International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

Connections in Cold Form Beam Column Steel Sections Using Beam-Column Connector

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Abstract- *The main aim of the study is to increase the use of cold form steel in steel structure by studying cold form steel connections. Usually cold form steel is used only in purlins of truss, non-load bearing wall, partition walls, floor deck system etc. in this Paper the attempt have been made to study the application of cold form steel beam-column screwed connection using beam-column connector by determining its load carrying capacity of various connection configurations.*

Keywords: **Light Gauge, Cold-Formed Steel, CATIA, Hypermesh, ANSYS, Finite Element Analysis**

1. INTRODUCTION

The use of steel structure in now a day's construction being very popular as compared to RCC structures because of the fact that they provide high strength, very fast in construction, they are light in weight so easy erection and installation etc.

Based on the manufacturing process structural steel is classified into two types; hot rolled sections and cold formed light gauge steel structures. There are mainly two methods of forming light gauge steel sections, cold rolling for use in mass production formed at room temperature and pressing in press-brakes use in small quantities also for producing some special shapes. These members are then connected by bolts, rivets, screws, welds or by special fasteners.

Cold formed light gauge steels are very thin and thickness varies from 0.75 to 4 mm and having yield strength of 230 to 420 mpa. The steel is coated with zinc or a mixture of zinc and aluminum to protect it from decay of material. Thickness of this coating depends on environmental condition and marine environments require more protection. Cold formed light gauge members are divided into (i) framing members such as studs, joists, beams etc (ii) long span roof deck, floor and wall panels (iii) wall claddings and standard roof deck..

Cold formed steel framing (CFSF) precisely refers to steel members in light frame buildings or temporary building construction which are made entirely of sheet steel. The most common shape used for CFSF members is a lipped channel, although Z-sections, C-sections, tubular, hat and other shapes have been used. Cold formed steel are most often framed for floors, roofs and walls, now a days they are also using for structural and decorative assemblies.

2. MODELING

The design of connection is done according to British code BS 5950-5:1998.

Table 1 : Sectional Properties

Web Depth	100 mm
Top and Bottom	50 mm
Lip Depth	15 mm
Thickness	1.05 mm
Full Sectional Area	459 mm^2
Grade	550 N/mm^2
Yield Strength	550 N/mm^2
Nominal Ultimate Strength U_s	654 N/mm^2
Design Strength, P_y	550 N/mm^2
Center of Gravity, C_g	51mm
Moment of Inertia, I_{xx}	970048 mm^4
Moment of Inertia, I_{yy}	193537 mm^4
Sectional Modulus, Z_x	16.562 ^{3}

2.1: Model Considered for the Analysis

1. Beam and column are connected with single row of screws using beam column connector at the junction (C1)

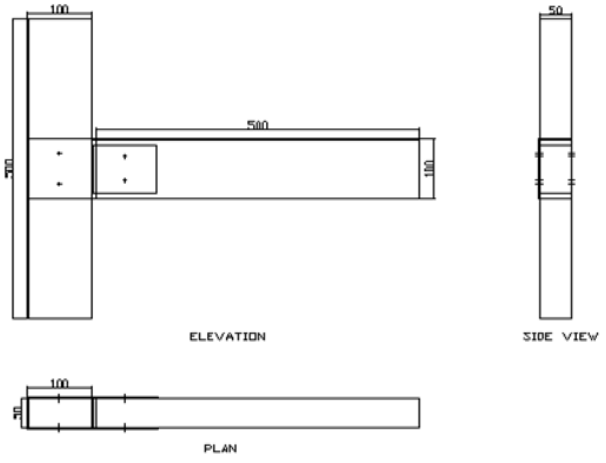

Fig.-1: Connection C1

2. Beam and column are connected with double row of screws using beam column connector at the junction (C2)

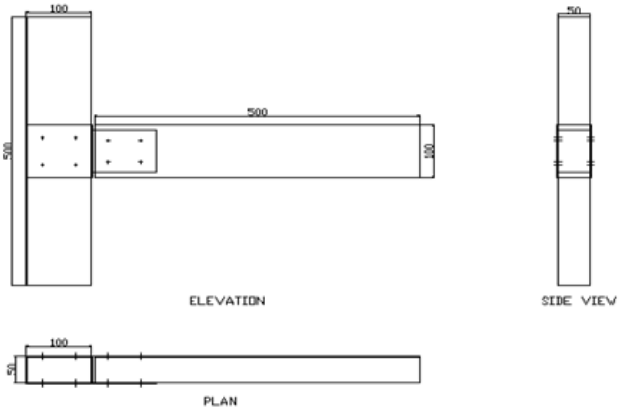

Fig.-2: Connection C2

3. Beam column connected by angle plate (50x50x1) along with beam column connector at the junction using single row of screws (C3)

