# 9th India International Water Week-2026

**CLIMATE RESILIENT WATER MANAGEMENT**

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# Imaging Hidden Distress: Electrical Resistivity Mapping Of Earthen Dams For Water Security


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# Importance of the Study



**Challenges in Earthen Dam that poses threat to Water Security and Dam Safety Management**

**Geotechnical & Structural vulnerability**

- Seepage & Piping
- Overtopping
- Foundation & slope failure
- Biological interference

**Hydrological & Environmental**

- Climate change
- Reservoir sedimentation

**Institutional & Governance obstacles**

- Aging
- Resource & technical deficits
- Data disconnects
- Public awareness

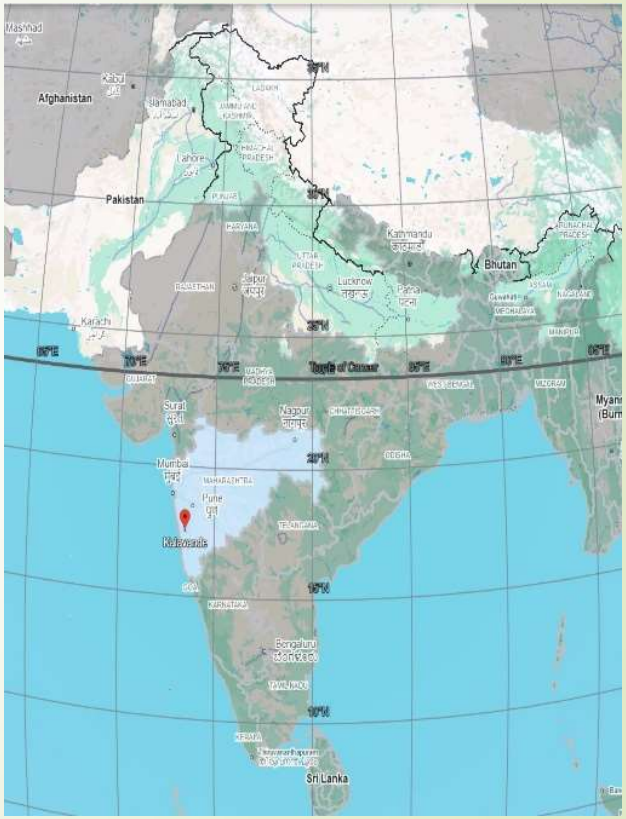
# Study Area: Kalwande dam, Maharashtra

## Salient Features

- Type: Earthen
- River: Local Nallah of West flowing rivers from Tapi to Tadri
- Location: Kalwande village, near Chiplun, Ratnagiri district.
- Catchment Area: 3.42 Sq. Km
- Purpose: Drinking and irrigation
- Live storage: 1.97 TMC and
- Dead storage: 0.04 TMC.
- Length: 210 m
- Height: 18.06 m
- River bed level: 86.44 m.
- Downstream Berm height:96.00 m RL.
- Cultivated command area: 166 Ha
- Irrigation command area: 111 Ha
- Cropped are: 150Ha.





# Challenges & Objective

- **Significant seepage:** Around the H.R. wall chainage 166.90 m.
- **Seepage:** Chainage 96 meters, with the water level at 95.72 meters and a storage capacity of 33%.
- **Geo-membrane treatment applied on the upstream side between chainages 97 meters and 212 meters.**
- ✓ **Purpose: Identify the extension of the cavities/cracks and the existence of distressed zones if any, in the body of the earthen dam and foundation.**







**Geo-membrane lining in the downstream of Kalwande Dam, Maharashtra**

# Acquisition Geometry: Electrical Resistivity Imaging

## Details of the locations of the profiles

| Sl No | Profile No | Location of profile | RD (m) | | Electrode spacing (m) | Profile length (m) |
|---|---|---|---|---|---|---|
| | | | From | To | | |
| 1 | P1 | Dam axis | 210.9 | 68.9 | 2 | 142 |
| 2 | P2 | Dam axis | 150.9 | 8.9 | 2 | 142 |
| 3 | P3 | D/S berm | 27.70 | 134.20 | 1.5 | 106.5 |
| 4 | P4 | D/S berm | 104.20 | 210.70 | 1.5 | 106.5 |

