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Commentaries

Seismic retrofit technique of existing reinforced concrete column with sidewall using polymer-cement mortar and prefabricated reinforcing unit

Shigeru Tago*[1], Tomoaki Sugiyama*[2], Takayuki Ido*[1], and Yasuhiro Matsuzaki*[2]

Keywords: Seismic retrofit, RC Column with sidewall, polymer-cement mortar, shear, prefabricated reinforcing unit, capacity and ductility

Authors proposed a seismic retrofitting technique for existing RC columns with cast-in-place RC sidewall using polymer-cement mortar (PCM). In the technique, additional shear reinforcement (hoops of column and/or horizontal shear reinforcements of sidewall; prefabricated reinforcing unit) is adhered to the surfaces of existing RC column with RC sidewall by applying PCM. The strengthened area (additional reinforcement and PCM) and existing member are strongly joined by the high adhesive strength of the PCM. (Fig.1, Fig.3)

This seismic retrofitting technique improved the shear capacity and ductility of the RC column with sidewall. The additional shear reinforcement on the sidewall (horizontal reinforcement bar) improved the shear strength of the RC column with RC sidewall, and the additional shear reinforcement on the column (hoop) improved the ductility of the RC column with RC sidewall (Fig.2). In the design, the strengthened area and the amount of shear reinforcement are determined in order to control the structural performance (capacity and/or ductility) of the strengthened RC column with RC sidewall.

The design/construction guideline of this technique obtained the technology assessment of the Japan Building Disaster Prevention Association. The present paper introduces the effect of this seismic technique and the outline of the guideline.

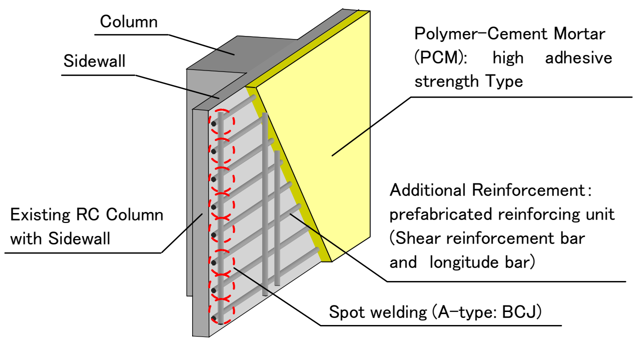

Fig.1 Outline of Seismic retrofitting technique

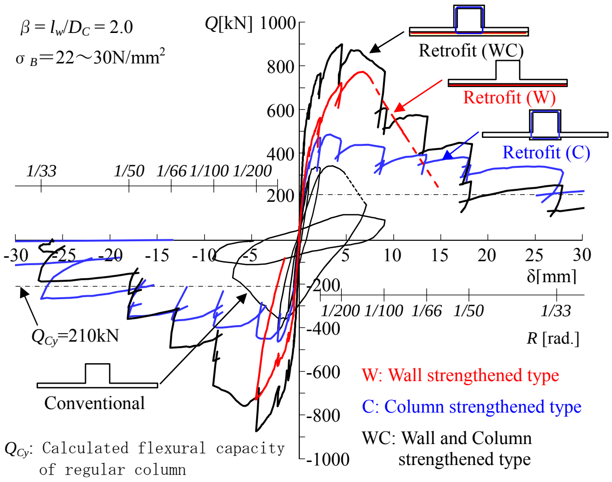

Fig.2 Typical effects of retrofitting technique

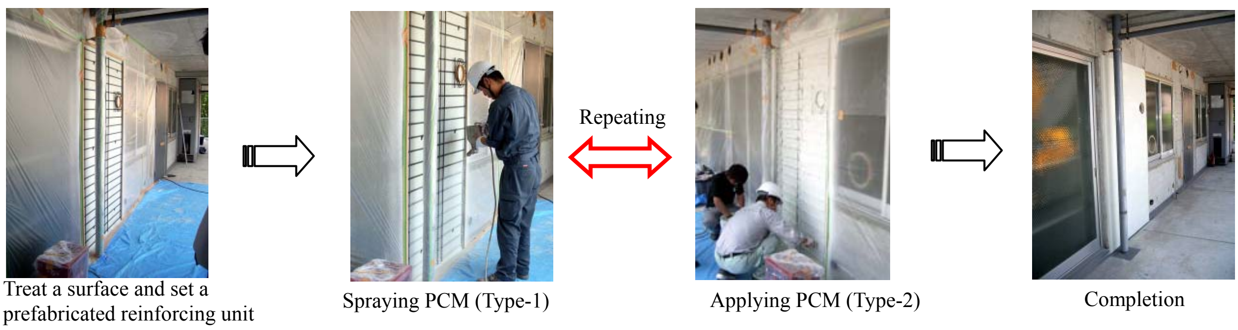

Fig. 3 Example of construction

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Commentaries

Revision of Japanese Industrial Standard (JIS)A 6207 "Silica fume for use in concrete"

