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INVESTIGATION OF INTERNAL CURING IN CONCRETE USING PUMICE AGGREGATE

Ashish Kumar , Mr.Abhishek Kr Upadayay (Asst.Professor)

M.Tech Civil Structural Engineering Department, Mewar University Chittorgarh, Rajasthan

ABSTRACT

Concrete curing is paramount importance in order for concrete to meet performance requirements. Conventionally curing has been conducted by means of water sparkling on the concrete external surface. For performance and environmental reasons, internal curing has been gaining increased attention. However in a developing country like Ethiopia more data is needed for the effectiveness of this curing technique when used in various concrete mixtures.This experimental investigation addresses potential utilization of internal curing in concretes. For this study internal curing was addressed by means of the most locally available light weight Aggregate in Ethiopia which is pumice aggregate, A total of twelve mixes were designed among which nine mixes with different pre wetted pumice replacement (10%, 20% and 30%) and water to cement ratio (0.4, 0.45 and 0.5), For comparison the remaining three mixes are conventional concrete with water to cement ratio of 0.4, 0.45 and 0.5. For internally cured concretes, different curing conditions were created. In the first method, the internally cured concretes placed inside laboratory with and without polyethylene cover. In the second method, the internally cured concrete was placed outside laboratory with and without polyethylene cover. Fresh concrete and Hardened concrete properties including slump, unit weight and 28 days compressive strength were assessed.

Introduction

Concrete is a stone like material obtained artificially by hardening the mixture of cement, inert- aggregate material (fine and course) and water in predetermined proportions [1]. Concrete has been the construction material used in the largest quantity for several decades. In recent years improved techniques are used to reduce the construction difficulties and improve the performance of concrete both in terms of strength and durability. Internal curing considered as one such technique by 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. Lightweight aggregate includes Expanded shale, clay and slate (ESCS) structural ceramic and aggregate which is less than half of the unit weight of ordinary aggregate. The amount of saturated light weight aggregate for internal curing is a function of the type and size of the light weight aggregate, the amount of moisture in the light weight aggregate, the type and amount of cementitious materials in mixture, the water to cement (w/c) ratio at the mixing and duration of external moist curing provided to the concrete mixture.

Internal curing was originally defined by the American concrete institute (ACI) as “supplying water throughout a freshly placed cementations 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.”

In2013,ACI-308changedthedefinitionof IC states that“ internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water.” In general conversation, IC is often referred to as “curing concrete from the inside out” IC using pre-wetted expanded shale, clay or slate lightweight aggregate is a simple and practical way of supplying additional curing water throughout the concrete mixture .This is done by replacing some of conventional sand in the mixture with an equal volume of pre-wetted Expanded Shale Clay and Slate fine aggregate. The objective of internal curing is to provide source additional water so that the capillaryporosity of the hydrating cement paste will remain saturated. Benefits of internal curing include increased hydration and strength development, reduce autogenous shrinkage and cracking, reducedperme ability ,and increased durability.The impact to finternal curing begins immediately with the initial hydration of cement. when Philleo originally suggested the concept of internal curing using pre-wetted fine lightweight aggregate (LWA),the goal was to provide a means for supplying adequate curing water to the interior of high strength concrete members without

applying of external curing.

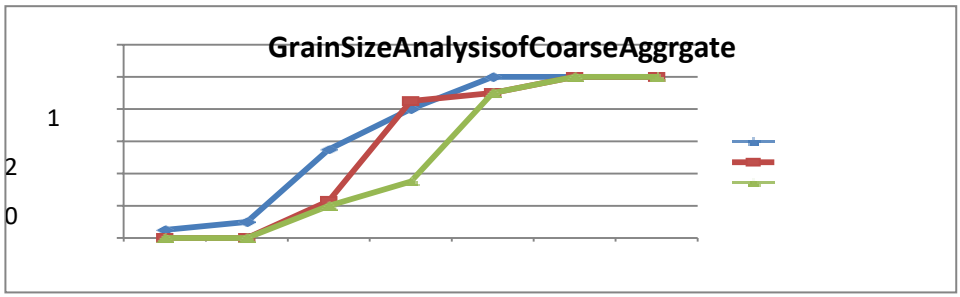
Construction industry is one of the major consumers of water resource in the world .The construction of a 100,000sq.ft. Multi-story structure can require about 10 million liters of water for production curing and site development activity. a double lane flyover can consume 70 million liters of water on the same scale. Construction is one of the major consumers of water resources in the world. From Ethiopian perspective internal curing has wider prospect due to unavailability of modern equipment and unskilled labor external curing cannot be achieved properly. Therefore internal curing using light weight aggregate will be the best solution.

