IAEG XII Congress

15 – 19 September 2014 - Turin (IT)

Engineering Geology for Society and Territory

6.11 GEOLOGICAL MODEL IN MAJOR ENGINEERING PROJECTS

THE "A12 – TOR DÈ CENCI" MOTORWAY: GEOLOGICAL REFERENCE MODEL AND DESIGN SOLUTIONS IN PRESENCE OF SOFT SOILS

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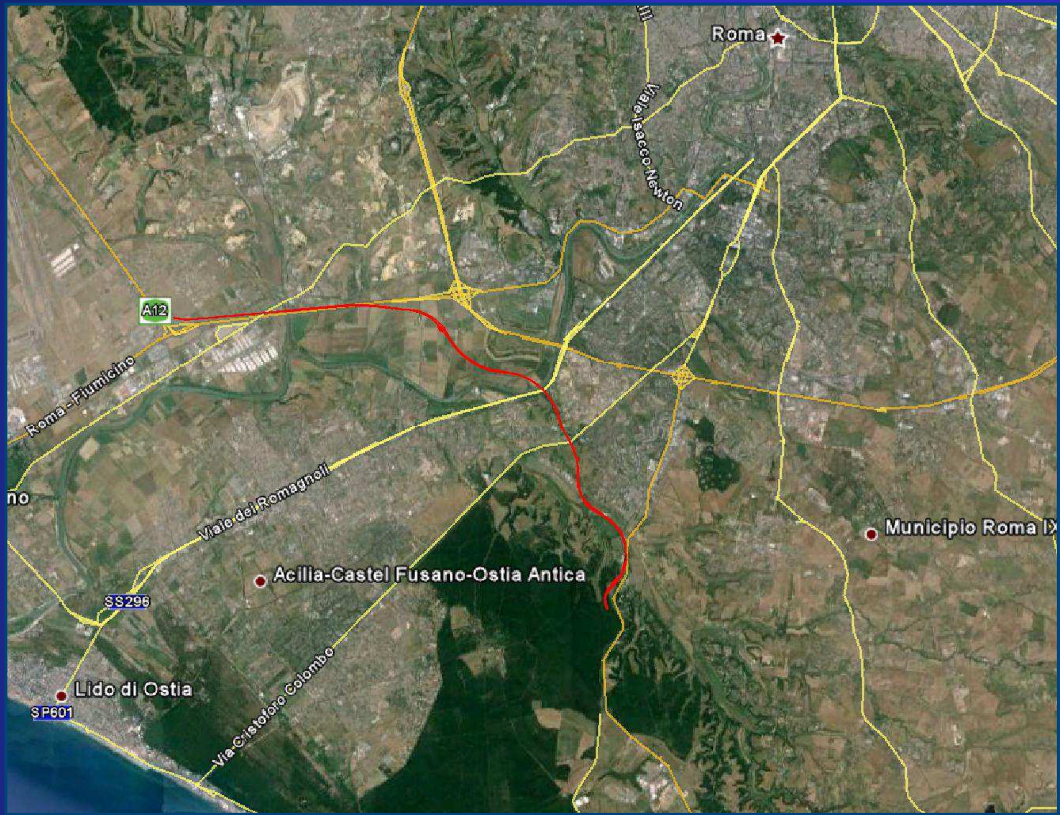
PROJECT FEATURES



Collocation

New connection between the A12 «Roma-Civitavecchia» and the «Roma (Tor dè Cenci) - Latina» motorways. Roman countryside (Fiumicino Plain) and the hinterland.

Type of project

The road project extends for about 16 km. It is composed by 4 viaducts of considerable development (the longest exceeds 2,7 km and another one crosses the Tevere River) and one artificial tunnel.

