



1^ο Φόρουμ Διαλόγου – Πάτρα, 7 Νοεμβρίου 2025

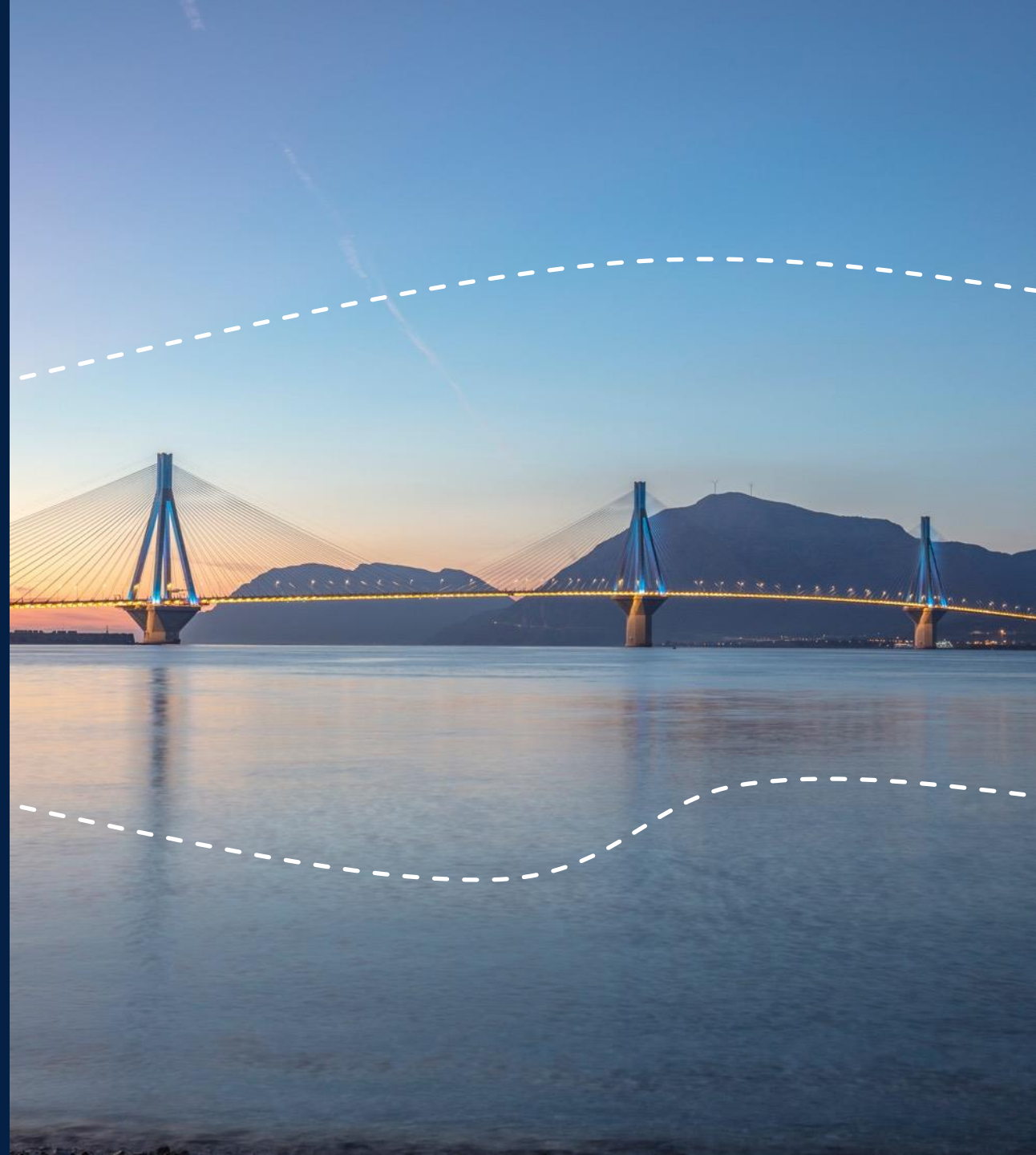
**Κατασκευάζοντας σε ρήγματα:
Η περίπτωση της γέφυρας Ρίου-Αντιρρίου
«Χαρίλαος Τρικούπης»**

**Building near fault; the case study of Rion-
Antirion Bridge “Charilaos Trikoupis”**

Άρης Σταθόπουλος-Βλάμης, CTO, GEFYRA S.A.

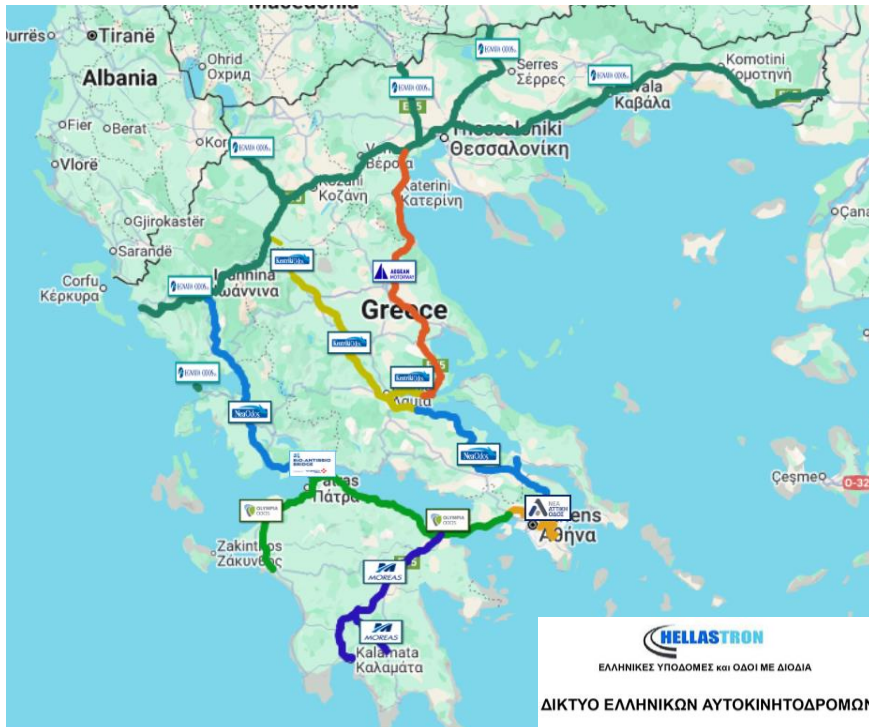

**ΓΕΦΥΡΑ
ΡΙΟΥ-ΑΝΤΙΡΡΙΟΥ**

POWERED BY  **VINCI**
HIGHWAYS



RION – ANTIRION BRIDGE CONCESSION PROJECT HIGHLIGHTS

- Connects mainland Greece with Peloponnese
- Links west motorway network of Greece, connecting significant ports



- Project was assigned to GEFYRA S.A consortium in 1996
- A 42-Year Concession Agreement was put into effect in 1997 (7 years for Design and Construction)
- Construction completed in 2004, 4 months ahead of due date
- No significant accident during construction
- No exceedance of budget
- 9 International Awards by the scientific community

GEFYRA S.A.

