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Design and Analysis of Helicopter Rotor Hub for Strutural Loads

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ABSTRACT:
The rotor system is the rotating some portion of a helicopter which produces lift. The rotor comprises of a pole, hub, and rotor blades. The pole is a hollow cylindrical metal shaft which expands upwards from and is driven and now and then bolstered by the transmission. At the highest point of the pole is the connection point for the rotor blades called the hub. The rotor blades are then joined to the hub by any number of various techniques. Principle rotor systems are arranged by how the primary rotor blades are appended and move with respect to the fundamental rotor hub.

As the rotor spins, every cutting edge reacts to inputs from the control system to empower helicopter control. The focal point of lift in general rotor system moves in light of these inputs to impact pitch, roll, and upward movement. Here the helicopter rotor hub must convey the edge weight and aerodynamic powers as rotational rates. For that case, of helicopter rotor hub quality will be determined.

In this task, the 3D model of helicopter fundamental rotor hub will be done in UNIGRAPHICS and imported into ANSYS software to perform static analysis to investigate quality of rotor hub and optimize by utilizing diverse materials.

Keywords:- Rotor, System, Rotating, Hollow, Cylindrical, Hub, Rotor, Blades, Blades, Spins, Inputs, Roll, Aerodynamic, Rotational, Optimize, Software, Static, Analysis, Materials, Finite

INTRODUCTION

1.1 HELICOPTER ROTOR HUB INTRODUCTION

Helicopters are in numerous sizes and shapes, yet most offer a similar significant segments. These segments incorporate a lodge where the payload and group are conveyed; an airframe, which houses the different segments, or where parts are appended; a power plant or motor; and a transmission, which, in addition to other things, takes the power from the motor and transmits it to the primary rotor, which gives the aerodynamic powers that make the helicopter fly. At that point, to shield the helicopter from swinging because of torque, there must be some kind of against torque system. At last there is the arrival outfit, which could be slides, wheels, skis, or buoys. This part is a prologue to these segments.

The helicopter's wings are called Main Rotor Blades. The shape and the point of the blades travel through the air will decide the amount Lift compel is made. After the helicopter lifted off the ground, the pilot can tilt the blades, making the helicopter tip forward or in reverse or sideward.

Essentially the wings of the plane make a lift compel when they travel through the air. As we known, amid flight, there are four powers following up on the helicopter or plane and those are LIFT, DRAG, THRUST, and WEIGHT. With the end goal to make the wings to travel through the air, obviously, the plane itself needs to move. A helicopter works by having its wings travel through the air while the body remains still.

THE MAIN ROTOR SYSTEM:

The rotor system found on helicopters can comprise of a solitary principle rotor or double rotors. With most double rotors, the rotors turn in inverse ways so the torque from one rotor is restricted by the torque of the other. This drops the turning inclinations. As a rule, a rotor system can be named either completely verbalized, semi inflexible, or unbending. There are varieties and mixes of these systems. A completely verbalized rotor system for the most part comprises of at least three rotor blades. The blades are permitted to fold, quill, and lead or slack autonomously of one another. Every rotor sharp edge is appended to the rotor hub by a level pivot, called the fluttering pivot, which allows the blades to fold all over. Every cutting edge can climb and down freely of the others. The fluttering pivot might be situated at different separations from the rotor hub, and there might be more than one.

The position is picked by every producer, fundamentally with respect to security and control. Every rotor cutting edge is additionally appended to the hub by a vertical pivot, called a drag or slack pivot, that allows every edge, autonomously of the others, to move forward and backward in the plane of the rotor plate. Dampers are typically fused in the structure of this kind of rotor system to avoid over the top movement about the drag pivot. The purpose behind the drag turn and dampers is to hold the expanding pace and deceleration of the rotor blades. The blades of a totally articulated rotor can in like manner be feathered, or turned about their range savvy hub. To state it even more basically, feathering suggests the changing of the pitch purpose of the rotor blades.

1.1. Enunciated:

Articulated rotors are the most prepared and most by and large used sort of rotor system. Each front line is made to move vertically ("rippling") and on a dimension plane ("drag"), and change its pitch self-sufficiently of the others and their turn about the central post. This empowers the blades to "clear," or move in light of the earth shattering basic forces following up on the rotor.

1.1.1. Semi-Rigid Rotor System

A semi rigid rotor system considers two one of a kind improvements, rippling and feathering. This system is normally included two blades, which are inflexibly joined to the rotor hub. The hub is then associated with the rotor post by a turning bearing or faltering turn. This empowers the blades to see-saw or overlay together. As one sharp edge overlays down, substitute overlap up. Feathering is developed by the feathering turn, which changes the pitch purpose of the front line.

1.1.2. Rigid Rotor System

The rigid rotor system is mechanically clear, yet in a general sense complex in light of the way that working weights must be put resources into bowing instead of through turns. In this system, the blades can't overlay or lead and slack, yet they can be feathered.

1.2 ROTOR CONFIGURATIONS

1. COAXIAL ROTORS:

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Coaxial rotors are a couple of helicopter rotors mounted one over the other on concentric shafts, with a similar hub of pivot, however that turn in inverse ways (contra-revolution). This design is a component of helicopters created by the Russian Kamov helicopter

Fig. shows the coaxial rotors

2. INTERMESHING ROTORS:

Intermeshing rotors on a helicopter are an arrangement of two rotors turning in inverse ways, with every rotor pole mounted on the helicopter with a slight point to the next, in a transversely symmetrical way, so the blades intermesh without impacting. The course of action enables the helicopter to work without the requirement for a tail rotor. This setup is once in a while alluded to as a synchropter.

