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Comparing Performance of Braced Circular Grid Panels and Braced Rectangular Thin Panels

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Abstract: Now a days many industries have adopted metal shear panels (MSP'S) in steel structures. MSP'S are effective seismic force-resistant components that are widely used in seismic regions to resist lateral forces. Structural mitigation measures can be adopted to reduce structural damage through engineered actions to maintain structural stability and integrity.

This study investigates seismic performance of a combined braced circular damped grid panels (BCDP) and comparing its performance with rectangular braced ductile thin shear panels (BDSP).

BCDP specimens are made by replacing rectangular panels on BDSP specimens by concentric circular grids. The system consists of a wall panel, X braced system and to develop an efficient damping characteristics damped circular grid panels provided at crossing of X bracing. It is expected that when reverse cyclic load applied, whole load not transferred to the frame or bracing but to the circular grids. The result showed that when load applied, the frame will not fail instead the circular grid starts yielding and a greater number of cycles can be accommodated without failure and effectively increased seismic capabilities of the system. The specimens are designed and modelled under various parametric studies and investigated analytically. The study includes seismic analysis and push over analysis using ANSYS software.

Keywords*: *Metal shear panel, Circular grid panel, reverse cyclic load, Bracing, Push over analysis

I. INTRODUCTION

Metal shear panels are effective in mitigating earthquake risks and also recently it has been proven that adoption of metal shear panels in steel structures after a strong earthquake can help to restrengthen and restore a damaged building .Rectangular metal shear panels are the most commonly discussed which includes a concentric rectangular thin shear panel, a surrounding flange plate, and X-shaped brace segments, even though this system shows better seismic performance, this systems fails under shear panel buckling and yielding. Therefore, a new model is introduced to overcome this by replacing rectangular panels on BDSP specimens by concentric circular grids since circular panels do not fail under buckling.

According to FEMA Protocol a structure can be ensure seismic stability only when it has no failure up to 4% drift. The most important benefit of metal shear panels is improvement in the energy dissipation capacity caused by stable hysteretic behaviour [1], different materials are adopted for manufacturing of shear panels such as pure aluminium, stainless steel, ordinary carbon steel and low yield steel [1,2].

The out of plane buckling in thin metal shear panels can be limited by adopting steel plates with different opening shapes especially circle shaped [3,4]. Nakashima [5] conducted an experimental investigation on six shear panel specimens made of low-yield steel under cyclic loading. Also, metal shear panels have been proved advantageous to moment-resisting steel frames for improving the seismic behaviour and mitigating earthquake risks [6].

Metal shear panels with rectangular shaped panels (BDSP models) do not satisfies FEMA protocol as it fails before 4% drift and fails under shear panel buckling.

These issues can be addressed by conducting studies on a combined braced circular damped grid panels (BCDP models) and investigate different ways to improve ductility and lateral load carrying capacity.

II. OBJECTIVE

1) To investigate and compare lateral loading performance of circular and rectangular panels (Pushover Analysis).
2) Investigating lateral loading performance of grid panel under various dimensional parametric study to determine optimum configuration of panel.

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III. METHODOLOGY

The main goal of this study is to enhance the seismic performance of structures by improving ductility, energy dissipation capacity and lateral load carrying capacity. For that, a combined braced circular damped grid panels were modelled and results are compared with rectangular shaped thin shear panels. The study's primary goal is to use the ANSYS WORKBENCH software to compare the performance under various parametric studies, the parameters used are thickness of plates, number of concentric grids, diameter of circular panels to eliminate failure of panels under shear panel buckling and to obtain improved seismic performance.

A. FEM Modelling of Frames

Total BCDP specimen was modelled using ANSYS Workbench and compare with BDSP model. The proposed BCDP specimens are made by replacing rectangular panels on BDSP specimens by concentric circular grids are shown in fig 1 and fig 2. Dimensional details of panels are shown in table 1.A monotonic displacement was applied to the system to achieve a story drift angle of up to 4% according to FEMA protocol. To achieve the shear panel yielding prior to the failure of the surrounding components, the bracing system should have a higher yield strength than shear panels.so shear panel adopted were Chinese standard-conformant Q331B steel (fy =330 MPa) and bracing system were Chinese standard-conformant Q345B steel (fy = 345 MPa) and has Young's Modulus 200 GPa and Poisson's ratio as 0.3.