Studies, geological surveys and site investigation campaigns

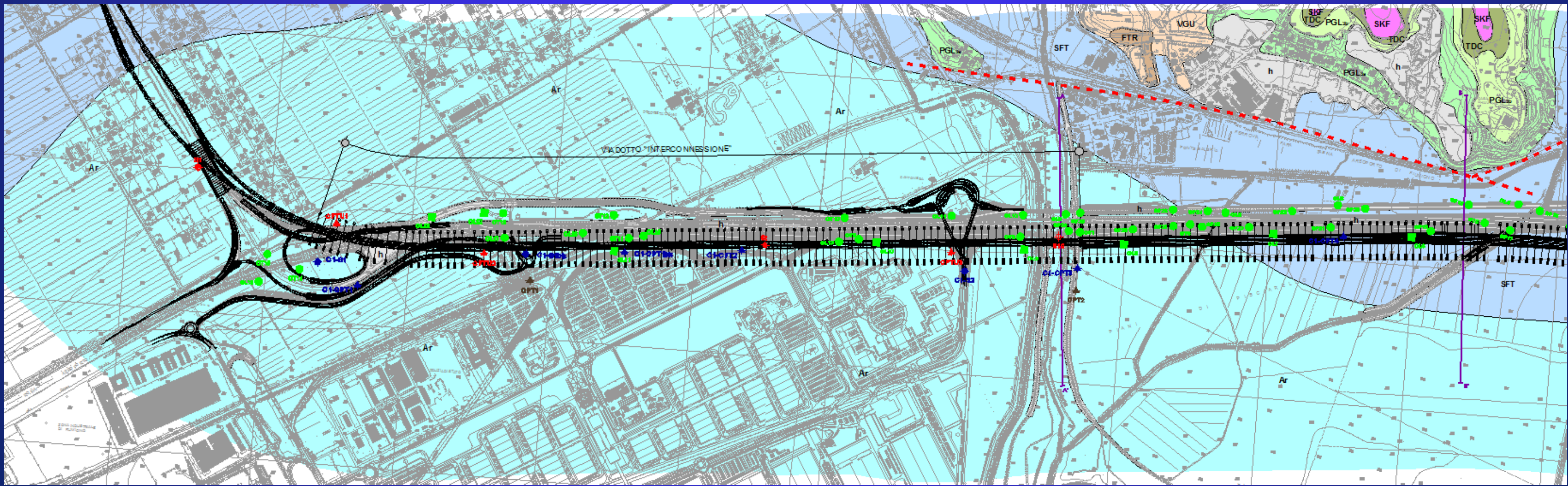
2 PHASES

Preliminary Project

- n. 65 boreholes
- n. 27 static penetration test (CPT and CPTU)
- n. 2 trenches
- n. 31 boreholes from preexisting investigations

Definitive Project

- n. 12 boreholes
- n. 75 dynamic penetration tests (SPT)
- n. 11 static penetration test with piezocone (CPTU)
- n. 5 geophysical tests (Down Hole)



Extract from the geological map of the project, containing the site investigation campaign

Geological Reference Model

Different genetic environments → *then* → Different phases of depositions and erosions

↓ *then*

Sedimentary prevulcanic substrate, consisting of:

1. Marine units
2. Transitional units
3. Continental units

Geological Reference Model
Semplified stratigraphic succession

Recent sediments of fluvial-lacustrine environment
(Sintema of the Tiber river, recent floods)

↑

Transitional and alluvial soils
(Ponte Galeria Formation, delta environment with transition from fluvial units to infralittoral and intertidal ones)

