Alsea Bay Bridge Replacement

Maurice D. Miller, *HNTB Corporation*

As the nation's infrastructure ages, replacement of bridges has become more commonplace. Many of the bridges to be replaced will have historic significance and may have established an identity for the local community. Replacement of these historic bridges may be the only feasible option when the structure can no longer safely serve its transportation function. This is especially true when the cost of rehabilitation becomes prohibitively high. When replacement has been determined to be the only option left, owners are often faced with the challenge of justifying replacement to the community. Opposition can be overcome or reduced by education of the community to the need for replacement. An effective means to mitigate the loss of the historic bridge is to provide a replacement structure that meets the needs and aesthetics of the community. The Alsea Bay Bridge at Waldport, Oregon, is one example of how an owner can successfully overcome local opposition and provide a replacement structure that enhances the community. This paper will document how the Oregon Department of Transportation was able to replace a high-profile, extremely popular structure that could no longer meet the transportation needs of the highway system with a new bridge that provides aesthetic features complementing the local community. The tradition established by the previous bridge was preserved by adapting parts of the old bridge into waysides and bridgeheads. The resulting structure, which incorporates the old with the new, has provided the community with a new focal point.

The aging of the transportation infrastructure has resulted in more than 30 percent of the 588,150 bridges in the United States being substandard and in need of rehabilitation or replacement. Many of these bridges will be eligible for inclusion in the National Register of Historic Places. The characteristics that make them historic—integrity of location, design, and setting—are the very issues that cause the local community to want to save the bridge. However, replacement becomes necessary when the bridge can no longer safely meet its transportation function.

The Alsea Bay Bridge is one example of the successful replacement of a historic bridge. The existing bridge met all of the requirements for a historic bridge, enjoyed both local and statewide support, and provided an identity to the local community. Through a combination of community involvement and education, the Oregon Department of Transportation (DOT) was able to replace the bridge by providing a structure meeting the aesthetic requirements of the local community.

In the following comments, a brief review of the requirements for historic bridges is first presented; this is followed by a discussion of how the existing Alsea Bay Bridge met these requirements and why the bridge could no longer safely fulfill its transportation function. The measures developed to mitigate the loss of the existing bridge and how aesthetics were an important element of the mitigation are also presented.

Historic Bridge Requirements

To be eligible for inclusion in the National Register of Historic Places a bridge must meet only two requirements:

- It must be at least 50 years old.
- It must have historic significance. Historic significance in architecture and engineering is present in structures of state and local importance possessing integrity of location, design, setting, material, workmanship, feeling, and association. In addition, bridges have historical significance if they
  - are associated with events that have made a significant contribution to the broad patterns of history;
  - are associated with the lives of persons significant in the past;
  - embody the distinctive characteristics of a type, period, or method of construction;
  - represent the work of a master; and
  - possess high artistic values.

The rehabilitation of a historic bridge must meet two criteria: the rehabilitated structure must be safe, and the restored structure must fulfill its function in the overall transportation system.

The hierarchy of actions to preserve a historic bridge is as follows:

- Identify, retain, and preserve the historic structure.
- Protect and maintain the historic structure.
- Rehabilitate the historic structure.
- Replace the historic structure.

When the last action is deemed necessary, mitigation of the loss of the structure is required. This mitigation can be as simple as photographic documentation and preservation of the plans of the existing bridge. Bridges providing historic and cultural significance and local identity to the community require more complicated mitigation measures. In these cases, the owner must develop strong local and state support for replacement of the bridge. In addition, the replacement structure should fulfill the cultural and aesthetic desires of the community.

Such was the situation facing the Oregon DOT when replacement of the bridge carrying Oregon Coastal Highway US-101 over Alsea Bay became necessary. The Alsea Bay Bridge project demonstrated that bridge replacements involving strong opposition and controversy can be successful. The Oregon DOT overcame both local and state opposition to replacement of the bridge through community education, development of community ownership of the project, and strong measures to mitigate the loss of the existing bridge (*1,2*).

First Alsea Bay Bridge

The Alsea Bay Bridge is located in central Oregon on Coastal Highway US-101 at Waldport, in Lincoln County. A location map is shown in Figure 1.

The bridge spans Alsea Bay at the mouth of the Alsea River, where this waterway meets the Pacific Ocean. The bay is about 3,000 ft wide and is relatively shallow at the crossing. At high tide the water fills the bay, but at low tide about half of the bay is exposed and becomes a popular area for walking, wading, and beachcombing.

