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Performance of Alccofines, Quarry dust, Steel Slag and GGBFS on Strength Properties in High Strength Concrete

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Abstract
The blistering and bustling perception (or) disquiet in the "21st century" is "Ecological protection" and "pollution control". The boundless fears of ailing effects of environmental contamination has caught attention of populace and governing authorities prompting the implementation of various counter measures to curb the pollution to lower levels. Delineation to aforementioned disquiet is the odd and even rule in the "National Capital Region" (NCR) and limitation of "diesel vehicle's" which are ridden for more than 10 years of their life cycle to enter numerous significant urban areas in India. This experimental study is aimed at intend to give partial solution to all the aforementioned issues. This study deals with fractional supplanting of cement with 20% GGBFS with 5% and 10% of alccofines (a product of GGBFS) and complete substitution of NRS with stone dust (100%) and steel slag in 0%, 10%, 20%, 30%, 40%, 50%, 60%, 100% consolidated with stone dust for M60 grade of concrete. For all the above annotations blend with 10% alccofines performed marginaly superior to 5% AF. It also proved that 100%SS and 100%QD supplanted blends are ready to be inducted to industrial usage. Economy wise 5% alccofines and 100%SS was proved to be most economical of the lot.

Keywords: Alccofines, GGBFS, Compressive Strength, Split Tensile strength and Flexural strength.

Introduction
Accentuation has been made in the transportation area but not in the industrial sector. Since we have seen no new pollution control convention being made for real commercial enterprises like cement and steel are anticipated. They are one of the world's biggest polluters with earlier delivering up to 10% of the aggregated globe's carbon di-oxide. Adding to those tribulations because of financial deceleration in PRC. India has emerged as world's "chief manufacturer and consumer" of the cement and its products. Each ton of OPC created prompts generation of 700kg-900kg of carbon di-oxide to the earth. India produces cement in abundance of 515million ton's each year (0.9x515 = 463.5 million tons of CO_2) every year.

We Civil Engineers are the foremost end client of steel as well. Indeed, even they create part of dirtying gasses which we are talking about, yet with that they additionally produce lingering waste which are generated in every batch of unprocessed material going into the furnace called slag in the industrialized process of steel. Environmentalist's campaign informs us about the fact that the world being doomed if these pollutions are not abridged. Henceforth the need to enhance our environment has prompted the utilization of these industrial residual by-products as substitution cement in concrete industry without disquieting any of its properties by its inclusion.

1. Research Significance
Heterogeneous materials like cement, water, and aggregates combined together forms a homogenous substance called concrete. In that as complete substitution of cement is not achievable only partial substitution is acknowledged. We utilize the steel industries "GGBFS" waste as fractional substitute of cement in powder form and slag sand in fine aggregate's form. It's been over 2000 years since the replacements for cement began. As per the documentation the utilization of replacement was first done at Italy (Naples) in 75 BC for theater construction in Pompeii town of roman domain.

The researchers have come a long way since then and need for substitution has come down to aggregates also. Since concrete is to a great extent devoured material in the universe.70-80% of that volume is made of aggregates and subsequently over abuse of natural sand is seen. Leading the local authorities of numerous nations and states on the planet. Banning of sand mining prompted lack of "Natural River Sand" (NRS) and shot the prices to sky high (Rs.70, 000 to 1, 20,000 for every truck load) prompting increment in construction expenditure.

2. Experimental Program
This part deals with deepened research of the considered triple blend with different percentage of materials utilized for the exploring examination. And its individual and blend properties are talked about.

3. Experimental Agenda
To study the performance attributes of the triple mix concrete and contrast it with NCC.

4.

Materials

Range of materials utilized for exploration study is briefed underneath with their imperative properties.

Cement(C): OPC grade 53 Birla super was used in accordance with IS 12269. The fundamental properties test report is depicted beneath.

Table 1: Physical Properties of Cement Sample

Test method : IS 4032(part 3-6)1988 (reaffirmed 2009) and : IS 4032 (part 2)-1999 (reaffirmed 2008)			
Sl No.	**Test conducted**	**results**	**Requirements at par IS :12269-2013**
1	consistency	27.2%	Not specified
2	setting time- Initial	38 min	Shall not be less than 30 min
	setting time- Final	311 min	Shall not be more than 600 min
4	Compressive strength a) 72 ± 1h b) 168 ± 1h c) 672± 1h	37.7MPa 45.2MPa 58.3 MPa	Not lesser than 27.0 Mpa Not lesser than 37.0 Mpa Not lesser than 53.0 Mpa
5	Fineness(by blain's air permeability)	335 m^2/Kg	Not less than 225 m^2/Kg
6	Soundness (Le-chatelier's method)	0.5mm	Not be more than 10mm
7	Soundness (autoclave expansion)	0.018%	Not more than 0.8%
8	Sp. gravity	3.15	---------

Alccofines (AF):

A "micro fine" invention based of GGBFS was utilized named "alccofines 1203". Which was acquired straight forwardly from the manufacturing corporation. It had the accompanying properties.