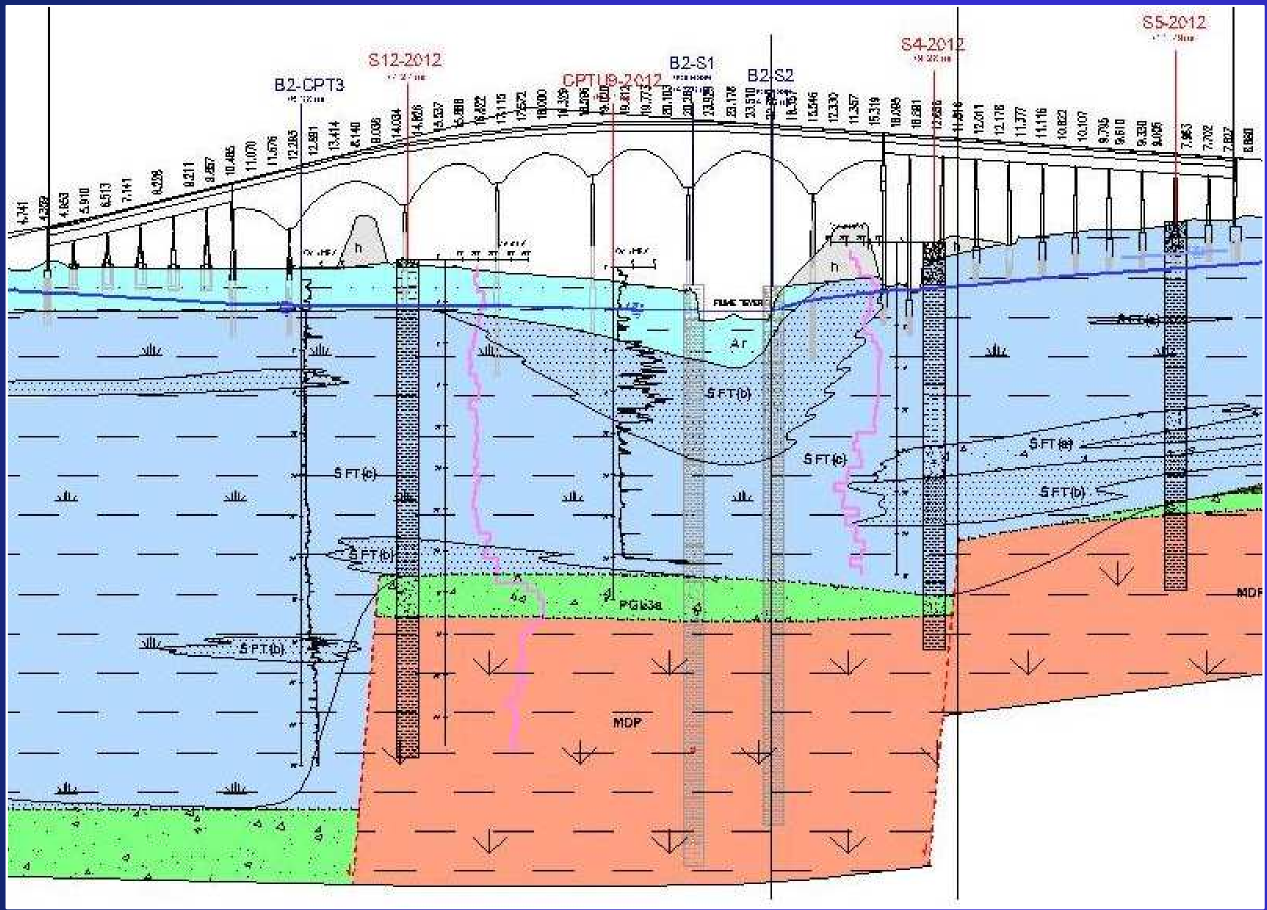
↑

Monte delle Piche Formation
Marine clayey deposit
(the oldest geological formation founded during site investigation activity)

THE MAJOR VIADUCTS

«Tevere Viaduct» - *Geological Reference Model*

(1424,86 m long)



Tevere Viaduct

Alluvial deposits
(Tiber River System, SFT)

Marine clay substrate
(Monte delle Piche formation, MDP) with *steps* structure
(faults NNE-SSW) – its depth varies from 25-30 m to more than 65-70 m towards W

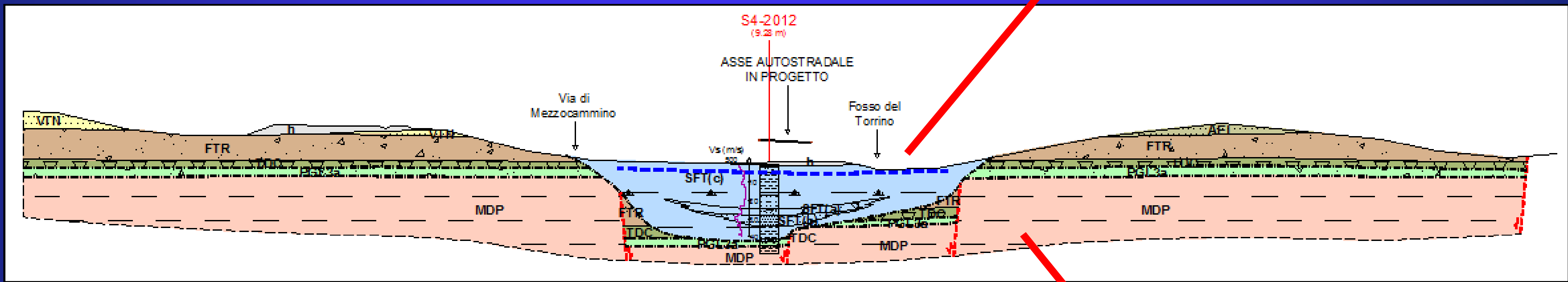
Variable thickness of recent organic and compressible sediments

The Major Viaducts

«Tevere Viaduct» - *Geological Reference Model*

(1424,86 m long)

Alluvial deposits
(Tiber River System, SFT)