The first bridge, of reinforced concrete construction, was opened to traffic in 1936 and is shown in Figure 2. From the north end the bridge consisted of a 124-ft approach span; three 150-ft deck arch spans; three through tied-arch spans of 154, 210, and 154 ft; three 150-ft deck-arch spans; and 1,469 ft of deck girder approach spans. The total length of the bridge was 3,028 ft. It had a 24-ft roadway with a 3.5-ft sidewalk on each side (Figure 3). The three through arches provided 70 ft of vertical clearance above low water, allowing small watercraft, including sailboats, to enter Alsea Bay from the ocean.

Concrete pylons, shown in Figure 4, were placed at both ends of the bridge. These pylons were 17 ft high and had raised decorative designs. Concrete spires accentuated the portals of the tied-arch spans. The through-arch spans were braced with concrete cross frames, which accented the arch spans. These features are shown in Figure 3.

The overall appearance of the bridge was described as one of grace, rhythm, and harmony with the marine setting (Environmental Impact Statement, Draft 4(f), Ealuation). Acting as the focal point in the scenic backdrop of the Waldport community, the bridge provided height, dimension, and aesthetic qualities to the bay area.

The bridge also had regional significance, because it was one of five structures built on the central portion of the Oregon Coast to replace existing ferries. The five bridges, ranging in length from 1,570 to 5,305 ft, were all multispan arch structures. The Alsea Bay Bridge was the only bridge in the group that was built entirely of reinforced concrete. To add further historic significance, the bridge was reputed to have been the longest reinforced concrete tied-arch bridge in the Northwest.

In addition to being ranked as one of the finer examples of concrete bridges in America, the Alsea Bay Bridge was noteworthy because of its designer. The five coastal bridges, in addition to several hundred others, were designed under the supervision of Condon B. McCullough, a noted bridge engineer who served the Oregon State Highway Department from 1919 to 1946. McCullough, a nationally recognized pioneer in the de-

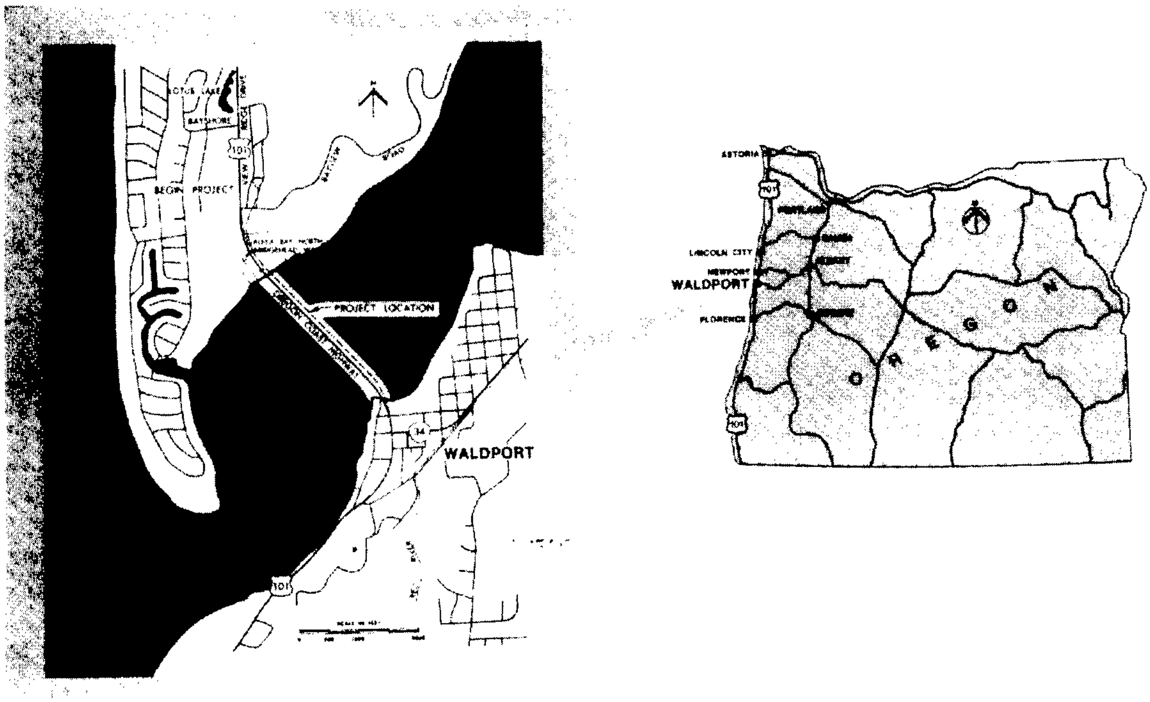

FIGURE 1 Location map.

sign of concrete bridges, promoted sound structural and architectural principles in his designs. The Alsea Bay Bridge was an excellent example of how his bridge designs enhanced and conformed to the environment.