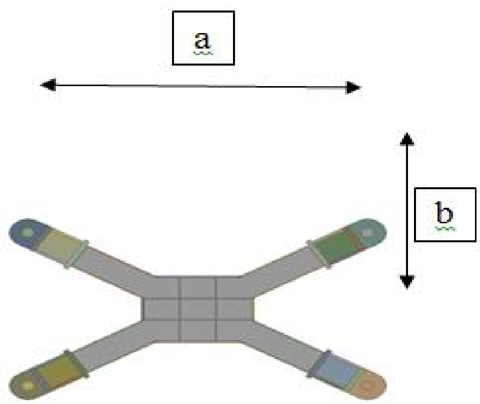

Fig 1: BDSP Panel

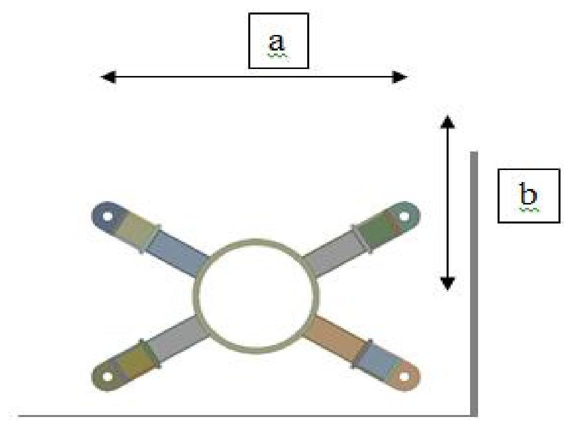

Fig 2: BCDP Panel

TABLE 1

Specimen	Flange thickness (mm)	Plate thickness(mm)	Dimension (a, b) mm
BDSP 450mm X 350mm	6	3	1400,840
BCDP 1CP 600 mm	6	20	1400,840

The specimens under consideration and parametric dimensions are shown in Table 2. Total 9 specimens were modelled using ANSYS.

TABLE 2

Specimen	1R		2R		3R		CP
	D	T	D	T	D	T	
3CP10X10X10	600	10	400	10	200	10	4
3CP15X15X15	600	15	400	15	200	15	4
3CP20X20X20	600	20	400	20	200	20	4
2CP15X15	600	15	400	15	NIL	NIL	4
2CP22.5X22.5	600	22.5	400	22.5	NIL	NIL	4
2CP30X30	600	30	400	30	NIL	NIL	4
1CP30	600	30	NIL	NIL	NIL	NIL	4
1CP45	600	45	NIL	NIL	NIL	NIL	4
1CP60	600	60	NIL	NIL	NIL	NIL	4

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B. Boundary condition and loading

The left and right end of the frame were stimulated by restraining translation in one direction only; z axis (roller support). Loading protocol used is FEMA protocol and a monotonic displacement was applied to the system to achieve a story drift angle of up to 4% according to FEMA protocol.

IV. RESULT AND DISCUSSION

The model is subjected to nonlinear static analysis and Figure 3 to 20 represents the total deformation and equivalent plastic strain. Based on the study optimum configuration were identified.

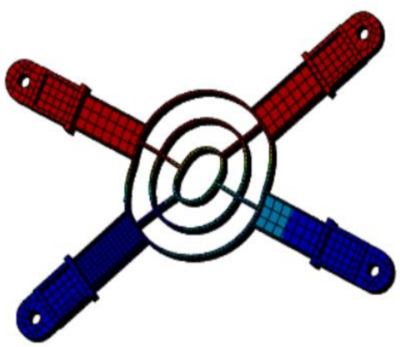

Fig 3: Total deformation (3CP 10mm)

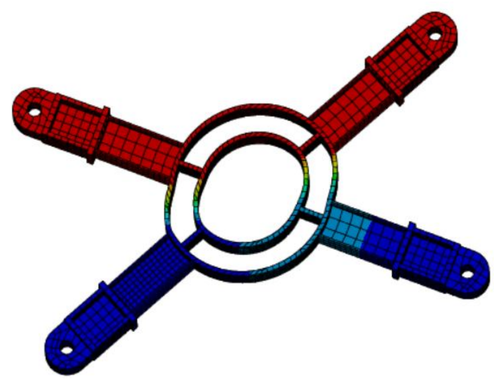

Fig 4: Total deformation (2CP 15mm)

