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A Comparative Study on the Strength of Structural Elements by Incorporating Waste Latex Paint in Concrete

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ABSTRACT
Reuse and recycling keep materials out of waste disposal cycle for long time while preserving natural resources. Waste Latex paint (WLP) contributes significantly towards liquid waste and its disposal has become a major concern for environment. This project focuses on sustainable development through the recycling of waste latex paint by incorporating in concrete. It also aims at determination and comparison of strength characteristics of normal structural concrete and by incorporating different percentage of WLP by partially replacing required water content. From the laboratory test results it has found that introduction of waste latex paint can improve some key properties of concrete such as workability, durability, flexural strength etc.
Keywords- Concrete, Recycling, Waste Latex Paint, Water content

I. INTRODUCTION

Solid, gaseous or liquid waste, singly or combined can create serious problems for human and the environment if they are not treated, transported and managed safely. Latex paint can be highly toxic to the environment and also have adverse effects on health if not disposed properly. It not only harms aquatic life, wildlife but pollutes groundwater also, if dumped on the ground. This study is focused on discovering a suitable re-use option to reduce disposal and pollution problems emanating from waste latex paint and to develop a profitable building material from the waste latex paint. Latex paint is a water-based dispersion containing resins, solvents, pigments, and additives. It includes all paints that use synthetic polymers such as poly acrylic, poly vinyl acrylic (PVA), styrene acrylic, etc. as binders. Whereas recycled latex paint is made primarily with leftover which are collected from residents, painting contractors and other paint users.

The main aim of the study is to produce a concrete mix capable of maintaining or improving the properties of the hardened concrete while increasing the efficiency of the construction process. It is established that waste latex and acrylic based paint is a suitable additive to Concrete, results in maintaining strength and improving workability, providing a viable substitute to standard chemical admixtures currently used to achieve comparable results [1]. Increased water content is required to ensure that the waste paint is distributed evenly within the concrete mix, which maintains the compressive strength without the addition of excessive air content.

A concrete mix design of 1: 1.44: 3.03: 0.5 is selected and a number of tests are conducted to evaluate the properties of various fresh and hardened concrete when mixed with an optimum dosage of the waste paint. Detailed study of properties of waste latex paint concrete focused upon workability, compressive strength, tensile strength etc. were studied to assess the hardened properties of the concrete.

II. OBJECTIVE

The objective of this paper is to determine the strength characteristics of recycled WLP for application in normal strength structural concrete, which will give a better understanding on the properties of concrete with recycled WLP. It aims to conduct a research on recycled WLP and construct the concrete specimen by using different percentage of recycled WLP. Laboratory testing of normal strength concrete with recycled WLP is also to be performed. The analysis and comparison of the results are reported for further research.

III. METHODOLOGY

In this study waste paint is used as a partial replacement for mixing water in concrete. The testing was carried out in two stages, initially without the addition of WLP and in next stage with the addition of waste latex paint. Various laboratory test methods are conducted to check the ability of waste latex paint to replace standard chemical admixtures presently used in concrete to some extent and also to confirm the strength properties of the new mix.

Results in the various properties of fresh and hardened latex paint will verify the potential of waste paint as a successful cementitious admixture. Inferences are gathered on concrete compressive strength, tensile flexural strength, spread (workability) etc.

IV. EXPERIMENTAL MATERIALS

4.1 Cement

Ordinary Portland pozzolona cement (53 Grade) was used for the entire specimen. The specific gravity of cement was found in the laboratory by using Pyconometer and other accessories and obtained the value as 3.15.

4.2 Fine Aggregate

River sand was used as fine aggregate for all specimens. The specific gravity of fine aggregate used for concrete was determined and found to be 2.65. The sand used for casting was sieved passing through IS 600µ Sieve and retaining on IS 300µ sieve.

4.3 Coarse Aggregate

The coarse aggregate used in the mix are hand broken granite stones obtained from local quarries. Size of aggregate used for all specimens was 20mm. The Specific gravity of coarse aggregate was determined and found to be 2.60.

4.4Recycled Latex Paint

Recycled latex paint is made from unused latex paint collected from households, government, and painting contractors. New materials are added to improve the paint's consistency and to make standard colours.

V. EXPERIMENTAL PROCEDURE

5.1Preparation of Concrete Mix by Blending WLP

The control mixture is prepared by the following procedure: Water and WLP are manually mixed, saturated and surface-dried coarse aggregates are premixed with part of the mixing water (containing WLP), fine aggregates and cementitious materials are then added and mixing resumed for 2 minutes with the remaining mixing water and chemical admixtures being added over the first minute of mixing. After a 2 minute rest period, 3 minute mixing sequence is conducted. Setting time of cement has been determined. The following tests are conducted over the prepared specimens.

Acid attack Test is modified in this investigation for testing of concrete specimen subjected to sulphuric acid at the age of 28 days.

Leaching tests were conducted on three replicate concrete specimens subjected to 300 freezing-and-thawing cycles for mixtures incorporating 0%, 5%, 15%, and 25% WLP as partial replacement for mixing water.