As the bridge owner, the Oregon DOT had to make a difficult decision when this bridge became functionally obsolete and deteriorated to a point where repair was not economically justifiable. This decision was further complicated because the bridge's design and designer made it eligible for inclusion in the National Register of Historic Places.

Several factors contributed to the obsolescence of the existing bridge: narrow roadway widths (two 12-ft traffic lanes), a lack of shoulders, and a restricted load-carrying capacity. In addition, because of the harsh marine environment, the bridge had deteriorated significantly.

In 1967 a marine borer infestation of the timber piles caused the collapse of 17 of the supports for the south deck girder approach spans. Emergency repairs were made; however, these repairs were considered to be only temporary.

Chloride intrusion from the marine atmosphere caused severe corrosion of the reinforcing steel in the concrete members. The bottom of the concrete deck had a chloride ion content 3 times greater than the level recommended for repair of concrete structures. Corrosion of the reinforcing steel, due to the penetration of the chloride ion, had cracked and broken the deck extensively along its entire length. The beams and girders supporting the deck also had absorbed chloride in amounts 2 to 4 times greater than the level at which repairs are recommended. The concrete arches had similar problems. The high chloride ion content coupled with the humid conditions of the bay area resulted in corrosion of the embedded reinforcing steel, which caused cracking of the concrete throughout the length of the structure.

Bridge rehabilitation was rejected when the Oregon DOT concluded that a restoration would not satisfy safety and transportation criteria. There could be no assurance that the rehabilitation would be effective or would increase the life span of the bridge. Continued deterioration of the timber piles could not be prevented. The integrity of some of the reinforcing steel in the concrete members had been lost, and the chloride ion content in the concrete made rehabilitation impractical. The need to replace the bridge was confirmed by an independent study prepared by Parsons Brinkerhoff Quade and Douglas.

Even though the Oregon DOT presented a very strong case that replacement of the existing bridge was justifiable for both safety and economic reasons, there was strong opposition to replacement. The bridge was described as "the crown jewel of the Oregon Coastal

FIGURE 2 First Alsea Bay Bridge (looking southwest).

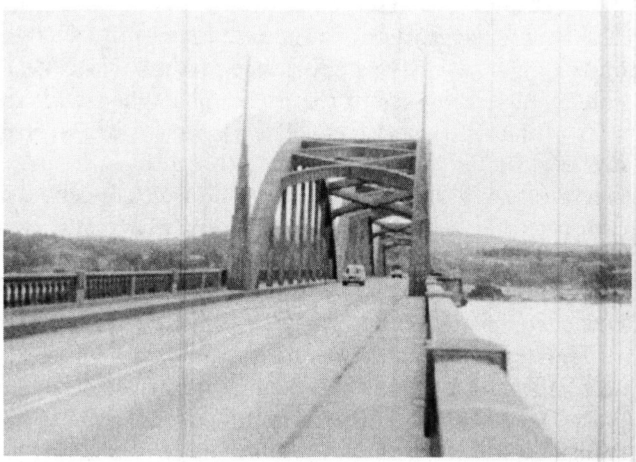

FIGURE 3 First Alsea Bay Bridge showing roadway at through concrete arch spans. Concrete spires provided emphasis to arch span.

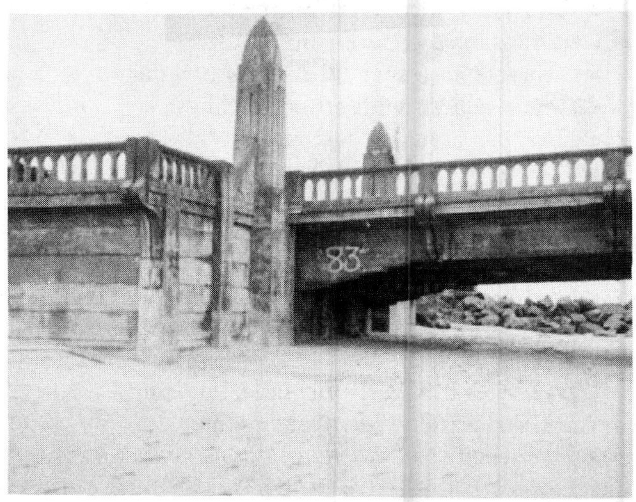

FIGURE 4 South abutment of first Alsea Bay Bridge showing concrete pylons.

