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Non Yielding Retaining Walls with EPS Geofoam

Mohamed S. Belal[a*], Sayed M. Sayed[b], Tamer M. Sorour[c]
[a] Graduate M.Sc. student, Structural Engineering Department, Ain Shams University, Egypt.
[b] Assistant Professor of Geotechnical Engineering, Ain Shams University, Egypt
[c] Assistant Professor, Structural Engineering Department, Ain Shams University, Egypt

ملخص البحث
الحوائط الساندة يتم تصميمها لمقاومة الضغط الجانبى نتيجة الردم والأحمال الاضافية الناتجة من الأساسات للمبانى المجاورة.يتم وضع ألواح الجيوفوم ذات الصلابة المنخفضة بجوار المنشآت الساندة لتخفيض الضغط الجانبى على هذه المنشات بسبب قابلية ألواح الجيوفوم للإنضغاط. تم بناء نماذج عددية بهدف محاكاة تأثير نتائج استخدام الجيوفوم بجوار الحائط الساند وذلك من خلال التجارب التى قام بها Ertugrul و Trandafir. أظهرت النتائج فعالية استخدام الجيوفوم فى خفض الضغط الجانبى المتكون على الحائط الساند وذلك من خلال عملة كمادة قابلة للانضغاط خلف الحوائط الساندة.تم بناء مجموعة من النماذج العددية بواسطة برنامج Plaxis 2D V8.5. تم عمل دراسة بارامترية لتوضيح تأثير كثافة الجيوفوم المستخدم وسمكه خلف الحائط الساند فى تخفيض الضغط الجانبى.

Abstract
Retaining walls are constructed to resist earth pressure and lateral thrust due to backfilling and surcharge pressures from foundations of adjacent structures. Expanded polystyrene (EPS geofoam) panels of low stiffness installed vertically against the rigid non-yielding retaining structures to reduce the lateral earth pressure due to its compressible behaviour. In the present study, numerical models are developed to validate the physical test results for rigid nonyielding wall reported by (Ertugrul and Trandafir 2011). The results show the effectiveness of EPS geofoam in reducing lateral earth pressure as an inclusion material behind retaining structures. A series of numerical analysis was performed by using the verified finite-element models using Plaxis 2D V8.5 software. A parametric study has been adopted to illustrate the effectiveness of EPS geofoam density and the thickness of the geofoam buffer in reducing the developed lateral earth pressure.

Keywords
Retaining wall, EPS geofoam, Reducing earth pressure, Finite element analysis

1 Introduction
Lateral Earth pressure is the most important parameter that is needed to be considered in the design of retaining structures. Retaining structures (gravity cantilevered, reinforced concrete retaining walls, bridge abutments or basement walls…...) design based on two considerations, first safely resistance to the lateral earth pressure, second safely resistance to surcharge load from adjacent structures and earthquake loads. Lateral earth pressure resulting from backfill mass is the most acting parameter on the design of the retaining walls. One of the most effective solutions used to reduce lateral earth pressure resulting from supported backfill is Expanded Polystyrene (EPS geofoam). Expanded Polystyrene (EPS geofoam) is a super-lightweight, closed cell, rigid, plastic foam. Its unit weight puts it in a separate category compared to other types of engineering lightweight materials. EPS geofoam density can be considered the main index in most of its properties where compression strength, shear strength, tension strength, flexural strength, stiffness, creep behavior and other mechanical properties depend mainly on the density of EPS geofoam. EPS geofoam is a multi-function material, which makes it effective to be used in many

construction applications. EPS geofoam can be used as a buffer between the backfill materials and the retaining wall as well as a backfill material behind the retaining structure (Horvath 1995). EPS provide a reduction of lateral earth pressure and flexural deflection of non-yielding retaining structures due to soil arching effect resulted from EPS lateral compression (Horvath 1995). Use of EPS geofoam as a backfill material (Horvath 2010) may cause the excessive settlement to surface ground adjacent to the retaining structure. Placing the EPS geofoam as a buffer behind the retaining structure can take the lateral earth pressure coming from the backfill materials and transfer a small amount of pressure to the retaining wall due to EPS compressible behaviour (Trandafir, Moyles, and Erickson 2010; Ertugrul and Trandafir 2011; Aytekin 1997; Bathurst, Zarnani, and Gaskin 2007; Athanasopoulos-Zekkos, Lamote, and Athanasopoulos 2012).
(Trandafir, Moyles, and Erickson 2010) present the results of a finite element modeling study discussing the reduction of lateral Erath pressure of retaining walls with different heights (3m,6m,9m, and 12m) using EPS geofoam as a buffer against the wall. The study has indicated the predicted load isolation efficiency for different EPS thickness and densities where the results are based on retaining cohesion soil mass. In a more recent study, (Ertugrul and Trandafir 2011) verified physical model tests with a finite element numerical model using UWLC (form8 2006). The behavior of the retained soil mass and EPS geofoam was reasonably well predicted using an elastoplastic model for the soil and linear elastic formulation for the EPS geofoam, interfaces between soil and EPS geofoam into consideration.
Control yielding in backfill material by EPS geofoam helps to economize project design as it reduces the structural demand to reduce the developed forces (Horvath 1995). EPS geofoam is manufactured all over the world with different densities and sizes. After validation, a parametric analysis has been performed in order to illustrate the effectiveness of changing EPS geofoam properties and thickness on the developed lateral earth pressure. Also, the soil relative density influence on the produced earth pressure acting on the retaining wall while using EPS geofoam.

2 Methodology

This research presents numerical modeling of the utilization of EPS geofoam to reduce lateral earth pressure on the non-yielding retaining wall where the analysis comprises the validation of a numerical model with the results of a physical test presented by (Ertugrul and Trandafir 2011)

2.1 Test Set up after (Ertugrul and Trandafir 2011)

(Ertugrul and Trandafir 2011) used a sandbox with dimensions of (2x1x1) m in the physical tests. The model is comprised of steel wall with dimension (700*980*8) mm (height * length* thickness) rigidly welded to a steel base of (980*500*8) mm (length *width*thickness). Four earth pressure cells with 40 kPa capacities were fixed vertically at 200 mm spacing along the wall height. Across-sectional sketch of the test set up is shown in Figure 1. For validation with the numerical study, the laboratory test has been done using EPS geofoam with three different thicknesses t/h equal (0.07,0.14 and 0.28) where “t” refers to the EPS thickness and “h” refer to the wall height where the geofoam density is 15kg/m^3 for all validation models.

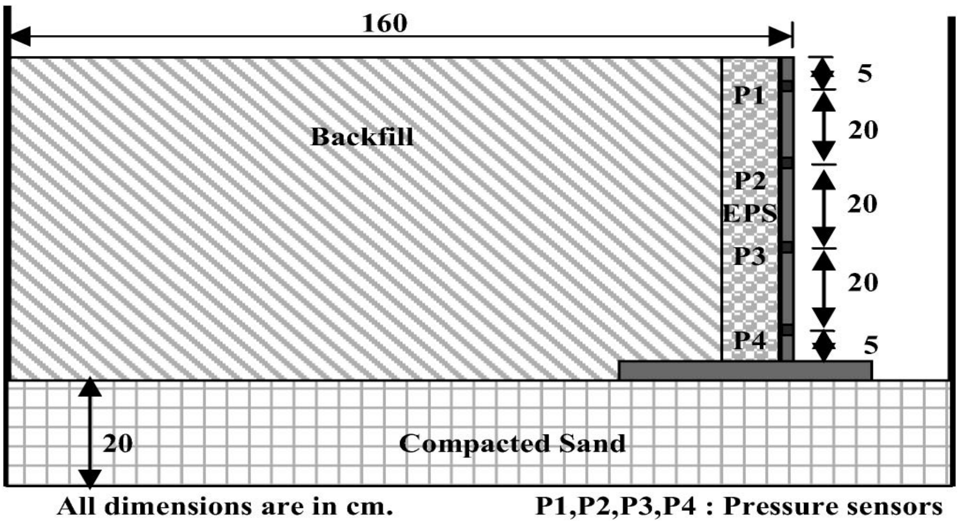

Figure 1: Cross section of the test set up. (Ertugrul and Trandafir 2011).

