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Accelerated Bridge Construction on Maui's Hana Highway †

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Abstract: Through the partnership between the Hawaii Department of Transportation (HDOT) and the Central Federal Lands Highway Division (CFLHD) of the Federal Highway Administration, six of the bridge structures along the State-owned portion of the Hana Highway will be replaced. Due to the nature of this road, and the limited opportunities for detours and road closures, along with context-sensitive solution design and right-of-way considerations, these structures will be replaced utilizing an accelerated bridge construction (ABC) technique known as a lateral bridge slide. To our knowledge, this project will be the first implementation of this ABC technique.

Keywords: accelerated; bridge; construction; Hana; highway; lateral; slide; FHWA; ABC

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1. Introduction

The Central Federal Lands Highway Division (CFLHD), in partnership with the Hawaii Department of Transportation (HDOT), is preparing to deliver a construction project to replace six bridge structures along the Hana Highway on the northeast coast of Maui, Hawaii (See Figure 1). The Hana Highway is an iconic thoroughfare, stretching over 50 miles, with over 600 curves and nearly 60 bridges, many of which are one-lane bridges. Through extensive coordination with stakeholders, and outreach to the public, the bridges are being replaced in a context-sensitive manner, to continue to contribute to the character of the Hana Highway, which is a historically significant asset, subject to compliance with Section 106 of the National Historic Preservation Act, among other federal, state, and local regulatory compliance requirements.

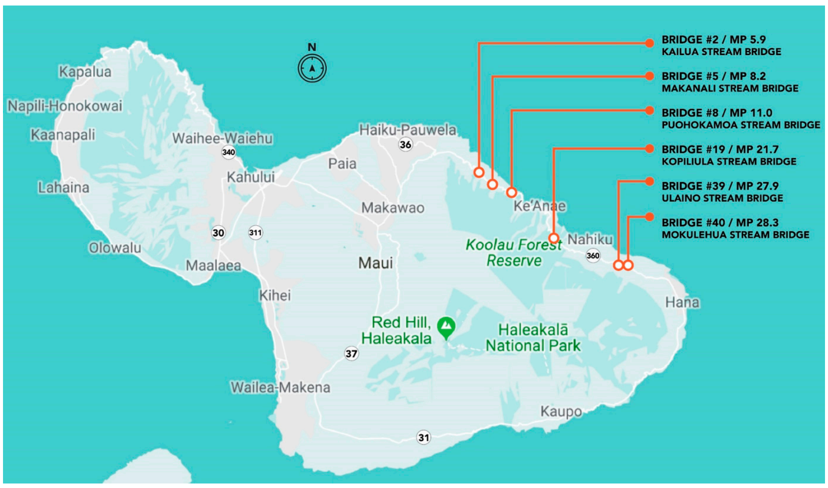

Figure 1. Hana Highway bridge replacement locations. (Source: FHWA-CFLHD).

In general, the existing reinforced concrete superstructures will be replaced by similar, one-lane bridge superstructures, capable of supporting modern AASHTO LRFD Bridge Design Specification loads, and including upgrades of key safety features, such as bridge railings, in a context-sensitive manner. The existing bridges are typically supported by either concrete rubble masonry (CRM) abutments, or reinforced concrete piers and abutments, flanked by CRM wingwalls. For each of the bridges, these abutments, piers, and wingwalls are considered to be key contributing elements to the character-defining features of the structures, and attempting to preserve these elements of the bridges was considered to be of paramount importance during design development. Because of this, five of the six bridges will be replaced by constructing a new superstructure, in a context-sensitive manner, which will be supported on micropile foundations located behind the existing structures. The bridge foundations will be hidden from view, and concealed behind the original bridge abutments and wingwalls, which are to remain, as shown in Figure 2.

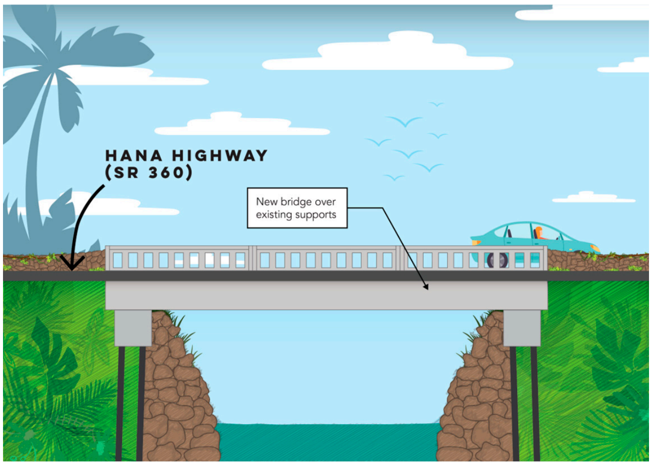

Figure 2. Artistic schematic of a typical longitudinal section of the proposed Hana Highway bridges. (Source: FHWA-CFLHD).

