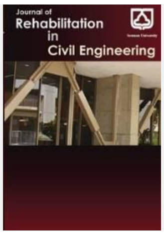
Journal of Rehabilitation in Civil Engineering 12-2 (2024) 97-110



Journal of Rehabilitation in Civil Engineering

Journal homepage: https://civiljournal.semnan.ac.ir/

Numerical Investigation of Pinned Fuse with Simple Replacing in Steel Eccentrically Braced Frames and Design Parameters Determination

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ARTICLE INFO

Article history:
Received: 03 January 2023
Revised: 25 May 2023
Accepted: 05 July 2023

Keywords:
Replaceable fuse;
Lateral load resistant systems;
Eccentric frames;
Bracing frame;
Link beam.

ABSTRACT

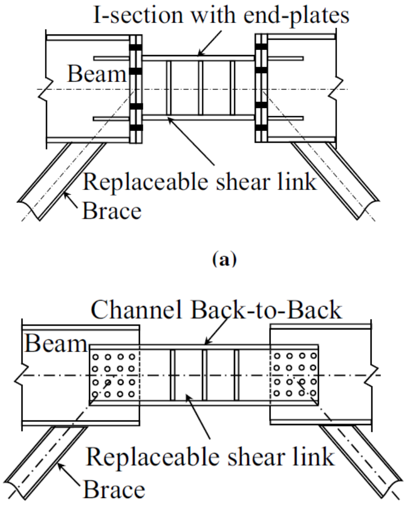
In seismic areas, steel structures are considered one of the best choices due to the inherent properties of materials such as integrity and ductility. Recent research to simplify the repair of earthquake-resistant steel structures after severe earthquakes has focused on designing structures that have localized plastic damage at the desired locations, which dissipates earthquake energy and easily replace after severe earthquakes. It is replaceable, so that the normal life of the residents can be immediately restored with low repair costs. However, repairing and regenerating damaged organs is a challenging and time-consuming process. In this study, the proposed fuse element consists of a number of steel sheets that connect the link beam to out-of-link beam through a complete joint connection, in the form of groove and tongue by pin. When cyclic loads (compressive and tensile) are applied to the eccentric frame, the fuse causes the concentration of force in the beam by showing shear behavior and thus dissipates the force of the earthquake. The results of the numerical studies conducted on the integrated three-dimensional finite element model of the eccentric frame equipped with a fuse show that the damage was limited to the fuse section, and no other structural components were damaged. Also, this system has shown similar hysteresis behavior in tension and pressure, and the coefficient of behavior of this system is higher than conventional eccentric frames, which indicates better performance and ductility of this system. On the other hand, since the damage is concentrated on a relatively small element, and the connection of this member to the frame is fully jointed, so after a large earthquake, with a small cost, it is easy to replace the damaged fuse and the building will be usable.

E-ISSN: 2345-4423

How to cite this article:
Soltani, S., Javaheri-tafti, M., & Vetr, M. (2024). Numerical Investigation of Pinned Fuse with Simple Replacing in Steel Eccentrically Braced Frames and Design Parameters Determination. Journal of Rehabilitation in Civil Engineering, 12(2), 97-110. https://doi.org/10.22075/jrce.2023.28997.1752

1. Introduction

One of the common and earthquake-resistant systems are lateral bracing frames. Among these systems, moment frames, especially the special moment frame, can be considered as a seismic bearing system that has high ductility and low stiffness [1-6]. On the other hand, concentrate braced frames (CBF[1]) and eccentrically braced frames (EBF[2]) are more popular for tall buildings due to their high stiffness properties that help control drift [7]. Eccentrically braced frames have been developed to improve plasticity properties of buildings that are not present in Concentrate braced frames, along with high stiffness. These frames are made either with the link beam connected to the column or the middle link beam. The excellent hysteresis behavior of EBF frames, using shear link beams, makes these systems an effective alternative to both buckling frame systems as well as Concentrate braces. Generally, horizontal shear link beams are located in the middle or at the end of the beam. However, large deformation of shear link beams should be accepted in severe earthquakes. These frames have great flexibility and plasticity and, if designed correctly, have more flexibility (to create openings) than converging braced frames. The damping area in eccentric bracing frames is located at the link beam; which is mainly under the shear force. Until the Northridge earthquake occurrence (1994), it was recommended to connect the link beam to the column in eccentric frames by welding. These connections were very similar to the commonly welded beam-to-column connections in buckling frames that failed in a brittle form during the Northridge earthquake. Therefore, instead of welded joints, the performance of bolted joints to the column in eccentric braced frames was studied, which also provided the possibility of easy repair. The results indicated that the replaceable screw joint performance is comparable to welded joint. Of course, since all the inelastic deformation occurs in the shear panel (horizontal link beam), the main frame members are not damaged. But despite the high seismic energy loss, the main weakness of the eccentric braced frame system with horizontal link beam (H-EBF) is difficult and time-consuming repair or replacement of the link beam after the earthquake. Based on these examinations, it was found that short links, with closely spaced stiffeners, exhibit good behavior and that an appropriate designed bolted shear link can act as a replaceable link in eccentrically braced frames. Hence two replaceable bolted connection beams, (a) – I-shaped cross-section with end plate connections, and (b) – channel beam with back-to-back webs, as shown in Fig. 1, were designed and extensive laboratory research was done about these systems [2], [5-8].



(a)

(b)

Fig. 1. Two configurations of shear links of eccentric braced frames (EBFs), (a): constructed using I-shaped section with end plate, (b): constructed using channel section with back-to-back flanges [12].

