Shaking Table Tests on The Seismic Performance of Bridge Abutments with EPS And Soil Reinforcements in The Backfill

SHENG LIAN

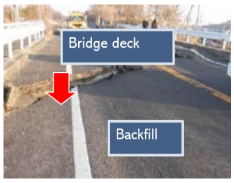
(Outline of Master Thesis, September 2020)

Department of Civil Engineering, The University of Tokyo, Japan

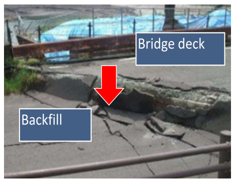
Introduction

Previous large earthquakes reported numerous damage cases on bridge abutments such as residual lateral displacements of abutment body and relative settlements at backfill-abutment wall interface. These damages disrupted normal traffic operation and hence posed a threat to post-earthquake rehabilitation and economic activities.

In light of it, this study focuses on different soil reinforcement methods in the backfill in order to determine the optimal aseismic countermeasure layout that is both effective and practically applicable on site.



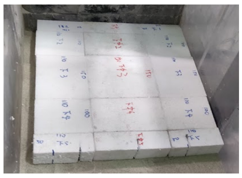
Tohoku earthquake (2011)



Kumamoto earthquake (2016)

Previous research

Expanded Polystyrene (EPS), geogrids and soil nails are three main types of soil reinforcement methods adopted in the field. Previous research focused on the combined use of these reinforcements for existing structures, but the effects of different geometries or material properties of reinforcements were not fully studied. This study hence investigated how EPS stiffness and nail length/diameter affect overall structure seismic performance. Specifically, EPS of lower stiffness and through-out soil nails penetrating from the top of abutment body to subsoil layer were adopted.

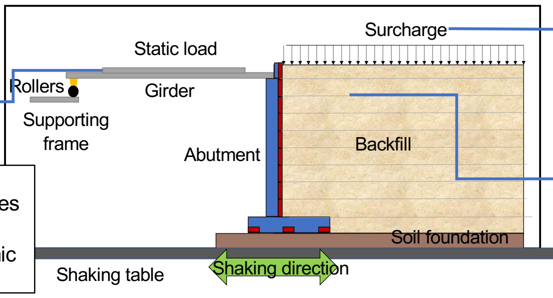


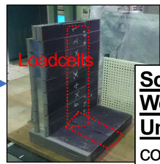
EPS of lower stiffness

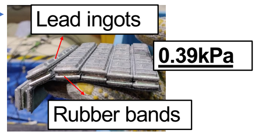
Through-out type soil nails

Experimental models

Scale: 1:20
one end: attached to abutment top via hinges
the other end: with rollers on a supporting frame→facilitates girder sliding under seismic input.



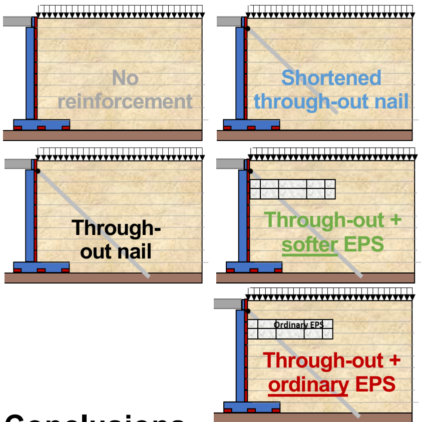




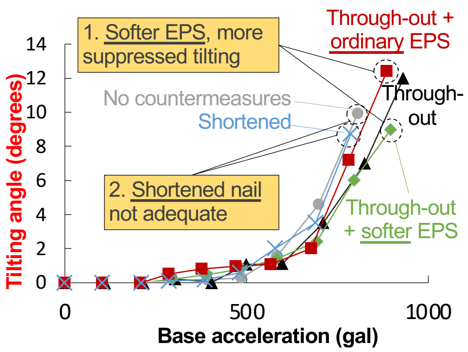
Scale: 1:20; **Material**: Aluminum
Weight: 48.7kg; **Volume**: 0.0194m³
Unit weight: 25.1kN/m³→ simulate comparable seismic responses as prototype

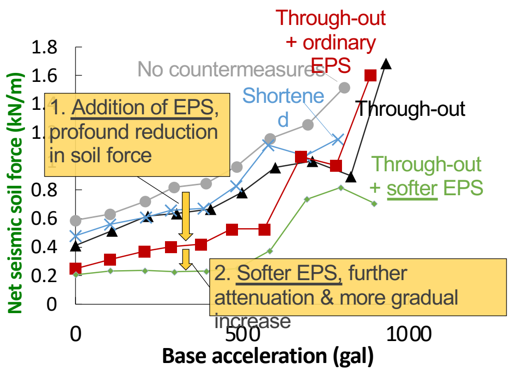
Experimental cases

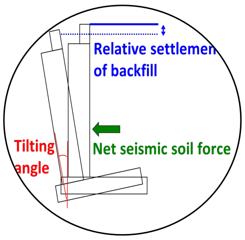
5 out of the 12 cases were selected for parametric study purpose. Seismic performance of the abutment model was evaluated against parameters shown in the figure circled.

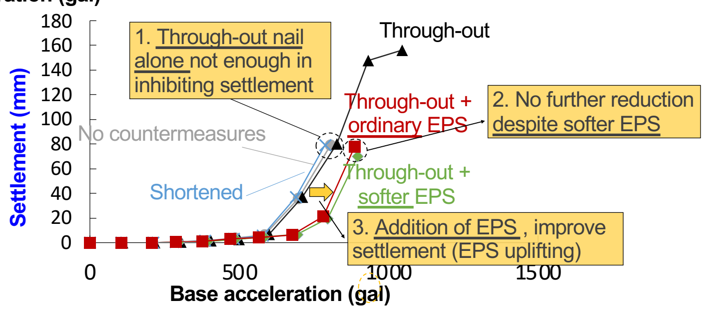


Results & Discussion





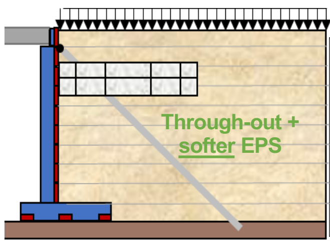




Conclusions

① To confirm benefit of **through-out type nails**	⇨	Tilting and lateral displacement ↓
② To verify **length effect**	⇨	- Inadequate if shortened / - Deep nail penetration needed
③ To investigate benefit of **EPS backfill**	⇨	- Relative settlement ↓ (uplift) - Soil force & overturning moment ↓
④ To check **stiffness effect** of **different EPS**	⇨	- Soil force & moment further↓ (if softer) - Settlement condition almost unchanged

Proposed



Merits:
✓ consistent and continuous tensile force (nail)
✓ better attenuation of seismic soil force (softer EPS)
✓ practical applicability (shallow excavation)