Hiroyasu NARUSE[*1], Shigeyoshi NAGATAKI[*2], Hideaki GOMI[*3] and Hiroshi JINNAI[*4]

Keywords: JIS A 6207, silica fume, loss on ignition, activity index testing method, x-ray fluorescence analysis, trace elements

Japanese Industrial Standard (JIS) A 6207 "Silica fume for use in concrete" was revised in May 2011. The major revisions are as follows. 1) The loss on ignition of dry silica fume shall be less than 4.0%. 2) W/B for the test of activity index shall be 30%. In Japan, silica fume is primarily used for ultra-high-strength concrete. Therefore, W/B for the test of activity index set in W/B which is near to the general mixture proportion of ultra-high-strength concrete. In addition, the findings of silica fume quality (including content of trace elements and water-soluble trace elements) in Japan and abroad, the findings of overseas standards, and study results of chemical analysis by x-ray fluorescence are listed.

Table.1 Mixture proportion of mortar for revised activity index test

Unit:g

JIS	Mortar	Cement	Silica fume	Fine sggregate	Water and Chemical admixture
Revised	Base mortar	964±2	0	1350±5	289±1
	Using SF	868±1.8	96±0.2		

Table.2 Mixture proportion of concrete

Content of Silica fume	W/B (%)	Water (kg/m^3)	Absolute volume (coarse aggregate) (m^3/m^3)	Slump flow (cm)	Air content (%)
OP:SF=9:1[a] (weight)	20	155	0.33	65.0±10.0	2.0±1.0

[a] OP : ordinary portland cement, SF : silica fume

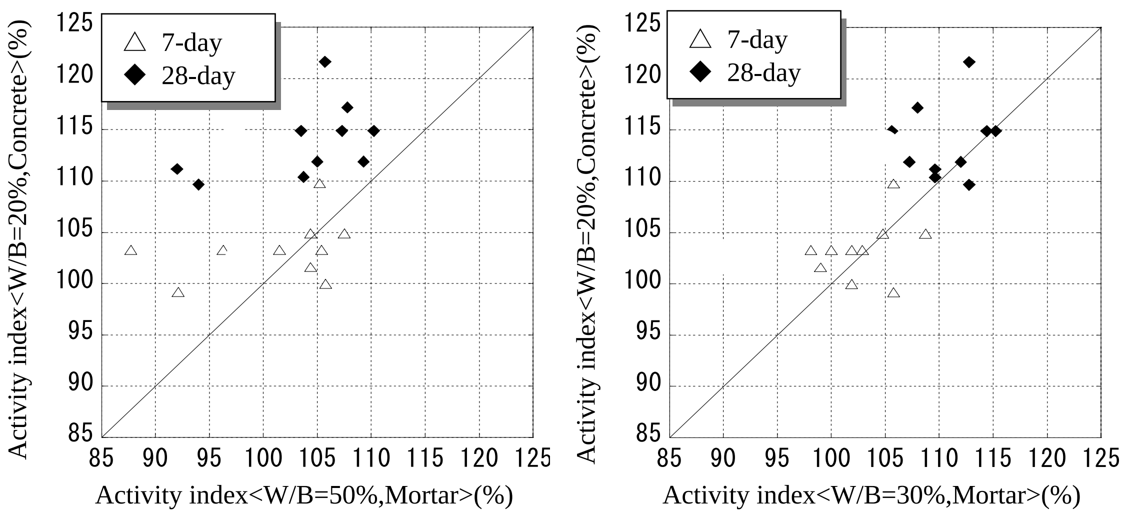

Fig.1 Relations of activity index of mortal and concrete

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Technical reports

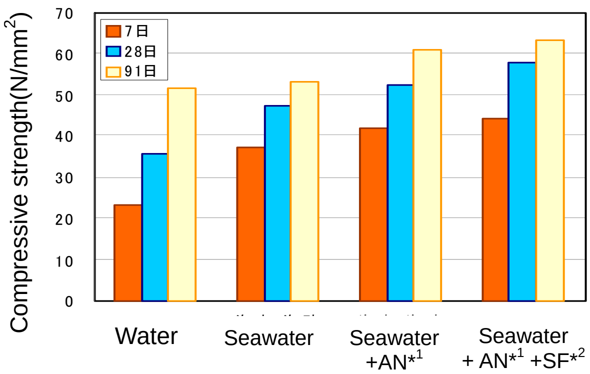
Development of Concrete Made with Seawater and Un-washed Sea Sand

