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Commentaries

Recent Topics on Prestressing Steel

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Keywords: JIS Revision、Factory applied corrosion protection, Delayed-curing epoxy-resin pre-grouted strands, Epoxy coated & filled strands, galvanized strands,Enhanced anti-fretting fatigue behavior, 2230MPa grade High Strength Strands, S-shaped strands and Z-shaped strands

1. Revision of Japanese Industrial Standards

In the revised edition of Japanese Industrial Standards(JIS) on prestressing steel in 2008, thread bars were standardized. Therefore following five types of prestressing steels are now available: wire, strand, round bar, thread bar and quenched and tempered bar in small diameter. It would be recommended that such properties as fatigue, anti-stress corrosion cracking, D-value are specified in JIS in the future. JIS just specifies the properties of prestressing steel. As for the performance of cable systems including anchorages, fib and PTI prepare recommendations for post-tensioning & stay cables. ASTM and BS are internationally influential standards on prestressing steels.

2. New prestressing steel

There are two topics on new prestressing steel.

One is factory applied corrosion protection. The other is 2230MPa grade high-strength strand.

(1) Factory applied corrosion protection

Epoxy-resin pre-grouted(EPG) strands and epoxy-coated & filled(ECF) strand are the most popular ones in Japan. EPG strand is usually applied for internal tendons, and ECF strand is mainly applied for external tendons and stay cables. Galvanized and wax filled HDPE extruded strand is also getting popular for stay cables. In order to use these steel correctly, one should pay attention to the following matters.

- Influence on the properties by the coating process
- Long term behavior of the coating material
- Use of the appropriate anchorage system
- Quality control system

(2) 2230MPa grade high-strength strand

2230MPa grade high-strength strand is developed and already applied for bridges and tanks. All of those strands were ECF strand, because there are no concern on stress corrosion issue with it. This strand is ductile enough, according to the results of D-value test and cryogenic test (fig-1). Although the recent stress corrosion cracking test by FIP method shows no big differences from 1860Mpa grade strand, it is expected to comprehensively investigate how the anti-stress corrosion property is.

Photo-1 Variety of factory applied corrosion protection (from left to right; ECF strand (smooth), ECF strand(grit impregnated),HDPE extruded ECF strand, EPG strand, unbonded strand(greased and HDPE extruded), galvanized strand, galvanized and wax filled HDPE extruded)

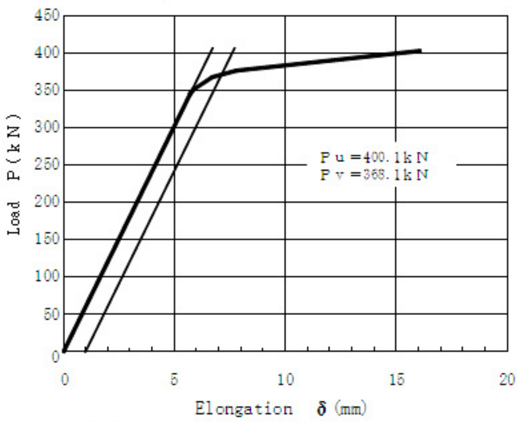

Fig-1 Example of load-elongation curve of 2230MPa grade high-strength strand under cryogenic condition(-196℃)

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Technical reports

State of the Art Report on Corrosion Verification of Steel Bars in Concrete Structures

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Keywords: verification for chloride attack on concrete structure, diffusion coefficient of chloride ion into concrete, threshold value of chloride ion concentration for corrosion initiation, corrosion rate on steel bars in concrete, threshold value of corrosion amount for crack generation, JSCE Standard Specifications for Concrete Structures

Research committee on corrosion evaluation and protection for steel bars (rebars) in concrete (338 Committee) was established in September 2007 as one of research committees in Japan Society of Civil Engineers. In the Committee, the following research works has been carried out; (1) Framework of durability verification for concrete structures deteriorated by chloride attack, (2) Clarification of inspection and monitoring for rebar corrosion in concrete, (3) Protection and repair system for deteriorations due to rebar corrosion and their quantitative performance evaluation method. In this report, the research results on a future strategy of durability verification system for concrete structures in Standard Specifications for Concrete Structures are summarized.

