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Commentaries

Promotion of Fly Ash Concrete in Sustainable Society

Koichi MAEKAWA[*1]

Keywords: fly ash, mix design, workability, performance-based design, construction, manual

The resistance of fly ash concrete against chloride ion penetration, carbonation, alkali- aggregate reaction and cracking is presented, and the evaluation method for workability is proposed by the sub- committee of fly ash concrete in JSCE. Based upon this knowledge, a new mix design recommendation is made by explicitly taking into account fly ash additives as hardening binder and fine powders, and the procedure of design and construction planning is summarized.

Fly ash is not treated as the part of clinker-based cement or the part of aggregates. The proposed manual specifies fly ash as an independently defined constituent component of concrete mixture. The performance based design scheme is selected as the platform on which the strength of hardened fly ash concrete, workability before hardening and its durability related quality can be quantitatively assessed. The committee proposes the general water to cement-fly ash ratio model for engineering practice with the effectiveness factor which represents the contribution of fly ash on the strength development as shown in Figure 1.

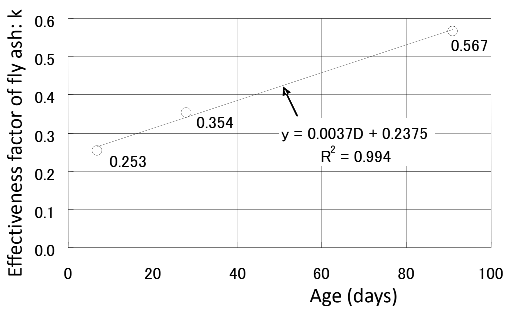

Fig.1 Effective ratio of fly ash on strength

We have the similar story on the workability assessment. Figure 2 shows three boundaries of workability limit states; overall consistency, segregation resistant limit state and excessive viscosity limit. These limit states has been specified for workability design method of conventional concrete. The committee verified the applicability to the fly ash concrete, and it was found that dosage of

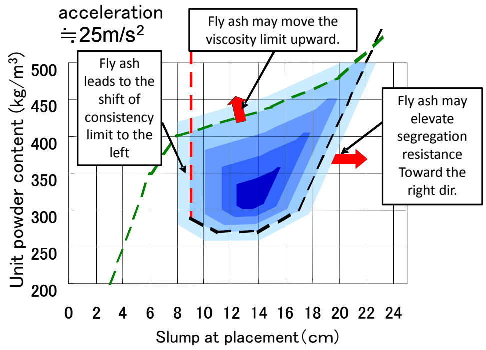

Fig.2 Limit-state boundary of workability

fly ash in mixture may fairly shift all limit states boundaries according to the particle shape and grading. In this framework, unit weight of powder materials is assigned as a governing factor. Thus, the effectiveness of both clinker-based cement and fly ash can be taken into account together and the quality of micro-particle features can be explicitly reflected on the practical design, which may realize more efficient use of fly ash.

The effectiveness of fly ash on the chloride ion penetration is quantitatively evaluated in the proposed design by comparison with the normal cement concrete as shown in Figure 3. Replacement of cement with fly ash brings about higher resistance and durability. The manual presents the way to assess the durability performance of fly ash concrete on alkaline aggregate reaction, crack resistance and carbonation quantitatively.

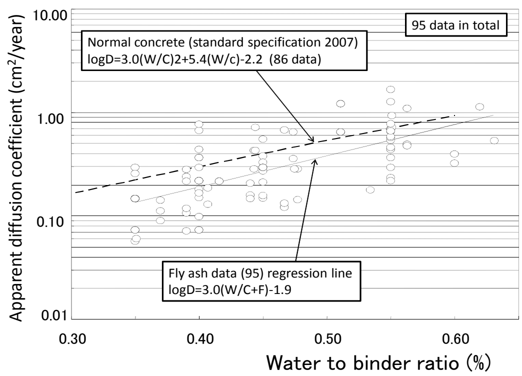

Fig.3 Apparent chloride diffusion coefficient

*1 Professor, Dept. of Civil Engineering, The University of Tokyo, Dr. Eng., JCI member

(email : maekawa@concrete.t.u-tokyo.ac.jp)

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Technical reports

Countermeasures for Pier Mass Concrete under Construction of Uratakao Bridge

Ken KAWAI[*1], Takashi SHINODA[*2], Kumiko SUDA[*3] and Yoshimitsu WATANABE[*4]

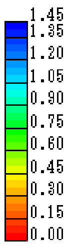
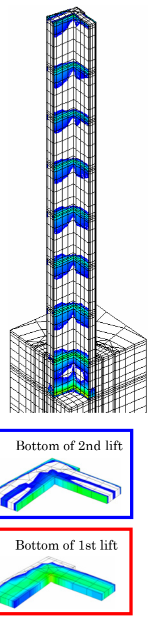
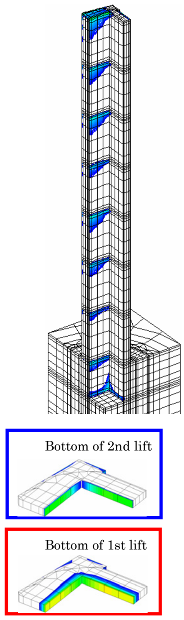
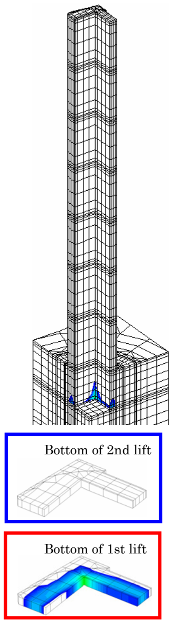
Keywords: mass concrete, low heat and resist shrinkage blast-furnace cement, thermal stress analysis , concrete age of quality control material

