Design and Analysis of Twist Drill Bit

Dr. Jayananda Kumar T[1] | B V N V NarasimhaButcheswara Rao N[2]| Venkata Reddy A[3]| R S phani Krishna Y[4]| Rahul Kumar[5]

[1,2,3,4,5]Department of Mechanical Engineering, Godavari Institute of Engineering and Technology (A), Rajahmundry.

Abstract: Drill bit is considered as backbone of drilling process. For optimisation of drilling process bit selection is considered as key aspect. In the present work we used high speed steel asbase material & results are compared with high carbon steel & titanium alloy to select more efficient one out of these three. Modelling of drill bit is done on SOLIDWORKS 2020 and the analysis is performed on ANSYS WORKBENCH 19.2 software. For both modelling & analysis the geometry, input parameters and boundary conditions of drill bit are same. According to the analysis results it is observed that the titanium alloy shows the maximum effective strain with minimum equivalent stress compared with high carbon steel.

KEYWORDS: SOLIDWORKS, ANSYS WORKBENCH 19.2, Drillbit, Titanium alloy.

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INTRODUCTION:

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. It is simple, quick and economical way for making holes without losing the surface finish. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the work-piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work-piece, cutting off chips from the hole as it is drilled. The basic function of drill machine is to construct hole of different size in solid materials. Drilling had wide range of applications in aerospace, automobile manufacturing, construction&medicalindustries, semiconductors and other manufacturing units. From construction field to oil digging drilling had wide range of applications.

Effile tower had 2.5 million rivet joints. That means drill had that much part in the construction of one of the greatest architectures of human. In this modren world, machining industries are focusing on the gaining of a drill bit which has advancement in the surface finishing, higher accuracy, high life span & higher material removal. In today's fast changing situation in manufacturing industries, application of optimisation techniques in metal cutting process is necessary to gain higher efficiency in short period of time to severe competitiveness and growing demand of quality product in the market.

So they are going for different materials for a drill bit to gain the improved product quality, less wear & cutting force

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives, nomenclature and overall description. In Section 2, materials and methodology are defined. In Section 3, we discussed modelling and analysis. Section 4 shares information about the results that have obtained. Section 5 gives the conclusions that are concluded from the work. Section 6 tells us about the future scope and concludes the paper with references.

1.1 NOMENCLATURE OF TWIST DRILL BIT:

- **Axis:** It is the longitudinal center-line of the drill.
- **Diameter:** Largest diameter measured across the top of the lands behind the point.
- **Back Taper**:The diameter reduces slightly toward the shank end of the drill, this is known as “back taper”.Back taper provides clearance between the drill and work-piece preventing friction and heat.
- **Body:** It is the part of the drill from its extreme point to the commencement of the neck.
- **Neck:** The portion with reduced diameter in between body and shank.
- **Shank:** It is the part of the drill by which it is held and driven. The shank may be straight or taper.
- **Tang:** The flattened end of the taper shank is known as tang.
- **Point:** It is the conical sharpened end of the drill.
- **Flank:** Surface of drill which extends behind the lip to flute.
- **Flutes:** The grooves in the body of the drill are known as flutes.
- **Flute Length:**The length of flute measured from the drill point to the end of the flute run out.Flute length determines the maximum depth of drilling.
- **Margins:** The cylindrical portion of the land that is not cut away to provide clearance.
- **Helix Angle:** Angle formed between a line drawn parallel to the axis of the drill and the edge of the land. (30° or 45°)
- **Point angle:** This is the angle included between the two lips projected upon a plane parallel to the drill axis and parallel to the two cutting lips. (118°).
- **Chisel Edge:** it is the point where two cutting lips meets at extreme tip.
- **Chisel Edge Angle:** Angle between chisel edge and cutting lip measured plane normal to axis.

