

Replacement of Sand By PVC Pipe Waste in Pavement Blocks

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Abstract:

In the present research an attempt has been made to replace some part of fine aggregate (sand) by an industrial waste, the industrial waste under investigation is produced when the PVC pipes are cut into the desired sizes, it is a very thin flaky substance having a specific gravity of 1.5. This material is very voluminous in nature, so it reduces the workability of concrete if used in large percentage. So this material cannot be used in very large quantities but it can successfully replace sand up to 20 percent when used in pavement blocks. Experimentation was done at a water-cement ratio ranging from 0.43-0.35. Compressive strength of the concrete has been evaluated at 7 days, 14 days 21 days and 28 days. Results of the investigation indicate that compressive strength of the concrete decreases as the percentage of PVC waste material increases. 7 day strength of the concrete has varied from 35.55 MPa to 70.01 MPa and 28 day strength has varied from 56.7 MPa to 76 MPa. Water absorption was well within the limits and varied from 4.67% to 7.26% by mass. The results revealed that this waste material can satisfactorily replace sand in small amount also it is a great way to dispose of the waste and hence is a step forward in the quest for a greener concrete.

Keywords: Green Concrete, PVC waste material, compressive strength, water absorption, fine aggregate, partial sand replacement, pavement block.

I. INTRODUCTION

Buildings and other structures that we live in have a tremendous effect on our global environment. Concrete is the world's most abundant building material which can be shaped to make roads, bridges, dams, tunnels, buildings etc. Recently, a research study shows that each year more than six billion tons of concrete is produced worldwide which generates a huge amount of carbon dioxide and other green-house gases into the environment that leads to global warming. In recent years, global concerns about climate changes have led the researchers to find ways to minimize carbon dioxide and other greenhouse gas emission. Green Construction seeks to balance resource efficiency, health, and social concerns throughout the life cycle of a structure. Among them green concrete has a variety of benefits to offer in achieving this goal

This project is an attempt towards reducing the cost of concrete production and to make it environment friendly by using PVC waste material. The objective of the project is to compare the compressive strength of interlocking concrete paver blocks (ICPB) having various proportions of PVC waste material as a constituent

II. SPECIFICATIONS OF THE MATERIALS

Relevant Indian Standards were adopted while selecting the materials and at every stage it was made sure that everything is in accordance to the respective Indian codes and all the materials conform to their respective codes

A. CEMENT

In order to develop high strength concrete, use of high strength cement is recommended. Hence Ordinary Portland Cement having a 28 day compressive strength of 43 MPa (manufacturers name — Ultratech) complying with IS: 8112 – 1989 has been adopted in present investigation

B. FINE AGGREGATE

For the production of strong durable concrete, good quality sand should be used. A sieve analysis of the sand was done having a fineness modulus of 2.9 and the sand was zone 2 sand.

C. COARSE AGGREGATE

Coarse aggregates conforming to IS 383 were used. Crushed / Semi-crushed aggregates were used. The maximum size which was used was 12mm. (as specified in IS 15658:2006)

D. WATER

Potable water (in accordance with IS: 456) was used for casting and curing.

