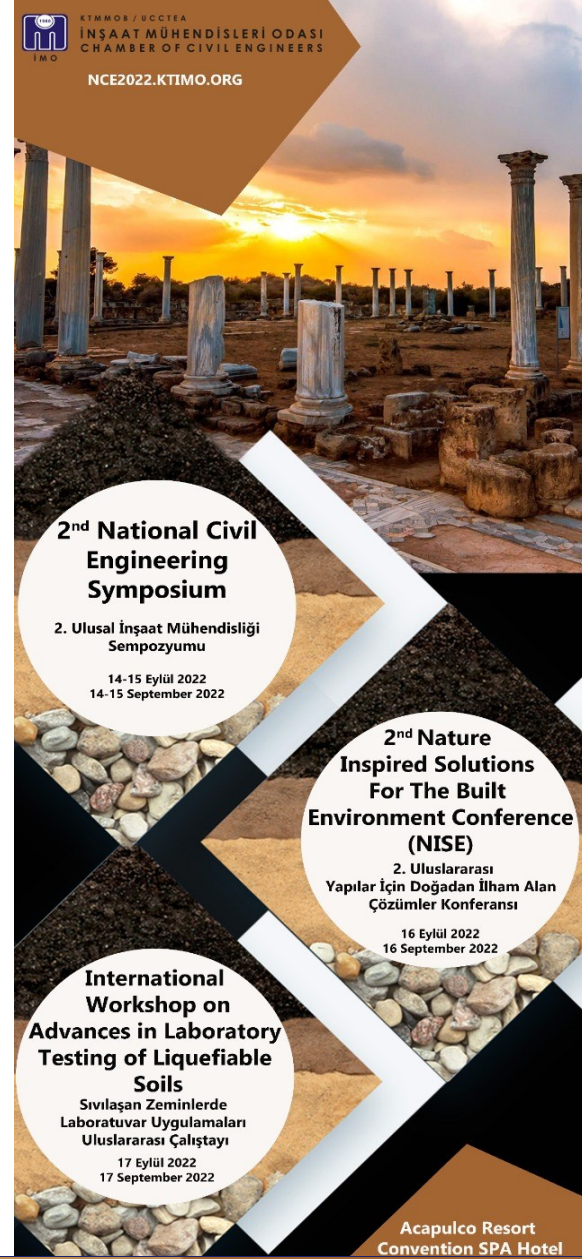


# Dynamic response of shallow mat footings on coir geotextile reinforced sand under cyclic loading

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**2<sup>nd</sup> National Civil Engineering Symposium**  
2. Ulusal İnşaat Mühendisliği Sempozyumu  
14-15 Eylül 2022  
14-15 September 2022

**2<sup>nd</sup> Nature Inspired Solutions For The Built Environment Conference (NISE)**  
2. Uluslararası Yapılar İçin Doğadan İlham Alan Çözümler Konferansı  
16 Eylül 2022  
16 September 2022

**International Workshop on Advances in Laboratory Testing of Liquefiable Soils**  
Sıvılaştan Zeminlerde Laboratuvar Uygulamaları Uluslararası Çalıştayı  
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# Literature



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# Literature

- Evaluating seismic hazards is an important aspect of geotechnical engineering, as these can induce plenty of ground hazards:
  - Large settlements
  - Soil liquefaction
  - Damage on the foundation and utilities
- Many studies were conducted to propose solutions, mostly in the lab:
  - Do not count for the on-site effective strength
  - Do not count for the on-site boundary conditions
- For that reason, shaking table test, where large soil specimens can be placed and earthquake loading scenarios can be reproduced, has been adopted to better simulate the field conditions under more realistic testing arrangements



**Figure 1.** Some effects of soil liquefaction after the 1964 Niigata earthquake

# Literature

- Among the many available ground improvement techniques, reinforcing the soil with geotextiles is considered one of the oldest and most effective methods to improve the soil prosperities.
- Application examples: buildings, roads, bridges, landfills, and slopes stability.
  - Improve the bearing capacity
  - Shear strength
  - Higher interface friction
  - Resistance to cyclic loading



**Figure 2.** Geotextiles



**Figure 3.** Geogrids

# Ziggurat of Nanna at Ur (2300 BC)



## Reinforcement



woven reed mats

embedded in sand between bricks  
(drainage)

Present adaptation:



**Figure 4.** Mesopotamia: large settlements, reinforcement with woven reed mats, (Kérisel, 1985)

Kérisel, J. (1985, August). The history of geotechnical engineering up until 1700. International Conference on Soil Mechanics and Foundation Engineering.

