CRACKS IN BUILDINGS:
Some Remedial Measures

IS THAT CRACK SERIOUS?

- Simplest questions to ask.
- One of the most difficult to answer.
- Prof. Mealcom Hollis-"Surveying buildings is an art, verifying the cause of failure is a science"

Classification of Cracks

Structural crack	Non structural crack
Incorrect design Faulty construction Overloading	Internal induced stress in building material

Continue…

- Non Structural Crack

❖Penetration of moisture through crack

❖Weathering action

❖Result in corrosion of reinforcement

❖Structure become unsafe (structural crack)

Classification of cracks
(Based on width)

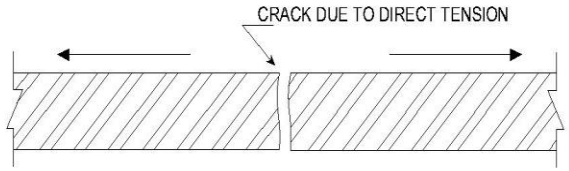
Type	Width
Thin	< 1 mm
Medium	1-2 mm
Wide	> 2 mm

Common sight of crack

Vertical Horizontal Diagonal	Straight Toothed Stepped Map pattern Random	Uniform throughout Narrow at one end and gradually widening at the other

Internal stress in Building component

- Compressive
- Tensile
- Shear
- Building material
- 1. Masonry, Concrete, Mortar
  2. Weak in tension/shear
  3. Causing tension/shear crack

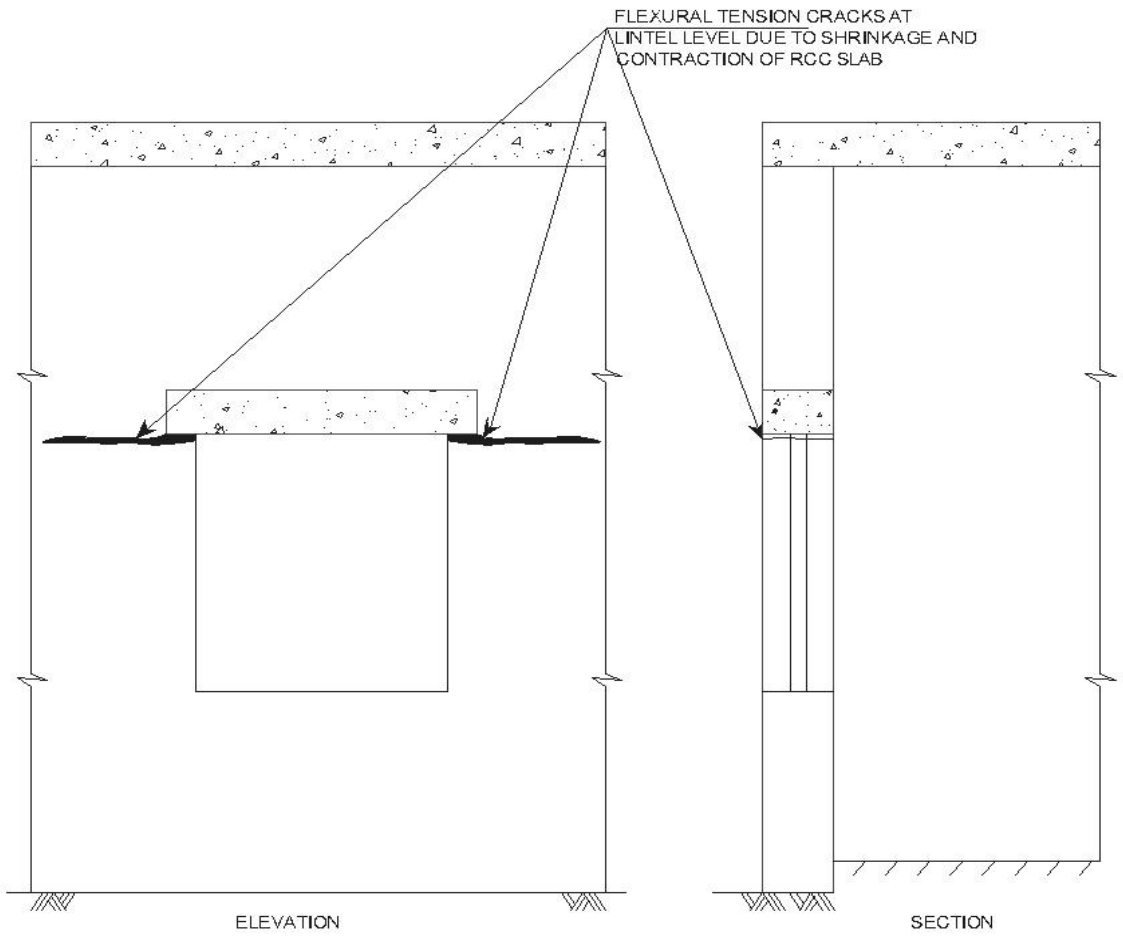


Tensile Crack in Masonry Wall

Present trend in construction

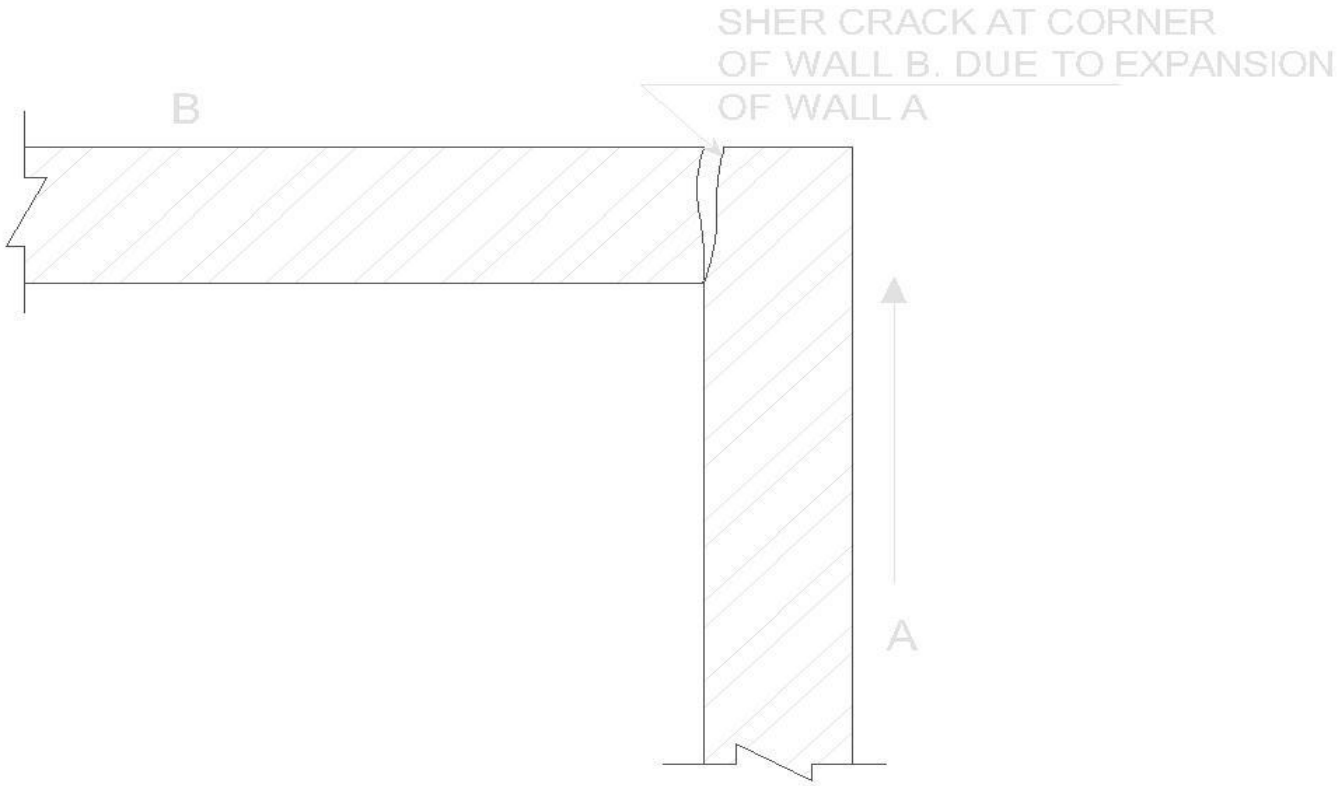
- Modern Structure
- Tall, slender, thin wall
- Designed for higher stress
- Constructed at fast pace
- More crack prone

