LECTURE # 6

In this lecture you will learn about:

Causes of Failure:

- Cracks and corrosion.
- Thermal changes.
- Bad Design.
- Faulty Construction.
- Foundation Failure.
- Fire accidents.

Course Name:

"Material Testing, Repair & Maintenance"

Course Code: CT-245

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CAUSES OF FAILURE

The causes of building collapse can be classified under certain heads as:

- Cracks and corrosion
- Thermal changes
- Bad Design
- Faulty Construction
- Foundation Failure
- Fire accidents and many more.

CRACKS AND CORROSION

- A properly designed and constructed concrete is initially water-tight and the reinforcement steel within it is well protected by a physical barrier of concrete cover which has low permeability and high density.
- Concrete also gives steel within it a chemical protection.
- Steel will not corrode as long as concrete around it is impervious and does not allow moisture or chlorides to penetrate within the cover area.
- Steel corrosion will also not occur as long as concrete surrounding it is alkaline in nature having a high pH value.

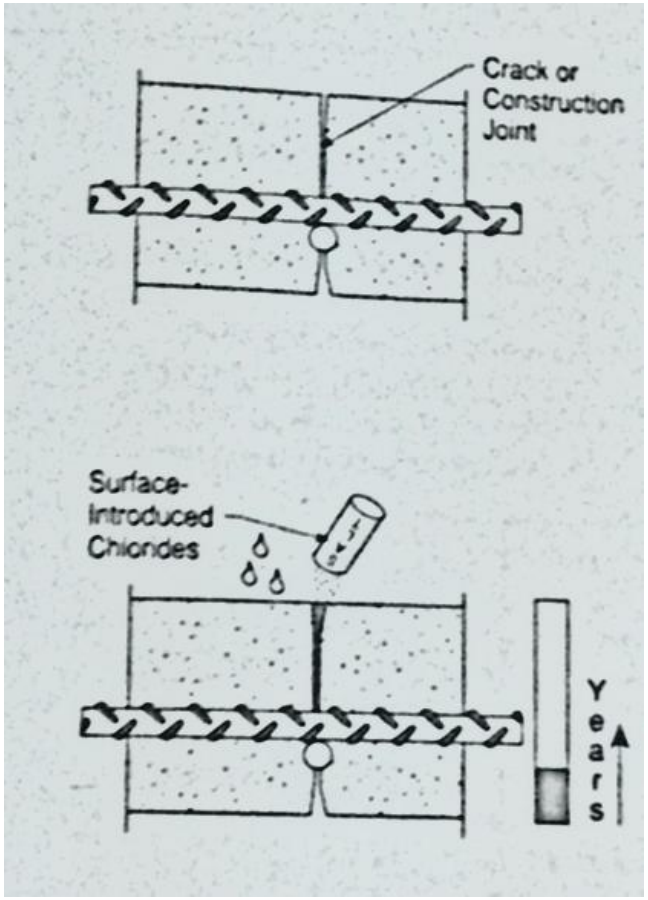
CRACKS AND CORROSION

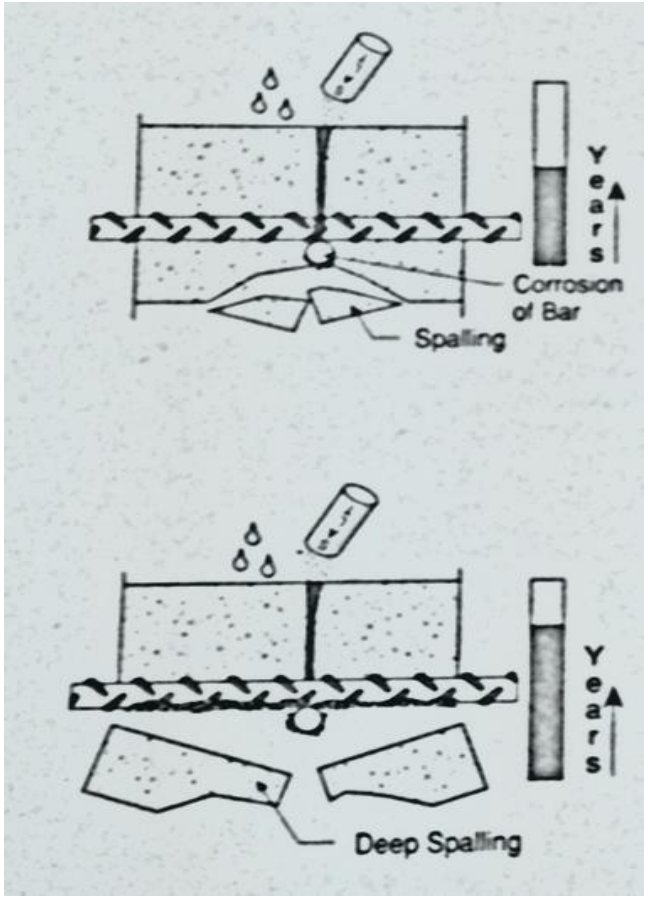
- Due to wetting and drying cycles, heating and cooling cycles, loading and unloading cycles, cyclic loading, leaching of lime and most importantly additions and alterations done on the structures, isolated cracks, voids, entrapped air and large capillary pores get interconnected and external moisture and chlorides find their way to reinforcement steel and corrosion starts.

Main causes:

- Sulphate attack
- Carbonation

SULPHATE ATTACK





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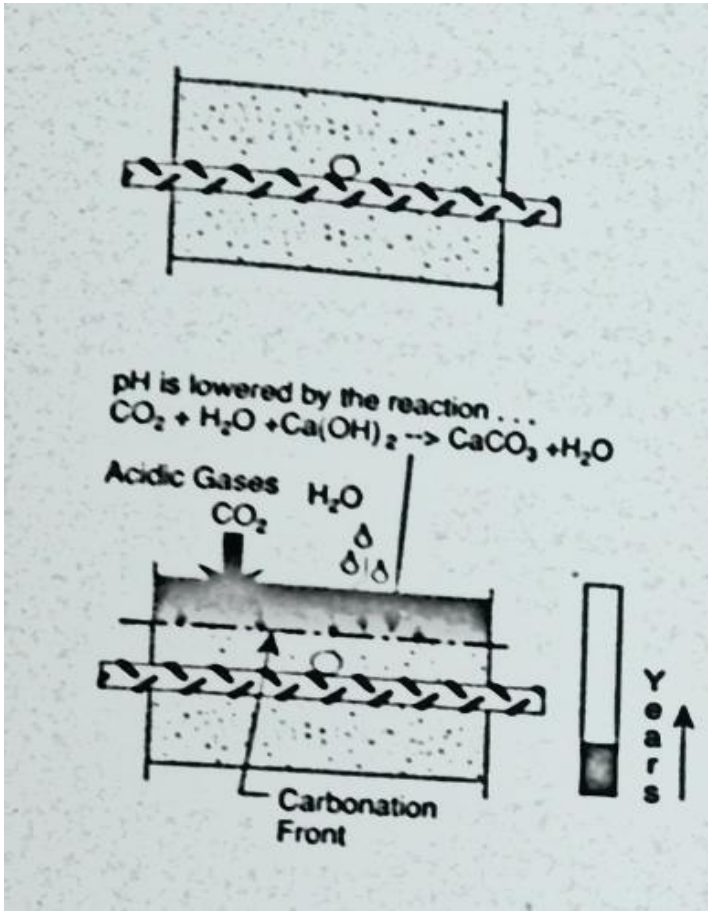
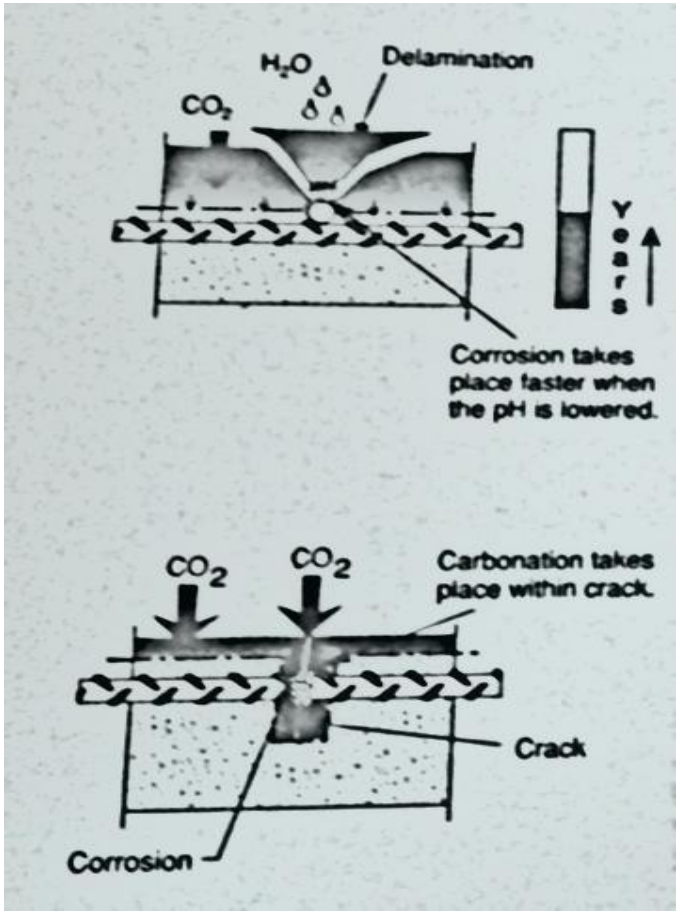
CARBONATION





