

**INNOVATION IN PORTUGUESE BRIDGES**

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# **INNOVATION IN PORTUGUESE BRIDGES**

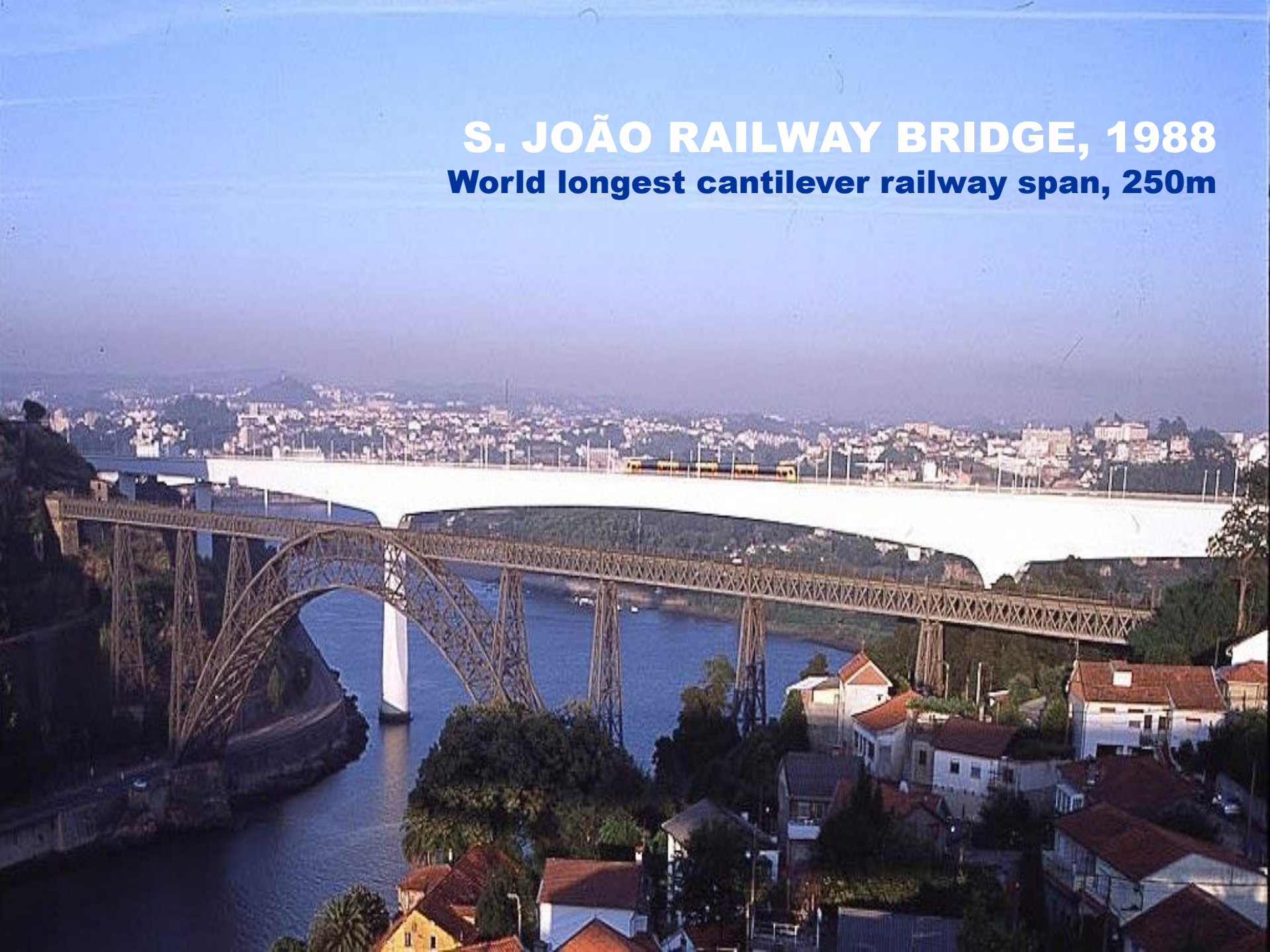
**“30 YEARS OF BRIDGE CONSTRUCTION”**

**FERNANDO BRANCO**





**S. JOÃO RAILWAY BRIDGE, 1988**  
**World longest cantilever railway span, 250m**





# INNOVATION IN PORTUGUESE BRIDGES



**SÃO JOÃO Bridge – Span 250m, 1988  
(world 12th, 1st in railways)**





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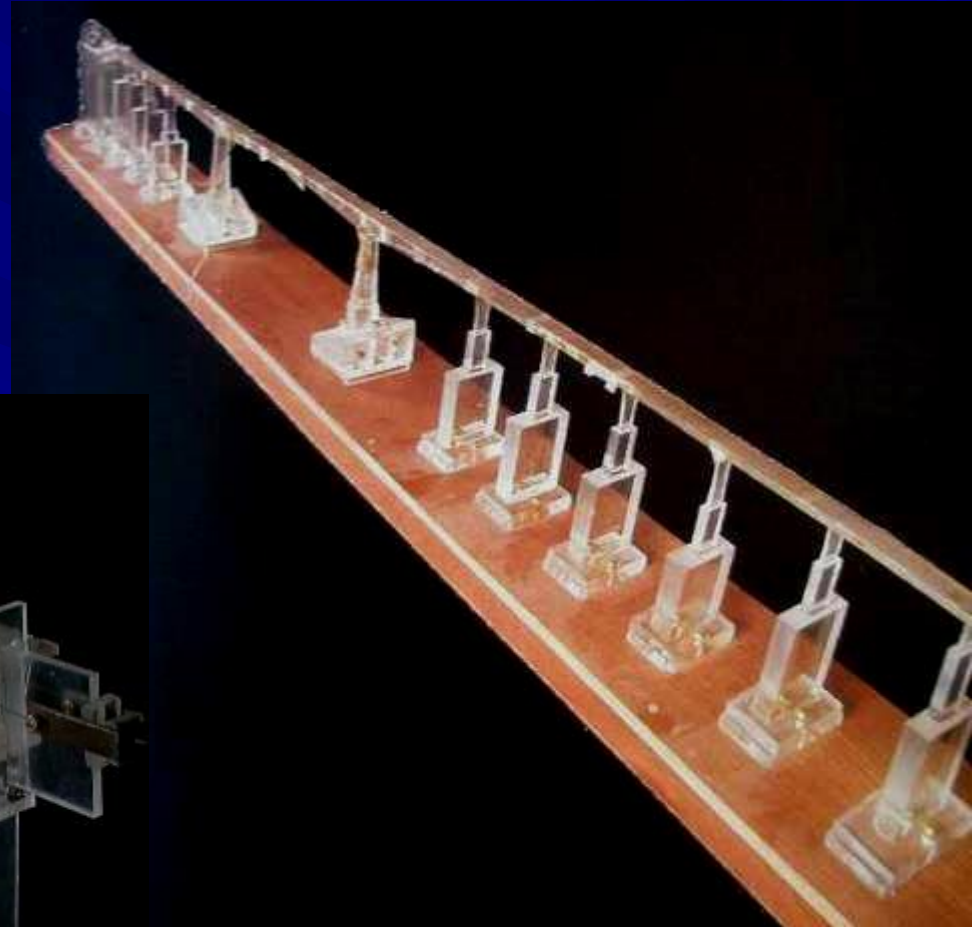