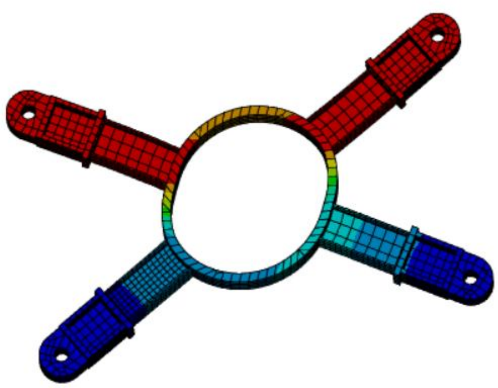

Fig 5: Total deformation (1CP 30mm)

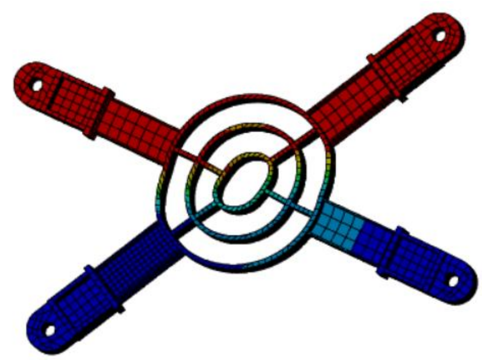

Fig 6: Total deformation (3CP 15mm)

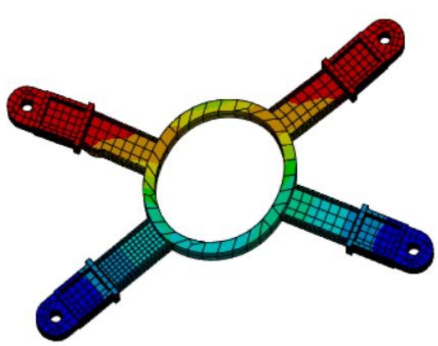

Fig 7: Total deformation (1 CP 45mm)

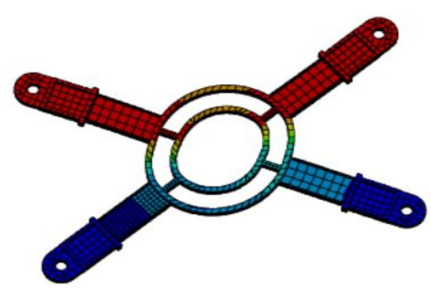

Fig 8: Total deformation (2CP 22.5mm)

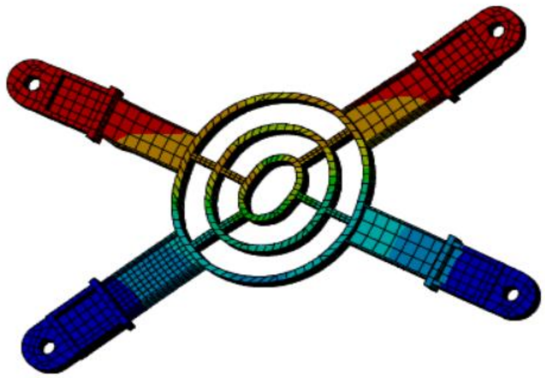

Fig 9: Total deformation (3 CP 20 mm)

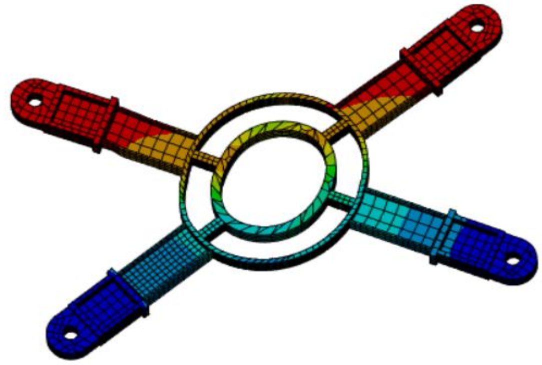

Fig 10: Total deformation (2CP 30mm)

