Davorin Kolic , Mohammad Irshad
Neuron Zagreb Ltd.
IDC Washington Ltd.

Feasibility of Peljesac Bridge Variants

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Concrete Engineering

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Strait crossing on example of the bridge

Land – peninsula PELJESAC in the south of Croatia

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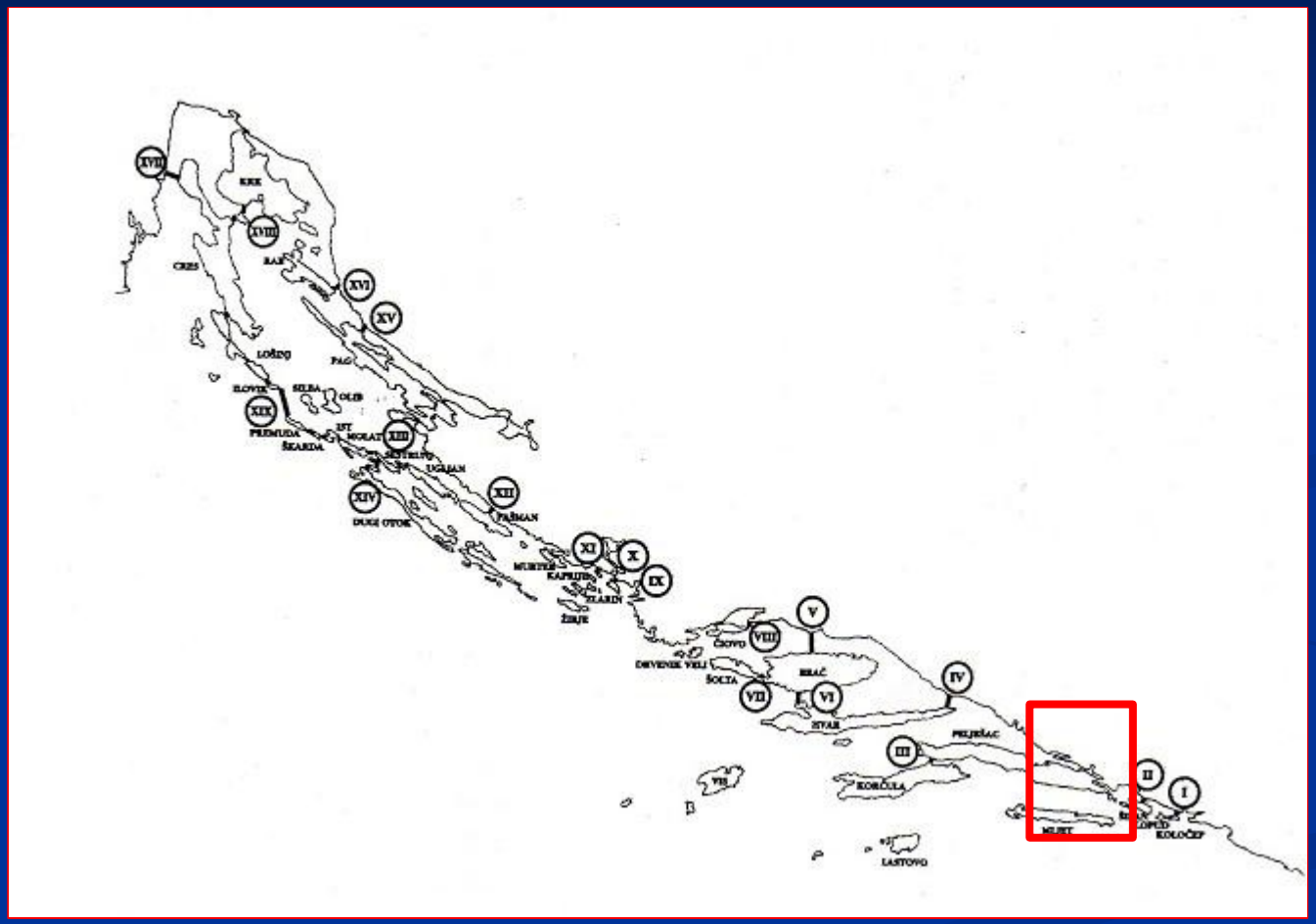
4. Feasibility : Economical optimization
5. Conclusion

1. About the Project

Location and the size of the project in southern Croatia



Adriatic coast :

- >1000 islands
- > 1000 km of land coast

Less population due to the

emigration in last 150 yrs

About 20 locations where strait crossings could be easily performed.

Connection with motherland as a basis for development of micro- and macro region.

1. About the Project

Location and the size of the project in southern Croatia

Crossings on the Adriatic coast :

- connections land-island or land-land or island – island
- lengths : 750 – 10 000 m
- max sea depths : 5 – 70 m
- average sea depths : 3-50 m

•Geology : limestone in banks
sedimentary deposits

Agressive surrounding :

Wind, earthquake, salt.

1. About the Project

Location and the size of the project in southern Croatia

Location of crossing 2300 m long.

Land – peninsula Peljesac crossing :

- road crossing
- min 2 lanes
- except in summer period (tourists) not so much traffic is to be expected
- strategic reasons
- basis for development
- public financing

  (Republic of Croatia)

2. Project development

Bridge Rion-Antirion, Greece

Crossing of 2250 m length constructed as cable-stayed bridge with 4 pylons, 5 spans, max.560 m

Main data :

* DBOT project (concession)
* traffic connection
* Idea >100 years old
* Project development
  >20 years long
* basis for development
* costs ~13.000 €/m²
* private financing
  (bank consortia)
  20 % financing costs

2. Project development

Excerpt from „Hong Kong – Zhuhai – Macau Bridge : Feasibility Study“

Impacts and influences :

