitoring process had a minimum deadline of 3 months.

The prototypes had to include, as a minimum:

- Description of the prototype
- Trial period
- Place in the bridge to be intervened
- Equipment to be installed
- Other participating companies or institutions
- Bridge parameters to be directly measured
- Key Performance Indicators (KPI) to be obtained from the measured parameters
- Criteria for the success of the trial
- Success range of the KPI.

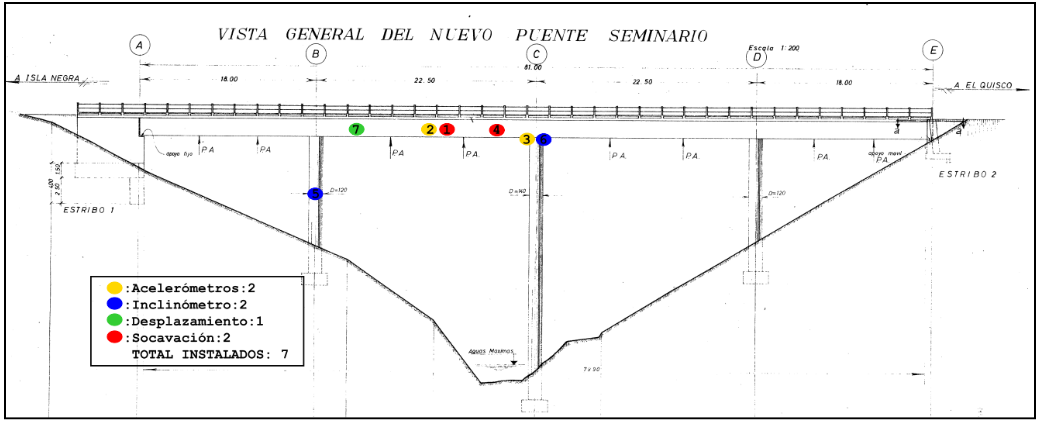
Seminario Bridge

A total length of 81m and width of 10.2m. The bridge is made up by 4 openings, 2 steel girders, reinforced concrete slabs, 3 concrete slabs piles, abutments with wing walls.

Seminario Bridge – Installation Sensor

A total of 41 sensors were installed in this bridge in the following places:

- Steel girders, at the mid-span section.
- Concrete slab, at the mid-span section.
- Abutment back walls.
- Abutment support.
- Piles support.
- Average height of piles.
- Stiffeners placed on the girders.



Instrumentation

Wireless accelerometer installed on a steel girder

Sensor for monitoring scours, fitted on the reinforced concrete pier

Instrumentation

Displacement sensor, installed on an expansion joint

Accelerometer with built-in battery, installed on a steel girder support

Instrumentation

External battery-powered sensor

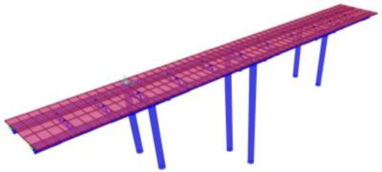
Solar panels power

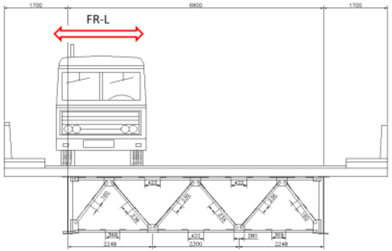
Activities carried out on bridges

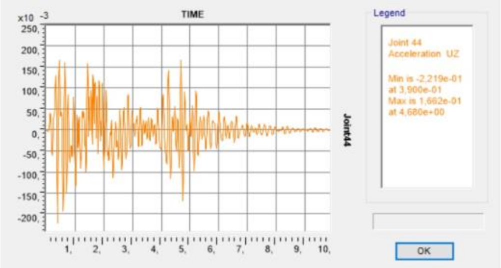
Gathering of information, plans and background

Continuous monitoring of the Seminario Bridge, composed of 2 triaxial Vibration sensors, 2 static and dynamic tension sensors, 2 Inclination sensor and 1 Displacement sensor.
Visual inspection and drone and satellite image analysis.

Numerical model and Instrumented Vehicle Campaign Programmed

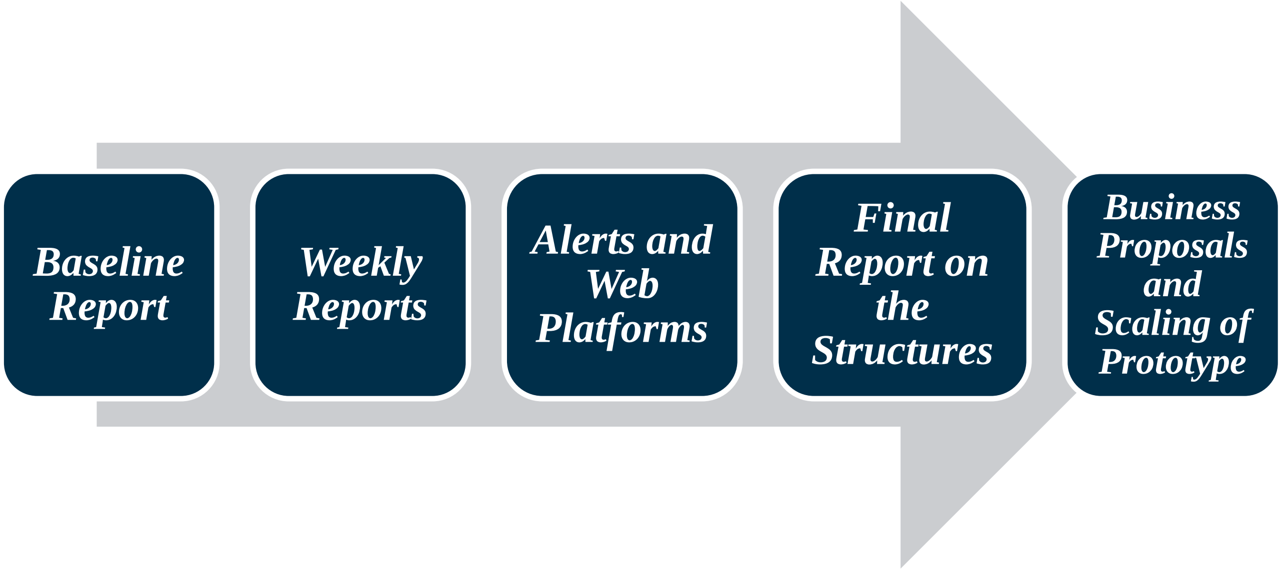






Results

As a result of the monitoring prototypes for Seminario Bridge, different deliverables were provided



Results

In the steel beam, maximum peak accelerations of 0.92g in the vertical direction and 112mg in the horizontal direction, when the structure was subjected to normal and random vehicle traffic.

Values measured during the monitoring of the Seminario Bridge, are much higher than the theoretical values (model).

The maximum variations of the specific deformations measured in the steel girder during the monitoring of the seminary bridge were 273□m / m and 240□m / m.

The corresponding stresses in the steel are respectively 55.9MPa and 49.2MPa, or approximately 22.4% and 19.7% of the yield point of the steel. This stress fluctuation is slightly above the expected range for the structure in service.

Final Comments

- The process allowed improving the know-how in the bridge behavior for new structures and rehabilitation process.
- Provide and adequate monitoring system could deliver complementary information of performance indicators of the bridge.
- The real-time bridges monitoring is a very useful tool in situations where it is required to know the actual structural condition of a bridge.
- The Ministry of Public Works is under review the current National Code, in order to include reference and mandatory regulation on Load Test procedure: static and dynamic.

Acknowledge

Reinaldo Cabezas: Ex Ministerio de Obras Públicas
Francisca Espinoza: Dirección de Vialidad - MOP
Leonardo Acuña: Dirección de Vialidad - MOP
Hernán Pinto: Pontifica Universidad Católica de Valparaíso
Fernando Rodrigues: PROCERT, Brasil
Ricardo Reginensi: Consultor Independiente
Luis Lazo: Empresa ECOPSA SpA

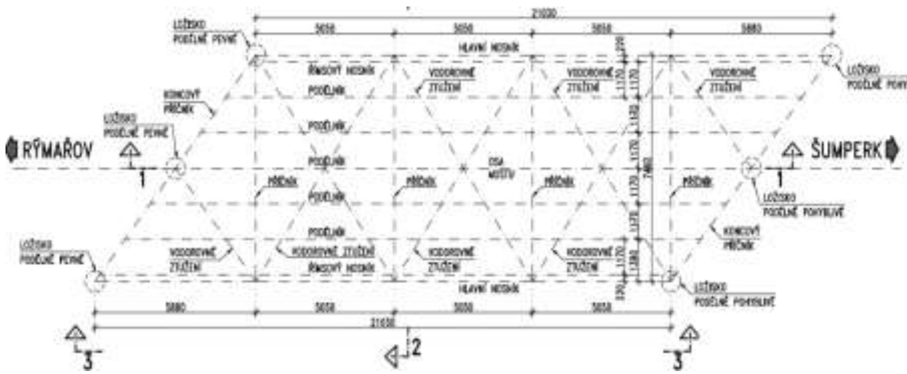
The ultimate testing of the 113-years riveted bridge in Petrov

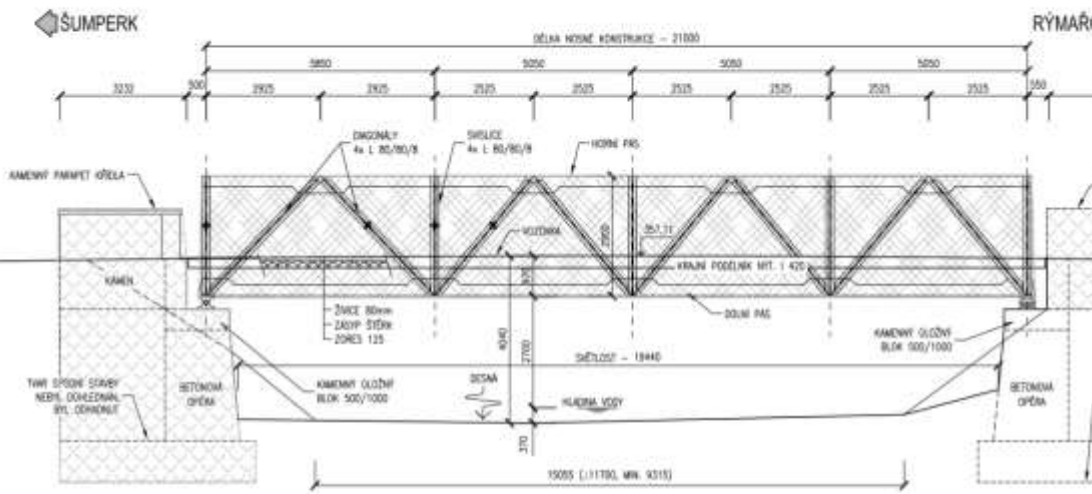
Pavel Ryjáček et.al.

