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Anti-Freezing Admixtures Effects on the Concrete Properties

Danish Hussain Thoker[1], Pushpendra Kumar Sharma[2*]

[1]*M. Tech Scholar, SCE, Lovely Professional University, Phagwara, Panjab, India*
Mail: [I] danishthoker0139@gmail.com

[2]*Professor, SCE, Lovely Professional University, Phagwara, Panjab, India*

**Corresponding Author: p.sharmaji10@gmail.com*

Abstract: *Geographically speaking, Kashmir is located in a region where weather conditions remain adverse. The fluctuation of the temperature remains in flux. Especially, during winter temperature often goes down below 0^0 C. So, concreating seems maximum constraints during winter at the places like Kashmir where temperature is too low. Keeping in view, the present review was intended to explore how the anti-freezing admixtures affect the concrete properties as reported in previous existing research; so as to investigate or leave the scope for further research on the mitigation of these adverse effects. In the same consonance, many researchers have observed the effect of Sodium nitrite, Potassium carbonate, urea, calcium nitrite etc. with strong resistance. So, trends of previous research studies have been analysed and the authors have made their best efforts to explore and update the knowledge of various admixtures and their effects on concrete in prevailing similar weather conditions as that of Kashmir.*

Key words:*Anti-Freezing Admixtures, Sodium Nitrite, Potassium Carbonate, Temperature Cold weather concretingetc.*

1. Introduction

Concrete is most extensively utilized constructional material, which iscontinuously exposed to the fluctuations in humidity and temperature. Thephysic-mechanical properties of the concrete changedue to prevailing atmosphericconditions.The Kashmir valley and Ladakh occupies unique position in the entire world, keeping the geographical conditions under consideration. Especially during winter season, the temperature often fluctuates from 5^oc during day to -10 during night. In high cold regions like Kashmir and Ladakh during winter season freezing of water is common condition. Consequently, during winters period some precautionary measure are adopted while construction, to avoid the adverse effect of sub-zero temperature. Also in these regions, concrete is subjectedto frost action due to which durability getsaffected. Because of water present in fresh concrete, ice formation occurs at the time of exposure to the sub-zero temperatures; resulting almost 9% increase in volume which is the root cause of concrete and structural integrity damages.

It has been observed thatin Kashmir and Ladakh people including Government annually spend lot of money to facilitate concreting in cold environmentand for the extension of the construction spell. The daily average temperature is lower than 5°C for 5 consecutive days, and the concrete works will enter the winter construction. At this time, the concrete project needs to consider the low temperature from the design of the mix ratio, the initial

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temperature of the raw materials, to the pouring, forming, curing and removal of the mould. Besides this, low temperature mainly affects the hydration rate of cement and volume expansion after water freezing, leading to prolonged coagulation hardening, internal structural damage and slow growth of strength. If the curing temperature of the concrete is reduced to 10°C, the setting time will be doubled. If the concrete curing temperature is lowered to -5°C, the fresh concrete will be subjected to freezing, and the compressive strength at the later stage will be lost by more than 50%. Therefore, a series of winter construction techniques in cold regions is to protect early-stage concrete from freezing damage. Under negative temperature, incorporation of anti-freezing admixtures in concrete and proper insulation measures are common methods in winter construction of concrete in cold regions.Antifreeze admixtures refers to a chemical substance that makes a concrete mixture free from freezing damage in a negative temperature environment. Many inorganic salts and some organic substances have anti-freezing property. The mode of action can be divided into two categories: one is a very low eutectic temperature with water, which has the ability to reduce the freezing point of water, and allows the concrete to perform hydration at negative temperatures, such as sodium nitrite and sodium chloride. However, if the amount is insufficient or the temperature is too low, it will still cause freezing damage.

In the present study an attempt has been made by the investigator to study theresearch problem which reads as "Anti-freezing admixtures effects on concrete properties"

2. Operational Terminology

The operational definitions of the terms used in the present study are detailed discussed as follows

2.1 *Anti-Freezing Chemical Admixtures*

Anti-freezingchemical admixtures are chemical substances that are used as ingredient of concreteto change the property of concrete. Usually, these chemicals are added relatively in a smallamount by weight of cement so as tovaryspecificpossessions of fresh and hardened concrete. During the cold temperature these chemical admixtures are employed to nullify the effect of freezing on concrete.

