

CONCEPTUAL DESIGN in Model Code 2020 for New and Existing Structures

Hugo Corres

fib President

Prof. Technical University of Madrid

FHECOR ■ Ingenieros Consultores

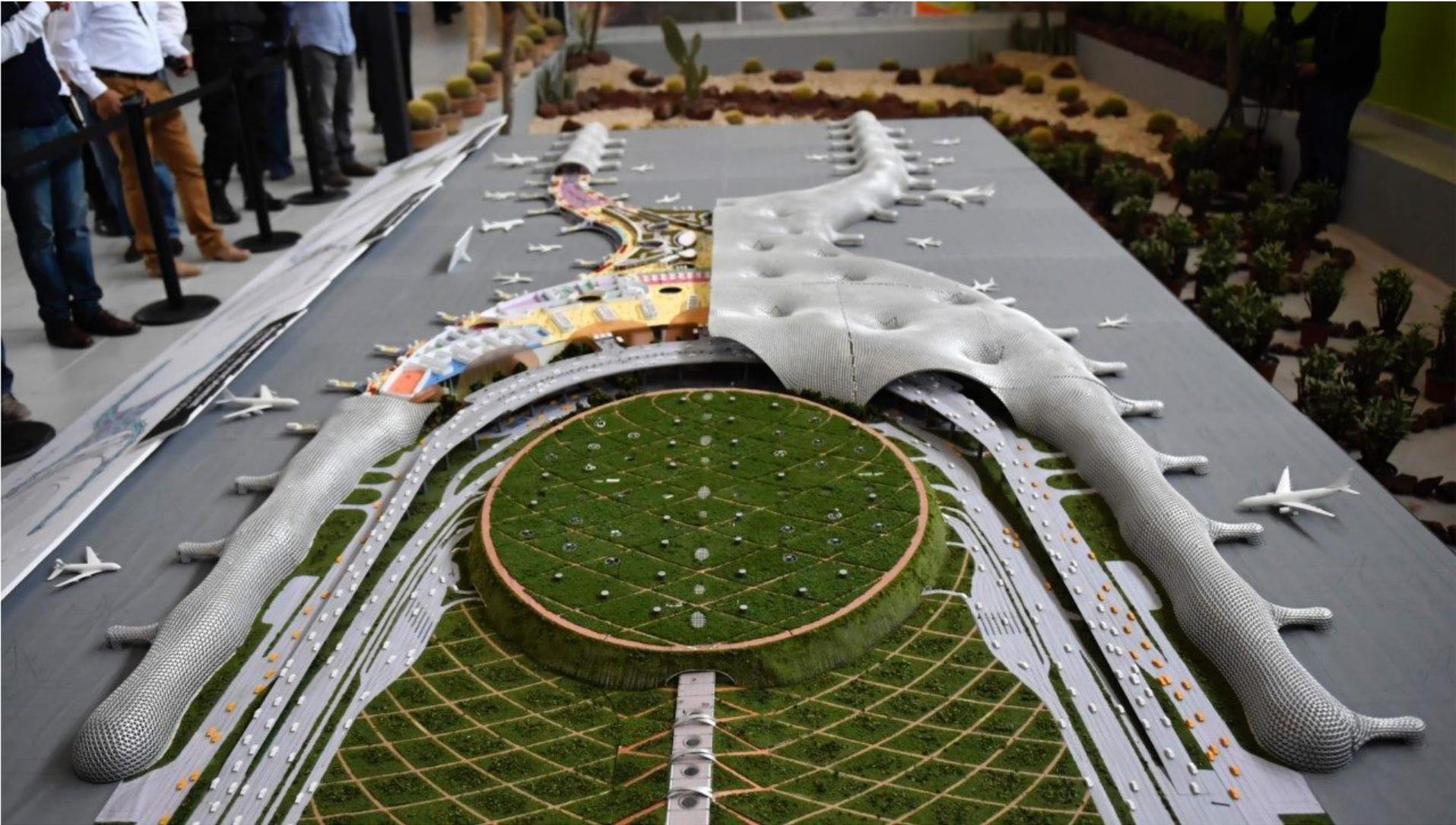
fib-Hungarian Group

Budapest 10th of April of 2018

GUERNICA

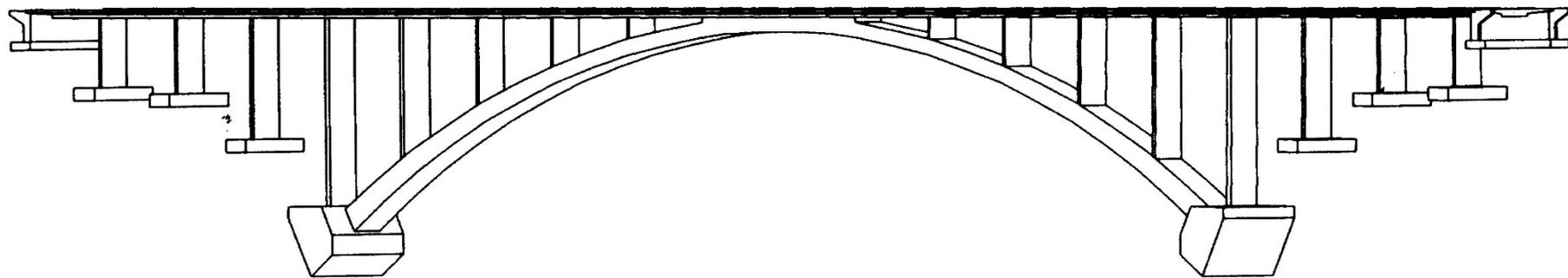
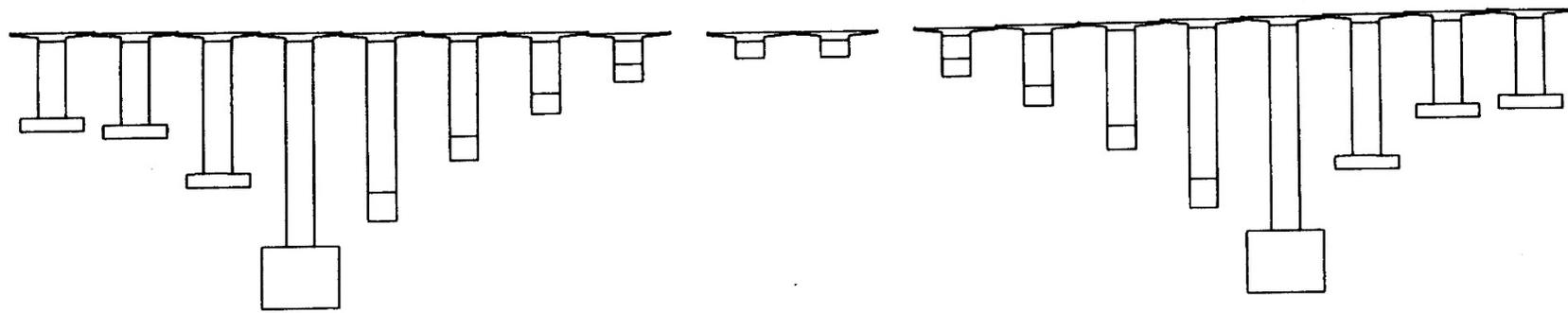
PABLO PICASSO (1881-1973)

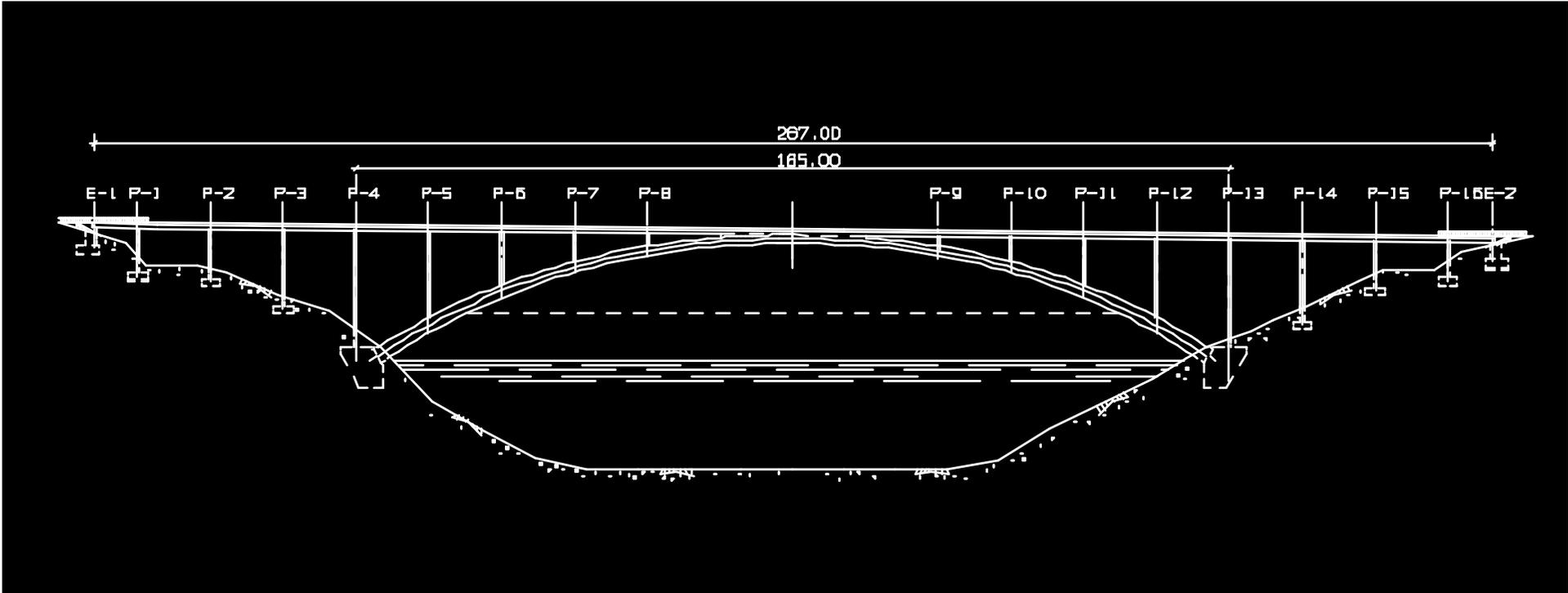




BRIDGE OVER THE BURGUILLO RESERVOIR BEFORE CONSTRUCTION







BRIDGE OVER THE BURGUILLO RESERVOIR BEFORE AND AFTER CONSTRUCTION

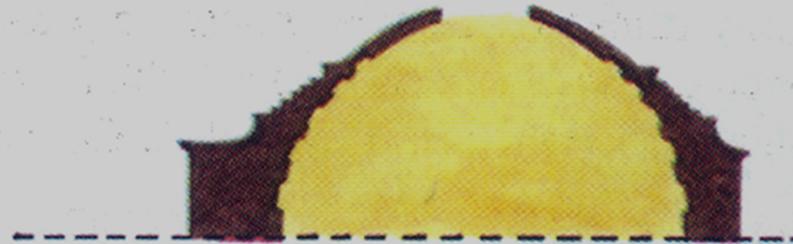


THE DOME OF THE PANTHEON AND SAINT PETER'S BASILICA. 2nd Century (125-128) AD

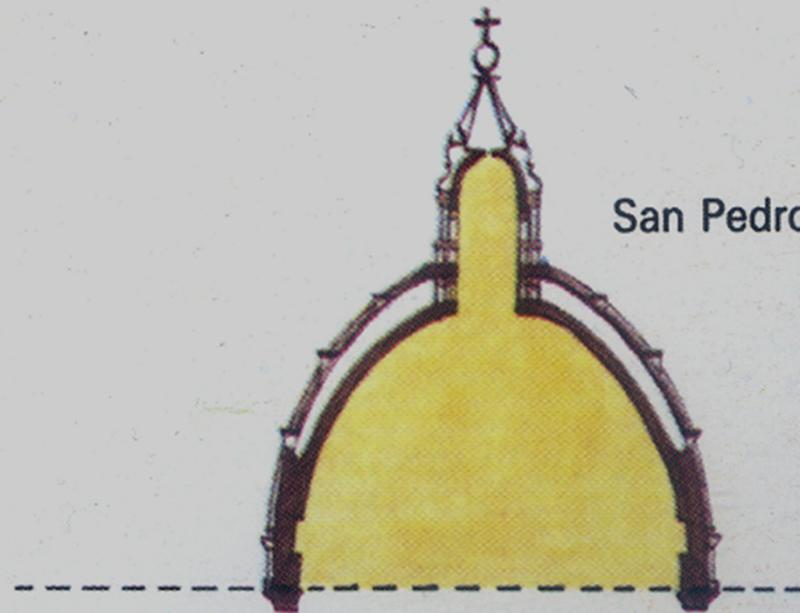


0 50 100 150 200 pies
0 10 20 30 40 50 60 metros

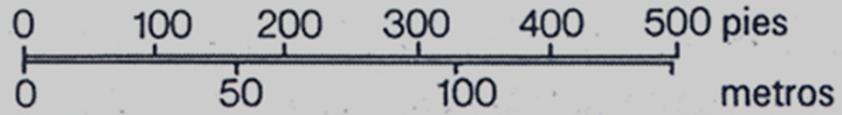
Sección de las cúpulas
(a la misma escala)



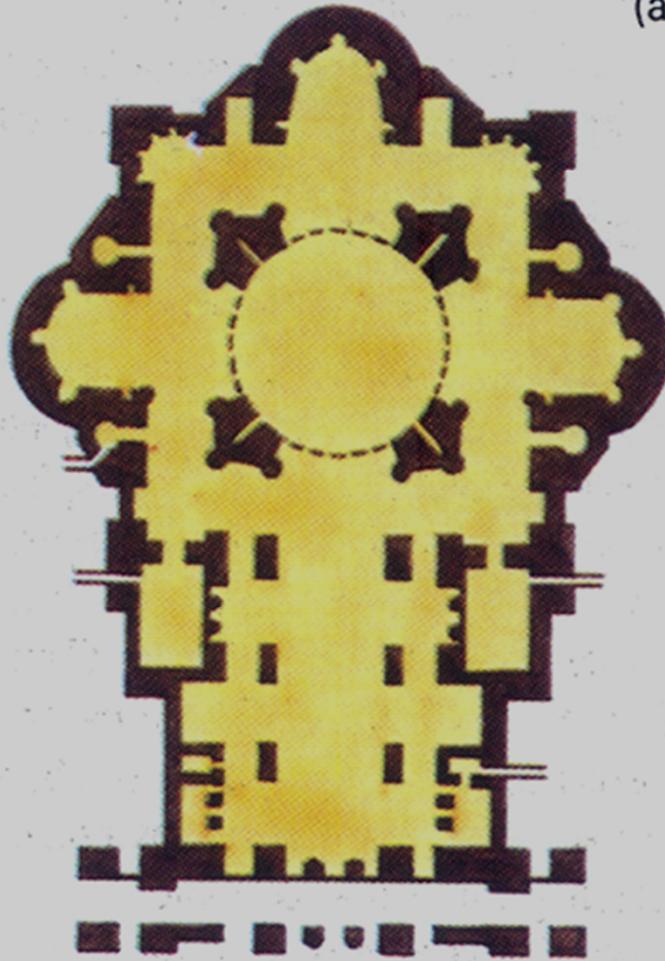
Panteón



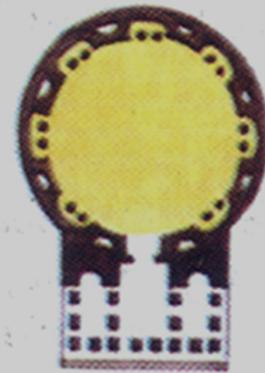
San Pedro



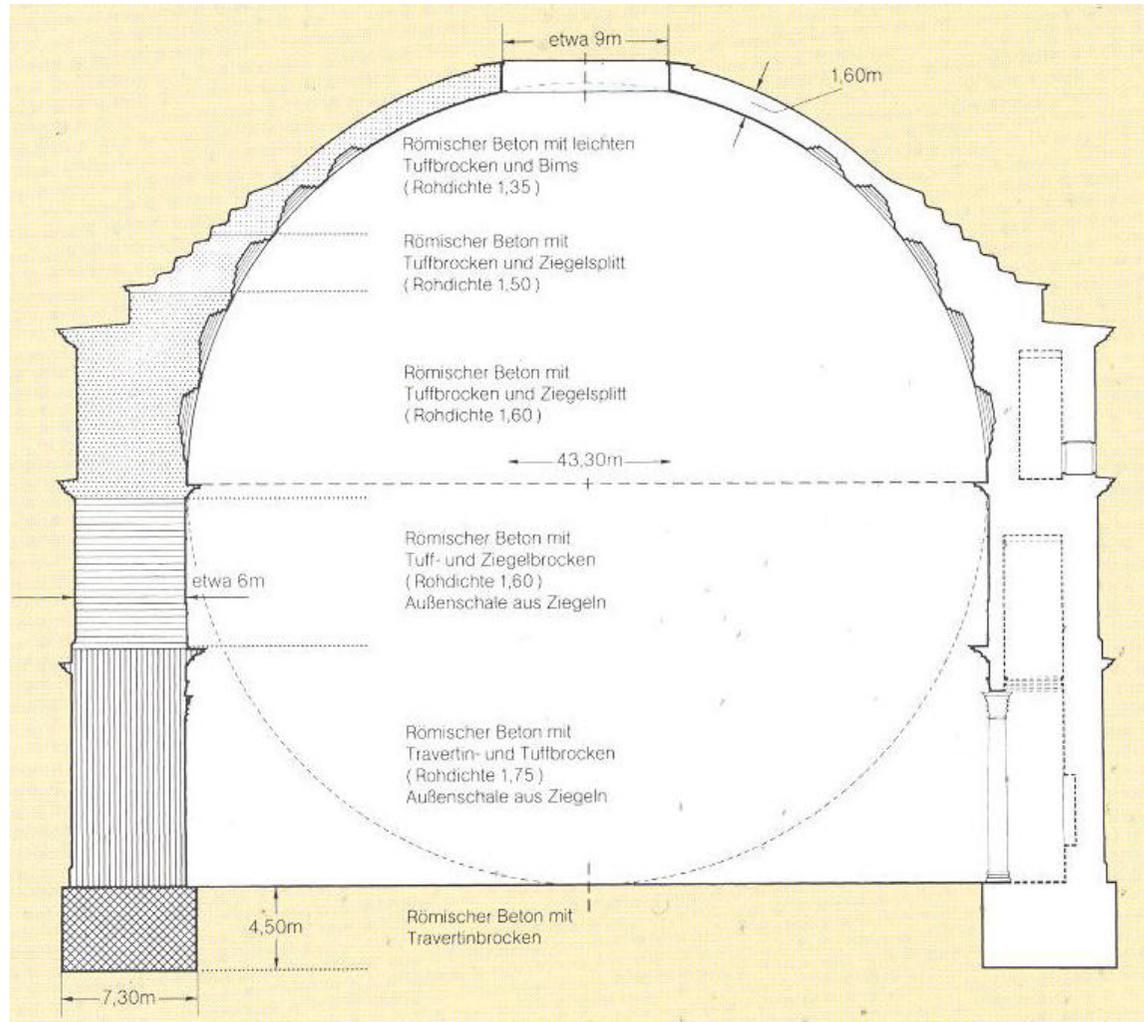
Planta
(a la misma escala)

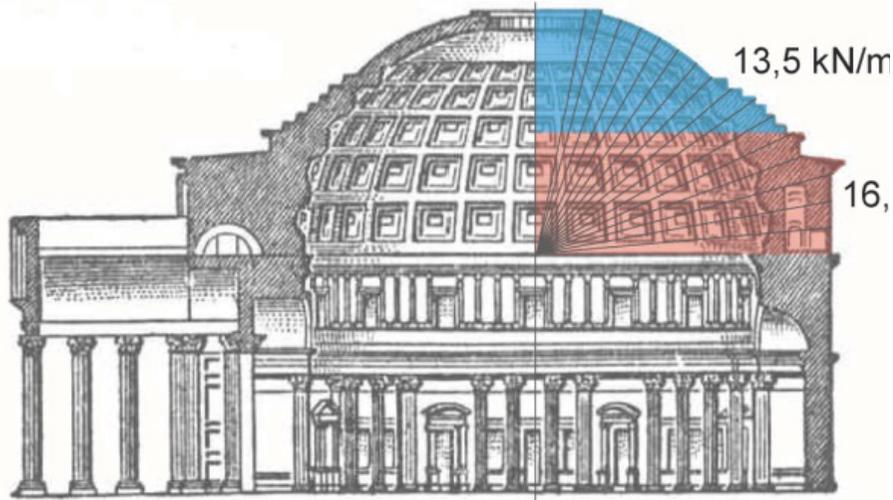


San Pedro

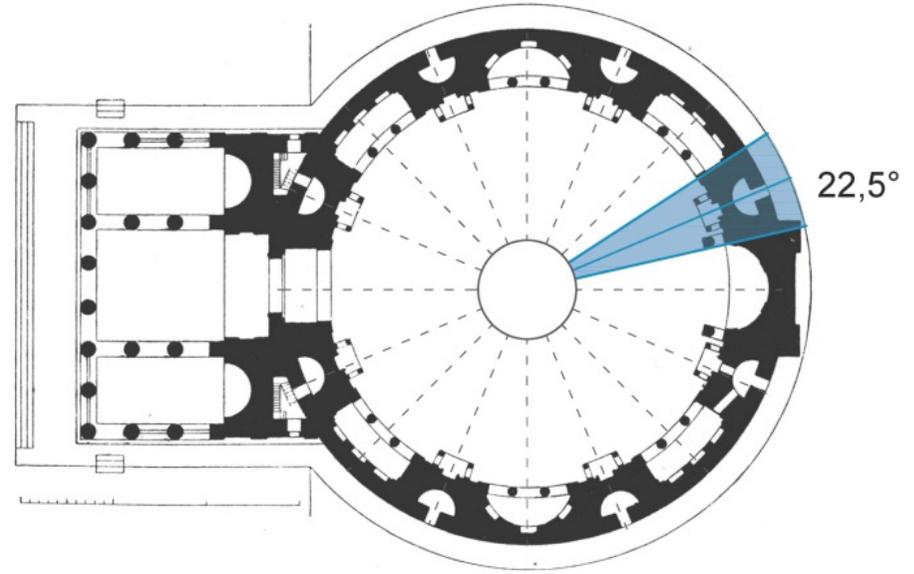


Panteón



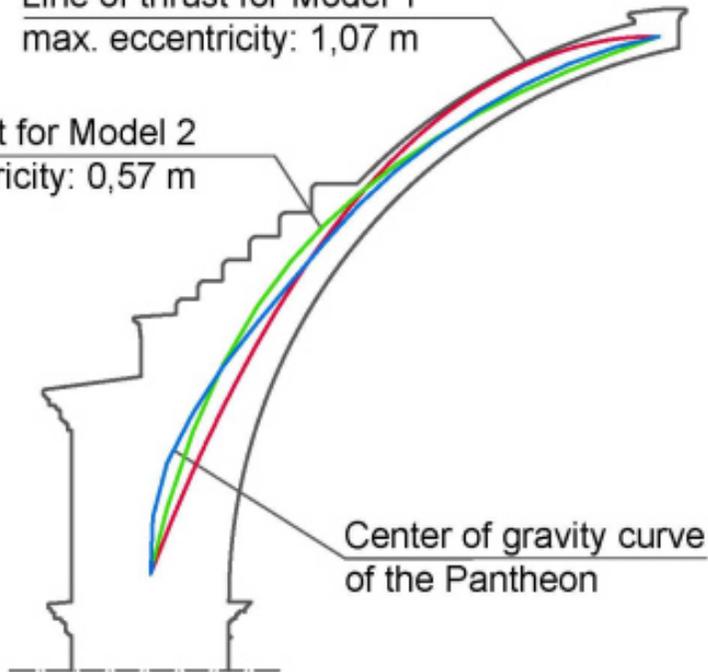


12. ROM: PANTHEON.

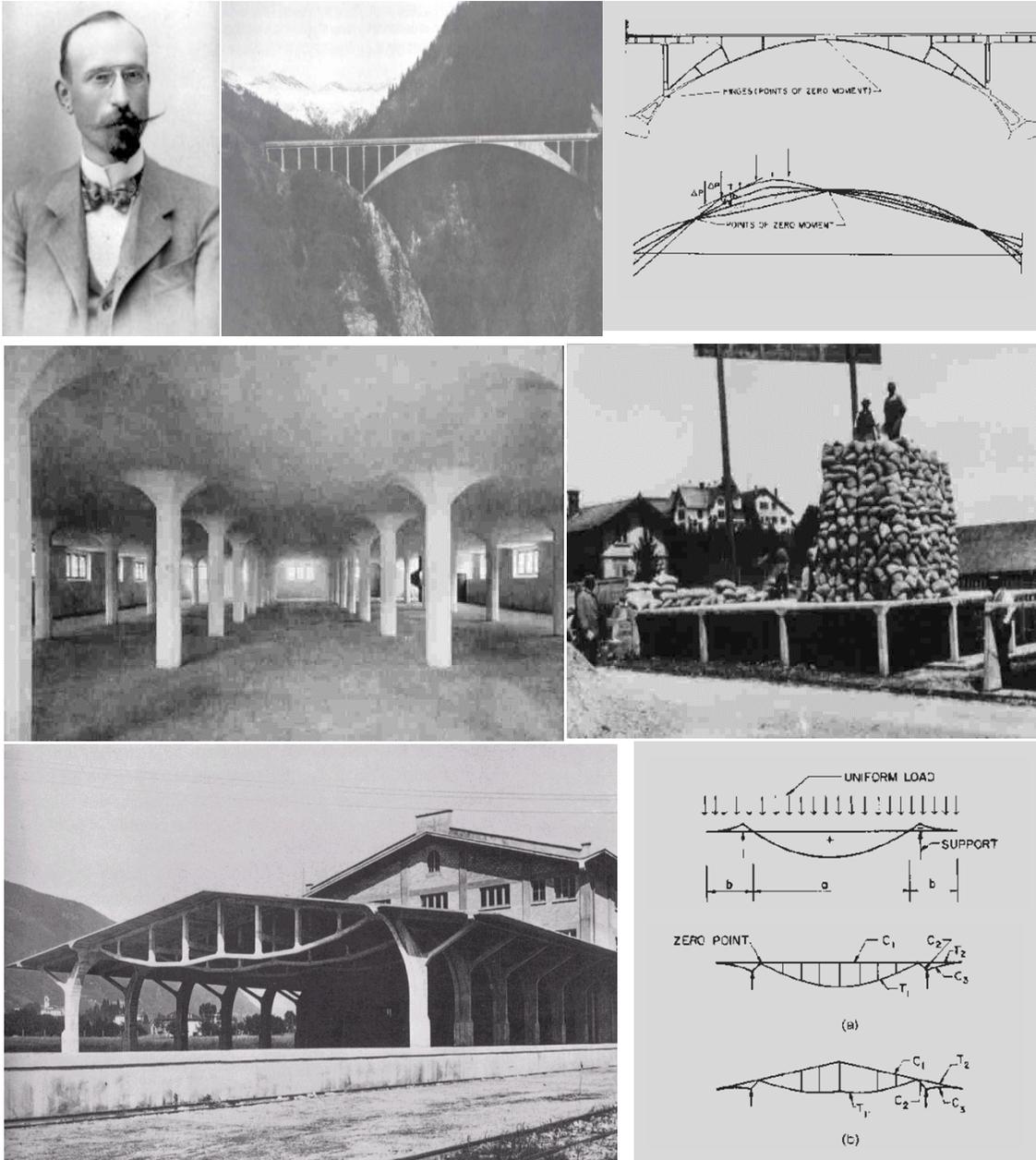


Line of thrust for Model 1
max. eccentricity: 1,07 m

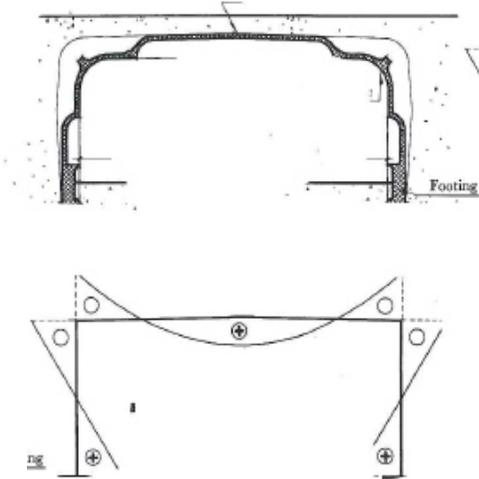
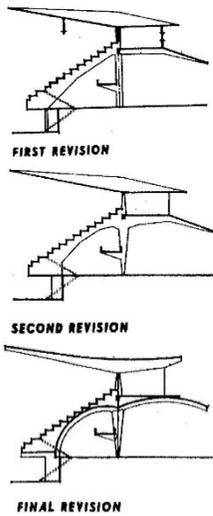
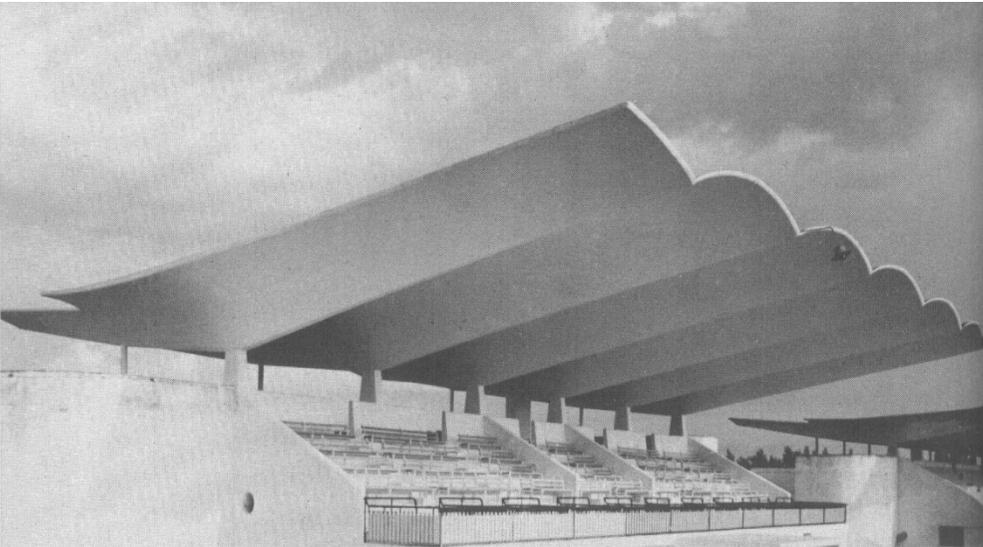
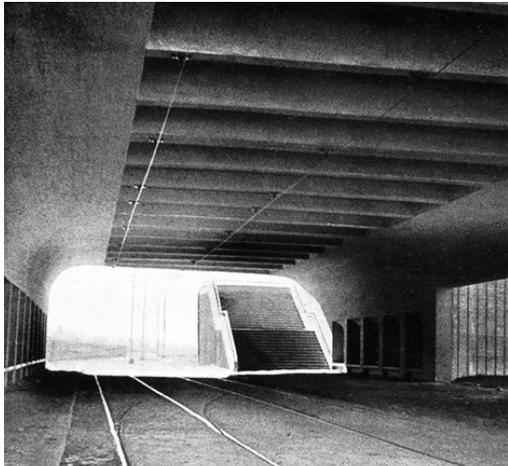
Line of thrust for Model 2
max. eccentricity: 0,57 m



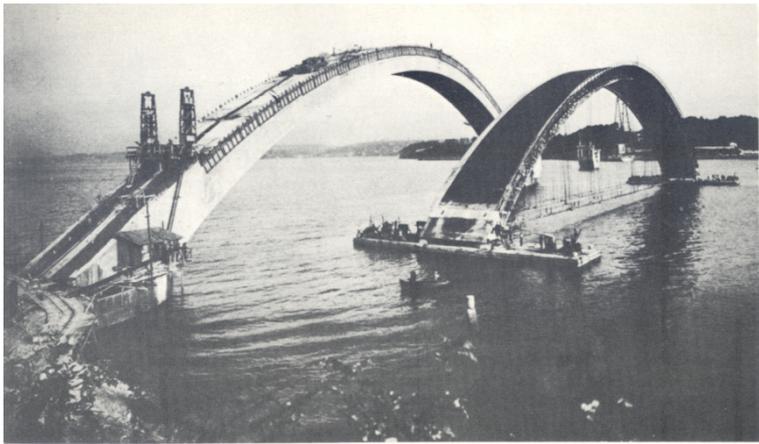
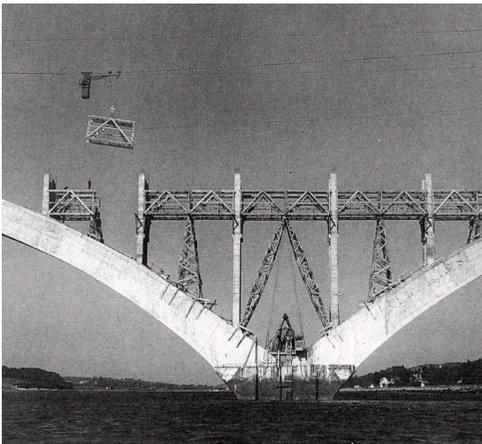
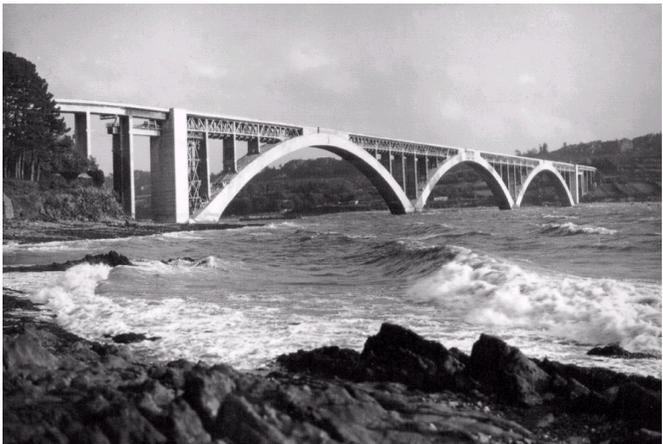
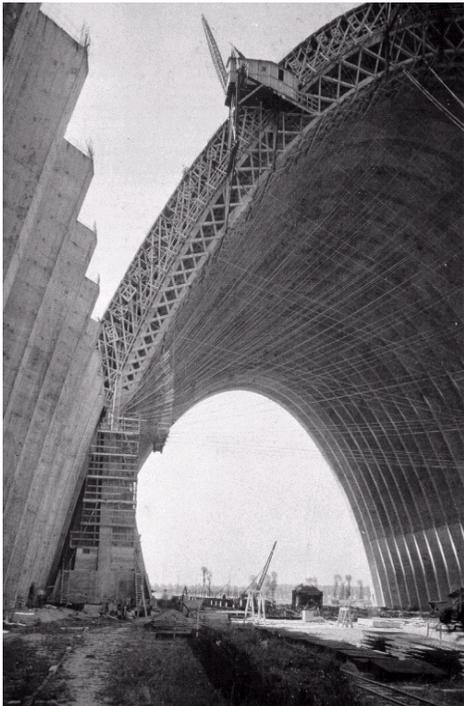
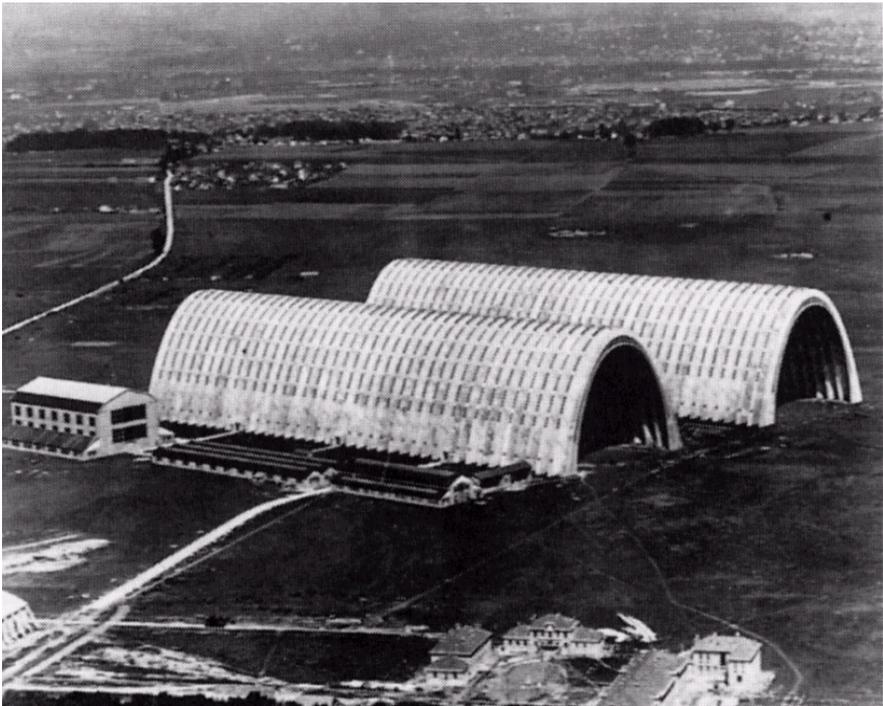
ROBERT MAILLART (1872-1940)



