Disk loading

From Wikipedia, the free encyclopedia

In fluid dynamics, **disk loading** or **disc loading** is the average pressure change across an actuator disk, such as an airscrew. Airscrews with a relatively low disk loading are typically called rotors, including helicopter main rotors and tail rotors; propellers typically have a higher disk loading.[1] The V-22 Osprey tiltrotor aircraft has a high disk loading relative to a helicopter in the hover mode, but a relatively low disk loading in fixed-wing mode compared to a turboprop aircraft.[2]

The MV-22 Osprey tiltrotor has a relatively high disk loading, producing visible blade tip vortices from condensation of the marine air in this photo of a vertical takeoff.

Contents [hide]

Rotors [edit]

C-27J Spartan with propeller tip vortices condensation. The C-27J uses the same engines as the MV-22, but has higher disk loading.

Disc loading of a hovering helicopter is the ratio of its weight to the total main rotor disc area. It is determined by dividing the total helicopter weight by the rotor disc area, which is the area swept by the blades of a rotor. Disc area can be found by using the span of one rotor blade as the radius of a circle and then determining the area the blades encompass during a complete rotation. When a helicopter is being maneuvered, its disc loading changes. The higher the loading, the more power needed to maintain rotor speed.[3] A low disc loading is a direct indicator of high lift thrust efficiency.[4]

Increasing the weight of a helicopter increases disk loading. For a given weight, a helicopter with shorter rotors will have higher disk loading, and will require more engine power to hover. A low disk loading improves autorotation performance in rotorcraft.[5][6] Typically, an autogyro (or gyroplane) has a lower rotor disc loading than a helicopter, which provides a slower rate of descent in autorotation.[3]

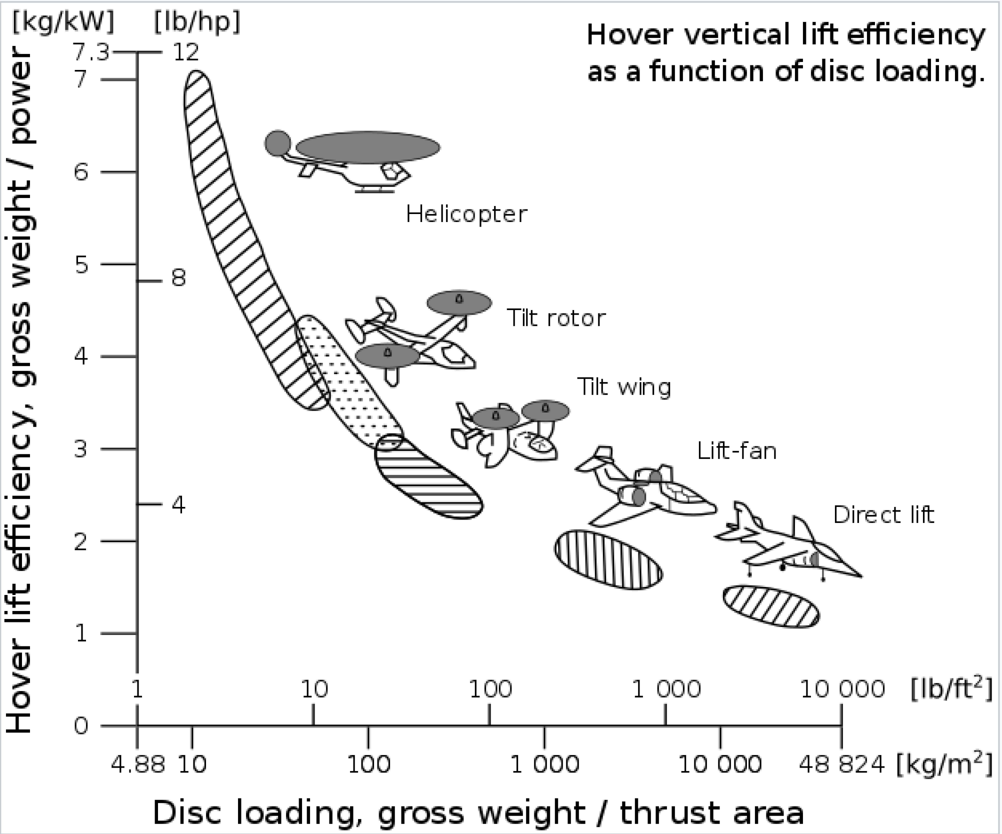
Propellers [edit]

In reciprocating and propeller engines, disk loading can be defined as the ratio between propeller-induced velocity and freestream velocity.[citation needed] Lower disk loading will increase efficiency, so it is generally desirable to have larger propellers from an efficiency standpoint.

Examples [edit]

