

Detailed Specification for
Landslide Early Warning Instrumentation & Real Time
Monitoring System

This **field based landslide early warning instrumentation & real time monitoring system** is to be installed and made operational on a turn-key basis at Tangni Landslide area on NH-58 (12km ahead of Pipalkoti in Chamoli District of Uttarakhand and comprises of the following major components:

- A. Instruments for wireless based real time landslide monitoring system**
- B. Site Preparation for Instrumentation**
- C. Field Installation of Instruments**
- D. Integration of instruments/sensors with the control station**
- E. Maintenance of the real time landslide monitoring system**

(A) Instruments for wireless based real time landslide monitoring system

1. Vibrating Wire Piezometer – 2 No.

- Type: Vibrating wire type
- Range: 0-0.5 MPa
- Diameter: 20mm
- Accuracy: ± 0.5 % FS or better
- Operating Temperature: -20 to $+60^{\circ}\text{C}$ or better
- Material: Stainless Steel
- Maximum Overpressure: 150% of range
- Filter type: Standard High Air Entry Ceramic 50 micron porosity or better
- Environmental Protection: IP68
- Cable: 4-Core shielded from sensor to the top of the borehole (approx. 50 m)
- Casing: ABS access tube for the borehole depth
- Other accessories for installation

2. MEMS based In-place Inclinator (IPI) Sensors – 13 Nos.

- Sensor: Biaxial Sensor on wheel pairs
- Measuring Range: $\pm 15^{\circ}$
- Sensor Accuracy: $\pm 0.1\%$ FS or better
- Operating Temperature Range: -20°C to $+60^{\circ}\text{C}$ or better
- Environmental Protection – IP68
- Sub-assemblies:
 - Spacer assembly: 3m gauge length
 - Wheel assembly: Each in-place inclinometer sensor is fitted with pairs of pivoted sprung wheels
 - Suspension kit with protective cap
 - Placement tubing for placing string of sensors

- Protective rope to prevent loss of sensor down hole
- Individual 4 or 6 conductor single cable from each sensor in the borehole to the top surface or a single cable threaded in a daisy chain fashion, connecting each sensor with wireless node.
- Casing: ABS self aligning four grooved access tube around 70 mm O.D. and 3 m length each for the borehole depth
- Other accessories for installation

3. Soil Moisture Sensors – 4 Nos.

- To measure water content of the soil.
- Measurement range: 0 to 0.3 m³.m⁻³ or better
- Accuracy: ±0.03 m³.m⁻³ or better
- Temperature range: -20°C to +60°C or better
- Environmental Protection: IP68

4. Automatic Rain Gauge – 1 No.

- Tipping bucket type
- Corrosion free stainless steel outer housing
- Accuracy: ±5% or better
- Resolution: 0.5 mm or better
- Range: 0 to 500 mm/hr or better

5. Nodes for IPI, Vibrating Wire Sensors and Soil Moisture Sensors

For IPI Sensors: 4 Nodes

- ✓ State-of-the-art protocols
- ✓ ultra low power consumption
- ✓ true multi-hop capabilities
- ✓ node to node up to 400m range
- ✓ Multiple Channels: Minimum 8 channels
- ✓ Resolution: 0.001 or better
- ✓ Accuracy: ±0.5 % FS or better
- ✓ Power Supply: 12 V DC
- ✓ MESH NETWORK: multichip communication enables nodes to send the readings wirelessly through any other node of the network. The communication mesh is smart, dynamically re-adapting the communication paths.
- ✓ Easy Plug & Play: sensor connection through user friendly connectors.
- ✓ Environmental Protection: IP68

For Vibrating wire sensors: 2 Nodes

- Measurement Method: Frequency measurement (vibrating wire)
- Measurement range: 500 Hz to 5 KHz
- Resolution: 0.1 micro-seconds or better
- Accuracy: ±0.5 % FS or better
- Temperature measurement range: -20°C to +50°C or better
- Power Supply: 12 V DC
- Output voltage (excitation): 5V up to 150mA; -5V up to 150mA
- ADC resolution 24 bits
- Input channels: Minimum 8 channels
- 1 Thermistor (2 wires) channel

