Chapter 6
Soil Compaction

1. Compaction, in general, is
   (a) densification of soil by removal of water from the voids of the soil.
   (b) densification of soil by removal of air from the voids of the soil.
   (c) densification of soil by removal of both air and water from the voids of the soil.
   (d) movement of rollers over the soil subgrade.

2. The degree of compaction of a soil is measured in terms of its
   (a) moisture content.
   (b) bulk unit weight.
   (c) dry unit weight.
   (d) shear strength.

3. During compaction, with an increase in moisture content, the dry unit weight of soil
   (a) always increases.
   (b) always decreases.
   (c) first increases, reaches a peak value, and then decreases.
   (d) remains unchanged.

4. The moisture content of soil at which the maximum dry unit weight is attained is generally
   referred to as
   (a) optimum moisture content.
   (b) maximum moisture content.
   (c) minimum moisture content.
   (d) none of the above.

5. Laboratory soil compaction test is used to obtain
   (a) decrease in volume of the soil.
   (b) maximum unit weight of the soil.
   (c) optimum moisture content of the soil.
   (d) both (b) and (c).

6. The Proctor compaction mould has a volume of
   (a) 943.3 cm³.
   (b) 1000 cm³.
   (c) 2124 cm³.
   (d) none of the above.

7. In the modified Proctor compaction test, the soil is compacted in the compaction mould in
   (a) 3 layers.
   (b) 5 layers.
   (c) 7 layers.
   (d) 9 layers.
8. In the standard Proctor compaction test, the mass of the hammer is
   (a) 2.5 kg.
   (b) 4.536 kg.
   (c) 5 kg.
   (d) 10 kg.

9. In the modified Proctor compaction test, the drop of the hammer is
   (a) 101.6 mm.
   (b) 304.8 mm.
   (c) 457.2 mm.
   (d) none of the above.

10. The number of hammer blows for each soil layer in the standard Proctor compaction test is kept at
   (a) 25.
   (b) 50.
   (c) 75.
   (d) 125.

11. The compaction energy per unit volume of soil used for the standard Proctor compaction test is
    (a) 591.3 N-m/m\(^3\)
    (b) 591.3 kN-m/m\(^3\)
    (c) 2696 kN-m/m\(^3\)
    (d) 2696 N-m/m\(^3\)

12. A compaction curve is plot of
    (a) bulk unit weight versus moisture content.
    (b) dry unit weight versus moisture content.
    (c) maximum dry unit weight versus optimum moisture content.
    (d) none of the above.

13. If for a compacted soil bulk, unit weight is 18.3 kN/m\(^3\), and moisture content is 12%, its dry unit weight will be
    (a) 16.3 kN/m\(^3\)
    (b) 18.3 kN/m\(^3\)
    (c) 20.5 kN/m\(^3\)
    (d) none of the above.

14. For a given moisture content, the theoretical maximum dry unit weight is obtained when degree of saturation is
    (a) 0%.
    (b) 25%.
    (c) 50%.
    (d) 100%.
15. If specific gravity of soil solids is 2.68, and the water content of soil is 10%, its zero-air-void unit weight will be  
   (a) 3.7 kN/m$^3$  
   (b) 7.1 kN/m$^3$  
   (c) 20.7 kN/m$^3$  
   (d) none of the above.

16. The factors that affect soil compaction are  
   (a) Soil type and moisture content.  
   (b) Moisture content and compaction effort.  
   (c) Soil type and compaction effort.  
   (d) Soil type, moisture content and compaction effort.

17. The compaction curve for soils that have a liquid limit between 30 and 70% is  
   (a) single peak curve.  
   (b) one and one-half peak curve.  
   (c) double peak curve.  
   (d) odd-shaped curve.

18. As the compaction effort is increased,  
   (a) both the maximum dry unit weight of compacted soil and the optimum moisture content are also increased.  
   (b) both the maximum dry unit weight of compacted soil and the optimum moisture content are decreased.  
   (c) the maximum dry unit weight of compacted soil is increased, and the optimum moisture content is decreased.  
   (d) the maximum dry unit weight of compacted soil is decreased, and the optimum moisture content is increased.

19. The standard Proctor compaction test is not suitable for  
   (a) soils with particles of all sizes.  
   (b) clayey soils.  
   (c) silty soils.  
   (d) sandy silty soils.

20. Which of the following rollers provides compaction by a combination of pressure and kneading action?  
   (a) Smooth-wheel roller  
   (b) Pneumatic rubber-tired roller  
   (c) Sheepsfoot roller  
   (d) Vibratory roller

21. Which of the following rollers is most effective in compacting clayey soils?  
   (a) Smooth-wheel roller  
   (b) Pneumatic rubber-tired roller  
   (c) Sheepsfoot roller  
   (d) Vibratory roller
22. Which of the following rollers is suitable for profiling subgrades and for the finishing operation of fills with sandy and clayey soils?
(a) Smooth-wheel roller
(b) Pneumatic rubber-tired roller
(c) Sheepsfoot roller
(d) Vibratory roller

23. In addition to soil type and moisture content, the factors that may affect soil compaction in field are
(a) thickness of lift, and pressure applied by the roller.
(b) thickness of lift, pressure applied by the roller, and the area over which the pressure is applied.
(c) thickness of lift, pressure applied by the roller, the area over which the pressure is applied, and the number of roller passes.
(d) none of the above.

24. As the number of passes of the roller is increased, the dry unit weight of the compacted soil
(a) is also increased.
(b) is decreased.
(c) remains constant.
(d) is increased up to a certain number of passes beyond which, it remains approximately constant.