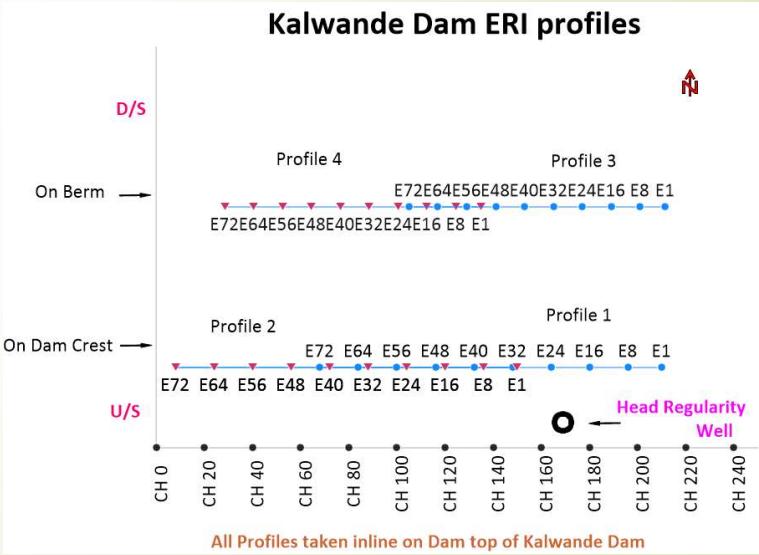



**Layout of ERI profile at (a) the axis and (b) the downstream berm of the Kalwande Dam.**










Layout map of ERI profiles conducted at Kalwande dam, Maharashtra

# Results

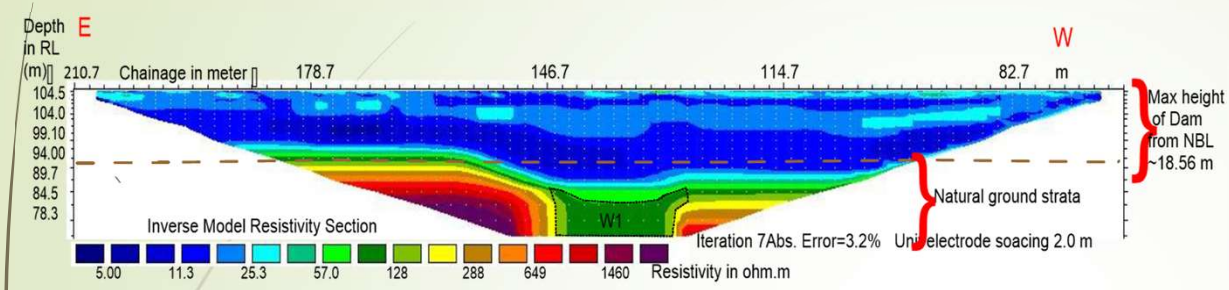
**Ranges of resistivity values of different Litho unit in Basaltic rocks (Zambre and Thigale, 1980)**

| Sr. No | Range of Resistivity (Ω-m) | Type of rock |
|---|---|---|
| 1 | 4-6 | Black cotton soil with sand |
| 2 | 6-10 | Black cotton soil with calcified soil/murum |
| 3 | 10-12 | Black cotton soil/murum |
| 4 | 12-26 | Black cotton soil with murum |
| 5 | 26-60 | Highly weathered and fractured basalt |
| 6 | 60-100 | Highly fractured basalt |
| 7 | 100-250 | Weakly fractured basalt |
| 8 | >250 | Hard compact basalt |

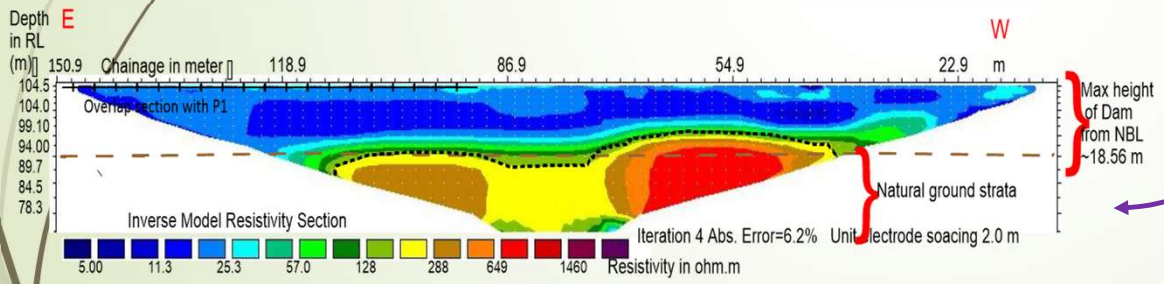
**General resistivity ranges of different litho units for earthen embankment**

| Sr. No | Range of Resistivity (Ω-m) | Type of strata |
|---|---|---|
| 1 | 10-60 | Compact soil layer saturated with water |
| 2 | 60-250 | Compact soil layer (if within dam body |
| | | Weathered/ fractured basalt saturated with water (if in foundation rock) |
| 3 | >250 | Hard compact basalt/bed rock |

