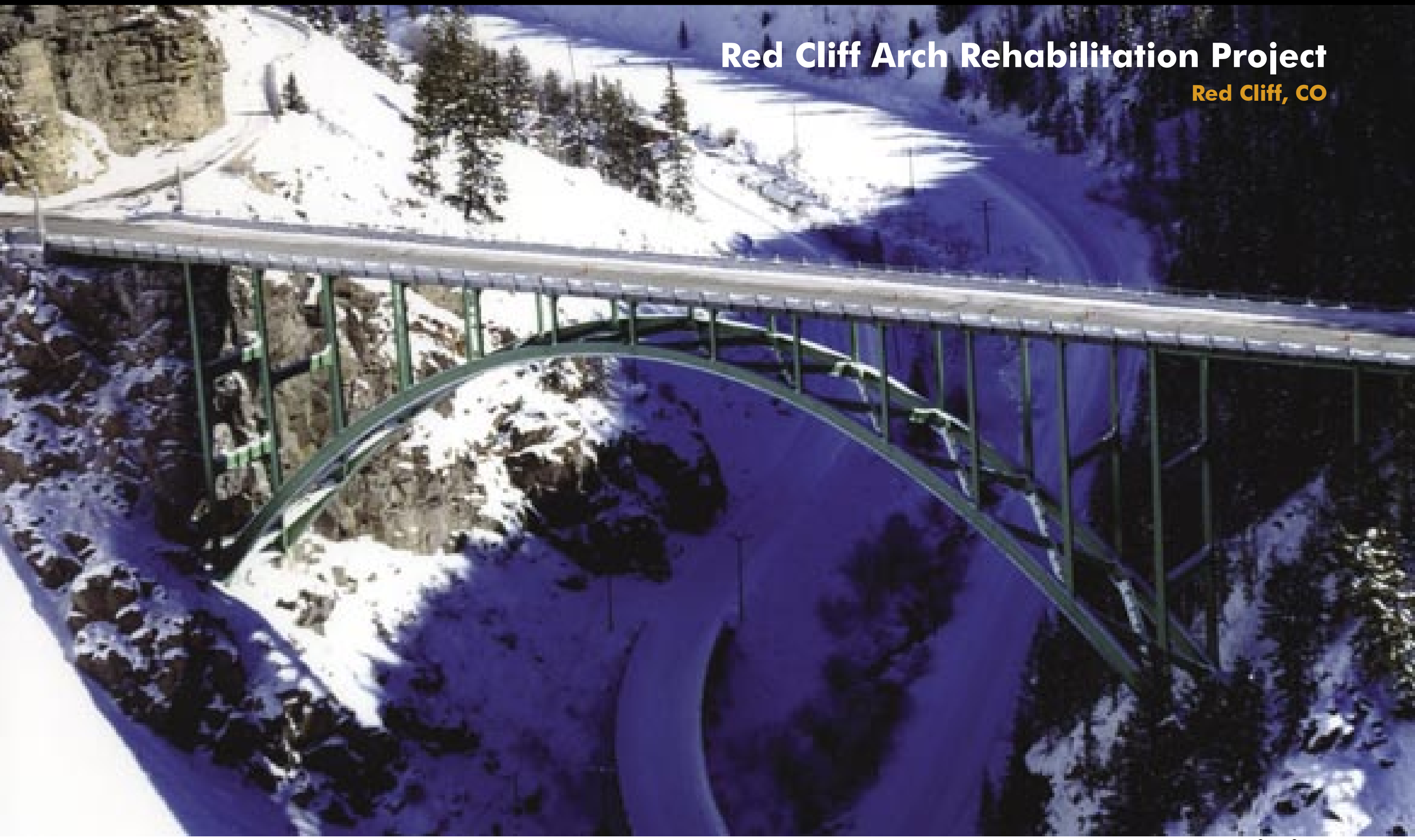
NATIONAL AWARD

RECONSTRUCTED

Red Cliff Arch Rehabilitation Project

Red Cliff, CO



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Located near Red Cliff, CO, southwest of Vail on U.S. Highway 24, the Red Cliff Arch Bridge was originally completed in 1941. Sixty-three years later, the bridge was in dire need of help. Due to age, as well as loads and traffic that were not envisioned in the 1940s, the bridge needed an extensive rehabilitation.

The newly rehabilitated Red Cliff Arch Bridge was dedicated in November 2004. Preserving the structure's historical integrity, while updating it to current safety standards and strength requirements, was the driving force behind the project.

