IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Exploring Zeolite As Partial Replacement Of Cement For Self Curing And Strength Enhancement

G.NEERAJ[1], G.SUJITHA[2],K.B.HARSHITHA PRIYA[3],T.UDAY KIRAN[4]

[1]Assistant Professor in Civil Engineering Department, JNTUA College Of Engineering, Kalikiri, Andhra Pradesh, India.

[2]B.Tech Student, Civil Engineering Department, JNTUA College Of Engineering,Kalikiri, Andhra Pradesh, India.

[3]B.Tech Student, Civil Engineering Department, JNTUA College Of Engineering, Kalikiri, Andhra Pradesh, India.

[4]B.Tech Student, Civil Engineering Department, JNTUA College Of Engineering, Kalikiri, Andhra Pradesh, India.

ABSTRACT

Concrete is a composite material,which is composed by ordinary Portland cement,water and also included granular aggregates which are fine aggregate and coarse aggregate .The increasing demand for sustainable and high-performance construction materials has led to the exploration of alternative cementitious materials. This study investigates the potential of M30 concrete grade having a partial replacement of cement by natural zeolite , focusing on its effects on self-curing properties and strength enhancement. Zeolite, a naturally occurring aluminosilicate, is known for its high water retention capacity and pozzolanic activity, making it a promising candidate for improving concrete performance. In this research, different replacement levels of cement with zeolite by 5%,10%,15%,and 20% of cement weight were evaluated for their impact on workability, hydration, compressive strength, and self-curing efficiency. To evaluate the performance of this modified concrete, both fresh and hardened properties are analyzed. Fresh properties, such as workability and slump, are tested to ensure the concrete mix remains practical and easy to handle during placement. Hardened properties, including compressive strength and split tensile strength are measured after 7days and 28 days.To understand the performance of concrete at different levels of zeolite Powder replacement,the cubes were cast and evaluated after seven and twenty-eight days.The best percentage of replacement of zeolite in cement is calculated by performing tests on the cubes casted with zeolite replacement ratios in concrete.

Keywords: Zeolite, Superplatisicer, M30 Grade , Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

Concrete is one of the most widely used construction materials, but its performance is often affected by inadequate curing and early-age shrinkage, leading to reduced strength and durability. Traditional curing methods require external water supply, which may not always be feasible, especially in dry or water-scarce regions. To address this issue, zeolite powder has emerged as a promising material due to its ability to act as a self-curing agent while also enhancing concrete strength.

Explores the potential of zeolite powder as a cement partial replacement, focusing on its dual role as a self-curing agent and strength enhancer. By evaluating different replacement levels, the research aims to determine the optimal percentage of zeolite incorporation for maximizing both hydration efficiency and structural integrity. The findings could provide a sustainable and cost-effective solution for improving concrete quality while reducing cement consumption.

Zeolite powder is a naturally occurring aluminosilicate with a high water absorption and retention capacity. When incorporated into concrete, it absorbs water during mixing and gradually releases it over time, ensuring continuous internal curing even in low-moisture environments. This self-curing property reduces the dependence on external water supply, making it particularly useful for regions facing water shortages or construction projects in remote areas where traditional curing is impractical.

This study investigates the potential of zeolite powder as a cement partial replacement, focusing on its dual benefits of self-curing and strength enhancement, especially in water-scarce regions. By analyzing different replacement levels, the research aims to determine the optimal zeolite dosage for maximizing hydration efficiency and mechanical performance. The findings could contribute to more sustainable, durable, and resource-efficient concrete solutions for modern construction.

1.1 RESEARCH BACKGROUND

Zeolite is an aluminosilicate mineral that can be found naturally or manufactured synthetically, characterized by its porous, honeycomb-like structure. It is renowned for its ion-exchange capabilities and its ability to absorb various substances, making it extremely versatile. Natural zeolites originate from volcanic ash interacting with alkaline groundwater, whereas synthetic ones are crafted for specific industrial applications. Availability and Sourcing Zeolite is readily accessible worldwide. In India, significant natural deposits are located in Maharashtra, Gujarat, and Tamil Nadu.We ensured to get the product from online industrialisation platforms like Indiamart .It is available in powder form. This replacement enhances the strength, and chemical resistance of concrete while also reducing the carbon emissions associated with cement production Experimental work is then conducted in JNTUA College as per IS standards to assess the Zeolite chemical and physical characteristics.

