Finding a link between measured indicators and structural performance of concrete arch bridges

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SUMMARY OF RESEARCH ACTIVITY

1 MONITORING

STANDARD PERIODIC
- VISUAL INSPECTION
- IN SITE TESTING
- LABORATORY TESTING

PERIODIC LONG-TERM
- with SENSORS installed for recording and reading data periodically

CONTINUOUS
- with SENSORS installed
- DATA TRANSFERE and
- ANALYSIS EQUIPMENT

LINK TO WG2 ?

CATEGORISATION OF MONITORING METHOD IN REGARD TO QUANTITY INDICATED

2 PERFORMANCE INDICATORS

STRUCTURAL
- GEOMETRY
- DETAILS
- MATERIALS
- INTEGRITY
- DYNAMIC CRITERIA
- …

ENVIRONMETAL
- EXPOSURE PARAMETERS
- LOCAL TRAFFIC
- TERRAIN CATEGORY
- SEISMIC ACTIVITY
- WIND INFLUENCE
- …

ECONOMIC
- founding for different INSPECTIONS METHODS
- required KNOWLEDGE LEVEL
- costs of different RETROFIT MEASURES
- OPTIMUM DURABILITY (remaining life-time)

LINK TO WG2 ?

LINK BETWEEN MEASURED INDICATOR AND STRUCTURAL PERFORMANCE OF INTEREST

3 ASSESSMENT OF STRUCTURAL PERFORMANCE

CORRO-SION PROGRESS	SERVICE-ABILITY	CAPACITY FOR TRAFFIC	SEISMIC PER-FORMANCE	PERFORMANCE DUE TO WIND ACTION	REMAINING DURABILITY

SAMPLE STRUCTURES: RC ARCH BRIDGES

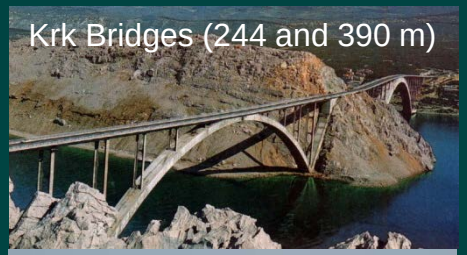
1 MONITORING

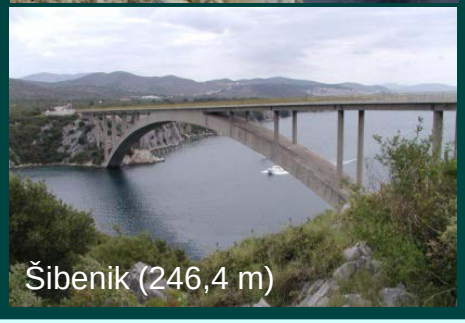
FIRST GENERATION

Krk 1980 | Pag 1968 | Šibenik 1966

SECOND GENERATION

Maslenica 1997 | Skradin 2005 | Cetina 2007





Which monitoring method (technique) to be used for measure certain quantity in order to define adequate performance indicator?

Uncertainties in measured data and in collecting data?

2 PERFORMANCE INDICATORS

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STANDARD PERIODIC Collecting experience from past inspection and assessment

- geometrical surveying
- visual inspection
- loading tests

- hammer sounding
- rebound hammer
- half-cell potentials
- ultrasonic method
- crack width measurements

- pull of test
- physical and mechanical prop.
- permeability properties
- alkalinity properties
- chloride content
- bond strength

+ establish regular inspection and include any other necessary technique

PERIODIC LONG-TERM OR CONTINUOUS

Activate monitoring and collecting new long-term data

- wind direction and speed
- displacements
- corrosion progress
- humidity
- strain, temperature

