International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Experimental Study of Compressive Strength of Bitumen Ferrocement

Mitali Patil[1], Khandekar S.D.[2], Patil J.R[3]

[1, 2, 3]Savitribai Phule Pune University, Department of Civil Engineering RMD School of Engineering, Warje, Pune-411058, India

Abstract: ***Ferrocement is new construction technique which is quite popular throughout the world. Ferrocement consists of cement mortar and reinforcement in the form of wire mesh. Bitumen ferrocement is modified type of ferrocrete in which wire mesh is covered with bitumen and it uses as reinforcement. The investigation is proposed on 'effect of reinforcement orientation on compressive strength of ferrocement. This investigation highlights on eleven different combinations of orientations and layers of square wire mesh reinforcement and its effect on compressive strength of ferrocement. The ferrocement cubes casted with single and double layers of reinforcement placed in transverse, vertical and diagonal plane. Some cubes casted with bitumen ferrocement. The conclusion for this investigation shows vertical orientation offers more compressive strength than horizontal orientation. Also the strength offer by bitumen ferrocement will be comparing with ferrocement cubes. The application of bitumen ferrocement is swimming pool. Due to use of bitumen ferrocement material becomes watertight. Also it can be used for construction of road pavement, construction of small arch bandharas and retaining walls.***

Keywords: Bitumen, Compressive strength, Ferrocement, square mesh

1. Introduction

Ferrocement or ferrocrete is a system of reinforced mortar or plaster applied over layers of such as chicken wire or woven or expanded metal mesh or fibers and possibly closely spaced small diameter steel rod such as rebar. It is a versatile material which is less pollutant and also not requires skilled labours and constructed with locally available materials, so it reduces the cost of construction. Wire mesh used in ferrocement may be steel or galvanized and available in different shapes such as square, hexagonal, diamond shape. The committee 549 of American Institute for concrete submitted the following definition of ferrocement as, "Ferrocement is a type of reinforcement concrete in thin elements, currently constituted by micro- concrete of hydraulic cement, reinforced with thick layers of continuous netting, in wire, with relatively small diameter. The net may be metallic or in other material." In 1848, ferrocement first used for construction of small boat by Frenchman Joseph Louis Lamboat. Then it was used during Second World War for construction of boats and slowly it is used by worldwide in much application.

Compressive strength is the capacity of material or structure to withstand loads tending to reduce size. The compressive strength of ferrocement is governed by volume fraction of reinforcement. The volume fraction of reinforcement is the volume of reinforcement per unit volume of ferrocement. The compressive strength also depends on the specific surface which is bonded surface area of ferrocement per unit volume of ferrocement. The orientation of reinforcement which is the angle in degree between the reinforcement mesh and the direction of applied stress has also a significance related to compressive strength of ferrocement.

So there is need of using ferrocement mix for water tighting structures like swimming pool, water tank, retaining wall etc. therefore, in presence study bitumen has been used in ferrocement to improve imperviousness without compromising compressive strength of ferrocement mix.

2. Literature Review

Although other forms of ferrocement may have existed earlier, credit for using it should go to Joseph Louis Lamboat in France, who constructed a rowing boat from a net of wires and thin bars, and filled with cement mortar. Lambot applied for patent in year 1855 for his invention with name 'Ferciment' Sharma et.al (2013) [4] reported ferrocement covers all dimension of sustainability and also durable material. It has better crack arrest mechanism and efficient autogenesis healing of micro cracks, fire resistant, damage being negligible and easily repairable. Ferrocement can be used in various applications such as housing application rural application such as water tank, grain silos, canal lining, and some special applications as precast sandwich wall, ferrocement water filters, ferrocement segmental shells etc.

Kute et.al (2013)[6] studied the effect of orientation of wire mesh on ferrocement. The conclusion arises from the study that compressive strength of ferrocement increases with increase in total volume fraction of reinforcement (%) and specific surface of reinforcement (mm^2/mm^3) for horizontal and vertical orientation of hexagonal mesh; the orientation of reinforcement i.e. transverse to axis of loading offers more compressive strength than that of vertical orientation i.e. parallel to axis of loading.

