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Innovative Design and Fabrication Assemble And Removing The Piston Pin From Connecting Rod (Piston Removal-PR)

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Abstract

The design and fabrication are the important elements in translating the idea to a product.This paper presents the capability of 3D solid model in assissting the fabrication process in development and improvement a real product (innovation). The objectives of this project are to design the jig and fixture to remove pin in the piston using pro engineer software (Pro/E), second is to fabricate the jig and fixture using machining process and finally is to improve the method when assembly and removing the pin piston by using the jig compare to conventional method by analyze the effect on the piston parts, the piston pin, connecting rod and piston block. The result shows that the application of jig and fixture have the reduced damage on piston pin, connecting rod and piston head surfaces. These jigs and fixture are used at main assembly line to assemble the engine components. The experiments also conducted on the locator pins (custom made jig) between mild steel and aluminum. It is found that the wear progressily generate on aluminum pin locater compare to mild steel. The result is obtained from experiment conducted.

Keyword: Solid Model,Piston pin,jig and fixture

1.0 INTRODUCTION

Piston slap is caused by changes in direction of the piston side force. This event occurs many times throughout an engine cycle. However, major piston slap has been found to occur near top dead center during firing. This is due to the fact that the impact energy is greatest due to the high pressure in the cylinder chamber at this time. Thus, large enough engine noise has resulted in spark ignition engines is simply reduced by changing the geometric parameter of the known as wrist pin offset. Offsetting the piston has the effect of reducing slap impact since transition from one side to the other occur prior to peak cylinder conditions, and thus with less impact energy. This has generally been the "fix" for reducing of noise caused by piston slap in spark ignition engines and has proved to be successful, relative to the other noise source levels.

Therefore, we will discuss the problems and solution-revelation, the scope an objectives that must be done be for implementing the project. Manufacturing engineering is an engineering field that is expanding rapidly in terms of technology as well as the interests of the people. Performance human race always produces something new and be able to ease and convenience of the work done. With this new range of tools designed to facilitate work or save time as well as providing a more effective.

Nowaday mechanics have a problem in remove the "piston pin" from the piston.During the disassemble of pin piston from connecting rod mechanic usually use the hammer and screwdriver by ordinary method. By using the ordinary method, the chances/probability of damages for the pin piston,piston surface and the bearing is high because of the impact of load on the piston increase when the mechanic hits the pin piston to remove it. So when the piston,piston pin, connecting rod and bearing damage the engine will vibrating because of misalignment. So the accuracy of the rotation and alignment is lower. To that extend, the new approach of assembly the piston pin on connecting rod should be considered and develop. The hardness of the piston pin is comparatively greather than the piston (aluminum) and connecting rod so during removing piston pin by hammer the piston pin is increase the impact load on piston and connecting rod.

Product design development uses the output of the other design concepts, including strategic designing, to create consistent, coherent ideas and resources that can be used to guide this project. The project scope of the work is the obtaining an innovative product that can be defined as a new product that will become an innovation with aid of imigination that translate to product with application of complex engineering skills, computer aided design and Pro/ENGINEER (PTC's parametric).

The machining process that involves in this project are milling, turning, drilling, grinding and threading. The machines that use is locate at TATiUC workshop.

The material that uses is aluminum and mild steel. This project is about focusing on design and fabricate the jig and fixture to assemble and disassemble piston pin(wrist pin) from connecting rod (Piston Removal – PR). Besides that, it is to analyze the effect on the piston part which the comparison between using the jig and not use the jig after the PR was completed. These jigs and fixture are used at main assembly line to

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assemble the engine components. The result that obtained after comparison process will be recorded.

2.0 JIGS AND FIXTURE CONCEPTUAL DESIGN

2.1 JIGS AND FIXTURE

The Jigs and fixture also known as production devices holder are generally work holders with without tool guiding setting arrangement. Jigs are provided with tool guiding elements such as drill bushes. These direct the tools to the correct position on the workpiece. Jigs are rarely clamped on the machine table because it is necessary to move the jigs with the machine spindle. [1] Fixtures hold the workpiece securely in the correct position with respect to the Machine cutter during operation. There is sometimes a provision of the fixture 'setting' the tool with respect to the workpiece fixture, but the tool is not guided as in a jig. Fixtures are often clamped to the machine table. [1]

Fixture can also be defined as a special tool used for locating and firmly holding a work piece in the proper position during a manufacturing operation. As a general rule it is provided with device for supporting and clamping the workpiece. In additional, it may also contain devices for guiding the tool prior to or during its actual operation.

