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Use of Rapid Curing Concrete to Optimize Project Schedule

A. P. Ghodele[1], S. K. Kulkarni[2]

[1]P. G. Student: Civil Engineering Department, D.Y Patil Institute of Engineering& Technology Ambi Savitribai Phule Pune University Pune

[2]Associate Professor: Civil Engineering Department, D.Y Patil Institute of Engineering& Technology Ambi, Savitribai Phule Pune university, Pune

Abstract: ***Rapid curing concrete construction entails many methods for accelerating construction. Regular acceleration methods include time incentives for project completion. Many construction companies have been using these time incentives for many years, and often contractors will meet these requirements by increasing the size of construction labor. Rapid fast curing concrete construction techniques a contractor can often complete a project without increasing team size or changing normal labor schedules. This project optimized the project schedule by adopting a suitable method to prepare a mix design of rapid curing concrete. After completion of an experimental program, results are compared to those of normal curing days using MSP. The aims are achieved by arriving at a favorable solution to industrial projects in terms of time and money saving. The comparison of results with normal curing days yields the cost-benefit ratio.***

Keywords: Rapid curing concrete, Optimize project schedule, MSP, Cost-benefit ratio

1. Introduction

In the post-downturn period of the past five to six years, more owners protest on accelerated schedules. Institutions that needed to delay execution of projects in 2009 to 2011 are pressured to “back down” the delays, and fast-track is often the result. Others see a competitive advantage in improving their speed-to-market to establish or increase their foothold in an emerging field. Finally, some are attempting to reduce escalation of construction costs in a now-growing market or eliminate the “lost profit” of uncompleted, revenue-generating facilities. Rapid curing concrete construction resolves these problems by providing high-quality, long-lasting construction with quick public access. Rapid curing concrete techniques are suitable for new construction, reconstruction or resurfacing projects.

Rapid curing of concrete construction entails many methods for accelerating construction. Traditional acceleration methods include time incentive for project completion. Agencies have been using these completion-date incentives for many years, and often contractors will meet these requirements by lengthening the work day or increasing the size of construction crews. Rapid fast curing concrete construction techniques a contractor can often complete a project without increasing crew size or changing normal labor schedules.

Rapid curing concrete construction techniques allow contractor to consider concrete for projects thought unreal because of lengthy concrete cure-times. Some specifications require cure intervals from 15 to 21 days. With rapid curing concrete techniques concrete can undergo strengths in less than 24 days.

To build a fast-track project, both the contractor must make some changes to conventional construction processes. Often this entails high-early-strength (Rapid curing) concrete it reduces the total work days required to complete a work by minimizing a curing period of concrete. These project components can decrease construction time, required manpower and cost of the project.

1.1 Objectives

The main objective of this work is to optimize project schedule by using rapid curing concrete:

- To overcome the problem of delay in construction by using rapid curing concrete.
- To study design of concrete mix and prepare a mix design for rapid curing concrete by using various curing agent.
- To maximize cost & benefit ratio of the project by optimizing project scheduling with the help of rapid curing concrete.
- To enhance the project schedule.

2. Literature Survey

[1]Shuai et al. Author reported that heat curing decreases the maximum achievable degree of hydration, long-term rate of increase of compressive strength, anti-permeability, and durability of concrete as it ages.

In this study, the authors explored the suitability of internal curing for solving these problems and improving the performance of heat-cured concrete. Internal curing significantly improved the rate of increase in the later-stage strength, a degree of hydration, and penetration resistance of heat-cured concrete; this was especially true when subsequent standard curing was also performed. It also resulted in a better interfacial transition zone with a more homogeneous distribution as well as a microstructure with a lower porosity around the internal curing material in the case of the heat-cured mortar. Heat-cured concrete exhibited a lower maximum achievable degree of hydration and rate of increase in strength in the later stage. Internal curing is a suitable method for solving these problems caused by heat curing, this is especially true if it is incorporated with subsequent standard curing. The internal curing environment provided by the lightweight fine aggregate can improve the penetration resistance of the heat-cured mortars, even though the measured results were probably higher than the actual values. Internal curing improved the characteristics of the interfacial transition zone (ITZ) in heat cured concrete, resulting in the formation of an ITZ with a homogeneous distribution and a lower porosity around the LWFA.

In conclusion, internal curing is a suitable method of improving the performance of heat-curedconcrete. However, when using heat curing, it is essential to pay close attention to the properties of the internal curing material used, making sure they are appropriate for the various heat-curing regimesinvolved. Otherwise, the effect of internal curing would be minimal.