Figure-1(Two configurations of shear links of eccentric braced frames (EBFs), (a): constructed using I-shaped section with end plate, (b): constructed using channel section with back-to-back flanges

According to AISC (2016), to meet the performance requirements, replaceable shear link beams in the plastic state during standard cyclic loading tests must achieve a rotation of 0.08 radians without fracture or severe strength loss. About link beams with back-to-back channel beams, the hysteresis behavior becomes slightly narrowed due to bolt slipping

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[1] Concentrically Braced Frame

[2] Eccentrically Braced Frame

and support deformations. However, such connections provide a larger deformation capacity than end-plate connections. Although, the behavior of both samples is satisfactory, but the link beam replacement (fuse) with the channel beam section is more flexible than the link beam connected with the end plate due to the presence of residual deformations.

In the past researches, the connection of the link beam to the out-of-link beam was in the form of end plates or bolting of channel sections. After the earthquake and at the time of replacing the fuse due to the distortions in these sheets, it was difficult to match all the screw holes with each other, and sometimes some of the screw holes had to be made wider than the specified condition in phase design. However, in the present study, joint connection is used to connect the link beam to the out-of-link beam. This connection consists of 3 steel sheets that connect the link beam with a full joint connection to the out-of-link beam in the form of groove and tongue by pin. Due to the jointness of the connection area, the fuse element only exhibits a shearing behavior, and there is no need to align several screw holes with each other or widen the screw holes during replacement. The fuse can be removed or installed easily by removing or inserting a pair of pins.

The second point is the practicality of this replaceability. In the past studies, replaceability was only mentioned as an advantage and its details were not discussed. In the past examples, for example Figure-1, to remove the damaged fuse after the earthquake, how to replace the fuse that is buried inside the roof? But in this study, taking into account the system main beams (which was in the perpendicular to EBF), gravity load is not applied on the fuse. Also, the connection of the braces to the fuse is made with screws and embedded inside the wall. (Not in the corner of the roof). Therefore, by removing the joinery layer on the wall and temporary opening the braces and removing the pins of the connection area, in a completely practical and effective way, the fuse is moved down and it simply comes out of its place. It is done in the same way for installation. All these steps of installing and replacing the fuse have been practically done in the lab.

2. Fuseelement

The desired fuse, Simple Replaceable Fuse (SRF[1]), consists of a link beam set and a number of steel sheets that are connected to the frame with a pair of pins. Sheets, according to the forces that created in them, should exhibit completely elastic behavior during the earthquake and should not enter the plastic zone in any way; and only the link beam can experience hyper elasticity deformations.

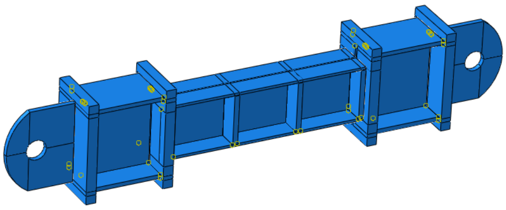

Fig. 2. replaceable fuse.

The main purpose of making this fuse is to guide and control the earthquake force in the link beam area and to protect other elements of the frame from damage. On the other hand, the most important concern of the researchers has been the fuse building and easily replacement with its optimal6 performance.

In most replaceable models, screw connections are used, which after an earthquake, due to the caused damage as the fuse is replaced, it just becomes clear that very small deformations have occurred and caused distortion in the connection plate. This issue causes since the new fuse is replaced, the previous holes do not compatible easily with the new fuse, and this issue is a series of problems' beginning for replacing screw fuses. One of the

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[1] Simple Replaceable Fuse

distinguishing features of this study compared to other studies having replaceable links is in the way of connecting the fuse to the bracing system. In this research, by maintaining the link beam optimal performance, three steel sheets that are connected by tongue and groove joint are used to connect the fuse to the beam outside the link.

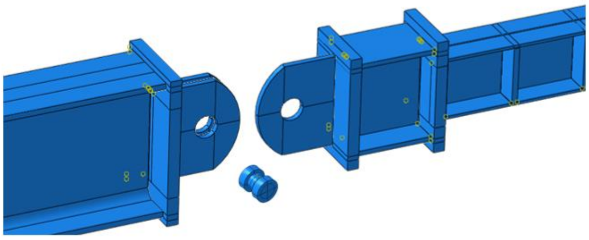

Fig. 3. Fuse connection method.

The ends of the connecting plates, for free rotation are as curved form, and this makes replacing of the fuse easy. This connection set (tongue and groove sheets) is connected to a vertical end sheet and in this way, it is connected to the short beam outside the link on one side and to the long beam outside the link on the other side.

According to Fig.4, the longitudinal axis of the braces (dashed line), and the longitudinal axis of the fuse (solid line) intersect at the beginning of the connecting beam. Determining and choosing the location of this intersection has been one of the main points in determining the system behavior. For example, the intersection of the brace longitudinal axes and the connection area's pin causes instability in the structure, and to solve this issue, the connection area is removed to outside of the brace and link beam intersection site.

3. Shear link beam design (fuse)

3.1. Design principles

In this study, the link beam is designed in a way that by yielding and losing energy, as a ductile fuse, prevents the buckling of braces.

