A BRIEF REVIEW ON DIFFERENT STEEL MEMBERSUNDER COMBINED AXIAL LOAD AND MOMENTAS PER IS: 800 2007

GargiDanda De[1], Mohan Gupta[2]

[1]*Assistant Professor, BIT, Durg*
[2]*Professor & Head Civil Engineering Department, BIT Durg*

Abstract

In a compression member when significant bending is present, it's called a beam-column. It is very common that the structural members are subjected to a combination of axial force and bending moment. Example of Compression members subjected to axial load and bending in structure are innumerable. Slender beam-columns are weak in torsion and may be subjected to lateral-torsional buckling. In this paper behavioural studies will be done on rolled and built up members with manual calculations and excel sheet for perfection.

Keywords: *Beam-Column, Buckling, Radius of Gyration, Rolled Steel*

---***---

1. INTRODUCTION

Beam-column are very common structural members which are referred to a combination of axial force and bending moment. Example of Compression members subjected to axial load and bending in structure are steel mast, towers, etc. Masts are the tall structures with relatively small cross-section i.e., a large ratio between the height and the maximum width. There are many challenges for the engineers who are associated with the set all and slender structures. The number of collapses of masts is relatively far greater than for other types of structures.

It is normally a steel structure pin connected to its foundation and braced with guys or other elements. A mast is a simple vertical post embedded in the foundation or rigidly fixed in vertical position to support the overhead equipment with can tilever assembly.

2. DESIGN OF A COMPOUND COLUMN

A built-up section is a more practical design than using a rolled shape in many situations. This is particularly true when there is a very long unsupported column length involved such that to meet the L/r requirements would require one of the heavier rolled sections. Another factor of primary importance is that the radius of gyration of built- up members can be controlled to produce maximum section efficiency. This efficiency cannot be obtained using the standard rolled sections, where the ratio of r_x/r_y is often 1.5 to 5 or more, unless bracing is provided with respect to the Y axis.

It is somewhat more difficult to produce an optimum, or least-weight, built-up section since there are several design parameters to satisfy, including:

1. Types of members to use.
2. Arrangement of the basic members, including any size limitations for overall section dimensions.
3. The resulting computed values of I_x, I_y, r_x and r_y and KL / r_{max}, which produce the allowable compression stress.

One or more iterations are usually required to finally develop a satisfactory section. Built-up sections may be built using rolled section, but more commonly are constructed using lacing or batten plates. The design of a built-up member requires at least the following steps:

1. Assumeanallowableaxialcompressivestress(assume110-120n/mm^2)
2. Findoutthegrossarearequired
3. Grossarea=axialloadonthecolumn/assumepermissiblecompressivestress
4. Tryasection
5. Arrangethecomponentmembersofthesectioninsuchaway, thatthemomentofinertiaofthesectionaboutboththeprincipalaxisisthesame,i.e.,I_{xx}=I_{yy},
6. Findoutthevalueoftheleastradiusofgyrationwhichwillbeequaltor$_{xx,}$ becauseI$_{yy}$ismadeequaltoorgreaterthanI$_{yy}$,sothattheradiusofgyrationislargestpossibleinboththedirection.
7. Calculateslendernessratiol/r, anoteshouldbemadethattheeffectivelengthforbattenedcolumnswillbeincreasedby10%.
8. Forthecalculatevalueofslendernessratiol/r,findoutthevalueofallowableaxialcompressivestress(P_{ac}).
9. Nowcalculatethesafeloadfortheassumedsection.
10. Safeload=P_{ac}xareaofthesection.

If it is equal to or little more than the axial load, the section is satisfactory, otherwise tried for another section.

Latticing and Battening are the means of connecting the various component members of a compound section and they should be designed that the failure of the composite section may be only due to the direct crushing and not due to buckling.

The lacing is most commonly used; the rolled steel flats, angles and channels are used for lacing. Battening is another method of connecting the different component members of a built-up section. It is generally not used where the column is subjected to eccentric loading.