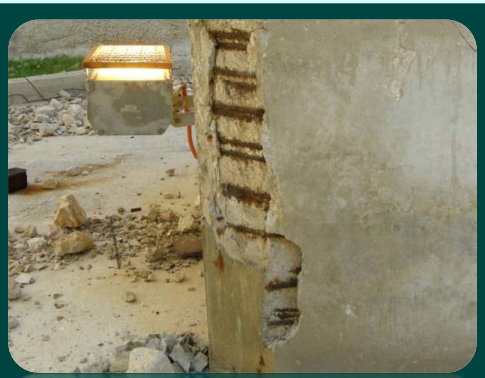
2 PERFORMANCE INDICATORS

SAMPLE STRUCTURES: RC ARCH BRIDGES

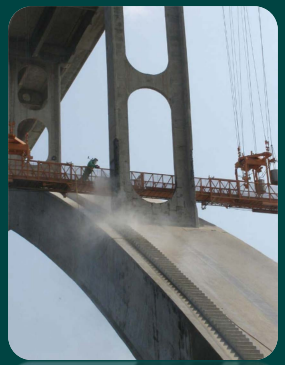
1 MONITORING

Šibenik Bridge: deterioration at the underside of bridge deck

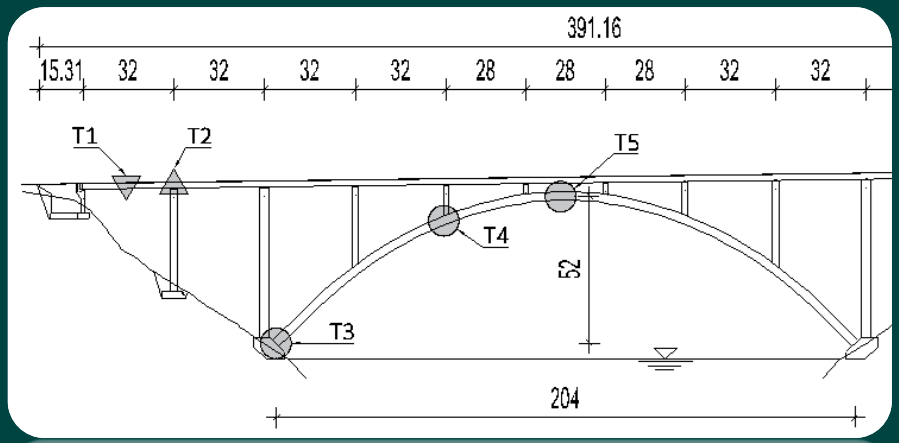
Pag: delamination at the edge of the arch abutment

