International Journal of Aquatic Science
ISSN: 2008-8019
Vol 15, Issue 01, 2024

Investigation on Ferrock Concrete Using M-Sand

Ms. Harshali Koparkar[1], Prof. A.B.Dehane[2]

[1]P.G student, Department of Civil Engineering, BDCOE, Sewagram, Wardha.
[2]Assistant Professor, Department of Civil Engineering, BDCOE, Sewagram, Wardha.

Email: [1]harshalikoparkar@gmail.com, [2]amar.dhn98@gmail.com

Abstract: Concrete is widely used in construction. Concrete, the second most used material after water around the globe which accounts for 8 to 10% of total CO2 emissions is mainly due to cement. These CO_2 is responsible for global warming and pollution. In this project there is replacement of cement with the percentage of Ferrock and River sand is replace with M-sand. Ferrock is a waste material of steel. Ferrock is an iron based binding compound which utilizes variety of waste materials to form a carbon negative building material. From Researchers the best suitable proportion of Ferrock is Iron dust (60%), fly-ash (20%), Metakoalin (12%) and limestone (8%). M-sand is manufactured sand which is crushed from stone or gravel also known as machine made sand, artificial sand or crushed stone sand. In this M20 Grade concrete is used and for that the mix design was done having the different composition of cement, Fine Aggregate, Coarse Aggregate M-sand Ferrock and Water. The cubes are tested after the curing duration of 7 days and2 days. In this research work, there was replacement of the cement with the ferrock having a percentage variation 10 % and 20%.And replacement of River sand with M-Sand in percentage variation 0%, 50% and 100%. With the replacement of cement with ferrock and River sand with M-sand it was found that compressive strength was increased, and durability of the concrete was also increased. Also, it was economical as ferrock is a waste material which is available free of cost and M-sand is also cheaper than River sand, so it reduced the overall cost of the work. Also, the Ferrock has a property to absorb the Carbon dioxide from the environment so it is also reducing the air pollution.

Keywords: Compressive Strength, M-Sand, Ferrock, Iron Dust, Mix Design.

1. INTRODUCTION

Currently reducing greenhouse gases such as CO2 in the atmosphere and researching new methods to achieve the goal are areas of active investigation. Concrete, which utilizes cement as its most widely used construction component is considered the foundation of modern civilization. However, it is also the fourth largest source of carbon emissions, this highlights the urgent need for sustainable alternatives to cement production and the development of carbon capture technologies in the concrete industry. So, this study explores the potential of using ferrock as a partial replacement of cement, with the key ingredients being iron dust-a by-product of iron from iron mills. The composition of ferrock is iron dust, fly ash, metakaolin, limestone. To reduce the usage of natural sand it is replaced with M sand as replacement of river sand to ensure optimum binding and performance characteristics based on existing literature. Iron dust, a byproduct of the iron industry, is combined with trace amounts of

calcareous material, fly ash, and metakaolin to make this novel material, which would otherwise be disposed of in landfills. This study's specific goal is to build a Ferrock concrete and evaluate it against M20 grade conventional concrete. To determine its true performance, a variety of parameters are compared to traditional concrete, including workability, compressive strength. The ideal composition of these ingredients, as per literature, iron dust 60%, fly ash 20%, metakaolin 12%, lime stone 8%, Ferrock concrete is a relatively new material in the field of construction that has gained attention due to its potential environmental benefits and unique properties. Although many researches worked on the ferrock involvement in concrete, there are scare researches in the field of using high strength involving ferrock and with replacement of river sand with M sand. This current research aims to provide an overview of the current research and developments related to Ferrock concrete, including its composition, manufacturing process, mechanical properties, and environmental sustainability Current research investigates the mechanical properties, such as compressive strength, flexural strength, and durability aspects of Ferrock concrete. It presents the influence of different factors, including mix design and strength and durability performance. One of the significant advantages of ferrock concrete is its potential for reducing carbon emissions and utilizing industrial waste materials, making it a more sustainable alternative to traditional concrete. The environmental sustainability aspects of ferrock concrete. It discusses the reduction in carbon emissions compared to control concrete and highlights its potential for waste material utilization. It also addresses the challenges and opportunities in scaling up the production of ferrock . This serves as a foundation for further research and development in utilizing ferrock concrete in construction applications. With the world wide decline in the availability of construction sands along with the environmental pressures to reduce extraction of sand from rivers, the use of manufactured sand as a replacement is increasing. With the ban on sand mining implemented by different states, and with the increasing demand for river sand for construction works, many civil engineers have expressed the need to promote use of manufactured sand in the construction industry. As per reports, manufactured sand is widely used all around the world and technicians of major projects around the world insist on the compulsory use of manufactured sand because of its consistent gradation and zero impurity. There is a need for ‘clean sand’ in the construction from the point of view of durability of structures. Indiscriminate mining and quarrying is posing threat to the environment. As the demand for Natural River sand is surpassing the availability, has resulted in fast depletion of natural sand sources. Manufactured sand is the answer for this problem especially when some states have already banned the use of river sand for construction. This sand has been defined well in IS 383-1970, under clause 2.0

