

2013 INTERNATIONAL VAN EARTHQUAKE SYMPOSIUM

ABSTRACT VOLUME

23-27 OCTOBER 2013

VAN / TURKEY

COMMITTEE

HONORARY CHAIRMAN

Prof. Dr. Peyami BATTAL
Rector of Yüzüncü Yıl University

CHAIRMAN

Prof. Dr. İsmail Sait DOĞAN
Yüzüncü Yıl University, Dean of Faculty of Engineering Architecture

ORGANIZING COMMITTEE

Ali ÖZVAN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Geological Engineering

Mutluhan AKIN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Mining Engineering

Mücip TAPAN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Civil Engineering

Sedat BEKİROĞLU
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Architecture

Sefer ÖRÇEN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Geological Engineering

Suvat PARİN
Yüzüncü Yıl University, Faculty of Literature, Department of Sociology

Vural OYAN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Mining Engineering

EXECUTIVE COMMITTEE

Göksel ULAY
Yüzüncü Yıl University, Van Vocational School, Department of Technical Programs

COMMITTEE

İsmail AKKAYA
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Geophysical Engineering

Mustafa TOKER
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Geophysical Engineering

Müge AKIN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Civil Engineering

Şükran SEVİMLİ
Yüzüncü Yıl University, Faculty of Medicine, Department of Medical Ethics and History

SECRETARIAT

Mutluhan AKIN
Coordinator of the Secretariat

Ayşegül Feray MEYDAN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Geological Engineering

Çetin YEŞİLOVA
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Geological Engineering

Zehra Funda TÜRKMENOĞLU
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Mining Engineering

Koray KARABULUT
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Architecture

Mustafa GÜLEN
Yüzüncü Yıl University, Faculty of Engineering Architecture, Department of Architecture

CONTENTS

I. A. Tegos & M. Tsitotas , *A proposal for total bridge monolithicity as a substitute for seismic isolation in multi-span bridges*..... 84

C. Yenidoğan et al., *Field evidence and numerical investigation of the Mw = 7.2 October 23 Van, Tabanli and the Mw > 5.7 November earthquakes of 2011*..... 86

M. Kutanis et al., *Using spectral matched strong ground motion records for performance assessment in Van province*..... 87

M. Mosoarca & A. Anastasiadis, *New factors influencing the failure mechanisms of reinforced concrete buildings located in seismic areas*..... 88

G. Köse et al., *Improvement in the RVS method by correlating with the preliminary assessment results*..... 89

M. Kutanis et al., *Comparisons of the code performance assessment procedures with observed field performances*..... 91

I. A. Tegos & T. Chrysanidis, *Experimental contribution to the ductility improvement of R/C seismic walls*..... 92

N. Eser et al., *Usage of an infill-wall model having only compression capacity to determine seismic behavior*..... 93

B. Uysal et al., *Determine mechanical properties of laminated wood materials which produce with scotch pine wood and different fiber clothes (FRP)*..... 95

Ö. H. Bettemir, *Disaster management after massive earthquakes: Erciş – Van Case*..... 96

İ. Keskin & Z. Celep, *A parametric study on seismic safety of school buildings in Turkey regarding seismic codes 1975 and 2007*..... 97

T. Bayram & B. Y. Çelik, *Solid waste problem and earthquake* 99

İ. E. Bal et al., *On the seismic performance of RC school buildings in Van*..... 101

T. Aksakal et al., *Energy dissipative connections and fastening of claddings to the precast system*..... 103

B. Taşkın et al., *2011 Van Earthquakes: Structural and geotechnical aspects*..... 105

Ö. Çavdar, *Determination of the earthquake performance of a reinforced concrete structure by using pushover method*..... 107

İ. Kazaz, *Seismic demand at the base of structural walls in frame-wall systems*..... 108

E. Işık & A. Sözen, *Application of seismic protection design for installations*..... 110

S. Coşkan & M. E. Kartal, *The effect of different concrete strengths determined on 2011 Van earthquake on the structural performance of buildings*..... 111

R. Özçelik & B. Binici, *Seismic strengthening of RC frames with different retrofitting techniques*..... 112

İ. Yüksel & S. Coşkan, *Earthquake behavior of reinforced concrete frames subjected to rebar corrosion*..... 113

2013 INTERNATIONAL VAN EARTHQUAKE SYMPOSIUM

ENGINEERING

Usage of an infill-wall model having only compression capacity to determine seismic behavior

