Study of High Volume Fly Ash Concrete with Recycled Aggregates

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Abstract- *The use of recycled aggregate from construction and demolition wastes is showing prospective application in construction as an alternative to natural aggregates. It conserves natural resources and reduces the space required for landfill disposal. In this paper, strength characteristics of high-volume fly ash (FA)-based concrete with recycled aggregate of M25 grade were studied. The recycled aggregates were collected from a demolished structure 20years of age. Natural aggregate (NA) was replaced with recycled aggregate (RA) in different percentages of 5, 10, and 15% to study the effect of recycled-aggregate concrete on compressive strength characteristics. The experiments were conducted for different ages of concrete such as 3, 14, and 28days. From the detailed investigations Recycled Aggregate gives satisfactory results. by compromising strength 40 to 50% with a major reduction in cost.*

I. INTRODUCTION

Demolition of old and deteriorated buildings and traffic infrastructure, and their substitution with new ones, is a frequent phenomenon today in a large part of the world. The main reasons for this situation are changes of purpose, structural deterioration, rearrangement of a city, expansion of traffic directions and increasing traffic load, natural disasters (earthquake, fire and flood), *etc*. For example, about 850 millions tones of construction and demolition waste are generated in the EU per year, which represent 31% of the total waste generation [1]. In the USA, the construction waste produced from building demolition alone is estimated to be 123 million tons per year [2]. The most common method of managing this material has been through its disposal in landfills. In this way, huge deposits of construction waste are created, consequently becoming a special problem of human environment pollution. For this reason, in developed countries, laws have been brought into practice to restrict this waste: in the form of prohibitions or special taxes existing for creating waste areas.

Attempts have been made to investigate the possibility of use of stone dust as partial replacement of sand in concrete. Due to its benefits such as useful disposal of this by-products, reduction in use of natural sand consumption as well as increasing the strength parameters and increasing the workability of concrete was noted (Jain *et al.*, 1999). The optimum dust content is found to be 10% for compressive strength and split tensile strength (Eren *et al.*, 2007). Increasing the dust content up to 30%, improved compressive strength of concrete and minimum absorption obtained when dust content was 20%. Dust content higher than 30% decreased the compressive strength and dust content more than 20% increased the absorption of the concrete (Hameed and Sekar, 2009). In the study of utilization of crushed stone waste in concrete it was concluded that adding 40% sand may be replaced by stone waste in concrete without compromising the quality of concrete (Sahu *et al.*, 2009). It is used for different activities in the construction industries such as road construction, manufacture of building materials, bricks, tiles and autoclave blocks. Every year 200-400 tons of stone dust is generated by the stone cutting plants and is dumped as waste leading to serious environmental and dust pollution. So it is necessary to dispose the stone dust waste quickly and efficiently. One of the possible uses lies in the construction industry (Patel and Pitroda, 2013). Aggregate is one of the main ingredients in concrete production. It accounts for about 75% of any concrete mix. The strength of the concrete produced depends on the properties of aggregate used (Sivakumar *et al.,* 2014).

The world is resting over a landfill of waste hazardous materials which may substitutes for natural sand. Irrespective of position, location, scale, type of any structure, concrete is the base for the construction activity. In fact, concrete is the second largest consumable material after water, with nearly three tonnes used annually for each person on the earth. India consumes an estimated 450 million cubic meter of concrete annually and which approximately comes to 1 tonne per Indian. We still have a long way to go by global consumption levels but do we have enough sand to make concrete and mortar? Value of construction industry grew at staggering rate of 15 % annually even in the economic slowdown and has contributed to 7-8 % of the country's GDP (at current prices) for the past eight years. Thus, it is becoming increasingly discomforting for people like common people who talk about greening the industry to have no practical answer to this very critical question. In fact we have been sitting over a landfill of possible substitutes for sand. Industrial waste and by-products from almost all industry, which have been raising hazardous problems both for the environment, agricultural and human health can have major use in construction activity which may be useful for not only from the economy point of view but also to preserve the environment as well. Some of the researchers did the work to find the alternatives for natural sand and they concluded about different industrial waste and their ability to replace the much sought after natural river bed sand.

Construction and Demolition waste There is no documented quantification of amount of construction and demolition (C&D) waste being generated in India. Municipal Corporation of Delhi says it is collecting 4,000 tonnes of C&D waste daily from the city which amounts to almost 1.5 million tonnes of waste annually in the city of Delhi alone. Even if we discount all the waste which is illegally dump around the city, 1.5 million of C&D waste if recycled can significantly substitute demand for natural sand by Delhi. Recycled sand and aggregate from C&D waste is said to have 10-15 per cent lesser strength then normal concrete and can be safely used in non-structural applications like flooring and filling. Delhi already has a recycling unit in place and plans to open more to handle its disposal problem. Construction and demolition waste generated by the construction industry and which posed an environmental challenge can only be minimized by the reuse and recycling of the waste it generates (Akaninyene A. Umoh 2012) [11].