Thus, jig is types of fixture with means for positively guiding and supporting tools for drilling, boring, and related operation. Hence, the drill jigs which are usually fitted with hardened are bushing to located, guide, and support rotating cutting tools.[2] Jigs and fixtures represent embodies of the principle of the transformation of skill. The skills of the experienced craftsmen, designers and engineers are permanently built into the fixture and are thereby made continuously available to the unskilled operator. One important goal is to design a fixture in such a way as to make it foolproof, and thereby contribute to added safety for the operation as well as the work. [2]

A jig is a special device that holds, supports, or is placed on a part to be machined. It is a production tool made so that it not only locates and holds the workpiece but also guides the cutting tool as the operation is performed. Jigs are usually fitted with hardened steel bushings for guiding drills or other cutting tools. A jig is any of a large class of tools in woodworking, metalworking, and some other crafts that help to control the location or motion (or both) of a tool.[7]

A fixture is a device for locating, holding and supporting a workpiece during a manufacturing operation. It is a production tool that locates, holds, and supports the work securely so the required machining operations can be performed. [6] With fixtures, an edge finder, centre finder, or gage blocks position the cutter. Examples of the more-common fixtures include milling fixtures, lathe fixtures, sawing fixtures, and grinding fixtures. Moreover, a fixture can be used in almost any operation that requires a precise relationship in the position of a tool to a workpiece. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. [2]

Fixtures must correctly locate a workpiece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the workpiece in that location for the particular processing operation.

Jigs are similar to fixtures, but they not only locate and hold the part but also guide the cutting tools in drilling and boring operations. A fixture should be securely fastened to the table of the machine upon which the work is done. Examples include mill fixtures or lathe fixtures. But the function of the fixture can also identify a fixture type. So can the basic construction of the tool. Thus, although a tool can be called simply a mill fixture, it could also be further defined as a straddle-milling, plate-type mill fixture. [9]

2.2 ELEMENTS OF JIGS:

Locating element: locating element is position the workpiece accurately with respect to the tool guiding or setting elements in the fixture. Clamping element: these hold the workpiece securely in the located position during operation. Then Element for positioning or fastening the job or jig on machine on which it is used.

2.3 ADVANTAGES OF JIGS AND FIXTURE

Where jigs and fixtures eliminate individual marking, positioning and frequent checking. This reduces operation time and increases productivity. In interchangeability term, jigs and fixtures facilitate uniform quality in manufacture. There is no need for selective assembly and similar components are interchangeable. [1]

For skill reduction, jigs and fixture simplify locating and clamping of the workpieces. Tool guiding elements ensure correct positioning of the tools with respect to the workpieces. There is no need for skillful setting of the workpieces of tools. Any average person can be trained to use jigs and fixtures the replacement of a skilled. Workman with unskilled labor can affect substantial saving labor cost. [1] Cost can be reduce by higher production and reducing in scrap, easy assembly and savings in labor costs result in substantial reduction in the cost of workpieces produced with jigs and fixtures. [1] There is no need to examine the quality of produce provided that quality of employed jigs and fixtures is ensured. [14,15]

2.4 MEANING OF LOCATION

It is very important to understand the meaning of location before understanding about the jigs and fixtures. The location refers to the establishment of a desired relationship between the workpiece and the jigs or fixture correctness of location directly influences the accuracy of the finished product. [4,5] Before deciding the locating points it is advisable to find out the all possible degrees of freedom of the work piece. Then some of the degrees of freedom or all of them are

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restrained by making suitable arrangements. These arrangements are called locators. [1,3]

2.5 CLAMPING

To restrain the workpiece completely a clamping device is required in addition to locating device and jigs and fixtures. A clamping device holds the workpiece securely in a jig or fixture against the forces applied over it during on operation. Clamping device should be incorporated into the fixture, proper clamp in a fixture directly influence the accuracy and quality of the work done and production cycle time:[1,2,3] It should rigidly hold the workpiece.Besides that, Clamping device should be capable to be unaffected by the vibrations generatedduring an operation.

