Report on the Measurement of the Form of SHOTCRETE GRID BEAM-FREE FRAME Using Point Cloud Data

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Abstract –

We conducted a measurement accuracy and laborsaving in the spraying slope frame work by appli-cation of ICT earth works using UAV was verified by using field of actual work.

In the UAV survey, it was possible to apply the Ministry of Land, Infrastructure, Transport and Tour-ism (MLIT) standards to the UAV survey by facing front of a slope.

The measurement accuracy of the cross-sectional measurement of the frame was ensured by setting the frame cross-section at 5 mm/pixel and 90% wrapping, and In the area measurement, a difference of -1% to +2% could be calculated.

The introduction of UAV is expected to significantly reduce the time required to work in the field on steep slopes.

The measurement of a 1500m2 of a field was completed with about 50% less labor than the con-ventional method.

Keywords –

i-Construction; UAV; Spraying Slope Frame Construction Method; Form measurement

1 Introduction

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) says it will promote "i-Construction" with the aim of improving productivity and making construction sites more attractive.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has established various standards for ICT construction in order to promote "i-Construction".

At present, the guidelines for ICT earthworks and ICT paving have been established, and in March 2020, the glue surface construction was added.

In this report, we report on the measurement of the construction status of the slope surface by aerial photogrammetry using an unmanned aerial vehicle (UAV), which was carried out in 2019.

The results of the survey were used to confirm the accuracy of the measurements and to verify labor-saving measures.

2 Contents of the survey

The test was conducted at the Echigo-Kawaguchi Service Area on the Kanetsu Expressway, as shown in Figure 1.

Figure 1. Map of Kanetsu Expressway Area

The glue surface here had collapsed due to heavy rainfall in July 2017,to restore the disaster, we planned and commissioned the reinforcement using sprayed method frames and Tests were conducted as part of this work (test area was about 50 meters high and 30 meters wide).

Figure 2. Test Area (50m×30m)

The verification items were selected from the "Earthwork Construction Management Guidelines" of the East Nippon Expressway Co. It has been done.

The four items selected were (1) measurement of length, (2) measurement of cross section width and height, (3) measurement of extension, and (4) measurement of the area.

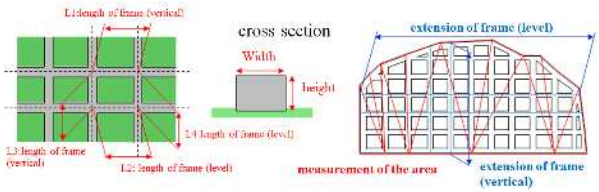


Figure 3. Verification items of sprayed frames

2.1 Measurement method

For the measurement of the profile of the spraying slope frame by UAV survey, the point cloud data obtained by field surveying with the 3D reconstruction data created by the method described in the previous section, the position of the workpiece was confirmed by tape surveying, and the shape dimensions and the extension was measured.

However, considering the differences in slope, complicated undulations and structural details, the issues to be addressed in the application of the slope work were discussed and some of the specifications were modified as shown in Table 1.

Table 1. Summary of Improvement Measures

item	ICT earth works standards (MLIT) : March 2018	Try and compare
photo shoot	downward direction	⇒facing front of a slope
measurement performance	pixel size 10mm/pix	pixel size ⇒5mm/pix
LAP rate	next to 80% lap course 60% lap	⇒next to 90% lap ⇒course 90% lap
reference point	outside of shooting area (outer edge)	⇒inside of shooting area

3 Inspection

3.1 Comparison with actual measurements (frame shape)

This presents the results of the comparison of measurements from 3D data and tape surveying of the frame profiles, i.e. (1) length of frame, (2) width and height of frame, (3) extension of frame area.

3.1.1 Length of the frame and section of the frame

The difference between the frame length and the reference value, which is the actual measurement, was less than ±1 cm. As for the cross-sectional width (W), an error of a few millimeters from the reference value was observed, but it was found that the NEXCO standard is not applied to the cross-sectional area. values. A maximum height (H) error of -55 mm was confirmed. When the comparison was carried out with the modified plan (5mm/pixel, 90% lap), the maximum margin of error was 9 mm. They converged.

