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Design and Fabrication of Multipurpose Vehicle

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ABSTRACT: In the era of mechanical world you have to deal with new technology and ideas so the first thing is design which should be stable in surrounding. To get the final product we will use such a frame which can be modified for car, boat and as well as for helicopter. Frame have to deal with three type of moving objects so it is important to analysis before it's fabrication, that it can bear forces. We should have to visualize it's modification and material.

KEYWORDS: Fabrication; Design analysis; Meshing; Simulation; Shear stress

I. INTRODUCTION

We have to analysis different materials for best result that can help to bear the forces. The software solid works is used here to check elasticity of different materials. This belongs to static simulation in solid works [1,2]. There are different types of helicopter and here we are dealing with a flying machine having rotor above and tail rotor. Helicopter is such a vehicle which don't need runway and can make stable itself by different mechanisms. But there are complexions for its flight so we have to deal with different theories to solve complexions like momentum theory of hover, vortex theory, moment theory of climb, element theory, dynamic theories for blades power losses due to drag and flight for forward, rear, and right side [3]. In fluid dynamics, the momentum theory or disk actuator theory is a theory describing a mathematical model of an ideal actuator disk; the rotor is modeled as an infinitely thin disc, inducing a constant velocity along the axis of rotation. The basic state of a helicopter is hovering. This disc creates a flow around the rotor. Under certain mathematical premises of the fluid, there can be extracted a mathematical connection between power, radius of the rotor, torque and induced velocity. The rotor is modeled as an infinitely thin disc, inducing a constant velocity along the axis of rotation. The basic state of a helicopter is hovering. This disc creates a flow around the rotor. Under certain mathematical premises of the fluid, there can be extracted a mathematical connection between power, radius of the rotor, torque and induced velocity [4]. For a helicopter it is important study about the blades and blade element theory is an important article it is a mathematical process. It involves breaking a blade down into several small parts then determining the forces on each of these small blade elements. These forces are then integrated along the entire blade and over one rotor revolution in order to obtain the forces and moments produced by the entire propeller or rotor. One of the key difficulties lies in modeling the induced velocity on the rotor disk. Because of this the blade element theory is often combined with the momentum theory to provide additional relationships necessary to describe the induced velocity on the rotor disk [5]. Blades have very importance for the flight of helicopter, blades we are going to use made of aluminum and have all properties of aerodynamics, symmetrical blade of naca with airfoil database coordinates (naca 0012) [6]. Data are presented for lift coefficients from near zero through maximum values at Mach numbers from 0.30 to 0.86 and Reynolds numbers of 3.0×10^6 to the sixth power with transition fixed. A limited amount of data is presented near zero and maximum lift for a Reynolds number of 6.0×10^6 to the sixth power with transition fixed. In addition, transition free data is presented through the Mach number range from 0.30 to 0.86 for near zero lift and a Reynolds number of 3.0×10^6 to the sixth power [7]. The analysis of the two dimensional subsonic flow over a National Advisory Committee for Aeronautics (NACA) 0012 air foil at various angles of attack and operating at a Reynolds number of 3×10^6 is presented. The flow was obtained by solving the steady-state governing equations of continuity and momentum conservation combined with one of three turbulence models [shear stress transport (SST)] aiming to the validation of these models through the comparison of the predictions and the free field experimental



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measurements for the selected air foil. The aim of the work was to show the behaviour of the air foil at these conditions and to establish a verified solution method. The computational domain was composed of 80000 cells emerged in a structured way, taking care of the refinement of the grid near the air foil in order to enclose the boundary layer approach. Calculations were done for constant air velocity altering only the angle of attack for every turbulence model tested. This work highlighted two areas in computational fluid dynamics (CFD) that require further investigation: transition point prediction and turbulence modelling. The laminar to turbulent transition point was modeled in order to get accurate results for the drag coefficient at various Reynolds numbers. In addition, calculations showed that the turbulence models used in commercial CFD codes does not give yet accurate results at high angles of attack[8].A comprehensive data base is given for the low speed aerodynamic characteristics of the NACA 0012 airfoil section. The Langley low-turbulence pressure tunnel is the facility used to obtain the data. Included in the report are the effects of Mach number and Reynolds number and transition fixing on the aerodynamic characteristics. Presented are also comparisons of some of the results with previously published data and with theoretical estimates The Mach number varied from 0.05 to 0.36. The Reynolds number, based on model chord, varied from 3×10^6 to the 6th to 12×10^6 to the 6th power [9].To get actual results of helicopter blades, 8in \times 10 feet cord and length of blade respectively simulated done in software solid works the results were close to actual report the results are for maximum and minimum rpm and also for maximum angle of attack and for minimum angle of attack [10]. A portable boat for all commercial and recreational uses, with particular application to shallow water situations. The boat comprises a multi-tube flotation perimeter hull constructed of connected, epoxy-laminated foam cores and totally encased with a vinyl polyester fabric; a reinforced floor portion and, a full rear transom means. This water craft is strong, yet flexible, unsinkable and virtually impervious to punctures and abrasion damage. These positive benefits are accomplished without sacrificing the advantages of lightweight construction and ease of transportation [11]. Mechanism for transmitting power to two members from a common power source, one of these members having to be driven continuously and the other having either to be halted, to be driven by said common power source, or to be used as a motor for driving the rest member which is then disconnected from the source. Such a power transmitting mechanism can be applied to helicopters with advantage, the first continuously driven member being the hydraulic, electrical or pneumatic ancillary systems and the second member the rotor or rotors[12]. A model helicopter rotor pitch control mechanism is provided. The mechanism comprises a seesaw; a stabilizer bar attached to said seesaw; a mixing lever pivotally supported by said stabilizer bar, said mixing lever having a first end and a second end; an upper swash lever to which said first end is connected by way of a rod and a main rotor grip to which said second end is connected by way of said rodn [13]. A stabilizer bar has an aerodynamically shaped member, such as a winglet, on opposite ends thereof, and the bar is connected to rotate on its longitudinal axis and is mounted to tilt about a pivot axis at right angles thereto connecting it to a rotor shaft that also carries a pair of rotor blades the pitch of which can be changed about their longitudinal axis, that is parallel with the stabilizer bar pivot axis. A pair of oppositely directed mixing levers on opposite sides of the rotor shaft and connected parallel with the stabilizer bar for tilting movement there with is connected by first control linkages to diametrically opposite sides of a wobble plate assembly, and by second control linkages to vary the pitch of the pair of rotor blades. An arm attached to the stabilizer bar in the plane of the aerodynamically shaped members has an end disposed in alignment with the pivot axis of the stabilizer bar that is connected by a control rod to the wobble plate assembly 90° from the connections of the first control linkages, for cyclic adjustments of the pitch of the aerodynamically shaped members [14].

