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OPTIMIZATION OF DESIGN PARAMETER OF VERTICAL MACHINING CENTER COLUMN FOR THE WEIGHT AND RIGDITY

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Abstract-*The headstock and column are important part of VMC (Vertical Machining Centre), however there are many designing parameters which may influence rigidity and weight of headstock and column, so to find the designing parameters the designing of the part is a very important task. For this work, the 3D CAD model for the base line and the optimized design has been created by using commercial 3D modeling software CREO, and after that we will go for static structural analysis of the components, from this analysis we will find out the weakest point of the component and further we will work on to enhance that part. There are different methods to increase the rigidity of the components by introducing ribs or making hollow component and filling it will aluminum foam or we change the material of column by doing this we can increase the rigidity as well as optimize the weight of the component.*

Keywords- Static Structural analysis, vertical machining center, Design Optimization.

1.0 INTRODUCTION

Production is process to convert raw material into finished goods. Production is done by efforts of both man and machines using materials and tools. Day by day due to increase in production the new technology are developing and effort of human are reducing, as automation is increasing in machines. Prepared program consist of information and instructions which controls the machines instead of manual control. This has led to increase in production rate and in low wait and higher accuracy, such a machine is a vertical machining center. Vertical machining center can be used for many operation like drilling, laser cutting, water jet cutting etc.Vertical machining center comprises of many components like pallet clamp unit and pallets convey our units arranged with the front side of the bed. A saddle is provided above the bed which moves in along X-axis. A column is provided above the saddle surface which can move in Y-axis. Headstock is provided in front face of the column, which can slides vertically. A tool magazine and automatic tool exchange, both are arranged alongside the bed and numerical control is provided to control the saddle the column ,the headstock ,the pallet clamp unit ,pallet conveyor units ,the tool magazine and tool exchange device.

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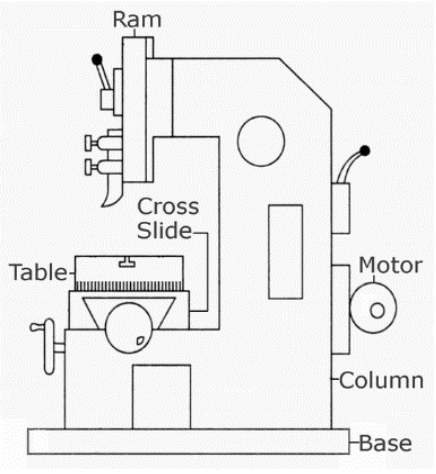

Figure 1: Vertical Machining Centre

2.0 MODELING AND SIMULATION OF VMC COLUMN

The major dimensions of the machine bed are as follows:
Length=745mm (On X-axis)
Width=700mm (On Z-axis)
Height= 1900 mm (On Y-axis)

Applying Loads
Load -1329.6 N
On Column Front face of slider

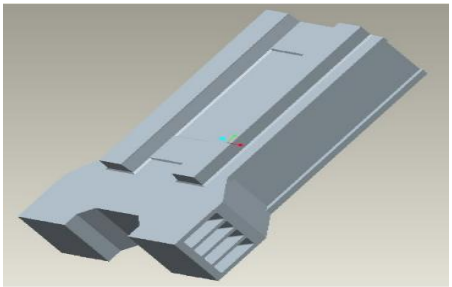

Figure 2: 3D CAD Model of VMC Column

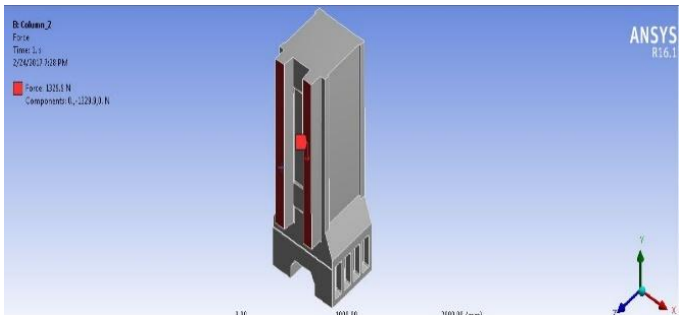

Figure 3: Loads applied on column sliders facefor material FG260

3.0 FINITE ELEMENT ANAYSIS OF VERTICAL MACHIING CENTRE COLUMN

Materials Properties:

MATERIAL PROPERTIES	YOUNG MODULUS	POSSION RATIO	DENSITY
GREY CAST IRON FG260	1.1e+005N/mm^2	0.28	7.2e-006 kg mm^{-3}
GREY CAST IRON FG300	1.8e+005N/mm^2	0.31	7.35e-006 kg mm^{-3}

Table 1: Properties of material

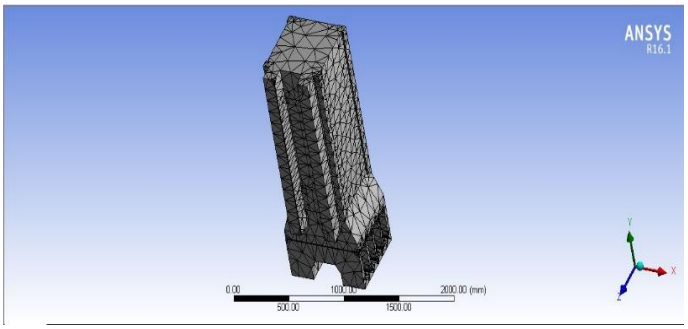

Figure 4: Discretization of material FG260

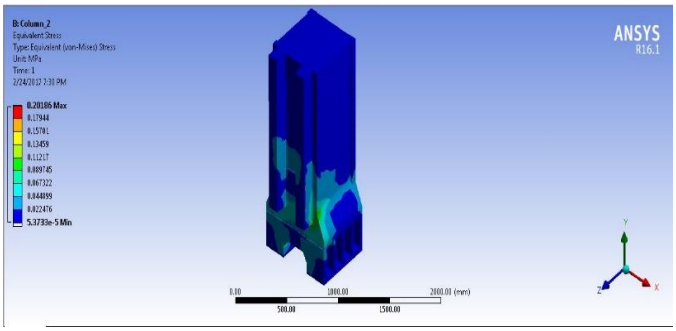

Figure 5: Von Misses Stress for material FG260

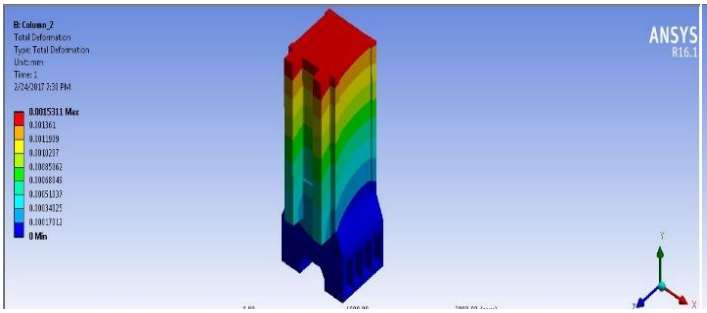

Figure 6:Total Deformation of FG260

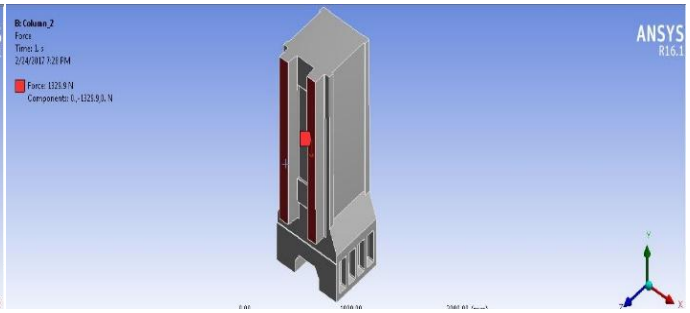

Figure 7: Loads applied on column sliders for material FG300

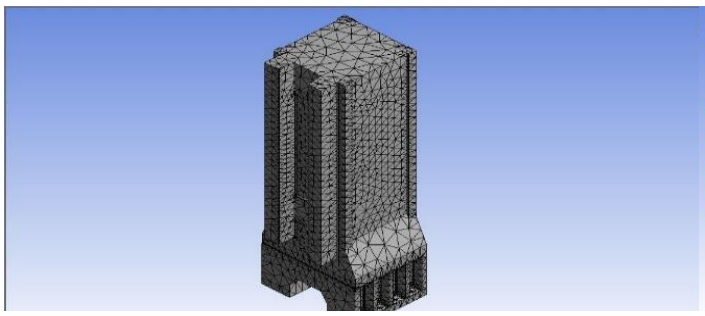

Figure 8: Discretization of the material FG300

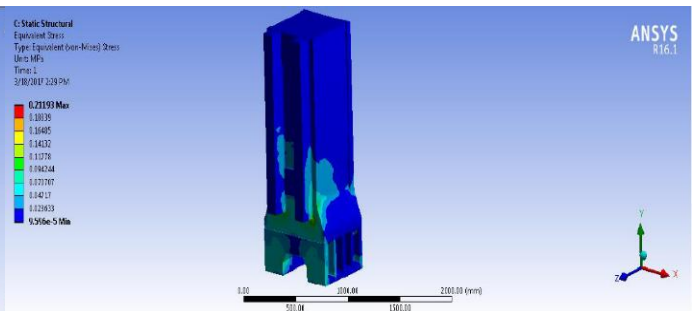

Figure 9:Von-Misses stress on material FG300

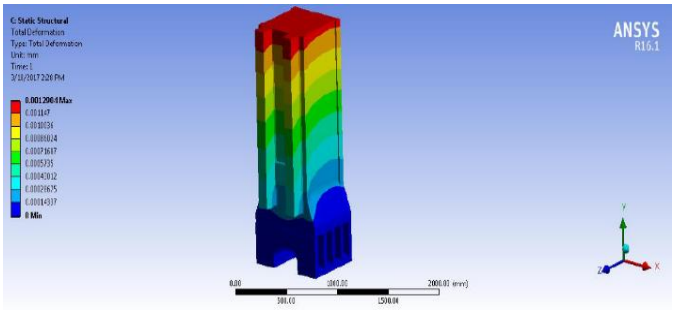

Figure 10: Total Deformation of material FG300

4.0RESULTS & DISCUSSION

The results of static structural analysis of vmc columnfor both the standards of grey cast iron i.e. .FG260 and FG300 using ANSYS.

Results		
0	**Deformation**	**Von-miss Stress**
Minimum	0. mm	5.3733e-005 MPa
Maximum	1.5311e-003 mm	0.20186 MPa

Table 2: Results of material FG260

Results		
	Deformation	**Von-miss stress**
Minimum	0. mm	9.596e-005 MPa
Maximum	1.2904e-003 mm	0.21193 MPa