(Concession Company)

Vinci Concessions 72,3%



**KINOPRAXIA GEFYRA
S.A.**

(Contractor)



VCGP 53,00%



**COWI (BUCKLAND &
TAILOR), DENCO &
TECHNICAL ADVISORS**
(Design Checker)

**AECOM
(FABERMAUNSELL)**
(Supervision Engineer)

GEFYRA LITOURGIA

(Operator)

Vinci Concessions 70,5%



**RIO-ANTIRIO
BRIDGE**

POWERED BY **VINCI**
HIGHWAYS

RION – ANTIRION BRIDGE PROJECT DESCRIPTION (1/4)

Environmental Conditions

Weak Sea Bed

No bedrock encountered in first 100 m during soil investigations, while geological studies indicated similar conditions for up to 500 m.

Water depth up to 65 m

Uniform sea bed at depth of 60 m with steep slopes near coast.

High Seismicity & Tectonic movements

Active normal faults on both sides of Corinthian gulf, at the vicinity of Bridge while the tectonic kinematic of area indicates separation of Peloponnese from mainland Greece with rate of ~15-20 mm/year.

Strong Wind Area

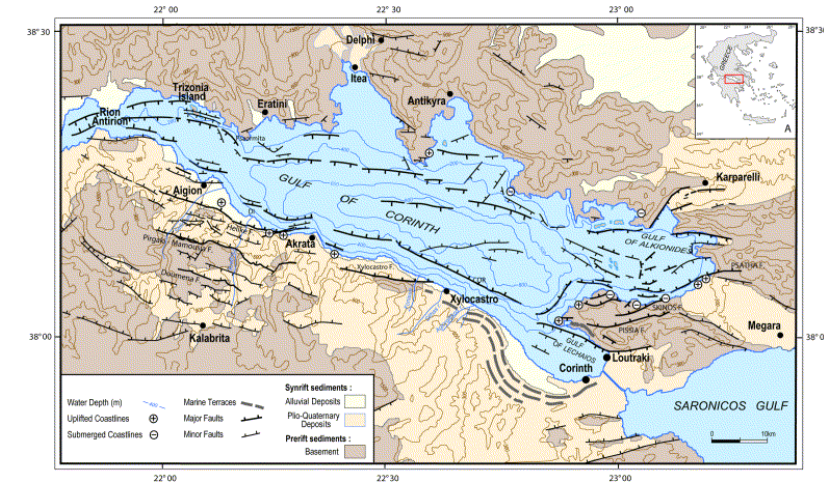
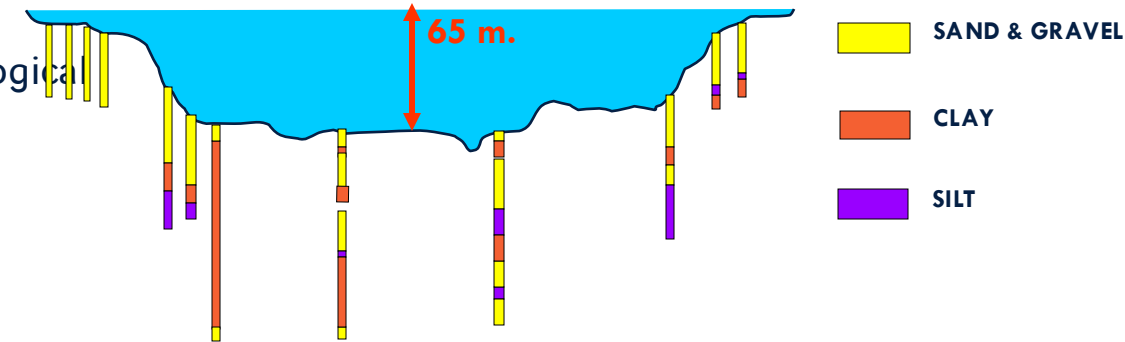
Due to morphology of surrounding mountains, Rion-Antirion strait is prone to the frequent & strong winds with the most frequent winds to have direction perpendicular to Bridge axis.

Corrosivity

Environment Corrosivity Classified C5-M (ISO 12944).

Navigation channel

Significant marine traffic through Rion - Antirion strait.

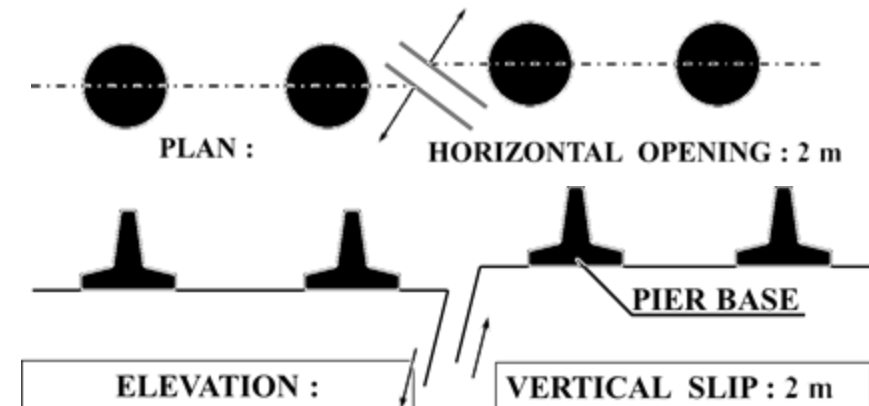
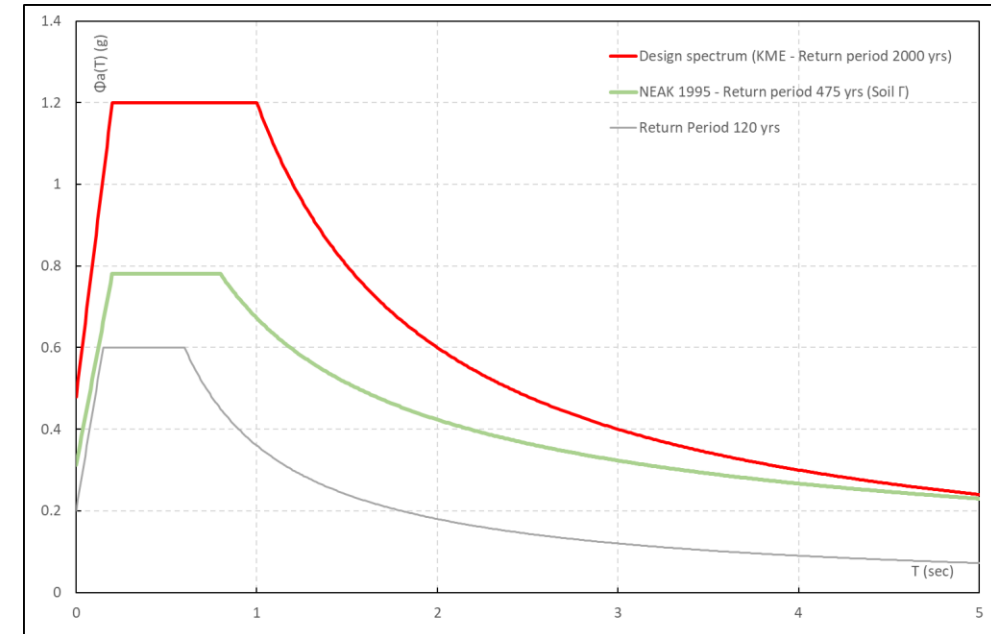


RION – ANTIRION BRIDGE PROJECT DESCRIPTION (2/4)

