ARCADIS

MILLAU BRIDGE

Infrastructure

Environment

Buildings

From the dream to the reality

Summary

- Where and why
- History
- Global Design
- Structure & Foundation Design
- Construction

WHERE & WHY ?

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WHERE & WHY ?

- To complete the A75 alternative north-south road to the A7/A6 in the Rhône Valley
- To avoid the crossing of the city of Millau by the RN9 and its huge traffic jams every summer

WHERE & WHY ?


UNITED KINGDOM
ROYAUME-UNI
London
Londres
NETHERLANDS
PAYS-BAS
Brussel
Bruxelles
Lille
BELGIUM
BELGIQUE
LUXEMBURG
LUXEMBOURG
GERMANY
ALLEMAGNE
N
PARIS
Strasbourg
Rennes
Nantes
SWITZERLAND
SUISSE
Lausanne
La Rochelle
Lyon
ITALY
ITALIE
A75
Torino
Turin
Bordeaux
Viaduc
de Millau
Montpellier
Nice
Toulouse
Marseille
Corse
Ajaccio
0
200 km
SPAIN
ESPAGNE


Engayresque
Paris
A75
Millau
Barcelone
RN9
Tarn
Barrière
de péage
MILLAU
Grand
viaduc
de Millau
RN9
A75
La Cavalerie
Section concédée
Échangeur
2 km

HISTORY

- 1975: Governmental decision to build the A 75
- 1989: Choice of the final route westward to Millau
- 1991: THE IDEA of an upper crossing of the valley
- 1992: Preliminary studies of the bridge (SETRA)
  - multiple cable stayed bridge (2 solutions)
  - classical concrete or metal (2 solutions)

HISTORY

- 1993: Competition for the design – Stage 1
  - 8 Engineers teams + 7 Architects teams, all 15 in parallel
  - analysis of the basic design and new proposals
- 1994: Mixing Engineers + Architects in 5 teams
  - to check the feasibility of a so exceptional bridge
  - to let the competitors imagine an alternative solution
  - to mix the engineers and the architects
- 1995 - 1996: Competition for the design

HISTORY

- 1996 July:

The multiple cable-stayed solution is retained and awarded to

THALES – ARCADIS – SERF + Norman FOSTER

& Michel Virlogeux

- 1997 – 1998: Preliminary and Final Design

- 1998 May, 20: Governmental decision for a concession

HISTORY

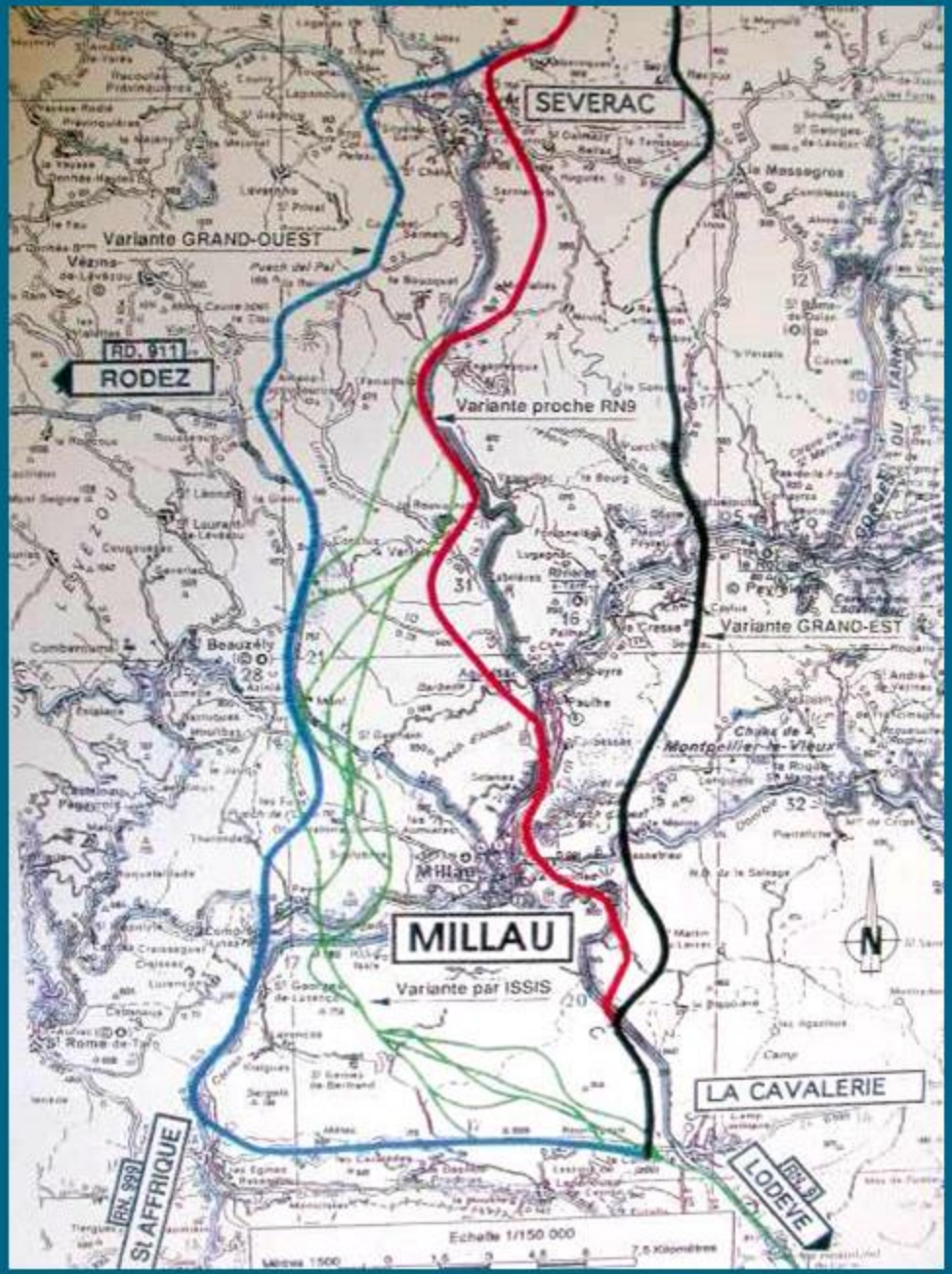
- 2000 – 2001: Bidding phase for the concession
- 2001 May, 30: EIFFAGE signed the concession contract
- 2001 – 2004: Construction
  - December 2001, 14: 'First stone'
  - December 2004, 14: Opening to the users

