



Quantifying the Value of Structural Health Monitoring

# Industry Innovation Days

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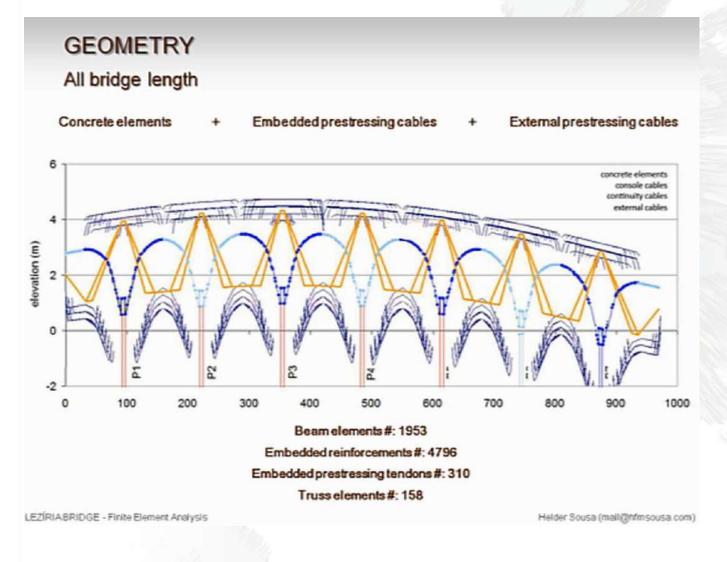
## Objective - Bottom line







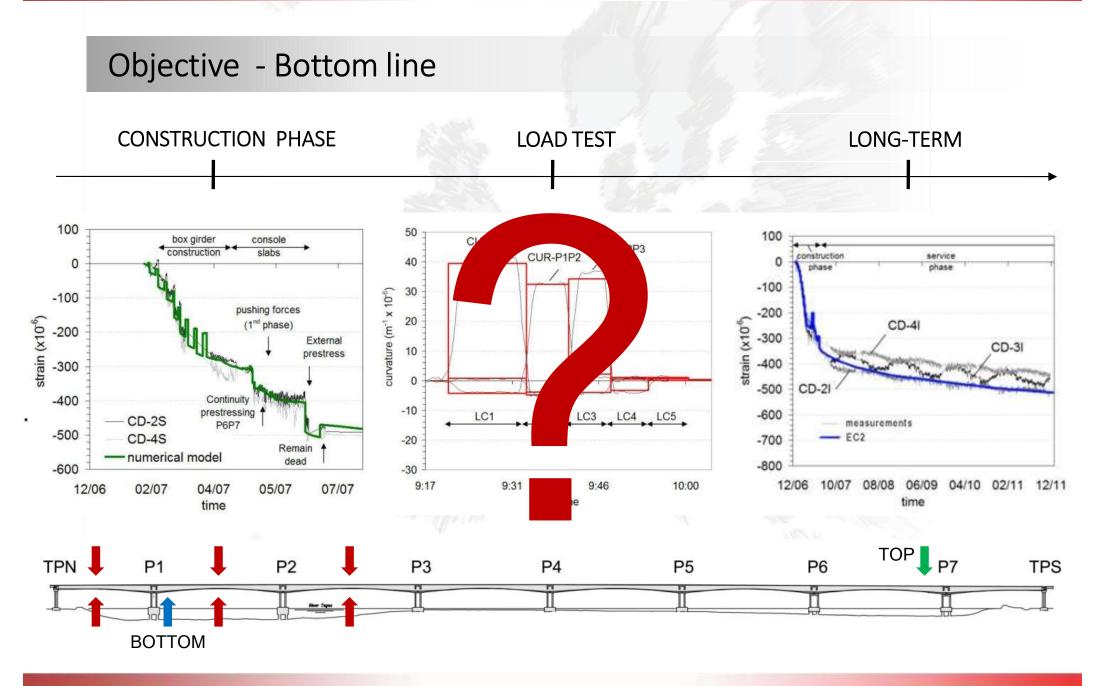
### Objective - Bottom line



- Complexity of the geometry, materials and time-history
- Numerical simulation throughout the bridge lifetime (construction phase + operational life)
- Time-dependent
   effects (shrinkage &
   creep and thermal
   effects)











#### Remedial actions

- Do nothing
- Strengthening (e.g. additional prestressing)
- Reduce traffic speed

#### Indicators

- Strain of concrete at piers and deck
- Rotations in the deck near the supports
- Deflections at mid-spans (from the virtual bridge)
- Displacement in bearings

Observations

Indicators

Crack sizes

### Knowledge on decision context

- Decision maker: private company (owner/operator of the bridge)
- Additional stakeholders: State, users, insurance company
- Minimize costs / maximize income
- Constraints: Budget, functionality/ serviceability, SLS (Eurocode threshold requirements), inspection times
- Ensure reputation

