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Effect of Wax Emulsion Curing Compound on Compressive Strength of Concrete

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ABSTRACT: Today concrete is most widely used construction material due to its good compressive strength and durability. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. so in this project we first fix mix design after that by same proportion we done 3 different batches First batch was cured in a temperature-controlled curing tank in the laboratory. The second batch was cured by the application of an external curing compound under prevailing site conditions. The 3rd batch was cured with internal curing agent. From each batch, 3 cubes were tested for compressive strength at 3-days age, at 7 days age, 14 days and 28 days age of concrete and average values were taken. Results were analyzed, we found that at strength of after using such curing does not affect more or it gains by near about 7 to 10 % so it was concluded that in areas with shortage of water, curing compounds can be effectively used with improved strength and sustainability of self-curing concrete.

KEYWORDS: Self-curing concrete, dose of Super plasticizer, Water/Cement ratio, curing compound, internal & External curing, and compressive strength.

I. INTRODUCTION

Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Any laxity in curing will badly affect the strength and durability of concrete. Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time if the concrete is to achieve its potential strength and durability. Curing may also encompass the control of temperature since this affects the rate at which cement hydrates. The curing period may depend on the properties required of the concrete, the purpose for which it is to be used, and the ambient conditions, ie the temperature and relative humidity of the surrounding atmosphere. Curing is designed primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it is gaining strength.



Fig. Wax application process

Why Wax Emulsion?

The primary purpose of any concrete curing compound is to form a membrane on the fresh concrete surface that prevents the rapid evaporation of water. This water is crucial for the hydration process of cement, which is what gives concrete its strength and durability.

Wax emulsions excel at this by:

- **Forming a physical barrier:** When applied to the concrete, the water in the emulsion evaporates, leaving a thin, continuous film of wax on the surface. This wax film acts as a highly effective barrier against moisture loss from the concrete.
- **Cost-effectiveness:** Compared to other curing methods (like continuous water ponding or wet coverings), wax emulsions are generally more economical in terms of material cost, labor, and time.
- **Ease of application:** They can be easily sprayed onto large surfaces, making them very efficient for projects like roads, runways, and large slabs.

Advantages of Wax Emulsion Curing Compounds:

- **Excellent Moisture Retention:** This is their core strength.

By preventing water evaporation, they ensure that the cement can properly hydrate, leading to:

- **Increased Strength:** Concrete achieves its designed strength.
- **Reduced Shrinkage and Cracking:** Minimizes plastic shrinkage cracking and drying shrinkage, which can compromise structural integrity.
- **Enhanced Durability:** Improves resistance to abrasion, freeze-thaw cycles, and chemical attack
- **Time and Labor Efficient:**
- **Single application:** One application can provide sufficient curing for the entire critical period, eliminating the need for continuous watering or re-wetting.

- Reduces manpower: Requires less labor compared to traditional wet curing methods.
- Faster construction schedules: Contributes to quicker project completion.
- Versatility in Application:
- Ideal for large areas where traditional water curing is impractical (e.g., highways, airfields, industrial floors).
- Can be used on vertical or sloping surfaces where keeping water on the surface is difficult (e.g., walls, columns, beams).
- Improved Surface Quality:
- Helps in achieving a denser and harder surface.
- Reduces surface dusting.
- Can sometimes provide a slightly glossy finish, which might be desirable for certain decorative concrete applications.
- Non-toxic and Non-flammable (Water-Based Emulsions): Most modern wax emulsions are water-based, making them safer to handle and apply.
- Fugitive Dye Option: Many wax emulsion compounds come with a temporary fugitive dye that helps applicators visually confirm uniform coverage. The dye fades after a short period.

