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Internal Curing for Concrete Pavment

Avinash B Haral, Dr. Sachin S. Saraf Prof. Ashish R. Bijwe
Dr. Rajendra Gode Institute of Technology & Research, Amravati, (Formerly known as IBSS College of Engineering, Amravati), Sant Gadge Baba Amravati University, Amravati Maharashtra, India

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ABSTRACT
In concrete production, curing is of utmost importance to ensure desirable properties like strength, durability, shrinkage etc. Loss of water through evaporation reduces the hydration r ate and eventually r esults in limite d strength and h igher p ermeability. Generally, curing is done either by supplying additional water from external source or by peventing m oisture l oss t hrough pl astic s heeting. H owever, i n a developing country l ike Bangladesh, curing i s c onsidered a s a n a dditional s tep a nd of ten overlooked. There is a lso s carcity of water i n m any regions of t he country. In addition, many local contractors do not have the knowledge and skill to ensure proper curing. As a result, durability of general concreting work has become a concern in the country. Under such scenario, internal curing (IC) could be adopted to improve the overall quality of concrete. IC 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 as per mix design. But generally production of this type of concrete is difficult and costly. Lightweight aggregates absorb considerable water during mixing which apparently can transfer to the paste during hydration. Utilization of over burnt clay as Light W eight Aggregate (LWA) t o produce internal cu ring concrete c an be considered a s a n effective s olution i n B angladesh since bur nt c lay i s cheap and locally available. U nit weight of burnt c lay is nearest 1000 k g/m3 and water absorption capacity of more than 10%. So it can be recommended as LWA with high absorption capacity. However, people striving for high strengths are not eager to use lightweight aggregates. A promising solution might be a partial replacement of coarse aggregate with lightweight aggregates. Super absorbent polymers (SAP) can also be used as a means of internal curing since they absorb large amount of water when get saturated. If SAP is mixed with ingredients and segregation can be avoided then it can be a solution to ensure internal curing. IC can assure proper hydration and eventually results in concrete w ith d esirable me chanical p roperties. A t th e s ame time , th is process of IC can s ave extra water required for pondi ng (natural c uring pr ocess). Therefore, internal cu ring al

so has significant environmental impact. However, very limited s tudy i s available o n internal cu ring o f concrete in co ntext o f Bangladesh. Therefore, i n t he p resent study, a co mprehensive ex perimental program has b een designed and implemented to i nvestigate t he effect o f l ocally available material in internal curing of co ncrete mixes. A total o f eighteen mixes were designed among which ni ne mixes ha d three d ifferent p ercent replacement o f coarse aggregate w ith locally available li ghtweight aggregate (10%, 2 0% a nd 30% r eplacement of S tone Chips with burnt c lay chips) and t hree di fferent water c ement ratios (0.4, 0.45 and 0.5). Six mixes w ere d one with no r eplacements f or comparison. Three c oncrete mixes were also prepared using SAP (from readily available baby di apers) us ing admixture having three different water cement ratios (0.4, 0.45 and 0.5). Admixture was us ed t o improve w orkability of c oncrete u sing SAP. For IC, different c uring conditions were simulated. In one method, samples were air cured by placing them in a dry p lace inside t he laboratory w ith and without polythene c over. Samples (both covered and uncovered) were also naturally cured. Such condition was simulated by placing t hem i n a nope n dry space out side t he laboratory. These curing c onditions were selected to replicate the ambient conditions. In order to evaluate internal curing capacity of LWA and SAP, desorption tests were conducted and found that both of them desorbs huge amount of water a t pa rticular temperature and r elative humidity condition. So, both L WA a nd S AP a re suitable c andidates f or internal c uring. Compressive strength te sts of d ifferent co ncrete specimens under v arious curing conditions were done on 3, 7 a nd 28 d ay. Modulus of elasticity was also determined at the age of 28 day. Durability tests (water permeability and chloride permeability) were conducted on 28 day cured specimens. A comprehensive comparative study was then carried out t o e valuate t he effect of di fferent m ix pr oportions and curing conditions on internal curing capability of proposed utilization of burnt clay and SAP application. It i s found t hat i n all cases of proposed m ethods c oncrete m ixes experience internal curing. Comparison of test results reveals that mixes covered with polythene sheets a nd ha ving 20% replacement with bur nt c lay produced hi ghest compressive strength and lowest permeability (both water and chloride permeability) as compared to mixes with no replacement.

