Experimental Investigation on Paver Blocks Using Lateritic Stones Aggregates and Pva Fibers

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Abstract- *Laterite is one of the abundant rock formations found in the tropical and semi tropical zones all over the world. In India the lateritic rock formations are widely found along the western coastal parts of the sub-continent, India. These stones are commonly used as building blocks in the construction industries. These lateritic blocks tend to lose its strength properties when in contact with water. Hence various researches have been carried in the manufacture of more durable materials such as concrete blocks and reinforced concrete blocks with utilizes natural coarse aggregates. The excessive use of coarse aggregate resulted in issues related with mining and depletion. The present paper attempts to utilize the lateritic wastes as coarse aggregate in casting concrete paver blocks. The study is also focused on increasing the durability parameter based on the addition of polyvinyl alcohol fibres (PVA) and study the variation in the strength characteristics. The test revealed that an increase in strength is observed by the addition of lateritic aggregates and PVA fibres, with a maximum strength at 0.5% of PVA fibres was obtained.*

Keywords- Lateritic aggregates, PVA fibers, interlocking paver blocks, aggregate replacement

I. INTRODUCTION

Inter-locking concrete block (ICB) is one of the advanced construction materials available in the present construction industries. This technique was first introduced in Holland as a replacement for the paver bricks. The interlocking concrete blocks serve as an effective alternative material for commercial and industrial applications due to their strength, durability and their aesthetic appeal [1, 3]. Paver blocks made of concrete exhibit brittle failure patterns under heavy loads. These are usually used in pedestrians and for non load bearing structures. The interlocking concrete block also have low maintenance which gives them leverage over the traditional brick as they can be easily damaged due to the occurrence natural disasters which makes it a tedious job to clean the ruins leftover [2]. These interlocking concrete blocks are however available in two basic shapes i.e. rectangular shaped blocks and complex shaped blocks designed for specific research purposes [3] out of which the rectangular shaped blocks are commonly used. One of the benefits of the ICB is that it can be arranged in numerous patterns to get different visual effects [3].

Naturally available granite aggregates have formed a crucial part in the production of the concrete over the past decades and have continued to do so in the present times. But the excessive use of the granite aggregates in producing concrete has resulted in the depletion of the natural deposits, hence there is a need to find and a effective material in the replacement of the granite coarse aggregates [4]. The unlimited usage of the natural resources has resulted in the increase in the construction cost which has affected the construction industries. Therefore various researches have been carried out for the effective replacement of granite as coarse aggregate [4, 5]. Studies were also performed to increase the strength characteristics based on the addition of fibres.

Over the years use of fibres in the concrete has become a popular practice in the improvement of the materials. There are many types of fibres available in market such as steel fibres, glass fibres, PVA fibres and asbestos fibres etc. The use of PVA fibres has resulted in the reduction of the brittle failure when subjected to heavy loads [6] and increased the compressive strength [7].

In the present study an attempt has been made to study the effect of strength parameter of the concrete paver blocks with partially and completely replaced lateritic coarse aggregates by the addition of varying dosages of polyvinyl alcohol fibres. Overall the study is concerned with the behaviour of the concrete paver blocks by the addition of lateritic coarse aggregates and PVA fibres by replacing the granite coarse aggregate with a various proportion mentioned below.

II. OBJECTIVES

The aim of the present investigation is to

- Study the strength characteristics of the concrete paver blocks using lateritic aggregates as an alternative material.
- Determine the influence of addition of PVA fibers in concrete paver blocks.
- Determine the compressive strength of concrete paver blocks with and without addition of PVA fibres.

III. MATERIALS USED

The basic materials used for casting CIBs, are as follows:

A. Cement

For the present study OPC of 53 Grade cement was used. Fig 1.The cement was procured from the local market in Karkala, Karnataka. Initial tests for determining the basic requirements of the cement were conducted in accordance with the guidelines provided by IS: 12269-1987. The details of initial tests conducted on the cement have been listed in the following **Table 1.**

Fig. 1- Cement Sample

Table 1 – Properties of Cement

Property	Test results
Normal consistency	29.3%
Specific Gravity	3.10
Initial setting time	110 minutes
Final setting Time	270 minutes

B. Coarse Aggregates

The coarse aggregates used throughout the study were procured from local quarry in Halakatte, Karnataka. **Fig.2.** The size of the aggregates used in the present study was 12 mm passing and retained on 10 mm IS sieves. Tests was conducted on these aggregates as per the guidelines provided by **IS: 2386 (Part III) 1963.** The details of the tests conducted are tabulated in the following **Table 2.**