Structural Design –Design Loads & Requirements

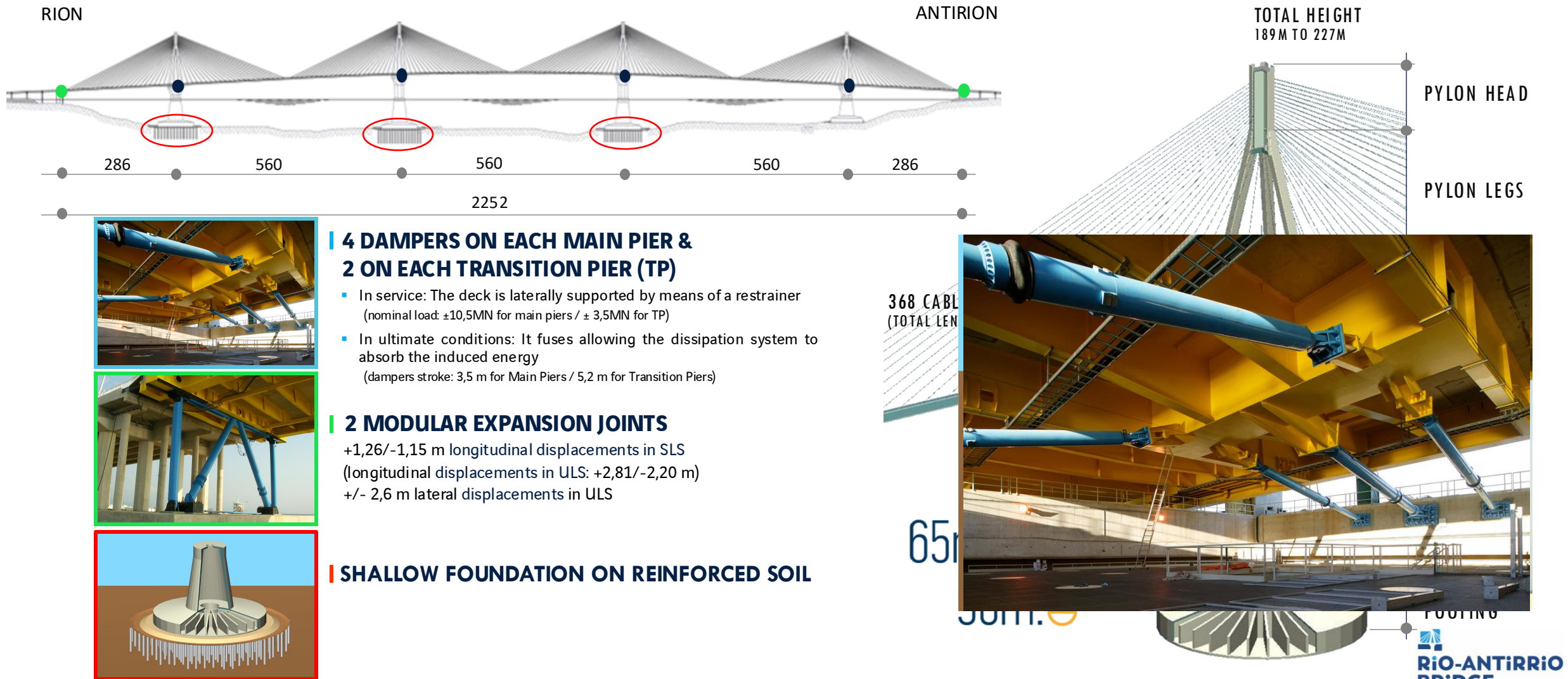
Seismic loads

- Seismic design load (Spectrum: pga 0.48 g, max Sa 1.20 g for T=0.2 up to 1.0 sec) - EQ with 2000 years Return Period.
- Tectonic movements:
 - Up to 2m (between adjacent piers) as separate load
 - Up to 1m (between adjacent piers) when combined with specified EQ