* Economic : unemployment > construction industry > trade

* Socio-economic : deeper socio-economic integration of entire area

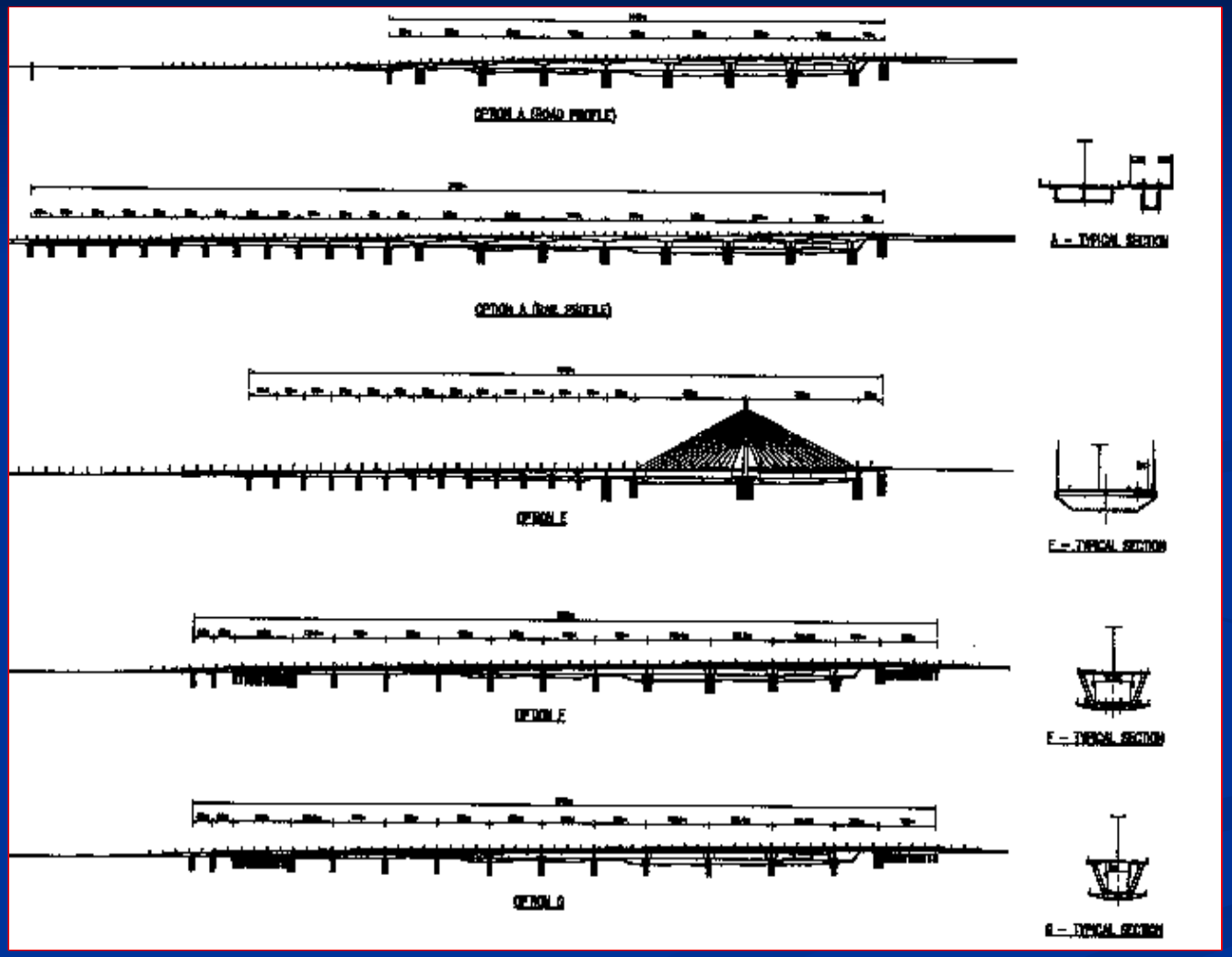
* Tourism industry : touristic lines Macau - Hong Kong - mainland China

* Logistics : Transport infrastructure + shipping (cargo terminals)