The Hana Highway is the only viable route for the travelling public between Maui's central valley, including urban areas such as Kahului and Wailuku, and the community of Hana, on the east side of Maui. Additionally, there are communities along the Hana Highway that rely on this route for not only commuter travel, but also for the commerce the highway provides, as one of the top tourist destinations on Maui. There is no viable detour, and long duration closures of the Hana Highway would cut off each of these communities, and result in significant economic loss. These constraints necessitate the need for an accelerated bridge construction (ABC) solution, or a temporary bridge, during the construction.

Although temporary bypass bridges are commonly used in bridge construction throughout Hawaii, they were not considered to be a viable option for the bridges proposed to be replaced along the Hana Highway. This is largely due to the limited right-of-way (ROW) information available to determine property ownership along the Hana Highway. With limited ROW information available, the property research process to obtain an easement for a temporary bridge would be extremely onerous and detrimental to the project schedule, as it would take years of research, going back to the Great Mahele of 1848.

As a result of the constructability and alternatives analysis summarized above, ABC was considered to be necessary for this project. After consultation with CFLHD, HDOT, industry constructability professionals, and community stakeholders, the lateral bridge slide ABC technique was considered to be a potential construction methodology.

2. Lateral Bridge Slide—What Is It?

The lateral bridge slide technique, or slide-in bridge construction (SIBC), as titled by the FHWA Every Day Counts program, entails the construction of a new bridge superstructure immediately adjacent to the final alignment on a temporary support structure, and the structure being slid into place. In general, the structure is slid into place by placing the structure on rollers or a sliding surface, and either pushing the structure with hydraulic jacks or post-tension jacks, or pulling the structure through the use of winches or pulley systems. This allows vehicular traffic to continue to utilize the existing facility, while the new structure is constructed. Then, under a short-duration closure (typically 2 to 4 days), the new structure is slid into place, as shown in Figure 3, and traffic is re-established.

Figure 3. General schematic of the lateral bridge slide technique, and a view of the typical site conditions around the structures. (Source: https://www.youtube.com/watch?v=YzYCSw5mACQ, accessed on 7 July 2023, FHWA—CFLHD).

2.1. Lateral Bridge Slide—General Design Considerations

In general, the design procedure for a slide-in bridge is not very different from that of a conventional bridge. The permanent loading is nearly identical to a typical bridge design, although consideration should be given to the increased stiffness of the end diaphragms and regions near the bearing areas and/or sliding surfaces, in order to avoid secondary stresses and/or cracking due to fluctuations in support (i.e., the temporary loss of contact of a portion of the sliding surface) during the slide. Additional stiffness near the supports allows for the redistribution of temporary loading throughout the transverse width of the structure, and avoids concentrating these temporary stresses on the immediately adjacent elements.

Generally, in a design-bid-build procurement, the temporary works associated with supporting the new superstructure off-line, and the slide procedure itself, is designed by the contractor, with the parameters and special requirements provided in the contract specifications, to aid in the contractor's design. The design for the loading on the temporary support is generally in conformance with design guidelines, such as the AASHTO Guide Specifications for Bridge Temporary Works, as an example. For sliding forces, it is common to consider up to approximately 20% of the dead load as a lateral design force during construction on the temporary works and on the permanent structure. Further consideration, to determine the application of the force, is contingent on the method of anchoring the jack or pulley system [1].