[2] Peiliang et al. The authors presented the effect of MK on the hydration, microstructure and volume stability of stream cured HSC preparing at low water to binder ratio and curing at high temperature. The properties of HSC with MK are obviously higher than that of reference specimen. In the presence of MK, the deleterious effects of heat treatment on microstructure are offset by MK, and no visible interface transport zone (ITZ) between aggregate and matrix can be observed. The total porosity is decreased from 14.4% to 11.3% by adding MK. Furthermore, a sharp reduction on the average pore diameter is observed in HSC with MK. The MK hinder the pore degradation caused by heat expansion during steam curing. Compared with the HSC without MK, the expansion caused by heat treatment is decreased by adding MK, and the drying shrinkage after steam curing is also decreased. Incorporation of aluminium results in the modification of the layer stacking of C-S-H and the reduction of its porosity, which makes the gel dense. This will contribute to the improvement of strength, microstructure and volume stability.

[3]Rahman et al. Authors represented the permeability of untreated concrete was notably increased. It also caused surface cracking. In all cases, under normal 28 day curing, the application of surface treatments at 210 min age, generally produced small increases in strength relative to unrefined concrete. Permeability values were correspondingly similar. With adverse curing, application of the curing agent, surface protectors or combinations of these at 210 min age, works to safeguard the 28 days strength and permeability of concrete relative to identically cured untreated concrete. Below 28 day unfavorable curing conditions, the union of the crystallising hydrophobic and curing agent treatments provided the highest level of strength protection, preserving 74% of the design mix strength. This treatment combination also had the strongest effect in preventing increased permeability under adverse curing conditions. As a single treatment on fresh concrete, the crystallising hydrophobic mineral filled surface cracks in concrete subjected to the 28 day adverse curing regime. Similar cracks in the accompanying untreated concrete remained open. Under normal 28 day curing provisions, early application of a combination of crystallising hydrophobic mineral followed by a wax based curing agent, appears not to influence concrete strength and also permeability. Furthermore, it appears that this union of early treatments works to safeguard the strength and permeability of concrete against the refusing effects of substandard curing provisions.

[4]Dalibor et al. The positive influence of curing on the static and dynamic modulus of elasticity of concrete, which was used in the experiment described herein, was positively proved. The concrete cured under water showed a constant increase in the modulus of elasticity. During the first few days, this increase was fairly steep. On the other hand, the uncured concrete showed a less significant increase in the modulus of elasticity during the first few days. Between the age of 28 and 90 days, the uncured concrete saw a gradual stagnation in the increase of the modulus of elasticity, which even began to decrease later. The 730-day dynamic modulus of elasticity was lower than at the age of 3 days. The static modulus of elasticity of the uncured concrete was lower at the age of 730 days than at 28 days. The degree of reduction in the modulus of elasticity in the uncured concrete was very significant compared to the cured concrete. A positive influence of concrete curing on the development of its modulus of elasticity was markedly more apparent in the air-entrained concrete.

[5]Yudong et al.The authors indicated the moisture content, in terms of comparative humidity, inside of high strength concrete slabs, with and without addition of PSLWA, exposed to normal indoor environment is investigated by continuously measuring the internal humidity of concrete immediately after slab casting until 28 days. The internal relative humidity of high strength concrete decreases with curing age since casting. The decreasing in relative humidity inside of concrete is an integrated result of cement hydration and water diffusion to the environment. The variation of relative humidity inside of concrete with time follows a vapor-saturated stage with 100% relative humidity (stage I) and a stage that relative humidity gradually decreases (stage II). A humidity gradient along the thickness of slab exists in early age high strength concrete. As PSL is added, the length of internal humidity saturated stage I is significantly prolonged and the decreasing rate of internal humidity in stage II noticeably decreased; within present addition range the more the PSLWA added, the stronger the internal curing effect. The humidity gradient along the thickness of the slab is reduced similarly. The highest depletion on internal humidity at 28 days since casting in high strength concrete slab down from 46.5% to 26.2% with a medium PSLWA addition ratio, and finally to 7.9% with a high PSL addition level.

