NATIONAL CONFERENCE ON INNOVATIVE TRENDS IN ENGINEERING & TECHNOLOGY – NITET-19
15-16th March 2019
NOVATEUR PUBLICATIONS
International Journal Of Innovations in Engineering Research And Technology [IJIERT]
ISSN: 2394-3696

DESIGN, ANALYSIS AND MANUFACTURING OF SPECIAL MANDREL FOR GEAR TEETH GRINDING

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ABSTRACT
In the present techno economic scenario every manufacturing industry takes great effort in cutting down costs by reducing errors in manufacturing and resources. Our present investigation is an attempt made in the same direction by designing a special mandrel which will eliminate run-out error of gear, reduce inventory cost and increase productivity by reducing the machining time.
Geer teeth Grinding, as a final process, exerts great influence on quality and accuracy of surface layer of teeth of gears. The mandrel and sleeve is designed in such a way that it can accommodate a range of gear sizes on a single mandrel instead of using separate mandrel for each gear. For example: For gear sizes of internal diameter 31-40 mm only one mandrel is required along with expandable sleeves.
As per the problem identified we designed a mandrel and sleeve, in CATIA-V5. Further it was analysed in the software for any aberrations. It was then simulated for real time working conditions. After complete analysis and approval of design , all modes of failures were tested and design was finalized and selected for fabrication.
KEYWORDS - Gear Teeth Grinding, Run-out Error, Mandrel, Expandable Sleeve, Machining Time

1. INTRODUCTION

When the teeth grinding of gear is to be performed, it is mounted on a mandrel. Mandrels or arbor's are tool components that are used to grip or clamp the material being machined (Gears in this case) or other moving tool components. Some mandrels are shaped bars of metal that are placed inside or next to the workpiece to be machined. The mandrel is tasked with holding the gear firmly without any movement. In the existing system of holding gears for teeth grinding process different types of mandrels are used for various bore diameters of gears. This results in a run-out error of approximately 20-25 microns and also increases cost of inventory and time required for gear teeth grinding. Ultimately this affects the quality of gears which are to be used for different purposes like in machine gearbox, automobile gearbox etc. This defect causes noises, vibration and also gear jamming. To avoid this we have designed a special mandrel and different expandable sleeve for eliminating run-out. Thus saving time and money wasted in rework. The design section of the paper will talk more about these items.

2. LITERATURE REVIEW:-

In past, there was less research and articles available on mandrel ,as the industries or small companies have manufactured the mandrels as per their requirement and there is no standard for it; Mandrels were designed as per the requirement. To accomplish this review, the consultation of a number of patents on mandrels were used.They are:

(Plach E.,1978) suggested an expandable chuck which can be used singly with a dummy support at the end of a mandrel where only a support is required for gear mounting. Alternatively, a pair of such expandable chucks may be provided, one at each end of the mandrel, where greater support capability is required. While the chuck disclosed is intended for use with hollow core . It will be apparent that it may have additional applications. It can be used to rotate gear or other hollow tubular members and conceivably could be employed as part of a power train arrangement for transmitting rotary motion.

(Williams L, 1989) concluded that the expandable mandrel is directed towards providing an improved apparatus for being inserted between a mandrel and the sleeve to act as a spacer between the mandrel and the gear. This concept is to provide a plurality of elongated and elastic means extending through the transverse apertures of the beam members for joining the beam members to one another to form an expandable sleeve for being inserted over the outer circumference of the mandrel and for being inserted into the eye of the coil of strip material.

(Poonam D. Chavan) *et al*. in her study of a study of gear run-out checking fixture explained that fixtures are widely used in industries due to their quality of increasing the accuracy and minimizing the operational time. The use of fixture eliminates frequent checking, individual marking, positioning and non-uniform quality in the manufacturing process.

3.METHODOLOGY:

A. MANDREL DESIGN:

A mandrel is a flanged, tapered or threaded bar that grips a work piece to be machined in a machine tool.A flanged mandrel is a parallel bar of a specific diameter with an integral flange towards one end.and threaded at the opposite end and tapper at the middle part.workpiece is gripped between the flange and the nut on the thread ie. On the tapered surface .The taper on mandrel is of approximately 1:20 i.e. 1 mm for 20 mm length.

