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Analysis of Rotor Blade Root of Helicopter

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ABSTRACT
In this paper the stress generated at the root of rotor blade of helicopter has been analysed. This stress is caused by aerodynamic forces acting on rotor blades of helicopter. Strain analysis and total deformation has also been displayed for better understanding of behavior of material against aerodynamic forces.

Keywords
Helicopter rotor blade, Helicopter rotor blade root, Rotor blade root, Stress analysis, Rotor blade stress analysis, Strain analysis, Total deformation.

1. INTRODUCTION
Helicopters are widely used in aviation industry for civil and military purposes. They have variety of uses like in rescue operations, transportation, preventing forest fires, etc. They are also used for military purposes like getting supplies and moving troops from one place to another in severe environmental conditions. Helicopters are of different types depending upon their rotor configuration which is designed to counteract the torque generated by the main rotor of helicopter. Some of these types are Tail rotor, Fenestron or FANTAIL, NOTAR (NO Tail Rotor), Tandem, coaxial rotor, intermeshing, etc. Main rotor and rotor blades are one of the most important parts of helicopter. Rotor helps helicopter to generate lift and to move forward with help of rotating blades which are attached to the rotor hub. These rotor blades push the air down which gives lift to the helicopter. These rotating blades are at very high speeds and thus they face very strong aerodynamic forces which generate stress in them. This stress can damage rotor blade and especially the rotor blade root and hub attachment which is very important part of rotor system of helicopter. In this paper we have analysed the stress generated by the pressure acting at the root of rotor blade of helicopter using ANSYS software.

2. MODEL DESIGNING
A typical model of helicopter rotor blade is designed using CATIA V5 software (Fig 1.1). The root section is split from remaining portion of rotor blade using split command (Fig 1.2).

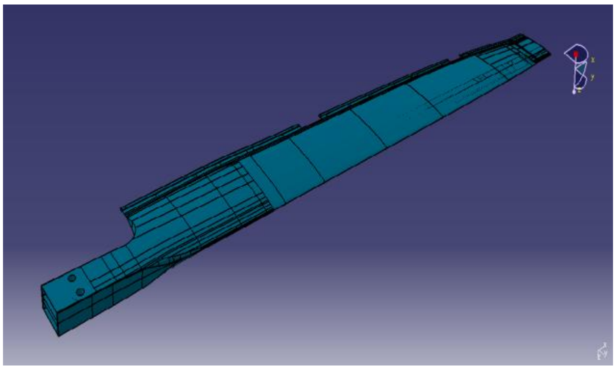

Fig 1.1: Rotor Blade Design

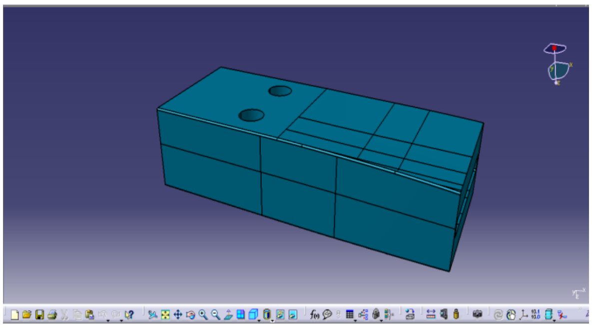

Fig 1.2: Root of Rotor Blade

3. MATERIAL SPECIFICATION
Material used for analysis is steel alloy with properties given in Table 1.

Table 1. Material properties

Young's Modulus	200 GPa
Yield Stress	400 MPa
Tensile strength	550 MPa
Poisson's Ratio	0.3

4. CALCULATIONS
Radius of rotor blade (R) = 5.5 m

R.P.M of rotor = 300

Velocity (v) = 172.788 m/s

Density of air (ρ) = 1.225 Kg/m^3

Dynamic pressure = $1/2\rho v^2$

= 0.0182661 MPa

5. F.E.M ANALYSIS
The designed model (Fig 1.2) is imported to ANSYS software. After design is imported meshing is applied on the design (Fig 2).

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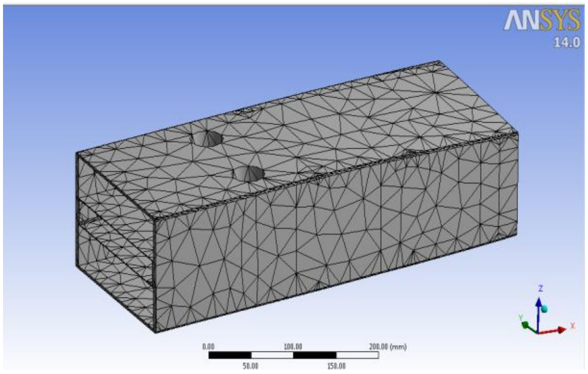

Fig 2: Meshing of Rotor Blade Root

5.1 Fixing and application of load

After meshing is done, the rotor blade root is fixed (Fig 3.1) and pressure is applied of 0.0182661 MPa in direction opposite to the rotation of rotor (Fig 3.2).

