Analysis of Compressive Strength of Concrete with Comparison of Concrete Grade

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Abstract— Compressive strength of concrete is the most important input data for engineering computations during the design of reinforced concrete structures. In this analysis, compressive strength of concrete is determined by the compressive testing machine. In this research work, we have constructed cubes as a specimen size of 150mm x 150mm x 150mm.We used two grades of concrete which are M20 and M25 grade of concrete. We tested cubes at 7, 14, 28 days of casting. The materials which are used in this study are OPC cement, coarse aggregate, fine aggregate and water. Concrete should be strong enough to bear the desired stresses within the permissible factor of safety. However, it is known that the variance of compressive strength test result by CTM becomes large and it is difficult to evaluate precisely the compressive strength, so we use average compressive strength.

Key words: OPC, Compressive strength, Concrete, CTM, Aggregates, Cubes

I. INTRODUCTION

Compressive strength of concrete is determined by testing of molded specimens or it can be determined by core specimens drilled from existing structures. In this testing, the specimens are loaded up to failure to find compressive strength, usually under standardized laboratory testing conditions. Molded specimens, however, do not always represent the genuine condition of structural concrete. The strength of concrete can be estimated from the measured results with limited reliability. CTM is a classic testing method based on the compression of concrete which became popular in the industry of construction. Increasing the strength of concrete with age has led to the development of this method to measure its compressive strength.

To find a reliable method for strength estimation one should study all the influencing factors that can have any effect on the strength measurement, and also that can have any effect on the variability of the strength of the concrete structure checked-up. The estimation should be based on a comprehensive study with the number of test results high enough to provide an acceptable reliability level. The estimation should take care of the rules of mathematical operations. In this study, we have taken specimen size of 150mm x 150mm x150mm. This is the destructive test of concrete. The main purpose of testing concrete cubes is the compressive strength of a cube which is sign of the strength of concrete. It is possible to correlate the flexural compressive and flexural tensile strength of concrete and its modulus of elasticity is correlated to cubes strength of concrete. It helps in determining whether the mix proportions are satisfactory or not and to check whether they need some more changes. The variations, in compressive strength of cube at site from time to time for a specified grade of concrete, give an indication of the quality control. If concrete cubes casted from same mix are tested at different time, it helps in determining the rate of gain of strength. Compressive strength test of concrete may also be conducted on 150mm diameter and 300mm high cylinders in accordance with IS : 516-1959 instead of on cubes. The value of cylinder strength may be increased by 25% to get the equivalent strength for 150mm cubes.

II. MATERIALS USED

A. Cement

We have been using OPC cement of 43 grade. Now-a-days, it is widely used in construction industry.

PROPERTIES	TEST RESULTS	STANDARD RESULTS AS PER IS CODE
Consistency	31%	30 %
Initial Setting Time	80 minute	Not less than 30 minute
Final Setting Time	320 minute	Not more than 600 minute
Fineness	8 %	Not less than 10 %
Specific Gravity	3.152	3.15
Compressive Strength	45 N/mm^2	Not less than 43 N/mm^2

Table 1 Physical Properties of Cement

It is manufactured by grinding Portland clinker with the addition of some quantity of gypsum, water or both and not more than 1% of air entraining agents.

B. Coarse Aggregate

The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates. Crushed granite aggregate of 4.75-20 mm sizes are used for control concrete for comparison. Coarse aggregate of size 20 mm and 10 mm both are used in this project. Coarse aggregate produced from the crushing of granites shall be sound and durable.

S.NO.	PROPERTIES	TEST RESULTS
	Maximum Size	20 mm
	Fineness Modulus	7.65
	Specific Gravity	2.72
	Water Absorption	0.3 %
	Crushing Value	17
	Impact value	09

Table 2: Physical Properties of Coarse Aggregate

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S.NO.	PROPERTIES	TEST RESULTS
	Fineness Modulus	2.78
	Specific Gravity	2.68
	Silt Content	2.52 %
	Water Absorption	0.9 %
	Bulking	31.5

Table 3: Physical Properties of Coarse Aggregate

C. Fine Aggregate

Red sand (Morang) is used throughout the study as the fine aggregate conforming to grading zone II as per IS 383:1970. The sand was air-dried and sieved to eliminate any heavy particles before mixing. The fine aggregate also helps the cement paste to hold the coarse particles.

D. Water

Water is an important part of concrete as it actively participates in the chemical reaction with cement. For proper chemical action, the amount of water required is about 25 % of the weight of cement used and more water is used for proper workability of concrete. The water used for both mixing and curing should be free from harmful amount of oils, acids, alkalis, salts, organic materials. The water is tested in accordance with IS: 3025-1984 to 1988 (parts 1-32).In this project clean potable water is used.