Fig. shows the Intermeshing rotors

3. TRANSVERSE ROTOR:

Transverse rotor rotorcraft have two extensive flat rotor congregations mounted next to each other. Couple rotor helicopters, in any case, utilize counter-rotating rotors, with each counteracting the other's torque. This arrangement additionally has the upside of having the capacity to hold more weight with shorter blades, since there are two sets. The majority of the power from the motors can be utilized for lift, while a solitary rotor helicopter utilizes capacity to counter the torque.

Fig. shows the Transverse rotor

4. TANDEM ROTORS

Tandem rotor helicopters have two vast even rotor gatherings mounted one before the other. Subsequently the majority of the power from the motors can be utilized for lift, though a solitary rotor helicopter utilizes capacity to counter the torque. Focal points of the pair rotor system are a bigger focus of-gravity range and great longitudinal security. The two rotors are connected by a transmission that guarantees the rotors are synchronized and don't hit one another, notwithstanding amid a motor disappointment.

Fig. shows the Tandem rotor

MAIN ROTOR HUB:

The bearing less fundamental rotor is the plan setup for the Army's cutting edge battle helicopter; it offers structure effortlessness (less parts), weight decrease, better support, and more control power and mobility. An orientation less rotor is an exceptional instance of a pivot less rotor, in which the pitch bearing and in addition the fold and slack pivots are killed (see Figure 1). Pitch control from the pitch connect to the primary cutting edge is transmitted by means of a torsionally firm torque tube. This thusly turns a torsionally delicate flex shaft, which works successfully as a pitch bearing. The flex shaft is really a noteworthy part of the bearing less rotor plan; it conveys the radiating burden and takes into consideration the cutting edge fold, lead slack, and turn movements. There is, in any case, an absence of defenselessness data for the flight-basic flex bar component owing to ballistic harm systems. What's more, the impacts of flex bar ballistic harm on the rotor and helicopter system's execution are not sufficiently comprehended.

The recovered main rotor head assembly, VH-OHA

Fig.The fracture location (arrowed) is located at rotor station (RS) 10.35, the location of the inboard bolt hole in the fitting to spar joint.

The objective of the present research is to analytically investigate rotor and aircraft performance effects caused by flexbeam damage. The present investigation was performed using the University of Maryland advanced rotorcraft code (UMARC) [1]. The bearingless main rotor (BMR) system, including flexbeams, torque tubes, and main rotor blades, was modeled as a number of elastic beam finite elements, wherein each beam element undergoes flap bending, lag bending, elastic twist, and axial deflections. Flexbeam ballistic damage was simulated as changes in the span-wise distribution of the mass, bending and torsional stiffness of flexbeam element.

This is just the basic information's for the beginners which did not know any things about the helicopter or airplane before and wants to know some principles that why the helicopter can fly but not in deep details. For the people that want to know more than what I have in here, please go to the text book which have many professors wrote them or go to the specific helicopter manuals. The details about the helicopter has so much to put it all in the WEB.

The wings of the airplane create a lift force when they move through the air. As we known,during flight, there are four forces acting on the helicopter or airplane and those are LIFT , DRAG , THRUST ,and WEIGHT .(please go back and see on What makes an airplane fly ? section).In order to make the wings to move through the air , of course, the plane itself has to move. A helicopter works by having its wings move through the air while the body stays still. The helicopter's wings are called Main Rotor Blades. The shape and the angle of the blades move through the air will determine how much Lift force is created. After the helicopter lifted off the ground, the pilot can tilt the blades, causing the helicopter to tip forward or backward or sideward.

1.3 NOMENCLATURE AND TECHNICAL TERM

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Blades: The blades of the helicopter are airfoils with a very high aspect ratio (length to chord). The angle of incidence is adjusted by means of the control from pilots.

The main rotor of the helicopter may have two, three,four , five or six blades, depending upon the design. The main rotor blades are hinged to the rotor head in such a manner that they have limited movement up and down and also they can change the pitch (angle of incidence). The controls for the main rotor are called Collective and Cyclic Controls.

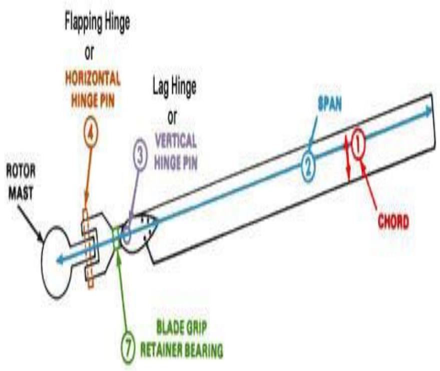

Fig. shows the main rotor blade system

Blade Root: The inner end of the blades where the rotors connect to the blade grip's.
Blade Grips: Large attaching points where the rotor blade connects to the hub.
Rotor Hub: Sit on top of the mast, and connects the rotor blades to the control tubes.
Main Rotor Mast: Rotating shaft from the transmission which connects the main rotor blades to helicopter fuselage.

Fig. shows the main rotor hub system

Swash Plate Assembly: The swash plate gathering comprises of two essential components through which the rotor pole passes. One component is a circle, connected to the cyclic pitch control. This circle is fit for tilting toward any path however does not pivot as the rotor turns. This non-rotating circle, regularly alluded to as the Stationary Star is connected by a course surface to a second plate, frequently alluded to as the Rotating Star which turns with rotor and connected to the rotor sharp edge pitch horns.

