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INNOVATIVE STUDY ON DIFFERENT BOLT ARRANGEMENTS ON DAMAGE CONTROL FUSE PLATE

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Abstract: This study has been undertaken to investigate the load carrying capacity of different bolt arrangement in HSS steel beam column joint with damage control fuse plate connection. Fuse plate with 4 bolt arrangements are analyzed using ANSYS 16.0. Extensive research has been carried out on steel moment frames to improve the cyclic performance of moment connections with different bolt arrangements. . The connection features are modified bolt arrangements designed to promote distribution of forces across the bolt group. The behavior of twelve bolt fuse plate connection with butterfly, zigzag, hexagonal, x-shape, configuration under cyclic loading was analyzed using ANSYS 16.0. Here four models of bolt arrangements are introduced. .This paper aims to obtain proper ranges for the geometric design parameters such as pitch, spacing for different bolt arrangements. In this order, 4 bolt fuse plate connection were tested under the cyclic loading to evaluate the performance of connections, and then a parametric study was carried out using the verified numerical models**.**

Index Terms **–** Bolt arrangement, fuse plate, connection.

1.INTRODUCTION

Recently, the demand for repair ability, fast recovery, and function continuity of buildings after strong earthquakes keeps increasing, which play vital roles in regional disaster mitigation and restoration. The increasing demand for continuous use of structures after earthquakes stimulated the research on developing modern buildings with high seismic resistances and easy, fast, and low-cost reparability. The combination of high-strength (HS) steel and energy-dissipation devices such as fuses offers possible solutions to develop low-damage, damagecontrolled, or even damage-free seismic structures. A damage-control fuse is a type of passive energy-dissipation device. A fuse usually serves to limit the maximum load transferred to the protected structural components and provides certain energy dissipation capacity to withstand seismic loads. The study on thickness, slenderness ratio, type of fuse plate are been carried out .here we are going to make analysis on bolt arrangement of on fuse plate .This paper mainly aims to develop finite element model for different bolt to evaluate the load carrying capacity in each of them

2. OBJECTIVE OF PROJECT

- To evaluate different bolt arrangement

3. MATERIAL PROPERTIES

It is seen that the beam column joint with fuse plate under cyclic loading will gain strength degradation due to local buckling. To reduce these effects different types of bolt arrangements are provided. The bolt diameter is 26mm M10. Number of bolt provided in one plate is twelve, in which six bolts are provided on one section of I beam and next six on other side. The adopted arrangements based on fuse plate are:

- Butterfly Arrangement
- ZIG-ZAG Arrangement
- Hexagon Arrangement
- X-Shape Arrangement

From the above four models the more moment carrying capacity is for Butterfly arrangement. Hence this model is taken for further analysis

Tabel 1: Material Properties

Properties	Steel	Bolt
Young's Modulus, (kPa)	$2x10^{11}$	$2x10^{11}$
Yield strength, (MPa)	792	225
Poisson's ratio	0.3	0.3

4. MODELLING ANALYSIS OF FUSE PLATE WITH DIFFERENT BOLT ARRANGEMENT

Flat fuse plate with 640x160x12mm was modelled and connected with M24 bolt with 26mm diameter, were used to joint beam and column. Then different bolt arrangements are modelled. butterfly, zig-zag, hegagonal , x-shape was modelled in 25 mm increased length. The pitch of bolt is taken as 2.5d0 and end to bolt spacing is taken as 1.5do.

