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RESEARCH ARTICLE

OPTIMIZATION OF GGBS AND NANO CLAY ON CEMENT MORTAR

Kiran, S.,[1,*] Akash Babu, L.A.,[2] and Dr. Sadath Ali Khan Zai[3]

[1,2]Ph.D. Research Scholar, Dept of Civil Engineering, UVCE, Bangalore University, Bengaluru-560056
[3]Professor, Dept of Civil Engineering, UVCE, Bangalore University, Bengaluru – 560056

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Corresponding Author:
Kiran, S.,

ABSTRACT

Recent advances in nano-technology in construction industries, proves that integration of nano clay particles with cement leads to high strength more and more demand to minimize the quantity of cement used in the concrete. This paper main aim for optimization of Ground granulated Blast Furnace slag (GGBS) and Nano Clay (NC) as a partial replacement to cement to be used in the cement mortar with mix CM 1:3, with mixes Mix G1 to Mix G5 for GGBS and for Nano Clay mix NC1 to Mix NC5. The test specimens consists of cubes (70.6 mm), The test results shows the significant improvement in compressive strength for Mix G3 and Mix NC3 as compared to other mixes and same has been optimized. Thus the optimum dosage obtained as 30% GGBS and 3% nano-clay addition exhibited the highest compressive strength and is adopted.

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INTRODUCTION

Cement mortar is a mixture of cement, fine aggregates and water is taken in proper proportion, while cement and fine aggregate are properly mixed in required proportions. Cement plaster is made by mixing cement and sand in acquired definite proportions for different types of plastering. Cement plaster is applied to both interior and exterior walls to give them a smooth surface. Nano science is the field in engineering and materials science, with the advancement of nanotechnology nano materials were used to make it applicable in concrete or mortar mix to enhance the physical and mechanical properties of mortar or concrete. Efforts are made on incorporating nanoparticles into mortar, nanoparticles play a significant role in improving mechanical performance of cement mortar. Nano particles in cementitious-concretes materials significantly modifies their behaviour not only in the fresh but also in the hardened conditions as well as the physical, mechanical and microstructure development. The binder are mineral admixtures like fly ash, ground granulated blast furnace slag (GGBS), rice husk ash, etc., with polymeric or chemical admixtures used depending on the application. Ground-granulated blast furnace slag is a latent hydraulic binder forming calcium silicate hydrates (C-S-H) after contact with water. It significantly reduces the risk of damages caused by alkali–silica reaction (ASR), provides higher resistance to chloride ingress and provides

LITERATURE REVIEW

Mechanical, [6] durability and micro structural properties of mortar with Nano clay of 0.5, 1 and 2% by weight of cement, water binder ratio 0.55, the cube specimens of 50mm are water cured for 7 and 28 days, the compressive strength, flexural and tensile strength was increased by 11%, 5% and 9% respectively by 2% optimized Nano clay by weight of cement, increase of water needed to reach consistency and reduces its capillary. From SEM images convention mortar hydrated products are recognized in modified mortar, no secondary products are recognized thus the mortar using replacement will have more homogeneity and denser. [2] Experimental investigations on mechanical, micro structural and rheological measurements with Nano clay of 1, 2, and 5% water cement ratio of 0.5 with different types of kaolin clay based on fineness. The 50mm cube specimens are water cured for 12hours, 16hours 24hours and 28 days, the compressive and tensile strength about 30%. The strength enhancement is slower in early ages but 28days it achieved maximum strength. [1] Microstructure and mechanical properties of Nano metakaolin at 750°C blended with OPC in cement mortar with 0% and 5% replacement by weight of cement with 1:3 with water binder ratio 0.4. The mortar cube of 7*7*7cm are water cured and tested for 3, 7 and 28 days there by increasing compressive strength by 10.93% for 5% replacement. [4] Durability and mechanical properties of Nano metakaolin blended with cement mortar by 0, 1 and 2% as a replacement, Kaolin calcined at low temperature at 600°C, 700°C to

