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Stress–strain response of plastic waste mixed soil

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ABSTRACT

Recycling plastic waste from water bottles has become one of the major challenges worldwide. The present study provides an approach for the use plastic waste as reinforcement material in soil. The experimental results in the form of stress–strain-pore water pressure response are presented. Based on experimental test results, it is observed that the strength of soil is improved and compressibility reduced significantly with addition of a small percentage of plastic waste to the soil. The use of the improvement in strength and compressibility response due to inclusion of plastic waste can be advantageously used in bearing capacity improvement and settlement reduction in the design of shallow foundations.

1. Introduction

The bottled water is the fastest growing beverage industry in the world. According to the international bottled water association (IBWA), sales of bottled water have increased by 500% over the last decade and 1.5 million tons of plastic are used to bottle water every year. Plastic bottle recycling has not kept pace with the dramatic increase in virgin resin polyethylene terephthalate (PET) sales and the last imperative in the ecological triad of reduce/reuse/recycle, has emerged as the one that needs to be given prominence. Fig. 1a shows a typical group of the water bottles available in market used for the drinking purposes. The general survey shows that 1500 bottles are dumped as garbage every second. PET is reported as one of the most abundant plastics in solid urban waste (de Mello et al., 2009) Fig. 1b shows the plastic bottle present in garbage. Waste Recovery Program, WRAP (2005) indicates that the reduction of waste benefits the natural environment with indubitable economical advantages, since waste represents a large loss of resources and raw materials that could be recovered, recycled or considered for other uses. In 2007, it is reported a world's annual consumption of PET bottles is approximately 10 million tons and this number grows about up to 15% every year. On the other hand, the number of recycled or returned bottles is very low (ECO PET, 2007). On an average, an Indian uses 1 kg of plastics per year and the world annual average is an alarming 18 kg. It is estimated that approximately 4–5% post-consumer plastics waste by weight of Municipal Solid Waste (MSW) is generated in India and the plastics waste generation is more i.e. 6–9% in USA, Europe and other developed countries. As per data available on MSW, approximately, 4000–5000 tonnes per day post-consumer plastics waste are generated. Chen et al. (2010) indicates that reuse of plastic waste is an important step in the development of clean energy and in conjunction with the promotion of new waste plastics recycling programs could contribute to additional reductions in GHG emissions and fossil fuel consumption. Hence, there needs to be concerted efforts in the reuse of plastic waste from water bottles and this study is in this direction.

This study presents simple way of recycling plastic water bottles in the field of civil engineering as reinforcing material. The plastic waste mixed soil behaves as reinforced soil, similar to fiber-reinforced soil. The concept of soil reinforcement has dramatically changed the function of soil as a construction material. The introduction of the soil reinforcing techniques has enabled engineers to effectively use unsuitable in situ soils as reliable construction materials in a wide range of civil engineering applications. Reinforced soil construction is an efficient and reliable technique for improving the strength and stability of soils. The technique is used in a variety of applications, ranging from retaining structures and embankments to subgrade stabilization beneath footings and pavements. It is noted that, in the literature very few studies are available on the use of plastic mixed soil. The possible advantages of using the plastic wastes are that the plastic waste can be consumed in useful geotechnical engineering applications. In one of the earliest papers on the use of plastic waste in combination with soil, Consoli et al. (2002) indicates that one of the most promising approaches is the use of fiber-shaped waste materials in the combination with soil and cement. Materials such as polyethylene terephthalate (PET) plastic bottles are profusely and widely produced, yet used little for engineering purposes, and the overwhelming majority of them are placed in storage or disposal sites. The plastic waste when mixed with soil results in improvement of soil

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