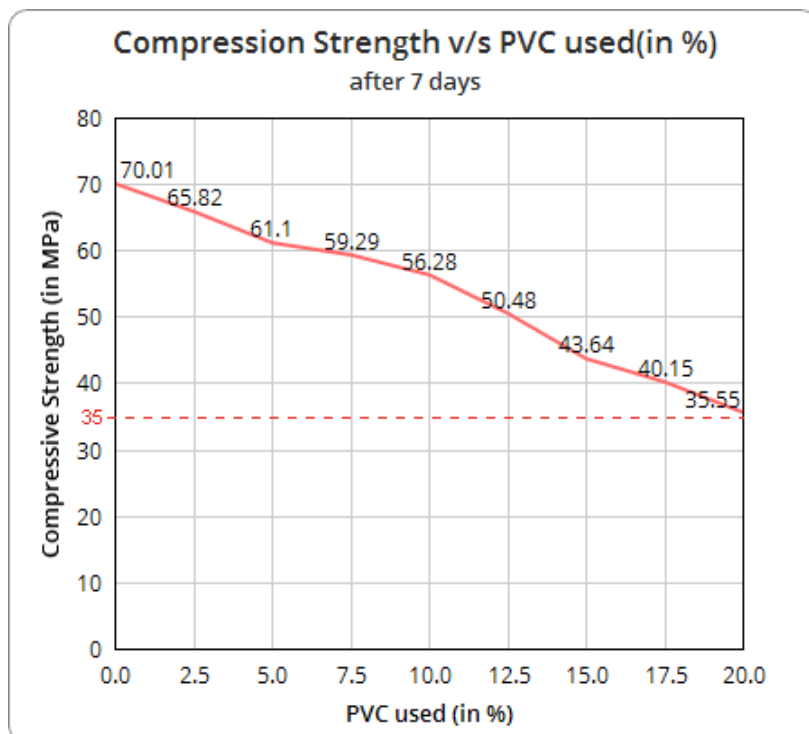
III. EXPERIMENTAL PROCEDURE

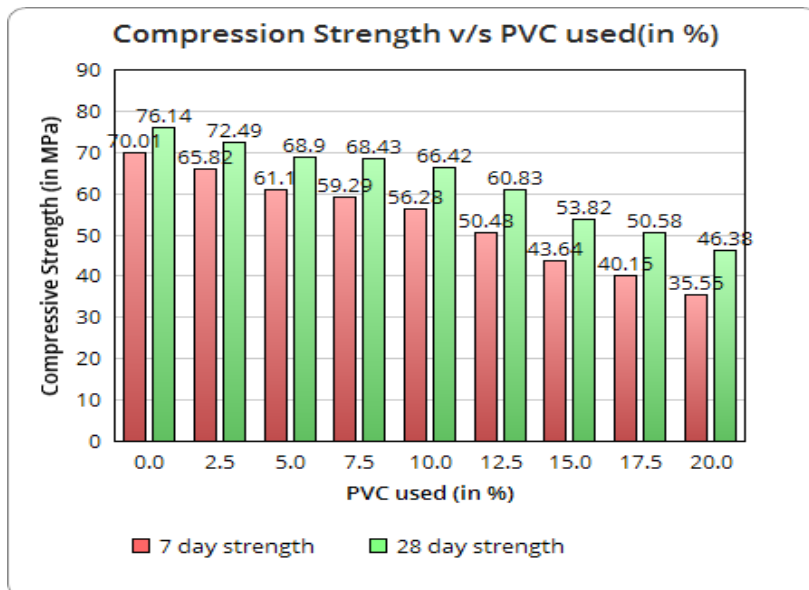
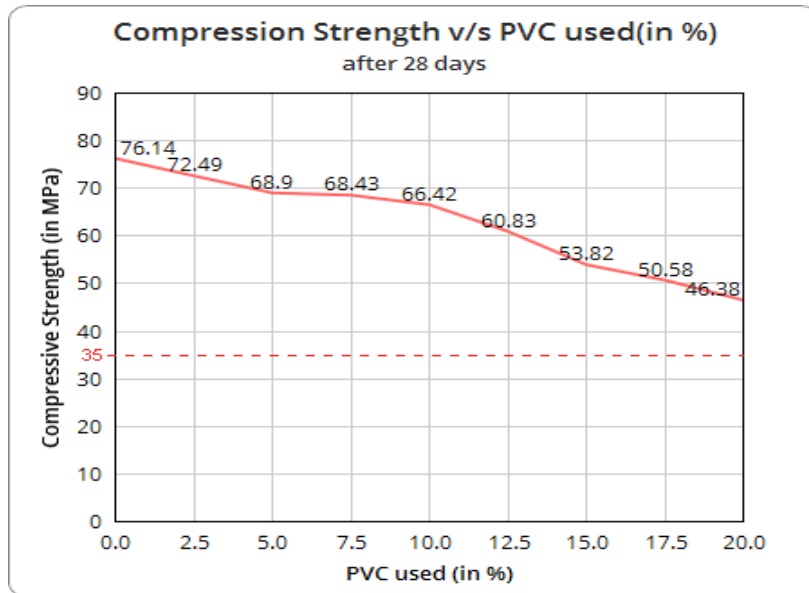
According to IS 15658:2006; for light traffic conditions a depth of 60 mm is required for the Interlocking Concrete Paver Blocks and subsequently a Concrete Strength of minimum 35 MPa is required. Now, according to IS 15658:2006 the value of standard deviation for M-35 concrete is 5.0 MPa. Hence a target mean strength of 43.25 MPa was desired. Correspondingly the water-cement ratio was taken as 0.43. The experimental program included eight sets of different mixtures of concrete having various percentage of PVC waste along with sand as fine aggregate. The first set had 0% PVC waste, the amount of PVC was increased by 2.5% of fine aggregate in each set. For the present investigation the proportion of cement, fine aggregate and coarse aggregate has been calculated and is kept constant throughout. Only the amount of sand is changed in the mixture and is replaced by PVC waste. The amount of coarse aggregate and fine aggregates used were 61.6% and 38.4% respectively of total aggregates and the amount of water was calculated by absolute volume formula keeping all other constituents constant. Rubber moulds having a volume of 1860 cm³ were used for casting Interlocking Concrete Paver Blocks. After 24 hours of setting, the blocks were de-moulded. After the de-moulding process the blocks were kept for moist curing under water, and were tested for compressive strength after 7 days of moist curing and 28 days of moist curing. Each strength value is the average of 5 specimens.

