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A STUDY ON CORROSION POTENTIAL OF LIGHT WEIGHT STEEL FIBRE REINFORCED CONCRETE UNDER EXTREME EXPOSURE CONDITION

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Abstract:

In this study, The corrosion potential in saline water depends on various factors, including the chloride concentration, pH level, moisture content, and temperature. Higher chloride concentrations and lower pH levels generally increase the likelihood of corrosion The corrosion potential of lightweight steel fiber reinforced concrete (LSFRC) under extreme exposure conditions can vary depending on several factors. These factors include the composition of the concrete mix, the presence of corrosive agents in the environment, and the durability characteristics of the steel fibers used. LSFRC generally contains low-density aggregates and steel fibers that are often coated or made of stainless steel to enhance their corrosion resistance. However, under extreme exposure conditions such as highly aggressive environments or prolonged exposure to corrosive agents, there is still a potential for corrosion To determine the corrosion potential of LSFRC under extreme exposure conditions, it is important to consider factors such as the chloride ion concentration, pH level, moisture content, and temperature of the surrounding environment. Conducting detailed testing and analysis, such as electrochemical techniques, can provide valuable insights into the corrosion behavior and potential of LSFRC under these conditions. It is worth noting that ongoing research and advancements in materials science and engineering continually strive to improve the corrosion resistance of lightweight concrete and its various reinforcements, including steel fibers.

Introduction:

Lightweight concrete is a type of concrete that is designed to have a lower density compared to traditional concrete. It achieves this by incorporating lightweight aggregates or foaming agents into the mixture, resulting in a reduced weight while maintaining adequate strength and durability. The lightweight steel fiber reinforced concrete (LSFRC) is exposed to saline water, there is a potential for corrosion due to the presence of chloride ions. Chloride ions can penetrate the concrete and reach the embedded steel fibers, initiating the corrosion process. [1].

The corrosion potential in saline water depends on various factors, including the chloride concentration, pH level, moisture content, and temperature. Higher chloride concentrations and lower pH levels generally increase the likelihood of corrosion. Lightweight steel fiber reinforced concrete (LSFRC) is a type of concrete that incorporates steel fibers to enhance its structural performance. It is specifically designed to have a lower density compared to traditional concrete, making it lighter and more suitable for applications where weight reduction is desired. The steel fibers used in LSFRC are typically short, discrete fibers made of either carbon steel or stainless steel. These fibers are added to the concrete mix during the batching process, and they are uniformly distributed throughout the mixture. The addition of steel fibers provides several benefits to the concrete, including improved tensile strength, ductility, crack resistance, and impact resistance. Lightweight concrete with steel fiber reinforcement refers to a type of concrete that combines the characteristics of both lightweight concrete and steel fiber reinforced concrete (SFRC). It is designed to have reduced density while incorporating steel fibers to enhance its structural properties.

The production of lightweight concrete with steel fiber reinforcement involves incorporating lightweight aggregates or using foaming agents to reduce the overall density of the concrete mixture. These lightweight aggregates can include materials like expanded clay, shale, or slate. By using lightweight aggregates, the concrete achieves a lower weight compared to traditional concrete.

In addition to the lightweight aggregates, steel fibers are added to the mixture to provide reinforcement. The steel fibers are typically short, discrete fibers made of either carbon steel or stainless steel. These fibers enhance the concrete's tensile strength, ductility, crack resistance, and impact resistance.

The combination of lightweight aggregates and steel fiber reinforcement in this type of concrete offers several advantages:

1. Reduced weight: The use of lightweight aggregates results in a lighter concrete mixture, making it easier to handle and transport.

2. Improved structural performance: The addition of steel fibers enhances the concrete's strength and toughness, improving its ability to withstand loads and resist cracking.

3. Enhanced durability: Steel fiber reinforcement helps reduce cracking, improve resistance to shrinkage, and enhance the overall durability of the concrete.

4. Thermal and acoustic benefits: Lightweight concrete inherently offers improved thermal and acoustic insulation properties, while steel fibers can contribute to sound absorption and fire resistance.

Lightweight concrete with steel fiber reinforcement finds applications in various construction projects, including precast elements, flooring systems, bridge decks, and industrial floors, where the combination of reduced weight and enhanced structural performance is desire.

Litreture Review:

P.S. Mangat and Kribanandan Gurusamy et al. (1997) The following conclusions are based on experimental results given in this paper:Low carbon steel and corrosion resistant (galvanised) steel fibres which are exposed at concrete surface are prone to corrosion under marine exposure.Melt extract (stainless steel) fibres exposed at concrete surface did not show signs of corrosion after 2 000 cycles of marine exposure.The activation level of 0.4 per cent C1- by weight of cement does not apply to steel fibres embedded in concrete since corrosion was not initiated.

