EXPERIMENTAL STUDY ON COMPRESSIVE STRENGTH VARIATION OF CONCRETE CUBES DUE TO CHANGE OF CONSITITUENTS AND ADDITION OF ADMIXTURE.

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ABSTRACT: *The compressive strength variation in concrete cube due to change in the type of basic constituents with and without the presence of admixture, has been investigated in this research work. 14 cubes of 6 in. x 6 in. x 6 in. were casted in order to observe the variation in compressive strength with and without the presence of admixture. The ratio of ingredients for concrete mix for each combination has been designed with the help of ACI mix design. These cubes have been tested after 14 days of casting. The admixture used for this purpose of increasing compressive strength, is Sika Chemical(Sikament® 520 BA). This chemical is used for the production of high quality and free flowing concrete in hot climates. It is added in concrete mix equal to 1.5% of the weight of cement. Different types of basic ingredients have been changed in each and every combination with respect to some commonly available material. The main objective of this research work is to find the best combination of basic constituent's types with respect to compressive strength. The result obtained is then compared with the corresponding combination without admixture, in order to observe the change in compressive strength with the addition of an admixture while changing other indigents of the concrete mix.*

Keywords: Compressive Strength, ACI mix Design, Concrete, Sika Chemical (Sikament® 520 BA).

1. INTRODUCTION:

Concrete is extensively used artificial material used the world over. It is used for the purpose of construction in the world. It is the second most used things in the world after the water. Concrete in its hardened state, it acts like a rock because the concrete stiffness gain by its ingredients as they get packed in such a way that the coarse aggregate's voids are filled by the sand and voids between the sand get filled with water-cement paste. So in this way, the whole concrete becomes very hard against the loading. It means that individual ingredient of concrete play a vital role in the stability of concrete. The hardness, workability, and strength resemble the properties of individual ingredients. So the ingredients of concrete must possess such properties which help the concrete in future to withstand the worst environmental conditions**[1-2]**.

Out of different properties of concrete, Concrete compressive strength is most useful and essential property. It is the indicator of the overall properties of concrete because all other properties are related to it.Concrete mix is basically designed to meet the structure requirement by providing the durability, and stability property. For designers of structures, the compressive strength is very important for designing a structure because it indicates the performance measure of a structure that how it will act under loading conditions. Compressive strength of concrete is the resistance against compression. This strength can be find out by various method like testing cubical or cylindrical cube in compression-testing machine. It is determined because for its used in quality control, acceptance of concrete, or for estimating the concrete strength in a structure for the purpose of scheduling construction operations. So the compressive strength of concrete is very important because it is resisting ability of concrete against compression. Man attempts have been made to find the appropriate combination of its basic and supplementary ingredients to gain desirable compressive strength in an economical suited way like less cost and more strength**[3-8]**.

Admixtures are those chemicals that are added in concrete mix other than basic ingredients during or before mixing to enhance or alter some of the properties of concrete in its fresh or hardened state. The admixture used for this experimental study is Sika Chemical (Sikament® 520 BA).

2. EXPERIMENTAL PROGRAM

2.1 Properties of Materials:

14 concrete cubes of 6 in. x 6 in. x 6 in. were casted in laboratory as shown in fig. For this purpose, material was collected from different sources. As we were working with different types of basic ingredients which are located at different places where they are in good condition, so 3 basic types of ingredients were decided that is easily available in near areas. For example, Sargodha crush was collected from 11 Pull where it generated or extracted from a quarry, Margalla Crush was collected from Islamabad where it is easily available and SakhiSarwar crush from D.G. Khan where its quarries are present. Like that fine aggregates like Lawerance-pur Sand from Rawalpindi and Ravi from the Lahore and Chenab from Sargodha where it is easily available. And In Cement, three different types of cements i.e. WPC, OPC and SRC were used and all of them belong to the same manufacturer company. Sika Chemical (Sikament® 520 BA) that is used for increasing compressive strength and workability of concrete was also purchased from the Islamabad.