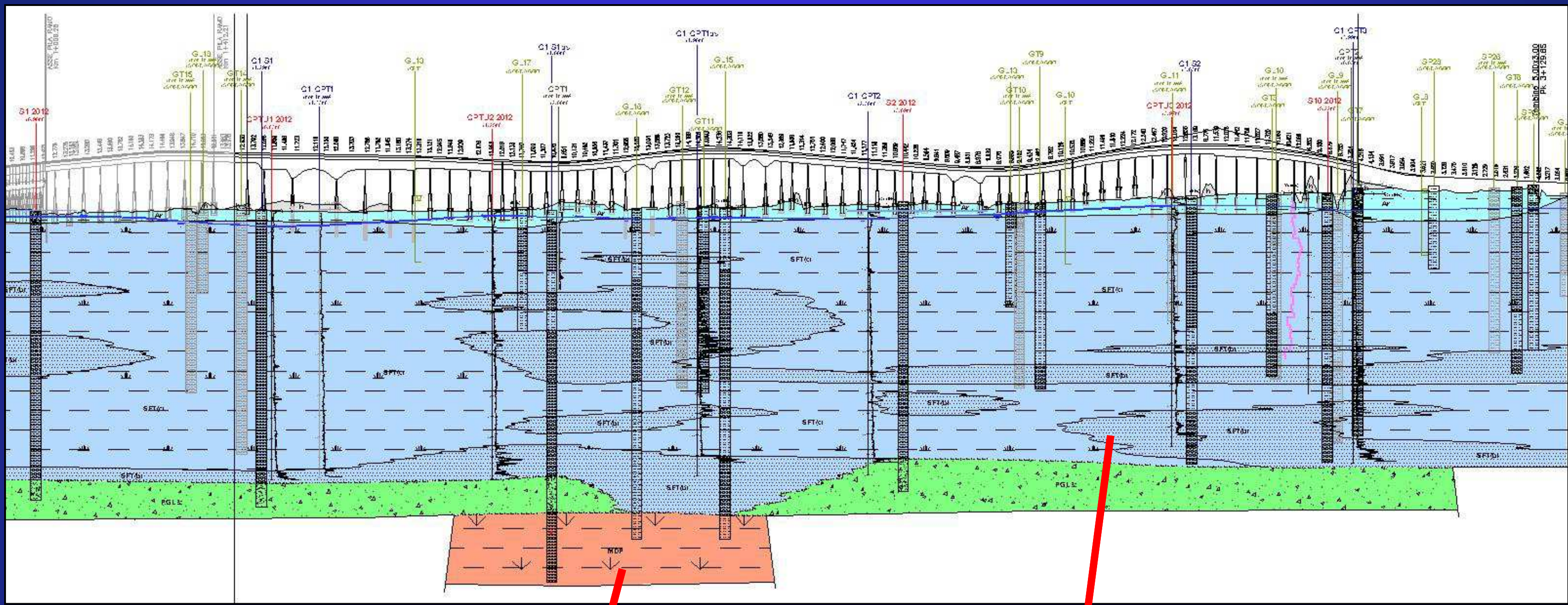
Geological cross-section, near the eastern abutment of the viaduct

Marine clay substrate (Monte delle Piche formation, MDP) with ***steps* structure** (faults NNE-SSW) – its depth varies from 25-30 m to more than 65-70 m towards W

THE MAJOR VIADUCTS

«Interconnessione Viaduct» - *Geological Model*

(2250 m long)



Interconnessione Viaduct

Regular depths of the substrate, deeper than 70 m

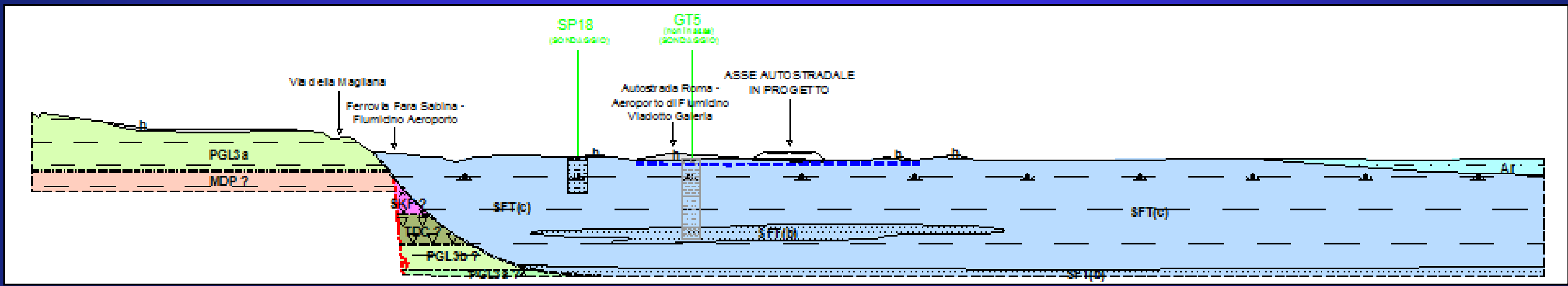
Alluvial deposits in uniform arrangement

