

4. DESCRIPTION OF RETROFIT MEASURES

4.1 MODEL “GREGOR”

A first model considered is the so called Model "Gregor". This one is a consists of a regular structure, 22m high, 20m long and 15m wide. It has six floors, four bays and three frames. The frames are identical in both directions: three meter in height and 4.5 m span, with 50cm rectangular columns. The beams are also 50cm high. The reinforcement has been chosen as described for the buildings of interwar time . As for beam reinforcement no data has been available the assumption of typical reinforcement for beams in a building designed today has been made.

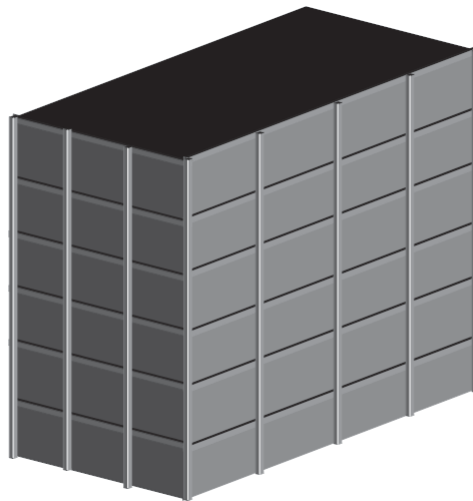


Figure 4.1: Axonometric view of model “Gregor”

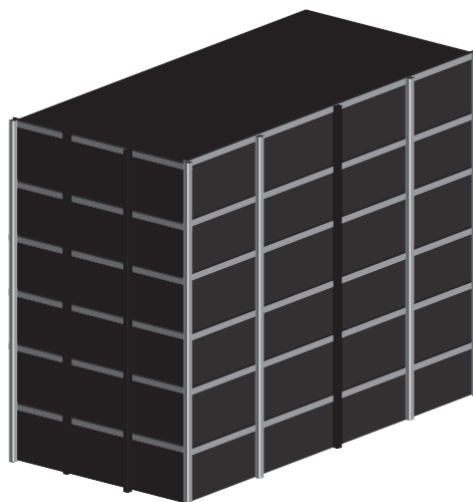


Figure 4.2: Axonometric view of the layout of metal-jacketed columns in model “Gregor”

At this moment two retrofit measures, adequate for bare frame building, have been considered. The first one is the jacketing with steel of half of the column height (1-1,5m; here 1,5m have been considered). Different methods have been developed²⁵. The advantage of this method is that almost no increase of the section results.

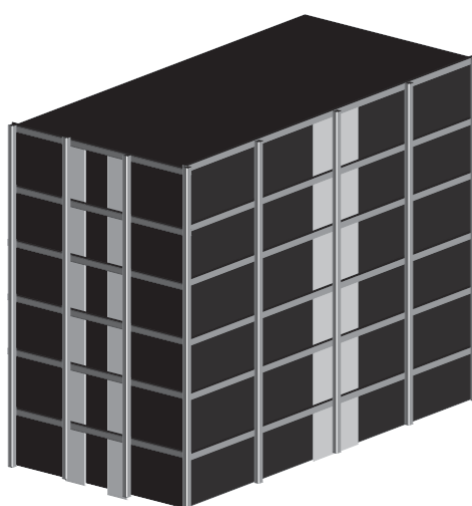


Figure 4.3: Axonometric view of the layout of side walls added to columns in model “Gregor”

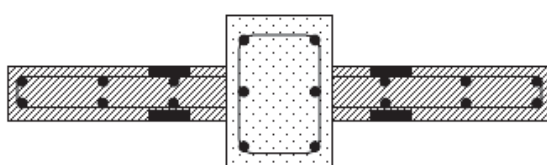


Figure 4.4: Detail of the reinforced concrete side wall type in horizontal section

The second measure considered regards the addition of side walls to columns. On the long side walls are added to the middle column left and right. On the short side one side wall is added to each of the two columns in the middle within the same frame. This measure will assure ductility of the building, near the increase of strength²⁶. Detailed description of these retrofit has been already made at the beginning of the report. For none of them is there a section included in the software so it had to be simulated.