**Objectives** 

#### Asset information

- Landmark bridge (980 m) Service life: 100 years
- Structural type: Prestressed concrete bridge built by the cantilever method with
- Demands: environmental exposure (relative humidity, temperature and wind), traffic loads and (possibly) ship impact
- Design information

Repair records

accelerations)

piled foundation

As built information: Materials properties (i.e. concrete, prestressing steel, loads); Finite Element model (virtual bridge - baseline - refined FE model set up at the end of construction including real geometry, materials and prestressing forces) Inspection records

Monitoring data records (strains, rotations, displacements,

Change system (repair, maintenance, strengthen and renew

Models of Real World

Exposures/loads

knowledge

Vulnerability / direct con. Prior/posterior

Robustness / indirect con.

Robustness / indirect con.

Vulnerability / direct con.

**True State of Nature** 

Exposures/loads

- Minimize operational costs
- Maximize income (toll)
- Avoid reputation loss

Collect Information Monitoring: strains, rotations, bearing displacements

Visual inspections: mapping cracks on concrete

Objective function(s) based on perfomance (e.g. life-cycle costs, resilience,...) to minimize costs / Optimization maximize income.

### **Perfomance**

Rate of deflection over time





### Objective - Bottom line

- SHM has been progressively/widely applied in Civil Engineering structures
- Understanding of the value of SHM, particularly before its implementation, remains an open issue
- A novel utilization of applied decision analysis on <u>how to</u>
   assess the value of SHM is being addressed in the COST Action
   TU1402 Quantifying the Value of SHM



To <u>improve decision basis</u> for design, operation and life-cycle integrity management of structures and facilitates <u>more cost</u> <u>efficient, reliable and safe strategies</u>





### Objective – Jump our COST Action into industry

 To establish and/or strengthen the communication along this supply chain Government

Showcase composed by real applications,

with clear evidence of maturity degree (TRL 4 and/or above)

& Authorities **Concessionaires** & Owners Manufactures & Engineers Academics & Researchers SOCIETY **Technology** validated in lab (TRL 4) Technology validated in relevant environment (TRL 5) Technology demonstrated

(TRL 6)

 To show the Value of SHM Information mainly focussing on owners and local authorities

in relevant environment System prototype demonstration in operational environment (TRL 7)





### Concept – how to trigger this jump?

A <u>dedicated workshop</u>
 targeting mainly the end
 users of the supply-chain,
 i.e. owners/concessionaires
 & governments/authorities

Special sessions in suitable conferences that also target the industry, in addition to the research community



<u>Translate</u> (i.e. speak in a cost-basis language) the Value of SHM to people directly, or indirectly, responsible for management of Civil Engineering structures

SLIDE **9 | 14** 



### Workshop in an industrial partner

- Get feedback from industry regarding the developments made in the case studies
- This will <u>serve as a test to the case studies</u> presented in an industrial environment and get their reaction
- This workshop should work as a <u>preparatory/validation</u> work to be presented in the special sessions at suitable conferences

The concept and language used for this workshop should be practical and objective and therefore, different from the usual that has been taken place until now in the COST Action TU1402



### Conferences – special sessions in suitable conferences

• IABSE 2018, Nantes, France

IABSE 2019, Guimarães, Portugal

Conferences targeting also practical perspectives of management of Civil Engineering structures

EWSHM 2018, Manchester, UK

• IABMAS 2018, Melbourne Australia

Some marginal contribution from these as well



### Conferences – Special session in IABSE 2018, Nante, France

### Why invest in SHM of Civil Engineering infrastructures?

- Show evidence, mainly from an owner/authority perspective, of the benefit of applying SHM systems in Civil Engineering structures supported by the Value of SHM Information theory.
- Authors willing to submit a piece of work to this session need to keep in mind the targeted audience - owners/authorities
- Applications on full scale structures are welcome, with a meaningful message, i.e. if there is a benefit or not in using this type of systems supported by the Value of SHM Information theory.
- Formal joint collaborations between both
   academia & industry, either in the manuscript
   and/or the oral presentation is a plus.

Submission deadline
(abstract):
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### Deliverables

- Official video of the Industry Innovation Days COST Action TU1402 with the purpose of disseminating the successful case studies (up to 3/5min maximum)
- <u>Dissemination by means of official channels</u> of the European Commission (e.g. European Industry Day 2018? or 2019?)
- <u>Technical recommendation</u>, at the European level, <u>to support</u> owners and concessionaires in <u>the renegotiation of the</u> <u>contract terms with local authorities</u> related to the asset management of Civil Engineering structures



# Thank you for your attention

http://www.cost-tu1402.eu/