# Materials



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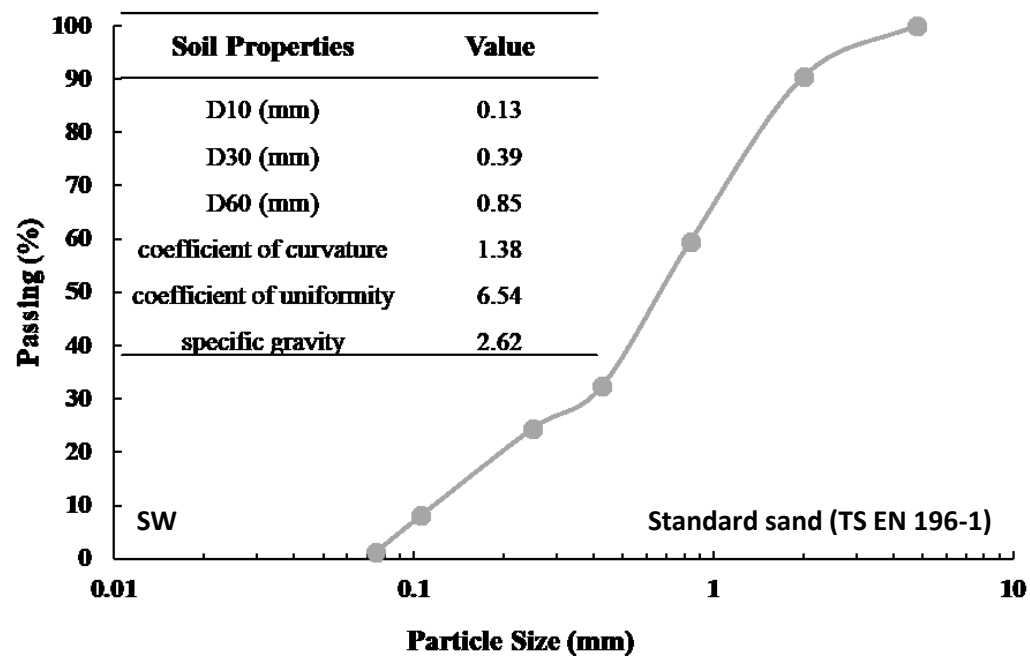
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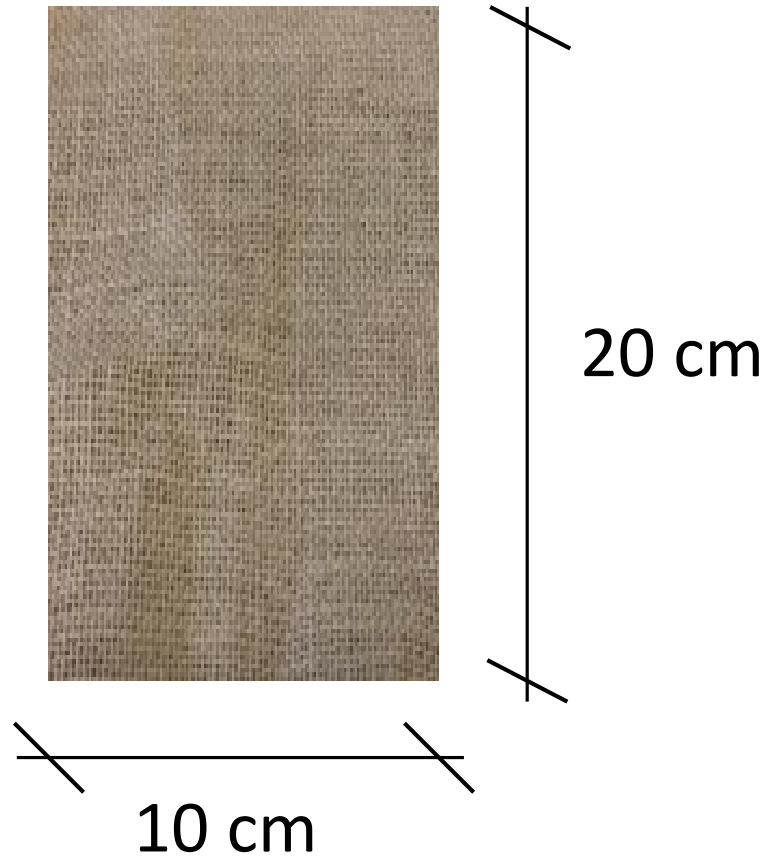


**Figure 5.** Particle size distribution and physical properties of the sand.



**Figure 6.** Coir geotextiles used as a reinforcement in the study.

# Materials



- Coir Geotextile
- Tensile strength (Grab Breaking Load):
  - 0.84 KN
- Mass per unit area:
  - 237 g/m<sup>2</sup>
- Coir opening size:
  - 0.2 mm