²⁵ For the purpose of this work the detailing is less essential, but further literature can be found in Dritsos [2000], p.195.

²⁶ Further literature is Dritsos [2000], page 64.

The performance of the other two retrofit methods proposed rely on comparison with the performance of a building with masonry infill, not yet modeled. These are the addition of a complete structural wall within a “column” of frames situated one over the other and the alternatively addition of steel braces within the same frames.

In case of addition of structural wall the new panel will be connected to the frame (or, in the lowest floor with the foundation) on all four sides, usually using chemical fixation with epoxy resins of the panel Re-bars into holes made previously within the reinforced concrete frame. An enlargement of the foundation is also required. The addition of reinforced concrete structural wall within the whole frame leads to a strength increase of the building²⁷.

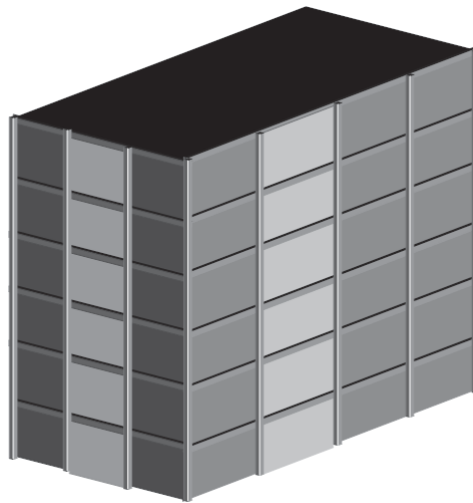


Figure 4.5: Axonometric view of the layout of structural walls added to frames in model “Gregor”

²⁷ adapted after FEMA [1992] p. 26.

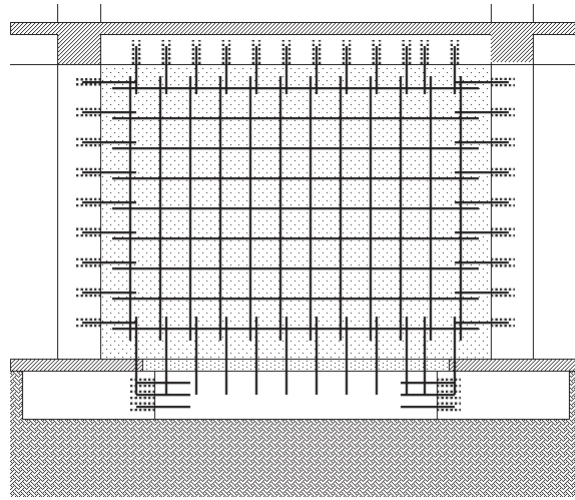


Figure 4.6: Detail of the frame retrofit with structural wall in vertical section

Diagonals are usually made out of steel and not concrete. However, several buildings in Bucharest are known to have concrete diagonals, some of them had such diagonals which were later removed during a whole-building-retrofit measure based mainly on column jacketing with reinforced concrete.

Steel diagonals are nowadays the practice. They can be fixed externally in frame nodes²⁸ or fixed within a second frame, built into the concrete frame. For this study the doubling of the frame has been considered, as the quality of concrete in existing building can be considered not very reliable. From the multitude of possible layouts of the braces the “V” has been chosen.