Namık Eser*

Yildiz Technical University, Dept. of Civil Engineering, Istanbul, Turkey

Serkan Bekiroğlu

Yildiz Technical University, Dept. of Civil Engineering, Istanbul, Turkey

Yusuf Ayvaz

Yildiz Technical University, Dept. of Civil Engineering, Istanbul, Turkey

ABSTRACT

Displacements and internal forces of infilled frames, change dramatically compared to the behavior of the bare frame when they are subjected to static and dynamic loads, respectively. The contribution of the infill-wall having complex interaction with frame to seismic behavior of the bare frame is ignored when equivalent seismic load method is used. However, it requires taking into account of the contribution of the infill-wall when it comes to detailed analysis to understand the seismic behavior properly. Infill-walls are generally modeled as panels or equivalent compression struts (macro model) in the literature. Macro models are used commonly so as to observe the effect of infill-wall in practice. In the literature, the equivalent strut models are utilized in case of irreversible loading such as static loading depending on linear properties of infill-wall. Such use will cause to take away from the real behavior with the start of the reversible loading. In this study, a new infill-wall model will be introduced to take into account the reversible behavior and bearing capacity of an infill wall. To get impression about applicability of the model a simple reinforced concrete frame is taken into consideration under the seismic record of Van Earthquake dated October 23, 2011. It is concluded that if infill walls are considered in the seismic analysis, the plastic hinges are observed at the different distribution and

Paper ID: 123

USAGE OF AN INFILL-WALL MODEL HAVING ONLY COMPRESSION CAPACITY TO DETERMINE SEISMIC BEHAVIOR

Res. Asst. Namık Eser
Yildiz Technical University, Dept. of Civil Engineering, Istanbul, Turkey

Asst. Prof. Dr. Serkan Bekiroğlu
Yildiz Technical University, Dept. of Civil Engineering, Istanbul, Turkey

Prof. Dr. Yusuf Ayvaz
Yildiz Technical University, Dept. of Civil Engineering, Istanbul, Turkey

ABSTRACT: Displacements and internal forces of infilled frames, change dramatically compared to the behavior of the bare frame when they are subjected to static and dynamic loads, respectively. The contribution of the infill-wall having complex interaction with frame to seismic behavior of the bare frame is ignored when equivalent seismic load method is used. However, it requires taking into account of the contribution of the infill-wall when it comes to detailed analysis to understand the seismic behavior properly. Infill-walls are generally modeled as panels or equivalent compression struts (macro model) in the literature. Macro models are used commonly so as to observe the effect of infill-wall in practice. In the literature, the equivalent strut models are utilized in case of irreversible loading such as static loading depending on linear properties of infill-wall. Such use will cause to take away from the real behavior with the start of the reversible loading. In this study, a new infill-wall model will be introduced to take into account the reversible behavior and bearing capacity of an infill wall. To get impression about applicability of the model a simple reinforced concrete frame is taken into consideration under the seismic record of Van Earthquake dated October 23, 2011. It is concluded that if infill walls are considered in the seismic analysis, the plastic hinges are observed at the different distribution and damage level of the system when compared to those of bare frame.

Key words: Infill-wall, reversible loading, bearing capacity, macro models, bare frame

*Corresponding author's email: namikeser@gmail.com

1. Introduction

The structural design and the evaluation of the performance are made according on the basis of the treatment of the system elements and the simplifier acceptances found at safe area in the sense of the forces oncoming to structural system. When deciding to the structural system of the structure, it should take into consideration the static and dynamic strength conditions. The different structural systems may be conferredfor the same structure as particular to strength condition.With a model to create for the structural system determinate special to strength condition, it is viable either the surveillance of the structure or the analysis belonging to design stages. No matter what the making of the analysis by any reason for the structure, the essential point to be successful is the right model of the structure for good representing its right behavior. In the process of classic design the infill-walls are evaluated as force not a part of structural system.

But at horizontal dynamic reversible loading cases such as earthquake and wind, it is known that the infill-walls play an important role in the structural system. Even making system improvement via strengthening the infill-walls is also offered as an application for structural strengthening in Turkish Seismic Code (TSC) 2007. In design process or at evaluation of structural performance, the reasons of why it is left out of bearing contributions are:

1) The strength of the materials constituent the infill-walls are pretty little.

2) The variability of the material, the mortar mixture, the workmanship of the wall is surplus.

3) The difficulty and the uncertainty of the wall behavior through the projection of model.

In our country, the ground motions are very active so the dynamic response of structures are important as well as the static response and that's why at the installation of structural system, effects of walls over responses of structural systems are so critical that those can dramatically change the responses.. However, regarding of the effect of walls in modeling may be expensive in terms of process of analysis. Dynamic analysis is extremely onerous alongside static calculation, either. No longer, many standards are evaluating the dynamic calculation at scope of mandatory for most structures. In this sense, consideration of walls in structural system when analyzing the dynamic behaviors should be mandatory.

