Problem 1(15%):

The engineer performed a series of drained direct shear tests on a saturated soil specimen from the site. The measured water content of the specimen was 28%, and the sieve analysis results are shown in Table 1.1. Please find:

(a) (5%) Plot the soil particle size distribution curve.

(b) (5%) Calculate the saturated unit weight of the direct shear specimen (It is important to note that the dimensions of the direct shear box are as follows: length = 10 cm, width = 10 cm, height = 2.5 cm.).

(c) (5%) Table 1.2 presents the parameters from direct shear tests conducted on two soil samples collected from the site. If the specimen is located 15 m below ground, what is the possible shear strength of the soil measured by the direct shear test? (Assume groundwater table is at the ground surface).

Table 1.1 Results of a sieve analysis

US sieve	Opening(mm)	Mass retained on each sieve(g)
4	4.750	0
10	2.000	18
20	0.850	36
40	0.425	54
60	0.250	72
80	0.180	54
100	0.150	54
200	0.075	54
Pan	-	18

Table 1.2 Strength properties of two types of soils

Soil Properties	c' (kN/m^2)	ϕ' (°)
Soil 1	40	27
Soil 2	0	32

Problem 2 (30%):

A thick NC clay layer was found at the construction site. The average effective overburden pressure at the middle of the clay layer is 200 kPa. The proposed structural load per unit area $\Delta\sigma_{(p)}$ is 120 kPa.

(a) (10%) Based on Figure 2.1, please discuss the mechanism of precompression briefly. Additionally, explain when we need to consider precompression.

(b) (10%) Determine the total primary consolidation settlement without precompression.

(c) (10%) What is the surcharge, $\Delta\sigma_{(s)}$, need to eliminate by compression the entire primary consolidation settlement in 20 months?

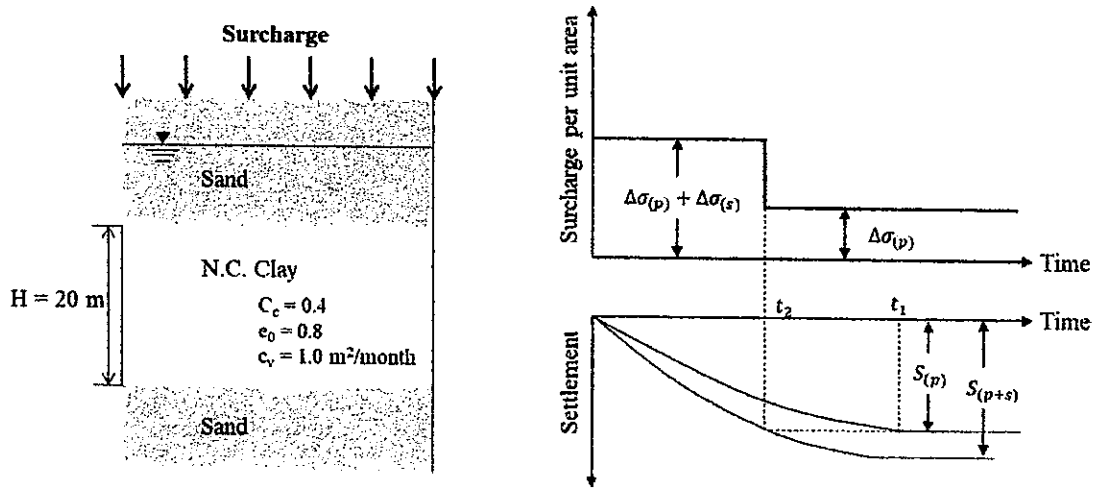

Figure 2.1 Principles of precompression

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Table 2.1 Variation of T_v with U

U (%)	T_v	U (%)	T_v	U (%)	T_v	U (%)	T_v	U (%)	T_v
0	0								
1	0.00008	21	0.0346	41	0.132	61	0.297	81	0.588
2	0.0003	22	0.0380	42	0.138	62	0.307	82	0.610
3	0.00071	23	0.0415	43	0.145	63	0.318	83	0.633
4	0.00126	24	0.0452	44	0.152	64	0.329	84	0.658
5	0.00196	25	0.0491	45	0.159	65	0.304	85	0.684
6	0.00283	26	0.0531	46	0.166	66	0.352	86	0.712
7	0.00385	27	0.0572	47	0.173	67	0.364	87	0.742
8	0.00502	28	0.0615	48	0.181	68	0.377	88	0.774
9	0.00636	29	0.0660	49	0.188	69	0.390	89	0.809
10	0.00785	30	0.0707	50	0.197	70	0.403	90	0.848
11	0.0095	31	0.0754	51	0.204	71	0.417	91	0.891
12	0.0113	32	0.0803	52	0.212	72	0.431	92	0.938
13	0.0133	33	0.0855	53	0.221	73	0.446	93	0.993
14	0.0154	34	0.0907	54	0.230	74	0.461	94	1.055
15	0.0177	35	0.0962	55	0.239	75	0.477	95	1.129
16	0.0201	36	0.102	56	0.248	76	0.493	96	1.219
17	0.0227	37	0.107	57	0.257	77	0.511	97	1.336
18	0.0254	38	0.113	58	0.267	78	0.529	98	1.500
19	0.0283	39	0.119	59	0.276	79	0.547	99	1.781
20	0.0314	40	0.126	60	0.286	80	0.567	100	∞