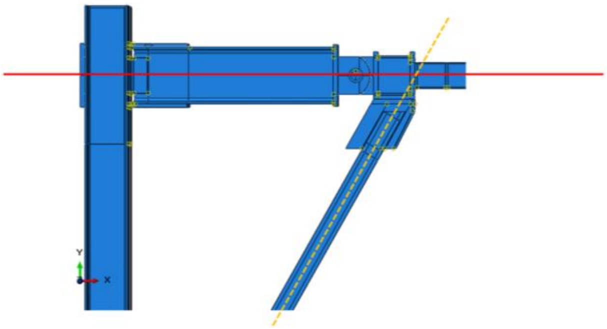

Fig. 4. The intersection of the longitudinal axes of the brace and the fuse.

The inelastic response of a link beam is strongly influenced by the length, and the ratio $\frac{M_P}{V_P}$, in the cross section of the link beam. Using plastic analysis, plastic shear strength V_P and plastic bending strength M_p can be determined:

$$V_p = \frac{F_{yw}}{\sqrt{3}} t_w\left(d - 2t_f\right) = 0.6F_y A_w \tag{1}$$

$$M_p = F_{yf} t_f (b - t_w)\left(d - t_f\right) + \frac{F_{yw} t_w d^2}{4} = ZF_y \tag{2}$$

where F_{yw} and F_{yf} are the yield stress in web and flange respectively, t_w web thickness, d beam depth, t_f flange thickness, b flange width, A_w web area, F_y yield stress and Z is the base of the plastic section. The shear link beam has very good ductility and energy dissipation [9-10], [19-21], [11-18]. In fact, the high effect of isotropic strain hardening and the combination of bending and shear leads to an increase in the bending strength and plastic shear capacity. In the final state, the shear capacity and bending strength will reach $1.5V_p$ and $1.2M_p$ respectively. Also, in order that shear failure occur before the bending failure of the horizontal link beam, the length of the link beam (e) should be limited to the following:

$$e \le \frac{2\times 1.2M_p}{1.5V_p} = 1.6\frac{M_p}{V_p} \tag{3}$$

Especially, the classification is based on the normalized link beam length (ρ), which is $\rho = {V_p . e}/{M_p}$ is defined. The capacity-based design method seeks to limit shear link beams in the inelastic region, so that all other frame members are designed to behave elastically. According to the AISC[1] seismic rules, link beams with $e \leq 1.6 \frac{M_p}{V_p}$ or $\rho \leq 1.6$ are shear link beams that mainly yield in shear and have a maximum rotation of 0.08 radians under seismic load in the link beam. The relative displacement angle of the frame (θ) can be calculated according to the rotation angle of the link beam (γ), as shown in (Fig. 5).

$$\theta_p = \gamma_p \frac{e}{L} \tag{4}$$

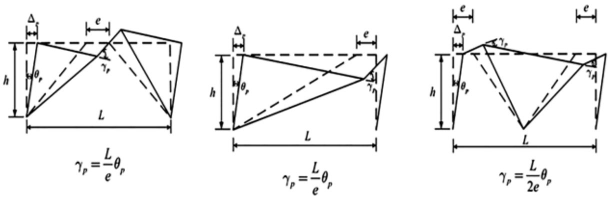

Fig. 5. Rotation of the link beam in the eccentrically braced frames, [11].

Also as discussed above, under the base shear applied to the frame, when the link beam enters the inelastic region, the other members of the frame meanwhile outside the link beam, must be designed to remain elastic. The members outside the link beam are designed to resist the forces caused by the complete yielding of the link beam and entering its strain hardening region. For short link beams ($\rho \leq 1.6$), the generated forces can be calculated as in AISC (2016), (link beam section= $1.25 R_y V_p$), (link beam end bending in beam= $R_y V_p$, link beam end bending in brace $= \left[1.25 R_y V_p . e - R_y M_p\right] \geq 0.75 R_y M_p$ where R_y is the ratio of the expected yield strength to the minimum yield strength F_y. This ratio is used to define the strength of the material. It is based on the results of 16 link beams, made of A992 steel, the average strain hardening has reached 1.28 with variations from 1.17 to 1.44, [25]. Other studies [9-10], [20-21], [11-18] generally set the link beam strength factor to 1.5 For this purpose, the members outside the link beam are designed to resist the forces caused by the complete submission of the link beam and entering its strain hardening region [23-25].

3.2. Design assumptions

In this study, we considered assumptions to design the desired frame. The selected frame is a span of a 10-story building with educational application, which is located in an area with high seismic risk. The lateral load resistant system of this structure is a special eccentrically braced frame in one direction and a special buckling frame in the other direction. The direction of roofs beaming has been considered in a way that the main beams are placed on the buckling frame and the special eccentric frame only plays a role to resist against the lateral load. This assumption has been considered in order to investigate more closely the behavior of the system under the lateral load, as well as the easier replacing of the fuse.

Considering that short link beams ($\rho \leq 1.6$) show better ductility and energy loss, the dimensions of the short link beam have been chosen; so that in addition to have an optimal cutting behavior, have easily replacing. The length of the link beam, which is the distance between the braces and the beam intersection point, is 400 mm. A pair of stiffeners are used at the beginning and end of the beam and on both sides of the web. Also, according to the beam's web height, which was calculated to be less than 600 mm, the installation of the middle stiffener is sufficient only on one side of the web. In the desired frame, the link beam is located in the middle of the span, and the beams outside the link are connected to the columns through fixed joints. This fixed joint is made through the installation of overhead

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[1] American Institute of Steel construction

sheet, sitting sheet and web sheet. Also, a distance of two centimeter is considered in the connection area to the column. In the column joint area, due to the presence of forces in this area, we have to use continuity plates and double sheets to prevent the column wing and web crushing. To connect the continuity plates to the column wing, you can use the full penetration groove welding, and the same type of weld or double corner weld to the connect column web.

