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Comments by the Author of the Introductory Report

Remarques de l'auteur du rapport introductif

Bemerkungen des Verfassers des Einführungsberichtes

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Foundation Structures for Tall Buildings

This presentation in Working Session IV concerns the foundation structures for tall buildings. In the writer's Introductory Report (Ohsaki 1976), he has pointed out a number of problems associated with design of foundations for tall buildings.

The first problem is the heavy weight of a tall building which requires large bearing capacity of supporting soil stratum. Bearing capacities of sand stratum, gravel stratum, or heavily over-consolidated clayey stratum are usually in the range of 150 to 400 tons/sq.meter, as shown in Fig.1, allowing the

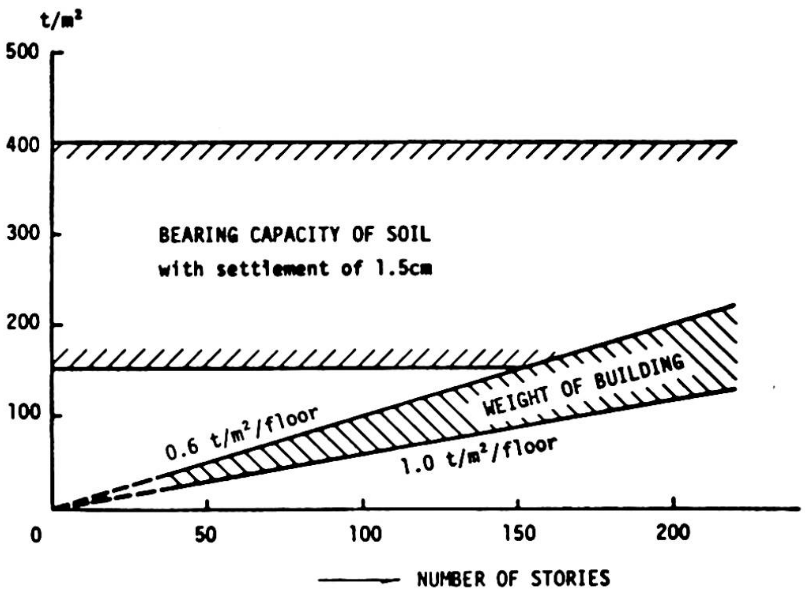

Fig.1

settlement of approximately 1.5 centimeters. On the other hand, unit weights of tall buildings of typical, steel construction are estimated to be in the range of 0.6 to 1.0 tons/sq.meter/floor. Therefore, the total weights of buildings are in the triangular range in Fig.1, which shows that there is no serious problem in foundation design, if soil stratum of such strength can be encountered within the depth of a building basement.

If such stratum is located at a certain depth below the base of a building, a pile foundation can be used and, fortunately, no fundamental problem has been met so far in performance of pile foundation. The application of floating foundation may also be possible, which balances the weight of building and the weight of excavated soil so that no additional load would be applied to the supporting soil stratum. It is possible theoretically up to the building of approximately 40 stories; however, it seems that there has been no experience of applying the idea of floating foundation actually to high-rise buildings.

The second problem is the effects of wind force. As shown in Fig.2, when a building is subjected to wind force, the overturning moment causes an increase

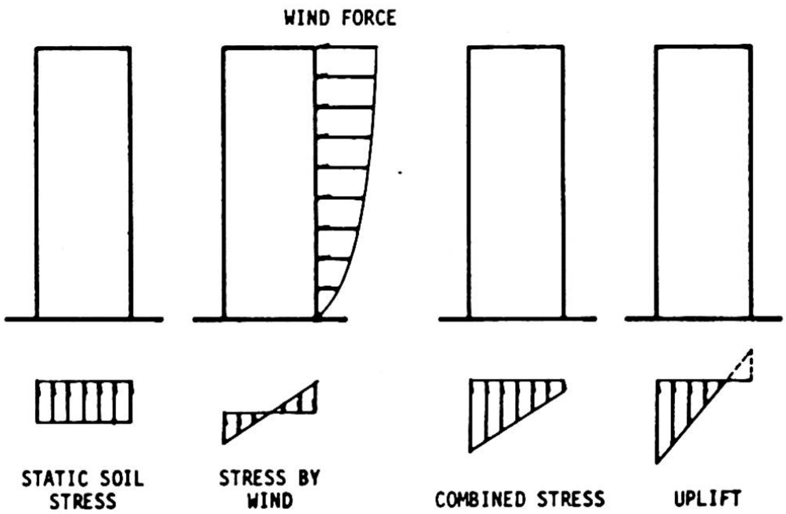

Fig.2

of soil reaction stress on one side and a decrease on the other side. Usually, as the combined stress is within twice the static stress, if Fig.1 is again considered, there would be no danger of failure of supporting soil. If overturning moment increases still more, uplift takes place as also shown in Fig.2, which indicates a tendency to make the structure unstable. However, the uplift can readily be prevented by providing setback as shown in Fig.3 and, when the setback can not be provided, anchoring shown in Fig.3 may be an effective way, but it has not been actually utilized for tall buildings up to the present time.