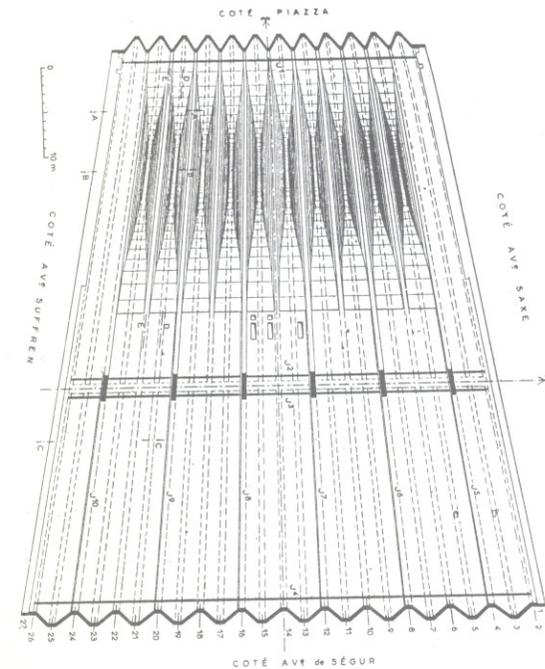
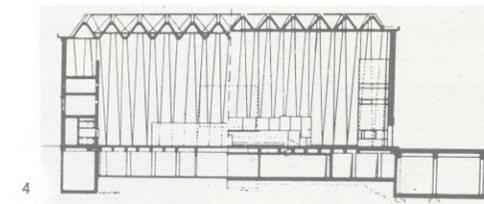
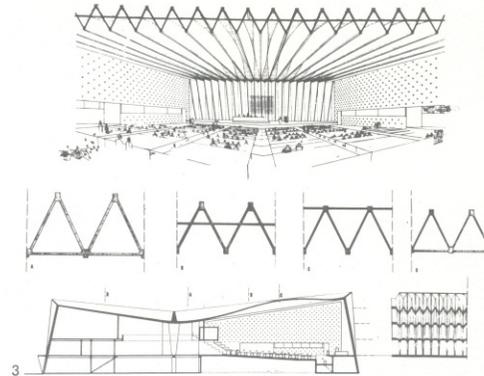
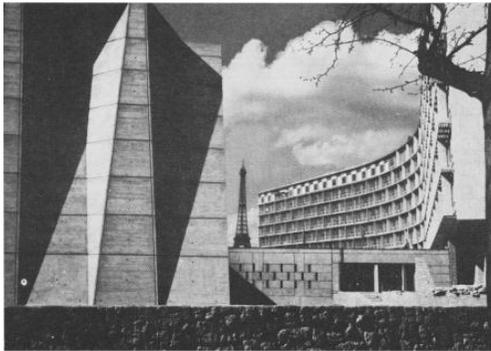
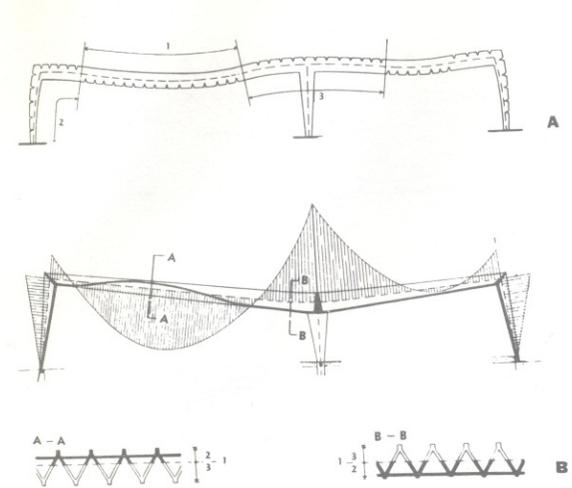
EDUARDO TORROJA (1899-1961)



EUGÈNE FREYSSINET (1879-1962)



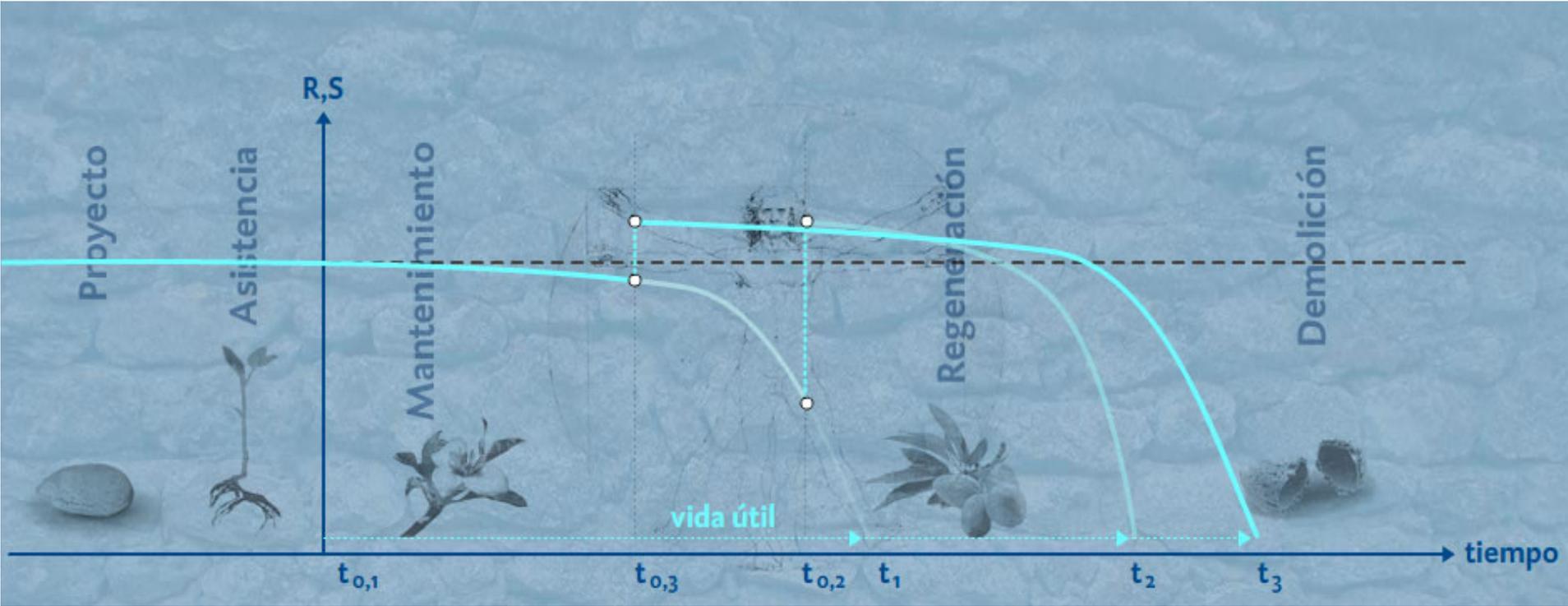
PIER LUIGI NERVI (1891-1979)



OLAV OLSEN (1913-1998)

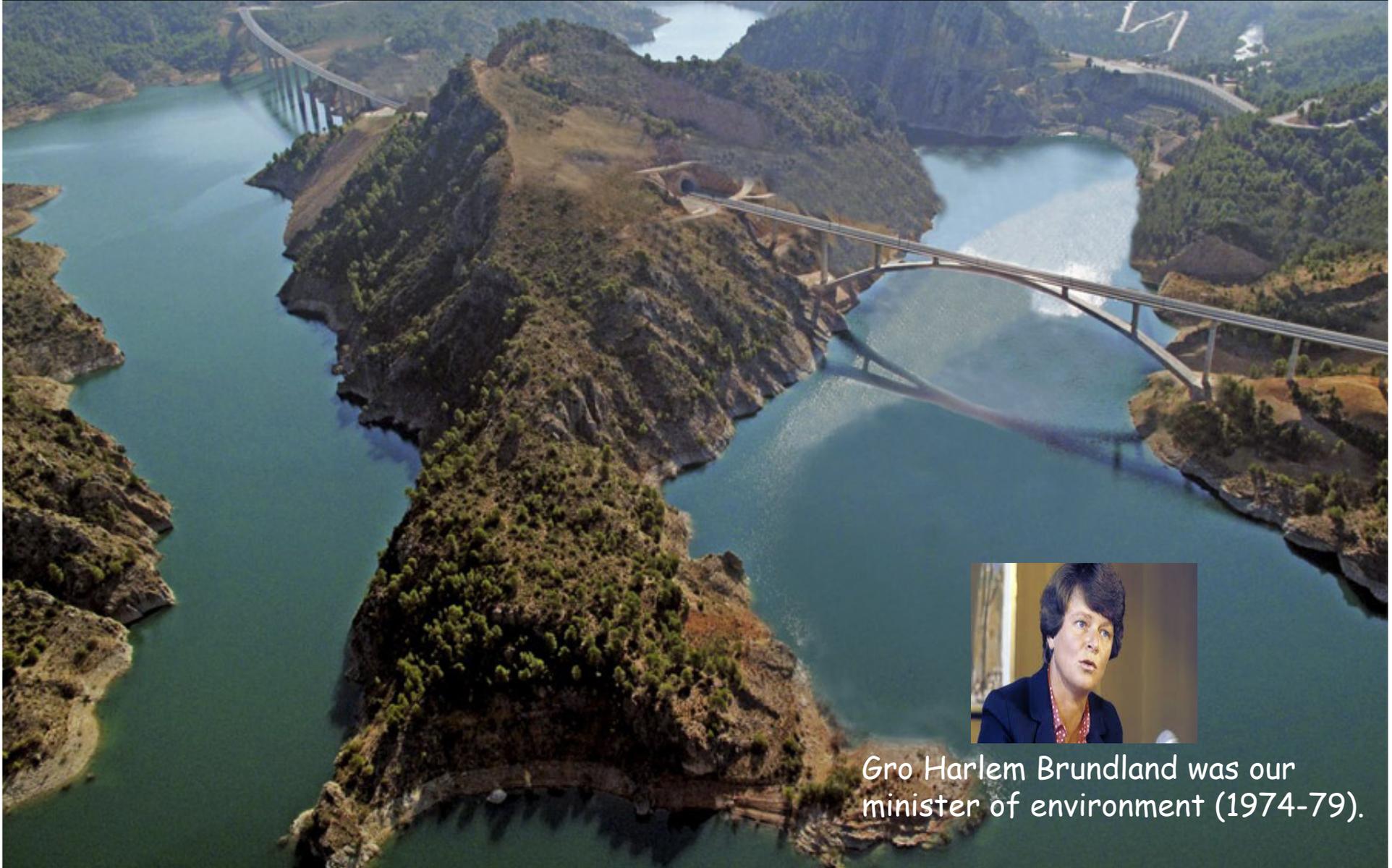


SERVICE LIFE

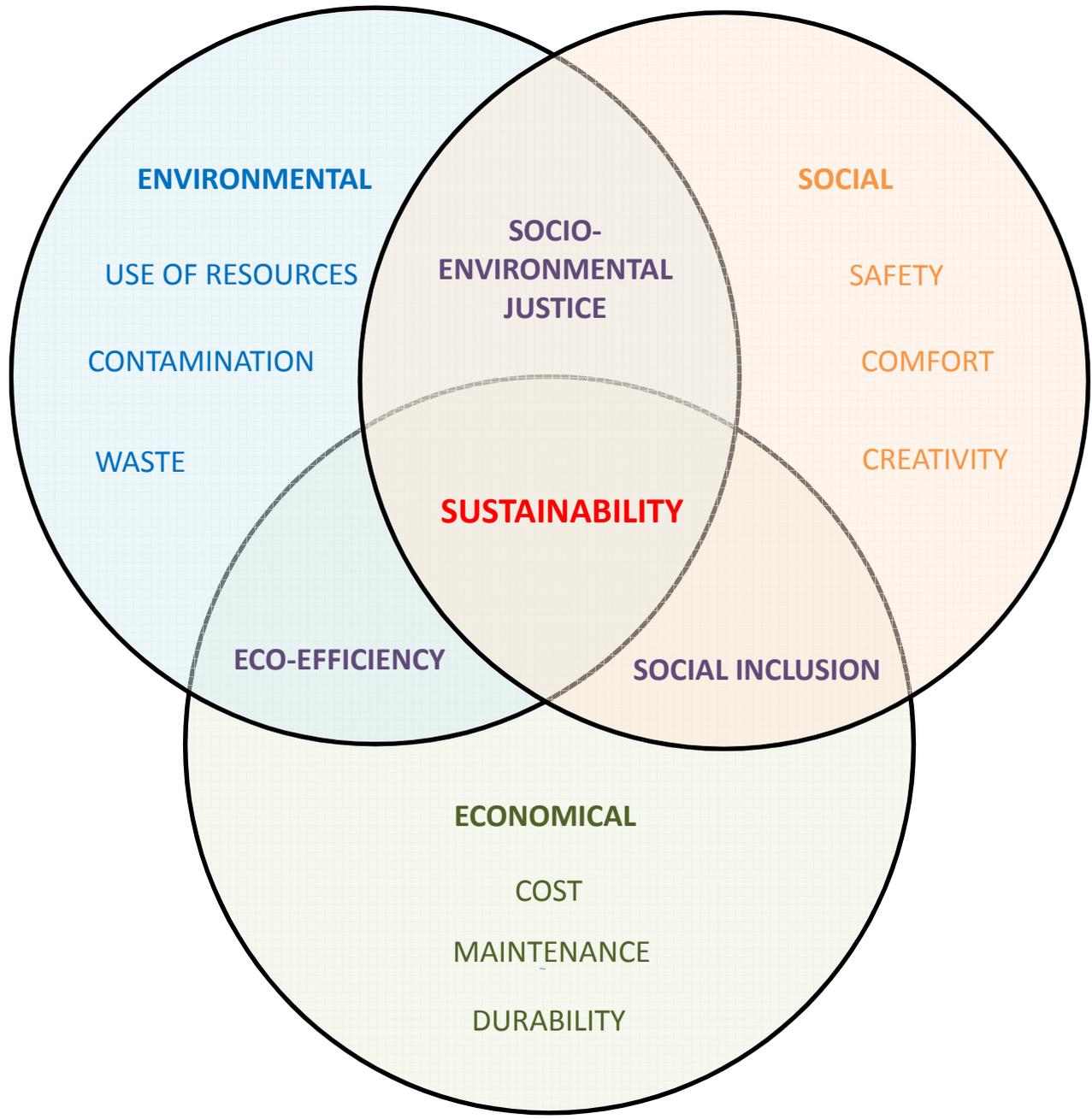


Desenvolvimento Sustentável atende as necessidades presentes sem comprometer as necessidades das gerações futuras.

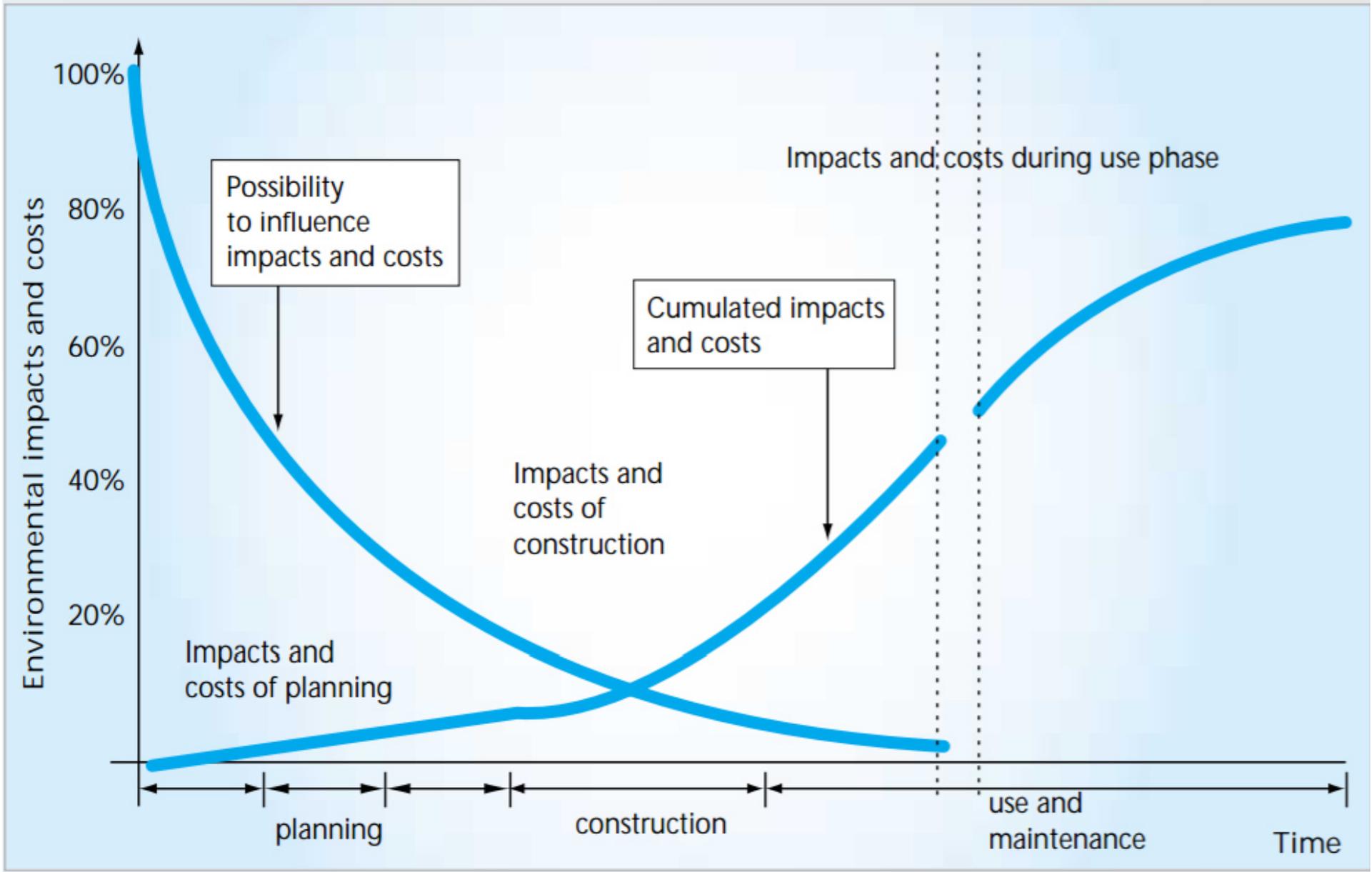
Our Common Future or Brundtland Report, 1987



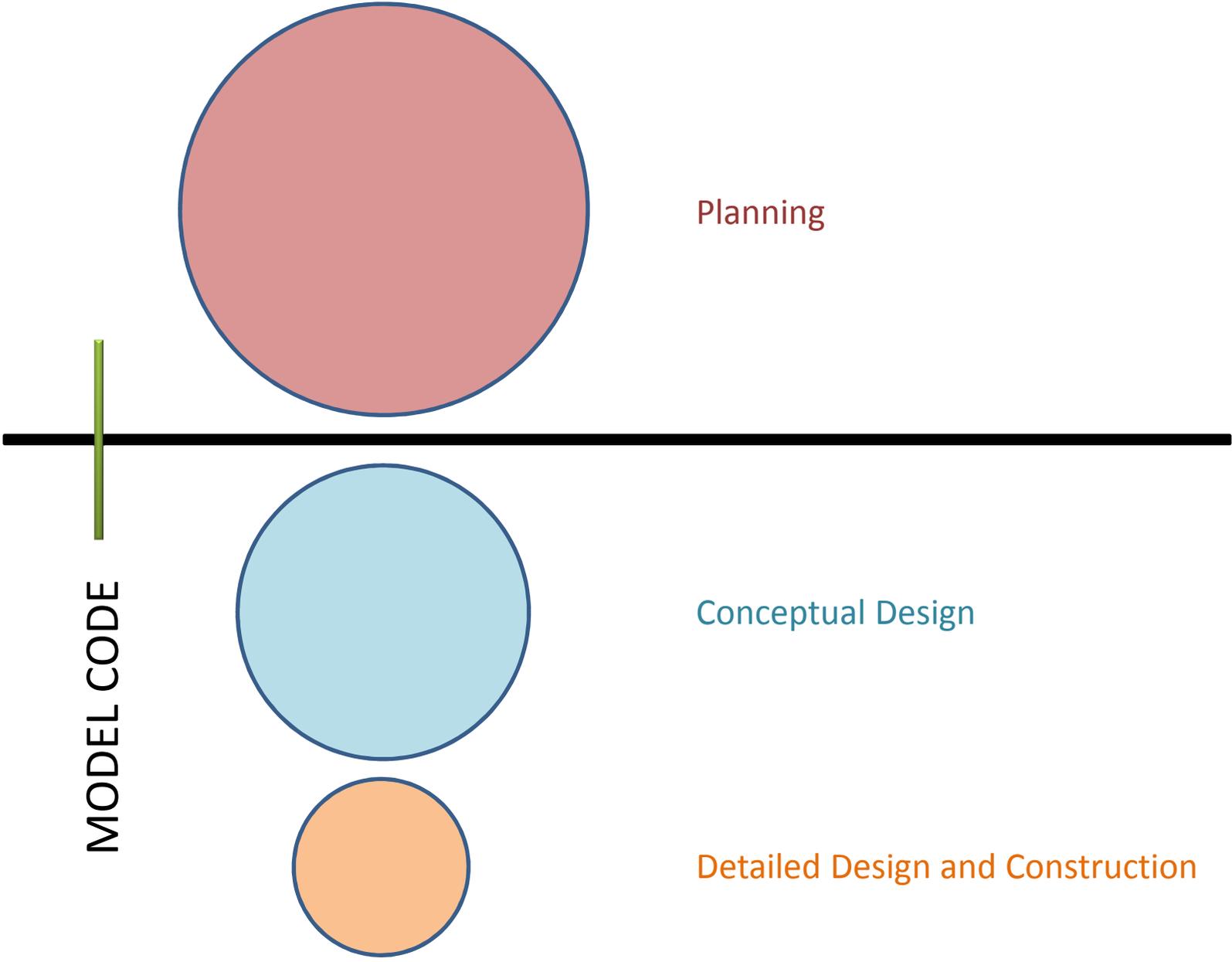
Gro Harlem Brundtland was our minister of environment (1974-79).



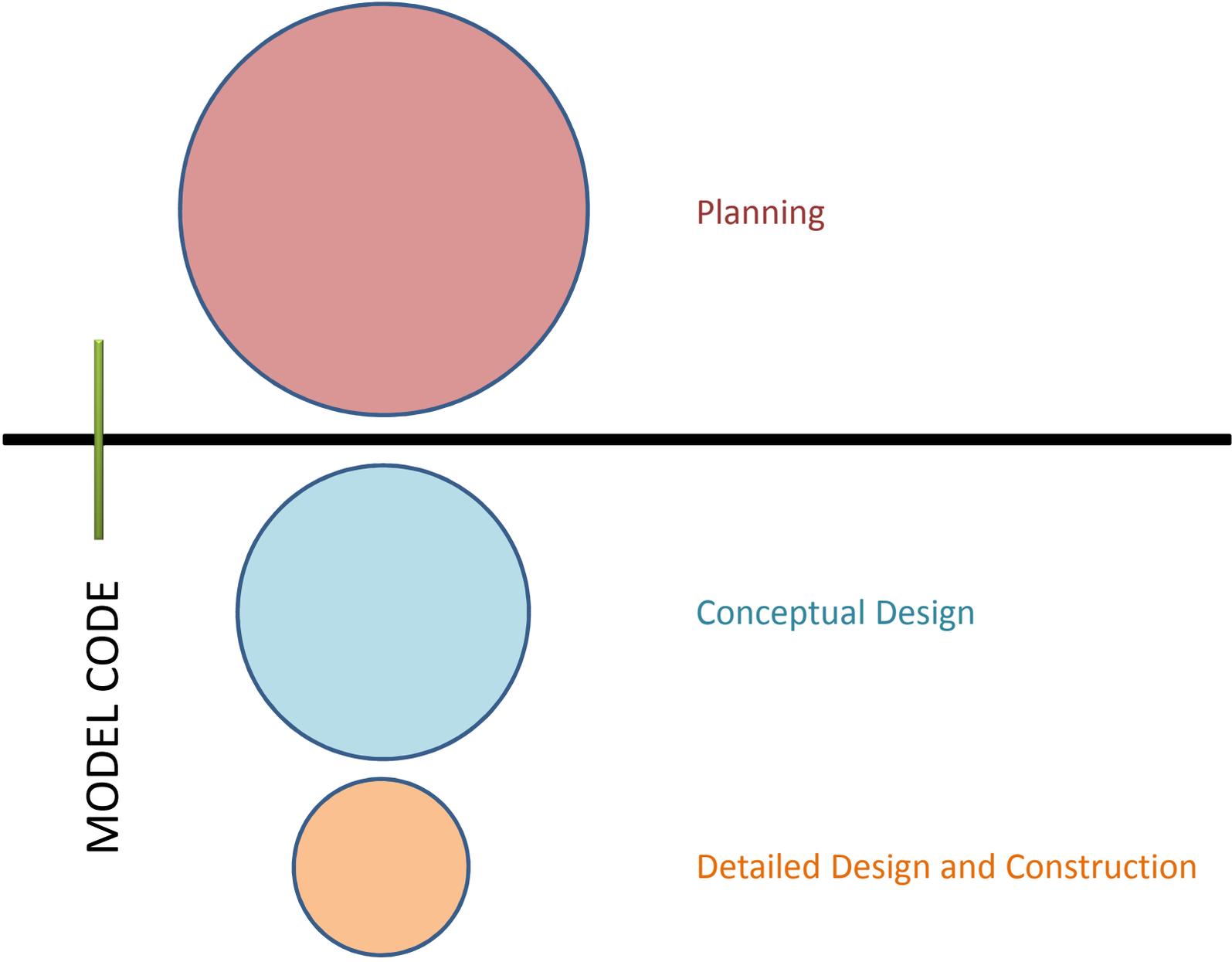
Influence of design decisions on life-cycle impacts and costs of an average European or North American building



Source: Kohler, N. et al "Life-cycle analysis of the built environment". Sustainable building construction







