Experimental Investigation on the behaviour of Ultra High Strength Concrete with Agro Waste

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Abstract **-Wide variety of research is being done on concrete to improve characteristics. Waste materials as a partial replacement would bring out favorable results and at the same time would also reduce CO_2 emission from cement industries by reducing the consumption of cement and other artificial admixtures. One such attempt is to use Bagasse Ash (BA) in Ultra High Strength Concrete(UHSC). Utilizing BA as a partial replacement to cement has found to increase the basic characteristics such as Workability, abrasion resistance, surface permeability, resistance against chemical attacks of Ultra high strength concrete which is currently existing in a setback zone. Apart from all the above BA has also proved to enhance the compressive strength of UHSC. India being a large agricultural sector and sugar cane is a major product of the farmers to an extent of 300 million tons/year, out of which 10 million tons of BA are obtained as waste from industries and hence they can be collected and utilized in the construction industry. BA replacement helps in saving a huge amount of money which in turn improves our economy. This paper explains the fresh concrete characteristics utilizing BA in various proportions to that of concrete**

Keywords—UHSC, BA, workability, mixing sequence.

1. INTRODUCTION

Construction industries use large quantity of cement. According to the survey made by "Global cement industry trends", about 397.4 metric tonne of cement is being consumed over a very short span, Hence cement industries act as a major source of CO_2 emission. Approximately India contributes about 220 million tonnes of CO_2 as per United States Geological Survey (USGS), mineral program cement report Jan 2011; thus cement industries pose threat to environment. Even a little amount of replacement of cement matters a lot in the construction field and it also plays a major role in economical construction as wastes are effectively utilized.

2. NEED FOR STUDY

The rapid improvement in construction sector and waste generation from construction and other industrial and non-industrial sector brought a consensus that the construction industry needs a more structured and systematic means for the identification of innovative technologies using available materials that promote efficiency and effectiveness more economically by recycling and reusing of these wastes and also by reducing the transportation charges, thus reducing environmental impacts.

3. MATERIALS USED IN UHPC

Cement: Cement is mainly used as binder material in UHPC

Quartz sand: Quartz sand used in UHPC as filler material instead of fine aggregate which has very high hardness value.

Quartz powder: This is the main ingredient which induces the reactivity while heat curing.

Silica fume: This will increase pozzolanic reaction.

Steel Fibre: This ingredient will increase the tensile strength of concrete as well as ductility.

Super Plasticizer: Which increases the workability due to very low water cement ratio while mixing

Water: Improves the working ability

4. ADVANTAGES OF USING UHSC

Owing to the advantages of using Ultra High Strength Concrete though UHSC increases the material cost. The following are the major advantages that can be accomplished.

- Since UHSC possess very high strength resulting in reduced cross section of elements. The volume of concrete required for the construction is reduced.
- The density of the UHSC is comparatively low there by reduction in self-weight of the structure.
- Due to high early strength UHSC reduces the shoring and stripping time there by saves the cost for the form work
- Longer spans and fewer beams for the same magnitude of loading.
- Reduced axial shortening of compression supporting members.
- Reduction in the thickness of floor slabs and supporting beam sections which are a major component of the weight and cost of the majority of structures.
- Superior in long term service performance under static, dynamic and fatigue loading.
- Low creep and shrinkage.
- Greater stiffness as a result of a higher modulus

5. MATERIAL STUDY

Bagasse Ash :

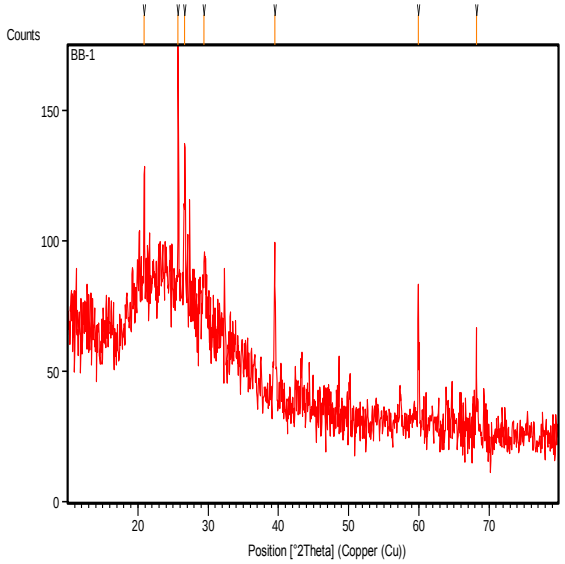
Bagasse Ash before heating in furnace

Bagasse Ash after heating in furnace for 1hr; 2hr;3hr and 4hr resp.,

Grinding of Bagasse Ash

Bagasse Ash passing 150micron sieve

XRD and EDAX results of Bagasse Ash burnt at 500^0 C-1hr



Element	Weight%
O K	58.88
Mg K	1.46
Al K	2.45
Si K	27.91
S K	0.29
K K	3.83
Ca K	3.42
Fe K	1.75

Bagase Ash was taken and confined burning was undergone for various temperature and duration ranging from 450^0C – 650^0C from 1 hr till 4hr and all those samples were tested for XRD at Alagappa university, karikudi and EDAX at Karunya university, Coimbatore. From the values obtained $5oo^o$C 1hr sample was in amporous state, with higher silica content.

6. MIX DESIGN

In the absence of a well established comprehensive method for the design of UHPC mix, it was arrived based on trial and error which is the practice adopted everywhere to get the desired strength. The trial mix proportion was carried out for UHPC with steel fibres. Best trial mix was selected and was cast which was obtained from literatures which is summarized in table 1.

