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Concreting in Extreme Weather Condition

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Abstract: ***Over the last 30 years, scientific research has increasingly implicated human activities in contemporary regional- to global-scale climatic change. Over the last decade, this research has extended to the detection of the fingerprint of human activities on individual extreme weather events. Is it possible to say that this or that weather extreme was 'caused by' human activities? Pursuing answers to this question raises many difficult philosophical, epistemological and political issues. High temperatures affect concrete at all stages of the production and placing process and most of the effects have consequences for long-term strength or durability. Some of the problems resulting from high temperatures are presented in the chapter. Concrete at high temperature loses workability at a faster rate because of the combined effects of loss of water through evaporation and the more rapid rate of the hydration reaction. Hydration of cement in concrete is an exothermic reaction, that is, it produces heat. A number of different methods are used to alleviate the effects of hot weather. They are mostly aimed at reducing the temperature of the concrete at the time of placing by either cooling the ingredients, reducing the heat gain experienced during mixing, transit and placing or by cooling the concrete itself. Furthermore, in cold water effects concrete which is placed at low temperatures, but which is not allowed to freeze and receives good curing, develops higher ultimate strength, greater durability and is less subject to thermal cracking than similar concrete placed at higher temperatures. The main problems associated with cold weather are frost damage to immature concrete and slow gain in strength leading to later stripping times and the possibility of increased damage when the shutters are removed.***

1. Introduction

Today's modern world there different techniques are introduced in the civil engineering world which makes the construction easy and fast. So according to our project we are discussing about the construction techniques of concreting in extreme weather conditions. The main of our project is the difference between the normal concreting and extreme weather condition. When we tested the normal concrete block in the lab the strength of the block is good but on the other hand when we apply the concrete in a construction site in a building or any other structure the strength of the concrete is reduced. The reason behind this is atmospheric condition. When the block is tested on the lab there is no or very little effect of atmosphere hence the strength of concrete is great but on the other hand when applied on the building there is a great effect of atmosphere hence the strength of the concrete is reduced. So from this problem we studied about the various problems arises in the concreting due to atmospheric condition. By extreme condition we mean that

1) Extreme Hot Weather Condition
2) Extreme Cold Weather Condition

These are the two types of extreme weather condition hot and cold condition. These two conditions adversely Affect the concreting condition and give rise to affect the strength of the concrete. There are two condition in which concreting is done hot weather concreting and cold weather concreting. In hot weather concreting the problem is removal of moisture content from the There are two condition in which concreting is done hot weather concreting and cold weather concreting. In hot weather concreting the problem is removal of moisture content from the concrete block due to rise in temperature. This is the serious problem which gives rise to he reduce in strength of concrete. Secondly on the other hand a concreting is done which is known as cold weather concreting. In this concreting it is very difficult to handle the concreting process because in this condition the temperature is drop down so that the setting time of the concrete is reduced so it becomes very complicated to handle the concrete mix and apply the concrete in the construction site.

So these are the two problems which arises due to increase and decrease in temperature. So in this project we investigate the effect arises due to rise and falls in temperature and overcome the effect and gets the solution to achieve the safe and adequate strength

1.1 Hot Weather Concreting

When the temperature of freshly mixed concrete approaches approximately 20 degree centigrade adverse site condition can adversely impact the quality of concrete. Ambient temperature above 40 degree and lack of a protected environment for concrete placement and finishing can contribute to difficulty in producing quality concrete. The precautions required to ensure a quality and product will vary depending on the actual conditions during concrete placement and the specific application for which the concrete ill be used. In general if the temperature at the time of concrete placement will exceed 20 degree centigrade a plan should be developed to negate the effects of high temperature

1.2 Cold Weather Concreting

Cold weather concreting is a common and necessary practice and every cold weather application must be considered carefully to accommodate its unique requirements. The current American concrete institute definition of cold weather concreting as stated in ACI 306 is "when the ire temperature has fallen to or accepted to fall below 5 degree centigrade during the protection period". This definition can potentially lead to problems with concrete freezing at an early age Rule number one is that all concrete must b protected from freezing until it has reached a minimum compressive strength of 500 psi which typically happens with in first 24 hours. In addition whenever air temperature at the time of concrete placement is below 5 degree centigrade and freezing temperature within first 24 hours after placement are excepted the following general issues should be considered:-

1) Initial concrete temperature as delivered.
2) Protection while concrete is placed, consolidated and finished.
3) Curing temperature to produce quality concrete.