**1985**  
**First PCs**  
**Macintosh**





## Small scale models





# INNOVATION IN PORTUGUESE BRIDGES



## S. JOÃO BRIDGE

**LAST BRIDGE WITH  
SMALL SCALE  
MODELS**

**FIRST BRIDGE WITH  
NUMERICAL  
MODELS**





# **INNOVATION IN PORTUGUESE BRIDGES**

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## **SPECIAL STUDIES**





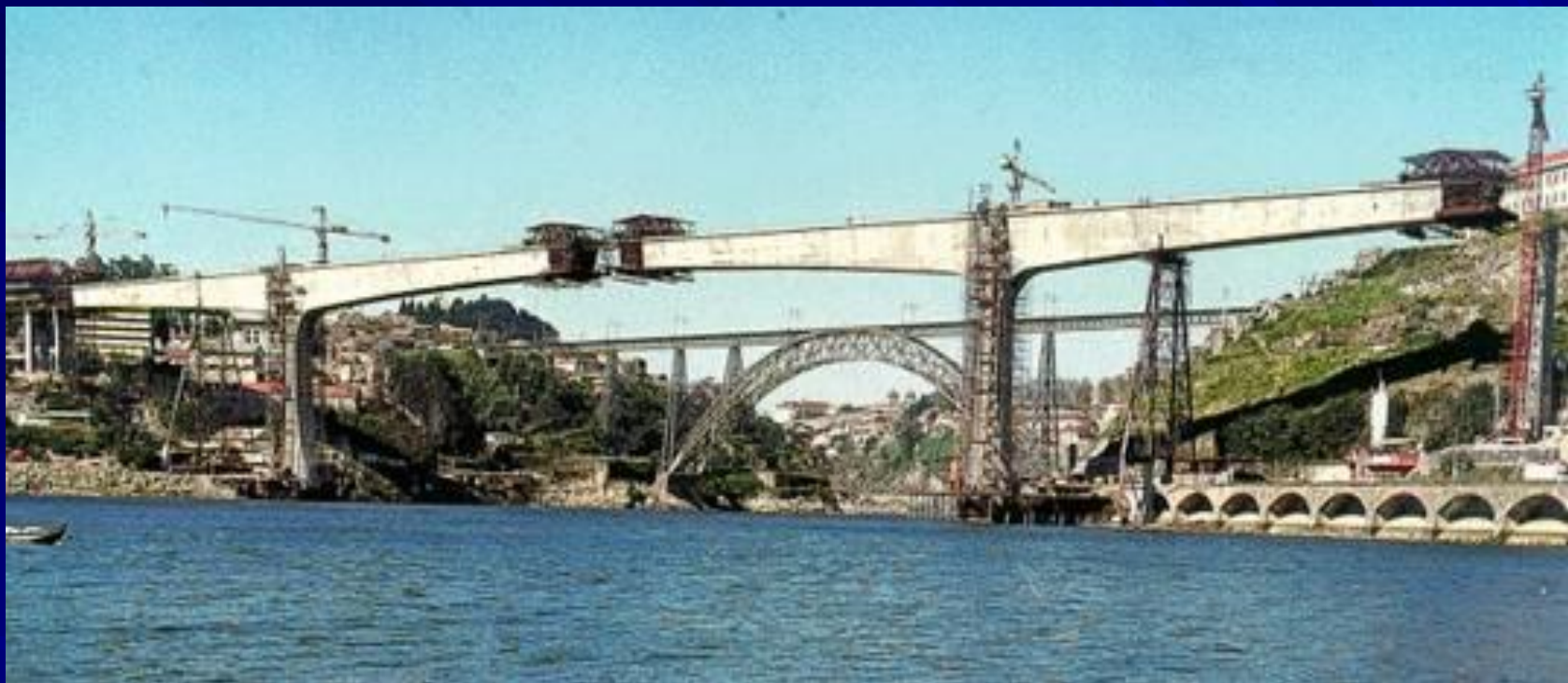
## 1. THERMAL ACTIONS





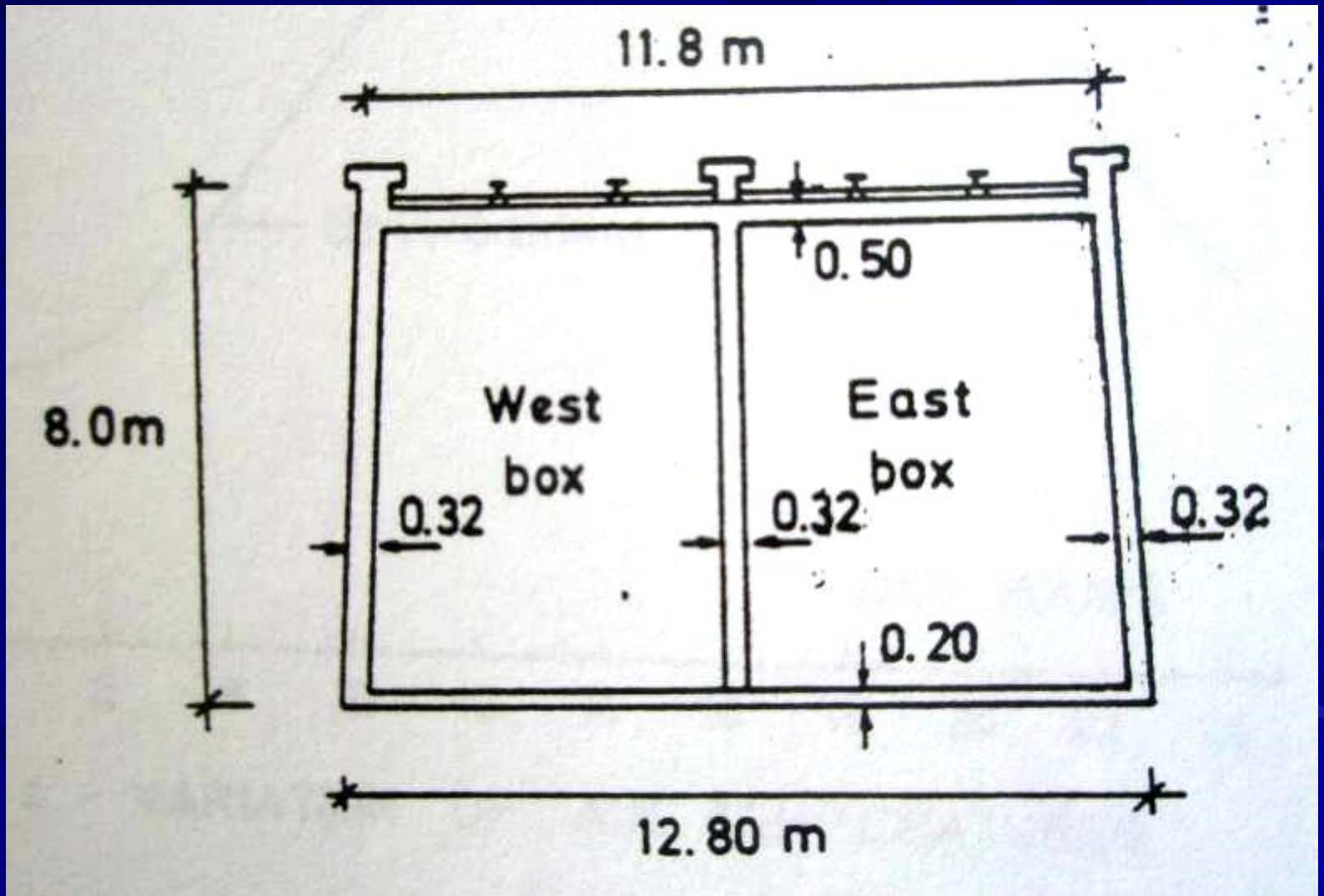
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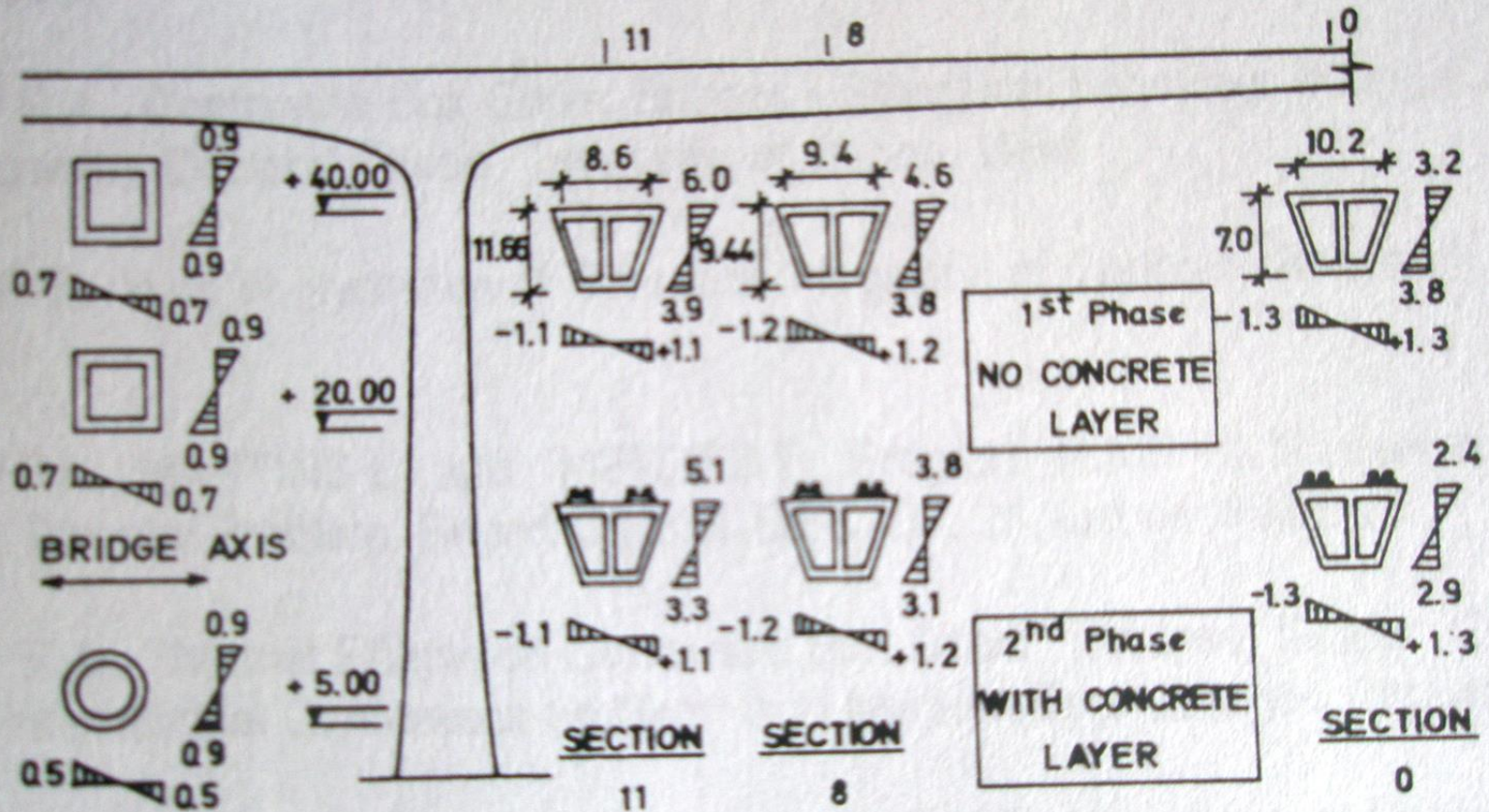


Fig. 6 - Maximum thermal gradients under summer conditions





## 2. HEAT OF HYDRATION





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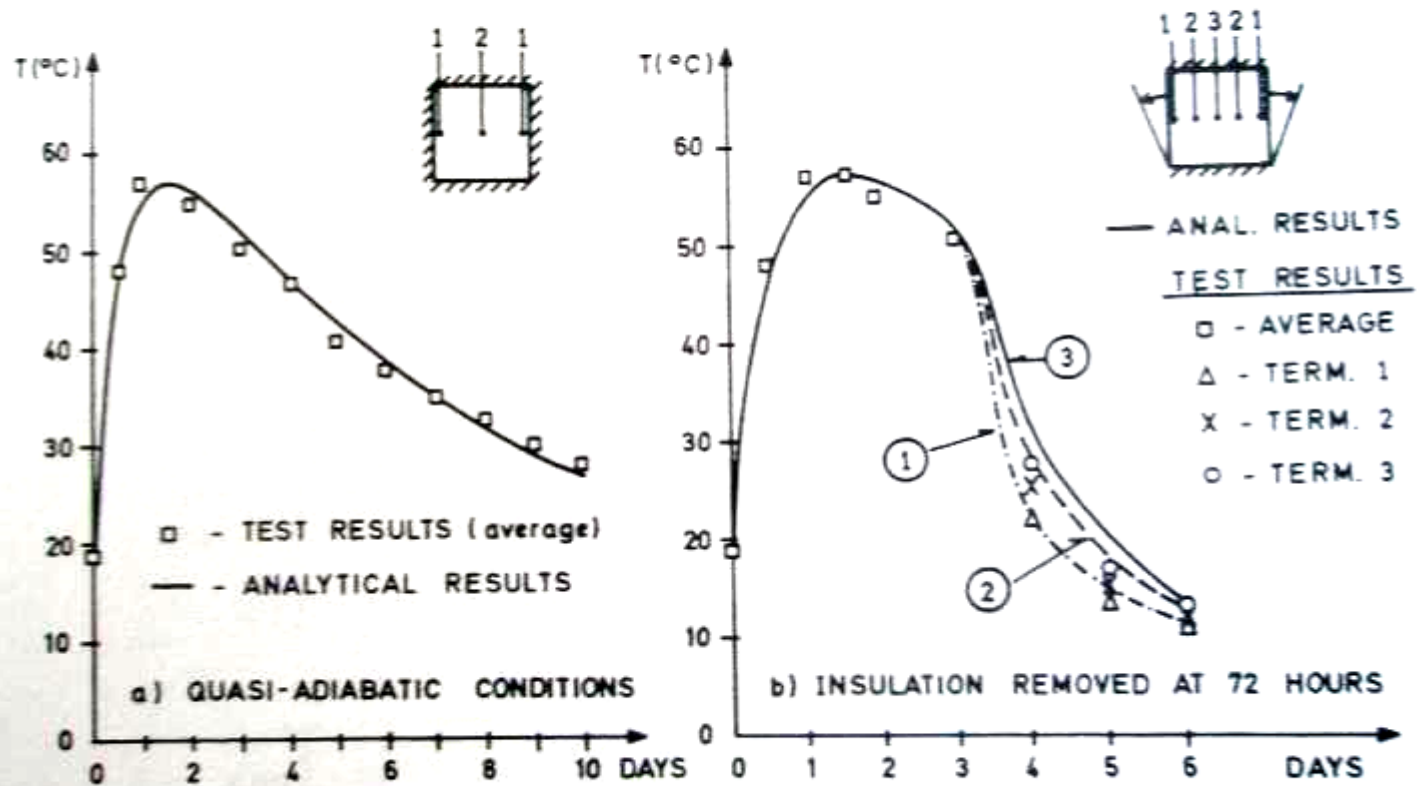
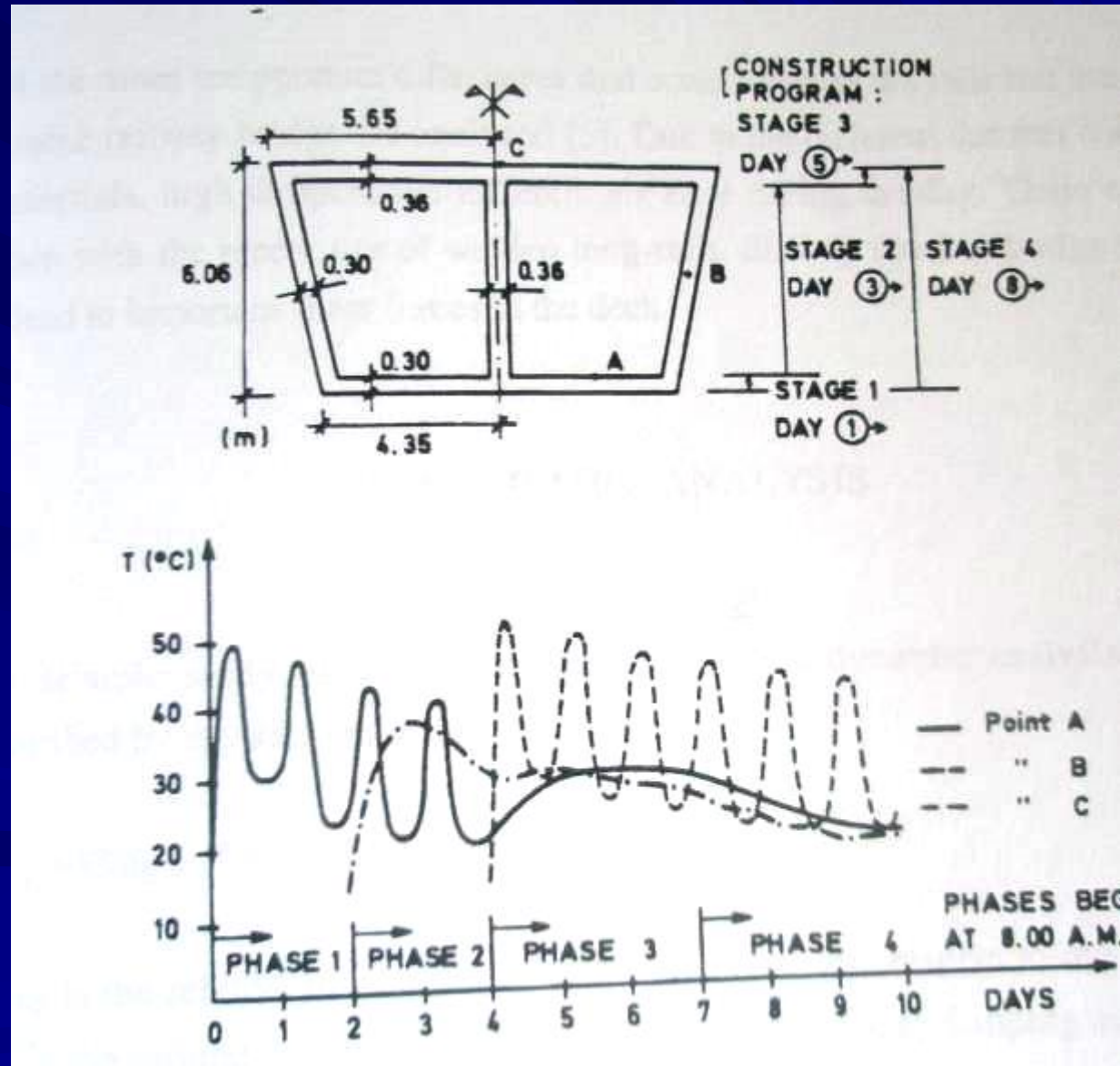


