

# IMPACT OF NANO ZEOLITE ON PROPERTY OF M20 CONCRETE

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**ABSTRACT**-The application of nanotechnology has given the endeavors to improve the qualities of concrete a new level. Because of their minuscule particle size, nano materials have the ability to alter the microstructure of concrete by altering its characteristics. This study focuses on using 200–500 nm nano zeolites to increase concrete's strength. Nano zeolite at weight percentages of 0.25%, 0.50%, 1%, 1.15%, 1.25%, and 1.50% was used in place of cement in an experimental inquiry. According to the tests, concrete's early-age strength has increased significantly, but its overall strength has slightly increased. The strength of concrete increased as the amount of nano zeolite raised up to 1.15%, and using more nano zeolite negatively affected the concrete's qualities. However, because of the increased fineness, higher replacement levels had a minor impact on workability. Overall, the study finds that nano zeolite can serve as a sustainable supplemental cementitious material to improve the strength and durability characteristics of M20 concrete.

**Keywords:** Nano Zeolite, Nano Materials, Properties, Strength, M20 Concrete

## INTRODUCTION

The building material of the future and present is concrete. One of the most widely used materials of the twenty-first century, it may be found in everything from industries to bridges to airports, as well as residential buildings. Concrete's strength and durability must be increased because to the rapid population development and technology advancements to meet these demands. Because of its bulk and adhesive qualities, cement is a key component among the other materials needed to make concrete. Therefore, a thorough understanding of the cement hydration mechanism and the development of superior alternatives are necessary to manufacture concrete with enhanced qualities. To improve concrete's qualities, several substances referred to as supplemental cementitious materials, or SCMs, are added. These consist of fly ash, blast furnace slag, bacteria, silica fumes, and rice husk. Among the several technologies now in use, nanotechnology shows promise as a means of improving the properties of concrete.

## NANO MATERIALS

Use in Concrete Materials classified as nonmaterials has particles as small as nanometers. Because of their minuscule size, these materials are highly effective for altering the ultrafine characteristics of concrete. A larger surface area is also a result of the particles' modest size. A pozzolanic reaction can proceed more quickly since its pace is proportional to the available surface area. To get the desired effects, only a tiny proportion of cement needs to be changed. By occupying the tiny holes and spaces in the microstructure, these nano particles increase the permeability and strength of concrete. Concrete's compressive, tensile, and flexural strengths have all increased when nano-zeolite has been added to the mix. Because it sets quickly, admixtures are typically needed when designing the mix. After hydration, nano-zeolite mixed cement can produce C-S-H gel nano crystals. These nano crystals fit into the cement concrete's micropores, decreasing permeability and enhancing concrete strength.

## MOTIVATION OF THE STUDY

A greater compressive strength can only be achieved by using more cement. However, one of the main causes of pollution is cement. By substituting a certain amount of cement with nano materials, concrete strength can be increased and pollution can be reduced. Since even a little amount of Nano-Zeolite can drastically change the properties of the material, a detailed analysis of the microstructure of the concrete is required to understand the interactions.

The research papers currently in print illustrate the use of admixtures in concrete mixes.

Admixture has been utilized in this investigation to determine how any foreign material affects the concrete's strength. This study aims to clarify the microstructure of a nano-zeolite in order to explain how it affects concrete's strength.

## LITERATURE REVIEW

**Taras Markiv, Khrstyna Sobol. (2016)** Experiments have demonstrated that the addition of natural zeolite boosts strength. Additional calcium may be produced and the phase composition of cement hydration products can be altered by adding zeolite and chemical admixtures to concrete. hydrosilicates and hydrogelenite. The pore structure of concrete improves.

**Ehsan Mohseni (2017)** 10% zeolite and 15% tuff made up the concrete with the highest compressive strength. When zeolite was substituted for cement, the amount of water absorption was greatly decreased. However, concrete samples that substituted tuff for sand showed no appreciable absorption. The chloride diffusion coefficient of the control specimen decreased by up to 55% in the T15Z10 sample. Therefore, it can be said that the specimens were considerably more resistant to chloride once tuff and zeolite were added. Concrete samples containing tuff saw a drop in compressive strength of 9.2% to 15.7% after 236 days of immersion in sulfuric acid, whereas samples containing tuff and zeolite experienced a reduction of 13.07% to 21.4%. Conversely, the plain's decreased strength In contrast, the strength reduction of the plain concrete sample was 5.01%. After being exposed to hydrochloric acid for 180 days, specimen 15T15Z experienced the largest mass loss, 4.8%.

