

## HOW TO PROCEED TO DESIGN FOUNDATIONS SUMMARY

- 1.** Study the structural system, dead loads, live loads, earthquake, wind loads (study the load groups), calculate column loads, moments
- 2.** Select a trial foundation system, size, depth etc.
- 3.** Calculate total (gross) and net foundation pressures
- 4.** Study the site investigation report, borehole logs, field tests (SPT, CPT, PM etc.), laboratory tests (index and engineering properties), and decide on an idealized soil profile together with all soil properties
- 5.** Calculate the ultimate bearing capacity of the soil for the trial foundation making use of B.C. formulas. Apply a factor of safety (2.5-3.0, generally 3.0) and find safe

bearing capacity which is “allowable bearing capacity” (*zemin emniyet gerilmesi*) if settlements are acceptable. Review the allowable total, differential settlements of various types of foundations on cohesive and cohesionless soils. If settlements are not acceptable then reduce the safe bearing capacity to satisfy the settlement criteria

**6.** Compare the foundation pressure (gross or net, preferably net) with the allowable bearing capacity. If not satisfied make another trial for the foundation and, follow the same procedure. Here it should be reminded that Turkey is in a seismically active area and consider dynamic loading. If the loads are high and the soil is weak, and even a raft foundation is not proper then try two alternatives: a) pile (deep) foundations b) a ground improvement technique

An economical comparison should be made, and other criteria are also considered (availability, time of construction etc.)

7. Check the groundwater level, and if it interferes with the basement construction consider both construction measures and waterproofing.

8. If pile foundation alternative is studied consider a trial design with diameter, depth, type (driven, bored etc.), spacing, pattern, and calculate ultimate and allowable capacities together with group settlement if possible.

9. Settlement calculations are significant part of a foundation design. In a trial calculation first net foundation pressure is distributed throughout the layers, and depth of analysis is specified. This may be determined by considering the depth at which increase due to foundation pressure corresponds to 20 % of overburden pressure (net). If a very stiff layer is at a shallower depth then analysis may be terminated at that depth. For cohesionless soils also see Burland and Burbidge (1985) who recommend the depth of analysis.

10. The depth of analysis is divided into sublayers if required, and stress increase due to foundation loading is calculated at the center of each layer. Compressibility of each layer should be specified. This can be accomplished by field tests and/or laboratory tests conducted. In cohesionless soils field tests are used. Both lab and field tests are made use of in cohesive fine soils. Correlations for moduli ( $E'$ ,  $E_U$ ),  $m_v$ ,  $C_c$  are given in various references, and some are given in our website (~ce410) including basic soil engineering properties (e.g.  $\phi$ ,  $c_u$ ).

11. In cohesionless soils total settlements are calculated by using field moduli  $E_s(E')$  (from field tests) and in cohesive soils either making use of effective modulus  $E'$  or  $E_U$  (undrained modulus) and coefficient of compressibility obtained in lab ( $C_c$  or  $m_v$ ) (i.e. immediate settlement + consolidation settlement). Consider also rebound and reloading in deep basements.

12. Soft organic soils show secondary consolidation settlements. These are usually more than primary settlements in many organic deposits and last very long. Therefore this potential has to be investigated in detail studying the site investigation report, and additional testing and sampling should be required if not satisfied. Secondary consolidation settlement estimates should be done (see ~ce410). Consider also collapse of cohesionless soils (collapsible soils) and swell potential of stiff unsaturated plastic clays.

13. Finally make comparisons of different -technically sound - alternatives along with:

A) Economy      B) Availability      C) Time of Construction      D)  
Other Criteria