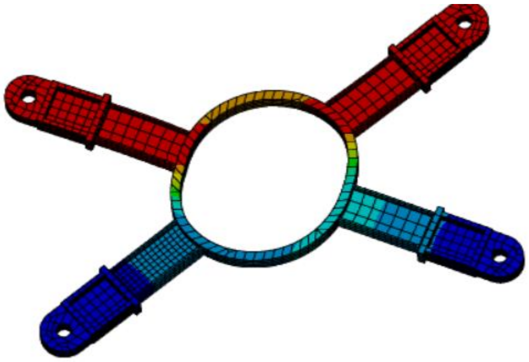

Fig 11: Total deformation (1CP 60mm)

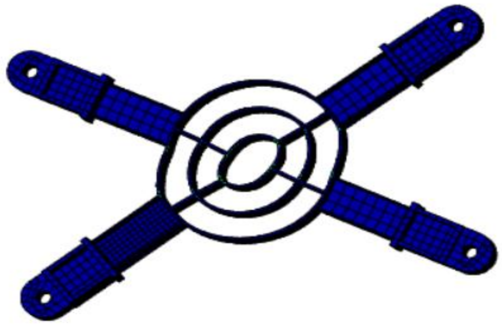

Fig12: Equivalent plastic strain (3 CP 10mm)

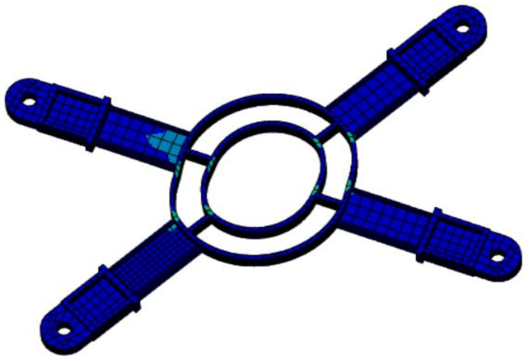

Fig 13: Equivalent plastic strain (2 CP 15 mm)

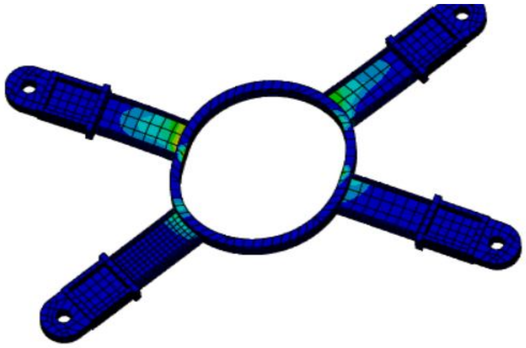

Fig 14: Equivalent plastic strain (1 CP 30 mm)

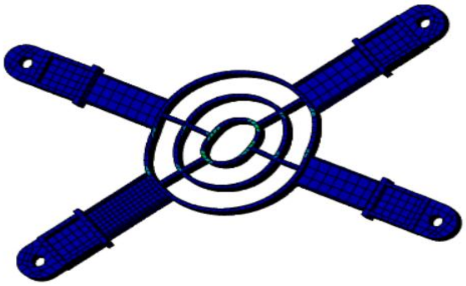

Fig 15: Equivalent plastic strain (3 CP 15 mm)

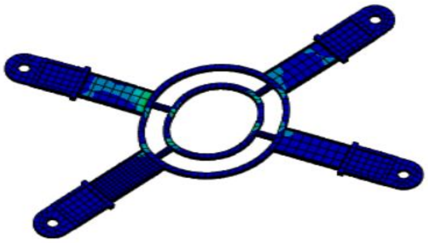

Fig 16: Equivalent plastic strain (2 CP 22.5 mm)

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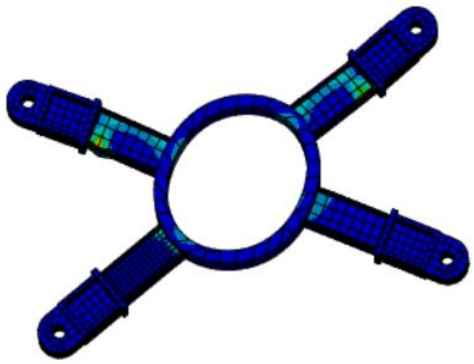