Jean-Louis Granju*, Sana Ullah Balouch, et al. (2005) The results confirm that steel fibres are less vulnerable to corrosion than steel bars are. After 1 year exposure to marine saline fog: there is no corrosion in the parts of the cracks thinner than about 0.1 mm, ! in the wider parts of the cracks (the tested samples had CMOs=0.5 mm), a light corrosion of the fibres with no reduction of their section was observed.

Victor Marcos-Meson[a,b,c,*], Alexander Michel[a],et al. (2017) In simpler terms, The durability of cracked SFRC exposed to chlorides and carbonation is under discussion at the technical and scientific level. There is substantial insight among academics regarding the existence of a critical crack width, below 0.20 mm, where fibre corrosion is limited and the structural integrity of SFRC can be ensured for long-term exposures. However, the mechanisms governing corrosion of carbon-steel fibres in cracked SFRC subject to chloride and carbonation exposure are still unclear. In particular, the influence of fibre corrosion on the residual strength of SFRC is in focus and under discussion.

2. Materials

The materials utilized in this study were readily accessible within the local region of Lucknow, India.

(1) Cement

(2) Fine aggregate

(3) Pumice lightweight aggregate

(4) Water

Cement

S.no	Properties	Test Result
1	Specific Gravity	2.627
2	Standard Consistency	30%
3	Initial Setting Time	31 min
4	Final Setting Time	270 min

Aggregate

In this study, Pumic Stone (cinder) crucshed sand and Pumic Stone (cinder) coarse aggregates were utilized in the concrete mixtures. The fine aggregate used in this work is zone-1, and coarse aggregates ranged in size from 5mm to 20mm, as determined through sieve analysis (Table 1). Due to its lightweight and porous nature, cinder is often used in construction and landscaping projects. It can be used as a lightweight aggregate in concrete mixes or as a drainage material in gardens and landscaping.

Properties of Pumice Lightweight Aggregate

S.N	Properties		Test Result
1	Specific Gravity		1.05
2	Sieve Analysis		2.75
3	Water Absorption		55%
4	Bulk Density	Loose Bulk Density	0.49 g/cm^3
		Rodded Bulk Density	0.48 g/cm^3
5	Impact Test		22%
6	Crushing Test		80.5%

Table 1

Properties of materials

S.No.	Property	Results
1	Fineness of Cement	2%
2	Specific gravity of cement	2.687
3	Standard consistency of cement	34%
4	Initial setting time	131 min
5	Specific Gravity of fine aggregate	2.487
6	Water absorption of fine aggregate	2.990%
7	Fineness modulus of fine aggregate	3.525 mm
8	Specific gravity of coarse aggregate	2.582
9	Fineness modulus of coarse aggregate	7.036 mm
10	Water absorption of coarse aggregate	2.7862%

Water plays a crucial role in the concrete mixture. When water is added to the cement, it reacts chemically to form a paste, which binds the aggregate particles together. This hydration process hardens the concrete over time. The amount of water used in the mixture affects the workability, strength, and durability of the concrete. It's important to maintain the right water-to-cement ratio for optimal performance. Too much water can weaken the concrete, while too little water can make it difficult to work with and result in a weaker structure. The quantity and quality of water is required to be looked into very carefully. Fresh potable water confirming IS-456-2000 was used for the preparation of the concrete.

Mix proportion

The mix design for this experiment followed the guidelines of IS-10262:2019 and IS-456. Five mix samples were prepared, each with different proportions. For each mix, a total of 10 cube specimens, The first Five cube mix of M20 Grade Of Concrete and Other Five cubes of M25 Grade of concrete.

