Form 2

**Dissertation Abstract**

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|---|---|---|---|
| Dissertation title | Stability of underground cavity caused by internal erosion<br>（内部侵食に起因する地盤内空洞の安定性） | | |


Abstract

*※ The abstract should be in keeping with the structure of the dissertation (objective, statement of problem, investigation, conclusion) and should convey the substance of the dissertation.*

Internal erosion is one of the major causes of the failure of hydraulic structures, road pavement, and the naturally deposited ground as well. Cave-in often caused by hidden cavity in the subsurface of the ground, which is triggered by internal erosion of soil. Between 2013-2017 numerous sinkholes have been observed in Armala area of Pokhara valley in central Nepal. Based on the site investigation results, it was presumed that internal contact erosion was occurred between the sand seam and silty clay layers. In recent years, collapse of a sinkhole or a hidden cavity is widely observed on the road pavement of the urban city. And the number of such underground cavities in the road pavement in Tokyo area of Japan increased after the gigantic 2011 Tohoku earthquake. Although the mechanism of cavity formation and the stability of the soil arching have been widely investigated, still limited research has been done under seismic loading condition. This study focuses on mainly two parts. (1) Internal contact erosion to understand the phenomenon that leads to sinkhole formation using the soil material having similar physical and geometrical properties of the onsite soil. (2) Seismic stability of the subsurface cavity. In the contact erosion test, three series of test were performed considering the effect of fully saturated and unsaturated condition of fine soil, soil configurations and applied overburden pressure. In case of seismic stability of subsurface cavity, shaking table tests were performed considering the conditions of water level on the model ground to form the cavity, drained condition, and the effect of reinforcement on arching. A woven geotextile and a triangular geogrid were used as a reinforcement material. From this study, the followings were observed. From contact erosion test, contact erosion is significant only when the flow velocity exceeds the critical velocity. The observation result shows that the contact erosion phenomenon leads to the surface settlement if the coarse material is non-cohesive and uniformly graded under the soil configuration of coarse material overlying the fine soil condition. But erosion phenomenon leads to the formation of a subsurface cavity under the soil configuration of fine soil overlying the coarse material condition. In addition, due to the breakage of particle to particle bonding stable cavity at the interface was not observed in the fully saturated condition of the fine sand. Test result shows, there is no significant effect of overburden pressure on the critical flow velocity, but it has inverse

effect on the erosion rate. The test results indicated that the fine soil overlaying coarse soil scenario clearly shows the internal erosion that ultimately leads to piping. This situation reflects the Armala site condition that undergoes sinkholes. From shaking table test, seismic stability of the subsurface cavity is greatly affected by the amount of water around the cavity. It was observed that the stability of the cavity decreased with the increase of water at the bottom of the cavity. Test result shows that the stability of the cavity increases with the increase of H/W ratio. The effect of reinforcement was highly noticed at the fully drained condition of the model ground.