FIG. 1 - CONCRETE CUBES TESTING.





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## 3. THE CREEP PROBLEM





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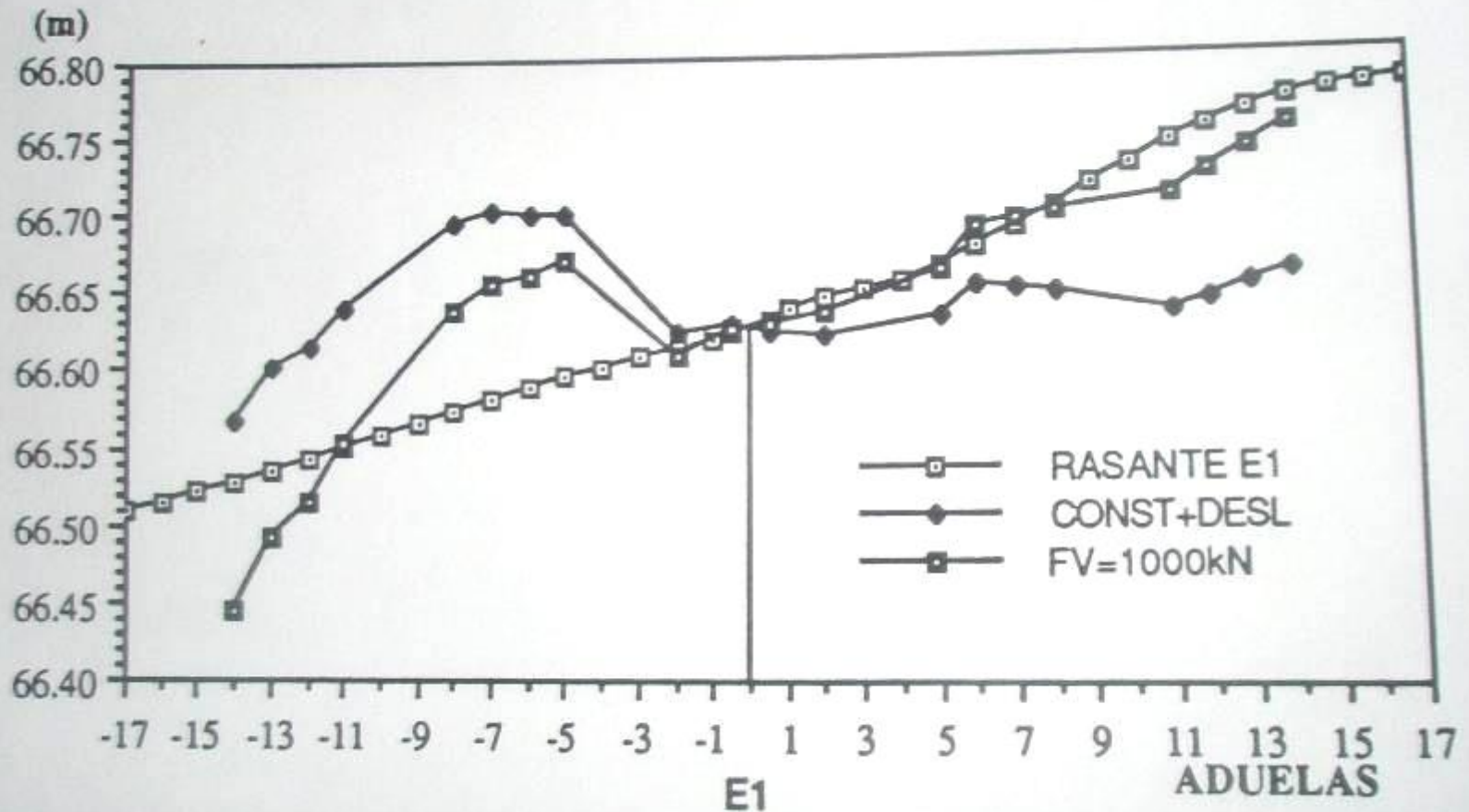


Fig. 5 - Deformadas a Tempo Infinito- Efeito de  $F_v=1000\text{kN}$





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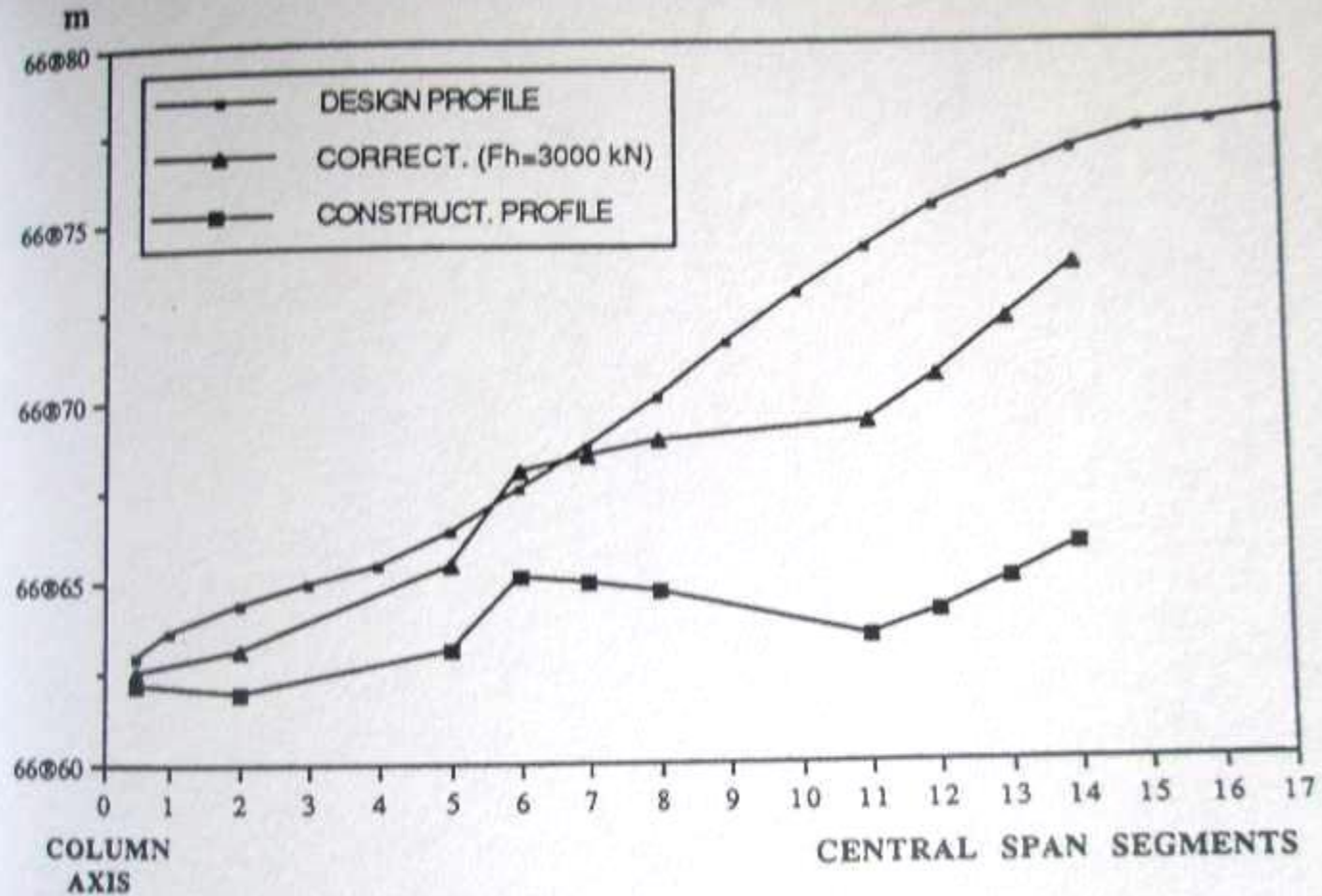


Fig.9: Correction of the longitudinal profile with a closing longitudinal force at midspan





