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Influence of groundwater level changes on the seismic response of geosynthetic-reinforced soil retaining walls

Key words:
Geosynthetic-reinforced soil retaining wall; Groundwater level; Earthquake; Stability analysis

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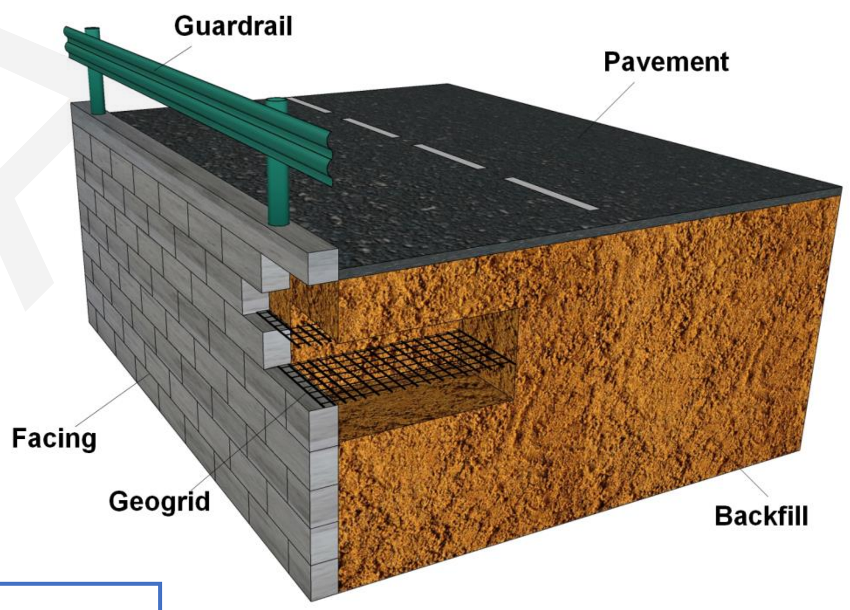
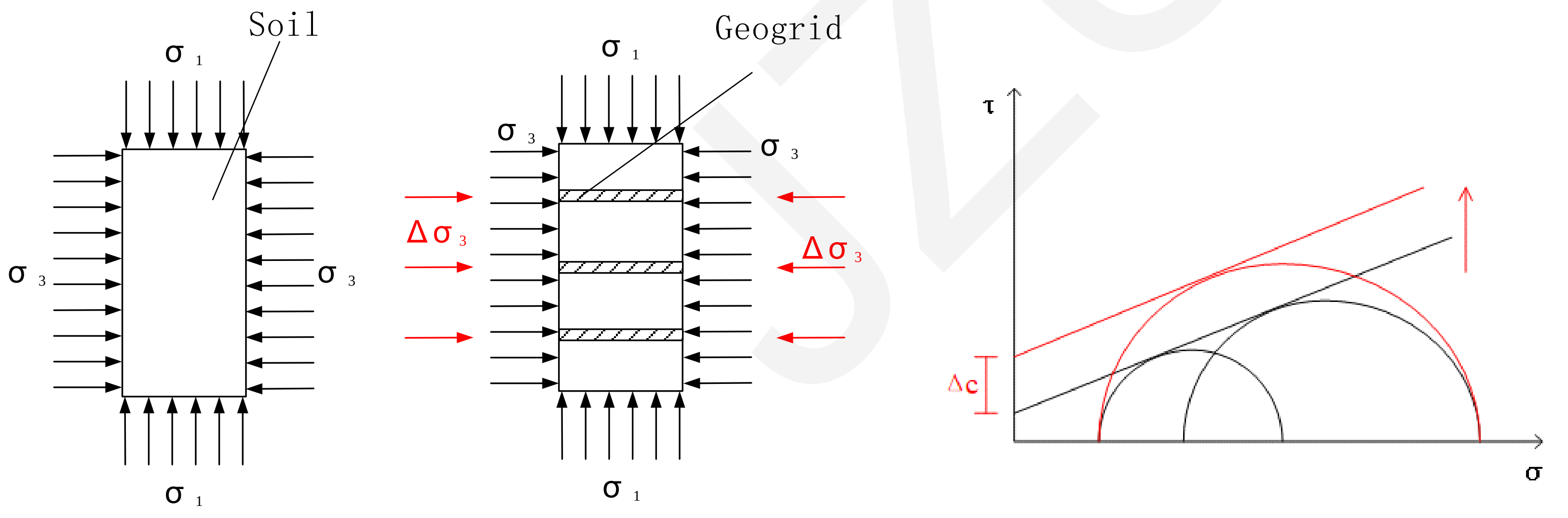
Research object

Geosynthetic-reinforced soil retaining wall (GSRW) mainly composed of three parts: “Backfill, Geogerid and Facing”.

