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Design and Analysis of Multiangle Drilling Machine

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Abstract - *Now-a-days industries uses different milling machines to drill holes at various locations and orientation. Use of such milling machine increase initial cost incur in purchasing machine. Some industries uses angle vice to drill the hole at any orientation. But with the use of such angle vice time required to orient the job increases. It also required more human effort to orient the job in case of large workpiece like IC Engine block.*
With the use of multiangle drilling machine we don't need to move the workpiece in any direction. We can only need to rotate the knob of machine to obtain required angle. So it reduces cost incur in milling machine and also human effort.

***Key Words*: Multiangle Drilling, Bevel Gear, Spline shaft, Double cardan universal joint, Design, Analysis.**

1. INTRODUCTION

Drilling is the process of creating required size hole by removing metal with the help of cutting tool called drill bit. Any drilling operation is normally done with the help of drilling machine in workshop. It produces cylindrical hole in a workpiece of required thickness and diameter. Drilling machine generally consist of motor, base, column, drill head, spindle, table, etc.

Types of drilling machine:

Drilling machines are manufactured in different types and method of spindle movement and the required accuracy.

The different types of drilling machines are:

1. Portable drilling machine (or) Hand drilling machine
2. Sensitive drilling machine (or) Bench drilling machine
3. Upright drilling machine
4. Gang drilling machine
5. Radial drilling machine
6. Deep hole drilling machine
7. Multiple spindle drilling machine

In the workshop for straight drilling on horizontal surface generally vertical drilling machine is used. Generally most of the drilling operations are done on drilling machine. But sometimes lathe machine can also be used to drill the hole in workpiece. But in case of drilling on lathe workpiece is rotating and feed is provided by sliding tailstock.

By using vertical drilling machine we can't drill on inclined surface. To drill on inclined surface we require angle vice. But in case of heavy workpiece operation of angle vice require more human effort. Also it take more time to align the job at specific orientation. Also we can drill single hole at a time by using vartical drilling machine because of single spindle.

Sometimes there is a problem while inclined drilling on inclined surfaces, in such cases we can use multiangle drilling machine which produce drill in required angel on inclined surfaces. For that we use bevel gear, spline shaft, Double Carden Universal Joint, ball bearing, Rack and pinion Arrangement for making of multiangle drilling machine.

2. LITERATURE REVIEW

We studied the research paper on Universal Joint[1] from which we get idea about power transmission through universal joint. We studied construction and various component use to make universal joint. Also we studied working of universal joint. After reading the research paper we also get the idea about stresses coming on different parts of universal joint. We understand that the fork pin of universal joint experience more stresses at the point of contact with the fork. This causes more wear and tear at the point of contact of fork and fork pin. Due to more wear and tear undesirable vibrations are produced in transmission system. We also get the idea about design and analysis apply on universal joint. By using the same paper we understand the boundary conditions applied for analysis and also meshing used for analysis to get more and more accurate result.

We also studying from research paper of spline shaft[2] from which we get idea about torque transmission through spline shaft. Also we studied how the torque is transmitted through spline shaft. Also we get idea about stresses produced in the spline shaft under various loading conditions. Also we understand the causes of failure of spline shaft due to variable torque transmission. Also we get the idea about stress concentration areas of spline shaft. Also we get idea about how to apply boundary condition and which type of meshing required for better result?

We also studying from research paper of bevel gear[3] we get the idea about power transmission through bevel gear. Also we get idea about stresses produced in the bevel gear under various power transmission conditions. Also we understand the causes of failure of bevel gear due to variable torque transmission. We get the idea about bending failure and pitting failure of bevel gear due to bending stresses and

contact stresses respectively. Also we get the idea about stress concentration areas of bevel gear. also we get idea about how to apply boundary condition and which type of meshing required for better result?

By using research paper on Multi Spindle Drilling Head[4] we cover most of the calculation part of the project. WE get the calculation ideas of prime mover, spindle, shaft, drill holder, etc. Also we get idea about stresses produced in the same component under various loading conditions. Also we understand the causes of failure of such component due to variable torque transmission. Also we get the idea about stress concentration areas of components. Also we get idea about how to apply boundary condition and which type of meshing required for better result?

3. PROBLEM DEFINITION

Today we are facing various major problems regarding traditional vertical drilling machine, some of the problems are mentioned below:

1. Due to less flexibility of workpiece in the Vertical Drilling Machine, we are designing the Multi Angled Drilling Machine.

2. We were having many difficulties while designing the components of the Project on paper.

3. While drilling on different inclined surface by using vertical drilling machine, it takes more time for handling of workpiece by using angular vice because of its heavy weight , So time required for drilling increases.

