



Assessment of the structural safety of reinforced concrete balconies

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Summary

This paper reports about the structural safety of cantilevered reinforced concrete balconies of apartment buildings in the Netherlands. The concrete floor of this type of balconies is between 80 mm and 150 mm thick. This type of balconies was mainly constructed between 1950 and 1970. After a collapse of a balcony situated at the 9th floor level of an apartment building, investigations started to the causes. Pit corrosion of the reinforcement, induced by chlorides, had reduced the cross section of reinforcement steel. Besides that, the position of the reinforcement was 10% lower as prescribed in the design and the permanent loads were 28% higher as assumed in the design. As follow up, the structural safety of another eleven buildings with similar balcony structures were assessed. In six of the eleven buildings measures related to structural safety had to be taken. It was clear that owners of this type of building in the Netherlands need to assess the risk of lack of structural safety. To promote an efficient assessment of the structural safety, a step by step method was developed. In the step by step method three specific risks are evaluated: pit corrosion, a lower position of the reinforcement as described in the design and higher permanent loads as assumed in the design. For the assessment of existing structures, lower partial safety factors are used. With drawings and calculations of the structure and the results of non-destructive tests a first check of the structural safety can be done. After that, the sensitivity of the structure to cracks and corrosion of the reinforcement are estimated. If the sensibility is low, further investigations are postponed, if not further investigation into the presence of chlorides and corrosion rate is necessary. The assessment ends with a conclusion: the structural safety meets the requirements or measures have to be taken.

Keywords: assessment of structural safety, existing structures, balconies, multi apartment blocks, corrosion of reinforcement steel

1. Introduction

In May 2011 a cantilevered concrete floor plate situated at the 9th floor level of an apartment building in Leeuwarden, the Netherlands collapsed; the floor plates below also collapsed due to the impact of the falling weight (fig.1). Fortunately there were no injuries. The building was constructed in 1965. Before the collapse there were no signs indicating a structural defect. The collapsed plates were part of the balcony corridors that lead to the entrance of the apartments. Because of doubts about the structural safety of the other cantilevered concrete plates the owner decided to evacuate the residents. A first inspection showed corrosion of the reinforcement in the fracture surface. The decision was made to demolish the cantilevered concrete plates and to replace them by a new structure. After this decision, a more intensive research was done to the causes of the collapse. It was concluded that pit corrosion of the reinforcement was the cause of the sudden collapse; a lower position of the reinforcement and permanent loads higher than assumed in the design were also of influence.

Following to these conclusions two housing associations decided to assess the structural safety of similar balcony structures of another eleven apartment buildings. These assessments led to the conclusion that in six of the buildings measures related to structural safety had to be taken.