Table 1: Design of b-series

Batten column	**B-175**	**B-200**	**B-250**
B(mm)	175	200	250
Areacm^2	48.76	56.42	77.34
Ixx(cm^4)	8230.8	9568	12912.4
Iyy(cm^4)	2446.6	3638.6	7633.6
Zxx(cm^3)	548.7	637.9	860.8
Zyy(cm^3)	280	364	611
Yyy(cm)	7.08	8.03	9.94
σ_{ac}(N/mm^2)	68	78.8	99
σ_{bcx}(N/mm^2)	82	93.7	112.3
σ_{bcy}(N/mm^2)	165	165	165

Table 2: Design of 254 series of UC section

Section	**254x254x167**	**254x254x132**	**254x254x107**	**254x254x89**	**254x254x73**
mass	167.1	132	107.1	88.9	73.1
depth	289.1	276.3	266.7	260.3	254.1
width	265.2	261.3	258.8	256.3	254.6
web th	19.2	15.3	12.8	10.3	8.6
flange th	31.7	25.3	20.5	17.3	14.2
root rad	12.7	12.7	12.7	12.7	12.7
b/T	4.18	5.16	6.31	7.41	8.96
d/t	10.4	13.1	15.6	19.4	23.3
ixx	30000	22500	17500	14300	11400
iyy	9870	7530	5930	4860	3910
rxx	11.9	11.6	11.3	11.2	11.1
ryy	6.81	6.69	6.59	6.55	6.48
exx	2080	1630	1310	1100	898
eyy	744	576	458	379	307
zxx	2420	1870	1480	1220	992
zyy	1140	878	697	575	465
D/T	9.119874	10.92095	13.0097561	15.0462428	17.8943662
slratioxx	101.7254	103.5501	105.1213961	105.763359	106.9058642
area	213	168	136	113	93.1
sl ratio	119.6769	121.8236	123.6722307	124.427481	125.7716049
fcc	137.6792	132.8698	128.9273047	127.366928	124.6591284
sig ac	63.8616	62.28584	60.96394719	60.4331181	59.50150571
sig bcx	1899.24	1858.542	1885.674	1722.882	1668.618
sig bcy	2238.39	2238.39	2238.39	2238.39	2238.39
ev	1907.45	1574	1337.45	1164.55	1014.45
ac stress	8.955164	9.369048	9.834191176	10.3057522	10.89634801
ac ben comx	110.9091	143.5294	181.3513514	220	270.5645161
abencoyy	10	12.98405	16.35581062	19.826087	24.51612903
Safe < 1	0.073201	0.094116	0.115371052	0.14912082	0.186600426

