Design and Development of a Bandsaw Machine Roller Bracket for Weight optimization

Mr. Pratik R. Magdum[1], Mr. Vijay A. Kamble[2], Mr. Ajit R. Balwan[3]

[1]Student M.E. Mechanical (Product Design & Development), DKTE Society's Textile & Engineering Institute, Ichalkaranji Kolhapur Maharashtra India
[2,3]Asst. professor Department of Mechanical Engineering, DKTE Society's Textile & Engineering Institute, Ichalkaranji Kolhapur Maharashtra India

---

Abstract – *optimization of weight of a machine tool is an inevitable trend for machine tool manufacturing and designing industry to achieve requirements of material saving, energy saving and environment protection in a strategic manner. This project deals with a structural optimization for weight of roller bracket of horizontal bandsaw machine. Roller bracket are used in supporting stock bar where as total 6 brackets are used. With the help of Altair CAE Optimization tools, it has possible to decrease weight (min. material) of roller bracket by 27%. Total cost saving per machine can be achieved till Rs.336/-. Rapid prototyping is then used for product development for comparative study purpose.*

***Key Words*: Topology Optimisation, Weight Reduction, Roller Bracket, Rapid Protyping**

1. INTRODUCTION

To conserve natural resources and minimize use of energy, weight reduction has been the main focus of machine tool manufacturers in the present scenario. Optimization is one of the techniques used in designing field to achieve the best designing conditions. This will accomplish a very essential need of the industry towards designing of quality products with lower costs. Weight reduction can be achieved by the introduction of better material, better manufacturing processes and design optimization. This project is sponsored by SPM TOOLS, Ichalkaranji a company of FIE GROUP. This company is leading in market for manufacturing bandsaw machine Main product of company is HORIZONTAL BANDSAW MACHINE. Sawing machine is an important machine tool of mechanical workshop. A sawing machine is a machine tool designed to Cut off bar stock, tubing, pipe, or any metal stock within its Capacity, or to cut sheet stock to desired contours. The sawing Machine functions by bringing a saw blade containing cutting. Rollers are used to carry weight of stock bar which is going to get cut by bandsaw machine and these rollers are supported by roller brackets. Total 6 Roller Brackets are used in the whole assembly which weighs 3 kgs each.

1.2 OBJECTIVES OF PROJECT

1. To optimize the structural design of the roller bracket
2. Reduce the cost by minimizing the weight of the material.
3. Minimize load on resources by using minimum material.

2. METHODOLOGY

Phase I: - Collection of data from operational instructional manual and design and development department of SPM TOOLS, Ichalkaranji. **(Pre-Processing)**

Phase II: - Static analysis in Altair Hyperworks of current roller bracket to find out max. Displacement and stress and Setting topology optimization parameters such as design variable, responses, constraints, objective and manufacturing constraints and submit for topology optimization and make appropriate change structural change**.(Topology Optimization, Analysis)**

Phase III: - Design Validation using photo elastic model of 5 mm thickness optimized model. Development of a fixture on 3d printer to conduct a stress test on Polariscope instrument to validate the stress regions & its range near about numerical test. **(Experimental Stress Analysis and Design Validation).**

Phase IV: - In last stage, prepare part drawing of a optimized roller bracket for product development on 3-d printer. **(Rapid Prototyping)**

3. NUMERIAL ANALYSIS IN HYPERWORKS

Table -1: material property of Grey cast iron, specification & loading conditions.

Sr no.	Parameter	Description	Value
1	E	Young's Modulus (Mpa)	66000
2	NU	Poisson‟s Ratio	0.27
3	RHO	Density (kg/m3)	7200
4	F	Force(N) factor of safety 1.5	2028.9
5	M	Wt. before optimization	3

3.1 FORCES ACTING ON ROLLER BRACKET AND INITIAL ANALYSIS.

Loading condition on roller bracket:

For project we have taken FCAF 250

Band saw machine and their max. Bar holding capacity is **250mm**

Volume of bar/mm = 3.14*radius2 * Length = 3.14*125*125 * 1 mm = 49093.75 mm^3

Weight of bar/ mm = volume * density (steel) = 49093.75*0.0000078 (kg/mm3)=0.383 kg

Roller 1

Weight on roller 1 = Wight of bar per mm * total length = 0.383 * 720mm = 275.76 kg