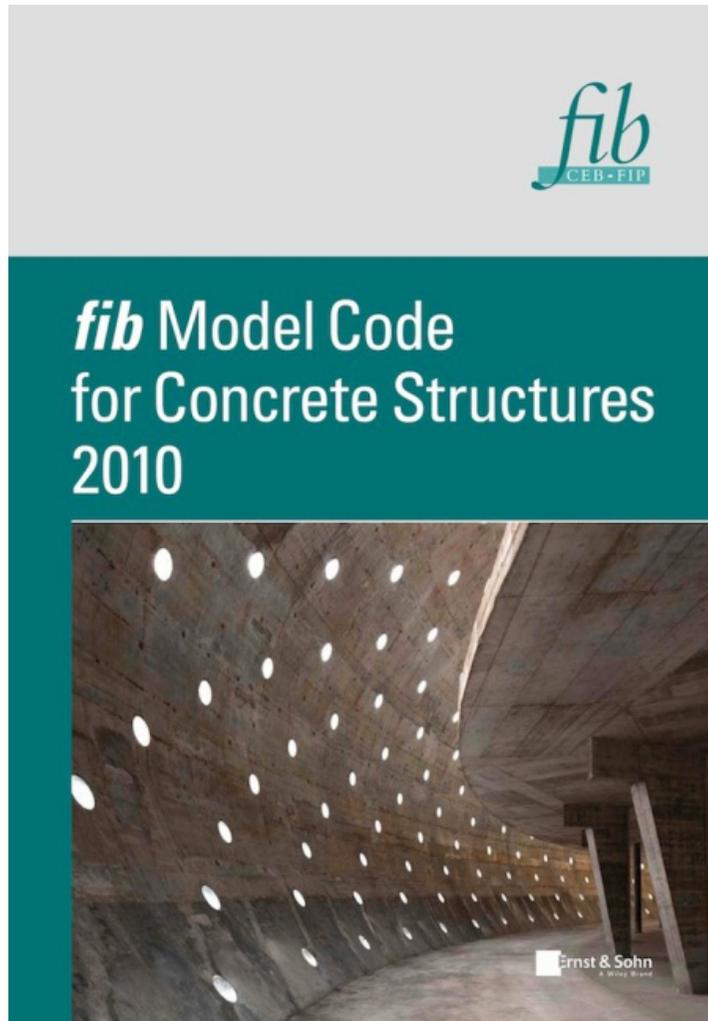
MODEL CODE

Planning

Conceptual Design

Detailed Design and Construction

CONCEPTUAL DESIGN



Preface

Notations

PART I: PRINCIPLES

PART II: DESIGN INPUT DATA

PART III: DESIGN

7. Design

7.1 Conceptual design

7.2 Structural analysis and dimensioning

7.3 Verification of structural safety (ULS) for predominantly static loading

7.4 Verification of structural safety (ULS) for non-static loading

7.5 Verification of structural safety (ULS) for extreme thermal conditions

7.6 Verification of serviceability (SLS) of RC and PC structures

7.7 Verification of safety and serviceability of FRC structures

7.8 Verifications of limit states associated with durability

7.9 Verification of robustness

7.10 Verification of sustainability

7.11 Verifications assisted by numerical simulations

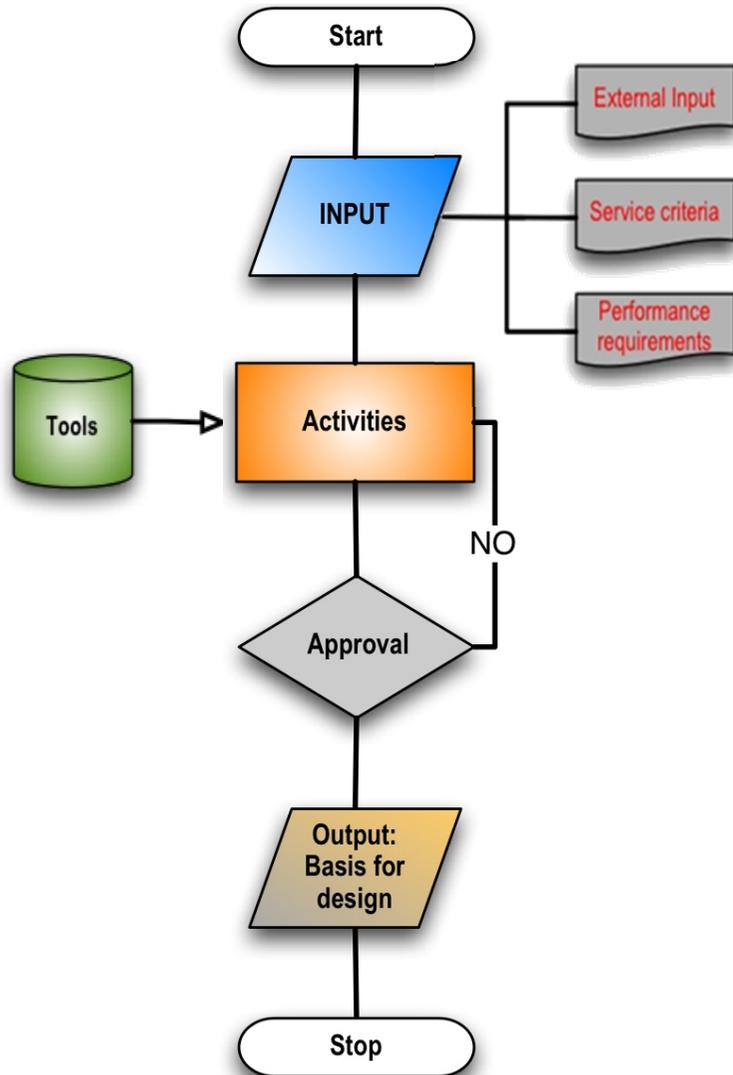
7.12 Verifications assisted by testing

7.13 Detailing

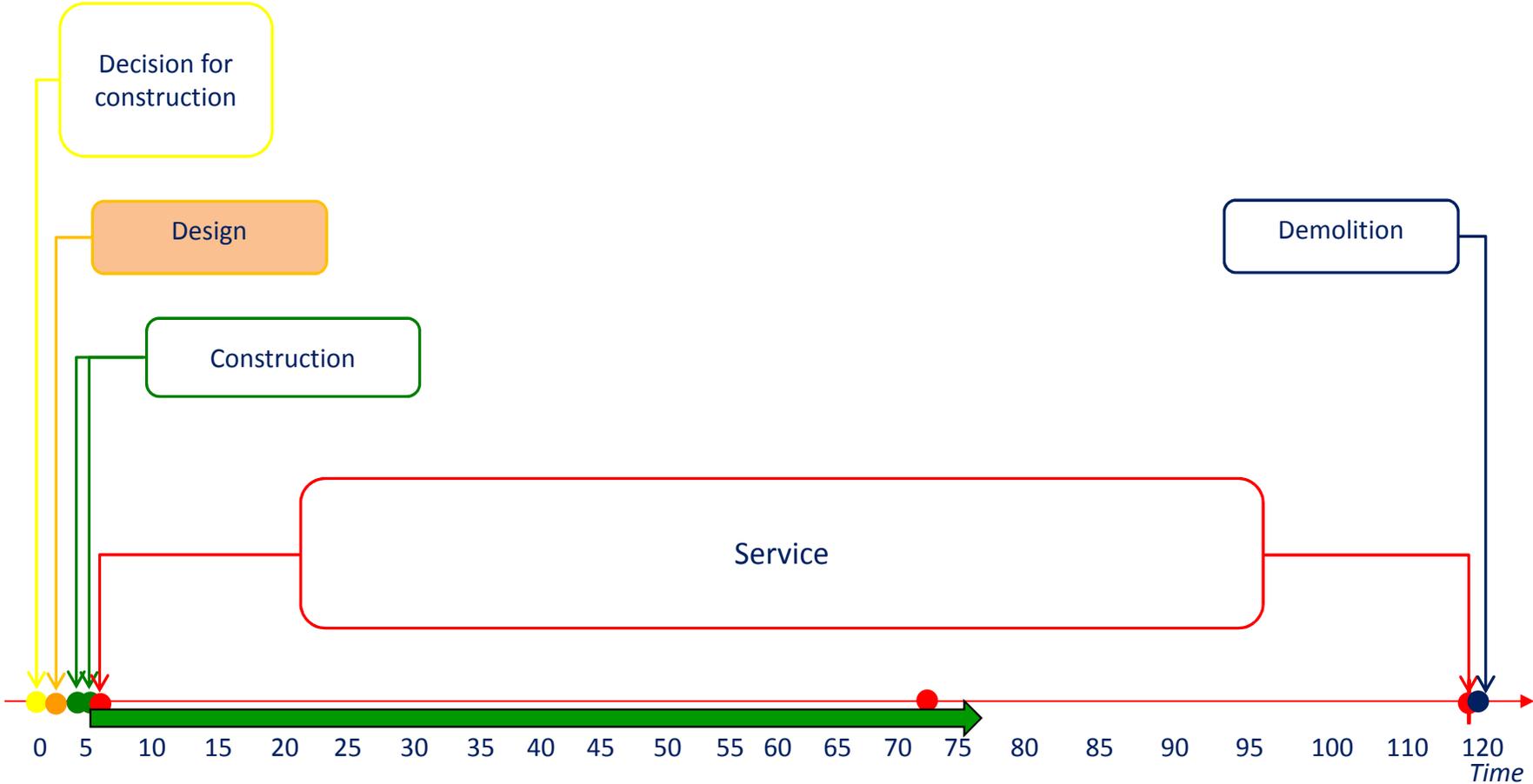
PART VI: CONSTRUCTION

~~PART V: CONSERVARION AN DISMANTLEMENT~~

CONCEPTUAL DESIGN: GENERAL PROCESS

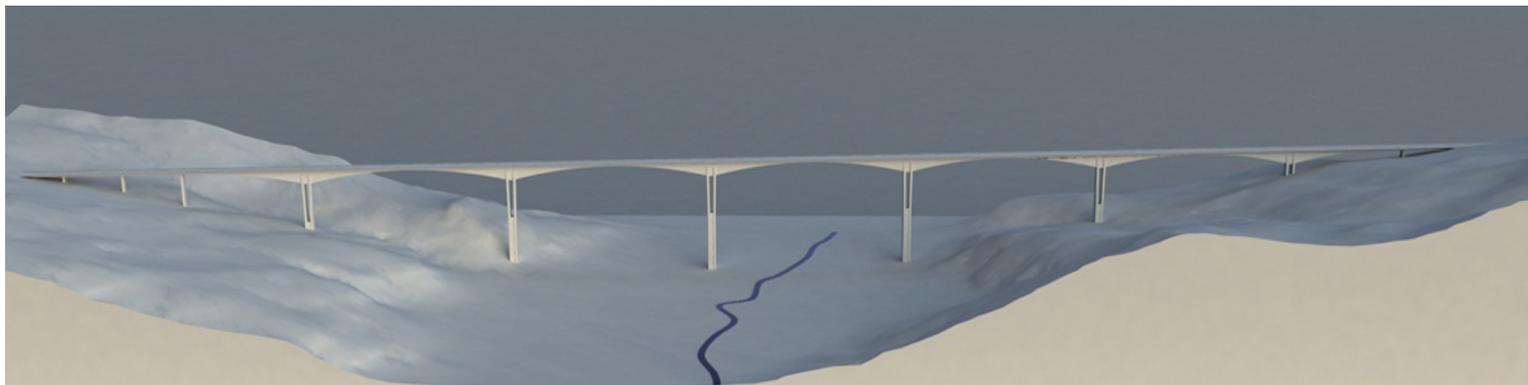


Conceptual Design in New Structures



Cases of study

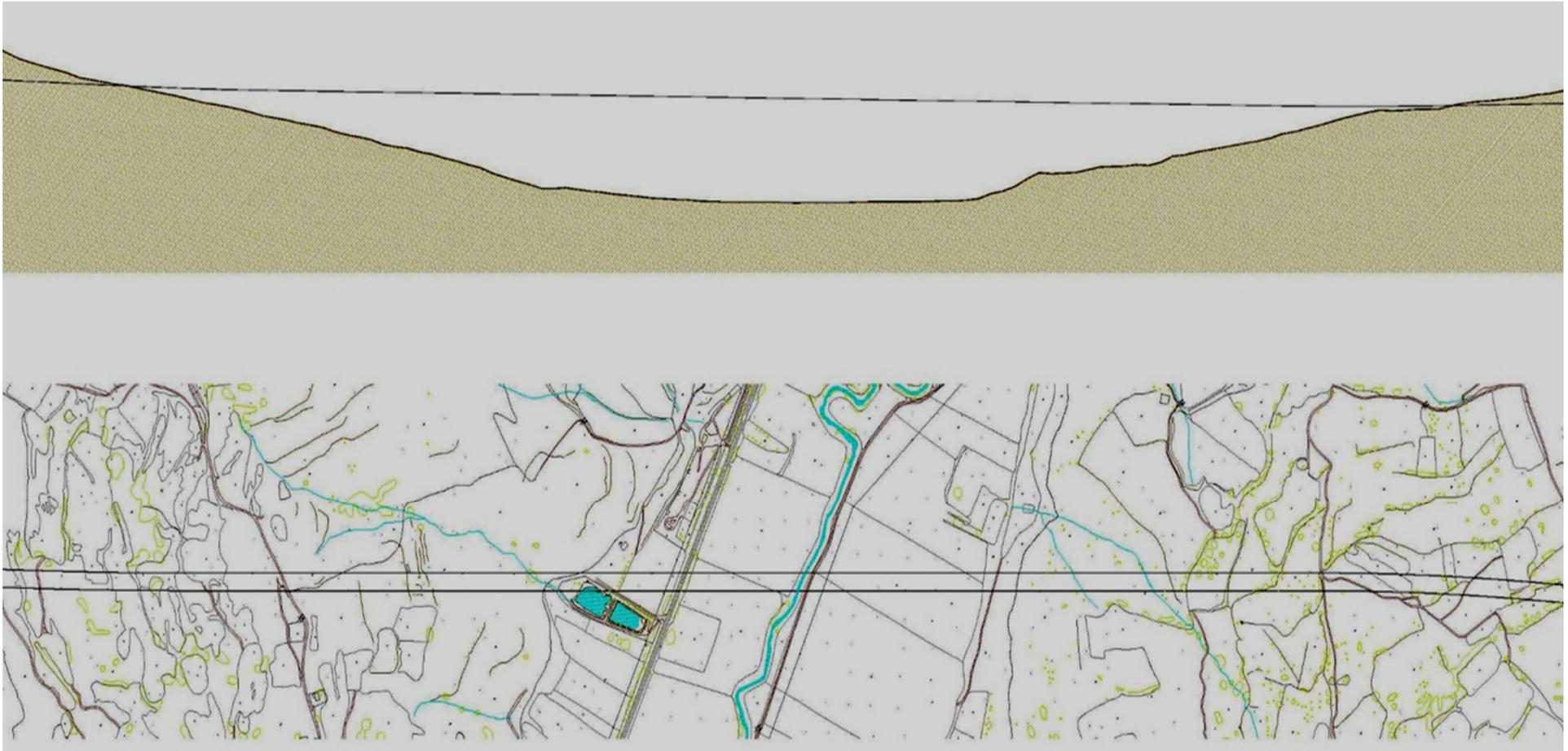
Viaduct over the River Tajuña



4

Cases of study

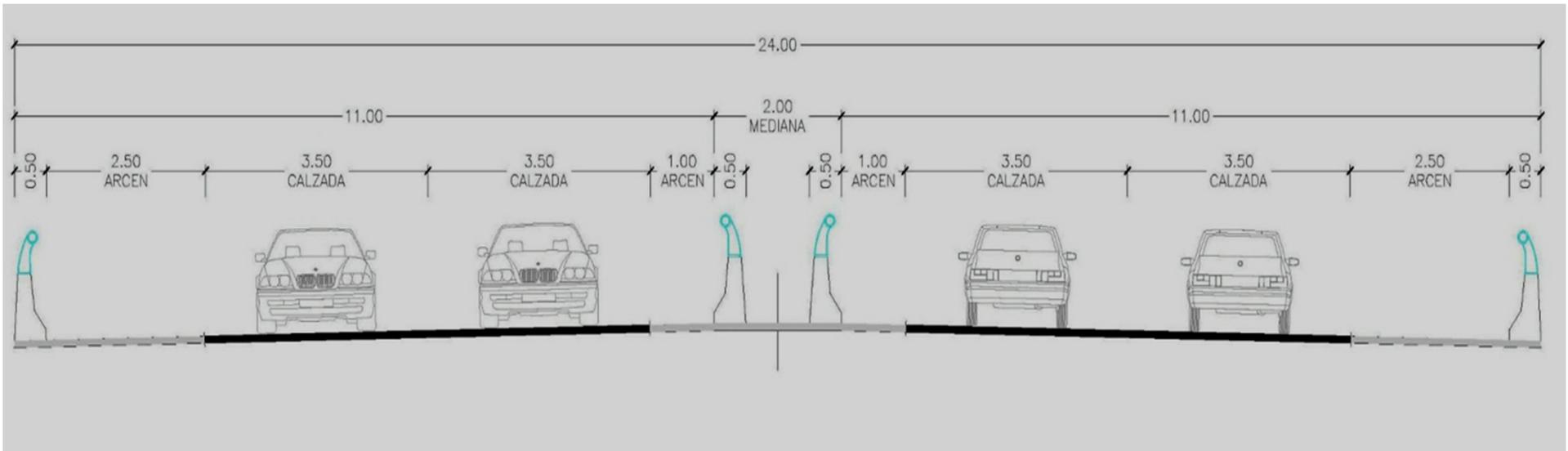
Viaduct over the River Tajuña



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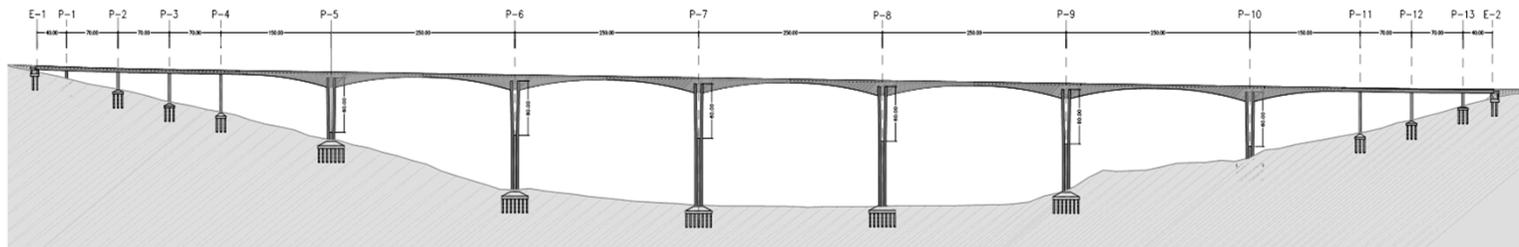
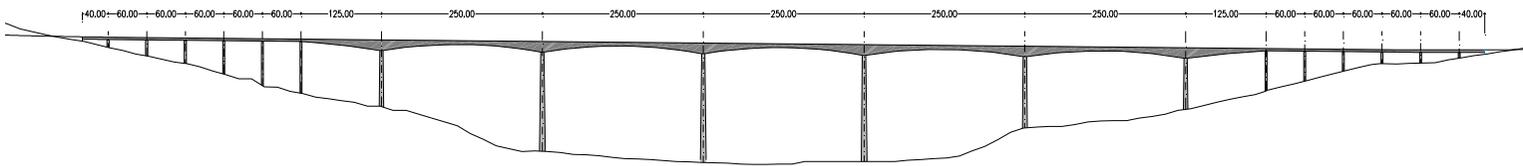
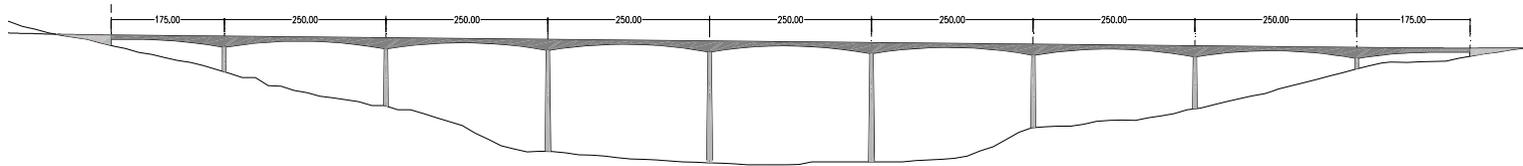
Cases of study

Viaduct over the River Tajuña



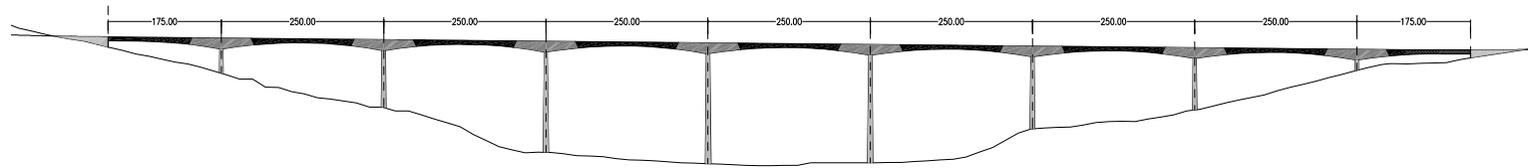
Cases of study

Viaduct over the River Tajuña



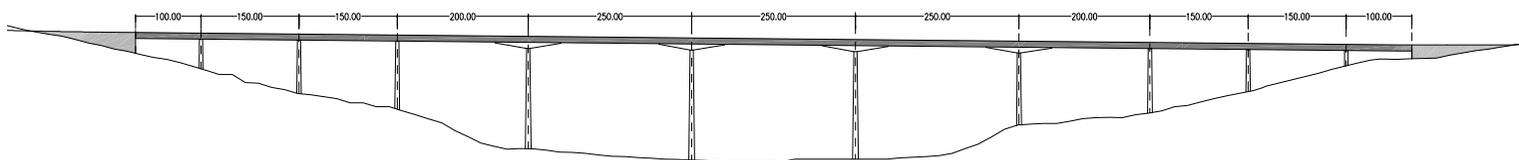
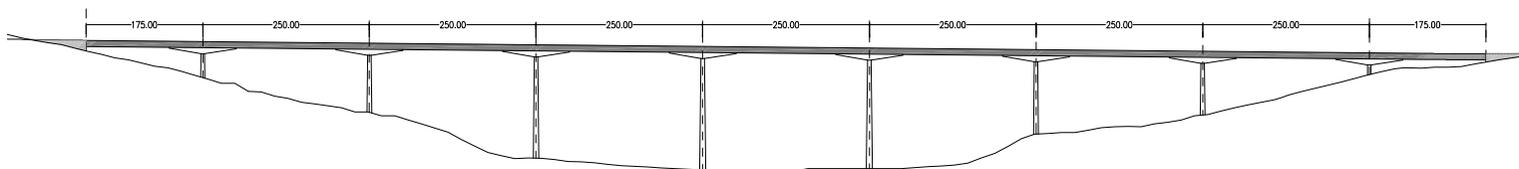
Cases of study

Viaduct over the River Tajuña



Cases of study

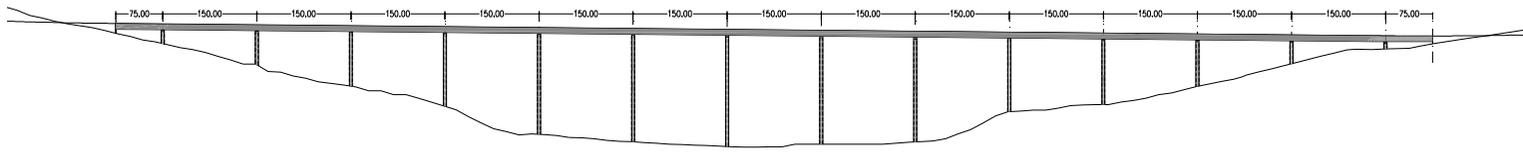
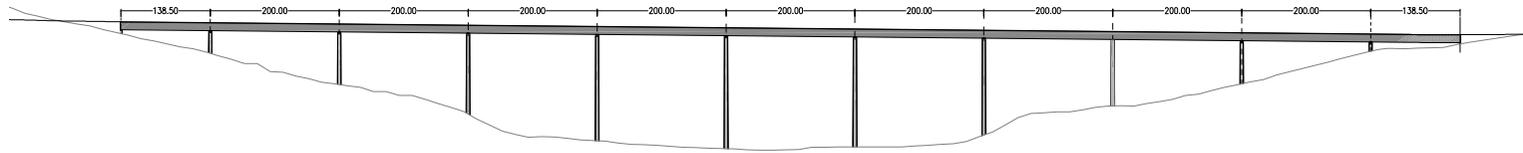
Viaduct over the River Tajuña



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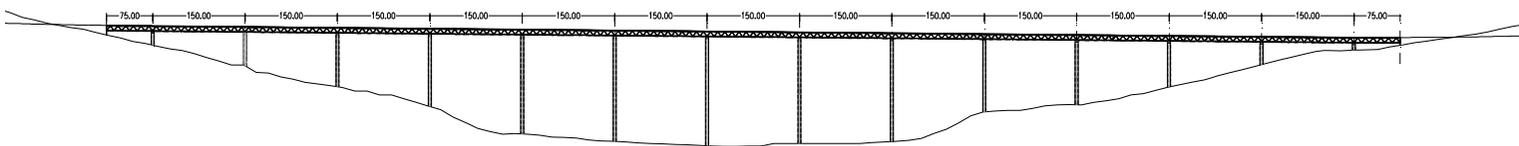
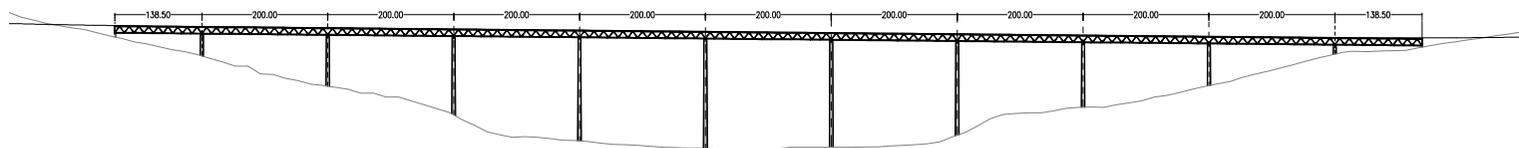
Cases of study

Viaduct over the River Tajuña



Cases of study

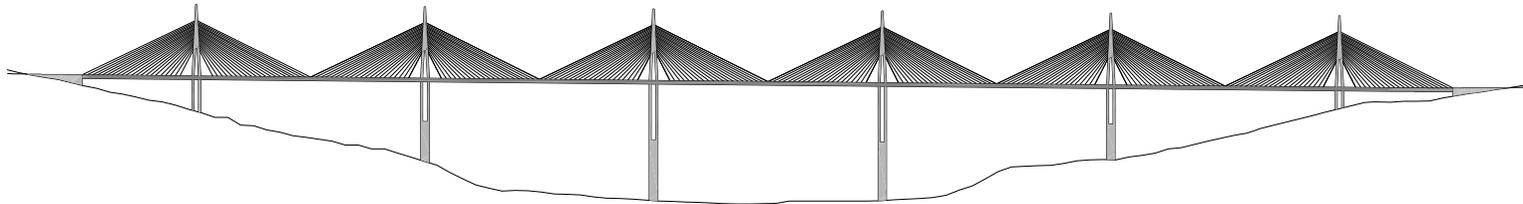
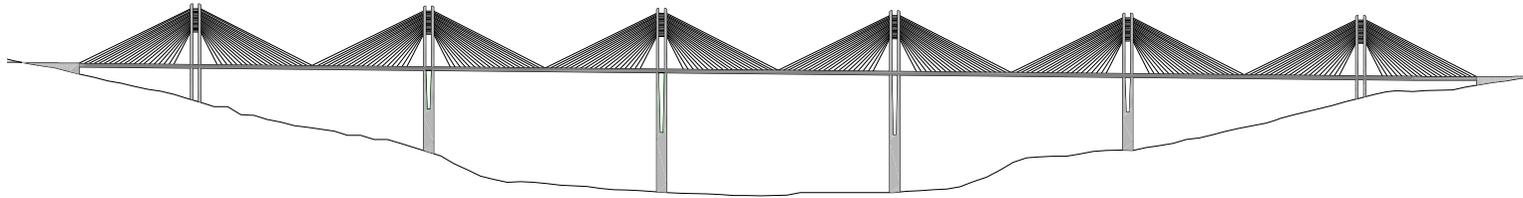
Viaduct over the River Tajuña



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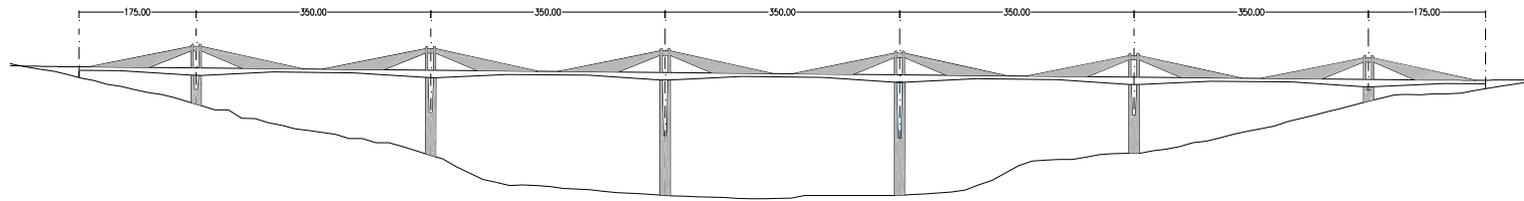
Cases of study

Viaduct over the River Tajuña



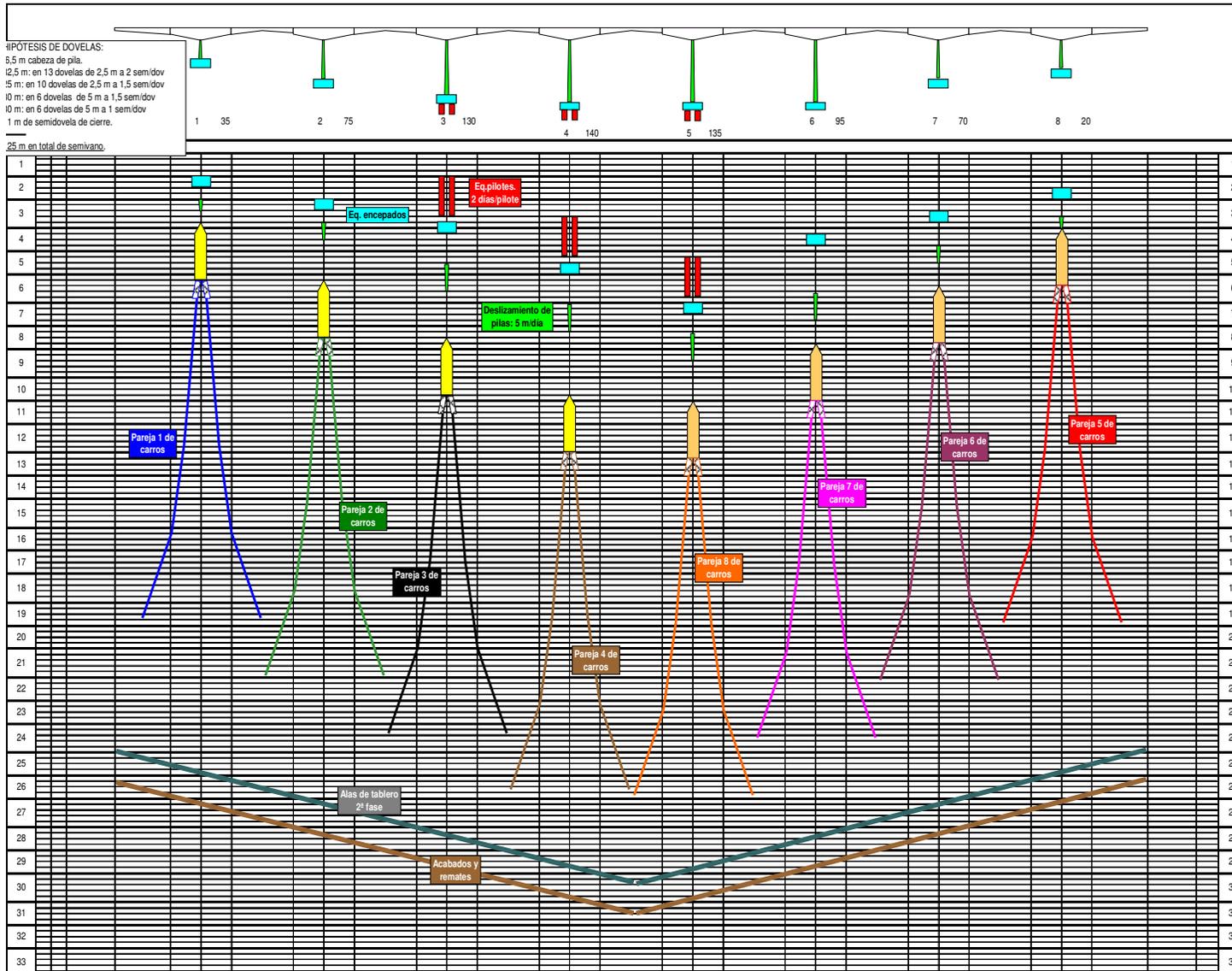
Cases of study

Viaduct over the River Tajuña



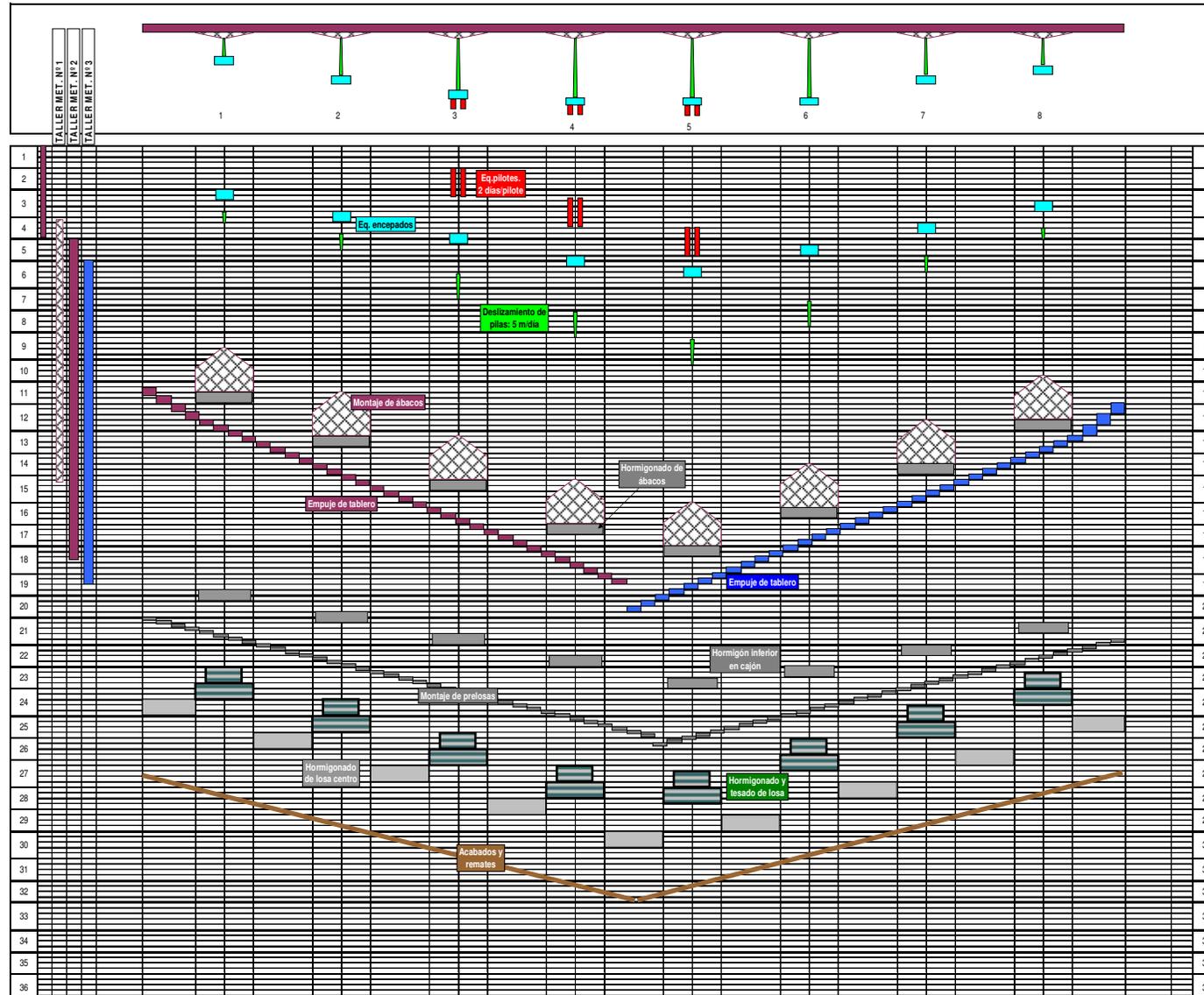
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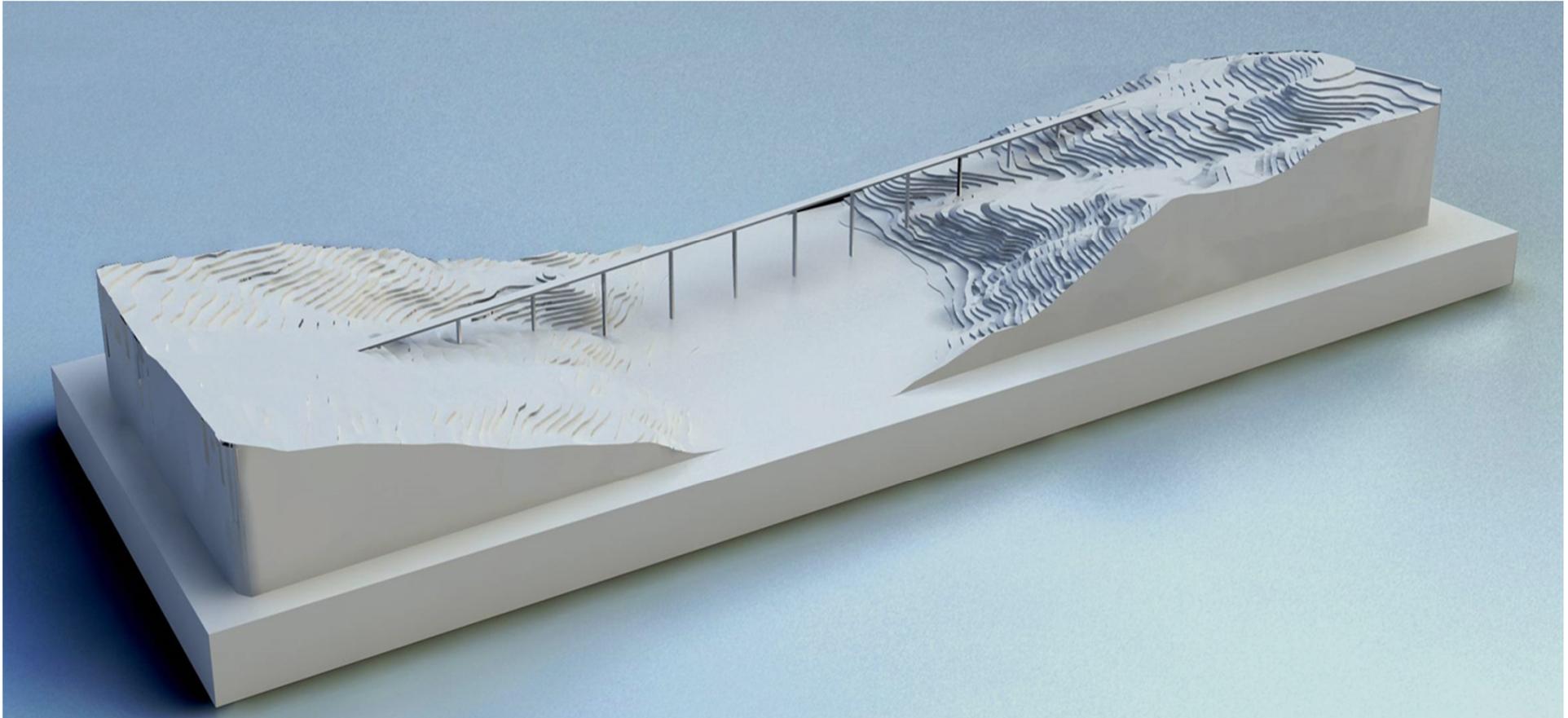
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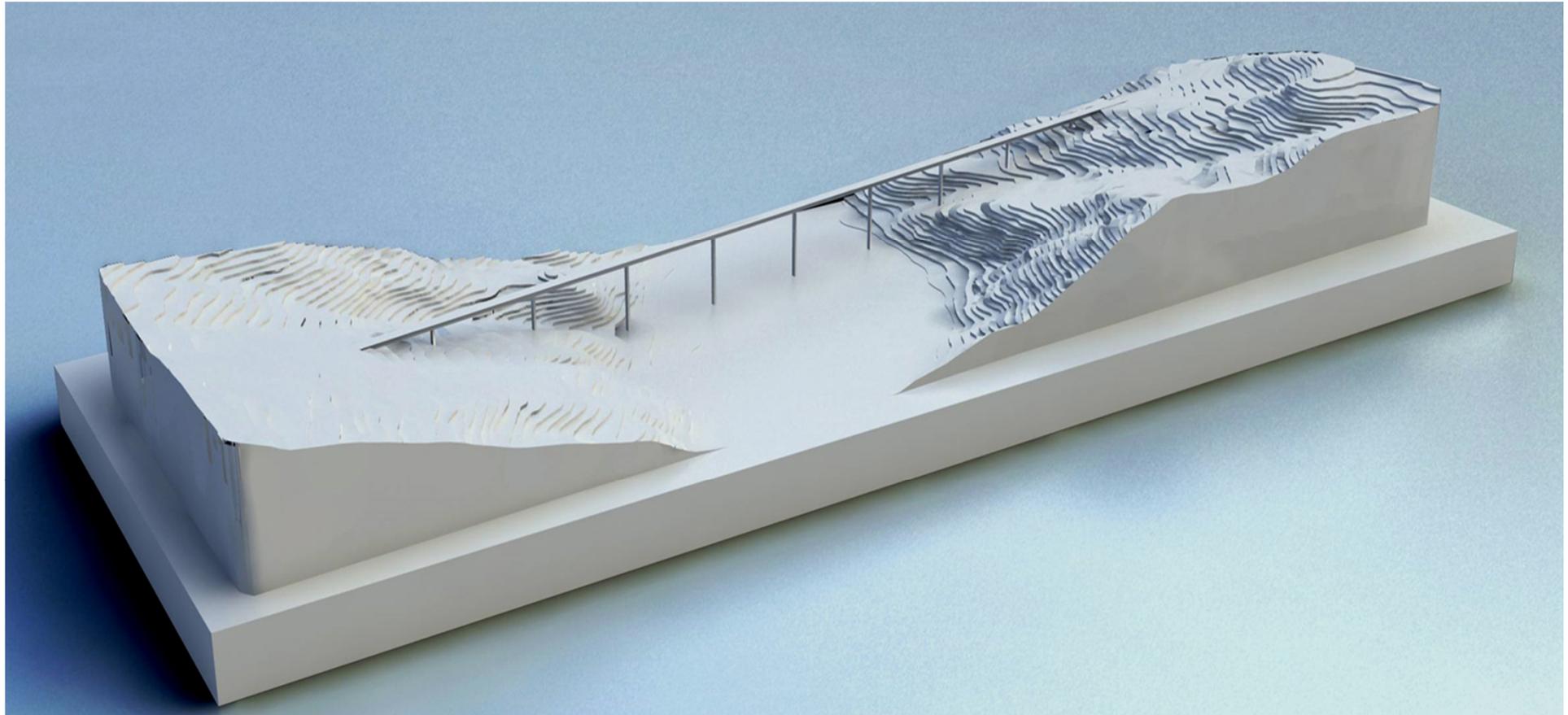
Cases of study

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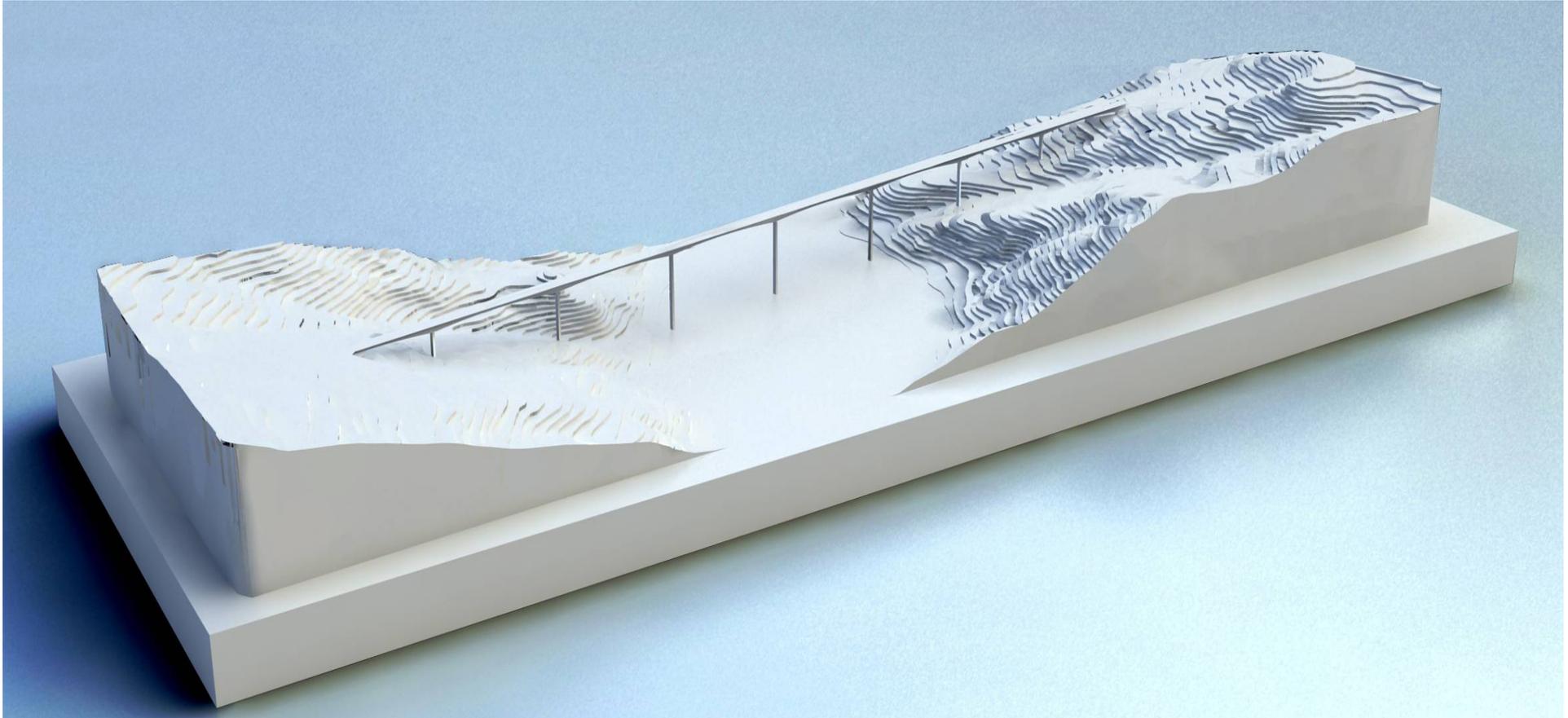
Cases of study

