ULTIMATE LIMIT STATE DESIGN OF STRIP FOUNDATION

CONCEPTION A L'ETAT LIMITE ULTIME DES FONDATIONS EN BANDE

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SYNOPSIS

A practical design procedure is suggested for geotechnical and structural ultimate limit design of a strip foundation, which is resting on frictional soil. The procedure takes roughly account of serviceability limit state by using the mean settlement of the total foundation and by using the criterion of angular distortions.

This paper is based on practical experience of the author. A light industrial building founded on silty sand is used as an example. Soil investigations and tests with large model foundations have been earlier made by Bergdahl et al. (1986). The structural sceleton of the building consists of two storey, two portal steel frames, figure 1.

The strip foundation of the frame is dimensioned in imagined ultimate limit state, when the contact pressure distribution and the soil pressure are calculated as ultimate soil bearing pressure and the acting forces of the superstructure are calculated in imagined ultimate limit state (ULS). The acting forces include the normal forces and the moments of the frame columns.

The bearing capacities are determined using the formula of Brinch Hansen and the contact pressure distribution in imagined ultimate limit state is roughly determined according to the settlement calculations of theoretically separated minimum foundations, figures 2 and 3. To obtain real knowledge of settlements an elastic-plastic empirical model law according to Horn (1970, 1972) (figure 4) has been taken into use.

Settlement calculations have been made using 3-dimensional deformation modulus E_d according to the tests of Bergdahl et al. (1986) and to the method of Schultze and Sherif (1973) based on SPT-test.

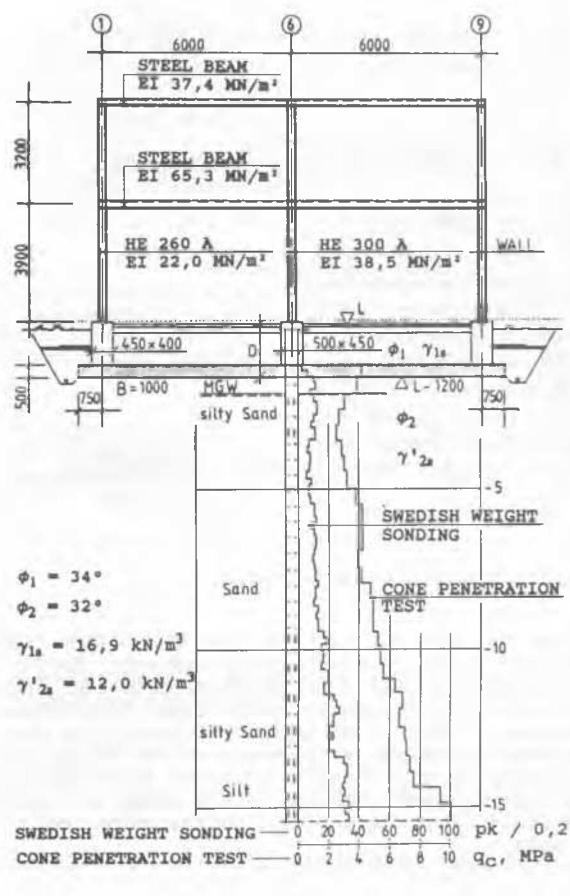

Figure 1. Light industrial building founded on silty sand.

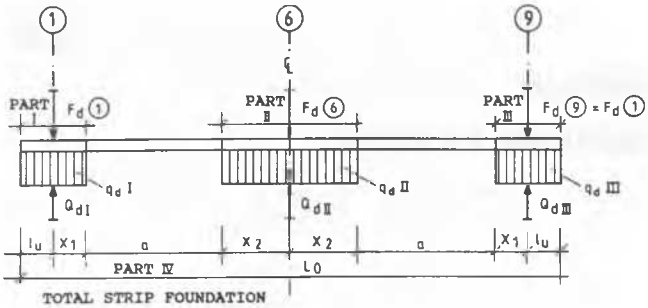

Figure 2. Total strip foundation and separated minimum parts I, II and III. Acting forces in ULS (F_d) from the superstructure and opposing force Q_d are subjected to soil pressure in ULS (q_d).

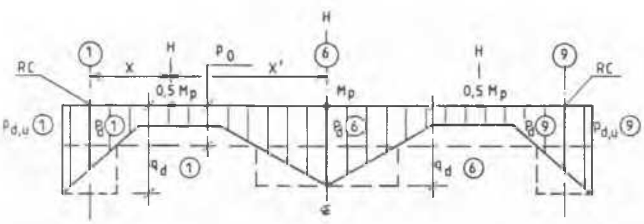

Figure 3. Contact pressure distribution (p_d), plastic hinges (H) and rotational centers (R.C.)

