

Innovative Instrumentations for Landslide and Debris flow monitoring

There appear geological disasters including collapse, slide, and debris flow. In addition to natural slopes, the excavated slopes referred to as cut slopes e.g. roadway slopes resulting from roadway excavations, which seriously result in a threat to public safety. In order to react to the considered phenomenon, TWSI offers a series of cost effective products for displacement measurement and introduces the StormPanel to optimize the community-based early warning systems and provide other new solutions with Smart Repeater for durable and reliable environmental monitoring.



◎ Automatic, Digital

The system adopts the auto-monitoring and event trigger method. Using TWSI Digital Wire Extensometer for monitoring landslides ensures an evolutionary up-grade to conventional analog transducer. When the variations occur, the signal of per 1 mm displacement triggers the transmitter in pulse mode, at the same time, the digital data of highly precise position in absolute format can be read in serial mode. If no variations occur, transducer and transmitter consumes very low power and will be awakened by RTC and then transmit periodically to refresh the status.

◎ Real-time, Trigger alarm, Wireless, Flexible

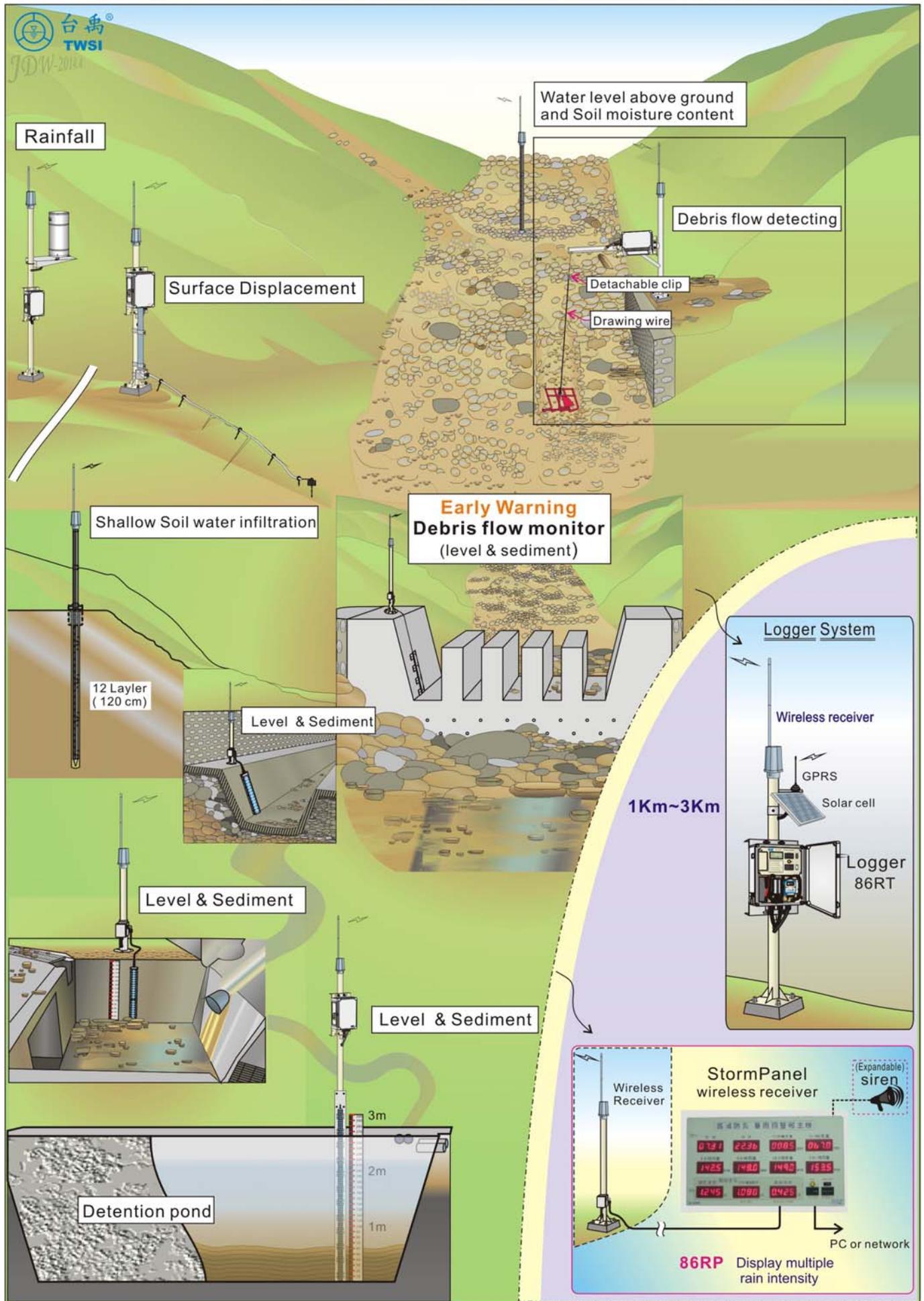
The TWSI Digital Extensometer detects event and triggers a transmitter which in turn sends instantaneous messages with RF signal for data acquisition and further alerts. The monitoring data are received and displayed on either StormPanel or SCADA systems. The transmitters are battery operated with a battery life of 2-5 years. With licensed free RF modules for wireless transmission, messages from multiple transmitters within a area can be received and/or repeated, the real-time monitoring and early warning for landslide or slope safety can be achieved.

◎ Precise, Stable, False Alarm Prevention, Cost-effective

Advantages of such a method over conventional methods include the following: real time response to geo-deformation, precise displacement data; no need of filtering of cyclic fluctuations associated to daily cycle/year cycle and immunity to electromagnetic interference.