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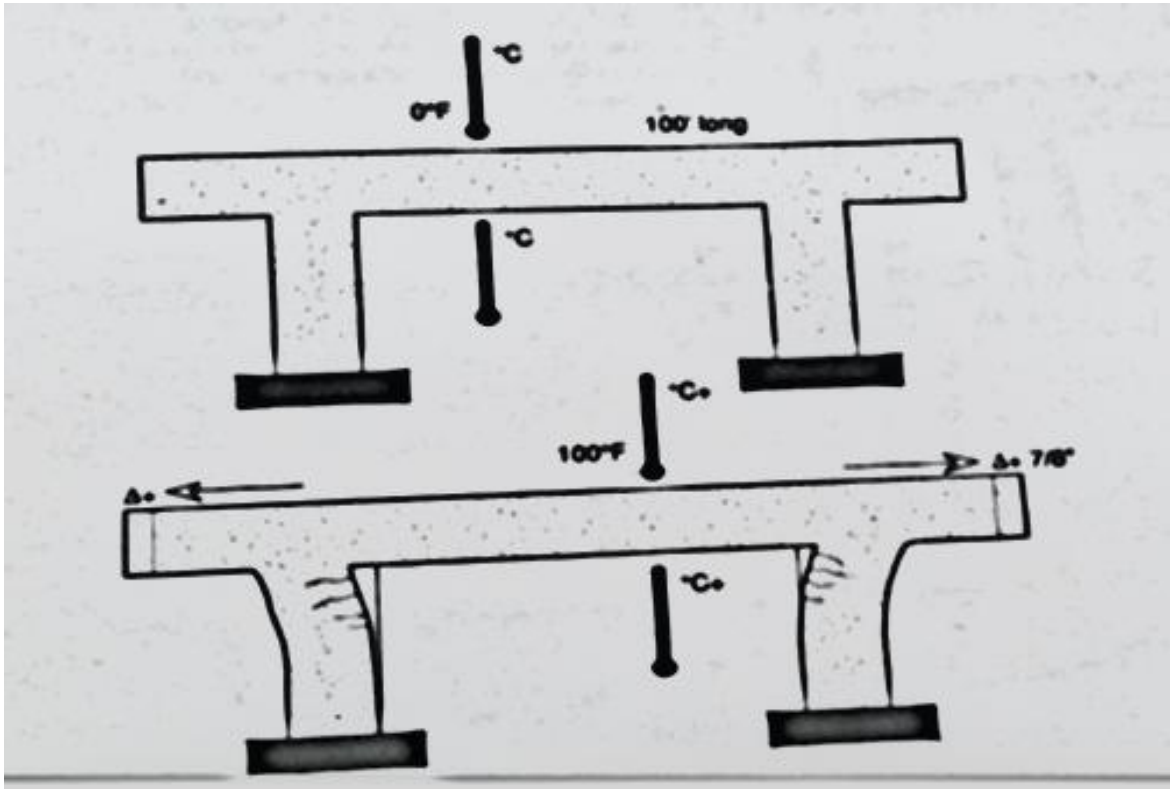
THERMAL CHANGES

