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Ferrocement Composites for Strengthening of Existing School Structures in Albania

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ABSTRACT

The study includes analyses of existing school structures built with retaining unreinforced masonry, where some structural problems have been identified as a result of the degradation of masonry parameters over the years, which reduce their carrying capacity. In Albania, as a high seismic risk country, it is very important to design and evaluate anti seismic structures. From the economic point of view, there are two possibilities: their reinforcement or collapse to replace them with new structures. The possibility of choice is given to us after assessing their current situation and performance. The new and old Albanian design codes do not have established procedures for their seismic evaluation. For this reason, it is necessary to evaluate and improve the carrying capacity of these school structures projects selected in Tirana which are designed in accordance with the old codes [KTP-78, 1978; KTP-89, 1989], nowadays based on the calculation of structural Eurocodes such as EN1996, with ETABS V15.9 software.

Ferrocement is a low-cost material that improves resistance, stiffness and ductility for masonry school structures. The study provides recommendations and results for the application of this reinforcement technique to similar traditional techniques applied in our country and Balkan region.

Keywords : URM-buildings[1], seismic performance, stress and strain investigation, stiffness and ductility.

[1] Unreinforced masonry building

I. INTRODUCTION

Albania is a country with moderate seismic activity and positioned near the tectonic plate of the Mediterranean. Recent devastating earthquakes, in September and November 2019, have shown that urm buildings[1] have suffered maximum damage and are responsible for loss of life. Due to many reasons, such as the age of buildings, structural interventions over the years, degradation of materials and old design codes, make these types of buildings sensitive to earthquakes.

The case study is a school building, with a urm-structure[1] without frame elements. Therefore, they are more vulnerable to seismic actions. More than 40 years have passed since the design and construction of this category of buildings. The long period of design has contributed to the degradation of masonry and its components, affecting the reduction of bearing capacity. In this study we will evaluate the structure of the school for the action of the elastic design spectrum according to the Eurocodes.

II. CASE STUDY INFO & DATA

A. Technical specifications

The project and specifications for this building are taken from the national technical archives of Tirana (figure 1). Loads for slab are taken 6.00 kN/m^2. The bricks class is M75 with a compression resistance of 7.5MPa and mortar of M25-class with a resistance of 2.5MPa. The wall thickness is 600mm in basement, 380mm in ground floor and 250mm in first and second floor.

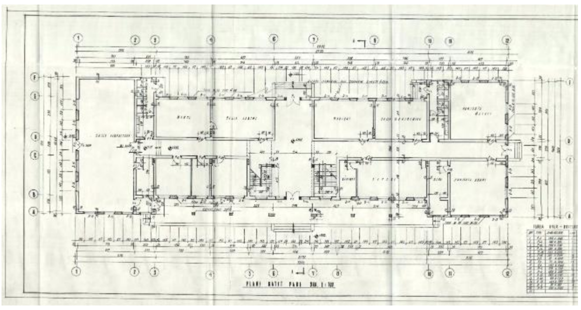

Fig. 1 –The floor plan of the "20 December School" (Technical archive of Tirana, Albania)

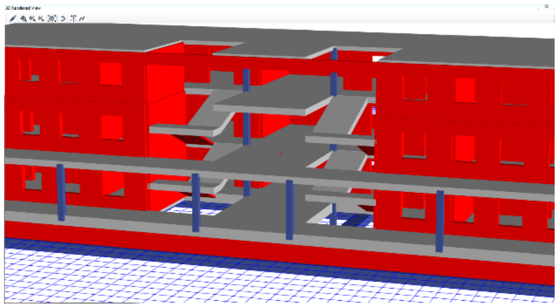

Fig. 2 – the model in 3D, ETABS V15.9

B. Seismic spectrum.

According the EC-8 we are focused on peak ground acceleration PGA[2], the category of the soil, the predicted magnitude (in the case of our country is M> 5.5) and the behavioral factor. Albania has a variety of seismic PGA[2] from 0.12-0.33g (Sulstarova, et al., 2004). Eventually the selected parameters are:

- Soil category: B
- Spectral acceleration: ag/g = 0.27m/s^2
- Behavioral factor: 2 (the spectrum is elastic)

III. PHYSICAL MODEL OF THE BUILDING

The calculations were performed through the ETABS program. To model the masonry, we are based on Tomazevic's study which is using the element type "shell-thick" consisting of layers with nonlinear behavior. Layers will represent the properties of masonry in axial compression and shear strengths. (Tomazevic, 1999)

[2] *Peak ground acceleration*

The non-linear static analyses consider non-linearity behavior of structures by producing of their capacity curve, which can be obtained reducing the pushover analysis result through the definition of a "substitute" S.D.O.F equivalent system.[3]