Table 2

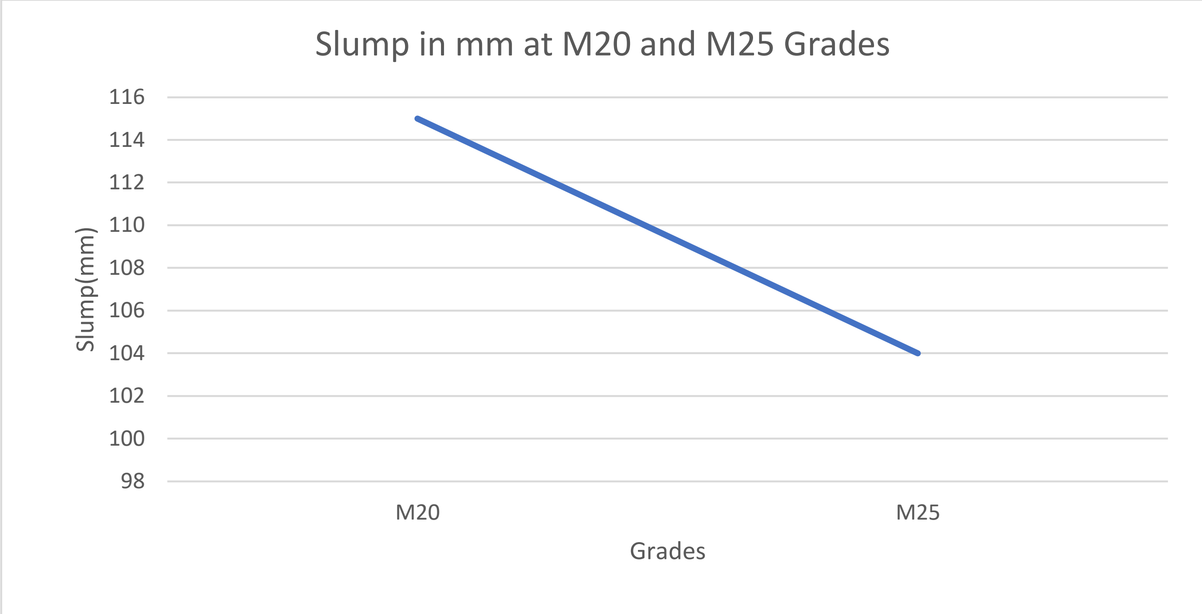
Mix Proportion

S.no	Grade	Mix proportion
1	M20	1:1.5:3
2	M25	1:1:2

Slump test

In order to assess the workability of fresh concrete, the slump test, as per the IS 1199-2018 standard, is performed. The test involves using a specially designed mould known as a slump cone. The cone has a base diameter of 200 mm and a smaller opening at the top measuring 100 mm in diameter and 300 mm in height. The cone is filled with concrete in three layers, with each layer being compacted 25 times using a 16 mm diameter rod to eliminate any air voids. The top surface of the concrete is leveled, and then the cone is carefully removed. The height of the slump, or the deformation of the concrete, is then measured to determine its workability.

The results of slump test was 110 mm and 102 mm, for M20 &M25 respectively.



2.3 Test Setup

For the experimental testing, cube moulds with dimensions of 150×150×150 mm were used to measure the compressive strength of the concrete. A total of 10 cubes were produced. The cubes were cured for 7 and 28 days before testing. Furthermore, non-destructive tests such as the rebound hammer test (as per IS 516 [PART 5/SEC 1]) and ultrasonic pulse velocity (UPV) test (as per IS 516 [PART 5/SEC 1]) were conducted on the cubes….