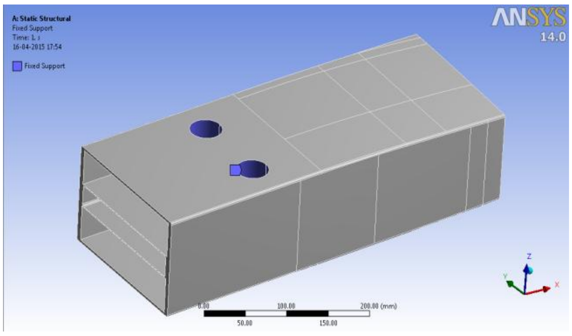

Fig 3.1: Fixing of Design

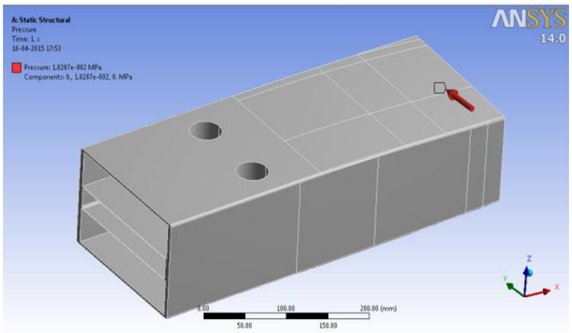

Fig 3.2: Application of Pressure

5.2 Stress analysis

Von-Mises stress analysis is applied after application of loads which gives accurate information about amount of stress generated in rotor blade root design (Fig 4).

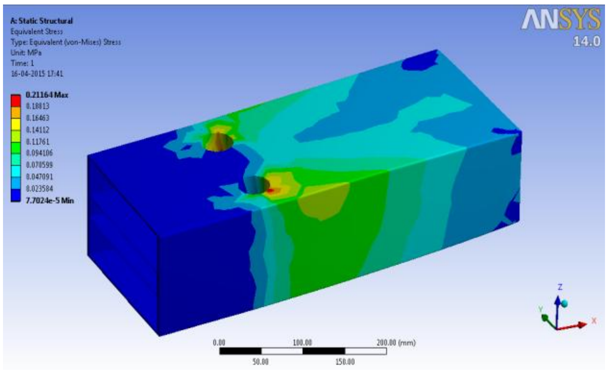

Fig 4: Von-Mises Stress Analysis

5.3 Strain analysis and total deformation

Equivalent strain analysis is applied on the design model after stress analysis is completed (Fig 5.1). After strain analysis the total deformation of rotor blade root design is analysed (Fig 5.2).

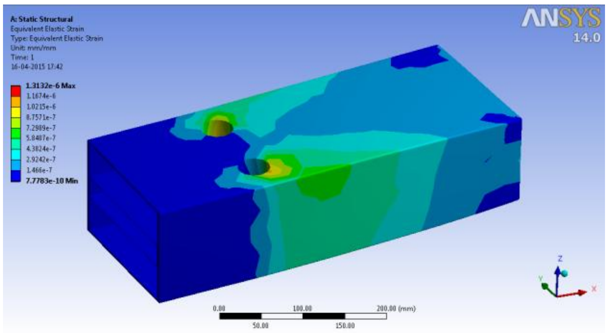

Fig 5.1: Equivalent Strain

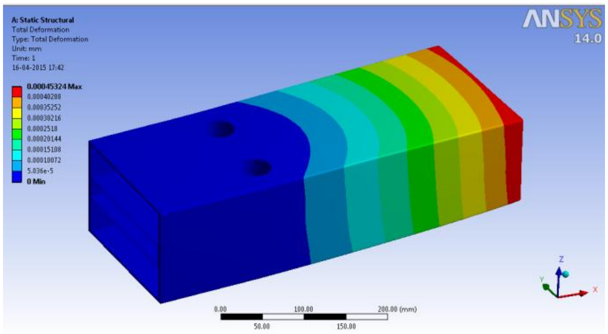

Fig 5.2: Total Deformation

6. CONCLUSION

Analysis methodology for root of rotor blade using CATIA V5 and ANSYS software has been developed. Results for given analysis are shown in Table 2.

Table 2. Analysis Results

Maximum Von-Mises Stress	0.21164 MPa
Total Deformation	0.00045324 mm
Maximum Equivalent Strain	1.3132e-6

It can be concluded that all results are under allowable limits.

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