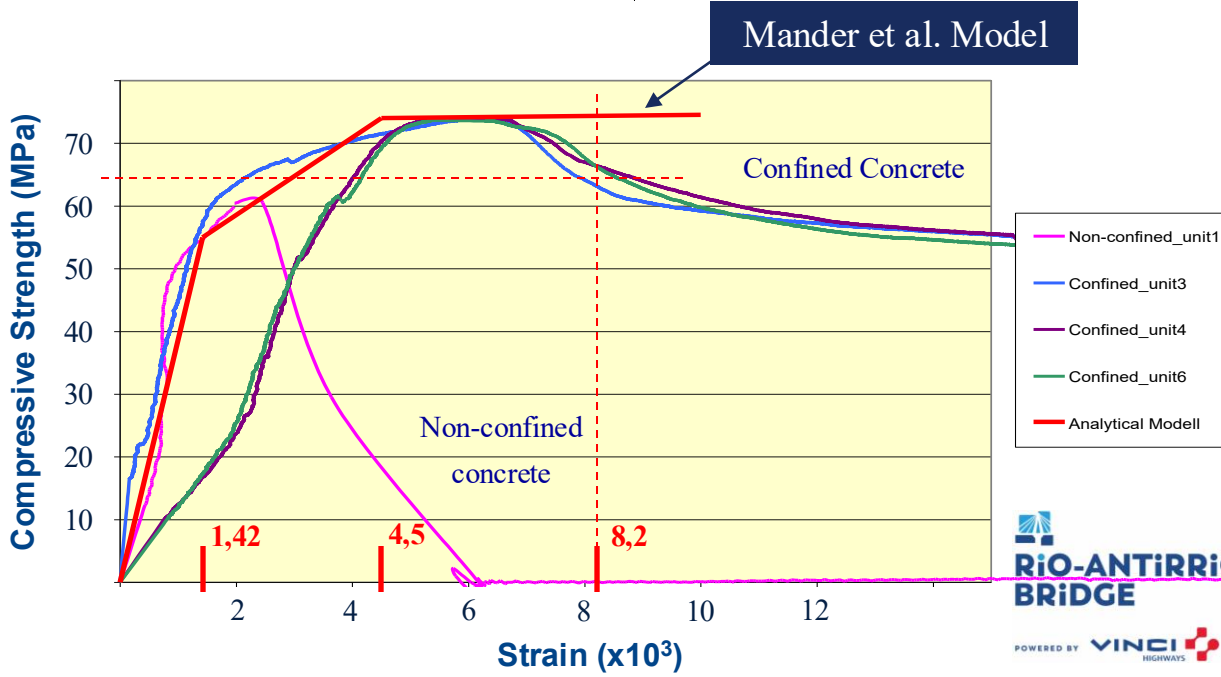
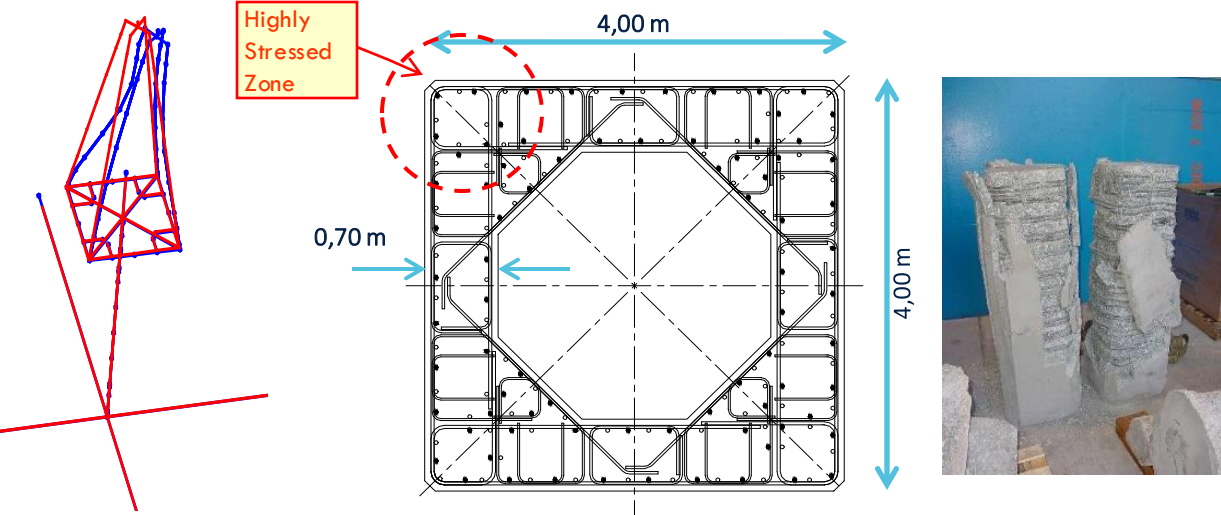
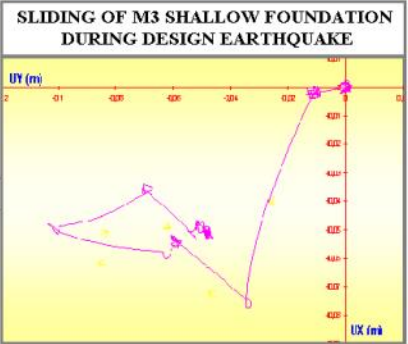
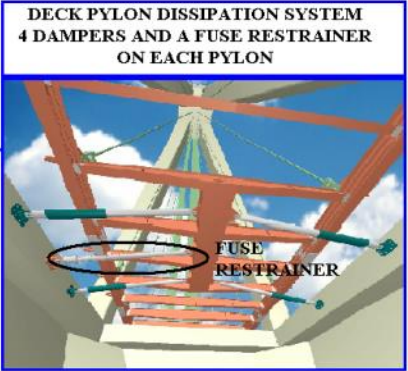
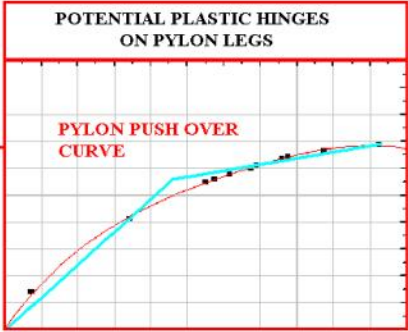
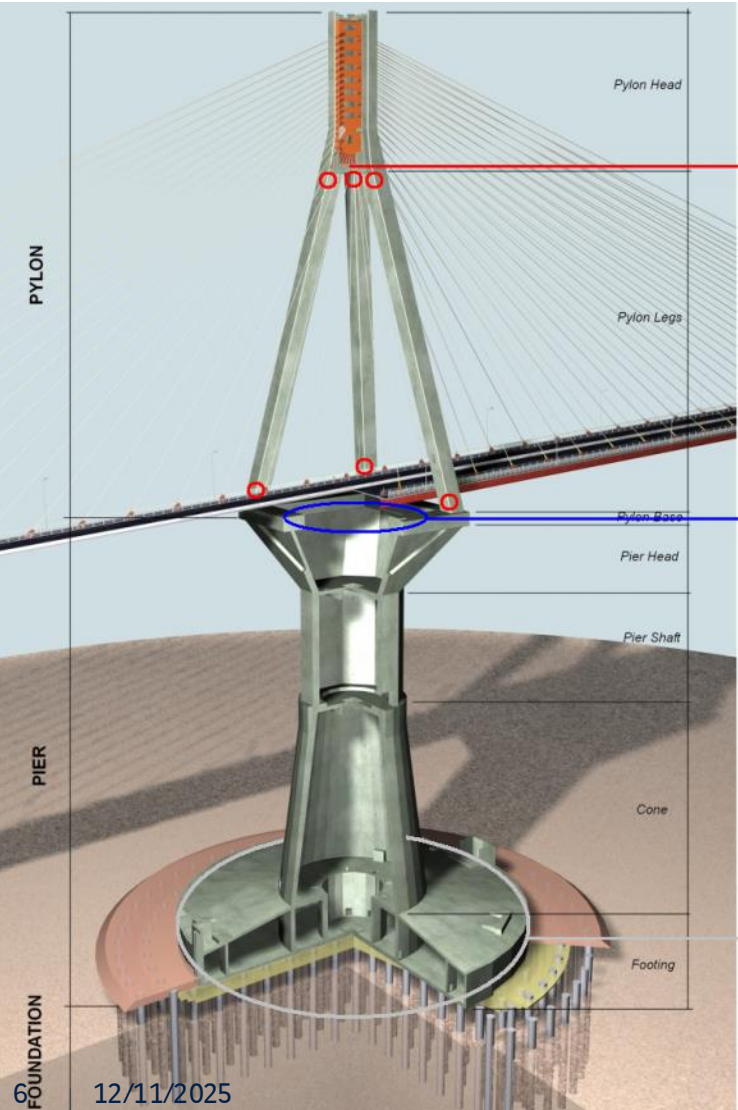
RION - ANTIRION BRIDGE PROJECT DESCRIPTION (3/4)

Main Bridge - Structural Features - Overview



RION - ANTIRION BRIDGE PROJECT DESCRIPTION (4/4)

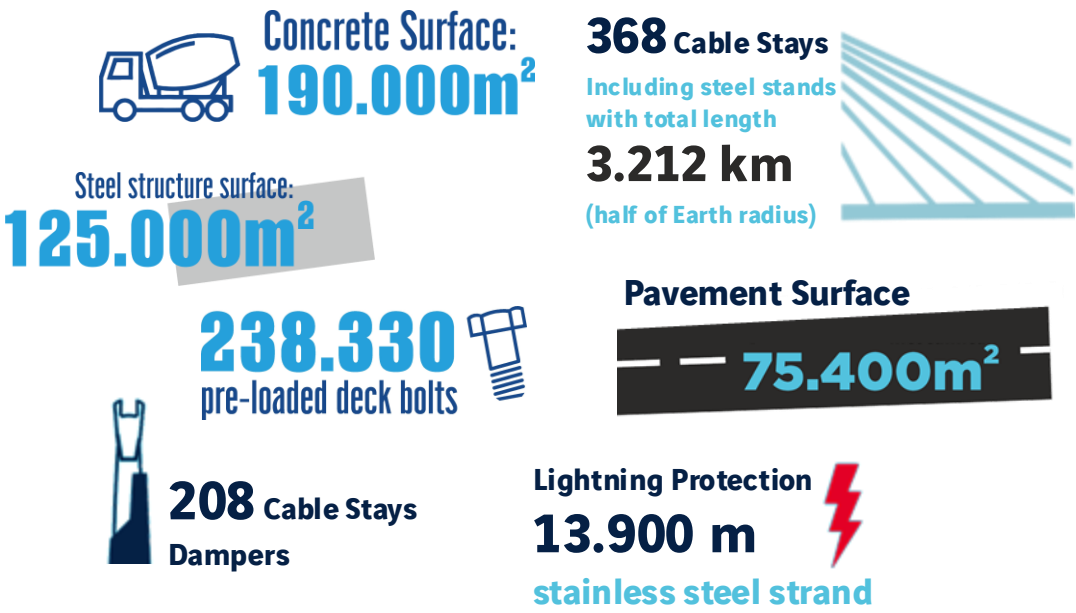
Design Performance-Seismic Design Concept