2.2. Recent Examples of Lateral Bridge Slides

The lateral bridge slide technique has become fairly common in the United States. Some recent bridge slide examples within the last decade include the following structures:

- The Sellwood Bridge Replacement in Oregon
- The Mesquite Bridge Project in Nevada
- The I-84/Dingle Ridge Road Bridge Slide in New York
- The SR-201 Bridge in Utah

For more information related to the lateral bridge slide technique, below are a few technical resources which review design, construction, contracting, cost estimating, and key elements of the lateral bridge slide technique:

- FHWA Every Day Counts Slide-In Bridge Construction [2]
- Florida International University ABC University Transportation Center Project and Research Database [3]
- Iowa State University Institute for Transportation [4]

3. Hana Highway Bridges—Potential for the Lateral Bridge Slide Technique

The proposed superstructure will be slightly longer that the existing bridge, to preserve the existing substructure and foundation elements, as part of the historic mitigation strategy. The proposed structures along the Hana Highway are single-span structures supported on simple, semi-integral abutment caps over drilled micropiles. The construction of the substructure elements, behind each existing abutment, is anticipated to be performed utilizing overnight closures of the Hana Highway. During daytime hours, the work areas could be plated over, to allow traffic to operate normally.

The temporary supports for the construction of the new structure could be constructed adjacent to the existing structure, to allow the existing structure to remain in service. Due to the challenging, steep topography near the structures, foundation system(s) will need to be constructed as part of the temporary support structure.

Once the new superstructure is complete, and the on-alignment substructure is installed, the roadway will be shut down to allow for the slide installation procedure. It is anticipated that this shutdown will last for up to 4 days. Advanced communication and coordination with local emergency services is critical during the closure. Depending on the contracting and schedule, the coordination of the slide activities across several structures may be required, to minimize the closure times of the Hana Highway. To minimize traffic impacts, precast elements and high-early-strength concrete will be used to allow for one lane operations once the superstructure is slid into place. Temporary barriers placed along the travel lane will be used to allow for the cast-in-place operations to complete the exterior geometries of the slab, and the restoration of the site outside of the roadway, following the re-opening of the road. The generalized procedure for the potential use of the bridge slide technique for the Hana Highway bridges is presented in Figure 4.

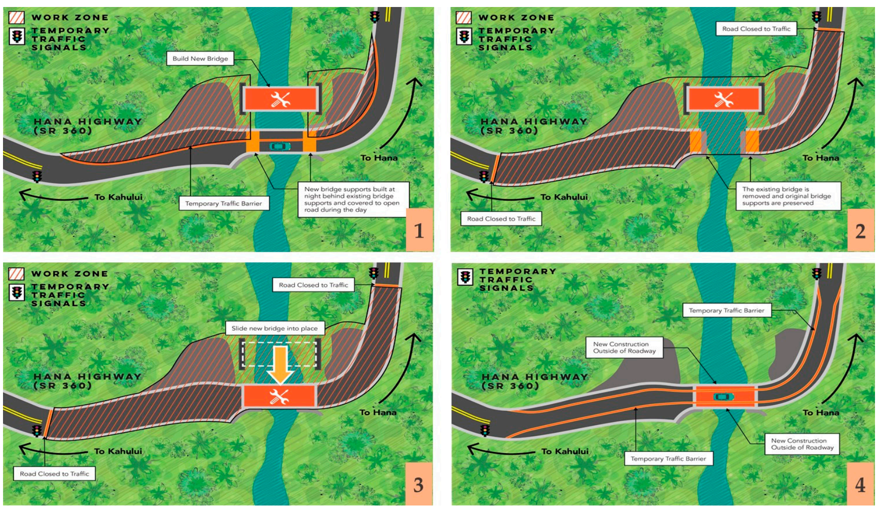

Figure 4. The generalized procedure for the potential Hana Highway bridges lateral slide. (Source: FHWA-CFLHD).

The construction is scheduled to commence in spring/summer 2025.

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References

1. Utah, D.O.T. *Michael Baker Corporation. Slide-in Bridge Construction Implementation Guide, Planning and Executing Projects with the Lateral Slide Method*; Federal Highway Administration: Washington, DC, USA, 2013.
2. U.S. Department of Transportation—Federal Highway Administration. Available online: https://www.fhwa.dot.gov/construction/sibc/ (accessed on 17 February 2023).
3. Florida International University—Accelerated Bridge Construction University Transportation Center. Available online: https://utcdb.fiu.edu/search/ (accessed on 16 February 2023).
4. Zhengyu, L.; Katelyn, S.F.; Justin, M.D.; Brent, M.P.; LaViolette, M. *Lateral Slide of Muti-Span Bridges: Investigation of Connections and Other Details—Phase 1*; Iowa State University Institute for Transportation: Ames, IA, USA, 2021.