**Figure 7.** A piece of the coir geotextiles used as it was used.

# Experimental Procedure



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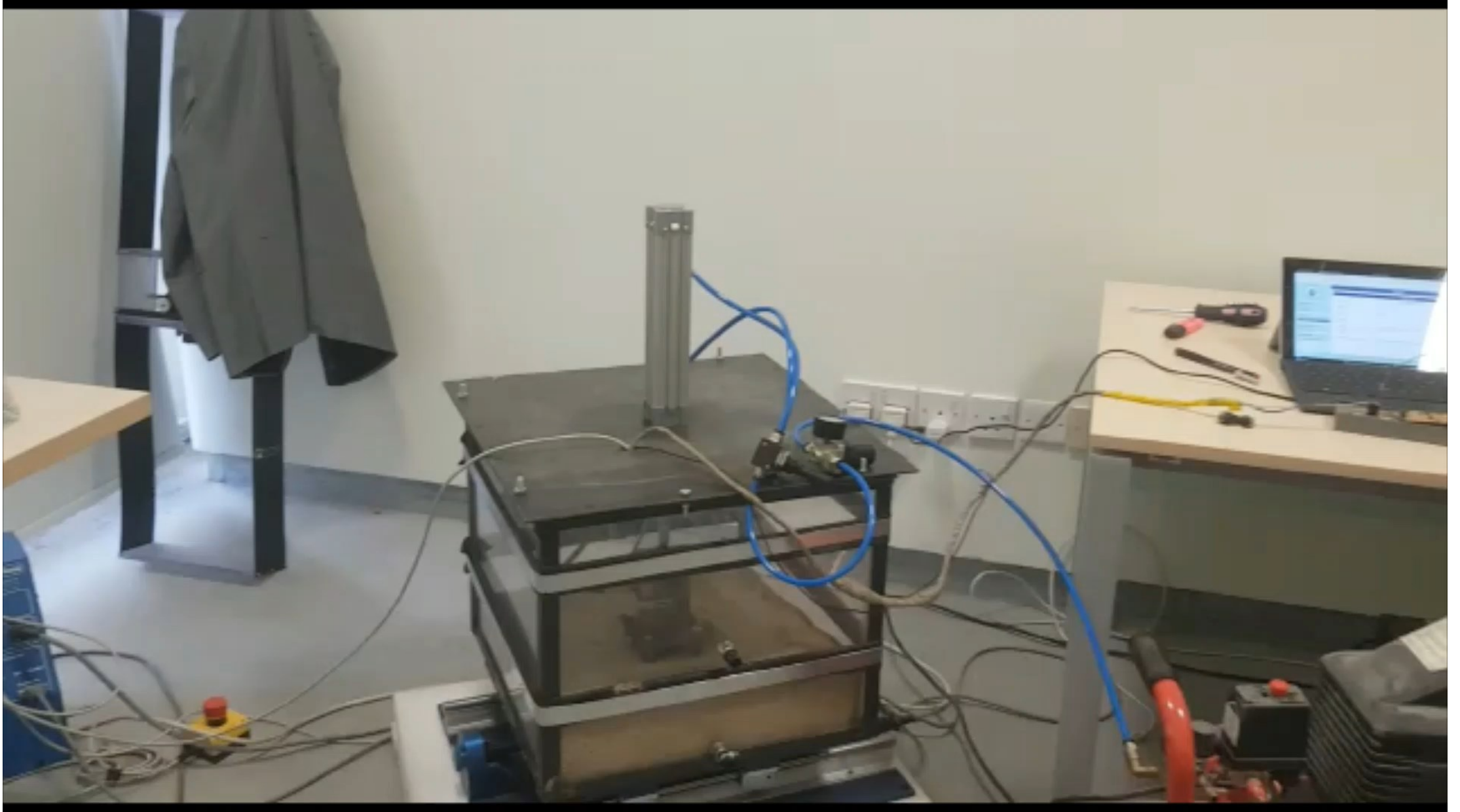
