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Demolition Waste as Cement Replacement in Concrete

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Abstract

Demolition of old structures to make way for new and modern ones is common features in metropolitan areas due to rapid urbanization. Very little demolished concrete is recycled or reused. Due to strict environmental laws and lack of dumping sites in urban areas, demolished waste disposal poses problems. In the present work, experimental investigations were carried out to evaluate the effect of partial replacement of regular cement in concrete by different parts of demolished wastes. For the study, concrete cubes were cast by replacing part of cement with recycled powder. The cubes were tested at 7 and 28 days. The compressive strength of these cubes is compared with the strength of referral concrete (Design mix concrete, M_{25}). Test results show that behavior of recycled waste concrete with partial replacement of cement (20%) by recycled waste powder is almost similar to that of referral concrete.

Key words : *Compressive strength; Concrete; Demolition waste; Demolition waste powder.*

1. INTRODUCTION

Over the years there has been a change in the use of building materials. Cheep and locally available materials such as moulded earth bricks, stones, thatch, timber, steel, aluminium, plastics and fibres of various types and forms have replaced the traditional and costly materials. However, all these materials have been developed to meet specific requirements of climate, availability of skilled labour and specific raw materials to effect the desired economy.

Demolition wastes obtained from a structure predominantly consists of concrete, foreign matter such as various type of finishes, claddy materials, lumber, dirt, steel, hardwares, woods, plastics etc. The process of removal of impurities and crushing of rubble into suitable and desired aggregate particle size can be carried out in a continuous and sequential manner using appropriate mechanical devices such as jaw crushers, impact crushers, swing hammer crushers etc. The three processes used for processing of demolished waste are (i) Dry (ii) Wet and (iii) Thermal - which are used individually or in combination.

Water absorption of coarse aggregate and fine recycled aggregates must be determined in the laboratory before any concrete mix design using recycled aggregates. The water demand of fresh concrete is increased, the strength and probably the durability of hardened concrete is reduced. For this reason, it is not recommended to use recycled fine aggregate for production of quality concrete. Due to high water absorption of recycled aggregates, it is sometimes suggested to use pre-soaked aggregates for production of recycled concrete.

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2. MATERIALS & METHOD

The present work is an attempt to explore the possibility of using recycled concrete as a material of hope for twenty first century. The present work is a part of comprehensive programme wherein experimental investigations were carried out to assess the possibility of partial replacement of regular concrete materials by a cheaper substitute i.e. demolition waste. For this study, cubes were cast by replacing part of cement by different parts of demolished waste. The cement was replaced by the powder obtained from the crushing of demolition waste (passing 600µ Sieve). In this study, cubes were cast by replacing part of OPC (10, 20, and 30%) with the powder obtained from demolition waste. The cubes of referral mix design (M_{25}) as per IS: 8112-1989 were also cast using OPC (43 grade): Fine aggregate: Coarse aggregate in the ratio of 1:1.67:3.33. The w/c ratio was 0.50. All the cubes were tested at 7 and 28 days, after curing for specified periods in tap- water. The workability of the different mixes was measured by slump value.

The properties of different regular materials used for making referral and recycled concrete are as follows

2.1 Cement

Ordinary Portland cement of Birla (43 grade) brand obtained from a single batches trough out the investigation was used. The ordinary cement content contains mainly two basic ingredients namely argillaceous and calcareous. The physical properties of OPC as determined are shown in Table 1. The cement satisfies the requirement of IS: 8112-1989.

2.2 Fine aggregate

Fine aggregate is obtained from locally available river sand, which is passed through 4.75 mm sieve. The fineness modulus of fine aggregate was 2.74 and specific gravity was 2.63.

2.3 Coarse aggregate

Coarse aggregate was obtained from locally available crushed stone aggregate about 12 mm maximum of single lot size has been used through out the experiment. Specific gravity of the coarse aggregate was 2.64 and the fineness modulus of coarse aggregate was 6.22.

2.4 Water

Potable water is used for mixing and curing.