Table 2: Physical Test on alccofines 1203 Sample

TEST METHOD : IS : 1727-1967 (REAFFIRMED 2008)		
Sl No.	**Test conducted**	**Results**
1	Sp. gravity	2.83
2	Compressive strength at 7days as% of control sample	115
3	% Oversized retained on 45micron IS sieve	Nil
4	fineness	>12,000
5	bulk density	700-900Kg/m^3

Table 3: Physical Test Report on GGBS (Ground Granulated Blast Furnace Slag)

Test conducted	**Test result**	**Test method**
Sp. gravity	2.87	IS: 1727-1967
Fineness-specific surface in m^2/Kg by blain's permeability method	329	IS: 1727-1967
Comparative compressive strength * 7 day 28 day	 61.2 72.4	---
Residue 0n 45 micron sieve,%	0.6	IS: 1727-1967
Compressive strength(Mpa)* 7 day 28 day	 25.1 39.7	IS: 4031(part 4 & 6)-1988
* 70% GGBFS and 30% OPC 53 grade (the quantity of GGBFS :cement chosen as per the greatest acceptable limit of GGBFS permissible in IS: 455-1989, revision 4)		

Fine Aggregates (FA):

We have utilized three diverse sorts of FA namely NRS, Q.dust, S.sand. NRS & QD was acquitted from local supplier whereas SS was obtained from the same JSW facility as of GGBFS. Their properties:

Table 4: Physical Properties of Natural Sand

Sl No	**Properties**	**values**
1	Sp. Gravity	2.60
2	Modulus Of Fineness	3.20
3	Bulk Density	1458 kg/m^2
4	zone of Grading	Zone II

Table 5: Physical Properties of Quarry/Stone Dust.

Sl. No	**Properties**	**Results**
1	Material Finer Than 75microns	11.6(max 15%)
2	Sp. gravity	2.58
3	Water absorption (%)	4.0
4	Bulking (%)	4.0
5	Bulk density(Kg/lit) Loose Rodded	 1.755 1.964
6	Modulus of fineness	3.315
7	Zone of Grading	Zone II

Table 6: Physical Properties of Iron Slag Sand

Sl No	Properties	values
1	Sp. Gravity	2.55
2	Modulus Of Fineness	3.70
3	Bulk Density	1348 kg/m^2
5	Water Absorption	3.0%
4	zone of Grading	Zone II

Experimental Procedure

Strength Test on Concrete with Alccofines

The casting and testing of concrete with Alccofines specimens for Compression and Split tension are conducted in accordance with IS 516-1959 (Reaffirmed 1999)

Compression Test

Compression test is carried out on specimen cubical in shape. The cube specimen is of size 150mm. A steel cube Moulds were coated with oil on their inner surface and are placed on plate. The amount of cement, Brick powder, M-sand, And coarse aggregate required for cubes are weighed. The materials are first dry mixed and then mixed with water and calculated amount of superplastizer. The top surface is finished using trowel. After 24 hours concrete cubes are demoulded and the specimens are kept for curing under water.

Split Tensile Test

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have designed which assure uniform distribution of the pull applied to concrete while a number of investigations involving the indirect measurement of tensile strength have made. The widely used test is split tensile strength test.

Results and Discussion

This sector concentrates on the variety of test's directed and its outcomes with legitimate reasoning and discussion on mechanical and longitivity factors for the M60 mix supplanted by fragmentary part with two varying materials. Alccofines and SS supplanted with aforementioned interim and mixes casted at laboratory and cured in automated temperature controlling curing tanks. Samples are cured at 28±0.5 ^{0}C of temperature.

Compression Test:

The examples of 150x150x150mm are cast in the count of 3 samples per test/per day/per mix. Dry Blending performed in "Skillet Mixer" is proficient than the rolling drum blender. At later stages the required Superplastizer and water were included for wet blend stage. The vibration duty was conducted using table vibrat0r machine. After elapsed time of 24hrs of ambient curing, the examples were placed in water bath for curing at controlled temperature of 28±0.5 ^{0}C and tried at 7, 14, 28, 56 days using computerized compression test apparatus at par with IS 516.