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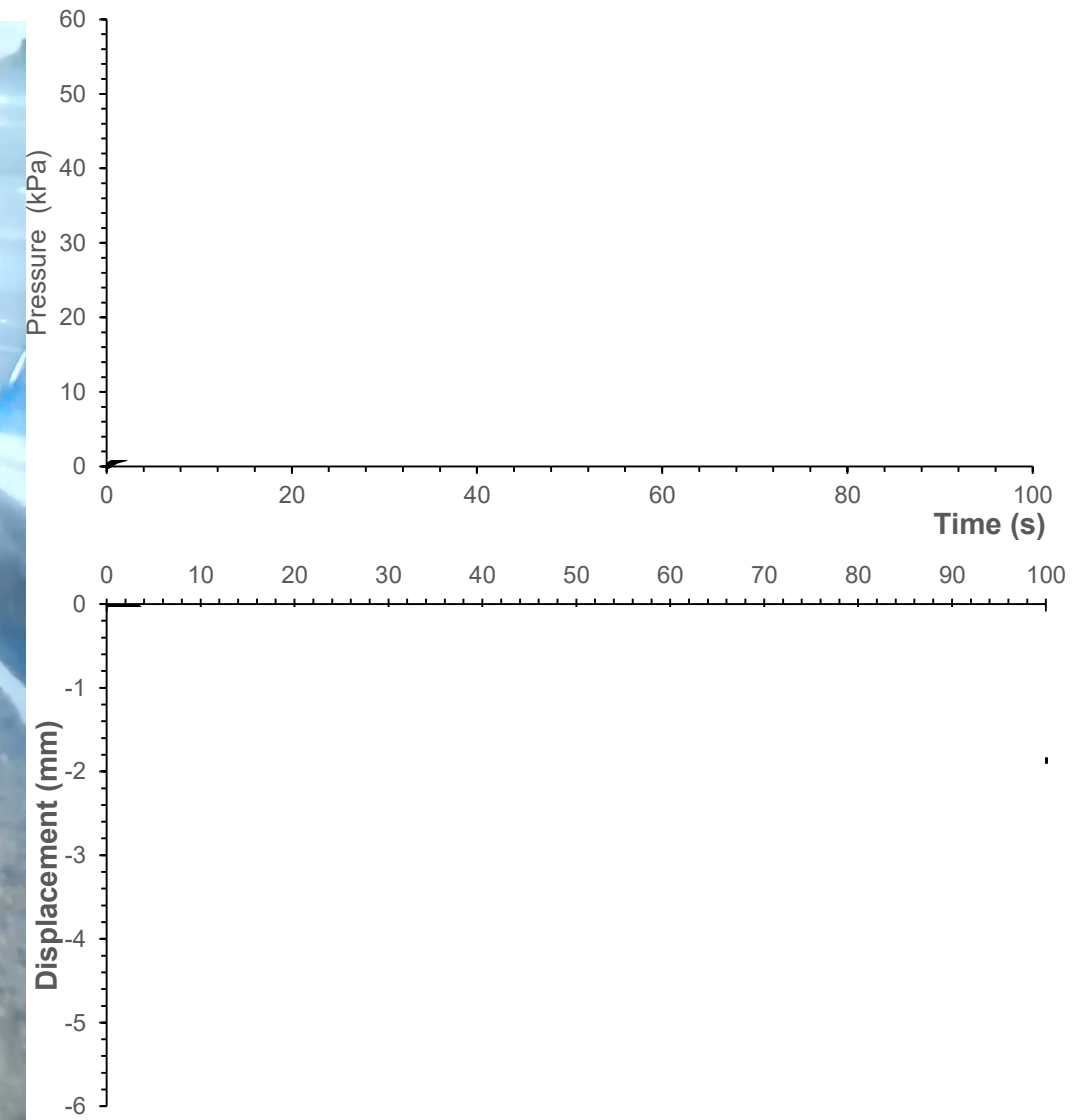
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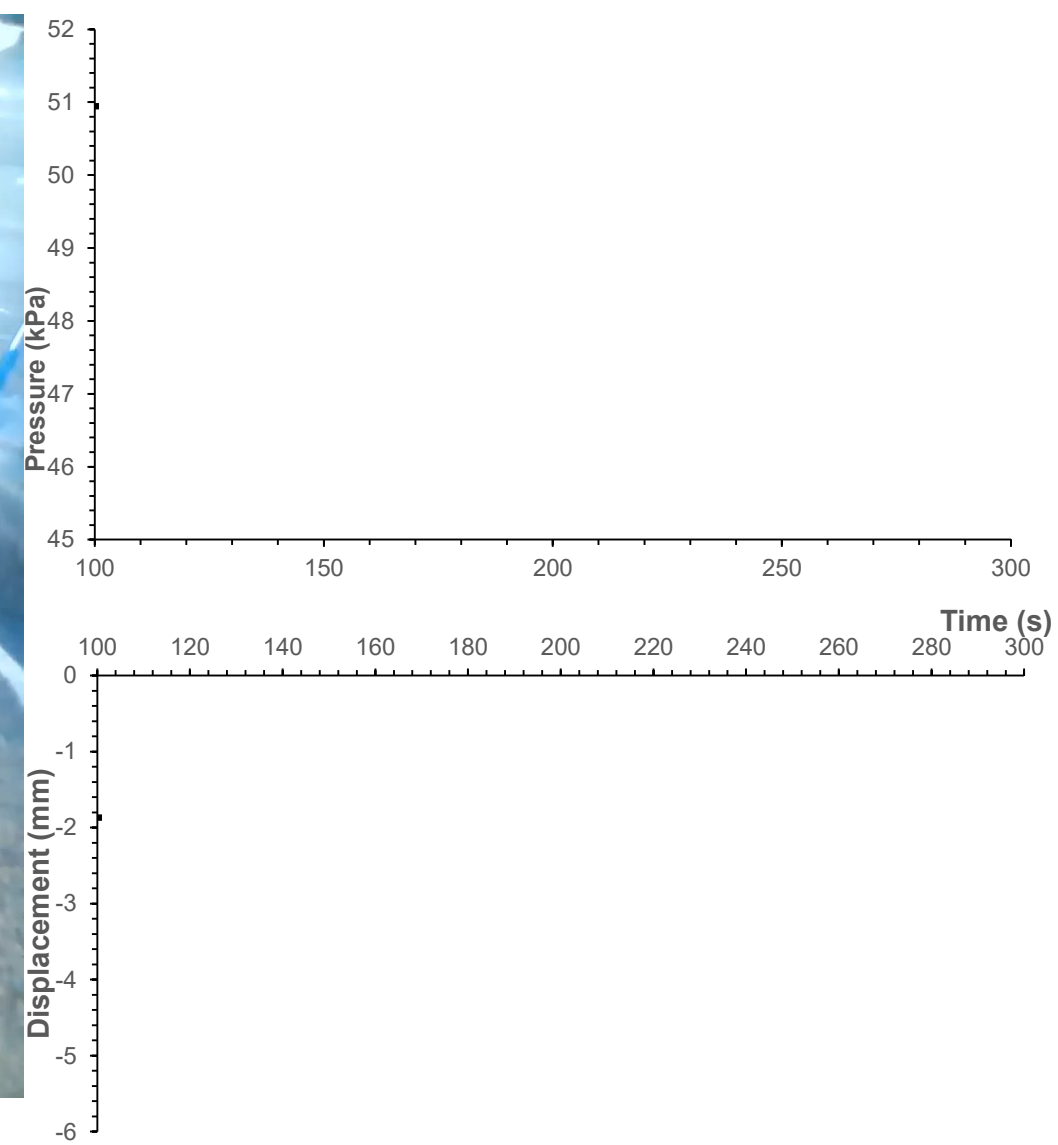