Continue…



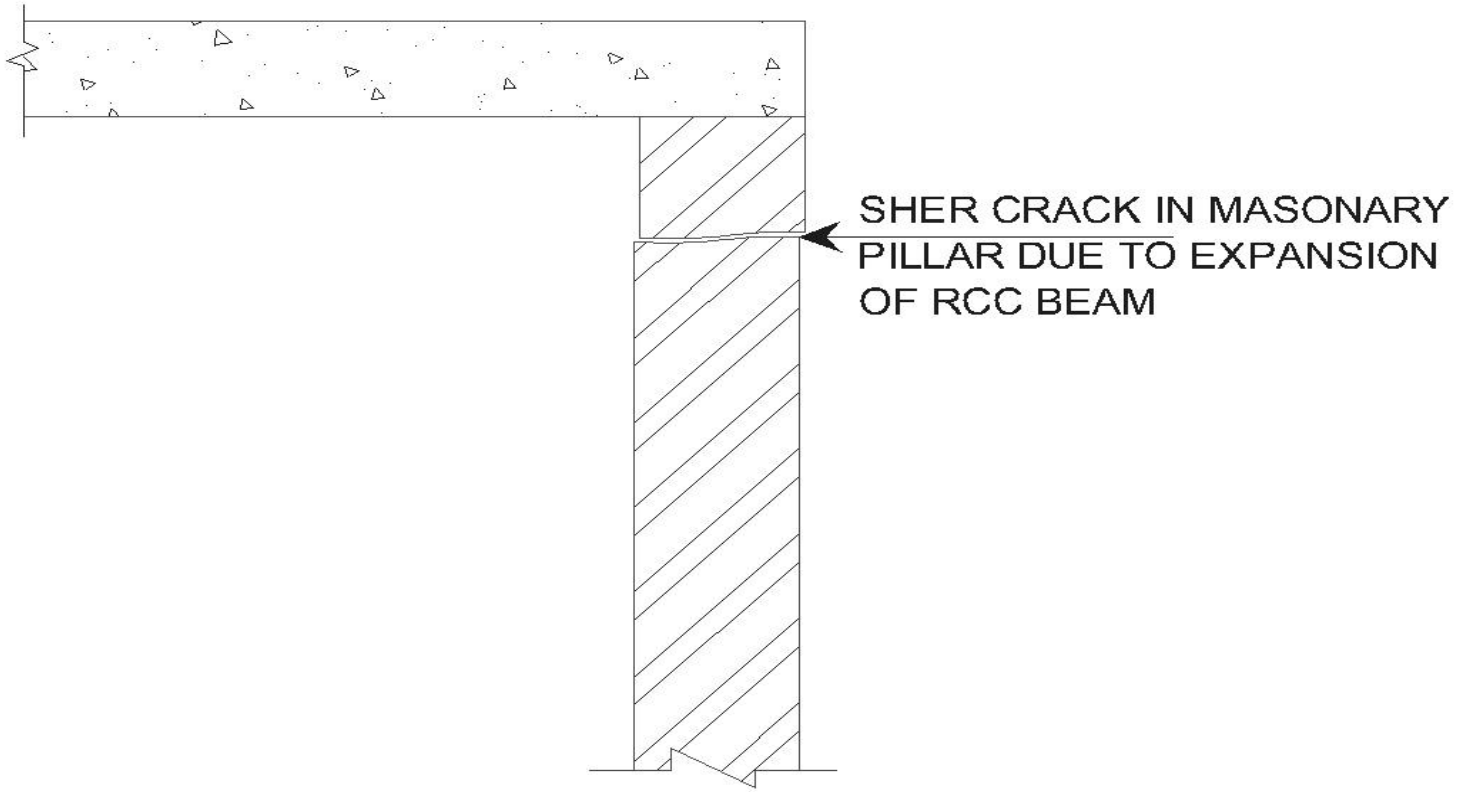
Flexural Tension Crack in Wall Masonry

Continue…



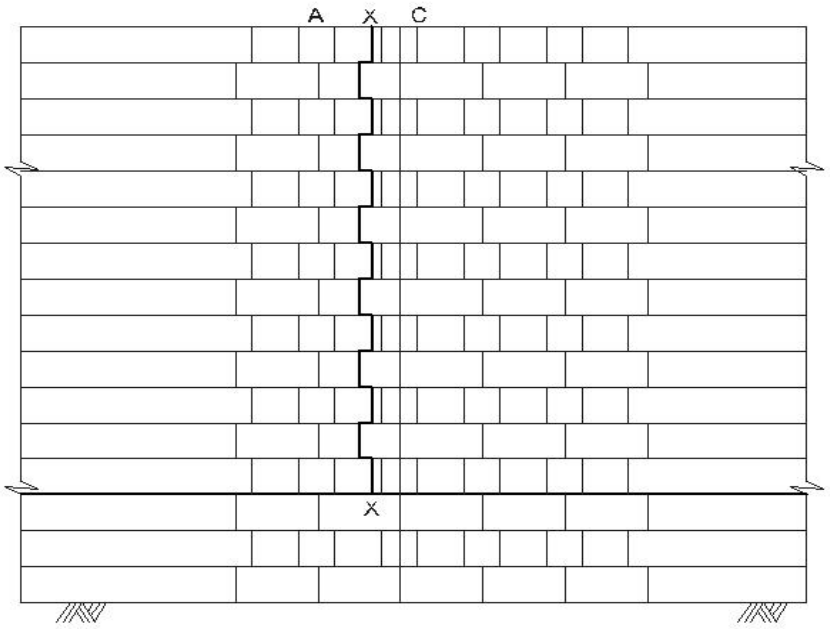
Shear Crack in Masonary Wall

Continue…



Shear Crack in Masonary Pillar
at Beam Support

Continue…



Cracking Due to Expansion of Brickwork

Cause of cracks in buildings

- Moisture change
- Thermal variation
- Elastic deformation
- Creep
- Chemical reaction
- Foundation movement and settlement of soil
- Vegetation