Viaduct over the River Tajuña



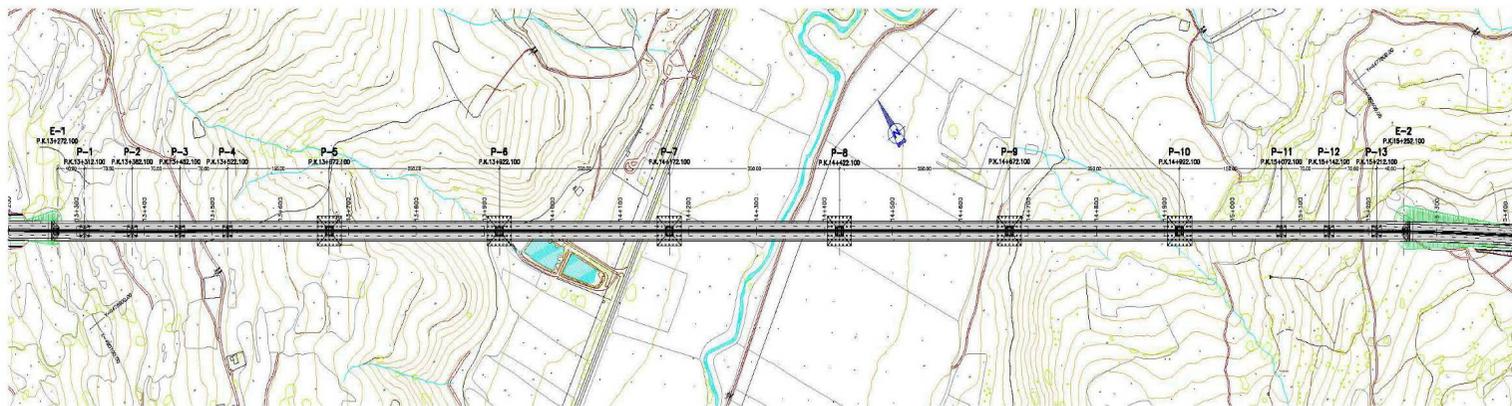
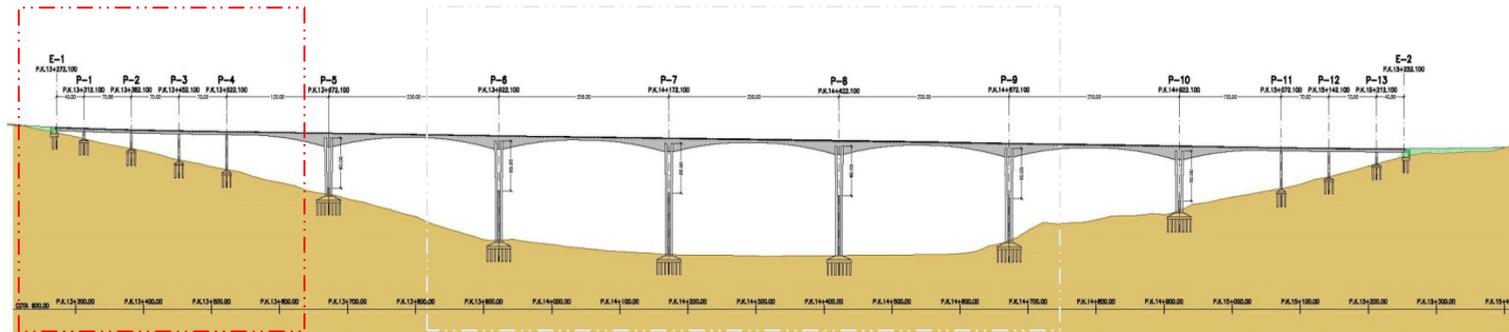
Cases of study

Viaduct over the River Tajuña



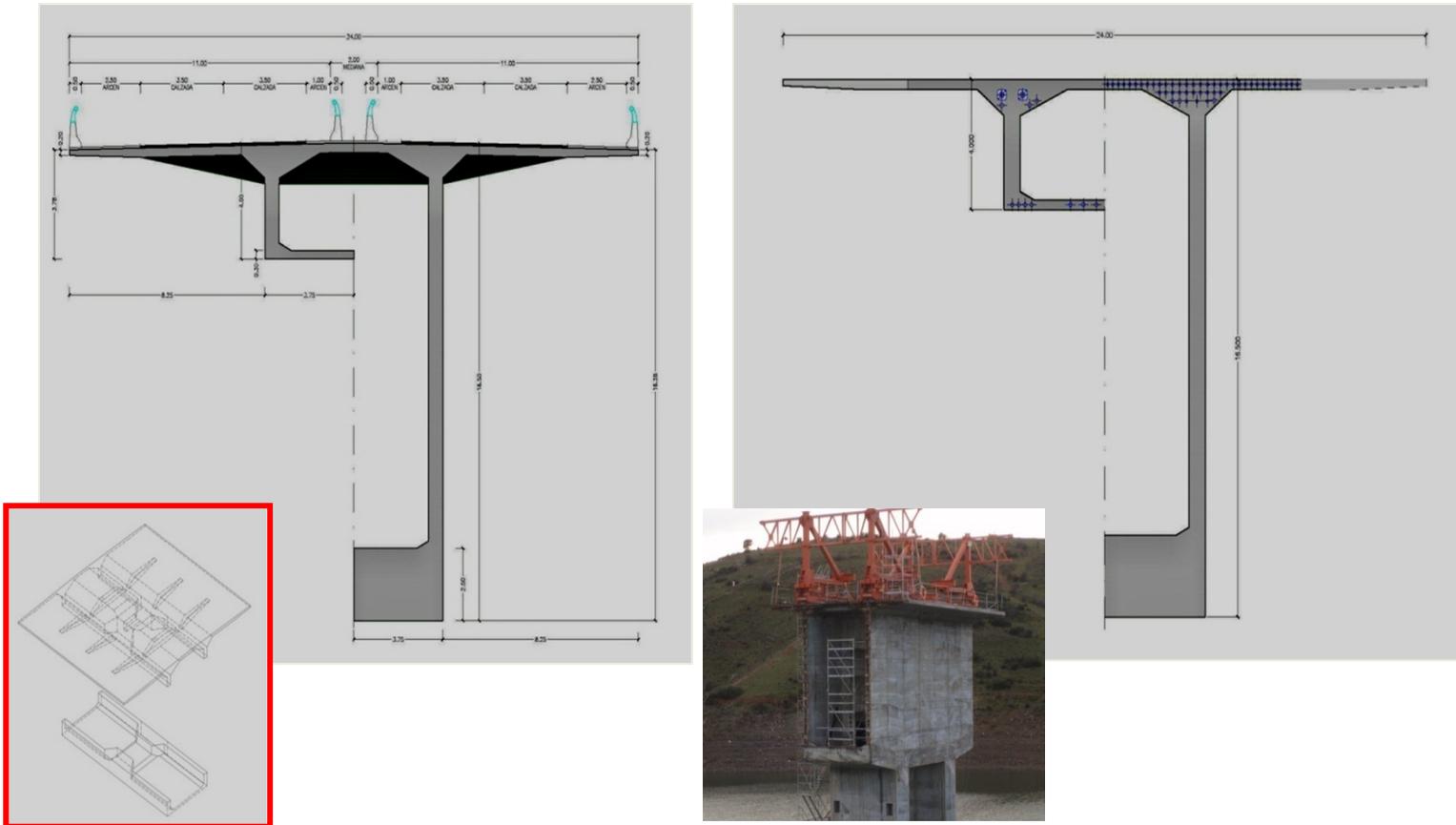
Cases of study

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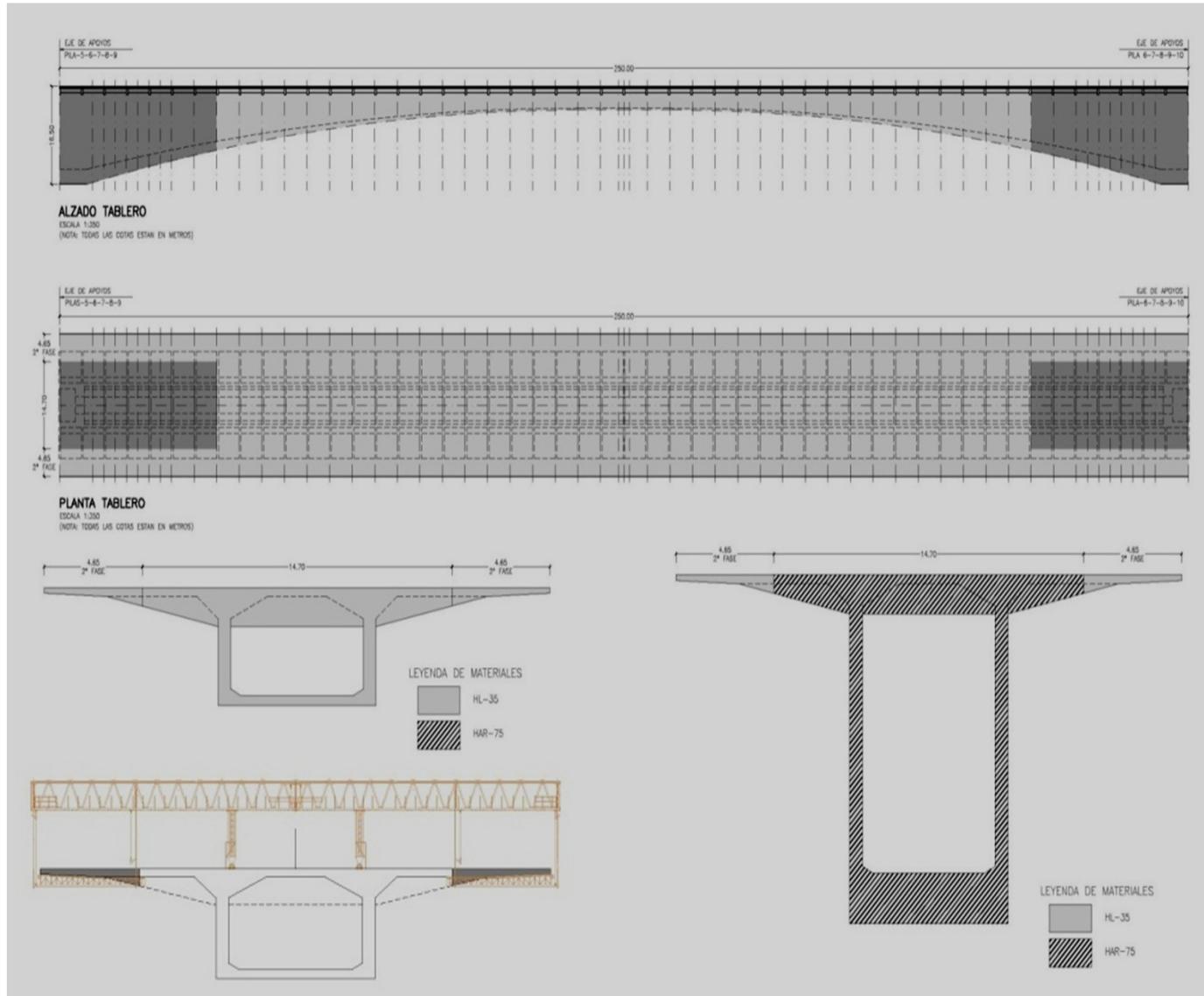
Cases of study

Viaduct over the River Tajuña



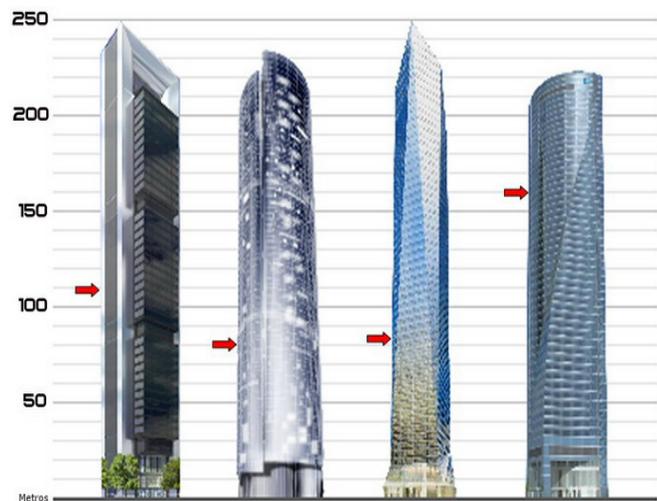
Cases of study

Viaduct over the River Tajuña



Cases of study

Viaduct over the River Tajuña



Cases of study

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Cases of study

Viaduct over the River Tajuña



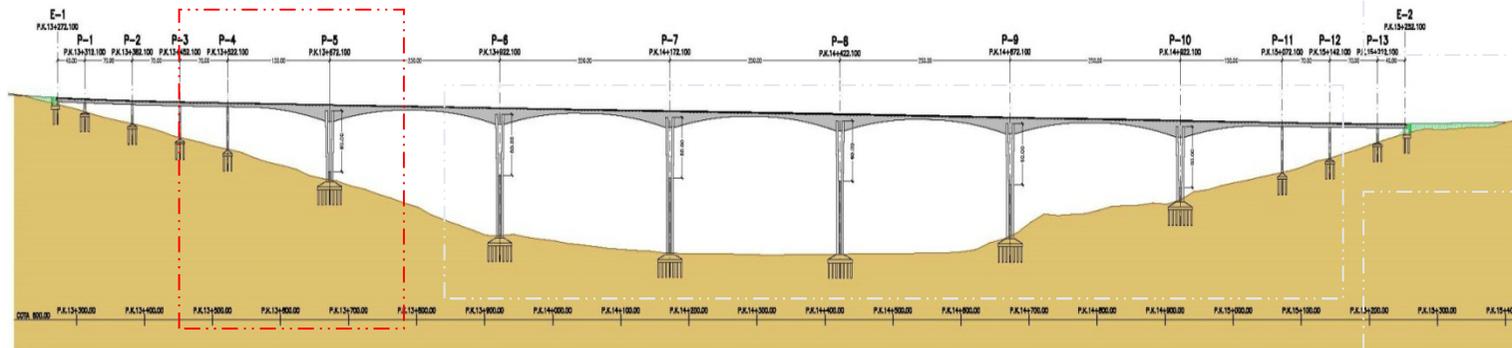
Cases of study

Viaduct over the River Tajuña



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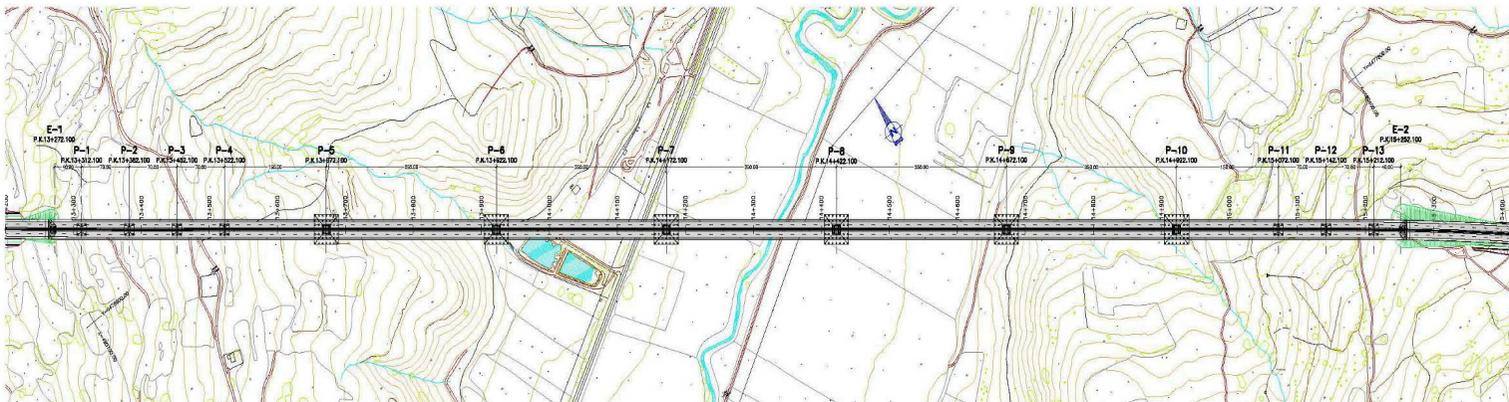
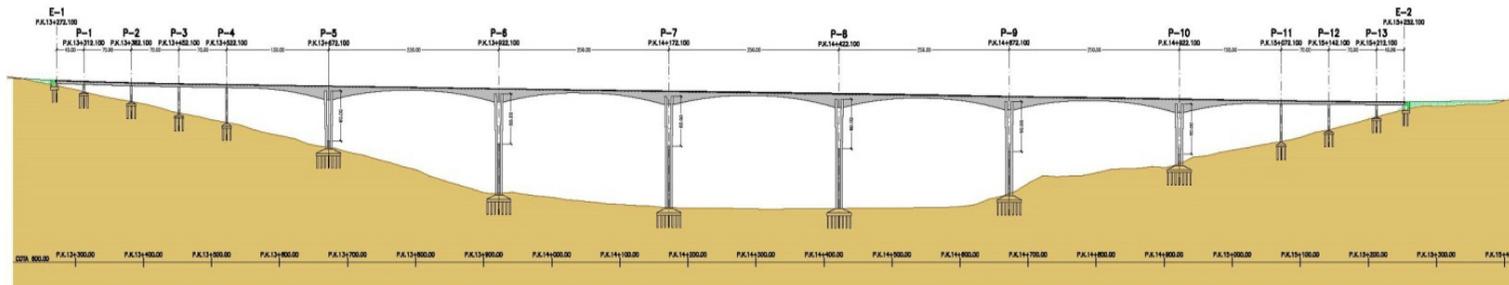
Cases of study

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Viaduct over the River Tajuña

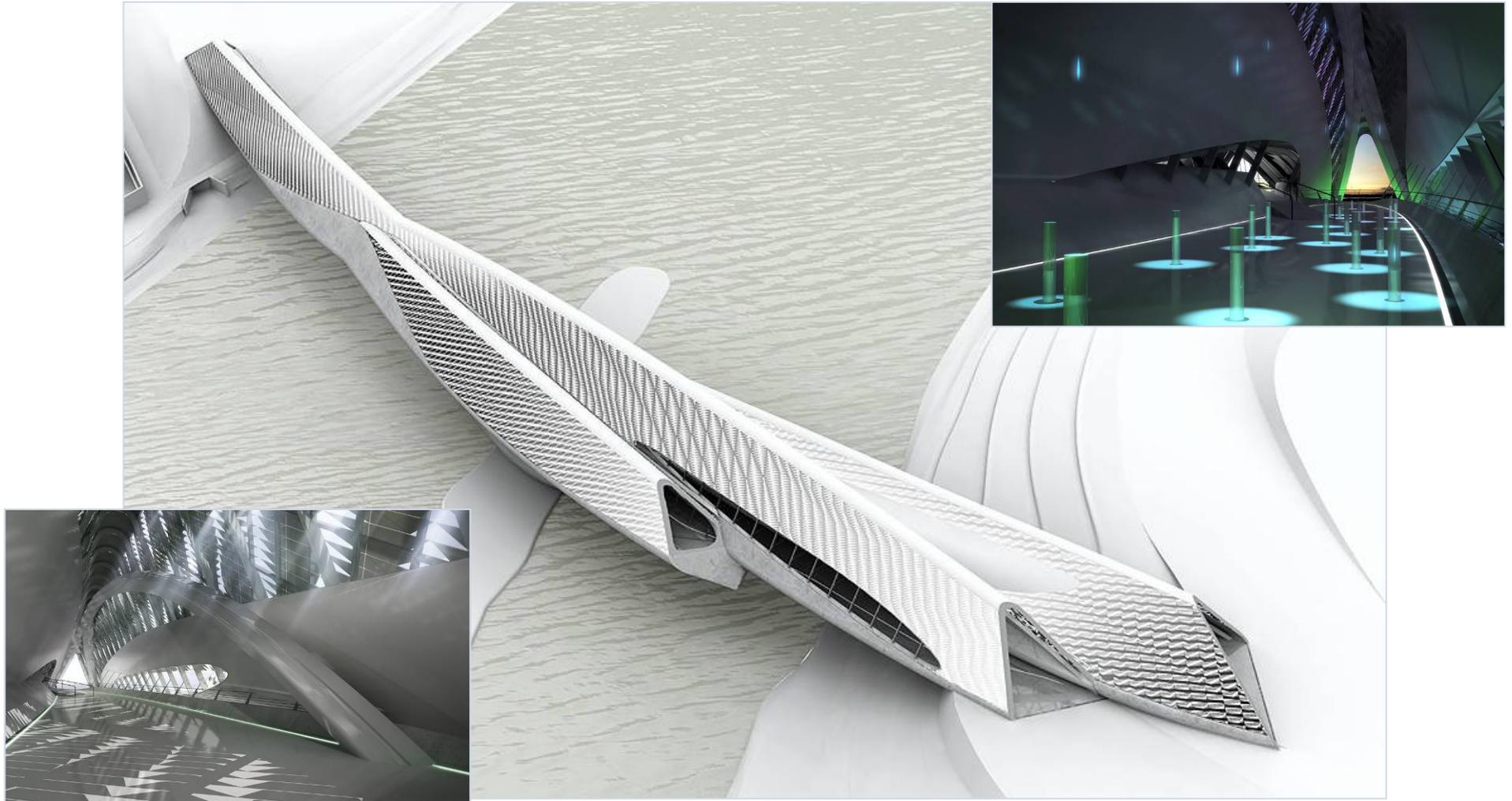


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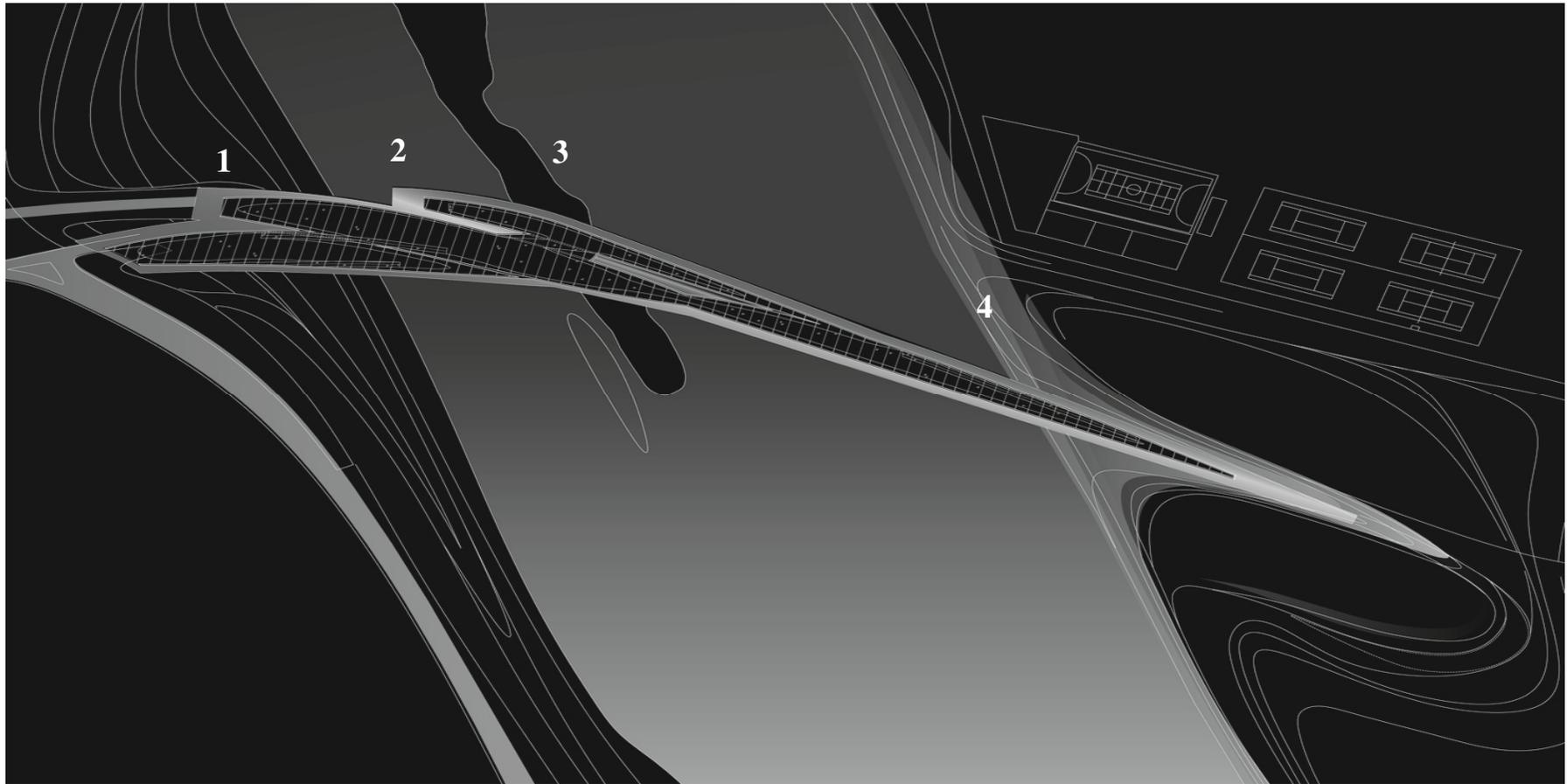
Viaduct over the River Tajuña



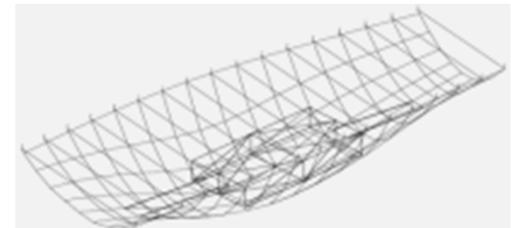
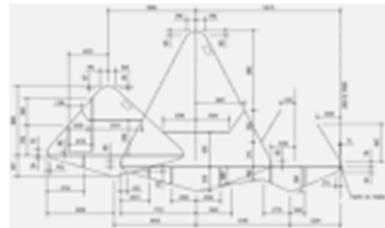
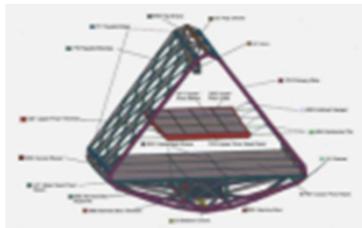
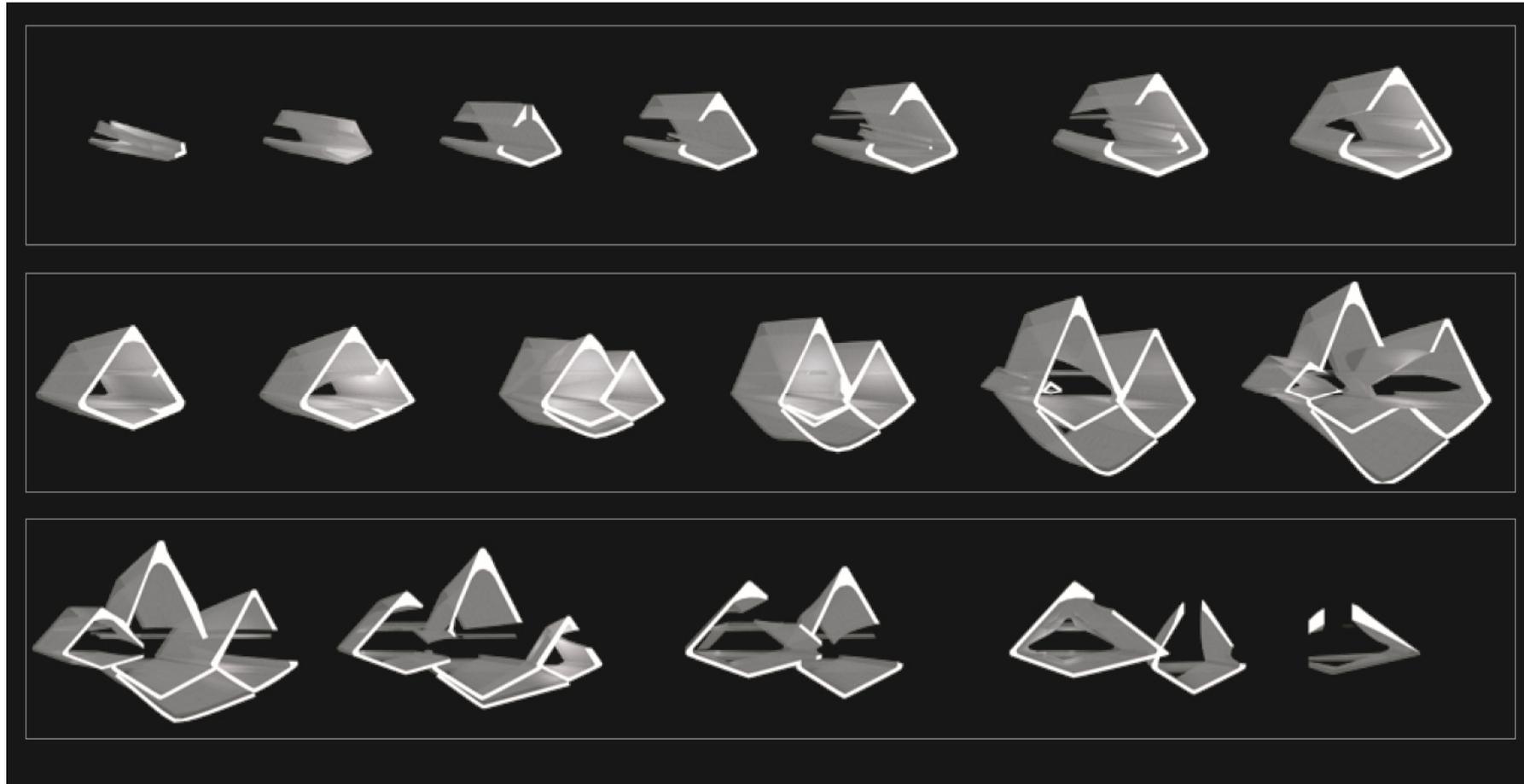
Zaragoza Expo 2008. Pavilion Bridge



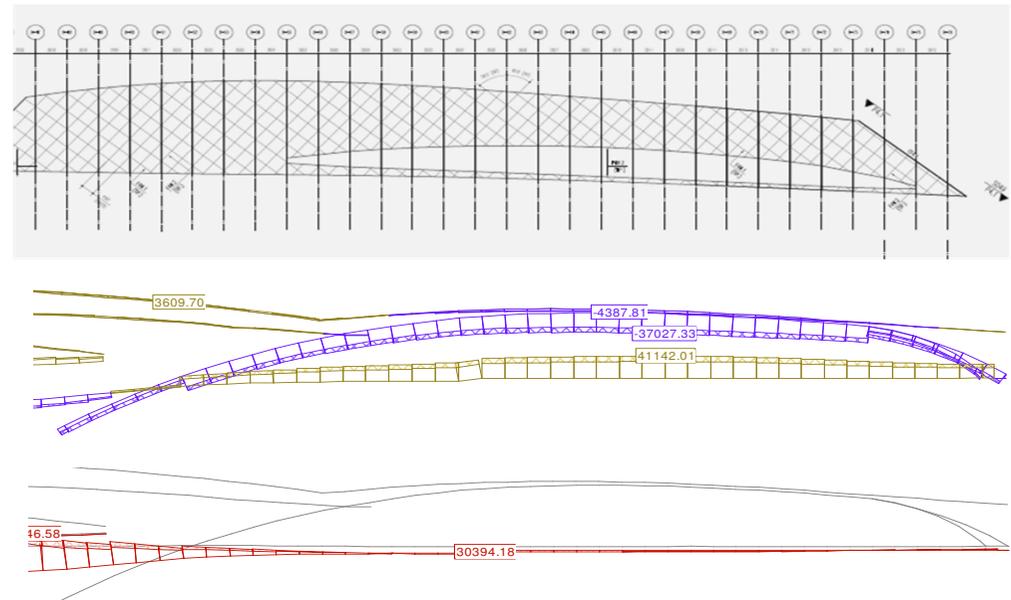
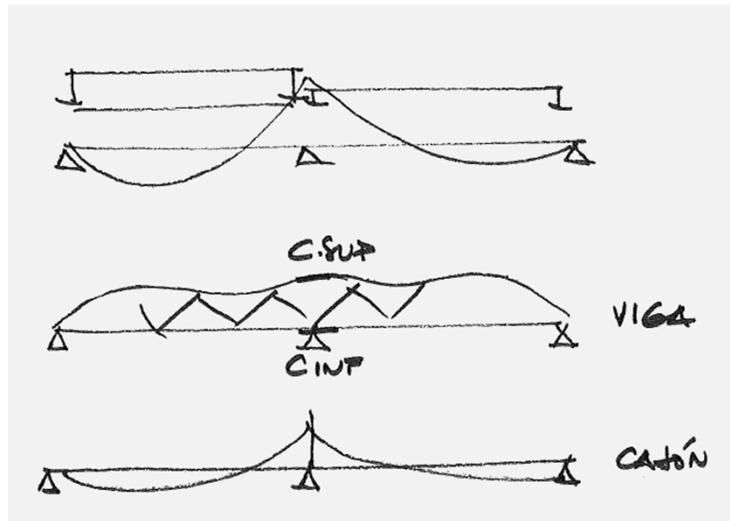
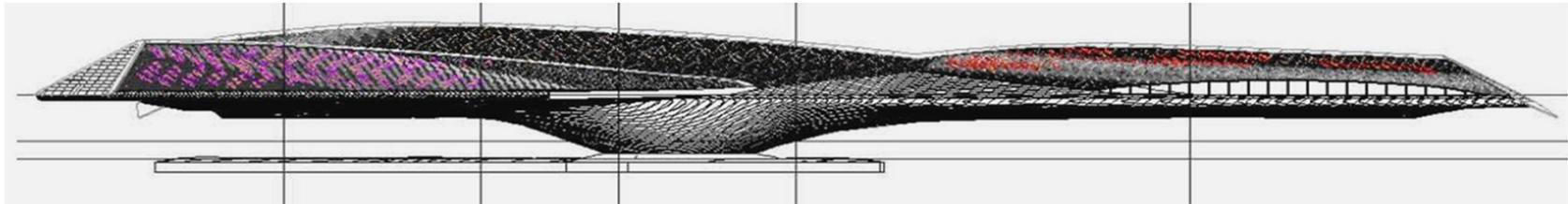
Zaragoza Expo 2008. Pavilion Bridge



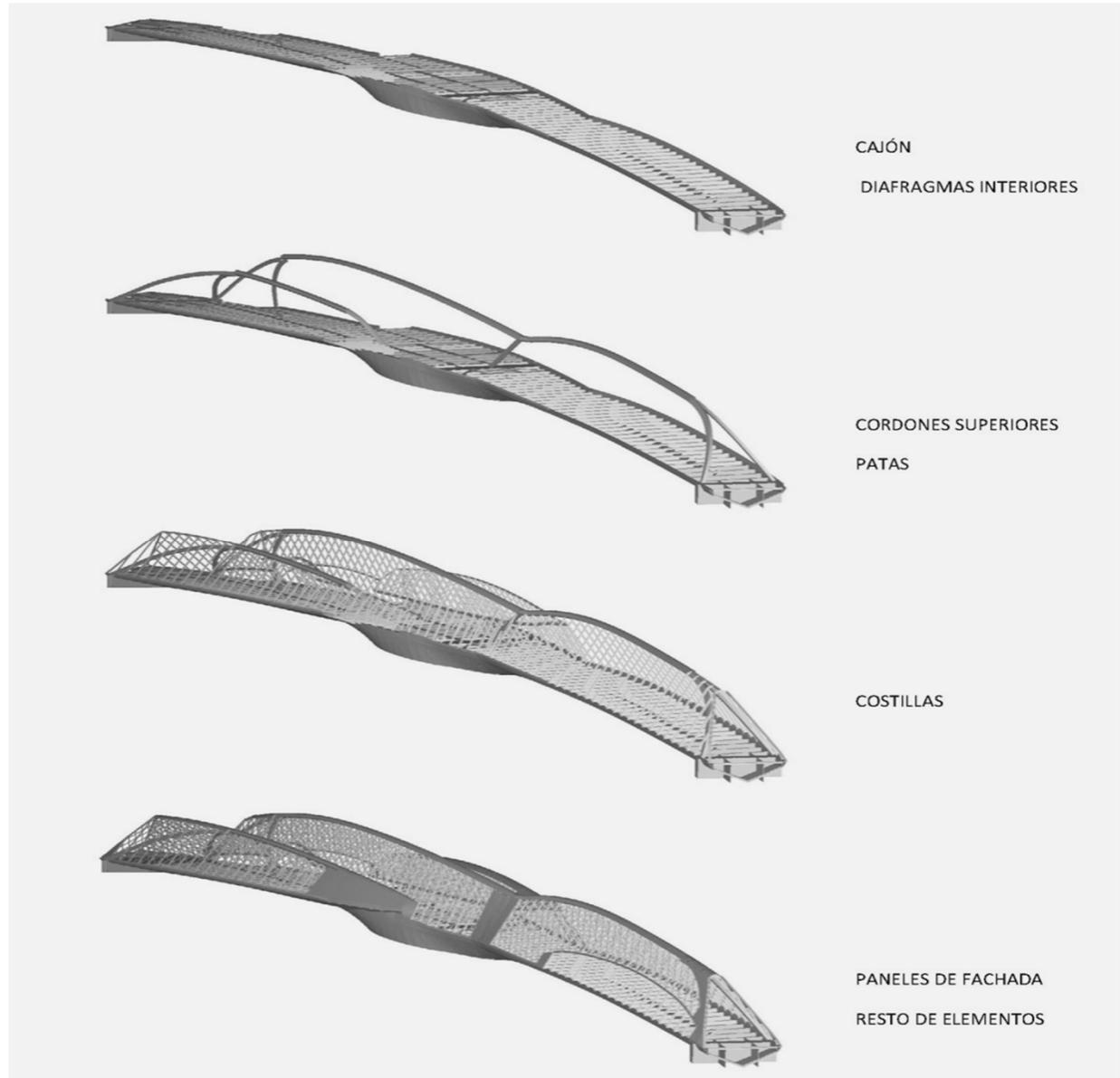
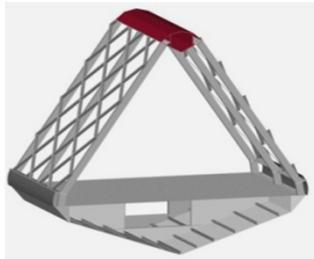
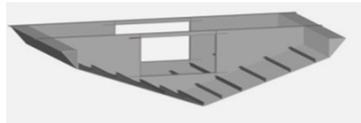
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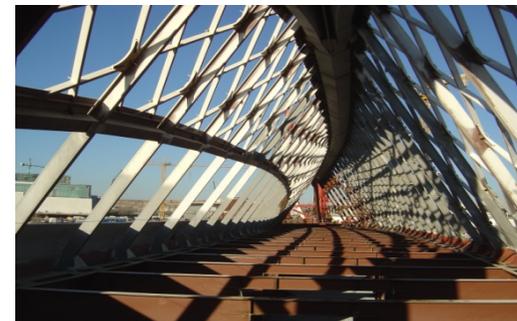
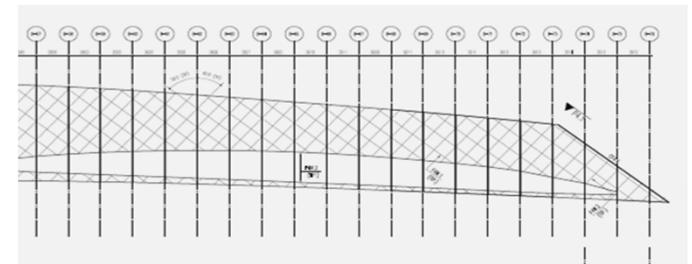
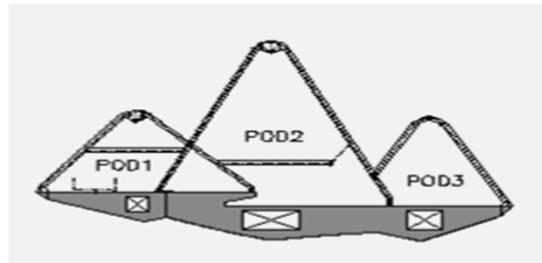
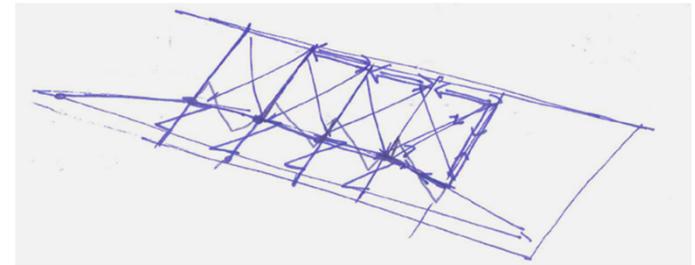
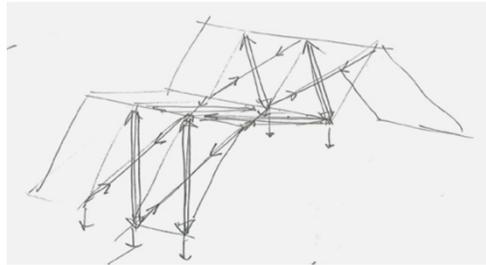
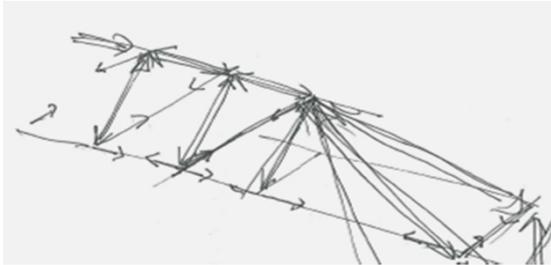
CAJÓN
DIAFRAGMAS INTERIORES

