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Title	Authors
Commentaries/ A Guideline of Practice for Crack Control in Mass Concrete	Ryoichi SATO, Shigeyuki SOGO, Tsutomu.KANAZU, Toshiharu KISHI, Takafumi NOGUCHI, Toshiaki MIZOBUCHI and Shingo MIYAZAWA
Technical reports/ Development of Emergency Rapid Retrofitting Method Using Fiber Sheet Containing Hydraulic Resin	Ryota KASAKURA, Masamitsu SUZUKI, Fumihiro OJIMA, Masanori ITO, Takeshi MAKI, and Yoshitaka KATO
Technical reports/ Exposure Test of Reinforcing Bars on Rust Inhibitor	Junichi KADORIKU
Technical reports/ Recent Trend of the Transverse Prestressing Technology in the Concrete Slab of Highway Bridges	Shoji IKEDA, Tsutomu KADOTANI and Kei HIRAI
Construction records/ Development of two kinds of new erection method for the rationalization of construction in urban viaducts —The Second Keihan Expressway, the viaducts of Nasu-dukuri area and Aoyama area—	Hirotsugu MIZUNO, Yoshimasa NAKAMURA, Kei MURODA and Akira MOROHASHI

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Commentaries

A Guideline of Practice for Crack Control in Mass Concrete

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Keywords: mass concrete, cracking index, cracking probability, 3D-finite element method, crack width

The guideline published from JCI in 1986 is newly revised, in which the advanced technologies in design and construction fields in the last two decades are included. The contents are as follows.

Chapter 1 General
Chapter 2 Basic principle of crack control in mass concrete
Chapter 3 Planning for crack control
Chapter 4 Verification method of thermal crack
Chapter 5 Construction and construction control
Chapter 6 Inspection

- Reference materials
- A~~n~~ computed example of thermal cracking indexes
- Verification examples of thermal crack control

The scope of a guideline is described in chap.1. It is noted in section 1.1 that the guideline should be used for verifying thermal crack caused by volume change of concrete due to hydration heat and autogenous shrinkage and can be applied to the design of concrete structures with the design compressive strength up to 60N/mm^2, and that drying shrinkage is not considered. The definition of technical words and the explanation of symbols are described in section 1.2 and 1.3, respectively.

The basic principle of crack control in mass concrete is described in chap.2. The target for crack control which includes crack prevention and crack width control and its verification indexes are explained in section 2.2, and the verification procedures in design–construction flow are also explained in section 2.3.

The prerequisite conditions in verifying thermal cracking such as the restrained conditions of the structures, the computational conditions of the FEM, the type of cracks for the verification, etc. are described in chap.3. The verification indexes, that is, the cracking indexes and those limit values are also described in section 3.1 and 3.2. The measures for thermal crack control investigated in the design and the construction processes are explained in section 3.3.

The thermal crack verification method is described in chap.4. The verification procedures using the cracking probability (see Fig.1) and the cracking index are explained and the design values of physical properties of concrete used for the FEM are suggested. The outlines of the FEM adopted in the guideline as an ordinary used method are also explained. The simplified verification method for convenience of the design work is also suggested.

The considerations in executing the planning for crack control are explained in chap.5. It is also noted that the construction and the control plans should be made up before the execution.

The basic ideas of the inspection are described in chap.6. It is noted that the inspection is executed to confirm whether the target for crack control is achieved in the completed structures.

Twelve reference materials, which support the validity of the suggested verification method, are appended.

One analyzed example of thermal cracking by the FEM and the examples of six types of mass concrete structures verified by the suggested method are also appended.

