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Commentaries

Test Methods for Reliable Construction
—Summary of Committee Report : JCI-TC074A—

Toshiki AYANO [*1], Kimitaka UJI [*2], Masaro KOJIMA [*3] and Tsuyoshi MARUYA [*4]

Keywords: certainty of execution, concrete in the structure, filling capability, quality of cover concrete, quality test method

The performance of concrete in a built structure may not always meet the performance requirements established at the design stage. The limit state design method is assumed to consider possible differences by material factors. In actual construction, however, efforts are made to minimize the difference between the strength of specimens and the in-situ strength by careful execution in accordance with various guidelines at each stage of transportation, placement, consolidation, finishing, curing, and form/shoring removal. In view of the current design technology and the state of execution, it is vital to develop assessment test methods to accurately confirm the achievement of the established specifications at each stage of execution along with the development of techniques to determine detailed material factors. At the stage of form removal, for instance, it is important that the attainment of an in-situ compressive strength of 5 N/mm^2 can be accurately confirmed by an appropriate test method. For this reason, the Committee aims to investigate the current state of quality assessment test methods required for each stage of execution, as well as to elucidate the test methods to evaluate the property of concrete and their adequate timing to be applied in each execution stages, so as to ensure the execution of concrete having the performance intended in the design.

The Committee conducted execution tests, assuming the cases with or without adequate execution carried out based on concrete quality assessment test results. The committee activities also included tests on column and wall members to investigate the effects of execution methods on the qualities of concrete in the structure. Even if two concretes have the same slump, their placing performances widely differ depending on viscosities. If executed by different methods, the differences in their qualities after hardening will become wider. It is hoped that, in the near future, test methods to grasp their effects will be established and a system to reflect the test results to actual execution will be formulated, so as to assure the certainty of execution in the performance-oriented design and construction of structures.

The Committee also conducted a questionnaire survey on test methods to confirm whether the various specifications established before execution are actually ensured, particularly regarding those originally developed in respective companies and those practiced based on experience. In regard to fresh concrete, many respondents answered that they employ their own test methods for quality assessment at the stages of trial mixing and proportioning. These include new test methods to grasp the difference in the workability when vibration is applied. This is presumably because, with the recent high degree of freedom in proportioning and material selection, engineers are exploring test methods, other than slump testing, that allow them to distinguish between mixtures showing the same slump but having different fresh properties, within the range of ensuring segregation resistance. In these test methods, however, judgment is currently made qualitatively by comparison between different mixture proportions. It is hoped that evaluation will be made in regard to the relativity with the ease of actual placing and consolidation.

There has been a remarkable progress in the development of new materials in Japan as well as worldwide as represented by self-compacting concrete and high strength concrete. Concrete technology has been developed by mutual influences of the material, deign, and execution sectors. However, a number of problems remain unsolved in the rationalization and labor-saving of construction technology. The Committee has conducted research into test methods, particularly those necessary for secure execution. One of the goals of this research is to make execution intelligent in the near future.

*1 Prof., Graduate School of Okayama University, Dr.E., JCI Member
*2 Prof., Tokyo Metropolitan University, Dr.E., JCI Member
*3 Takenaka Corporation, JCI Member
*4 Taisei Corporation, JCI Member

（email：toshiki@cc.okayama-u.ac.jp）

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Technical reports

The Development of Precast Prestressed Concrete I-shaped Beam with Multiple Openings

Shin-ichiro KAWAMOTO[*1], Masato IIJIMA[*2], Shin-ichi TAKEZAKI[*3] and Shigeaki BABA[*4]

Keywords: precast prestressed concrete beams, high strength reinforced bars, I-shaped beam, openings, ultra rapid strength ultra high strength concrete

The utilization of high strength reinforcement bars as prestressing steel instead of normal tendons has already been put to practical use in Precast Prestressed Concrete Beams (PCa PC Beam) with pre-tensioning method. Large amount of prestress transfer by SD685 reinforcement with large diameter and the adoption of high-strength concrete from 80 N/mm^2 to 100 N/mm^2 (Fc80~100) enable the reduction of the elements' section.

This time, PCa PC I-shaped beam with multiple openings (T-POP : Taisei Precast Optimized beam with Prestress) has been developed. The feature of this method is that the longer span can be achieved because the weight of the beam can be lightened compared with usual PC beam.

A lot of equipment openings can be as freely arranged as in the case of steel beam. And the vertical vibration due to walking on the floor is smaller than that of the steel beams, which means the better habitability. Moreover the amount of the CO_2 exhaust in producing the beam can be reduced than the steel beam. As a result, this method can be applied to hospitals and factories, etc. besides offices. The concrete in this development achieves the quite fast gain of the strength, more than 100N/mm^2 (Specified concrete strength: Fc 130 N/mm^2) within 16 hours. Therefore, the term of the beam manufacturing in the precast factories can be shortened and the stable supply of these beams to large projects has been achieved.

