State Route 52 over Clear Fork River

Morgan County, Tennessee

Situated in the Big South Fork National River and Recreation Area the bridge is a four-span welded plate girder structure with spans of 145'/220'/350'/280'. The superstructure is composed of four girders spaced 12' on centers, supporting a 42'wide composite concrete slab. Rising over 200' above the river, with only limited workspace for cranes, weights needed to be held to the minimum practical. Using HPS 70W steel helped achieve this.

Because the bridge site was located in a national park and near a historic district it was necessary to develop a project that minimized impacts both physically and visually on the surrounding area. Accordingly, the approach roadway and bridge combined to limit alterations to the landscape by virtually eliminating excavation. Additionally, the bridge design provided for erection of steel girders from the existing road network supplemented by incremental launching of sections comprising the third pier's negative moment section and span four. Further, aesthetic considerations were accomplished through the use of unpainted weathering steel, to blend into the forest setting and use of rustication strips at 10" intervals vertically on the pier columns to enhance the visual proportions of their extreme heights.

Optimization and Innovation in Design

Optimization of design must start at the initiation of the design process. With a length of 995', a totally jointless bridge was not practical. Further, abutment one, on the low end of the 2.24% grade, was founded on rock. Pier one, 63' in height and only 145" from the first abutment, was determined to be easily deflected $1\frac{3}{8}$", the maximum possible displacement, without any significant moment addition at its base. Similarly, the second and third piers, with column heights of

183' and 124' respectively, could also deflect the maximum amount based on thermal movement accumulations presuming that the first abutment was fixed. Calculations also indicated that the force developed by gravity loads acting on the frictional resistance of sliding bearing surfaces would exceed the force required to deflect the piers. Accordingly, it was decided to design the bearings at the first abutment and all piers as fixed. Expansion bearings and a roadway expansion device were placed only at the second abutment.

The next consideration for optimization was selection of a web depth and thickness. Generally speaking, in spans up to 350' transversely stiffened girders are more economical than transversely and longitudinally stiffened girders. Further, optimization is achieved when the depth to thickness ratio is at the maximum allowable limit. In this case a 96" deep, 3/4" web was chosen for the non-hybrid HPS 70W section over the second and third piers. In the positive moment section, analysis was required to determine the minimum allowable thickness of the web. The 96" grade 50W web was only 1/2" thick.

Constructability

In order to utilize the smaller reasonable section in the positive moment regions it was necessary to break the positive moment pours into segments remembering that, as a slab section is poured and cured, subsequent stresses are accumulated on the resulting composite section.

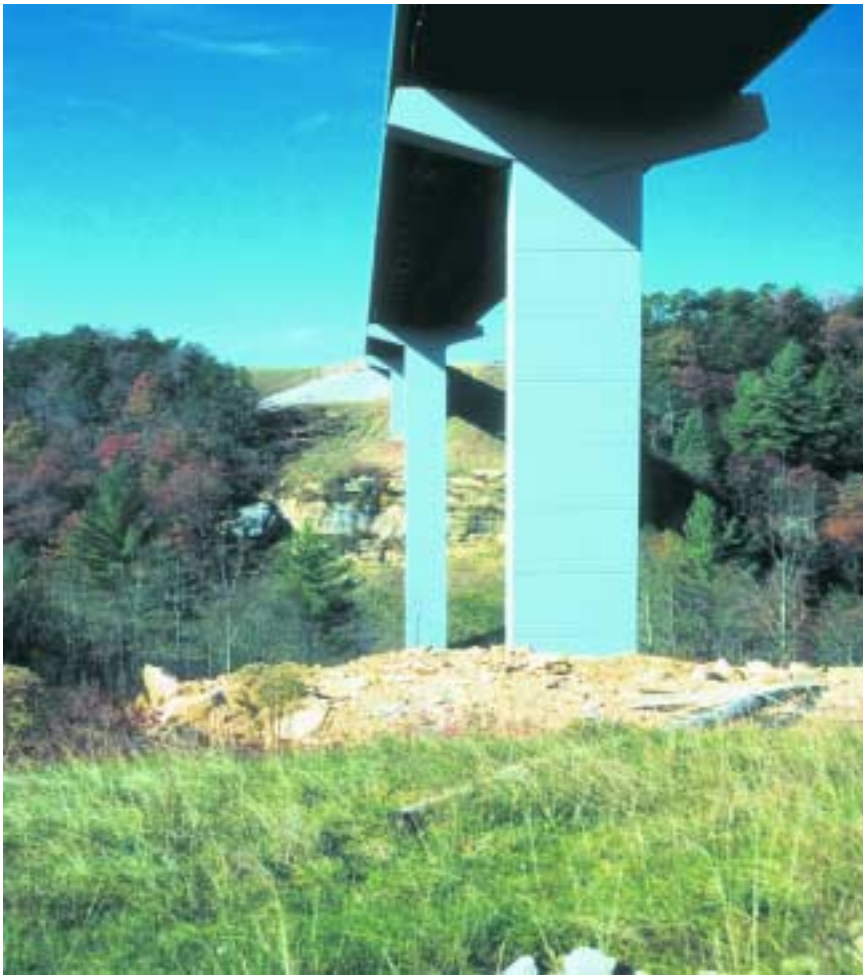
Span one and span two, up to the dead load inflection point near the second pier, were designed as non-hybrid using grade 50W steel. The negative moment sections at the second and third piers were designed solely of HPS 70W, while the positive moment sections of spans 3 and 4 were designed as hybrid girders, utilizing grade 50W webs and compression flanges while using HPS 70W in the tension flanges. All stiffeners and cross frame material are grade 50W.

Utilizing HPS 70W for the pier sections at the second and third piers reduced their lifting weights 30% over a grade 50W design.

Economics

The overall cost of the girders for the Clear Fork River bridge, in place, was $1.03 per pound, vs $1.18 per pound for a similarly designed all HPS 70 bridge constructed previously even though the girders were fabricated at the same plant, shipped further and were more difficult to erect. Stockpiled prices for HPS 70W steel for both bridges were $0.30 per pound. The completed cost for the complete structure was $95.34 psf.

In conclusion, State Route 52 over the Clear Fork River project was a textbook example of how sensitivity, careful planning, astute design and innovation can come together to create a virtually maintenance free, economical, environmentally sensitive and monumental bridge crossing.



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