Study on the Factor Contribution of Micropile Pullout Resistance

A THESIS

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Declaration by the Research Scholar

This is certified that the thesis entitled **"Study on the Factor Contribution of Micropile Pullout Resistance"**, submitted by me to the Indian Institute of Technology Mandi for the award of the Degree of Master of Science (by research) is a bonafide record of research work carried out by me under the supervision of **Dr. Venkata Uday Kala**. The content of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any Degree or Diploma.

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Declaration by the Research Advisor

This is certified that the thesis entitled **"Study on the Factor Contribution of Micropile Pullout Resistance"**, submitted by **Tejinder Thakur** to the Indian Institute of Technology Mandi for the award of the Degree of Master of Science (by research) is a bonafide record of research work carried out by him under my supervision. The content of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any Degree or Diploma.

Signature:
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ABSTRACT

In Himalayan region, the inaccessible and steep slopes form the hindrances for construction of the foundation for structures like transmission line towers, snow barrier, snow net fence, guided structures and wind turbines which have to resist uplift loads. In such circumstances, micropile is found to be very effective solution due to its ease of installation at difficult sites in urban and mountainous areas. The performance of micropile is highly influenced by multiple parameters even when installed in similar ground conditions. The critical review of literature states the effectiveness of the micropile pullout resistance depends on various design factors as pile embedment ratio (L/D), diameter (D), surface characteristics of the pile (shape, roughness, soil-pile friction angle δ), method of installation and the soil properties (unit weight of the soil γ, shear strength parameters c, ϕ). However, limited studies bring out the factor effects and their contributions.

The current research work elucidates the multi-parameter experimental study in a test pit of dimension 2.5m (width) × 6m (length) × 2.5m (depth) filled with fine sand, hosting cement grouted micropiles having L/D ratio of 10, 20 and 30 and diameter of 40, 50, 60mm. The factors used in this study comprises of L/D ratio, diameter, unit weight of soil, grouting pressure, grout flow rate and grout material with each factor having different levels. Taguchi method has been adopted in order to optimise the number of experiments by design of experiments and further obtaining optimum levels for the factors and percentage contribution/influence of each factor. The major focus was to maximise the ultimate uplift load and minimise the corresponding vertical displacement, thereby achieving optimum performance of the micropile. Further for a better understanding of soil-structure interaction, the roughness generated on the interface is studied by direct shear tests to analyse the interface skin friction by using different roughness of abrasive paper with the soils.

The obtained results show the dominance of L/D ratio and diameter on the pullout resistance of micropile. The optimum levels obtained for each factor reveal that the increment of level for factors, L/D ratio, diameter, grouting pressure and unit weight increases the uplift capacity. The pressure grouting enlarged the diameter of the pile by pressurizing the inner surface of the borehole. This resulted in increasing the surface roughness and bond strength at the interface and thus increasing the overall pullout capacity of the micropile. Further, the interface studies reveal that interface parameters adhesion (c_a), and interface friction (δ) are the function of surface roughness of the interfacing member with the soil.

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