SOIL COMPACTION

Field Compaction

Field Compaction

- Most of the compaction in the field is done with rollers. The four most common types of rollers are:-
- Smooth-wheel rollers (or smooth-drum rollers)
- Pneumatic rubber-tired rollers
- Sheep foot rollers
- Vibratory rollers

Drum rollers

Pneumatic rollers

Sheep foot Rollers

Specifications for Field Compaction

- In most specifications for earthwork, the contractor is instructed to achieve a compacted field dry unit weight of 90 to 98% of the maximum dry unit weight determined in the laboratory by either the standard or modified Proctor test.

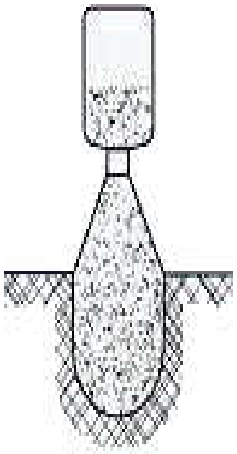
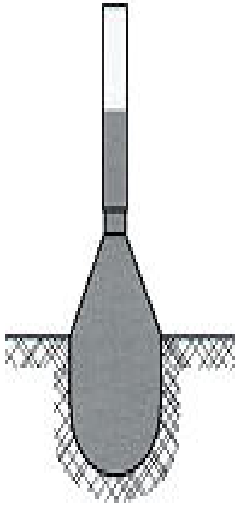
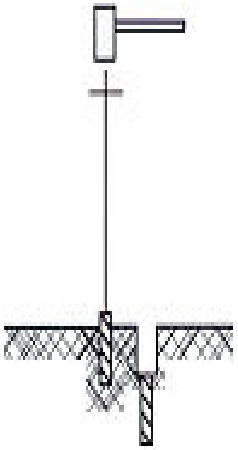
- This is specification for relative compaction, which can be expressed as

$$R\ (\%) = \frac{\gamma_{d(field)}}{\gamma_{d(max\text{-}lab)}} \times 100$$

Measurement of Field Compaction

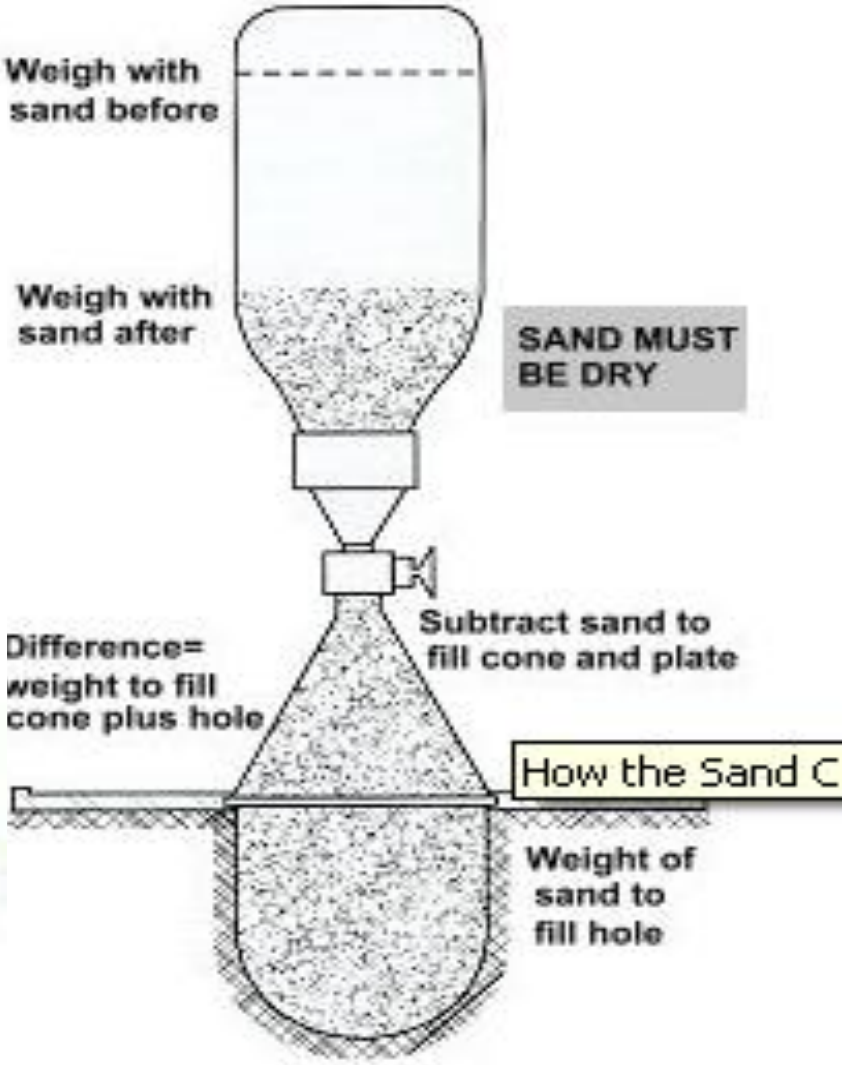
- Most common methods are
  - Nuclear Method
  - Sand Cone method
  - Rubber Balloon method

