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Recent Developments in Structural Precast Concrete in Great Britain

Récents développements concernant la construction en béton préfabriqué en Grande-Bretagne

Neuere Entwicklungen bei der Vorfabrikation von Betonelementen in England

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The prefabrication of structural concrete members has been given considerable impetus in Great Britain during the last two years. In part, this is due to a shortage of artisans skilled in the traditional building crafts, which has compelled firms to seek means of fabricating elements away from the site. Initially entrusted to relatively unskilled labour, this work of prefabrication is demanding no less skill from its operators. It is leading to the development of new crafts and it requires greater management skill from those in charge of both fabrication and erection. Fortunately, this demand is quickly being recognised by training establishments and greater efficiency of production may be expected in the next few years.

The most significant increase in the use of precast concrete during the past two years has been in multi-storey flats. Industrialised housing is a relatively new features of the British economy and much has been learnt from other European countries, particularly Denmark, France and Sweden. There are now nearly four hundred licensed systems of prefabricated houses and multi-storey flats. A large proportion of these use precast concrete.

It seems likely that, in the future, there will be a slowing up in the demand for system-built flats and houses and that more attention will be given to the manufacture of small elements designed to standard dimensions, giving architects and engineers a wider choice of prefabricated units. As yet, the precasting industry is not organised to take advantage of this eventual demand, though there is a refreshing flexibility being shown in some of the more recent systems which make them adaptable to buildings such as hospitals and offices as well as to the multi-storey flats for which they were originally intended.

The enlarged building programme, which has been promoted by the Government, initially in schools, but now in hospitals, houses and communications, has done much to speed up the development of prefabrication techniques. However, cost remains the chief criterion of choice between in-situ concrete and precast. The more promising developments during the last two years have been those which compete economically with in-situ work. There has

been a tendency to incorporate in structures the maximum number of small repetitive units and to use these in a form of composite construction. This is done most advantageously when the structural framing system and the joints are kept as simple as is practicable.

Valuable work has been done by the Ministry of Public Building and Works in the adoption of partial prefabrication for a number of tall buildings. Examples of this method of combining in-situ concrete with precast elements are illustrated in Figs. 1 and 2. This type of construction can be briefly summarised as involving the maximum number of repetitive precast elements, simple joints, in-situ concrete for connection of the precast elements, with horizontal forces carried to the ground by floors and walls acting as horizontal and vertical girders.

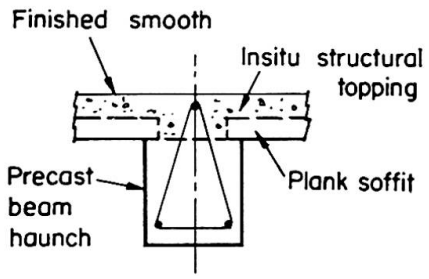

Fig. 1.

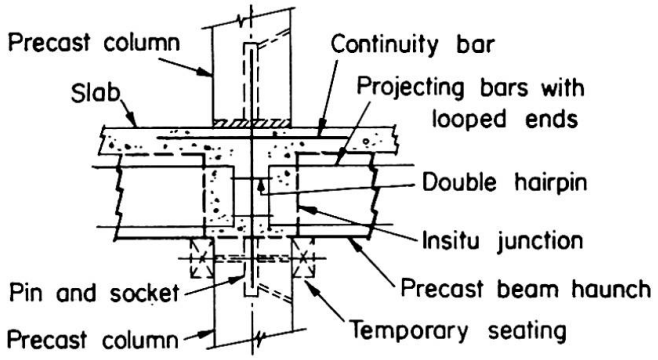

Fig. 2.

The Ministry, in conjunction with industrial organisations is also developing an "open" building system, encouraging the prefabrication of standard profiles for structural elements and cladding. The adoption of a system of this form will impose a tight discipline on both architects and engineers, but it offers the most promising results for a fully-stretched building industry.

Another development is the manufacture of very large units, limited only by crane capacity and transport facilities. Cranes have increased both in capacity and in mobility. It has become practical to employ a heavy crane for a short period on site, using a light crane or hoist for the day-to-day work of construction. Because of the difficulties of casting in-situ the 10 ft (3 m) thick top biological shield at Calder Hall nuclear power station, the dia-grid plug for a subsequent reactor was precast on the ground, 50 ft (15 m) in diameter and about 10 ft (3 m) deep. This required a 350 ton (356,000 kg) lift.