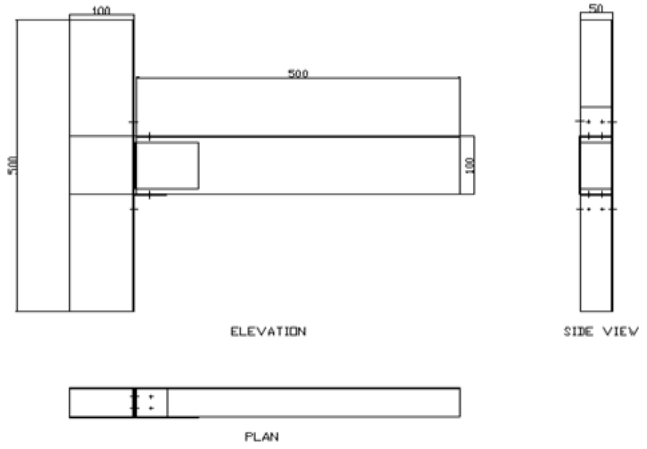

Fig.-3: Connection C3

4. Beam column connected by angle plate (50x50x1) along with special connector at the junction using double row of screws (C4)

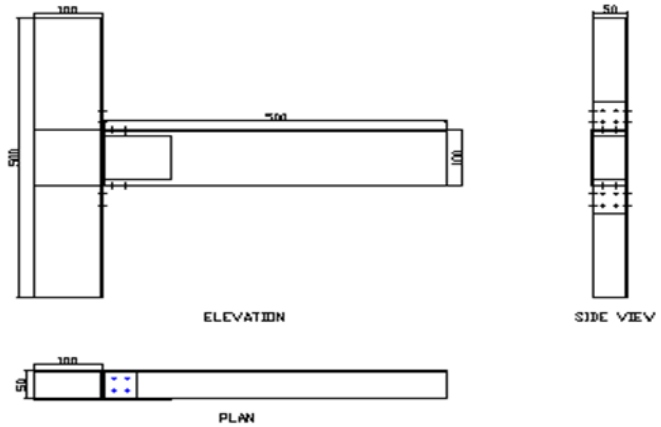

Fig.-4: Connection C4

2.2 : Experimental Analysis

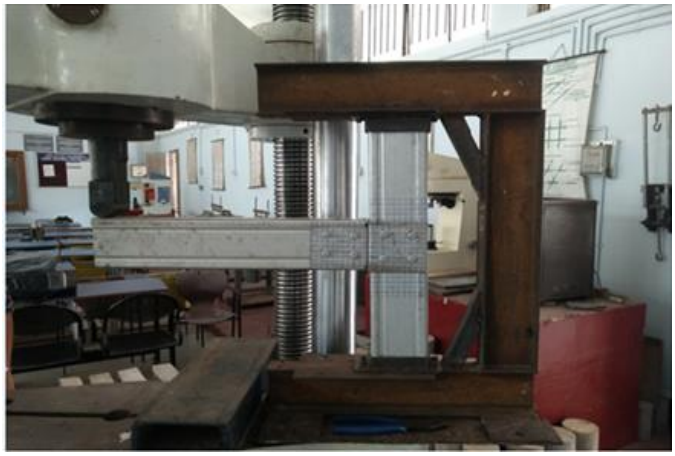

Fig.-13: Experimental Setup

3. EXPERIMENTAL AND FEM RESULTS

3.1. Experimental results of beam and column connection with single row of screws using beam column connector at the junction (C1)

Table No. 3.1.

