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Comparative Analysis On High Performance Concrete Of M45 & M50

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ABSTRACT:- *Modification in cement concrete to improve its strength and durability is need of the hour. Cement concrete has many drawbacks such as low tensile strength, susceptibility to chemical attack, corrosion of reinforcement and low durability. Research is being carried out to overcome these drawbacks.*

The use of blended cement is becoming common in these days. This is as an attempt made by researches in the direction of utilization of materials which are available in nature abundantly. The new admixture 'SikaCim' is one such organic material which is being tested and used in recent times. This organic chloride free liquid admixture is found to be satisfactory in improving the characteristics of cement concrete. While there is much to be done in order to standardize the properties of admixture, an attempt is made in the present work to investigate the influence of the admixture 'SikaCim' on the compressive strength and workability of concrete. The experimental study of this investigation consists of concrete mix for target mean strength. The mix was worked out giving certain proportions by keeping the water cement ratio constant for different mixes of M50 and M45. The mix is obtained with water-cement ratio 0.35 for M45 and 0.3 for M50. For this mix the different percentages of admixture i.e. 0%, 0.1%, 0.15%, 0.2%, 0.25% and 0.3% by weight of cement. These percentages were added in mix of cement: fine aggregate: coarse aggregate in the ratio 1:1.707:2.852 for M50 and 1:1.534:2.562 for M45. Specimens were tested up to failure to study the behaviour in compression..

I. INTRODUCTION

Advances in cement and concrete research are continuous and ongoing despite advances in the production of accelerated setting and high strength cement ,the development of Portland cement with varying controlled setting times and high compressive strength and higher rate of strength development would be highly beneficial to the cement and the construction industries, especially in the area of new materials ,admixtures , reduced usage of cement, self curing concrete, self compacting concrete, economical production of concrete. For example producing ready mix concrete transportable to longer distances ,enhancing initial setting time beyond 30 minutes, will revolutionize construction industry, enabling quality construction practices in inaccessible places. Reduced usage of water in concrete production and curing could be yet another for reaching global research effort. While achieving the above objectives ,concrete durability and strength requires to be enhanced.

The performance of concrete both short and long term is being in greater research in the recent years. In these conditions, ordinary concrete may fail to provide the required quality or desirability. In such cases admixtures are used to modify the properties of ordinary concrete so as to make it more suitable as per the requirements.

High performance concrete is a concrete mixture, which possess high durability and high

strength when compared to conventional concrete. This concrete contains one or more of cementious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The term 'high performance' is somewhat pretentious because the essential feature of this concrete is that it's ingredients and proportions are specifically chosen so as to have particularly appropriate properties for the expected use of the structure such as high strength and low permeability. Hence High performance concrete is not a special type of concrete. It comprises of the same materials as that of the conventional cement concrete. The use of some mineral and chemical admixtures like Silica fume and Super plasticizer enhance the strength, durability and workability qualities to a very high extent.

High Performance concrete works out to be economical, even though it's initial cost is higher than that of conventional concrete because the use of High Performance concrete in construction enhances the service life of the structure and the structure suffers less damage which would reduce overall costs.

Concrete is a durable and versatile construction material. It is not only Strong, economical and takes the shape of the form in which it is placed, but it is also aesthetically satisfying. However experience has shown that concrete is vulnerable to deterioration, unless precautionary measures are taken during the design and production. For this we need to understand the influence of components on the behaviour of concrete and to produce a concrete mix within closely controlled tolerances.

The conventional Portland cement concrete is found deficient in respect of :

1. Durability in severe environs (shorter service life and frequent maintenance)
2. Time of construction (slower gain of strength)
3. Energy absorption capacity (for earthquake resistant structures)
4. Repair and retrofitting jobs.

II. RELATED WORK

M. Myint Lwin, Formerly Washington State Department of Transportation

Washington State Department of Transportation (WSDOT) has developed and used high-performance concrete (HPC) mixes containing fly ash and silica fume in several highway bridges since 1992. The concrete has high compressive strength attaining 10,000 psi (69 MPa) by 28 days, low chloride permeability averaging less than 1,000 coulombs by 56 days, and generally lower shrinkage and creep values than conventional concrete. In 1995, WSDOT was interested in expanding the use of high-performance concrete and participated in a demonstration project sponsored by the Federal Highway Administration (FHWA). The project, known as SR 18 over SR 516 east-bound in King County, consists of a three-span continuous prestressed concrete bridge. The center span has a length of 137 ft (42 m) and the end spans are each 80 ft (24 m) long. The roadway deck is 38 ft (11.6 m) wide, carrying two 12-ft (3.7-m) lanes and 4-ft (1.2-m) and 10-ft (3.0-m) wide shoulders. The bridge is located in earthquake zone "C" with an earthquake acceleration coefficient equal to 0.25g. The design complies with the new AASHTO LRFD Bridge Design Specifications. Construction of this project started in July 1996 and the bridge was completed and opened to traffic in October1997.

Laszlo Dunaszegi, Stantec Consulting Ltd., Calgary.