In general, according to what was explained in the previous section, all the frame members, except the link beam (fuse), should be designed in a way that remain in the elastic region during the earthquake and do not enter the nonlinear region. For this purpose, these members are designed for a force greater than what is created in them. According to the steel structures design regulations, the internal force of these members (which are referred to as control force members) must be multiplied by an additional resistance factor (Ω0). Therefore, control force members are designed for this increased force. Only the link beam (deformation

control member) is designed for its actual force. This way of designing causes forces to be transferred to the weaker member, which is the link beam, as the frame is subjected to the lateral load caused by the earthquake. The link beam also amortizes the sustained force by accepting ultra-elastic deformations. Meanwhile, the force in other members does not exceed from their elastic limit and remains in the elastic area. As a result, after a big earthquake, the only member that has experienced major deformations and probably has permanent deformations is the member that we expected; i.e., the link beam (fuse). After the occurrence of such an earthquake, the structural fuse is replaced with a little cost and in a short period of time, and the structure can be reused immediately after that.

4. The finite element model of the link beam

Most of the inelastic behavior of eccentrically braced frames is limited to the shear link beam. Since large shear forces and bending moments are applied to the link beams, the relation is appropriate that includes shear and bending effects in elastic and inelastic states. An accurate model of a shear link beam in the time of applying load must consider the effects of plastic moment or shear with strain hardening. In the link beams performance analysis, for shear and bending behaviors, elastic and inelastic deformations should be considered. For modeling and investigating the model, ABAQUS software is used.

4.1. Mechanical properties of materials

In order to public access, cheap construction of fuse and production and widely used of it in the construction industry, its material should also be cheap and available, in addition to the simplicity of fuse construction. The material of the sections is ST37 steel with a density of $\rho = 7.85 \times 10^{-9}\ \frac{\text{ton}}{\text{mm}^3}$ and other elastic and plastic properties present in Tables 1 and 2, based on DIN 17100 St37-2 Steel.

Table. 1. elastic properties.

Poisson's ratio	Young's modulus
0.3	$\mathbf{20 \times 10^5}$ **Mpa**

Table. 2. Stress and strains.

Stress (Mpa)	**Strain**
235.3596	0
265.93423	0.05
277.528195	0.09
300.08349	0.018
324.600115	0.033
353.0394	0.056
353.0394	0.088
353.0394	0.13

4.2. Interaction

Since in this study the behavior of the connections is not desired and our attention is focused on the link beam behavior, the design has been in a way that all the joints remain in the elastic region and without damage during the loading period. In view of that the type of connections is not the subject of this research, for the simulation of the welded connections of the Tie, and for the curved sheets and pins connecting the link beam to the beam outside the link, which are in direct contact with each other, Contact limit and two types of vertical and tangential contact are used. In vertical contact, a Lagrangian equation is used to solve the equations; and tangential contact models the friction between two surfaces using a coefficient of friction, which is defined by the user and is about 0.4 for steel.

4.3. Loading

The loading method used in this research is based on method B of ASTM[1] (2011) E2126-11 regulations. In this loading method, the range of motion is a percentage of the target displacement. These cycles will continue until failure occurs or a significant drop in resistance is observed. The load application steps are based on the percentage of target displacement. since the purpose of this research is to investigate and compare the behavior of eccentric bracing frame with Interchangeable link beam, in this research, instead of changing the location of the target, the maximum real relative displacement (Δ_m) or Drift has been used. The value of Δ_m, which is obtained by considering the effects of $P - \Delta$ in the calculation of Δ_m, should not exceed the permissible value of Δ_a to do in the following relations. Height of the floor is h.

in buildings with more than five floors → $\Delta_a = 0.020h$ (5)

Accepting that the desired frame is located in a building with more than 5 floors, so the maximum real relative displacement will be equal to:

$\Delta_m \leq \Delta_a = 0.020h = 0.02 \times 2400 = 48$ mm (6)

With a displacement of ±0.6 mm in the first stage of initiation and growth, loading continues according to the third column of Table-3 for the next stages. The first five stages of loading are repeated once each and the subsequent stages are repeated three times each.

Table 3. Loading protocol by method B of ASTM [29].

Minimum Number of Cycles	Amplitude, Δ_m%	Displacement (mm)
1	1.25	0.6
1	2.5	1.2
1	5	2.4
1	7.5	3.6
1	10	4.8
3	20	9.6
3	40	19.2
3	60	28.8
3	80	38.4
3	100	48
3	120	57.6
3	140	67.2
3	160	76.8
3	180	86.4
3	200	96

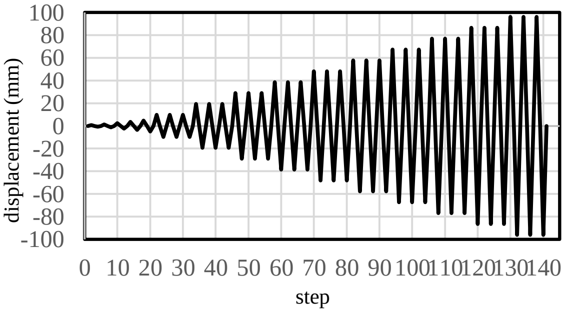

Fig. 6. Loading protocol by method B of ASTM [29].