Fig. demonstrates the principle rotor system

Transmission: The transmission system transmits motor capacity to the principle rotor, tail rotor, generator and different frill. The motor is worked at a relative rapid while the principle rotor turns at a much lower speed. This speed decrease is practiced through decrease outfits in the Transmission System

Vibration

Vibration sources in the helicopter are the principle rotor, tail rotor, motors and other rotating systems as water driven siphons and aviation based armed forces following up on the fuselage, e.g. tail shake. Fundamental rotor vibrations emerge particularly in forward flight. The rotor encounters differing liquid speeds and approaches at the progressing and withdrawing edge. Fluctuating range shrewd circulations of lift and drag energize the cutting edge's twisting modes. This outcomes in exchanging rotor hub loads, particularly vertical powers and parallel and longitudinal pole minutes. The happening vibration frequencies are regularly a numerous of the sharp edge number and the unrest recurrence. Utilizing more rotor blades and a littler fluttering pivot balance can decrease Vibrations .In rapid flight, vibrations can happen if the withdrawing edge experiences solid powerful slow down while the propelling sharp edge encounters transonic stream with the intrinsic stuns. Another wellspring of vibrations is BVI particularly in not too bad flight. Insufficient cutting edge following can be an extra wellspring of vibrations.

Writing REVIEW

1. Dynamic Analysis of Helicopter Bearing less Main Rotor With Hub Flex shaft Damage Configurations by Ki C. Kim, This report archives a dynamic analysis of a helicopter bearing less fundamental rotor system with harmed hub flex bar setups. The analysis was performed utilizing an exhaustive helicopter air flexible code dependent on limited component/sharp edge component hypothesis. The bearing less principle rotor (BMR) system, including flex bars, torque cylinders, and fundamental rotor blades, is demonstrated as various versatile bar limited components, wherein each shaft component experiences fold bowing, slack bowing, flexible contort, and pivotal avoidances. Aerodynamic powers on rotor blades are determined utilizing semi enduring aerodynamic hypothesis with a direct in-stream display. Flex bar ballistic harm is recreated by changes in the range insightful conveyance of the mass, twisting and tensional firmness of flex pillar component. Results are first determined for a delicate in-plane, five-bladed, bearing less rotor, with a whole (pattern) arrangement. Results are then determined for this rotor system with harm portrayal. The impacts of this harm on rotor and helicopter system exhibitions are resolved as far as cutting edge modular shapes and frequencies, rotor system air flexible reaction and burdens varieties. Ballistic harm to the hub flex shaft can fundamentally influence the dynamic conduct of the bearing less rotor system.

2. Structure of Nacelle and Rotor Hub for NOWITECH 10MW Reference Turbine bySandeep Singh Klair,Wind turbine advancement has been impressive in the most recent years. One of's NOWITECH will likely do examine on substantial seaward breeze turbines. A bed plate and hub for the NOWITECH 10MW reference turbine has been examined, as indicated by IEC 61400. The work depends on Ebbe Smith's proposal about bed plate structure, and Mohammad Akram Khan's postulation about rotor shaft and rotor hub plan. A totally new bed plate has been structured, and examined with more right limit conditions incorporating a yaw holding on for contact surfaces and jolt associations between ribs. The hub got minor changes, and is dissected with a jolt association and pitch direction. The mass of the new bed plate is 99.6 tons, and a has top worry of 217.5MPa which is legitimized in discourse. The pinnacle worry in the hub is 126MPa.

3. Three dimensional pressure analysis of a helicopter principle rotor hub utilizing cyclic symmetry by Richard l.Rotelli,jr, a three dimentonal stretch analysis of the new fundamental rotor hub structure fo the SH-2F helicopter was performed utilizing the cycle symmetry highlight of MSC/NASTAN. The FEMGEN collaboration illustrations work generater was utilized to make the one – eighth symentry limited component demonstrate.

The basic reaction of the rotor hub to a few distinctive stacking conditions, as anticipated by MSC/NASTAN, was shown graphically by the FEMGEN intelligent outcomes seeing system. Exhibited along these lines, the resulta of the NASTRAN analysis positively affected the new plan of the principle rotor hub.

4. Modes shape and consonant analysis of various structures for helicopter sharp edge byAbdelkader NOUR 1, Mohamed Tahar GHERBI 1, Yon CHEVALIER, This examination concerns the dynamic conduct of a helicopter cutting edge. The goal is to reproduce by the limited components technique, the conduct of a cutting edge of various materials under an aerodynamic load. This examination was led to assess the aerodynamic burdens connected and assessed by a numerical reproduction the frequencies and Eigen modes and compute the anxieties following up on the structure for various modes. The investigation of the transient conduct has permitted the assurance of the vibration reactions because of unbalance and diverse excitation modes.

5. Stream Characteristics of a Five-Bladed Rotor Head by Moritz Grawunder, Roman Reß, Victor Stein, Christian Breitsamter, and Nikolaus A. Adams, This work shows the analysis of the stream qualities of a rotating five-bladed rotor head including cyclic pitch. The primary target is recognizing potential for productivity gains. The outcomes are acquired through numerical recreations dependent on the incompressible shaky Reynolds arrived at the midpoint of Navier Stokes conditions. Cyclic pitch movement is displayed through work distortion. It is demonstrated that the pitch control component contributes impressively to the parasite drag. Along these lines enhancing the aerodynamic fairing of these segments gives potential to drag decrease. Besides, it is demonstrated that the cyclic pitch movement of the cutting edge sleeves relevantly affects the aerodynamic qualities.

