EXPERIMENTAL STUDY OF THE BEHAVIOR OF LIGHT EMBANKMENTS MADE OF A NEW POLYSTYRENE REINFORCED BY A POLYGLASS GEO-MEMBRANE

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The technique of light embankment in expanded polystyrene (EPS) has become a favoured solution, since it can delay the onset of degradation, especially at the level of road and railroad bases, by virtue of its high mechanical characteristics. This paper proposes the study of the mechanical behavior of a type of polystyrene geomaterial, recently manufactured in Algeria, under uni-axial loading conditions. An experimental work was developed to evaluate its mechanical behavior while it's reinforced by a geomembrane "polyglass" type. The uni-axial compressive strength, the shear strength and the shear stress at the interface (EPS-polyglass) will be studied. A number of one hundred (100) samples were made and classified into two categories, differing in density, dimensions, effect of immersion in water and reinforcement by the geomembrane. This new material gave sufficiently good results, with an increase in Young's modulus (as a function of density variation and sample size). We observed percentages gains ranging from 69 to 240%. Furthermore, it was noticed that the compressive and shear strengths were directly influenced by the indicated parameters. This new expanded polystyrene, can be used as a lightweight backfill material and can contribute to solve some problems of road geotechnics and subgrade, with a reduction of costs (non-imported material) and an adaptation to the environment (non-pollution during its use).

Keywords: *Experimental, behavior, polystyrene, light backfill, polyglass, uni-axial, reinforcement.*

1. Introduction

The backbone of the transport system is the road and highway network, which has a direct impact on the economic development of a country investing in basic infrastructure [1]. In the projects of the routes, it is often necessary to cross poor reliefs, with low bearing capacity and especially in areas with high rainfall, which generate geotechnical problems during their operation, related to settlements and dangerous landslides [2]. In addition, the use of traditional backfill materials does not promote permanent stability of the pavement and the resulting degradations develop and spread rapidly. Since during the operation of roads by persistent loads of traffic, especially those exceptional and heavy, the problem of instability and settlement arises in compressible soils at low bearing capacity, for this reason, researchers have considered more reassuring and adequate solutions. The use of expanded polystyrene (EPS) is among the effective solutions, as it is a lightweight backfill material with a density of about one hundredth of the density of earth and has good thermal insulation properties, with some stiffness and compressive strength, comparable to that of medium clay [3]. This expanded polystyrene (EPS), which has been proven in engineering applications [4], for more than seventy years and it has been used to reduce settlements under embankments, dampen noise and vibrations and reduce lateral pressure on basements [5,6]. This has been confirmed by several experimental laboratory investigations, which have shown that this polystyrene can be, even, successfully used in geotechnical applications, especially in pavement and embankment bases [7-10]. In addition, polystyrene behaves differently from soils, in terms of stresses and strains, due to its low density and chemical composition (plastic/polymer with a chemical composition of C8H8) [11]. Gouda [12], in addition to the influence of its density on its mechanical behavior. The choice of the geomembrane, type "Polyglass", in our study, is justified by the fact that it is a waterproof product to all types of infiltration (rainwater, wastewater, hydrocarbon fluids and lubricants), in addition to the aspect of its surface that seems rigorous, converging towards the improvement of the interface friction in contact with other products (such as polystyrene). Also, it has been found that the use of this type of polyglass ensures an improvement in the compressive strength compared to other reinforcements used. The effect of strain rate on the static and dynamic behavior of EPS polystyrene was the study subject by Chen [13], where static and dynamic compression and tensile tests on lightweight polystyrene sandwich blocks, with densities of 13.5 kg/m^3 and 28 kg/m^3, at different strain rates, were performed. However, the studies that mention the insertion of "Polyglass" geomembranes for the reinforcement of lightweight polystyrene embankments are minimal (see rare). In this article, we propose the analysis of the mechanical behavior of a new type of polystyrene, recently manufactured in Algeria, under uni-axial loading conditions. These are expanded polystyrene blocks produced and supplied locally by

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a packaging plant located in the province of Boumerdes (46 km/ East of the capital Algiers). The manufacture was done by styrene (translucent granules) with the incorporation of a blowing agent and the expansion obtained by molding [14]. This study will aim, first, at the characterization of this new material, then the evolution of its shear strength and the study of the shear of the interface in contact with this type of geomembrane "Polyglass". This choice is made, since the polyglass has rot-proof qualities and excellent mechanical performances, such as the elongation at break and the great resistance to the perforation as well. Our experimental work, in laboratory, proposes a number of 117 test specimens, divided into three categories. The first category concerns the uniaxial compression tests (composed of 63 specimens), with taking into account the three different densities: 15, 20 and 25 kg/m^3 (21 specimens for each density). For the second and third category, intended for direct shear and interface shear tests, there will be 54 specimens, with the same density variation as before, giving 18 specimens for each density.

