Optimization of Weight of Cable Duct

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Abstract- Optimization of weight of cable duct is a value engineering project. This paper gives idea about cost reduction of component without affecting its function and quality. There are different ways to reduce the cost of component like weight reduction, optimizing design, alternative material, change manufacturing process etc. In this paper we consider weight reduction of material to reduce the cost of component. We made 3-D model of component by using UG NX6 CAD software. We calculate the deflection of part (Theoretical calculation) under loading condition of UDL for reduced thickness part. Again we verify with ANSYS 14 software. Vibration was major dominant factor so we measure the vibrations of the part by vibration pen. We found vibrations are within tolerance as per ISO 10816-3.

Keywords-Value Engineering, Vibration Measurement, Manufacturing Cost, 3-D software UG NX, Von Miss stresses, ISO 10816-3, Accerlation Integrated sensor.

INTRODUCTION

Value engineering is a scientific approach to reduce the cost of component without affecting its function and quality. This research investigates by reduction of weight of material we can reduce the cost of component as in manufacturing industries 70% cost reflects raw material cost and 30% is processing cost. Cable duct is a basically "C" section channel which is used for carrying the cables (see Fig-1) & it is structural part of a machine. It is basically assembly of 2 part top and bottom part (see fig-2). In existing design bottom part is having thickness of 3mm while top part has thickness of 1.5 mm.

Fig 1: Cables carrying Cable Duct

The maximum weight of cables in duct is 10kg by considering factor of safety 1.3. Reducing the thickness by 50% we found very little deflection in part. Vibration is major dominant factor in machine. Machine spindles running @ speed of 20000 rpm. We compare vibration of existing part with reduced part thickness and found vibrations are well within tolerance as per ISO 10816-3. We measure vibration in mm/sec as it indicates fatigue strength of the part. Vibrations are measured by piezoelectric accerlated integrated sensor. We did its transportation trial also as machine goes to different zones of the world.

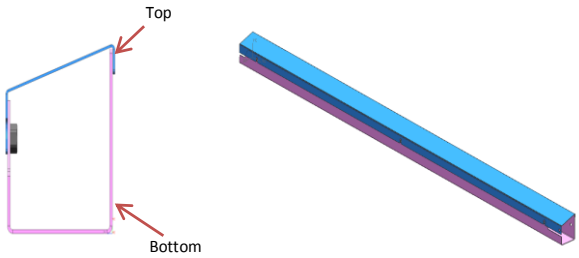

Fig 2: Assembly view of Cable Duct

ANALYSIS TECHNIQUE

First step of project was making 3-D model of part using UG NX software (see Fig-3). Same we imported in ANSYS in IGES format. Cable Duct part then meshed using tetrahedron elements. All required data filled in ANSYS software.

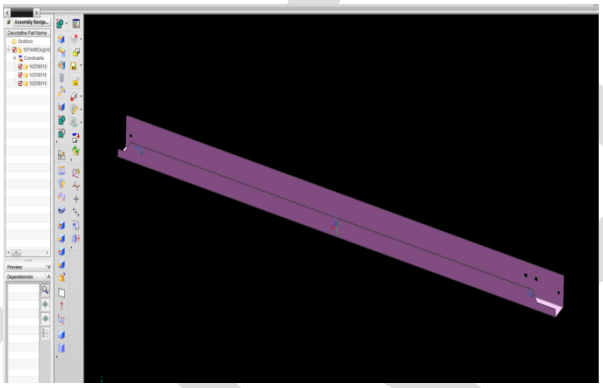

Fig 3: IGES Model for Cable Duct bottom

On existing design we found maximum deflection is 0.3 mm and von miss stress is 52 MPa (see fig-4).

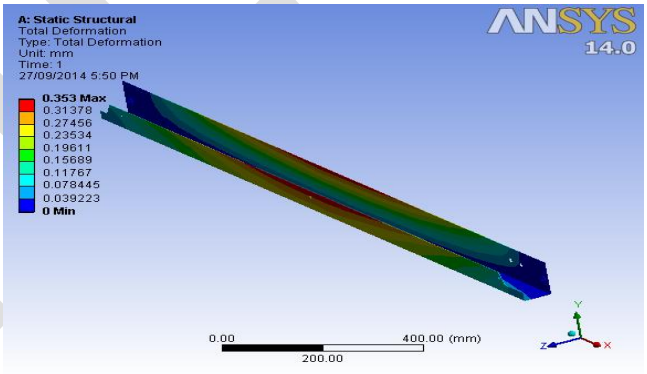

Fig 4: Max. Deflection of part for 3mm thick sheet

while in newly design part, we found 0.56 mm deflection and 64 MPa von missed stresses (see fig-5) are develop when part is under loading condition which is lesser than yield strength of the steel part