Moisture Movement

- Reversible Movement
- Material expands on absorbing moisture content
- Shrinks on drying
- Irreversible movement
- Material undergo some irreversible movement due to initial moisture change

Types and causes of cracks in Concrete

- Before hardening
  - Drying
  - Plastic shrinkage
  - Settlement shrinkage
  - Bleeding
  - Delayed curing

Continue…

- Constructional
  - Formwork movement
  - Excess vibration
  - Subgrade settlement
  - Finishing
- Early frost damage

Continue…

- After hardening
  - Unsound material
  - Long term drying shrinkage
  - Thermal
  - Moisture movement
  - Biological
  - Structural design deficiencies
  - Chemical
  - Corrosion of reinforcement

Plastic shrinkage cracks

- Concrete surface loses water faster than the bleeding action brings it to top
- Quick drying of concrete at the surface results in shrinkage
- Concrete at the plastic state can not resist tension
- Crack Depth 5 to 10 cm, width 3 mm
- Once developed difficult to rectify

Measure to reduce plastic crack

- Moisture the sub grade and form work
- Erect the temporary wind breaker
- Erect the temporary roof to protect green concrete from hot sun
- Reduce the time between placing & finishing
- In case of delay in finishing cover the concrete with polythene

Settlement shrinkage

- If concrete is free to settle uniformly, no crack occurs
- Obstruction to uniform settlement creates voids/cracks (Reinforcement/Aggregate)
- Settlement crack (common in deep beam)

Measure

- Pouring of concrete in layers with proper compaction
- Revibration, if possible

Bleeding

- Upward movement of water when concrete settle downs
- Internal bleeding
- Bleeding water trapped below reinforcement & aggregate
- Affects bonds between reinforcement and concrete
- Interface, prone to micro cracking
- Weak link in concrete
- Further loading propagate cracking

Continue…

- External Bleeding
- Upward movement of water emerged at top surface
- After evaporation : surface – Porous and abrasion resistance very little.

General Observations

- Mason floats concrete when bleeding water still standing.
- Results
- Downward movement of coarse aggregate
- Upward movement of fine particles (cement and water)
- Top surface
- Presence of fine materials develops crack and craziness

(Craziness: occurrence of closely spaced crack at surface)

Delayed Curing

- Common practice
- Delayed curing
- Interruption in continuous curing
- Curing not done for required period
- Major cause for shrinkage
- Minimum 7 to 10 days curing required

Constructional Effects

- Crack/Deformation of plastic concrete (After Compaction)

-Lack of rigidity of formwork (Remains unnoticed)

-Use of high consistency concrete (present trend)

: Pumping requirement, Use of superplasticizer

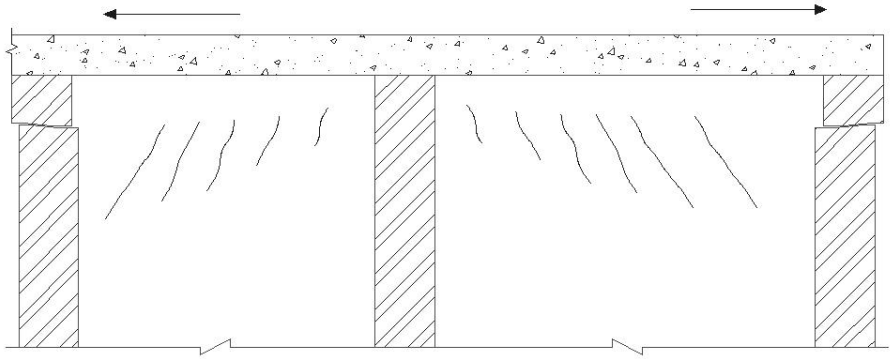
-Avoid segregation by proper vibration

- Segregated Concrete Mix- Exhibits high shrinkage crack

Unsound Material

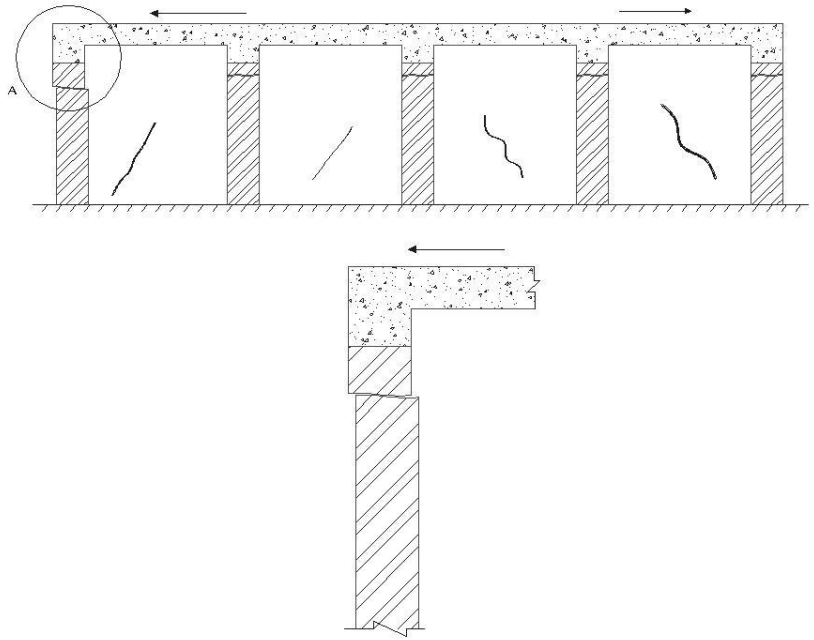
- Use of crushed sand very common now
- Amount of dust (<75 micron): Very high
- Presence of excess dust :
  - Causes crack formation
  - Interfere with setting time, Shrinkage and Bond
- Maximum %age of fine = 3% (Coarse aggregate)

