SPECIFIC GRAVITY AND DENSITY

1- **Specific gravity:** Aggregate contain two types of pores permeable (open pores) and impermeable (closed pores)

- **Absolute Specific Gravity:** It is the ratio of the weight of a certain volume of aggregate (except for permeable and impermeable pores in the substance) to an equal volume weight of water.

  In order to find this kind of specific weight, the material must be crushed "completely" to remove the effect of impermeable pores, i.e. impermeable and set this type of weight not Important in concrete works because the aggregate is not used as a powder.

Abolute S.G = $\frac{mass\ of\ the\ solid\ excluding\ all\ pores}{mass\ of\ the\ water\ occuping\ a\ volume\ equal\ to\ the\ solid}$

- **Bulk S.G (Dry)** = $\frac{Wdry}{\text{Wssd}-Wimmersed}$
- **Bulk S.G (SSD)** = $\frac{Wssd}{\text{Wssd}-Wimmersed}$
- **S.G (Apparent)** = $\frac{Wdry}{\text{Wdry}-Wimmersed}$

2- **Density (γ)**: is the weight per unit of volume of a aggregate.

$\gamma = \frac{W}{V}$ where: w= total weight V= total volume

The density and the specific gravity of an aggregate particle is dependent upon the density and specific gravity of the minerals making up the particle and upon the porosity of the particle.

- **Bulk density:** the weight of unit volume of aggregate (including air voids) open and closed in aggregate. Bulk density depend on :

- Grade of compaction the aggregate.
- Size distribution and shape of aggregate.
- Humidity or moisture content of aggregate.

3- **Porosity and absorption** of aggregate influence on properties of concrete, because the aggregate occupies about 3/4 of the volume of concrete:

- ❖ Bond between it and hydrated cement paste.
- ❖ Resistance of concrete to freezing and wethering.
- ❖ Chemical stability of concrete.

Absorpton % = $\frac{B-A}{A}$

A: weight of dry aggregate

B: weight of saturated surface dry aggregate

Sieve Analysis of Aggregates

It is a process of dividing a sample of aggregate into various fractions, each contains particles between specific limits. The resultant 'particle size distribution' is called the gradation. The seive can be described by the size of openning and the number of opening per squar inch. Seive (4.75mm) or No. 4 is dividing line between coarse and fine aggregate.

Standard sizes of the sieve are:- 80, 40, 20, 10, 4.75, 2.36, 1.18, 600µ, 300µ,150µ

The gradation of aggregate is very important not only for concrete strength but for workability also. In fact the gradation of fine aggregate has much greater effect on concrete qualities. Fine aggregate should not be very coarse as it may cause **segregation or bleeding**. It should not be very fine also, otherwise it will have more water demand.

Sieve size		Mass retained g	Percentage retained	Cumulative percentage passing	Cumulative percentage retained
BS (1)	ASTM (1)	(2)	(3)	(4)	(5)
10.0 mm	$\frac{3}{8}$ in.	0	0.0	100	0
5.00 mm	4	6	2.0	98	2
2.36 mm	8	31	10.1	88	12
1.18 mm	16	30	9.8	78	22
600 µm	30	59	19.2	59	41
300 µm	50	107	34.9	24	76
150 µm	100	53	17.3	7	93
<150 µm	<100	21	6.8	–	–
		Total = 307		Total = 246	
				Fineness modulus =	2.46

The gradation of FA has been done by dividing into four zones i.e. Zone-1, Zone-11, Zone-111 &Zone-1V. The grading limits are shown in Table-3.

Table-3

IS Sieve	Percentage Passing			
	Zone-I	Zone-II	Zone-III	Zone-IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
*** 600 µ**	**15-34**	**35-59**	**60-79**	**80-100**
300 µ	5-20	8-30	12-40	15-50
150 µ	0-10	0-10	0-10	0-15

* Since the values for 600 µ size are not overlapping for different zones, it is used for confirming the zone of a sample of fine aggregate .

Zone-I represents the coarse and zone-IV represents the finer sand. Fine aggregate belong ينتمي to Zone-IV should not be used in reinforced concrete works unless tests have been made for suitability of mix proportion.

Fineness Modulus of Aggregates

Fineness Modulus is used in determining the degree of uniformity درجة التماثل of the aggregate gradation التدرج الحبيبي للركام. It is an empirical number رقم وضعي او تجريبي relating to the fineness of the aggregate. when the value of Fineness Modulus is high, the aggregate is coarser. Fineness Modulus is defined as the sum of the cumulative percentages retained on specified sieves divided by 100.

Table 3. Sample calculation of Fineness Modulus

Sieve Size	Percentage of individual fraction retained, by weight (%)	Cumulative percentage retained by weight (%)	Percentage passing by weight (%)
4	2	2	98
2	13	15	85
1	25	40	60
0.5	15	55	45
0.25	22	77	23
0.125	20	97	3
Pan	3	~~100~~	0
Total	100	Σ = 286	

FM = 286/100 = 2.86

1- **Fineness Modulus of Coarse Aggregates**: Fineness modulus of coarse aggregates is an index number مؤشر رقمي which represents the average size of the particles in the coarse aggregate. It is calculated by performing sieve analysis with standard sieves.

The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of Fineness Modulus. Higher the aggregate size higher the Fineness modulus.

Hence fineness modulus of coarse aggregate is higher than fine aggregate.

Coarse aggregate means the aggregate which is retained on 4.75mm sieve when it is sieved through 4.75mm. To find fineness modulus of coarse

aggregate we need sieve sizes of 80mm, 40mm, 20mm, 10mm, 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm.

Determination of Fineness Modulus of Coarse Aggregates To find fineness modulus we need to perform sieve analysis and for that above mentioned sieve sizes, Mechanical vibrator and digital weights scale.

2- Fineness Modulus of Sand:

Fineness modulus of sand (fine aggregate) is an index number which represents the mean size of the particles in sand. It is calculated by performing sieve analysis with standard sieves. The cumulative percentage retained on each sieve is added and subtracted by 100 gives the value of fineness modulus.

Fine aggregate means the aggregate which passes through 4.75mm sieve.

To find the fineness modulus of fine aggregate.

We need sieve sizes of 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm. Fineness modulus of finer aggregate is lower than fineness modulus of coarse aggregate.

Determination of Fineness Modulus of Sand To determine the fineness modulus, we need standard sieves, Mechanical vibrator, dry oven and digital weight scale.

Table-2

Sand	FM
Fine Sand	2.2 – 2.6
Medium Sand	2.6 – 2.9
Coarse Sand	2.9 – 3.2

FM more than 3.2 is generally considered unsuitable for concrete.