EXPERIMENTAL INVESTIGATION ON HIGH PERFORMANCE CONCRETE USING RECYCLED CONCRETE AGGREGATES

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ABSTRACT

Concrete is the most extensively used material of the world for all infrastructural facilities. During the last decades, it has been realized that besides strength, there are other equally important criteria for the cauterization of concrete such as durability, workability, and toughness. Therefore, considerable attention has been paid to the research and development of high performance concrete (HPC) with a view to enhance the potential of the material to increase the service life to about 100years, instead of customary 40 to 50 years and to provide satisfactory performance under different aggressive environment.

Keyword: High performance concrete, Recycled Concrete Aggregates.

I.INTRODUCTION

Concrete is the most extensively used material of the world for all infrastructural facilities. In the foreseeable future, there seems to be no alternative to concrete as a construction material. During the last two decades, it has been realized that besides strength, there are other equally important criteria for the cauterization of concrete such as durability, Workability, and toughness. For example, in prestressed concrete bridges, the concrete should have not only high strength but also very little shrinkage and creep properties. For bridges, offshore structures, highway and airport pavements and machine foundations, concrete should possess high fatigue strength. For nuclear containers exposed to very high temperatures, the concrete must have high resistance to thermal cracking. Therefore, considerable attention has been paid to the research and development of High Performance Concrete (HPC) with a view to enhance the potential of the material to increase the service life to about 100 years, instead of customary 40 to 50 years and to provide satisfactory performance under different aggressive environment.

II. RECYCLED CONCRETE AGGREGATES

Recycled aggregate concrete utilizes demolition material from concrete and burnt clay brick masonry construction as aggregate. Reuse of demolition waste disposal and is also helpful in reducing the gap between the demand and supply of crushed granite fresh aggregate. While the amount of demolition waste materials generated in India has not yet been quantified properly, it is thought thatpresently the yearly rate of demolition of buildings and other structures in the major cities has reached 1 to 2 percent.

This is mainly due to the following reasons:

1. Demolition of structures, which have become obsolete either in serving the basic functions or due to structural deterioration.
2. Demolition of structures for better economic gains (through new construction)
3. Waste construction material formed due to natural disasters like earthquakes, cyclone and flood and
4. War – inflicted damages.

Most of the waste materials produced by demolishing structures are disposed by dumping them as landfill or for reclaiming land. But with the demand for land increasing day by day, the locations, capacity and width of the land that can receive waste materials are becoming limited. Added to it, the cost of transportation makes disposal a major problem. Hence, reuse of demolition waste appears to be an effective solution and the most appropriate and large-scale use would be to use it as aggregates to produce concrete for new construction. After the Second World War, a number of European countries (notable among them are Germany, England and Netherlands) and Japan have made attempts to study and reuse demolition materials in the construction of civil engineering works.

III. HIGH PERFORMANCE CONCRETE

According to ACI the definition of HPC is "Concrete meeting special performance and uniformity requirements which cannot be achieved routinely using only conventional constituents and normal mixing, placing and curing practices"

These requirements may involve enhancements of the following:

1. Ease of placement and compaction without segregation
2. Long-term mechanical properties
3. Early-age strength
4. Toughness
5. Volume stability
6. Long life in severe environments

HPC opens up new opportunities in the utilization of "Concrete". It is often said that HPC is an engineered concrete, which is produced by adopting certain not-so-common ingredients and methods so as to overcome the limitations of conventional Normal Strength Concrete (NSC). Tracing back the history of the development of HPC, it could be seen that work in this field was initially limited to High Strength Concrete (HSC).

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IV.MECHANISM OF HPC

Under compressive loads, failure in normal concrete occurs either within the hydrated cement paste or along the interface between the cement paste and aggregates particles. This interface, called the „transition zone ‟ , is a weak area in normal concrete. To improve strength and other properties, it is necessary to strengthen weak areas reducing the water-binder ratio (w-b) and using supplementary cementitious material like micro silica tends to strengthen the transition zone. When Portland cement hydrates, a considerable quantity of calcium hydroxide, Ca (OH)2 is produces, typically 22-24 percent. Micro silica which has a more percentage (over 85 percent) of amorphous silica-dioxide reacts with calcium hydroxide to form calcium silicate hydrate (C-S-H). This gives strength as well as improves the impermeability.

Fig.1. Demolished concrete waste

Properties of Fine Aggregates and Coarse Aggregate:

S.No	Property	Fine Aggregate		Coarse Aggregate	
		Natural	Recycled	Natural	Recycled
1. 2. 3. 4.	Specific Gravity Bulk density (gm/cc) Water absorption % Fineness Modulus	2.40 1.60 3 .402 2.95	2.50 1.49 3.97 6.45	2.80 1.452 .251 6.7	2.68 1.49 2.63 7.1

Test Results of silica fume:

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Sl.No	**Description of test**	**Results obtained**	**Requirements as per ASTM C 1240**	**Remarks**
Physical test				
	Percent retained on 45 µ	0.63%	10% maximum	Essential requirement
	Accelerated pozzolanic activity index with OPC at 7 days	127%	85% minimum	
	Specific surface area	20.9m2/gm	15.30m2/gm	Optional requirement
Chemical test				
	SiO2%	90.0	85.0 minimum	Essential requirements
	Moisture content %	0.5	3.0 maximum	
	Loss on igniton %	1.65	6.0 maximum	
	Carbon %	0.88	2.5 minimum	
Other parameters				
	Bulk density, kg/m3	680	500 – 750	Not specified in ASTM