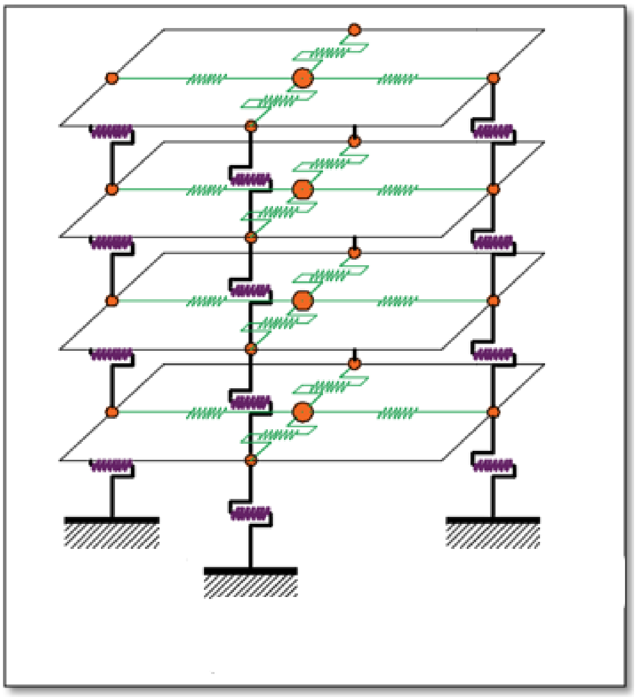

Fig. 3- Physical equivalent model (made by author)

PROPOSED MODEL OF NEW WALLS

Ferrocement will be modeled as a layer which overlaps on the outside of the masonry. For this will be used the existing modeling of the masonry whith nonlinear layers. To the layered element we will add a layer representing the reinforcment. Since the reinforcements are of various types, there is a wide range of options in the selection of reinforcements (Geostudio, 2000). We will concentrate on behavior of ferrocement components, steel reinforcement with fy=533N/mm^2 and concrete C20/25.

IV. MODAL ANALYSIS RESULTS

Allowed periods (Eurocode 8, Part.1, 2004):
[T]= 0.075 x Hg^ 0.75=0.34s

T_1=0.357s >[T]=0.34s (Exceeded translation - direction Y and a bit torsion) (fig.6)
T_2=0.269s (Translation move by direction X) (fig.7)
T_3=0.251s (Clear torsion) (fig.8)

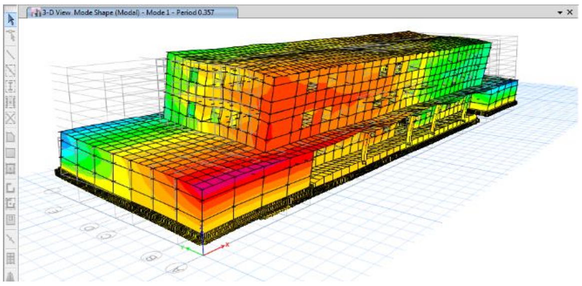

Fig. 4 – first mode (screenshot made by author)

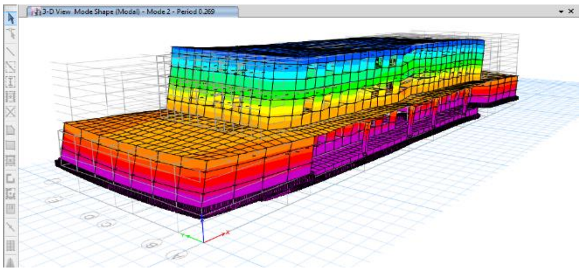

Fig. 5 – second mode (screenshot made by author)

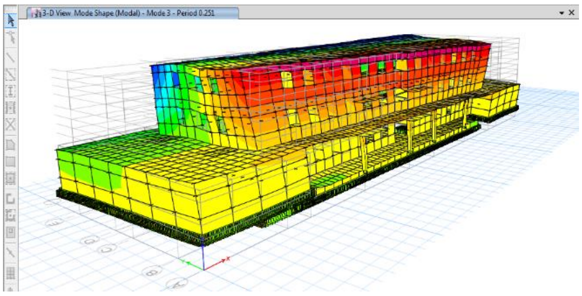

Fig. 6 – third mode (screenshot made by author)

For the displacement monitoring point, is selecting a point on the terrace of the building. Below we present the results of the nonlinear analysis. Max. displacement according combination 1 is 22.6mm (X-direction) and 50.2mm (Y-direction).

[3] *SDOF - single degree of freedom systems*

V. NONLINEAR ANALYSIS BEFORE AND AFTER INTERVENTIONS

Similarly, as in modal analysis is noticed that the structure has problems with the displacement and the creation of plastic hinges on the joints in the areas where the beams merge with walls. There are also problems in the area when basement wall with 60cm width merge with foundation. Reffering to the capacity curves the structure does not have a performance point in the current state and the target displacement dt = 16.2mm.*