The walls are taken into consideration in numerical models of structural systems as plane element or equivalent strut elements. Malcolm Holmes (1961) used firstly the equivalent compression strut approach when researching the effect of the filling finding in steel frame to system behavior. Thereafter, Stafford Smith and Carter (1969), Mainstone (1971), Madan et al. (1997), Kakaletsis and Karayannis (2008) put signatures to studies which improve the equivalent strut model. The micro models constituted with the finite elements method are also used by Kanaan and Powell (1973), Hao et al. (2002) and Asteris (2003). At the literature, micro and macro models are corresponding to finite element and equivalent strut elements, respectively. It is seen to the applications such the diagonal-spring(Mostafaei and Kabeyasawa, 2004), the horizontal-spring models (Mostafaei and Kabeyasawa, 2004), the co-usage the central element and equivalent strut (Rodrigues et al., 2010).

During the earthquake, the action of walls with structural system is a nonlinear behavior. This behavior may be seen in the working style of the wall. The walls, by their nature, transmit the pressure and sliding effects at planar medium. They do not have ability of tension effect. In committed tests and surveys, depending on the earthquake way, it is understood that they resist to earthquake effects with diagonal compression block throughout a belt (Mehrabi et al., 1996). Shortly, defining the nonlinear features as working under pressure but non-working under tension at plane element is much more difficult with respect to defining equivalent strut element due to size effect. Therefore in this study, the walls are taken into consideration as nonlinear strut elements having the properties mentioned before.

2. Infill Wall Model

To be able to take notice of the infill-wall effect at structure firstly we should know the failure modes of the infill-walls. Even so the strength of infill-walls under the shear and pressure effect and the interaction with the framework are extremely complicated, the experimental results show that, in the system according to the geometric and material features of the wall, it may take place the power depletion at 4 fundamental modes. These are sliding-shear failure, compression failure, diagonal tension failure, general shear failure. For the four type failure species, a deformation capacity with theoretical precision is not defined and, with respect toFEMA 306, diagonal cracking starts from %0.25 level of which nonlinear behavior also began to be seen to approximately %0.5 by ending to completely cornerwise cracking (its termination). For the Corner crushing, despite of occurring at similar levels, its level changes depending of cyclic load feature. As for the Sliding shear mode, giving level is unlikely and it can be seen at different levels depending to other modes. The General shear mode is seen as the effective mode to determine the wall deformation capacity. The

deformation capacity is identified in terms of floor translation and for example it recommended for brick masonry as %1.5.

After deciding the mode which will determine the capacity for the infill-wall, the requisite to settle is the capacity value for the mode requested. After calculating the capacity of the Compression failure and Sliding shear failure, the lower mode values may be taken as limit value (Mostafaei et al., 2004). At numerical investigation part of this study, the treatment is made by way of compression capacity. It may be defined by the force-figure modulation correlation.

According to FEMA 306, the correlation between the shear capacities of a wall which are determined for monolithic loading value (V_{mi}) and ultimate value (V_{mf}) as a result of periodic loading may be found with the help of the equation (1) described below. For the V_{mf} value at literature, after the maximum point V_{mi}, the capacity decrease for value $0.8V_{mi}$ and it is seen that the drift proportion from that value is considered as limit (Mehrabi et al., 1996). At numerical investigation in this study the relationship is accepted as in the equation (1).

$$V_{mf} = 0.3V_{mi} \tag{1}$$

In the American standard ASCE 41-06, the correlation between force proportion and drift for non-reinforced infill-walls is shown in Figure 1. But the values of force and displacement proportions in Figure 1 is assumed as given in this study.

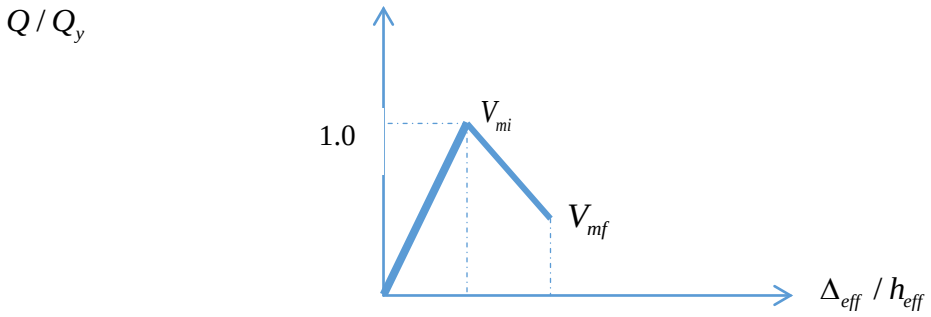


Figure 1 - The correlation between force proportion and drift for non-reinforced infill-walls

The infill-walls are easily lose their pressure strength at earthquake effect because their stiffness is lower than stiffness of structural system where they are in. When equivalent strut models are considered to model behaviors of the infill-walls, the deficiency in their capacities can be modeled by plastic hinges. These hinges reach their plasticization level in axial way on diagonal struts over which they are defined. Here, the deformation is given by kind of floor translation. The necessary transformations for the characterization of the plastic hinge should be made in equations from 3 to 7 and are also graphically explained in Figure 2.

