ABSTRACT

Evaluation of capacity of an existing building and addition of an extra storey

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The main objective of the current study is the evaluation of the capacity of an existing building and the addition of an extra storey. The single-storey residential building of this study, which also includes a basement, was built in 1962 and it is situated in the area of Kalamaki, Athens. The design of the aforementioned building which is a spatial moment resisting frame was contacted according to the 1959 Greek seismic provisions. The structural materials used are concrete B120 (fy=;), and steel Stl fy=;).

Initially, modelling and analysis of the structure was accomplished by means of SAP200. The evaluation of the capacity performed according to the requirements imposed by Greek Seismic Codes (E.A.K. 2000' and 'Ε.Κ.Ω.Σ 2000) regarding areas of seismic zone I (A=0.16g), showed crushing inadequateness in the majority of the structural elements. Hence, the strengthening of the building was required.

However, due to the fact that the addition of an extra storey had already been decided, strengthening of the building's initial frame using perimetric jackets and placing new structural components at the perimeter of the existing building (with embedded shear walls) were considered necessary. Therefore, the additional storey will be supported by both the new perimetric vertical elements (that are joined by special steel elements (δεν την ξέρω τη λέξη) with the existing ones) and the existing elements that have been strengthened. In this way, all seismic loads will be borne by the new structural elements. Analysis and evaluation of the strengthened structural system illustrated deficiencies in a small number of beams of the existing frame. Thus, construction of additional topical jackets was considered mandatory. Concrete of type C20 and steel of type S500 were selected for the construction of both the strengthening parts and the new elements. When analysis was completed, and sufficiency of existing elements was ensured, both new and existing (strengthened with jackets) elements were designed.

During the final stage of this study, behavior of the strengthened building was assessed by means of nonlinear static analysis (pushover analysis) for the design earthquake and the available capacity with regard to seismic forces was calculated. Analysis was performed using SAP2000 version 10.0.7, while XTRACT was utilized for defining the hinge properties of the elements. Furthermore, dynamic non-linear analysis was conducted applying two horizontal orthogonal accelerograms along the x and the y axis of the structure. In particular, the accelerograms used were two horizontal orthogonal components recorded during the earthquake occurred at Sepolia, Athens in the year 1999.

Results of this analysis illustrated that the strengthened structure demonstrated a quite satisfying behavior both in the case of the design earthquake and in the case of an even stronger seismic event. In the first case (design earthquake), the analysis showed that the structure almost remained in the elastic range of behavior - a small number of sections yielded- while in the second case a large number of not-excessive yields appeared (high seismic energy absorption) and also it can be observed that the number of plastic hinges formed at beams was larger than in columns (collapse prevention).