2. Experimental program

2.1 Principle of investigations

The main objective of this investigation is the applicability of Algerian polystyrene as a new lightweight material in the construction of embankments. It is research that revolves around the characterization and study of the predominant repetitive stresses involved in the construction of road embankments, namely compression, shear and interface shear. For that, an experimental program allowing extracting the required mechanical parameters (strength, modulus of elasticity, shear modulus) is envisaged.

2.2 Test methods

The experimental investigation will concern the tests of compressive strength, direct shear strength and interface shear strength. The objective is to study the behavior of the EPS polystyrene, alone, then reinforced by the geomembrane "Polyglass Elastoflexe HP" [15]. The densities of the EPS polystyrene used are: 15, 20 and 25 kg/m3. The materials were available in cubic form with different specimen sizes and were taken in accordance with ASTM D7557-09 [16] for different tests. The specimen cutting work was done at Packshield Industries limited, which is a manufacturer and supplier of EPS geomembrane in Mumbai, India [17]. A series of 117 specimens, divided into two test categories (compression and shear) were proposed. Sixty-three (63) specimens divided into three modes (the first without reinforcement, the second with reinforcement by one layer and the third with reinforcement by two layers). All the reinforcements are carried out by application of the geomembrane" Polyglass". For the first category, the tests will be carried out in uni-axial compression, with variable densities of: 15kg/m^3, 20kg/m^3 and 25kg/m^3, while the second and third categories, are intended for direct shear and interface shear tests, where 54 specimens distributed, the variable densities are identical to those of the first category.

2.3 Material properties

2.3.1 Geofoam EPS polystyrene

The expanded polystyrene blocks used in this study are locally produced. The manufacturing process is done by styrene (translucent granules) with the incorporation of a blowing agent and the expansion obtained by molding. Three densities were selected: 15 kg/m^3 (called D15), 20 kg/m^3 (called D20) and 25 kg/m^3 (called D25). The identification of polystyrene is done by density confirmation tests carried out in accordance with standards: NF EN 15037-04 [18], after allowing the samples to dry and stabilize for three days in the open air from the date of manufacture. The results obtained were 15.39 kg /m^3, 20.13 kg /m^3 and 24.16 kg /m^3, respectively, for the three densities, D15, D20 and D25. Water absorption tests were performed by placing samples of the different densities in a container filled with water and covered with a steel net to prevent the samples from floating on the water surface and to keep them submerged in water for 30 days [19,20]. For all tests, polystyrene blocks of three different cubic dimensions with volumes: 50 mm^3, 100 mm^3 and 150 mm3, with varying nominal densities (15 kg /m^3, 20 kg/ m^3 and 25 kg/ m^3) (Fig.1) were prepared. The samples are referenced in this report using the symbol EPS and the nominal density, for example (EPS 15).

Fig.1 - Prepared EPS Expanded Polystyrene Blocks

2.3.2 Polyglass Elastoflexe HP

It is a prefabricated, ultra-high performance elastomeric waterproofing membrane consisting of a blend of distilled bitumen and a high elasticity thermoplastic resin (SBS), comprising a high weight continuous yarn non-woven polyester reinforcement, reinforced with longitudinal glass fibers [21]. This reinforcement is considered a membrane with excellent mechanical properties of elongation at break and high punching resistance, as well as dimensional stability, which will ensure perfect adhesion to substrates and layers.

Table 1

Technical characteristics of Polyglass Elastoflexe HP

Technical characteristics	Unity	Nominal value
Length	M	≥ 10
Width	M	≥ 1
Thickness	Mm	5 ± 0.2
Tear resistance	N /mm²	≥ 0.8
Shear strength	N/mm²	≥ 0.25
Crack resistance	C°	≤ 15
Tensile elongation	%	50% (± 15)
Dimensional stability	%	≤ 20

Table 2

Identification of specimens made for shear tests

Density	Direct shear (kPa)			Interface shear (kPa)		
	50	100	150	50	100	150
D15	3	3	3	3	3	3
D20	3	3	3	3	3	3
D25	3	3	3	3	3	3

below summarizes the technical characteristics of this product.