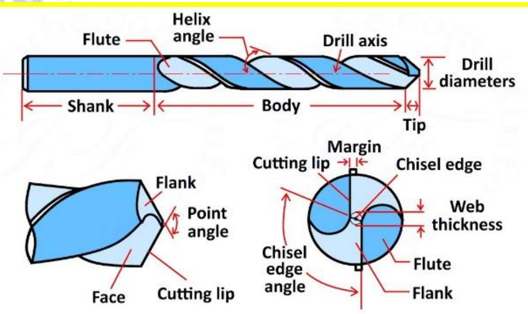


Fig - 1: Twist drill bit geometry.

1.2 Dimensions of drill bit:

The drill – bit model which we are used in this analysis is twist drill type. The standard dimensions of drill bit are shown in the following table and figure.

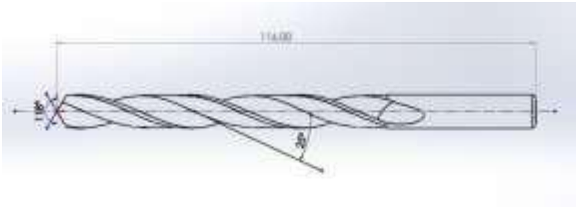


Table – 1: Drill bit specifications

Tool specifications	Values
Diameter of drill bit	8mm
Length of drill bit	116mm
Shank length	36mm
Helix angle	25^0
Point angle	118^0

MATERIALS AND METHODOLOGY

Materials used in this analysis are High Speed Steel (HSS), High Carbon Steel (HCS) and Titanium alloy.

HSS: When tool steels contain a combination of more than 7% molybdenum, tungsten and vanadium, and more than 0.60% carbon, they are referred to as high speed steels. This term is descriptive of their ability to cut metals at 'high speeds'

HCS: Generally, the high carbon steels contain from 0.60 to 1.00% C with manganese contents ranging from 0.30 to 0.90%. The pearlite has a very fine structure, which makes the steel very hard. Unfortunately this also makes the steel quite brittle and much less ductile than mild steel.

Titanium alloy: Titanium alloys are alloys that contain a mixture of titanium and other chemical elements. Such alloys have very high tensile strength and toughness (even at extreme temperatures). They are light in weight, have extraordinary corrosion resistance and the ability to withstand extreme temperatures.

METHODOLOGY

SELECTION OF MATERIALS

↓

DESIGNING OF DRILL BIT

↓

APPLICATION OF FIXED SUPPORT AND BOUNDARY CONDITIONS

↓

SOLVING THE PROBLEM

↓

RESULTS & CONCLUSION

DESIGN AND ANALYSIS

3.1 Design of drill bit using SOLIDWORKS software:

With the specifications mentioned in the table-1. A 3D model of drill bit is drawn using SOLIDWORKS 2020 software.

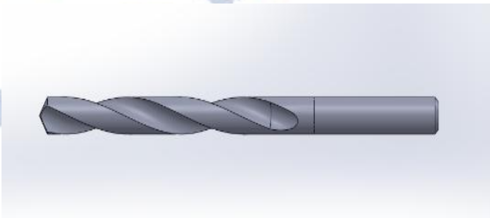


Fig – 3: Horizontal viewof drill bit.

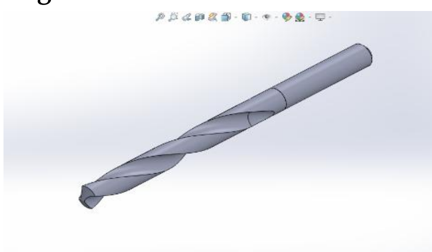


Fig – 4: Isometri view of drill bit

FEA-based simulation for deformation, maximum principal stress and maximum shear stress was carried out using ANSYS 19.2 workbench software. For analysis of stress and deformation in drill bit, torque data is required. Torque data for twist drill bit were obtained from reference. The value of torque is loaded into the model for simulation. The 3D model was imported to ANSYS. Meshing was carried out after defining the tool material, physical and mechanicl properties. 8257 number of nodes and 2837 number of elements are formed after meshing. The model is now solved for the required output data.