Through TWSI Digital Extensometer deployed at various locations, the displacement data derived from cable extension can be interpreted as various degrees of slope failure clearly.

Early Warning _ Landslide & Debris Flow Monitoring System



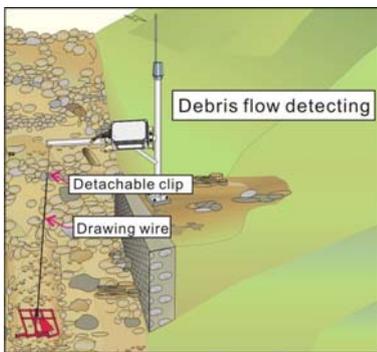
Precision, Event-Trigger, Wireless and Lightning-free Real-time Displacement Monitoring

with Digital Extensometers and Wireless Transmitter

Set up a warning system and/or repeater station in a suitable location within the transmission distance to receive signals from multiple transmitters. Besides the signal of displacement, it can receive other signals of crack, groundwater, and soil saturation status, etc.

- ❖ Detects the signal of displacement based on the amount and rate to identify different levels of landslide event and provides an alarm signal.
- ❖ Provides the signal periodically so as to ensure stable operation and also indicate the power status.
- ❖ Low power RF with transmission ranging up to 2km (with optional module) reduces the equipment and installation cost and power requirement.
- ❖ Extended cable up to a maximum of 400cm can reflect the landslide status.

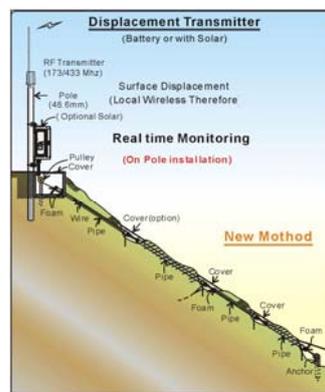
Debris flow monitoring



The transmitter is set in the stream.

It monitors the displacement of anchors or big rock in the stream bed and will provide an alarm signal based on the amount and rate of displacement transmitted from the trigger pulse.

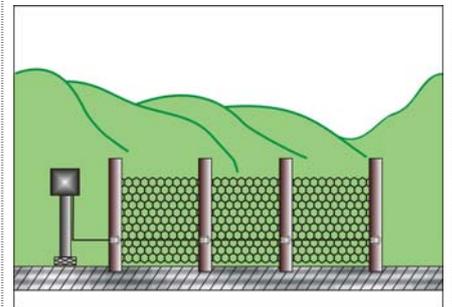
Landslide Monitoring



The transmitter is set in the upper and/or lower slope.

It monitors the potential and status of landslide, and will provide the signal per 1mm displacement and will trigger alarm according to the velocity change in the shallow ground.

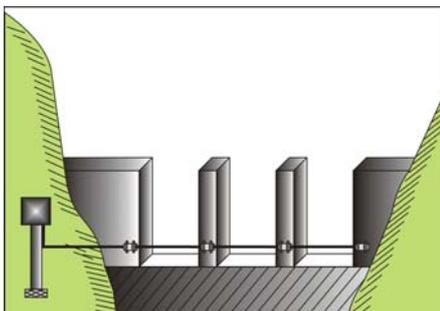
Rock-fall Warning



The transmitter is set on the Rock-Fall Catch Fencing.

It provides the signal per 1mm displacement. According to the amount of the rock-fall, the station can warn the roadway users in time.

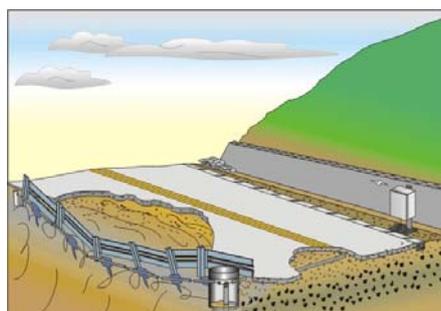
Debris flow warning



The transmitter is set in a slit dam or a debris dam.

It provides the signal in the process of flow squeezing action and will trigger alarm based on the amount and rate of displacement transmitted from the trigger pulse. When the intensity of debris flow increases, it may make the cable broken or even departed from the snap.

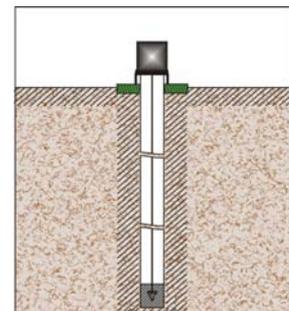
Roadway slope Monitoring



The transmitter is set in the roadway embankment.

It monitors the potential and status at the ground surface across the head scarp of the lower slide and will provide the signal per 1mm displacement, and trigger alarm according to the velocity change. The cable can extend from one side of the failure zone to the other side through a flexible pipe buried in the trench.

