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AN EXPERIMENTAL STUDY ON INTERNAL CURING OF CONCRETE USING PREWETTED LIGHT WEIGHT EXPANDED SLATE

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***Abstract*: Concrete curing is one of the most important factor in cement hydration. Applying water externally is conventional approach. Most of the water is wasted due to evaporation and runoff. Also external curing concentrates only on surface of the concrete and does not penetrate deeply. Hence the necessity for internal curing is increased. Internal curing provides a set of water filled reservoirs within the concrete that supply water on demand to the hydrating cement paste from the time of mixing. In this project pre-wetted expanded slate is used in various proportions in partial replacement of coarse aggregate. The concrete grade used here is M30. Experimental study is done for different mix proportions and they are analyzed. Higher strength, lower water to cement ratio (w/c) concrete has been advocated over the last two decades due to its increased strength and reduced permeability. The lower w/c of these concretes makes them susceptible to autogenous shrinkage. This autogenous shrinkage can be significant and can be a contributing factor to early age cracking. Internal curing was investigated as a potential method to improve the durability of concrete pavements and bridge decks. Pre wetted lightweight slate is used to supply water to the hydrating cement paste. This additional water can counteract the hindered strength development, suspended hydration, autogenous shrinkage, and early age cracking. An overview of the concepts behind internal curing is presented. It is important that the internal curing agent (pre wetted lightweight expanded slate (PLES in this case): be able to provide a sufficient volume of water, has a structure that allows the water to be released to the paste as needed, and is small enough so that they can be appropriately spaced in the matrix. Before concrete could be prepared the LWA was characterized to determine absorption and desorption properties. Compression strength, split tensile**
strength and flexural strength of concrete with different mixes are analyzed and the results are compared

Keywords— pre-wetted expanded slate, properties, compressive strength, split tensile strength.

1. INTRODUCTION

Concrete is a very strong and versatile mould able construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years. There are many types of concrete available, created by varying the proportions of the main ingredients below. In this way or by substitution for the cementitious and aggregate phases, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties.

Aggregate consists of large chunks of material in a concrete mix, generally a coarse gravel or crushed rocks such as limestone, or granite, along with finer materials such as sand.

Cement, most commonly Portland cement, is associated with the general term "concrete." A range of materials can be used as the cement in concrete. One of the most familiar of these alternative cements is asphalt. Other cementitious materials such as fly ash and slag cement, are sometimes added as mineral admixtures (see below) - either pre-blended with the cement or directly as a concrete component - and become a part of the binder for the aggregate.

Water is then mixed with this dry powder/aggregate blend, which produces a semi-liquid that workers can shape (typically by pouring it into a form). The concrete solidifies and hardens through a chemical process called hydration. The

water reacts with the cement, which bonds the other components together, creating a robust stone-like material.

Chemical admixtures are added to achieve varied properties. These ingredients may accelerate or slow down the rate at which the concrete hardens, and impart many other useful properties including increased tensile strength, entrainment of air, and/or water resistance.

Reinforcement is often included in concrete. Concrete can be formulated with high compressive strength, but always has lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension (often steel).

Experimental study is done for different mix proportions and they are analyzed. Higher strength, lower water to cement ratio (w/c) concrete has been advocated over the last two decades due to its increased strength and reduced permeability. The lower w/c of these concretes makes them susceptible to autogenous shrinkage. This autogenous shrinkage can be significant and can be a contributing factor to early age cracking. Internal curing was investigated as a potential method to improve the durability of concrete pavements and bridge decks. Pre wetted lightweight slate is used to supply water to the hydrating cement paste. This additional water can counteract the hindered strength development, suspended hydration, autogenous shrinkage, and early age cracking. An overview of the concepts behind internal curing is presented. It is important that the internal curing agent (pre wetted lightweight expanded slate (PLES in this case): be able to provide a sufficient volume of water, has a structure that allows the water to be released to the paste as needed, and is small enough so that they can be appropriately spaced in the matrix. Before concrete could be prepared the LWA was characterized to determine absorption and desorption properties. Compression strength, split tensile strength and flexural strength of concrete with different mixes are analyzed and the results are compared.

2. PRE-WETTED EXPANDED SLATE

Pre-wetted Expanded slate is used in this work, which is one type of sand stone. The specific gravity of this slate is 2.4 and it also having higher water absorption as 7.5%. The Pre-wetted expanded slate Weight is 1000 kg /m^3 this is also a light weight aggregate.

3. EXPERIMENTAL PROGRAM

3.1 Materials used

The materials which are used for this project are as follows:

3.1.1 Water

Water is an important ingredient of concrete as it actively participates in chemical reaction with cement. Clean potable water conforming to IS 456-2000 was used, the water used in the preparation of mortar should not necessary be distilled water, but must be free of all acids, based and others dissolved salts. Generally water has a pH of 7. The specific gravity of water is 1.

3.1.2 Cement

Cement is the important binding material in concrete. Ordinary Portland cement is the common form of cement. It is the basic ingredient of concrete, mortar, and plaster. It consists of mixture of oxides of calcium, silicon and aluminium. Specific gravity of cement is 3.14. The Ordinary Portland Cement 53 Grade was brought from Priya cements, Salem.

3.1.3. Fine aggregate

Ordinary river sand is used as fine aggregate. The sand is sieved in 2.36mm sieve as the sand passing through this sieve is use as fine aggregate. This was bought from construction site in Sona College of Technology, Salem.

3.1.4. Coarse Aggregate

The ordinary coarse aggregate is sieved in 20mm sieve and the aggregate passing through the sieve is used as coarse aggregate. The specific gravity of coarse aggregate is 2.68.

