Water seepage detection in IITJ buildings using GPR

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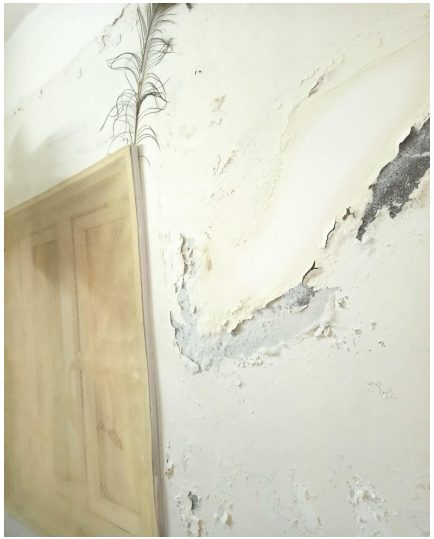
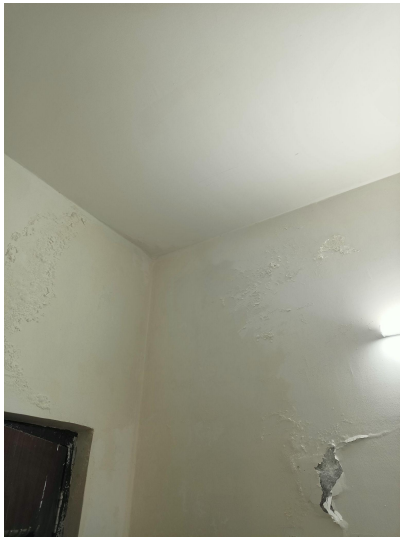
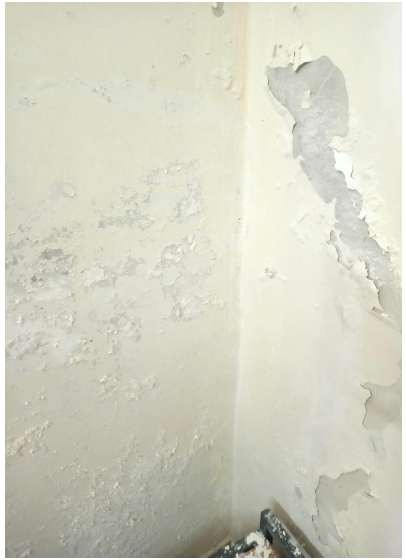
B21CI041

Problem:

Water seepage in IIT Jodhpur building walls and roof.

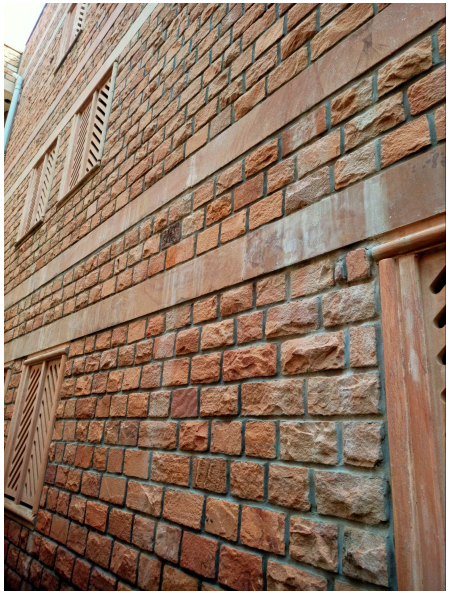






: Photos taken from room of G3 first floor.

: Photos are of Y4 hostel



: G3 walls from outside

Possible reasons for water seepage:

- **Cracks in walls:** There can be development of cracks due to:
  - Structural setting
  - Temperature changes
  - Poor workmanship
- **Inadequate waterproofing:** Insufficient waterproofing during construction or deterioration over time can lead to water penetration.
- **Faulty Joints:** Improperly sealed joints at corners, window sills, or door frames can allow water to seep through.
- **Capillary Action:** Porous building materials absorb water through capillary action, especially if not adequately protected.
- **Poor Drainage:** If rainwater isn't diverted away from the building's foundation, it can accumulate and seep through walls.