1.1. Objective

- The objective of this project is to design and fabricatesuch an automative that can fly, run and as well as float on water.
- purpose to facilitate the users for three different rides in a singleautomotive vehicle.
- This vehicle woldbe very helpful for military purpose.You can take any ride at any time at any situation,whether you want to cross a road or water or mountains.
- Here are some steps we are going to take to complete our objectiveOptimization of the controller gains of 2DOF controllers such as 2DOF-PI, 2DOF-PID and 2DOF-IDD controller in a two area wind thermal system using FPA.



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1.2. Aim of Work

- Structural design in software.
- Simulation of different structure and blades.
- Fabrication.
- Assembling (that make possible to can Fly, run and float over water).

1.3. Methodology

The methodology is show in Figure 1.

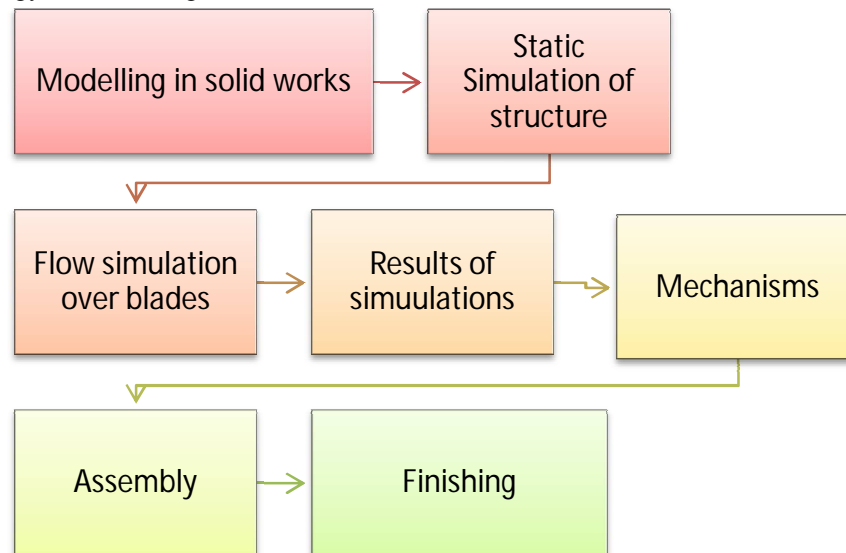


Figure 1: Methodology.

1.4. Physical Form of Model for Visualize

Physical form of model shown in Figure 2.



Figure2: Two area thermal wind system.



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II. STRUCTURE SIMULATION

Here the basic structure is simulated for different materials under 4000 N force from the front side which different nodes which shows that how much force it can bear. First i use Aluminium (6063-T6) and then steel (ANSI 4130 steel normalized at 870c) and after that i simulate for iron (ductile iron).

Simulation results shows that iron is best to that we can use in our structure and is easily available in Pakistan (Table 1).

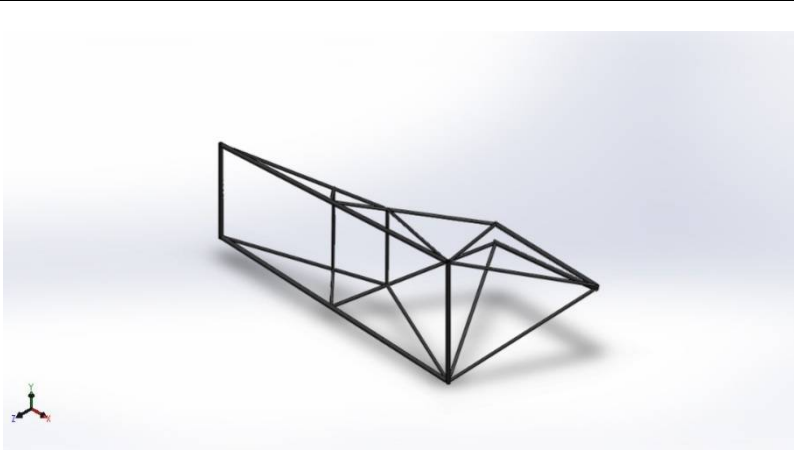
	Simulation of Chassis	
	Date: Thursday, July 27, 2017	
	Designer: Ali imran	
	Study name: basic frame	
	Analysis type: Static	
	Table of Contents	
	Description	1
	Assumptions	2
	Model Information	2
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	Material Properties	8
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Mesh information	11	
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Table 1: Simulation of chassis.

2.1. Description

It is about the simulation for the structure of vehicle.

2.2. Assumptions

In this we assume that the base is fixed and 3500 N force is applied normal to the top plane to check the stability of structure under that force.