²⁸ after Dritsos [2000], page 62



Figure 4.7: View of a building in Bucharest with reinforced concrete frame structure and diagonal braces



Figure 4.8: Detail view of reinforced concrete diagonal braces within a reinforced concrete frame structure for a building in Bucharest

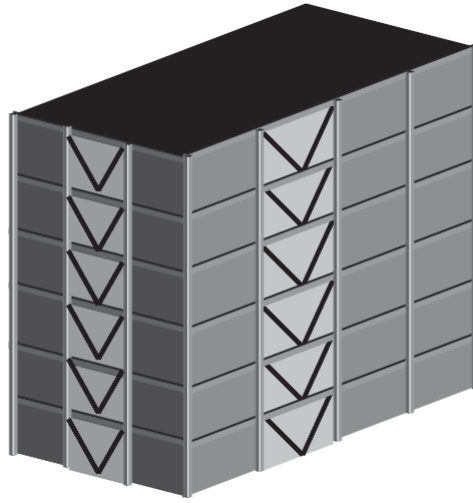


Figure 4.9: Axonometric view of the layout of steel braces added to frames in model “Gregor”

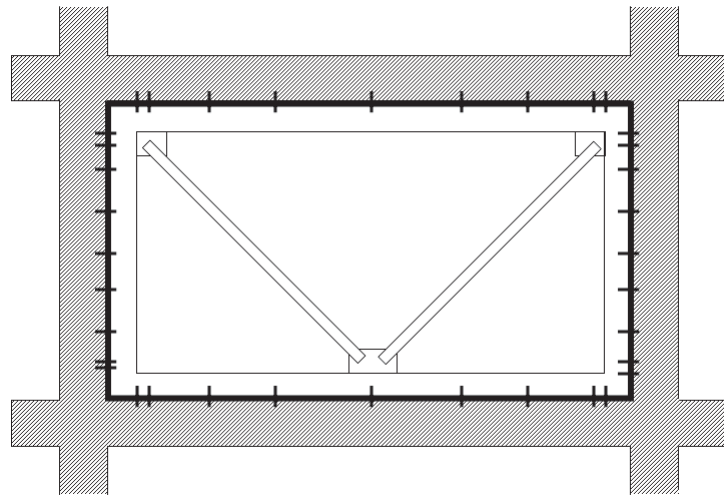


Figure 4.10: Detail of the frame retrofit with V-shaped steel braces in vertical section

4.2 MODEL “OEZZI”

The second model considered, the so called *Model "Oezzi"* does not present much differences to the one which has just been described. The building has five storey only, five bays and also three frames. The frame spans are different, and for the frames with windows a smaller span of 3.5m has been adopted, which is met in the Romanian building practice, as it will be seen later in this paper. The fully infilled panels have the same size as in model “Gregor”.

For this model no retrofit method has been simulated yet, as they rely on the presence of masonry infill, not yet modelled. These are two innovative retrofit measures, based on fibre reinforced polymers. One of them uses glass fibre to enhance masonry cohesion²⁹, the other one uses an additional framework of carbon fibre³⁰. Both are suitable for frames with masonry infill, not for bare frame or bare masonry buildings.

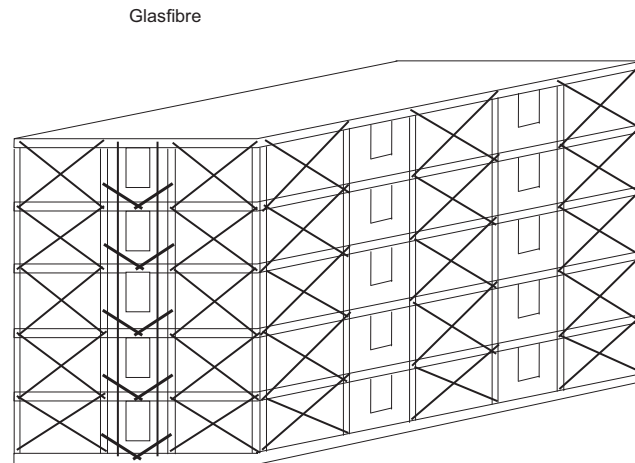


Figure 4.11: Axonometric view of the layout of glas fibre retrofit of infill masonry walls in model “Oezzi”

