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Design and Analysis of Radial Arm used in Drilling Machine

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A B S T R A C T

A machine tool's ability to create a necessary physical feature in the shortest amount of time and at the lowest possible operating cost is ultimately what determines how well it performs. Any machine tool's structure is traditionally designed with static rigidity and the lowest possible natural vibration frequency in mind. In conventional designs that employ the strength of materials approach, the machine tool's static and dynamic rigidities are examined first.

In this project, radial arms were created using the CAD-tool (CATIA parametric software). Boundary conditions are applied to the analysis of various materials, including carbon steel, AISI-1050 steel, EN31, and EN 8 steel.

Static, modal analysis and fatigue analysis was performed. From these analyses, deformations, stress, frequency values, life of component and safety factors were observed for all materials by ANSYS software. From all these results here we are going to conclude which material has less deformation and which material has fewer amounts of stress values.

Keywords: Radial arm, Drilling machine, ANSYS software, Deformation.

1. Introduction

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips (swarf) from the hole as it is drilled.

In rock drilling, the hole is usually not made through a circular cutting motion, though the bit is usually rotated. Instead, the hole is usually made by hammering a drill bit into the hole with quickly repeated short movements. The hammering action can be performed from outside the hole (top-hammer drill) or within the hole (down-the-hole drill, DTH). Drills used for horizontal drilling are called drifter drills.

2. Literature Review

Analysis Of A Radial Drilling Machine Structure Using Finite Element Method [1] In the present paper an attempt has been made to study the behavior of the structure of a radial drilling machine due to static loads using beam finite elements. In calculating the stiffness of the beam element, the warping effects of the cross section has also been included. Using “front solution” technique, the whole machine tool structure has been analyzed for different combinations of the cross sections of the radial arm and the column. From this study the best cross section for the structure of the machine has been suggested.

Optimum Design of Radial Drilling Machine Structure to Satisfy Static Rigidity and Natural Frequency Requirements [2] A computational capability is developed for the optimum design of radial drilling machine structure to satisfy static rigidity and natural frequency requirements using finite element idealization. The radial drilling machine structure is idealized with frame elements and is analyzed by using different combinations of cross-sectional shapes for the radial arm and the column. From the results obtained, the best combination of cross-sectional shapes is suggested for the structure. With this combination of cross-sectional shapes, mathematical programming techniques are used to find the minimum weight design of the radial drilling machine structure. A sensitivity analysis is conducted about the optimum point to find the effects of changes in design variables on the structural weight and the response quantities.

Design of a Universal Micro Radial Drilling Machine [3] In the present growing world of emerging technology, the micro machining process has demanding operation in various sectors like aerospace, oil, defense, automobile, biomedical science and many industries at micro and nano levels of manufacturing and designing. In various different types of micro machining, micro drilling is one of the tools based micro machining operations. Generally micro drilling is used to fabricate micro holes in micro products. Main emphasis is drilling speed (R.P.M) and the feed rate of the spindle. In this study, the cutting speed and feed rate will be taken as process parameters. We tried to increase the accuracy by giving feed to drill spindle through lead screw instead of direct feed. Here are some aspects which are considered in the design of universal micro radial drilling machine.

3-Directional Flexible Drilling Machine [4] 3-Directional drilling machine which can be used based on drilling holes in various location and movement and easily operation done with high accuracy. Productivity can be improved by reducing total machining time and reduced human effort and reduced manufacturing cycle time. Key words: Drilling machine, Performance, Movement, Material, Operation etc.

Solar Powered Drilling Machine [5] This project is fabrication of solar power drilling machine which shows capability of drilling other than old. Other than that, it is important to study pneumatics for drilling which are the main topic for this project. So, at the end of this project, we will be practicing on how to build and steps to follow to complete the requirement for this project.

This project are also provided to familiarize us about the technology on drilling a metal which is used pneumatic concept yet has rapidly grown especially in the automotive and electrical industry. Furthermore, the strong concern is to obtain better product quality with lower cost. Then, drilling is important processes in the metal industry; the former is flexible in processing whilst the latter is effective in production.

Modal Analysis of Machine Tool Column Using Finite Element Method [6] The performance of a machine tool is eventually assessed by its ability to produce a component of the required geometry in minimum time and at small operating cost. It is customary to base the structural design of any machine tool primarily upon the requirements of static rigidity and minimum natural frequency of vibration. The operating properties of machines like cutting speed, feed and depth of cut as well as the size of the work piece also have to be kept in mind by a machine tool structural designer. This paper presents a novel approach to the design of machine tool column for static and dynamic rigidity requirement. Model evaluation is done effectively through use of General Finite Element Analysis software ANSYS. Studies on machine tool column are used to illustrate finite element-based concept evaluation technique. This paper also presents results obtained from the computations of thin-walled box type columns that are subjected to torsional and bending loads in case of static analysis and also results from modal analysis. The columns analyzed are square and rectangle based tapered open column, column with cover plate, horizontal partitions and with apertures. For the analysis purpose a total of 70 columns were analyzed for bending, torsional and modal analysis. In this study it is observed that the orientation and aspect ratio of apertures have no significant effect on the static and dynamic rigidity of the machine tool structure.

