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Comparison of different Boom sections of Mobile Crane

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Abstract- It is one of the major problems encountered with heavy duty mobile cranes to provide a telescopic boom with the required and desired strength in different extended positions of booms without having the boom unduly heavy relative to size and weight of outermost section of boom. The problem becomes more complicated when the boom design consist of four pate sections. Nowadays "U" pressed boom sections are available as they have advantages over four plate section booms. In this paper the available options of boom sections are compared. Eight types of boom sections available will be analyzed on the bases of their strength and weight. 3D modeling is done using SOLID WORKS and analysis of eight types of boom sections is done. And advantages and disadvantages of these sections are discussed.

Keywords: Boom section, Mobile crane.

1. INTRODUCTION

Mobile cranes usually have telescopic type of booms that are used to handle unduly heavy loads and these have capability to extend to great heights. Boom is integral part of mobile cranes. High strength and light weight boom sections are required for telescopic booms of mobile cranes. It is important to know the differences between the available boom section options and to know the advantages and disadvantages of these sections so that comparison can be made and the best suited boom sections can be used for crane boom design in order to achieve the light weight and high strength comparable to similar types of booms of comparable reach and heavy load lifting capacity. Four plate boom sections were very common till 2002 as shown in figure. But nowadays "U" section is used in India because of many advantages of "U" section compared to four plate section of boom. In foreign countries many more shapes of boom sections are available.

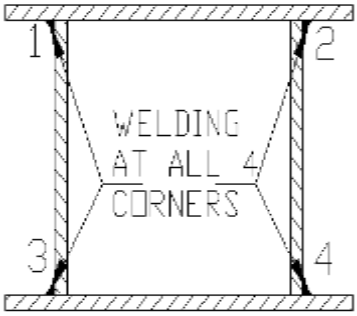

Figure 3 Four plate boom section

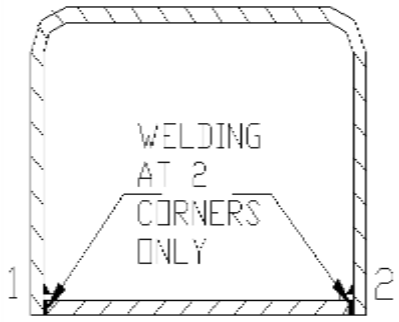

Fig.4 "U" shaped boom section

2. MATERIAL OF BOOM SECTIONS:

The material used is ASTM A36
Mechanical properties are:
Mass density - 7,800 kg/m^3
Shear modulus - 79.3 GPa
Poisson's Ratio – 0.260
Yield strength – 250 Mpa
Tensile strength - 400–550 MPa

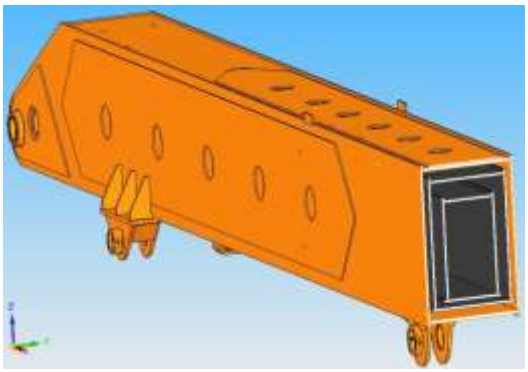

Fig.1- Boom with four plate section

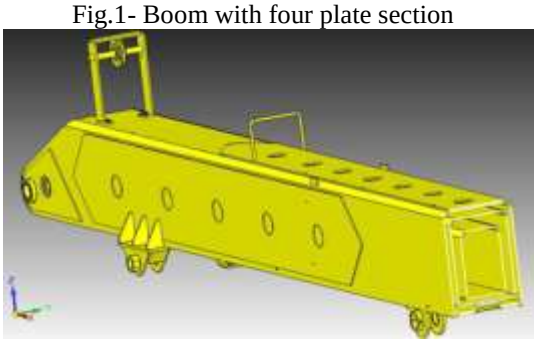

Fig.2- Boom with "U" section

3. COMPARISON OF BOOM SECTIONS

The different boom sections are made in Solid Works for comparison. The 3D models of different boom sections are generated in Solid Works. The dimensions of webs are taken of same length in all types of boom sections. The thickness of webs and flanges is taken 8mm in all cases. Height of webs is taken 350mm and distance between two webs in the sections is taken 200mm. Length of all boom sections is taken 1000mm.Mass properties and section properties are evaluated using Software. The comparison between different boom sections is made so as to check which type of boom section is well suitable for mobile crane to handle the unduly heavy loads.

Types of different Boom Section options

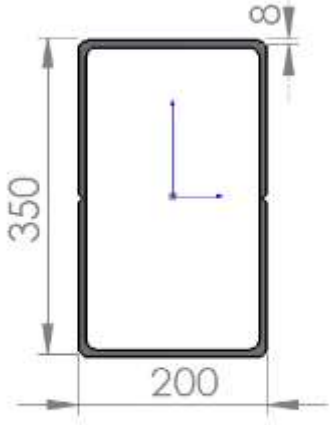

Fig.5 - 2 "U" Section

Fig.6 - Four Plate SAW assembly

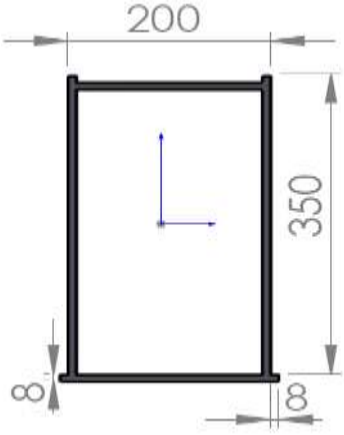

Fig.7- Four plate section (1)

