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Approval & Reception Procedure

DEE – Structures and Buildings Department		
Quality Control of Structure Health Monitoring System Construction	Document No.:	**ARP/DEE/017**
	Date:	**2023/03/01**
	Page No.:	**1 of 8**

1. General Description and Scope

- The content of this document is suitable for long -term health monitoring system after the structure construction is completed;
- Quality control shall comply with project's technical specifications / contract rules.
  - If the project's technical specifications / contract rules have stated the requirements for quality control, the quality control shall comply with the stricter requirements between the project's technical specifications / contract rules and the requirements of the ARP.
  - If the project's technical specifications / contract rules have not specifically stated requirements for quality control, the quality control shall comply with the requirements of this ARP.

2. Phase I - Planning

2.1 Document submission – The contractor shall submit at least the following documents for approval:

2.1.1 Monitoring system design plan, shall include at least the following information:

- ❑ Monitoring scope;
- ❑ Monitoring items list (cf. Table 1);
- ❑ Monitoring system schema;
- ❑ Monitoring method and health assessment program (i.e., alert value, sampling frequencies, data storage system, etc.);
- ❑ Electricity power acquisition, telecommunication connection scheme;
- ❑ Repair and treatment plan under special events (i.e., typhoon, earthquake, collision);

2.1.2 Monitoring system construction method, shall include at least the following information:

- ❑ Detailed list of equipment and construction materials;
- ❑ Catalogues, technical specifications, and manufacturer qualification of each

proposed equipment to be purchased.

- ❑ Installation and construction method and process;
- ❑ Construction schedule;
- ❑ Construction safety measures and risk assessment;
- ❑ Protection plan for electrical equipment after installation;

2.1.3 Detailed construction drawings, shall include at least the following information:

- ❑ Drawing contents and general description;
- ❑ Wiring diagram, working platform locations;
- ❑ Plan and elevation drawings, include equipment location and quantity;
- ❑ Detailed drawing of equipment and instruments.

2.2 Acceptance criteria of planning documents:

2.2.1 The type, technical specification of every equipment must comply with the requirement of design documents or contract rules;

2.2.2 The planning of monitoring points must follow the principles of representative, practical, economic and simple;

2.2.3 The accessibility of location of monitoring instruments should be considered for future maintenance;

2.2.4 Proof checking must be done by qualified engineer provided that any temporary structure will be applied for construction;

2.2.5 The protection of electrical equipment should be considered against water, dust, lightning, external collision and damage.

3. Phase II - Construction

3.1 Document Submission – The following materials should be submitted while each equipment arrives on site:

- ❑ Delivery notes: including numbering and quantity;
- ❑ Product certification from original manufacturer;
- ❑ Valid calibration certificate for every electrical sensor;

3.2 Acceptance criteria:

- ❑ The documents submitted should be able to prove that all equipment purchased complies with the approved plan;
- ❑ All calibration certificate should be issued by a lab that is approved by the quality control party and within its validity period;
- ❑ If the quality of any equipment is questionable, additional sampling tests should be performed by the quality control party.

3.3 On site installation:

- ❑ Every equipment and wire should have their numbering marked with labels, and the labels should be firm and durable;
- ❑ Every equipment and wire should be recorded by photograph before being covered up, and the location of every photo should be clearly documented;
- ❑ All cables should have recognition code and the location information of each ends.

4. Phase III - Delivery

4.1 The monitoring system should meet the technical requirements specified by contract rules or the owner;

4.2 All the equipment and cables should have proper protection installed;

4.3 The contractor should provide detailed test reports of cables; (cf. **Table 2**)

4.4 The contractor should provide a report of on-site adjustment and test run; (cf. **Table 2**)

4.5 The contractor should provide technical manual of the system, and the following information should be included:

- ❑ Site plan of the system;
- ❑ The numbering of all equipment and cables;
- ❑ The procedure of acquiring monitoring data;
- ❑ Information about maintenance;
- ❑ The initial settings and initial readings of all equipment;

4.6 . The contractor should provide user manual of the system, and the following information should be included:

- ❑ System introduction and working process;
- ❑ Instructions for software operation (software for structure monitoring, data collection, data transmission and communication services, etc.)
- ❑ Instructions for software installation (including environment deployment).

4.7 The contractor should provide the instructions for hardware maintenance, and the following information should be included:

- ❑ Introduction to the system operating environment (equipment work conditions, power conditions);
- ❑ Introduction to the hardware composition (sensors, data processing instruments, internet instruments, etc.);
- ❑ The locations, functions and monitoring contents of all equipment;
- ❑ Table of sensors and their corresponding channels.