**Table 1.** Testing program details.

	Condition	Geotextiles	Applied wave	Amplitude (cm)	Frequency (Hz)
<b>Test 1</b>	unsaturated	-	sinusoidal	1	1
<b>Test 2</b>	unsaturated	Coir	sinusoidal	1	1
<b>Test 3</b>	unsaturated	-	sinusoidal	1	2
<b>Test 4</b>	unsaturated	Coir	sinusoidal	1	2
<b>Test 5</b>	saturated	-	sinusoidal	1	2
<b>Test 6</b>	saturated	Coir	sinusoidal	1	2





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e

# Results



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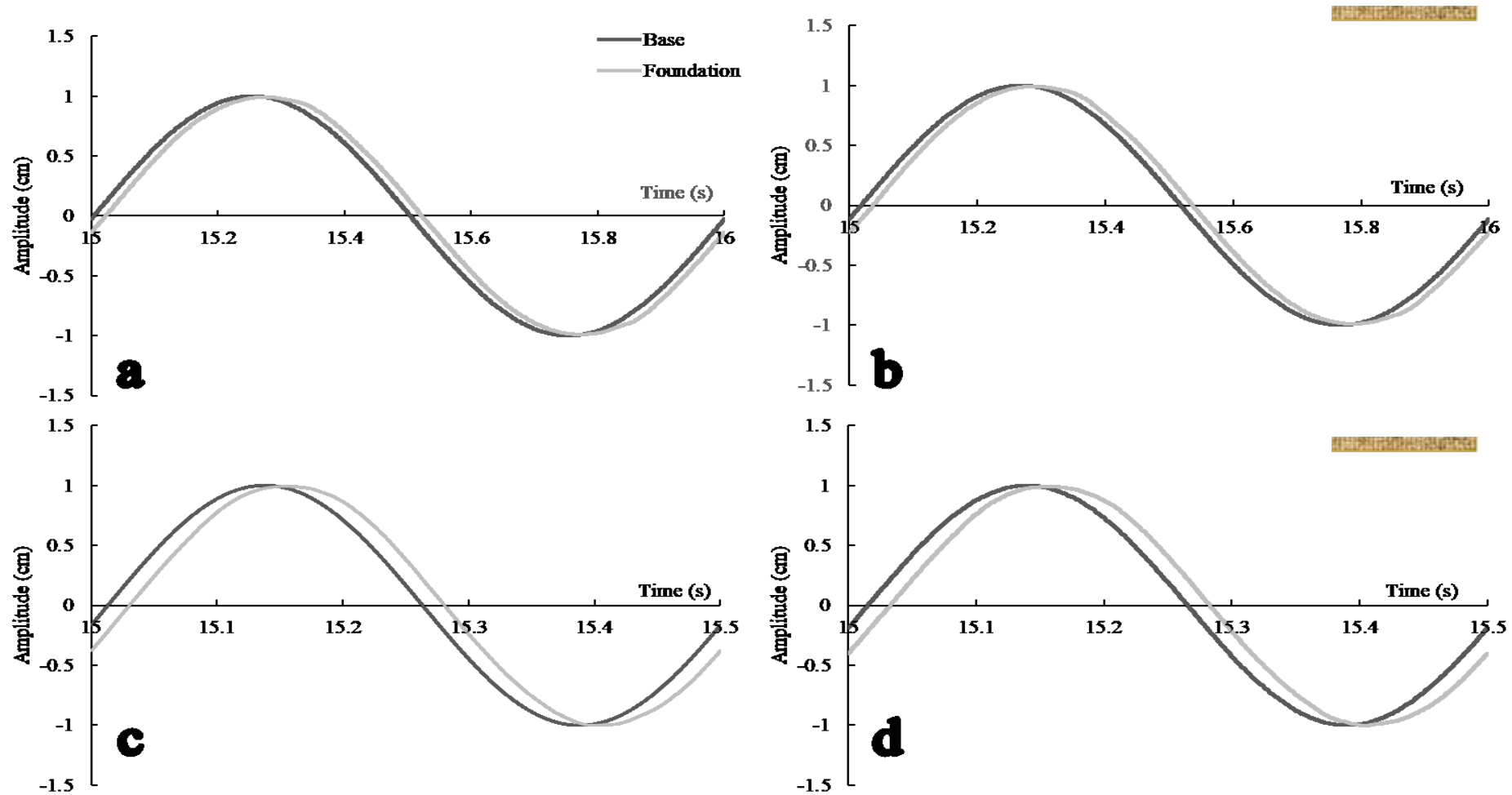


