A STUDY ON WORKABILITY AND SPLIT TENSILE STRENGTH OF MULTI BLEND CONCRETE OF M20 GRADE

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Abstract - *The production of cement results in production of greenhouse gases in atmosphere, which will leads for global warning. Hence, the researchers are currently focusing on use of waste materials which are having cementing properties, which can be replaced in concrete as partially for cement, without comprising on its strength and durability, which will result in decrease of cement production thus reduction in emission of greenhouse gases, in addition to sustainable management of the waste. The properties of concrete mainly depend on the constituents used in concrete. The waste product like fly ash, Ground Granulated Blast Furnace slag (GGBS), silica fume, metakaolin etc. which has cementitious properties was used as partial replacement material for cement. This paper presents a study on mechanical properties of concrete made with multi component cement i.e., cement is blended with optimum.% of fly ash, Ground Granulated Blast Furnace slag (GGBS), silica fume & metakaolin. Study includes concepts of multi blended cement exploits the Compressive strength of multi blend concrete.*

Key Words: *Fly ash, GGBS, silica fume, metakaolin, multi blend concrete etc.,*

1. INTRODUCTION

Fly ash, Ground Granulated Blast furnace Slag, Silica fume, Metakaolin and many others, are some of pozzolanic substances which can be used as partially alternatives for cement in concrete. In present study i.e., Multi Blended Concrete is concrete in which binding multiple numbers of components. At gift look at, cement is blended with four components, namely Fly ash, GGBS, Silica Fume & Metakaolin. The fly ash, GGBS & silica fume materials are through products life, manufacture of metallic & silicon alloys respectively, whereas metakaolin is dehydroxilated form of clay mineral kaolinite. In present investigation studied about compressive strength of MULTI BLEND CONCRETE.

2. Materials and Their properties

2.1. Cement

In the present investigation, commercially available 53 Grade ordinary Portland cement supplied by Zuari Cement, having Sp. Gravity 3.15, fineness modulus is 290 m^2/kg, Normal consistency is 30%, initial setting time 45mins, final setting time is 6hr. 40min. and compressive strength of mortar is 54.2 MPa.

2.2. Fly ash

Fly ash conforming to the requirements of IS 3812 and IS 1727 (1967) and produced from RTPP muddanur (class F i.e., low calcium fly ash) with Specific gravity of 2.2 and specific surface area of fly ash 280 m2/ kg was used as supplementary cementitious material in concrete mixtures. 85% of particles are passed through 45µm sieve.

2.3. Ground Granulated Blast Furnace Slag (GGBS)

In this present investigation, commercially available GGBS particle size less than 20 micro meters was supplied by ASTRRA chemicals pvt. Limited, Chennai with specific gravity 2.85 was used for all concrete mixtures. Specific surface area of GGBS used in present investigation is 390 m2/ kg.

2.4. Silica fume

Silica fume used in present investigation is densified silica fume for good results. Silica fume is bought from AASTRRA Chemicals Pvt. Ltd. from Chennai. The specific gravity of used silica fume is 2.2. Specific surface of Silica fume 15,000 to 30,000 m2/ kg.

2.5. Metakaolin

Metakaolin is a dehydroxylated form of the clay mineral Kaolin or china clay. Stone which are rich in Kaolin are called China clay or Kaolin, traditionally used inside the manufacture of porcelain. The particle length of Metakaolin is smaller than cement debris, but not as first-rate as silica fume. Metakaolin used on this present experimental have a look at is acquired from ASTRRA chemical substances, Chennai. The specific gravity of Metakaolin is 2.2 with spherical shape of particles.

2.6. Aggregates

Aggregate properties greatly influence the behavior of concrete, since they occupy about 80% of the total volume of concrete. The aggregate are classified as

(I) Fine aggregate
(II) Coarse aggregate

Properties of sand are fine aggregates i.e., sand are specific gravity with 2.65, fineness modulus with 2.83(zone-II) and water absorption with 1%.

Properties of 20mm coarse aggregate are specific gravity with 2.76 and water absorption 0.5%

3. MIX DESIGN

For required, designed according to IS10262-2009. For a target mean strength of 26.6 N/mm^2, the water/binder ratio with medium workability condition equal to 0.5 (for moderate exposure) was considered from IS 10262-2009. The mix proportion is as follows

Water : Cement : Fine aggregates : Coarse aggregate

176 : 352 : 717.69 : 1220.085

0.5 : 1 : 2.03 : 3.46

4. OBJECTIVES

- The main objective of the study is to use waste materials produced from industries and to reduce environmental pollution.
- To find the optimum content of the fly ash, GGBS, silica fume & metakaolin used in different proportions for increasing the compressive strength.

