

**LONG SPAN PRESTRESSED CONCRETE  
BRIDGES OF SEGMENTAL CONSTRUCTION  
STATE OF THE ART**

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**SUMMARY REPORT 121-1 (S)**

**SUMMARY OF  
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# SUMMARY REPORT 121-1 (S)

In highway bridge construction there is an increasing trend toward the use of longer spans. This trend is the result of a number of different requirements relating to safety, economy, function, and aesthetics. A substantial number of long span bridges have been constructed throughout the world utilizing prestressed concrete box girders. This form results in a very compact structural member, which combines high flexural strength with high torsional strength.

The objective of this report is to examine in detail one means of achieving long spans in bridge structures, namely, segmental precast box girder construction. Segmental precasting involves the manufacture of the bridge structure in a number of short units. During erection these are joined together, end to end, and post-tensioned to form the completed superstructure. The segmental pattern for a typical bridge is shown in Fig. 1. The reason for casting in short segments is essentially that box girders, unlike I-girders which have narrow width, cannot be readily transported in long sections. In addition, the short units are suited to fairly simple methods of assembly and post-tensioning. The length and width of the segments are chosen so as to be most suitable for transportation and erection.

## Types of Cross Section

The superstructures of these bridges generally conform to three main types: (a) single cell box girder, (b) pair of single cell box girders connected by the deck slab, and (c) multicell box girder. These types are sketched in Fig. 2.

Single cell box girders are generally used in relatively narrow bridges. As the width increases, the bending moments in the deck slab increase and hence the thickness must increase. Beyond some critical width it becomes more economical to use a multicell box or multiple single cell boxes.

In the case of multiple single cell box girders, the basic single cell units are cast separately and are connected after erection with a concrete joint and transverse post-tensioning. Thus, in general, it will be possible to have smaller basic units in this case than with a multicell box.

## Structural Systems

Most of the bridges considered are continuous over all or several spans. Bridges having spans up to about 250 ft. are generally of uniform depth, whereas those with greater spans generally vary in depth

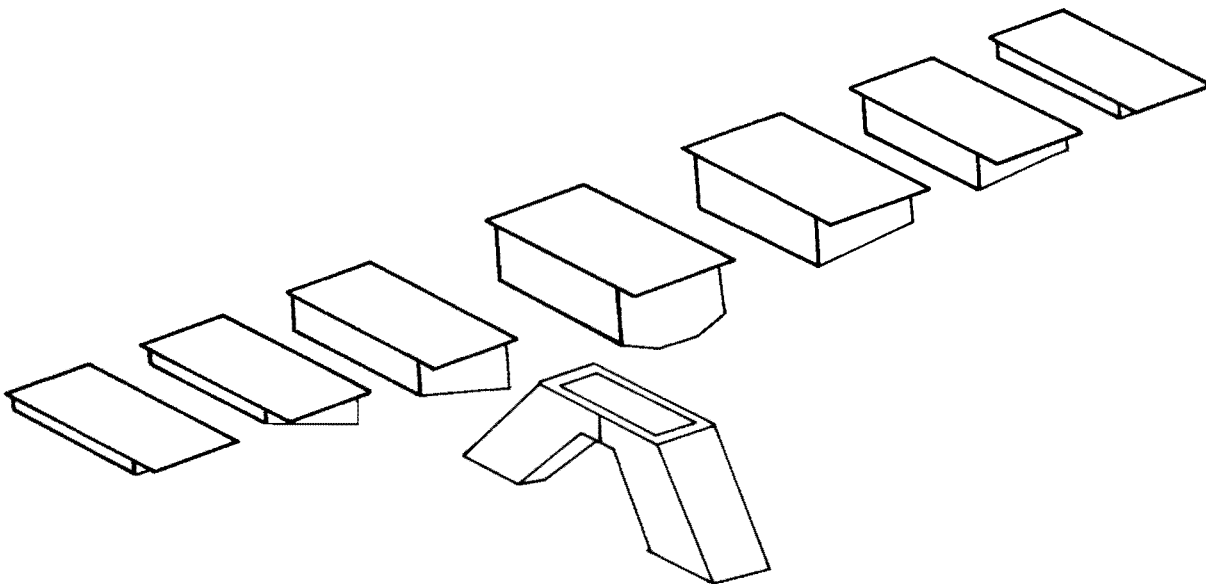


Fig. 1. Superstructure of the Oosterschelde Bridge, The Netherlands.