GLOBAL DESIGN

- Site conditions
- Users comfort
- Global wind effect

SITE CONDITIONS

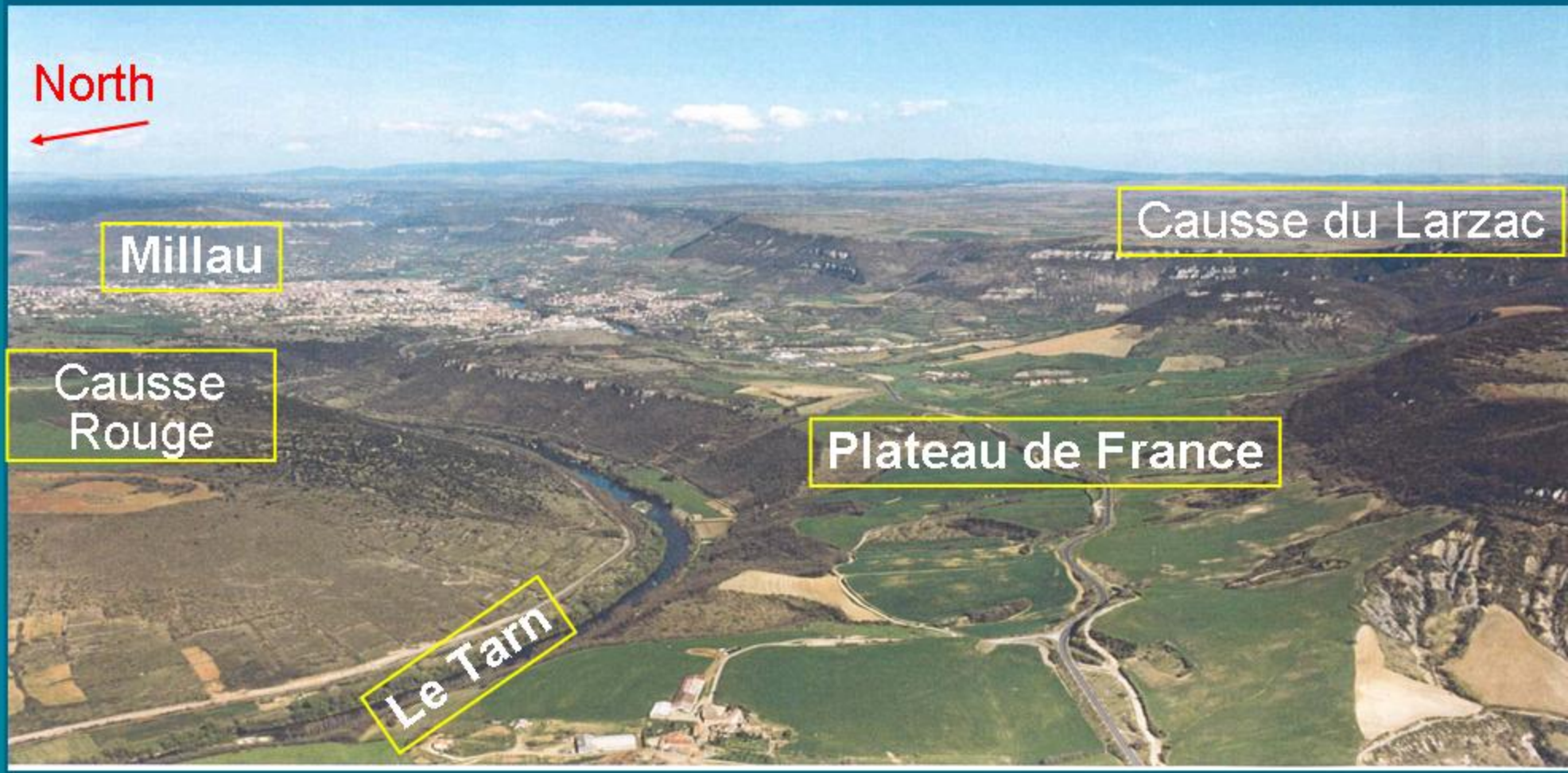
1989
Green route



Global Route

SITE CONDITIONS

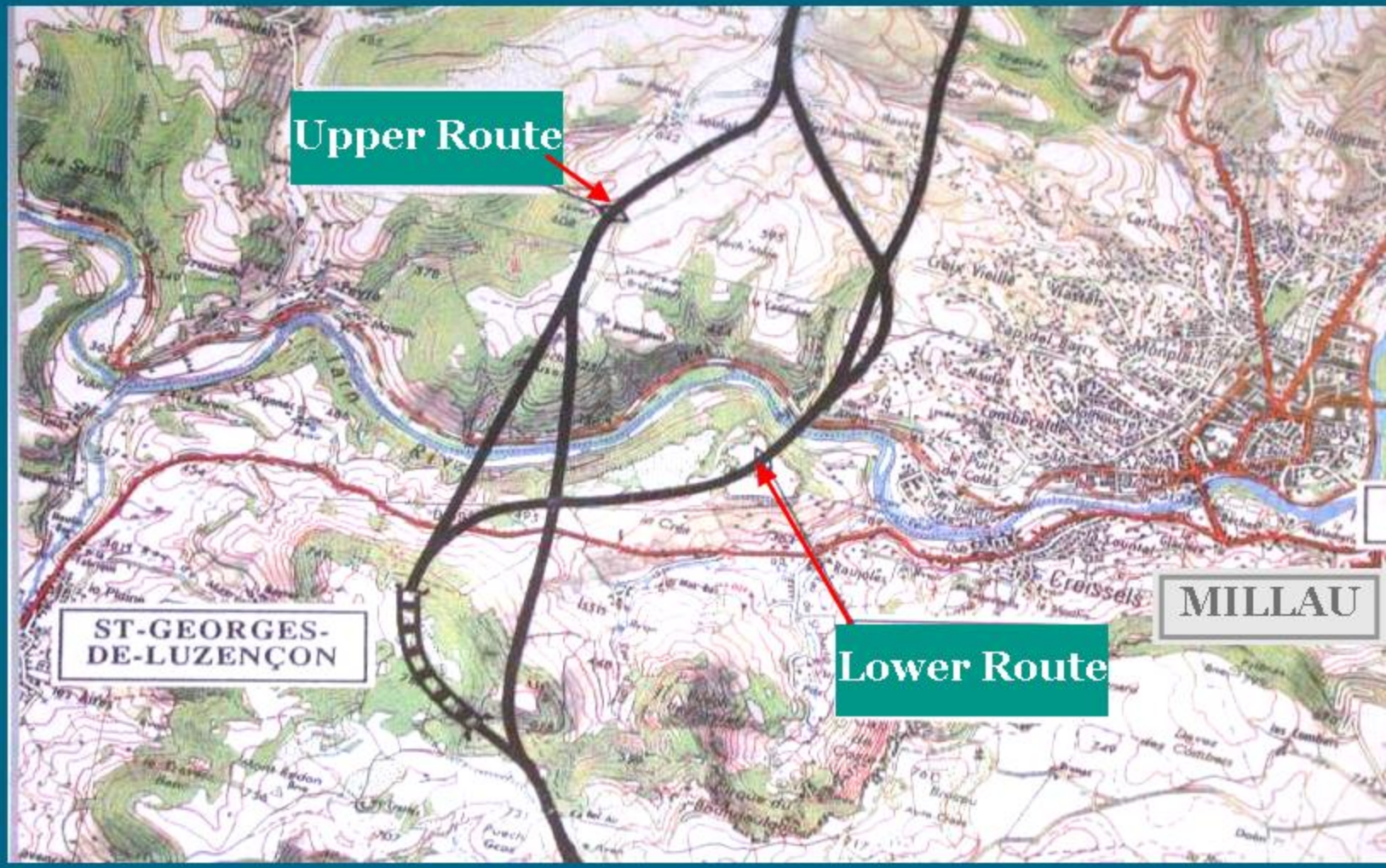
The Tarn valley



SITE CONDITIONS

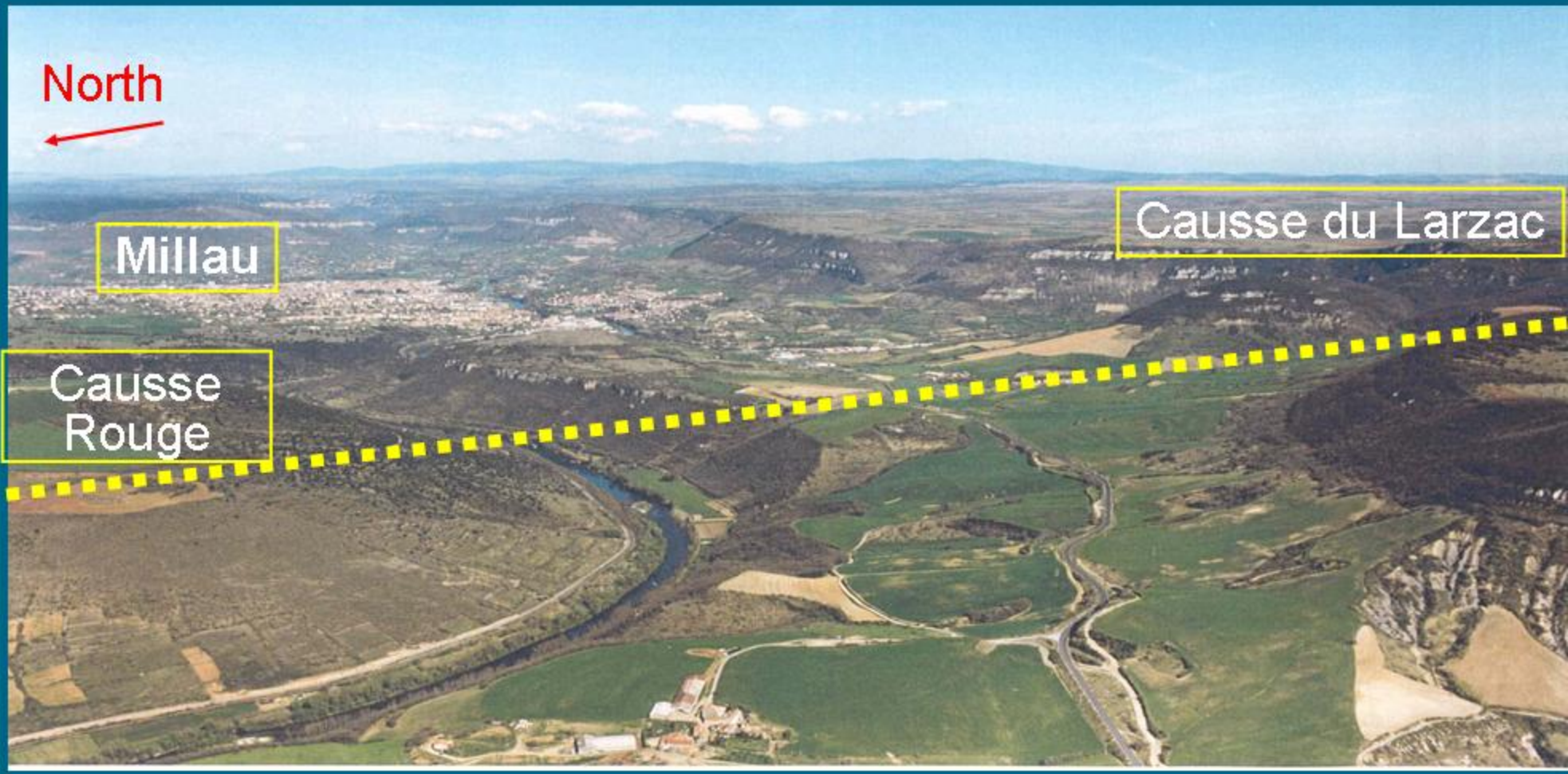
Local route

1991
Upper route



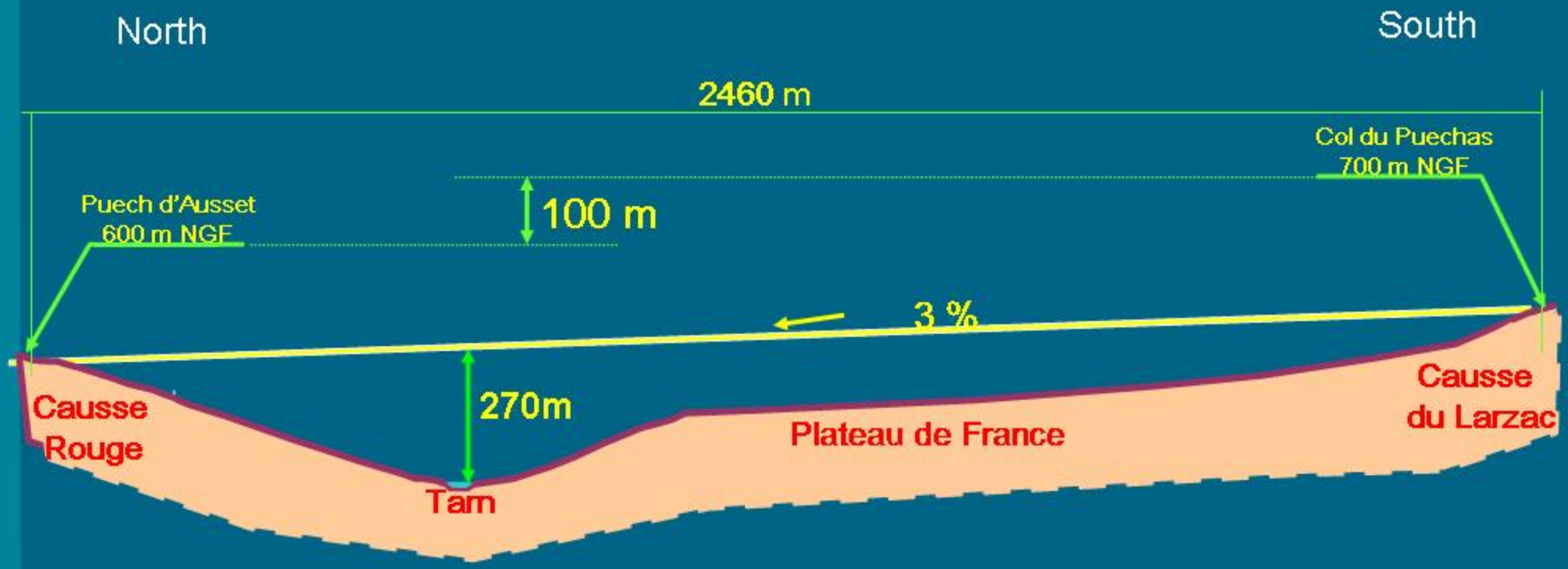
SITE CONDITIONS

Track



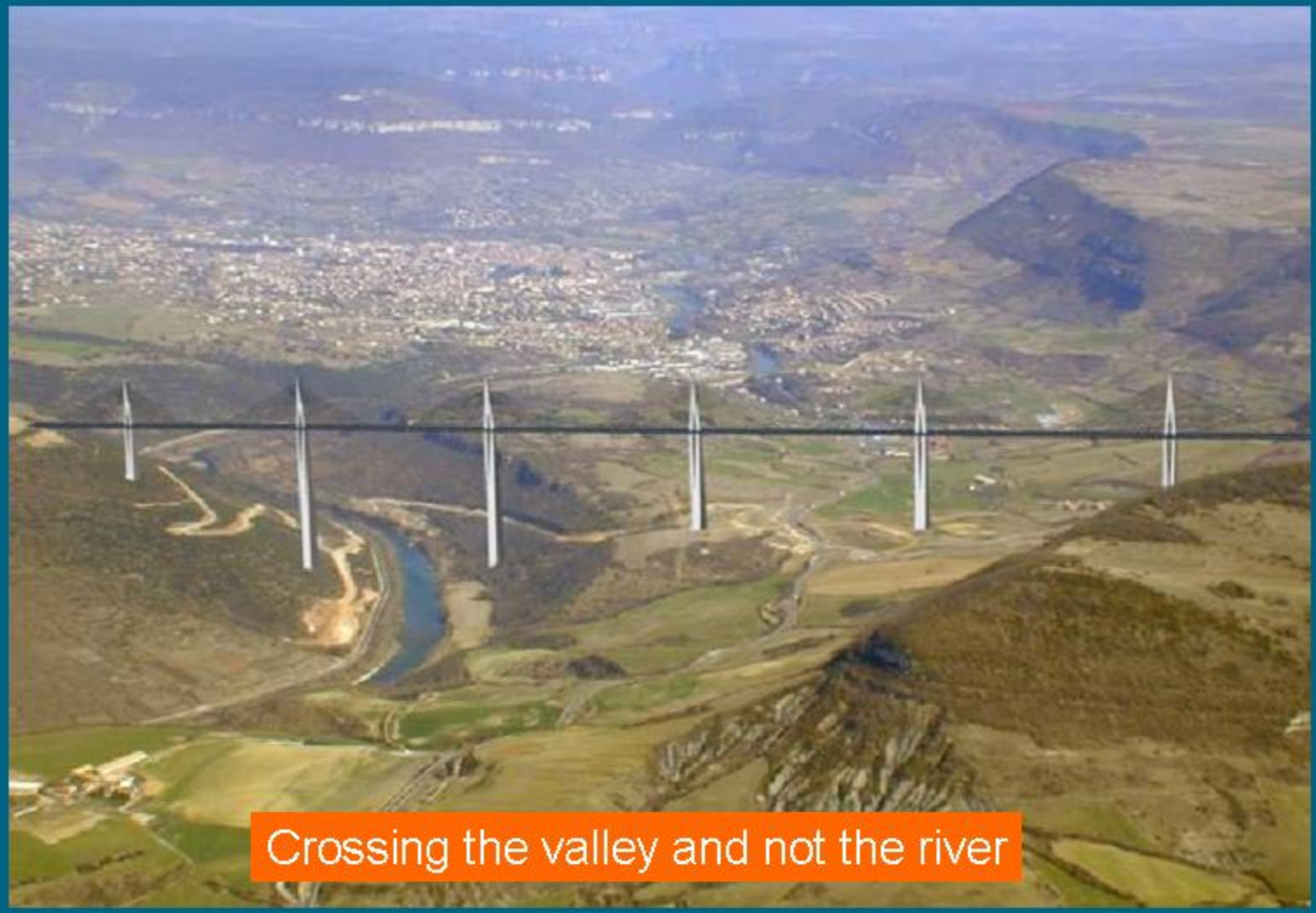
SITE CONDITIONS

Longitudinal Profile



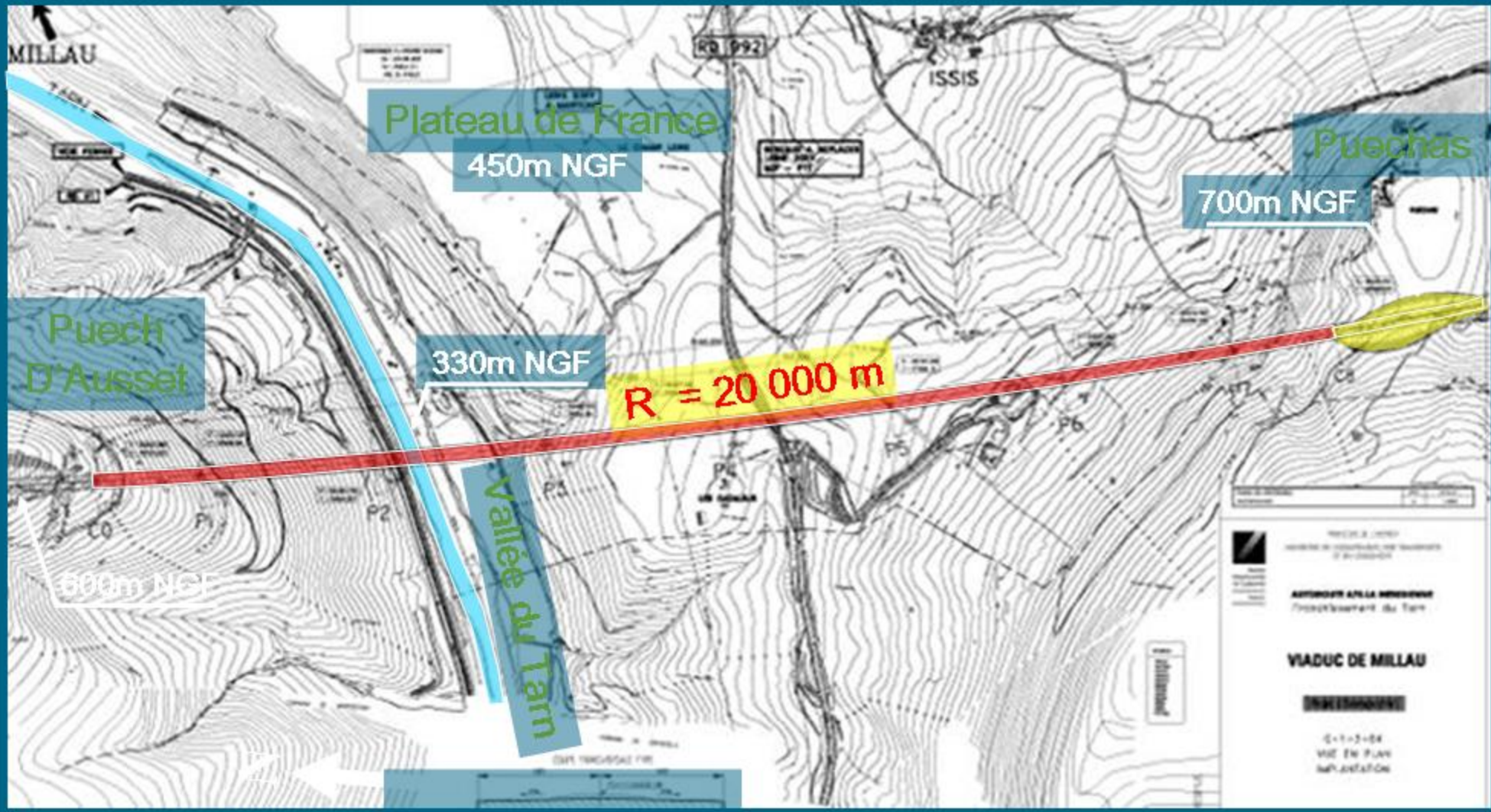
SITE CONDITIONS

The Dream …



USERS COMFORT

Horizontal curve

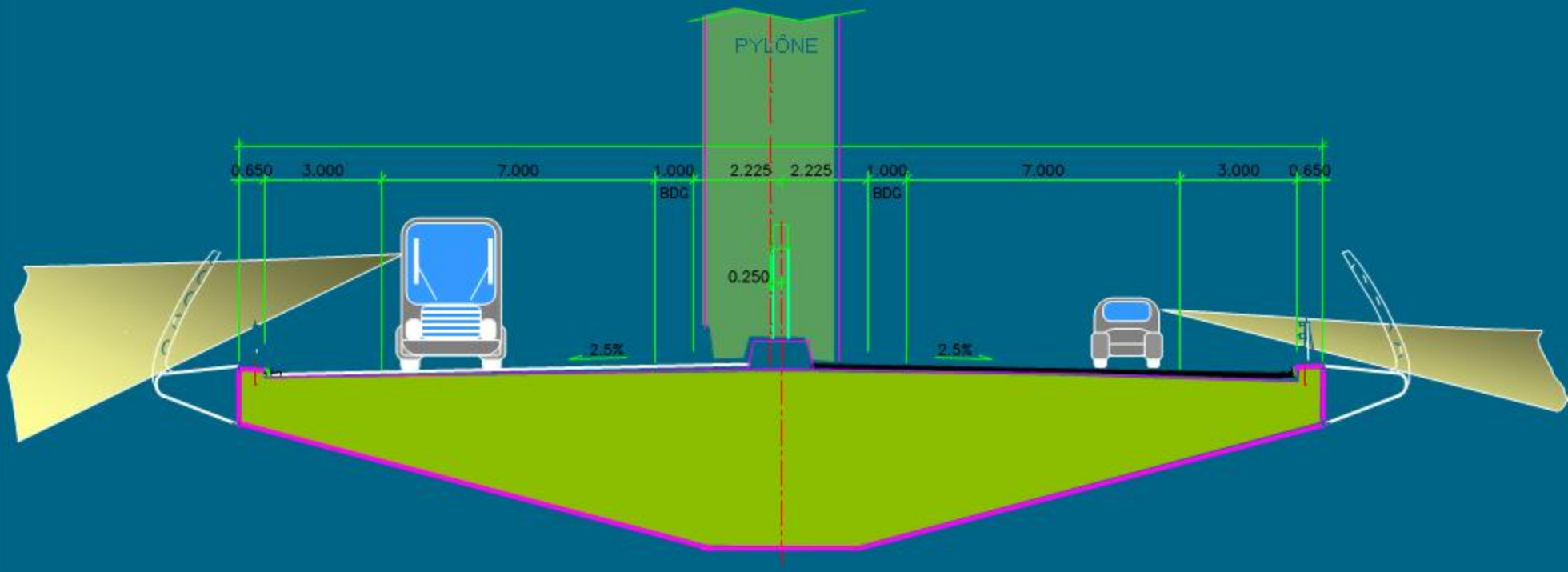


GLOBAL DESIGN

The curve

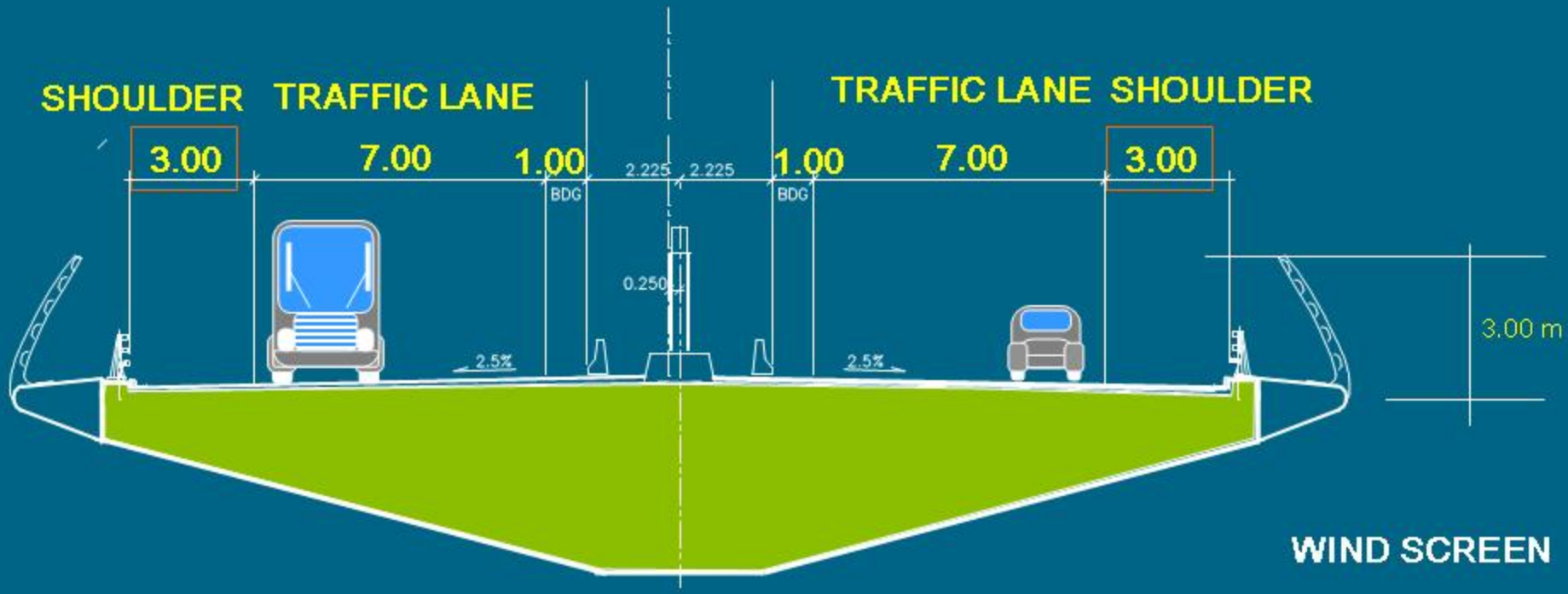
USERS COMFORT

Cross section



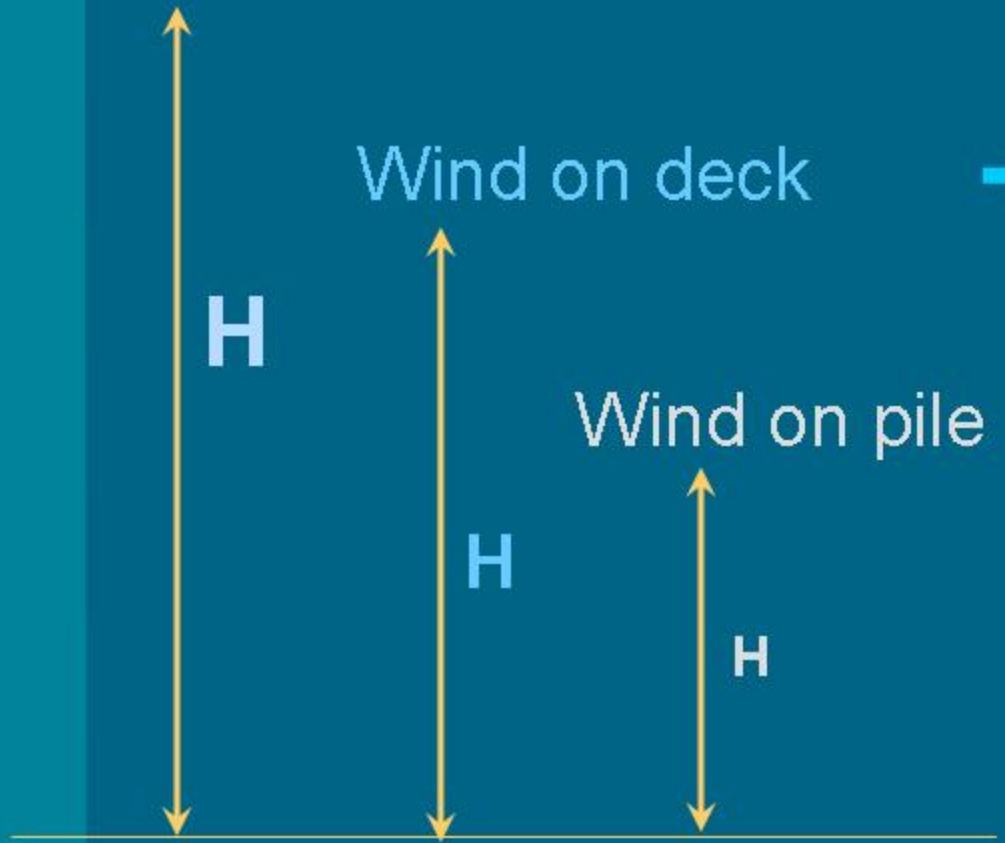
USERS COMFORT

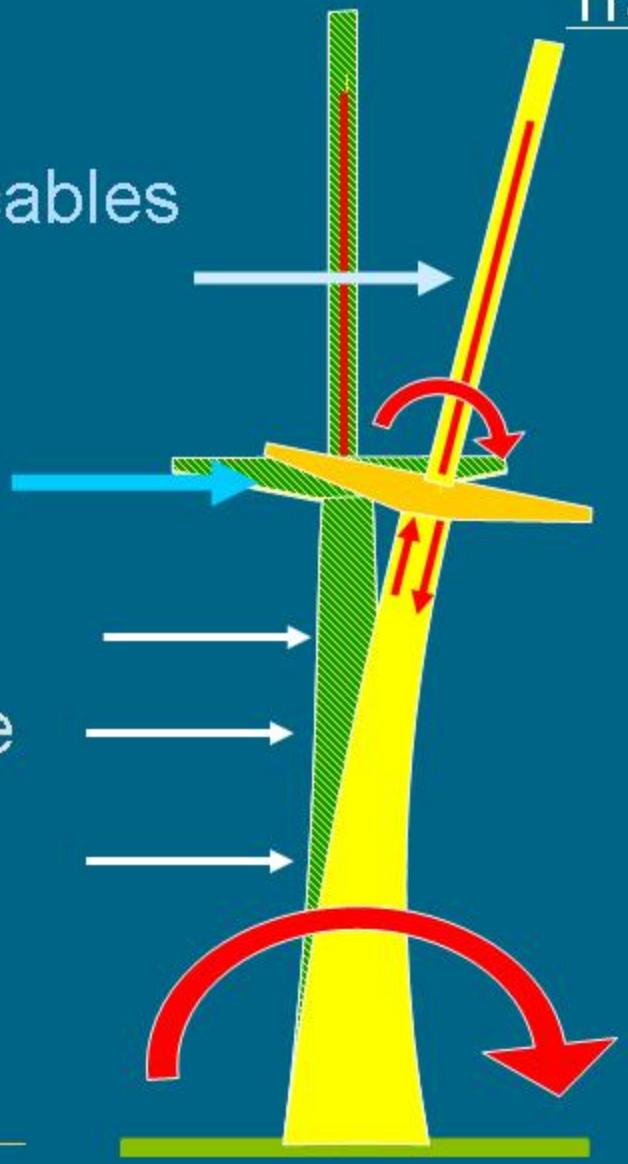
Cross section



GLOBAL WIND EFFECT

Wind effect on pylons & cables





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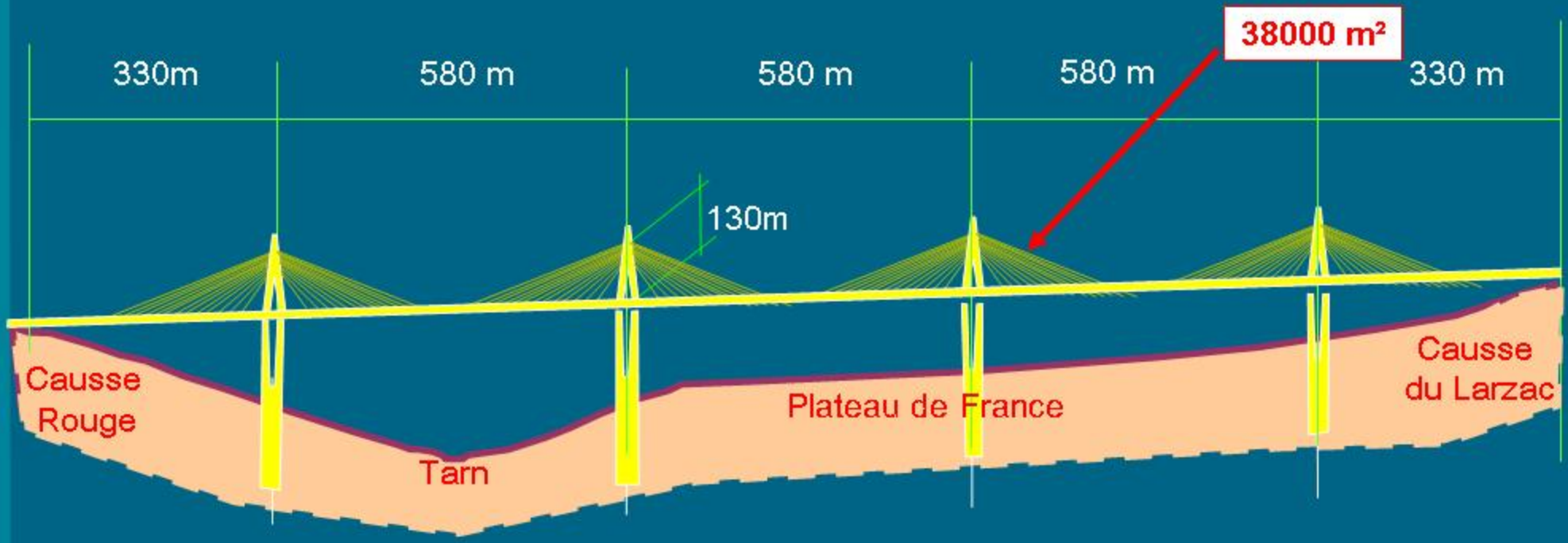
GLOBAL WIND EFFECT

