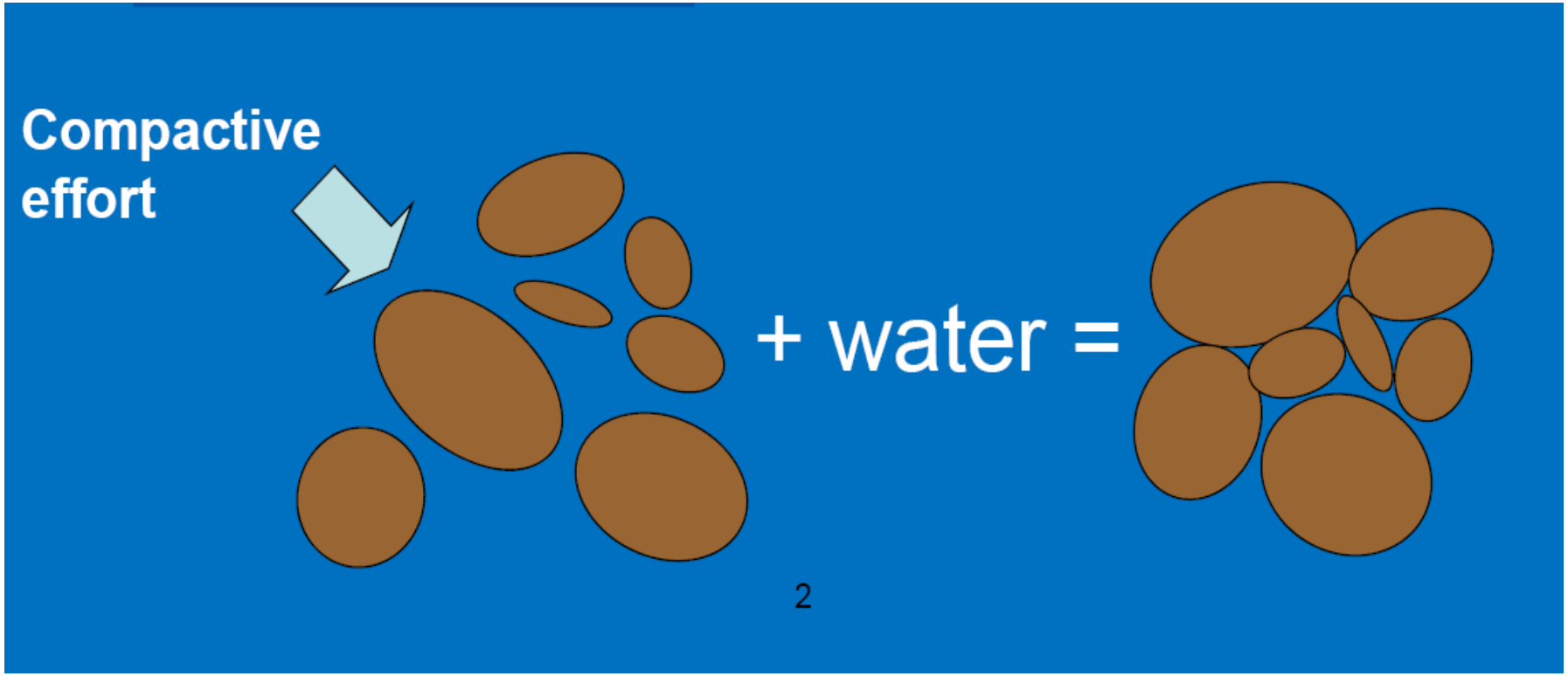
MECHANICAL MODIFICATION

COMPACTION

Dr. Supia Khatun
Department of Civil Engg.
Aliah University
Newtown Campus Kolkata

What is compaction?

A simple ground improvement technique, where the soil is densified through external compactive effort.



Advantages of Compaction

1.Increases shear strength

2.Reduces compressibility

3.Reduces permeability

4.Reduces liquefaction potential

5.Controls swelling and shrinking

6.Prolongs durability

Strategies for compaction process are

•In the case of constructed fills, specify placement conditions (water content, density,depth of layers, etc.)

•Select appropriate equipment (roller compactor, tamping) and method of operation (number of passes, patterns of tamping,etc.).

•Set up adequate control procedures (type and number of tests, statistical evaluation,etc.).

