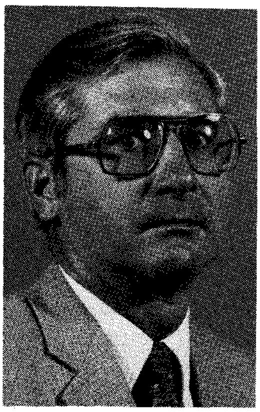
Value Engineering vs. Alternate Designs in Bridge Bidding



Compares the advantages and disadvantages of alternate designs and value engineering in bidding of bridges as experienced in the State of Florida.

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The State of Florida has been utilizing the concept of bidding alternate designs in bridge construction for the past 30 years. We realize that some of the practices in Florida are not applicable in other parts of the United States. Obviously, construction costs are affected by many conditions, such as the availability of building materials, equipment, and skilled labor. Nevertheless, the method of bidding alternate designs has worked well for us in Florida and has proven to be cost effective.

The other prevalent method of bidding is based upon value engineering. One advantage of this method is that the contractor and the Department of Transportation have an opportunity to share in certain savings that an enterprising contractor might initiate. It is certainly a good way for an innovative contractor to make a profit.

Conversely, value engineering has some built-in disadvantages. First of all, the contractor must be the low bidder before he can initiate a value engineering proposal. This may well cut out some of the more imaginative and innovative contractors who happened to bid high on the project as submitted to them.

Unfortunately, many value engineering submittals reflect inferior quality. Frequently, the contractor makes material commitments prior to bidding which could be extremely difficult to alter once he is the successful bidder. This fact alone makes it hard for a contractor to

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NOTE: This article is based on a presentation given at the Long Span Concrete Bridge Conference in Hartford, Connecticut, March 18-19, 1980. The conference was sponsored by the Federal Highway Administration, Portland Cement Association, Prestressed Concrete Institute, Post-Tensioning Institute, and Concrete Reinforcing Steel Institute.

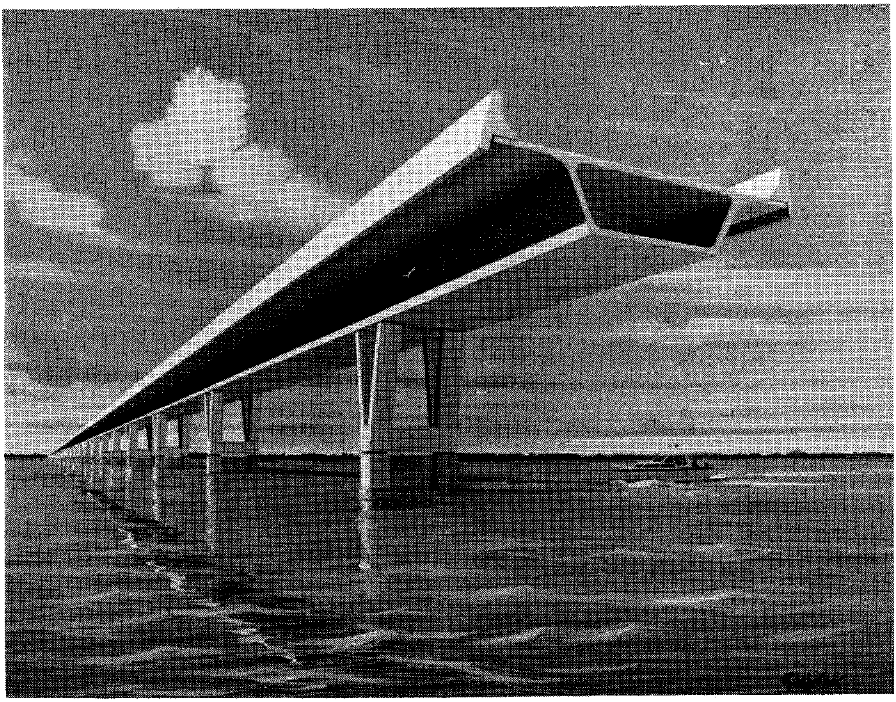

Fig. 1. Rendering of Long Key Bridge in Florida. The successful bid used precast segmental span by span construction with precast V-piers and drilled shaft foundations. (Courtesy: Figg and Muller Engineers, Inc.)