3. Materials and methods

3.1 AISI 1050 STELL

Carbon steels contain carbon as the main alloying element. They are designated by AISI four-digit numbers and contain 0.4% of silicon and 1.2% of manganese. Molybdenum, chromium, nickel, copper, and aluminum are present in small quantities.

3.2 EN 8 STEEL

EN8 steel material is suitable for all general engineering applications requiring a higher strength than mild steel such as:

- general-purpose axles
- shafts,
- gears,
- bolts and studs.

3.3 EN 32 STEEL

EN32 is a case hardening steel with low tensile strength and is used in general engineering for the production of lightly stressed components.

The material displays good weldability and machinability characteristics in the supplied condition and has a hard-wearing surface. EN32 is classed as an unalloyed low carbon grade.

3.4 Carbon steel

The term "carbon steel" may also be used in reference to steel which is not stainless steel; in this use carbon steel may include alloy steels. High carbon steel has many different uses such as milling machines, cutting tools, such as chisels and high strength wires. These applications require a much finer microstructure, which improves the toughness.

As the carbon percentage content rises, steel has the ability to become harder and stronger through heat treating; however, it becomes less ductile. Regardless of the heat treatment, a higher carbon content reduces weldability. In carbon steels, the higher carbon content lowers the melting point.

Materials –mild steel

Young's modulus	=	205000mpa
Poisson's ratio	=	0.3
Density	=	7850kg/mm^3

Materials –EN 31 steel

Young's modulus	=	200000mpa
Poisson's ratio	=	0.3
Density	=	7750kg/mm^3

Materials –EN8 steel

Young's modulus	=	210000mpa
Poisson's ratio	=	0.3
Density	=	7210kg/mm^3

Materials –Carbon steel

Young's modulus	=	202000mpa
Poisson's ratio	=	0.31
Density	=	7450kg/mm^3

3.5 Static Analysis

In the present work, the worst drilling conditions are considered, which lead to the following cutting forces in the radial drilling machine tool:

Thrust force, P = 17167.5N

3.6 3D CATIA model for Radial arm in drilling machine

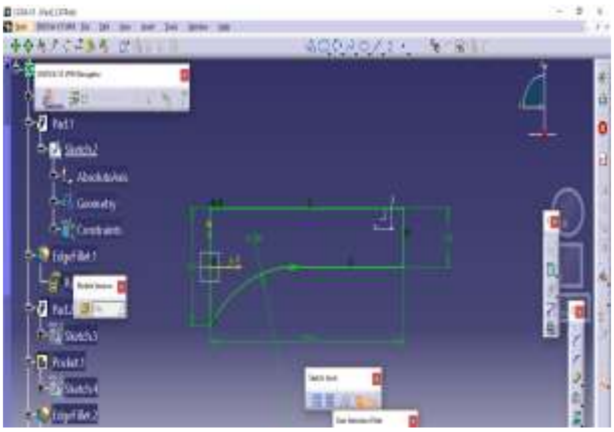

Fig. 1 – Draw the Sketch as shown in the fig by applying constrains

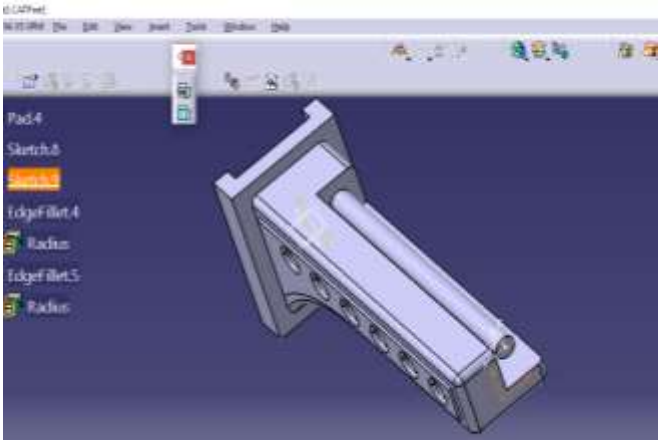

Fig. 2 – Apply pad and pocket for holes

Fig. 3 – Apply edge fillets to remove sharp edges

3.7 Introduction to ANSYS

3.7.1 Structural Analysis

ANSYS Autodyn is pc simulation device for simulating the response of materials to brief period immoderate loadings from impact, high strain or explosions. ANSYS Mechanical ANSYS Mechanical is a finite element analysis device for structural assessment, together with linear, nonlinear and dynamic research. This pc simulation product gives finite elements to version conduct, and helps cloth models and equation solvers for a extensive variety of mechanical design issues. ANSYS Mechanical also consists of thermal assessment and matched-physics abilties regarding acoustics, piezoelectric, thermal–structural and thermo-electric assessment.