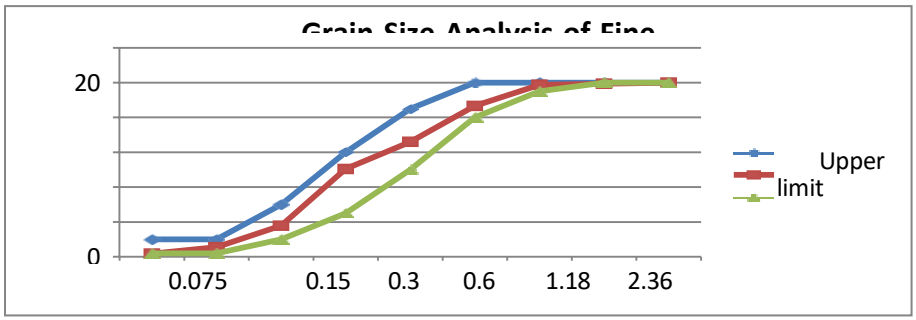
Light weight aggregates are classified as natural and artificial light weight aggregate. The main natural light weight aggregate are dolomite, pumice, scoria, volcanic cinder and tuff. Except for dolomite all are volcanic in origin. Pumice and scoria are more widely used for hollow and solid concrete block production in Ethiopia. Internal curing is rapidly emerging way to improve curing of concrete. In this study pumice light weight aggregate were used for internal curing because of its high absorption capacity, ranging from 10% to 30 % replacement. From the study it's expected that due to the ability of the pumices to release the water during hydration process .The internally cured concrete could achieve better compressive strength capacity. Also due to pumice having lesser unit weight, internally cured concretes would show lesser unit weight than conventional concretes.

MATERIAL PROPERTIES AND EXPERIMENTAL PROGRAM

Concrete mixture is mixture of cementious material, aggregate, and water. Aggregate is commonly considered inert filler which accounts for 60 to 80 percent of the volume and 70 to85 percent of the weight of concrete. Although aggregate is considered inert filler, it is necessary component that defines the concretes thermal, elastic dimensional stability. Aggregate is classified as two different types coarse and fine. Coarse aggregate usually greater than 4.75mm (retainedno.4sieve)the compressive strength is an important factor in the selection of aggregate. Physical and mineralogical properties of aggregate must be known before mixing concrete to obtain a desirable mixture. These properties include shape and texture, size gradation, moisture content, specific gravity reactivity soundness and bulk unit weight .These properties along with the w/c material ratio determine the strength, workability and durability of concrete.In these research different types of tests performed to determine the material properties of concrete ingredients. Sieve analysis, specific gravity, absorption capacity and unit weight tests

Figure:sieves for coarse and fine aggregate





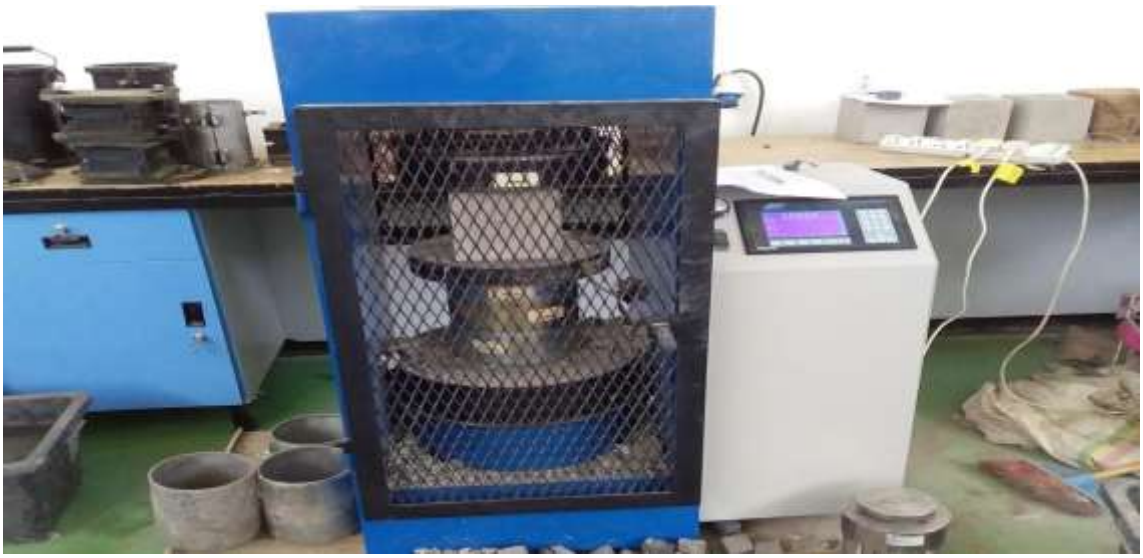
Property Test of Cement

Initial setting time and final setting time are the two important physical properties of cement initial setting time is the time taken from adding of water to the starting of losing its plasticity, and also Final setting is time lapsed from adding water to complete loss of plasticity. The cement used OPC DANGOTE CEMENT .The test conducted using vacant apparatus consists ofmovablerodbutbeforedeterminingsettingtimeconsistencyofcementfindouttotheamountof water should be added to get standard consistency.

