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# Review on Different Methods for Temperature Control in Mass Concrete

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**ABSTRACT:** Mass concrete is a concrete used for large structure such as bridges, dams and multistoried buildings. In recent years, large structure construction has increased because of its many structural benefits. The structure will be more durable if it has ability to resist weathering action thermal cracking and abrasion while maintain its desire engineering properties specifically temperature of concrete causes the thermal cracking several construction methods are used such as precooling of concrete aggregates, post cooling of concrete, insulation of concrete member and pouring the concrete in thin lifts. Aim of this paper is to review the study of different type of methods.

**KEYWORDS:** Pouring, Bridges, Dams, Durability, Thermal cracking, Precooling, Post cooling.

## I. INTRODUCTION

Mass concrete structures having large concrete contents, mat foundations, piers and structural columns. According American Concrete Institute, "any volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat from hydration of the cement and attendant volume change to minimize cracking".

In mass concrete one of the major problem is heat generated in the core of such a structure, due to heat of hydration at a slow rate leading to the formation of high temperature differential. This increases the risk of cracking in structures which directly affects the durability. To minimize the risk of cracking, various preventive methods are reviewed in this paper like precooling, post cooling, insulation and using low heat materials etc.

These methods are really useful for certain locations, because climate does play a role in curing of concrete. Some areas that are colder would benefit more by using insulation method and locations with warmer climate should use post cooling and low heat materials to reduce the temperature of concrete. Precooling is also one of the best method to be used as it using cold mixing water or replacing it with ice and also liquid nitrogen (LN) is used in this method.

## II. LITERATURE REVIEW

### GENERAL:

In this review paper, the study of different types of methods is going to held for mass concrete structure. It is new technology and it is used for large structures so to study this concept some authors have given their research. That are given below.

#### 1. Mohamed Abdel Raheem (2018) :

Author has focused that, In mass concrete structure the heat of hydration released in substantial amount can be problematic Heat of hydration can produce crack in concrete. ie structure may lead to fail. This literature repos shows a comprehensive study of the previous methods for controlling the temperature rise due to heat of hydration in mass concrete.. This paper also presents an analysis. of these methods using findings from previous studies.

#### 2. T.C. Nguyena, X.B. Luub(2019):

In this paper author the heat which is produced in the cement hydration is rather high in mass concrete structures like dams, pavements, piers. In fact, it takes a longer time to cool the inner of the mass than its surface. The main reason for this result is that having the temperature difference between the hot inner mass and its cooled surface. Such a gap like that is the cause of appearing a large number of cracks in the surface of the mass concrete at several days age. In this study, the application of using a sand-layer insulation to control mass concrete block cracks at an early age. Specifically, these processes are performed by the program Midas Civil 2017 in cases: without sand-layer insulation, and with the application of using sand-layer insulation have thickness in range of 0–7 cm for heat preservation.



### 3. Yogiraj Sargam et al (2019):

In this paper author explained the high-temperature differentials in mass concrete structure pose great risks of temperature-induced stresses and cracking. Prior knowledge of temperature development within such a structure is essential. In this context, this paper presents a case study in which the construction of a mass concrete bridge foundation in low, USA was investigated and a computer program, Concrete Works (CW), was used to predict its overall thermal performance with an aim to prevent thermal cracking.

### 4. Rui Faria et al (2019):

Author have studied the heat of the hydration-induced temperature evolution of a 3.30 m thick raft concrete foundation for wind turbines at the early ages was monitored in situ through a temperature sensor testing system. The temperature variation patterns and risk of cracking were studied. Finite element analysis (FEA) conducted on the temperature fields determined the lower thickness threshold requiring temperature control. A comprehensive temperature control approach suitable for thick raft foundations was proposed based on a practical engineering project.

### 5. M. Basoeki et al (2019):

In this paper author have given detailed study on the control heat of hydration of mass concrete. using the concrete bio-admixture, bioconc. Due to heat of hydration in concrete it may This can occur cracks & leads to structure failure. paper reports the results of research using the biocort, admixture, bio conc as a @dmiztusmicrofiller. In order to Control researched object, it was compared with precooling masscon and fly ash based how heat mascon.

### 6. John Gajda and Maratha Vangeem (2021):

In this paper author studied the specifications generally limit temperatures in mass concrete to prevent cracking and durability problems. Temperature limits are specified to seemingly arbitrary values of 135 F (57 C) for the maximum allowable concrete temperature and 35 F (19 C) for the maximum allowable temperature difference between the center and surface of the mass concrete section. Typically, the contractor must meet all of the specification requirements, but without a good understanding of mass concrete, keeping concrete temperatures within limits can be a difficult task.