The Confederation Bridge is an 8.1-mile (13-km) long bridge across the Northumberland Strait between Prince Edward Island and New Brunswick, Canada. Opened in 1997, the bridge consists of gravity-based piers and a single-cell box-girder superstructure. It was constructed under a design-build-operate-transfer contract in which the developer operates the bridge for 35

years and then transfers the bridge to the federal government.

III. EXPERIMENTAL STUDY

The experimental programme involved the casting and testing of 144 cube specimens of concrete of standard size (150mmx150mmx150mm) for testing on workability and compressive strength of M45 and M50. The concrete cubes were divided into 6 groups of 0%, 0.1%, 0.15%, 0.2%, 0.25%, 0.3% admixture by weight of cement. For each percentage 12 cubes were tested. Universal Testing Machine was used to test the specimens.

MATERIAL PROPERTIES

Ordinary Portland cement(Ultra Tech cement) of 53 grade confirming to IS : 12269-1987 is used

Physical Properties of cement are evaluated from laboratory tests.

- **Consistency:** This test is done as per IS: 8112-1989. The consistency was found to be 32 % with 7 mm reading in the vicat apparatus
- **Initial setting time**: Initial setting time of cement is 30 minutes.
- **Final setting time** : Final setting time of cement is 600 minutes.
- **Specific Gravity of cement** :This test has been done as per test procedure mentioned in the IS code 269-1989. Specific Gravity of cement is found to be 3.14
- **Fineness**: fineness of cement by sieve analysis is found to be 3%

COARSE AGGREGATE

Crushed stone aggregate (angular) 20 mm maximum size confirming to IS 383-1970 requirements has been used .

Specific Gravity of coarse aggregate is 2.61

Fineness modulus of coarse aggregate is found to be 7.44

WATER :

Potable water was used for mixing and curing.

ADMIXTURE

SikaCim admixture was used which is a water reducing admixture.

A. MIX DESIGN PROCEDURE FOR M 50 GRADE CONCRETE

Grade Designation = M-50

Type of cement = ultratech 53 grade cement

Admixture = Sikacin

Specific Gravity of Cement = 3.14

Fine Aggregate = Zone-II

Specific gravity of sand = 2.55

Specific gravity of Coarse Aggregate = 2.61

Maximum water cement ratio = 0.45(from IS456)

Mix Calculation: -

1. Target Mean Strength ,f'ck=fck+t.S

where fck=compressive strength of concrete

S=standard deviation (value of S is 5 from table 1 IS 12062-2009)

t=a standard value depending upon the accepted proportion of low results and number of tests=5

f'ck=50 + (5 X 1.65) = 58.25 Mpa

2. Selection of water cement ratio:- Assume water cement ratio = 0.32

3. Calculation of water: - Approximate water content for 20mm max. Size of aggregate = 180 kg /m3 (As per Table No. 2 , IS : 10262).

As plasticizer is proposed we can reduce water content by 20%.

Now water content = 180 X 0.8 = 144 kg /m3

4. Calculation of cement content:- Water cement ratio = 0.32

Water content per cum of concrete = 144 kg

Cement content = 144/0.32 = 450 kg / m3

5. Calculation for C.A. & F.A.: [Formula's can be seen in earlier posts]-

Volume of concrete = 1 m3

Volume of cement = 450 / (3.15 X 1000) = 0.1433 m3

Volume of water = 144 / (1 X 1000) = 0.1440 m3

Total weight of other materials except coarse aggregate = 0.1433 + 0.1440 = 0.2873 m3

Volume of coarse and fine aggregate = 1 – 0.2873 = 0.7127 m3

Volume of F.A. = 0.7127 X 0.38 = 0.2708 m3 (from table3 IS10262-2009)