As a countermeasure for pier mass concrete under construction of Uratakao Bridge, we study on the effect of concrete age for quality control, and on the effect of cement variation, by thermal stress analysis method.
As a result, low heat and resist shrinkage blast-furnace cement was advantageous on the point of cracking control, cost performance, and carbon-dioxide emission.

This cement is new material, and it had never been used for bridge construction work in Tama area of Tokyo. Therefore, we confirmed quality of the cements, and originally set the standard for quality control, considering that the cement show higher performance than the JIS standard one.

Photo.1 Construction of Uratakao Bridge

Table 1 Result of thermal stress analysis

Type of cement	Ordinary portland cement	Low heat portland cement	Low heat and resist shrinkage blast furnace cement
Minimum crack index  (In a white part, the crack index is 1.45 or more)			

*1 Hachiouji Construction Office, Tokyo branch, Central Nippon Expressway Company Limited
*2 Hachiouji Construction Office, Tokyo branch, Central Nippon Expressway Company Limited
*3 Tokyo Civil Engineering Branch, Kajima Corporation, JCI member
*4 Tokyo Civil Engineering Branch, Kajima Corporation

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Construction records

Underwater Construction Works for Seismic Strengthening of Bridge Piers using Steel Plate Wrapping Method with Interlocking Joint

—Construction Works for Strengthening Piers of Ryogoku Bridge—

Akihito TSURUGA[*1], Yutaka TANIMURA[*2], Ken-ichi OZAWA[*3] and Masafumi KUBO[*4]

Keywords: seismic strengthening, steel plate wrapping method, interlocking joint, underwater construction, anti-washout underwater mortar

1. Introduction

Ryogoku Bride is located in Nihonbashi, Chuo ward of Tokyo. It was constructed in 1932 as a part of the recovery works after the Great Kanto Earthquake and is currently an important bridge in transportation network of Tokyo.

The strengthening works were carried out on two bridge piers during the low-water season and the strengthened parts are almost underwater. The so-called "steel plate wrapping method with interlocking joint" was adopted with the intention of minimizing the impact on river traffic and shortening the construction duration.

2. Using steel plate wrapping method with interlocking joint

"Steel plate wrapping method" is a seismic strengthening method in which the existing structural members are wrapped with steel plates.

"Interlocking joint" is a mechanical method to firmly joint two steel plates without the need of in-situ welding, by using a special tooth-shape structure at the end of jointed plates. In this method, the tooth-shape halves of interlocking joint are welded to the end of fabricated steel plates. At the site, these plates will be mechanically jointed by interlocking joint.

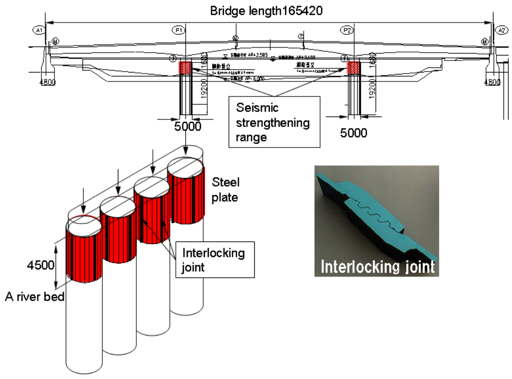

Fig.1　Seismic strengthening outlines

3. Seismic strengthening structure

The verification of seismic resistivity indicated that due to insufficient amount of hoop ties, piers of Ryogoku Bridge need to be strengthened to upgrade their shear resistance.

Strengthened part of each pier column was 4.5m in length, from the river bed to the bottom of the transverse beam. After wrapping pier columns with 6mm steel plates, mortar is filled into the gap between steel plate and the pier.

4. Construction method

The steel plate for strengthening was divided into 4 parts, taking into account the difficulty of underwater assembling work. At the joint between these parts, the interlocking ends were attached in advance.

The steel plates were fabricated at the factory and coated with an anti-corrosion layer before transported to the site for underwater construction. The mortar for filling the gap was anti-washout underwater mortar.