Table 7: Compressive Strength Attributes of 5% Alccofines Blends and NCC

Sl No.	Taxonomy	Aggregated strength (N/mm^2) cube examples at 7,14,28 and 56 days			
		7day	14day	28day	56day
1	0MS0	57	63	67	74
2	5MS0	67	71	78	81
3	5MS10	65	66	69	77
4	5MS20	66	68	70	77
5	5MS30	66	69	71	78
6	5MS40	68	70	73	79
7	5MS50	70	75	79	83
8	5MS60	67	73.5	78	80
9	5MS100	64.5	72	76	78

Table 8: Compressive Strength Attributes of 10% Alccofines Blends and NCC

Sl No.	Taxonomy	Aggregated strength (N/mm^2) cube examples at			
		7day	14day	28day	56day
1	0MS0	57	63	67	74
2	10MS0	70	77	80	85
3	10MS10	67	68	70	78
4	10MS20	68	70	72	79
5	10MS30	70	71	72	79
6	10MS40	70	73	75	80
7	10MS50	72	75	81	85
8	10MS60	69	74.5	77	83.5
9	10MS100	65	73	75	81

From aforementioned tabulations and charts the subsequent outcome was observed

Contrasted with NCC all the supplanting levels of all the changeable parameters demonstrated superior outcomes (strength attributes) at all examination days. At all the days (7,14,28,56) 50%SS supplantings demonstrated best possible strength results. Even attainment of 85MPa for M60 grade concrete with 10% AF supplanting level. On all the experimentation days we can observe a clear trend of diminish in value after 50% replacements of SS. Yet, despite the fact that there was plunge in strength attribute 100%SS and 100%QD supplants realize target strength's and demonstrated enhanced performance than NCC with NRS. Objective strength of 69.0MPa was realized at 14 days it self for all the examples examined. Astonishingly examples of 30%, 40%, 50%, 60% SS supplants with 10% AF and 50%SS with 5% AF realized them at 7 days it self. Showing the capability of alccofines to accelerate the strength.How ever 100%QD supplanted illustrations performed imperceptibly unrivaled than 100%SS supplanted one's throughout. attaining the ultimate strength of 85MPa and 81MPa respectively with 10%AF at 56 days. 10% alccofones replacemets demonstrated

marginaly enhanced performance compared to 5%. Yet, as economy is likewise our motive 5% alccofines ought to be just adequate to acehive strength well above 69MPa.10%AF + 20%GGBFS + 70% OPC + 50%SS + 50%QD blend proved to be the optimum blend and supplant levels 100% SS can be used safely if alccofines are inducted into the blend. it is also cheaper than QD.

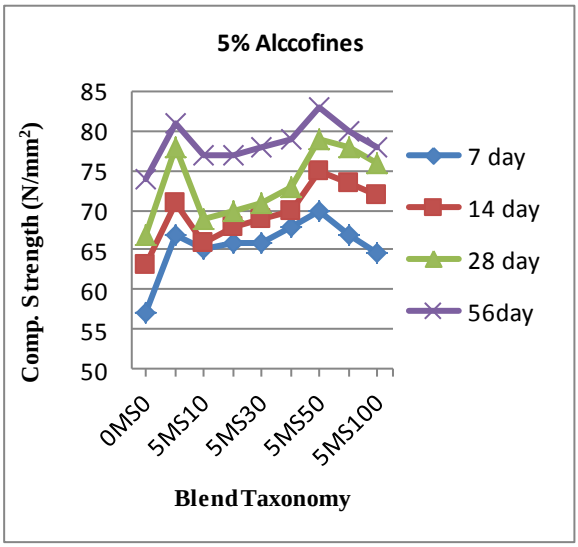

Figure 1: Line Graph Illustration of compression attributes with 5% Alccofines

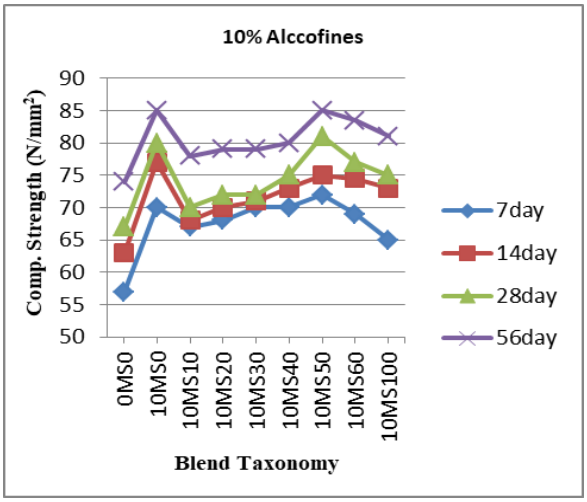

Figure 2: Line Graph Illustration compression attributes with of 10% Alccofines

Split-Tensile Test (ST)

To determine tensile attributes of concrete this test is widely acknowledged and conducted at par with IS: 5816-1999. The cylindrical moulds of 150mm in breadth and 300mm in stature are cast. 3 examples were cast per supplant per varying parameter like alccofines, SS, QD. The casting procedure is same as the aforementioned attribute and is cured for 28 days. Test is caried out with computerized CTM. Load is applied on the example by insertion of two semicircular plates over and underneath the example to make certain that load is concentrated on solitary pirticular path to crack the example. subsequent outcomes being observed from examination progression are tabulated underneth.