4. If we required to drill on inclined surfaces of heavy workpiece (for example IC Engine block) and if we used angle vice then it required more human effort because of its heavy weight.

4.OBJECTIVES

The aim of this project is to Design And Analysis of Vertical And Multiangle Drilling Machine.

1. Designing the Multi Angled Drilling Machine will be done by using Modelling Software like Auto CADD and SolidWorks.

2. The designed assembly will be analyzed on Analysis Software like ANSYS.

3. With the use of multiangle drilling machine we don't need to move the workpiece in any direction. We can only need to rotate the knob of machine to obtained required angle. By adjusting the knob we can change the angle of drill bit according to requirement.

4. With the use of Multiangle Drilling Machine we don't need to move workpiece in any direction. So human effort required to move any heavy workpiece are reduces. In this machine human need to adjust only knob provided to machine to change the angle of drill bit according to requirement.

5. WORKING

Multiangle Drilling Machine work on the same Principle that of normal Vertical Drilling Machine. Tip of drill bit apply force on workpiece which produce hole on workpiece.

By Using Multiangle Drilling machine we can Drill Vertical as well as inclined hole on the workpiece surface at a time. So we can done multiple operation in a single feed of the machine. To achieve inclined drilling we use different mechanical component such as Universal Joint, Spline Shaft, Bevel Gear, Rack and Pinion Arrangement, etc.

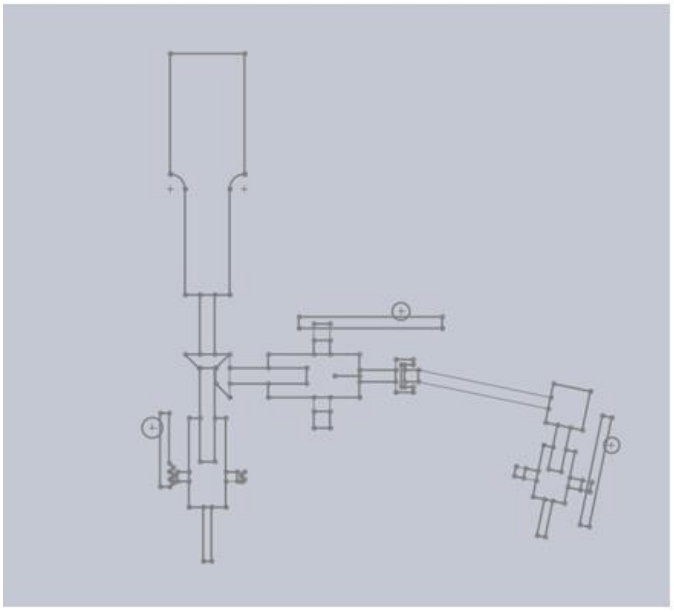
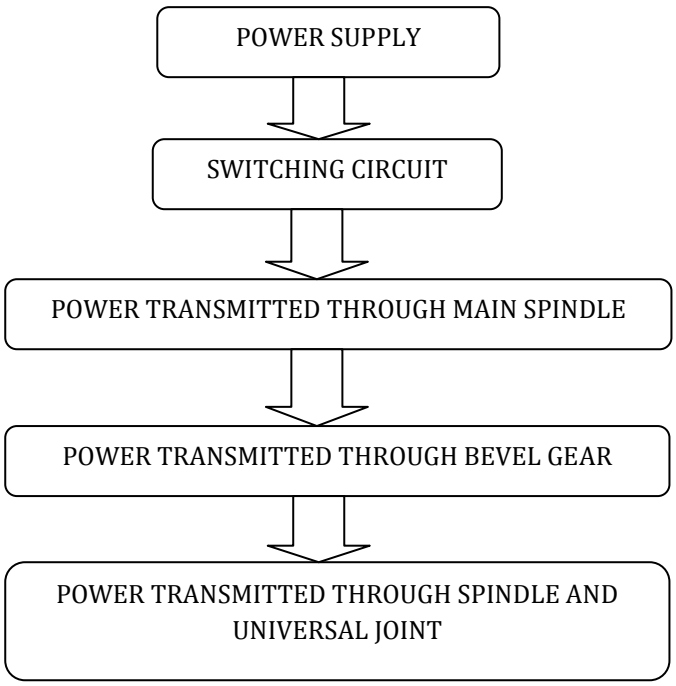
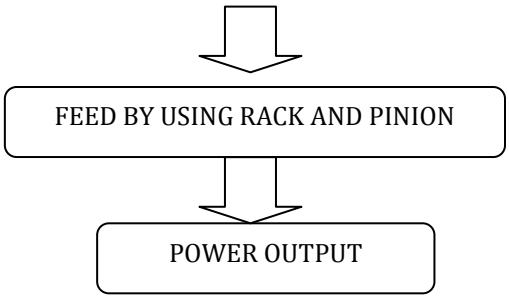


