Journal of Engineering and Applied Sciences 2 (12): 1693-1696, 2007
ISSN: 1816-949X

Determination of the Effect Point and the Lateral Friction Effect of a Pile under Static Loading

[1]M. Meksaouine and [2]H. Benyaghla
[1]Département d'Hydraulique, Université Badji Mokhtar, Annaba, Algérie
[2]Département de Génie Civil, Université du 8 Mai 45, Guelma, Algérie

Abstract: The theoretical study, presents milked of a problem of interaction ground-structure, thus making it possible to bring a contribution in the determination of the effect of point and the effect of lateral friction for isolated solicited piles in static loading. The theoretical tool used is the kinematic theorem of the theory of the limit analysis, in the case of a material of Coulomb, by developing a model in three dimensions.

Key words: Piles, statique loading, effect point, lateral friction effect, cinématique, limit analysis

INTRODUCTION

We propose to contribute to enrichment of knowledge which results from several centuries on the piles, tie profit of a tool which up to now was little exploited in this field; the theory of the limiting analysis using the kinematic theorem which can deal with very complex problems in the space of massive soil. This research is devoted to a brief presentation of the method of the calculation of rupture (or limit analysis) and to the calculation of the limiting load of an insulated pile. We propose two mechanisms or models in three dimensions (in axisymetry), respectively for smooth pile and rough pile, with the use of the kinematic theorem of the limiting analysis.

CALCULATION IN THE BREAK

Calculation has the rupture has the aim of determining a field of potentially bearable loads for a structure whose loading depends on a finished number of parameter: it does not enter in its applications of research to know the state of the constraints and deformations of the ground on a level of requests given since it only aims at framing a field, it uses a criterion of rupture and not a law of behaviour. This is of a great convenience considering the difficulty in working out such a sufficiently realistic law. The stability of a configuration can't be established by the calculation of the rupture only with the help of severe assumptions on the material (the principle of normality of Hill, 1950) which we will not make. In the space of the loadings the field of these loads is convex and contains the null loading. Every loading located apart from the field will involve the ruin of the system. But a loading in the field could be described only as potentially bearable. For the framing of the edges of the field, the two steps approaches by the interior and approaches by outside are complementary. The first, known as static approach, is done in the direction of security. It consists with exhibit a statically acceptable stress field and to express that it satisfies the criterion of rupture. A certain number of studies were made on this subject so much for the mediums purely coherent (Davis *et al*., 1980) that for the rubbing mediums (Mulhauss, 1985). The smoothness of the approach is dependent on the intuition of the researcher and his capacity to carry out the best compromise between a realistic field and realizable analytical calculations. Work previously quoted was the experimental validation object and showed that it approached reality suitably. The second approach is known as kinematics. Among others, the preceding authors applied it to the cavities of the purely coherent grounds (criterion of rupture of TRESCA), like for the rubbing mediums of other work using the criterion of COULOMB (Meksaouine *et al*., 2000). Indeed, in the latter the increase of the dissipated power is sometimes explicit the field speed considered. We thus propose to develop such an approach, in the case of the criterion of rupture in this simplified case (Criterion of COULOMB) and to see up to what point it is exploitable for the determination of the effect of point and the effect of lateral friction for isolated solicited piles requested in static loading.

Corresponding Author: M. Meksaouine, Département d'Hydraulique, Université Badji Mokhtar, Annaba, Algérie

STATEMENT OF THE METHOD AND THE CHOICE OF THE CONFIGURATION

Approach kinematic for a coherent medium rubbing the kinematic approach: The kinematic approach (superior limit) of the calculation of rupture is based on the design of virtual mechanisms of rupture. Inspired by the forms of the collapse observed on small-scale models. It makes it possible to build an approach by the outside (i.e., excess) of the field of stability. The condition necessary of stability is obtained for each mechanism by writing that the P ext power of the external efforts in the mechanisms considered cannot exceed the maximum resistant power P_{max}^{res} corresponding.

$$P\ ext < P_{max}^{res}$$

The quantity P_{max}^{res} is a functional calculus of the virtual mechanism considered and it depends only on material. It physically represents the maximum power that the massive is able to develop in the mechanism considered, because of its capacities of resistances.