2.6 SOLID MODELING

A solid model is a digital representation of the geometry of an existing or envisioned physical object. Solid models are used in many industries, from entertainment to health care. They play a major role in the discrete-part manufacturing industries, where precise models of parts and assemblies are created using solid modeling software or more general computer-aided design (CAD) systems. [13] The solid modeling technology is implemented in dozens of commercial solid modeling software systems, which serve a multi-billion dollar market and have significantly increased design productivity, improved product quality, and reduced manufacturing and maintenance costs (Requicha, 1988; and Rossignac, 1992). Solid modeling impacts a great variety of design and manufacturing activities.

Examples include early sketches, design decisions, space allocation negotiations, detailed design, drafting, interactive visualization of assemblies, maintenance-process simulation, usability studies, engineering changes, reusability of design components, and analysis of tolerances (Requicha, 1993).

2.7 DESIGN

By generating 3D model the an estimation of manufacturing process can be forecast and analyzed thus it will reduced product development phase. In this case the machining process can be planed properly. it will be necessary to design the jig in 3D model whereby the design can be manipulated with different requirement of engineering. The good design should be not to complex and would compromise within available manufacturing tool and equipments. when the design come out with complex shape, it can be difficult to fabricate a part because of manufacturing limitation, therefore the information of manufacturing limit should be adhered by the designer, thus the design should be practical and not to complex.

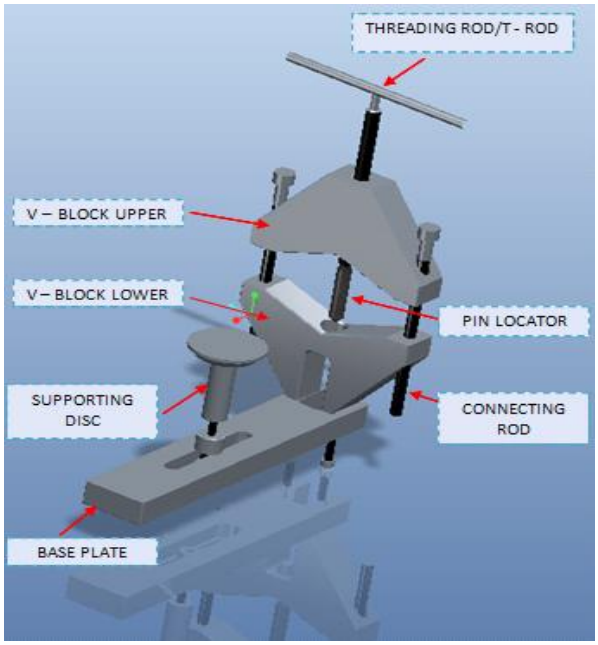

Fig.1- Jig and Fixture 3D Drawing

2.8 MATERIAL SELECTION

For this project, aluminum is being used to make the of jig and fixture because its properties and machinibality criterias. This is because aluminum is lighter and easy to shape by machining process, therefore, its reduce of fabrication time and the jig and fixture is portable because of lighweight.

3.0 FABRICATING

3.1 Machining

The next process is machining. The material was cut near to size and pre machining on milling for squaring. Then, the fixture was milled into the size. The cylindirical parts were machined on lathe (connecting rod disc, Adjustable connecting rod disc, threading rod, and pin locator). Finally, the parts going through a quality inspection on measurement of part dimension that must according with design requirement. The grinding and filing should be necessary for finishing process for safety especially in eleminating sharp edges.

The V clamp (upper and lower blocks) then drilled on three position for clamping purposed and the centre down hole for piston pin disposal. The lower block of V clamp is stand on base plate by mechanical fastener (bolt). Supporting disc is used to leveling the connecting rod for centre allignment of piston pin and pin locator.

4.0 RESULT AND DISCUSSION

4.1 Testing Jigs and Fixture

This process is to simulate the purpose of the jig. The jig should be able pressing the pin piston from the connecting rod without given side effect to the pin and rod. Fig 2 and fig 3 below, show the process assemble and removal the piston by using PR.

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Fig.2- Jig and fixture Assemble

Fig.3- Pin Removal

4.2 Checking Procedure

Profile projector Mitutoyo PV-5000 with 20X magnification and film scale is used to check the effect on the piston part and locator pin.