Some measures to avoid cracks



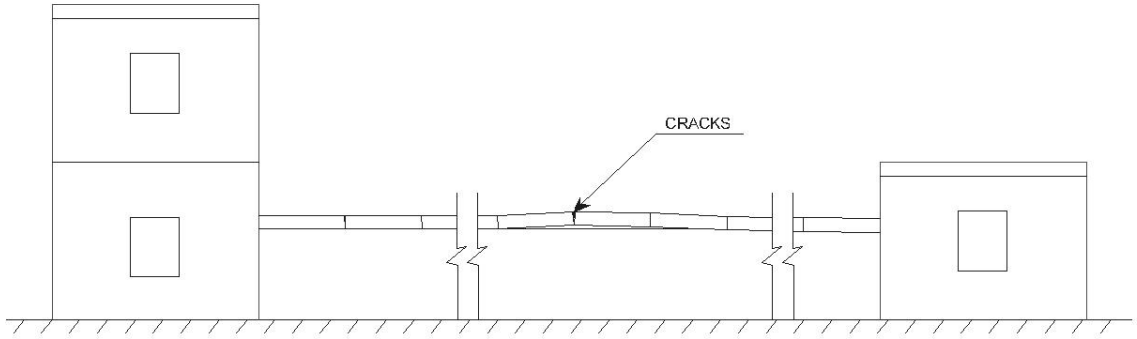
Cracking in Top Most Storey of a Load Bearing Structure

Continue…



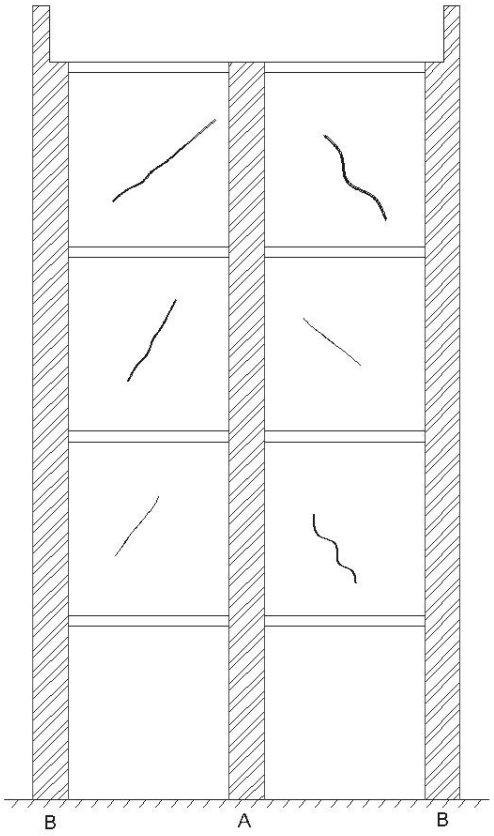
Cracking in Cladding and Cross Walls of a Framed Structure

Continue…



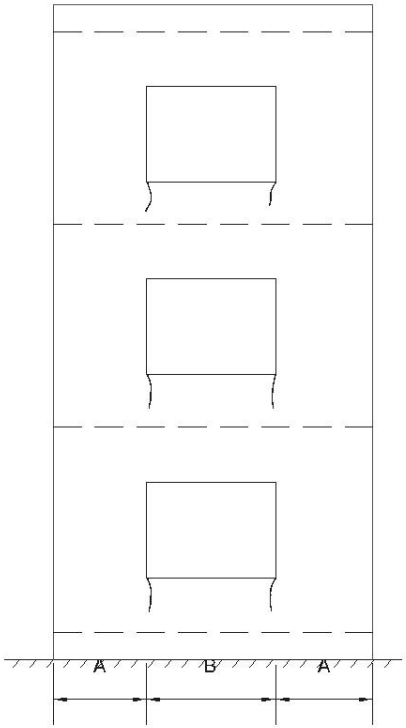
Arching up and Cracking of Coping of a Long Garden Wall

Continue…



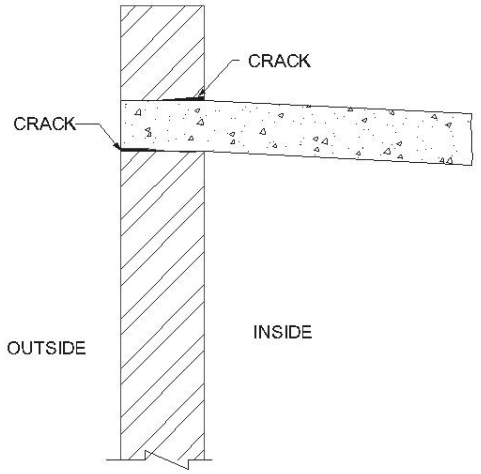
Diagonal Cracks in Cross Walls of Multi-Storied Load Bearing Structures

Continue…



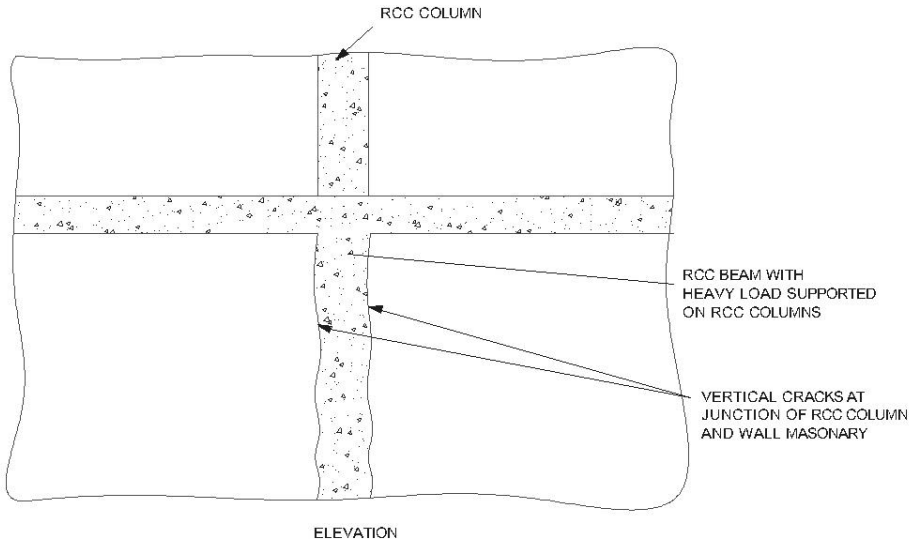
Vertical Cracks in Multi Storyed Building Having Window Openings in Load Bearing Wall