Problem 3 (15%):

Table 3.1 shows the results of the CD test.

(a) (5%) Determine the strength parameters.

(b) (5%) Determine the inclination of the failure plane in soil with the major principal plane

(c) (5%) What is the deviator stress at failure when the effective confining stress, σ_3', is 100 kPa. And determine the normal stress and shear stress on the failure plane.

Table 3.1 Results of the CD test

# of specimen	σ_3' (kPa)	$(\Delta\sigma_d)_f$ (kPa)
1	75	150
2	150	300
3	200	400

Problem 4 (10%):

Considering that a particular site is located in a high soil liquefaction risk zone and the groundwater level is near the surface, what potential problems might arise during excavation at this site, and what solutions could be implemented?

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Problem 5 (30%):

A pile foundation is being designed for a construction site with the following parameters:

- Pile diameter (D) = 0.5 m
- Critical depth for point resistance and skin friction (L') = 20D
- Effective earth pressure coefficient (K) = 0.7
- Bearing capacity factors:
  - i. For undrained conditions: $N_c^* = 9$
  - ii. For $\phi' = 34°$: $N_q^* = 21$

Please find：

(a) (10%) The ultimate skin friction resistance, Q_s

(b) (10%) The ultimate end bearing resistance, Q_b

(c) (10%) If FS = 1.5, the allowable bearing capacity of the pile, Q_a = ?

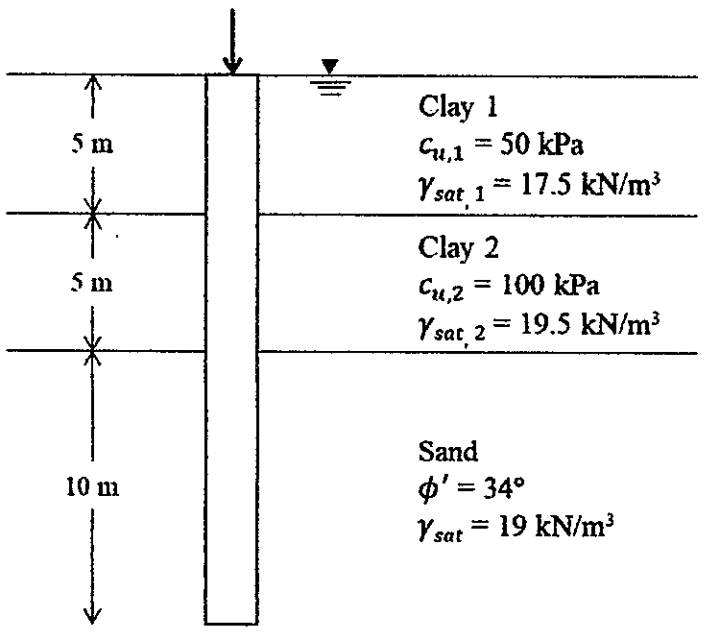

Figure 5.1 The pile foundation at the construction site

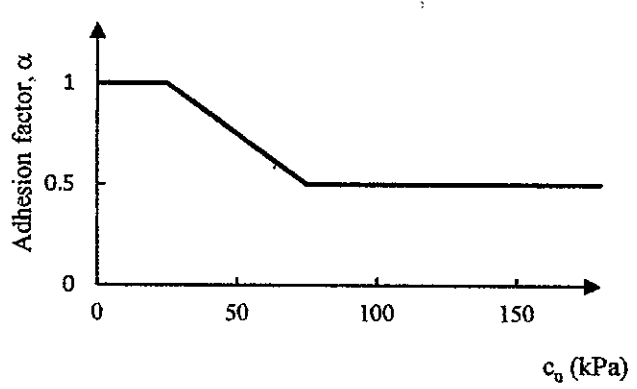

Figure 5.2 Adhesion factor vs. undrained shear strength

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