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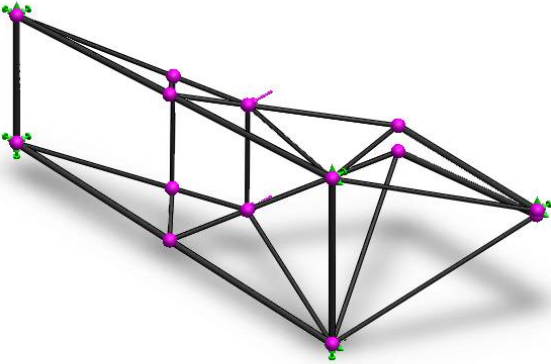
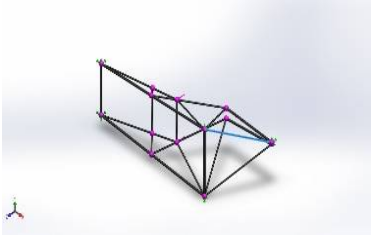
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2.3. Model Information

Model information shown in Table 2.

 <p>Model name: Chassis 2 Current Configuration: Predeterminado<Como mecanizada></p>		
Beam Bodies:		
Document Name and Reference	Formulation	Properties
Beam-1(Recortar/Extender18) 	Beam – Uniform C/S	Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005m ² Length: 841.994mm Volume: 5.47295e-005 m ³ Mass Density: 7100kg/m ³ Mass: 0.388579kg Weight: 3.80808N



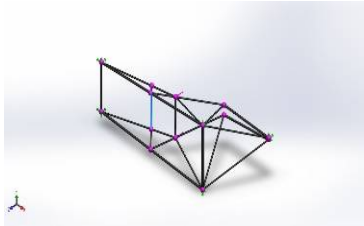
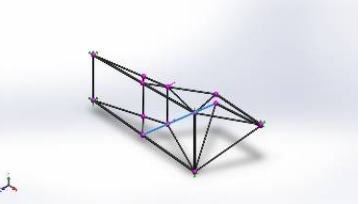
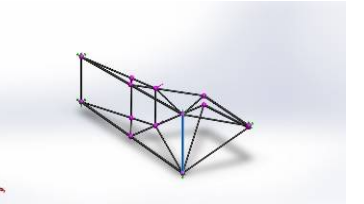
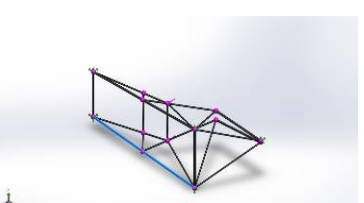
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<p>Beam-2(Miembro estructural5)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length: 502.075mm Volume: 3.26402e-005 m³ Mass Density: 7100 kg/m³ Mass: 0.231745kg Weight: 2.2711N</p>
<p>Beam-3(Recortar/Extender13)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:884.548mm Volume:5.74797e-005 m³ Mass Density:7100 kg/m³ Mass:0.408106kg Weight:3.99944N</p>
<p>Beam-4(Recortar/Extender13)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/22.2 × 1.65 Section Area: 0.000106524 m² Length:754.507mm Volume:8.04211e-005 m³ Mass Density:7100 kg/m³ Mass:0.57099kg Weight:5.5957N</p>
<p>Beam-5(Recortar/Extender5)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/22.2 × 1.65 Section Area: 0.000106524 m² Length:1619.52mm Volume:0.000172169 m³ Mass Density:7100 kg/m³ Mass:1.2224kg Weight:11.9795N</p>



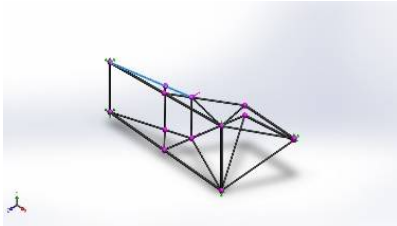
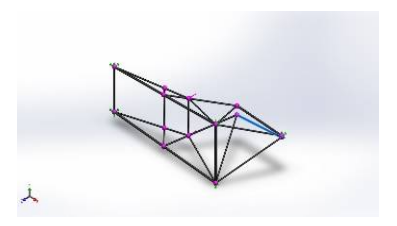
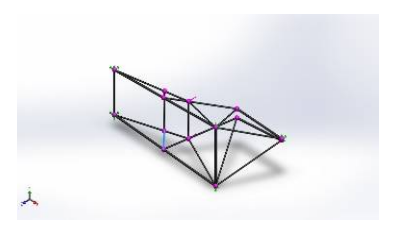
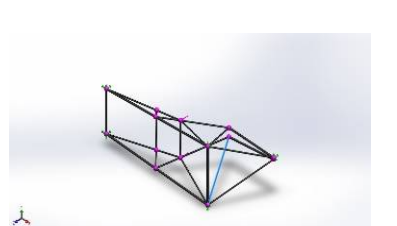
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<p>Beam-6(Recortar/Extender2)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:969.942mm Volume:6.31334e-005 m³ Mass Density:7100 kg/m³ Mass:0.448247kg Weight:4.39282N</p>
<p>Beam-7(Recortar/Extender19)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/22.2 × 1.65 Section Area: 0.000106524 m² Length:735.41mm Volume:7.8341e-005 m³ Mass Density:7100kg/ m³ Mass:0.556221kg Weight:5.45097N</p>
<p>Beam-8(Miembro estructural5)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:236.633mm Volume:1.53758e-005 m³ Mass Density:7100kg/ m³ Mass:0.109168kg Weight:1.06985N</p>
<p>Beam-9(Recortar/Extender17)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:859.654mm Volume:5.54902e-005 m³ Mass Density:7100kg/ m³ Mass:0.393981kg Weight:3.86101N</p>