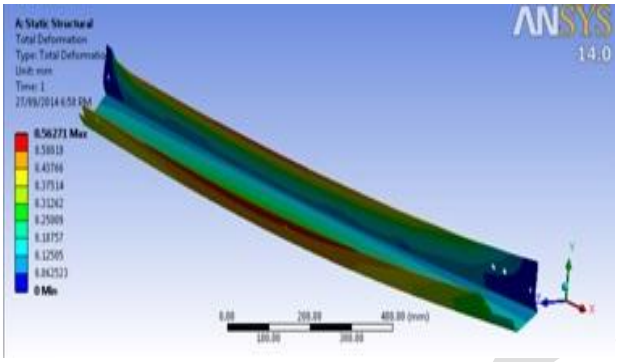

Fig 5:Max. Deflection of part for 1.5 mm thick sheet.

DESIGN OF EXPERIMENT

Vibration Trial

In order to take vibration reading we use piezoelectric accerlated integrated sensor (vibration pen). Vibrations readings are taken in mm/sec which indicates fatigue strength of the part. We ran our machine @ different speed and take readings at 6000, 10000, 15000 and 20000 rpm. As part length is long nearly 1.7 m so we take readings at 3 positions like @ starting point, middle point & End point of cable duct & we name it as position 1, position 2 and position 3 respectively.

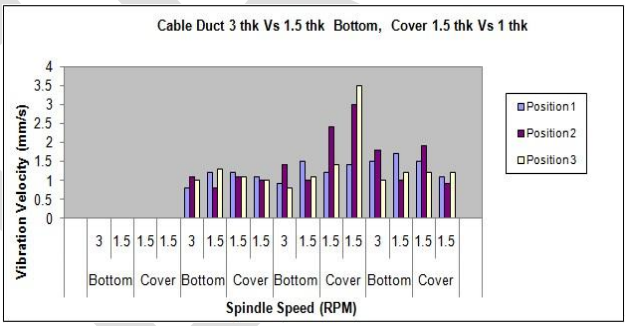

Fig 6: Vibration reading for Left side of machine

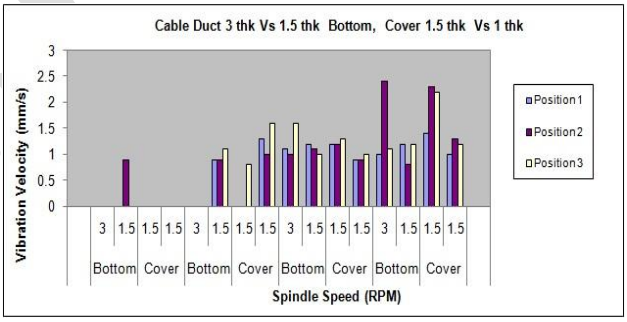

Fig 7: Vibration reading for Right side of machine

Above graph clearly shows that maximum vibration on newly design part is 2.5mm/sec which is well within the tolerance as per ISO 10816-3

Transportation Trial
We also taken transportation trial of the part as machines goes to different regions of the world. We find appropriate solution (see fig – 7) in order to avoid bent of the part during transportation

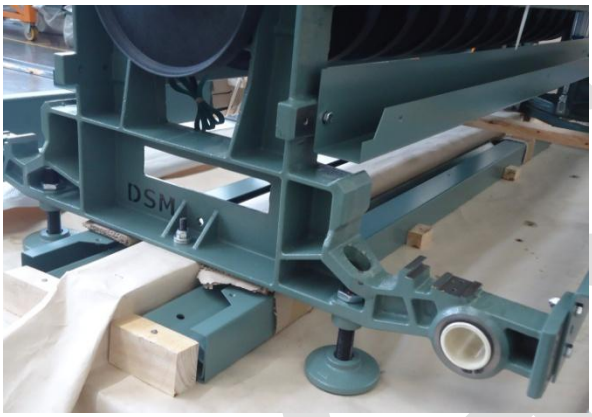

Fig 8:Packing with four wooden supports

MANUFACTURING COST COMPARISON

Costing of Bottom Cable Duct Part

Table No-1 shows manufacturing cost of existing part. Cost of any part calculated on hourly basis of consumption. Any process cost is divided into 3 steps.