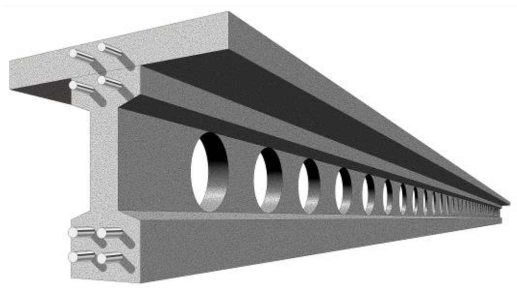

Fig.1 Outline of T-POP (section)

Photo.1 Actual size of PCaPC beam

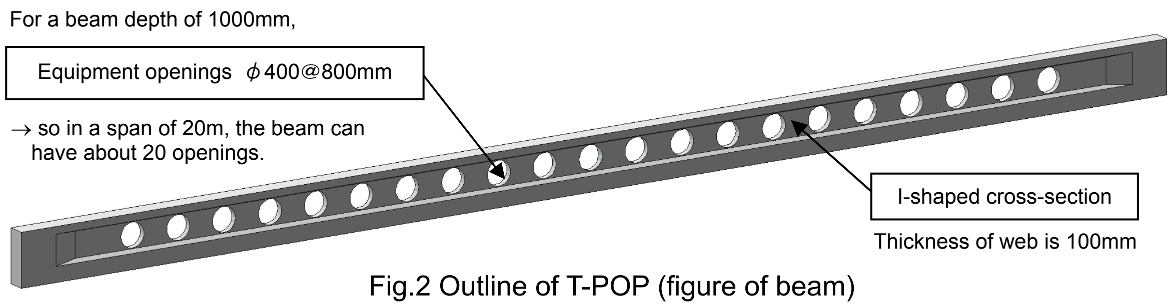

Fig.2 Outline of T-POP (figure of beam)

*1 Structural Engineering Group, Design Division, Taisei Corporation, JCI Member
*2 Technology Promotion Department, Building Construction Division, Taisei Corporation, JCI Member
*3 Building System and Material Research Section, Technology Center, Taisei Corporation, JCI Member
*4 Disaster Prevention Research Section, Technology Center, Taisei Corporation, JCI Member

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Construction records

Construction Works for a High-Rise Base-isolation R/C Building with Numerous Random Openings in Outer Structural Walls

Tetsushi KANDA[*1], Takemi YASUMI[*2], Haruki MOMOSE[*1], and Yasunori SUZUKI[*3]

Keywords: drying shrinkage, cracking, expansive agents, low heat Portland cement

Photo 1 Appearance of a constructed building

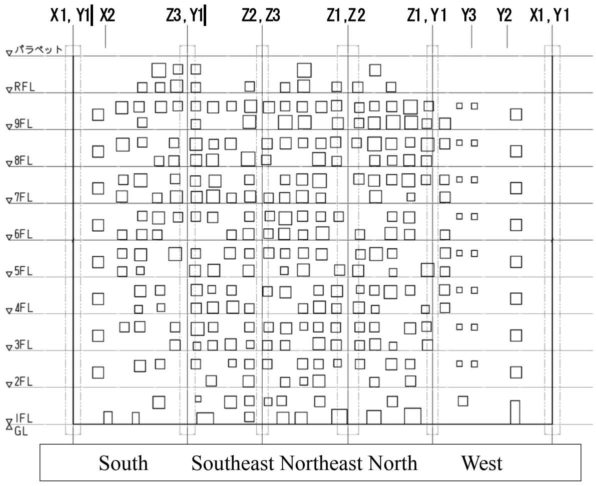

Fig. 1 Numerous random openings in outer walls

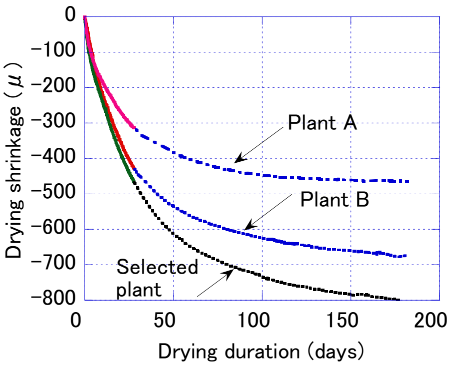

Fig. 2 Drying shrinkage in base concrete

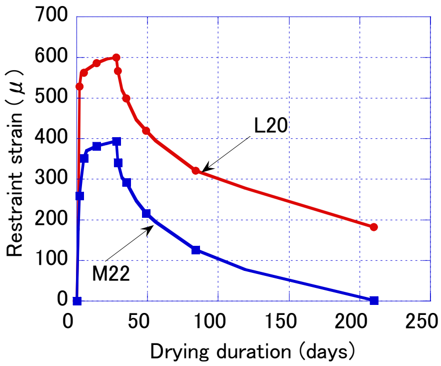

Fig. 3 Restraint shrinkage of non-shrinkage concrete

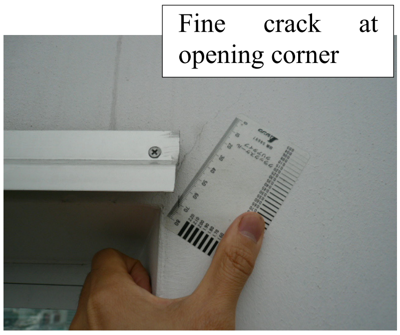

Photo 2 Very fine cracking at a corner of opening

A highly architectural high-rise R/C building were constructed (Photo 1). The most unique feature in this building is random numerous openings in outer structural walls (Fig. 1). A serious concern is cracking at corners of openings.