2. RESEARCH METHODOLOGY

2.1 Material Used

1) **Cement**:-In this project work, 53 grade of Ordinary Portland Cement is used. As per the Indian Standard the different tests are done for the accuracy such as Fineness Test, Soundness Test, and Consistency Test & Initial and Final Setting time. Apart from this the other things regarding cement are monitored such as color test, presence of lumps, strength test and date of packaging. Cement is used as a binder in concrete. Ordinary Portland cement refers from IS 269-2015.

Table: 1 Properties of cement

Fineness:	2%
Soundness:	1.2 mm
Consistency :	28%
Initial setting time:	85 min
Final setting time:	230 min

2) Coarse Aggregate: - Aggregate is one of the most important ingredient of the concrete which is responsible to provide the strength to the structure. To get the better result we used aggregate size 10 mm to 20 mm and as per the Indian Codal Provisions we did the test such as crushing test, Abrasion test, Impact test, Shape test. In these test the sample is passed as per the Indian Codal Norms.

Table: 2 Properties of Coarse Aggregate

S.N	TEST	RESULT	SPECIFIED BY IS CODE:383 2016
1	Fineness Modulus	7.13	5.5 to 8
2	Flakiness index	6.57 %	15%
3	Elongation index	10.04 %	15%
4	Abrasion value	14.78%	50%
5	Impact value	5.67 %	50%
6	Specific Gravity	2.7	2.5-3.0

3) Fine Aggregate(River sand and M-sand):- As per the Indian Codal Provisions we did the test such as Fineness modulus, Specific Gravity, silt content .In these test the sample is passed as per the Indian Codal Norms.

Table 3 Properties of Fie Aggregate

Test	River Sand	M-Sand	Specified by IS Code
Fineness Modulus	2.7	2.98	2.6-3.0
Specific Gravity	2.53	2.78	2.5 to 3.0
Silt Content	0.74 %	2.60 %	3%-River sand 15% -M-sand

4) Ferrock: - Iron powder 60%, Fly ash 20%, Metakaolin 12% and Limestone powder 8%

Table 4: Properties of Ferrock

Fineness:	2.5%
Soundness:	1.5 mm
Consistency :	30%
Initial setting time:	90 min
Final setting time:	285 min

2.2 Proportion of Material as per the Mix Design for M20 Grade Concrete

Table 5: Proportions of Material

Cement	FA	CA	Water
1	1.8	3.2	0.5

3. RESULT

Table 6: Compressive Strength Test Result of Cubes

S.N	Ferrock %	M-sand %	7th days Compressive strength N/mm^2	28th days compressive strength N/mm^2
1	0	0	13	22
2	0	50	12.40	21.5
3	0	100	13	21
4	10	0	12.5	22
5	10	50	13	22.5
6	10	100	13.5	24
7	20	0	12.40	21
8	20	50	12.5	20
9	20	100	12.5	19.5

Fig1. Compressive Strength Test on Concrete

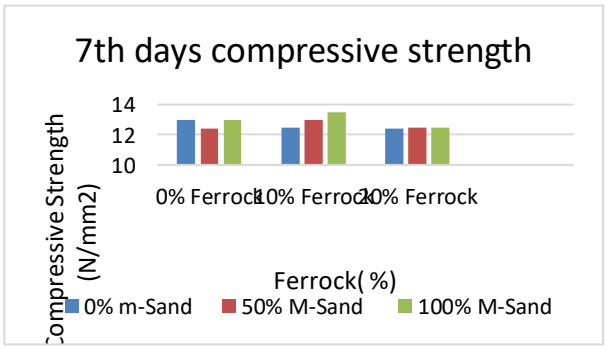

Fig 2. Shows the graphical representation of 7th days compressive strength of M20 grade concrete

