

# Detection of Hair-line Cracks in IITJ Buildings Using Ground Penetrating Radar (GPR)

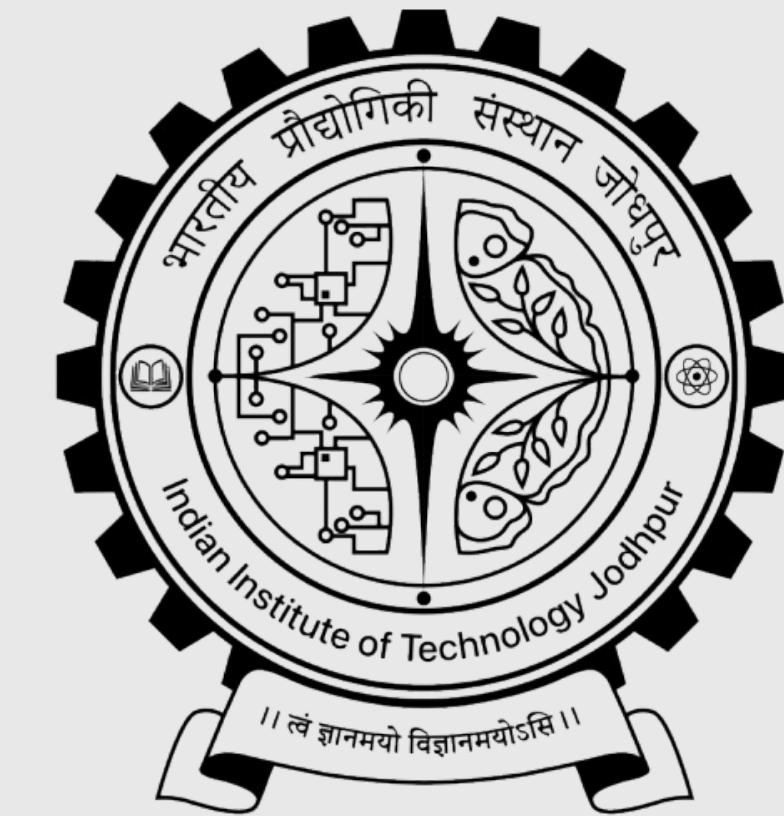
## BTech Project

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# OBJECTIVE

- Detect and analyze hairline cracks and moisture zones within IIT Jodhpur buildings.
- Explain seepage causes within IIT Jodhpur buildings.
- Investigate the effectiveness of GPR in detecting subsurface irregularities, including visible and non-visible cracks.
- Assess the limitations of GPR for identifying minute structural defects and evaluate factors impacting its efficacy
- Use of GPR for non-invasive detection of structural issues.



# Introduction

- **GPR:** Non-invasive, electromagnetic method for subsurface scanning.
- **Purpose:** Identify moisture zones, cracks, and structural defects.
- **Relevance:** Essential for preserving integrity in IITJ's structures.
- **Challenges:** Detecting non-visible, small-scale defects in concrete walls.

# What is GPR?

- Ground Penetrating Radar.
- An advanced, non-destructive testing method for subsurface scanning.
- Radio Detection and Ranging.
- Emits high frequency electromagnetic reflection.
- Very low power of emission
- Ultra-Wide Band (UWB): Uses a wide range of frequencies
- SIR 4000



# What is GPR?

## Components:

- **Antenna:** Transmits and receives electromagnetic waves.
  - 1600 MHz
- **Control Unit:** Manages signal generation, timing, data recording, and processing.
  - Serves as the interface for operating the GPR and visualizing data.
- **Software (RADAN):** Processes collected data to enhance signal interpretation.





