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132. Influence of Environment on Resin Coated Mortar

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Abstract

In the field of building and structural construction, newly developed techniques are being used to develop more advance performance of materials. Hence when structures are exposed to adverse climatic conditions, they can easily sustain the environmental attack. Polyester resin material is nowadays, experimented by researchers worldwide in order to improve structural performance, by using it in generic repairs and to fight against adverse environmental actions. This manuscript aims to investigate the performance of polyester resin as coating agent on mortar cube specimens against wear and tear of natural environment. The casted specimens, were evaluated on the basis of water absorption and compressive strength test, while exposed to two different set of conditions i.e. 1) Exposure to ambient environment 2) Water. The samples were coated with 0-3 layers of resin. Results reveal that resin reduced the water absorption of specimens which ultimately resulted in higher compressive strength. Therefore, concluding resin is promising material which can be used in structural repairs, which are exposed to adverse environmental wears and tears i.e. rain, wind, extreme temperatures. Overall, this experiment will be useful for improving performance of structural material in hazardous environment.

Keywords: Polyesterresin; mortar; coating; natural environment; water absorption; compressive strength.

1. Introduction

Due to continuous environmental change, and seasonal exposures, structures are facing rigorous environmental challenges. In-order to provide practical economical solutions, researchers are experimenting on alternative materials which could serve the purpose of sustainable structural preservation. These materials include liquid membrane, polyethylene sheets, bitumen coating, cementitious waterproofing, and sodium bentonite. But, unfortunately, it cannot be determined from previous research techniques, which material yields the optimal performance against environmental abrasion.

Polyester resin material is used for its diverse adaptability and versatility in the field of applied industrial materials. Moreover resin, has also being experimental and used widely with concrete. Resin concrete is used in maintenance and rehabilitation of structures. Resin materials prove to provide water impermeability, setting time, handling, casting and setting time (1). Polyester resin has also being usefully used to improve mechanical properties of soil i.e. strength and stiffness. To be noted, here in this study strength is increased while adding resin (2).

Due to the primary property of resin material of fast setting time, good compressive strength, it is also applicable in polymer concrete (PC), making it a good alternative for cement concrete, having a wide application in engineering field of repairs, sanitation, motorways and bridge repair works (3). Epoxy is known for toughness, reduced shrinkage property, and easy application. Epoxy resin is used for providing high adhesion and binding agent (4). Resin was experiment in water retaining structures as a grouting material, and has proven itself as a sustainable material for preventing water loss (5). Researchers suggest resin material in the field of environment, since it has wide practical range of applications i.e. shrinkage, viscosity, workability, strength, resistance against wear and tear (6). A study experiment with supplementary cementitious material (SCM) to foresee possible effect on strength and water absorption. SCM has yields higher strength and lower water absorption. (7).

Carbonation has a good correlation with water permeability when tested with white and ordinary concrete (8).
To the best knowledge of authors, sufficient research gaps had being identified which emphasis on using resin material to foresee its performance in adverse environmental conditions and exposure to water. This study aims to improve the life cycle of mortar related structural elements by using resin as repair material.

2. Objective and Scope

This manuscript aims to foresee application of resin as coating agent on mortar specimens whilst expose to ambient environment and water with an interval of 15 to 60 days. This study aims to evaluate the performance with the help of testing the strength and water absorption. Comparative comparison is done with specimens without any coat of resin material. Mortar was casted with a ratio of 1:6 (cement: sand ratio). Whilst water cement ratio of 0.05 was maintained.

3. Methodology

The detail methodology and experimental design is expressed in Fig. 1.

3.1.1 Selection of Material

The used materials are also explained in the following paragraphs.