2.4 Preparation of test specimens

In this experimental program, three categories of specimens with different contact cross-sections were made for testing: uni-axial (unconfined), direct shear, and interface shear. The total number of test specimens is 117, divided into: 54 samples for the 1st test, 27 for the 2nd and for the 3rd test as well.

2.4.1 Uni-axial compression

Uni-axial compression was performed to evaluate the influence of density, the effect of water immersion, the effect of sample size, and the behavior of EPS polystyrene specimens reinforced with the Polyglasse HP membrane. For each density taken, sections of three different dry volumes were made. Water immersion is treated for the submerged case and two reinforcements (one layer and two layers of Polygalss geo-membrane) (Table 2). Figs. 3 and 4, illustrates the unreinforced and reinforced blocks, respectively for the three densities D15, D20 and D25. For the uni-axial test, for the three densities (D15, D20 and D25), three (03) specimens of each dry section of 50 mm^3, 100 mm^3, 150 mm^3, three specimens for the section immersed in water, three specimens for the case of reinforcement by a layer of polyglass and finally, six specimens for the case of reinforcement by two layers of polyglass were taken. A total of 21 specimens for each density.

2.4.2 Direct shear and interface shear

The objective of the direct shear test on expanded polystyrene (EPS) blocks is an attempt to understand the behavior of the shear strength parameters of EPS [22]. The direct shear test is performed on the EPS block with three different densities, namely, 15kg/m^3, 20kg/m^3, and 25kg/m^3, under three different values of normal stress of 50kPa, 100 kPa, and 150 kPa. For the interface shear tests, the same procedure was adopted, with the three densities already listed and the same normal stress values. Table 2, gives the values taken for both types of shear tests. Khan et al [23], illustrated very clearly the principle of each direct

Fig.2 - Unreinforced polystyrene samples


Fig.3 - Reinforced polystyrene samples


Fig.4 - Apparatus and direct compression test

shear and EPS/PVC interface shear test, on each EPS polystyrene block and the distribution of stress forces.

2.5 Test procedure

2.5.1 Uni-axial direct compression

The purpose of the direct compression is to evaluate the effects of the following parameters: the strength of the specimen by varying the density, the effect of moisture by immersing the specimens in water for a period of 30 days, the size of the specimen by taking three different volumes, and finally, the effect of the reinforcement by the polyglass geo-membrane. All tests were performed according to ASTM D1621-10 [24], with room temperature, at a head speed equal to 1mm/min. All the samples (specimens), were compressed between the upper (fixed) and lower (mobile) plates of the universal electromechanical machine (UTM-0108), ensuring the continuity of the loading until the distance between the upper and lower plates reached a specific predetermined value (Fig.4).

2.5.2 Direct shear and interface EPS-Polyglasse

For the direct shear test, the automatic direct/residual shear machine UTS-2060 was used (Fig.5). And a total of 27 tests were performed. The

Fig.5 - Automatic shearing machine UTS-2060

maximum load on the specimen was in the range of 5kN. The sample dimensions tolerated by this machine are (60 × 60 × 20) mm. The shear is driven by a high-resolution servo motor and a set of gearboxes. The speed is fully variable in steps over the range of 0.00001 to 9.99999mm/ min with a reverse value of 10mm/min. All tests were conducted in accordance with ASTM D3080 [25], under three different normal stresses: 50 kPa, 100 kPa and 150 kPa. Horizontal displacement was applied at the recommended rate of 1mm/min and all tests terminated when the maximum displacement was reached automatically and stopped by shearing. If no maximum response is observed, maximum shear is considered at 10% horizontal displacement. In the EPS/Polyglass Elastoflexe HP interface tests, the geomembrane was placed in the upper box, while the Polyglass sample was put in the lower box. This arrangement was adopted because the Polyglass geomembrane is considered incompressible with respect to the geomembrane under the applied load and, therefore, ensuring that the shear surface remains aligned with the separation plane between the upper and lower parts of the box. Another advantage of this configuration is that it minimizes the tilt that can be experienced if the lower block deforms unevenly during loading.