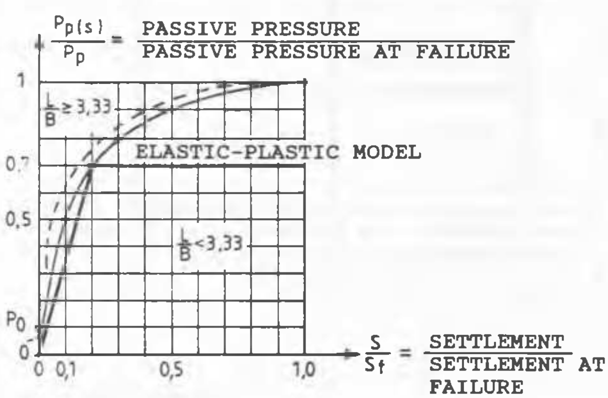

Figure 4. Elastic-plastic model.

The plastic moments (M_p) of the structure are calculated with the kinematic method. Sufficient ductility for the plastic rotation has been checked by Eurocode (1989) and FIP-Recommendations (1984). The angular distortions are calculated by using settlements which are estimated applying the contact pressure distribution in the imagined ultimate limit state divided by a safety factor according to the given building code.

Thus the settlement and the angular distortion are considered the criterion of the serviceability state. The calculated ultimate limit state moments divided by the same safety factor as earlier mentioned are close to the serviceability limit state (SLS) moments determined using the modulus of compressibility method and the modulus of subgrade reaction method. The influence of groundsoil has been analyzed in serviceability limit state by subgrade reaction method using Winkler's springs and by compressibility method with the help of Sherif's and König's (1975) tables.

The results of the moments of the foundation of the light industrial house are presented in the figures 5 - 6. The numeric results are presented in graphic form; the results deal with cases in which the fixing to the superstructure of the foundation varies from flexible to rigid.

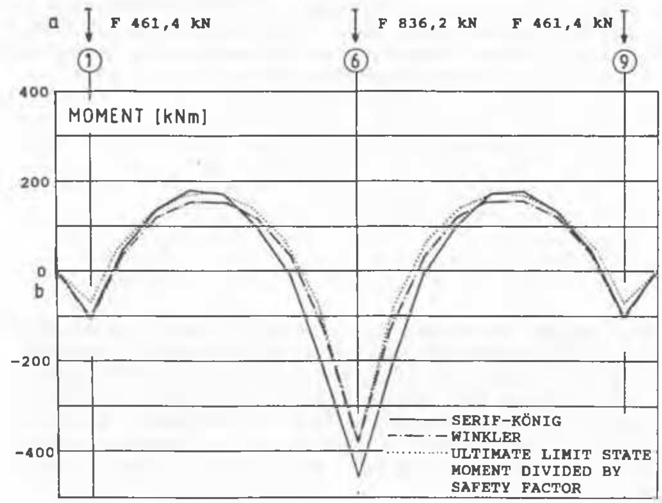

Figure 5. Strip foundation. a) Acting forces from the superstructure. b) Moment diagrams.

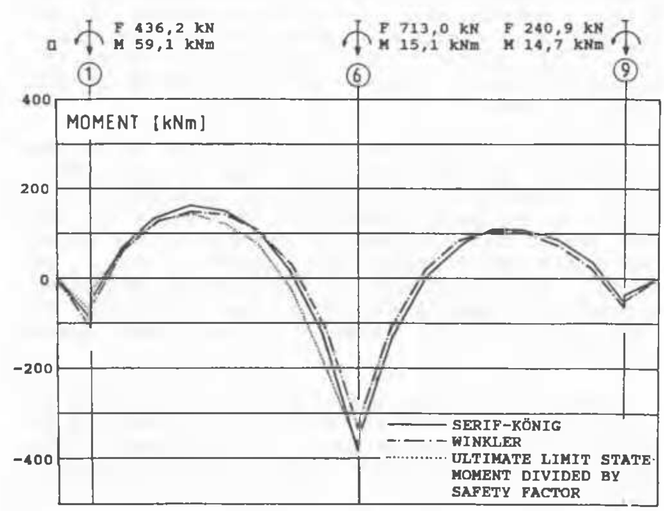

Figure 6. Strip foundation. a) Acting forces and moments from the superstructure. b) Moment diagrams.

