Compressive Strength of Ultra High Strength Concrete

[1]Apoorv Salve, [2]Sumit Bondekar, [3]Sarthak Mahajan, [4]Prateek Jha, [5]Assist. Prof. Shivani Singh Baghel, [6]Dr. Rakesh Patel

Student, Department of Civil Engineering, Oriental institute of science and technology, Bhopal (M.P.)[1,2,3,4]

Guide, Department of Civil Engineering, Oriental institute of science and technology, Bhopal (M.P.)[5]

HOD, Department of Civil Engineering, Oriental institute of science and technology, Bhopal (M.P.)[6]

Abstract— The strength of ultra-high strength concrete (UHSC) with axial compressive strength more than I 00 MPa is presented in this paper. There are mixes have been cast in this project. Based on the slump test, the compression tests with twelve cubical specimens (150mm) at 3 days, 7 days, 28 days and 90 days, split cylinder tests with six cylinder specimens (100 mm x 200 mm) at 28 days and 90 days; and porosity test with two slabs (200mm x 300mm) for twelve coring specimens at 3 days, days, 28 days and 90 days, the compressive strength of UHSC with ratio of cement on fine and coarse aggregates are to I: 1.5:2.5, 2.5%, 3% and 4% of superplasticiser, 10% of silica fume and; 25% and 27% of water cement ratio are to be investigated. The observation of strength on each specimen with various percentage of superplasticiser will be made up to 90 days of strength. Graph of stresses vs. days will be plotted for further analysis as well as the calculation of modulus of elasticity (E).

Keywords- Strength Concrete, Split Cylinder, Compressive

I. INTRODUCTION

According to previous experiments, ultra-high strength concrete (UHSC) has exceptional mechanical properties (high compressive and tensile strength, large E-modulus) and excellent durability properties regarding concrete and reinforcement corrosion (low permeability to gases and liquids, resulting in high resistance to the penetration of ions, excellent freeze-thaw resistance with or without de-icing salts, and high abrasion resistance). In any case, the disfigurement conduct of the UHSC-Lattice in contrast with ordinary strength concrete is an opposite issue. Until the pinnacle load the way of behaving is dominatingly direct flexible, enormous distortions at pinnacle can not be noticed, and the arrived at post-top strain is almost zero. These realities call attention to the exceptionally weak material way of behaving. The referenced changes impact positively plan applicable properties like bowing, shear, twist and punching bearing limit as well as the obligation of support and the conduct under concentrated stacking [1, 2]. Toward the start of the improvement a focal center was simply given to the substantial innovation perspectives to increment compressive and elasticity, so trial results for plan significant properties were of optional interest. Be that as it may, before ultra high strength cement can be utilized in the training nearby and in this way it tends to be exploited the remarkable mechanical and solidness properties, sufficient models to depict the bearing way of behaving and plan ideas should be given. The basics are wide trial examinations to look at the impact of changed material properties and conduct.

II. COMPRESSIVE STRENGTH OF UHSC

They also added that the compressive strength was determined on cylinders (0 1 00/h = 200 mm) and on cubes (1 00 x 100 mm'). The used smaller dimensions of the specimens compared to those used in DIN 1048 (DIN 1048, Teil 5, 1991) are necessary, because of available testing machines. The same specimens were also used for the Reference mixes. In order to find answers concerning the dependency of the compressive strength on the slenderness, also cylinders with different heights were cast. The time development was measured for all concrete types at 7, 28 and 56 days, for some of it also after 3 and 90 days. All specimens were water cured at 20°C until the test.

Dirk WeiBe and Jianxin Ma in June 2004, also determined that UHSC are not only the high compressive strengths after 28 days but its high early age strength is also quite remarhble. So, 80 - 120 N/mm' after 3 days are easily possible according to Figure 1. Therefore this concrete type is fairly interesting for prestressed reinforced concrete members, because the pretensioning can be applied earlier. The aim of a similar strength development could be achieved according to Figure 1. The Reference mix 2 has a slightly lower increase, which can be explained with the lower binder content.