ISSUE DEFINITION AND METHODOLOGY

As the rotor spins, every sharp edge reacts to inputs from the control system to empower helicopter control. The focal point of lift all in all rotor system moves because of these inputs to impact pitch, roll, and upward movement. Here the helicopter rotor hub must convey the sharp edge weight and aerodynamic powers as rotational paces. For that case, of helicopter rotor hub quality will be determined.

The philosophy followed in my task is as per the following:

- 3D demonstrating of helicopter rotor hub will be finished by utilizing NX-CAD software and it is foreign into ANSYS software to do limited component analysis.
- Perform static analysis on the helicopter rotor hub and reports the avoidances and stresses.
- Perform dynamic analysis (MODAL and HARMONIC) to discover characteristic frequencies and working frequencies on the helicopter rotor hub.

Perform static and dynamic analysis on helicopter rotor hub for materials like as aluminum amalgam.

FINITE ELEMENT ANALYSIS OF HELICOPTER ROTOR HUB

Finite Element Modeling (FEM) and Finite Element Analysis (FEA) are two most prominent mechanical building applications offered by existing CAE systems. This is credited to the way that the FEM is maybe the most mainstream numerical method for taking care of designing issues. The strategy is general enough to deal with any perplexing state of geometry (issue space), any material properties, any limit conditions and any stacking conditions. The sweeping statement of the FEM fits the analysis necessities of the present complex building systems and structures where shut frame arrangements are administering balance conditions are not accessible. Furthermore it is a proficient structure device by which fashioners can perform parametric plan contemplating different cases (distinctive shapes, material burdens and so on.) examining them and picking the ideal structure.

5.1 FINITE ELEMENT METHOD

The FEM is numerical analysis method for acquiring inexact answers for wide assortment of designing issues. The strategy started in the avionic business as an instrument to examine worries in muddled airframe structures. It became out of what was known as the framework analysis strategy utilized in air ship structure. The technique has picked up prevalence among the two scientists and professionals and after such huge numbers of advancements codes are produced for wide assortment of issues.

SECONDARYANALYSIS OF HELICOPTER ROTOR HUB

Auxiliary analysis includes the arrangement of physical laws and arithmetic required to contemplate and anticipate the conduct of structures. The subjects of basic analysis are designing ancient rarities whose honesty is judged to a great extent dependent on their capacity to withstand loads; they generally incorporate structures, extensions, airplane, and boats. Basic analysis fuses the fields of mechanics and elements and in addition the numerous disappointment speculations. From a hypothetical point of view the essential objective of auxiliary analysis is the calculation of misshapenings, interior powers, and stresses. By and by, basic analysis can be seen all the more conceptually as a technique to drive the building configuration process or demonstrate the soundness of a plan without a reliance on straightforwardly testing it.

STRATEGIES FOR PERFORMING STRUCTURAL ANALYSIS

To play out a precise analysis a basic specialist must decide such data as basic burdens, geometry, bolster conditions, and materials properties. The consequences of such an analysis normally incorporate help responses, stresses and removals. This data is then contrasted with criteria that show the states of disappointment. Progressed basic analysis may inspect dynamic reaction, dependability and non-straight conduct.

Portrayal:

ANSYS is a Finite Element Analysis (FEA) code broadly utilized in the Computer Aided Engineering (CAE) field. ANSYS software permit to develop PC models of structures, machine segments or systems, apply working burdens and other plan criteria and concentrate physical reactions, for example, feelings of anxiety, temperature disseminations, weight, and so on. The ANSYS program has an assortment of structure analysis applications, going from cars to such profoundly refined systems as flying machine, atomic reactor regulation structures and scaffolds. There are 250+ components determined for different applications in ANSYS. In the present application shell, shaft and mass components that have auxiliary static and dynamic analysis capacities were considered.

FINITE ELEMENT MODELING:

3D model of the Helicopterrotor Hubwas created in UNIGRAPHICS from the plan counts done. The model was then changed over into a parasolid to import into ANSYS. A Finite Element show was produced with strong components. The components that are utilized for glorifying the Helicopterrotor Hubwere portrayed underneath. A definite Finite Element display was worked with strong components to glorify every one of the segments of the Helicopterrotor Hub. Static and Modal analysis were completed to locate the common frequencies. Changes were likewise actualized to move the key normal recurrence. The components that are utilized for glorifying the Helicopter rotor Hub are strong 187.The depiction of every component is given beneath.

Accessible Commercial FEM software bundles

- ANSYS (General reason, PC and workstations)
- SDRC/I-DEAS (Complete CAD/CAM/CAE bundle)
- NASTRAN (General reason FEA on centralized servers)
- LS-DYNA 3D (Crash/affect reproductions)
- ABAQUS (Nonlinear unique analysis)
- NISA (A General reason FEA apparatus)
- PATRAN (Pre/Post processor)
- HYPERMESH (Pre/post processor)

5.**2 PRINCIPAL STRESSES**

An essential plane is any plane in which the shear stresses are zero. The ordinary anxieties that are following up on this plane are hence the foremost burdens. ... This implies for a two dimensional system, three out of four pressure parts are autonomous (σxx, σzz, and σxz).

5.3 VON-MISESS STRESS AND VON-MISSES THEORY

HYPOTHESES OF FAILURE:

Deciding the normal method of disappointment is an imperative initial phase in breaking down a section plan. The disappointment mode will be impacted by the idea of load, the normal reaction of the material and the geometry and requirements. In a designing sense, disappointment might be characterized as the event of any occasion viewed as unsatisfactory based on part execution. The methods of disappointment considered here are identified with mechanical burdens and auxiliary analysis. A disappointment may incorporate either an unsatisfactory reaction to an impermanent load including no perpetual harm to the part or an adequate reaction which involves lasting, and at times calamitous, harm. The reason for speculations of disappointment is to foresee what blend of central anxieties will result in disappointment. There are number of speculations to depict disappointment criteria, of them these are the broadly acknowledged hypotheses.

