

Design and Analysis of Connecting rod using Reverse Engineering method

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Abstract—Connecting rod is the most important part in the automobile sector it forms the link between piston and crankshaft. It is mostly used for the conversion of the reciprocation motion to rotary motion. Connecting rod receives the forces from the piston which are continuously varying in nature so stress on the connecting rod is continuously varying. So the design of the connecting rod is the most important criteria. The design changes of the connecting rod is not economical, because today's connecting rod is having cross section of I and the I cross section is having the largest load carrying capacity per unit weight of the connecting rod so the cross section change is not possible so only the corner radius of the connecting rod would be the option for the change without much more stress concentration

Key words – connecting rod, piston, crankshaft, I cross section.

I. INTRODUCTION

Connecting rod is used in reciprocating engine to connect the piston to the crank shaft. Together with the crankshaft it forms a simple mechanism which converts reciprocating motion to rotary motion. Mostly connecting rods are used in automobile sector. It has wide variety of application in automobile field. Basically connecting rods are manufacture with the forging operations; also connecting rods are to be manufacture with the casting process. The shape of the connecting rod is such that it can take the maximum variable load with minimum stress so that it can with stand the dynamic load.

The connecting rod takes the various forces like inertia forces, gas pressure force, and transmits that force to the crank shaft. The cranks produce the turning moment which cause the motion. A connecting rod in a high performance engine is subjected to inertial forces and bearing loads.

Connecting should be able to withstand these forces for a large number of cycles. In order to reduce the forces exerted during operation, the connecting rod should light weight as possible as and should have very high fatigue strength. The connecting rod undergoes cyclic tension, compression as well as bending. The connecting rod is subjected to a combination of axial and bending stresses.

Furthermore the connecting rod is subjected to a large compressive load so that it is imperative that buckling does not occur

II REVERSE ENGINEERING

Engineering a product – To design the new product you must have a concept of new product started with new concept and full developed the product which includes its design, manufacturing, process planning and related data. Every aspect of the product has been laid out and complete decision about product has been taken out and we cannot know the final shape of the product. This type of development of new product with fully new concept is called as engineering a product. In many of the industry engineering the product is to be done in the product developed department.

Reverse engineering-In reverse engineering you are given a model which are engineered by someone. This product is a working product. Probably the product developed successfully. But you know what were the concepts behinds the products such as the complex products what are its sub components and what is the function of this product. You have been given a solid model and pre pair the cad model from that for which no CAD model is exist.

Reverse engineering includes the following step's

- Physical Model
- 3D Scanner
- Point Cloud Data
- Surface Model
- CAD model changes
- RP/CAM
- CNC
- Product Mould

From the physical part scanning is done using the co-ordinate measurement machine. From that we import the output of the scanning machine in to the modeling software like CATIA. From the point cloud data generate the surface model. From the surface some desired changes is to be done. Now the changed design is used for the manufacturing of the new component.

Basically two methods are available for scanning the components,

Contact methods- in this method the probe is touches the components of the parts and measures the co-ordinates.

Ex - CMM (Co-ordinate Measurement Machine) needle scanner.

Non-contact methods- This is non-contact scanner laser is used for the scanning

Ex - Laser scanning machine

Procedure for 3D Scanning Using CMM

The needle scanner is a contact type co-ordinate measuring machine (CMM). The needle is moved in the cartesian co-ordinate system along the 3 axis (X,Y,Z) by independent motors. The needle is connected to the piezoelectric sensor which gets activated when the needle touches the object. The motors are connected these sensors which detects the location of the needle in the cartesian space. The needle touches the surface of the object and the co-ordinate of the respective points is displaced and stored in the memory.

Software Capabilities

Dr. PICZA scanning software features a dynamic graphic display and diverse editing functions. It offers numerous editing functions, including a handy convex/concave inversion function for making molds, a mirror function for creating symmetric data, a tilt adjustment function, curve smoothing, and a function for adjusting the height of surfaces. The scanning software can preview the image from any angle using a wide frame. It also displays color and texture renderings. PICZA scanned data can be stored in its original format, or exported in DXF, IGES, VRML, or as Point Cloud data (ASCII).

The needle scanner contact type co-ordinate measurement machine is as follow which is used for the measurement of the co-ordinates of the gas turbine blade model.



Fig. 13 DNeedle Scanner Co-Ordinate Measurement Machine.

The software used helps in automating the scanning process. It collects the data everytime the needle touches the object and stores it as point cloud data set. The scan area is to be selected and the rest work is done automatically. User needs to provide the pitch in X and Y plane i.e the minimum needle movement in X and Y direction to search for next point.

Specification of 3D scanner contact type CMM.

Table 1 Specification of CMM.

<i>Sr.no.</i>	<i>Description</i>	<i>Specification</i>
1	Name of the machine	3D scanner contact type PIX 30
2	Supplier	m/s APSOM infotex ltd. New Delhi
3	Scanning area	300×200×70mm
4	Scanning pitch	0.2mm in X and Y direction
5	Sensor or scanning method	Contact laser type
6	Scanning step	0.05mm
7	Scanning speed	30mm/sec in XY plane
8	Output file type	.dxf, .stl, .txt, .pix etc.