3.7.2 Modal analysis

Modal analysis is the study of the dynamic properties of systems in the frequency domain. Examples would include measuring the vibration of a car's body when it is attached to a shaker, or the noise pattern in a room when excited by a loudspeaker.

Modern day experimental modal analysis systems are composed of 1) sensors such as transducers (typically accelerometers, load cells), or non contact via a Laser vibrometer, or stereophotogrammetric cameras 2) data acquisition system and an analog-to-digital converter front end (to digitize analog instrumentation signals) and 3) host PC (personal computer) to view the data and analyze it.

Classically this was done with a SIMO (single-input, multiple-output) approach, that is, one excitation point, and then the response is measured at many other points. In the past a hammer survey, using a fixed accelerometer and a roving hammer as excitation, gave a MISO (multiple-input, single-output) analysis, which is mathematically identical to SIMO, due to the principle of reciprocity. In recent years MIMO (multi-input, multiple-output) have become more practical, where partial coherence analysis identifies which part of the response comes from which excitation source. Using multiple shakers leads to a uniform distribution of the energy over the entire structure and a better coherence in the measurement. A single shaker may not effectively excite all the modes of a structure.

3.7.3 Fatigue analysis

In materials science, fatigue is the weakening of a material caused by cyclic loading that results in progressive and localized structural damage and the growth of cracks. Once a fatigue crack has initiated, each loading cycle will grow the crack a small amount, typically producing striations on some parts of the fracture surface. The crack will continue to grow until it reaches a critical size, which occurs when the stress intensity factor of the crack exceeds the fracture toughness of the material, producing rapid propagation and typically complete fracture of the structure.

Fatigue has traditionally been associated with the failure of metal components which led to the term metal fatigue. In the nineteenth century, the sudden failing of metal railway axles was thought to be caused by the metal crystallizing because of the brittle appearance of the fracture surface, but this has since been disproved.

4. Results and discussion

4.1 Static analysis results

Material	**Deformation (mm)**	**Stress (N/mm2)**	**Strain**	**Safety factor**	
				Min	**Max**
Mild steel	0.04971	19.392	9.71381e-5	1.1113	15
EN 31 steel	0.046204	18.025	9.0514e-5	1.1956	15
EN 8 steel	0.044611	17.403	8.7393e-5	1.2383	15
Carbon steel	0.043815	17.092	8.532e-5	1.2608	15

4.2 Modal analysis results

Material	Deformation 1 (mm)	Frequency (Hz)	Deformation 2 (mm)	Frequency (Hz)	Deformation 3 (mm)	Frequency (Hz)
Mild steel	51.654	589.85	53.367	860.667	48.181	2636.2
EN 31 steel	49.64	566.85	51.286	827.1	46.302	2533.4
EN 8 steel	48.241	550.88	49.841	803.79	44.997	2462.0
Carbon steel	46.955	536.18	48.512	782.36	43.797	2396.3

5. Conclusions

3D modeling in CATIA parametric software and analysis in ANSYS software.

In this thesis, static, fatigue and modal analysis was done with different materials such as mild steel, EN 31 steel, EN 8 steel and carbon steel.

•By observing the static analysis results, the stress values are much less for carbon steel when compared to other materials.

• By observing the modal analysis results, the frequencies values are much less for carbon steel when compared to other materials.

• By observing the fatigue analysis results, the safety factor values are much more for carbon steel when compared to other materials.

• So we can conclude the carbon steel is a better material for radial arm.

References

NatarajanDepartment of Applied Mechanics, Indian Institute of Technology, HauzKhas, New Delhi-29, IndiaAvailable online 12 February 2003. https://doi.org/10.1016/0045-7949(76)900730.

S. S. Rao ,Ramana V. GrandhiJ. Mech., Trans., and Automation. Jun 1999, 105(2): 236-241 (6 pages)https://doi.org/10.1115/1.3258515

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G.Prasanth Kumar, P.GunaSekhar, P.Nadeem Khan P.Rajesh, B.V.Krishnaiah Under Graduate Student, Assistant professor Department of Mechanical Engineering Narayana Engineering College, Gudur Andhra Pradesh. Design & Fabrication of 360° Flexible Drilling MachineInternational Journal of Engineering Trends and Applications (IJETA) – Volume 5 Issue 2, Mar-Apr 2018

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