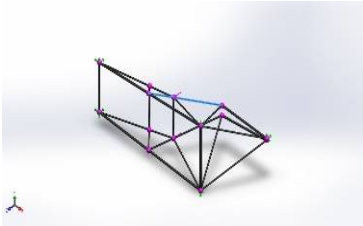
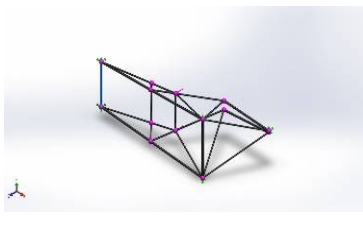
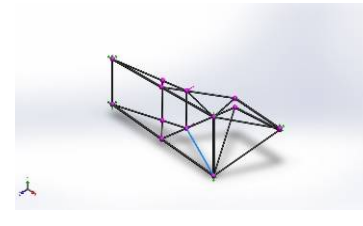
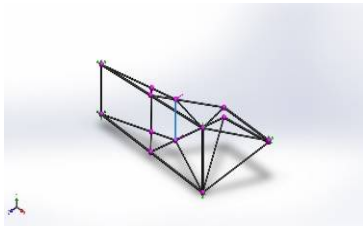
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<p>Beam-10(Recortar/Extender14)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005m² Length:884.646mm Volume:5.74884e-005m³ Mass Density:7100kg/ m³ Mass:0.408168kg Weight:4.00004N</p>
<p>Beam-11(Recortar/Extender4)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/22.2 × 1.65 Section Area: 0.000106524m² Length:583.915mm Volume:6.22305e-005m³ Mass Density:7100kg/ m³ Mass:0.441836kg Weight:4.33N</p>
<p>Beam-12(Recortar/Extender8)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005m² Length:728.445mm Volume:4.7377e-005m³ Mass Density:7100kg/ m³ Mass:0.336377kg Weight:3.29649N</p>
<p>Beam-13(Miembro estructural7)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:469.584mm Volume:3.05191e-005 m³ Mass Density:7100 kg/ m³ Mass:0.216686kg Weight:2.12352N</p>



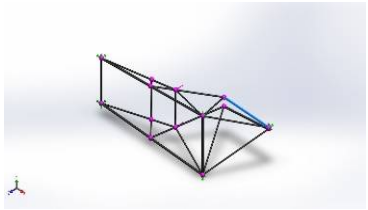
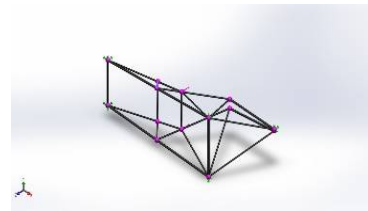
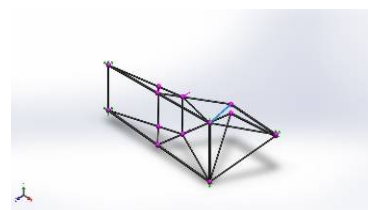
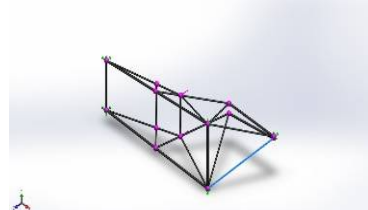
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<p>Beam-14(Recortar/Extender18)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/22.2 × 1.65 Section Area: 0.000106524 m² Length:735.414mm Volume:7.8367e-005 m³ Mass Density:7100 kg/ m³ Mass:0.556406kg Weight:5.45278N</p>
<p>Beam-15(Miembro structural5)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:235.632mm Volume:1.53185e-005 m³ Mass Density:7100kg/ m³ Mass:0.108761kg Weight: 1.06586N</p>
<p>Beam-16(Recortar/Extender15)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:850.724mm Volume:5.52962e-005 m³ Mass Density:7100kg/ m³ Mass:0.392603kg Weight:3.84751N</p>
<p>Beam-17(Recortar/Extender19)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:861.334mm Volume:5.59916e-005 m³ Mass Density:7100kg/ m³ Mass:0.397541kg Weight:3.8959N</p>



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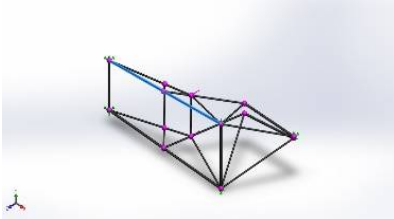
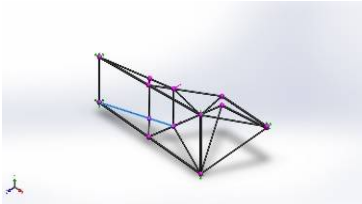
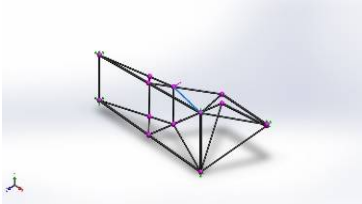
<p>Beam-18(Recortar/Extender10)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/22.2 × 1.65 Section Area: 0.000106524m² Length:1619.52mm Volume:0.000172158m³ Mass Density:7100kg/ m³ Mass:1.22232kg Weight:11.9788N</p>
<p>Beam-19(Recortar/Extender4)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:968.814mm Volume:6.3026e-005 m³ Mass Density:7100kg/ m³ Mass:0.447484kg Weight:4.38535N</p>
<p>Beam-20(Miembro estructural8)</p> 	<p>Beam – Uniform C/S</p>	<p>Section Standard-iso/pipe/14.2 × 1.65 Section Area: 6.50545e-005 m² Length:738.248mm Volume:4.80264e-005 m³ Mass Density:7100kg/ m³ Mass:0.340987kg Weight:3.34168N</p>

Table 2: Model information shown.

2.4. Study Properties

Study properties of modal shown in Table 3.

Study name	Basic frame
Analysis type	Static
Mesh type	Beam Mesh
Solver type	Direct sparse solver
In plane Effect	Off



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Soft Spring	Off
Inertial Relief	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Result folder	SOLIDWORKS document

Table 3: Study properties.

2.5. Units

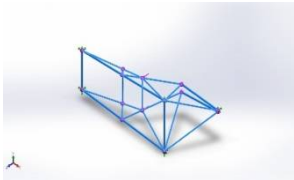
Units for modal shown in Table 4.

Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/ m ²

Table 4: Units for modal.

2.6. Material Properties

Material Properties for modal shown in Table 5.