Nobufumi TAKEDA [*1], Yoshikazu ISHIZEKI [*2], Shigeru AOKI [*3] and Keishiro IRIYA [*4]

Keywords: seawater, un-washed sea sand, chloride ion, ground granulated blast furnace slag, fly ash, water-tightness, CO_2 emission

We developed high-density and hard concrete using seawater and unwashed sea sand .The internal organizations of that concrete was denser compared with normal concrete, and it was clear that the water-tightness, early strength, and long-term strength of seawater and unwashed sea sand concrete were increased. Reinforced concrete structures that used a non-corrosive reinforcing bar were durable in the long term. The construction of concrete with sea water and unwashed sea sand could be used on remote islands or on the coast to reduce CO_2 emission and construction costs. This paper describes the properties of concrete with sea water and unwashed sea sand and the examination about application to the concrete structures.

Figure 1 shows the compressive strength of the concrete. The compressive strength of concrete, in which special admixture and silica-fume are mixed with seawater and unwashed sea sand, increases approximately 40% in 28 days age.



＊1：Special admixture
＊2：Pozzolan (Silica fume)

Fig.1 Compressive Strength of Concrete

SEM image of mortar with seawater and unwashed sea sand is shown in Photo1. It is thought that the strength increased by a generation of ettringite which has needle-shaped hydrate and filled in the void. The conditions of reinforcing rod after autoclave acceleration curing (33 cycles) are shown in Photo 2. Carbon rod and epoxy resin coated rebar into the concrete with seawater and un-washed sea sand did not corrode or deteriorate after autoclave curing.

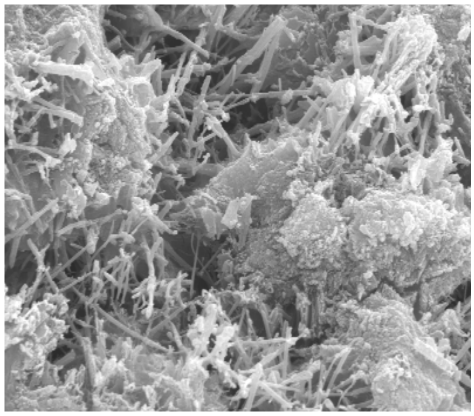
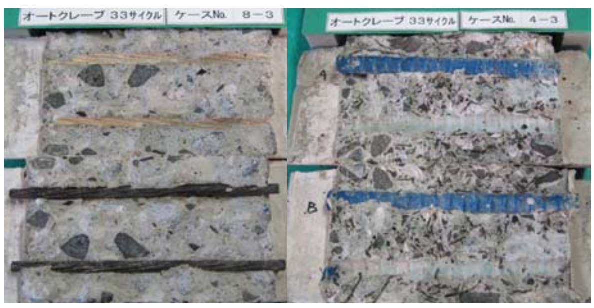


Photo 1 SEM image of Mortar



Carbon rod　　Epoxy Resin Coated Rebar

Photo 2 Reinforcing rod after Autoclave Curing

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Technical reports

Load Capacity Evaluation of Reinforced Concrete Girder Damaged due to Combined Effect

—An Example of Clinical Study Utilizing Decommissioned Bridge—

Taku HANAI[*1], Yoshitomi KIMURA[*2] and Michihiro NAKAJIMA[*3]

Keywords: clinical study, decommissioned bridge, load capacity evaluation, chloride induced deterioration

One of the pillars of research activities of Center for Advanced Engineering Structural Assessment and Research (CAESAR) is a "clinical study." The research utilizing decommissioned bridges is a component of the clinical study. The research consists of examinations of corrosion level of steel inside of concrete, evaluations of remaining strength of deteriorated members, verifications of newly developed non-destructive testing methods, and so forth. In this paper, as an example of this clinical study, the load capacity evaluation of deteriorated reinforced concrete girders is presented.

