# Aggregates cont…



-Aggregates are mass of crushed stone, gravel, sand composed of individual particles, in some cases clays & silts

-The largest particle size in aggregates may have a diameter as large as 150 mm and the smallest particle can be as fine as 5 to 10 microns.

## Classification of aggregates: cont…

### -According to Size:



Fine aggregate F.A. diameter ≤ 5 mm

F.A. content usually 35% to 45% by mass or volume of total aggregate

# (a) Unit Weight (Bulk Density) and Voids



-The weight of the aggregate required to fill a container of a specified unit volume.

-Volume is occupied by both the aggregates and the voids between the aggregate particles.

-Depends on size distribution and shape of particles and how densely the aggregate is packed

- Loose bulk density
- Rodded or compact bulk density

## (b) Specific Gravity



-The weight–volume characteristics of aggregates are not an important indicator of aggregate quality, but they are important for concrete mix design.

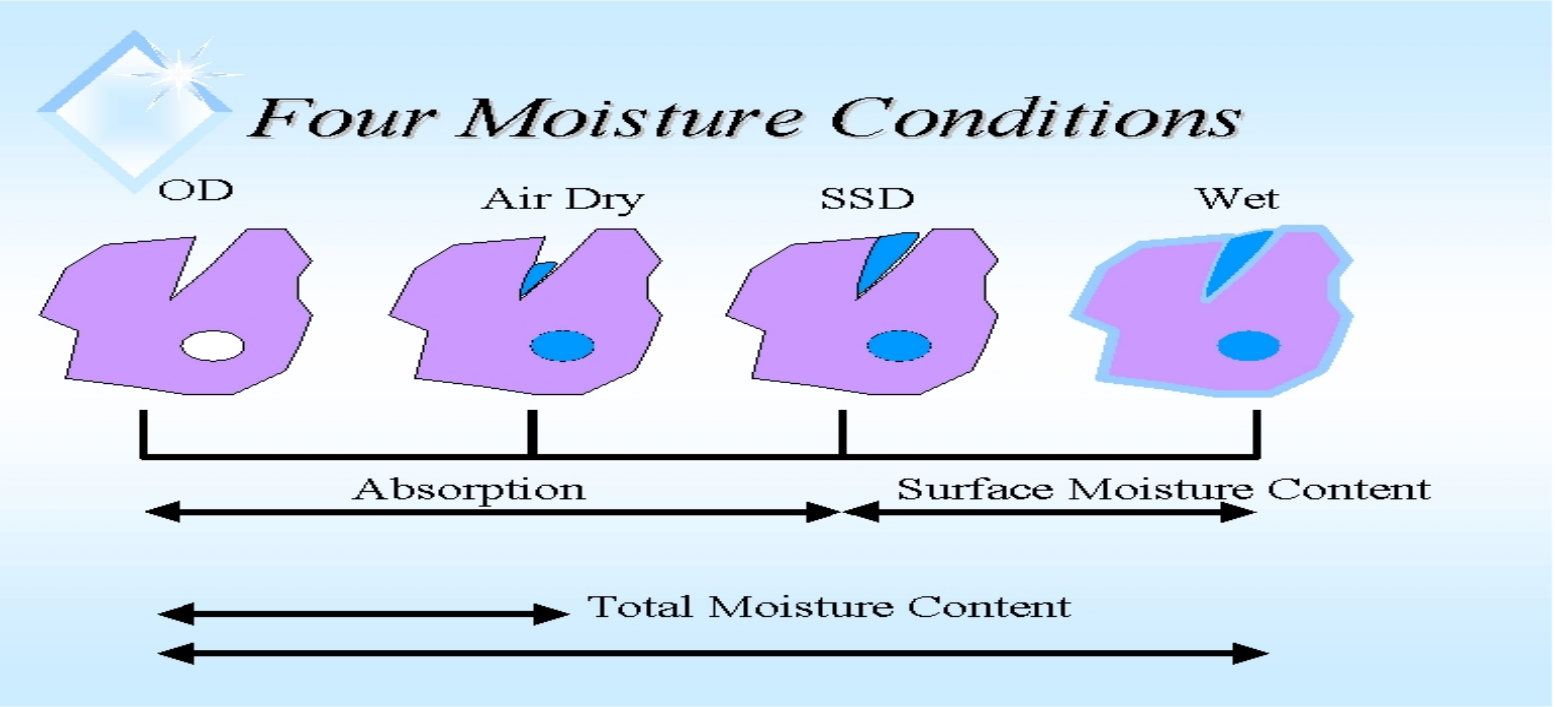
-Specific gravity is the mass of a material divided by the mass of an equal volume of distilled water.