Model Reference	Properties		Components
	Name:	Ductile Iron	SolidBody 1(Recortar/Extender18)(Chassis 2),
	Model type:	Linear Elastic Isotropic	SolidBody 2(Miembro estructural5)(Chassis 2),
	Default failure criterion:	Max von Mises Stress	SolidBody 3(Recortar/Extender16)(Chassis 2),
	Yield strength:	5.51485e+008 N/m ²	SolidBody 4(Recortar/Extender13[1])(Chassis 2),
	Tensile strength:	8.61695e+008 N/m ²	SolidBody 5(Recortar/Extender5)(Chassis 2),
	Elastic modulus:	1.2e+011 N/m ²	SolidBody 6(Recortar/Extender2)(Chassis 2),
	Poisson's ratio:	0.31	SolidBody 7(Recortar/Extender19)(Chassis 2),
	Mass density:	7100 kg/m ³	SolidBody 8(Miembro estructural5)(Chassis 2),



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	Shear modulus:	7.7e+010 N/m ²	SolidBody 9(Recortar/Extender17)(Chassis 2),
	Thermal expansion coefficient:	1.1e-005 /Kelvin	SolidBody 10(Recortar/Extender14)(Chassis 2),
			SolidBody 11(Recortar/Extender4)(Chassis 2),
			SolidBody 12(Recortar/Extender8)(Chassis 2),
			SolidBody 13(Miembro estructural7)(Chassis 2),
			SolidBody 14(Recortar/Extender18)(Chassis 2),
			SolidBody 15(Miembro estructural5)(Chassis 2),
			SolidBody 16(Recortar/Extender15)(Chassis 2),
			SolidBody 17(Recortar/Extender19)(Chassis 2),
			SolidBody 18(Recortar/Extender10)(Chassis 2),
		SolidBody 19(Recortar/Extender4)(Chassis 2),	
		SolidBody 20(Miembro estructural8)(Chassis 2)	

Curve Data: N/A

Table 5: Material Properties for modal.

2.7. Loads and Fixtures

Fixtures and Loads for the modal shown in Tables 6a and 6b.


Fixture name	Fixture Image	Fixture Details	
Fixed-1		Entities: 5 Joint(s) Type: Fixed Geometry	5 Joint(s) Fixed Geometry

Table 6a: Fixtures for the modal.

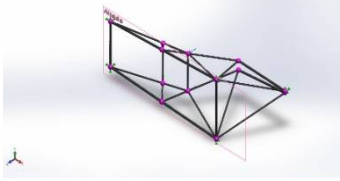
Load name	Load Image	Load Details
Force-1		Entities: 1 plane(s), 2 Joint(s) Reference: Alzado Type: Apply force Values: ---, ---, 4000 N Moments: ---, ---, --- N.m

Table 6b: Loads for the modal.



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2.8. Connector Definitions

In this type simulation joint connection are used (Table 7).

Mesh type: Beam Mesh.

Total Nodes	654
Total Elements	647
Time to complete mesh(hh:mm:ss):	00:00:05
Computer name:	

Sensor Details: No Data

Table 7: Simulation joint connection.

2.9. Resultant Forces

Resultant forces are shown in Tables 8a and 8b.

Reaction forces:

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	0	4.58E-05	-8000	8000

Table 8a: Reaction forces.



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Reaction moments:

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	1.974	-41.8032	25.1283	48.8143

Table 8b: Reaction forces.

Beams:

Table 9 shows the beams for modal.

Beam Name	Joints	Axial(N)	Shear1(N)	Shear2(N)	Moment1 (N.m)	Moment2 (N.m)	Torque (N.m)
Beam-1 (Recortar/Extender1 8)	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
Beam-2 (Miembro estructural5)	1	-40.0169	0.537179	-2.66546	-1.39843	1.06968	-0.0528
	2	40.0169	-0.53717	2.66549	2.7367	-0.8	0.052801
Beam-3 (Recortar/Extender1 6)	1	83.2541	-2.49757	23.1447	-0.67384	-0.42627	-1.62257
	2	1236.2	-12.3295	62.1854	19.5964	4.39345	5.46851
	3	-83.2541	2.4977	-23.1447	-6.37262	-0.33417	1.62257
Beam-4 (Recortar/Extender1 3)	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
Beam-5 (Recortar/Extender5)	1	-32.2843	-8.33024	27.224	10.1458	2.58291	1.57174
	2	30.3626	13.5015	-21.9962	-9.29866	-5.2024	-1.47819
	3	32.2843	8.33023	-27.224	10.7174	3.80096	-1.57175
Beam-6 (Recortar/Extender2)	1	-3109.61	2.02089	-13.6337	-0.51535	-0.83889	-2.30182
	2	3109.61	-2.02093	13.6337	-3.45106	0.250515	2.30182
	3	-3097.82	-7.07085	1.98845	0.522619	2.52537	-1.22846
Beam-7 (Recortar/Extender1 9)	1	-1120.78	80.9452	-39.4193	21.5301	42.3837	14.5386
	2	1121.6	-80.2633	41.0491	8.19046	15.7565	-14.524
	3	1120.78	-80.9452	39.4193	-21.315	-41.942	-14.5386