Table 1. Alternate bidding system for Long Key Bridge.

<table>
<tr><th colspan="2">Superstructure</th><th colspan="2">Substructure</th></tr>
<tr><td colspan="2" rowspan="2">Precast Girders—AASHTO</td><td>Precast Piles</td><td>Drilled Shafts</td></tr>
<tr><td>A</td><td>B</td></tr>
<tr><td rowspan="5">Segmental</td><td>Span by Span
V-Piers</td><td>C</td><td>D</td></tr>
<tr><td>Span by Span
Vertical Piers</td><td>E</td><td>F</td></tr>
<tr><td>Cantilever
Vertical Piers</td><td>G</td><td>H</td></tr>
<tr><td>First Option
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Pretensioning</td></tr>
<tr><td>Second Option
Barrier Curbs</td><td colspan="2">Cast-in-Place (Conventional)
Precast (Never Integral)</td></tr>
</table>

participate in a value engineering approach, and almost precludes the possibility of any significant innovations being offered.

The experience in Florida has shown that very few contractors have much interest in value engineering. In general, the state's contractors do not like the value engineering clause, because, they will tell you, they are not in the engineering business.

On the other hand, contractors seem to like the alternate design method of bidding.

The alternate design method for bidding, as developed by the Florida Department of Transportation, contains the following provisions:

- All alternate plans are complete documents.
- Alternate designs, in effect, provide value engineering before the bidding stage. This approach creates competition between well-engineered designs.
- Alternate designs are prepared for either steel vs. concrete or concrete vs. concrete.
- The design is normally done by in-house staff vs. consulting engineers, or consulting engineers vs. consulting engineers. In other words, we normally do not like to have the same consultants prepare the two alternate designs. We believe that by having more than one engineering team, more competition can be developed between each design alternate, and thus we are more likely to generate some really fresh ideas about solutions to problems through this competition.

In our Florida experience, we have realized considerable savings by utilizing the alternate design concept. The additional design costs usually run between 1.5 and 2.5 percent of the construction costs. Savings exceeding 15 percent of the construction costs have actually been attained, and obviously, the cost of design is relatively minor compared to the construction costs.

A good example of the savings possible in the use of alternate designs is the rebuilding of numerous bridges in the Florida Keys Bridge Replacement Project.

On the 12,144 ft (3704 m) Long Key Bridge (see Fig. 1) which was bid in July 1978 as the first of several projects, two basic sets of plans were prepared. The first one was a state in-house design using conventional AASHTO girder techniques. The other design was done by a consultant using a concrete segmental solution. Numerous sub-alternates were offered for each alternate.

The segmental alternate offered span by span construction using V-piers; span by span construction using vertical piers; or cantilever construction using vertical piers. Either precast piles or drilled shafts could be used with all three construction methods including also the AASHTO precast girder design. Table 1 gives a summary of the alternate designs (broken down by substructure and superstructure) for the Long Key Bridge.

The first option in segmental construction was a reinforced top slab, either with reinforced concrete epoxy coated joints or using pretensioning transversely.

Barrier curbs were the second option, either cast-in-place (conventional) or precast (never integral).

Drilled shaft foundations consist of drilling a hole to a predetermined elevation and placing concrete and steel. Loads vary from 350 to 450 tons per shaft. Precast prestressed concrete piles are placed in predrilled holes and are grouted.

The V-piers are precast and bear on neoprene pads at the top of the pile cap. Alternately, cast-in-place vertical piers could be used with neoprene bearings at the top of the pier.

In the span by span construciton method a barge crane places segments on a truss spanning between piers, then post-tensioning tendons are installed

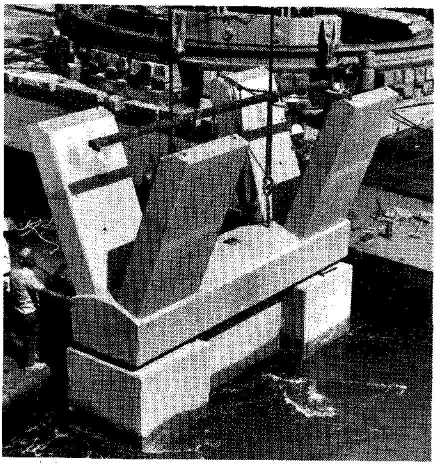

Fig. 2. Placing precast V-pier on cap (Long Key Bridge).

and stressed. There is no epoxy in the joints between segments.

