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Instrumentation system analysis for Structural Health Monitoring applied in Song-do M1 Campus Town project

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ABSTRACT

Structural Health Monitoring(SHM) has been considered to provide information on the current state of structures by measuring structural static and dynamic responses. SHM could be also used to provide reliable information about the performance of the system during blast, earthquake and typhoon. Effective sensors will help to make monitoring of structures with a proper array of sensors economically practical. To realize SHM system with suitable sensors, it needs to be designed considering both the characteristics of the smart sensor and the structures to be monitored. This paper is studied on the instrumentation system and the monitoring program for SHM system with server system, data logger system, monitoring program for PC and mobile applied in Song-do M1 Campus Town project.

1. INTRODUCTION

The objectives of the SHM system are to monitor the building responses and external loadings. SHM developed methods for analyzing complex structures and assemblages subjected to a variety of static and dynamic loadings.[1)] To realize SHM system with smart sensors, it needs to be designed considering both the characteristics of the smart sensor and the structural monitoring.[2),3)] This paper is studied on the instrumentation system and the monitoring program for SHM system with server system, data logger system, monitoring program for PC and mobile applied in Song-do M1 Campus Town project.

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2. STRUCTURAL HEALTH MONITORING SYSTEM

Figure 2.1 present the structural health monitoring system for Song-so M1 Campus Town project. Monitoring items and corresponding details are summarized in table 2.1 and 2.2. Monitoring items are GPS displacement, acceleration, strains, wind velocities and corresponding wind direction. Work scopes for Song-do M1 Campus Town project is nonlinear structural analysis to evaluate structural performance, alert levels, contingency plan, development of maintenance program and mobile application.

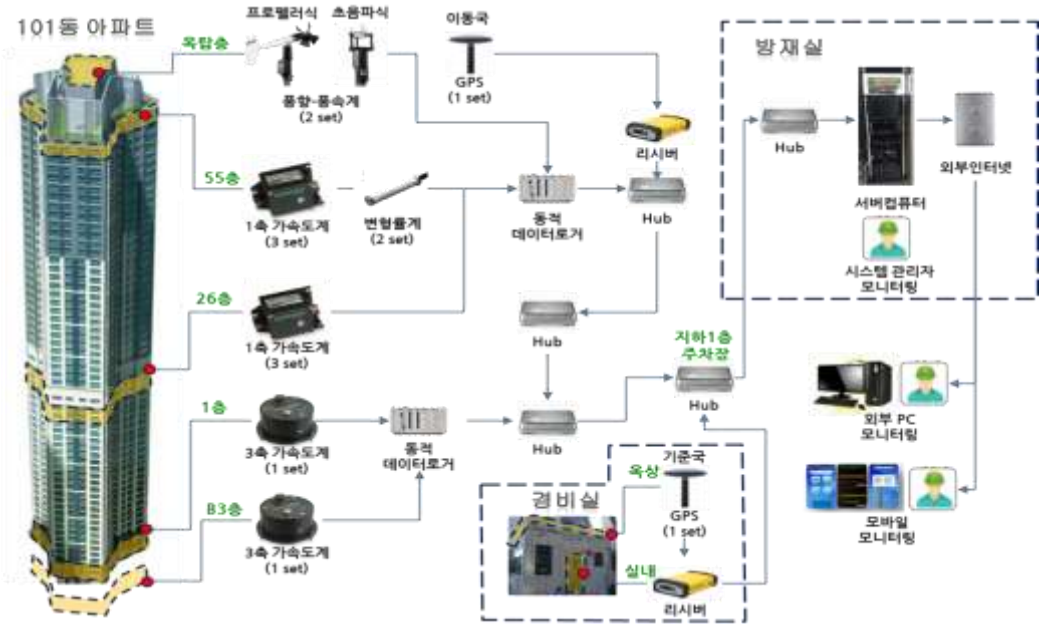


Fig. 2.1 Structural health monitoring system for Song-do M1 Campus Town project

Table. 2.1 Sensors and equipment

Sensors and equipment	Quantity	local situation	Purpose
Anemometer of ultrasonic type (86000)	1set	Roof	Wind speed and direction
Anemometer of propeller type (05103V)	1set	Roof	Wind speed and direction
GPS Antenna	1set	Roof	Displacements of building
	1set	The roof of the security offices.	
GPS Receiver	1set	55floor TPS room	Displacements of building
	1set	The roof of the security offices.	
1axis Accelerometer(ES-U2)	3set	55floor TPS room, AV/PS room	Building vibration
	3set	26floor TPS room, AV/PS room	
3axis Accelerometer(ES-T)	1set	1 floor TPS room	Ground vibration
	1set	Base 3floor PIT room	
Strain(KM-100B)	2set	55floor Core beam	Strain measurements
Dynamic data logger(DS-NET)	1set	55floor TPS room	Measurement data collection

