Geo^{3}T^2 April 9-10, 2015

8th GEOTECHNICAL, GEOPHYSICAL AND GEOENVIRONMENTAL TECHNOLOGY TRANSFER (Geo^{3}T^2) CONFERENCE AND EXPO

Geostructural Design and Construction Interfaces I-73 Taxiway Bridge Design-Build

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Taxiway Bridge … *yet to be seen on I-73*

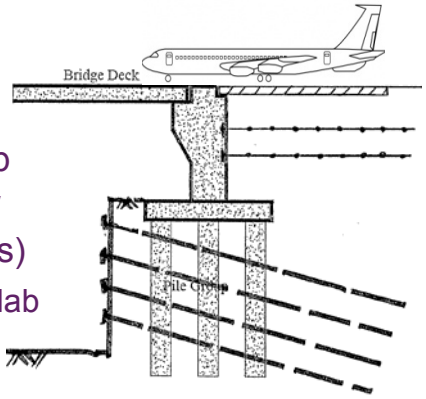
Image from: http://www.airliners.net/photo/World-Airways/McDonnell-Douglas-DC-10-30/1521550/&sid=912ca67a538a13a51967ab58b5c373a1

2

We Will Discuss ….

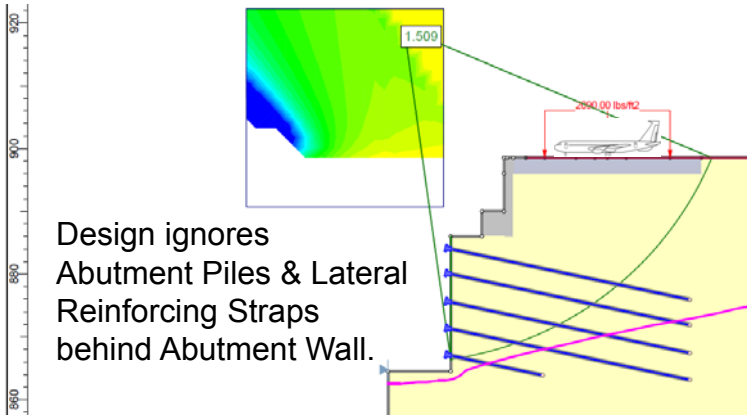
Geostructural Design and Construction Interfaces among ….

- Soil Nail Wall
- Bridge Abutment Piles
- Bridge Abutment Pile Cap
- Bridge Abutment Wall (w/ Lateral Reinforcing Straps)
- Approaching Structural Slab



3

I-73 Taxiway Soil Nail Wall Design



Design ignores Abutment Piles & Lateral Reinforcing Straps behind Abutment Wall.

4

Geostructural Interaction

Construction Sequence

Abutment Piles → Pile Cap during Soil Nail Wall

→ Abutment Wall → Backfill → Bridge Approach Slab

Soil/Ground Movement is Inevitable! ….

- Where there is *Stress*, there is … *Strain*.
- Where there is *Foundation Loading*, there is … *Settlement*.
- Where there is *Excavation*, there is … *adjacent Ground Movement.*
- **Soil Nail Wall needs to move to mobilize Nail Resistance.**

Quiz

Is the Soil Nail Wall Movement

"Favorable" or "Un-Favorable"?

5

Soil Nail Wall Movements

"*Un-Favorable*" … Potential Concerns:

Would Soil Nail Wall Movement affect:

→ Pile Abutment Foundation Piles (Micropile vs H-Pile)?

→ Pile Cap Position?

→ Bridge Abutment Wall?

→ Approach Slab Designs?

How to Evaluate Soil Nail Wall Movements?

6

Soil Nail Wall Movements

Clough, G. W., and O'Rourke, T. D. (1990). "Construction induced movements of insitu walls." *Design and performance of earth retaining structures*, Geotech. Spec. Publ. No. 25, ASCE, New York, N.Y., 439–470.

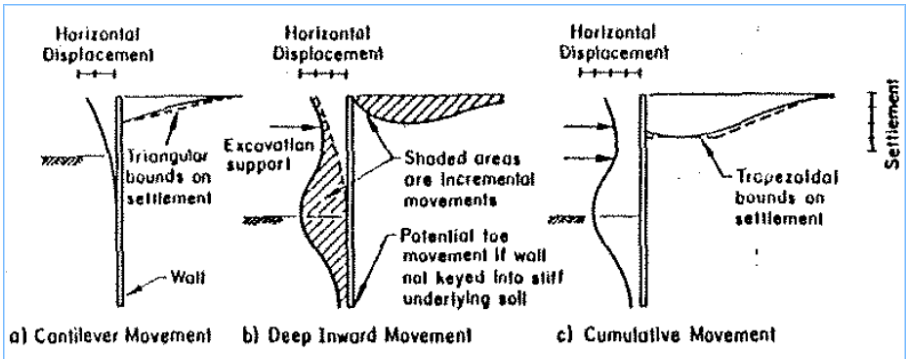


Figure 6. Typical Profiles of Movement for Braced and Tied-Back Walls.