ASSET MANAGEMENT

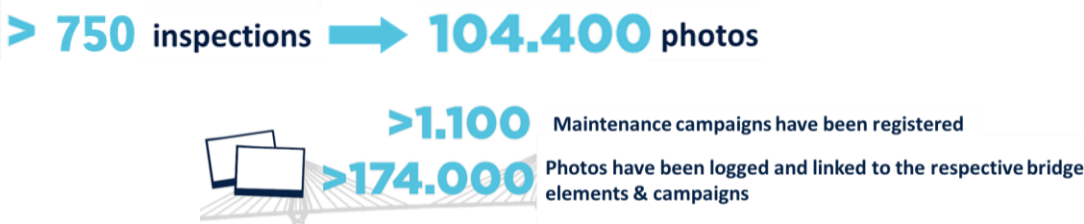
Technical department Scope of Works

Inspected Assets

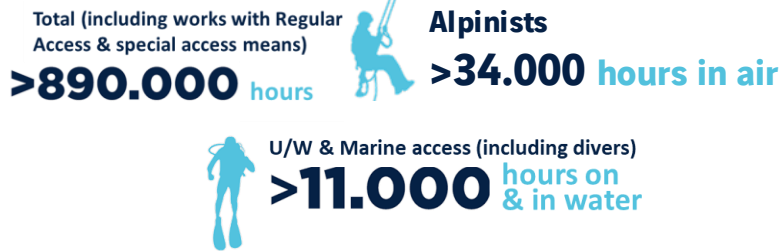


Monitoring	Maintenance	Special Events Structural Management	Other
Visual Monitoring (inspections)	Regular Maintenance (Planned)	Earthquake	Additional works
Material Monitoring	Corrective/Heavy Maintenance	Strong wind	Technical Improvement works
Instrumented Monitoring Structural monitoring system (permanent) Geometrical monitoring		Fire	Remedial works
		Ship collision	Other administrative/ engineering support
		Major accident	

Monitoring & Maintenance



Resources



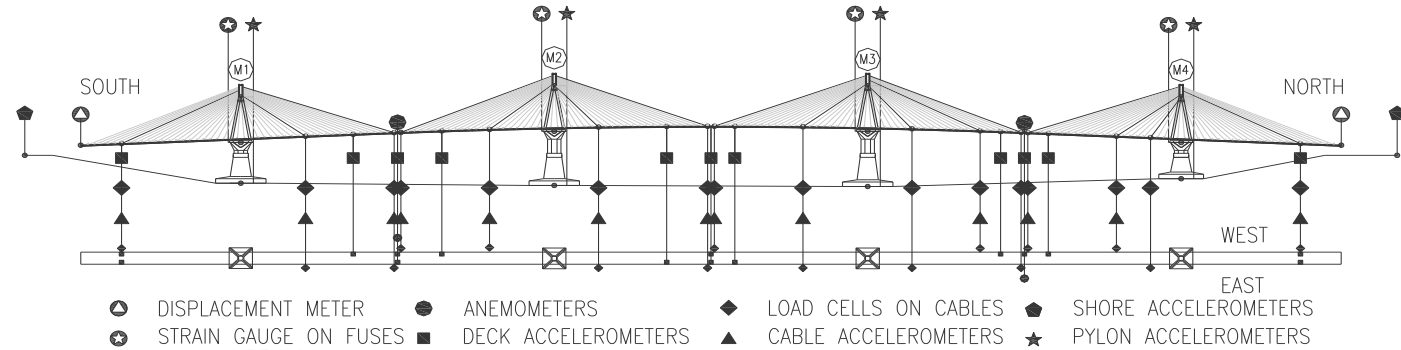
ASSET MANAGEMENT

Instrumented Monitoring – SHM overview (Permanent System)

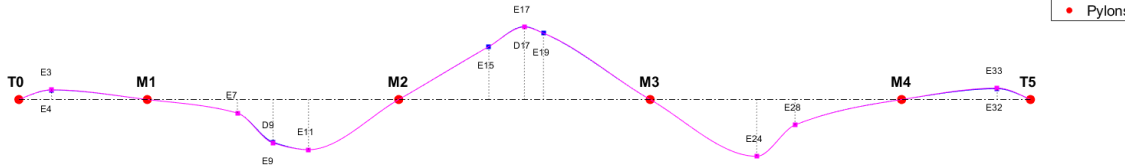
Monitoring System operation provides:

1. Characterization of real actions
2. Dynamic characteristics of actual structure
3. Design verification and feedback
4. Structural health status determination
5. Assist on the Operation/enhance user safety (black ice risk/ strong winds/seismic events)

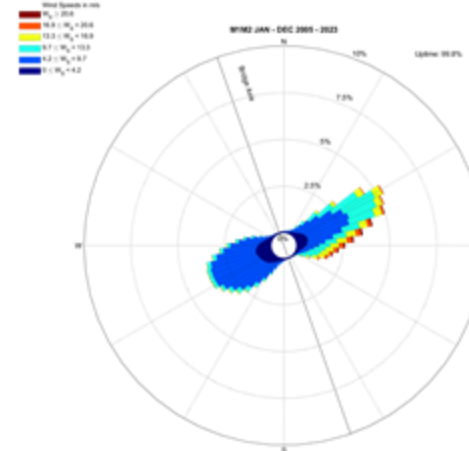
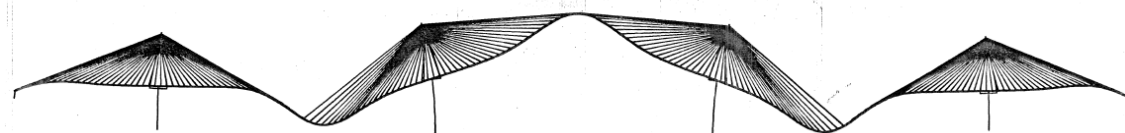
SHM System operating since 2004 (2005-2024 overall up time > 98%)



Average Mode N=443
SSI Mode-3: $f=0.219\text{Hz}$
 $T=4.572\text{sec}$



VIBRATION MODE: 3 PERIODE: 4, 8353

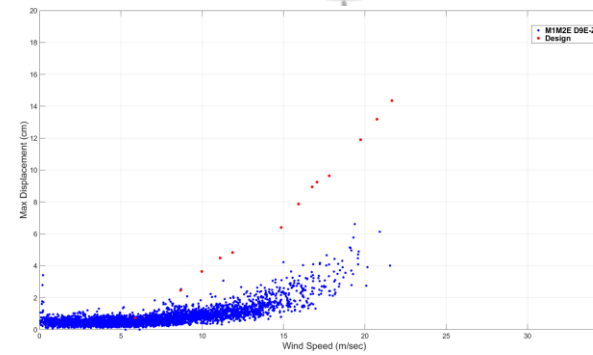


History Files analysis: Slow varying processes/statistical parameters of structural response

History files: 1 value every 30 sec

Dynamic Files analysis: Dynamic process/actual measurements of structural response