Volume of C.A. = 0.7127 – 0.2708 = 0.4418 m3

Therefore weight of F.A. = 0.2708 X 2.55 X 1000 = 690.54kg

Therefore weight of C.A. = 0.4418 X 2.61 X 1000 = 1153.098 kg

Water : Cement : Fine aggregate : Coarse aggregate =0.32 : 1 : 1.534 : 2.562

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B. MIX DESIGN PROCEDURE FOR M45 GRADE CONCRETE

Grade Designation = M-45
Type of cement = ultratech 53 grade cement
Admixture = Sikacin
Specific Gravity of Cement = 3.14
Fine Aggregate = Zone-II
Specific gravity of sand = 2.55
Specific gravity of Coarse Aggregate = 2.61
Maximum water cement ratio = 0.45(from IS456)
Mix Calculation: -
1. Target Mean Strength ,f'ck=fck+t.S
where fck=compressive strength of concrete
S=standard deviation (value of S is 5 from table 1 IS 12062-2009)
t=a standard value depending upon the accepted proportion of low results and
number of tests=5
f'ck=45 + (5 X 1.65) = 53.25 Mpa
2. Selection of water cement ratio:- Assume water cement ratio = 0.35
3. Calculation of water: - Approximate water content for 20mm max. Size of aggregate = 180 kg /m3 (As per Table No. 2 , IS : 10262).
As plasticizer is proposed we can reduce water content by 20%.
Now water content = 180 X 0.8 = 144 kg /m3
4. Calculation of cement content:- Water cement ratio = 0.35
Water content per cum of concrete = 144 kg
Cement content = 144/0.35 = 411.4 kg / m3
5. Calculation for C.A. & F.A.: [Formula's can be seen in earlier posts]-
Volume of concrete = 1 m3
Volume of cement = 411.4 / (3.15 X 1000) = 0.1306 m3
Volume of water = 144 / (1 X 1000) = 0.1440 m3
Total weight of other materials except coarse aggregate = 0.1306 + 0.1440 = 0.2749 m3
Volume of coarse and fine aggregate = 1 – 0.2749 = 0.7251 m3
Volume of F.A. = 0.7251 X 0.38 = 0.2755 m3 (from table3 IS10262-2009)
Volume of C.A. = 0.7251 – 0.2755 = 0.4495 m3
Therefore weight of F.A. = 0.2755 X 2.55 X 1000 = 702.54kg
Therefore weight of C.A. = 0.4495 X 2.61 X 1000 = 1173.35 kg

Water : Cement : Fine aggregate : Coarse aggregate =0.35 : 1 : 1.707 : 2.852

RESULTS

A. TEST RESULTS OF M45:

TABLE 1; compressive strength of concrete for different percentages of admixtures for M45 grade:

PERCENTAGE OF ADMIXTURE	3 DAYS STRENGTH N/sq.mm	7 DAYS STRENGTH N/sq.mm	14 DAYS STRENGTH N/sq.mm	28 DAYS STRENGTH N/sq.mm
0.0	25.5	28.5	37.2	55.3
0.1	27	31.5	42.52	59.62
0.15	27.5	32.33	41.55	60.19
0.2	28.42	32.40	44.28	60.75
0.25	27.65	31.20	43.24	58.70
0.3	24.95	29.45	45.68	56.25

TEST RESULTS OF M50:

TABLE 2; compressive strength of concrete for different percentages of admixtures for M50 grade:

PERCENTAGE OF ADMIXTURE	3 DAYS STRENGTH N/sq.mm	7 DAYS STRENGTH N/sq.mm	14 DAYS STRENGTH N/sq.mm	28 DAYS STRENGTH N/sq.mm
0.0	29.3	31.5	43.8	60.9
0.1	31.1	36.13	46.92	64.7
0.15	32.31	37.56	47.2	67.2
0.2	34.12	38.6	49.35	70.54
0.25	33.23	38.1	49	70.12
0.3	31.8	37.3	48.85	68.13

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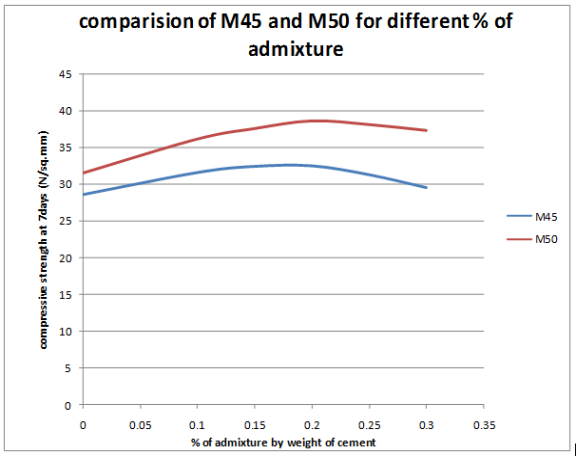

Fig 1: compressive strength at 7 days (N/sq.mm) Comparison of M45 and M50 for different % of Admixture

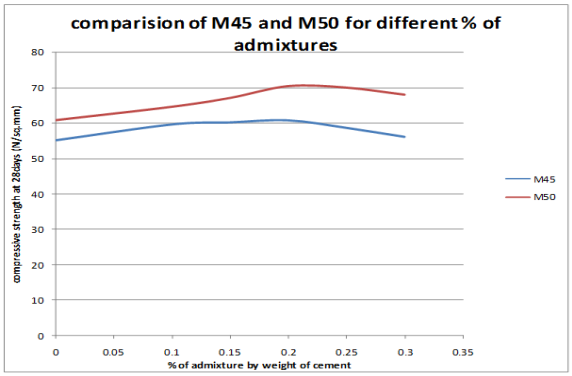

Fig 2: compressive strength at 28 days (N/sq.mm) Comparison of M45 and M50 for different % of Admixture

CONCLUSION

Results of the experimental investigation on the compressive strength of concrete cubes of M45 and M50 when added with different % of admixtures to the weight of cement is reported .

- The maximum compressive strength of concrete is achieved at 0.2% of admixture.
- The rate of gain of strength is maximum at 0.15% admixture .
- The incremental increase in strength is more to M50 compare to that of M45.
- The optimum percentage of admixture for M45 and M50 is 0.2% of admixture to cement weight.
- The compressive strength of concrete cubes increased by15% with the addition of admixture.

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