A Study of ground measuring systems with vibrating wire displacement sensor application

Gun-hyoung Park*, Seung-ki Ryu**, Yeo-hwanyoon***
Korea Institute of Construction Technology, Korea
E-mail : godpark@kict.re.kr*, skryu@kict.re.kr**, kictyyh@kict.re.kr***

1. Introduction

Due to pressure, loads and stresses acting on road facilities upon the external environment, structural deformation of the facility may be generated. And structural deformation leads to the accident of the ground collapse, and it can result in numerous fatalities. The accident was prevented by sensor installation for detecting changes in the external environment to advance can prevent accidents. Because of Safety inspection is being occasional manual measuring in most of the tunnels, it is extremely difficult to predict of the accident. This study is based on real-time data acquisition techniques with vibrating wire displacement sensor application.

2. Facilities Inspection Standards and Items

For the safety of facilities, the type of inspection, inspection items and the enforcement date to be defined and implemented on Safety inspection of the facility and safety diagnostic precision guidance. Safety checks are divided into routine maintenance, overhaul, emergency checks, precise safety diagnosis. Tunnel is checked status of surface crack in General inspection, and it is checked Crack orientation, crack pattern and crack propagation in routine maintenance check, and it is checked with the mortar pad in overhaul check, and it is checked Crack with ultrasonic pulse velocity method and impact elastic wave inspection in precise safety diagnosis.

Inspection periodic consists of a simple by the naked eye inspection, and it is performed every six months or more. These checks is checked the static condition of the facility, but it can't determine change of external environment by pressure, load, stress, aging and etc. The automated systems collect suddenly occurring variations Through a periodic inspection.

3. Vibrating wire displacement sensor

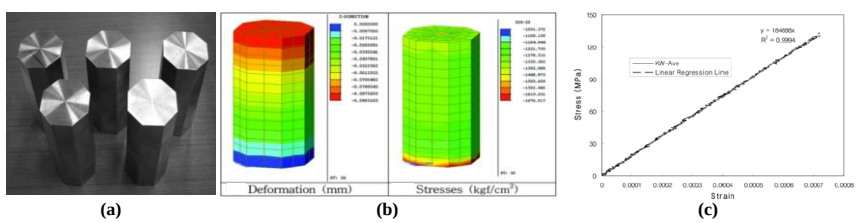

Figure 1. (a) octalsteel spectrums, (b) calculated displacements and stress at the specimen for 50ton loading, (c) test results for strain gauges

Vibrating wire strain gauges are frequently used for measuring strains of a structure in fields of structural monitoring of building and civil engineering. The attached or imbedded gauges measure the deformation of a structure by measuring the average strain on a member's section equal to the gauge length. However, only the points of installed can be measured, so that the limit depends on the number of sensors.To overcome these limitations, Interval measuring sensor is applied to the strain bar. The long tube is located in vibrating wire connected to the strain bar was constructed to detect the influence.

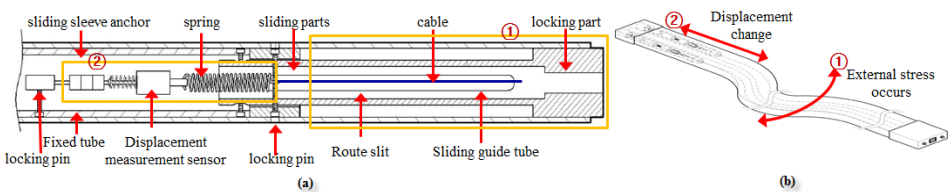

Figure 2. (a) internal configuration of vibration wire sensor, (b) signal flow

The sensor is mechanical transducer rather than electrical converter. Sensor cable is fixed at a constant tension is applied. Then, the electromagnetic force can be formed by placing a magnetic coil is installed on the vibrating wire. From device output signals the magnetic coil is formed on the strong electromagnetic force to power the vibrating wire. As a result, the resonance frequency is measured frequency/sec through the magnetic coil in the output device.

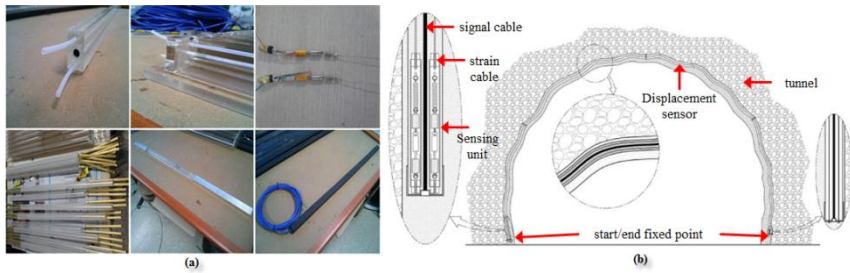

Figure 3. (a) the production process of vibrating wire sensors, (b) the installation

A constituent material of the strain sensor bar is considered primarily liquidity and strength. In order to protect the sensor and the sensor bar, shrink tubing sealed aluminum housing and enhance the moisture resistance, strength gains and minimize the external influences. When applied to a tunnel, the sensor configured to be installed with a set of 16 sensors by the measuring point.

4. Ground measuring system

The ground displacement data are periodically collected and transmitted from sensors to data center. The data is collected by a wired or wireless. The data are composed of displacement data of whole sensor. Displacement angle can be calculated from displacement amount. By analyzing a displacement angle of all sensor information, the point information of an abnormality occurs can be grasped. The real-time information and the historical data can be expressed to the operator.

Figure 4. ground measuring system configuration and monitoring program layout

5. Conclusion

We propose a displacement measurement technique with vibrating wire sensor, this technology reduces the risk of collapse of the ground facilities and it can be monitored at all times.With continuous monitoring and status information management of the ground facilities, disasters such as ground collapse can be prevented.This technology has utilized in various fields such as surface of slope, measurement of building construction and etc.

6. Acknowledgment

This research was supported in part by grant “Development of high-reliable USN sensor node and data analysis system for ground collapsing prevention” project of “Ministry of Science, ICT and Future Planning department of Korea”.[2012-10044011]

7. References

[1] Ministry of Land, Transport and Maritime Affairs, “Safety inspections and safety diagnostic precision commentary detailed instructions(Tunnel)”,Detailed instructions, Korea Infrastructure Safety Corporation, 2011
[2] Park Min-Cheol and Han Heui-Soo, “Model Experiments and Behavior Analyses of The Tunnel Support Using TDR Sensor”, Journal of KoreanGeo-Environmental Society, Vol.12 No.9, 2011
[3] Lee Hong-Min & Park Hyo-Seon, “Estimation of the maximum stress of a beam-column based on average strains from vibrating wire strain gages”, The Architectural Institute of Korea, Vol.29 No.1, 2009