Dynamic files: High frequency (100 Hz) records of limited duration (typically 3sec)



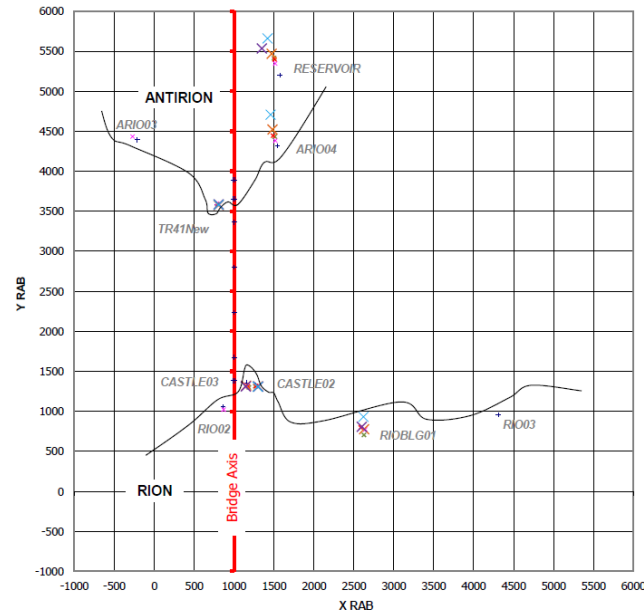
ASSET MANAGEMENT

Instrumented Monitoring - Geometrical Monitoring - NON Permanent System

Measurements and evaluation of:

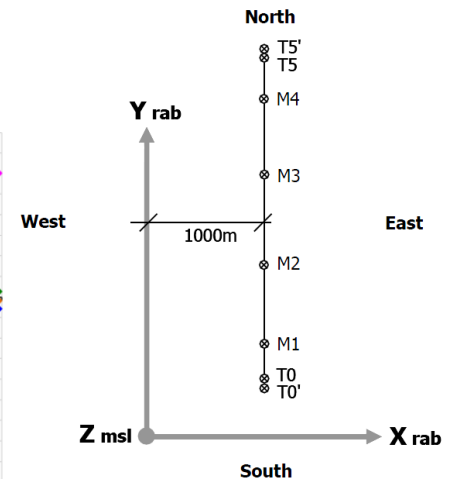
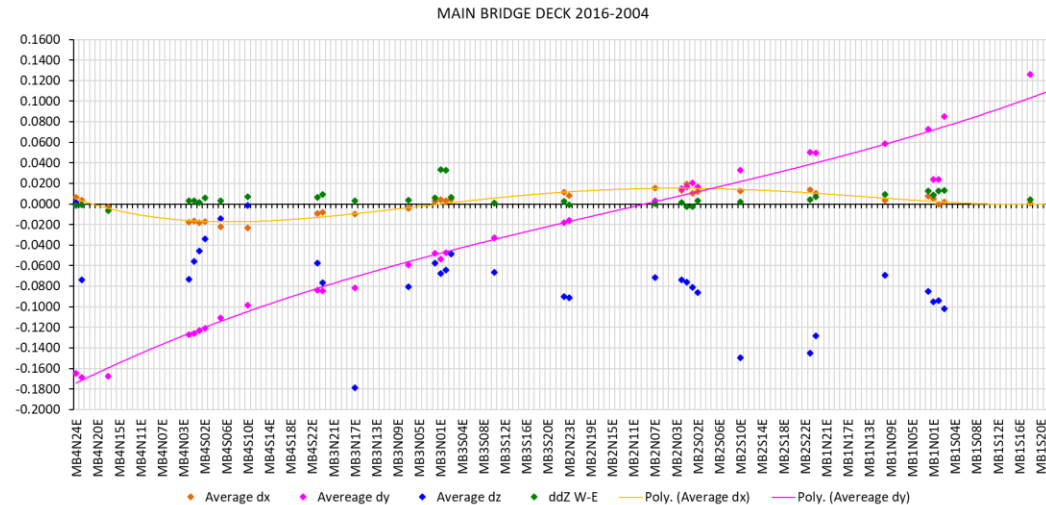
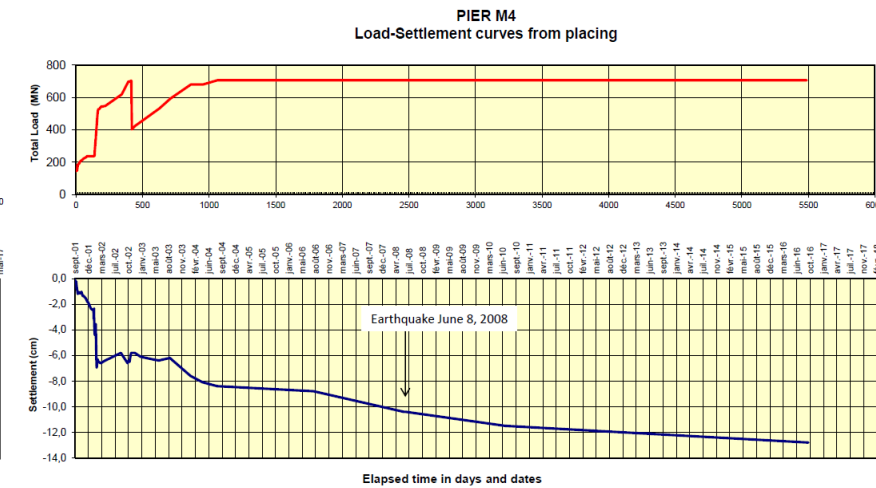
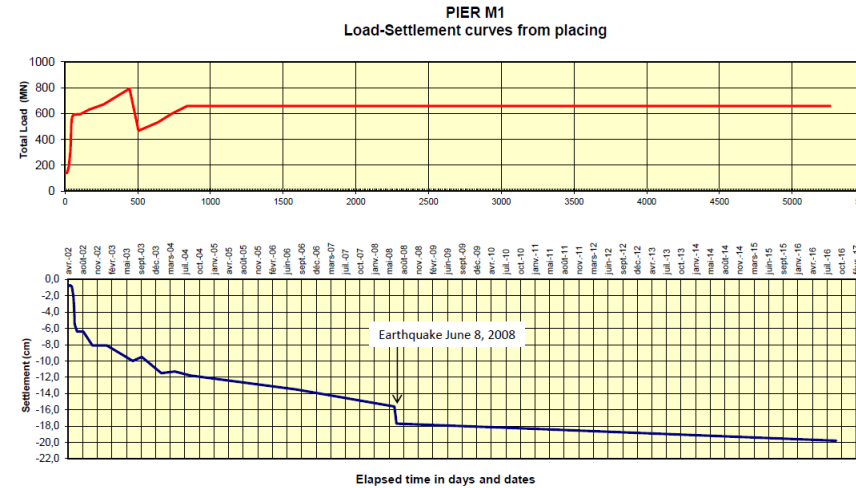
- Tectonic movements
- Piers tilt & settlement
- Deck geometry
- TP settlement

The processed data are analyzed & compared with theoretical results



- + ZERO POINT 2004
- + CAMPAIGN 2006
- + CAMPAIGN 2008 Before Earthquake June 8
- + CAMPAIGN 2008 After Earthquake June 8
- + CAMPAIGN 2010
- + CAMPAIGN 2011
- + CAMPAIGN 2016