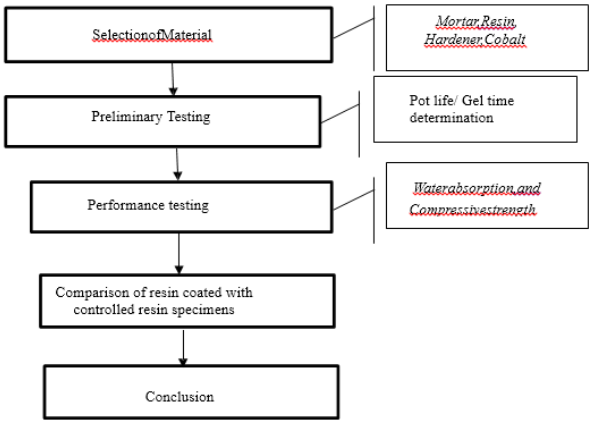

Fig1. Experimental design study

Cobalt: Used for imitating the hardening process.
Hardener: In this experiment it was used in liquid form.
Sand: In this experiment, the samples were made which passed through sieve #16.
Cement: Cement available in market was used known as ordinary Portland cement.

3.2. Preliminary Testing

The hardener and cobalt were applied in a manner, so that a gel time of 30 minutes and solidification of 36 hours could be achieve

4. Results and Analysis

4.1. Water Absorption

ThewaterabsorptiontestwasperformedinaccordancewithBS1881, Part122. Triplicate specimens were tested for watering after one and sixty days exposed ambient environment and immersed in water. The percent absorption is calculated by equation 1.

$$W_a = \frac{W_w - W_d}{W_d} \quad (1)$$

W_a=Percentage of water absorption
W_w= Weight of wet specimen
W_d =Weight of dry sample

Fig 3 and 4, yield the output for water absorption test. During the experiment period (up to 75 days), temperature observed to which the specimens were exposed to ambient temperature was as high as 50°C. The collected samples were subjected to high temperatures, rain, dust, and wind. The results obtained from the experimented specimens (resin layer coating) for water absorption are significant. The results provide sufficient evidence a reduction in water absorption is noted with increase of number of resin coated layers, whilst exposure to water and environmental conditions were evident. The test performed after one day showed that the average water absorption varies from 2.9% (controlled) to 0.96% (three resin layer) for samples having exposure to environment. Apart from deterioration of resin coat, due to exposure to conditions, the material solidified and yielded extra-performance, water absorption was reduced to nearly 1% when specimens were subjected to 3 layers.