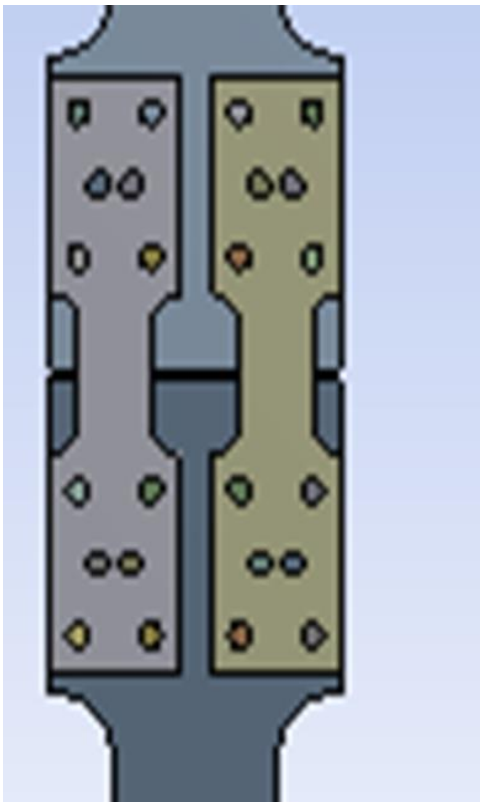
For the butterfly arrangement with M24 bolts with 26 mm diameter with bolt pitch 2.5do and 1.5do end to bolt distance is placed in a butterfly model in Fig 1(a). 6 bolts are placed at the one side and 6 at other size of fuse plate with respect to two I beam section

For zigzag arrangement bolts are arranged in the form of two straight line, such as 6 bolts in first straight line with 2.5do spacing between them and next line the bolt are placed at a distance of 2.5do from first line and at a position in the bolt will as centre between bolt in first line Fig1(b)

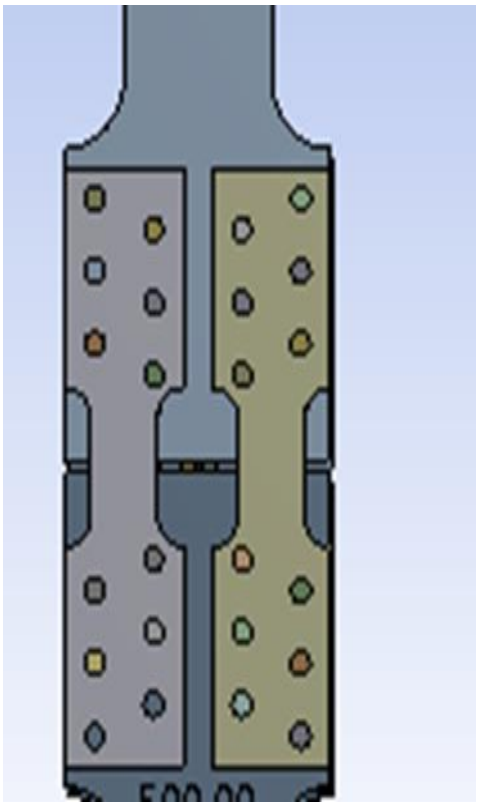
For hexagonal arrangement, bolts are arranged in the form of a hexagon such that two bolts are connected in 1.5do and 2.50do spacing shown in Fig 1(c).

For x-shaped arrangements bolts are provided in the shape of 'X' shown in Fig 1(d). Here also four bolt are provided at the top of the beam flange and other four at the bottom flange. The overall arrangement forms in the shape of X.

From the above four model the best model was selected. From the analysis it can be concluded that the best model was the bolt arrangement with butterfly bolt configuration.



(a)



