EFFECT OF GEOMETRICAL PARAMETERS ON BUCKLING STRENGTH OF MILD STEEL COLUMN FOR VARYING WALL THICKNESS

Sajal Kumar[1], Sudhir Kumar Kashyap[2]

[1]*Post Graduate Scholar, B.I.T Sindri Dhanbad-828123*
[2]*Senior Principal Scientist, CSIR-CIMFR, Barwa Road, Dhanbad -826015*

Abstract

Buckling of a column depends on the various geometrical parameters and material. Buckling strength mainly depends on the crushing strength, area of cross section length and the radius of gyration. For the mild steel hollow columns having length and outer diameter same and different wall thickness, buckling load for fix-fix end condition decreases as the radius of gyration increases. It has also been observed that with increment in slenderness ratio (l/k) the wall thickness and buckling load increases. Additionally, buckling load decreases as the ratio of inner to outer diameter increases.

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1. INTRODUCTION

As per literature review it has been observed that the bending behavior of columns depends on different parameters like the end condition, geometrical imperfection and the size[1,2,3,4,5,6,7,8]. . Also, the effect of geometrical parameters on the buckling of different shaped (e.g. rectangular ,square, circular, conical) columns[9,10,11,12] have been studied. In this paper the effort has been made to analyze the buckling behavior of hollow mild steel column fix-fix end condition. Figure 1 shows the Image of mild steel columnswhose outer diameter are fixing and cross sectional areas vary keeping the length constant. An experimentation setup has been done with mild steel columns having outer diameter 60mm; length 1520mm and varying wall thickness like 1.6mm, 1.8mm, 2.3mm, 2.9mm and3.3mm.

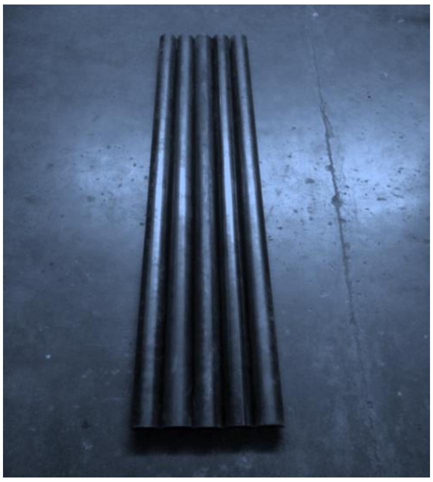

Fig 1: Hollow mild steel column)

The chemical composition of each column is shown in table. Table 1 shows the different percentage of carbon, silicon and manganese. Carbon percentage varies from 0.0418 to 0.0574 in each column.

Table 1: Chemical composition of given mild steel column

Column no	C %	Si%	Mn%
1	0.0418	0.0224	0.203
2	0.0496	0.0205	0.215
3	0.0514	0.0234	0.254
4	0.0574	0.0214	0.463
5	0.0485	0.0283	0.227

2. EXPERIMENTATION

To find the experimental value of buckling load the experimentation is done the on the 100 ton vertical compression testing machine Figure 2. During the experimentation we measure the load of buckling for the different column. The value obtained for buckling load for different wall thicknesses have been shown in table 2.

Specification of 100 Ton Vertical Compression Testing Machine:
Capacity-100 Tones
CMRI/SDT43/CTM-01
Voltage-440
Phase-3
Cycles-50
Type-7IN48DCJ
Number-E 6/1015

Fig 2: Experimental setup

Table 2: Columns and their wall thickness

Column no	Wall thickness inmm.	Experimental buckling load
1.	1.6	6
2.	1.8	7.5
3.	2.3	11.5
4.	2.9	14.7
5.	3.3	18

3. IMPACT OF GEOMETICAL PARAMETERS ON AXIAL COMPRESSIVE BEHAVIOUR

As it has been seen in the literature reviews that the compressive behavior of a member very much depends on the geometrical parameter where as buckling load depends on the moment of inertia and length. The various geometrical parameters of the columns are shown in the table 3 given below.