### 7. Malik I. Alamayreh et al (2022):

In this paper, author have studied different techniques. for cooling mass concrete structures in order to increase structural integrity and reduce the influence of cement hydration, which causes cracking in concrete structures, and it directly. affects the durability. This research has focused the coding system design and the different refrigerants. cooling system performance aims in producing higher quality massive concrete.

### Concluding remark:

From the above literature we have studied the aspects, characteristics and different types of temperature controlling methods in mass concrete which are really useful for the durability of structure.

## III. REVIEW METHODOLOGY

### Methods of temperature control

Methods of controlling mass concrete temperatures range from relatively simple to complex, and from inexpensive to costly. Depending on a particular situation, it may be advantageous to use one or more methods over another-

1. Low-heat materials
2. Pre cooling of concrete
3. Post-cooling of concrete
4. Surface insulation

**1. Low-heat materials** : M. Basoeki have explained the detailed study of low heat materials used in mass concrete structure to avoid thermal cracking or to control heat of hydration in concrete. The product is called bioconc low heat concrete he used in order to control heat of hydration. It reduces cement by up to 40%. Research data result from thermocouple monitoring the shown that bioconc low heat concretes peak temperature 63°C within 29.5 hours after pouring. The only disadvantage of this product is it can be used in cold weather and is more expensive than ordinary cement.

Select lowheat of hydration cement or mixture cement . Use low cement contents (120 to 225 kg/M3) Class F fly ash generates about half as much heat as the cement that it replaces and is often used at a replacement



rate of 15 to 25%. Ground granulated blast-furnace slag is often used at a replacement rate of 65 to 80% to reduce heat. Use large sized aggregates 75-120 mm high aggregate contents up to 80% of total.

**2. Pre cooling of concrete:** Malik Almayreh has explained precooling concrete system in massive concrete production energy analysis and refrigerant replacement. In that have given detailed study of paper he pre-cooling techniques in concrete. Liquid nitrogen is also used Use of chilled mix water. And sometimes replacement of mix water by ice.

Efforts to cool aggregates have the most pronounced effects on the concrete temperature because they represent 70 to 85% of the weight of the concrete. Liquid nitrogen can also be used to precool concrete or concrete constituents. But this option can significantly increase the cost of concrete. Drawback of this method is cost of L2N is high and operators and maintenance personnel must wear, protective clothing and safety gear and must be trained in its safe use and handling.

**3. Post-cooling of concrete:** Mohamed Abdel Raheem has explained all the construction methods used for controlling temperature in mass concrete structures. In that he has explained studied the pre-cooling technique used for controlling heat of hydration in concrete..

Cooling pipes in mass concrete are sometimes used to reduce maximum concrete temperatures and to quickly reduce interior temperatures. This method can have high initial and operating costs, but benefits can often. It is important to emphasize again that significant internal and surface thermal cracking can result if post-cooling is improperly designed or performed. Disadvantage of this method is only that it can easily produce local tensile stress around the pipe and a sharp cooling can produce a large global tensile stress

**4. Surface insulation:** Mohamed Abdel Raheem has in mass concrete structures. The material used for insulation can come in many forms, but it all depends on how much the temperature needs to be reduced. Insulation or insulated formwork is often used to warm the concrete surface and reduce the temperature difference, which in turn minimizes the potential for thermal cracking.

Insulation often has to remain in place for several weeks or longer. Removing it too soon can cause the surface to cool quickly and crack. Many types of insulation materials are available, and insulation levels can be optimized to meet required temperature differences and maximize the rate of cooling. Surface insulation is inexpensive but must be placed for long time, which can cost additional money.

The average value of the three temperature values can be calculated and recorded by the computer. Besides, "temperature control system of TSTM" is adopted to control the specimen temperature, which is composed of temperature controlled mould (test mould), pump, circulating pipes, and temperature control box .

#### IV. DISCUSSION

In this paper we get the review of overall methods that be useful to reduce the temperature in mass concrete. This methods are really useful, it reduces the heat of hydration in the cement that may lead to thermal cracking. This results in making the structure more durable. This methods should be done while pouring concrete on construction site. Methods like precooling, post cooling, surface insulation are the methods use ice water, liquid nitrogen and sand layers for insulation respectively. These methods better results as compared to normal concrete.

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