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CHANGE IN DESIGN OF HANDLE SUPPORT FOR COST REDUCTION AND MANUFACTURING PROCESS OPTIMIZATION

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***Abstract*—Optimization of manufacturing process and cost reduction are two main factors each organization plans to achieve. Achieving these goals require knowledge about the manufacturing process and all parameters which affect manufacturing.Working on solving problems in optimization of manufacturing process ultimately helps to reduce the cost of manufacturing and in turn the cost of product with improvement in sequence of processes. The following project is carried out for designing the handle support for all ratings of electric breakers. Project was carried out by first defining general background, actual problem, existing manufacturing method, change in design, analysis of parameters which affect design, design analysis, decision, costing, implementation and conclusion. The design analysis was carried out with help of CATIA software. The outcome of project resulted in savings for the organization and also helped to improve the function of product with optimization of manufacturing processes.**

***Keywords*—Optimization, Von Mises Stress, Translational Displacement, Deformation, Impact Factor.**

I. INTRODUCTION

The function of handle support is to support the weight of handle and reaction of components attached to it. It must support the trip rod link and not deform under its own weight, applied forces and torque. The following project is carried out for designing the handle support for all ratings of electric breakers. The handle support for all range of electric breakers is same. The idea behind project was that the two functions of handle support could be fulfilled by two separate components. These will help in reduction of bulky size, reducing the cost of material, manufacturing cost and also optimizing the manufacturing process. The scope of project is limited to electric breakers since considering several parameters like space, supporting links cannot be applied in case of manual breakers.

Changes in design helped to achieve optimization of manufacturing process and cost reduction. The problems encountered were the cost of product, excess of manufacturing process, time for manufacturing and scope of improvisation in the function of product.

II. PROBLEMS WITH EXISTING DESIGN

- Cost of purchasing:

Cost of 1 handle support of electric breaker is Rs.71.527. Cost of manufacturing can be reduced through efficient design.

- Cost of material and amount of material

Current rate of mild steel is Rs.48.50 per kg. Weight of existing electric breaker handle support blank is 0.548kg which accounts to Rs.26.578 per blank.

- Excess of manufacturing processes

Various manufacturing processes carried out are [3]:

- Blank cutting with help of sawing operation

Cutting the blank of dimension 133mm*26mm*21mm Total 2 processes

- Shaping

Total 7 operations 6 for surfaces and 1 operation to incorporate handle curvature and restrict motion

- Drilling

Total 9 processes

- Threading

Total 3 processes

- Zinc Plating

Total 1 process

III. EXISTING DESIGN OF HANDLE SUPPORT AND TRIP ROD

The following two diagrams show the existing design of trip rod and handle support [2]