In the cantilever scheme of erection the segments are placed symmetrically about the pier with the aid of an overhead launching gantry. The segments would be epoxy coated thus functioning both as a sealer and lubricant. Post-tensioning tendons are placed in two stages — first for cantilever construction, then for final stress adjustment.

The transverse prestressing of the top slab will reduce the amount of reinforcing bars needed. The prestressing is released when the concrete for the segments reaches 4000 psi (27.6 MPa).

On the Long Key project, there were eight bidders, seven of whom bid the concrete segmental solution. The low bidder, Michael Construction Company of Florida, Inc., bid on span by span erection with precast V-piers (see Fig. 2) and drilled shaft foundations; top slab transversely prestressed (in the upright position); and barrier curbs cast-in-place (slip formed).

The difference between the low bid and the AASHTO girder bid was $2.6 million.

Because of the above success on Long Key Bridge, we used the same alternate design approach for Seven Mile Bridge (see Fig. 3). This structure has a 35,000 ft (10,675 m) long span and was bid in March of 1979.

Again, two sets of documents were prepared, one by the Florida Department of Transportation using precast

Table 2. Alternate bidding system for Seven Mile Bridge.

<table>
<tr><th colspan="2">Superstructure</th><th colspan="2">Substructure</th></tr>
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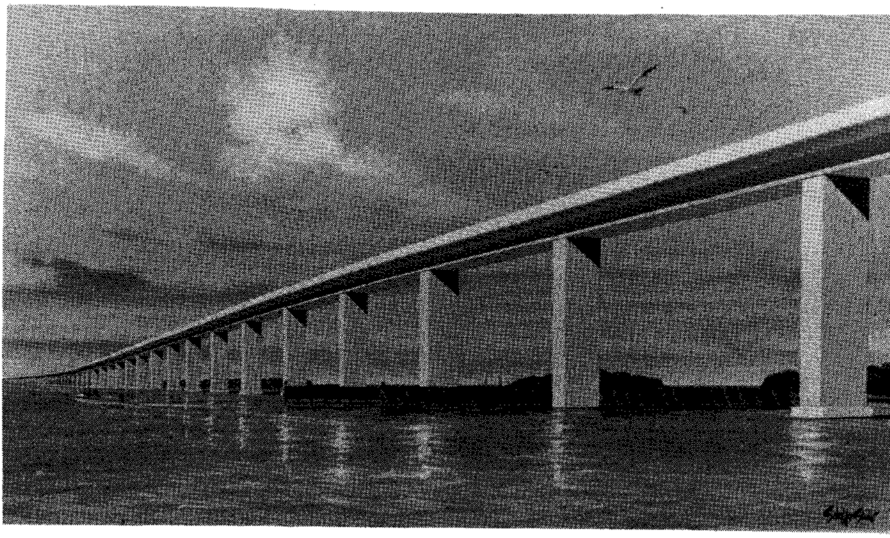

Fig. 3. Rendering of Seven Mile Bridge in Florida. (Courtesy: Figg and Muller Engineers, Inc.)

AASHTO girders, and the other in concrete segmental construction prepared by a consultant.

The design alternates for foundations and the segmental design were the same as on Long Key (see Table 2) except that the precast V-piers were not offered for Seven Mile Bridge.

Six contractors bid this job, and all six bid the segmental solution. We had budgeted $52 million for this bridge, and the low bid by Misener Marine of Tampa, Florida, was $45 million.

The two contractors differed in their approach to these two similar projects—Long Key and Seven Mile bridges.

For example, at Long Key Bridge, the contractor elected to do on-site casting, to utilize drilled shaft foundations, pretensioned top slabs, precast V-piers and erection employing the span by span method. Fig. 2 shows the placing of a V-pier on a cap.

On the other hand, at Seven Mile Bridge, the contractor chose to cast the bridge segments 450 miles away from the job site at his casting yard in Tampa (see Fig. 4), then barge the segments to the Keys site. He elected to use drilled shaft foundations, erection span by span, also, but selected a conventionally reinforced deck.

These two projects emphasize the point that it is extremely difficult to predict the course of action of contractors.