High thickness of organic and compressible sediments

The Major Viaducts

«Interconnessione Viaduct» - *Geological Model*

(2250 m long)



Geological cross-section, east to the viaduct

Alluvial deposits in a uniform arrangement

DESIGN SOLUTIONS

Foundations

Geological Reference Model
Geothecnical features of soils

- High deformability
- Low resistance
- Different thickness of soft soils

Design input → *Different kind of foundation*

- Transfer of overload (deep foundations: driven piles, diaphragms, bored piles)
- Transfer of a net overload similar to the lithostatic load (direct compensated foundations)

Design Solutions - *Foundations*

«Tevere Viaduct»

(1424,86 m long)

Two Parts

13 spans, variable from 30 to 150 m

- *Outside the levees of the river* = Direct compensated foundations or indirect foundations with driven piles
- *Inside the levees of the river* = indirect foundations with diaphragms

11 spans, from 30 m (spans of the shore) to 40 m (intermediate spans)

Indirect foundations with large diameter bored piles (D = 1500 mm)

DESIGN SOLUTIONS - *FOUNDATIONS*

«Interconnessione Viaduct»

(2250 m long)

Composed by:

62 spans on the northbound carriageway with variable ports from 26 to 126 m

65 spans on the southbound carriageway with variable ports from 26 to 126 m

- Direct compensated foundation with protruding plinth on the terrain surface
- Deep foundations with piles of 70 m in corrispondence of spans larger than 40/45 m

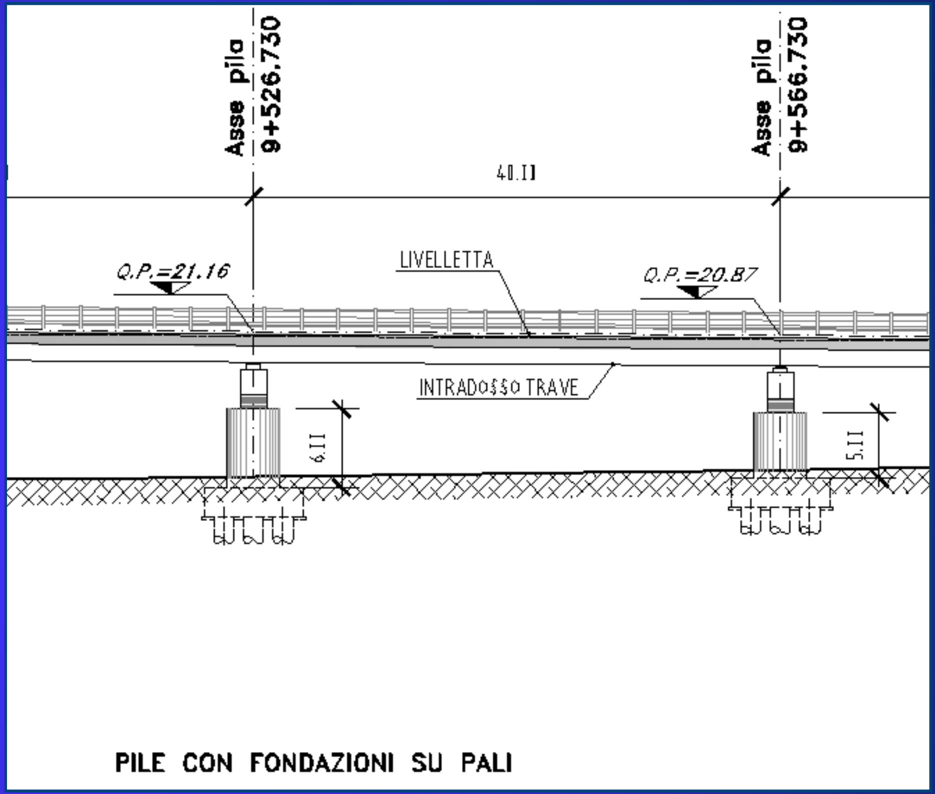
DESIGN SOLUTIONS - *FOUNDATIONS*

1. *Large diameter bored piles*

Bored piles with φ= 1000/1500 mm.