2.2 Material properties of EPS geofoam

The physical model tests utilized a vertical EPS panel characterized by a density of 15 kg/m^3 where it was simulated as Mohr-Coulomb material in this study (Zarnani and Bathurst 2009). The stress-strain behavior of geofoam was specified through uniaxial compression tests. As shown in figure 2, (σ_a _ σ_r) represents the deviator stress (Where σ_a and σ_r represent the axial and radial stress). Based on the uniaxial compression test results, the yield strength of the EPS geofoam is found as 38 kPa, with maximum strain 2%, according to this results, Young modulus of geofoam E=1900 kPa. To get cohesion values and internal friction angle of EPS geofoam analysis is carried out by (Padade and Mandal 2012) for different densities of EPS Geofoam using triaxial loading tests. Referring to these tests result, the correlation of cohesion values with respect to the corresponding density of EPS Geofoam best fitted to a curve was expressed Equation (1).

$$C = 894.7\,\gamma^2 - 214.3\,\gamma + 45 \qquad [1]$$

where C is the cohesion (kPa) and γ is the density of EPS Geofoam (kN/m^3).
From the previous equation and the results reported by (Padade and Mandal 2012) table 1, we can get the Shear strength parameters of EPS Geofoam with density 15 kg/m^3 for the validation of the model Cohesion (C) =33.75 kPa, the angle of internal friction (φ) =1.5°

Table 1: Properties of Expanded polystyrene (EPS) Geofoam. (Padade and Mandal 2012).

The density of EPS Geofoam (kN/m^3)	**Cohesion C (kPa)**	**The angle of internal friction (°)**
0.15	33.75	1.50
0.20	38.75	2.00
0.22	41.88	2.00
0.30	62.00	2.50

According to Equation (2) reported by (Horvath 1995) For EPS geofoam with a density of 15 kg/m^3 Poisson ratio is estimated at 9%.

$\mu_f = 0.0056*\rho_f + 0.0024$ ……………………...…………………………………….. [2]

Where ρ_f =Density of geofoam (kg/m^3) and μ_f =Poisson ratio of geofoam.

Regarding the previous figures and equation, the modeling parameters for EPS geofoam with a density of 15 kg/m^3 for validation in the numerical modeling are concluded and illustrated in (Table 2).

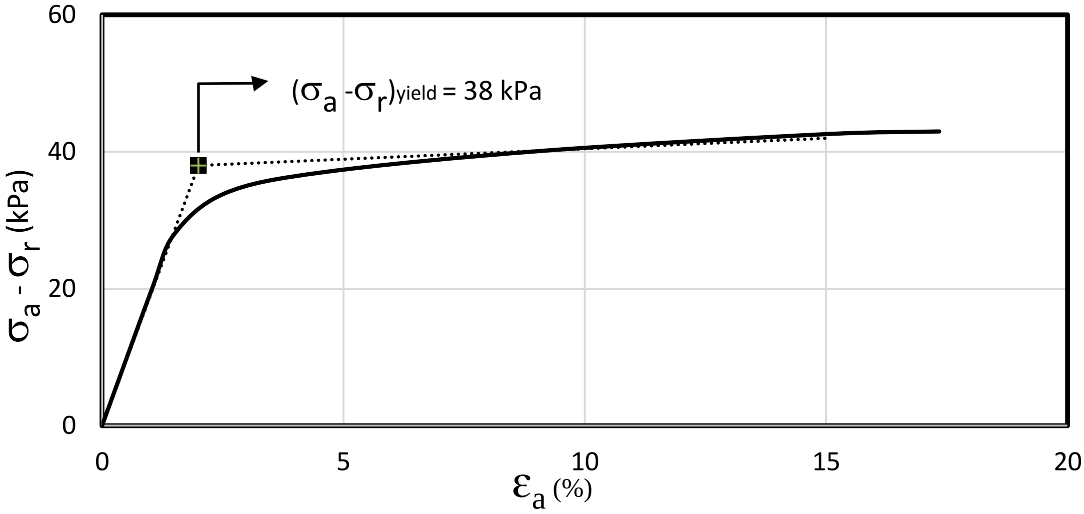

Figure 2: Results of uniaxial compression test ($\sigma_r = 0$) on geofoam (Ertugrul and Trandafir 2011)

Table 2: EPS geofoam material properties.

2.3 Retaining wall and backfill materials properties

Parameters	EPS geofoam	Reference
Unit weight (kN/m^3)	0.15	
Young modulus (kPa)	1900.00	(Ertugrul and Trandafir 2011)
Fiction angle (φ)°	1.50	(Padade and Mandal 2012)
Cohesion (C) (kPa)	33.75	(Padade and Mandal 2012)
Poisson ratio %	9.00	(Horvath 1995)

The retaining wall facing of 0.7 m high and 8 mm thickness is modelled using beam element in numerical simulation with Plaxis as an elastic material with the following properties; Young's modulus (E=1.61e8kPa) and density (7800kg/m^3) respectively). (Ertugrul and Trandafir 2011) reported the backfill materials unit weight is 16.5kN/m^3 with a relative density equal 70 %. For modelling, the same assumption is considered to approach good validation with the laboratory model. The granular backfill is modeled with a Hardening Soil Model (HSM) as it's the best fit according to Plaxis manual handbook. The (HSM) is an advanced model used for the simulation of soil properties.

As for the Mohr-Coulomb model for simulation, limiting states of stress are described by means of friction angle (phi), cohesion (c) and the dilatancy angle (psi). To get the soil parameters relation between φ' values and relative density of soil can be represented by an analytical equation reported by (Bowles, n.d.) as presented in Equation (3).

$$\varphi'(°) = 28° + 15° D_r (\mp 2°) \ldots\ldots\ldots\ldots\ldots \text{[2]}$$

where φ' is the angle of shearing resistance and Dr is the relative density of soil in decimal. For the elasticity modulus of soil with reference to assumed relative density, (Stroud 1989) give the value of SPT-(N1) 60 with reference to backfill relative density as shown in (Figure 3.a) where SPT-(N1) 60 equal 30000 for relative density 70%. Stroud (1988) stated that the relation between SPT-N – Es depends on the load level (q_{net} /q_{ult}) applied on the soil. By using a wide database, Stroud (1988) proposed relation between SPT-N – Es – (q_{net} /q_{ult}) for both cohesion and cohesionless soils (Figure 3.b). Here, q_{net}: net foundation pressure and q_{ult}: net ultimate bearing capacity. For a hardening soil model E_{50} (q_{net} /q_{ult}) =0.5. As a result the relation get the value of E_s =21000 kN/m^2 where Es/N60(mN/m^2) =0.7 as shown in Figure 3.b.

Backfill material physical properties' used for tests reported by (Ertugrul and Trandafir 2011) is shown in Table (3), where the backfill hardening soil model properties for verification are listed in Table 4.