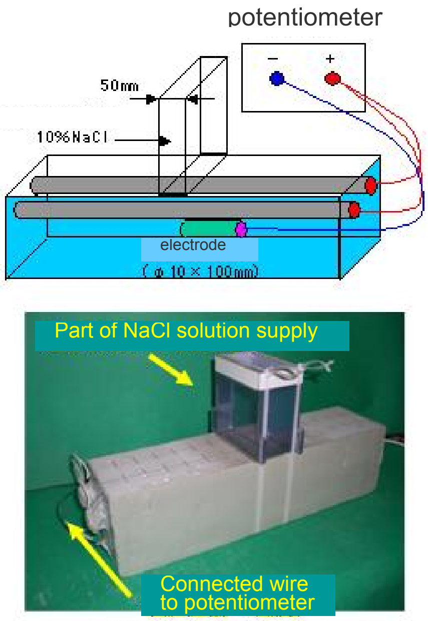

Fig.1 Monitoring method of half-cell potential

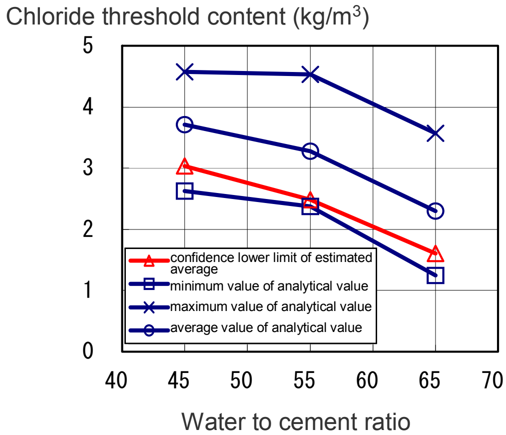

Fig.2 Threshold chloride content to water-cement ratio

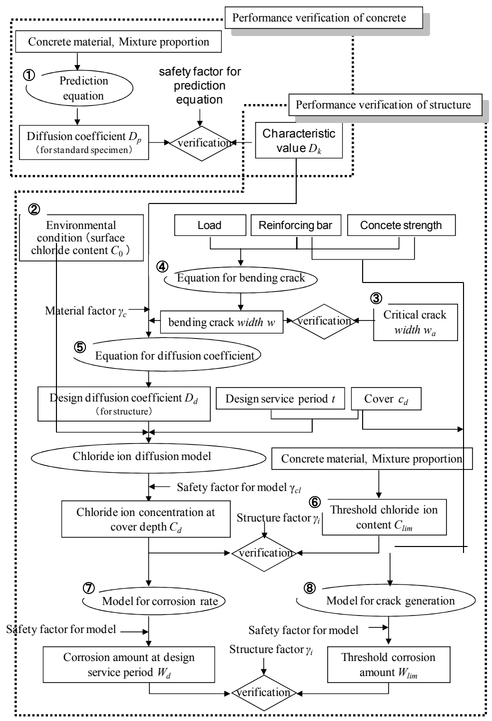

Fig.3 Performance verification on chloride attack

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Technical reports

Performance Confirmation Test of Secondary Execution Short Anchor Bolts

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Keywords: short anchor bolts, pull-out test, shear test

There is the case to install a steel bracket for end of the abut widening and a steel member for prevention cable for collapse of bridge setting in the existing concrete pier for seismic reinforcement by anchor bolts of the secondary execution. Anchor bolts of the secondary execution are necessary a drilling to the existing concrete deeply and there is a problem in execution characteristics to be in danger to injure inside steel materials. Therefore the fundamental performance of the secondary execution anchor bolt that shortened fixation length to 150mm was examined, it assumed adoption to the bracket structure that only shear power acted on mainly.

In experiments, the anchor bolts of two kinds of diameters of D25 and D38 which are adopted for setting of the collapse prevention structure of bridges were used. Photo 1 is the state of damage after the drawing examination. In D25, the corn-shaped destruction starting point became comparatively shallow position and in D38 it became comparatively deep position.