Their lengths depend on the entity of

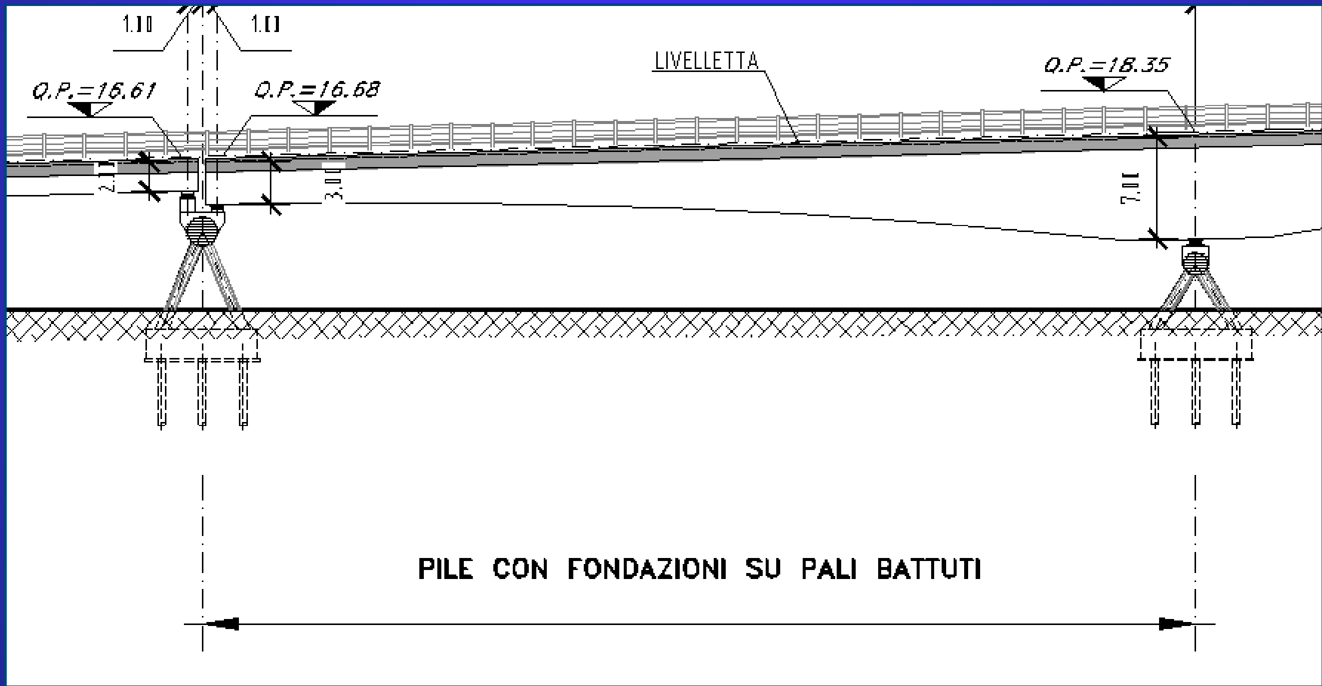
the applied loads



DESIGN SOLUTIONS - *FOUNDATIONS*

2. Driven piles

This kind of piles is abut within the substrate formations



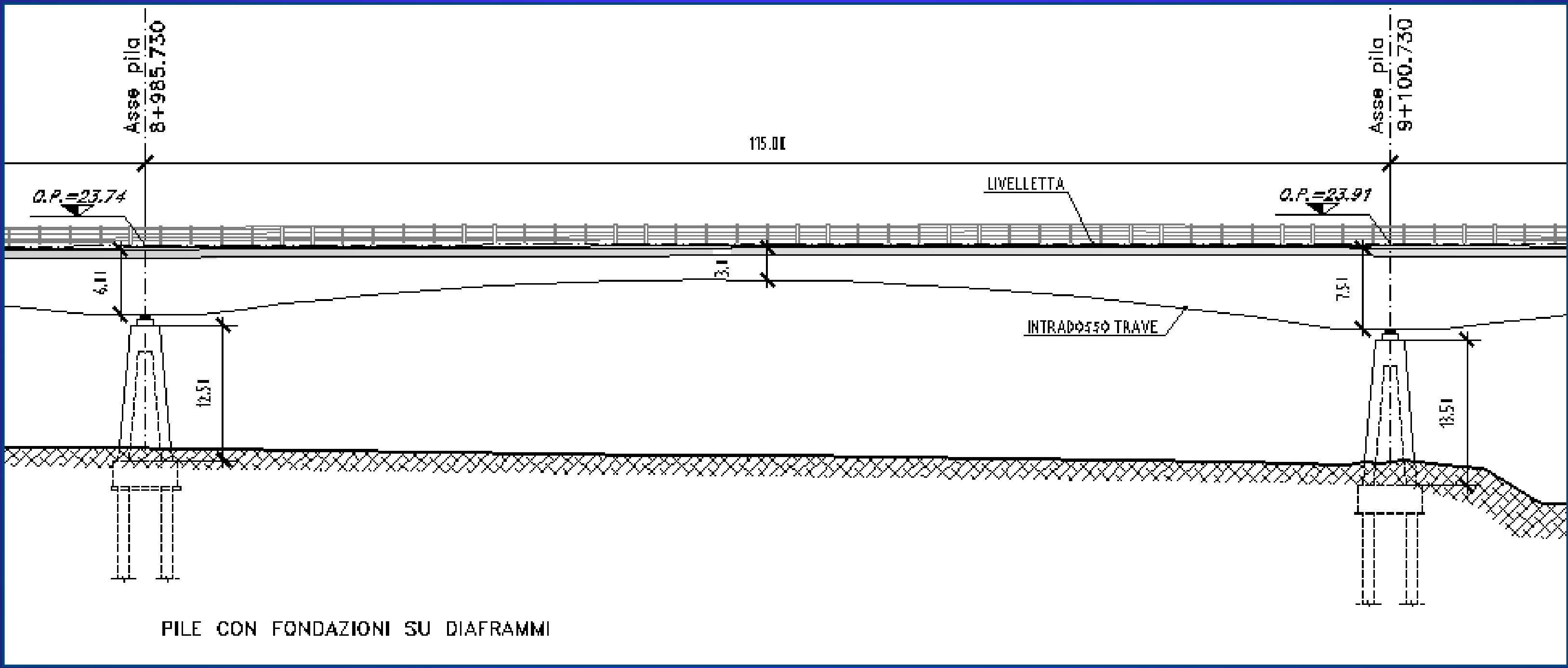
DESIGN SOLUTIONS - *FOUNDATIONS*

3. *Deep foundations with diaphragms*

Objective: anti-undermining

Diaphragms thickness: 1 m

Diaphragms length: 55-60 m

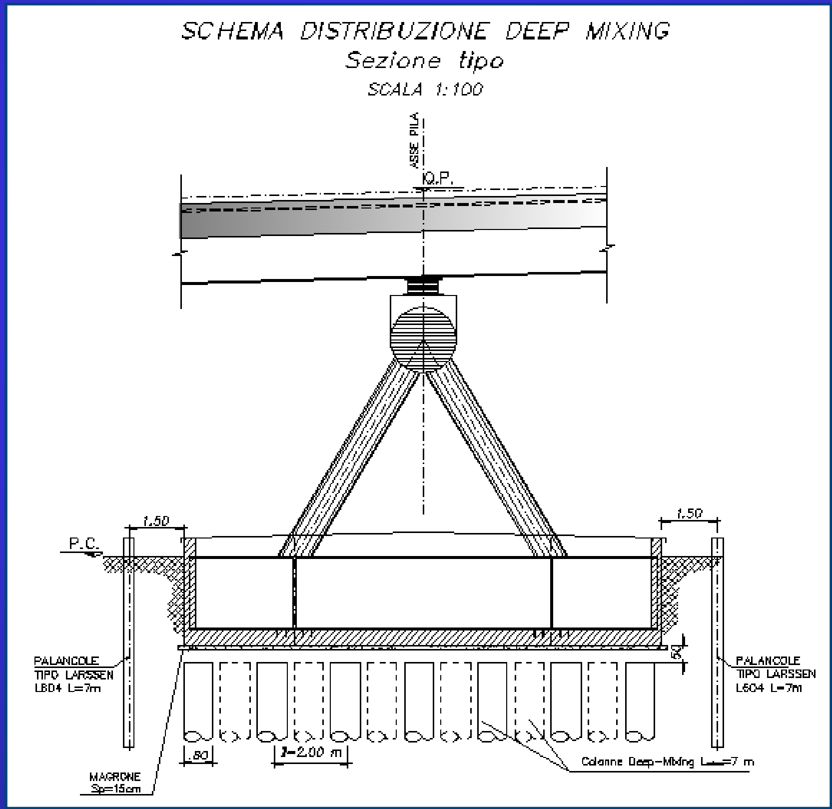


DESIGN SOLUTIONS - *FOUNDATIONS*

4. Compensated foundations

Objective: to limit the subsidence of the soils

Use of *deep-mixing*: to improve the soils features above the foundations



Design Solutions

Road body

Geothecnical features of soils

