MODELLING AND MOTION ANALYSIS OF SINGLE ARM ROBOT

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ABSTRACT

Industrial robots are the most manufactured and used types of robots in the production industry at these days to minimize the labor cost. Many industries must have the benefit of using them for their batch production. In order to enhance its performance improvement of design of industrial robots is required, which will direct the further enhancement in the robotics industry. Therefore, there is an effort to give the concept of optimum design of robot by considering the different the design parameters which makes it more efficient and reliable to use in the manufacturing industry.
Nowadays, for optimization the modeling and simulation tools are the widely used to facilitate and accelerate the design process such as dynamic simulation, structural analysis, optimization frame work.
In this project we are going to design the model of ABB SINGLE ARM ROBOT. By using the 3D CAD modeling tool that is CATIA V5 R20. After completion of part modeling and assembly we will do the kinematic analysis in CATIA. By this analysis we will constrain degrees of freedom of robot. After this process we will do static structural analysis on main bar by using ANSYS. Then we will conclude whether our design is safe or not. Hence this gives a concept to get an optimum arm design to increase production rate.

INTRODUCTION

The most aged methods of metal engaged procedures are shearing and bending. These are the basic operations that are performed for metal working. Shearing is a mechanical operation, cutting of large sheets of metal into smaller pieces of predetermined sizes. When an operation completes an entire perimeter forming a line with closed geometry is known as blanking. Shearing machines are of different types, but a typical shear generally consists of,

- A fixed bed to which one blade is attached.
- A vertically moving crosshead which mounts on the upper blade.
- A series of hold-down pins or feet which holds the material in place while the cutting occurs.

A gaging system, either front, back or squaring arm, to produce specific work piece sizes. Shearing operation is generally conducted manually, but it can be conducted using mechanical, pneumatic and hydraulic means also. Currently, the operation is performed manually at the industry but at a very high risk. The raw material is collected by the worker and feeding is done into the shearing machine manually till the sheet is induced completely into it. This operation is very hazardous to the personnel performing the operation. Also, there is a fair chance that automating this process might speed up the rate of work when compared to the manual execution. To overcome these disadvantages, the entire manual process in the shearing process is to be automated. In this project, a pick and place machine is designed to lift the raw material sheets one by one to the shearing machine. Suction cups are designed as holders for these machines to hold the metal sheets and place it on the conveyor belt of the shearing machine. This auto feeding mechanism will be operated by the sheet guide. This project undergoes an in-depth study of related topics that are explained in-detail in the future sections. Our main intension is to design this is entire 10 manually operated system (picking of sheet from stack to feed) into automation, such that it reduces the risk-factor during feeding operation. On developing this system, we reduce the time of action performed that leads to increase in productivity.

PROJECT STATEMENT

The thesis examines the compelling design of a robotic arm i.e. a pick and place machine and auto feeding mechanism that improves the safety of the workers. The main intension of designing this pick and place machine is there will be no need of manual operation of picking the sheet form stack to shearing machine and the auto feeding mechanism is a continuous process were the productivity could be effected.

BACKGROUND STUDY

This project is discussed mainly on Design and structural analysis of a robotic arm, which reduces the man power and might have a good effect on production rate. This change can motivate the industry and academics such that the business of the firm is increased. The development in automation can reduce the revenue cost and raise in capability of delivering the services at low cost scaling. To look at the safety of the workmen, we designed a pick and place operator i.e. a robotic arm and for the feeding mechanism two pneumatic cylinders are designed. Earlier we have studied about different feeding mechanisms among those we have designed a new model i.e. using the pneumatic cylinders pushing the sheet forward through the cutting blades

RESEARCH PROBLEM

In sheet shearing operation, picking of sheet and feeding is undergoing manually which is time taking and risk factor is involved in it. So, for the first phase (picking of sheet from stack) we need to avoid that by using an automotive application i.e. pick and place operator and the auto feeding mechanism is initiated with two cylinders parallel to the sheet. As we have discussed above the pick and placer is regulated as a continuous operation for picking the sheets and placing it on the conveyor belt.

SCOPE OF IMPLEMENTATION

The basic idea in this project is implementation of robotic arm. Though it can be implemented in various methods, when different parameters are taken into consideration this model is the most feasible way of implementation. Other ways of enactment the model is enabling them to adapt to the surroundings.

OBJECTIVES AND DESIGNING

Modelling and Simulation of the pick and place mechanism. We need to have a time study between currently undergoing manual operation and newly designed automated operation. X The frequency of this operator, it’s repeatability, lifetime etc. are to be found out. X The choice of the end effector, it’s design and analysis should be carried out and documented.