Geosynthetic-reinforced soil retaining wall (GRSW)

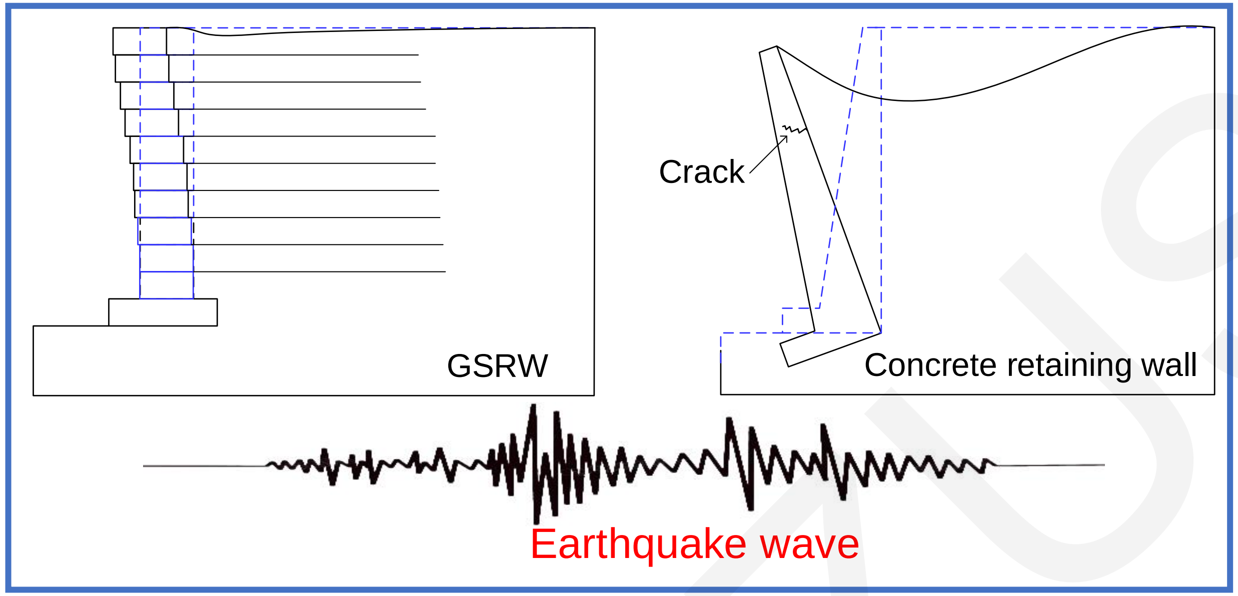
- Backfill
- Geogrid
- Facing

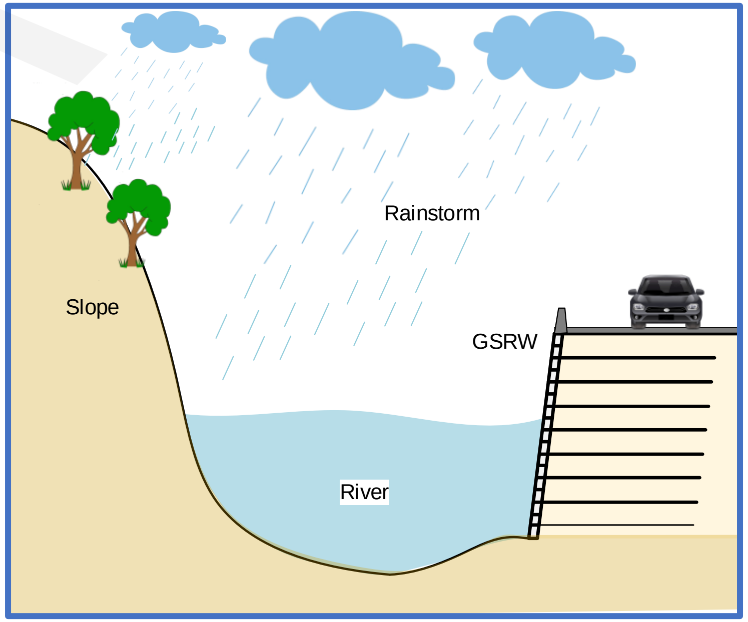




The working principle of GSRW is to enhance the soil strength through the friction between geogrid and soil.