Octahedral or bending vitality hypothesis (von mises-hencky)

$\sigma 1^2+\sigma 2^2+\sigma 3^2-\sigma 1\sigma 2-\sigma 2\sigma 3-\sigma 3\sigma 1 = \sigma y^2$. As indicated by this hypothesis disappointment is expected to happen when the greatest shear strain vitality surpasses the shear strain vitality in a basic malleable test. This is particularly legitimate for pliable material; in this the vitality which is really in charge of the contortion is mulled over.

FACTOR OF SAFETY

Configuration stretch: A machine part when exposed to most extreme admissible pressure is sufficiently extensive to forestall disappointments amid troublesome conditions.

- Ultimate quality: It is characterized as the greatest pressure a material can withstand while being extended before falling flat or breaking.

- Factor of wellbeing is characterized as the proportion of material quality and admissible pressure. Material quality incorporates extreme quality, or yield quality or perseverance quality.

- For weak materials having static load, factor of wellbeing is the proportion of extreme quality and configuration stretch.

- For malleable materials having static load, factor of security is the proportion of yield quality and configuration push.

5.4 STRUCTURAL ANALYSIS OF HELICOPTER ROTOR HUB USING Aluminum MATERIAL

Static analysis is utilized to decide the removals, stresses, strains and powers in structures or segments caused by burdens that don't instigate noteworthy dormancy and damping impacts.

MATERIAL PROPERTIES:

Aluminium Mechanical Properties:

Young's modulus = 71GPa
Yield Strength = 130Mpa
Tensile Strength = 350Mpa
Density = 2665kg/m3
POISON RATIO = 0.3

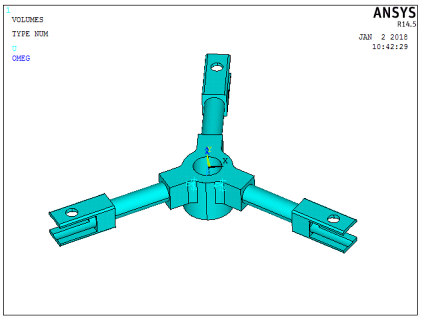

Fig. Imported hub model in Ansys

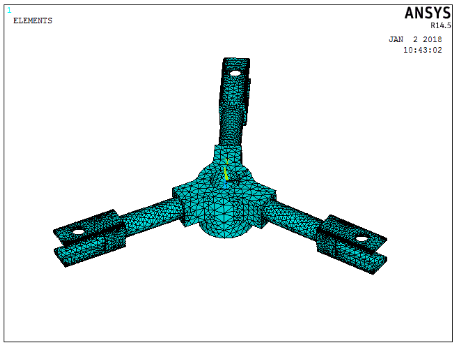

Fig. Mesh model

Boundary conditions:

- The rotating shaft location is fixed in all dof.
- Rotor blade weight (9810 N) is applied on Helicopter rotor Hub.
- Angular velocity (15 mm/s) was applied on Helicopter rotor Hub.

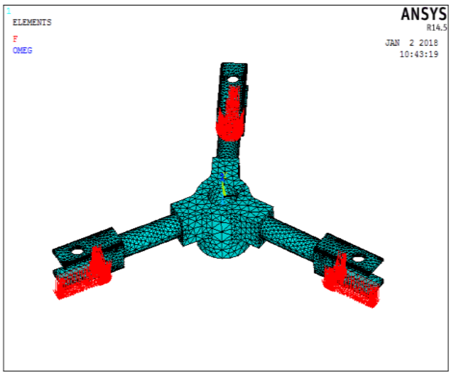

Fig. Rotor blade weight is applied on Helicopter rotor Hub.

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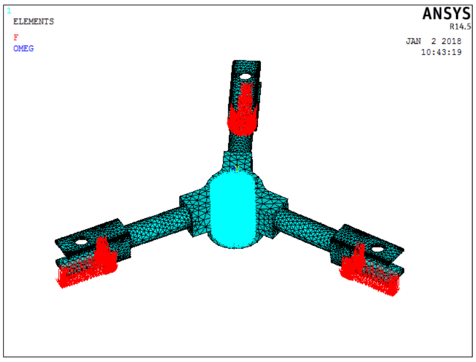

Fig. The rotating shaft location is fixed in all dof.

Results

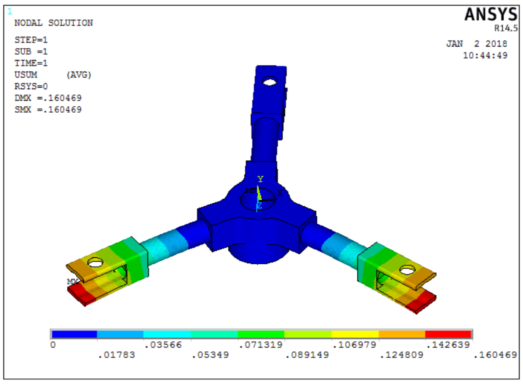

Fig. Resultant deformation

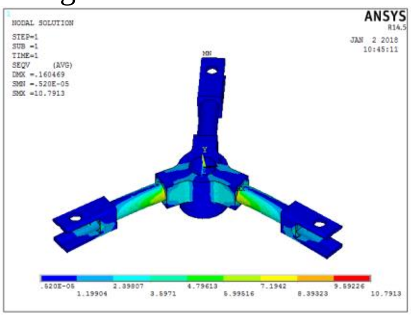

Fig. Resultant von misses stress

From the analysis, it is observed that the maximum deformation 0.160mm and VonMises stress 10.79MPa observed on Helicopter rotor Hub. The yield strength of the material (Aluminium) used for Helicopter rotor Hub is 180 MPa. According to the VonMises Stress Theory, the VonMises stress of Helicopter rotor Hub is less than the yield strength of the material. Hence the design of Helicopter rotor Hub is safe for the above operating loading conditions.

