QUALITY SPECIFICATIONS FOR ROADWAY BRIDGES,
STANDARDIZATION AT A EUROPEAN LEVEL

TU1406 WG4 Final report Appendix A15

Bridge Case study

Girder bridge A1.008 Brentenmais, Austria

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cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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1. GENERAL DATA OF THE BRIDGE

The object A1.008 “Brentenmais” (valley interchange L 2108 U. GERINNE TÜ "BRENTENMAIS" - D = 3.80) is located on the motorway A1 km 19,794 west of Vienna. It was built in 1963 as a prestressed concrete structure.

The bridge consists of two separate structures per carriageway (RFB Wien, RFB Salzburg). The two superstructures lie on common abutments and separate piers and are up to identical to the bank ratios. The structures are prestressed concrete bridges are formed and consist of a two-tiered plate beam with pressure plates over the Piers.

The superstructures have their fixed point in the axis 50, there are concrete joints formed. On the pillars of the structure is located on large elastomeric bearings. In addition is located on each pillar a fixed camp. At the abutment 10 are transversal bearings available.

The pillars are formed on the foot with a concrete joint.

The road surface is drained through pipes under the slab.

The bridge was widened in 2005/2006 and damaged the concrete rehabilitated. It was concreted on the side of the carriageway slab and the edge beams were new manufactured. The structure was upgraded with a potted concrete. Figure 1 & 2 gives an impression of the overall structure. (DI Brandstätter Ziviltechniker GmbH et al, 2012)

Figure 1 *Side View of the Bridge (RFB Salzburg, Westward View)*

Figure 2 *View from under the Bridge (between the two structures)*

1.1. TRAFFIC INFORMATION

The last information about the traffic are from the last counting in 2017.
Number of cars / 24 h: 27.267
Percentage of the heavy vehicles from the total amount / 24 h:2,24%

1.2. FOUNDATION

The foundations are not accessible. According to the plans the pillars standing on pad foundations, the abutments standing on strip foundations.

1.3. SUBSTRUCTURE

The substructure consists of the two abutments and six pillars, three per directional carriageway. The abutments consist of reinforced concrete and are stone-clad. The pillars are two-cell hollow piles made of reinforced concrete. The intermediate yokes (massive columns) have a height of 22.5 m and 35.5 m, respectively. The columns have a concrete joint on the foot and are attached to the head by a fixed bearing

1.4. SUPERSTRUCTURE

The superstructure consists of cast in-situ reinforced concrete slab, 2 rubber profile deformation joints and 8 simple steel (sheet) bearings at both ends.

1.5. ACCESSORIES

The cover plate is asphalt layer (14 cm) and the safety railings are made from galvanized steel. Slope protection is made from reinforced concrete.

1.6. LOAD CAPACITY

The bridge class corresponds to a road bridge class 1 (special transports up to 200 ton), solo approach according to RVS 15.02.23. A load limit is not set. The angle restriction is limited to 100 gon.

1.7. GENERAL DATA ACCORDING TO WG4 – SUB GROUP A

ASFINAG

Datenblatt B A1.008

Name: L 2108 U. GERINNE TÜ BRENTENMAIS - D=3,80

Straße: A 1 West Autobahn **km:** 19,794 L 2108 Landesstraße bei km 1,001

Verwalter: ASFINAG **Erhalter:** SG-EMS N **BL:** Niederösterreich

Anmerkung:

Obj.Nr.: A1.008 Brückentragwerk **Status:** Erhaltung

Fahrbahn: A01_L: 19,653-19,935, A01_R: 19,653-19,935

System: Balken/Plattentragwerk-durchlaufend **Lichtraum H/B:** 0,03 / 0,00 [m]

Norm: B 4002 (1970) **Baujahr:** 1963

Brückenklasse: Strbr. Kl. I (SFZ 200t),Alleingang(RVS 15.02.23) **Lastbeschränkung:** [t]

Winkel: 100 [gon]

Unterbau:

Widerlager: WL1, Schwergewichtswiderlager, keine Angabe / WL2, Schwergewichtswiderlager, keine Angabe

Pfeiler: Hohlpfeilerscheibe, keine Angabe

Überbau:

Material: Spannbeton **KH:** 3,58 [m]

Querschnitt: Plattenbalken-vollwandige Stege, volle Platte **LN:** 0,0 [%] **QN:** 0,0 [%]

Länge: 285,00 [m] **Breite:** 30,00 [m] **lichte Weite:** 279,40 [m] **Fläche** 8.550,00 [m²]

Felder: 68,07 + 73,00 + 73,00 + 68,07 = 282,14 [m]

Lager: Verformungslager / Topfgleitlager / Topflager / Betongelenk, 4 Stk.