are water cured for 7 and 28 days and permeability tests are conducted. The enhancement of compressive strength is 310% and 200% for 1% and 2% Nano clay respectively. The permeability coefficient with 1% and 2% are 140% and 250% more than the conventional mortar, also the addition of Nano clay increases the speed of drying capacity. From SEM analysis, it is observed that the mortar becomes denser and it acts as packing material and fills interstitial spaces inside the hardened mortar, ultra-fine particles fill the voids in cement making microstructure paste denser, free lime released during hydration and produces more C_3S resulting in improvement of mechanical properties. [5] Durability and mechanical properties of cement mortar containing Nano Silica and Nano clay partially replaced with OPC 43 by varying percentage from 0.5 to 2% by weight of cement, water cement ratio of 0.40 of mix 1:3 water cured. Mortar cube of 50mm tested for compressive strength and 85mm*50mm for durability parameters, the specimens are cured for 7, 28, 56 and 90 days, thereby compressive and split tensile strength was increased by 1.5% of Nano Silica and 2% of Nano clay, the durability results also improved for the same percentage, water absorption and distribution of chloride ions have better permeability and more strength than the control mix. [1] mechanical properties of cement mortar by partial replacement of GGBS with varying percentage of 0, 5, 10, 15 and 20 by weight of cement with CM 1:2.75, w/c 0.5, the cube specimens of 50mm are considered for 3, 7, 14 and 28 days water cured, the increment in the compressive strength containing 15% of GGBS but the curing period is also increased but for 5% replacement there is 24.36% higher than conventional mortar, even then for 10% the improvement in strength and loss is observed. [7] Compressive strength containing Ground Granulated Blast furnace slag under different temperatures (10^oC, 20^oC, 30^oC, 40^oC and 50^oC) with 0, 20, 35, 50 and 70% of GGBS is replaced, w/b is 0.4, 50mm cubes are casted and cured for 28 days. The enhancement of compressive strength at initial stages is higher because the hydration is more at early stages later on the strength is also reduced, 2 N/mm^2, 20 N/mm^2 and 26 N/mm^2 achieved @ 10^0C, 40^0C and 50^0C respectively. Even a 10^0C increase in curing temperature above standard curing temperature considerably accelerates the strength development of mortars containing high levels of GGBS at 40^0C and 50^0C, the strength of GGBS mortars is more or less equivalent to that of Portland cement mortar after 3 days.

RESEARCH SIGNIFICANCE

This experimental investigation is to obtain the optimum dosage of GGBS and Nano clay to be used in cement mortar as a partial replacement to cement in CM 1:3 as to obtain the maximum strength to be used in plastering for masonry as sustainable construction with innovative cohesive materials.

MATERIALS AND METHODS

The materials considered in this present investigation are OPC 43 Grade Ramco cement, M sand passes through a 4.75 mm sieve and retained on 150µ (zone II), Nano clay (1nm-200nm) (Montmorillonite), Ground granulated blast Furnace pulverized Slag of specific gravity 2.32 and water (Ordinary potable water of pH 6.7).

TEST PROGRAM: The series of ninety testing specimens consists of Cubes (70.6 mm), with cement mortar mix 1:3. In this experimental studies which includes five mixes are considered for optimization of Nano clay and GGBS are considered for cement mortar to study the compressive strength properties of the cement mortar.

1.The below mix considered for optimization of GGBS

MIX G1 = (Cement 74% + M Sand 100%+ 26% GGBS)
MIX G2 = (Cement 72% + M Sand 100%+ 28% GGBS)
MIX G3= (Cement 70% + M Sand 100%+ 30% GGBS)
MIX G4 = (Cement 68% + M Sand 100%+ 32% GGBS)
MIX G5= (Cement 66% + M Sand 100%+34% GGBS)

2.The below mixes considered for optimization of Nano clay

MIX NC1 = (Cement 99% + M Sand 100%+ 1% Nano Clay)
MIX NC2 = (Cement 98% + M Sand 100%+ 2% Nano Clay)
MIX NC3= (Cement 97% + M Sand 100%+ 3% Nano Clay)
MIX NC4 = (Cement 96% + M Sand 100%+ 4% Nano Clay)
MIX NC5= (Cement 95% + M Sand 100%+ 5% Nano Clay)

The present experimental investigation involves the determination of compressive strength properties of cement mortar for Mixes MixG1 to MixG5 and Mix NC1 to Mix NC5 for Compressive strength of 3 days, 7 days, 28 days and the results are tabulated. Firstly, mixing Nano-powder with cement establishing Nano-powder and blended composite. After mixing process, Nano powder and cement blended composite prepared and placed in the mixer. Fine aggregate was added and mixing dry composite then finally water is added.

