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Comparative Study Between Externally Cured Concrete And Internally Cured Concrete

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Abstract— **It is often said that there are two types of concrete: concrete that has cracked and concrete that is going to crack. Unfortunately, this is true all too frequently. Many of these redundant cracks develop soon after the concrete is placed and, in addition to being unprepossessing, can contribute to reduce long term durability.. Internal curing has been defined by the American Concrete Institute (ACI) as "supplying water throughout a freshly placed cementitious mixture using reservoirs, via pre-wetted lightweight aggregates, that readily release water as needed for hydration or to replace moisture lost through evaporation or self-desiccation". While external curing water is applied at the surface and its depth of penetration is influenced by the quality of the concrete, internal curing enables the water to be distributed more equally throughout the cross section. In our research we have used expanded clay shale(LWA) as replacement for coarse aggregates in 5%, 15%, and 25 %. We have considered M20 grade of concrete for our research.**

Index Terms— **Internal curing, LWA, Polymer Absorbent, Clay Shale and workability.**

I. INTRODUCTION

Curing is the maintenance of a satisfactory moisture content and temperature in concrete for a period of time immediately following placing and finishing so that the desired properties may develop. Curing has a strong influence on the properties of hardened concrete; increase durability, strength, water tightness, abrasion resistance and volume stability.

A. Curing methods

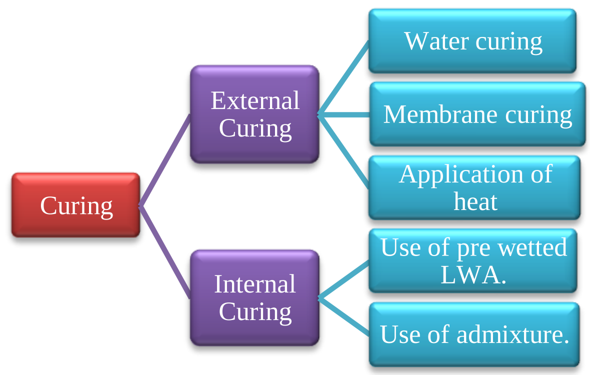

Fig 1.Types of curing

B. Materials

Materials used for internal curing:-

- Saturated LWA(low weight aggregates).
- Admixtures; Polyethylene-glycol.
- Polymer absorbent.

C. Advantages

- Reduction in cracking and shrinkage.
- Reduction in concrete weight.
- Increase in flexural rigidity, durability, compressive and tensile strength.
- It is the alternate of construction in desert regions where major scarcity of water is there.

D. Expanded clay shale

Expanded shale and clay lightweight aggregates made from natural shale and clay. This building material offers excellent results in both quality and performance in a variety of engineering and horticultural projects. Product applications include highway and road surfaces, concrete bridge decks, high-rise buildings, concrete products, geotechnical applications; and for horticultural projects as a soil amendment or conditioner.

