

“Technical Research and Development for Road Policy Quality Improvement” Study Summary

No.	Title	Principal Researcher
No.30 - 5	The evaluation of collapse risk of subsurface cavities and the development of their countermeasures	Univ. of Tokyo Prof. R.Kuwano

Aiming at the rational countermeasures for road cave-ins, techniques of survey, diagnosis, repair and prevention for subsurface cavities are developed. Those techniques are integrated as the solution.

1. Backgrounds and Objects

Countless subsurface cavities are being generated under roads in the urban area. Some of them would collapse and may cause road cave-in accidents. In order to prevent this, the ground penetrating radar technique is effective to find cavities before their collapse. Appropriate repair treatment should be then carried out for the cavities according to their properties and collapsing risk. In this research, the effective countermeasure was developed for steps of survey, diagnosis, repair and prevention for subsurface cavities. Mechanism of cavity formation and expansion was investigated and collapse risk of cavities was evaluated. The selection of repair and prevention methods for a cavity was proposed. The developed techniques for survey, diagnosis, repair and prevention steps were integrated as the solution for road cave-in problem.

2. Activities in Research Period

Methods and contents for the study were as follows;

Analysis of previous cavity data: evaluation of effective range and reliability of ground penetrating radar, relationship of cavity locations and environmental factors

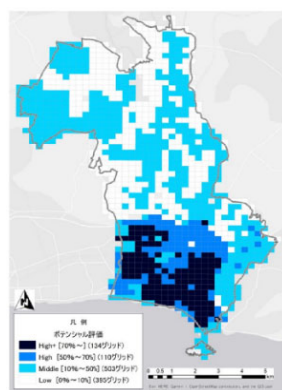
Laboratory model test: investigation of mechanism of cavity formation and expansion

Numerical analysis: evaluation of collapse risk of cavity, survey for detecting deep cavities

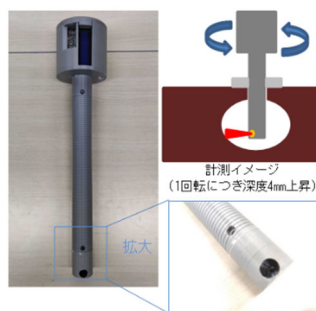
Monitoring of cavities in roads: evaluation of rate of cavity growth

Test field pavement: evaluation of collapsing risk, performance of repair work

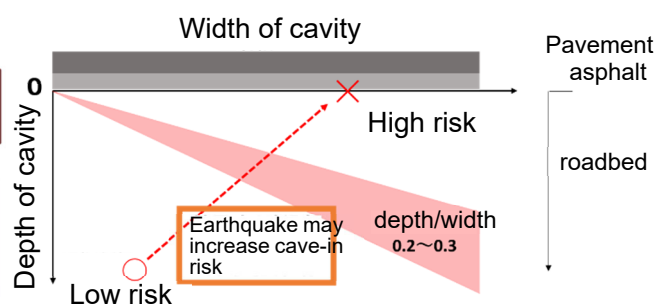
3. Study Results



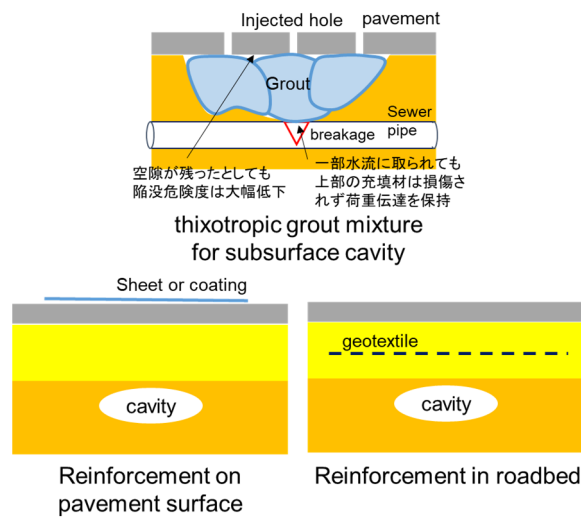
Cavity potential map for Fujisawa-city



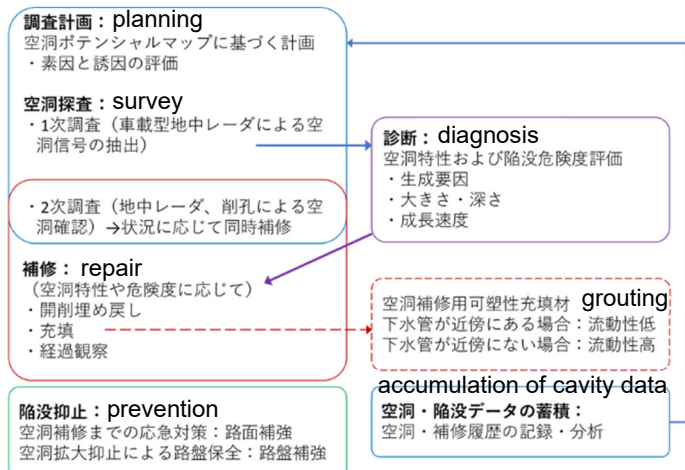
Point cloud observation device for a subsurface cavity



Evaluation of collapsing risk for a subsurface cavity



Repair and prevention treatment for a subsurface cavity



The solution for road cave-ins

4. Papers for Presentation

Kuwano,R., Ihara,T. and Muroi,K. (2019), Governing factors for the risk evaluation of subsurface cavity against surface collapse, the 1st domestic symposium on Transportation geotechnical engineering (in Japanese).

Kuwano,R., Kuwano, J. Ihara,T. and Sera,R. (2020), The test field pavement for the evaluation of collapse risk of subsurface cavities, Seisan Kenkyu, Bimonthly Journal of Institute of Industrial Science, The University of Tokyo, Vol.72, No.4, pp.319-322 (in Japanese).

Tan,T., Kuwano,R., Kinjo,M. and Kozakai,N. (2020), Development of thixotropic grout mixture for subsurface cavity with re-excitation potential, The 55th annual conference of JGS, Kyoto, 23-2-2-03 (in Japanese).

5. Study Development and Future Issues

Applying the solution developed in this research, road/infrastructure managers are expected to handle subsurface cavities in more effective manner. They can select appropriate treatment for cavities according to the condition and situation. It is preferable to accumulate and utilize the cavity data to update the knowledge and share the experience among infrastructure managers and engineers.

6. Contribution to Road Policy Quality Improvement

Current standard practice against a subsurface cavity is “finding a cavity and backfilling it by open excavation before its collapse”. It works well and contributes to the mitigation of cave-in accidents. For more rational and effective measures, following are considered important; appropriate survey planning considering regional trend and cavity formation potential, the evaluation of collapsing risk for a cavity, and choice of repairing methods according to cavity properties. In this research, measures of subsurface cavities were developed for steps of survey, diagnosis, repair and prevention and those techniques were integrated as a solution for road cave-in problem.

7. References, Websites, etc.

Website for the 1st and 2nd liaison meeting on countermeasures for subsurface cavities:

<https://geo.iis.u-tokyo.ac.jp/category/urcmlm/>