To check the quality of materials, different tests were performed. Tests for Coarse aggregate like sieve analysis, Aggregate Impact Value, etc. and it was found that for 11 the pull crush, the AIV, Specific gravity, and water absorption were 10.77, 2.62, 0.5% respectively. For Margalla crush, these values were 15.88, 2.56 and 0.4% and for SakhiSarwar, these were 16.54, 2.54 and 0.7% respectively. Similarly for fine aggregate different tests like fineness modulus, specific gravity, and bulk density were performed and it was found that the bulk density, Specific Gravity and fineness modulus of Chenab sand were1650 kg/m^3, 2.56 and 2.48 respectively. For Ravi sand, the value was found to be 1566.7 kg/m^3, 2.63 and 2.49, in case of Lawrence-Pur sand, these were 1586.7 kg/m^3, 2.67 and 2.53 respectively. Similarly, for cement fineness, initial and final setting time and standard consistency test etc. were performed.

2.2 Mix Design:

After finding the physical properties of each ingredient, ACI mix design is used to find the mix ratio of concrete cubes. The assumed compressive strength was taken as 15 MPa at the start of design. W/C for every combination was also derived from this design procedure.

Fig. 1. Ordinary Portland Cement used.

2.3 Preparation of Test Specimen:

After designing the ratio for concrete mix, cubes were casted. The material was placed, mixed and casted in laboratory according to the specifications mentioned in the table-1 given below. All 14 cubes, i.e. 7 without admixture and 7 with admixture were casted in cubical mould, in 3 layers and each layer was tampered with tampering rod for 25 blows as shown in fig. 2, 3, 4, 5, 6, 7, 8.

Fig. 2. Cube of combination no. 1 mentioned in table 1.

Fig. 3. Cube of combination no. 2 mentioned in table 1.

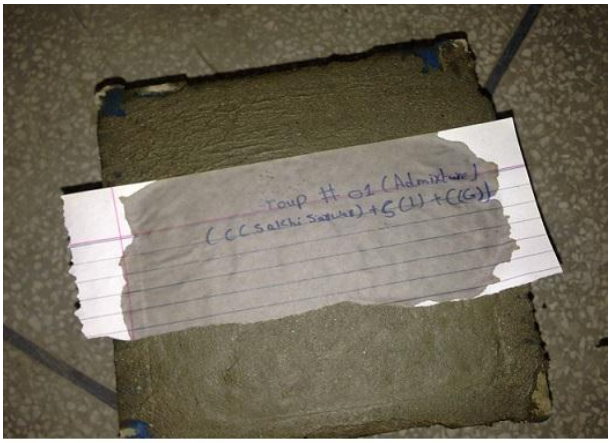


Fig. 4. Cube of combination no. 3 mentioned in table 1.

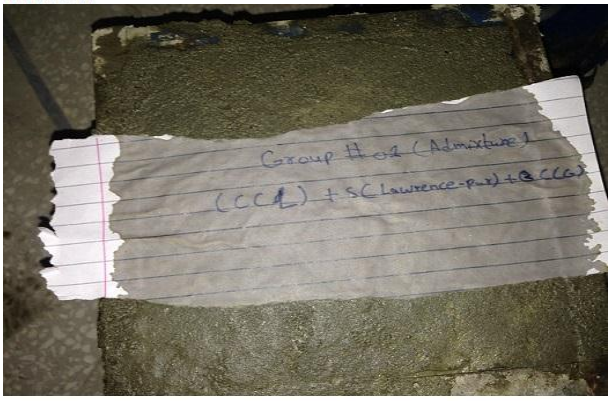


Fig. 5. Cube of combination no. 4 mentioned in table 1.