1. Machining Setup Time
   It is time required to setting all the parameters of the machine in order to start the manufacturing of the part which includes tooling change, RM put up, programming etc.

2. Machining Time
   It is time require to do machining on the part. It can be also called as a processing time for manufacturing the part

3. Labour Time
   It is time consumed by operation in order to manufactured one part.

Existing Bottom part is manufactured by Laser Cutting-Straightening-Tapping-Bending-Powder coating. (Table No-1)

Sr. No	Operation	Resource	Time requitred in hr	Value INR	Break up
1	sheet 3x1250x2500	10592148	9.27Kg	478.44	
2	Laser Cutting	45212	0.001	2.47	Machiniing Setup Time
			0.03	51.5	Machining Time
			0.06	5.89	Labour Time
	Operation 0010		0.091	59.86	
3	Straightning	45214	0.001	1.12	Machiniing Setup Time
			0.005	2.96	Machining Time
			0.014	1.12	Labour Time
	Operation 0020		0.02	5.2	
4	Tapping	45217	0.001	0.09	Machiniing Setup Time
			0.008	2.66	Machining Time
			0.008	1	Labour Time
	Operation 0030		0.017	3.75	
6	Bending	45215	0.001	0.27	Machiniing Setup Time
			0.009	6.35	Machining Time
			0.014	1.42	Labour Time
	Operation 0040		0.024	8.04	
7	Powder coating	45219	0	0	Powder coating setup time
			0.006	45.96	Powder coating time
			0.046	4.47	Labour time
	Operation 0050		0.052	50.43	
8	Material over heads	45121		9.57	Administration
			Total Manufacturing Cost	615.29	

Table 1: Manufacturing cost of 3mm thick old bottom part

Sr. No	Operation	Resource	Time requitred in hr	Value INR	Break up
1	sheet 1.5x1250x1750	10709966	4.75Kg	207.8	
2	Laser Cutting	45212	0.001	2.47	Machiniing Setup Time
			0.022	38.84	Machining Time
			0.045	4.44	Labour Time
	Operation 0010		0.068	45.75	
3	Straightning	45214	0.001	1.12	Machiniing Setup Time
			0.005	2.96	Machining Time
			0.014	1.12	Labour Time
	Operation 0020		0.02	5.2	
4	Nut welding	45216	0.001	0.56	Machiniing Setup Time
			0.017	4.93	Machining Time
			0.023	2.4	Labour Time
	Operation 0030		0.041	7.89	
5	Hexsgonal weld nut	10259616	-	1.44	3pcs
6	Bending	45215	0.001	1.23	Machiniing Setup Time
			0.009	6.35	Machining Time
			0.014	1.42	Labour Time
	Operation 0040		0.024	9	
7	Powder coating	45219	0	0	Powder coating setup time
			0.006	60.75	Powder coating time
			0.046	4.47	Labour time
	Operation 0050		0.052	65.22	
8	Material over heads	45121		4.21	Administration
			Total Manufacturing Cost	346.51	

Table 2: Manufacturing cost of 1.5mm thick new Bottom part

Costing ofTop Cable Duct Part

Manufacturing cost of newly design part is shown in Table No-2. As we reduced the thickness engagement of threading of part become less so we induced weld nut for bottom part. Due to use of weld net threading engagement becomes more.

Manufacturing process for newly design part is Laser Cutting-Straightening-Nut Welding-Bending-Powder coating.

Sr. No	Operation	Resource	Time requitred in hr	Value INR	Break up
1	sheet 1.5x1250x1750	10709966	2.84Kg	133.9	
2	Laser Cutting	45212	0.001	0.1	Machiniing Setup Time
			0.02	37.51	Machining Time
			0.04	4.29	Labour Time
	Operation 0010		0.061	41.9	
3	Straightning	45214	0.001	0.97	Machiniing Setup Time
			0.005	2.97	Machining Time
			0.014	1.12	Labour Time
	Operation 0020		0.02	5.06	
6	Bending	45215	0.001	0.1	Machiniing Setup Time
			0.01	6.35	Machining Time
			0.014	1.42	Labour Time
	Operation 0040		0.025	7.87	
7	Powder coating	45219	0	0	Powder coating setup time
			0.006	35.4	Powder coating time
			0.046	4.47	Labour time
	Operation 0050		0.052	39.87	
8	Material over heads	45121		4.21	Administration
			Total Manufacturing Cost	232.81	