FÜG: WL 1, Fingerkonstruktion-mit Dichtfunktion / WL 2, Fingerkonstruktion-mit Dichtfunktion

Fahrbahn: Bituminöser Belag (14) **Belagsstärke:** 14 [cm]

Abdichtung: Polymermodifizierte Bitumenbahnen **Entwässerung:** verrohrt in Gewässerschutzanlage

Randbalken: [L1] keine Angabe 1,25/311,00 MonoBW: nein keine Angabe, [R1] keine Angabe 0,92/309,00 MonoBW: nein keine Angabe, [L2] keine Angabe 0,92/309,00 MonoBW: nein keine Angabe, [R2] keine Angabe 1,25/311,00 MonoBW: nein keine Angabe B/L in [m]

Geländer: Links1, Syst IV, Stahl / Rechts2, Syst IV, Stahl

Leitschienen: Links1 Leitschiene mit Hochbord, H2, Stahl / Rechts1 Leitschiene mit Hochbord, H3, Stahl / Links2 Leitschiene mit Hochbord, H3, Stahl / Rechts2 Leitschiene mit Hochbord, H2, Stahl

Leitwände:

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Figure 3 *Datasheet page 1 of the Brentenmais bridge*

ASFiNAG

Datenblatt B A1.008

Name: L 2108 U. GERINNE TÜ BRENTENMAIS - D=3,80

Straße: A 1 West Autobahn **km:** 19,794 L 2108 Landesstraße bei km 1,001

Verwalter: ASFINAG **Erhalter:** SG-EMS N **BL:** Niederösterreich

Anmerkung:

Kontrolle: 2 **Prüfung:** ZT Brandstätter **Note:** 2 nächste Prüfung 2018

Dienstag, 18. Dezember 2018 Seite 2 von 2

Figure 4 *Datasheet page 2 of the Brentenmais bridge*

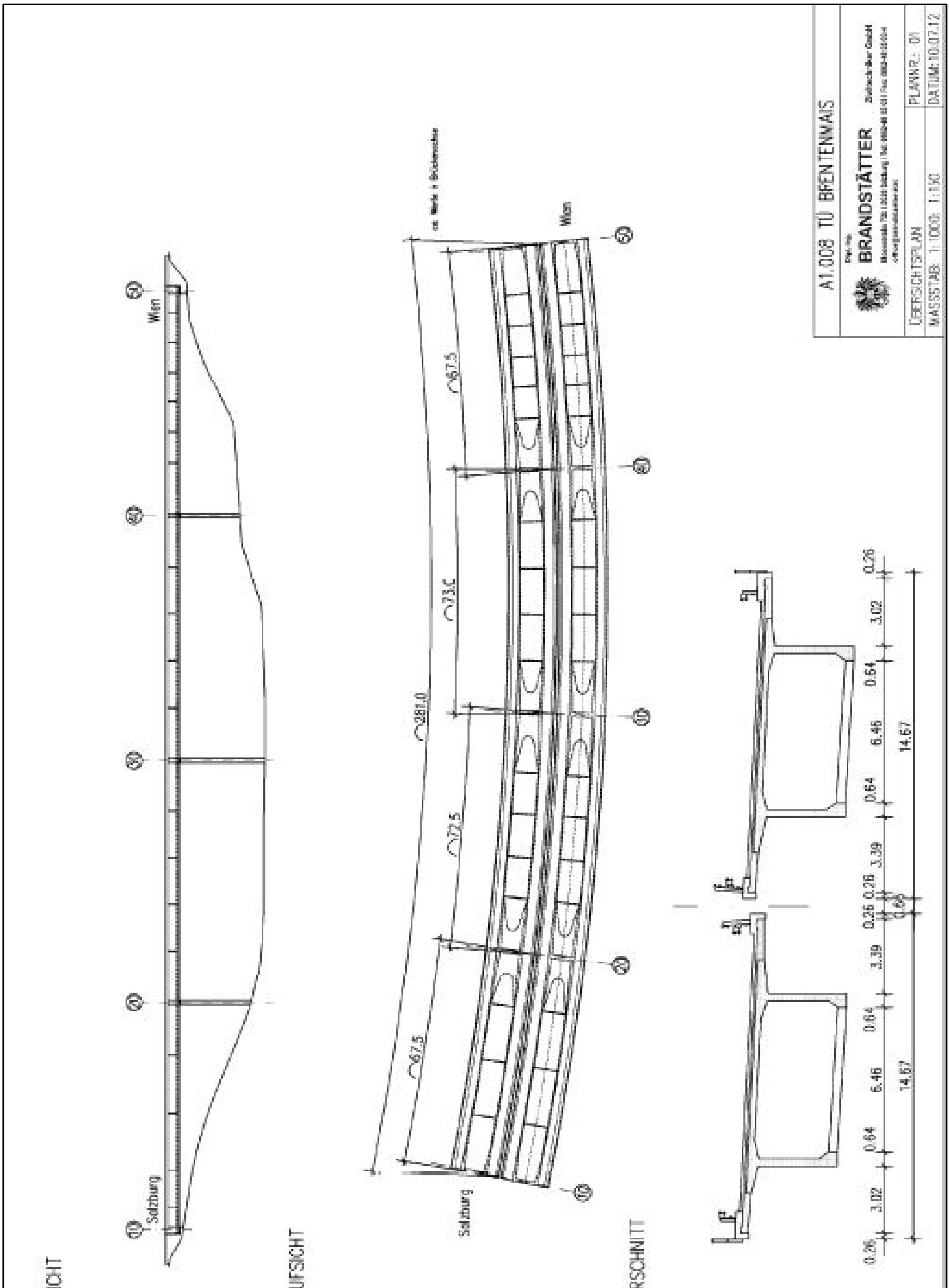


__Figure 5__ scanned plan of the Brentenmais bridge

2. TECHNICAL CONDITION

Because the report of 2018 is not yet available, the data of the last inspection 2012 were processed here （DI Brandstätter Ziviltechniker GmbH ,2012).

2.1. LEGAL BASIS OF THE INSPECTION

The inspection of the bridge structure was carried out in accordance with RVS 13. 03.11 - version 1.10.2011. It replaced the RVS 13.03.11 (13.71) from August 1995. The used rating system is shown in the table 1

Rating System (RVS 13.03.11)		
1	sehr guter Zustand	very good condition
2	guter Zustand	good condition
3	ausreichender Zustand	sufficient condition
4	mangelhafter Zustand	poor condition
5	schlechter Zustand	bad condition

Table 1 *Rating System according to RVS 13.03.11, Oct. 1th 2011*

According to the decree BMVIT-300.041 / 0086-IV / ST-ALG / 2011 objective object in the following sections:

2.1.1. INSOECTION PROCEDURE

The test covers all accessible surfaces of the structures. Those components that are not of the terrain can be inspected from, using the inspection equipment of ASFINAG (Bridge device) reached and immediately inspected. In difficult to reach fields, the visual inspection is carried out using a pair of binoculars.
If the need arises for further tests, they shall be classified as follows under item 7.2
Special Test Methods and Devices "of the above Directive.

2.1.2. DOCUMENTATION

The documentation is a written and planned presentation of the examination results.
About the bridge monitoring of the structures referred to in the said Directive the observations made on the inspection are considered as defects in the Plan sheets represented by symbols and described in the damage documentation. In the explanation, the damage patterns found are generally described.
At the bearings and road junctions, the measured positions were in tables shown.
Characteristic defects were recorded in photographs. The picture numbers were in the planned presentation and included in the damage documentation.

2.2. PRINCIPAL INSPECTION REPORT 2012

During the inspection these types of defects were discovered.