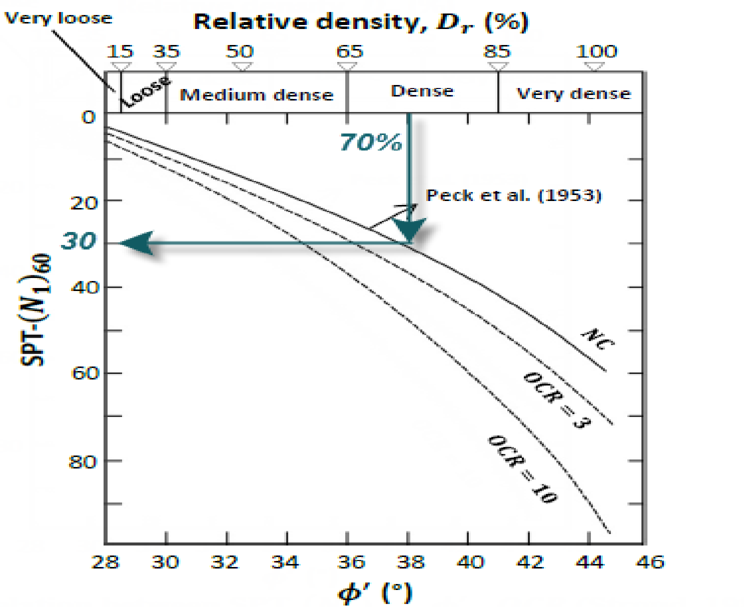

Figure 3.a: A relation between SPT-(N1)60 – OCR after (Stroud 1989)

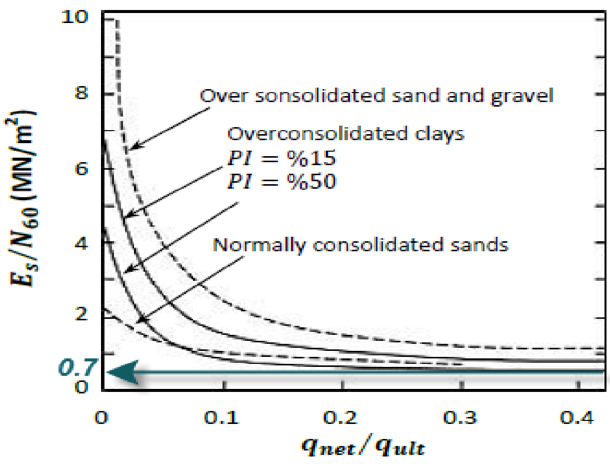

Figure 3.b: Relation between E_s – SPT-N and (q_{net} /q_{ult}) after (Stroud 1989)

Table 3: Constitutive model Backfill Properties after (Ertugrul and Trandafir 2011).

parameters	Backfill	Foundation
Unit Weight (kN/m^3)	16.5	17.5
Young's modulus (kPa)	5200	5500
Poisson's Ratio (γ)	0.33	0.33
Friction Angle (degrees)	43.5	45
Dilatancy Angle (degrees)	22.5	22.5

Table 4: Hardening soil model (HSM) parameters for backfill materials.

Parameters	Backfill
Unit weight (kN/m^3)	16.5
E_{50}^{ref} (kN/m^3)	21000
E_{oed}^{ref} (kN/m^3)	20000
Power (m)	0.5
Friction angle φ (degrees)	38.5
Dilatancy angle Ψ (degrees)	6.5
C_{ref}	0.01

3 Numerical Modelling

Finite element program Plaxis 2D was utilized, the numerical plane strain model with a 15-node element was used to simulate the retaining wall model. The results of the instrumented retaining wall model tests served the calibration and validation of a two – dimensional plane strain model. The boundary condition for the FE analysis involves restrain horizontal and vertical displacement along the bottom horizontal boundary and restrain horizontal displacement along both sides of the vertical boundary of the backfill side and the wall side.

The geofoam material is modeled as purely cohesive material as reported (Zarnani and Bathurst 2009) where the backfill soil was modeled as a hardening soil model (HSM).

At-rest maximum soil pressure (γHK_0) acting at the base of the wall stem was calculated as 3.5 kPa where the height of the model is 0.70 m, the backfill unit weight is 16.5kN/m^3 and the friction angle of the backfill is 43.5°. According to the equation proposed by (Jaky 1944), (i.e., $K_0 = 1 - \sin \varphi$, in which K_0 = coefficient of lateral earth pressure at-rest), thus much smaller than the yield stress of the geofoam (i.e, σ_{yield} =38 kPa). At rest maximum soil, the pressure acting on the wall stem was measured from (Ertugrul and Trandafir 2011) for the physical model without using EPS geofoam. As shown in Figure 4 at rest pressure coefficient could be taken K_0 = 0.48 for modeling the backfill material.
Elastoplastic Mohr-Coulomb interface elements were introduced at the wall stem-geofoam, geofoam-backfill, and wall base-foundation contacts. The interface properties were back-calculated through a numerical calibration process by (Ertugrul and Trandafir 2011) that aimed to match the calculated stresses and the test data. For wall stem-geofoam, geofoam-backfill, wall stem-backfill interfaces friction angle was 15°, 24°, and 32°, respectively. The interfaces have been defined for Plaxis as materials with friction angles equal to interface friction angle. The experimental procedure of the model test has been followed in the development of a numerical model using Plaxis 2D V (8.5) as illustrated in Figure 5. The height of the retaining wall of the model is 0.70m and its thickness is 8mm.The backfill dimensions of length 1.60m behind the retaining wall. The rigid foundation base dimension is 2.00 m width and 0.20 m thickness.

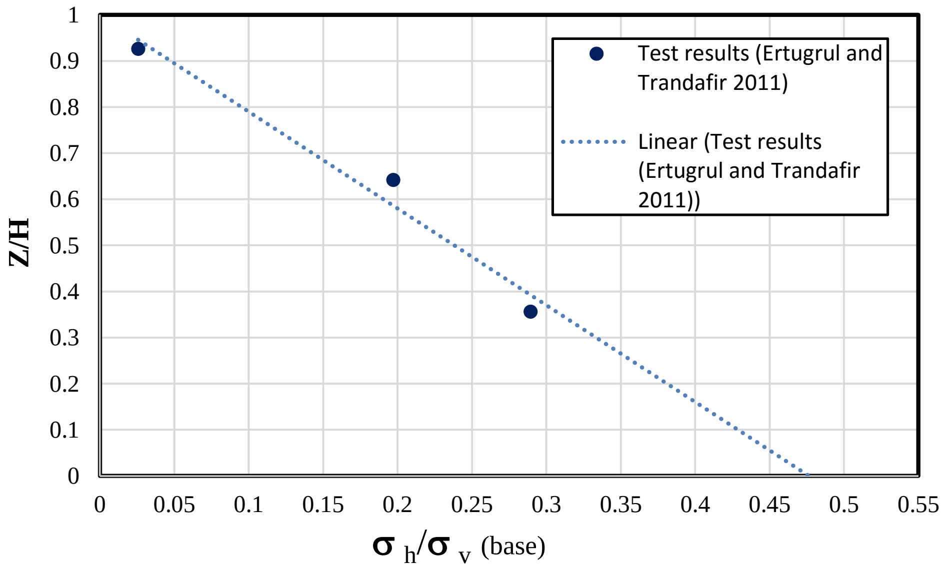

Figure 4: Test results for retaining wall without using EPS geofoam after (Ertugrul and Trandafir 2011).