Disk loading comparison

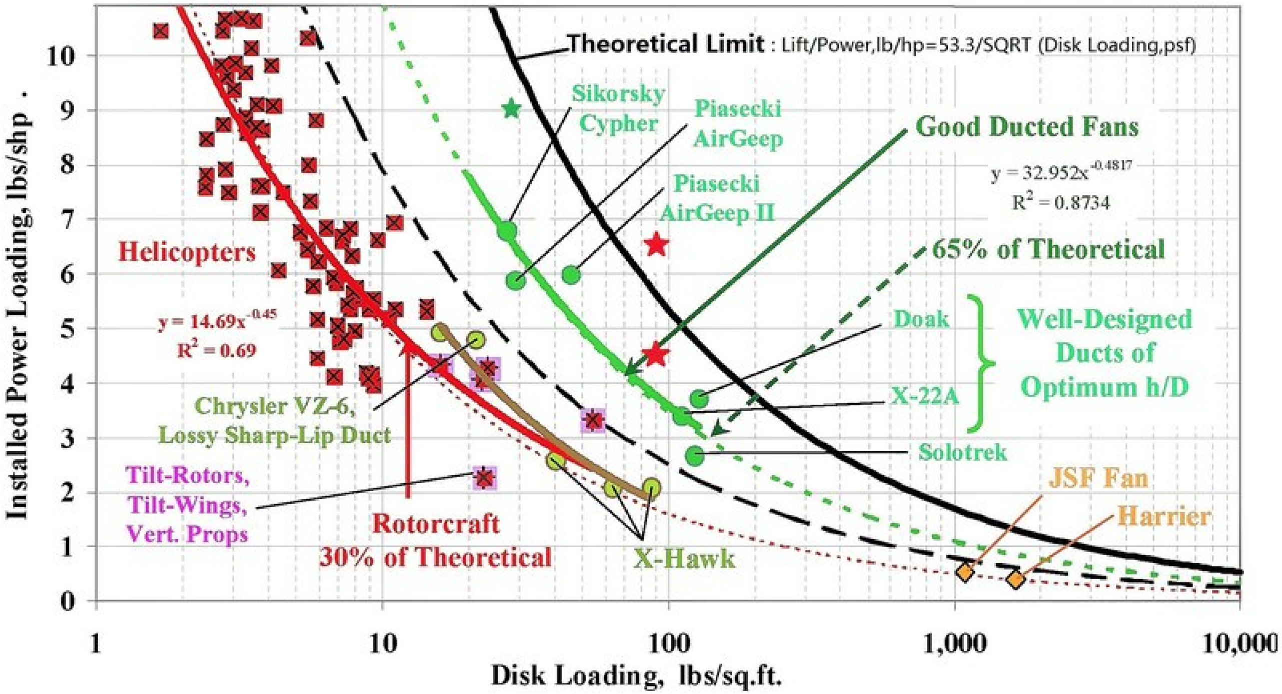
Aircraft	Description	Max. gross weight	Total disk area	Max. disk loading
Robinson R22	Light utility helicopter	1,370 lb (635 kg)	497 ft^2 (46.2 m^2)	2.6 lb/ft^2 (14 kg/m^2)
Bell 206B3 JetRanger	Turboshaft utility helicopter	3,200 lb (1,451 kg)	872 ft^2 (81.1 m^2)	3.7 lb/ft^2 (18 kg/m^2)
CH-47D Chinook	Tandem rotor helicopter	50,000 lb (22,680 kg)	5,655 ft^2 (526 m^2)	8.8 lb/ft^2 (43 kg/m^2)
Mil Mi-26	Heavy-lift helicopter	123,500 lb (56,000 kg)	8,495 ft^2 (789 m^2)	14.5 lb/ft^2 (71 kg/m^2)
CH-53E Super Stallion	Heavy-lift helicopter	73,500 lb (33,300 kg)	4,900 ft^2 (460 m^2)	15 lb/ft^2 (72 kg/m^2)
MV-22B Osprey	Tiltrotor V/STOL	60,500 lb (27,400 kg)	2,268 ft^2 (211.4 m^2)	26.68 lb/ft^2 (129.63 kg/m^2)



Correlation between disc loading and hover lift efficiency, for various VTOL aircraft

See also [edit]

- Wing loading



Size of this JPG preview of this TIF file: 800 × 476 pixels. Other resolutions: 320 × 190 pixels | 640 × 381 pixels | 1,024 × 609 pixels | 1,280 × 762 pixels | 2,013 × 1,198 pixels.

Original file (2,013 × 1,198 pixels, file size: 1.73 MB, MIME type: image/tiff)

Open in Media Viewer

File information Structured data

Captions Edit

English Add a one-line explanation of what this file represents

Summary [edit]

Description	**English:** Disk loading vs. power loading for VTOL aircraft (original work by S. Paul Dev of D-STAR Engineering Corp., Shelton, CT, USA, reproduced with permission
Date	12 July 2019
Source	Own work
Author	Ryanyunjiang

JAVAPROP – USERS GUIDE

Initial Creation: June 2009 – Last Revision: August 2018 - Martin Hepperle

Table of Contents

5. Validation of JAVAPROP

To compare the results of JAVAPROP with experimental data, a set of test results for a propeller according to design 5868-9 of the Navy Bureau of Aeronautics was selected. The propeller geometry as well as the test data can be found in NACA Report 594. The propeller used airfoils of the Clark Y type and had 3 blades. Data shown in Figure 26 are for the configuration "Nose 6, Propeller C". The blade geometry according to the NACA report has been imported into JAVAPROP via the geometry card. The blade angle at 75% of the radius was adjusted to match the angles given in the report and the results produced by the Multi-Analysis card were collected in an Excel spreadsheet. No further tweaking was performed. The comparison shows that JAVAPROP predicts the general performance characteristics in the typical "linear" operating range quite well. For this example, thrust and power are somewhat under-predicted, indicating that possibly the zero lift angle of the Clark Y airfoil in JAVAPROP might be too low. A more likely explanation however, is that the blade angle of the NACA tests refers to the flat underside of the blade while JAVAPROP uses the x-axis of the airfoil section for reference. Unfortunately the NACA reports do not give a clear indication, how exactly the blade angle was measured. In case of a Clark Y airfoil having 12% thickness, the difference amounts to about 2°. Note that the angle difference depends on the airfoil thickness if the lower surface is maintained as a straight line.

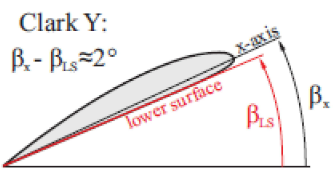


Figure 25: Possible reference lines for blade angle measurement.

