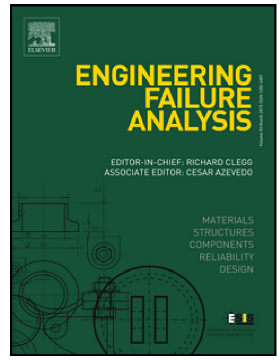
Accepted Manuscript



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PII: S1350-6307(17)30211-X
DOI: doi: 10.1016/j.engfailanal.2017.07.033
Reference: EFA 3251

To appear in: *Engineering Failure Analysis*

Received date: 24 February 2017
Revised date: 17 July 2017
Accepted date: 31 July 2017

Numerical study on damage mechanism of post-tensioned concrete box bridges under close-in deck explosion

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Abstract

To understand the behavior of post-tensioned concrete box bridges under blast loads, a typical concrete cantilever bridge is exposed to close-in deck explosion. The objectives of the current study are investigating the blast wave resonance entered into the box (confined condition) and the bridge's main components damage mechanism. For this purpose, 5, 150, 355, 550, 700 and 1200 kg TNT weights are chosen as load varying cases and parametric study analysis are done in two main explosion scenarios. Averagely, after the explosion, high impulsive blast loads hit the bridge deck and penetrate into the deck. Less than 5 percent of the incident blast overpressure succeeds to propagate into the box-shaped deck. However, according to the confined conditions within the box, blast waves can be amplified up to about 2.7 times. In most load cases, the concrete is damaged in the anchorage zone of some pre-stressing tendons, leading to the loss of effective post-tensioned forces. On the other hand, those tendons directly exposed to the blast impact are observed to be failed and the crushing of the concrete reduces the effective post-tensioned forces and stability of the entire bridge remains uncontrolled. Therefore, it is necessary to apply some energy absorbing or properly fused systems to reduce the close-in deck explosion effects. The obtained results can help bridge designers recognize weak points along post-tensioned box bridges under explosion loads and contribute into easier identification of retrofit and strengthening methods.

Keywords: Explosion; cantilever bridge; post-tensioned concrete; box-type bridge; blast simulation.

1. Introduction

As the number of terrorist attacks, wars, car accidents, explosion of fuel-carrying vehicles, and other blast-leading events increases, the need for studying and determining appropriate solutions to avoid undesirable damages to strategic and vital structures potentially exposed to such blast loads have been highlighted. During past decades, numerous blast accidents and terrorist attacks have occurred throughout the world, incurring a large deal of casualties and financial losses on damaged structures [1].

At the start of an explosion event, the state of explosive charges changes from solid to gas. The compressed gas pressure created by the explosion exceeds the ambient pressure. As a result,

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