# A Review Paper on Study on Automated Curing System for Mass Concreting Work

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***Abstract-New mechanized curing framework for mass cement has been created to enhance the nature of solid structure and to spare development time and cost. The guideline of this framework is the mechanized water course arrangement of warmed curing water. Connected curing water on the surface of mass solid keeps the temperature contrast amongst focus and surface of the structure underneath the edge of particular. Ridicule up test and field application has been directed to examine the execution of this framework. In the outcomes, new robotized curing framework lessened the possibility of warm split event and enhanced nature of the solid structure also.***

***Keywords-Mechanized curing, solid, warm breaks, warm protection compressive quality.***

## I. INTRODUCTION

During the construction of large structures such as dams, piers of bridges, large foundation etc. The amount of heat is always considered that will be generated and the resulting volume change occurring due to change in temperature it. Volume changes occur due to varying temperature in the concrete structures which increase rapidly in the initial stages due to hydration of cement and decreases in the later stages as the reaction ceases. Per unit distance temperature variation between two points in a structure is called thermal gradient. These are produced when the heat being generated due to hydration reaction and it gets dissipated to the surrounding environment. The temperature at the surface of the concrete is lower than the temperature at the core of the concrete. This lower temperature at the surface results in contraction of the exposed surface of the concrete. Since the interior concrete is more mature in comparison to the surface it restricts the contraction which creates tensile stress on the surface. The tensile strength of this early age concrete is not fully developed, if the tensile stresses developed due to temperature gradient are more than the undeveloped tensile strength of the concrete, cracking

An understanding of the mix proportion, environmental, and construction parameters that affect the development of mass concrete is crucial to provide a sustainable mass concrete structure. The concrete at an early age behaves according to the heat generated in the core of the concrete which in turn guides the distribution of temperature during hydration.

Specific heat capacity, thermal diffusivity and emissivity also affect the temperature profile of a concrete element. Also the rate of development of mechanical strength of concrete increase with temperature and therefore can be expressed as function of time and temperature.

Previous research in developing the numerical models for distribution of temperature in mass concrete has focused on using non-specific heat production function for temperature rise. Also the models made in the past have treated the heat generation due to hydration as uniform throughout the mix, which in fact is not practical. The heat generation is the function of time and temperature and is different at different location in the mass concrete.

The focus of this research is to correctly formulate the finite element (FE) model considering the non-homogeneous heat generation and distribution and to find out the resulting thermal gradients and the stresses at various points.

Since the core temperature is more mature than the outer surface and also surface is exposed to the environmental temperature, these acts as a restraint against the contraction of the surface resulting in tensile stresses which will create the possibility of cracks. These cracks will ultimately affect the load bearing capacity of the concrete and minimize its durability. Thermal stress mainly depends on the difference in temperature, modulus of elasticity, coefficient of thermal expansion and degree of restraint of the mass concrete structures.

### *Mass Concrete*

Mass concrete is defined by American Concrete Institute (ACI) Committee 207 as “Any volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat from hydration of cement and attendant volume change to minimize cracking”. According to various research the inner core of the mass concrete experience compressive stresses since it expands but is restrained by the less mature outer surface concrete having slower hydrating rate. Unlike the inner concrete the outer surface experience tensile stresses as it gets pushed by the expanding core of the concrete. Since concrete is weak in tension the cracks will occur closer to the surface and propagates towards the edges and corners.

### *Thermal Gradients*

Per unit remove temperature variety between two focuses in a structure is called warm angle. These warm slopes are framed because of differing temperatures between the surface which is cooled by the surrounding temperature and the solid center where the temperature is high because of exothermic hydration response. The run of the mill qualities of mass cement is appeared in Figure 1 and Figure 2 exhibits the warm angles because of warmth of hydration of bond. Greatness of these warm slopes is reliant on the putting temperature, warm properties, encompassing temperature, precipitation and wind speed.

## II. Literature Survey

A wide variety of concrete polymer complex materials is under investigation in a no of laboratories around the world. For this materials growth, the older skill of hydraulic cement concrete is combined with the newer knowledge of polymers to shape new and enhanced materials of construction. Polymer impregnated precast concrete (PIC) is the more developed of the complex and exhibit the highest degree of strength and durability properties improvements. Polymer concrete (PC), collective vault with polymer appears to be a promising material for cast-in-place application. Frequent application of PIC is currently under expansion which indicated a large potential for this material.

