



# Existing Bridges: Widening, Rehabilitation and Replacement

An Online Continuing Education Course for Engineers

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## Introduction

Bridges are vital to our everyday lives. They help facilitate our transportation needs by easing travel time and connecting different regions throughout the world. Bridges facilitate transportation in cities, resulting in a growth in economic development and a migration of people.

Even though bridges are a necessity to enable this economic and population growth, older and functionally obsolete bridges can create a strain on the increasing highway volumes. This growth can negatively affect existing bridges, increasing traffic congestion and accident rates. This heightened traffic volume can overload an existing bridge because bridges were not designed to accommodate current design standards and practices. Overloading the bridge can compromise its structural integrity of the bridge and affect the safety of the public.

Local and state agencies have difficult decisions on how to deal with existing bridges that are structurally deficient or functionally obsolete. According to the American Society of Civil Engineers (ASCE) 2025 infrastructure report card, approximately 7% of the 600,000 bridges in America are under “poor” condition. While these bridges are not a cause for immediate alarm, they are susceptible to frequent rehabilitation and repair work. The Federal Highway Association (FHWA) estimates that bridge replacement costs total approximately \$70 billion and rehabilitation costs of approximately \$47 billion. The number of bridges that need considerable work compared to the available funding needed for these existing bridges yields a considerable deficit in America.

To address existing bridges that are structurally deficient or functionally obsolete, there are currently three alternatives that are considered: retrofit, widen the existing bridge, or replace the entire bridge. Each action will need careful consideration that focuses on public safety, constructability, cost, and long-term impacts. This course will go through the advantages, disadvantages, and limitations of each alternative as well as numerous case studies.

## Bridge Widening

Bridge widenings are used to make improvements to the existing roadway, such as larger shoulder widths, additional travel lanes, or a shared-use path for pedestrians and bicyclists. Widening an existing bridge ensures that future traffic volume is met and alleviates traffic congestion, helping to reduce accident rates.

Widening an existing bridge consists of installing additional substructure and superstructure units to connect to the existing bridge. Traffic is diverted or shifted to create a safe work zone for the construction of the bridge. Temporary walls are usually needed to retain soil for the temporary excavation of the permanent retaining walls or substructure units.



*Figure 1: Widening of Existing Bridge*

Before a bridge widening can be recommended as the preferred solution, a cost analysis is necessary to evaluate the feasibility of the proposed structure. Direct costs are all materials, labor, and construction costs that directly relate to the bridge. Indirect costs include maintenance and future repairs over the life span of the bridge. A comparison between direct and indirect costs is needed to analyze the feasibility and sustainability of the proposed bridge widening. While costs have a high significance factor, other factors must be considered before moving forward with a bridge widening as a practical alternative. These factors need to be carefully studied and thoroughly vetted during the project development phase.

## **Service Life Evaluation**

Service life evaluation is an essential factor to consider with bridge widenings. Bridges are currently designed for a minimum service life of 75 years, with older bridges originally designed for 50 years; however, the condition of the bridge can drastically deteriorate before the service life is reached. Bridges can become structurally deficient for many reasons, including higher traffic volume than originally designed, weather conditions that can lead to corrosion of reinforcement, and foundation issues due to erosion or scour.



*Figure 2: Existing Bridge with Corrosion (Source: ASCE)*

Bridge repairs and rehabilitation over the service life are regularly done, but can become expensive if it is a recurring problem. If the existing bridge is near the end of its service life or frequent repairs are needed to rectify structural deficiencies, the preferred recommendation is to proceed with a full bridge replacement.

## Maintenance of Traffic

In areas with high traffic volume (interchanges and highways), widening an existing bridge will require a complex maintenance of traffic (MOT) plan, arising from temporary construction challenges. Bridge widenings or replacements can take months to years until completion, depending on the complexity of the project. Ongoing construction means large work zones and temporary traffic shifts, increasing congestion and heightened safety risks for both the public and the workers. While only temporary, it creates frustration with local businesses and drivers. Site constraints of the bridge may require traffic to be closed during certain phases of construction, causing detours for an extended period. For example, if proposed girders involve temporary shoring at an intersection, no traffic can proceed in the area until the towers are removed.

While detours and temporary road closures are possible solutions for the challenges discussed above, they need to be considered early in the project development phase. If space limitations are a constraint, right-of-way acquisitions or temporary easements may be needed to construct the bridge. Identifying all stages of the bridge widening early will allow ample notice for the public and adjacent businesses to prepare accordingly.

