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Technical reports

Development of Large-scale Precast Concrete Skew Box Culvert with Looped Joint Connection

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Keywords: Looped joint connection, Skew, Half precast construction method, Box culvert, segment

Usually, many of the large box culverts with over 5m width are skewed, and in-situ concrete is used from a viewpoint of economic efficiency. However, precast concrete products can shorten a period of construction work and keep uniform quality.

In this study, an economical precast concrete box culvert which could be applied for skew structures. The schematic drawing of this box culvert which has 75 degree skew is shown in Fig. 1. Upper slab and side wall were segmented and both were connected by looped joint connection on the corner. The upper slab is prestressed reinforced concrete (PRC) in order to decrease its deflection. In this system, skew angle can be changed from 60 degree to 90 degree.

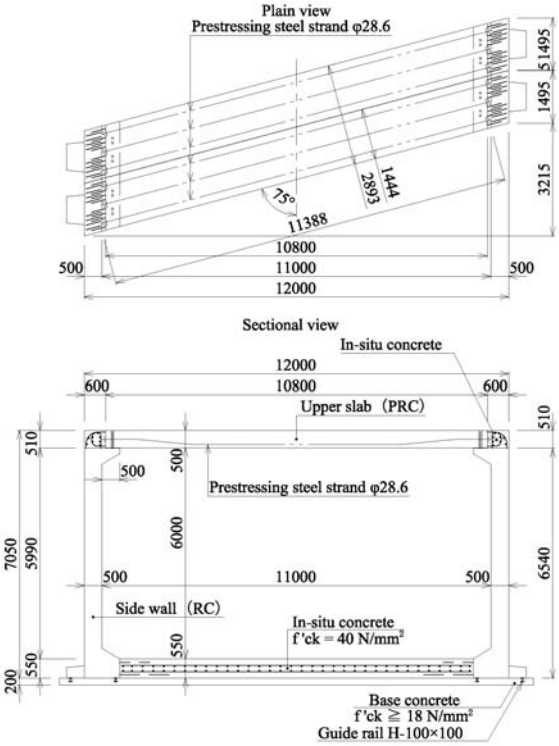

Fig.1 Schematic drawing of developed skew box culvert

First of all, the element experiment on looped joint connection system (Fig.2) was conducted. As the results, the relationship between load and displacement of the specimen was almost same as that of the specimen without joints. In addition, decrease of ultimate load did not observed for the specimen which had 75 degree skew.

After that, the full-scale specimen was assembled, and then construction performance and structural performance were investigated. The developed box culvert could be assembled safely. A guide rail could shorten the time until horizontality and perpendicularity of side walls were adjust.

Based on the experimental results, the skew box culvert with looped joint connections had equivalent structural performance to an ordinary box culvert using in-situ concrete. The looped joint connection system on the corner was effective.

Also, it was found that the method considering the rigid frame on elastic foundation was preferable to the calculate stress resultant of large-scale box culvert. When this method was used, the calculated displacement and strain had good agreement with the experimental results.

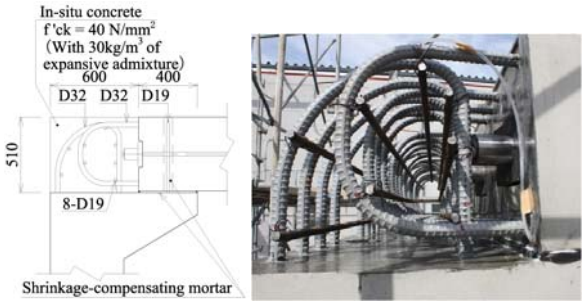

Fig.2 Looped joint connection system

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Technical reports

Water-supplying concrete cure system

—Practical use and effect of water-supplying concrete cure system after formwork removal—

Yukinori FURUKAWA[*1], Kazuto FUKUDOME[*2] and Akira SHONO[*3]

Keywords: curing, water-supplying cure, practical use, removal formwork removal, durability, air permeability

1. Introduction

In construction of concrete structures curing is one of the extremely important processes for achieving required concrete performance. Cement is required to hydrate enough so that concrete can provide required performance such as strength, durability, etc. That is, after concrete placement, concrete shall be cured by maintaining moist condition and appropriate temperature for a necessary period. At this time, it is important to supply water from the outside concrete. However, curing with water supplying for the vertical surface of concrete after formwork removal is very difficult.

From the above-mentioned point of view, authors developed the water-supplying concrete cure system that enables the water supply curing for vertical surface of concrete after formwork removal.

This report shows the outline of the water-supplying concrete cure system, and introduces the effect of this system on concrete performance and the examples of practical application.

2. Outline of the water-supplying cure system

The water-supplying concrete cure system is shown in Fig.1. This system is composed of curing seat, suck entrances, a suck machine, water pump, and water supply tube. The principle of this system is shown as follows.