Fig -1: 2D Sketch of Multiangle Drilling Machine

5.1 HOW DOES IT WORKS ?





6. DESIGN AND CALCULATIONS

6.1 Prime Mover

Hole Diameter (d) = 6 mm & 7 mm
Plate Thickness (t) = 10 mm
Material of the Work piece = Cast Iron
Power Required = $\{D^2 \times 1.25 \times N \times K \times (1.5 \times Fn) + 0.056)\}/10^5$
For Hole Diameter of 4 mm
Power = $\{6^2 \times 1.25 \times 720 \times 1.5 \times ((1.5 \times 0.0635) + 0.056)\}/10^5$
Power = 0.073 kw
For 2 Spindles = 2×0.073 = 0.146 kw
Power Required = 0.14×1.341 = 0.1957 HP
For Hole Diameter of 7 mm
Power = $\{7^2 \times 1.25 \times 720 \times 1.5 \times ((1.5 \times 0.0635) + 0.056)\}/10^5$
Power Required = 0.1 kw
For 2 Spindles = 2× 0.1 = 0.2 kw
Power = 0.2×1.341 = 0.2682 HP
Total power required to drill hole = 0.2682+0.2682
= 0.5364 HP
Therefore we can use the motor of 1HP.

6.2 Spindle

Consider Spindle Diameter = 16 mm
Material used for Spindle = Mild steel
Power (P) = 2πNT/60
Torque (T) = $(0.7457 \times 10^3 \times 60)/(720 \times \pi \times 2)$
T = 9890 N-mm
Consider there is 25% overload
T = 12362.5 N.mm
Diameter of Spindle (D) = $[(16/\pi \times \tau) \times Kt \times Mt]^{0.33}$
$40 = [(16/\pi \times \tau) \times 12362.5 \times 2]^{0.33}$
$\tau = 1.7594$ N/mm^2

Shear stress developed in spindle is 1.7594 N/mm^2. This value of shear stress is less as compare to yield stress of spindle material. (415 N/mm^2).
Therefore spindle design is safe.

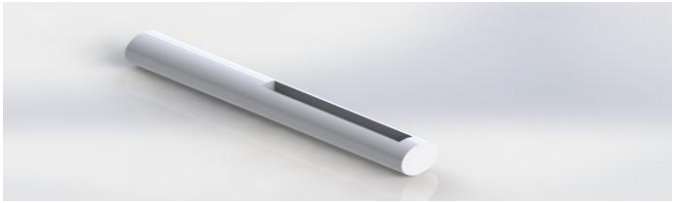


Fig -2: Spindle Shaft

6.3 Shaft

Shaft Material = Mild Steel
Shaft diameter = 20 mm
Torque experienced by shaft = 12362.5 N-mm
For Shear Stress,
$D = \{(16/\pi \times \tau \times (1-K^4)) \times Mt \times Kt\}^{0.33}$
$40 = \{(16/\pi \times \tau \times (1-0.571^4)) \times 2 \times 12362.5\}^{0.33}$
Shear stress (τ)= 1.96 N/mm^2

Shear stress developed in shaft is 1.96 N/mm^2. This value of shear stress is less as compare to yield stress of spindle material. (415 N/mm^2).
Therefore spindle design is safe.