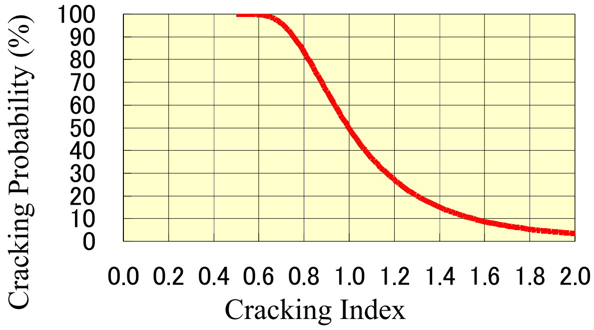

Fig. 1 Suggested Cracking Probability Curve

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Technical reports

Development of Emergency Rapid Retrofitting Method Using Fiber Sheet Containing Hydraulic Resin

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Keywords: rapid retrofitting, hydraulic resin, fiber sheet, shear failure

After disasters such as earthquakes, it is necessary to quickly repair damage in order to ensure safety and speed recovery efforts. However, conventional methods require large-scale operations and the repair effect may be delayed. Therefore, the authors propose an emergency rapid retrofitting method utilizing fiber sheets containing hydraulic resin (TST-FiSH) for the repair of reinforced concrete structures. The goals of this new method are to provide higher safety, speed, and ease of construction compared to conventional methods. The basic properties were evaluated by adhesion test, the repair effect was investigated by beam specimen, and the structural performance was confirmed by column specimen.

Specimen *A* and *B* compared the conventional epoxy method and the TST-FiSH to understand the repair effect after damage. Shear damage was given to the specimen by primary loading, and aramid fiber sheets were wrapped around the shear span. Secondary loading was conducted after 6 days curing. Loading was displacement-controlled by member angle, and member angle was increased sequentially until failure.

The failure conditions after secondary loading and the load-displacement curves of the second loading for both specimens are shown in Fig. 1, and the loads at yielding of the outer-most axial reinforcement for both specimens are shown as dashed lines in Fig. 1.

The stress capacity of specimen *A* with epoxy resin and aramid displacement occurred along the diagonal crack surface which was formed during primary loading after yielding of the axial reinforcement, and the load became less than the yield load at member angle ±8/100. Loading continued only on the plus side and after member angle 10/100 the aramid fiber sheet broke when the failure load was reached. The failure mode is believed to be flexural shear failure because load decreased suddenly at member angle ±8/100 and the failure condition was predominantly due to shear deformation (Fig. 1). Specimen *B* repaired with aramid TST-FiSH suffered greater displacement along the diagonal crack surface formed during primary loading after yielding of axial reinforcement. The load began to decrease slowly from ±4/100, until it became less than the yield load at member angle ±8/100. The failure mode appeared to be flexural shear failure, the same as specimen *A*, due to the influence of the diagonal cracks from the primary loading. Loading continued only on the plus side, and after member angle 10/100 the aramid fiber sheet broke when the failure load was reached. The repair effect of TST-FiSH for column member with shear damage was confirmed to be the same as that of the conventional method.

As a result, in comparison with conventional fiber sheet wrapping method, it was confirmed that TST-FiSH can provide the same repair effect and with only one-tenth of the construction time. This paper reports these experimental results and the applicability of emergency rapid retrofitting method TST-FiSH.

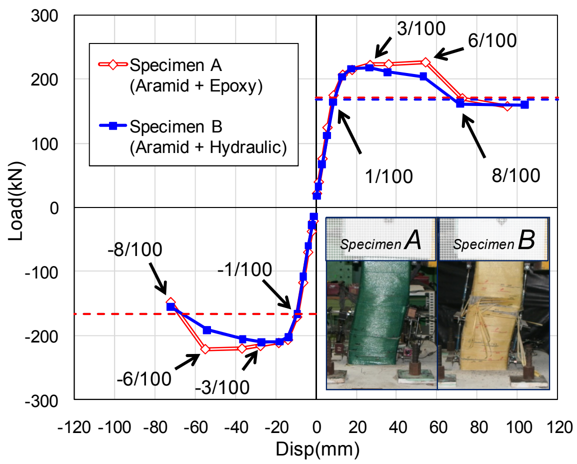

Fig. 1 Load-displacement curve and the failure conditions

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Technical reports

Exposure Test of Reinforcing Bars on Rust Inhibitor

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Keywords: reinforcing bar, rust, rust inhibitor, exposure test, bond test

