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# Analysis of Eccentrycally Braced Frame (EBF) Structure With Self Centering System Modification

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**Abstract:** ***Basic Concepts for EBF Designs the strength and ductility of portal structures aredesigned with direct relation to the strengths and ductility of the links. For EBF design theenergy dissipation of earthquakes occurs through plastic deformation in the link element during a major earthquake. However, plastic deformation of links may result in a framework in permanent structural failure conditions and difficult to repair after an earthquake occurs. An earthquakeresisting structural system called a self-centering system is a system that uses a gap-opening behavior in selected critical joints between the major structural elements without overriding the energy dissipation on the element to provide nonlinear softening behavior, ductility, and energy dissipation without significant inelastic deformation resulting in damage to the corresponding major structural portion. Next the self-centering system will be combined with an eccentrically a gap-opening review will be conducted on the link element of the EBF structure. Added energy dissipation bar. earthquake. In this research SCEBF will be modeled with 3 types of link model that is short link, intermediate link and long link. By modeling the structure of the multi-story building with the number of 12 floors using SAP 2000 to get the feasibility of the earthquake resistant building structure and for the portal model using ABAQUS. The result of this research is the building structure using short links (short links) to give better response to the value drift and inter-floor intersections compared to intermediate links (intermediate links) as well as long links (long links). Portal structures using intermediate links (intermediate links) provide better response to hysteresis values than short links (short links) and long links (long links).***

**Keywords:** eccentrically braced frame, self-centering, earthquake load, hysteresis loop

## 1. Introduction

The Eccentrically Braced Frame (EBF) frame structure of the Eccentrically Braced Frame (EBF) Steel Frame (EBF) is proposed as an earthquake-resistant steel frame structure in order to qualify for modern earthquake design at medium earthquake load. Eccentrically Braced Frame (EBF) exhibits similar lateral stiffness with Concentrically Braced Frame (CBF), and similar resilience to Frame Moment Resisting Frame [1]. EBF combines the advantages of high elastic stiffness and high ductility in Story Drift. The elastic stiffness of the frame is reinforced concentrically with the resilience and stable energy dissipation of the moment retaining frame. The type of structure used is an earthquake retaining system by reviewing the melting failure in one of link.

When extreme seismic loads occur, conventional seismic designs have the main focus of ensuring the prevention of collapse in order to ensure human safety in the building [2]. For EBF design the energy dissipation of earthquakes occurs through plastic deformation in the link element during a major earthquake. However, plastic deformation in links may result in order in permanent structural failure conditions and difficult to repair after an earthquake occurs [3]

According to Richard Sause and James M. Ricles the alternative design approach concentrates on structures that fail to be improved to achieve performance in higher seismic conditions. While the main structure remains planned to remain inelastic minor deformed. After the earthquake damage only special elements that need to be replaced. In this case self-centering systems will provide an elastic element that will return to its original undeformed position.

## 2. Related Works

A typical Configuration of the proposed Eccentrically Braced Frame Self-Procurement (SC-EBF) {[3] with detailed link end links with Gap Opening. In this configuration the components are adjacent to the collector or column beams, depending on the EBF configuration. On each web on a cross-section of the link is placed a high-strength steel tendon located at the center depth of the beam. The posttensioned tendon aims to provide a pre-tap strength on the beam. In the connection between the link dab beam given Shape Memory Alloy (SMA) bolt symmetrically. The purpose of mounting SMA is to increase the pre-compression between the link and the adjacent components. Shear forces are used to prevent the vertical slip between the Link and the adjacent components if friction on the part of the component is considered insufficient to withstand the shear force in the link.