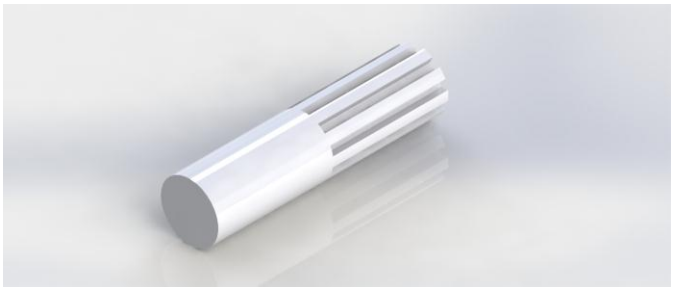


Fig -3: Spline Shaft

7. ANALYSIS OF COMPONENTS

7.1 Spindle

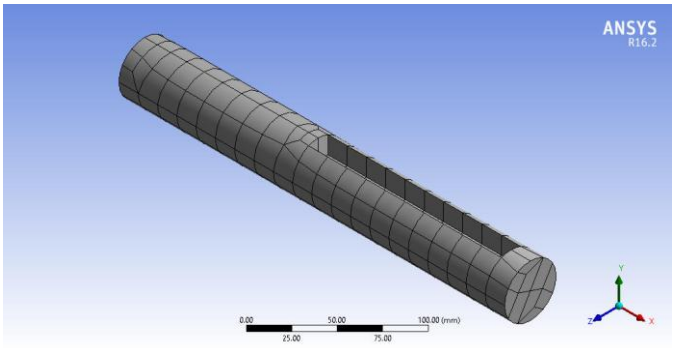


Fig -4: Meshing

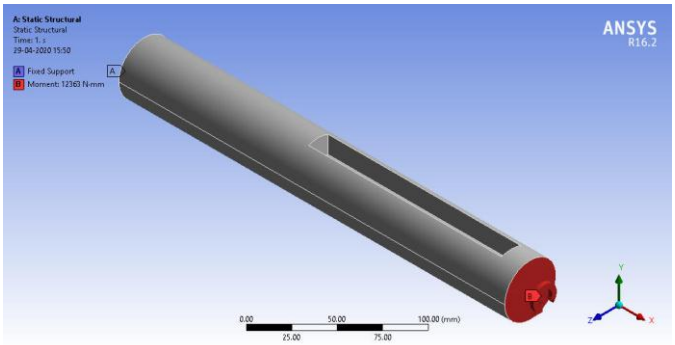


Fig -5: Boundary Conditions

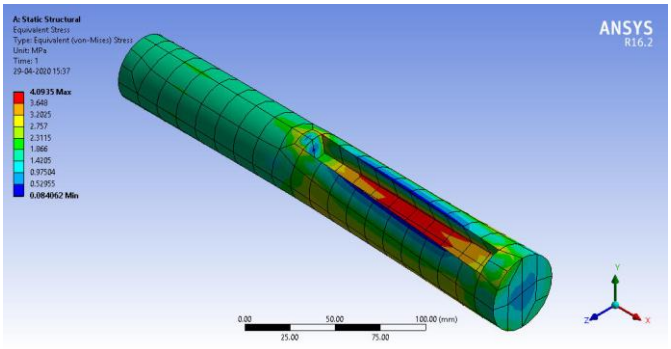


Fig -6: Equivalent Stress

The equivalent stress induced in the spindle is 4.0935 N/mm^2.

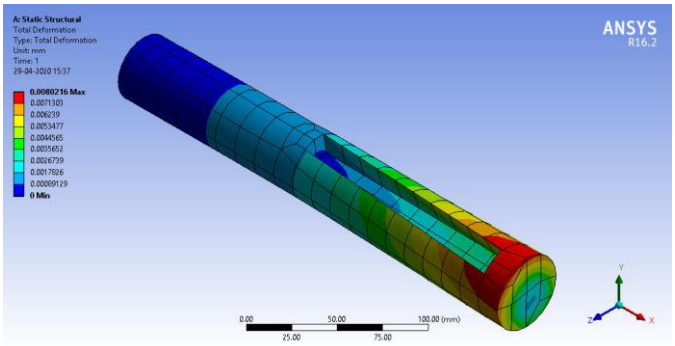


Fig -7: Total Deformation

The total deformation observed in the spindle is 0.008 mm.

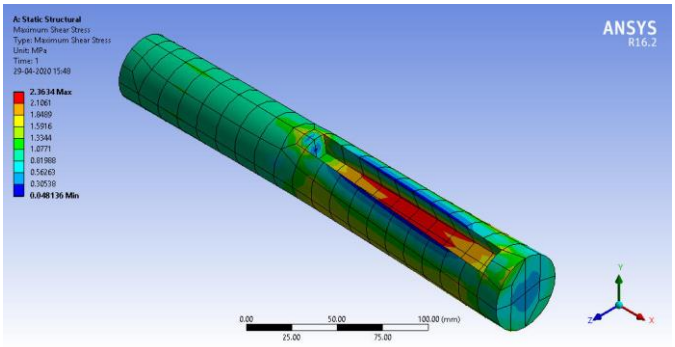


Fig -8: Maximum Shear Stress

When we apply Moment of 12362.5 N/mm^2, Shear stress developed in spindle is 2.3634 N/mm^2. This value of shear stress is less as compare to yield stress of spindle material i.e. (415 N/mm^2).

Therefore spindle design is safe.

