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# EFFECT OF NANOMATERIAL ON MECHANICAL PROPERTIES OF HIGH STRENGTH CONCRETE

**P. Mohan Vamsi Krishna[1], Dr.K.V.S Gopala Krishna Sastry[2]**

1(*M.Tech student, Department of Civil Engineering, GPREC, Kurnool, AP, India*)
2(*Professor, Department of Civil Engineering, GPREC, Kurnool, AP, India*)

**ABSTRACT:**

*The use of High-strength concrete (HSC) has become inevitable for high rise buildings. Usage of Nano materials in concreteeither individually or blended with other materials showed better mechanical properties of HSC. In the present study Nano calcium carbonate (NC) was replaced in concrete at 1%, 2% and 3% by the weight of the cementitious material in concrete. The strength properties like compressive, split tensile and flexural strengths of HSC were studied for replacement of cement with Nano $CaCo_3$. It was noticed that maximum strength properties are achieved at 1% Nano $CaCo_3$.*

***Keywords*** *-High-strength concrete, Silica fume, Nano calcium carbonate.*

## 1. INTRODUCTION

As the population is increasing, the spatial comfort of the people is minimized. To overcome this, High rise buildings came into existence using HSC. As per IS 456-2000, concrete having compressive strength higher than 60 Mpa is considered as HSC. By using HSC the time required for the construction can be reduced. Pozzolan materials like silica fume, Fly ash and Ground granulated blast furnace slag (GGBS) were also added in limited proportions to produce the HSC. Silica fume is highly reactive compound compared to other pozzolan materials and is most commonly used pozzolan. Low water cement ratio is used to produce HSC which leads to the micro and Nano size pores in the concrete. Use of Nano particles in the concrete fills the voids in the structure making it denser thereby contributing more strength. There are many Nano materials which are in existence like Nano Silicon dioxide, Nano titanium dioxide, Nano aluminium oxide and Nano Calcium carbonate. The mechanical properties like compressive, split tensile and flexural strengths are increased with the addition of Nano materials [1]-[4]. Addition of Nano Calcium carbonate not only improves strength but also performance of the high volume fly ash concretes [5]. Addition of Nano Calcium carbonate improved strength properties of concrete besides slump value showing less workability [6].

## 2. EXPERIMENTAL PROGRAMME

### 2.1 Materials

The following materials were used in the present study.

#### 2.1.1 Cement

Ordinary Portland Cement (OPC) of 53 grade produced by ULTRA TECHcompany with specific gravity 3.14.

#### 2.1.2 Coarse aggregate

Coarse aggregate (nominal maximum size of 12.5 mm with specific gravity 2.808)from local quarry.

#### 2.1.3 Fine aggregate

Sand from the banks of thungabadra river confirming to zone 2 having specific gravity of 2.63.

#### 2.1.4 Silica fume

Silica fume with an average particle size of 0.1 to 0.3 micrometers having 99.5% purity fromAastra chemicals Company, Chennai.

#### 2.1.5 Nano calcium carbonate

Commercially available Nano calcium carbonate having an average particle size of 15 to 30 nanometers with 99.9% purity.

#### 2.1.6 Water

Potable water confirming to IS 3025-1984 [7].

#### 2.1.7 Super Plasticizer

Polycarboxylate ether based super plasticizer having 1.08 specific gravity.

### 2.2 Mix design

The present study is carried out with reference to M80 grade of concrete. As per ACI code, water cement ratio for M80 grade concrete obtained was 0.24. Compressive strength test was performed on 100mm×100mm×100mm size cube at 28 days as per code IS 516-1959[8]. Flexural strength test was carried out on beam of size 500mm×100mm×100mm at 28 days as per code IS 516-1959[8]. Split tensile strength test was done on cylinder of size 100mm diameter and 200mm height at 28 days as per code IS 5816-1999[9]. Nano Calcium carbonate is replaced with the cementitious material from 1% to 3% with an increment of 1% for every mix. Three samples were tested for each strength property and average value is considered. The mechanical properties of HSC with added Nano material is compared with that of HSC without Nano material. The proportions of the HSC mixes are presented in Table 1.

Table -1: Proportions of HSC per cubic meter

| Mix designation | Cement ($Kg/m^3$) | Silica fume ($Kg/m^3$) | Sand ($Kg/m^3$) | Coarse aggregate ($Kg/m^3$) | Water (liters) | Super plasticizer ($Kg/m^3$) | Nano $CaCo_3$ ($Kg/m^3$) |
|---|---|---|---|---|---|---|---|
| Reference mix | 543 | 60 | 695 | 1045 | 150 | 7 | - |
| NC 1% | 537 | 60 | 695 | 1045 | 150 | 7 | 6 |
| NC 2% | 531 | 60 | 695 | 1045 | 150 | 7 | 12 |
| NC 3% | 525 | 60 | 695 | 1045 | 150 | 7 | 18 |

## 3. RESULTS AND DISCUSSION

The target strength achieved for M80 grade reference mix was 94 Mpa. The mechanical properties of HSC with Nano $CaCo_3$ showed improved strengths when compared to the reference mix. HSC with 1% Nano material showed optimum increase in strength than other Nano proportions. The maximum compressive strength improvement of 13.8% over reference mix was noticed at 1% replacement of Nano $CaCo_3$. The split tensile and flexural strengths were increased by 9.8% and 11.3% at 1% dosage of Nano Calcium carbonate over reference mix. The strength variations were shown in the table 2.Fig.1 shows the variation of compressive strength for different % of Nano $CaCo_3$. Variations of split tensile strength of HSC with % of Nano $CaCo_3$ represented in Fig.2. Flexural strength variations of HSC with % of Nano $CaCo_3$ is depicted in Fig.3.