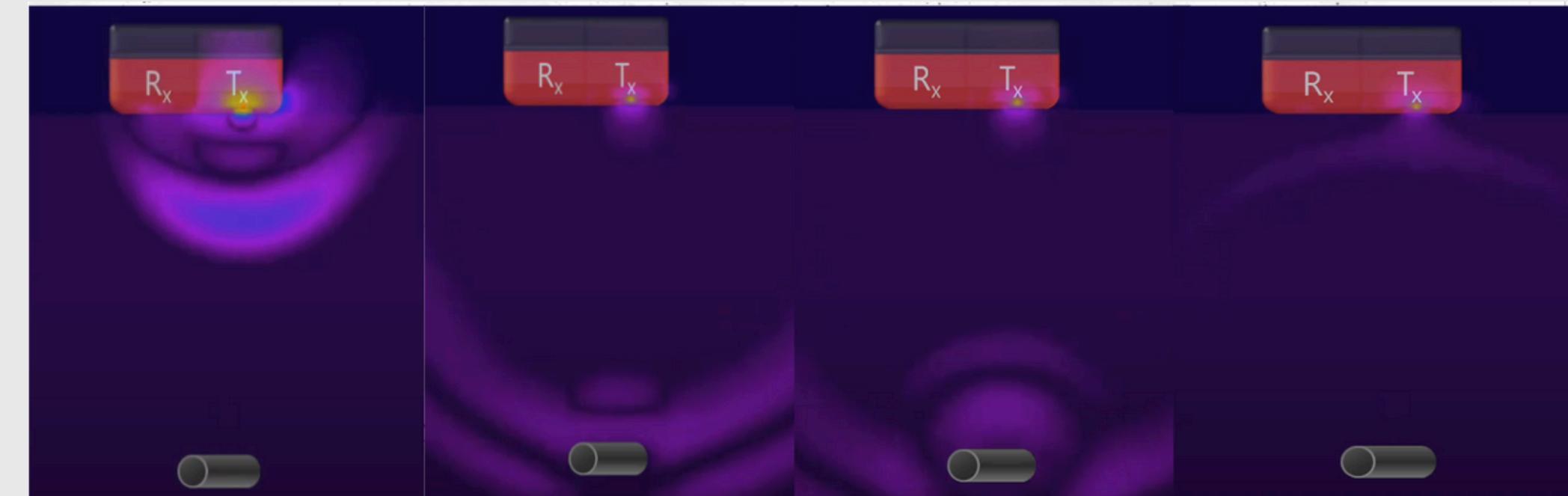
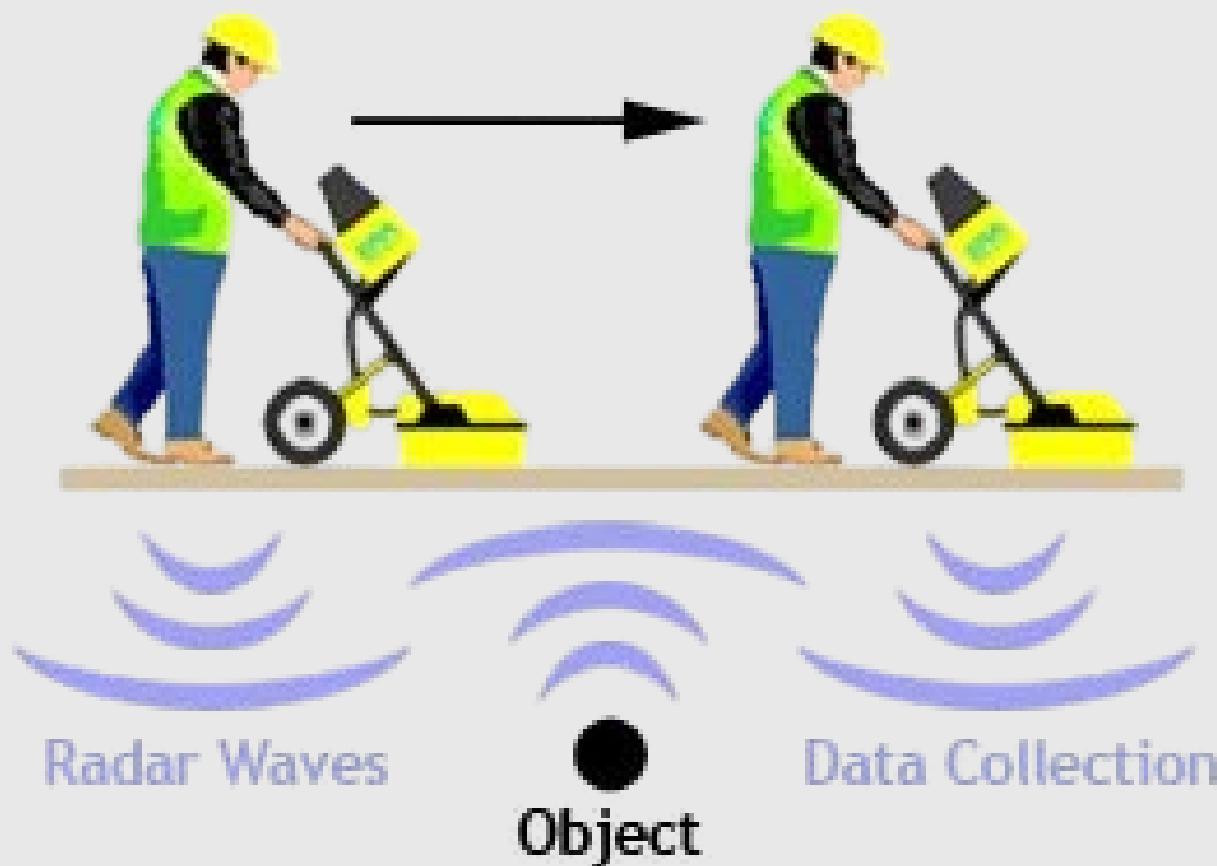
# Radar Shielding