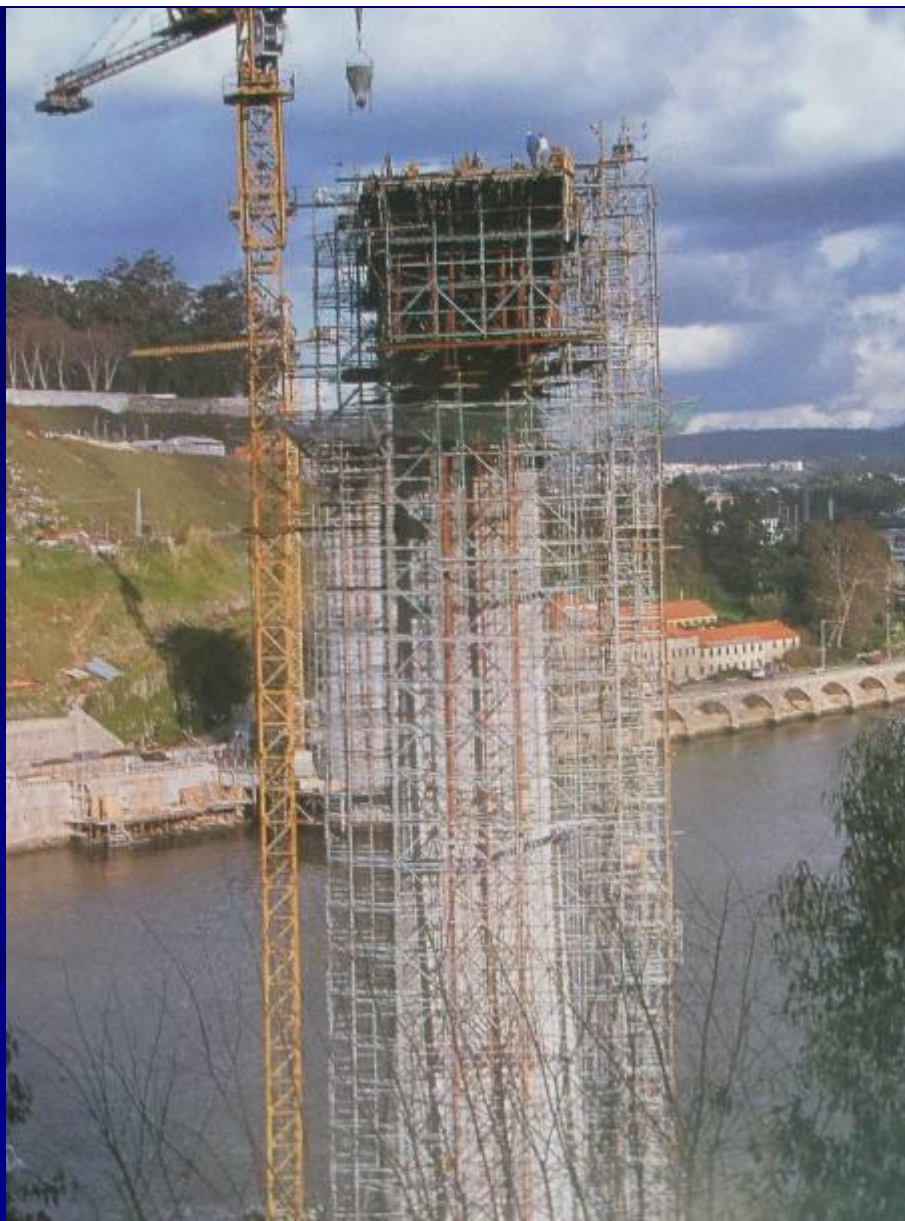
## 4. THE DECK COLUMN CONNECTION





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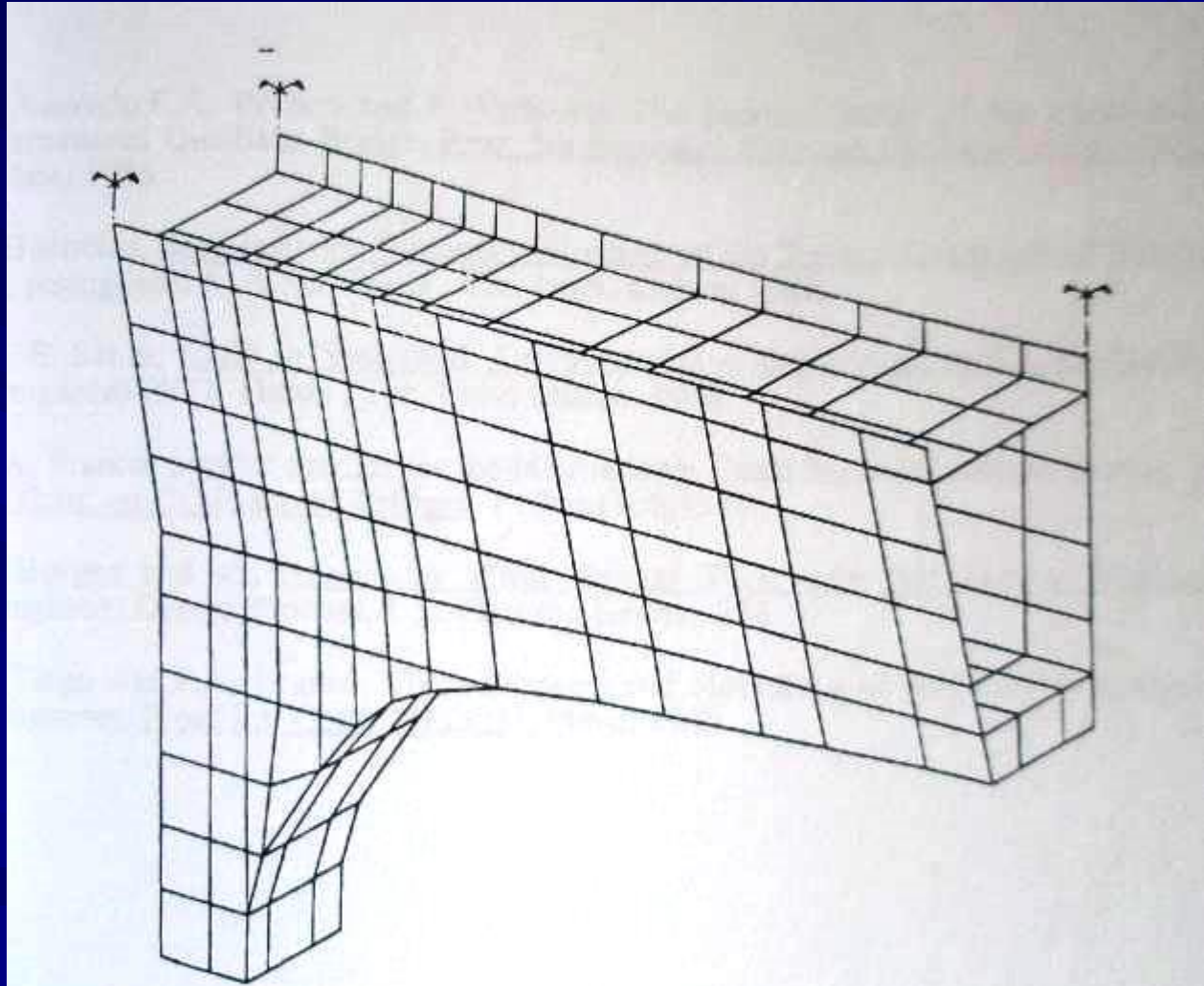


Fig.14 - 3D Finite Element Model of a Railway Bridge





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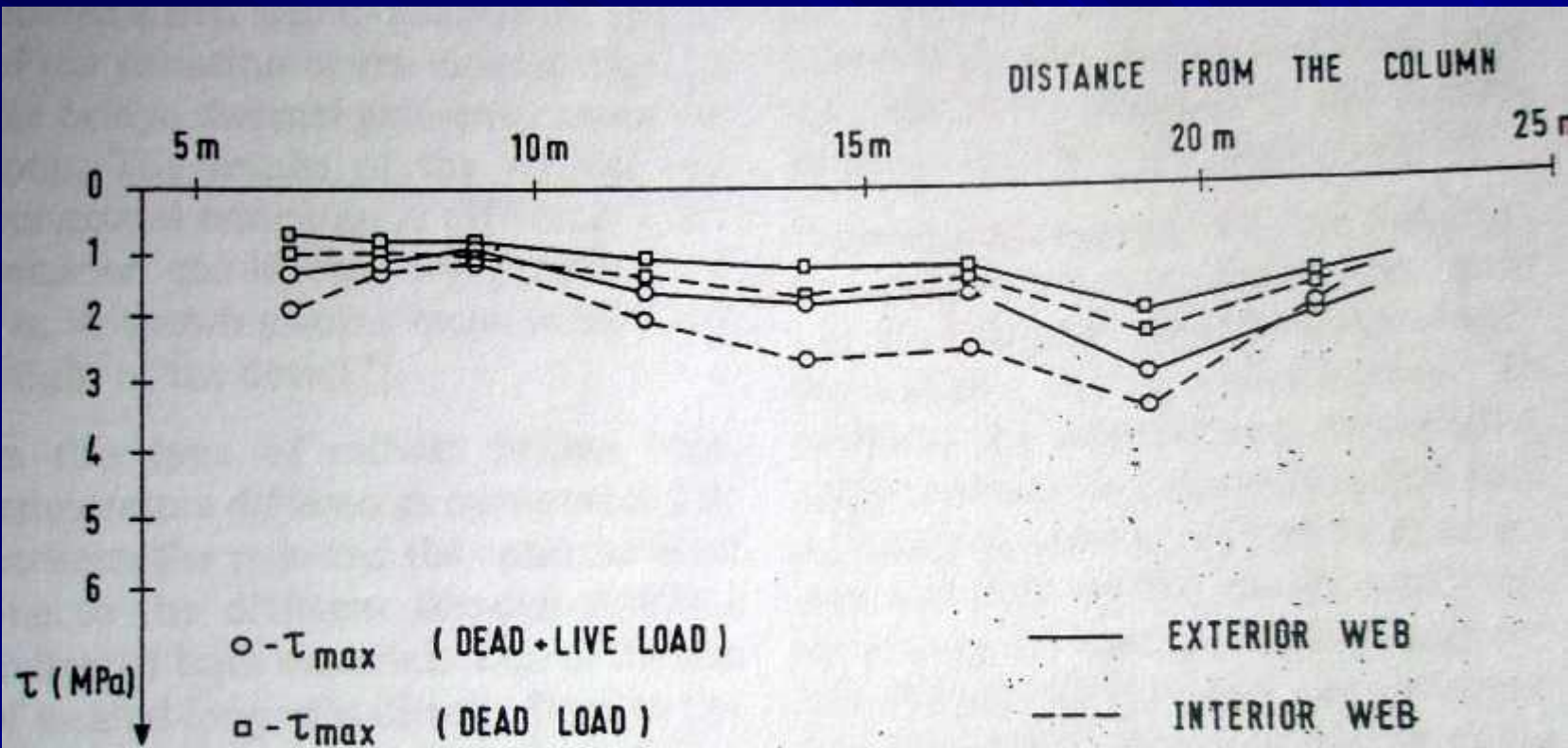


Fig. 3: Maximum shear stresses along the webs





## 5. THE MOVABLE FORMWORK





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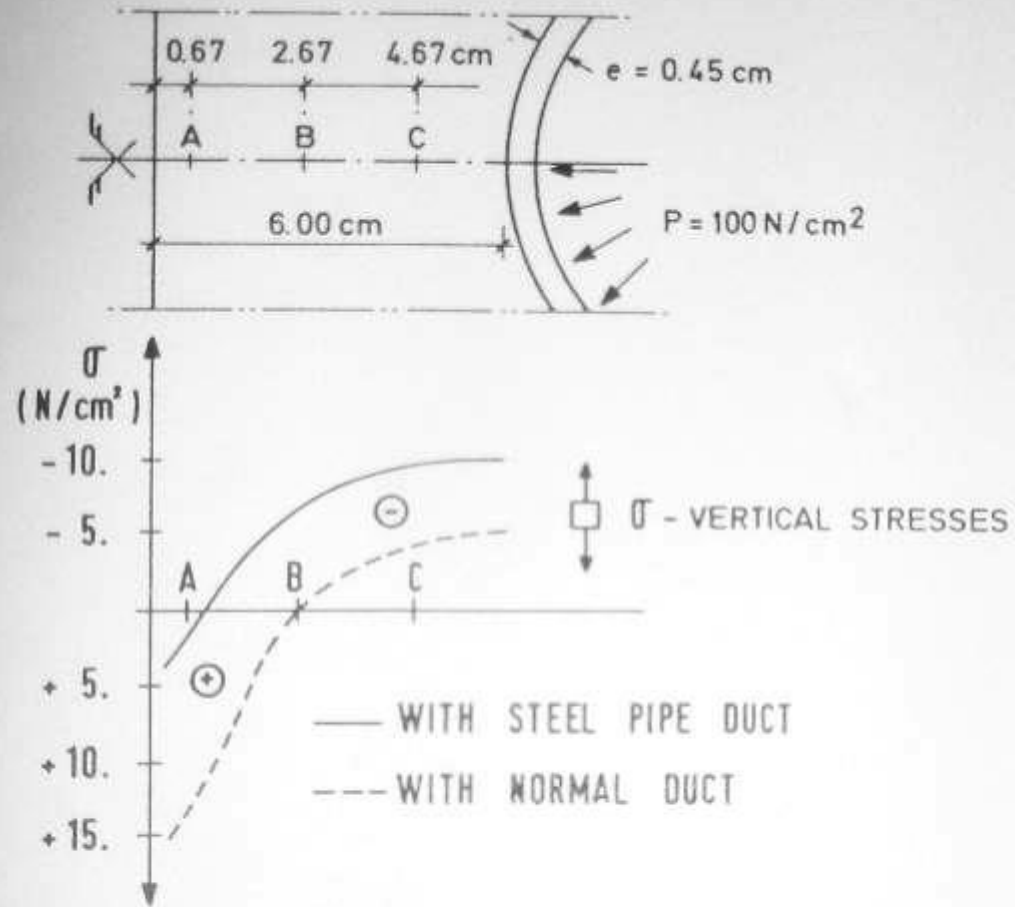
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# INNOVATION IN PORTUGUESE BRIDGES