2.2.1. Security Measures:

Equipment:
The bent guardrail at abutment Sbg., RFB Wien must be renewed.
This action is to be carried out immediately.

2.2.2. Durability Measures:

Superstructures:
• flaking, corrosion, nests:
Part of the spalling concerns already rehabilitated places. Here must be of it be compensated that after the renovation and therefore the remediation mortar was blown off. These places are to be renovated again. The corroded irons must be blasted, it is a corrosion protection and a bonding agent apply, then the reprofiling takes place. In the coupling joints the cracks are to be pressed.
These measures are medium term, preferably within six years to lead.
• cracks rehabilitated sites:
A large part of the renovated areas shows shrinkage cracks. A permanent protection against ingress of moisture and air is no longer guaranteed. At these points, the reinforcement must be exposed again. After that is the Repair site as described above.
These measures are medium term, preferably within six years
• Covering defects:
Systematically occurring, local covering defects of the bar reinforcement, the since the construction are there, rehabilitation is not effective, or the usability is not essential is carried out.
Substructures:
• flaking, corrosion:
Chipping must be remedied (rust removal, corrosion protection, bonding bridge and Reprofiling). Partly already renovated sites are affected.
These measures are medium term, preferably within six years to lead.
• the jointing of the concrete joints at the base of the columns is insufficient.
Bearing:
• corrosion bearing axis 10:
The anchor and bearing plates of the axis 10 have light to medium corrosion damage on. The affected camps are to be rusted and the Corrosion protection must be renewed.
This measure is medium term, preferably within six years to lead.
Edge beam:
• The open putty joints must be renewed.
This measure is short-term, if possible within three years to lead.
• The spalling at the edge beam at the FÜK, RFB Vienna must be rehabilitated.
This measure is medium term, preferably within six years to lead.
• The same formwork anchors are to be cut off and against corrosion protect.
This measure is medium term, preferably within six years to lead.
Equipment:
• The corroded hinges at the descents in the middle of the lane are closed renew.
This measure is medium term, preferably within six years to lead.

Recommended actions
• The hollow boxes are heavily polluted by bird droppings. These should be before the to be cleaned next inspection.
• The drainage channel between axis 10 and 30 is heavily overgrown, some are stones locker. That should be rehabilitated.
• The joints at the foot of pillar 40 (joint) must be renewed.

Special test instructions for the control:

• On the renovated and partially open cracks at the coupling joints in the Field 20-30 and the cracks in the 10-20 field special attention should be paid. Here should be up to the next main bridge test be performed.
• In extreme temperatures, the movement reserves of the bearings and the FÜK be controlled in the axis 10.

The functionality and resilience of the object in the previous scope can be confirmed.

2.3. HISTORICAL INSPECTION DATA

In Table 2 previously collected data is shown (not complete).

Type	Principal Inspection	Rehabilitation	Routine Inspection	Principal Inspection	Routine Inspection	Routine Inspection	Principal Inspection
Year	2002	2005/2006	2010	2012	2014	2016	2018
Substructure			2	2	2	2	
Superstructure			2	3	3	3	
Bearing			2	2	2	2	
Expansion Joints			1	1	1	1	
Roadbed			2	2	2	2	
Waterproofing, Drainage			2	2	2	2	
Edge Beam			2	2	2	2	
Equipment			2	2	2	2	
Total Object			**2**	**2**	**2**	**2**	

Table 2 *Historical Inspection Data (not complete)*

2.4. DEFECTS SHOWN IN PLANS

Legend

R	Crack
W	Crack width [mm]
AF	Working joint, open
KF	Coupling joint, open
N	Nest
H	hollows
A	Chipping
W	Water, Moister, wet surfaces
SA	rehabilitated place
Ü	exposed rebar, low concrete coverage, exposed tension cable
K	Rust flag, corrosion
S	Sintering, stalactite formation
I	poor injection condition
FS	void

2.5. FOTO DOCUMENTATION

Pier 30, chipping, corrosion

Pier 40; hinge, open joint


Main girder 4 (HT4), cracks


Main girder 4 (HT4), nest, chipping, corrosion


Main girder 2, chipping corrosion


Bearing, axis 10, main girder 2 (HT2), corrosion


Safety barrier, bend

3. VULNERABILITY ASSESSMENT VULNERABLE ZONES

The vulnerable zones are presented in the pictures below.