3. Results and discussion

3.1 Uni-axial compression without reinforcement

3.1.1 Stress - strain behavior

The average stress-strain curves, shown in Figures 6a, 6b and 6c, are obtained from the compression tests (uniaxial). They show the elastoplastic behavior without peaks. Three phases are visible; the elastic phase (linear), the elastoplastic phase (curvature) and the pseudo-plastic phase with bearing. This is confirmed by the results of previous research, such as those of: Atmatzidis in 2001 [26] and Ghotbi in 2019 [27]. The values obtained for: yield strength, compressive strength, and initial modulus of elasticity, are summarized in Table 3 for the three densities D15, D20 and D25, regardless of the shape of the specimen (dry or immersed). Quantitatively, the compressive stresses at the elastic limit (for the 1% deformation) influence the results obtained, with gains of 212% (for density 15 kg/m^3), 100% (for density 20 kg/m^3) and 113.7% (for density 25 kg/m^3). The influence of sample size and density is shown in Fig.7, where it is observed that the stress increases with density and sample size. This gives significant values for the elastic modulus (E) of polystyrene, with values of 2.3Mpa, 5.3MPa and 7.9MPa, respectively for densities D15, D20 and D25, for large sample sizes (150mm^3). Concerning the limit of the elastoplastic phase (deformation at 5%), the same remarks are observed, with percentages of 43.8%, 67% and 51%, respectively for densities D15, D20 and D25 and with a decrease of 33% for the immersed case.

Table 3

Compressive strength at different strain rates

Density (kg/m^3)	D15 Constraint Values σ (kPa)			D20 Constraint Values σ (kPa)			D25 Constraint Values σ (kPa)		
	1%	5%	10%	1%	5%	10%	1%	5%	10%
Cube 50	8	32	45.2	26	63	84	43	104	114
Cube 100	12	45	56.4	32	103	114	44	122	135.2
Cube 150	24.5	46	53.7	52	107	118	94	157	169.4
Submerged	25	25.4	61.3	45	100.2	94.8	45	105	117.2