* Environmental : flora, fauna, heritage, noise, ecology

2. Project development

Bridge over Danube river from Vidin, BG – Calafat , RO

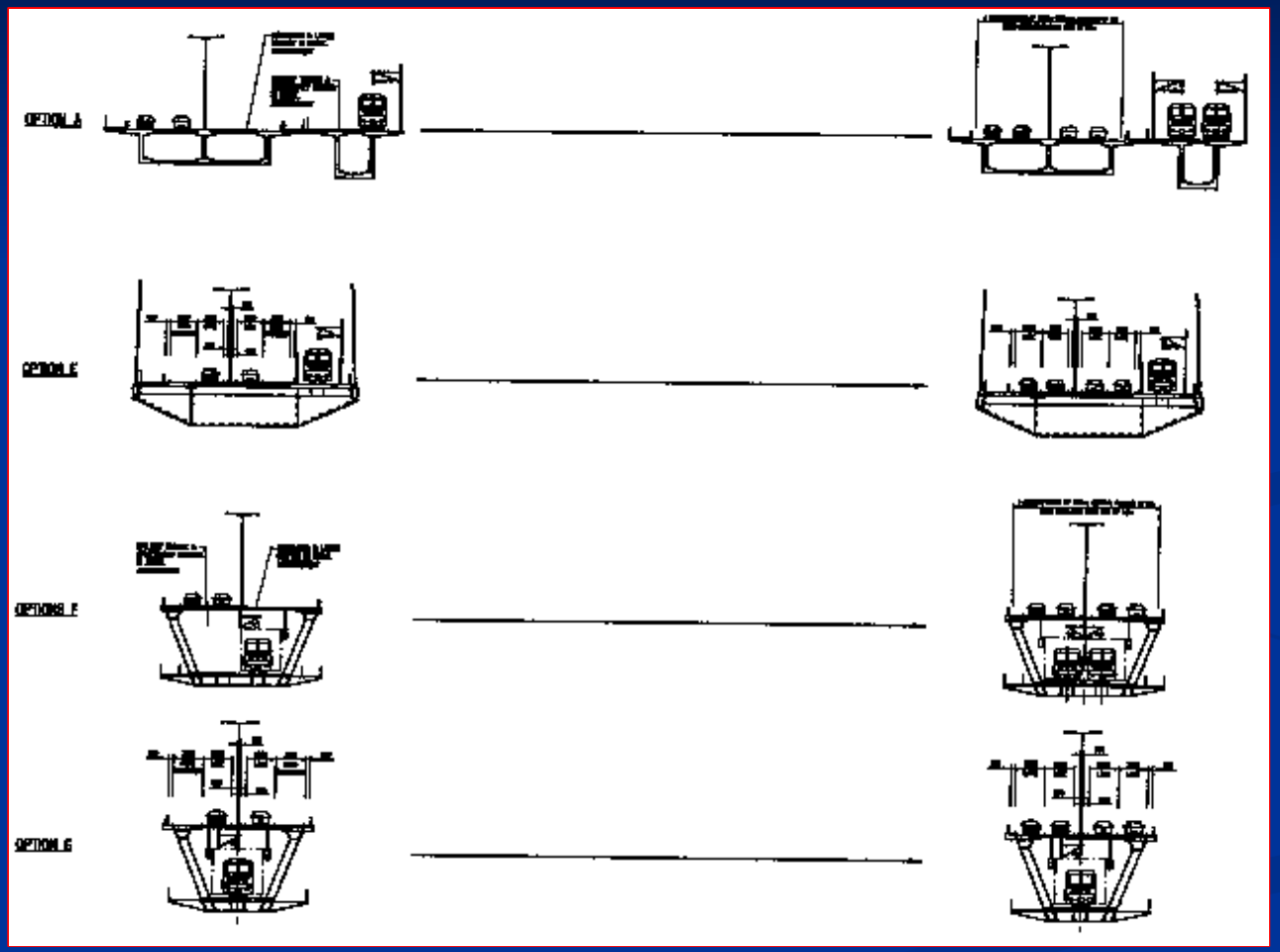


Main data :

* prelim.phase
* traffic connection
* Road + rail
* basis for development
* costs : undefined
* EU financing
  (fight for each €)
* Internationally
  announced project

2. Project development

Bridge over Danube river from Vidin, BG – Calafat , RO



Main data :

* 2200 m long

* divided in phases

* Phase I :

should cover not more than existing needs

Investigated :

concrete, steel, composite options

5 remained for final decision

3. Comparing options

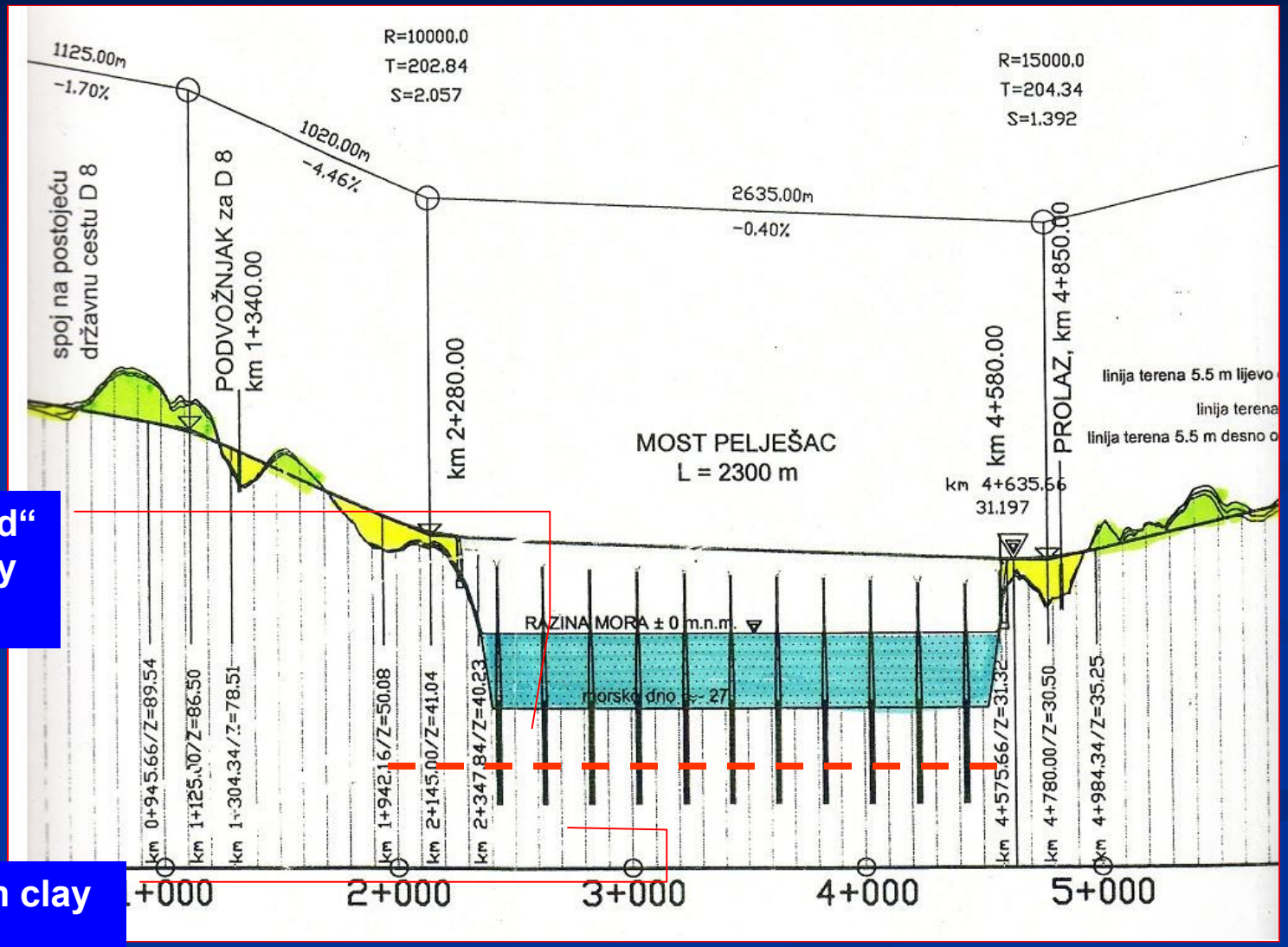
Boundary conditions for strait crossings on the Adriatic coast