Similar levels of the efficiency indicate that the lift to drag ratio of the Clark Y airfoil model in JAVAFOIL corresponds well to the tests.
Large deviations occur in the regions towards the left, where the propeller stalls. Here the flow is largely separated, three dimensional, unsteady and also depending on the external flow field (e.g. crosswind, wind tunnel interference). Such flow regimes are beyond the assumptions of the underling theory so that no good match can be expected here. It should be noted, that the experimental data show considerable scatter and irregular behavior in this regime too.

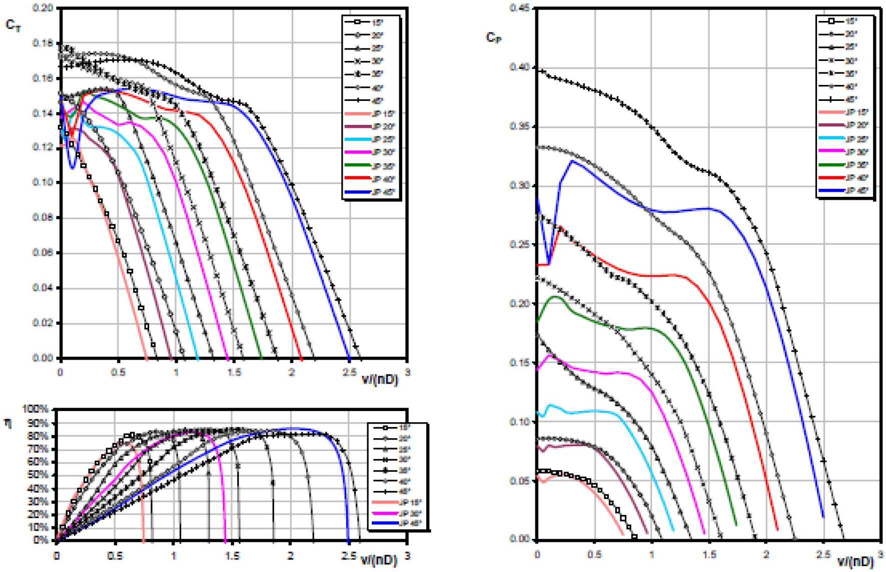


Figure 26: Prediction by JAVAPROP and experimental data from NACA R-594 (symbols).

Another comparison was performed for the propeller described in NACA Report 350. The results compare slightly worse, but still acceptable. The power coefficient predicted by JAVAPROP drops steeper with increasing advance ratio than the experiments indicate. This may be due to differences in the airfoil polars towards lower and negative lift coefficients.

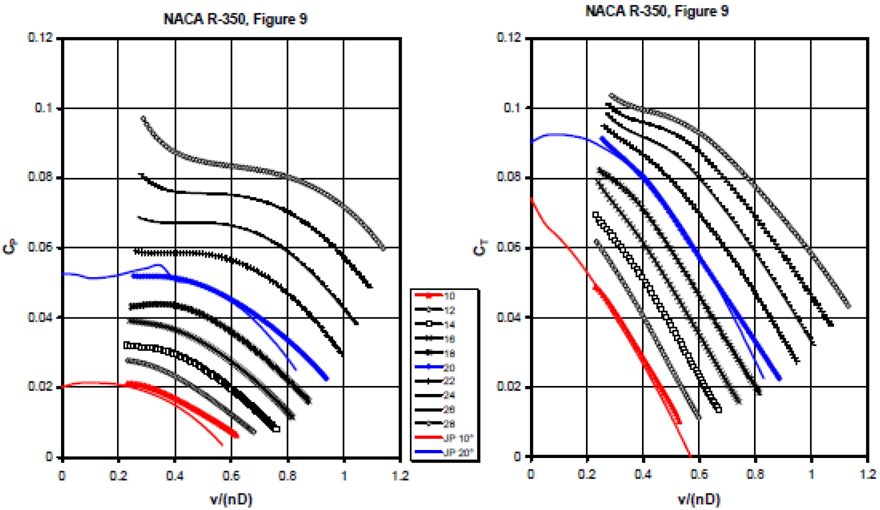
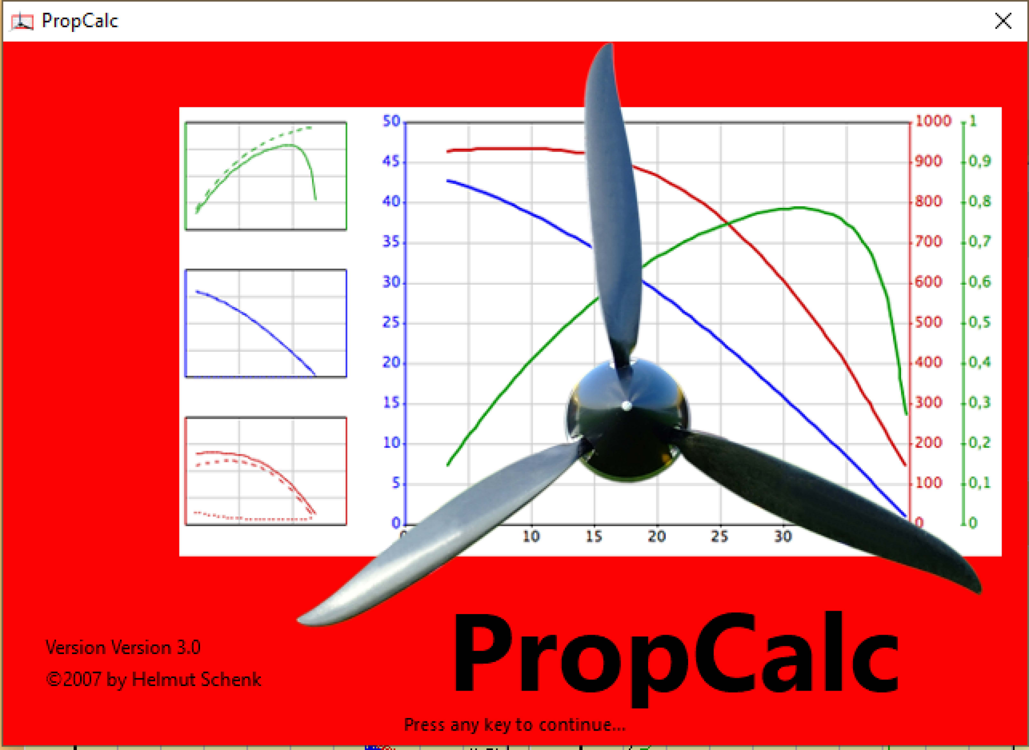