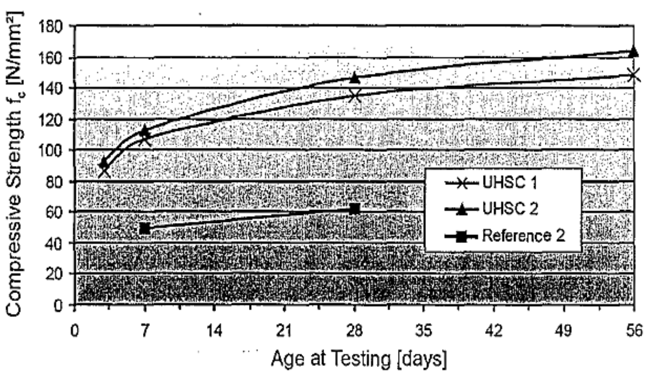

Figure 1: Time development of cylinder compressive strength

2.1 Tensile strength of UHSC

UHSC's reachable tensile strength is heavily influenced by the mix's composition, particularly the type and quantity of the binder material used. For the most part acknowledged is the reality, that the rigidity increments under relatively, similarly concerning high strength concrete. In addition, it must differentiate between plain and fiber-reinforced ultra-high strength concrete. With a specific measure of filaments it is feasible to definitely increase the rigidity. Split tensile strength was measured using cubes (I 00 x I 00 x 100 mm') at all tested concrete ages, using experimental research by Dirk WeiBe and Jianxin Ma in June 2004. The time development of the splitting tensile strength is comparable between the Reference and UHSC in terms of compressive strength. The way they act at such a young age is remarkable. UHSC 2 (the RPC) has a lower strength after three days than UHSC I, but after seven days, the values are now the opposite. The thing that matters is as of now around 1.5 N/mm2 , which increments throughout the opportunity to around 2.5 N/mm2 as displayed in Figure 2 underneath.

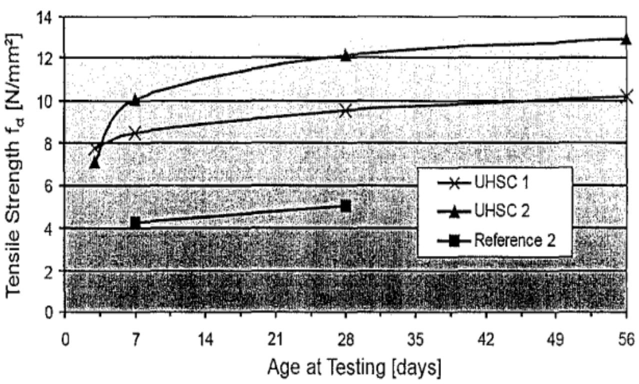

Figure 2 Time development of splitting tensile strength

III. METHODOLOGY

The physical properties of density and strength of concrete are determined, in part, by the proportions of the three key ingredients, water, cement, and aggregate. You have your ch9ice of proportioning ingredients by volume or by weight. Proportioning by volume is less accurate, however due to the time constraints of a class time period this may be the preferred method. A basic mixture of mortar can be made using the volume proportions of

- Water
- Cement
- Sand

Most of the student activities can be conducted using this basic mixture. Another "old rule of thumb" for mixing concrete is I cement : 2 sand : 3 gravel by volume. Mix the dry ingredients and slowly add water until the concrete is workable. This mixture may need to be modified depending on the aggregate used to provide a concrete of the right workability. The mix should not be too stiff or too sloppy. It is difficult to form good test specimens if it is too stiff. If it is too sloppy, water may separate (bleed) from the mixture [GJ. Remember that water is the key ingredient. Too much water results in weak concrete. Too little water results in a concrete that is unworkable.

I. If predetermined quantities are used, the method used to make concrete is to dry blend solids and then slowly add water (with admixtures, if used).
2. It is usual to dissolve admixtures in the mix water before adding it to the concrete. Superplasticizer is an exception.

3. Forms can be made from many materials. Cylindrical forms can be plastic or paper tubes, pipe insulation, cups, etc. The concrete needs to be easily removed from the forms. Pipe insulation from a hardware store was used for lab trials. This foam-like material was easy to work with and is reusable with the addition of tape. The bottom of the forms can be taped, corked, set on glass plates, etc. Small plastic weighing trays or Dairy Queen banana split dishes can be used as forms for boats or canoes.

4. If compression tests are done, it may be of interest to spread universal indicator over the broken face and note any color changes from inside to outside. You may see a yellowish surface due to carbonation from C02 in the atmosphere. The inside may be blue due to calcium hydroxide.

5. To answer the proverbial question, "Is this right?" a slump test may be performed. A slump test involves filling an inverted, bottomless cone with the ~oncrete mixture. A Styrofoam or paper cup with the bottom removed makes a good bottomless cone. Make sure to pack the concrete several times while filling the cone. Carefully remove the cone by lifting it straight upward. Place the cone beside the pile of concrete. The pile should be about 112 to 3/4 the height of the cone for a concrete mixture with good workability.