The base mortar was mixed at the plant and transported to the site and anti-washout admixture was added into the agitator. Table-1 shows the mix proportion used in strengthening work

Tab.1Mix proportion of underwater anti-wash-out mortar (Unit: kg/m^3)

W/C (%)	W	C	S	SP1 (C×%)	SP2 (C×%)	SP3
45.0	300	667	1,220	6.67 (1.00)	14.0 (2.10)	1.3

SP1 : Air entraining water reducing agent
SP3 : Underwater anti-segregation admixture
SP2 : High-rank air-entraining water-reducing admixture

*1 Ministry of Land, Infrastructure, Transport & Tourism, Tokyo National Highway Office, Construction Supervisor
*2 Ministry of Land, Infrastructure, Transport & Tourism, Tokyo National Highway Office, Maintenance leader.
*3 Shimizu Corporation, Tokyo Civil Engineering Division, Project Manager,
*4 Shimizu Corporation, Civil Engineering Technology Division, Concrete group, Manager,
(email : kubo.m@shimz.co.jp)

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Construction records

Construction of Tunnel Lining using Middle Fluidity Concrete
—Hokkaido Transversal Expressway, KURUKI Tunnel—

Shoji NAKAMA[*1], Yoshihiro TANIFUJI[*2], Shunsuke MORI[*3] and Kuniaki SAKURAI[*4]

Keywords: tunnel, lining, middle fluidity concrete, form vibrator, labor saving, quality improvement

1. Introduction

Compaction work in a narrow space is necessary to place the lining concrete in a tunnel construction, therefore, the trouble, such as “un-filling” and “the back cave”, might be caused. The industrial method using the middle fluidity concrete (Photo 1) which fluidity is higher than the ordinal concrete and the form vibrators installed on a movable form were applied in Kuruki Tunnel of Hokkaido Transversal Expressway to improve the work efficiency and the concrete quality.

2. Outline of construction technique

40 form vibrators in total (550W of output for one) were set on the surface of movable form to obtain the vibration energy (about 3.7J/L) that is necessary for concrete to be filled in the entire movable form. Four pressure gauges were fixed on the side and the three other gauges were fixed in the crown part to measure the concrete pressure and also to confirm the concrete filling in the crown part.

After placing $4m^3$ of concrete, the corresponding form vibrators were turned on for totally 30 seconds (15 seconds in twice). While placing side part, the pressure values were measured by the pressure gauges and concrete placing speed was managed within 1.2m/h.

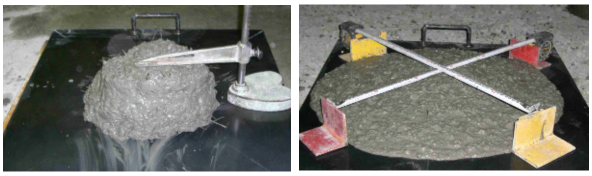
It is difficult to fill concrete into the crown part with ordinary lining concrete. However, middle fluidity concrete was confirmed to be filled securely into the crown part through the measurements of the pressure gauges.

3. Surface situation and quality of lining concrete

When ordinary lining concrete is used, the striped pattern is caused around the crown part. However, when the middle fluidity concrete is used, the striped pattern is hardly observed (photo 2). It was observed that the surface situation of concrete can be improved by using middle fluidity concrete. In addition, it was confirmed that the lining of middle fluidity concrete has a steady quality, from the result of gas permeability of concrete measured by the Torrent method.

4. Summary

The industrial method using the middle fluidity concrete and form vibrator is the construction technology in which the quality does not depend on worker's skill level, and a high-quality tunnel lining stably can be constructed. We hope a lot of lining work will be used to improve the quality of tunnel lining concrete.



Ordinal concrete (Slump 15±2.5cm) | Middle fluidity concrete (Slump flow 35-50cm)

Photo 1 Slump-flow of Middle fluidity concrete

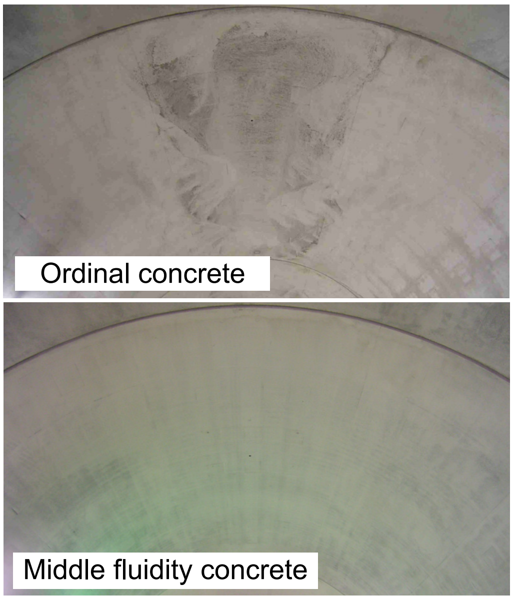


Photo 2 Surface of tunnel lining using ordinal and Middle fluidity concrete

*1 Manager, Oyubari Tunnel west-sector construction office, Obayashi Corporation, JCI Member
*2 Deputy Manager, Hokkaido Regional Head Office, East Nippon Expressway Company Limited
*3 Engineer, Hokkaido Regional Head Office, East Nippon Expressway Company Limited
*4 Chief, Civil Engineering Technology Division, Obayashi Corporation, JCI Member

（email：sakurai.kuniaki@obayashi.co.jp）