Bansal et.al (2004) [7] reported effect of wire mesh orientation on the strength of stressed beams retrofitted with ferrocement jackets has been studied. The results show that the per cent increase in load carrying capacity for beam retrofitted with ferrocement jackets with wire mesh at 0, 45, 60 degree angle with longitudinal axis of beam, varies from 45.87 to 52.29 per cent. Also a considerable increase in energy absorption is observed for all orientations.

The results of testing folded and flat ferrocement panels reinforced with different number of wire mesh layers were presented by Mohamad Mahmood (2008)[8]. The main objective of these experimental tests is to study the effect of using different numbers of wire mesh layers on the flexural strength of folded and flat ferrocement panels and to compare the effect of varying the number of wire mesh layers on the ductility and the ultimate strength of these types of ferrocement structure. The experimental results show that flexural strength of the folded panels increased by 37% and 90% for panels having 2 and 3 wire mesh layers respectively, compared with that having single layer.

Prakash et.al (2013) [9] conducted research work is to maintain the eco-balance by preventing the open site dumping of the Blast furnace slag (BFS). This replacement has been found to improve the strength characteristics of ferrocement and also makes it lightweight. Replacement of BFS helps in reducing weight of the structure and thus improving its earthquake resistance. Marginal decrease in ultimate strength with increase in mesh content has been observed and this may be due to bulking of small diameter wires of mesh.

Many researchers were used another materials other than wire mesh or with combination of it such as steel fibers, styrene butadiene rubber latex, scrap tyre, fly ash, BFS, Rise Husk, Coconut Fibers etc. for construction of ferrocement structures.

3. Experimental Program

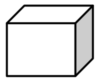
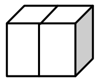
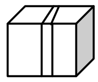
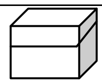
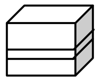
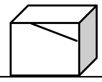
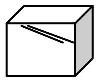
Constituents of Ferrocement: the main constituents of ferrocement are Matrix and reinforcement. In which matrix contains cement and sand and reinforcement contains square wire mesh. Ordinary Portland cement of grade 53 was used in experimental program. Sand used for investigation was locally available and confirming to I.S. 383:1970. All necessary primary tests were taken on both cement and sand. Water used for mixing and curing should be potable water which is free from salts, alkalis, acids etc. The square mesh of spacing 0.5 cm with wire diameter of 0.6096 mm was used. The weight of mesh per unit area was 2.29 x 10^{-3} kg/m^2. The mesh was provided in the size of 70 mm x 70 mm in the cube moulds in single and double layer of different orientations. The specific surface for this layer was as 0.0123 and 0.0246 respectively. Bitumen used for this investigation was of industrial grade having specific gravity 1.01.

The ferrocement mix was prepared with cement: sand proportion of 1:3 by weight. The water cement ratio adopted was 0.45. All the cubes were demoulded after 24 hours after casting and placed in Accelerated Curing Tank having potable water at 55^0C for 19 hours and then cubes were keeping in room temperature for next 20 hours before testing.

4. Specimens and Testing Details

The table 1 shows the different ten designation of ferrocement with one additional control specimen.

Table 1: Designation of Ferrocement Cube

Sr. No.	*Designation*	*Orientation of mesh*	*Particulars*
1	M.C.S		Mortar Control Specimen
2	C1V		One mesh, vertical . at centre
3	B1V		One bitumen mesh, vertical at centre
4	C1H		One mesh, horizontal at equal distance
5	B1H		One bitumen mesh, horizontal at centre
6	D1		One mesh, diagonal
7	BD1		One bitumen mesh, diagonal.

5. Results and Conclusions

The result of various tests conducted on cement, sand, cement mortar, bitumen ferrocement, and ferrocement are given and discussed in following sections. The results of physical properties of cement and sand shown in table 2 and table 3 respectively.

