Segmental Precast Concrete Bridges

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INTRODUCTION

This method of constructing long span bridges is rapidly becoming very popular around the world. The idea was innovated by the French and it has been further developed and perfected by Dutch engineers. Some countries other than France and Holland in which segmental precast bridges have been built are Austria, Spain, England, Israel, Turkey, Japan, Australia, Canada and the United States.

PRINCIPLES OF CONSTRUCTION

From Figure 1, it is apparent that this type bridge is erected in cantilever, beginning at each pier and cantilevering in balance in each direction. First the pier segment is set in a precise manner; then a segment is set on each side of the pier segment and post tensioning tendons pass clear through all three segments. Now another segment is erected on each side of the three in place and tendons pass through all five segments. From the design point of view, these cantilever tendons not only accommodate the erection but also handle the negative moments over the pier from dead and live load after the bridge is made continuous.

TWO METHODS OF PRECASTING

To be successful, the segments must be match cast, one against the one it will be adjacent to in the finished structure. In this way a perfect fit is achieved and the joint is made waterproof with an epoxy glue. In the design no tension is allowed at the joints even though the epoxy is superior to concrete in strength in tension and has better creep characteristics.

Long Line Method

Two methods have been used to manufacture precast segments. First was the long line method which requires a soffit to be built as long as half a span. The pier segment is built at the end and adjacent segments are cast moving the side form and inner form down the soffit. When the half span is completed, all segments are moved to storage except the pier segment which is rotated 180 degrees and the process is repeated only this time the opposite half span is being constructed.

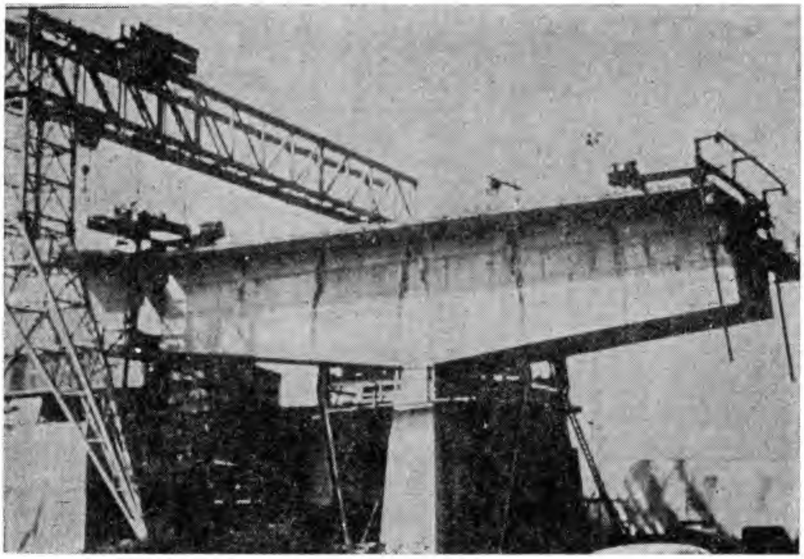

Figure 1

The long line method, or any variations of it, has one very distinct disadvantage however, in that deformation can not be compensated for as manufacture proceeds. All deformations must then be corrected in the field when possible or accepted as an undesirable situation.

Short Line Method

The short line method eliminates this fault and should be called for in specifications. This method utilizes a very sophisticated and complex form which is entirely adjustable not ony to the geometry of structure but also to compensate for all deformations due to cantilever deflections, posttensioning camber, and the time dependent deformations of creep and shrinkage. In this method the segments are actually cast in a form other than their apparent geometric shape but when erected in cantilever the final-structure-geometry is exactly as desired. Of course the deformations must be calculated precisely for these adjustments but computer programs are available for this.

BEAR RIVER BRIDGE—NOVA SCOTIA

The Bear River Bridge in Nova Scotia is an example of a long complicated structure, over 2,000 ft., which was built properly with a short line form. This bridge has a five degree curve, a spiral, a two degree curve and another spiral to tangent. All of this horizontally plus a sag vertical curve and its resultant super-elevation make for complex geometry. Yet this bridge was manufactured from March to August at which time the erection began. By Thanksgiving Day—only three months time—the bridge was open to traffic. The segments fit perfectly and the resultant geometry was as desired.

The erection of the Bear River Bridge was done using cranes and barges available to any contractor and without any special equipment so often used in Europe. To complicate this operator's task was the world's highest tide which occurs in the Nova Scotia area. The tide was 21 feet every 12 hours at the bridge site so the operator was going up or down every time a lift was made.

PCS BRIDGES BUILT AND PLANNED

Now over one hundred of these precast concrete segmental bridges have been built over the world and at least 20 are in the design stage. In addition to the project in Corpus Christi, and the two Indiana is planning, several more are in preliminary stages in the United States. Our company, Segmental Technology and Services, is currently involved with several more preliminaries in Indiana, Ohio, Michigan, Colorado and Missouri and we are doing a final design with all deformations for North Dakota.

ADVANTAGES OF PCS BRIDGES

One might wonder why a new method of constructing long span bridges can become popular so quickly. The advantages are many. These include:

1) Economy—proved time after time in competitive bidding and in accurate estimating.
2) Esthetics—the shape with closed bottom, sloping sides, variable depth if desired and full curvature provides very eye-pleasing structures.
3) Quick Construction—as evidenced at Bear River. The superstructure is manufactured as the substructure is being built and as soon as it is ready erection provides the finished structure with very little cast in place concrete.

4) Durability—Concrete of plant quality kept in compression with prestress forces, use of waterproof membranes, elastomeric bearings and waterproof expansion joints provide long span structures with little or no maintenance required.

5) Long Spans—Here is a method which actually becomes more competitive the longer the span is up to 400 or more feet. Spans actually have gone to 720 ft. Unit costs are less for segmental precast concrete structures in the 300 to 400 ft range, compared to competitive materials, than in the 200 to 300 ft range. This is due to the fact that only the webs are deepened with little extra concrete and a few extra steel tendons.

6) Contractor Acceptance—No one is eliminated in bidding on these structures. Segments can be made in any precast plant or on the job site on large projects. If that is done quality is as in a plant because plant conditions must prevail for production and economy.
   Any contractor can bid because erection equipment is the only item which may not be available to the average bridge contractor but it is of a type readily rented.

CLOSURE

We now have a very interesting new type of long span bridge available. Indiana is taking the lead and at least one of these should be under contract by 1974. We're looking forward to working on many more.