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Analysis and Optimization of Fixture for the Welding Of Automotive and Non-Automotive Components

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Abstract: The present work consists of welding fixtures which are designed for the components which are difficult to weld in the normal way or without any holding unit. Researching the possibilities for fixture design optimization has been in the sphere of interest of a number of authors worldwide for a longer period. Fixture design process and fixture design technique with conventional methods has been obsolete. This paper presents a review of fixture design analysis and optimization in terms of fixture layout, clamping position and part deformation. In any given manufacturing industry lots of non-standard unit or components required to complete the given fixture. These non-standard unit are adding to the design cost and time, and also libraries for non-standard parts cannot be made which gives no other option than to redesign the given part or unit. These non-standard parts are required in all types of industries, like BIW, heavy, construction machinery, aerospace, and rail. In this paper optimization of this non-standard unit will be done.

Keywords: Welding Fixture, Analysis, Optimization, Fixture Design, Standard unit.

I. INTRODUCTION

The fixture is utilized to find, bolster and totally compel the workpiece amid machining. The outline of fixture that licenses precise machining of the workpiece by keeping the commitment of workpiece/apparatus versatile twisting to the machining blunder inside the predefined resilience is a basic stride in process arranging. A critical part of apparatus configuration is the improvement of the fixture design, i.e., places of locators and clips, and bracing powers, with the end goal that workpiece twisting because of cinching and machining strengths is minimized.

The fixture is a kind of major tooling which is utilized all through assembling, get together, examination and different operations to frame and secure the required position and introduction of the workpiece as required by outline determinations.

Appropriate apparatus configuration crucially affects item quality as far as exactness, precision and complete of the machined part. Around 40% of the rejected parts are brought about by dimensioning errors which are identified with poor apparatus plan.

II. LITERATURE REVIEW

Optimization of Machining fixture layout is done using the genetic algorithm method that minimizes the deformation of the machined surface due to clamping and machining forces over the entire tool path: The paper discussed two variations of the application of the GA to the fixture layout optimization problem. The fixture layout synthesis problem described in this paper is a typical example of such a problem [1].

Design and Analysis of Work Holding Fixture: In existing design, the fixture set up is done manual, so the aim of this project is to replace with the fixture to save time for loading and unloading of the component. In this project, modeling is done using solid works and Static analysis of the model is done in order to solve the problem formulation. It reduces or sometimes eliminates the efforts of marking, measuring and setting of work piece on a machine and maintains the accuracy of performance. The work piece and tool are relatively located at their exact positions before the operation automatically within negligible time. Semi-skilled operators can be assigned the work so it saves the cost of manpower also. There is no need to examine the quality of produce provided that quality of the employed fixture is ensured [2].

Optimization of machining fixture layout for tolerance requirements under the influence of locating errors is done: This paper proposes a Genetic Algorithm (GA) based optimization method to arrive at a layout of error containing locators for minimum machining error satisfying the tolerance requirements and providing a deterministic location. A three-dimensional work piece under the 3-2-1 locating scheme is studied. Results indicate that by optimally placing the error containing locators the geometric error component of the machining error can be substantially reduced thus enabling compliance with overall dimensional requirements. The model presented here is generic in the sense that the same can be applied to any critical feature of the workpiece by choosing appropriate datum points. The fixture layout would be optimized so as to minimize the overall machining error. In this work, the locators are assumed to contain an error in their normal direction [3].

The Iterative Fixture Layout and Clamping Force Optimization are done using the Genetic Algorithm: This paper presented a GA-based iterative fixture layout and clamping force design optimization procedure for a complaint workpiece. It highlights the interdependence of the layout and clamping force optimization steps. This interdependence is illustrated via a 3-D milling fixture design optimization example problem. It is shown that the reduction in workpiece from error induced by elastic deformation during clamping and machining is considerably larger with the iterative procedure than with the layout or clamping force optimization alone [4].