Loads (KN)	Deflection(mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.1	5.1	0.048	0.608	0.0106
0.2	11.8	0.096	1.408	0.02457
0.4	35.8	0.192	4.265	0.07444
0.6	64.1	0.288	7.606	0.13275
0.8	91	0.384	10.734	0.18736
1.0	118.2	0.48	13.833	0.24144
1.2	147	0.576	17.072	0.29718

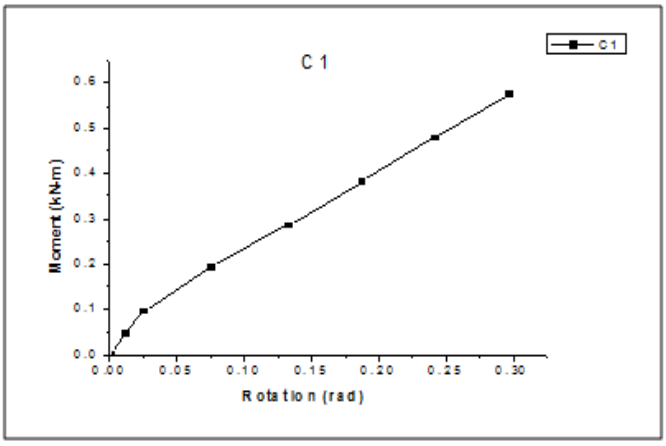

Chart -1: Experimental Results of Connection C1

3.2. Experimental results of beam and column connection with double row of screws using beam column connector at the junction (C2)

Table No. 3.2.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.1	5.4	0.048	0.644	0.01125
0.2	11.1	0.096	1.324	0.02312
0.3	21.3	0.144	2.54	0.04434
0.4	31.6	0.192	3.766	0.06574
0.5	39.8	0.24	4.74	0.08272
0.6	49.6	0.288	5.89	0.10296
0.7	72.3	0.336	8.56	0.14950
0.8	106.1	0.384	12.46	0.21754
0.9	126.2	0.432	14.72	0.25709

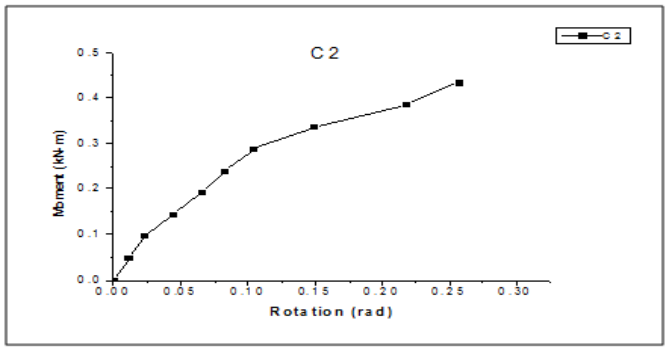

Chart -2: Experimental Results of Connection C2

3.3.Experimental results of beam and column connection connected by angle plate (50x50x1) along with beam column connector at the junction using single row of screws (C3)

Table No. 3.3.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.2	1.2	0.096	0.143	0.00249
0.4	3.1	0.192	0.369	0.00645
0.6	5.5	0.288	0.656	0.01145
0.8	9.2	0.384	1.097	0.01916
1.0	14.8	0.48	1.765	0.03082
1.2	28.2	0.576	3.361	0.05868
1.4	42.4	0.672	5.047	0.08810
1.6	57.4	0.768	6.818	0.11901
1.8	92.4	0.864	10.89	0.19017
2.0	163.2	0.96	18.77	0.32773

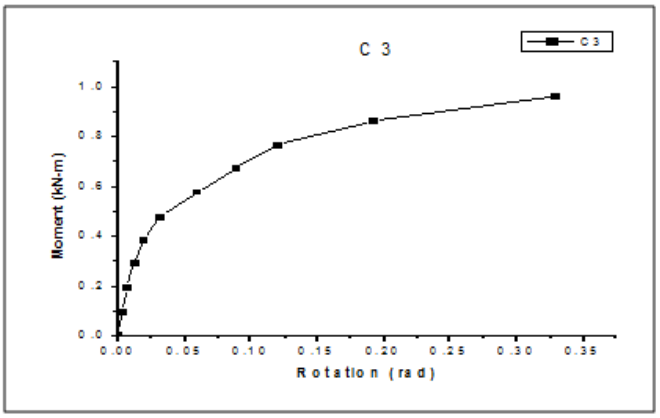

Chart -3: Experimental Results of Connection C3

3.4.Experimental results of beam and column connection connected by angle plate (50x50x1) along with beam column connector at the junction using double row of screws (C4)