III. Mix Design For M 20 Grade Of Concrete

A. Design Stipulations

Characteristic Compressive Strength required at the end of 28 days: 20 N/mm2
Maximum size of Aggregate: 20mm
Type of Exposure: Moderate
Degree of Quality Control: Good
Method of concrete placing: Manually
Workability: 45 mm (slump)

CEMENT	WATER	COARSE AGGREGATE	FINE AGGREGATE
413	186	1170	677

Table 4: Mix Proportion of M-20 Grade

B. Test Data for Materials

Specific Gravity of Cement: 3.152
Specific Gravity of Coarse Aggregate: 2.72
Specific Gravity of Fine Aggregate: 2.68

C. Target Mean Strength of Concrete

For a tolerance factor of 1.65, the obtained target mean strength for the given grade of concrete
= 20 + 4 x 1.65 = 26.60 N/mm^2

D. Selection of Water Cement Ratio

The water cement ratio for the obtained target mean strength is 0.45.This is equal to the value prescribed for Moderate conditions in IS 456-2000.

IV. MIX DESIGN FOR M 25 GRADE OF CONCRETE

A. Design Stipulations:-

Characteristic Compressive Strength required at the end of 28 days: 25 N/mm2
Maximum size of Aggregate: 20mm
Type of Exposure: Moderate
Degree of Quality Control: Good
Method of concrete placing: Manually
Workability: 70 mm (slump)

CEMENT	WATER	COARSE AGGREGATE	FINE AGGREGATE
426	192	668	1154

B. Test Data for Materials:-

Specific Gravity of Cement: 3.152
Specific Gravity of Coarse Aggregate: 2.72
Specific Gravity of Fine Aggregate: 2.68

C. Target Mean Strength of Concrete:-

For a tolerance factor of 1.65, the obtained target mean strength for the given grade of concrete
= 25 + 4 x 1.65 = 31.60 N/mm^2

D. Selection of Water Cement Ratio:-

The water cement ratio for the obtained target mean strength is 0.45.This is equal to the value prescribed for Moderate conditions in IS 456-2000.

E. Mixing Proportion:

Quantity of mix: 1 m^3

The mixture proportioning was done according the Indian Standard Recommended Code IS 10262:2009. The target mean strength was 31.60 MPa for OPC control mixture, the total binder content 426 kg/m^3, fine aggregate has been taken 668 kg/m^3 coarse aggregate has been taken 1154 kg/m^3 the water to cement ratio was kept constant 0.45.

V. Testing Of Cubes

We tested the cubes of size 150 mm x 150 mm x 150 mm by CTM machine to determine the compressive strength of concrete. The compression test on concrete cubes is the most commonly used test. We have casted 6 cubes of each grade as a specimen for testing and determining the compressive strength of concrete.

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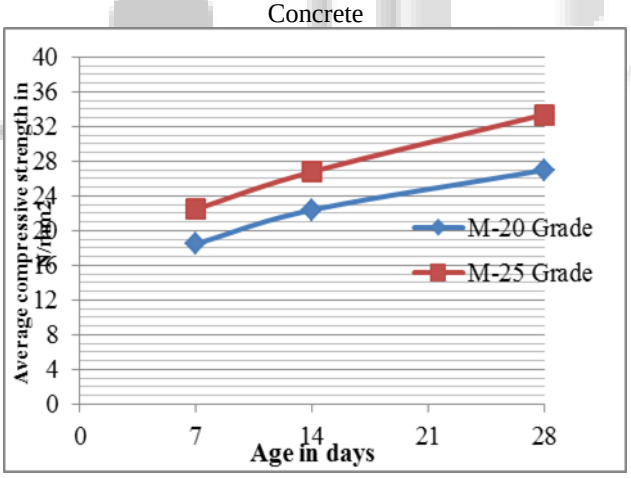
Fig. 1: Compressive Testing Machine

COMPRESSIVE STRENGTH	AGE(DAYS)	GRADE OF CONCRETE	
		M 20	M25
Average Compressive Strength N/mm^2	7	18.5	22.5
	14	22.4	26.8
	28	27	33.4

Table 4 Results of the Compressive Strengh of Concrete



VI. CONCLUSION

Based on the study we drawn some conclusions about use of grade of concrete on the basis of comparison of compressive strength of different grade of concrete. The following conclusions are drawn:-

1) As compared the initial ages, increases the compressive strength of concrete with increases time period.
2) The optimum strength is obtained at 28 days testing.
3) OPC 43 grade cement has more strength as compared to other cements and easily available in market.
4) Concrete cubes under axial compression failed in lateral tension due to Poisson's effect.
5) The contact surface between concrete cube and plate of the testing machine should be smooth otherwise inclined cracks may form.
6) 150 mm x 150 mm x150 mm size cubes attained its 70 % strength at the 7 days of casting.

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