Type of cracking:

- **Cracking of plastic concrete:** *Plastic shrinkage cracking* When moisture evaporates from the surface of freshly placed concrete faster than it is replaced by bleed water, the surface concrete shrinks. Due to the restraint provided by the concrete below the drying surface layer, tensile stresses develop in the weak, stiffening plastic concrete. This results in shallow cracks of varying depths that may form a random, polygonal pattern, or be essentially parallel to one another
  - Rapid loss of moistures is due to:
    - High air and concrete temperatures,
    - Low relative humidity, and
    - High wind velocity at the surface

Type of cracking:

- **Cracking of hardened concrete:** A common cause of cracking in concrete is restrained *drying shrinkage*.
  - Loss of moisture from the cement paste constituent, which can shrink by as much as 1%.
  - Aggregate particles provide internal restraint that reduces the magnitude of this volume change to about 0.06%.
  - Tensile stresses are caused by differential shrinkage between the surface and the interior concrete.
  - The magnitude of the tensile stresses induced by volume change is influenced by:
    - Amount and rate of shrinkage,
    - Degree of restraint,
    - Modulus of elasticity, and
    - Amount of creep.

Type of cracking:

- Autogenous shrinkage “is a special case of drying shrinkage” that results from self-desiccation (internal drying) in concretes with water-cementitious material ratios (w/cm) below 0.42, but most often observed at a w/cm below 0.30.
- Autogenous shrinkage occurs without the loss of moisture from the bulk concrete

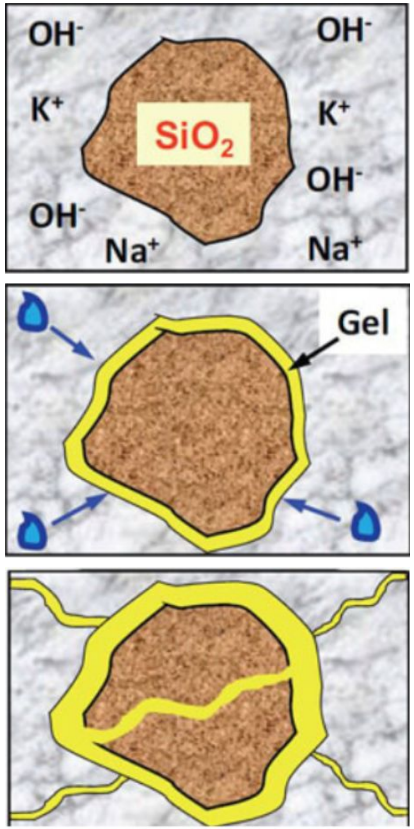
Type of cracking:

- Alkali aggregate reaction(ASR): Reaction with poorly crystalline or amorphous silica present in the aggregates and alkalis in the pore solution
- Silica gel is similar to C-S-H but lower in density and Ca/Si ratio
- Leads to expansion and cracking in aggregates
- Manifests as map cracking

- Reaction between the alkali hydroxides (Na, K, & OH) from the cement and unstable silica, SiO, in some types of aggregate.

- The reaction produces an alkali-silica gel, which absorbs water from the surrounding paste…

- The internal expansion eventually eventually leads to cracking of the surrounding concrete



Aim:

Evaluating the effectiveness of ground-penetrating radar (GPR) in detecting hairline cracks and water seepage in concrete structures at IIT Jodhpur.

GPR application in building health monitoring:

- **Crack Detection and Mapping:** Identify and map cracks within concrete structures, including hairline cracks.
  - High-resolution images
  - Visualizing the extent and orientation of cracks
  - No damage to the structure.
- **Rebar and Post-Tension Cable Inspection:** Locating and mapping rebar and post-tension cables within concrete.
- **Concrete Thickness Measurement:** Measure thickness of concrete slabs
  - detect any variations from the original design.
  - Identifying areas where cracks formed due to thinning or deterioration of the concrete.

GPR for reinforcement corrosion assessment:

- **Moisture Content Analysis:** Detect moisture intrusion in concrete
  - Identifying areas with high moisture content.
- **Void Detection:** Identify voids or gaps within concrete structures
- **Pavement Structure Evaluation:** Assess the condition of pavement structures
  - Detecting subsurface anomalies like voids, cracks, or moisture intrusion

GPR for reinforcement corrosion assessment:

Assessing the applicability of ground penetrating radar (GPR) for detecting water seepage in IIT Jodhpur buildings

References:

- https://baustela.hr/app/uploads/2021/02/materials-14-00975-v2.pdf
- GPR Assessment Method of Reinforced Concrete Structures: A Review | Request PDF (researchgate.net)
- Applications of GPR | Inspecting Concrete Structures | GPR Data Inc.
- (PDF) Early Detection of Corrosion Damage in Reinforced Concrete Using GPR Array Imaging Method (researchgate.net)
- Using Ground Penetrating Radar Methods to Investigate Reinforced Concrete Structures | Surveys in Geophysics (springer.com)
- https://drive.google.com/file/d/12zc6L-SHyYT-Iq3LtHdTqno-UoOIvfLf/view