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[1] American Society for Testing and Materials

4.4. Sample stability

Basically, the out-of-plane lateral stiffness in the lower wing of the shear link beam affects the placement of the braces and the behavior of the fuse. Based on analytical studies on lateral stability conditions, lateral restraints along the length of the link beam are used to control lateral torsional buckling to prevent out-of-plane movement at the bottom of the shear link beams.

4.5. Meshing

The method and element used for meshing is the Structure technique and the solid element called C3D8R, which is an 8-node cubic or brick-shaped, three-dimensional, linear element with a reduced formulation. The reduced formulation is chosen in order to reduce the calculation time, because in the case of higher order elements, the calculation time becomes very high. Also, the presence of contact surfaces in the model becomes the problem nonlinear, which makes the linear elements of the response convergence easier to choose. At least three members are used in the thickness of the steel flanges, plates and stiffeners in order to properly redistribute the bending behavior. In order to reach the appropriate mesh size, the analysis was performed with different mesh dimensions until the analysis results converged. In the parts of the model where higher stress concentration is expected, the meshing is finer as well.

5. Numerical results

In order to investigate the desired fuse, first, a 10-story educational building in an area with high seismic risk was modeled in ETABS software. Then by determining the type and required sections dimensions of the frame, finite element study has been conducted on the single-span frame with replaceable fuse, SRF.

5.1. Cyclic displacement results

From the finite element modeling, the results which obtained are caused by applying horizontal cyclic displacement to the outer faces of the columns at a distance of about 1510 mm from the center of the link beam, at the level of the floor ceiling. (Fig. 7).

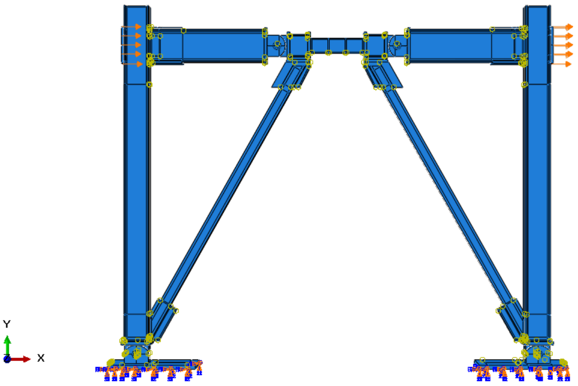
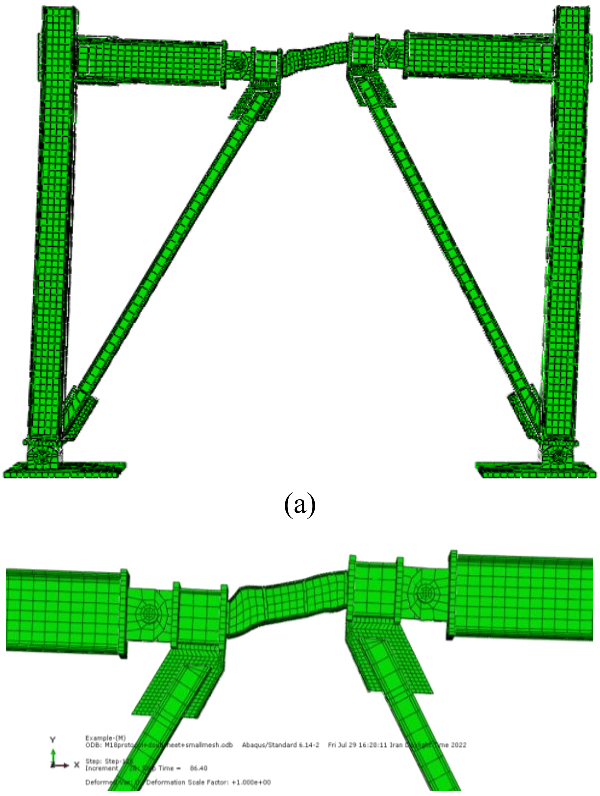


Fig. 7. The location of the lateral load at the level of the floor ceiling.

Fig. 8, shows the deformed form of the target frame under the applied displacement.



(a)

(b)

Fig. 8. (a) Deformation of the frame, (b) Deformation of the link beam.

Based on the results obtained from the analysis of the frame under cyclic displacement, the main concentration of stresses has occurred in the link beam and while other parts of the structure remain in the elastic region, the link beam undergoes many deformations upon entering the nonlinear region, which has suffered and has caused significant consumption of energy. In Fig. 9, colored graphs of Von Mises stress (s, mises), resulting from cyclic displacement, are presented.