* wind : bura / jugo, along entire cost
- earthquake : strong influence, along entire coast
- salt : intensive influence, with wind + sun
- prefered structures : no preference, since now mostly arches
- crossing lengths : 2000 – 7500 m, max. 10 000 m
- foundation : mostly caissons(since now), 50 m depth
- ship traffic : low, (in mid-span max 50 m height)

expected costs increases : mostly foundation + maintenance

3. Comparing options

Longitudinal alignment : bridge to Peljesac

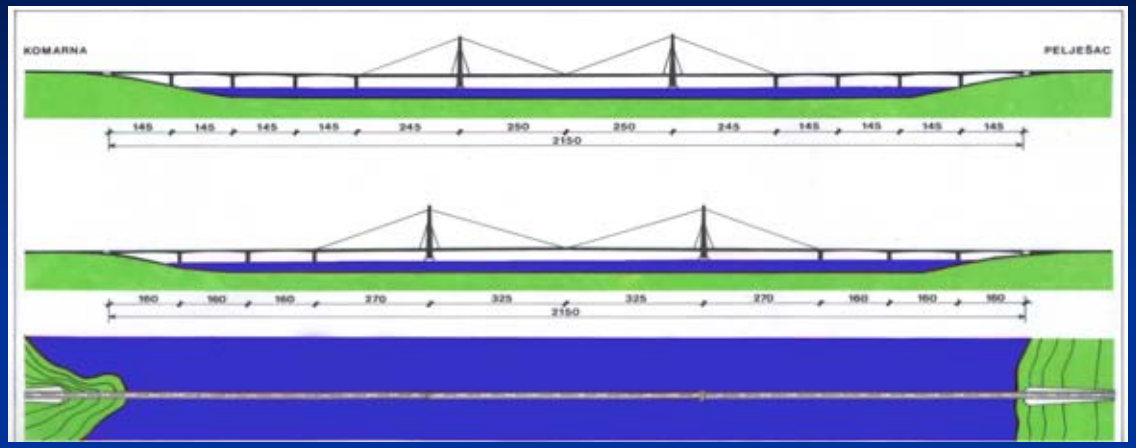


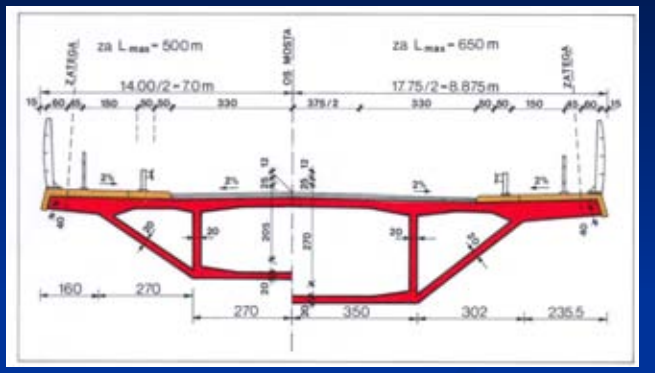
7 m „mud“ silt, silty sand