- Blocking and Reducing Radar Signal Transmission
- Heavily Shiel antennas
  - Surrounded by metal
  - Insulated with a carbon foam
- Minimizing Interference
- Protecting Sensitive Equipment



# Working of GPR

- **Transmitter:** Sends electromagnetic pulses into the ground at specific frequencies.
- **Receiver:** Captures the reflected signals that return from subsurface objects.





# GPR in Concrete Crack Detection

**Purpose:** Rapidly scans beneath surfaces without damaging the structure.

## Use in Infrastructure:

- Detects cracks, voids, moisture zones within concrete.
- Common in structural integrity checks for roads, bridges, and buildings.
- Non Destructive Technique (NDT)
- Scan Spacing and Data Integrity



# Scan Spacing and Data Integrity

## Importance of Scan Density:

- Closer scan spacing (higher density) increases detection accuracy.
- Essential for identifying smaller defects and maintaining data quality.

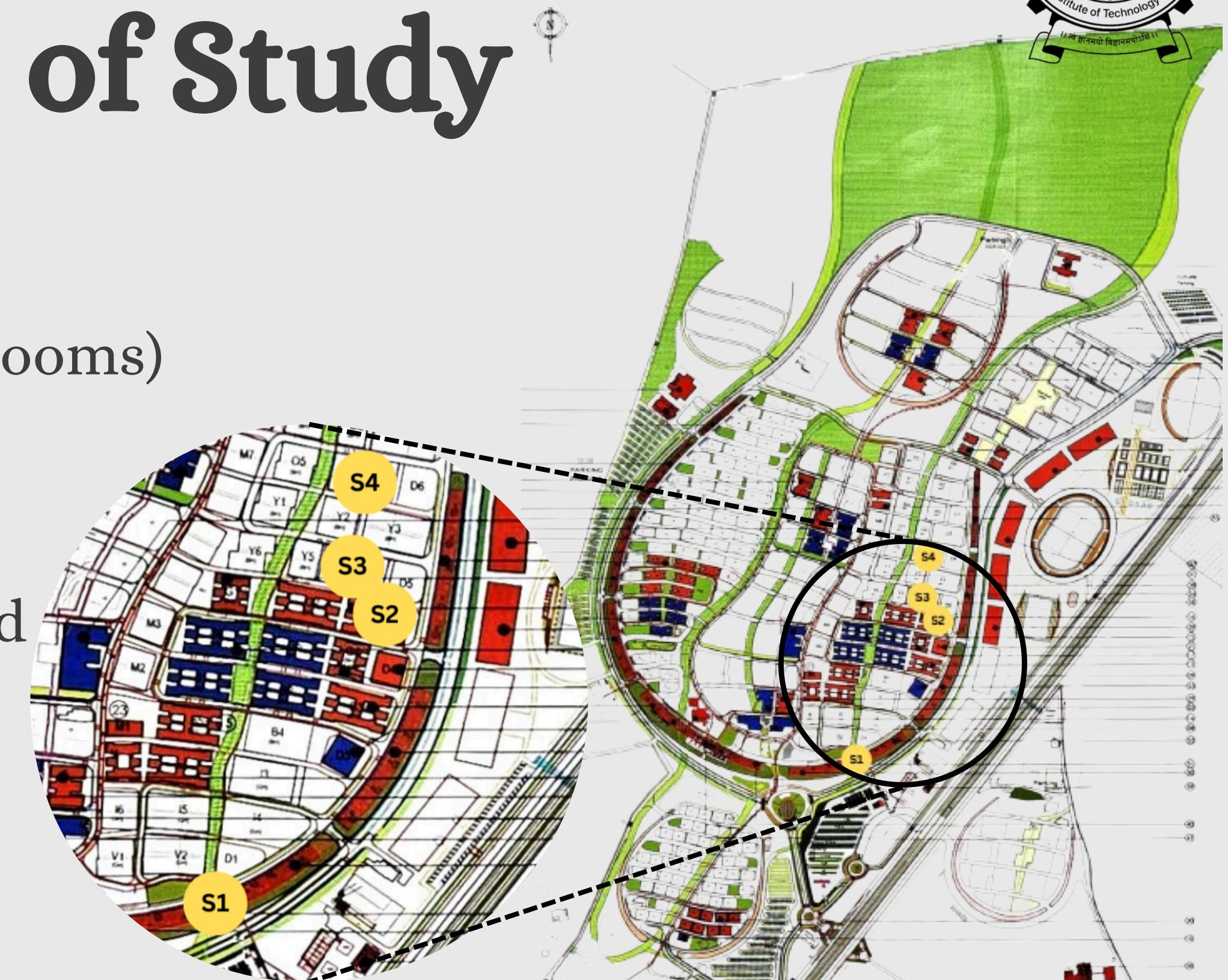




# Area of Study

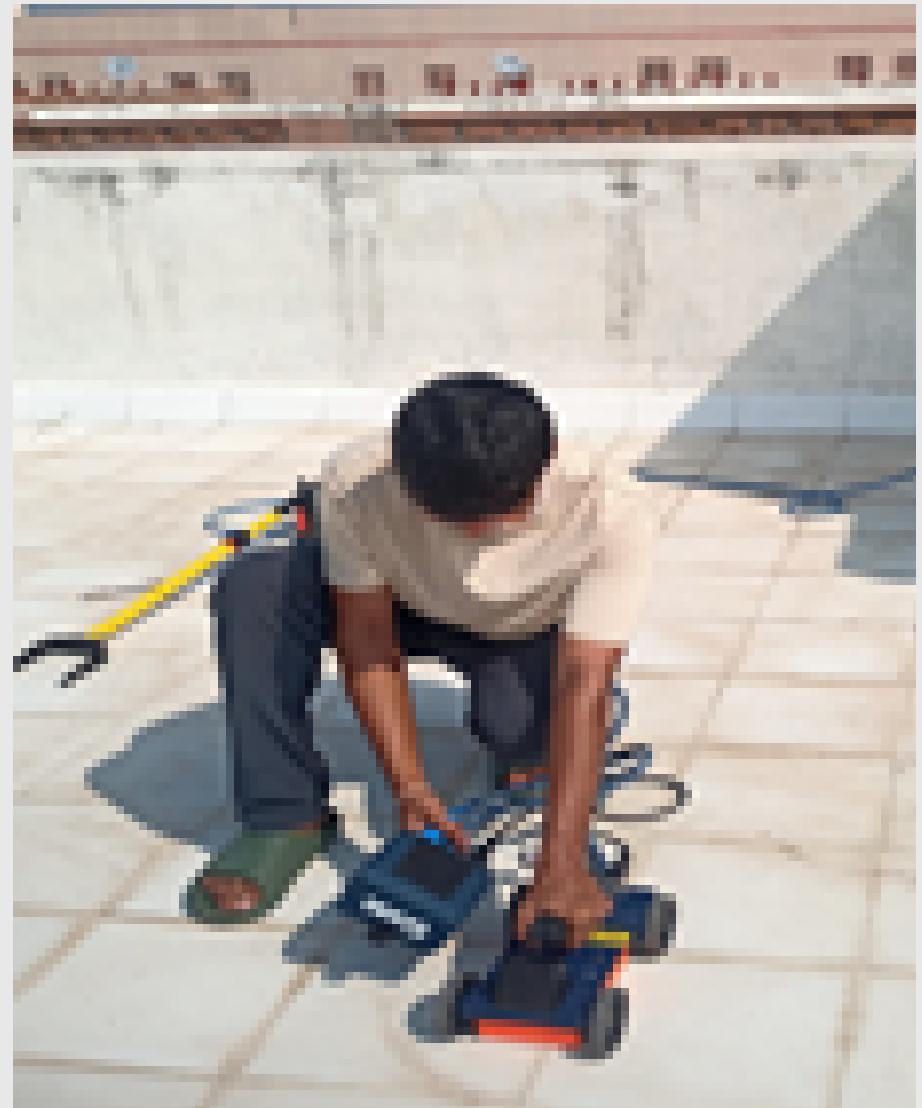
## Buildings surveyed:

- S-1 E-3 Berm
- S-2 G-3 Hostel (terrace and rooms)
- S-3 Y-4 Hostel (exterior)
- S-4 O-4 Hostel (exterior)
- Focused on high-seepage and visibly cracked areas.





# Data Collection



# Data Processing

Colour  
Processing

Time Zone  
Processing

IIR Filter

Noise Band  
Removal

Gain Adjust

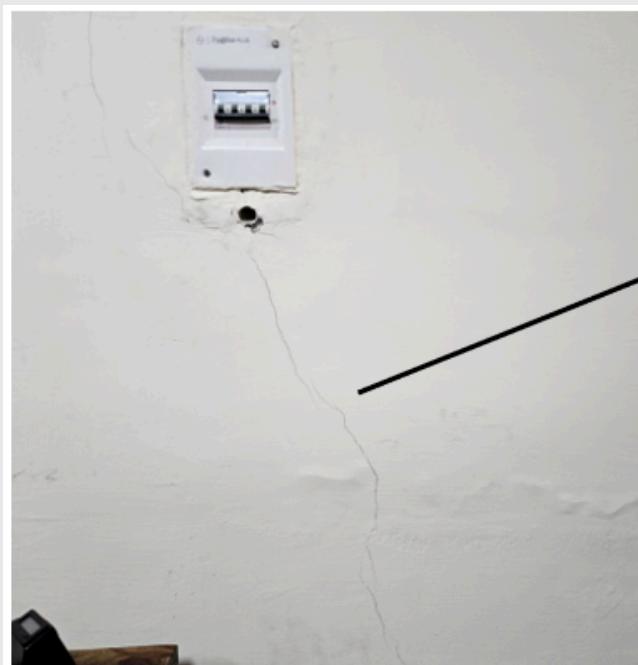
Migration



# Results and Interpretation

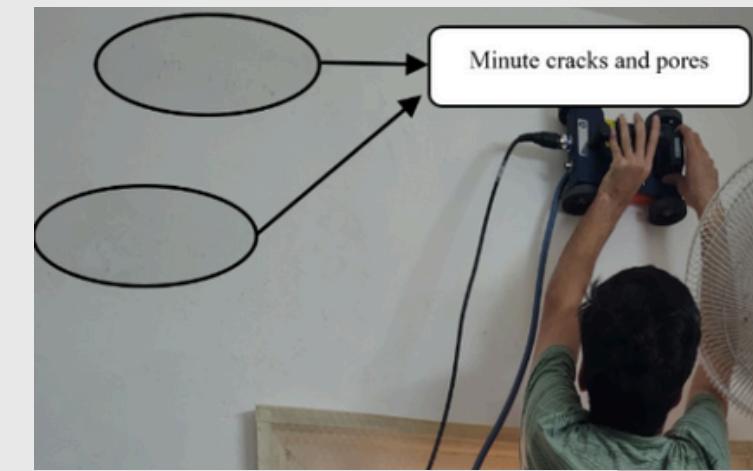
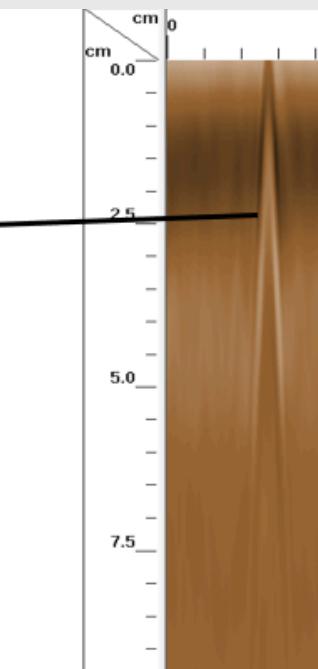
- Moisture zones found in G-3 terrace, Room 225.
- E-3 Berm: Detectable visible cracks.
- Y-4 and O-4: Detected surface abnormalities; limitations in deeper detection where no visible cracks exist.