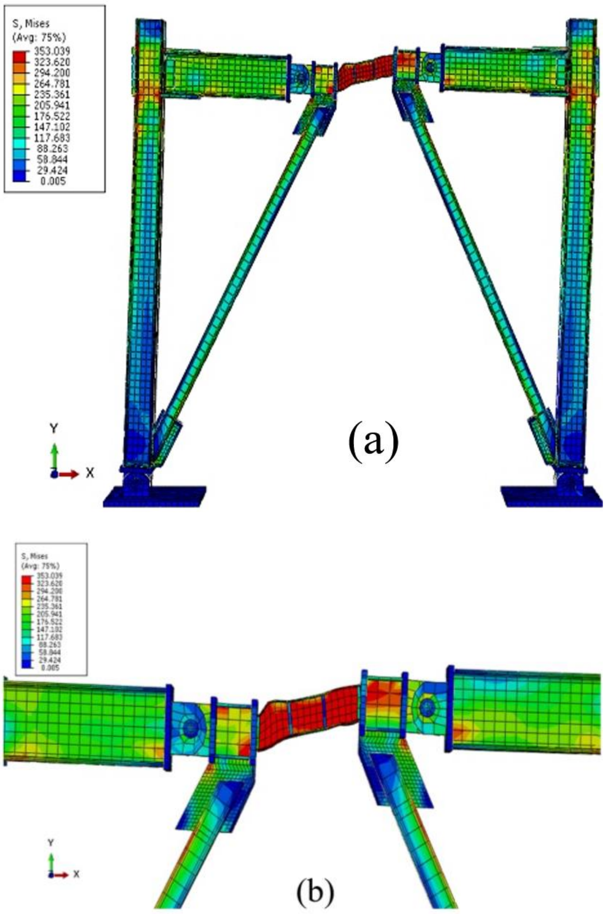


Fig. 9. Von Mises stress color diagram, (a) in the frame, (b) in the connecting beam.

For the purpose of specifying more precisely the behavior of the link beam with joint connection in the frame, the colored graphs of shear stress (S, S12) are presented in fig. 10.

In the link beam and other frame members the axial force is negligible. Fig. 11 shows the more critical points of these stresses for the X, Y and Z directions, respectively.

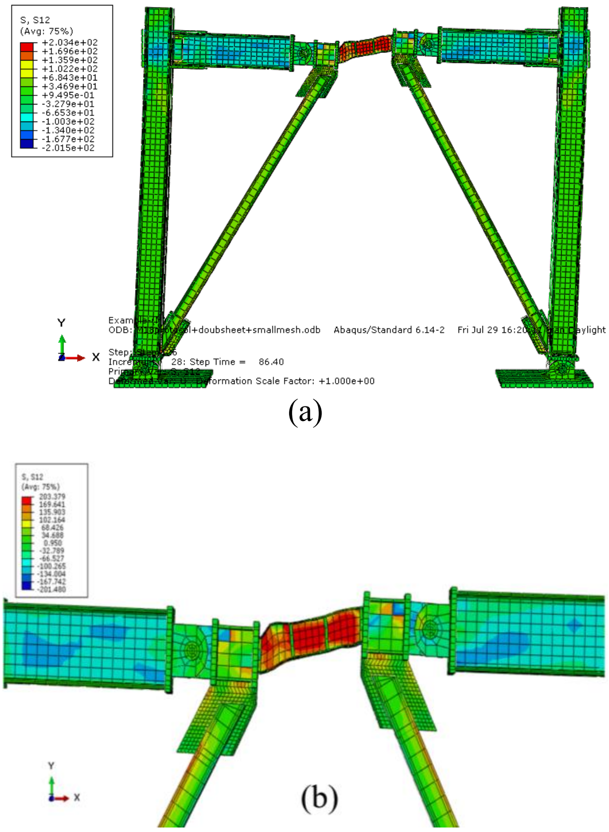
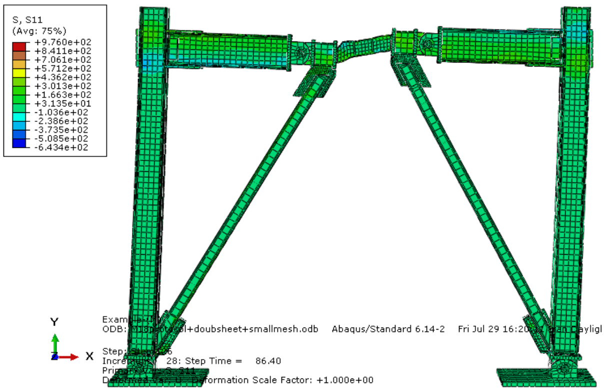


Fig. 10. Color diagram of shear stress (a) in the frame, (b) in the link beam.

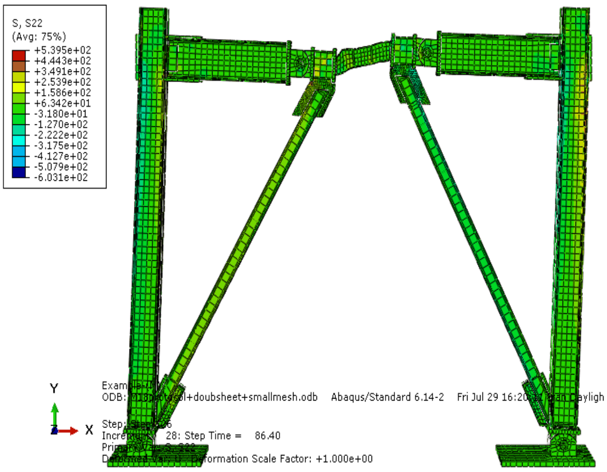
6. Analysis of the results

In order to reach forces such as displacement, the forces applied to both columns at each stage of displacement should be added together according to the direction of the forces due to the fact that in this modeling displacement has been introduced to the frame columns. According to the results obtained from the ABAQUS software, the sum of forces and displacements applied in the X direction leads to draw a hysteresis diagram as shown in Fig. 12.