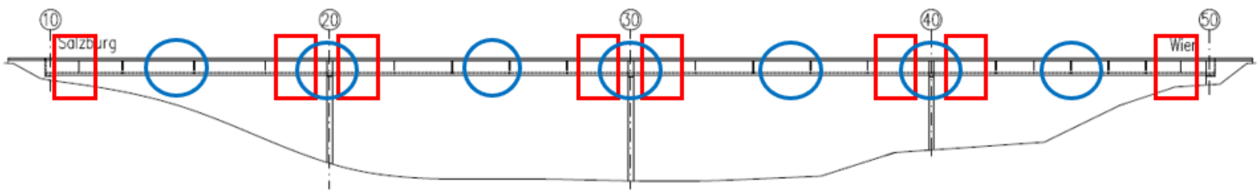
Legend

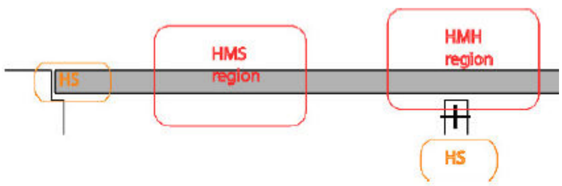
Shear failure

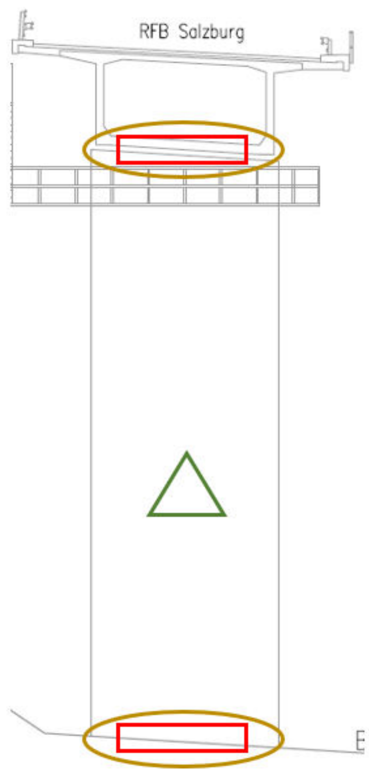
Bending failure

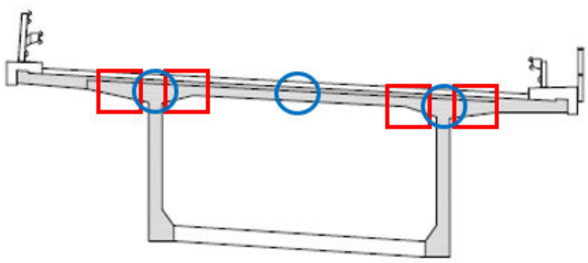
Buckling

HMS	Sagging
HMH	Hogging
HS	High shear regions









3.1. POTENTIAL FAILURE MODE OF THE BRIDGE

In accordance with current condition of the bridge following failures are considered seen in table 3:

ure	Group	Component	Material	Design & Construction	Failure mode	Vulnerable Zone	Damage	Damage process	KPI	PI	PI Over all		Time
											R	S	
Girder Bridge GC 1	Structural elements	main girder	Reinforced concrete	1963	bending failure mode	HMS region	section loss of reinforcement	efflorescence	Reliability	2	3	3 (5)	25
								swelling	Reliability	3			25
								Corrosion	Reliability	3			25
						HMH region		swelling	Reliability	3			25
								Corrosion	Reliability	3			25
					shear failure mode	beams' webs		efflorescence	Reliability	2			25
								swelling	Reliability	3			25
								Corrosion	Reliability	3			25
		cross beam	prestressed concrete	1963	bending failure mode	HMS region	section loss of reinforcement	swelling	Reliability	3			25
								Corrosion	Reliability	3			25
		Piers	Reinforced concrete	1963	pier failure	edge of piers	spalling	swelling	Reliability	2			25
						piers	section loss of reinforcement	Corrosion	Reliability	3			25
						concrete joint	exposed joint	water penetrability	(Symptom)				25