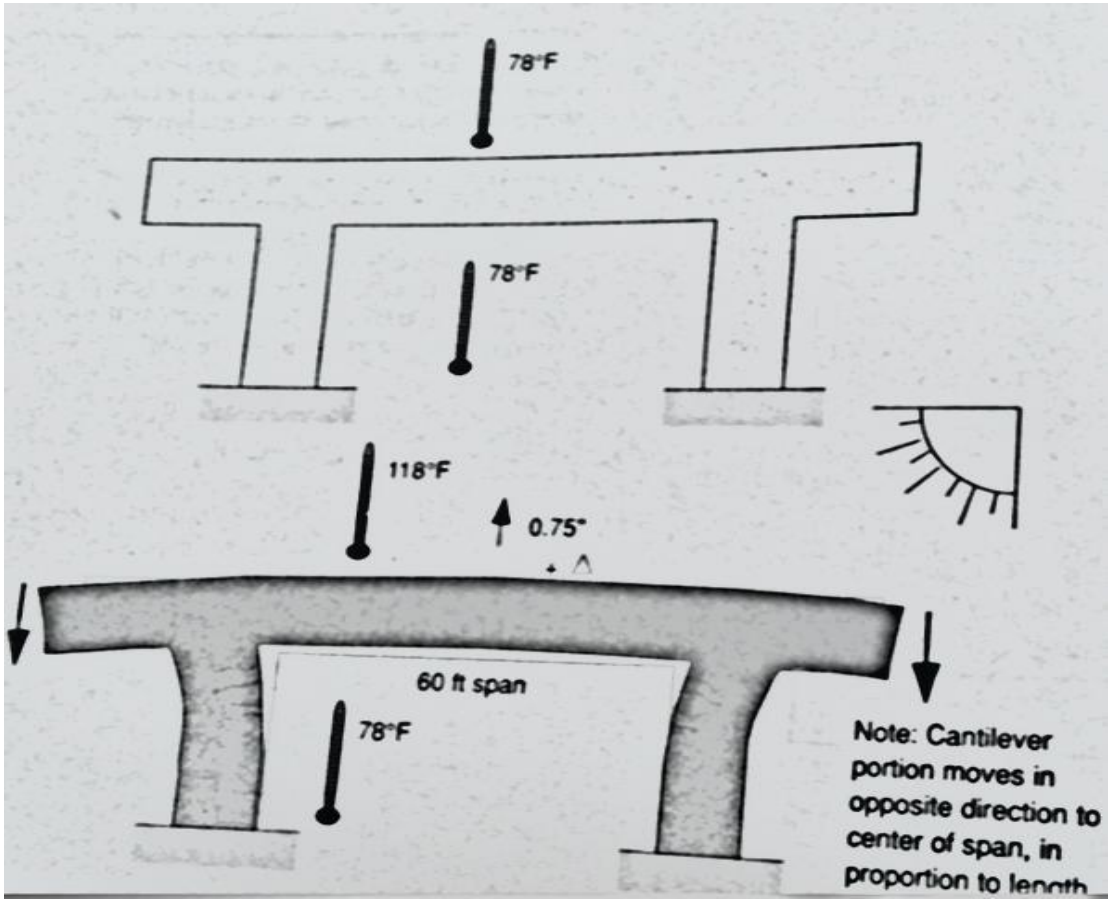
- Thermal volume change:



EVEN THERMAL LOADS

- Temperature gradients exist in many structures. The temperature of the deck slab exposed to direct sunlight may reach 48oC, while the underside of the deck slab may be only 26oC. A 22oC difference known as **diurnal solar heating.** This causes the top surface to have a tendency to expand more than the bottom surface. This results in a upward movement during heating and downward movement during cooling

EVEN THERMAL LOADS



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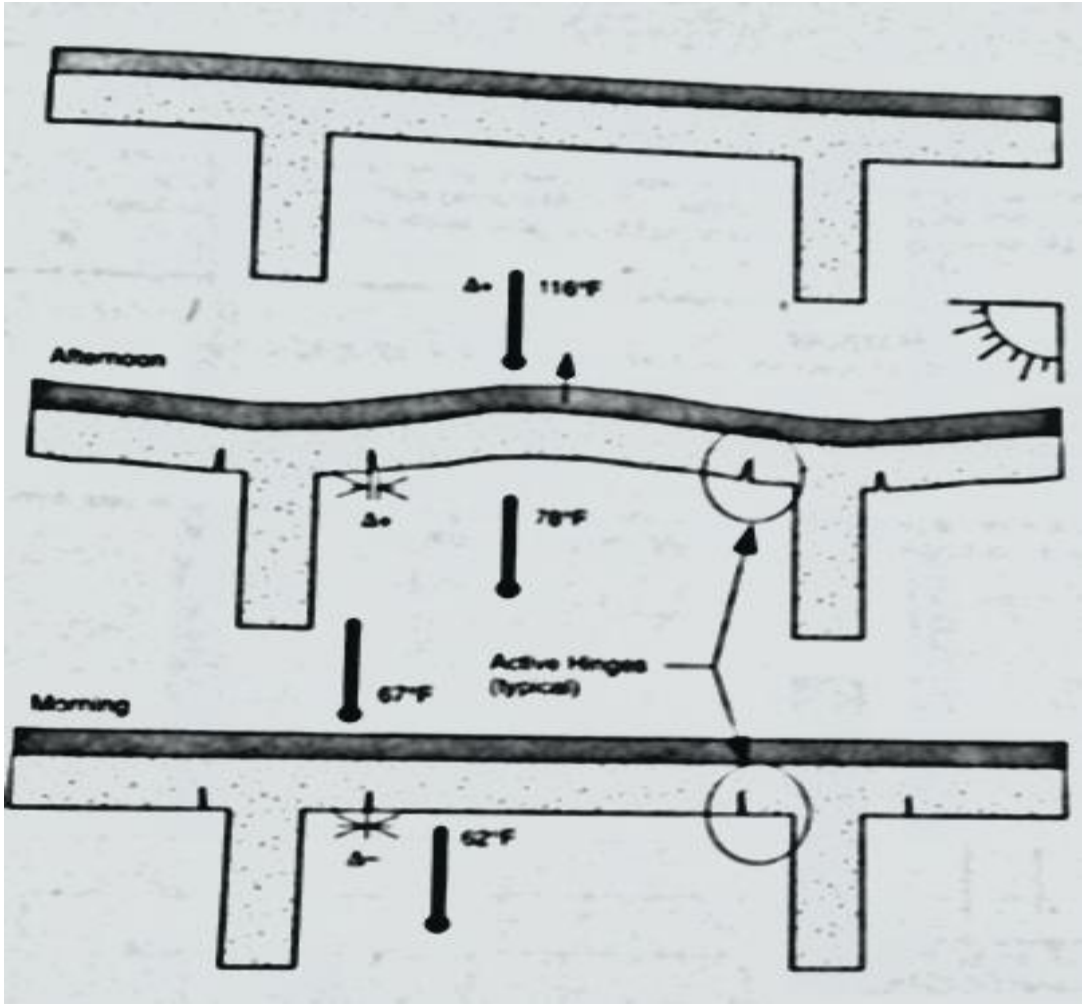
EVEN THERMAL LOADS