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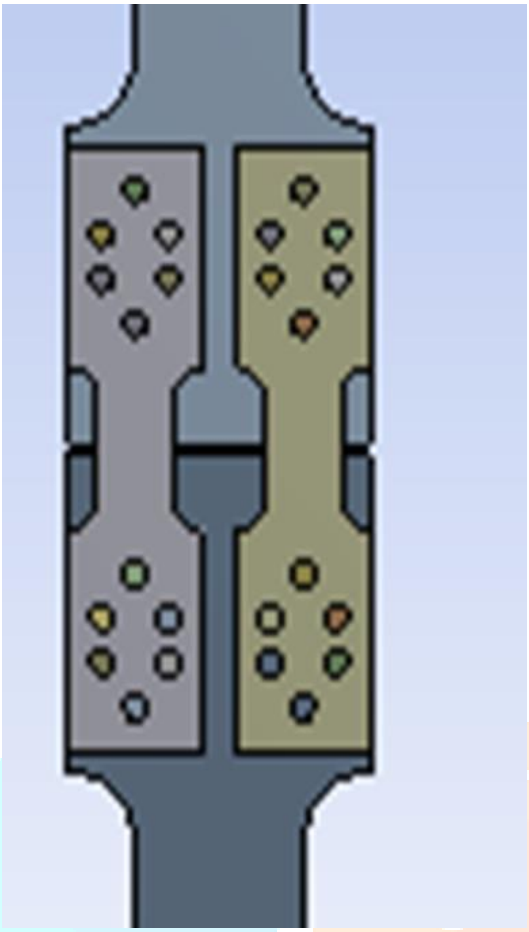
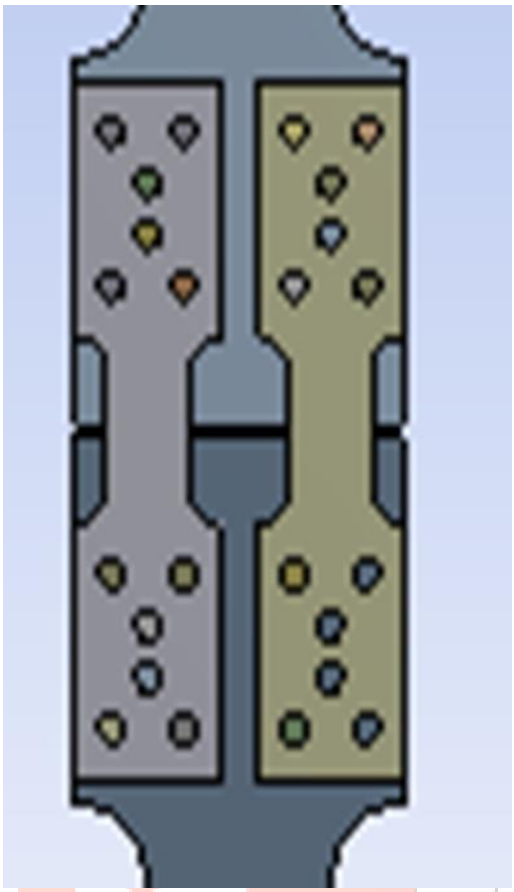


(c)



(d)

Fig 1: Bolt Arrangements; (a) Butterfly Shape, (b) Zigzag Shape, (c) Hexagonal Shape, (d) X Shape

5. RESULTS

Load carrying capacity and stiffness of bolt arrangements columns of different patterns are listed in Table 2

Table 2: Results of different bolt arrangement in fuse plate

Models	Maximum Load, (kN)	Maximum Displacement, (mm)
Butterfly	335	130
Zigzag Shape	296	100
Hexagonal	294	110
X Shape	332	120

The cyclic load is applied on beam tip by providing the displacement as 15 mm. The top and bottom support is taken as fixed below