Pour dry concrete mix into a suitable container for the amount of mix to be made, replace up to 25 percent of the water with any of the latex paint. A control concrete mixture with a water-cement ratio (w/c) of 0.5 and mixtures with similar (w + WLP)/c incorporating 5%, 15% and 25 % of WLP as partial replacement by mass of mixing water are prepared. Mix the paint well before combining it with the concrete. Add the rest of the water and 10 percent more to make a wetter mix than normal. Make sure that the paint is mixed well, until there are no dry pockets or visible patches of paint. Apply the well mixed concrete and the latex paint mixture and allow drying for the recommended time. There will be less shrinkage of the concrete due to the latex paint filling in more of the air pockets.

5.2Preparation of Test Specimens

Concrete mainly contains cement, water, fine aggregate and coarse aggregate. Whereas, control concrete, in this context means replacement of 5%, 15% and 25% of the mixing water with recyclable latex paint. Various tests are conducted on controlled concrete and standard concrete by preparing test specimens as follows.

Table 1 Number of specimens prepared for testing

Percentage of Latex paint partially replaced (%)	Cubes (15cm × 15cm × 15cm)		Cylinders (Diameter 15 cm & 30 cm Long) Prisms (10cm × 10 cm × 50cm)		Beam (16cm × 20cm × 100cm)		
	7 days	14 days	28 days	7 days	14 days	28 days	28 days
0 %	3	3	3	1	1	1	1
5 %	3	3	3	1	1	1	-
15 %	3	3	3	1	1	1	-
25 %	3	3	3	1	1	1	1

Concrete cube samples were casted on the mould of size 15cm × 15cm × 15cm. After about 24 hours the specimens were de-moulded and curing was continued till the respective specimens were tested after 7, 14 and 28 days for compressive strength. Concrete cylinders of size 15cm diameter and 30cm long were casted to find the split tensile strength of concrete. Concrete prisms of size 10cm × 10cm × 50cm were cast to find the flexural strength of the concrete and R.C.C beams of size 16cm × 20cm × 100cm, using 4 numbers of 10 mm diameter and 8 mm diameter stirrups at 120 mm c/c were cast to find the flexural behaviour of the concrete. All samples were made by incorporating 5%, 15%, and 25% of WLP as partial replacement by mass of mixing water in concrete and after 24 hours of casting, the specimens were de-moulded and kept in water for curing. The number of specimens prepared is tabulated in Table 1.

VI. EXPERIMENTALMETHODOLOGY

6.1Test on Compressive Strength of Concrete with the Addition of WLP

Compressive strength of specimens was tested by using compression testing machine on cube specimens of control concrete and ordinary concrete. These values are plotted in Fig. 1 which shows the variation of compressive strength with percentage of latex paint added to the mix at 7 days, 14 days and 28 days.

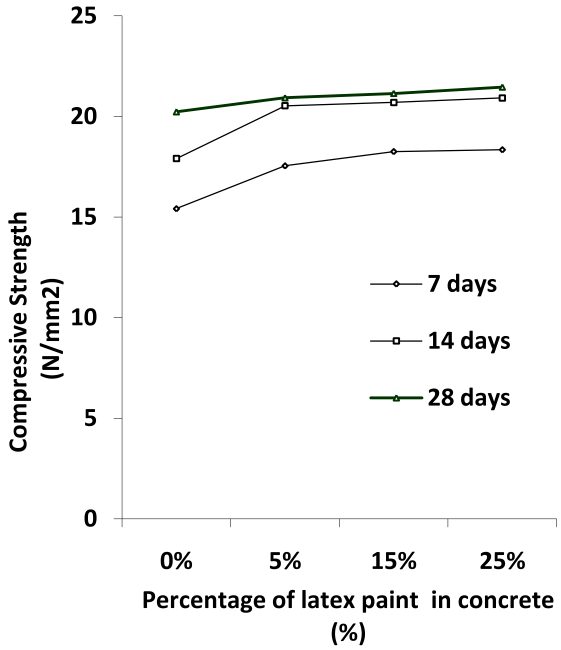

Fig. 1 Variation of compressive strength with age of concrete.

6.2Test on Split Tensile Strength of Concrete with the Addition of WLP

The test results on cylindrical concrete specimen with addition of various percentage of waste latex paint were compared with conventional concrete specimen and variation of split tensile strength with age of concrete at varying latex paint percentages were plotted in Fig. 2.

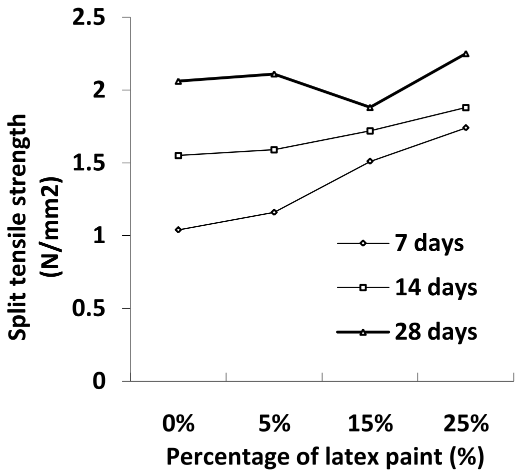

Fig. 2 Variation of split tensile strength with age of concrete

6.3Flexural strength of concrete with WLP

Flexural strength of the specimen is expressed as the modulus of rupture. The experimental results are plotted in Fig. 3.