Continue…



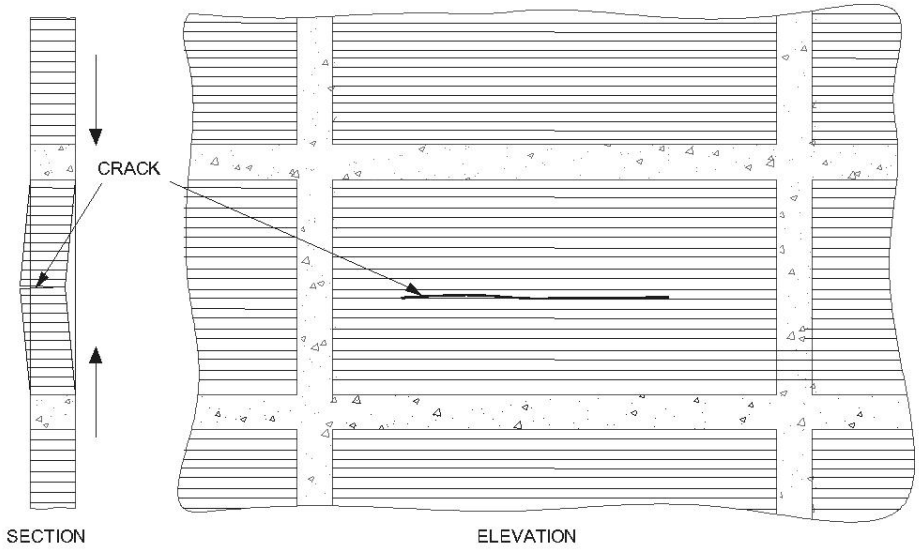
Horizontal Cracks in a Wall at Supports Due to Excessive Deflection of a Slab of Large Span

Continue…



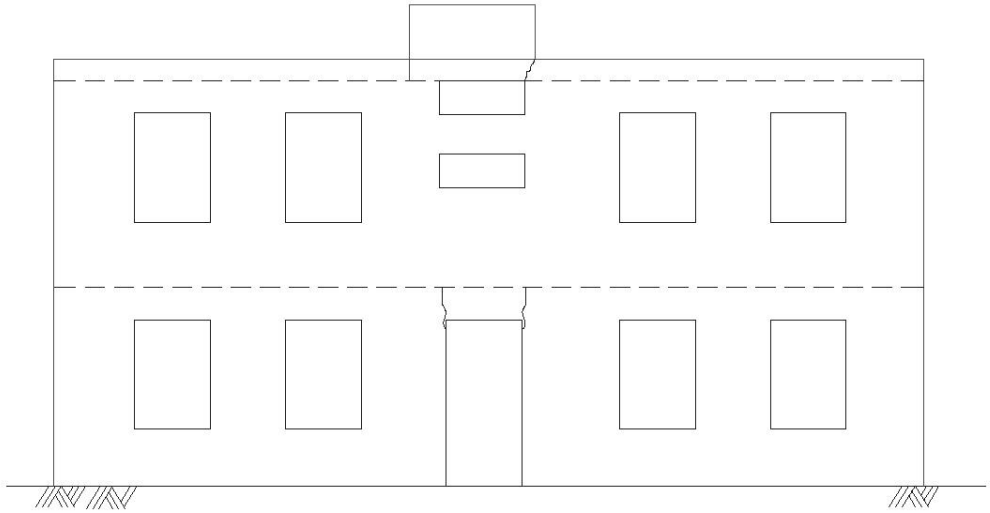
Vertical Cracks at Juction of RCC Column and Wall Masonary in a Load Bearing Structure

Continue…



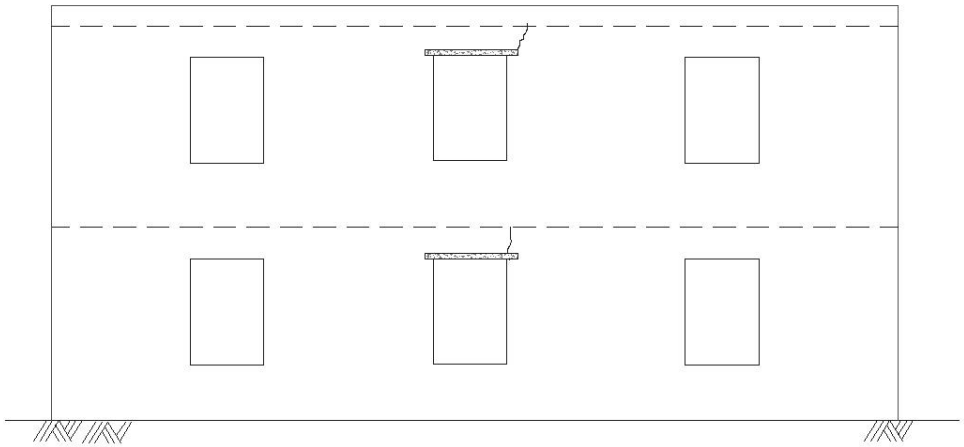
Horizontal Cracks in Brick Panels of a Framed Structure

Continue…



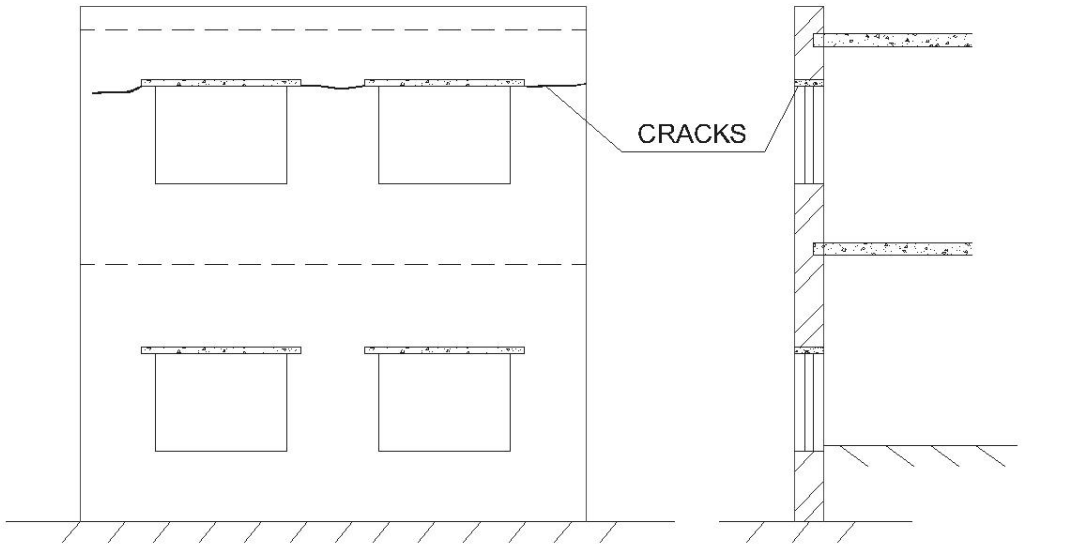
Vertical Cracks in the External Wall around Staircase Opening in a Long Building