**Mohsen Zadeh, Pouria, Seyed F et. Al. , (2019)** The goal of this study is to determine the ideal ratio of zeolite and meta-kaolin to water micronanobubbles for the mechanical and long-term qualities of concrete samples. According to the studies, the concrete samples' compressive and flexural strengths rose by 3.7 and 17.85%, respectively, when 10% zeolite was added. It reduced water absorption in 30 minutes, 24 hours, and chloride permeability by 4.34, 16.61, and 41.52% after 28 days as compared to the control sample. The combination of 10% zeolite and 10% meta-kaolin with 100% micro-nano water bubbles generated the greatest results when compared to the control sample, boosting the compressive, tensile, and flexural strengths. Furthermore, it decreased chloride penetration and 24-hour water absorption by 80.45% and 17.56 percent, respectively, at 90 days in comparison to the control sample.

**Mohamed AE et. Al. ,(2025)** Concrete's durability and mechanical qualities were greatly enhanced in New Zealand. By lessening the effects of different exposure scenarios, NZ has the potential to make concrete more ecologically friendly. Because of pozzolanic reactions, 3% NZ showed the best mechanical properties under normal circumstances. 1.5% NZ was proven to be the most helpful percentage for mechanical qualities in samples that were exposed to internal chloride and sulfate attack. This is because New Zealand has a high proportion of aluminum, which makes ettringite more likely to occur. For materials subjected to external chloride and sulfate assault, 4.5% NZ was determined to have the best mechanical qualities. Because of delayed hydration, NZ functions as filler at a young age.

## METHODOLOGY

### Mix proportion:

| Water | Cement | Fine aggregate | Coarse aggregate |
|-------|--------|----------------|------------------|
| 0.45  | 1      | 1.49 ~ 1.50    | 2.924 ~ 3.00     |

Mix calculations:

Volume of concrete = 1 m<sup>3</sup>

Volume of cement = 0.185 m<sup>3</sup>

Volume of fine aggregates = 0.275 m<sup>3</sup>

Volume of coarse aggregate = 0.540 m<sup>3</sup>

Water-Cement ratio= 0.45

## RESULT

Compressive Strength Test Results

(Dimension of Cube = 150mm×150mm×150mm)



**Figure 1:** Universal Testing Machine for Compressive Strength Test

For a batch of 9 cubes of 150mm side, 9 cylinders of 150mm dia & 300mm length, 9 beams of 100mm depth- breadth & 500mm length, the volume of concrete required

**Table 1:** 28-Day Compressive Strength (N/mm<sup>2</sup>) Test Result

| Sample No. | Control | 0.25% Nano Zeolite | 0.50% Nano Zeolite | 1% Nano Zeolite | 1.15% Nano Zeolite | 1.25% Nano Zeolite | 1.50% Nano Zeolite |
|------------|---------|--------------------|--------------------|-----------------|--------------------|--------------------|--------------------|
| 1          | 23.975  | 25.834             | 25.985             | 27.985          | 30.120             | 28.287             | 25.177             |
| 2          | 24.388  | 26.038             | 27.117             | 29.456          | 32.932             | 29.120             | 28.215             |
| 3          | 26.013  | 27.007             | 29.925             | 30.848          | 33.923             | 29.863             | 28.432             |

