Concrete mix design

Design

Site conditions often restrict the quality and quantity of Ingredient materials. Concrete mix design offers a lot of flexibility on type of aggregates to be used In mix design. MIX design can give an economical solution based on the available materials If they meet the basic IS requirements. This can lead to saving In transportation costs from longer distances. C) Other properties: Mix design can help us to achieve form finishes, high early strengths for early disheartening, concrete with better flexural strengths, concrete with punctuality and concrete with lower densities.

Requirements of mix design Concrete mix design is the method of correct proportioning of ingredients of concrete, in order to optimize the above properties of concrete as per site requirements. The site engineer should give following information while giving material for mix design to the mix design laboratory: - a) Grade of concrete (the characteristic strength) b) Workability requirement In terms of slump c) Other properties Of required): - l. Retardation of Minimal set (to avoid cold Joints In case of longer leads or for ready-mix concrete) ii.

Slump retention (in case of ready mix concrete) iii. Punctuality (In case of ready mix concrete) v. Acceleration of strength (for pretest members or where early disheartening is desired) v. Flexural strength (normally required for concrete pavements) d) Ascertain whether condition of exposure to concrete is mild, moderate severe or very severe. Proper investigation of soil should be done to ascertain presence of sulfates &chlorides, in case of doubt. E) What is the degree of control at site? Following factors indicate degree of control at site: - I.

Batching - weigh batching / volume batching. N. Type of aggregates - whether mixed graded aggregate will be pseudo mm, mm aggregates will be used separately. Ill. Testing of concrete - whether casting & testing of concrete successful be done regularly at site. Lb. Source of aggregate - whether sources of sand and aggregate will be standardized or likely to change frequently. V. Supervision - whether qualified staff will be present to supervise concreting workman material properties. Factors affecting the choice of mix proportions The various factors affecting the mix design are: A.

Compressive strength It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean compressive strength required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix. The other factor affecting the strength of concrete at a given age and cured at a prescribed temperature is the degree of compaction. According to Abraham's law the strength of fully compacted concrete is inversely proportional to the water-cement ratio. A. Workability The degree of workability required depends on three factors.

These are the size of the section to be concreted, the amount of reinforcement, and the method of compaction to be used. For the narrow and complicated section with numerous corners or inaccessible parts, the concrete must have a high workability so that full compaction can be achieved with a reasonable amount of effort. This also applies to the embedded steel sections. The desired workability depends on the compacting equipment available at the site. B. Durability The durability of concrete is its resistance to the aggressive environmental conditions.

High strength concrete is generally more durable than low strength concrete. In the situations when the high strength is not necessary but the conditions f exposure are such that high durability is vital, the durability requirement will determine the water-cement ratio to be used. C. Maximum nominal size of aggregate In general, larger the maximum size of aggregate, smaller is the cement requirement for a particular water-cement ratio, because the workability of concrete increases with increase in maximum size of the aggregate.

However, the compressive strength tends to increase with the decrease in size of aggregate. IS 456: 2000 and IS 1343: 1980 recommend that the nominal size of the aggregate should be as large as possible. D. Grading and type of aggregate The grading of aggregate influences the mix proportions for a specified workability and water-cement ratio. Coarser the grading leaner will be mix which can be used. Very lean mix is not desirable since it does not contain enough finer material to make the concrete cohesive.

The type of aggregate influences strongly the aggregate- cement ratio for the desired workability and stipulated water cement ratio. An important feature of a satisfactory aggregate is the uniformity of the grading which can be achieved by mixing different size fractions. E. Quality Control The degree of control can be estimated statistically by the variations in test results. The variation in strength results from the variations in the properties of the mix ingredients and lack of control of accuracy in batching, mixing, placing, curing and testing.

The lower the difference between the mean and minimum strengths of the mix lower will be the cement-content required. The factor controlling this difference is termed as quality control. L. Mix Proportion designations is in the terms of parts or ratios of cement, fine and coarse aggregates. For e. G. , a onscreen mix of proportions 1 : 2: 4 means that cement, fine and coarse aggregate are in the ratio 1 : 2: 4 or the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate.

The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass Factors to be considered for mix design The grade designation giving the characteristic strength requirement of concrete. The type of cement influences the rate of development of compressive strength of concrete. Maximum nominal size of aggregates to be used in concrete may be as rage as possible within the limits prescribed by IS 456: 2000. The cement content is to be limited from shrinkage, cracking and creep.

The workability of concrete for satisfactory placing and compaction is related to the size and shape of section, quantity and spacing of reinforcement and technique used for transportation, placing and compaction. Mix Design Procedure as per IS: 10262. 1 . Determine the mean target strength Ft from the specified characteristic compressive strength at 28-day FCC and the level of quality control. Ft = FCC + 1. 65 S , where S is the standard deviation obtained from the Table of approximate contents even after the design mix. 2.

Obtain the water cement ratio for the desired mean target using the empirical relationship between compressive strength and water cement ratio

so chosen is checked against the limiting water cement ratio. The water cement ratio so chosen is checked against the limiting water cement ratio for the requirements of durability given in table and adopts the lower of the two values. 3. Estimate the amount of entrapped air for maximum nominal size of the aggregate from the table. 4. Select the water content, for the required workability and maximum size of aggregates (for aggregates in saturated surface dry condition) from table. . Determine the percentage of fine aggregate in total aggregate by absolute volume from table for the concrete using crushed coarse aggregate. 6. Adjust the values of water content and percentage of sand as provided in the table for any difference in workability, water cement ratio, grading of fine aggregate and for rounded aggregate the values are given in table. 7. Calculate the cement content form the water-cement ratio and the final water content as arrived after adjustment. Check the cement against the minimum cement content from the requirements of the durability, and greater of the two values is adopted. 8.

From the quantities of water and cement per unit volume of concrete and the percentage of sand already determined in steps 6 and 7 above, calculate the content of coarse and fine aggregates per unit volume of concrete from the following relations: where V = absolute volume of concrete= gross volume (1 mm) minus the volume of entrapped air Sc = specific gravity of cement W = Mass of water per cubic meter of concrete, keg C = mass of cement per cubic meter of concrete, keg = ratio of fine aggregate to total aggregate by absolute volume FAA, Ca = total masses Sac = specific gravities of saturated surface dry fine and coarse aggregates, respectively 9. Determine the concrete mix proportions for the first trial mix. 10.