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Infrastructure Development Institute—JAPAN

KUMONOS is a total station which has a built-in crack scale and 3D database management system.

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Cracking Inspection System KUMONOS

1. Introduction

In recent years there have been lots of serious accidents caused by deterioration of infrastructure not only in Japan but also in many countries. Therefore the demand for preventive maintenance and management of those structures has been steadily growing and became urgent nowadays.

Our company has been contributing to maintenance and management by performing various types of measurements of those structures. We promote technology development and introduce the latest technologies to "measure safely and accurately."

Among all inspection and monitoring methods that are used, crack inspection is especially necessary for maintenance of concrete structures.

In the conventional methods of crack inspection a dedicated ruler, called crack scale is used to measure widths. Shapes and lengths of the cracks are recorded by sketching. Such methods require close-up visual inspection, so that scaffolding or boom-lift at out-of-reach places become a necessity. This increases labor costs and significantly decreases efficiency. Moreover, workers safety is jeopardized.

Since the conventional inspection methods rely heavily on human factors such as professional skills and diligence of a particular worker, it tends to be difficult to record shape, length and width of a crack accurately.

Remote Concrete Measurement System “KUMONOS”

2. Overview of the Inspection Method

We developed “Crack Inspection System “KUMONOS” that makes possible to safely measure cracks from a long distance away without using neither scaffoldings nor the boom-lifts; and allows to record crack’ shapes and evaluate their width with an order of 0.4mm from distances as far as 100m away. Then, the shape, length and width of the crack can be converted into the data and recorded quantitatively. Furthermore, since three-dimensional coordinates of measured cracks are saved, consecutive measurements at the same locations allow monitoring and quantifying their continuous growth and expansion.

As crack data obtained by "Crack Inspection System KUMONOS" can be expressed in three dimensions, it can be used in combination with 3D data obtained by 3D laser scanner which is also one of our key technologies. Based on these data, maintenance and management of infrastructure objects can be conducted thoroughly and efficiently.

Method Comparison

Experiment to compare conventional method with KUMONOS

Ⅰ.Conditions

Subject: 3 people with 2-day technical training
Object: 5 simulated cracks drawn on a sheet of paper (Figure 1)
Conditions: distance – 50 meters, 1 measurement

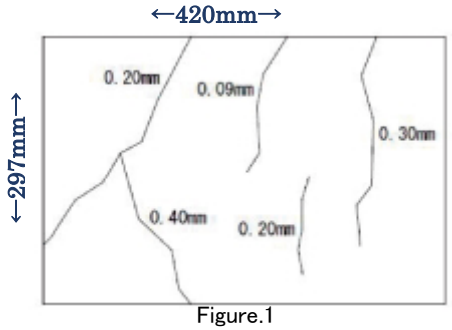

Figure.1

Ⅱ. Methodology

①Attach sheet with cracks to the wall as in Figure 2.

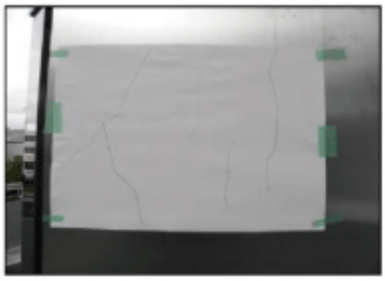
Figure.2

②Monitor position and shapes of cracks in two following ways:
-Observe the cracks through a pair of binoculars and sketch them on the paper as in Figure 3


Figure.3

-Measure cracks using KUMONOS (Figure 4)

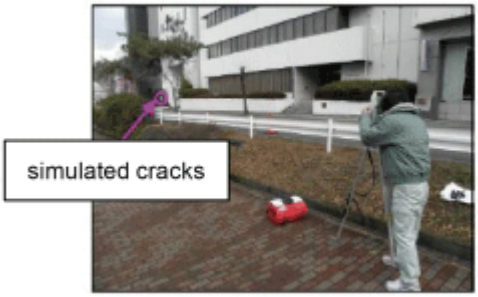

Figure.4

③Prepare resulting drawing in AutoCAD
④Over impose resulting drawings from both methods and analyze the differences.

