Comments by the author of the introductory report: Developments in manufacture and assembly

VIb

Comments by the Author of the Introductory Report

Remarques de l'auteur du rapport introductif

Bemerkungen des Verfassers des Einführungsberichtes

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Developments in Manufacture and Assembly

I will give a preliminary talk on Sub-theme VIb of Theme VI, Precast Structures. This sub-theme has the objective of discussing methods of manufacturing elements used in various precast structures and methods of connecting elements together to form assemblies.

The first step towards success with precast structures is the economical manufacture of elements of the specified shapes and dimensions, and which possess the required strengths, durabilities and degrees of watertightness. Numerous studies have accordingly been carried out regarding manufacturing techniques for each type of element so that the present situation in the world is that manufacturing methods are showing progress year by year. As a result, there are many elements for which top-class revolutionary techniques of current concrete technology are being utilized.

Designing and practices concerning such matters as joints between precast concrete elements, connections between precast concrete members, and connections between precast and cast-in-place concrete members are of the greatest importance in construction of assemblies, and much research has been done along these lines in the past.

There are six papers contained in the Preliminary Report which come under Theme VIb.

The paper of Messrs. Dratva and Gebauer discusses the results of studies to obtain high-strength concrete using portland cement clinker as concrete aggregate. The compressive strengths of concrete using ordinary aggregate and concrete using portland cement clinker are illustrated in the paper, and in the case of clinker the strength is approximately 80 N/mm^2 at the age of 28 days, which is 1.45 times the strength in case of ordinary aggregate. The strength in case of using clinker on crushing is even higher, being approximately 1.6 times that for ordinary aggregate. The effect of clinker on concrete is prominent also for flexural strengths as for compressive strengths. This is due to the great improvement in bonding properties between clinker and cement paste brought about by hydration of the clinker.

It is concluded that the use of portland cement clinker is a way of readily obtaining concrete of high strength. Needless to say, however, examination of the economics will be necessary.

Mr. Dartsch's paper discusses means of increasing concrete strength at very young age. If it were possible to strengthen concrete of young age, stripping time could be shortened to facilitate reuse of forms, which would be advantageous since manufacturing costs of precast members could be reduced.

In the paper, comparisons of compressive strengths when short fibers of steel, glass and synthetic resin of lengths of about 3 cm are mixed in concrete at a ratio of just 0.6% by volume with compressive strength without fibers are illustrated. The effects of these short fibers on concrete strength at early ages within several hours of mixing are clearly indicated with strengths being as high as double the ordinary strength.

Furthermore, the paper states that the addition of fibers does not adversely affect the long-term properties of concrete, that practical addition quantities are 1% by volume or less, and concludes that this measure is economical.

Messrs. Murata, Okuyama and Kokubu discuss a method of increasing torsional strength of prestressed concrete piles.

This method conceives of providing a considerable quantity of spiral reinforcement in a prestressed concrete pile, and placing concrete containing a suitable amount of expansive component for chemical prestress in the peripheral direction. The outside mold is removed after steam curing in order to restrain expansion of concrete by the spirals and impart chemical prestress.

There is a graph in this paper in which angle of twist is indicated on the abscissa and torsional moment on the ordinate. The torsional cracking moment of a prestressed concrete pile with the combined utilization of chemical prestress is increased to 1.5 times that of an ordinary prestressed concrete pile. It is shown that ordinary prestressed concrete piles rapidly lose resisting capacities after development of cracks, but piles with both mechanical and chemical prestress resist torsion until yielding of spirals.

Messrs. Watanabe and Idemitsu discuss the use of a pretensioned cable truss they had devised for erection of a concrete arch consisting of precast blocks. A pretensioned cable truss may be considered as a suspension bridge with stiffening girders replaced by lower cables. The required pretensioning is provided by operating jacks inserted at the ends of upper cables and chain blocks installed at hangers. Cross beams for supporting concrete blocks are fixed to the hangers.

The arch is first divided into a number of parts in terms of width. For example, the arch is divided into three strips and the middle strip is first erected. The strips of the arch on either side are erected after concrete of the middle strip has hardened. The concept in this case is that the total load would be carried by the middle strip of the arch with no load applied to the pretensioned cable truss. Connections are made by placement of cast-in-place concrete at joints between blocks, at joints between strips, and at the arch crown.

The authors surmise from results of model tests that work could be carried out much more rapidly and economically by utilizing pretensioned cable trusses for bridge erection than by using arch centers.

The paper by Messrs. Brachet, Olivier-Martin and Denis first discusses the results of investigation on prestress in pretensioned concrete girder bridges. Since steam curing is performed on girders of this type, losses in prestress occur due to expansion and relaxation of prestressing tendons, and these losses have been measured.

Losses in prestress were calculated from measured values of tensile forces acting on prestressing tendons obtained from readings of temperature-compensating strain gages, couplers with these gages attached to them being connected to the prestressing tendons and embedded in concrete. Along with other matters, it is stated that on comparing values measured at couplers set outside concrete with those at couplers embedded in concrete, the latter are found to show complex variations when steam curing is performed due to the influence of bond between concrete and prestressing tendons.