25. The optimum number of roller passes that yield the maximum dry unit weight economically attainable ranges from
(a) 1 to 2.
(b) 4 to 6.
(c) 10 to 15.
(d) none of the above.

26. The term relative compaction is
(a) the degree of field compaction relative to the laboratory compaction.
(b) a ratio of the maximum dry unit weight achieved in the field compaction to the maximum dry unit weight obtained in the laboratory compaction test.
(c) used for specifications of earth work.
(d) both (b) and (c).

27. In most specifications for earthwork, the contractor is instructed to achieve a compacted field dry unit weight of
(a) 90 to 95%
(b) 80 to 85%
(c) 70 to 75%
(d) 60 to 65%
of the maximum dry unit weight determined in the laboratory by either the standard or modified Proctor test.
28. In most field projects, the contractors are asked to achieve a relative compaction of
   (a) 40 to 45%.
   (b) 70 to 75%.
   (c) 90 to 95%.
   (d) 100%.

29. A typical correlation between relative compaction and relative density for granular soils is
   (a) \( R = 70 + 0.2D_r \)
   (b) \( R = 80 + 0.2D_r \)
   (c) \( R = 80 + 0.5D_r \)
   (d) \( R = 90 + 0.2D_r \)

30. Which of the following methods for determining the field unit weight of compacted soil
    essentially requires a drilled hole?
    (a) Sand cone method
    (b) Rubber balloon method
    (c) Nuclear method
    (d) Both (a) and (b)

31. A nuclear meter for determination of in situ density uses a radioactive isotope source that
    provides
    (a) \( \alpha \) rays.
    (b) \( \beta \) rays.
    (c) \( \gamma \) rays.
    (d) all of the above.

32. A parallel orientation of clay particles results in
    (a) single-grained structure.
    (b) dispersed structure.
    (c) flocculated structure.
    (d) all of the above.

33. If the clay is compacted with a moisture content on the dry side of the optimum moisture
    content, it will possess
    (a) flocculated structure.
    (b) dispersed structure.
    (c) both (a) and (b).
    (d) none of the above.

34. Which of the following soil structures of clayey soil results in its lower dry unit weight?
    (a) Flocculated structure
    (b) Dispersed structure
    (c) Both (a) and (b)
    (d) Single-grained structure
35. Select the incorrect statement.
   (a) The hydraulic conductivity of clayey soil decreases with an increase in moisture content and reaches an approximate minimum value at the optimum moisture content.
   (b) The strength of compacted clayey soils generally decreases with the remoulding moisture content with a great loss of strength at approximately optimum moisture content.
   (c) If two soil specimens are compacted to the same dry unit weight, one of them on the dry side of optimum, and the other on the wet side of the optimum, the specimen compacted on the dry side of the optimum will exhibit greater strength.
   (d) None of the above.

36. The presence of organic materials in soil
   (a) does not affect its strength.
   (b) decreases its strength.
   (c) increases its strength.
   (d) may decrease or increase its strength.

37. In engineering applications, for compaction work, soils with a high organic content, say more than 10%,
   (a) are undesirable.
   (b) are desirable.
   (c) may be desirable as embankment materials.
   (d) may be desirable for foundation materials.

38. Which of the following groups of compacted soils has practically no compressibility and expansion?
   (a) CH
   (b) SM
   (c) MH
   (d) GW

39. A vibroflot unit is typically
   (a) 0.5 m long.
   (b) 1.1 m long.
   (c) 2.1 m long.
   (d) none of the above.

40. The suitability number for excellent backfill material ranges from
   (a) 0 to 10.
   (b) 10 to 20.
   (c) 20 to 30.
   (d) 30 to 50.

41. The degree of compaction achieved by the dynamic compaction method at a given site depends on
   (a) weight of hammer.
   (b) height of hammer drop.
   (c) spacing of locations at which the hammer is dropped.
   (d) all of the above.
42. The general soil grain sizes suitable for compaction by blasting are the same as those for compaction by
   (a) vibroflotation.
   (b) dynamic compaction.
   (c) both (a) and (b).
   (d) none of the above.
Answers, Hints and Discussion

1. (b)
2. (c)
3. (c)
4. (a)
5. (d)
6. (a)
7. (b)
   Discussion: (a) is correct for the standard Proctor compaction test.
8. (a)
   Discussion: (b) is correct for the modified Proctor compaction test.
9. (c)
   Discussion: (a) is correct for the diameter of the compaction mould; and (b) is correct for the drop of the hammer in standard Proctor compaction test.
10. (a)
    Discussion: (a) is correct also for the modified Proctor compaction test.
11. (b)
    Discussion: (c) is correct for the modified Proctor compaction test.
12. (b)
13. (a)
    Discussion: Eq. (6.2): \( \gamma_d = \frac{18.3}{1+0.12} = 16.3 \text{ kN/m}^3 \)
14. (d)
15. (c)
    Discussion: Eq. (6.4): \( \gamma_{zav} = \frac{9.81}{0.10 + \frac{1}{2.68}} = 20.7 \text{ kN/m}^3 \)
16. (d)
17. (a)
    Discussion: (b) and (c) can be correct for soils that have a liquid limit less than about 30%; (c) and (d) can be correct for soils that have a liquid limit greater than about 70%.
18. (c)
19. (a)
20. (b)
21. (c)
    Discussion: (d) is correct for granular soils.
22. (a)
23. (c)
24. (d)
25. (b)
26. (d)
27. (a)
28. (c)
29. (b)
30. (d)
31. (c)
32. (b)
33. (a)
Discussion: (c) is correct for the clay compacted with a moisture content on the wet side of the optimum moisture content.
34. (b)
35. (d)
36. (b)
37. (a)
38. (d)
39. (c)
40. (a)
41. (d)
42. (a)