For Soil Moisture Sensors: To be coupled with above nodes

6. Automatic Data Logging System – 1 No.

- Suitable for real-time landslide monitoring
- Facility to call data from slave nodes integrated with VW peizometer/ IPI/Rain Gauge/Soil moisture sensors
- Frequency: 2.4 GHz (ZigBee)
- Network Topology: Mess Network
- Memory storage: 16Mb/2Mb flash memory
- Communication interfaces: Should have facility to communicate with slave nodes wirelessly and send data on web server for web based monitoring
- Power supply: 12V DC
- Should have facility to download data by laptop
- Temperature range: -20°C to +60°C or better
- Compatible with all the above sensors and nodes
- Should have capability to communicate with minimum 25 or more slave nodes.
- All sensors networked through nodes are required to be integrated with the automatic data logging system.

7. Web based Monitoring Software – 1 No.

- Database server with web server based monitoring software
- Graphic like a map, ground plan or a photograph can be put on the screen and marked with installed sensors. The sensor locations should indicate a pop up box having the corresponding sensor details
- Capable of downloading both raw data and processed data from all the sensors
- Graphical display facility of sensor data in hourly/daily/weekly/monthly/yearly basis.
- Monitoring software to be password protected
- Multiple users' facility at any time from any internet-connected PC in real time.
- Processing and monitoring ASCII files with numerical data
- Imports from any data acquisition system
- Allows input of manual data
- Watchdog function to generate an email and/or text message alarm and/or hooter alarm
- Four alarm levels configurable per sensor
- Detailed alarm logging
- Automatic generation of reports in pdf format

8. Solar Panel, Batteries & Accessories – As per requirement for the whole system

- 12V 50W solar panels with weather proof structure
- 12V 10A Charge controller for charging 12V SMF batteries from solar panel
- 12V 65AH sealed maintenance free (SMF) batteries

(B) Site Preparation for Instrumentation

- Total drilling length of about 120 m with about 6 nos. of 100 mm dia boreholes at 6 locations on hill slopes with each bore hole depth upto 20 meters

- approximately (2 boreholes for piezometer and 4 boreholes for inclinometer sensors installation)
- 100 mm dia boreholes to be made with triple tube wire-line drilling and at least 2-3m beyond the in-situ fresh bed rock level; however, depth of borehole will vary from location to location depending on the depth of in-situ bed rock. Core logging as per standard format and preservation of core samples (soil/debris/rocks) in aluminum core boxes are also to be done.
 - Supply and installation of PORTA Cabin of 3m X 2m X 2m size for control station

(C) Field Installation of Instruments

- A total of 2 VW piezometers will be installed in 2 boreholes (one sensor in each borehole) on the landslide slope.
- A total of 13 in-place inclinometer sensors will be installed at different depths in 4 boreholes.
- A total of 4 soil moisture sensors will be installed in top soil at different selected locations on the landslide slope.
- All the sensors need to be integrated with a total of 6 nodes at suitable locations on landslide slope for effective communication with the data logging system.
- Porta Cabin needs to be erected near the landslide body for establishing the Control Room.
- Automatic data logging system with batteries is required to be installed inside the Control Room.
- Automatic rain-gauge station and solar panel with weather proof facility needs to be installed near/at roof top of the control room.
- Digital display and alarm (hooter) need to be installed near control room/road side and to be solar powered.

(D) Integration of instruments/sensors with the control station

All the surface and sub-surface installed sensors are to be integrated/ networked through nodes with the automatic data logging system and web based monitoring software for their proper functioning. Digital display and alarm system need to be integrated with data logging system. The integrated system should be made fully functional. The integration is intended for real time data display at site as well as real time data access at CSIR-CBRI, Roorkee.

(E) Maintenance of the real time landslide monitoring system

The real time landslide monitoring system needs to be installed at Tangni Landslide on NH-58 (12km ahead of Pipalkoti in Chamoli District of Uttarakhand) should include the annual maintenance of the whole system to keep it functional round the clock up to 31st March 2021.