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SEISMIC ANALYSIS OF A HIGH RISE BUILDING PROVIDED WITH CRESCENT SHAPED BRACES

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Abstract – *Steel braced frames are the widely used for structural adequacy in providing sufficient lateral strength and stiffness to a structure. Various steel braces are used in practice, such as x-braces, diagonal braces, V-braces, and eccentric braces. Similarly Crescent shaped braces are also a new innovation in this field. The CSB is a unique hysteretic lateral resisting device that provides additional design freedom to frame structures. In this study, a comparison is made between the performances of a CSB, K- shaped braces and V- shaped braces in improving the seismic resistance of a G+15 story building using ETABS software. The study concludes from the results that CSBs are much more efficient than V- shaped and K- shaped braces.*

Keywords: **Steel braces, CSBs, V-shaped braces, K-shaped braces, hysteretic devices.**

1. INTRODUCTION

Steel is a vital progress material and plays a very significant role in growing social orders. Most of structures for e.g., home, parking lots, educational institutes and skyscrapers rely on steel because of its high strength and good ductility. Earthquakes are vibrations emanating from a source of disturbance within the earth crust which release energy in form of seismic waves. These travel through earth's surface leading to a greater destruction of property and also increase the death toll. Steel braced frames are the widely used for their structural adequacy in providing sufficient lateral strength and stiffness to a structure. The steel braces contribute to seismic energy dissipation by deforming elastically under ground motion. Various steel braces are used in practice, such as x-braces, diagonal braces, V-braces, and eccentric braces. The objectives of work;

1. To analyse the seismic responses of a high rise building provided with Crescent shaped braces (CSBs).
2. To compare the seismic performance of the K and V-shaped braces with CSBs.

2. LITERATURE REVIEW

Cesare and Ponzo (2017), studied the seismic retrofit of reinforced Concrete Frame Buildings with Hysteretic Bracing Systems. The study investigated the mechanical properties of the hysteretic Energy Dissipation Bracing (EDB) systems. The performance of this damping system in reducing seismic responses was also studied. **Kammouh, et.al, (2017),** studied the performance-based seismic design of multi-storey frame structures equipped with crescent-shaped brace. They proposed and developed a new performance-based approach for the seismic design, i.e, crescent shaped braces. The hysteric characteristics of the CSBs as well as their mechanical properties were studied. **Palermo et.al, (2017),** conducted experimental tests on Crescent Shaped Braces which are hysteretic devices. They compared the effectiveness of the design formulas for the seismic design of CSB and the predictions of a simplified non-linear model in terms of force displacement envelop response. **Kammouh, Cimellaro (2016),** studied the application of Crescent-Shaped Brace passive resisting system as a retrofitting system in existing multi-storey frame structures. This case study, in an already existing structure, yielded important information regarding the nature of the bracing system.

3. SEISMIC ANALYSIS OF HGH RISE BUILDING WITH CSB

3.1 Details of the building

The plan dimension of the building taken for the study is 40 m x 20 m. The structural models have the same story height of 3m and have a uniform mass distribution over the height. Bay width is of 5m in both X- and Y- directions.

Table 1 Details of building

Grade of Concrete	M25
Grade of Steel	Fe 415
Thickness of Slab	150
Live Load	4 kN/m^2
Live Load on Roof	1.5 kN/m^2
Floor Finish	2 kN/m^2

The section properties of columns, beams and K and V braces are given below in table 2. The building is a steel high rise building with concrete floor. The bracing systems adopted are also steel sections.

Table 2 Section properties

Story	Column	Beam	Brace
S-6 to S-15	400 x 750	400 x 600	ISB 172 x 92 x 4.8
S-5	400 x 750	400 x 600	ISB 172 x 92 x 4.8
S-4	400 x 750	400 x 600	ISB 172 x 92 x 4.8
S-3	400 x 750	400 x 600	ISB 172 x 92 x 4.8
S-2	400 x 750	400 x 600	ISB 172 x 92 x 4.8
S-1	400 x 750	400 x 600	ISB 172 x 92 x 4.8
GF	400 x 750	400 x 600	ISB 172 x 92 x 4.8

3.2 Modeling and Analysis

The building is modeled in ETABS software, provided with Eccentric V shaped, K shaped and Crescent shaped braces respectively. Performance of the building is studied for each of the types of braces and results compared. Four different configurations of the bracings namely 1, 2, 3 and 4 are provided.