	1set	1floor TPS room	

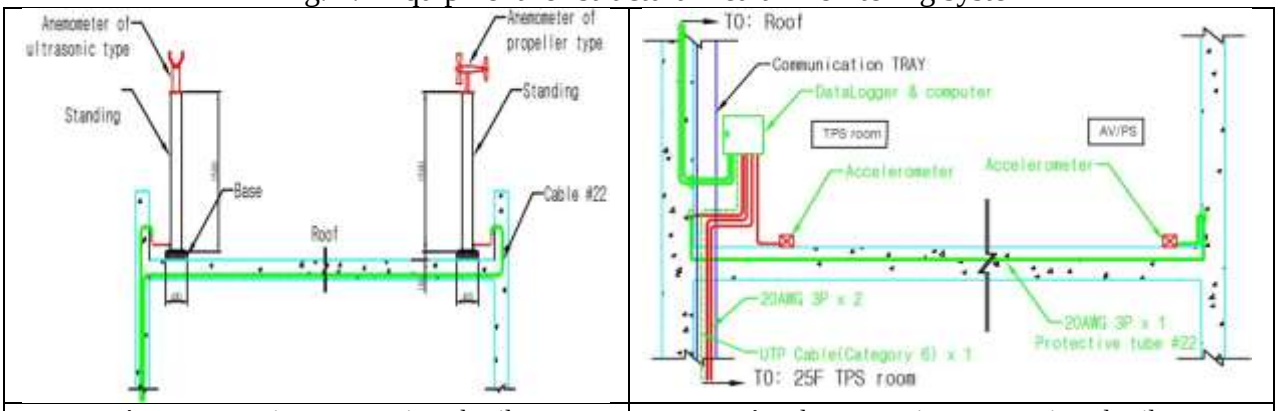
Table. 2.2 Installation system

Devision	Anemometer	GPS	Accelerometer	Strain transducer
Data sampling	10Hz		100Hz	
Storage cycle	1 minute	1 hour	1hour	
Storage time	1minute	10 minute	10minute	
Result	Average wind and direction of 1 minute.	10 minute data	10 minute acceleration	Strain
Level trigger condition	Wind 17m/s exceed	X-axis : 50mm Y-axis : 40mm Z-axis : 35mm exceed	Accelerometer : 0.02g exceed Seismograph : 0.03g exceed	1000um/n exceed
Level trigger storage time	1minut	10minut		
Storage file	Txt file	CSV file		
Analysis	Wind speed and direction	Signal through analysis of coordinate transformation/ Displacement of top floor.	Natural Frequency of structure/Mode shape factor	Regional strain measurement

Detailed structural conditions should be reliably identified through analysis of measured data. The SHM unit is equipped with sensors, a data logger and an analysis computer.(Fig. 2.2 and 2.3) The evaluated information can be directly provided to clients using wire or wireless data transmission.

		
1axis accelerometer (Model : ES-U2)	3axis accelerometer (Model : ES-T)	Strain Transducer (Model : KM-100B)
		
HUB (Model : HP-1405-5)	GPS antenna (Model : Zehpyr Geodetic Mark 2 Antenna)	Anemometer (Model : 86000)

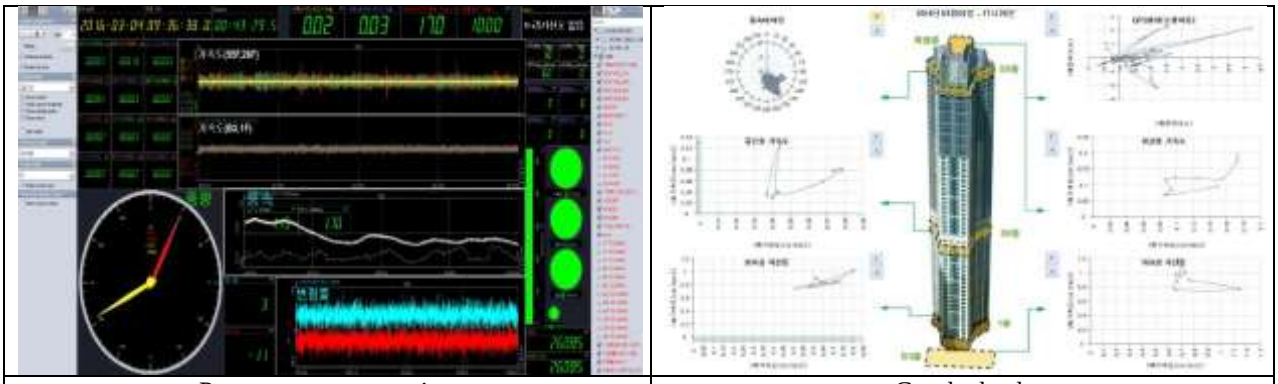
Fig. 2.2 Equipment for structural health monitoring system



Anemometer instrumentation detail	Accelerometer instrumentation detail

Fig. 2.3 Instrumentation detail installed for Structural health monitoring system

Errors in SHM system are originated from not only the monitoring system itself but also from external environmental effects. It is required to compensate for environmental effects by performing test operation, after installation of SHM is completed.[4),5)] Reliable safety managements during construction can be achieved based on measured data. Engineers can check current monitoring values, retrieve raw data and summary files, view graphs of measured data in any PC where the monitoring program is installed. Alarm signals appear when excessive structural behaviors and external loads are detected in Song-do M1 Campus Town project.(Fig. 2.4)



Program screen running	Graph check

Fig. 2.4 Program screen running and graph check for Structural health monitoring system

3. CONCLUSIONS

Uniaxial force balance accelerometer needs to provide on scale recording of earthquake motions at near-fault locations and in a wide variety of structure types. Because it is extremely low-noise, it can detect motions of the ambient vibration field at most urban site from DC to 200Hz. It needs to allow simple field calibration and reduce processing confusion. A wide range of data logo modules is available to support almost any type of input and output signals. These multi-function modules can be combined in countless ways, provide top-notch data recording and process control. Popular connector options enable convenient sensor connection and in combination with the

easy-to-use software this ensures a time saving system setup. Optic LAN also is a very expensive but there is no limit on the interval. And in the case of hub, wire interval can be installed generally until the 100m. GPS is affected by accuracy of the atomic clock. So the price of GPS is various in accordance with accuracy. Finally, the work scopes and budget of items can be proposed after request of client. But based on the measurement data, effective sensors will help to make monitoring of structures with a suitable array of sensors economically practical.

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