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Beam-8 (Miembro estructural5)	1	-30.7501	-9.97106	19.7017	-1.25194	-1.54023	0.434858
	2	30.8713	9.51257	-19.7388	-3.38194	-0.73978	-0.44265
Beam-9 (Recortar/Extender1 7)	1	-1123.14	2.03797	6.54529	-0.13198	0.035793	2.26522
	2	1123.14	-2.03857	-6.54576	5.84027	-1.81378	-2.26522
Beam-10 (Recortar/Extender1 4)	1	-54.7123	0.596797	-25.3643	6.21567	0.027132	-1.79176
	2	-2126.98	13.6375	-56.5479	17.9579	4.51776	5.0185
	3	-54.6196	-0.44915	-25.5663	-0.99893	0.083215	-1.88085
Beam-11 (Recortar/Extender4)	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
Beam-12 (Recortar/Extender8)	1	-5511.2	-9.36763	1.99804	-1.49085	-0.96445	-1.84576
	2	5511.21	-4.81002	3.16763	-0.73142	-2.21235	1.84857
Beam-13 (Miembro estructural7)	1	1732.17	1.53026	-0.48636	0.86666	6.28292	0.010904
	2	-1731.84	8.28008	-33.069	0.158441	-4.04222	0.068035
Beam-14 (Recortar/Extender1 8)	1	-1963.06	-76.3519	-37.4036	19.8284	-40.5568	-13.6683
	2	1963.06	76.3522	37.413	7.10556	-14.4167	13.6683
Beam-15 (Miembro estructural5)	1	18.4393	7.80705	-19.0907	-0.74406	-1.10577	0.743421
	2	-18.5428	-8.19836	18.8245	-3.71311	-0.81325	-0.74836
Beam-16 (Recortar/Extender1 5)	1	1996.36	-1.3643	5.89712	-5.48878	-1.32482	2.10449
	2	-1996.36	1.36325	-5.89627	0.34605	0.134622	-2.10449
Beam-17 (Recortar/Extender1 9)	1	-1.94264	0.097391	0.002419	0.000927	-0.0291	0.086961
	2	1.94264	-0.09739	-0.00242	0.001209	-0.05691	-0.08696
Beam-18 (Recortar/Extender1 0)	1	-17.6287	12.5074	-15.3478	6.49639	4.74013	-1.69907
	2	-18.7444	6.40297	-19.133	-7.52362	-3.08562	-1.8066



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	3	17.6287	-12.5074	15.3478	6.41326	5.78034	1.69907
Beam-19 (Recortar/Extender4)	1	-4575.23	3.63362	9.34393	-0.16405	-1.15494	2.52382
	2	4575.22	-12.3043	-5.72179	2.82964	-0.15588	-2.5189
	3	-4553.9	-9.65857	-1.05629	-0.17314	3.39869	0.921853
Beam-20 (Miembro estructural8)	1	4463.51	-2.41114	-3.44493	0.732984	-1.3731	-1.96406
	2	-4463.13	55.0289	20.4017	2.2173	-1.83042	1.98254

Table 9: Beams for modal.

Beam stresses:

Tables 10a- 10c shows the Beam Stresses for modal.

Beam Name	Joints	Axial(N/m ²)	Bending Dir1 (N/m ²)	Bending Dir2(N/m ²)	Torsional (N/m ²)	Upper bound axial and bending(N/m ²)
Beam-1 (Recortar/Extender18)	1	0	0	0	0	0
	2	0	0	0	0	0
Beam-2 (Miembro estructural5)	1	615128	7.62046e+006	5.82901e+006	-143861	1.02093e+007
	2	615128	1.49131e+007	4.35941e+006	143865	1.61523e+007
Beam-3 (Recortar/Extender16)	1	-1.27976e+006	3.67195e+006	-2.3229e+006	-	5.62476e+006
	2	1.90025e+007	1.06787e+008	-2.39412e+007	1.48998e+007	1.2844e+008
	3	-1.27976e+006	-3.47263e+007	1.82097e+006	4.42094e+006	3.60538e+007
Beam-4 (Recortar/Extender13)	1	0	0	0	0	0
	2	0	0	0	0	0
Beam-5 (Recortar/Extender5)	1	-303072	1.98993e+007	-5.06597e+006	1.54135e+006	2.08371e+007
	2	285031	-1.82378e+007	1.02037e+007	-	2.11832e+007
	3	-303072	-2.10205e+007	7.45498e+006	-	2.26064e+007
Beam-6 (Recortar/Extender2)	1	-4.78e+007	-2.80829e+006	4.57137e+006	-	5.31651e+007
	2	-4.78e+007	1.88059e+007	1.36513e+006	6.27164e+006	6.66554e+007
	3	-4.76188e+007	2.84791e+006	-1.37615e+007	-	6.16719e+007
Beam-7 (Recortar/Extender19)	1	1.05215e+007	-4.22278e+007	8.31289e+007	1.42576e+007	1.03761e+008
	2	1.05291e+007	1.60643e+007	-3.09038e+007	-	4.53588e+007
	3	1.05215e+007	-4.18059e+007	8.22625e+007	-	1.02797e+008
Beam-8 (Miembro estructural5)	1	472682	6.82222e+006	-8.39316e+006	1.18484e+006	1.12888e+007
	2	474545	-1.84292e+007	4.03126e+006	-	1.93395e+007



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					1.20607e+006	
Beam-9 (Recortar/Extender17)	1	-1.72647e+007	-719214	-195047	6.17192e+006	1.80098e+007
	2	-1.72647e+007	-3.18254e+007	-9.88381e+006	-	5.05895e+007
Beam-10 (Recortar/Extender14)	1	-841022	3.3871e+007	-147848	-	3.47124e+007
	2	3.26954e+007	-9.78578e+007	2.46186e+007	4.88192e+006	1.33602e+008
	3	-839597	-5.44345e+006	-453461	-	6.30191e+006
Beam-11 (Recortar/Extender4)	1	0	0	0	0	0
	2	0	0	0	0	0
Beam-12 (Recortar/Extender8)	1	-8.47166e+007	-8.12409e+006	5.25558e+006	-	9.43925e+007
	2	-8.47167e+007	3.9857e+006	-1.20558e+007	5.02904e+006	9.74142e+007
Beam-13 (Miembro estructural7)	1	-2.66265e+007	-4.72269e+006	3.42375e+007	29710.7	6.11881e+007
	2	-2.66213e+007	863390	2.20273e+007	185372	4.86655e+007
Beam-14 (Recortar/Extender18)	1	1.84284e+007	-3.88903e+007	-7.95456e+007	-	1.06972e+008
	2	1.84284e+007	1.39364e+007	2.82761e+007	1.34041e+007	4.99524e+007
Beam-15 (Miembro estructural5)	1	283443	-4.05459e+006	6.02566e+006	2.02556e+006	7.54625e+006
	2	285035	2.02338e+007	-4.43163e+006	-	2.09985e+007
Beam-16 (Recortar/Extender15)	1	-3.06874e+007	2.991e+007	-7.21931e+006	2.03902e+006	6.14563e+007
	2	-3.06874e+007	1.88573e+006	-733594	5.73401e+006	3.27108e+007
Beam-17 (Recortar/Extender19)	1	-29861.7	5052.03	158595	-5.734e+006	188537
	2	-29861.7	-6589.06	-310138	236939	340069
Beam-18 (Recortar/Extender10)	1	165491	-1.27416e+007	9.29701e+006	-	1.59384e+007
	2	-175965	-1.47564e+007	6.05196e+006	1.66623e+006	1.61252e+007
	3	165491	1.25786e+007	-1.13372e+007	-	1.70993e+007
Beam-19 (Recortar/Extender4)	1	-7.03291e+007	-893953	6.29359e+006	1.66622e+006	7.66859e+007
	2	-7.0329e+007	-1.54195e+007	-849432	-	8.57719e+007
	3	-7.00013e+007	-943503	-1.85205e+007	6.86311e+006	8.85458e+007
Beam-20 (Miembro estructural8)	1	-6.86118e+007	-3.99425e+006	-7.48242e+006	-	7.70936e+007
	2	-6.86059e+007	1.20828e+007	9.97448e+006	5.35138e+006	8.42738e+007