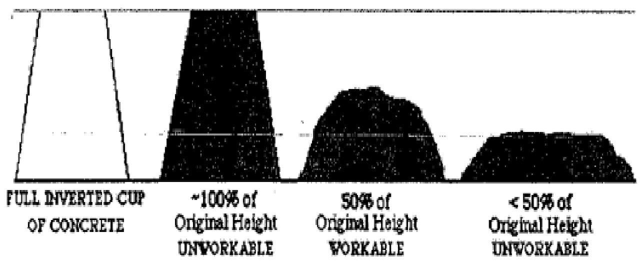

Figure 3: Slump test to determine workability

6. To strengthen samples and to promote hydration, soak concrete in water (after it is set).

7. Wet sand may carry considerable water, so the amount of mix water should be reduced to compensate.

8. Air bubbles in the molds will become weak points during strength tests. They can be eliminated by: o i. packing the concrete. o ii. Tapping the sides of the mold while filling the mold. o iii. "rodding" the concrete inside the mold with a thin spatula.

9. Special chemicals called "water reducing agents" are used to improve workability at low water to cement ratios and thus produce higher strengths. Most ready-mix companies use these chemicals, which are known commercially as superplasticizers. They will probably be willing to give you some at no charge.
10. You can buy a bag of cement from your local hardware store. A bag contains 94 lb. (40kg) of cement. Once the bag has been opened, place it inside a garbage bag (or two) that is well sealed from air. This will keep the cement fresh during the semester. An open bag will pick up moisture and the resulting concrete may be weaker. Once cement develops Jumps, it must be discarded. The ready mix company in your area may give you cement free of charge in a plastic pail.

IV. DATA ANALYSIS

According to the graph above, all compressive strengths achieved by each mix design from three specimens are maximum values. For mix designs m500a and m500b; 150mm cube mould, 3% and 4% of superplasticiser respectively and 0.27 water cement ratio were used. The compressive strength of these mixes at 90th day was 88.32MPa and 88.41MPa respectively. While the other four mixes use lOOmm cube mould, 2.5% and 3% of superplasticiser alternately and 0.25 water cement ratio were used. Thus, these mixes obtained compressive strength of 95.77MPa for m550a, 90.11MPa for m550b, 110.9MPa for m600a al' 128.5MPa for m600b which is the highest strength achieved among all mixes at 90th day.

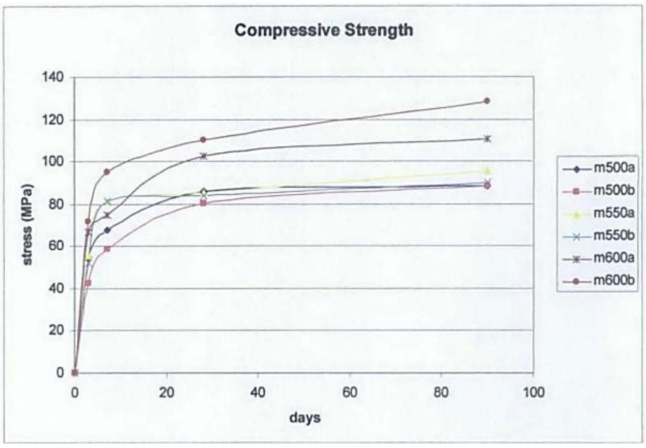

Figure 4: Compressive strength for all mix designs

The strength of cylinders of each mix was measured at 28th and 90th day of age only. The method used was split cylinder test. From Figure 5 above, we observed that all mix designs in category "b" have lower strain compared to category "a" which consists of 3% of superplasticiser. They have higher tensional strength because of obtaining optimum amount of superplasticiser unlike category "b" where they're having too low or too high percentage of superplasticer that made them weak in tensional strength.
Porosity of each mix was measured at the age 3, 7, 28 and 90 days and the result is shown as in Figure 9 above. Both m500a and m500b have high percentage of porosity which is 2.558% and 2.319% respectively at age of 3 days. As they cured through age of 90 days, their porosity were still decreasing where the porosity are 1.892% and 1. 7190/o.

