Important Compaction of Soil Formulas PDF

Formulas
Examples
with Units

List of 37
Important Compaction of Soil Formulas

1) Compaction Equipment Formulas

1.1) Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$y = \frac{16 \cdot W \cdot S \cdot L \cdot E \cdot PR}{P}$$

Example with Units

$$297.5995\,\text{m}^3/\text{hr} = \frac{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 0.50 \cdot 2.99\,\text{m}^3}{5}$$

1.2) Compaction Production by Compaction Equipment when Efficiency Factor is Average Formula

Evaluate Formula

Formula

$$y_a = \frac{16 \cdot W \cdot S \cdot L \cdot PR \cdot 0.80}{P}$$

Example with Units

$$476.1592\,\text{m}^3/\text{hr} = \frac{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3 \cdot 0.80}{5}$$

1.3) Compaction Production by Compaction Equipment when Efficiency Factor is Excellent Formula

Evaluate Formula

Formula

$$y_{ex} = \frac{16 \cdot W \cdot S \cdot L \cdot PR \cdot 0.90}{P}$$

Example with Units

$$535.6791\,\text{m}^3/\text{hr} = \frac{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3 \cdot 0.90}{5}$$

1.4) Compaction Production by Compaction Equipment when Efficiency Factor is Poor Formula

Evaluate Formula

Formula

$$y_p = \frac{16 \cdot W \cdot S \cdot L \cdot PR \cdot 0.75}{P}$$

Example with Units

$$446.3992\,\text{m}^3/\text{hr} = \frac{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3 \cdot 0.75}{5}$$

1.5) Efficiency Factor using Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$E = \frac{y \cdot P}{16 \cdot W \cdot S \cdot L \cdot PR}$$

Example with Units

$$0.5 = \frac{297.59\,\text{m}^3/\text{hr} \cdot 5}{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3}$$

1.6) Number of Passes given Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$P = \frac{16 \cdot W \cdot S \cdot E \cdot L \cdot PR}{y}$$

Example with Units

$$5.0002 = \frac{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 0.50 \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3}{297.59\,\text{m}^3/\text{hr}}$$

1.7) Ratio of Pay to Loose using Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$PR = \frac{y \cdot P}{16 \cdot W \cdot S \cdot L \cdot E}$$

Example with Units

$$2.9899\,\text{m}^3 = \frac{297.59\,\text{m}^3/\text{hr} \cdot 5}{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 0.50}$$

1.8) Speed of Roller given Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$S = \frac{y \cdot P}{16 \cdot W \cdot L \cdot PR \cdot E}$$

Example with Units

$$2.9999\,\text{km/h} = \frac{297.59\,\text{m}^3/\text{hr} \cdot 5}{16 \cdot 2.89\,\text{m} \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3 \cdot 0.50}$$

1.9) Thickness of Lift given Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$L = \frac{y \cdot P}{16 \cdot W \cdot S \cdot E \cdot PR}$$

Example with Units

$$7.1748\,\text{mm} = \frac{297.59\,\text{m}^3/\text{hr} \cdot 5}{16 \cdot 2.89\,\text{m} \cdot 3.0\,\text{km/h} \cdot 0.50 \cdot 2.99\,\text{m}^3}$$

1.10) Width of Roller given Compaction Production by Compaction Equipment Formula

Evaluate Formula

Formula

$$W = \frac{y \cdot P}{16 \cdot S \cdot L \cdot PR \cdot E}$$

Example with Units

$$2.8899\,\text{m} = \frac{297.59\,\text{m}^3/\text{hr} \cdot 5}{16 \cdot 3.0\,\text{km/h} \cdot 7.175\,\text{mm} \cdot 2.99\,\text{m}^3 \cdot 0.50}$$