Table 10a: Beam Stresses for modal.



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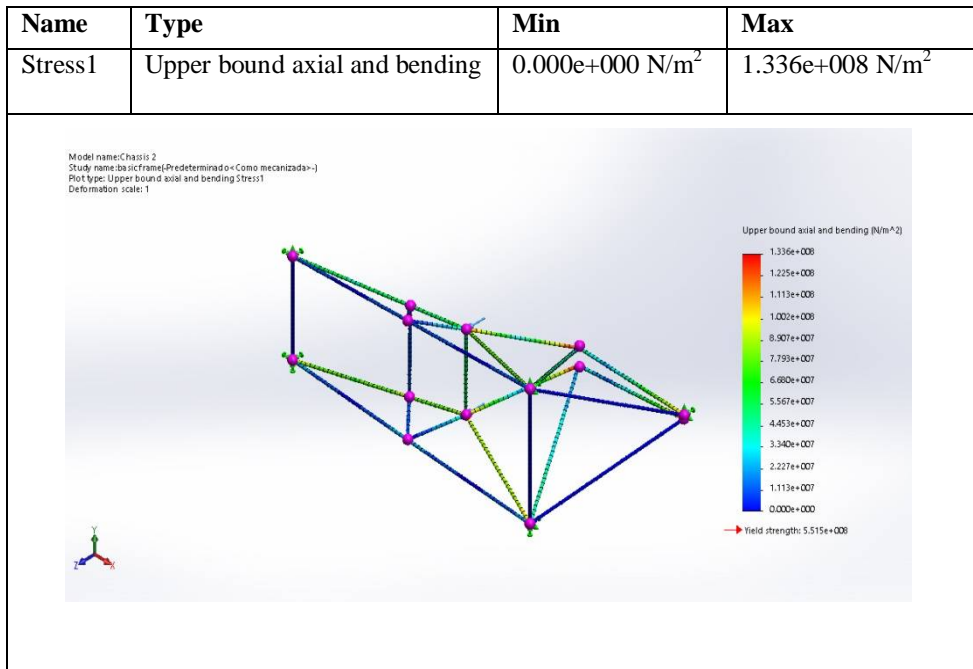


Table 10b: Stress 1.

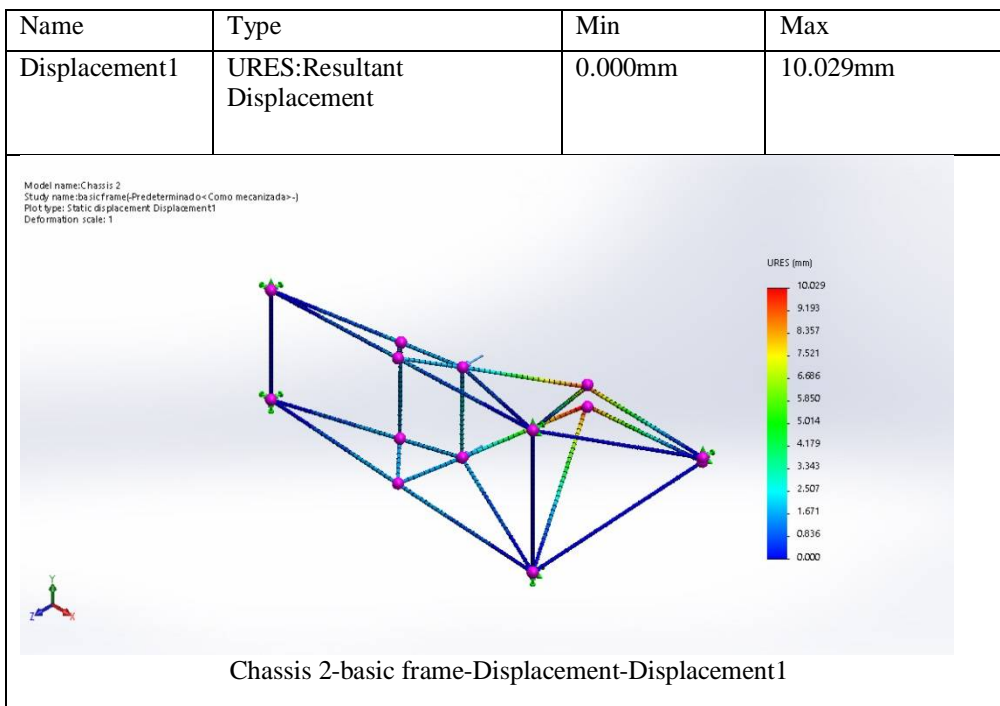


Table 10c: Displacement 1.