# Results and Interpretation

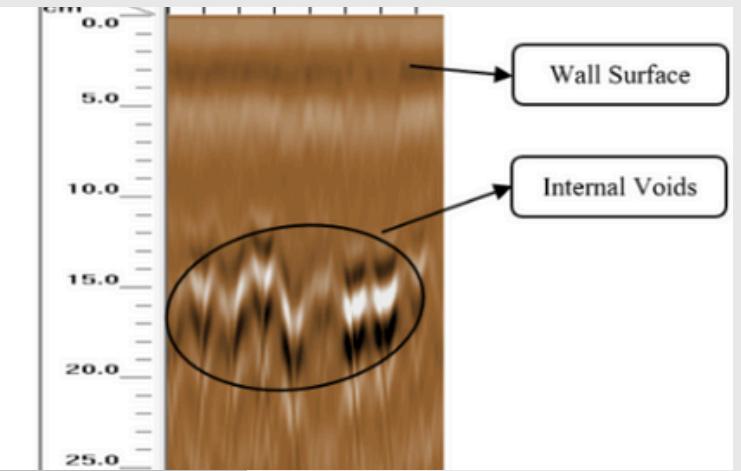


**E-3 Berm**

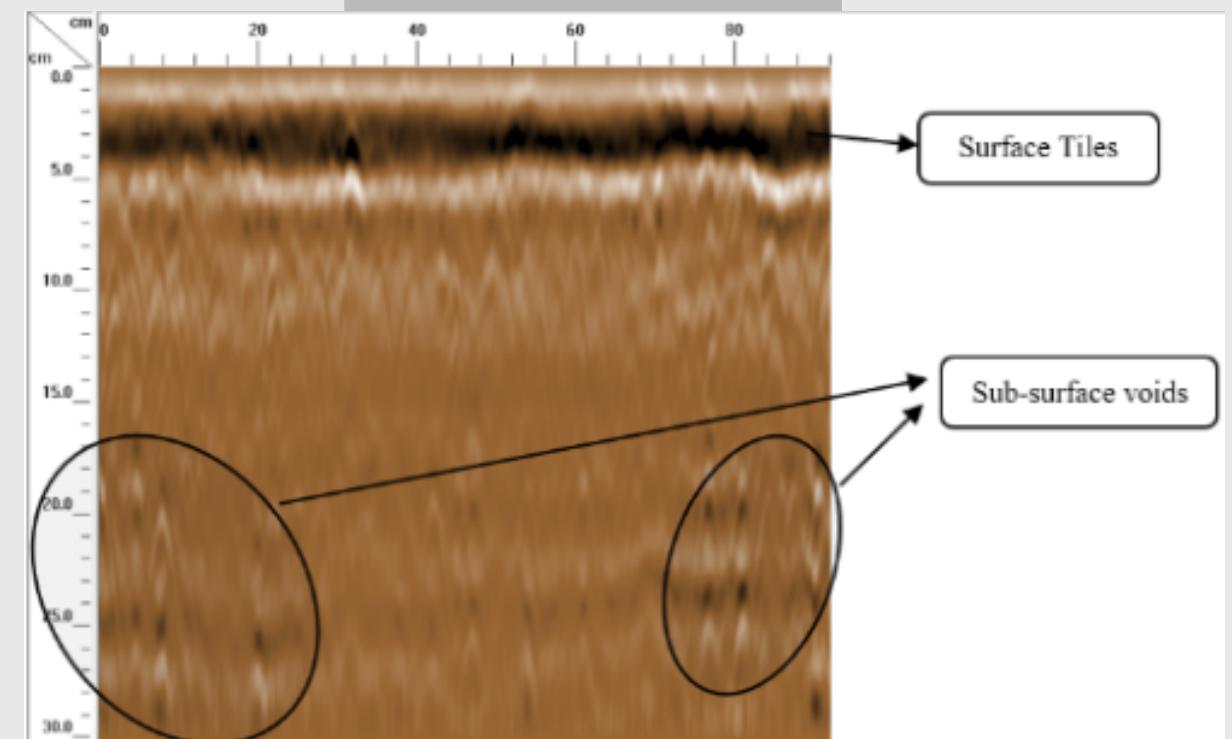