Osa Bridge was a reinforced concrete bridge located about 90 m from the coast line of Japan Sea. The bridge suffered chloride induced deterioration. It was repaired multiple times, such as coating to prevent chloride intrusion and steel plate reinforcement. After the 45 years of service, the bridge was finally demolished since the redeteriorations were repeated. Evidence of ASR was also found in this bridge. Just before the demolition, cracks reaching 10 mm wide, corrosion on steel plates, and separation of coating were found (Photo 1).

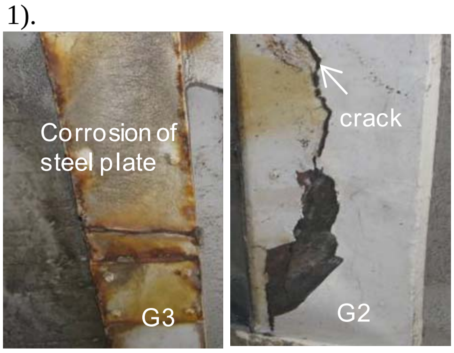

Photo 1 Deterioration on Underside of Girder

In its five girders, G2 and G3, which are without and with steel plate reinforcement respectively, were sampled and loading tests were conducted. Before the loading tests, coating was removed to examine the damage. As past repairs, several types of materials for replacement of deteriorated concrete were found. Also, many cracks and cover concrete separation were found on the girder surface (Fig. 1).

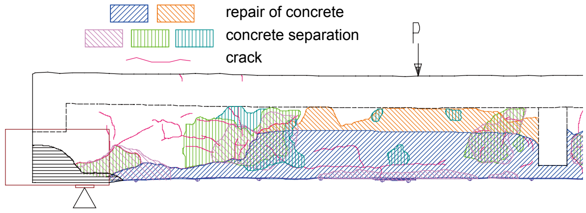

Fig. 1 External Condition of Girder after Removal of Coating

The loading test results are compared with analysis (Fig. 2). In this analysis, cross-sectional area loss of rebars is considered. Since the analysis result considering steel plate gives 24% higher value compared with test result for G3, the steel plate is considered not to contribute to the ultimate strength.

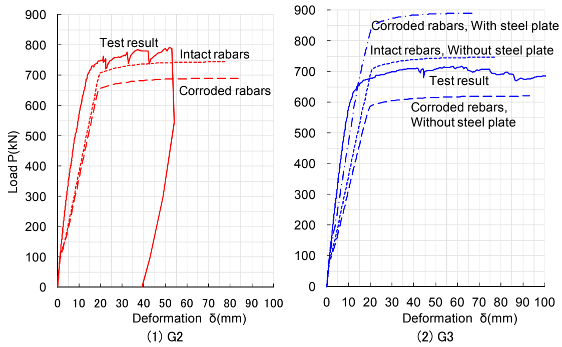

Fig. 2 Test Results and Analysis

Although the bridge has complex repair history and unclear factors, the analysis estimates the strength within 15% if area loss of rebars is taken into account.

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Technical reports

The influence of fine particle contents in crushed limestone coarse aggregate on the properties of high-strength concrete

Kensuke HAYASHI*1, Katsuhiko TADA*2, Kazuo YAMADA*3 and Hirotaka KAWANO*4

Keywords: Limestone aggregate, Fine particle contents, High-strength concrete, Fresh properties, Hardened properties

In March 2009, JIS A 5005 "Crushed stone and manufactured sand for concrete", was revised and the regulation of fine particle content in coarse aggregate was changed from 1.0 mass% to a maximum of 5.0 mass%. This revision aims at effectively utilizing fine particle, produced in the manufacturing and transportation process of aggregate, within limits that do not negatively influence the quality of general-strength concrete. In this study however, the evaluation test of concrete was done to clarify the influence to the quality of high-strength concrete by increasing the fine particle content in limestone aggregate from 1.0 mass% to 5.0 mass%. Moreover, examination of series I and II, shown below, was set up in consideration of various factors.

Series I: varieties of limestone coarse aggregate sources, fine aggregate types, and cement types.

Series II: water to cement ratio

During the evaluation test of the quality of concrete, air content and fluidity (slump or slump flow) tests were carried out as fresh properties, and the compressive strength and the elastic modulus were carried out as hardened properties.

