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Technical Requirements for Nondestructive Testing (Electromagnetic Method Based on Remote Field Eddy Current) on Prestressed Concrete Cylinder Pipe

预应力钢筒混凝土管无损检测（远场涡流电磁法）技术要求

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1 Scope

This Document specifies the working principle, detection system, calibration test, test object, test preparation, test implementation and quality control requirements for non-destructive testing of the integrity of prestressed steel wire by electromagnetic method based on remote field eddy current for prestressed concrete cylinder pipes; describes the data analysis method; and gives the basic content of the result report.

This Document is applicable to the inspection of prestressed concrete cylinder pipes used in water conservancy, municipal and other projects.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 19685 Prestressed Concrete Cylinder Pipe

3 Terms and Definitions

For the purposes of this Document, the following terms and definitions apply.

3.1 Prestressed concrete cylinder pipe; PCCP

A pipe made by wrapping a hoop prestressed steel wire on the outside of a concrete pipe core with a steel cylinder and making a protective layer of cement mortar.

[SOURCE: GB/T19685-2017, 3.1.1, with modifications]

3.2 Electromagnetic method based on remote filed eddy current

A detection method for judging the integrity of PCCP steel wire by detecting the change of the remote field eddy current by using the low-frequency electromagnetic field to generate the remote field eddy current in the PCCP thin steel cylinder.

3.3 Reference pipe

An intact pipe section with the same parameters as the test object.

3.4 Baseline curve

Relationship curve that characterizes the electromagnetic signal of the reference pipe (3.3) versus the axial position of the pipe.

3.5 Calibration pipe

Reference tube (3.3) where the number and location of broken wires can be controlled manually.

3.6 Calibration curve

The change curve of the electromagnetic signal of the calibration pipe (3.5) at different numbers and locations of broken wires.

3.7 Calibration test

Activation process to obtain calibration curve (3.6).

4 Working Principle

The electromagnetic technology based on the remote field eddy current, which the transmitting coil transmits a magnetic field in the prestressed concrete cylinder pipe, and the receiving coil receives the magnetic field signal generated by the eddy current in the prestressed steel wire. By comparing the magnetic field signal detection curve of each pipe section with the reference curve, the abnormal signal caused by wire breakage and the pipeline with broken wire are identified. By analyzing the parameters such as the amplitude and phase of the abnormal signal, combined with the characteristics of the calibration curve, the location of the broken wire is estimated, and estimate the number of broken wires.

5 Detection System

5.1 The detection system is mainly composed of data acquisition system, data analysis and processing software and mobile platform.

5.2 The data acquisition system includes a transmitting coil and a receiving coil, and has functions such as start, stop, pause, real-time acquisition, display, storage, and playback. The

b) Technical data such as as-built drawings or construction drawings of the pipeline;

c) PCCP piping design parameters;

d) Existing PCCP test data;

e) Information on existing calibration pipes or piping information suitable for making calibration pipes;

f) Relevant information required for data analysis.

The site survey shall include:

a) Check the distribution of ground objects, landforms, traffic and pipelines in the survey area;

b) Open the well to visually check the water level, silt and structure of the well;

c) Check the manhole position, pipe position, pipe diameter, material, etc. in the collected data.

8.2 A test plan should be prepared before the test, and the test plan should include the following:

a) The entrusting party of the inspection task, the inspection content, and the construction period requirements;

b) Overview of piping works;

c) Test data quality control measures;

d) Workload and work schedule;

e) Personnel organization, facilities and equipment (including testing instruments and their supporting facilities, vehicles, communication tools, safety equipment, etc.);

f) Possible problems and solutions;

g) The result data to be submitted, etc.

8.3 For the PCCP pipeline using the impressed current cathodic protection method, the impressed current cathodic protection circuit shall be disconnected 2 weeks before the detection.

8.4 Before the on-site inspection, the pipeline is empty and well ventilated; and the working environment shall not affect the health and safety of personnel.

