

## SYNOPSIS

The problem investigated is the rotational failure of long shallow footings due to the action of static and dynamic loads which induce a turning moment on the footing. Eccentric, oblique and horizontal loads are the common types of loads which cause a turning moment on the footing. Unlike central vertical loads which tend to punch the footing into the soil, the above mentioned loads may rotate the footing about an axis, thus creating a different mechanics of failure.

In practice, structures are often acted upon by eccentric loads; wind loads act horizontally; the earthquake pulses act as a horizontal dynamic load at the centre of gravity of the structure. It has been observed that structures under the action of such loads fail by tilting.

A review of the existing literature indicates that most of the present theories on bearing capacity are essentially based on the concept of punching failure. The pioneer workers Prandtl (1920) and Tezaghi (1943) have based their theory on such a concept. Krey (1939) in his theory based on punching failure has considered a one sided failure pattern. This theory may perhaps be applied to rotational failure problems. Skempton (1951) has

extended the basic bearing capacity formula for purely cohesive soils to cover a more general case of foundations with surcharge. Meyerhof (1948-68) has done an extensive study of the problem of bearing capacity covering all types of practical variables. Brinch Hansen (1961) has generalised the Terzaghi equation of bearing capacity to incorporate the influence of the various parameters affecting the bearing capacity in the form of inclination, depth and shape factors. Meyerhof and Brinch Hansen have also suggested empirical methods of taking into account the eccentricity of loads.

The problem of dynamic bearing capacity has created interest in research workers and designers during the last decade when the performance of foundations under transient loads engaged the interest of the engineering profession. In this field Triandafilidis (1965) has made an analytical study based on the concept of rotational failure. The analysis is applicable only to purely cohesive soils. The work by Wallace (1961) in this field is based on punching failure.

It has yet to be verified experimentally whether with the help of these theories and methods of calculation, the static and dynamic bearing capacities of a footing under rotational failure could be predicted. A detailed experimental investigation and subsequently an analytical study is therefore undertaken.

The two aspects of the problem - the static and dynamic bearing capacities - are studied separately and presented in Part I and Part II of the text. The problem is first analysed under static loading conditions and subsequently under dynamic loading conditions.

Under static loading, an exploratory test programme is carried out to check whether the rotational failure problem could be explained with the help of the existing theories and empirical methods of calculation. A special loading rig by which a rotational failure could be induced in a footing is fabricated locally. By a series of tests, the failure pattern and the failure load are determined. A comparison of these with the existing theories indicated the unique nature of the rotational failure problem. The failure pattern and failure load were found smaller than those predicted by the existing theories and calculation methods especially in the case of highly frictional soils.

A detailed experimental programme with the different variables changed is therefore carried out. From the results of about 175 tests it was possible to establish the failure pattern under rotational failure. Based on this failure pattern, a rational method of calculation is developed to compute the bearing capacity of footings under rotational failure for any position of the axis of rotation.

The position of the axis of rotation for free rotation conditions is determined, and the derived equations are transformed to give the corresponding bearing capacity. The validity of the derived equations is ascertained by comparing the calculated results with the experimental ones.

A series of field tests under static loading is conducted to check whether the suggested method of calculation, based on the laboratory observations are applicable to field conditions. A close agreement was found between the predicted and measured failure loads in the field tests.

Under dynamic loading conditions a series of 90 exploratory tests are conducted with different types of loads and other variables changed. From the observations made the failure pattern under dynamic loading is determined. A few measurements of load are also taken to check whether the existing theories could predict the dynamic bearing capacity under rotational failure. Since it was found that the dynamic bearing capacity under rotational failure is smaller than that given by the existing theories in the case of frictional soils, an analytical study is taken up.

Based on the observed failure pattern, equations are derived to calculate the dynamic bearing capacity. The calculated results are verified by a detailed series of 18 controlled tests, in which the predicted load is compared with the measured one.

A simple design technique of a long shallow footing subjected to both static and dynamic loads is presented.

Based on the analysis of the experimental and calculated results certain definite conclusions are arrived at, a summary of which is presented in the text.

The present study is distinct from the earlier works on the bearing capacity problem in respect of the failure criterion. In the experimental investigation a rotational failure is induced in the footing. This aspect is considered in the analytical study also. The problem is analysed making use of a wide range of loading conditions - ranging from static to dynamic loads - and also considering the effect of various parameters influencing the bearing capacity, thus allowing one to make general conclusions regarding the rotational failure of footings. The design technique given is simple and is based on the derived equations, the validity of which is ascertained experimentally under laboratory and field conditions.