Fly Ash

Fly ash (FA) is a by-product of coal combustion in the generation of electricity, i.e., a finely segregated residue captured from the flue gas at coal fired power plants. Fly ash provides a dramatic lubricating effect which greatly reduces water demand (2% to 10%). Most of the fly ash particles are spherical and amorphous, ranging in size between 10 and 100 microns. The spherical shape of fly ash particles causes an improvement in the workability and the particles alter the flocculation of cement resulting in lowering the quantity of water required (Rafat Siddique 2000). The use of quarry dust in concrete causes reduction in workability and hence increases in the quantity of cement required whereas the use of fly ash in concrete offers improved workability and reduction in cement content (Raman et al 2004). Hence concurrent use of quarry dust and fly ash in concrete will lead to a wide range of economic and environmental benefits With increasing energy costs and heightened concerns about the impact of concrete construction and maintenance activities on the environment, there has been an attendant increase in interest and research activity on the use of FA and other recycled materials in concrete, including those targeting ASR prevention (Malvar and Lenke 2006).

Güneyisi et al (2006) investigated the rebar corrosion in concrete made of blended cements which contained various proportions of Portland cement clinker, blast furnace slag, natural pozzolans, and limestone powder. Relative to the plain cement concrete, the specimens with blended cements showed superior corrosion performance and generally longer time to corrosion cracking, which correlated very well with the splitting tensile strength data.

In general, FA addition in concrete is considered an effective measure to mitigate chloride-induced corrosion of rebar in concrete. For instance, using FA blended cement is known to reduce chloride permeability and improve sulfate resistance of concrete (Saraswathy and Song 2006). Dhir et al (1997) used the equilibrium method and found that the chloride binding capacity of cement paste increased with the increase in FA replacement level up to 50% and then declined at 67%. In the case of admixed chloride, the increase in chloride binding due to the replacement of FA was also found (Byfors 1986). The increase in chloride binding could also be ascribed to the production of more gel during hydration, which results in better physical adsorption of chloride (Kayyali and Hague 1988). Other researchers (Byfors et al 1986) also found that partial replacement of cement with FA has a positive effect on the chloride binding when the cement paste was exposed to a chloride environment. Ampadu et al (1999) found the partial replacement of cement by FA only showed significant benefits in reducing the chloride diffusivity in cement paste at later ages of curing and a 40% replacement level was the best.

Saraswathy and Song (2006) investigated the effect of admixing activated FA on the corrosion resistance of concrete and found that the FA addition significantly improved the corrosion performance of concrete up to a critical moderate replacement level (20% to 30%) and the chemical activation of FA worked the best.

Kamal et al (2006) have investigated the efficiency of mineral admixtures in mortar and reported that, the spherical shape of fly ash particles causes an improvement in the workability, and the particles alter the flocculation of cement which results in lowering of the quantity of water required. Quan (2005) have concluded that the addition of fly ash causes a reduction in the water required for a given slump, typically in the order of 5-15 % when compared with a portland cement mix. Shigeyoshi Nagataki and Yukikazu Tsuji (2000) recommended that compared with conventional concrete, the concrete with 30 to 50 percent cement replacement by fly ash shows substantial increase in strength and corrosion resistive properties.

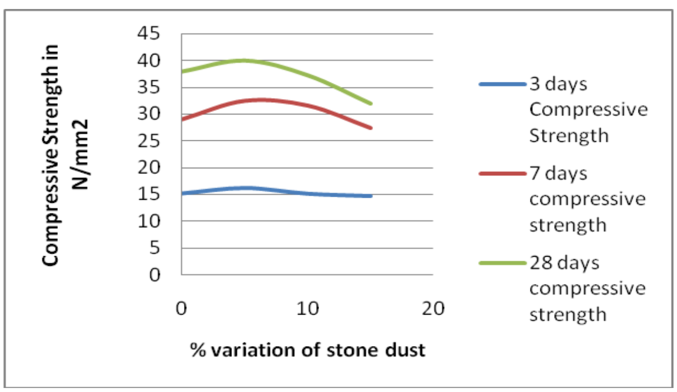
II. METHODOLOGY

An experimental investigation was conducted Study of High Volume Fly Ash Concrete with Recycled Aggregates (HVFAC) to get the strength of specimens (cubes) made with the use of stone dust and recycled aggregates as partial replacement of fine aggregates and coarse aggregates respectively. The strength of conventional concrete and other mixes were determined at the end of 7 and 28 days of water curing. To study the effect of stone dust and recycled aggregates inclusions, cubes of a design mix M25 grade concrete were cast. The 150 mm cubes were tested for compressive strength. The M25 mix proportion was (1:1.56:2.91) at w/c ratio of 0.40.