II. LITERATURE SURVEY

Bentz.D.P. has studied that the substitution of light weight aggregate (LWA)sand for a portion of the normal weight sand to provide internal curing for a mortar is examined with respect to its influence on ITZ percolation and chloride ingress. Experimental measurements of chloride ion penetration depths are combined with computer modelling of the ITZ percolation and random walk diffusion simulations to determine the magnitude of the reduced diffusivity provided in a mortar with IC vs. one with only normal weight sand. In his study, for a mixture of sands that is 31% LWA and 69% normal weight sand by volume, the chloride ion diffusivity is estimated to be reduced by 25% or more, based on the measured penetration depths. **Holm.T.A**. has stated that for more than 80 years, shale's, clays, and slates have been Copyright to IJIRSET expanded in rotary kilns to produce structural grade LWA for use in concrete and masonry units. Millions of tons of structural grade LWA produced annually are used in structural concrete applications. **Khokrin, N.K**, discussed the unique physical characteristics of rotary kiln expanded slate lightweight aggregate for producing high performance and high strength lightweight concrete. The compressive strength, elastic modulus, splitting tensile strength, specific creep, and other properties of lightweight concrete are significantly affected by the structural properties of the lightweight aggregate used. Concrete production, transportation, pumping and placing are also affected .**Hoff. G.C.** described the use of near-saturated lightweight aggregate (LWA) as a replacement for a portion of the normal weight aggregate (NWA) in high-strength/high-performance concrete in order to mitigate or eliminate the self-desiccation and autogenous shrinkage that can occur which can further lead to early age cracking and long-term durability problems. The amount of LWA used to achieve beneficial internal curing is a function of the type of LWA, its size and amount, the degree of moisture preconditioning the LWA receives, the amount and type of binder(s) in the mixture, the water binder ratio at mixing, and the amount and duration of external moist curing provided to the concrete element. **Arnon Bentura et.al .**studied that the concrete with saturated lightweight aggregate exhibited no autogenous shrinkage, whereas the normal-weight concrete with the same matrix exhibited large shrinkage. The study shows that the partial replacement of normal-weight aggregate by 25% by volume of saturated lightweight aggregate was very effective in eliminating the autogenous shrinkage and restrained stresses of the normal-weight concrete. It is noted that the internal supply of water from the saturated lightweight aggregate to the high-strength cement matrix caused continuous expansion, which may be related to continuous hydration. **Ryan Henkensiefkenet. al** has indicated that while internal curing may have been originally developed to reduce autogenous shrinkage and mitigate early-age cracking in high performance concretes, its application has far-reaching consequences for the performance of concrete throughout its lifetime By providing an on-demand source of extra water, internal curing can improve the slump retention, workability and finishability of fresh concrete and reduce deformations and cracking due to plastic, autogenous and drying shrinkage.

III. MATERIALS PROPERTIES

A. Cement

The Ordinary Portland Cement of 53 grade conforming to IS: 12269-1987 is used. The various tests performed for the cement and its properties are shown in Table 1.

B. Coarse aggregates

The fractions from 20 mm to 4.75 mm are used as coarse aggregate, conforming to IS: 383 is use. The properties of coarse aggregates such as specific gravity and water absorption are shown in Table2. These values are within the range as given in IS 383-1970.

C. Fine aggregates

The river sand conforming to the requirements of IS: 383 – 1970 is used as fine aggregate. The river sand is washed and screened to eliminate deleterious materials and over size particles. Its properties are shown in Table 2.

D. Expanded clay shale

Expanded Clay Shale is a lightweight aggregate that is an ideal growing media for hydroponic or aquaponic systems. Expanded shale clay has improved physical properties such as reduced dead weight, high internal stability, high permeability, and high thermal resistance (Fig.2). The properties such as specific gravity and water absorption of shale are given below in Table 2.

Fig 2. Expanded clay shale

Table 1. Physical properties of cement

S N	Property	Experimental value
1.	Fineness	2.5%
2.	Soundness	1mm
3.	Initial setting time	60 min.
4.	Specific gravity	3.1

Table 2. Properties of aggregates

S N	Properties	Fine aggregates	Coarse aggregates	LWA
1	Specific Gravity	2.67	2.71	1.64
2	Bulk Density (kg/m3)	1630	1570	1057
3	Fineness modulus	2.19	6.45	3.38
4	Water absorption %	0.52	0.45	15.6

IV. EXPEREIMENTAL PROCEDURES

A. Mix Design

The grade of concrete opted for our test is M20. The mix design for the concrete blocks is prepared as per IS 10262-2009. The expanded shale is mixed in proportions of 5%, 15% and 25% by replacing the coarse aggregates.

The free water-cement ratio required for the target mean strength of 27.59 N/Sq mm is 0.37. This is lower than the maximum value of 0.55 prescribed for Moderate exposure in IS: 456-1978.

Table 3. Mix designation Replacement of Expanded Shale in Coarse aggregates

Mix Designation	Replacement By expanded shale
M0	0%
M1	5%
M2	15%
M3	25%

V. RESULTS, CONCLUSION AND DISCUSSION

A. Slump test

For testing the workability of concrete we have used cone slump test for various mix designation. Values obtained are within the permissible limit as per IS 456-2000 and are shown in Table 3.

