FORMULATION OF TYPICAL DESIGN OF CONCRETE MIXTURE

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ABSTRACT

Production of good quality concrete requires meticulous care exercised at every stage of manufacture of concrete. It is interesting to note that the ingredientsof bad concrete are the same. If meticulous care is not exercised and good rules arenot observed, the resultant concrete is going to be of bad quality. With the same material if intense care to exercise control at every stage it will in good concrete.

INTRODUCTION

One of the all most aims of evaluating the various properties of ingredients of concrete is to enable a concrete technologist a design a concrete mixture for a particular a concrete mixture is not a simple task on account of widely varying properties of the constituent materials, the condition that prevail at the site of workand the conditions that are specified for a particular work for which the mixture is designed. With better understanding of the properties of the constituent materials than in the past, this chapter presents the guidelines for the design of typical concrete mixture using the ingredients described in earlier chapter and simple calculation for proportioning of M_{20} Grade concrete [1-3].

METHODOLOGY

The method of concrete mix design consist of following steps

- Design specification
- Testing of materials
- Calculating target strength for mix proportioning
- Selecting water/cement ratio
- Calculating water content
- Calculating cement content
- Mix calculations
- Mix proportion

DESIGN SPECIFICATIONS

The data required for mix proportioning is as follows.

Grade designation	= M_{20}
Type of cement	= OPC 53 Grade
Maximum nominal size of aggregates	= 20mm
Minimum cement content	= 250kg/m_3
Maximum water-cement ratio	= 0.50
Workability	= 25mm
Type of aggregate	= Crushed Angular Aggregate

TESTING OF MATERIALS

The results obtained by testing the required materials are as follows

Cement Used	= OPC 53 grade cement
Sp. Gravity of Cement	= 3.15
Sp. Gravity of Water	= 1.00
Sp. Gravity of 20 mm Aggregate	= 2.80
Sp. Gravity of Sand	= 2.69
Sieve Analysis of Coarse Aggregates	= 4.8
Sieve Analysis of Fine Aggregates	= 2.5

TARGET STRENGTH CALCULATION

The target compressive strength of concrete can be determined using the formulagiven below.

$f_{ck}'' = f_{ck} + 1.65s$

Where,

f_{ck}'' = Target compressive strength at 28 days in N/mm^2.

f_{ck} = Characteristic compressive strength at 28 days in N/mm^2.s =

Standard deviation

The value of standard deviation can be taken IS code 10262-2009, Table 1.f_{ck}'' =

20 + 1.65*4 = 26.6 Mpa.

SELECTION OF WATER-CEMENT RATIO

For calculation, the maximum water cement ratio is 0.50 as given in IS code 456-2000 according to the exposure conditions.

Adopted water cement ratio is 0.46.

SELECTION OF WATER CONTENT

Selection of water content depends upon a number of factors such as

- Aggregate size, shape & texture
- Workability
- Water cement ratio
- Type of cement and its amount
- Type of admixture and environmental conditions.

Factors that can reduce water demand are as follows

- Using increased aggregate size
- Reducing water cement ratio
- Reducing the slump requirement
- Using rounded aggregate
- Using water reducing admixture

Factors that can increase water demand are as follows

- Increased temp. at site
- Increased cement content
- Increased slump
- Increased water cement ratio
- Increased aggregate angularity
- Decrease in proportion of the coarse aggregate to fine aggregate

The quantity of maximum mixing water per unit volume of concrete may be selected from the table in IS 10262-2009. The maximum water content required for the 20mm size of aggregate is 186 kg/m^3.

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CALCULATING CEMENTIOUS MATERIAL CONTENT

From the water cement ratio and the quantity of water per unit volume of cement,the amount of cementious material is calculated.

C = 186/0.46 = 404.35 kg/m^3.

MIX CALCULATIONS

A	Volume of concrete	1m^3	1m^3
B	Volume of cement	(Mass of cement/specific gravity of cement)*(1/1000)	= (404.35/3.15)*(1/1000) = 0.128
C	Volume of water	(Mass of water/specific gravity of water)*(1/1000)	= (186/1)*(1/1000) = 0.186
D	Volume of air	2% of 1m3.	= (2)*(1/100) = 0.02
E	Volume of total aggregate (C.A+F.A)	[a-(b+c+d)]	= 1 – (0.128+0.186+0.02) = 0.665m^3
F	Mass of coarse aggregate	e*Volume of coarse aggregate*specific gravityof coarse aggregate*1000	=(65/100)*0.665*2.80*1000 = 1209.6 kg/m^3
G	Mass of fine aggregate	e*Volume of fine aggregate*specific gravityof fine aggregate*1000	= (35/100)*0.665*2.69*1000 = 626.77 kg/m^3