Ⅲ. Results

Comparison Accuracy (Position and Shape)

KUMONOS	Conventional Method
1mm ~ 3mm	28mm ~ 46mm

*Accuracy: The difference between the figure and the cracks to be measured

The Result of Measuring the Widths (Only Using KUMONOS)

Crack No.	Actual Width (mm)	Result				Accuracy
		A	B	C	Average	
1	0.20	0.22	0.22	0.18	0.21	±0.02
2	0.40	0.42	0.36	0.44	0.41	±0.04
3	0.09	0.10	0.14	0.14	0.13	±0.05
4	0.20	0.22	0.18	0.22	0.21	±0.02
5	0.30	0.32	0.29	0.32	0.31	±0.02

*Accuracy: The difference between the figure and the cracks to be measured
Obviously, KUMONOS is way more accurate than the conventional method
Width accuracy is within 0.05 mm even when measured from 50m away.

4. 3D Laser Scanning Technology

3D laser scanner is an instrument that acquires 3D positional coordinates of the target object by laser beams emitted from the instrument. Just by pressing a button on the instrument, it is possible to acquire positional coordinates of all surrounding as a point cloud data (large number of measures points combined in one entity) in a short time. KUMONOS Corporation has introduced 3D laser scanners into the market way ahead of other manufacturers.

In recent years, this technology has been used in the following sites:

■Plants and Ships

3D laser scanner can measure shapes as they are, making it the ideal solution for measurements of and in vehicles and complex facilities such as ships, airplanes, inside manufacturing or chemical plants and etc. Modeling of piping and instrumentation based on point cloud data makes it possible to handle it as CAD data thus simplifying design and drafting, monitoring and management. It enables easy checks on interference by complicated piping, securing distances between welds and etc. 3D scanned data is also used to formulate plans for expansion of facilities and layout changes.

■Historic Buildings and Cultural Properties

At the time of Kumamoto earthquake in 2016, we performed measurements of real-time situation using a 3D laser scanning technology. Aiming at early recovery of Kumamoto Castle, the 3D data was used to examine the structural conditions to implement restoration planning.

We became number one in Asia for 3D laser scanner sales in three consecutive years. We have been accumulating achievements and experiences in various fields since 20 years ago when we started development of the technology.

Figure.5 Example of scanning inside of a plant

Figure.6 Point cloud data

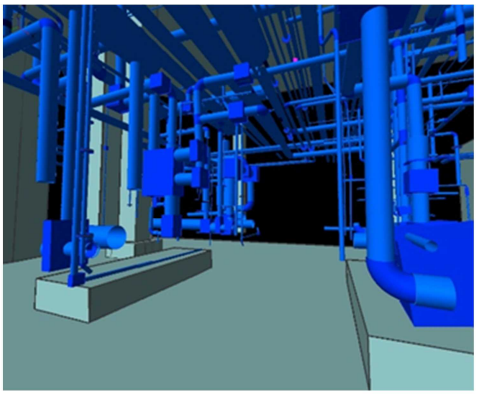

Figure.7 Modeling data from point cloud data

5. Recent Activities

We can offer expertise with wide variety of 3D laser scanners. Both fixed types and mobile types are available. Fixed types are used for measurement in the fixed state on tripods, and mobile types are used for measurement while moving. In particular, we are the only company in Japan that can use backpack-type 3D laser scanners with which you can perform measurements by carrying the scanner on your back. Such backpack-type scanner was used in Nepal for measurements aimed at recovery and restoration of urban and cultural heritage areas heavily damaged by the earthquake of 2015.

Furthermore, we have been expanding our business scope in the sports field. We are also planning of introducing 3D laser scanning technology and wall diagnostic system to stadium maintenance as well as utilizing 3D measurement data for VR technology in the future.

Figure.8 Point Cloud data of Sports Stadium

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About IDI and IDI-quarterly

Infrastructure Development Institute (IDI)-Japan is a general incorporated association operating under the guidance of Ministry of Land, Infrastructure, Transport and Tourism of Japanese Government.
IDI provides consulting services for mobilizing International Assistance to developing countries, promoting international exchange of information and human resources, and supporting globalization of project implementation systems targeting both developed and developing countries in the field of infrastructure.

IDI has been publishing the free quarterly journal “IDI Quarterly” since1996 for the purpose of introducing information relating to public works and construction technologies developed in Japan to foreign countries. We have distributed the journal to administration officials in more than 90 countries around the world by e-mail.

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