From the resultant data, the increase of fine particle content in limestone coarse aggregates decreases the fluidity of fresh concrete to some degree. The decrease in fluidity, however, can be compensated by an increase in dosage of superplasticizers to realistic range such as 10 % (Fig.1). Regarding other properties such as air content, compressive strength, and the elastic modulus, no significant changes were detected (Fig.2). Thus, the effect of the increase in fine particle content can be assumed to be negligible within the range of this study. It can therefore be concluded that it is possible to use limestone aggregate as before, after a simple confirmation examination of typical concrete properties even when the fine particle contents increases.

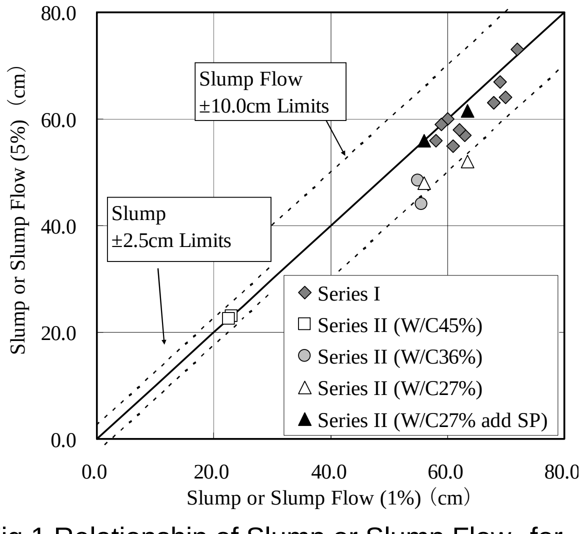

Fig.1 Relationship of Slump or Slump Flow for the cases of 1 & 5% of fine particle contents

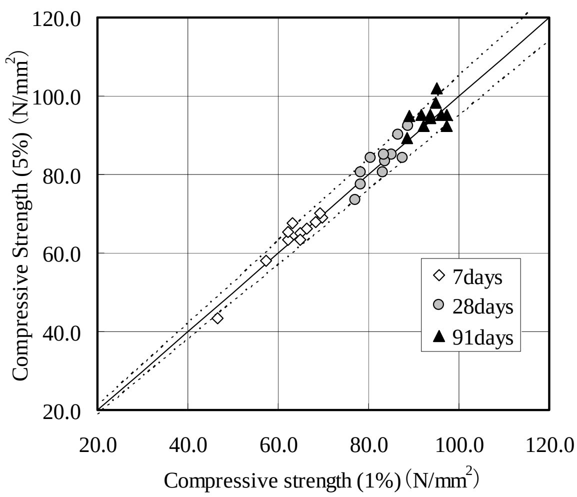

Fig.2 Relationship of Compressive Strength for the cases of 1 & 5% of fine particle contents

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Construction records

Design and Construction of Shield Tunnel and Concrete Slabs

—Central Circular Shinagawa Route, Metropolitan Expressway —

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Keywords: EPB, Long distance tunnel, Large diameter tunnel, Concrete road slabs

Metropolitan Expressway, Central Circular Shinagawa Route, located on the south of the Central Circular which is the most inside route of the three circular routes under construction in capital region, is under construction in Tokyo, Japan. Shinagawa Route is composed of twin two-lanes expressway tunnels which are planned to connect between Bay Shore Route at Ohi and No.3 Shibuya Route at Ohashi, and is a final tunnel driving of the Central Circular Expressway to close the loop.

Main works are excavation of large shield tunnel of 8km in length and 12.3m in diameter, Gotanda turnoff of tunnel / retaining walls / embankment, four ventilation shaft, Ohashi Junction of tunnel / viaduct that connects to No.3 Route, Ohi Junction of embankment / retaining walls / viaduct that connects to Bay Shore Route, tunnel interior and fire prevention facilities.

Shinagawa Route shield tunnel mainly passes through the hard layer whose N-value is more than 50. An earth pressure balance type Tunnel Boring Machine (EPB) with an outer diameter 12.55 meter is used for the rapid tunnel excavation. The tunnel area is approximately 120 square meters, and the total excavation volume is approximately 1 million cubic meters. The planned excavation progress is approximately 350 meter per month. To put up with the long excavation, the cutter bit of the machine can be replaced.

Road tunnels need fire endurance just in case of accidents. As the lining segments of Shinagawa Route include polypropylene, segments have fire endurance and the secondary lining is omitted.