Span length

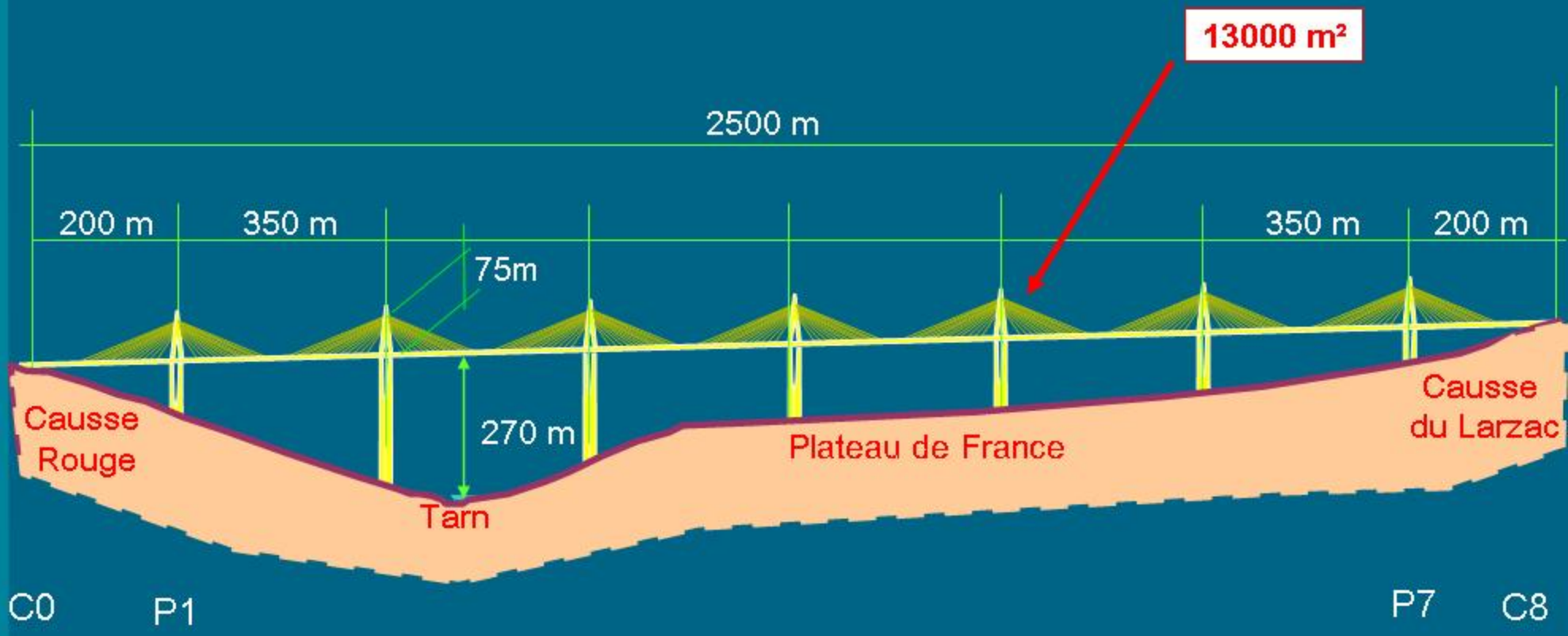
4 piers - 3 spans 580m



GLOBAL WIND EFFECT

Span length

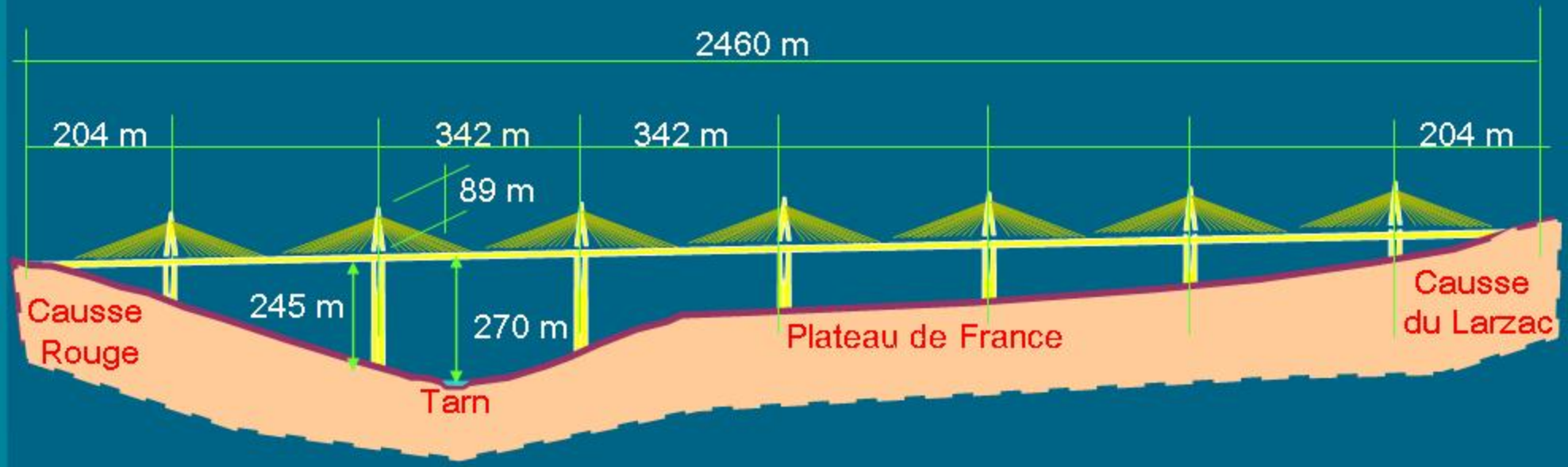
7 piers - spans 350m



GLOBAL WIND EFFECT

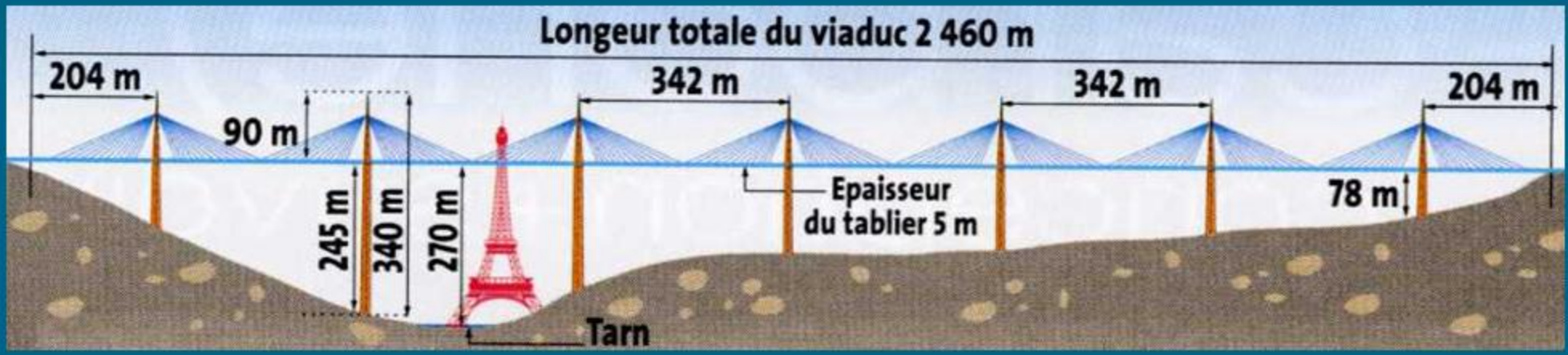
Span length

The final choice = 6 current spans 342 m + 2 side spans 204 m



GLOBAL DESIGN

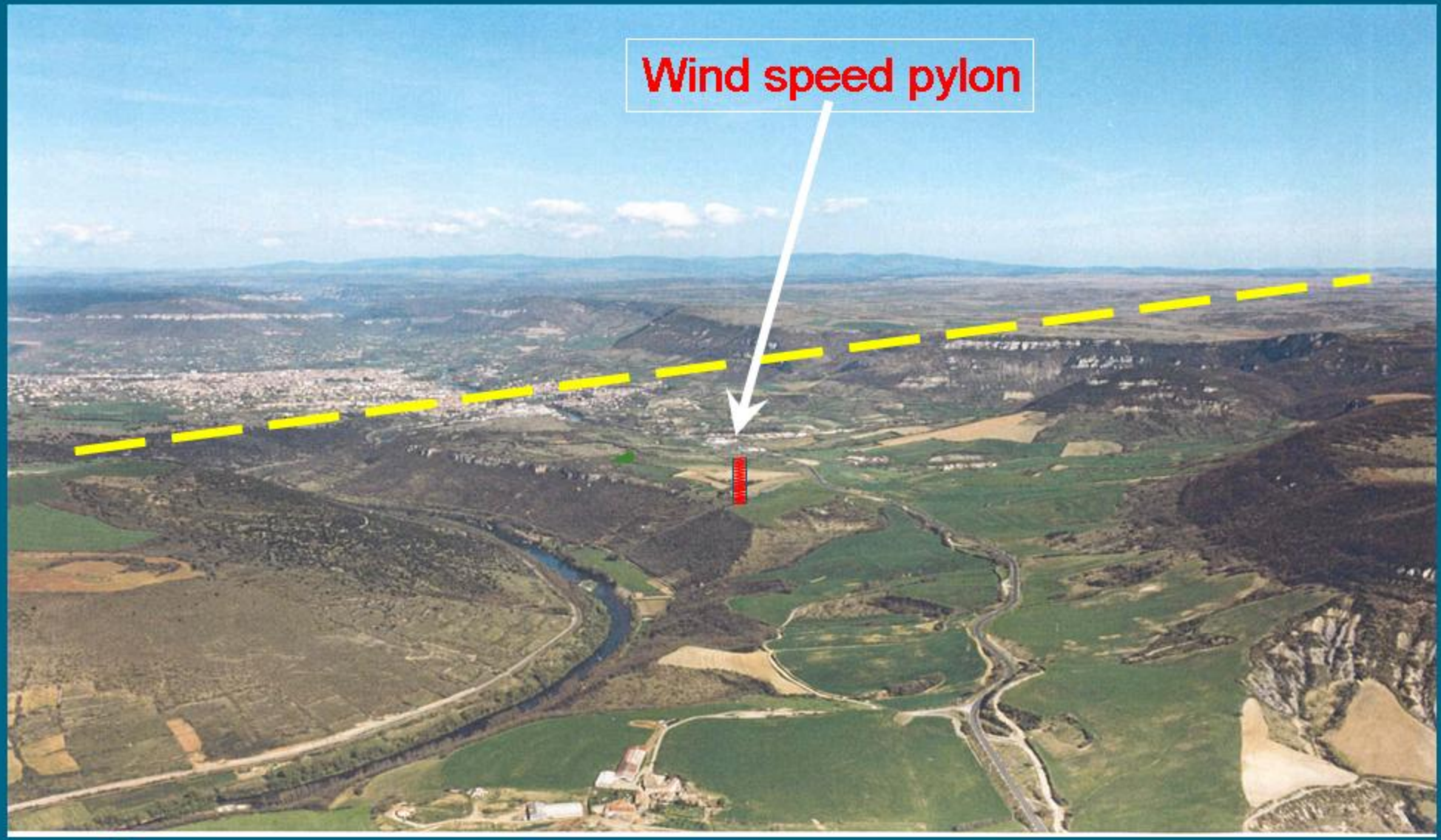
Dimensions



STRUCTURE & FOUNDATION

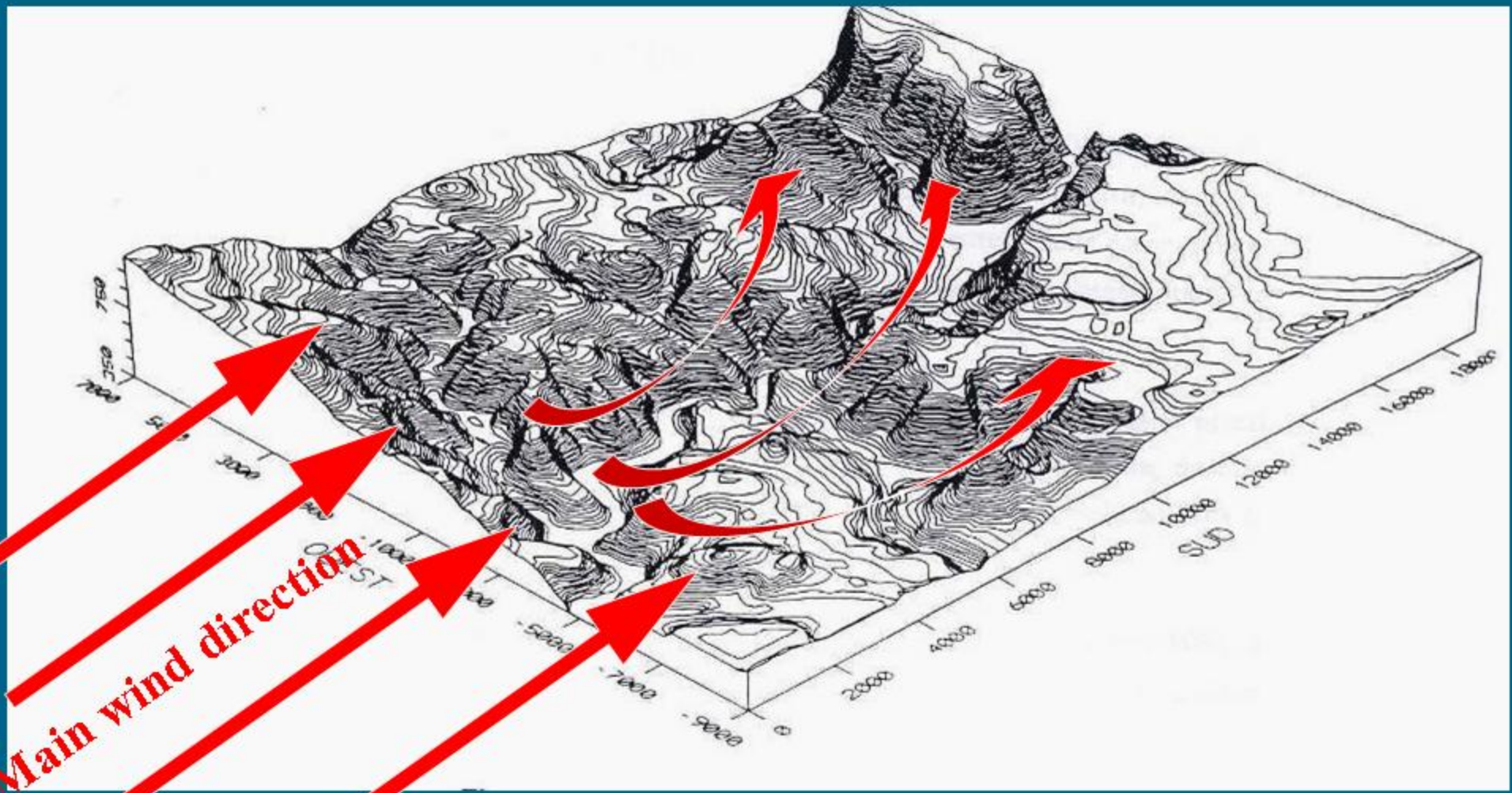
- Wind forces
- Multiple cable-stayed deck behavior
- Deck & Pylons design
- Piers design
- Foundation design

Wind measurement



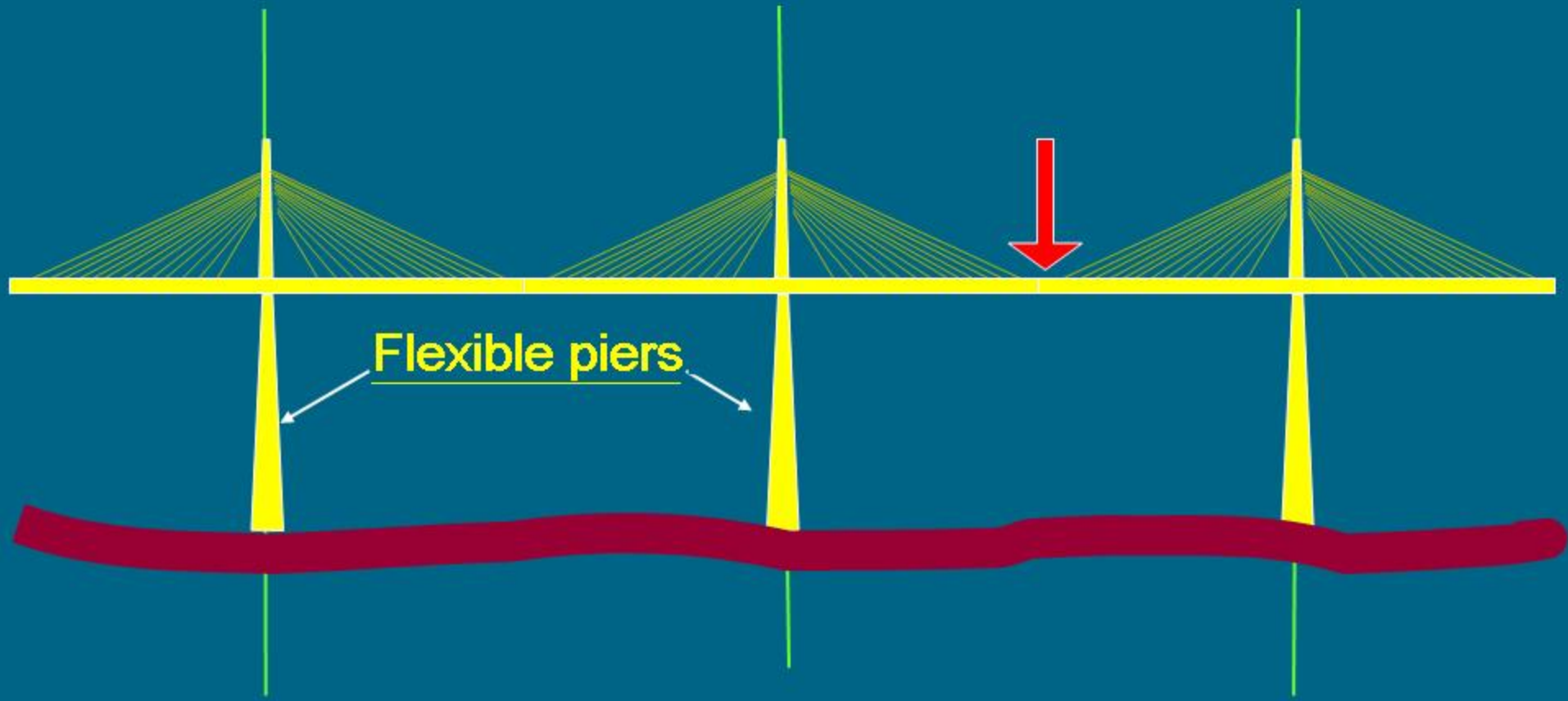
WIND FORCES

Wind model



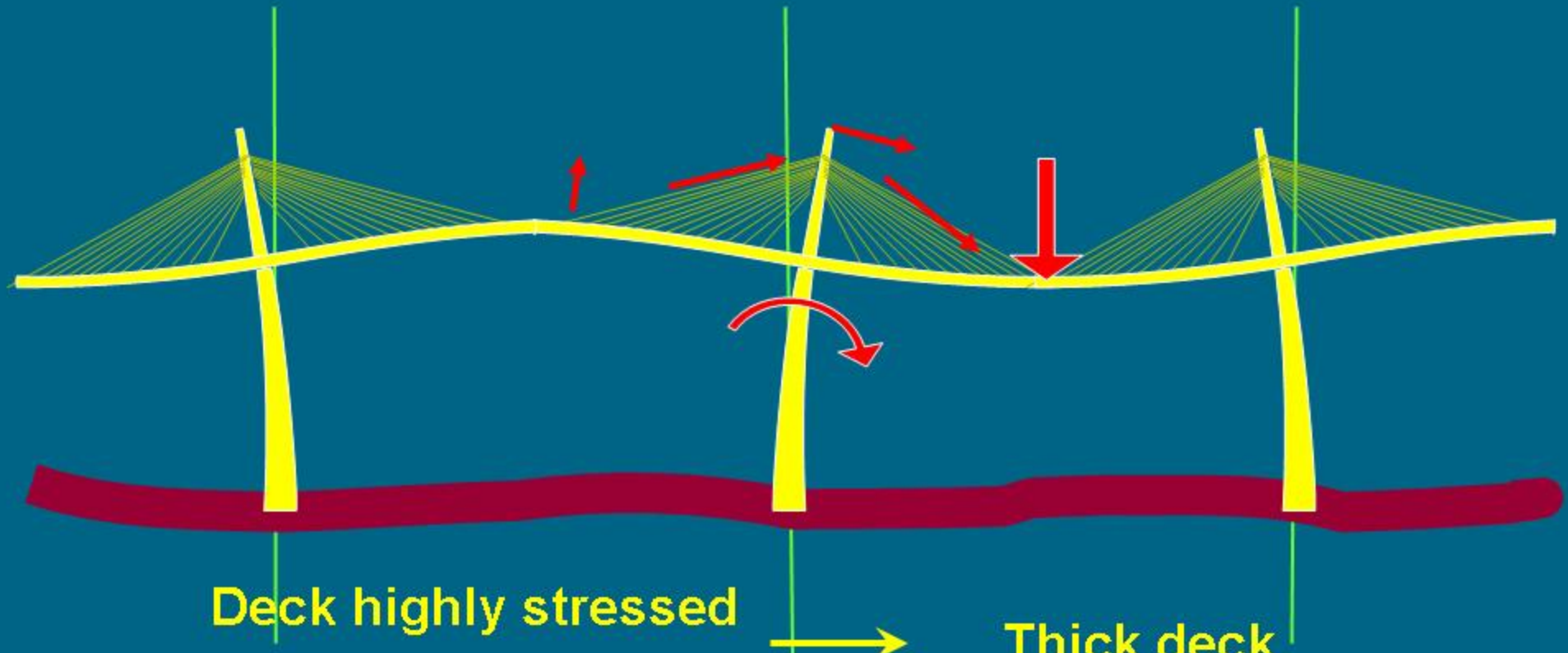
MULTIPLE CABLE STAYED BRIDGE BEHAVIOR

Flexible piers



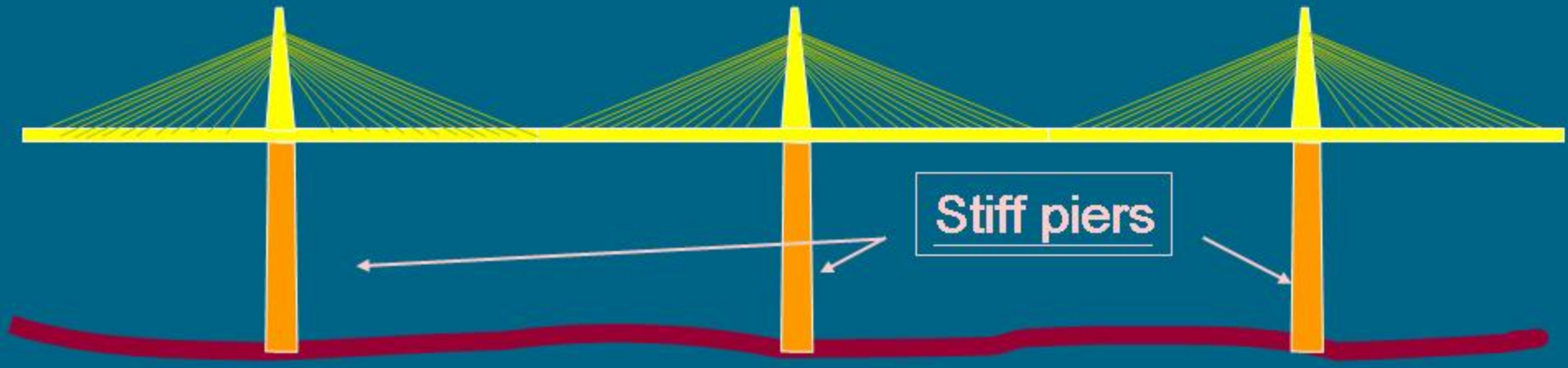
MULTIPLE CABLE STAYED BRIDGE BEHAVIOR

Flexible piers



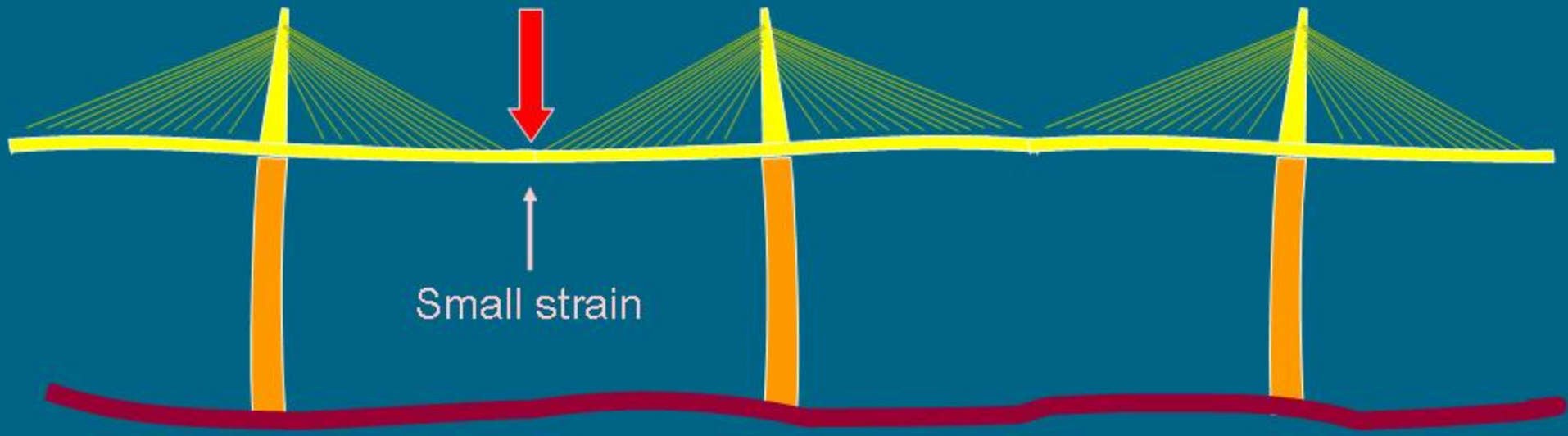
MULTIPLE CABLE STAYED BRIDGE BEHAVIOR

Stiff piers



MULTIPLE CABLE STAYED BRIDGE BEHAVIOR

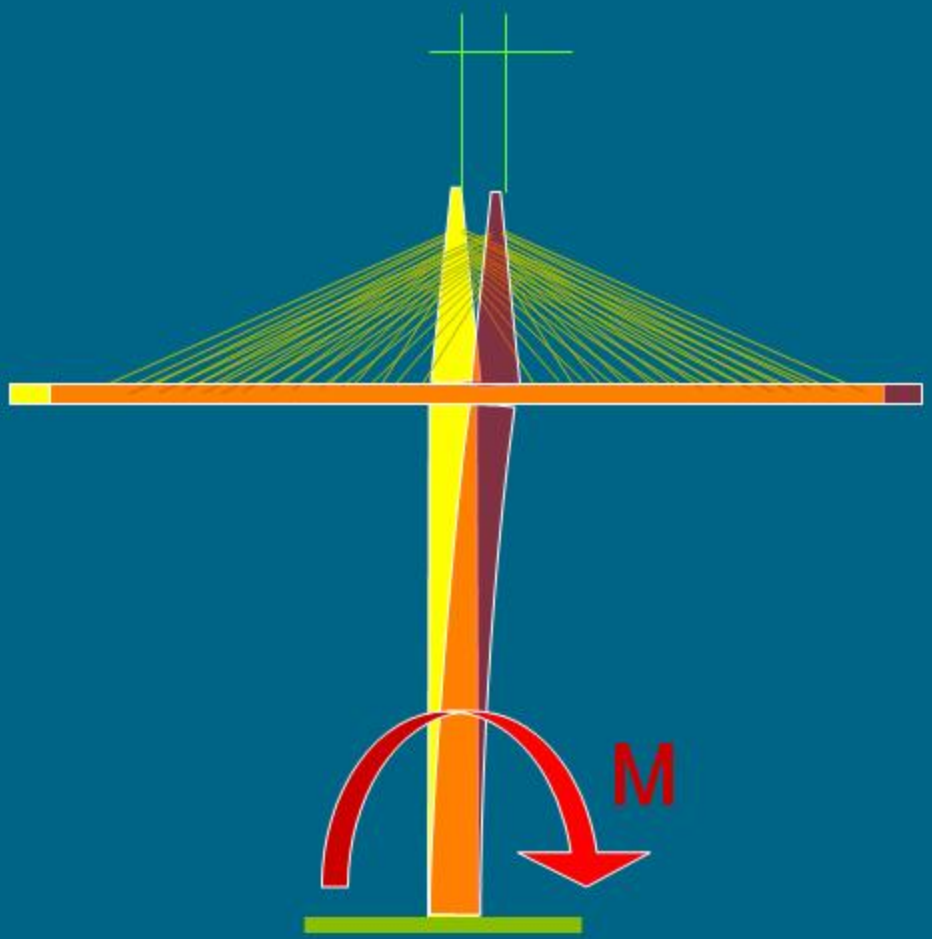
Stiff piers

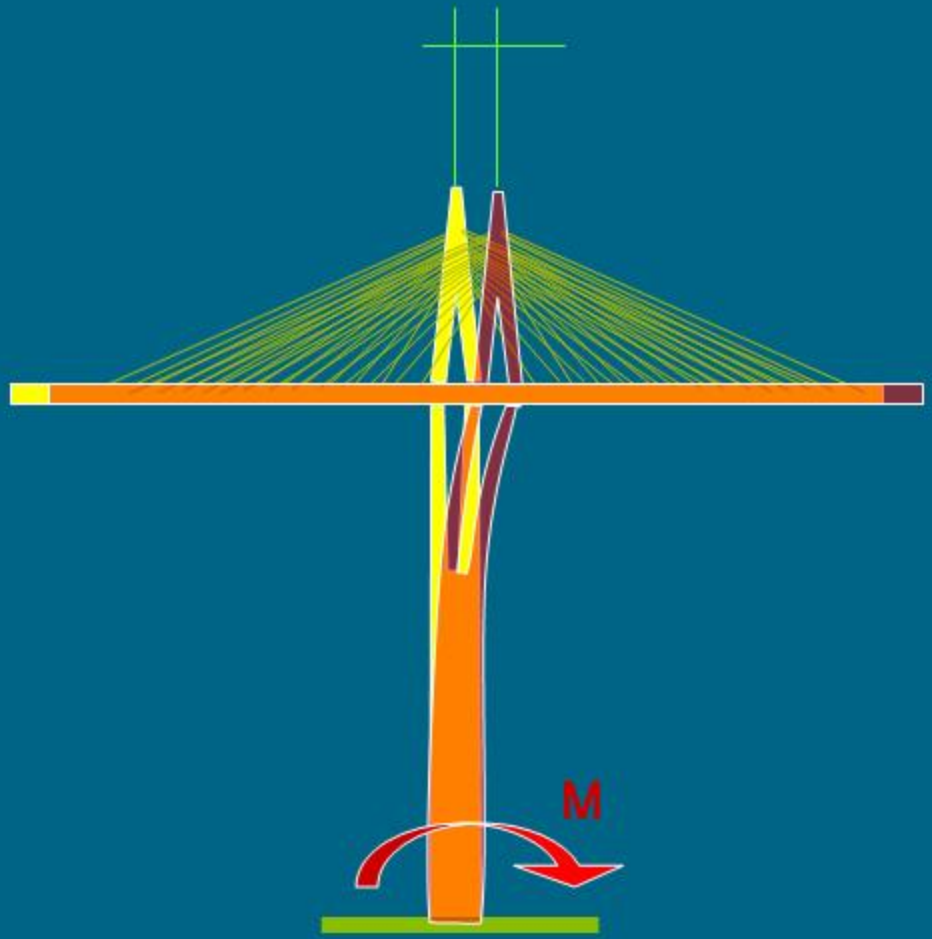


Deck less stressed ⟶ **Thin deck**

MULTIPLE CABLE STAYED BRIDGE BEHAVIOR

Linear var.





