CONCRETING IN SPECIAL CONDITIONS

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Abstract

Concreting in special conditions refers to the application of specific techniques and methods of concrete works in conditions such as extreme temperatures (low and high), high humidity, underwater works, aggressive environments, under high pressure or in areas with increased seismic risks. In such conditions, the concrete must be adapted to ensure the necessary strength, durability and safety. In cold conditions, concrete with the addition of additives to accelerate hardening is used, while in hot conditions, additives that slow down the hardening process should be used. Concreting in wet conditions or under water requires the application of special techniques, such as the use of waterproof concrete or concreting in cavities under water. In addition to the main problems when concreting in these conditions, we also use appropriate protection measures for the mentioned cases. Proper preparation of materials, control of temperature, humidity and installation technology are key to achieving the desired performance of concrete structures. In addition to the above, attention must also be paid to temperature and humidity control, as well as quality preservation during the entire concreting process.

Keywords: *concreting, extreme temperatures, humidity, pressure, aggressive environments*

JEL work classification*: L7*

1 INTRODUCTION

Concreting is a key stage in construction works when building buildings, and concrete is one of the most important building materials we use. In special conditions, concreting becomes challenging due to various factors that make it such as extreme temperatures, humidity, the presence of aggressive substances, and complex geological and climatic conditions. Regarding the above, different special conditions that affect concreting and the techniques that are applied in order to achieve the desired result in the specified conditions must be analyzed.

2 SPECIAL CONDITIONS IN CONCRETING

1.1. Extreme temperatures

Concreting in conditions of very low or very high temperatures requires special measures to prevent premature hardening or cracking of the concrete.

1.1.1. Concreting at low temperatures

In winter conditions, low temperatures can cause water in the concrete to freeze, which hinders the hydration process. This can lead to poor strength, poor concrete quality and cracking due to ice expansion. In addition, freezing of concrete can cause the formation of micro-cracks and reduce the long-term durability of concrete. Also, too rapid cooling of concrete occurs when concrete cools too quickly, and thermal stresses can occur that cause cracking, which is especially problematic in concrete structures that require high strength. For these conditions, various additives are used, such as means to accelerate hardening, and the use of heated aggregate and water, as well as the application of special installation methods and technology. With all the necessary protection measures, concreting at low temperatures can be carried out safely and efficiently, which enables construction even in the most difficult conditions.

1.1.1.1. Measures to protect concrete at low temperatures.

In order to protect the concrete in these conditions, it is necessary to use the following:
Heating the water: The water used in the mixture must be heated before adding it to the concrete. It is ideal to use a water temperature of around 50-60°C.
Aggregate heating: Aggregates, such as sand and gravel, can also be heated to increase the temperature of the mix.
Curing of cement: In some cases, warm cement can be used, because warm cement reacts faster with water and helps the concrete harden faster.
The use of additives to accelerate the hardening: they speed up the cement hydration process, thus reducing the risk of water freezing before the cement is fully hydrated, and anti-freezing additives such as calcium chloride, which help prevent the mixture from freezing and accelerate the hardening of the concrete.
Thermal blankets and insulation: After pouring the concrete, protect the surface of the concrete from freezing with thermal insulating blankets, geotextiles, plastic films or special heating cables.
Plastic sheets and geotextiles: These materials can help keep the concrete warm and prevent freezing during the curing process.
Site heating: In some cases, it may be necessary to use portable heaters or heating systems to raise the temperature of the environment and concrete at the site.
Concreting during the day: If possible, concreting should be done during the day when temperatures are higher. However, if

concreting must be carried out at night, additional protection and heating measures are required.
Temperature monitoring: It is important to monitor the temperature of the concrete to ensure that it does not fall below the critical 5°C before initial strength is achieved. This can be achieved by installing a temperature sensor in the concrete mix.
Temperature of the concrete mixture: The recommended temperature of the concrete mixture in cold conditions is between 10 and 20°C, in order to allow proper hardening.