8.5 Use a non-water-soluble and non-toxic marker to mark and number each section of the PCCP pipeline, including standard PCCP pipes, short pipes and steel pipes. Give priority to using the serial number of the entrusting party and verify it on site. If necessary, self-mark it; and carry out the segment numbering according to the exhaust valve.

8.6 Ancillary facilities and positions on the pipeline, such as exhaust valves, butterfly valves, emptying valves, maintenance wells, etc., shall be accurately recorded. When possible, establish the corresponding relationship between the number of each PCCP pipe section and the PCCP buried mileage (or plane coordinates).

9 Test Implementation and Quality Control

9.1 Before testing, check the integrity of the testing system, and calibrate the odometer on the mobile platform. The transmitting coil and receiving coil shall be as close as possible to the inside of the pipe wall, but not in contact with the pipe.

9.2 Set the parameters of the detection system according to the working parameters obtained from the calibration test; and adjust the frequency, amplitude, phase and signal magnification of the transmitting signal according to the diameter of the pipe, until a clear signal can be collected.

9.3 The pipeline number stored in the detection system shall correspond to the actual number of the pipeline.

9.4 The traveling direction of the detection process shall be consistent with the water flow direction.

9.5 A test shall be carried out before the official start of the detection. After three repeated tests are performed on the first five sections of pipes, it is confirmed that the parameters of the test equipment are set reasonably and the working conditions are normal, and then the signal data of each pipe section shall be formally collected.

9.6 During the testing process, periodic verification shall be carried out through repetitive detection. The frequency of periodic verification shall ensure that the detection object between the two exhaust valves is carried out at least once. If a problem is found or suspected in the detection system, it shall be re-commissioned and confirmed to be normal. The pipelines that cannot be confirmed to be tested under normal working conditions shall be retested.

9.7 When there is an abnormal signal that cannot be determined during the detection process, a record shall be made, and if necessary, the abnormal signal segment shall be re-tested.

10 Data Analysis

10.1 Analyze the detection curve of each pipe section of the detection object; compare the deviation of amplitude and phase; identify whether the wire is broken; estimate the number of

Appendix A

(Normative)

Calibration Method of Broken Wire by PCCP Nondestructive Testing (Electromagnetic Method Based on Remote Field Eddy Current)

A.1 Determine the reference pipe and calibration pipe

A.1.1 Select two intact pipes with the same parameters as the inspected pipes as reference pipes and calibration pipes, respectively. Record the technical parameters of the pipe, including (but not limited to): pipe specification and model, wall thickness of pipe core, concrete strength grade of pipe core, thickness of mortar protective layer, thin steel cylinder (thickness, material), steel wire (diameter, strength grade), winding wire (pitch, number of layers), whether with short-circuit steel strip, whether there is external anti-corrosion layer, production date, etc.

A.1.2 The two ends of the reference pipe or the calibration pipe are connected in series with a pipe of the same diameter to simulate the actual installation of the pipe and obtain the complete data signal of the reference pipe and the whole section of the calibration pipe.

A.1.3 Use the detection equipment of the electromagnetic method based on remote field eddy current to scan the background signal of the reference pipe from the two directions of the pipe socket and the joint, and obtain the reference signal data when there is no broken wire.

A.1.4 When only one pipe meets the requirements of the inspected pipeline, first use the pipe as the reference pipe to complete the collection of reference data, and then process it into a calibration pipe.

A.2 Processing calibration pipe

A.2.1 Select 3 ~ 5 representative areas to cut out windows on the mortar protective layer to be used as the calibration pipe, at least including the center position of the pipe and the positions 50mm ~ 100mm away from the end face at both ends of the pipe. The length should be 100mm ~ 150mm along the pipe circumference of each window; and the number of exposed steel wires along the axial length of the pipe should be no less than 50. The schematic diagram of the position of the calibration window is shown in Figure A.1.

------ The End ------