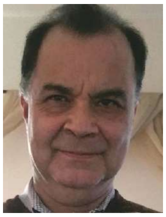
# Foundation Reuse: An Option for Bridge Reconstruction Projects



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According to Federal Highway Administration (FHWA) National Bridge Inventory 2017 data, 9% of bridges are structurally deficient and 15% are older than the average design life of 70 years for bridges.[1] Widening, replacement, or significant rehabilitation of these bridges, particularly those in urban areas, is challenging because of mobility and traffic demands. In many cases, bridges will require superstructure replacement, while the foundation still has significant functional value. Therefore, reuse of these foundations can result in significant time and cost savings.

## Reconstruction Options

*Foundation reuse* is herein defined as using existing foundation or substructure of a bridge, as whole or in part, when the existing foundation has been evaluated for new loads. Foundation reuse includes reuse of substructure components both above and below ground, including rehabilitation of existing substructure and foundation elements when the superstructure has been replaced.

Figure 1 illustrates different foundation construction options with the following descriptions:[2]

- In option 1, a new foundation is constructed that avoids the existing foundation. In this case, reconstruction is carried out at a new location without affecting the mobility on the bridge during construction, although switching to the new alignment may involve mobility impacts.
- In option 2, the existing bridge foundation is demolished prior to construction of a new foundation.
- In option 3, the existing foundation is reused as is, with or without minor repairs such as patching or chloride removal.
- In option 4, the existing foundation is reused but with some form of retrofitting or strengthening.

Options 3 and 4 illustrate foundation reuse. The remaining substructure elements of bridges in these two options may also be suitable for reuse, with or without rehabilitation.

The forthcoming *FHWA Best Practice Manual for Bridge Foundation Reuse* (available summer 2018 at www.fhwa.dot.gov/research/publications/technical) addresses critical issues encountered during decision-making on foundation reuse, such as assessment for structural integrity, durability, load-carrying capacity, repair, and strengthening. To highlight significant benefits of foundation reuse, the manual includes numerous case examples.

## Integrity Assessment

Existing substructure elements being considered for reuse have been exposed to the environmental elements, and they were not necessarily constructed with quality assurance/control practices consistent with modern code requirements. To redesign existing foundations that are compliant with the American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*,[3] there must be confidence in the material properties and the current condition of the substructure.

## Durability and Remaining Service Life

At the forefront of foundation reuse are the following two questions: First, "How much remaining service life does the foundation have?" Second, "Will the advanced age of the reused components increase life cycle costs?" Some issues, such as chloride ingress or carbonation in concrete, may have reduced the service life remaining without yet creating noticeable damage. Repairs performed on issues identified during the integrity evaluation, such as spalling or delamination, can have service lives, or expected service life costs, unlike those of an intact structure. In many cases, strengthening is employed to simultaneously aid with both durability and capacity issues by repairing existing damage or planning for future deterioration that lowers the capacity of the damaged element.

## Capacity Assessment

The overall goal of capacity assessment is to prove that a desired level of capacity exists

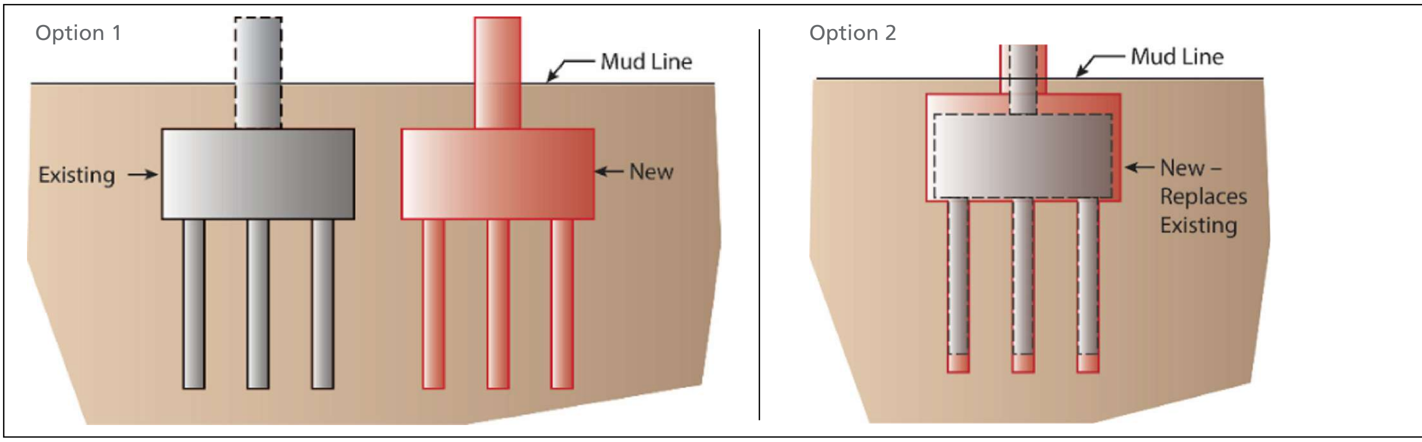


Figure 1. Foundation reconstruction options. Figure: Federal Highway Administration.

within the context of current AASHTO LRFD specifications and guidelines from state departments of transportation. The capacity assessment covers scenarios ranging from verifying original design capacity to determining load-and-resistance-factor design capacity for a foundation designed using allowable stress design or load factor design, and determining whether an increased nominal capacity is available (if there is reserve capacity). The capacity assessment would then be useful for determining the extent of strengthening required, if necessary.

## Innovative Materials and Foundation Enhancement

The integrity, durability, and capacity assessments provide a list of deficiencies associated with the substructure being proposed for reuse. The selection of foundation-strengthening measures considers the issues identified during analyses to produce an acceptable reuse design. A different approach could be to lower the weight of the superstructure with the usage of lightweight concrete. For example, using lightweight concrete for the bridge deck can lower its weight by 10% or more.

## Example: I-95 Replacement

The Interstate 95 (I-95) corridor replacement project replaced 11 aging and deteriorated bridges located near the junction with Interstate 64.[4] These bridges were subjected to high traffic volumes that could not be accommodated through diversion to local roads or other highways.

This ambitious project was a success, in part due to foundation reuse. The dead load on the foundations was reduced by about 7% with the use of lightweight concrete decks in the replacement superstructures. Substructures were repaired by providing corrosion protection for the existing foundations and reused; substructures for 10 of the 11 bridges were reused after installation of cathodic protection, while two required electrochemical chloride extraction. The use of prefabricated bridge elements meant that bridge and lane closures could be limited to weekday nights. The four-year project was completed more than three months ahead of schedule and at a savings of nearly $16 million compared with fully replacing the bridges.



## References


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