Field Density Testing Method

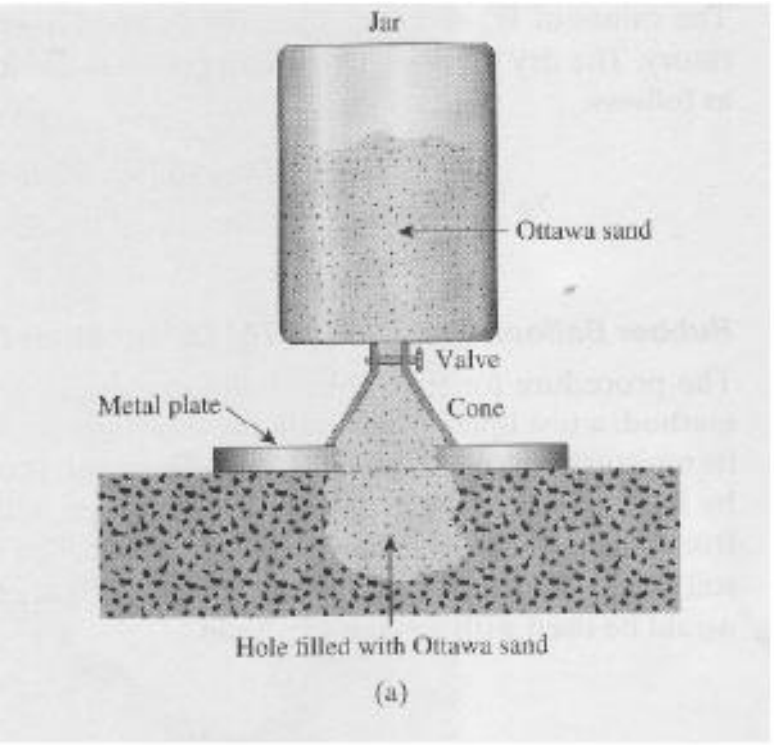
	Sand Cone	Balloon Dens meter	Shelby Tube	Nuclear Gauge
				
Advantages	* Large sample * Accurate	* Large sample * Direct reading obtained * Open graded material	* Fast * Deep sample * Under pipe haunches	* Fast * Easy to redo * More tests (statistical reliability)
Disadvantages	* Many steps * Large area required * Slow * Halt Equipment * Tempting to accept flukes	* Slow * Balloon breakage * Awkward	* Small Sample * No gravel * Sample not always retained	* No sample * Radiation * Moisture suspect * Encourages amateurs
Errors	* Void under plate * Sand bulking * Sand compacted * Soil pumping	* Surface not level * Soil pumping * Void under plate	* Overdrive * Rocks in path * Plastic soil	* Miscalibrated * Rocks in path * Surface prep required * Backscatter
Cost	* Low	* Moderate	* Low	* High