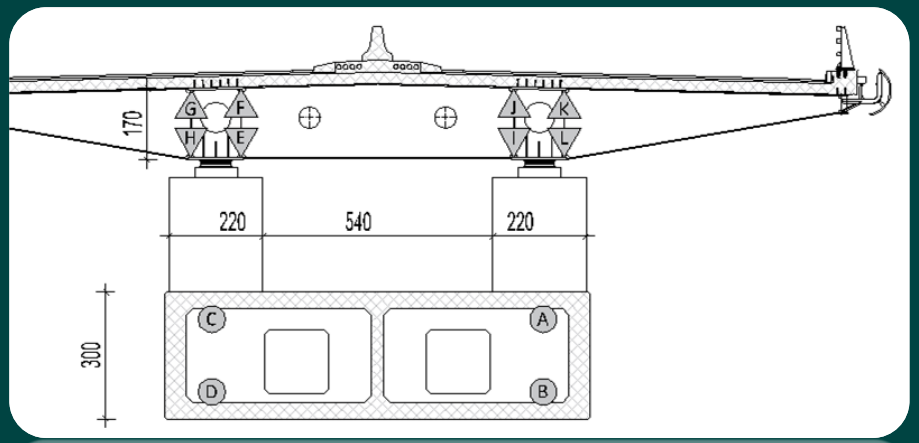


Maslenica: Reinforcement corrosion on column S10



Krk: optical sensors embedded into columns



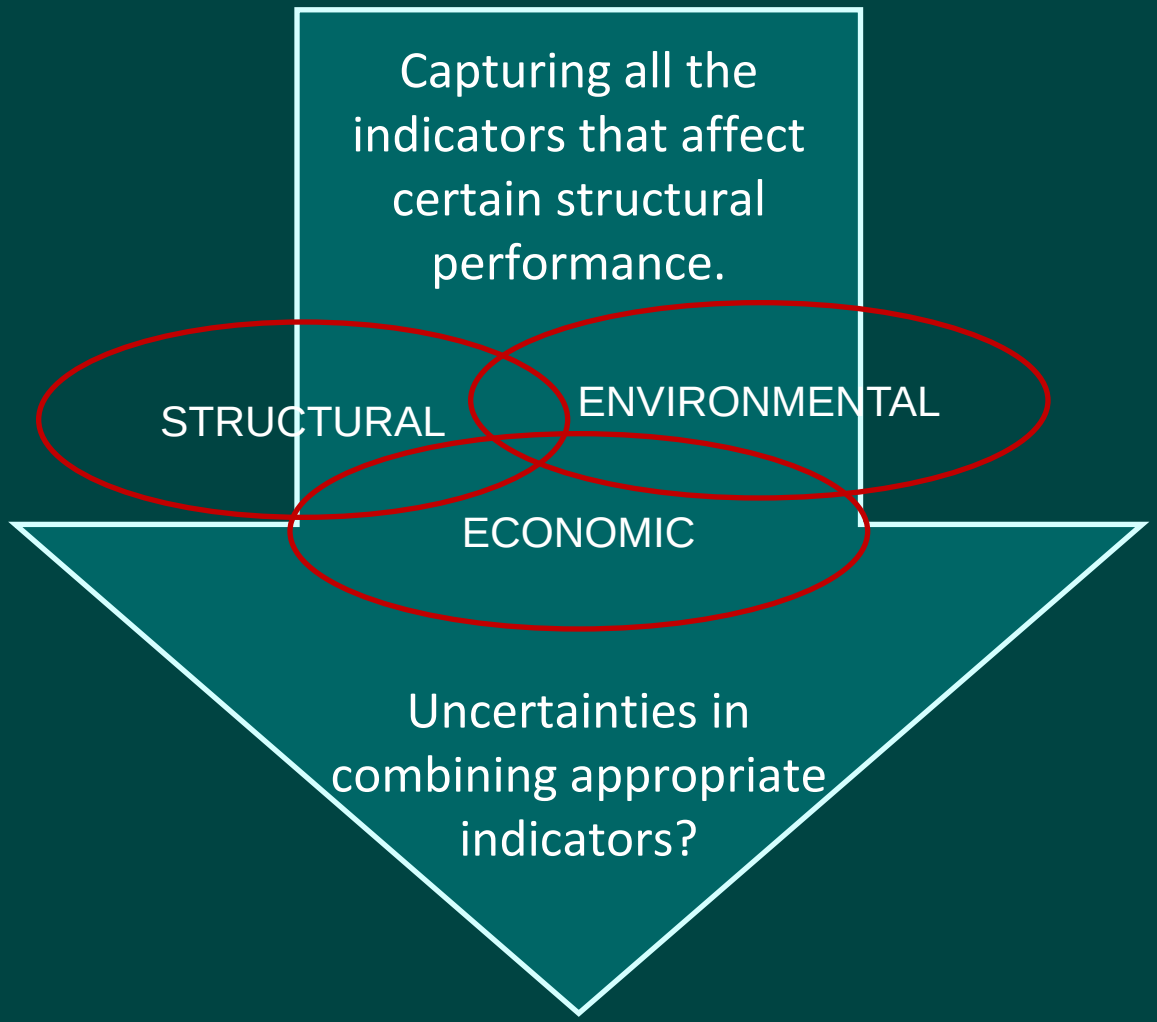


Skradin: strain gauges

2 PERFORMANCE INDICATORS

EXAMPLE: SEISMIC PERFORMANCE OF RC ARCH BRIDGES

2 PERFORMANCE INDICATORS

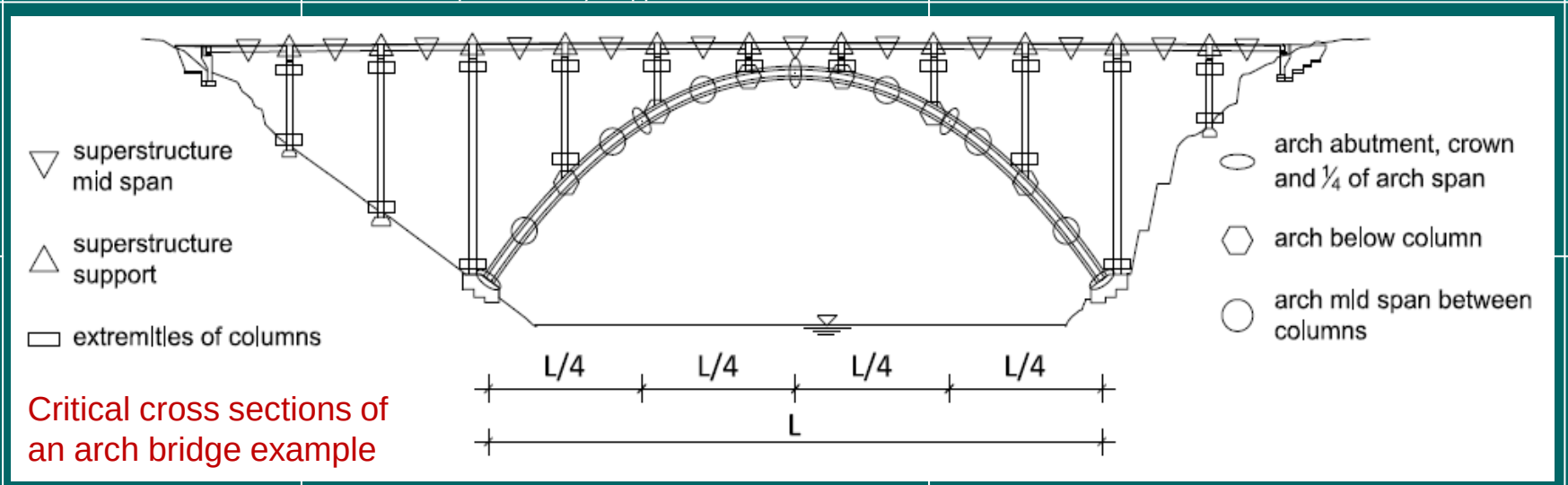


3 ASSESSMENT OF STRUCTURAL PERFORMANCE

EXAMPLE: SEISMIC PERFORMANCE OF RC ARCH BRIDGES

2 PERFORMANCE INDICATORS

Knowledge level	Data collection and minimum requirements of in-situ inspection and testing			Confidence factor
	Geometry	**Details**	**Materials**	
KL2 bridges of the average importance	Arch and pier axis, superstructure grade line, cross section dimensions.	Amount and detailing of longitudinal reinforcement, amount and detailing of confining reinforcement in critical regions, depth of concrete cover (delamination), connection between members (arch-pier, pier-superstructure), support conditions	Concrete strength, Steel yield strength, ultimate strength and ultimate strain	1,2
KL3 bridges of critical importance				1,0