[illegible]			Material	Design &	Failure mode	Vulnerable	Damage	[illegible]	[illegible]	[illegible]	PI Over all		[illegible]
		Bearing	Elastomer & steel cast	1963	Bearing Failure	Axis 50	Corrosion	Corrosion	Reliability	2			35
		Abutment	Reinforced concrete	1963	Abutment failure	Abutment axis 50	section loss of reinforcement	swelling	Reliability	2			25
								Corrosion	Reliability	2			25
		edge beam	Reinforced concrete	1963	bending failure mode	along the whole structure	cracks	water penetrability	(Symptom)				15
							section loss of reinforcement	Corrosion	Reliability	2			15
		cantilever plate	Reinforced concrete	2005	Deck bending failure		cracks	water penetrability	(Symptom)	2			15
	Equipment	guardrail	steel	n. k.	Accident		Deformation	Impact	Safety	(5)			0/25
		inspection descent	steel	1963	Disintegration		Corrosion	Corrosion	Safety	3			15
		footbridge	steel	1963	Disintegration		Corrosion	Corrosion	Safety	3			15
		Draining installation	PVC	2005	Failure of Draining	Mounting point	Corrosion	Corrosion	Reliability	2			15

4. MATERIAL TESTING

Material testing is not available.

5. KEY PERFORMANCE INDICATORS

Accordance to COST TU1406 WG3, the used key performance indicators in this case study are based on failure modes and agreed performance areas. These indicators are:

- • RELIABILITY
- • SAFETY
- • AVAILABILITY
- • ECONOMY
- • (if applicable) ENVIROMENT

In the scenarios listed below, the most important performance indicators of the COST TU1406 WG3 and the experience values in the Austrian lifecycle analysis of bridges were combined. Two lifecycle approaches are cited, and the factors cost, reliability, availability and security are compared.

An evaluation of the KPI environment was waived due to the weak data basis.

The Brentenmais Bridge has its 2nd rehabilitation in 2005/06.

The viewing point will be t = 56 years of the bridge. The total lifespan of the building was assumed to be 100 years. After this time, a life-cycle calculation will reveal whether further rehabilitation or rebuilding the bridge is more useful.

5.1. PREVENTIVE SCENARIO

In the preventive scenario, the recommendations of the WG4 Technical Report are adhered to maintain knowledge of the bridge condition and the average lifetime of the bridge elements.

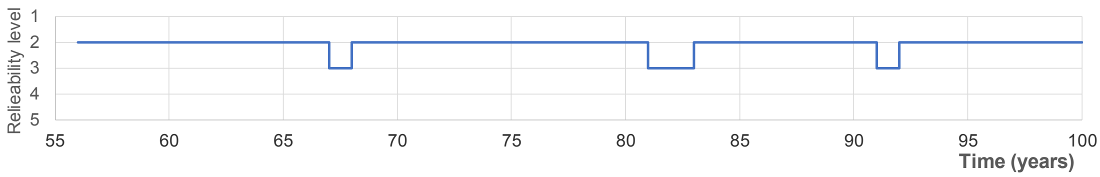
The frequency of maintenance / repair measures is considered essential for maintaining a good reliability and safety level of the bridge.

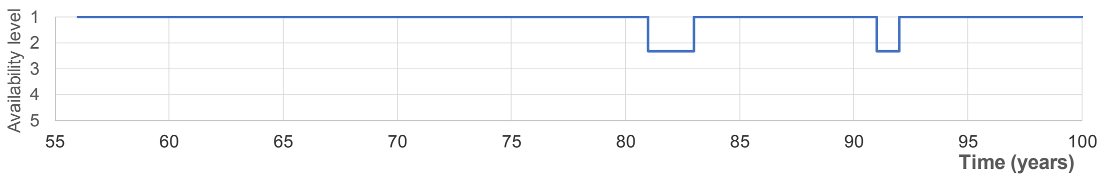
Maintenance and repairs are carried out before the end of the service life of the bridge. Individual elements are replaced when the average lifetime is reached.