Settlement monitoring

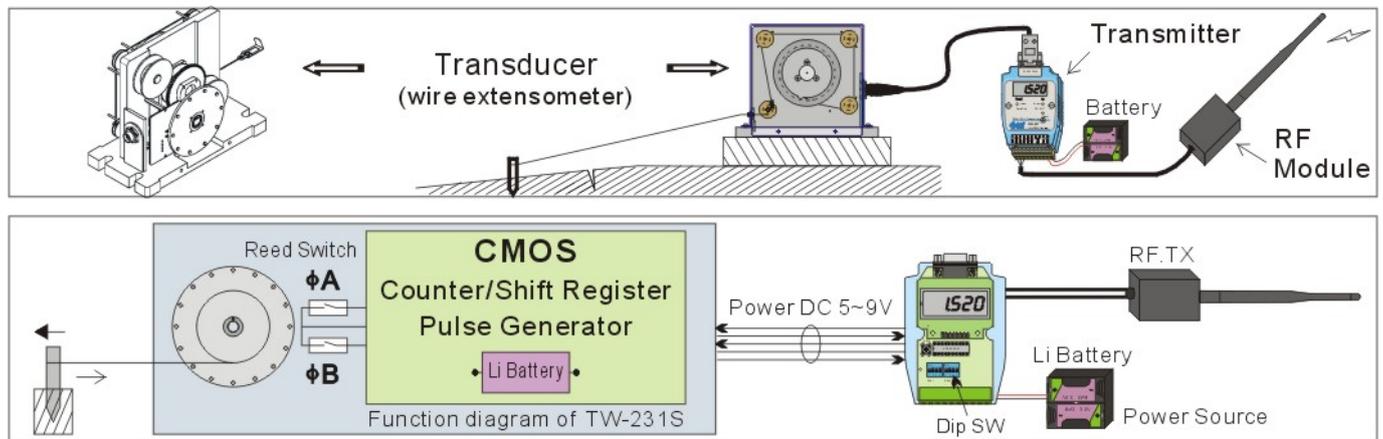


The transmitter is set on a ground surface.

Anchors are mounted at the bottom of a borehole. The transmitter measures the amount of displacement between the anchors and the transducer base. It will also provide an alarm signal when the trigger pulse exceeds a preset level.

Evolution of Landslide Monitoring

Digital Extensometers and Wireless Transmitter



Highlight

- With absolute position data output, no care must be taken to avoid noise and fluctuation.
- Actual landslide event can be triggered by pulse signal to transmitter for data acquisition and disaster warning.
- Battery powered wireless transmission is easy for installation and can achieve maximum safety from lightning damage.

Background

Since the conventional geotechnical instrumentation has been based on analog sensors, so the user must measure the resistance, voltage, and current or vibrating wire frequency. The analog type sensor such as strain gauge, potentiometer, and those which with output DC4~20mA, are excited mostly by an external power source, and needs a warm-up period to move to the stable state, and by means of ADC, to obtain an averaged digital data in order to have a realistic variance. Temperature effect and electromagnetic interference also have impact on the realistic variance. When it comes to dynamic measurement of displacement, the interval of periodic measurement should be shortened, therefore it will consume more power and must equip with a larger solar panel or an AC power having a battery back up. In this case, to address the issue of lightning risk, more cost will also be introduced.

Rationale

The Digital Extensometer uses a constant torque spring, which controls cable tension while cable extension rotates a precision potentiometer. Once the objective moves, it pulls the cable and the signal corresponding to the length and the direction of displacement will be produced with a multi-polar magnetic disk and dual reed switches. The internal CMOS module of the encoder enables the serial data

output for displacement in absolute format. If no variations occur, encoder and transmitter consume little power, when variations occur; the reed switch goes on/off and produces a pulse to trigger the transmitter and the digital displacement data can be received for real-time data acquisition.

Performance

- Reed switch activates the built-in absolute encoder; stable data corresponding to mechanism displacement without fluctuation and precise parameter for warning threshold can be obtained.
- Li-battery mounted in the PCB of the CMOS module enables continues counting when the transducer is disconnected with the transmitter or logger.
- Long stroke up to 400cm with 1mm precision signals transmitted to station in event trigger mode; the amount and rate of displacement signal can be considered the best indicator of various deformation conditions or the failure process.
- Wireless transmission ranging up to 2km (with optional module); 8~16 monitoring sites can be covered to send simultaneously the signals to logger or warning station; with a RF receiver, it can form a repeater station or a main station.
- Adaptable, easy to install as a stand-alone warning system or upgrade existing alert stations with additional sensors or an updated data logger for soil and water monitoring.

Applications

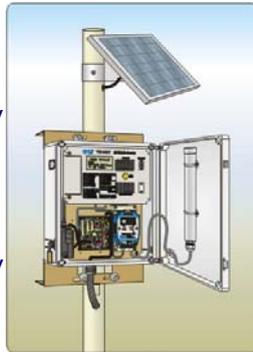
- Debris flow warning
- Landslide Monitoring
- Slide surface monitoring
- Monitoring of depth to the landslide slip-plane
- Settlement monitoring

Innovative Instruments for Landslide and Flash Flood

Specifications:

Data Acquisition and Repeater (TW-86RT)

1. Input : Contact closure for Rain and RS-232 for wireless Receiver
2. Power : Solar with built-in battery
3. Display : 4x16 LCD data display
4. Output : RS-232 to GPRS and FSK to VHF Transmitter
5. Data logger : 512k Flash memory
6. Data intervals : 1/5/10/60 minutes



Digital Wire

Extensometer (TW-231S)

1. Type : Constant torque spring loaded
2. Measuring Range : 4m
3. Resolution : 1 mm
4. Accuracy : ± 0.1 % F.S.
5. Pulse signal : 20 ms pulse for every 1mm increment / decrement
6. Output : Absolute Serial Data String
7. Wire tension : 1.5kg
7. Measuring Cable : Diameter 0.9mm nylon-coated stainless steel
8. External tension wire : 30m length Maximum



Wireless Transmitter (TW-348T)

1. Tx interval : 1/10 minutes and triggered by pulse
2. Display : 4 digit 10mm LCD
3. Frequency : 433/434MHz
4. Data string : Header+ ID code+ data value+CRC-16
5. RF power : 25 mW
6. Power supply : DC 6V battery or 3.6V lithium battery; replaceable once per 2~5 year.



