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EXPERIMENTAL STUDY ON MOISTURE CONDENSATION OF CONCRETE

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ABSTRACT

This experimental study investigates the effects of moisture condensation on concrete structures. Moisture ingress significantly affects durability; therefore, a protective chemical coating was developed to reduce water absorption and enhance the lifespan of concrete. A reagent was prepared and applied to concrete cubes, which were then exposed to moisture. Subsequent tests included water absorption and compressive strength analysis. In the water absorption test, normal concrete cubes (NCC) absorbed more water compared to existed concrete cube (ECC) and plane concrete cube (PCC). In the compressive strength test, NCC exhibited higher strength than ECC and PCC. PCC showed the lowest strength due to reduced water absorption. Overall, the reagent-coated cubes absorbed less water than NCC but achieved lower compressive strength. These findings suggest that while the prepared coating effectively minimizes water absorption, it may compromise compressive strength,

KEYWORDS: Existed Concrete Cube (ECC), Plane Concrete Cube (PCC), Normal Cement Concrete (NCC), Polyacrylate Defoamer

INTRODUCTION

Condensation on concrete is a common issue in many buildings, arising from the interaction between indoor humidity and cooler surface temperatures. This phenomenon occurs when warm, moist air meets a surface that is below the dew point temperature, causing the moisture in the air to condense into liquid water. The primary cause of condensation is the presence of excess moisture in the indoor environment. Factors such as high humidity from cooking, bathing, or drying clothes indoors can contribute to this problem. Additionally, inadequate ventilation can trap moisture-laden air inside, exacerbating the issue. When this moist air meets cooler concrete, especially in poorly insulated areas condensation forms. Moisture condensation on concrete occurs when warm, humid air meets cooler surfaces, such as concrete, windows, or ceilings. The moisture in the air condenses on the surface when it cools below the dew point, which is the temperature at which air becomes saturated with moisture and can no longer hold all the water vapor.

Moisture condensation the process whereby water vapors transforms into liquid when it contacts surfaces below the dew point can have wide-ranging impacts on building's performance and longevity. Its effects extend beyond more surface dampness and can compromise both aesthetics and structural integrity prolonged.

Fig. 1: Moisture occurred beam

MATERIALS AND METHODS

18 concrete cubes (size 150 mm × 150 mm × 150 mm) were cast and tested to study moisture condensation effects on coated and uncoated concrete. The cubes were divided into three curing groups (7, 14, 28 days). Each group contained six cubes: two with existing commercial coating, 2 with newly prepared coating, and two uncoated reference samples. 3.2.2 Materials and specimens

- Cement: Use Ordinary Portland cements (OPC).
- Sand: Use well-graded, clean fine aggregate (sand).
- coarse aggregate: the aggregate should be well graded
- Water: Use potable water

3.2.3 Mix proportion

M20 grade of concrete used 1:1.5:3 for cement: Sand coarse aggregate.

3.2.4 Specimen Preparation

- Mixing
  - Weigh the materials according to the proportions above.
  - Mix the cement and sand dry in a mixer for about 1–2 minutes to ensure uniformity.
  - Gradually add water while mixing thoroughly for another 2–3 minutes until you achieve a homogeneous, workable concrete.

- Molding

Mould Dimensions: Prepare moulds 150mm×150mm with a thickness of 150mm.

- **Casting:** Pour the mixed concrete into the moulds. For each mould, fill in layers (if needed) and use a tamping rod or vibratory table to compact the mix, ensuring that there are no trapped air voids.
- Initial curing

After casting, cover the moulds with plastic sheets to prevent rapid moisture loss. Allow the concrete to set in the mould for 24 hours at room temperature.

- **Demolding and curing**

Carefully remove the specimens from the moulds after the initial 24 hours. Cure them for a standard period (7 days, 14 days, and 28 days) to develop full strength and stable properties.

3.3 Coating application

- Method: Apply your moisture condensation prevention coating uniformly using brush method Before applying the coating you should clean the surface of concrete cube by using the brush or wire brush after cleaning apply the coating using brush by the 2 coats vertical and horizontally.
- Curing time: allow the coating to cure as per its specified guidelines (e.g. 24 hours) in a controlled environment (ambient temperature and stable humidity).
- **Moisture Exposure**

Place all coated and reference cubes in the designated moisture exposure environment for 30 days to simulate condensation/moisture conditions. Maintain and record ambient conditions (temperature and relative humidity)

During exposure.

