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Design of Gear Cutting Fixture for CNC Gear Hobbing Machine

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***Abstract*-** The present work deals with the design of Gear Fixtures for L200 and H250 CNC Gear Hobbing Machines. The task on hand was to design fixture for the components, namely Reduction ideal gear and 4t1i and 3rd speed gear for gear box used in HMT Tractors. Fixture design and selection starts with the component and the manufacturing operation to be performed. The criteria for this design process are accuracy, positive location, repeatability, production rate and importantly, the reliability under the action of the cutting force and shear experienced. The clamping forces and construction easiness have also been accounted for design. The proposed design was then checked for safety under the action of the involved stresses. The calculations of the cutting force are shown and proved that the forces at various vital points in the design are well below safety limits. Expert analysts then approved the design.

***Index Terms*-** Gear hobbing machines, jigs and fixtures, gear fixtures

I. Introduction

Manufacturing tolerancing is intended to determine the intermediate geometrical and dimensional states of the part during its manufacturing process. These manufacturing dimensions also serve to satisfy not only the functional requirements given in the definition drawing, but also the manufacturing constraints, for example geometrical defects of the machine, vibration and the wear of the cutting tool. Many research works were treated the tolerancing problem with different approaches, Rong and Bai [1] analyzed a dependent relationship of operational dimensions to estimate machining errors in terms of linear and angular dimensions of a work piece. Cai et al. [2] proposed a method to conduct a robust fixture design to minimize work piece positional errors as a result of work piece surface and fixture setup errors. Djurdjanovic and Ni [3] developed procedures for determining the influence of errors in fixtures, locating datum features and measurement datum features on dimensional errors in machining. These studies were conducted when a static case was assumed. Kim and Kim [4] have developed a volumetric error model based on 4x4 homogenous transformation for generalized geometric error. Eman and Wu [5] have developed error model accounts for error due to inaccuracies in the geometry and mutual relationships of the machine structural elements as well as error resulting from the relative motion between these elements. Kakino et al. [6] have measured positioning errors of multi-axis machine tools in a volumetric sense by Double Ball Bar (DBB) device. Takeuchi and Watanabe [7] have shown five-axis control collision free tool path and post processing for NCdata. In the work of [8], the authors present an experimental semi study of the vibratory behavior of the cutting tool golds of the operation of slide-lathing, is the object to show that it is possible to consider the roughness average of the part machined starting from displacement resulting from the nozzle of the tool. In the work of [9] a study was presented on the influence of the position of the cutting tool on dynamic behavior in milling of thin walls, and in work of [8-10], authors thus illustrate the influence of the trajectory of the cutting tool on the surface quality tolerances of manufacture for machining on the machine tool has numerical control.

II. Problem Formulation

The clamping of the work piece by using ordinary mechanical work holding devices uses single work piece for machining in each cycle. So this increase the cycle time hence decreases the productivity. Hence there was a need to design a special work holding devices. According to the specification given by the customer, about the requirement like maximum diameter of the blank, number of teeth to be cut, module, etc. The fixture is designed based on these parameters. The customer use the machine tool for batch production i.e., why the fixture is also designed in such a way that just by changing the upper half part of the fixture, the customer can switch on to other batch production with different specification and apart from this change of speed, feed by changing the gears according the requirement. The problem was to reduce the cycle time by reducing clamping and unclamping time. Since the machining should be vibration free to accurate machining, the problem has been overcome by actuating the mechanism through hydraulic cylinder. Since the machining is carried out for multiple numbers of jobs, it reduces the machining time and hence the overall manufacturing lead-time.

The type of fixtures depends on the component design and type of machine used. Shaft type component require a totally different type of locating and driving arrangement compared to the disc type component with a locating bore. The type of fixture can be grouped into the following categories as:

- Locating mandrel and face clamping for disc types of gear blanks with controlled bore for location.
- Collet type of shaft type components having a controlled diameter for location.
- Fixture with carrier drive for shaft type components located between center

The following factors are to be considered while designing work holding fixtures for gear hobbing applications:
1. The overall size of the component should be within the capacity of the machine.
2. For gear hobbing fixture, the component should be positioned as near the table as possible, allow hob approach on both sides.
3. The fixture should be checked for easy loading and unloading of the component.
4. The number of blanks loaded in each setup should depend upon the accuracy requirement; parallelism and squareness of the locating bore in the component.
5. Long work pieces should be supported within an additional steady rest opposite to the cutting side.

III. MANUFACTURING PROCESS

The manufacturing process is analyzed for the following components involved in the manufacture of the fixtures. The maximum diameter required for the finished special center is 35 mm. Therefore we select a diameter of 40mm, which is commercially available. The length of the bar is cut to 195mm. The standard sleeve is MT4.1.

SL NO	COMPONENT	MATERIAL	MACHINE
1 2 3	Special center Special Cassette Base Collet	Tool Steel C45 Spring Steel	L200 (bobber) WS1 L200 (bobber)

The work piece is turned to diameter of 36mm including the finishing tolerances arid is faced to a length of 182 with tolerance of 5mm. After turning the work piece is taken for stress relieving operation in which the material's temperature is increased to about 180-200. The above operation removes any stresses during the turning and facing operation. The pregrinding operation is carried out with tolerance of at least 0.3mm excess in diameter on all surfaces. The work piece is then heat treatment to hardened and tempered to HRC of 62-64. Finally finish grinding to the required size is done followed by thread grinding operation. This operation ensures that threads formed are soft because finish grinding removes the hardened case and soft core is exposed.

IV. CONCLUSIONS

The present work emphasize on Gear fixture Design for the components namely lay Shaft for gearbox used for HMT Tractor, and Worm Wheel used in Car Steering Mechanism of Chinese Car. The present design of the machine could eliminate the marking out, measuring and other setting methods before machining and thereby enhance the machining accuracy and product capacity. It could also reduce the expenditure on the quality control of the finishing products. It reduces the operator's labor and consequent fatigue as, the handling and unloading of component. The proposed designs were checked for safety under the action of the involved stresses and were found to be well within the safety limits. The expert's analysis in HMT then approved the designs. The same can be adopted for similar component manufactured in the same machine.

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