

ICUS

# KUWANO LAB.

## [Prevention of Ground Cave-in]

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### Hidden Cavity in the Ground Causing Ground Cave-in

Local subsides or cave-in's of the ground often occur in urban area. The complicated underground situation as well as the necessity of urgent restoration do not usually allow full investigation of the real cause. The detailed mechanism of the phenomenon has not been, therefore, well understood.

Cave-in is usually initiated by the formation of cavity in the ground due to soil loss. When the location of the cavity is deep in the ground, the detection of the cavity is not easy. Then it is possible that the hidden cavity expands to eventually cause sudden collapse. In this study, characteristics of formation/expansion of cavity and surrounding ground loosening are investigated, aiming at effectively indicating dangerous pattern of cavity and loosening.

### Factors of cavity formation/expansion

**Pre-existing conditions:**

- presence of buried structures
- unbounded soil or backfill
- geology • topography • ground water
- history of excavation etc.

The site condition has strong erosion potential.

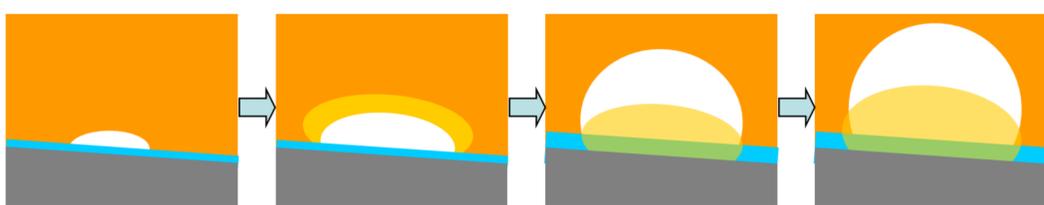
**Switch-on events:**

- ageing or failure of buried structure
- rain
- earthquake etc.

The transportation path for the eroded (leaked) soil is established.

Cavity formation/expansion is accelerated.

### Internal erosion by the flow of ground water



Formation of small cavity due to erosion at some point

Erosion progressed. Cavity and surrounding loosened area expand

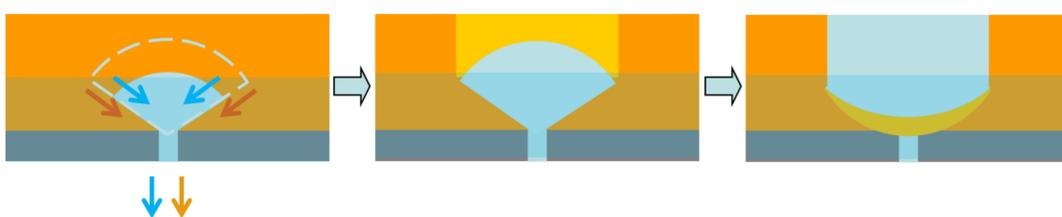
Failure of cavity ceiling

By repetition of erosion and failure of cavity ceiling, a cavity moves upward



Sinkhole caused by internal erosion in volcanic "Shirasu" layer in Miyakonojo, Miyazaki (Sept. 2016)

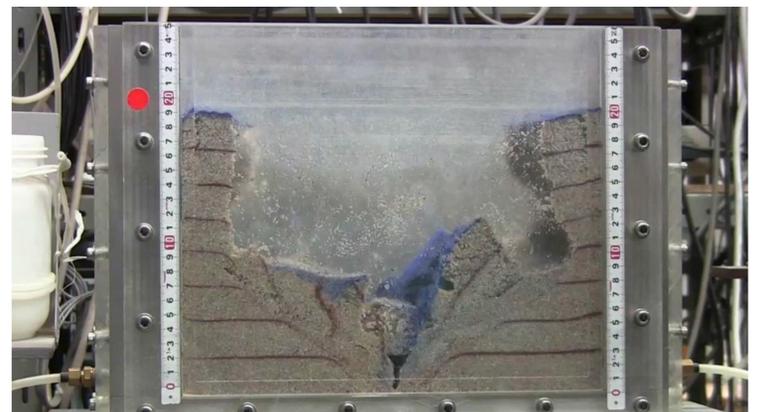
### Leakage of unbounded soil through a hole



Soil below the ground water level flows with water through the hole. A cavity can expand.

Ceiling of the cavity reaches near the ground surface.

Collapse of the soil above the cavity



Simulation of road cave-in accident by laboratory model test

