

## Parametric study and reliability-based evaluation of alternate load path design in reinforced concrete slabs

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### Abstract

In normal design situations, RC slabs are in general designed using small deformation theories while taking into account linear elastic behaviour. However as indicated by previous large structural failures the importance of considering the behaviour of RC slabs at large deformations is as important. Based on multiple experimental studies it is clear that RC slabs can develop alternate load paths and consequently generate a significant strength reserve by membrane action once large deformations occur due to the removal of a load-bearing element. This strength reserve is of major importance as this could result in an important increase of the structural robustness for RC buildings. In this contribution a parametric study with a numerical model is performed to investigate the design possibilities on membrane action in RC slabs. Next the reliability of the developed membrane action and alternate load path is calculated for a reference case which is subjected to the removal of a central support considering the static and pseudo-static behaviour.

**Keywords:** Alternate load paths, membrane action, structural robustness, parametric study, reliability study, RC slabs

### 1 Introduction

Regarding past large structural failures, such as the collapse at Ronan Point (1968) and the bombing of the Murrah Federal Building (1995), the necessity to design for structural robustness has been underlined and recognized in the engineering community. In general structural robustness can be defined as the property of a structure to survive an extreme event, including man-made and natural hazards, without being damaged to an extent disproportional to the initiating event. Taking into account the initiating event, parts of the building are mostly subjected to some local damage and consequently to large deformations. In case of a robust design this local damage should not result in

disproportional or progressive failure in the structural system. One of the strategies to decrease the danger on progressive collapse is the provision of alternate load paths which increase the continuity and structural redundancy within the structure and allow a redistribution of loads to limit the damage extent. Based on experimental and numerical experiments, it is clear that RC slabs may provide significant alternate load paths by the development of membrane action at large deformations. To model this membrane action in simply supported laterally unrestrained slabs, Herraiz [1] developed a numerical model which has been verified by multiple experimental results. In this contribution, the numerical model of Herraiz is extended to perform a parametric study on some