Faculty of Civil Engineering, CTU in Prague, Czech Republic

Bridge basic data

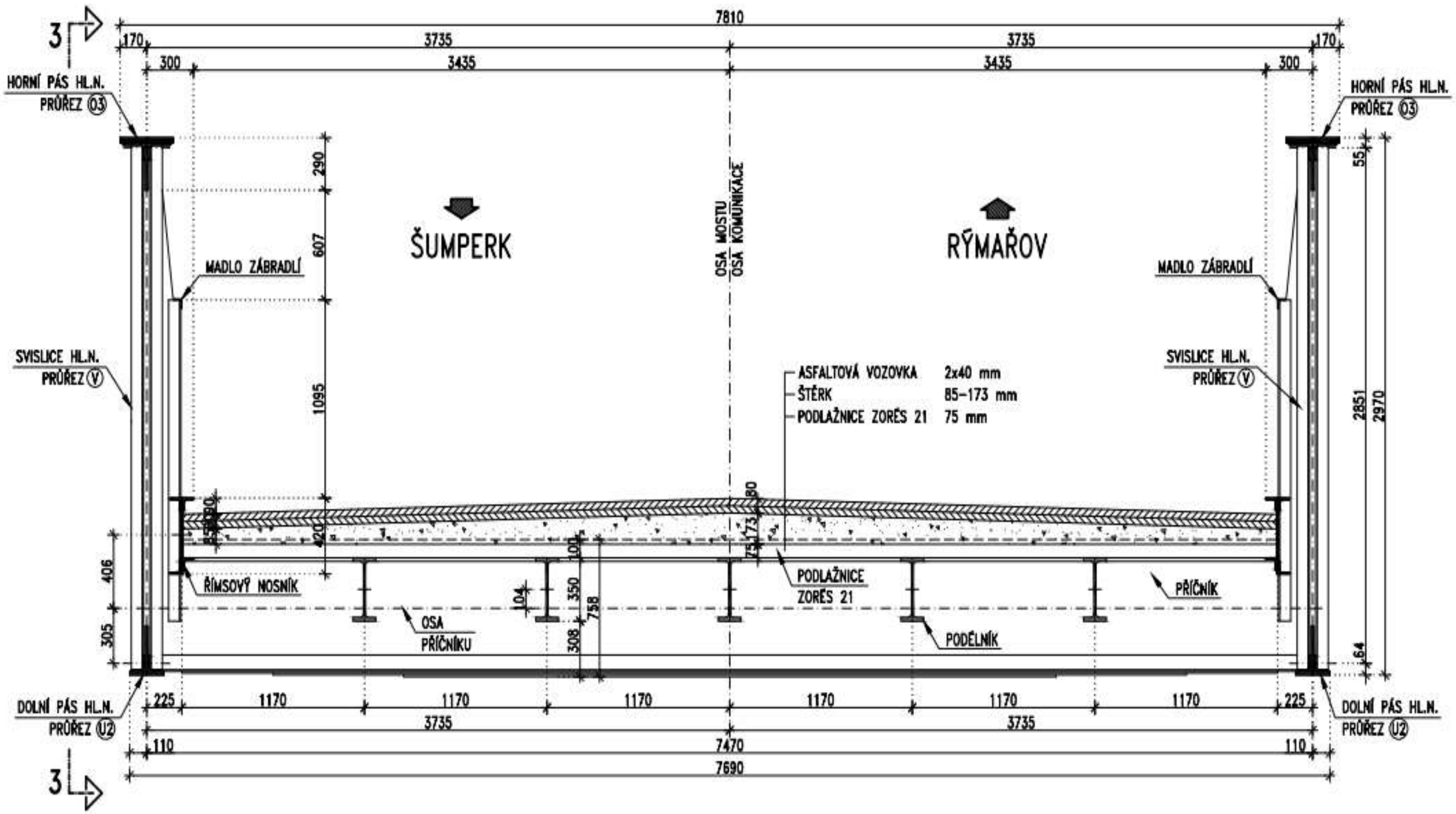
- Span 21 m
- Skew angle 52°
- Bridge width 7,8 m
- The bridge built in: 1906
- Fabricator: nearby *Zöptauer und Stefanauer Eisebau und Eisehütten*





Bridge basic data

- Bridge rating: VII – Emergency (I to VII scale).
- Official load capacity **4** t for all vehicles and **5** t for single vehicle
- Bridge deck – Zores steel profiles and gravel with asphalt, masonry substructure



Bridge basic data

- Main defects connected with the corrosion
- In some parts, especially horizontal plates, most of the thickness was corroded

Experimental program

The chance to use this structure for the scientific purposes, before the planned demolition. Following experimental program was approved:

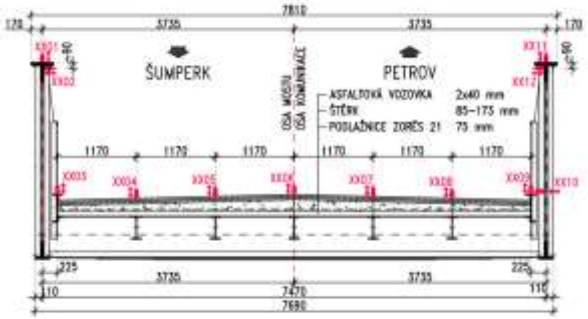
- the long-term monitoring of the bridge
- the strengthening of a part of the bridge with SMA,
- performing the load test before and after the strengthening,
- **modal analysis** of the bridge for the undamaged and artificially damaged state to analyse the possibilities of the damage detection,
- **the local load test on the corroded Zores deck,**
- **the load test on the extreme load level of the main girder.**

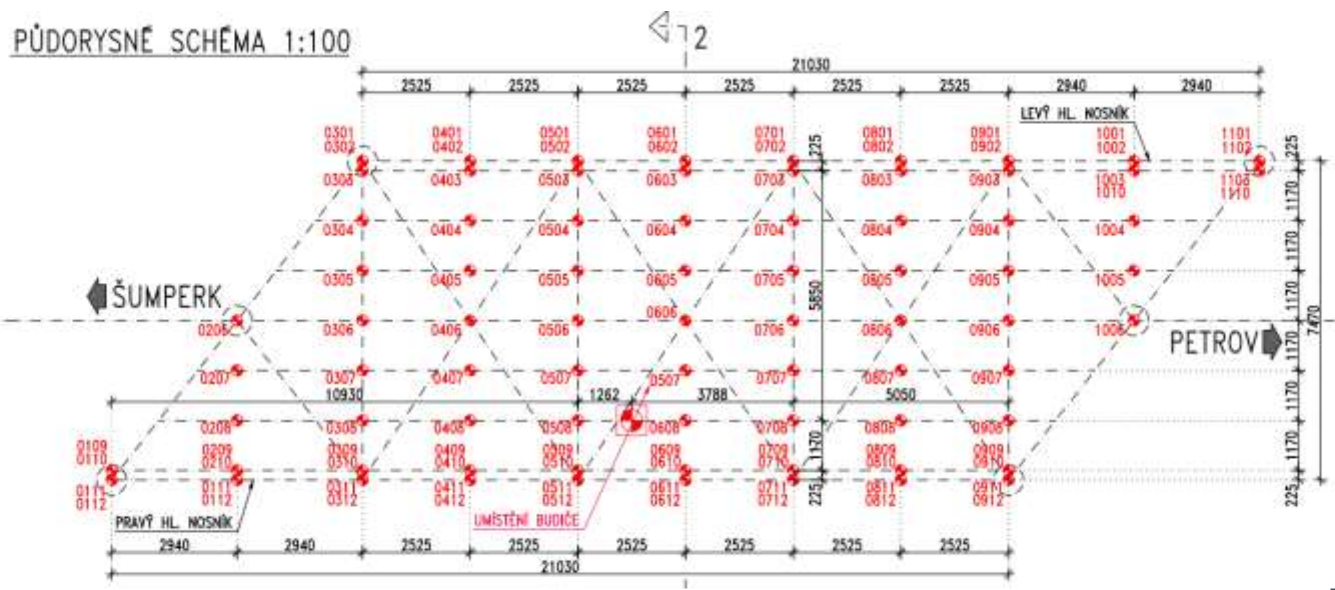
In this presentation, the last three tests will be described and discussed.

Modal analysis damage detection

The main goal was to identify the damage with the modal analysis method, based on the real damage of the bridge

- Electrodynamic exciter and net of the measured places
- Following members were cut in the cumulated way:
- PM1 – upper chord
- PM2 – diagonal
- PM3 – lower chord

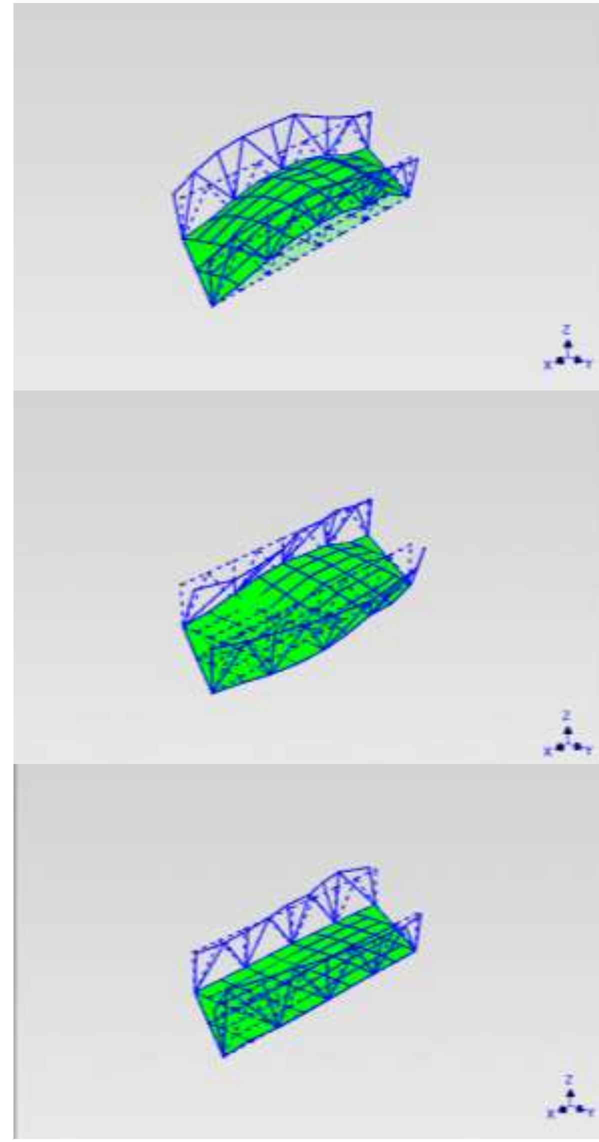




Modal analysis damage detection

Undamaged bridge

No. (j)	Natural frequency $f_{(j)}$ [Hz]	$U_{k=2,0}$	
(1)	6,50	± 0.03	1. bending shape
(2)	8,64	± 0.03	2. bending shape
(3)	9,83	± 0.03	horizontal vibration of the main girders
(4)	10,48	± 0.03	horizontal vibration of the main girders
(5)	10,86	± 0.03	horizontal vibration of the main girders
(6)	11,99	± 0.03	horizontal vibration of the main girders
(7)	12,22	± 0.03	horizontal vibration of the main girders
(8)	13,99	± 0.03	horizontal vibration of the main girders



Modal analysis damage detection

PM1 – damage of the top chord

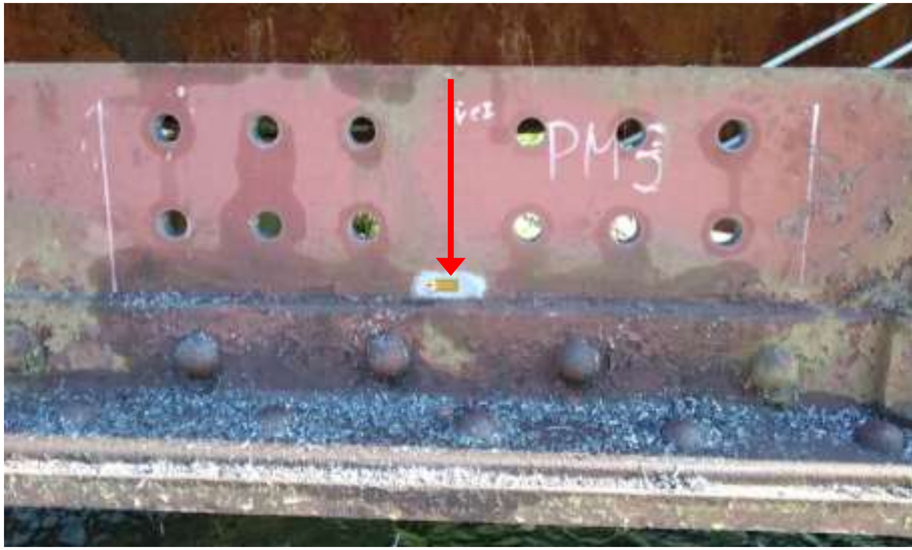
Poř. č. (j)	Natural frequency $f_{(j)}$ [Hz]	$U_{k=2,0}$	
(1)	6,50	± 0,03	1. bending shape
(2)	8,62	± 0,03	2. bending shape
(3)	9,84	± 0,03	horizontal vibration of the main girders
(4)	10,50	± 0,03	horizontal vibration of the main girders
(5)	10,88	± 0,03	horizontal vibration of the main girders
(6)	12,01	± 0,03	horizontal vibration of the main girders
(7)	12,22	± 0,03	horizontal vibration of the main girders
(8)	14,01	± 0,03	horizontal vibration of the main girders

