AUTOMATED AND HIGH SPEED MECHANICAL SYSTEM FOR ASSEMBLING OF SELF CENTERING RELEASE BEARING IN AUTOMOBILE INDUSTRIES

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Abstract

The moto of this research paper is to design and simulation of a fully automated and high speed assembly system design for self-centering release bearing, which can reduce human efforts, time consumption and eventually cost of a final product. This system increases efficiency and production rate on an assembly line. This system has been designed by using PTC Creo 2.0 a modelling software. For the gripping purpose a self-centering gripper is used, which is designed in such a way that it holds the bearing hub with center matching technology and assemble it over self-centering release bearing within the exact tolerance zone. To control all motions of the grippers and the center matching tools the rod less pneumatic cylinders are used. At the end, the computer aided structural analysis and validation of the bearing hub and the gripper have been performed using ANSYS Workbench 16.0 to study the stresses developed and deformation pattern during the process of assembly.

KEYWORDS: High Speed Assembly, Cost Effectiveness, Self-Centering Gripper, Pneumatic Rod less Cylinders, Modeling and Structural Analysis

Introduction

"*Any sufficiently advanced technology is equivalent to magic*": - Arthur C. Clarke. High speed and automation are the part of this magic. In high speed technological world automation played very important role for industrialization. To achieve satisfactory value for the product, it has to be made perfect by means of precision, accuracy, tolerance control and high speed. This paper introduces how to assemble a self-centering release bearing with high speed as well as with fully computerize system.

A Self-centering release bearing is used to prevent noise caused by the release bearing pressing unevenly on the diaphragm spring. It fixes on transaxles and align itself with the centerline of diaphragm spring which helps to prevent noise associated with clutch disengagement. Both bearing hub and self-centering release bearing are made from A36 steel material. For proper functioning the bearing should be perfectly assembled. As we know assembly of two objects with high speed is a complicated job especially for fully automated system. Hence to make it possible a new technique has been developed which explains how to assemble two parts (Hub and Self-Centering Bearing) exactly by matching the centers of those parts irrespective of their shapes and sizes. It is very important to assemble all the components properly to prevent any malfunctioning and thus a precise self-centering gripper and center matching tools have been designed. As the tolerance control is one of the main factors, the center matching concept doesn't rely on an outer geometry.

2. AUTOMATED AND HIGH SPEED SELF CENTERING RELEASE BERING ASSEMBLY SYSTEM.

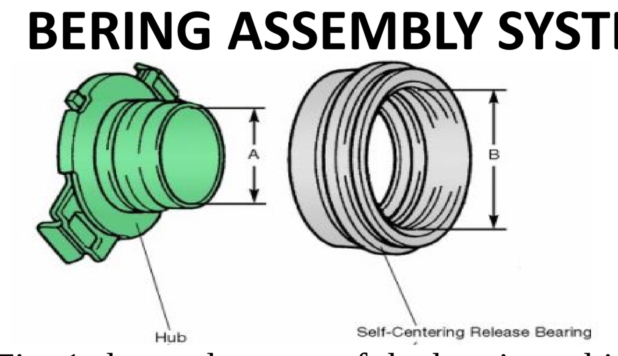

Fig. 1.shows the parts of the bearing which will get assembled in this system.

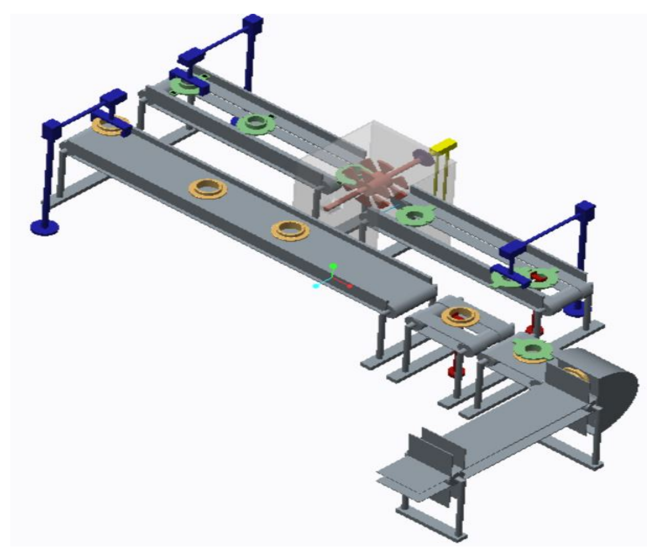
Fig.2. Model of an automated assembly unit for self-centering release bearing

First of all, two assembling parts i.e., bearing hub and self-centering bearing will bring together on the assembly line by using conveyors. Then a self-centering gripper will hold the bearing hub and place it to the assembling station where two objects will get assembled. The movement of this gripper will be managed by using the pneumatic rod less cylinder. Meanwhile a center matching tool will exactly match the centers of bearing hub, and self-centering release bearing which will assure that the whole assembly process runs without any mismatching.

