| RUET |

CREEP

9th May, 2020

- Creep is time dependent deformations of concrete under permanent loads (self weight), PT forces and permanent displacement.
- When concrete is subjected to compressive loading it deforms instantaneously. This immediate deformation is called instantaneous strain. Now, if the load is maintained for a considerable period of time, concrete undergoes additional deformations even without any increase in the load. This time-dependent strain is termed as creep.

Recording

CREEP

Talking: Dr. Md. Shafiqul ISLAM

Factors Affecting Creep

- Mix Proportion
- Aggregate Properties
- Age at Loading
- Curing Conditions
- Cement Properties
- Temperature
- Stress Level

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Mix Proportion

- The amount of paste content and its quality is one of the most important factors influencing creep.
- A poorer paste structure undergoes higher creep.
- creep increases with increase in water/cement ratio.

Aggregate Properties

- Aggregate undergoes very little creep.
- It is really the paste which is responsible for the creep.
- Aggregates influence creep of concrete through a restraining effect on the magnitude of creep.
- The higher the modulus of elasticity the less is the creep.
- Light weight aggregate shows substantially higher creep than normal weight aggregate.

Age at Loading

- Age at which a concrete member is loaded will have a predominant effect on the magnitude of creep.
- The quality of gel improves with time. Such gel creeps less.
- Whereas a young gel under load being not so stronger creeps more.
- The moisture content of the concrete being different at different age also influences the magnitude of creep.

Curing Condition

- In view of the smallness of creep strains, the amount of water expelled during creep from the micro pores into the macro pores (or vice versa) must also be small, probably much less than 0.1 percent of the volume of concrete (since typically creep strains do not exceed 0.001, and even this is not due entirely to water but also to expelled solids).
- Larger the curing smaller the creep.

Cement Properties

- The type of cement effects creep in so far as it influence the strength of the concrete at the time of application of load.
- Fineness of cement affects the strength development at early ages and thus influence creep.
- The finer the cement the higher its gypsum requirement so that re grinding of cement in laboratory without the addition of gypsum produces an improperly retarded cement, which exhibits high creep.

Temperature

- The rate of creep increases with temperature up to about 70$_{o}$ C when, for a 1:7 mix and 0.6 w/c ratio.
- It is approximately 3.5 times higher than at 21$_{o}$ C.
- Between 70$_{o}$ C and 96$_{o}$ C it drops off to 1.7 times tan at 21$_{o}$ C.
- As far as low temperature is concerned, freezing produces a higher initial rate of creep but it quickly drops to zero.
- At temperature between 100C and 300C, Creep is about one half of creep at 210C.

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Stress Level

- There is a direct proportion between creep and applied stress.
- There is no lower limits of proportionality because concrete undergoes creep even at very low stress.
- Higher the stress higher will be the creep.

EFFLORESCENCE

WHAT IT IS

A change on the surface to a white coloured powdery substance upon exposure to air as a crystalline substance through a loss of water

Concrete surface

Masonry surface

WHY OCCURS-THE CAUSES

- One or more of the constituents of concrete may contain salts
- A high water-cement ratio resulting in a more porous concrete that allows movement of water and salt solutions
- Inadequate curing which may leave un-hydrated products near the surface of the concrete
- Exposure to rain or other water sources (moisture allows salts to be transported to the surface where they accumulate as the water evaporates)

WHY OCCURS-THE CAUSES

- Slow rate of evaporation of water allowing time for salts to permeate to the surface (this is why efflorescence tends to be more of a problem during the winter months; in summer, high temperatures may cause evaporation and hence depositing of salts within the concrete rather than on the surface)
- Variability of concrete (e.g. from compaction or curing) can result in localized problems where water can permeate more easily through the concrete

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HOW TO PREVENT

- Use ingredients containing as little soluble salt as possible.
- Use waterproofing admixtures to reduce permeability of concrete/mortar. Note that as some of these products may cause efflorescence themselves (e.g. water-soluble soaps) always check with the manufacturer.
- Use a denser concrete, again to reduce permeability. However, this may increase the shrinkage.
- Use **cement : lime : sand** mortars no stronger than required for the application to minimize possible soluble salt levels.

HOW TO PREVENT

- Lime should be hydrated lime free from calcium sulphate.
- Avoid premature drying.
- Apply curing compounds or same-day sealers to reduce exposure to wetting.
- Protect hardened concrete from exposure to moisture by maintaining surface sealers and site drainage, and from rising groundwater by placing a plastic membrane under slabs.
- For masonry, ensure flashings, damp-proof courses and copings are detailed correctly, cover the top course at the end of each day's work, tool joints with a 'V' or concave shaped jointer to compact the mortar at exposed surfaces, provide wide eaves and avoid wetting from sources such as sprinklers

HOW TO REPAIR

METHOD-1 (BRUSHING)

Soluble salt deposits can be removed with a stiff-bristle broom. Note that all brushed-off material should be totally removed by vacuum cleaning or other means.
If the result is not satisfactory, scrub with clean water then lightly rinse the surface. Note that adding water may result in further deposits. Repeated dry brushing as the deposits appear is probably the best treatment.
Insoluble salt deposits (hard, white, scaly or crusted) cannot be removed by water washing, although the use of a high-pressure water jet is effective

HOW TO REPAIR

METHOD-2 (USING DILUTE ACID SOLUTION)

Extreme care is required when handling acids. When diluting hydrochloric acid always add the acid to the water, never the reverse. Ensure good ventilation and avoid contact between the acid and the reinforcement. Use only diluted acid to clean the concrete surface.

The recommended proportions are **1 part hydrochloric acid to 20 parts water**. Always saturate the surface with water before applying the dilute acid solution. When applying the solution, ensure that the surface is moist but without any free water being present. The applied solution should be allowed to react on the concrete surface for **10 to 15 minutes**. The surface should then be thoroughly rinsed and scrubbed with lots of clean water. Repeat rinsing at least twice or until all traces of the acid solution have been removed. The process may be repeated if necessary to produce the required surface finish.