1.2 SCOPE OF THE WORK

This experimental study's main objective is to enhance the strength by the replacement of cement with zeolite by self curing.In major areas, scarcity of water is more ,where conventional concrete requires major amount of water. The study will involve casting standard cubes (150x150x150 mm) to assess compressive strength, and cylinders (150 mm diameter, 300 mm height) for the split tensile strength. In self curing concrete,there is no requirement of water for curing.In this self curing concrete experiment ,this project involves, zeolite as an self curing agent because of its high water absorption capacity. Also intended to use the plasticizer for more strength requirement .zeolite is used in proportions as 5%,10%,15%,20% of cement weight.Self curing concrete involves the M30 grade designed concrete,OPC 43 grade cement, fine aggregate of zone-1,coarse aggregate ,water, zeolite powder and plasticizer. Fresh concrete properties such as slump cone and compaction factor will also be evaluated and compared to conventional concrete. This concrete is casted in cubes and undergoes self curing for 7 and 28 days. The tests are conducted for knowing the strengths by Rebound Hammer Test ,Compressive Strength Test, Split Tensile Test.

1.3 OBJECTIVES OF RESEARCH

The following are the key goals of this investigation:

1. Evaluate the integration of Zeolite as partial replacements for cement and curing agents in M-30 grade self-curing concrete.
2. To figure out the workability, split tensile strength, and compressive strength of both new and hardened concrete after 7 and 28 days of self curing.
3. To evaluate the feasibility of using zeolite as a partial replacement for cement in concrete mixtures ranging from 5% to 20%.
4. To study the self-curing capability of zeolite-based concrete and assess its effectiveness in reducing external curing requirements.
5. To analyze the effect of zeolite on the fresh and hardened properties of concrete, such as workability, compressive strength, and durability.
6. To determine the optimum replacement level of zeolite that provides maximum self-curing efficiency without compromising strength and performance.
7. To contribute to sustainable construction practices by reducing cement usage and exploring environmentally friendly alternatives.

Advance sustainable concrete technologies by addressing water management and aggregate sustainability to satisfy the requirements of contemporary building.

II. REVIEW OF LITERATURE

The mechanical properties of have all been studied recently by a number of scholars.

Geetha and Dr. Malathy (2011)[3] In this research they compare the strength and durability properties of different grade concrete by using polymeric materials without use of any external water. During this experimental work grade of concrete selected was M20, M30 and M40. Spinacia oleracea (palak) of 0.6% to 0.8% weight of cement is added as admixture to concrete while preparing concrete. Erukkampal at 0.2% to 0.4% and polyethylene at 0.2% to 0.4% of cement were used as self curing agent. During experimental work split tensile strength, compressive strength, acid resistance, sea water resistance and accelerated corrosion of concrete was observed. The strength as well as durability properties of specimens with palak green was better than other three alternatives and proved be best when compared to external curing. Also the cost of internal curing was cheaper than external curing.

Avinash and Gajendra (2022)[17] The objective of this experimental investigation was to develop self-curing concrete using light expanded clay aggregate (LECA) to save water in making concrete and construction. The study focused on comparing the strength characteristics of normal strength concrete cast with the self-curing agent LECA and conventionally cured concrete. A trial and error method was adopted for designing the normal strength internal curing concrete of grade M30. The study used replacements of 10%, 20%, and 30% of LECA by volume of aggregate to produce internal-curing concrete. The compressive and flexural strength of the concrete was tested for 7 and 28 days of curing. The results of the study showed that the compressive strength of mix proportion MD2 (Aggregate 90% and LECA 10%) was maximum compared to other mix designs except for MD1 for 7 days of curing. Similarly, the flexural strength of concrete mix proportion MD2 (Aggregate 90% and LECA 10%) attained maximum strength compared to other mix designs except for MD1 for both 7 and 28 days of curing. In conclusion, the use of LECA as a self-curing agent in concrete has the potential to save water in making concrete and construction. The results suggest that, mix proportion MD2 with 10% LECA replacement can provide higher compressive and flexural strength compared to other mix designs. Further research can explore the use of other self-curing agents and their effectiveness in concrete.

JosephP.Rizzutoetal. (2020)studied the effect of self-curing admixture onconcrete properties in hot climate Conditions. The following study was carried out bymixing concretes at a temperature of 25C and 50 C by incorporating1.5% of PEG400 in the concrete.Trials were also carried out by varying the temperature of mixing water which was varied from 5C to 35C. The results indicated that self-curing concretes out performed those concretes which were subjected to normal curing regime[3]

MagdaI.Mousaetal.(2015)studied the mechanical properties of self-curing concrete. In this study two self curing agents were used,which are pre-soaked ightweight aggregates and polyethyleneglycol at different dosages with different proportions of silica fume.A2% incorporation of PEG in SCC yielded better results in comparison to concretes containing 1% and 3% PEG.Usage of 15% Pre-soaked lightweight aggregate yielded better results in comparison to concretes containing 5% and 10% of pre-soaked aggregates[4]

III. EXPERIMENTAL WORK

3.1 MATERIALS USED

A. Cement: Ordinary Portland cement of grade 43 is prepared for the experiment, it acquired from the Coromandel cement company, which is free from lumps. The key properties of the tested cement are as follows: The specific gravity is 3.15, with a fineness of 9.43%. The consistency value measures 27.5, while the initial and final setting times are 196 minutes and 543 minutes, respectively.