5.5 MODAL ANALYSIS OF HELICOPTER ROTOR HUB USING ALUMINIUM MATERIAL

MODAL ANALYSIS

Modal analysis is used to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a transient dynamic analysis, a harmonic response analysis, or a seismic analysis.

NATURAL FREQUENCY

Natural frequency is the frequency at which a system naturally vibrates once it has been set into motion. In other words, natural frequency is the number of times a system will oscillate (move back and forth) between its original position and its displaced position, if there is no outside interference.

The natural frequency is calculated from the formula given below. The natural frequencies depend on stiffness of the geometry and mass of the material.

$$f = \left(\frac{1}{2\pi}\right)\left(\sqrt{\frac{k}{m}}\right)$$

k=stiffness properties

m= Mass

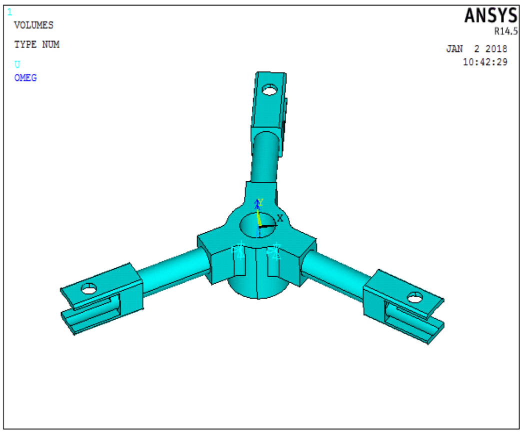

Fig. Imported model in Ansys

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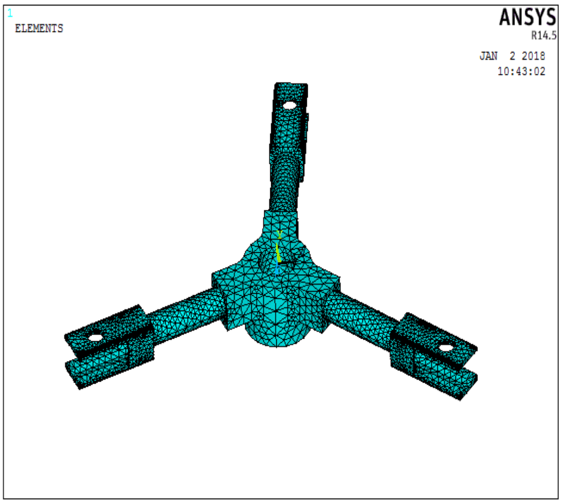


Fig. Finite element Meshed model

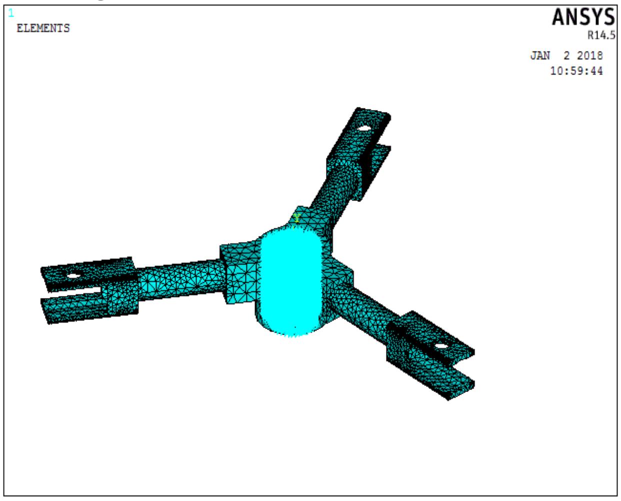
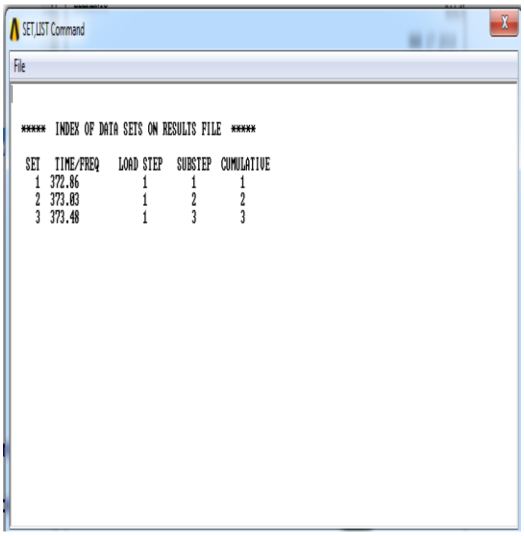


