In an effort to develop an expert system for the design of pile foundation, 4809 simulations of pile foundations were carried out using Finite Element Method (FEM) on soil types with wide range of unit weight, poisson ratio, modulus of deformation and shear parameters. The corresponding unit skin friction ($r_s$) and unit tip bearing capacity ($r_t$) values were calculated. This input and output data of FEM was used for the development of an artificial neural network (ANN) with 20 hidden neurons. A significantly high value of coefficient of determination ($R^2$) averaging 0.99996 was achieved for the ANN during training, validation and testing stages indicating a high performance network. The skin friction depth factor ($D_{sf}$) and end bearing capacity depth factor ($D_{eb}$) which gives the variation of $r_s$ and $r_t$ with depth were calculated by FEM. Pile loading test is considered to be the most reliable method for the determining pile load capacity. In the present study, 50 case histories of bored cast-in-place piles were studied. The information regarding soil profile, cone tip penetration resistance ($q_c$) and pile loading test results for all the pile case histories was gathered from the literature. The soil parameters were calculated from $q_c$ by use of correlations obtained from the literature. The developed ANN was simulated to calculate $r_s$ and $r_t$ from soil parameters of a pile. The direct method was also developed to determine $r_s$ and $r_t$ from $q_c$ and soil type. The values of $r_s$ and $r_t$ so found were improved by using pile loading case histories data and multiple regression technique. The ultimate load carrying capacities of piles under study were then calculated by ANN and compared with the actual load taken by piles through field pile loading tests in case histories under study. It has been observed that the ultimate load carrying capacities of most of pile case histories computed by ANN did not match with the values computed by pile loading tests. Hence the correlation factors were calculated for the correct prediction of the load carrying capacity of pile using ANN. Two correlation factors i.e skin friction correlation factor ($C_{sf}$) and end bearing capacity correlation factor ($C_{eb}$) were calculated. This was done by comparing $r_s$ and $r_t$ obtained from ANN and those obtained from direct method involving $q_c$ and soil types. The relationship between the correlation factors and soil parameters was found
using nature inspired techniques namely Particle Swarm Optimization (PSO), Firefly algorithm (FF), Cuckoo Search (CS) and Bacterial Foraging (BF). The PSO has also been found to be more efficient in terms of time taken and has attained higher value of coefficient of correlation with field pile load capacities. Hence, it can be concluded that PSO algorithm is the most suitable algorithm for the optimization of pile foundation design in a constrained environment. Using correlation factors, the target data of ANN is modified to develop revised ANN. The product of output of revised ANN and depth factor performs better than available methods for prediction of \( r_s \) and \( r_t \) for bored pile foundation. The closed form solution has also been given. The comparison of the proposed ANN method with conventional direct methods has shown considerably better results. The best mean value of \( Q_{up}/Q_{um} \) equal to 1.044, the minimum standard deviation of \( Q_{up}/Q_{um} \) equal to 0.1619 and the maximum value of coefficient of correlation of \( Q_{up}/Q_{um} \) equal to 0.9821, is given by proposed method when compared with direct methods. The comparison demonstrates that the suggested method is significantly accurate than direct CPT methods.