7. COMPATIBILITY TEST

Super Plasticizers have become indispensable constituents of any designed concrete mix today. Property of fresh and hardened concrete is strongly influenced by the interaction of Superplasticizers and cement. A careful selection of SP is essential. Hence an attempt has been made to understand the effect of Superplasticizers investigating effect of SP on the properties of cement pastes for various w/c ratios.

Proportion of super plasticizer to that of cement	Time taken in seconds
1	80.1
1.1	57
1.2	55
1.3	42.12
1.4	41.5
1.5	41.23
1.6	41.52

From the results, it can be observed that better compatibility with selected cement in terms of workability dosage was found to be 1.4%..

8. CONSISTENCY AND SETTING TIME

Variation Of BA to that of Cement	**Consistency of BA to that of Cement**	**Initial Setting Time in minutes**
5%	0.32	35
10%	0.36	35
15%	0.38	60
20%	0.42	100

From the above tabular column it found that the setting time increased with the BA replacement

9. SPECIFIC GRAVITY

Trail mix	Cement	Silica fume	Quartz sand	Quartz powder	Steel fiber
1	3.15	2.46	2.50	2.86	314

10. MIXING SEQUENCE

Mixing is an important factor for studying these new cementitious materials. This procedure is often neglected and this might be a source when analysing the experimental results.

A trial Mixing sequence was adopted that the pattern as follows,

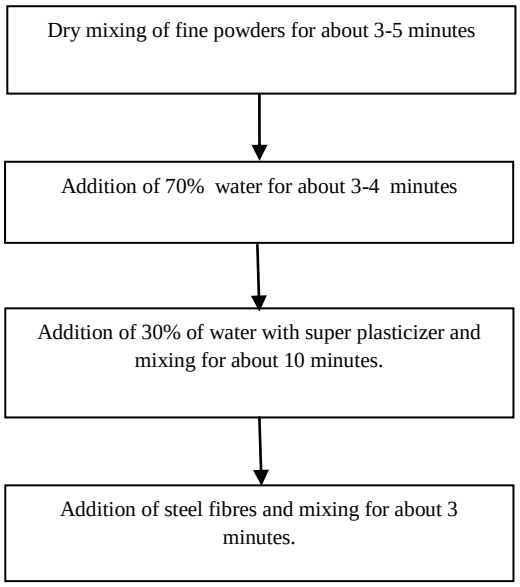
TABLE 1 : SELECTED MIX PROPORTION FOR UHSC

Trail mix	Cement (g/m^3)	Silica fume (g/m^3)	Quartz sand (g/m^3)	Quartz powder (g/m^3)	Steel fiber (g/m^3)	Super plasticizer (l/m^3)	Water (l/m^3)
1	950	234	1030	95	234	40.1	162

TABLE 2 FLOW TABLE RESULT FOR BA

Trial	0% BA			5% BA			10% BA			15% BA		
blows	15	25	35	15	25	35	15	25	35	15	25	35
direction	Flow of material in cm											
1	19.4	18	17	21.4	20.2	19	19	18	16	19.5	18	16
2	19.3	18	17	20.9	19.5	18	21	18.5	17	19	17.5	14
3	20	18.9	17.6	20.7	19	18.6	20.5	18.5	17.5	19.4	18.4	17
4	20	19.2	17.8	20.4	18.6	18.6	19.5	19	17.5	19.3	19	18
5	20.6	20.1	19.4	20	18.7	18	19.5	18	17.5	19.1	18.3	17.4
6	20.7	20	19.2	20.7	18.8	18.2	19.5	18.5	17	20	19.2	18

Mixing sequence is tabulated as follows,



1. WORKABILITY

Workability test was carried out in flow table test, which is shown in the below figures.

Immediately after mixing, the workability for the UHSC was found using Flow table. As an inherent property UHSC possess a very low workability, Thus the workability after addition of BA onto UHSC was studied and the results were summarized is table 2. From the results it has been found that the addition of BA onto UHSC as a partial replacement has improved the workability .

2. CURING SYSTEMS

Three different types of curing systems were adopted. The concrete specimens were cured in normal, steam and heat curing. Steam and heat curing is adopted so that the unhydrated particles in UHPC starts to react in accelerated curing. The temperature maintained is $90^{o}c$ for steam curing and $160^{o}c$ for heat curing. Initially the concrete specimens for durability test were cured for 24 hours and sub sequentially the specimens were cured normally.

Heat curing

Stream curing

SUMMARY AND CONCLUSION

A detailed review of the literatures was carried out to study the various behaviour of agro wastes such as groundnut ash, coconut shell ash and bagasse ash. It was found that agro waste plays a very supporting role in concrete's properties. Literature shows that among various agro wastes bagasse ash has dominant characteristics that enhances the property of concrete

From the literature survey, it can be concluded that,

1. RPC requires superplasticizers for better workability, but addition of bagasse ash onto the concrete avoids this problem, as they inherently have higher workability. It is also notable that Bagasse ash is one of the best agrowaste that gives better workability.
2. Addition of bagasse ash onto concrete gives better resistivity to sulphate attack and hence can be preferably used in saline and other corrosive environmental regions.
3. Bagasse ash provides better bonding between the materials in weaker zone which enhances the strength of concrete.
4. The required amount of hydration for attaining strength gain by the concrete can be easily enhanced by addition of bagasse ash due its watery nature.
5. Despite of all these advantages, bagasse ash retards the setting time of concrete, which plays a major role for suppliers those have ready-mix plant at larger distance.

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