Probing the ways to search optimization concreting condition in cold weather

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Abstract: Concreting conditions was specific in cold air because in cold weather, concrete setting and coolness of concrete is delayed and it is possible that low amount of cement paste is broken due to the formation of ice and considering the above issue, determining the time to start concrete curing is very hard and determining the age of concrete in that age, the concrete is very resistant against freezing, is hard. Thus, it is required to do some cautious measurements during casting, finish, curing, operation and concrete fixation in cold weather. The contractor should consider the protection against cold weather before delivering his proposal. Because if it is not so, the costs of corrective methods and controlling regulation plans including modeling and re-calculation of the structure based on the existing resistance and using additives to achieve better results are the responsibility of contractor. In this study, the required strategies to cope with cold air to achieve the required results and optimized operation by considering ideal conditions of workers are required.
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1. Introduction

Sun, wind, rain and snow are nature forces that we should be prepared to cope with them. For examples, it is possible that the temperature of the concrete is increased very much despite the temperature is not high. The wind is also dangerous for concrete projects. Namely, for the projects being carried out in high height because in high height, the wind speed is high. Due to this fact, when the wind speed is very high, the operation should be stopped. In addition to the sun and wind, unsuitable temperature (hot or cold air) has bad effect in concrete projects. Low temperature increases the negative risk level of the projects. Due to this fact, keeping good conditions for concrete is important and it is required to have the required knowledge of concreting and keep it in cold air. In this case, without any problem, providing, casting and keeping concrete are done.

There are different methods to protect concrete against cold weather but it should be considered that their difference is in the combination of consumed materials and the regions to be protected and the aim of all of them is the same. The aim of all the methods is to protect against the concrete that is saturated and don't have enough resistance against the injury of ice formation in concrete structure. This is due to the increasing possibility of freezing plastic concrete at low temperature and reduction of resistance and its durability due to freezing.

In all the methods, the specificity of concreting conditions at cold weather and the necessity of doing required actions to prevent the reduction of concrete temperature is emphasized. Because if this case is considered and it is planned, the required costs will be less than the costs being used for doing the required tests to determine the reason of failure, fixing defect concrete and soling the differences of the problems due to the lack of planning for cold weather. Indeed, protecting concrete against cold weather is not restricted to the period of providing and casting concrete and it should be considered during the operation of concrete structure and in case of its failure, the failure should be removed [1-2]. Considering the importance of considering the required strategies for protecting concrete against cold weather before, during and after concreting and during the operation of concrete structures, the required strategies should be recommended.

Cold weather and freezing conditions and its influence on concrete

For freezing conditions under which attention should be given to the concrete, various definitions are presented. For example, America concrete institution introduced cold air conditions as followings: The average daily temperature is not more than 40 (the average daily temperature by determining the minimum and maximum temperature during the day and night and averaging between two values is determined) or air temperature for 0.5 hours in a day and night is not more than 50. In another definition, cold air is called an interval in which the average daily temperature to less than 4 (40) drops for three consecutive days or more. In other

definitions, cold air is introduced as another way. For example, freezing land, the temperature of 2 , etc. Based on the optimized concrete temperature, cold air is defined. Some of the researchers introduced the optimized temperature as 4-40. While other researchers know the temperature 10-16, the best temperature for concrete. When the temperature is lower than the lower limit of suitable temperature for the concrete, it is called cold air [3-7].

Cold weather reduces the speed of concrete setting. The researches showed that for each 10 reduction, the temperature of the concrete for concrete setting is increased three times. For example, the concrete achieving the required setting during 6 hours at temperature of 70 at 50 the required time for setting is more than 11. This increases the required time for concreting and finishing. It should be considered that the time for the required operation of the concrete is increased and this increases some costs such as hourly workers [6]. In addition to the reduction of setting speed, the reduction of resistance and durability are raised. In a research, it is shown that in plastic case, if the concrete temperature is lower than the suitable amount, the concrete freezes. If the plastic concrete freezes, its potential resistance can be reduced to more than 50% and its durability will be affected negatively [8].

The strategies before concreting in cold weather

To create the satisfactory conditions for gaining the required resistance by concrete, the temperature should be increases. The required temperature is related to the surrounding environment and concrete. To provide the hot concrete, the hot raw materials are used. But the temperature of concrete should not be very much because the concrete at high temperature creates some problems such as rapid hardening, requiring more water and heat cracks. If the concrete is provided in the workshop, a good place should be provided for heating water, aggregate and storing them. Besides concrete, the framework should be heated to prevent sudden temperature change in concrete. In addition, other components such as concrete exit pipe from the lorry being relate to the concrete should be hot and insulated. If concreting is done on concrete surface, the concrete should not be put on the frozen land. We should wait until the land temperature is increased or by some straw or some other materials at the night before concreting, freezing earth should be avoided.