4.8 All the above-mentioned testing works should be carried out by professionally qualified personnels from the contractor;

4.9 All the equipment used in the above-mentioned testing works must come with appropriate and effective calibration certificates;

4.10 Testing and acceptance records must be signed and confirmed by professional engineers in corresponding areas; test methods and sampling ratio can be decided according to the referenced documents.

5. References

[1].《公路橋樑結構安全監測系統技術規程》 JT/T 1037-2022
[2].《建築與橋樑結構監測技術規範》 GB 50982-2014
[3].《綜合佈線系統工程設計規範》 GB 50311-2016
[4].《綜合佈線系統工程驗收規範》 GB/T 50312-2016
[5].《基於以太網技術的局域網系統驗收測評規範》 GB/T 21671-2008
[6].《智能建築工程質量驗收規範》 GB/T 50339-2013
[7].《Information technology – Generic cabling for customer premises》 ISO/IEC 11801
[8].《Commercial building telecommunications standard》 EIA/TIA – 568

The latest version of the above codes should be used unless being specified in contract document or agreed by design party.

Table 1 Common monitoring items

Type		Monitoring parameter
Environment and load	Vehicles	Axle weight, total weight, speed of vehicle
	Wind	Wind speed, direction, pressure
	Earthquake	Vibration (velocity and acceleration)
	Temperature	Air temperature, concrete temperature
	Humidity	Air humidity
Global structural reaction	Vibration	Velocity and acceleration
	Deformation	Deflection, transversal and horizontal deformation
	Displacement	Displacement of bearings, expansion joints, vertical displacement of beam end
	Inclination	Inclination of structure
Local structural reaction	Strain	Strain on critical section of the structure, prestressed cable or steel beams
	Cable force	Cable force of cable-stayed bridge, suspension bridge or prestressed cable
	Bearing	Reaction force of bearing

Table 2 Check list for Structural monitoring system construction

Check items for sensors					
Check items	**Material/Equipment control**	**Installation control**	**Check frequency**	**Reference standards**	**Remarks**
Each material and equipment are consistent with the approved proposal	√	√	Check All	Contract rules, design documents, [1], [2]	Shall submit all the records for review and archive.
Installed locations are consistent with the drawings	—	√			
The appearance of the sensor is complete and the installation is firm	—	√			
All sensors have necessary protection measures	—	√			
Numbering labels are clear, intact and durable	—	√			
Check items for wiring system					
Check items	**Material/Equipment control**	**Cable test**	**Check frequency**	**Reference standards**	**Remarks**
Cables and wires	√	√	1. Check All; 2. Sampling test: with the ratio of 5-15%. Take at least 2 samples if the overall number is under 10.	Contract rules, design documents, [3], [4]	Shall submit all the records for review. Shall carry out sampling test by the quality control party.
Labels of cables	—	—	Check All		Shall submit all the records for review.
Labels of cable management equipment	—	—			

Table 2 Check list for Structural monitoring system construction (continued)

Check items for data transmitting system					
Check items	**Material/ Equipment control**	**Installation control**	**Check frequency**	**Reference standards**	**Remarks**
Each material and equipment are consistent with the approved proposal	√	√	Check All	Contract rules, design documents	Shall submit all the records for review and archive.
Installed locations are consistent with the drawings	—	√			
The appearance of the equipment is complete and the installation is firm	—	√			
The system works normally under normal power supply	—	√			
Numbering labels of every equipment and instruments are clear, intact and durable	—	√			
Numbering labels of all cables are clear, intact and durable	—	√			
The chassis and equipment in the control center are properly grounded	—	√			
The cables are properly laid in line tubes or wire grooves, Orderly aligned and fixed straight, not tangled. Exposed cables are protected by sleeves.	—	√			

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Quality Control of Structure Health Monitoring System Construction	Document No.:	**ARP/DEE/017**
	Date:	**2023/03/01**
	Page No.:	**8 of 8**

Check items	Material/ Equipment control	Installation control	Test frequency	Reference standards	Remarks
System performance test	—	√	1. Check All; 2. Sampling test: with the ratio of 10%, take at least 10 samples. Take at least 2 samples if the overall number is under 10.	Contract rules, design documents , [5], [6]	Shall submit all the records for review. Shall carry out sampling test by the quality control party.
Fault tolerance test	—	√			
Application performance test	—	√			
Function test	—	√			
Management function test	—	√			