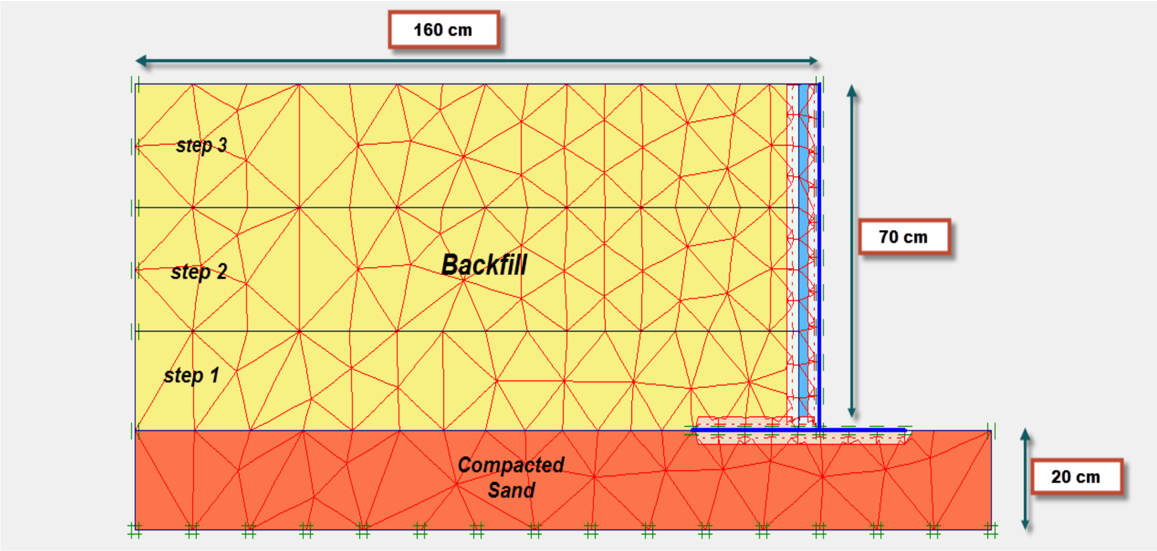

Figure 5: Plaxis grid for modeling of retaining wall

3.1 Model Validation

The results of the instrumented retaining wall model tests served for the calibration and validation of the two-dimensional plane-strain FE model. According to (Ertugrul and Trandafir 2011), retaining wall models with EPS geofoam are considered EPS geofoam of relative thickness t/h=0.07,0.14,0.28. Where t= geofoam thickness and h= wall height. Comparison of physical model test results and numerical model results in terms of lateral earth pressure variation along the height of the wall using 3- step model for backfilling are shown in Figures (6,7 and 8). For the first model shown in figure 6, using geofoam with relative thickness 0.07, the results show a good agreement with experimental data from physical test results for the upper part of the wall with a small variance for the lower part. For the second model shown in figure 7, using geofoam with relative thickness 0.14, the results illustrate a good agreement with experimental data from physical test results for the upper and lower part of the wall with a small variance for the middle measurement. for the third model, using geofoam with relative thickness 0.28, the results show good agreement for the upper part of the wall but a small deviation for the lower part close to the wall about 30% of the wall height. The figures demonstrate that numerical results are reasonably closer to physical test results, lateral earth pressures are decreased with increasing EPS geofoam thickness along the wall height. the results of numerical models of retaining wall with EPS geofoam buffer thickness t/h=0.07, t/h=0.14 are presented in Figures 6, 7 and 8 respectively.

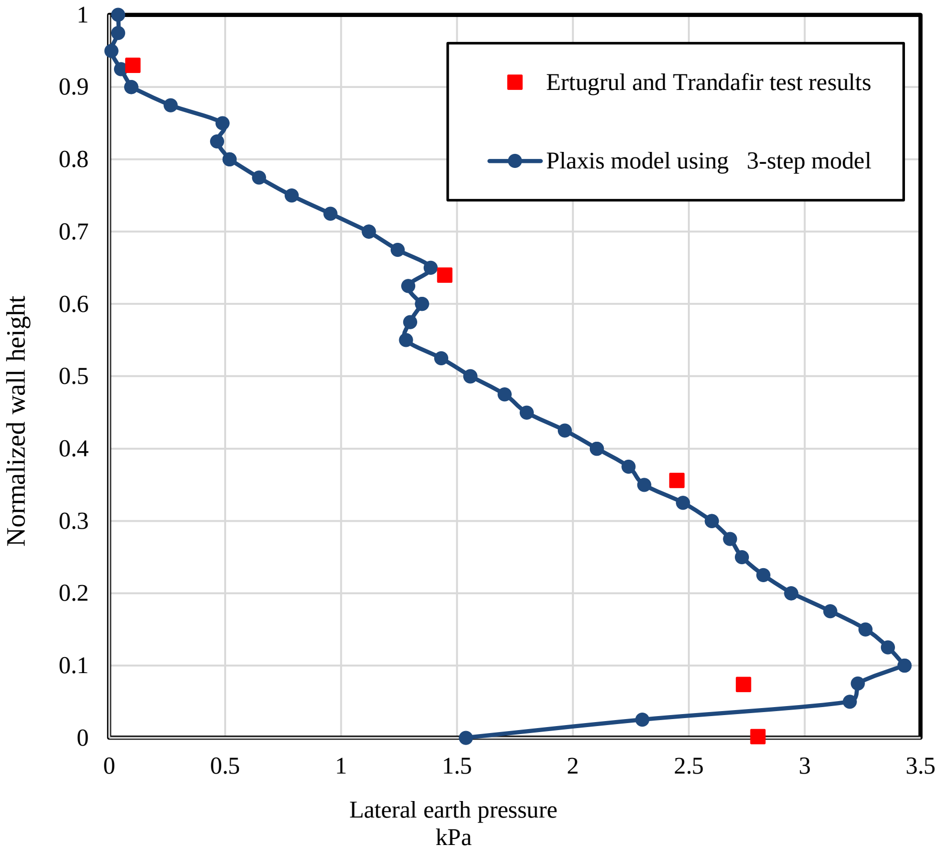

Figure 6: Numerical plaxis model results for 3-steps model with (t/h=0.07).

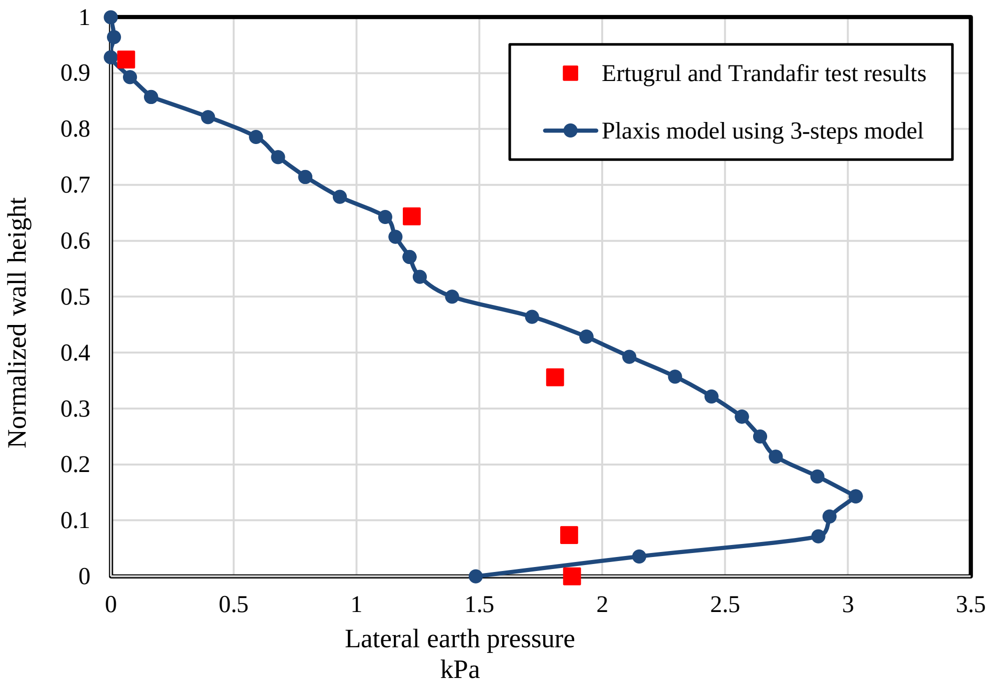

Figure 7: Numerical plaxis model results for 3-steps model with (t/h=0.14).