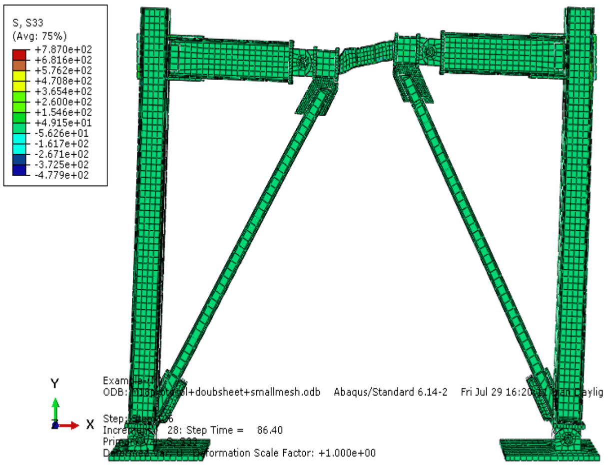
Moreover, as it is illustrated in Fig. 10, if the points presented in the design section are followed, and the design is done correctly, we will see the concentration of shear force in the link beam, which means the occurrence of shear yielding in the link beam. According to the main idea of the design, that for Interchangeable, were initially two bending joints on both sides of the link beam, we should never have allowed the formation of a third bending joint in the link beam.



X axis



Y axis



Z axis

Fig. 11. color diagram of the axial stresses of the frame.

Because with the formation of the third bending joint, the failure mechanism was formed in the beam and the frame collapsed without bearing an acceptable amount of shear force. Yielding has occurred in the link beam and is of a shear type consequently. The colored graphs of the equivalent plastic strain (PEEQ) in the change of the maximum location are depicted in fig. 13, as well.

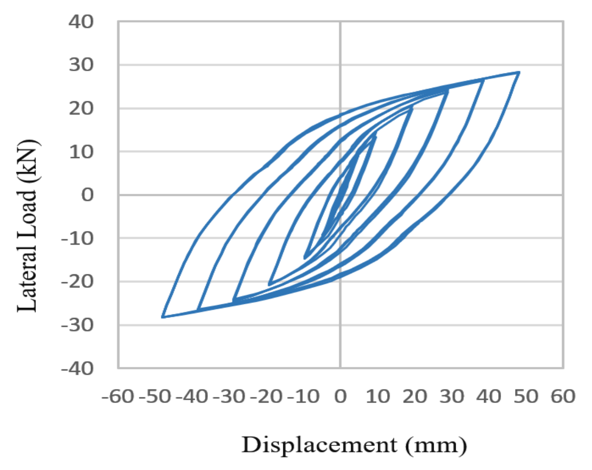


Fig. 12. Hysteresis diagram of the frame under cyclic displacement.

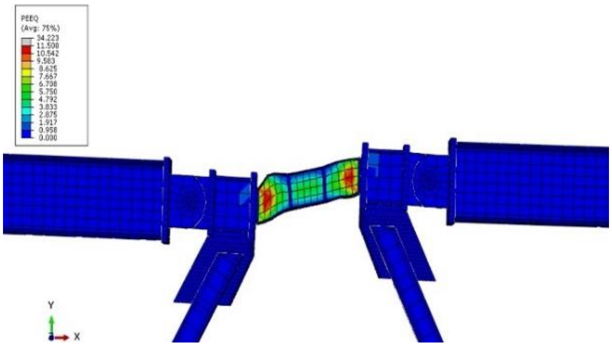


Fig. 13. Diagram of PEEQ in maximum displacement.

6.1. Verification

In general, the purpose of this research is to investigate the behavior of the introduced fuse and to determine the design parameters and behavior coefficient for the eccentrically braced frame equipped with SRF.

In another part of this project, which includes full-scale experimental modeling, the experimental tests prove the claim of the researchers that the fuse enters the non-linear area and the rest of the frame members are protected during the earthquake. The behavior of the frame in the experimental test is consistent with the numerical studies and the correctness of the behavior of the fuse has been confirmed. As an example, the final images of the experimental test (number-1), the eccentrically braced frame system equipped with SRF is presented to determine the correctness of the model (Fig. 14).