Table 3: Various geometrical parameters of columns)

Column no	Wall thickness	Radius of gyration (k) mm	Slenderness ratio (L/k)	Area of cross section (mm^2)	Ratio of inner to the outer radius
1.	1.6	20.65	36.80	293.40	0.947
2.	1.8	20.59	36.91	328.94	0.940
3.	2.3	20.41	37.23	416.70	0.923
4.	2.9	20.36	37.32	519.95	0.900
5.	3.3	20.08	37.84	587.53	0.890

This table shows that as wall thickness of the pipes increase then radius of gyration decrease and slenderness ratio (l/k) increases. Both radius of gyration and slenderness ratio affect the buckling load of the pipe or column as shown in the curves in figure 3A & 3B.

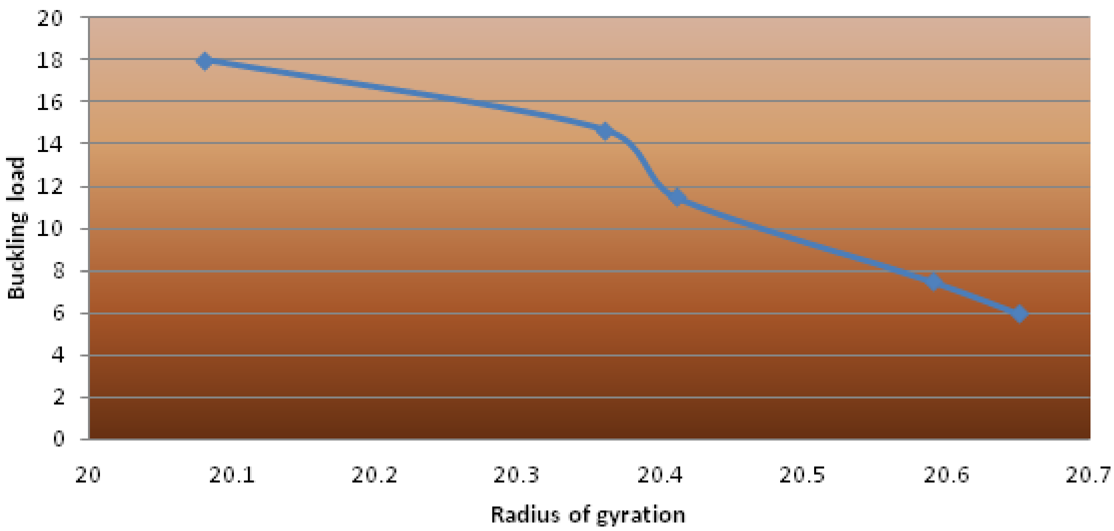

Fig 3A: Effect of radius of gyration on the buckling load

From the figure 3A it is observed that as the radius of gyration increases the buckling load decreases. For the column having wall thickness from 1.6.to 1.8 mm the rate of increase of buckling load with decrease of radius of gyration is 535%. For the columns having thickness of 1.8 to 2.3 mm the rate of increase of buckling load with decrease of radius of gyration is 2222.2%.Again the column having thickness of 2.3 to 2.9 the rate of increase of buckling load with decrease of radius of gyration is 6400% i.e very high rate of increase of buckling load with decrease of radius of gyration. For the wall thickness 2.9 to 3.3 buckling load increase with rate of 1178.5%.Therefore it can be concluded that when the wall thickness varies from 2.3 to 2.9 buckling strength of the column increases with a very high rate.