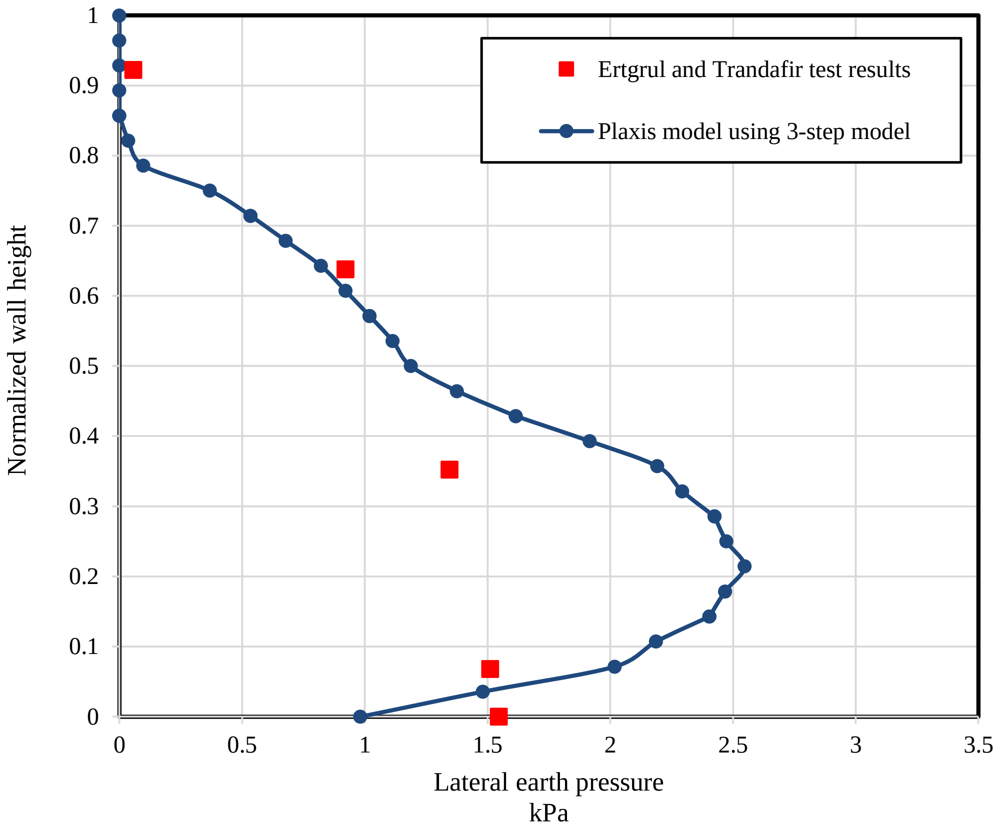

Figure 8: Numerical Plaxis model results for 3-steps model with (t/h=0.28).

4 Parametric study

A parametric study has been performed to demonstrate the effect of EPS geofoam buffer thickness, density and the backfill relative compaction change on the resulting lateral earth pressure acting on the non-yielding wall. The study is based on the wall of a basement with a depth of 12m height. The EPS geofoam used in this study is in accordance with the American Specifications ASTM D6817 as shown in Table 5. EPS geofoam properties are obtained from ASTM D6187 where the angle of internal friction and cohesion obtained from (Padade and Mandal 2012) for modeling. Poisson ratio value is calculated by using correlation reported by (Horvath 1995) the same as validation study. The description of the finite element models is presented in Figure 9.

Tables (6,7 and 8) present the list group of analytical models performed by Plaxis 2D to study the effect of changing EPS geofoam density, thickness and relative density of soil on the resulting lateral earth pressure acting on the non-yielding wall.

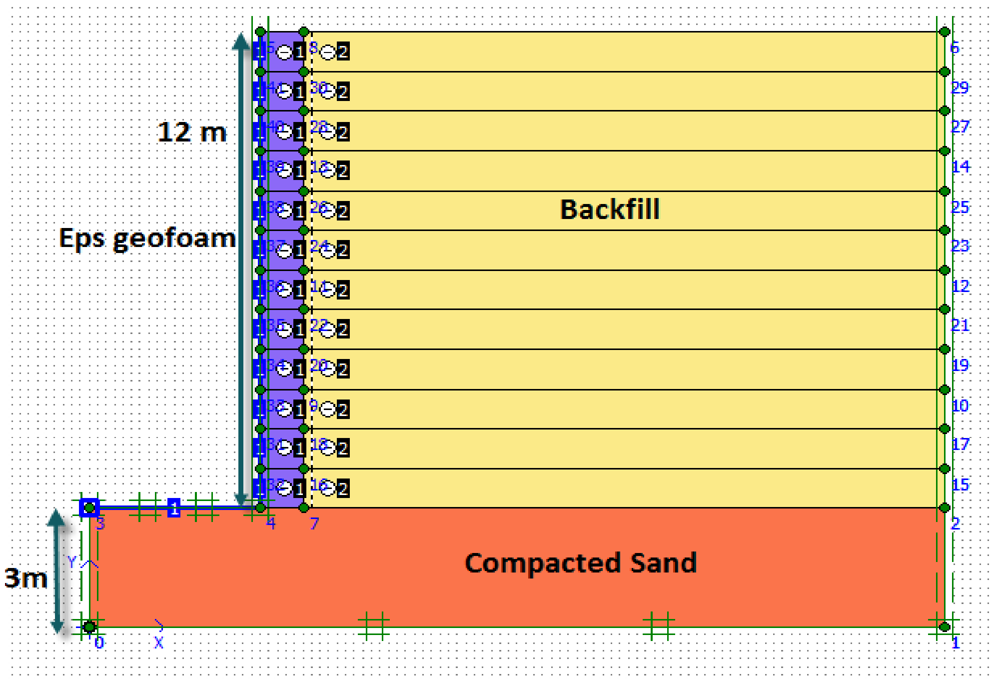

Figure 9: Cross-sectional sketch of the Parametric models

Table 5: Typical physical properties EPS Geofoam according to (ASTM D6817).

	ASTM D6817		
Properties	**EPS 15**	**EPS 22**	**EPS 46**
Density (kg/m^3)	14.4	21.6	45.7
Elastic modulus (kPa)	2500	5000	12800

Table 6: Numerical models for EPS geofoam with constant density.

List of figures	**Soil Relative Density %**	**EPS Thickness (cm)**	**EPS Density (kg/m^3)**
Figure 10	75	20	14.4,21.6,45.7
Figure 11	75	100	14.4,21.6,45.7

Table 7: Numerical models for EPS geofoam with a constant thickness.

List of figures	**Soil Relative Density %**	**EPS Thickness (cm)**	**EPS Density (kg/m^3)**
Figure 12	75	20,50,100	14.4
Figure 13	75	20,50,100	45.7

Table 8: Numerical models for EPS geofoam with different relative density.

List of figures	Soil Relative Density %	EPS Density (kg/m^3)	EPS thickness (cm)
Figure 14	50,75,100	45.7	20
Figure 15	50,75,100	45.7	100

4.1 Effect of EPS density influence

The first group of the parametric study models are to illustrate the effect of using EPS geofoam with different densities (14.4 Kg/m^3, 21.6 Kg/m^3 and 45.7 Kg/m^3) to reduce the lateral earth pressure on the basement wall while using EPS buffer with constant thickness (20 cm and 100 cm). Figure 10 presents the first set of models in which that the produced lateral earth pressure on the wall in case of using EPS geofoam with density 45.7 Kg/m^3 and constant thickness 20 cm, which leads to maximum lateral earth pressure values due to high density and low elasticity. On the other hand, the produced lateral earth pressure is minimum in case of using EPS geofoam with density 14.4 Kg/m^3, while using the earth pressure for density 21.6 Kg/m^3 is in between. The results show the produced earth pressure varies from 90% to 97% of the at rest pressure with a small variance for each case according to the small thickness of EPS geofoam. To study the effect of geofoam density on the reduction of lateral earth pressure more, the same parametric study has been done but with a larger thickness of geofoam buffer equal 100 cm to illustrate the EPS geofoam density effectiveness on reducing earth pressure. As shown in Figure 11, the results show that using geofoam with a density of 14.4 kg/m^3 produces lateral earth pressure lower than EPS geofoam with the density of 21.6 kg/m^3 and 45.7 kg/m^3. The results show the produced earth pressure varies from 68% to 82% of the At rest pressure with the bigger variance for each case according to the bigger thickness of EPS geofoam. The use of a low-density EPS geofoam reduces lateral pressure on the basement wall varying in accordance with the density of the geofoam used. From the two previous examples, the effect of reducing the density of the geofoam used to reduce the lateral pressure is illustrated. The results show that the use of low-density geofoam is more effective when using geofoam buffer with greater thickness. The effectiveness of EPS geofoam buffer thickness will be discussed in the following models.