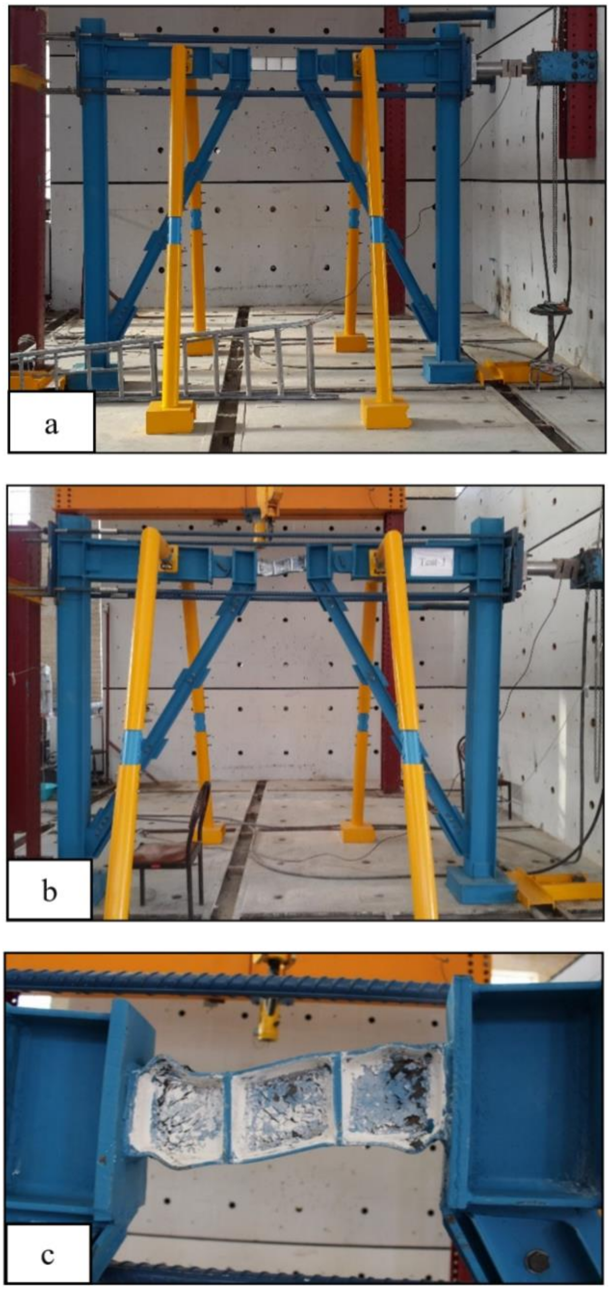


Fig. 14. Verification by experimentally tests. (a) Before Test, (b) After Test, (c) Close ups fuse after test.

6.2. Frame design parameters

In this study, the Priestly and Paulay method was used to idealize and bi-linearization the pushover curve, and the Chopra method was used to calculate the design parameters. In this method, the first part of the two-line curve cuts the pushover curve at $0.75V_y$ and then continues to V_y, and the slope of the second part of the two-line diagram is zero ($\alpha = 0$). In other words, the second part of the curve is horizontal and V_0 is equal to V_y. In this case, the area under the push-over diagram is assumed to be equal to the area under the bilinear curve diagram.

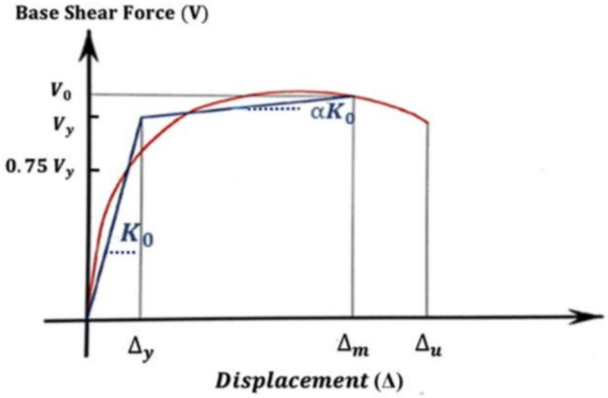


Fig. 15. Bilinearization of Pushover diagram by Priestly & Paulay method.

The components of the behavior coefficient consist of four parameters, which are mentioned in relation (7) is shown in the research of Berkeley University researchers, [30].

$$R = R_s R_\mu R_R R_\xi \tag{7}$$

In above relation, R_s: additional resistance coefficient, R_μ: coefficient due to ductility, R_R: uncertain coefficient and R_ξ: damping coefficient of the system, which is described in detail in [30], and the results of each are shown in the table below. The desired frame is presented.

Table4. Design parameters of eccentrically braced frame with interchangeable link beam.

Parameter	Value	Parameter	Value
V_S	90.5628	V_E	**893.87**
δ_S	4.8000	δ_E	**47.3769**
K_E	18.8672	R_s	**2.3068**
V_0	322.576	R_μ	**4.2786**
δ_m	86.4000	R_R	**1.00**
V_y	208.912	R_ξ	**1.00**
δ_y	11.0727	μ	**7.8029**
K_1	1.5089	R	**9.8701**

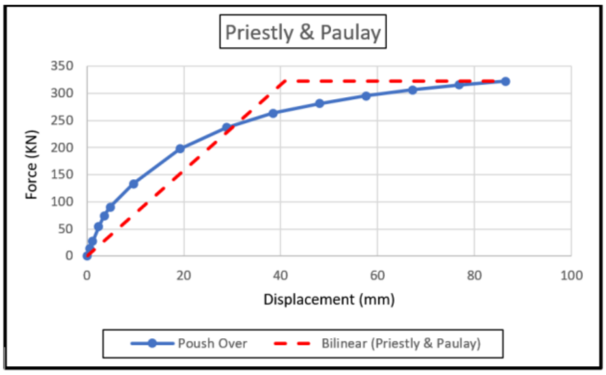


Fig. 16. Bilinearization of pushover diagram of eccentrically braced frame is introduced.

7. Conclusion

As discussed in this investigation, the analytical study of Interchangeable fuse in eccentrically braced frames has been discussed. In this research, the amount of energy consumption in the Interchangeable link beam was investigated by drawing the hysteresis diagram/force-displacement. In order to achieve the desired results, the design of the steel frame has been done by ETABS software and modeling analysis by ABAQUS software.

Totally, against lateral loads caused by earthquakes, the eccentric bracing frame is a reliable system. This system, which with its high hardness and ductility, behaves very well during an earthquake, requires proper design and implementation without defects for its proper operation during an earthquake. The results of the system, especially the coefficient of behavior and the coefficient of plasticity, showed that, in case of accurate design and flawless implementation, during an earthquake, a significant portion of the force enters the link beam and is used to change its shape. In other words, Interchangeable link beam, by accepting a significant shear deformation, enters the nonlinear area and with its damage, other parts of the structure remain immune. The important point of this research is that the joint connection of the link beam to the beam outside the link and the braces makes the fuse or link beam easily and quickly interchangeable after the destruction caused by the earthquake and they come back and can be used as the structures with this system quickly return to operational mode.

Acknowledgements

None.

Conflict of interest

All authors state that there is no conflict of interest.

Statements and declarations

All author declares: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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