Reliability of RC members submitted to gas explosions

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Abstract

The present contribution addresses the reliability level implicitly required by the current design codes for the principle load-bearing elements (beams and columns) in ordinary RC structures exposed to accidental situations associated with gas explosions. A representative set of members is defined varying the parameters with the greatest effect on design within reasonable ranges. Following the establishment of the significant hazard scenarios, limit state functions for the relevant member failure modes are defined taking account of dynamic effects induced by high loading rates. Subsequent to a strict member design ($E_d = R_d$) according to a consistent set of codes, structural failure probabilities are derived and analyzed in the light of target ceilings demanded by current codes. The findings may be used to deduce structure-related risks and acceptance criteria for their assessment. Such criteria would facilitate rational decisions on both, the need and the appropriate choice of risk-reduction measures to counteract the effects of gas explosions in buildings.

Keywords: reliability, risk, probability, explosions, blast, accidental actions, reinforced concrete, building structure, acceptance criteria, codes

1 Introduction

Gas explosions account for a substantial number of accidental actions in buildings [1]. Recognizing the associated hazard potential, gas explosions are explicitly dealt with in the Eurocodes where they are demanded to be accounted for "in the design of all parts of the building where gas is burnt or regulated…" [2]. However, in the majority of ordinary buildings designed nowadays the risks associated with gas explosions are normally not counteracted by any kind of structure-related measures and either consciously accepted or simply ignored in structural design. Among possible reasons therefore, one might quote the occurrence rate of explosion events, by most engineers probably perceived as very low, and the reluctance to allocate funds to mitigate such kind of low-probability events [3]. Whatever the reasons are, the question which rises is if "doing nothing" is a justified practice from the perspective of risk-acceptability. A knowledgeable answer to this question cannot be easily given however, since under the implicit approach adopted in everyday practice for structural safety-related decision the risks are not quantified nor are the acceptable risk levels established [4,5].

In prior research on structure-related risks under persistent loading conditions [4,5], acceptable risk

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