Fig. 1 Trip rod

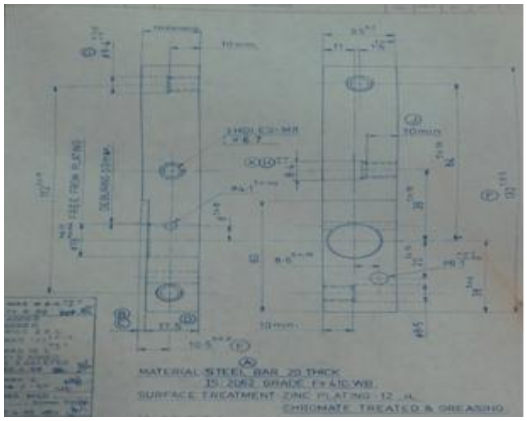

Fig. 2 Existing Handle support

IV. CHANGES IN DESIGN[7][8][9]

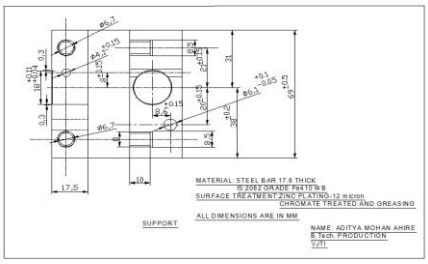

Fig. 3 New Handle support Design

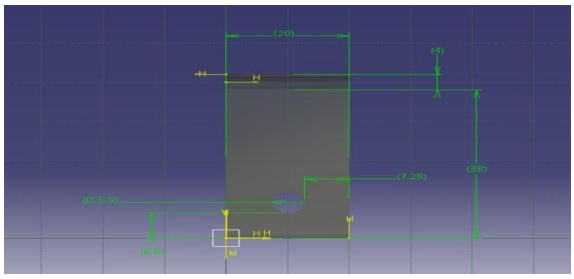

Fig. 4 Front View of Trip Rod Support

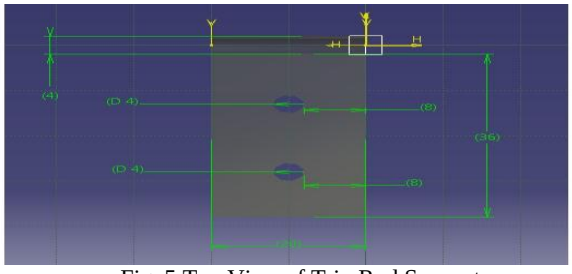

Fig. 5 Top View of Trip Rod Support

V. FORCE ANALYSIS

Force analysis diagram shows the forces acting on handle and trip rod support.

Forces acting on handle support are as follows:

g- Universal gravitational constant

TABLE I
FORCE ANALYSIS OF HANDLE SUPPORT [4]

Sr. No	Weight Parameter	Value(N)	Quantity	Symbol
1	Handle support weight	1.69	1	W
2	Gruber pin diameter 6.1mm	0.039	1	P
3	Gruber pin diameter 4.1mm	0.014	1	Q
4	Component of weight of handle support link	1.01	1	R
5	Clamping force or force at bolts	1.376	2	N

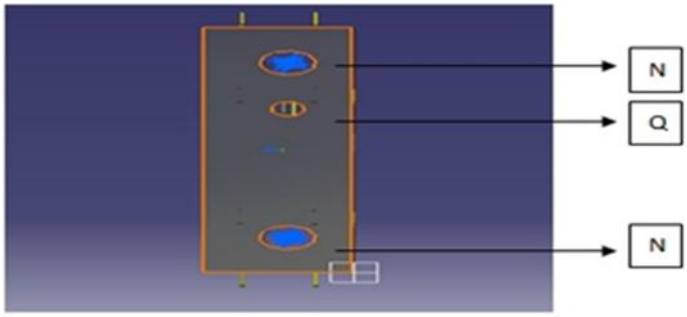

Fig. 6 Force Analysis of Handle Support from Front View

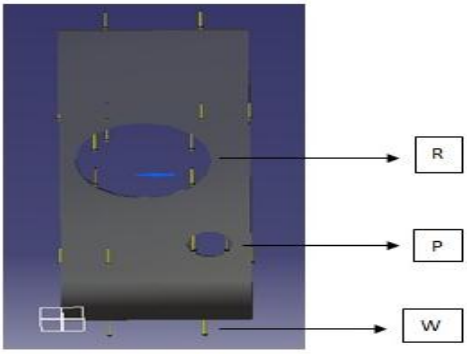

Fig. 7 Force Analysis of Handle Support from Side View

Forces acting trip rod support are as follows:

g- Universal gravitational constant

TABLE II
FORCE ANALYSIS OF TRIP ROD SUPPORT [4]

Sr. No	Weight Parameter	Value(N)	Quantity	Symbol
1	Trip rod support	0.276	1	W
2	Reaction force at 5.5mm diameter	0.105	1	P
3	Clamping force or force at bolts	0.191	2	N

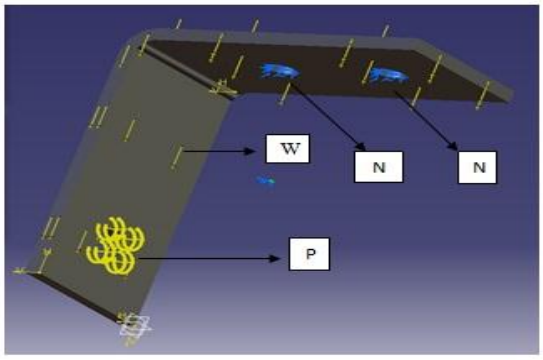

Fig. 8 Force Analysis Diagram of Trip Rod Support

Torque value is variable. In design analysis, torque value considered is 5 N-m.

VI. Manufacturing of New Handle Support for Electric Breaker

Material of handle support: Steel IS: 2062 Grade Fe 410 WB [5]

The manufacturing sequence is as follows [1]:

- Blank cutting
- Shaping
- Drilling
- Threading
- Zinc plating

This completes the manufacturing process of handle support.