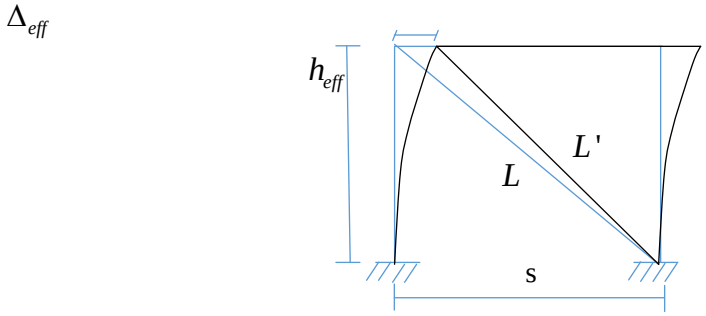


Figure 2 - Definition of deformation on equivalent strut via floor translation in graphical way

$$L'-L=deformation \tag{2}$$

$$L^2=s^2+h^2 \tag{3}$$

$$(L')^2=h^2+(s-\Delta)^2 \tag{4}$$

$$(L')^2=h^2+s^2-2s\Delta+\Delta^2=L^2-2s\Delta+\Delta^2 \tag{5}$$

$$L'-L=\sqrt{L^2-2s\Delta+\Delta^2}-\sqrt{s^2+h^2} \tag{6}$$

For the equivalent compression strut the correlation between force proportion and drift which should be input at plastic hinge definition will start upward at time when the non-linear behavior begins and the deformation value correspondence to shear capacity of the wall is obtained in the equation (7) with the help of geometric relationship and graphical representation described above.

$$L'-L''=\left(\sqrt{L^2-2s(h0.015)+(h0.015)^2}-\sqrt{s^2+h^2}\right)-\left(\sqrt{L^2-2s(h0.0025)+(h0.0025)^2}-\sqrt{s^2+h^2}\right) \tag{7}$$

The model of wall should have ability of in-plane transshipment during the earthquake. Because of the reversible effect of the earthquake, cracks on the wall occurred and do progress according to the earthquake way. The cracks happened under the earthquake in the walls are given in Figure 3 (a).

Until the cracks in the wall grow, the framework system which encloses them depending upon the earthquake way makes a transposition movement as in Figure 3(c). Meanwhile from the left up edge to the right down edge on a diagonal line way, it is understood that the earthquake force goes down in the wall by constituting a pressure effect. In case of the reverse direction effect of the earthquake, the same situation will be valid along the direction which combines the other corners of the wall. At the literature for the bandwidth transferred a compression effect, the relationship is presented and is calculated in from equation (8) to equation (10) as given in TSC (2007).

$$a_{wall}=0.175(\lambda_{wall}h_c)^{-0.4}r_{wall} \tag{8}$$

Here a_{wall} equivalent diagonal width at wall plane (mm), h_c column length (mm), r_{wall} diagonal length of the wall (mm) λ_{wall} is given in equation (9).

$$\lambda_{wall}=\left[\frac{E_{wall}t_{wall}\sin 2\theta}{4E_c I_c h_{wall}}\right]^{\frac{1}{4}} \tag{9}$$

Here E_{wall} and E_c is respectively the elasticity module of the wall and structural system, t_{wall} and h_{wall} the thickness and height of the wall (mm), I_c the moment of inertia of the column (mm^4) and θ the angle of the diagonal with base of the wall. The axial stiffness of the diagonal compression element is given in equation (11).

