Outline of Guidelines for Performance Verification of Corrosion-Protective Prestressing Steel for External Cables of PC Box Girder, 2012

PC 箱桁外ケーブルに用いる防錆被覆 PC 鋼材の性能照査指針の概要

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1. Introduction

This is the English edition of the Guideline for Performance Verification of Corrosion-Protective Prestressing Steel for External Cables of PC Box Girder, published in 2012 by the Japan Prestressed Concrete Institute under Prof. Hiroshi Mutsuyoshi as committee chairman (**Fig.1**). The guidelines contain the methods for verifying performance of resin corrosion-protective prestressing steel for external cables of prestressed-concrete (PC) box-girder highway bridges in Japan. The authors believe that the wealth of knowledge and experience assembled, accumulated through using these cables in Japan, will prove useful for bridge engineers all over the world.

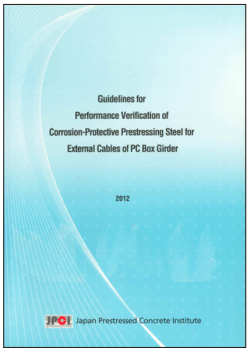
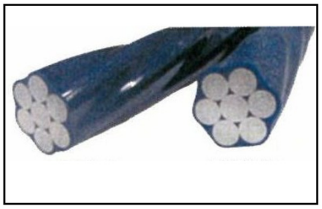


Fig.1 Guidelines for Performance Verification of Corrosion-Protective Prestressing Steel for External Cables of PC Box Girder 2012

2. Scope of the Guideline

(1) Outline

The aim of this guideline is to present required performances of prestressing steel with anti-corrosion resin coating for external cables of PC box girders and relevant test methods. This guideline basically covers single-layer coated prestressing steel on its surface and in its internal voids (**Fig.2**). The design service life of corrosion-protective prestressing steels shall be 100 years.



Surface and gaps are coated and filled with epoxy resin by the method of electrostatic powder coating.

1) Epoxy-coated prestressing steel

Internal voids are filled with thermal plastic resin by extrusion molding.

2) Polyethylene-coated prestressing steel

Fig.2 Typical example of single-layer coated prestressing steel

(2) Table of Contents

Chapter 1 General Provisions
Chapter 2 Materials
Chapter 3 Service Environment Survey and Corrosivity Classification
Chapter 4 Performance Requirements and Performance Verification Methods
Chapter 5 Quality Control Methods
Chapter 6 Installation of Corrosion-Protective Prestressing Steel

3. Special Features of the Guidelines

(1) Performance Requirements and Performance Verification Methods

Table-1 shows the performance verification methods used to evaluate each requirement. In general, when tests specified in **Table-1** are conducted and the performance verification standards have been met, this is enough for the relevant performance requirements for corrosion-protective prestressing steel, which need to be met during the design service life, to be considered as fulfilled.

(2) Quality Control Methods

Prestressing steel coating shall be checked by three types of quality control tests.

A) Benchmark tests: The performance verification tests specified in Chapter 4 shall be conducted as benchmark tests in the product development stage.
B) Periodic control tests: Periodic control tests shall include the neutral salt spray tests, bending tests, and physical property verification tests for the coating material.
C) Daily control tests: The verification test for coating thickness and pinhole detecting tests shall be conducted as daily control tests.

(3) Tensioning Corrosion-protective Prestressing Steel

The coating layer in anchorage positions of corrosion-protective prestressing steel should not be removed before tensioning in order to maintain the corrosion-protective performance. Also, at anchorages of corrosion-protective prestressing steel, it is possible for the coating layer to prevent the anchoring wedge teeth from biting into the prestressing strands, eventually causing anchorage sliding. Therefore, when anchoring corrosion-protective prestressing steel, in accordance with the thickness of coating layer, a dedicated anchoring device with an adjusted height of anchoring wedge teeth should be used in order to allow the wedge teeth to bite sufficiently into the prestressing strands. Inspections of corrosion-protective prestressing steel during and after arrangement shall be conducted.

Table-1 Performance verification method of items

Performance verification item	Performance verification method		
	Test	Test method	Performance verification criteria
Weather proofing	Repeated cooling/heating test	Put the sample in an environment whose temperature varies between -20°C and 40°C during a cycle (one day), repeating this cycle for 100 days.	Conduct pinhole detecting tests and make sure there are no cracks or other defects in the coating material.
Water resistance	Pinhole detecting test for coating layer	Use a dry type pinhole detector installed in the production line to perform this test. Loading voltage should be minimum film thickness × 4.55 × 1.5V (single-coated steel).	Make sure there are no pinholes.
	Continuous condensation method	Use a coated prestressing steel specimen and leave it in an environment with a temperature of 50°C and a relative humidity exceeding 95% for 2,400 hours.	Make sure there is no rust on the steel.
Salt resistance	Neutral salt spray test	Spray 5% NaCl solution onto the coated prestressing steel for 3,600 hours.	Make sure there is no rust on the steel.
Chemical resistance	Acid/alkali immersion test	Immerse coated prestressing steel in 3 molar $CaCl_2$, 3 molar NaOH, saturated $Ca(OH)_2$, 5% H_2SO_4 solution, heated to 23°C, for 1,000 hours.	Make sure there is no rust on the steel.
Damage resistance	Bending test	Wind coated prestressing steel on a cylinder 32 times greater than the diameter of the steel.	Conduct pinhole detecting tests and make sure there is no cracking in the coating layer.
	Load-in abrasion test	Use a concrete block (R = 3,000mm, L = 1,000mm) to simulate a deviation part, apply a tensile force of 20.3kN or more to the coated prestressing steel, and move it several times while maintaining the tensile force (allow it to slide in the protection pipe).	Conduct pinhole detecting tests and make sure there is no wear of the coating layer.
	Tensile fracture test	Conduct a tensile test on the coated prestressing steel, causing the steel to fail.	Make sure there is no scattering of coating resin when the steel is broken.
	Impact resistance test	Subject the coated prestressing steel to impact by dropping a bob onto it from a specific height.	Make sure there is no damage to the coating layer due to the bob impact (no exposure of surface of prestressing steel strand).
	Double-placement compressive test	Arrange the coated prestressing steel in a parallel configuration and apply a live load equivalent to the web force occurring during tensioning (33.3kN for 19S15.2mm) from both above and below.	Make sure there is no damage to the coating layer due to contact between the steel (no exposure of surface of prestressing steel strand).