Highway," and a Save the Bridge group was started and enjoyed both local and statewide support.

Through a program of education and involvement, the Oregon DOT successfully overcame this opposition and developed an acceptable replacement bridge project. The Oregon DOT held information meetings with the local Waldport community to describe the need for the project and the serious condition of the existing bridge, to present alternative alignments, and to discuss the environmental impact study process. Measures were taken to make the community a part of the decision-making process and to develop a sense of community ownership of the new bridge.

A Citizens Advisory Committee was formed in 1980 to work with the Oregon DOT during the development of the project. This committee was composed of representatives of the historic community, local governments, businesses, and citizens. The committee's duties included helping the Oregon DOT identify community concerns and values and identify environmentally sensitive areas and alternative solutions for study. In addition, the committee was instrumental in selecting the preferred alternative for the bridge site.

Type Selection

At the conclusion of the environmental impact study, HNTB Corporation was selected by the Oregon DOT to prepare preliminary bridge concept studies for a new crossing of Alsea Bay on the existing alignment. These concept studies were developed in enough detail so that the Oregon DOT, working with the Citizens Advisory Committee, could select three alternatives for preliminary design studies.

The bridge types studied included the following:

- Cable-stayed concrete girders,
- Cable-stayed concrete box girder,
- Concrete arch with Vierendeel bracing,
- Concrete arch with cross bracing,
- Twin-cell concrete box girder,
- Concrete finned box girder,
- Cable-stayed steel box girder,
- Cable-stayed steel girder with twin H-pylons,
- Cable-steel girder with single pylon,
- Steel through tied-arch with Vierendeel bracing,
- Steel through tied-arch with cross bracing,
- Steel deck arch,
- Steel tied-arch with Vierendeel bracing,
- Steel tied-arch with cross bracing, and
- Haunched steel girders.

Elevations and cross sections of the bridge types and cost estimates were prepared for each alternative. Estimated costs ranged from $31,112,000 for the twin-cell concrete box girder alternative to $44,300,000 for the cable-stayed steel girder with a single pylon. In August 1985 the studies were presented to the Oregon DOT, FHWA, and the Citizens Advisory Committee for the purpose of selecting three alternatives for further study.

The three representatives of the Citizens Advisory Committee unanimously selected the tied-arch bridge with Vierendeel bracing for the main span with concrete delta-pier approach spans as the preferred alternative. This unanimous selection of the tied-arch bridge type allowed the project to proceed with preliminary development of the arch concept. For comparative purposes, a concrete box girder main span with box girder and bulb-tee approach spans was also developed in the preliminary planning stage.

After selecting the approved bridge type, the Citizens Advisory Committee was asked to assist in presenting the preferred alternative to their fellow citizens. The Oregon DOT also took part in these presentations to continue the dialog with the community and to answer questions about the construction of the new bridge. This procedure helped to obtain community support and acceptance of the recommended alternative.

The Citizens Advisory Committee's selection of the bridge type was influenced by their feelings toward their community and toward Condon McCullough. The bridge type was selected to reflect McCullough's arch concept used for the first bridge and the other four bridges on Oregon Coastal Highway US-101. The delta-pier approach spans were selected as a concept that McCullough might have used if he were designing a current bridge. In addition, the appearance of the bridge, both as it related to Waldport and as the individual parts related to the whole, was also a strong factor in the bridge type selection.

Care was taken in the preliminary design to balance the structural and aesthetic requirements of the bridge. This was especially true for the support of the arch span on the delta piers. For appearance reasons it was desirable to have the axes of the arch ribs aligned with the axes of the delta-pier struts. The placement of the bearings for the tied arch offset the arch rib from the delta-pier struts. To remedy this the tied-arch concept was dropped and a two-hinged arch was used. The two-hinged arch, with bearings placed at the intersection of the arch rib and delta pier and centered on the axes of both, satisfied the structural and aesthetic requirements.