Fig 17: Equivalent plastic strain (1 CP 45 mm)

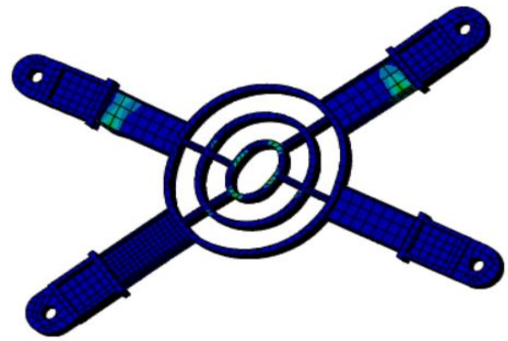

Fig 18: Equivalent plastic strain (3 CP 20 mm)

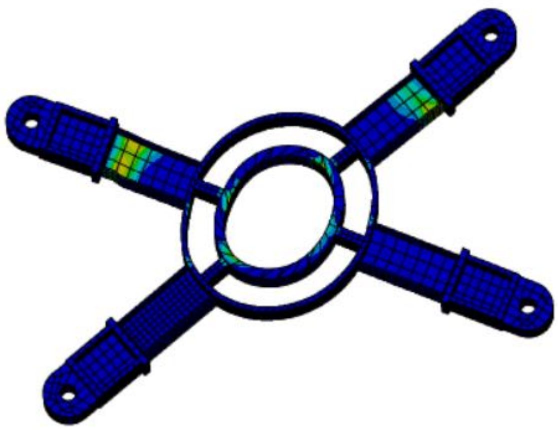

Fig 19: Equivalent plastic strain (2 CP 30 mm)

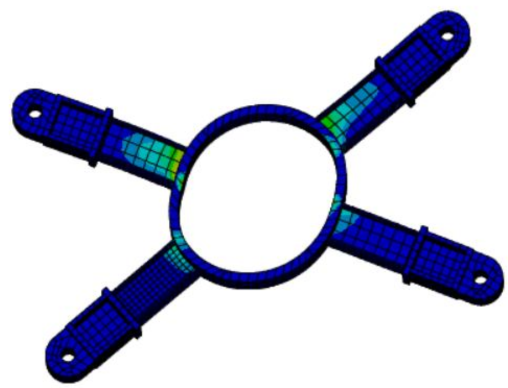

Fig 20: Equivalent plastic strain (1 CP 60 mm)

