8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

COMPARISON OF SEISMIC DISPLACEMENT OF GRAVITY RETAINING WALL AND REINFORCED SOIL WALL ACCORDING TO PERFORMANCE BASE

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Keywords: Permanent deformation, Earthquake, Performance level

The performance design procedure of retaining wall is based on the permanent deformation of walls after the earthquake. During earthquake, wall acts as a solid element with coupled rotation and sliding movements on non-elastic base. This mechanism develops yield surface in wall and backfill. The expected performance of the gravitational wall in earthquake is dependent on amount of load and lateral displacement. In this study, two types of walls considered for follow up, non-reinforced gravitational wall (NRGW) and reinforced gravitational (RGW) wall reinforced with geosynthetic.

The NRGW modelled in FLAC software with finite difference method. Nonlinear time history analysis with six different earthquake record (Azmit 1997-1998, Tabas 1997 and Montenegro 1997), applied in the model. The geotechnical characteristics of the wall with two types of soil are declared in Table 1. The geometrical dimension and analytical model is depicted in Figure 1.

Table 1. Geotechnical characteristics of the soil for NRGW model (Deyanova et al., 2016).

Layer	Density (kg/m^3)	ϕ (Degree)	K_0	G_0	ν	Ψ	Model
Embankment	1700-2000	27.5-37.5	1-sin ϕ	$7000\frac{(2.17-e)^2}{1+e}(\sigma_0')^{0.5}$	0.3	5	Non-linear hysteretic + Mohr-Coulomb failure criterion + viscous damping
Foundation	2000	37.5	1-sin ϕ				
Base	2400	-		2×10^9	0.29	-	Linear viscoelastic
Wall	2400			2.2×10^9	0.28		

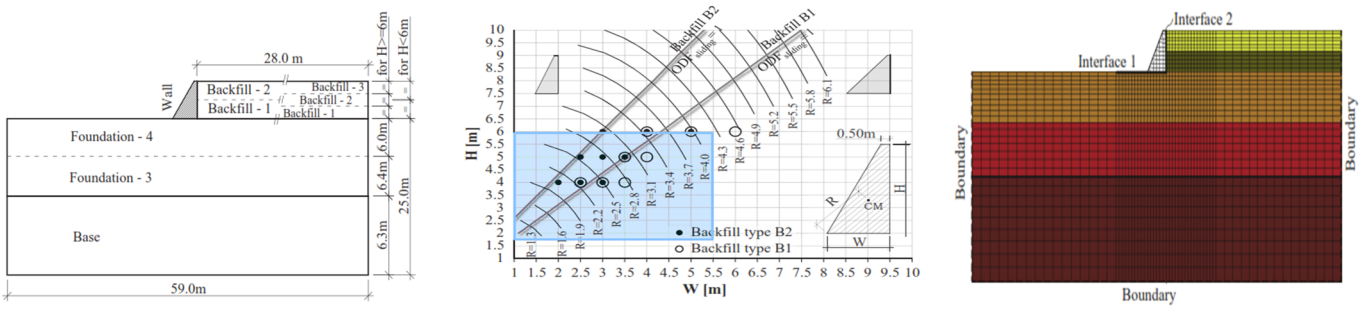

Figure 1. Geometrical dimensions of the model (left) and analytical model (right).

The performance of RGW reinforced by geosynthetic, predicted by dynamic methods through limitations on lateral forces. The slope of wall façade (β), angle of shearing resistance of the backfill (ϕ'), apparent soil-reinforcement friction factor ($f_{s/GSY}$), ratio of reinforcement length to wall height (L/H), ratio of reinforcement spacing to wall height (s/H), critical seismic coefficient (k_c), were the assumed parameters in the parametric study of the wall performance, as depicted

in Figure 2. Table 2 declares the amount of assigned values for assumed parameters in the parametric study.

The analysis of the NRGW indicated that two mechanism of failure would be occur; a) failure due to the great displacement of soil beneath the foundation around the toe, will lead to huge distortion of the wall, b) failure is attributed to the residual displacement of the wall greater than 10 percent of wall height. The analysis of the RGW indicated that the failure is initiated on the sliding surface and all the geosynthetic reached to the ultimate capacity. Total collapse would occur in the backfill and propagate in the wall. Through this approach, the maximum acceleration and its equivalent displacement as the critical parameters for the failure of the RGW stated.

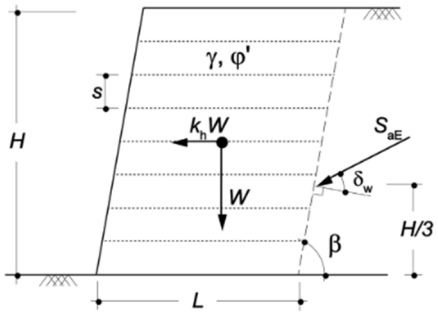

Figure 2. Schematic parameters of the RGW walls.

Table 2. The assumed parameters for the parametric study of the RGW (Gaudio et al., 2018).

Parameter	Unit	Value
height	m	4.8-7.2-9.6
density	kN/m^3	18-20-25
L/H	-	0.7-0.8-0.9-1.0
β	degree	70-80
ϕ'	degree	32-35-38
k_c	-	0.005 to 0.3

The results indicated that, the NRGW will experience residual displacement up to 55 cm and the displacement-based design is vital. The calculated safety factor of sliding in NRGW is 1.2-1.3. These walls in semi hazardous areas with PGA 0.2 to 0.35 are safe. The conventional methods to design the NRGW such as Monono-Ocabe method predict lower amount of forces and displacement for these kind of walls (Mononobe, 1929). Newmark method agree with the results of NGRW and would be more applicable (Newmark, 2001). The behaviour of RGW is much better than NRGW in earthquake performance. It is related to the use of remained capacity of RGW in redistribution of displacement of plastic hinges. In RGW, pattern of mechanism in soil are related to soil bearing capacity, sliding and overturning. They are based on bearing capacity and displacement demand of the wall. The development of internal hinges will increased up to the ultimate reinforcement capacity. It was greater than all of the soil mechanisms and enormously, strengthen the RGW performance.

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