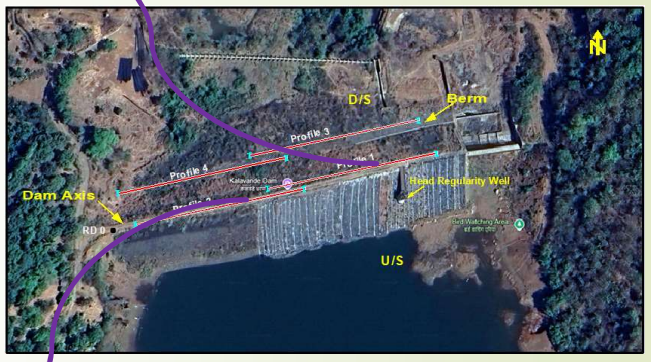
# ERI sections on the Dam axis



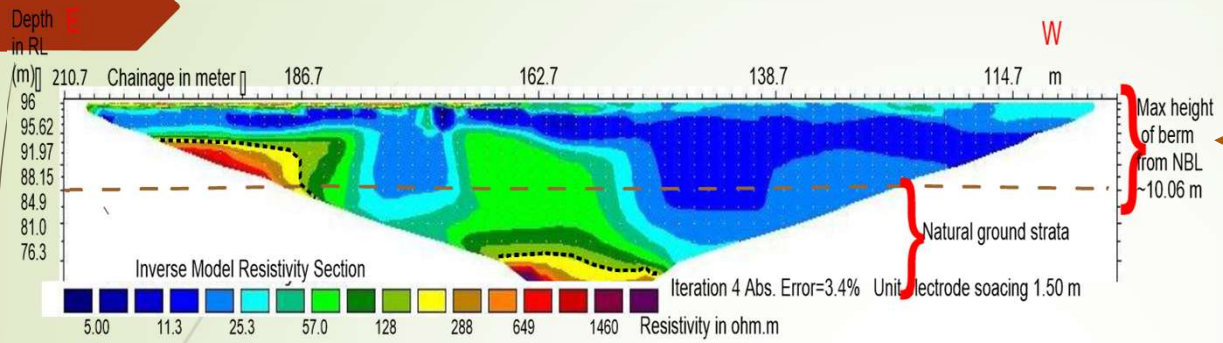

Electrical resistivity imaging profile P 1 upstream side near head regulating well



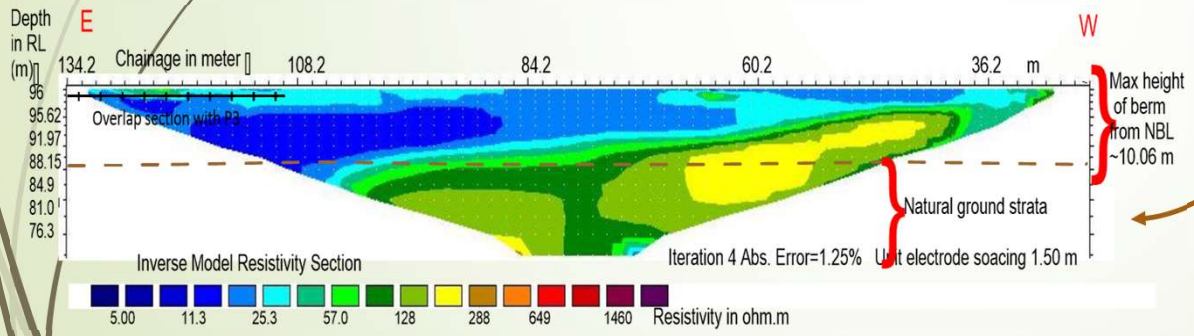

Electrical resistivity imaging profile P2 upstream side near head regulating well



