SPENCER CREEK BRIDGE – A BRIDGE REPLACEMENT PROJECT ON OREGON'S SCENIC COASTAL HIGHWAY 101

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ABSTRACT

Existing reinforced concrete deck girder bridge was built in the 1940s on Highway 101, a scenic Pacific coastal roadway. The bridge needed to be replaced due to severe deterioration, corrosion, and age. The bridge site is located adjacent to the Beverly Beach State Park, one of the most popular state parks in Oregon. After several years of ODOT studies for alternative routes and bridge appearance, a deck arch bridge was selected to replace the existing structure and to provide an aesthetic gateway from the Park to the beach. However, there were design constraints that needed to be addressed during the bridge design phase. These included poor soil condition for an arch bridge, anticipated extreme scour, and a sensitive environment. To accomplish the task, a unique foundation system was designed using deadman anchors and struts buried under wall backfill attached to drilled shaft caps. This unique strengthening method was employed to resist horizontal reactions from precast post-tensioned arch ribs. Precast voided slabs made continuous for liveload were designed for the bridge superstructure. High performance concrete and stainless steel reinforcement combined with precast post-tensioned elements were specified to increase life expectancy of the new bridge while minimizing impact to the environmentally sensitive creek and providing an aesthetically pleasing structure.

Keywords: Concrete, Precast, Prestress, Post-tension, Slab, Bridge, Deck-Arch, Mechanically stabilized earth wall, Constructability, Bridge aesthetics

INTRODUCTION

The existing Spencer Creek Bridge, as shown in Fig. 1, was located north of Newport, Oregon on US Highway 101, which is the major north-south transportation along the Oregon Coast and designated as a National Scenic Byway and an All-American Road. The existing three-span reinforced concrete deck girder bridge was built in the 1940s and was severely deteriorated due to corrosion. The existing bridge was 182 ft long and 35.3 ft wide. With a combination of increasing traffic volume and vehicle loads, Oregon Department of Transportation (ODOT) initiated an emergency contract to build a detour bridge, which was anticipated to have 8-year design life. The bridge site has encountered critical erosion of embankment and is located adjacent to the Beverly Beach State Park, one of the most popular state parks in Oregon. After several years of ODOT studies[1] for alternative routes and bridge appearance, a deck arch bridge was selected to replace the existing structure and a new highway alignment was shifted about 50 feet to the east. However, there were a number of design constraints that needed to be addressed during the bridge design phase. These included poor soil conditions, not ideal for an arch bridge, anticipated extreme scour from significant wave action in winter storms, and sensitive environmental area surrounding Spencer Creek.

Fig. 1 – Existing Spencer Creek Bridge

BRIDGE DESIGN AND CONSTRUCTION

H.W. Lochner, Inc. was selected as the bridge consultant for the project. Roadway, hydraulics, and environmental engineering designs were performed internally within ODOT. The new Spencer Creek Bridge is 210 ft long, 51.3 ft wide and consists of 6 continuous spans supported by three concrete arches. The plan and elevation of the new bridge is shown in Fig. 2 and a 3-D rendering is shown in Fig. 3. The development of the replacement bridge had a significant criterion of applying an arch bridge at the site to provide an aesthetic gateway from the Park to the beach. As mentioned, the soil condition at the site consisted of alluvium deposit from the Spencer Creek consisting of silty-sand, clayey-silt, and organic debris, not suitable for laterally supporting an arch bridge. To accomplish the task, a foundation system was designed using grouped 6-ft drilled shafts to bedrock to support the arches and mechanically stabilized earth (MSE) walls for the approach embankment. Both are known to provide good performance during seismic events. A unique feature was added to the foundation system by using deadman anchors and struts buried under the 40-foot high MSE wall backfill attached to drilled shaft caps. This unique strengthening method was employed to resist horizontal reactions from precast post-tensioned arches found on the weak soil.

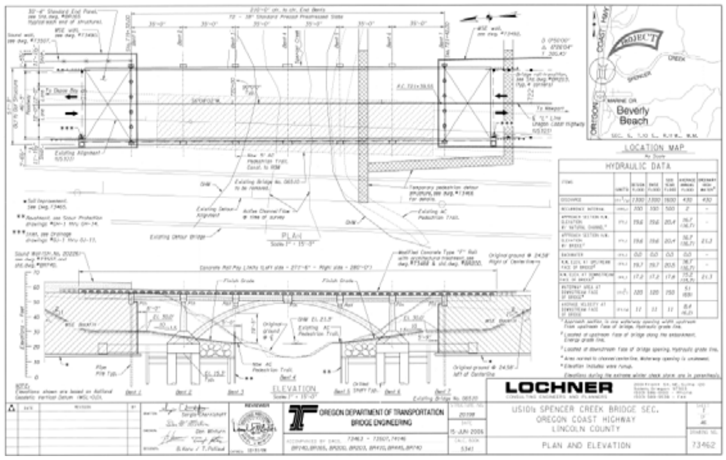


Fig. 2 – Plan and Elevation of New Spencer Creek Bridge

Fig. 3 – 3-D Rendering of New Spencer Creek Bridge

Due to the sensitive environment at the bridge site, precast concrete was chosen for main structural members including the arches and the slab superstructure, since the amount of falsework and formwork could be reduced, thereby impact to the environment was minimized. The precast concrete construction also provided better quality products compared to those with cast-in-place concrete construction.

