Geotechnical Engineering–I

BSc Civil Engineering – 4th Semester

Lecture # 10

27-Feb-2015

by

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Lecture Handouts: https://groups.google.com/d/forum/geotec-1

"SOIL" as Construction Material

Soil is essential construction material of most construction projects:

- *Retaining walls*, *Embankments*,
- *Highways*,
- *Airports*,
- *Dams*, *Dikes*, etc.

Advantages of using soil:

- Easy *availability*
- *Durable*, and *long-lasting*
- Low *cost*

"SOIL" as Construction Material

Typical soils at *in-situ state*

- *weak*, *highly compressible*, or have *high permeability*
  - *Not ideal* for construction projects

Improvement of engineering properties (soil stabilization) is required;

- Mechanical stabilization ⟹ *Compaction*
- Chemical stabilization

In most civil engineering projects, whenever soils are imported or excavated and re-applied, they are **compacted**.

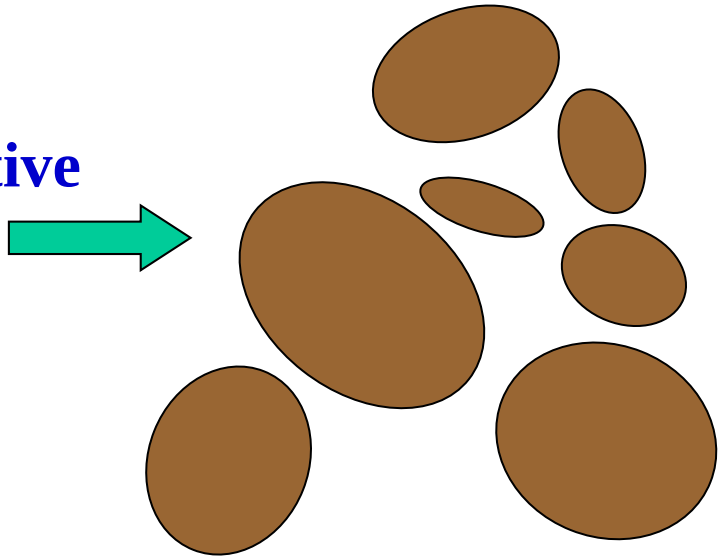
COMPACTION

Ground improvement technique in which soil is *densified* through external *compactive effort*.