VII. Manufacturing of Trip Rod Support

The basic dimension of blank is 42mm*20mm*2mm [5]

The manufacturing sequence is as follows [1]:

- Piercing
- Blanking
- Bending
- Plating

VIII. Optimization of Manufacturing Process

TABLE III

Optimization of Manufacturing Process

Process Name	Existing manufacturing process quantity	New manufacturing process quantity
Blanking	1	1
Shaping	7	6
Drilling	8	7
Threading	3	2
Zinc Plating	1	1
Total time for manufacturing 1 job (hrs)	0.366666	0.308833

IX. Design Analysis of Handle Support

The design analysis is carried out with the help of CATIA software [6]

The scale of deformation is exaggerated to see the deformation. The factor of deformation in terms of maximum displacement is increased. The handle support appears a bit deformed at the section where handle rests.

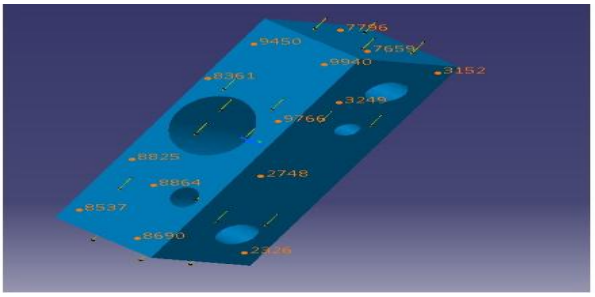

Fig. 9 Deformation Analysis of Handle Support

All the value in critical section of analysis as well as remaining regions lies within the 440Mpa value. Stress doesn't exceed beyond the permissible value and hence, design is safe.

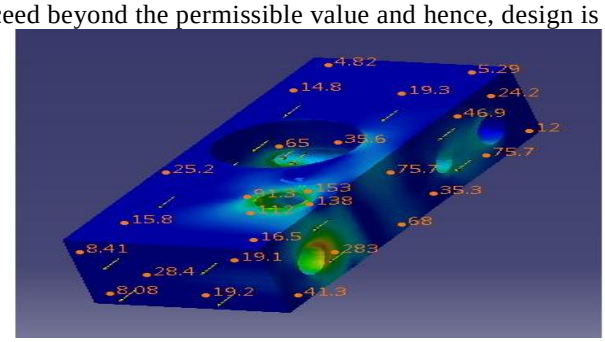

Fig. 10 Von Mises Stress Analysis of Handle Support

As per design and standard specification the allowable displacement value is 0.5mm. Since all the values in analysis lie within the 0.5mm value, design is safe.

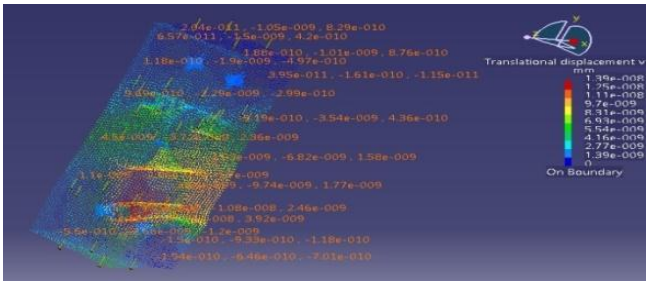

Fig. 11 Translational Displacement Analysis of Handle Support

X. Design Analysis of Trip Rod Support

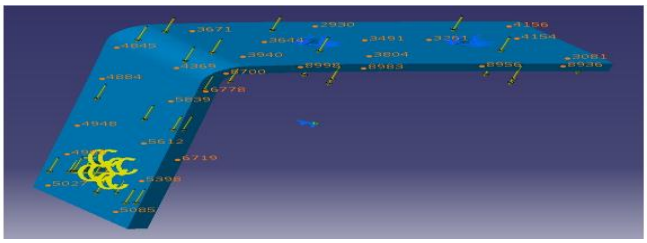

Fig. 12 Deformation Analysis of Trip Rod Support

All the value in critical section of analysis as well as remaining regions lies within the 440Mpa value. Still, the stress doesn't exceed beyond the permissible value and hence, design is safe.

