WEIGHT OPTIMIZATION OF PALLET USING TAGUCHI APPROACH AND FEA

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ABSTRACT

Rotary tables have fixed or adjustable indexing angles. The table stops for a specified period of time so that an operation can be performed at each station during every revolution..[2] The supporting bearings of rotary tables determine both the load capacity and accuracy. Re circulating ball bearings are cheaper than Angular contact bearings. But angular contact bearings provide better load capacity and axial stiffness. Cross-roller bearings are also used. For a large sized table with high load capacity, the hydrostatic bearings are also used. Selection of rotary tables requires an analysis of specifications and features.[4] Rotary Table is also called as rotary indexing table is used in machine tool as an aggregate for machining of components on multi faces. To find the exact shape of the rotary pallet which has optimum stress & deflection by removing the unwanted material to reduce the weight of rotary table. Analysis of a rotary table pallet will be done for a certain loading condition of an existing model and stresses as well as deflection will be determined for same model by using finite element analysis.[4]

Keyword:-*FEA, Rotary Face Pallet, Taguchi Approach, etc.*

1. INTRODUCTION

Rotary Table is also called as rotary indexing table is used in machine tool as an aggregate for machining of components on multi faces. A component can be clamped in fixture assembly mounted on round table can be milled, drilled, boring, tapping, etc operations can be perform. Rotary Table are available in market with different indexing positions like 180°, 90°, 1° and continuous rotation Incremental angle of 0.001°. Rotary axis is essential for machining the complex jobs where the machining forces are not at 90 or 180 degree to each other. Even if the jobs are rectangular, these can be machined in one setup using rotary table to improve the accuracy and productivity. Rotary table is designed with heavy duty axial radial roller bearing to take heavy loads. Rotary tables with dual lead worm and worm wheel with from correction are widely used for longer life and sustained accuracy.[1]

An automatic movable table supports a work piece and slides or pivots inside and outside of the machining center. Multiple pallets allow an operator to set up a part while another is being machined. In the CNC machines, fixtures are still required to locate and hold the work pieces while machining. The work holding devices should have the following uniqueness:[6]

1. It must have required accuracy and must have matching reference surfaces with the reference system.
2. It allowed performing a number of operations on different faces in a single setting.
3. It must enable quick loading and unloading.
4. It must be fool-proofing to avoid incorrect loading of the job.
5. It must be sufficient rigidity to fully withstand the cutting forces.
6. It must be safe in use and loading and unloading.
7. It must have a sufficient of clamping force for use of full roughing cuts.

8. It must be simple in construction maximum as possible.

Automatic pallet change over systems is used in modern CNC machines. These pallets simply move for interchanging their positions on the machine table. While machining is being done on a job kept on one pallet, the other pallets are accessible to the operator for clamping and unclamping raw material or finished product. This saves a lot of material handling and set up time, resulting in higher productivity.[7]

The purpose of this work is to develop a Pallet to enhance the effectiveness of machining centers with multi-pallet automatic pallet changers. Rotary tables are provided with Pneumatic or Hydraulic Brake to support cutting forces. Some of the salient features of rotary tables comprises of the following:

1. Hydraulic / Pneumatic clamping options.
2. Dual lead worm and worm gear set for backlash elimination.
3. Large module worm / worm wheel set for heavy duty application.
4. Radial or axial roller bearings for high rigidity.

Rotary Table is also called as rotary indexing table is used in machine tool as an aggregate for machining of components on multi faces.[2]

2. PROBLEM DEFINITION

To find the exact shape of the rotary pallet which has optimum stress & deflection by removing the unwanted material to reduce the weight of rotary table. Analysis of a rotary table pallet will be done for a certain loading condition of an existing model and stresses as well as deflection will be determined for same model by using finite element analysis.

Comparison of the results will be done for the modified pallet obtain by trial and error method, to maintain the allowable stresses and deflection.

2.1 OBJECTIVE

1. Design of critical parts like Pallet considering machining force and weight of the work piece into the account.
2. Optimization of weight of the pallet for particular loading conditions and structural rigidity by analytical method.
3. Structural and Dynamic Analysis of pallet will done using finite element package
4. Validation of the theoretical optimization results with finite element results.

The Dynamic analysis is carried out to check the dynamic behavior of the critical components like housing and pallet**.**

2.2 SCOPE

1. Removing the unwanted material of the pallet.
2. Reduce the weight of rotary table pallet.
3. Easy to handle.
4. Less machining work require by using steel plates for housing.
5. Use of weldment body for housing there is no need of mould and pattern for manufacturing housing.
6. Maintain the high machining accuracy.
7. Reduce the manufacturing cost.

2.3 METHODOLOGY

The first step is to calculate the parameters by using the given specification. Based on the geometric dimension obtained cad model of the rotary pallet and casing is generated using an appropriate CAD modeling software like **SOLIDEDGE, CATIA V5**. The generated model is discretized using meshing software Ansys14.5. The discretized models are solved with appropriate boundary condition. The results are obtained are analyzed and required modification to geometric model is carried out and the process is repeated once rotary pallet geometry is optimized.