CORDONES SUPERIORES
PATAS

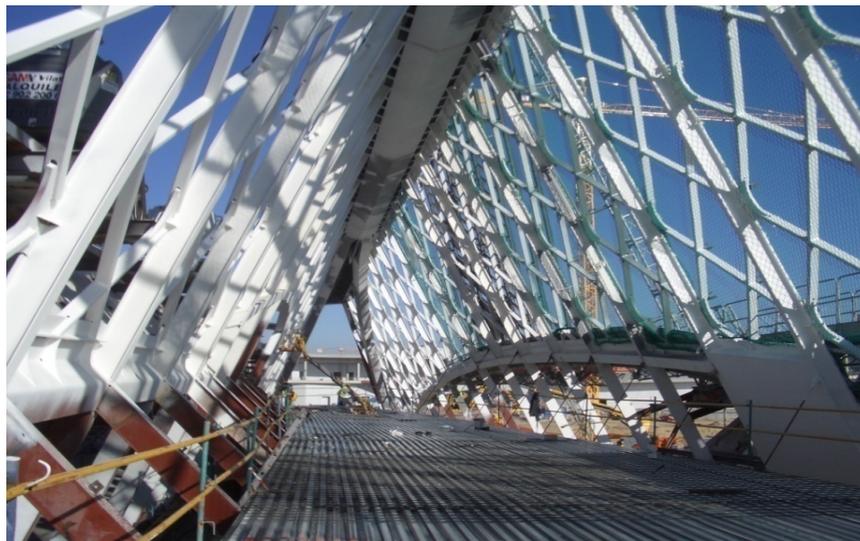
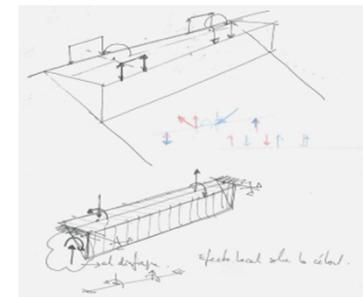
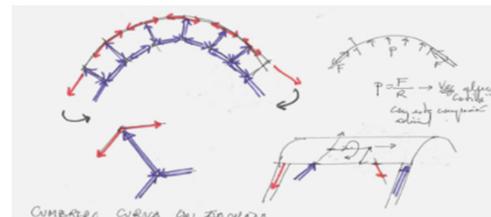
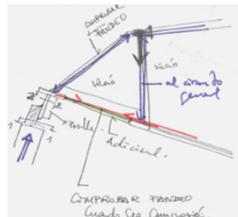
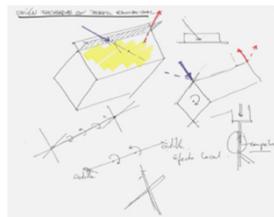
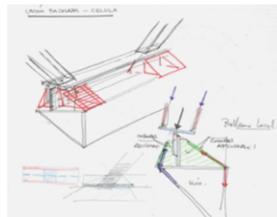
COSTILLAS

PANELES DE FACHADA
RESTO DE ELEMENTOS

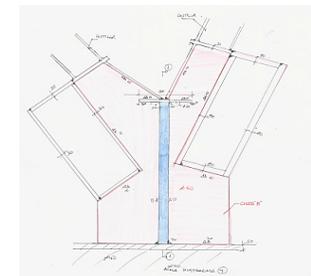
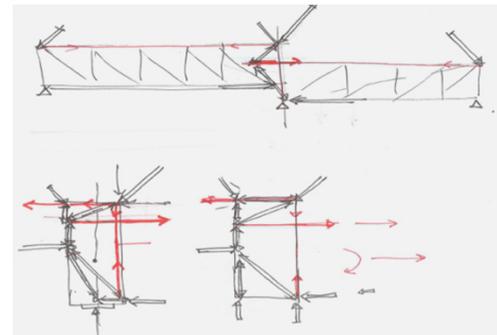
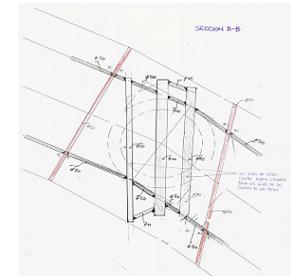
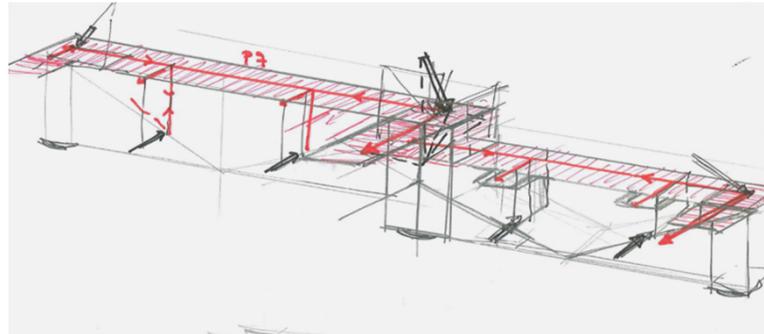
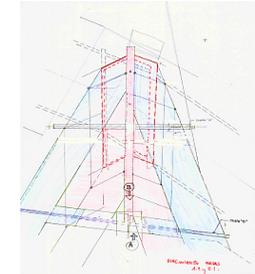
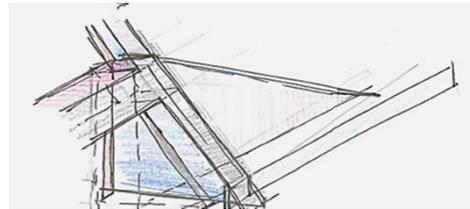
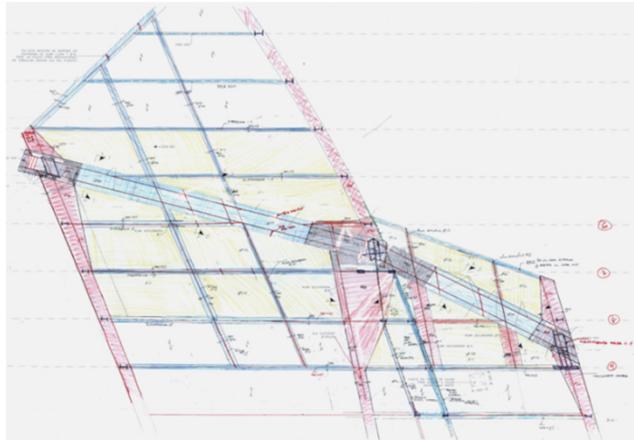
Zaragoza Expo 2008. Pavilion Bridge



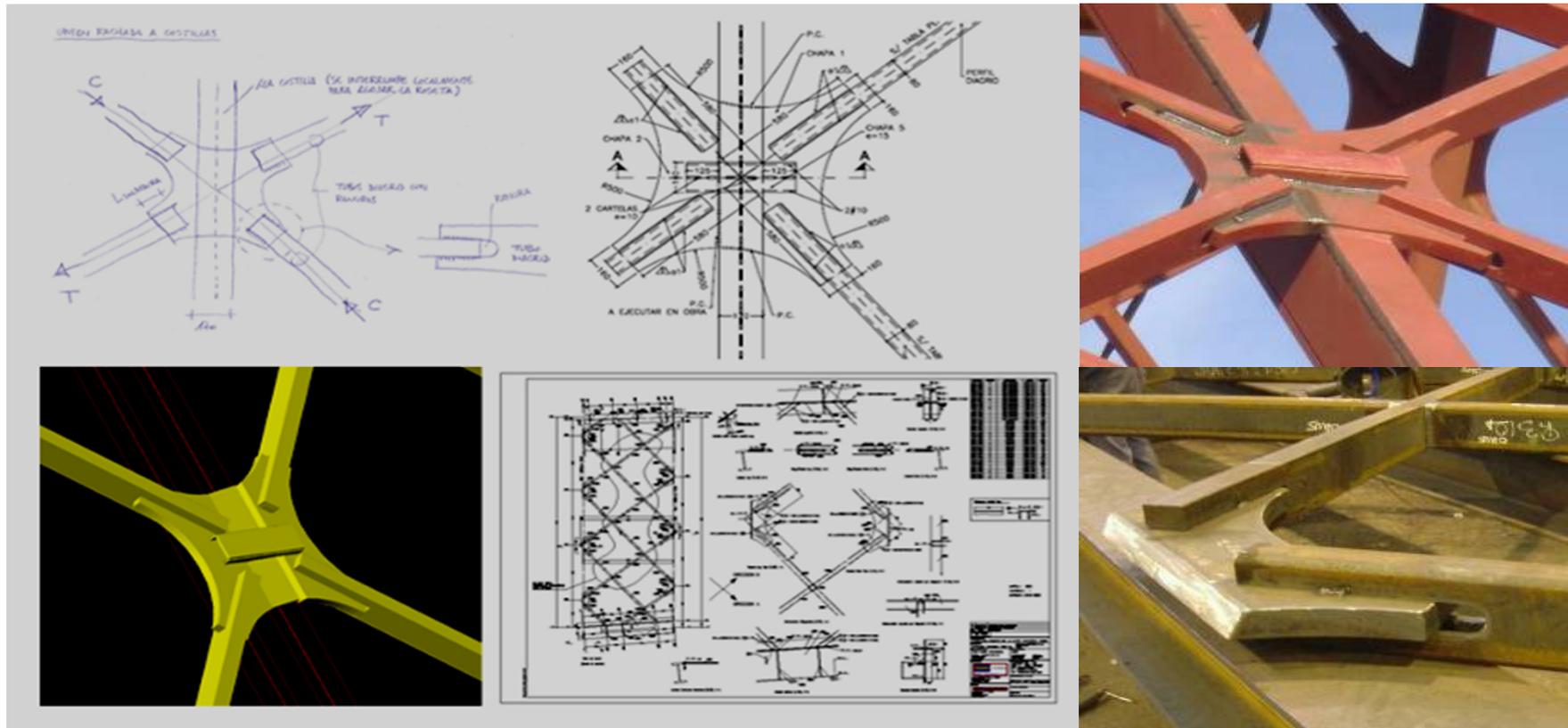
Zaragoza Expo 2008. Pavilion Bridge



Zaragoza Expo 2008. Pavilion Bridge

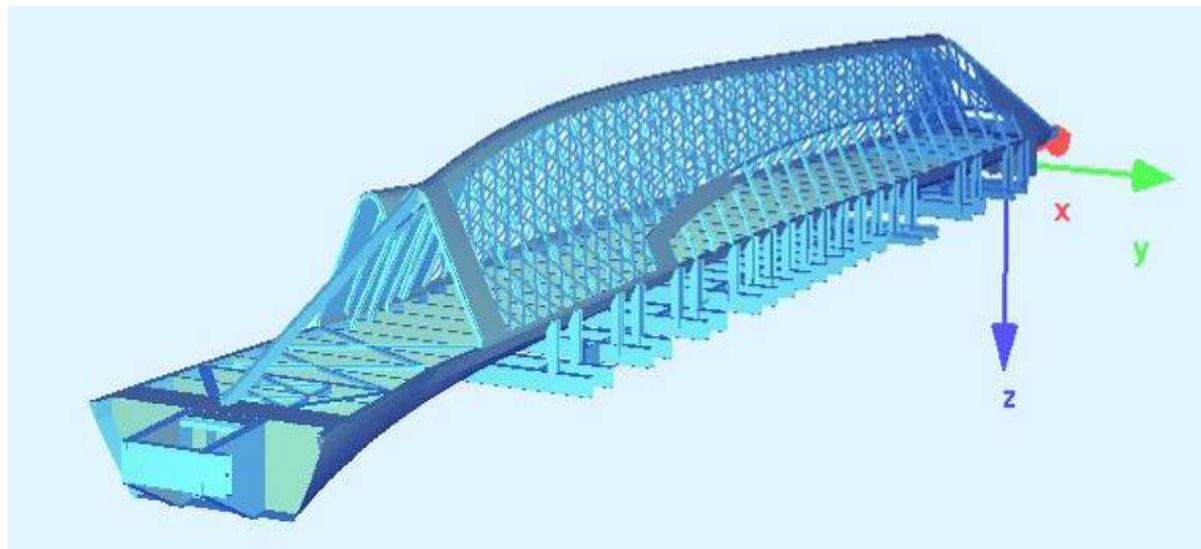
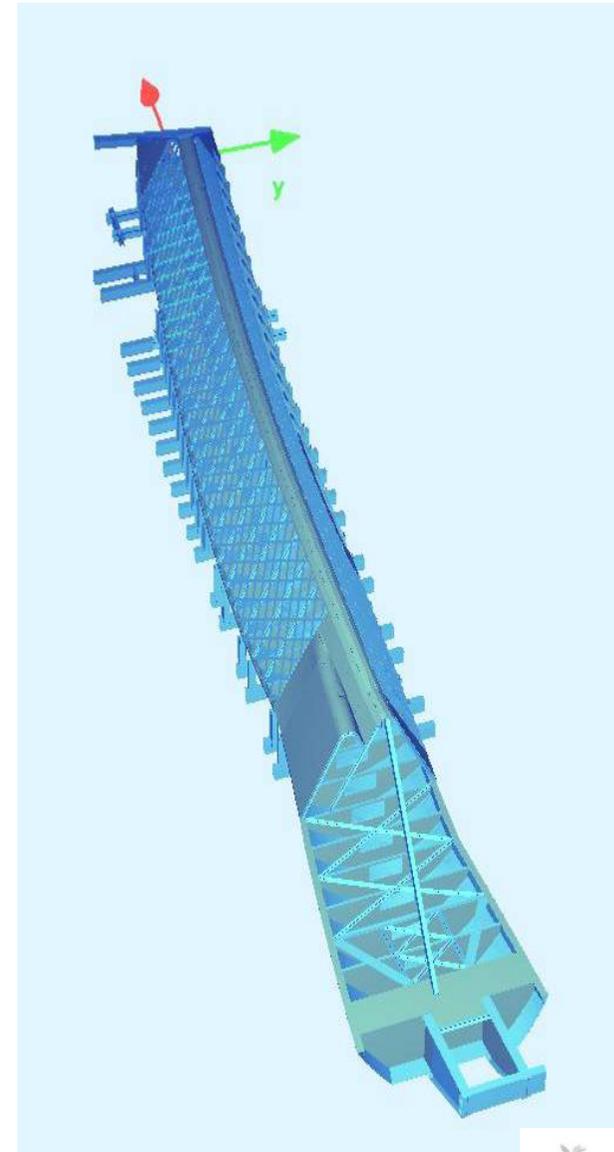
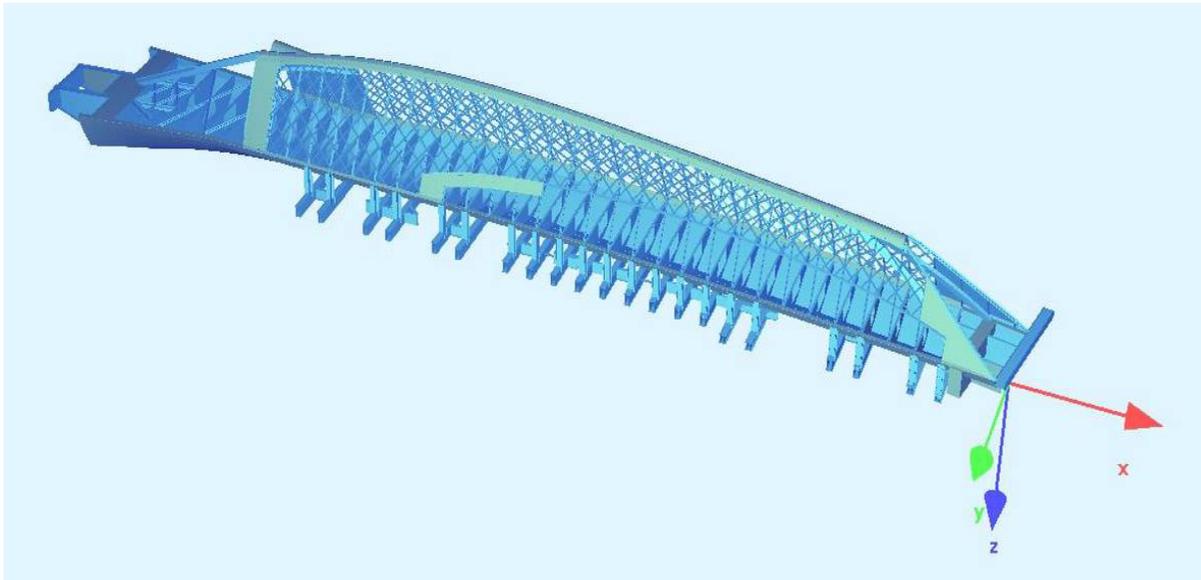


Zaragoza Expo 2008. Pavilion Bridge. Details



Strengths and weaknesses of structural engineering and its relation with conceptual design

Zaragoza Expo 2008. Pavilion Bridge. Structural Project



Zaragoza Expo 2008. Pavilion Bridge (Spain). Construction Process: Launching



Zaragoza Expo 2008. Pavilion Bridge (Spain). Construction Process: Launching



Zaragoza Expo 2008. Pavilion Bridge (Spain). *Construction Process: Launching*



Zaragoza Expo 2008. Pavilion Bridge (Spain). *Construction Process: Launching*



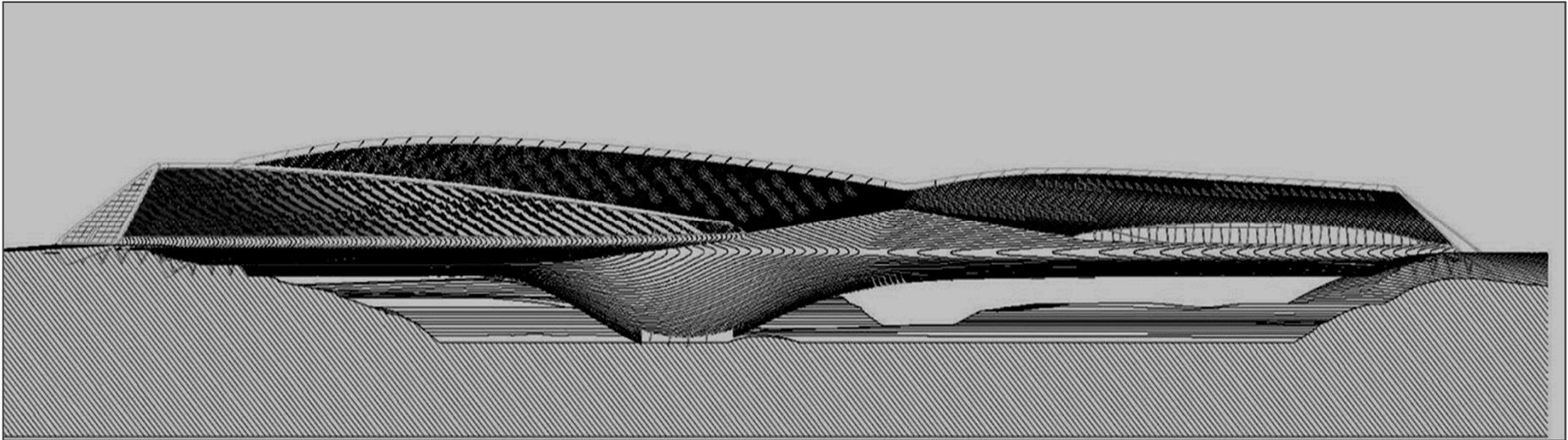
Zaragoza Expo 2008. Pavilion Bridge (Spain). *Construction Process: Launching*



Zaragoza Expo 2008. Pavilion Bridge (Spain). *Construction Process: Launching*



Zaragoza Expo 2008. Pavilion Bridge (Spain).



Project data

Project location
date
typology
characteristics
scope of project
client

Balaguer I Pedestrian Bridge
Balaguer, Lleida
2000

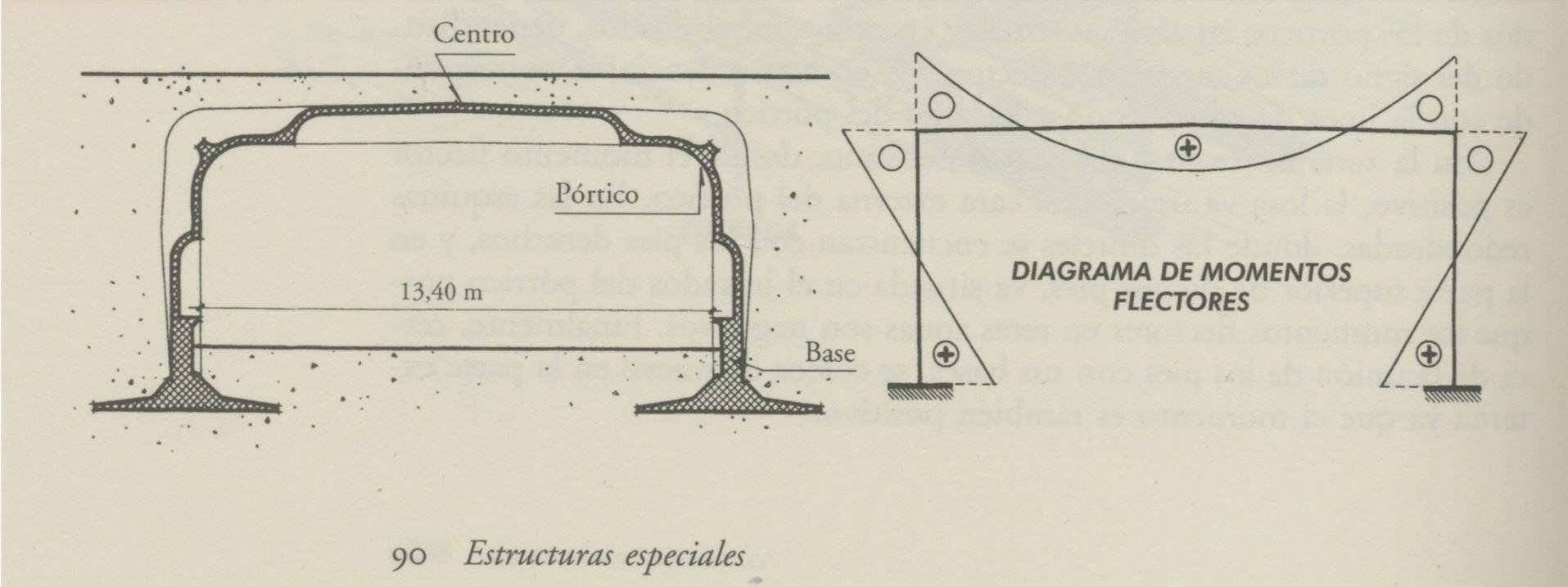
pre-stressed concrete continuous beam with dorsal fin
two 46.60 + 46.60m spans and 5.00m width deck
detailed project design and construction supervision
Ayuntamiento de Balaguer

Spain / 2000

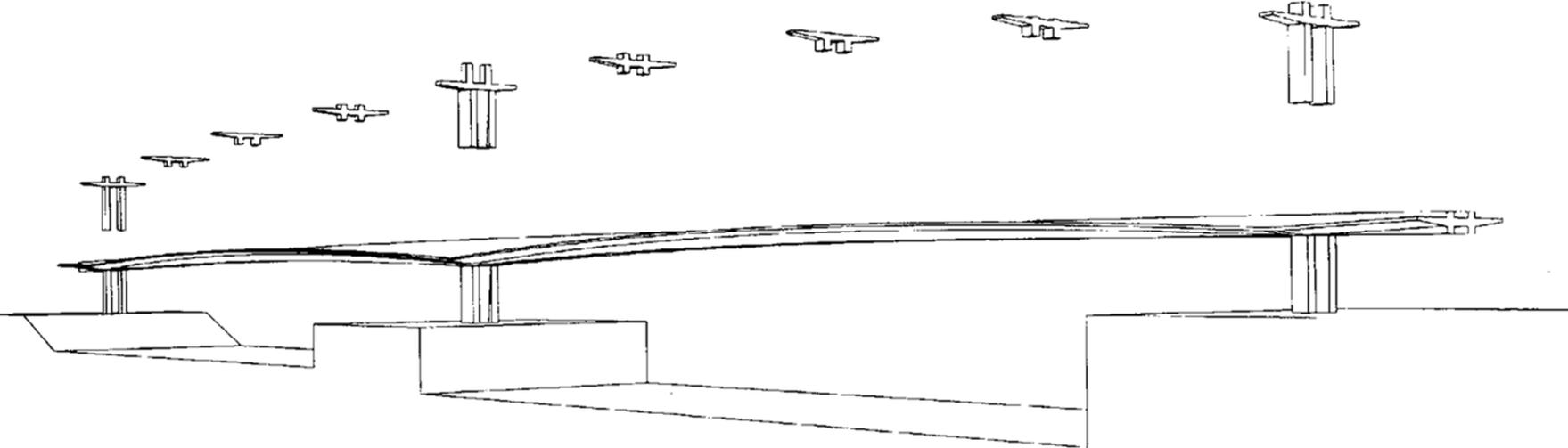
Balaguer I Pedestrian Bridge



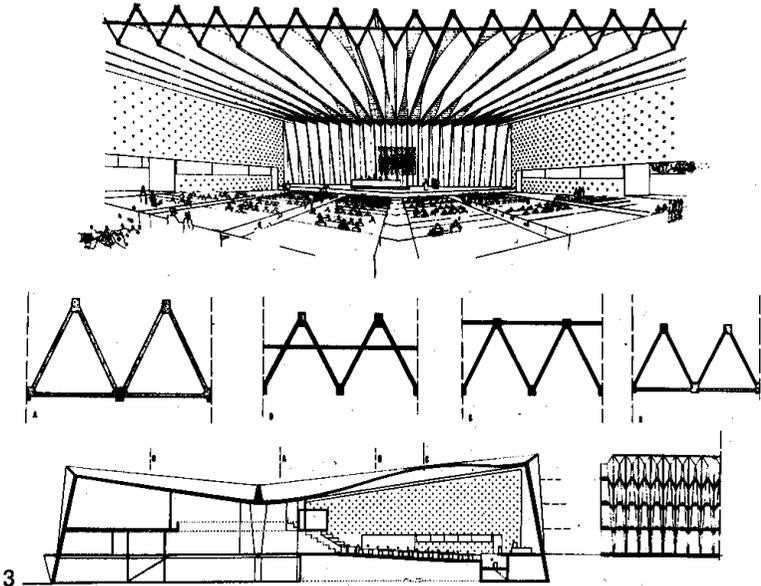
BALAGUER I PEDESTRIAN BRIDGE



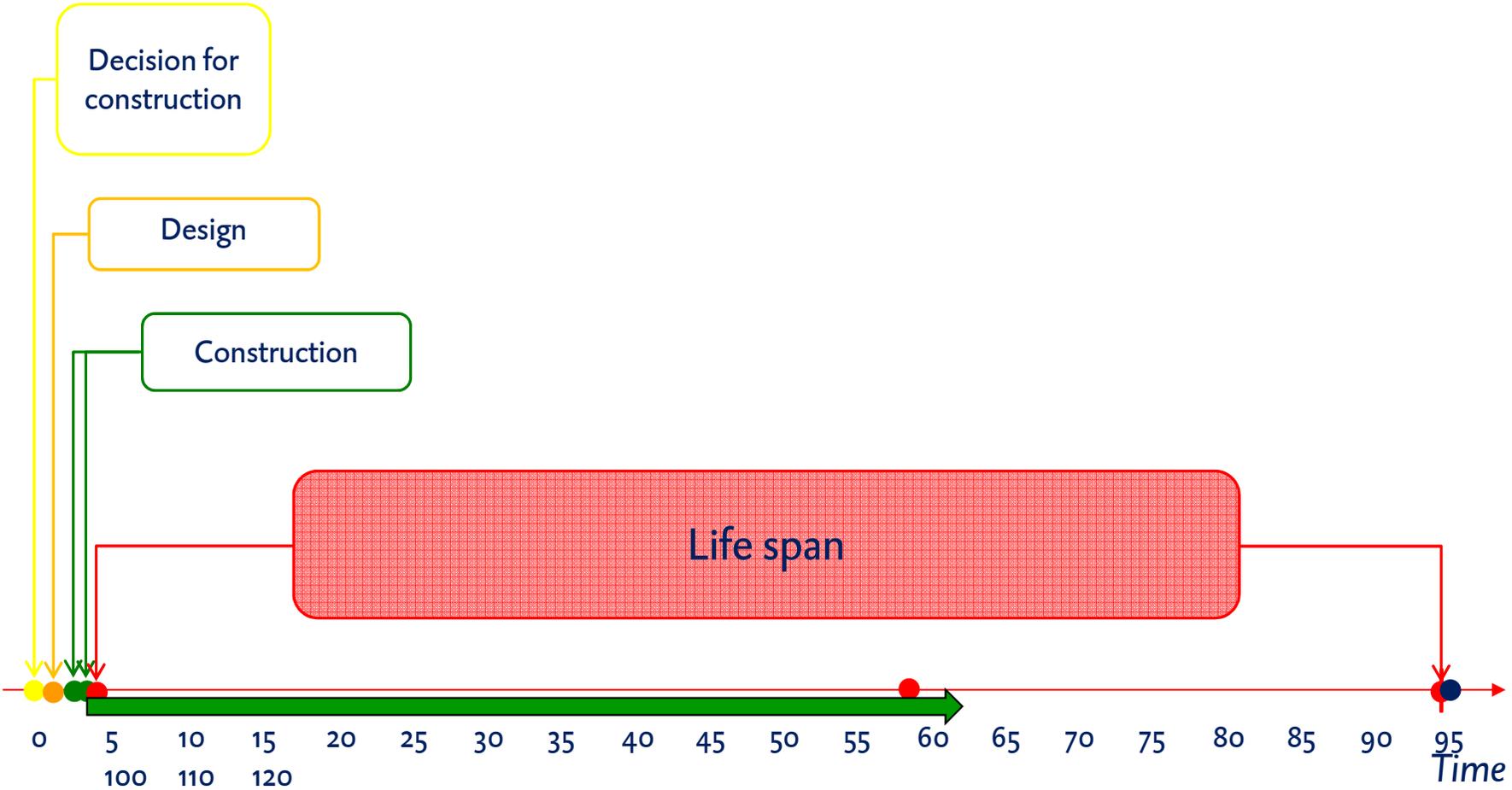
BALAGUER I PEDESTRIAN BRIDGE



BALAGUER I PEDESTRIAN BRIDGE



Conceptual Design in Exiting Structures



VIADUCT OF LOS SANTOS



VIADUCT OF LOS SANTOS



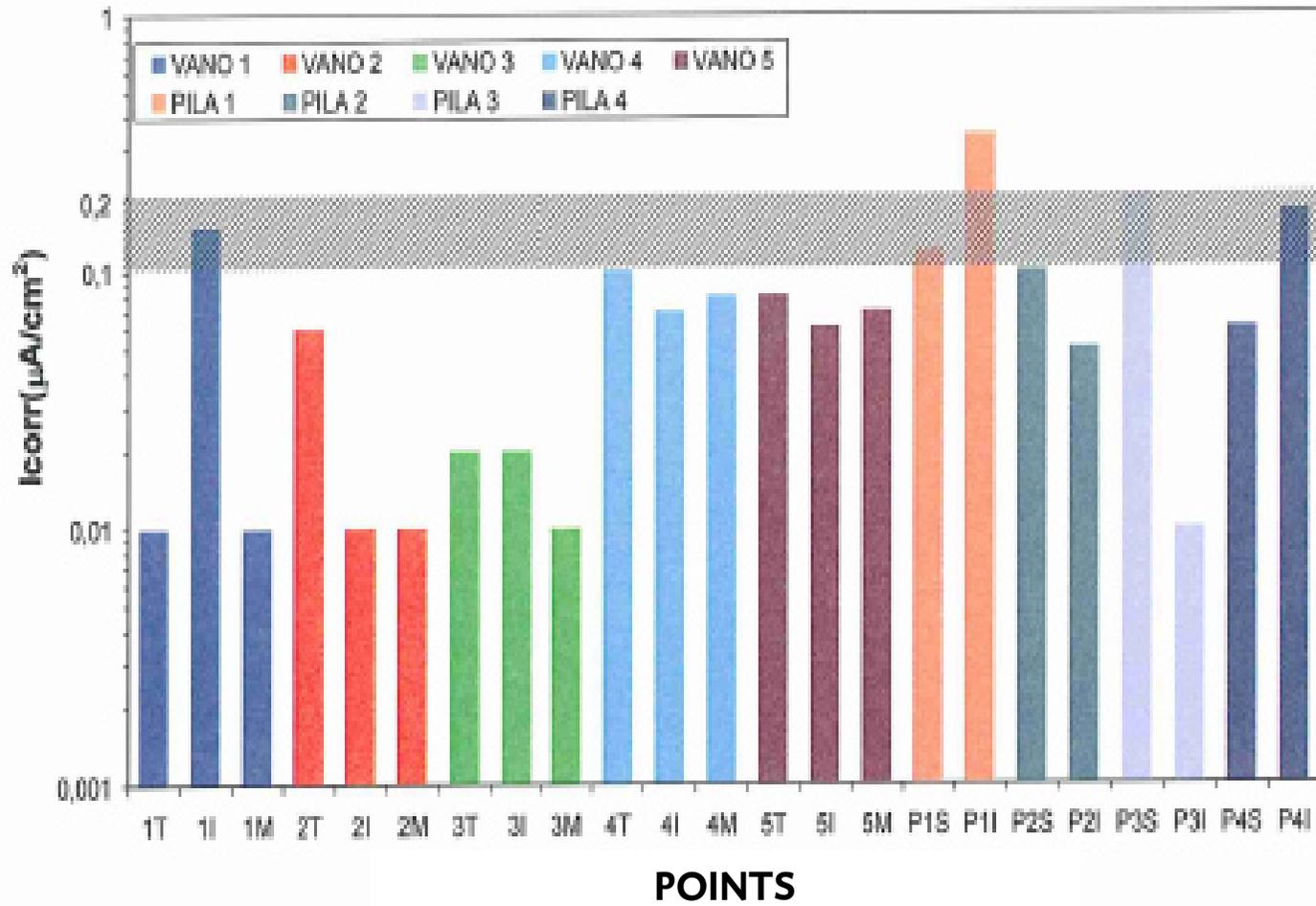
Assessment is a verification of a capability of the structure.