In the construction of buildings sometimes the extension of a building is planned. Recently, some construction of new buildings were interrupted by the depression. In such case many reinforcing bars are exposed to the air on the way to construction, and it is possible that those bars are covered with rust. This paper describes the results of exposure test and bond test on reinforcing bars. In the exposure test I exposed reinforcing bars to the air for two years. The examination factor is the presence of rust inhibitors, the kind of rust inhibitor, the exposure place(relation to the seaside and so on), the strength and diameter of reinforcing bars. In the bond tests I used the standard bond test specimen. The examination factor is the presence of rust , the presence of rust inhibitors, and the kind of rust inhibitor.

The exposure test showed that the decrease of bar weight by rust is little and the effect of rust inhibitors are enough. The bond test showed that the bond strength of bars with rust inhibitors decreased.

table.1 specimens of exposure test

presence or kind of rust inhibitor			Diameter of bar D13	D25	D38
Basic materials	SD345[*1]			○	
	SD390[*1]			○	
	SD490[*1]			○	
Mortar inhibitor	J product	Thin[*2]	○	○	○
		thick[*2]	○	○	○
	HJ product	thin	○	○	○
		thick	○	○	○
Resin inhibitor	K product	thin	○	○	○
		thick	○	○	○
	HK product	thin	○	○	○
		thick	○	○	○
	L product	thin	○	○	○
		thick	○	○	○
	M product	thin	○	○	○
		thick	○	○	○
	N product	thin	○	○	○
		thick	○	○	○
Other inhibitor method	tube			○	
	galvanize			○	
	stainless			○	

*1:strength of reinforcing bar,SD345:345N/mm^2
*2:thickness of rust inhibitor

table.2 decrease of bar weight by rust

	SD345			SD390			SD490		
No	weight	dec[*1]	%	weight	dec	%	weight	dec	率%
1	1879.5g	3.3g	0.18	1893.9g	1.7g	0.09	1895.8g	3.6g	0.19
2	1865.7g	3.2g	0.17	1890.8g	2.0g	0.11	1893.0g	3.6g	0.19
3	1865.2g	3.9g	0.21	1892.9g	2.1g	0.11	1891.7g	3.8g	0.20
4	1864.0g	3.1g	0.17	1895.7g	1.7g	0.09	1893.4g	3.5g	0.18
5	1869.9g	2.8g	0.15	1893.8g	1.5g	0.08	1891.3	3.6g	0.19
	average		0.18	average		0.10	average		0.19

*1:dec:decrease of bar weight

photo.1 exposure test

table.3 result of bond test

factor	basic	rust	J thin	J thick
ratio	1.00	1.02	0.96	0.87
factor	HJ thin	HJ thick	K thin	K thick
ratio	0.91	0.80	0.77	0.90
factor	HK thin	HK thick	L thin	L thick
ratio	0.91	0.81	0.81	0.86
factor	M thin	M thick	N thin	N thick
ratio	0.86	0.86	0.77	0.68

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Technical reports

Recent Trend of the Transverse Prestressing Technology in the Concrete Slab of Highway Bridges

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Keywords: transverse prestressing, concrete slab, pre-grouted prestressing strand, multi-unbonded epoxy-coated strand cable, delayed-hardening epoxy resin, strand with individually epoxy-coated wires, durability

1. Introduction

Transverse prestressing has been widely recognized in the concrete slab of highway bridges to control cracks and prevent from deterioration. Figure-1 shows a cross section of a box girder and an example of placement of PC cables. A pre-grout method was developed to solve the problem of the reliability of cement grouting. But the pre-grout method has many problems that should be solved. On the other hand, an unbonded transverse prestressing method is proposed as a new method. This paper describes present problems and recent trends about the transverse prestressing method.

