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Guide for Widening Highway Bridges

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Guide for Widening Highway Bridges

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Many highway bridges become functionally obsolete due to inadequate width before they become structurally deficient. Widening is generally more economical than complete replacement. Thus, there is a mandate to share the results of research and experience pertaining to bridge widening. This guide discusses technical issues related to the widening of concrete bridges and bridges with concrete decks. The primary focus of this document is on bridge decks, even though substructure issues are raised and discussed. The effects of differential movements between the existing and new portions are discussed, including movements due to traffic on the existing structure during construction. General recommendations are made pertaining to the choice of structure type, design details, and construction methods and materials.

The materials, processes, quality-control measures, and inspections described in this document should be tested, monitored, or performed as applicable only by individuals holding the appropriate ACI certifications or equivalent.

Keywords: bridge decks; bridge widening; bridges (structures); concrete construction; deflection; formwork (construction); reinforced concrete; reinforcing steel; substructure; superstructure; traffic vibration.

CONTENTS

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Design and construction engineers should investigate several potential issues if a bridge is to be considered for widening. These include retention of bridge elements, traffic control, structural constraints, economy and feasibility, expected increase in traffic volume, life span, and construc-

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tion limitations. Certain elementary procedures should be followed to study the feasibility of widening. These include:

a) Review the drawings and specifications of the original structure.

b) Review any revisions of engineering documents (for example, plans, specifications, and design calculations) that might have been approved during the original construction.

c) Thoroughly inspect the structure and note changes to in-place conditions, such as deterioration of structural members due to environmental factors (for example, deicing salts, weathering, and collision of heavy trucks).

d) Obtain additional subsurface information to accommodate increased superstructure loads, including soil borings.

e) Review previous changes or upgrades to the structure.

f) Perform structural analysis with allowance for existing deterioration to confirm that the existing elements are adequate for increased loads (due to widening and compliance with current design standards). If the existing elements are part of the replacement, all possible geometric properties need to be considered.

One of the first considerations for widening a bridge is to determine whether to retain structurally adequate parts of the bridge deck. Entire bridge deck replacement should be considered if the bridge deck is severely deteriorated, the existing bridge deck will become less than a half of the new bridge deck width, or both (Seible et al. 1991; "Operation Bridgeguard" 1992). If the bridge deck, or a portion of it, is to be retained and connected to a new deck, the design should provide for bending moment and shear transfer through the longitudinal joint between the new and old portions of the bridge deck. The steel passing through the construction joint should be protected from possible increases in corrosion potential between the old and new concrete.

Another important matter is the consideration of whether substructures, such as footings, pier caps, and abutments, should be widened to accommodate widening a superstructure. Potential interaction between the new substructure and the existing substructure should be considered. The design professional should be aware of possible problems that could occur when a bridge is widened on both sides. In most cases, the existing portion is trapped between new sections, making it difficult to replace the middle section.

1.2—Scope

This document provides design professionals and constructors with general guidelines for bridge widening. The widening of highway bridges is commonly conducted to improve the functionality of existing structural systems. Several factors contribute to this demand:

a) Increased traffic volumes requiring additional lanes

b) Safety hazards of narrow bridges requiring wider shoulders

c) Provision for bikeways and pedestrian walkways

Government-funded programs are enabling public agencies to widen many functionally obsolete bridges as needed to improve safety. If a bridge was designed for current live loads and has not deteriorated appreciably, widening is likely more cost-effective than complete replacement. It is imperative to perform in-depth nondestructive testing (NDT) and invasive testing to quantify the level of existing concrete deterioration and section losses in existing sections, and design protection methods to prevent future deterioration prior to investing in widening a structure.

Many problems unique to bridge widening are not encountered in new bridge work. Failures or serious maintenance problems can be created by misunderstanding these problems. Each bridge widening is unique.

This guide emphasizes construction practices, but because construction sequence, structure type, framing details, and other decisions critical to the success of the work are determined during the design phase, some discussion of design concepts must be included. Structural analysis and design for widening bridges are not addressed. Much of the discussion that follows also applies to new bridges constructed in stages, part width at a time.

CHAPTER 2—DEFINITIONS

2.1—Definitions

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology," http://terminology.concrete.org.

CHAPTER 3—GENERAL DESIGN CONSIDERATIONS

3.1—General

Certain aspects of structural type selection, framing considerations, and design details are unique to bridge widening. AASHTO (2010) and others (Silano et al. 1992) provide specific design guidelines. Questions a design professional should consider before commencing design include:

a) By widening the superstructure, does the substructure also require widening?

b) Was widening the substructure foreseen in the design of the existing bridge?

c) Should one or both sides be widened?

d) Is a parallel structure justified as an alternative to widening?

e) Does widening the structure provide adequate vertical clearance?

f) Have geotechnical/ground conditions been evaluated?

g) Does widening provide an acceptable life for the existing section?

In general, current bridge codes and design loads applicable to the route on which the structure is located should be used for bridge widening. Constructing a widening to current standards creates the opportunity of later replacing or strengthening all or portions of the original bridge so that the entire structure can be upgraded.

Bridges to be constructed for special purposes (for example, military bridges) may require higher design loads than standard truck loads shown in AASHTO (2013) due to heavier traffic loads, a lack of load limits, or a lack of enforcement of load limits. Specific structural considerations may be necessary for widening a bridge in seismic regions; for example,