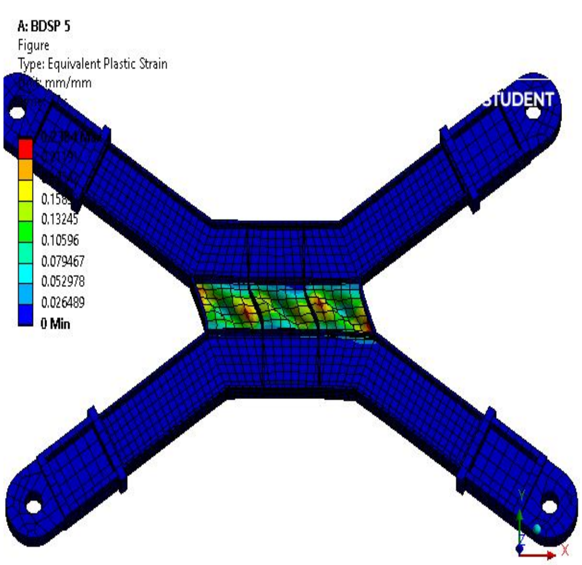

Fig 21: Total Deformation BDSP

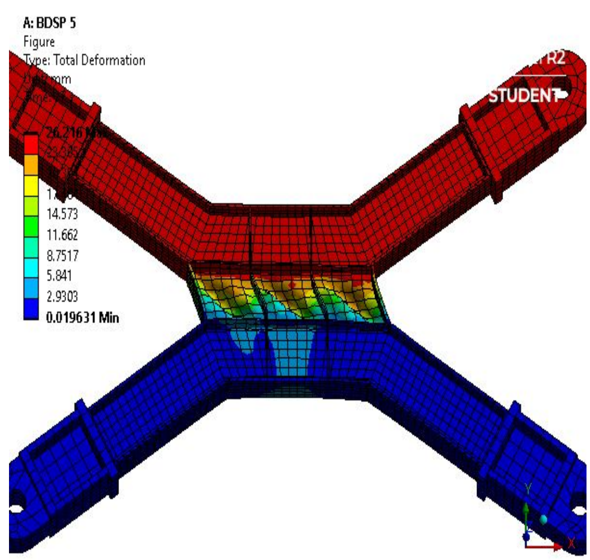

Fig 22: Equivalent plastic strain BDSP

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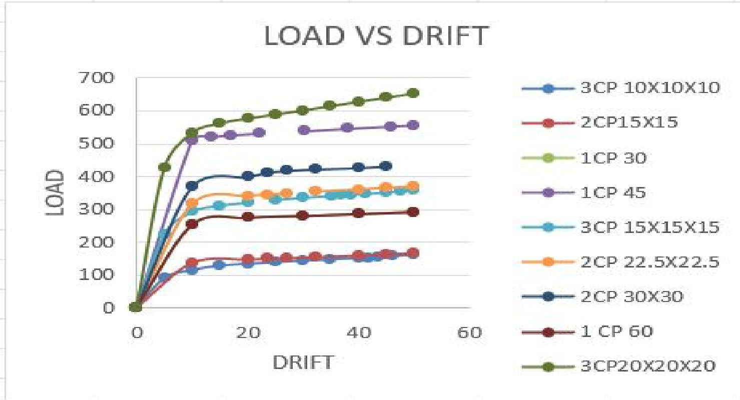


Chart-1: Load- Drift curve

Table 3: Performance of BCDP Panels

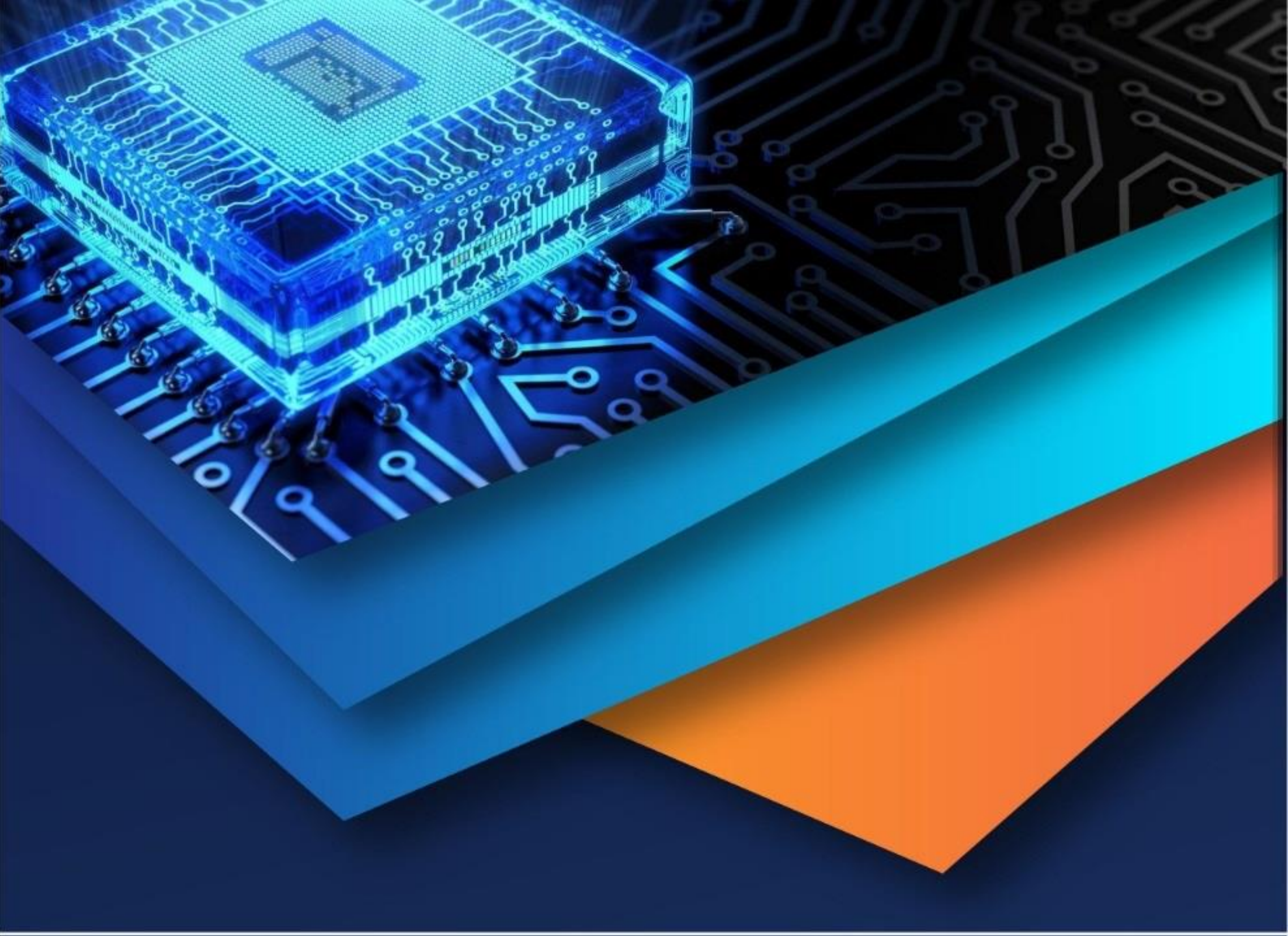
SPECIMENS	Δy mm	Δu mm	Pu kn	μ ductility
RP	2.8517	16	316	5.61
3CP10X10X10	5.0147	50.071	162.77	9.98
3CP15X15X15	5.03	50.09	359.87	9.95
3CP20X20X20	**5.03**	**50.05**	**652.26**	**9.95**
2CP15X15	10.057	50.09	169.11	4.98
2CP22.5X22.5	10.076	50.094	369.5	4.97
2CP30X30	10.057	45.15	431.86	4.47
1CP30	10.082	50.092	292.49	4.97
1CP45	10.052	50.055	555.51	4.98
1CP60	10.082	50.092	292.4	4.97