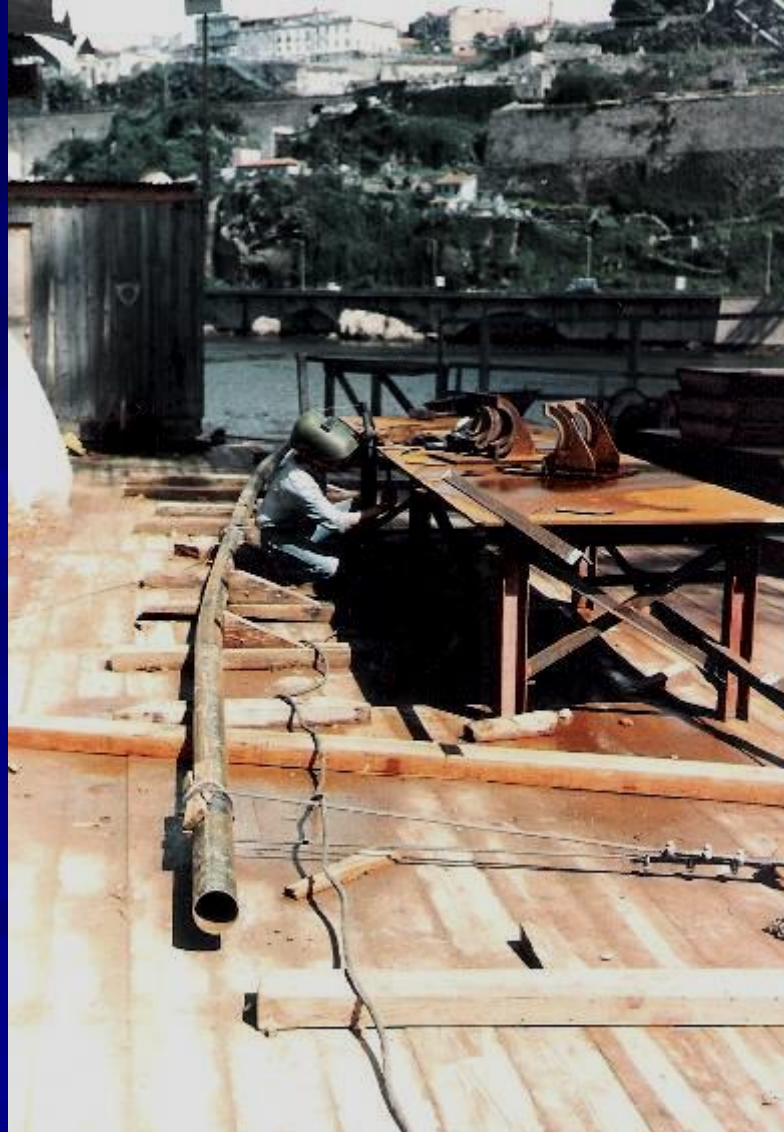
*Fig. 7: Vertical stress distribution in the web due to prestress cable curvature*





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## 6. THE DYNAMIC DAMPERS





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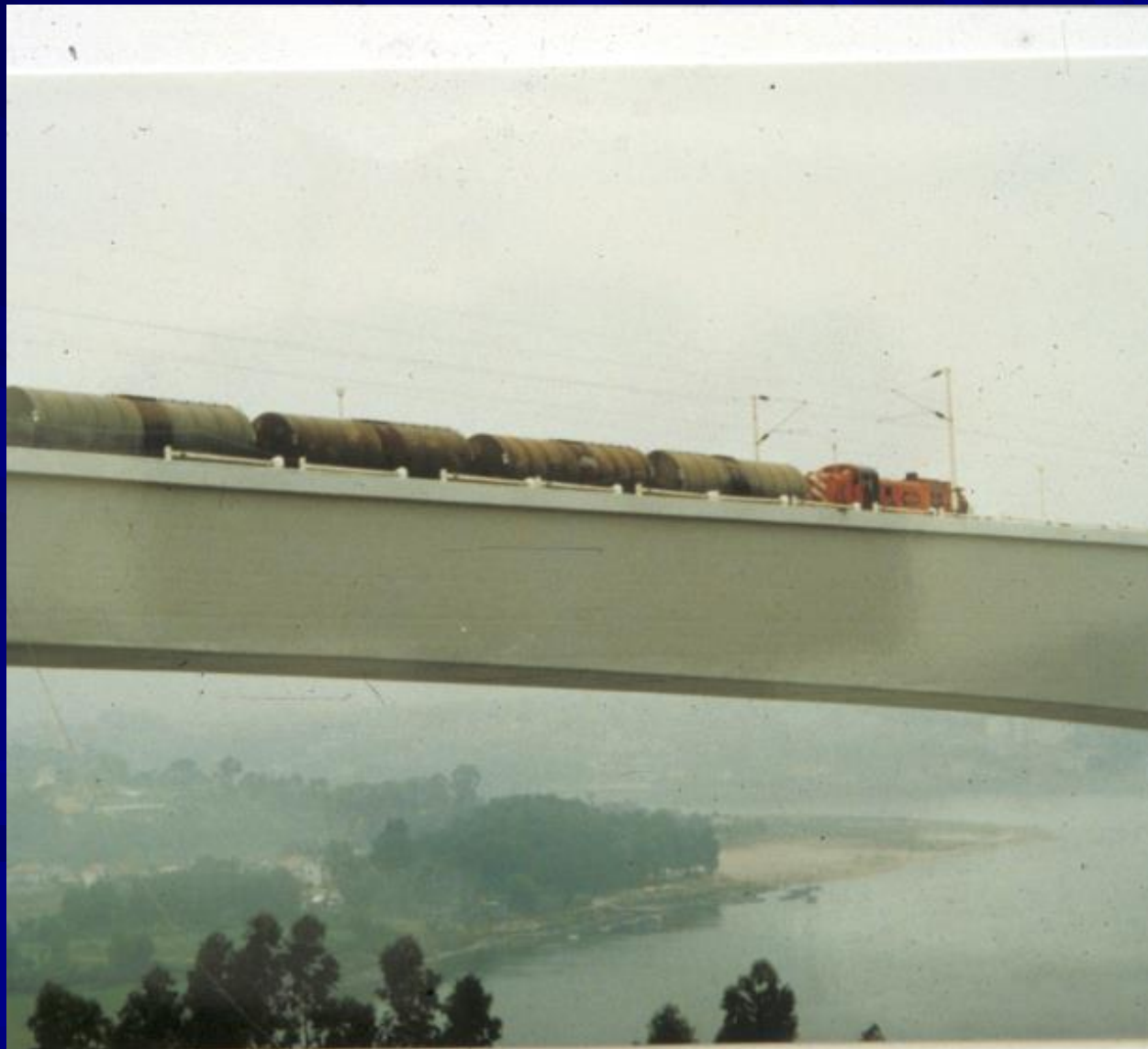
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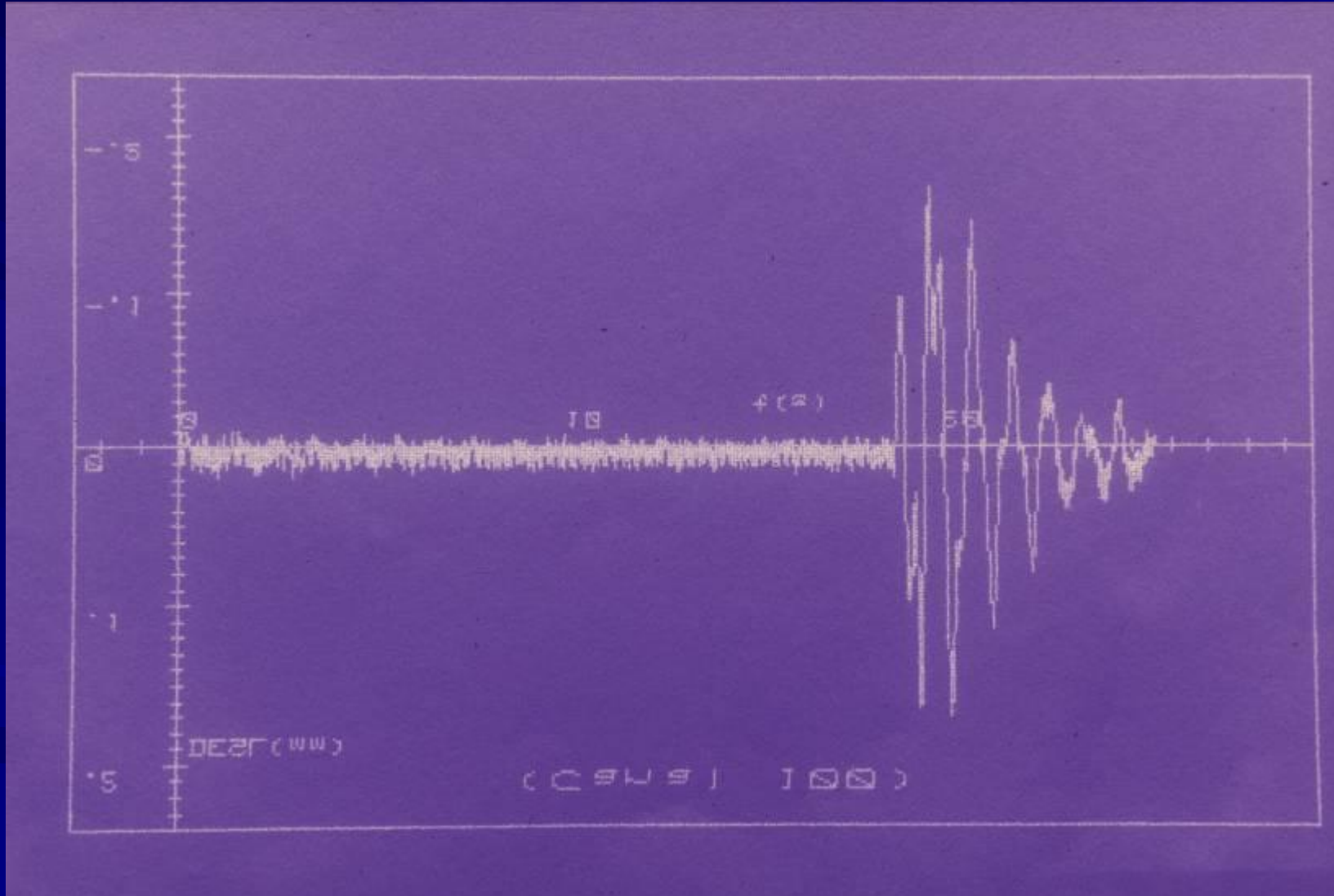
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**GUADIANA INTERNATIONAL BRIDGE, 1991**