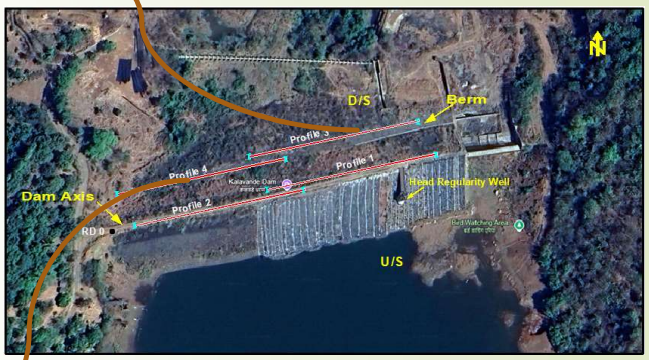
# ERI sections on the Downstream Berm



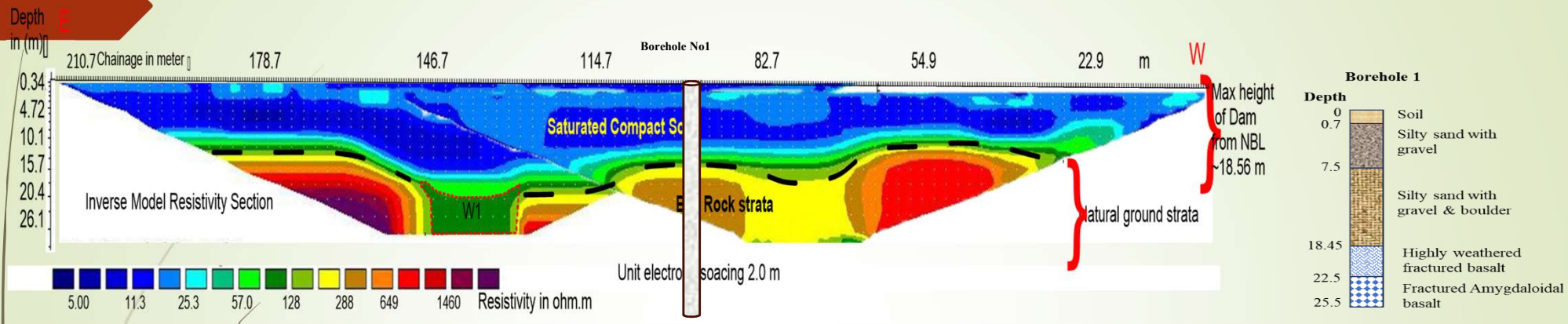

Electrical resistivity imaging profile P3 on the line of downstream at berm



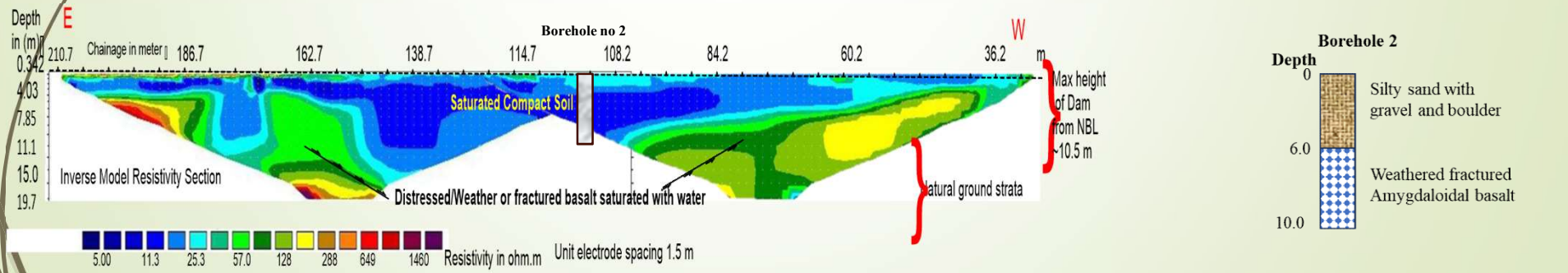

Electrical resistivity imaging profile P 4 on the line of downstream at berm



## Comprehensive view of ERI profiles P1 and P2 upstream side near head regulating well




## Comprehensive view of ERI profiles P3 and P4 at downstream of dam at berm



# Conclusions

## Dam Axis: Key Findings

- **Two prominent subsurface resistivity layers are identified along the dam axis, along with a distinct distressed zone.**
- **Upper low-resistivity layer (<60 Ω-m):**
  - Extends to a depth of approximately 14–16 m.
  - Interpreted as saturated compact soil.
- **Underlying high-resistivity layer (>250 Ω-m):**
  - Represents comparatively hard and compact bedrock strata.
- **Distressed Zone (W1):**
  - Resistivity range of 60–250 Ω-m.
  - Located between Ch. 124.9 m and Ch. 144.9 m.
  - Occurs at depths greater than 20 m within the foundation strata.
  - Indicates a potentially distressed/fractured or weathered foundation zone.

## Downstream Berm: Key Findings

- **First continuous low-resistivity layer (<60 Ω-m):**
  - Present throughout the profiles.
  - Thickness varies from **5 m to 15 m**.
  - Maximum vertical extent occurs near **Ch. 114.0 m**.
  - Indicates saturated conditions and possible seepage influence.
- **Underlain Moderate-resistivity zone (60–250 Ω-m):**
  - Interpreted as fractured to weathered basalt.
  - Likely saturated with water.
- **Isolated High-resistivity patches:**
  - Occur at localized depths.
  - May represent comparatively competent or less-weathered rock masses.

- **The result signifies the very low resistivity values of < 60 Ω-m were very prominent in the dam body.**
- **Moreover, the foundation strata observed below the dam body is highly weathered/fractured basalt which is also more prone to seepage.**

# Recommendations

- Low resistivity zones observed in the dam body recommended to be verified by borehole logging and treated with suitable grout material.
- The distressed zone observed in the foundation strata also recommended to be validated with borehole lithologs and treated with suitable grout material upon confirmation.


Thank you