Table 1: MIX Proportions

PVC waste used(%)	cement(kg/m ³)	aggregates(kg/m ³)			water(kg/m ³)	W/c ratio
		fine		coarse		
		PVC waste	sand			
0	483	0	645	1074.4	207.7	0.43
2.5	483	16.125	628.875	1074.4	203.23	0.42
5	483	32.25	612.75	1074.4	198.76	0.41
7.5	483	48.375	596.625	1074.4	194.54	0.4
10	483	64.5	580.5	1074.4	190.16	0.39
12.5	483	80.625	564.375	1074.4	185.23	0.38
15	483	96.75	548.25	1074.4	180.84	0.37
17.5	483	112.875	532.125	1074.4	175.88	0.36
20	483	129	516	1074.4	170.98	0.35

IV. RESULTS OF COMPRESSIVE STRENGTH TEST





A chart showing comparison between 7 day & 28 day strength of concrete blocks

The compressive strength test results showed that there is a continuous decrease in strength as the percentage of PVC waste is increased. The decrease in strength is very gradual till 10% but after that it decreases sharply and reaches almost to the minimum desired value (35 Mpa).

V. WATER ABSORPTION TEST RESULTS

Table 2

WATER ABSORPTION TEST RESULTS		
S.No	PVC Used (in %)	Water Absorbed
1	0	6.26
2	2.5	4.67
3	5	6.9
4	7.5	6.57
5	10	6.7
6	12.5	5.48
7	15	6.12
8	17.5	5.96
9	20	6.2

Water absorption test results show that all the blocks are within the limit of 7% as specified in the IS 15658:2006

VI. CONCLUSION

In the present investigation a total of 9 different concrete mixes comprising of 1 controlled and 8 PVC waste mixes have been investigated. The objective of the investigation was to explore the possibility of PVC waste material in producing environment friendly pavement blocks. The PVC waste material used here is a white thin powder like substance which floats over water and is very bulky and voluminous in nature, all these reasons make it difficult to use in high quantities, as it reduces the workability of concrete. But it can be used to replace sand by 20 % to get satisfactory results but the optimum range in which it gives best results is 10-12.5% without much affecting the workability. The workability can be improved to some extent by using chemical admixtures.

The 7 day compressive strength results vary from 70.01MPa to 35.5MPa, but at the optimum value of PVC(10%) the compressive strength value is 56.28 MPa. All the blocks passed the water absorption tests.

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