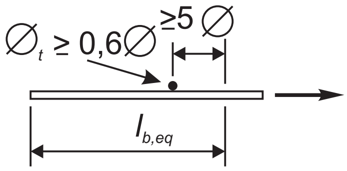

Fig. 4. Equivalent length of anchorage for welded cross bar according to EN 1992-1-1-2009

From practical design experience it is known that in the manufacture of welded reinforcements and welded fabrics (especially in cases when cross reinforcement is placed for reasons of design) the ratio of diameters of welded cross and longitudinal bars is usually ≥ 0,25. So, in the standard the decrease of anchorage effective length for such welded reinforcement units isn't taken into consideration. That's why, it's necessary to find out the generalized coefficient of a welded cross bar influence on the anchorage of a longitudinal bar so that it should include the maximum possible amount of factors: the ratio of reinforcement diameters, shearing strength class, amount of shrinkage, the amount of cross and distribution bars in the zone of anchorage and so on.

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STUDY OF THE EFFECT OF PLASTICIZER ON THE PHYSICAL AND MECHANICAL PROPERTIES OF CONCRETE MIXTURE AND CONCRETE IN ACCORDANCE TO THE INTERNATIONAL TEST METHODS

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This article is devoted to the methods in preparation of concrete, corporation between the American and the European methods, climates in the Middle East countries, the effect of weather on the concrete: heat, moisture and curing of concrete,

Concrete is the most widely used construction material through the world and has gained a unique place in the construction industry, it is used more than any other man-made material in the world. As of 2006 around 7.5 cubic kilometers of concrete are made each year, more than one cubic meter for every person on Earth [1].

Concrete is a hardened building material created by combining a chemically inert mineral aggregate (usually sand, gravel, or crushed stone), a binder (natural or synthetic cement), chemical additives, and water.

During hot weather conditions, a number of on-site factors can work against deriving optimal performance from concrete. When combined with low relative humidity and strong winds placing and finishing requires special care. Recently this problem have been more effect on the construction business in the Gulf Arab States such as Qatar and Saudi Arabia according with the hot weather, the water scarcity and the cost of extracting. The coastal cities environment in Saudi Arabia and the Gulf states are classified globally as one of the high-risk on the concrete structures because they contain the highest percentage in the world of ultraviolet and infrared rays with the lack of rain every year [2]. We suppose that the appropriate methods for solving this problem in preparing of concrete is by adding some chemical admixtures, depending some precautions and curing concrete.

Firstly, we will review the following points:

1. The international methods in preparation of concrete

• GOST - State Standard Gost

GOST standards are regional standards administered by the Euro-Asian Council for Standardization, Metrology and Certification (EASC).

The collection of GOST standards includes over 20,000 titles used extensively in conformity assessment activities in 12 countries. Serving as the regulatory basis for government and private-sector certification programs throughout the Commonwealth of Independent States (CIS), the GOST standards cover energy, oil and gas, environmental protection, construction, transportation, telecommunications, mining, food processing, and other industries. The following countries have adopted GOST standards in addition to their own, nationally developed standards: Russia, Belarus, Ukraine, Moldova, Kazakhstan, Azerbaijan, Armenia, Kyrgyzstan, Uzbekistan, Tajikistan, Georgia, and Turkmenistan [3].

• BSI – British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. Royal Charter incorporates it [4].

• New European standards for concrete

European Standards are being introduced gradually to replace the current British Standards used in the construction industry. The standards are being implemented across Europe to create harmonization between all member states and remove trade barriers between members. This harmonization will create and promote opportunities to increase free trade throughout the European Community.

From 1 December 2003, the British standard for concrete, BS 5328, was withdrawn and replaced by the new European standard for concrete, EN206-1. This Europe wide standard is complemented by the British version of the concrete standard, BS 8500. In the UK, EN 206-1 shall be called BS EN 206-1 and together with BS 8500-1 and BS 8500-2, will offer direction and guidance on the specification, production and control for ready mixed concrete [5].

• American Concrete Institute

The American Concrete Institute (ACI) Founded in 1904 and headquartered in Farmington Hills, Michigan, USA, the American Concrete Institute is a leading authority and resource worldwide for the development and distribution of consensus-based standards, technical resources, educational programs, and proven expertise for individuals and organizations involved in concrete design, construction, and materials, who share a commitment to pursuing the best use of concrete [6]. It should be noted that the Middle East countries and the Gulf States usually were used the European method. Recentlythey use the American method.

2. The difference between the American and European methods

Table 1 represents the basic regulations on the manufacturing methods, storage and testing of concrete samples.