Design, Development, and Analysis of Hydraulic Fixture for machining Engine cylinder block on VMC: In this paper, the design requirements of the fixture were studied and according to that two types of CAFD had done in CATIA V5. Verification of the fixture design is carried out using ANSYS workbench. Meanwhile clamping forces are calculated at 40, 50 and 60 bar hydraulic pressure by using analytical and numerical methods which are validated and are taken into consideration during the static analysis of the fixture and cylinder block, so from FEA result the 1st type of fixture assembly design is to be considered for manufacturing the final fixture system. Also, the FEA results of total deformations for 1st type fixture design model are validated by comparing results from experimental tests carried on fixture cylinder block, so from validation results for total deformation by FEA and Experimental tests are near equals. Hence we conclude that results values of total deformations and von-mises stresses from FEA are true. Means the fixture is accurately designed analyzed and manufactured [5].

Fixture Design Automation and Optimization Techniques: Review and Future Trends are studied. This paper presents a literature review in computer aided fixture design (CAFD) in terms of automation and optimization techniques over the past decades. First, the reason behind the necessity of automated fixture design is stated. According to the degree of automation, fixture design methods are then categorized based on significant works done in the CAFD field. Regarding the need of automated fixture design systems, optimization techniques, which are mostly used for automated CAFD methods, are closely considered. The significant optimization techniques are then studied in the case of applications and working principles. At the end, the current weaknesses of the existing methods and the research fields, which require deeper studies as future trends are presented as well [6].

General shortcomings in CAFD can be as follows:

- Along with the research maturity, considerable CAFD research needs to be conducted to develop more automated comprehensive functioning systems in order to support the total fixture development process automatically.
- Most of the CAFD methods have been verified for simple workpieces which are not representative of those combated in industry; hence, the helpfulness of developed approaches cannot be stated with confidence.

A Review of Design and Analysis of Work Holding Fixture: The aim of this project is to replace with the fixture to save time for loading and unloading of the component. The fixture provides the manufacturer for flexibility in holding forces and to optimize the design for machine operation as well as process function ability. The operating conditions like speed, feed rate and depth of cut can be set to higher values due to the rigidity of clamping of work piece by the fixture. Operators working become comfortable as his efforts in setting the work piece can be eliminated. Semi-skilled operators can be assigned the work so it saves the cost of manpower also. There is no need to examine the quality of produce provided that quality of the employed fixture is ensured [7].

Development, Fabrication and Analysis of Fixture are done: Considering the static forces over the component which is in contact with the fixture is analysed, it shows the total deformations and the stresses acting on the fixture during the machining process done on the fixture. Hence these results indicate that the design is well within the safe limits. Hence the design is safe [8].

Computer aided fixture design: Recent research and trends are done. Recent achievements in the development of computer-aided fixture design methodologies, systems and applications have been examined in this paper. Fixture design still continues to be a major bottleneck in the promotion of current manufacturing, though numerous innovative CAFD techniques have been proposed. Those techniques also need time to be tested and evaluated in real manufacturing environments and integrated with other product and process design activities. Therefore, several research aspects are promising and challenging [9].

Design and Finite Element Analysis of JIGS and Fixture for Manufacturing of Chassis Bracket are obtained: This project is about the design and analysis of Jigs and fixture which is used in the manufacturing of chassis bracket of Bajaj car RE60 (passenger car). So in this project, they were design jigs and fixture while manufacturing of chassis bracket and analyzing stress and strain developed in jigs and fixture and chassis bracket. In this, they minimized the different problem of breakage of jigs and fixture. By performing analysis on jigs and fixture they find out stress acting on jigs and fixture and bracket [10].

III. METHODOLOGY

The technique is a deliberate approach for acknowledgment of aggregate assignment. It comprises of taking after subtle elements:

- Study of components: The investigation of the segment is the most imperative and the initial step for the originator. The segment drawings are deliberately investigated to extricate the most extreme conceivable data. The vital data accessible is the basic measurements, finding and clips territories.
- Geometric model of components: Geometric displaying of the segment is as of now done utilizing Solid Edge considering all the basic measurements.