No. (j)	Natural frequency $f_{(j)}$ [Hz]	$U_{k=2,0}$	
(1)	6,50	± 0,03	1. bending shape
(2)	8,58	± 0,03	2. bending shape
(3)	9,83	± 0,03	horizontal vibration of the main girders
(4)	10,51	± 0,03	horizontal vibration of the main girders
(5)	10,88	± 0,03	horizontal vibration of the main girders
(6)	12,01	± 0,03	horizontal vibration of the main girders
(7)	12,22	± 0,03	horizontal vibration of the main girders
(8)	14,02	± 0,03	horizontal vibration of the main girders

Modal analysis damage detection

PM3 – damage of the lower chord + PM1+PM2

No. (j)	Natural frequency $f_{(j)}$ [Hz]	$U_{k=2,0}$	
(1)	6,52	± 0,03	1. bending shape
(2)	8,59	± 0,03	2. bending shape
(3)	9,84	± 0,03	horizontal vibration of the main girders
(4)	10,55	± 0,03	horizontal vibration of the main girders
(5)	10,89	± 0,03	horizontal vibration of the main girders
(6)	12,08	± 0,03	horizontal vibration of the main girders
(7)	12,27	± 0,03	horizontal vibration of the main girders
(8)	13,85	± 0,03	horizontal vibration of the main girders

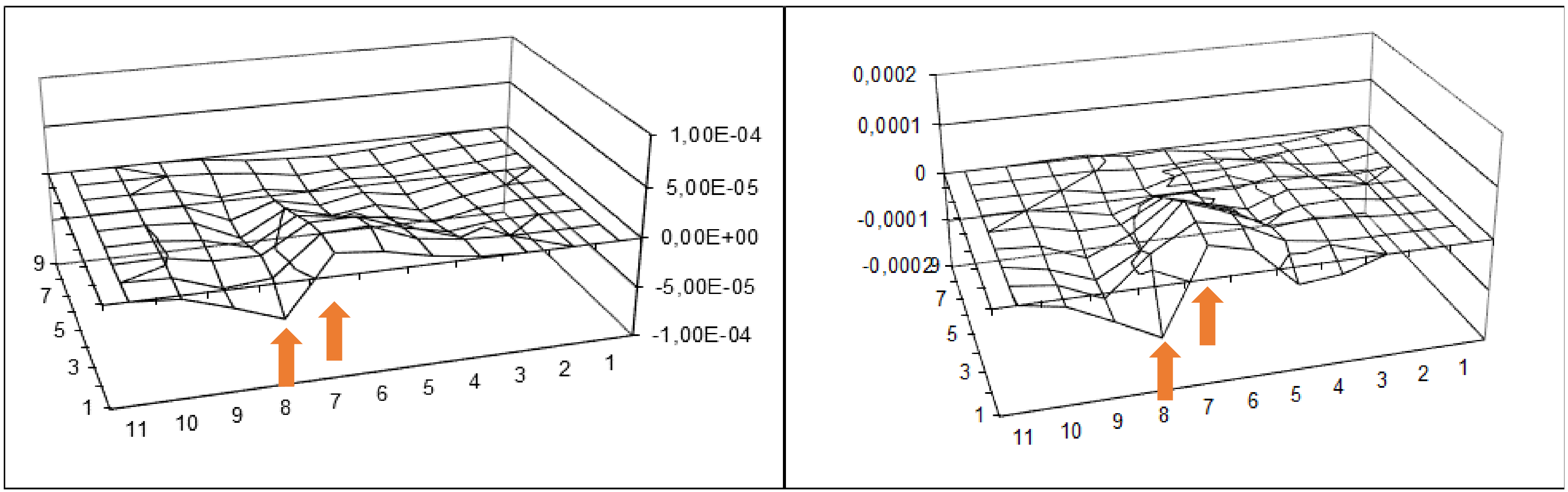


Modal analysis damage detection

- The damage has almost no impact on the natural frequencies and mode shapes, changes smaller than 1%
- Next method used:
- Change of the mode shapes curvature CAMOSUC(j),x (Change of mode surface curvature)
- But this method failed to detect that damage.

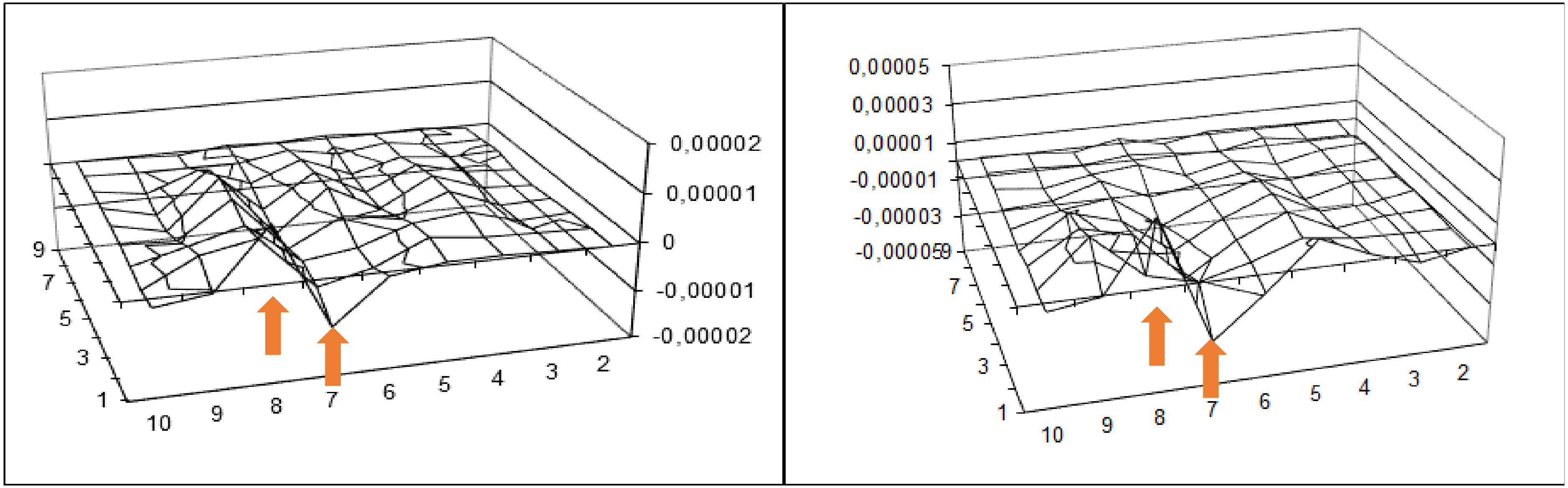
Modal analysis damage detection

- However, the change of the diagonal members of the modal flexibility matrix [δ] - the change of the deflection created by the unit fictive force in the given point works quite well.



Modal analysis damage detection

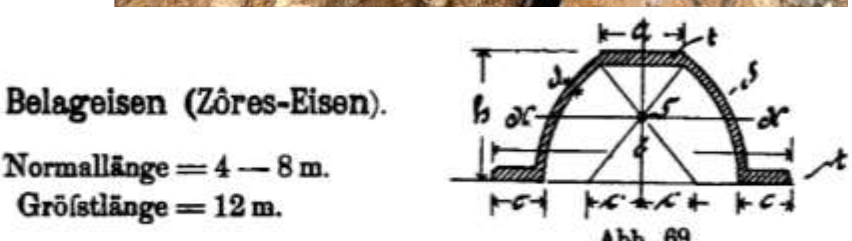
- Also, the second derivation of the modal flexibility matrix [δ´´] change works quite well.
- The dense net of the sensors is necessary.



Local load test

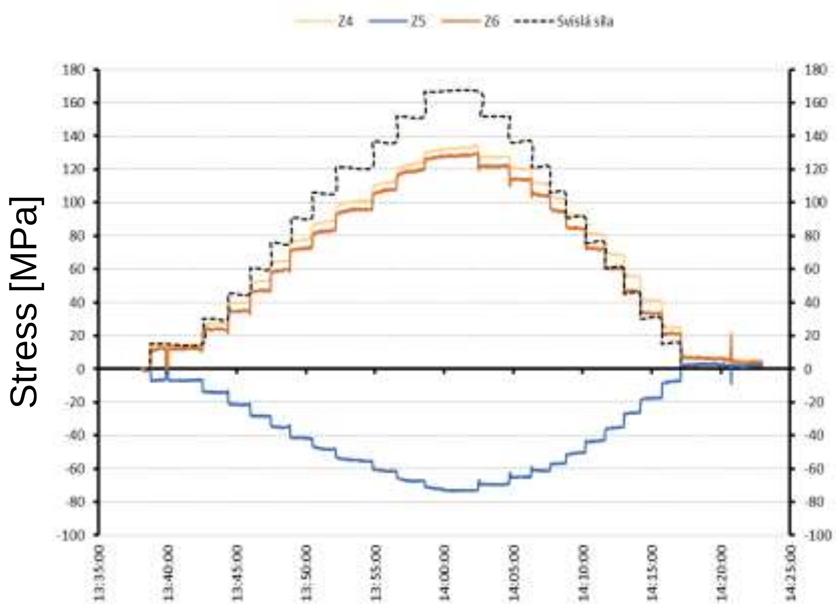
The “Zores” deck local load test

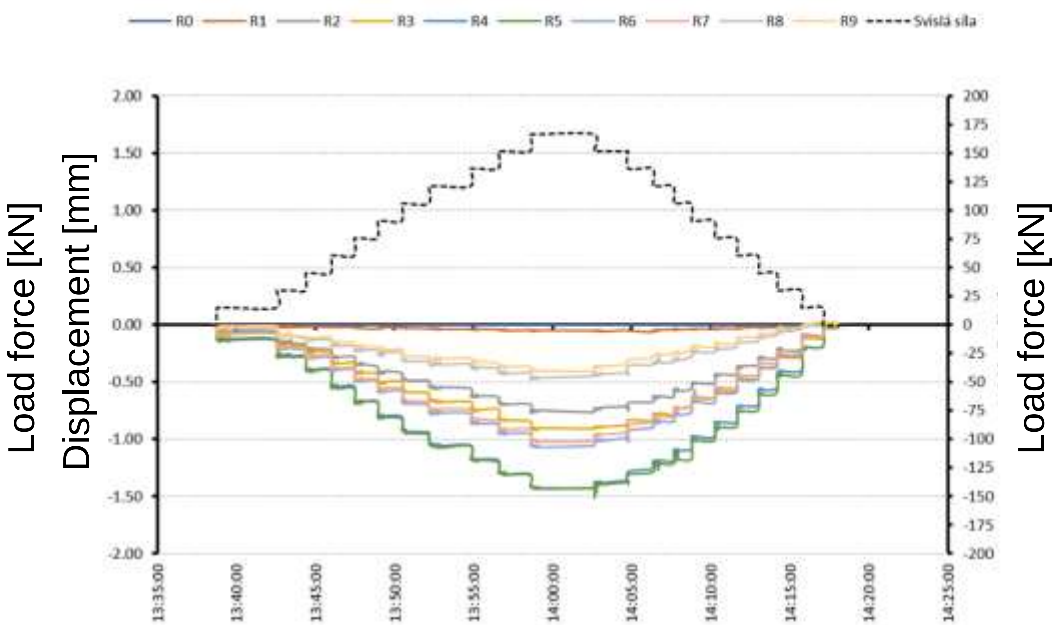
- 11 concrete panels of the total weight of 17t.
- Load „wheel“ area 0,4x0,4 m



Local load test

- Load 17t – deflection 1,4 mm, stress max. 130 Mpa
- Elastic behavior of the deck
- The asphalt pavement contributes to the load capacity – impact **35** %
- Wheel capacity 33 t, that means axle load capacity **66** t