Figure 27: Data predicted by JAVAPROP and experimental data from NACA R-350 (symbols).

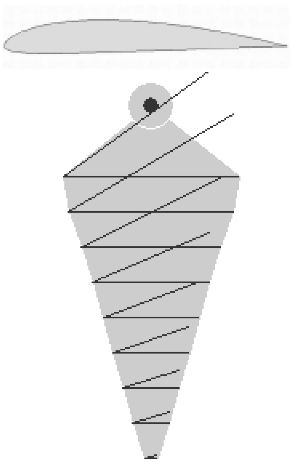

PropCalc
50
45
40
35
30
25
20
15
10
5
0
10
15
20
25
30
1000
900
800
700
600
500
400
300
200
100
0
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
PropCalc
Version Version 3.0
©2007 by Helmut Schenk
Press any key to continue...

Propeller

File Edit Window Help

Name: 12-01-21 Smaller 2000mm Propeller

Airfoil: CLARK-Y



Diameter [mm]: 2000

Blades: 2

% of radius	Chord [mm]	Blade angle [°]
20%	496.9	44.9
30%	465.3	33.9
40%	394.6	27.1
50%	327.5	22.6
60%	270.9	19.5
70%	216.2	17.1
80%	158.4	15.3
90%	100.2	13.9
100%	33.1	12.8

Chord Factor: 1

Blade angle adjust: 0

Delete New Save


PropCalc: PropCalcData.rpd
File Edit Window Help
Real, ideal efficiency
Coefficient CT, CT parts
Coefficient CP, CP parts
Thrust [N]
Thrust, Power, Efficieny
P [W]
Eta
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65
v [m/s]
CLARK-Y
12-01-21 Smaller 2000mm Propeller
n[rpm] 1740
Result table
P/D 0.7 0.77
Blade angle adjust 0°

Will Give the proper results in JavaProp Has the Correct Spinner 11-27-21 SMALLER 2000mm diam with proper airfoils.tx...

File Edit Format View Help

r/R [-]	c/R [-]	β [°]	H/D [-]	r [mm]	c [mm]	H [mm]	t [mm]	Airfoil [-]
0.0000	Spinner	-	-	-	-	-	-	-
0.0500	0.1777	73.9	0.5	50.0	177.7	1088.4	21.6	interpolated
0.1000	0.3138	63.4	0.6	100.0	313.8	1254.7	38.2	interpolated
0.1500	0.4499	52.9	0.6	150.0	449.9	1246.2	54.7	interpolated
0.2000	0.4969	44.9	0.6	200.0	496.9	1252.3	60.4	interpolated
0.2500	0.4924	38.7	0.6	250.0	492.4	1258.4	59.9	interpolated
0.3000	0.4653	33.9	0.6	300.0	465.3	1266.6	56.6	interpolated
0.3500	0.4302	30.1	0.6	350.0	430.2	1274.8	52.3	Clark Y, Re=100,000
0.4000	0.3946	27.1	0.6	400.0	394.6	1286.1	48.0	interpolated
0.4500	0.3596	24.6	0.6	450.0	359.6	1294.5	43.7	interpolated
0.5000	0.3275	22.6	0.7	500.0	327.5	1307.7	39.8	interpolated
0.5500	0.2981	20.9	0.7	550.0	298.1	1319.6	36.2	interpolated
0.6000	0.2709	19.5	0.7	600.0	270.9	1335.0	32.9	interpolated
0.6500	0.2456	18.2	0.7	650.0	245.6	1342.8	29.9	Clark Y, Re=100,000
0.7000	0.2162	17.1	0.7	700.0	216.2	1353.1	26.3	interpolated
0.7500	0.1860	16.2	0.7	750.0	186.0	1369.1	22.6	interpolated
0.8000	0.1584	15.3	0.7	800.0	158.4	1375.1	19.3	interpolated
0.8500	0.1308	14.6	0.7	850.0	130.8	1391.2	15.9	interpolated
0.9000	0.1002	13.9	0.7	900.0	100.2	1399.4	12.2	interpolated
0.9500	0.0696	13.3	0.7	950.0	69.6	1411.0	8.5	interpolated
1.0000	0.0331	12.8	0.7	1000.0	33.1	1427.5	4.0	Clark Y, Re=100,000