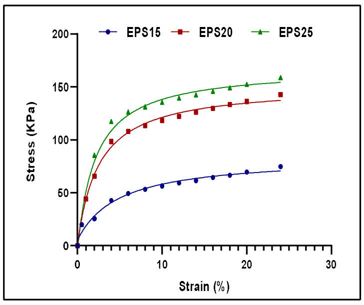

Fig.6a - Stress-strain curves for 50mm^3

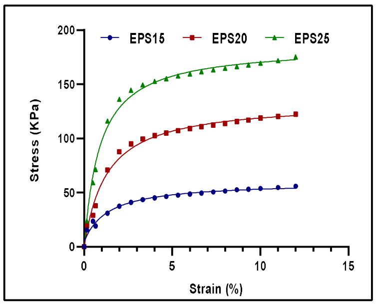

Fig.6b -Stress-strain curves for 100mm^3

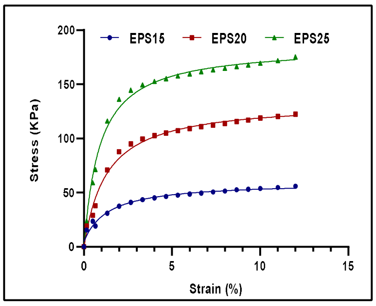

Fig.6c -Stress-strain curves for 150mm^3

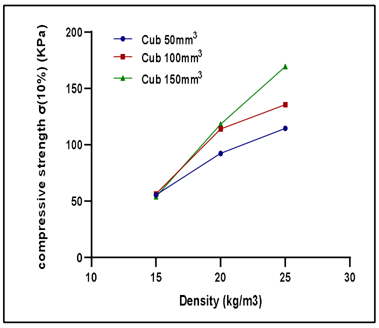

Fig. 7 - Variation compressive strength $\sigma_{10\%}$ with density

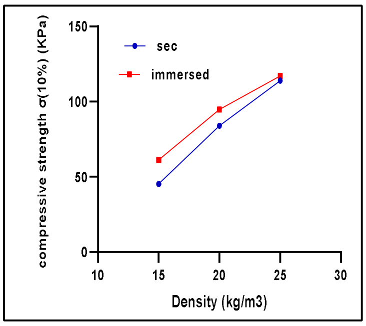

Fig.8 - Influence density on the compressive strength σ10 %

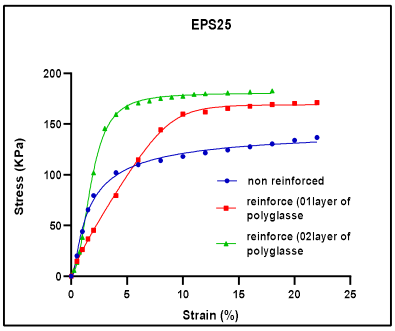

Fig.9 - Stress-strain behavior of EPS reinforced by polyglass

3.1.2 Influence of the polystyrene immersion in water

Fig.7, illustrates the behavior of the tested specimens, under uniaxial compression, in a dry and immersed state. The strength values in the case of immersed specimens are slightly higher than those in the dry state, due to the role played by the amount of water absorbed, which means an increase in stiffness and especially during the elastic phase. In addition, researchers have shown that the absorption of water by polystyrene (EPS) depends on the magnitude of the applied stress [28], which is not the case in our study. Also, the difference in strength between the two cases (dry and submerged) for each value of applied density is 16.1 KPa (for D15), 10.8 KPa (for D20) and 3.2KPa (D25), respectively. The D25 density polystyrene is not strongly affected by this change in strength and this may be due to the low water absorption of the denser specimen. Furthermore, it is concluded that the water immersion of Geofoam EPS polystyrene, is not seriously affected by the immersion time.

3.1.3 Effect of reinforcement on polystyrene behaviour

For the study of the direct compression of the polystyrene EPS Geofoam reinforced by the geomembrane "Polyglass" (second phase of our study), we will present the results obtained by the curves: stress - strain, according to the density of the specimen and the number of layers of reinforcement. These results show that the mode (number of layers) of reinforcement influences the compressive strength, for any density taken. The most reinforced specimens give better strength values and the best performing density is D25. This is confirmed, as the evolution of compressive strength increases linearly with density, which explains that reinforcement has a remarkable influence on strength [29], especially when the polystyrene is denser. We observe a gain of 49.8% and 36.7% (in compressive strength), respectively for one and two layers of polyglass reinforcement for density D25 (Fig.9). This gain is reduced by 9.2% and 13.7%, respectively for one and two layers for density D20. The gain is negligible for density D15. We conclude that it is better to reinforce with two layers for the densest polystyrene, and with one layer for the least dense polystyrene.

3.1.4 Evolution of the modulus of elasticity

The modulus of elasticity of the tested block evolves according to the studied parameters (density, reinforcement, water immersion), for this, it is essential to use a theoretical method, based on trial and error or correlation [30]. For this purpose, for the elastic phase of the curve, the strain scale is divided into uniform strain intervals ($\Delta\varepsilon$) and for each of them a corresponding stress value ($\Delta\sigma$) is measured. In this way, the ratio ($\Delta\sigma/\Delta\varepsilon$) is calculated, which represents Young's modulus of elasticity (E). In this way, the evolution of this modulus (E) as a function of density can be traced. This elastic modulus of polystyrene (EPS) has a constant value in the linear elastic region. Table 4 summarizes the values of the modulus of elasticity at different densities for all cases studied. For dry sections, the modulus E increases with density and specimen size. Comparing the values obtained with

Table 4

Evolution of modulus E for all uniaxial compression tests

Section	50 mm^3	100 mm^3	150 mm^3	Submerged 50mm^3	1 nappe polyglas	2 nappes polyglass
Density	Modulus E (kPa)					
15	822	2200	2300	2530	1165	1165
20	1600	3720	5360	3910	1750	1760
25	2637	5430	7900	5000	2637	4320

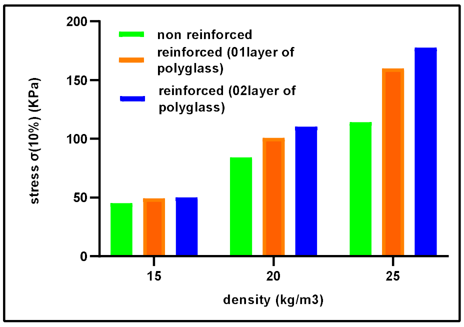

Fig.10 - Difference in stress with case study

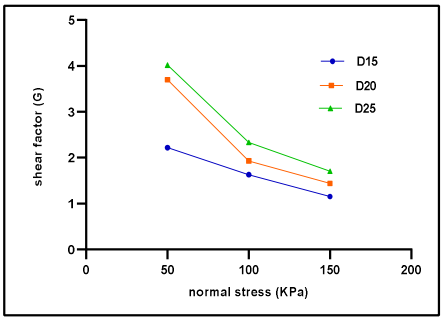

Fig.11 - Shear factor with normal stress

respect to the density D15, for all sizes, we can see: For the section 50 mm^3 and, the rate of increase is: 95% and 220% for densities D20 and D25 respectively, while the increase is lower for the section 100mm^3, with rates of: 69% and 149%, for densities D20 and D25 respectively.