Table 1 – The basic regulations on the manufacturing methods, storage and testing of concrete samples

Method	American Concrete Institute	European standards for concrete
Form, size and number for compressive test	Cylinder, 300 × 50d mm and 2 cylinders or more for testing	Cubes, 100 × 100 × 100 mm and 3 cubes for testing
Storage and Curing	Room with temperature = 23±2° C / Tank fill ofwater in temperature = = 23±2°C	Room with temperature = 20° C / chamber at normal temperature = 20 ± 2° C with a relative humidity of not less than 95 %.
Compressive strength for samples	By using special compressive machine for cylinders	By using special compressive machine for cubes

The differences are manifested in the form of methods, the minimum number of samples and storage conditions. For example, in ACI – American Concrete Institute usually uses cylinder with 150 mm diameter and 300 mm of height, but EN - European standards for concrete usually uses cubes, that are length, width and height equals 100 mm. Also there is a difference between ACI and EN in storage and curing samples, for example, storage in ACI shall be in a room with a temperature approximately 23 ± 2° C. After 24 ± 8 h we must remove the specimens from the molds and cure them by using water storage tanks from the time of molding until the moment of test. For EN, storage specimens shall be in a room with temperature 20° C and curing must be in a chamber at normal temperature 20 ± 2° C with a relative humidity of not less than 95 %.

3. The effect of hot weather on the concrete and the ways of precautions

Generally, the climate in the Middle East is very hot and dry in the summer. In Lebanon (Beirut) for example hot with temperature average is approximately +32° C and humidity 55 %, but the climate in the Gulf States is not only very hot, but also very dry. The temperature average in Saudi Arabia (Makah) in the summer is approximately +44° C, with humidity 25 % and +42° C, 29 % in Qatar (Doha).

Using and placing concrete during the hot summer months present far different challenges than use and placement during cold weather. The summer month effects of temperature, wind, and air humidity can all have a negative impact on the performance of concrete. For purposes of concrete use and placement, «hot weather» can be defined as any period of high temperature during which special precautions need to be taken to ensure proper handling, placing, finishing and curing of concrete. Hot weather problems are most frequently encountered in the summer, but critical drying factors such as high winds and dry air can occur at any time, especially in arid or tropical climates [7].

Higher temperatures cause water to evaporate from the surface of the concrete at a much faster rate and cement hydration occurs more quickly, causing the concrete to stiffen earlier and improving the chances of plastic cracking occurring. Concrete cracking may result from rapid drops in the temperature of the concrete. This occurs when a concrete slab or wall is placed on a very hot day and which is immediately followed by a cool night. High temperature also accelerates cement hydration and contributes to the potential for cracking in massive concrete structures. Higher relative humidity tends to reduce the effects of high temperature. Other hot weather problems include increased water demand, which raises the water – cement ratio and yield lower potential strength, accelerated slump loss that can cause loss of entrained air, fast setting times requiring more rapid finishing or just lost productivity [7]. It should be noted that the international specifications and codes recommend procedures for placing concrete in a hot and cold climate, they do not adequately address the influence of the total environment. ACI 305R, «Guide to hot weather Concreting» for example, defines hot weather as any combination of high ambient temperature, high concrete temperature, low relative humidity, wind velocity and solar radiation that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration [8].

We supposed that the following list of precautions will reduce or avoid the potential problems of hot-weather concreting:

• Use materials and mix proportions that have a good record in hot-weather conditions.
• Cool the concrete, one, or more of its ingredients (aggregates and mixing water).
• Add ice if it is needed to lower the temperature of concrete.
• Use a concrete consistency that allows rapid placement and consolidation.
• Reduce the time of transport, placing and finishing as much as possible.
• Schedule concrete placements to limit exposure to atmospheric conditions, such as at night or during favorable weather conditions.
• Consider methods to limit moisture loss during placing and finishing, such as sunshades, windscreens, fogging, or spraying.
• Apply temporary moisture-retaining films after screening.
• Organize a preconstruction conference to discuss the precautions required for the project.
• Consider modifying the concrete mixture to include set retarders and water reducers, and the lowest practical cement factor[9].

4. The need to use chemical admixtures

Water reducers, retarders, and superplasticizers are admixtures for concrete, which are added in order to reduce the water content in a mixture or to slow the setting rate of the concrete while retaining the flowing properties of a concrete mixture. Admixtures are used to modify the properties of concrete or mortar to make them more suitable to work by hand or for other purposes such as saving mechanical energy.

ASTM C494 Type F and Type G, High Range Water Reducer (HRWR) and retarding admixtures are used to reduce the amount of water by 12 % to 30 % while maintaining a certain level of consistency and workability (typically from 75 mm to 200 mm) and to increase workability for reduction in w/cm ratio. The use of superplasticizers may produce high strength concrete [10].

