J. Civil Eng. Mater.App. 2019 (September); 3 (3): 149-161

Journal of Civil Engineering and Materials Application
Journal home page: http://jcema.com

Received: 13 April 2019 • Accepted: 15 July 2019

Research

doi:10.22034/jcema.2019.201428.1002

Evaluation of Seismic Behavior of Bridges under Effect of Abutment Modeling

Behzad Haseli

Department of Civil Engineering, Kharazmi University, Tehran, Iran.

* Correspondence should be addressed, Department of Civil Engineering, Kharazmi University, Tehran, Iran. Tel: 09373971292; Fax: +9888923503 Email: b.haseli@yahoo.com

ABSTRACT

These Bridges are vital part of the transportation network Department of Civil Engineering. Their destruction caused by the occurrence of a strong earthquake can cause irreparable damages to the regional economy. One of the effective factors on seismic response of a bridge is abutment and it's modelling. In most cases, analysis of seismic behavior and modelling of bridges is done using simplifying assumptions. This simplification may cause major changes in prediction of seismic behavior of bridges. Using simplified, roller and full models for abutment is very important in design and evaluation of seismic behavior of bridges. Backfill is a vital factor in modelling abutments. In this study, abutments were analyzed in three scenarios under records related to three stations of Imperial Valley earthquake (1979) and responses compare in two states with and without backfill. The results showed that minimum response (for deck, pier column and abutment) were related to the first modelling scenario (roller abutment) and maximum response were related to the fifth modelling scenario (simplified abutment as suggested by Shamsabadi for cohesive soil). Modelling of backfill was effective on displacement and rotation of pier column and displacement of deck and moment of abutment. For all records of earthquake, wall pier abutment (sixth scenario) was considerably consistent with modelling based on Caltrans guideline for sandy soil (second scenario). In height ranging from 5 to 9 meters, the suggested modelling (wall pier abutment) can be used instead of Caltrans method. In this height range, the results (maximum abutment displacement and abutment pressure) vary from 11to 23%.

Keywords: abutment modelling, soil-abutment interaction, abutment stiffness, roller abutment, simplified abutment.

1. INTRODUCTION

One of the effective factors on seismic response of bridges is abutment and its modeling. Seismic responses of different parts of a bridge modeled by considering soil hardness will be considerably different from the case where abutments are modeled a roller or simplified abutments [1, 2]. Hence, there are different methods for modeling abutments, such as:

1. Roller abutment
2. Spring abutment
3. Simplified abutment using linear springs
4. Complete abutment
5. Abutment modeling by considering the effect of soil-abutment interactions

Abutments are suitable for conveying forces of inertia at the time of the earthquake. Abutments are designed by considering governing principles of retaining walls based on soil resistant and active pressure theory. Most studies conducted on seismic response of bridges are related to dynamic behavior of bridge deck; little is known about the role of abutments in seismic response of bridges. Under San Fernando earthquake in 1971, it was found that resistance provided by abutment back wall has an important influence on dynamic behavior of some bridges [1]. Douglas and Davis (1946) suggested relations to calculate initial stiffness of rectangular abutment back wall [2]. In 1988, Wilson presented a relation to calculate maximum displacement of abutment back wall vertically and to calculate stiffness of abutment vertically [3]. These relations were used by Duncan and Mokwa (2001) to estimate stiffness of piles [4]. To study on the effects of different parts of resistant bridges under earthquake, important studies were conducted by megally and Zheng. By conducting large-scale experiments, Megally et al. (2001) presented a non-linear model for interior and exterior shear keys on abutments. Based on abutment back wall, Shamsabadi (2010) [5] calculated maximum displacement of abutment and determined equivalent hardness of backfill considering