

RTRI Develops Slope Soil Testing Machine

RTRI developed a small-sized, light-weight, multi-directional penetration test machine. This test machine drives a rod in a horizontal direction from a drain hole of a slope and checks degradation of slope soil under concrete layer. With this machine, the survey can be conducted at lower cost compared to a large-scale horizontal boring survey.

1. Background of development

Since the ground needs to be cut away when a railway line is constructed in a mountainous area, there are a lot of cut-out slopes along railway lines in Japan. Some of them are covered with concrete to protect them from winds and rainfalls. However, the strength of the ground under concrete layer decreases over time, the ground becomes loose and may push forward the protection layer and finally collapse (Fig. 1). It is impossible to check soil degradation visually, as it is covered with concrete. In the conventional approach, pits have been excavated in concrete layer and the soil through boring surveys including large installations and the degradation has been visually confirmed. But it has been required to develop a testing machine to check soil degradation more easily and with lower cost to maintain stability of trackside slopes.



Fig. 1 Collapsed slope

2. Overview of multi-directional penetration test machine

In the field of geotechnical engineering, simple dynamic cone penetration testing is widely conducted for the purpose of measuring bearing capacity of the ground in vertical direction. In the simple penetration testing, 5kg weight is repeatedly dropped in vertical direction from the height of 0.5m, through a guide rod. The strength of the soil can be measured by counting the number of blows required to drive 0.1m of rod end penetration into the soil.

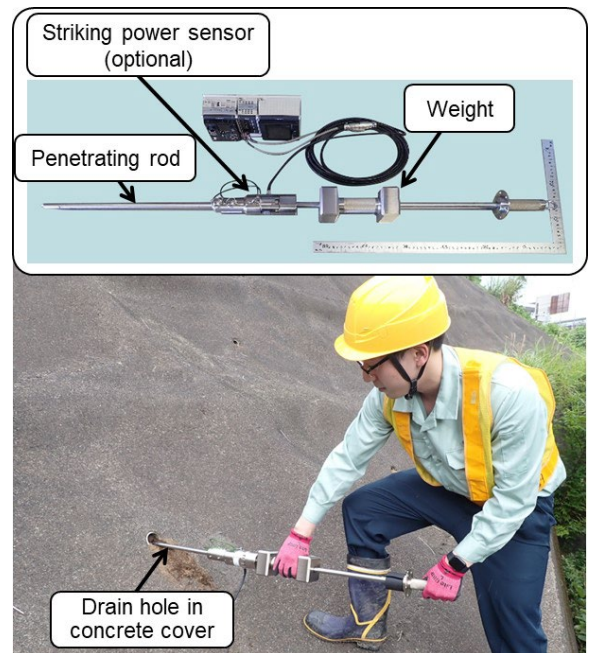


Fig. 2 Multi-directional penetration test machine

RTRI has developed a multi-directional penetrating test machine (Fig. 2) based on the principle of cone penetration testing. While simple cone penetration testing is only available for vertical-direction geotechnical surveys, the rod of this testing machine can be placed in multiple directions, mainly in horizontal direction, from a drain hole of a slope (Fig. 3). By measuring the number of blows by weight

required to drive the rod 0.1m into the soil (penetration resistance), degraded scope can be assessed (Fig. 4).

【Features】

- Compact machine (10kg). Easy to transport to test sites. Tests can be conducted on a site adjacent to a railway track because it does not require a large-scale temporary installation. Furthermore, since it is unnecessary to remove concrete layer for slope protection, the test takes just 10 minutes for one spot.
- Total testing cost is about 1/20 of a horizontal boring survey.
- The weight adds blows to penetrate the soil by sliding back and forth through guide rod at a specified interval. It mitigates variation in human striking power. The test results on scope of soil degradation have shown the same accuracy as those by a horizontal boring survey.
- As this test measures soil softness quantitatively, the scope of degradation can be determined more accurately than by visual checking in a horizontal boring survey.
- Test results can be converted to the data of the existing simple corn penetration test. In addition, variation in human striking power can be corrected by using load cell (optional) and more accurate test data can be obtained.
- RTRI has also developed a nomogram to judge stability of the slope based on the data of soil degradation scope and slope grade.

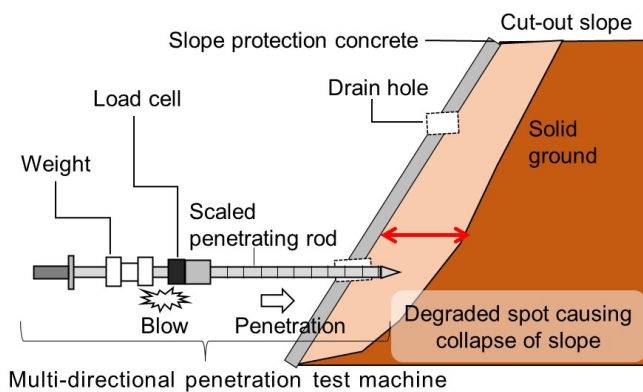


Fig. 3 Testing with multi-directional penetration test machine

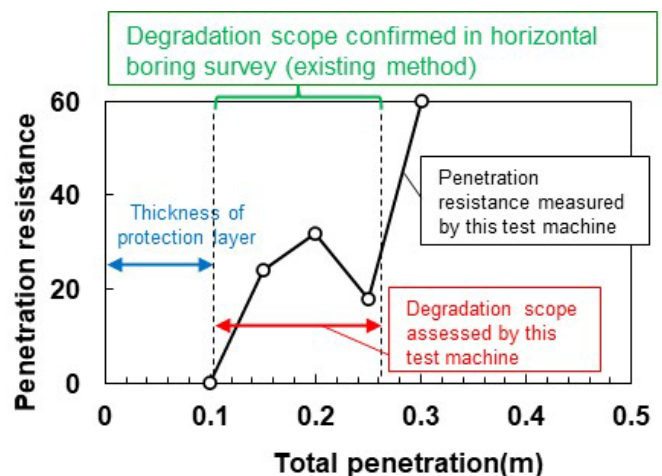


Fig. 4 Penetration resistance measured by multi-directional penetration test machine

【Date of release and use by railway operators】

This testing machine was released by Sakata Denki Co., Ltd. in August this year. Several rail operating companies are to use this machine in order to specify the spots of slopes to be repaired and reinforced.