Sand Cone

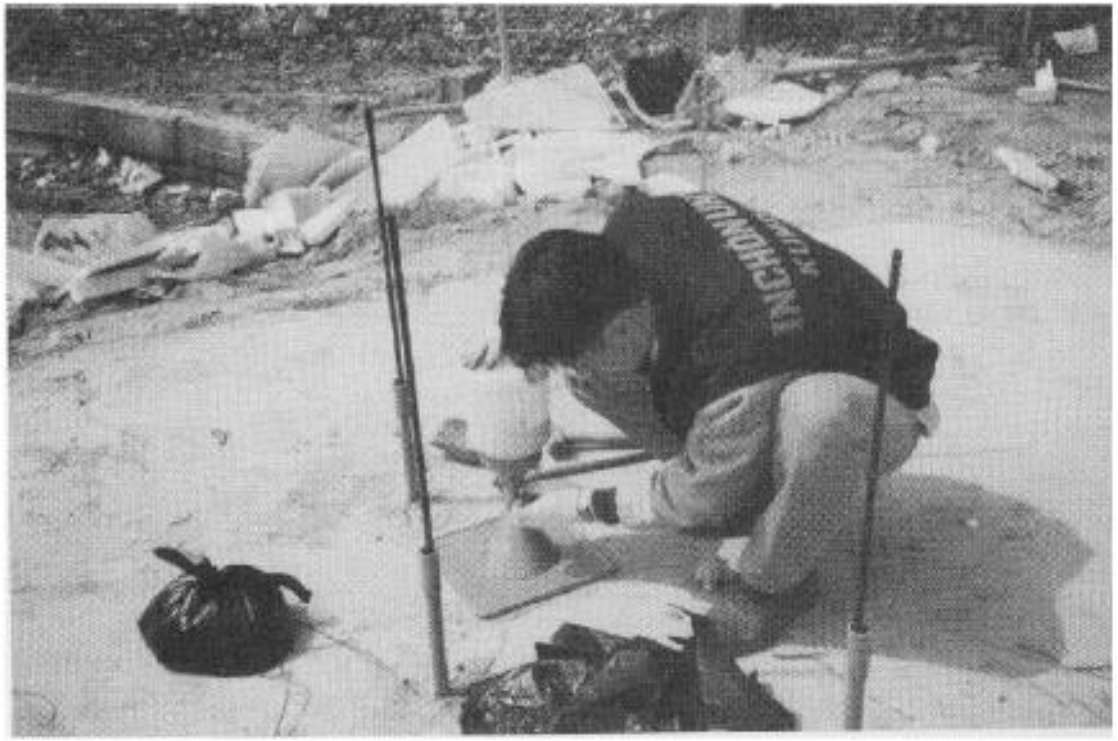

INTEC


Weigh with sand before
Weigh with sand after
SAND MUST BE DRY
Subtract sand to fill cone and plate
Difference= weight to fill cone plus hole
How the Sand C
Weight of sand to fill hole

Sand Cone


Jar
Ottawa sand
Valve
Metal plate
Cone
Hole filled with Ottawa sand
(a)

(a)



(b)

Sand Cone Method

- The sand cone device consists of a glass or plastic jar with a metal cone attached at its top.
- The jar is filled with very uniform dry Ottawa sand.
- The weight of the jar, the cone, and the sand filling the jar is determined, (W_1).
- In the field, a small hole is excavated from the area where the soil has been compacted.
- If the weight of the moist soil excavated from the hole (W_2) is determined and the moisture content of the excavated soil is known, the dry weight of the soil (W_3) can be obtained as:

Sand Cone Method (Cont.)

$$W_3 = \frac{W_2}{1 + \frac{w(\%)}{100}}$$

- After that, the cone with sand-filled jar attached to it's inverted and placed over the hole and allowed the sand to flow out into the hole.
- The weight of the jar, the cone, and the remaining sand in the jar is determined (W_4) so

$$W_5 = W_1 - W_4$$

W_5-weight of sand to fill the hole and cone

Sand Cone Method (Cont.)