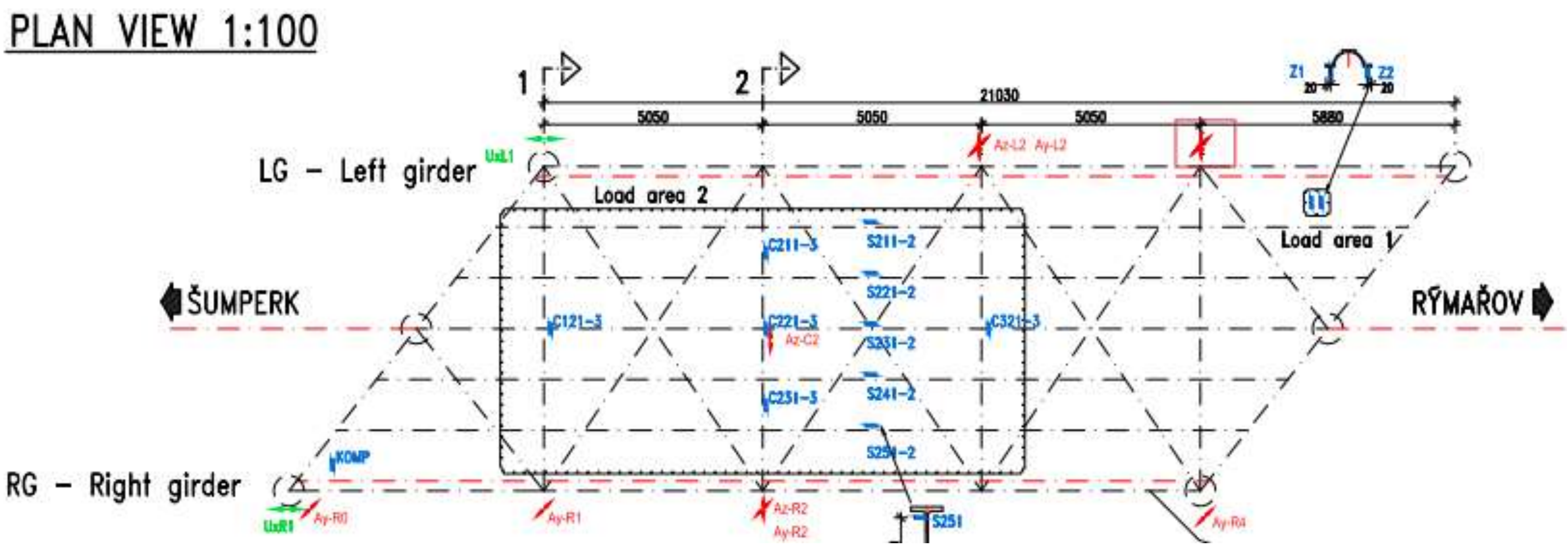




Global load test

The global load test with following goals:

- to analyze the real bridge behavior in the non-linear loading phase,
- to find out the real load bridge capacity,
- to detect nonlinearities for the numerical model consideration.

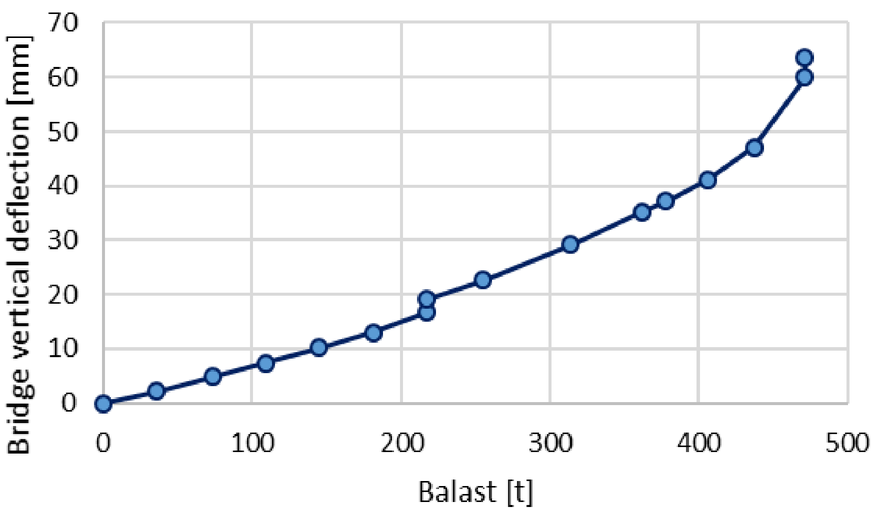


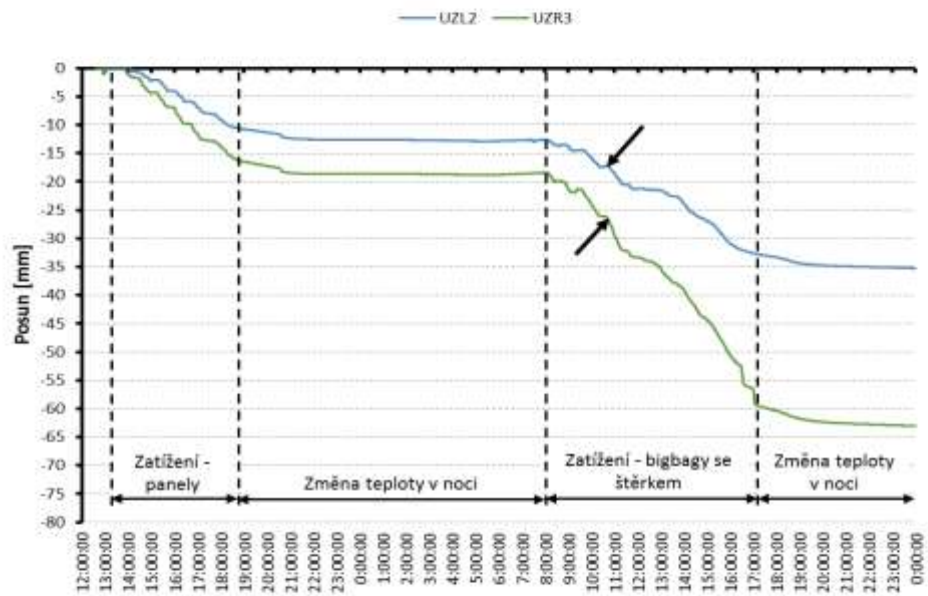
Global load test

- 144 concrete panels of 3x1x0,215 m,
- 158 plastic big bags with the gravel filling
- Total load - **475** tons

Global load test results

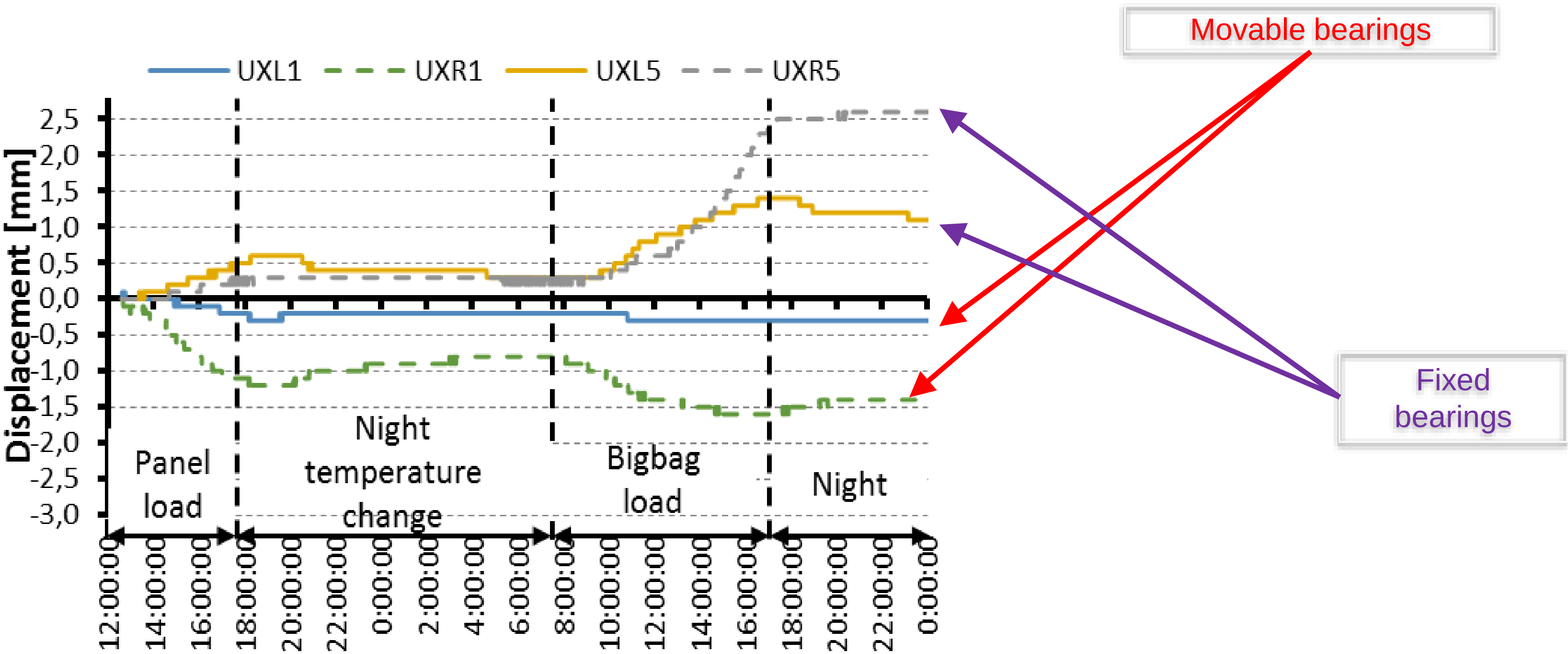
- Total maximal deflection – 63 mm
- Permanent deflection on the right girder - 25 mm (40% of the total deflection).
- Observed the riveted joint slip and superstructure yielding





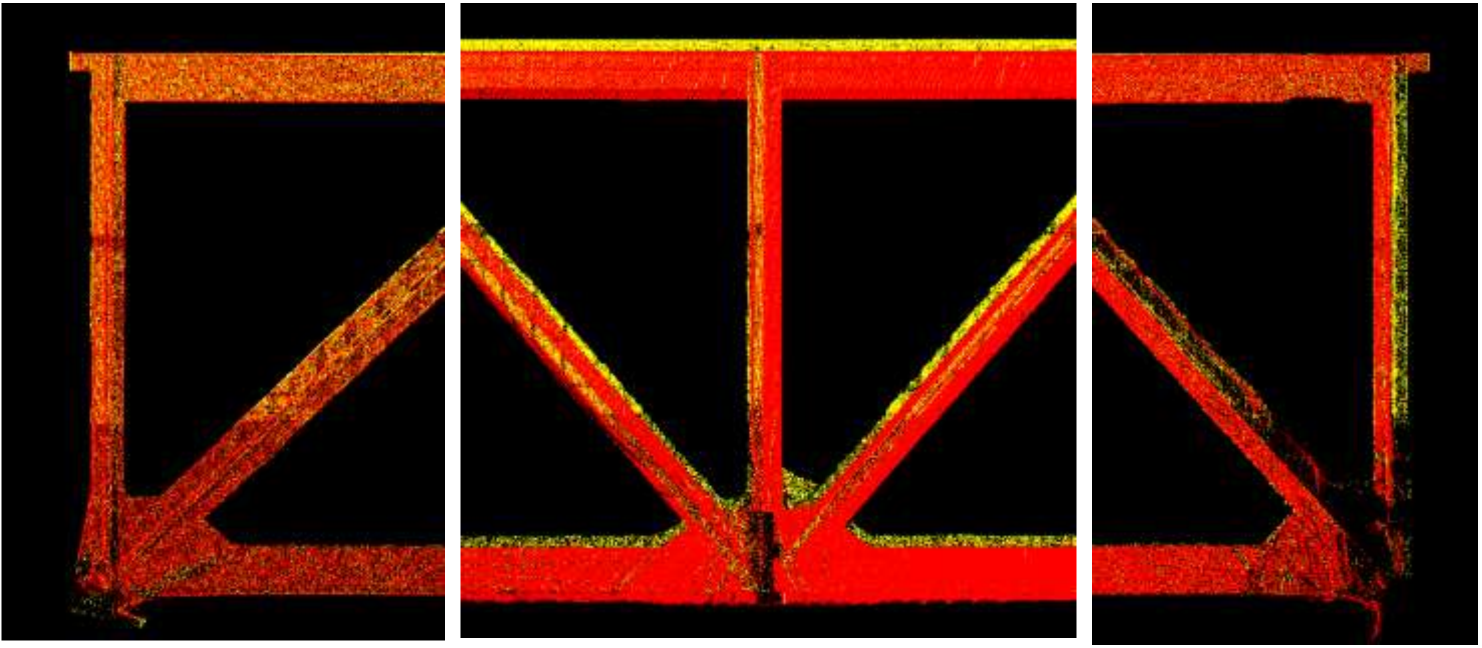
Global load test results

- The horizontal displacement of the movable bearings was smaller than the displacement of fixed bearings.
- Movements - horizontal bearing - 1,5mm, fixed bearing - 2,6 mm
- In comparison – simply supported beam should horizontally move app. 14mm