5. EXPERIMENTAL PROGRAM

The Concrete combos have been produced at a constant water/Cement ratio of 0.5 and one conventional concrete mix and 14 different combinations with exceptional percentages of fly ash, GGBS, silica fume and metakaolin are organized as mixture also. Initially for control mixture workability is found, and then 3 cylinders were casted, tested for 7 days, 14 days and 28 days. Same is done for other concrete mixtures in which cement is partially replaced with fly ash, GGBS, silica fume and metakaolin. Cement is partially replaced with materials for optimum dosages of fly ash, GGBS, silica fume and metakaolin

Initially cement is replaced with fly ash, and then to the optimum replacement of FA, GGBS will be added in varying proportions. To the optimum replacements of FA and GGBS, SF is added in varying proportions as partial replacement, and from this we will get optimum replacement of SF. Finally Metakaolin is replaced partially in cement along with optimum replacements of FA, GGBS, and SF. Summary of % of replaced binding material is given in table1

Table – 1: Summary of % of replaced binding material

	Cement (%)	FA (%)	GGBS (%)	SF (%)	Metakaolin (%)
N	100				
NF1	90	10	0	0	0
NF2	80	20	0	0	0
NF3	70	30	0	0	0
NF4	60	40	0	0	0
NF2G1	75	20	5	0	0
NF2G2	70	20	10	0	0
NF2G3	65	20	15	0	0
NF2G4	60	20	20	0	0
NF2G2S1	67.5	20	10	2.5	0
NF2G2S2	65	20	10	5	0
NF2G2S3	62.5	20	10	7.5	0
NF2G2S1M1	65	20	10	2.5	2.5
NF2G2S1M2	62.5	20	10	2.5	5
NF2G2S1M3	60	20	10	2.5	7.5

FA : Fly Ash

GGBS : Ground Granulated Blast-furnace Slag

SF : Silica Fume

N : Normal concrete

NF1 : Normal concrete with 10% Fly ash

NF2 : Normal concrete with 20% Fly ash

NF3 : Normal concrete with 30% Fly ash

NF4 : Normal concrete with 40% Fly ash

NF2G1 : Normal concrete with 20% Fly ash and 5% GGBS

NF2G2 : Normal concrete with 20% Fly ash and 10% GGBS

NF2G3 : Normal concrete with 20% Fly ash and 15% GGBS

NF2G4 : Normal concrete with 20% Fly ash and 20% GGBS

NF2G2S1 : Normal concrete with 20% Fly ash, 10% GGBS and 2.5% silica fume.

NF2G2S2 : Normal concrete with 20% Fly ash, 10% GGBS and 5% Silica fume.

NF2G2S3 : Normal concrete with 20% Fly ash, 10% GGBS and 7.5% Silica fume.

NF2G2S1M1: Normal concrete with 20% Fly ash, 10% GGBS, 2.5% Silica fume and 2.5% Metakaolin.

NF2G2S1M2: Normal concrete with 20% Fly ash, 10% GGBS, 2.5% Silica fume and 5% Metakaolin.

NF2G2S1M3: Normal concrete with 20% Fly ash, 10% GGBS, 2.5% Silica fume and 5% Metakaolin.

6. EXPERIMENTAL RESULTS

6.1 Workability

In this paper we have compared the workability of normal concrete and to the replacements of fly ash, GGBS, metakaolin and SF. slump of normal and multi blended concrete are shown in table 2. Graph shown in chart 1 is the variation in slump to optimum replacements of blended materials i.e., to NF2, NF2G2, NF2G2S1, & nF2G2S1M1.

Table – 2: SLUMP OF CONCRETE

Type of concrete	Slump in mm
N	40
NF1	42
NF2	44
NF3	45
NF4	42
NF2G1	45
NF2G2	45
NF2G3	43
NF2G4	43
NF2G2S1	48
NF2G2S2	45
NF2G2S3	43
NF2G2S1M1	50
NF2G2S1M2	48
NF2G2S1M3	47

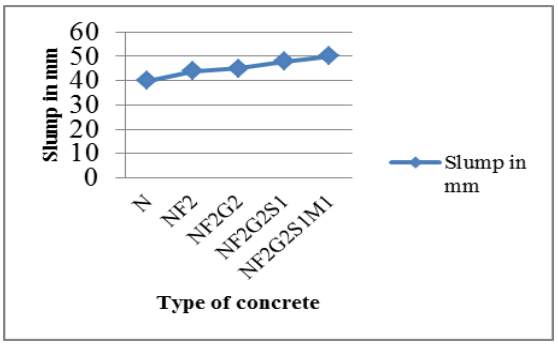

Chart- 1: Comparison of Slump of Normal concrete With the optimum dosages of Multi blended Materials

6.2. Split Tensile Strength

The Split Tensile strength of concrete is found in laboratory by compressive testing machine at age of 7days, 14days and 28days curing by casting cylinders of size150mm×300mm. The results are tabulated which are given below. The results in table 7 in are shown for optimum replacement of blended materials. The remaining proportions of blended materials which are shown in table 1 are less in strength when compared to the normal concrete. Variation of graph for optimum % replacement of blended materials is shown in chart-6. Split Tensile strength of remaining proportions is shown in tabular columns from 3 to 6 along with graphs shown from chart 2 to 5.