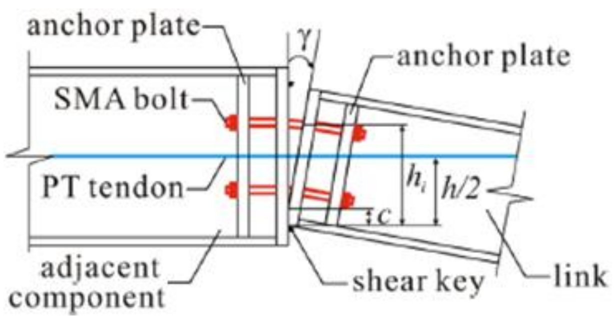


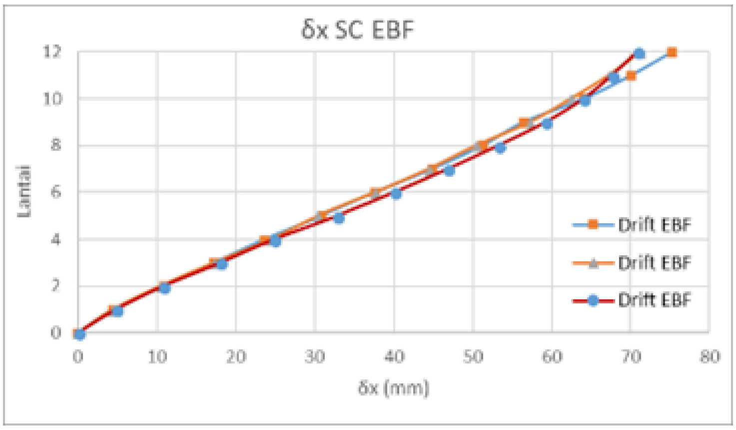

**Figure 1:** Interaction of link after gap opening

## 3. Methodology

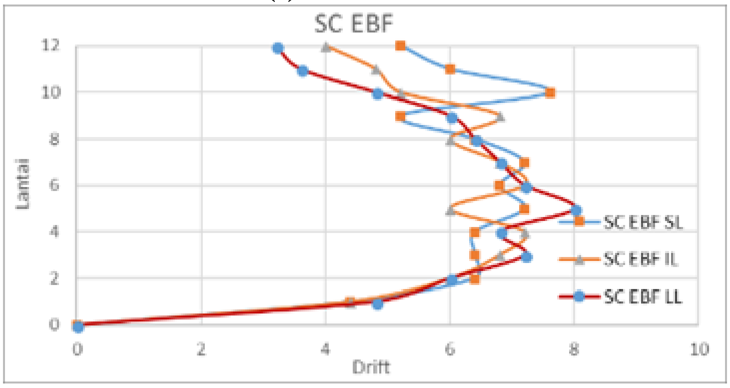
The study was conducted using SAP2000 auxiliary program for building model with SCEBF structure which added Self-centering device in the form of SMA BOLT. Then for the portal will be modeled using ABAQUS program. Analyzes with variations of links are short links (SL) with 1 m long, intermediate links with Length 2 m, and long links with length 3m. Analytical calculations will cover the bursting burden of the spectrum response for the Building and the cyclic load for the portal

## 4. Result

### a) Drift




(a) deck deviation

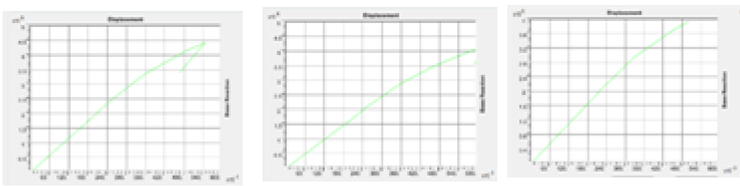



(b) drift

**Figure 2:** Deck deviation and drift structure

above shows that the lateral drift generated in the SCEBF-SL building model is larger than the other two models, and the SCEBF-LL building model has the smallest deck decimal value. With the SCEBF-LL building model as a reference, the SCEBF-SL and EBF-IL building models experienced an increase in deck deviation of 2.36% and 3.35%

The same behavior applies to drift except for decks of reversion. Drift decks in SCEBF-SL buildings are larger than other building models with SCEBF-IL and SCEBF-LL building models each experiencing a reduction of 6.06% and 7.98% drift deckscurve of push over



