

Bids Reveal Economy of Precast Post-Tensioned Girders on Bridge Project

by

H. Hubert Janssen, P.E., and Leo Spaans, P.E.

Principals

Janssen & Spaans Engineering, Inc.

Indianapolis, Indiana

The economy of a bridge deck constructed with steel plate girders vs. precast, post-tensioned I-girders was recently compared on a project in Indiana.

The bridge crossing the White River on U.S. 231 is 1405 ft (428 m) long and 48 ft 4 in. (14.7 m) wide. The Indiana Department of Transportation provided contractors with the option

of bidding a steel plate girder design having eight spans, variable from 90 to 180 ft (27.4 to 54.9 m), or an alternate design having nine equal spans of 133 ft 9 in. (40.8 m) made with post-tensioned I-girders and two additional spans totaling 202 ft 6 in. (61.72 m) made with Type IV girders.

The department received seven bids, of which the five low bids were for the concrete girder alternate. The low concrete bid was \$4,811,714, which is \$557,075 below the low steel bid of \$5,368,789.

A comparison of the low steel and concrete bids provided in Table 1 reveals the pricing structure. Note that cost savings on "bridge items only" are substantially higher than may be apparent from the bids themselves.

The cost difference between the low steel and concrete alternates was achieved despite the disadvantage caused by the concrete alternate having one additional pier.

The deck section of the post-tensioned girder alternate is shown in Fig. 1. Four 6 ft 2 in. (1.88 m) deep girders spaced at 12 ft 6 in. (3.81 m) make up the deck width. The deck

Table 1. Bid tabulation analysis, U.S. 231 Over White River.

Concrete alternate (post-tensioned girders)	Steel alternate (steel plate girders)	Savings
Concrete girders, 6500 lin. ft at 120 = 781,000	Steel girders	
Post-tensioning (in place) = 135,000	(2,200,000 lb) = 1,756,000	
Erection = 75,000		
Bearings = 20,000	Bearings = 93,870	
Concrete girders in place	Steel girders	
6500 lin. ft at 155 per lin. ft = 1,011,000	in place = 1,849,780	
Expansion joints = 34,720	= 52,795	
Concrete deck and cross girders = 575,009	= 565,628	
Rebar in deck and cross girders = 281,831	315,748	
Superstructure 1,902,560	2,784,041	881,401
Substructure 747,191	855,039	107,848
Bridge 2,694,751	3,639,081	944,330
Bridge area 70,000 sq ft	Bridge area 70,000 sq ft	
Cost per sq ft of bridge concrete \$37.80	Cost per sq ft of bridge steel \$51.91	
Savings 37%		

Metric (SI) conversion factors: 1 lin. ft = 0.305 m, 1 sq ft = 0.093 m², 1 lb = 0.4536 kg.

