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Feasibility test of cavity exploration using a prototype muography detector/ミュオグラフィ試作検出器を用いた空洞探査の実現可能性試験

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Shield tunneling methods are widely used to construct large underground tunnels. Although the methods are considered safe, subsidence accidents due to underground cavities created during tunnel excavation have occurred in recent years. To prevent such accidents, it is necessary to detect the cavities and take some measures. Various exploration methods such as ground-penetrating radar have been used to detect such cavities. However, it is difficult to detect cavities deeper than 10 m underground using those conventional methods.
To resolve this issue, we propose an exploration method using the muography technique [1]. Muography is a noninvasive exploration method that utilizes cosmic-ray muons. By measuring muon fluxes at multiple locations underground, information on underground density distribution can be obtained as in a CT scan. Our goal is to develop a disaster prevention system for cave-ins. As a first step, a dedicated prototype muography detector is being developed.
In this presentation, we will report the results of the feasibility test using the prototype detector capable of determining the direction of incoming cosmic rays. For the test measurement, clay bricks were piled above the detector to form a cavity. The muon flux was measured with and without the cavity, and the spatial distribution of transmittance was determined. In the obtained distribution, there was a high-transmittance region corresponding to the cavity position. The size of cavity was estimated from that of the high-transmittance region. A PHITS simulation [2] was then performed incorporating a realistic building structure, and it reproduced the experimental results well.

References
[1] L. Bonechi, R. D'Alessandro, A. Giammanco, Atmospheric muons as an imaging tool, Reviews in Physics, 5,100038 (2020)
[2] T. Sato, Y. Iwamoto, S. Hashimoto et al., Features of Particle and Heavy Ion Transport code System (PHITS) version 3.02, J. Nucl. Sci. Technol. 55, 684-690 (2018).

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