The savings on the three Keys bridges with alternate designs that have been bid within the last 20 months [Long Key, Seven Mile, and Channel No. 5 (Fig. 5)] amount to $12.6 million on $72.3 million worth of construction (Table 3).

Table 3. Comparative savings using alternate designs for various Florida Keys bridges.*

Bridge Project	Low Bid (million $)	Savings (million $)
Long Key	15.3	2.6
Seven Mile	45.0	7.0
Channel No. 5	12.0	3.0
Total	72.3	12.6

*Note: The segmental alternate design was low bid in each of the above projects.

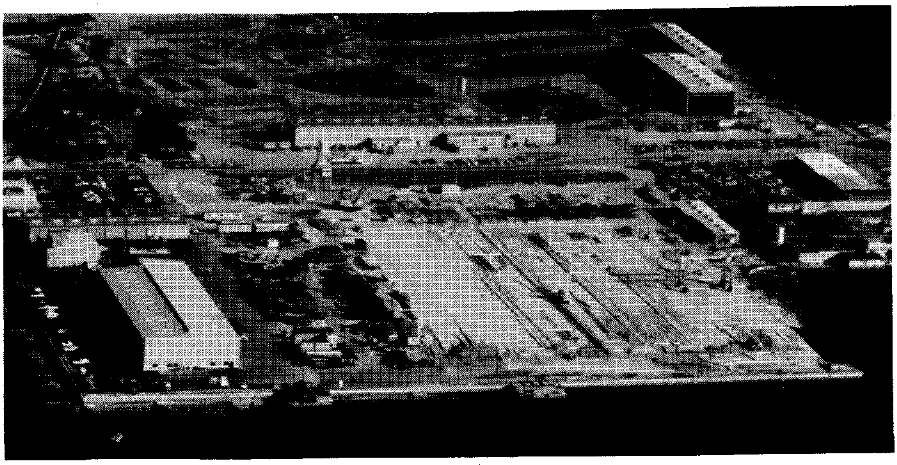

Fig. 4. Casting yard in Tampa, Florida, for Seven Mile Bridge.

Another interesting project is the Dames Point Bridge (see Fig. 6) near Jacksonville, Florida. This cable-stayed prestressed concrete structure has a center span of 1300 ft (397 m) and when built will surpass the Pasco-Kennewick Intercity Bridge which has a center span of 981 ft (299 m).

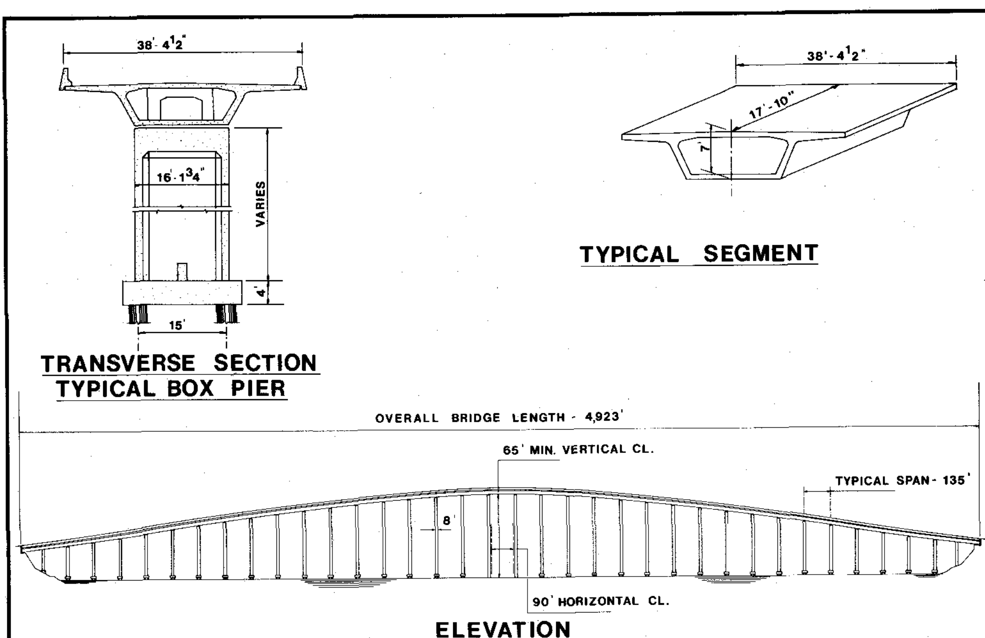

Fig. 5. Typical segment, pier section, and elevation of Channel No. 5 Bridge, Florida Keys. (Courtesy: Figg and Muller Engineers, Inc.)

