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STUDY OF DURABILITY OF CONCRETE

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Abstract – Concrete is one of the mostly used and most basic cementing materials used for the construction of buildings, structures etc. Hence if one wants proper, strong and durable construction, he should put more emphasis on the quality of building materials and their adequate usage accordingly. The various properties of the concrete decides the later strength and life of the built structure such as strength, water tightness, toughness, shrinkage and creep, durability etc. Out of the various properties of concrete which are looked into, durability is also one of the important one and the same will be discussed in the following article. Durability can be stated as the ability of the structure, building or any other material to last longer without any damage to it. This covers resistance to weathering, attacks by chemicals etc while keeping the properties of the concrete unchanged.

Key Words: Durability, freezing-thawing, abrasion, weathering, exposure.

1. INTRODUCTION

The usage of cementing material has been in records since very ancient times dating back to hundreds of years. Romans, Greek, Mesopotamians and Egyptians all have records of using cementing material of one or the other type. However in present time, cement is the most easily available, better strength and comparatively economical with respect to other cementing materials and has taken important place in construction.

In India, the first cement factory was set up in 1904 in Tamil Nadu and till date the number has crossed 50 which produce Portland cement. India has an installed capacity of 200 million tonnes of cement.

Concrete is the product of mixing cement, fine and coarse aggregates and water as per standards so as to meet the given needs of the job keeping in mind the workability, strength, economy and durability.

Concrete should be able to take up all the loads for which it has been designed. Thus durability is the property by virtue of which concrete can withstand all the loads coming upon it without damaging the structure. There are many external forces whether they are physical, chemical or mechanical which lessen the life of structure. Quality of concrete in such cases decides the level of damage caused by environment. These all are to some extent governed by durability of concrete.

1.1 Understanding durability and its effects on the structure

According IS: 456-2000, "a durable concrete is the one that performs satisfactorily in the working environment during its anticipated exposure during service".

Durability can be understood in many ways. It is defined as the time duration upto which concrete in hardened state can withstand the weathering effects satisfactorily. This property is affected by water cement ratio by a large extent. A good concrete should be durable in hardened state.

There are various types of concrete available and different concretes need different level of durability as per the exposure and other environmental conditions. The main constituents of concrete, their ratios of mixing, their mutual interactions, their placing and afterwards curing all affect the durability of the concrete and thus affect the life of the concrete.

Durability also affects the environment conservation to some extent. For example, if a concrete used in any structure is durable, it will not require replacement or repairing again and again to some years at least. Thus conserving the natural and other resources as replacement and repairing leads to depletion of natural and other resources to some or more extent.

It can also be understood by following example. Assume the design life of any structure is 40 years, although the building often lasts 50-60 years or even more upto 100 years and in some cases even more than 100 years. This happens because of the durability of the concrete used in the structure. Mostly structures are not deteriorated rather they are demolished as they exceed their design life. These all explain the durability of the structure.

2. FACTORS AFFECTING DURABILTY

These factors can be broadly classified under two sections

i) The concrete system

ii) The service environment

The concrete system depends on the materials and processes involved. Materials depend in turn on the binding material type and content, design mix and admixtures. On the other hand process relates to the way of mixing, transporting, placing, workmanship and curing.

The environmental considerations are either physical or chemical such as freezing- thawing, wearing and abrasion, dissolutions, expansion-compression and leaching etc.

It can be more easily and deeply understood under following factors relativity

i) **Weathering-** Exposure to the environment affects the durability of the concrete to a large extent. The resistance to such weathering is very important but there is no such lab test to check the extent of weathering accurately. But the corresponding codes should always be referred to check whether the right grade of cement is being used as per the environmental conditions.

Structures are subjected to abrasion or impacts, flowing water with high kinetic energy etc resulting in wearing or cavitations or even large scale pitting in some cases in the structure or flooring depending upon the corresponding use. Such damages can be avoided by using proper quality of concrete.