The precast arches are comprised of 6 precast arch ribs cast at a Knife River plant in Harrisburg, Oregon and delivered to the construction site and connected together at the crown crossbeam closure pour. Each arch rib was 70 ft long, weighed 160 kips, and contained 28-#14 reinforcing bars as flexural steel. In addition, the arch ribs were post-tensioned to prevent cracking during the shipment as well as to control cracking throughout the bridge life. Production of the precast arch ribs is shown in Fig. 4.

Fig. 4 – Arch Rib Production

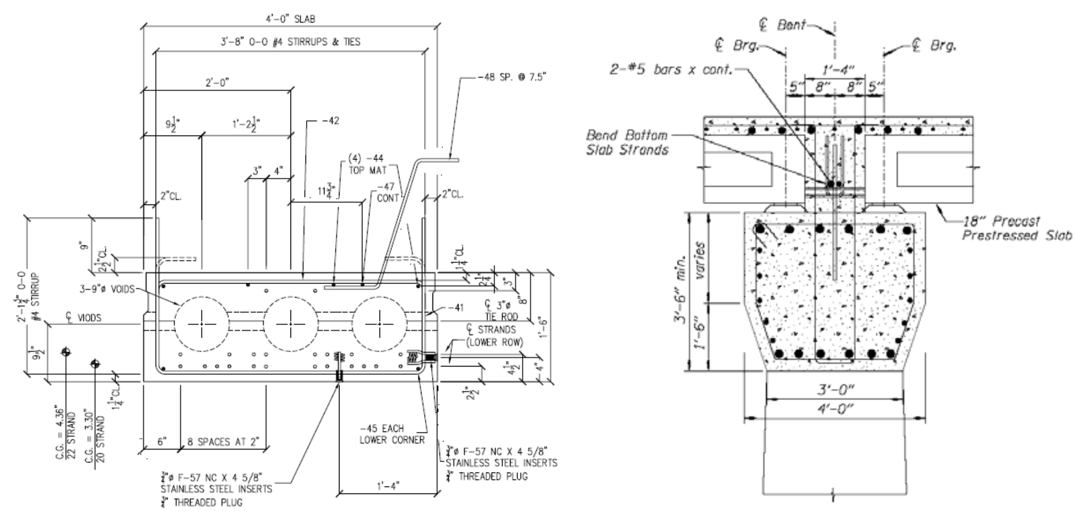
The precast arch ribs were delivered to the construction site on the sides, and then the arch ribs were rotated up and set on top of the drilled shaft caps and on platform falsework in the middle of the creek. The south-east arch rib set is shown in Fig. 5. To complete a full arch, the reinforcing bars extending from the inside of each arch rib were connected at the top support using metal-filled mechanical splices, as shown in Fig. 6a before placing concrete. For the bottom support, each arch rib was set in the arch socket, as shown in Fig. 6b, and later surrounded by concrete.

Fig. 5 – South-East Arch Rib Set

a) b)

Fig. 6 – a) Mechanical Splices for Arch Reinforcing Steel; b) Arch Socket Reinforcing Cage

Precast prestressed voided slabs made continuous for liveload were designed for the bridge superstructure. Sectional details of the precast slabs are shown in Fig. 7a. Prestressing strands extending out from the precast slab ends were hooked at bents to provide good continuity between the precast slabs. The hook lengths were calculated based on design recommendations as described in FHWA-RD-11-14 report[2]. The end connection details at bents are shown in Fig. 7b. According to ODOT design and drafting manual (BDDM)[3] all concrete needed to be high performance concrete and stainless steel bars were required in concrete deck and crossbeams for bridges in the coastal area. This included all rebars extending into the concrete deck. As a result, stainless steel was specified for stirrups in the precast slabs. Note that isolation between different alloys, i.e. stainless and black steel, was made per ODOT specification[4].



a) b)

Fig. 7 – a) Precast Prestressed Voided Slab; b) End Connection for Precast Slabs

The high performance concrete and stainless steel reinforcement combined with precast pretressed and post-tensioned elements were specified to increase life expectancy of the new bridge while minimizing impact to the environmentally sensitive creek and providing an aesthetically pleasing structure. Fig. 8 shows construction of the new Spencer Creek Bridge in June, 2008. The total construction cost of the project is $19,800,000. The construction contract was awarded in October, 2006 and was anticipated to be complete in October 2008.

Fig. 8 – New Spencer Creek Bridge Construction

CONCLUSIONS

The high performance concrete and stainless steel reinforcement combined with precast elements were specified to increase life expectancy of the new Spencer Creek Bridge. The design minimized impact to the environmentally sensitive creek and provided an aesthetically pleasing structure.

REFERENCES

1. Spencer Creek Bridge US Highway 101, Final Environmental Impact Statement and Final Section 4(f)/6(f) Evaluation, Federal Highway Administration and Oregon Department of Transportation, March 2006.

2. Salmons, J. R., “End Connections of Pretensioned I-Beam Bridges,” *Report No. FHWA-RD-77-14*, Federal Highway Administration, Washington, D.C., November 1974, pp. 41-46.

3. Bridge Design & Drafting Manual (BDDM), Oregon Department of Transportation, 2004 (with 04/2005 revisions).

4. Oregon Standard Specifications for Highway Construction, Oregon Department of Transportation, 2002.