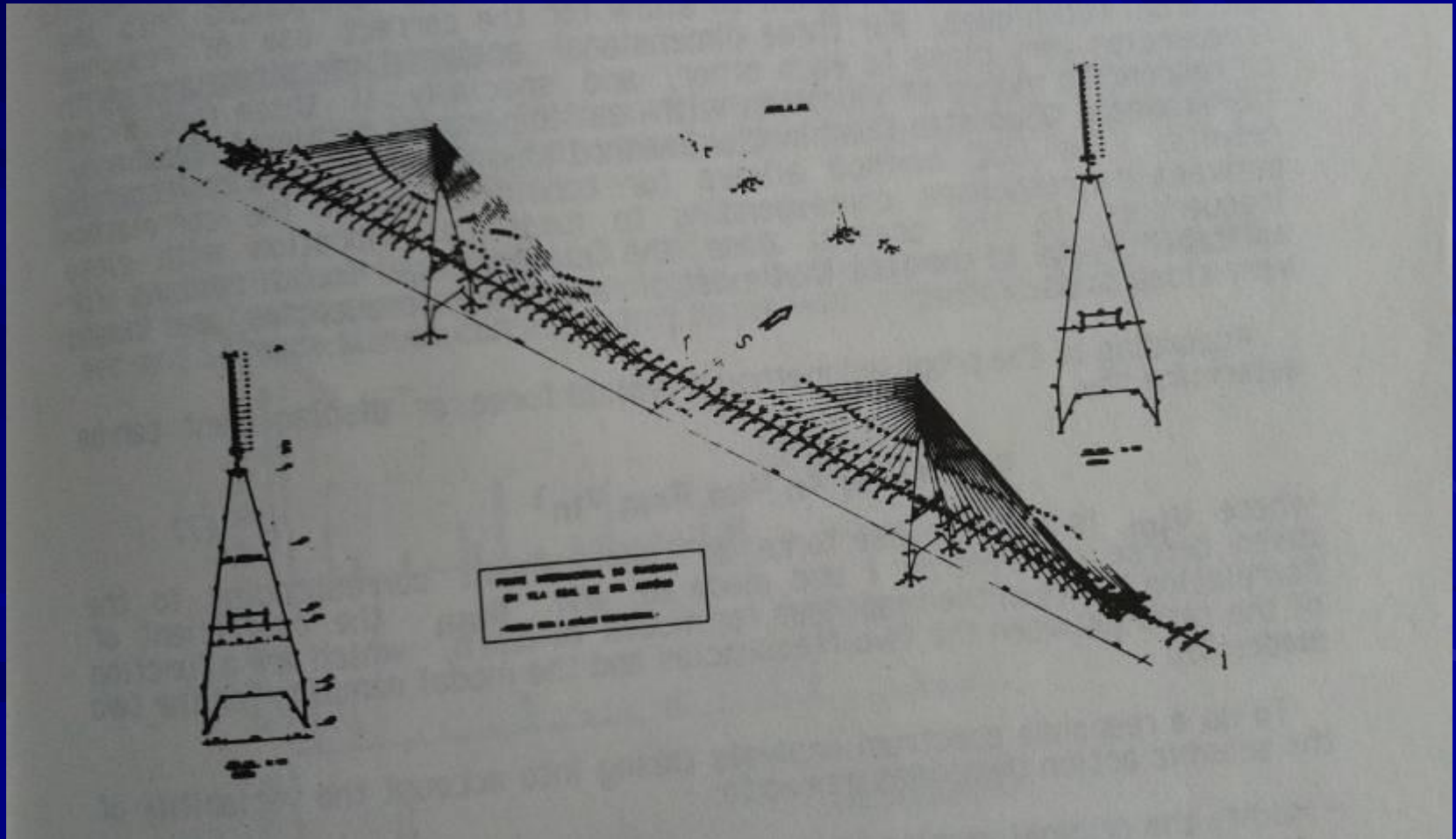
# INNOVATION IN PORTUGUESE BRIDGES





# INNOVATION IN PORTUGUESE BRIDGES

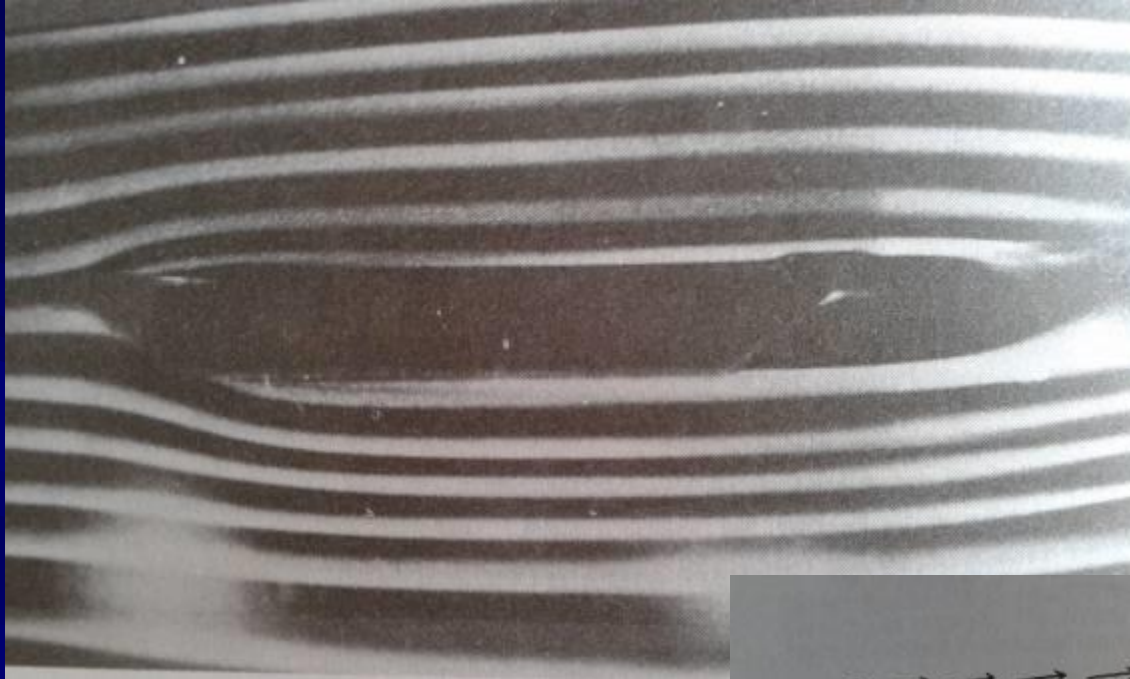
## SEISMIC STUDIES



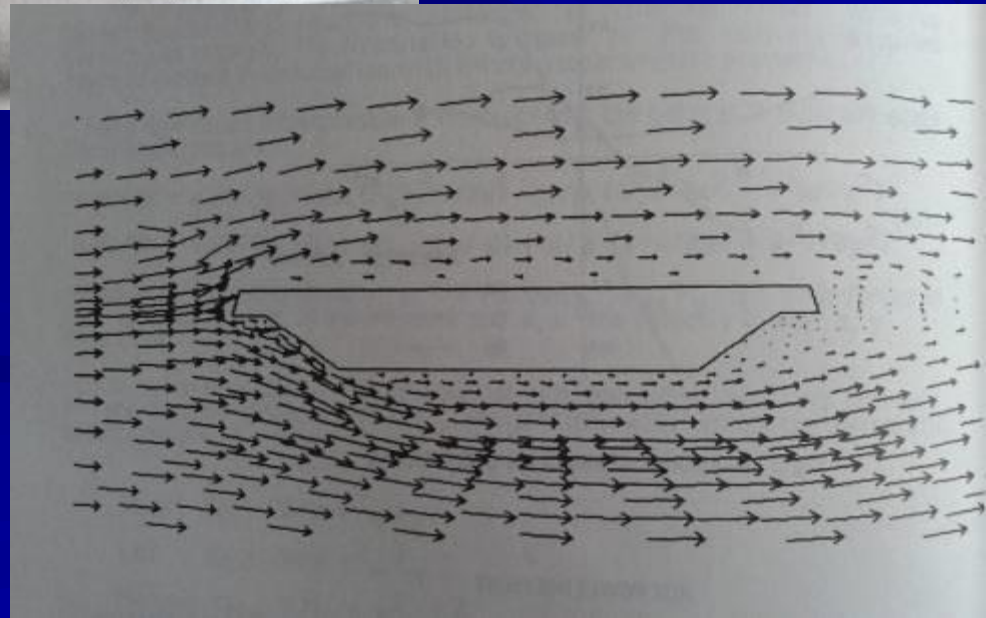


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***WIND STUDIES***





# INNOVATION IN PORTUGUESE BRIDGES

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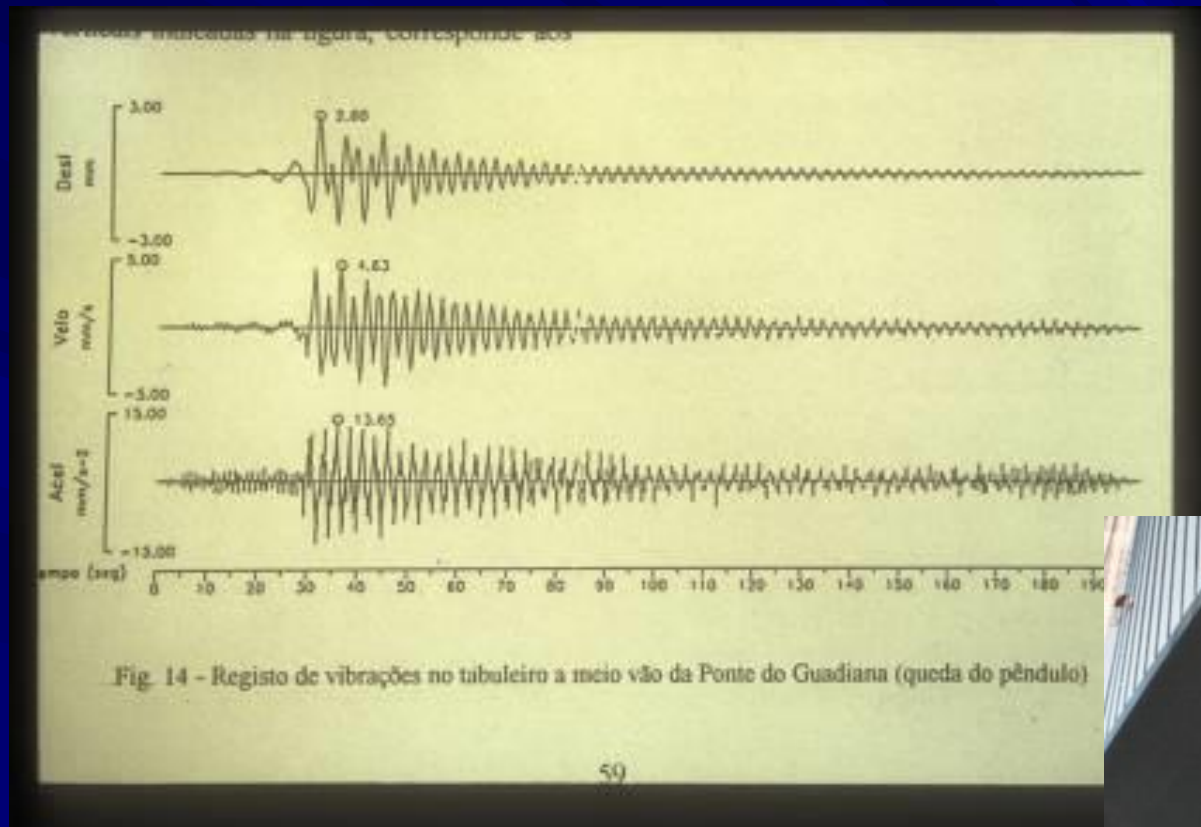