Properties of Condensed Silica Fume:

Components	**Value (%)**	**Components**	**Value (%)**
Chemical properties		**Physical properties**	

SiO2	90 – 96	Specific gravity	2.2
Al2O3	0.5 – 0.8	Surface Area (m2/kg)	20,000
MgO	0.5 – 1.5	Size (Micron)	0.1
Fe2O3	0.2 – 0.8	Bulk Density (Kg/m3)	576

V.SUPERPLASTICIZER

For processing HPC, the most important chemical admixture is the super plasticizer, which is the High-Range Water-Reducing Admixture (HRWRA). There are four types of super plasticizers.Super plasticizers are water reducers which are capable of reducing water content by about 30 percent. For this present investigation, a super plasticizer namely CONPLAST SP 430 has been used for obtaining workable concrete at a w/b ratio of 0.32.

Mix Designation	**Proportions of RCA & NFA**	**Proportions of RCA & NCA**
M1	40% RCA &60% NFA	70% RCA &30% NCA
M2	40% RCA &60% NFA	60% RCA &40% NCA
M3	40% RCA &60% NFA	50% RCA &50% NCA

VI.RESULTS AND DISUSION

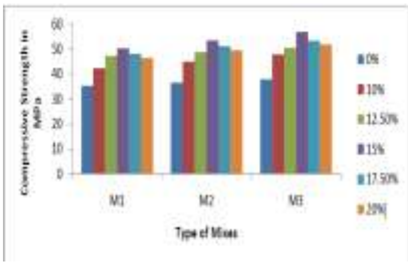

Fig.2. 7th day Cube Compressive Strength

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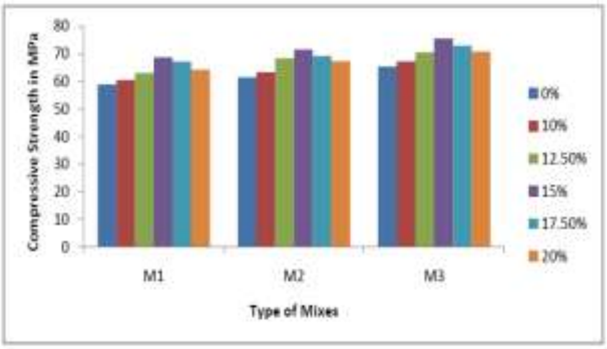

Fig.3. 28th day Cube Compressive Strength

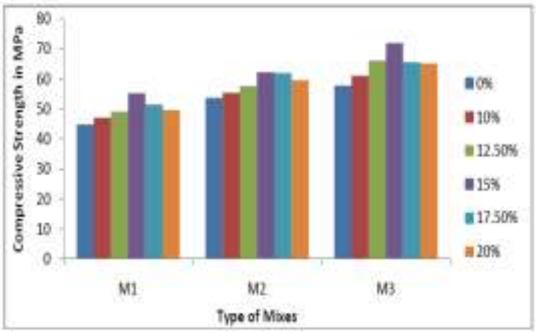

Fig.4. 28th day Cylinder Compressive Strength

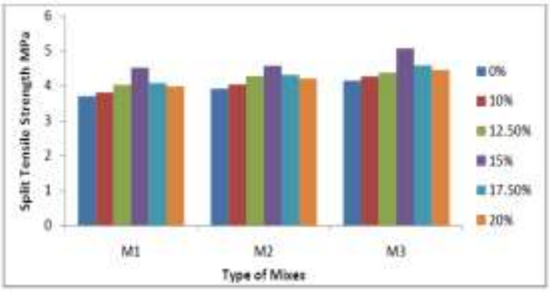

Fig.5. 28th day Split Tensile Strength

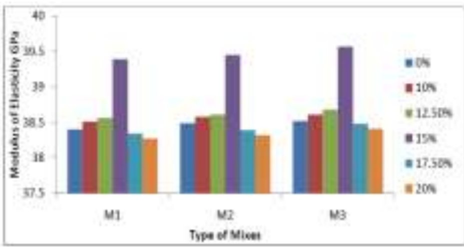

Fig.6. 28th day Modulus of Elasticity

From the test results it was observed that the maximum compressive strength is obtained for mixes with 15% silica fume at all ages of curing. For all mixes the optimum replacement level of silica fume was found to be 15%. The compressive strength development is due to the pozzolanic reaction and filter effects of silica fume. In the pozzolanic reaction, the silica fume reacts with calcium hydroxide and produces more C-S-H gel.

VII.CONCLUSIONS

Based on the investigations carried out on the High Performance Concrete, the following conclusions were drawn.

This study shows that RCA (Recycled Concrete Aggregate) in concrete can provide many technical benefits and it would also be fair to say provide many environmental and expected cost benefits. This study has shown that, regardless of original concrete type or strength, recycled good quality aggregates can be produced with plant similar to that used for the production of crushed – rock aggregates

The results of strength development demonstrate that the RCA source are original concrete type has a negligible effect on concrete strength, at a given RCA content.

The concrete durability results indicate that comparable performance irrespective of RCA content or source is achievable, providing the strengths of RCA concretes are matched. Cement replacement level of 15% with silica fume in concrete mixes was found to be the optimum level to obtain HPC at the age of 28 days for all three mixes.

The optimum level of replacement of natural sand is 40% with recycled concrete aggregate. For all the above three mixes, the optimum level of replacement of coarse aggregate is 50% with recycled concrete aggregate.

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