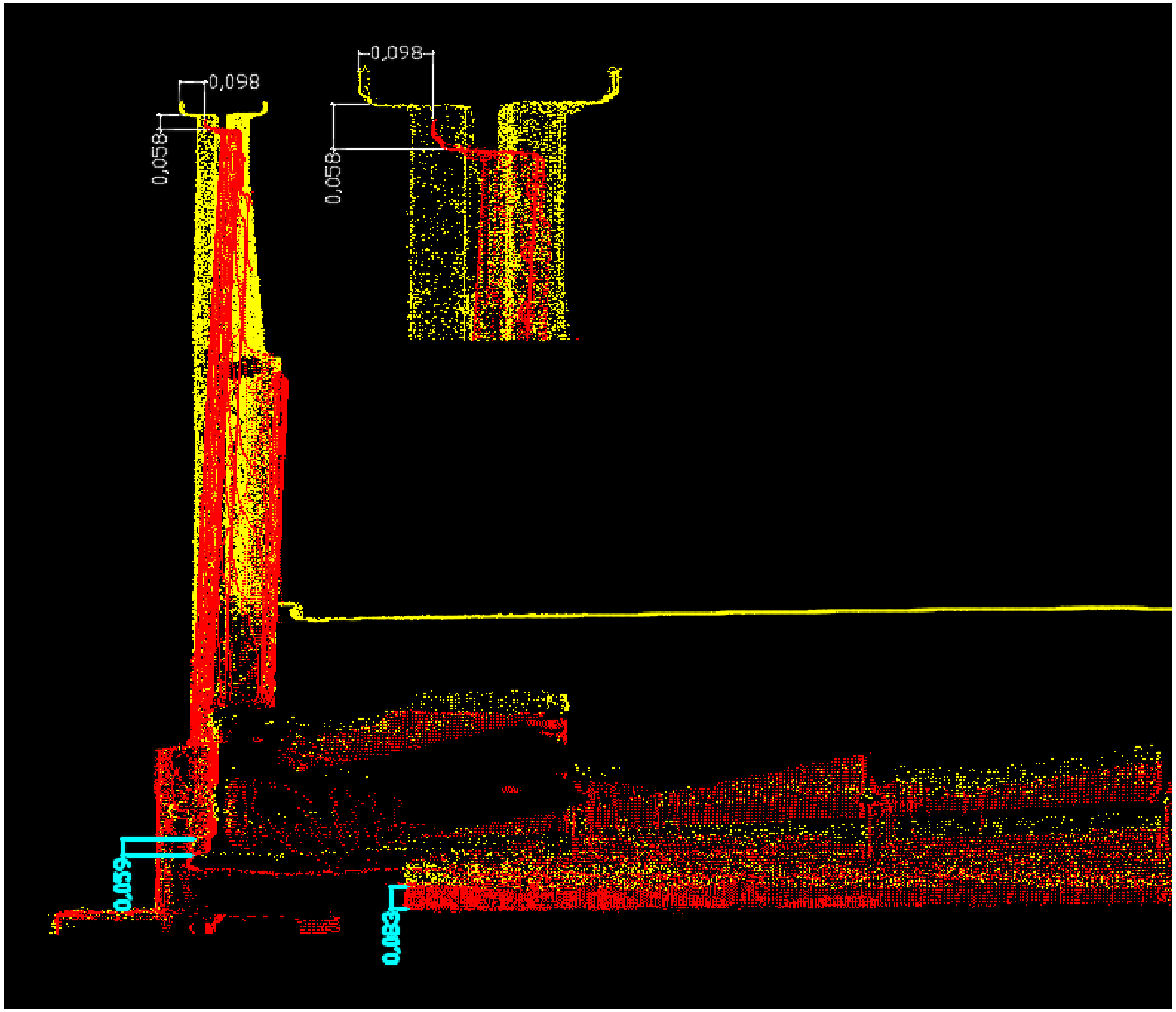
Global load test results

- Laser scan - original (yellow) and final deflection (red) show, that bearings almost did not move.
- Reason:
  - Corroded bearings and restraint of the bridge at the abutment.
  - The end cross beam was in under the asphalt layer partly casted by concrete to the abutment



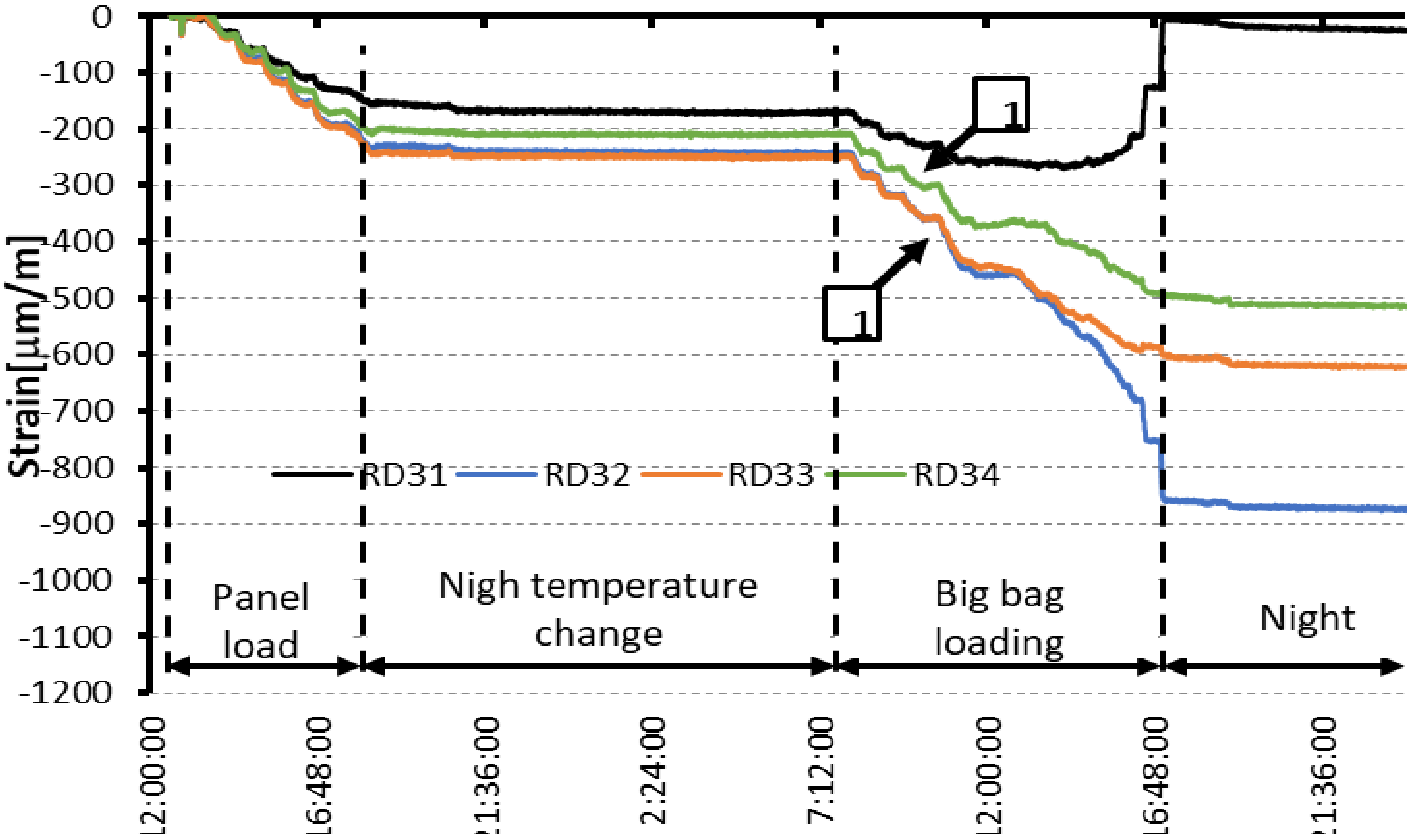
Global load test results

- Comparison of the unloaded and loaded cross section of the bridge



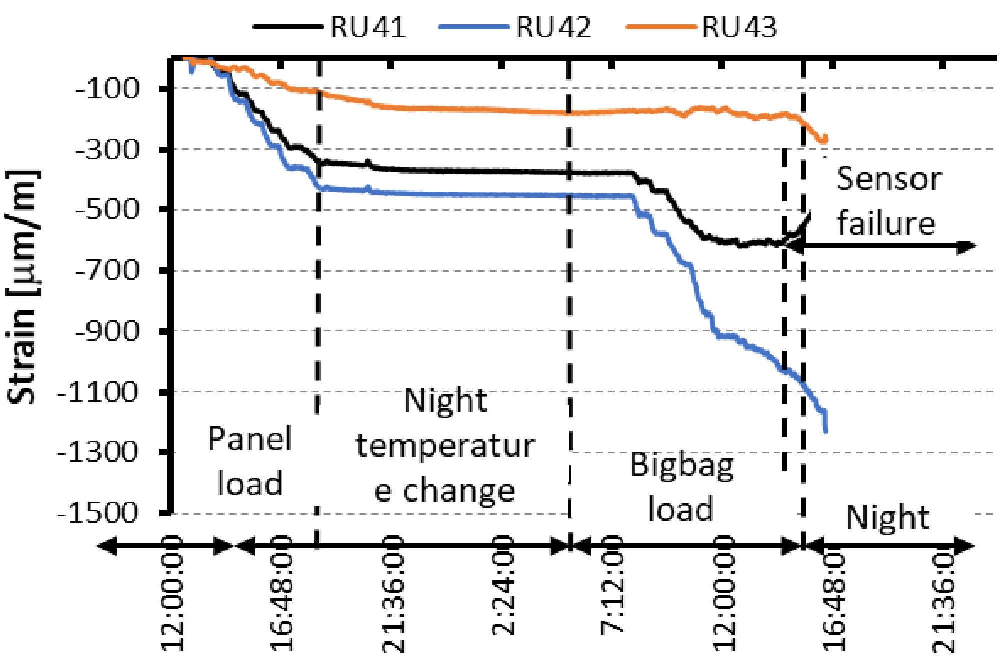
Global load test results

- Significant damage of several members
- The diagonal RD3 - reached the plasticization of 69%
- The stress is rising strongly up, getting close to the critical load



Global load test results

- Upper chord – see stress increase because of the lateral bending moment
- The moment results from the increase of the lateral imperfection



Global load test results

The bridge condition after the load test:

- Blocked movable bearings, plastic deformations,
- Riveted joints did not allow only the rotational slip, but also the slip in the axis of the member (app. 1 mm in the lower chord and diagonal)

Conclusions

- Unique chance to understand the real behaviour of the steel riveted bridge

The main conclusions are:

- the axle load capacity of the corroded deck can be estimated as **66** t,
- the global load test showed the yielding and the increase of the nonlinear behavior, with predicted collapse at **516 t**
- the permanent deflection can be explained only by the longitudinal slip in the riveted joints,
- the restrained end cross beam significantly influenced the bridge behavior. The movable bearing almost did not move even under the extreme load.