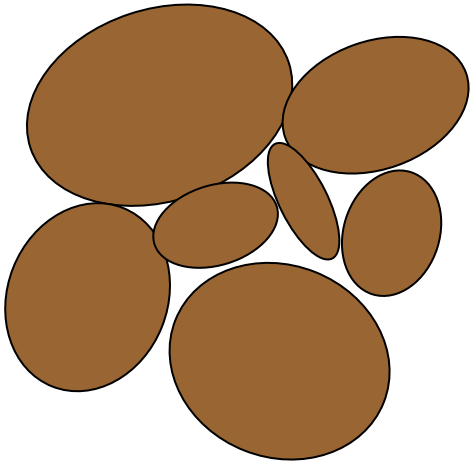
Measurement of Compaction

→ in terms of *dry unit weight*, γ_d

Compactive effort



+ water =

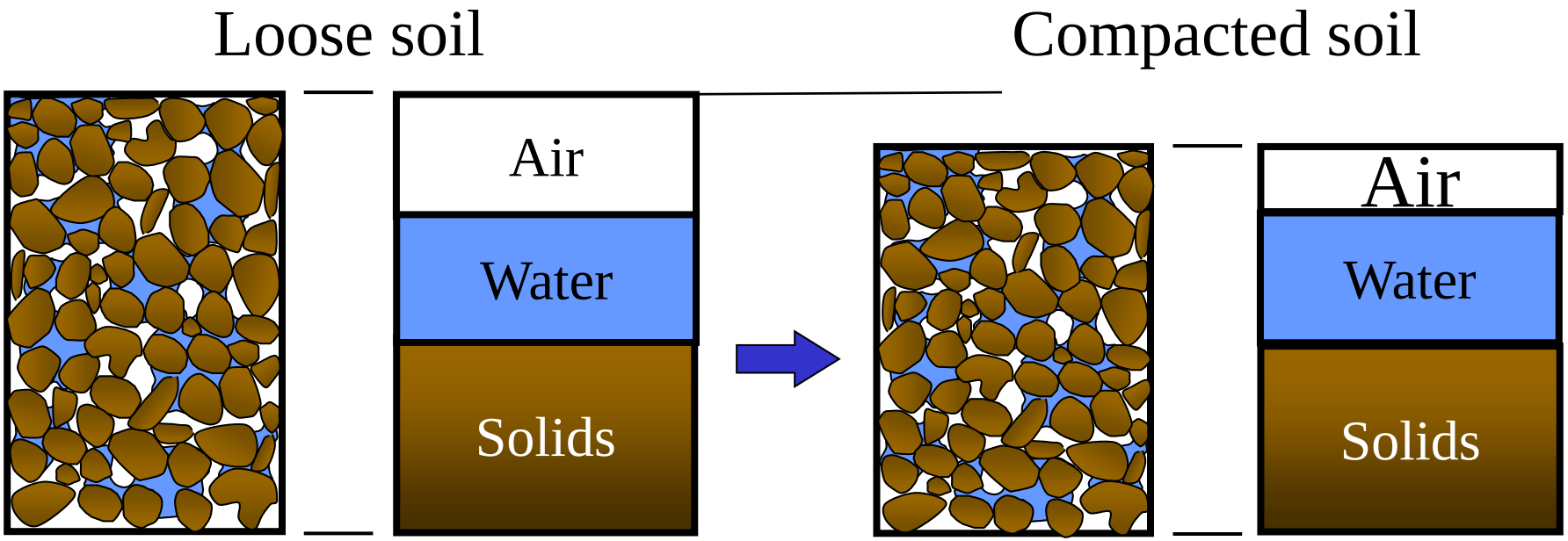


COMPACTION

Soil densification by applying *mechanical energy* to reduce *air voids*

reduces air content, but *not the water* content

can't compact saturated soil (almost always true)



