Experimental Work on Multiblended Concrete

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Abstract— In the present work conventional concrete is try to make multi-blended concrete by utilizing waste materials like mineral admixtures that is Fly ash, Silica fume, Ground Granulated Blast Furnaces Slag, Rice husk ash, with varying percentages (%) and different combinations for a concrete of grade M30. By the experimental work it shows that the replacement of cement by combination of Silica fume and Ground Granulated Blast Furnaces Slag has given high strength.

Key words: Concrete, Mix Proportioning, Compressive Strength, Tensile Strength

I. INTRODUCTION

A. *Concrete Mix as a System:*

Concrete is by far the most widely used man made construction material and studies indicating that it will continued so in the years and decades to come. Such versatility of concrete is due to the fact that from the common ingredients, namely cement, aggregate and water (and sometimes admixtures), it is possible to tailor the properties of concrete so as to meet the demands of any particular situation. The advances in concrete technology has paved the way to make the best use of locally available materials by judicious mix proportioning and proper workmanship, so as to result in a concrete satisfying the performance requirements. While the properties of the constituent materials are important, the users are now interested in the concrete itself having desired properties. In the true sense, concrete is thus the real building material rather than the ingredients like cement and aggregates, which are only intermediate products. This concept of treating concrete as an entity is symbolized with the progress of ready-mixed concrete industry, where the consumer can specify the concrete of his needs without bothering about the ingredients, and further in pre cast concrete industry where the consumer obtains the finished structural components satisfy the performance requirement. Therefore treating concrete in its entity as a building material. The various aspects covered are the materials, mix proportioning, and elements of workman ship, method of testing and relevant statistical approach to quality control and special precaution needed in extreme weather concreting. The discussion on these aspect centres on the appropriate provisions in the various Indian standards which are relevant. While considering the concrete mixes as material in itself, note has to be taken of the actions and interactions of its constituents on the characteristics of the end product which may often give rise to conflicting demands. For example, the requirement of workability demand that water content in the mix should be more, where as the requirement of compressive strength depend upon lower water cement ratio and therefore the water content be kept as low as practicable. In this context the concrete mix forms the "System". Concrete mixes are also characterised by the fact that, unlike the other common structural materials like steel, these are mostly manufactured at site, the inherent variability of their properties and need for proper quality control, therefore becomes important considerations.

II. USE OF DIFFERENT COMBITION OF MINERAL ADMIXTURE IN MULTIBLENDED CONCRETE

A. *Fly Ash:*

Fly ash is very much similar to volcanic ashes used in production of the earliest known hydraulic Cements about 2,300 years ago. Those cements were made near the small Italian town of Pozzuoli - which later gave its name to the term "pozzolan". A pozzolan is a siliceous or siliceous / aluminous material which when mixed with lime and water forms a cementitious compound. Fly ash is the best known, and one of the most commonly used, pozzolans in the world. Fly ash is the notorious waste product of coal based electricity generating thermal power plants, known for its ill effects on agricultural land, surface and sub-surface water pollution, soil and air pollution and diseases to mankind. Researchers have proposed few ways of reusing fly ash for variety of application. One of the most common reuse of fly ash is in cement concrete. Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. That capability is one of the properties making fly ash a desirable admixture for concrete. These materials greatly improve the durability of concrete through control of high thermal gradients, pore refinement, depletion of cement alkalis, resistance to chloride and sulphate penetration, and continued micro structural development through a long-term hydration and pozzolanic reaction. The utilization of by-products as the partial replacement of cement has important economical, environmental and technical benefits such as the reduced amount of waste materials, cleaner environment, reduced energy requirement, durable service performance during service life and cost effective structures.

B. *Rice Husk Ash:*

Rice milling generates a by product know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran .Rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA). This RHA in turn contains around 85 % - 90 % amorphous silica. So for every 1000 kgs of paddy milled, about 220 kgs (22 %) of husk is produced, and when this husk is burnt in the boilers, about 55 kgs (25 %) of RHA is generated. Pozzolanas are materials containing reactive silica and/or alumina which on their own have little or no binding property but, when mixed with lime in the presence of water, will set and harden like cement. Pozzolanas are an important ingredient in the production of alternative cementing materials to Portland cement (OPC). Alternative cements provide an excellent technical option to OPC at a much lower cost and have the potential to make a significant contribution towards the provision of low-cost building materials and consequently affordable shelter. Pozzolanas can be used in combination with lime and/or OPC. When mixed with lime, pozzolanas will greatly improve the properties of lime-based mortars, concretes and renders for use in a wide range of building applications. Alternatively, they can be blended with OPC to improve the durability of concrete and its workability, and considerably reduce its cost.

