International Journal of Research in Engineering, Science and Management (IJRESM)
www.ijresm.com
Volume-1, Issue-4, April 2018

Study of Paver Block using E-Waste

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***Abstract*—In this paper, a study for producing paver blocks utilizing electronic waste with partially replaced coarse aggregates is introduced. Waste rounded steel bearings are included in concrete of paver blocks in different rates. Compressive strength of paver blocks with conventional and electronic waste are compared. Test results demonstrate the comparison of strength between normal paver block and electronic waste paver block.**

Index Terms— compressive strength, paver block specimen

I. Introduction

A) Paver Blocks:

Concrete paver blocks were first introduced in Holland in the fifties as replacement of paver bricks which had become scarce due to the post-war building construction boom. These blocks were rectangular in shape and had more or less the same size as the bricks. During the past five decades, the block shape has steadily evolved from non-interlocking to partially interlocking to fully interlocking to multiply interlocking shapes. Consequently, the pavements in which non-interlocking blocks are used are designated as Concrete Block Pavement (CBP) or non-interlocking CBP, and those in which partially, fully or multiply interlocking blocks are used are designated as Interlocking Concrete Block Pavement (ICBP).

B) Types of Paver Blocks:

There are two basic types of paving blocks – concrete and clay.

1) Concrete Paving 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.

2) Clay Paving Blocks:

Clay paving blocks (also called as bricks or cobbles) are generally available as typical, rectangular bricks, although custom shapes can be made for specific projects. Unlike the concrete paving blocks, both the surfaces of most clay blocks are fully useable or interchangeable.

C) Electronic Waste:

Electronic waste or e-waste describes discarded electrical or electronic devices. Used electronics which are destined for reuse, resale, salvage, recycling, or disposal are also considered e-waste. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution.

Waste rounded steel bearings are included in concrete of paver blocks in different rates. Compressive strength of paver blocks with different rates of waste steel aggregates and utilizing elastic cushions is examined. Test results demonstrate that including different rates of waste steel aggregates in paver blocks gives up to 50% more strength quality than customary paver blocks.

II. Material and Method

A) Ordinary Portland cement:

Ordinary Portland Cement (OPC) of 43 grade conforming to IS 8112:1989 is used throughout this investigation. This cement is by far the most important type of cement. Prior to 1987, there was only one grade of OPC which was governed by IS 269-1976.After 1987, higher grade cements were introduced in India. The OPC was classified into 3 grades, namely 33 grade, 43 grade and 53 grade depending upon the strength of cement at 28 days when tested as per IS 4031-1988.If the 28 days strength is not less than 33N/mm2, it is called 33 grade cement, if the strength is not less than 43N/mm2, it is called 43 grade cement and if the strength is not less than 53N/mm2, it is called 53 grade cement.

TABLE I
PROPERTIES OF CEMENT

Description	Numerical values
Grade	43
Fineness(retained on 90 micron sieve) in %	1.17
Initial Setting Time(minutes)	90
Final Setting Time(minutes)	540
Specific Gravity	3.15

Aggregates are the important constituents of concrete. They give body to the concrete, reduce shrinkage and effect economy. Earlier, aggregates were considered as chemically inert materials but now it has been recognized that some of the aggregates are chemically active and also that certain aggregates exhibit chemical bond at the interface of aggregate and paste. To know more about the concrete it is very essential that one should know more about the aggregates which constitute major volume in concrete. Without the study of the aggregate in depth and range, the study of the concrete is incomplete. Cement is the only factory made standard component in concrete. Other ingredients namely water and aggregates are natural materials and can vary to any extent in many of the properties. The depth and range of studies that are required to be made in respect of aggregates to understand their widely varying effects and influence on the properties of concrete cannot be underrated.

1) Sieve analysis of aggregate:

This is the name given to the operation of dividing a sample of aggregate into various fractions each consisting of particles of the same size. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which we call gradation.

A convenient system of expressing the gradation of aggregate is one in which the consecutive sieve openings are constantly doubled such as 10mm,20mm,40mm,etc.Under such a system, employing a logarithmic scale, lines can be spaced at equal intervals to represent the successive sizes.