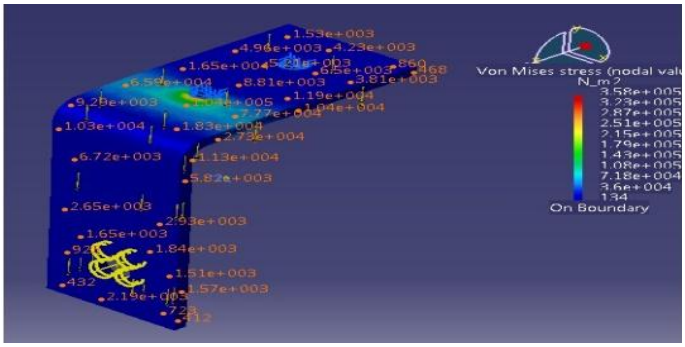

Fig. 13 Von Mises Stress Analysis of Trip Rod Support

As per design and standard specification, the allowable displacement value is 0.5mm. Since, all the values in analysis lie within the 0.5mm value, design is safe.

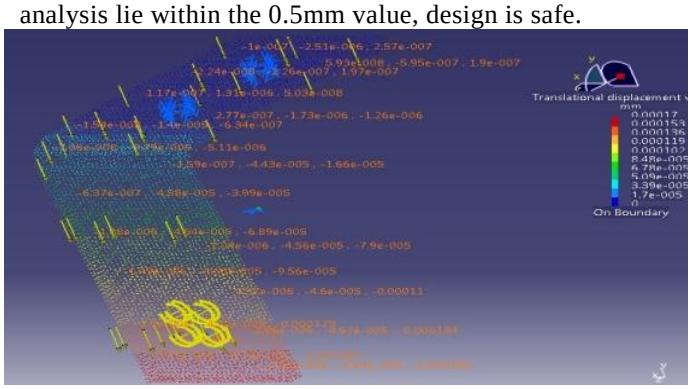

Fig. 14 Translational Displacement Analysis of Trip Rod Support

XI. COSTING

TABLE IV
COSTING OF EXISTING, NEW HANDLE SUPPORT AND L BRACKET

Parameters	Value	Handle Support(Existing)	Handle Support(New)	L Bracket
RM Rate/kg		48.5	48.5	48.5
Blank weight KG		0.548	0.227	0.02515
Net Weight KG		0.403	0.169	0.02341
Scrap Weight KG		0.145	0.058	0.00174
Scrap cost in Rs	20	2.9	1.16	0.0348
Raw material rate		23.678	9.8495	1.184975
CONVERSION				
Shift rate		480	480	350
Break hours	1			
Number of working hours	7			
Shift rate per hour		68.57142857	68.57142857	50
Machining time/piece (hrs)		0.366666	0.308833333	0.004861
Machining cost		25.14281143	21.17714285	0.243056
Plating cost/kg	14	5.642	2.366	0.32774
Production cost/piece		54.46281143	33.39264285	1.755771
Overhead + 97% efficiency		0.923544343	0.706294286	0.017124
Packaging per kg cost	4	1.612	0.676	0.09364
Profit	12%	3.694177371	2.825177143	0.068495
Cost		60.69253314	37.60011428	1.93503
Excise duty	12%	7.283103977	4.512013714	0.232204
Education cess	2%	0.14566208	0.090240274	0.004644
Sub total		68.1212992	42.20236827	2.171877
VAT	5%	3.40606496	2.110118414	0.108594
Final rate/piece		71.52736416	44.31248668	2.280471

A. *Impact cost and factor calculation*

TABLE V
SAVINGS AND PROFIT PERCENTAGE CALCULATION FOR NEW HANDLE SUPPORT DESIGN AND L BRACKET

Parameters	Handle support(existing)	Handle Support(new)	L Bracket
Cost	71.52736416	44.31248668	2.280471
GMCR	9313	9313	9313
Total annual cost	666134.3424	412682.1885	21238.03
Handle support(existing) cost			909184.3
Handle Support(new) and L Bracket combined cost			433920.2
Savings			475264.1
Profit or cost cutting (%)			52.27368

GMCR- Gross mean consumption rate for year 2013

XIII CONCLUSION

The objective of project was to optimize the manufacturing process, improve design and reduce the cost of product. These entire objectives have been satisfied by carrying out the analysis. The optimization of manufacturing process is obtained by improving sequence of manufacturing processes, reducing the number of operations used in manufacturing thereby reducing the cost of manufacturing and manufacturing time. Design is safe since from deformation analysis diagram, stress analysis diagram and displacement diagram it can be assured that all these parameters are well within the prescribed critical values. Cost of the handle support is reduced with estimated savings per year value of Rs. 475264.1081 and profit percentage of 52.274%

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