- Step by step design calculations: It is done to decide the different plan parameters that decide drive instigated on the segment amid welding operation.
- Solid modeling of the tool: 3-D displaying of the whole Component is done utilizing Solid Edge programming. For the better comprehension of 2D drawings and perception, demonstrating has been as of now done. The required measurements are controlled by computation, which is utilized amid demonstrating of the device.
- Analysis: a Structural investigation will be conveyed utilizing ANSYS programming to decide the aggregate disfigurement and the anxieties initiated in the fixture amid operation.
- Optimization: After investigation of the fixture unit, as indicated by the need they will be upgraded and institutionalized. What's more, Optimized Models will be re-made utilizing Solid Edge.

The unit as shown in fig.1 is the clamping unit which is used in a welding fixture. This unit is used for supporting, proper fitting, locating, leveling of the component etc. As studied these unit are used in repeated and large numbers. Because of repeated and regular use of these types of the unit or similar unit time needed for design and manufacturing is a major problem, therefore, they need to standardize for saving the time of different designs and manufacturing of this repeating unit. This unit is categories in different varieties like heavy, medium, and low duty fixture. The classification is done according to the weight of the component or loading condition like in between 1-5 tones, 5-10 tones etc.

There is need to design and optimize this unit in software like ANSYS, Hypermesh etc. software. After optimization is completed, the ready model is run under different loading conditions in between specific weight of the component. Finalize the obtained design if errors are negligible and fixture withstands the stresses developed from loading.

TABLE I
DETAILS OF CLAMPING UNIT FIXTURE USED

Sr. No.	Assemblies	Weight	Height	No. of unit	Component weight
1	Project I	23.81	345.15+…	4	294
2	Project II	10.1287	432	2	83
3	Project III	10.41	302+…	2,2	5.79
4	Project IV	13.68	428.21	1	4.25
5	Project V	9.12	424	1	4.25
6	Project VI	24.2	408.48	2	1041.34

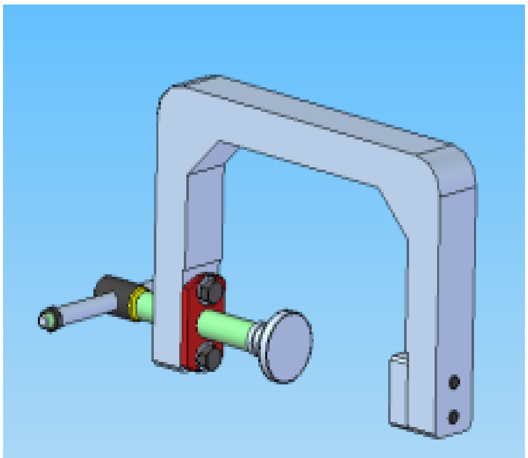
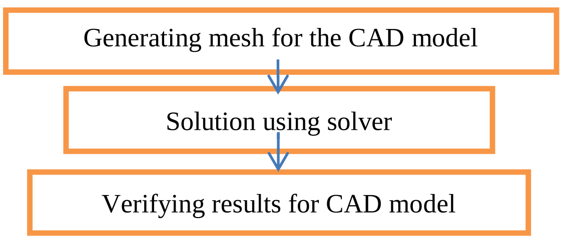


Fig. 1- Clamping Unit (C-Clamp)

IV. ANALYSIS



Structural analysis will be carried using Solid edge software to determine the total deformation and the stresses induced in the fixture during operation.

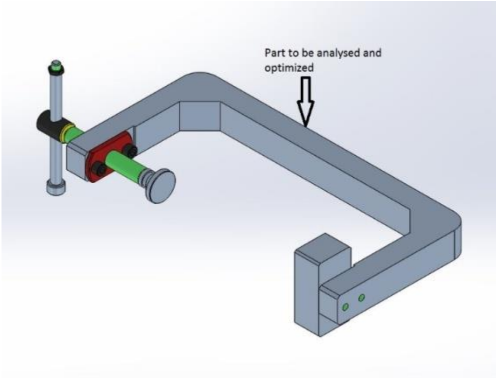


Fig.3 Clamp unit I

These are a special type of fixture unit, to design these separately aside from the simple unit can very time-consuming. This non-standard unit can be standardizing and there is a lot of this unit in every fixture assembly. According to a maximum weight of the components, the highlighted parts are to be modified according to optimization.