Thank you for your attention

Research was supported by NAKI II project of Ministry of culture of the Czech Republic (No. DG18P02OVV033) “The methods for achieving the sustainability of industrial heritage steel bridges”.

The role of the load test on the digital birth of railways bridges

Ideas for a New Work Item Proposal (NWIP)

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Universitat Politècnica de Catalunya

Stefan Wagmeister
Austrian Standards International

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Rahul Tomar, Christian Martinez de la Rosa
DTT, Digital Twin Technologies, Köln, Germany

Game engine developers

Irina Stipanovic, Sandra Skaric
Infraplan Konzult, Zagreb, Croatia

Infrastructure Management consulting

Stefan Wagmeister
Austrian Standards, Vienna, Austria

Standard body

www.ashvin.eu

Digital Twins as assistants for improving productivity, safety, resource efficiency and economy in infrastructure systems

Design

Construction

Maintenance

ASHVIN has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958161

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Demo 1. Load tests in bridges

Demo 2. Renovation design of a residential building

Demo 3. Zadar Airport. Maintenance of runway

Demo 4. Construction of an industrial building.

Demo 5. Construction of an office building.

Demo 6. Construction of an office building

Demo 7. Maintenance of road bridge

Demo 8. Generative design of footbridges

Demo 9. Maintenance of a Stadium roof

Demo 10. Behaviour of a quay Wall.

Demo 1. Load tests in bridges


A Coruña
Gijón
Santander
Bilbao
Donostia-San Sebastian
Toulouse
Montpellier
Cannes
Aix-en-Provence
Marseille
Santiago de Compostela
Oviedo
Vigo
Pamplona
Andorra
Girona
Valladolid
Zaragoza
Barcelona
Porto
Salamanca
Tarragona
Aveiro
Madrid
Coimbra
Castellón de la Plana
Toledo
Balearic Sea
Portugal
Valencia
Spain
Lisbon
Ibiza
Palma
Badajoz
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Murcia
Alicante
Seville
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Algiers
مدينة الجزائر
Granada
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Faro
Marbella
Batna
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Alboran Sea


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DE LA MATA
CÁCERES
TALAVERA DE
LA REINA
BADAJOZ
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Línea de Alta Velocidad
MADRID-EXTREMADURA
FRONTERA PORTUGUESA

Ashvin Demosite #1.
Viaducto de Valdelinares
Plasencia-Cáceres. AVE. Extremadura, Spain.

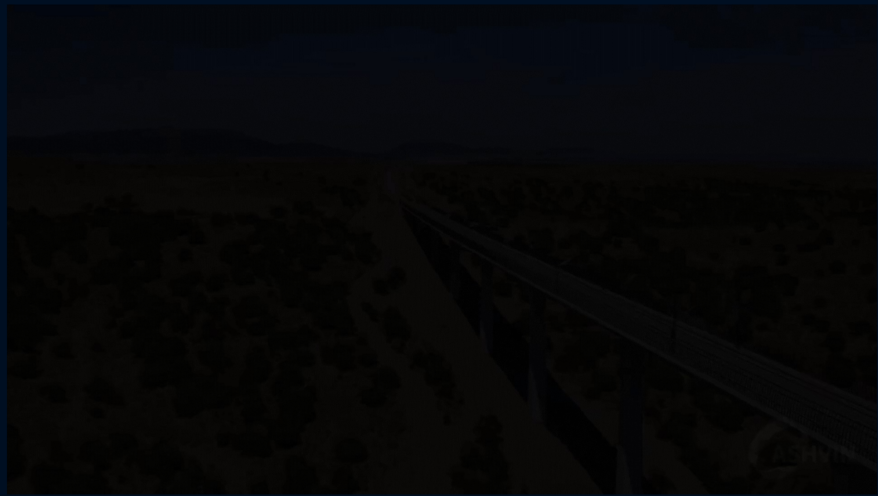
Ashvin Demosite #1.
Underpass. PI-3.90.
Plasencia-Cáceres. AVE. Extremadura, Spain.

Ashvin Demosite #1.
Viaducto de la Plata.
Plasencia-Cáceres. AVE. Extremadura, Spain.

Ashvin Demosite #1.
Viaducto del Tajo.
Plasencia-Cáceres. AVE. Extremadura, Spain.

Ashvin Demosite #1.
Viaducto de Almonte.
Plasencia-Cáceres. AVE. Extremadura, Spain.

Dynamic load test of spans 2 and 3. El Tajo Viaduct. Extremadura, Spain. 2021



Load tests → **Digital birth**

Considerable Investment by owners/managers/companies

Design of the test. Simulation and prediction

Logistics preparation. Locomotives, loads, traffic cuts

Measurements. Sensors, LIDAR, Imagery

Report. Proof load test and model verification

Manifold stakeholders

1

Design of the test. Simulation and prediction

Logistics preparation. Locomotives, loads, traffi 2 ts

Measurements. Sensors, LIDAR, Imagery

3 4 5 …

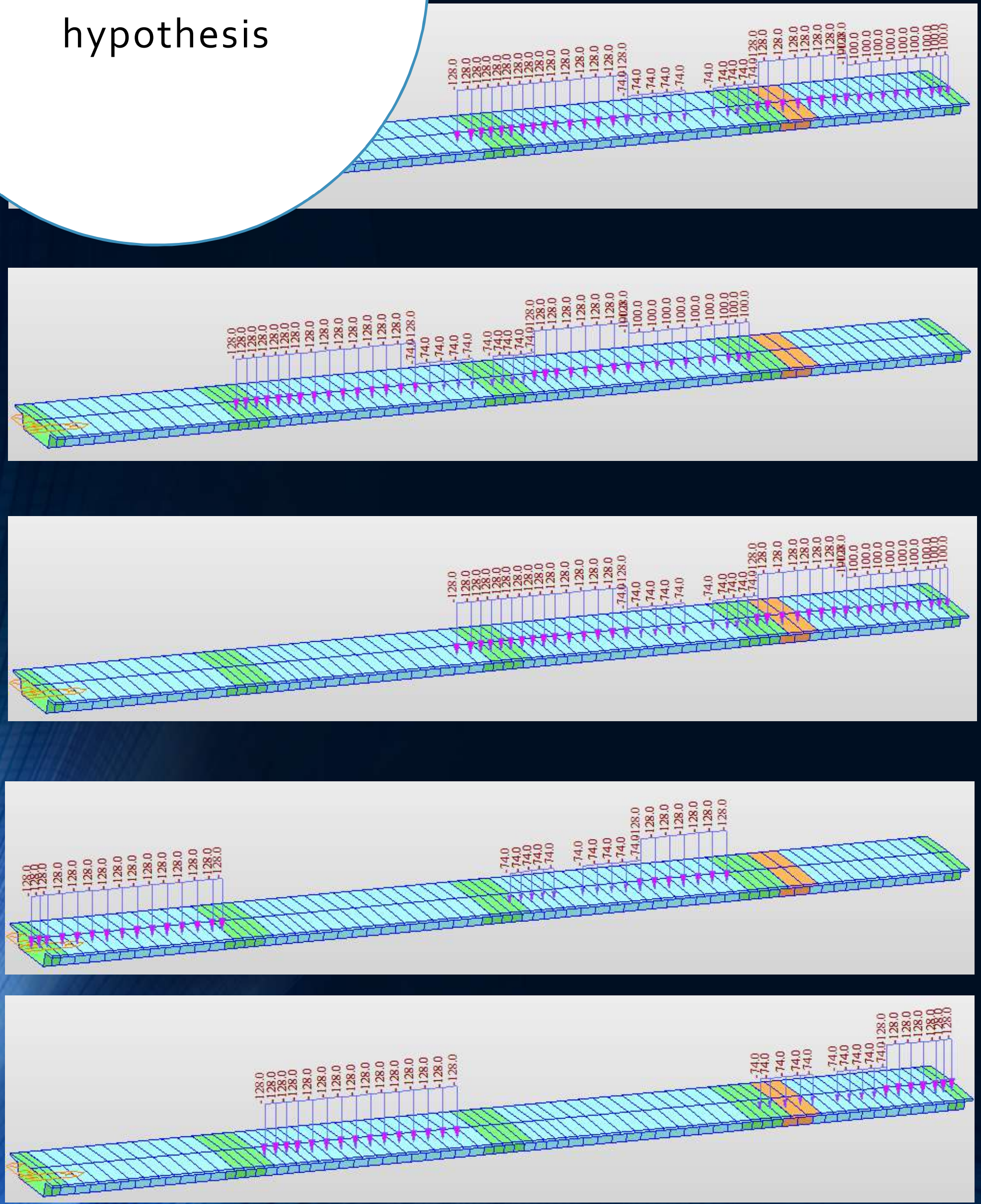
Report. Proof load test and model verification