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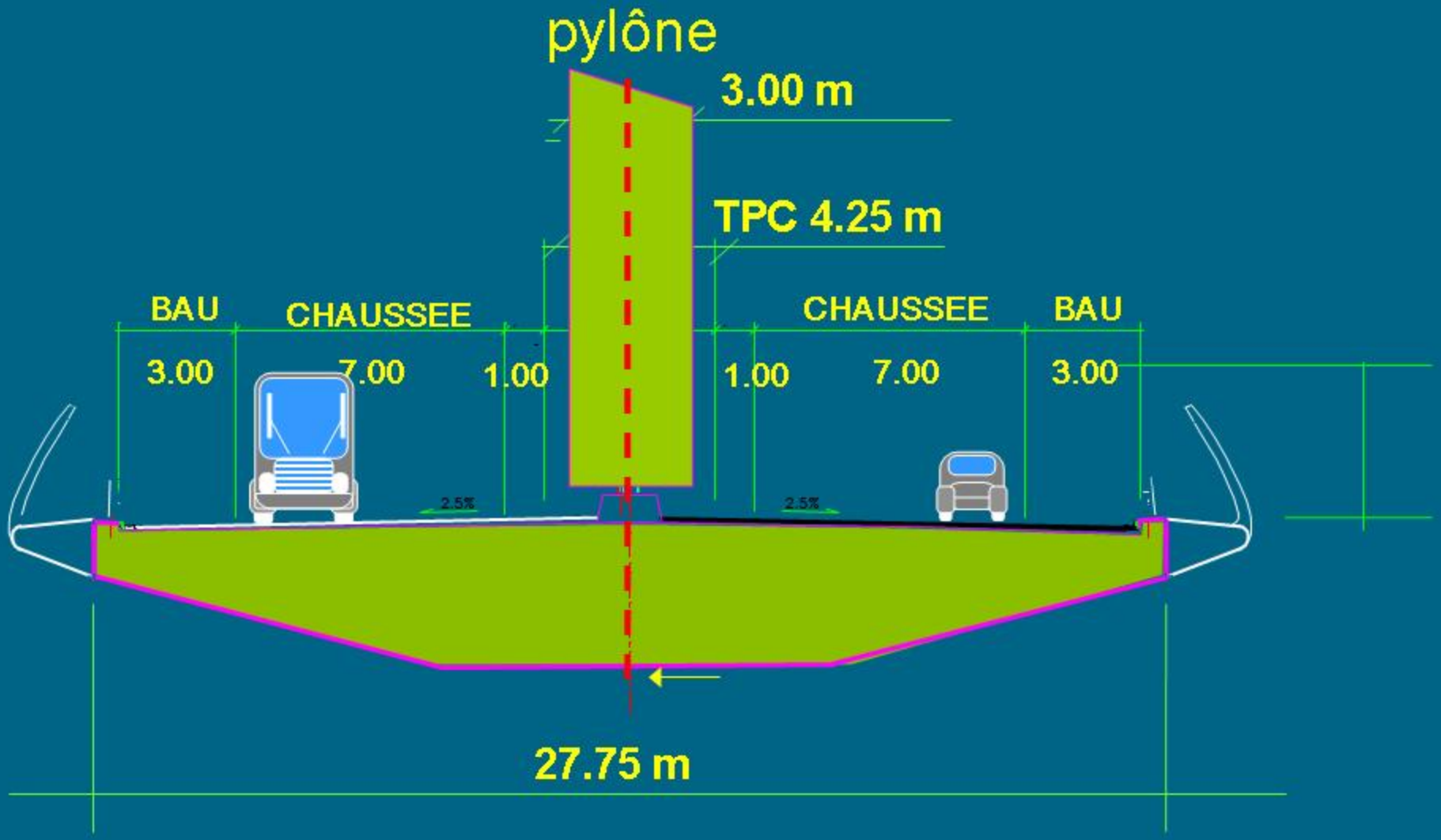
DECK DESIGN