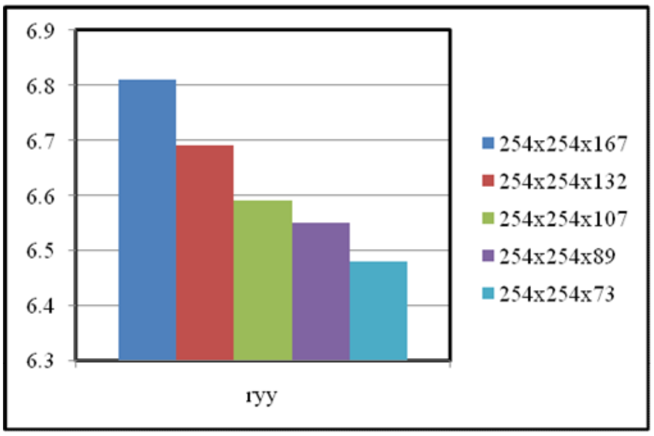

Fig. 1: Radius of gyration of 254 series of UC section

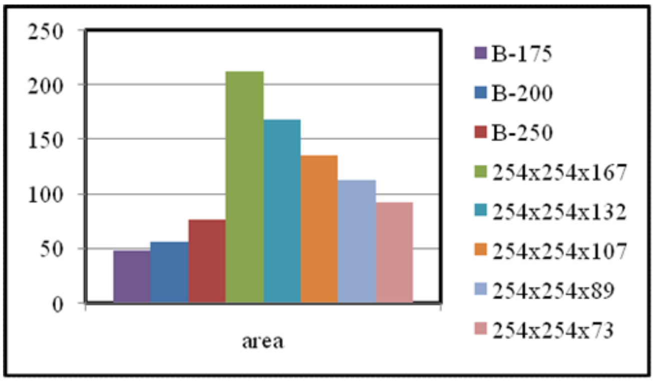

Fig. 2: Area of UC and B-series section

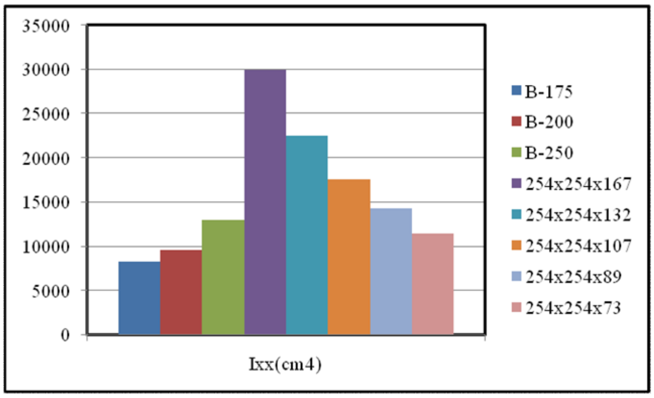

Fig. 3: Moment of inertia of UC & B-series

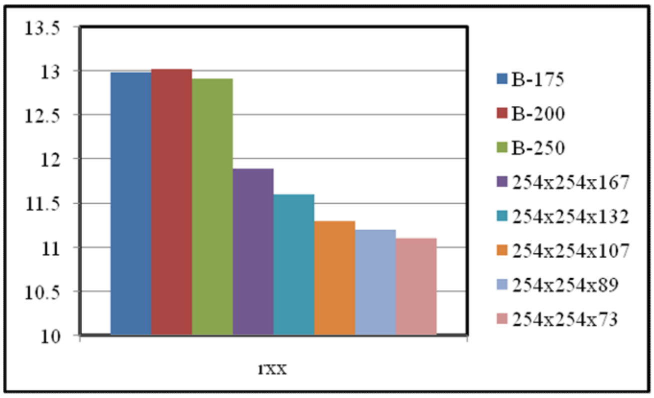

Fig. 4: Radius of gyration of UC & B-series

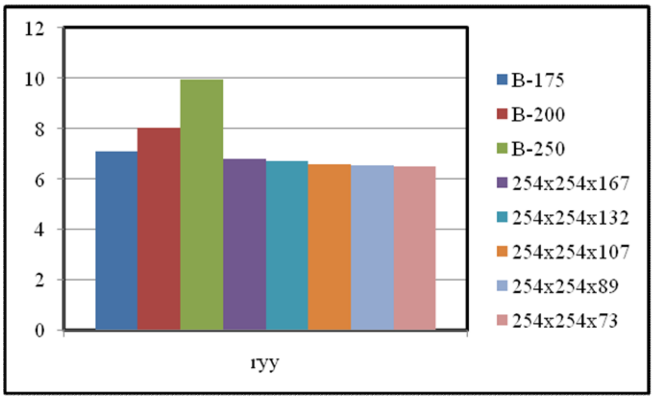

Fig. 5: Radius of gyration of UC & B-series

Here in this bar chart radius of gyration about y-axis compared with B-series and UC 254 series of section. It shows that 254 series is not suitable in replace of B-series. By increasing the section here 305 series of UC section can be try.