Loading tests of a continuous girder made by joining two precast simple girders through placement of concrete between them are next described, and it is reported that reactions due to loading agreed well with theoretical values. I believe the results of long-term loading tests will be described in today's discussion.

Mr. Machida describes performances in construction of two T-beam bridges and one truss bridge utilizing precast members of extremely high-strength concrete for the Sanyo super-express line of the Japanese National Railways.

This extremely high-strength concrete used good-quality aggregate and a water-cement ratio of approximately 0.30, greatly lowering unit water content by addition of a large amount of good-quality water-reducing admixture. In tests conducted prior to construction, it was confirmed that concrete of 28-day compressive strength of 750 kgf/cm^2 and slump of 12 cm could be obtained with a unit cement content of 485 kg/m^3, sand percent of total aggregate of 40% and the use of a polyaromatic sulfonate water-reducing admixture at a rate of 0.75% by weight of cement.

The truss bridge was a Warren truss of 45-m span as shown in Fig. 1. Fig. 2 shows connection of floor beams and Fig. 3 assembly of upper chords.

Based on these job performances, the rate of reduction in dead weight by the use of extremely high-strength concrete is indicated, while it is concluded that a truss bridge is economical since the construction period at the project site can be shortened.

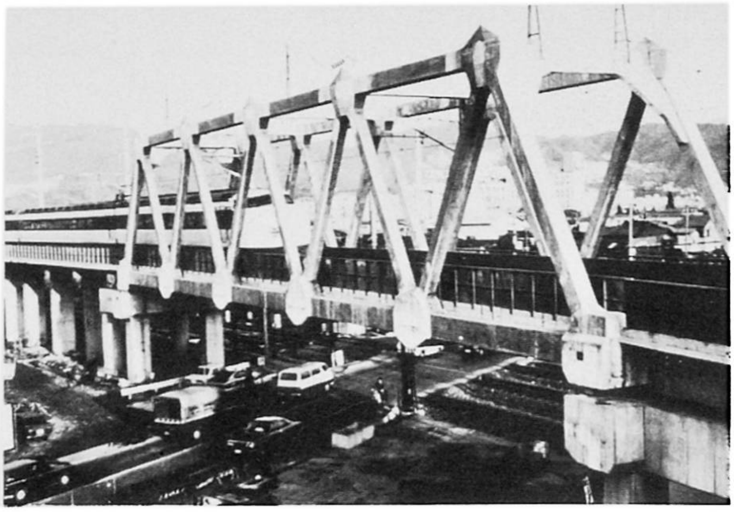

Fig. 1 — Concrete truss bridge of Sanyo super-exress line.

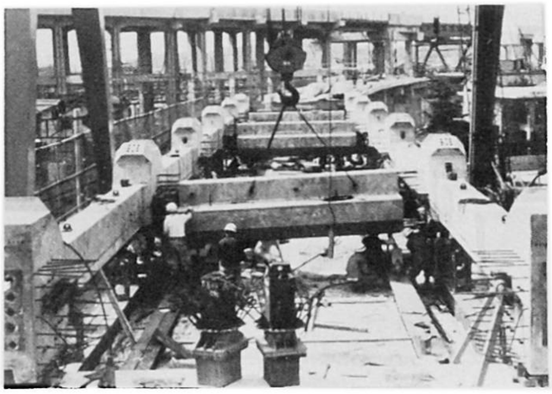

Fig. 2 — Connection of floor beams for truss bridge.

Fig. 3 — Assembly of upper chords for truss bridge.

Each of the six papers which I have just described provides information useful for solving the respective problems involved. However, the methods of designing and constructing a precast structure will differ greatly depending on the purpose for which the structure is used, the size of the structure, the topography, the geology, and other conditions of the jobsite. Accordingly, the problems discussed in these papers comprise only an extremely small part of the whole and there is naturally a considerable number of important problems remaining to be taken up.

The general advantages of the precast construction method are that it is possible to save manpower, that it is possible for rapid construction to be carried out, and that it is economical. However, it has come to be recognized that there are further advantages such as that obstruction of traffic and water flows can be reduced through elimination of shoring, and that disruption of the environment accompanying construction can be lessened. Recently, it is often the case that these newly recognized advantages are of importance. Research works are being carried out in many countries throughout the world, structure by structure, in order that these advantages will be demonstrated. It is sincerely hoped that valuable discussions concerning the fruits of these works will take place amongst those gathered here today.

A prominent feature of precast construction in recent years is that precast elements have become large-sized with development of larger construction equipment. In order to deal with the larger sizes of elements, improvement in concrete quality, reduction of concrete weight, increasing the reliabilities of elements including accuracies of dimensions, and development of surer and more economical methods of joining elements are problems of particular importance which have arisen. I am especially looking forward to lively discussions ensuing in regard to these problems.