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Effect of Axle Overloading on Pavement Structural Behaviour with Improved Clayey Subgrade Using PET Fibres

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Abstract Clayey subgrade soils are considered to have a lower bearing capacity, which may develop early pavement failure due to diverse axle loading. To avoid such failure issues, these soils must be treated prior to the beginning of the construction work. In the recent past, soil stabilization with plastic waste has become popular to reduce waste and improve soil behaviour. The current study aimed to use polyethylene terephthalate (PET) waste bottles to improve clayey subgrade soil for pavement construction. The PET fibre content varied between 1% and 5% by weight of the dry soil to investigate its influence on compaction, California bearing ratio (CBR), unconfined compressive strength (UCS), and tri-axial shear strength. The modified soil matrix with PET was further stabilized using Terrasil (0.1%) in order to improve the strength properties of the treated soil with ageing. Overall, the influence of the addition of the PET fibre on the structural behaviour of flexible pavement under diverse axle loading conditions was evaluated using Finite Element (FE) techniques. The pavement model is computationally implemented in ANSYS to study pavement structural behaviour in terms of surface deflection, vertical stress and strain on the subgrade layer, maximum shear strain in the bituminous layer, and tensile strain at the base of the bituminous layer under standard loading and overloading by 1.25 and 1.5 times. The test results indicated that the addition of PET fibres in subgrade soil significantly increases the CBR, UCS, and internal friction angle and decreases the compaction characteristics. The use of PET fibres in subgrade stabilization can result in a significant reduction in pavement thickness. FE analysis results compare pavement rutting performance and show that overloading reduces rutting life.

Keywords Clayey Subgrade Soil, Soil Stabilization, Polyethylene Terephthalate, Terrasil, ANSYS

1. Introduction

Road infrastructure has gradually increased, but it is found very often that pavement failure occurs at an early stage due to overloaded vehicles. The majority of users want to reduce transportation costs by overloading vehicles, although there are restrictions imposed by the regulatory authorities on the axle loads. The overloading phenomenon acts as an unexpected force, causing degradation in pavement performance even before the design life [1]. In most cases, roads are damaged due to heavy trucks, which usually have more than 0.80 MPa of tyre pressure along with overloading. Heavy vehicles, which account for about 15-20% of total traffic, are responsible for 60% of pavement damage and degradation [2]. Existing literature indicates that when a pavement is 5% overloaded, the