Table – 3: Split Tensile strength of concrete with fly ash replacement (10%, 20%, 30%, & 40%)

Mix proportion	07 days (MPa)	14 days (MPa)	28 days (MPa)
N	0.9	1.1	1.7
NF1	0.8	1.0	1.7
NF2	0.85	1.1	1.8
NF3	0.6	0.9	1.3
NF4	0.55	0.8	1.2

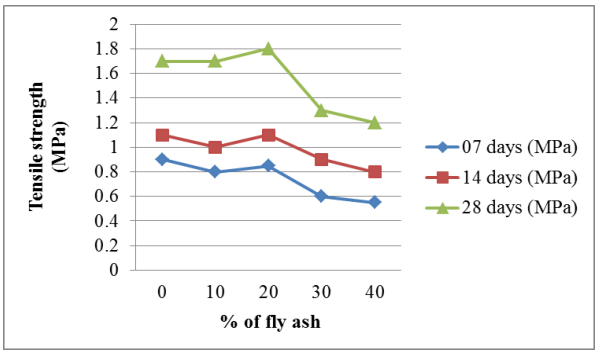

Chart -2: Split Tensile strength for partial replacement with fly ash (10%, 20%, 30%, & 40%)

Table -4: Split Tensile strength of concrete with Optimum FA (20%) + varying proportions of GGBS (5%, 10%, 15% & 20%)

Mix proportion	07 days (MPa)	14 days (MPa)	28 days (MPa)
N	0.9	1.1	1.7
NF2G1	0.65	0.75	1.3
NF2G2	0.9	1.1	1.7
NF2G3	0.75	0.95	1.4
NF2G4	0.7	0.75	0.9

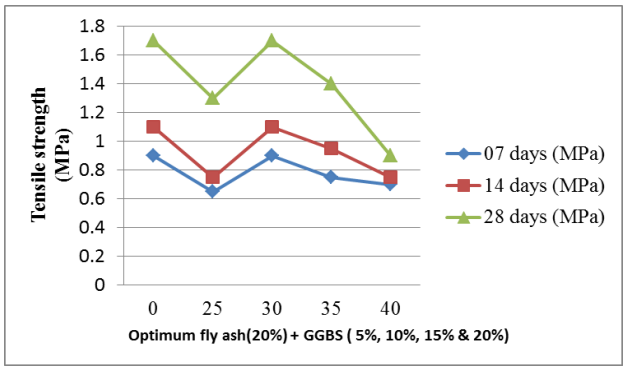

Chart-3: Split Tensile strength of concrete with optimum fly ash (20%) + varying % of GGBS (5%, 10%, 15% & 20%)

Table – 5: Split Tensile strength of optimum fly ash (20%) + GGBS (10%) + varying silica fume (2.5%, 5% & 7.5%)

Mix proportion	07 days (MPa)	14 days (MPa)	28 days (MPa)
N	0.9	1.1	1.7
NF2G2S1	1.0	1.35	1.85
NF2G2S2	0..8	1.1	1.55
NF2G2S3	0.7	0.85	1.15

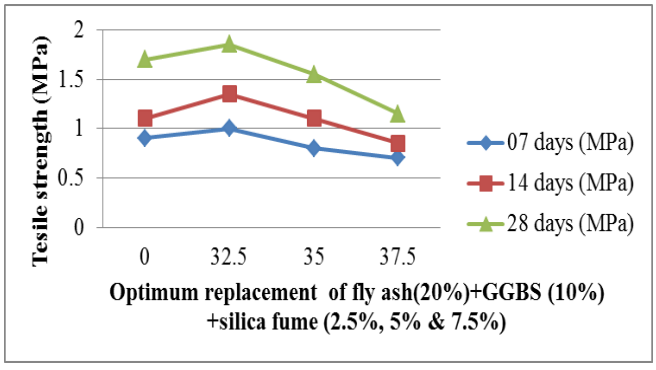

Chart – 4: Split Tensile strength Vs optimum fly ash (20%) + GGBS (10%) + silica fume (2.5%, 5% & 7.5%)