Detail	Standard compaction	Modified compaction
Mold volume,cm^3	1000	1000
Diameter,mm	105	105
Height,mm	115.5	115.5
Rammer diam,mm	50	50
Drop,mm	300	450
Mass,Kg	2.7	4.9
Number of blows	3	5
Blows /layer	25	25
Energy input,KJ/m^3	596	2703

Laboratory Compaction Test

- to obtain the compaction curve and define the optimum water content and maximum dry density for a specific compactive effort.

Standard Proctor:

- 3 layers
- 25 blows per layer
- 2.7 kg hammer
- 300 mm drop

hammer

1000 ml compaction mould

Modified Proctor:

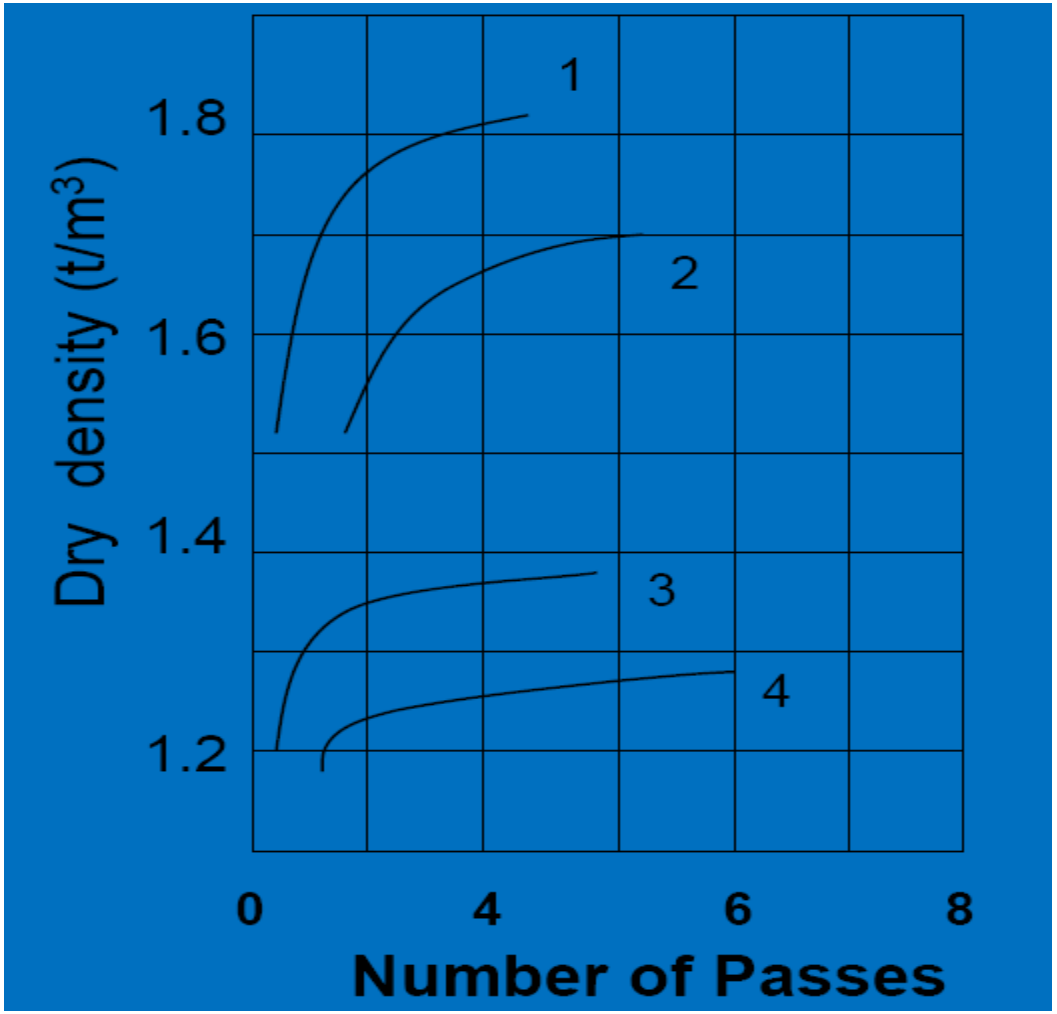
- 5 layers
- 25 blows per layer
- 4.9 kg hammer
- 450 mm drop