- The volume of the hole excavated can now be determined as

$$V = \frac{W_s - W_c}{\gamma_{d(sand)}}$$

W_c = weight of sand to fill in cone only

$\gamma_{d(sand)}$ = dry unit weight of Ottawa sand used

- The dry unit weight of compaction made in field can now be determined as:

$$\gamma_d = \frac{dry\_weight\_of\_soil\_excavated\_from\_the\_hole}{volume\_of\_the\_hole} = \frac{W_3}{V}$$

Example

- Determine the dry unit weight of compaction in the field

Dry unit weight of Ottawa sand = 104 kg/m^3

Weight of Ottawa sand to fill the cone = 0.258 kg

Weight of jar + cone + sand (before use) = 13.21 kg

Weight of jar + cone + sand (after use) = 6.2 kg

Weight of moist soil from hole = 7.3 kg

Moisture content of moist soil = 11.6%

Example

Solution :

- The weight of the sand needed to fill the hole and cone is = 13.21 – 6.2 = 7.01 kg
- The weight of the sand used to fill the hole is

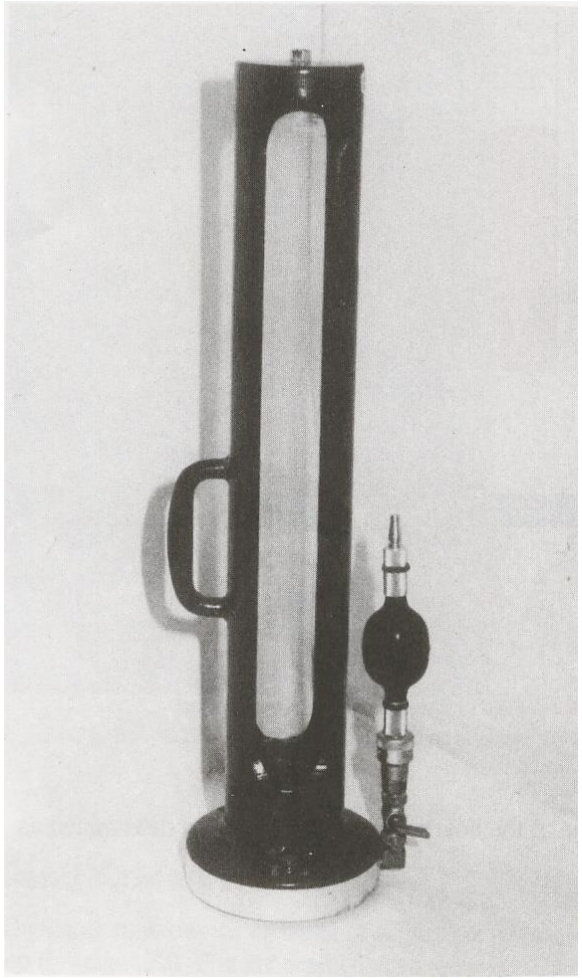
  = 7.01 – 0.258 = 6.752 kg
- The volume of the hole, V = 6.752/104 = 0.0649 m^3
- Dry weight of soil from the field is $W_3=W_2/(1+w(\%)$

  = 7.3/ (1+11.6/100) = 6.54 kg
- Hence the dry unit weight of compaction is $Y_d=W_3/V$

  = 6.54/0.0649 = 100.77 kg/m^3

Rubber Balloon Method

- The procedure same with sand cone method
- But, the volume of the hole is determined by a rubber balloon filled with water from a calibrated vessel from which the volume can be read directly.



Nuclear Method

- The instrument measure weight of the wet soil per unit volume and also the weight of water present in a unit volume of soil
- The dry unit weight of compacted soil can determined by subtracting the weight of water from the moist unit weight of soil.