1.1.2. Concreting at high temperatures

In hot conditions, the concrete mixture hardens faster, which can lead to cracking and poor quality concrete. The use of cold aggregates, shading of concrete surfaces, and the addition of additives that slow down the hardening of concrete can help in these conditions. Concreting at high temperatures also presents a specific challenge in the construction industry. High temperatures can affect the quality of concrete, accelerate the hardening process, reduce the working life of the concrete mixture and cause numerous damages to the finished structure. Given these risks, it is necessary to apply special techniques and protective measures to ensure optimal concrete properties.

1.1.2.1. The main problems in concreting at high temperatures

Concrete hardening too quickly: When the temperature rises, the rate of cement hydration increases, which means that the concrete can harden too quickly. This can lead to a reduction in the working time required to evenly distribute the concrete, thus increasing the risk of non-uniform concrete properties.
Cracking of concrete: Rapid hardening of concrete can cause the formation of thermal stresses within the mass of concrete itself. These stresses can cause cracking of the concrete surface, which can lead to a decrease in the quality and longevity of the building.
Loss of water in the concrete mixture: High temperatures can cause rapid evaporation of water from the concrete, which reduces the amount of water needed for hydration. This can lead to a reduction in concrete strength and an increase in porosity, which increases the risk of reinforcement corrosion and reduces weather resistance.
Uneven hydration: High temperatures can cause uneven hydration, whereby the outer layers of concrete harden faster while the inner layers remain soft, which can lead to uneven strength properties.

1.1.2.2. Measures to protect concrete at high temperatures:

Use of cold materials
Aggregate Freezing: Using cold aggregate can help reduce the temperature of the concrete mixture. The aggregate can be stored in cool places or even frozen to reduce the effect of high temperatures on the mixture.
Water cooling: Water used for mixing concrete should be cold, and in hot conditions ice water can be used to control the temperature of the concrete mixture.
Retarders: The use of additives that slow down the hydration process is known as the use of retarders. These additives extend the hardening time of concrete, which enables better control of the concreting process in conditions of high temperatures.
Plasticizers: The plasticity of concrete can be improved by using plasticizers, which allows better workability of the concrete mixture and reduces the risk of cracks due to rapid water evaporation.
Reduction of ambient temperature: If possible, concreting should be carried out in the early morning or late evening hours to avoid temperature peaks during the day.

Shading of concrete surfaces: Concrete that has been poured should be protected from direct solar radiation by using different shading materials such as plastic films, canvas or even special roofs.
Application of water mist:
In areas with extreme temperatures, water mist can be used to wet the concrete surface. This procedure helps to reduce the rate of water evaporation from the surface of the concrete, which prevents premature drying and allows proper hydration of the cement.

1.2. Concreting in conditions of high humidity and underwater conditions

Concreting in conditions of high humidity or underwater conditions requires the use of special types of concrete that are resistant to water, special approaches and techniques to ensure the long-term strength and resistance of the concrete. Such concretes contain additives that increase water tightness, such as silicate or acrylic coatings, and the use of concrete with a high cement content for better water resistance. Concreting in underwater conditions, whether it is for foundations in water areas, building ships, underwater platforms or dams, requires very specific techniques due to the constant contact of concrete with water. The quality of concrete can be seriously compromised if the concrete is not poured properly under underwater conditions, as water can adversely affect the concrete's curing process. The use of additives, adequate protection of concrete from excessive moisture retention, and the application of various insulation techniques can significantly help prevent problems. In underwater conditions, specialized underwater concrete, the use of concrete forms and pipes, and additives that increase the concrete's resistance to water and salt, are key to ensuring the quality and stability of concrete structures.

1.2.1. The main problems when concreting in conditions of high humidity

Excessive water retention: High humidity can slow the evaporation of water from concrete. If water remains in the concrete for too long, it can slow down the cement hydration process, resulting in a decrease in concrete strength. Depending on the conditions, excessive water retention can also cause greater porosity in concrete, reducing its long-term resistance to moisture and other adverse conditions.
Decrease in strength: If concrete contains too much moisture, its strength may decrease. This is particularly problematic in situations where it is necessary to achieve strength quickly, such as structures that are subject to heavy loads in the early stages.
Distortions and deformations of concrete: High humidity can lead to deformations of concrete during the hardening process. In extreme conditions, distortion of concrete structures can occur due to excessive moisture intake, especially in combination with high temperatures.