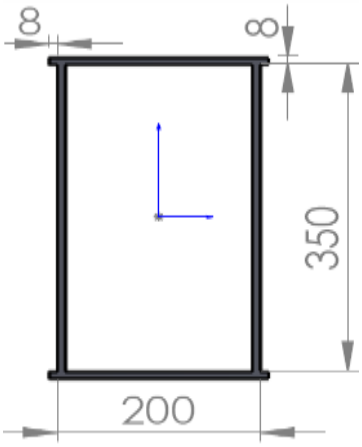

Figure 8 - Four plate section (2)

Figure 9 - "U" bend SAW assembly

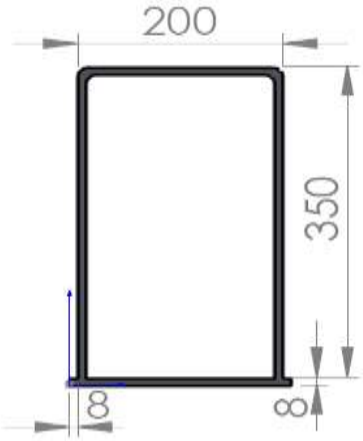

Figure 10 - "U" bend fillet section

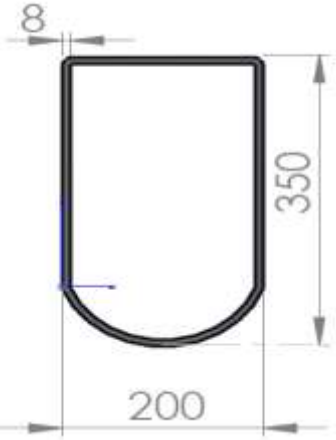

Figure 11 - Extruded Section (1)

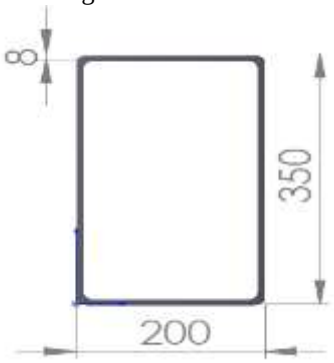

Figure 12 - Extruded Section (2)

These above given types of boom sections are modeled in solid works and their inertia, weight, volume, surface area are compared in order to predict which type of section is best suitable to achieve high strength and lower weight as shown in Table 1.

Table 1 Comparison of different types of Boom Sections.

Sr. No	Boom sections	Ix(mm^4)	Iy(mm^4)	Volume (mm^3)	Mass (gm)	Surface area (mm^2)
1	2U Section (Figure 5)	59403008	143035928	8501333.3	8501	2126319.0
2	4plate(2) (Figure 8)	65076395	167918794.	9056000	9056	2282112
3	Extruded section(2) (Figure 12)	59816688	143036079	8544000	8544	2118751.7
4	Extruded section(1) (Figure 11)	52613518	119173623	7889984.2	**7890**	1988274.8
5	4 plate SAW (Figure 6)	63861584	175102028	8992000	8992	2409984
6	4 plate(1) (Figure 7)	62510934	151113214	8800000	8800	2217600
7	U bend fillet (Figure 10)	62446542	155095911	8800000	8800	2200431.8
8	U bend SAW (Figure 9)	59600334	142018350	8512000	8512	2199855.8

Four Plate Section versus "U" Section

1. Residual stresses are much higher in four plate section than "U" section due to double weld length.
2. Distortion is more in four plate section due to more heat input than double "U" pressing.
3. Chances of weld defects are more in four plate section since the four plate
   Joint is usually made for MIG/MAG welding and on the other side the "U" pressing is made for submerged arc welding.
4. In four plate section the weld joint is made for fillet weld while in "U" pressing the weld joint is butt joint. Strength of butt joint is better than fillet joint.
5. Geometrical inaccuracy is more in case of four plate section since it is difficult due to more heat input.
6. Bending joint efficiency is more than 1 in case of "U" sections whereas bending joint efficiency is less than 1 in four plate sections.
7. "U" section is produced by cold forming process but the four plate section is hot formed and have heat affected zones more by 50%.
8. Wear pad wearing will be less in "U" pressed boom due to better geometrical accuracies.

4. CONCLUSION

"U" sections are better than that of four plate sections. Aesthetics are poor in four plate section as compared to formed "U" sections. Theoretical strength is higher in "U" section than four plate section. It is concluded that four plate sections of booms is more suitable than "U" pressed section of boom so as to achieve high strength and lower weight. The extruded section shown in figure 11 is having the lower weight. It is best suitable for boom construction. In china it is already in use but in India because of cost issue this type of section is not in use.

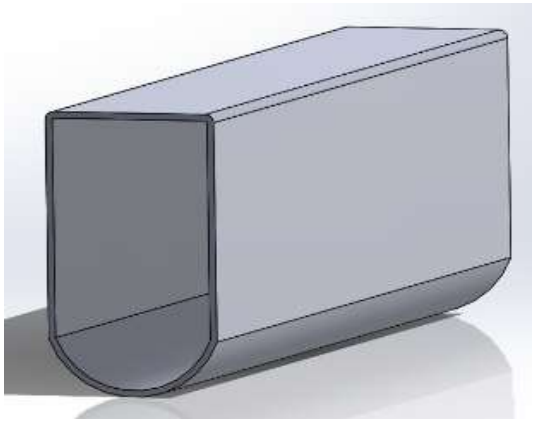

Figure 13 Extruded Boom section

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