Table No. 3.4.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation(degree)	Rotation (radian)
0	0	0	0	0
0.2	5.6	0.096	0.668	0.01166
0.4	10.2	0.192	1.217	0.02124
0.6	13.7	0.288	1.634	0.02853
0.8	16.4	0.384	1.956	0.03415
1.0	19.3	0.48	2.302	0.04018
1.2	22.1	0.576	2.635	0.04600
1.4	25	0.672	2.981	0.05203
1.6	30.5	0.768	3.635	0.06345
1.8	34.9	0.864	4.158	0.07258
2.0	39.5	0.96	4.703	0.08210
2.5	77.3	1.2	9.147	0.15967
3.0	100.3	1.44	11.812	0.20599
3.4	119.3	1.632	13.954	0.24360

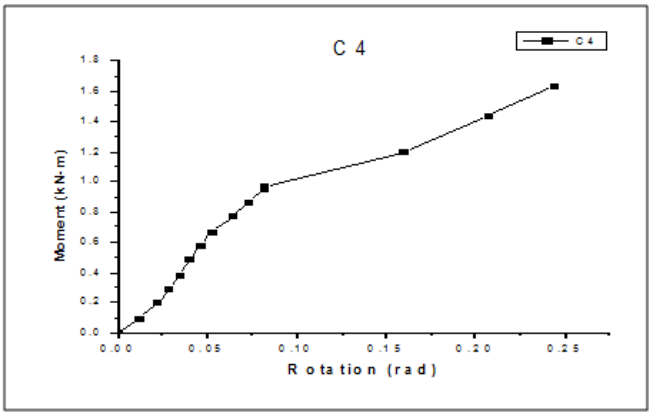

Chart -4: Experimental Results of Connection C4

3.5. FEM results of beam and column connection with single row of screws using beam column connector at the junction (C1)

Table No. 3.5.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.1	2.488	0.00443	2.16	0.03770
0.2	4.976	0.00796	4.33	0.07558
0.4	9.952	0.03188	8.67	0.15133
0.6	14.928	0.04786	13.01	0.22709
0.8	19.904	0.06378	17.35	0.30285
1.0	24.88	0.07972	21.69	0.37861
1.2	29.856	0.09567	26.03	0.45436

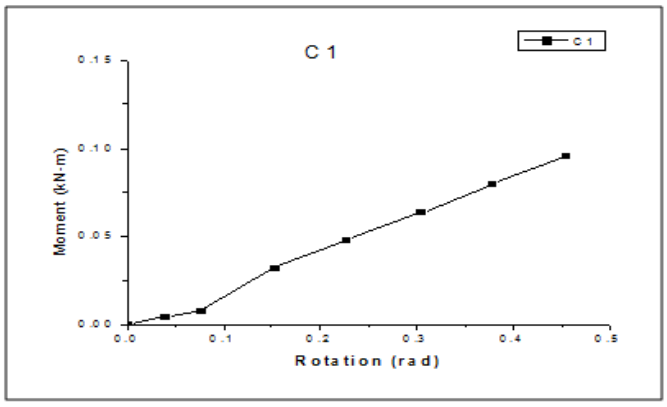

Chart -5: Experimental Results of Connection C1

3.6. FEM results of beam and column connection with double row of screws using beam column connector at the junction (C2)

Table No. 3.6.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.1	2.318	0.0055	1.2259	0.0214
0.2	4.637	0.0109	2.401	0.042
0.3	6.955	0.0163	3.551	0.062
0.4	9.274	0.0217	4.726	0.0825
0.5	11.592	0.0271	5.9007	0.103
0.6	13.911	0.0325	7.0579	0.1232
0.7	16.229	0.038	8.2208	0.1435
0.8	18.548	0.0433	9.395	0.164
0.9	20.866	0.0487	10.541	0.184