Table 3: Manufacturing cost of 1.5mm thick old top part

Sr. No	Operation	Resource	Time requitred in hr	Value INR	Break up
1	sheet 1x1250x1750	10756705	1.90Kg	82.76	
2	Laser Cutting	45212	0.001	0.19	Machiniing Setup Time
			0.02	35	Machining Time
			0.04	4	Labour Time
	Operation 0010		0.061	39.19	
3	Straightning	45214	0.001	0.97	Machiniing Setup Time
			0.005	2.97	Machining Time
			0.014	1.12	Labour Time
	Operation 0020		0.02	5.06	
6	Bending	45215	0.001	0.1	Machiniing Setup Time
			0.01	6.35	Machining Time
			0.014	1.42	Labour Time
	Operation 0040		0.025	7.87	
7	Powder coating	45219	0	0	Powder coating setup time
			0.006	60.75	Powder coating time
			0.046	4.47	Labour time
	Operation 0050		0.052	65.22	
8	Material over heads	45121		4.21	Administration
			Total Manufacturing Cost	204.31	

Table 4: Manufacturing cost of 1mm thick newtop part

RESULT AND DISCUSSION

The study of ANSYS shows that if we change the thickness of the part then it will not affect function of the part. Deflection and stresses developed on the part are well below than yield strength of the part. Also all transportation trials are ok.The basic agenda of this project is to having cost reduction in part by reducing its thickness. Using ANSYS software we calculate deformation of part under loading condition. Vibration analysis also done with the help of Vibration pen by SKF. Result of ANSYS software & vibration analysis is within safe zone.

Following points are observed

1. Present cost of Cable duct part (top + bottom):- INR 848.1 /-
2. Cost of the part after weight reduction of cable duct (top + bottom):- INR 550/-
3. Approximate cost saving per part :- **INR 298/-**
4. No. of parts used in machine (top + bottom):- 60
5. Approximate cost saving per machine:- **INR 17880/-**

Vibration analysis is also found within the limit as per standard ISO 10816 – 3.

Deformation of part under loading condition also found negligible & which will not affect the functionality of the part. Inside area of cable duct channel we kept same so volume of cable duct with new design & old design will remain same.

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CONCLUSION

This project was carried out with the aim of reduction of cost for machine. By doing analysis of part after reducing the thickness we reduce the cost. We also save 6kg of raw material steel per assembly which saves natural resources also. With the help of all above data we conclude that we can reduce the cost of component by value engineering method.

REFERENCES:

[1] Peter KO' Farrell, August 2010 "Value engineering in Construction Project management " Waterford institute of technology
[2] Susan helper (working paper 6033), may 1997 "Complementarily and cost reduction evidence from auto supply industry " western reserve university
[3] V. Srinivasan, July 2005 "Impact of cost unit reduction on gross profit : Increase or Decrease return? " Stanford university
[4] Sara Yngvesson, 2007"planning cost reduction event with the aim of reducing of assembly time" Chalmer university of Technology
[5] Jayashankar M. SwamiNathan, 2001"Product line design with component commonality and cost reduction effort" University of north Carolina
[6] Dennis H. Shreve, 1994" Introduction to vibration technology" IRD Mechanalysis, Inc. Ohio-43229
[7] International standard organization, ISO standard 10816, machinery groups in vibration measurement process
[8] International standard organization, ISO standard 2954, machinery groups in vibration measurement process"1954
[9] AUSTIN, S.A. and THOMSON, D.S., 1999. Integral value engineering in design. Proceedings of COBRA 99 Conference, RICS, Salford, September 1999
[10] Jessup, S., Mitchell, C. (2013) :Developing a standard approach to the Value Engineering process for the Civil Engineering Industry: A Theoretical, Case Study and Industry Perspective. CEEC General Assembly Brussels 25-27 April 2013
[11] A Survey on the Application and Role of Value Engineering in Pars Simin Chemical manufacturing company (the manufacturing unit of Pars Simin white plastic paints) Seyed Mohammad No' Pasand Asil1, EsmaeilRamzanpour
[12] APPLYING VALUE ANALYSIS TO A VALUE ENGINEERING PROGRAM Paper for AAHSTO VE Conference 1999 Ken L. Smith, PE, CVS Value Engineering Manager
[13] A Functional Basis for Engineering Design: Reconciling and Evolving Previous Efforts by Julie Hirtz,Stone, Daniel A. McAdams, Simon Szykman, and Kristin L. Wood
[14] ON THE AGENDA OF DESIGN MANAGEMENT RESEARCHby Glenn Ballard1 and Lauri Koskela