2. Effect of Hot & Cold Weather in Concreting

Concrete is not recommended to be placed in temperature above 40 degree centigrade and below 5 degree centigrade without proper precaution as laid down in IS: 7681(part -1 or part-2 as the case may be)IS: 7861 part 1 deals with hot weather concrete and part 2 deals with the cold weather concreting.

2.1 Effects of Hot Weather in Concreting

1) **Accelerated Setting:-**A higher temperature of fresh concrete results in more rapid hydration of cement and leads to reduced workability, accelerated setting. This reduces the handling time of concrete.
2) **Reduction In Strength :-**Concrete mixed , place and cured at higher temperature normally develops higher early strength than the concrete produced and cured at normal temperature but at 28 days or later the strength are generally lower.
3) **Increased Tendency To Crack:-**Rapid evaporation may cause shrinkage and cracking and subsequent cooling of hardened concrete would introduce tensile stresses.
4) **Rapid Evaporation Of Water During Curing Period:-** It is difficult to retain moisture for hydration and maintain reasonably uniform temperature condition during the curing period.
5) **Difficulty In Control Of Air Content In Air Entrained Concrete:-**It is more difficult to control air content in air entrained concrete. This adds to the difficulty of controlling workability. For a given amount of air entraining agent, hot concrete will entrain less air than concrete at normal temperature.

2.2 Effects of Cold Weather Concrete

The production of concrete in cold weather introduces special and peculiars problem which do not arise while concreting at normal temperature. Quite apart from the problems associated with setting and hardening of cement concrete, severe damage may occur if concrete, which is still in the plastic state, is exposed to low temperature thus causing ice lenses to form and expansion to occur within the pore structure. Hence it is essential to keep the temperature of the concrete above a minimum value before it is placed in the formwork. In the absence of special precautions, the effect of cold weather concreting may be as follows:

1) **Delayed Setting:** When the temperature is falling to about 5 degrees centigrade or below, the development of strength of concrete is retarded compared with normal concrete.
2) **Freezing of Concrete at Early Stage:** The permanent damage may occur when the concrete is in fresh stage is exposed to freeze before certain pre hardening period. Concrete may suffer irreparable loss in properties to an extent that compressive strength may get reduced to 50% of what could be excepted for normal temperature concrete.
3) **Stresses Due to Temperature Differentials:** Large temperature differentials within the concrete member may promote cracking and affect its durability adversely. It is a general experience that large temperature differentials within the concrete member may promote cracking and have a harmful effect on the durability. Such differentials are likely to occur in cold weather at the time of removal of form insulation.
4) **Repeated Freezing and Thawing:-**If concrete is exposed to repeated freezing and thawing after final set and during the hardening period, the final qualities of the concrete may also be impaired.
5) **Test Specimen:** Although one concrete mix was taken i.e. 1:2:4 with *wlc* ratio 0.65 but the temperature was varied. It was varied according to possible extreme weather temperature, which a concrete mix can come across during first three days. Temperatures selected were BOC, 25°C and 50°C. To create high temperature Oven was utilized which was available in laboratory

3. Different Tests Carried Out

I. Compressive Strength
II. Workability (Slump test)
III. Compacting factor
IV. Modulus of Rupture
V. Splitting tensile strength
VI. Equivalent cube strength

4. Compressive Strength

The strength of concrete is controlled by the proportioning of cement, coarse and fine aggregates ,water, and various admixtures The ratio of the water to cement is the chief facto for determining. Concrete strength as shown in figure1. The lower the water-cement ratio, the higher is the compressive strength

Procedure

Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90% of average of strength of three similar concrete cubes prepared with distilled water. For quality control in case of mass concreting, the frequency of testing of compressive strength by cube test is as follows.