What is for the section 150mm^3, the rates are much higher and are of: 133% and 243.5%, for densities D20 and D25 respectively. This represents an increase of 207.8% for a density of 15 kg /m^3, 144.5% for a density of 20 kg/m^3 and 90% for a density of 25 kg/m^3. The water content (water immersion) has a positive influence by increasing Young's modulus (E), especially for the less dense section, which can be explained by a stiffness developed by the amount of water absorbed and generated during the crushing test. It seems that the 2-layer reinforcement gives a higher modulus of elasticity depending on the density of the specimen. Indeed, a gain of 112% for the two-layer reinforcement and only 16.5% for the single-layer reinforcement and this, for the density of 25 kg/m^3 (Fig.10). This large difference can be justified by the fact that when the density of polystyrene exceeds 20 kg/m^3, reinforcement with other materials is more effective and more loaded. Specimens with a higher density and sufficient reinforcement by the "Polyglass" geomembrane can be used as an alternative solution to cope with the low load-bearing capacity of lightweight embankments.

3.2 Direct shear and interface shear

For the shear tests, whether direct (polystyrene mono-block) or interface geo-membrane polystyrene / Polyglass, we studied the relationship: a/shear stress-horizontal displacement, b/evolution of shear strength with the variation of the shear factor with the normal stress. This study will be with the different values of densities [31]. It was found that for the geomembrane - EPS polystyrene interface, the adhesion (C-cohesion) and friction angle (ϕ) of the interface increased slightly with the increase of the density of the polystyrene. Similarly, the measured shear strength of the interface showed proportionality with density and mechanical characteristics. In addition, the incorporation of the "Polyglass" geomembrane changed the strength mechanism of the EPS polystyrene from cohesive to cohesive-frictive [32].

3.2.1 Direct shear of polystyrene

The shear parameters, resulting from the different tests carried out, gave results, including a very increasing evolution of the shear strength when the displacements are between 0 and 2mm and this evolution reduces, after the elasto-plastic limit for the least dense specimens (D15) and with the highest normal stress of 150 kPa, the values increase to reach the limit of 173 kPa, then they decrease significantly until the residual values. For specimens D20 and D25, beyond the elasto-plastic phase, the values reach 166 kPa (for D20) and 221 kPa (for D25). The ratio of the shear stress at failure to the normal stress applied at that point, which results from the shear factor (G), shows a decreasing trend as the normal stress is increased (Fig. 11). These results show that when the load is increased axially (normal stress), this factor (G) decreases significantly, with differences of -61%, -54%, and -42%, respectively for densities D25, D20, and D15. Similarly, the shear strength increases with polystyrene density, with 70%, 43%, and 27% increases, respectively, for densities D15, D20, and D25. As the axial load increases when the density is equal to 20 and 25 kg /m^3, the shear strength also increases, which is considered an advantage for the interface joint.

3.2.2 Interface shear (Polystyrene –Polyglass)

The study of the interface behavior between the two materials polystyrene EPS and polyglass showed that the adhesion (cohesion C) increased proportionally with the density of polystyrene, with rates of 122.6% (between D15 and D25) and 109% (between D20 and D25). While the angle of friction (ϕ), decreased only from 10.5 to 44.5% and does not seem to obey the density variation. The results indicate that the inclusion of the geomembrane "Polyglass" leads to a considerable increase in shear strength, which allows us to conclude, that the shear stress, increases significantly with horizontal displacement. The axial load (normal stress) of 150 kPa, gave a higher elasto-plastic limit, with values of 175 kPa, 220 kPa and 260 kPa, respectively for densities D15, D20 and D25. For the shear factor (G), there is a decreasing trend when the normal stress is increased. These results show that as the normal stress increases, the factor (G) decreases significantly, with deviations of -58%, -56.4% and -41%, respectively for densities D25, D20 and D15. Regarding the shear strength, it increases as a function of the density of polystyrene, with rates of increase of 55%, 32% and 26.5%, respectively for densities D15, D20 and D25.