To study the mechanism and analysis of the parts a model have been developed and showed it below in fig.2.

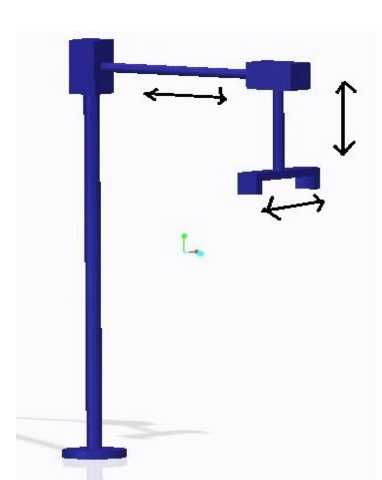
Fig.2.1 pneumatically operated mechanical rod less cylinder assembly system

2.1 ROD LESS CYLINDER: Generally in conventional assembling systems, robotics arms are used but here in this paper pneumatic rod less cylinders have been used for X,Y and Z direction motion. Such devices have some good advantages over conventional robotic arms such as, less complexity, easy to operate, long stroke applications, and cheaper than that of robotic arms. We can use rod less cylinders where the space is limited. Fig 2.1 show the model of rod less cylinder assembling system.

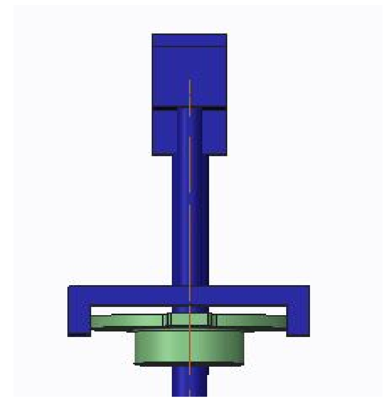
Fig.2.2 self-centering gripper

2.2 SELF-CENTERING GRIPPER: The jaws of self-centering gripper moves symmetrically due to whih the object can be held exactly at the center. Such grippers work on hydraulic, pneumatic or electric inputs. Here in this system, the pneumatic self-centering gripper have been used. The picture of the gripper has showed in fig 2.2

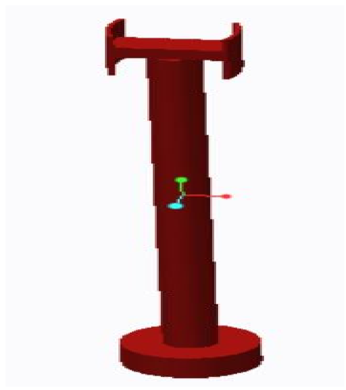
Fig.2.3 Center matching Tool

2.3 CENTER MATCHING TOOL: The main focus of this research paper is how to match centers of two objects in fully automated and high speed assembling system. As we know if any mismatch occurs during the assembly, the parts will get damage and it will cost more. So to prevent this malfunctioning, pneumatic center matching tool is designed and showed in fig 2.3

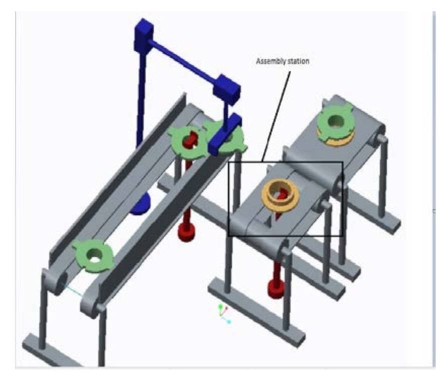
Fig.2.4. Assembly Station

2.4. ASSEMBLY STATION

3. FINITE ELEMENT ANALYSIS OF GRIPPER WITH PNEUMATIC RODLESS CYLINDER UNIT:

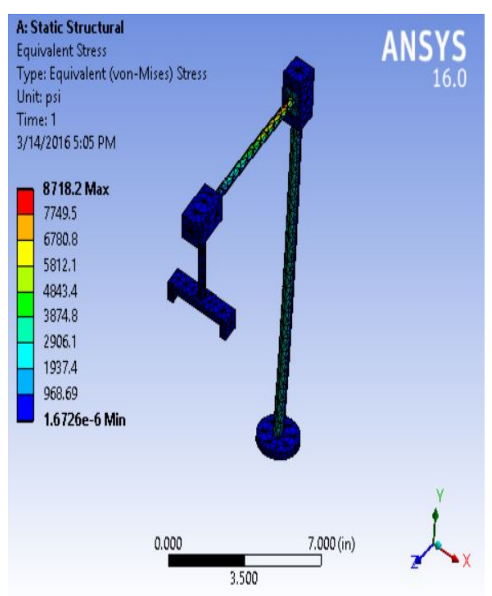

Fig.3.1 Stress analysis of mechanical holding system

The material used for this unit is A36 steel. According to fig.3.1 the maximum stress occurs during the assembling process is 8718.2psi and the yield stress of A36 Steel material is 36259 psi so according to the given formula, it shows that the designed system works properly with the safety factor greater than 2.

$$factor\ of\ safty = \frac{Yield\ stress}{Actual\ stress}$$

As the entire load acts on the tip of the overhanging rod less pneumatic cylinder, there will be a chance of bending thus to check this bending deformation, an analysis has been done. According to fig 3.2 it shows very negligible deformation, which means this system can safely install for assembling process. Table 1 shows various deformation values of system with respect to stress positions.