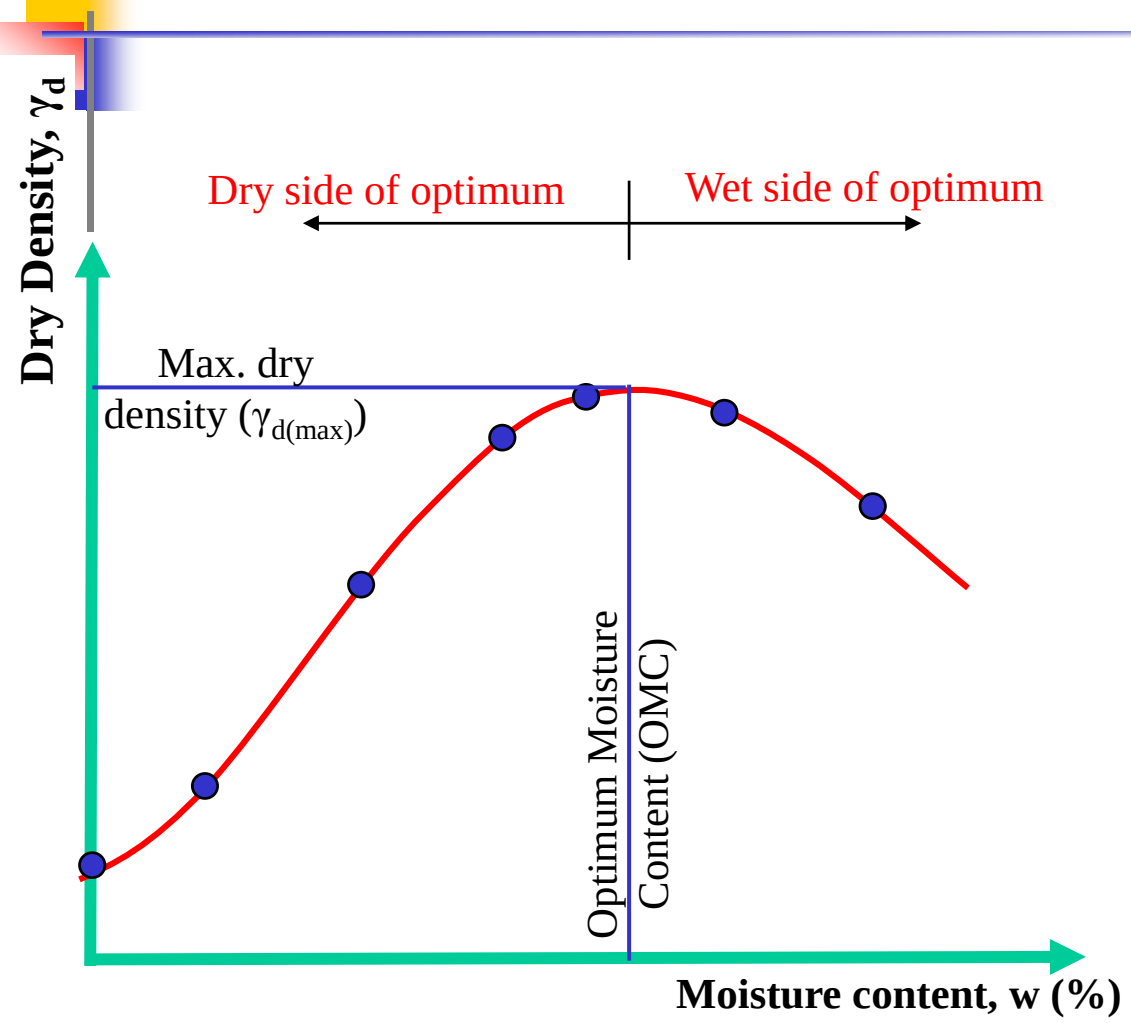
BENEFITS OF COMPACTION

- *Soil strength* → Increase
  - Bearing capacity
  - Slope stability, etc
- *Volume changes* → Decrease
  - Settlement
  - Swell potential, etc
- *Hydraulic conductivity* → Decrease

FACTORS AFFECTING DEGREE OF COMPACTION

- *Soil type*
  - gradation, composition, minerals, etc.
- *Compaction effort*
- *Moisture content*

EFFECT OF MOISTURE CONTENT



Dry side of Optimum

Water acts as a lubricant → becomes easy for particles to rearrange and orient.

Wet side of Optimum

Too much water → replaces soil particles

Optimum Moisture → density is maximum

Optimum moisture content (OMC): Moisture content of soil at which maximum density can be achieved for a given compactive effort.

