

Manufacture of Concrete Paver Blocks with Recycled Demolition Waste

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ABSTRACT: Due to rapid urbanization there is a great increase in building construction, so is the demolition. There is no proper disposal of the demolition waste. About 530 million tons of C&D waste is generated annually. But only a few amounts of demolished concrete is recycled or reused. In this study, experimental investigations have been carried out to evaluate the effect of complete replacement of fine aggregate by demolition waste on compressive strength, which is compared with a conventional block. The concrete blocks were made in M20 mix. Further, the test was carried out in concrete paver block, in M40 mix design. The concrete paver blocks show 91% strength attainment at 28 days and it is only a marginal deterioration in the compressive strength. Therefore, the concrete blocks made with demolition waste can be used in low load bearing pavements.

Key words: C&D waste, paver block, replacement, recycling

1 INTRODUCTION

One of the major challenges of our present society is the protection of environment. Some of the important elements in this respect are the reduction of the consumption of energy and natural raw materials and consumption of waste materials. These topics are getting considerable attention under sustainable development nowadays. The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. It conserves natural resources and reduces the space required for the landfill disposal. Any construction activity requires several materials such as concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement concrete remains the main construction material used in construction industries.

For its suitability and adaptability with respect to the changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of wastes and by-products in cement and concrete used for new constructions. The utilization of recycled aggregate is particularly very promising as 75 per cent of concrete is made of aggregates. The enormous quantities of demolished concrete are available at various construction sites,

which are now posing a serious problem of disposal in urban areas. This can easily be recycled as aggregate and used in concrete. Research & Development activities have been taken up all over the world for proving its feasibility, economic viability, and cost effectiveness. [1, 2, 3]

2 MATERIALS AND METHODS

2.1 Demolition waste

Demolished waste was collected from the area around Sri Ramakrishna Engineering College, Thudiyalur, Coimbatore. Demolished waste on being tested in laboratory showed pozzolanic properties. Demolished waste as a pozzolanic material was used as fine aggregate. Properties of recycled aggregates are given in Table 1

Table 1. Physical properties of recycled demolition waste.

Properties	Observed values
Color	Brown
Specific gravity	2.172
Sieve analysis	1.18mm-600microns
Water absorption	3%

2.2 Cement

In this work, ordinary Portland cement was used. The ordinary cement content mainly has two basic ingredients namely, argillaceous and cal-

careous. The physical properties of OPC as determined are in Table 2. The cement satisfies the requirement of IS: 8112-1989.

Table 2. Properties of cement

Properties Requirement as per IS: 8112-1989	
Properties	Observed values
Normal consistency	28%
Initial setting time	30 minutes
Final setting time	600 minutes
3 days compressive strength	23.67 N/mm ²
7 days compressive strength	34.67 N/mm ²
28 days compressive strength	44.33 N/mm ²
Soundness	10

2.3 Fine aggregate

The fine aggregate is locally available river sand, which is passed through 4.75 mm sieve. The specific gravity and its fineness modulus of the sand were found to be 2.33 and 2.56 respectively. The sand used was clean and was free of clay, loam, dirt and any organic or chemical matter.

2.4 Coarse aggregate

Normally crushed stones are used as coarse aggregate in concrete. The coarse aggregate locally available crushed stone aggregate, 20 mm and 10mm sizes were used in the experiment. The specific gravity of coarse aggregate was found to be 2.7.

2.5 Water

Water is important constituent of concrete for the chemical reaction. Combining water with a cement material forms a cement paste by a process known as hydration. In general, water suitable for drinking is also suitable for mixing concrete. Locally available drinking water was used in the present work. On addition of higher percentage of demolished waste, the requirement of water increased w/c ratio to 0.50.

3 EXPERIMENTAL INVESTIGATION

3.1 Conventional concrete cube

The concrete mix design is done in accordance with IS: 10262 (1982). Good stone aggregate and natural river sand of zone-II was used as coarse

aggregate and fine aggregate respectively in the regular conventional mix. Maximum size of coarse aggregate was 20 mm. Sieve analysis conforming to IS: 383-1970 was carried out for both the fine and coarse aggregate. Cubes of 15mm size were cast. Compressive strengths of this concrete were observed.

