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Investigation of Permeability Properties of Fiber Reinforced Light Weight Concrete

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Concrete, Workability, compressive strength, split tensile strength, Flexural strength.

ABSTRACT

Degradation of Concrete by the acid attack, the occurrence of reinforcement corrosion and associated damage of Concrete because of water intrusion is progressively being recognized as some of the threatening Durability problems in Reinforced Concrete Structures. High Performance Concrete is a novel construction material with improved properties like Higher Strength, Durability, Higher Constructability, etc. In the present investigation an exertion has been made to inquire about the joint impact of addition of silica fume and Steel Fibers on the Durability of SFR-HPC with regard to Impermeability of Concrete. A HPC of M40 grade was considered and Permeability test were performed to find the persistence of Steel Fiber Reinforced High Performance Concrete. The main variables considered in this study are. Four various proportions of Micro Silica viz. 0%, 5%, 7.5%, 10% by weight of Cement. Three different Aspect Ratios of Steel Fibers i.e. 60, 70, 80. Three different Volume Fractions of Fibers i.e. 0.5%, 0.75%, 1.0%.

A total of 39 numbers of Concrete specimens were cast with and without Micro Silica and Steel Fibers and tested as per IS: 3085 specification for Permeability. An average of 3 specimens was taken for each mix and Coefficient of Permeability was determined. Test results indicate that by adding of Micro-Silica to Plain Concrete up to 10% decreases its Permeability by about 52%.Further, addition of Micro Silica 5% and Steel Fibers fraction of 1.0%, reduces its Coefficient of Permeability from 10.48×10-5centimeter/second to 3.69×10-5 centimeter/second. The reduction is about 35%. It is also noted that addition of 7.5% Micro Silica and Steel Fibers above 0.75% fraction, results indicate in increase in Coefficient of Permeability value. Further experimental results reveals that addition of 10% Micro Silica along with Steel Fibers do not reduce the value of Coefficient of Permeability of Concrete.

In all, the results of present investigation gave an insight on possible way of improving impermeability of Concrete by making use of mineral admixtures like Micro Silica in combination with Steel Fibers.

INTRODUCTION

Concrete production exists around the world as a leading material in construction for our infrastructure and essentially today, this man-made stone has risen as a most versatile and universally recognized tool to build with. The durability of concrete is characterized as the capacity of the material to stay workable for in any event the required lifetime of the structure. Likewise, its durability is fundamental in safeguarding the infrastructure of society. Amongst the different strategies to improve the Durability of Concrete, and to accomplish High Performance Concrete, the utilization of Micro Silica is a newly approach.

In many situations, the durability of concrete is likewise legitimately identifies with its permeability which again depends a great deal upon its protection from entrance of dampness. The dampness which goes into the concrete can prompt to disintegration of steel reinforcement and diminishes the life of the structures radically. Accordingly, the durability of concrete depends to great extent upon the penetrability of concrete which is characterized as the simplicity with which it enables the liquids to go through it. Moreover, it is by reducing the permeability, the time is known to be extended so as to prevent any aggressive chemical to get into the concrete where it can do its damage. Consequently, a significant proportion of improving concrete impermeability is to initially improve the capacity of opposing shrinkage and arresting crack.

II. EXPERIMENTAL PROCEDURE

The following experimental program was made to find out the durability property of concrete in terms of Permeability by usage of Micro Silica as Partial Cement replacement material along with Steel Fibers.

The materials utilized in the test program are Cement, Coarse Aggregates, Fine Aggregates, Water, Micro Silica, Steel Fibers, Super plasticizer.

CEMENT

Ordinary Portland Cement of 53 Grade confirming to IS: 12269 was used. It was tested for Physical properties. The detailed test results are given in Table 3.1

Table 3.1 Physical Properties of Ordinary Portland Cement

Fineness modulus = 705.56 /100 = 7.05

3.1.3 FINE AGGREGATE

Locally accessible River Sand confirming to IS: 383 was utilized as Fine Aggregate. The Physical properties of Fine Aggregate were explored. The details are given on Table 3.2 and Table 3.4.

III TEST RESUULTS

As mentioned earlier in section 3.5 the details of Permeability test, the Results and Analysization of Test are talked about in this section.The permeability test was done on different Mix Cases of Micro Silica and Steel Fibers as describe in Table 3.7. To determine the Coefficient of Permeability, the quantity of water percolating, Area of Specimen, time for which permeability test was done, pressure head and thickness of specimen were observed.