Table 3: Results of material FG300

The comparative results for linear static structural analysis for the material Grey Cast Iron of standard FG260& FG300 are shown above in the table 2 & table 3.

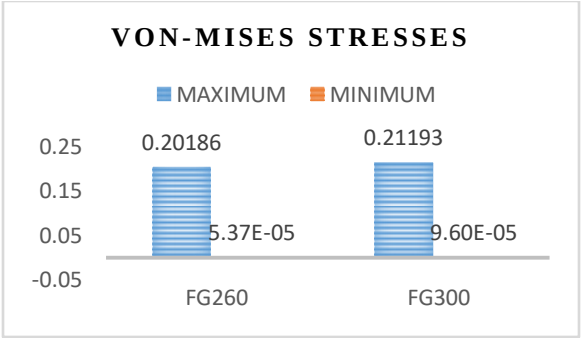

Figure 11:Comparison min and max Von miss stress betweenFG260 and FG 300 material.

Rigidity for material can be given by R= $\frac{F}{L}$
Where
R = rigidity of the material. (N/mm)
F = Force in (N)
L = Deformation (mm)
For FG260 Rigidity = 2357.54 N/mm
For FG300 Rigidity =2797.85 N/mm

5.0 CONCLUSION

The following points are concluded for a vertical machining center

- From the above results, the rigidity of the column structure is increased by 440.31N/mm from 2357.54 N/mm to 2797.85 N/mm i.e. (approximately 18.67%).
- The optimize weight for the vertical machining center column is increased by 33 kg from 1583.2kg to 1616.2 kg,(approximately 2%) but this will not affect the cost of the manufacturer much because the price difference is around 3% between the Grey cast iron standards i.e. FG260 and FG300.
- The von miss stress for FG260 was increase from 0.20186 N/mm^{2}to 0.21193 N/mm^2 i.e. by 4.98%.
- The effect of von missstress was increased but it is in permissible safe limit.

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