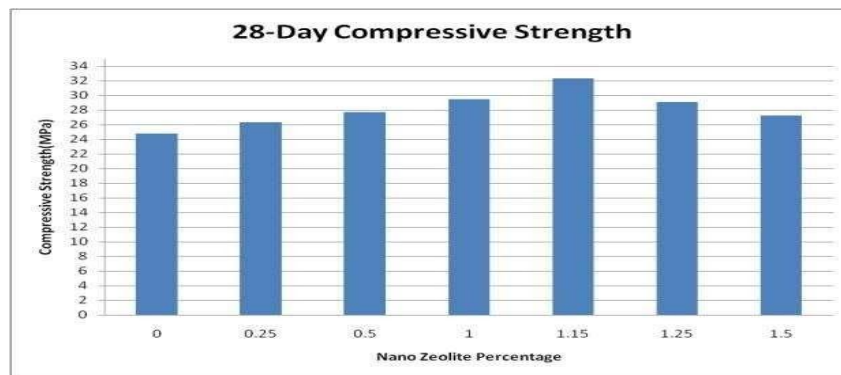


**Figure 2:-**Day Compressive Strength Test

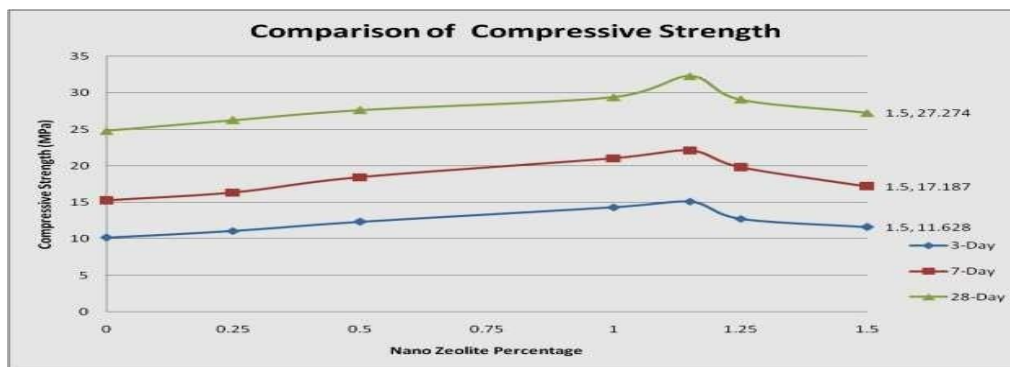


**Figure 3:** Comparison of Compressive Strength Test

**Table 2:** 28-Day Split Tensile Strength (N/mm<sup>2</sup>) Test Result

| Sample No. | Control | 0.25% Nano Zeolite | 0.50% Nano Zeolite | 1% Nano Zeolite | 1.15% Nano Zeolite | 1.25% Nano Zeolite | 1.50% Nano Zeolite |
|------------|---------|--------------------|--------------------|-----------------|--------------------|--------------------|--------------------|
| 1          | 3.194   | 3.598              | 3.946              | 4.435           | 4.733              | 3.997              | 3.790              |
| 2          | 3.218   | 3.667              | 3.973              | 4.454           | 4.768              | 4.014              | 3.815              |
| 3          | 3.255   | 3.682              | 4.001              | 4.485           | 4.772              | 4.033              | 3.820              |

### Flexural Strength Test Results

**Table 3:** 28-Day Flexural Strength (N/mm<sup>2</sup>) Test Result

| Sample No. | Control | 0.25% Nano Zeolite | 0.50% Nano Zeolite | 1% Nano Zeolite | 1.15% Nano Zeolite | 1.25% Nano Zeolite | 1.50% Nano Zeolite |
|------------|---------|--------------------|--------------------|-----------------|--------------------|--------------------|--------------------|
| 1          | 6.045   | 6.617              | 6.875              | 9.225           | 10.093             | 7.897              | 7.281              |
| 2          | 6.613   | 7.983              | 8.482              | 9.568           | 10.181             | 8.612              | 8.070              |
| 3          | 8.357   | 8.128              | 9.602              | 10.974          | 11.103             | 9.014              | 8.302              |