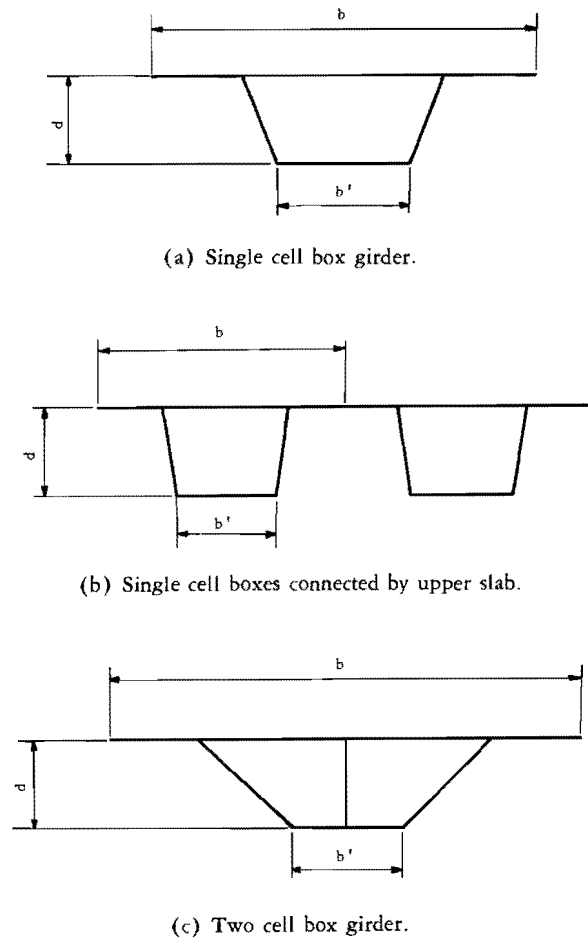


Fig. 2. Box girder cross section types.

from a maximum at the support to a minimum at midspan. The advantage of uniform depth is that all of the precast units can be the same, thus facilitating mass production. In the case of uniform bridges the span/depth ratio is generally in the range of 20 to 27.

### Precast Segments

Precast segments are generally around 10 ft. in length. This is a convenient size for transportation and erection. The weights of most segments lie in the 20 to 60 ton range. Segments that will be connected by glued joints require much greater precision than those connected by concrete joints. It has been shown, with the French bridges, that this precision can be obtained by casting the segments one against the other.

### Erection Procedures

Erection on falsework with close-spaced supports is the simplest method of construction when conditions permit, as in the case of viaducts over land and not passing over existing roads. Lifting and placing techniques will depend on the exact site conditions. For bridges having three or more spans over water or over existing roads, where intermediate support is not possible, the cantilever method will probably be the most suitable. There will be a critical span length, however, below which it will be more economical to use a falsework truss.

### Joints

The joints between the precast segments of a bridge are of critical importance. They must have high strength and durability and must be reasonably easy to construct.

The most widely used joints are unreinforced concrete joints and epoxy resin joints. For bridges erected by the cantilever method, the construction time depends largely on the rate of setting of the joints. With the cantilever form of erection, epoxy resin joints, which have a much faster rate of setting, have an obvious advantage over concrete joints. For bridges constructed on falsework, unreinforced concrete joints have been used in nearly all cases. They are simple to make and do not require fine tolerance in the precast segments.

### Methods of Analysis

Major analytical investigations concerning cellular box girders have dealt with the complete box girder, i.e., no consideration was given to segmental construction or analysis during segmental erection. Although work has been done concerning box girders with various end conditions, diaphragm situations, stiffness properties, etc., there is no information available regarding work done on the problem of segmentally constructed box girders. Considerations such as longitudinal and/or transverse prestress, computation of losses, jointing, and stresses during erection will not, of course, change the problem at hand completely; they will, however, add several additional complications heretofore not considered.

### Conclusions

It is clear from the numerous bridges already constructed that segmentally precast box girders provide an effective means of achieving long spans.

A variety of box girder shapes and prestressing systems have been used. The most suitable cross-sectional shapes for bridges of 30 ft. to 50 ft. width appear to be a one or two-cell box or a pair of single cells connected by the deck slab.

Efficient casting techniques have been developed to obtain the tolerances required, both for concrete jointing and for epoxy resin jointing. In the latter case the required precision is obtained by casting the segments one against the other.

The most frequent methods of construction are erection on falsework and cantilever erection. The former is the simpler method if the temporary supports can be set at close intervals. Otherwise, cantilever erection or a combination of both methods may be more suitable.

In most of the precast bridges considered, joints have been either of concrete or of epoxy resin. Both types have proved satisfactory. For cantilever erection, epoxy resin joints are superior, as they

allow a greater speed of construction. Dry joints have been rarely used and there is insufficient information available to evaluate them.

There is need for some study of the relative advantages and economy of box girders and possible alternative structural elements.

Detailed comparative studies of precast and cast-in-place box girder bridges are not available. However, some advantages of precasting are clear. Better quality control is possible and greater speed of erection. With standardization and mass production it is probable that precasting will have a significant economic advantage over cast-in-place construction.

The full text of Research Report 121-1 can be obtained from R. L. Lewis, Chairman, Research and Development Committee, Texas Highway Department, File D-8 Research, 11th and Brazos Streets, Austin, Texas 78701 (512/475-2971).