- Bearing capacity
- Durability conditions
- Remaining service life
- Etc.

- Assessment **is not part of** the Conceptual Design process
- It is **an essential input** for Conceptual Design of Excising Structures
- It has to be carried out **before** to the Conceptual Design process
- Conceptual Design is the process **to find the way to manage, minimize, mitigate, etc.** the assessment results

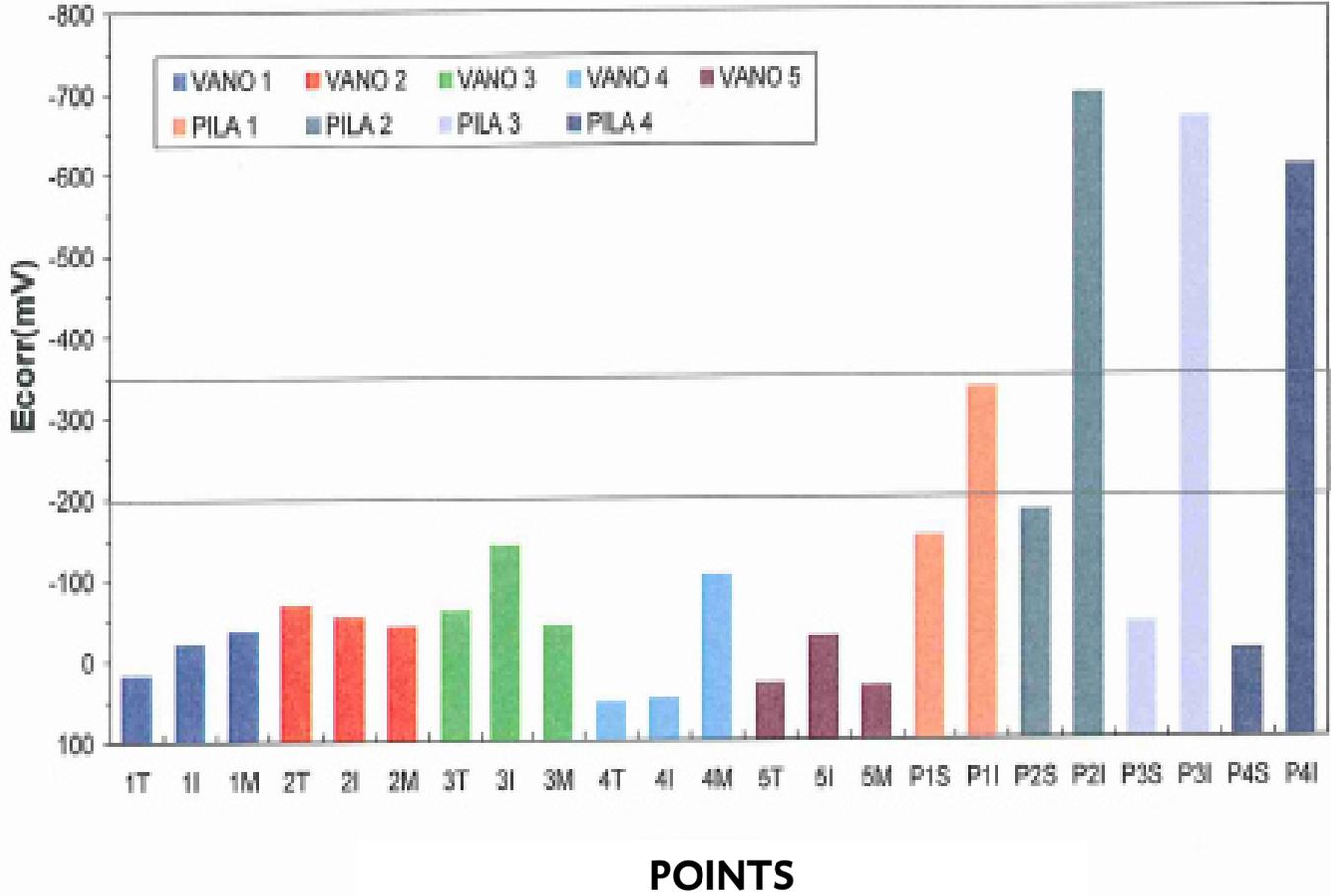
VIADUCT OF LOS SANTOS

CORROSION INTENSITY

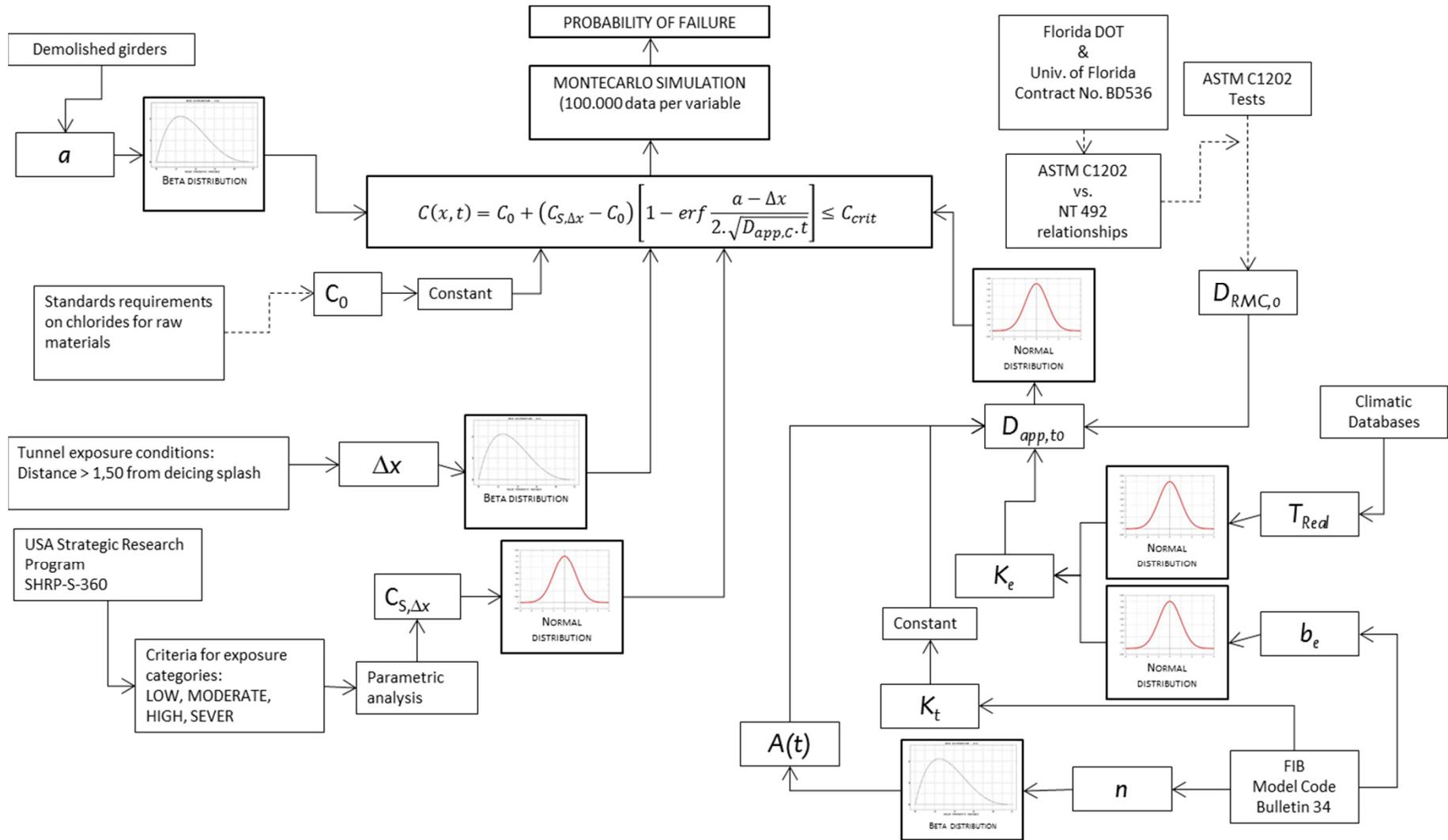


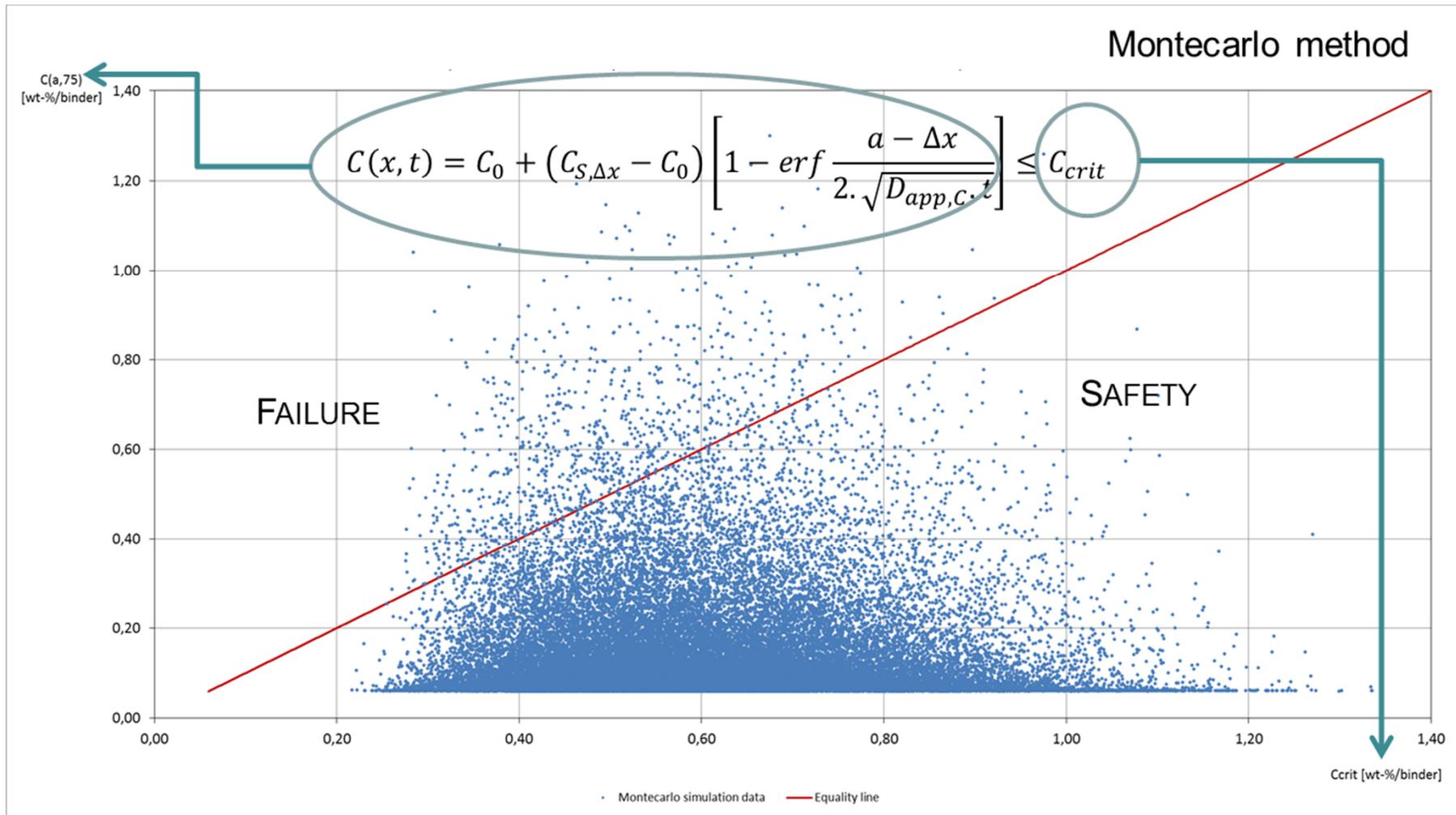
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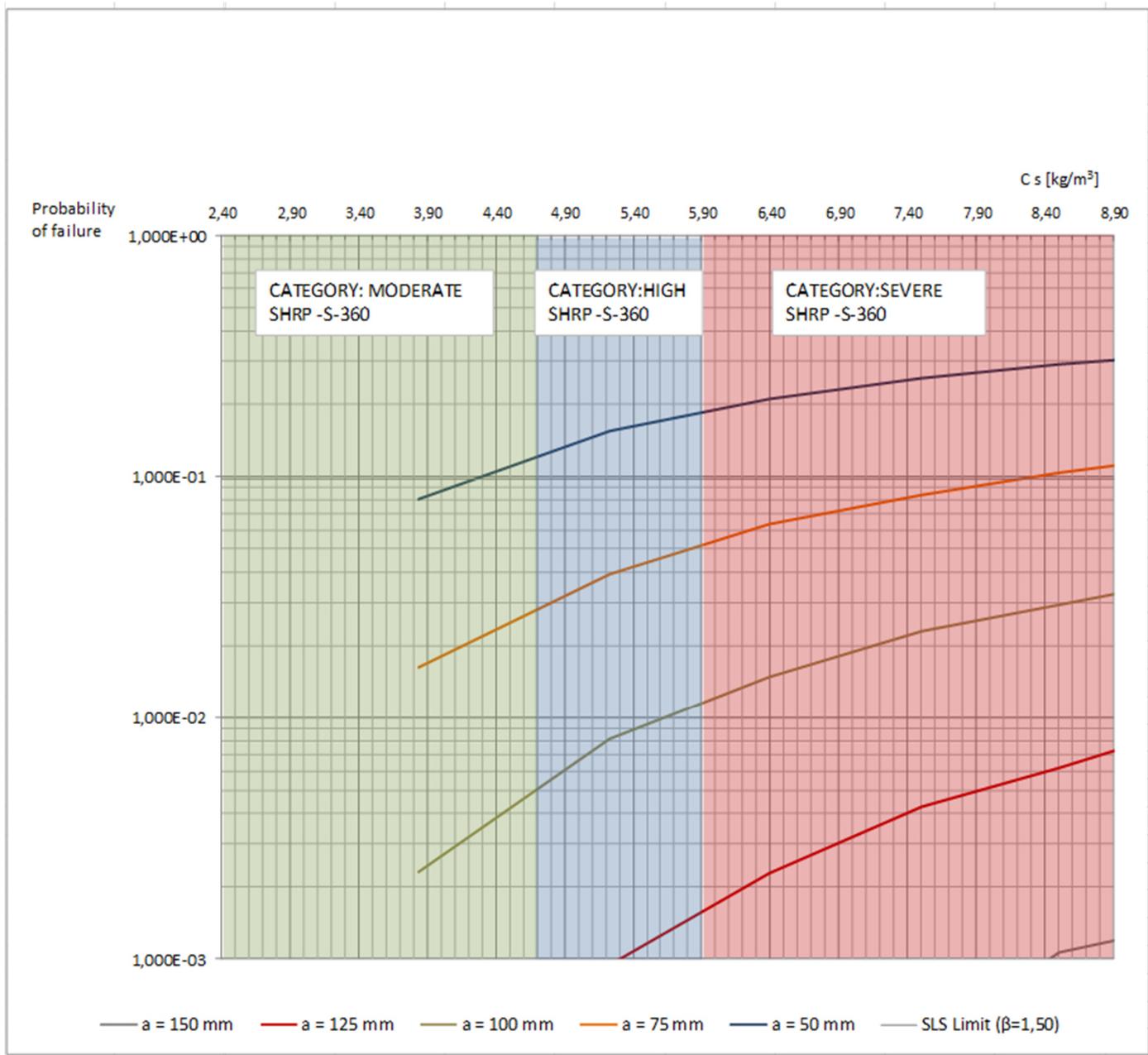
CORROSION POTENTIAL



PROBABILISTIC APPROACH TO REBAR CORROSION. REFERENCE: FIB MODEL CODE FOR SERVICE LIFE DESIGN



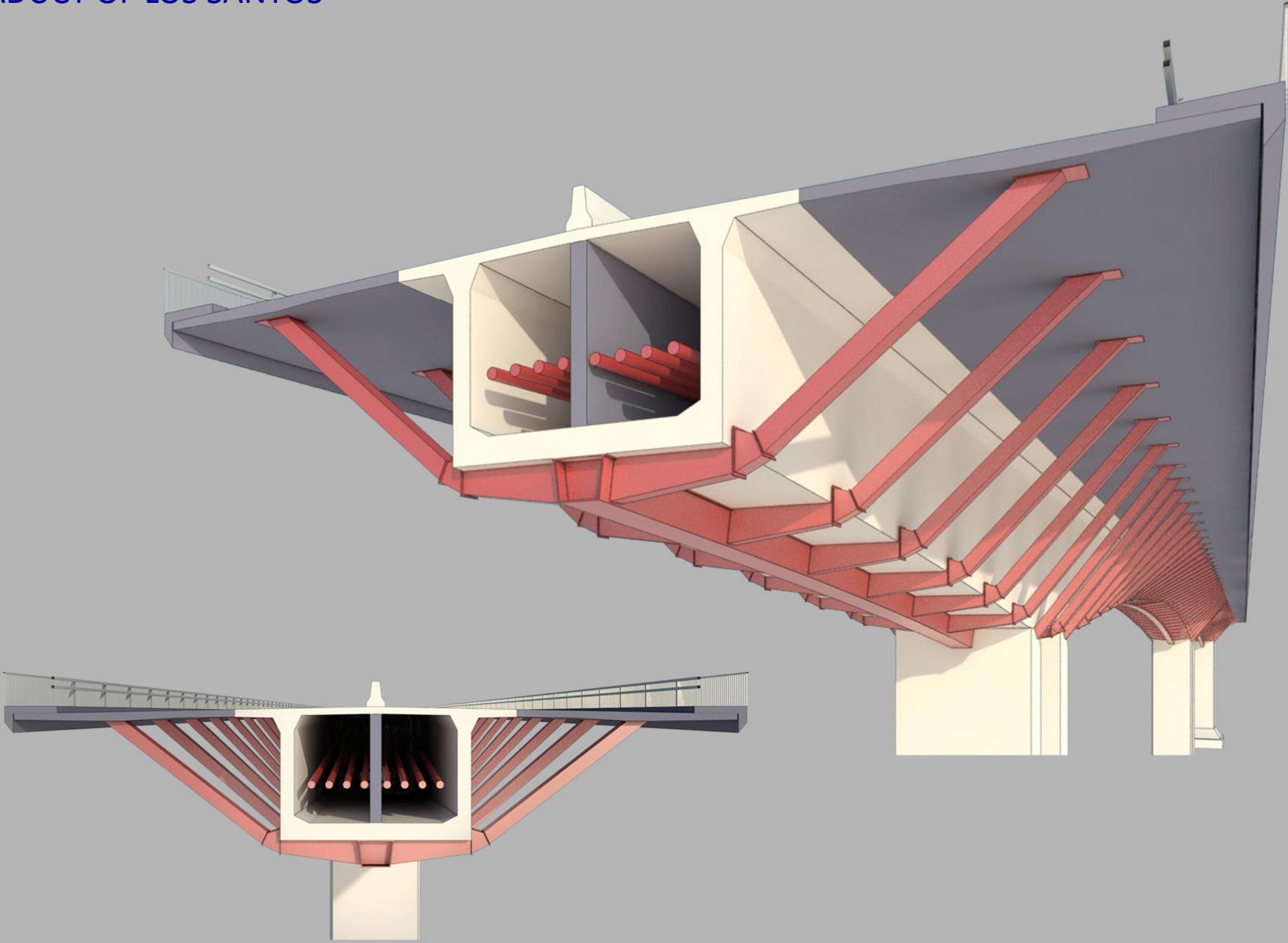




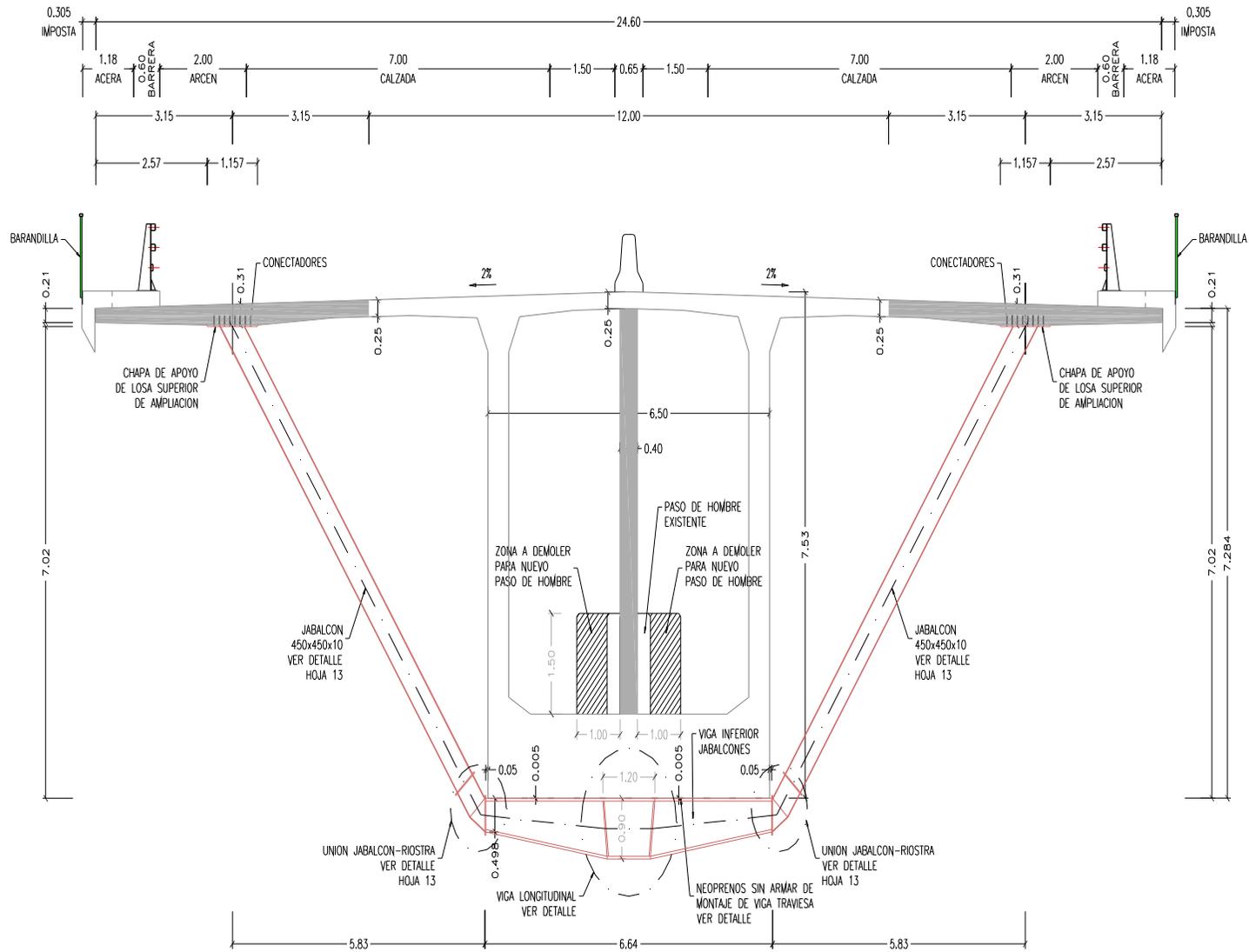
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VIADUCT OF LOS SANTOS

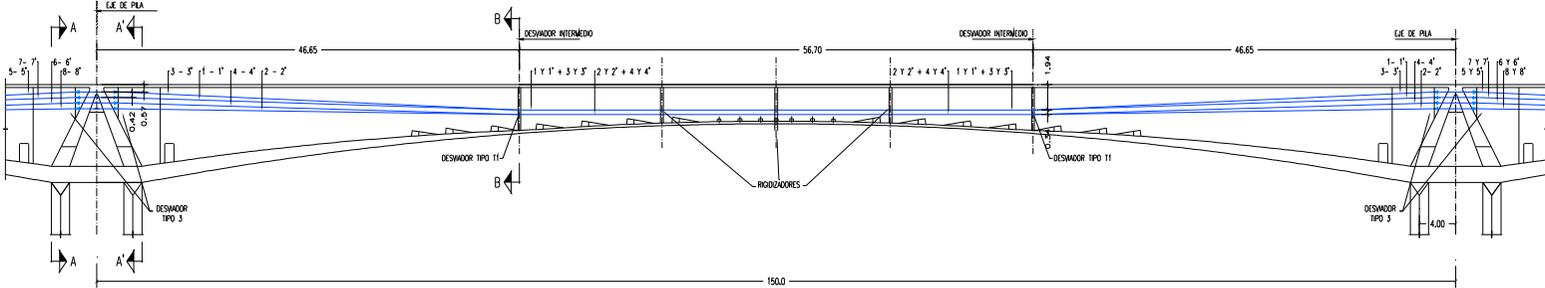
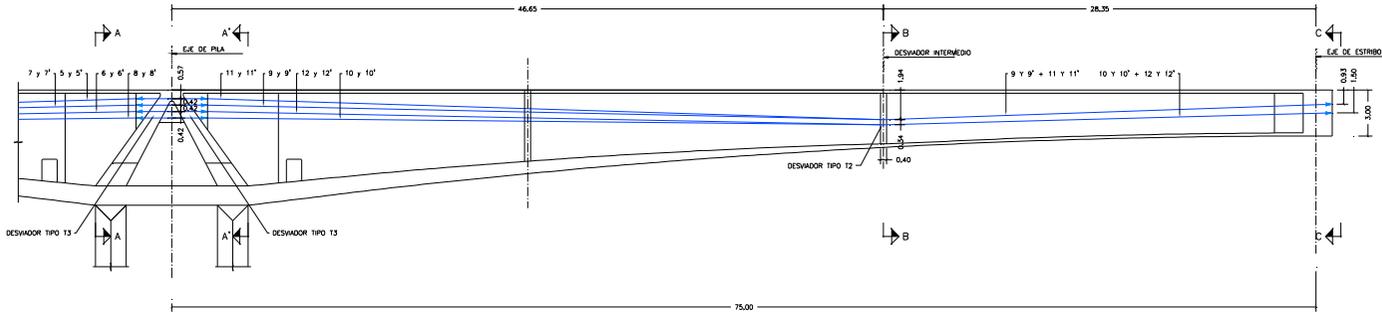


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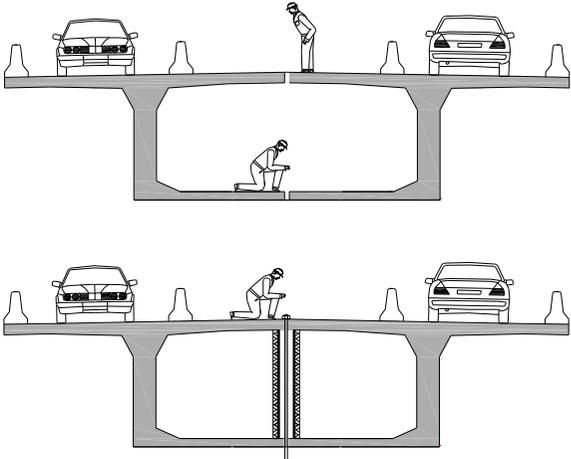
Adopted cross-section

VIADUCT OF LOS SANTOS

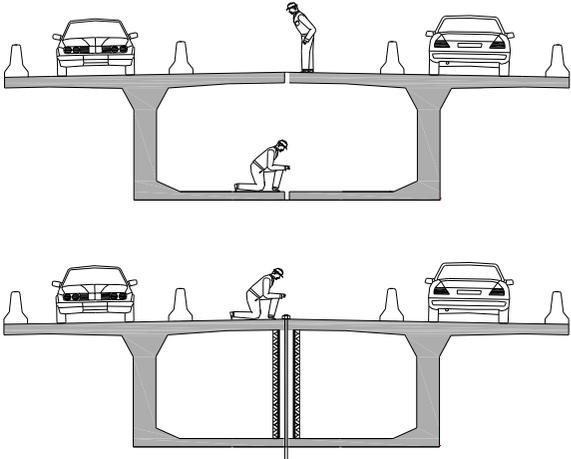


External prestressing

VIADUCT OF LOS SANTOS



VIADUCT OF LOS SANTOS



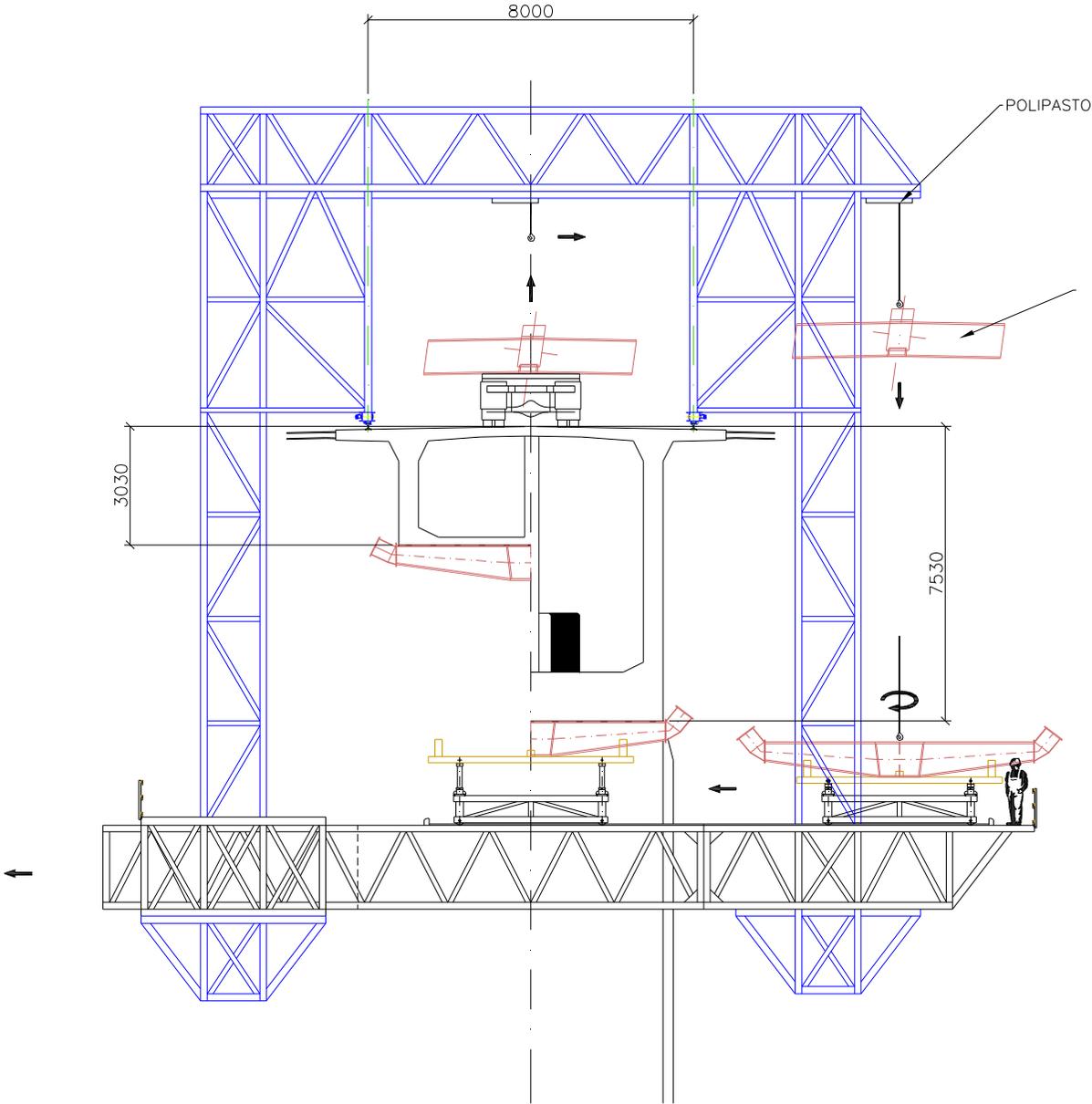
Execution of the inner web

VIADUCT OF LOS SANTOS



AMPLIACION DEL PUENTE DE LOS SANTOS

VIADUCT OF LOS SANTOS



VIADUCT OF LOS SANTOS

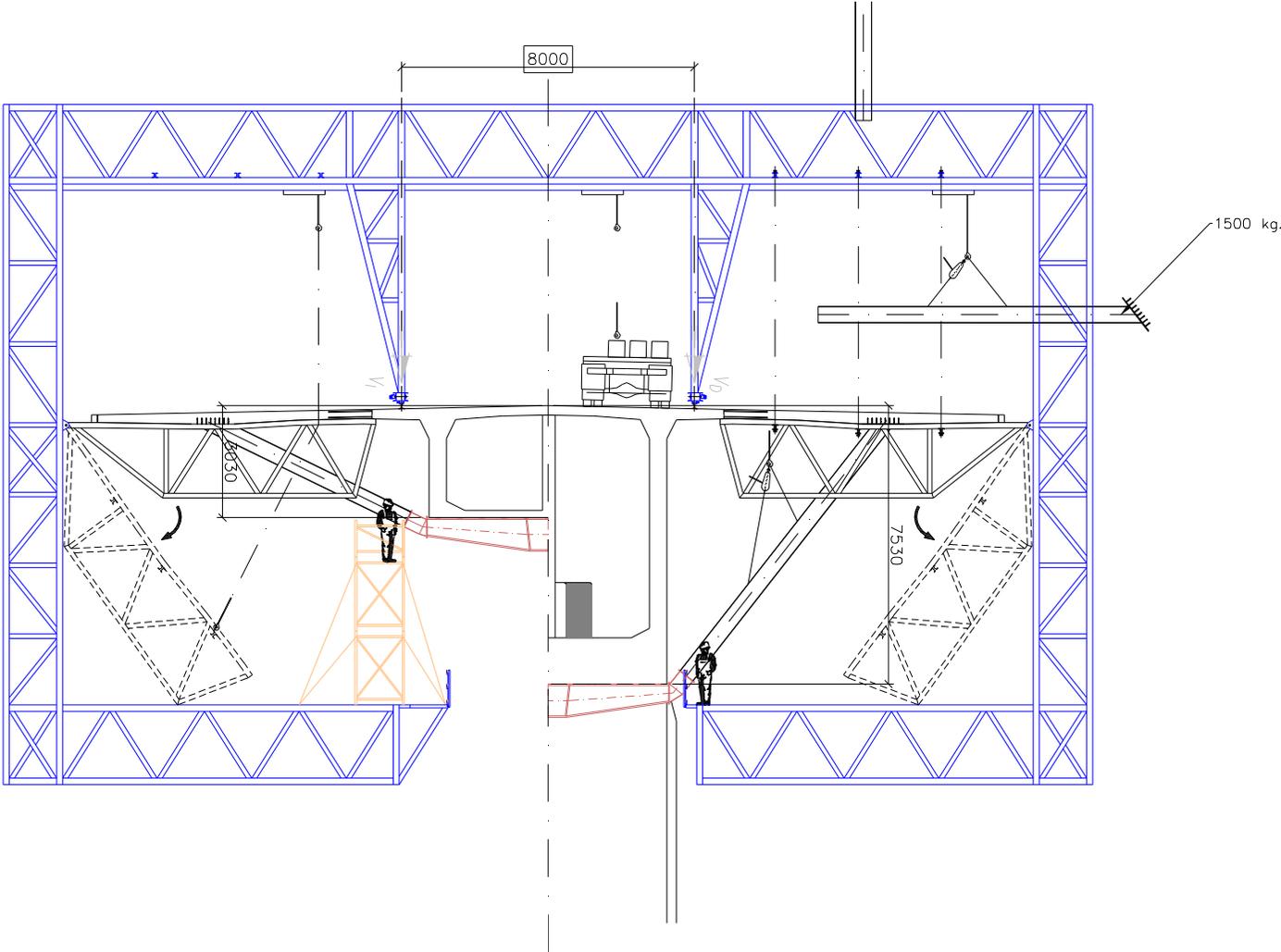


Execution of the steel structure under the existing superstructure

VIADUCT OF LOS SANTOS



VIADUCT OF LOS SANTOS



VIADUCT OF LOS SANTOS



Execution of the slabs in the broadening areas

VIADUCT OF LOS SANTOS

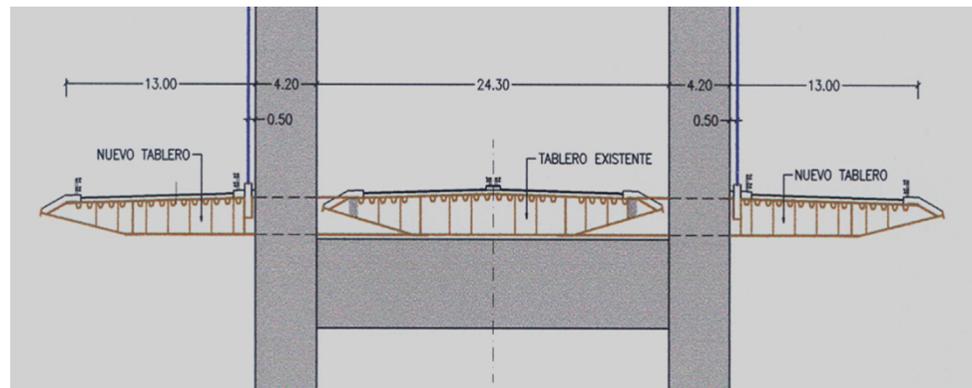
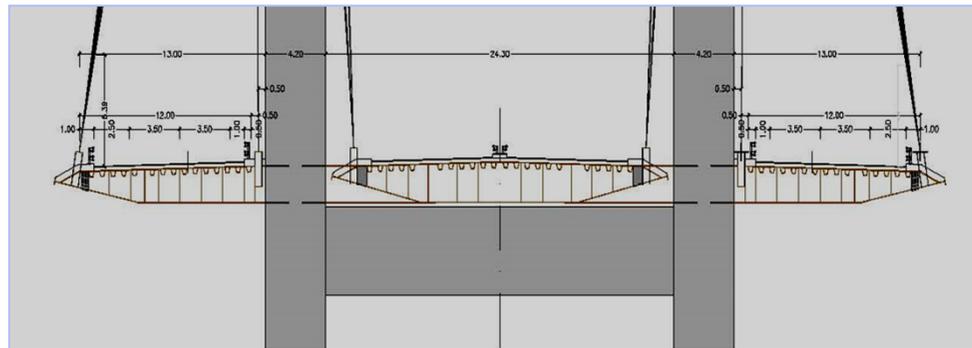
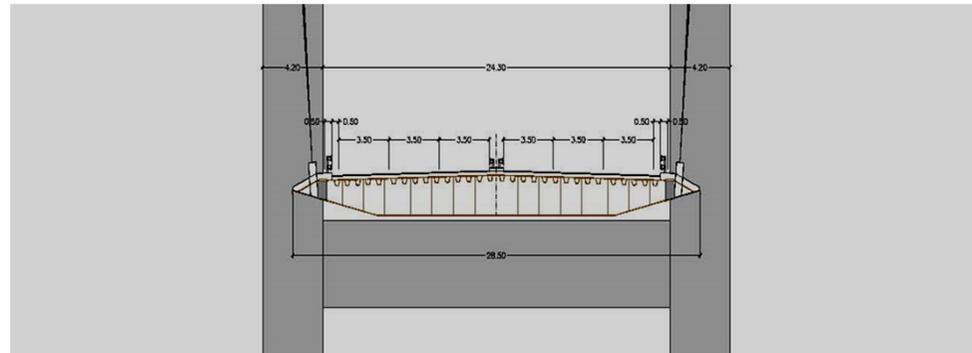


RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE

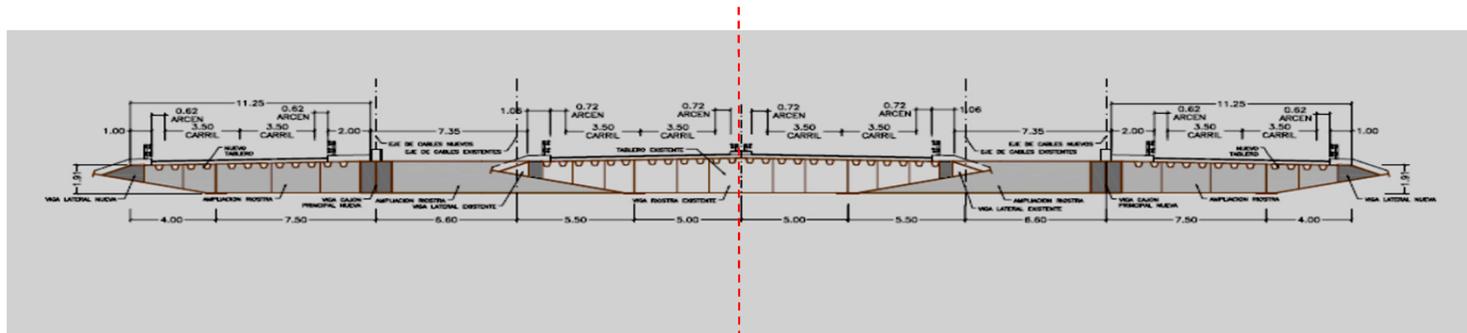
POSSIBILITIES TO IMPROVE THE CAPACITY OF EXISTING STRUCTURE



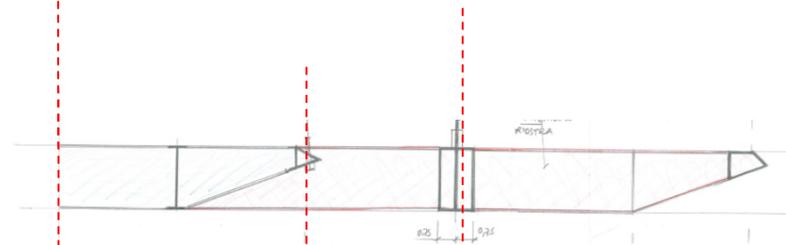
Widening the existing structure

RANDE CABLE-STAYED BRIDGE

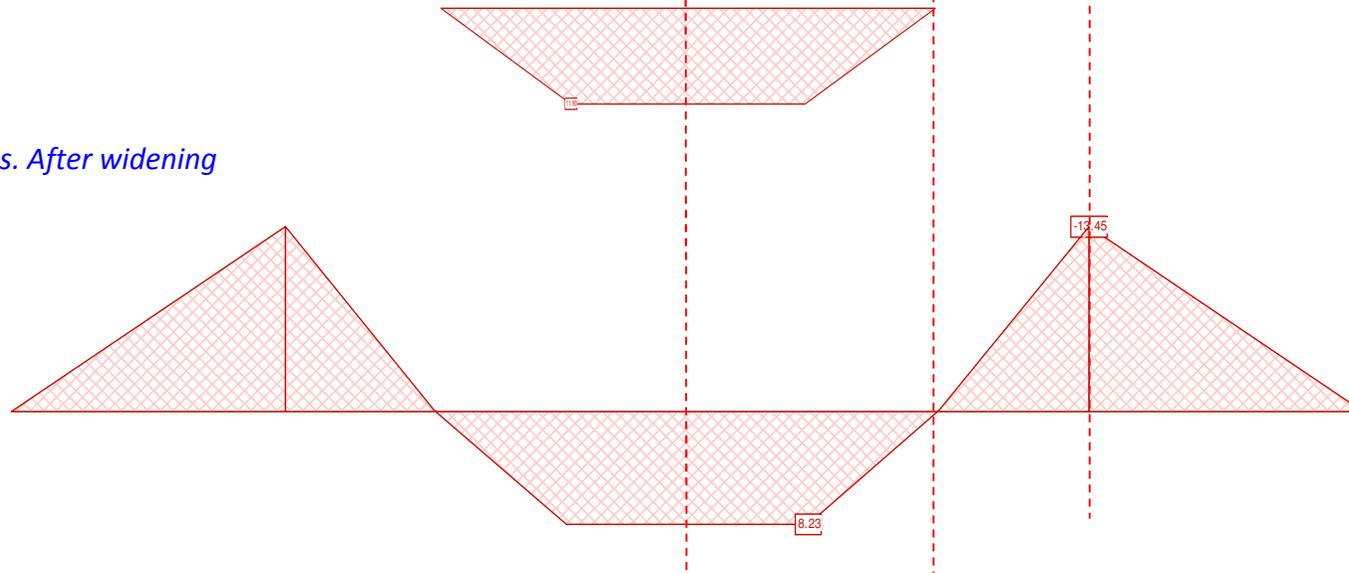
WORKS CARRIED OUT IN THE SUPERSTRUCTURE



Bending moments. Before widening

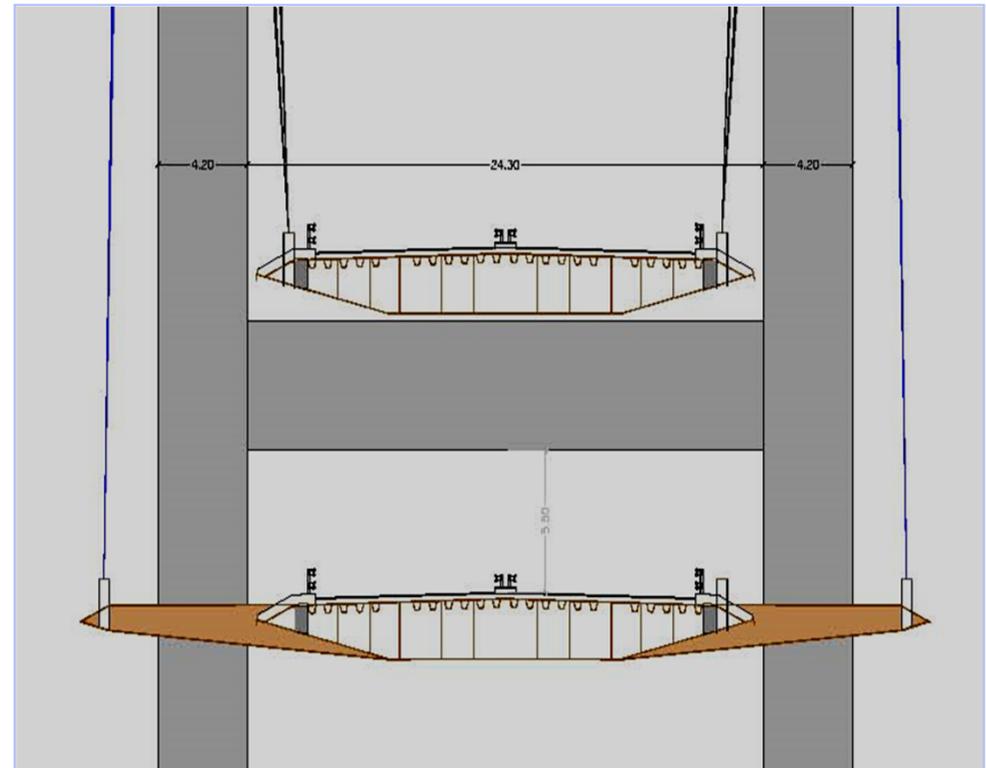
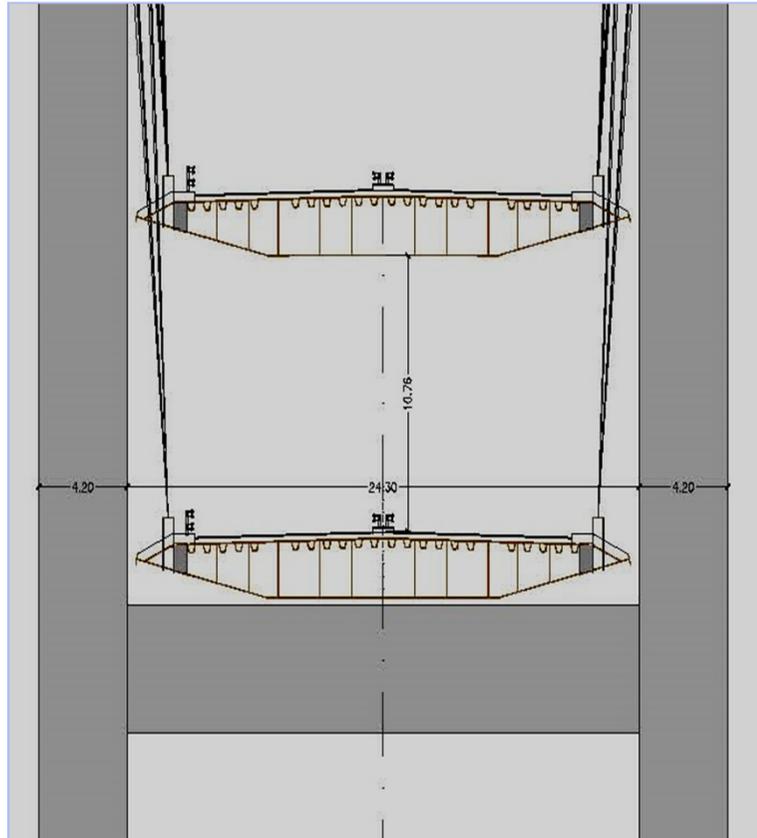


Bending moments. After widening



RANDE CABLE-STAYED BRIDGE

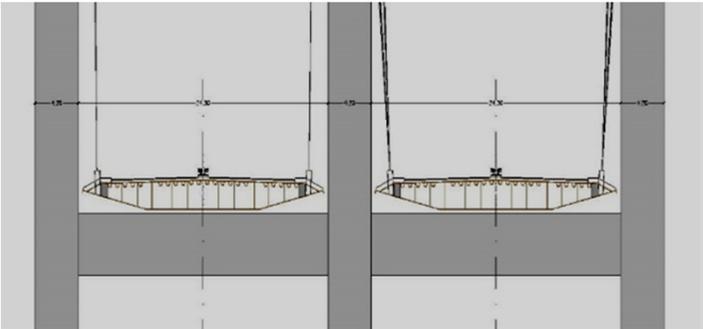
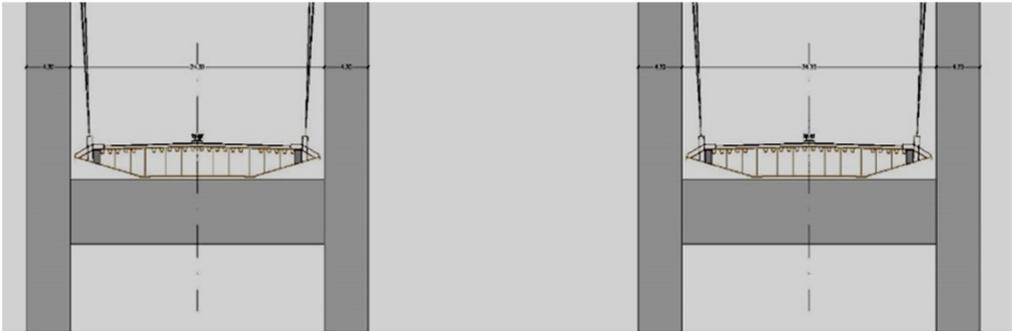
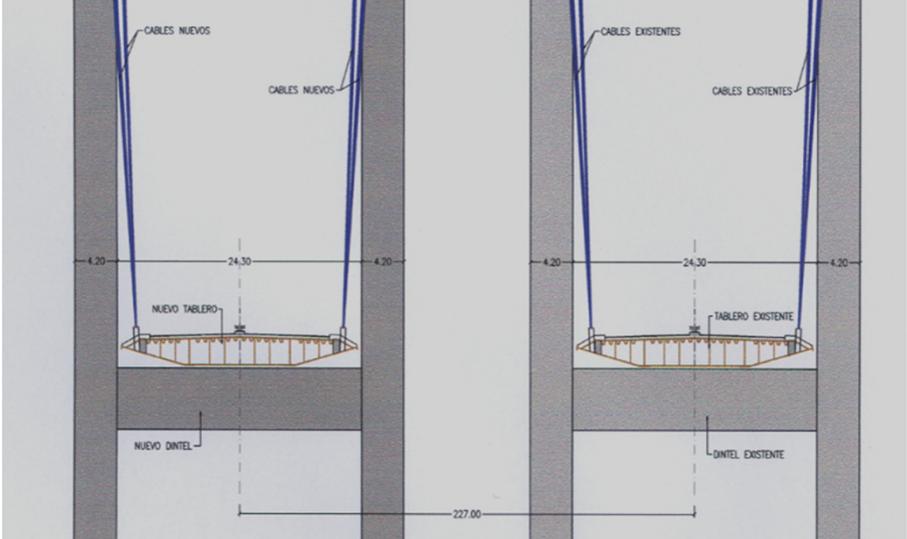
POSSIBILITIES TO IMPROVE THE CAPACITY OF EXISTING STRUCTURE



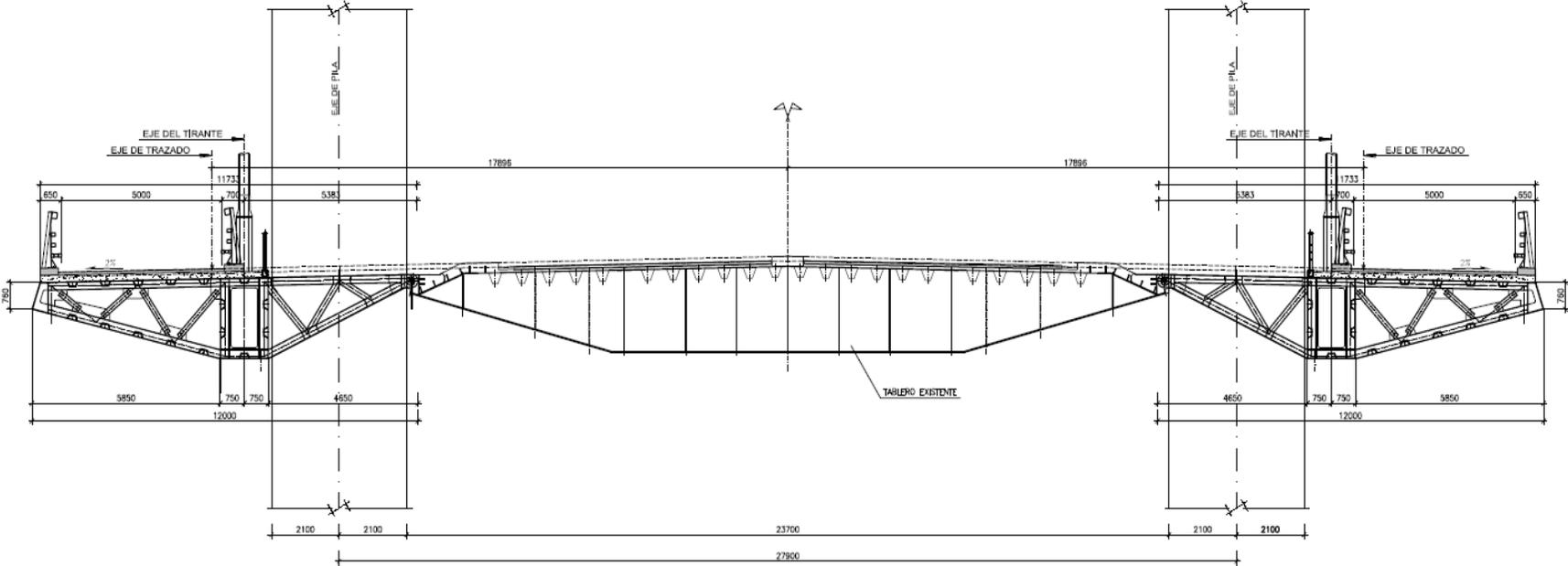
Widening of the Existing Structures

RANDE CABLE-STAYED BRIDGE

SOLUTIONS THAT ARE PARALLEL TO EXISTING BRIDGE

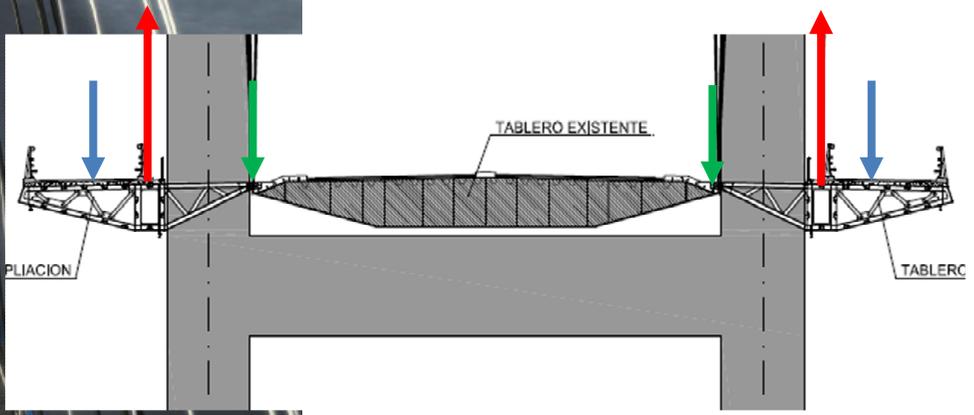


RANDE CABLE-STAYED BRIDGE



SECCION TRANSVERSAL DEL TABLERO
ESCALA 1/75

RANDE CABLE-STAYED BRIDGE

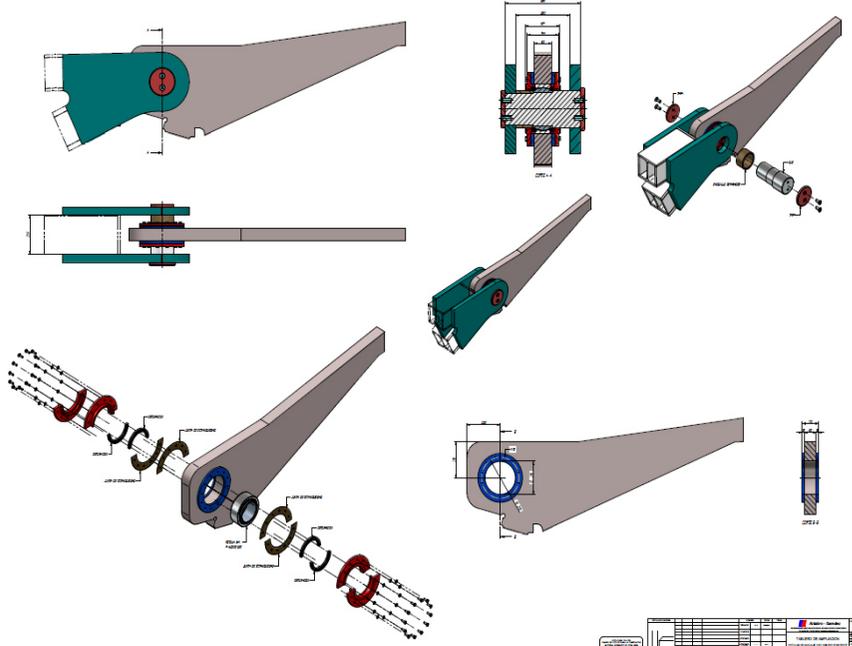
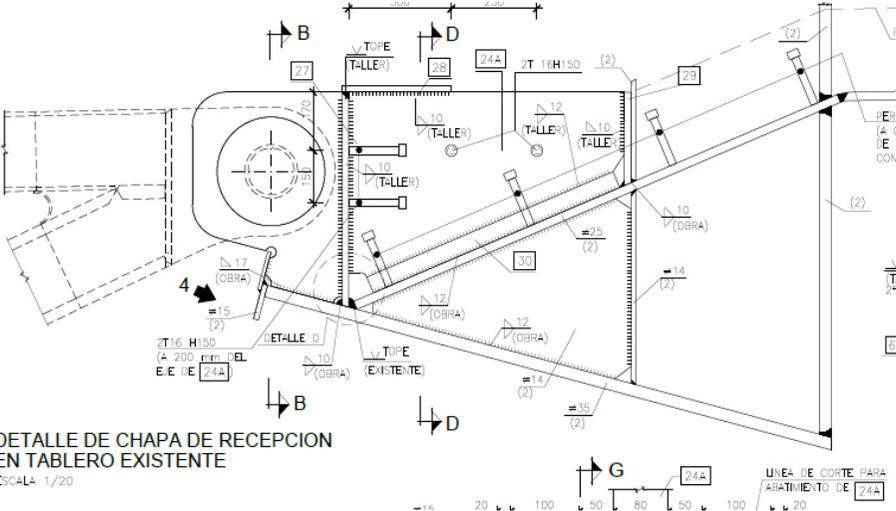
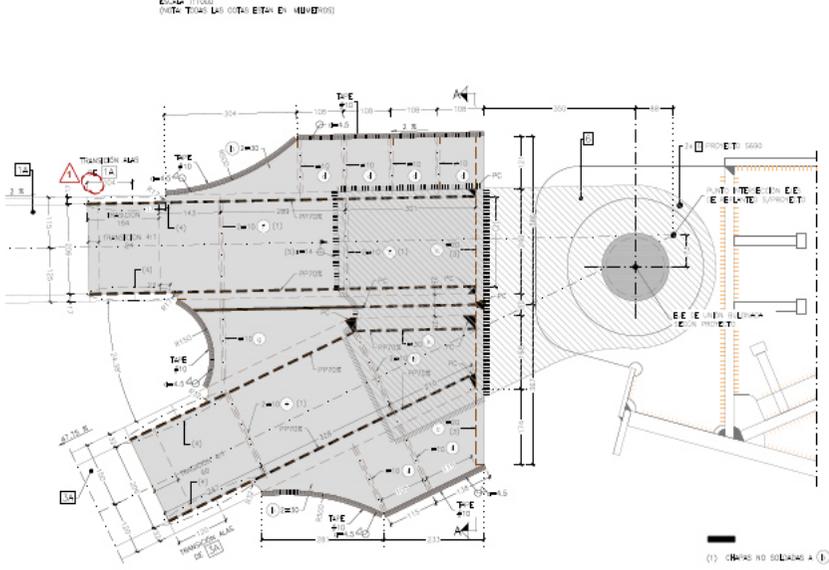


RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE

HINGES



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RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE

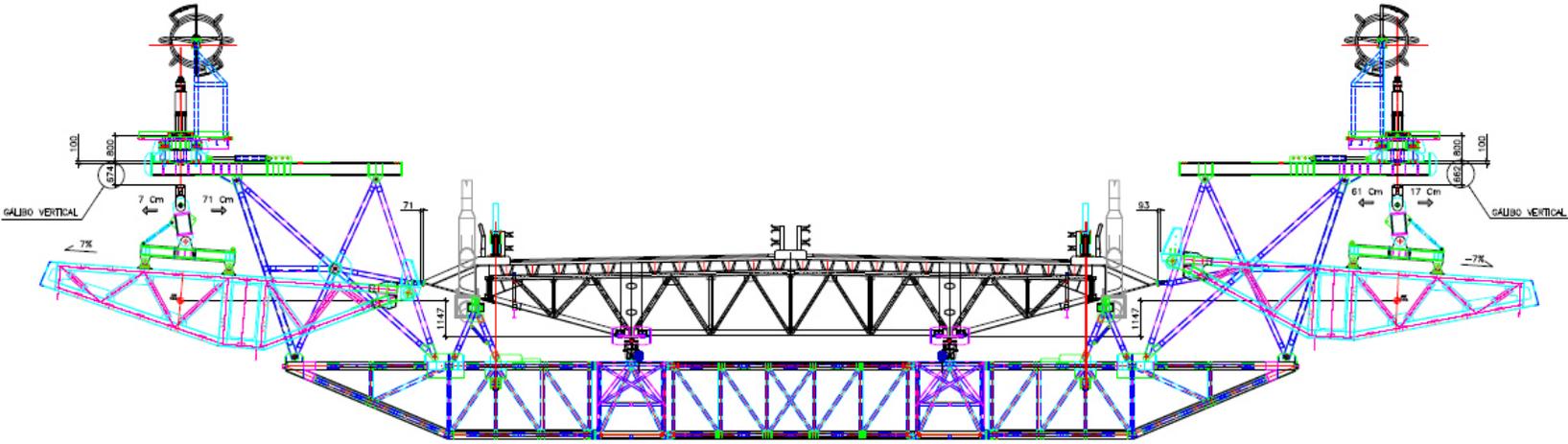


RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE

TRAVELERS



SECCIÓN TRANSVERSAL – ANÁLISIS GALIBOS EN MANIOBRA IZADO DOVELA CON PTE. TRANSVERSAL +7% Y -7%
ESCALA 1:150



RANDE CABLE-STAYED BRIDGE

TRAVELERS



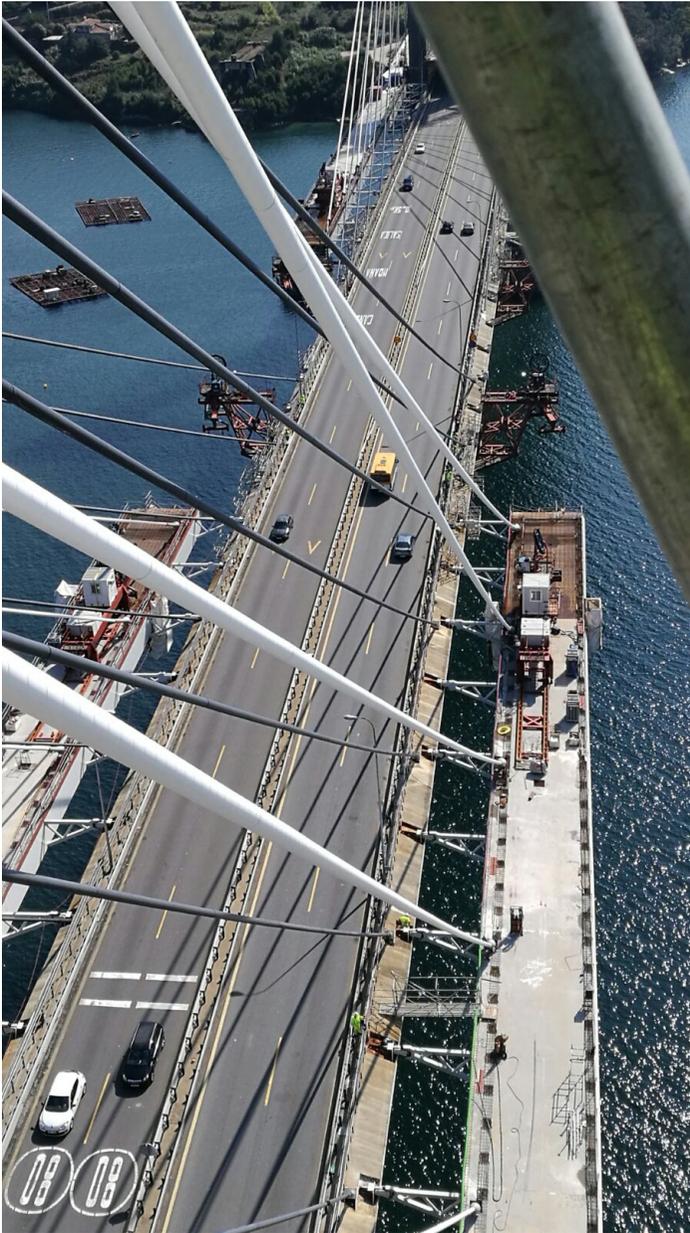
RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE



RANDE CABLE-STAYED BRIDGE

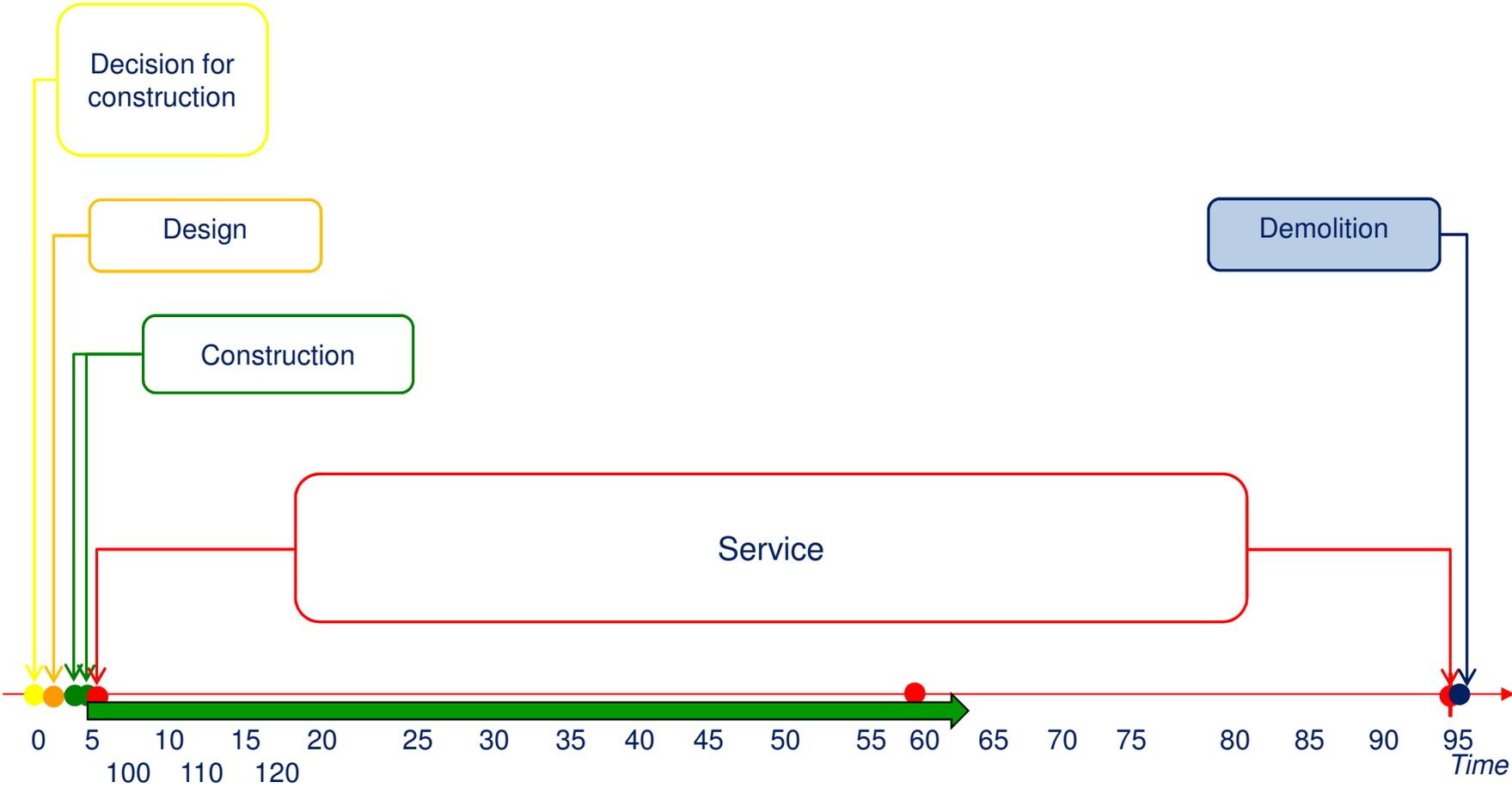


fib-Hungarian Group



Budapest 06th of April of 2018

Conceptual Design in Dismantled Structures



LA TOJA BRIDGE



LA TOJA BRIDGE



LA TOJA BRIDGE



LA TOJA BRIDGE



LA TOJA BRIDGE

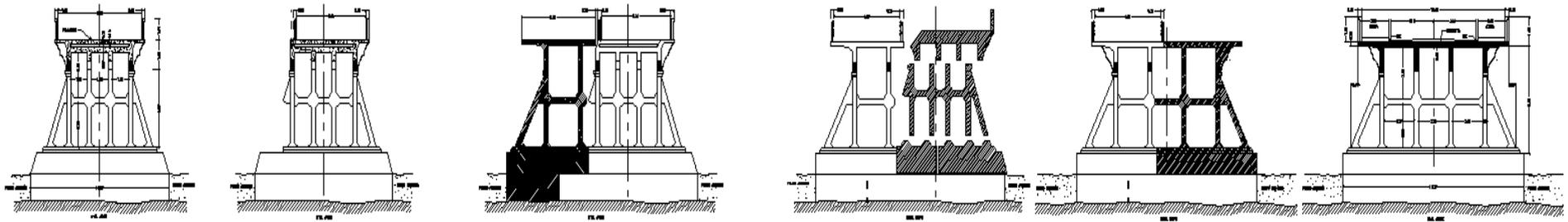


FIG. 01 : TRAMADO PREVILO
 FIG. 02 : CONSTRUCCION DE ACCESOS
 FIG. 03 :
 -SUPERF. 03 : MONTAJE PUENTE PUNTA SOBRE PUNTA LONGAROS

FIG. 04 :
 -SUPERF. 04 : DEMOLICIONES PARCIALES DEL PUENTE PREEXISTENTE

FIG. 05 :
 -SUPERF. 05 : CONSTRUCCION DE LAS BARRAS DE CIMENTACION
 -SUPERF. 06 : MONTAJE DE PLANTEL, PUNTALES Y CONSTRUCCION DE ANCLAJES DE PLANT
 -SUPERF. 06 : CONSTRUCCION DEL REMATELERO NORTE

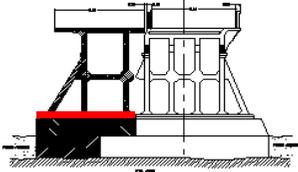
FIG. 06 : DEMOLICION DEL PUENTE PREEXISTENTE

FIG. 07 : CONSTRUCCION DEL REMATELERO SUR

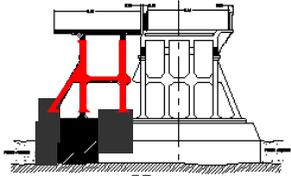
FIG. 08 : PUNTE EN TIELLO Y ACCESOS
 FIG. 09 : FINALIZACION DE LA OBRA



LA TOJA BRIDGE



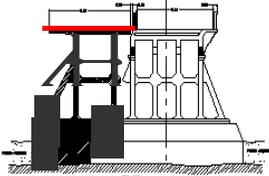
LA TOJA BRIDGE



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LA TOJA BRIDGE

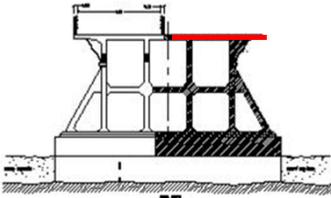


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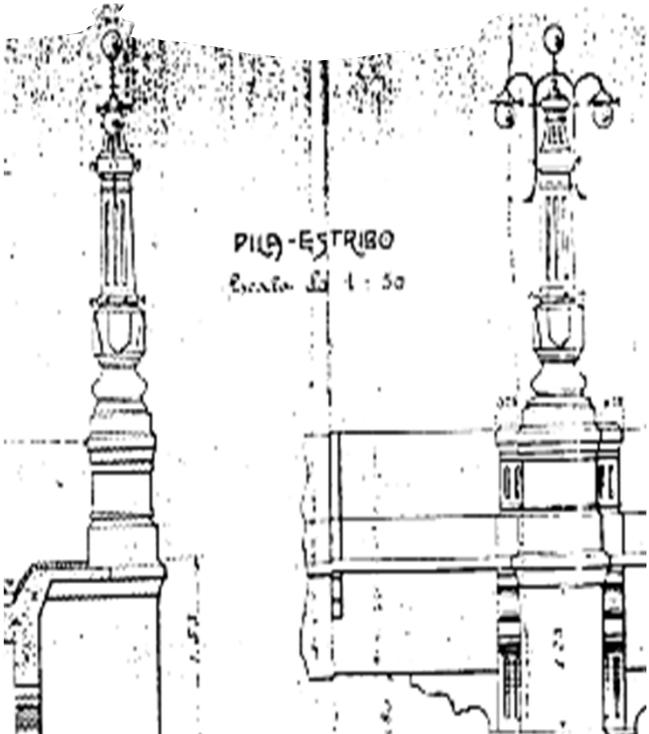


Budapest 06th of April of 2018

LA TOJA BRIDGE



LA TOJA BRIDGE



LA TOJA BRIDGE



OBSERVATORIO DE DURABILIDADE DA PONTE DA TOXA

AGOSTO DE 2002

- XUNTA DE GALICIA (C.P.T.O.P.V.)
- U.D.C. – U.P.M.
- VÍAS Y CONSTRUCCIONES, S.A.
- FHECOR INGENIEROS CONSULTORES, S.A.