Table 2: Physical Properties of Cement

Sr. No.	*Particulars*	*Requirements as per I.S. 12269:1987*	*Test Results*
1	Fineness	Min 0.1	0.13
2	Initial Setting Time	Min 30 minutes	75 minutes
3	Final Setting Time	Min 60 minutes	380 minutes
4	Soundness by Le Chatelier	Max 10 mm	8 mm
5	Specific Gravity	3.15	3.15
6	Standard Consistency	-	29

Table 3: Physical Properties of Fine Aggregate

Sr. No.	**Particulars**	**Test Results**
1	Specific Gravity	2.80
2	Fineness Modulus	3.03
3	Water Absorption	0.45%

All cured specimens were tested in compression testing machine. The % volume of mesh reinforcement and specific surface of all the specimens were noted. Table 4 shows the results of compressive strength of ferrocement and bitumen ferrocement boxes of 70 x 70 x 70 mm size with various combination of wire mesh.

Table 4: Results of Compressive Strength

Sr. No.	Designation	Specific Surface mm^2/mm^3	Volume of mesh reinforcement	Compressive strength
1	M.C.S	-	-	23.81
2	C1V	0.0123	1	19.72
3	B1V	0.0123	1	29.59
4	C1H	0.0123	1	25.85

5	B1H	0.0123	1	15.98
6	D1	0.161	1	14.28
7	BD1	0.161	1	22.10

The mesh was placed with horizontal, vertical and diagonal orientation with respect to axis of loading. The result shows the significance of orientation on compressive strength. In case of ferrocement horizontal orientation shows more compressive strength than the vertical and diagonal orientation. As the volume of mesh reinforcement increase the strength also increases by 13.79% in case of vertical orientation. In case of bitumen ferrocement horizontal orientation didn't take more compressive strength but in case of vertical orientation it increases significantly. Similarly in case of diagonal orientation it was increased by 54.76%.

6. Conclusion

In the present study the efficacy of ferrocement and bitumen ferrocement is studied with planned test program on cement mortar cubes with various combinations of mesh and bitumen content. Based on study following conclusions are drawn.

1) The compressive strength of bitumen ferrocement increases with increase in total volume fraction of reinforcement and specific surface of reinforcement (mm^2/mm^3) for vertical orientation of square mesh.
2) Vertical orientation and diagonal orientation of bitumen ferrocement offers more compressive strength than same orientation of ferrocement.

References

[1] Shetty M.S. "Conrete Technology Theory and Practice" SChand and Company publication, Ramnag, New Delhi,2012.
[2] Gambhir M.L., "Conrete Technology Theory and Practice" Tata Mcgraw Hill Publication, New Delhi.
[3] Sharma P.C. (2013), "Ferrocement: An innovative advent to sustainability and versatility", National Journal of Ferrocement, Page number 16-24
[4] Divekar P. (2013), "Industrialized Housing with Ferrocement", National journal of Ferrocement, Page number 43-48
[5] Kute S., Kulkarni P., Waghmode R., Joshi P. (2013), "Effect of orientation and specific surface of reinforcement on compressive strength of Ferrocement", National Journal of Ferrocement, Page number 175-179
[6] Bansal P. , Kumar M., Kaushik S. K. (2005), "Effect Of Wire Mesh Orientation On Strength Of Beams Retrofitted Using Ferrocement Jackets" , International Journal of Engineering, Volume 2 : Issue 1
[7] Kulkarni N. M., Gaidhankar D.G. (2013), "Analysis and Design of Ferrocement Panels an Experimental Study", International Journal of Inventive Engineering and Sciences (IJIES) ISSN: 2319–9598, Volume-1, Issue-5.
[8] Prakash K E, Shesha Prakash M N, Gangadharappa B M, Suresh G S(2013), "Behaviour of Light-Weight Ferrocement under Monotonic Axial Compression" , International Association of Scientific Innovation and Research,13-358
[9] I. S. 12269-1987 for Cement.
[10] I. S. 383:1970 for Fine Aggregates.

Author Profile

Mitali Patil received the B.E.in Civil Engineering degree from Pune university in 2012. and Perusing M.E. degrees in Construction & Management from Savitribai Phule Pune University. Currently working as Assistant Professor in RMDSSOE, Warje, Pune