Review on A Shrinkage of Concrete By Using Bacteria

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Abstract- *A contraction or shrinkage result from loss of moisture and an expansion or swelling result from ingress of moisture. In mass or sealed concrete and high performances concrete, hydration of cement leads to internal consumption of moisture, resulting in autogenous skrinkage , and prior to setting while still in a plastic state, plastic shrinkage of cement paste will occure if loss of moisture is permitted. Shrinkage in concrete structure may leed to cracks which reduce the durability of concrete against aggressive mediums. In prestressed concrete element shrinkage result in a significant loss of prestressing forces.*

Keywords- Concrete, Bio Mineralisation, Calcium Carbonate, Bacterial Concrete

I. INTRODUCTION

During the hardening process of concrete due to the effects of cement hydration and concrete drying process due to water loss, there is a reduction of the concrete volume. Concrete shrinkage is a characteristic where the concrete changes its volume over time in a way that it decreases dimensions of unloaded concrete constructions proportionally in all directions. As porous hard material, concrete starts deforming as soon as it is exposed to mechanical, thermal or hydrologic effects. Therefore, when it comes to origin of concrete shrinkage we can talk about its three aspects: chemical, thermal and hydrologic processes. which is result of hydration continuation after concrete binding, ie reduction in relative humidity due to the hydration process.

The term shrinkage is loosely used to describe the various aspects of volume changes in concrete due to loss of moisture at different stages due to different reasons.Types of Shrinkage in Concrete

To understand this aspect more closely, shrinkage can be classified in the following way:

(a) Plastic Shrinkage in concrete
(b) Drying Shrinkage in concrete
(c) Autogeneous Shrinkage in concrete
(d) Carbonation Shrinkage in concrete

The Types of shrinkage are explained as below:

a) **PLASTIC SHRINKAGE** :-

Plastic shrinkage is contraction in volume due to water movement from the concrete while still in the plastic state, or before it sets. This movement of water can be during the hydration process or from the environmental conditions leading to evaporation of water that resides on the surface on the wet concrete. So, the more the concrete bleeds, the greater the plastic shrinkage should be. Plasticshrinkage isproportional to cement content and, therefore, inversely proportional to the w/c ratio.proportional to cement content and, therefore, inversely proportional to the w/c ratio. Concrete shrinkage of this type manifests itself soon after the concrete is placed in the forms while the concrete is still in the plastic state. Loss of water by evaporation from the surface of concrete or by the absorption by aggregate or subgrade, is believed to be the reasons of plastic shrinkage. The loss of water results in the reduction of volume.

Fig 1. Plastic shrinkage

b**) Drying Shrinkage :-**

Just as the hydration of cement is an ever lasting process, the drying shrinkage is also an ever lasting process when concrete is subjected to drying conditions. The drying shrinkage of concrete is analogous to the mechanism of drying of timber specimen. The loss of free water contained in hardened concrete, does not result in any appreciable dimension change. It is the loss of water held in gel pores that causes the change in the volume. Under drying conditions, the gel water is lost progressively over a long time, as long as the concrete is kept in drying conditions. Cement paste shrinks more than mortar and mortar shrinks more than concrete.

Concrete made with smaller size aggregate shrinks more than concrete made with bigger size aggregate. The magnitude of drying shrinkage is also a function of the fineness of gel. The finer the gel the more is the shrinkage.

Fig 2. Drying shrinkage

c.) **Autogeneous Shrinkage :-**

Autogeneous shrinkage, also known as "basic shrinkage," is the shrinkage due to chemical reactions between cement with water, known as hydration, and do not include environmental effects such as temperature and moisture changes. Its magnitude is usually ignored in concretes with w/c more than 0.40.In a conservative system i.e. where no moisture movement to or from the paste is permitted, when temperature is constant some shrinkage may occur. The shrinkage of such a conservative system is known as autogeneous shrinkage. Autogeneous shrinkage is of minor importance and is not applicable in practice to many situations except that of mass of concrete in the interior of a concrete dam.