***LOAD TESTS***





# INNOVATION IN PORTUGUESE BRIDGES



***DYNAMIC TESTS***





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*CABLE DYNAMICS*



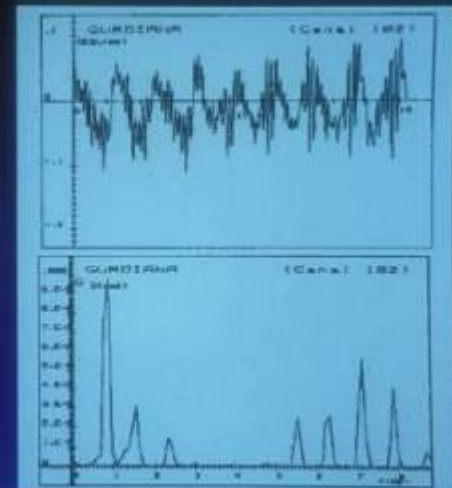


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Cable Frequencies

$$f_n = \frac{n}{2L} \sqrt{\frac{F}{m}}$$



DECivil



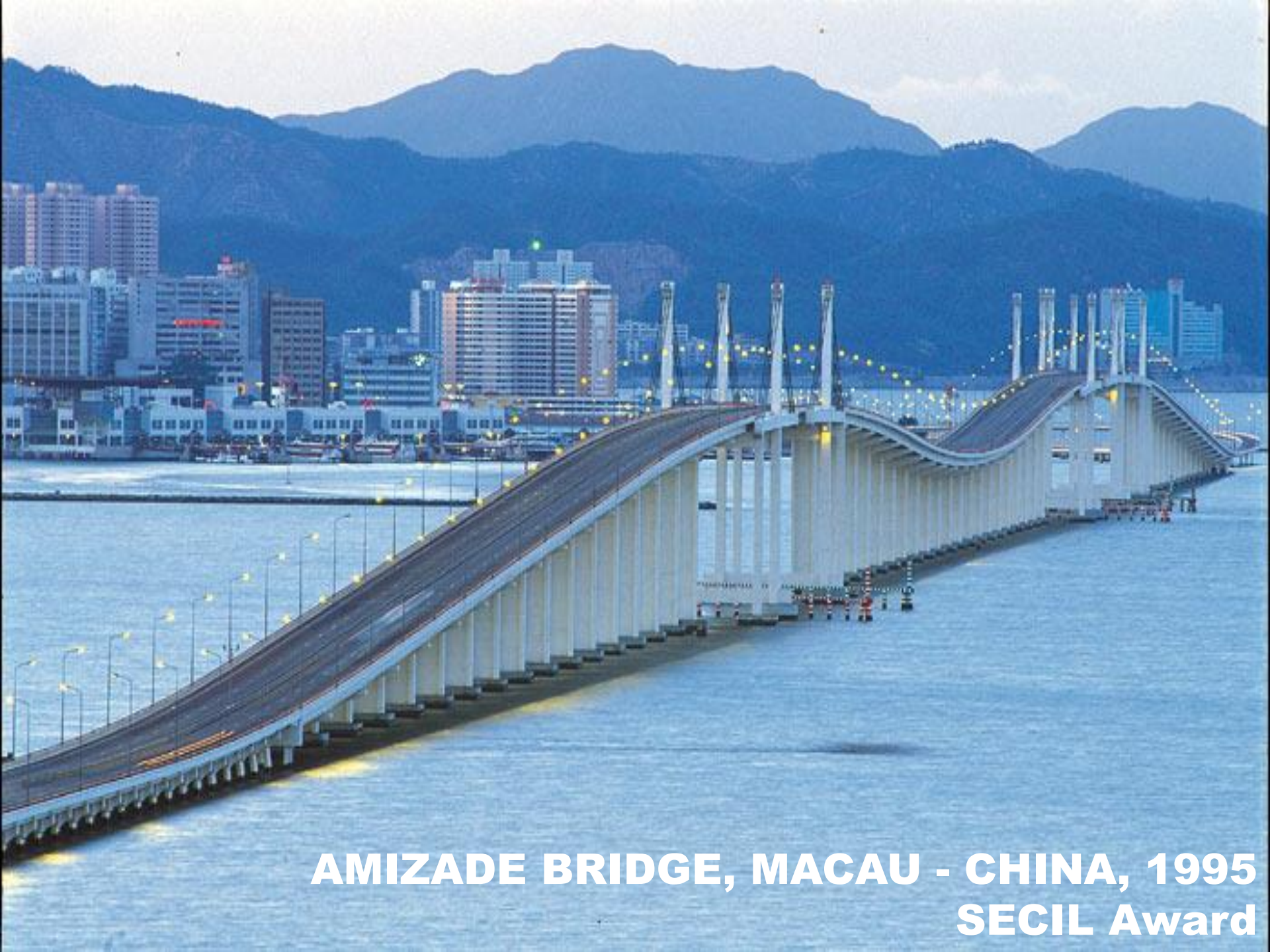


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**AMIZADE BRIDGE, MACAU - CHINA, 1995  
SECIL Award**



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*Length - 4.7 km*





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# **PONTE VASCO DA GAMA, 1998**

**Europe longest bridge, 12,4 km**



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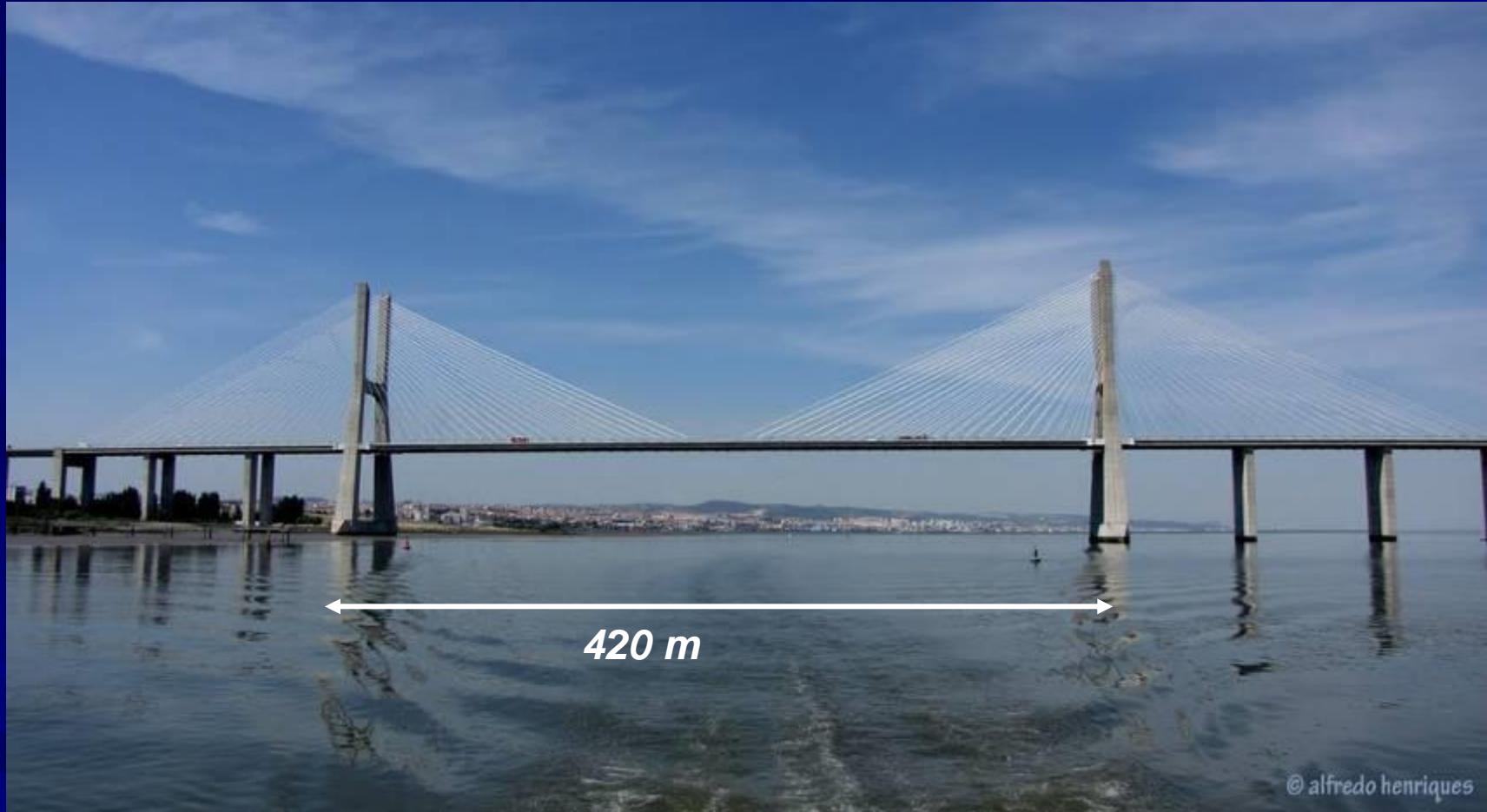
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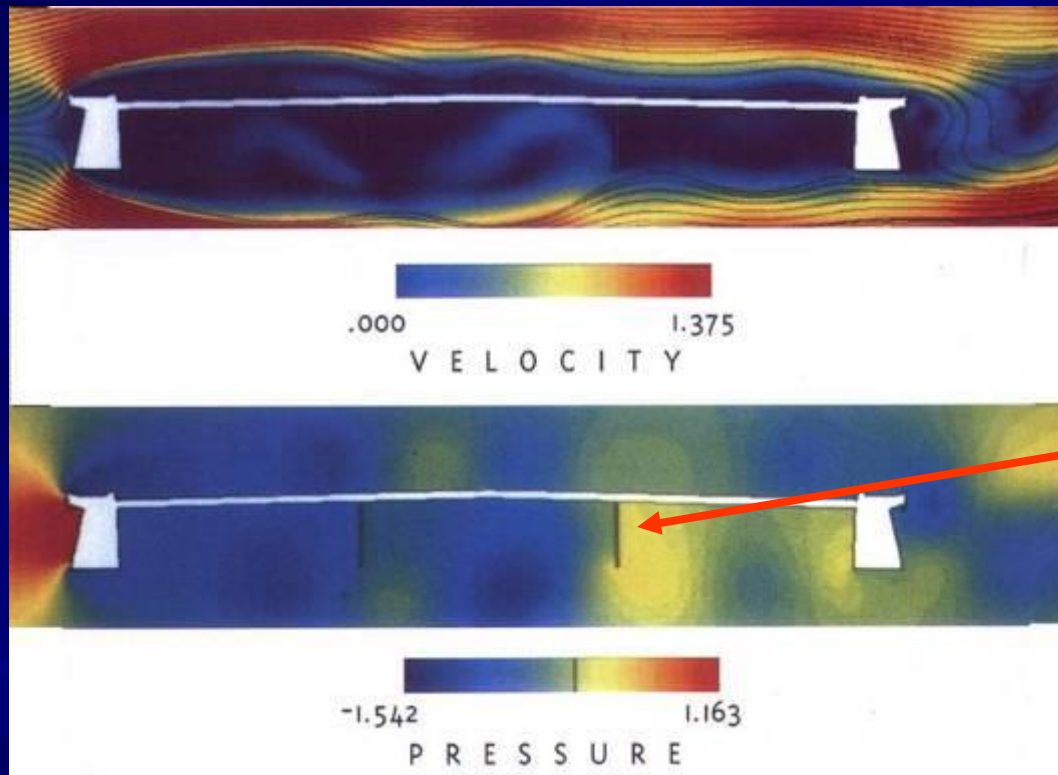
***SEISMIC DAMPERS***





# VIDA DE UMA OBRA

## AERODYNAMIC DESIGN



**DEFLECTORS**



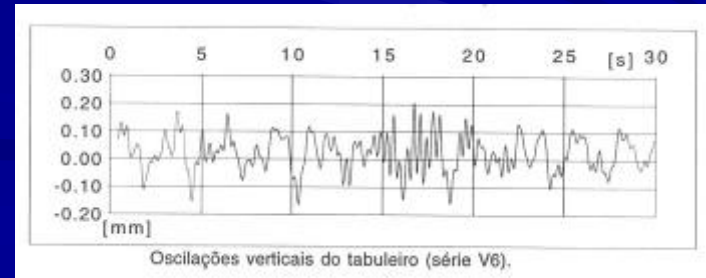
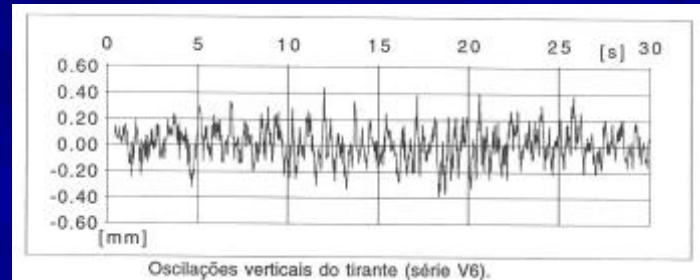
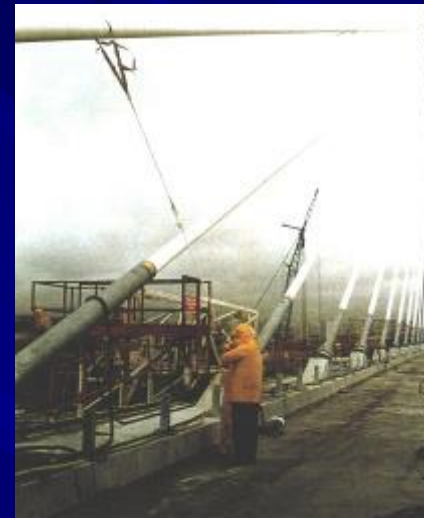