INGREDIENTS: - Acrylic latex Binder (30 g)

Acrylic latex binder is a water-based polymer used in coatings and construction materials to enhance durability, flexibility, and adhesion. Acrylic latex binders form a continuous, flexible film upon drying, which acts as a protective barrier against moisture, ultraviolet radiation, and environmental wear. This film ensures long-term surface integrity and enhances the performance of coatings.

Deonized water (180 g)

Deionized water functions primarily as a high-purity solvent used in laboratories, industries, and medical applications because it is free from dissolved mineral ions. Its lack of ions makes it ideal for processes where contamination, scaling, or interference from minerals must be avoided

Calcium carbonate / mineral filler (70 g)

Calcium carbonate ($CaCO_3$) functions as a versatile mineral filler that improves strength, reduces cost, and enhances performance in plastics, paints, adhesives, paper, and construction materials. It is one of the most widely used fillers because of its abundance, safety, and ability to impart multiple beneficial properties

Dispersant (polyacrylate) (15 g)

Polyacrylate dispersants function by adsorbing onto particle surfaces, preventing agglomeration, and keeping solid particles evenly distributed in a liquid medium. They are widely used in paints, paper, ceramics, water treatment, and construction materials because they stabilize suspensions and improve processing efficiency.

Defoamer (5 g)
Foam Control → Breaks bubbles and prevents foam formation in liquids
Improves Processing → Prevents overflow, pump cavitations, and mixing inefficiencies caused by foam

Applying reagent on concrete cube
According to Indian Standards (IS-codes), coatings applied on concrete cubes must follow the same principles as painting or protective treatment of concrete surfaces. IS 2395 and IS 11714

Surface preparation
- Ensure cube surface are clean, dry, and free from dust, grease, laitance, or loose particles.
- Remove contaminates by washing, brushing, or solvent cleaning.
- Repair cracks or voids with suitable fillers or epoxy before coating.

Priming
- Apply a primer coat compatible with the chosen paint system.
- Primers improve adhesion and seal the porous concrete surface.

Application of coating
- Apply coating in uniform layers using brush, roller, or spray.
- Maintain recommended dry film thickness (DFT) for durability.
- Allow proper drying/curing time between coats as per manufacturer's instructions.

Number of coats
- Typically, two or more coats are applied depending on exposure conditions.

After applying the coatings, the cubes were left to dry for 24 hours. Following the drying period, the cubes were exposed to moisture by covering them with wet gunny bags. The cubes were properly wrapped with the gunny bags, and water was poured on them continuously to maintain moisture conditions. This procedure was carried out for duration of 30 days. Named the concrete cubes by using the permanent marker according to curing days 7 days, 14 days, 28 days.
- ECC- Existed concrete coating.
- PCC- Prepared concrete coating.
- NCC- Normal concrete cube.

8.1.1 Water Absorption Test on Concrete Cubes (IS 516:1959)
- Apparatus required: weighing balance, curing tank, cleaning cloth
- Procedure:
- Specimen preparation: use concrete cubes of size 150x150x150 mm after curing and exposure as per experimental design.
- Record the dry wet of each concrete cube (W1)
- Immerse the specimens completely in the water at room temperature for 24 hours
- Remove the specimen; wipe off surface water with a damp cloth.
- Record the saturated weight (W2)
- Calculation of water absorption
- Water absorption (%) = (W2-W1/W1) X 100

Fig. 2:Water absorption of test

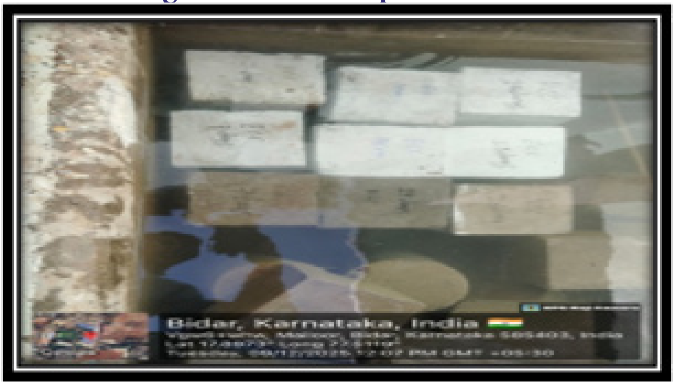
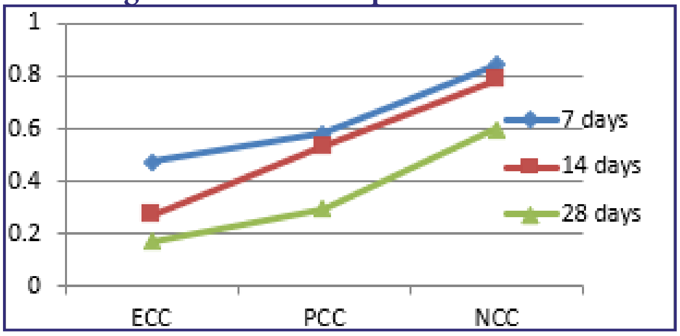