Sample	Weight of cement (g.m)	w/c	Mixed Time(min)	Penetration time(sec)	Penetration (mm)
1	400	25	3min	30	8
2	400	30	3min	30	11
3	400	33	3min	30	42

Compressive Strength Test

Compressive strength of concrete is the most important parameter used in the design of concrete structures. Consequently quality of concrete manufactured is often measured by its compressive strength. Compressive strength can be defined as the measured maximum resistance of a concrete or mortar specimen to an axial load, usually expressed in psi(pound sper square inch)at an age of 28 days. In practical terms about 90% of its strength gained in the first 28 days. In this test the concrete cubes cured for 28 days internally and externally (for control sample).



RESULT AND DISCUSSION

In this chapter, test results of the experimental works are discussed in detail. The properties of internally cured concrete with different percentage replacement of pumice aggregate, with different curing condition and with different w/c ratio are compared with the externally cured concretes .The properties of internally cured light weight concrete and externally cured concrete were analyzed and compared based on the recorded values of slump test and unit weight test. Finally, the optimum replacement of pre wetted pumice aggregate for internal curing process identified by comparing internally cured and externally cured concrete based on the recorded 28 days compressive strength test.Hence in this study five types of curing conditions were implemented. These are shown in the following table.

Curing Conditions	
Normal curing under water(externallycured)	NC
Inside laboratory with polyethylene cover	ILWP
Inside laboratory with out polyethylene cover	ILWOP
Out side laboratory with polyethylene cover	OLWP
Out side laboratory without polyethylene cover	OLWOP