II. METHODOLOGY

- Compressive strength of concrete is main strength of concrete .in design also mainly we consider compressive strength of concrete.
- So We try to find effect of curing compounds on compressive strength of concrete.
- In this project variation in compressive strength of medium strength, M_{30} concrete with different curing techniques is discussed.
- Initially several trials were carried out for mix design of medium strength self compacting concrete.
- Once the mix design was achieved, three batches of concrete cubes were cast as per ASTM standard.
- Water cement ratio and quantity of aggregate and sand were kept constant as required by selected Mix Design.
- Slump Test was carried out on each batch in order to ascertain concrete flow for self-compacting concrete. First batch was cured in a curing tank in the laboratory.
- The second batch was cured by the application of an external curing compound under prevailing site conditions.
- The 3rd batch was cured with internal curing agent.
- From each batch, 3 cubes were tested for compressive strength at 7-days age, at 14 days age and 28 days age of concrete and average values were taken.
- Results were analyzed.
- Show the set up & failure of cube after loading Fig 10 show of comparison of compressive strengt
- Determination of compressive strength of Concrete
- Apparatus
- Compression testing machine
- Specimen
- 9 cubes of 15 cm size of M_{30} for each method of curing
- Hand Mixing
- (i) Mix the cement and fine and coarse aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color
- (ii) Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch
- (iii) Add water and mix it until the concrete appears to be homogeneous and of the desired consistency

Sampling

- (i) Clean the moulds and apply oil
- (ii) Fill the concrete in the moulds in layers approximately 5cm thick
- (iii) Compact each layer with not less than 25 strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at lower end)
- (iv) Level the top surface and smoothen it with a trowel

Curing

- The test specimens are stored in moist air for 24 hours and First batch was cured in a curing tank in the laboratory.
- The second batch was cured by the application of an external curing compound under prevailing site conditions.
- The 3rd batch was cured with curing agent.

Procedure

- (I) Cubes which are kept in water for removal from water after specified curing time and wipe out excess water from the surface.
- (II) Take the dimension of the specimen to the nearest 0.2m
- (III) Clean the bearing surface of the testing machine
- (IV) Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- (V) Align the specimen centrally on the base plate of the machine.
- (VI) Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- (VII) Apply the load gradually without shock and continuously at the rate of 140kg/cm²/minute till the specimen fails
- (VIII) Record the maximum load and note any unusual features in the type of failure.

Show the set up & failure of cube after loading



Fig 10 show of comparison of compressive strength

Wax emulsion curing compounds are primarily used in the construction industry, particularly for concrete, but their applications extend to various other fields due to the beneficial properties of wax emulsions.

Here are the general uses of wax emulsion curing compounds:

Concrete Curing:

- **Primary Application:** This is the most significant use. When applied to fresh concrete, wax emulsion curing compounds form a thin, continuous film that acts as a moisture barrier. This film prevents rapid evaporation of water from the concrete, ensuring proper hydration of the cement.
- **Enhances Strength and Durability:** Proper curing leads to concrete with higher compressive and tensile strength, increased resistance to abrasion, and improved durability.
- **Reduces Dusting:** They help create a harder, dust-free surface.
- **Cost-Effective:** They eliminate the need for traditional, labor-intensive curing methods like continuous water spraying or wet hessian covers.
- **Suitable for Large Areas:** Ideal for curing large concrete surfaces such as highways, airport runways, bridge decks, industrial floors, and precast concrete components.
- **Temperature Control:** White pigmented versions reflect sunlight and heat, helping to maintain a more uniform temperature in the concrete, especially in hot climates.
- **Water-Based:** Most are water-based, making them environmentally friendly and safe to use.

How Wax Emulsion Works as a Curing Compound:

- When applied to fresh concrete, a wax emulsion forms a non-penetrating, continuous film on the surface. This film acts as a barrier, preventing or significantly reducing the evaporation of water from the concrete. This is crucial for proper concrete curing because
- **Efficient Cement Hydration:** Concrete gains strength and durability through a chemical reaction called hydration, which requires a continuous supply of water. By preventing water loss, the wax emulsion ensures that the cement can hydrate efficiently.
- **Reduced Shrinkage and Cracking:** Rapid drying of concrete leads to shrinkage, which can cause surface cracks (e.g., drying shrinkage cracks, crazing, spalling, flaking). The moisture retention provided by the wax film minimizes these issues.
- **Improved Durability and Hardness:** Proper curing leads to stronger, denser concrete with enhanced resistance to abrasion, dusting, and other forms of deterioration.
- **Properties and Advantages of Wax Emulsion Curing Compounds:**
- **Film Formation:** Upon contact with the cementitious surface, the emulsion breaks down, and the wax particles coalesce to form an impervious film.
- **Moisture Retention:** They are highly effective at retaining moisture within the concrete, often achieving high water retention rates (e.g., over 85% or even up to 95%).
- **Single Application:** Typically, only one application is needed to provide effective curing for the entire curing period.
- **Eliminates Traditional Methods:** Wax emulsions eliminate the need for traditional curing methods like continuous water spraying, wet hessian, or sand, saving labor and time.
- **Easy Application:** They can be easily applied by spraying, brushing, or rolling, making them suitable for large areas like pavements, runways, bridge decks, as well as vertical or sloping surfaces.
- **White Pigmentation (Optional):** Many wax emulsion curing compounds are white pigmented. This white color helps reflect sunlight, keeping the concrete surface cooler and reducing the risk of thermal cracking due to excessive heat buildup.
- **Minimizes Surface Defects:** By ensuring proper hydration and reducing water loss, they help prevent issues like dusting, shrinkage cracks, and poor surface hardness.
- **Dissipating Nature:** Many modern wax emulsion curing compounds are designed to naturally weather away over time (e.g., 4-8 weeks) when exposed to UV light, eliminating the need for mechanical removal in many cases.
- **Economical:** They can be a cost-effective curing solution due to reduced labor and water requirements.

- Non-Toxic and Non-Flammable: Most are formulated to be non-toxic and non-flammable, contributing to safer application.
- VOC Compliant: Many formulations meet Volatile Organic Compound (VOC) regulations.

Typical Applications:

- * Industrial floor slabs
- * Exterior pavements (roads, runways, parking lots)
- * Bridge decks
- * Walls and columns
- * Canal linings
- * Any freshly laid concrete where effective moisture retention is critical for proper curing.

In summary, wax emulsion curing compounds are a widely adopted and effective solution for ensuring proper hydration and optimal performance of concrete by forming a protective, moisture-retaining film on its surface.

Wax emulsion curing compounds are widely used in concrete construction to ensure proper hydration and strength development. They work by forming a thin, impermeable membrane on the concrete surface, which traps moisture within the concrete and prevents its premature evaporation.

Here are the key physical properties of wax emulsion curing compounds.

1. Appearance and Consistency:

- * Color: Typically white, which often includes a white pigment (like titanium dioxide) to reflect sunlight and minimize heat absorption by the concrete. Clear or translucent versions are also available, sometimes with a fugitive dye that fades over time to help with even application.
- * Physical Form: Liquid, typically a free-flowing emulsion.
- * Viscosity: Water-thin to low-medium viscosity, making them suitable for spray application.

2. Performance-Related Properties:

- * Moisture Retention: This is the most crucial property. Wax emulsion curing compounds are designed to significantly reduce moisture loss from the concrete. High-quality compounds can retain 85% to 95% or more of the original moisture content. This is often tested to standards like ASTM C309 or NZS 3109.
- * Film Formation: Upon application, the water in the emulsion evaporates, leaving behind a continuous, non-penetrating wax film on the concrete surface. This film acts as the moisture barrier.
- * Adhesion: The film adheres to the fresh concrete surface to effectively seal it.
- * Durability of Film: The wax film is designed to remain intact for the critical curing period (typically up to 28 days or more). Some formulations are designed to naturally degrade over time due to UV exposure, while others may require mechanical removal if subsequent coatings are to be applied.
- * Application Temperature: Minimum application temperatures are specified by manufacturers (e.g., above 7°C).
- * pH Level: Often alkali

III. CONCLUSION

This project report outlines a comprehensive experimental program to evaluate the impact of various curing compounds on the compressive strength of concrete. By comparing the performance of different curing compounds with traditional water curing and uncured concrete, this study aims to provide valuable data for optimizing concrete construction practices.

The findings will contribute to better selection of curing methods, leading to more durable and stronger concrete structures, particularly relevant in regions where water conservation is a priority or traditional curing methods are logistically challenging. The successful completion of this project will demonstrate a clear understanding of concrete curing mechanisms and the practical application of different curing technologies.

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