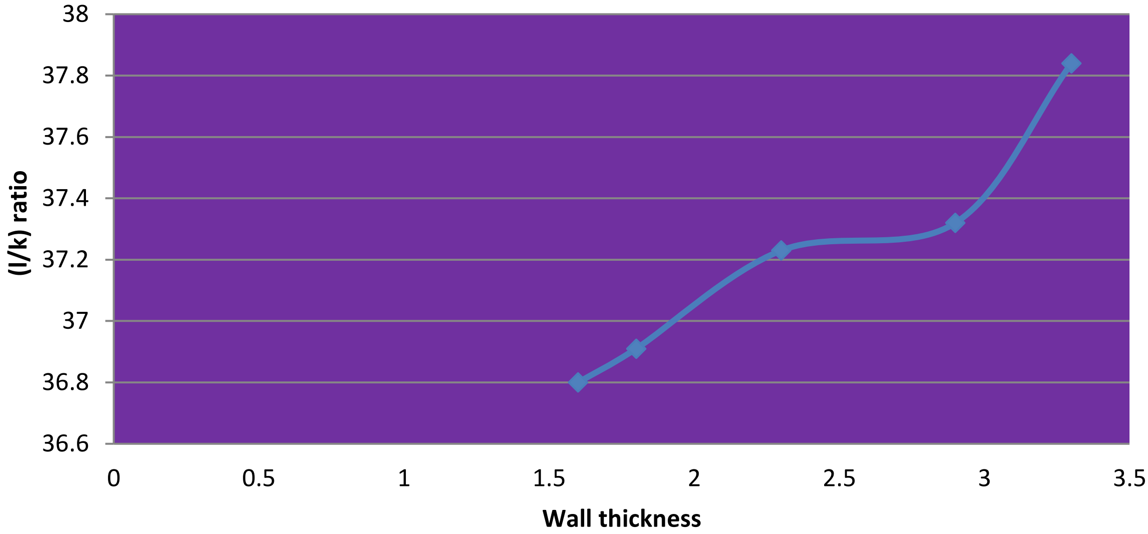

Fig 3B: Graph of Slenderness ratio to the wall thickness of the column

It is observed that with increase in wall thickness the (l/k) ratio also increases .It can be seen in figure 3B that as wall thickness varies from 1.6 to 1.8 the rate of increase of (l/k) ratio is 55%. When thickness increase from 1.8 to 2.3 the increment rate is 65% again when the thickness from 2.3 to 2.9 increment of 15% and when thickness increase from 2.9 to 3.3 the rate of increment is 130%.Therefore as the wall thickness varies from 2.3 to2.9 the rate of increase of slenderness ratio is comparatively lower and as thickness varies from 2.9 to 3.3 comparatively higher.