**Table 4.17:** Comparison of Flexural strength test result for 28 day

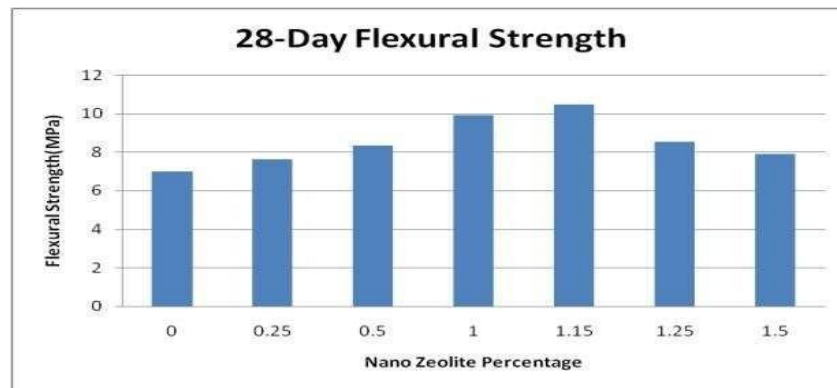


**Figure 5:** 28-Day Flexural Strength

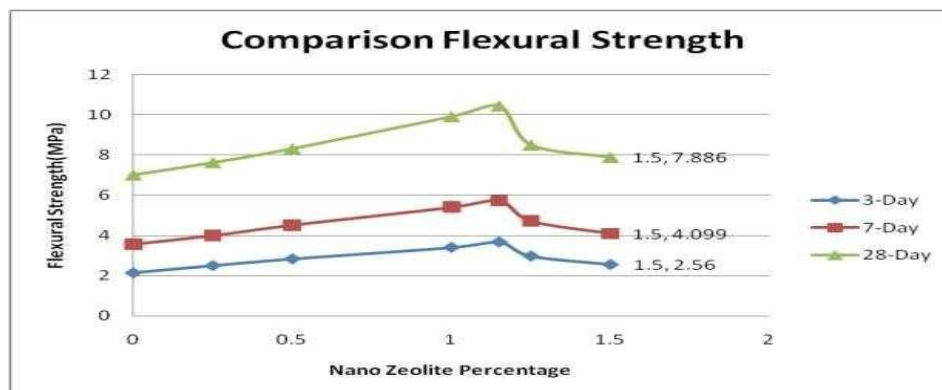


**Figure 6:** Comparison of Flexural tensile Strength

## CONCLUSION

Several inferences are made from the specimen's test results. The following section provides justification for these conclusions. The inferences made are:

1. Adding a small amount of nano-zeolite increases the strength of concrete specimens. The largest increase in strength occurs when 1.15% of the cement weight is replaced with nano-zeolite.
2. Adding nano-zeolite significantly improves early-age strength of concrete, surpassing the 28-day rise.
3. Previous research on Nano-Concrete suggests that adding Nano Zeolite has a minor impact on the overall quality of the concrete, as evidenced by Ultrasonic Pulse Velocity and Field Emission Scanning Electron Microscope Micrograph tests, which show a uniform and compact microstructure.
4. The increase in strength is explained by the nano-zeolite particles filling in the microstructure's voids, which stops  $\text{Ca}(\text{OH})_2$  crystals from growing. Furthermore, the nano zeolite transforms calcium hydroxide crystals into C-S-H gel by a reaction. Concrete's increased strength is due to a decrease in the  $\text{Ca}(\text{OH})_2$  concentration.
5.  $\text{Ca}(\text{OH})_2$  crystals are found in the Interfacial Transition Zone (ITZ), located between aggregates and cured cement paste. Nano Zeolite reacts with these crystals and reduces their concentration, hence strengthening the ITZ. Because of the lower concentration, Nano zeolite is consumed in the reaction, limiting the growth in strength over time.
6. Adding Nano Zeolite to the solution compacts and uniformizes the microstructure of the C-S-H gel by filling its pores.

## SCOPE FOR FUTURE RESEARCH

The usage of nano-zeolite in concrete has been thoroughly studied, although a complete understanding has yet to be reached. The size effects of nano-zeolite can be thoroughly researched in the future. A thorough examination of the microstructure at different times of the year can provide a very good understanding of the processes occurring in the concrete. Given the cost of nano-silica, new low-cost production techniques can be developed.

## REFERENCES

- 1) AlirezaNaji Givi, Suraya Abdul Rashid, Farah Nora A. Aziz and Mohamad Amra MohdSalleh (2010). Experimental investigation of the size effects of  $\text{SiO}_2$  nano particles on the mechanical properties of binary blended concrete. Composites: Part B 41, 673-677.
- 2) A.M. Said, M.S. Zeidan, M.T. Bassuomi and Y. Tian. (2012). Properties of concrete in incorporating nano-silica. Construction and Building Materials 36, 838-844.
- 3) Heidari, A., and Tavakoli, D. (Sept 2012). A study of mechanical properties on ground ceramic powder concrete incorporating nano  $\text{SiO}_2$  particles. Construction and Building Materials Vol. 38, 255-26.
- 4) (Mukharjee, Bibhuti Bhusan, 2014) Mukharjee, Bibhuti Bhusan, Barai and Sudhirkumar V. (2014). Influence of incorporation of nano-silica and recycled aggregates on compressive strength and microstructure of concrete. Construction and Building Materials 71, 570- 578.
- 5) Maekiv, T. (2016). Mechanical and durability properties of concretes in incorporating natural zeolite. 16 (4), 554-562.
- 6) Ehsan Mohseni, Waiching Tang (2017) " Chloride Diffusion and Acid Resistance of Concrete Containing Zeolite and Tuff as Partial Replacements of Cement and Sand" 16-20, 2017.
- 7) Mohsen Zadeh P, Saghravani SF, Asadollahfardi G. Mechanical and durability properties of concrete containing zeolite mixed with meta-kaolin and micro-nano bubbles of water. Structural Concrete. 2019 Apr;20(2):786-97
- 8) (Mohamed AE, Abdelaziz MA, Farid AS, Osman KM. Nano-Zeolite-Modified Concrete: A Comprehensive Study of Mechanical Properties, Corrosion Resistance, and Microstructural of Concrete under Varied Exposure Conditions. Cleaner Engineering and Technology. 2025 Jan 31:100900.)