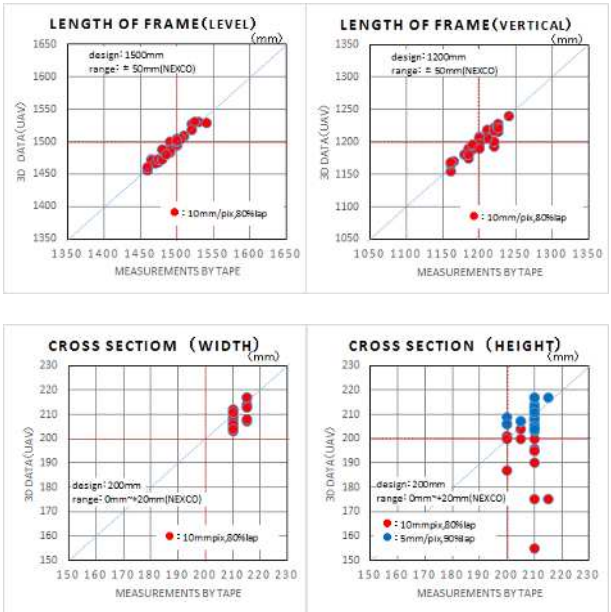


Figure 4. measurement of length, width and height

3.1.2 Length of the entire framework

The results of the comparison of the length of the entire framework with the actual measurement showed that the extension of the frame was a few centimeters (less than ±1%) in both vertical and horizontal directions.

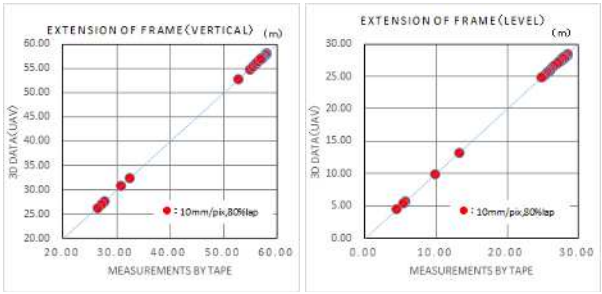


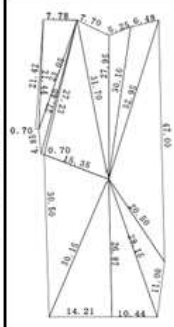
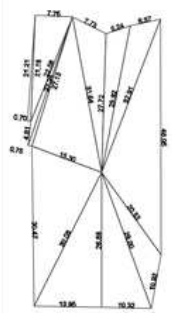
Figure 5. measurement of extension

3.2 Comparison and verification of actual measurement results (area)

The area was verified by comparing the results of the UAV survey with the development of the tape survey (triclinic method).

The difference between UAV survey and actual measurement is less than -1% in the calculation of area by actual measurement and co-located measurement as shown in Table 2. The total area of each frame increased by a little less than 2% compared to the actual measurement, indicating that the total unevenness was measured.

Table 2. Area Comparison

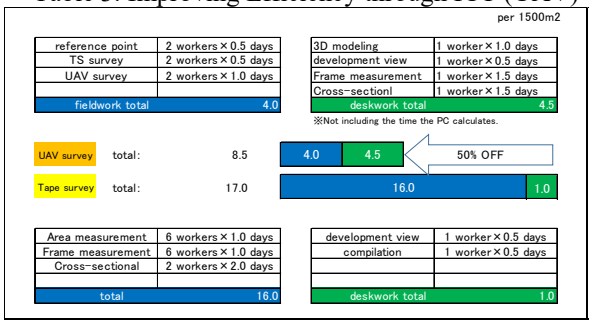
	Tape Surveying.	3D data(UAV)	3D data(UAV) (in detail))
AREA	1522.67m²	1510.52m²	1548.16m²
difference		-12.15m² (-0.8%)	+25.49m² (+1.7%)
development view			

3.3 Verification of efficiency through the use of ICT

Surveying by UAV of the workpiece (per 1500m2) requires more off-site work than actual measurement (tape surveying). The reduction is about a quarter. However, the total reduction effect is about half due to the increase in internal work such as analysis work. As shown in Table. 3, the work was performed on a steep slope, and the use of the UAV made the work site safer. In addition, we have improved in the following areas.

Figure 6. Status of surveying works

Table 3. Improving Efficiency through ICT (UAV)



4 Summary

The UAV surveying method for measuring the workmanship of the sprayed-on slope is the same as the UAV method. It is considered possible to apply the "as-is" rule to the case. As for the cross-section of the frame, 5mm/pixel, 90% wrapping is considered to be sufficient. However, the restriction of flight zones by trees and other factors needs to be considered. The area is affected by the subdivision of the triclinic method, but can be calculated with a difference of about -1 to +2%. In addition, safety has been improved and workloads have been reduced by about 50% compared to the conventional measurement method.