-Three types of specific gravity are defined depending on how voids in aggregates particles are considered and used in concrete.

# (e) Absorption and Surface Moisture



-Moisture condition for aggregates are described as; oven dry, air dry, saturated surface dry SSD, Damp or wet



## (a) Strength



-In practice, majority of normal aggregates are considerably stronger than concrete

-Aggregate strength is generally important in high-strength concrete

-The tensile strength of aggregates ranges from 0.7 to 16 MPa , while the compressive strength ranges from 35 to 350 Mpa

# Grading of aggregates cont…



-A reasonable combination of fine & coarse aggregate must be used. This can be expressed by maximum density or minimum voids concept.

-As agg. get finer, the surface area increases that means more surface area → more paste & water requirement

# Grading of aggregates cont…



-The Fineness Modulus (FM) m ethods is used to determining the agg grading.

- The grading of the particles in an agg. sample is performed by "sieve analysis". The sieve analysis is conducted by the use of "standard test sieves". Test sieves have square openings & their designation correspond to the sizes of those openings.

Ex:A 500gr sample of a Fine Agg. was sieved. Determine FM?

| Sieve | Amount Retained on (gr) | Amount Retained on (%) | % Cumulative Retained on |
|---|---|---|---|
| 9.5 | 0 | 0 | 0 |
| 4.75 | 30 | 6 | 6 |
| 2.36 | 80 | 16 | 22 |
| 1.18 | 100 | 20 | 42 |
| 0.6 | 120 | 24 | 66 |
| 300um | 125 | 25 | 91 |
| 150um | 35 | 7 | 98 |
| Pan | 10 | 2 | 100 |