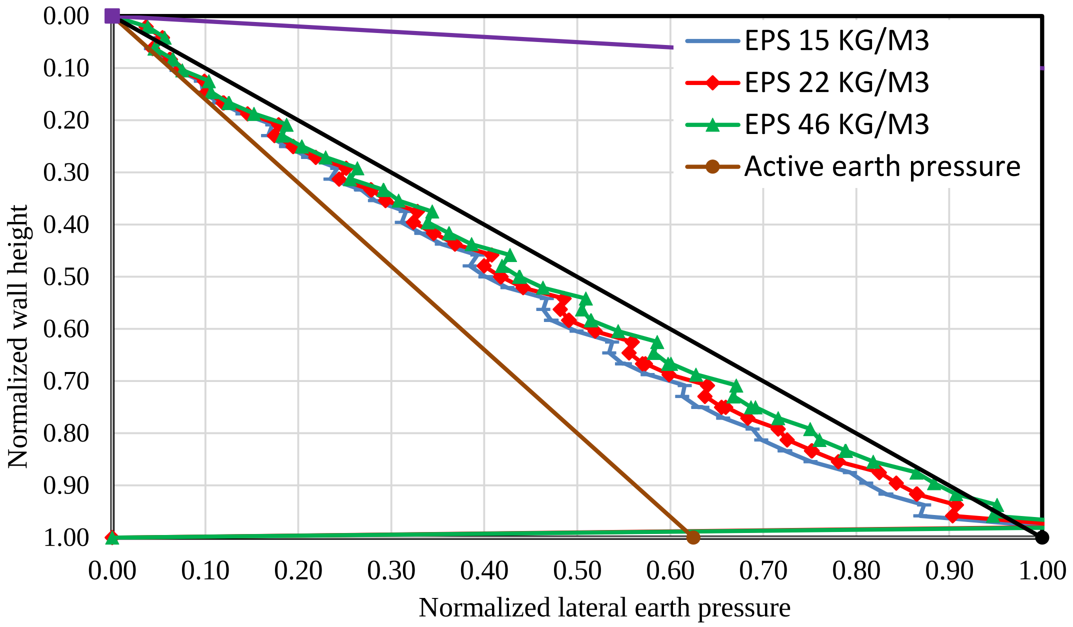

Figure 10: Numerical results for 12m basement wall with using EPS geofoam thickness 20 cm with backfill relative density 75%.

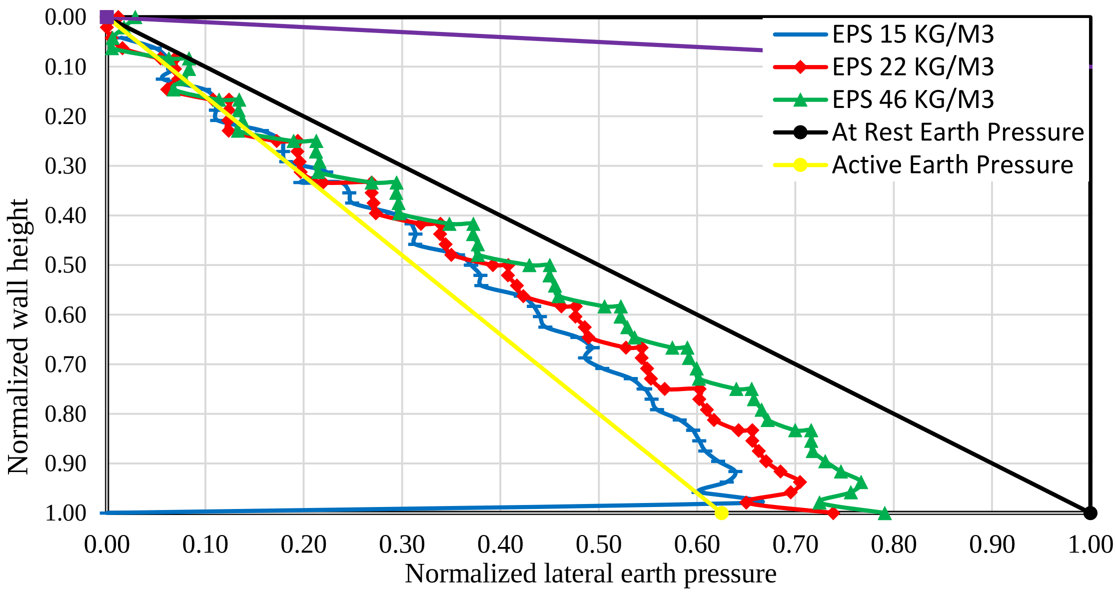

Figure 11: Numerical results for 12 m basement wall with using EPS geofoam thickness 100 cm with backfill relative density 75 %

4.2 EPS thickness influence

The second groups of models are done using constant relative density (75%) and variable thickness for EPS geofoam with density 14.4 and 45.7 kg/m^3 according to ASTM D6817. The results present the lateral earth pressure acting on the wall along its height for different geofoam thicknesses (Figure 12). For EPS geofoam thickness 20 cm (about 1.7 % of the wall height) the produced lateral earth pressure is about 92% of at-rest pressure and for geofoam thickness 50 cm (about 4.2% of the wall height) the lateral earth pressure is about 79 % of at-rest earth pressure while for thickness 1m (about 6.7% of the wall height) the lateral earth pressure is nearly close to the active earth pressure for the lower part of the wall about 69 % of at-rest pressure. Its observed that the lateral earth pressure decreases with increasing geofoam thickness along the wall height. Figure 13 illustrates the same previous numerical study but with geofoam density 45.7 kg/m^3, the geofoam thickness 20 cm produces a lateral earth pressure 94 % of at-rest pressure and for thickness 50 cm produced a lateral earth pressure 81% of at rest pressure while the geofoam thickness 100 cm produce a lateral earth pressure about 71 % of at rest pressure. Results show for the upper part of the basement wall, the earth pressure has nearly no difference but for the lower part, the pressure variance is clear as the pressure increases along the wall height.

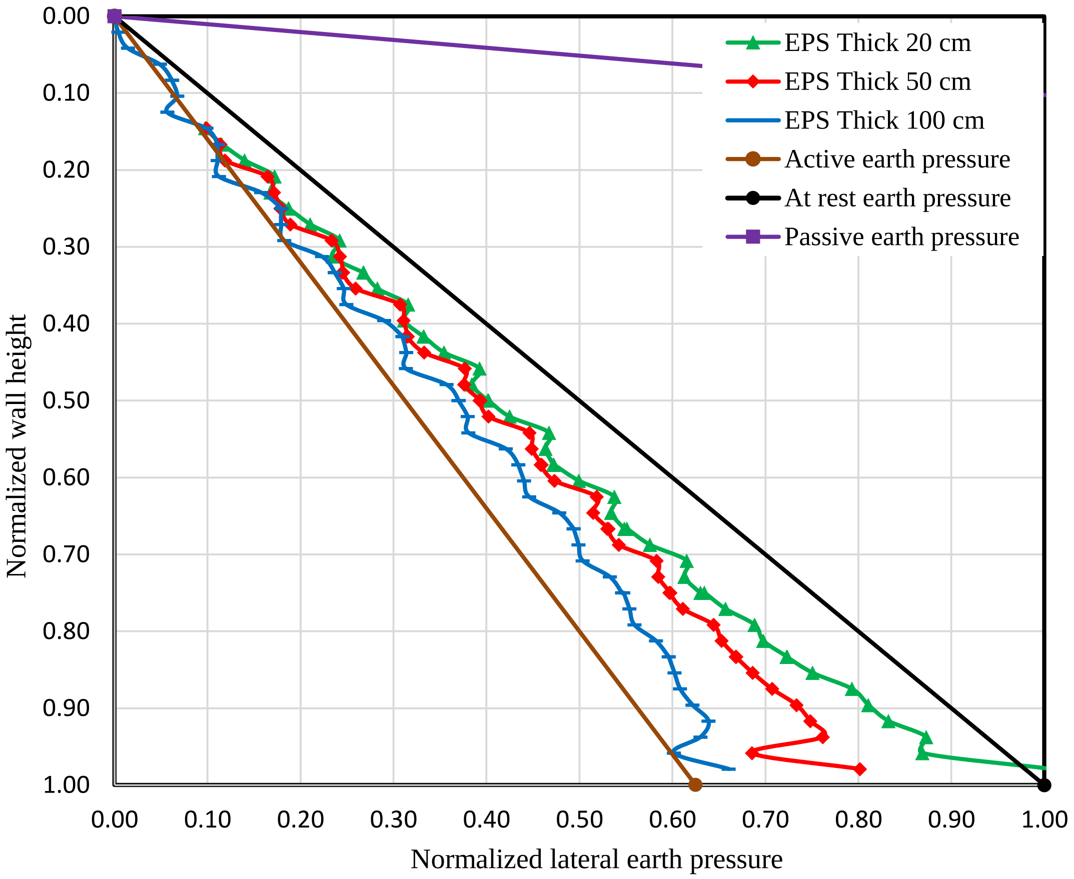

Figure 12: Numerical results for 12m basement wall with using EPS geofoam density 14.4 kg/m^3 with backfill relative density 75 %.