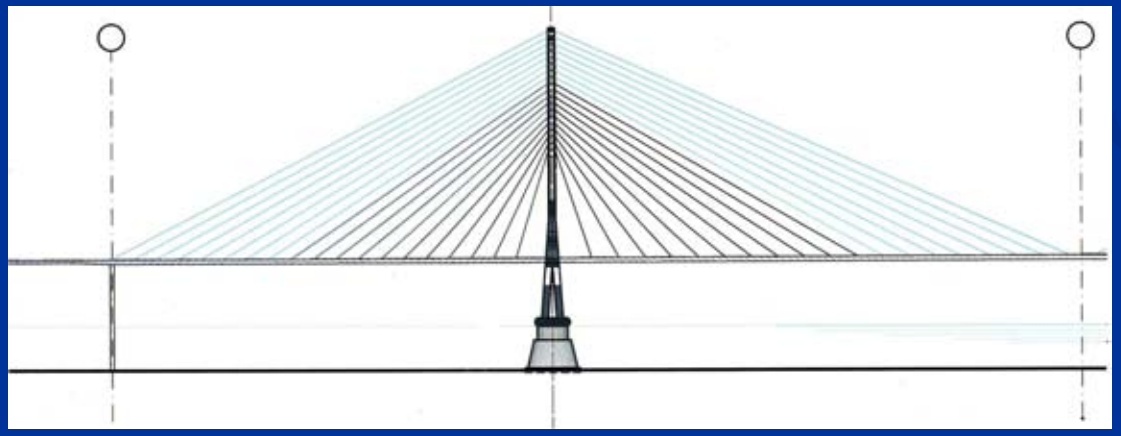
63 m clay

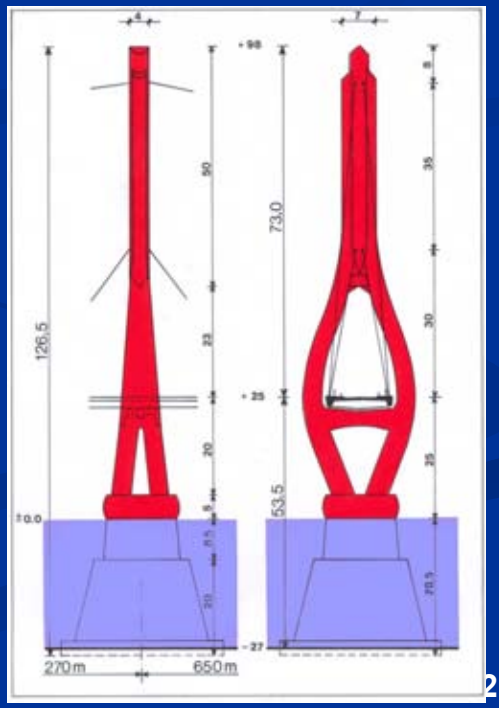
3. Comparing options

Some options with cable stayed bridges





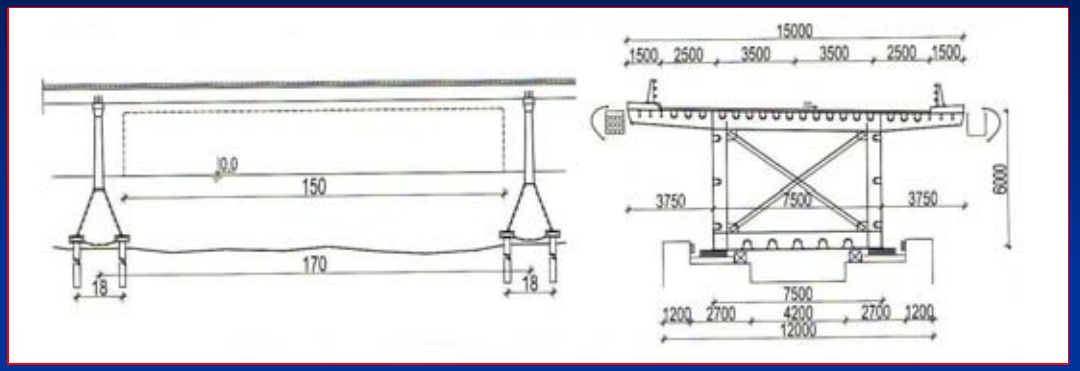




Early investigations for the crossing with concrete CBS (Kolic, Radic, 2003-04),opt. No.“1“

3. Comparing options

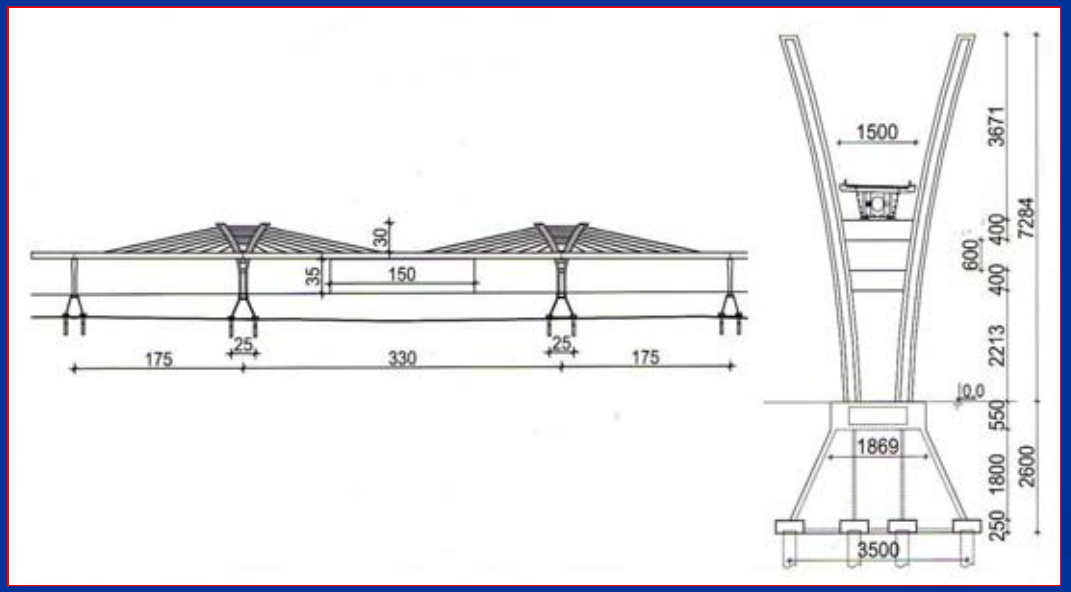
Some options for the crossing to Peljesac



Last preffered solutions for the crossing :

Continuous hollow box girder,

- spans 170 m (opt. No.“2“)



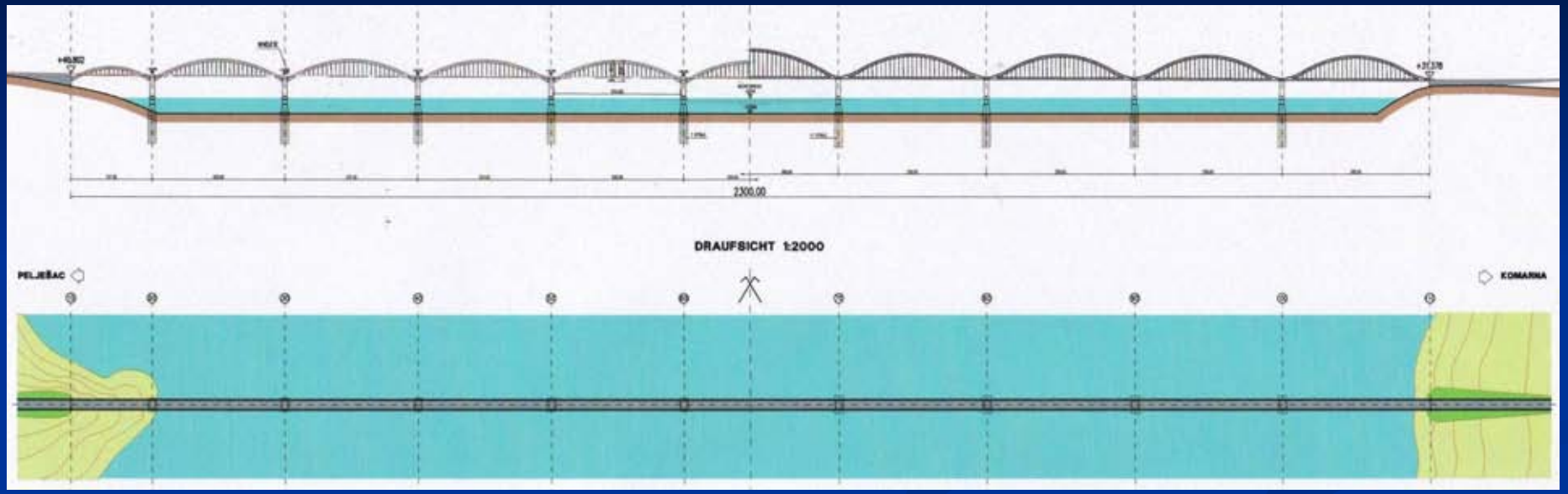
Continuous hollow box girder with the main span with 2 pylons