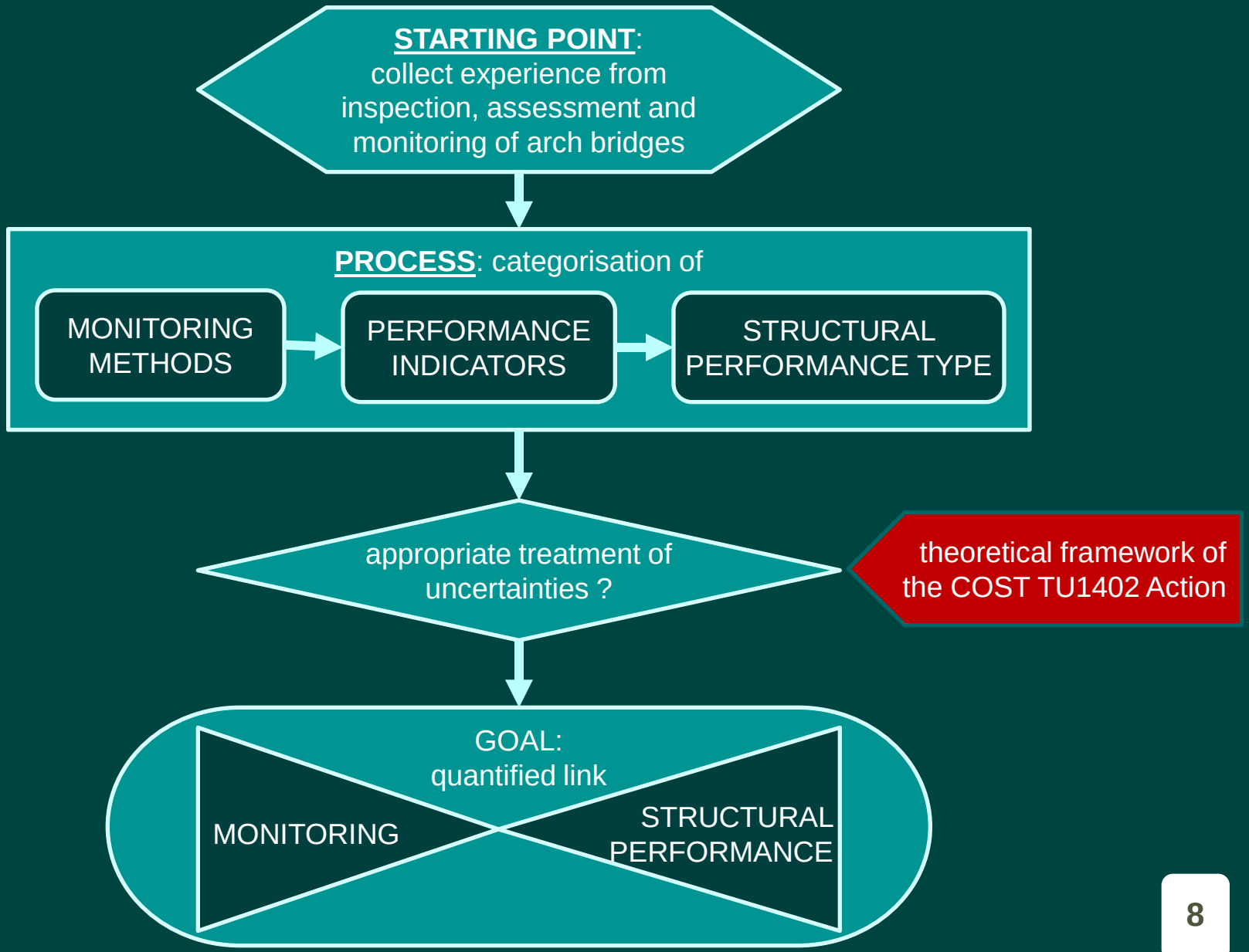
Critical cross sections of an arch bridge example

Notes

- Structural parameters such are cross section dimensions or effective reinforcement might be changed due to deterioration processes from combined exposure to the sea and wind which are environmental parameters.
- Higher knowledge level for a bridge of critical importance will require more extensive inspection works and comprehensive bridge monitoring.
- It is of a great importance to establish the most significant locations of the arch bridge to be inspected such are we proposing with this example.

3 ASSESSMENT OF STRUCTURAL PERFORMANCE

ACTIVITY PLAN FLOWCHART



Thank you for your attention!

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