B. Fine Aggregate: In this study, fine aggregate passing through a 2.36 mm sieve was employed. Laboratory tests determined the sand's specific gravity (2.64) and fineness modulus (2.95), The fine aggregate was graded as per IS 383:2016 and classified under Zone-I based on its particle size distribution.

C. Coarse Aggregate: The coarse aggregates utilized in this experimental investigation consisted of a graded blend of 20 mm and 10 mm nominal sizes, proportioned at 56:44 by weight as per the recommendations of *IS 383:2016* (for concrete-grade aggregates). The aggregates were procured from local sources to ensure regional applicability. Comprehensive characterization was performed in accordance with the following Indian Standard test methods: yielded values of gravity are 2.680(20mm) and 2.664(10mm),Water absorption is recorded as 1.64%and shape indices noted are Flakiness indices as 12.34%,Elongation indices are 16.54%.

D.Zeolite: Zeolite is an aluminosilicate mineral that can be found naturally or manufactured synthetically, characterized by its porous, honeycomb-like structure. It is renowned for its ion-exchange capabilities and its ability to absorb various substances, making it extremely versatile. Natural zeolites originate from volcanic ash interacting with alkaline groundwater, whereas synthetic ones are crafted for specific industrial applications.

For this study, the aggregate, Zeolite is used in proportions of cement weight as 5%,10%,15%,20%. The following tables provide specific information on the Zeolite chemical and physical characteristics.

Table 1: Physical properties of Zeolite.

S. No	Property	Test Result
1	Specific gravity	2.57
2	Fineness	91%
3	Water absorption	22%
4	Ph	7 to 8

Table 2: Chemical properties of Bethamcherla stone.

S. No	Property	Test Result
1	Silica (Sio2)	45.64%
2	Calcium Oxide (Cao)	11.32%
3	Sodium	2.16%
4	Magnesium Dioxide (Mgo)	3.16 %
5	Potassium	6.41%
6	Alumina (Al2O3)	18.69 %
7	Ferric Oxide (Fe2O3)	8.97 %
8	Loss on ignition (LOI)	3.44 %
9	Bulk Density	0,70%

Table:3 Zeolite Chemical structure

S. No	Chemical Aspect	Details
1	Chemical name	M^n+\n1/n$^-$\n$_x$.yH\n$_2$O
2	Chemical formula	Mx/n[(AlO2)x(SiO2)y]
3	Molecular structure	Interconnected tetrahedra of SiO4 and AlO4
4	Functional groups	Si-O,O-Al-O,Si-OH, and O-H
5	Polymerization	The process of using zeolites,crystallines alluminosilicates materials with a porous structure, as a catalyst or template for polymer formation.
6	Appearance	White or colorless,porous,crystalline solids, often with a powdery or granular texture.
7	Solubility	Insoluble

E. Nitobond SBR Latex:

The self-curing agent utilized in this investigation is Nitobond SBR Latex which is applied at weight percentages of 1.1% of cement weight .Nitobond SBR Latex is known for its excellent water-retention properties, which help to reduce water evaporation during the curing process. By incorporating Nitobond SBR Latex into the concrete mix, it enhances hydration and improves the overall strength of the concrete. This addition aims to address water management issues and contribute to more efficient curing practices.

Figure 1: Nitobond SBR Latex

Table 4: Chemical properties of Nitobond SBR Latex

S.No	Product properties	Results
01	Physical state	A pale yellow to light yellow
02	Chemical composition	Polycarboxylic ether -based liquid
03	Relative density at 20 centigrade	1.073
04	pH	7.05
05	Dry material content(%)	25.42
06	Chloride ion content(%)	0.0012
07	Ash content(%)	1.75
08	Recommended dosages	0.2-1.2% bwoc

The table outlines the general chemical composition and key properties of Nitobond SBR Latex. The precise characteristics can differ depending on the degree of polymerization and hydrolysis, which are customized for specific uses.

F. Water: Concrete must be mixed with clean water that has no dangerous quantities oils, organic compounds, acids, and alkalis or other deleterious chemicals. In this investigation, we used portable tap water from the JNTUA college campus water plant that met the IS456-2000 standards for casting concrete and curing the specimens.

3.2 MIX PROPORTIONS

The study aimed to evaluate the effect of zeolite powder as a partial cement replacement (5%, 10%, 15%, and 20% by weight) on the properties of M30-grade concrete, designed with a water-cement ratio of 0.5 as per *IS 10262:2009*. Specimens were cast and tested for workability (slump test), compressive strength, and split tensile strength, following standard protocols. The self-curing efficiency and water retention capacity of zeolite-modified concrete were assessed by comparing results with a conventional control mix (0% zeolite). Performance was evaluated at 7- and 28-day curing intervals to determine the optimal zeolite replacement level that maintains or enhances concrete quality while reducing cement consumption.