- main span 330 m (opt. No.“3“)

Unfortunately : options developed with no official competition and public announcement

3. Comparing options

Bridge variants for the crossing to Peljesac



Set of concrete arches

Option no. „4“, steel deck

spans 225 m, 10 columns

RC piles 2.5 m diameter

Set of „Langer“ girders

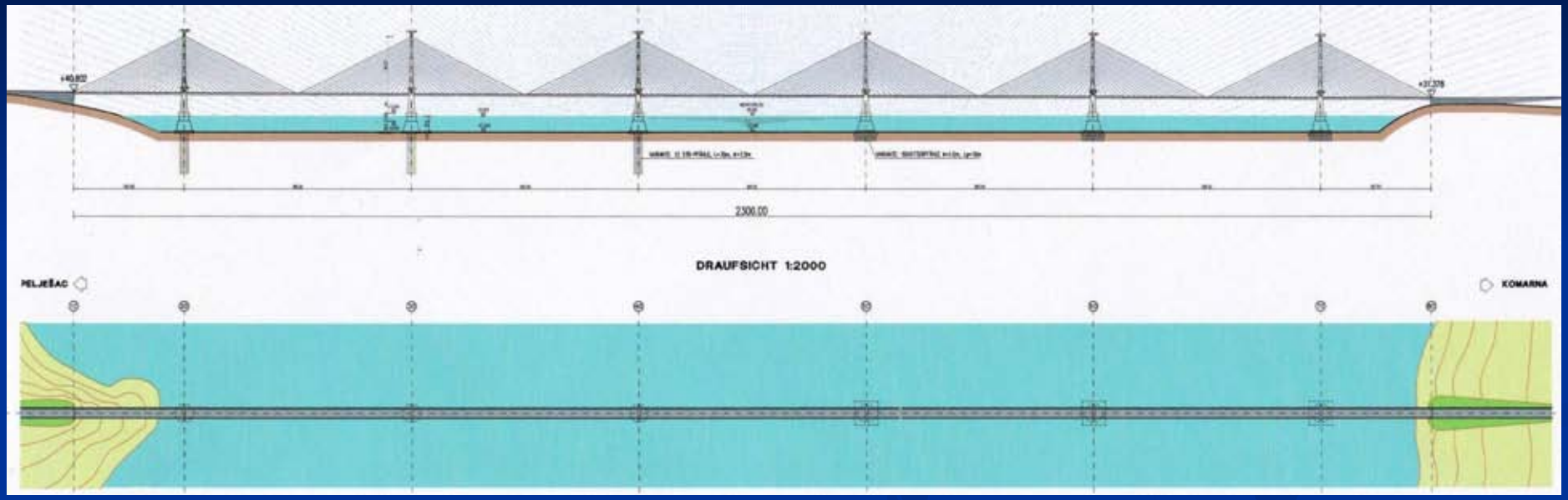
Option no.“5“, steel deck

Spans 300 and 250 m, 8 columns

RC piles 2.5 m diameter

3. Comparing options

Bridge variants for the crossing to Peljesac



CBS with 6 pylons

Option no. „6“, steel deck

spans 385 m, 6 pylons

Foundation : RC piles 2.5 m diameter