F. Bosché and B. Biotteau in article Laser Scanning and the Continuous Wavelet Transform for Flatness Control says that Current methods for surface flatness control in construction are based on sparse measurements and therefore may lead to inaccurate and imprecise results. Terrestrial Laser Scanning (TLS), with the accuracy and density of 3D point clouds it can provide more complete and reliable control of surface flatness in construction. This paper presented a novel approach to floor flatness control that harnesses the measurement density that TLS can deliver and the power of the CWT (Continuous Wavelet Trans-form) to accurately detect and locate undulations of any frequency in a floor elevation profile.

Ju-hyung Ha et. al.; In order to control thermal cracking of the turbine foundation concrete of large power plants, we conducted hydration heat analysis, field application and measurement with variables including changes in concrete mix design, curing methods, (1) In case of mass concrete, there is a risk of cracking due to internal and external restraint caused by hydration heat, and it is thought that the effects of risks and measures can be predicted through preliminary hydration heat analysis similarly to actual construction. (2) By changing type1 normal cement concrete mixing to slag cement concrete for low hydration heat, it was possible to lower the probability of cracking caused by external restraint of large mass concrete structures. (3) By applying the curing automation system that actively controls inside and outside temperature difference, we were able to control inside and outside temperature difference below 20°Cat the initial concrete placement, which controlled the surface cracking caused by hydration heat internal restraint. (4) Upon applying thermal insulation curing, we could control inside and outside temperature difference to a very small degree, but when we removed the thermal insulation materials after the end of curing, the surface rapidly cooled down, which caused surface cracking from thermal shock. To prevent this, the thermal insulation should be appropriately controlled by preliminary hydration heat analysis. (5) The turbine foundation of large power plants is a very important structure, and due to the size, the risk of cracking caused by hydration heat is high. However, after reviewing the probability of cracking by hydration heat analysis, when required, we can control cracking appropriately through applying low heat concrete mix design and active temperature control curing.

Ju-hyung Ha et. al.says that, New automated curing system for mass concrete has been developed to improve the quality of concrete structure and to save construction time and cost. The principle of this system is the automated water circulation system of heated curing water. Applied curing water on the surface of mass concrete keeps the temperature difference between center and surface of the structure below the threshold of specification. Mock-up test and field application have been conducted to investigate the performance of this system. In the results, new automated curing system reduced the chance of thermal crack occurrence and improved quality of the concrete structure as well.

Mao et al. in Automation and Robotics in Surveying Processesutilised a robotic total station and innovative computing algorithms to monitor the alignment status of the TBM machine, which avoids the problems with accuracy and tedious calibration processes on using the conventional laser station. Various regular surveying processes, such as point layout and soil deformation monitoring, can benefit from innovative hardware development, like robotics total stations and laser scanning, which speed up the checking processes of the accuracy and quality of construction.

Matthias Bock et. al. concluded that for testing innovative fiber placement heads, larger amounts of pre-consolidated tapes (cured slittapes) with consistent quality are required. For this purpose an automatic curing system is developed. This system uncoils independently the tape and wounds it iridescent on a roll core after a heating process. For the design and parameterization of the system, it is necessary to conduct a series of preliminary studies. The boundary conditions for a complete cure of slit tapes are established by DSC analysis. The matrix of the fiber composite material cures at a temperature of 180°C over a period of 80 minutes approximately completely. Lower temperatures result in significantly longer curing times. The glass transition temperature of the resin is approximately 195°C.

With infrared radiation heating, the slit tape cures with the system within 220 seconds at a temperature of 180°C. To increase the effectiveness of the system, the possibility of subsequent annealing in the wound state is tested. Samples with different curing degrees are prepared and wound on a rotary body, and then fully cured in a tempering furnace. The results are cured samples with different radii of curvature. Prepregs are relatively flexible in the uncured state. The drapability wanes with increasing cross-linking of the matrix. To divert cured tapes, the smallest possible bending radius is determined. To ensure the greatest variability, the system is built modularly. On the uncoil module for the supply spool a braking device is added. The force of the tape can be continuously adjusted up to 30 N. Additionally an independent rotation of the coil is prevented. After removal the backing film, the slit tape is transferred centrally into the next module. In the cure module, the slit tapes are cured by using the determined boundary conditions such as power and distance via IR emitters. In the coil module the cured slit tapes are iridescent wound onto a core with a linear axis with sliding eye. A multi-axis controller contributes the electromechanical components.