Scale for displacements :
1 square = 50 x 50 mm

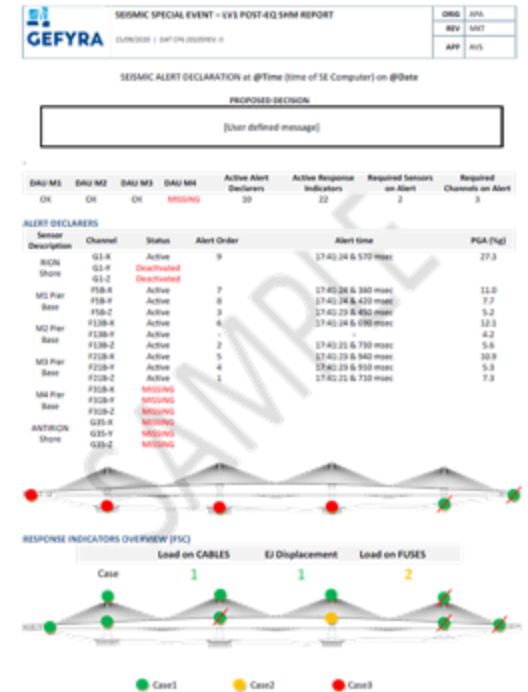
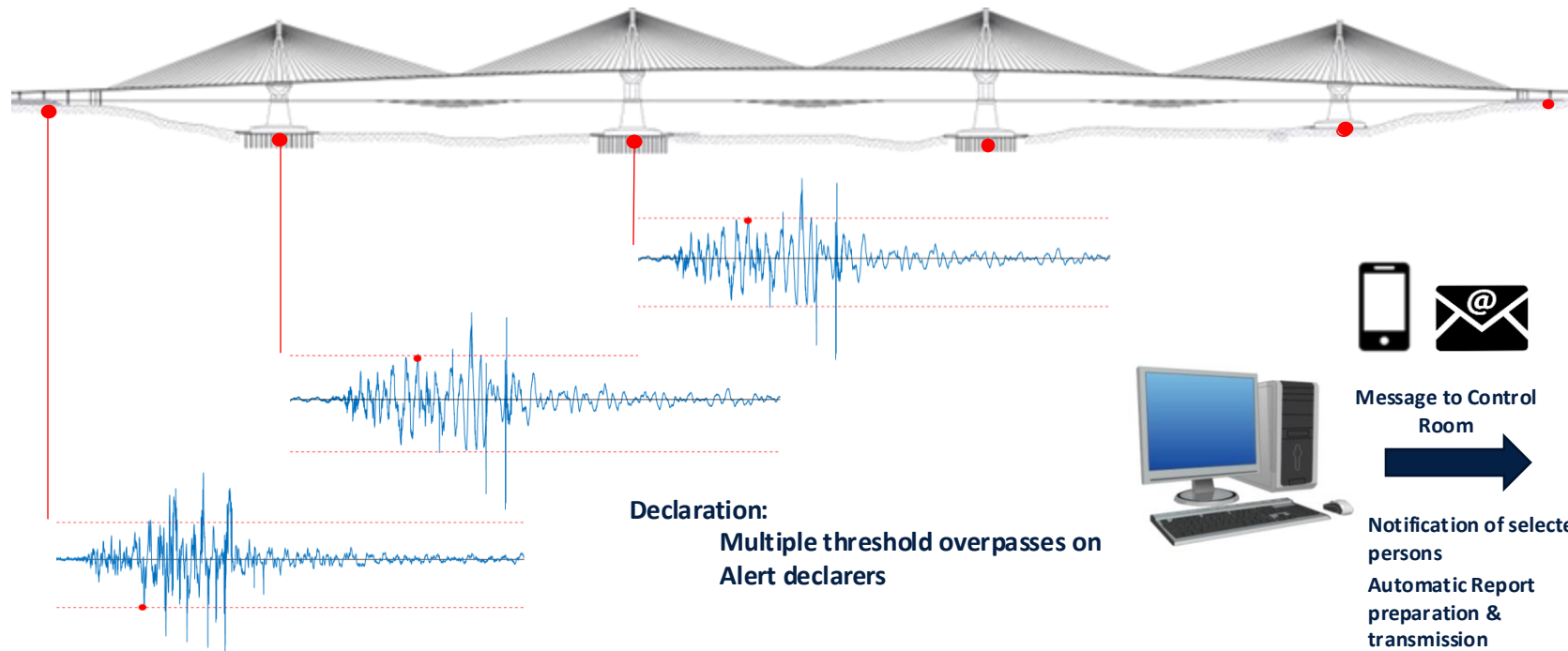


ASSET MANAGEMENT

Instrumented Monitoring - Seismic event follow-up

Automated Event Management (Smart Monitoring)

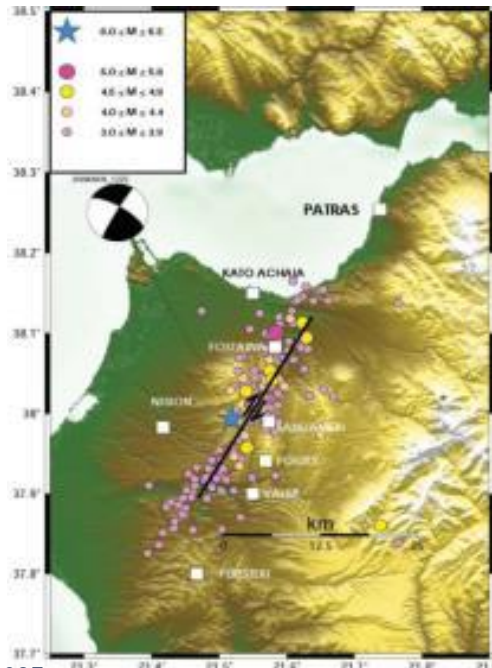
1. Automated ***detection*** of earthquake events
2. ***Classification*** of structural response
3. Proposed ***decision on traffic management*** (Real time)
4. ***Automated report*** preparation and transmission



SPECIAL EVENT

2008 JUN 08 EQ (1/2)

- Magnitude $M_w=6,4$
- 36km from Rion-Antirion site.
- Focal depth: 31km
- Max PGA recorded from on-shore accelerometers: 0.127g (at Rion bank)



SPECIAL EVENT

2008 JUN 08 EQ (2/2)

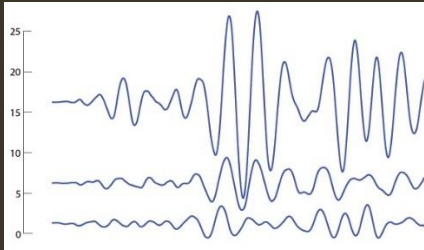
	 Level 1 Inspection	 Level 2 Inspection	 Level 3 Inspection	 Level 4 Inspection & geometric control	 Final step Remedial works
Elapsed time	15 min	4 hours	2 days	2 months	5 months
Inspector	On duty Officer (non technical)	Trained structural inspectors	Trained structural inspectors	Trained structural inspectors and specialized suppliers	
Findings	No findings	Sign of movement on fuses (Pylon)	Minor non structural damage	Minor non structural damage	

Monitoring Report

First review of monitoring data recorded

SLS was not exceeded

Indication of deck release (fuses)

