FERROCEMENT CONCRETE "Experimental Study On Mechanical Properties OfFerrocement Concrete"

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Abstract:

This study investigates the mechanical properties of ferrocement concrete and specifically focuses on the compressive strength of M40 grade ferrocement concrete blocks. Ferrocement, a composite material comprising cement mortar and metal mesh reinforcement, exhibits considerable potential for various construction applications. Understanding its mechanical behavior, particularly in the context of higher-grade mixes like M40, is crucial for optimizing its application in structuralelements such as blocks. The experimental methodology involves a comprehensive assessment of the mechanical properties of ferrocement, encompassing tensile, compressive, and flexural strength tests. Subsequently, attention is directed towards the examination of M40 grade ferrocement concrete blocks, emphasizing the crucial parameter of compressive strength. This grade is chosen for its significance in structural applications where high-strength materials are essential.The findings from the experimental tests shed light on the overall mechanical performance of ferrocement and provide specific insights into the compressive strength characteristics of M40 gradeblocks. The study aims to identify the optimal mix proportions and reinforcement strategies to enhance the load-bearing capacity of these blocks. Practical implications for construction, such as increased durability and structural integrity, are integral to the objectives of this research. As the construction industry continually seeks sustainable and resilient materials, the outcomes of this study contribute valuable knowledge to the utilization of ferrocement in high-strength applications. The results are expected to guide engineering practices in optimizing the design and production of M40 grade ferrocement concrete blocks, fostering advancements in efficient and durable construction materials.

1. INTRODUCTION

The construction industry is continually evolving, driven by the need for materials that offer both sustainability and structural resilience. Ferrocement, a composite material comprising cement mortar and metal mesh reinforcement, has emerged as a promising candidate due to its potential for high strength, durability, and versatility. This study delves into the mechanical characterization of ferrocement concrete and specifically focuses on the compressive strength analysis of M40 grade ferrocement concrete blocks.

1.1 Background:

Ferrocement, pioneered by P.L. Nervi in the mid-20th century, has gained attention for its unique composition, combining the strength of concrete with the ductility of steel. The presence of closely spaced and evenly distributed metal mesh reinforcement distinguishes ferrocement from conventional concrete. This configuration significantly enhances its tensile strength, crack resistance, and flexural capabilities. Despite its promising attributes, there is a need for a systematic exploration of ferrocement's mechanical properties to harness its full potential.

1.2 Significance of Mechanical Characterization:

Understanding the mechanical properties of ferrocement is crucial for its widespread adoption in construction. Tensile, compressive, and flexural strengths are fundamental parameters that govern the material's behavior under

various loading conditions. By comprehensively characterizing these properties, we can gain insights into the material's structural performance and identify areas for improvement. This research contributes to the fundamental understanding of ferrocement, providing a basis for optimized applications in construction.

1.3 Focus on M40 Grade Ferrocement Concrete Blocks:
The choice of M40 grade is motivated by the need for high-strength materials in construction projects. M40 represents a concrete mix with a characteristic compressive strength of 40 MPa, making it suitable for load-bearing elements in structures where superior strength is essential. This study narrows its focus to ferrocement concrete blocks of M40 grade, aiming to explore their compressive strength characteristics. This specific emphasis aligns with the demand for materials capable of withstanding substantial loads in modern construction practices.

1.4 Objectives of the Study:
The primary objectives of this research are twofold: firstly, to comprehensively characterize the mechanical properties of ferrocement, including tensile, compressive, and flexural strengths, and secondly, to conduct a detailed analysis of the compressive strength of M40 grade ferrocement concrete blocks. Through experimental testing, this study aims to identify optimal mix proportions and reinforcement strategies, providing practical insights for the effective use of M40 grade ferrocement blocks in structural applications.