Nannan Shi et. al. in Experimental Study on Early-Age Crack of Mass Concrete under the Controlled Temperature History Thermal deformation under restrained conditions often leads to early-age cracking and durability problems in mass concrete structures. It is crucial to monitor accurately the evolution of temperature and thermal stresses. In this paper, experimental studies using temperature stress testing machine (TSTM) are carried out to monitor the generated thermal cracking in mass concrete. Firstly, components and working principle of TSTM were introduced. Cracking temperatures and stress reserves are selected as the main cracking evaluation indicators of TSTM. Furthermore, effects of temperature controlling measures on concrete cracking were quantitatively studied, which consider the concrete placing temperature (before cooling) and cooling rates (after cooling). Moreover, the influence of reinforcement on early-age cracking has been quantitatively analyzed using the TSTM.

Neerej K.P et. al. in article Automatic Curing System for Concrete Structures concluded that presents the development of an automatic curing system for concrete structures. Strength and durability of concrete is attained only by proper curing. It is very essential to maintain proper moisture content in concrete throughout the hydration process. Curing helps in mitigating cracks that affect the durability and life of concrete. Thus, curing is essential process in concrete structures. The research focuses on monitoring the moisture and temperature levels using sensors in a concrete structure and to maintain the threshold levels throughout the curing period. Water will be supplied only when the sensor values goes below the threshold level. Wireless networks for this system enables safe and reliable communication between field sensors and the controller and thus increase the flexibility of the system. Proper water management is possible with the proposed system thus wastage of water can be minimized. Also there is very less human interaction required for this system.

Ok-pin Na et. al., in article A Study on the Thermal Crack Control of Large Turbine Foundation using Automated Curing System, states thatThe thermal crack occurrence from hydration heat is one of the most important factors that significantly affect structural quality and construction period in mass concrete. Therefore, appropriate methods to control the thermal crack are necessary for mass concrete. In this study, the probability of thermal cracking was checked by FEM analysis prior to the construction of turbine foundation in a combined thermal power plant. Subsequently, the change of concrete mix design and application of automated curing system were proposed to prevent thermal crack occurrence. The proposed concrete mix design and automated curing method have been applied to actual turbine foundation construction site and the effect of the proposed thermal crack control methods has been evaluated through field measurement of the temperature, strain, thermal crack occurrence.

Ung-Kyun Lee ET. Al, The productivity and efficiency of projects can be improved by adopting information technology in the construction industry. Management workload, involving such activities as measurement and collecting and classifying data, can be reduced by information technology because of automatic sensing technology. Wireless technology can reduce the distance between the working area and the site office. In addition, the Internet can not only remove the distance between site offices and the head office, but also send the information to project managers and workers. Ultimately, construction information management can be systematized, and new estimation methods created, if the data are stored constantly at other sites, by applying artificial intelligence techniques such as neural networks, case-based reasoning, and so on. A ubiquitous computing environment using mobile devices can accelerate operations. At anytime, anywhere, people can connect to the Internet, and changing conditions can be identified .

Wang et al. in Automation in Construction Quality Control proposed an integrated system encapsulating Building Information Modelling (BIM) and Light Detection and Ranging (LiDAR) for on-site information collection and construction quality control. It can help quality managers quickly and accurately identify and manage defects; an improvement to time-consuming inspections that had to be performed at specific positions.

## III. CONCLUSION

Automated curing also reduces thermal cracking in mass concrete. It will become very helpful method to reduce thermal cracking of massive and important concrete structures.

## REFERENCES

[1]. ACI Committee 207, Report on Thermal and Volume Change Effects on Cracking of Mass Concrete, 207.2R-07, American Concrete Institute, 2007.

[2]. ACI Committee 209, Prediction of Creep, Shrinkage, and Temperature Effects in Concrete Structures, 209R-92, American Concrete Institute, 2008.