The strategies after concreting in cold weather

After concreting, its temperature should be increased. This is done for increasing the resistance of concrete against cold weather. Some of the standards are required to keep the temperature of the newly casted concrete for 3 days higher than21 or for 5 days higher than 10 . For keeping the concrete hot after casting it in the frame of some insulated boxes are used. This case prevents the escape and rapid cooling of the concrete. In addition, if the weather is very cold, some heated boxes are used. At first, the concrete cannot be covered by some insulators because some grits are produced. It is important to decide to use what type of concrete or to what time it can be kept without any cover [5]. To keep the concrete of the surrounding environment hot, some heaters can be used. But the heathers without ventilators should not be used because the carbon dioxide exiting from the heather is reacted with the surface concrete and weak dusty surface is generated. Thus, we should be ensured that the gases exist and the heater shouldn't be used beside the concrete. To insulate the environment, an insulated plastic or a good tent should be used. If the cold weather is used with wind blowing or wind barrier, the temperature of concrete should be fixed. As the cold weather is dry, the water solution and anti-freeze additives should be splattered on the concrete surface. This avoids water exists from the concrete surface. For concrete finishing, Shemsheh is used or a trowel is used [3].

By measuring temperature in concrete surface, the effect of the strategies for heating the concrete can be found. In addition, by measuring temperature in determining the fact that we can take the frame, it should be decided and we shouldn't remove the frame before the required time. Because by taking the frame out, its surface is cooled earlier and some cracks are generated. According to the studies, we should take out the frame when the difference of concrete level temperature and inside it is 35 [4].

Besides all the strategies being used for keeping the concrete hot, the workers should be kept warm also. Because until the workers are not warm enough, we shouldn't expect to do its best. Thus, we can say that the first step in keeping the concrete warm is to keep the workers warm and from warming the workers, we can do the following:

1- To wear more clothes
2- The fingers should be kept warm because the veins of the fingers are close to the surface and reducing of workability.
3- To drink much water because in cold weather, the body loses much water.
4- It shouldn't be allowed to have cold feet and hands
5- Face mask should be used
6- More activity should be done because the muscles create heat
7- The workers shouldn't be soaked
8- Heating tools should be used for heating the resting place of the workers
9- For warming the hands and feet, rest should be taken

10- The workers should be encouraged to have heating tools creating heat with chemical operation. In this case, they can warm their hand.
11- In case of high wind, the work should be stopped.

Using additives to cope with cold weather

To reduce water freezing inside the concrete, the ratio of water to cement can be decreased. This causes that the concrete gain rapidly the required strength to deal with the low temperature. In addition, some cement with low resistance gaining time is used. The other solution is using some materials besides the main materials of concrete to increase the best quality of concrete and reducing its failure in resistance against freezing. The mentioned materials are called additives. The additive can be some dryers in this case, due to the shortage of water, the negative effects of water freezing is low [9].

There are some anti-freezing additives to minimize water freeze in the concrete. The mentioned additives increase the temperature that the concrete can be cured well. Other form of additive that is used much is accelerator. Using accelerator reduces the final setting time. In other words, the concrete is finished earlier. If rebar is used with the concrete, the additives shouldn't contain chlorine. It should be considered that the effect of accelerator is limited if the temperature is between 5, 8 . In addition, we shouldn't use many mentioned additives. Because if more accelerators are used, the concrete will have early setting or plastic cracks. Thus, we should consider the recommended amount by the manufacturer of the additives [10].

Air-entraining admixture helps the concrete to deal with the cold air. This is done via small bubbles. This causes that the water on the verge of being freezing, without damaging the concrete are collected in a place. The main sources of producing air-entraining admixtures are including:

a. Vegetable and animal fats and oils and their fatty acids
b. Natural resins of wood reacting with the existing limestone in the cement and a resin solution are formed. Some of the insoluble resins in water are neutralized before by sodium hydroxide.
c. Mineral and organic chemical materials [9]

Due to the incorrect use of Air-entraining materials, make the standards of using air –entraining materials. Humid concrete is expanded like most of the concretes being exposed to air and this case blasts it. If Air-entraining admixture is used in the concrete, small air bubbles act as safety valve and neutralize the effect of expansion. This issue can be justified as water is hardened in capillary holes of cement and is expanded due to freezing. If the volume of expansion is greater than the access space, the extra water not being frozen is getting forward due to expansion pressure. Release of this hydraulic pressure depends upon the permeability of cement paste, submersion degree, the distance of the closest air hole not being filled with water and freezing degree. If in each point, hydraulic pressure is higher than tensile strength of cement paste, local rupture is created. By repeating the cycle of freezing and melting in wet environment, the water enters the cracks and rupture is developed. Air bubble in the concrete is as a reservoir in which the expanded water enters with pressure and it prevents the pressure on the concrete and the resistance of concrete is increased against freezing and melting. Thus, the concretes with saturated water and freezing and melting cycles, air entraining materials should be used in them to increase the durability of the concrete [11].