Fig.4- Piston pin effect

Fig.5- Piston pin check effect using P.Projector.

Fig.6- Piston surface

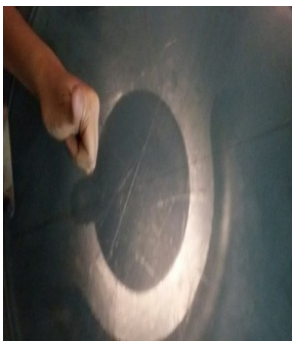

Fig.7-Piston surface check effect using P.Projector.

4.3 Result

The magnified image from projector shows that there is no dent, crack or scratch on the piston pin and housing surface after five experiments were carried out for assemble and removal the piston pin, as shown fig 4, fig 5,fig 6, and fig 7.

Part	*No of Test*				
	1	2	3	4	5
Piston Pin	Ok	Ok	Ok	Ok	Ok
Surface Piston	Ok	Ok	Ok	Ok	Ok

Table 1: Experiment conduct using jig

4.3.1 Material For Custom made Locator Pin

Fig.8- Aluminum pin locator.

Fig.9- Aluminum pin locator.

Fig.10- Mild steel pin locator.

Fig.11- Mild steel pin locator

Result shown that Aluminum custom made pin locator has pronounced effect on the surface. Scracthed and dented clearly found on side where the area of pin locator meet piston pin at fourth and fifth experiment as shown on fig 8 and 9. The wear and screcth occurred pronouncedly at the first contact area between pin locator and piston pin and progress rapidly when more pressure exerted by rotating pin locator screw. Instead, for the mild steel locator pin, there was no visible effect on the locator pin after the five times test as shown in fig 10 and 11. Thus, mild steel is suitable for use on this jig to assemble the piston pin.

		PART	*No of Test*				
			Wear				
			1	2	3	4	5
Assemble	Locator Pin	Mild Steel	No	No	No	No	No
		Aluminum	No	No	No	wear (scratched)	wear (Dented)
Removal		Mild Steel	No	No	No	wear (scratched)	wear (scratched)
		Aluminum	No	No	wear (scratched)	wear (dented)	wear (dented and scratched)

Table 3: Assembly and removal process using jig

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5.0 RECONMENDATION

After the overall review approach, it is recommended that there are several things can be highlighted for purposes of modification and improvement of this project. The recommendations as follow;

i)Changing the locator pins from Alumium to Mild steel to reduce wear on pin locator in preventing wear that can cause un even force or load when assemble and dissamble piston pin.

ii)Plug the nut in the hole on the upper part to strengthen and smooth movement of T-handle to operation when the force is applied on it. On this project the thread (tapper) in the upper part is not suitable due to soft aluminum material.

In addition, the upper and lower parts, do post improvements with rubber or soft substance on the surface of the upper and lower part jig in order to avoid scratches on the piston surface when assemble and removing the piston pin. The availability of these products, its enable mechanical work replacing energy oriented approach of conventional method and at the same time its preventing a damage on piston parts. Therefore, the product is very suitable for workshops that provide service and repair of motor vehicle engines. This jig also can be used during a engine overhaul and piston assembly.

6.0 CONCLUSION

The jig and fixture is implementing new approach on the method to assemble and dismantle the piston pin instead the conventional method by hammering. The main objective is to reduce the damage on piston pin, piston block and connecting rod as result of conventinal method. This innovative mechanize jig and fixture offer the new procedure of removing and assemble piston pin at cheapest engineering price. The experimental result convinced that, this product appears to work well as per objective to remove and install a piston pin from connecting rod.

Product design and development requires that engineers consider trade-offs between product attributes in the areas of costs, weight manufacturability, quality and performance. "The optimum" design is in fact usually one in which compromises are acceptable, but understanding the impact of design decisions on all relevant attributes is tremendously difficult. Engineers are faced with the difficult challenge of determining how to arrive at the overall design, making the right compromises, and not sacrificing in critical attributes like safety.

Therefore, the product is very suitable for workshops that provide service and repair of motor vehicle engines. This jig can be used during a engine overhaul and piston assembly, as well as be used as a portable press machine to remove a piston pin that stuck in the piston.

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