Force on roller 1 = weight * 9.81 = 2705.2 N

Roller 2

Weight on roller 2 = Wight of bar per mm * total length = 0.383 * 240mm = 91.92 kg

Force on roller 2 = weight * 9.81 = 901.7 N

Roller 3

Weight on roller 3 = Wight of bar per mm * total length = 0.383 * 480mm = 183.8 kg

Force on roller 3 = weight * 9.81 =1803.5 N

Total no of roller used in machine are 6 in which max load on roller 1 ,

factor of safety 1.5

So total force for design roller bracket is = 2705.2*1.5 = **4057.8 N**

Total force on each bracket is 4057.8/2 = 2028.9N

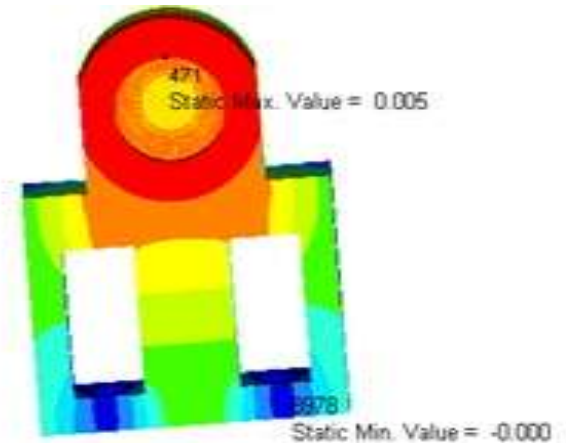

Fig -1: Analysis result

Static analysis was performed by using optistuct solver. it is observed that the maximum displacement Developed is 0.005mm & Stress developed is 10.2 N/mm^2.

Table 2: Analysis Result

Description	Value	Node
Max disp.lacement (mm)	0.005	471
Von Mises stress (N/mm2)	10.214	52203

4. TOPOLOGY OPTIMIZATION AND CONCEPTUAL CAD MODEL PREPARATION

Topology Optimization technique gives an optimum material distribution within given design space. [7] The design space defined using solid elements. The topology optimization set up in which first is design variable selected as solid, Design responses such as displacement, volume fraction, objective, design constraints-displacement as 0.005 mm upper limit & volume fraction, finally objective is weighted comp.

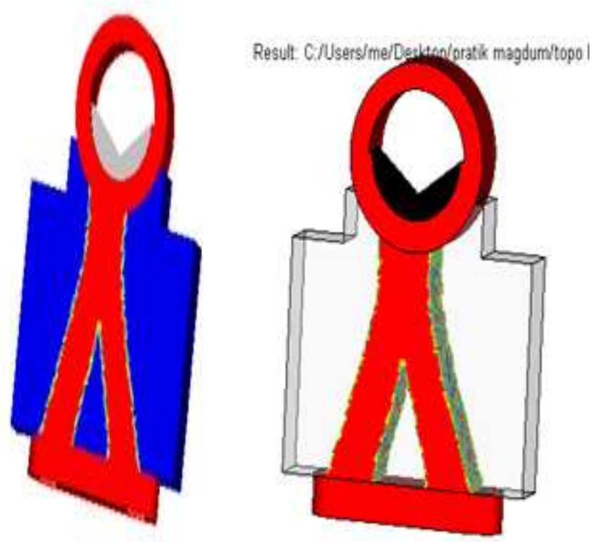

Fig -2: Topology Result - Element Densities Of Roller Bracket

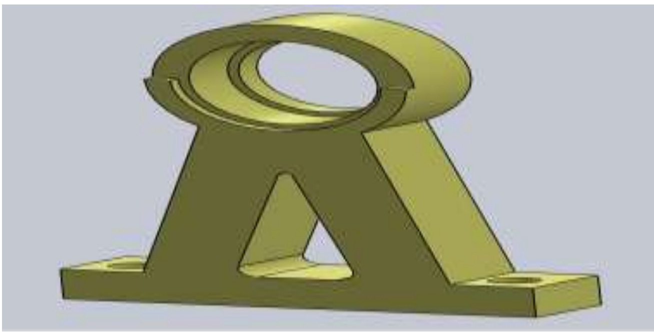

Fig -3: Conceptual CAD model for Analysis

Fig 3 shows that a conceptual design which imported in a CAD system using an iso-surface generated with OSSmooth, which is tool available in OptiStruct. This IGES model imported in solid works makes changes as per manufacturing aspect. Figure 3 Shows CAD model of optimized roller bracket.