Operational aspects of shallow compaction:

Operating frequency

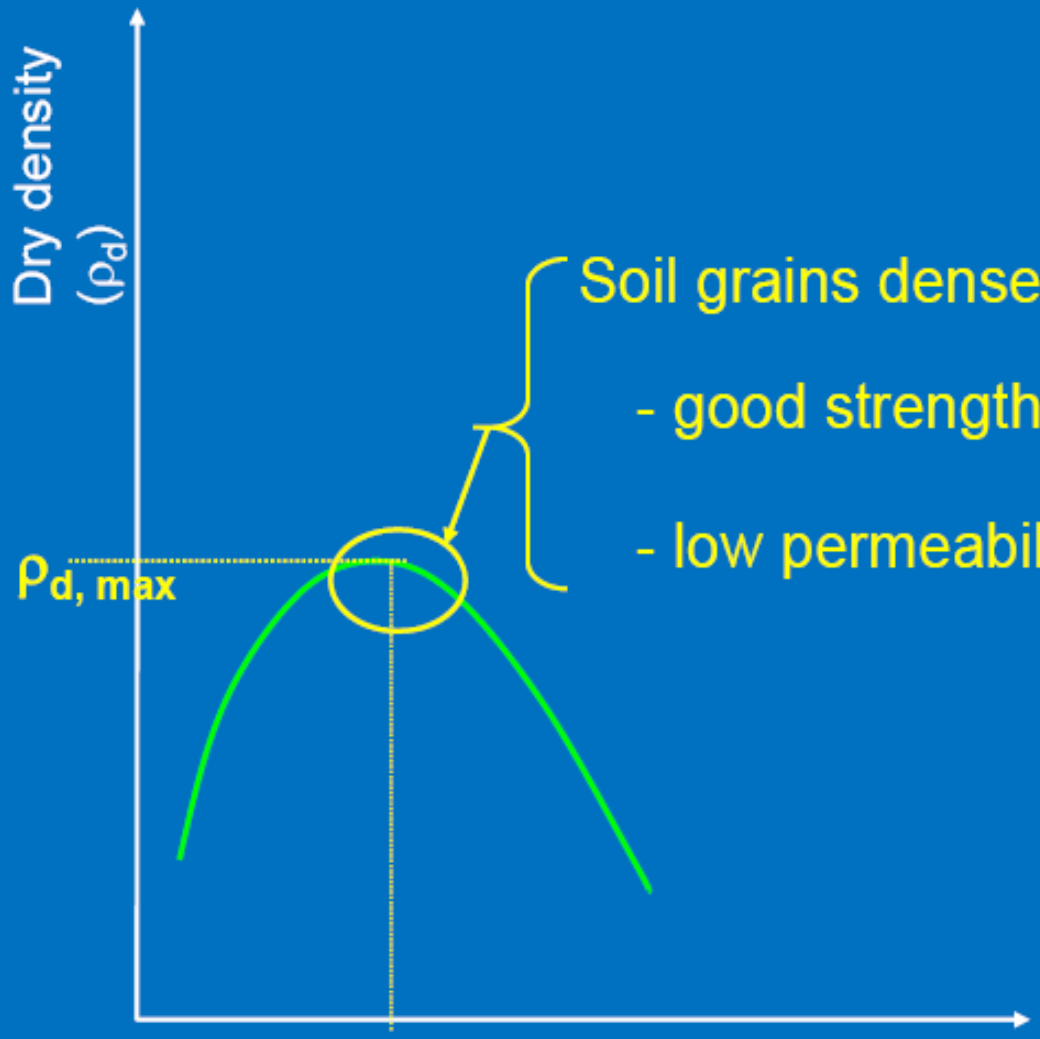
Number of passes

Depth of layers.



Relationship between number of passes of a roller and the density obtained.