## Bridge Widening: Sequence of Construction

A sample bridge widening sequence of construction is described below. The sequence of construction must ensure public safety, maintain a minimum number of traffic lanes to accommodate existing traffic volume, and remain constructible throughout all phases.

### Step 1: Divert traffic

The roadway and bridge are prepped to divert traffic. Temporary signs and traffic cones/barriers are placed to alert drivers of an upcoming construction zone. Temporary pavement and/or restriping may be needed as part of the phasing sequence. A temporary concrete barrier is placed along the longitudinal limits of the bridge to allow for a safe work zone and vehicular protection.

### Step 2: Install temporary retaining walls

The height of the bridge can vary depending on existing site conditions and span lengths. When a bridge is being widened, the existing retaining walls are modified to extend out to the limits of the new bridge. Limited space and site constraints will require temporary retaining walls for excavation. These temporary walls provide shoring for the construction of the new permanent retaining walls.

Mechanically Stabilized Earth (MSE) walls are commonly used at the bridge abutments. These retaining walls use compacted backfill and geotextile reinforcement to resist lateral forces from the soil. MSE walls will have an outer panel facing, adding a finished look. MSE walls that have been widened will also have a vertical rectangular panel at the interface of the existing and new wall to help against the differential settlement between the two walls.



*Figure 3: Finished MSE Wall After Widening (Source: Google Street View)*

During bridge widenings, temporary retaining walls such as sheet piles are placed parallel to the bridge adjacent to the widening limits. Once driven, the existing soil is excavated to the desired depth to construct the leveling pad and to place the geotextile reinforcement. Sheet piles may be steel or concrete, depending on availability and contractor preference. A combination system can also be used,

such as a timber-lagging wall or secant wall, when exposed wall height or unsuitable soil conditions require larger sections to meet design capacity or to avoid existing utilities or drainage structures. If the retained wall height exceeds a certain height or if soil conditions are not ideal, soil anchors may be required to resist the lateral loads on the retaining wall.

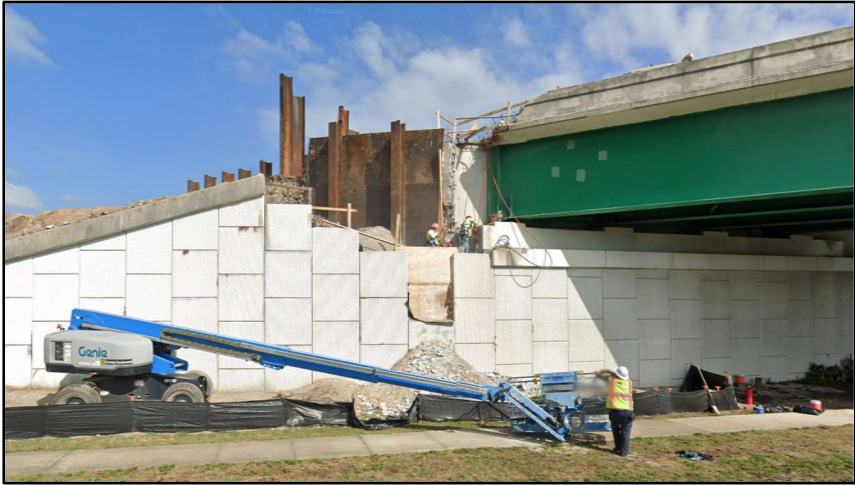


Figure 4: Temporary Retaining Wall, Pre-Excavation (Source: Google Street View)