5. REANALYSIS OF CONCEPTUAL MODEL

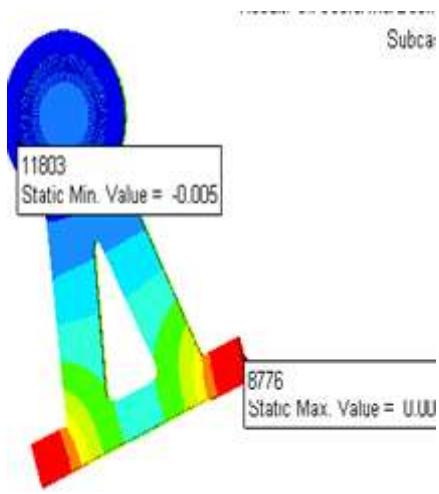

Fig -4: Conceptual CAD model Analysis for displacement.

Again conduct analysis on newly optimized Roller bracket model. Setup all meshing, boundary and loading condition. Cross Check that displacement and stress of optimized model do not exceed value Initial model. Figure 4 and Figure 5 Shows displacement result of optimized Roller bracket. Displacement of optimized Roller bracket is 0.005mm (equal 0.005mm of initial model) & stress 8.12 (N/mm2).

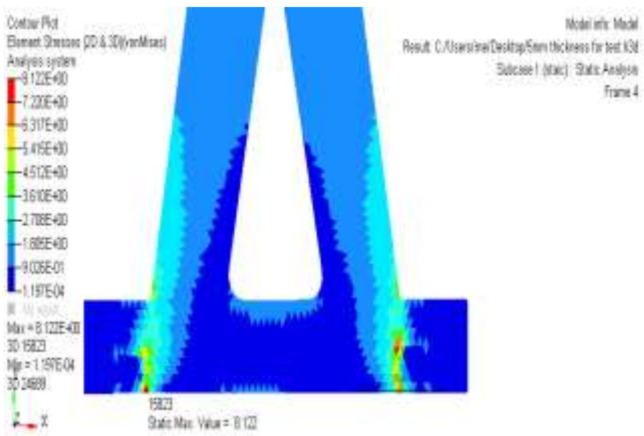

Fig -5: Conceptual CAD model Analysis for stress

6. EXPERIMENTAL VALIDATION

For experimental validation purpose we conducted test on Polariscope instrument. Here we validated stress regions & value. A photoelastic model from epoxy resin material was prepared from 2-Dimensional drawing of a optimized roller bracket. A fixture was manufactured using 3d-printer.

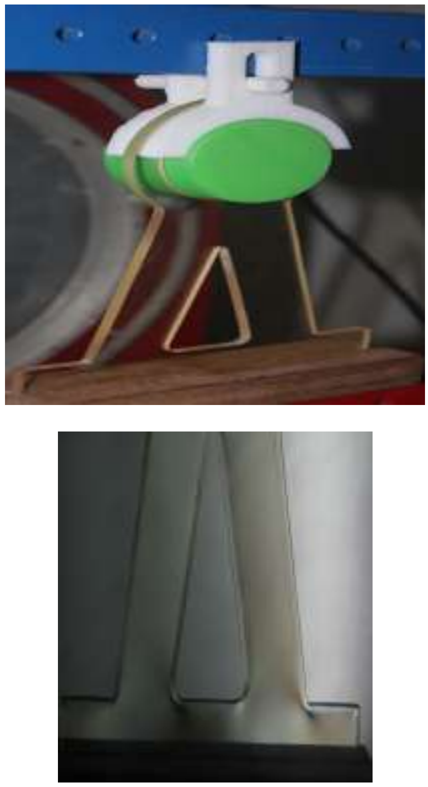

Fig -6: Experimental test on photoelastic model of optimized roller bracket on polariscope.

Table 3: Comparative Analysis Result

Stress in numeriacal anlysis (hyperworks software)	Stress in experimental (polariscope test)
8.122 N/mm2	7.89 N/mm2

Values of Stress in numerical analysis (Hyperworks software) & Stress in experimental (Polariscope test) are varies within 3 %. So it is successfully validated.