Fig 3.Autogeneous shrinkage

d.) **Carbonation Shrinkage:-**

Carbon dioxide present in the atmosphere reacts in the presence of water with hydrated cement. Calcium hydroxide [Ca(OH)2] gets converted to calcium carbonate and also some other cement compounds are decomposed. Such a complete decomposition of calcium compound in hydrated cement is chemically possible even at the low pressure of carbon dioxide in normal atmosphere. Carbonation penetrates beyond the exposed surface of concrete very slowly. The rate of penetration of carbon dioxide depends also on the moisture content of the concrete and the relative humidity of the ambient medium. Carbonation is accompanied by an increase in weight of the concrete and by shrinkage.

Carbonation shrinkage is probably caused by the dissolution of crystals of calcium hydroxide and deposition of calcium carbonate in its place. As the new product is less in volume than the product replaced, shrinkage takes place. Carbonation of concrete also results in increased strength and reduced permeability, possibly because water released by carbonation promotes the process of hydration and also calcium carbonate reduces the voids within the cement paste. As the magnitude of carbonation shrinkage is very small when compared to long term drying shrinkage, this aspect is not of much significance

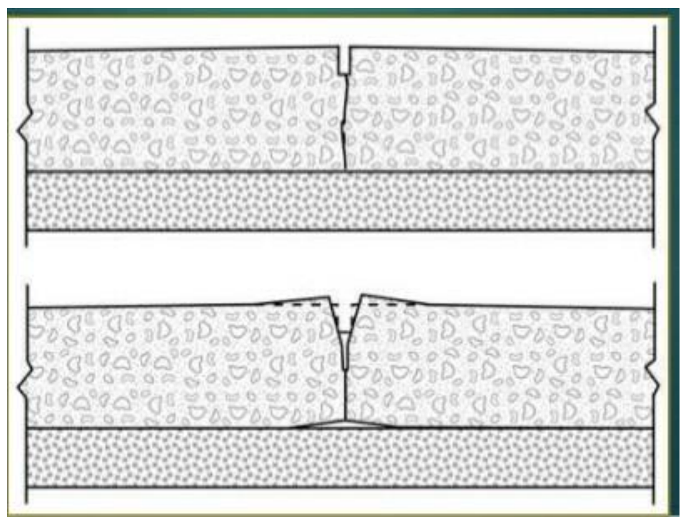

Fig 4. Carbonation shrinkage

Factors Affecting Shrinkage of Concrete:-

a) Humidity (Drying Condition)
b) Water Cement Ratio
c) Hardness of Aggregates
d) Moisture Movement in Concrete
e) Type of Coarse Aggregates
f) Shape of Aggregates

Other factors that have an effect on the magnitude of shrinkage include mix proportions, material properties, curing methods, environmental conditions, and geometry of the specimen. Water content has been found to affect the magnitude and rate of drying shrinkage in concrete. Other factors include elastic properties of the aggregate used in the concrete mix; in general, aggregate with a high elastic modulus will produce low shrinkage concrete. Aggregates which contain clay minerals will affect shrinkage behavior as well.

a) Humidity (Drying Condition):-

One of the most important factors that affects concrete shrinkage is the drying condition or in other words, the relative humidity of the atmosphere at which the concrete specimen is kept. If the concrete is placed in 100 per cent relative humidity for any length of time, there will not be any shrinkage; instead there will be a slight swelling. The typical relationship between shrinkage and time for which concrete is stored at different relative humidities is shown in Figure.

Effect of Humidity on Concrete Shrinkage:-

The graph shows that the magnitude of shrinkage increases with time and also with the reduction of relative humidity. The rate of shrinkage decreases rapidly with time. It is observed that 14 to 34 per cent of the 20year shrinkage occurs in 2 weeks, 40 to 80 per cent of the 20year shrinkage occurs in 3 months and 66 to 85 per cent of the 20year shrinkage occurs in one year.

b) Water Cement Ratio:-

Another important factor which influences the magnitude of shrinkage is water/cement ratio of the concrete. The richness of the concrete also has a significant influence on shrinkage. Aggregate plays an important role in the shrinkage properties of concrete. The quantum of an aggregate, its size, and its modulus of elasticity influence the magnitude of drying shrinkage.

c) Hardness of Aggregates:-

Harder aggregate with higher modulus of elasticity like quartz shrinks much less than softer aggregates such as sandstone.