3.3 CASTING OF SPECIMENS

This study investigated the performance of self-curing concrete with cement partially replaced by natural zeolite (5%–20% by weight). An M30-grade mix was designed per *IS 10262:2019, batched by weight, and cast into oil-coated moulds (cubes: 150×150×150 mm; cylinders: 150×300 mm) to prevent adhesion. Specimens were compacted in three layers using a 16 mm tamping rod (IS 516:1959), demoulded after 24 hours, and subjected to self-curing (specify method, e.g., polyethylene glycol). Compressive strength was tested at 7 and 28 days (IS 516:1959*), with results compared to conventional concrete.

Figure 2: Casting of cubes, cylinders.

3.4 SELF-CURING

Self-curing concrete, also known as internally cured concrete, is designed to retain moisture within the concrete mass, reducing.

Role of Zeolite in Self-Curing:

Zeolite acts as an internal curing agent by absorbing water during the mixing process and gradually releasing it as the cement hydrates. This internal reservoir of water helps maintain internal relative humidity, reduces autogenous shrinkage, and ensures more complete hydration, especially in the early stages. This is particularly beneficial in Remote or hot environments where proper curing is difficult.High-performance concrete mixes with low water-to-cement ratios. Comparing strength gain of zeolite mixes with conventional water-cured concrete.Observing the reduction in surface drying cracks.Measuring internal moisture retention and weight loss over time.Monitoring the hydration progress using compressive strength as an indirect measure.

By varying zeolite content from 5% to 20%, the study aims to determine the optimum level of zeolite that provides maximum self-curing efficiency while maintaining or improving concrete properties.

3.5 TESTING METHODS

3.5.1 Workability test: The workability of fresh concrete mixes with variaying zeolite containing (5%,10%,15%,20%) was evaluated using the slump cone test as per IS 1199-1959.This method is used to measure the consistency and ease of handling the concrete. The standard dimensions of slump cone test is 30x20x10cm.The concrete is placed into standard slump cone in three layers, each tamped 25 times.After lifting the cone ,the vertical slump was measured to determine workability.

3.5.2 Rebound Hammer Test: The Rebound Hammer Test is also known as the Schmidt Hammer Test.This test comes under Non destructive Method used to assess the surface hardness and also approximates the compressive strength of concrete. In this study, it was used to assess the increment of strength of self curing concrete mixes with 5%,10%,15% and 20% of zeolite replacement levels.

3.5.3 Compression Test: Compression testing is a type of mechanical testing used to determine the compressive strength and behaviour of materials under compressive loads. M30 grade concrete was prepared by using Ordinary Portland Cement 43 (OPC), natural sand, coarse aggregate (ranging from 10mm to 20mm), zeolite powder and Nitobond SBR latex. Three specimens were made for each mix to find out average values. The specimens were taken out of the moulds after a 24-hours period and subjected to curing periods of 7 and 28 days.

3.5.4 Split Tensile Test: The split tensile test determine the tensile strength of concrete, which is essential for designing and evaluating concrete sructures.M30 grade concrete was prepared by using Ordinary Portland Cement 43 (OPC), natural sand, coarse aggregate (ranging from 10mm to 20mm), zeolite powder and Nitobond SBR latex. Three cylindrical moulds were cast for each mix to determine average values. The samples were taken out of their moulds after one day, and subjected to curing periods of 7 and 28 days.

IV. TEST RESULT AND DISCUSSIONS

4.1 GENERAL

The tests were accomplished on both freshly mixed and hardened concrete. The Fresh concrete mixture was tested for slump of workability. Tests on hardened concrete are finished, including compressive strength and split tensile strength tests.

4.2 FRESH PROPERTIES OF CONCRETE

Workability was evaluated using the slump cone test (*IS 1199:1959*). The results indicated a progressive reduction in workability with increasing zeolite replacement levels (5–20% by cement weight), attributed to the material's high water absorption characteristics. To mitigate this effect, Nitobond SBR latex superplasticizer was incorporated into the mix. The relationship between zeolite content, superplasticizer dosage, and resultant slump values is graphically presented in below graph, demonstrating the interplay between cement replacement and workability adjustment

Table-5 : Slump test results.

% Of Zeolite powder	Slump Value mm	Workability
0%	85	Moderate
5%	45	Very low
10%	30	Very low
15%	21	Very low
20%	10	Very low

