Parametric study of the load-bearing mechanisms in RC beam-grids to resist progressive collapse

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1 Abstract

Recently, several structural failures demonstrated the disastrous consequences of progressive collapse and raised the awareness of the engineering community. However the low probability of progressive collapse makes it uneconomical to design every building against progressive collapse using conventional design methods. Furthermore in most cases the initiating events of progressive collapses are unknown during the design. As such, consideration of secondary load-carrying mechanisms can be an effective alternative. These mechanisms include compressive arch action (CAA) and tensile catenary action (TCA) in reinforced concrete (RC) beams. Several researchers have investigated the effects of CAA and TCA experimentally and numerically in individual RC beams. However to date limited studies have been carried out to study these mechanisms in RC beam-grids. Hence in this contribution a validated numerical model is developed to study and quantify the individual contributions and development of the different mechanisms in RC beam-grids. Parametric studies are performed in relation to the influence of the aspect ratio of the grid, reinforcement ratio and ultimate reinforcement strain.

Keywords: RC beam-grids, parametric study, progressive collapse, membrane action.

2 Introduction

Despite many significant theoretical and technological developments in the last decades, one unfortunately has to realize that structural robustness is still an issue of controversy. In this context several structural failures such as the collapse at Ronan Point (London 1968) and the WTC towers (New York 2001) demonstrated the disastrous consequences of progressive collapse and raised the awareness of the engineering community to design for structural robustness [1], [2]. Moreover recent construction techniques allow to build and design structures with minimal material consumption to optimize costs and contemporary architectural trends require the use of high-performance materials which lead to light and flexible structures. However these tendencies result in a smaller inherent redundancy in the structure and a larger vulnerability to loading situations outside the design envelope. Hence, to avoid the high consequences related to progressive collapse structural robustness should be incorporated in the design of new buildings. Taking into account the low probability of progressive collapse using conventional design methods, it is uneconomical to design every building against progressive collapse. Furthermore in most cases the initiating events of progressive collapses are unknown during the design. As a consequence one of the common strategies to increase structural

https://doi.org/10.2749/newyork.2019.1071
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