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Making of Paver Blocks With the Help of Demolished Building Waste

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Abstract: ***Now a days threr is a significant world-wide interest to solve the environmental problems caused by industrial waste such as waste generated from demolished structure. For making sustainable devolopment by using these waste materials for manufacturing of paver blocks. Many manufatrures were making paver blocks by using cement and various ingredients. This technology has been introduced in Indian construction activities, a decade ago, for specific construction of various floorings namely footpaths, parking areas etc. but now being adopted extensively in different uses where the conventional construction of pavement using the demolished building waste can be made to make green concrete paver blocks. 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.***
Keywords: Demolishen, Paver blocks.

I. INTRODUCTION

This technology has been introduced in India in construction, a decade ago, for specific requirement namely footpaths, parking areas etc. but now being adopted extensively in different uses where the conventional construction of pavement using waste of demolished buildings .

During the past five decades, the block shape has steadily evolved from non-interlocking to partially interlocking to fully interlocking to multiply interlocking shapes . The main challenge before the Indian concrete industry now is to meet the demand of economical and efficient construction materials required by large infrastructure needs *due* to rapid industrialization and urbanization. All these call for use of good quality concrete with use of minimum resources (eg. Limestone, energy &money) and achieving maximization of strength, durability and other intended concrete properties. In recent years there has been an increasing worldwide demand of concrete paving blocks for the footpaths, roads and airfields which has led to a local depletion of aggregates. In some urban areas, the enormous quantities of aggregate that have already been used means that local materials are no longer available and the deficit has to be made up by importing materials from other locations.

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]

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II. MATERIALS AND METHODS

A. 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.

B. Cement

In this work, ordinary Portland cement was used. The ordinary cement content mainly has two basic ingredients namely, argillaceous and calManufacture of Concrete Paver Blocks with Recycled Demolition Waste G. Balasubramanian, D. Salvia, D. Bharathi Sri Ramakrishna Engineering College, Coimbatore-22, India 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 Electronic Journal of Structural Engineering 20(1) 2020 78 careous. The physical properties of OPC as determined. The cement satisfies the requirement of IS: 8112-1989.

C. Fine Aggregate

The fine aggregate is locally available river sand, which is passed through 4.75 mm sieve. The specific gravity and it 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.

D. 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.

E. 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.

III. EXPERIMENTALINVESTIGATION

A. 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.

B. 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.

C. 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]

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IV. TESTING OF PROPERTIES

A. *Ater 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 microstructure, 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%

B. *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 from 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.

C. *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.

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. The compression test result of the cubical specimens of concrete mix with complete replacement of fine aggregate by demolition waste.
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. The compressive test result of the paver block specimens with demolition waste as aggregate
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. 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

V. SHAPES AND CLASSIFICATION OF VARIOUS PAVER BLOCKS

There are four generic shapes of paver blocks corresponding to the four types of blocks as below the different shapes of paving blocks:

1) *Type A:* Paver blocks with plain vertical faces, which do not key into each other when paved in any pattern,
2) *Type B:* Paver blocks with alternating plain and curved/corrugated vertical faces, which key into each other along the curve/corrugated faces, when paved in any pattern,
3) *Type C:* Paver blocks having all faces curved or corrugated, which key into each other along all the vertical faces when paved in any pattern and
4) *Type D:* 'L' and 'X' shaped paver blocks which have all faces curved or corrugated and which key into each other along all the vertical faces when paved in any pattern

VI. DIFFERENT SHAPES OF PAVER BLOCKS

Concrete blocks are mass manufactured to standard sizes. This makes them interchangeable. Typical concrete paving blocks have one smooth face and one rough, although some paving blocks so come with reversible surfaces (can be used both sides). The performance characteristics of concrete paving blocks make it suitable for the heaviest duty applications, able to support substantial loads and resist shearing and braking forces. The concrete paving bricks are a porous form of brick formed by mixing small stone hardcore, dyes, cement and sand and other materials in various amounts.

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VII. WASTE MATERIAL USED FOR MAKING PAVER BLOCKS

A. *Definition of Waste*

"Wastes materials are substance or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law"**.** Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc. or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc. Waste is any substance which is discarded after primary use, or it is worthless, defective and of no use. If the large amount of waste materials generated were used instead of natural materials in the construction industry there would be three benefits:

1) Conserving natural resources.
2) Disposing of waste materials (which are often unsightly).
3) Freeing up valuable land for other uses.