Figure:Non porous Concrete Cubes

Figure: Porous Concrete Cubes

Figure: Curing days Cubes

Table: Compressive Strength Test in M40 Grade porous concrete

Cube S. No	Curing days	Load (KN)	Compressive test (N/sq.mm)
1	7 Days	330.0	38.10
		320.0	38.15
		315.0	39.84
2	28 Days	920.0	40.89
		918.0	40.80
		909.0	40.40
3	56 Days	1110.0	49.33
		1090	48.44
		1120.0	49.78

Figure: Compressive Strength Test in porous concrete 7 Days

Figure: Split Tensile test

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IV RESULTS AND DISCUSSION

Test outcomes got for Penetrability study are given in the previous chapter along with the graphs indicating the impact of silica fume and Steel strands on Permeability of Concrete. The outcomes are average of three specimens. In the following test, detailed discussions are presented on the role of micro Silica and Steel strands on the performance of Concrete in terms of Coeff, of Permeability.It is very well seen from Figure 4.1 that the test results for Coefficient of Permeability of Concrete specimen without Micro Silica is 10.48 x 10-5 cm/sec for concrete specimen without Micro Silica. As we add Micro Silica, the coefficient of Permeability reduces to 9.46×10-5cm/sec, 7.61×10-5 cm/sec, and 5.42×10-5cm/sec respectively for 5%, 7.5%, and 10% Micro Silica addition. The reduction is almost 50% of that of Conventional Concrete as shown in Figure 4.8. This reduction is because of Filler effect achieved on addition of Micro Silica.

Filler Effect: The specific surface of Micro-Silica used is greater than Cement. It is about multiple times more than the specific Surface of Cement. This unmistakably demonstrate that the particle size of Micro Silica is much is lot little than the atom size of Cement. Accordingly, when we add the silica fume to the plain concrete, it possesses the small spaces present between the bond particles and furthermore in between the Concrete particles and the aggregates. Such a physical marvel is known as the Filler effect which lessens the porousness which thusly diminishes the Penetrability.

(a) Variation of Coefficient of Permeability of Concrete with Various Percentage Fractions of Steel Fibers having 5% Micro Silica

It is very well seen from Figure 4.2 that on addition of 5% Micro Silica the Permeability is 9.46×10-5 cm/sec. On adding of Steel strands having cubic fraction 0.5%, 0.75%, and 1.0% the Permeability reduces to 5.13×10-5cm/sec, 4.37×10-5cm/sec, and 3.69×10-5cm/sec, respectively. This is because of the adding of silica fume and Steel strands in Concrete.

(b) Variation of Coefficient of Permeability of Concrete with Various Percentage Fractions of Steel Fibers having 7.5% Micro Silica

From Figure 4.3 it tends to be seen that on adding of silica fume 7.5% and Steel Fibers fraction 0.5%, the coefficient of Permeability reduces to 3.72×10-5cm/sec. Again on further increasing of Steel Fibers fraction to 0.75%, and 1.0%, the coefficient of Permeability increases from 4.96×10-5cm/sec to 10.39×10-5cm/sec. This increase in permeability is due to the Balling effect achieved on

adding of Steel strand volume fraction 0.75%. On mixing of fibers, these fibers will clump together and the pores present in the specimen will be cracked. This might be the reason for increase in Permeability on addition of Fibers above 0.5%.

(c) Variation of Coefficient of Permeability of Concrete with Various Percentage Fractions of Steel Fibers for 10% Micro Silica

For concrete specimen having only 10% Micro Silica, the Coefficient of Permeability is 5.42 x 10-5 centimeter/second when compared to 8.42 x 10-5 centimeter/second for specimens having 10% Micro Silica and Steel Fibers Fractions 1.0%. This indicates that coefficient of Permeability increases as the volume portion of strands increases. This is because on addition of Micro Silica 10% and Steel Fibers Fraction 0.5%, only the filling phenomenon will takes place and there will not be any effect on the pores of the concrete specimen. This is shown in Figure 4.4.

V CONCLUSIONS

These are the following Conclusions are given from the test outcomes and discussions.

· Addition of 5% Micro Silica reduces the Coefficient of Permeability to 9.46×10-5 cm/sec, when compared to 10.48×10-5 cm/sec for sample without silica fume. As the addition of silica fume increases to 7.5% and 10%, the coefficient of Permeability reduces to 7.61×10-5 centimeter/second and 5.42×10-5 centimeter/second, respectively. The reduction is about 48%.