Compaction Curve



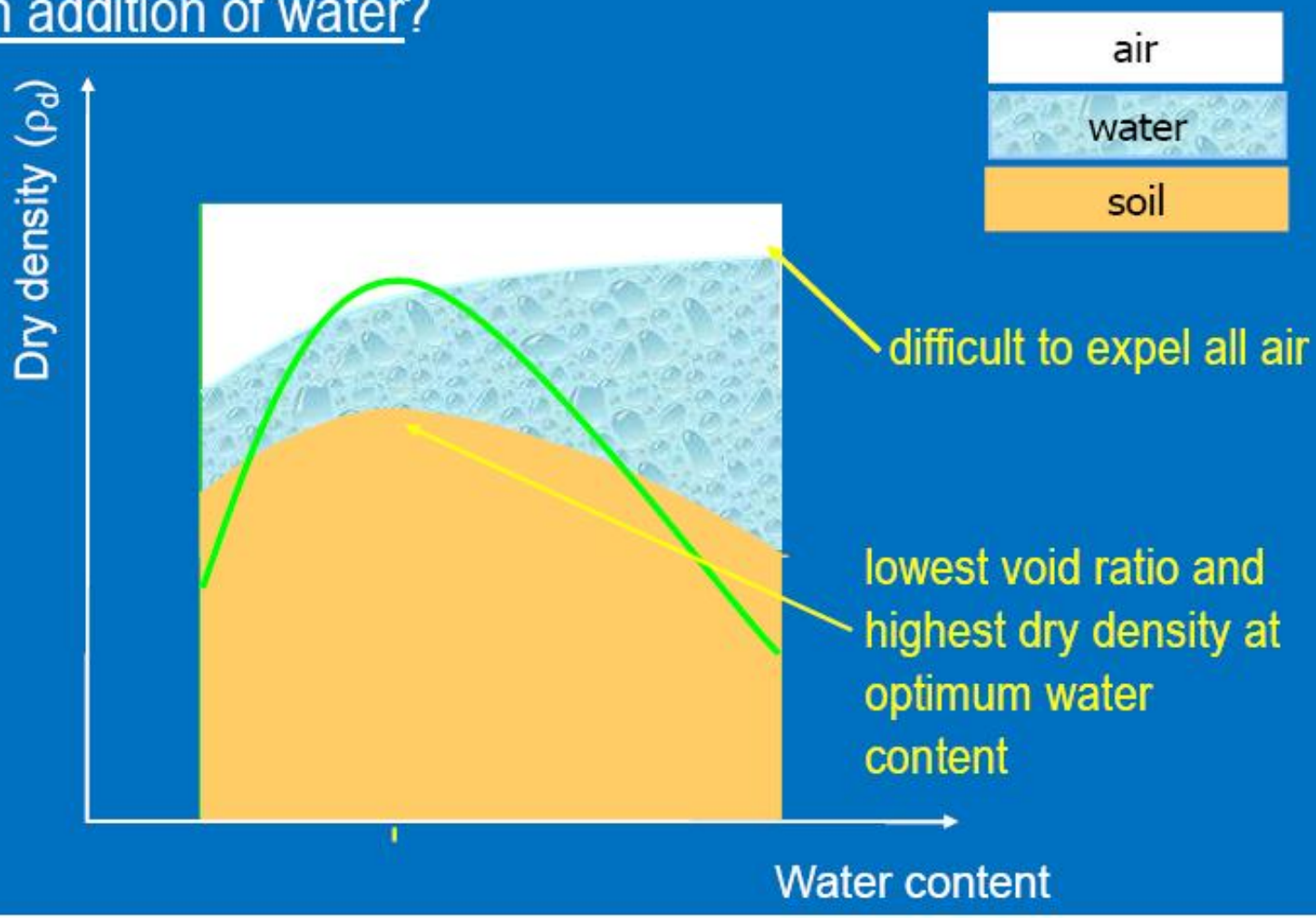
Soil grains densely packed

- good strength and stiffness

- low permeability

Compaction Curve

What happens to the relative quantities of the three phases with addition of water?