Also the aggregates used in concrete should be checked and tested as they cover around 70% of the constituents. The aggregates formed from shales, clayey rocks should be avoided as they are easily subjected to deterioration under normal weather conditions.

i) **Humidity-** Generally, moisture enters in the structure through joints in the concrete and adjoining material. If joints are properly designed, they will not be affected. If moisture enters the structure, it damages the reinforcement, leading to rusting and rotting. Slowly corrosion takes place and hence the durability is badly affected. Hence in moist areas special attention should be given to joints.

ii) **Freezing and thawing-** The damage to the concrete in cold areas which are susceptible to snowfall and very cold temperature range, is done by the hydraulic pressure developed due to expansion of water present in the concrete unreacted, when freezed. Not all the water of concrete is hydrated during hardening but Some of the water is left unreacted in between the concrete, this water freezes when temperature falls below zero and turns into ice and thus expands creating hydraulic pressure inside the concrete. When the temperatures rises again it leads to melting of the ice formed thus leaving space for attacking agents and also the change in pressure gradient takes place. Again temperature drop will create more space and so on. This cycle of freezing- thawing keeps going. More is the water content in the concrete, more will be the cycles of freezing and thawing thus lesser time to damage the structure with each passing cycle. This cycle of freezing and thawing results in loss of compressive strength of concrete, or its flexural strength or reduction in weight

If there is entrained air in concrete then these voids give room for expansion and thus releasing the internal pressure formed

Thus in such case, we can say that concrete with lesser water cement ration is more durable. Also air entrained concrete should be preferred in such areas as the loss of workability, due to lesser water cement ratio, can be make up with entrapped air and better workmanship

iii) **Chemical and sulphate attacks-** Though this type of attack is lesser comparatively but they result in leaching of the cement, action of sulphates and acids etc. They can be handled by using proper sulphate resisting cements like alumina cement, super sulphate cement or sulphate resisting cement etc. In marine areas, if cracks are present, outside water with chemicals react with the concrete water and ingredients resulting later in serious damages and thus affecting durability.

Calcium and magnesium sulphates are present in some soils which react with the lime and calcium aluminates to form calcium sulphate and sulpho aluminates eventually resulting in expansion as well as damaging of the concrete.

The solution to this lies in using denser concretes having lesser water cement ratios, cements with lesser C3A or air entrained concretes

iv) **Sea water-** Special care is needed in sea water cases in mix design and quality of material. Here concrete is subjected to continuous wetting and drying due to tides or simple water splash. This effect is severe in reinforced concretes rather than plain concrete due to corrosion. In such cases minimum cover of 50 mm should be provided so that the continuous impact of water pressure does not expose the reinforced bars.

Thus from above given factors its visible that quality of cement and water cement ratio play an important role apart from other factors, in making a structure durable. Below is given one table to give an upper limit of water content in concrete exposed to different conditions

SI.NO.	DEGREE OF EXPOSURE	MAX. WATER-CEMENT RATIO
1	Exposed to air , not fully saturated	0.70
2	Constantly wet and subjected to freezing	060
3	Road kerbs	0.55

Table -1: table showing maximum water cement ratio

Also, IS: 456 should be once checked for confirming the grade of cement and water contents to avoid any mistake in construction.

2.1 Consequences of insufficient durability

- Lesser service life
- Corrosion of reinforcement bars
- Lesser strength of concrete
- Easily attacked by external agents
- Unaesthetic appearance
- More repairing costs
- Hazardous structures built
- Acids, alkali-aggregates reactions
- Pressure on natural resources as replacement or repairing done time and again
- Wastage of time, energy and money.

3. CONCLUSIONS

It is well known by now that it is durability of a structure that makes it serve for longer duration of time without being a headache for the serving people. We know so many ancient structures which still exist despite the fact of being over the design life and it is all because of the highly durable concrete. Ancient people used rich concrete without compromising with the quality and time leading to highly durable structures. Thus if the above mentioned factors and suggestions are kept in mind then structures built will serve mankind in better ways. There are various external as well as internal causes starting from weathering conditions, temperature, humidity, abrasion, attacks from liquids and acids to some physical causes like volumetric changes and frosts action that make the properties of the concrete different and thus affect the life of structures.

Engineers should put more emphasis on early and timely inspection of the quality of concrete and the placing techniques to avoid any later stage mistake. This not only saves the time of engineers but also conserve the natural and other resources as regular replacement and repairing only wastes time, energy and money. Also it is utmost important to have durable structures so that they are not hazardous to any life making use of the structure and serve the purpose of construction for longer time without damaging.

Now-a-days so many special techniques are available to make up the losses done by the external agents and thus improving the durability of the structures. Also, there are now special types of concretes available like self healing concrete and self compacting concrete that repair the losses themselves only and resulting into stronger and more durable structures. But these techniques are expensive ones and engineers should emphasize more on the pre construction and during construction measures to avoid any ill effects later.

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