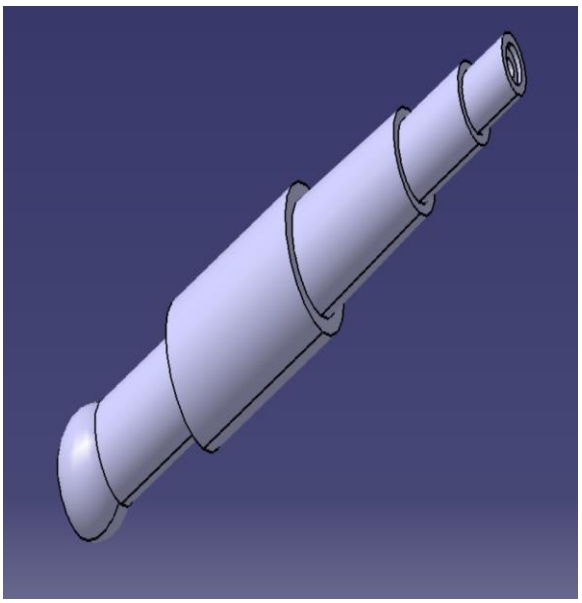


Fig.1 3D View of Mandrel

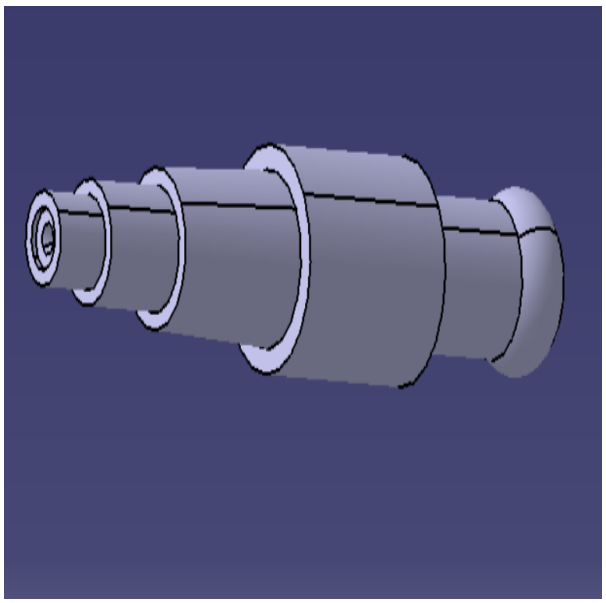


Fig.2 3D View of Mandrel

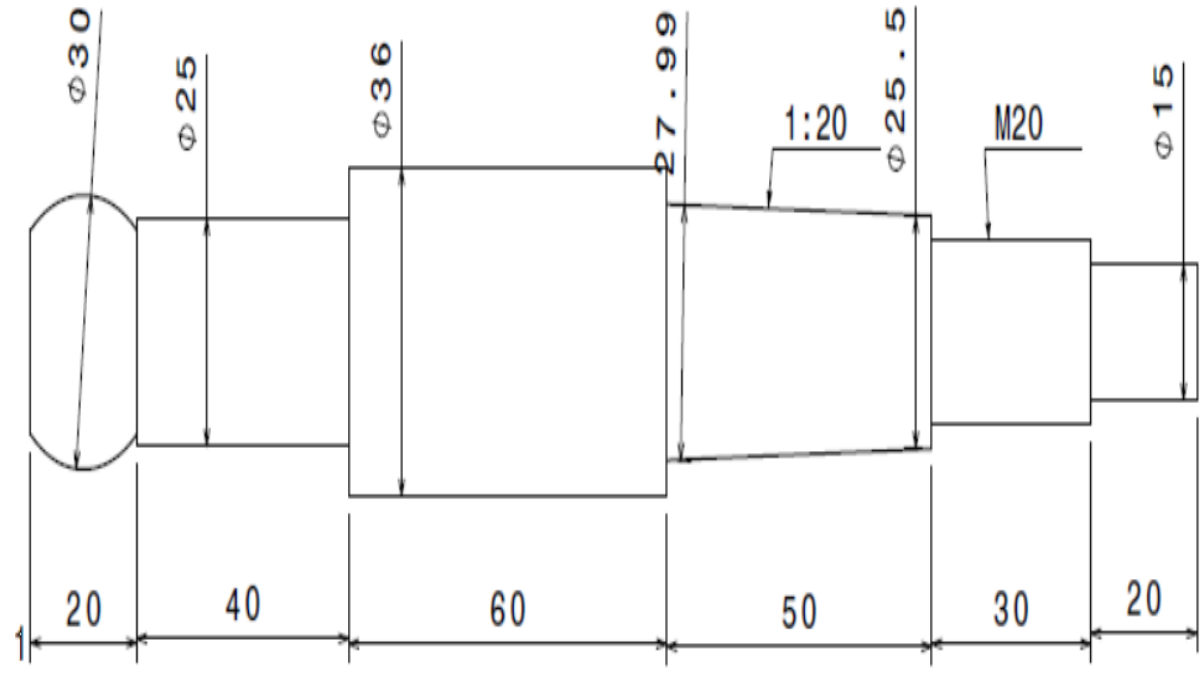
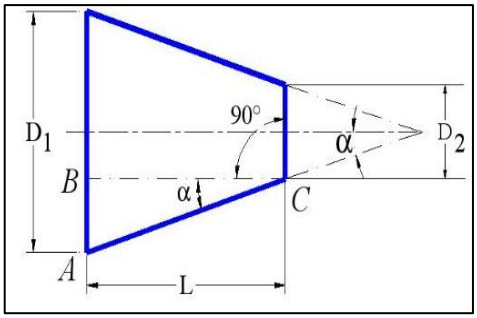