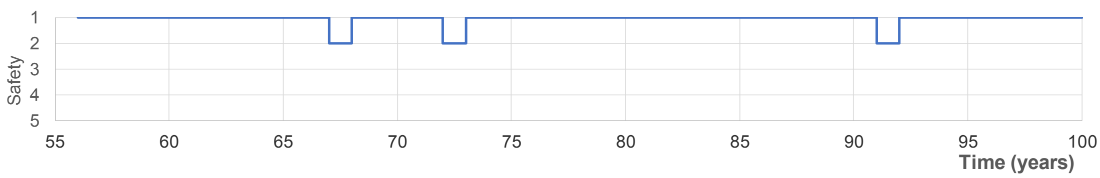
When calculating, real data was used if possible. Maintenance cycles and costs have been adapted in accordance with current regulations regarding the WG4 technical report.

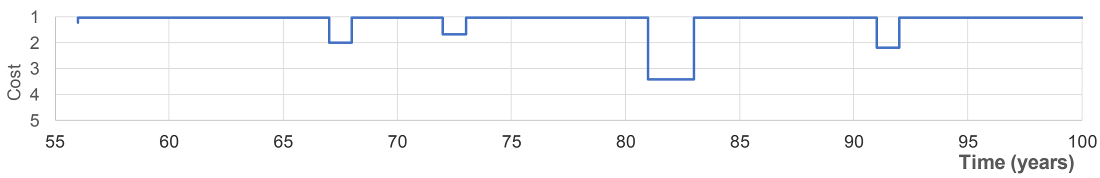
If possible, measures have been merged to reduce the number of individual construction sites.

The graphs below show the history of each KPI value up to the end of the dimensioned life cycle.







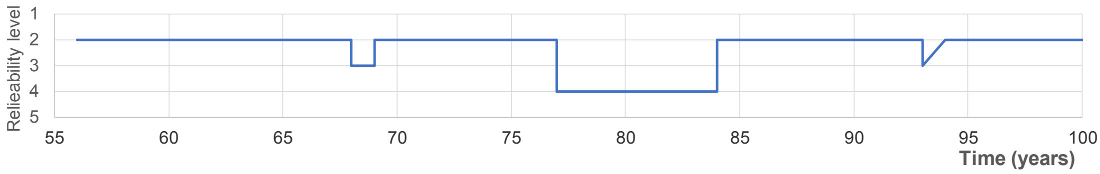


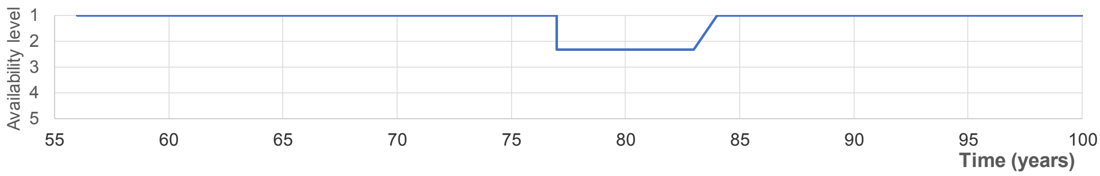
5.2. REFERENCED -LACK OF MIONEY SCENARIO

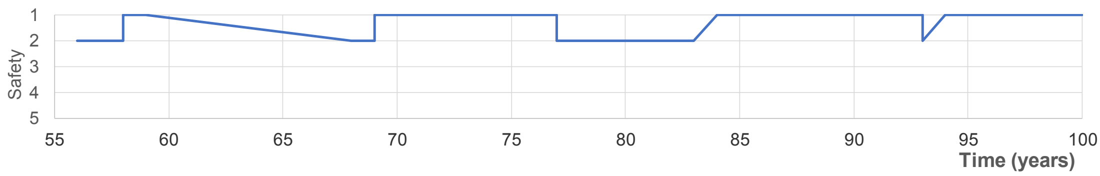
In this scenario, bridge end-of-life inspection measures are expected to become more frequent to ensure safety and reliability of the bridge and to perform only the most necessary maintenance. If possible, rehabilitation measures are suspended or delayed.