2.2 *Properties of Concrete*

It is very difficult to place concrete in colder climate and to protect it against freezing specially the freshly prepared concrete. There are many methods to speed up hardening of the concrete in cold environment but the most adopted and effective one is using admixtures of anti-freezing characteristics in cement by weight. Therefore, it is the process in which chemical substances are used to gain the early strength of concrete.

3. Objective of the Study

To explore the level of anti-freezing admixtures effects on the concrete properties. In addition to this, the present study intends to investigate or leave the scope for further research on the justification of these adverse effects.

4. Literature Review

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The researchers used calcium nitrate 30% andhydroxyethoxyamine 5% (A), calcium nitrate (B) and polyhydroxyamine(C) as an anti-freezing admixture to examine the concrete strength in compressionexposed to frost action in presence of these admixtures. They noticed that for different temperature variations and admixture fractions, the concrete strengthin compression did not reach 30MPa. It had been seen that in all ranges of temperature variations, under which concrete was cured, the concrete strength in compression decreased and the maximum decrease wasobserved in between 0℃ to -5℃ among all [1].

Researchers observed some identical change instead of some parameters. It has been mentioned that at -5℃ for 7 days cure with calcium nitrate mixed concrete have more than 4.5 times compressive strength than that of normal control samples. But the compressive strength value decreased gradually from 15.53MPa at -20℃ with the decrease in temperature. In 14 and 28 days freezer cure case decrement in compressive strength continues. There is a great variation in compression strength values with change in temperature i.e. from -5℃ to -20° C [2].

The investigators used urea as an anti-freeze admixture to know its effect on strength gaining on fresh concrete and investigated that usingurea workability of concrete increases from 4cm to 12 cm. They also concluded that maximum compressive strength obtained when sample contains 6% urea at -5℃, also without containing urea if samples are subjected to deep freezing reduction in compressive strength occurs. From the SEM images it could easily be seen that samples containing admixtures have dense micro structure and contact zones between aggregate and cement paste increases, resulting in increase in hydration process. Hence, early strength attainment [3].

The researcher investigated the effects of anti-freezing admixtures such as calcium nitrate and urea on concrete under freezing ambient temperature. They noticed that both admixtures have significant and positive effectsi.e. anti-freezing concrete gained strength more rapidly than controlled one at -5℃ to -10℃ for 7 days of curing. From the results he conforms that calcium nitrate have good setting property i.e. acts as accelerator [4].

The researchers investigated the effect of anti-freezing admixtures like calcium nitrate in relation of freezing and thaw cycle and also theurea. They concluded that addition of these anti-freezing additives to concrete decreases the water absorption by 7.7% and 12.1% using urea and calcium nitrate respectively. He further investigated that with the increase in number of sub-zero temperatures anddefrosting cycles, the effect of anti-freezing agents on water sorption also increases. Also the results revealed that samples havingCalcium Nitrate ($CaNO_3$)were denser and compacted microstructure as compared to samples containing urea [5].

A researchers groupspecially developed Rapidite as anti-freeze admixture for concrete setting acceleration which also increasesedits workability. Using rapidite about 1.8% of cement compressive, tensile and flexural strength increases [6].

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The research group used sodium nitrate and potassium carbonate as an anti-freezing admixture. The result showed that strength (compressive, split tensile and flexural)of concrete exposed to -5℃ for first 2 days increases by using 5% of potassium carbonate and 6% of sodium nitrate. He also noticed that modulus of elasticity had good compatibility with compressive strength, however poisons ratio did not seems to follow any specific trend [7].

5. Conclusion

Usually all the different anti-freezing admixtures follow the same trend of increasing strength below freezing temperature up to certain temperature of -5° C.

Certain admixtures like calcium nitrate acts as an accelerator

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