Continue…



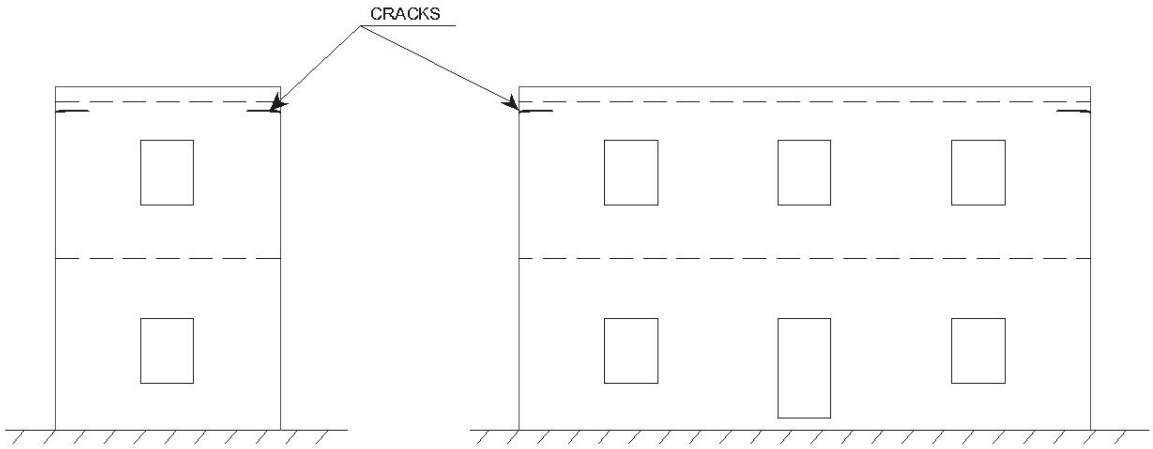
Cracks in the External Wall around
RCC Balcony

Continue…



Horizontal Cracks at Window Lintel Level Due in Top Most Storey

Continue…



Horizontal Cracks at Corner of Top Storey Below Slab Level Due to Lifting of Corners

Thermal expansion and shrinkage

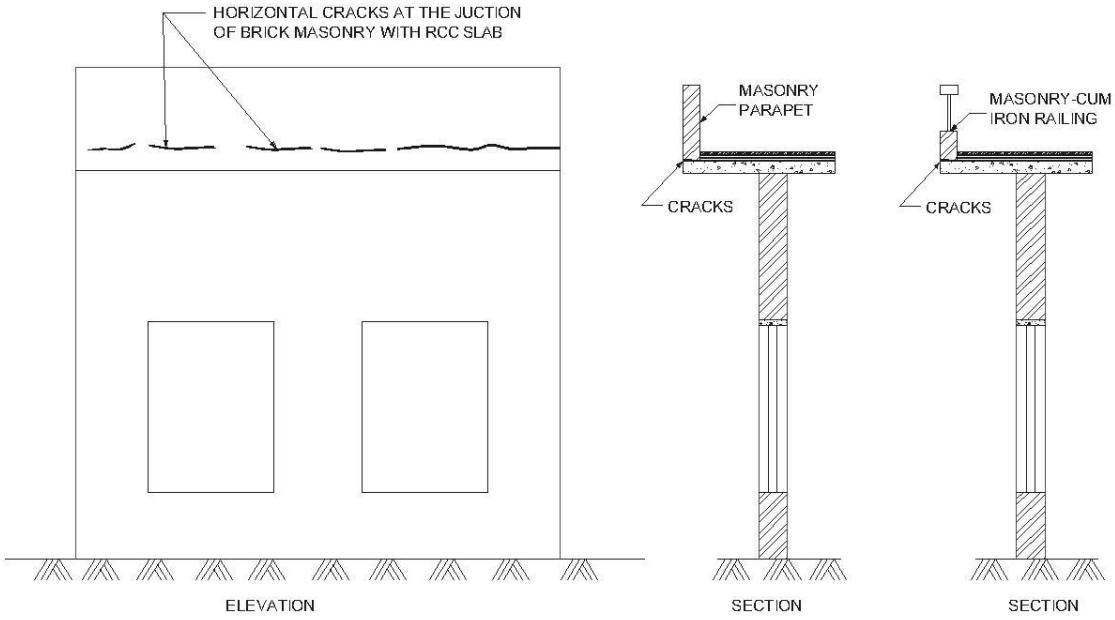
- Assume characteristics compressive strength of concrete -25 MPa
- Modulus of elasticity – $5000x \sqrt{fck}$ N/mm^2

  $- 5000 \times \sqrt{25} = 2.5 \times 10^4$ N/mm^2
- Flexural strength $= 0.7 \times \sqrt{fck} = 3.5$ N/mm^2
- Coefficient of thermal expansion of concrete = $10 \times 10^{-6}/°c$
- Diurnal Variation in temperature = 20 °c

Continue…

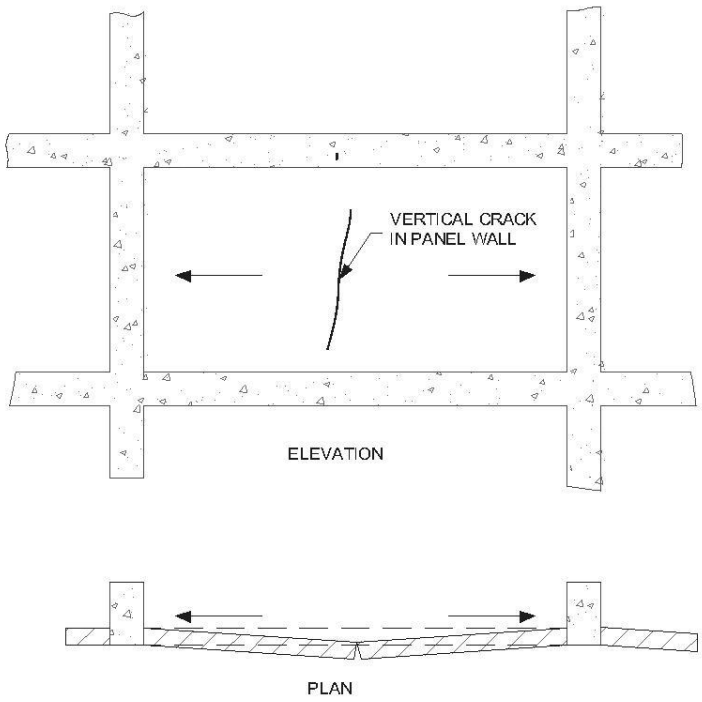
- Thermal shrinkage strain = $20 \times 10 \times 10^{-6}$
- Modulus of elasticity = Stress/Strain
- 2.5×10^{4} = Stress/200×10^{-6}
- Tensile Stress = 5.0 N/mm^2
- Tensile Strength of concrete = 3.5 N/mm^2
- Sure to cause crack