2) Relative Compaction Formulas

2.1) Dry Density given Relative Compaction in Density Formula

Evaluate Formula

Formula

$$\rho_d = R_c \cdot \gamma_{dmax}$$

Example with Units

$$11.9\,\text{kg/m}^3 = 2.5 \cdot 4.76\,\text{kg/m}^3$$

2.2) Maximum Dry Density given Relative Compaction Formula

Evaluate Formula

Formula

$$\gamma_{dmax} = \frac{\rho_d}{R_c}$$

Example with Units

$$4\,\text{kg/m}^3 = \frac{10\,\text{kg/m}^3}{2.5}$$

2.3) Relative Compaction given Density Formula

Evaluate Formula

Formula

$$R_c = \frac{\rho_d}{\gamma_{dmax}}$$

Example with Units

$$2.1008 = \frac{10\,\text{kg/m}^3}{4.76\,\text{kg/m}^3}$$

3) Soil Compaction Test Formulas

3.1) California Bearing Ratio for Strength of Soil that Underlies Pavement Formula

Evaluate Formula

Formula

$$CBR = \left(\frac{F}{F_s}\right)$$

Example with Units

$$0.5 = \left(\frac{3\,\text{N/m}^2}{6\,\text{N/m}^2}\right)$$

3.2) Coefficient of Permeability given Rate of Flow of Water Formula

Evaluate Formula

Formula

$$k = \left(\frac{q_{flow}}{i \cdot A_{cs}}\right)$$

Example with Units

$$0.9185\,\text{m/s} = \left(\frac{24\,\text{m}^3/\text{s}}{2.01 \cdot 13\,\text{m}^2}\right)$$

3.3) Cross-Sectional Area of Soil Conveying Flow given Rate of Flow of Water Formula

Evaluate Formula

Formula

$$A_{cs} = \left(\frac{q_{flow}}{k \cdot i}\right)$$

Example with Units

$$12.0609\,\text{m}^2 = \left(\frac{24\,\text{m}^3/\text{s}}{0.99\,\text{m/s} \cdot 2.01}\right)$$

3.4) Density of Sand given Volume of Soil for Sand Filling in Sand Cone Method Formula

Evaluate Formula

Formula

$$\rho = \left(\frac{W_t}{V}\right)$$

Example with Units

$$4\,\text{kg/m}^3 = \left(\frac{80\,\text{kg}}{20\,\text{m}^3}\right)$$

3.5) Dry Density of Soil given Percent Compaction of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$\rho_{dsc} = \frac{C \cdot \gamma_{dmax}}{100}$$

Example with Units

$$4.284\,\text{kg/m}^3 = \frac{90 \cdot 4.76\,\text{kg/m}^3}{100}$$

3.6) Dry Density of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$\rho_d = \left(\frac{\gamma_t}{1 + \left(\frac{M}{100}\right)}\right)$$

Example with Units

$$11.9956\,\text{kg/m}^3 = \left(\frac{12\,\text{kg/m}^3}{1 + \left(\frac{0.037}{100}\right)}\right)$$

3.7) Field Density in Sand Cone Method Formula

Evaluate Formula

Formula

$$\rho_{fd} = \left(\frac{W_t}{V}\right)$$

Example with Units

$$4\,\text{kg/m}^3 = \left(\frac{80\,\text{kg}}{20\,\text{m}^3}\right)$$

3.8) Field Density of Soil given Dry Density of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$\gamma_t = \left(\rho_d \cdot \left(1 + \left(\frac{M}{100}\right)\right)\right)$$

Example with Units

$$10.0037\,\text{kg/m}^3 = \left(10\,\text{kg/m}^3 \cdot \left(1 + \left(\frac{0.037}{100}\right)\right)\right)$$

3.9) Force per Unit Area Required for Penetration of Standard Material Formula

Evaluate Formula

Formula

$$F_s = \left(\frac{F}{CBR}\right)$$

Example with Units

$$6.383\,\text{N/m}^2 = \left(\frac{3\,\text{N/m}^2}{0.47}\right)$$

3.10) Force per Unit Area Required to Penetrate Soil Mass with Circular Piston Formula