The mix calculations per unit volume of concrete shall be done as follows

MIX PROPORTION

The mix proportion required for the grade M_{20},

Mass of Cement in kg/m^3	404.35
Mass of Water in kg/m^3	186
Mass of Fine Aggregate in kg/m^3	626.77
Mass of Coarse Aggregate in kg/m^3	1209.6
Water Cement Ratio	0.46

The required mix ratio is **1: 1.55: 2.99.**

OBSERVATIONS

The mould is filled with concrete in four layers. Each layer is tamped 25 times by the tamping rod taking care to distribute the strokes evenly over the cross section. The mould is removed from the concrete by raising it slowly and carefullyin a vertical direction. The difference in level between the height of the mould and height of subsided concrete is noted and it is taken as slump value. The slump testsconducted shows slump value of 70 mm. The medium degree of workability is obtained from the test result [4].

The sample of concrete to be tested is placed on the top hopper upto the brim. The trap door is opened so that the concrete falls into the lower hopper.Then the trap door of the bottom hopper is opened and the concrete is allowed to fall into the cylinder. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades supplied with the apparatus. The outside of the cylinder is wiped clean. The concrete is exactly filled upto the top level of the cylinder and is weighed to the nearest 10 grams. This weight is known as "Weight of partially compacted concrete". The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5 cm deep.

The layers are heavily rammed or preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete is then carefully struck off level with the top of the cylinder and weighed to the nearest 10 grams. This weight is known as "Weight of fully compacted concrete" [5].

The cube specimens are demoulded after 24 hours from the process of moulding. If the concrete has not achieved sufficient strength to enable demoulding the beam specimens, then the process must be delayed for another 24 hours care should be taken not to damage the specimen during the process because, if any damage is caused, the strength of the concrete may get reduced. The concrete specimens were placed in a curing tank after demoulding. Then the specimens are taken out of the curing tank after curing and tested.

Compressive test are made at recognized ages of the test specimens. Least three specimens, preferably from different batches shall be made for testing at each selected age. The cubes are placed in the compression testing machine in such manner that the load is applied to the opposite sides of the cube as cast. The load is applied at the rate of 140 kg/cm^2/min (approximately) until the failure ofthe specimen [6-9].

RESULTS AND DISCUSSIONS

The result of the investigations carried out for finding out compressive strength, split tensile strength, flexural strength using silica fume as partial replacement of cement.

Table 1 Compressive strength of concrete

% of silica fume	Compressive strength of concrete N/mm^2		
	7 Days	14 Days	28 Days
0	14.83	19.74	26.78
10	16.24	23.49	29.37
20	17.53	25.37	33.92
30	15.17	22.18	27.14
50	13.47	17.86	22.58

Table 2 Tensile strength of concrete

% of silica fume	Tensile strength of concrete N/mm^2		
	7 Days	14 Days	28 Days
0	13.88	17.74	21.79
10	15.94	20.43	25.56
20	18.41	22.98	27.41
30	14.28	18.56	23.18
50	11.91	15.87	19.23

Table 3 Flexural strength of concrete

S.no	% of silica fume	Flextural strength of concrete N/mm^2
1	0	3.46
2	10	4.12
3	20	5.05
4	30	3.92
5	50	3.08

CONCLUSION

- From the results obtained in compression testing, tensile testing and flexural testing it is found that the compression strength, tensile strength and flexural strength was found to be increasing up to and 20% replacement of cement by silica fume and full coarse aggregate.
- Silica fume can be used to replace cement and fully fine aggregate in concrete. Addition of silica material helps to reducing the utilization of cement in concrete.
- The compressive strength of concrete with the replacement of silica fume and fullyfine aggregate at a rate of 20% shows a higher result than the control concrete and also it increase the split tensile strength of the concrete with the addition of these silica material.
- The flexural strength of concrete with the replacement of silica fume at a rate of 20% shows a higher result than the normal concrete at only 28days.
- Water absorption of the specimens are constantly reducing with increase in addition of these silica materials.
- In feature further study can be done by using different type of admixtures.
- The quality of concrete was found to be good compared to control concrete. Hence this replacement technique will turn in a fruitful concrete in future.

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