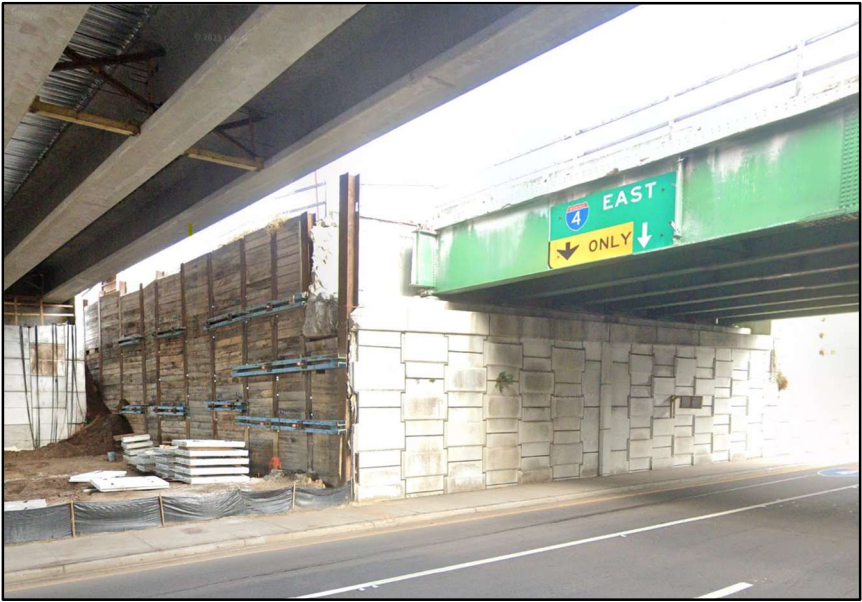
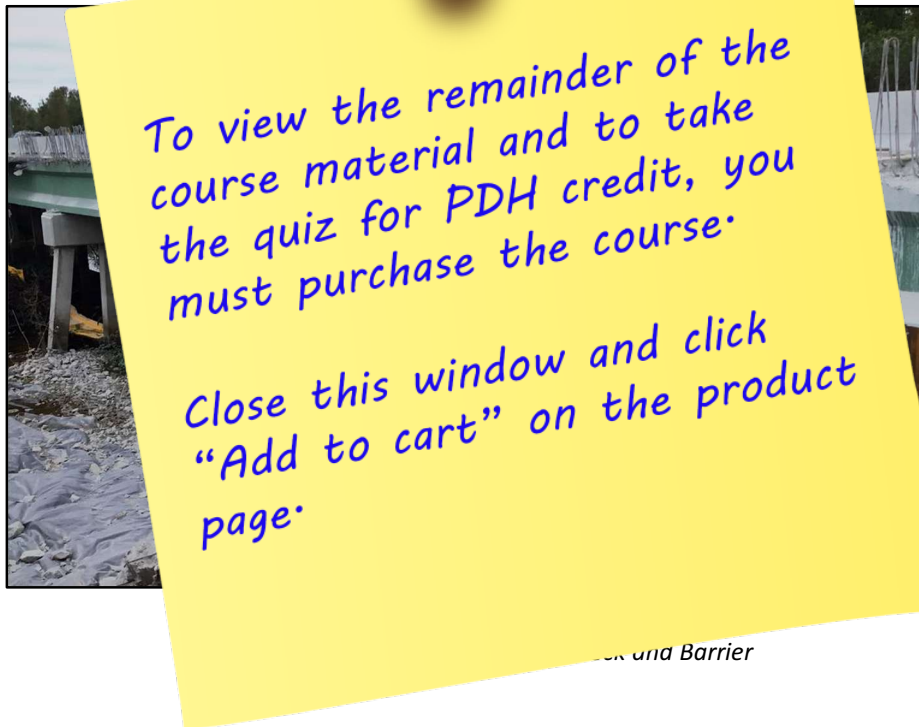


Figure 5: Anchored Timber-lagging Wall, After Excavation (Source: Google Street View)

### Step 3: Remove portion of existing bridge

A temporary barrier is placed to separate the existing traffic from the construction work zone. The existing barrier and a portion of the existing deck along the cutline are removed. Precautions must be taken to not damage to the existing girder top flange during the deck removal. Precautions must also ensure that the existing deck reinforcement is not damaged during removal, as it will be used to splice for continuity with the proposed bridge deck steel.

The existing substructure can also be removed. Existing piles and piers can be overloaded due to the addition of the new widening, or existing damage to the piers can result in a new proposed substructure. If existing piles/footings are not to be used, they are cut off a certain distance below the ground surface level and abandoned in place. This is due to the difficulties of extracting driven piles in situ, particularly concrete piles, which can crack during



### Step 4: Install proposed substructure

Piles are driven at abutments to their desired tip elevation. If there are intermediate piers, spread footings or pile-cap foundations will be needed for the bridge widening. The distance between the existing travel lane to the proposed pier foundation needs to be verified to confirm there is adequate clearance for driver safety. If the edge of the travel lane direction to the footing is too close and cannot provide adequate space for a temporary slope excavation, a temporary retaining wall system will be needed for stability.