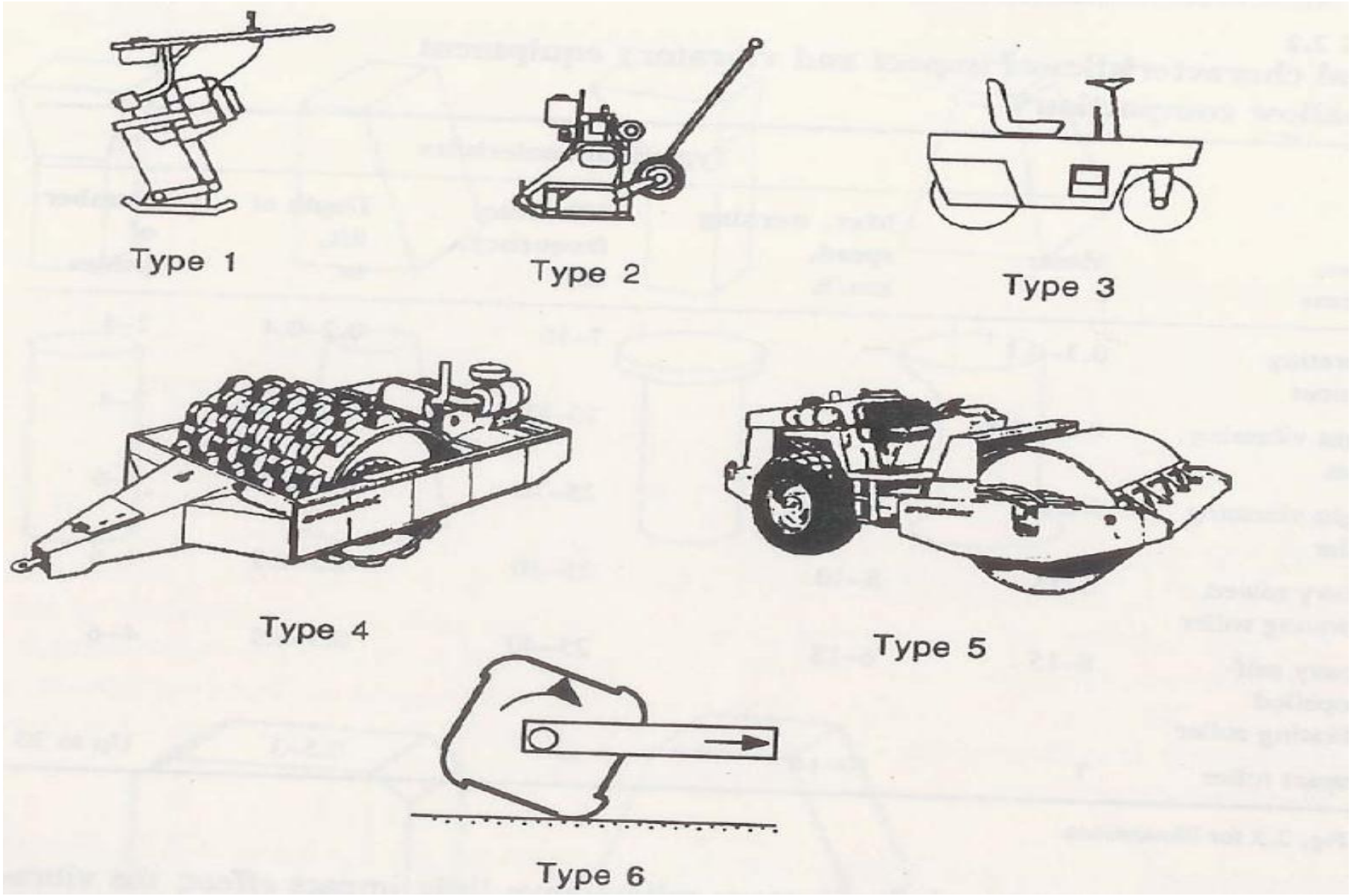
Shallow Surface Compaction:

Static rollers:

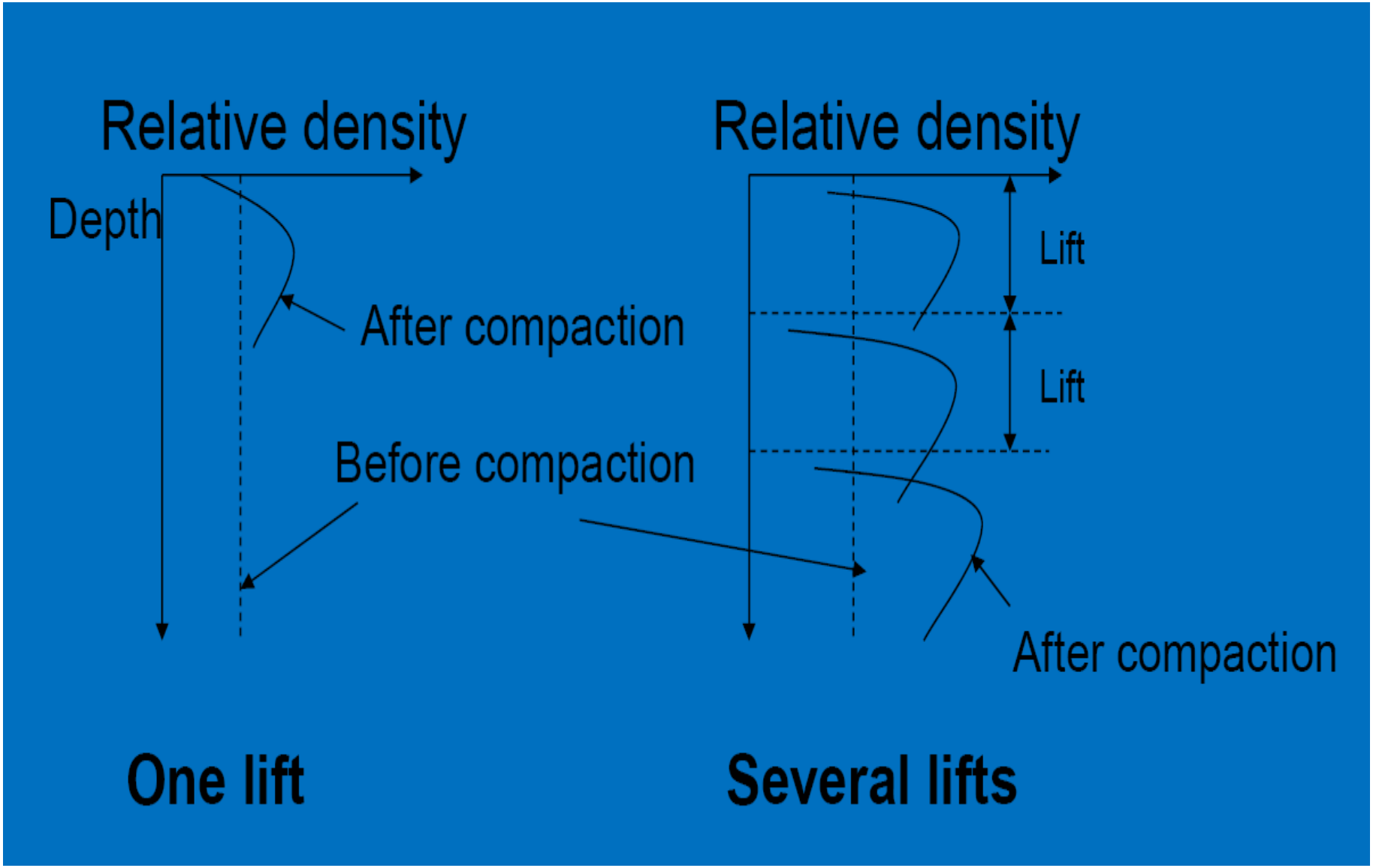
- Smooth steel rollers and pneumatic rollers.
- Sheepsfoot rollers.
- Grid rollers.

Impact and vibratory equipment:

- Tampers,rammers and plate compactors
- Vibrating rollers.
- Impact rollers



Vibratory and impact compactors for shallow compaction



showing density in sand before and after compaction

Table showing typical characteristics of impact and vibratory equipment for shallow compaction:

Type no. and Name	Mass,t	Max.speed, Km/hr	Vibrating frequency, HZ	Depth of lift,m	Number of passes
1.Vibrating rammer	0.3-0.1	-	7-10	0.2-0.4	2-4
2.Light vibrating plate	0.06-0.8	1	10-80	0.15-0.5	2.-4
3.Light vibrating roller	0.6-2	2-4	25-70	0.3-0.5	4-6
4.Heavy towed roller	6-15	8-10	25-30	0.3-1.5	4-6
5.Heavy self propelled roller	6-15	6-13	25-40	0.3-1.5	4-6
6.Impact roller	7	10-14	-	0.5-3	Up to 30