2. LITERATURE SURVEY

"TO INCREASE COMPRESSIVE STRENGTH OF FERROCRETE BLOCK", Arjun S Ghodake, Apurva A. Jibhkate M.Tech. (Structural Engineering) Department of Civil Engineering G.H. Raisoni College of Engineering, Nagpur, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org IC-QUEST - 2016 Conference Proceedings.
The purpose of this paper is to explore the effect of orientation of mesh reinforced cement on compressive strength of Ferrocrete. Ferrocrete involves the use of conventional cement with fine aggregates and several layers of steel, with the advantage of higher strength than conventional reinforced concrete, limited formwork and thinner sections. In addition to basic statement on effect of orientation due to mesh reinforce cement on compressive strength of Ferrocrete, the report draws attention to crack pattern during failure, slowly and with plenty of warning of breaking of structure and strong bonding with in structure due to meshreinforcement. This report must be considered preliminary. as new advances are made in the technology of Ferrocrete it is likely to became rapidly, absolute unless continually brought up to date.

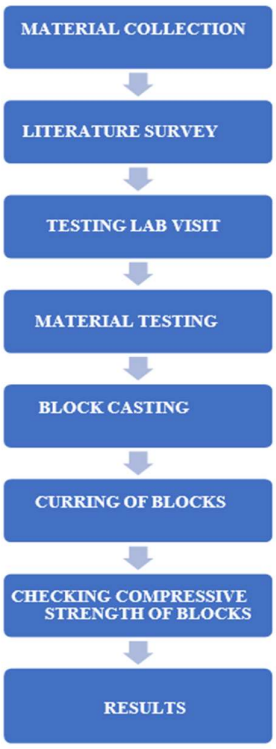
"FERROCEMENT BLOCKS UNDER COMPRESSIVE LOADS." Lecturer Dr.Abdulkader G. Anwar Department of Geotechnical Engineering, Faculty of Engineering,Koya University, Erbil, Iraq. International Journal of Engineering Trends and Technology (IJETT) – Volume 33 Number 7- March2016
Ferrocement blocks or masonryblocks are a type of thin concrete made of cement sand matrix with closely spaced relatively small diameter wire meshes, with or without steel bars of small diameters called skeletal steel. Masonry is a well proven building material possessing excellent properties in terms of appearance, durability and cost in comparison with alternatives. However, the quality of the masonry in a building depends on the materials used, and hence all masonry materials must conform to certain minimum standards. The basic components of masonry are block, and mortar, the latter being a composite of cement, lime, sand and sometimes of other constituents. Such blocks in addition to wire mesh were investigated experimentally under compressive strength. A total of nineblocks were constructed and tested under compressive load. The dimensions of blocks were (400x200x200) mm. The main parameters considered in the present investigation were the number of wire mesh layers (2), and type of constituent materials (mix proportions). The behavior of block models under compressive loading was observed by reading the loads and observing the initial and crack patterns and mode of failure. It is concluded that the compressive strength of ferrocement blocks having (2 wire meshes) is considerably higher than that of mortar blocks without mesh layers only by about (73.4 %). The behavior is less significantly affected when wire mesh is added to ferrocement blocks with (2 mesh layers), the increase was about (57%) with concrete blocks, and finally the presence of wire mesh reinforcement in the blocks decreases the water absorption compared with the corresponding concrete blocks.

A REVIEW STUDY OF APPLICATION OF FERRO-CEMENT. Ankit Batra1, Sumit Ghangas2, Lalit Kumar3 Hardik Saxena. International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072.
Ferro cement is one the advancement that is happening in the field of civil engineering. It has low self-weight, and thus gives fewer loads on to the structures. In this paper, we have studied different properties of the

Ferrocement like tensile behavior, cracking, compression, fire resistance and impact Resistance. Based on Tests performed, various applications and itsbenefits over normal cement will be identified. Ferro-cement primarily consists of cement, sand, wire meshes and various admixtures. The main difference between reinforced concrete and Ferro-cement is the scale. Reinforced concrete uses larger size reinforcing bar as compared to wire/meshes in Ferro-cement. Reinforced concrete consists of less volume of the metallic part as compared to that of the Ferro-cement. It does not contain large size aggregate as used in reinforced concrete only cement mortar is used. Sometimes depending on the requirement Ferro-cement may consists oflarge size bars along with wire mesh. The number of layers of wire mesh to be provided depends on the applications for which it is going to be used.