C. *Ground Granulated Blast Furnace Slag:*

Blast furnace slag is a by-product of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace, and the resulting molten slag floats above the molten iron at a temperature of about 1500oC to 1600ºC. The molten slag has a composition of 30% to 40% silicon dioxide (SiO_2) and approximately 40% CaO, which is close to the chemical composition of Portland cement. After the molten iron is tapped off, the remaining molten slag, which mainly consists of siliceous and aluminous residues is then rapidly water- quenched, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size which is known as ground granulated blast furnace slag (GGBS). The production of GGBS requires little additional energy compared with the energy required for the production of Portland cement. The replacement of Portland cement with GGBS will lead to a significant reduction of carbon dioxide gas emission. GGBS is therefore an environmentally friendly construction material. It can be used to replace as much as 80% of the Portland cement when used in concrete. GGBS concrete has better water impermeability characteristics as well as improved resistance to corrosion and sulphate attack. As a result, the service life of a structure is enhanced and the maintenance cost reduced. High volume eco-friendly replacement slag leads to the development of concrete which not only utilizes the industrial wastes but also saves significant natural resources and energy. This in turn reduces the consumption of cement.

D. *Silicafume:*

The American concrete institute (ACI) defines silica fume as “very fine non crystalline silica produced in electric arc furnaces as a by-production of elemental silicon or alloys containing silicon”

It is usually gray coloured powder, somewhat similar to Portland cement or some fly ashes. Silica fume is usually categorised as supplementary cementitious material. This term refer to materials that are used in concrete in addition to Portland cement.

E. *Sources and Characteristics of Silica Fume:*

Silica fume is an artificial pozzolanic material, produced by the reduction of high quality quartz with coal in an electric arc furnace in the manufacture of silicon or Ferro silicon alloy. Silica fume is, when collected, an ultrafine powder having the following basic

1) *Properties:*

- It contains at least 85% SiO_2
- Mean particle size between 0.1 and 0.2 micron
- Minimum specific surface of 15000m²/kg
- Spherical particle shape

2) *Admixtures:*

Allows to use admixtures that conforming to IS: 9103-1999, concrete Admixtures- Specifications. The admixtures can be broadly into two types:

Chemical admixtures and mineral admixtures. The common chemical admixtures are as follows.

1) Air-entraining admixtures.
2) Water reducing admixtures.
3) Set retarding admixtures.
4) Set accelerating admixtures.
5) Water reducing and Set retarding admixtures.
6) Water reducing and Set accelerating admixtures.

The common mineral admixtures are as follows.

1) Fly ash.
2) Ground granulated blast-furnace slag.
3) Silica fume.
4) Rise husk ash.
5) Metakaoline.

These are cementitious and pozzolanic materials.
Super plasticizer: CONPLAST SP 430

III. Literature Review

A. *S.L PATIL et al*

From the research work it was found that, the addition of fly ash in plain concrete shows improvement in compressive strength, flexural strength, tensile strength, for that the optimum results. If fly ash is available in the mix, this surplus lime becomes the source for pozzolonic reaction with fly ash and forms additional C-S-H gel having similar binding properties in the concrete as those produced by hydration of cement paste. The reaction of fly ash with surplus lime continues as long as lime is present in the pores of liquid cement paste.

B. *S. ARIVALAGAN et al*

Based on the experimental investigation, the GGBS can be used as an alternative material for cement consumption and reducing the cost of construction. Use of industrial waste saves the environment and conserves the natural resources. The degree of workability of concrete was normal with the addition of GGBS up to 20% replacement level for M30 grade of concrete. The general GGBFS literature indicates that the replacement of OPC by GGBFS typically results in lower early strength (7 to 28 days), greater long term strength, lower chloride ion permeability, less creep, greater sulphate attack resistance, greater alkali silica reactivity (ASR) durability, enhance workability, less bleeding, lower heat of hydration, and thaw durability are somewhat mixed, although in general, the use of slag appears to non-detrimental. Besides lower early strength, the downsides to the use of GGBFS include extended curing times, increase slat scaling increase plastic shrinkage cracking, and increased air entrainment required dosage.

C. *S. BHANJA et al*

The results of the present investigation indicates that, other mix design parameters remaining constant, silica fume incorporation in concrete results in significant improvement in the tensile strength of concrete, along with the compressive strength. The optimum silica fume replacement percentages for tensile strength have been found to be a function of w/c ratio of the mix. The optimum 28 days split tensile strength has been obtained in the range of 5-10% silica fume replacement level, whereas the value for flexural strength ranged from 15% to 25%.

D. MD NORATAN et al

Numerous investigations on the use of RHA (rice husk ash) in concrete production have been done, and all produced positive results. However, the ash used in most of the investigations was produced under controlled laboratory condition. Hence, its applicability under massive concrete production level is unclear. This study incorporates rice husk ash which is the by-product of rice husk used as fuel for the parboiling process in paddy mill. The ash is used in its original state without undergoing further treatment such as grinding and sieving hence it is termed 'raw' rice husk ash (RHA). The optimum level of cement replacement with RHA was found to be between 10% and 20%. In order to realize higher level of replacement, RHA is blended with fine lime stone powder (LP), pulverized fuel ash (FA) and silica fume (SF). Multiple mineral additives replacement of cement was also found able to offset possible deleterious effects of single mineral additive replacement