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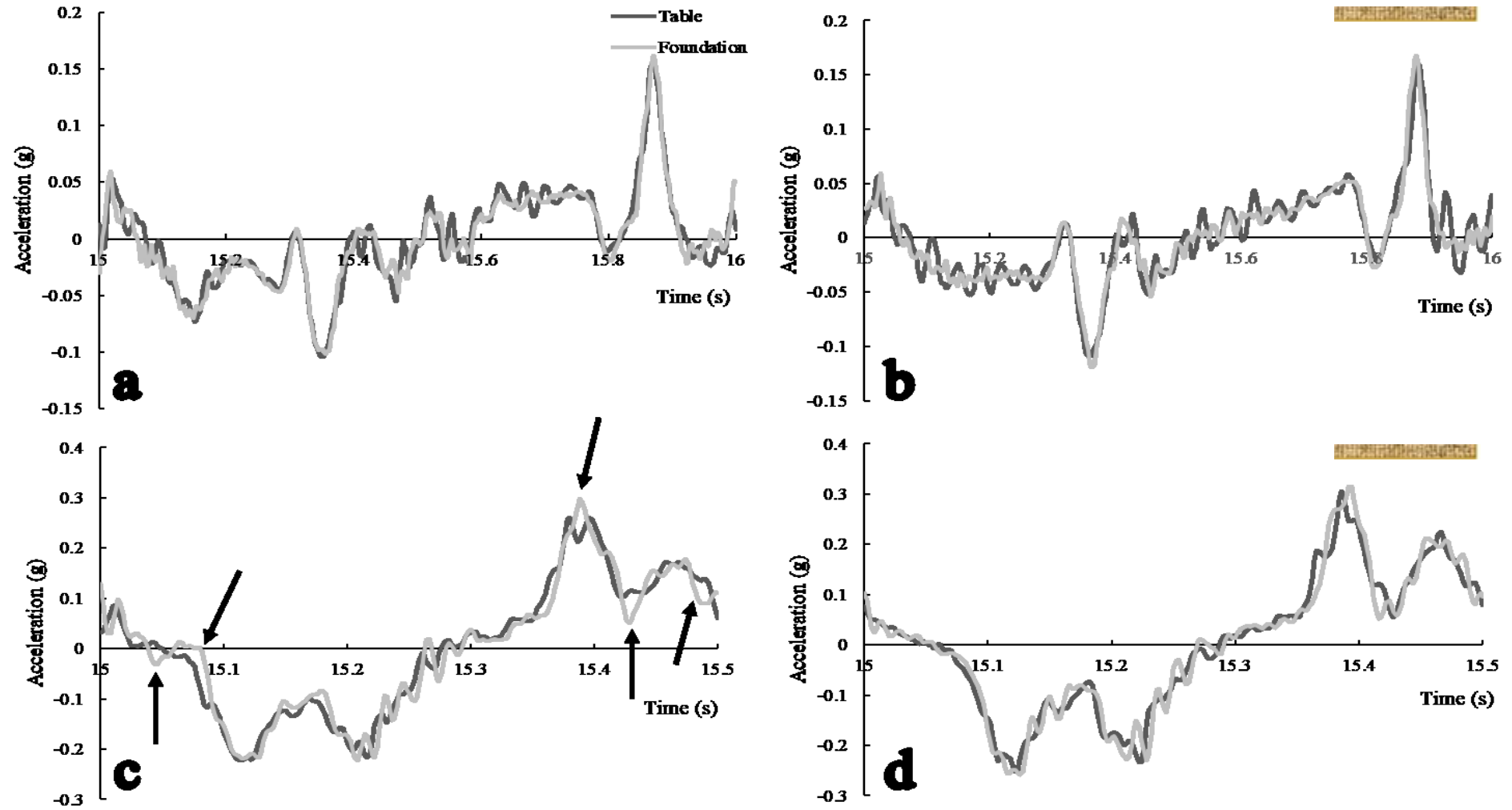