Generating Mesh for cad models

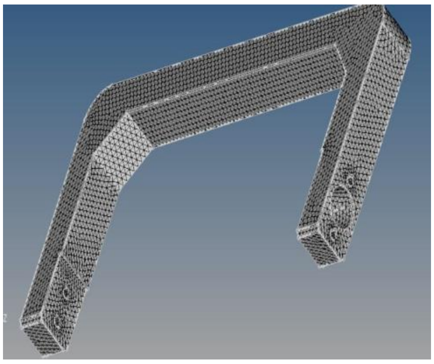


Fig.2 Part I-Clamp unit I mesh

The mesh for all these clamp unit parts is generated in Hyperworks. Minimum sizing of 4mm was generated after giving mesh to the model. These unstructured Mesh elements comprised of a tetrahedral mesh. With mesh enhancement tool fine elements of a minimum length of 0.8 mm are generated. Feature angle generated is 30 degrees.

TABLE 2: BOUNDARY CONDITIONS

Sr. No.	**Name of the component**	**Applied Constraint on(6 DOF)**	**Force (Kgf)**
1	Clamp unit IV Part	On right sided area	2 (to the left side of - Z direction)

V. RESULTS AND DISCUSSIONS

Structural analysis:

Figures given below indicate contour plots of von mises stress after structural analysis. The analysis is carried out in HyperWorks software using Optistruct as a Solver. Von - mises stress obtained from the analysis are used as stress constraint for optimization.

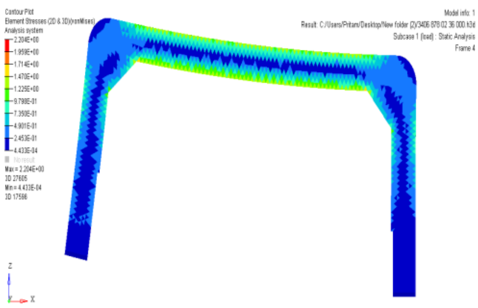


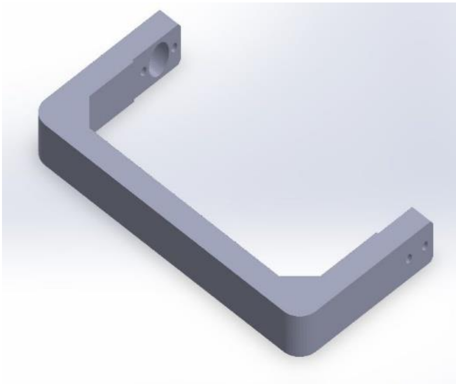
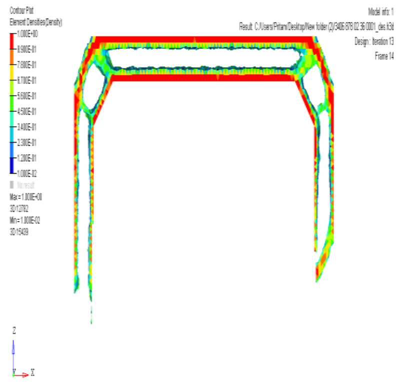
Fig. 3 Contour Plot of Von Mises stress for Clamp unit IV part

As fig. 3 indicates, are maximum stresses developed are 2.204 E^{+00} and minimum stresses developed are 4.433 E^{-04}. In this component, the middle portion is having maximum stress developed, therefore, the strengthening is given in this portion.

Topology optimization:

After analysis of the components, very less stress induced regions of components are removed in the topology optimization process. The objective of topology optimization is to minimize the total volume of fixture unit without any failure due load applied or the stress induced in the parts. To retain the strength required for given load, von mises stresses obtained from the analysis are used as stress constraint for topology optimization. The table below shows the original component and optimized results side by side to observe volume reduced due to topology optimization.

TABLE 3: ORIGINAL COMPONENT AND OPTIMIZED RESULTS

Original Component	Optimized Results
	

Using obtained results from topology optimization CAD models can be made to be replaced the original parts of the fixture unit.

Optimized Cad Models:

The Optimized CAD models are modeled using Optimization results obtained earlier. OSSMOOTH feature is used for smoothing the area obtained in the Hyperview. After collecting dimensional data, modified surfaces are modeled. These CAD models are not a perfect copy of the optimized results as the results are way too complicated to make them into physical models.