From design point of view 305x305x97 section is the save one. Then by comparing with existing B-series mast

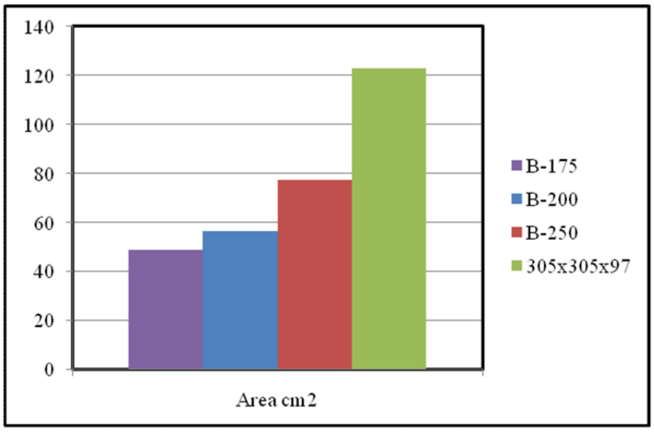

Fig. 6: Area of 305x305x97 & B-series

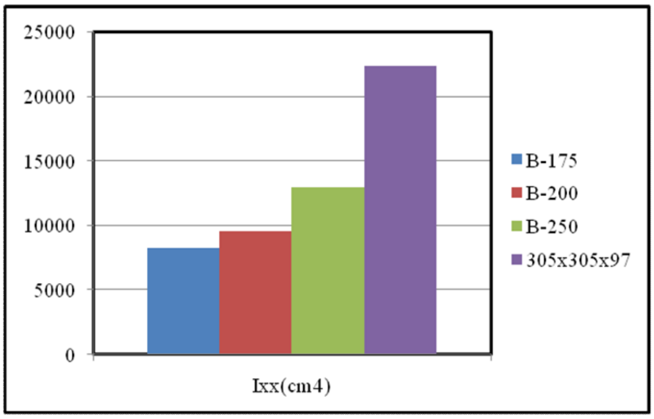

Fig. 7: Moment of inertia of 305x305x97 & B-series

Here from this bar chart 305x305x97 UC section is compared with B-series, it is noted that moment of inertia about x-axis is much higher than B-series.

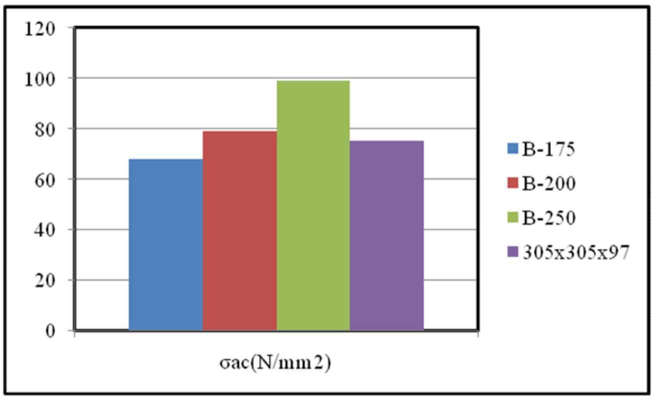

Fig. 8: Actual stress of 305x305x97 & B-series

Actual stress of the UC section is higher than B-175, but with compare with B-200, it is slightly less. The actual stress of B-250 is much higher here.

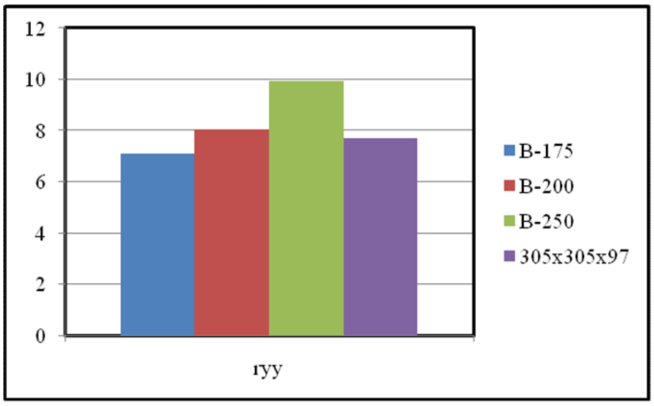

Fig. 9: Radius of gyration of305x305x97 & B-series

The radius of gyration of this new section is approximately same as B-200, and better than B-175.