d)Moisture Movement in Concrete:-

Concrete shrinks when allowed to dry in air at a lower relative humidity and it swells when kept at 100 per cent relative humidity or when placed in water. Just as drying shrinkage is an ever continuing process, swelling, when continuously placed in water is also an ever continuing process. If a concrete sample subjected to drying condition, at some stage, is subjected to wetting condition, it starts swelling. It is interesting to note that all the initial drying shrinkage is not recovered even after prolonged storage in water which shows that the phenomenon of drying shrinkage is not a fully reversible one. Just as the drying shrinkage is due to loss of adsorbed water around gel particles, swelling is due to the adsorption of water by the cement gel. The water molecules act against the cohesive force and tend to force the gel particles further apart as a result of which swelling takes place. In addition, the ingress of water decreases the surface tension of the gel.The property of swelling when placed in wet condition, and shrinking when placed in drying condition is referred as moisture movement in concrete.

e) Type of Coarse Aggregates:-

Different aggregate type will have different properties and will therefore have different effects on concrete shrinkage. In general, concretes made with high moduli of elasticity non- shrinking aggregates will have low shrinkage.

f) Shape of Aggregates:-

The size and shape of coarse aggregate influence the loss of moisture and it has therefore an indirect effect on the shrinkage of concrete. In general, the smaller the aggregate size, the more surface area, more water is absorbed as a result and, therefore, more shrinkage. This means that whenever low shrinkage is desired, largest aggregate size should be used.

Effect of shrinkage of concrete :-

Cracking due to shrinkage occurs mainly because of restraint. The restraint can be externally applied as with a bonded overlay or due to internal factors, such as reinforcement or nonuniform shrinkage within the thickness of the concrete member. Concrete that is unrestrained, for example a 4 x 8 in. (100 x 200 mm) cylinder, will not crack due to shrinkage. The modulus of elasticity and creep characteristics of concrete also affect its cracking tendency. The mechanism by which cracking occurs is quite simple. In a given environment, concrete that is unrestrained has the potential to shrink a given amount. If all or a portion of that shrinkage is restrained, tensile stresses will develop.

Curling is the uplifting of a slab at its edges. It is caused by differential shrinkage between the top surface and the bottom of the slab due to moisture and temperature changes. In addition to being unsightly, the potential for cracking due to traffic loads, and in some instances the self weight of the slab, is created. Curling can be reduced or eliminated by minimizing moisture and temperature related volume change differentials within a slab. Therefore, among other things, techniques that lead to a reduction of drying shrinkage are desirable.

Concluding discussion about the shrinkage strain

The paper explains the basic types of shrinkage: carbonation shrinkage, plastic shrinkage, temperature shrinkage, chemical shrinkage, autogenous shrinkage, and drying shrinkage. This division was obtained after reviewing and analyzing a large number of relevant literature.

Therefore, total shrinkage should be taken as the sum of each individual volume change due to carbonation, thermal change, drying and autogenous shrinkage. The cause of all types of shrinkage (except carbonation shrinkage) is a loss i.e. usage of water in concrete. Water can exit from the concrete into environment or it can be used during cement hydration.

Carbonation shrinkage occurs in the hardened concrete and it is particularly visible in construction on highways and big cities (carbon dioxide is present up to 0,3 %). total shrinkage. This type of shrinkage has bigger influence on massive constructive elements (for example, dams, basic foundations), when these elements are exposed to conditions of prevented ultimate strains i.e. when one side is thermally isolated (for example, pavements) as well as when concreting in extremely hot climate conditions .

The paper describes that due to its self healing abilities, eco-friendly nature, increase in durability etc, it is better than the conventional technology. It is very effective in increasing the strength and durability of concrete. It also shows better resistance to drying shrinkage, resistance to acid attack, better sulphate resistance. Bacterial concrete prepared with admixtures like silica fume, fly ash etc, also gives better strength and durability. This paper improved our understanding on bacterial concrete. Due to the introduction of bacteria into concrete there has been increase in the compressive and flexural strength with decrease in permeability, water absorption and corrosion of reinforcement when compared to conventional concrete.

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