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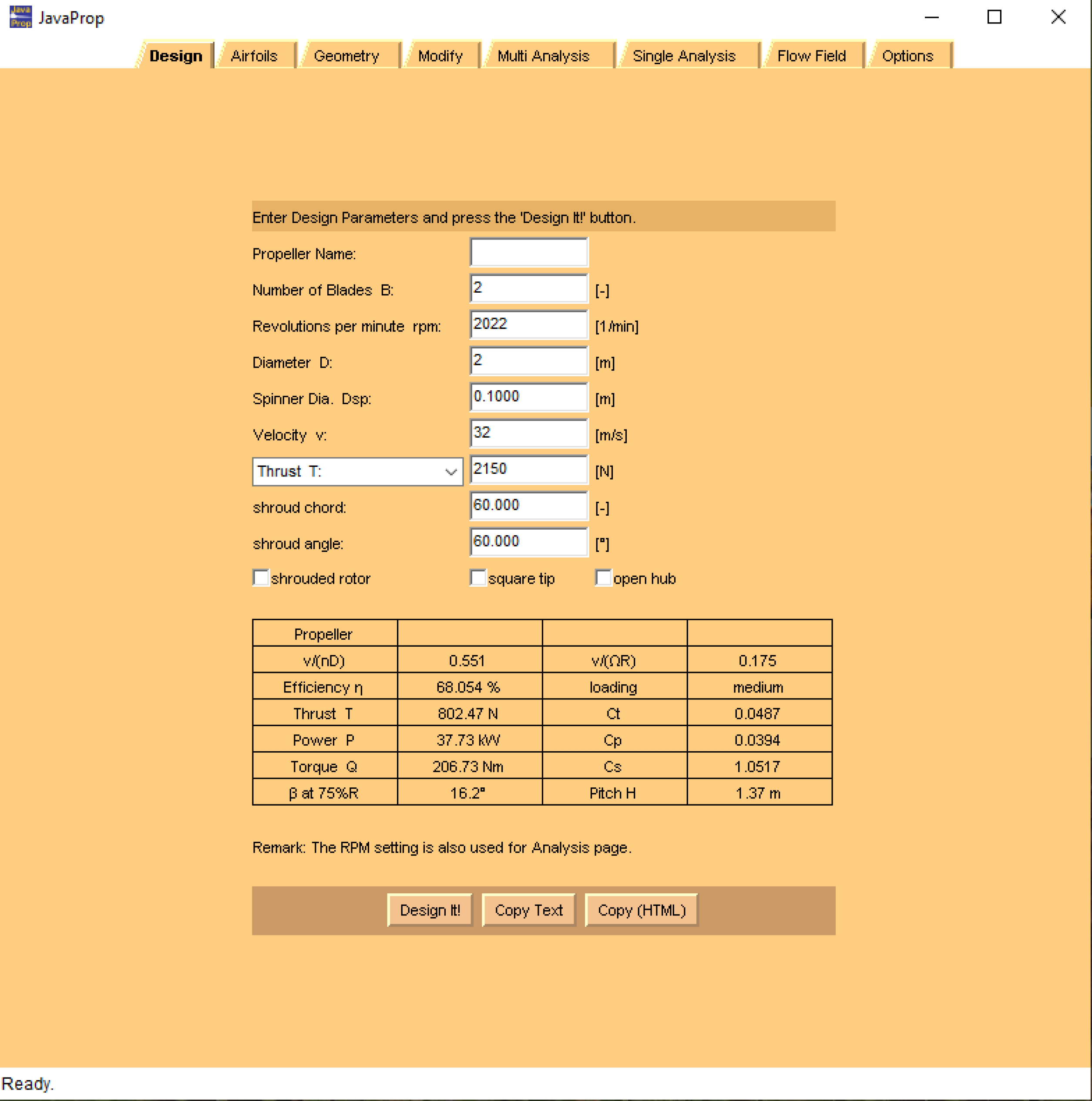
JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Adjust the desired Option(s).
JavaProp
Version 1.70 - August 1, 2021.
Copyright © 2001-2021 Martin Hepperle
• Translations
- Translation to English by Martin Hepperle, 2001.
- Translation to German by Martin Hepperle, 2001.
- Translation to French by Giorgio Toso, 2002.
- Translation to Italian by Giorgio Toso, 2002.
- Translation to Portuguese (European) by João Alveirinho Correia, 2008.
• Your current system settings
- Your user name is Bobbi.
- You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
- System language code is en.
- Selected country is United States, selected language is English.
Country Settings:
English (United States)
(decimal character is: '.')
Density ρ:
0.9334
[kg/m³]
Kinematic Viscosity ν:
0.000014607
[m²/s]
Speed of Sound a:
340.29
[m/s]
Save...
Load...
Clear preferences on exit
Air
Water
Ready.


JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Enter Design Parameters and press the 'Design It!' button.

Propeller Name:

Number of Blades B: 2 [-]

Revolutions per minute rpm: 2022 [1/min]

Diameter D: 2 [m]

Spinner Dia. Dsp: 0.1000 [m]

Velocity v: 32 [m/s]

Thrust T: 2150 [N]

shroud chord: 60.000 [-]

shroud angle: 60.000 [°]

shrouded rotor   square tip   open hub

Propeller			
v/(nD)	0.551	v/(ΩR)	0.175
Efficiency η	68.054 %	loading	medium
Thrust T	802.47 N	Ct	0.0487
Power P	37.73 kW	Cp	0.0394
Torque Q	206.73 Nm	Cs	1.0517
β at 75%R	16.2°	Pitch H	1.37 m

Remark: The RPM setting is also used for Analysis page.

Design It!   Copy Text   Copy (HTML)

Ready.

JavaProp

Design | **Airfoils** | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Select the desired airfoils and angle of attack for each station.

r/R = 0.00: Clark Y, Re=100,000

angle of attack: 3.0 [°]

r/R = 0.333: Clark Y, Re=100,000

angle of attack: 3.0 [°]

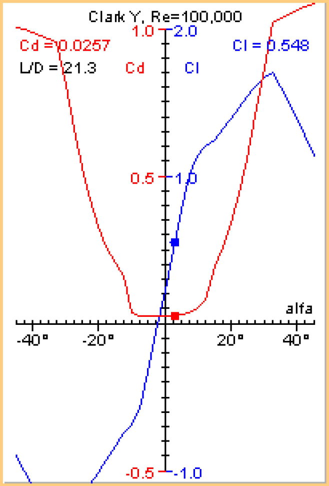
r/R = 0.667: Clark Y, Re=100,000

angle of attack: 3.0 [°]

r/R = 1.00: Clark Y, Re=100,000

angle of attack: 3.0 [°]

suppress airfoil drag



Ready.