[6] Dejian et al.The authors reported the prediction models for the working w=c ratio, the critical time, and the IRH variations in early-age concrete internally cured with SAPs. A prediction model for the working w=c ratio was proposed in consideration of age of concrete, effective and IC w=c ratios, which could be utilized to predict IRH variations in early-age concrete internally cured with SAPs. A prediction model for the critical time of IRH in early-age concrete internally cured with SAPs was proposed in consideration of effective and IC w=c ratios. In consideration of working w=c ratio and critical time, as well as age of concrete, a prediction model for the IRH in early-age concrete internally cured with SAPs was proposed. These models showed the good accuracy of the test results.

[7]Sallehan Ismail et al. The authors inspect the mechanical and durability properties of concrete integrate with treated recycled concrete aggregateunder various curing conditions. Three different curing regimes were applied, namely, continuous normal water curing, initial water curing for 28 days before exposure to an open-air environment, and initial water curing for 28 days before aspect to seawater. Two concrete mixes were produced by replacing 60% of the coarse aggregate using treated and untreated RCA with one control specimen (100% natural coarse aggregate) to examine the mechanical strength and durabilityproperties of the concrete. The microstructure of these mixes was studied via scanning electron microscopy. The integration of untreated RCA reduces the mechanical strength and durability of the concrete anyway of the curing conditions.

[8]Jianhui et al. High performance cement-based materials, such as high performance concrete have been widely used and still face the risk of cracking caused by shrinkages, especially autogenous shrinkage. Internal curing is a proper method to minimize or even eliminate self-generated shrinkage and has effects on dry shrinkage. The commonly used internal curing materials contain super-absorbent polymer and porous materials. Porous materials commit to lightweight aggregate. The authors has been divided the internal curing materials into two categories depends on water-absorbing mechanism. The effects of these two categories of internal curing materials on shrinkage of high performance cement-based materials are evaluated. The addition of internal curing materials releases internal curing water, postpones the drop of internal RH, and reduces autogenous shrinkage, but increase chemical shrinkage. The addition of internal curing materials with extra water increases drying shrinkage. The mechanisms of shrinkage on internal curing are also discussed. However, those mechanisms only focus on certain type of shrinkage. To minimize the risk of cracking more effectively, the relationship of different type of shrinkages should be accepted.

[9]Mazen et al. The authors researched to optimize the performance of concrete under normal curing conditions are showed. A crystallising hydrophobic admixture and curing agents were added to concrete to increase its resistance against serious environmental conditions. A two-stage approach was follow by adding the crystallising admixture to fresh concrete followed by curing agents, in a liquid forms, in a special application process, followed by reveal concrete to normal and adverse curing conditions. Authors suggests that protecting concrete with the crystallising admixture followed by applying wax based curing agent improves concrete strength and its resistance to water access than concrete cured with the liquid curing agent.Authors referred to increasing water content after applying the water-based curing agent.

[10]Xiao-Yong Wang, Ki-Bong Park. Authors represented that after deshutering the formwork, concrete is disclose to environmental air and dries. Due to the reciprocal action between hydration and drying, the strength development of outdoor air-cured concrete is different from that of water-cured concrete. The authors proposed a numerical procedure to evaluate the interactions among cement hydration, moisture diffusion, and compressive strength development. By using a desorption isotherm considering the degree of hydration of cement, the relative humidity reduction due to self-desiccation is calculated. A moisture diffusion equation considering the microstructure growth of concrete is suggested. A hydration model considering the relative humidity is also put ahead. By combining the hydration model with the moisture diffusion model, the separate degree of hydration with varying concrete depths is calculated. Using the individual degree of hydration at different depths, the average degree of hydration is intended. The compressive strength is evaluated using the average degree of hydration.

3. Research Methodology

3.1 General

Using rapid curing concrete optimize a project schedule. This phase presents the method of the study on the comparison of rapid curing concrete scheduling with conventional curing scheduling. An industrial building is taken for comparing and it includes the preparation of a plan, data collection from various sites, estimation of quantities, and determination of project duration, cost analysis.

3.2 Data Collection

Data collection is done for an industrial building situated at to optimize the curing period of conventional and rapid curing concrete constructions.

3.3 Rapid curing concrete mix design

Rapid curing concrete is designed to minimize the curing period of concrete as compared to conventional curing period of concrete. By applying this mix design 24 cube elements of size 150x150x150 mm, 24 column elements of size 150x150x300mm, 24 beam element of 150x150x600 mm has been cast for compressive, an axial flexural strength of concrete.

3.4 Test Result

Optimizing curing period of concrete from test result as shown in chart no 1 & 2.