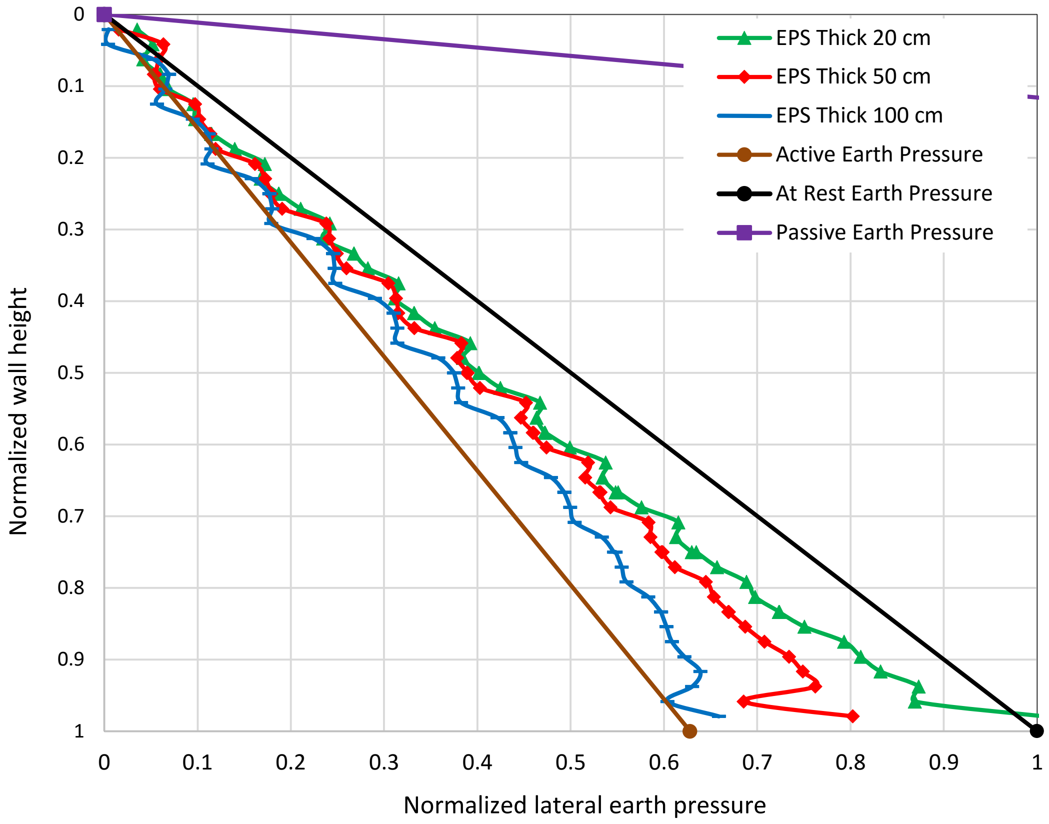

Figure 13: Numerical Results for 12m Basement wall with using EPS geofoam Density 45.7 kg/m^3 with Back Fill Relative Density 75 %.

4.3 The factor of thickness and density influence:

From the previous results, we can conclude a relation between EPS geofoam stiffness factor (η) and normalized lateral earth pressure factor (F). To maintain this relation, the following values for η and F are assumed in Equation 4 and 5.

η = ((EPS thick (m)/1(m)) ÷ (EPS density (kg/m^3)/1000 (kg/m^3))…………………..[4]

(F) = ($\sigma_h - \sigma_{ha}$) ÷ ($\sigma_{ho} - \sigma_{ha}$)……………………………..…………………………..…..[5]

Where η is the stiffness factor of EPS geofoam

F is normalized lateral earth pressure.

σ_h is the maximum lateral earth pressure.

σ_{ha} is active lateral earth pressure.

σ_{ho} is at-rest earth pressure.

The results of the previous numerical models results are concluded in table 9 as a function of the parameters η and F. Figure 14 shows the best fit equation for the relation between EPS geofoam stiffness and normalized lateral earth pressure factor where the equation could be used to expect the deformed lateral earth pressure on the wall with reference to EPS geofoam stiffness factor (density and thickness).

Table 9: Stiffness factor of EPS geofoam η and normalized lateral earth pressure F values.

Figures	Thick (cm)	Density (kg/m3)	η	F
Figure 10	20	14.4	13.33	72%
	20	21.6	9.09	80%
	20	45.7	4.35	89%
Figure 11	100	14.4	66.67	7%
	100	21.6	45.45	21%
	100	45.7	21.74	31%
Figure 12	20	14.4	13.33	72%
	50	14.4	33.33	33%
	100	14.4	66.67	7%
Figure 13	20	45.7	4.35	89%
	50	45.7	10.87	40%
	100	45.7	21.74	31%

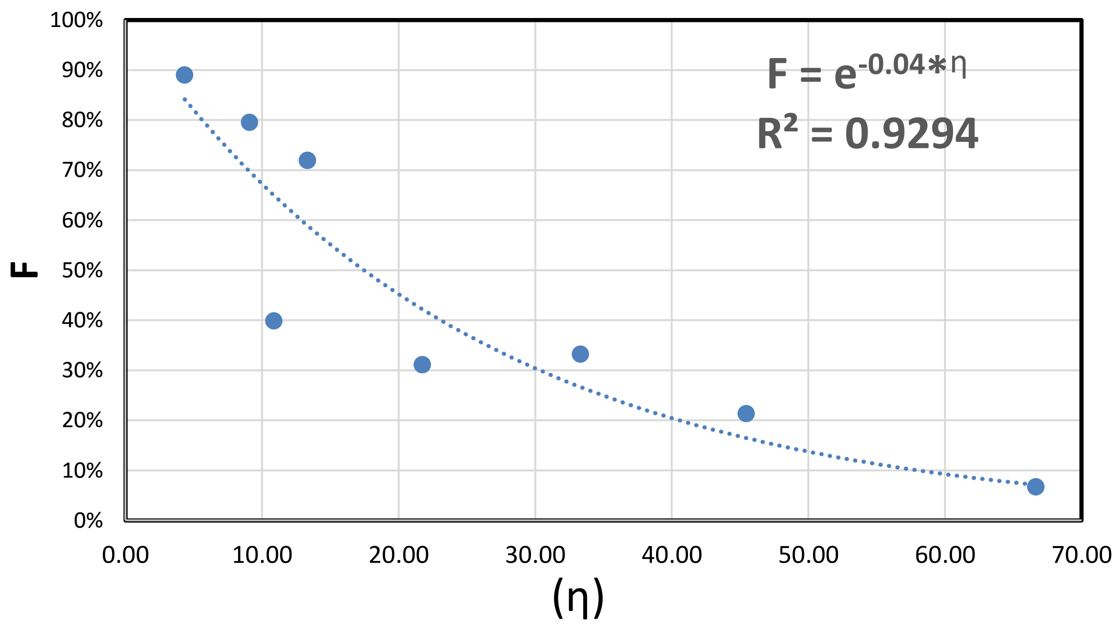

Figure 14: The relation between EPS geofoam stiffness factor and normalized lateral earth pressure factor.

4.4 Soil relative density influence

Backfill relative density is one of the factors that affect the mechanism of reducing lateral earth pressure, but this influence changes according to used EPS geofoam thickness and density. The results concluded from for the parametric study performed using geofoam thickness 20 cm and density 45.7 kg/m^3 with variable backfill relative densities (50%,75%, and 100%) are presented in figure 14. The results illustrate that there is no remarkable difference between the produced lateral earth pressures but for the maximum relative density (100%), the lowest lateral earth pressure was concluded. For further study the same EPS geofoam density (45.7 kg/m^3) but with bigger buffer thickness (100 cm) is used, the results presented in figure 15 show that the lowest lateral earth pressure has resulted from backfill with maximum relative density 100%.

