A Discrete Bond Law for Precast Panels Systems without Reinforcement

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Summary

This paper discusses the possible application of finite element non-linear modelling to a construction system using precast concrete panels. Details are given of the shell elements used for modelling panels and joints, focusing in detail on the non-linear law conferred to the link elements used to represent resistance to relative sliding movement at the interface among panels. The paper relates in particular to an emulative system using cast-in-place joints, without transverse reinforcement. Also the results of pushover analyses, conducted first on a single wall (with the purpose of studying the effect of joint failure on the capacity of the system), then on an entire building erected using the same construction system are presented, assessing the applicability in seismic regions and considering different numbers of storeys.

Keywords: precast concrete panels; pushover analysis; finite element modelling; emulative approach; shear transfer.

1. Introduction

Structures affording a robust system composed of precast concrete panels provide a solution that is effective and inexpensive, compared to conventional building systems, and has already been widely adopted in Italy and in other countries.

The significant advantage offered by this type of structure is that the precast panels function simultaneously as vertical structural elements as the horizontal bracing system and as finished façade elements, reducing the overall design and building costs of a given project when compared to other solutions using prefabricated components.

Nonetheless, the use of this type of structural solutions in areas of high seismic risk continues to be limited by regulations and by local standards, which in the majority of the cases simply advise against their use.

2. Precast concrete construction approaches in seismic zones

Following several major earthquakes in the 1970s and '80s, such as those of Tamgshan (China) in 1976, Gazly (Russia) in 1976, Vrancea (Romania) in 1977 and Spitak (Armenia) in 1988, where many buildings erected using precast components either suffered serious damage or collapsed completely, designers began developing methods able to provide structures of this type with the strength and ductility needed to withstand severe seismic actions: the key factors in guaranteeing these performance characteristics were details of construction and the careful control of materials.

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