3.5 Project duration

This is the main thing to find out the difference of project duration between rapid curing concrete curing and conventional concrete.

3.6 Finally by collecting all data in MSP software and finding the total cost-benefit ratio

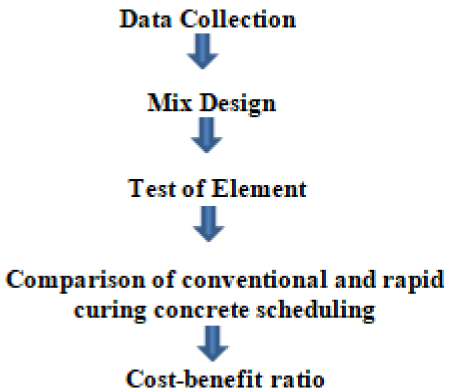

Figure 1: Flow of proposed research methodology

4. Results and Discussions

For the evaluation comparison of the conventional curing of concrete with rapid curing concrete is done.

1) Test Result

Chart 1: Compressive test result of a cube

The strength of cube was calculated for 21 to 28 days of concrete curing to optimize the curing period of concrete.

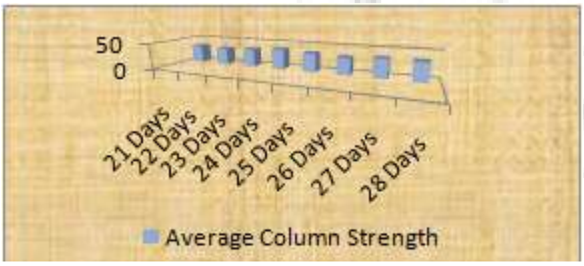

Chart 2: Compressive strength result of a column

The strength of column was calculated for 21 to 28 days of concrete curing to optimize the curing period of concrete.

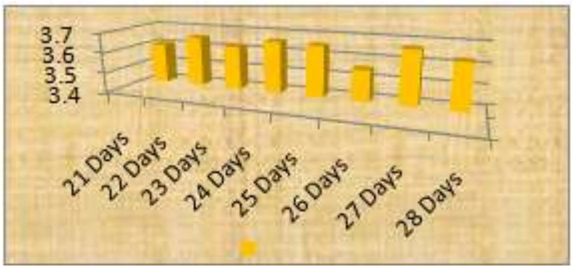

Chart 3: Flexural strength of a beam

The strength of beam was calculated for 21 to 28 days of concrete curing to optimize the curing period of concrete.

From above result, it was observed that on 24 days curing result are sufficient to get 100% strength of concrete. for following analysis 24 days for curing period of concrete considered instead of 28 days.

2) Scheduling of Project using MSP

a) Scheduling by using conventional concrete.

Table1: Total days required by to complete work by using conventional concrete.

Sr. No.	Work Details	Days
1	Total days required	101

The required total days was calculated by taken concrete curing period by 28 days. In the above days taken a curing period of a beam, trimix, column, lintel etc.

b) Scheduling by using rapid curing concrete.

Table 2: Total days required by to complete work by using rapid curing concrete

Sr. No.	Work Details	Days
1	Total days required	92

The required total days was calculated by taken concrete curing period by 24 days. In the above days taken a curing period of a beam, trimix, column, lintel etc.

3) Cost-benefit ratio

In cost-benefit ratio determined the effect of optimizing scheduling by using rapid curing concrete on the cost of shed construction. It's determined using a worker and staff requirement per day on a site. By using this analyzed the total saved amount of construction.

Table 3: Assuming total worker per day

Sr. No.	Position	Nos	Daily Wages
1	Site Engineer	1	1200
2	Site Supervisor	1	800
3	Skilled Labour	6	800
4	Unskilled Labour	10	500

A total amount of work by conventional concrete is 101X11800= 11, 91,800 rupees.
A total amount of work by rapid curing concrete is 92X11800= 10, 85,600 rupees.

Total saving of cost 1,06,200 rupees.

5. Conclusion

This paper presents the effect of rapid curing concrete to optimized project schedule. From the result presented in this paper, the following conclusion is drawn.

1) Result obtained suggests that the total cost and total duration have been optimized by using rapid curing concrete.

2) Completing a project before 9 days by optimizing scheduling by using a rapid curing concrete.
3) Total cost of construction 11,91,800. Reduced cost of project up to 1,26,200 rupees.
4) Reduced 8.91% overhead cost of the worker. [5]Hence enhanced project schedule.

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