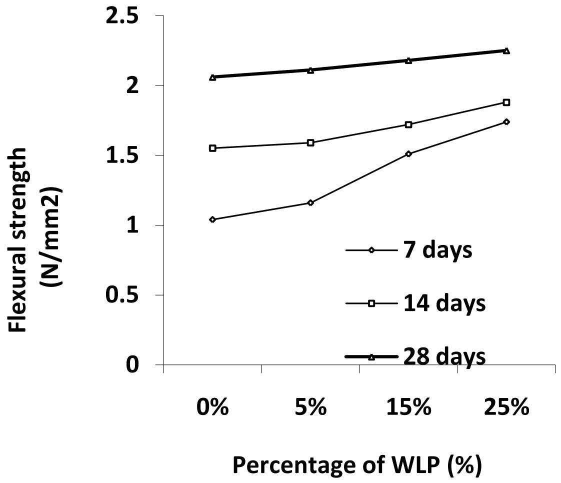

Fig.3 Variation of flexural strength with age of concrete

6.4 Workability of Concrete

The workability of concrete by the addition of waste latex paint at varying percentages is measured in terms of slump by conducting slump test. The observations are tabulated in Table 2.

Table 2 Workability of concrete

Percentage of latex paint (%)	Slump (mm)
0%	85
5 %	100
15%	105
25%	120

6.5Flexural behaviour of concrete beam with WLP

The main aim of this experiment is to determine the maximum load carrying capacity of beam specimens with and without the addition of WLP. This was carried for M20 grade concrete and 25% latex paint concrete. The specimen is subjected to two point loading and the load at the failure of the specimen is noted down. Flexural strength of the specimen is expressed as the modulus of rupture. The deflection with rate of increase of loading for conventional concrete and concrete incorporating 25% of WLP as partial replacement by mass of mixing water in concrete is graphically shown in Fig. 4 and Fig. 5.

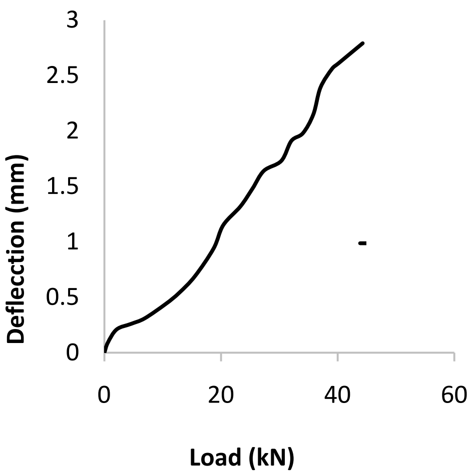

Fig. 4 Load deflection curve

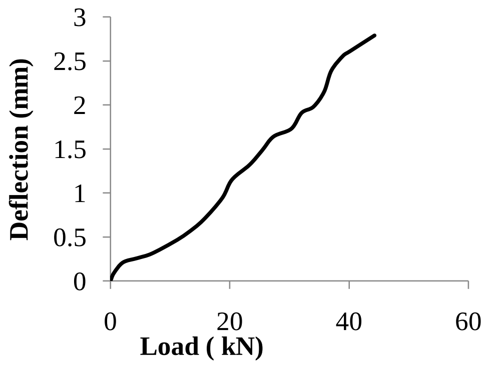

Fig.5 Load deflection curve for control concrete

VII. CONCLUSION

Based on limited experimental investigation concerning the strength properties of structural elements, the following observations are made regarding the influence of partially replaced waste latex paint

a) Compressive strength increased with WLP addition giving acceptable results upto 25% partial replacement of water
b) The split tensile strength also significantly increased as the partial replacement of WLP increases in the conventional concrete structural elements.
c) The flexural strength of concrete increased with addition of WLP and highest value is obtained at 25% partial replacement of mixing water. Flexural behavior of beam indicates crack appears comparatively at a higher rate of loading in 25% partial replacement of WLP than in 0% WLP addition.
d) From the slump test result, it is observed that application of WLP as an admixture improves the workability of concrete.
e) Initial setting time of concrete was not reduced due to WLP addition, whereas the final setting is slightly reduced, which is perceived as an advantage.
f) The durability of concrete is also significantly enhanced due to WLP addition, and no significant emission of toxic substances is detected in leaching tests of WLP concrete specimens.
g) Environmental effects from wastes and disposal problems of waste can be reduced.
h) The primary ingredients of paint and their possible influence on the characteristic properties of cementitious materials also should be investigated.
i) The disposal problems of structures using WLP after their life span should be subjected to further research.

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