## Index

### A
- adverse weather conditions
  - compaction in, 18–19
- ASTM D558, 22, 25–26, 51, 52
- ASTM D559, 26
- ASTM D560, 26
- ASTM D698. See Standard Proctor Test (ASTM D698)
- ASTM D1556. See sand cone method (ASTM D1556)
- ASTM D1557. See Modified Proctor Test (ASTM D1557)
- ASTM D2166, 22
- ASTM D2167. See rubber balloon method (ASTM D2167)
- ASTM D2216. See oven-dry method (ASTM D2216)
- ASTM D2435, 22
- ASTM D2850, 22
- ASTM D2937. See sand cone method (ASTM D2937)
- ASTM D3107, 42
- ASTM D3665, 39
- ASTM D4235, 16, 22, 27–29, 43, 54
- ASTM D4254, 16, 22, 27–29, 43, 54
- ASTM D4287, 30
- ASTM D4564, 30, 39–40
- ASTM D4634. See microwave-oven method (ASTM D4634)
- ASTM D4718, 32, 34, 36, 53–54
- ASTM D4914. See sand replacement in test pit method
  (ASTM D4914)
- ASTM D4944. See calcium carbide gas pressure tester
  method (ASTM D4944)
- ASTM D4959. See direct heating method (ASTM D4959)
- ASTM D5030. See water replacement in test pit method
  (ASTM D5030)
- ASTM D5080. See rapid determination of percent
  compaction (D5080)
- ASTM D5084, 22
- ASTM D6938. See nuclear method (ASTM D6938)
- ASTM STP523, 43
- ASTM test methods, 1, 4–5, 8, 22
- Atterberg Limits, 8

### B
- backfill, 9, 11f, 36
- backscatter mode
  - of nuclear gauge, 36, 37f, 38

### C
- calcium carbide gas pressure tester method (ASTM D4944),
  25, 44, 48–54, 87f, 91f
  - calibration curve with, 49–50, 88f
  - and nuclear density method, 38
  - and sand replacement in test pit method, 42
- Casagrande, Arthur, 2–3
- CH soil, 30, 35
- clay, 13–17, 22, 51–52
- clayey soil, 13–15, 17–19, 52–54
- clay silt, 22
- CL soil, 30, 33, 35
- cohesionless soils, 15f, 16t
  - equipment used with, 16, 20
  - methods for evaluating density and unit weight of,
    26–29
  - relative density methods for, 22
  - and sleeve method, 40
- cohesive soils
  - and rubber balloon method, 33
  - and vibrating tamping foot rollers, 20
- compacted soil
  - soil classes of, 68t
  - typical properties of, 64–65t
  - variables determining density of, 2
- compaction, 13
  - in adverse weather conditions, 18–19
  - effect of compactive effort on, 14f
  - effect of effort of on penetration resistance, 61f
  - effects of on shrink and swell of soil, 16–17
  - equipment for, 3, 9, 11, 19–20, 66–67t
  - history of, 2
  - impact methods of and types of soil for, 22
  - influence of on engineering properties, 16–18
  - quality control flow chart for, 60f
- compaction curve, 2
  - for dry density, 25
  - and energy applied, 13f
  - family of, 8f
  - of gravel, 15
  - for modified compaction test, 14, 23
  - and percent saturation, 26f
  - for reference density, 71f, 72f
  - relationship of to ZAV curve, 15
  - of sand, 15f, 28f
  - of soil-cement mixtures, 25
  - for standard compaction test, 14, 23
  - for wet density, 25
- compaction tests, standard reference, 22–23

### D
- density
  - and cohesionless soils, 16, 22, 26–29
  - compaction curve for dry density, 25
  - comparing to standard reference, 51, 55
  - curve for for dry soil conditions, 19
  - of finer particle rock fill, 43
  - index test method of, 26–29
  - and nuclear method, 36, 38, 39
  - plotting of, 59
  - and rapid determination of percent compaction, 55–57
  - relative method of, 22, 27f, 29
  - and rubber balloon method, 33
  - and sand replacement in test pit method, 40–41
  - and sleeve method, 40
  - variables determining, 2
  - and vertical vibration, 28
  - of very-coarse-grained soils, 42–43
- density, standard reference, 14
  - compaction curve for, 71f, 72f
  - comparing to compacted soil, 51, 55
<table>
<thead>
<tr>
<th><strong>Index</strong></th>
</tr>
</thead>
</table>
| influence of on engineering properties and performance of soil, 22 and Modified Proctor Test, 54 selection of, 4–5, 55 and Standard Proctor Test, 54 density test, in-place, 8, 12, 30 and clayey soil, 17–18 and cohesionless soils, 16 comparing to laboratory tests, 55, 59 and drive cylinder method, 51, 78f, 79f and nuclear method, 51–53 and rubber balloon method, 51, 52, 76f, 77f and sand cone method, 51, 52 and sand replacement in test pit method, 52 and silty soil, 17–18 and water replacement in a test pit method, 43, 52, 80f, 81f and ZAV curve, 15 direct heating method (ASTM D4959), 25, 44, 47–48, 51, 52, 54 and finer particle rock fill, 43 moisture determination using, 86f and nuclear density method, 38 direct transmission mode of nuclear gauge, 36, 37f, 38 disk ing, 12f drainage zones, 9 drive cylinder method (ASTM D2937), 8, 19, 30, 35–36, 51, 78f, 79f, 90f dumped fill, 9  