Deck width - Pylon impact

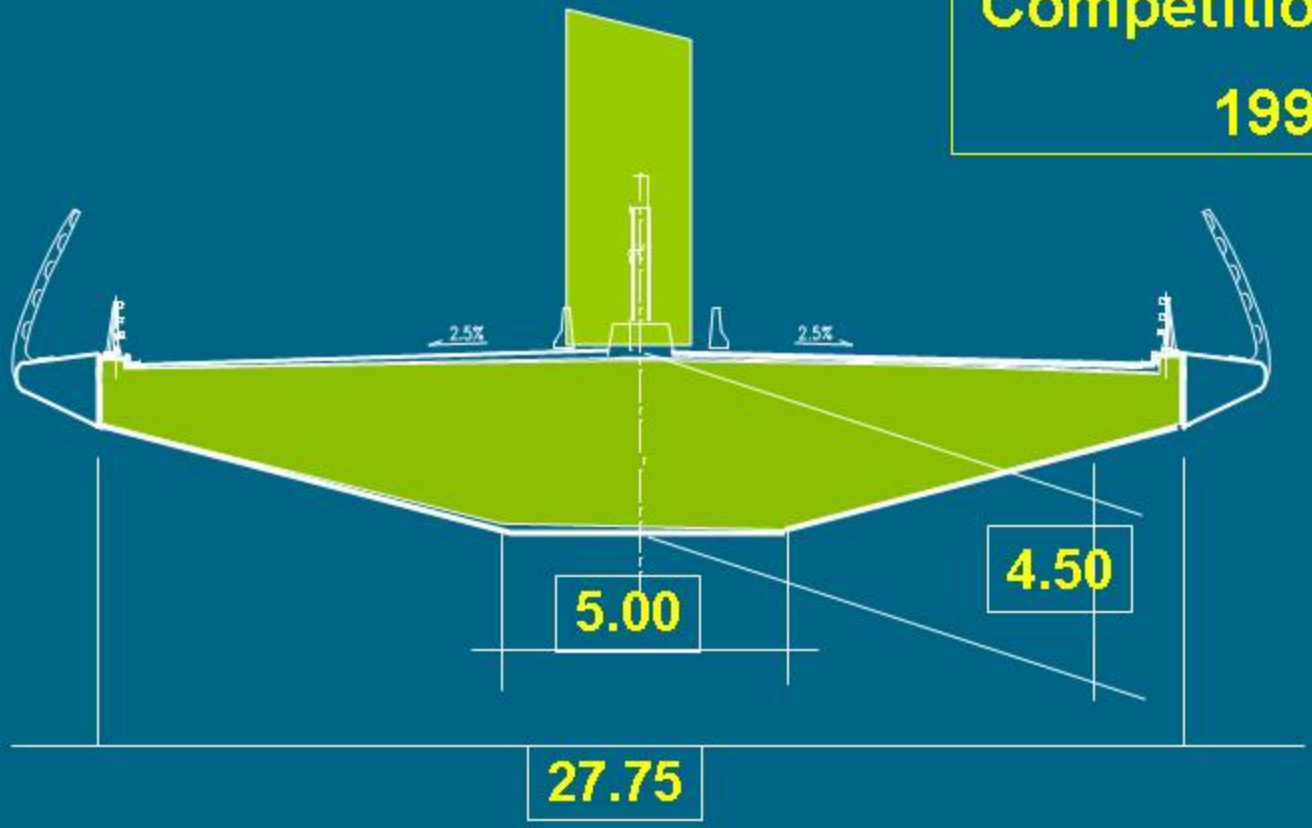


DECK DESIGN

Cross section shape

Competition Design

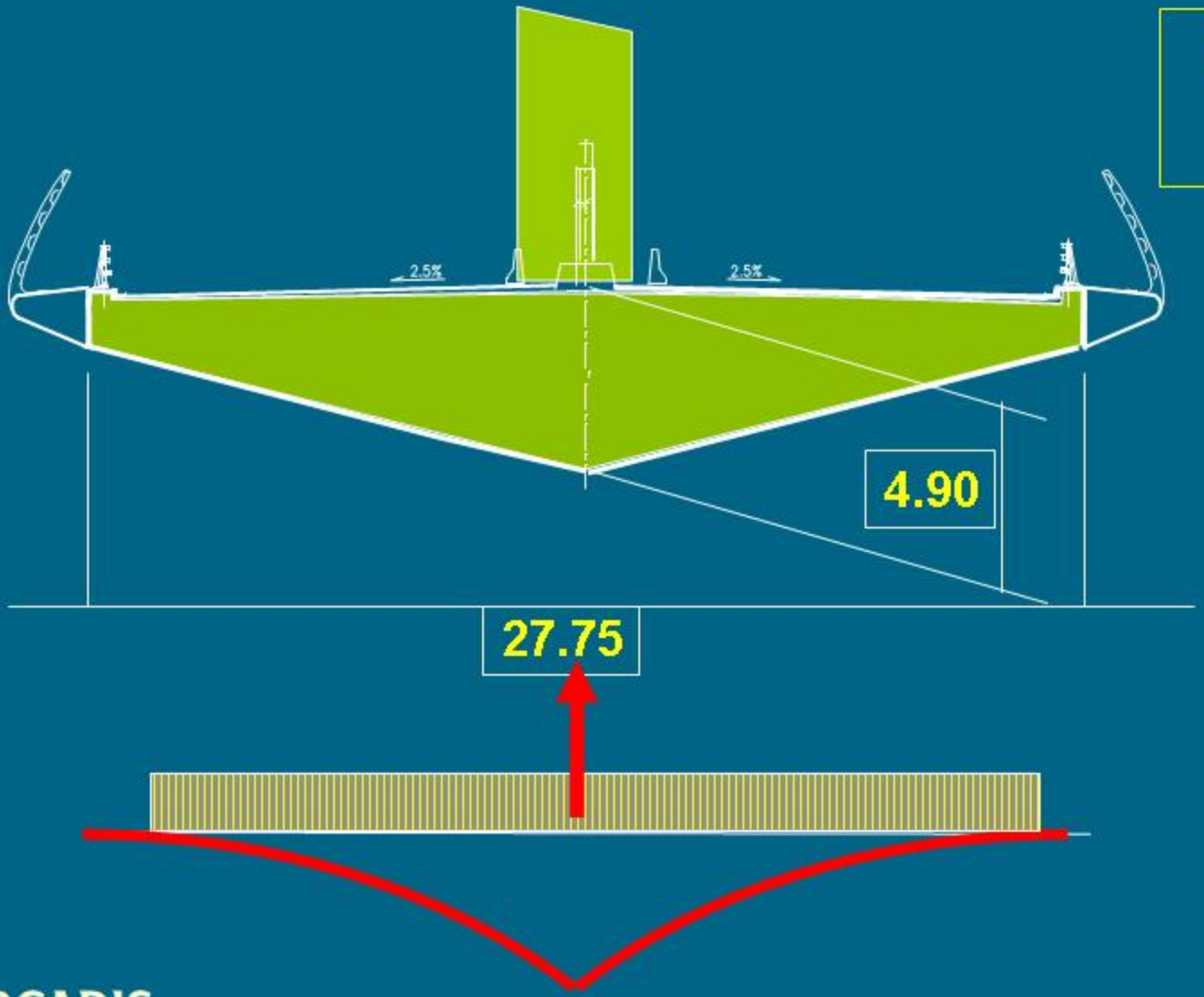
1996



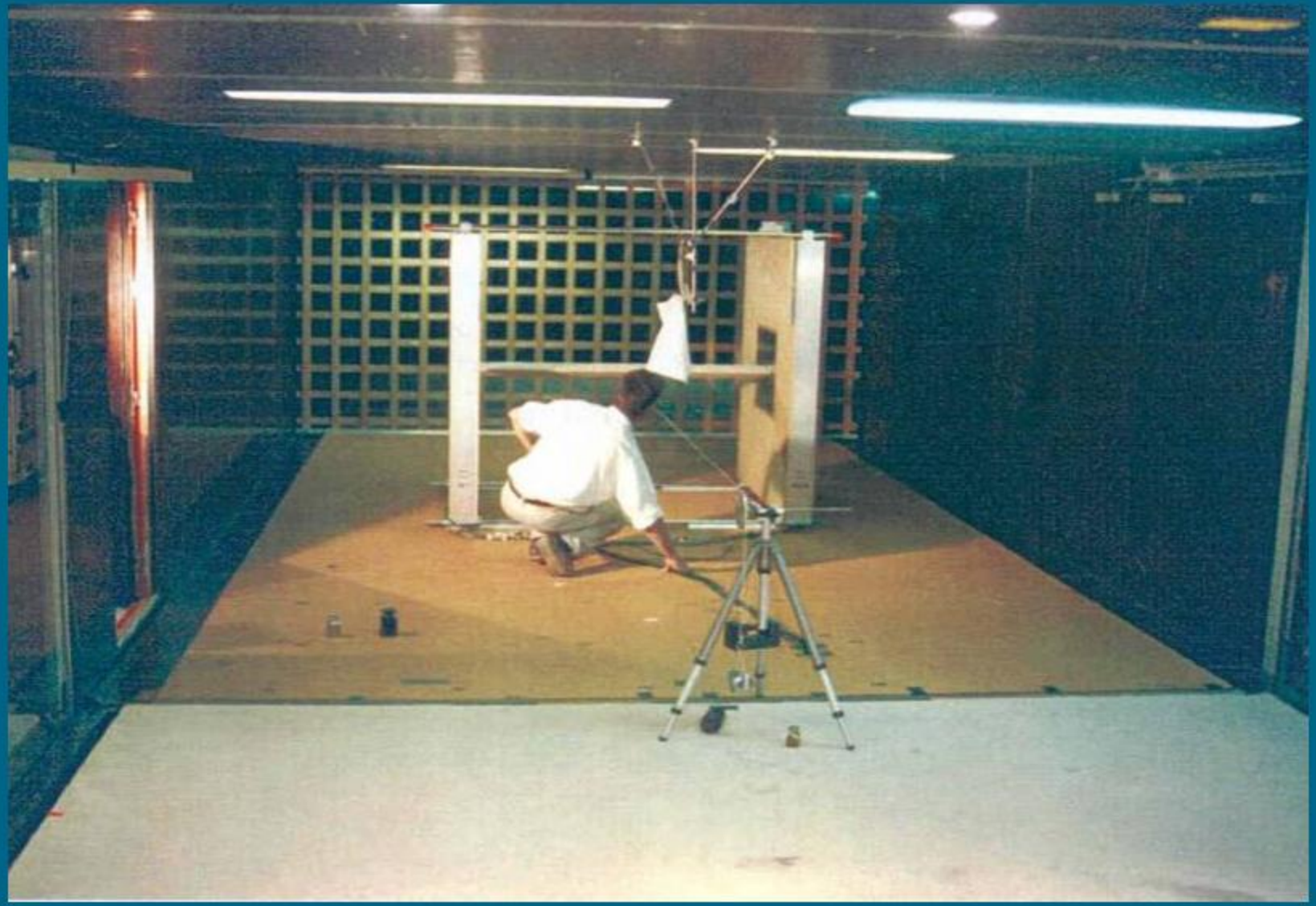
DECK DESIGN

Cross section shape

Design 1998



Wind tunnel

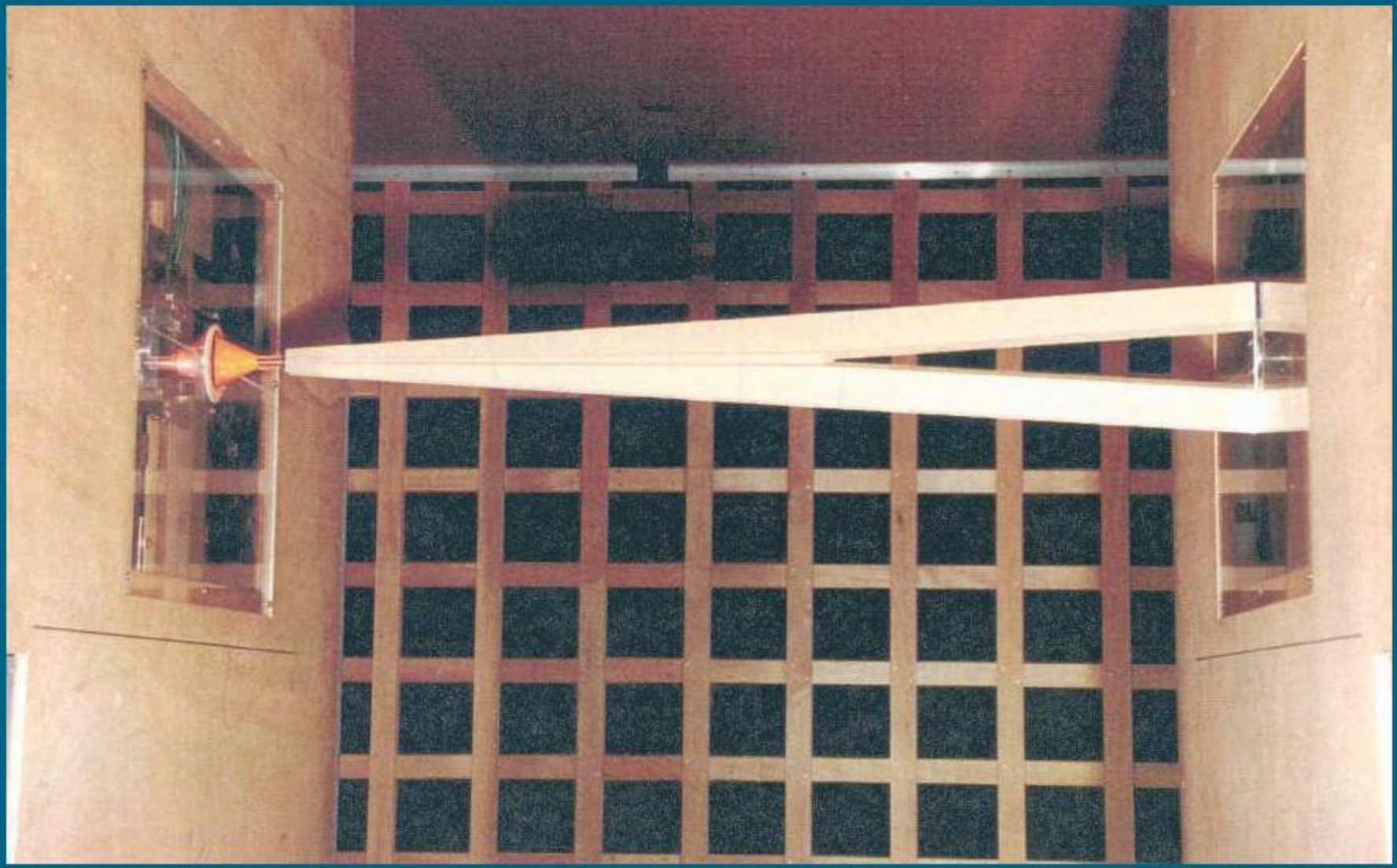


DECK & PYLON DESIGN

Wind tunnel

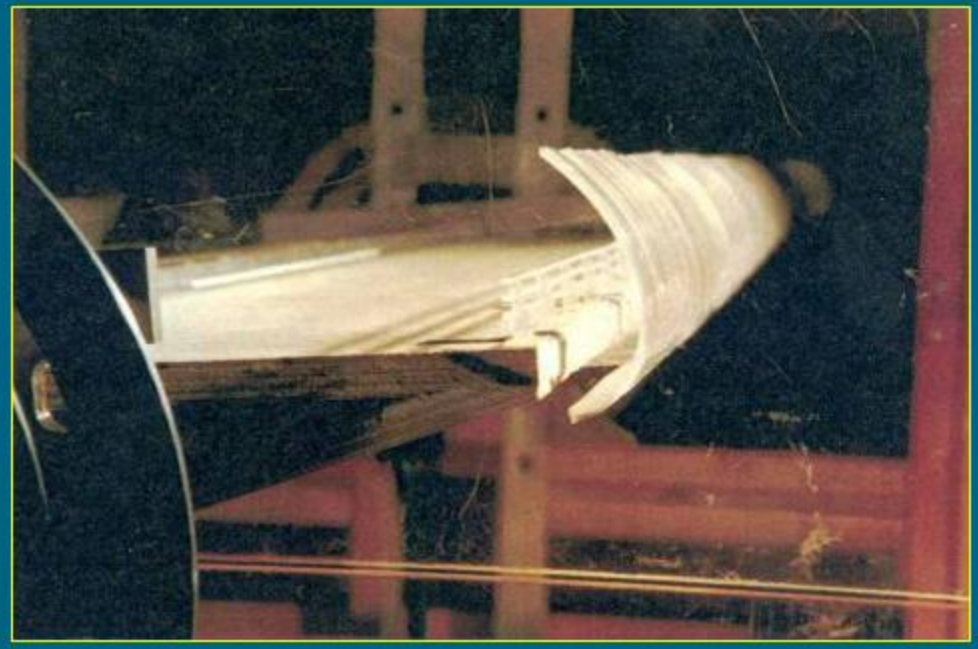
DECK & PYLON DESIGN

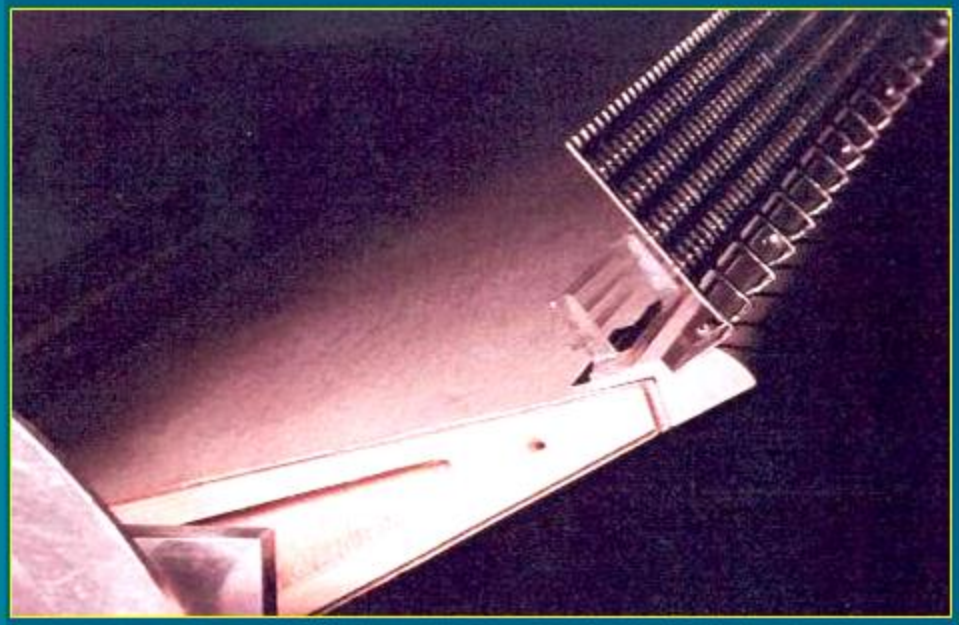
Wind tunnel



DECK & PYLON DESIGN

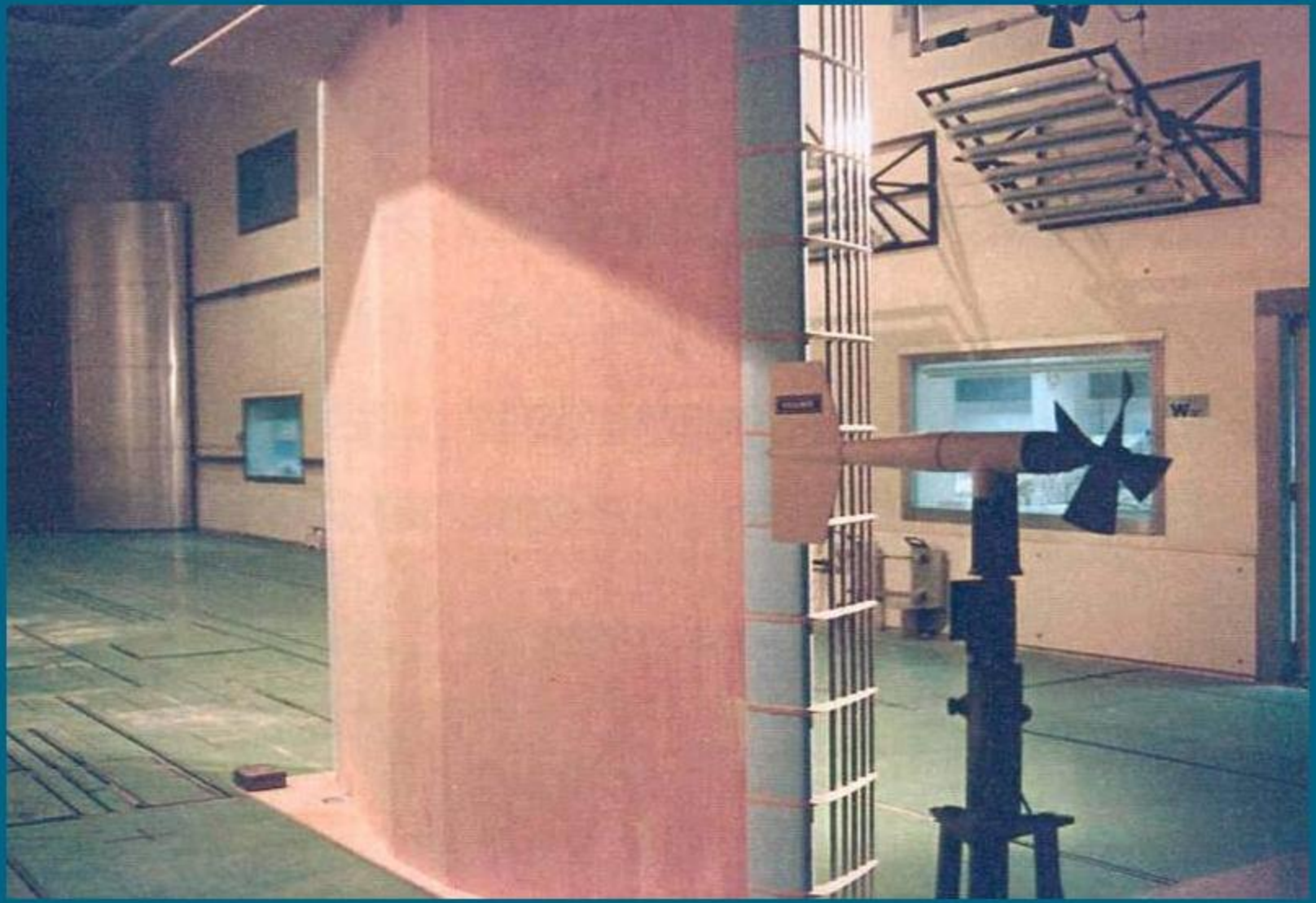
Wind tunnel





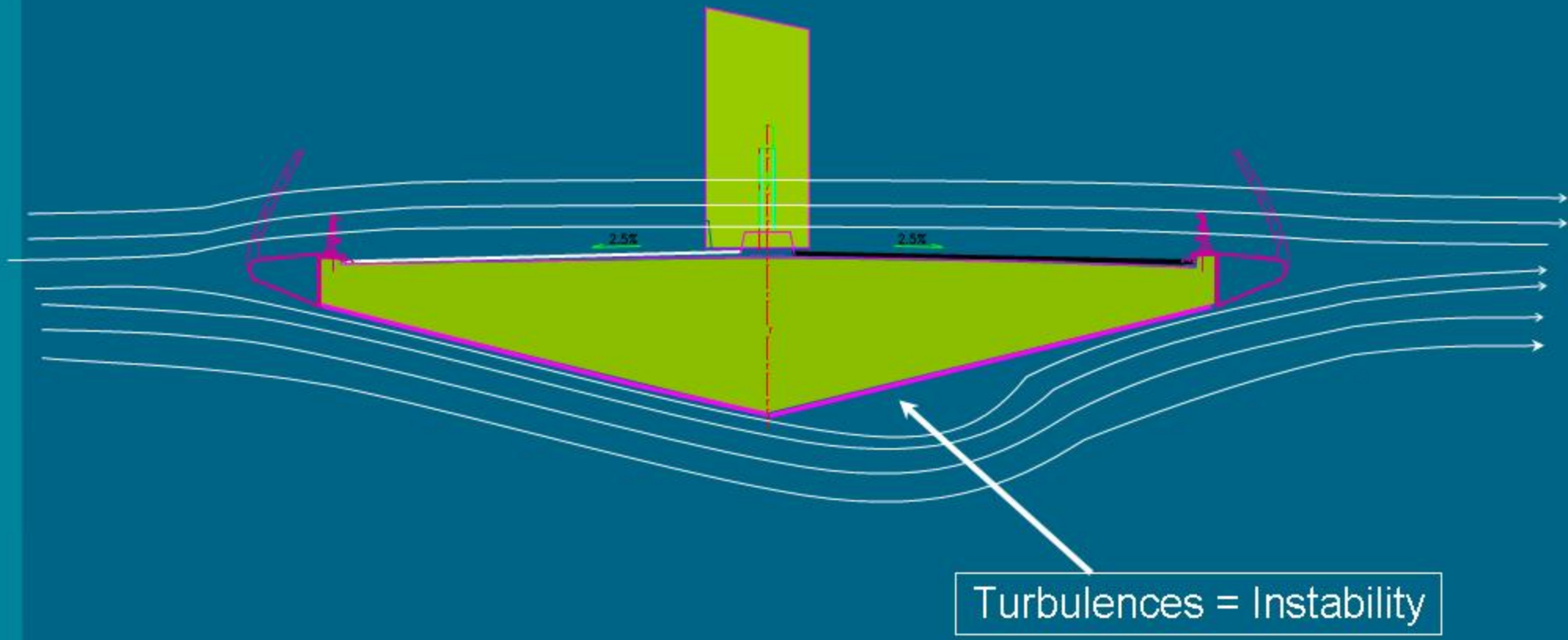
DECK & PYLON DESIGN

Wind tunnel



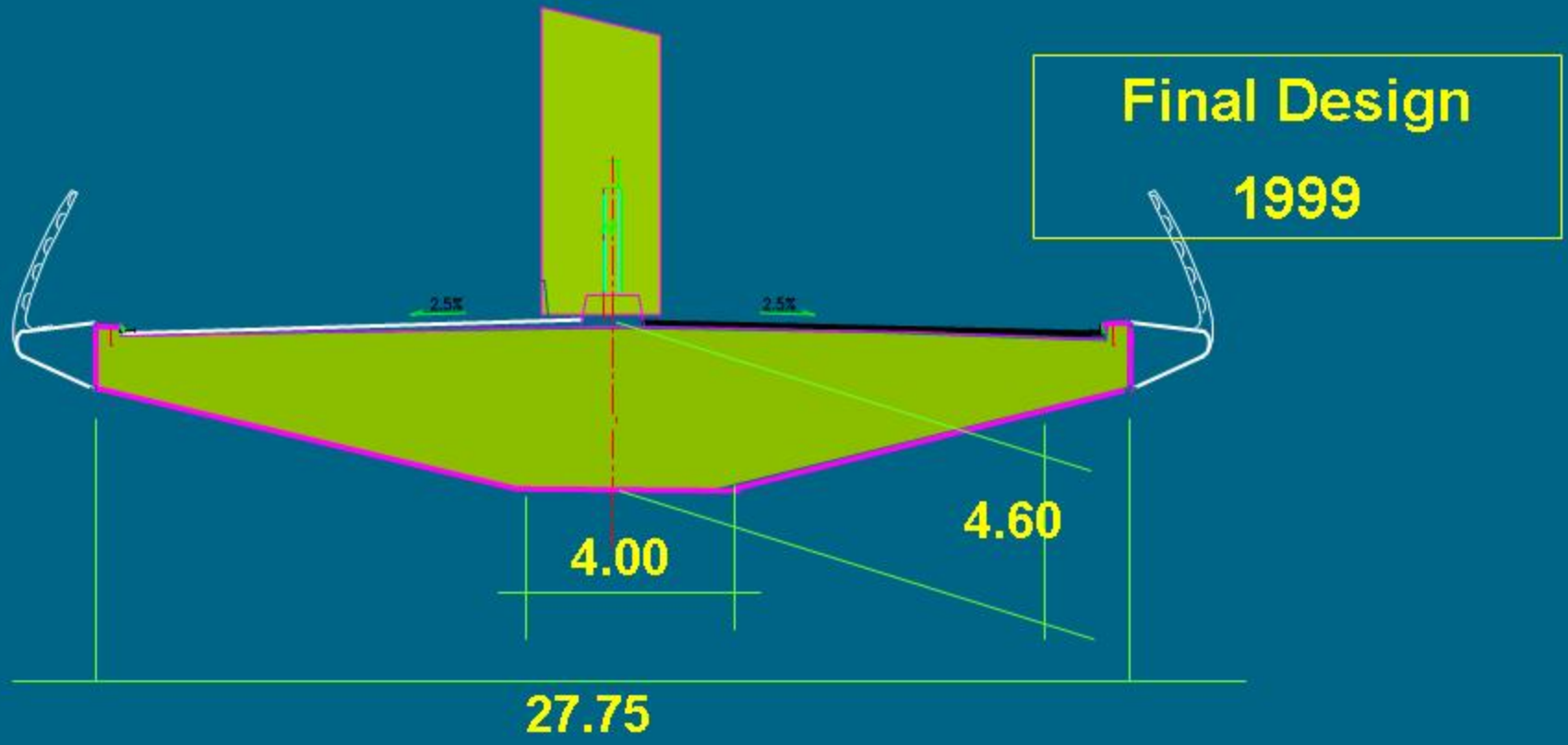
DECK DESIGN

Cross section shape



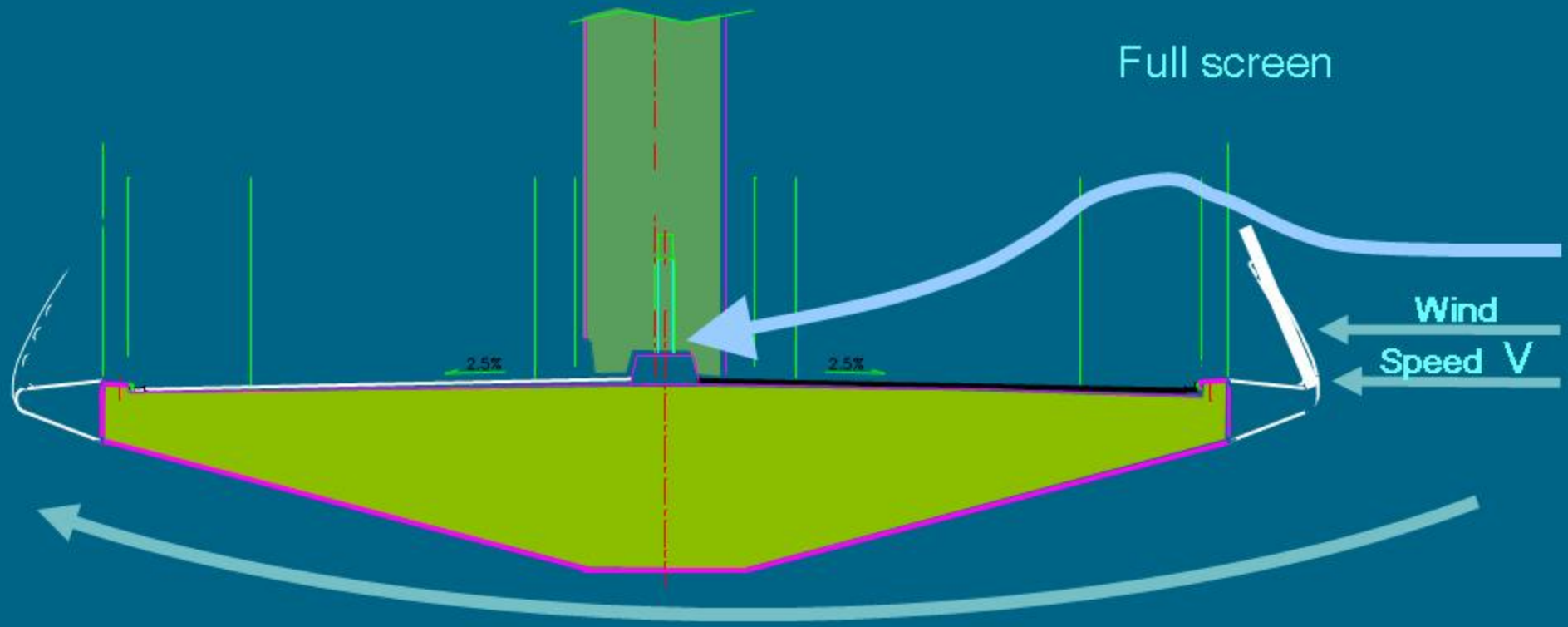
DECK DESIGN

Cross section shape



DECK DESIGN

Wind screen



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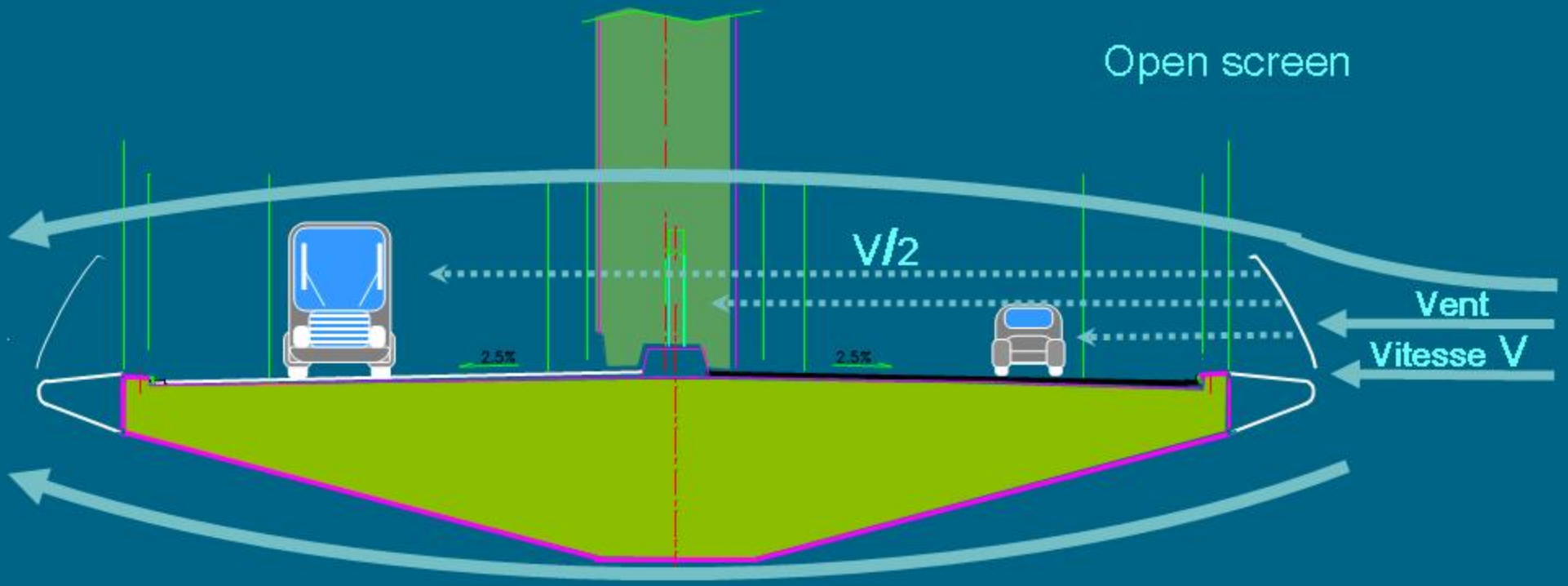
Wind screen



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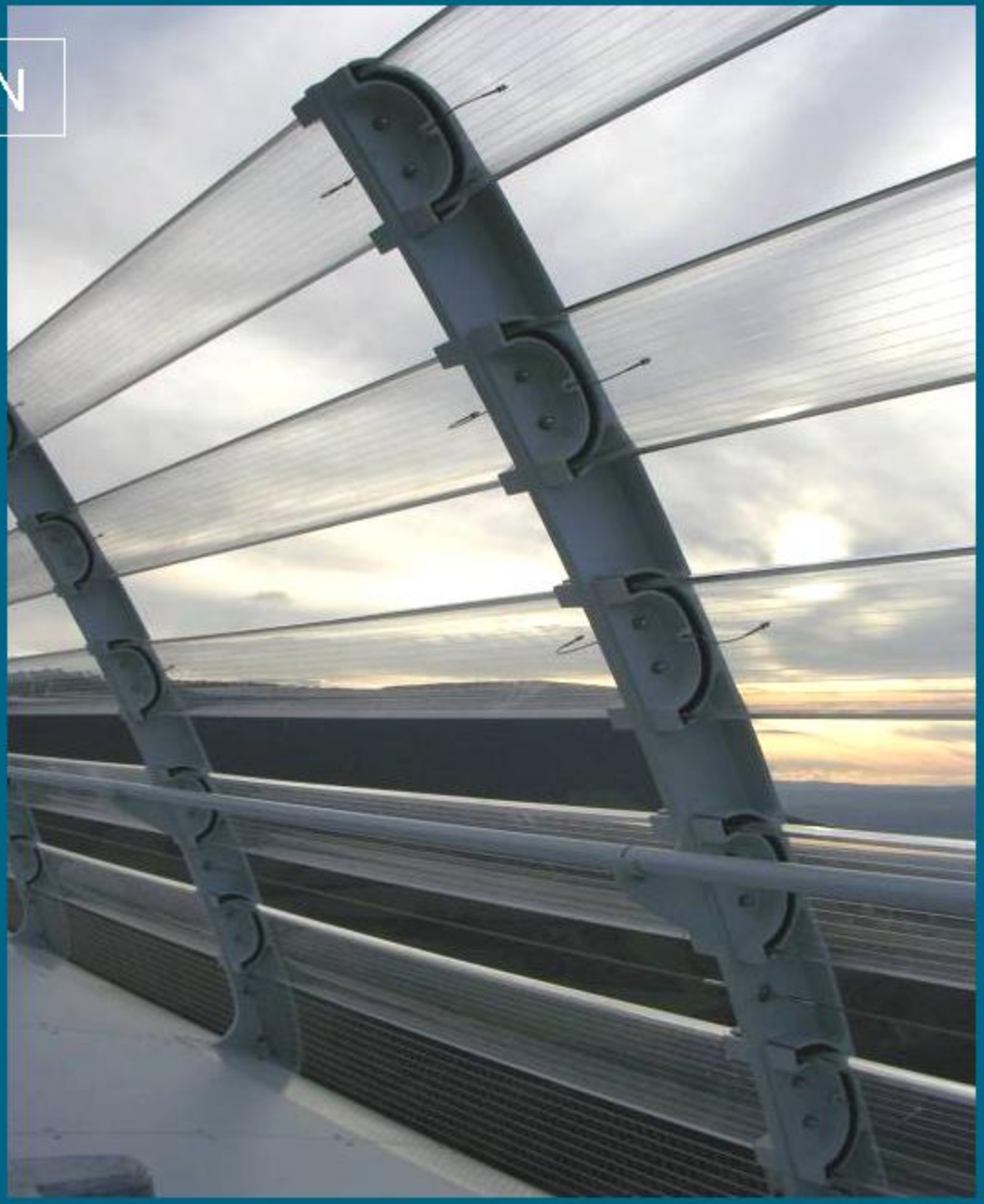


Wind screen

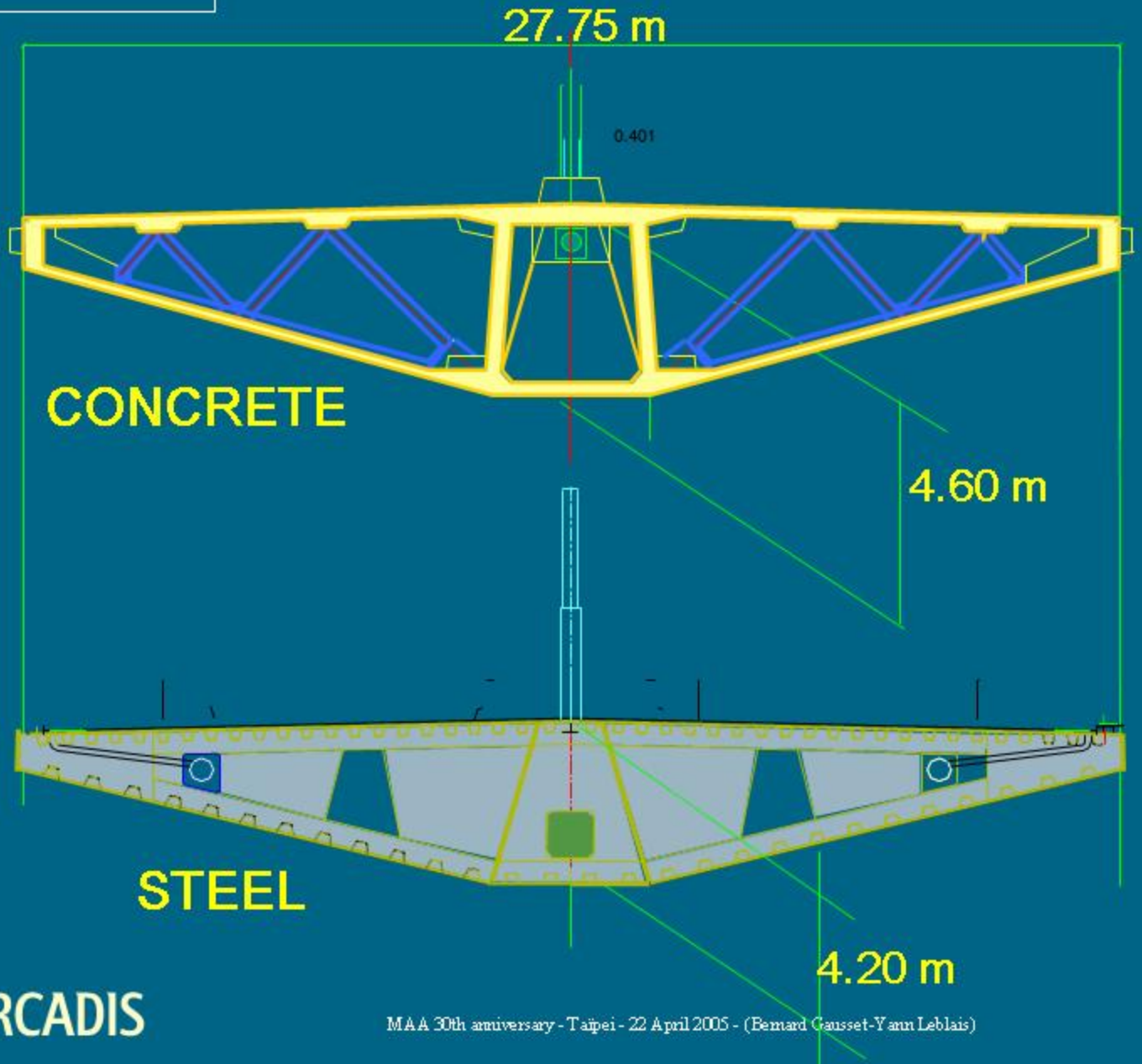
(built)

CONSTRUCTION

Wind screen

DECK DESIGN

Material



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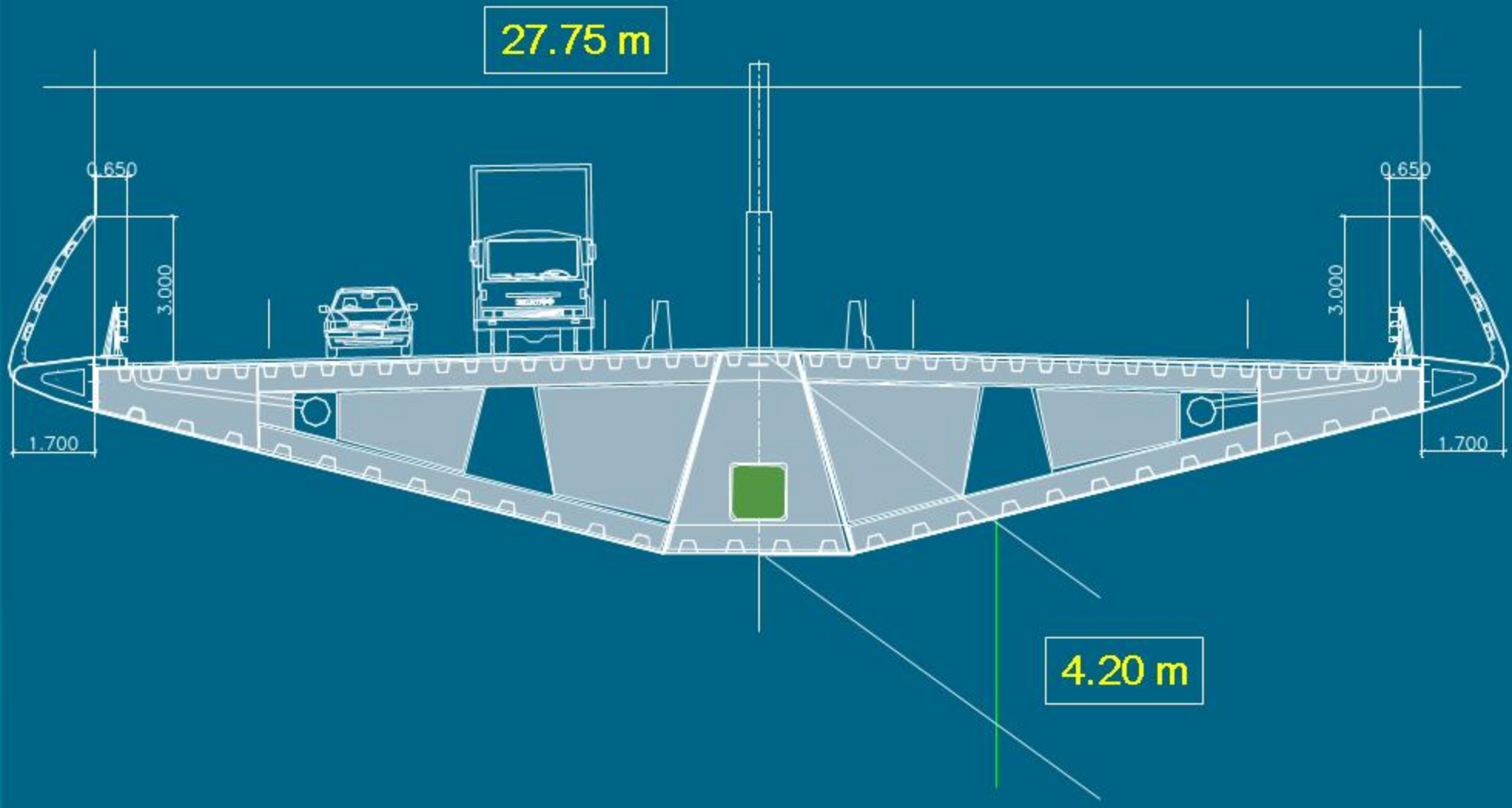
DECK DESIGN