CBS with 6 pylons

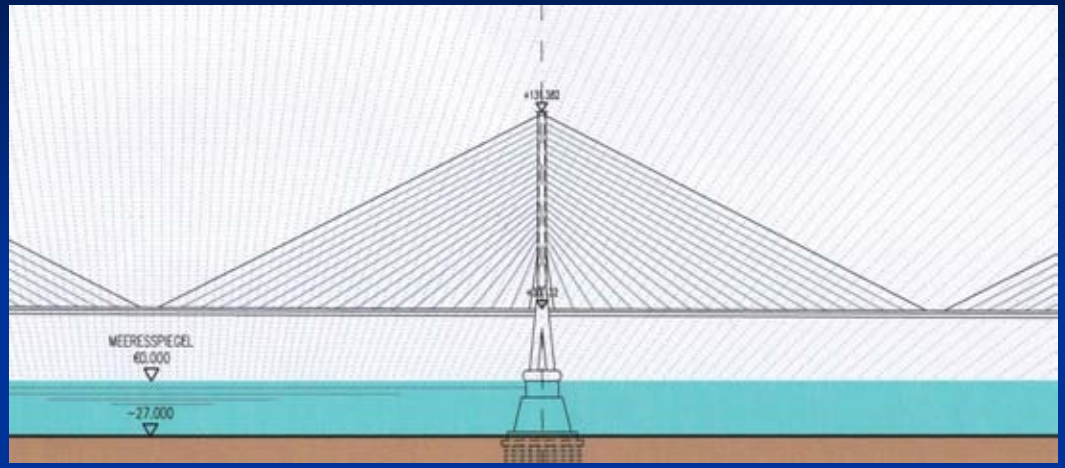
Option no.“7“, steel deck

spans 385 m, 6 pylons

„stone columns“ of 1.0 m diameter as soil improvement

4. Feasibility : Economical optimization

Superstructure : Optimization of structural elements and costs



Pylon of CBS variant

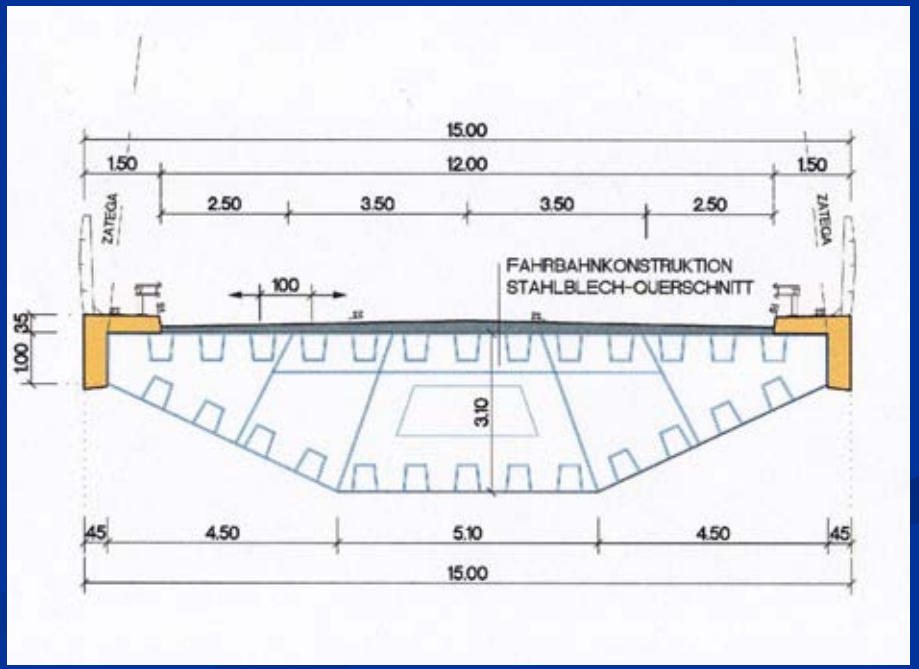
Design against :

salt, earthquake, wind

CBS stiffening girder cross section :

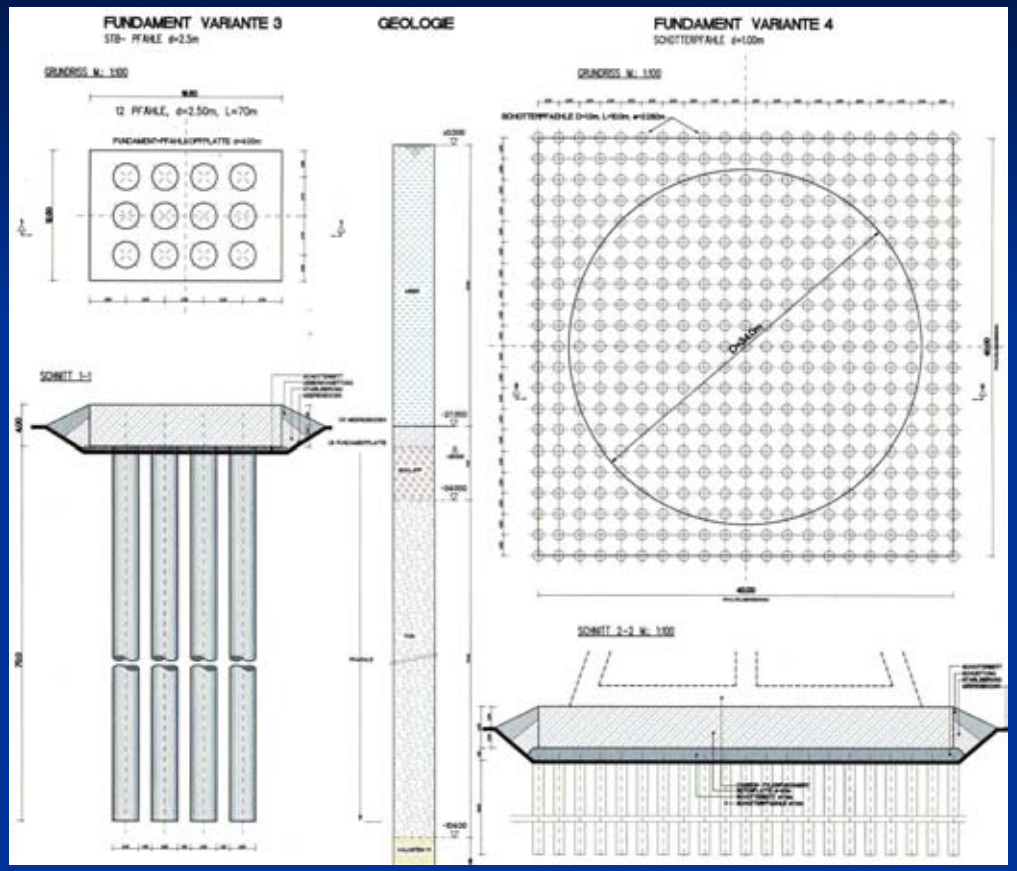
steel hollow box

protection against wind



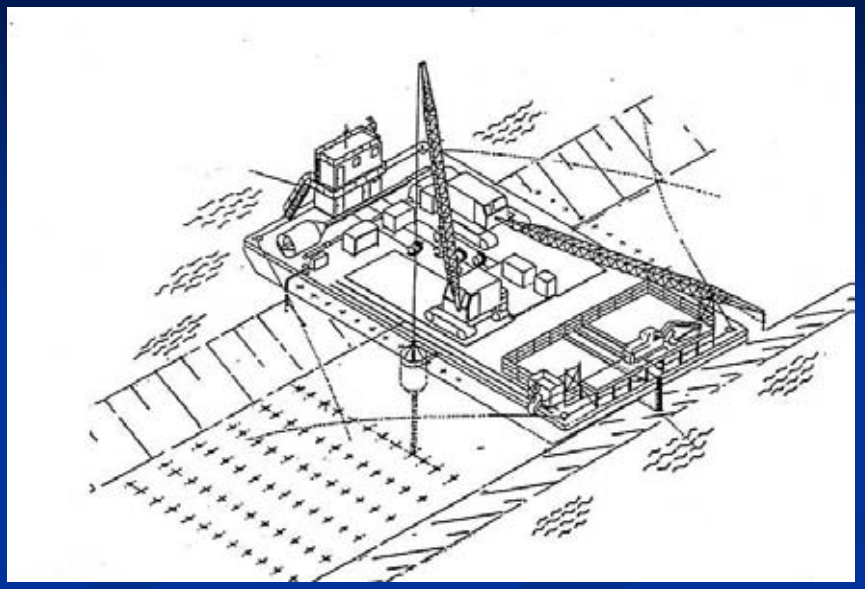
4. Feasibility : Economical optimization