7

Soil Nail Wall Movements

Clough & O'Rourke (1990)

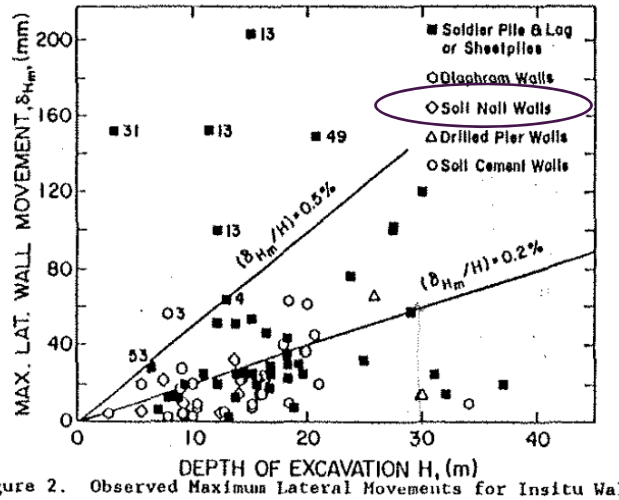


Figure 2. Observed Maximum Lateral Movements for Insitu Walls in Stiff Clays, Residual Soils and Sands.

8

Soil Nail Wall Movements

FHWA Geotechnical Engineering Circular No. 7
"Soil Nail Walls" (2015)

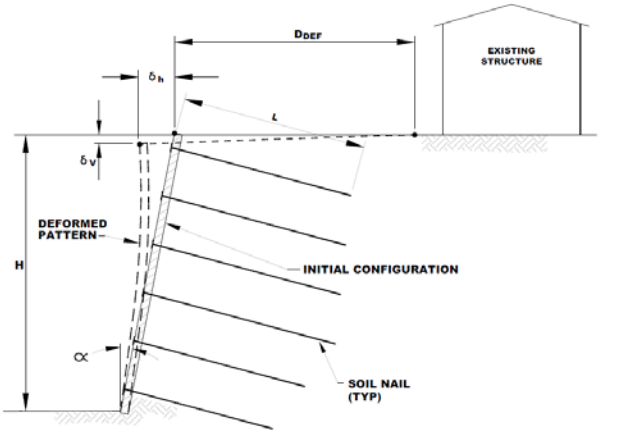


Figure 5.16: Illustration. Deformation of soil nail walls. Modified after Clouterre (1991) and Byrne et al. (1998).

9

Soil Nail Wall Movements

FHWA GEC 7, "Soil Nail Walls" (2015)

$$D_{DEF} = C\,(1-\tan\alpha)\,H$$

Table 5.12: Values of $(\delta_h/H)_i$ and C as Functions of Soil Conditions

Variable	Weathered Rock and Stiff Soil	Sandy Soil	Fine-Grained Soil
$(\delta_h/H)_i$	1/1000	1/500	1/333
C	0.8	1.25	1.5

Note: Modified from Clouterre (1993) and Byrne et al. (1998).

The movements shown above are considered to be relatively small and comparable to those obtained with braced systems and anchored walls. These estimates of deformations have essentially become recommended design values. The adopted tolerable deformation criterion is project-dependent and should consider not only the magnitude of deformation but also the extent of the area behind the wall that may be affected by wall movements. As a first estimate, horizontal deflections greater than 0.005 H during construction should be a cause for concern, as they generally represent an upper limit of acceptable performance.

10

Soil Nail Wall Movements

Rawat & Dey (2014), "*Finite Element Modeling of Soil Nailed Wall: Case Study Clouterre Project, France*". Proceedings of India Geotechnical Conference, Dec., 18-21, 2104

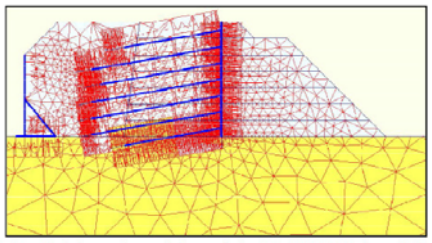


Fig. 4 Adopted meshing of the PLAXIS FE model

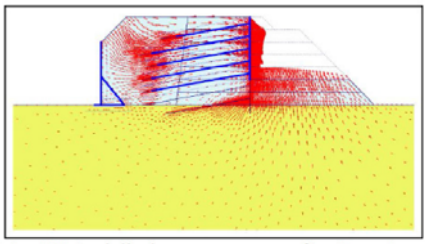


Fig. 4b Total displacement arrows after Stage 5

11

Soil Nail Wall Movements

Rawat & Dey (2014)