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting find removed specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimensions of the specimens to the nearest 0.2mm and there. Weight shall be noted be foretasting

5. Workability (Slump Test)

A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality

Procedure

1) The mold for the slump test is a frustum of a cone, 300 mm (12 in) of height. The base is 200 mm (8in) in diameter and it has a smaller opening at the top of 100 mm (4 in).
2) The base is placed on a smooth surface and the container is filled with concrete in three layers, whose workability is to be tested.
3) Each layer is temped 25 times with a standard 16 mm (5/8 in) diameter steel rod, rounded at the end.
4) When the mold is completely filled with concrete, the top surface is struck off (leveled with mould top opening) by means of screening and rolling motion of the temping rod.
5) The mould must be firmly held against its base during the entire operation so that it could not move due to the pouring of concrete and this can be done by means of handles or foot - rests brazed to the mould.
6) Immediately after filling is completed and the concrete is leveled, the cone is slowly and carefully lifted vertically, an unsupported concrete will now slump.
7) The decrease in the height of the center of the slumped concrete is called slump.
8) The slump is measured by placing the cone just besides the slump concrete and the temping rod is placed over the cone so that it should also come over the area of slumped concrete.

The decrease in height of concrete to that of mould is noted with scale. (usually measured to the nearest 5 mm 1in4)

Figure 5.2: Vebe Consistometer

6. Prevention

6.1 Curing in Hot Weather

1) The need for moist curing of concrete slab is greatest during the few hours after finishing.
2) To prevent the drying of exposed concrete surface, moist curing should be commence as soon as the surface are finished.
3) When the air temperature is at above 27*C, curing during the basic curing period should be accomplished by water spray or by using saturated absorptive fabric.
4) For mass concrete, curing should be by water for the basic curing period when the air temperature is above or at above 20℃, in order to minimize the temperature rise of the concrete.

6.2 Curing in Cold Weather

Try these recommended tips for curing concrete during winter:

1) Maintain a proper water-cement ratio. The water to cement ratio should not be more than 0.40 under freezing conditions.
2) If temperatures are too cold, a propane heater and polyethylene enclosure could be used to maintain temperatures hot enough, to avoid freezing point.
3) Use Portland cement Type III, cement that helps in setting without reducing concrete's quality. It is important because high moisture content can induce corrosion problems in steel reinforcement.
4) Control chloride ions by suing fly ash, silica fume and furnace slag.

Figure 6.1: Curing Process in Extreme Weather

6.3 Using Admixture in Hot Weather Condition

The summer time effects of wind, temperature, and air humidity can collectively have a detrimental impact on the performance of concrete. Higher temperatures cause a faster rate of water evaporation and cement hydration, thereby stiffening concrete earlier and increasing the Risk

1) Retarders

These are designed to retard setting times so that the concrete worker has enough time to finish the surface of the concrete. It is also useful for maintaining concrete slump during long haul times to construction sites. Retarders temporarily stop the chemical action of hydration but after the planned delay hardening develops at an accelerated rate.

2) Water Reducing Retarders

Water reducing admixtures improve important properties of concrete in both its plastic and hardened condition. When wet the handling properties can be greatly improved without the addition of extra water. In hardened concrete the properties of the concrete are improved because of the more effective dispersion and hydration of cement. The retarding portion of the admixture delivers similar properties to the detail outlined above. Sika BV40R and BV45R are examples of admixtures which provided both reducing and retarding properties.

3) Retarding Superplasticisers

Super plasticisers provide substantial improvements in workability and flow ability without increased water, this allows for a lower need of vibration. Ideal applications include slender components, columns and beams with congested reinforcement, situations where concrete discharge is difficult and applications requiring fast and efficient placement of concrete. Sikament 1000R is an admixture which provides all these benefits as well as set retardation.

In Cold Weather Condition

1) Accelerator

Accelerating admixtures can help offset the effects of low temperatures by increasing the rate of cement hydration. This aids in the concrete setting time and the development of early strength in the concrete.

2) Air Entring Agent

Entrained air greatly improves concrete freeze/thaw resistance to damage. The addition of an air entraining agent causes millions of extremely small air bubbles to be introduced into the concrete matrix. This 'entrained' air remains in the concrete where the larger, naturally 'entrapped ' air will make its way to the concrete surface during normal placing operations.