Field Compaction

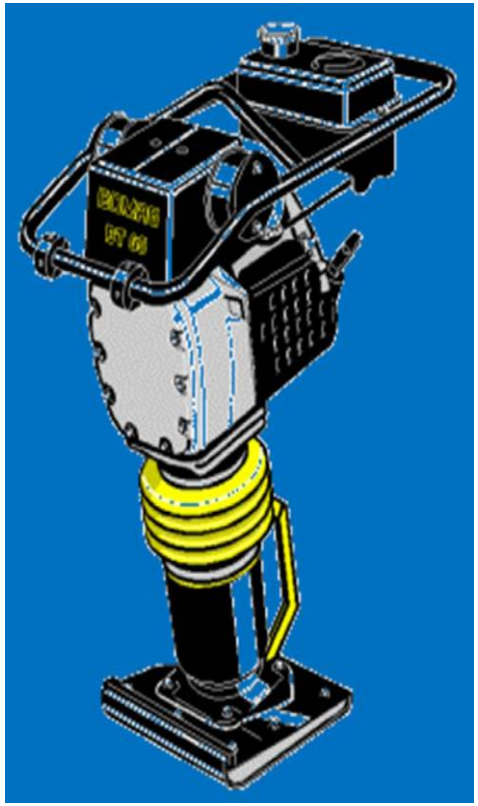
Different types of rollers (clockwise from right):

- Pneumatic rubber tired roller
- Vibratory roller
- Smooth-wheel roller
- Sheepsfoot roller

Smooth Wheeled Roller

Compacts effectively only to 200-300 mm; therefore, place the soil in shallow layers (lifts)