Evaluate Formula

Formula

$$F = CBR \cdot F_s$$

Example with Units

$$2.82\,\text{N/m}^2 = 0.47 \cdot 6\,\text{N/m}^2$$

3.11) Hydraulic Gradient given Rate of Flow of Water Formula

Evaluate Formula

Formula

$$i = \left(\frac{q_{flow}}{k \cdot A_{cs}}\right)$$

Example with Units

$$1.8648 = \left(\frac{24\,\text{m}^3/\text{s}}{0.99\,\text{m/s} \cdot 13\,\text{m}^2}\right)$$

3.12) Maximum Dry Density given Percent Compaction of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$\gamma_{dmax} = \left(\rho_{dsc}\right) \cdot \frac{100}{C}$$

Example with Units

$$4.76\,\text{kg/m}^3 = \left(4.284\,\text{kg/m}^3\right) \cdot \frac{100}{90}$$

3.13) Percent Compaction of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$C = \frac{100 \cdot \rho_{dsc}}{\gamma_{dmax}}$$

Example with Units

$$90 = \frac{100 \cdot 4.284\,\text{kg/m}^3}{4.76\,\text{kg/m}^3}$$

3.14) Percent Moisture Content given Dry Density of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$M_{sc} = 100 \cdot \left(\left(\frac{\gamma_t}{\rho_{dsc}}\right) - 1\right)$$

Example with Units

$$180.112 = 100 \cdot \left(\left(\frac{12\,\text{kg/m}^3}{4.284\,\text{kg/m}^3}\right) - 1\right)$$

3.15) Percent Moisture in Sand Cone Method Formula

Evaluate Formula

Formula

$$M_{sc} = \frac{100 \cdot \left(W_m - W_d\right)}{W_d}$$

Example with Units

$$100 = \frac{100 \cdot \left(10.0\,\text{kg} - 5.0\,\text{kg}\right)}{5.0\,\text{kg}}$$

3.16) Rate of Flow of Water through Saturated Soil by Darcy's Law Formula

Evaluate Formula

Formula

$$q_{flow} = \left(k \cdot i \cdot A_{cs}\right)$$

Example with Units

$$25.8687\,\text{m}^3\text{/s} = \left(0.99\,\text{m/s} \cdot 2.01 \cdot 13\,\text{m}^2\right)$$

3.17) Settlement of Plate in Load Bearing Test Formula

Evaluate Formula

Formula

$$\rho^1 = \Delta \cdot \left(\frac{1 + B}{2 \cdot B}\right)^2$$

Example with Units

$$0.0027\,\text{m} = 4.8\,\text{mm} \cdot \left(\frac{1 + 2000\,\text{mm}}{2 \cdot 2000\,\text{mm}}\right)^2$$

3.18) Volume of Soil for Sand Filling in Sand Cone Method Formula

Evaluate Formula

Formula

$$V = \left(\frac{W_t}{\rho}\right)$$

Example with Units

$$17.1306\,\text{m}^3 = \left(\frac{80\,\text{kg}}{4.67\,\text{kg/m}^3}\right)$$

3.19) Volume of Soil given Field Density in Sand Cone Method Formula

Evaluate Formula

Formula

$$V = \left(\frac{W_t}{\rho_{fd}} \right)$$

Example with Units

$$20\,\text{m}^3 = \left(\frac{80\,\text{kg}}{4.0\,\text{kg/m}^3} \right)$$

3.20) Weight of Dry Soil given Percent Moisture in Sand Cone Method Formula

Evaluate Formula

Formula

$$W_d = \frac{100 \cdot W_m}{M_{sc} + 100}$$

Example with Units

$$4\,\text{kg} = \frac{100 \cdot 10.0\,\text{kg}}{150 + 100}$$

3.21) Weight of Moist Soil given Percent Moisture in Sand Cone Method Formula

Evaluate Formula

Formula

$$W_m = \left(\left(M_{sc} \cdot \frac{W_d}{100} \right) + W_d \right)$$

Example with Units

$$12.5\,\text{kg} = \left(\left(150 \cdot \frac{5.0\,\text{kg}}{100} \right) + 5.0\,\text{kg} \right)$$