AFTER INTERVENTIONS, FERROCEMENT ADDED
New layers with non linear behaviours

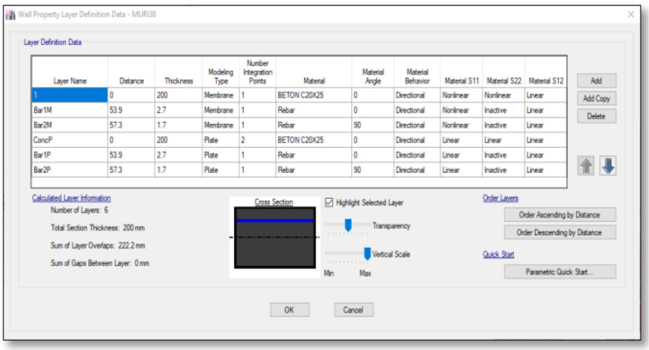

Fig.7 – New wall with ferrocement new layers, *(screenshot made by author)*

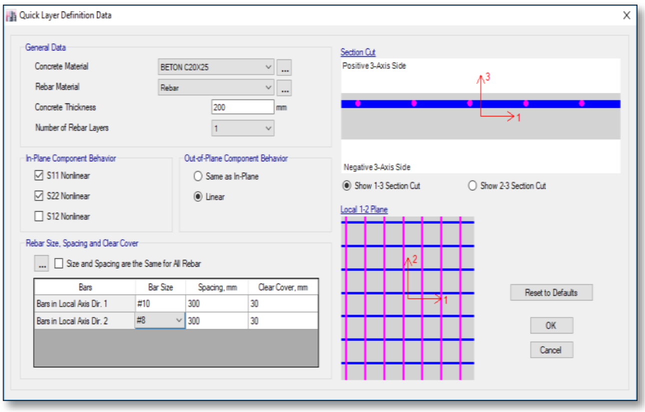

Fig.8 – Details of new wall (screenshot made by author)

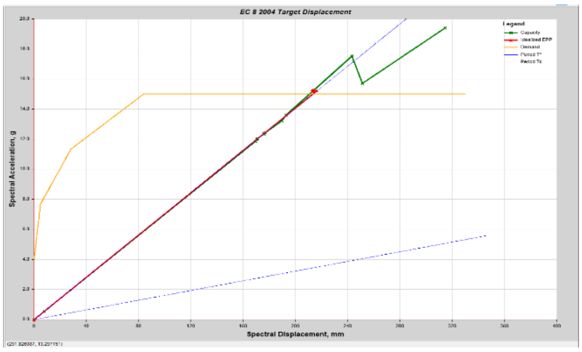

Fig.9 – Pushover curve after interventions, performance point, *(screenshot made by author)*

	Target displ. (cm)	Shear force (kN)	Ductility μ	T (sek)
EC8-Y without structural interventions	1.62	464	2.0	0.357
EC8-Y with ferrocement layers	0.98	640	3.1	0.336

Table 1 – Conclusions data

VI. CONCLUSION

After the intervention the structure reacts better and this is shown by some of the following parameters:

- A performance piont is found after interventions according to EC pushover analysis. (Table 1)
- Modal parameters are in allowed values

- Target displacement according to ULS[4] is in allowed values. (Table 1)
- The shear resistance of the walls in global plan is increased. (Table 1)

Also there is a performance point and a target displacement. Improvement was observed in two main directions, the carrying capacity and displacements. The increase in bearing capacity is explained by the redistribution of forces in the new retrofitted masonry, better activating the floor-slab, avoiding local collapses. Also, the distribution of shear forces throughout the building has been improved. This means better use of masonry materials and an effective distribution of seismic energy.

VII. REFERENCES

[1]. Bilgin, H. & Korini, O., 2012. Seismic capacity evaluation of unreinforced masonry residential buildings in Albania. Nat. Hazards Earth Syst. Sci., pp. 3753-3764.

[2]. Calvi, G. M., 1999. A displacement-based approach for vulnerability evaluation of classes of buildings. J Earthquake Eng. 03, p. 411–438.

[3]. Code, E. m. d., 2005. Design of masonry structures, General rules for reinforced and unreinforced masonry structures. Part.1 EN 1996-1. s.l.:s.n.

[4]. Committee, 5. A., 1982. Ferrocement Materials and Applications Publication. s.l.:SP.61.

[5]. Eurocode 8, Part.1, 2004. Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings. Brussels: Management Centre: rue de Stassart, 36 B.

[6]. Geostudio, A. &., 2000. Tensile test of steel, Tirana: s.n.

[7]. Koçiaj, S. & Sulstarova, E., 1975. Katalogu i tërmeteve të Shqipërisë, Tirana: Qendra Sizmologjike, ASH të.

[8]. Sulstarova, Aliaj, Peci & Muco, 2004. Catalogue of earthquakes in Albania with Ms=>4.5 for the period 8-2004, Tirana: Seismological Institute Tirana.

[9]. Tomazevic, M., 1999. Earthqauke-resitant design of masonry buildings, Series on Innovation in Structures and Construction. In: Innovation in Structures and Construction. London: Imperial College Press.

[10]. Tomazevic, M., 2007. Damage as a Measure for Earthquake Resistant Design of Masonry Structures: Slovenian Experience. Volume 122, pp. 1040-1047.

[11]. Universiteti Politeknik i Tiranës Instituti i Gjeoshkencave, E. U. d. M., 2019. Monthly Bulletin of Seismology, Nr.6, ISSN: 2664-410X, Tirana: s.n.

[12]. Valluzzi, M., 2012. Round Robin test for composite to brick shear bond characterization. RILEM, Materials and Structures.

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[4] *ULS-Ultimate limit state*