Fig. 2 - Coarse Aggregate Sample

Table 2 – Properties of the coarse aggregates

Characteristics	Test Results
Specific Gravity	2.69
Water Absorption	0.40%
Impact value	18.14%
Aggregate Crushing	27.04%

C. Lateritic Aggregates

The lateritic aggregates used for the present study was procured from the local quarry situated in Belman, Karnataka. Fig.3. the size of the lateritic aggregates used was 12 mm passing and retained on 10 mm IS sieves. The properties of the lateritic aggregates are listed in **Table 3.**

Fig. 3 -Lateritic Aggregate Sample

Table 3 – Properties of the lateritic aggregates

Characteristics	Test Results
Specific Gravity	2.73
Water Absorption	0.75%
Impact value	23.80

D. Fine Aggregates

Locally available river sand was used as fine aggregates.**Fig.4**.The fine aggregates used were passing through 4.75 mm IS sieve. The test for determining the properties of the aggregates were conducted as per the guidelines prescribed the IS 383- 1970 and the results of the above tested have been tabulated in the following **Table 4.**

Fig. 4- Fine Aggregate Sample

Table 4 – Properties of the fine aggregates

Particulars	Test Results
Specific Gravity	2.67
Water Absorption	2.20%
Fineness Modulus	2.806
Grading Zone	Zone- II

E. Fibers

In the present investigation PVA fibers was selected as the fibres which was procured from Bhilwara, Rajasthan. **Fig 5.** The fibers used were of polyvinyl fibres type RECS 15, having diameter of 38 micron, length of 6 mm and an aspect ratio of 430. The properties of the PVA fibers have been tabulated in **Table 5.**

Fig 5- Polyvinyl Alcohol Fibers

Table 5 – Properties of the Polyvinyl Alcohol Fibres

Test parameter	Results
Specific gravity	1.19 – 1.32
Tenacity	7 – 11 g/den
Elongation	11% – 20%
Heat resistance	80^{0}C
Melting point	No melting observed
Resistance to weak alkali	Very good
Abrasion resistance	Good
Soluble at	90^{0}C

IV. METHODOLOGY

The sequence of the work conducted in the study has been described as follows. Relevant material was collected followed by material procurement. The initial tests were conducted on materials as per the codal provisions. The ICB pavers were first prepared with conventional mix design for M30 grade and further replacing the coarse aggregate (Granite) proportion of the mix by 50% and complete replacement (100%) with the addition of varying percentage of the PVA fiber proportion mixing by 0%, 0.25%, 0.50% and 0.75% for concrete mix M30. **Table 6** provides the details regarding the mix design for one paver block. The paver bocks where prepared for Non-Traffic areas such as building premises, public gardens etc. as per IS 15658 – 2006. The test results were then analysed for gain in strength for various mixes.

Table 6 Mix Proportion for M-30 Grade of concrete

Material used	Water cement Ratio	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)
Coarse aggregate	0.38	1	2.12	2.31
Laterite aggregate	0.38	1	2.12	2.35

A. Test for Workability

The test for workability was conducted on different mix proportions of concrete by slump cone apparatus. Slump test were conducted for Nominal mix, replacing the coarse aggregate by lateritic aggregate in proportions of 50% and 100%, along with variation in fiber dosage of 0.25%, 0.5%, 0.75%. **Table 7** provides the details of the workability of various specimens.

Table 7. Slump Test Results

Coarse aggregate	Lateritic aggregate	Fibres (%)	Slump value (mm)
100%	0%	0	30
		0.25	30
		0.50	20
		0.75	0
0%	100%	0	35
		0.25	30
		0.50	30
		0.75	0
50%	50%	0	30
		0.25	30
		0.50	25
		0.75	0

B. Preparation of the specimen for compressive strength test

The specimens were casted in zig-zag shape mould with a depth of 100 mm, length 242.5 mm and breadth of 118.33 mm. **Fig. 6.** The blocks were then de-moulded after 24 hours of casting and were placed in curing tanks over the period of 7 days and 28 days. The specimens on the day of

testing were kept for normal air drying at room temperature before loading them in the compressive testing machine. And the test for compressive strength was conducted for 7days and 28days using compressive testing machine as shown in **Fig.7**.