Table 3: Radius of gyration of305x305x97 & B-series

Mast type	B-175	B-200	B-250	305x305x97
r_{xx}	12.99239381	13.02249	12.92116	13.4
r_{yy}	7.083528364	8.030648	9.93488	7.69

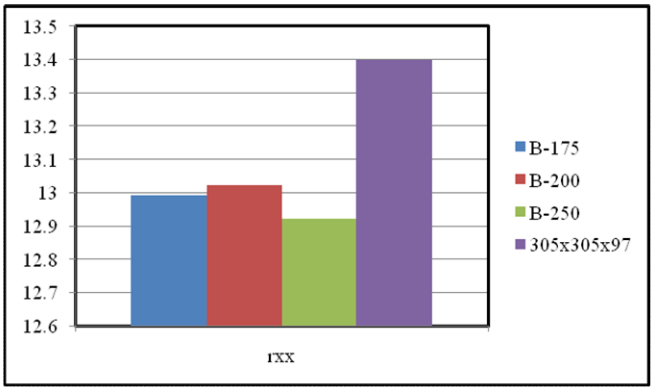

Fig. 10: Radius of gyration of305x305x97 & B-series

The radius of gyration of UC section about x-axis is much higher than B series.

From these bar graph this will be satisfy that 305x305x97 UC section can be use instead of B9.9-175 & B-200 mast.

3. CONCLUSION

- For replacement of built up section, higher sections are tried, which have safe design. On these sections 305x305x93 have theoretically better onthe performance of radius of gyration, and on various stresses.
- So, in place of B-175 and B-200 which are used as an anchored mast and the mast carry balanced weight, may be tried with 305x305x93.
- All these are theoretical calculations according to IS 800:2007 code. So laboratory test will be required for implementation.
- Here it is clear that built up section is always preferable for higher load cases and on different load combination.

REFERENCES

[1] UlrikStottup-Andersen, "Masts and towers", Euro steel 2005, Maastricht Nederland, June 2005.
[2] Steel columns of rolled wide flange section, progress report no.1, by Bruce Johnston and Lloyd Cheney, American Institute of Steel construction column research at Lehigh University. Committee of technical research, AISC.
[3] Indian standard IS 800 – 1984 code of practice for general construction in steel, first revision, copyright 1995, Bureau of Indian standards.
[4] Indian standard IS 875 codes of practices.
[5] Indian standard IS 800 – 2007 code of practices.
[6] Indian standard IS 808:1989 – 2004 Hot rolled steel sections, edition 4.1.
[7] Indian standard IS 1852:1985 – 2003 code of practices.
[8] Overhead equipment mast – Indian Railways Institute of Electrical Engineering, Nasik Road.
[9] H. Partab, Modern Electric traction, edition 1989, Dhanpat Rai and sons.
[10] Joseph E. Bowles, Structural Steel Design, copyright 1981, McGrawhill Book Company.
[11] Buick Davison and Graham W. Owens, Steel Designers' manual, Blackwell Publishing, 6th edition.
[12] N. Subramanian, Design of Steel Structures, Oxford University press 2008.
[13] Bhagwan Das Ahirwar – Reliability of 25 KV traction, IREEN journal, vol.13, no.4, oct-Dec 2003.
[14] Om Prakash –"Optimisation of cost of electrification", IRIEEN journal, vol.III, Oct-Dec 1993, No.4.
[15] R.K Saxena – "Enhancement of speed potential of OHE", IRIEEN Journal, vol.IX, Oct-Dec 1999, No.4.