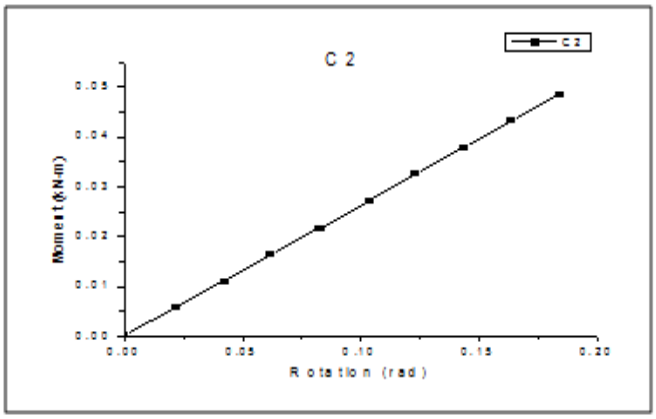

Chart -6: Experimental Results of Connection C2

3.7. FEM results of beam and column connection connected by angle plate (50x50x1) along with beam column connector at the junction using single row of screws (C3)

Table No. 3.7.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.2	1.944	0.0084	4.04	0.07052
0.4	3.888	0.0169	8.09	0.14121
0.6	5.838	0.0254	12.13	0.21173
0.8	7.779	0.0339	16.19	0.28260
1.0	9.725	0.0422	20.23	0.35312
1.2	11.671	0.0509	24.28	0.42382
1.4	13.616	0.0594	28.32	0.49434
1.6	15.561	0.0679	32.37	0.56503
1.8	17.506	0.0764	36.42	0.6357
2.0	19.451	0.0849	40.46	0.70625

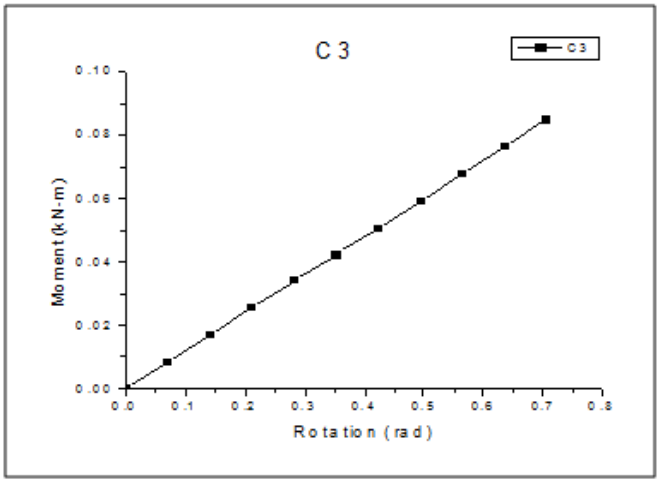

Chart -7: Experimental Results of Connection C3

3.8. FEM results of beam and column connection connected by angle plate (50x50x1) along with beam column connector at the junction using double row of screws (C4)

Table No. 3.8.

Loads (KN)	Deflection (mm)	Moment (KN-m)	Rotation (degree)	Rotation (radian)
0	0	0	0	0
0.2	1.212	0.0053	2.0254	0.035354
0.4	2.637	0.0141	4.0198	0.070167
0.6	4.814	0.0219	8.1395	0.142079
0.8	8.838	0.0303	12.215	0.213219
1.0	10.92	0.0388	16.384	0.285991
1.2	12.31	0.0484	20.654	0.360527
1.4	14.01	0.0572	24.598	0.429371
1.6	16.71	0.0656	28.756	0.501951
1.8	18.23	0.0744	32.354	0.564757
2.0	24.26	0.0910	42.126	0.735332
2.5	29.99	0.0998	52.635	0.918773
3.0	35.23	0.1090	59.235	1.033979
3.4	39.56	0.1194	69.789	1.21820