Continue…



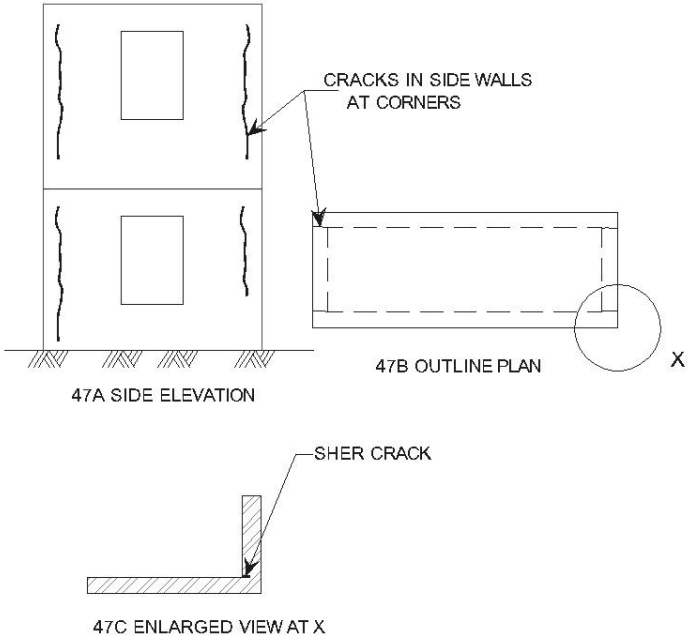
Horizontal Cracks at the Base of Brick Masonary Parapet (or Masonary-cum-Iron Railing) Supported on a Projection RCC Slab

Continue…



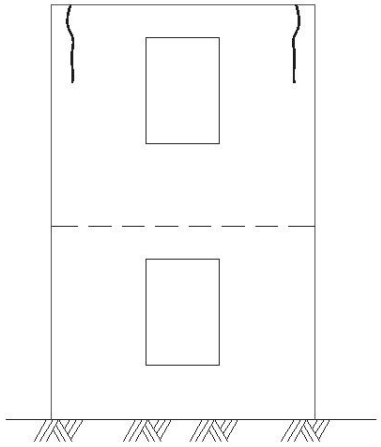
Vertical Cracks in Brick Wall of Framed Structure Due to Expansion of Brickwork

Continue…

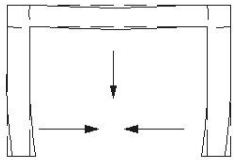


Vertical Cracks at Corner in the in the Side Walls of a Building Due to Thermal Movement

Continue…



48A ELEVATION

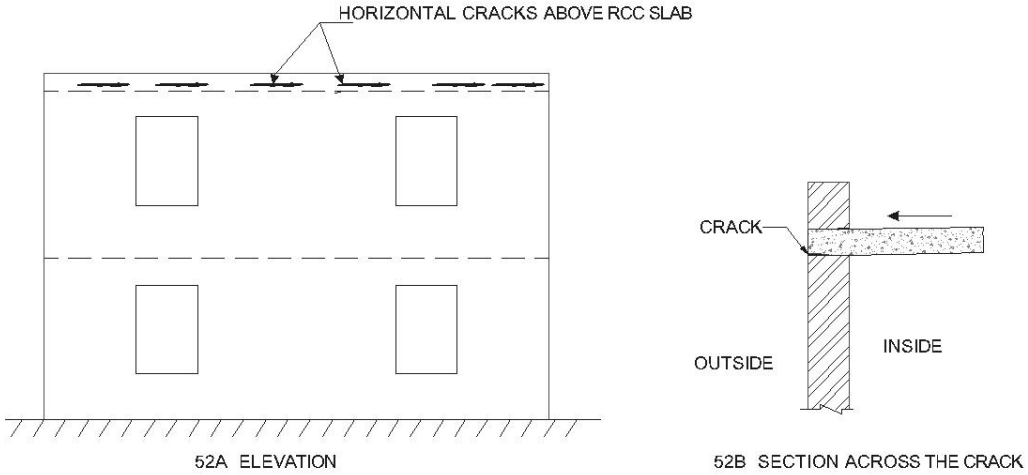


Arrows Indicate Direction of Pull Of Slab on Walls

48B MECHANISM OF CRACKING

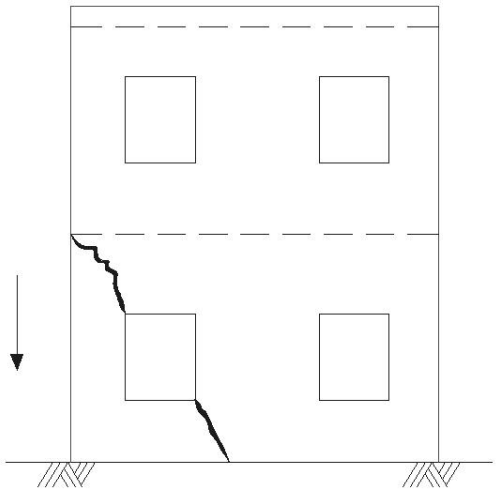
Vertical Cracks at Corner in the in the Top Storey of a Building Due to Drying Shrinkage and Thermal Contraction of Slab

Continue…



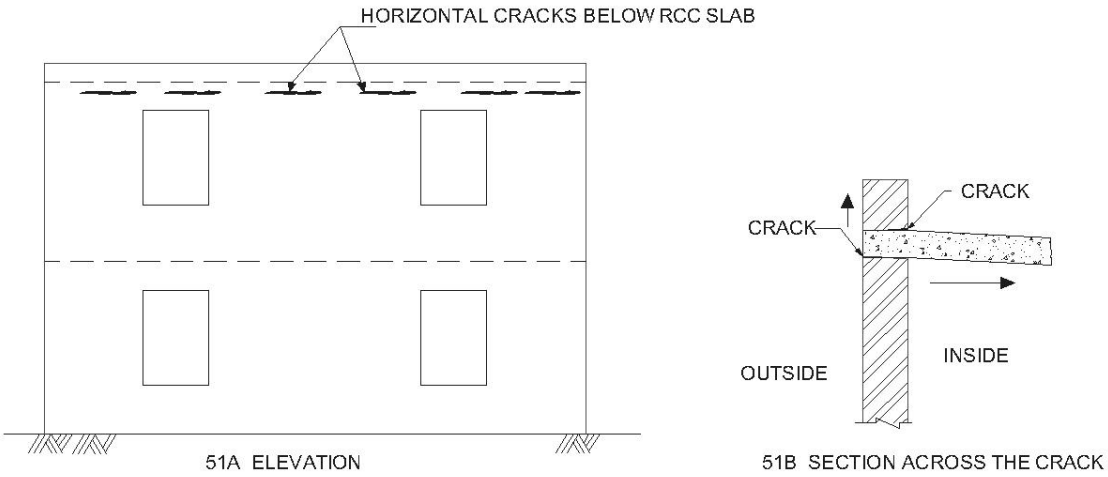
Horizontal Cracks Above the RCC Slab in Top-Most Story Due to Arching and Expansion of Slab