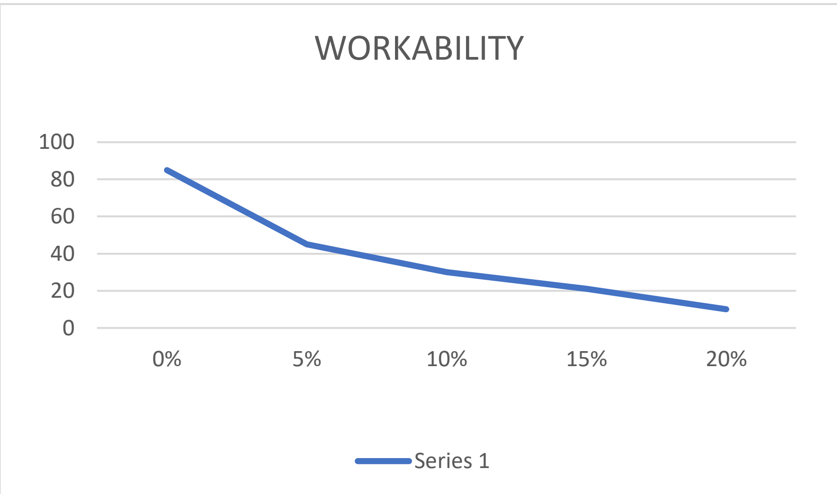


Figure-3:Results of 7days workability

Increasing zeolite content (5-20%) progressively reduces concrete workability, with slumps dropping from 85mm to 10mm. While superplasticizers help, workability remains "very low" at all replacement levels. Practical use requires limiting zeolite to ≤5% or developing enhanced workability solutions, highlighting the need to balance sustainability with constructability.

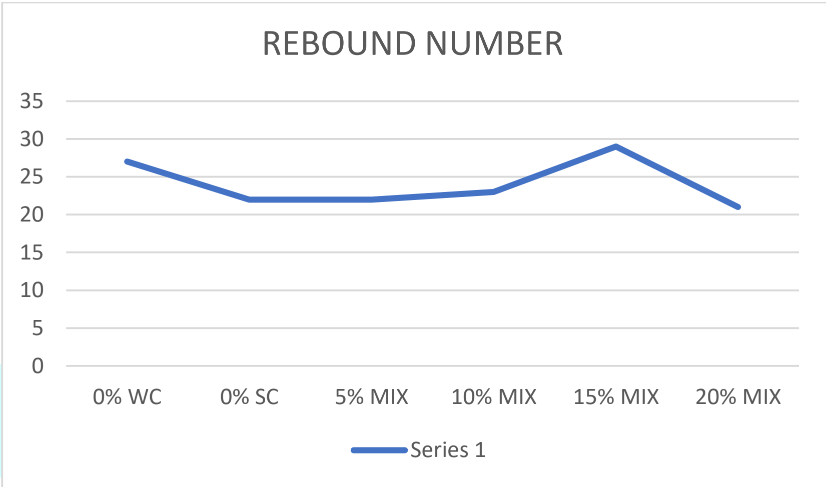
4.3 HARDENED PROPERTIES OF CONCRETE :

Testing the hardened properties of concrete is essential for verifying the quality and performance of cementitious composites. The evaluation methods must maintain rigorous precision while remaining practical for field and laboratory applications. Standardized procedures (e.g., IS 516:1959 for compressive strength) ensure reliability, whereas simplified techniques enhance accessibility without compromising accuracy. This dual focus on methodological robustness and operational feasibility forms the cornerstone of concrete quality assurance

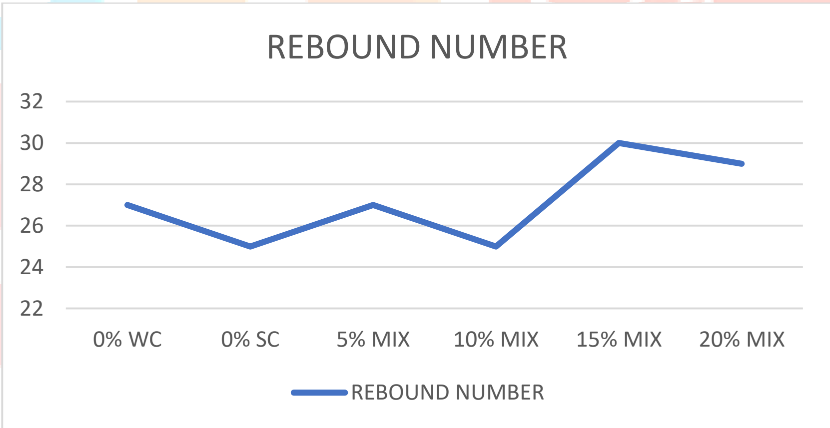
AGE OF CUBES	% OF ZEOLITE	AVG.REBOUND NUMBER	COMPRESSIVE STRENGTH(N/mm^2)
7DAYS	0%(WC)	27	24
	0%(SC)	22	20
	5%	22	20
	10%	23	18
	15%	29	27
	20%	21	17
14DAYS	0%(WC)	27	24
	0%(SC)	25	21
	5%	27	24
	10%	25	21
	15%	30	28
	20%	29	27
28DAYS	0% (WC)	28	26
	0%(SC)	26	21
	5%	27	23
	10%	27	23
	15%	30	28
	20%	29	27

A. **Rebound Hammer Test: The** principle of rebound hammer test is ,it measures surface hardness through a spring driven hammer rebound, this corelates to compressive strength. Since it's an non-destructive testing, it yields the rapid strength enhancement of cured members.