To account this concern, non-shrinkage concrete was realized in this construction project with two steps. First, ready-mixed concrete is selected to have lowest drying shrinkage (Fig. 2). Second, low heat or medium heat Portland cements were adopted in conjunction with expansive agents. These two options realized non-shrinkage concrete as shown in Fig. 3.

As a result, a few cracks were observed in this building in two years after completion, which were very fine illustrated in Fig. 3. We concluded that adopting non-shrinkage concrete in this project is successful.

*1 Kajima Tech. Res. Inst., JCI member
*2 Tokyo Building Branch, Kajima Corporation
*3 Sumitomo-Osaka Cement Corporation, JCI member

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Construction records

Design and Construction of The Asahina River Bridge Down-line

—7-span Continuous strutted Corrugated steel Web PC Box Girder Bridge—

Jiro IWATATE[*1], Kazuhiko HOSOHATA[*2], Katumi YUKI[*2] and Shinichi TAKABAYASHI[*2]

Keywords: New Tomei Expressway, corrugated steel web, struts

The New Tomei Expressway is being constructed by Central Nippon Expressway Company Limited for completion in 2012 as a traffic artery that can drastically eliminate the congestion of the present Tomei Expressway and recover rapid transportability and punctuality, the intended functions of the Expressway, and enhance traffic safety in the event of emergencies, such as earthquake, disaster or construction work, to serve as a substitute for the present Tomei Expressway. The New Tomei Expressway, coupled with completion of the New Meishin Expressway, will further reinforce the connectability of the three major urban areas to contribute to the economic development of Japan.

The Asahina River Bridge is located between the shizuoka interchange and the Fujieda Okabe interchange of New tomei Expressway.

Structural type of The Asahina River Bridge is PC 7-span continuous corrugated steel web box girder bridge with struts. The Bridge have the total length of about 670m , the effective width of 16.5m(for three lanes) and the maximum span of 150m.The span is maximum grade with this Structural type.

The construction method is cantilever erection method. Due to the structural characteristic of this bridge, i.e. rigid-frame of long prestressed concrete span, creep and election steps deeply influence on the seismic behavior at the bottom of the pier. Therefore, careful investigation of election steps had been carried out.

From the results of 3D-FEM analysis, reinforcement bars had been arranged at the portion suffering from local stress that caused in the construction steps.

Fig.1 Finished photograph

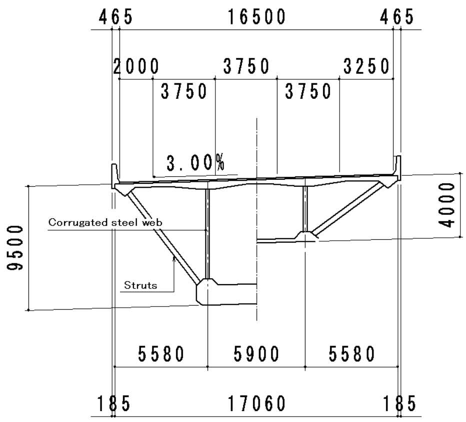

Fig.2 Standard section view

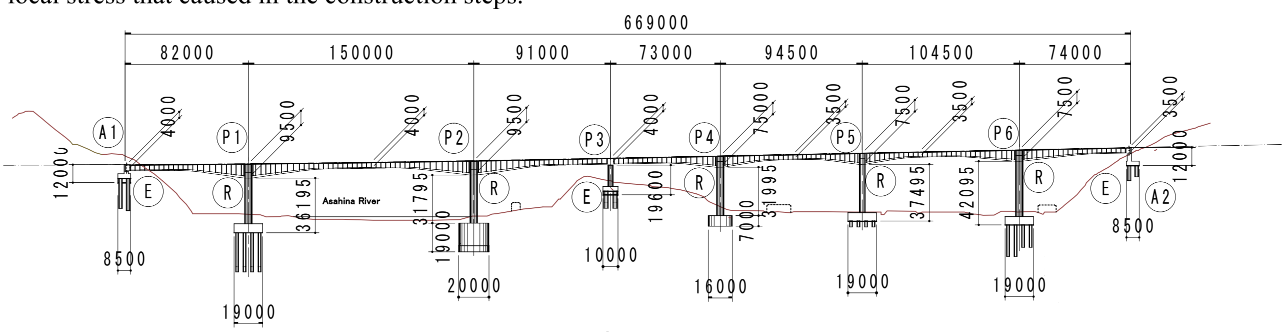

Fig.3 Side view

*1 Project Manager, Shiauoka Construction Office, Central Nippon Expressway Company Limited

*2 Joint venture composed of KAWADA Construction Industry Ltd., and Kyokuto Kowa Corporation Ltd.