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## The progressive failure of 15 balconies and the engineering techniques for their reconstruction

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### ABSTRACT

Despite the fact that structural failures are not desirable, it's worth to observe that it always provides relevant information for enhance design and building techniques. Additionally, failure investigations can provide a clear understanding of the involved technical problems, avoiding known mistakes to be produced again. However, the causes of many structural failures are not registered in the technical literature, in a way that some unsubstantiated information produced by the media is usually prominent. The lack of technical reports concerning structural failures gives rise to the repetition of very basic errors, which may inclusive produce progressive failures. In this context, the present paper aims at providing the main reasons for the progressive failure of 15 reinforced concrete balconies of a residential building in Maringá, Paraná state, Brazil. The engineering techniques used for demolishing and reconstructing the balconies of the mentioned building are also discussed. Finally, it is important to highlight that the activities described in this article have contributed in a very positive way for recovering the right of property, the psychological health and the feeling of security of the residents of this damaged building.

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### 1. Introduction

Brazil has been presenting an increasing number of victims related to structural failures, even not facing major natural actions like tornados as well as human actions like terrorism. Some reinforced concrete failures in Brazil, for example, are fully described in [10,11,21]. Elsewhere around the world this undesirable situation is also present, as can be seen in [7,9,14–17,23].

It is also not difficult to find structural accidents involving non-housing structures made of reinforced or prestressed concrete structures. Refs. [8,13,18,20,22], for example, have published some findings regarding failures related to non-housing structures.

Apparently, many accidents are consequence of misconduct and negligence. Maybe for that reason is just possible to find a few records concerning structural failures in the literature. However, the well-dressed divulgation of some accidents, just focusing on the scientific reasons of the problem, could contribute to the enhancement of the structural codes, as well as for the improvement and learning of the freshmen engineers. Additionally, the technical description of structural accidents could contribute at least for the awareness of experienced engineers on the need of keeping the proper conduct of the profession.

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