7.2 Spline Shaft

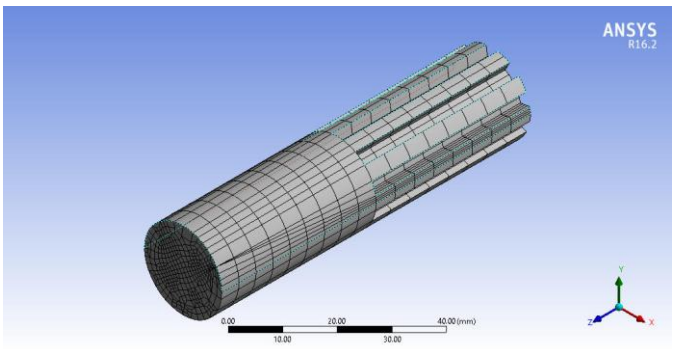


Fig -9: Meshing

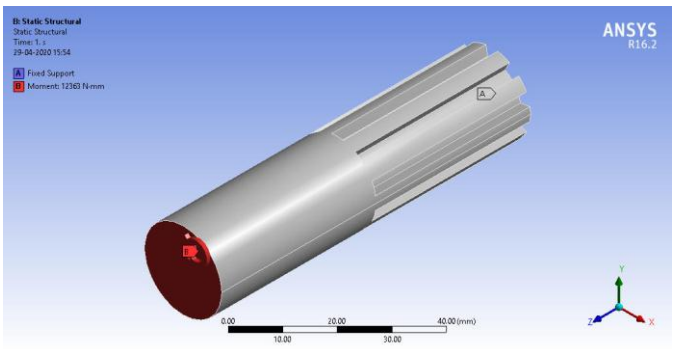


Fig -10: Boundary Conditions

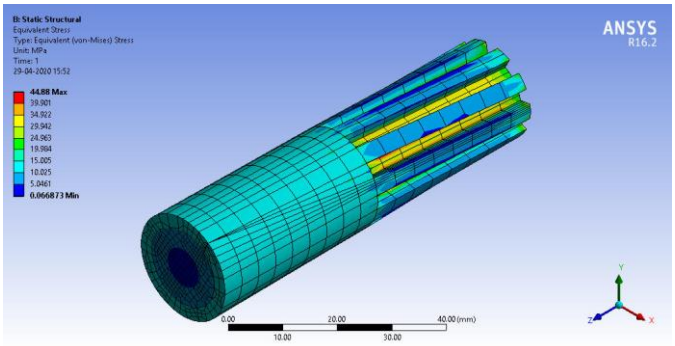


Fig -11: Equivalent Stress

The equivalent stress induced in the spindle is 4.0935 N/mm^2.

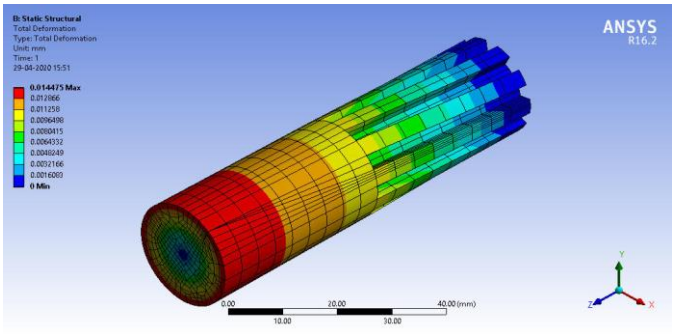


Fig -12: Total Deformation

The total deformation observed in the spindle is 0.008 mm.

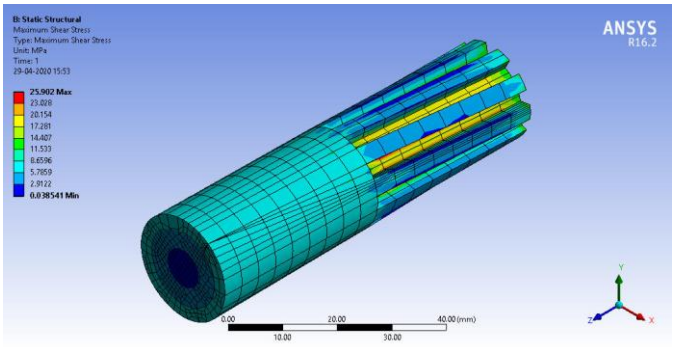


Fig -13: Maximum Shear Stress

When we apply Moment of 12362.5 N/mm^2, Shear stress developed in spline shaft is 25.902 N/mm^2. This value of shear stress is less as compare to yield stress of spindle material i.e. (415 N/mm^2).

Therefore spindle design is safe.

8. CONCLUSION

By Using Multiangle Drilling machine we can Drill Vertical as well as inclined hole on the workpiece surface at a time. So we can done multiple operation in a single feed of the machine. Also this machine is more advantageous over the conventional drilling machines. This machine will reduce human effort in great extent.

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