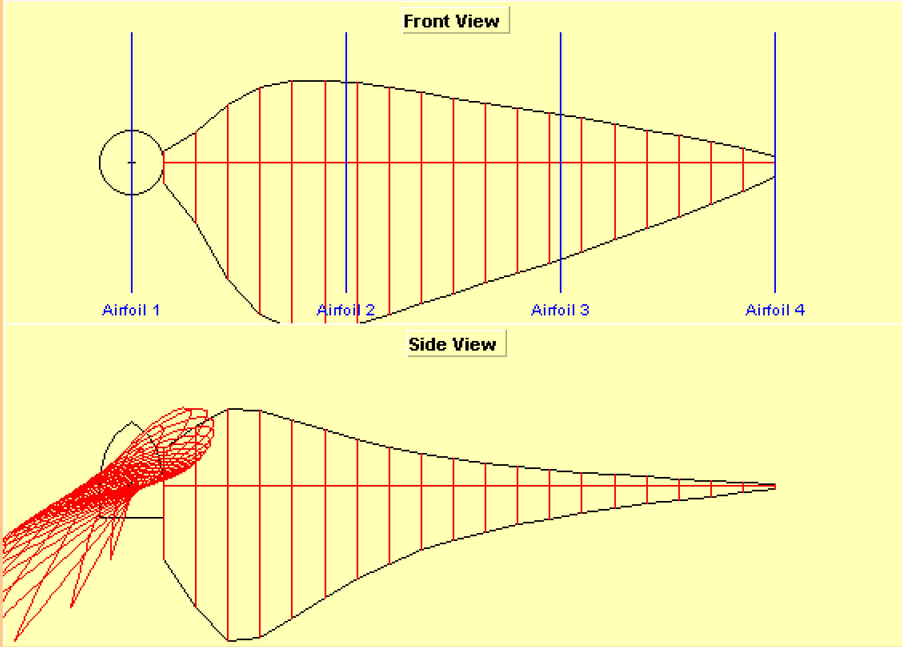
JavaProp

Design | Airfoils | **Geometry** | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Propeller Geometry.

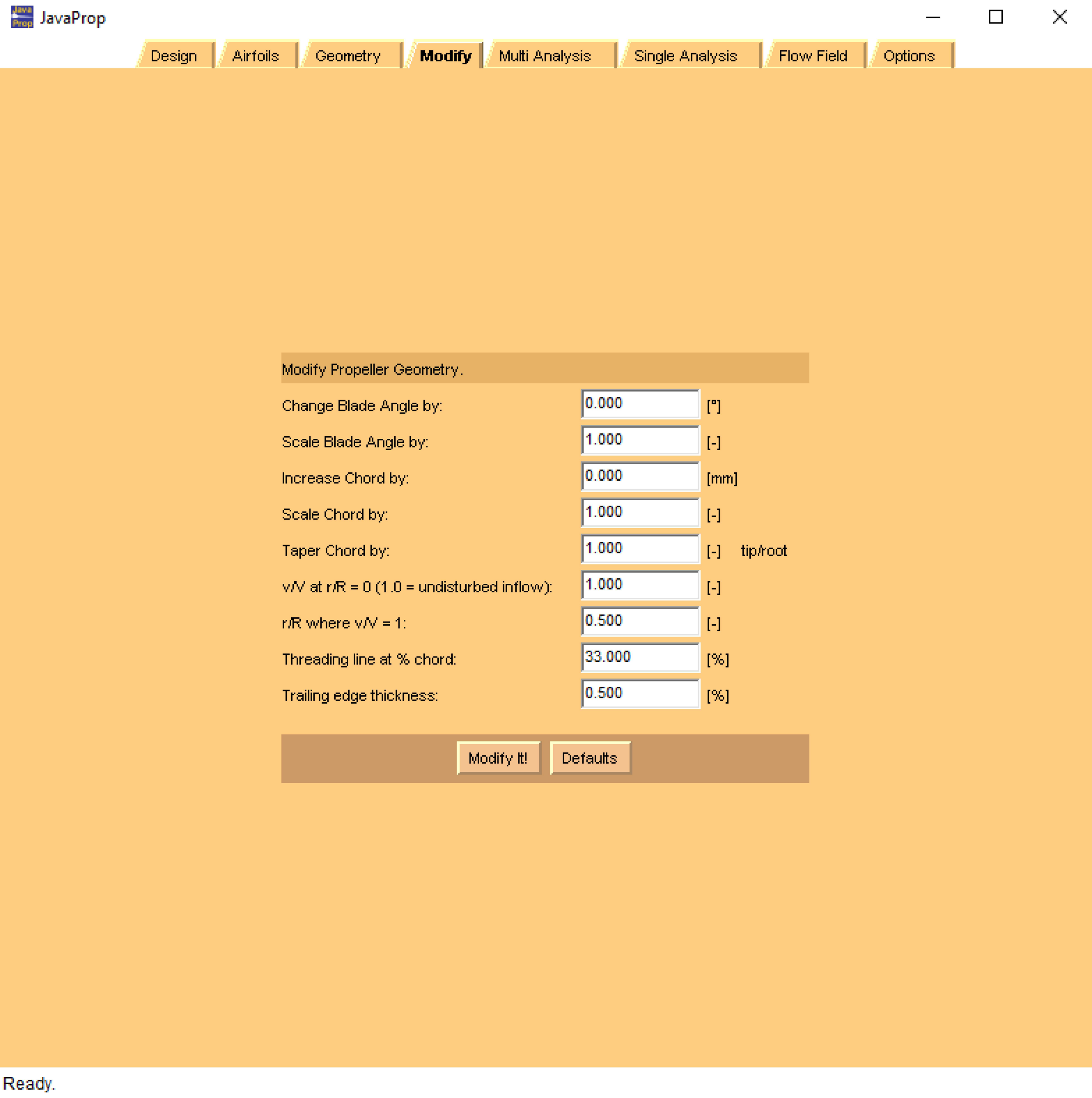
r/R	c/R	β	H/D	r	c	H	t	Airf
[-]	[-]	[°]	[-]	[mm]	[mm]	[mm]	[mm]	[-]
0.0000	Spinner	-	-	-	-	-	-	-
0.0500	0.1777	73.9	0.5	50.0	177.7	1088.4	21.6	interpol
0.1000	0.3138	63.4	0.6	100.0	313.8	1254.7	38.2	interpol
0.1500	0.4499	52.9	0.6	150.0	449.9	1246.2	54.7	interpol
0.2000	0.4969	44.9	0.6	200.0	496.9	1252.3	60.4	interpol
0.2500	0.4924	38.7	0.6	250.0	492.4	1258.4	59.9	interpol
0.3000	0.4653	33.9	0.6	300.0	465.3	1266.6	56.6	interpol

