

## ABSTRACT

Earth retaining structures such as retaining walls, bridge abutments, bulkheads, braced excavations and mechanically stabilized walls are often subjected to different loading conditions. Among various parameters that need to be considered in the design of retaining structures, lateral earth pressures and horizontal displacements resulting from the supported backfill are the most predominant. These are the influencing parameters on the performance of the structure under variety of loading conditions. The development and implementation of methods, for the reduction of earth pressures and wall displacements, reduce the structural capacity requirements and lead to the overall construction economy. With the efforts of reducing the lateral earth pressures and wall displacements of the earth retaining structures, light weight/compressible novel materials came into practice that are effectively serve the purpose. These materials include expanded polystyrene (EPS) geofoam, waste plastic, fly-ash, pure shredded tire, and sand – tire chip mixtures, etc. Other hand, scrap tires are undesired urban waste and are increasing every year. Scrap tire stockpiles can pose health hazard and fire hazard, thus alternative approaches to utilize large amounts of scrap tires has received attention of engineering community. Reuse of scrap tires prevents wastes that require disposal in landfills and also preserve the natural resources towards attaining sustainability. Use of scrap tire-derived materials as alternative materials in civil engineering applications, especially in geotechnical applications, has been practiced in several occasions.

Aim of the present research work is to investigate the beneficial effects of the use of scrap tire derived geomaterials in retaining wall applications. Sand and tire chips were chosed for preparing sand – tire chips (STC) mixtures. Index and mechanical properties of different STC mixtures (0–100%) were determined through laboratory investigations and optimum mixing ratio of STC was evaluated. A series of physical retaining wall models of 600 mm

height were tested under static and dynamic conditions to investigate the model behavior using different STC mixtures as lightweight fill material and tire chips as a compressible inclusion. The effects of STC mixtures, compressible inclusions layer thickness, surcharge pressures, base excitations (frequency and acceleration) and earthquake excitations on the performance of the retaining walls were studied. Results were analyzed to understand the effect of each of the considered parameters on the horizontal wall displacements, lateral earth pressures and acceleration amplifications at different elevations of the wall. Numerical model was developed to simulate the static and shaking table tests on wall models, using a computer program FLAC (Fast Lagrangian Analysis of Continua) and used for parametric studies. Further, two retaining wall systems were designed using STC0 and STC30 mixtures and financial benefits were evaluated.

The addition of tire chips to sand (up to approximately 30–50%) resulted in significantly increased shear strength. The optimum mixing ratio of sand and tire chips, which show better compressibility characteristics (due to lesser void ratio) and high load-carrying behaviour (due to high shear strength), is in the range of 30–40% by weight. The model studies with STC mixtures as lightweight backfill material indicated significant improvement in wall behaviour in terms of displacements and lateral earth pressures and accelerations. Maximum reduction in displacement is in the order of 65%, for optimum STC mixture (STC30), under both static and dynamic loading condition. By using STC30 material dynamic induced pressures were reduced by, up to 80%. Tire chips as compressible inclusion, behind the wall showed remarkable advantage in reducing displacements (upto 25% reduction) and lateral earth pressures (up to 60 % reduction), under static loading. The corresponding reductions in dynamic case were, up to 75% and 80%, respectively. The developed numerical model, for retaining wall with different STC mixtures, is able to simulate the behaviour of laboratory models and showed the maximum reductions in displacement and pressures for STC30 backfill.

With the assumed rates of TC, sand, and other materials, using STC30 mixture backfill showed an average saving of 20% to 30% in the total estimated cost of construction.

Overall, the present research work concludes that the STD geomaterial possess the beneficial engineering properties which indicate the promising potential for the use in Geoengineering applications. STC mixtures prove to be a cost effective lightweight fill material and reduce the demand for traditional materials with the replacement by recycled scrapped tire chips. Thus, use of STD material in geotechnical applications will create a sustainable future.