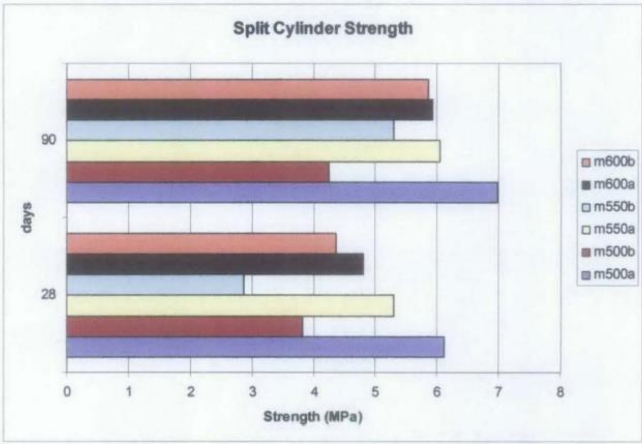

Figure 5: Strength of cylinders obtained from split cylinder test

The percentage porosity of other four mixes was still decreasing but they obtained much lower percentage compared to those two mixes. This happens because of the size of mould used for designing the cube which is 150mm cube mould. Due to that, the total volume calculated was a lot, hence more mix proportion needed for mixing as welJ as water. Since volume of water has increased, therefore during dehydration of specimens, pores or voids were created in between aggregates. Thus leads to higher percentage of porosity and lower in compressive strength.

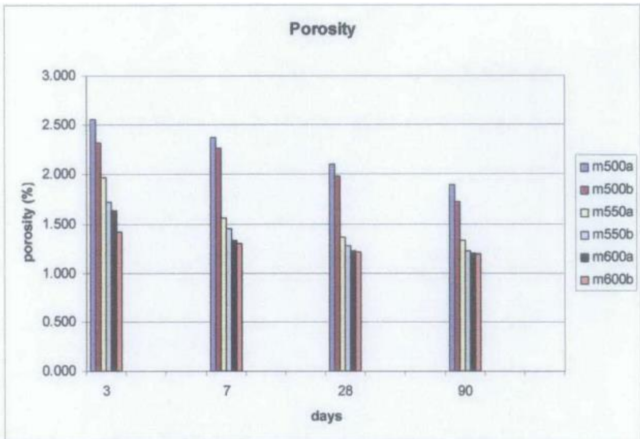

Figure 6: Percentage of porosity for all mix designs

V. CONCLUSION

The highest strength that i have achieved for this experiment is 128.5PMa from m600b at the age of901 h day. These increasing strengths have reached the objective of this paper which is obtaining maximum strength of more than I OOMPa. For the lowest porosity obtained is 1.189% also by mix design of m600b while the highest tensional strength is 6.9852MPa with modulus of elasticity of

12.5GPa. As a conclusion, mix design of m600a and m600b which consist ofOPC, SF, Fagg, Cagg, SP and Water have already achieved the objective of this experiment at the age of 28 days. Comparing this result with normal concrete where it reaches its maximum strength at age of 281 h day, UHSC could obtain higher compressive strength within 28 days.

REFERENCES

[1] Aulia, T. B.: Effects of Polypropylene Fibers on the Properties of High- Strength Concretes. Leipzig Annual Civil Engineering Report No. 7 (2002), pp. 43 - 59.

[2] Ko"nig G, Dehn F, Faust T. Proceedings of 6'h International Symposium on utilization of High Strength & High Performance Concrete, Vol. 1-2, Leipzig; 2002.

[3] WeiBe, D.: Verbundverhalten der Bewehrung in UHFB. In: Konig, G.; Holschemacher, K.; Dehn, F. (Hrsg.): Ultrahochfester Beton, pp. 199 - 214. Bauwerk Verlag Berlin, 2003.

[4] U.S. Federal Highway Administration (2007). Ground Granulated Blast-Furnace Slag, Silica Fume and Fly Ash.

[5] Remmel, G.: Zum Zug- und Schubtragverhalten von Bauteilen aus hochfestem Beton. Deutscher AusschuB fiir Stahlbeton (German Committee of Reinforced Concrete), No. 444, 1994.

[6] Pigeon, M., P. C. Aitcin, and P. LaPlante. 1987. Comparative study of the air-void stability in a normal and a condensed silica fume field concrete. ACl Journal 84 (3):194-99 (May-June).

[7] Ozyildirim, C. 1986. Investigation of concrete containing condensed silica fume: Pinal report. Report no. 86-R25 (January). Charlottesville: Virginia Highway & Transportation Research Council.

[8] Luther, M. D. 1990. High-performance silica fume (microsilica)-Modified cementitious repair materials. 69th annual meeting of the Transportation Research Board, paper no. 890448.

[9] Luther, M.D. !989. Silica fume (microsilica): Production, materials and action in concrete. In Advancements in Concrete Materials Seminar, 18.1-18.21. Peoria, Ill.: Bradley University

[10] Kosmatka, S.H.; Panarese, W.C. (1988). Design and Control of Concrete Mixtures. Skokie, IL, USA: Portland Cement Association, pp. 17, 42, 70, 184.