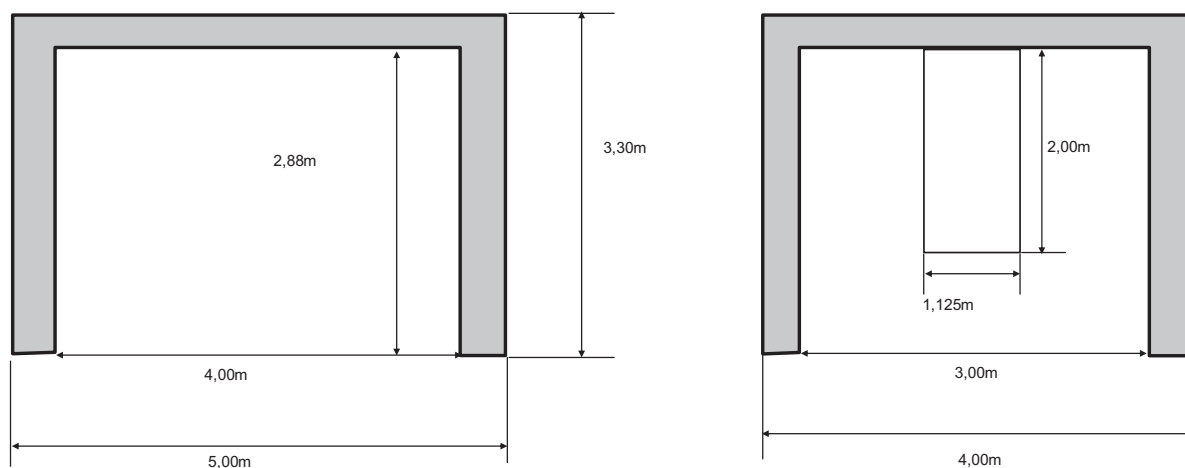


Figure 4.12: Dimensioning of the reinforced concrete frames with masonry infill in model “Oezzi”

²⁹ after Stempniewski et al. [2001]

³⁰ after Borgogno [2001], p. 13-16.

Synthetic results of a work carried out by Gülay Öztürk, a civil engineering student at the University of Karlsruhe³¹, are presented in the following:

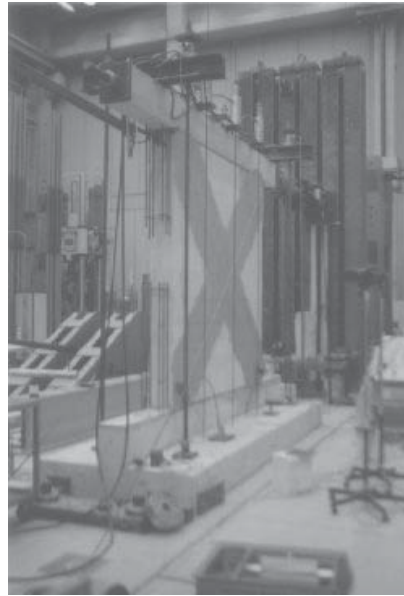


Figure 4.13: Experimental tests on masonry wall reinforced with glass fibre in the laboratory of the “Institute for Massivbau”

Carbonfibre

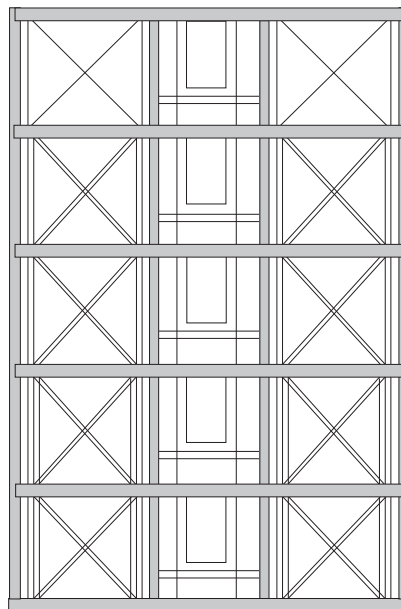


Figure 4.14: Layout of reinforcing carbon fibre on a RC building with masonry infill and five floors.