The aesthetic requirements are satisfied because the arch ribs line up with the inclined struts of the delta pier. The solution is also very functional because the thrust vector from the two-hinged arch flows directly into the centroidal axes of the inclined struts. Since the reactions of the arch are centered on the axis of the delta-pier strut, axial forces, with very little bending

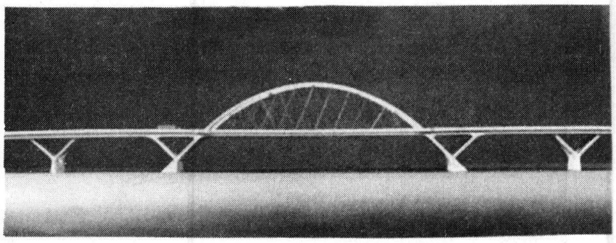

FIGURE 5 Arch rib and delta elevations.

moments, are produced in the strut. Figure 5 provides an elevation of the arch ribs and delta piers.

The spatial relationship of the delta-pier height and width to the span height and length was a crucial element of the visual design of the structure. As the profile grade descends, the spans are shortened and the heights of the deltas are decreased proportionately. These relationships are shown in the aerial photograph of the bridge shown in Figure 6.

Spans starting from the northwest are 235 and 235 ft; 450-ft arch span; and 235, 230, 225, 215, 205, 195, 155, 145, 140, 135, and 120 ft. The roadway provides two 12-ft traffic lanes in each direction, separated by a 4-ft median. On the outside of the 12-ft lanes are 6-ft shoulder/bikeways with 6-ft sidewalks. The total width, out-to-out of structure, is 79 ft.

In addition to the consideration given to the design and appearance of the new Alsea Bay Bridge, care was also given to preserve the character and history of the first Alsea Bay Bridge. The Oregon DOT provided measures to preserve the historical aspects of the first bridge.

Mitigation Measures

Before demolition of the first bridge, photographs and documentation were made in accordance with the Historic American Engineering Record standards. To make this documentation readily available to the public, a visitors' center was constructed at the south end of the bridge (Figure 7). The theme of the visitors' center is Transportation Development on the Oregon Coast. To preserve the historical aspect of the design of the first bridge, a biography of Condon B. McCullough was included along with photographs of other Oregon coastal bridges designed by McCullough.

The wayside also includes features that can be used to teach children about bridge engineering. A computer is available at the center to demonstrate the basics of bridge engineering. Facilities for building model bridges are also available. Because of its educational appeal, the visitors' center has become a field trip destination for area schoolchildren.

The wayside has also become a popular tourist attraction, with several hundred people visiting weekly. This popularity is due in part to the details that were incorporated into the wayside to preserve the historical aspects of the first Alsea Bay Bridge. The incorporation of these details into the visitors' center allows the user to view the old and new features of the Alsea Bay Bridge and at the same time enjoy beach activities.