Foundation settlement…



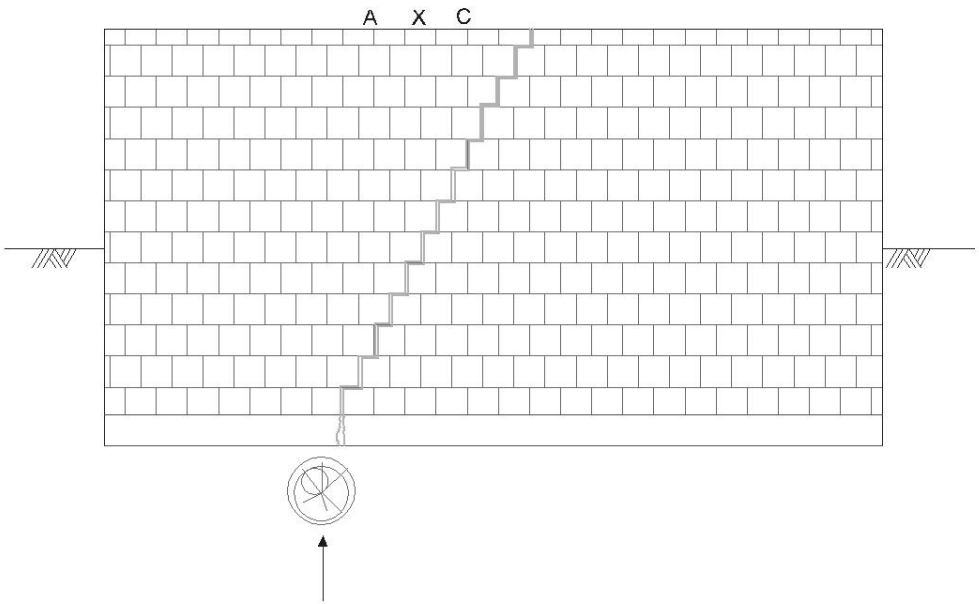
Cracks at the Center of a Building
Due to Foundation Settlement

Continue…



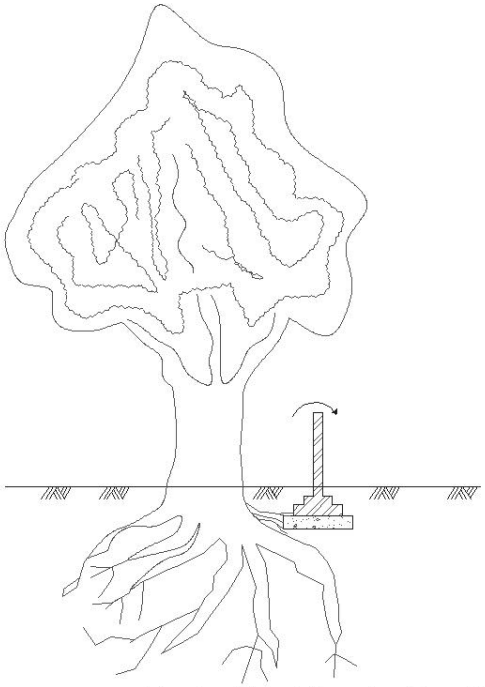
Horizontal Cracks in Top-Most Story Below Slab Due to Shrinkage and Deflection of Slab

Crack due to vegetation…



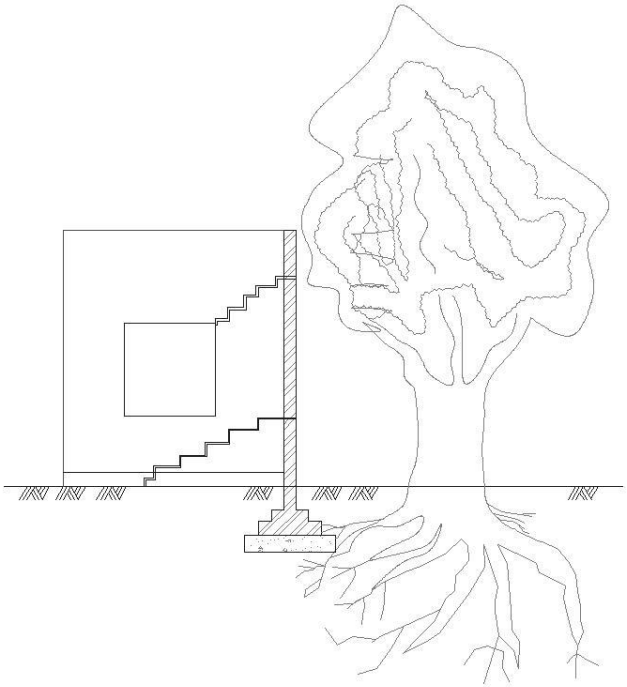
Cracking of a Compund Wall Due to Growing Roots Under Foundation

Continue…



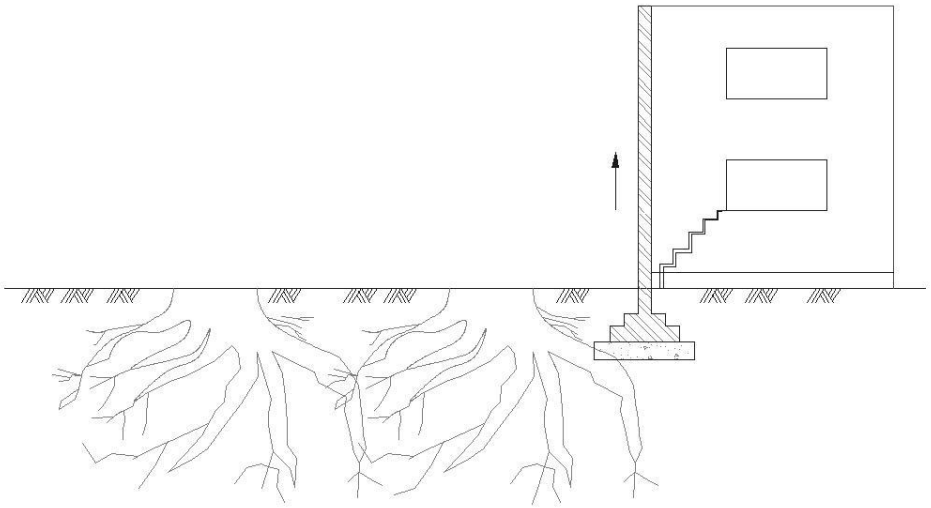
Roots of Fast Growing Tree Under
The Foundation of Compound Wall May
Topple Down the Wall

Continue…



Trees Growing Close to a Building on Shrinkable Soil may Cause Crack in the Walls

Continue…



Cracking Due to Expansion of Soil, if Construction is Taken up Soon After Removal of Tress

Thanks…..