Fig. 6 -Casted Paver Blocks

V. RESULTS AND DISCUSSIONS

This gain in the compressive strength is due to the Pozzolanic reaction of the cement leading to the formation of the hydrated cement paste and the enhanced bonding between the hydration products, aggregates and fibres [4]. However it has been observed that the strength decreases after the addition of 0.50% of fibre from 29.30 MPa and 38.26 MPa for 7th day and 28th day may be due to the decrease in workability and poor bonding [8]. The increase in the compressive strength can be observed in the concrete paver blocks with 100% lateritic aggregates and 0%, 0.25% and 0.50% polyvinyl alcohol fibres from 27.8 MPa to 39.2 MPa for 7th day and 28th day. However, the gain in strength is not equivalent i.e. slightly lesser than the paver blocks with 100% coarse aggregates. The strength of the paver blocks decreases after 0.50% fibre addition as 25.9 MPa and 37.3 MPa which is lesser when compared to paver blocks with 100% coarse aggregates. This is due to the weak bonding between the hydrated cement paste, fibre and the lateritic coarse aggregates [4]. From the **Fig. 8,** it can also be seen that the compressive strength for the paver block with 50% granite Aggregates and 50% lateritic aggregates with the PVA fibre dosage of 0%, 0.25% and 0.50% increases from 29.3 MPa to 41.63 MPa for 7th day and 28th day whereas the strength decreases after the 0.50% of fibre addition.

A. Slump Test

Based on the slump test the test for workability was determined. The result shows that the addition of fibres has affected the workability of concrete mix. Increase in PVA fibers resulted in decrease in workability of concrete mix this can mainly because for poor bonding and depressiveness in the mix [8].

B. Compressive Strength

Compressive strength test conducted on the concrete paver blocks. The test results are presented in **Table 8.** Paver blocks casted with coarse aggregates (100%) and 0%, 0.25% and 0.50% polyvinyl alcohol fibres showed an increasing trend in strength gain from 31.18 MPa to 40.15 MPa for 7th day and 28th day test specimen.

Fig 7 - Compression Test on Paver blocks

Table 8- Compressive strength test results of Paver blocks for 7th day and 28th day

Coarse Aggregate	Lateritic Aggregate	Fibres (%)	Compressive Strength MPa	
			7th day	28th day
100%	0%	0	25.23	34.19
		0.25	27.53	36.43
		0.50	31.18	40.15
		0.75	29.30	38.26
0%	100%	0	22.10	31.50
		0.25	24.56	35.96
		0.50	27.80	39.20
		0.75	25.90	37.30
50%	50%	0	23.62	32.62
		0.25	26.80	36.10
		0.50	29.30	41.63
		0.75	28.80	38.40

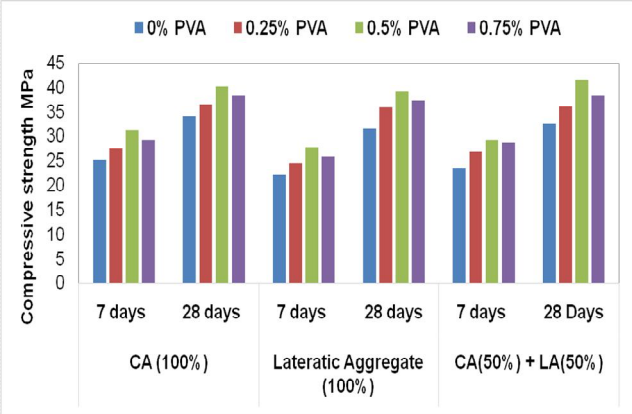

Fig 8 - Variation of Compressive strength for various specimens

VI. CONCLUSION

- The compressive strength of the paver blocks partially replaced (50%) lateritic aggregates and with 0.5% PVA fiber dosage showed an increase in compressive strength from 29.3 MPa to 41.63 MPa i.e. 42.08% gain in strength was observed over the curing period for 28 days.
- The compressive strength of the paver blocks with 100% lateritic aggregates and 0.5% fiber dosage showed a gain in strength from 27.8 MPa to 39.2 MPa i.e. 41% increase over the curing period of 28 days.
- The test results for the paver blocks with 50% of granite as coarse aggregates replaced with lateritic coarse aggregates showed a marginal increase in the compressive strength till the fibre dosage of 0.50%. A grain in compressive strength was found about 42.10% over a period of 28th days.
- From the test results it was also found that the replacement of coarse aggregate with 50% of lateritic aggregate was found maximum with 0.5% of PVA fiber dosage.
- Overall the study reveals the effective use of lateratic aggregates in the replacement of the granitic course aggregate.

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