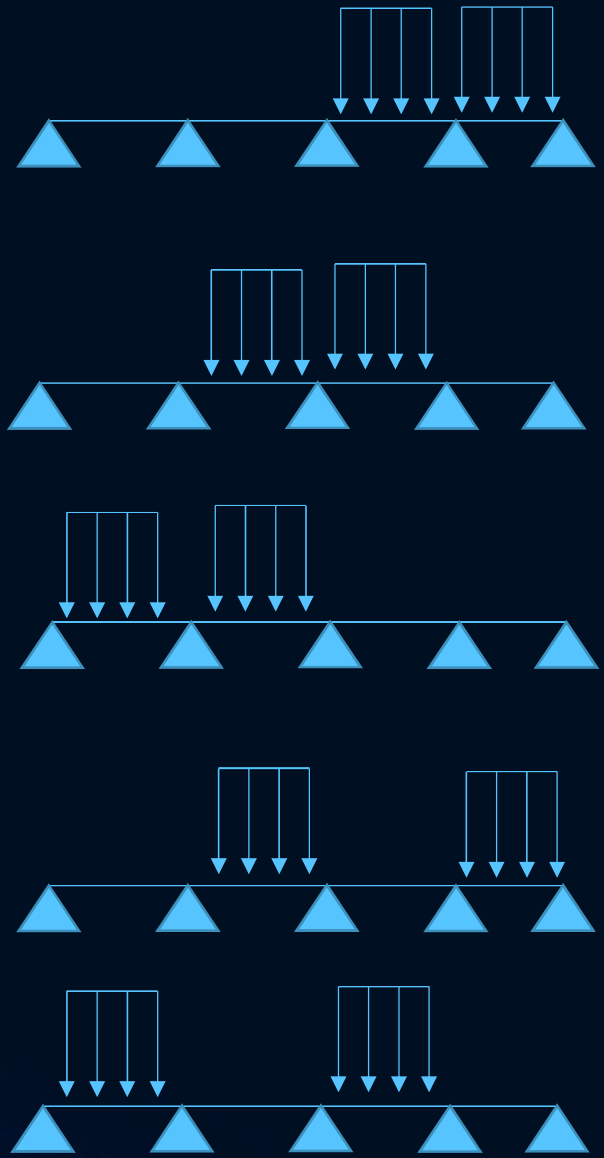
PDF

Models

Prediction for several hypothesis

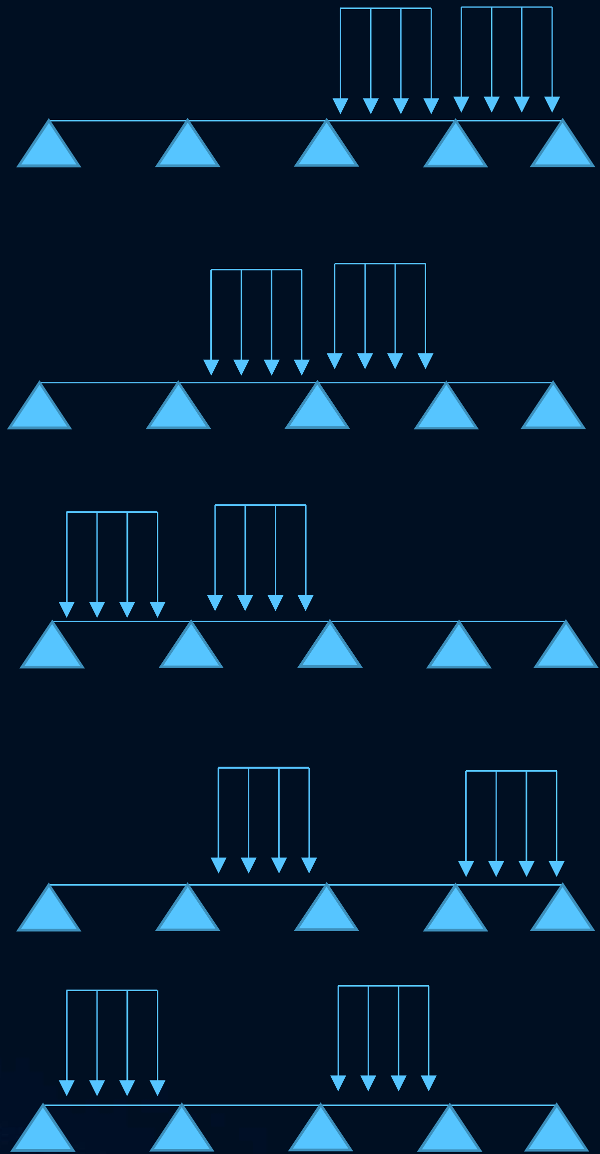
Ashvin demosite #1.Viaducto de la Plata





Logistics

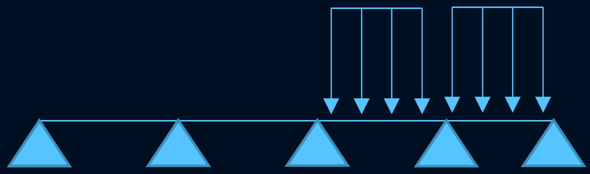
Collaboration with operators

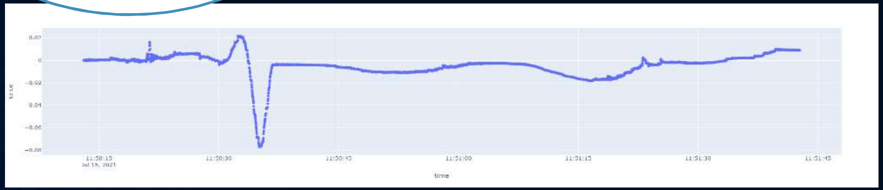


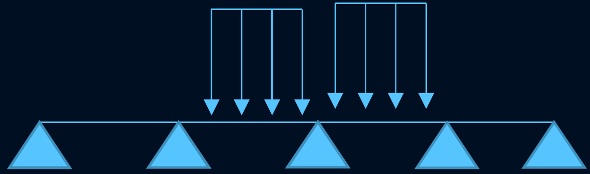
Ashvin demosite #1. Viaducto de la Plata

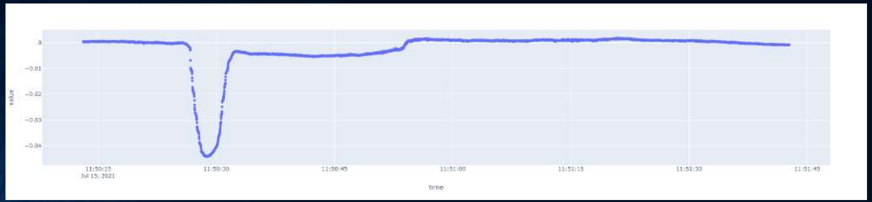
Measurements

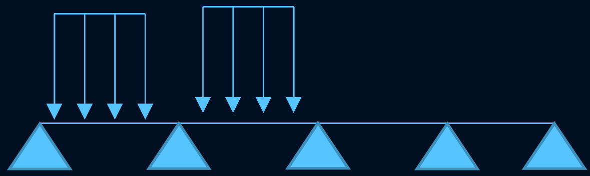
Analysis of the response using sensors

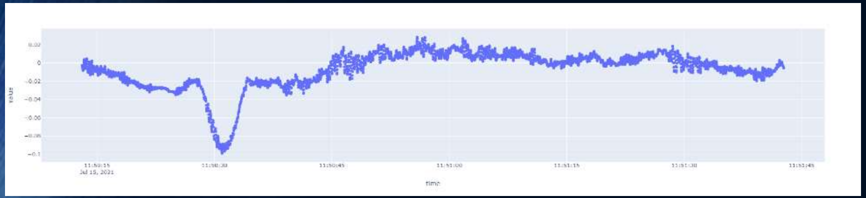


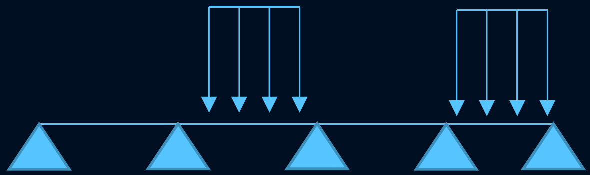


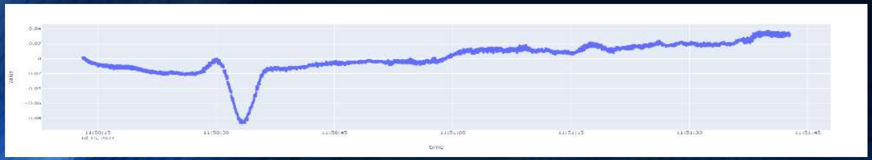


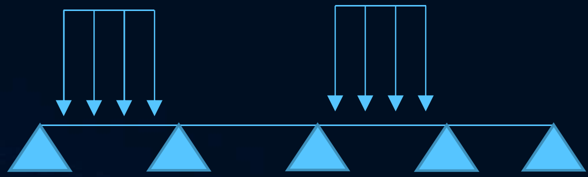








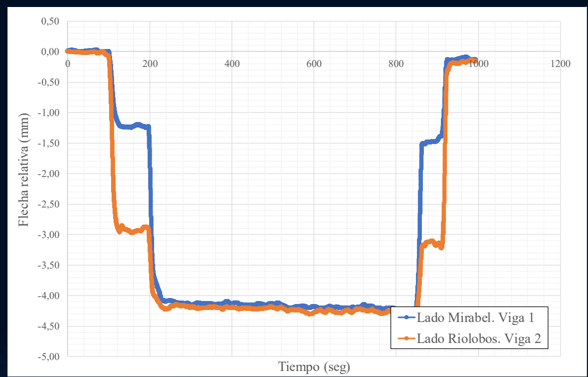


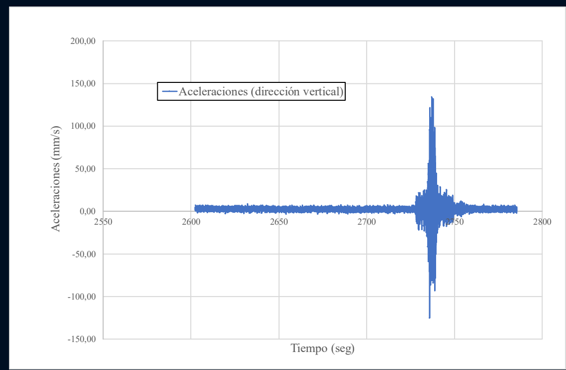


Ashvin demosite #1. Viaducto de Valdelinares

Measurement

Sensors

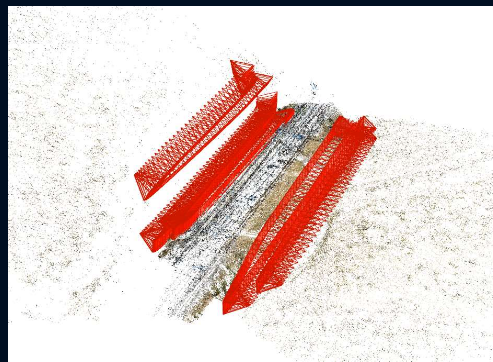




Ashvin demosite #1.Viaducto de Valdelinares

Measurement

Images
Computer vision

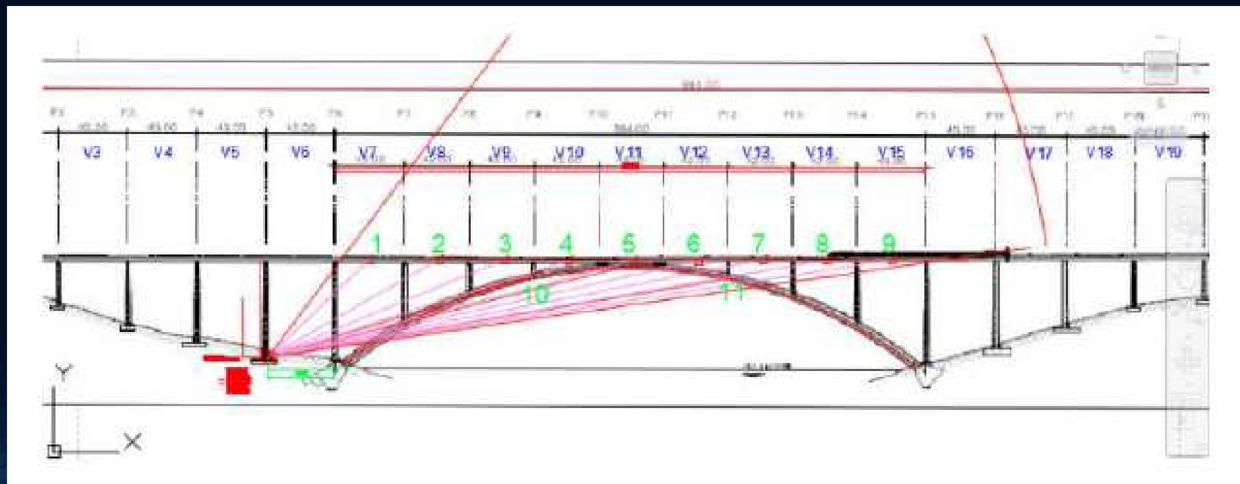


Ashvin demosite #1.Viaducto de Almonte

Measurement

Remote sensing

GB-InSAR



Ashvin demosite #1.Viaducto de Valdelinares

Report

alues		Mode 1 (vertical)	Mode 2 (vertical)	Mode 4 (transversal)	Mode 5 (transversal)
		3,9	**4,36**	**6,81**	**7,64**
	Hipothesis	Registered peak values (Hz)			
		1	2	3	4
1	40 km/h	3,99	4,32	5,92	6,63
	Max	4,19	5,00	5,87	7,12
	Braking + Max	4,26	4,75	6,24	7,10
8	40 km/h	3,99	4,74	6,26	7,17
	Máxima	4,12	4,45	6,57	7,01
	Braking + Max	4,18	4,63	6,19	7,24

Frequency domain values		Mode 1 (vertical)	Mode 2 (vertical)	Mode 4 (transversal)	Mode 5 (transversal)
		3,9	**4,36**	**6,81**	**7,64**
Average	40 km/h	3,99	4,53	6,09	6,90
	Max	4,16	4,73	6,22	7,07
	Braking + Max	4,22	4,69	6,22	7,17
Measurement / Prediction	40 km/h	102,3%	103,9%	89,4%	90,3%
	Max	106,5%	108,4%	91,3%	92,5%
	Braking + Max	108,2%	107,6%	91,3%	93,8%