3.2 Meshing of the model:

The most important part in any computer simulations is meshing, because it can show drastic changes in results you get. Meshing is the process in which the continuous shape of an object is divided into thousands or more number of shapes to, properly define the shape of the object. These small pieces are called finite elements or simply elements. These elements connect all characteristic points called nodes that lieon their circumference. The main purpose of meshing is to make the problem solvable using finite element.

The results are calculated by solving the relevant governing equations numerically at each of the nodes mesh. The governing equations are almost always partial differential equations, and Finite element method is used to find solutions to such equations. The pattern and relative positioning of the nodes also affect the solution, the computational efficiency & time.

Number of nodes formed = 8257

Number of elements formed = 2837

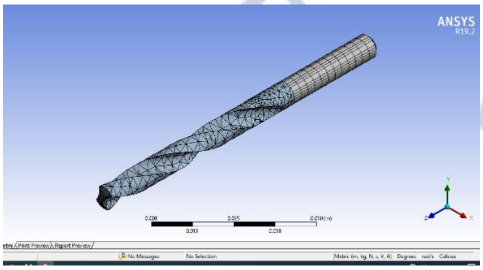


Fig – 5: Meshing of drill bit in ANSYS

3.3 Applying forces and conditions:

After designing and meshing, boundary conditions such as fixed support is given to shank and torque of 100 Nm is given to body to get the required resuts.