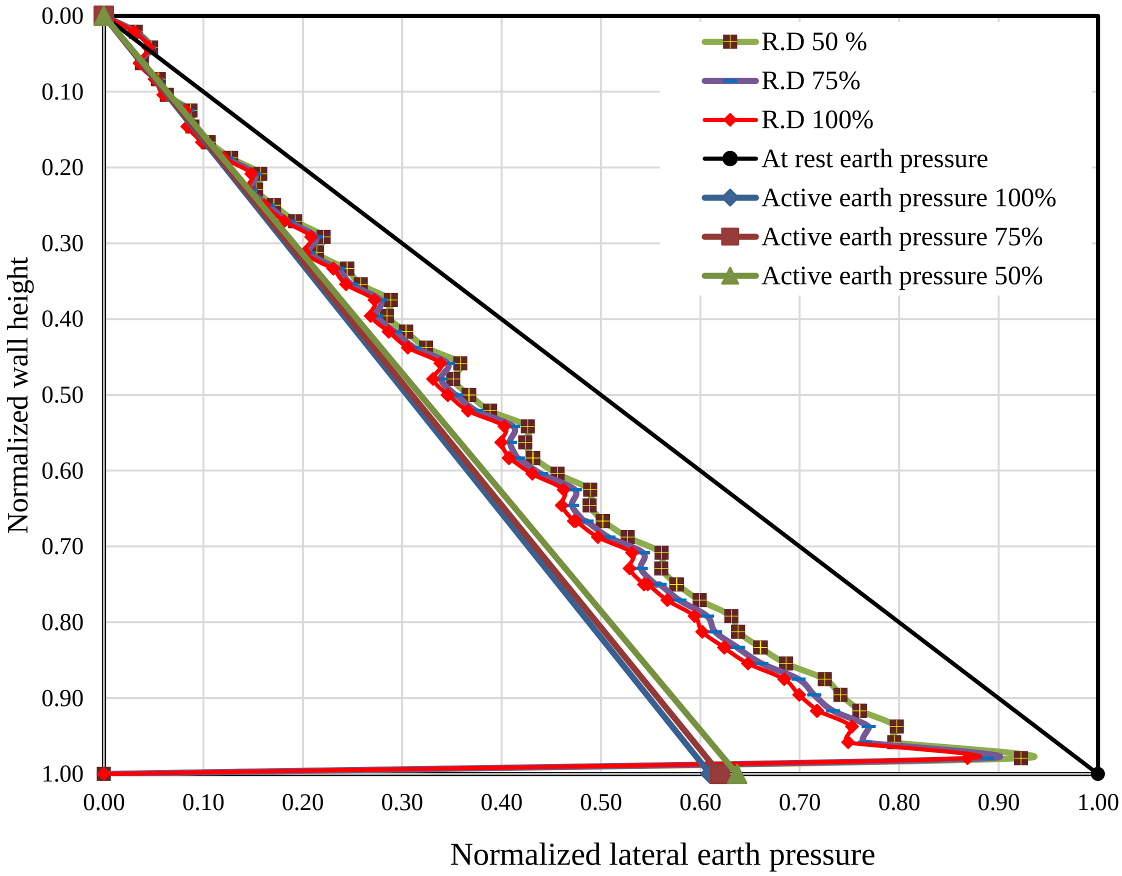

Figure 14: Numerical results for 12m basement wall with using EPS geofoam thickness 20 cm with EPS geofoam density 45.7 kg/m^3 for variable backfill relative density.

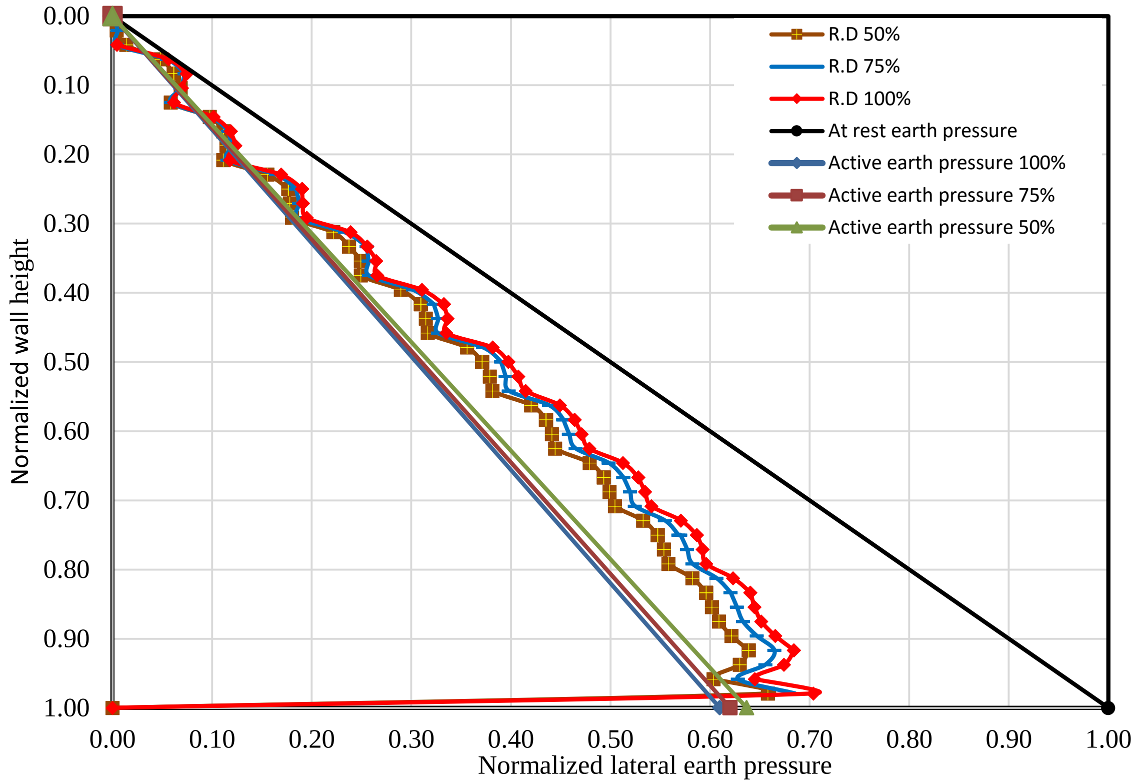

Figure 15: Numerical results for 12m basement wall with using EPS geofoam thickness 100 cm with EPS geofoam density 45.7 kg/m^3 for variable backfill relative density.

5 Conclusions

The present study highlights the effectiveness of using EPS geofoam as a buffer material behind the retaining walls as a compressible inclusion. Numerical simulations of retaining walls with geofoam inclusions are presented using Plaxis 2D V8.5. The developed numerical model was first validated by comparing results from small-scale model test reported that showing a good agreement between the measured lateral earth pressure and the model. Furthermore, a parametric study was performed using numerical models to illustrate the effectiveness of EPS density and thickness on reducing lateral earth pressure on basement wall with depth 12m also the backfill relative density effects on the induced lateral earth pressure. The following are concluded:

1- the Increasing thickness of geofoam buffer leads to a reduction in lateral earth pressure acting on the retaining wall while it is more effective in case of using geofoam with lower density.

2- Reducing the density of EPS geofoam Produces a reduction of the lateral earth pressure acting on the retaining wall, this reduction is more effective in case of using a larger thickness of geofoam buffer.

3- EPS geofoam thickness and its density (thereby its modulus of elasticity and Poisson's ratio) are the most dominant factors affecting the reduction of lateral earth pressure. Due to the reduction in lateral earth pressures acting on the wall, design demand parameters like bending moment and shear forces will be reduced. Thus, geofoam effectively function in reducing the load and minimizing the design demands.

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