3.2.3 Relationship direct shear and interface shear

Based on the results obtained from the two test cases direct shear of the EPS monoblock and shear of the EPS/Polglasse interface, we observed that the values related to the EPS/Polglasse interface shear tests are higher than the contribution of the direct shear for the following parameters: cohesion, shear strength τ (Kpa) and the shear factor G (Fig. 12), with differences of 19. 15%, 34.5% and 16.2% for cohesion, 8.42%, 20.2% and 24.65% for shear strength and 8.4%, 23% and 24.6% for shear factor G for densities D25, D20 and D15 respectively. On the other hand, the friction angle ϕ seems not to be subject to this comparison, as it concerns the molecules of each material separately.

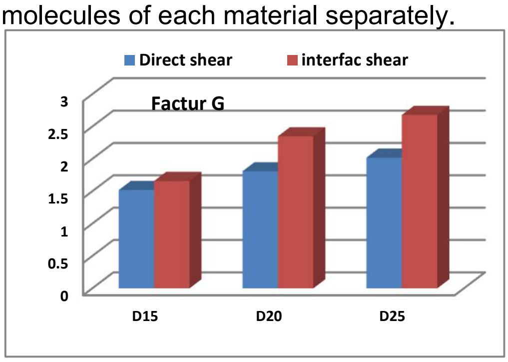

Fig. 12 - Comparison direct shear/interface shear with Polyglasse of shear factor G

4. Conclusions

Different series of tests were carried out on samples of a new expanded polystyrene EPS, manufactured in Algeria, which is intended to be used as a lightweight backfill material. Several parameters were studied in order to estimate their influence on the behavior of the tested specimens, namely: density, size, humidity (dry and immersed states), as well as the reinforcement with the polyglass geomembrane. Based on the results obtained, the general behavioral trend of this new type of polystyrene was in good agreement with previous research.

From the test results, it is observed that the stress-strain relationship of EPS, is closely related to the density and size of the specimens and no shear failure was observed in the uni-axial compression test. Regarding the compressive behavior of EPS, increasing density results in better compressive stress at the yield point with gains up to 212%. The higher density test specimens (D25) failed at lower strain due to the increase in stiffness.

The compressive stress-strain curve for EPS shows three phases: an elastic linear, an approximate plateau followed by a rapid increase in stress due to compaction and cell densification. The behavior of EPS depends, therefore, significantly on the density and size of the specimen, which explains the values found for the elastic modulus (E) of the largest size polystyrene (150 mm3), with values of 2.3Mpa (density D15), 5.3MPa (density D20) and 7.9MPa (density D25). As the water absorption by the polystyrene (EPS) depends on the amplitude of the applied stress, which is not the case in our study, it turned out predicated on our results, that the immersion in water of the Geofoam EPS polystyrene, is not seriously affected by the immersion time, especially for the case of the highest density (D15).

For the reinforcement of polystyrene blocks (EPS) with Polyglass, the most reinforced specimens (two layers) give better resistance values for the highest density (D25), gains from 37 to 50%. It’s advocated to reinforce with two layers the densest polystyrene, and with one layer for the least dense polystyrene (D15 and D20). Regarding the ideal location of the membrane "Polyglass", the study of the behavior of the interface between the two materials polystyrene EPS and polyglass, showed that the adhesion (cohesion C) increases proportionally with the density of polystyrene, with rates ranging from 109 to 122.6%. The results indicate that the inclusion of the "Polyglass" geomembrane leads to a considerable increase in shear strength. Also, the results show that when the normal loading stress increases, the shear factor (G), characterizing the shear of the EPS/Polyglass interface, decreases significantly, with deviations ranging from -58 to -41%. The shear strength increases as a function of the density of the polystyrene, with rates of increase that vary from 27 to 55%. It is preferable (or even necessary) to place the "Polyglass" or another type of geomembrane at the interface, because of the shear strength values that are better than those obtained in case of direct shear of the EPS.

This study has shown that the use of the new expanded polystyrene, reinforced with the "polyglass" geomembrane, can be considered a suitable and reassuring solution for light embankment road infrastructures with low bearing capacity, considering the mechanical characteristics it presents. In addition, this new expanded polystyrene can be used as a light backfill material and can contribute to solving the problems related to road geotechnics, with a reduction in costs (non-imported material) and environmental adaptation (non-pollution when used).

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