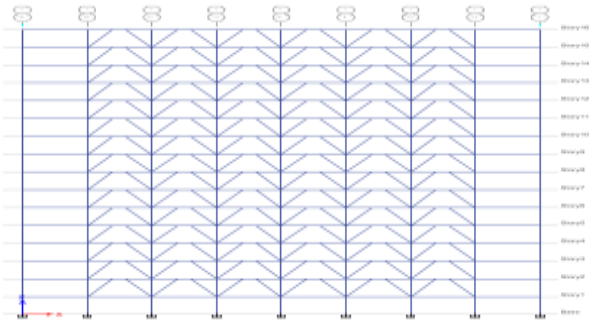

Fig.1 K1 Model

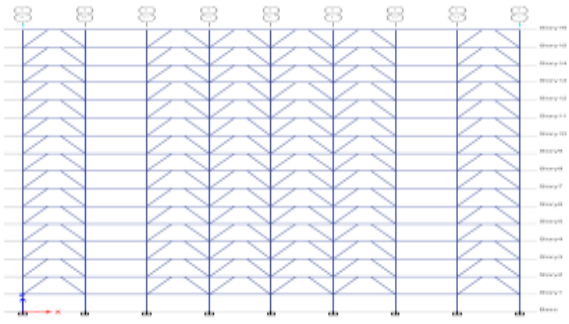

Fig.2 K2 Model

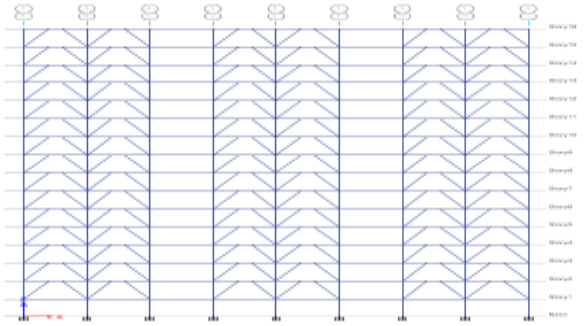

Fig.3 K3 Model

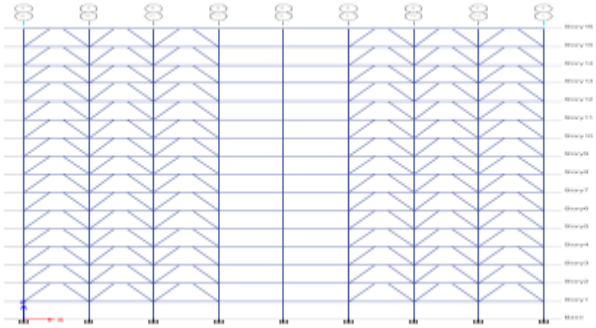

Fig.4 K4 Model

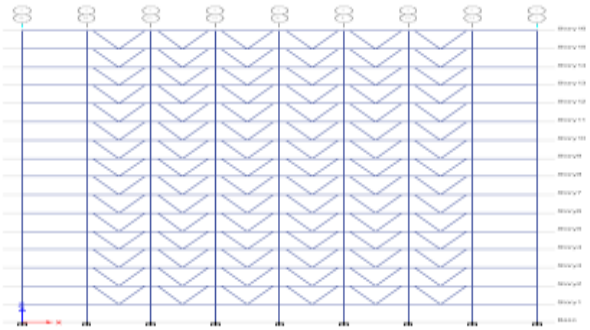

Fig.5 V1 model

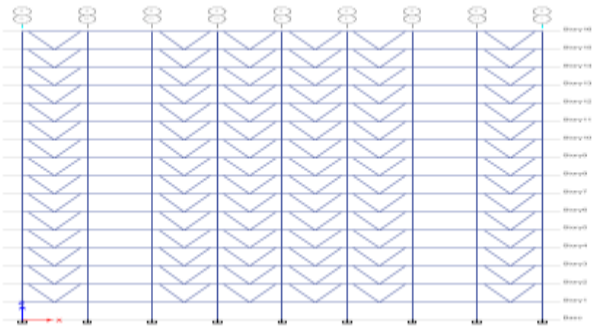

Fig.6 V2 model

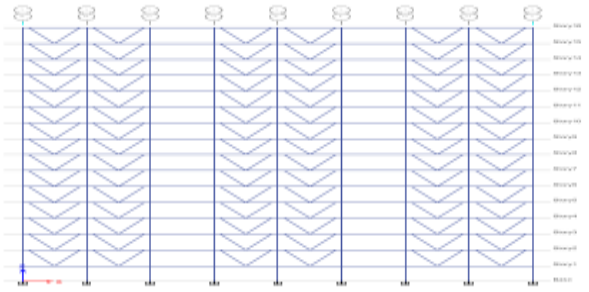

Fig.7 V3 model

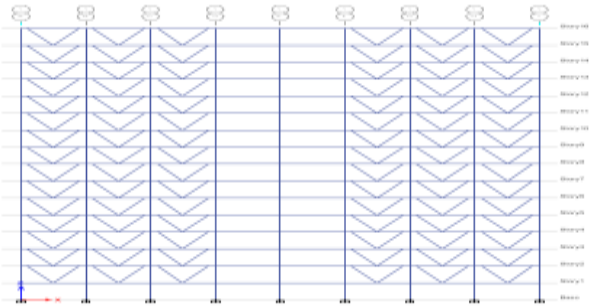

Fig.8 V4 model

Crescent shaped braces are provided in the G+15 building and response spectrum analysis is carried out. Similar to the other two types of braces, CSBs are also provided in four different configurations. They are CSB1, CSB2, CSB3 and CSB4. The models and their corresponding figures and obtained results are shown in following figures.

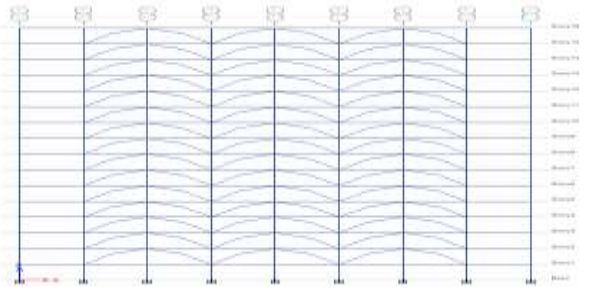

Fig.9 CSB model 1

Fig.10 Max. displacement of CSB model

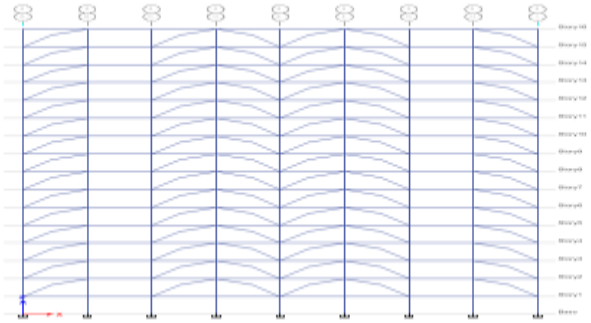

Fig.11 CSB model 2

