Abstract of PhD Thesis Submitted by Amit Jain (2016CEZ8434)

Behavior of Rock-Socketed Piles under Axial Static and Cyclic Loading

Significant development on infrastructural growth happens in India recently among the various infrastructural sectors such as tall buildings, longest span bridges in high altitude regions (like Chenab bridge), transmission towers and deep basement walls etc. These structures may demand deep foundations for transferring heavy vertical compressive loads, lateral/moment loads and uplift loads at the project sites with poor soil conditions coupled with shallow bed rock levels. When soil cover at these sites is very shallow thick and poor, large magnitude of loads acting in different directions, pile foundations used for supporting these structures may need be socketed into weathered rocks to even hard rocks. The loads coming on these structures and eventually to the rock-socketed piles may act cyclically and dynamically depending on the nature of loading conditions and project locations in seismically active regions. Under such circumstances, it is imperative to understand the response of piles socketed into rock under cyclic and/or dynamic loading as well and design the piles accordingly, in addition to designing those pile for static loading.

In this study, a comprehensive experimental program is designed involving testing of model rock-socketed piles embedded in synthetic weak rock conditions under both static and cyclic axial loading. Model aluminum piles were instrumented to measure the axial strain along the pile length. Synthetic rock blocks were casted considering the different cement-sand mix ratios (1:6 (SR16) and 1:8 (SR18)) which are targeted to simulate weak and soft rock conditions. 72 model experiments (36 static loading tests and 36 cyclic loading tests) were carried out on model pile having of *L/D* ratios: 6, 9 and 12, indicating different socketing length of piles. In static loading tests, the tests were carried out under different rate of loading by varying the strain rate. The vertical load-settlement response was measured from the static loading tests. It is found that the load carrying capacity of rock-socketed piles increases with an increase in strain rate. The axial pile capacity values were estimated as per IS code formulae and the values are found to have close agreement with the measured axial pile capacity values under static loading. Cyclic loading tests were conducted by varying different frequencies of loading and Cyclic Loading Ratio (CLR=0.25 and 0.50). The static load ratio (SLR) was maintained in all cyclic loading tests. The accumulated settlement is found to increase with cyclic loading and the effect is prominent upto 100 number of cycles, beyond which the further increase in cyclic settlement is insignificant. The frequency of loading, socketing length and cyclic loading ratio is found to affect the settlement of rock-socketed piles; however, a detailed further study is needed simulating wide range of rock conditions and loading conditions.

Numerical analysis of model-scale dimensions of rock-socketed piles subjected to static and cyclic loading was performed using finite element software, *Plaxis*3D. The model aluminium pile was modelled to behave as linear elastic material using an embedded beam element. Synthetic rock was idealized as a nonlinear material assuming elastic perfectly plastic behavior, using Mohr-Coulomb criterion. Boundary conditions were modelled as per the conventional conditions. The procedures of numerical analysis adopted for studying the response of rock-socketed piles under combined loading was validated using the present model experimental data. The numerical analysis carried out is able to predict the response of piles socketed in weak rocks under static and cyclic loading with a very good accuracy. Numerical analyses were also carried out considering the prototype dimensions of rock-socketed pile and actual rock conditions/properties. Numerical analysis using even the simple Mohr-Coulomb criterion is able to predict the response of rock-socketed pile in weak rock under axial static loading., However, the predicted response of rock-socketed pile under cyclic loading seems to have more error using such simple Mohr-Coulomb criterion. Further work is needed analysing the response of rock-socketed piles under cyclic loading.