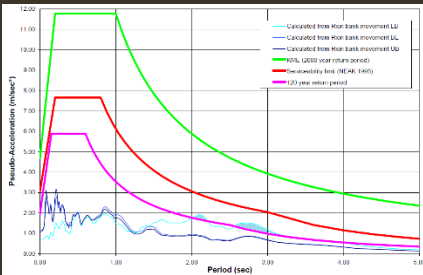


Analysis of Monitoring data

Expertise analysis on collected data

Evaluation of similar EQ's return period

T= 80 to 120 years

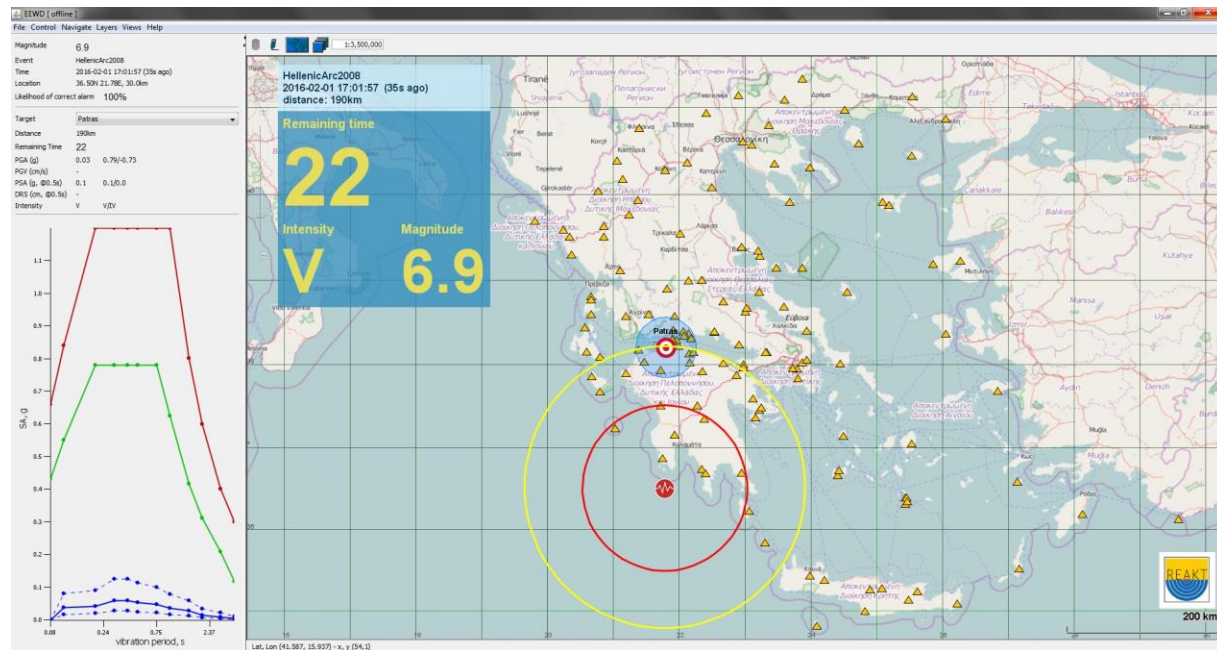


Deck re-alignment and fuse replacement



TOWARDS EEW IN THE BRIDGE

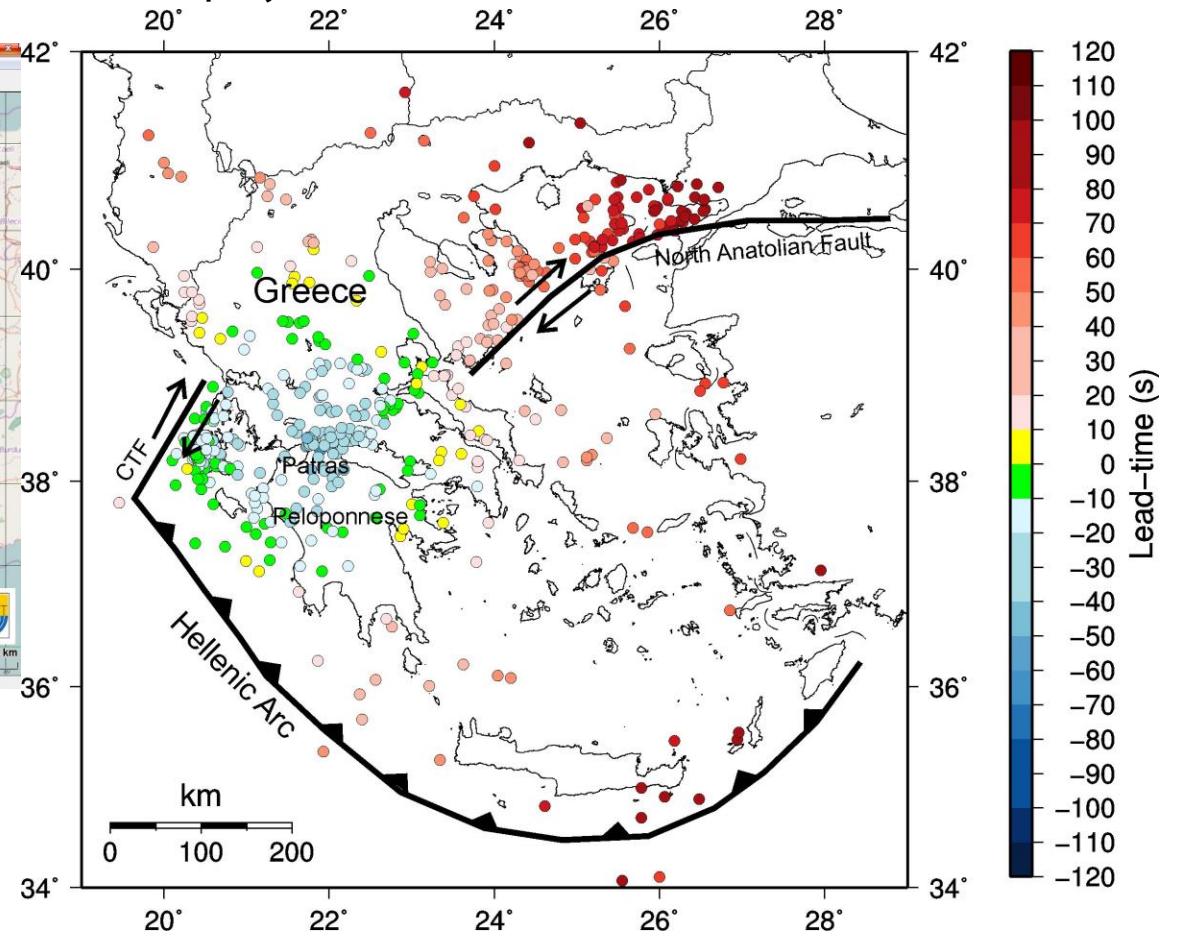
- Virtual Seismologist EEW installation in the framework of EU-funded project REAKT



Conclusions: Extremely useful tool for infrastructure operators.

However, additional efforts are required to significantly reduce the lead time to receive the EEW alerts before S-waves arrivals for moderate epicentral distances.

For Rion-Antirion Bridge project would be a complementary tool to its SHMS





**THE BRIDGE REMAINS A CONSTANT
TECHNICAL CHALLENGE EVEN BEYOND THE
CONSTRUCTION ERA**

Ευχαριστώ για την προσοχή σας
Thank you for your attention