III. RESULT

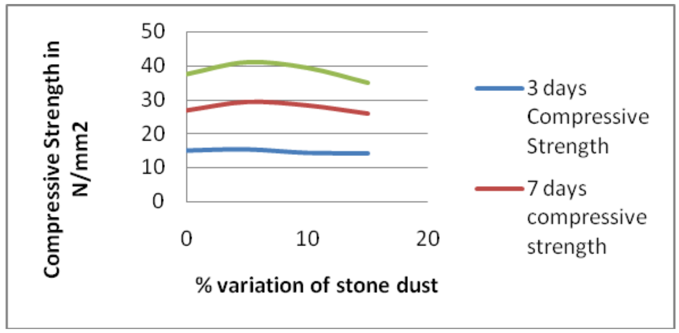
Result shown below according % Stone dust variable and % of Recycled Aggregate

S. No .	% Stone dust variable	% of Recycled Aggregate	3 days Compressive Strength (MPa)	7 days Compressive Strength (MPa)	28 days Compressive Strength (MPa)
1	00	0	15.20	28.97	37.93
2	05	0	16.10	32.45	39.93
3	10	0	15.15	31.56	37.21
4	15	0	14.75	27.32	32.00



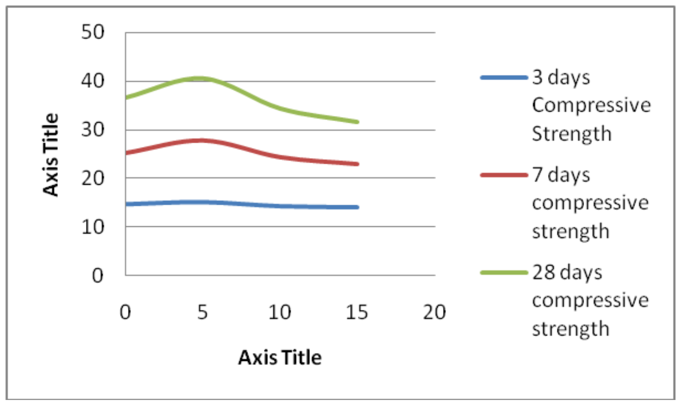
Graph 1: 0% of Recycled Aggregate

S. No.	% Stone dust variable	% of Recycled Aggregate	3 days Compressive Strength (MPa)	7 days Compressive Strength (MPa)	28 days Compressive Strength (MPa)
1	00	5	14.98	26.94	37.55
2	05	5	15.38	29.45	41.11
3	10	5	14.25	28.42	39.44
4	15	5	14.1	26	35



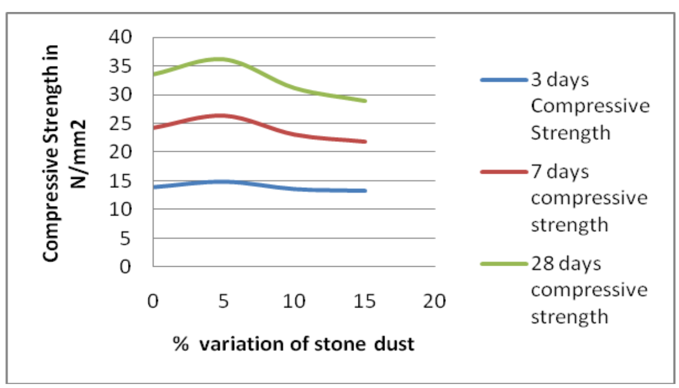
Graph 2: 5% of Recycled Aggregate

S. No .	% Stone dust variable	% of Recycled Aggregate	3 days Compressive Strength (MPa)	7 days Compressive Strength (MPa)	28 days Compressive Strength (MPa)
1	00	10	14.68	25.32	36.62
2	05	10	15.12	27.88	40.55
3	10	10	14.28	24.44	34.33
4	15	10	14.05	23.00	31.55



Graph 3: 10% of Recycled Aggregate

S. No .	% Stone dust variable	% of Recycled Aggregate	3 days Compressive Strength (MPa)	7 days Compressive Strength (MPa)	28 days Compressive Strength (MPa)
1	00	15	13.98	24.33	33.62
2	05	15	14.9	26.44	36.21
3	10	15	13.65	23.11	31.23
4	15	15	13.35	21.87	29



Graph 4:1 5% of Recycled Aggregate

IV. CONCLUSION

1. At 5% stone dust and 5% fly ash gives best result of compressive strength in Study of High Volume Fly Ash Concrete with Recycled Aggregates
2. The use of waste materials in the production of Plain concrete has benefits in not only reducing the amount of waste materials requiring disposal but can provide construction materials with significant savings over new materials. This study is oriented towards utilizing recycled concrete aggregates waste (fly ash) in the production of plain concrete.

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