Wireless Receiver (TW-348R)

1. Frequency : 433MHz/434MHz
2. Data Rx : Header +ID code+ data value+CRC-16
3. Range : By Tx power (700 m)
4. Standby current : 10 mA
5. Display : 10mm LCD
6. Output : RS-232/RS-485 port, ID+ data string; with additional output port for wireless rain gauge



Smart StormPanel (TW-86RP/TW-84RP)

1. Displays : 11sets, 4digits, 25mm character height red LED display.
2. Dynamic displays : Dynamic integrate and display for 10min to 24hrs, with six items of rainfall intensity and accumulated rainfall
3. Alert function : The built-in buzzer alert device automatically can sound alarm when values exceed pre-set threshold value.
4. Power-saving & backup : Smart power saving mode, the panel works for more than 36 hrs with built-in battery during AC power failure.
5. Data logger : The built-in 512k flash memory can store rainfall data for 420 days (5min/per).
6. Dimensions : 650x350x60mm, wall hanging weatherproof coated aluminum frame.



Rain Gauge (TW-210S)

1. Type : Tipping-bucket
2. Orifice : 200 \pm 6 mm
3. Resolution : 0.5 mm/pulse
4. Accuracy : $\leq \pm 3$ %
5. Material : S304 stainless steel



Cable-Extension Float-Operated level transducer (TW-264S/TW-265S)

1. Type : Float operated, spring loaded (suspended by single steel cable)
2. Range : 6/10m
3. Resolution : 5 mm /2mm
4. Accuracy : ± 0.1 % F.S.
5. Output : Absolute Serial Data String Stilling well : ϕ 4~6 inch