Table 3 Mix design for conventional concrete cube

Grade designation	M20
Cement type	OPC 43 grade
Max nominal size of aggregate	20mm
Water cement ratio	0.5
Exposure condition	Moderate
Cement content	420 kg/m ³
Water content	186 kg/m ³
Coarse aggregate	1121.68 Kg/m ³
Fine aggregate	564 Kg/m ³

3.2 Concrete Cube with fine aggregate replacement

The concrete mix design is done in accordance with IS: 10262 (1982). Good stone aggregate is used as coarse aggregate. Crushed demolition waste passed through 2.25mm sieve was used as fine aggregate. The demolition waste used here exclusively denotes the brick and mortar waste. [4,5,6] To evaluate the effect of complete replacement of fine aggregate on compression strength cubes of 15mm size were cast and various tests were done.

3.3 Paver block with replacement of Fine aggregate

The concrete mix design is done in accordance with IS: 10262 (1982). Good stone aggregate of 10mm size was used. Fine aggregate was the demolition waste. Paver blocks of suitable dimensions, thickness, and shape was casted in hydraulic press. [7]

Table 4 Mix design for conventional concrete paver block

Grade designation	M40
Cement type	OPC 53 grade
Max nominal size of aggregate	10mm
Water cement ratio	0.5
Exposure condition	Moderate
Cement content	400 kg/m ³
Water content	160 kg/m ³
Coarse aggregate	660 Kg/m ³
Fine aggregate	467 Kg/m ³

4 TESTING OF PROPERTIES

4.1 Water absorption Test

Durability of concrete plays a critical role in controlling its serviceability. Furthermore, durability of the concrete is mainly dependent on the capacity of a fluid to penetrate the concrete's micro-structure, which was called permeability. High permeability led to the introduction of molecules that react and destroy its chemical stability. Pore structure mainly involved volume and size of the interconnected voids. Hence water absorption test is done to test the durability.

Weight of the paver block with demolition waste as FA = 5.926 kg

Weight of the paver block with demolition waste as FA after oven drying = 5.753 kg

% water absorbed = $(5.926 - 5.753) * 100 / 5.926 = 2.91\%$

4.2 Efflorescence Test

When water percolates through poorly compacted concrete or through cracks or along badly made joints, the lime compounds within the concrete leached out which leads to the formation of salt deposits on the surface of concrete, known as efflorescence. This caused primarily by calcium hydroxide one of the hydration components and slightly soluble in water, migrating to concrete surface through the capillary system. After evaporation, the solid calcium hydroxide reacts with the atmospheric CO₂ to form CaCO₃, a white deposit on the concrete surface [8, 9, and 10]. The paver blocks have not shown any of the white patches deposited after it was taken out of 24 hours of water immersion.

4.3 Compression Test

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defined period of time. Compression tests are used to determine the material behavior under a load. The maximum stress a material can sustain over a period under a load is determined. In this study cubical specimens of 150 mm size were made in M20 mix for regular concrete and concrete with demolition waste and paver blocks in M40 design mix with demolition waste.

4.3.1 Compression Test results of conventional concrete cube & replaced cube with demolition waste

The compression test results of the cubical specimens of 150 mm size of M20 concrete mix was taken at 7, 14, 21 and 28 days are given in the figure 1

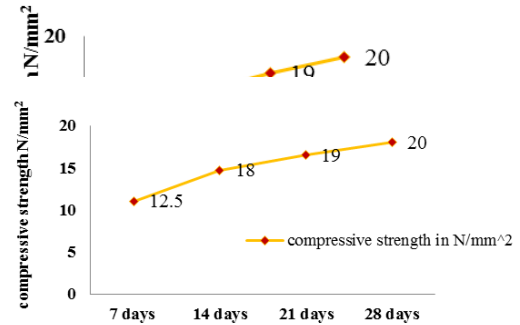


Fig.1 Compression strength of conventional cube

The compression test result of the cubical specimens of concrete mix with complete replacement of fine aggregate by demolition waste is given in figure 2.