Large precast members are used increasingly in bridges. The beams on the approach viaducts of the new Medway Bridge, illustrated in Fig. 3, are 135 ft (41 m) long and weigh 190 tons (193,000 kg). Larger units are used in the high roofs of single storey buildings, such as power stations, where formwork and centering costs would be high, and, for a similar reason, in theatres,

churches and other places of assembly where advantage can be taken of the decorative finishes and interesting shapes that can be achieved in concrete. Large precast members have also been used where short construction periods have embraced the winter months. An interesting form of precasting is shown in Fig. 4, where one of a series of folded plate units weighing 6½ tons (6600 kg) for the roof of a bakery in Swansea, is being loaded. The 2-in. (5 cm) slabs,

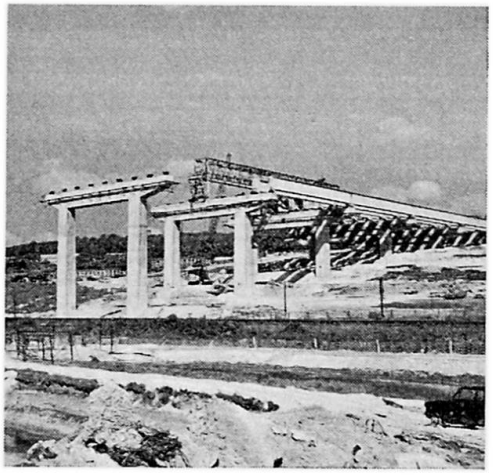

Fig. 3. Medway Bridge approach viaduct.

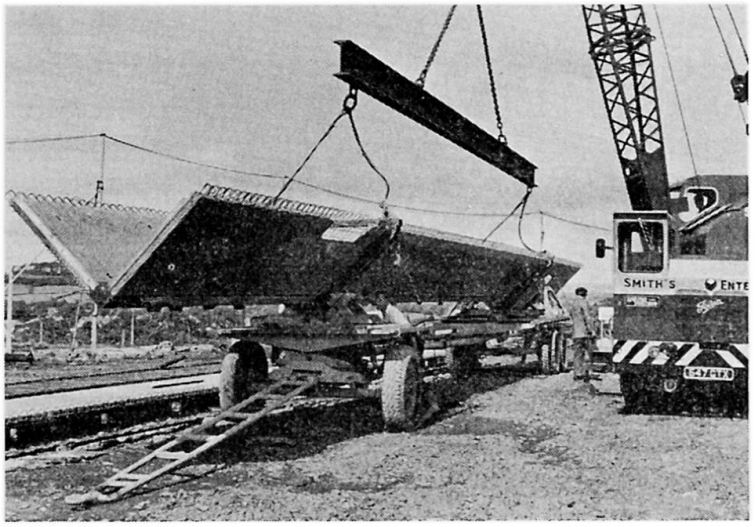

Fig. 4. Precast units for foldes plate roof.

3 ft. 7 in (1.1 m) wide and 67 ft. 8 in (21 m) long were cast horizontally in a stressing bed. Pairs were then set in a wooden cradle and the valleys cast to form the V-units of the folded-slab roof.

A further interesting and attractive use of precast members is illustrated in Fig. 5 showing the hoisting of cruciform units, and Fig. 6 showing the completed structure — a cricket pavilion, with the units incorporated in the roof.

As yet, the only specific example of the use of profiles interchangeable between different precasting firms is in the standard range of bridge beams,

described in the Report. I-section standard beams are now used extensively, but Hollow box sections are not yet being manufactured to the standard dimensions. This is because bridges with spans greater than fifty feet can be designed more economically in a different form, or precasting firms, not yet set up for the manufacture of standard units, can offer a less expensive non-standard section. Fig. 7 shows the very extensive used made of prestressed

Fig. 5. Cruciform units for a pavilion roof.

