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Evaluation of Shear Strength Properties of Modified Expanded Polystyrene Aggregate

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Abstract

The paper presents the results of series of direct shear tests made on recycled waste expanded polystyrene foams (EPS). Waste EPS were thermally modified in an oven at 130 ^{o}C through 15 minutes and crushed into aggregate size before tested. Heat treatment of the EPS increased its density from 15 kg/m^3 to nearly 200 kg/m^3. Shear strength behavior of modified EPS were investigated in loose and dense states under three different normal stresses. The test results showed that shear strength behavior of modified EPS is similar to that of sand. Internal friction angle of modified waste EPS in the dense state is higher than of loose state.

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*Keywords:*Sand; modified EPS; shear strength; waste materials; soil stabilisation;

1. Introduction

Geofoam (Expanded Polystyrene, EPS) refers to block or planar low density plastic foam solids when used as a light weight soil substitute or for thermal insulation in geotechnical applications [1]. EPS geofoam in common use has density of 15 to 30 kg/m^3 having a comparable strength and stiffness as medium clay. EPS is a very light weight material with good compressive strength, high water resistance and excellent cushioning properties. Most of these characteristics are affected by the density and fusion of the molded foam material.

A number of investigations were carried out towards the evaluation of the salient properties of EPS geofoam including density, compressive strength, modulus of elasticity, yield strength, Poisson's ratio, flexural strength, tensile strength, shear strength, creep deformation and thermal conductivity, etc. Among these properties, density, compressive strength, modulus of elasticity, creep properties and thermal conductivity are most commonly used in evaluating the performance of EPS geofoam in different geotechnical applications. Confining pressure on EPS geofoam may result from lateral pressures due to soil or hydrostatic pressure. Some studies have also shown that

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increase in confining stress will reduce strength [2-3]. Anasthas et al. [4] performed triaxial tests on cylindrical samples of two different densities to investigate effect of confining stress on compressive resistance. The compressive strength of EPS geofoam tested at small confinement pressures (0 to 20 kPa) have shown that the strength increased as the confining stresses increased [5]. But the strength increase noted was very small. In recent years using geofoam, which are measured as a lightweight material, in geotechnical applications have increased. EPS geofoam is approximately 100 times lighter than most soil and at least 20–30 times lighter than other lightweight fill alternatives. This extreme difference in unit weight compared to other materials makes EPS geofoam an attractive fill material. Because it is a soil alternative, EPS geofoam embankments can be covered to look like normal sloped embankments or finished to look like a wall [6-8].

Using EPS as retaining wall backfill or subbase has several potential benefits. In areas where the underlying soil is weak or compressible, the lower unit weight of foam-sand mixture would apply a smaller vertical stress than conventional backfill, leading to lower settlement and increased global stability. The horizontal stress on a retaining wall would be lower than with conventional backfill, resulting in a less expensive retaining wall design. In many countries, due to the increasing cost of raw materials and the continuous reduction of natural resources, the use of waste materials is a potential alternative in the construction industry. In this study waste EPS were crushed at certain size and hardened with heat treatment. A series of direct shear test were carried out to investigate its shear strength behavior and compare it with sand.

2. Materials and Methods

The production of MEPS was prepared by heat treatment as shown in Fig.1. The optimum time and temperature were 15 minute and 130 ºC respectively. Sieve analysis was carried out on MEPS sample and the Particle size distribution curve is given in Fig.2.

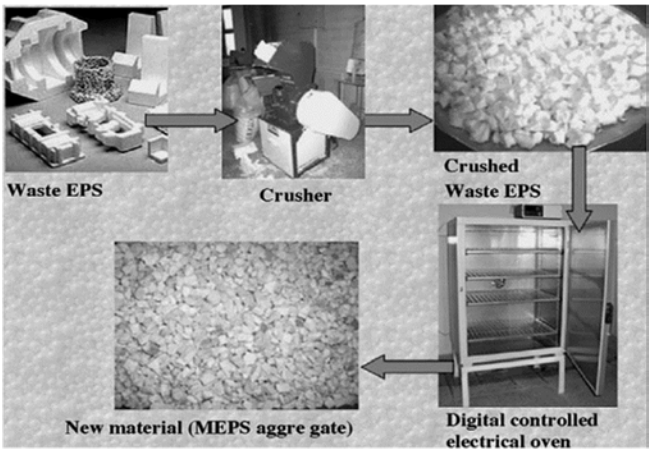

Fig.1. Process of MEPS production [9].

A fully automated direct shear device was used in this study (Fig.3). The total dimensions of the upper and lower shear boxes were 60 x 60 x 25 mm. Fig.3 shows direct shear device used in this study. All tests were carried out under dry condition. During the shearing test, shearing displacement was kept equal to 1 mm/min for all tests. Four different normal stresses namely 14, 28, 56, and 112 kPa were applied to samples before applying shear stress. Shear stresses were calculated at 6mm horizontal displacement of box.