1.2.2. Measures to protect concrete in conditions of high humidity

Control of temperature and humidity: When concreting in conditions of high humidity, it is important to ensure adequate monitoring of the temperature and humidity of the environment. Concrete should be protected from excessive exposure to moisture during the hardening process, but also prevent evaporation of water from the concrete mixture.
Use of moisture-reducing admixtures: Additives that reduce moisture retention in concrete can be used to ensure optimal hydration. Also, moisture control agents, such as retarders, can be used to prevent excessive moisture absorption.
Concrete insulation: Protection of concrete from direct contact with water and moisture

can be achieved by using protective materials such as plastic foils or blankets that allow controlled evaporation and preservation of adequate humidity of the concrete mixture.

1.2.3. The main problems in concreting under underwater conditions

Effect of water on hydration: In underwater conditions, concrete can come into contact with large amounts of water that can cause dilution of the mixture, thereby interfering with the normal process of cement hydration. Water can wash away some of the cement, reducing the strength of the concrete and its resistance to aggressive conditions.
Osmotic pressure: In some cases, water coming from an underwater environment can cause osmotic pressures in the concrete, which can result in cracking or spalling of the concrete over time. This phenomenon is particularly worrisome in areas with high water salinity, such as seas or oceans.
Problems with concrete placement: In underwater conditions, the concrete must be placed in a form that prevents expansion or shearing of the concrete mix due to water movement. If concrete is poured in the wrong way, segregation can occur, in which heavier aggregates fall to the bottom while lighter materials rise, negatively affecting the quality of the concrete.

1.2.4. Measures to protect concrete in underwater conditions

Use of underwater concrete: Underwater concrete is a special type of concrete used for concreting in underwater conditions. This concrete must be formulated to have the proper consistency, strength and water resistance. Underwater concrete often includes additives that increase its density and help prevent segregation and dilution of the mixture when it’s in contact with water.
Use of concrete formwork: In underwater conditions, special concrete formwork is often used, which enables precise shaping and placing of concrete. These forms help to stabilize the concrete mixture while it hardens. Formwork can be metal or plastic and is often used for concreting in the depths of the sea or at high altitudes.
Use of microsilicates and other additives: Microsilicates or other additives can be added to concrete to improve its resistance to moisture and reduce the risk of erosion or reaction with salt water. These additives increase the density and strength of concrete, which enables its greater stability in underwater conditions.
Concreting using concrete pipes: Concreting at sea often involves the use of concrete pipes that allow the concrete to be placed under underwater conditions. These pipes allow the concrete to be poured underwater and to form within a closed frame, thus preventing contact with large amounts of water before the concrete has reached the required strength.
Control of concrete temperature: In conditions where underwater concrete must be placed in very cold water (such as underwater dams in cold rivers), the concrete must be heated or admixtures that accelerate concrete hardening are used to prevent freezing of the concrete mixture.

1.3. Concreting in aggressive environments

Concreting in aggressive environments presents special challenges. In industrial areas or near the sea, concrete can be exposed to aggressive chemicals, such as sulfuric acids, chlorides and other corrosive compounds. Such conditions can lead to corrosion of reinforcement, weakening of concrete, cracking or erosion of the surface layer, which requires special approaches in the selection of materials, design and protection of concrete. Then special concretes resistant to chemical attacks are used, such as concretes with a high content of

Portland cement, silicate concretes or concretes enriched with additives that reduce porosity. Proper maintenance and application of protective systems, such as durability additives and concrete injection, can further ensure the long-term stability of concrete structures and reduce future repair costs.