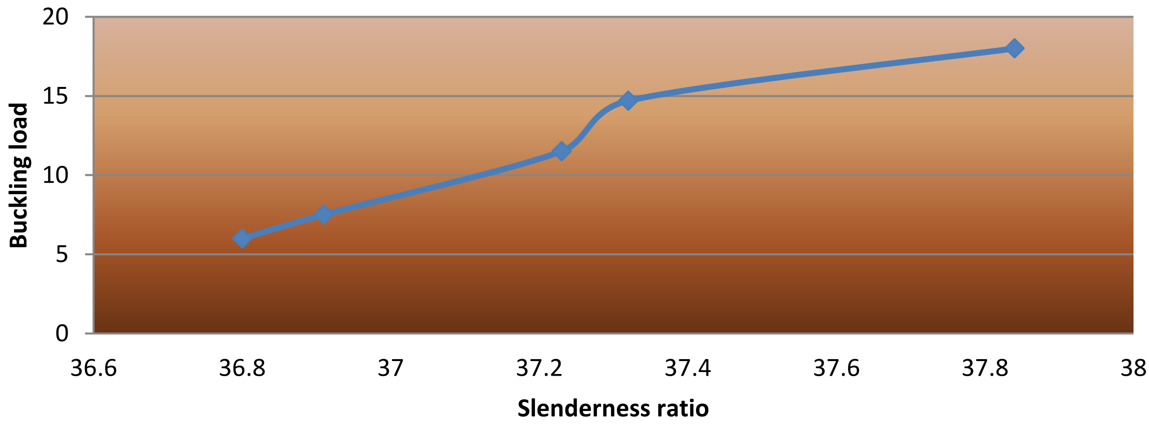

Fig 3C: Graph of buckling load vs. (l/k) ratio of column

As length varies but cross sectional area remains same the buckling load decreases with increase in (l/k) ratio. But, in this experimental study the case is reverse when cross sectional area increases keeping outside diameter and length constant and varying inner diameter the said load increases with (l/k) ratio. According to the figure 3C it is observed that rate of increase of buckling load with respect to increase in slenderness ratio is 1363.6% when wall thickness is varied from 1.6 to 1.8 mm. Correspondingly, With increase in wall thickness from 1.8 to 2.3 the rate of increase of buckling load with respect to increase in slenderness ratio is 1230.6 %, the rate of this increase for 2.3 to 2.9 is 3555.4 %which is comparatively higherand for thickness 2.9 to 3.3 the rate is 634.6% i.e. on lower side.

Therefore, from the figure 3B and 3C it can be concluded that as the wallthickness varies from 2.3 to 2.9 the rate of increase of (l/k) ratio is comparatively lower but rate ofincrease of buckling load with respect to the slenderness ratio is comparatively higher .On the other hand it is observed as wall thickness varies from 2.9 to 3.3 the rate of increase of slenderness ratio is comparativelyhigher but the rate of increase of buckling load with respect to the slenderness ratio is comparatively lower.

The figure 3D shows the curve between the buckling load and the ratio of inner to outer diameter. The graph shows that as the ratio of inner to outer diameter increases the buckling load decreases with slow rate.

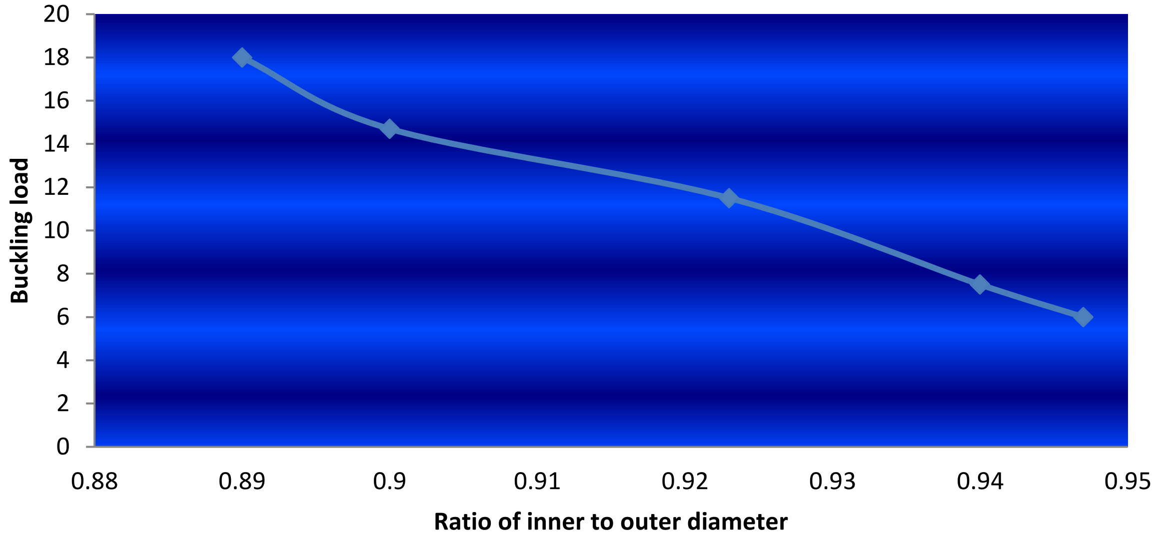

Fig 3D: Buckling load vs. ratio of inner to the outer diameter

As we go through figure 3D given above wall thickness varies from 1.6 to 1.8 the percentage rate of incrementin buckling loadwith respect to decrease in ratio of inner diameter to the outer diameter is 2148.5% . As go through the wall thickness from 1.8 to 2.3mm the percentage rate of increment in buckling load with respect to decrease in ratio of inner diameter to the outer diameter is 23529.4%. For wall thickness varying from 2.3 to 2.9 rate of increase is 13913% and subsequently for wall thickness increment from 2.9 to 3.3 mm percentage rate of increase of buckling load 33000 %. Here, it is observed that the rate of increase is comparatively lower for 2.3to 2.9mm wall thickness and comparatively higher for 2.9 to 3.3mm.