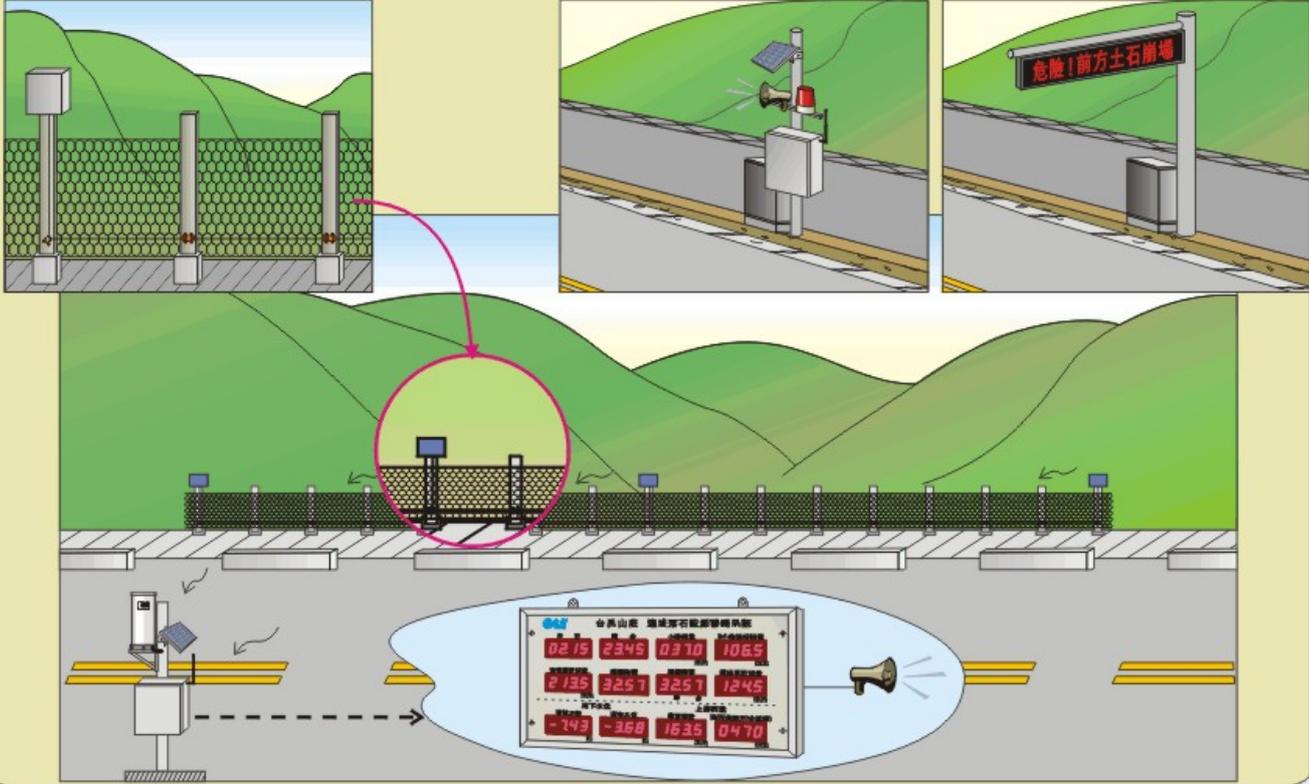


Related product: Shallow Soil Saturation Monitoring

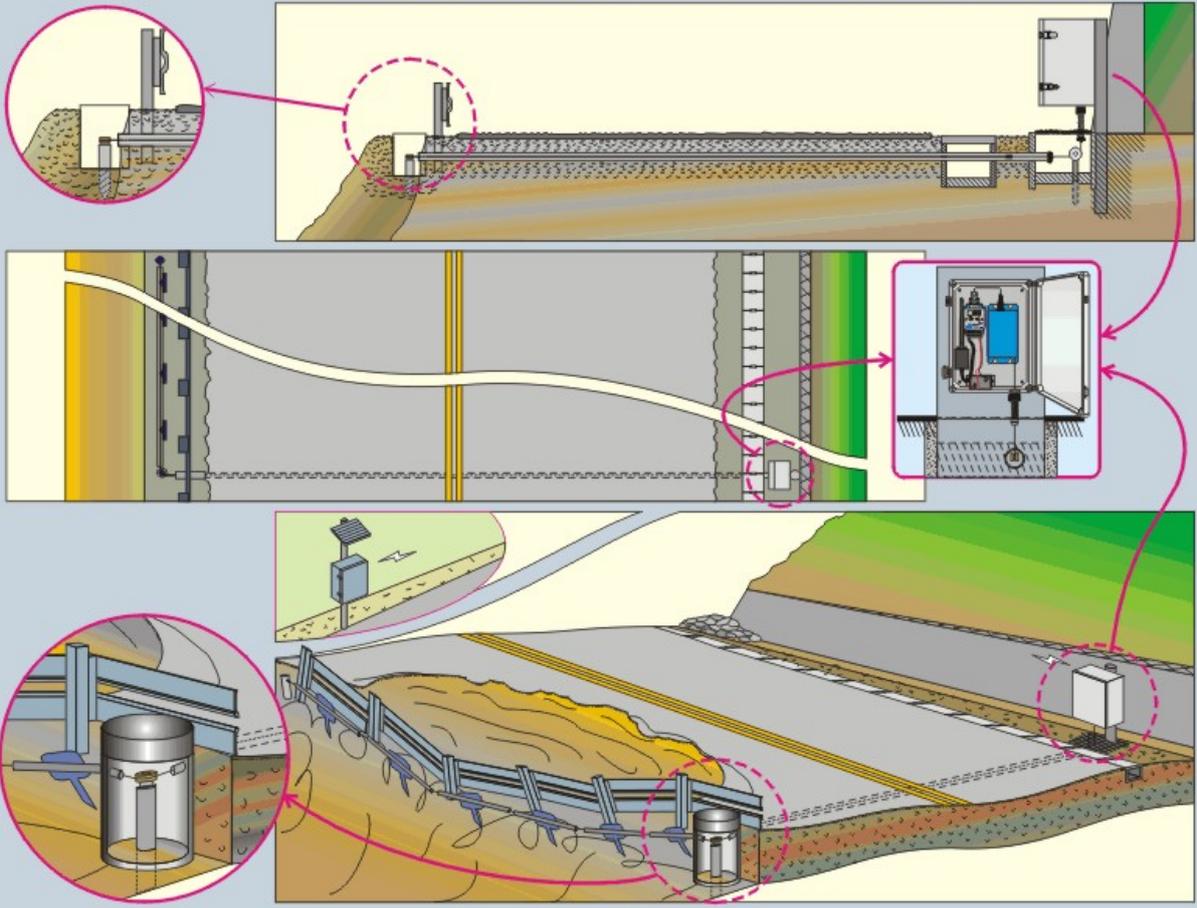


Innovative Roadway Slopes Monitoring and Alert System