**(a) SCEBF-SL** **(b) SCEBF-IL** **(c) SCEBF-LL**

**Figure 3:** Push over curve

Ductality of SCEBF-SL:

$$\mu_{EBF\text{-}S} = \frac{\delta_m}{\delta_y} = \frac{544.56}{245.88} = 2.21$$

Ductality of SCEBF-IL:

$$\mu_{EBF\text{-}I} = \frac{\delta_m}{\delta_y} = \frac{500.28}{219.63} = 2.27$$

Ductality of SCEBF-LL:

$$\mu_{EBF\text{-}L} = \frac{\delta_m}{\delta_y} = \frac{599.02}{251.78} = 2.37$$

From the above calculation shows that the structure of SCEBF-LL has the greatest ductility value between the three models that is equal to 2.37 and SCEBF-SL structure has the lowest ductility value that is equal to 2.21 whereas SCEBF-IL structure has ductility value between the three models that is equal to 2.27. It can be concluded that the SCEBF-LL structure is more ductile than the SCEBF-SL and SCEBF-IL structures.

### b) Deformation and Stress

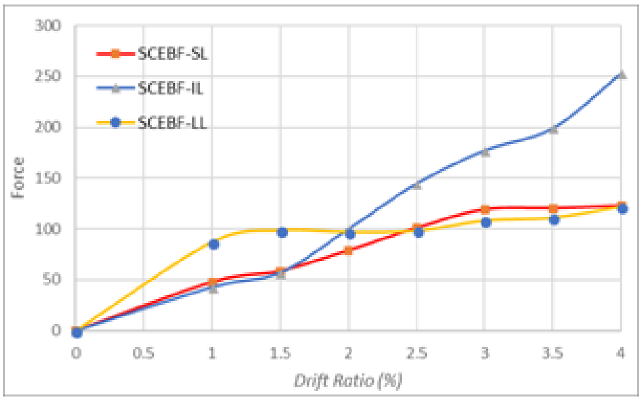
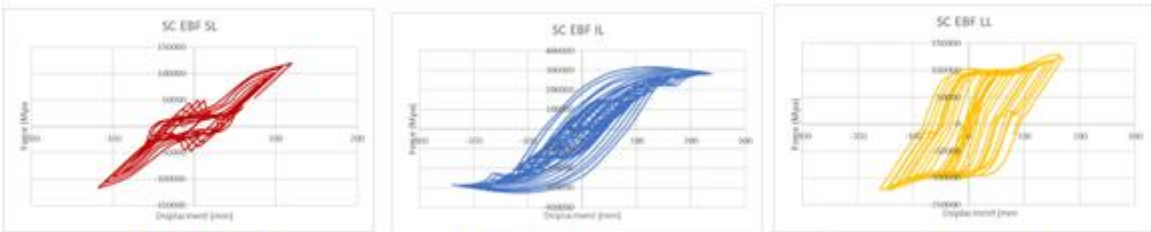



**Figure 5:** Stress and ratio drift curve

From the results of stress curve analysis and drift ratio, it can be concluded that SCEBF-IL model has the highest voltage value at 4% drift ratio with 252.08 Mpa value. SCEBF-LL has the second highest value of 121.68 MPa, and the last is SCEBF-SL model with a voltage value of 119206.20 MPa. But it can also be seen in the 1% (initial) drift ratio of the highest value of SCUF-SL and SCEBF-LL model and the last is SCEBF-IL model.

### c) Hysteresys energy




(a)SCEBF-SL (b) SCEBF-IL (c) SCEBF-LL

**Figure 5:** Hysteresys loop

shows that in the SCEBF-IL model the maximum voltage reached is 315.419 MPa in the displacement position with a value of 238 mm, this makes this model has the largest voltage value and the largest displacement value of the three existing models.

## 5. Summary

1) Building structure using short link (short link) giving better response on drift and inter-floor value than intermediate link (medium link) or long link (long link).
2) Portal structures using intermediate links (intermediate links) provide better response to hysteresis values than short links (short links) and long links (long links).

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