VIII. ADVANTAGES

Various advantages of paving block,

1) Capability of being moulded in different sizes, shapes, and colours
2) Good stability and durability, if properly manufactured and installed.
3) Easy to produce ,Easy laying
4) Good indoor climate (balanced humidity; cool)
5) Various attractive patterns can be formed
6) Equipment to produce tiles can be easily made by local workshop.

The rubber mould are used for casting paving block of Type C: Paver blocks having all faces curved or corrugated, which key into each other along all the vertical faces when paved in any pattern. They were made in such a manner as to facilitate the removal of the moulded specimen without damage.

A. *Weighing*

The proportions or the materials are taken by weight or by volume. The procedure we adopted was by weighting of the material this is more accurate method than volumetric method hence we preferred this method.

B. *Mixing*

After taking weights of all the ingredients there was the next procedure of mixing. First take the coarse aggregate than fine aggregate sand and then cement with fly ash in hump manner. Then first mixing was carried out in dry mixing for 3 times. Then again the material hump was created. Then small pond was created and the calculated quantity or specified water was poured in the pond. Then the materials was wet mixed from out to in. The wet mixing was carried for 3 times. The mixing was done manually. To get good result the mixing can be done by small mechanical mixes.

C. *Compacting*

Compacting of concrete was done after placing the mixed concrete in the mould of 15 cm x 15 cm x 15 cm as well as paving rubber mould. The compaction was carried out manually with tamping steel rods and vibrating concrete externally. The concrete was filled in 3 layers. Each layer was tamped 25 times for cube casting and for the paving blocks 10 mm thickness of doramite and colour mixture after that concrete mixture. For paving blocks Air curing is used. Because of The necessity for curing arises from the fact that hydration of cement can take place only in water-filled capillaries. This is why loss water must be prevented. Furthermore, water lost internally by self-dedication has to be replaced by water from outside Thus, for complete and proper strength developments, the loss of water in concrete from evaporation should be prevented, and the water consumed in hydration should be replenished. This the concrete continues gaining strength with time provided sufficient moisture is available for the hydration of cement which can be assured only by creation of favorable conditions of temperature and humidity. This process of creation of an environment during a relatively short period immediately after the placing and compaction of the concrete, favorable to the setting and the hardening of concrete is termed curing (The paving blocks are kept under shadow for curing. The curing is done for 7 and 28 days. For paving blocks & concrete cubes of size 0.15X0.15X0.15 m Air curing method is used. The paving blocks and concrete cubes are kept under shadow for curing. The curing is done for 7 and 28 days. In case of dry-air curing, the specimens were weighed and exposed to dry air.

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IX. OBJECTIVES OF PROJECT

1) To check the strength of the block made with the help of demolished building waste.
2) To save cost required for cement, sand and other ingredients required for making paver blocks.

X. CONCLUSION

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

XI. ENCOLSURES (TEST RESULTS)

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Test Report
Precast Concrete Blocks for Paving - Compressive Strength

Customer Name	: Guru Gobind Singh Polytechnic	Branch Code	: 03
Office Address	: Khalsa Educational Complex, Guru Gobind Singh Marg, Nashik	Material Code	: PT
		Sample Ref No.	: 11757
Site Name	: Guru Gobind Singh Polytechnic , Nashik	Record No.	: 119/1-1
Nature of work	: —	Bill No	: 202122NSK1750
Grade of concrete	: NA	Date of Mat. Recd	: 04-Jan-2022
Description	: Shape - Colorado 60mm Thickness	Date of Casting	: 25-Dec-2021
		Date of Testing	: 05-Jan-2022
		Date of Issue	: 05-Jan-2022

OBSERVATIONS & CALCULATIONS :

Sr.No	ID Mark	Age (Days)	Plan Area (mm²)	Actual Thickness (mm)	Weight (kg)	Comp Strength(N/mm²)			Average (N/mm²)
						10 %	20 %	30 %	
1	Shape - Colorado	11	38439	60	6.021	10.67	10.93	8.98	***
2	Shape - Colorado	11	39077	60	6.160	14.00	14.76	11.69	
3	Shape - Colorado	11	38591	62	6.319	15.64	16.00	12.62	

References :
1) IS 15658 - 2017 Precast Concrete Blocks for Paving Specifications.