Table 9: Split Tensile Strength Attributes with 5% Alccofines Blends and NCC

Sl No	Taxonomy	Aggregated strength (N/mm^2) at 28day	Taxonomy	Aggregated strength (N/mm^2) at 28day
5% Alccofines Blends			10% Alccofines Blends	
1	0MS0	3.45	0MS0	3.45
2	5MS0	4.56	10MS0	4.95
3	5MS10	3.51	10MS10	3.93
4	5MS20	3.85	10MS20	4.12
5	5MS30	4.08	10MS30	4.19
6	5MS40	4.11	10MS40	4.96
7	5MS50	4.45	10MS50	5.01
8	5MS60	4.4	10MS60	4.48
9	5MS100	4.25	10MS60	4.40

From aforementioned tabulations and charts the subsequent outcome was observed.

Split tensile attributes follow the same trend as that of compressive attributes. Demonstrating strength augmentation with increment in slag supplants till 50%SS then lesson's steadily for 60% and 100% supplanted examples. The aforementioned trend was watched for both 5% AF as well as 10% AF supplant. Maximum strength 5.01 MPa was observed for 50%SS replaced in 10%AF blend showing increment of 31.13% of strength which is a immense improvement. Whereas 5% bend mix portrayed 22.5% augmentation for the same level of supplanting over NCC. Even 100% SS supplanting showed the augmentation of 18.12% and 21.41% for 5% and 10%AF respectively. Also 100% QD delineated a decent 25.31% and 30.30% increment over NCC. Subsequently both QD and SS 100% supplanted blend can be used safely with regards to split-tensile strength also.

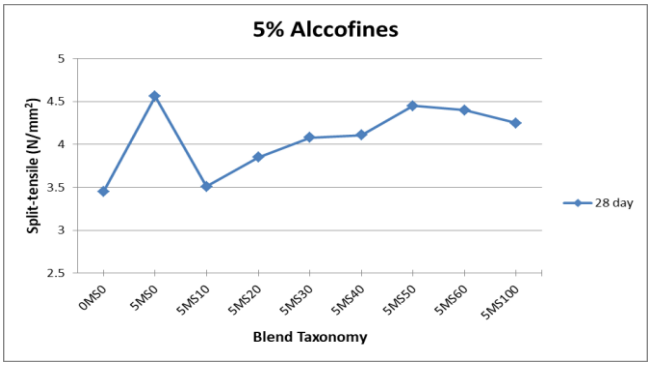

Figure 3: Line Graph Illustration of Split-Tensile Attributes with 5% Alccofines

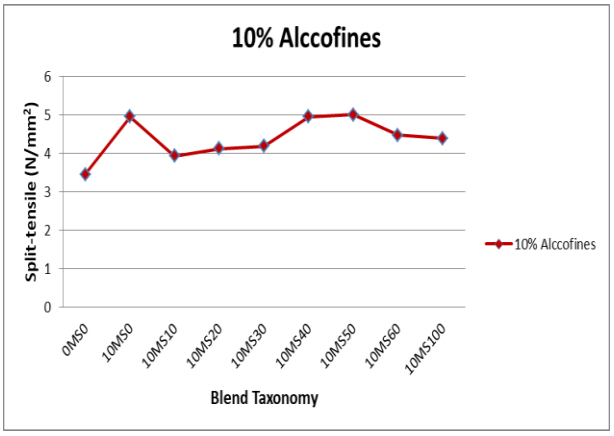

Figure 4: Line Graph Illustration of Split-Tensile Attributes with 10% Alccofines

Conclusion

This experimental exploration has discovered numerous outcome's and trends. Henceforth we can wrap up this thesis with the subsequent deliberations.

- Compressive strength attributes of both mortar and conrete and split-tensile attributes portrayed augmented outcomes contrasting to NCC with 50%SS (optimum) supplant. 100%SS and 100%QD supplants also portrayed better attributes than NCC, although QD had trivial dominance over SS.
- Percentage of drying shrinkage augmentation was observed with augmentation in SS supplant levels. Only NRS performed superior than SS and QD.

For all the above annotations blend with 10% alccofines performed marginaly superior to 5% AF. It also proved that 100%SS and 100%QD supplanted blends are ready to be inducted to industrial usage. Economy wise 5% alccofines and 100%SS was proved to be most economical of the lot.

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