Initially the pallet is designed for dimensions specified by the customer and it is easily suit the HMC machines for various operations but was not having any considerable deflection. The pallet of size 200 mm diameter is designed for deflection and stresses. The optimized weight of modified pallet is validated by analytical method as well as software. The analysis has been carried out on the existing Pallet by FEA to check the stresses and deflection. The process flow chart to carry out finite element analysis of the rotary pallet.

3. TAGUCHI APPROACH

Optimization is the vital tool which being used now a day in engineering application and welding is no exception for it. Taguchi not only enhance quality but also observe process parameter variation. In this work taguchi along with DOE is used for experimentation. Parameters are selected as per the DOE which provides a best tool to achieve not only the quality of product but also process efficiency. When a large number of experimental works have to be carried out when the number of process parameters increases. Therefore to reduce the number of experiments and to obtain good quality of investigation the term named DOE. It is factorial design and linear regression techniques have been widely used in engineering analysis. These techniques consist of experiments with an objective of acquiring data in a controlled way, executing these experiments in order to obtain information about the behavior of a given process. DOE is used for calculating the independent variable values at as per limited different experiments. [7]

4. DESIGN AND MODELLING OF ROTARY PALLET

Pallet is the most critical component in the rotary table assembly. Design of the pallet should take care of several aspects like work holding space, less deflection, fixture mounting facilities, T – slots for rigid fastening, specific load carrying capacity, and required elevation, less weight as per standard r=data and its modeling is done in PRO-E software as shown in figure 1.

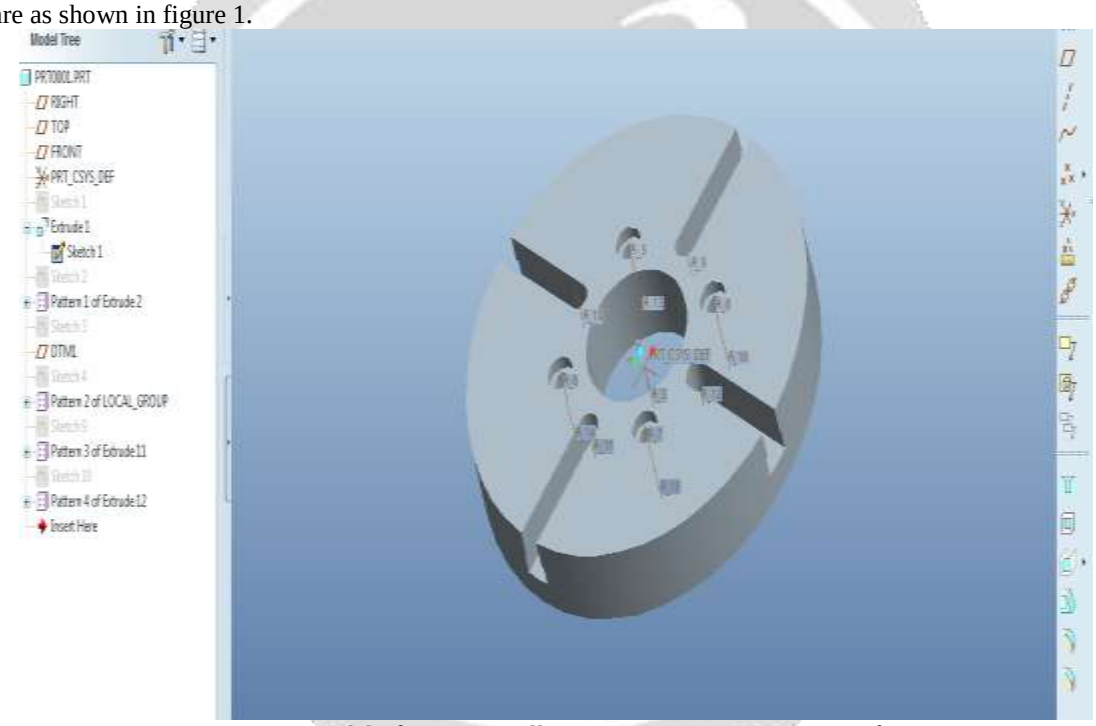

Fig -1 CAD model of Existing pallet (RNA-200) using PRO-E software

5. PLANNING FOR PROJECT STAGE II

The finite element method is numerical technique, well suited to digital computers, which can be applied to solve problems in solid mechanics, fluid mechanics, heat transfer and vibrations. The procedures to solve problems in each of these fields are similar in all finite element models of the domain (the solid in solid mechanics problems) is divided into a finite number of elements. These elements are connected at points called nodes. In solid models, displacements in each element are directly related to the nodal displacements. The nodal displacements are then related to the strains and the stresses in the elements. The finite element method tries to choose the nodal displacements so that the stresses are in equilibrium (approximately) with the applied loads. The nodal displacements must also be consistent with any constraints on the motion of the structure.

The finite element method converts the conditions of equilibrium into a set of linear algebraic equations for the nodal displacements. Once the equations are solved, one can find the actual strains and stresses in all the elements.

By breaking the structure into a larger number of smaller elements, the stresses become closer to achieving equilibrium with the applied loads. Therefore an important concept in the use of finite element methods is that, in general, a finite element model approaches the true solution to the problem.

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