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Effect of EPS Geofoam Inclusions on Retaining Wall: A Review

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Abstract – Several researchers demonstrated that expanded polystyrene (EPS) geofoam can be use as compressible inclusions behind retaining wall to attenuate earthquake-induced dynamic loads. This review is presenting the previous research on the deformable EPS geofoam used as compressible inclusions behind retaining wall. The objective of this study is to analyse the effect of EPS geofoam inclusions on retaining wall. This paper presents a review and the comparison of the results presented by the earlier researchers. It was observed that the use of EPS geofoam gives better result in reducing lateral earthquake forces. Also increasing the thickness and density of EPS decreases the horizontal deformation. Whereas decreasing the density of EPS decreases the isolation efficiency. However, further studies should be done to understand the effect of position of EPS behind retaining wall other than vertical inclusions such as horizontal inclusions.

Keywords— EPS geofoam, retaining wall, compressible inclusion, lateral earth pressures, wall displacements

I. INTRODUCTION

Expanded polystyrene (EPS) geofoam has the ability to withstand vertical and horizontal stresses when used as a fill material. The most significant properties of EPS geofoam is its stability, durability, and resistance to moisture and deterioration. The EPS inclusion deforms readily under applied stress or displacement as compared to other system component. Since the density of the geofoam can be altered as desired, it can replace all the past materials as compressible inclusion or lightweight fills. Geofoam products are used in retaining structures, underground structures and buried pipelines to counteract the earthquake induced forces. In seismic earthquake applications, EPS geofoam products have a better ability to absorb earthquake induced forces due to its flexibility property which may gain value up to 10% strain.

II. LITERATURE REVIEW

Abdelsalam et al. (2016) carried out a numerical analysis to study the behaviour of yielding and non-yielding walls with geofoam inclusions [1]. A laboratory test was conducted to measure the shear strength and interface properties between geofoam-soil, and geofoam-concrete and geofoam-geofoam. Results showed that Water effect on geofoam-sand interface was negligible but significant on the geofoam-geofoam interface, as the interface properties decreased by around 19%. Geofoam-concrete interface was significantly affected by the concrete surface roughness. Lateral pressure was significantly reduced by 65% using inclusion with t/h=0.50.

Padade et al. (2014) made an attempt to understand the function of EPS geoblocks as compressible inclusions behind retaining wall [2]. 2-D plain strain finite element stimulations were carried out using Plaxis 2D software on three different densities of EPS geofoam 15, 20 & 30 kg/m^3 with thickness 50,100,150 mm respectively. It was observed that the horizontal deformation of the facing panel decreased with increasing thickness and density of geofoam. Backfill settlements were also decreased with increasing thickness and density of geofoam. Lateral pressure was decreased with increasing density and thickness of geofoam.

Padade et al. (2012) carried out a numerical and experimental studies of series of tests on EPS geofoam under triaxial loading conditions on four different densities of EPS geofoam 0.15, 0.20, 0.22 and 0.30 kN/m^3 [3]. It was observed that peak deviator stress values of EPS geofoam increased with the increase in density of material. The cohesion value increased with increasing density of geofoam, where as marginal increment was observed for angle of internal friction.

Ertugrul et al. (2012) studied the importance of application of EPS geofoam as a compressible inclusion behind non-rigid retaining walls [4]. Significant reduction in the earth thrust behind the wall Relative thickness and stiffness of the geofoam inclusion appear to be the most dominant factors affecting the lateral wall thrust reduction. The presence of the softer EPS inclusion at the upper half of the wall improves the load performance. The presence of EPS inclusions showed reduction of static lateral earth pressure in rigid retaining wall.

Zarnani et al. (2009) used FLAC to carry out a numerical modeling on expanded polystyrene (EPS) geofoam buffer to reduce seismic-induced dynamic load against rigid wall structures [5]. Lateral earth pressure and EPS buffer strains were calculated for non-yielding retaining walls subjected to various earthquake loads.Results shows significant decrease in the seismic induced dynamic loads on the wall in the presence of vertical EPS geofoam. Also lateral load decreased with increasing thickness of EPS geofoam .The stiffness EPS geofoam played a significant role in load reduction efficiency.

Athanasopoulos et al. (2007) carried out a numerical modeling on EPS geofoam seismic buffers [6]. The flexibility of the retaining wall on the performance of EPS geofoam buffers was studied. It was found that increasing the flexibility of the wall increases the isolation efficiency. In the study, five deformable EPS geofoam materials with densities varying between 1.3 kg/m3 to 16 kg/m3 were used between the granular backfill and the rigid retaining wall. Dynamic load reduction induced by deformable EPS buffers decreased with increasing peak amplitude of the excitation. It was observed that isolation efficiency decreased significantly for excitation frequencies in the zone of the backfill-buffer retaining structure.

Bathurst et al. (2007) investigated the effect of EPS buffers on the lateral earth pressures against retaining walls under dynamic excitations [7]. 1-g shaking table tests were done on 1m high rigid walls with compressible EPS geofoam inclusions. Different loading conditions were evaluated on the deformable EPS inclusion and backfill. The base of the rigid wall backfill model was allowed to undergo Harmonic base excitations. Results showed that for the seismic thrust, reductions up to 40% could be achieved at the peak excitation amplitude 0.7g. The initial tangent modulus of the EPS geofoam played a significant role in decreasing the lateral forces.

Horvath et al. (1997) describes the concept of geofoam compressible inclusions to reduce the magnitude of earthquake-induced dynamic forces against rigid earth retaining wall structures [8]. Shaking table test was done where huge differences were observed in dynamic force reduction in non-yielding walls with and without EPS geofoam seismic buffer. It was observed that reduction in dynamic load increased with decreasing seismic buffer density. The maximum dynamic force reduction on the facing panel was around 31% at a peak base acceleration of 0.7g.

III. CONCLUSIONS

Based on the study, it can be concluded that horizontal deformation of EPS geofoam decreases with increasing thickness and density. Also increasing the thickness and density of EPS caused upward shifting of the failure surface further away from the toe of the wall. Decreasing the density of EPS decreases the isolation efficiency. The vertical EPS compressible inclusion behind retaining wall are the most commonly used. Thus, further studies can be done by changing the positions of EPS such as inclusions in horizontal directions etc., to understand its behavior in both static and dynamic load case.

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