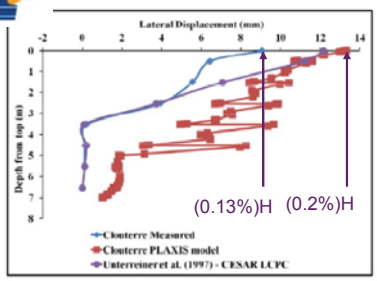


Fig. 7a Lateral displacements at wall facing

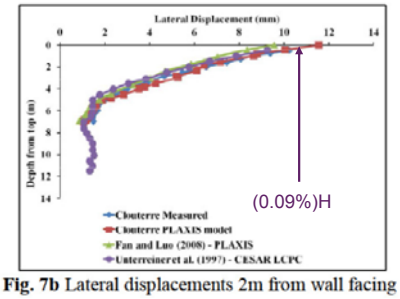


Fig. 7b Lateral displacements 2m from wall facing

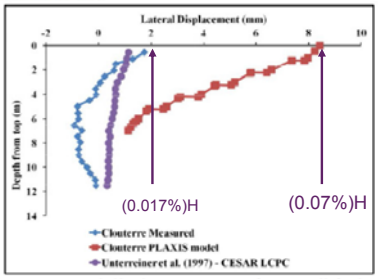


Fig. 7c Lateral displacements 4m from wall facing

12

Soil Nail Wall Movements

"***Favorable***"

- Give a common example that movement is "Favorable" …. *(Active Earth Pressure)*

- *For Taxiway Project,*
  - *…. Lateral Stress Increase on Abutment Wall due to Aircraft Load; based on optimized Approach Structural Slab Design*

13

Soil (Nail Wall) & Approach Slab Interaction

LADOT (2014), "*Field Demonstration of New bridge Approach Slab Designs and Performance*", Report No. FHWA/LA.13/520

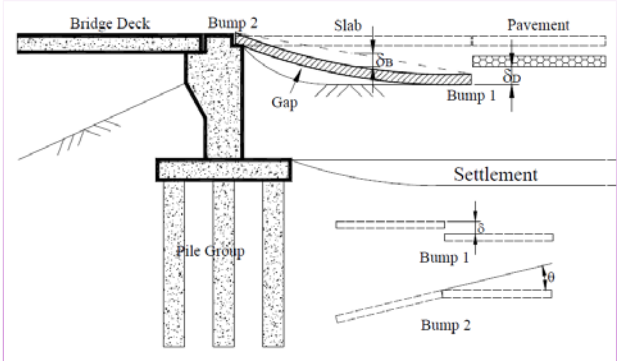
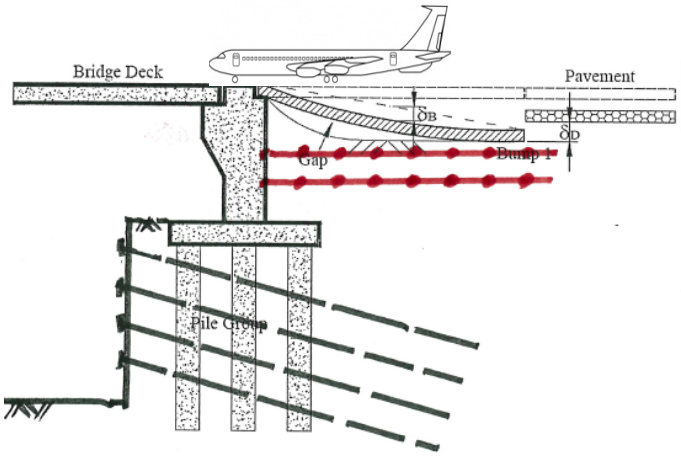