Safety was also a critical concern during construction. With the bridge 200' above a valley floor, traditional scaffolding was not feasible. The bridge crosses over an existing county road, a river, and a railroad. Any falling material would have been hazardous not only to the public, but also to the environment. A hard platform scaffolding system was required and provided several safety and schedule benefits.

Owner
Colorado Department of Transportation, Denver

Engineer of Record
Colorado Department of Transportation, Staff Bridge Branch, Denver

Engineering Software
SAP2000
Georgia Beam

General Contractor
Lawrence Construction Co., Littleton, CO

Since Highway 24 is the main access to this popular ski destination, closure of the highway was a concern. In order to achieve a superior concrete product for the deck, a complete closure for the bridge was deemed necessary. To minimize the impact on the town, the contract required the bridge to be completely closed from April until July. After the first of July, the bridge needed to be open to at least one-way traffic. This closure would provide the least impact to the ski traffic as well as for the summer tourist season. Once available, the second lane could be used for storage of construction equipment for continuing work on the bridge.

The bridge width was increased to 6' in order to increase safety for the increasing bicycle traffic along the route, as well as for regular traffic. The bridge was modeled using finite element modeling software to determine the allowable increase of dead loads.

A SAP computer model was used to determine allowable construction loads as well as removal and placement sequences. It was decided to keep the new dead loads on the bridge the same as or less than the original dead loads. This simplified the design by removing the necessity of checking all the existing connections. A bare concrete deck was used to minimize the dead loads. Because of the widening, the overhang became larger. To minimize the effects of the large overhang, a mandatory construction joint was placed beyond the exterior stringer. The core of the deck was placed first and allowed to gain strength. The curb and remaining deck was then placed with their loads distributed to the newly composite bridge core. To increase strength of the rehabilitated bridge, shear studs were added to stringers to create a composite deck.

Girder flanges ¾" and thicker of ASTM A7 steel were preheated in order to weld the shear studs. The composite strengthening allowed the load restrictions to be removed from the bridge.

Due to the action of the arch, both the removal and replacement sequence of the deck was rigorously controlled. The removal of the existing bridge deck was required to be symmetrical about the center of the arch. The contractor was allowed to be only two spans out of symmetry at any one time. The removal process was aided by the fact that the original deck had not been made composite with the stringers.

Because the stringers were embedded in the deck, the exact conditions of the top flanges were unknown. Ultrasonic testing conducted before construction indicated little section loss. A contingency plan was formulated to deal with any excess corrosion that may have been found on the flanges. Excessive corrosion was not discovered and remediation of the existing steel stringers was minimal. The new deck pour was also controlled to minimize deflections. With the help of the finite element model, acceptable deflections were determined and the pour sequence evaluated. Field measurements during the pours corroborated the computer model's estimates.

Although there had never been any accidents on the bridge, a new safety rail was added to the bridge to protect the public. The original silver painted ornamental rail was stripped, cleaned, and then galvanized. It was then placed on concrete corbels outside of the safety rail. These corbels were added to maintain the original appearance of the bridge.

The steel superstructure required some minor modifications during the rehabilitation. Due to rock fall near the northern abutment, several members had been bent and damaged. These members were heat-straightened prior to being repainted. In order to prevent future damage, the rock face was netted and anchored. The netting is almost invisible and does not affect the visual appearance of the bridge.

The original clip-angle stringer connections were showing signs of distress. Some had already cracked and had been previously repaired. Where space allowed, these connections were made redundant by adding new angle supports. The original support brackets used during construction were removed in order to install the new support angles. Where space or connection details precluded the use of the new support angles, the original A7 steel angles were replaced.

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Unfortunately, the connections of the columns to the arch also proved to be conducive to corrosion. Pockets of debris formed on the upper side of the connection which exacerbated the corrosion potential. In an effort to minimize the problem, larger holes were added to allow the debris to pass. This also allowed construction personnel to clean out accumulated debris due to the crumbling deck from the interior of the columns.

Due to water draining down the arches, corrosion on the concrete piers was also a continuing problem. The piers were rehabilitated during this project to replace the deteriorated concrete. Flow diverters were added at the base of the arches to minimize the future damage.

Forty percent of the project cost included removing the old paint system and repainting the bridge. Due to the age of the bridge, lead-based paint was assumed to be present. A containment system was required on the bridge for the complete capture, containment, and collection of all coating debris, spent abrasives, and dust. The new coating consisted of a three-ply paint system, an organic zinc primer, an epoxy intermediate coat, and an aliphatic polyurethane top coat. ★