A STUDY ON STRUCTURAL STABILITY OF FERRO CEMENT REPLACEMENT WITH RCC FOR LOW-COST BUILDINGS. M. PRAVEEN KUMAR M. Tech Structural Engineering Indira Institute of Technology and Sciences, Markapur D. THRIMURTHI NAIK M. Tech (Asst. Professor) Indira Institute of Technology and Sciences, Markapur Aijreas volume 3, issue 2(2018, feb) (issn-2455-6300) online anveshana's international journal of research in engineering and applied sciences.
Achintya et al (1991) He exhibited the conduct for block in filled fortified solid edges subjected to horizontal load, through an exploratory approach. The quality of mortar is found to have significant effect on the parallel solidness and quality of the in filled outlines. Casings tried with fortified block board have demonstrated inconsequential change in disappointment quality. The solidness of the in filled outline diminishes quickly after the start of breaks. Diptesh Das and Murthy (2004) He considered the impact of block stonework infill in seismic outline of strengthened solid edge structures. It was demonstrated that the block infill dividers exhibit in strengthened solid edge structures decrease the auxiliary float yet increment the quality and solidness. Likewise, the pliability of the structure is lessened due to the infill. Building composed by the proportional supported edge strategy demonstrated better general execution. Santiago Pujal et al (2008) He analyzed the fortified solid structure was repaired and reinforced with strong block infill dividers. These dividers were compelling in expanding the quality (by 100%) and solidness (by 500%) of the first strengthened solid structure. The reinforced structure supported float inversions with amplitudes of up to 1.5% of the tallness of the structure without unnecessary solidness lessening. Results from numerical reproductions done utilizing models adjusted to coordinate test outcomes propose that it is likely that the reinforced structure would not achieve float proportion surpassing 1.5% amid ground movement.

3. METHODOLOGY



3.1 Testing Lab Test:

Objective of the Visit: To get permission for testing compressive strength of ferrocement concrete block and for collecting information about ferrocement concrete block testing machine.

Location: TCS LAB of Dr. D, Y. PATIL SCHOOL OF ENGINEERING, LOHEGAON.

Fig No. 6: Testing Lab Visit

3.2 MIX PROPORTION:

Mix Proportion for the ferrocement concrete block of m40 grade as per **IS3370PART4:2009**

Cement: Sand: Aggregate: water =1:2:4:0.45 for 400mmx200mmx200mm size block.
Density of cement: - 1440kg/m3
Density of Aggregate: - 1450-1550 kg/m3
Density of Sand: - 1450 -1600 kg/m3

For block size for 400mmx200mmx200mm
Volume of block = 0.016m3
Dry Volume= wet volume x 1.54
=0.016x 1.54
Dry Volume= 0.02464m3

1]For Cement:
= Dry Volume x Ratio of Cement/Sum of Ratio x Density of Cement
= 0.02464 x 1/7 x 1440
= 5.07 kg of Cement per Block.
For 9 blocks of ferrocement concrete= **45.64 Total 61kg**

2] For Sand:
= Dry Volume x Ratio of Sand/Sum of Ratio x Density of Sand
= 0.02464 x 2/7 x 1600
=11.26 kg of Sand per block.
For 9 blocks of ferrocement concrete = 11.26 x 9 =**101.34 kg**

3]ForAggregate:
= Dry Volume x Ratio of Aggregate/Sum of Ratio x Density of Aggregate
= 0.02464 x 4/7 x 1550
= **21.82 kg per block**.
For 9 blocks of ferrocement concrete= **196.38 kg**

4] For Water:
= 0.45 x Cement in kg
= 0.45 x 45.64
= **21 Liters of Water**

3.3 MATERIAL TESTING:

3.3.1. TESTS ON CEMENT:

1) **DETERMINE FINENESS OF CEMENT BY SIEVE ANALYSIS.**

***PRACTICAL SIGNIFICANCE:**
In Civil Engineering construction, properties of Cement play an imp role. Fineness is an imp property of Cement. The fineness of Cement has an imp bearing on the rate of hydration and thereby on its strength. This practical will enable us to select the relevant type of cement based on hydration, amount of water required for slump and its strength in concrete.