Vibrating Plates



- **for compacting very small areas**
- **effective for granular soils**

Sheepsfoot Roller

Provides kneading action; “walks out” after compaction Very effective on clays

Impact Roller

Provides deeper (2-3m) compaction. e.g., air field

Suitability of Rollers

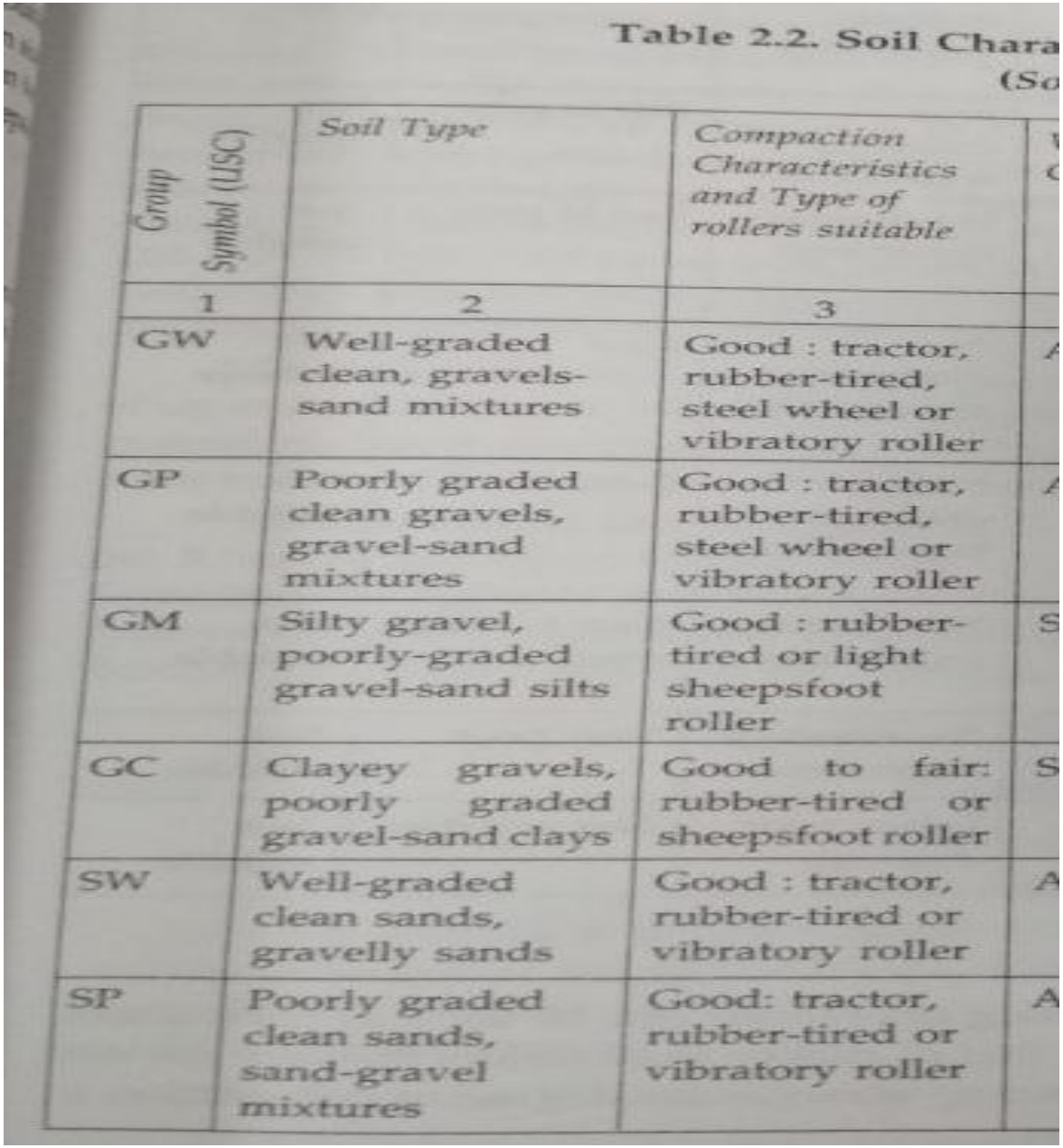


Table 2.2. Soil Chara
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Group Symbol (USC)	Soil Type	Compaction Characteristics and Type of rollers suitable	
1	2	3	
GW	Well-graded clean, gravels-sand mixtures	Good : tractor, rubber-tired, steel wheel or vibratory roller	A
GP	Poorly graded clean gravels, gravel-sand mixtures	Good : tractor, rubber-tired, steel wheel or vibratory roller	A
GM	Silty gravel, poorly-graded gravel-sand silts	Good : rubber-tired or light sheepsfoot roller	S
GC	Clayey gravels, poorly graded gravel-sand clays	Good to fair: rubber-tired or sheepsfoot roller	S
SW	Well-graded clean sands, gravelly sands	Good : tractor, rubber-tired or vibratory roller	A
SP	Poorly graded clean sands, sand-gravel mixtures	Good: tractor, rubber-tired or vibratory roller	A

1	2	3	
SM	Silty sands, poorly graded sand-silt mixtures	Good : rubber-tired or sheepsfoot roller	
SC	Clayey sands, poorly graded sand-clay mixtures	Good to fair : rubber-tired, or sheepsfoot roller	
ML	Inorganic silts and clayey silts	Good to poor : rubber-tired or sheepsfoot roller	
CL	Inorganic clays of low to medium plasticity	Good to fair : sheepsfoot or rubber-tired roller	
OL	Organic silts and silty clays, low plasticity	Fair to poor : sheepsfoot or rubber-tired roller	
MH	Inorganic clayey silts, elastic silts	Fair to poor : sheepsfoot or rubber-tired roller	
CH	Inorganic clays of high plasticity	Fair to poor : sheepsfoot roller	
OH	Organic clays and silty clays	Fair to poor: sheepsfoot roller	
Pt	Peat	Not suitable	

Properties of Compacted Soil

Soil classification	Range of densities, t/m^3		
	Very loose state	Laboratory std. compaction	Very dense state
GW	1.8–1.9	2.0–2.2	2.2–2.3
GW-GM, GM, GW-GP, GP-GM	1.7–1.9	1.8–2.1	2.1–2.3
GP	1.8	1.8–2.0	2.2
SW	1.5–1.7	1.8–2.1	2.1
SW-SM, SP-SM, SM	1.3–1.6	1.8–2.0	1.9–2.1
SP	1.4–1.6	1.6–1.9	1.8–2.0

Sand properties	Density index,* %				
	0–15 (very loose)	15–35 (loose)	35–65 (medium dense)	65–85 (dense)	85–100 (very dense)
N value, blows/300 mm	< 4	4–10	10–30	30–50	> 50
CPT resistance,† MPa	< 5	5–10	10–15	15–20	> 20
Dry unit weight, kN/m^3	< 14	14–16	16–18	18–20	> 20
Friction angle, degrees	< 30	30–32	32–35	35–38	> 38