Substructure : Foundations



Foundation options :

RC piles and Stone (gravel) columns, as soil improvement measure



Immersed tunnel Aktion – Preveza, Greece

Stone (gravel) columns :especially applicable in : earthquake zones, liquefiable soils (sand, silt)

Designed for :

Merc: 7,3 deg. In 1000 years (0.4 g)

Merc. 7,5 deg. In 500 years (0.32 g)

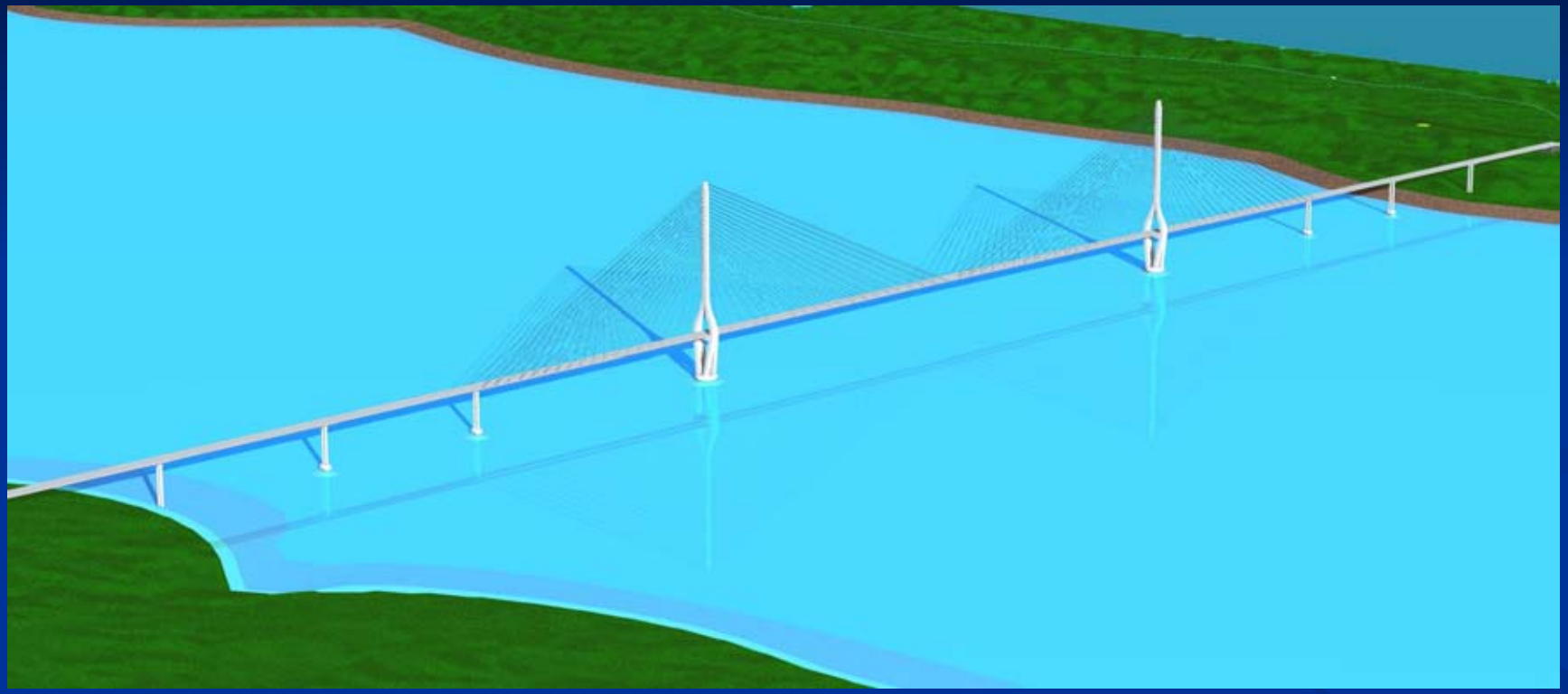
4. Feasibility : Economical optimization

Overview of overall estimated project costs

Nr.	Structure type	Max. Span [m]	No.of Found.	Tot. Costs [Mill.€]	Unit Costs [€/m²]	Substr. Costs [%]	Superstr. Costs [%]	Relat. [%]
1	Cable stayed bridge (fig.1) 2 pylons, RC piles	500	8	226.0	6.559	47.0	53.0	110
2	Variant "5", steel box (fig.2) 13 columns	170	13	241.0	6.989	52.0	48.0	118
3	Variant "9", cable-stayed 2 pylons, RC piles	330	12	231.0	6.691	48.0	52.0	113
4	RC Arch bridge, steel deck 10col., RC piles	225	10	700.0	20.312	17.0	83.0	341
5	Langer girder, steel arches 8 columns, RC piles	300	8	227.0	6.589	44.0	56.0	111
6	Cable stayed bridge, 6 pyl., steel box,RC piles	385	6	205.0	5.914	40.0	60.0	100
7	Cable stayed bridge, 6 pyl., found. on "Stone colum."	385	6	209.0	6.054	42.0	58.0	102

4. Feasibility : Economical optimization

Optimization of structural elements and costs



CBS : economically and aesthetically most attractive

Stay cables : 24.0 mill. € for 2 pylon option

Dispersion of estimated costs for all options due to foundations.

5. Conclusion

- Analysis and design based on cost-optimization approach

  already for very early conceptual design phase

- Estimating overall project costs including :

  construction, project development, design consultancy etc.

- Competition of solutions and variants :

  bringing cost reduction potential