Transmit the signals of slope deformation and alert road users

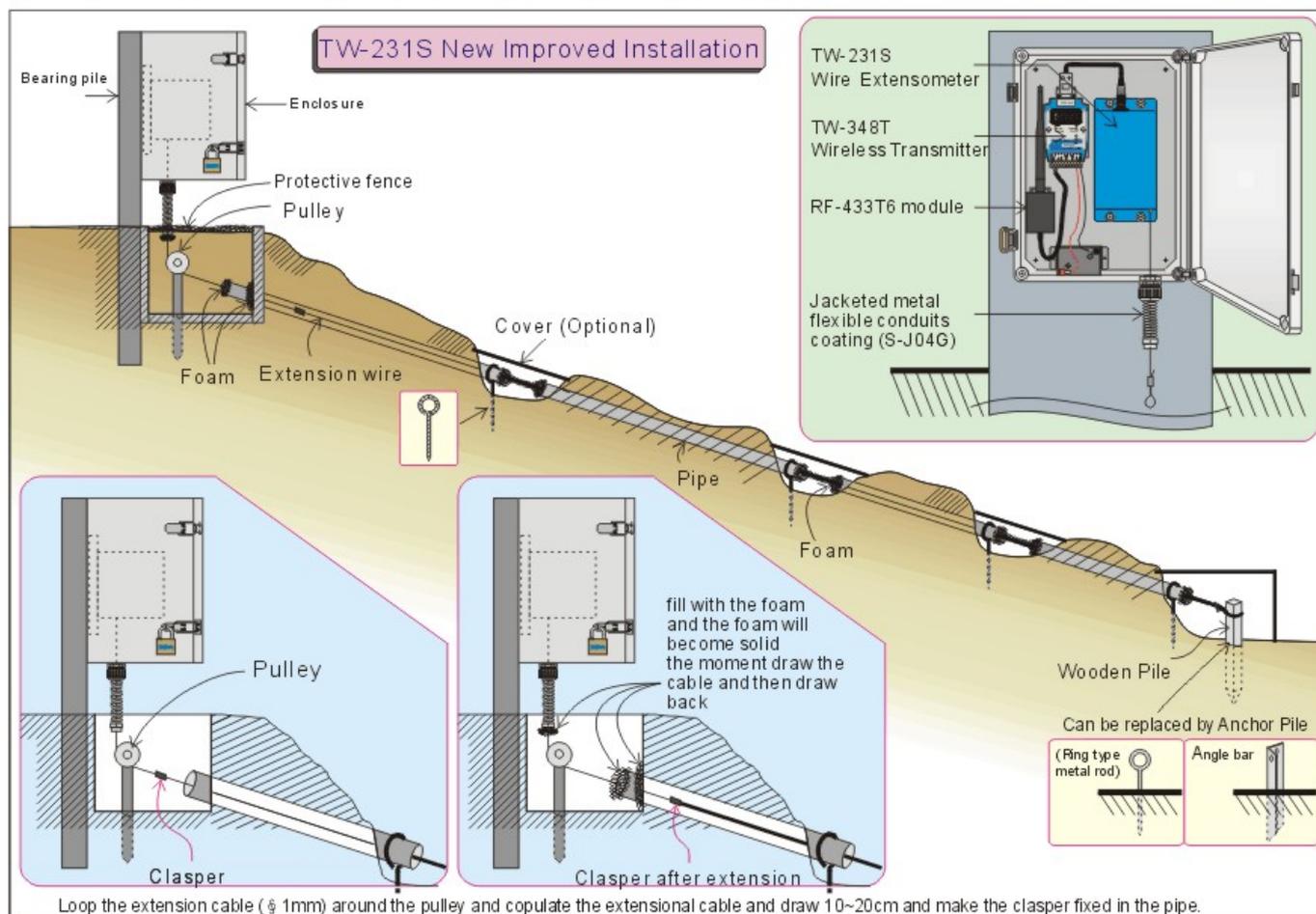
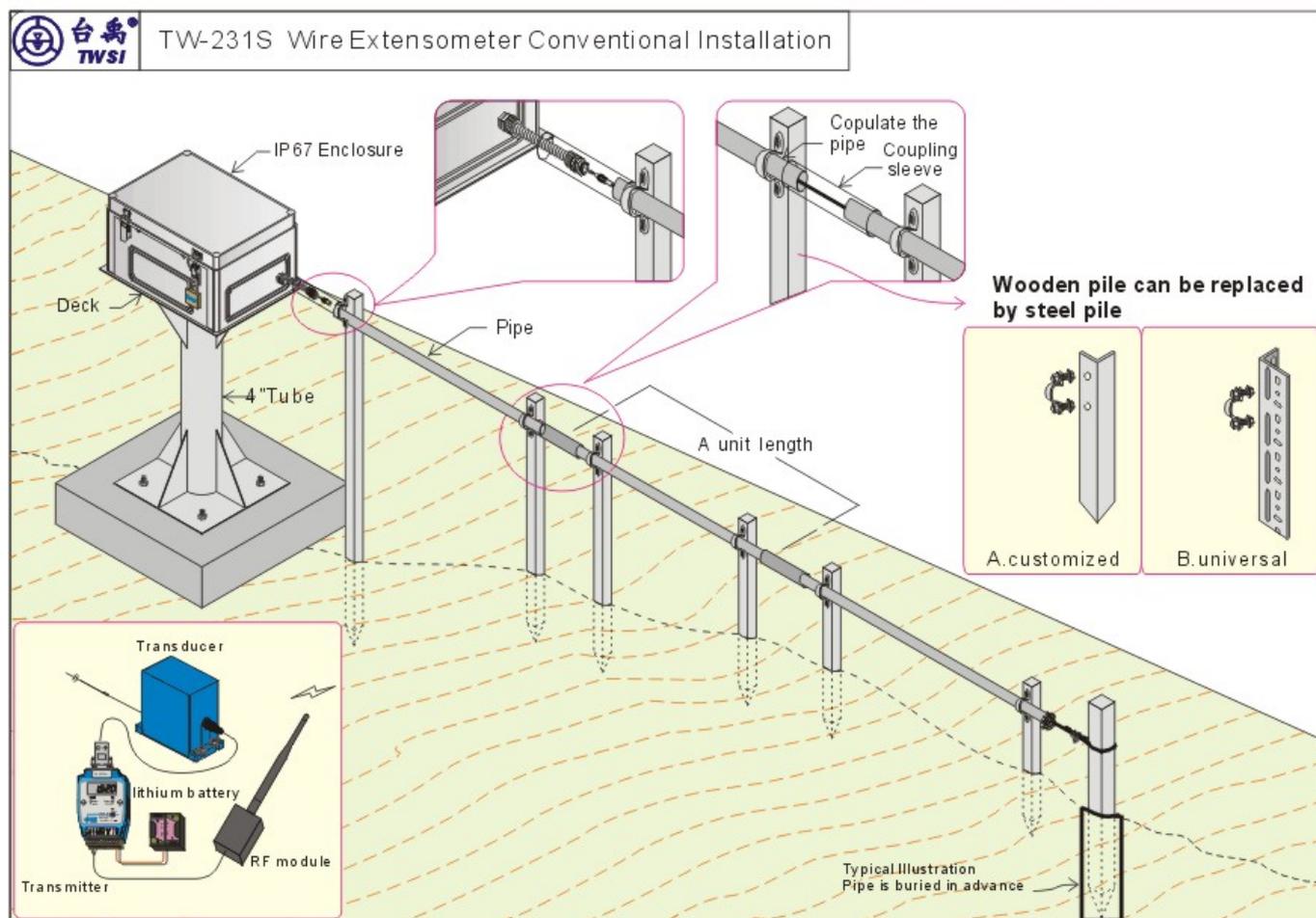


