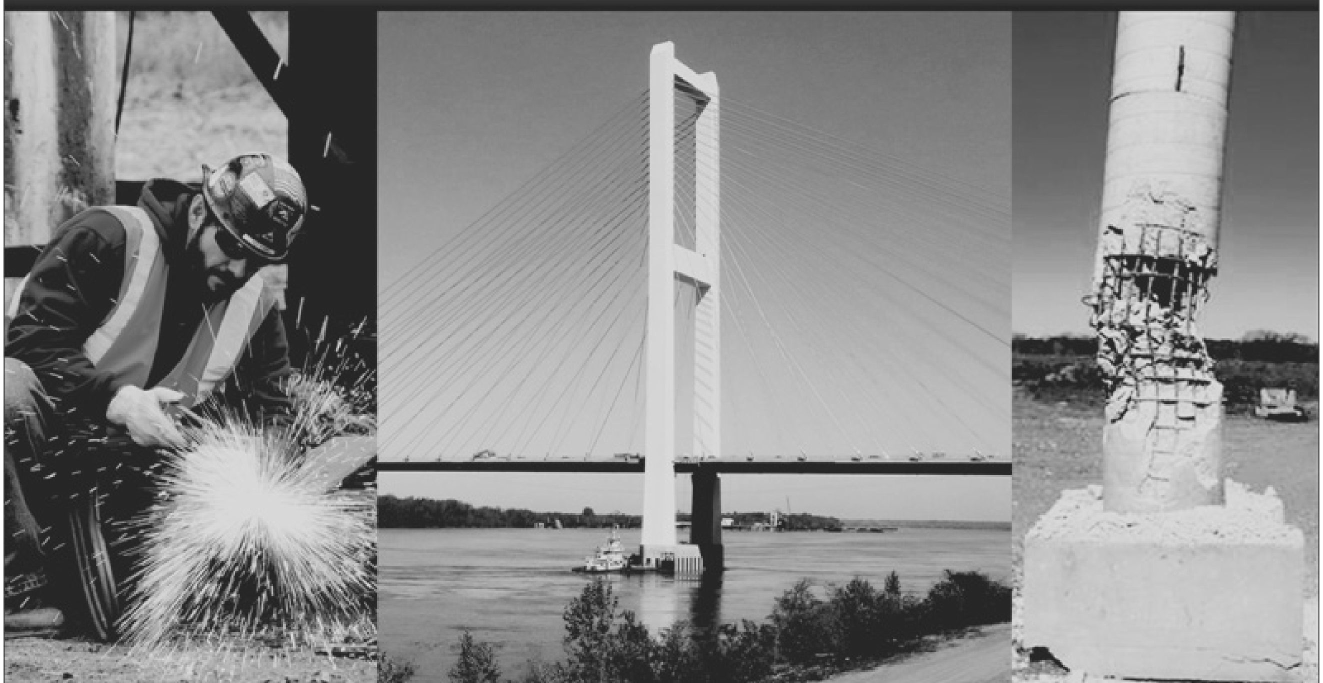
2011

Bridge Security Guidelines



American Association of State Highway and Transportation Officials

FOREWORD

The events that unfolded during the September 11 attacks on America prompted bridge engineers to face a new and unusual form of extreme event design. This new and unusual extreme event prompted the engineering community to consider blast-resistant design in bridge analysis. Historically designers considered extreme event design to be limited to natural phenomenon such as earthquakes. Until September 11, 2001, rarely in the history of bridge design have engineers entertained designing bridges for an extreme event induced by man.

Shortly after September 11, concerns of possible attacks on our nation's bridges led the United States government to initiate the Blue Ribbon Panel (BRP), a panel of experts comprised of the country's most accomplished and renowned bridge engineers. This panel, along with the American Association of State Highways and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA), was tasked with examining bridge and tunnel security; developing strategies and practices for deterring, disrupting, and mitigating potential attacks; and providing guidance to highway infrastructure owners and operators.

The knowledge and expertise of the BRP members laid the foundation for the understanding of bridge and tunnel security and are recognized for their significant contribution. Among the many BRP findings and recommendations are that outreach and education are needed to develop greater awareness and professional capacity to address bridge and tunnel security challenges. In their opinion, trained professionals are needed to understand and meet these challenges.

