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Damage Induced by Recycled Aggregates on the Short-Term Tensile Behaviour of a High-Strength Geotextile

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Abstract

This paper presents the mechanical, chemical and environmental degradation induced by recycled Construction and Demolition Wastes (C&DW) on the short-term tensile behaviour of a nonwoven polypropylene (PP) geotextile reinforced with polyester (PET) yarns. In order to study the chemical and environmental degradation a damage trial embankment (2m x 3m in plant) was constructed using recycled C&DW as filling material. The damage caused by the mechanical actions during installation was also simulated by installation damage laboratory tests. Wide width tensile tests were performed on geotextile samples exhumed from the trial embankment after 12 months, on laboratory damaged samples and on intact (as-received) samples. Their short-term tensile behaviour is compared. Scanning electron microscope (SEM) images of intact and exhumed specimens are also presented.

Keywords: Recycled aggregates; Construction and Demolitions Wastes; Geosynthetics; Geosynthetics degradation; Geosynthetics damage

1 Introduction

Recycled Construction and Demolition Wastes (C&DW) have been increasingly used as recycled aggregates in pavement sub-bases and other road construction applications (Vieira and Pereira, 2015a). Furthermore, unpaved roads constructed with recycled C&DW materials can be effectively reinforced with geosynthetics, where they may also have separation (soil layers with different particle size distribution) and drainage functions. However, one of the main questions of using geosynthetics in ground applications is their durability. This aspect is particularly significant if an alternative aggregate is being used.

The damage caused by mechanical actions during the installation and the chemical and the biological degradation are important issues to be considered in geosynthetics behaviour. The changes in their

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physical, mechanical and hydraulic properties, induced by the above-mentioned degradation processes, can control the performance of the structures where these materials are used.

The available long-term tensile strength of a geosynthetic (AASHTO, 2012; FHWA, 2010), T_{al}, or the design strength for the ultimate limit state (BS 8006, 2010), can be estimated as:

$$T_{al} = \frac{T_{ult}}{RF_{ID} \times RF_{CR} \times RF_{D}} \quad (1)$$

where T_{ult} is the ultimate tensile strength (per unit width), RF_{ID} is the installation damage reduction factor, RF_{CR} is the creep reduction factor and RF_{D} is the durability reduction factor (that accounts for the strength loss caused by chemical and biological degradation of the polymers used in the geosynthetic). Instead of the durability reduction factor, RF_{D}, the British Standard BS 8006 (2010) considers two reduction factors: a reduction factor for weathering, RF_{W}, and a reduction factor for chemical/environmental effects, RF_{CH}.

To study the chemical and biological degradation induced on geosynthetics by recycled aggregates coming from C&DW, damage trial embankments were constructed. The exhumation of geosynthetic samples was predicted after 6, 12 and 24 months of embankments construction. The results herein presented are part of a broaden research project and are related to high-strength geotextile samples exhumed after 12 months of installation.

In order to minimize the installation damage of the geosynthetics during the embankments construction, a lightweight compaction process was adopted. The mechanical damage induced by the recycled aggregates on the geotextile was simulated in laboratory, carrying out installation damage tests, but using recycled C&DW as damaging material.

2 Materials and Methods

This research study was carried out using a commercial available geosynthetic, frequently used as reinforcement, consisting of a polypropylene continuous-filament needle-punched nonwoven and high-strength polyester yarns (Figure 1). In order to study the effects of recycled C&DW on the short-term tensile behaviour of this geocomposite (or high-strength geotextile), intact (as supplied by the manufacturers), damaged (in the laboratory) and exhumed specimens were taken from the same roll and they were tested using the same methods and equipments.

Figure 1: Photograph of the high-strength geotextile (ruler in centimeters).

In order to study the chemical and biological degradation induced by recycled C&DW on three distinct geosynthetics, damage trial embankments were constructed (Figure 2). It should be noted that their construction method and dimensions (2m x 3m in plan and 0.45m high) are not adequate for other purposes, namely the analysis of the embankment behaviour. The results herein presented are related to geotextile samples exhumed after 12 months of installation (Figure 2b).