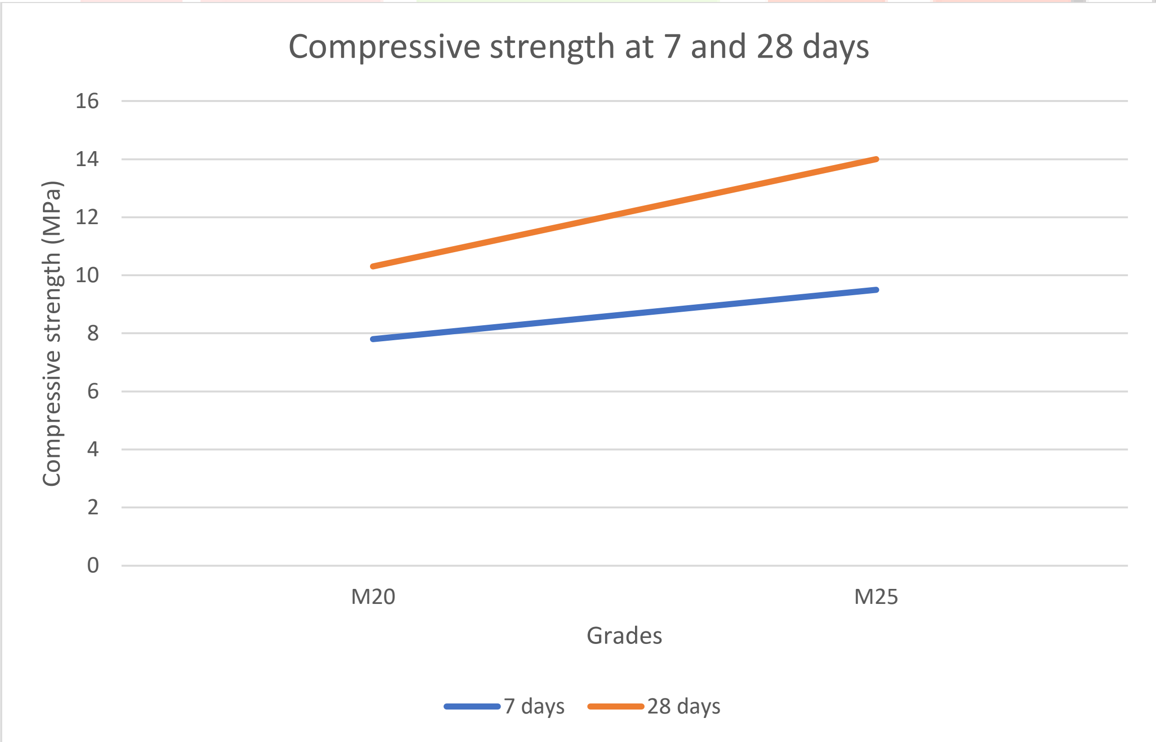
Fig. 1. Slump test

Fig. 2. Mouldes

Fig. 3. Compression testing

Compressive strength

Figure 6. Compressive strength test is performed to determine the compressive strength of the concrete cube specimens using a Universal testing machine of 100-ton capacity as per IS 516-1959. the compressive strength results of cubic specimens containing Light Weight aggregate (LWA) for a water-to-cement ratio (w/c) of 0.60. The specimens were tested at 7 and 28 days, respectively. The compressive strength of Pumice LWAC 12 Mpa 14.7 Mpa.



Ultrasonic pulse velocity (UPV)

The pulse velocity is influenced by various factors, including the elastic properties of the material, its density, and any internal flaws or voids. By comparing the measured pulse velocity with established standards or reference values, it is possible to assess the quality and integrity of the material. m the test results of ultrasonic pulse velocity test, the average pulse velocity of M20 & M25 concrete, Pumice LWAC 2.97 Km/s ,3.07 Km/s,3.10Km/s,3.18 Km/s respectively.

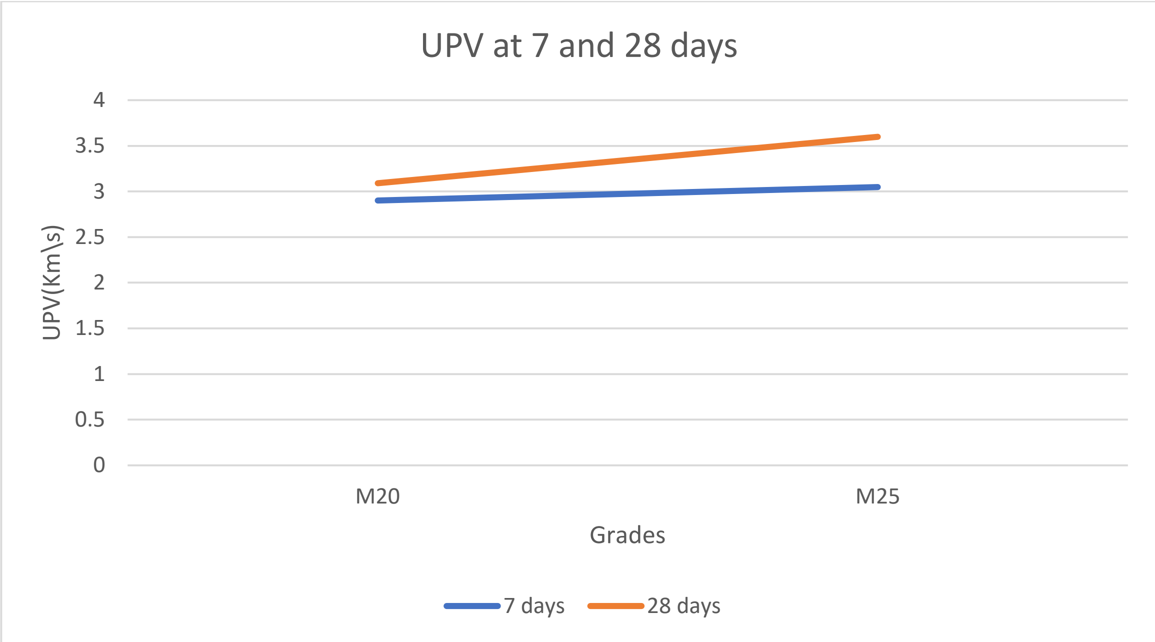
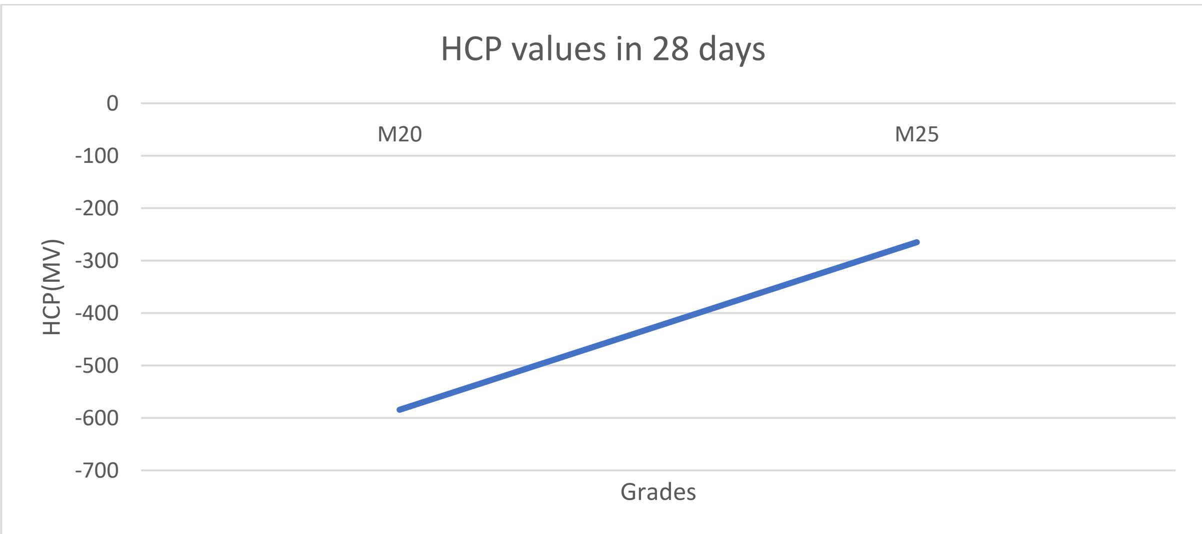