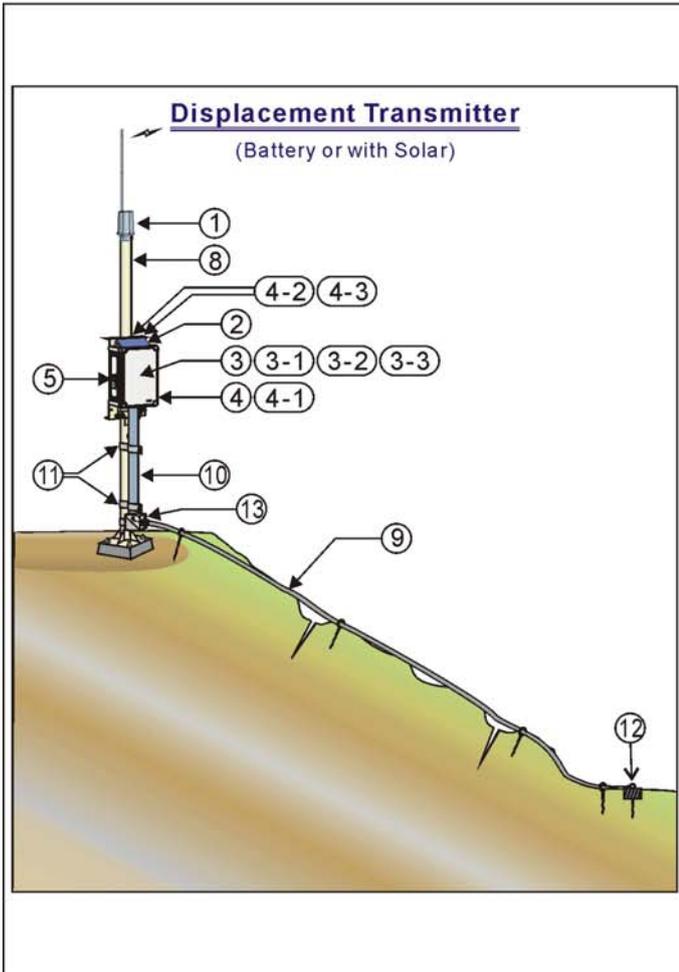
Alert & Monitoring of Roadway Slopes Flow away of Structure



Long stroke transducer with paddle stems effectively detect roadway slopes flow away from the structure

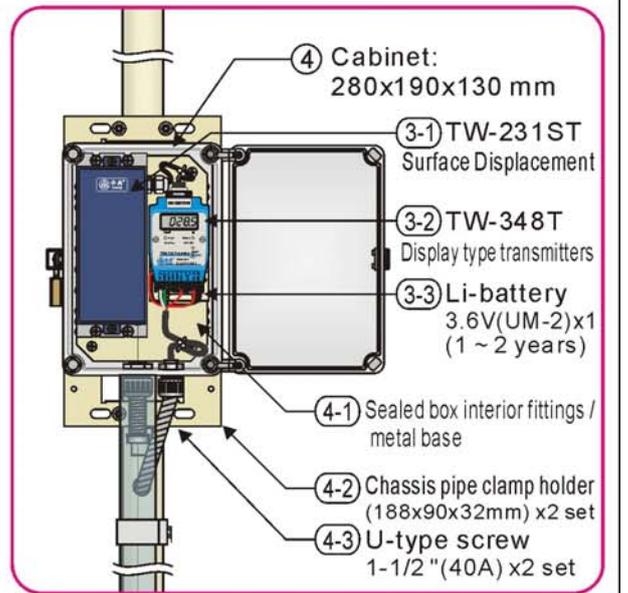
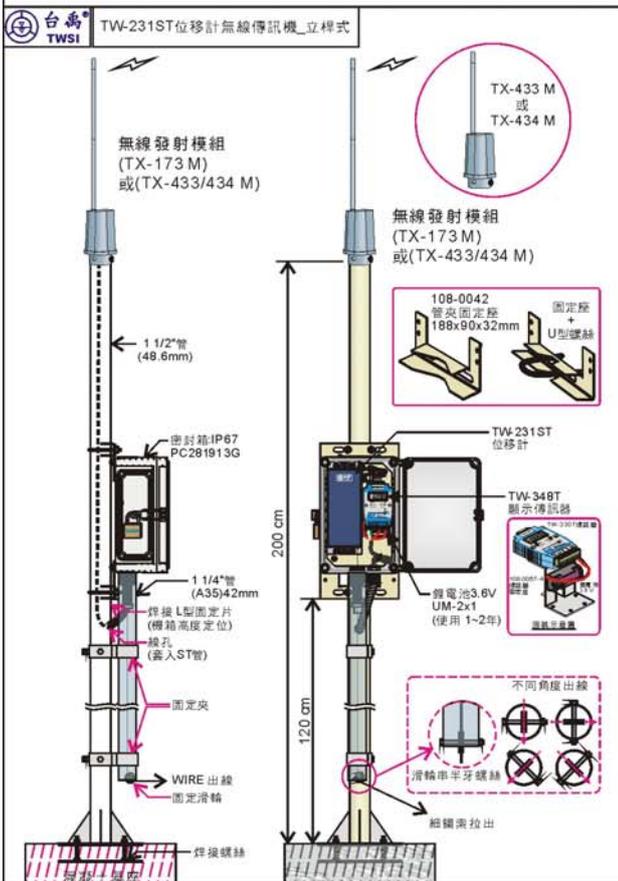
Adaptable Wire Extensometer Installations