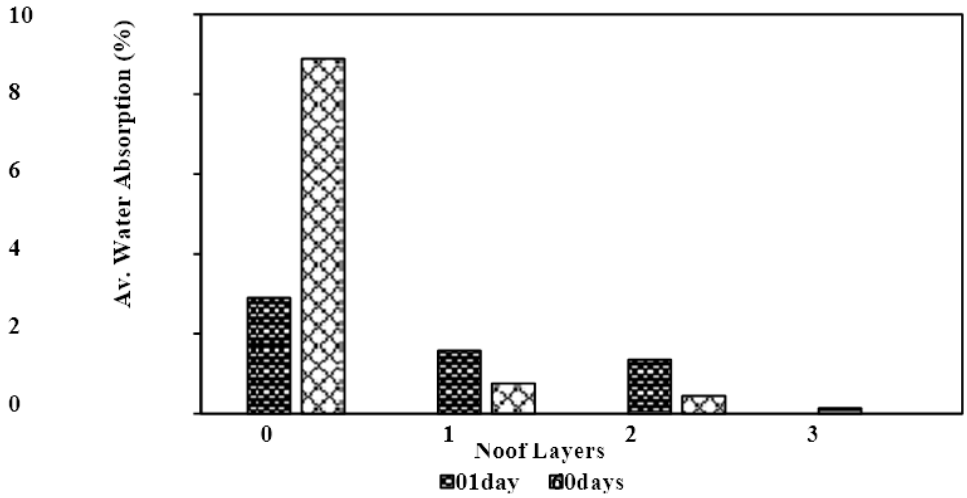

Fig.2. Average water absorption (%) in ambient environment

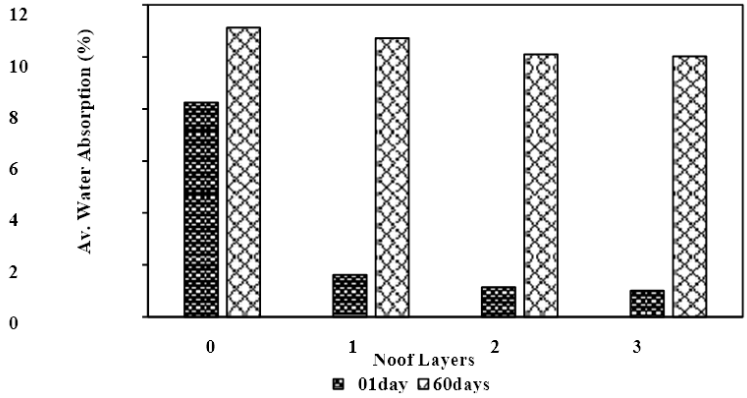

Fig.3. Average water absorption (%) dipped in water.

4.2. Compressive Strength Test

This manuscript covers the testing of compressive strength via means of Universal Testing Machine (UTM) as per ASTM C 109-05 (C109, 2002). Fig 6 and 7, yields the effect of exposure conditions on compressive strength. The compressive strength results reveal direct relation of number of layers to strength of mortar. The maximum and minimum compressive strength recorded for ambient environment were 17.41 MPa (3 resin layers) and 8.67 MPa (controlled), respectively. However in case of exposure to

water, 15.21 MPa (3 resin layers) and 7.10 MPa (controlled) were measured as maximum and minimum compressive strength, respectively. Further observing fig 6 and 7, reveals that increase in number oflayers for resin coats had a positive impact on compressive strength. On average compressive strength for resin coated samples is 69%, more than non-coated specimens, whilst having exposure to both environment and water. Nevertheless, this increase is observed up to 60 days exposure because compressive strength tends to decline when tested after 75 days. Application of resin, directly yields increase in initial strength gaining unlike other curing techniques i.e. wax curing where sealant is used. Significant increase in strength is noted, since evaporation process is restricted, ultimately specimens are exposed to pro-longed curing. However, continuous exposure disposed of resin layer which leads to reduction in compressive strength for both exposure conditions and reason could be diminishing of resin layers which provided additional strength to mortar.

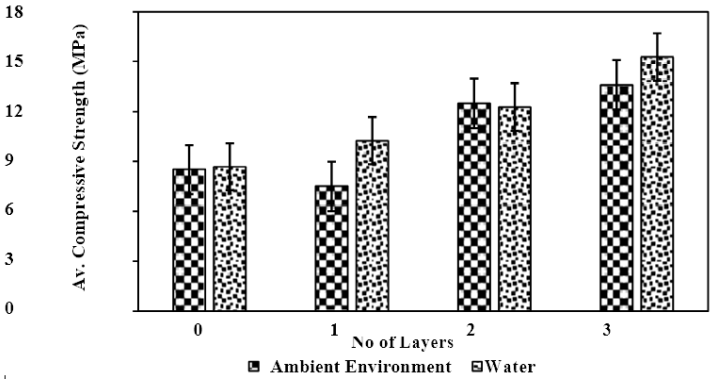

Fig4. Average Compressive strength(MPa) of mortar.

5. Conclusions

The water absorption is hence reduced when using resin layers in mortar. Increasing the number of layers of increases the compressive strength and water absorption capacity. Resin can also be used as a sealant. The water absorption of three layer so resin coated mortar is nearly zero when tested after exposure of sixty days to ambient environment incline high temperatures of 50°Candheavy rainfall. There in coating was diminished in case of specimens dipped in water for one day and sixty days. The compressive strength is also enhanced by 76% after application of three layers of resin coating when compared to controlled specimens keeping all other conditions similar.

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