Visible Crack



Minute cracks and pores



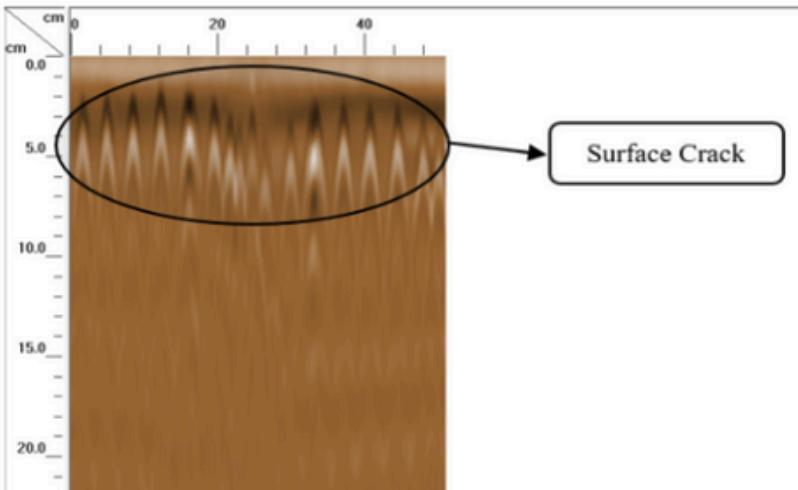
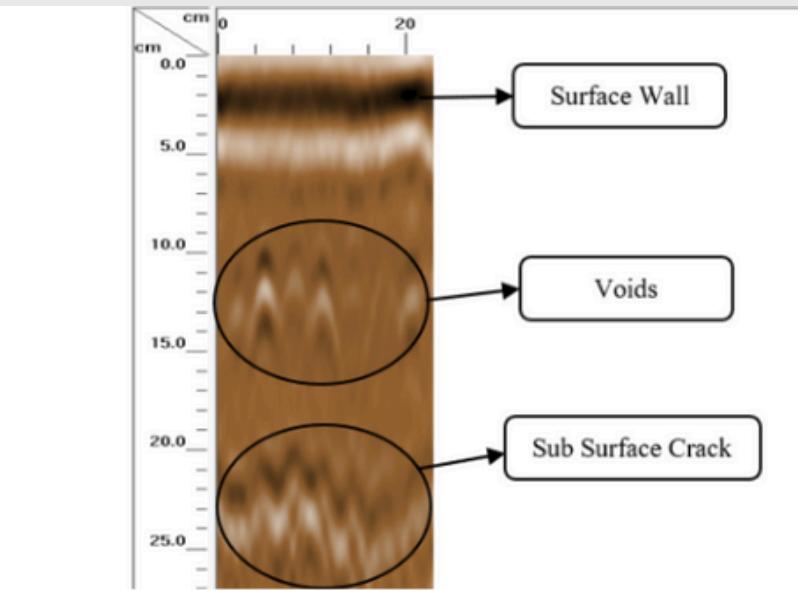
**G-3 Hostel**