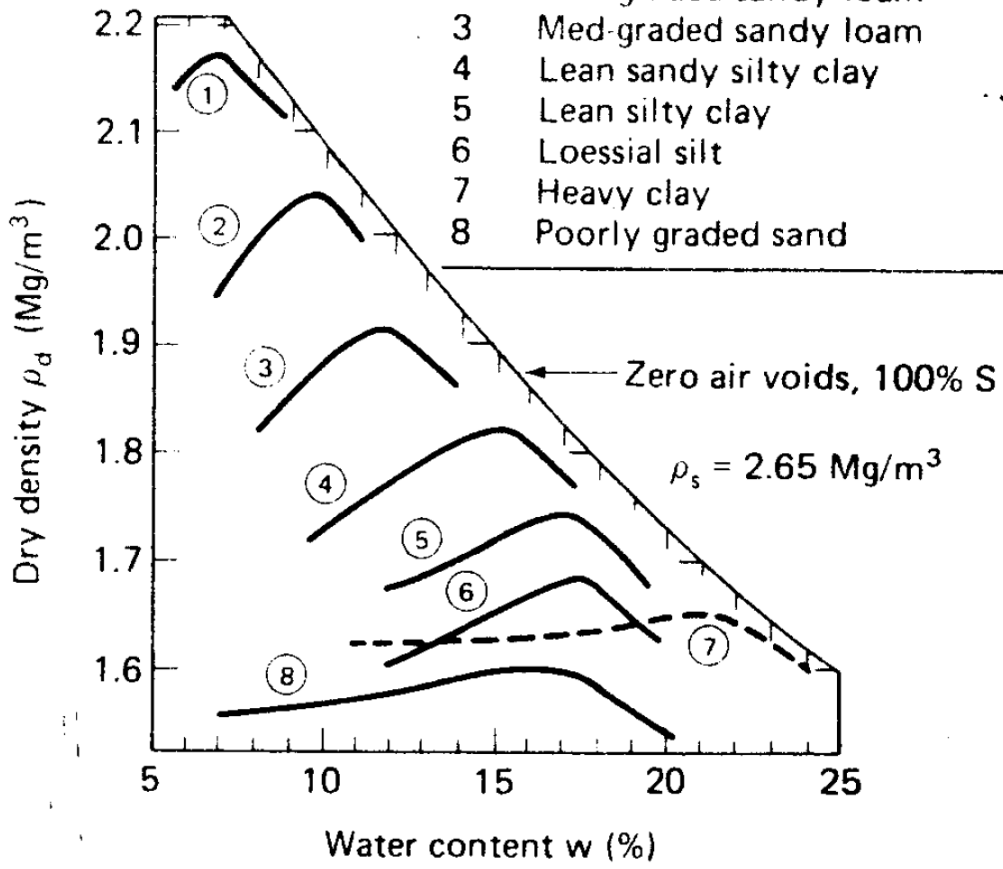
EFFECT OF MOISTURE CONTENT

Property	Side of Optimum	
	Dry	**Wet**
Soil Structure	More random (Flocculent)	More oriented (parallel)
Shear Strength	More	Less
Stress ~ strain behavior	Brittle	Ductile
Swelling	More → high water deficiency	Shrink more → abundance of water
Permeability	More	Less
Compressibility	More	Less

EFFECT OF SOIL TYPE

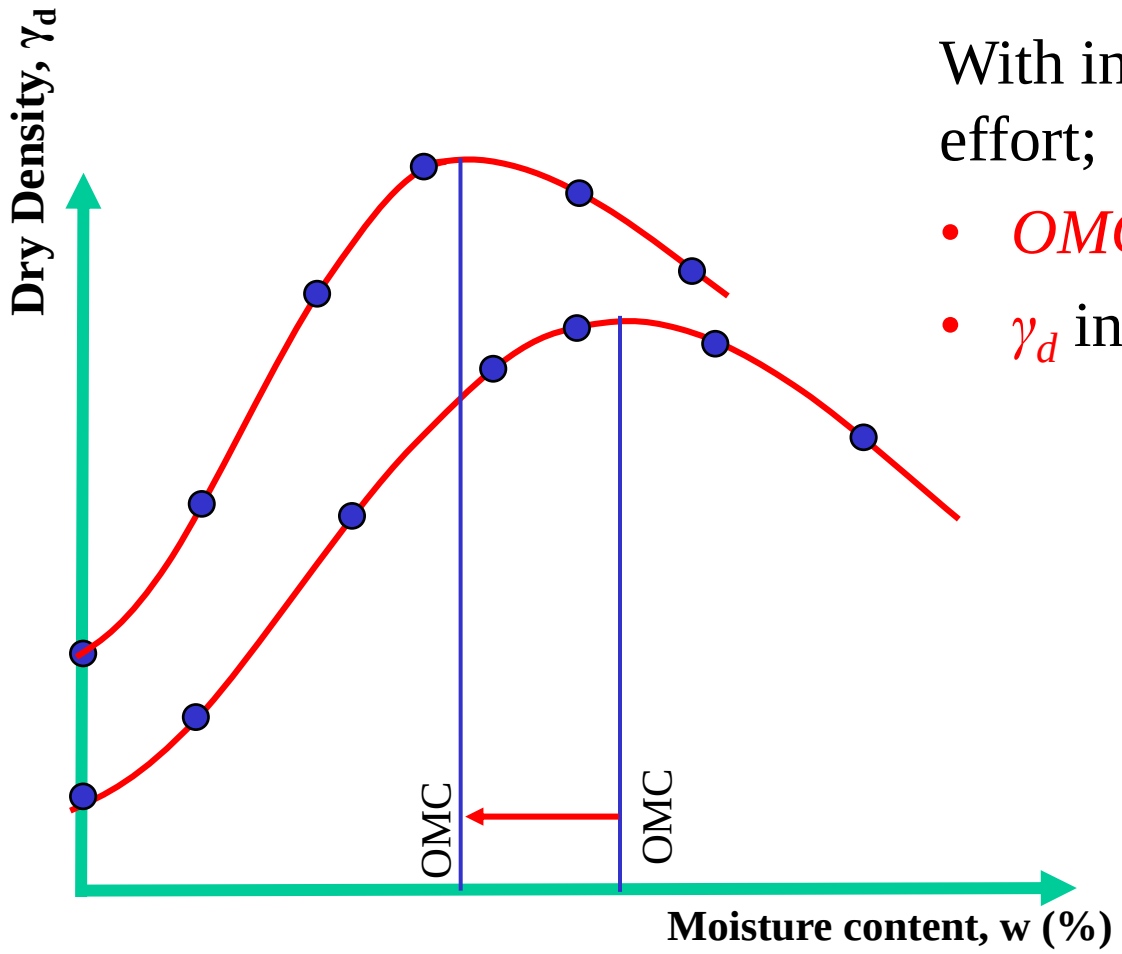
Soil texture and plasticity data

No.	Description	Sand	Silt	Clay	LL	PI
1	Well-graded loamy sand	88	10	2	16	N.P.
2	Well-graded sandy loam	72	15	13	16	N.P.
3	Med-graded sandy loam	73	9	18	22	4
4	Lean sandy silty clay	32	33	35	28	9
5	Lean silty clay	5	64	31	36	15
6	Loessial silt	5	85	10	26	2
7	Heavy clay	6	22	72	67	40
8	Poorly graded sand	94	– 6 –		N.P.	–



OMC of fine-grained soils is higher than coarse-grained soils.