In a foundation slab, the outer part shaded in Fig.4 is most effective to resist the overturning moment, while the middle part is not so effective mechanically. Moreover, if permanent settlements are produced beneath the edge of a foundation slab under repeated wind loadings, the presence of the middle part is rather harmful causing the so-called riding effect, which will accelerate the rocking motion of the superstructure. In consideration of these and other facts, Schlaich and Otto suggest an idea of ring foundation for a tower structure, and describe in detail many examples of their design experiences of actual tower structures in their Preliminary Report (Schlaich & Otto 1976).

The last problem is the effects of seismic forces. In Japan of extremely high seismicity, seismic forces are usually larger than wind forces for typical buildings of less than approximately 50 stories. However, as a general shape of acceleration response spectrum in Fig.5 indicates, the earthquake input to tall and flexible buildings is rather small when compared with low and stiff

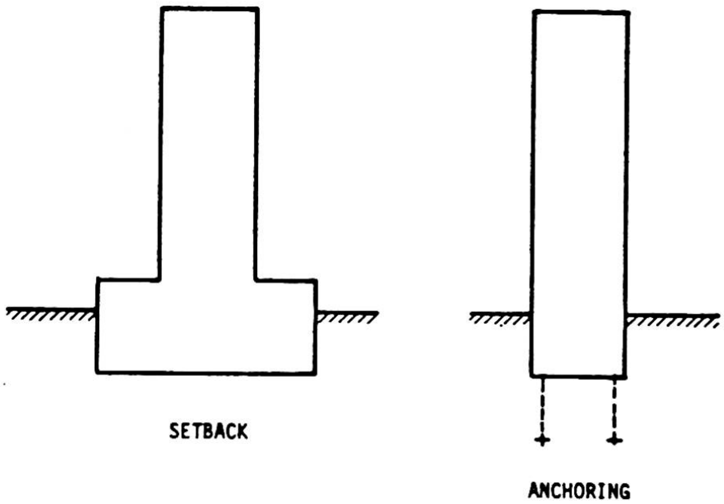

Fig.3

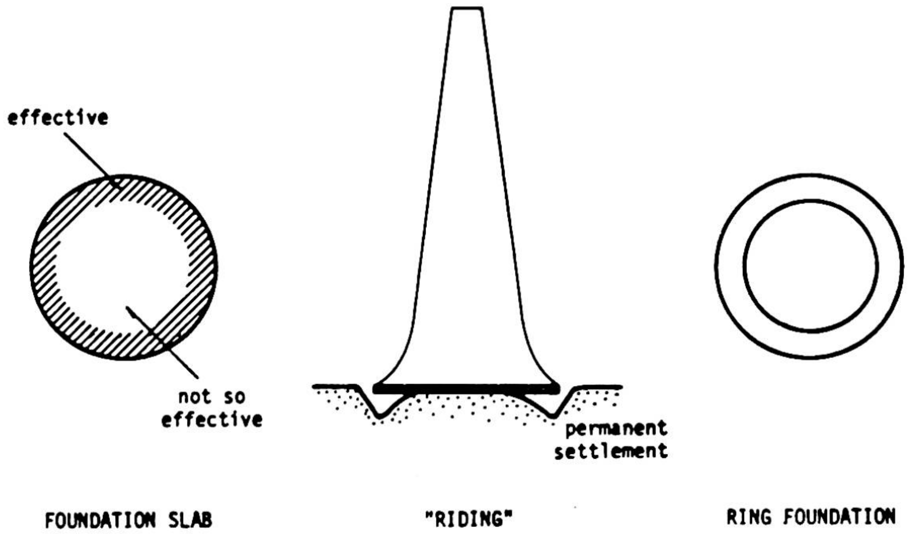

Fig.4

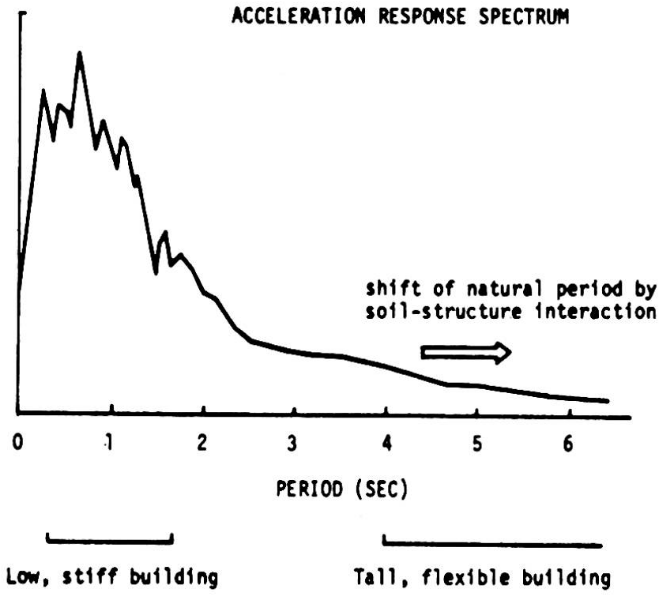

Fig.5

buildings. Moreover, the effect of soil-structure interaction tends to still reduce the input force, although the interaction effect is not important in general for flexible buildings.

In conclusion, there may be several problems in foundation design specific to tall buildings, they will not be of great difficulty to overcome unless soil conditions are extraordinarily unfavorable.

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