3.22) Weight of Sand Filling Hole in Sand Cone Method Formula

Evaluate Formula

Formula

$$W_t = \left(V \cdot \rho \right)$$

Example with Units

$$93.4\,\text{kg} = \left(20\,\text{m}^3 \cdot 4.67\,\text{kg/m}^3 \right)$$

3.23) Weight of Soil in Sand Cone Method Formula

Evaluate Formula

Formula

$$W_t = \left(\rho_{fd} \cdot V \right)$$

Example with Units

$$80\,\text{kg} = \left(4.0\,\text{kg/m}^3 \cdot 20\,\text{m}^3 \right)$$

3.24) Width of Full Size Bearing Plate in Load Bearing Test Formula

Evaluate Formula

Formula

$$B = \left(\frac{1}{2 \cdot \sqrt{\frac{\rho^1}{\Delta} - 1}} \right)$$

Example with Units

$$2000\,\text{mm} = \left(\frac{1}{2 \cdot \sqrt{\frac{0.0027\,\text{m}}{4.8\,\text{mm}} - 1}} \right)$$

Variables used in list of Compaction of Soil Formulas above

- A_{cs} Cross Sectional Area in Permeability *(Square Meter)*
- **B** Width of Full Size Bearing Plate *(Millimeter)*
- **C** Percent Compaction
- **CBR** California Bearing Ratio
- **E** Efficiency Factor
- **F** Force per Unit Area *(Newton per Square Meter)*
- F_s Force Per Unit Area Standard *(Newton per Square Meter)*
- **i** Hydraulic Gradient in Soil
- **k** Coefficient of Permeability *(Meter per Second)*
- **L** Lift Thickness *(Millimeter)*
- **M** Percent Moisture
- M_{sc} Percent Moisture from Sand Cone Test
- **P** Number of Passes
- **PR** Pay Ratio *(Cubic Meter)*
- q_{flow} Rate of Flow of Water through Soil *(Cubic Meter per Second)*
- R_c Relative Compaction
- **S** Roller Speed *(Kilometer per Hour)*
- **V** Volume of Soil *(Cubic Meter)*
- **W** Width of Roller *(Meter)*
- W_d Weight of Dry Soil *(Kilogram)*
- W_m Weight of Moist Soil *(Kilogram)*
- W_t Weight of Total Soil *(Kilogram)*
- **y** Production due to Compaction *(Cubic Meter per Hour)*
- y_a Compaction Production (Effi. Factor is Average) *(Cubic Meter per Hour)*
- y_{ex} Compaction Production (Effi. Factor is Excellent) *(Cubic Meter per Hour)*
- y_p Compaction Production (Effi. Factor is Poor) *(Cubic Meter per Hour)*
- γ_{dmax} Maximum Dry Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used in list of Compaction of Soil Formulas above

- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m), Millimeter (mm)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Meter (N/m^2)
  Pressure Unit Conversion
- Measurement: **Speed** in Kilometer per Hour (km/h), Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Hour (m^3/hr), Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion

- γ_t Bulk Density of Soil *(Kilogram per Cubic Meter)*
- Δ Settlement Foundation *(Millimeter)*
- ρ Density of Sand *(Kilogram per Cubic Meter)*
- ρ_d Dry Density *(Kilogram per Cubic Meter)*
- ρ_{dsc} Dry Density from Sand Cone Test *(Kilogram per Cubic Meter)*
- ρ_{fd} Field Density from Sand Cone Test *(Kilogram per Cubic Meter)*
- ρ^1 Settlement of Plate *(Meter)*

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