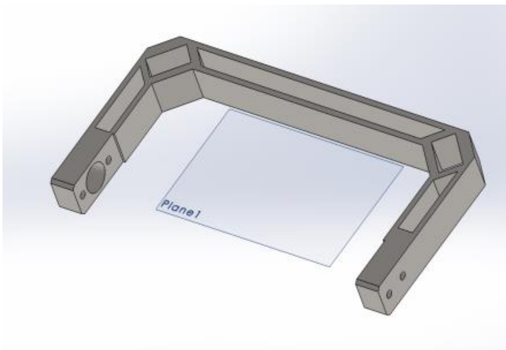


Fig.4 Modified Clamp unit IV Part

TABLE 4 COMPARISON OF WEIGHT OF PARTS AFTER AND BEFORE OPTIMIZATION

Sr. No	Original Weight (grams)	Weight after Optimization (grams)	Weight Reduced (grams)
1	889.51	593.09	296.42

Optimized model is all in standard size; therefore they can be easily available. Extra machining and casting will not be needed for the model, therefore, reducing costs. Assuming nearly 3000 parts are created per year, materially reduced approximately will be 100 tons which will reduce the material cost accordingly.

CONCLUSION

Thickness optimization and a material reduction of welding fixture parts are done in this project. Results obtained from this project are thoroughly reviewed and discussed by reviewers. Re-designation and optimization are taken into consideration. Implementation of the project is to be done in next 6 months.

REFERENCES

[1]. Kulankara Krishnakumar, Shreyes N. Melkote (2000), “Machining fixture layout optimization using the genetic algorithm”, *International Journal of Machine Tools & Manufacture*, 40 (2000) 579–598.

[2]. S. Vishnupriyan, M. C. Majumder, K. P. Ramachandran (2010), “Optimization of machining fixture layout for tolerance requirements under the influence of locating errors”, *International Journal of Engineering, Science and Technology*, Vol. 2, No. 1, 2010, pp. 152-162.

[3]. Shivaji Popat Mengawade, Vaibhav Bankar, Pratik P. Chaphale (2016), “Design and Analysis of Work Holding Fixture”, *IJSRD - International Journal of Scientific Research & Development*, Vol. 4, Issue 06, 2016.

[4]. Krishnakumar Kulasekara Srinath Satyanarayana Shreyes N. Melkote (2002) “Iterative Fixture Layout and Clamping Force Optimization Using the Genetic Algorithm”, *Journal of Manufacturing Science and Engineering*, Vol. 124.

[5]. Abhijeet Swami, Prof. G.E. Kondhalkar (2016), “Design, Development, and Analysis of Hydraulic Fixture for machining Engine cylinder block on VMC”, *International Research Journal of Engineering and Technology (IRJET)*, Volume: 03 Issue: 08 | Aug-2016.

[6]. H. Hashemi, A. M. Shaharouna, S. Izman , B. Ganjia, Z. Namazianb , S. Shojaeic (2014), “Fixture Design Automation and Optimization Techniques: Review and Future Trends”, *International Journal of Engineering*, Vol. 27, No.11.

[7]. Shivaji Mengawade, Vaibhav Bankar, Pratik P Chaphale, (2016), “A Review of Design and Analysis of Work Holding Fixture”, *International Journal of Engineering Research and General Science*, Volume 4, Issue 2, March-April, 2016.

[8]. Kiran Valandi, M.Vijaykumar, Kishore Kumar (2014), “Development, Fabrication, and Analysis of Fixture”, *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 3, Issue 4, April 2014.

[9]. Hui Wanga, Yiming (Kevin) Ronga,b, Hua Li b, Price Shaunb (2010), “Computer-aided fixture design: Recent research and trends”, *Elsevier*, 42 (2010) 1085–1094.

[10]. Sawita D. Dongre, Prof. U. D. Gulhane, Harshal C. Kuttarmare, (2014) “Design and Finite Element Analysis of JIGS and Fixture for Manufacturing of Chassis Bracket”, *International Journal of Research in Advent Technology*, Vol.2, No.2, February 2014.