show: **Views** | Pitch/Diameter



Copy Text | Copy (HTML) | Print... | Save... | Import...

Ready.


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Modify Propeller Geometry.
Change Blade Angle by: 0.000 [°]
Scale Blade Angle by: 1.000 [-]
Increase Chord by: 0.000 [mm]
Scale Chord by: 1.000 [-]
Taper Chord by: 1.000 [-] tip/root
v/V at r/R = 0 (1.0 = undisturbed inflow): 1.000 [-]
r/R where v/V = 1: 0.500 [-]
Threading line at % chord: 33.000 [%]
Trailing edge thickness: 0.500 [%]
Modify It!
Defaults
Ready.

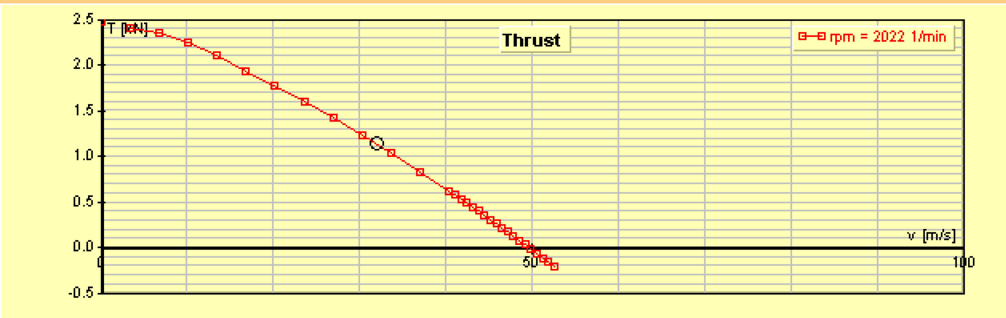
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs	Tc	Pc	η	η*	stalled	v	rpm	Power	Thrust	Torque
[-]	[-]	[-]	[%]	[%]	[%]	[m/s]	[1/min]	[kW]	[kN]	[Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	2022	71.417	2.4776	337.28
089072	9.999999	9.999999	12.73	15.03	57.00 !	3.37	2022	63.715	2.4065	300.91
172714	9.999999	9.999999	21.29	27.97	2.00 !	6.74	2022	74.382	2.3501	351.28
258904	9.999999	9.999999	30.33	39.38	0.00 !	10.11	2022	74.622	2.2387	352.42
345906	7.880574	9.999999	38.31	49.45	0.00 !	13.48	2022	73.870	2.0995	348.87
434938	4.637481	9.999999	45.35	58.40	0.00	16.85	2022	71.725	1.9305	338.74
525503	2.950149	5.718842	51.59	66.05	0.00	20.22	2022	69.317	1.7685	327.36

show: Coefficients Cp, Ct | Coefficients Pc, Tc | **Thrust** | Power | rpm | Torque



☐ Add to existing plots | Analysis with rpm=prescribed | (Results are valid for B, rpm, D, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