***RELEVANT COURSE OUTCOMES:**
1. Use relevant types of Cement in Different site conditions.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

***OBSERVATIONS AND CALCULATIONS**

SR.NO	PARTICULARS	Quantity
1.	Weight of cement (W)gm	100gm
2.	Weight of cement retained (W1) gm	7gm
3.	% weight of cement retained on sieve	7%

***SAMPLE CALCULATION:**
% of Weight Retained= WI/W= 7/100 = 0.07

RESULTS:
Fineness Of Cement= 7% Which is below the IS value (10%) and hence cement is in

GOOD CONDITION:

2) DETERMINE STANDARD CONSISTENCY, INITIAL AND FINAL SETTING TIMES OF OPC 53.

***PRACTICAL SIGNIFICANCE:**

Cement is inevitable ingredient used as pasting material in construction activity and therefore its properties such as Standard Consistency, Initial and Final Setting Time bears a significant impact on the strength of structure. After performing this practical, students will develop the competency of selecting the correct W/c ratio in concrete operations.

***RELEVANT COURSE OUTCOMES.**

1.Use relevant types of cement in different site conditions.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

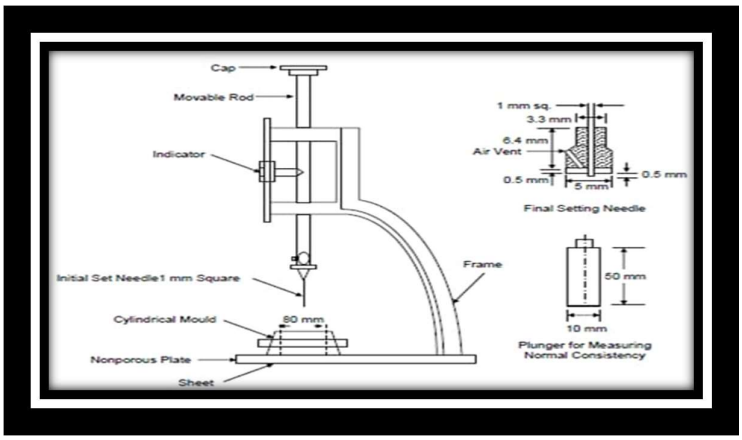
***OBSERVATION AND CALCULATION:**

- Type and brand of cement= OPC
- Grade of cement = 53
- Quantity of cement sample = 500gm
- Water temperature = 26

SR.NO.	Weight of Cement W1	Volume of Water W2	%age of Water= (W2/W1) *100	Penetration of Plunger
	g	1g = 1ml	%	Mm
1	500	120	24	9
2	500	130	26	11
3	500	135	27	12

RESULT:

The range between the standard consistency of cement typically falls within 25% to 30% water by weight of dry cement therefore its SAFE.



3.2.2 TEST ON SAND

Determine Bulking of Sand.

Practical Significance: While preparing concrete, quantity of aggregates must be known. Due to bulking, fine aggregate shows completely unrealistic volume. The consideration must be given to the effect of bulking in

proportioning the concrete by volume. If care is not taken to the effect of bulking, in the case of volume batching, the resulting concrete may have less sand than required and concrete becomes harsh. It will also affect the yield of concrete for a given cement content.

Relevant Course Outcomes

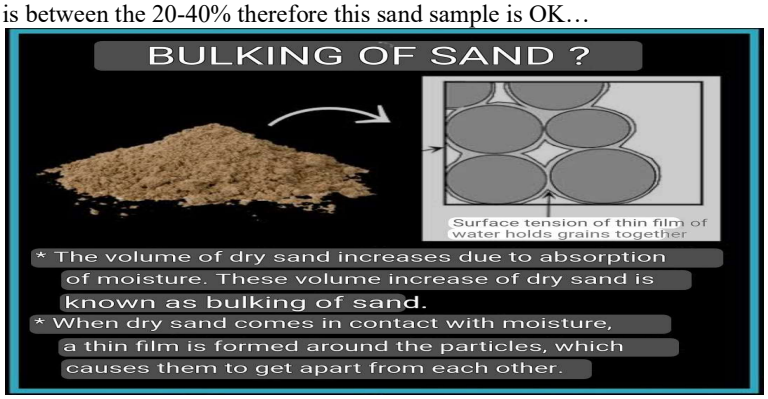
- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