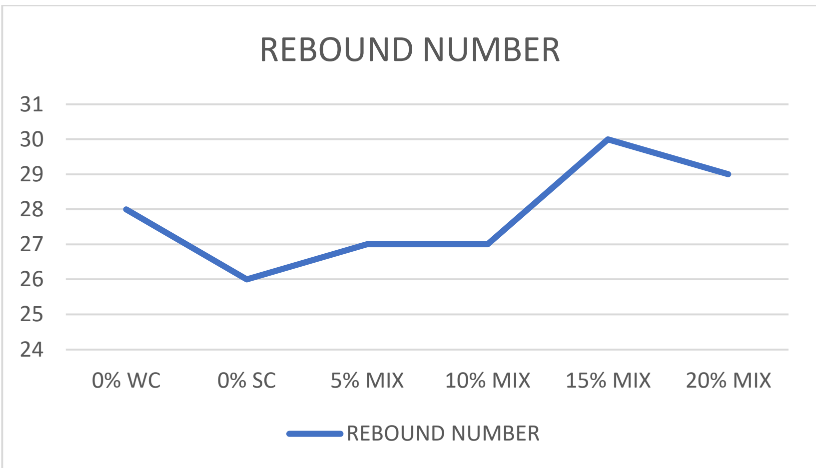
Table-6:Results of Rebound Hammer Test



The above drawn graph represents the Rebound Number for 7 days of self-curing of zeolite mixes.



The above drawn graph represents the Rebound Number for 14 days of self-curing of zeolite mixes.



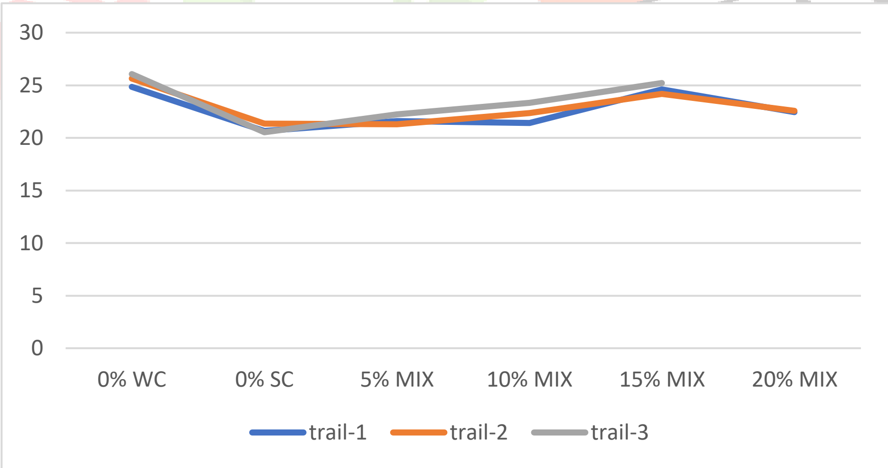
The above drawn graph represents the Rebound Number for 28 days of self-curing of zeolite mixes

B. Compressive strength test:

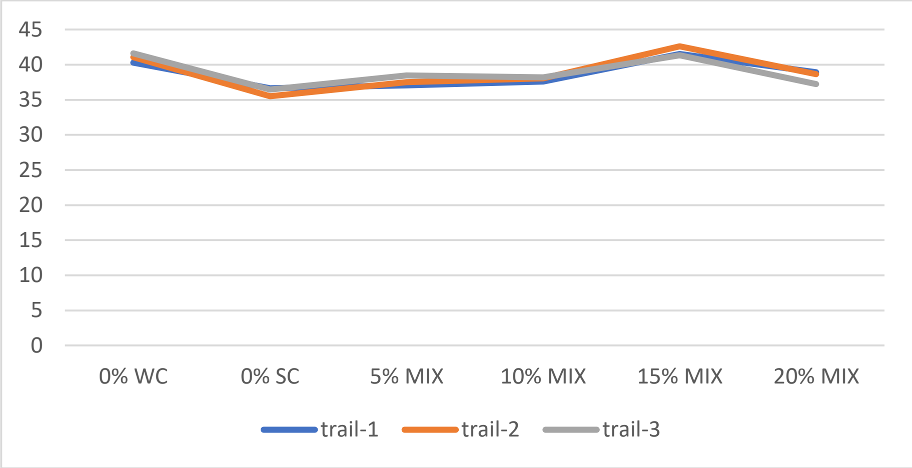
The compressive strength test is a fundamental method for evaluating concrete's structural capacity, performed by subjecting cured cube specimens to axial loading until failure. Conducted at standard curing ages (typically 7 and 28 days), this test follows established protocols (IS 516:1959) to ensure reliable measurement of the maximum load-bearing capacity per unit area (expressed in N/mm² or MPa). As a critical quality control metric, it directly reflects the influence of mix design, curing conditions, and material properties on concrete's mechanical performance, serving as a major indicator for structural suitability in experimental applications.