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III. OVERVIEW

From the simulation of software we come to know that it can bear the force of 4000 N because by applying force it did not cross the elastic limit and from von-mises theory it is clear that material is below the yielding force in the action of force.

IV. FLOW SIMULATION

Flow simulation is basically thrust which is created by the blades and thrust is different at different angles. The blade we used for the flow simulation is Naca-0012 it is symmetrical as it is clear from its airfoil four digit section. First digit shows the maximum height of the mean camber of blade in percent of chord and here digit is 0. Second digit shows the maximum height of camber from the leading edge in percent of chord and here it is 0. Last two digits show the thickness of blade in percent of chord digits are 12. Here the thrust results are at 650 rpm which is maximum rpm according to our theoretical calculations and at various angles (Table 11).

λr Tip speed	C_t Thrust coefficient	N rpm
150	0.0036	470
160	0.00321	501
170	0.00271	532
180	0.0025	564
190	0.0021	595
210	0.0018	650

Table 11: Flow simulation.

These calculations should be in specific range and our calculations are in range due to which we get good results.

4.1. Standard Values

In flow range = 6.4 to 14.3 m/s
Coefficient of thrust = 0.004 to 0.006
Calculations:
In Flow range = 6.998 m/s
Coefficient of thrust = 0.00434
Induced power = 32.16 hp
Total power = 65 hp

4.2. General Information

Objective of the simulation:

We want to get desired inflow for the flight of vehicle and according to this simulation our climb rate is perfect which we need. These are basic results for every helicopter.



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4.3. Analysis Environment

Software Product: Flow Simulation 2016 SP4.0. Build: 3501
CPU Type: Intel(R) Core(TM) i3-4030U CPU @ 1.90GHz
CPU Speed: 1900 MHz
RAM: 8096 MB / 134217727 MB
Operating System: Windows 10 (or higher) (Version 10.0.14393)

Model Information:

Model Name: Assembly for blades.SLDASM
Project Name: bladesimulation results

Project Comments:

Unit System: SI (m-kg-s)
Analysis Type: External (not exclude internal spaces)

4.4. Size of Computational Domain

Table 12 shows size of the computational domain.

X min	-3.577 m
X max	3.577 m
Y min	-0.498 m
Y max	0.100 m
Z min	-3.644 m
Z max	3.638 m

Table 12: Computational domain.

4.5. Simulation Parameters

Mesh Settings: Basic Mesh.

Basic Mesh Dimensions (Table 13).

Number of cells in X	100
Number of cells in Y	50
Number of cells in Z	50

Table 13: Basic mesh dimensions.

Analysis mesh:

Total Cell count:407816
Fluid Cells: 407816



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Solid Cells:30806
 Partial Cells: 56600
 Trimmed Cells: 0

Additional physical calculation options:

Heat Transfer Analysis:
 Heat conduction in solids: Off
 Flow Type: Laminar and turbulent
 Time-Dependent Analysis: Off
 Gravity: Off
 Radiation:
 Humidity: Off

4.6. Material Settings

Material Settings: Fluids, Air.

4.7. Ambient Conditions

The ambient conditions for the modal simulation (Table 14).

Thermodynamic parameters	Static Pressure: 101325.00 Pa Temperature: 293.20 K
Velocity parameters	Velocity vector Velocity in X direction: 0 m/s Velocity in Y direction: 0 m/s Velocity in Z direction: 0 m/s
Turbulence parameters	

Table 14: Ambient conditions for the modal simulation.

4.8. Goals

Surface Goals: SG Force (Y) 1(Table 15).

Type	Surface Goal
Goal type	Force (Y)
Faces	Face<3>@blade for simulation-1
	Face<1>@blade for simulation-1
	Face<2>@blade for simulation-2
	Face<2>@blade for simulation-1
	Face<1>@blade for simulation-2
	Face<3>@blade for simulation-2



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Coordinate system	Global coordinate system
Use in convergence	On

Table 15: Surface goals: SG force (Y).

4.9. Analysis Time

Calculation Time: 10998 s

Number of Iterations: 93

4.10. Results for Minimum Angle

Analysis Goals (Table 16).

Name	Unit	Value	Progress	Criteria	Delta	Use in convergence
SG Force (Y) 1	N	4994.54	100	272.989	262.1	On

Table 16: Analysis goals.

4.11. Global Min-Max-Table

Global Min-Max (Table 17).

Name	Minimum	Maximum
Density (Fluid) [kg/m ³]	0.94	1.38
Pressure [Pa]	78582.59	127052.68
Temperature [K]	275.35	320.63
Temperature (Fluid) [K]	275.35	320.63
Velocity [m/s]	4.30E-04	236.214
Velocity (X) [m/s]	-63.266	62.065
Velocity (Y) [m/s]	-61.66	57.588
Velocity (Z) [m/s]	-236.003	235.972
Mach Number []	1.25E-06	0.69
Mach Number RRF []	0	0.88
Velocity RRF [m/s]	0	293.952
Velocity RRF (X) [m/s]	-237.479	237.552
Velocity RRF (Y) [m/s]	-61.66	57.588
Velocity RRF (Z) [m/s]	-293.626	293.778
Vorticity [1/s]	1.60E-04	32805.5
Relative Pressure [Pa]	-22742.41	25727.68



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Shear Stress [Pa]	0	146.76
Heat Transfer Coefficient [W/m ² /K]	0	0
Surface Heat Flux [W/m ²]	0	0
Surface Heat Flux (Convective) [W/m ²]	0	0

Table 17: Global min-max.

V. CONCLUSION

Minimum Angle

I was required climb rate between 15 to 20 m/s and this simulation has good results at its maximum rpm 650 rpm and at angle of attack nearly 5 degree. These results are for minimum angle.

Maximum Angle

Now we simulate at maximum angle between 10 to 15 degree at this angle we get 10327 N thrust force which shows that it is good for climb rate.

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