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SEISMIC VULNERABILITY OF RC FRAME BUILDINGS WITH VARIOUS PLAN SHAPE WITH ACCOUNT FOR NONBEARING INFILL WALLS

О.В. Мурашко, Б. Ільхам. **Сейсмічна вразливість залізобетонних каркасних будинків з різною формою плану з урахуванням ненесучого стінового заповнення.** Статтю присвячено чисельному дослідженню двох важливих факторів, що впливають на сейсмостійкість залізобетонних конструкцій. ***Мета:*** Метою дослідження є вивчення поведінки різних порушень плану будівель при землетрусі з урахуванням ненесучіх стін. ***Матеріали і методи:*** При проведенні дослідження використовували метод кінцевих елементів і нелінійний статичний метод. Необхідні розрахунки виконували у програмному пакеті Etabs. ***Результати:*** Отримано співвідношення між сейсмостійкістю регулярної та нерегулярної форм в плані, беручи до уваги ненесуче стінове заповнення, що сприяє розвитку Української системи оперативної візуальної оцінки фактичної сейсмостійкості будівель. Згідно з результатами порівняння семи варіантів форм плану доведено, що сейсмостійкість моделей із стіновим заповненням значно збільшено в порівнянні з каркасом без заповнення (до двох і більше разів), також регулярність розглянутих схем змінюється до 35 %.
Ключові слова: сейсмічна уразливість, нелінійний статичний аналіз, нерегулярність у плані, стінове заповнення, залізобетонний каркас.

O.V. Murashko, B. Ilham. **Seismic vulnerability of RC frame buildings with various plan shape with account for nonbearing infill walls.** Paper devoted to numerical investigation of two important factors that influence on seismic resistance of reinforced concrete structures. ***Aim:*** The aim of the research is to study the behavior of different plan irregularities of buildings under earthquake influences with taking into account nonbearing infill walls. ***Materials and Methods:*** Next analytic methods were used in this research: finite element method and static pushover analysis. Calculations were performed using pushover analysis with Etabs Software. ***Results:*** We obtained seismic resistance ratio of regular and irregular shapes with taking into consideration non bearing infill, which helps to develop Ukrainian system of rapid visual assessment of actual seismic resistance of buildings. According to the results of comparison of seven variants of plan shape, it is seen that seismic resistance of models with infill wall have considerably increased compared with bare RC framed (up to two times and more); and also regularity for the considered schemes varies up to 35 %.
Keywords: seismic vulnerability, pushover analysis, plan irregularity, infill walls, reinforced concrete frame.

Introduction. Earthquakes are one of the greatest challenges to designers of buildings and civil engineering structures. Modern international experience in investigations and codes shows the importance of two factors that significantly influence on actual seismic resistance of structures: plan form shape and nonbearing walls [1…6].

The aim of the research is an analytical study of the behavior of different plan irregularities of buildings with nonbearing wall infill under earthquake influences.

Materials and Methods. The finite element method and static pushover analysis were used in this research: The ATC-40 [1] and FEMA-356 [2] documents contain simplified non linear static analysis (pushover) utilized to estimate the seismic responses of structures with taking into consideration their nonlinear behavior. Pushover analysis helps to decrease calculation time period with comparison to more accurate time-history analysis. That caused application of pushover analysis in this work. Calculations were performed using pushover analysis with Etabs Software.

The effect of irregularities was analyzed using the most geometric building plan-shapes applied in Ukraine and abroad (Table 1).

Spectral displacement, spectral acceleration and base shear were the key parameters to ascertain the effect of structural configuration on the behavior of buildings under earthquakes. The second parameter that was also analyzed is influence of nonbearing infill walls.

The Layout of plan having 6x6 bays of equal length of 6 m.