Table 1 : Properties of cement

S.No.	Properties	Requirements (IS: 8112-1989)	Observed values
1.	Normal Consistency		
2.	Initial Setting time	30 minutes(min)	113 minutes
3.	Final Setting time	600 minutes(max)	317 minutes
4.	7 days compressive strength	33 N/mm^2	34.67 N/mm^2
5.	28 days compressive strength	43 N/mm^2	46.33 N/mm^2
6.	Soundness test	10 mm	2.5 mm
7.	Fitness test 90 µ sieve	--	0.98 %

Note: CR – Cement Replaced.

3. RESULTS & DISCUSSION

The results of the present investigation are included in Table 2 and are also plotted in Fig.1 & Fig.2. Fig.1 shows the variation of slump value of different recycled concretes with varying proportions of replacement of cement. Fig. 2 shows the effect of replacement levels of cement on the strength of concrete mixes at both 7 and 28 days.

3.1 Workability

Workability is the relative ease with which concrete can be mixed, placed, compacted and finished. While casting specimens, slump test was carried out to determine the workability of different mixes as per IS: 6461-1973. Table 2 shows the values of slump for different replacement levels of cement as well as of referral mix. It isobserved that to maintain same slump as referral,

Table 2 : Average compressive strength of concrete cubes

Types of concrete	Average Compressive strength N/mm²		Slump mm
	7 Days	28Days	
Referral concrete (0% Demolition waste)	33	38	30
10% CR concrete	29	34	26
20% CR concrete	25	30	26
30% CR concrete	22	25.5	24

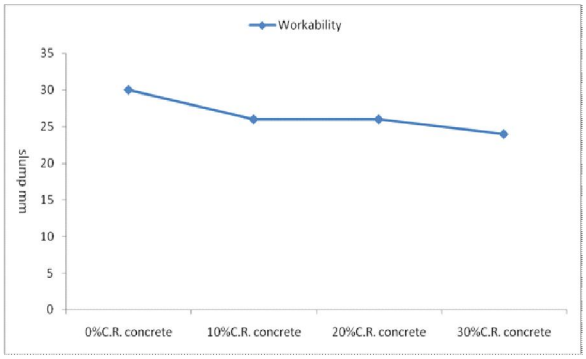

Fig. 1 : Workability of recycled and referral concrete for different cement replacement levels

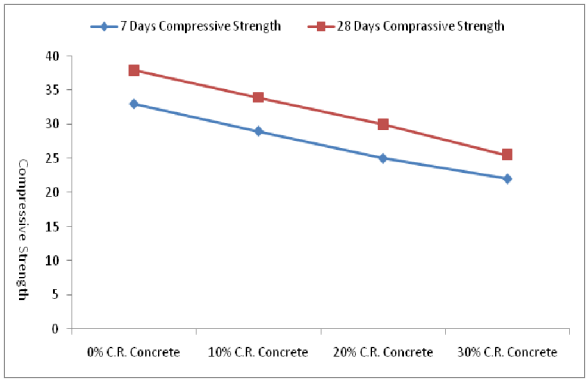

Fig. 2 : Compressive strength of recycled and referral concrete for different cement replacement levels

higher water quantity is needed and its requirement increase marginally with replacement level for all the cases. The variation of slump value is shown in Fig. 1.

3.2 Compressive Strength

Table 2 shows the values of compressive strength for different replacement levels of cement, fine aggregate and coarse aggregate, only one at a time as well as of referral mix. The variation of compressive strength is shown in Fig. 2. It is observed that recycled concrete made using 10% replacement of cement gives the strength comparable to the strength of referral concrete and beyond this replacement level the strength decreases considerably. Upto a replacement level of 20%, the M-25 grade concrete is almost obtained when waste material is used for replacement of cement. The strength of recycled concrete is about 89, 78 and 67% of referral concrete at 28 days for 10, 20 and 30% replacement of cement with demolition waste powder respectively. The variation of strength of recycled concrete with cement replacement is shown in Fig. 2.

4. CONCLUSION

The following conclusions are drawn from this study.

1. Water required producing the same workability increases with the increase in the percentage of use of demolition waste.
2. The strength of recycled concrete is marginally affected upto 10% replacement of cement by demolition waste powder. However, with further increase in demolition waste content, the strength decreases.
3. The recycled concrete upto 20% replacement of cement by demolition waste powder may be used as an alternative to M-25 grade concrete as strength of recycled concrete upto 20% replacement of cement by demolition waste powder is slightly less than that of referral concrete .

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