Table-7 : Compressive Strength test results at 7 days and 28 days

AGE OF CUBE	TRAILS	0% MIX(N/mm^2)		5% MIX (N/mm^2)	10% MIX (N/mm^2)	15% MIX (N/mm^2)	20%MIX (N/mm^2)
		WC	SC				
7DAYS	T-1	24.86	20.67	21.61	21.41	24.61	22.46
	T-2	25.64	21.34	21.29	22.36	24.18	22.58
	T-3	26.07	20.52	22.23	23.34	25.22	21.25
28 DAYS	T-1	40.28	36.63	37.05	37.63	41.52	38.92
	T-2	41.08	35.49	37.51	38.07	42.64	38.67
	T-3	41.62	36.48	38.48	38.20	41.36	37.24



The above drawn graph represents the Compressive strength for 7 days of self curing of zeolite mixes.



`

The above drawn graph represents the Compressive Strength for 28 days of self-curing of zeolite mixes.

The compressive strength test results demonstrate a clear relationship between zeolite replacement levels and concrete performance. At 7 days, the control mix (0% zeolite) achieved the highest strength (24.86–26.07 N/mm²), while zeolite-modified mixes (5–20%) showed marginally lower values (20.52–25.22 N/mm²). Notably, the 15% replacement mix exhibited comparable or even superior strength to the control in some trials (e.g., 25.22 N/mm²), suggesting potential optimal performance at this dosage. By 28 days, all mixes gained strength, with the control (40.28–41.62 N/mm²) and 15% zeolite mix (41.36–42.64 N/mm²) outperforming others, while 5–20% replacements consistently ranged between 35.49–38.92 N/mm².

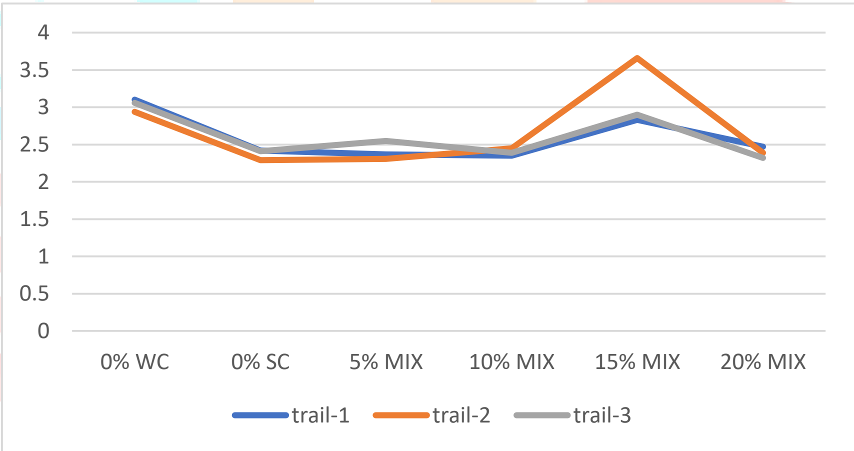
The data indicates that zeolite can partially replace cement without significantly compromising compressive strength, particularly at 15% replacement, which matched or exceeded the control at both ages. However, higher replacements (20%) showed slightly reduced strength, likely due to dilution effects or incomplete pozzolanic activity. These findings suggest that zeolite replacement up to 15% is structurally viable, but beyond this threshold, careful mix optimization is required. Further research could explore long-term durability and workability trade-offs to validate practical applicability

C. Split tensile Strength test

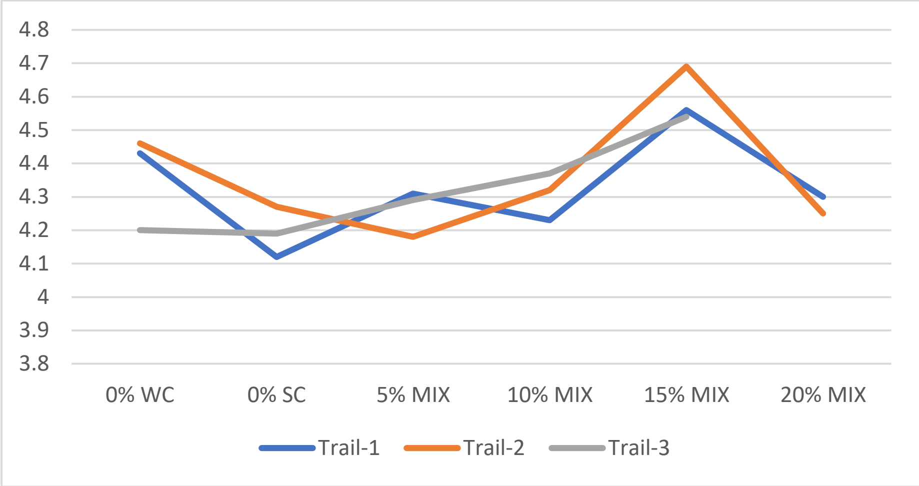
The tensile strength of concrete can be determined by this indirect test. Concrete specimens were tested for spillting tensile strength on cylinders 150 mm in diameter and 300 mm in height after 7 and 28 days of self curing. IS 5816 199 was used to conduct the test. A splitting tensile strength test was conducted on cylindrical specimens positioned on the compression testing machine. The values for splitting tensile strength are graphed below, which show the load applied till failure.