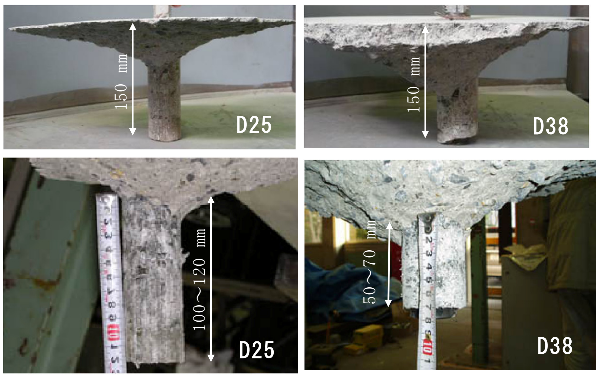

Photo.1 Pulling destruction form

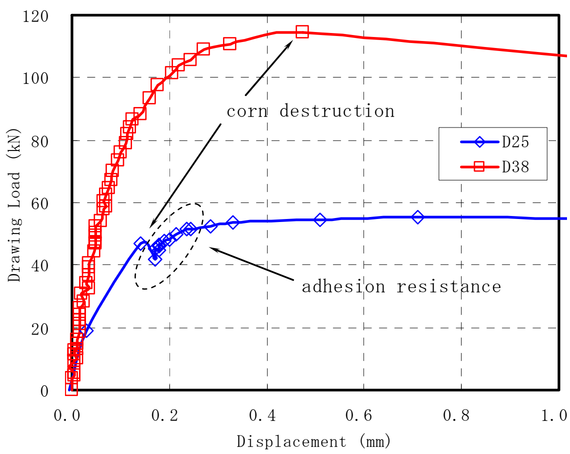

Fig.1 Load – displacement relations

Fig.1 is the relations of drawing load and plumb displacement of concrete. It was shown that it shifted to the system to resist only by anchor bolt and adhesion of the concrete after corn-shaped destruction occurred in D25. But in D38, the adhesion resistance of an anchor bolt to the concrete it can contribute to adhesion resistance after the corn destruction were short. It was shown that it was pulled off while doing adhesion deterioration was caused like a chain reaction.

As a result, if it could prevent pulling destruction of the concrete at a shallow position, or find the adhesion proof stress of the anchor bolt in the deep part from the destruction starting point more than a form of corn destruction proof stress, and prevent partial compression destruction of the outer layer, it was shown the possibility that could expect reliable performance of load resistance by use for structures that shear resistance is dominant.

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Construction records

Construction of a Three-span Continuous PRC Panel-Stayed Bridge
—Agatsumagawa Bridge No.2 of the JR Agatsuma Line—

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Keywords: Panel-stayed bridge, curved bridge, cantilever erection method, railroad bridge, thermal crack, water content per unit volume of concrete, short fiber

Agatsumagawa Bridge No.2 is located about 1.0 km upstream of Iwashima St., JR Agatsuma Line. It has a plane curvature of 600m and crosses over Route 145, as well as the Agatsuma River, a class 1 river.

The bridge consists of a 41m long simple PRC box girder half-through bridge and a 390m long, three-span continuous PRC Panel-stayed box girder half-through bridge. Photo 1 shows the construction work in progress. Figure 1 shows general view of the bridge, which has the following features.

1) A Panel-stayed bridge with the longest span in Japan

A 167 m long central span is the longest in Japan for a Panel-stayed bridge.

2) A plane curvature of 600m and a longitudinal gradient of 2.4%

The bridge is Japan's first Panel-stayed bridge to have a plane curvature within the suspended portion of the bridge. The main girder is made of a ribbed box girder for high rigidity.

3) Fiber reinforced concrete

Polypropylene short fibers are used to prevent concrete spalling from the main girder, Panel and the main tower above the deck.

4) Structural design to match the landscape

The main tower is made of four independent pillars to render it as an image of a watch-tower representing the bond and integrity of the local community.

The construction was done by erecting the central span in 3m blocks using a form traveler and, for side spans, by casting 6m in-situ blocks on false-work systems. The central span was extended by two blocks for one block of side span. Upon connecting the box girder, secondary cables were installed and covered with concrete, and then stressed to apply compressive force.

Concrete for the box girder, main tower, and Panel had been given varying degrees of slump depending on the reinforcement congestion, binding condition, and member thickness. Also, different types of cement were used and expansive additives and reinforcing steel bars were added based on thermal stress analysis. In order to ensure the complete filling of concrete, many monitoring windows were set on the formwork.

Furthermore, water content per unit volume of concrete was carefully monitored when pumping short-fiber mixed concrete, since it was confirmed that insufficient water content causes the slump to drop rapidly.

Photo 1 Cantilever erection in progress

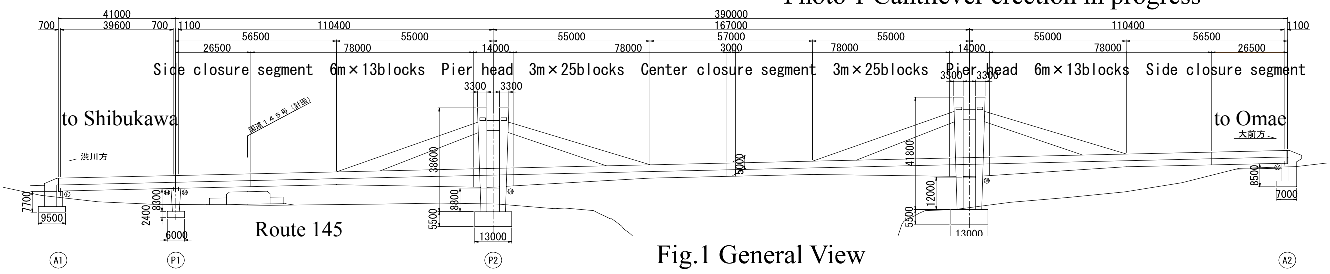

Fig.1 General View

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Construction records

Design and Construction of Steel Pipe Sheet-pile Cellular Seawall Connecting Reclaimed Land and Piled-elevated Structure of the D Runway in the Haneda Airport