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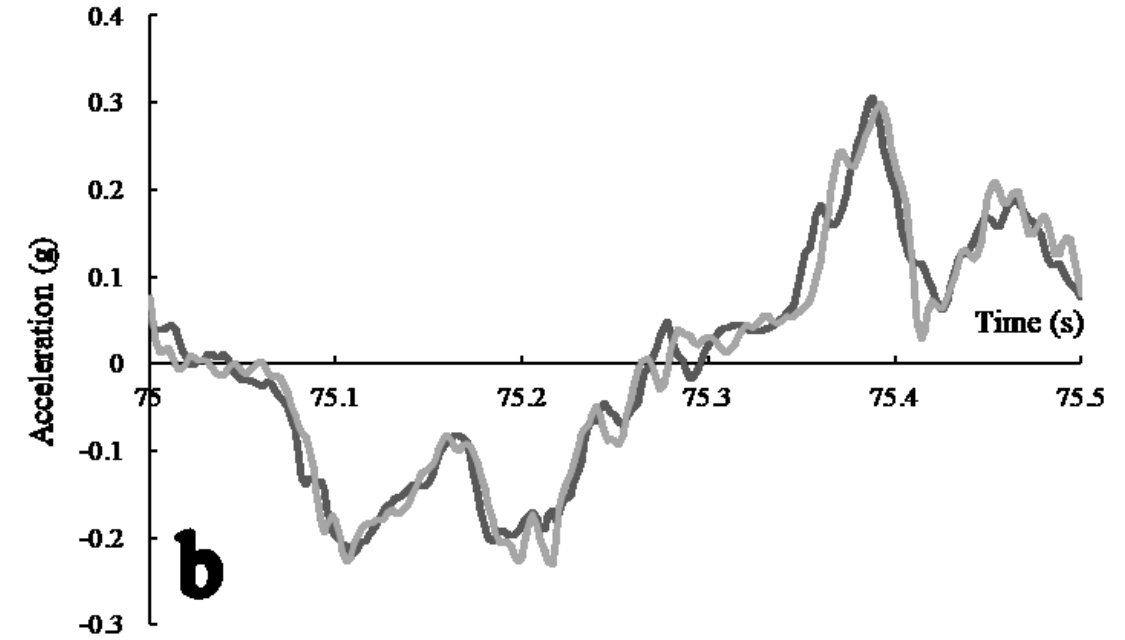
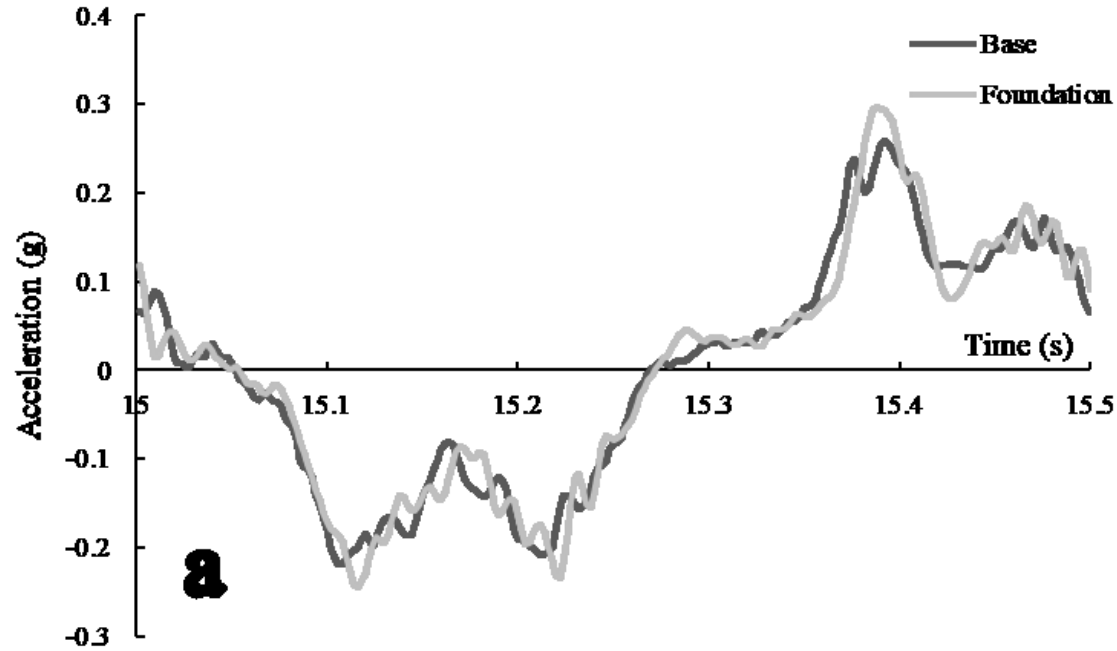
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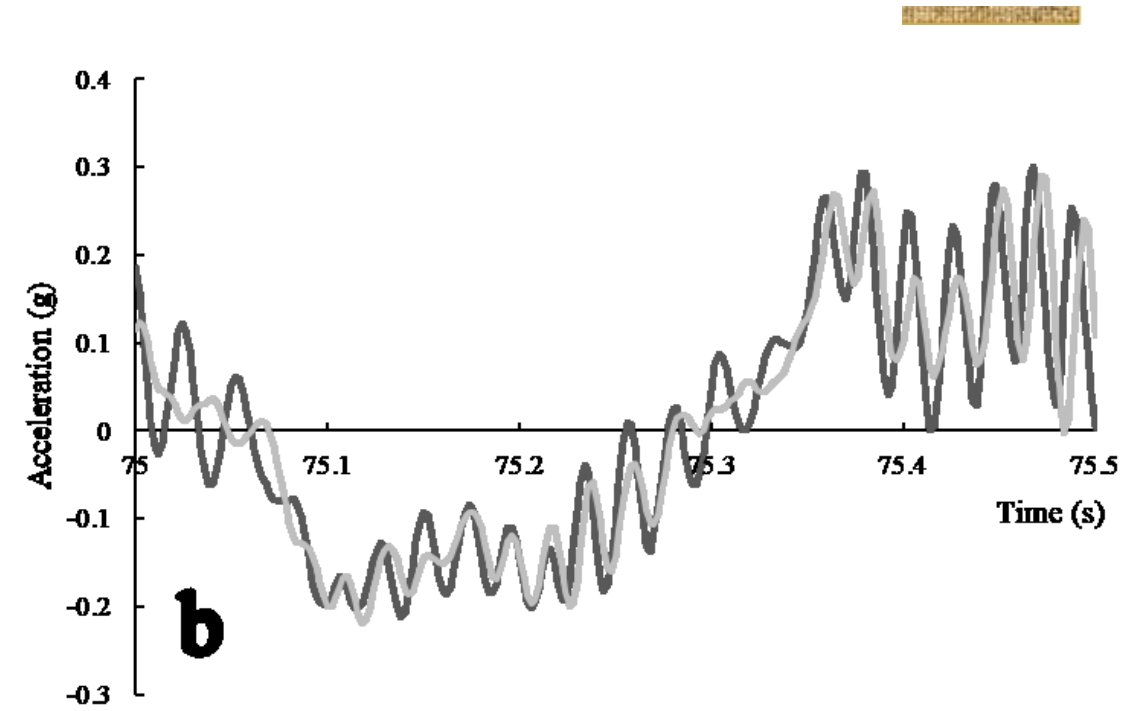
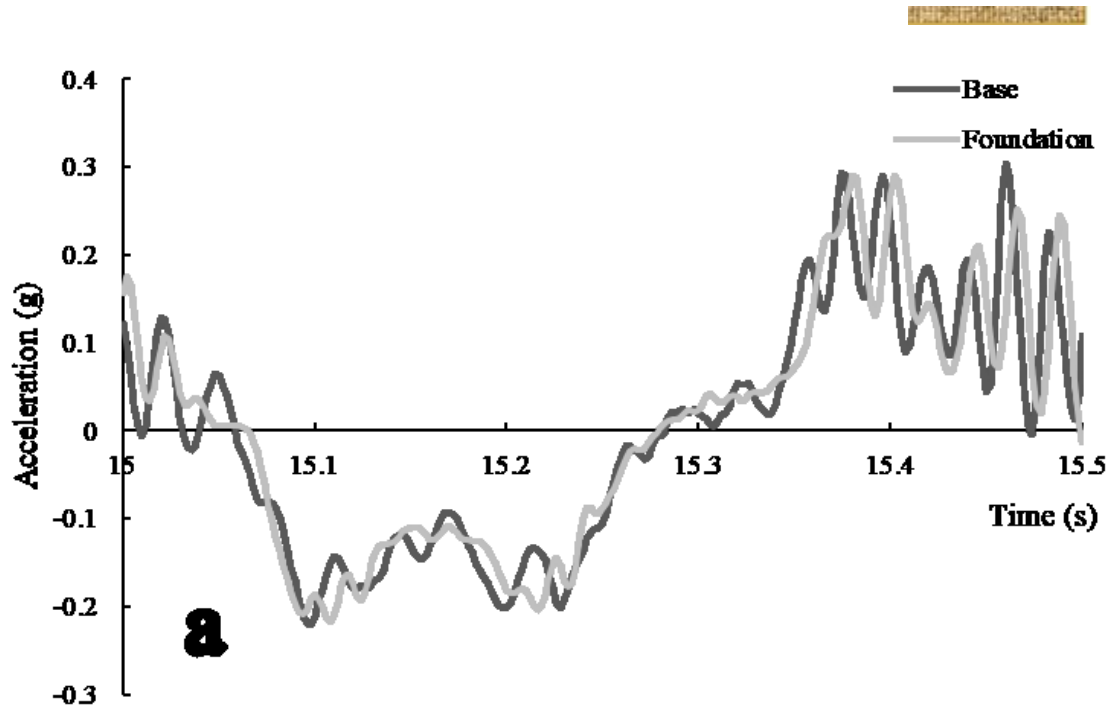
**Figure 12.** The amplitude for one cycle for unsaturated sand: a) 1Hz without geotextiles, b) 1Hz with geotextiles, c) 2Hz without geotextiles, d) 2Hz with geotextiles.



