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Numerical Analysis of the Effect of Geocell Reinforcement above Buried Pipes on Surface Settlement and Vertical Pressure

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Abstract : Dynamic traffic loads cause deformation of underground pipes, resulting in vehicle discomfort. This makes it necessary to reinforce the layers of soil above underground pipes. In this study, the subbase layer was reinforced. Finite element software (PLAXIS 3D) was used to in the simulation, which includes geocell reinforcement, vehicle loading, soil layers and Glass Fiber Reinforced Plastic (GRP) pipe. Geocell reinforcement was modeled using a geogrid element, which was defined as a slender structure element that has the ability to withstand axial stresses but not to resist bending. Geogrids cannot withstand compression but they can withstand tensile forces. Comparisons have been made between the numerical models and experimental works, and a good agreement was obtained. Using the mathematical model, the performance of three different pipes of diameter 600 mm, 800 mm, and 1000 mm, and three different vehicular speeds of 20 km/h, 40 km/h, and 60 km/h, was examined to determine their impact on surface settlement and vertical pressure at the pipe crown for two cases: with and without geocell reinforcement. The results showed that, for a pipe diameter of 600 mm under geocell reinforcement, surface settlement decreases by 94 % when the speed of the vehicle is 20 km/h and by 98% when the speed of the vehicle is 60 km/h. Vertical pressure decreases by 81 % when the diameter of the pipe is 600 mm, while the value decreases to 58 % for a pipe with diameter 1000 mm. The results show that geocell reinforcement causes a significant and positive reduction in surface settlement and vertical stress above the pipe crown, leading to an increase in pipe safety.

Keywords : dynamic loading, finite element, geocell-reinforcement, GRP pipe, PLAXIS 3D, surface settlement
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