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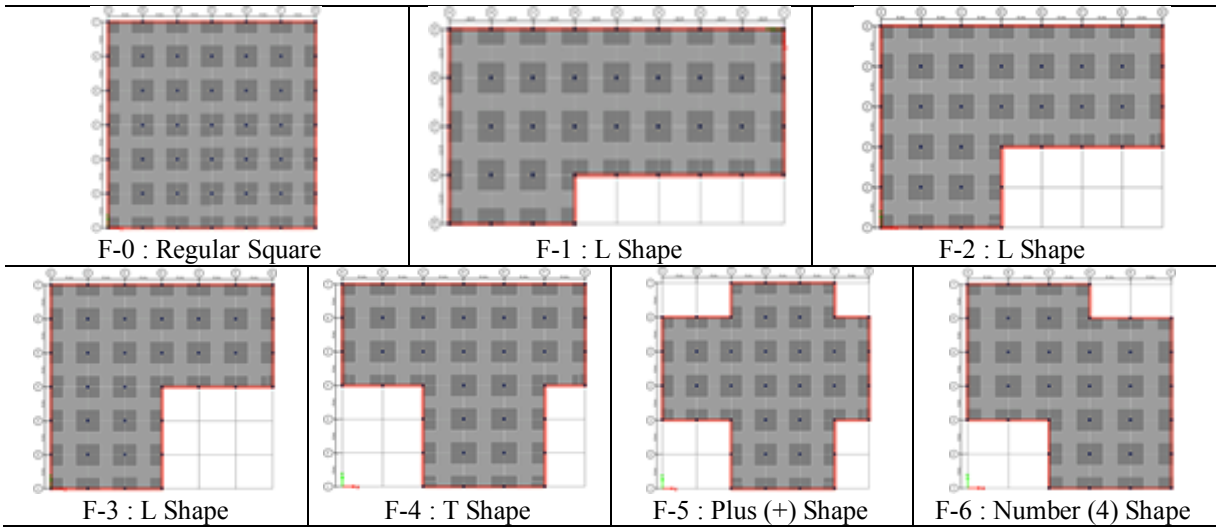
Table 1

Plan shapes of analyzed buildings



Following parameters were used in the analysis of the RC framed buildings models:

– Size of column: 400×400;

– Height of story: 3 m;

– Number of stories: 4 stories;

– Material properties of Concrete: C16/20;

– Material properties of infill: Aerated Concrete D 600.

Number of stories that was picked for investigation because of limitations in building codes for such structural scheme [4].

Main results of performed calculations are given in Fig. 1. Fig. 2 shows deformed shape for the same shape F-0 with and without nonbearing infill.

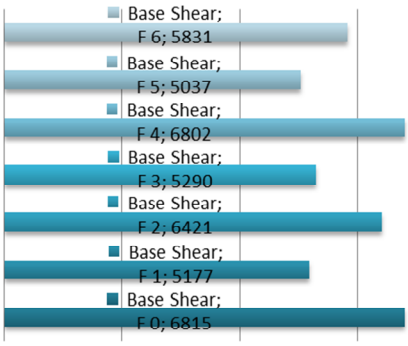


Fig. 1. Base Shear(KN) comparison for the seven models

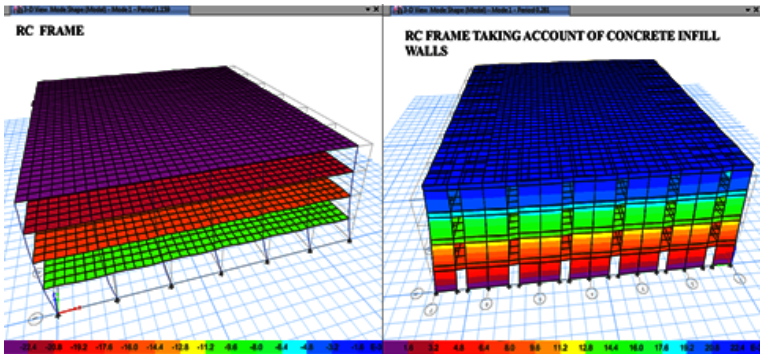


Fig. 2. Deformed shape for F-0 scheme without nonbearing infill (left) and with nonbearing infill (right)

Obtained results for both types of schemes: with and without non-bearing infill corresponds with field tests [7] that were performed by authors of this paper on eight multistory buildings in Odessa.

Conclusions. Based on the results of our research, we can draw the following conclusions:

– The performed investigations show that taking into account both: nonbearing infill walls and shape of building in plan leads to more accurate assessment of actual seismic resistance;

– The rectangular and T-shapes with infill walls has higher degree of seismic resistance compared with other shapes (17…35 %).

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