$$k_{wall}=\frac{a_{wall}t_{wall}E_{wall}}{r_{wall}} \tag{10}$$

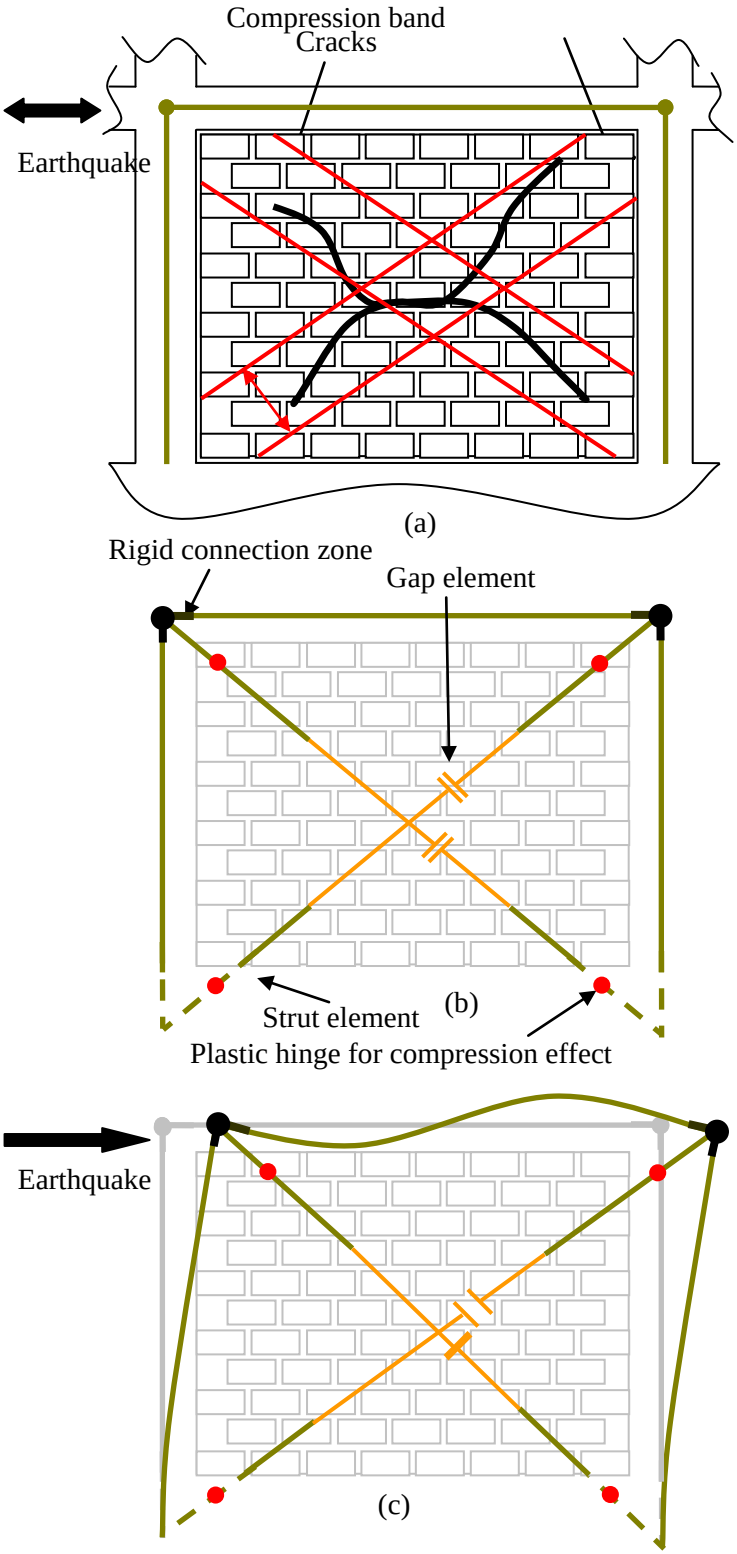


Figure 3 - The non-linear model of the wall (Eser, 2013)

With the help of the equations given above, the section sizes of the strut element in Figure 3 (b) are identified. Hereby the transmission of the compression effect will be provided by the strut elements positioned across at the span where the wall occupies. These elements are only elements which show stiffness only in the direction of their axis and they have not any contribution to the other direction stiffness at the points which merge in system. The crosses diagonal strut elements present for transposition not only for pressure but also for tension. For omitting their tension -taking abilities, the "gap" elements (see also Figure 3 (b)) which don't produce a stiffness against the tension effect are placed in the middle of them Thus, even non-being ability against tension effect of the wall is reflected to the model. On the other hand, this non-linear behavior may notbe reflected in linear static analysis. The modeling at this study is valuable in non-linear analysis. How the gap element produce the stiffness is given in the equation (11).

$$f = \begin{cases} k(d + open) & \text{if } d + open < 0 \\ 0 & \text{otherwise} \end{cases} \text{ (Sap 2000)} \qquad (11)$$

Here**k** is the spring constant, d is relative displacement occurred throughout axis of gap element, and **open** is the initial gap opening, which must be zero or positive. According to the equation (11) gap element produces stiffness only just under pressure effect, otherwise, does not under tension.

3. Numerical Investigation

For the purpose of understanding how a wall affects the structural behavior and whether the introduced wall model works or not, four mathematical models illustrating one-story and three-story frames with/without the introduced wall model are shown in Figure 4.