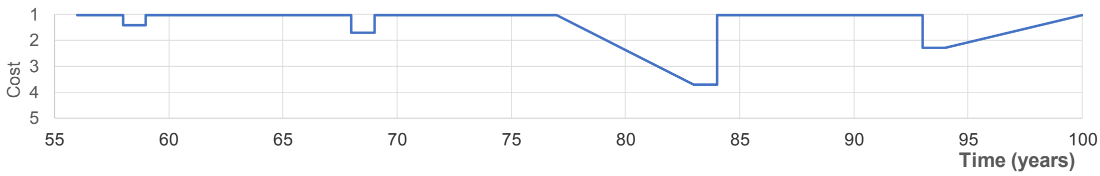
Nevertheless, here, if possible, rehabilitation measures were brought together.

The development of existing structural defects and estimated downtime are assumed as suggested in WG 4 Technical Report.





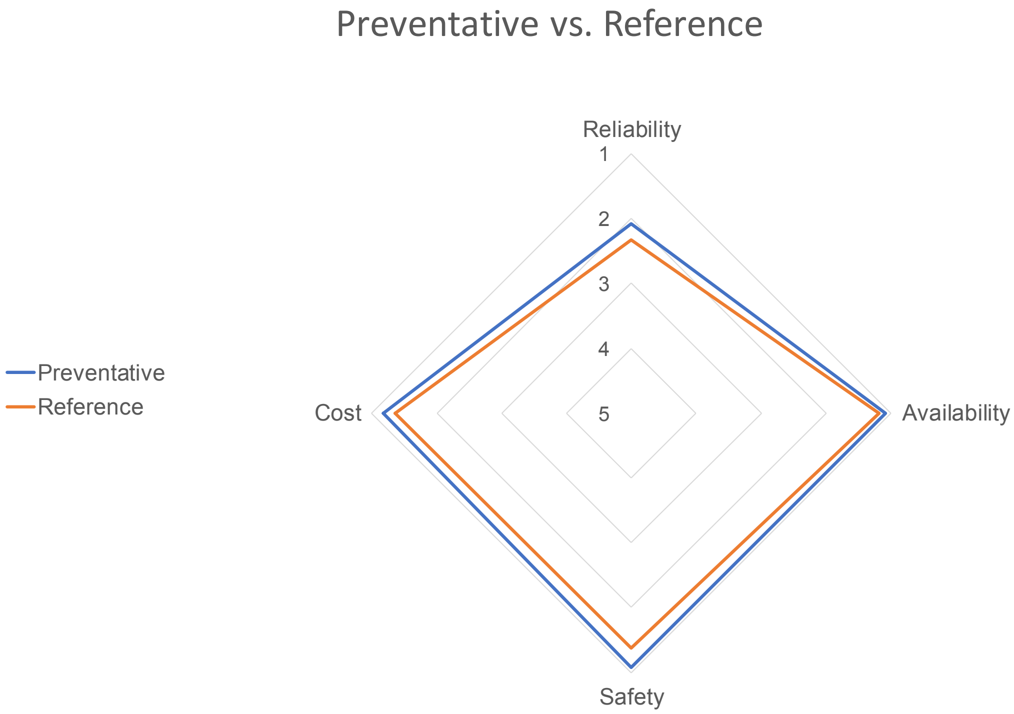




5.3. COMPARISON OF THE APPROACHES

A comparison of the two considered approaches is shown below in the "Spider" diagram.
When comparing two approaches, the preventive approach to this bridge is better. The costs are lower in a preventive scenario.
Availability and security are maintained at a high level throughout the period.

A comparison of the two considered approaches is shown in following “spider” diagram:



6. RESUME

In my opinion, working with the work paper works well. However, I had some problems regarding the definition of some KPIs.

Due to the short observation time (t = 44 years), there is no significant difference between the two scenarios. If you take inflation into account, the benefit of the predicted scenario becomes clearer, at least for the KPI costs.
It also raises the question of whether a KPI increases costs that are easier to understand for the management.

I had another issue with the KPI availability. From the experience of a PPP road operator with an availabilities accounting model, a definition of availability that expresses the limitations of each repair plan would be a better communicable KPI for management, even though it no longer relates directly to the structure.

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