- High deformability
- Low resistance

Probable subsidence of the road body

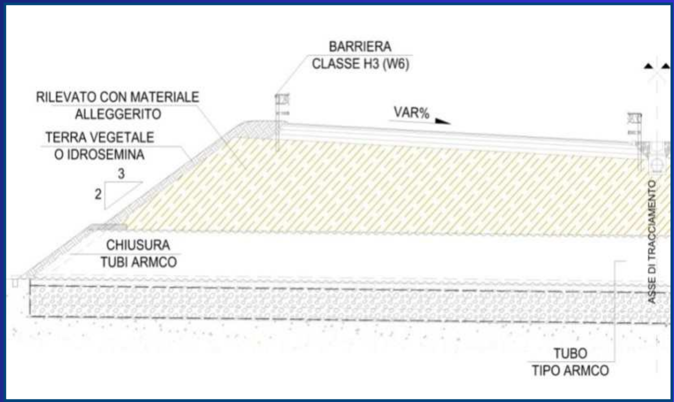
Reduction of overload transmitted

Different type of interventation

- Lowering project level
- Lowering height of the embankments
- Use of lightened material for embankments

DESIGN SOLUTIONS - *ROAD BODY*

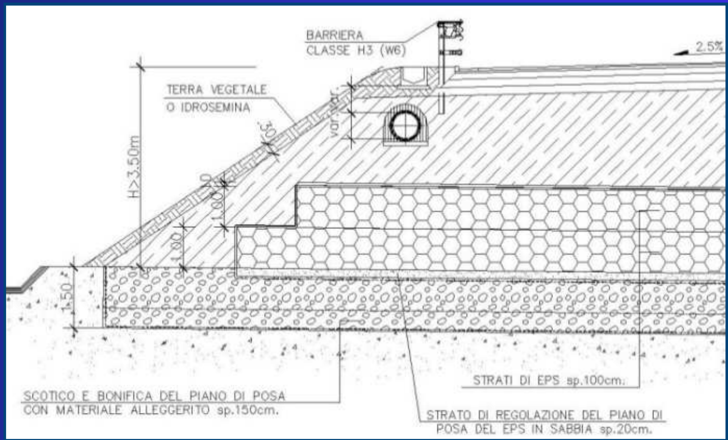
1. *Metal* pipes ARMCO type



Their installation allows the creation of necessary voids to reduce the body road weight

DESIGN SOLUTIONS - *ROAD BODY*

2. Sintered expanded polystyrene (EPS)



Lightweight and easy to handle material.

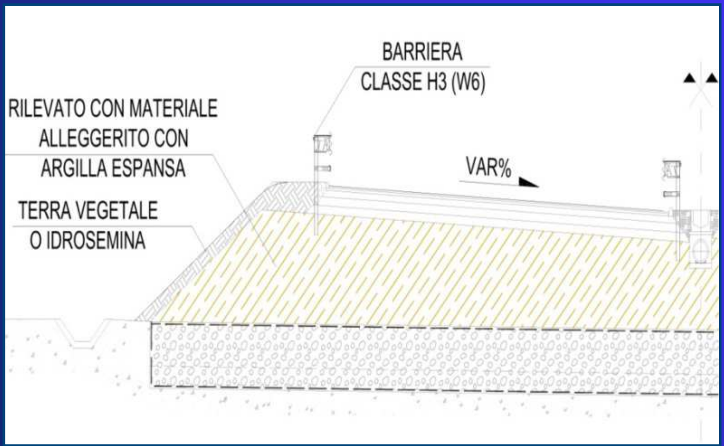
It allows to limit the subsidence of the soil, to reduce the movement of soils and the embankment area.

DESIGN SOLUTIONS - *ROAD BODY*

3. Expanded clay

It allows to:

- Reduce the subsidence due to the costruction of the road
- Increase the road durability
- Reduce maintenance costs



Conclusions

Refinement of both the Geological and Geotechnical Reference Models of the intervention area

Complex Geological situation with poor features (high thickness of soft soils with organic content)

Low resistance

High deformability

Careful evaluation of their behavior

Choice of appropriate design solutions

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THANKS FOR THE ATTENTION

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