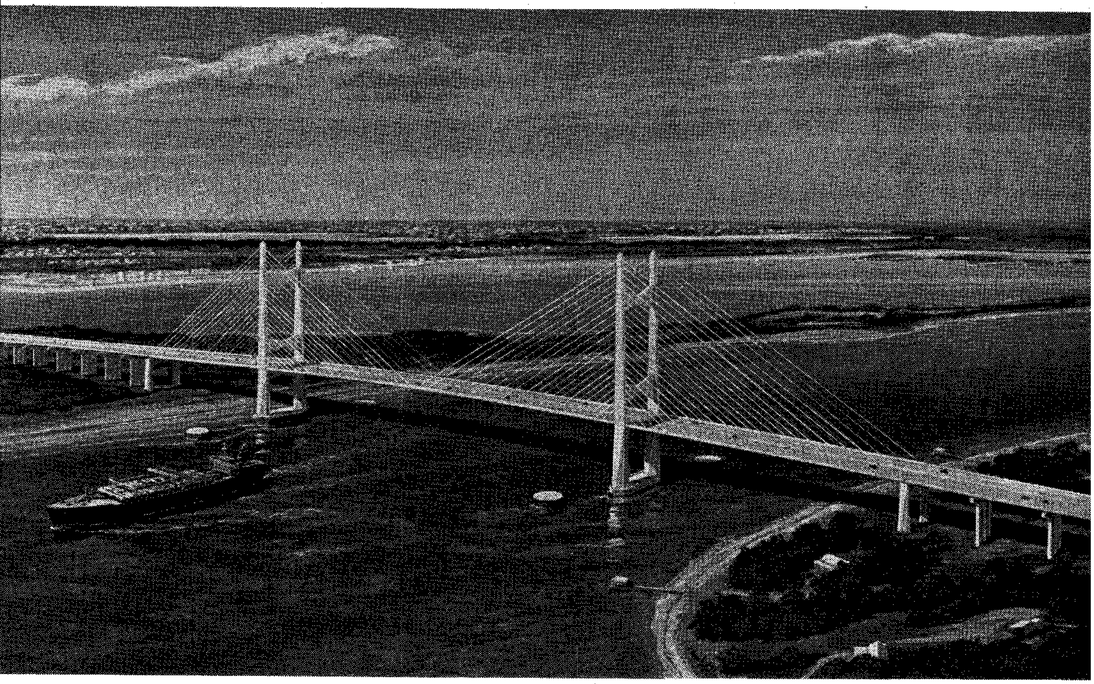

Fig. 6. Rendering of Dames Point Bridge crossing the St. Johns River near Jacksonville, Florida. (Courtesy: Howard, Needles, Tammen & Bergendoff.)

Design alternates were prepared for this bridge, one using concrete construction and the other employing a steel superstructure.

The additional engineering fee for the Dames Point Bridge was less than 1 percent of the contract bid. The bids were extremely favorable and slightly below the engineer's estimate. The low bid in concrete was $65 million and the low steel bid was $85 million—a savings of $20 million due to alternate designs being offered for bidding. We are of the opinion that alternate designs encouraged the contractors to sharpen their pencils when preparing their jobs; this was reflected in the price received.*

Currently, the Florida Department of Transportation is in the process of preparing plans for four major projects ranging in size from $5 million to $60 million, all using the alternate design concept.

The complexities in these structures range from rather straightforward, high level crossings to two very complex urban interchanges in South Florida.

The designs offered are segmental concrete vs. either steel box girders, steel plate girders, or AASHTO I-girders as the other alternate.

We in Florida are convinced that the alternate design approach to bidding is extremely cost effective, and allows us to get more bridge for the money. We are committed to the use of this approach to reduce construction costs by developing competition, and challenging engineers to be at their innovative best to stretch our transportation dollars.

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*Unfortunately, recent financing difficulties will force a second round of bidding for this bridge.

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