3) Superplaticisers

Superplasticsers are high range water reducers. These can lead to a 10% - 30% reduction in the water content of a given concrete mix, but with workability characteristics of a normal slump mix still retained. This is an important factor in cold weather because if the water/cement ratio of a concrete mix is reduced the resultant concrete will have enhanced durability and strength characteristics.

Figure 6.2: Admixture

7. Result

1) The findings and analysis pointed out three key points to managing construction projects in hot weather conditions. These are: experience (local knowledge); the labor force; and forward planning.
2) Construction during hot weather conditions can be managed without affecting project handover dates, as found in the UAE. As mentioned by Interviewee C, the hot weather conditions magnify the management and planning issues that exist and may go unnoticed during the lifetime of a project.
3) The experience of managing projects in such extreme hot weather conditions plays a vital role in future planning and scheduling of site activities.

In order to minimize labor intensive activities in the summer. This is done through controlling the labor force to allow for changes in shifts and to allow for work during nightshifts.

8. Conclusions

It is generally well recognized that when concrete has to be mixed and placed in either very hot or very cold weather, it is necessary to take precautions to ensure that the concrete is not damaged or adversely affected by the ambient weather conditions. At temperatures below freezing, for example, freshly placed concrete may be damaged by the formation of ice within its pore structure. In very hot weather the concrete may stiffen prematurely, preventing it from being compacted and finished properly, or the temperature of the concrete may rise to the point where thermal cracking occurs as it cools. It is perhaps not so well recognized, however, that even at moderate air temperatures, strong dry winds can cause concrete to dry out prematurely and to crack

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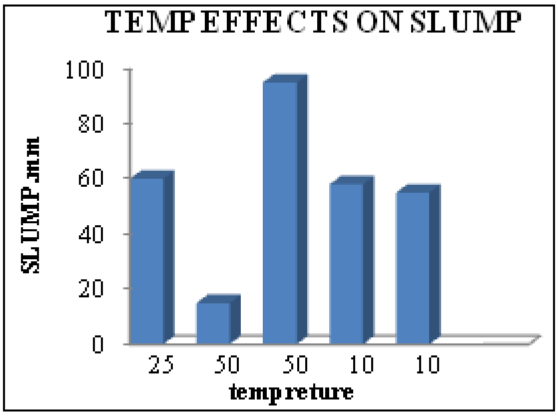
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60
40
20
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25
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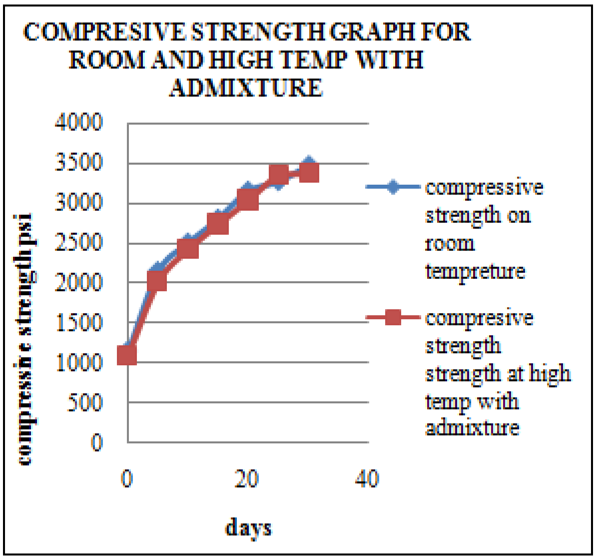
tempreture


