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### Specification for failure analysis of steel wire ropes

钢丝绳失效分析规范

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# Specification for failure analysis of steel wire ropes

## 1 Scope

This Standard specifies the terms and definitions, general principles and personnel capability requirements, general procedures, analysis methods, analysis reports and residual sample storage for failure analysis of steel wire ropes.

This Standard is applicable to the failure analysis of steel wire ropes for various purposes. It can be used as a reference for the failure analysis of steel wire and steel wire rope products.

**Note:** This Standard provides guidance for the failure analysis of steel wire ropes due to manufacturing defects, or handling, storage, installation damage, or broken wire, broken strand, fracture, corrosion, overload. Under normal circumstances, because the failed steel wire rope has been subjected to complex stresses such as load, bending, extrusion, and rotation, and the appearance, size, mechanical and technological properties of the steel wire rope and the steel wire in the rope have changed, so, the test results of its appearance, size, mechanical and technical properties shall not be used as the basis for judging whether the steel wire rope is qualified.

## 2 Normative references

The following documents are indispensable for the application of this document. For dated references, only the dated version applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 228.1, Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 238, Metallic materials - Wire - Reverse bend test

GB/T 239.1, Metallic materials - Wire - Part 1: Simple torsion test

GB/T 1839, Test method for gravimetric determination of the mass per unit area of galvanized coatings on steel products

GB/T 2972, Test method for uniformity of zinc coating on zinc-coated steel wire by the copper sulphate dip

The technical activity and management activity of taking necessary detection and analysis methods to comprehensively analyze the failed steel wire ropes, to find the failure cause, according to certain working procedures.

### **3.3 Macroscopic inspection**

Inspect the macroscopic characteristics of the steel wire rope visually or through a magnifying glass no greater than 10 times.

### **3.4 Microscopic inspection**

Inspect the microstructure, morphology, crystal structure and other microscopic characteristics of the steel wire in the steel wire rope by tools such as metallographic microscope or scanning electron microscope.

## **4 General principles and personnel capability requirements**

### **4.1 General principles**

The failure analysis of steel wire ropes shall be undertaken by an organization with independent legal personality and relevant technical capabilities.

When the client requires the trustee to issue a report for the failure analysis of steel wire ropes with third-party impartiality, the trustee shall have relevant qualifications and technical capabilities. The organization that undertakes the failure analysis of steel wire ropes shall follow the following principles:

- a) Comply with relevant national laws, regulations and rules; be fair, just, objective and scientific;
- b) Establish standardized, rigorous and complete failure analysis procedures;
- c) Make the analysis method scientific and rigorous, the analysis process thorough and comprehensive, the evidence conclusive, and the conclusion accurate;
- d) Record the phenomena that is observed in the analysis process and the test data in detail; save the necessary image data;
- e) If a simple method can be used to find out the cause of the failure, avoid complex and tedious analysis and testing.

### **4.2 Personnel capability requirements**

### 5.3 Site survey

If necessary, and the conditions for site survey are available, the organization responsible for failure analysis shall select personnel who are familiar with the use and maintenance of steel wire ropes to conduct site survey.

The site survey shall conduct necessary inspection, inquiry, data retrieval, measurement, photographing, and recording of the following items:

- a) Failure time, place, use environment, failure process and abnormal phenomena before the failure;
- b) Feature survey and description of the steel wire ropes on site;
- c) Technical documents such as steel wire rope product quality certificate, acceptance inspection report, installation record;
- d) Steel wire rope product use and design specifications or regulations;
- e) Records of daily use, inspection, maintenance of steel wire ropes;
- f) Physical specifications, models and failure signature of steel wire ropes;
- g) Characteristic parameters and status quo of the reel, pulley, back-up roll, connection and other devices in contact with the steel wire rope.