| **F** |
| family of curves, 55, 57, 58f, 62f, 63f  
field-testing methods, 19  
fine-grained soil, 22  
free-draining soil, 22  
frost heave problems, 16  
Frosting zones, 9  
heat sink  
and microwave oven method, 47  
hydraulic fill, 9  

| **G** |
| GC soil, 30, 33  
GM soil, 30, 33  
grading, 12  
grain size distribution, 8  
gravel, 52–54  
compaction testing of, 15–16  
and relative density method, 22  

| **H** |
| heat sink  
and microwave oven method, 47  

| **L** |
| linear construction, 12f  
low plastic soil, 20  

| **M** |
| mass, 13f, 33, 42  
method compaction control, 54  
MH soil, 30, 33, 35  
microwave oven method (ASTM D4643), 25, 44, 46–47, 51, 52, 54  
and nuclear density method, 38  
and sand replacement in test pit method, 42  
summary data sheet for, 85f  
ML soil, 30, 33, 35  
Modified Proctor Test (ASTM D1557), 3, 14, 23–24  
and compaction characteristics of soil, 22, 51, 52  
comparing in-place density test to, 59  
comparing to degree of compaction, 55  
and maximum dry density, 54  
and maximum dry unit weight, 29  
and rubber balloon method, 34  
and sheepsfoot roller, 20  
steps of, 24–25  
moisture content test. See water content test  
moisture density curve for, 2f, 22  
and sand cone method, 74f, 75f  
test methods for, 25–26  

| **N** |
| nuclear density method, 36–39  
nuclear gauge, 5, 8, 19, 36–39  
nuclear method (ASTM D6938), 30, 36–39, 44, 50–54, 90f, 91f  
compaction test data for, 82f  
and rapid method, 55  

| **O** |
| one-point compaction test, 55, 57–58  
one-point Proctor test, 55  
organic soils, 47  
oven dry method (ASTM D2216), 4, 25, 32, 44, 45–46, 51, 52, 54, 56, 84f  
and calcium carbide gas pressure tester method, 48–50  
and finer particle rock fill, 43  
and nuclear density method, 38  
and rubber balloon method, 34  
and sand replacement in test pit method, 42  

| **P** |
| penetration resistance curve, 17  
penetrometer needle test (ASTM D1558), 17  
percent compaction, 51  
plastic rebound, 14  
Proctor, R. R., 2  
rapid determination of percent compaction (ASTM D5080), 19, 30, 52, 55–58  
and drive cylinder method, 35  
and rubber balloon method, 33  
and sand cone method, 31  
rollers, 9, 11, 19–20, 89f  
rubber balloon method (ASTM D2167), 30, 33–35, 51, 52, 54, 90f  
in-place moisture density determination for, 76f, 77f  

| **S** |
| sand  
compaction curves for, 15f, 28f  
compaction testing of, 15–16  
and relative density method, 22 |
sand cone method (ASTM D1556), 8, 19, 30–33, 31f, 51, 52, 54, 90f
density and calibration for, 73f
in-place moisture-density determination for, 74f, 75f
sand replacement in test pit method (ASTM D4914), 30, 40–42, 52, 54–55
sandy fine grained soil, 51–52
sandy silt, 22
saturation, 25, 30
SC soil, 30, 33, 35
sieve, 8
silt, 13–15, 51–52
silty soil, 17–20, 52–54
sleeve method, 39–40
SM soil, 16, 22, 30, 33, 35
soil
  classification system of, 2–3
  engineering use of, 10f
  testing samples of, 5, 8
soil-cement mixtures
  test methods for, 25–26
soil liners, 11
soil load, 30
soil mass stress, 30
“Speedy Moisture Meter Test,” 48–50
Standard Proctor Test (ASTM D698), 2, 3, 14, 19, 23–24
  and compaction characteristics of soil, 22, 51, 52
  comparing in-place density test to, 59
  comparing to degree of compaction, 55
  and maximum dry density, 54
  and maximum dry unit weight, 29
  and rubber balloon method, 34
  and sheepsfoot roller, 20
  steps of, 24–25

T
test fill report, 89f
test pit configurations, 40f
tractor, crawler, 20

U
uncontrolled fill, 9
Unified Soil Classification System (ASTM D2487), 3, 49, 69f
Unified Soil Classification System (ASTM D2488), 3, 70f
unit weight, maximum dry, 25, 29
unit weight test, 24–30
  and drive cylinder method, 35
  and rubber balloon method, 33
  and sand cone method, 30–32
  and sand replacement in test pit method, 40–41
  and sleeve method, 40

V
vertical vibration, 28
void ratio, 30
volume, 33, 40, 42

W
water content, maximum, 22
water content, optimum, 2, 14, 24–25
  and compaction, 16–17
  comparing to compacted soil, 51
  and penetrometer needle test (ASTM D1558), 17
  and rapid method, 56
  and water-retaining structures, 9
water content test, 8, 17f, 24, 43–45
  comparing to optimum water content, 51
  and drive cylinder method, 35, 36
  and nuclear density method, 36–39
  and oven-dry method, 45–46
  and rapid determination of percent compaction, 55–57
  and rubber balloon method, 33, 34
  and sand cone method, 30–32
  and sand replacement in test pit method, 42
  summary data sheet for, 83f
water replacement in test pit method (ASTM D5030), 30, 42, 43, 52, 54–55
  in-place moisture-density determination for, 80f, 81f

Z
zero-air voids, 14–15, 25, 55, 59
zoned earth fills, 11, 12f