The aggregates used for making concrete are normally of the maximum size 80mm,40mm,20mm, 10mm, 4.75mm, 2.36mm, 600micron, 300micron and 150micron. The aggregate fraction from 80mm to 4.75mm are termed as coarse aggregates and those fraction from 4.75mm to 150 micron are termed as fine aggregates. The size 4.75mm is a common fraction appearing both in coarse aggregate and fine aggregate.

Grading pattern of a sample of aggregate is assessed by sieving a sample successively through all the sieves mounted one over the other in order of size with larger sieve on the top. The material retained on each sieve after shaking represents the fraction of aggregate coarser than the sieve and finer than the sieve above. Sieving can be done either manually or mechanically. In the manual operation, the sieve is shaken giving movements in all possible direction to give chance to all particles for passing through the sieve. Operation should be continued till such time comes that almost no particle is passing through.

TABLE II
SIEVE ANALYSIS OF FINE AGGREGATE

IS Sieve	% Retained	Cumulative % Retained	% passing
10mm	0.0	0.0	100
4.75mm	0.7	0.7	99.3
2.36mm	0.3	1.0	99.0
1.18mm	1.9	2.9	97.10
600µm	6.4	9.3	90.7
300µm	66.6	75.9	24.1
150µm	22.1	98.0	2.0
Pan	2.0	100	0
		F.M.=2.87	

TABLE III
SIEVE ANALYSIS OF 10MM AGGREGATE

IS SIEVE	% Retained	Cumulative % Retained	% Passing
20mm	0.0	0.0	100
10mm	62.82	62.82	37.18
4.75mm	35.91	98.73	1.27
2.36mm	1.27	100	0.0
Pan	-	-	-
		F.M.=2.61	

From the sieve analysis the particle size distribution in a sample of aggregate is found out .In this connection a term known as "Fineness Modulus" (F.M.) is being used. F.M. is an index of coarseness or fineness of the material. Fineness Modulus is an empirical factor obtained by adding the cumulative percentages of aggregates retained on each of the sieve ranging from 80mm to 150 micron and diving this sum by an arbitrary no 100.The larger the figure, the coarses is the material and having a fineness modulus more than 3.2 will be unsuitable for making satisfactory concrete.

Fig. 1. Normal and electronic block

2) Sieve analysis of aggregate:

The compressive strength of hardened cement is the most important of all the Properties. Therefore, it is not surprising that the cement is always tested for its strength at the laboratory before the cement is used in important works. Strength test are not made on neat cement paste because of difficulties of excessive shrinkage and subsequent cracking of neat cement. Strength of cement is indirectly found on cement sand mortar in specific proportions. The standard sand is used for finding the strength of cement. It shall conform to IS 650-1991.Three cubes are tested for compressive strength at the periods of 3 days, 7 days and 28 days. The strength of our used cement was found out to be 43N/mm^2 at 28 days.

Fig. 2. Compressive test of normal block

Fig. 3. Compressive test of e-waste block

B) Result:

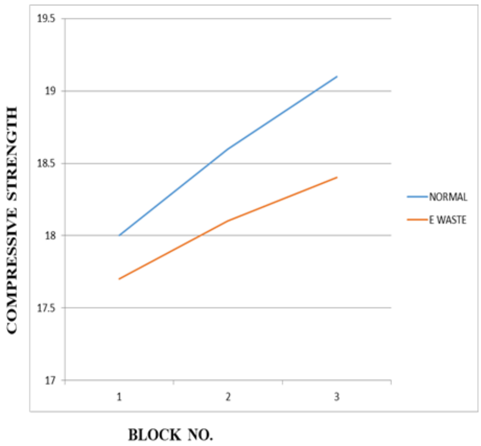

Fig. 4. Comparison of normal and e-waste paver block

III. Conclusion

The following conclusion was made after the completion our research work: The electronic waste is one of the biggest concern of the planet earth, using them in the same will be a global relief. The 14 day average compressive strength of K series block was found out to be 18.56 N/mm^2. The 14 day average compressive strength of A series block was found out to be 18.06 N/mm^2. Due to mixture of e-waste the tensile strength has been increased.

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