### 5.4 Samples and their protection

The client takes samples by himself; or the trustee performs site survey and takes samples. When intercepting or collecting samples for failure analysis, the following matters shall be paid attention to:

- a) Before intercepting the sample for failure analysis of the steel wire rope, carefully check the steel wire rope; select the representative failure part and intercept the sample; there shall be sufficient distance between the interception position and the failure part;
- b) When it is necessary to conduct analysis and testing of steel wire rope twisting parameters, physical and chemical properties, intercept a sample of sufficient length at the end of the steel wire rope or away from the failure part;
- c) When the steel wire rope, strand or steel wire has multiple damages or fractures, check carefully and identify; select representative samples;
- d) In order to avoid secondary damage or corrosion to the sample for failure analysis of the steel wire rope, take effective protective measures during sampling, loading and unloading and transportation.

Perform macroscopic observation classification and statistics of morphology and characteristics of typical damages or defects such as structural damage, wear, corrosion, extrusion, wire breakage, and fracture of failed steel wire ropes; record typical damages or defects.

#### **5.5.3.2 Microscopic inspection**

Perform microscopic morphology observation and analysis of typical damages or defects such as structural damage, wear, corrosion, extrusion, wire breakage, and fracture of failed steel wire ropes, including defect characteristics and fracture sources; record typical damages or defects.

#### **5.5.3.3 Micro-area composition analysis**

Perform micro-area composition analysis of typical damages or defects such as damage, corrosion, wire breakage, and fracture of failed steel wire ropes; record typical damages or defects.

#### **5.5.3.4 Metallographic structure inspection**

Test and record the metallographic structure, inclusions of the typical damaged or defective samples such as wear, corrosion, extrusion, wire breakage, and fractures of failed steel wire ropes and the non-damaged or defective samples.

## **6 Failure analysis method**

### **6.1 Appearance, size and failure signature inspection and measurement**

#### **6.1.1 Appearance quality of steel wire ropes**

Appearance quality of steel wire ropes, such as appearance, oiling, structure, twisting method, twisting defects, shall be detected visually.

#### **6.1.2 Feature size of steel wire ropes**

Wire rope length, diameter, lay length and out-of-roundness, strand gap and chord height, wire diameter (including central wire), rope core size shall be measured with wide-jaw vernier calipers, micrometers or feeler gauges, in accordance with the methods that are specified in the relevant product standards.

#### **6.1.3 Steel wire rope damage and defect**

Wire rope wear, corrosion, extrusion, wire breakage, skipped wire, intersected wire, broken strand, broken rope, wavy, cage deformity, rope core or strand protrusion, kinking, bending, rope diameter reduction or increase, and such

The uniformity test of galvanized coatings on split steel wire shall be carried out in accordance with the regulations of GB/T 2972.

The adhesion test of galvanized coatings on split steel wire shall be carried out in accordance with the regulations of GB/T 2976.

**Note:** The wrapping diameter of the adhesion test of galvanized coatings on split steel wire can be the diameter of the steel wire itself; the wrapping number can be 8 circles, or can be carried out according to customer requirements.

#### **6.2.4 Rope core and grease properties**

The determination lubricant content, moisture content and physical and chemical properties of the rope core and grease shall be carried out in accordance with the regulations of YB/T 4182 or NB/SH/T 0387.

### **6.3 Damage and defect inspection and analysis**

#### **6.3.1 Macroscopic inspection**

The morphology and characteristics of typical damages or defects such as structural damage, wear, corrosion, extrusion, wire breakage, and fractures of steel wire ropes shall be observed by visual inspection, stereo microscope or other tools.

#### **6.3.2 Microscopic inspection**

The microscopic morphology inspection of typical damages or defects, such as structural damage, wear, corrosion, extrusion, wire breakage, fracture and the fracture source of steel wire ropes shall be performed in accordance with the regulations of JY/T 010.

#### **6.3.3 Micro-area composition analysis**

The micro-area composition analysis of typical damages or defects such as damage, corrosion, wire breakage, and fractures of steel wire ropes shall be performed in accordance with the provisions of GB/T 17359.

#### **6.3.4 Metallographic structure inspection**

The inspection of metallographic microstructure for the steel wire in the steel wire rope shall be carried out in accordance with the regulations of GB/T 13298.

The determination of nonmetallic inclusions for the steel wire in the steel wire rope shall be carried out in accordance with the regulations of GB/T 10561.

### **6.4 Other test methods**

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