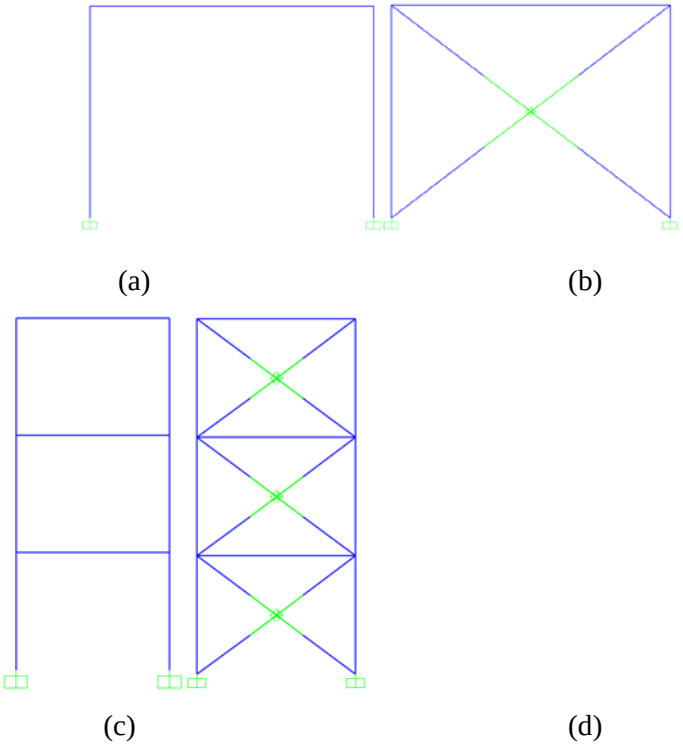


Figure 4. Mathematical models of one-story and three-story frames with/without wall

In Figure 4, a bay width is 4m and a story height is 3m, a column size is 0.30 m by 0.30 m, and an equivalent wall size is 0.25 m by 0.50 m. In all 4x14mm reinforcement which used in beam element, the two is used as down reinforcement, and the other two as up reinforcement. The column has a bar possessing diameter of 16 mm in each corner of its cross-section. Each beam in frame structures is loaded by a uniform distributed load of 25 kN/m. The introduced wall model has no mass. The cracked section stiffness is considered in the beams and the columns of the models. Compressive strength of concrete is assumed as 20 N/mm^2, and tensile strength of bar is 420 N/mm^2. It is supposed that the modulus of elasticity of the wall is 1000 N/mm^2, its pressure strength 1 N/mm^2, its thickness 200 mm. The treatments needed for equivalent compression strut modeling is found as; wall area 740 000 mm^2, the angle of beams with level 36.62, equivalent width (a) 525 mm. The compression failure capacity is calculated with the approach of FEMA 306. The V_i value is defined approximately as 42 kN, and the V_{mf} value as 12.6 kN. When the equation 8 is considered, the deformation capacity value is calculated at plastic zone as 2.77 cm.

It is indicated earlier that the wall model fits time history analysis conditions. Two analyses are going to be performed. One of them is free-vibration analysis and the other is time history analysis. In the time history analysis the responses of the mathematical models are going to be observed under October 2011 dated Van-Center earthquake (Ml=6.7, Mw=7.0) shown in Figure 5. The greater acceleration value throughout KG measured by Muradiye station which located at approximately 42 km distance from Ml=6.7 Van-Center earthquake outer center is 178.5 cm/sn^2. The record of earthquake is reduced to 35 seconds starting after the first 22 seconds.

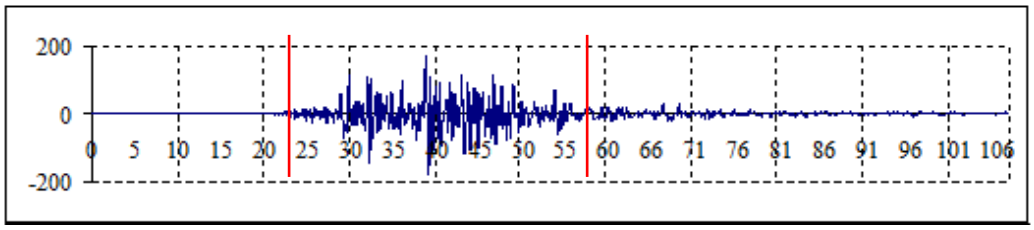


Figure 5. 23 The acceleration record in KG direction of 23 October 2011, Ml=6.7 Van-Center earthquake (Eser, 2013).

In free-vibration analysis, the periods of models without the wall are given in Table 1. The periods does not change in the models with the wall because the wall has nonlinear characteristic so that it just resists compression do not tension. The effect of the nonlinearity does not appeared at initial time. However, the period can change at any time step of time history analysis. The displacements at the top point of one- story and three story frame versus base shear force are shown in Figure 6 and Figure 7, respectively.

Table 1. The period values belonging to the frames

System type	1st period (secs)	2nd period (secs)	3rd period (secs)
One-story frame	0.242	0.01669	0.01666
Three-story frame	0.64	0.21	0.13