MECHANISMS OF RUPTURE AND HYPOTHESES OF CALCULATION

We will develop two three-dimensional mechanisms of rupture corresponding, respectively to a pile smoothes (for $\delta < \varphi$, Chen, 1975) and with a rough pile (for $\delta = \varphi$, Chen, 1975).

The common hypotheses of calculation are as follows:

- A coherent ground rubbing, limited by a horizontal free face.
- A pile smooth or rough, vertical, subjected to static loading, constant speed.
- A mobilization of the ground in thrust, reaction to the loading, with field speed kinematically acceptable allowing calculation according to the kinematic method or principle of the superior limit.

The awaited result is the determination of the effort of loading P of the pile causing the rupture of the ground medium, for various cases of roughness of the pile shaft.

Smooth pile: The mechanism of rupture for pile smoothes is composed of two blocks in symmetry of revolution (ABC) and (BDEC) around the axis of the pile, which slide one on the other thanks to a field speed kinematically being resulted with, respectively in V_1 and V_2 (Fig. 1).

This mechanism makes it possible to find the value of the load P as referred to above, than we will not pay here.

Rough pile: The mechanism for rough pile is composed of two complementary mechanisms of rupture (Fig. 2). Each one is a whole of blocks:

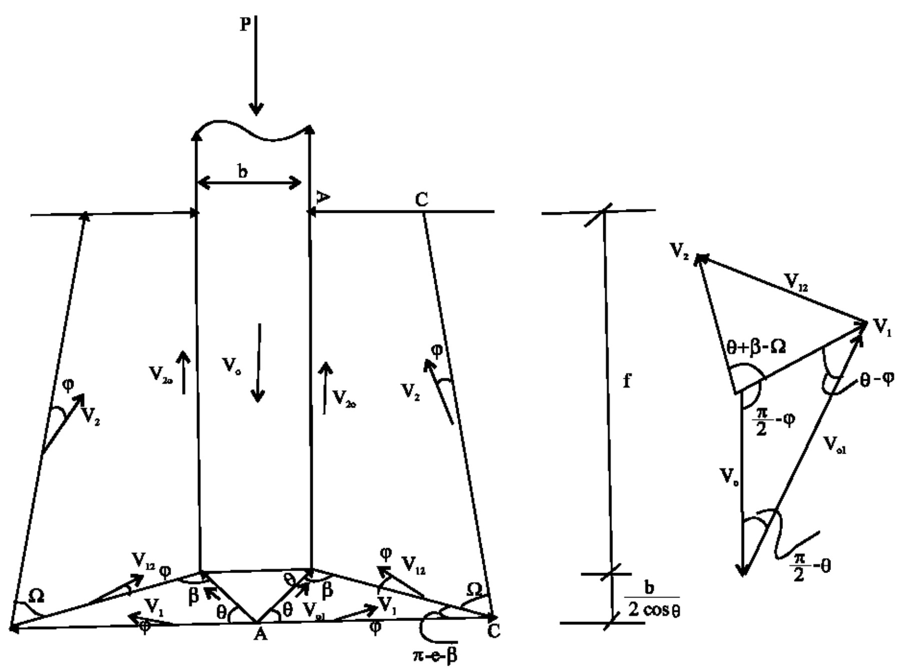

Fig. 1: Cut of mechanism for pile smoothes ($\delta<\varphi$) and speeds diagram

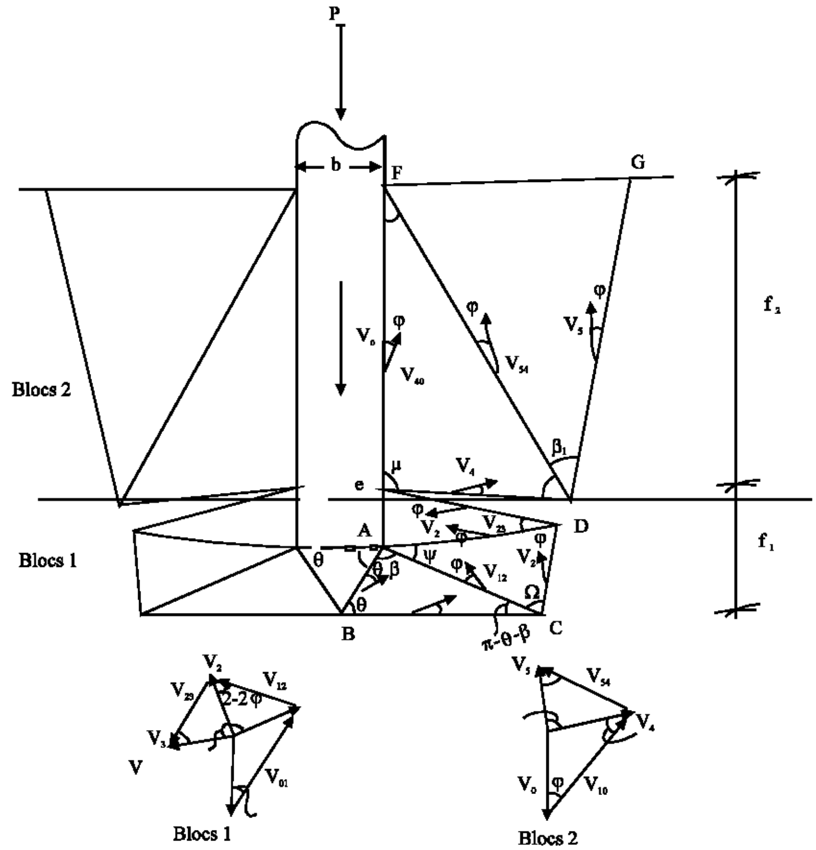

Fig. 2: Cut of mechanism for rough pile (δ = φ) and diagrams speeds

- The first with three blocks (ABC), (ACD) and (ADE) in symmetry of revolution around the axis of the pile, which slide one on the other thanks to a field speed kinematically being resulted with, respectively in V_1, V_2 and V_3.
- The second with two blocks (EDF) and (FGG) in symmetry of revolution around the axis of the pile,wich slide one on the other thanks to a field speed kinematically being resulted with, respectively in V_4 and V_5.

This mechanism makes it possible to find the value of the load P as referred to above, than we will not pay here.

EXPERIMENTAL COMPARAISONS AND CHECKS

According to the tests carried out by Kerisel (1964), this last indicates that the effect of point is of six to seven times more important than the lateral friction. What can explain the mechanism for smooth pile (Fig. 1), where friction is not really taken into account. Certain authors, indeed, consider that it is advisable not to take into

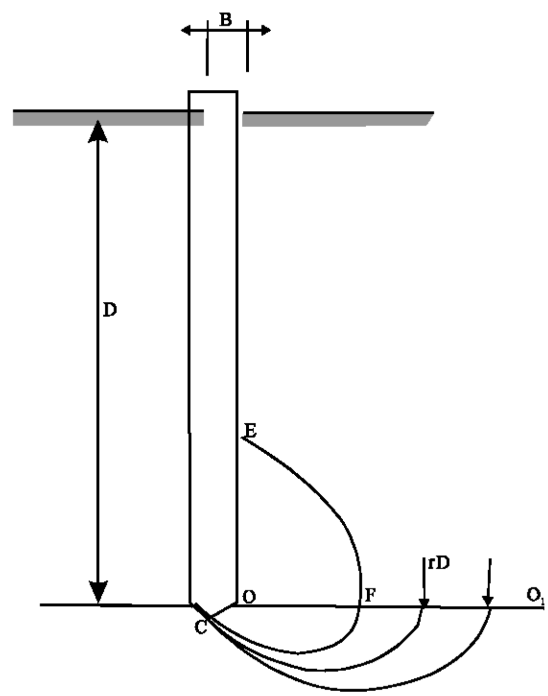

Fig. 3: Lines of slip resulting from point (Kerisel, 1964)