Air-entraining admixture is used for their resistance against deicing materials. To remove the ice and snow from the permanent way surface of the streets, roads, airport band and slab of the bridges, deicing chemical materials such as calcium color and sodium chloro are used. If this superstructure is made of concrete, continuous use of these materials to be laminated. The lamination depends upon the amount and frequency of consuming deicer materials. This failure is mostly physical and is not due to the physical reactions or crystal effects. Air bubbles are effective in concrete to prevent lamination. Air-entraining concrete is recommended for all concrete roads and is necessary for all the concretes being exposed to deicer materials [12].

In using air-entraining materials in concrete, we should considered to used them at proper time because in concreting in cold air, as during the construction of concrete, hot water is used, it is possible that the air-entraining admixture lose its effect. To compensate this loss, the additives should be added to the simple admixture when the materials reached the balance temperature. We should be careful about using the additives in the concrete because if the additive material freezes due to the low temperature, it will have negative effect on the new and hardened concrete. Some of the freezing additives are inclined to be separated to two or more phases and after being melted are separated also. If the admixture is mixed, the phases of additives are uniform in all part of the mixture. Due to this, to prevent the freezing, the additives should be put in suitable temperature before use. The mentioned temperature is different for various materials. Some materials freeze at the temperature of 28. Some of them freeze also at zero. In this case, we can get help from the providers and agents of distributing additives [13].

In addition to the suitable temperature of keeping additives, the suitable temperature of concrete admixture after the use of the material should be considered. To keep it warm, it is preferred that instead of increasing the temperature of reservoir; the room temperature should be increased. Because if the temperature of the concrete reservoir is increased, the temperature of the concrete is increased considerably and this reduces the effect of additives. In addition, the temperature of the required admixture generates some harmful gases. In addition, by increasing the temperature of the room, the freezing of pipes, pumps, contours and hoses are prevented [13].

If despite the strategies, the additive freezes, by increasing the temperature of admixture, it can be melted (at least to reach 50). Then, the mixture is mixed by a mechanical tool. In this case, vibration or low pressure is used. We should be careful about the air pressure because more air make the concrete full of foams and the foams cannot be distributed in the concrete uniformly. In addition, air source should be regarded to not to be combined with oil or water and make the concrete dirty. Due to the mentioned problems in using air pressure for mixing the admixture, concrete vibration is emphasized instead off air pressure [13].

After increasing the temperature of admixture and mixing it, to be ensured of its homogeneity, some tests are carried out. The tests are not costly and they can be done easily. Ph tests, specific mass, dryer slag furnace and radiance analysis were carried out on the concrete. The mentioned tests are not time-consuming and to avoid the failure of concrete or worse than it, the concreting is done [13].

2. Conclusion

Weather condition is an important factor in placing concrete and concrete splashing because the speeds by which the existing materials are set and gain resistance are important. Cold weather retards the chemical reactions and reduction of materials setting. This case damages the concrete. In addition, freezing air conditions are harmful for keeping the concrete and fixing it. Thus, if the weather is cold, the required strategies should be considered. Concreting in cold air is hard even at best conditions. Because of this, it is required that concreting is done in spring and summer. But if concreting should be done in cold condition, it should be considered as setting speed of concrete is high. This cases causes that cement paste has required resistance to resist against freezing conditions. Thus, the required concrete is a good and durable concrete.

To provide the concrete at the acceptable time, the recommended strategies such as keeping the concrete warm before and after concreting and considering good cover for workers to keep them warm and using additives and melting the snow covered on the frames and using wind barrier and using heater in the rest place of the workers, etc should be considered. In addition to the mentioned items, the experiences of the previous projects and the data of the previous projects should be used. In this case, it should be considered that to select the type of strategies, in addition to the costs, the quality should be considered. In addition, management issues such as reduction of workers efficiency in cases of wearing many clothes and hidden costs such as lighting costs due to the short time of the day and extra costs due to overworking of the workers (due to the reduction of efficiency of work at cold air) should be considered. It should be considered that in addition to the mentioned strategies, the recommendations of the concrete providers in the region of carrying out the project should be considered. Because they are familiar with the region and its conditions completely and they have valuable experiences in this regard and it removes the problems. It is required that the contractor considers the risk of concreting in cold air and reaches an agreement regarding the distribution of the mentioned risks.

Finally two items are mentioned. The first item is related to concreting in High Mountain. In cold air, concreting at high elevation is more problematic than concreting in low elevation and it is done with more delays. This is due to some issues such as reduction of temperature by increasing the height of accumulation of snow on the machineries used in the high elevation and the problem of taking the accumulated concrete on the frames. The next issue is related to the use of specific concretes and if we use them, in addition to achieving the mentioned goals for these concretes, concreting, keeping the concrete and its fixation is done easily. The sample was from the mentioned concretes with high strength. This concrete has low time for setting. This case reduces the time for keeping the concrete at suitable temperature to reach the required strength. The result of this case is saving time and reducing costs.

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