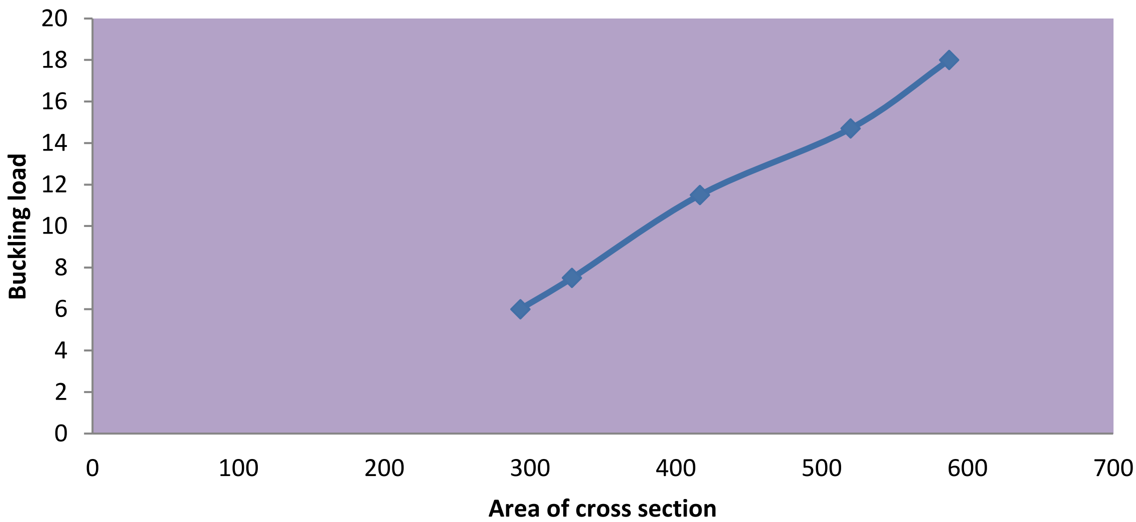

Fig 3E: Buckling load vs. area of cross section

As per depicted figure 3E for the columns of wall thickness of 1.6 and 1.8 the rate of increment of buckling load with increase of cross sectional area is 4.22%, for the column 1.8 and 2.3 the increment rate of buckling load with increase of cross sectional area is 4.56%, for the column of wall thickness 2.3 to 2.9 the rate of increase in buckling load is 3.09% and the rate of buckling load with increase of cross sectional area is 4.88% for the column 2.9 mm and 3.3 mm .

4. CONCLUSION

With this study it is concluded that hollow mild steel columns having fix length and outer diameter the bending behavior is good. The radius of gyration decreases with increase in wall thickness and on other hand buckling strength increases as the (l/k) ratio increases. It has also been observed that the rate of increase of buckling load with respect to ratio of inner to outer diameter is comparatively higher for the 2.9 to 3.3 mm wall thickness and lower for the 2.3 to 2.9 mm. Additionally, for the wall thickness which varies from 2.3 to2.9 the rate of increase of slenderness ratio is comparatively lower and as thickness varies from 2.9 to 3.3 higher. And also for the wall thickness which varies from 2.9 to 3.3 the rate of increase of slenderness ratio is comparatively higher but the rate of increase of buckling load with respect to the slenderness ratio is lower. These studies may be helpful for structural engineers while designing for erection and installation of any industrial establishment.

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