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Keywords: Haneda Airport, steel pipe sheet-pile cellular seawall, wave dissipating structure

The D Runway, the forth runway with 2,500m in length, is now under construction offshore of the Haneda Airport. Since part of the D Runway is extended to the mouth of the Tama River, the runway is designed as the hybrid structure: The runway area over the river is the piled-elevated structures, and the other area is reclaimed island. The structure connecting the reclaimed island and piled-elevated structures is a huge seawall with the height of over 30 meters, where the water depth is 18 meters below the sea level, and the elevation of the runway is 13.7m above the sea level.

The seawall must be provided with performance as the foundation that can bear the load of an airplane and as the anti-earth pressure structure that can withstand the earth pressure of reclamation and the lateral movement of the ground. To achieve such performance, a steel pipe sheet-pile cellular seawall with long and large diameter steel pipe sheet-piles driven into the bearing stratum to support the loads is adopted. And the steel pipe sheet-piles are arranged in a shape of the square cell to form foundation, which are connected with concrete slab (thk.=3m) at the top of the steel pipe sheet-piles to obtain the rigidity of the cell against the lateral movement of the ground. And furthermore, high strength pipe junctions are used in the steel-pipe sheet-piles to increase the rigidity of the cell and to reduce the displacement of the seawall.

For the superstructure of the seawall, a wave dissipating structure using circular concrete columns is adopted to reduce reflecting waves from the seawall. This wave dissipating structure can reduce the height of reflecting waves in storm below the level of the titanium panel which covers the whole steel girders of the piled-elevated structure for corrosion protection, and it can also reduce the life cycle cost for maintenance of the piled-elevated structure in a hundred years. The circular concrete columns are precast and pretension members with high strength (f_{ck}'=80 N/mm^2) produced by centrifugal compaction and steam curing and are secured the durability for chloride ion penetration in concrete during 100 years.

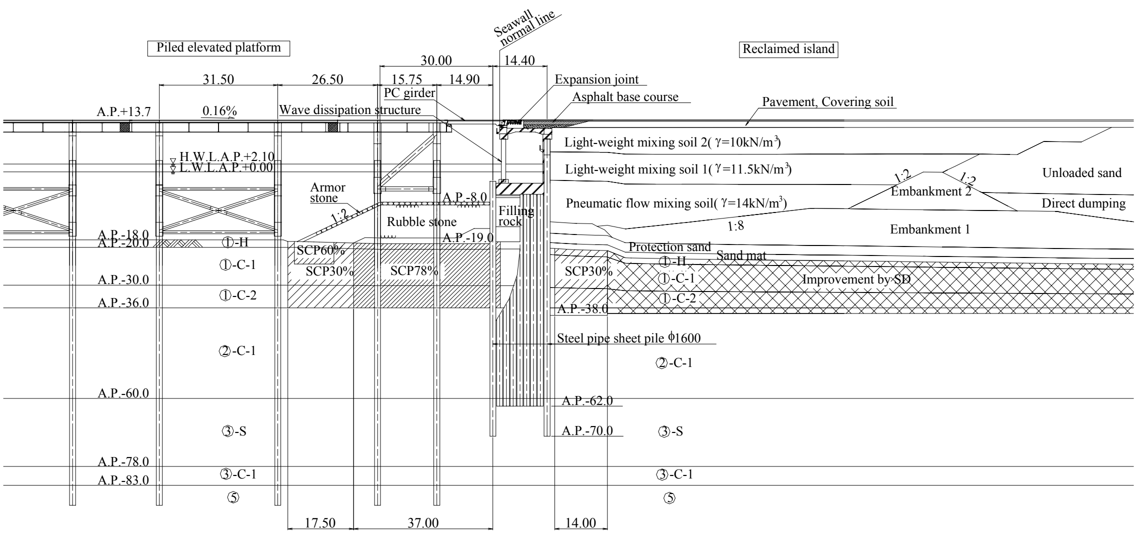

Fig.1 Cross section of steel pipe sheet-pile cellular seawall

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