ARTICULATED ARM ROBOTS

Articulated arm robots are generally used to perform risky, treacherous and highly repetitive and obnoxious works. This entire system is controlled by a trained operator using a portable device like a teach pendant to a robot to do its work manually. The main prospective is not the working of the robot, but how it is to be safeguarded in a regular usage in the industries.

END EFFECTOR OF THE ROBOT

The end effector is one aspect that what brings the robot to give adaptable solutions. This device is designed to have a great connection with the environment, and the working of end effectors depends completely on the robot applications. Basically, the end effectors is nothing but a gripper or a device that works according to different applications induced in it and when we consider it to robotic awareness. They are of different divisions like. Impactive, Ingressive, Astrictive, Contigutive. These works differently for different end effectors. Impactive this works as a jaw or fingernail that grasp physically by giving an explicit collision to the object that is to be acted.

METHODOLOGY

OBJECTIVES AND DESIGNING

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SCOPE OF APPLICATION

3D Product Lifecycle Management suite available in CATIA, multiple stages of product development (CAX), from conceptualization, design (CAD), manufacturing (CAM), and engineering (CAE) can be performed.
CATIA facilitates mutual engineering across disciplines, mechanical engineering, including shape design & surfacing, systems engineering and equipment.

SURFACING & SHAPE DESIGN

CATIA provides a suite of surfacing, reverse engineering, and visualization solutions to create, modify, and validate complex innovative shapes. From styling, subdivision, and Class A surfaces to mechanical functional surfaces.

EQUIPMENT DESIGN

The design of electronic, electrical as well as distributed systems such as fluid and HVAC systems, all the way to the production of documentation for manufacturing can be done by CATIA.

EXPERIMENTAL WORK : MODELLING OF ROBOT

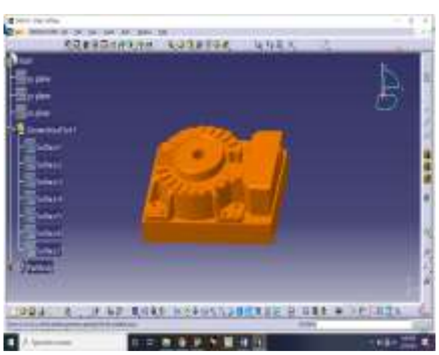

Fig.1 Base

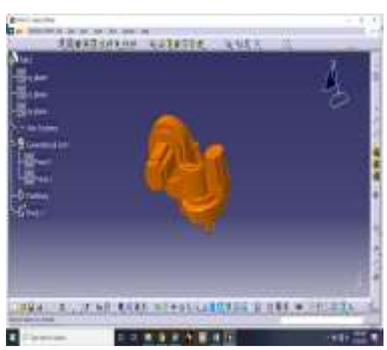

Fig.2 Link

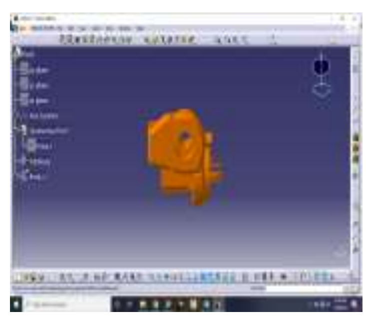

Fig.3 Joint

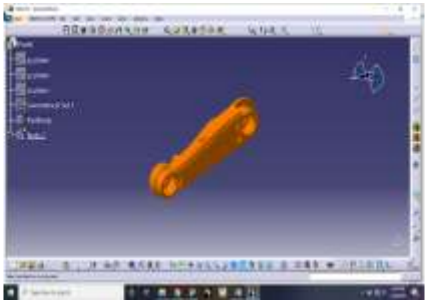

Fig.4 Manipulator-1 **Fig.5 Manipulator-2** **ig.6 End Effector**

ASSEMBLY OF ROBOT

Fig.7 Assembled part

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot.

THE BASICS STEPS INVOLVED IN FEA

Numerically, the structure to be examined is subdivided into a cross section of limited estimated components of straightforward shape. Inside of every component, the variety of dislodging is thought to be dictated by basic polynomial shape capacities and nodal relocations.Comparisons for the strains and hassles are created as far as the obscure nodal relocations. From this, the mathematical statements of the balance are amassed in a grid from which can be effortlessly being customized and illuminated on a PC. In the wake of applying the proper limit conditions, the nodal relocations are found by understanding the framework firmness mathematical statement.