Fig. Applied fixed load at center of rotor

RESULTS

Natural frequencies values



SET,LIST Command

File

***** INDEX OF DATA SETS ON RESULTS FILE *****

SET	TIME/FREQ	LOAD STEP	SUBSTEP	CUMULATIVE
1	372.86	1	1	1
2	373.03	1	2	2
3	373.48	1	3	3

Mode shape-1

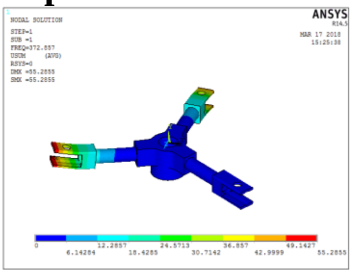


Fig. Deformation results at mode shape-1

Mode shape-2

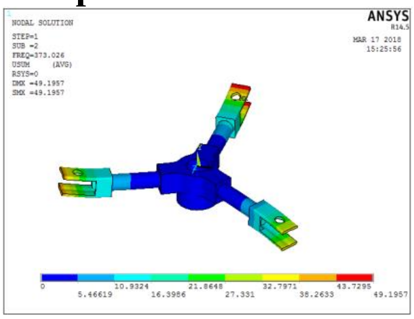


Fig. Deformation results at mode shape-2

Mode shape-3

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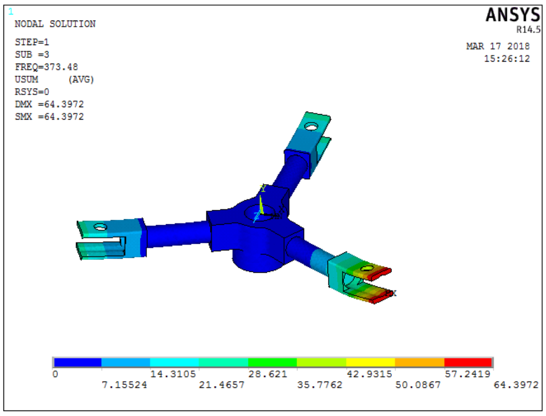


Fig. Deformation results at mode shape-3

From modal analysis results observed that Mass of helicopter hub is 9.06 kg and frequency range is 372.85Hz to 373.48 Hz.

HARMONIC ANALYSIS OF HELICOPTER ROTOR HUB USING ALUMINIUM MATERIAL

1.1. Harmonic response occurs at forcing frequencies that match the natural frequencies of your structure. Before obtaining the harmonic solution, you should first determine the natural frequencies of your structure by obtaining a modal solution.

1.2. A harmonic analysis, by definition, assumes that any applied load varies harmonically (sinusoidal) with time. To completely specify a harmonic load, three pieces of information are usually required: the amplitude, the phase angle, and the forcing frequency range

Boundary conditions:

- The rotating shaft location is fixed in all dof.
- Rotor blade weight (9810 N) is applied on Helicopter rotor Hub.
- Angular velocity (15 mm/s) was applied on Helicopter rotor Hub.

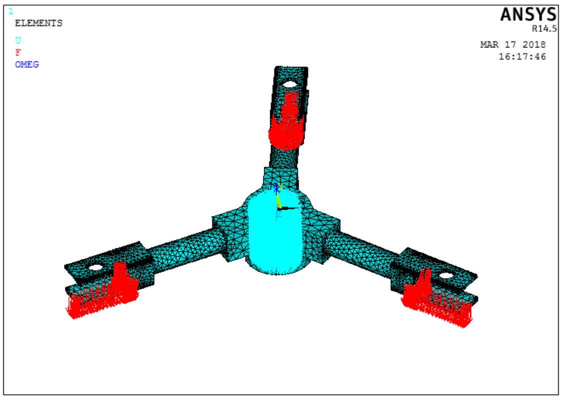
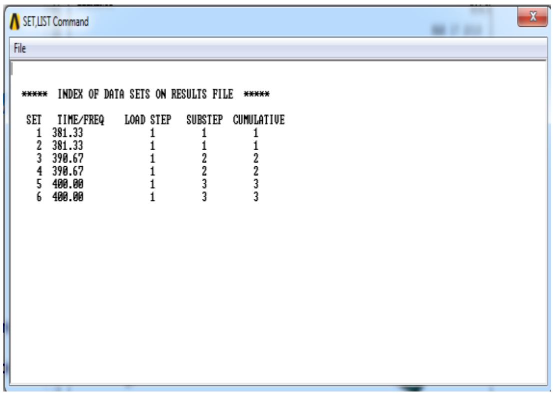


Fig. Applied boundary conditions

Results



***** INDEX OF DATA SETS ON RESULTS FILE *****

SET	TIME/FREQ	LOAD STEP	SUBSTEP	CUMULATIVE
1	381.33	1	1	1
2	381.33	1	1	1
3	390.67	1	2	2
4	390.67	1	2	2
5	400.00	1	3	3
6	400.00	1	3	3

Fig. Operating (forced) frequency

Mode shape-1

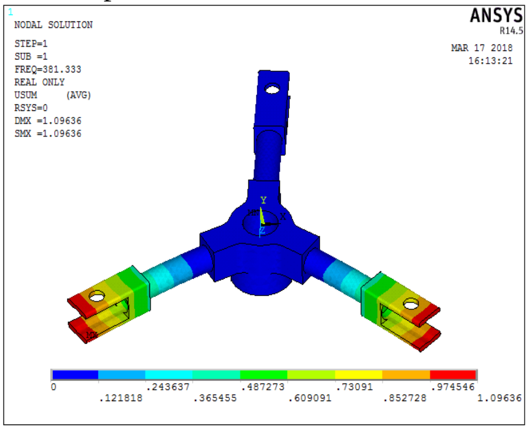


Fig. Deformation at mode-1

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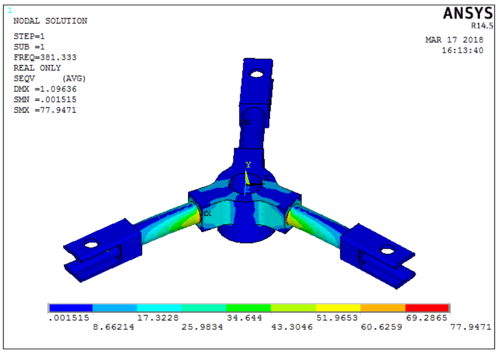