Keywords : Compressive strength, LWA, SAP, Self Compacting Concrete

I. INTRODUCTION

Concrete is a composite material composed mainly of water, aggregate, and cement. Reinforcement and different additives are included within concrete to achieve desired physical properties of the finished material. In recent years, improved techniques are used to reduce the construction difficulties and improve the performance of concrete both in t erms of strength and durability. Internal Curing may be considered as one such technique f or e nsuring pr oper h ydration w ithout a ddition of e xternal c uring water. Self Compacting Concrete (SCC) i s an other modern d ay concrete technique where co mpaction process may be av oided. S CC i s characterized b y a l ow yield stress, high de formability, a nd m oderate vi scosity ne cessary t o e nsure uni form suspension of s olid p articles during t ransportation and pl acement (without external compaction). Also, t here are s elf-leveling concrete w hich i s p olymer-modified concrete t hat does not r equire t he a ddition o f e xcessive amounts of water f or placement. S elf h ealing concrete (bacterial co ncrete) i s al so u sed t hat can h eal automatically.

As a result s tronger and improved concrete i s produced. Moreover, if internal curing may be ensured, natural curing is not required, which is done either by spraying or ponding. Therefore, additional water required for natural cu ring may be saved through this process. Generally, internal curing is done by incorporating natural or synthetic light weight aggregates. Production of such light weight aggregates i s of ten qui te costly s ince t hey are not ve ry commonly used i n developed c ountries. Fortunately, artificial l ight w eight aggregates l ike burnt c lay chips are very common in Bangladesh and have wide spread utilization throughout the country. Burnt clay chips can absorb water when kept under water due to their high porous surface and have potential to release water during hydration process. On the other hand, concrete made with burnt c lay chips as coarse aggregate exhibits lower strength. A prudent hypothesis i s t hat combination of c onventional s tone c hips a nd burnt c lay c hips may ensure both i nternal c uring a nd de sired s trength. H owever, proper investigation is necessary to evaluate the internal curing capacity of brick chip since very l imited r esearch data is available on this particular subject matter. In this study, a comprehensive attempt has been made to quantify the internal curing ability of locally av ailable burnt c lay c hips as partial r eplacement co arse a ggregate i n concrete. Also super absorbent polymer (SAP) from readily available baby diaper is used as internal curing material.

II. OBJECTIVES

[1] To find out suitable locally available materials for application of internal curing

[2] To apply internal curing of concrete with different curing conditions

[3] To apply i nternal curing of co ncrete with optimum w ater c ement ratio a nd optimum percent replacement of materials and compare the effects with normally cured concrete

[4] To evaluate the effectiveness of internal curing

III. SCOPE OF PROJECT WORK

In chapter one , objectives, s cope, m ethodology a nd l imitations of t he present study are described. In chapter two, a thorough chronological literature review on internal curing are presented. Definition and necessity of internal curing is written in this chapter. In chapter three, the whole experimental program is described. In this chapter, the amount and type of material and their properties are mentioned. The experimental pr ocedure is also mentioned i n chapter t hree. In chapter f our, all experimental results including compressive strength, modulus of elasticity and durability results (both w ater permeability a nd chloride p ermeability) are presented. I n this chapter, the comparison among test r esults ar e m ade an d discussed i n details. Moreover, s ome r elationships are a lso developed a mong strength, m odulus of e lasticity and durability. In c hapter five, conclusions a nd relevant recommendations are mentioned for future analysisTo reduce the cost of construction.

Burnt clay chips, sand and stone chips (SSD condition

IV.METHODOLOGY

A total of eighteen mixes were designed among which nine mixes had three different percent replacement of coarse aggregate with locally av ailable lightweight aggregate (10%, 20% and 30% replacement of Stone Chips with Burnt Clay Chips) and three different w ater c ement r atios (0.4, 0.45 a nd 0.5) . Six mixes w ere done with no replacements f or comparison. Three co ncrete m ixes w ere al so prepared using s uper absorbent polymer (from readily available baby diapers) having three different water cement r atios (0.4, 0.45 a nd 0.5) . F ive curing conditions w ere s elected a s ke eping specimens fully submerge under water, inside laboratory with polythene cover, inside laboratory w ithout pol ythene c over, out side l aboratory with pol ythene c over a nd outside l aboratory w ithout pol ythene c over. Compressive s trength, modulus of elasticity, w ater p ermeability a nd chloride p ermeability te st w ere p erformed a nd results were compared.

