3.2. Special concentrically X-braced frames which are braced in two middle adjacent spans. According to the results of this study ductility reduction factor of 16 special concentrically X-braced frames (SCBFs) which are braced in two middle adjacent spans, differs from 1.97 to 4.1. Also, according to the results of this study, the response modification factor which is proposed in the 4th edition of the Iranian code of practice for seismic resistant design of buildings, 2800 standard for SCBFs is more logical than the ASCE7's value. Because for X-braced SCBFs with the natural period of more than 1 second (approximately 10 stories and above), it would be hard to satisfy the ASCE7's ductility reduction factor in comparison with the ductility reduction factor of the 4th edition of the Iranian code of practice for seismic resistant design of buildings, 2800 standard. Also, the ductility reduction factor of SCBFs which are X-braced in two middle and adjacent spans indicate that for frames more than 10 stories, there would be a noticeable drop in the ductility reduction factor of frames. This is because the frames cannot experience the target displacement and before their maximum inelastic displacement get to the target displacement, the whole frame collapses due to reaching its mechanism. So, the codes should pay special attention to SCBFs and revise their proposed response modification factor. In addition, according to the Iran's national building code, part 10, steel structures, beams and columns of SCBFs should be checked for the analysis in which the bracing members get to their ultimate capacity. Therefore, for these frames the collapse mechanism is generally from buckling type, yielding all of bracing members, and hasty mechanism cannot be seen in these frames. Based on the results of this study, the response modification factor which is proposed by the 4th edition of the Iranian code of practice for seismic resistant design of buildings, 2800 standard, (R=5.5) is more logical than the value which is proposed by ASCE7, (R=6) for X-braced special concentrically braced frames, SCBFs.(Figures 3 and4)

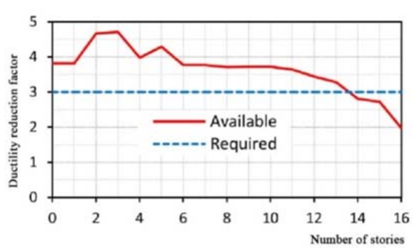

Fig. 3: Comparing the available ductility reduction factor with the required ductility reduction factor (SCBFs)

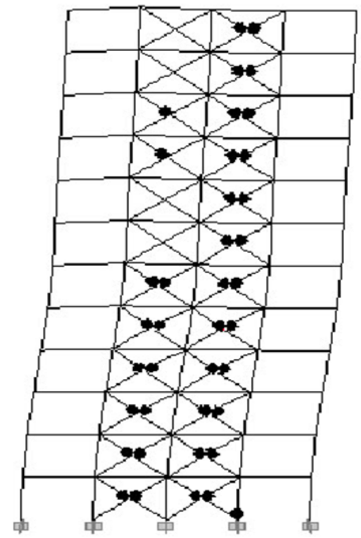

Fig. 4 Collapse mechanism of X-braced SCBF, 8 stories

Evaluating the Ductility of X-braced Frames which are Braced in two Middle Adjacent Spans

Abazar Asghari[1]

1- Introduction

Ordinary concentrically braced frames (OCBFs) are one of the most ancient and famous structural systems which have been used widely by structural designers. Buckling of bracings during earthquake is one of the main causes of anxiety in these structural systems since buckling of bracings can cause ductility reduction in OCBFs. In recent years there have been lots of studies about the ways to prevent buckling of braced members and also to increase the ductility of these structural systems. Based on the results of previous studies about these structural systems and also failure mechanisms in experimental or real earthquakes, design codes have tried to cover up the weakness of these structural systems. It is for this reason that the 4th edition of Iran's national building code, part 10 , steel structure, and AISC341-10 have introduced ordinary and special concentrically braced frames and also given each of them specific design provisions.

According to the mentioned design codes, for seismic design of beams, columns and X-bracings of OCBFs, there is no need for any complementary provisions. However, for special concentrically braced frames, according to Iran's national building code, part 10, steel structures,1392, designing strength of beams and columns should not be less than the following analysis: A) an analysis in which the force of bracings in tension is assumed to be $R_yF_yA_g$ and the force of bracings in compression is assumed to be $1.14\ F_{cre}A_g$.
B) An analysis in which the force of bracings in tension is assumed to be $R_yF_yA_g$ and the force of bracings in compression is assumed to be $0.3\times1.14\ F_{cre}A_g$, where: $R_yF_yA_g$ is the expected force of bracing in tension, $1.14\ F_{cre}A_g$ is the expected force of bracing in compression, A_g is the cross section of bracing member, R_y is the ratio of the expected yield stress of steel to the minimum identified stress of steel. For considering the required increase in strength, F2 is $_c$ the expected compression stress due to buckling in which F_{ye} is used instead of F_y, F_{ye} is the expected yield stress of steel and is equal to R_yF_y.

2- The frames studied in this research

In this study, for evaluating the ductility of X-braced frames which are braced in two middle and adjacent spans, 16 frames which are ordinary concentrically X-braced frames (OCBFs) and 16 special concentrically braced frames (SCBFs) are evaluated.

3- Conclusion

3. 1. Ordinary concentrically X-braced frames which are braced in two middle adjacent spans. According to the results of this study ductility reduction factor of 16 ordinary concentrically X-braced frames (OCBFs) which are braced in two middle adjacent spans, differs from 1.83 to 3.19. All of these values are more than the values which are expected by the 4th edition of 2800 standard, Iranian code of practice for seismic resistant design of buildings. In addition, from expected ductility reduction factor point of view, there is no imperfection in these structural systems. In fact, since these frames are designed for much more forces than special concentrically braced frames their bracing members' sections are much bigger than OCBFs. Bigger bracing section causes bigger Vy for OCBFs in comparison with SCBFs. Therefore, despite a lower δ_u, the expected ductility can be gained by OCBFs. Also based on the results of this study most of the OCBFs cannot reach the specified target displacement of the codes and before their maximum inelastic displacement reaches the target displacement, the whole structure collapses because of reaching its mechanism. However, despite this the expected ductility of the Codes can be accessed because of high level of design strength of OCBFs. Also the results of this study confirm that the height of X- braced OCBFs can be more than the height which is proposed by ASCE7(10.70 m) (see Figures (1 and 2)).

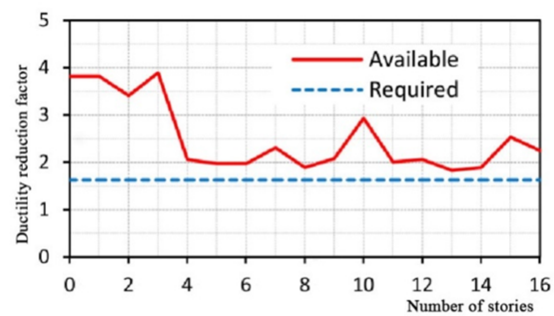

Fig.1 Comparing the available ductility reduction factor with the required ductility reduction factor (OCBFs)

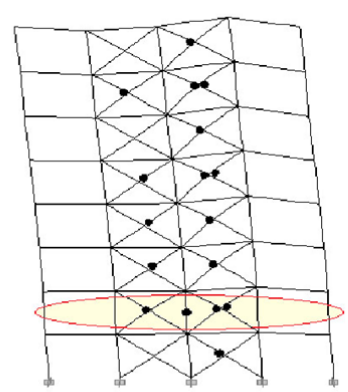

Fig.2 Collapse mechanism of X-braced OCBF, 8 stories

[1] Assist Professor of Urmia University of Technology.
Email: a.asghari.69@gmail.com