Chapter 14

Evaluation and Intelligent Modelling for Predicting the Amplitude of Footing Resting on Geocell-Based Weak Sand Bed Under Vibratory Load

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ABSTRACT

The main consideration while designing geo-structures to sustain vibration loads is the accuracy of the displacement amplitude estimation. The displacement amplitude of a footing on a geocell-reinforced bed exposed to vibration stress can be computed using sophisticated data. AI modelling has replaced many traditional methodologies. Thus, the current work introduces a hybrid paradigm called NFC-TSA, which stands for neuro-fuzzy controller and tunicate swarm algorithm. Comprehensive field vibration experiments provided the reliable database utilised to train and evaluate the model. To develop the model's precise prediction objective, displacement amplitude was used as an output index. Several parameters impacting the foundation bed, geocell reinforcement, and dynamic excitation were considered as input variables. Existing methods, ANN-EHO, JSA, MOA, RNN, and ANN-MGSA, were compared to the NFC-anticipated TSA's accuracy.

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INTRODUCTION

Engineers are under a lot of pressure to improve weak or soft soils because of the shortage of high-quality development sites brought on by growing urbanization. Soft soils can be strengthened using geosynthetics. A three-dimensional geosynthetic that provides confinement is called Geocell (Sheikh & Shah, 2020). The geocell's honeycomb design reduces the foundation material's lateral mobility. When building a pavement, Geocell can help with better drainage, fewer settlements, increased bearing capacity, and cheaper construction costs (Siabil et al., 2020; Kolathayar et al., 2020). By acting as a stiff mat and dispersing the traffic loads across a larger subgrade area, the soil-geocell composite layer increases the subgrade's capacity to support loads. According to research, geosynthetics can increase pavement service life, reduce foundation thickness for a given design life, and postpone rutting development (Sridevi et al., 2019; Irshad & Khilji, 2022). According to reports, placing the geocell at the base and subgrade interface improves performance. However, it was said that the design pavement thickness was crucial and could not be compromised (Biswas & Sarkar, 2022; Kolay et al., 2021). By crossing the vertical strain envelope of the performance test stress-strain curve with the vertical stress generated by the dead load, it is possible to determine the vertical strain in a geocell (Vismaya et al., 2022). The estimated vertical strain is first multiplied by the height of the abutment or wall (Sheikh et al., 2021) to determine the vertical settlement. Machine learning (ML) modeling techniques have rendered many previous procedures obsolete as a result of significant advancements in artificial intelligence (AI) and the development of powerful computer systems (Chatterjee et al., 2022; Mahima & Sini, 2022). The study used AI/ML technologies to forecast where Geosynthetics will end up. Thus, a system that can anticipate the settling of the Geosynthetics soil foundation intelligently and with more accuracy is needed, avoiding all the upfront assumptions and drawbacks frequently associated with conventional methodologies (Alsultan et al., 2022a; Mohammed and Alsultan, 2022).

Few researches have been done on the enhancement of dredged marine sand by the inclusion of geosynthetic materials, according to a study of the literature (Alsultan et al., 2022b; Kaur & Tiwari, 2018). The current study has filled this gap. Geosynthetic materials are frequently used in this reinforcing technique to dramatically enhance the behavioral and mechanical characteristics of soil (Mahima & Sini, 2021). The cost and ease of installation of geosynthetic material are both fair (Deshmukh et al., 2023). Geotechnical experts would want to employ it in reinforced soil due to its high performance (Alsultan and Awad, 2021; Kaur & Tiwari, 2021). The use of dredged dirt as a subgrade in unpaved roads has been investigated by Sheikh & Shah (2020) using a static plate loading approach. Geocell, a geosynthetic material with three-dimensional connections, is utilized to improve the base course's structural qualities (Mehta et al., 2023). Many studies have been done on planar geosynthetic reinforcement, but few studies have been done on three-dimensional geocell reinforcement. Comparing reinforced and unreinforced bases, reinforced bases have demonstrated clear benefits (Sheikh et al., 2021; Kaur & Tiwari, 2020). Locally, it is simple to find two different sorts of garbage: crushed quarry waste and dolomitic limestone. Static plate load studies were carried out to ascertain the increase in bearing capacity and the vertical stress distribution for three different base thicknesses at three different geocell heights (100, 125, and 150 mm) (120, 150, and 170 mm). Fakharian & Pilban (2021) performed pullout experiments using geocells with diagonal enhancements implanted in sand to enhance the load-deformation response to large planar tensile loads. Extensive pullout testing on scaled geocells embedded in silica sand can be used to determine how changes to load-deformation response, strength, and stiffness may affect these properties (Kiran Sagar Reddy et al., 2023). As a result, when subjected to tensile tensions along the