Fig. 8. Average upv at 7 & 28 days

Half-cell Potentiometer

A half-cell potentiometer, also known as a half-cell electrode or a reference electrode, is a device used in electrochemical measurements to determine the electrode potential of a half-cell. It consists of a reference electrode, a high impedance voltmeter, and a salt bridge. The reference electrode in a half-cell potentiometer provides a stable and known electrode potential against which the potential of another electrode can be measured. Common reference electrodes include the standard hydrogen electrode (SHE), silver/silver chloride electrode (Ag/AgCl), and calomel electrode (Hg/Hg2Cl2).



Conclusion

In summary, the experimental studies presented in the paper highlight the following conclusions:

It shows that increasing percentages of pumice aggregate will decrease the density of the concrete which results in lightweight aggregate concrete.

Its shows the increasing the grade Of Concrete is decresing the corrosion risk

Corrosion effect in saline water after 5 week

Anowledgement

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References

[1] R. S. Muralitharan, V. Ramasamy "Basic Properties of Pumice Aggregate" International Journal of Earth Sciences and Engineering, Volume 8, No.4, pp. 256 – 258, August 2015.

[2] A. Suba Lakshmi, S. Karthick, Gasper Helden, M. Dinesh Boopathi, V. Balaji Pandian "Experimental Investigation on Lightweight Concrete using Pumice Aggregate" International Journal of Innovative and Emerging Research in Engineering, Volume 4, Issue – 3, 176 – 183,2017.

[3] Rajeswari S, Dr Sunilaa George "Experimental Study of Lightweight Concrete by Partial Replacement of Coarse Aggregate using Pumice Aggregate" International Journal of Scientific Engineering and Research, Volume 4, Issue -5, 50 – 53, May 2016.

[4] IS 2386-4 (1963): Methods of test for aggregates for concrete, Part 4: Mechanical properties [CED 2: Cement and Concrete].

[5] IS 10262-2009, Guidelines for concrete mix design proportioning [CED 2: Cement and Concrete]. [18] IS 456-2000 Plain and reinforced concrete- code of practice (4th revision).

[6] IS 383-1970 "Specifications for fine & coarse aggregate from natural sources for concrete" [CED 2: Cement and Concrete].

[7] IS 516 (1959): Method of Tests for Strength of Concrete [CED 2: Cement and Concrete].

[8] IS 13311-2 (1992): Method of non-destructive testing of concrete-methods of test, Part 2: Rebound hammer [CED 2: Cement and Concrete].

[9] IS 8112-2013 "Specification of 43 grade ordinary Portland cement" [CED 2: Cement and Concrete]