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Technical reports

Unity Design Method for Sections from P C to R C using Interaction Diagram between Bending Moment and Pre-stressing Force

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Keywords: unity design method, flexural design of section, pre-stressed concrete, reinforced concrete, diagram of bending moment versus pre-stressing force

This report describes investigations on unity design method and its visual and numerical expression for sections from pre-stressed concrete members (PC) to reinforced concrete members (RC) using moment versus compression force diagrams.

Main results obtained are as follows.

(1) Fig.1. illustrates design processes and stress distribution transitions for sections from Full PC (FPC) having no tensile stress in the section to Partially PC (PPC) with allowable concrete tensile stress(σ ct). On moment(M) versus pre-stressing force(P) plane, bending moment acting the section increases slantwise with pre-stressing force according to the black line and stress distribution changes as shown in Fig.1. Since M-P relations of FPC and PPC are expressed by the red line and the blue line respectively. Since moment (M_{des}) applied to the PC beams is represented by a black line parallel to horizontal axis, following equations are obtained to calculate P for FPC and PPC beams.

$$P=\frac{M_{des}}{k_1-e} \tag{1}$$

$$P=\frac{M_{des}+\sigma_{ct}\cdot Z_2}{k_1-e} \tag{2}$$

Hence, e (=e_1+ e_2); eccentricity of;P, e_1 ;distance from centroid of rectangular section, e_2; distance between centroids of T and rec. sections, k_1; core radius of section, Z_2; geometrical moment of inertia

(2) Fig.2 shows design processes of pre-stressed reinforced concrete (PRC) members in addition to FPC and PPC. In Fig.2, M-P relations for PRC beam sections having ordinary reinforcement ratios (pt) which are obtained by approximating M-axial load (N) relations of RC columns in the range of tensile force in reinforcement by straight line are exhibited. When M_{des} is the same, according to Fig.2, decreases in P cause transition from FPC to PPC with concrete tensile stresses. More decreases in P produce flexural cracks and require tensile reinforcement for M_{des}. Necessary tensile reinforcement ratio are given by pt at the intersection points of the black line parallel to Pe-P relation (M_{des}. line) and M-P interaction relations for sections with pt and σ t(tensile stress of reinforcement) expressed by green lines.

Above explanations derive following equations. Eq.(3) is to calculate P under given pt, and Eq.(4) is to estimate pt under given P.

$$P=\frac{1}{\left(\frac{D}{2.54}-e_1\right)}\cdot\left(M_{des}-\frac{D}{2.54}\cdot 2\cdot pt\cdot b\cdot D\cdot\sigma_t\right) \tag{3}$$

$$pt=\frac{1}{2\cdot b\cdot D\cdot\sigma_t}\cdot\left[\frac{2.54}{D}\cdot\left\{\left(M_{des}+P\cdot e_1\right)-\frac{D}{2.54}\cdot P\right\}\right] \tag{4}$$

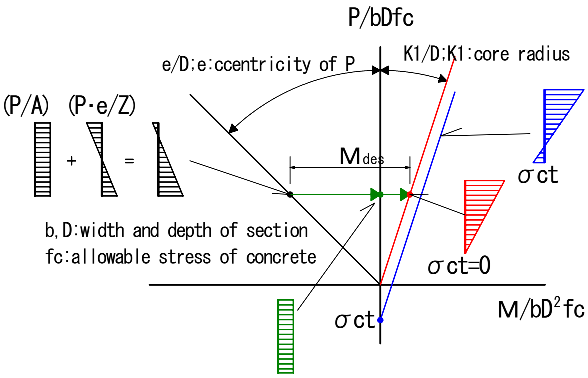

Fig.1 Illustration on design processes and stress distribution transition for PC, PPC