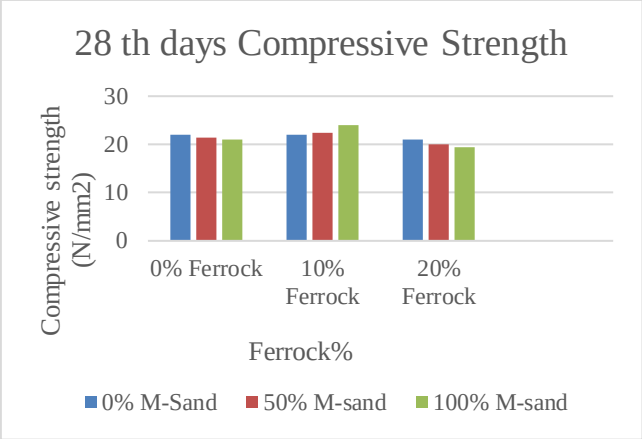

Fig 3. Shows the graphical representation of 28th days compressive strength of M20 grade concrete

4. CONCLUSION

- This investigation compares the impacts of ordinary Portland cement and ferrock, a blend comprising 60% iron oxide powder, 20% fly ash, 12% metakaolin, and 8% limestone, and it was found that we can replace cement by Ferrock up to 10%
- From the result it was concluded that compressive strength of concrete at 10 % replacement of cement by ferrock is more as compare to the conventional concrete
- In the current study it is evident that utilization of M-sand as partial replacement of river sand gives the required strength with eco-friendly properties like energy saving, resource saving, cost saving and it also increases the workability of concrete

5. REFERENCES

[1] D.S. Vijayan et al, 'Evaluation of ferrock: A greener substitute to cement" volume 22 part -3 2020 Pages 781-787
[2] Kavita Singh et al "Compressive strength study of green concrete using Ferrock" Multidisciplinary International Research Journal of Gujarat Technological University ISSN: 2581-8880 Volume 2
[3] Sakshi Agarwal et al "Ferrock material: A case study" International Journal of Research in Civil Engineering and Technology 2023; ISSN: 2707-8272 P-ISSN: 2707-8264
[4] S.Karthika et al "Sustainable development on Ferrock mortor cubes'' International Conference on Physics and Energy 2021 (ICPAE 2021)
[5] Niveditha et al "Ferrock: A Carbon Negative Sustainable Concrete" Internationl Journal Of Sustainable Construction Engineering And Technology Vol. 11 No. 4 (2021)
[6] Alejandro Lanuza Garcia et al " Ferrock –A life cycle comparison to ordinary portland cement" ISE 576-Industrial ecology April 24,2017
[7] Dr.S.Elavenil et.al " Manufactured sand-a solution and an alternative to river sand in concrete manufacturing" International Journal of Civil Engineering Research and Development (IJCERD) ISSN 2248 – 9436(Online), Volume 3, Number 1 Jan- March (2013),
[8] Shunbo Zhao et al" Experimental study on tensile strength development of concrete with manufactured sand"ELSEVIER Construction and building material Volume 138 1 May 2017 Pages 247-253

[9] T. Shanmugapriya et al "Optimization of partial replacement of m-sand by natural sand in high performance concrete with silica fume" International Journal of Engineering Sciences & Emerging Technologies, June 2012. ISSN: 2231 – 6604 Volume 2, Issue 2
[10] Vasavi Madala et al "Experimental Investigation On Performance Of Ferrock Concrete" ASMI-2023 IOP Conf. Series: Earth and Environmental Science 1280 (2023) 012008 IOP Publishing doi:10.1088/1755-1315/1280/1/012008

References: Indian Standard Codes:

1. Chemical analysis and tests on cement IS: 4031.
2. Codes for designing concrete mixes - IS: 456; 10262.
3. Code of Practices for Plain & reinforced concrete etc. IS 456 – 2000.
4. Compressive strength test for cement mortar cubes IS: 2250.
5. Methods of sampling and analysis of concrete IS: 1199