Table-8 : Split Tensile Strength test results at 7 days and 28 days

AGE OF CUBE	TRAILS	0% MIX(N/mm²)		5% MIX (N/mm²)	10% MIX (N/mm²)	15% MIX (N/mm²)	20%MIX (N/mm²)
		WC	SC				
7DAYS	T-1	3.10	2.42	2.37	2.23	2.83	2.47
	T-2	2.94	2.29	2.31	2.45	3.66	2.39
	T-3	3.06	2.41	2.55	2.39	2.90	2.32
28 DAYS	T-1	4.43	4.12	4.31	4.23	4.56	4.3
	T-2	4.46	4.27	4.18	4.32	4.69	4.25
	T-3	4.2	4.19	4.29	4.37	4.54	4.17



The above drawn graph represents the Split Tensile strength for 7 days of self-curing of zeolite mixes.



The above drawn graph represents the Split Tensile strength for 28 days of self-curing of zeolite mixes.

In this investigation, he split tensile strength test results demonstrate that concrete with zeolite replacement (5–20%) exhibits comparable performance to conventional concrete (0% zeolite) at 28 days, with all mixes achieving strengths within the range of 4.12–4.69 N/mm². While the 7-day results showed minor variations—such as slightly lower strengths for 5–10% replacements (2.29–2.55 N/mm²) and occasional higher values for 15% zeolite (3.66 N/mm² in T-2)—the 28-day data revealed consistent strength development across all mixes. Notably, the 15% zeolite mix consistently matched or exceeded the control (4.54–4.69 N/mm²), suggesting optimal performance at this replacement level.

These findings suggest that zeolite can effectively replace up to 15% of cement without significantly compromising tensile strength, particularly at later curing ages. The minimal disparity between zeolite-modified and control mixes at 28 days highlights the material's potential as a sustainable alternative.

V. CONCLUSION

In this experiment, we studied the effects of partial cement replacement with zeolite powder(5-20%) on the mechanical properties of concrete, focused on workability, Compression Strength and Split tensile strength. These experimental results yielded the following key conclusions**:**

i. It was reported that Zeolite contains higher water absorption capacity than other self-curing agents .

ii. The slump test resulted a progressive reduction in workability with increment of zeolite content(5-20%),categorizing the mixes as very low workability. Therefore ,the addition of Nitobond SBR Latex superplasticizer partially diminished this effect

iii. Rebound Hammer test shows that a 15% zeolite as a optimal replacement for strength of surface hardness and also supporting its use for quality controls of sustainable concrete production. It is seen that beyond the 15%,there is no progress of increase in strength levels.

iv. In Compressive strength tests demonstrated that a replacement of zeolite and addition of superplasticizer of 15% and 1.1%bwoc enhanced 16.67% of strength at 7days than conventional concrete,15.58% of strength at 28 days of self-curing respectively.

v. Split Tensile strength test results mirrored the compressive trends with 15% of zeolite mixes exceeding 17.72% at 7days of self-curing and 5.2% of strength at 28 days of self-curing of specimens respectively.

REFERENCES

[1] Concrete Technology: A Comprehensive Overview and Guide written by M. S. Shetty, published by S. Chand Publications.
[2] Portland cement grade 43 specifications in accordance with Indian standards (IS 8112:1989).
[3] IS 516 (20211) methods for determining the strength of concrete.
[4] IS 5816 (2018) Tensile strength test method for concrete splitting.
[5] Recommended Proportions for Concrete Mixes IS 10262 (2009).
[6] The practice code for both reinforced and unreinforced concrete, IS 456 (2000).
[7] Geetha and Dr.Malathy 2023 .Research on Self Curing Concrete using Bio-Admixtures .International Research journal of Engineering and Technology.
[8] Avinash and Gajendra 2022.Experimental study on Light Weight Concrete by using Light Expanded Clay Aggregate. International Journal for Research in Applied Science &Engineering Technology.
[9] J.Rizzuto,M.Kamal,H.Elsayad,A.Bashandy,Z.Etman,N.Aboel Roos 2020.Research on Effect of Self Curing admixture on concrete properties in hot climate conditions. University of West London.
[10] Magda I. Mousa, Mohamed G. Mahdy, Ahmed H. Abdel-Reheem, Akram Z. Yehia (2014) Mechanical properties of self-curing concrete (SCUC), Housing and Building National Research Center HBRC Journal. 3,654 665.