Fig.12 Max. displacement of CSB model 2

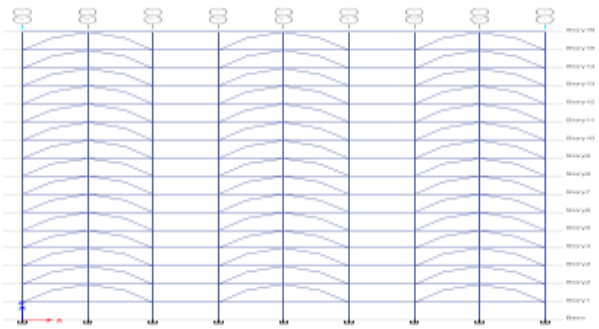

Fig.13 CSB model 3

Fig.14 Max. displacement of CSB model 3

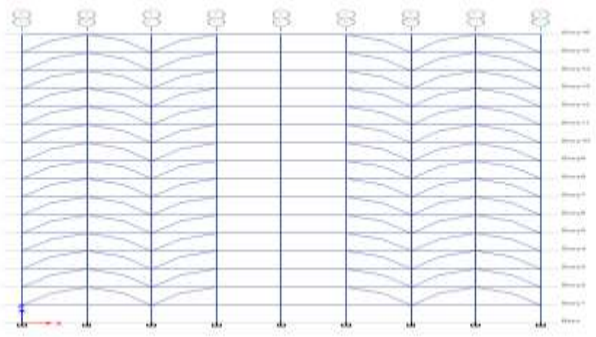

Fig.15 CSB model 4

Fig.16 Max. displacement of CSB model 4

Table 3 Comparison between K,V and CSB

Model	Max. displacement (mm)	Max. Story drift
K1	8.334	0.000232
V1	8.258	0.000233
CSB1	6.857	0.000178
K2	8.352	0.000232
V2	8.287	0.000233
CSB2	7.086	0.000183
K3	8.358	0.000232
V3	8.297	0.000233
CSB3	7.184	0.000184
K3	8.358	0.000232
V3	8.297	0.000233
CSB3	7.184	0.000184

CONCLUSION

The study focuses on CSBs, which are innovative bracing systems whose strength properties have been found to be satisfactory. Seismic response reduction efficiency of CSBs is studied. Results show that, between CSBs and K and V shaped braces, CSBs are more efficient in performance than the conventional bracing types.

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