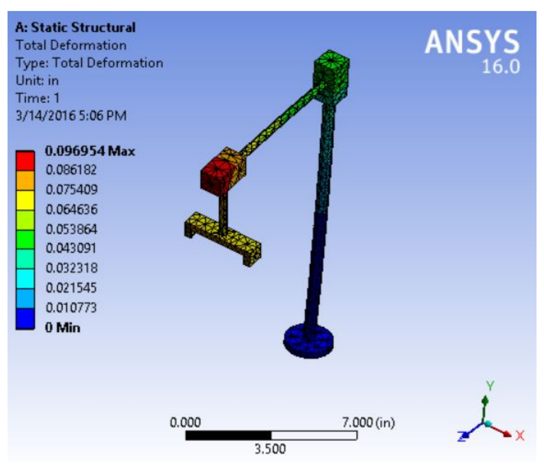

Fig.3.2 Deformation analysis of mechanical holding system

Number of test	Bearing hub gripper assembly Stress (psi)	Displace (inch)
1	8718.2	0.096954
2	7749.5	0.086182
3	6780.8	0.075409
4	5812.1	0.064636
5	4843.4	0.053864
6	3874.8	0.043091
7	2906.1	0.032318
8	1937.4	0.021545
9	968.69	0.010773

Table 1: Experimental result for mechanical holding system

4. FINITE ELEMENT ANALYSIS OF BERING HUB:

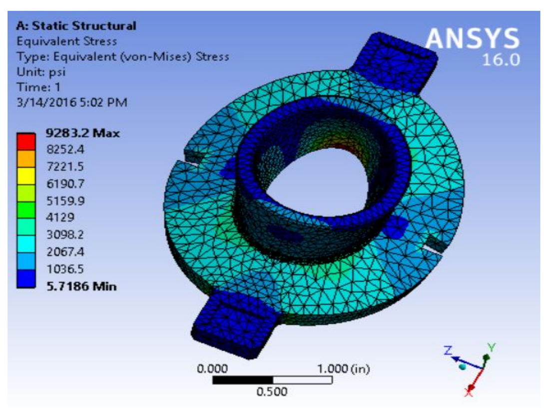

Fig.4.1 Stress analysis of bearing hub

Fig.4.1 indicates that the maximum stress occurs during the assembling process in bearing hub is 9283.2 psi. Here, in this system bearing hub has made by using A36 Steel material and which has yield stress is 36259psi. According to the formula of factor of safety given above, it comes more than 2. Thus, it shows that the bearing hub is able to sustain the gripping force during assembly. Table 2 indicates that the deformation of bearing hub with respect to stress developed.

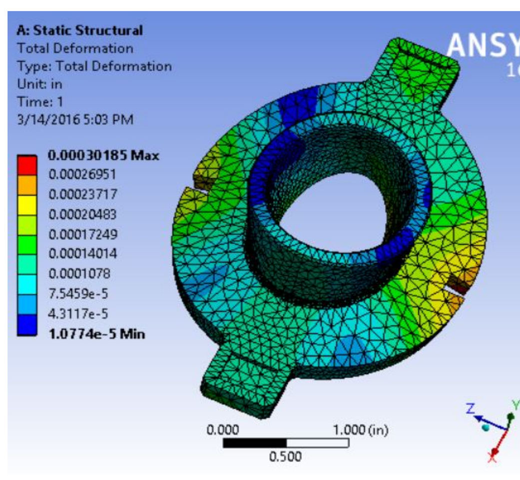

Fig.4.2 Deformation analysis of bearing hub

Number of test	Bearing hub Stress (psi)	Displace (inch)
1	9283.2	0.00030185
2	8252.4	0.00026951
3	7221.5	0.00023717
4	6190.7	0.00020483
5	5159.9	0.00017249
6	4129	0.00014014
7	3098.2	0.00010780
8	2067.4	0.00007549
9	1036.5	0.00004311

Table 2: Experimental result for bearing hub

Conclusion

This paper introduces a newly designed assembling unit which matches the centers of the assembling objects within a tolerance zone by using a precisely designed center matching tool and self-centering gripper. Finally, this design has been analyzed by using computerized analysis tool (ANSYS Workbench 16.0). The results of ANSYS has verified with the analytical calculation and it shows that this system works properly and can be used as an actual working model in automobile industries. There is some scope in future to improve the design by means of reducing the length of the rodless cylinder and low yield strength materials.