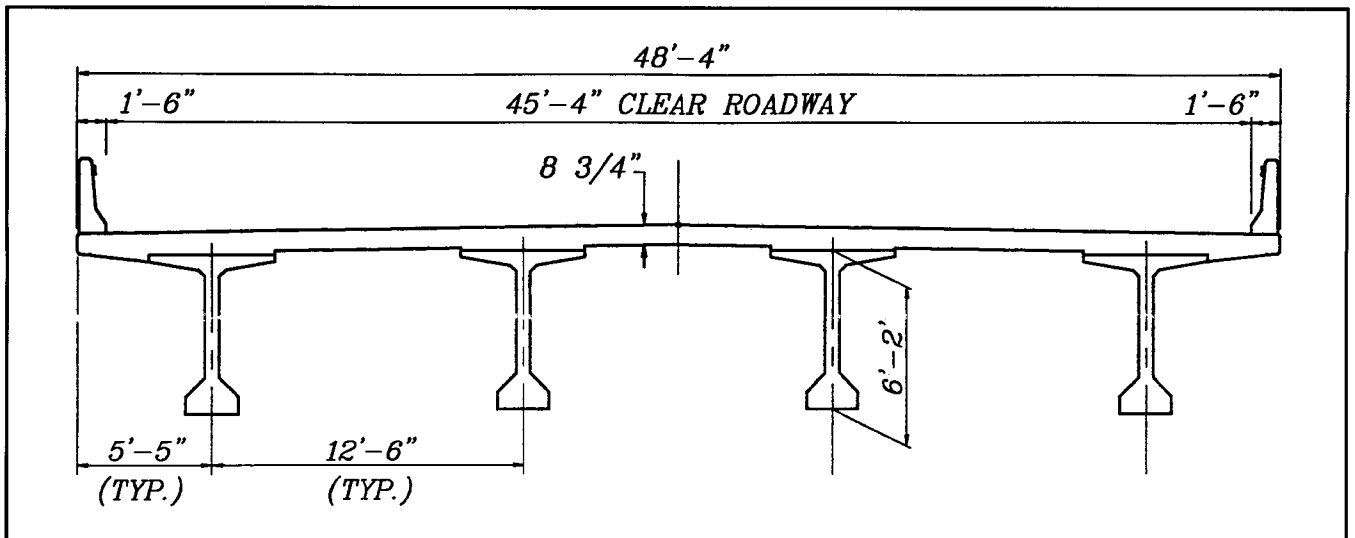


Fig. 1. Deck section of the post-tensioned girder alternate.

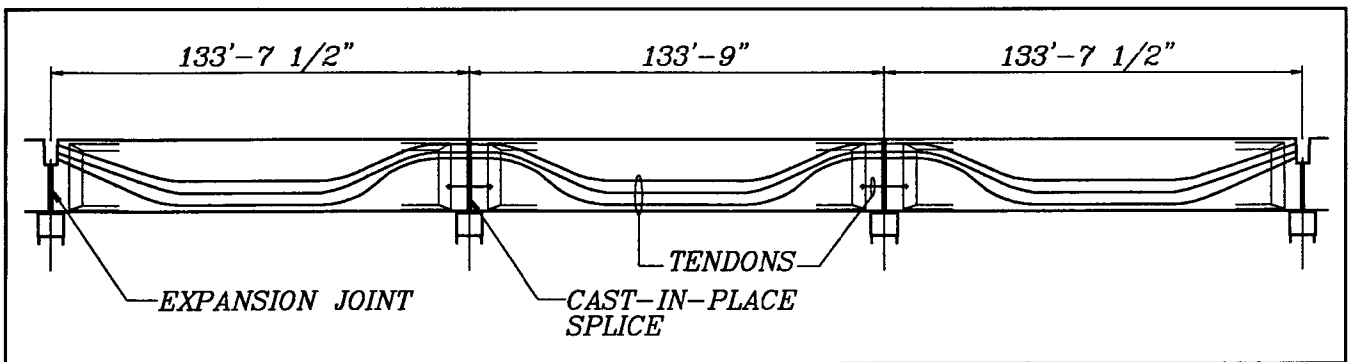


Fig. 2. Three spans at a time are made continuous by longitudinal post-tensioning, enabling expansion joints to be placed at three-span intervals.

overhangs are 5 ft 5 in. (1.65 m).

The economy of post-tensioned girder designs is determined by the large girder spacing which reduces the number of girder lines. The girders will be manufactured from 7000 psi (48 MPa) semi-lightweight concrete. They are pretensioned for handling and span from pier to pier. Three spans at a time are made continuous by longitudinal post-tensioning as shown in Fig. 2, thus enabling expansion joints to be placed at three-span intervals.

The deck is 8 3/4 in. (222 mm) thick. This thickness could be used despite the large girder spacing because of the span

reduction realized with 5 ft (1.52 m) wide girder top flanges. This resulted in additional economy.

The construction sequence will be:

- Step 1: Place all girders.
- Step 2: Cast girder splices and cross girders at the piers.
- Step 3: Stress two out of four longitudinal tendons.
- Step 4: Cast cross girders in span, place deck forms and reinforcing bars and stress one additional longitudinal tendon.
- Step 5: Cast the deck.
- Step 6: Stress the one remaining longitudinal tendon.

Credits

Owner: Indiana Department of Transportation, Indianapolis, Indiana.

Engineer for Concrete Option: Janssen & Spaans Engineering, Inc., Indianapolis, Indiana.

General Contractor: Force Construction Company, Inc., Columbus, Indiana.

Precast Concrete Manufacturer: Hydro Conduit Corporation, Lafayette, Indiana.