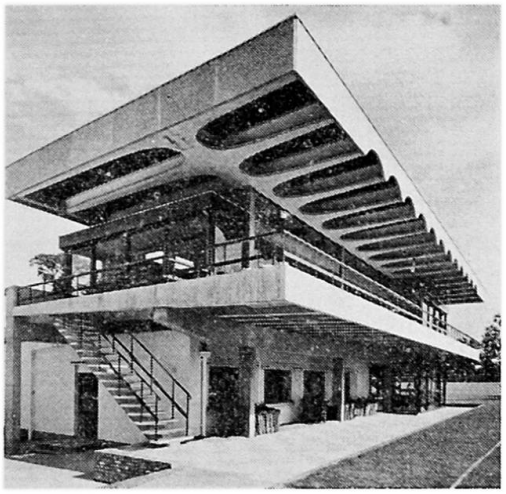

Fig. 6. Cricket pavilion in precast concrete.

Fig. 7. Prestressed bridge beams in the Chiswick-Langley motorway.

bridge beams on the Chiswick-Langley motorway, where the total of 4300 beams justified a slight departure from the standard profile.

An investigation by the Building Research Station into the combination of prestressing with normal reinforced concrete is showing encouraging results now that high-strength bars are available. Laboratory tests have been made on concrete beams subjected to varying amounts of prestressing force and reinforced with round mild-steel bars, high-tensile bars or strand. During the tests measurements were made of strains, deflections and cracking. For the

prestressed reinforced concrete beams the crack widths and deflections were less than in reinforced concrete beams of the same ultimate strength. This form of construction should be particularly effective for reinforcing steels of higher strength than those now in use, as crack width could be reduced, deflections limited, and greater span/depth ratios obtained.

The ideal joint between precast members remains as elusive as ever. It has been claimed, with some justification, that the grouted pin and socket joint is economical. It has the virtue of easy erection with wide tolerances; it introduces little uncertainty in design since the joint must be accepted as a pinned connection. Use is being made of the higher working stresses that are permitted on confined bearing areas of concrete. This allows the column load to be transferred directly through the concrete without lapping the steel. The pin and socket joint for a column to column connection, illustrated in Fig. 8, has been developed by the Ministry of Public Building and Works,

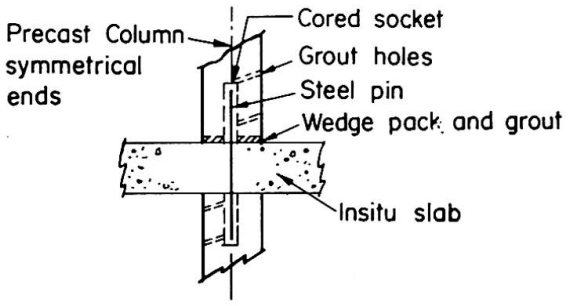

Fig. 8.

and its feasibility proved in tests carried out by the Cement and Concrete Association. In each of four tests of the joint, as designed, failure occurred in the top column. With a reduction by half in the number of stirrups in the column ends, failure again occurred in the upper column. A differing pattern of failure resulted from a weakening of the mortar joint and it was concluded that this should be of a strength not less than 75% of the concrete in the columns.

It would be useful to make a comprehensive survey of the behaviour of joint types in use, if only to show that certain types of joint remain satisfactory. Joint inefficiency will generally be demonstrated by increased maintenance costs and these may well become significant in the future.

Under the lead of the recently established Government Building Agency, precasting firms will in the near future be encouraged to produce elements within a standard range to predetermined dimensions, and this will probably represent the greatest challenge to the industry in the next three years. Side by side with this, significant developments in structural precasting can be expected as production within the building industry rises, whilst the labour force remains relatively static. Further developments of interest and technical importance may be expected before the eighth congress of the Association.

Summary

This report describes recent developments in structural precast concrete in Great Britain, and illustrates a number of recently completed projects. It brings up to date the report contained in the "Preliminary Publication" and emphasises such items as have been shown during the last two years to be of special importance.

Résumé

L'auteur décrit les récents développements qui ont marqué la construction en béton préfabriqué en Grande-Bretagne et cite un certain nombre de projets dont la réalisation vient de s'achever. Il complète la contribution contenue dans la "Publication Préliminaire" et met l'accent sur tout ce qui, au cours des deux dernières années, s'est révélé comme ayant une importance particulière.

Zusammenfassung

Der Verfasser beschreibt neuere Entwicklungen bei der Vorfabrikation von Betonelementen in England und berichtet über einige kürzlich erfolgte Ausführungen. Damit wird die im «Vorbericht» erschienene Arbeit ergänzt, und es werden die Punkte hervorgehoben, die sich in den letzten zwei Jahren als besonders wichtig erwiesen haben.