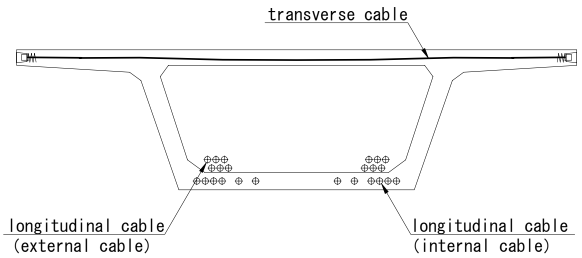

Figure-1 General cross section of box girder and example of placement of PC cables.

2. About transverse prestressing method

In general, in the transverse prestressing method post tensioning is adopted to introduce prestress. In post tensioning, PC cables are generally bonded with cement grout after prestressing. The pre-grout method is also developed recently as an alternative method. On the other hand, to solve problems of the pre-grout method, the unbonded transverse prestressing method is proposed in which each wire of the strand is coated by epoxy resin individually.

3. About unbonded PC strand

The following problems about the unbonded PC strand are described.

(1) Certainty of durability

An unbonded PC strand is covered by polyethylene sheath and filled by grease around the strand with individually epoxy coated wires. Mechanical properties and long-term durability of both the strand with individually epoxy coated wires and the unbonded PC strand have been confirmed, and a certificate for public use was acquired. Figure-2 shows an overview of the unboned strand.

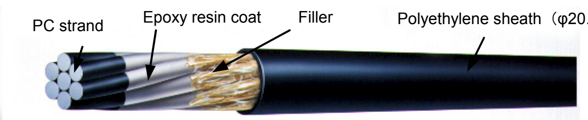

Figure-2 Unbonded strand with individually epoxy coated wires

(2)The performance during prestressing

According to the result of the friction coefficient test during prestressing for the multi-unbonded strand (3S15.2mm), the coefficient of friction is confirmed to be equal to that with the pre-grout method.

(3)Reduction of ultimate bending moment

The reduction can be avoided by decreasing the distance between PC strands or increasing the eccentric distance of the strand.

(4) Security of the performance of anchorage

It is important that anchorage performance is secured when the unbonded strand method is used. The strand with individually epoxy coated wires is highly safe for anchorage performance because wedge teeth bite metal layer directly through epoxy coat.

4. Summary

The transverse prestressing method is an extremely suitable method. However attention is necessary in the adoption of the method since each method has peculiar problems. It is important that designers understand these characteristics well and select the most suitable.

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Technical reports

Development of two kinds of new erection method for the rationalization of construction in urban viaducts

—The Second Keihan Expressway, the viaducts of Nasu-dukuri area and Aoyama area—

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Keywords: urban viaducts, rapid construction, environmental protection, precast segmental erection method, PC composite slab structure

The Second Keihan Expressway in Japan, linking Kyoto and Osaka is now under construction to bypass the existing road in order to ease the heavy traffic for the local residents. In the bridge construction of the expressway, rapid construction, environmental protection and improvement of safety as well as cost saving were required. To meet such requirement, unique segmental constructions which suit for the respective site condition were developed newly in the prestressed concrete viaducts of Nasu-dukuri area and Aoyama area.

In Nasu-dukuri area, since relatively wide area was available at the construction site, full-span-length U-shaped concrete girder was pre-casted at the site, unlike the conventional method of combining multi-divided precast segments, and the girder was lifted directory between piers with a lifting erection girder. The erection is called “U-girder lifting erection method” (Photo.1, 2).

On the other hand in Aoyama area, it was difficult to have wide casting area near the site or free space below the viaduct due to the site condition. Therefore, after the first starting span was constructed, the deck surface on the first span was used as an assembling area of precast segments. Segments were lifted and connected by prestressing, moved toward the newly erecting span, and then hung with an erection girder and positioned. The erection method is called “span by span erection with rear assembly system” (Photo.3, 4).

Through development of two erection methods which suit the respective site conditions, reducing the construction work substantially as well as cost saving was achieved compared with the conventional construction.

Photo.1 Transportation of the U-girder

Photo.3 Transportation of the girder

Photo.2 Erection of the U-girder

Photo.4 Erection of the girder

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