The actual physical part of the gas turbine blade in 2D is as follow. This is the wooden block which is use for the scanning purpose only. Use this profile for the scanning purpose and get the co-ordinate of the profile from which we can made the CAD model and further analysis can be done on that. To scan the 3D component we place the component on machines and set the pitch for X, Y direction. The starting window of needle scanner looks like this. For more accuracy select the less pitch for scanning. The minimum pitch for this machine is 0.005mm. The following figure 2 shows the windows for the contact type needle scanner. On that set the scanning pitch in vertical and horizontal direction here for scanning I use the horizontal pitch as 0.5mm



Fig. 2 Window of Dr.Picza needle scanner.

The complete procedure for using the needle scanner is explained following:

1. Place the object firmly on the platform ensuring that the object does not moves while scanning process. You may use two sided tape for fixing the object.
2. Start the software Dr. PICZA on your work computer. Click on NEW in the FILE menu and then the green color SCAN button on the toolbar.
3. Now the following SETTINGS screen appears. The blue area represents the maximum area that the needle scanner can scan. It is similar to the blue pad on the scan platform of the machine. The orange area represents the area that user wants to scan. The size of the scan area can be changed by dragging the edges. Also the location of scan area is movable within the blue area. The length and breath dimensions of the scan area is displaced on the right side input box. The red buttons at the corners of the scan area are used to check where the scan area is properly fixed i.e. when you double click in the red corner button the needle will be trying to locate the point on the platform. It is advisable that the scan area should be slightly more than the object area for scanning. Also if the object is symmetrical, then you can take the advantage of it and reduce the scan area accordingly. This will reduce the scanning area and the point cloud data.
4. After the scan area is finalised, the maximum Z-co-ordinate on the object is to be selected. This will help in reducing the scanning the point above this point and thus saves the scanning time. For setting maximum Z co-ordinate, check the Z dialog box and a point is displaced on the scan area. Drag it to the estimated region of maximum height on the object in scan area and then double click on it or input it manually.
5. Now we need to set the pitch for X and Y travel of the needle to collect the next point. It is set as per the requirement and complexity and size of the object.
6. Now the machine is completely ready to start the scanning. Press SCAN button on the lower right corner of the SETTINGS screen. The scanning starts. The following figure shows the scanning progress.

The scanning progress of the component the progress of the scanning is shown in the figure 2. The output of the 3D scanner gives the co-ordinates of the component. From these co-ordinates it is easy to generate the 3D CAD model. After scanning save the data in required format by import the data and save the file.

7. The output of the scanning is in .txt format and if we import those points in any modeling software it gives you the points cloud data.
8. The next step is to remove the noise from the point cloud data.
9. The point cloud data can be exported into various formats such as .dxf, .stl, .txt, .pix so chose any one appropriate file format for import in the modeling software.

Steps for developed the CAD model

Output of CMM-The output files of the CMM are .dxf, .stl, .txt, .pix so chose any one appropriate file format for import in the modeling software.

Import the data- The stl file which is to be imported in the CATIA required the normalized file format for that copy and paste the txt file in notepad and save it as a .asc file which is normalized file format for importing the data in the CATIA. Curve/surface fitting – To join the points cloud data we use the curve and surface. Add fillets, rounds etc. to join the gap between two surface and curve so we have to provide using the fillets and rounds. Manipulating the collected data to obtain a CAD model- The output of the 3D co-ordinate measurement machine is in the form of the co-ordinates. Basically in the txt format from these co-ordinate we import these co-ordinates in the modeling software like CATIA and using the various curve fitting option we fit the points and developed the curve or surface we need. Using the CAD model to obtain physical part- The modified geometry of the CAD model is then used for the further manufacturing of the component. Which is having the some type of similarities with the previous geometry?

The need for building CAD Models from physical parts

Design exist as clay, wood or foam models – In many industry to design the parts first physical model is to be developed such as clay and wood and from that a CAD model is to be developed for further changes.

Original manufacture of the part does not exist or does not produce the part any more- When we lost our part and if we need that parts again then we look for the original product supplier but if it is not exist then from the broken parts we do reverse engineering and pre pair the CAD model for the broken parts and then pre pair the product using in house method or shop floor method or ask the another supplier for provide the parts for that.

Inadequate or no documentation of original design – If the company producing the products have not documented its product properly but the physical model of the product is available and we have to re-documents then we have to build the CAD model from existing model.

Copying/analyzing/understanding others products – Basically for competitors how they are arrived at that geometry then we have to reverse engineering that components and used for the own application after modify that geometry.

Analyzing changes in an old part - Suppose I have a part which is worn out and we want to check out that the wear of the warn out part is considerable or not for that we built a CAD model of the worn out parts and compare the warn out part with the actual CAD model and check that weather the deviation of the worn out part is sufficient or not

Inspection of a manufactured part - To check the manufactured part is within limit or not we built the CAD model from the actual manufactured component and compare the actual CAD model with the manufactured one and set the tolerances.

Merits of Needle Scanner:

1. High precision and accuracy.
2. Requires less labor intensive.
3. Accurate dimensions can be obtained just by knowing the coordinates and distance between the two reference points.
4. Robustness against external force and error accumulation.
5. Can work with any type of object like metallic, non-metallic, white or black colored.

Limitations of Needle Scanner:

1. The Coordinate measuring machines are very costly.
2. The CMMs are less portable.
3. If the operating software cracks down it is difficult to restart the entire system.
4. It needs to construct some feature on its own as some parts of the work piece are unreachable by the probe.
5. Suitable for Planner scanning i.e. flat surface not having steep cuts or recesses. Thus the machine is capable to scan 2D features accurately only.

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