EFFECT OF COMPACTION ENERGY



With increase in compaction effort;

- *OMC* decreases
- γ_d increases

EFFECT OF COMPACTION ENERGY

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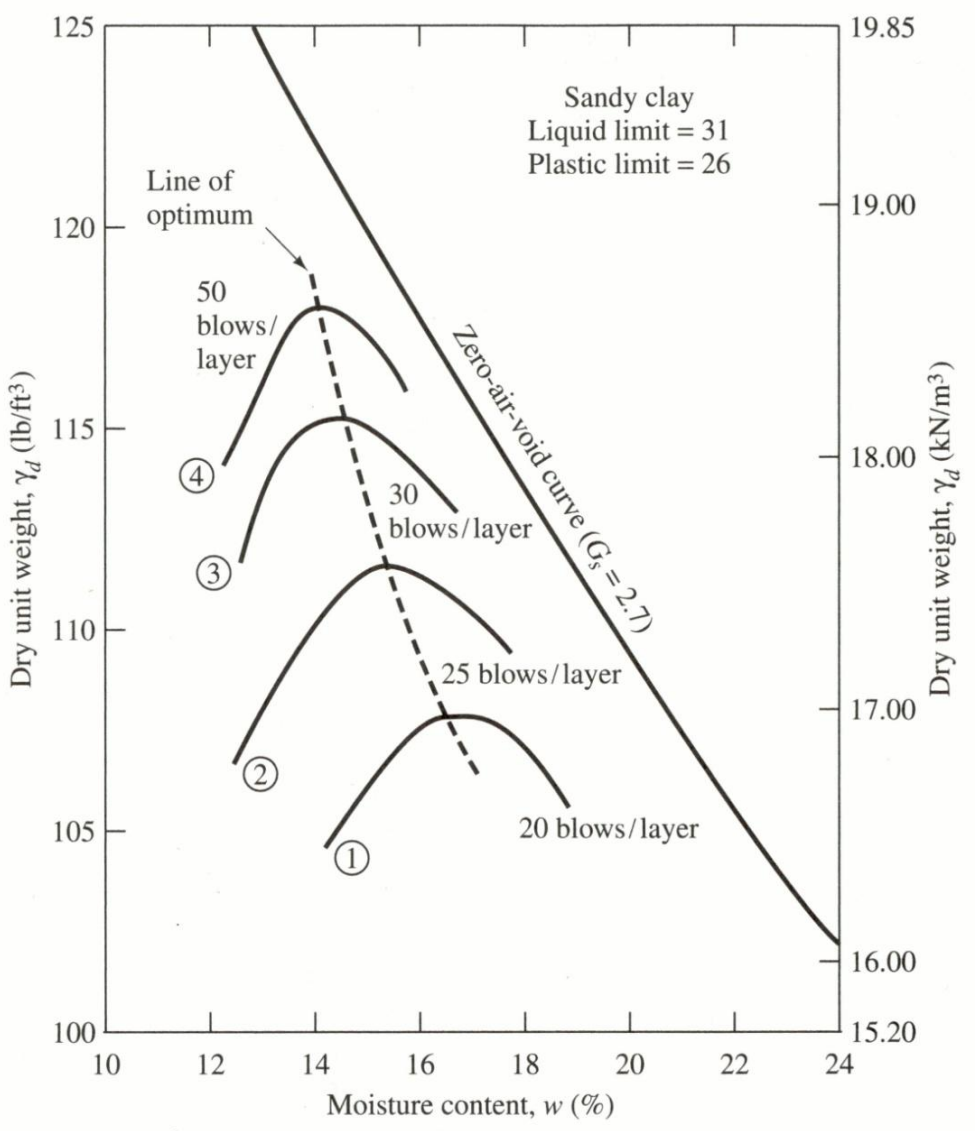

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