V. CONCLUSIONS

The main objective of this paper is to study and compare the seismic performance of BDSP and BCDP specimens and suggest an ideal BCDP model after various parametric study. Failure of BDSP specimen was due to shear panel buckling but BCDP do not induce any buckling failure. There is total 9 BCDP models and all specimens had no failure up to 4% drift angle, this ensures seismic stability for the system. Different parametric studies were conducted by varying shear panel thickness, diameter of circular grids and number of concentric circular grids. From the analytical study it was observed that all specimens have better yield displacement than the rectangular panel, three specimens have ductility about double that of rectangular panel and also load carrying capacity of most of the specimens are higher than rectangular panel. And the study shows that models with 3 connection plates with thickness 10mm, 20mm,15mm shows almost same ductility and yield deformation but the model with 3 Connection Plate of 20mm thickness showed highest load carrying capacity. So, we may conclude that BCDP models are better than BDSP models and BCDP with dimension 3CP20 is the ideal model.

REFERENCES

[1] Guohua Sun,Cheng Bao,Wenyuan Liu,Youzhen Fang ,Cyclic behavior of an innovative braced ductile thin shear panel. J Struct Eng 2021;32:973–986
[2] Jain S, Rai DC, Sahoo DR. Postyield cyclic buckling criteria for aluminum shear panels. J Appl Mech-T ASME 2008;75(2):0210151–8
[3] Valizadeh H, Sheidaii M, Showkati H. Experimental investigation on cyclic behavior of perforated steel plate shear walls. J Constr Steel Res 2012;70:308–16.
[4] Paslar N, Farzampour A, Hatami F. Investigation of the infill plate boundary condition effects on the overall performance of the steel plate shear walls with circular openings. Structures 2020;27:824–36
[5] NakashimaM.Strain-hardeningbehaviorofshearpanelsmadeoflow-yieldsteelI:Test. J Struct Eng 1995;121(12):1742
[6] DeMatteisG,LandolfoR,MazzolaniFM.SeismicresponseofMRsteelframeswith low-yield steel shear panels. Eng Struct 2003;25:155–68.



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