Displacement Transmitter Equipment:

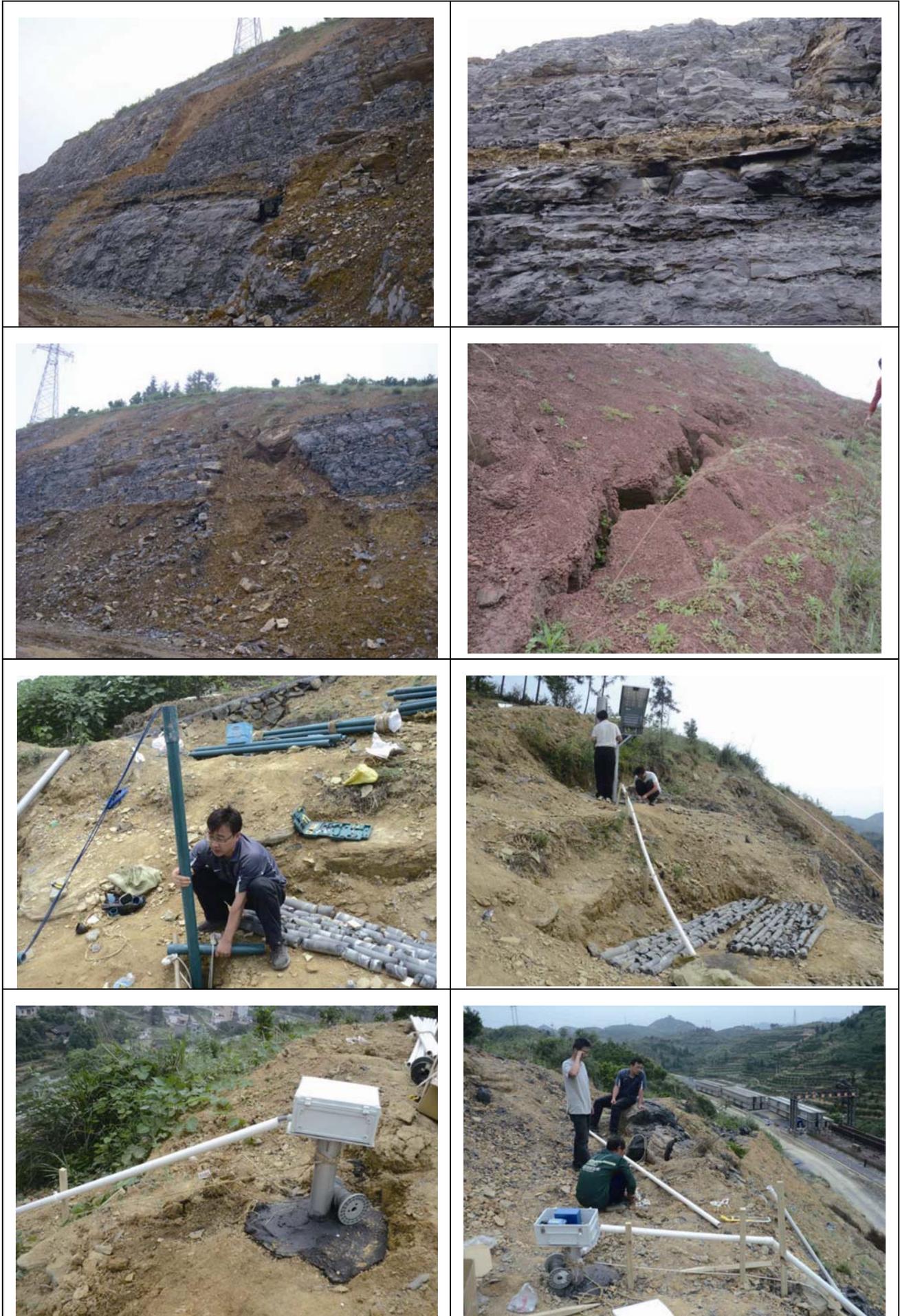
Part Number	Product Name / Size
① 102-	RF Transmitter (173/433 Mhz)
② 105-	Solar panel / with bracket
③ 101-	Digital Crack Transmitter & Sensor
③-1 101-TW-231ST	TW-231ST Surface Displacement
③-2 101-TW-348T	TW-348T Display type transmitters
③-3 181-	Lithium battery 3.6V UM-2x1
④ 151-4014	Cabinet:280x190x130 mm
④-1 108-0057-4 108-0058-3	Sealed box interior fittings / metal base
④-2 108-0042-1	Chassis pipe clamp holder (188x90x32mm) x2 set
④-3 Local Source	U-type screw Specification:1-1/2 "(40A) x2 set
⑤ 106-2001	STAINLESS (Lock 40mm) brass padlock
⑥	
⑦	
⑧ Local Source	Pole Diameter 48.6mm
⑨ Local Source	PVC Jacketed Galvanized Steel Flexible Conduits (Liquidtight) soft protection pipe
⑩ Local Source	Protection pipe PVC A35(1-1/4") 42 mm
⑪ Local Source	Pipe Clamp
⑫ Local Source	Anchor
⑬ Local Source	Pulley & Stainless steel screws
⑭	
⑮	



Case I : The dip slope slip monitoring in HuNan China, 2011



Case II : Fault zone monitoring collapse in GiSo China,2011



Case III : Wireless Landslide Monitoring System in Rambla Pacifico CA. USA, 2012