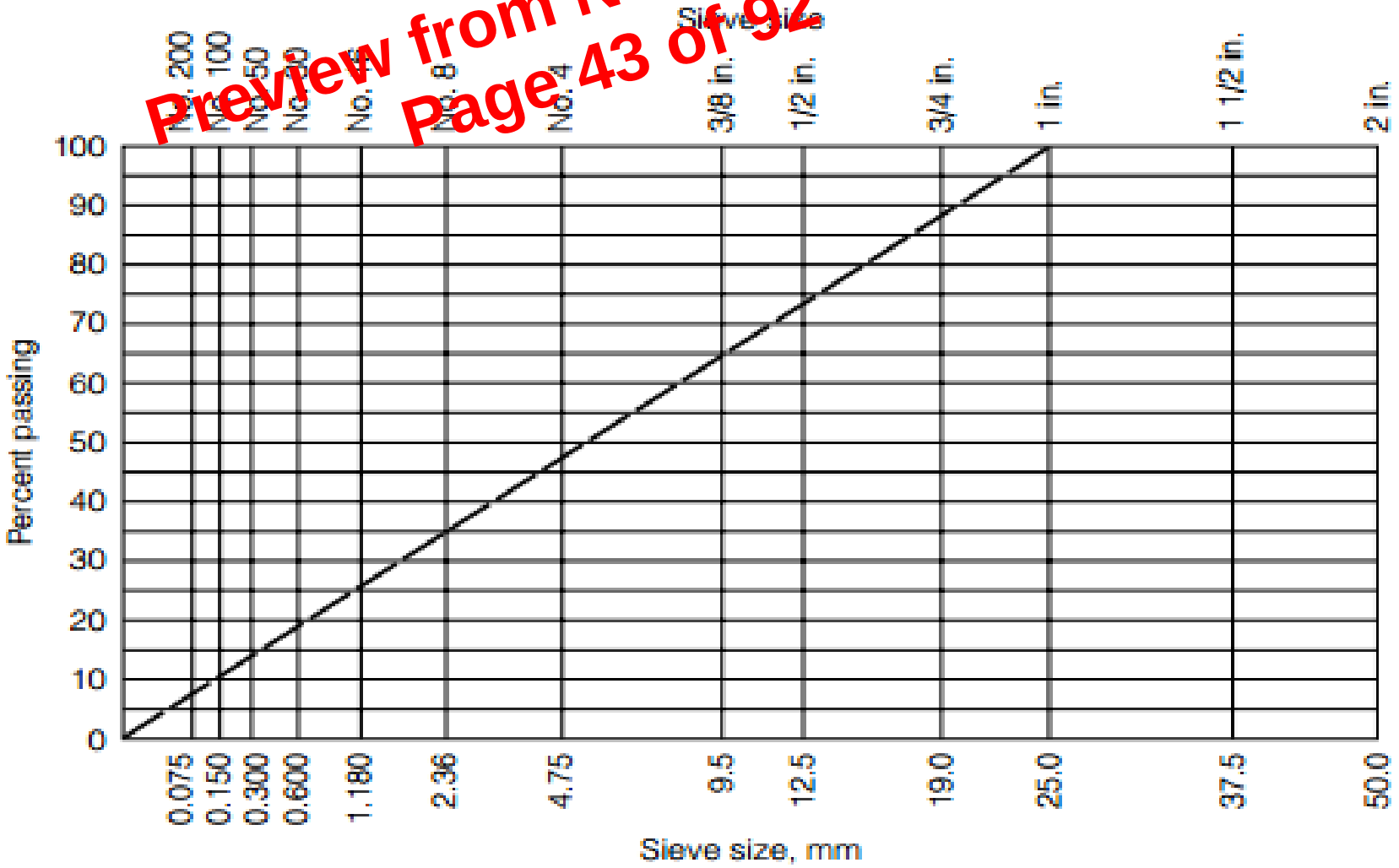
$$FM = \frac{6+22+42+66+91+98}{100} = 3.25$$

-Pan is not included.

# Grading of aggregates cont…

Typical maximum density gradation for a maximum size of 25 mm.





# Particle size distribution test cont…



-Typical sieve size;

80,63,40,20,16,10,4.75,2.36,1.18mm, 600,300,150 and 75micron

-A graph is plotted with sieve size on x – axis and percentage passing on y- axis .

-From the graph relative amount of various sizes of aggregates can be compared

## Aggregate Crushing Value Test (ACV) cont…



-The apparatus with the test sample and plunger in position is placed in compression machine and load applied gradually to maximum of 400kN

-The load is released and sample sieved on a 2.36mm sieve, the fraction passing the sieve weighed as B.

-Then Crushing value is obtained as (B/A) x 100

# 4.3 WATER

- Water is needed for two purposes:
  - chemical reaction with cement
  - workability



- only 1/3 of the water is needed for chemical reaction
- extra water remains in pores and holes results in porosity
- Good for preventing plastic shrinkage cracking and workability
- Bad for permeability, strength, durability.

# Water cont...

-Besides its quantity, the quality of mixing water used in concrete has important effects on fresh concrete properties, such as setting time and workability; it also has important effects on the strength and durability of hardened concrete.

-When non – potable sources of water are used, it is important to verify and document that the impurities in the water do no harm to concrete.

# Super-plasticizers (High-Range Water Reducers)



-These admixtures are added to concrete with a low-to-normal slump and water-cementing materials ratio to make high-slump flowing concrete.

-Flowing concrete is a highly fluid but workable concrete that can be placed with little or no vibration or compaction while still remaining essentially free of excessive bleeding or segregation.