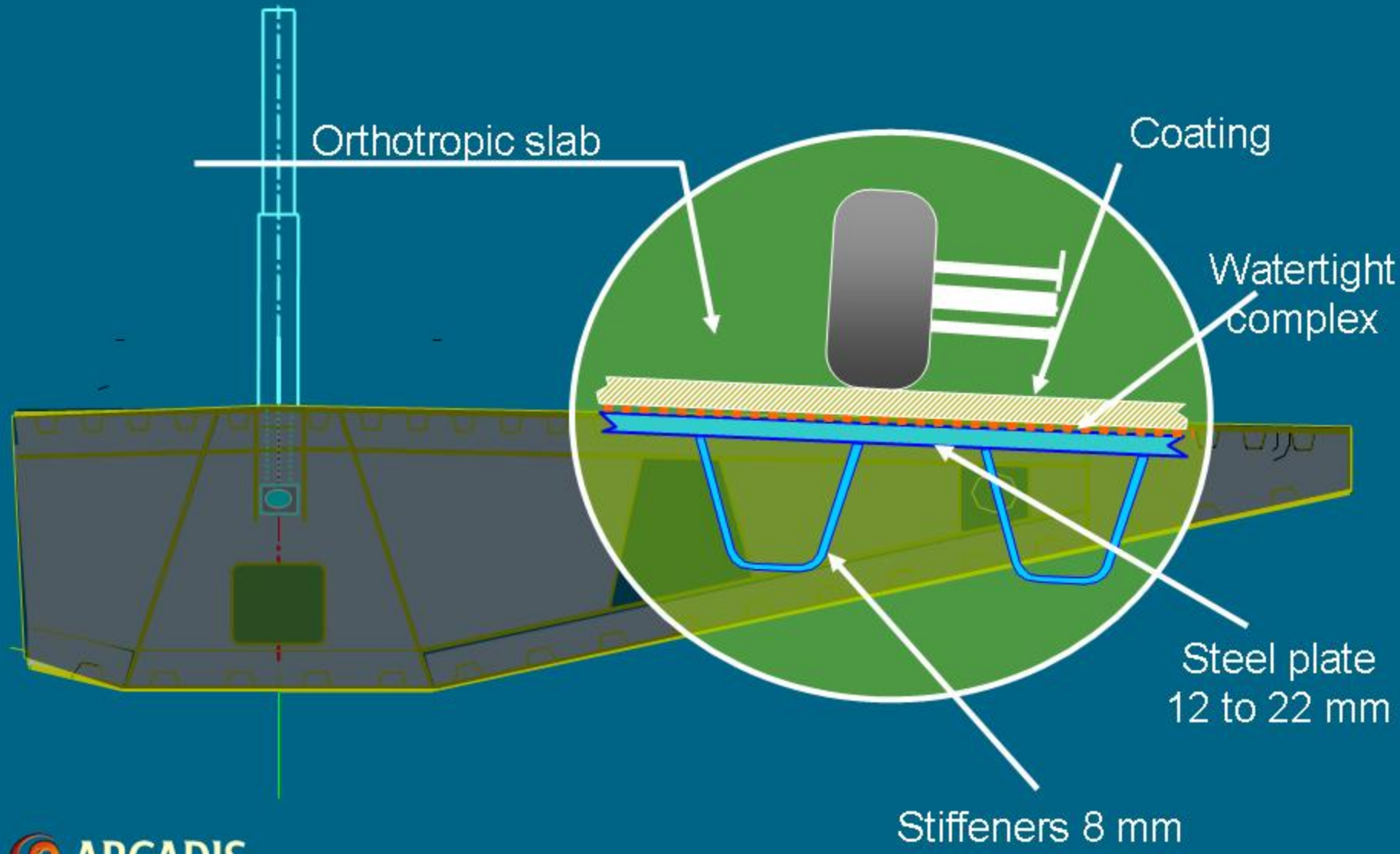
Material



ARCADIS

DECK DESIGN

Material



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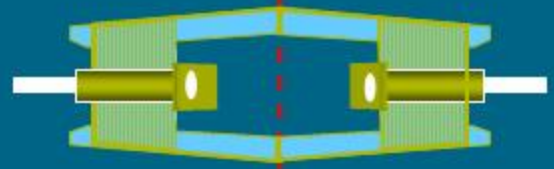
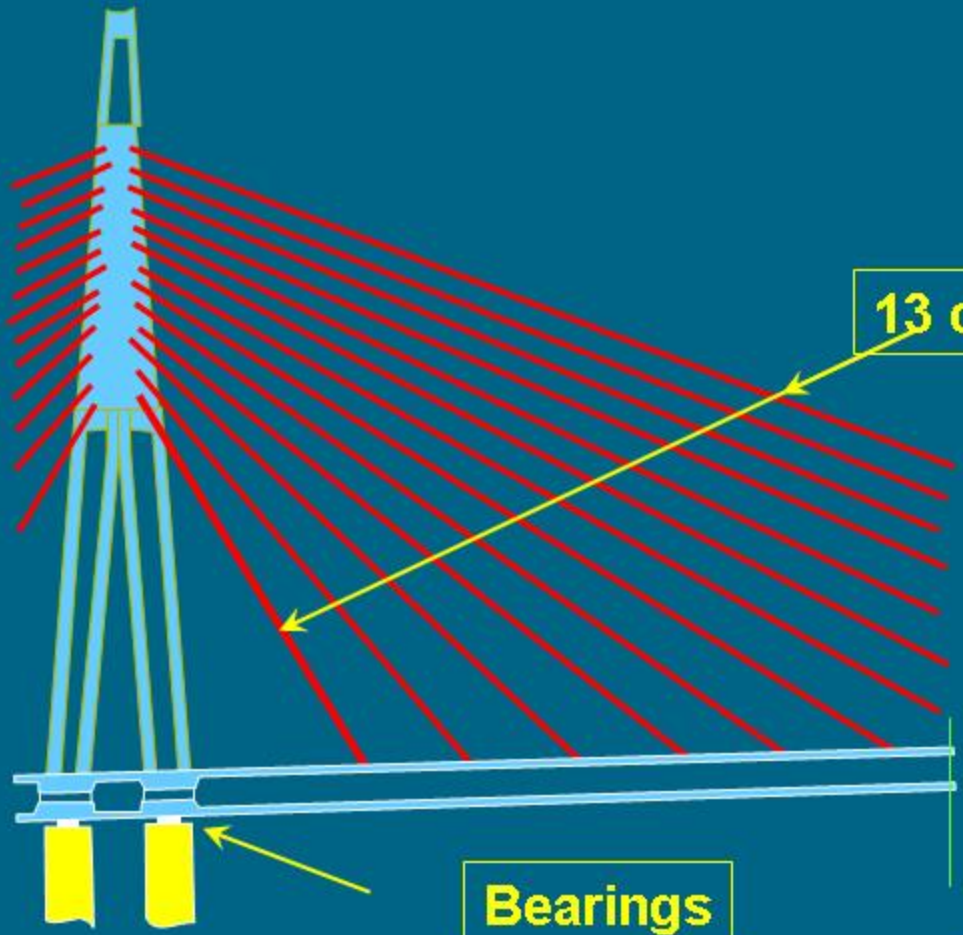
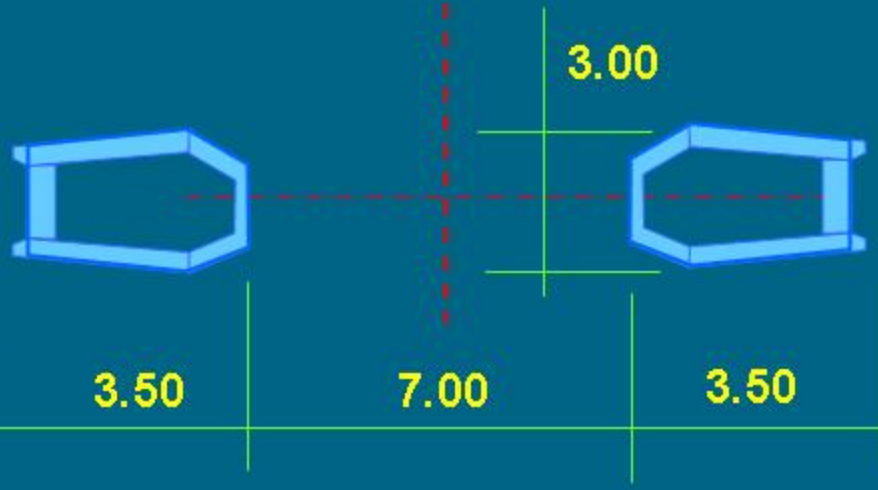
PYLONS & CABLES DESIGN

Steel deck & Pylon



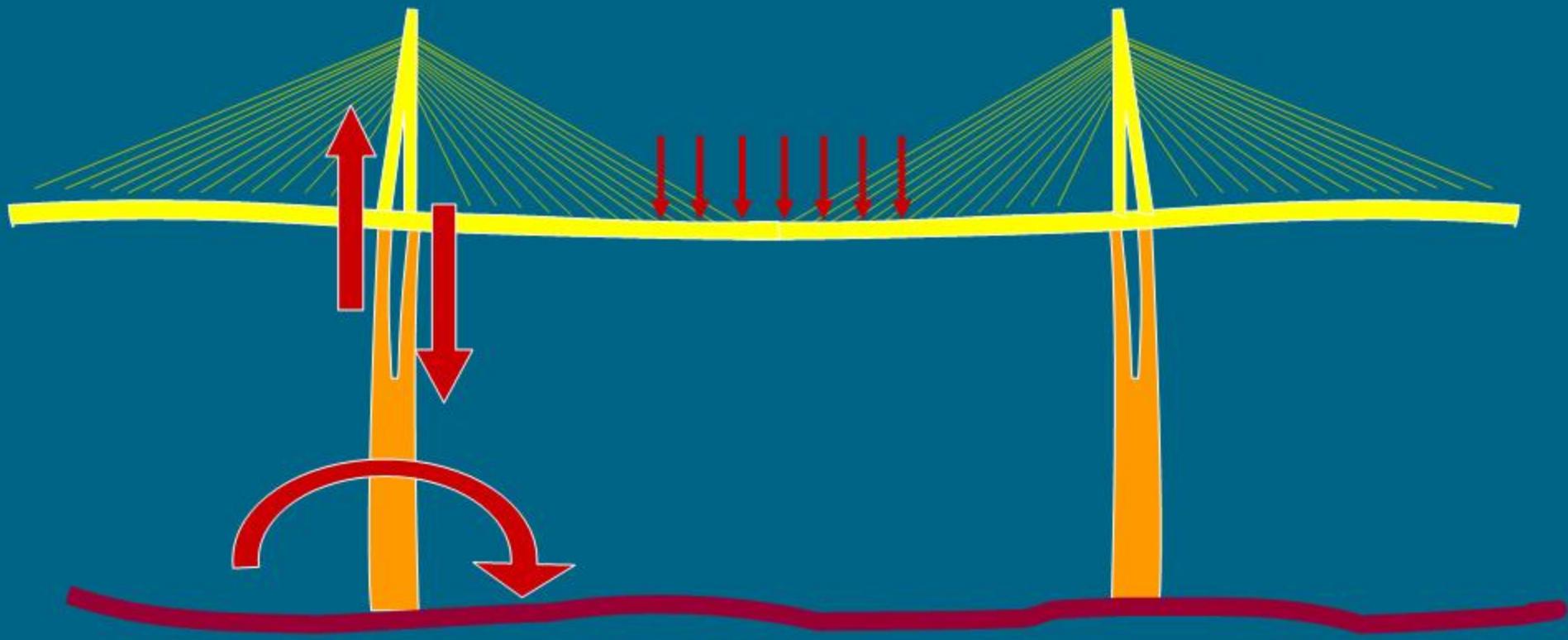




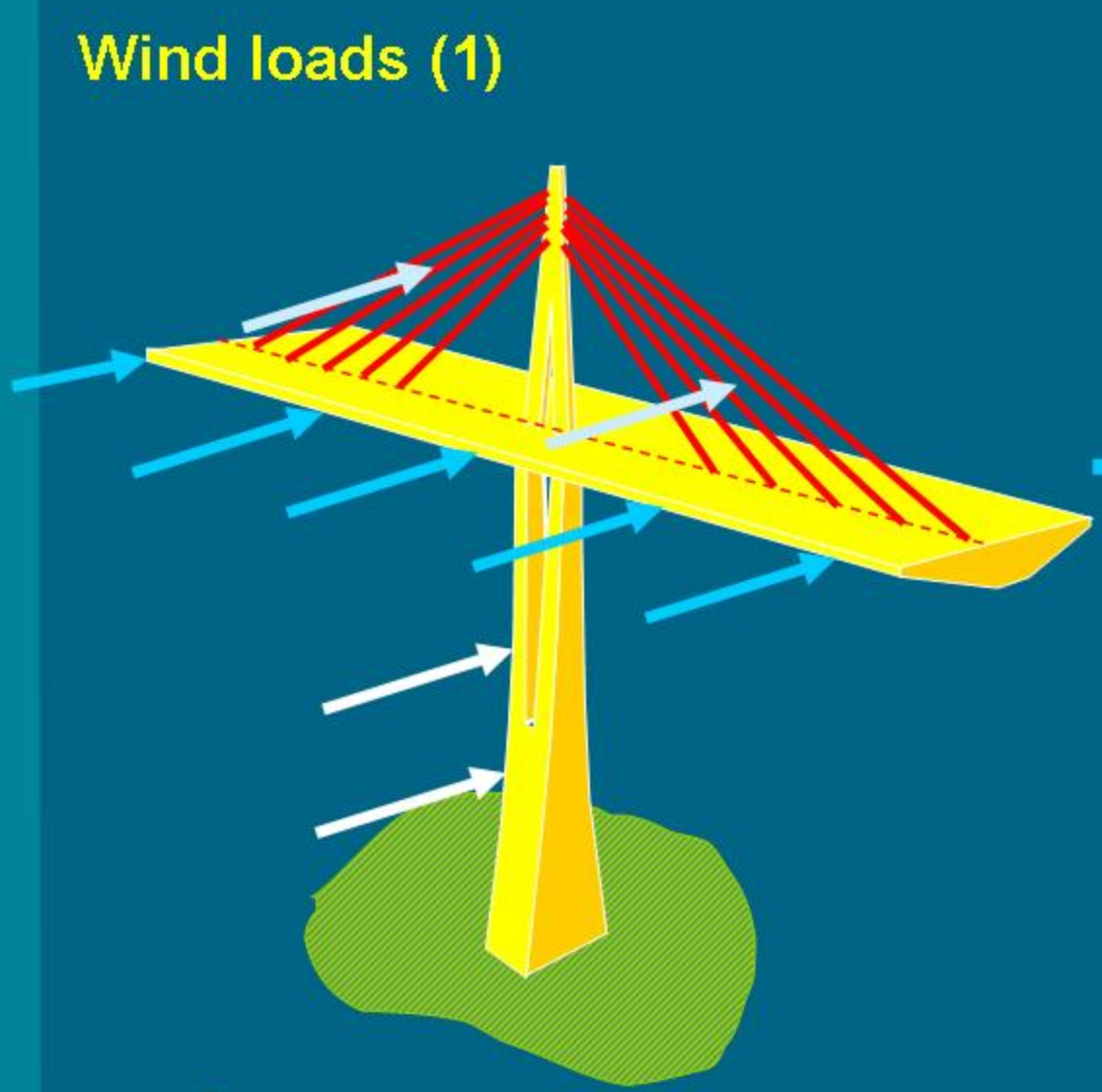
PYLONS & CABLES DESIGN

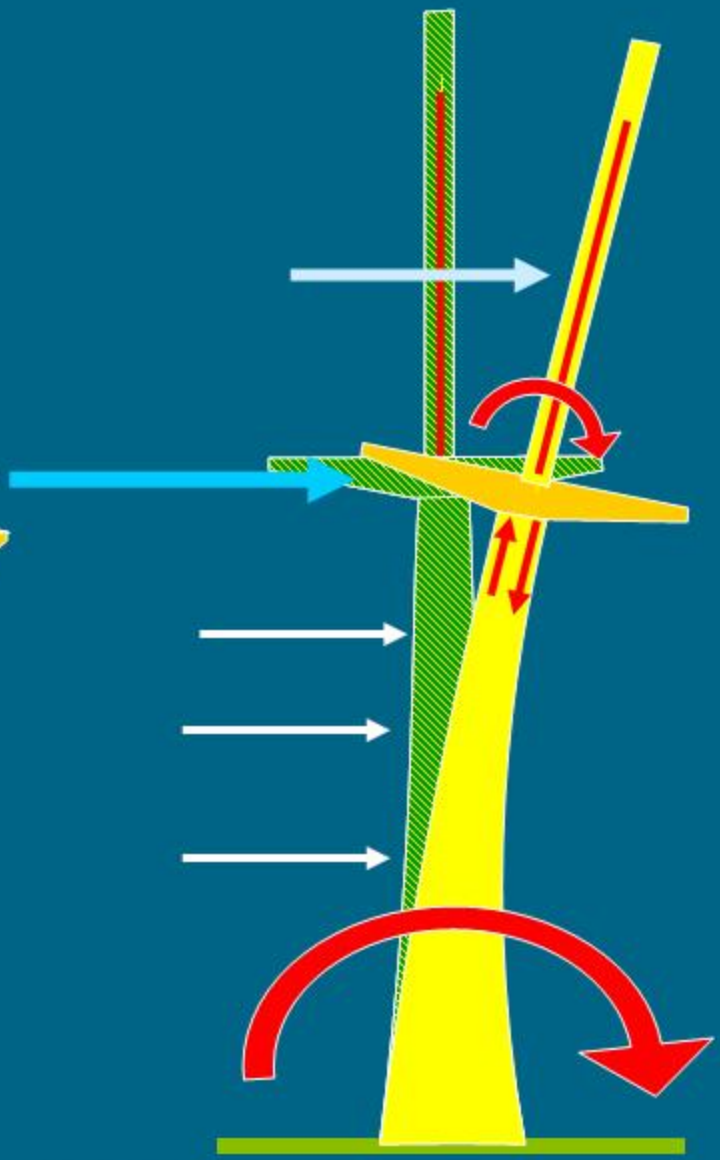
built

Static loads

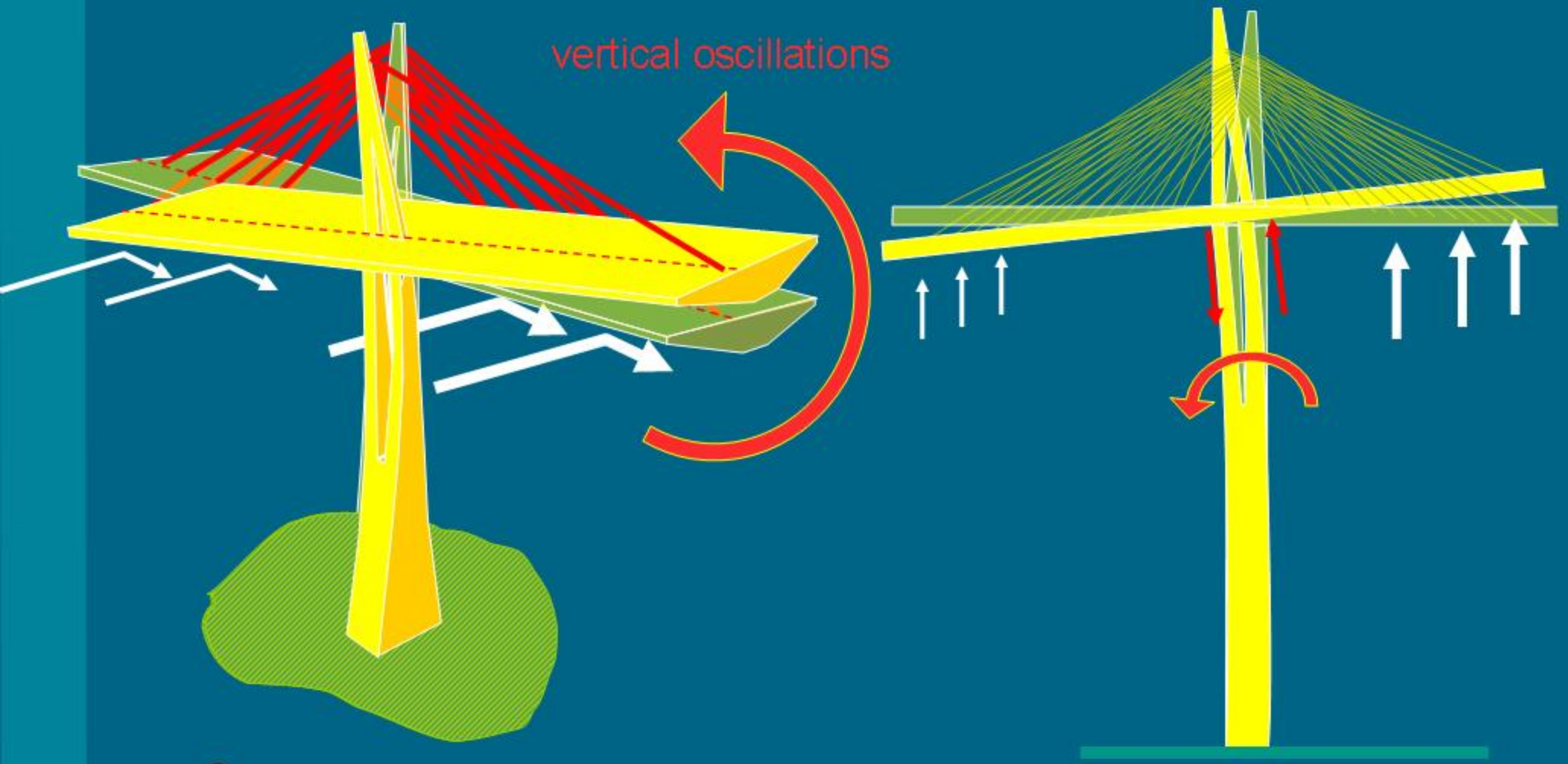


Wind loads (1)