S.NO.	DESCRIPTION	SAM-1	SAM-2	SAM-3
1	VOLUME OF DRY SAND	200	200	200
2	VOLUME OF SATURATED SAND	150	154	157
3	% OF BULKING OF SAND	33.33%	29.87%	27.38%

CALCULATIONS:

Average sand bulkage of above observation=(33.3+29.87+27.38)/3=30.19%

The sand bulkage is between the 20-40% therefore this sand sample is OK…



3.4 BLOCK TESTING

For checking compression strength of ferrocement concrete block of M40 grade under CTM (Compression Testing Machine.)

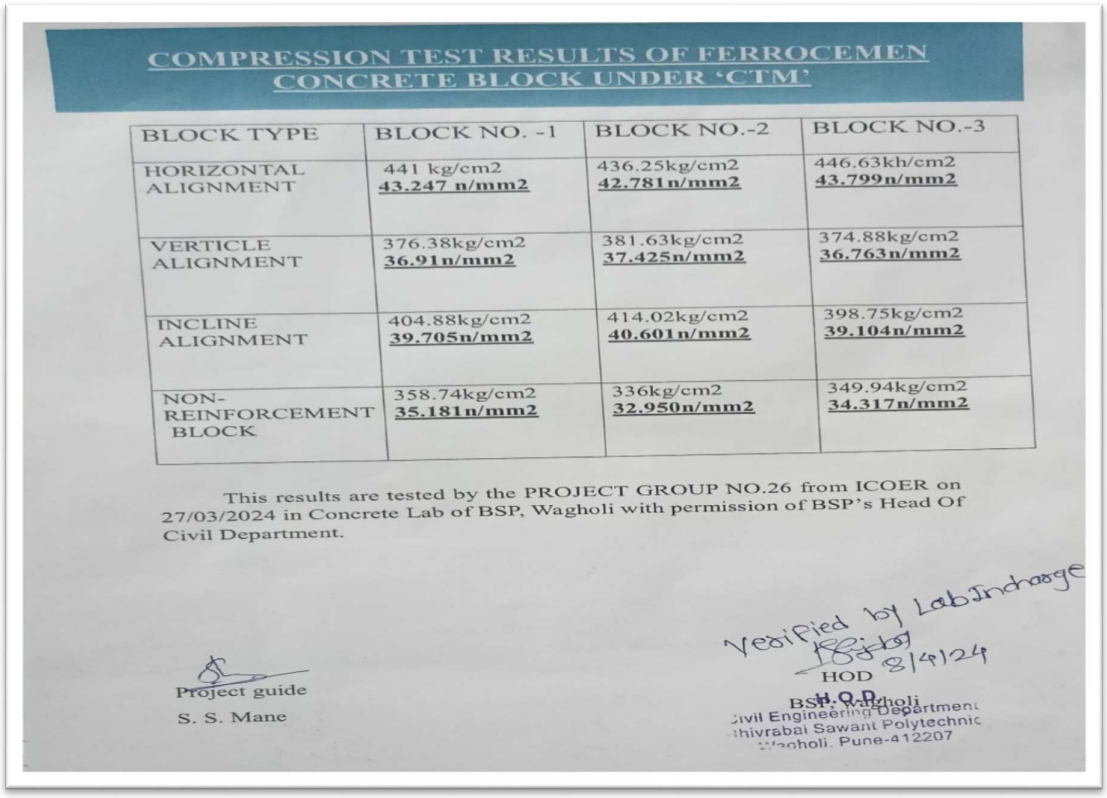
***COMPRESSION TESTING MACHINE:**

A compression testing machine is a specialized apparatus used to determine the compressive strength of materials, particularly concrete, rock, brick, and asphalt. It applies a compressive force to a specimen until failure occurs, allowing engineers to assess the material's quality and suitability for various applications. Compression testing machines come in different sizes and capacities to accommodate different types and sizes of specimens. They are crucial tools in materials testing laboratories, construction projects, and quality control processes in industries such as civil engineering, manufacturing, and research. Compression testing machines are equipped with load cells or hydraulic systems to measure the force applied to the specimen accurately. This allows for precise determination of the compressive strength. Modern compression testing machines often include software for data acquisition and analysis. This software records the applied load and deformation during the test and can generate detailed graphs and reports for further analysis.

