UNIT-4

DAMAGE IN STRUCTURES DUE TO FIRE

- DAMAGE IN STRUCTURES DUE TO FIRE
- PART 1: Fire Induced Damages in Structures
- PART 2: Fire Rating of Structures
- PART 3: Phenomenon of Desiccation
- DAMAGE IN STRUCTURES DUE TO FIRE
- PART 1: Fire Induced Damages in Structures
- Part I: Fire Induced Structural Damages
- Uneven volume changes in affected members, resulting in distortion, buckling and cracking. The temperature gradients are extreme - from ambient 70^{o}F (21^{o}C), to higher than 1500^{o}F (800^{o}C) at the source of the fire and near the surface.
- Spalling of rapidly expanding concrete surfaces from extreme heat near the source of the fire. Some aggregates expand in bursts, spalling the adjacent matrix. Moisture rapidly changes to steam, causing localized bursting of small pieces of concrete.
- The cement mortar converts to quicklime at temperatures of 750^{o}F (400^{o}C), thereby causing disintegeration of concrete.
- Reinforcing steel loses tensile capacity as the temperature rises.
- Once the reinforcing steel is exposed by the spalling action, the steel expands more rapidly than the surrounding concrete, causing buckling and loss of bond to adjacent concrete where the reinforcement is fully encased.
- Concrete undergoes cracking, spalling, and experiences a decrease in stiffness and strength as the temperature increases.
- Concrete has low thermal conductivity, which allows it to undergo heating for longer durations before the temperature increases significantly and damage occurs.
- The concrete compressive strength starts decreasing rapidly after its temperature reaches approximately 400°C (750°F).
- At temperatures of around 500^{o}C (932^{o}F), the concrete compressive strength is reduced to 50% of its nominal strength.
- The tensile yield strength of the steel decreases gradually up to 500^{o}C (932^{o} F). It is reduced to about 50% of its nominal yield strength at 600^{o}C (1112^{o}F). This essentially eliminates any factor

of safety, which is usually between 1.5 and 2.0.

- The steel yield strength decreases more rapidly for temperatures greater than 500°C (932°F), and failure may be inevitable if temperatures keep increasing while the loading is sustained.

Stages of deterioration due to Fire

- DAMAGE IN STRUCTURES DUE TO FIRE
- PART 2: Fire Ratings of Structures
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What is Fire Rating?

A fire rating refers to the length of time that a material can withstand complete combustion during a standard fire rating test. Fire testing of building materials and components of buildings -- such as joists, beams and fire walls -- is required in most places by building codes.

Other fire tests for things such as appliances and furniture are voluntary, ordered by manufacturers to use in their advertising. Wall and floor safes are examples of products for which fire resistance is a key selling point.

- PART 2: Fire Ratings of Structures

What is Fire Rating?

With the required tests, the results are measured in either units of time, because the emphasis is on holding up under fire (literally) long enough for the occupants of a home or building to escape, or by classification designations. This does not mean, necessarily, that the components of every new structure have to be fire tested. In most cases, the fire rating has been already established by testing the product before it is even put on the market.

- DAMAGE IN STRUCTURES DUE TO FIRE
- PART 3: Phenomenon of Desiccation
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- Desiccation is a phenomenon referring to dryness of the material induced by the loss of moisture