1) Mix design is done as per IS: 10262-2009
2) Mix proportion 1:1.65:2.84
3) Cement content = 400Kg/m³
4) Fine aggregates = 663.256 Kg/m³
5) Coarse aggregates = 1137.92 Kg/m³
6) W/C ratio = 0.45

IV. MATERIALS CALCULATIONS FOR ONE CUBIC METRE

Mix	Cement	Fly ash	Rice husk ask	Slag	Silica fume	Gypsum	lime	Fine aggregates	Coarse aggregates	W/C ratio	Sp in %
1	320	40	-	40	-	-	-	663.256	1137.92	0.45	2%
2	320	40	-	-	40	-	-	663.256	1137.92	0.45	2%
3	320	40	20	-	20	-	-	663.256	1137.92	0.45	2%
4	320	-	20	40	20	-	-	663.256	1137.92	0.45	1%
5	320	20	20	20	20	-	-	663.256	1137.92	0.45	1.5%
6	320	-	-	40	40	-	-	663.256	1137.92	0.45	1.5%
7	320	-	40	-	40	-	-	663.256	1137.92	0.45	0%
8	320	40	40	-	-	-	-	663.256	1137.92	0.45	1%
9	80	160	-	-	-	80	80	663.256	1137.92	0.45	0%

Table 1

All specimens are tested after 28 days and following are the readings of various mineral admixtures

V. RESULT AND DISCUSSION

A. Conventional Concrete:

MIX PROPORTION	W/C RATIO	COMPRESSIVE STRENGTH IN N/mm²	TENSILE STRENGTH	REMARK
1:1.6: 2.8	0.45	36	2.70	SLUMP 30mm

Table 2:

B. Multi Blended Concrete:

SI NO.	COMPOSITION	W/C RATIO	COMPRESSIVE STRENGTH IN N/mm²	TENSILE STRENGTH IN N/mm²	REMARK
1	10%FA+10%SL	0.45	39.11	2.31	2% SP
2	10%FA+10%SF	0.45	45.33	3.03	2% SP
3	10%FA+5%SF+5%RHA	0.45	35.55	2.68	2% SP
4	10%SL+5%SF+5%RHA	0.45	45.33	3.03	1% SP
5	5%RHA+5%SF+5%SL+5%FA	0.45	42.60	2.94	1.5% SP
6	10%SL+10%SF	0.45	52.44	3.25	1.5% SP
7	10%RHA+10%SL	0.45	31.11	2.50	0% SP
8	10%FA+10%RHA	0.45	36.00	2.70	1% SP
9	40%FA+20%GYP+20%LIME+20%CEMENT	0.45	9.70	1.40	0% SP

Table 3: Multi Blended Concrete

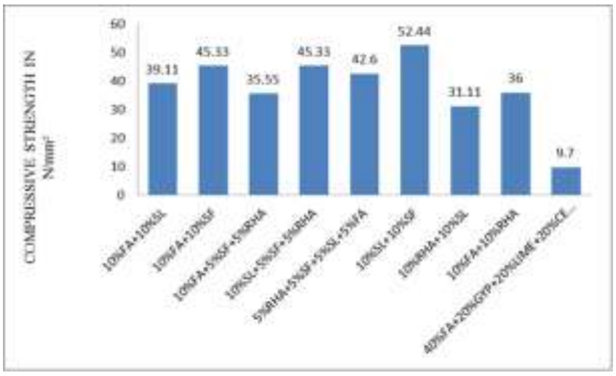

Fig. 1: Compressive Strength at Different Percentages

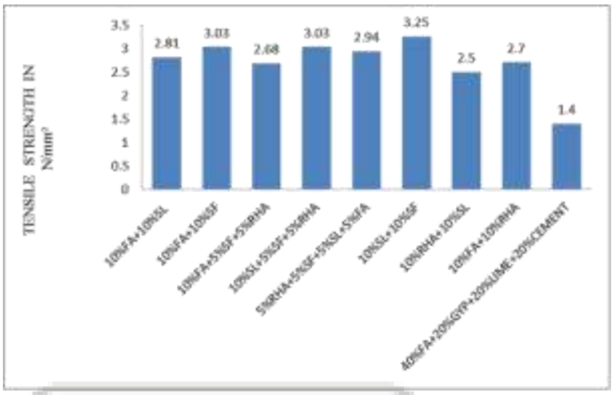

Fig. 2: Split Tensile Strength at Different Percentages

VI. Conclusion

1) Use of Silica fume and Ground Granulated Blast Furnace Slag in conventional concrete has given high strength.
2) In multi-blended concrete 10%slag + 10%silica fume the compressive strength has been increased up to30% as compared to conventional concrete.
3) 10% Silica fume, 5% Rice husk ash, 30% Fly ash and 20% Slag (GGBS) has given highest strength after 28days.
4) The use of combination of 10%SL + 5% SF + 5% RHA increases the water demand.
5) The use of fly ash in different mineral admixtures reduces the leaching of lime content.
6) The use of silica fume and Ground Granulated Blast Furnace Slag in conventional concrete has reduces the water demand and reduces the porosity of concrete.

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