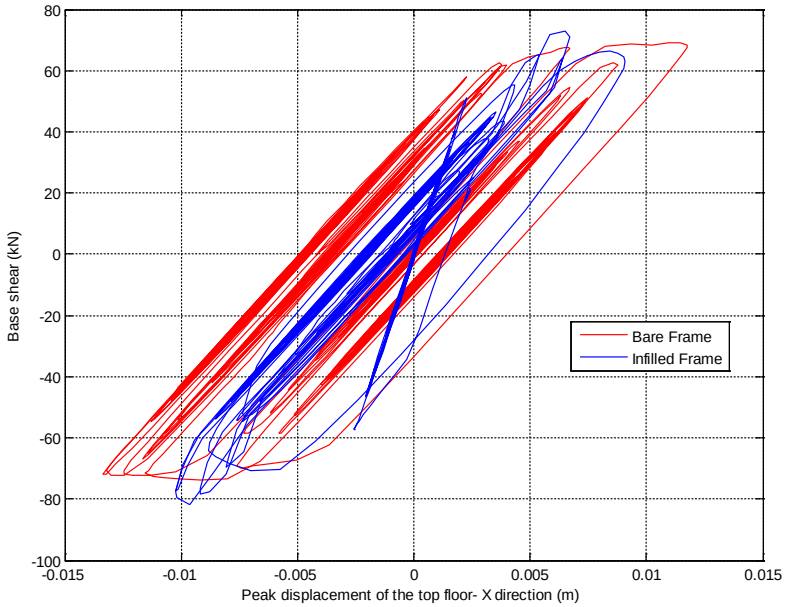


Figure 6. Graphic of base shear force versus peak displacement of the top floor for one-story frame with/without infill wall model

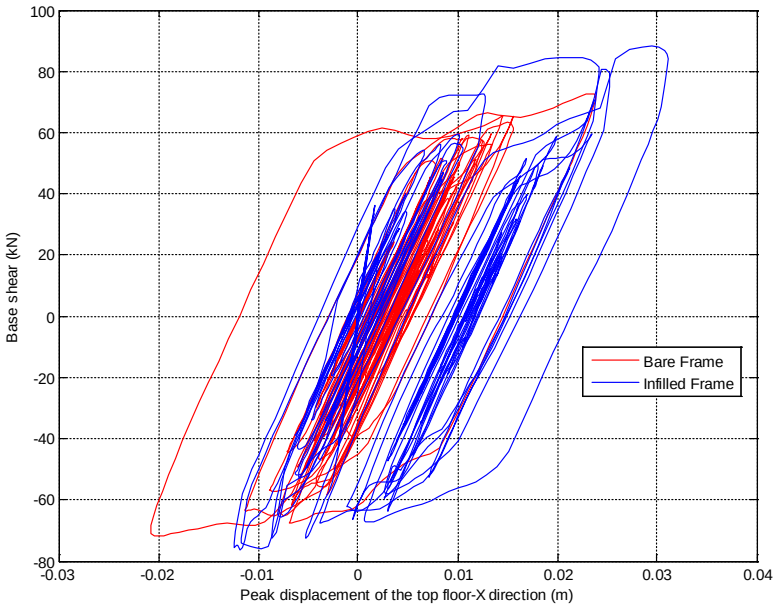


Figure 7. Graphic of base shear force versus peak displacement of the top floor for three-story frame with/without infill wall model

In Figure 6 the contribution of infill wall model in one story frame decreases value of peak displacement of the top floor for one-story frame, but it increases value of base shear force. In

Figure 7 both base shear force and peak point displacement of the top floor improve in comparison to three story frame without infill wall model. As seen from these two examples, modeling of infill wall in structural system can have dramatically different effect from one example to another. Therefore, it is worth to say that it is not possible at first glance that a structural system with infill wall has minor displacement at its top floor when compared to one without infill wall. The distributions of plastic hinges over one story and three story frames with/without infill wall modelare shown in Figure 8.