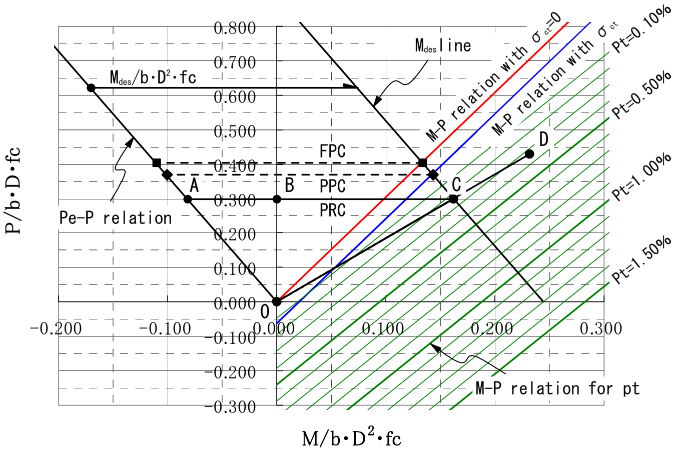

Fig.2 Schema on unity design method from PC to RC beam sections

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Construction records

The Method and Planning of Hi-speed Construction Technology for a Huge and High-rise Apartment Building

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Keywords: high rise RC housings, Pre-cast-concrete, system construction method

This building is a large scale RC-housing complex where a vast site of about 18,273.74 ㎡ in the area has 1,089 households by 33 stories. As for the shape, the long side direction is 105.8m, and the short side direction is 48.2m, and the multistory parking of the steel frame building is arranged in the Boyd part in the center shape. The column and the beam touched the outside, were arranged, and adopted column-beam connection joint integration pre-cast concrete industrial method "SumitomoMitsui Quick RC Integration-system" in the part. Pre-cast members were multiuse to other structural sub assemblages and making to the high quality and the labor saving aimed at. And the DOC industrial method that was an original technology SumitomoMitsui Construction was adopted and one floor was constructed in three days.

The feature in the "SumitomoMitsui-Quick-RC-Integration-system" isn't to generate the poured concrete in the joint part of the material as Fig-2. And, the workability is high and effective for shape that the column and the beam bound to the outside. And, making uniformly and the upgrade of the quality can be attempted by producing all of the column and the beam at the pre-cast factory. Moreover, the construction of the high-strength concrete on the site can avoid.

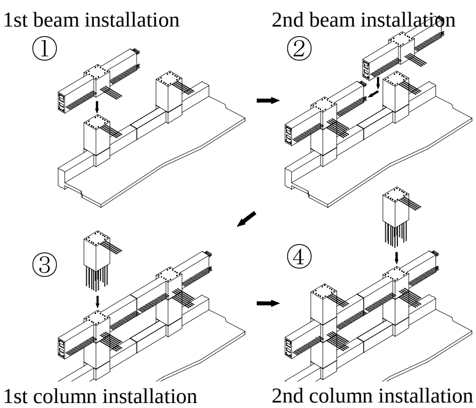

Fig.2 SumitomoMitsui Quick Rc Integration system

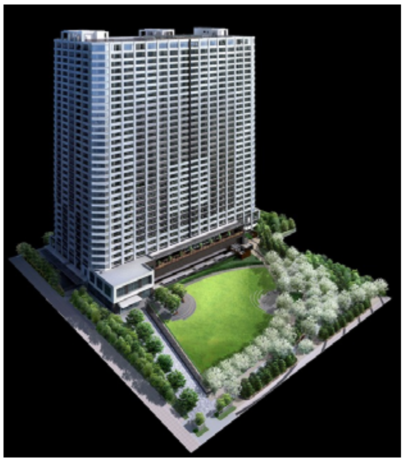

Fig.1 Completion drawing

The DOC industrial method is abbreviation of "one Day-One-Cycle". It's an industrial method of our original developed aiming at efficiency improvement and a short term of the term of works in the site mainly, and the housing complex is mainly developed. It's system construction to which is skeleton worker thing is advanced like the assembly line operation of the factory production because the building is divided in the industrial sector, and each occupational category repeats the same work every day. So it's an industrial method that it's becomes easy to secure and to upgrade the quality.