BASIC STEPS IN FEA

a) DISCRITIZATION OF THE DOMAIN: The task is to divide the continuum under study into a number of subdivisions called element. Based on the continuum it can be categorized into line or area or volume elements.
b) APPLICATION OF BOUNDARY CONDITIONS: From the physics of the problem we have to apply the field conditions i.e. loads and constraints, which will help us in solving for the unknowns. SYSTEM
c) EQUATIONS ASSEMBLING: The formulation of respective characteristic (Stiffness in case of structural) equation of matrices and assembly is involved in this. SOLUTION FOR SYSTEM
d) EQUATIONS: Solve the equations to know the unknowns. This is basically the system of matrices which are nothing but a set of simulations equations are solved.
e) VIEWING THE RESULTS: After the completion of the solution we have to review the required results. The first two steps of the above said process is known as
pre-processing stage, 3rd and 4th steps are the processing stage and the final step is known as post-processing stage.

PERFORMING A TYPICAL ANSYS ANALYSIS

Pre- processor	Solution processor	Post processor
Assigning element type	Analysis definition	Read results

Geometry definition	Constant definition	Plot results on graphs
Assigning real constants	Load definition	View animated results
Material definition	Solve	
Mesh generation		
Model display		

The ANSYS system has numerous limited component investigation capacities, extending from a straightforward, direct, static examination to a nonlinear, transient element investigation.
The following table shows the brief description of steps followed in each phase.

PRE-PROCESSOR

Preprocessor prepares the input data for ANSYS analysis. The general preprocessor (PREP 7) contains solid modeling and mesh generation capabilities, and is also used to define all other analysis data with the benefit of data base definition and manipulation of analysis data.
The preprocessor stage involves the following

- Specify the title, which is the name of the issue. This is discretionary yet exceptionally valuable, particularly if various configuration cycles are to be finished on the same base mode.
- Analysis types thermal analysis, modal analysis, Harmonic analysis etc.
- Creating the model: The model may be made in pre-processor, or it can be imported from other design software by changing the file format.
- Defining element type: these chosen from element library.
- Assigning real constants and material properties like young`s modules, Poisson's ratio, density, thermal conductivity, damping effect, specific heat, etc.
- Apply mesh: Meshing is nothing but dividing the whole area into discrete number of particles.

SOLUTION PROCESSOR

Here we create the environment to the model, i.e. applying constraints & loads. This is the main phase of the analysis, where the problem can be solved by using different solution techniques. Here three major steps involved:

- Solution type required, i.e. static, modal, or transient etc. is selected.
- Defining loads: The loads may be surface loads, point loads; thermal loads like temperature, or fluid pressure, velocity are applied.
- Solve FE solver can be logically divided into three main steps, the pre-solver, the solution and post-solver. Model read by pre solver which is created by the pre-processor and makes the arithmetical representation of the model and calls the mathematical-engine, which calculates the result. The result return to the solver and the strains, stresses, etc. for each node within the component or continuum are calculated by post solver.

POST PROCESSOR

Post processor analyzes results, which display stress and strain contours, distorted geometries, flow fields, safety factor contours, contours of potential field results; vector field displays shapes of mode and graphs related to time history. The post processor can also be used for algebraic operations, database manipulators, differentiation and integration of calculated results. Once the solution has been calculated, results can be reviewed in post processor. Two post processors are available: POST 1 and POST 26. We use POST 1, the general post processor to review the results at one sub step over the entire model or selected portion of the model. We can obtain contour displays, deform shapes and tabular listings to review and interpret the results of the analysis. POST 1 offers many other capabilities, including error estimation, load case combination, calculation among results data and path operations.

MESHING

Mapped area mesh contains either quadrilateral or just triangular components, while a mapped volume cross section contains just hexahedron components. In the event that we need this kind of lattice, we must form the geometry as arrangement of genuinely normal volumes and/or regions that can acknowledge a mapped network.

STRUCTURAL STATIC ANALYSIS

The load effects can be calculated on a structure by ignoring the damping and inertia effects, such as those caused by time varying loads can be calculated by structural static analysis. Steady equivalent loads like steady inertia loads and time varying loads are included in Static analysis. Static analysis is utilized to decide the removals, burdens, strains and powers in structures or segments brought about by burdens that don't instigate noteworthy dormancy and damping impacts. Enduring stacking and reaction conditions are accepted, i.e. the stress and the structure's reactions are expected to differ gradually as for time. The kinds of load can be applied in static analysis include:

- Force and pressure application on body.
- Steady state inertial forces.
- Displacement

ANALYSIS OF THERMAL BEHAVIOR.