4. RESULT & DISCUSSION

TEST RESULTS:

Followings are the results of compression strength of Conventional concrete block and Ferrocement Concrete Block under Compression Testing Machine.



COMPRESSION TEST RESULTS OF FERROCEMEN CONCRETE BLOCK UNDER 'CTM'

BLOCK TYPE	BLOCK NO. -1	BLOCK NO.-2	BLOCK NO.-3
HORIZONTAL ALIGNMENT	441 kg/cm2 **43.247 n/mm2**	436.25kg/cm2 **42.781n/mm2**	446.63kh/cm2 **43.799n/mm2**
VERTICLE ALIGNMENT	376.38kg/cm2 **36.91n/mm2**	381.63kg/cm2 **37.425n/mm2**	374.88kg/cm2 **36.763n/mm2**
INCLINE ALIGNMENT	404.88kg/cm2 **39.705n/mm2**	414.02kg/cm2 **40.601n/mm2**	398.75kg/cm2 **39.104n/mm2**
NON-REINFORCEMENT BLOCK	358.74kg/cm2 **35.181n/mm2**	336kg/cm2 **32.950n/mm2**	349.94kg/cm2 **34.317n/mm2**

This results are tested by the PROJECT GROUP NO.26 from ICOER on 27/03/2024 in Concrete Lab of BSP, Wagholi with permission of BSP's Head Of Civil Department.

Project guide
S. S. Mane

Verified by Lab Incharge
HOD
8/4/24
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BSP, Wagholi
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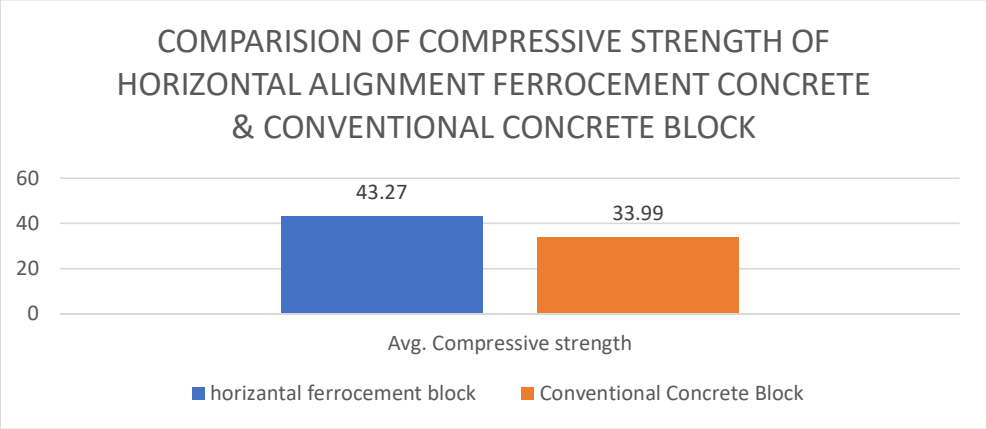
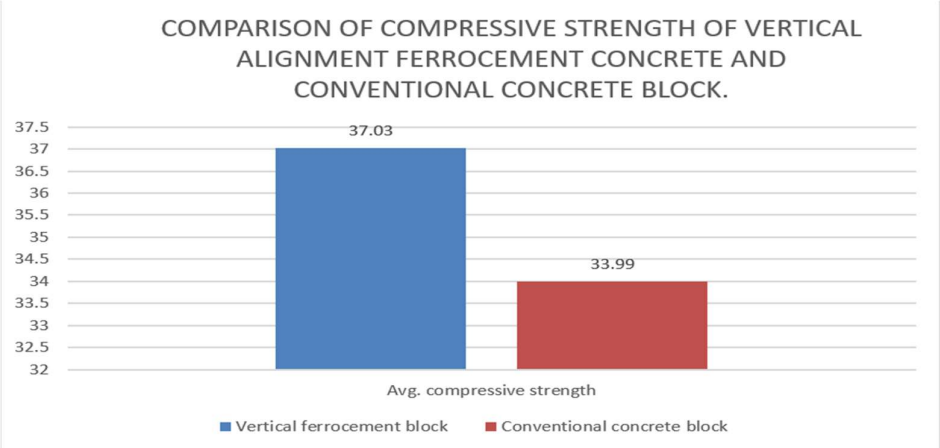
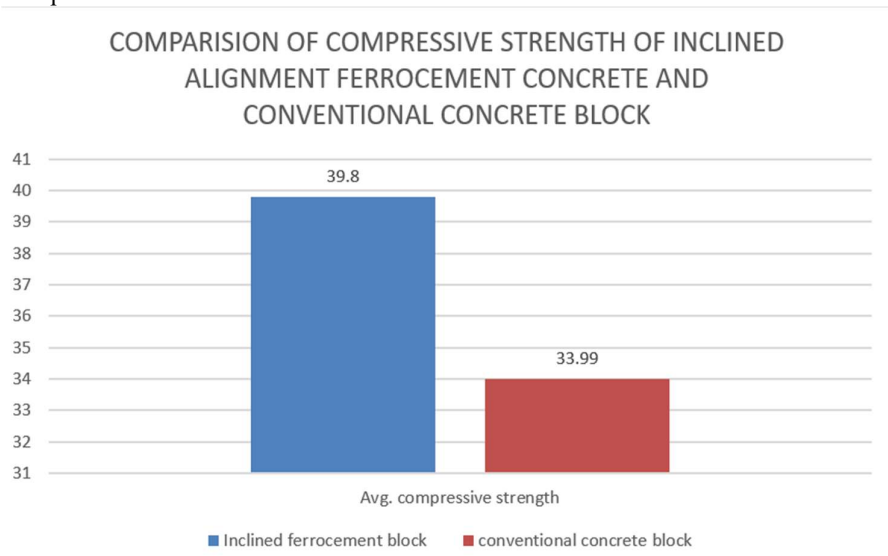
Wagholi, Pune-412207



