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.

**Switch-on events:**
- ageing or failure of buried structure
- rain
- earthquake etc.

The site condition has strong erosion potential.
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