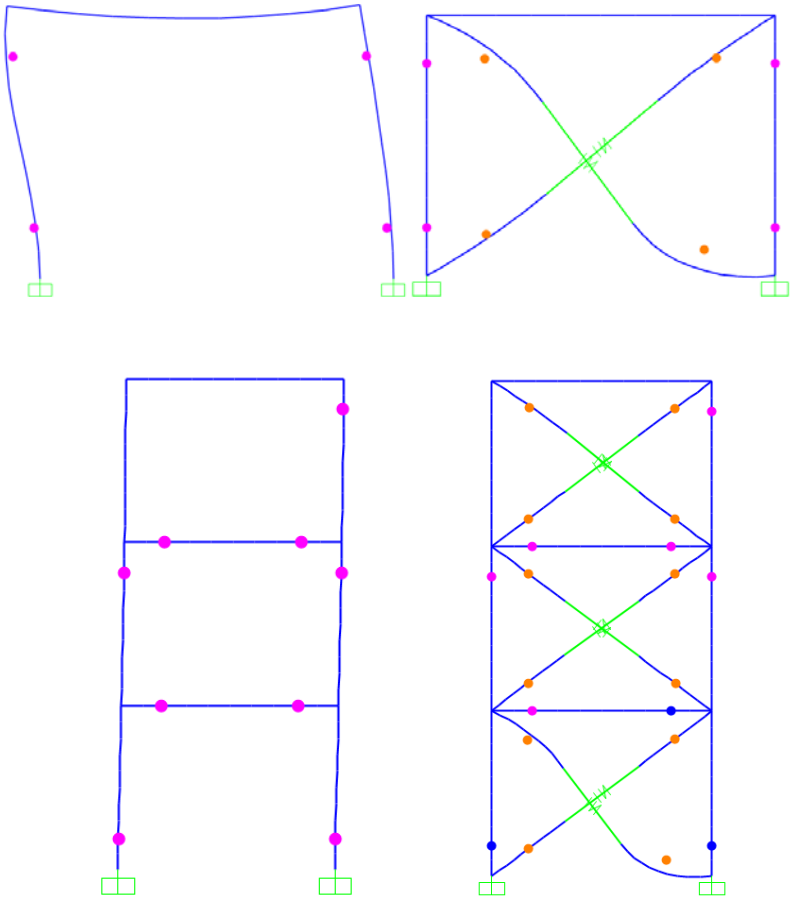


Figure 8. Distributions of plastic hinges over one story and three story frames with/without infill wall model

When the frames are modeling the hinges special to sections are defined automatically in SAP 2000. There is any intervention to color definition of hinges. The point here is not which regulation condition the colors will take notice but is that the favored plastic hinge values give result at various levels as seen to Figure 8. In Figure 8, it is clearly seen that, the columns and thebeam(s) at first floor in three story frame with infill wall model have more damage than one without infill wall model.

4. Conclusion and Suggestion

A new infill-wall model was introduced to take into account the reversible behavior and bearing capacity of an infill wall. The walls were taken into consideration as nonlinear strut elements. Consequently, the introduced strut element is successively operated with the two planar examples. When making the structural design and the performance evaluation at non-linear analysis this model can be used in way that infill-wall additives can be easily considered.

Therefore, the following results are observed: modeling the masonry walls has affected distribution of plastic hinge over the examples. Especially, columns and beam(s) member of the infilled frame take more damage than those of the bare frame at the bottom. Moreover, infilled frame has greater base shear. The model should be illustrated with three dimensional and in structures which have various system features. Additionally, by comparing with the results of the experimental studies, the generalization and development study should be made.

5. References

ASCE 41-06, (2006). Seismic Rehabilitation of Existing Buildings, ASCE

Asteris, PG., (2003). Lateral Stiffness of Brick Masonry Infilled Plane Frames. *Journal of Structural Engineering*, ASCE 129:8

Eser, N., (2013). Investigation of the Effects of Masonry Infill Wall on the Seismic Behavior of Reinforced Concrete Structures, Master Thesis, Department of Civil Engineering, YTU, Istanbul

FEMA 306, (1998). Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings, ATC, Redwood City, California.

Hao, H, Ma, G.W. ve Lu, Y. (2001). Damage Assessment of Masonry Infilled RC Frames Subjected to Blasting Induced Ground Excitations, Engineering Structures, 24:799-809

Holmes, M. (1961). Steel Frames with Brickwork and Concrete Infilling, Institute of Technology, Bradford, Paper No. 6501

Kakaletsis, D.J. ve Karayannis, C.G. (2008). Influence of Masonry Strenght and Openings on Infilled R/C Frames Under Cycling Loading, Journal of Earthquake Engineering, 12(2):197-221

Kanaan, A. E., and Powell, G. H. (1973). "DRAIN-2D, a general purpose computer program for dynamic analysis of inelastic plane structures." Report No. EERC 73-6 and EERC 73-22, Univ. of California, Berkeley, Calif. Revised Sept., 1973 and Aug., 1975.

Madan, A., Reinhorn, M., Mander, J.B. ve Valles, R.E (1997). Modelling of Masonry Infill Panels for Structural Analysis, Journal of Structural Engineering 123:1295-1302

Mehrabi, AB, Shing, PB, Schuller, MP, Noland, JL., (1996). Experimental Evaluation of Masonry-Infilled RC Frames. Journal of Structural Engmeenng, ASCE, 122:3

Mostafaei, H and Kabeyasawa, T., (2004). Effect of Infill Masonray Walls on the Seismic Response of Reinforced Concrete Buildings Subjected to the 2003 Bam Earthquake Strong Motion: A Case Study of Bam Telephone Center, Bull. Earthq. Res. Inst. Univ. Tokyo Vol.79 pp. 133-156

Rodrigues, H., Varum, H ve Costa, A., (2010). Simplified Macro-Model for Infill Masonry Panels, Journal of Earthquake Engineering, 14:390–416.

Sap 2000, (2011). Linear and Nonlinear Structural Analysis Program, Computers and Structures, Berkeley.

Stafford Smith, B and Carter, C., (1969). A Method of Analysis for Infill Frames. Proc. Instn. of Civ. Engrs., London, England, Vol. 44, 31-48

TSC (2007) - Turkish Seismic Code 2007