From the above graph it is observed by using ferrocement block with horizontal alignment compressive strength was increased as compared to conventional concrete block.



From the above graph it is observed by using ferrocement block with vertical alignment compressive strength was increased as compared to conventional concrete block.



From the above graph it is observed by using ferrocement block with inclined alignment compressive strength was increased as compared to conventional concrete block.

COST COMPARISION:

Cost for 1 ferrocement concrete block. (400mm x 200mm x 200mm)
Cement=5.07kg= 40rs
Sand/ Fine aggregate=11.26kg=22rs
Coarse aggregate=21.82kg=20rs
Wire mesh=0.5 m.ft=30rs
Total cost=112rs

Cost for 1 conventional concrete block. (400mm x 200mm x 200mm)
Cement= 50rs
Sand/ Fine aggregate=27rs
Coarse aggregate=15rs
Total cost= 92rs

5. CONCLUSION

After testing compressive strength of conventional concrete block and ferrocement block with various alignment it is concluded that,

- It is observed that in ferrocement concrete block when the alignment of wire mesh is horizontal then compressive strength is increased by 21.47% as compared to conventional concrete block of same size.
- It is observed that in ferrocement concrete block when the alignment of wire mesh is vertical then compressive strength is increased by 8.21% as compared to conventional concrete block.
- It is observed that in ferrocement concrete block when the alignment of wire mesh is inclined then compressive strength is increased by 13.01% as compared to conventional concrete block.
- From the above conclusion it is observed that the compressive strength of ferrocement concrete block with horizontal alignment is higher than the compressive strength of ferrocement concrete block with inclined and vertical alignment.
- The cost of the ferrocement concrete block is 112Rs/block which is higher than the conventional concrete block i. e.92 Rs/block, so the conventional concrete block is cheaper than the ferrocement concrete block but the compressive strength of ferrocement concrete block is higher than the conventional concrete block

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Professor) Indira Institute of Technology and Sciences, Markapur.

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