Guide Specifications for Wind Loads on Bridges During Construction

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INTRODUCTION

Wind load provisions in the *AASHTO LFRD Bridge Design Specifications* were developed for bridges after the deck is placed. Originally, these provisions traced their roots to research work performed in the early 1950s (Vincent, 1953). In 2015, AASHTO adopted new provisions for determining wind loads on bridges based on work by Wassef and Raggett (2014).

The response of bridge structures to wind loads before the deck is placed is significantly different from that of the completed bridges. The flow of wind around the structure and, thus, the wind pressure acting on individual girders is different. Another difference between bridges during construction and bridges in service is the short length of time expected between the erection of the girders and the placement of the deck. Wind maps used in *AASHTO LFRD Bridge Design Specifications* for bridges in service are based on 7 percent probability of exceedance in 50 years. During construction, the period between girder erection and the placement of the deck can be as short as a few weeks. For the same probability of exceedance, the wind speed decreases with the decrease of time period.

The basic general wind pressure equation used by many design specifications is as follows:

$$P_Z = \rho V^2 K_z G C_D$$

where:

P_Z = design wind pressure
ρ = constant related to the density of air
V = wind speed at a set elevation (usually 10 m or 33 ft)
K_Z = pressure exposure and elevation coefficient accounting for the effect of the elevation of the bridge or bridge component, site topography, and surrounding obstructions on wind speed
G = gust effect factor accounting for the distribution of wind pressure on the surface and/or the dynamic effects
C_D = drag coefficient accounting for the effect of the shape of the component on wind pressure

During construction of a multi-girder bridge, the drag coefficient varies from one girder to the next. Following are some of the factors affecting the drag coefficient for any of the girders in the cross section during the period between girder erection and deck placement:

- The Position of the Girder in the Girder Group—the windward girder is usually subjected to higher wind loads than other girders. The second girder typically sees a negative pressure, i.e. the pressure is in opposite direction to the wind direction. Wind loads start increasing for the following girders and generally become similar for girders six and higher.
- Type of Girder—steel I-girders, concrete I-girders and box-girders have different drag coefficients
- Geometry of the Girder Cross-Section—for the same type of girder, the geometry of the section affects the drag coefficient. For example, for the same I-girder depth, the drag coefficient varies with the variation in flange width. For box-girders, the drag coefficient is affected by the box width-to-depth ratio and by the slope of the webs.
- Ratio of girder spacing to girder depth
- The Angle between the Plane Passing through the Top of Girder Webs and the Horizontal—The value of this angle depends on the roadway cross slope or superelevation. The difference in this angle affects the flow characteristics of the wind around the girders and the resulting wind pressure.

Regardless of the differences between bridges during construction and completed bridges, very little research was performed on bridges during construction. Consolazio et. al. (2013), Consolazio and Edwards (2014), and Wassef and Raggett (2014) performed wind tunnel testing to determine wind loads on bridges during construction before the deck is placed. This work formed the basis for the design provisions presented herein. The proposed design provisions follow to a great degree the wind load design provisions specified in the *AASHTO LRFD Bridge Design Specifications,* but are modified to account for the difference between completed bridges and bridges during construction.

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TABLE OF CONTENTS

1—SCOPE

These guide specifications establish minimum requirements for wind loads on bridges during construction before the deck is placed. All other aspects of the design shall be performed in accordance to the *AASHTO LRFD Bridge Design Specifications* or as specified by the bridge owner, as appropriate.

C.1

The wind loads determined using these specifications are to be used for checking bridge girders, temporary and permanent bracing, and the permanent substructure during the erection of the girders and up to the time of placement of the deck. In cases where temporary bridge works, such as temporary support towers, are used during construction, the wind transmitted from the superstructure to the temporary components should be used in the design of the latter.

Except for determining the wind load from the superstructure transmitted to the temporary bridge works, all other aspects of the design of temporary bridge works should be performed in accordance to *AASHTO Guide Design Specifications for Bridge Temporary Works* (2017).