[3]. Committee B/525/2, Structural use of concrete -Part 1: Code of practice for design and construction, BS 8110-1:1997, British Standards Institution, 1997.

[4]. Frankel, Lawrence S., Gerald, Jones and Donald A. Winey 21 March (1984), "Modified latex polymer composition". U.S. Patent No. 4,814,373.

[5]. Ha, J. H., Cho, Y. G., Hyun, T. Y., Lim, C. K. Seo, T. S. and Lee, K. C., Field application of concrete automated curing system (I).Proceedings of theKorea Concrete Institute, Vol. 24, No. 2, pp. 725- 726, 2013.

[6]. Ha, J. H., Cho, Y. G., Hyun, T. Y., Lim, C. K. Seo, T. S. and Lee, K. C., Field application of concrete automated curing system (II). Proceedings of theKorea Concrete Institute, Vol. 25, No. 1, pp. 635-636. 2013.

[7]. Ha, J. H., Cho, Y. G., Lee, K. C., Lim, C. K. And Seo, T. S., Field application of concrete automated curing system (III).Proceedings of the KoreaConcrete Institute, Vol. 25, No. 2, pp. 43-44, 2013.

[8]. Ha, J.H., Cho, Y.G., Hyun, T.Y., Lim, C.K. and Seo, T.S., Control of Thermal Crack in Mass Concrete using Automated Curing System. Journal of the Korea Concrete Institute, Vol. 25, No. 2, pp. 195-200, 2013.

[9]. Ha, J.H., Jung, Y.S. and Cho, Y.G., Development of Automated Curing System for Mass Concrete. The International Symposium on Automation and Robotics in Construction and Mining 2013,Montreal, Canada, 2013.

[10]. Han, C. G., Oh, S. G., Shin, D. A., Jeon, C. K. And Kim, J., The insulating curing method of cold weather concreting using double bubble sheets, Journal of the Korea Concrete Institute, Vol. 18, No. 6, pp. 51-59,2006.

[11]. Hiroshi chida (1973) "IMPROVEMENT OF MECHANICAL PROPERTIES OF CONCRETE THROUGH THE ADDITION OF POLYMER LATEX" by A.C.I. Journal, journal vol.: 60, ISSN: 0889-325.

[12]. Ju-hyung Ha et. a.l; A Study on the Thermal Crack Control of Large Turbine Foundation using Automated Curing System; The 31st International Symposium on Automation and Robotics in Construction and Mining (ISARC 2014).

[13]. Ju-hyung Ha et. al.; DEVELOPMENT OF AUTOMATED CURING SYSTEM FOR MASS CONCRETE, Hyundai Engineering & Construction, Research & Development Division 102-4 Mabuk-dong, Giheung-gu, Yongin-si Gyeonggi-do, 446-716, Korea.

[14]. Korea Concrete Institute, Concrete standard specifications, Korea Concrete Institute, 2009.

[15]. M. Steinberg (1975) "CONCRETE POLYMER MATERIALS AND ITS WORDWIDE DEVELOPMENT" by A.C.I. Journal Vol.: 70, ISSN: 0889-325.

[16]. Matthias Bock et. al.; Development and construction of an automated curing system for CFRP-Slittapes; Advanced Intelligent Mechatronics, Kaohsiung - Taiwan, 2012.

[17]. Ministry of Knowledge Economy, The sixth basic plan for electricity supply and demand, MKEAnnouncement 2013-63, Ministry of Knowledge Economy, Korea, 2013.

[18]. Neerej K.P et. al.; Automatic Curing System for Concrete Structures; National Conference on Science, Engineering and Technology (NCSET – 2016); Volume: 4 Issue: 6 136 – 139; ISSN: 2321-8169.

[19]. Sanket Jiwane et. al. ;Automated painting and UV curing system based on Arduino; International Journal of Current Engineering and Technology; MITCOE, &DIAT, Pune,AMET-2017, IJCET INPRESSOSpecial Issue-7, March 2017; pp. 132-135; E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.

[20]. Ung-Kyun Lee et. al.; Mass Concrete Curing Management Based on Ubiquitous Computing; Computer-Aided Civil and Infrastructure Engineering 21 (2006) 148–155.