1.3.1. Main challenges when concreting in aggressive environments

Corrosion of reinforcement: Corrosion caused by chlorides. In environments with a high salt content, such as coastal, seawater or industrial areas, chlorides can penetrate the concrete and come into contact with the reinforcement. This causes corrosion of the steel in the concrete, reducing its strength and stability.
Alkali-silicate reaction (ASR): In some environments, especially those with high alkali content, a reaction can occur between the alkali in the cement and the silicate minerals in the aggregate, leading to the formation of gels that absorb water, creating pressure within the concrete and causing cracks.
Sulfuric acid and sulfates: In areas where sulfates are encountered, such as industrial plants, wetlands, or underground conditions, sulfates can react with hydrated calcium in concrete, forming harmful compounds that cause the concrete to expand and degrade.
Biological and Microbiological Threats: Microorganisms, such as bacteria and fungi, can thrive in moist environments and cause concrete to deteriorate. For example, bacteria that cause corrosion of concrete in drainage systems can cause physical damage to the material.
High temperatures: In industrial environments with high temperatures, such as steel, cement or petrochemical facilities, concrete must withstand temperature shocks that can cause cracking or weakening of the concrete. These high temperatures also accelerate corrosion processes and consequently reduce the durability of concrete structures.

1.3.2. Measures to protect concrete in aggressive environments

Use of special concrete mixes: Sulfate-resistant cements: For concreting in conditions where there is a risk of sulfate corrosion, a special cement (sulfate-resistant cement) is used. This cement reduces the risk of concrete degradation due to the reaction of sulfate with calcium in the concrete.
Use of high-density concrete: Low-pore, high-density concrete can reduce the penetration of aggressive substances such as chlorides and acids. High-density concretes also better tolerate aggressive chemicals and can be resistant to acids, making them ideal for chemically induced attacks.
Concrete with reduced pore content: Reducing the porosity of concrete by using fine aggregates, lower amounts of water in the mixture, and the use of plasticizing additives can improve resistance to chemical attack.
Protection of reinforcement: Corrosion protection of reinforcement: In aggressive environments it is very important to protect reinforcement in concrete. This can be achieved by using protective coatings on the reinforcement, such as epoxy coatings, or by using stainless steel reinforcement that is resistant to corrosion.
Use of Chloride Barriers: Placing physical barriers in the concrete or using special chloride protection systems also helps prevent reinforcement corrosion. Barriers can include layers of protection or the use of concrete with additional additives that make it difficult for chloride to penetrate into the concrete.
Increasing the durability of concrete: Additives to improve durability: Additives such as silicone, polymer or micro-silicate additives can improve the resistance of concrete to aggressive environments. These

additives increase the density of concrete and reduce the permeability of aggressive substances, such as sulfates or chlorides.
Injection systems: In cases where aggressive substances have already infiltrated the concrete, injecting the concrete with specialized compounds can help restore and protect damaged areas.
Proper maintenance: Maintenance of concrete structures in aggressive environments is essential for their longevity. Regular inspection of concrete, repair of cracks, protection of surfaces from chemical attacks and prevention of water penetration can extend the life of structures.

1.4. Concreting under high pressure

Concreting under high pressures is a challenge in the construction industry, especially in projects that require high strength and resistance of concrete to mechanical forces. High pressure can occur in various conditions, such as deep underwater facilities, underground facilities (eg mining and energy plants), tall industrial facilities, and even under conditions of heavy loads in building structures. Concrete used in such conditions must be specially designed to withstand high mechanical stresses and requires special materials, production techniques and quality control. Through the application of these measures, it is possible to successfully concretize in challenging conditions of high pressure, which enables the construction of stable and long-lasting facilities in industry, underwater and underground works.

1.4.1. The main challenges in concreting under high pressures

Deformations of concrete under high pressures: High pressures can cause significant deformations of concrete, even to the point where microcracks can occur within the concrete, reducing its strength and durability. The concrete must have sufficient strength to withstand these deformations without compromising the stability of the structure.
Risk of porosity: Under high pressures, concrete can become more porous because the increased force can cause the aggregate or cement paste to move within the mix. This can lead to a decrease in the concrete's resistance to water, moisture and chemical attacks. Also, increased porosity reduces the strength and durability of concrete.
Effect on hydration: High pressure can interfere with the natural process of cement hydration. If the concrete is not properly controlled during the initial setting stage, the high pressure can lead to a decrease in the setting of the cement, resulting in a decrease in the strength of the concrete. This is particularly problematic in underwater conditions, where it is necessary to ensure proper hydration of the concrete.
Increased risk of cracks and voids: If the concrete is not properly mixed or does not contain the correct proportion of fines and additives, the high pressure can cause cracks to develop. This can be particularly pronounced in very humid environments, where water can penetrate the concrete and cause additional damage.