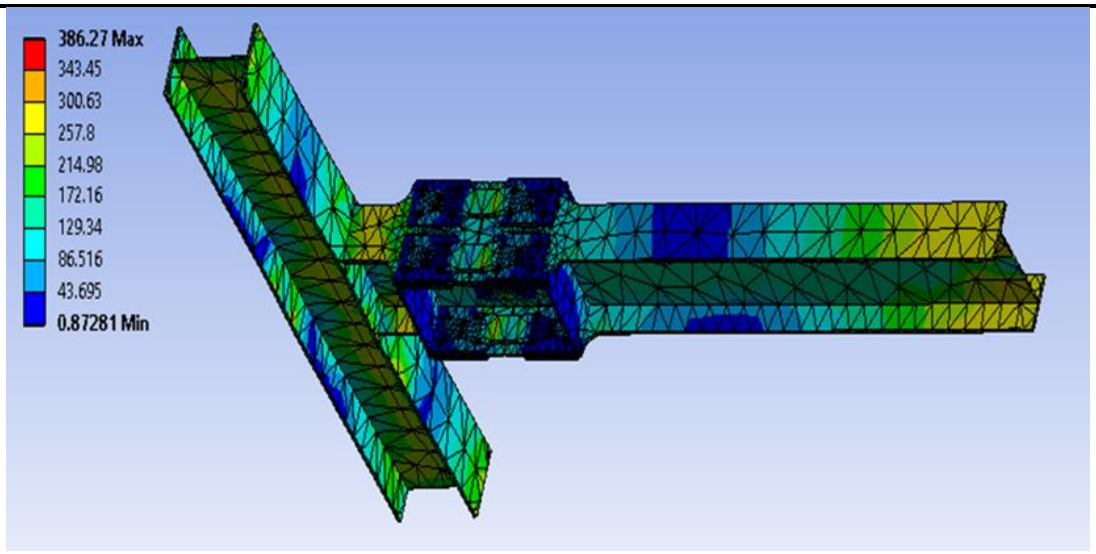


Fig 2(a) Shows Total Deformation in Butterfly Arrangement

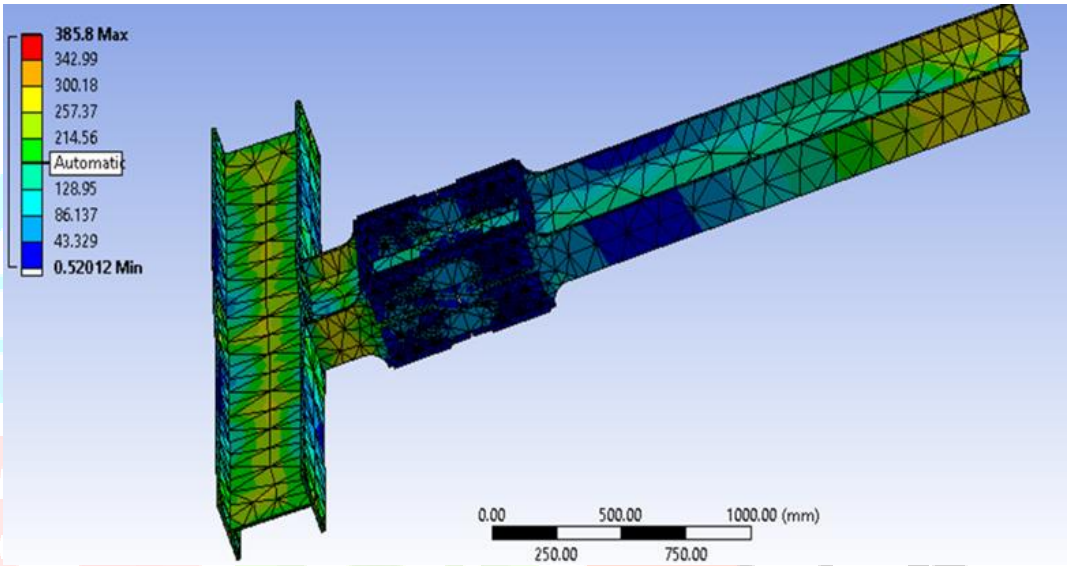


Fig 2(b) Shows Total Deformation in Zigzag Arrangement

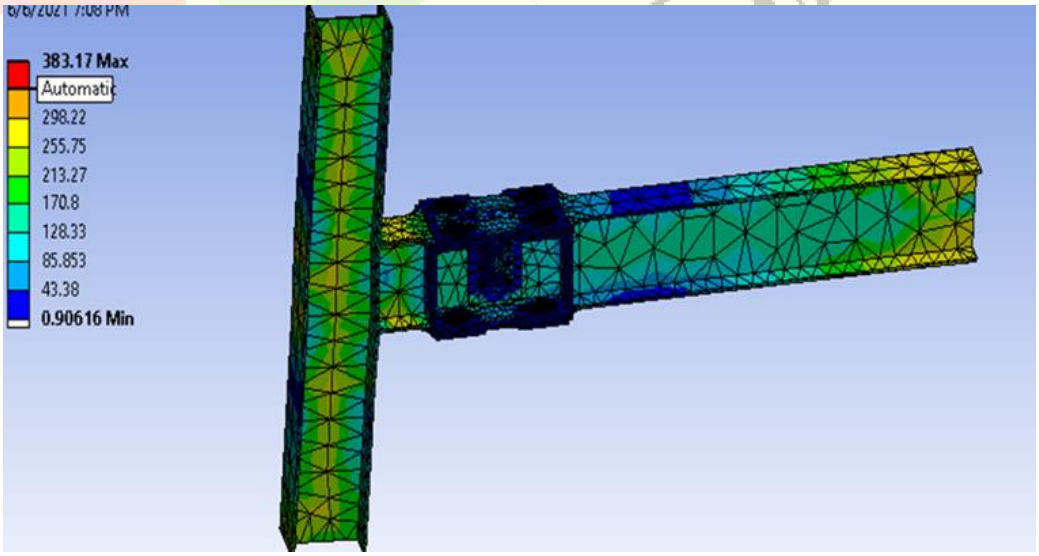


Fig 2(c) Shows Total Deformation in Hexagonal Arrangement

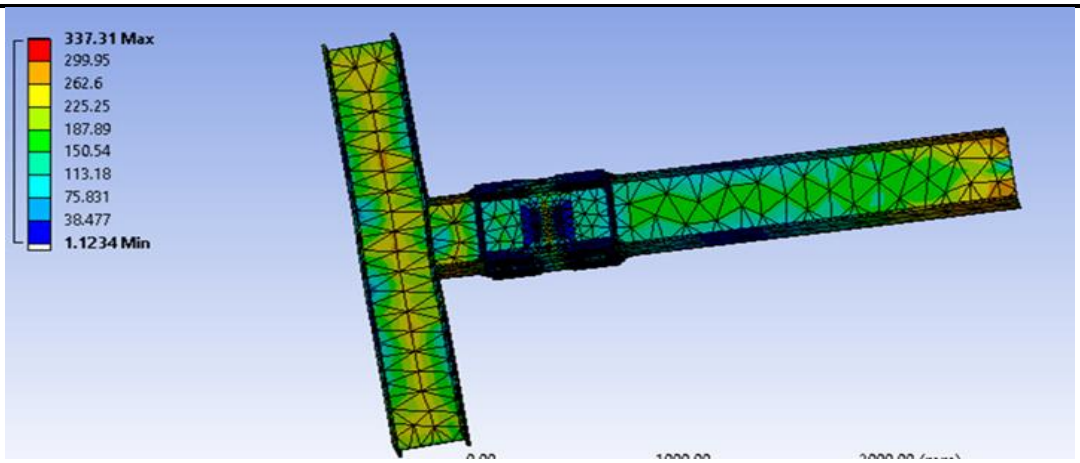