- Diurnal solar heating affects structures differently depending on the configuration. Simple span structures deflect up and down and are free to rotate at end supports. Continuous spans behave differently because they are not free to rotate at end supports. If enough thermal gradient exists along with insufficient tensile capacity in the bottom of the member, a hinge may form. Hinges forms randomly in newly formed cracks or near construction joints of the columns. Hinges open and close with daily temperature changes.

EVEN THERMAL LOADS



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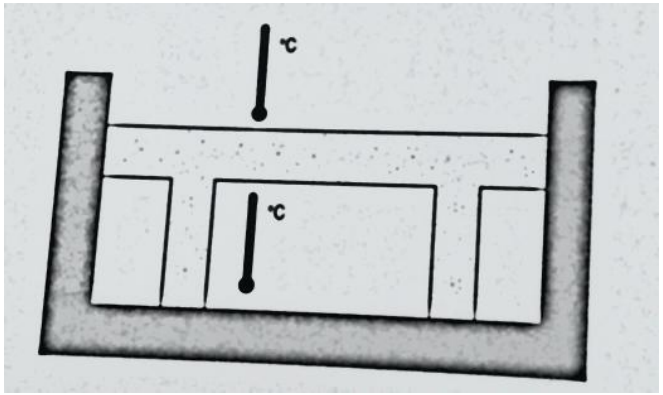
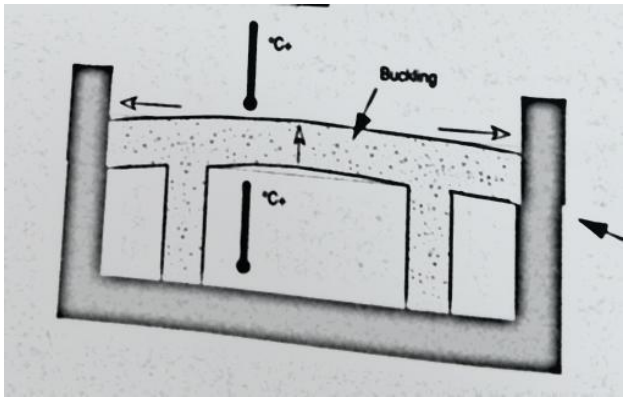
RESTRAIN TO VOLUME CHANGES

- If a structural member is free to deform as a result of changes in temperature, moisture or loads, there is no build-up of internal stress. If the structure is restrained, stress build-up occurs and can be very significant. The stress may result in tension cracks, shear cracks, and buckling.