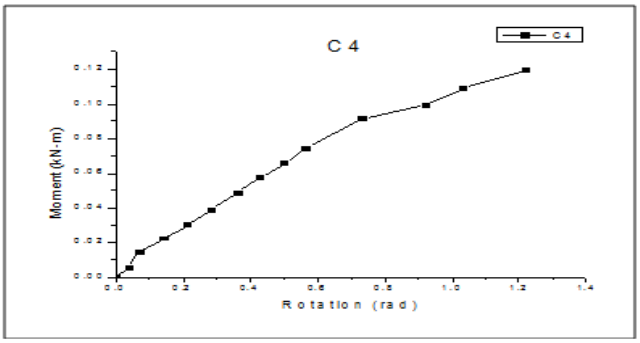

Chart -8: Experimental Results of Connection C4

4. CONCLUSION AND DISCUSSIONS

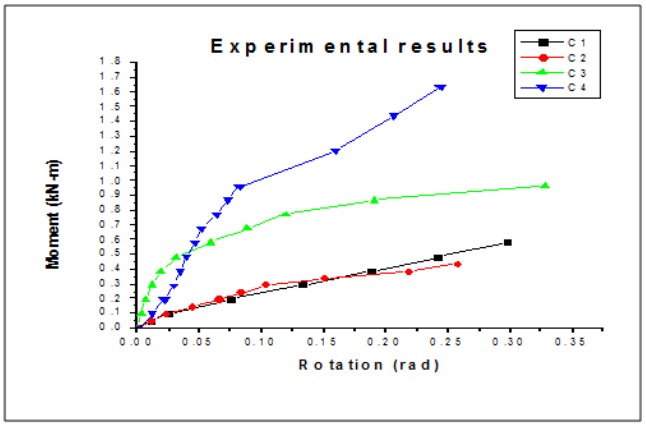

Chart -9: Experimental Results of all connections

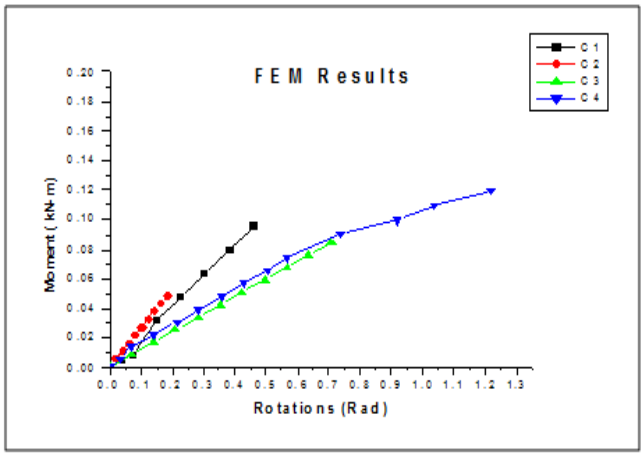

Chart -10: Analytical Results of all connections

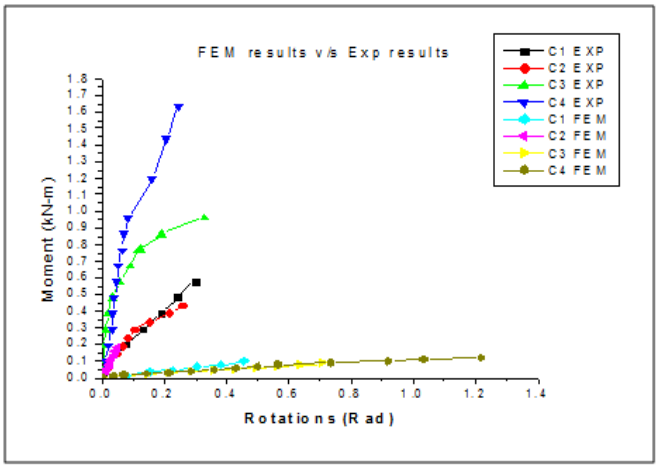

Chart -11: Experimental and FEM Results

5. CONCLUSIONS

Following conclusions are drawn from the present study

1. Connection C1 and C2 have more rotation at less amount of load than the connections C3 and C4, therefore it is not recommended.
2. The failure of connection in FEM analysis is due to the torsional buckling of the beam at the point of load applied.
3. The failure of connections C1 and C2 in experimental analysis is due to the distortion of beam-column connector at the weld.
4. The failure of the connection C3 and C4 is due to the distortion of angle plates as well as distortion of beam-column connector.
5. The connections C3 and C4 have high ultimate moment capacity than connections C1 and C2.

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