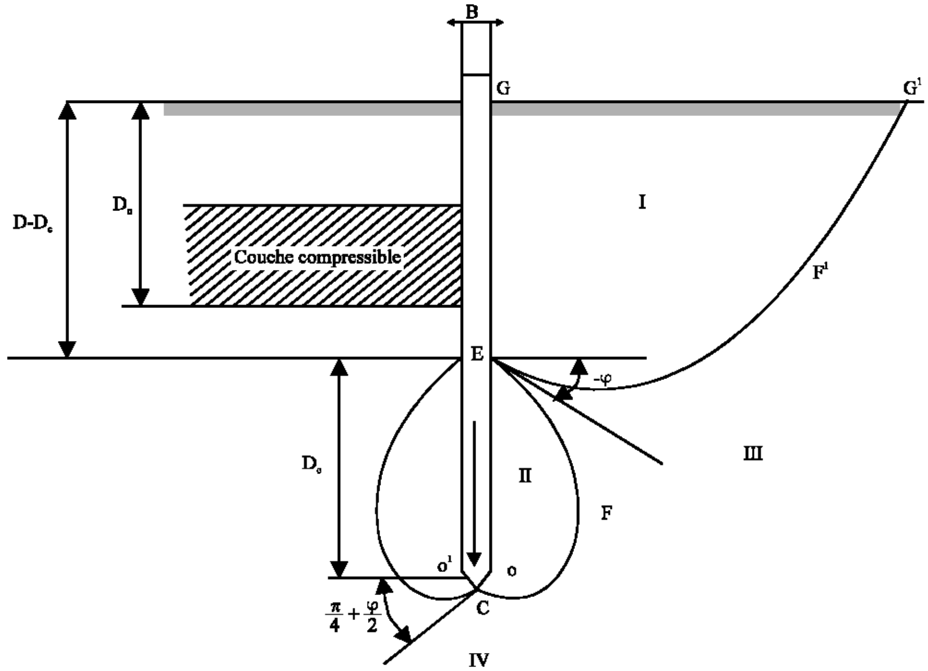

Fig. 4: Diagram of working of pile (Kerisel, 1964)

account the lateral friction on the height of reversal of the lines of slips, because he estimates that the ground is already mobilized by the point and in a state of ultimate equilibrium (Philipponat, 1979).

In calculations of the soles, one admits that the lines of slip stop on level OO1 (Fig. 3). And there is no reason for the lines of slip do not continue a point beyond and on the barrel itself according to a line such only CFE are not turned over (Fig. 3).

One can admit in a diagrammatic way, that the lines of slip which reign around a pile divide the medium into four zones (Fig. 4):

- Zone I, corresponding to lateral friction along the barrel, where the medium is in balance of quasi-thrust.
- Zone II, corresponding to the effort of point, where the medium is in balance of thrust.
- Zone III et IV, located beyond the lines of slip. The medium is not there in plastic balance, but pseudo-rubber band. We can see, here, that the mechanism for rough pile has a very great resemblance to the diagram of Fig. 4.

CONCLUSION

We can already admit that:

- Although our models or mechanism is still to perfect, there is all the same a great resemblance to reality.
- In the case where the pile is smooth, the lateral friction is not taken into account, although the effect of point is dominating.
- We find the mechanism for rough pile exactly, with Fig. 4, with in more the bulb of the effect of point going up on a part of the pile shaft.

REFERENCES

Chen, W.F., 1975. Limit analysis and soil plasticity. Amsterdam: Elsevier, pp: 637.

Davis E.H., M.J. Gunn, R.J. Mair and H.N. Seniviratne, 1980. The stability of shallow tunnels and underground openings in cohesive material. Geotechnique, 30: 397-419.

Hill, R., 1950. The mathematical theory of plasticity. Oxford: Clarendon Press, pp: 356.

Kerisel, J., 1964. Deep foundations basic experimental facts. Deep Foundations Conference. Mexico,

Meksaouine, M., P. Regenass, R. Kastner, A.H. Soubra and Y. Bourdeau, 2000. Etude de la butée sur un écran de largeur limitée en sol frottant. Revue Française de Génie Civil, édition Hermes, 4: 543-575.

Muelhaus, H., 1985. Lower bound solutions for circular tunnels in two or three dimensions. Rock Mech. Rock Eng., 18: 37-52.

Philipponat, 1979. Fondation et ouvrages en terre. Eyrolles, Paris.