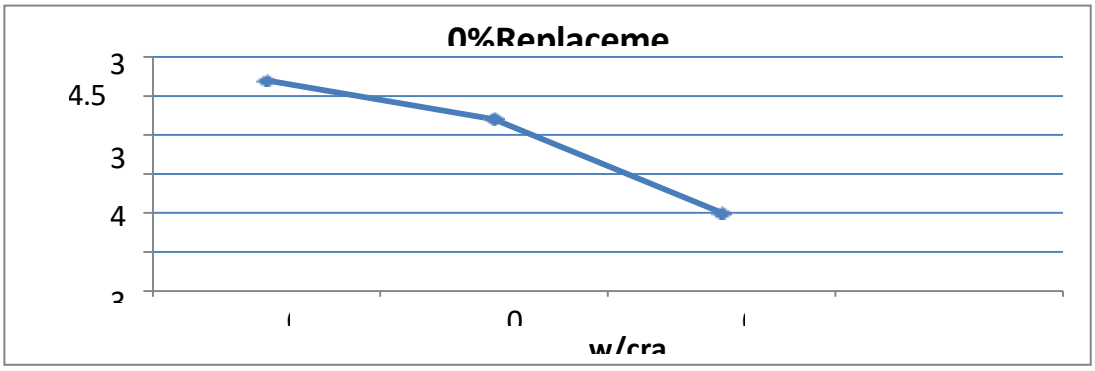
Table :Curing Conditions

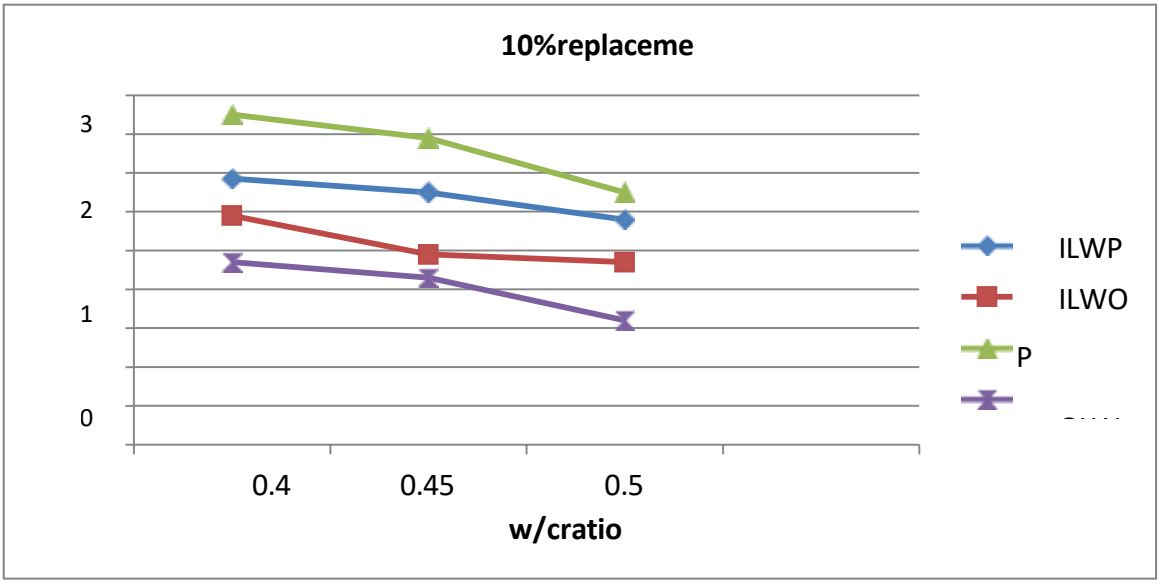
SLUMP TEST RESULTS

The slump test results illustrated in figure .The highest slump value were obtained from the samples with highest pre wetted pumice aggregate replacement .The lowest slump values were from those of the concrete made with conventional aggregates (0% replacement of pumice).

The recorded Slump test results reveal that an important advantage of using pre wetted pumice aggregates, which is enhanced workability that shall ease concrete for handling and finishing.

higher in pumice aggregates compared to conventional aggregate. Therefore the water released from the pre wetted pumice aggregate during mixing caused an increase in the flow ability of concrete mixture. Obtained values from the slump test illustrated as follows.





CONCLUSION

Based on the laboratory test result and experimental investigation ,the following conclusion drawn from the above performed study

The concrete mixtures having pre-wetted pumice aggregate replacement shows an increase in slump value than conventional concrete specimens .The slump increase reflects an overall enhanced workability of internally cured concrete.

1) Internal curing of concrete clearly affected by curing mode ,tests reveal that concrete which kept outside laboratory with polyethylene sheet shows highest compressive strength compared to the remaining curing mode.

2) Unit weight of internally cured concretes decreased, with increasing amount of percentage replacement of pre wetted pumice aggregate.

3) Among the three water to cement ratio of internally cured samples, The highest c-25 grade of concrete compressive strength achieved at 0.4 water to cement ratio, Therefore this water to cement ratio can be recommended as an optimum water to cement ratio compared to the others water to cement ratio values which is performed in this study.

4) From the recorded temperatures and the achieved compressive strength of internally cured concrete it can be conclude that when the temperature increase the strength of internally cured concrete will also increase It can be conclude that 20% replacement of pre wetted pumice aggregate is an optimum percentage replacement to achieve better performing internally cured concrete in terms of compressive strength.

5) From the overall material property test of pumice aggregate and experimental investigation of internal cured concrete by partial replacement of pre wetted pumice aggregate, It can be conclude that pumice is a suitable light weight aggregate as internal curing material.

REFRENCES

[1] Bentz D, (2007), Internal Curing of High performance blended cement mortars .ACI Material Journal ,408-414.

[2] Ries J.,(2012), The Economics performance and sustainability of internally cured concretes,part3.

[3] Lopez M.et al.(2008).Effects of internally stored water on creep of high performance concrete ACI materials Journal,105(3),265-273.

[4] Henkensiefken R.et al.,(2009),volume change &crackingin internallycured mixtures made with saturated light weight aggregates under sealed & unsealed conditions, cement and concrete composites,427-437.

[5]HoffJ.etal.,(2010),Theuseoflightweightfinesfortheinternalcuringofconcrete.pp1-4.

[6]BentzD.etal.,(2011),InternalCuring:A2010stateoftheArt review.

[7] Bentz ,D.P., and Synder,k.A.,(1999).protected pas to volume in concrete :extension to internal curing using saturated lightweight fine aggregate cement and concrete research ,29(11),1863- 1867.

[8] JensenO.et.al.,(2001),Autogenousdeformation&RH changesinperspectivecement&concrete research,31(12),1859-1865.

[9] Persson B.(1997),self-desiccation and its importance in concrete technology materials and

structures,30(5),293-305.

[10] Jensen O.et.al.,(2001), Autogenous deformation & RH changes in perspective cement & concrete research,31(12),1859-1865.

[11] Henkensiefken R.,Bentz D., Nantung T., &Weiss,J.(2009).Volume Change and Cracking in Internally cured Mixtures Made with saturated Light weight Aggregates Under Sealed and Unsealed Conditions. Cement and Concrete Composites,31(7) ,426-437.