1.4.2. Measures to protect concrete under high pressure

Use of high-strength concrete: High-pressure concrete must be specially designed to withstand high compressive forces without degradation. Usually, high-strength concrete is used (eg concrete class M50 and above) which contains aggressive aggregates such as granite and slate, as well as additives such as microsilicates or fibers, which increase its density and reduce porosity.
Use additives to strengthen concrete: In high-pressure conditions, special additives and fibers are often used to improve pressure resistance and reduce porosity. For example,

steel, glass fiber or polymer fibers can be added to increase the ductility of the concrete and reduce the likelihood of cracking under high pressures.
Increasing density and reducing porosity: Concrete is often adapted for high pressures by reducing its porosity. By using very fine cement paste, special aggregates and additives, concrete is made more compact and resistant to the penetration of water and other aggressive substances, which is key to its longevity.
Control of concrete hardening: In high pressure conditions, it is important to ensure that the concrete hardens properly. By using chemical additives to speed up or slow down the hardening, the hydration time of the concrete can be adjusted to enable its optimal hardening despite the external conditions. Also, temperature control is needed to prevent water from evaporating too quickly from the concrete.
Use of specialized concrete forms: In constructions that are under high pressure, specialized concrete forms are often used, which enable an even distribution of the force on the concrete. Formwork can be designed to withstand high pressures and increase the stability of concrete structures during the construction process.
Increasing the thickness of concrete layers: In many structures exposed to high pressures, the thickness of concrete layers can be increased to improve its ability to withstand high forces. This is particularly important in underwater or deep underground conditions, where the concrete must withstand high pressures from water or earth.

3 TECHNOLOGY OF CONCRETING IN SPECIAL CONDITIONS

Preparation of the concrete mixture: For special conditions, it is necessary to adjust the concrete mixture in accordance with the conditions on the construction site. This includes the selection of special additives, aggregates and water, and careful monitoring of the ratio of ingredients to achieve the desired properties.
Concrete temperature control: In conditions of extreme temperatures, it is necessary to use techniques that enable temperature control during the concrete process. In cold conditions, this includes the use of heated equipment, while in hot conditions, cold water and aggregates should be used, as well as the application of concrete protection from direct solar radiation.
Timely execution and protection of concrete: For successful concreting in special conditions, it is important to monitor the conditions during the entire process. This includes concrete temperature monitoring, timely placing and rolling of concrete, and ensuring protection against rapid drying or freezing.

4 CHALLENGES AND SOLUTIONS

Excessive rapid hardening of concrete: In hot conditions, concrete can harden too quickly, which can lead to poor structural properties. The use of concrete hardening retarders and application of concrete cooling using ice water or shading can help reduce this problem.
Concrete Cracking: Extreme temperatures, improper mixing of concrete and improper curing can cause concrete to crack. The use of appropriate additives, such as plasticizers and stabilizers, can significantly reduce this probability.
Problems with transporting concrete: In special conditions, it is often difficult to transport concrete to the construction site, especially in hot and humid conditions. The use of concrete pumps and silos can help transport concrete more efficiently to remote or hard-to-reach locations.

CONCLUSION

Concreting in special conditions represents a serious challenge in the construction industry. Understanding specific conditions such as extreme temperatures, high humidity, aggressive environments and high pressure is essential to achieve the quality and safety of concrete structures. The application of appropriate technologies, materials and methods of protection enables successful overcoming of these challenges. Innovations in concrete technology and constant research enable even more efficient approaches and solutions for concreting in demanding conditions.

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