RESULTS AND DISCUSSION

Hardened properties of cement mortar

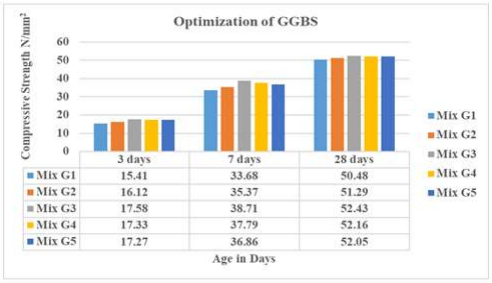
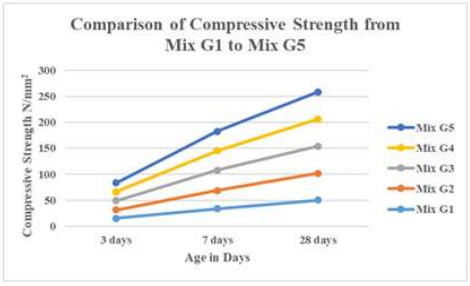


Figure 1. comparison of compressive Strength for all mixes cured for 3, 7, and 28days for GGBS

Table 1. Average compressive Strength of mixes Mix-G1 to Mix-G5

MIX	% of GGBS	Age of Sample	Load (KN)	Average Compressive strength (N/mm^2)
Mix G1	26	28 days	256.98	51.56
Mix G2	28		265.06	53.18
Mix G3	30		270.44	54.26
Mix G4	32		264.80	53.13
Mix G5	34		264.55	53.08



Compressive Strength for optimization: From the results it is noticed that Mix G1 has 50.48 N/mm^2, Mix G2 51.29 N/mm^2, Mix G3 52.43 N/mm^2, Mix G4 52.16 N/mm^2 and Mix G5 52.05 N/mm^2. It is observed that MIX-G3 has got maximum compressive strength and hence the same optimized percentage of GGBS is used for further investigations to optimize Nano clay.

Table 2. Average compressive Strength of mixes Mix-NC1 to Mix-NC5

MIX	% of Nano Clay	Age of Sample	Average Load (KN)	Average Compressive strength (N/mm^2)
Mix NC1	1	28 days	252.96	50.75
Mix NC2	2		256.30	51.42
Mix NC3	3		265.98	53.36
Mix NC4	4		265.33	53.23

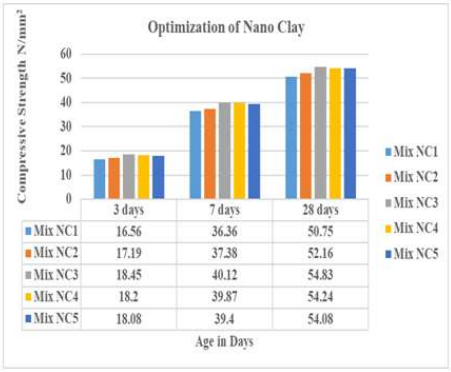
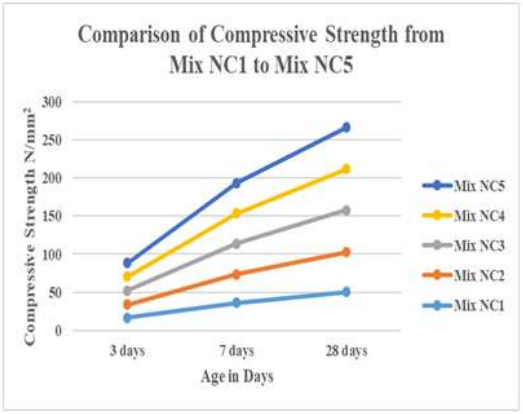


Figure 2. comparison of compressive Strength for all mixes cured for 3, 7, and 28days for nano clay



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From the experimental program, it can be observed that Mix NC1 has 50.75 N/mm^2, Mix NC2 52.16 N/mm^2, Mix NC3 54.83 N/mm^2, Mix NC4 54.24 N/mm^2 and Mix NC5 54.08 N/mm^2, also it is noted that the Mix-NC3 has got maximum compressive strength and is optimized

CONCLUSION

- The rate of gain in compressive strength of MIX G3 for 28 days is higher as compared to MIX 1 which indicates there is more improvement in the Compressive strength behavior.
- The incremental increase in compressive strength of MIX NC3 for 28 days is higher as compared to MIX 1. Therefore nano clay gives more bondage when it is used upto optimum dosage of replacement.
- After 30% of GGBS and 3% of nano clay there is a decrement in the compressive strength which shows that the materials are optimized, further there is no significance of increasing the dosage.
- Hence it is evident that from experimental results 30% GGBS and 3% Nano clay provides maximum compressive strength and same is optimized.

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