**Figure 13.** The acceleration for one cycle for unsaturated sand: a) 1 Hz without geotextiles, b) 1 Hz with geotextiles, c) 2 Hz without geotextiles, d) 2Hz with geotextiles.



**Figure 14.** One cycle acceleration for the 2 Hz test on saturated sand: a) the cycle 15s-15.5s, b) the cycle 75s-75.5s.



**Figure 15.** One cycle acceleration for the 2 Hz test on geotextile-reinforced saturated sand: a) the cycle 15s-15.5s, b) the cycle 75s-75.5s.

# Conclusions

In this study, the dynamic behavior of geotextile-reinforced and unreinforced fine sand was investigated using a plexiglass tank that was connected to a shaking table.

A specific designed foundation model with an accelerometer mounted on top was placed on top of sand layer with and without geotextile reinforcement and tested in saturated and unsaturated condition

- The inclusion of the geotextiles resulted in a softening in the acceleration response of the foundation model when compared to the unreinforced sand. This softening was less pronounced when increasing the frequency of the wave.
- As the dynamic loading progress in the saturated sample, the sudden movements of the table lose their effects on the foundation, which was extensively settle down due to the liquefaction effects.
- The effects of the dynamic loading in the reinforced saturated sample were not as prominent as the unreinforced sample, which shows the effectiveness of the coir geotextiles in resisting the damaging effect on the foundation

# Thank You for your attention



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