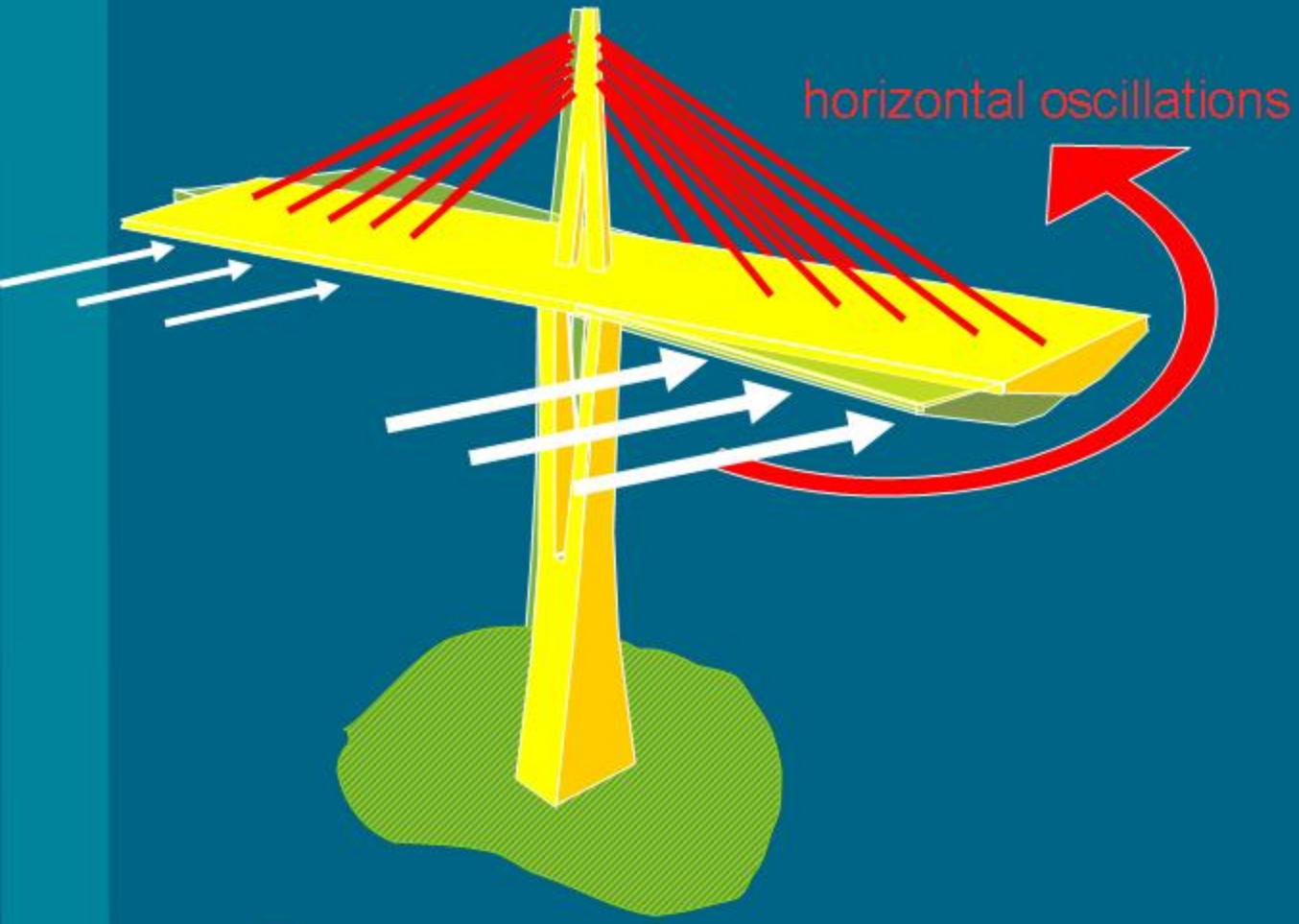


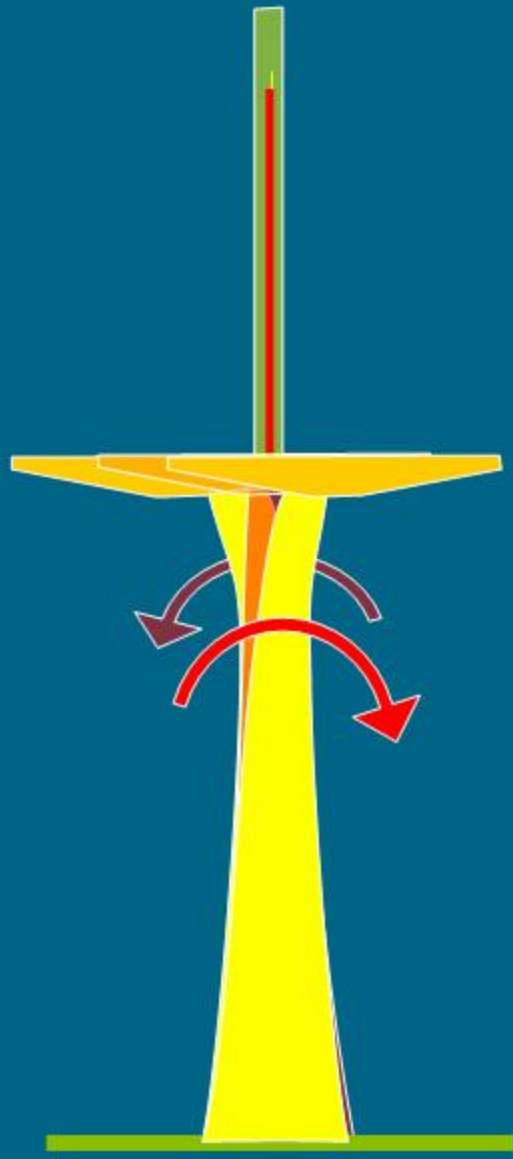


Wind loads (2)



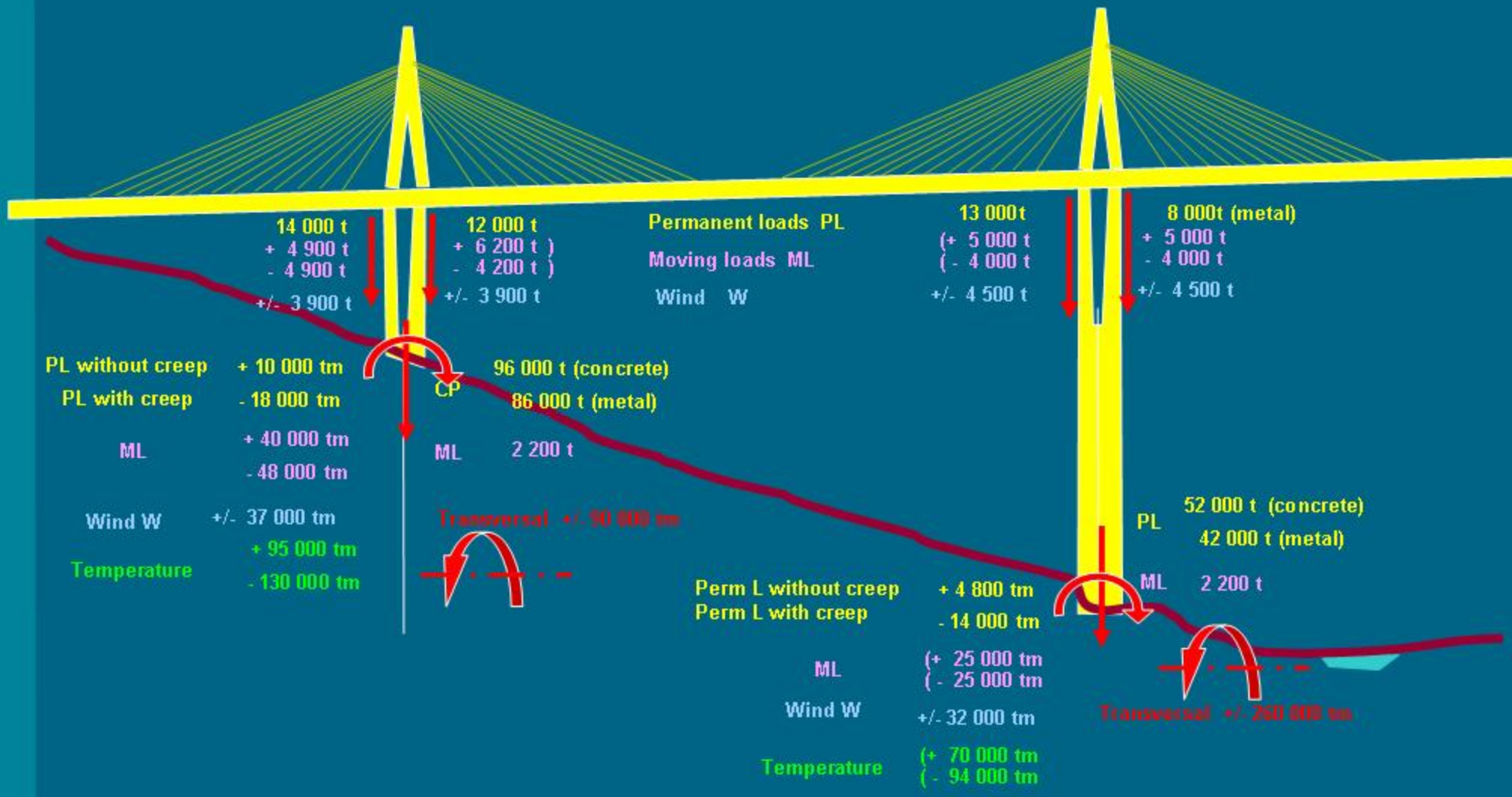
Wind loads (3)





PIERS DESIGN

Loads



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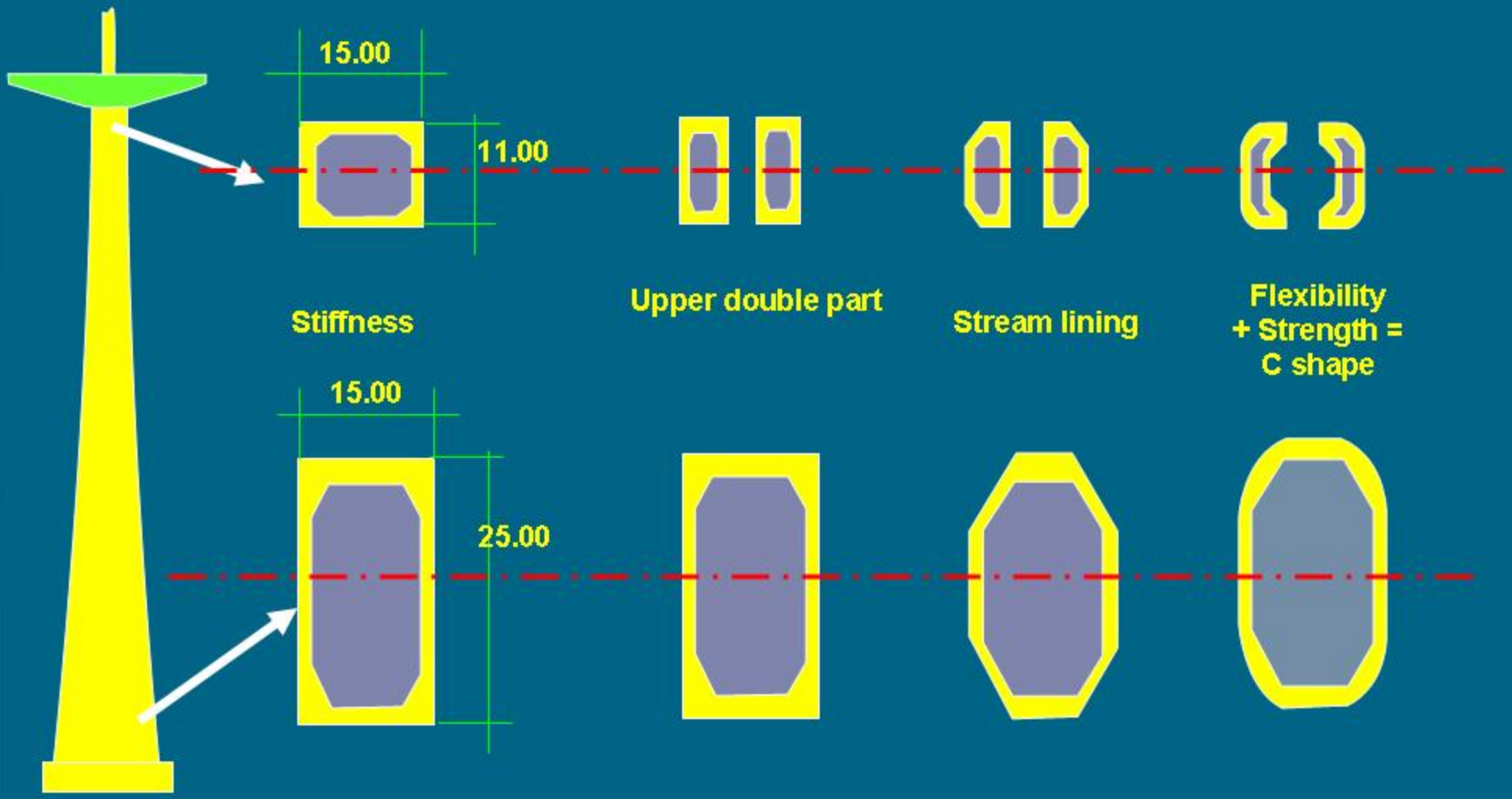
PIERS DESIGN