Table – 6: Split Tensile strength of optimum fly ash (20%) + GGBS (10%) + silica fume (2.5%) + varying proportion of metakaolin (2.5%, 5% & 7.5%)

Mix proportion	07 days (MPa)	14 days (MPa)	28 days (MPa)
N	0.9	1.1	1.7
NF2G2S1M1	1.0	1.35	1.75
NF2G2S1M2	0..8	1.05	1.35
NF2G2S1M3	0.7	0.75	1.1

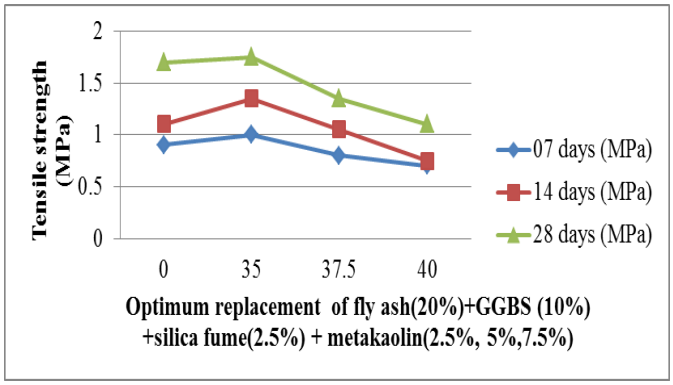

Chart – 5: Split Tensile strength Vs optimum fly ash (20%) + GGBS (10%) + silica fume (2.5%) + varying proportion of metakaolin (2.5%, 5% & 7.5%)

Table – 7: Split Tensile strengths for optimum replacements of materials used

Mix proportion	7 Days (MPa)	14 Days (Mpa)	28 Days (MPa)
N	0.9	1.1	1.7
NF2	0.85	1.1	1.8
NF2G2	0.9	1.1	1.7
NF2G2S1	1.0	1.35	1.85
NF2G2S1M1	1.0	1.35	1.75

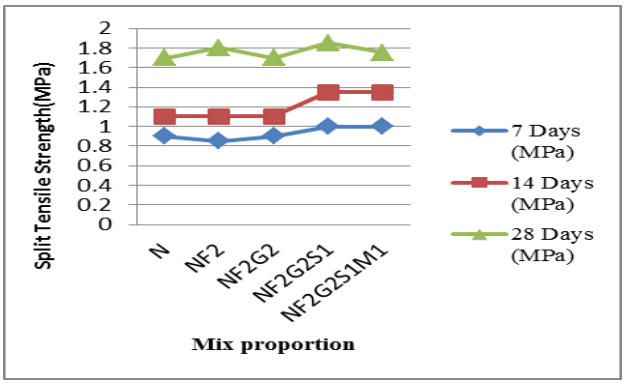

Chart – 6: Variation of Split Tensile strengths for optimum replacements of materials used

7. DISCUSSIONS

7.1. Workability

- The slump value in mm of normal concrete is improved by way of 10% at 20% replacement fly ash in cement content.
- The slump value in mm of normal concrete is improved b12.5% at 20% replacement of fly ash and 10% replacement of GGBS in cement content.
- The slump value in mm of normal concrete is improved by 20% at 20% replacement of fly ash and 10% replacement of GGBS, 2.5% of SF in cement content.
- The slump value in mm of normal concrete is improved by 20% at 20% replacement of fly ash and 10% replacement of GGBS, 2.5% of SF and 2.5% of metakaolin in cement content.

7.2. Split Tensile Strength

- The split tensile strength of concrete is increased upto a maximum of 5.8% at 20% replacement fly ash in cement content for 28 days of curing. By further addition of flyash, the split tensile strength reduced. The Split Tesile strength in early days have reduced when compared to normal concrete.
- The split tensile strength of concrete is same at 20% replacement fly ash and 10% replacement of GGBS in cement content at 7days, 14days and 28 days of curing respectively. By further addition of GGBS to the 20% fly ash replaced cement, the split tensile strength has been reduced.
- The split tensile strength of concrete is increased upto a maximum of 11.11% 22.7% and 8.82% at 20% replacement fly ash, 10% replacement of GGBS and 2.5% of silica fume in cement content at 07days, 14days and 28 days of curing respectively. By further addition of silica fume to the 20% fly ash and 10% GGBS replaced cement, the split tensile strength has been reduced.
- The split tensile strength of concrete is increased upto a maximum of 11.11%, 22.7% and 2.9% at 20% replacement fly ash, 10% replacement of GGBS, 2.5% of silica fume and 2.5% of metakaolin in cement content at 07days, 14days and 28 days of curing respectively. By further addition of metakaolin to the 20% fly ash and 10% GGBS and 2.5% silica fume replaced cement, the split tensile strength has been reduced.

8. REFERENCES

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