The results show that even through the soil-pressure and the settlements received by different presumptions and theories differ from each other it has no great bearing to the design moments of the foundation.

The design procedure in geotechnical and structural ultimate limit state is explained in figure 7. Using the mentioned procedure the engineer can design the strip foundation in ULS and at he can check the serviceability in SLS at the same.

If the engineer makes a rough supposition that the soil pressure is devided as an unity to the total length of the strip foundation, it leads to the overdesign in the strip foundation of just from 50 to 80 per cent.

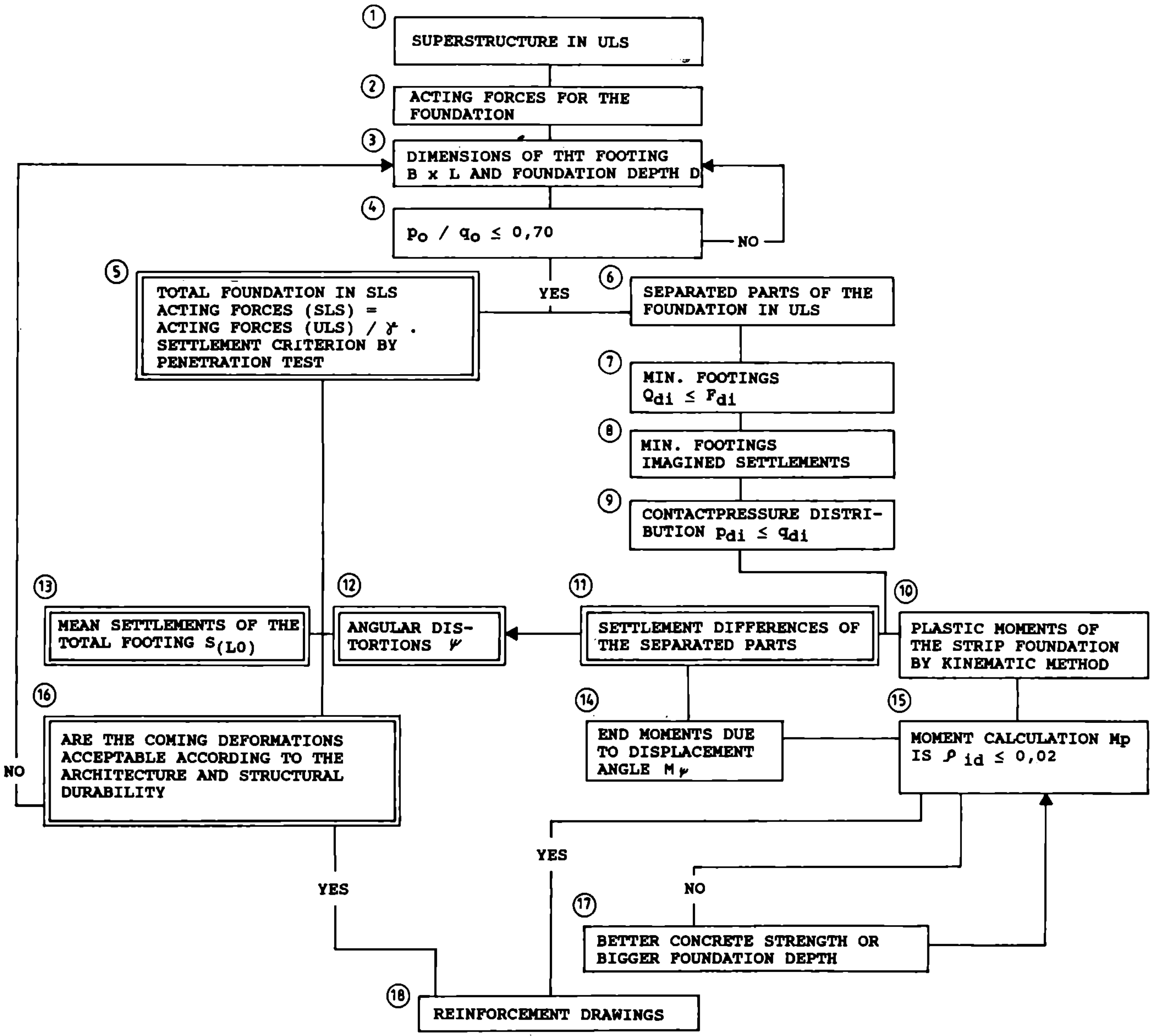

Figure 7. Geotechnical and structural design procedure in ULS for strip foundation. Double line of the box means serviceability state (SLS).

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