Fig 2(d) Shows Total Deformation in X Shape Arrangement

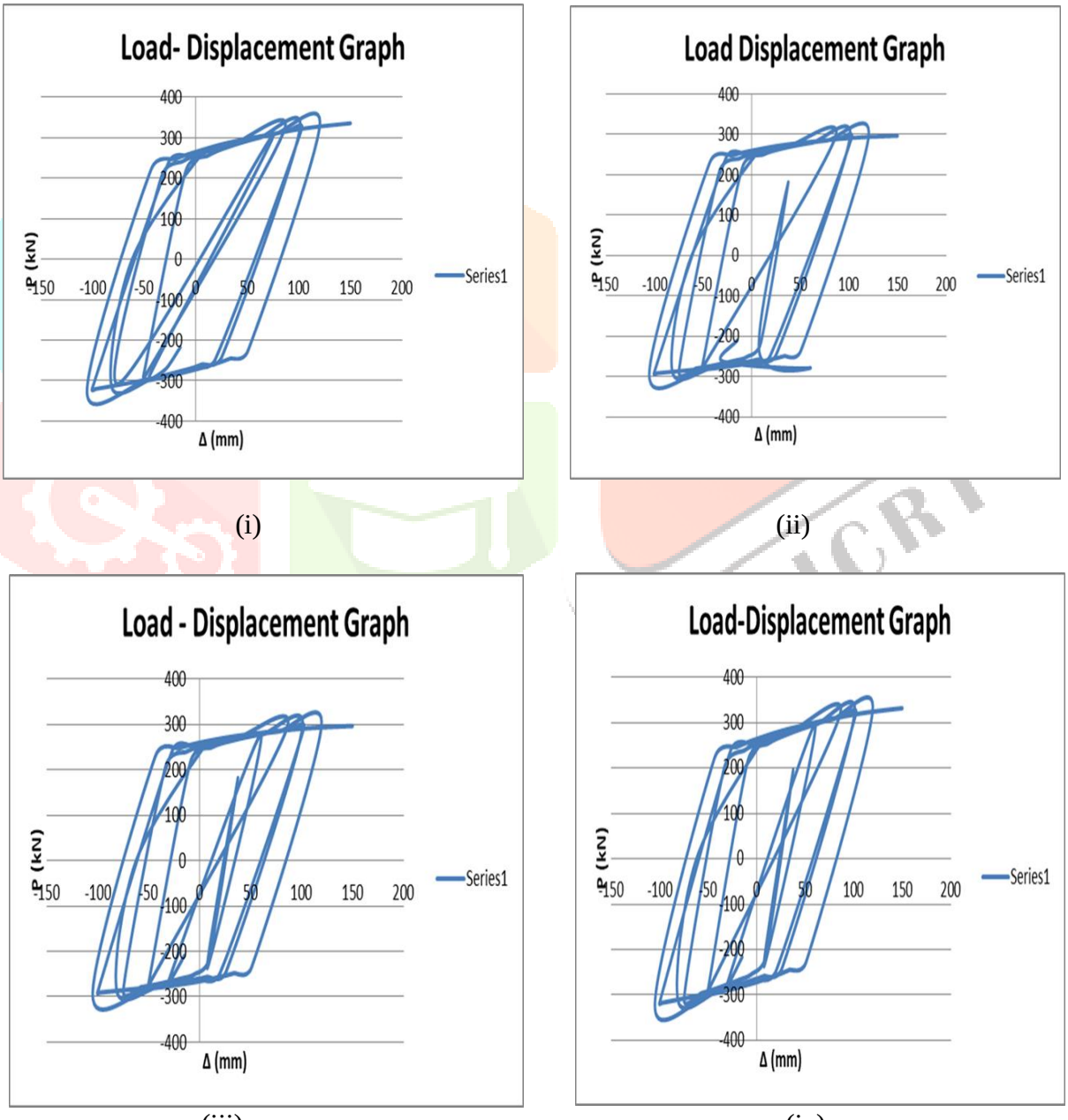


Fig 3 Load displacement graph (i) Butterfly, (ii) Zigzag, (iii) Hexagonal, (iv) X- shape

From graphs of load displacement(Fig 3) of four bolt arrangements butterffly shape had the max load and displacement with 335 kNand 130 mm. Then the second better arrangement was for x shape with 332kN and 120mm respectively.

6. CONCLUSIONS

From the analysis model 1 showed highest load carrying capacity and displacement as compaired to others. In Four bolt arrangements butterfly shape had better value.

7. REFERENCES

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