COMPRESIVE STRENGTH GRAPH FOR ROOM AND HIGH TEMP WITH ADMIXTURE
4000
3500
3000
2500
2000
1500
1000
500
0
compressive strength psi
0
20
40
days
compressive strength on room tempreture
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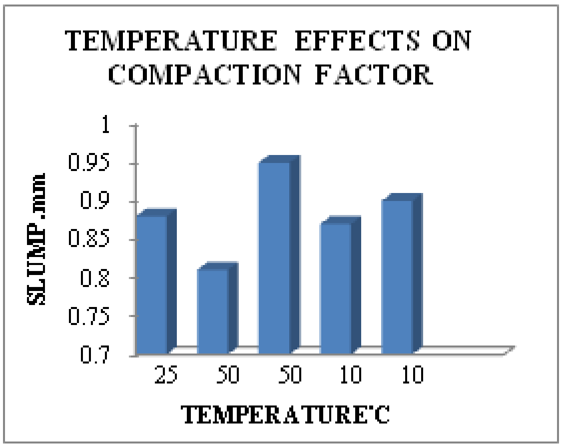
TEMPERATURE EFFECTS ON COMPACTION FACTOR
SLUMP .mm
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0.9
0.85
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50
10
10
TEMPERATURE'C

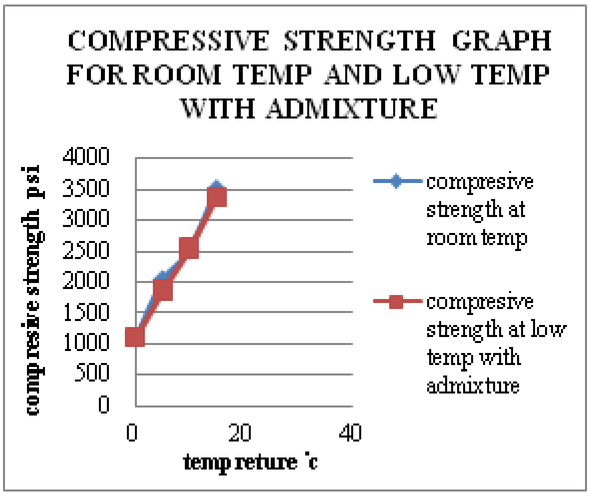

Table: Compressive Strength Of Cube At Various Ages

S.No	Condition	Temperature °C(first 3 days	Compressive Strength				
			1days	3 days	7 Days	28 days	Remark
1	Room Temperature	25°C	1100	2018	2510	3480	
2	High Temperature	500 C	1293	2167	2337	2990	14% reduction in 28 day strength
3	High Temperature with Admixture	50°C	1150	2150	2425	3370	3% reduction in 28 day strength
4	Low Temperature	8°C	945	1750	2520	3450	0.9% reduction in 28 day strength
5	Low Temperature with Admixture	8°C	1071	1840	2530	3350	4% reduction in 28 day strength

Table - Test Results for Compressive Strength of Cube at Various Ages
Mix ratio:-1:2:4 and w/c Ratio:-0.65

Table: Consolidated Table of Result (Mix ratio:-1:2:4 and W/c ratio: - 0.65)

Conditions	Slump mm	Compact Factor	TEST	1 Day	3 Days	7 Days	28 Days
Room Temperature 25°C	60	.88	Compressive Strength	1100	2018	2510	3480
			Splitting Tensile Strength	169	244	315	400
			Beam Tensile Strength	158	337	491	610
			Equivalent Cube strength	1065	1959	2423	3365
High Temperature 50°C	15	0.81	Compressive Strength	1293	2167	2377	2990
			Splitting Tensile Strength	190	250	275	334
			Beam Tensile Strength	211	280	464	557
			Equivalent Cube strength	1233	2190	2297	2892
High Temperature and Admixture Plastiment· Ar 340	95	0.95	Compressive Strength	1150	2150	2425	3370
			Splitting Tensile Strength	131	230	298	375
			Beam Tensile Strength	127	312	450	576
			Equivalent Cube strength	1082	2085	2392	3306
Low Temperature 8°C	58	.87	Compressive Strength	945	1750	2520	3450
			Splitting Tensile Strength	152	219	318	488
			Beam Tensile Strength	138	211	380	585
			Equivalent Cube strength	885	1712	2495	3412
Low Temperature Admixture Sodium Nitrite	55	.90	Compressive Strength	1071	1840	2530	3350
			Splitting Tensile Strength	156	249	332	448
			Beam Tensile Strength	175	316	489	650
			Equivalent Cube strength	1025	1796	2482	3314