Shape



PIERS DESIGN

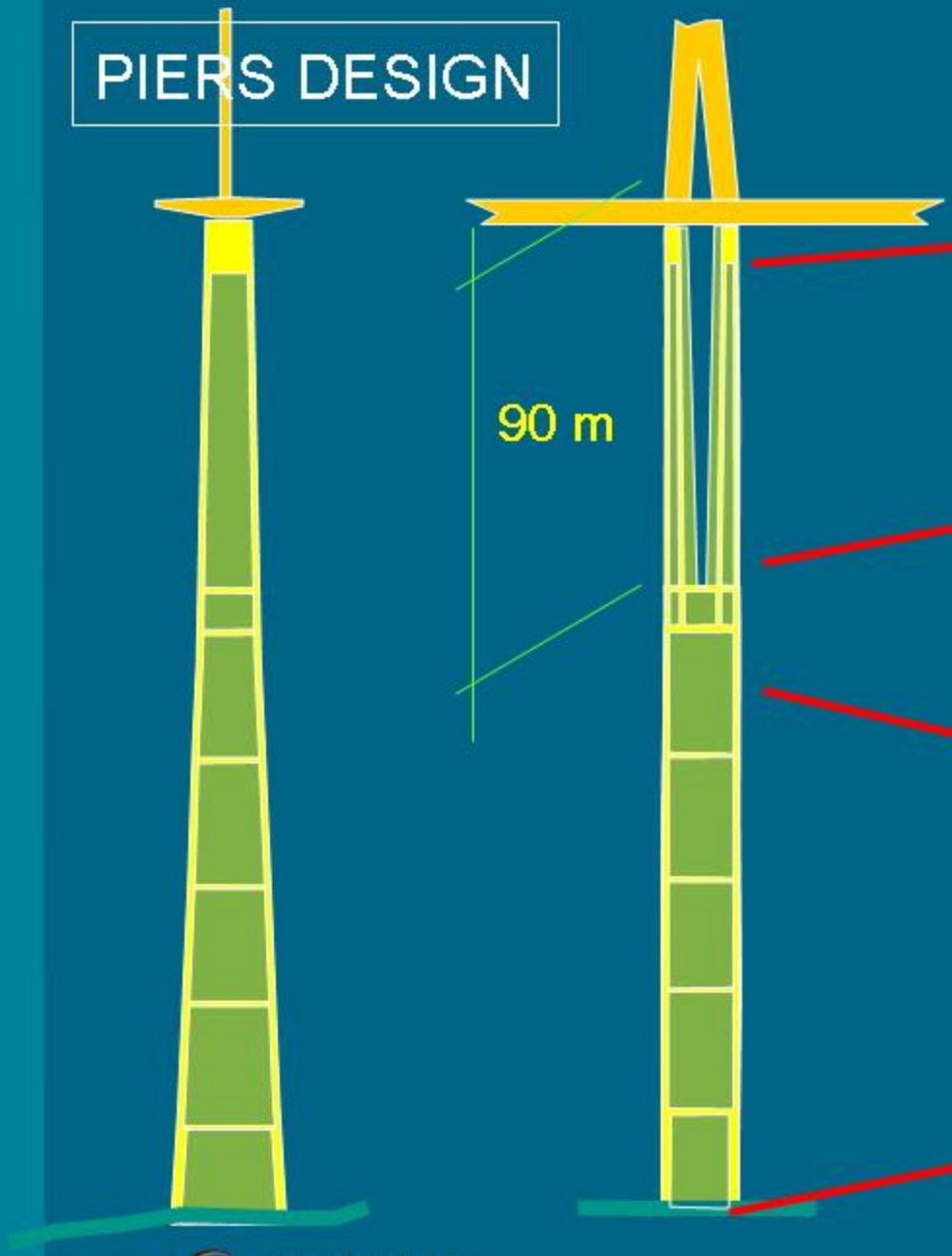
Shape

Esthetical & Structural combination

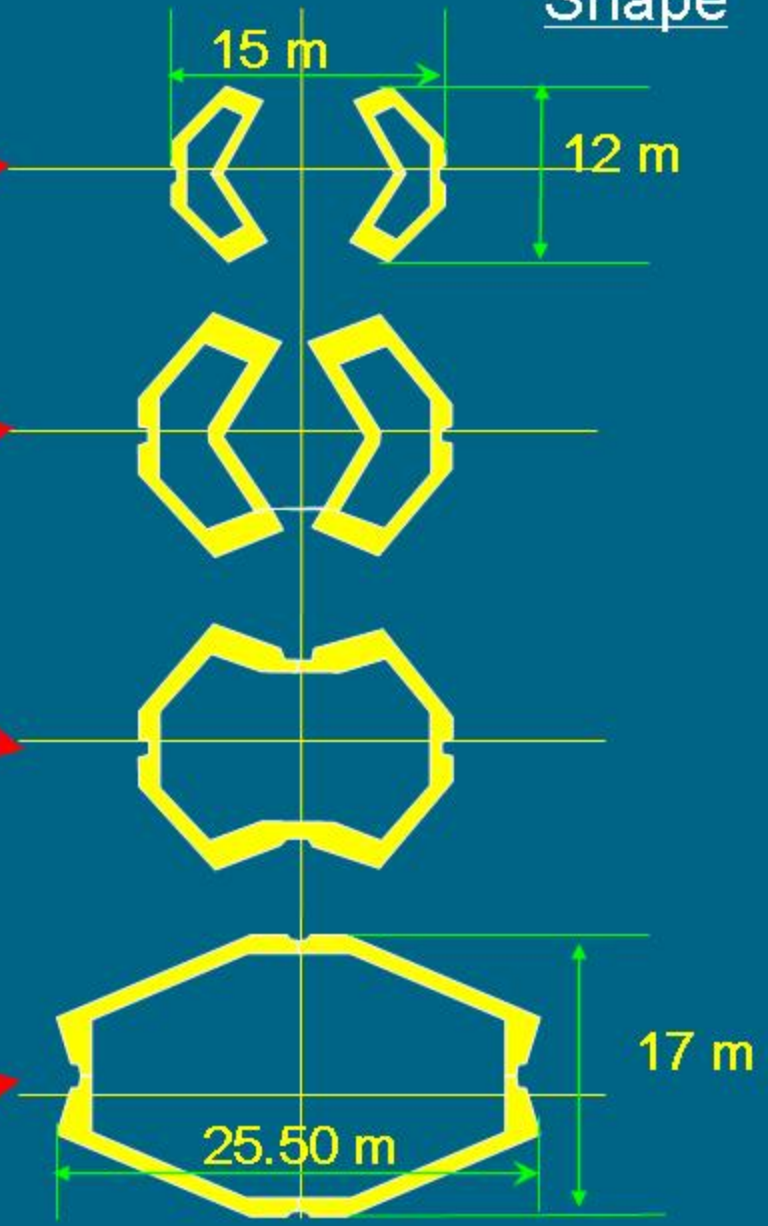
Triangular deck

Final design

PIERS DESIGN



Shape



ARCADIS

PIERS DESIGN

under construction

PIERS DESIGN

under construction

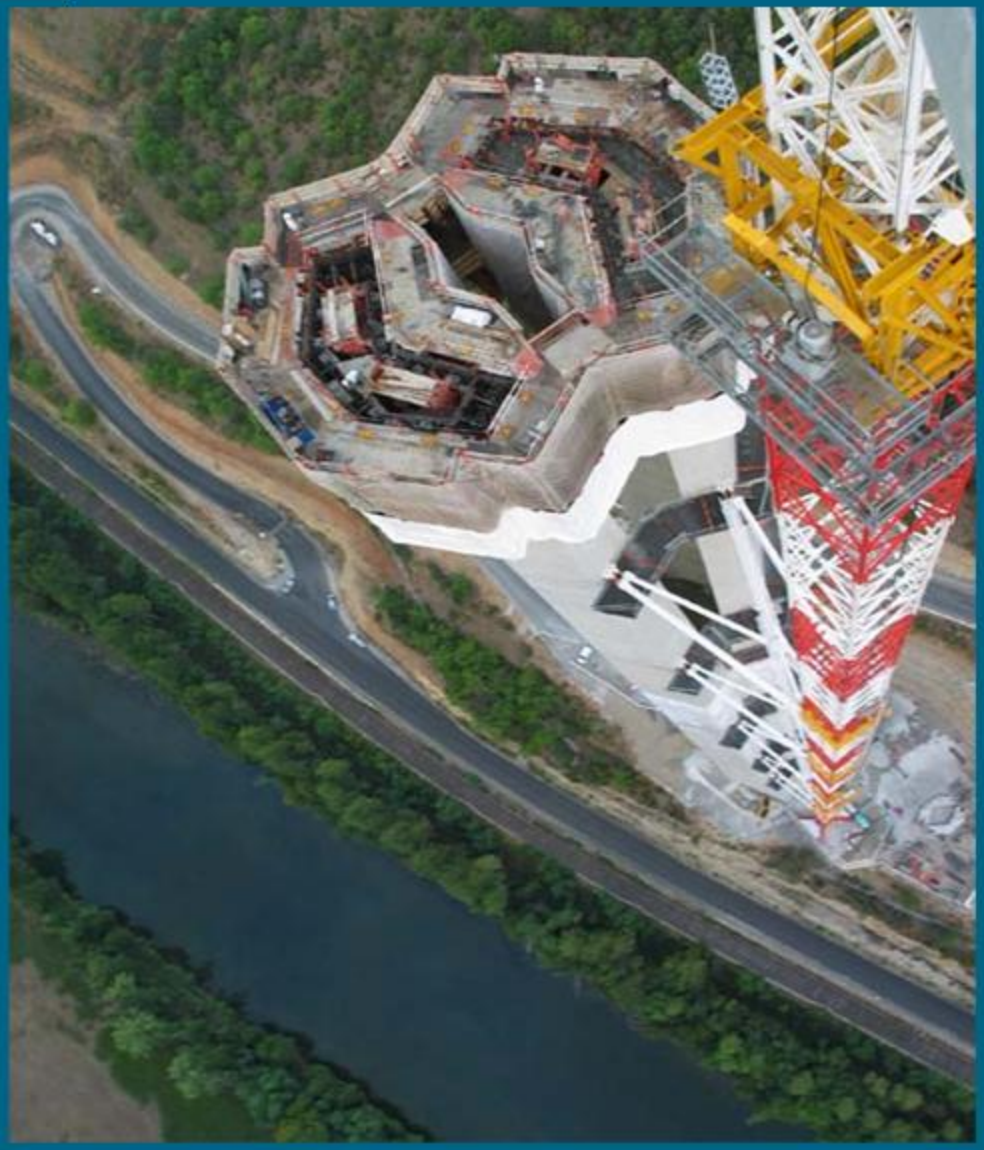
PIERS DESIGN

under construction

PIERS DESIGN

under construction

4m / 3 days



ARCADIS

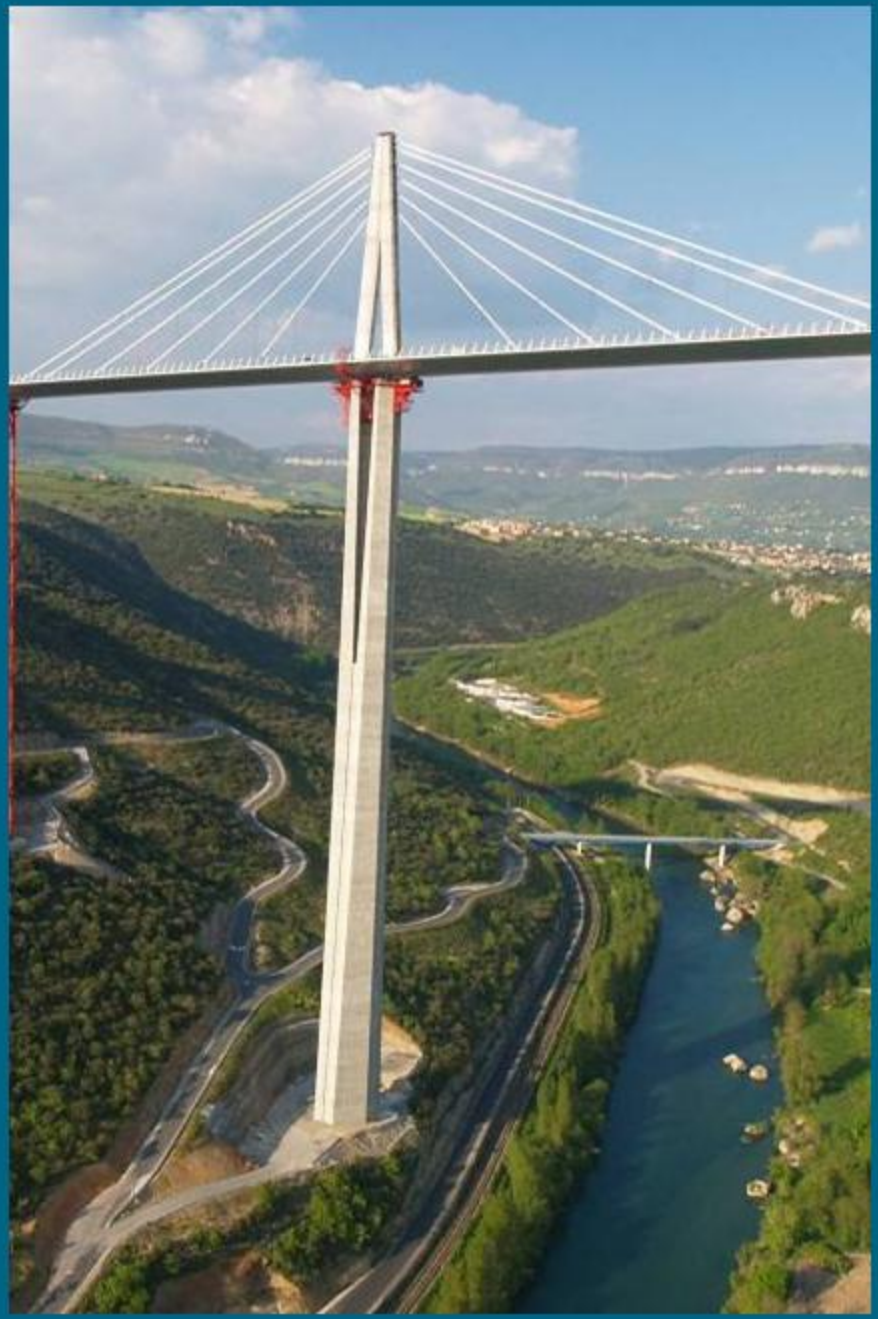
PIERS DESIGN

under construction

PIERS DESIGN

nearly completed

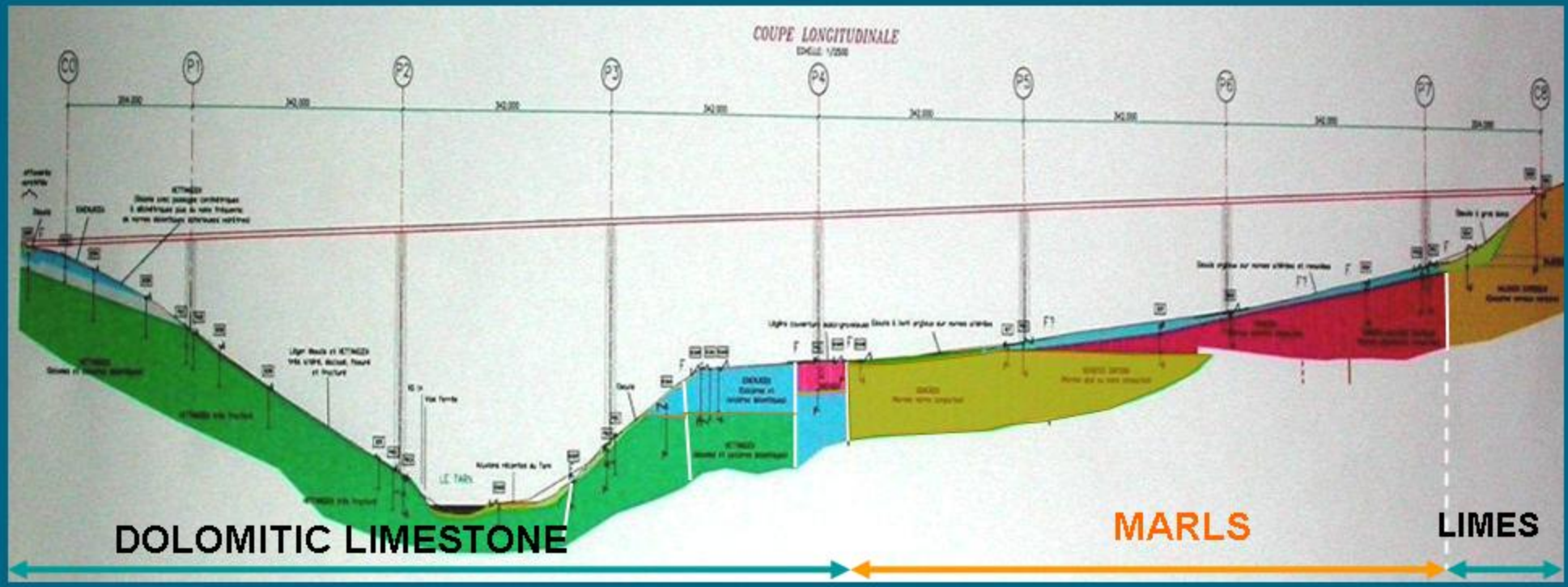
PIERS DESIGN



built

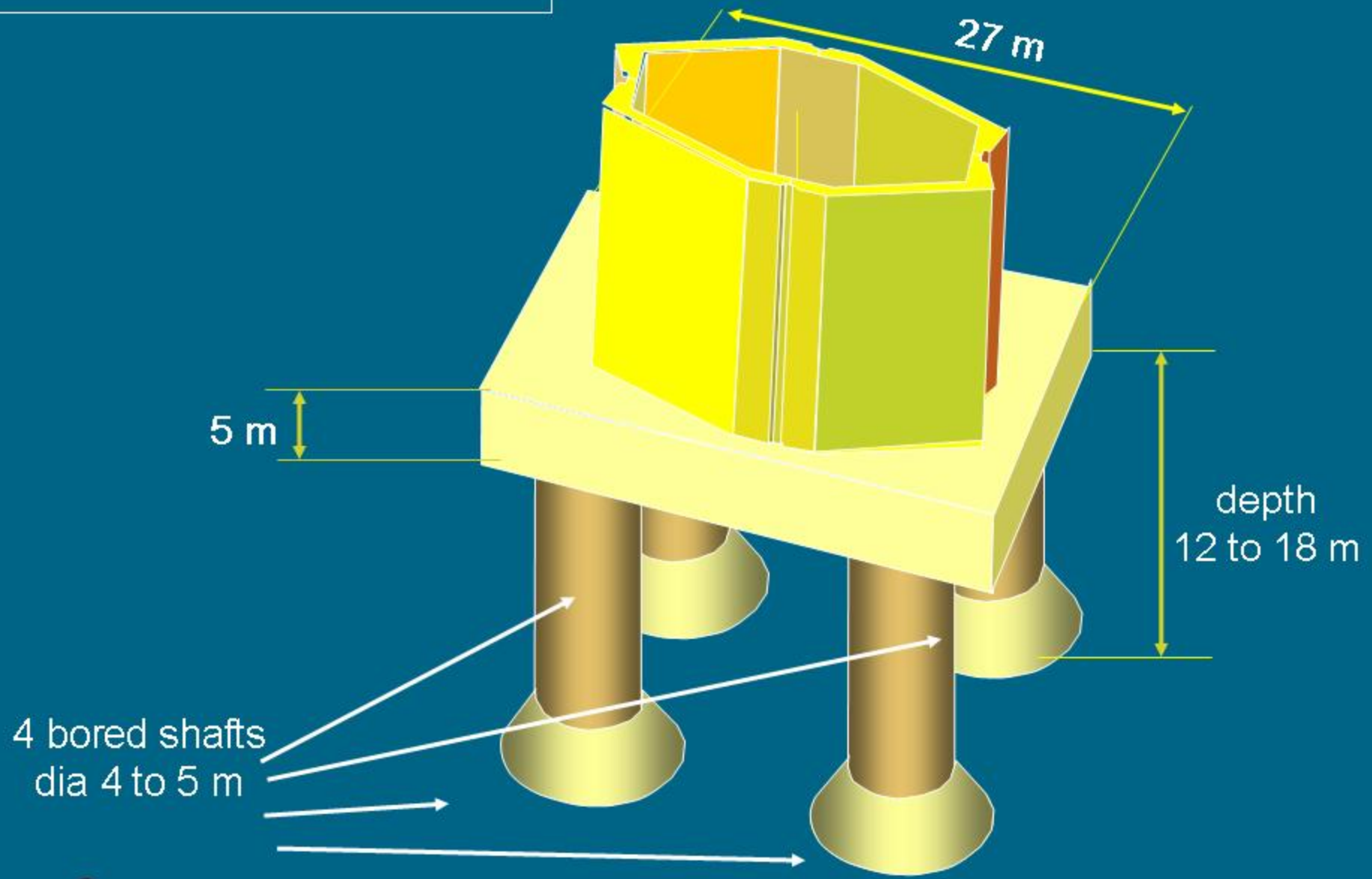
FOUNDATION DESIGN

Longitudinal ground profile



FOUNDATION DESIGN

Moroccan shafts



ARCADIS

FOUNDATION DESIGN

under construction

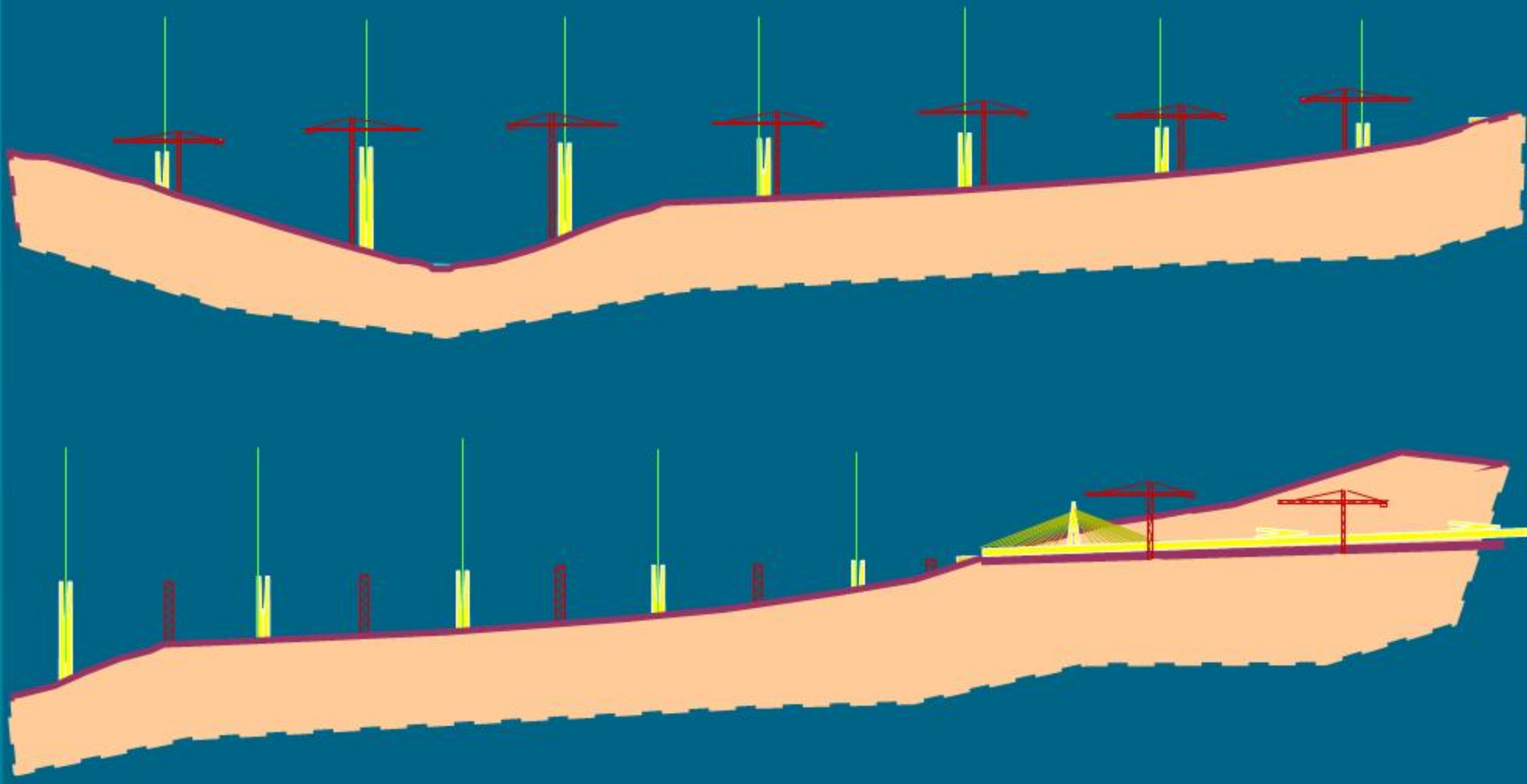
Karsts

CONSTRUCTION

- Steel deck
  - incremental deck launching from both sides
- Concrete deck (pm)
  - precast segments
  - balanced cantilever construction method

CONSTRUCTION

Deck launching



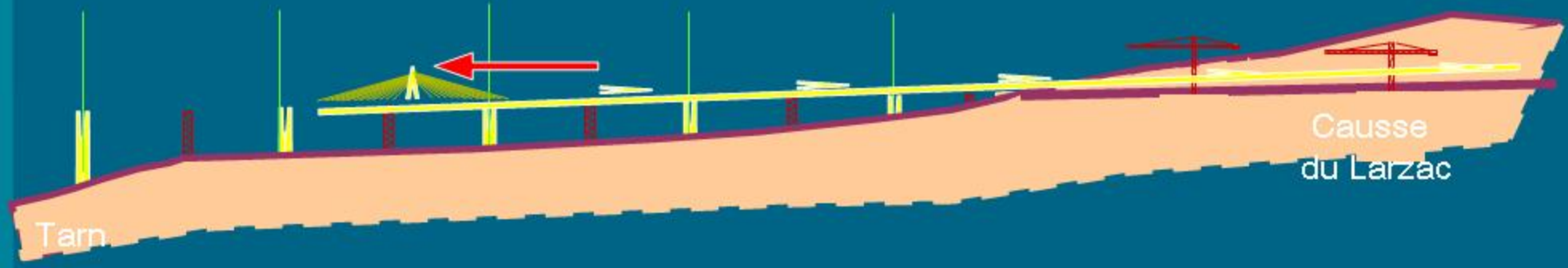
ARCADIS

CONSTRUCTION

Deck launching

3 (4) days for each 171 m

1 span / 2 to 3 weeks



CONSTRUCTION

CONSTRUCTION

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CONSTRUCTION

Deck launching

CONSTRUCTION

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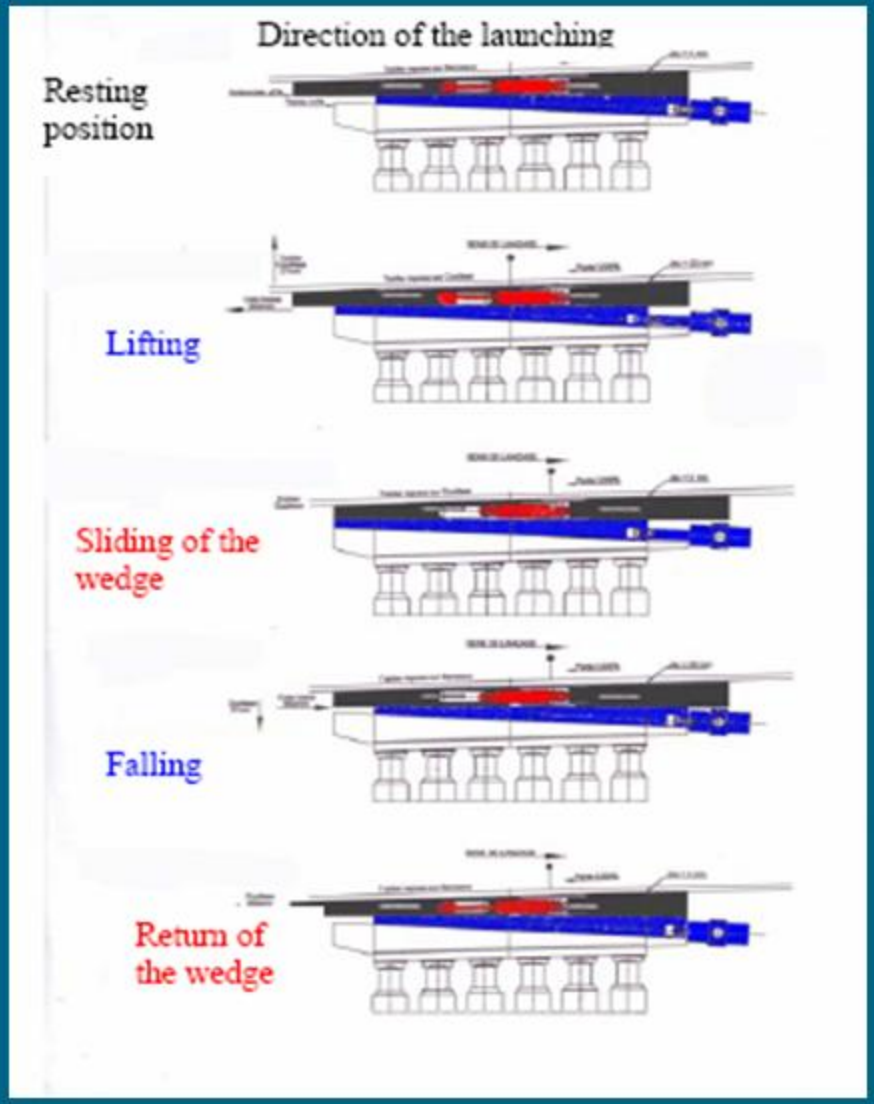
Deck launching

CONSTRUCTION

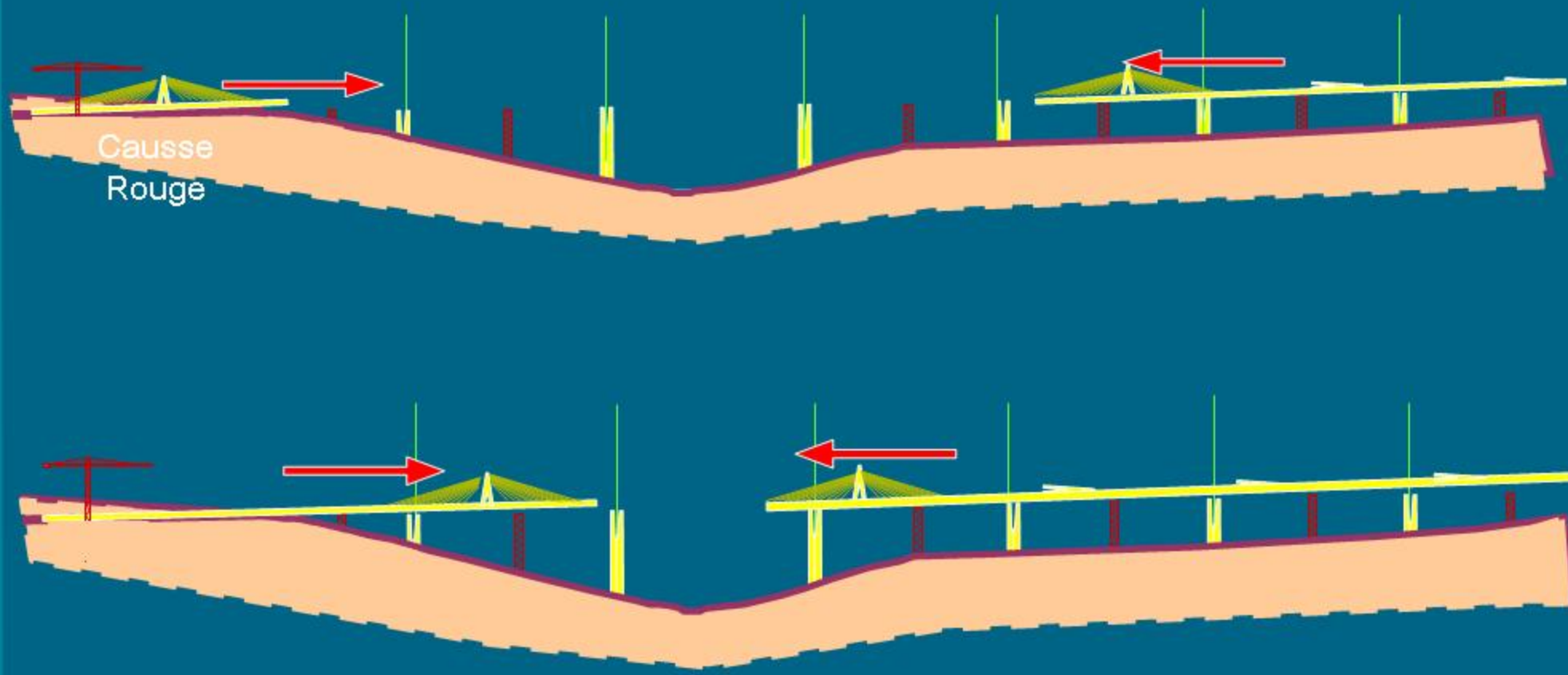
Deck launching device



Deck launching device

CONSTRUCTION

Deck launching



ARCADIS

CONSTRUCTION

Deck launching

CONSTRUCTION

Deck launching

CONSTRUCTION

Deck launching

CONSTRUCTION

Deck launching

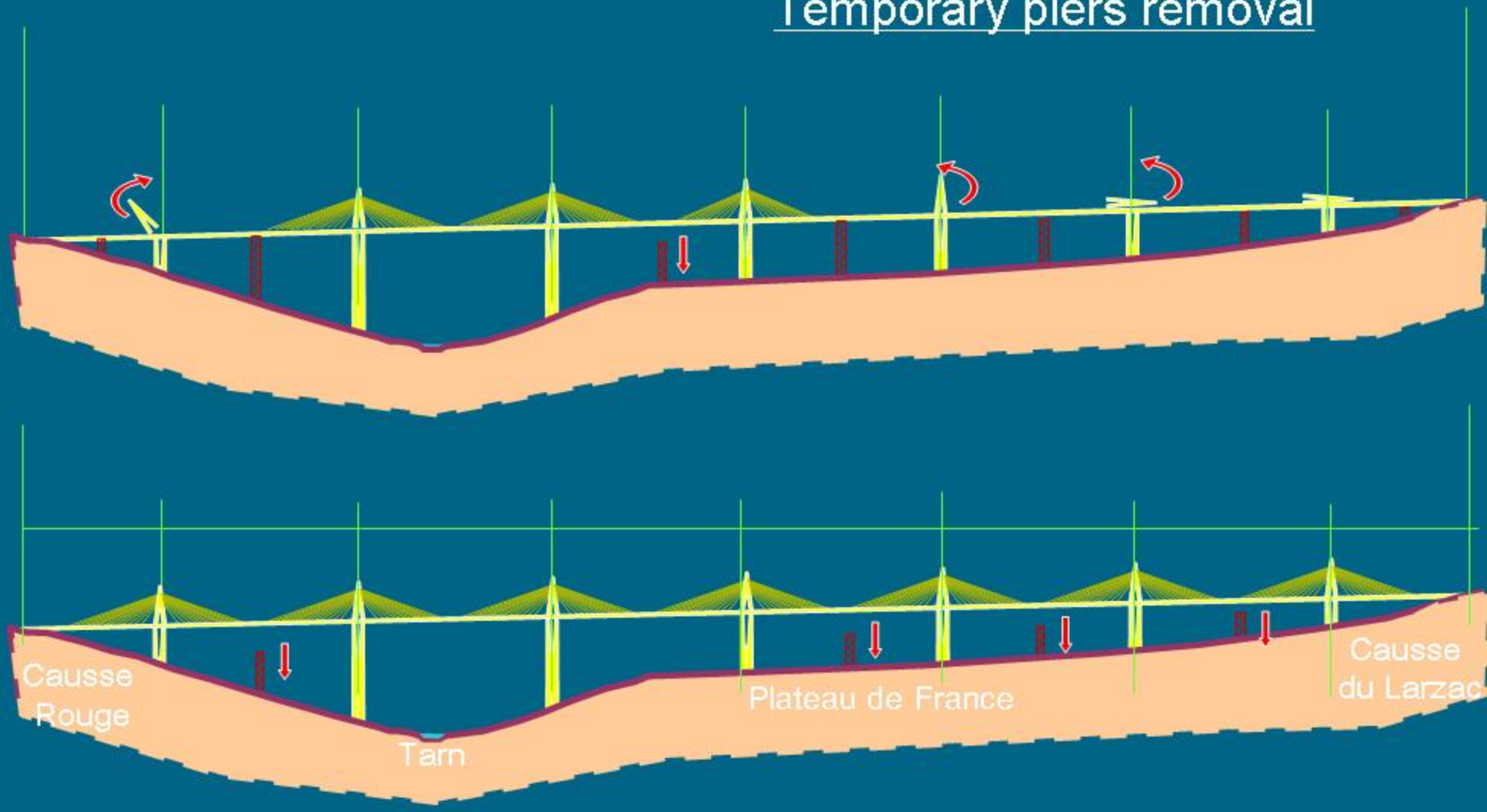
CONSTRUCTION

Deck launching

CONSTRUCTION

Pylons erection + Cables in tension

Temporary piers removal



CONSTRUCTION

Pylon erection

CONSTRUCTION

Pylon erection

CONSTRUCTION

Pylon erection

CONSTRUCTION

Removal of the temporary piers

CONSTRUCTION

Removal of the temporary piers

CONSTRUCTION

Removal of the temporary piers

CONSTRUCTION

from the South

CONSTRUCTION

… and the Reality