The Evolving Metropolis
2019 IABSE Congress
New York City

IABSE 90 YEARS

Rational Analysis for Understanding Skewed Steel Bridge Cross-Frame Behavior

Samir Bougacha, Ph.D., PE

Senior Supervising Structural Engineer

VRX Global, Inc.

Plano, Texas, USA
Samir.bougacha@vrxglobal.com

Samir Bougacha is a senior supervising structural engineer with VRX with nearly 3 decades of diverse experience in designing transportation and facility structures

Hongwei Cai, Ph.D., PE

Senior Structural Engineer

WSP USA

Dallas, Texas, USA
Hongwei.Cai@wsp.com

Hongwei Cai is a senior structural engineer with WSP-USA with 10 years of experience in structural analysis and design

Jeffry Booher, PE

Assistant State Bridge Engineer, Wyoming, DOT

Cheyenne, WY
Jeff.booher@wyo.gov

Jeffrey Booher is an assistant state bridge engineer for the Wyoming Department of Transportation Bridge Program

Marshall Newlin, P.E

Principal Bridge Engineer Wyoming, DOT

Cheyenne, WY
Marshall.Newlin@wyo.gov

Marshall Newlin is a principal bridge engineer for the Wyoming Department of Transportation Bridge Program

Contact: Samir.bougacha@vrxglobal.com

1 Abstract

The design of skewed I-girder steel bridges is common throughout the country. Such bridges have been fabricated and constructed and have generally performed well. Where issues have been encountered, they were primarily related to bridge construction and, quite often to the torsional behavior of the severely skewed bridge superstructure. Until recently, there have been few analysis and design guidelines available to the structural designer on the construction engineering of the skewed I-girder bridges. AASHTO [1] specifies that the contract documents should state the fit condition for which the cross frames are detailed for I-girder bridges. Recommendations are also provided for the estimation of the cross frame locked-in forces. This paper presents a case study in a fit-up analysis of multi-span skewed I-girder steel bridge using 3D finite element method modeling. Fit-up analysis was carried out to evaluate girder's web distortions, determine the cross-frames locked-in forces and compare them to the recent AASHTO's recommendations. The paper should provide designers with a more detailed understanding of a bridge's behavior in this condition as compared with the more generalized recommendations from AASHTO guidelines.

Keywords: I-Girders, Skew, FEM Model, Cross-frame, Dead Load Fit, Locked-in-forces, Layover.

2 Introduction

For horizontally curved or skewed steel I-girder bridges, assurance of fit-up is one of the critical attributes in the bridge construction engineering. AASHTO [1] provides a general guidance on the detailing of structural components using one of the three common fit conditions: No-Load Fit (NLF), Steel Dead Load Fit (SDLF), and Total Dead Load Fit (TDLF). NLF refers to the condition where the cross-frames are detailed to fit to the girders in their plumb position under zero load, in which case, the girder webs will be out-of-plumb after any dead load is applied. SDLF and TDLF refer to the conditions where the cross-frames are detailed to fit to the girders in their ideally plumb deflected position under the steel dead load and total dead load, respectively. National Steel Bridge Alliance, NSBA, Fit Task Force Committee [2] provides a set of recommendations on the level of steel detailing fit or lack of as a function of bridge skew index parameter, bridge skew angle, and span length. For this paper, the fit-up analysis was performed based

https://doi.org/10.2749/newyork.2019.1371
Distributed by Structurae