The vehicle management used our original distribution system "Foreman.Net" that was able to share construction information by the Internet promptly. Materials are carried with vehicles of about 100 on a day only in upper structure frame construction. This system was developed, and newly for the purpose of the carrying vehicle to the destination smoothly, and to decrease efficiency improvement and to reduce a communication error.

The scheme of execution of the upper structure frame construction that uses the above-mentioned technology and executions are described in this report.

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Construction records

The structural design and construction of the Sanagawa Bridge on New Tomei Expressway

—Prestressed concrete box girder rigid bridge constructed using the strong bar and concrete—

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Keywords: high strength concrete and re-bars, prestressed concrete box girder, high pier, concrete bucket, design-built bidding system

The Sanagawa Bridge was evaluated for cost-effectiveness and technological advancement including design suitability and construction methods through the design- build bidding system.

On the design stage, numerical models of the bridge were developed to estimate the seismic resistance of the bridge. On the construction stage, the concrete buckets are being used to cast strong concrete.

This paper describes the innovative design concept called "Super RC structure" which is focus of piers using the strong bar and concrete as well as the entire bridge structure and construction method.

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Fig.1 during construction

Ordinary RC structere	Super RC structere
concrete : f'ck＝30N/mm²	concrete : f'ck＝50N/mm²
re-bars : SD345	re-bars : USD685
stirrup : SD345	stirrup : SD490

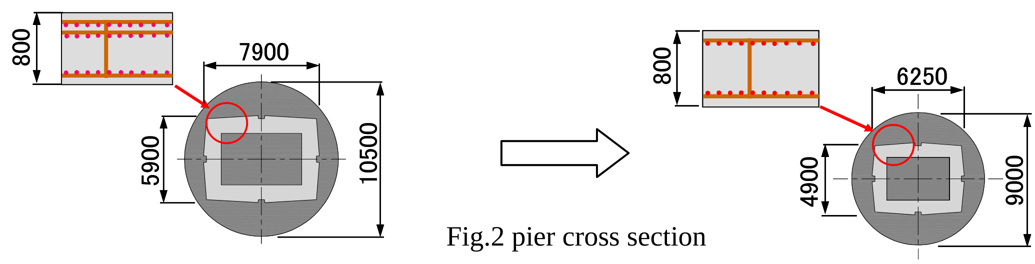

Fig.2 pier cross section

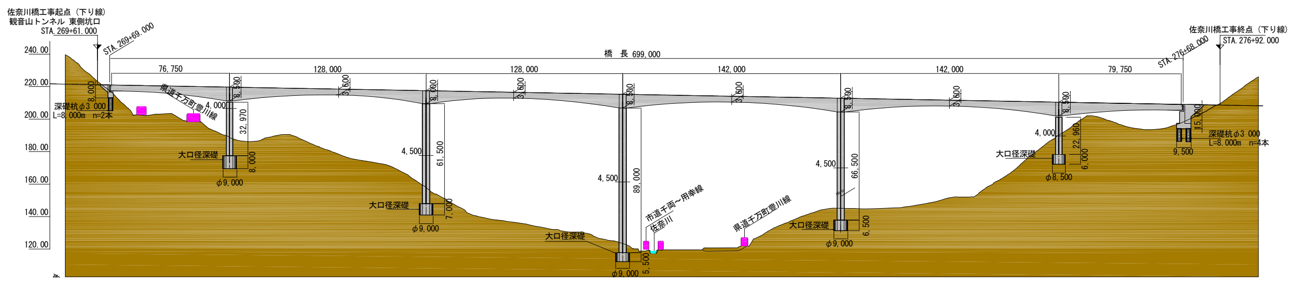

Fig.3 general view of the Sanagawa bridge

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