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Restoration of an Ancient Masonry Building after the 1990 Earthquake in Macedonia

Restauration d'un bâtiment ancien en maçonnerie après le séisme de 1990 en Macédonie

Instandstellung eines antiken Mauerwerksgebäudes nach dem Erdbeben von 1990 in Mazedonien

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1. STRUCTURAL SYSTEM AND STATE OF DAMAGE OF THE BUILDING

The analysed two storey residential building, dating from the beginning of the 20th century, was one of the buildings to suffer most from the earthquake in Gevgelija in December, 1990, that struck the frontier regions between Macedonia and Greece (intensity VIII - IX).
The building is quite impressive itself, measuring 100 meters in length and 11.8 meters in width, with a decorated entry on the south side and a well preserved elegant roof wooden structure.
Its structural system is quite complex: at the ground level a cast in situ concrete slab connects the massive brick facade walls with a row of steel profiled columns at midspan; at the first level a wooden floor strucure is supported by the walls and the columns.
The partition walls are of different dating and origin: the recently introduced ones are made of concrete, while the original ones consist of wooden frames filled with compacted earth.
The structure survived the earthquake but was considerably damaged. The damage was concentrated at the first level and at the roof, the concrete slab at the ground level preserving the lower part of the structure from any considerable damage. In the upper part the partition walls have been seriously damaged, some have collapsed. The facade brick walls, although quite massive, have cracked, especially at the roof level. The wooden floor structure has been seriously damaged, and in places has collapsed. The gable walls have been dislocated at the corners and have cracked, especially at the roof level. This changes were detrimental to the integrity of the structure as a whole.

2. PROPOSALS FOR REPAIR AND STRENGTHENING OF THE STRUCTURE

The project for repair consists of partial grouting at the places of damage on the facade walls, respecting at the same time the original facade and wall finishes. At the corners where important cracking and dislocation have taken place, vertical cast in situ elements have been embedded. All the original partition walls have to be replaced by new modern walls, made of brick. The old wooden floor structure has to be entirely replaced by a new one.

As for the strentghening of the structure genuiting of the key perpendicular walls with a 5 cm layer of concrete has been proposed. Thus, a sufficient capacity of stength and deformability in the perpendicular direction of the structure can be achieved, the capacity of the structure in its original state due to the limited length of the walls (11.8 m.) being very low.The stiffening of the structure at the level of the first floor is to be provided with genuiting of all the facade walls, from the inner side between the celling and the lentels, a vertical distance of 70 cm. In such a way the wooden floor structure is going to be braced by a concrete belt all around the perimeter of the building. Futhermore, a thin concrete slab is to be embedded at the top of the structure, connecting the individual wall elements and thus contributing to the overall stiffness of the structure. With these measures a synchronized behaviour of the individual wall elements will be obtained, thus enlarging the posteleastic capacity of the structure and preventing its collapse.

3. STABILITY VERIFICATION OF THE RETROFITTED STRUCTURE TO A MAXIMUM EXPECTED SEISMICITY LEVEL

The structure in its original and repaired state has been modeled using a simple cantilever system fixed at the base, with masses concentrated at the two floor levels. With this mathematical model a dynamic time history analysis with different earthquake records has been performed . The level of the maximum expected earthquake action, as well as the different types of seismic records to be applied, have been determined with a special seismological study. In the analysis, certain ductility capacity has been allowed to the masonry walls (1.8 for the genuited perpendicular walls and 1.5 for the longitudinal facade walls).
Even though the maximum expected earthquake level is very high (42 % of "g"), a satisfactory response for the retrofitted structure has been obtained. The required ductility by the earthquake does not exceed the ductility capacity of the walls, in longitudinal and perpendicular directions.
The analysis shows that the retrofitted structure posseses sufficient capacity of strength and deformability - ductility to survive strong ground motions without considerable damage.

BIBLIOGRAPHY

1. VELKOV M. and CVETANOVSKA B, Methodology of Repair and Strengthening of the Old City of Budva. IZIIS Report, Skopje, 1982

2. TOMAZEVIC M. and SHEPARD P, Mathematical modelling of masonry buildings for earthquake resistant analysis. IZIIS, Skopje, 1986

3. CALVI M. and MACHI G., Seismic Design of Reinforced Masonry Structures. Application of CEB recommendation, Pavia, 1987.