³¹ After Öztürk [2003]

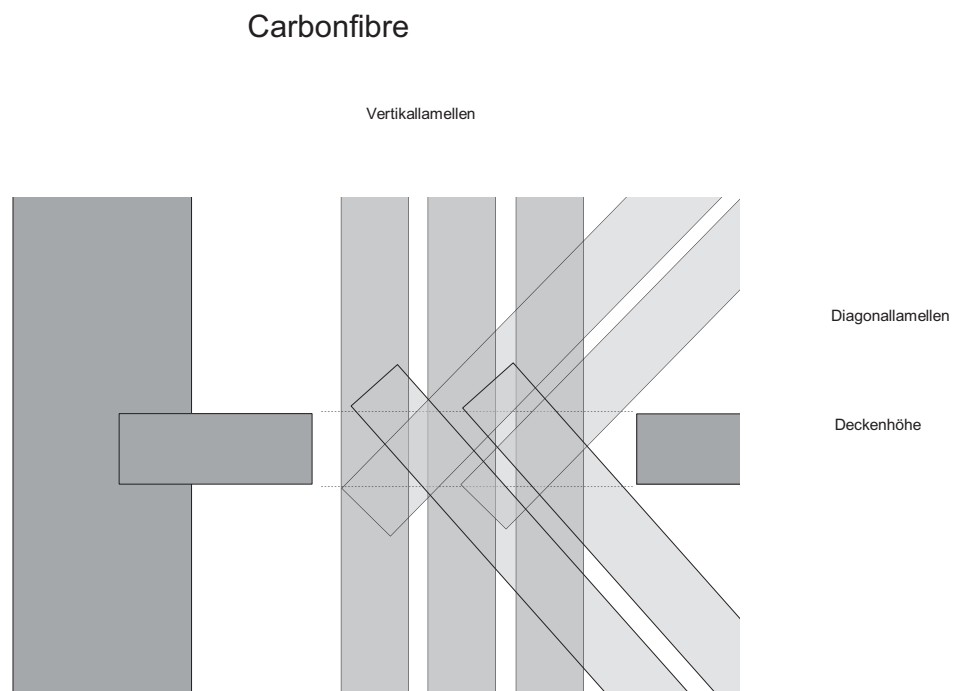


Figure 4.15: Detail of connection between carbon fibre lamellas

Glasfibre

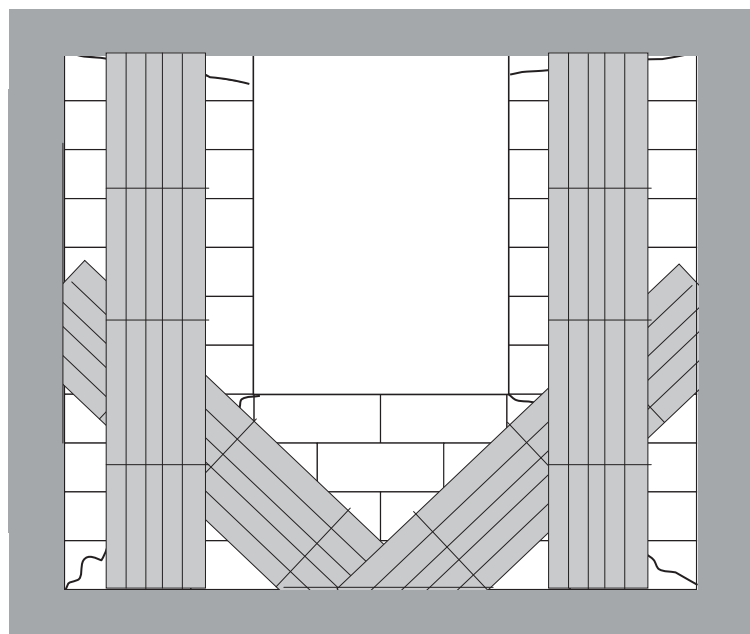


Figure 4.16: Detail on the layout of reinforcing glass fibre on a masonry infill wall with window