Table 8.2.4 water absorption test on 28 days cured Concrete cube on ECC, PCC, and NCC

Days	ECC	PCC	NCC
7	0.47	0.58	0.84
14	0.26	0.53	0.78
28	0.17	0.29	0.78

Fig. 2.1: Water absorption test result



8.3 Compressive strength test on concrete cubes

- **Applicable standard**
- **Code**: IS 516:1959, Method of Tests for Strength of Concrete (reaffirmed).
- Specimens and preparation
- **Cube size**: 150 mm × 150 mm × 150 mm-standard test cubes, cast from fresh concrete and compacted properly to avoid honeycombing.
- **Mould and surface**: Use clean, rigid metal moulds finish the top surface smooth and level after placing and compacting Primary concrete.
- **Curing**: Remolds after 24 ± 0.5 hours, then submerge in clean water at 27 ± 2 °C until the test age (commonly 7 and 28 days).
- **Number of specimens**: At least three specimens per test age to report an average strength and note individual variation.

- **8.3.1 Testing machine and setup**
- Machine: Use a calibrated compression-testing machine with smooth, clean platens, capable of applying load axially without shock.
- Specimen preparation: Wipe the cube dry, remove surface water and grit. If faces are uneven, cap or grind to achieve plane, parallel loading faces.
- Centering: Place the cube centrally on the lower platen so the load is applied perpendicular to the casting direction; align to avoid eccentric loading.

8.3.2 Loading procedure

- **Loading rate:** Apply load continuously and without shock at a uniform rate until failure. IS 516 specifies maintaining a steady rate of increase in stress (not sudden or pulsating), with typical practice guided by the code's requirement for uniform, controlled loading to failure
- **Failure:** Continue loading until the specimen fails; note the maximum load indicated by the machine now of failure.

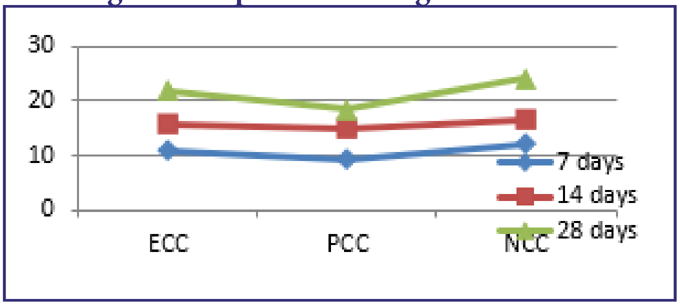
8.3.3 Calculation and reporting

- Compressive strength formula: P/A
- Where P is the maximum load at failure (N) and A is the loaded area of the cube face (mm2) for a 150 mm cube, A = 150 x 150 = 22500 mm2.

Table 8.3.2: Compressive strength NCC, PCC, ECC after 7, 14, and 28 days curing.

DAYS	ECC	PCC	NCC
7	10.865	9.26	12.005
14	15.83	15.04	16.46
28	21.755	18.535	24.04

Fig. 3: Compressive strength test result



- From the above graph NCC cubes have more compressive strength comparing to PCC and ECC

NCC > ECC > PCC
NCC- Normal concrete cube
PCC- Prepared coating cube
ECC- Existing coating cube

CONCLUSION

- In this project we found that the moisture condensation effects the concrete structure therefore we studied and prepared a concrete coating by using chemical ingredients which is going to prevent water absorption and protects our concrete structure and it increases lifespan of concrete structure.
- We created a reagent and applied on concrete cubes and we exposed those cubes to the moisture after that we tested water absorption and compressive strength test.
- In water absorption test NCC absorbed more water than ECC and PCC.
- In compressive strength test NCC achieved more strength than ECC and PCC

- PCC achieved less strength because it absorbed less water.
- By the result, we conclude that prepared reagent which applied on cube absorbed less water comparing normal concrete cube and achieved less compressive strength.

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