Remarks :
1) *** Sample constitutes of minimum eight specimen for compressive strength.

Notes :
1) The test reports and results relate to the particular specimen/sample(s) of the material as delivered/received and tested in the laboratory.
2) Any test report shall not be reproduced except in full,without the written permission from Durocrete.
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Authorized Signatory

Samadhan Gaikwad
(Technical Manager)

Checked by : Bharat Pagare

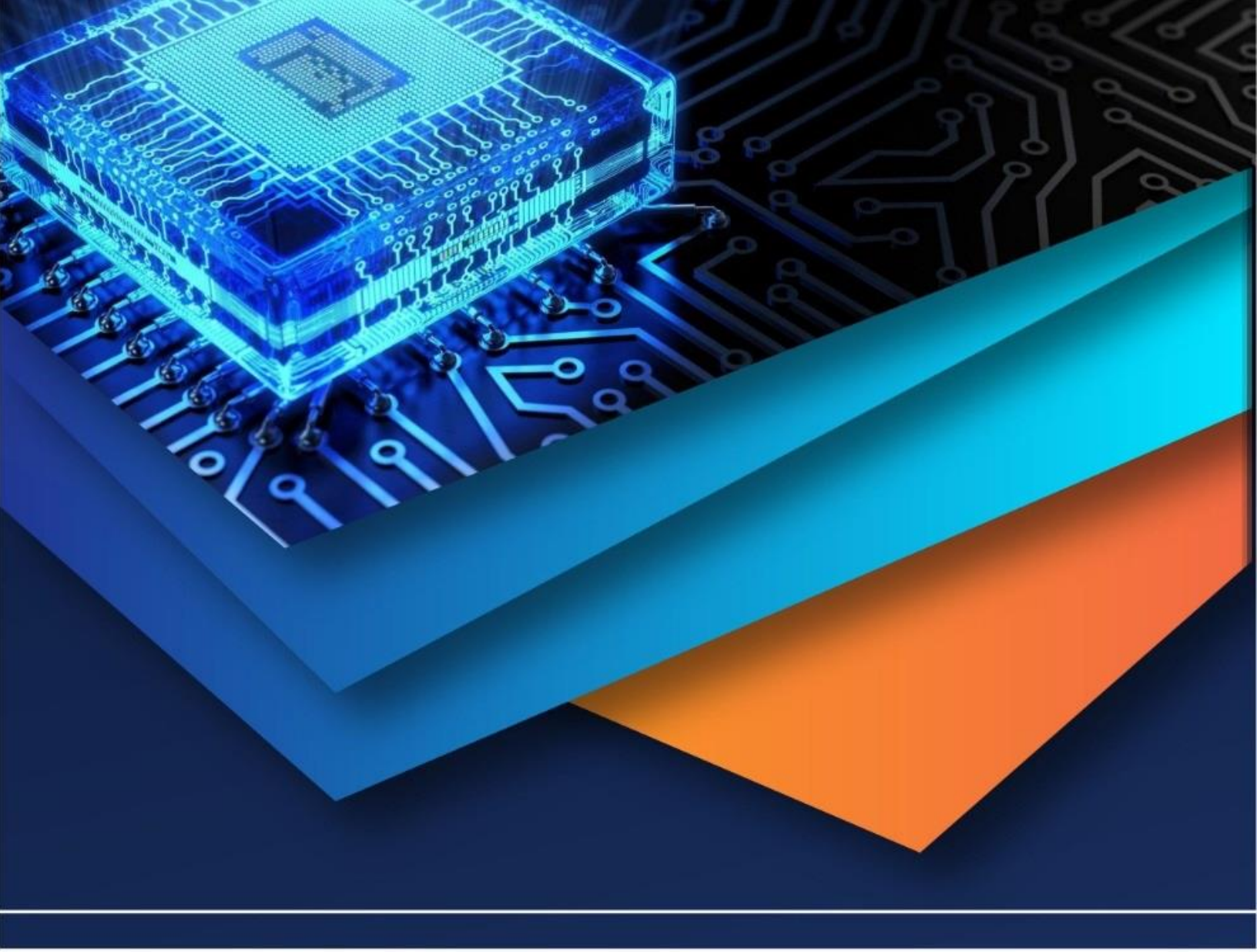
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