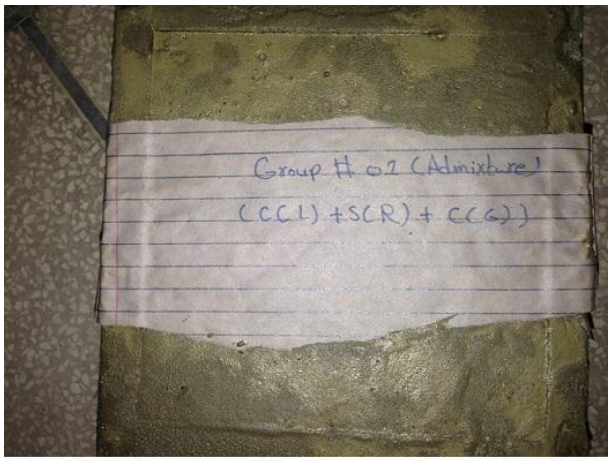


Fig. 6. Cube of combination no. 5 mentioned in table 1.

Fig. 7. Cube of combination no. 6 mentioned in table 1.

Fig. 8. Cube of combination no. 7 mentioned in table 1.

Fig. 9 & 10 . Cubes are in Curing tank.

After casting all the cubes were placed in the curing tank for 14 days curing as shown in fig. 9 & 10.

2.4 Test Performed:

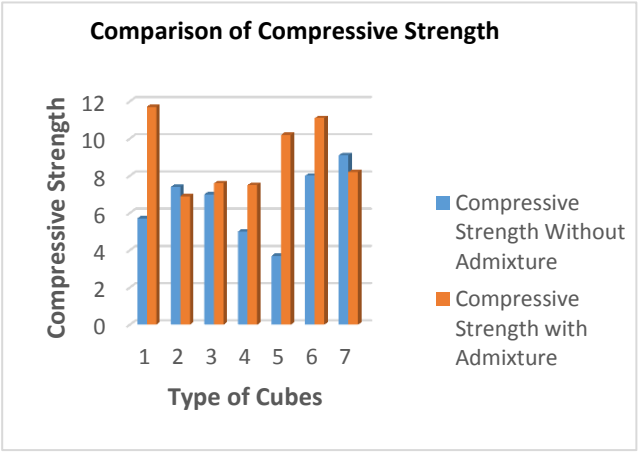
After 14 days of curing, the cubes were removed from curing tank. The compression test was performed on all cubes in compression testing machine of 3000 KN capacity at a loading rate of 250 KPa. Failure load in KN and failure pattern of each cube were noted as shown in figure.

Fig. 11. Crack appeared on the surface of cube.

Fig. 12. Load Applied in KN and Compressive strength in MPa.

3. RESULTS AND DISCUSSION:

The data recorded from the testing of cubes is used to plot a graph showing the variation in compressive strength of each cube separately in the form of Bar Chart as shown in figure. Table below also shows the values of compressive strength and failure load of each cube just to give the idea that maximum compressive strength is achieved when admixture is added into the cubes.



Graph-1. Comparison of Compressive strength from table-1.

Table-1. Compressive strength of Cube

Sr. No.	Description	Symbol		Without Admixture		With Admixture	
		Without Admixture	With Admixture	Compressive Strength (in MPa)	Load Applied (in KN)	Compressive Strength (in MPa)	Load Applied (in KN)
1	Coarse (11 Pull) + Sand (Local) + Cement (Grey) + Admixture	7	A	5.7	134.4	11.7	274
2	Coarse (Margalla) + Sand (Local) + Cement (Grey) + Admixture	1	G	7.4	173	8.9	162.1
3	Coarse (SakhiSarwar) + Sand (Local) + Cement (Grey) + Admixture	6	E	7	163.4	7.6	178.3
4	Coarse (11 Pull) + Sand (Lawerernce-pur) + Cement (Grey) + Admixture	5	D	5	116.9	7.5	175.4
5	Coarse (11 Pull) + Sand (Ravi) + Cement (Grey) + Admixture	4	B	3.7	86.5	10.2	238.9
6	Coarse (11 Pull) + Sand (Local) + Cement (White) + Admixture	2	F	8	186.6	11.1	258.9
7	Coarse (11 Pull) + Sand (Local) + Cement (S.R.C.) + Admixture	3	H	9.1	213	8.2	192.6

4. CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORKS:

Based on the results obtained from the experimental study that has been reported in this paper, the following conclusions are derived:

- All testswere made after 14 days of casting. That's why the obtained compressive strength of cubes is generally lesser than the designed strength which is expected after 28 days of curing.
- The difference in compressive strength of 1st combination is expected the same as obtained from this experimental study because it shows a simple change due to the addition of admixture which enhance its compressive strength.
- In 2nd combination, the change is slightly different from 1st one. It is because the without admixture strength is good and it's about to be approximately 60% of design strength while the with admixture cube strength is slightly lower as compared to the previous one that is 11.7 MPa and in this case it is 8.9 MPa. It is due to improper compaction because compaction is made by tampering rod not with any machine. So it might be the reason for this low strength. And it may also cause by the improperly bonded cement-water paste with aggregates.
- The compressive strength of the cube (with and without admixture) shows a remarkable change upon comparison at 14th day after casting.
- The change in compressive strength in all combinations of OPC cement is almost same except the combination that contain Ravi sand. The change is very significant. This change is due to the low strength of Ravi sand. This lower strength is due to the presence of very fine grains.
- The strength of a combination containing WPC is high in both forms. This is due to low amount of iron oxide and high $CaCo_3$ Content (less than 1% and greater than 95%). Which made the concrete stronger in term of compressive strength.
- While in last combination of SRC, the strength of the cube without admixture is higher than that of admixture containing cube. This is due to the chemical reaction that occurs in this combination. Because the SRC is used for protecting the structure from sulphate attack and while admixture used that used for this experimental study is a super plasticizer. It increases workability without increasing the amount of water. So both SRC and admixture undergo some kind of chemical reaction that lowers the strength.

From the results obtained from this research, the best combination in term of Compressive strength is of locally available material and OPC with admixture, while without admixture combination of locally available material with SRC is best.

Since this research is based on the 3 types of every ingredient only, to find the combination in term of compressive strength. So, in this regard, it is recommended that in future research will be conducted on the other type of coarse aggregate, cement (colour Portland cement, etc.), admixture (Water reducer, Air entraining etc.) and also using cylindrical concrete specimen rather than cubical one.

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REFERENCES:

1. M.S. SHETTY, "Concrete Technology: Theory and Practice", S. Chand & Company Pvt. Ltd., ISBN:978-81-219-0003-4, 2013.
2. M L Gambhir, "Concrte Technology: Theory and Practice", 5th Edition, McGraw Hill Education (India) Pvt. Limited, New Delhi 110 016, 2013.
3. WSDOT Materials Manual M 46-01.25.

4. Dr S L Pati, J N Kale, S Suman, "Fly Ash Concrete: A Technical Analysis for Compressive Strength", Suman et al. International Journal of Advanced Engineering Research and Studies E-ISSN2249-8974, IJAERS/Vol. II/ Issue I/Oct.-Dec.,2012 (page 1-2).

5. K.Ambiga, P.Meenakshi,"Studies on Strength of Concrete by Partial Replacement of Sand with Sawdust", Ambiga et al. International Journal of Advanced Engineering Research and Studies E-ISSN2249-8974, IJAERS/Vol. II/ Issue I/Oct.-Dec.,2015 (Page 1-2).

6. Yogesh R. Suryawanshi, Amar G. Kadam, Sagar S. Ghogare, Ramrao G. Ingale, Priyanka L. Patil, "Experimental Study on Compressive Strength of Concrete by Using Metakaolin", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 02 Issue: 02, May-2015 (Page 1-5).

7. Preeti Tiwari, Rajiv Chandak, R.K. Yadav, "Effect of Salt Water on Compressive Strength of Concrete", Preeti Tiwari et al. Int. Journal of Engineering Research and Application ISSN : 2248-9622, Vol. 4, Issue 4 (Version 5), April 2014 (Page 1-5).

8. Mmasetlhomo Tommy Gumede, ShodolapoOluyemi Franklin, "Studies on Strength and Related Properties of Concrete Incorporating Aggregates from Demolished Wastes: Part 2—Compressive and Flexural Strengths", Open Journal of Civil Engineering, 2015, 5, 175-184, Published Online June 2015 in SciRes (Page 1-10).