The steps needed to perform an analysis depend on the study type. You complete a study by performing the following steps:

- Create a study defining its analysis type and options.
- If needed, define parameters of your study. A parameter can be a model dimension, material property, force value, or any other input.
- Define material properties. Specify restraints and loads. The program automatically creates a mixed mesh when different geometries (solid, shell, structural members etc.) exist in the model.
- Define component contact and contact sets.
- Mesh the model to divide the model into many small pieces called elements. Fatigue and optimization studies use the meshes in referenced studies.
- Run the study.

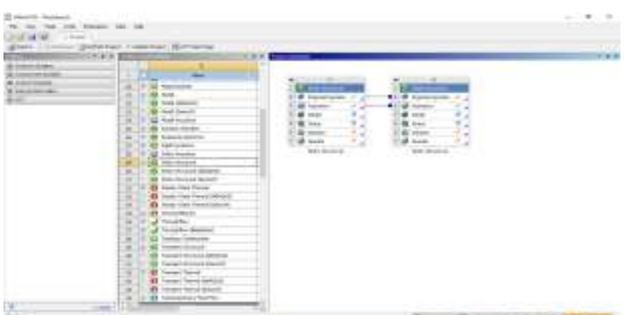

Fig.8Ansys Table

Fig.9 Material

Fig.10 Mesh

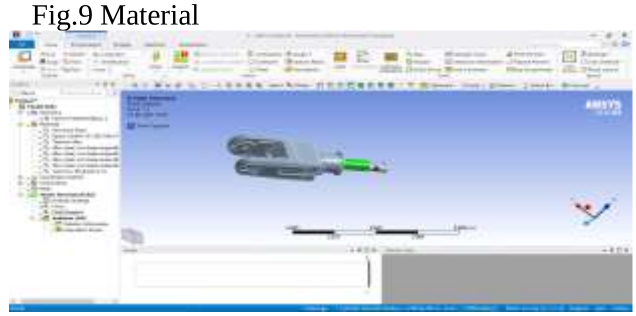

Fig.11 Fixed support

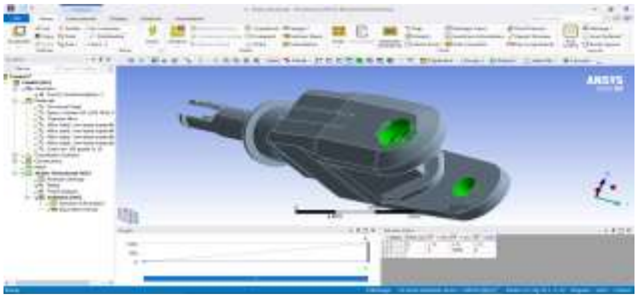
Fig.12 Force

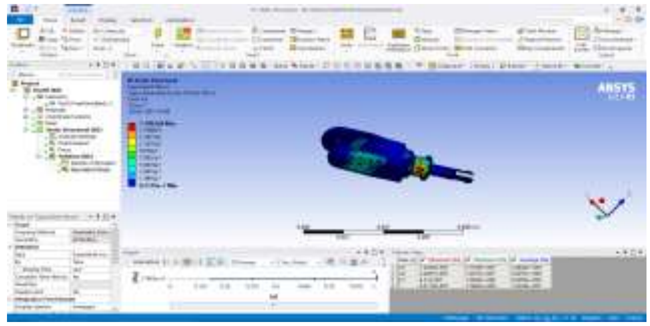
Fig.13 Output

RESULTS

Geometry	Total deformation	Equivalent stress	Equivalent strain
Existed geometry	0.060085	12.35	6.582e-5
Modified geometry	0.053493	11.117	5.6989e-5

CONCLUSION

In this project we have designed the part diagrams of the crank journal bearing, crank pin, crank webs, fly wheel and made the assembly of these components. We have designed the part design in 2D and 3D models and assembled it in the assembly design workbench.

Dynamic analysis has been performed on the crank shaft to find the defects in the formation of crank shaft. Analysis was done by considering steel alloy, 4340 as a material we got less deformation value for modified design then the existed design by decreasing stress we will increase the life of the object.

Hence the yield strength of the cast iron is 276MPA, after applying the load on the joint we get the equivalent stress of 172MPA, due to less equivalent stress our design is safe.

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