Sucked air between concrete and the seat by suck machine, the air becomes negative pressure from the ambient atmospheric pressure. It is possible to make closely attached to surface of concrete according to the difference of air pressure. In addition, it becomes possible to form the water film on surface of concrete by supplying water from the upper part of the space between the curing seat and concrete. The supplyed water is sucked with air by the suck equipment, circulated to be recycled again.

Moreover, the heat insulating effect can be expected by using the bubble buffer seat.

3. Effect of the water-supplying cure system

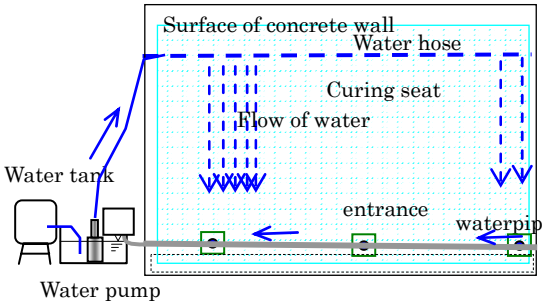

Fig.1 Water-supplying cure system

In order to understand the effect of water-supplying concrete cure system for performance of concrete, surface air permeability test by the double chamber method was conducted. The test result is shown in Fig.2. The air permeability coefficients of concrete that cured by water-supplying cure system are smaller than that of concrete cured in the mold for 5days.

Therefore, it has been understood that the water-supplying concrete cure system is effective to improve concrete performance.

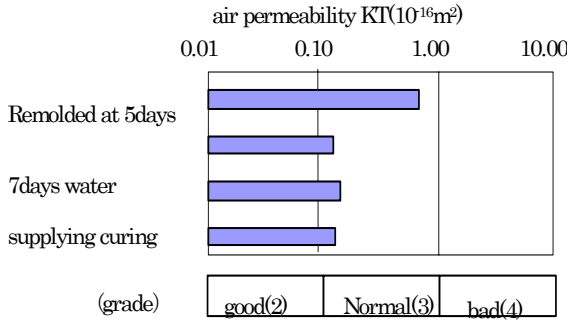

Fig.2 Results of air permeability test

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Construction records

Renewal Construction of RC Slab in Section of Daily Traffic with 100,000 Vehicles

—Mukaizano Bridge in the Kyushu Expressway—

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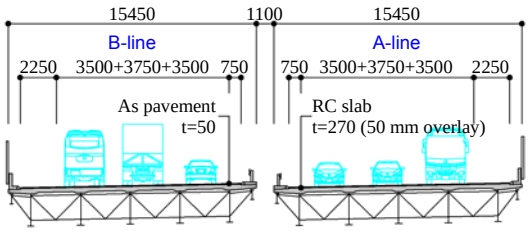
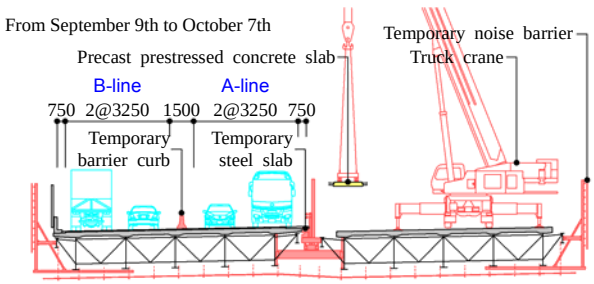
Keywords: steel plate girder bridge, slab replacement, precast prestressed concrete slab, lap splice joint with mechanical anchor, ground granulated blast furnace slag

Mukaizano Bridge, which was opened in 1975, is located in section of daily traffic with 100,000 vehicles in the Kyushu Expressway. Since about 10 years after opened, degradation spread in the RC slab on the steel plate girder bridge, due to the low-quality of concrete, heavy traffic volume, etc. Although the slab underwent several repairs including concrete overlay, degradation became significant. Therefore, renewal construction has been carried out to replace the entire RC slab as a comprehensive measure.

In this project, RC slab was replaced with precast prestressed concrete slab (see Fig.1). In Japan, loop splice joint is getting more popular as a joint of precast concrete slab. But, to reduce the traffic control period and suit the site condition, a new joint system (lap splice joint with mechanical anchor, see Fig.2 and Fig.3) of precast concrete slab has been adopted in this project.



(a) Before renewal



(b) Under replacement of A-line

Fig.1 Outline of slab replacement

In addition, to reduce the ingress of chloride ions and the quantity of CO_2 emissions, concrete in which 50% of the cement was replaced with ground granulated blast furnace slag was used (see Fig.4).