For unusual cases in hot weather and where careful inspection is maintained, a retardingadmixture may be beneficial in delaying the setting time, despite the somewhat increased rate of slump loss resulting from their use. Ahydration control admixture can be used to stop cement hydration and setting. Hydration is resumed, when desired, with the addition of a special accelerator (reactivate). Retarding admixtures should conform to the requirementsof ASTM C 494 (AASHTO M 194)[9].

We should be noted that like these admixtures usually used in the Gulf States such as Qatar and Saudi Arabia.

5. Curing of concrete in the hot areas

Curing has a strong influence on the properties of hardened concrete; proper curing will increase durability, strength, water tightness, abrasion resistance, volume stability, and resistance to freezing andthawing and deicers.

Curing and protection are more critical in hot weather than in temperate periods. Retaining forms in place cannot be considered a satisfactory substitute for curing in hot weather; they should be loosened as soon as practical without damage to the concrete. Water should then be applied at the top exposed concrete surfaces. On hardened concrete and on flat concrete surfaces in particular, curing water should not be more than about 11° C (20° F) cooler than the concrete. This will minimize cracking caused by thermal stresses due to temperature differentials between the concrete and curing water. The need for moist curing is greatest during the first few hours after finishing. To prevent the drying of exposed concrete surfaces, moist curing should commence as soon as the surfaces are finished and continue for at least 24 hours. The concrete should be protected from drying with curing paper, spraying fogging and sprinkling, heat-reflecting plastic sheets, pond of water or membrane-forming curing compounds [11].

In the first stage of experimental work conducted studies of the samples modified concrete by the method described in GOST.The studies used Portland cement CEM I 42,5N with an activity of 47,5 MPa at a rate of 350 kg per 1m³. The results are shown in Table 2.

Table 2 – The physico-mechanical characteristics of the concrete mixture and concrete

Number of sample	Type of admixtures	Consumption admixtures, % of the weight of cement	W/C	Mobility, cm	Density, kg/m³	Compressive strength, Mpa, at the age	
						7 days	28 days
1	Without admix.	–	0.55	4-5	2444	24.4	30.5
2	Superplasti-cizer C-3	0.6	0.55	20-21	2447	24.4	30.3
3			0.45	4-5	2474	34	43.5
4	Superplasti-cizer Type F	0.5	0.52	21-22	2449	24.3	30.2
5			0.42	4-5	2475	44.5	47.7
6	Superplasti-cizer Type G	0.5	0.52	21-22	2446	26.7	33.4
7			0.42	4-5	2483	42.8	46.3

Superplasticizer C-3 was added in an portion of 0,6 % of the weight of the cement, which increased the mobility of concrete mixture to 20 – 21 cm. When using superplasticizers of type F and G, similar performance was achieved on mobility of concrete by adding additives with the amount of 0,5 % of the weight of cement. The density of control composition and experimental concrete specimens ranges between 2444 – 2449 kg/m³. It should be noted that using less additives of type F and type G (compositions 4, 6) slightly reduced water consumption, compared with the composition 2. Using superplasticizers allows to increase the mobility of the concrete mixture 4 – 5 times compared to the control composition and at the same time get a full-strength concrete at the age of 7 and 28 days.

Adding superplasticizers provides an opportunity not only to increase the mobility of the concrete mixture, but also increase the strength of concrete while reducing water consumption. While maintaining the mobility of 4 – 5 cm in the experimental compositions 3, 5 and 7, water – cement ratio decreased to 0,42 – 0,45. Reducing water flow allowed to condense concrete structure, which is confirmed by an increase in the average of density of 40 kg/m³, as well as substantially increase the strength of concrete. At the initial stage of curing at 7 days, strength of concrete with the addition of C-3 increased by 40 % compared to the control composition 1. The greatest effect of reducing the flow of water is observed in compounds with the additions of type F and G, where strength increased 76 – 83 % more than of the control composition 1 and 26 – 31 % than composition 3.

It should be noted that in the 28 days strength value of compositions 5, 7 exceeds the value of 7 days only with 2 – 3,5 MPa. In this case, the strength of concrete with the addition of the C-3 (composition 3) is increased by 28 % and the figure will be closer to 5, 7.

Thus, reducing the flow of water allows to obtain concretes strength exceeding controlling composition after 28 days by 43 – 56 %. Effectiveness in strength occurs in the first days after adding type F and G to the compositions. Concrete that contain the additives gains about 90 % of the strength in the first 7 days according to the indicators at the age of 28 days.

According to the results in the first stage of the study, we can conclude that, for the manufactured, stored and tested specimens, and according to the procedure set GOST, significant effect of superplasticizers allows to increase the mobility of the concrete mixture by 4 – 5 times, while maintaining the required concrete strength or mobility of a given concrete mixture by reducing the water flow, and increasing the concrete strength by 1,4 – 1,55 times.

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