BAD DESIGN

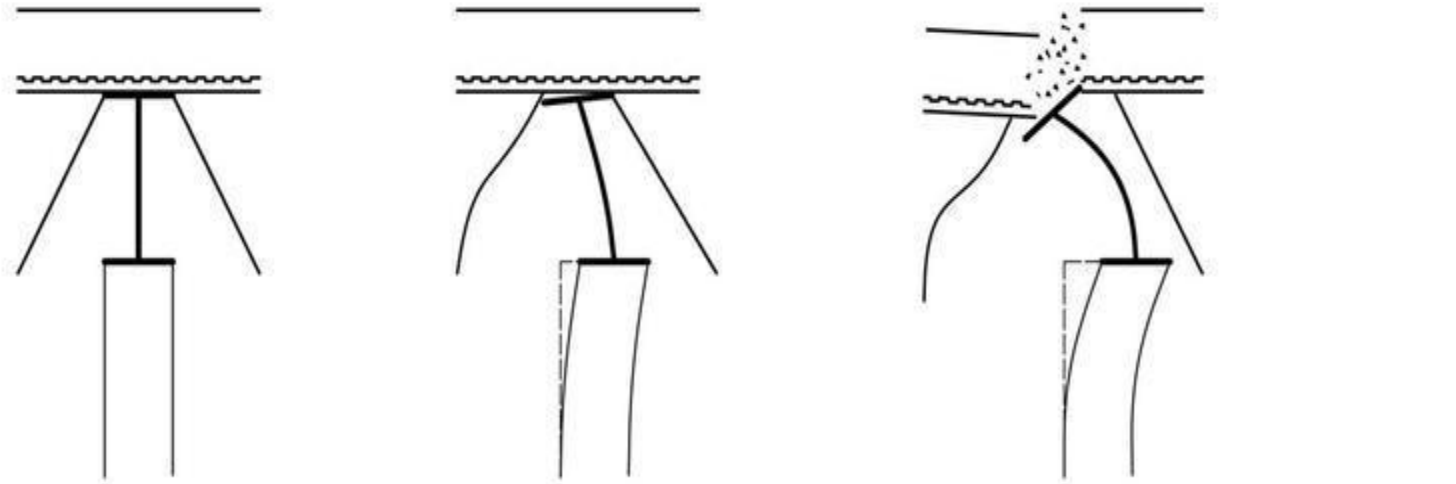
- Bad design includes not only errors of computation, but failure to take into account all the loads the structure should be able to carry for the building's intended use. Prudent design is based on established theories, reliance on accurate data, cognizance of the effects of repeated or impulsive stresses, and proper choice of materials based on in-depth understanding of their properties. Failures many a time enters a building project at the drawing board itself due to lack of due diligence by the engineer.

FAULTY CONSTRUCTION

- Faulty construction perhaps is the most important cause of structural failure. The lack of proper construction supervision and timely inspection by engineer & architect is a key contributor. Some faulty practices to be firmly checked and stopped are the use of salty sand to make concrete, the substitution of inferior steel for that specified, bad riveting, improper tightening torque on nuts, excessive use of the drift pin to make holes line up, bad welds, and all such practices well known as taboo in construction field.

FAULTY CONSTRUCTION PRACTICES

- Insufficient beam- column joint support:



- Original Position

- Column head displaces laterally
- Lower beam flange yields
- Web begins to buckle
- Joists begin to disconnect

- Column head displacement increases
- Beam flange and web buckling continues
- Joists Fail
- Collapse immediate

FOUNDATION FAILURE

- Houses and commercial buildings usually look very solid. Built with concrete, and beams, it’s hard to imagine what could cause them to crack and shift other than an earth quake.
- A foundation rightly designed is a pre-requisite for every structure to stand on, with ability to bear loads that the structure is carrying. The earth beneath the building should be (or made such) that structural loads can be sustained.

FOUNDATION FAILURE

- There are many causes of foundation failure, here are the five main ones.

1. Soil type – especially expansive clay soil
2. Poorly compacted fill material
3. Slope failure, mass wasting
4. Erosion
5. Poor construction

FIRE ACCIDENTS

Fire affects concrete in extreme ways, some of which are listed below:

- Uneven volume changes in affected members, resulted in DISTORTION, BUCKLING & CRACKING.
- Spalling of rapidly expanding concrete surfaces from extreme heat near the source of 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.

FIRE ACCIDENTS

- The cement mortar converts to quick lime at temperatures of 400^{o}C, thereby causing disintegration of the concrete.
- Reinforcing steel loses tensile capacity as temperature rises.
- Once the reinforcing steel is exposed to the spalling action, steel expands more rapidly than the surrounding concrete, causing buckling and loss of bond to adjacent concrete where the reinforcement is fully encased.


Thank You