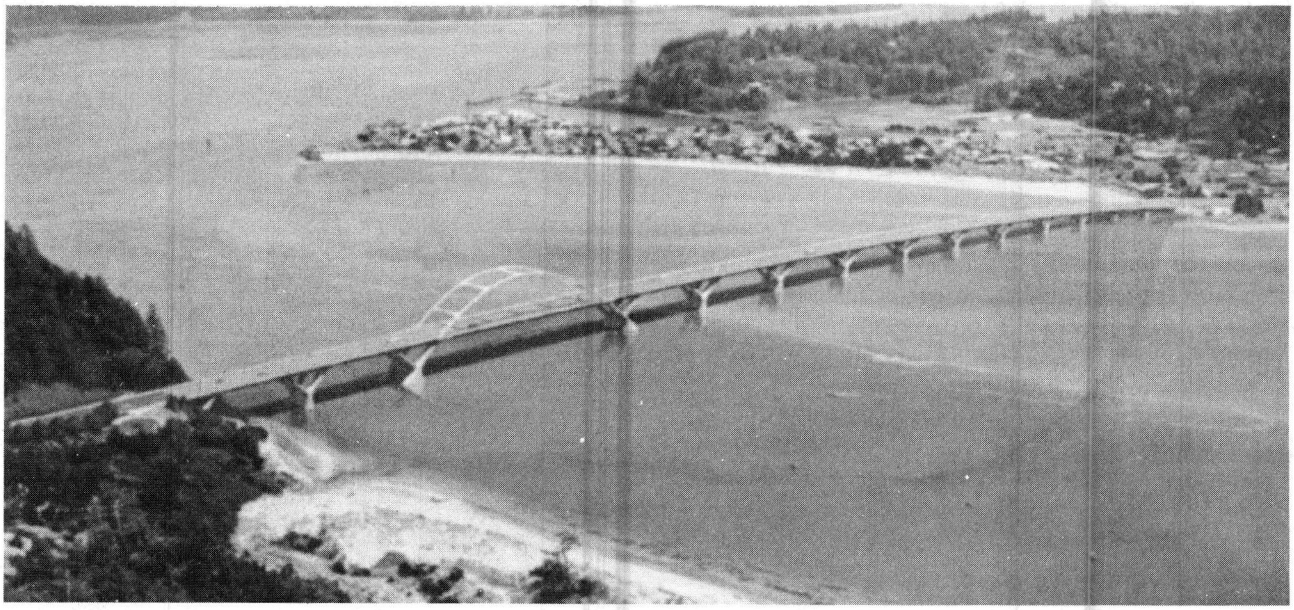

FIGURE 6 New Alsea Bay Bridge.

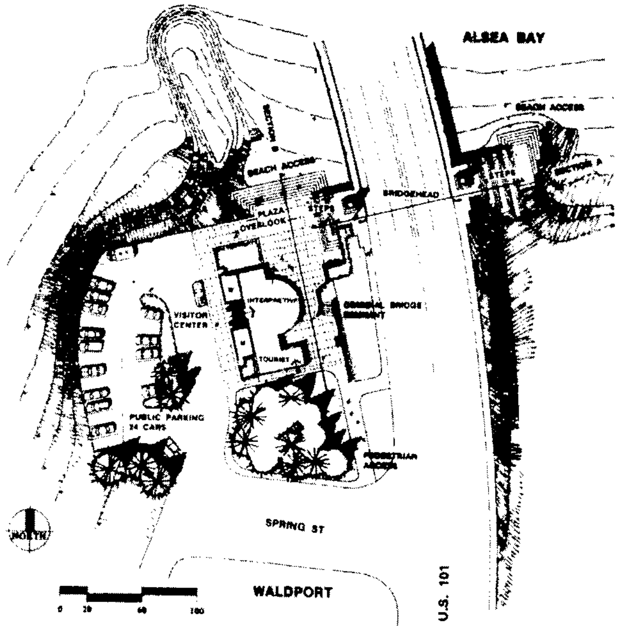

FIGURE 7 Plan view.

The pedestrian leaving the wayside to enter the beach is provided a viewing area of both the bay and the bridge. Handrails from the first bridge were preserved and reused. The original concrete pylons at the south abutment have been retained and serve as a bridgehead (Figure 8). These pylons are mounted on arch-shaped concrete supports and are placed over the sidewalks at the new south abutment location. The gothic arches of the pedestrian walk-throughs reflect the shape of the piers in the first Alsea Bay Bridge.

A wayside was also built at the north end of the bridge. This wayside, located well above the bay, offers a scenic vista of the city of Waldport, the bay, and the bridge. The concrete pylons at the north abutment of the first Alsea Bay Bridge have been left in place to enhance the view. These pylons are connected by a concrete handrail salvaged from the first bridge. The concrete spires that defined the entrance way to the through concrete arch spans of the first bridge, seen in Figure 3, now provide definition to the north wayside.

Lighting has also been provided to enhance the appearance of the bridge. Reflective architectural lighting of the arch spans, the delta piers, and the bridge head were provided in addition to the roadway illumination.

Conclusion

Historic bridges that can no longer safely serve their transportation function can be replaced with the support of the local community. Education of the community as to the necessity for replacement and then involving the community in key design decisions can be an effective means of obtaining support for the bridge replacement. Preservation of elements of the existing bridge in the new structure can also mitigate the loss of the bridge.

The successful completion of the new Alsea Bay Bridge demonstrates that historic bridges can be re-

FIGURE 8 Bridgehead at south abutment.

placed and the replacement can satisfy the local community's needs. The new bridge is not only serving its transportation function but it is continuing the tradition of the first bridge. The bridge continues to provide a focal point for the city of Waldport. The concrete piers and superstructure carry on the material composition of the first bridge. The delta piers and the post-tensioned concrete of the superstructure use current technology, similar to the designs of Condon McCullough. The two-hinged steel arch reflects the structure type of the first bridge.

The bridge is owned by the Oregon DOT. The design of the bridge was completed by the HNTB Corporation in 1987. CH2M Hill provided geotechnical engineering and structural design, CENTRAC Associates provided approach roadway design, and Zimmer-Gunsul-Frasca Partnership provided urban design. The bridge was constructed by General Construction Company for $38,000,000 and was opened to traffic in 1991. Upon completion of the bridge, the existing bridge was torn down, but not forgotten.

REFERENCES

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