7. DEVELOPMENT USING RAPID PROTOTYPING.

Fig -7: RP model and Final Casting manufactured.

8. RESULT AND DISCUSSION.

Table 4: Analyzed results for Roller Bracket

Parameter	Before Optimisation	After Optimisation
Max. Disp.(mm)	0.005	0.005
Weight(kg)	3	2.2
Total a cost saving/unit	3kg*70=210/-	2.2kg*70=154/- Total saving use of material = 3-2.2 =0.8 kg Total roller bracket used in machine = 6 =6*0.8= 4.8 kg Total a cost saving/unit =4.8*70= 336/-

9. CONCLUSIONS

1. Existing roller bracket replaced by a optimized roller bracket & its saves 0.8 kg material use per kg & saves 336/-machine.

2. It is successfully validated the values of Stress in numerical analysis were 8.122 N/mm^2 (Hyperworks software) & Stress in experimental (Polariscope test) was 7.89 N/mm^2 which varies within 3 %.

3. Other components can also be optimised and validated using same method and overall machine cost can also be with reduced weight to get a quantitative profit. Also it will result in reduction in natural resources utilization which will ultimately save the environment.

REFERENCES

[1] Mr.Sagar Awate, Prof.Arun Bhosale, "Bi-directional Evolutionary Structural Optimization of Brake Chamber Mounting Bracket" published in 'International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 05 | May-2016.

[2] Jikai Liu, Yongsheng Ma, "A survey of manufacturing oriented topology optimization methods" published in Advances in Engineering Software journal, 2016 page no. 161–175.

[3] Sanket C. Vinchurkar, P. M. Khanwalkar, "FEA and Topology Optimization of an Engine Mounting Bracket", published in 'International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, 2016

[4] Jasmin Bhimani, Sanket Pandya, Tejas Bhatt, Ankur Vachhani, "Topology Optimization Of Fixture Used For Quill Mounting", published in 'IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 3, Issue 1, Feb-Mar, 2015

[5] Purushottam Dumbre, Prof A.K.Mishra, V.S.Aher, Swapnil S. Kulkarni, ,"Structural Analysis of steering knuckle for weight reduction", published in ' International Journal of Advanced Engineering Research and Studies' E-ISSN2249–8974 Int. J. Adv. Engg. Res. Studies/III/III/April-June,2014.

[6] ErsanGönül, MuhsinKılıc, and FatihKarpat, "A Study on Design and Manufacturing for the Side Wall of Large CNC Portal Milling Machine", presented in '2nd International Conference on Research in Science, Engineering and Technology (ICRSET'2014)', March 21-22, Dubai (UAE) 2014.

[7] R. Rezaie, M. Badrossamay*, A. Ghaie, H. Moosavi, "Topology optimization for fused deposition modeling process" presented in 'The Seventeenth CIRP Conference on Electro Physical and Chemical Machining (ISEM)' Procedia CIRP 6 2013 page no. 521 – 526.

[8] Vivek Zolekar, Dr. L.N. Wankhade, "Finite Element Analysis and Optimization of I.C. Engine Piston Using RADIOSS and OptiStruct", published in „altair technology conference india. 2013

[9] He Bin, "Multi-Constraint Topology Optimization of Forging Machine Bed for Light Weight Design", published in „International Journal of Advancements in Computing Technology (IJACT)", Volume5, No.9, May 2013.

[10] H.B.Ramani, Neeraj Kumar, "Using Shape Optimization Tool in Ansys Software for Weight Reducation of Steel Connecting Rod", Engineering Research & Technology (IJERT)", Vol. 2 Issue 2, February-2013, ISSN: 2278-0181

[11] Malleswara Swami and K.SunilRatna Kumar,"Design and structural analysis of CNC vertical milling machines", Published in „International Journal of Advanced Engineering Technology", IJAET/Vol.III/ Issue IV/Dec. 2012/97-100.

[12] Rinkle Garg and Sunil Baghla, "Finite Element Analysis and Optimization of Crankshaft Design", Published in „International Journal of Engineering and Management Research", Vol.-2, Issue-6, December 2012, ISSN No.: 2250-0758, Pages: 26-31.