Table 4. Slump values

Mix Designation	Slump value (mm)
M0	37
M1	33
M2	35
M3	41

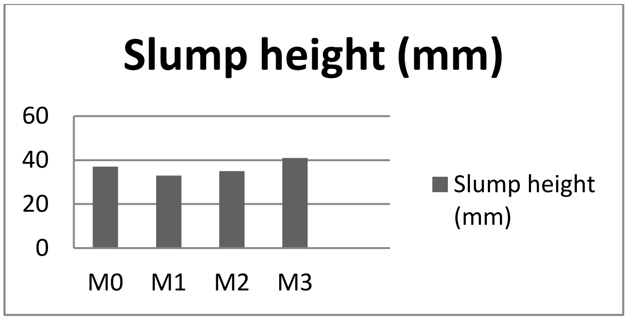

Fig 3. Various Heights Of Slump

B. Compressive strength test

The test is carried out on 150x150x150 mm size cubes, as per IS: 516-19599. The specimen is placed between the steel plates of the CTM and load is applied at the rate of 140 Kg/Cm^2/min and the failure load in KN is observed from the load indicator of the CTM.

The compressive strength of the concrete was measured at 7, 21, 28 days and calculated as an average of three cubes for each age as given in Table 5 Initially the internally cured concrete showed a lower compressive strength, but after 14 days , the strength of the concrete increased and exceeded the plain concrete. The compressive strength of the internally cured concrete was about 18-20% higher than the plain concrete because of the continuous hydration of the mixture at later periods, promoted by the extra water stored in the light weight aggregate. Though lightweight aggregate can be considered the weakest component in concrete the compressive strength of the internally cured concrete is higher than the plain concrete .The comparative study on the compressive strength of the concrete with respect to early strength and strength after 2 weeks (14 day and 28th day) compressive value is performed. From the experiment it is known that 5 % mix shows higher early strength. However, when compared to the control specimen all other the mixes with expanded shale doesn't show any significant reduction or increase in strength. There by designing the concrete for a compression for 25% of expanded shale help in reducing the cost for a certain value with increased performance and obtaining light weight concrete.

Table 5 Average Compressive Strength.

Mix Designation	Compressive strength (N/mm^2)		
	7 days	21 days	28 days
M0	24.37	29.4	35
M1	26.39	31.5	41.25
M2	21.25	40.5	45
M3	22.63	31.25	40.5

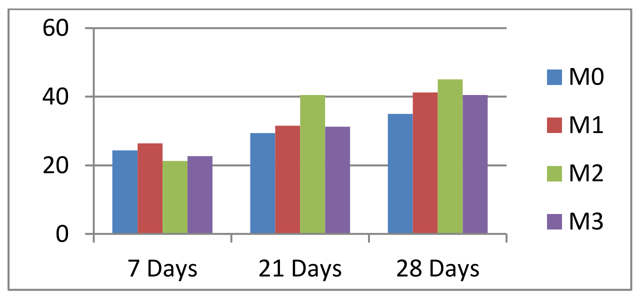

Fig 4. Compressive Strength Comparison (Bar graph)

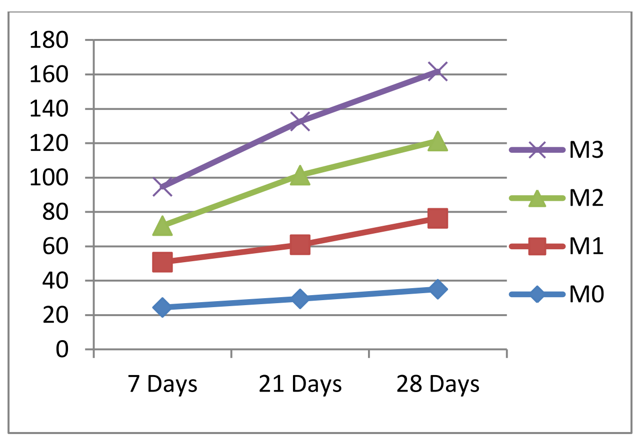

Fig 5. Compressive Strengths Comparison (Line graph)

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