Scientific problem

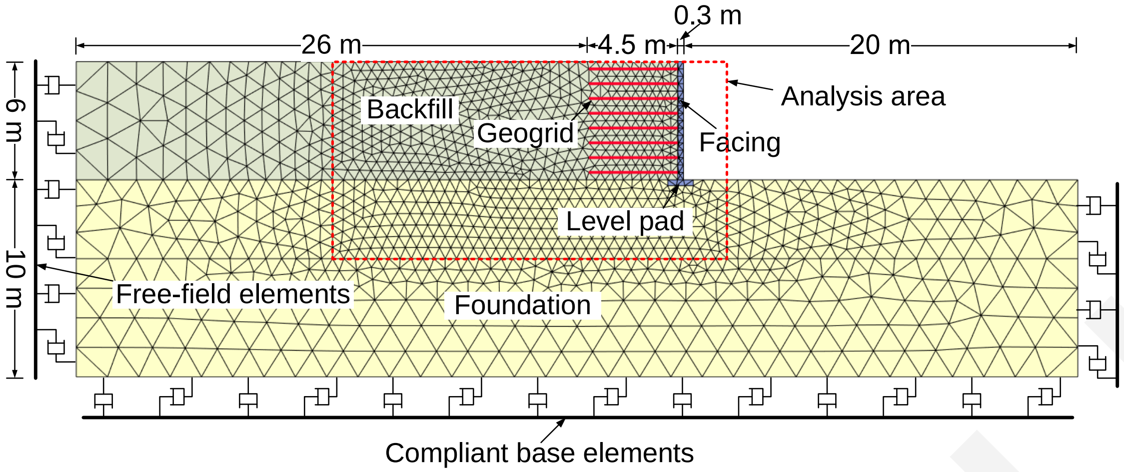




The seismic performance of GRSW is generally better than that of traditional concrete structures because of its flexibility, but water will still seriously threaten the strength and stability of its structures.

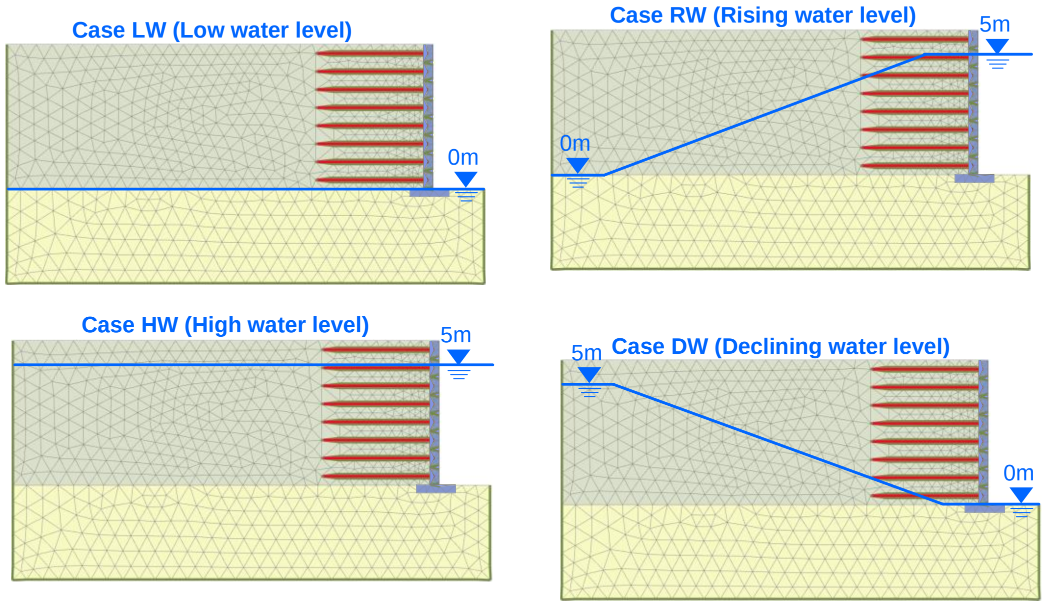
In this study, the stability of GSRWs under the multiple factors of earthquakes and groundwater changes have been investigated.

Research method



A dynamic finite element model was established using Plaxis 2D, and the boundary conditions were consistent with the field conditions, which was verified by a centrifuge shaking table test on a saturated GSRW.

We considered a continuous change process with four different groundwater level conditions, namely low water level, rising water level, high water level, and declining water level, denoted as Cases LW, RW, HW, and DW, respectively. The Kobe earthquake wave with a peak acceleration of 0.4 g was used as the input wave.



Conclusions

1. The seismic stability of GSRWs is worst when there is a rapid decline in groundwater level, because the drag forces generated by the water flowing from the inside to the outside of the GSRW damage the structure of the wall and cause a larger outward deformation. In addition, the moisture content of the soil remains high after the groundwater drops in a short period of time, resulting in small suction force in the GSRW.

2. GSRWs have the best seismic stability when the water table is rising, because the water pressure induced by the rising water level acts on the outside facing, preventing the retaining wall from deforming outwards. The drag forces generated by water flowing into the wall from the outside of the facing and the larger suction force in the GSRW further improve the seismic stability of this type of wall.

3. Compared with Case LW, the GSRW deformation in Case HW at the end of earthquake is more significant, as the high groundwater level leads to excessive pore-water pressure during earthquakes, which weakens the soil strength.

4. The stability of a GSRW is seriously threatened when large amounts of water are present in the wall. Therefore, we recommend that coarse-grained soils with good drainage properties should be used as backfill for GSRWs, and that the drainage design of the structure be carefully considered