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## R&D of Monitoring System for Detecting Surface Failure by pore pressure sensor with inclinometer

Principal Investigator Yasunori Shoji (OYO Corporation)

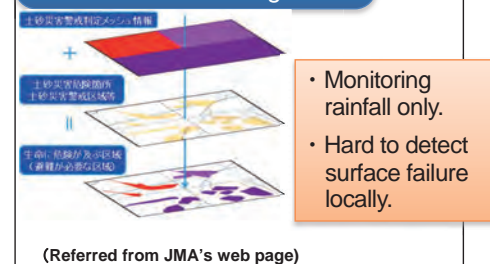


### R&D Objectives and Subjects

#### Objectives

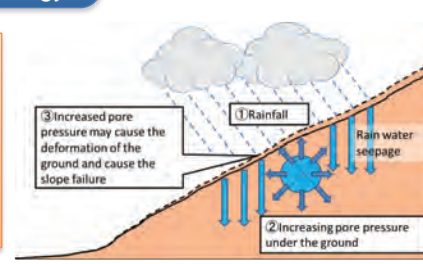
- Development of a monitoring system for detecting surface failure in-situ and transferring the data and alert to governments and residents.

#### Current technologies



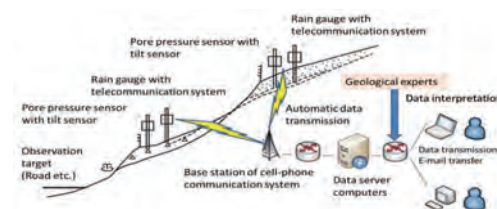
#### Newly developed technology

- Monitoring
  - 1) Rainfall,
  - 2) Pore pressure and
  - 3) Tilt of the slopes simultaneously.
- Suitable for detecting surface failure locally.



#### Subjects (2014-2016)

- System for monitoring ①Rainfall, ②Pore pressure, and ③Tilt of the slope simultaneously and transferring the data and alerts automatically to any place.
- Providing one-stop service of determining suitable monitoring locations, designing the system, installation, and achieving data transfer.



### Current Accomplishments (1/2)

(2014-2016)

#### 1. Determining monitoring locations

- The thickness and geology of the surface layer is investigated by using the Soil Layer Strength Rod developed by PWRI. Then suitable measurement locations are selected.



- Suitable monitoring location can be selected according to geological condition.

#### 2. Packaged system

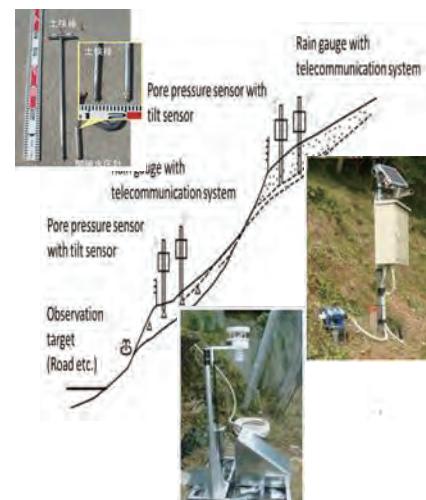
- Composed of
  - ①Rain gauge,
  - ②Pore pressure sensor,
  - ③Tilt sensor,
 wireless communication system, and power unit.

- Verification test on a slope near a national road is ongoing from October, 2015.

- We confirmed the verification test is operating normally as of December, 2016.

- At the moment, there is no evidence of slope failure at the observation point.

- The monitoring system was established.
- A monitoring system using an external power supply is not required.



#### Utilization example

Early warning data of slope failure will be transferred to public administrators and residents.



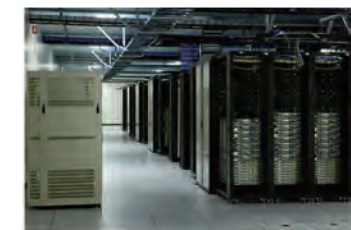
Early evacuation can be carried out and slope failure hazards can be mitigated.

### Current Accomplishments (2/2)

(2014-2016)

#### 3. Easy data acquisition, transfer, and display

The process of acquiring data, transferring the data, and issuing alert to public administrators and residents is automated.



Data center (image)

- Alert message is transferred by e-mail according to data.
- Message can be sent to cellular phone and PC by internet.
- Threshold level can be set at three levels at maximum.
- Message can be sent to 20 users at maximum simultaneously.

\* The message is subject to change.

- Easy to investigate the status of the slope at the monitoring point
- Can be customized to combine the data with a digital map to visualize the data for easy understanding.

#### Flow of utilization

1. Determining the monitoring location

2. Packaged system

3. Easy data acquisition, transfer, and display

The system, which can detect the status of the slope at an early stage of the failure, is established.

The system can contribute to conduct early evacuation and mitigate the slope failure hazards.

### Goals

#### Numerical targets

- Reduce cost by 20% compared to the current system
- One-stop service that reduces time by 30% from installation to data acquisition.

#### Users

Public administrators of local governments, road administrators, residents, etc.

#### How to use/Places of use

Places of use are slopes along roads and resident areas.

#### Sales method

Subcontract to consultants.

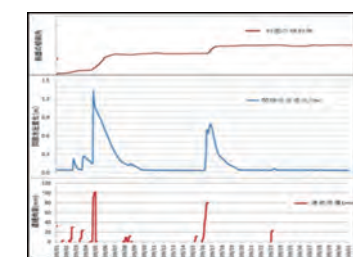
Prime consultant, who conducts Geological investigation experiments, enables one-stop service planning.

#### Services to Offer

Providing one-stop service of determining suitable monitoring locations, designing the system, installation, acquisition and transfer of data.



Location of the alerted slopes



Status of the slopes

The system can give status information of the slopes in real time in an easily understandable way.

→ Early evacuation reduces slope failure hazards.