As a result of BRP's findings, the National Cooperative Highway Research Program (NCHRP) funded *Blast-Resistant Highway Bridges: Design and Detailing Guidelines,* hereafter referred to as NCHRP 12-72. For this project, a research team was tasked to develop, design, and detail guidelines for improving the structural performance and resistance to explosive effects for new and existing bridges.

This research was conducted by Eric B. Williamson, Ph.D., Associate Professor of Civil Engineering at the University of Texas at Austin. Dr. Williamson also served as the project's principal investigator. In the interim, the AASHTO Subcommittee on Bridges and Structures (SCOBS) formed a new technical committee on bridge and tunnel security called Technical Committee T-1 and was responsible for the review of NCHRP 12-72.

By February 2010, NCHRP 12-72 was published as NCHRP Report 645, *Blast–Resistant Highway Bridges: Design and Detailing Guidelines.* This document provided scientific experiments, background, and analytical research for bridge engineers looking for design solutions to enhance the structural performance and resistance of concrete bridge columns.

Because of the demand on bridge engineers to minimize risk of damage to bridges and human life, AASHTO and FHWA considered the development of an AASHTO guide specification based on NCHRP 12-72 to be of high importance. Naturally, Dr. Williamson was considered to be the most logical source to prepare such document and its first draft was presented to Technical Committee T-1 for review and comments. In Fall 2010, the committee approved this document and placed it on the 2011 SCOBS annual meeting ballot items for adoption.

In May 2011, this agenda item received SCOBS's favorable vote and the document was titled as a guideline rather than a guide specification.

How to Use This Guideline

This stand-alone document and its content is provided to the designer as a guideline and not design specification. Because the subject of blast and bridge security is complex, the research under NCHRP 12-72 was confined to common bridge structures rather than unique bridges.

The research focused on columns because they are integral to virtually all bridges regardless of the superstructure type. Additionally, because the loss of a critical column could compromise the integrity of most bridges, the research team elected to focus its efforts on reinforced concrete columns.

Although this document provides the designer with information on the response of concrete bridge columns subjected to blast loads as well as blast-resistant design and detailing guidelines and analytical models of blast load distribution, it is not the end-all answer to every question that exists on this subject. In contrast, this guideline document and its research shall be considered as the stepping stone toward the education this subject truly deserves and shall receive in future years.

The content of this guideline should be considered in situations where resisting blast loads are deemed warranted by the owner or designer. In such situations, blast load shall be applied in combination with all other applicable loads and other factors should be considered, such as the possibility of scour as well as intentional vessel collision.

Ultimately, mitigation measures may be the most cost-effective and practical means to enhance bridge security against blasts.

In some situations, depending on the nature and size of threat, these guidelines can result in outcomes that the owner or designer may consider infeasible and perhaps even unreasonable. Such outcomes may be an indication of severity in design assumptions such as excessive explosives (amount of TNT), inadequate stand-off distance, or both. In such scenarios, owners and designers are encouraged to modify their design assumptions, such as stand-off distance, until they are able to arrive at tolerable design and detailing solutions.

Finally, these guidelines are not intended to be comprehensive; in fact, there are no recommendations in this document to design for a size of explosive or an appropriate stand-off distance. Such parameters are left to the discretion of owners, because they are in the best position to evaluate the specifics of a given situation.

Article numbering in NCHRP Report 645 was tied to that of *AASHTO LRFD Bridge Design Specifications*. Because this report has resulted in a stand-alone publication, it has been renumbered sequentially and article headers have been added in two cases. Table i-1 is included for those who are familiar with the NCHRP report. Appendix numbering has also been added for the user's convenience; see the Table of Contents.

Table i-1—Conversion of NCHRP Article Numbering to Sequential Numbering

Old Article Number (Referenced to LRFD)	New Article Number
2.7	1
2.7.1	1.1
2.7.2	1.2
2.7.3	1.3
2.7.4	1.4
—	2
3.4	2.1
3.7.5	2.2
3.14	2.3
3.14.16	2.3.1
3.15	2.4
3.15.1	2.4.1
3.15.2	2.4.2
—	3
4.7.6.2	3.1
4.7.6.3	3.2
5.10.13	4
5.10.13.1	4.1
5.10.13.2	4.2
5.10.13.3	4.3
5.10.13.4	4.4

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