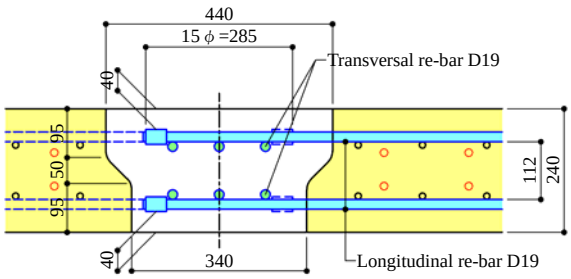


Fig.2 Lap splice joint with mechanical anchor

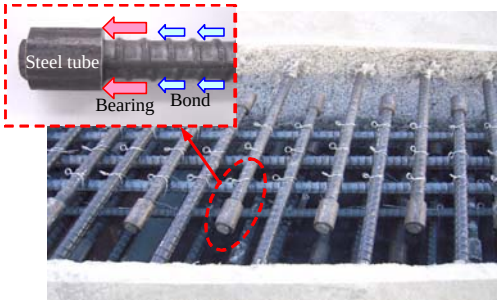


Fig.3 Lap splice joint with mechanical anchor

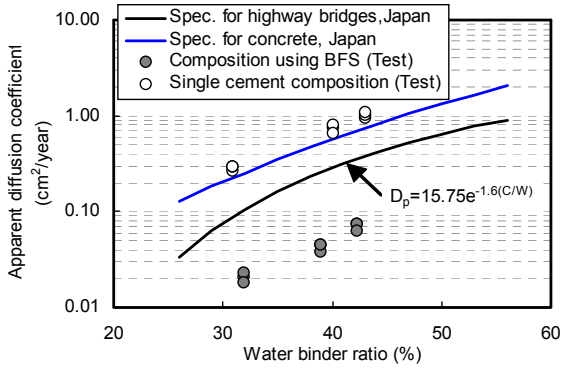


Fig.4 Apparent diffusion of BFS composition

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Construction records

Construction of a Large Scale Base-isolated Building using In-situ Concrete Plant

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Keywords: base-isolated building, in-situ concrete plant, low shrinkage concrete

This building consists of 5 individual building constructed on the 330m long and 180m wide base –isolated artificial ground. Initial deformation of base isolation rubber and cracks on large slab of the artificial ground due to drying shrinkage pose problems on the construction of base-isolated artificial ground. Target value of the deformation of the rubber by drying shrinkage of the concrete slab was set to be 40mm. To satisfy the target deformation, drying shrinkage of concrete was set to be less than 250 times 10^{-6}.

To reduce the deformation of the base isolation rubber and shrinkage of concrete slab, construction joints were settled and concrete was casted 2 and a half months later at the joints, as shown in Fig. 1.

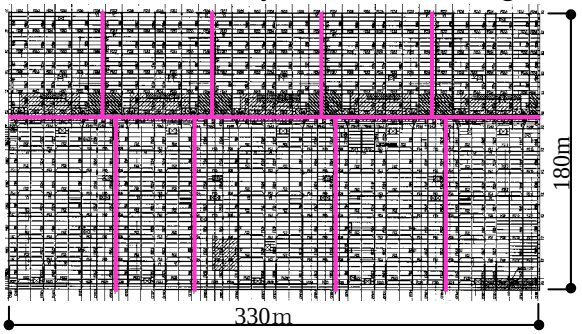

Fig.1 Construction joints on artificial ground

Materials used for concrete are shown in Table 1. Equipments of in-situ concrete plant is shown in Fig. 2. Fine aggregate was mixture of 2 two types of sand, as the ratio of mass of crushed sand and hill sand was 4 to 6. Crushed lime stone was used for coarse aggregate to reduce drying shrinkage of concrete. Both shrinkage reducer and expansive admixture were used to reduce drying shrinkage.

Test results on deformation of concrete of the artificial ground at actual construction are shown in Fig. 3. Shrinkage at 365 days after casting was 159 times 10^{-6}, which satisfied the target value as 250 times 10^{-6}.

Cracks on the artificial ground slab appeared on the traffic way at the age of 1 year after polishing surface of the slab, where concrete pumps and concrete agitator trucks passed through frequently. Most of the width of cracks was less than 0.2mm.

Table1 Materials used for concrete

Material	Properties
Cement	Ordinary portland cement, density 3.16g/cm^3
Fine agg.	S1:crushed sand, oven-dry density 2.61g/cm^3 (Hachioji) S2:hill sand, density 2.56g/cm^3 (Futtsu)
Coarse agg.	G1:Crushed lime stone, oven-dry density 2.69g/cm^3, Adsorption 0.24% (Torigata)
Water	Tap water
Admixture	High-range water reducer, AE agent
Admixture	Expansive Admixture 25kg/m^3, Shrinkage reducer 6kg/m^3

Fig.2 Equipment of in-situ concrete plant

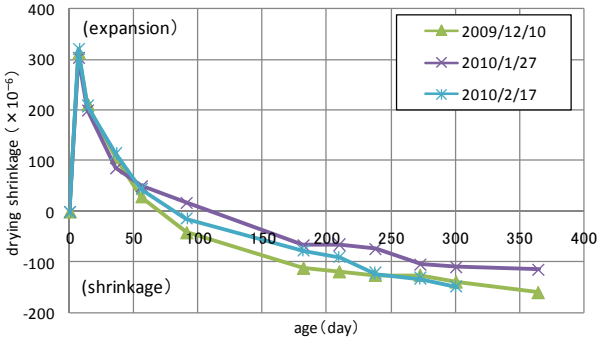

Fig.3 Deformation of concrete slab of artificial ground

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