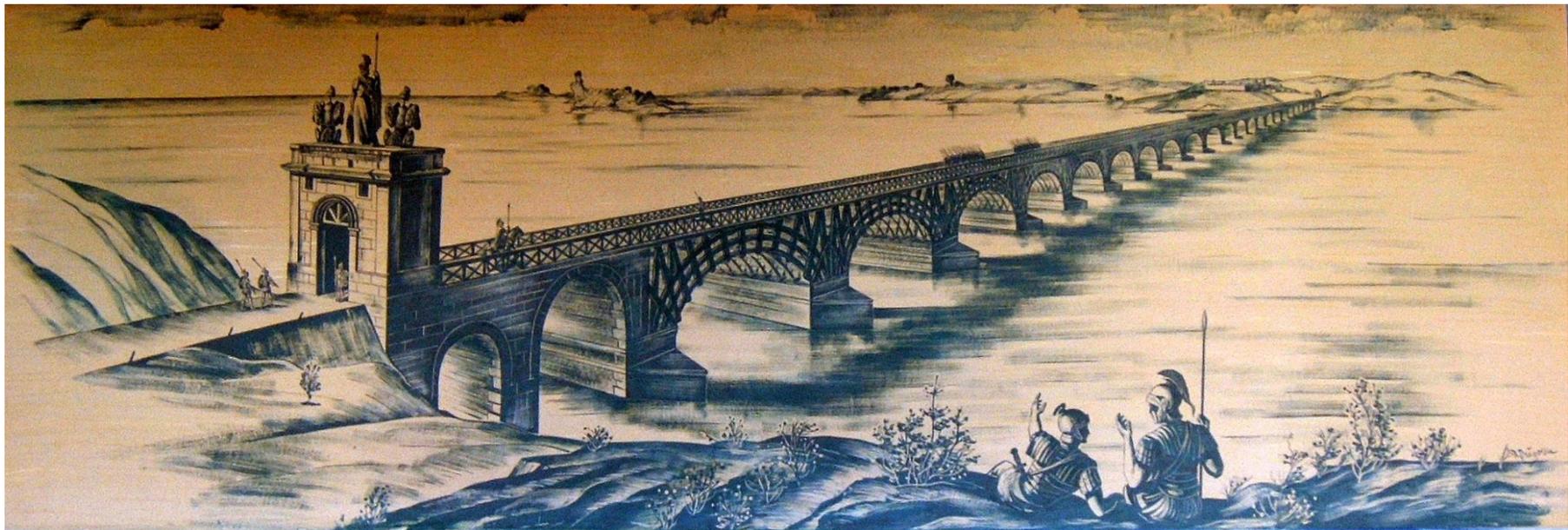
LA TOJA BRIDGE



Final Considerations

FINAL CONSIDERATIONS

APOLLODORUS OF DAMASCUS



GUERNICA

PABLO PICASSO (1881-1973)



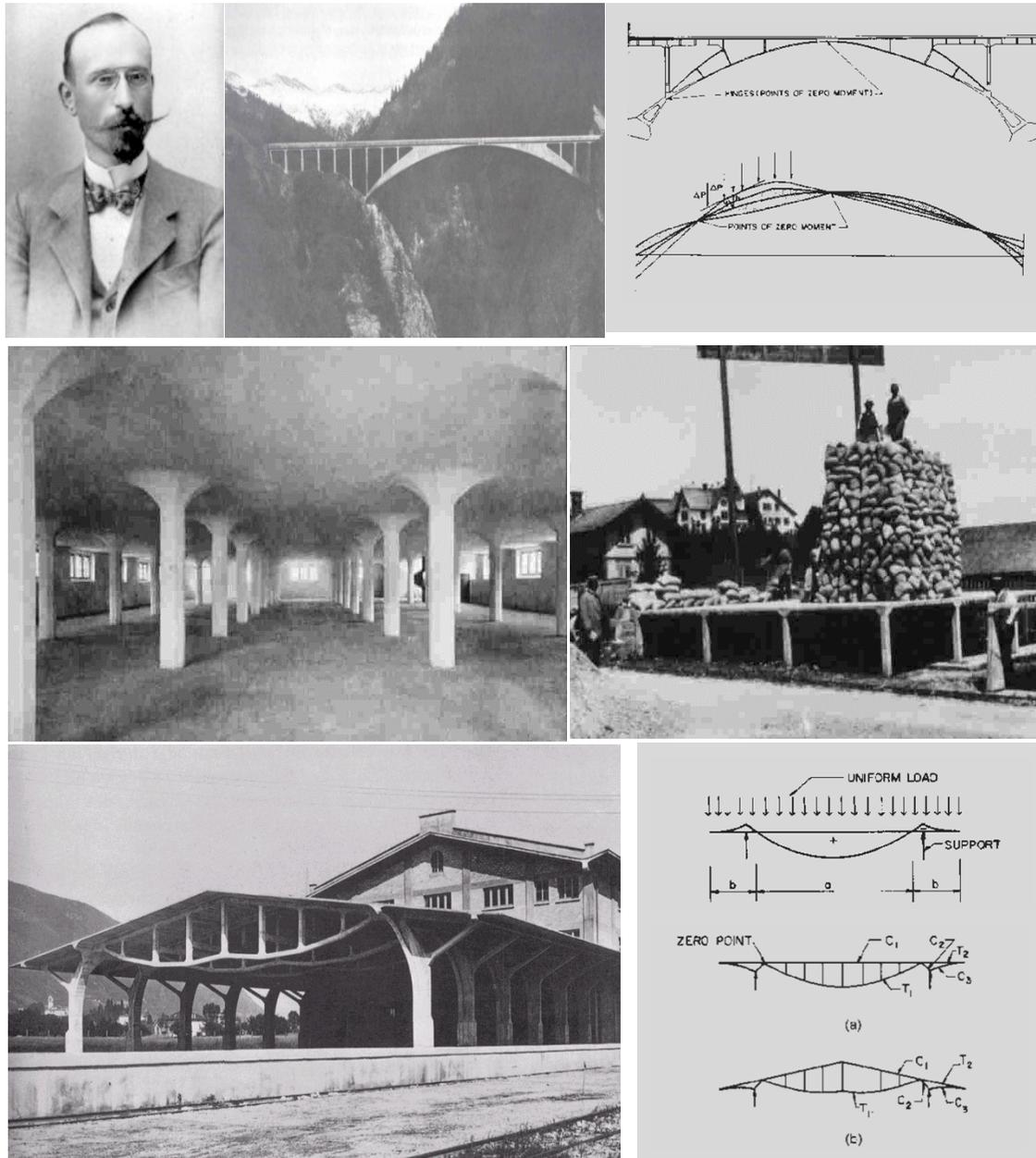
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Budapest 06th of April of 2018



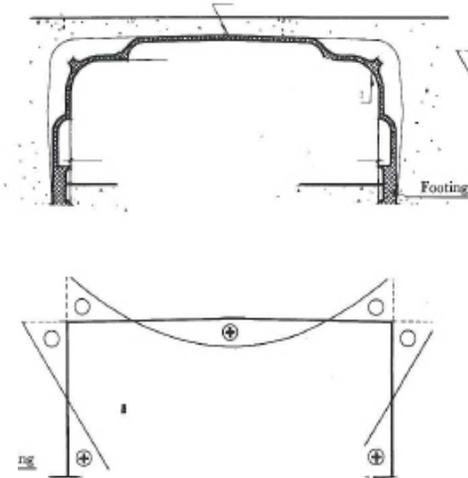
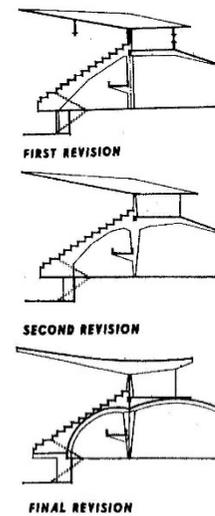
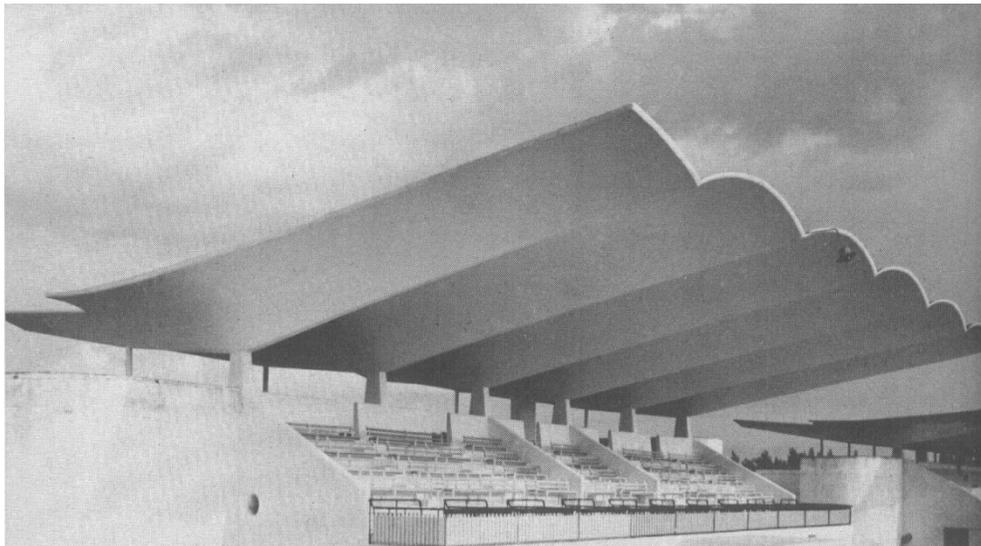
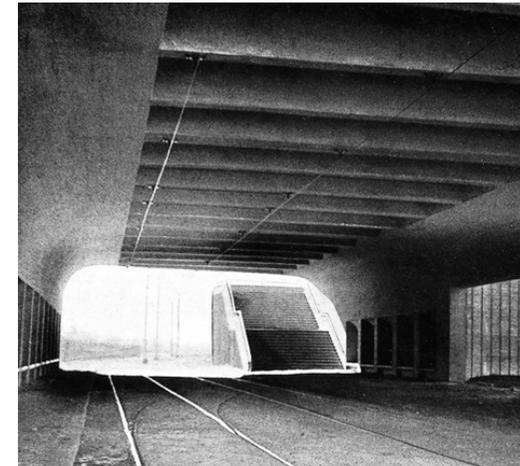
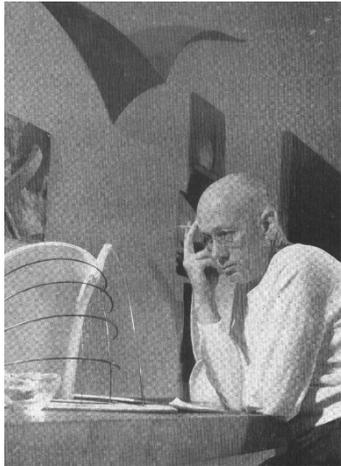
FINAL CONSIDERATIONS

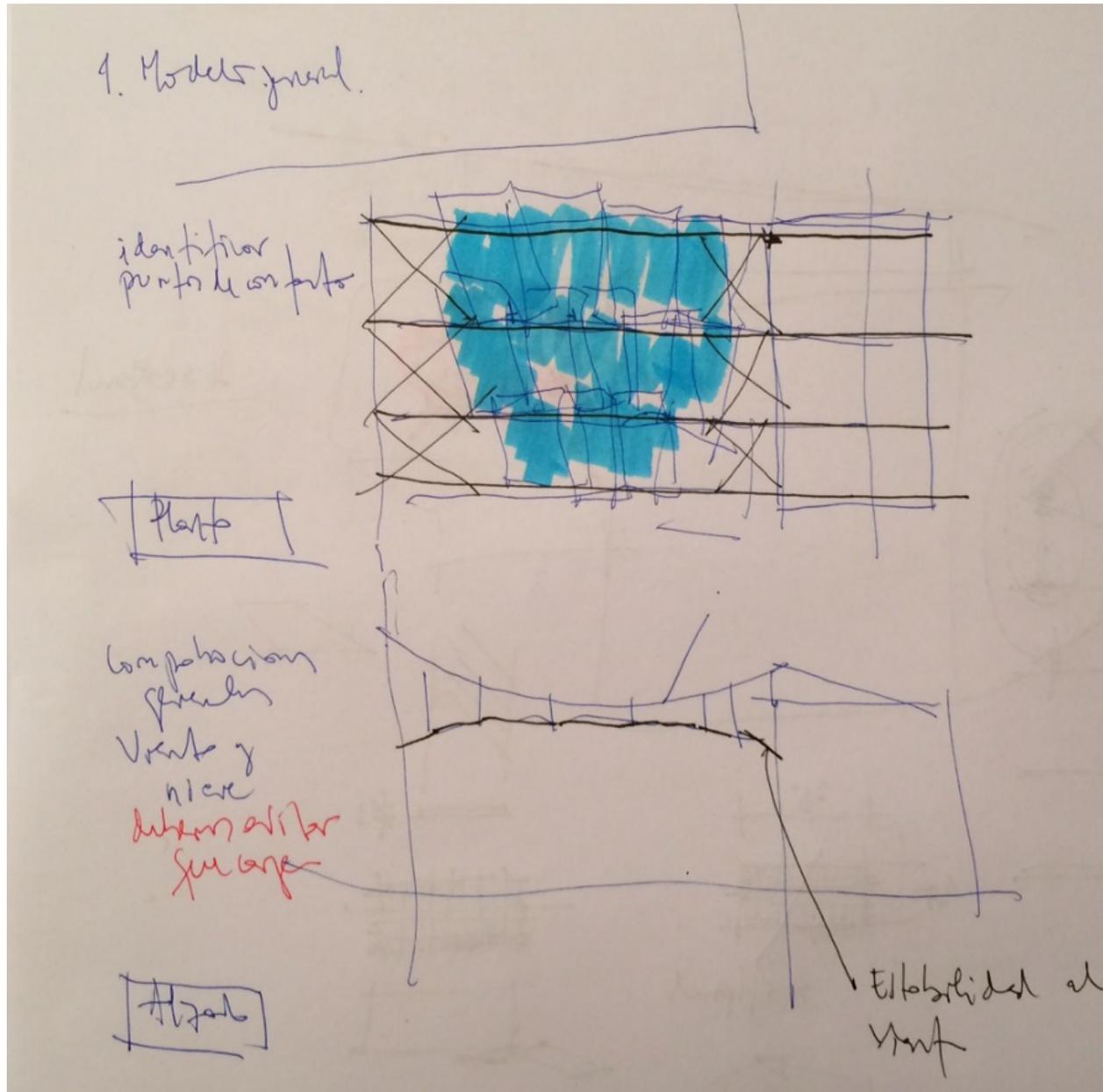
ROBERT MAILLART (1872-1940)

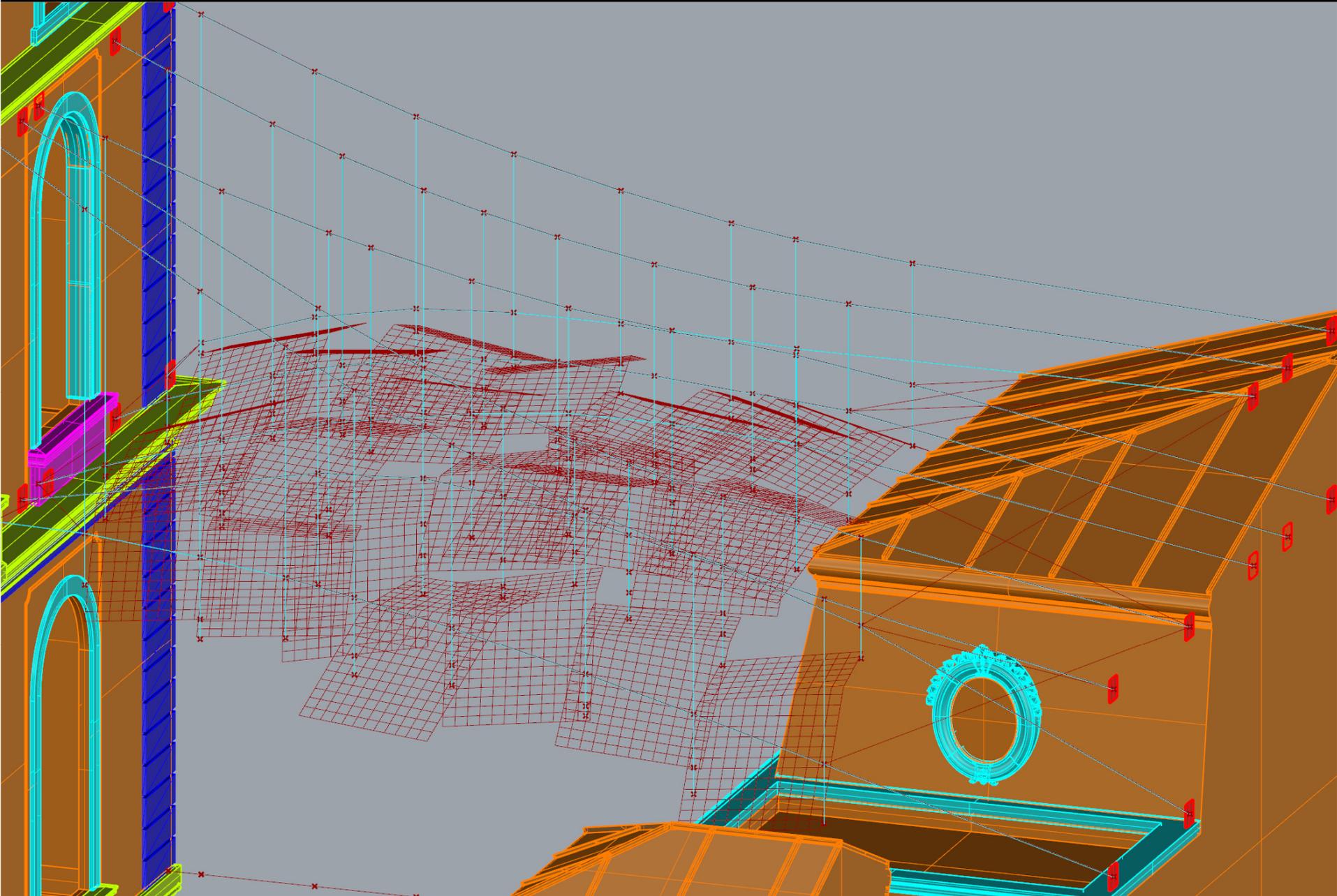


FINAL CONSIDERATIONS

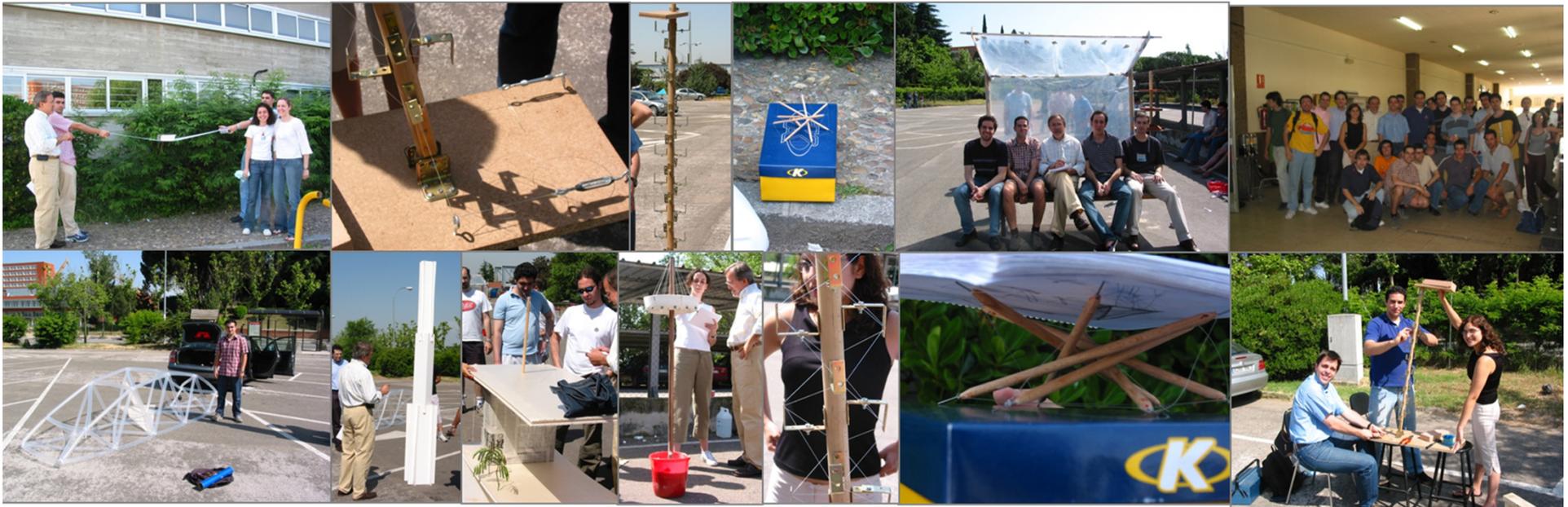
EDUARDO TORROJA (1899-1961)



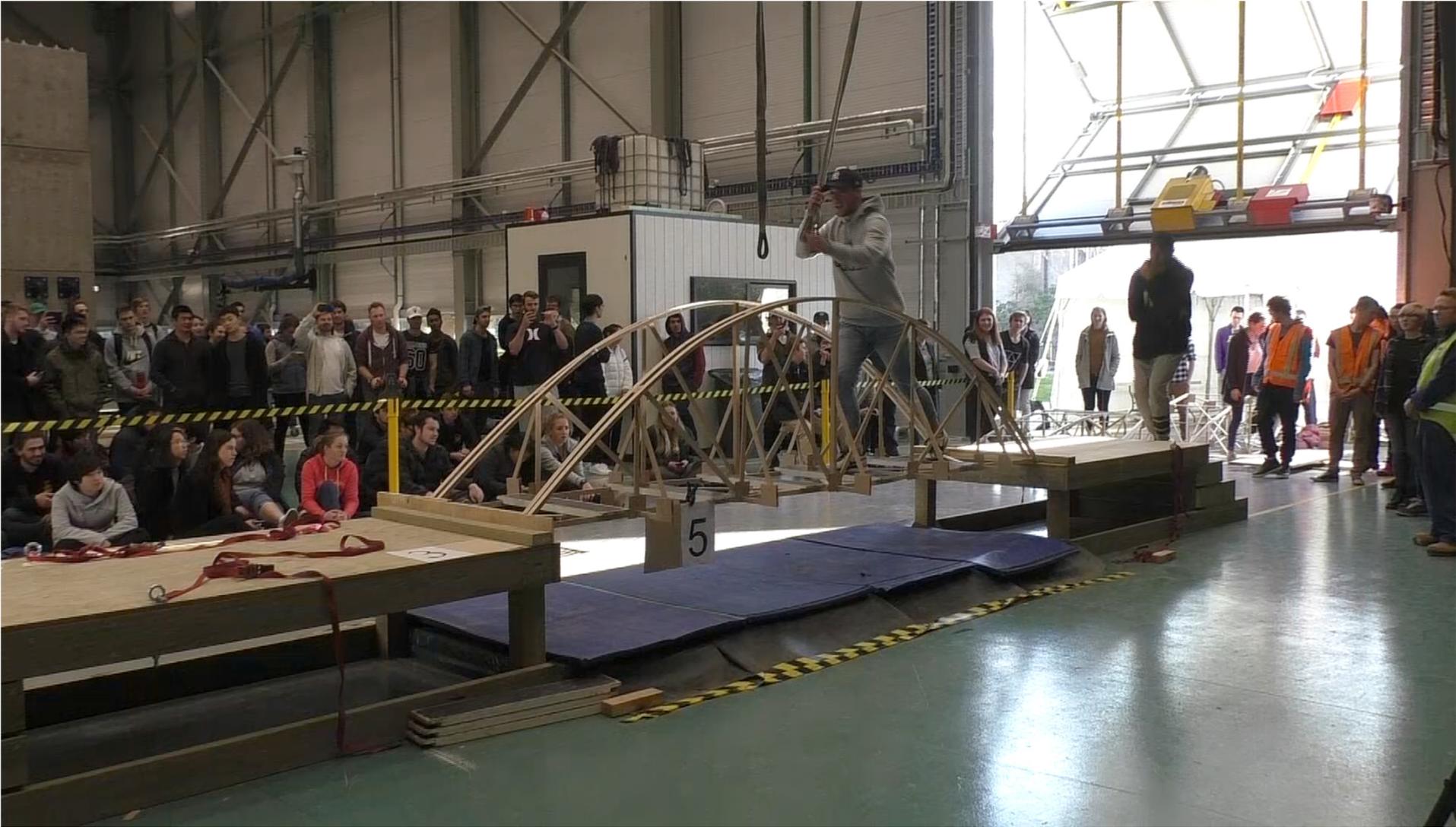








Students of the School of Civil Engineering of the Technical University of Madrid during the presentation of the class assignment of the subject Structural Typology, created by Torroja

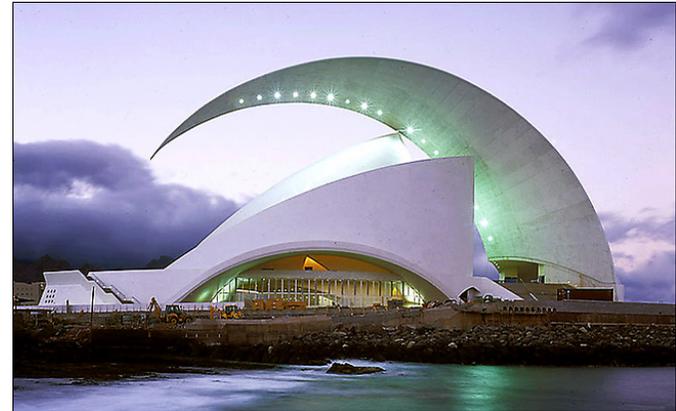
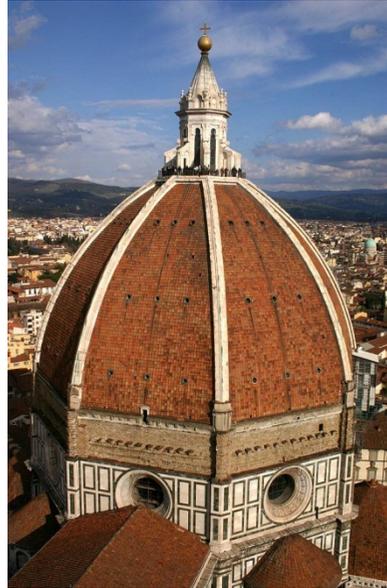




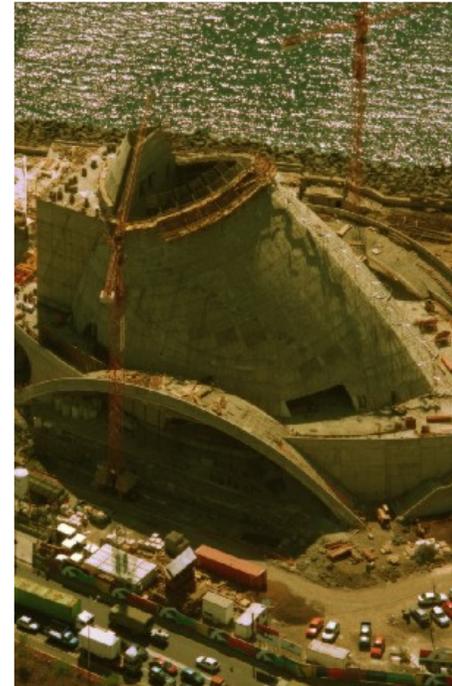
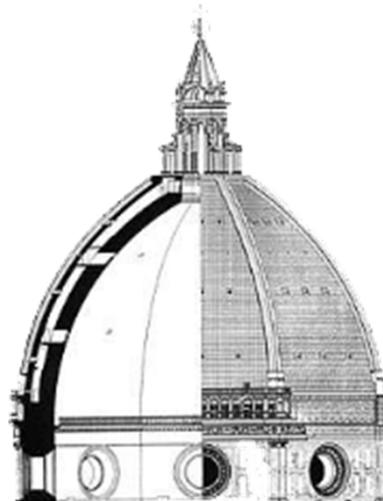
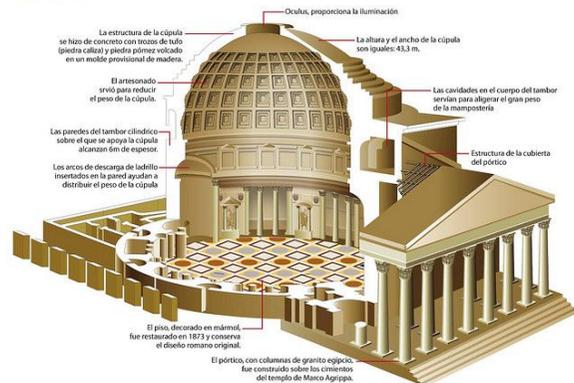


FINAL CONSIDERATIONS

THE VALUE OF HISTORY IN OTHER PROFESSIONS

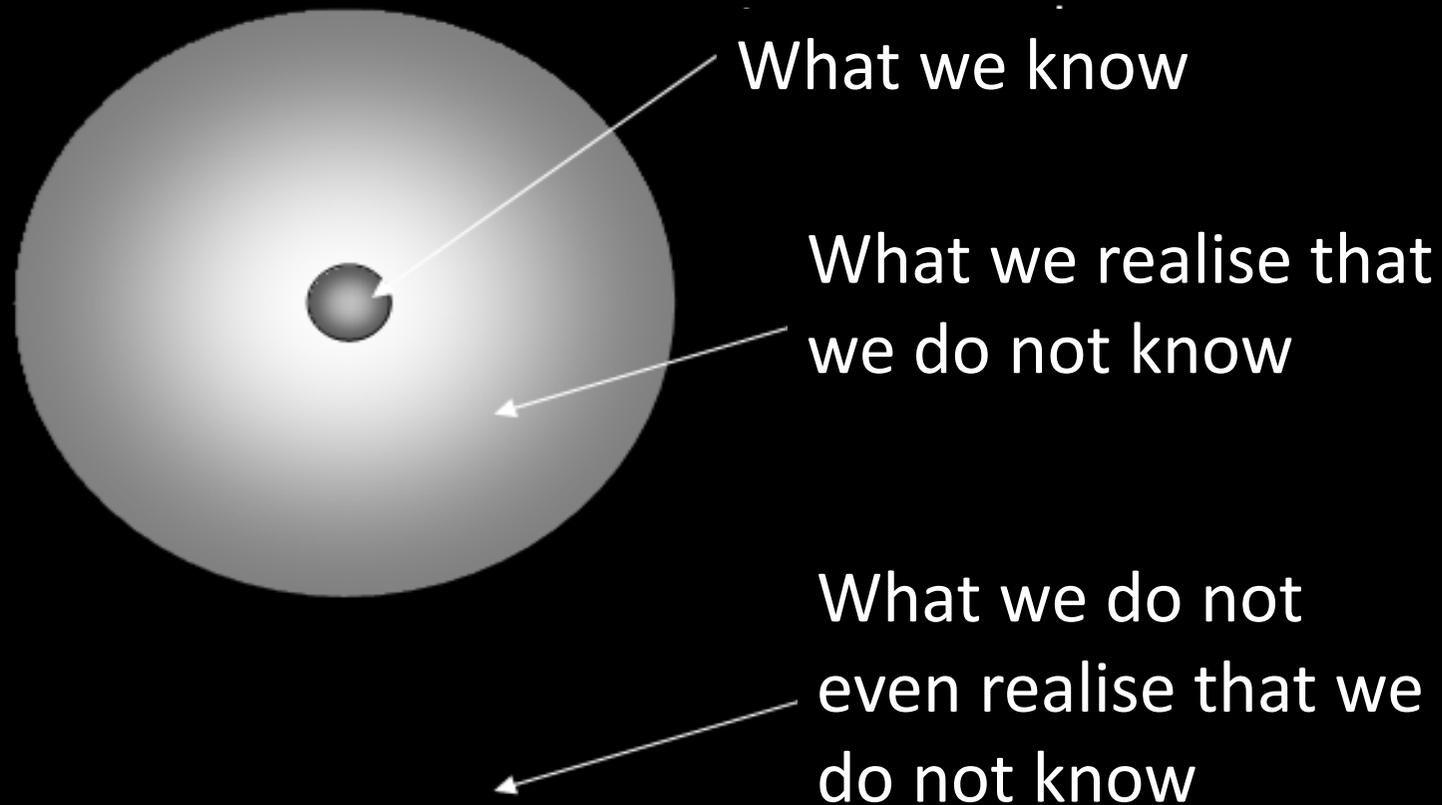


El Panteón



“Engineering is the art of modeling materials we do not wholly understand, into shapes we cannot precisely analyse, so as to withstand forces we cannot properly assess, in such a way that the public at large has not reason to suspect the extent of our ignorance.”

President of the Institution of Civil Engineers 1946



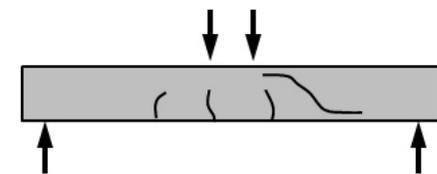
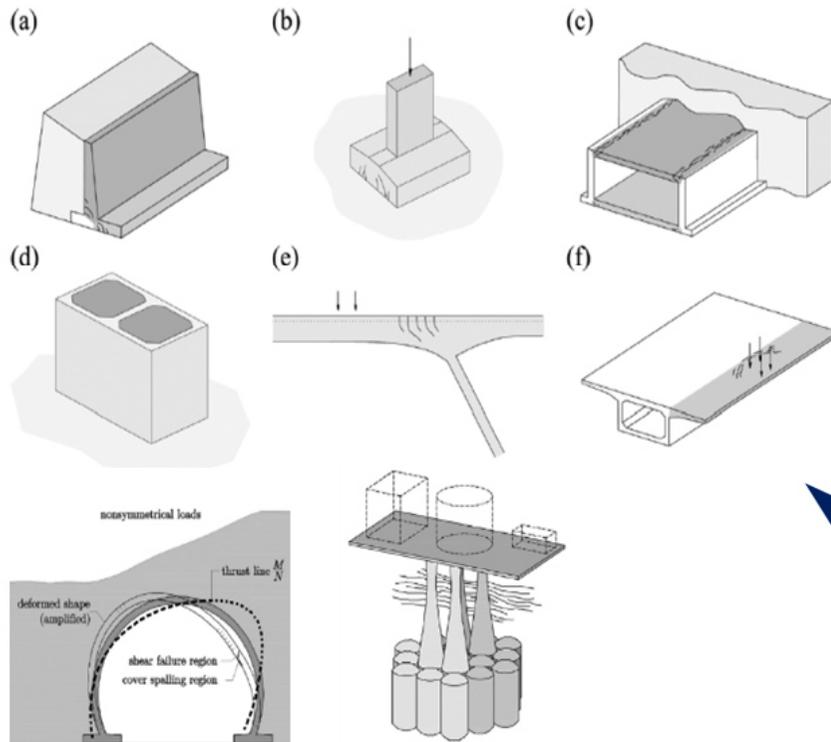
Mechanical models vs. empirical equations, the case of shear in members without transverse reinforcement

Practical needs

Simplification

Research

Testing



Understanding and modelling

$$V_R = \int_{\xi=0}^{d'} \tau \cdot b \cdot d\xi = b \int_{\xi=0}^{d'} \tau \cdot d\xi$$

Codes

Generalization

and not

Complication !



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