V. RESULT

It is foundt hat 20% replacement o f s tone chips with bur nt c lay c hips yielded best performing concrete. Both 10% and 30% replacement produce relative lower strength and durability a s compared t o 20% replacement. In case of 10% replacement, less water r emains a vailable t o e nsure i nternal c uring w hich i s ne cessary for proper hydration. On the other hand, 30% replacement produces more porous and permeable concrete. Therefore, 2 0% r eplacement may be considered a s opt imum pe rcent replacement for producing proper internal cured concrete.

In this study, specimens are kept at two different locations i.e. outside laboratory and inside l aboratory. Outside laboratory ha s be en us ed t o s imulate t he f ield c ondition whereas inside laboratory for lab condition. In both conditions, concrete covered with polythene sheet g ives b etter s trength a nd dur ability. A gain, samples c overed w ith polythene give m ore s trength a nd dur ability i n out side l aboratory c ondition t han inside laboratory. This is due to the fact that higher temperature in outside laboratory condition e nsured pr oper h ydration a nd e ventually pr oduced be tter performing concrete. Moreover, higher temperature accelerates the desorption rate which in turn resulted i n pr oper i nternal curing. Therefore, s amples pl aced a t ou tside l aboratory covered with polythene sheets ar e t ermed as the samples h aving optimum am bience for appropriate internal curing.

VI.CONCLUSION

Internal curing may aid the construction process both environmentally and economically resulting i nto ef fective r esource utilization s ince r eadily available an d relatively less costly lightweight aggregate has been used. The following conclusions may be tentatively drawn from the experiments performed in this study.

The following conclusions may be drawn from the experiment conducted.

1) Brick is a suitable lig ht-weight a ggregate f or u sing a s in ternal c uring material. From desorption test of saturated burnt clay chips it may be s aid that burnt clay chips can desorb more than 10% of water of its own weight at early stages which becomes a vailable dur ing h ydration. Therefore, a ddition of burnt c lay chips increases amount of internal water available for curing

2) Polythene cover can en sure internal cu ring m echanism for an y co ncrete member either exposed to natural environment or not. Without polythene cover, concrete exhibited ve ry poor s trength a nd d urability. Outside Laboratory w ith po lythene cover is the optimum curing condition obtained from the experiment

3) 20% replacement o f s tone c hips with burnt c lay chips produced t he better performing concrete both in terms of strength and durability. No external curing is needed in such case. It is also found that both 10% and 30% replacements ensured internal curing. However, 20% replacement yielded concrete with higher strength and durability

4) Among three water cement ratios of 0.4, 0.45 and 0.5; i nternally cured samples with w ater c ement r atio of 0.40 a chieved t he hi ghest s trength a nd d urability characteristics. S o th is w ater c ement r atio may be r ecommended as t entative optimum water content. It should be mentioned here that from trial experiment it was f ound t hat w ater cement r atios l ower than 0.4 produces extremely low workable concrete with lower strength and higher permeability

5) Super a bsorbent pol ymer (from ba by di aper) may be us ed f or i nternal curing. Using s uperabsorbent polymer, high flow-able c oncrete w ith ve ry hi gh workability may be a chieved us ing s uper pl asticizer. H owever, i t affects t he strength of mix. More than 20% strength reduction is observed for concrete with super absorbent pol ymer as co mpared t o normally c ured c oncrete w ith s tone chips. Also permeability will be quite higher than normal cured concrete.

6) Tentative r elationships b etween compressive s trength an d w ater cement r atio; compressive s trength an d m odulus o f el asticity; w ater p ermeability and w ater cement ratio; ch loride p ermeability and w ater cement ratio a re d eveloped considering opt imum i nternal curing conditions. From these equations; p robable strength an d d urability can eas ily b e es timated f rom an y given v alue of w ater cement ratio. Also from the value of compressive strength of concrete, modulus of elasticity may be determined

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