3.3 FACTORS AFFECTING THE MIX DESIGN

- Cost
- Specifications
- Grade of Concrete
- Type of cement
- Maximum nominal size of aggregate
- Grading of combined aggregate
- Maximum water / cement ratio
- Workability
- Durability
- Compressive strength

Cost

The cost of concrete is made up of

- **Material Cost**
- **Equipment Cost**
- **Labour Cost**

The variation in the cost of materials arises from the fact that cement is several times costlier than aggregates. So it is natural in mix design to aim at as lean a mix as possible. Therefore, all possible steps should be taken to reduce the cement content of a concrete mixtures without sacrificing the desirable properties of concrete such as strength and durability.

Specifications

The following point may be kept in mind while designing concrete mixes

- Minimum Compressive Strength required
- Minimum water/ cement ratio
- Maximum cement content to avoid shrinkage cracks
- Maximum aggregate / cement ratio
- Maximum density of concrete in case of gravity dams
- Environmental Exposure Conditions
- Degree of Workability

Grade of Concrete

- The grade of concrete gives characteristic compressive strength of concrete. It is one of the important factor influencing the mix design
- The grade M 20 denotes characteristic compressive strength f_{ck} of 20 N/mm^2. Depending upon the degree of control available at site, the concrete mix is to be designed for a target mean compressive strength (f_{ck}) applying suitable standard deviation.

Designation	Mix Proportion	Characteristic Compressive Strength in N/mm^2	Group (as per IS : 456 - 2000)
M5	1 : 5 : 10	5	Lean Mix
M7.5	1 : 4 : 8	7.5	
M10	1 : 3 : 6	10	Ordinary Concrete
M15	1 : 2 : 4	15	
M20	1 : 1½ : 3	20	
M25	1 : 1 : 2	25	Standard Concrete
M30	Designed	30	
M35		35	
M40		40	
M45		45	
M50		50	
M55		55	
M60		60	High Strength Concrete

Type of Cement

- The rate of development of strength of concrete is influenced by the type of cement.
- The higher the strength of cement used in concrete, lesser will be the cement content. The use of 43 grade and 53 grade of cement, gives saving in cement consumption as much as 15 % and 25 % respectively, as compared to 33 grade of cement. For concrete of grade M_{25} it is advisable to use 43 and 53 grade of cement.

Maximum Nominal Size of Aggregates

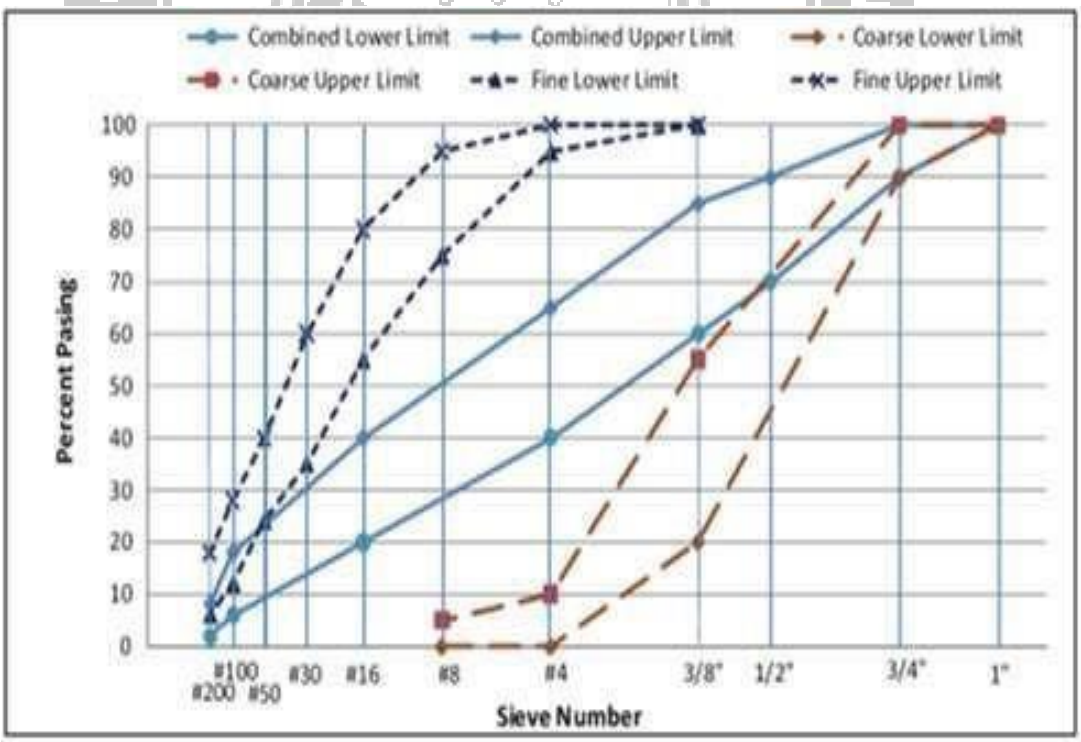
- The maximum size of C.Ais determined by sieve analysis. It is designated by the sieve size higher than larger size on which 15 %or more of the aggregate is retained. The maximum nominal size of C.A. should not be more than one-fourth of minimum thickness of the member.
- For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of the aggregate should usually be restricted to sum less than the minimum clear distance between the main bars or 5 mm less the minimum cover to the reinforcement, whoever is smaller?

- The workability of concrete increases with an increase in the maximum size of aggregate. But the smaller size of aggregates provide larger surface area for bonding with the mortar matrix which gives higher strength.

Grading of Combined Aggregates

- The relative proportions of the fine and coarse aggregate in a concrete mix is one of the important factors affecting the strength of concrete.

- For dense concrete, it is essential that the fine and coarse aggregate be well graded. In the case when the aggregate available from natural sources do not confirm to the specified grading, the proportioning of two or more aggregate become essential



Maximum Water / Cement Ratio

Abram's water / Cement ratio states that for any given condition of test, the strength of a workability concrete mix is dependent only on water / cement ratio. The lower the water / Cement ratio, the greater is the compressive strength.

Workability

Workability of fresh concrete determines the case with which a concrete mixture can be mixed, transported, placed, compacted and finished without harmful segregation and bleeding.

Durability

- Durability require low water/Cement ratio. It is usually achieved not by increasing the cement content, but by lowering the water demand at a given cement content.
- Water demand can be lowered by through control of the aggregate grading and by using water reducing admixtures