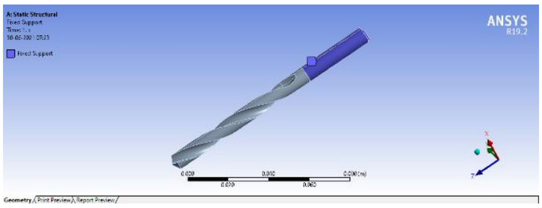


Fig – 6: Application of fixed support on drill bit

Fig – 7: Appliction of moment on drill bit

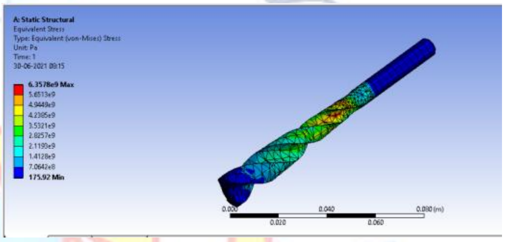


Fig-8: Equivalent stress in drill bit for HSS

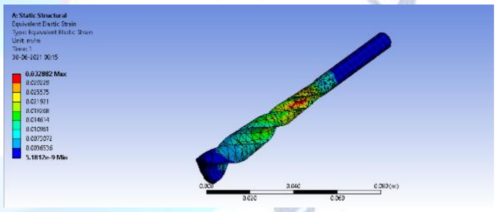


Fig-9: Equivalent strain in drill bit for HSS

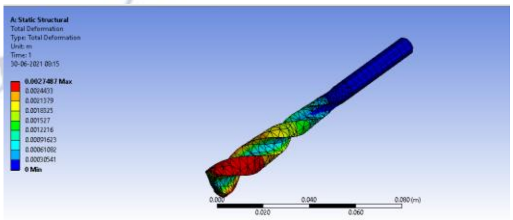


Fig-10: Deformation of drill bit for HSS

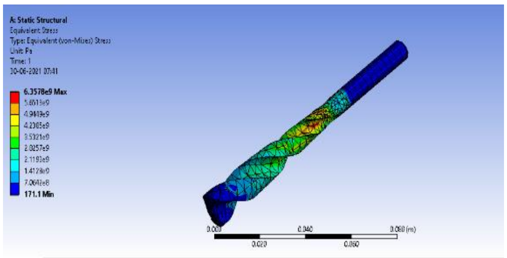


Fig-11: Equivalent stress in drill bit for HCS

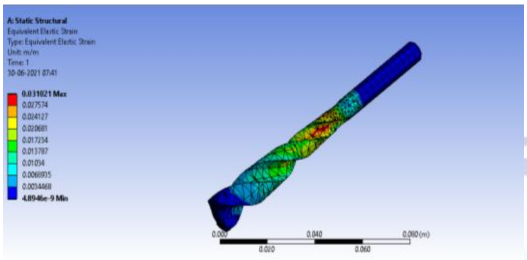


Fig-12: Equivalent strain in drill bit for HCS

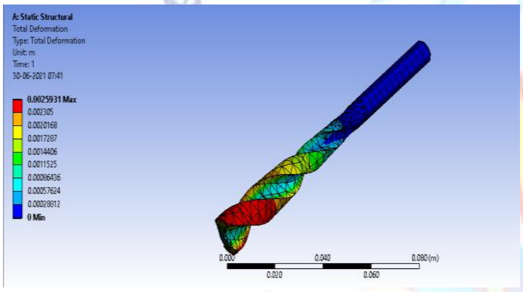


Fig-3: Deformation of drill bit for HCS

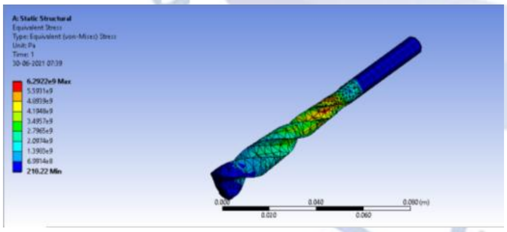


Fig-14: Equivalent stress in drill bit for TITANIUM ALLOY

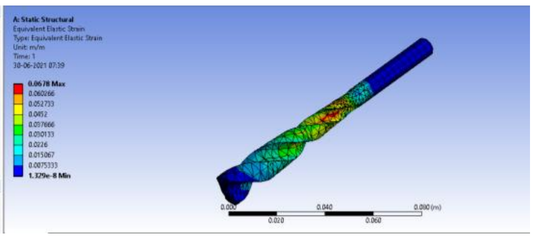


Fig-15: Equivalent strain in drill bit for TITANIUM ALLOY

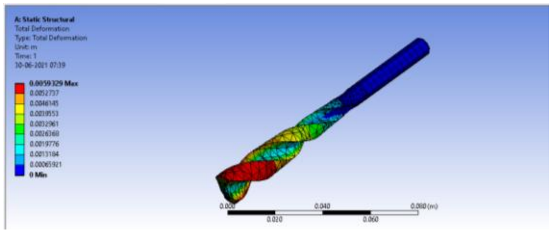


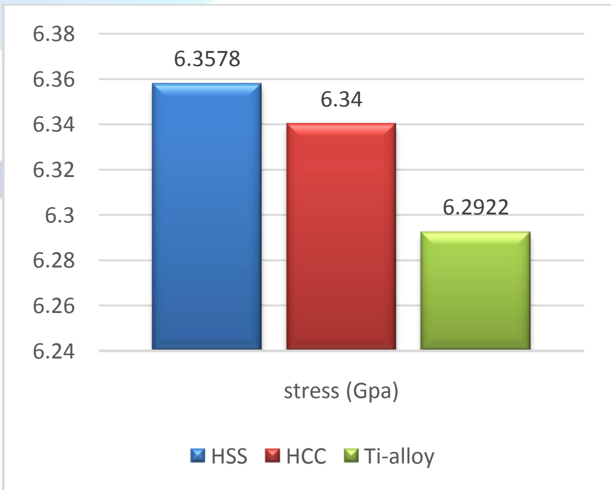
Fig-16: Deformation of drill bit for TITANIUM ALLOY