Fig. Von misses stress at mode-1

Mode shape-2

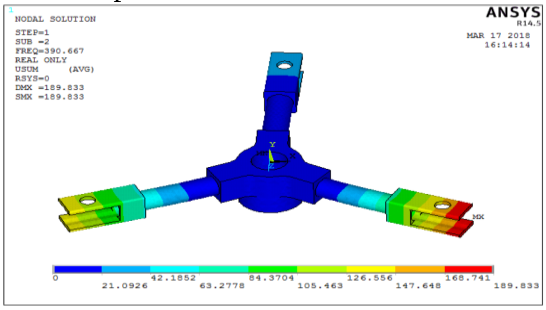

Fig. Deformation at mode-2

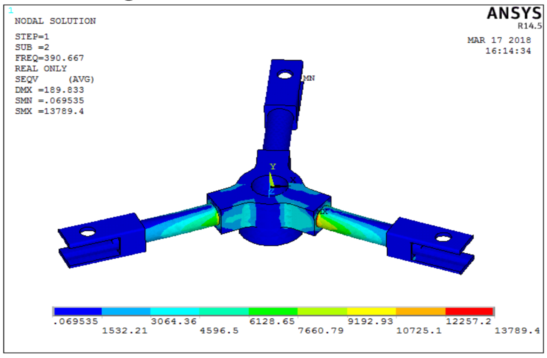

Fig. Von misses stress at mode-2

Mode shape-3

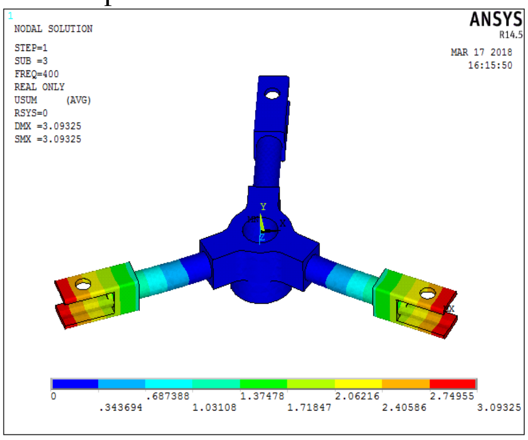

Fig. Deformation at mode-3

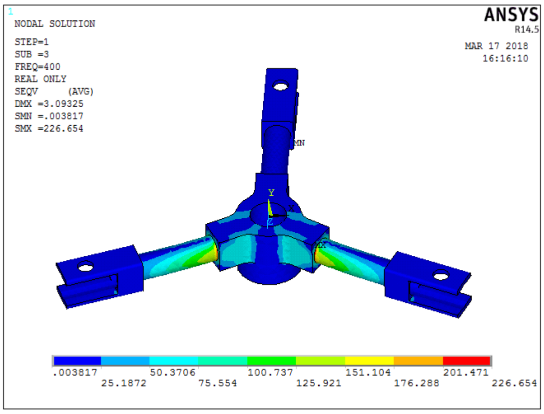

Fig. Von misses stress at mode-3

From harmonic analysis results, operating frequency range observed that 381 Hz to 400Hz. Also mode structure shape is also documented.

RESULTS AND DISCUSSIONS

Helicopter rotor Hub structure was contemplated for auxiliary conduct for Aluminum material. Here the Helicopter rotor Hub must convey the cutting edge weight and aerodynamic powers as rotational rates. For that case, of helicopter rotor hub quality will be determined. Likewise vibrations are shaped in rotational conditions reported in vibration analysis (modular and symphonious).

So the static, modular and consonant analysis are performed on helicopter rotor hub for aluminum amalgam.

Basic analysis of helicopter rotor hub with aluminum amalgam material:

From the Static analysis,

From the analysis, it is seen that the most extreme misshapening 0.160mm and VonMises pressure 10.79MPa saw on Helicopter rotor Hub. The yield quality of the material (Aluminum) utilized for Helicopter rotor Hub is 180 MPa. As indicated by the VonMises Stress Theory, the VonMises worry of Helicopter rotor Hub is not exactly the yield quality of the material. Consequently the structure of Helicopter rotor Hub is ok for the above working stacking conditions.

From modular analysis

Mass of helicopter hub is 9.06 kg and recurrence go is 372.85Hz to 373.48 Hz.
From consonant analysis
From consonant analysis results, working recurrence extend saw that 381 Hz to 400Hz.

CONCLUSION

As the rotor spins, every cutting edge reacts to inputs from the control system to empower helicopter control. The focal point of lift in general rotor system moves in light of these inputs to impact pitch, roll, and upward movement. Helicopter rotor Hub structure was examined for auxiliary and vibration conduct for Aluminum material. Here the Helicopter rotor Hub must convey the sharp edge weight and aerodynamic powers as rotational speeds.For that case, of helicopter rotor hub quality will be determined.

In this task the 3D model of Helicopter fundamental rotor Hub was done in UNIGRAPHICS and imported into ANSYS software to perform static analysis to investigate quality and dynamic attributes of rotor hub by utilizing Aluminum material.

From the above auxiliary analysis it is reasoned that the Helicopter principle rotor Hub has stresses and avoidances and recurrence extend (under 2000Hz) inside the plan furthest reaches of thought about material. From the above outcomes we can reason that the Helicopter fundamental rotor Hub with Aluminum material model had safe zone.

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