Fig.3 Mandrel for gear size dia (31-40) mm

The various dimensions of gears were categorised into 6 sets and accordingly 6 mandrels were designed similar to Fig.3

Gear size (internal dia in mm)	21-30	31-40	41-50	51-60	61-70	71-80
Mandrel	A	B	C	D	E	F



DESIGN CALCULATIONS

a) Taper Calculations:

Data:

D1= 28 mm

D2= 25.5 mm

L = 50 mm

$\tan \alpha = \frac{D1-D2}{2L}$

$= \frac{28-25.5}{2*50}$

$\tan \alpha = 0.025$

$\alpha = 1.6º$

b) Thread Dimensions

Mean Diameter 20 mm

Pitch 2 mm (Fine)

B. SLEEVE DESIGN :

Sleeve is one of the most widely used clamping device for fixing circular workpieces. Sleeve holds the work piece by expanding externally. A hollow sleeve with tapered surface having slits cut along its axis is designed. These slits have equal space and cut around its circumferential surface. Sleeve can hold a cylindrical work by outer diameter. Owing to the slits, one end of the sleeve can be squeezed to reduce its diameter, or it can be expanded to enlarge diameter and provide a secure grasping pressure against the work. Because there is a limit to the reduction obtainable in a sleeve of any given diameter, these work holding devices must be made in various sizes to match the particular work size in operation.