# CABLES AERODYNAMICS

## WIND TUNNEL TESTS

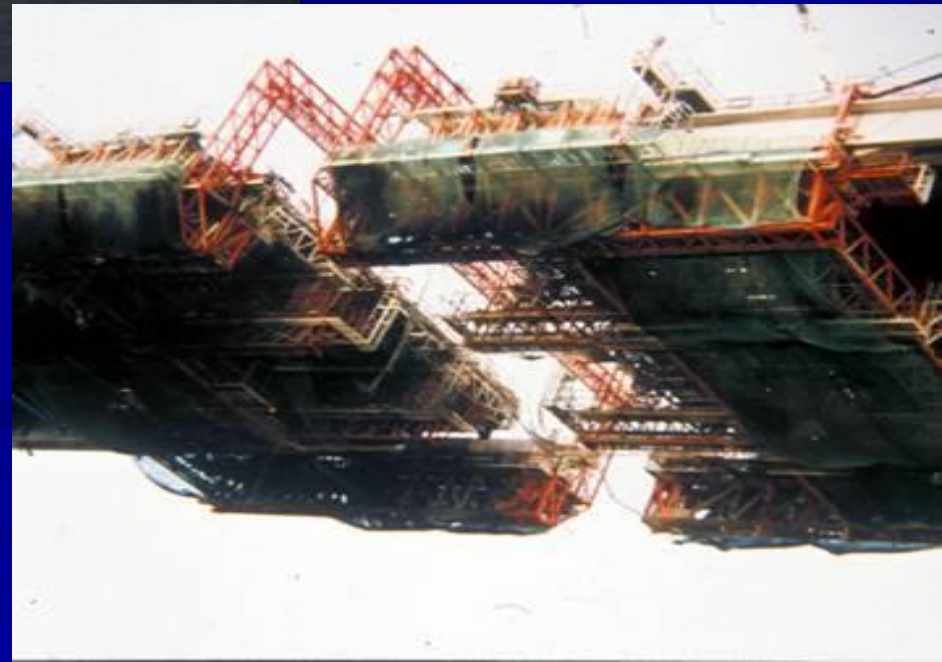


## IN SITU WIND TESTS





# CONSTRUCTION CONTROL





## ***PRECAST OF LONG BRIDGE***









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*BRIDGE TESTING*





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## *DYNAMIC TESTING*





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**INFANTE D. HENRIQUE BRIDGE, 2003**

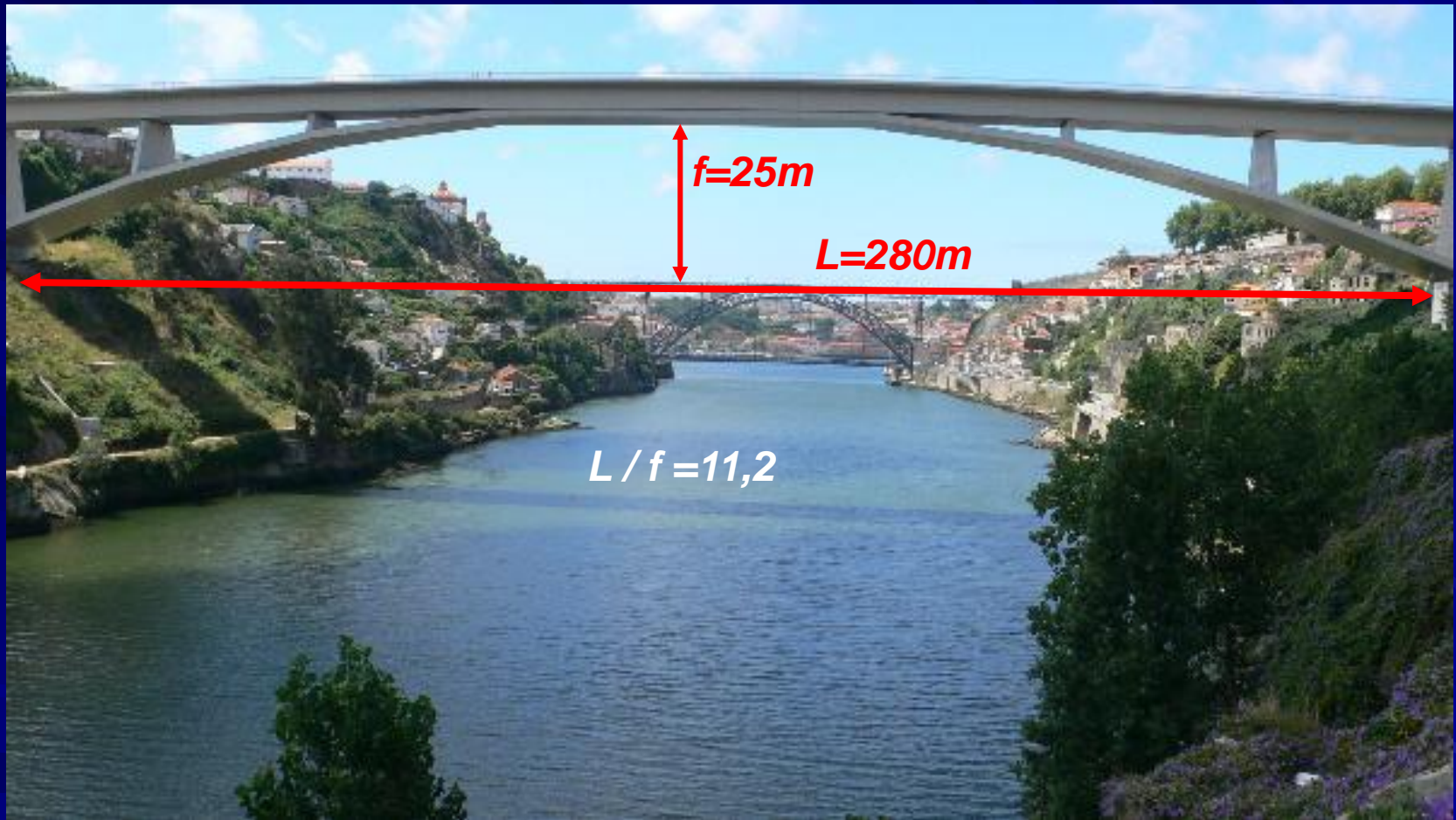


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## MONITORING AND THE CONSTRUCTION PROCESS





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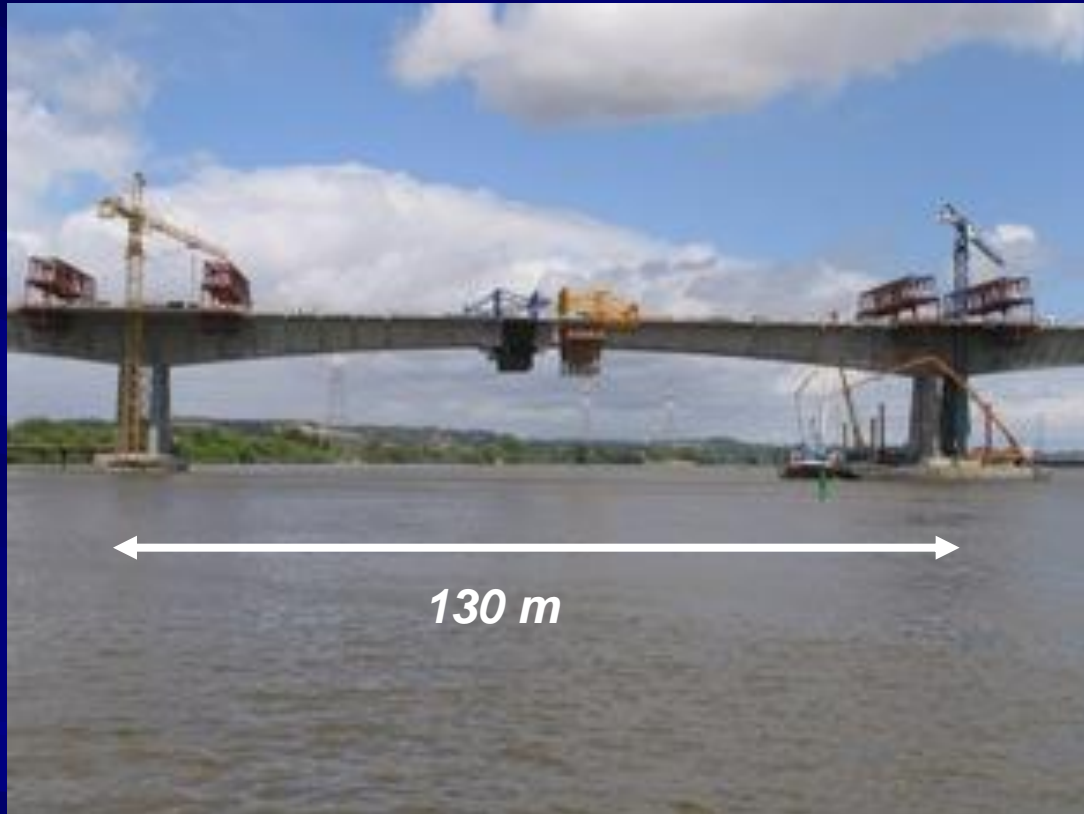


**LEZÍRIA BRIDGE, 2007**  
**12Km Long**  
**2nd in Europe**















# PONTE DA LEZÍRIA





















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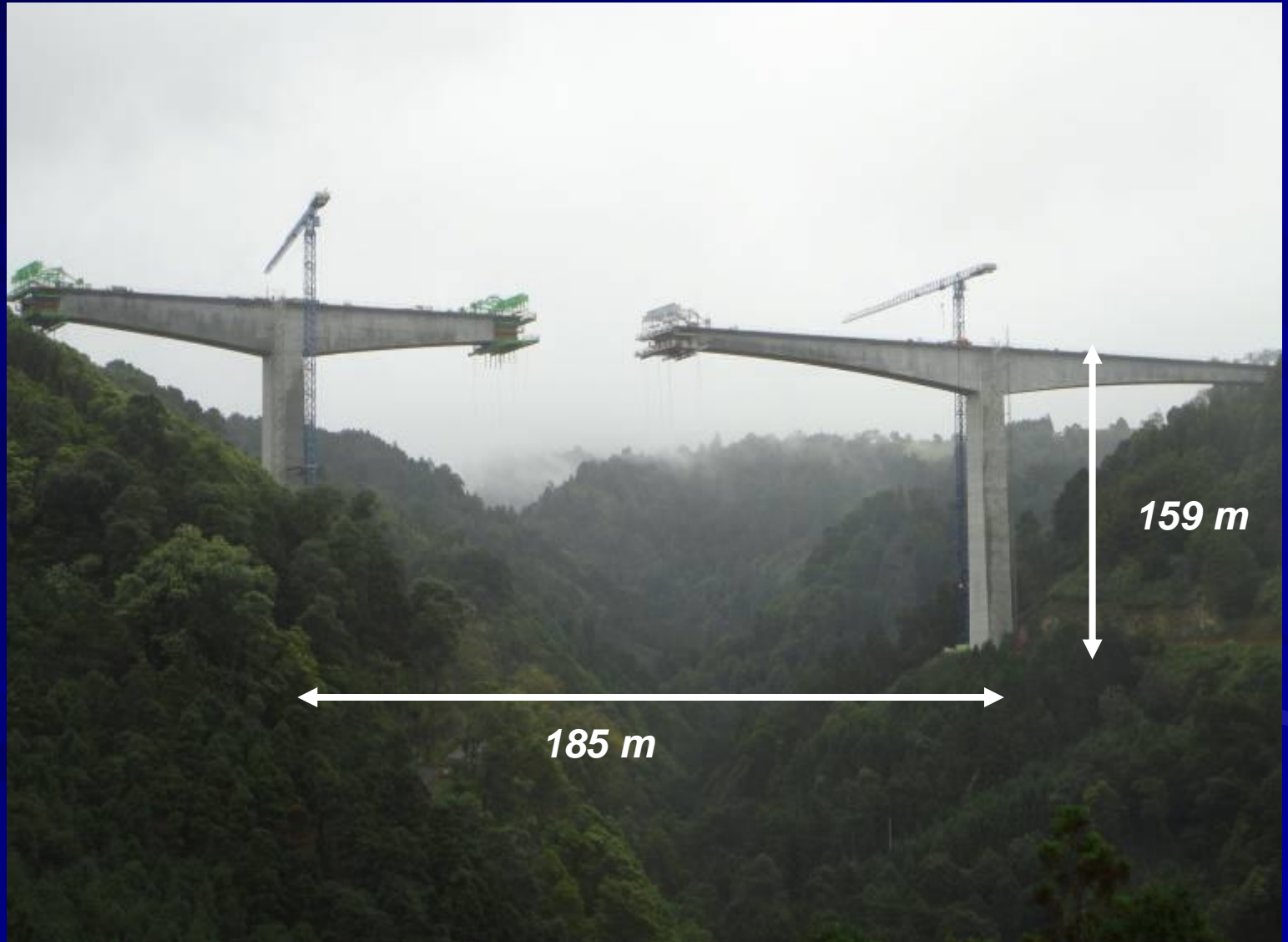


**BRIDGES IN AZORES HIGHWAYS, 2012**  
30 viaducts and 100 overpasses





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