Designing and Proportioning Normal Concrete Mixtures

(ACI 211.1-91) Reapproved 1997 Method

1. choose the workability (slump)

2. choose the maximum size of aggregate

- Generally the nominal maximum size of aggregate should be the largest that is economically available and consistent with dimensions of the structure.

The nominal max. size of Aggregate should Not Exceed

A. 1/3 of the slab depth

B. 3/4 of the minimum clear space between reinforcing bars

C. 1/5 of the narrowest dimension between the sides of forms

3. Estimation of mixing water and air content

4. Selection of water-cement or water-cementitious materials ratio.

The required w/c or w/(c+P) is determined not only by strength requirements but also by factors such as durability.

• For sever conditions of exposure, Table 4 gives limiting values

5. Calculation of cement content

The required cement content is equal to the estimated mixing-water content divide by the water-cement ratio

Cement content= water content (W)/ (w/c) ratio

6. Estimation of coarse aggregate content

wt. of C.a= Bulk volume of dry rodded C.a. × Bulk density

7. Estimation of fine aggregate content

All ingredients of the concrete have been estimated except the fine aggregates. Its quantity is determined by difference. Either of two procedures by the weight or by the absolute volume method:

• Absolute vol. of sand

$$1 = \left(\frac{w}{1000} + \frac{C}{3.15 * 1000} + \frac{C.a}{S.g * 1000} + \frac{F.a}{S.g * 1000}\right) + A$$

• Wt of F.a= Total wt of concrete - Total wt of (W+C+C.a)

8. Adjustments for aggregate moisture

Example : design a mix (according to ACI method) used in underground structure but not subjected to sever conditions and using the following information:

- 28 days strength =25MPa , S.D=3.6
- Slump=75-100mm
- Nominal max size of C.a=37.5mm, S.g=2.68, dry-roded mass of 1600kg/m^3
- F.a (Fineness modulus F.M=2.8, S.g=2.64)

Sol.

Step 1 - The slump is required =75-100mm

Step 2 – The Agg. to be used has a nominal max size of =37.5mm

Step 3 - The estimating mixing water (W)= 181kg/m^3 & volume of entrapped air=1%

Step 4 – The W/C ratio with a strength 25 MPa is found to be 0.61

Step 5 – The required cement content (C) = W/(W/C)= 181/0.61

C =296.7kg/m^3

Step 6 – The quantity of C.a=0.71×1600=1136kg/m^3

Step 7 – The required F.a may be determine on the basis of either mass or absolute volume as shown below:

A. Mass basis : the mass of F.a= 2410-(181+296.7+1136)=796kg

B. Absolute volume basis : the sand can be calculated as follows :

$$1 = \left(\frac{181}{1000} + \frac{296.7}{3.15 * 1000} + \frac{1136}{2.68 * 1000} + \frac{F.a}{2.64 * 1000}\right) + 0.01$$

F.a= 768.24 Kg