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FLY ASH - A SUBSTITUTE OF FINE AGGREGATE IN CONCRETE

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ABSTRACT

The sharp fall in underground water table in river basins is said to be the outcome of indiscriminate sand mining resulting in the deepening of river beds. The natural sand beds have voids of 45-50% in the soil where the rain water is retained by the river sand. This property of the river sand is mainly responsible for maintaining the ground water table in and around river basins. This paper deals with the partial replacement of river sand by fly ash in aggregate in concrete without compromising the strength.

INTRODUCTION

Unlike in the past, rivers are filled in the rains and after a few days of dry weather they become skeletal. This is due to the indiscriminate an illegal sand mining that results in the deepening of river beds. The river sand is mainly used as a fine aggregate in construction of buildings. The infrastructural development that taken place all over the world leads to great demand for river sand. Unless otherwise we find new materials for replacing fine aggregate in concrete, we cannot stop the illegal mining. In this experimental investigation an attempt has been made to replace river sand by fly ash. Fine aggregate was replaced with five percentages namely (10, 20, 30, 40 and 50) of fly ash by weight. Tests were performed on hardened concrete.

The quantity of fly ash produced in India is 80 million tons and its utilization is only 10% (Malhotra 1999). The use of fly ash based cement has two major benefits namely ecological and energy saving benefit plus improvements in properties of concrete (Khadilkar & Kulkarni 2003). In this study we explored the possibility of replacing fine aggregate with fly ash in concrete.

MATERIALS AND METHODS

Materials used: In order to study the properties of cement concrete, cubes, prisms, cylinders were cast . Ordinary Portland cement of 53 grade, natural river sand with maximum size of 4.75mm with specific gravity of 2.692 and fineness modulus 3.1 as per IS specification (IS: 383-1970), coarse aggregate of 20 mm as per is specification (IS: 383-1970) of specific gravity 2.3 and water absorption 0.5% and fly ash of class F from Mettur thermal power plant were used.

Preparation and casting of test specimen: Mix proportion used for study was 1 : 1.65 : 3.2 with w/c ratio of 0.55. Six mix proportions were used by varying the percentage replacement of fine aggregate with fly ash from 0-50% in increments of 10%. Concrete cube of size 150mm × 150mm, cylinder 150mm × 300mm and prism of size 100mm × 100mm × 500mm were used for studying various properties like compressive strength, split tensile strength and flexural strength respectively. The specimens were tested after curing at various periods of 7, 14, 28, 56 days.

RESULTS AND DISCUSSION

The test results for the various strength parameters of fly ash mixed fine aggregate concrete are given in Table 1. From the results, the strength parameters such as compressive strength, split tensile strength and flexural strength values for the mix were seen to be increased with progressive curing up to the study period of 56 days. Another notable finding is the improvement of strength (Siddique 2003) with the curing period in correlation with the percentage increase of replacement. Various types of strengths have been found to be maximum when the percentage of the fly ash with fine aggregate is 50%. Table 2 gives an account of reduction of river sand when fly ash is used as fine aggregate in relation to the world cement production. From the statistical study it is seen that the world cement production in the year 2020 (World Cement Annual review 1997) will be reaching 3 billion tons or more. In relation to cement production the requirement for river sand can be projected to be 9 billion tons considering average use as 1: 3. From Table 2 it is evident that by using fly ash as replacement for river sand, we can reduce its consumption up to 50% (approximately 4.5 billion

Table 1: Strength parameters using various percentage replacements of fly ash.

Strengthmpa	% of fly ash repalced	Age of specimen in days			
		7	14	28	56
Compressive	0	17.33	21.77	33.55	36.00
	10	22.22	26.22	40.44	41.33
	20	24.88	25.99	41.334	48.89
	30	26.667	27.33	41.78	53.33
	40	27.22	28.22	42.225	55.56
	50	28.44	29.55	43.56	56.44
Split Tensile	0	2.26	2.89	3.18	3.67
	10	2.97	3.46	3.89	4.10
	20	3.53	3.60	4.17	4.52
	30	3.11	3.53	4.44	4.95
	40	2.97	3.60	4.66	5.09
	50	3.11	3.88	4.88	5.23
Flxural	0	0.63	2.97	3.86	4.01
	10	2.94	3.62	3.96	4.23
	20	3.14	3.79	4.2	4.65
	30	3.14	3.84	4.56	5.17
	40	2.98	3.89	5.02	5.49
	50	3.45	3.96	5.21	6.18

Table 2:River sand reduction for concrete using fly ash as replacement.

Year	World cement production (WCP) (billion tons)	River sand requirement in billion tons (considering average use as 1:3)	Use of fly ash as replacement of river sand in billion tons (considering higher percentages)		
			30%	40%	50%
1995	1.5	4.5	1.35	1.8	2.25
2010	1.9	5.7	1.71	2.28	2.85
2020	3	9	2.7	3.6	4.5

tones). The reduction in river sand mining will prevent ground water table depletion as the river sand bed acts as natural check dam because of voids of 45-50 percent in sand where the water is retained (Nair 2005).

CONCLUSION

Ecofriendly building materials is the need of the hour for a sustainable development to meet the fast growth in infrastructural development. By using fly ash the river sand consumption can be reduced without compromising the strength of concrete. The reduction in river sand mining will prevent groundwater table depletion. Thus, the use of fly ash is two-fold, one the utilization of a waste material as building material and secondly, it helps indirectly in the replenishment of groundwater.

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