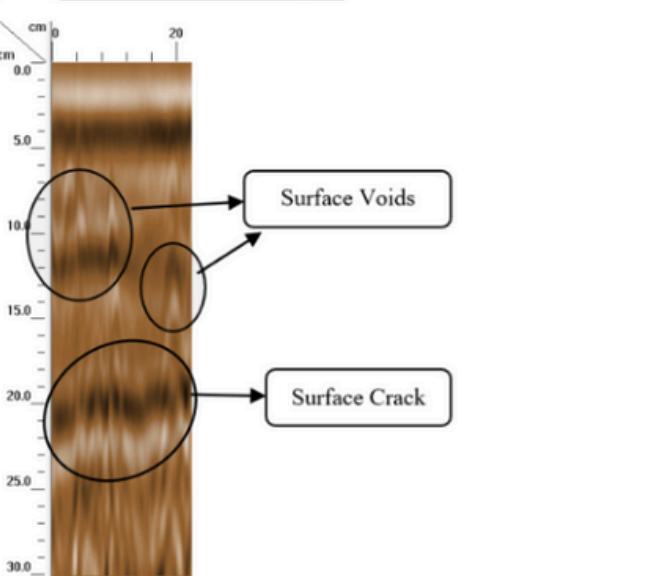
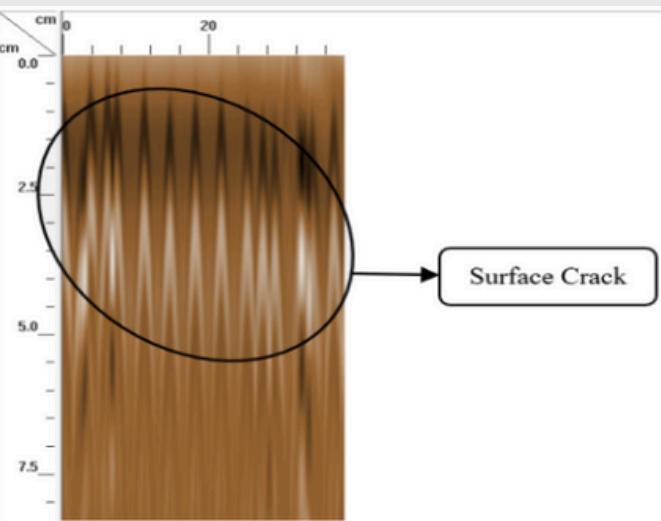
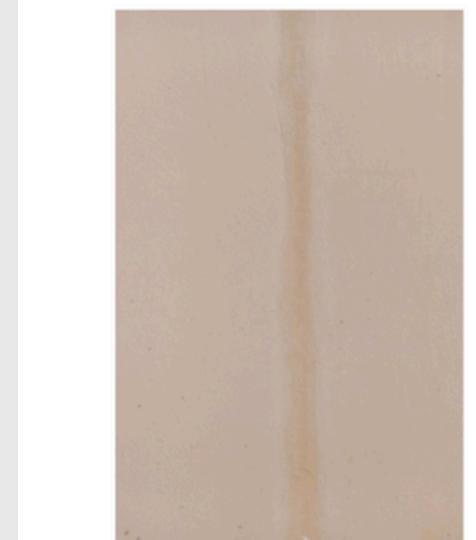
Surface Tiles

Sub-surface voids

# Results and Interpretation



**Y-4 Hostel**



**O-4 Hostel**



# Limitations

## GPR Frequency Limitations:

- Detectable crack size typically limited to those over 6 mm.
- Small, non-visible cracks present challenges due to lower resolution limits.



# Conclusion

- GPR effective for identifying visible cracks and larger subsurface defects.
- Limited in detecting minute, non-visible cracks.
- Findings highlight the need for supplementary inspection techniques.



# Further Recommendations

## Data Collection Area

Broaden scope across more buildings and locations for

## Alternative GPR Models

Test higher-frequency GPR models for finer crack detection.

## Improve Processing Algorithms for Data

Develop enhanced algorithms for clearer imagery and refined data analysis.

## Other NDT Techniques

Incorporate additional NDT methods (e.g., USPV) for confirmation.

**THANK  
YOU**