RESULTS

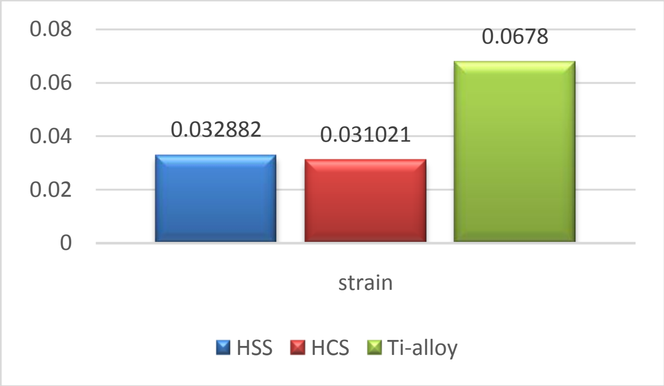
After meshing and apllying boundary conditions that are fixed support and moment of 100Nm, assigning of material to the drill bit is done in ANSYS and inserting the required results are done. They are:

1. Equivalent (von-mises) stress.
2. Equivalent elastic strain.
3. Total deformation.

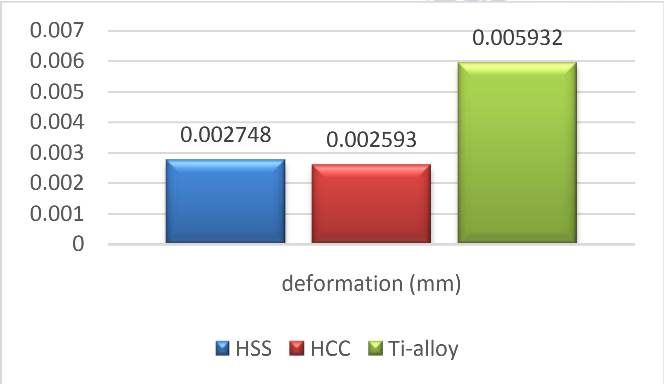
From the analysis we can see that there are total three materials (High Speed Steel, High carbon steel and Titanium alloy) used for analysis and got the different results with parameter, from that the titanium alloy is best of them which comes in the nearby comparison with HSS. Generally we use drill bits that are made from HSS. Thus we have used different materials for overall design of drill bit to check the von mises stress and total deformation under same condition of moment with fixed support.



Graph – 1: Comparison between HCS and titanium alloy with HSS on the basis of their equivalent stress.



Graph – 2: Comparison between HCS and beta titanium alloy with HSS on the basis of their equivalent strain.



Graph – 3: Comparison between HCS and titanium alloy with HSS on the basis of their deformation.

CONCLUSIONS

This research paper shows the finite element method analysis of twist drill bit made from HSS, HCS and Titanium alloy material using static structural analysis on ANSYS WORKBENCH 19.2. The boundary conditions are assumed to be the fixed support for the shank because it is fixed in the shank and 100Nm torque or moment to the body as it experiences while machining. These conditions are applied to all the materials and the tool geometry also being same. Finally, it can be concluded that from the two materials, titanium alloy is safer than the HCS on comparison with HSS. The resultant values for titanium alloy are: maximum equivalent elastic strain is 0.0678 mm/mm and maximum equivalent stress is 6.2922GPa with total deformation of about 0.006728 mm.

However the equivalent strain is more for titanium alloy it is best suitable material among these materials for selection of drill bit because it experiences less equivalent stress.

FUTURE SCOPE

The following areas are recommended for future research based on the conductes experiments

1. This thesis has dealt with the reliability and maintainability analysis of drill bit and future research should focus on greater use of DRILL BIT analysis to enhance its life cycle.

2. Due to competition, the manufacturing company may need to reduce the price of drill bits. As a consequence, the reliability of its structure will eventually be downgraded.

3. More research is needed to estimate the optimal preventive maintenance replacement intervals of the drill bits.

REFERENCES

1. https://shikshartin.wordpress.com/14/mtt/drill/drill-nomenclature/
2. https://www.thomasnet.com/articles/custom-manufacturing-fabricating/drill-bit-materials/
3. https://handymanguides.com/tips/strongest-drill-bits/
4. Shivani, “Modelling & analysis of drill bit with different materials” IRJET, Vol.6Issue 8, A u g 2019.