

ACI 370R-14

Report for the Design of Concrete Structures for Blast Effects

Reported by ACI Committee 370



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Report for the Design of Concrete Structures for Blast Effects

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Reported by ACI Committee 370

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This report addresses the design of structures to resist blast effects due to explosions. It describes the state of the practice for the guidance of structural engineers charged with the design of civil facilities that may be subjected to blast loads. This report addresses the steps commonly followed in this practice, including determination of the threat, calculation of structural loads, behavior of structural systems, design of structural elements, design of security windows, design of security doors, and design of utility openings. These steps can be applied to the design of new structures or to the retrofitting of existing structures.

Keywords: blast; blast analysis; blast-resistant buildings; blast-resistant design; ductility; dynamics; explosions; retrofit for blast; shock; overpressure.

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CHAPTER 1—INTRODUCTION

The design of concrete structures for blast resistance has been of great interest to the military and other federal agencies for several decades. In addition, certain specialized segments within the engineering community have also had to consider blast loads on structures as a result of potential accidents. For example, the petrochemical industry has designed for blast resistance in their facilities for many years. Even though there is considerable history in the design of structures to resist blast effects resulting from accidents or intentional acts, it is only recently that the general structural engineering community has shown a strong interest in the response of structures subjected to explosions and other high-rate loading phenomena, such as impact.

Following the attacks on the World Trade Center in New York and the Pentagon in Washington, DC, on September 11, 2001, the vulnerability of the nation's infrastructure to terrorism became a top priority for many state and federal government agencies as well as private consulting engineers. Though the significance of these attacks greatly increased engineering interest in the design of structures to resist extreme loads, statistics show that US interests have been targeted by terrorists with increasing frequency during the last several decades ([U.S. Department of State, 2003](#)), leading to significant financial and personal losses. As a result, the engineering community has learned important lessons that have allowed for improved methods of analysis and design to be developed. For example, lessons learned from the Oklahoma City bombing in 1995 and the U.S. embassy attacks in Tanzania and Nairobi in 1998 shaped present design guidelines for prevention of progressive collapse.

While the field of blast- and impact-resistant design is not as mature as other fields, such as seismic-resistant design, historical events such as those described are important to note because they help shape current practice and research interests. Just as the field of seismic-resistant design has advanced by learning lessons from past incidents, engineers working in protective design can similarly benefit from being aware of historical events and corresponding data. Although such information is typically outside the scope of work routinely undertaken by design engineers, awareness of these issues is important for understanding potential threats and associated loads that may result. While historical data can be used with reasonable confidence for predicting natural loads such as earthquakes and floods, the same claim cannot be made for man-made loads associated with potential terrorist threats. Thus, the intent of the discussion herein is to bring awareness to engineers and designers that many factors can influence the loads to which a structure may potentially be subjected, and it is only through awareness and consideration of the factors that affect the threat environment that engineers can estimate design loads.

1.1—Overview of report

Given the trends in terrorism and the required protection of building occupants at petrochemical facilities, it is clear that structural engineers must be able to design structures