

Vulnerability of Highway Bridges for Scour Problems

Darío Espinoza

Postgraduate Student
U Autónoma Metropolitana
D. F., México
espinfig@hotmail.com

Darío Espinoza, born 1985,
received his civil engineering
degree from the Instituto
Tecnológico de Tapachula,
Chiapas, México.

Consuelo Gómez-Soberón

Professor,
U Autónoma Metropolitana
D. F., México
cgomez@correo.azc.uam.mx

Consuelo Gómez received her
PhD in 2002 and she is professor
in the Structural Area.

Juan Javier Carrillo

Professor,
UNAM,
D. F., México
jjcas@pumas.ii.unam.mx

Juan Javier Carrillo is also
professor at the Universidad
Autónoma Metropolitana

Summary

In this paper we present a study of the behavior of common types of highway bridges in response to scour of their bearing elements, when exposed to design floods. For this purpose, we considered the inherent characteristics of the substructure and assessed potential failure conditions in relation to easily measurable parameters, which associate flood characteristics with a certain level of erosion of the stream bed. To conduct this investigation, we analyzed some of the expressions proposed in the literature to determine local scour at the pier base, in order to define the most influential parameters, which will be used jointly with the forces produced by the stream pressure of the water to reproduce the process of collapse or partial failure of piers. Simplified models were constructed, with which we obtained the response for rectangular piers considering the effect of scour.

Keywords: scour, bridge analysis, simplified models, parametric analysis

1. Introduction

One of the main problems found in a highway bridge that crosses a river under design flood conditions is erosion of the stream bed, which can be of such magnitude that it reaches the base of the bridge piers and consequently causes total failure of the structure. In addition, the information available is often insufficient to know in advance whether the conditions are critical.

In Mexico in recent years, extraordinary rainfall associated with the presence of hurricanes, mainly in certain regions of southern Mexico has resulted in substantial flooding. The floods have caused bridges to collapse, with the resulting loss of communications and emergency services to the affected communities. In 1943, the South Pacific Railway bridge sustained heavy damage due to the flooding of the Fuerte River, during a period of particularly heavy winter rains. Between 1973 and 1990, an annual average of flood damage of 173 billion pesos was reported for 1990 [1], without including non-quantifiable damages to the affected persons and production, as well as the death of approximately 104 people a year. Among damage sustained in this period, we can mention that caused by hurricane Janet, of September 30, 1955, which caused scouring of pier bases on a bridge in the Mexican state of San Luis Potosí. In October 2003, at the Infiernillo bridge, in the Mexican state of Michoacán, whose superstructure is formed by several sections of prestressed concrete girders and two central sections of trusses, scour caused one of the piers to tilt or collapse, requiring costly rehabilitation work [2]. In summary, bridges constantly present failures due to flooding or scour. For this reason, it is important to study the problem in depth to propose reliable and simple design and evaluation procedures that help to mitigate the damage.