Figure 1
Illustration of approach slab and its interaction with soil

14

Soil (Nail Wall) & Approach Slab Interaction

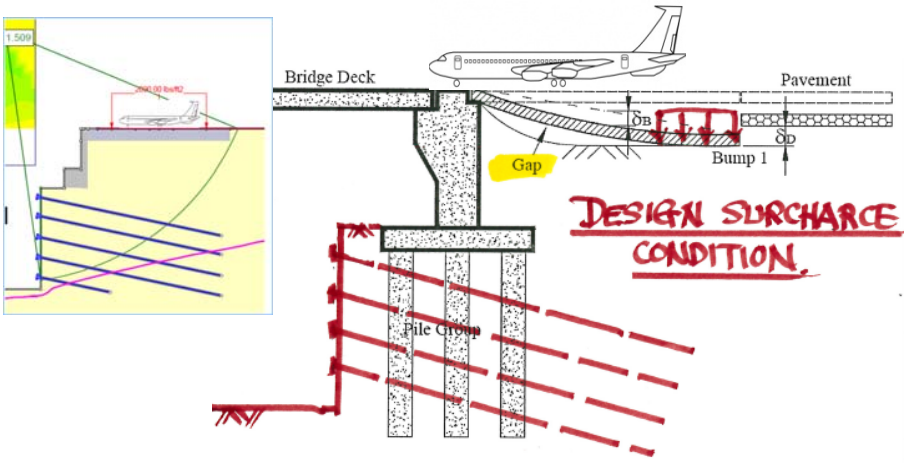
I-73 Taxiway End Bent Design Components



15

Soil (Nail Wall) & Approach Slab Interaction

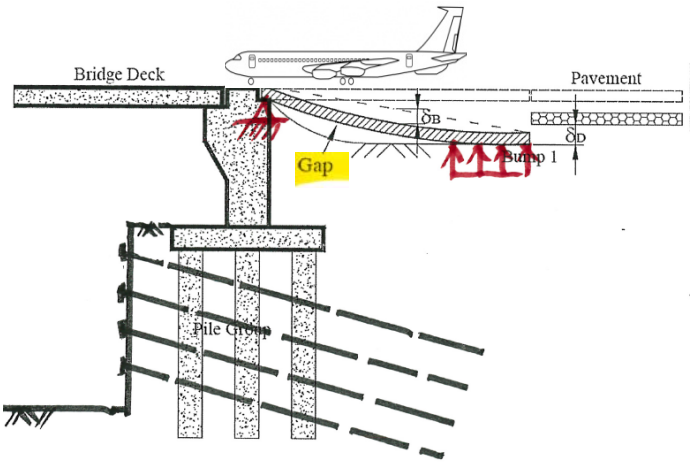
How would it affect the Soil Nail Wall Design?



16

Soil (Nail Wall) & Approach Slab Interaction

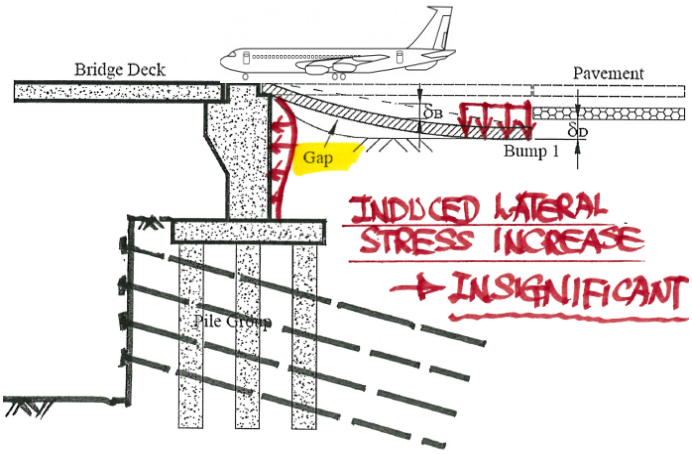
How would it affect the Approach Structural Slab Design?



17

Soil (Nail Wall) & Approach Slab Interaction

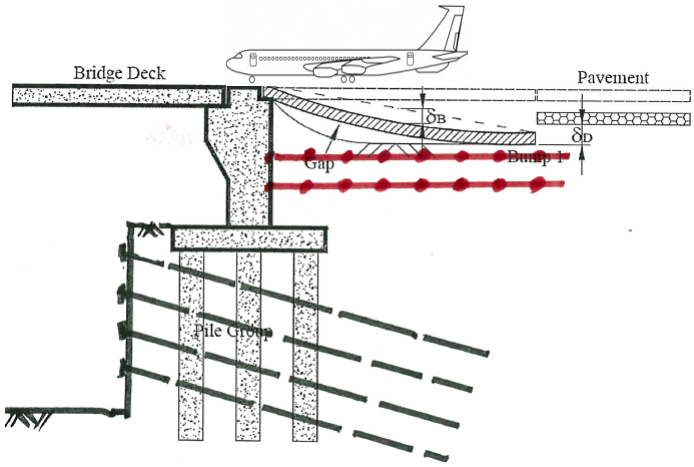
How would it affect the Abutment Wall Design?



18

Other Geostructural Interactions

Soil Nail Wall ↔ Reinforced Earth behind Abutment Wall ↔ End Bent Piles



19

Questions for further thoughts ….

- Benefits of Better Understanding of Geostructural Interactions
- Knowledge Database … Learning from others
- How to better understand Geostructural Interactions? …. "*Put yourself into the system*"
- Is Finite Element Analysis a useful tool?
- *Finally, Geostructural Interface/Interaction also means* …

  Interactions/Communications between Geotechnical and Structural Engineers!

20

Q&A

21

Thank you!

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22