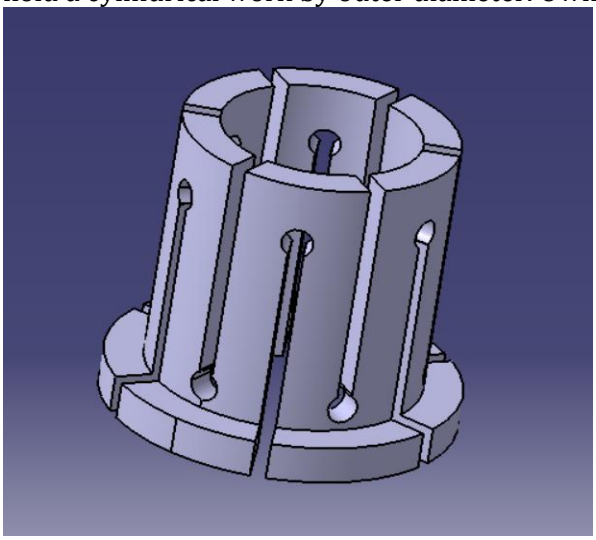


Fig.4 3D View of Sleeve

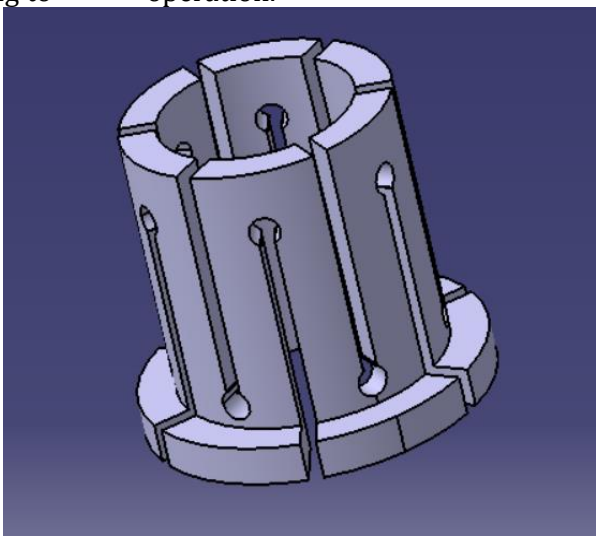


Fig.5 3D View of Sleeve

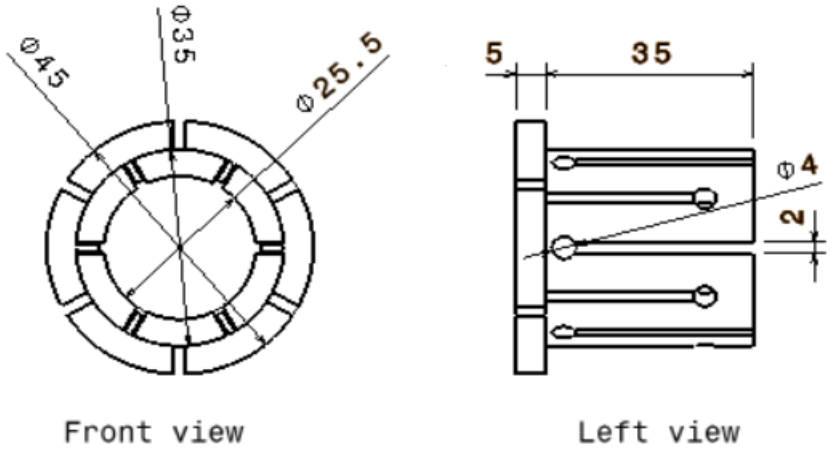


Fig.6 Sleeve for gear dia 35 mm

C. ASSEMLY DESIGN :

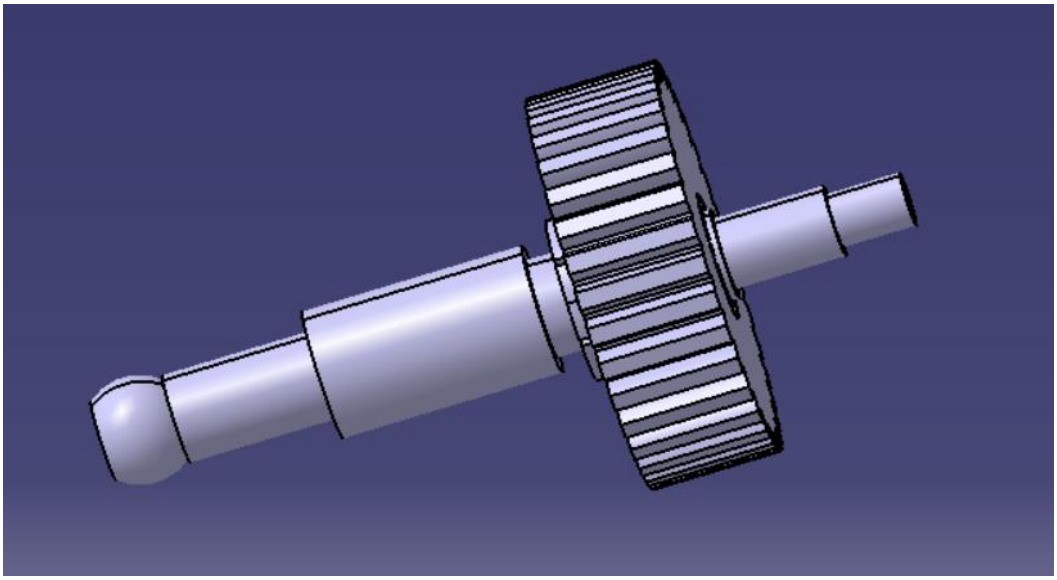


Fig.7 Assembly View of Gear on Mandrel

As shown in Figure 7 , sleeve remains fixed. By pushing the mandrel to the right side, taper surface of mandrel pushes the taper surface of the sleeve. Due to this pushing force, the sleeve has to expand ,which will clamp the job resting over it firmly. This restricts all 12 degrees of freedom of the workpiece. At the same time, the orientation of the workpiece is also taken care of. Location of the workpiece is also achieved with or without using workstops. Thus, the expanding sleeve draws the part firmly against the stop, producing a stable part location. Short grip lengths can be firmly held when the part is pulled back against a workstop. When machining just the outer diameter of the part, workstops may not be necessary.

4. MATERIAL SELECTION

EN24(Europeon Norms) steel is a high tensile alloy Steel known for its wear resistance properties and also where high strength properties. It is a popular grade of hardening alloy Steel. It can be further surface hardned to create components with enhanced wear resistance. Because of this reasons, we have chosen above material. Following table shows the chemical composition of material:

Table 1 : Chemical compostion of EN24

Material	C	Mn	Si	S	P	Ni	Ti	Cr	Mo
Composition	0.38	0.85	0.22	0.016	0.018	1.30	0.1	1.08	0.27

MANUFACTURING PROCESSES :

After getting required design and material, mandrel and sleeve are to be manufactured and implemented in actual work.

6. CONCLUSION:

The main objective of this project is to analyze the reduction in run out error during gear teeth grinding process. The rework is reduced as much as possible by creating a design followed by analysis of the mandrel and sleeve used presently and the newly designed mandrel and sleeve.

Implementation of project resulted in achieving the following benefits:

1) Run-out of gears is reduced.
2) Quantity of using various mandrels is limited.
3) Time required for gear teeth grinding is reduced.
4) Cost of preparing various mandrels are reduced.
5) Gear quality is improved.

ACKNOWLEDMENTS :

We would like to express our deep gratitude to Tatyaso A. Mane sir of Laxmi Hydraulicss Pvt. Ltd. who provided their valuable time and supported us for this research paper.

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