Digital Twin
Information Construct

Digital Twin
Information Construct

Active
connection

Physical Asset ⟷ Virtual Asset

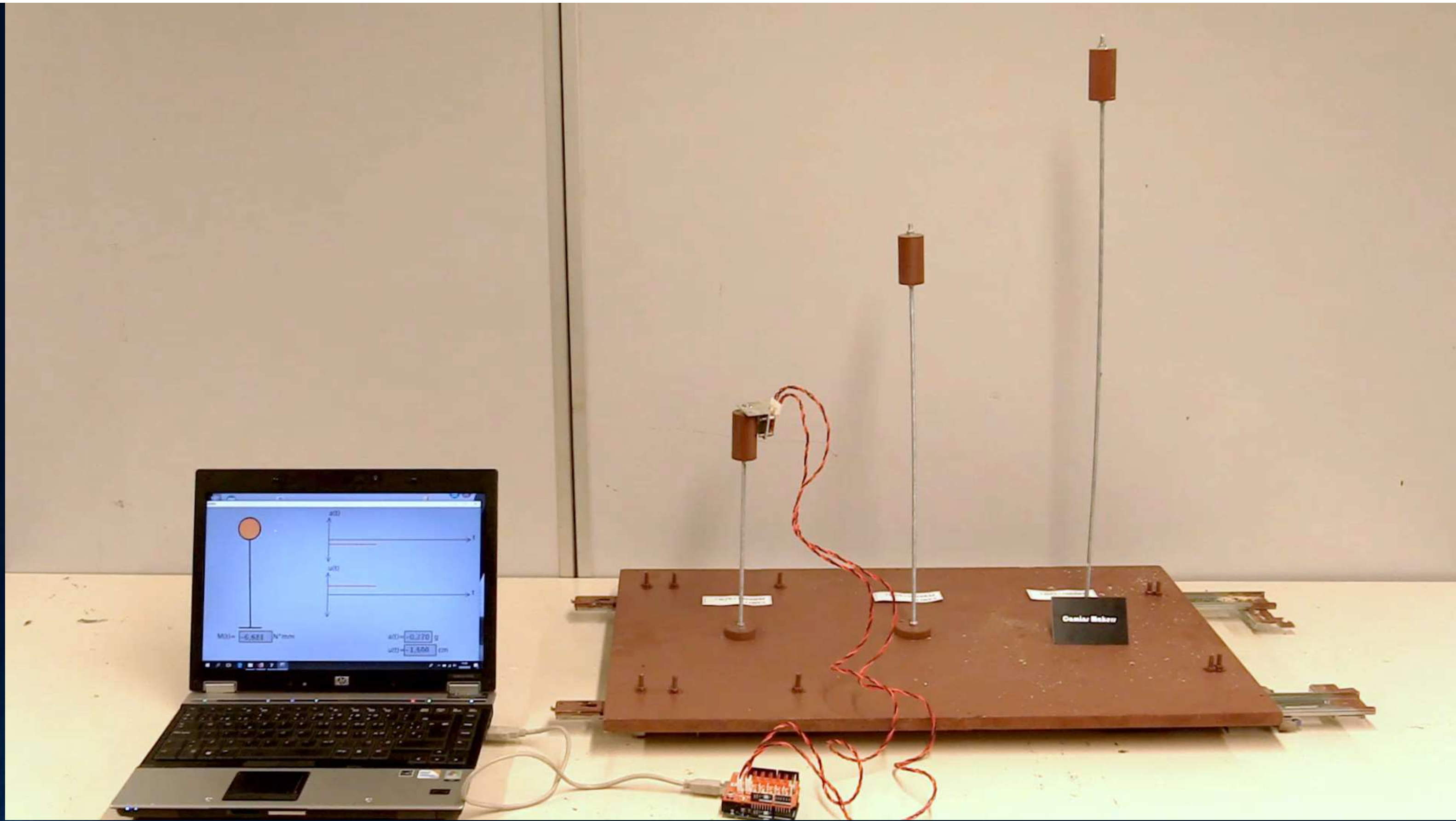
Digital Twin
Information Construct

Automated pipeline of information

Active

connection

Physical Asset ⟷ Virtual Asset



Single parameter Digital Twin of a pendulum (2017)
From acceleration to a simple GUI developed in Processing

Physical Asset → **Behavioral Virtual Asset**

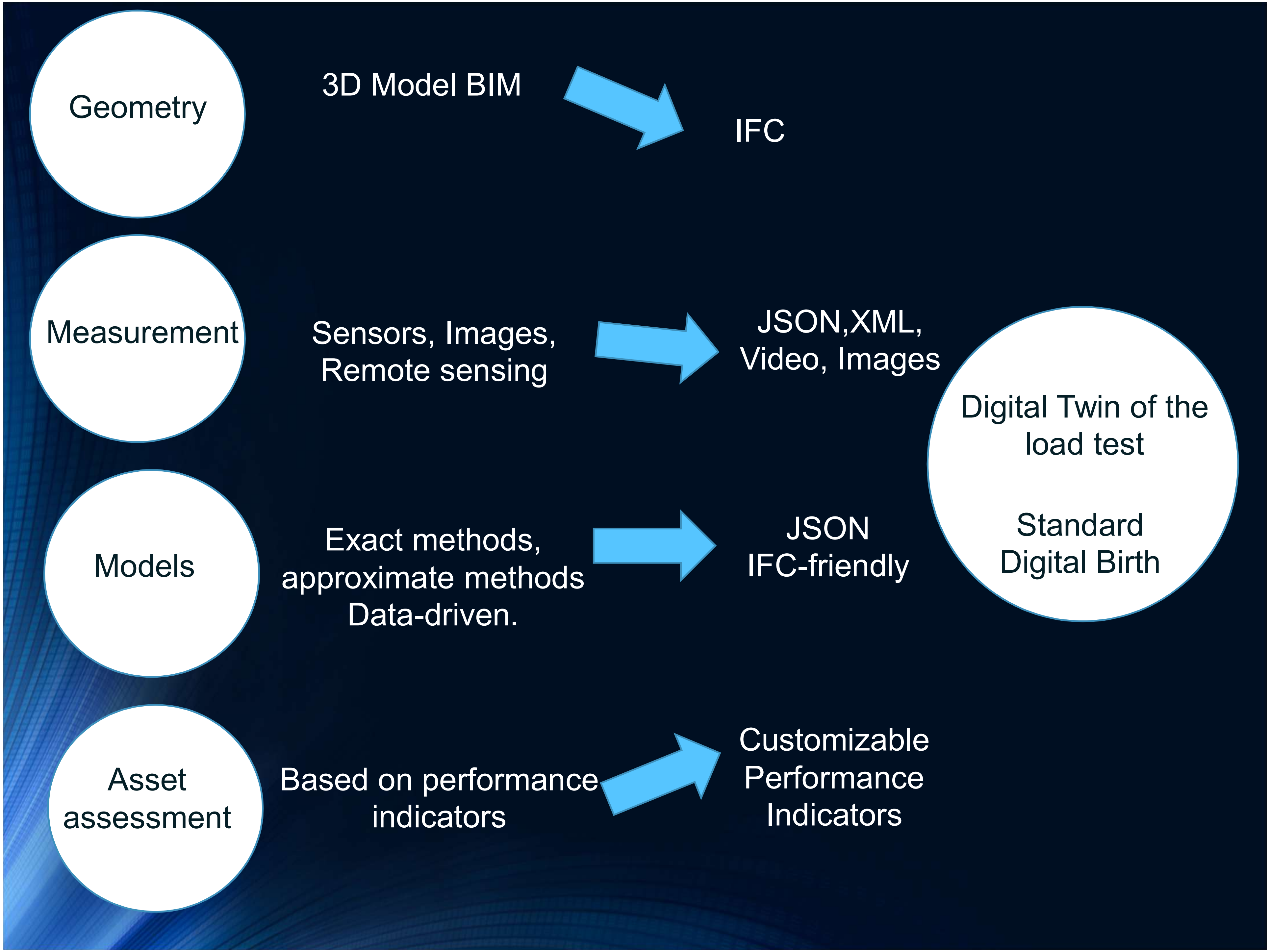
Two parameter Digital Twin of a plate (2017)
From pressure and position to a more sophisticated GUI developed in Python

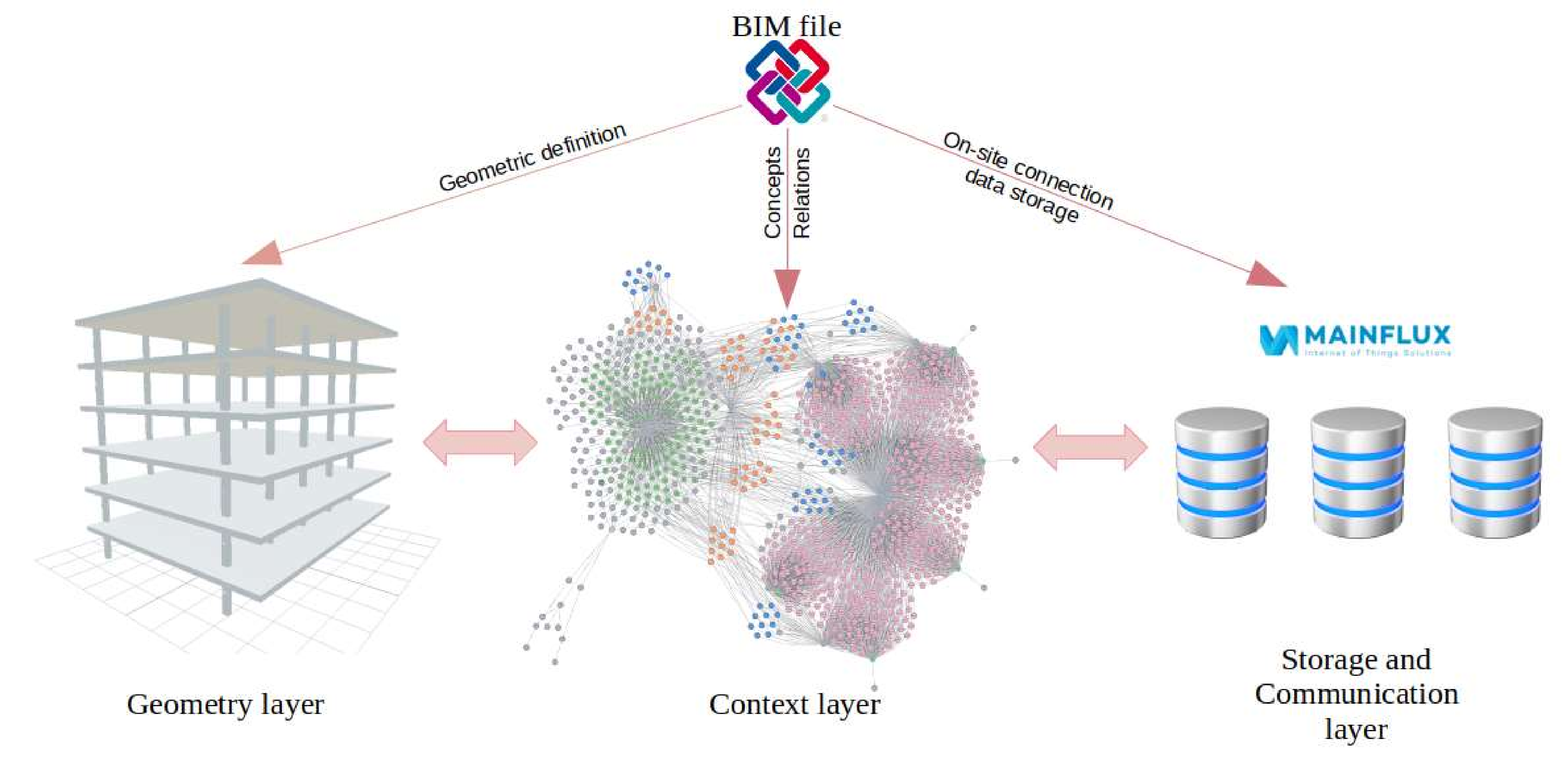
Physical Asset

Behavioral Virtual Asset

Automated pipeline of information

Physical Asset ⟷ Virtual Asset


Geometry
3D Model BIM
IFC
Measurement
Sensors, Images, Remote sensing
JSON,XML, Video, Images
Digital Twin of the load test
Standard Digital Birth
Models
Exact methods, approximate methods Data-driven.
JSON IFC-friendly
Asset assessment
Based on performance indicators
Customizable Performance Indicators


BIM file
Geometric definition
Concepts
Relations
On-site connection
data storage
MAINFLUX
Geometry layer
Context layer
Storage and
Communication
layer

Results

Ashvin consortium

NWIP led by
Austrian Standards International

Together with the

Ashvin consortium

Merge the needs

Load Tests Guidelines	Data Exchange Guidelines