For rapid excavation, the maximum width of the segment is 2m which is the widest in Japan, and the joint of segments is new invented one-path joint, which can be connected speedy. Segmented Linings as tunnel primary linings and other tunnel materials are lowered down using 55 ton class material lift installed at Ohi lunching shaft. To secure the quality of the assembling of the primary tunnel lining, a newly developed air vacuum holding system is mounted on the segment erector of the EPB. The EPB has 100 sets of 150 tons hydraulic jacks and the total thrusting force is 155,000 kN.

The road slabs are constructed concurrently along with the shield tunnel driving. Averaged monthly progress is 300 meters. The road slab is composite structure which is composed of a bottom steel plate (t=8mm), steel rib plates (t=10mm), reinforcement bars (D19) and early strength concrete (35kN/mm2). The cross sectional span of the slab is approximately 8 meter and the longitudinal length of each panel is 2.25 meters. The RC side walls which support the concrete road slabs are constructed using two sets of electrically mortared sliding form with the length of 15 meters each.

Central Circular Shinagawa Route

The north bound tunnel excavation is currently 80% completed. The concrete slabs works are 60% completed. This paper introduces the details of design and construction of the EPB Shield tunneling and concrete road slabs.

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Construction records

Construction of Earth Retaining Wall of Composite Structure for Road Tunnel

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Keywords: cut and cover tunnel, earth retaining wall of composit structure, concrete, crack, waterproofing

Currently, a ring road is under construction to relieve the chronic traffic congestion in the centre of Osaka. The Yodo-River Left-Bank Line (Total length: 10km) is located in the north side of the ring road, and the section in the charge of Kajima JV (Tunnel length: 357m) is a part of the Line. (See Fig.1)

This tunnel is constructed using open cut method. In this project, earth retaining wall (Soil Mixing Wall: SMW for short) is used not only as a temporary wall but as a permanent tunnel side wall which consists of concrete wall and core material of the SMW (H-beam). (See Fig.2)

However, there is a possibility of deterioration in quality of the concrete wall, such as lack of filling and cracks, because the thickness of the concrete wall is so thin (t=0.45m, If not composite structure, concrete wall thickness is approximately 1.4m.). Therefore, in order to satisfy required quality, we adopted some contrivance of improvement to the following three items.

1. Concrete material
2. The method of concrete construction
3. Waterproofing method

In this paper, we introduce the details of improvement.

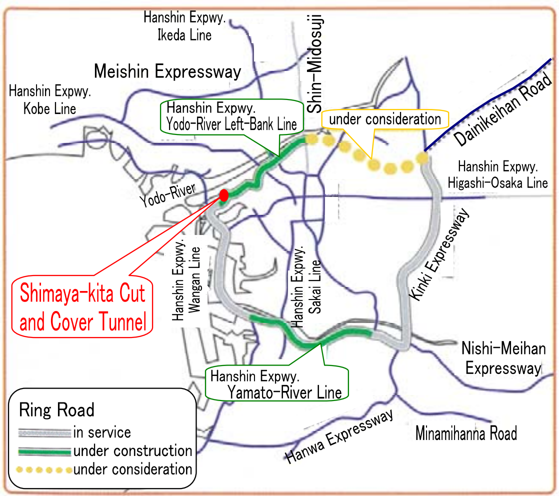

Fig.1 Ring Road Plan

PROJECT OUTLINE	
Project Name	Shimaya-kita Cut and Cover Tunnel Construction Project
Construction Period	December 28, 2006 – March 31, 2012
Owner	Hanshin Expressway Company Limited.
Contractor	Kajima-Zenitaka-Toa Joint Venture
Standard of Road	4 Lane, Design speed: 60km/hr
Tunnel Structure	2-Span Box Culvert Average width of tunnel: about 26.0m Average height of inner space: about 6.5m
Tunnel length	357m

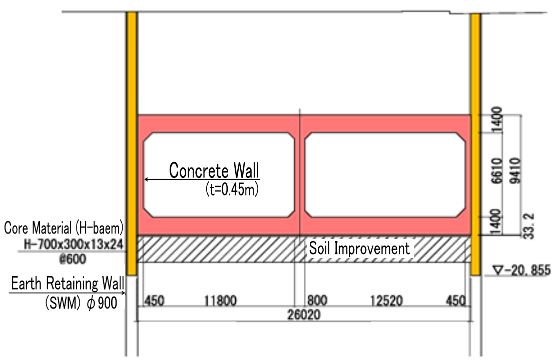

Fig.2 Cross Section

Fig.3 Completed Tunnel

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