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Repair and Rehabilitation - Three Case Studies in Bucharest

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Summary

Strengthening solutions of three buildings in Bucharest are presented. Two buildings are part of the Technical University of Civil Engineering and the third is a warehouse for high value equipment. They have been affected by three major earthquakes: in 1977, 1986 and 1990. The strengthening solutions were adopted after an accurate analysis on seismic structural performances. The three buildings have different static and spatial shape. The structural models are spatial, with uni- and bidimensional finite elements. The structural analysis was performed in elastic range with a common programme.

Keywords: Building , Seismic Assessment, Rehabilitation, Earthquake, Technical regulations.

Introduction

Bucharest, the capital of Romania, is affected by the earthquakes originated in Vrancea Region (Fig.1). These earthquakes have two main characteristics: the persistence of their focus in almost the same place and the hypocenters depth between 60 and 300 km [2].

The aim of the study was to locate the vulnerable points of the structures and their necessary rehabilitation methods. All the tree structures studied with present paper – reinforced concrete frames with rigid floors - have been spatial modelled with finite unidimensional finite elements (the frames) and bidimentional elements (the floors).
Each structure has been calculated under as many modes of vibrations were required for the modal mass to be summed up in the closest ratio to 100 %. The structures spectrum response were determined based on Code design spectra. The damping was considered to be 5 %. The structures were successively loaded on two perpendicular directions in their plan. There have been chosen the less favourable response from the stress requirements point of view.

Fig. 1

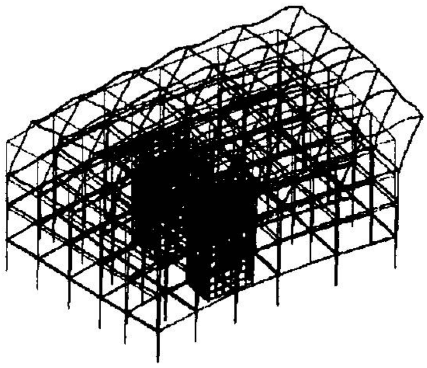

Fig. 2

"ROMTELECOM warehouse"

The building was built in 1940. It has a basement, a ground floor and two storeys with different heights (3.7 m, 4.15 m, 3.6 m, 4.55 m). In plan it has the shape of a circular sector with ca. 80.0 m radius and total area is 6180 m^2. An expansion joint has been provide.
The magnitude of the interstory drifts are of ca. 3.5 times larger than those required by the Code. The most stressed columns are: for Section A those in the corners of the buildings; for section B those of the outside bay. The structure has no redundant reserves and requires strengthening

Proposed solution for the rehabilitation is the same for both sections aiming to reduce the interstory deflection to that accepted by the Code. The solution consist of newly-added structural reinforced concrete walls interacting with existing frames. The displacements and the moments were greatly reduced in the existing structure. The maximum interstory drift is 0.0073 and is almost as with that required by the Code (0.0070). The sum of maximum displacements of the two sections is less than the size of the expansion/contraction joint. Fig. 2 presents the deformated shape of the strengthened Section B.

"The Buildings of the Faculty: Railway Department"

The building of the Railway Department - old part of the building - was built in 1947-1948. It is "L" shaped in plan. The main section has basement, ground-floor and three floors. The secondary section, was initially built with a high semi-basement (where is the sport hall) and one story, and between 1963-1965 two other additional storeys were built. The new building was built during 1972-1973. It is next to the old building previously described, separated by it through a joint, the two building allowing a free traffic flow between them. It is developed over six levels (basement, ground floor, four full floors and a partial one) and has a reinforced concrete elevator cage.

The buildings behaved reasonable well during the 1977, 1986 and 1990 earthquakes, with only small cracks in fill-mansory and local damages in the zone adjacent to the joining.
The buildings have structural redundant reserves allowing them to take over further seismic shocks. The building were proposed to be preserved without major strengthening works.
If some architectural works are to be undertaken a close qualified supervision must be assured to locate any hidden structural damage. The corresponding strengthening solutions must be provided and implemented if required. Also the joint between the two buildings must be cleaned.