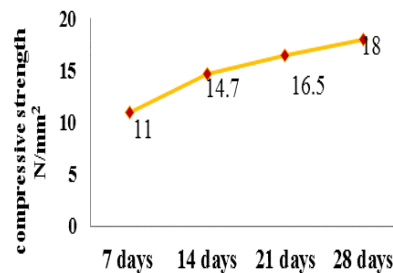


Fig 2 Compression strength of concrete cube with demolition waste

4.3.2 Compression Test results of paver block with normal aggregate and demolition waste as aggregate

The compression test results of paver block with regular aggregates is shown in figure 3

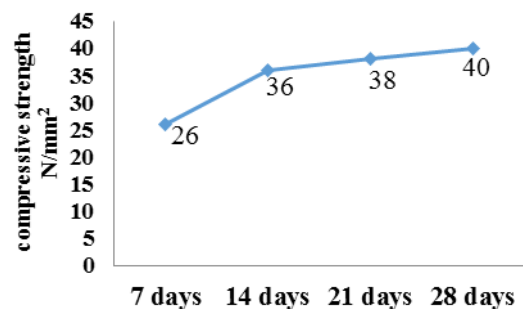


Fig 3 Compression strength of Normal paver block

The compressive test result of the paver block specimens with demolition waste as aggregate is given in the figure 4

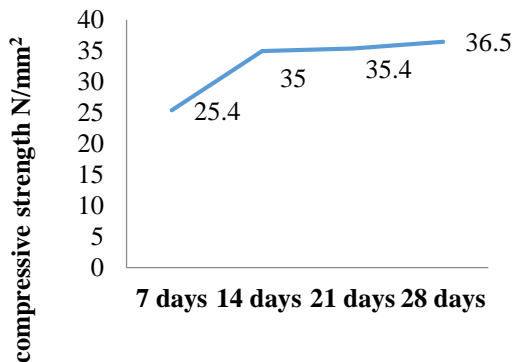


Fig 4 Compression strength of paver block with demolition waste as aggregate

4.3.3 Comparison of Test results

The comparison of compressive strength of a regular concrete mix to that of the concrete mix with fine aggregate replaced with demolition debris is shown in figure 5

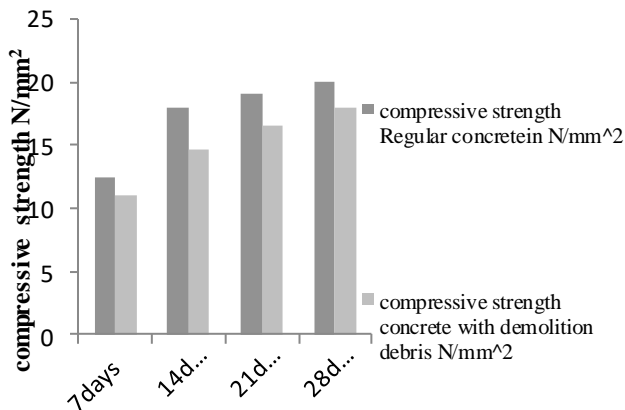


Fig 5 Comparison of compressive strength of cubes

The comparison of compressive strength of a regular concrete mix to that of the concrete mix with fine aggregate replaced with demolition debris in paver block is shown in figure 6

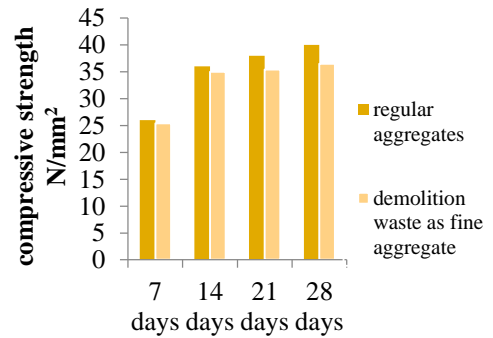


Fig 6 Comparison of compressive strength of paver block

5 CONCLUSION

- From the test results, it can be inferred that the replacement of fine aggregate by demolition waste can be recommended.
- The concrete paver blocks show 91% strength attainment at 28 days and these blocks can be used in low load bearing areas.
- Further this method of manufacturing concrete paver block is cost efficient.[11,12]
- As this method encourages the utilization demolition waste, it reduce the improper disposal of the same into landfills and it is more sustainable.

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