Table -2: Mechanical properties of HSC M80 grade

| Mix Designation | Compressive strength (Mpa) | Split tensile strength (Mpa) | Flexural strength (Mpa) |
|---|---|---|---|
| Reference mix | 94 | 5.7 | 6.2 |
| NC 1% | 107 | 6.3 | 6.9 |
| NC 2% | 104 | 6.1 | 6.8 |
| NC 3% | 103 | 6.0 | 6.1 |

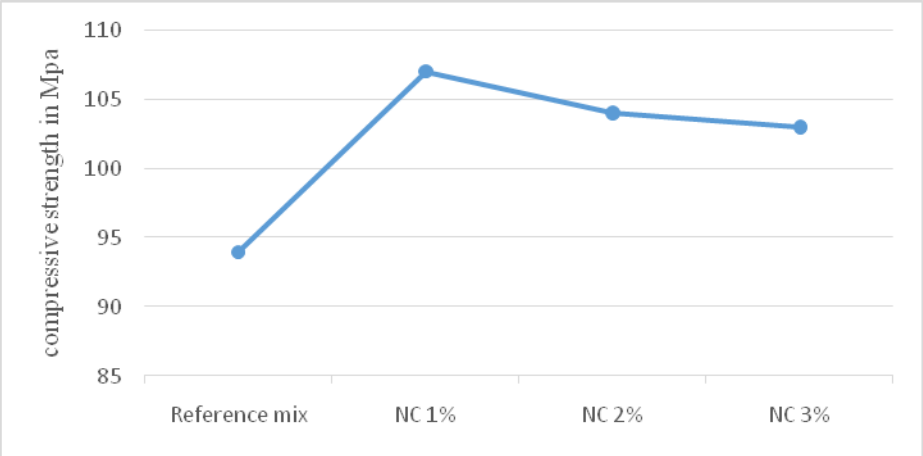


**Fig -1:**Variation of 28 days compressive strength of HSC with Nano $CaCo_3$.

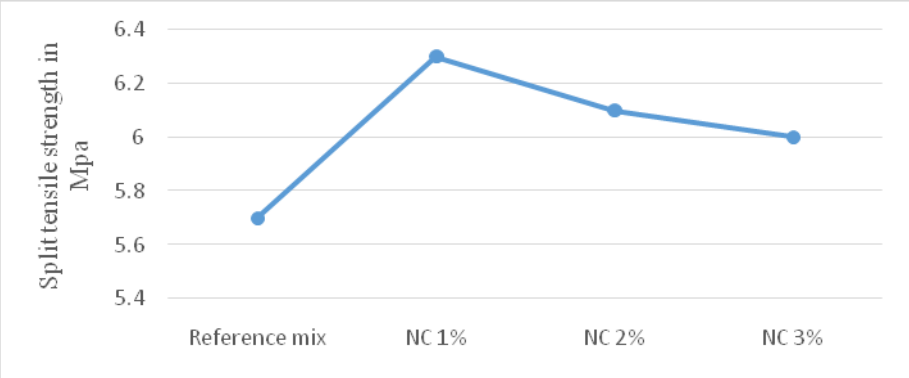


Fig -2: Variation of 28 days split tensile strength of HSC with Nano $CaCo_3$.

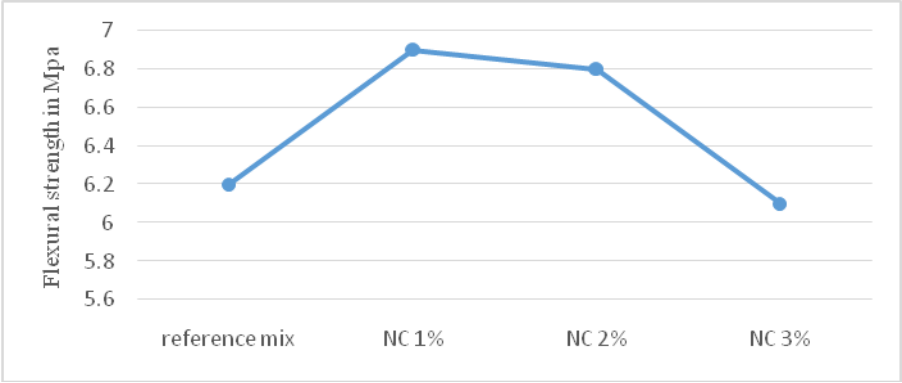


Fig -3: Variation of 28 days Flexural strength of HSC with Nano $CaCo_3$.

## 4. CONCLUSION

1. Addition of Nano Calcium carbonate to the high strength concrete led to increase in compressive, split and flexural strengths.
2. Compressive, split tensile and flexural strengths were improved at 13.8%, 9.8% and 11.3% respectively over the reference mix at 1% Nano Calcium carbonate in HSC.
3. Limited experimental study reveals that maximum strength improvements were obtained at 1% Nano $CaCo_3$.

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