3.1.5. Pre-wetted Expanded slate

The Pre-wetted Expanded slate is bought from Marble Shop
Whose specific gravity is 2.4 and water absorption is 7.5%.
The coarse aggregate is replaced by Pre-wetted Expanded slate as 10% , 15% , 20% & 25%.

Figure 1-Pre-wetted Expanded Slate

3.1.6 Super- Plasticizer

Super- Plasticizer used for concrete in this study is Conplast (430). It is used to increase the workability of the concrete. The specific gravity of Conplast is 1.21.

3.2 Properties of Coarse aggregate and pre-wetted expanded slate

TESTS	COARSE AGGREGATE	PRE-WETTED EXPANDED SLATE
Specific Gravity	2.74	2.4

Water absorption (%)	0.50	7.50

Table 1 – Comparison of properties

4. MIX DESIGN

The design of M-30 grade concrete is done by using the IS 10262 -2009 codal provision as follows:

5.1. Mix Proportion

- Cement = 1
- Fine Aggregate = 2.5
- Coarse Aggregate = 3.50
- Water = 0.4
- Super-Plasticizer = 0.01
-

6. COMPRESSIVE STRENGTH TEST

Figure 2-Test setup for cube specimen

Sl. No	Replacement % of PLES	Compressive strength at 7 days N/mm^2	Compressive strength at 28 days N/mm^2
1.	0	25.77	31.50
2.	10	22.78	30.27
3.	15	24.83	33.26
4.	20	26.27	37.25
5.	25	19.91	26.67

Table 3- Test results for compressive strength
(PLES- Pre wetted light weight expanded slate)

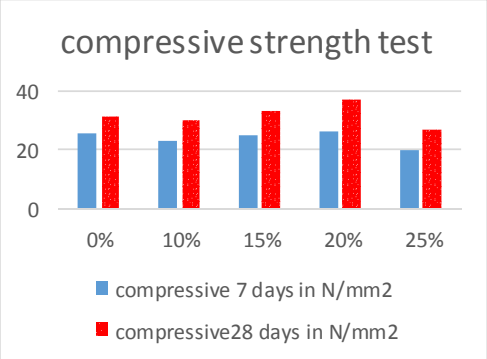

Chart 1- For compressive strength

7. SPLIT TENSILE STRENGTH

Figure 3-Test setup for cylinder specimen

Sl. No	Replacement % of PLES	Split tensile strength at 7 days N/mm^2	Split tensile strength at 28 days N/mm^2
1.	0	1.26	2.43
2.	10	1.34	2.12
3.	15	1.39	2.37
4.	20	1.44	2.60
5.	25	1.11	1.64

Table 4- Test results for split tensile strength

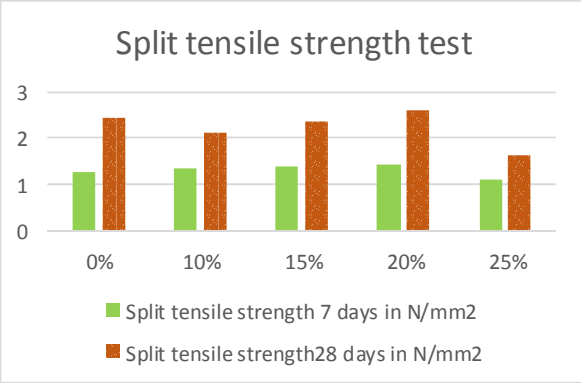

Chart 2- For split tensile strength

9. RESULTS AND DISCUSSIONS

* From the compressive strength test results, it can be seen that the compressive strength of Pre-wetted Expanded slate concrete mixes with 10%, 15%, 20% and 25% coarse aggregate replacement.

* From Table 3 that compressive strength of all mixes continued to increase with the increase in age.

* However, from table 3 the highest compressive strength was achieved by 20% replacement of Pre-wetted expanded slate, which was found about 37.25 N/mm^2 compared with 31.5 N/mm^2 for the normal M30 mixture.

* This means that there is an increase in the strength of almost 18% compared to the normal M30 mixture at 28 days of curing.

* However, mixtures with 25% replacement of Pre-wetted expanded slate gave the lowest compressive strength of 26.67 N/mm^2 when compared to other % of replacements which is less to the strength of the normal M30 mixture.

* From the split tensile strength test results, it can be seen that the split tensile strength of Pre-wetted expanded slate concrete mixes with 10%, 15%, 20% and 25% coarse aggregate replacement with Pre-wetted expanded slate, and were higher than the normal M30 mixture at all ages of curing.

* However, from table 4 the highest split tensile strength was achieved by 20% replacement of Pre-wetted expanded slate, which was found about 2.60 N/mm^2 compared with 2.43 N/mm^2 for the normal M30 mixture.

* This means that there is an increase in the strength of almost 7% compared to the normal M30 mixture at 28 days.

* However, mixtures with every 20% replacement of Pre-wetted expanded slate gave the highest split tensile strength than the strength of the normal M30 mixture.

* From compressive strength and split tensile strength results about 20% replacement of copper slag gives more strength than the normal30 mixture.

* Hence 20% replacement of Pre-wetted expanded slate with coarse aggregate will give good results in strength and durability of concrete which also reduces the cost and reduces the water wastage.

10. CONCLUSION

The following conclusions were drawn from the present study:

1. It is observed that for all percentage replacement of coarse aggregate by Pre-wetted expanded slate the compressive strength and split tensile strength of concrete is more than normal M30 mixture.
2. Compressive strength and Split tensile strength is increased due to high toughness of Copper Slag.
3. Copper slag gives less water absorption value than fine aggregate and gives more resistance to chloride than the control mix concrete.
4. Hence for normal practical applications upto 40% replacement of fine aggregate by copper slag should be recommended. Also it provides adequate strength at minimum cost.

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