· Addition of 5% Micro Silica along with various percentages of volume fraction of Steel Fibers, the coefficient of Permeability reduces from 5.13 × 10-5 cm/sec to 4.37×10-5 centimeter/second, and 3.69×10-5 centimeter/second, for 0.5%,0.75%,1.0% Volume fraction of Steel Fibers respectively. The reduction is about 65% with compared to specimen without Micro Silica and Steel Fibers.

· On addition of 7.5% Micro Silica and Steel Fibers having Aspect Ratio 70, the Coefficient of Permeability value decreases to 3.72 × 10-5 cm/sec, for Steel Fiber volume 0.5%. Further increment in Volume part of Fibers to 0.75% and 1.0%, the Penetrability value increments to 4.96×10-5 centimeter/second, 10.39×10-5 centimeter/second, respectively. This increase in permeability is due to Balling effect.

· Adding of 10% silica fume and Steel strands having Aspect Ratio of 80 does not have much effect on Permeability of Concrete. The value slightly reduces to 9.72 × 10-5 centimeter/second, 9.62 × 10-5 centimeter/second, 8.42×10-5 centimeter/second, when compared to 10.48×10-5 centimeter/second, for concrete specimen without Micro Silica and Steel Fibers.

· Steel Fibers Aspect Ratio also affects the Coefficient of Permeability value. Steel fibers having Aspect Ratio 60 and 5% Micro Silica, the permeability value decreases. But further adding of Micro Silica 7.5%, 10% and Steel Fibers having Aspect Ratio 70 and 80, the Permeability value increases respectively.

· For a given Aspect Ratio of Steel Fiber, Permeability of Steel Fiber Reinforced Concrete composites decrements as the Volume portion of strand increments. The rate of decrease of Permeability however decreases with the incrimination of Fiber content.

· The best combination obtained from the test results is with the addition of 5% Micro Silica and Fibers volume fraction 1.0% and having Aspect ratio 60.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Christelle Didier, Engineering ethics at the Catholic University of Lille (France): research and teaching in a European context, Eur. J. Eng. Educ. 25 (February) (2000) 325–335, https://doi.org/10.1080/03043790050200368.

[2] Michiel Brumsen, Ethics in engineering in The Netherlands: the role of professional associations, universities, and law, Int. J. Eng. Educ. 21 (3) (2005) 391–401.

[3] Hengli Zhang, Michael Davis, Engineering ethics in China, Bus. Prof. Ethics J. 37 (1) (2018) 105–135, https://doi.org/10.5840/bpej201821967.

[4] Geoffrey M. Hodgson, What are institutions? J. Econ. Issues 40 (1) (2006) 1–25, https://doi.org/10.1080/00213624.2006.11506879.

[5] Douglass C. North, Institutions, institutional change and economic performance. Political Economy of Institutions and Decisions, Cambridge University Press, Cambridge, 1990. https://books.google.com/books?id=oFnWbTqgNPYC.

[6] E. Ostrom, R. Gardner, A. Agrawal, J. Walker, J.M. Walker, J. Walker, Rules, Games, and Common-Pool Resources. ACLS

Humanities E-Book, University of Michigan Press, 1994. https://books.google.com/books?id=DgmLa8gPo4gC.
[7] Clifford Geertz, What is a country if it is not a nation? Brown J. World Aff. 4 (2) (1997) 235–247. [8] Sara R. Jordan, Phillip W. Gray, Responsible conduct of research training for engineers: adopting research ethics training for engineering graduate students, in: Engineering Ethics for a Globalized World, Springer, 2015, pp. 213–228.
[9] Gary Lee Downey, Juan C. Lucena, Carl Mitcham, Engineering ethics and identity: emerging initiatives in comparative perspective, Sci. Eng. Ethics 13 (4) (2007) 463–487, https://doi.org/10.1007/s11948-007-9040-7.
[10] Brock E. Barry, Joseph R. Herkert, Overcoming the challenges of teaching engineering ethics in an international context: a us perspective, in: Engineering Ethics for aGlobalized World, Springer, 2015, pp. 167–187.
[11] Abdi O. Shuriye, Mohammad H. Hassan, Waleed F. Faris, Islamic engineering ethics: foundation, integration and practice, Future Text Publication (2006) 67–73.
[12] E. Ostrom, Understanding Institutional Diversity, Princeton University Press, Princeton, 2005.
[13] Michael D. McGinnis, An introduction to IAD and the language of the Ostrom workshop: a simple guide to a complex framework, Pol. Stud. J. 39 (1) (2011) 169–183, https://doi.org/10.1111/j.1541-0072.2010.00401.x.