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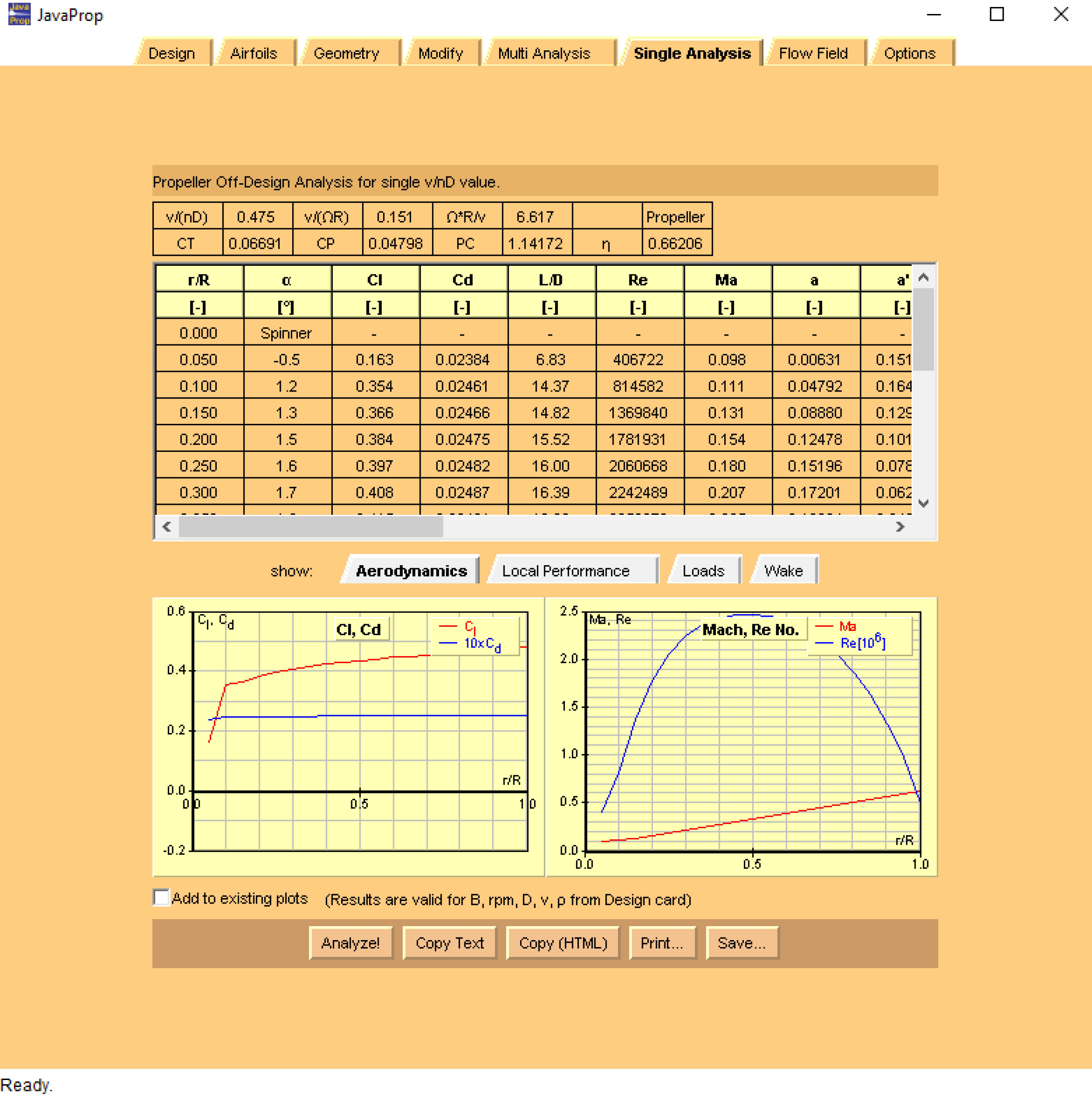
JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Propeller Off-Design Analysis for single v/nD value.
v/(nD) 0.475 v/(ΩR) 0.151 Ω*R/v 6.617 Propeller
CT 0.06691 CP 0.04798 PC 1.14172 η 0.66206
r/R α Cl Cd L/D Re Ma a a'
[-] [°] [-] [-] [-] [-] [-] [-] [-]
0.000 Spinner - - - - - - -
0.050 -0.5 0.163 0.02384 6.83 406722 0.098 0.00631 0.151
0.100 1.2 0.354 0.02461 14.37 814582 0.111 0.04792 0.164
0.150 1.3 0.366 0.02466 14.82 1369840 0.131 0.08880 0.129
0.200 1.5 0.384 0.02475 15.52 1781931 0.154 0.12478 0.101
0.250 1.6 0.397 0.02482 16.00 2060668 0.180 0.15196 0.078
0.300 1.7 0.408 0.02487 16.39 2242489 0.207 0.17201 0.062
show:
Aerodynamics
Local Performance
Loads
Wake
Cl, Cd
Cl, Cd
Cl
10xCd
r/R
Mach, Re No.
Ma, Re
Ma
Re[10^6]
r/R
Add to existing plots
(Results are valid for B, rpm, D, v, ρ from Design card)
Analyze!
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Print...
Save...
Ready.

JavaProp

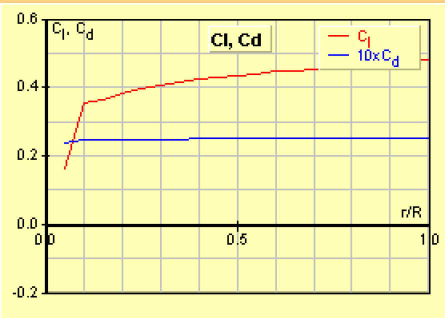
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

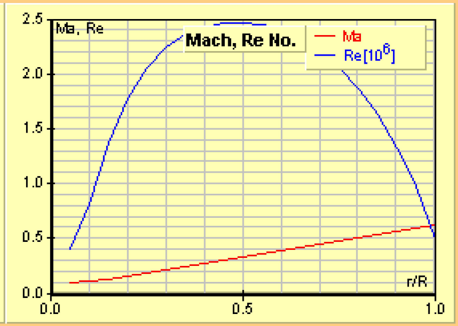
Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.475	v/(ΩR)	0.151	Ω*R/v	6.617		Propeller
CT	0.06691	CP	0.04798	PC	1.14172	η	0.66206

0.600	2.1	0.447	0.02508	17.81	2417858	0.383	0.21965	0.020
0.650	2.1	0.446	0.02508	17.80	2365373	0.413	0.22098	0.018
0.700	2.1	0.452	0.02511	17.98	2235555	0.444	0.21971	0.015
0.750	2.2	0.463	0.02517	18.39	2055649	0.474	0.21803	0.013
0.800	2.2	0.465	0.02518	18.45	1863628	0.505	0.21299	0.011
0.850	2.3	0.474	0.02524	18.78	1632387	0.536	0.21063	0.010
0.900	2.4	0.479	0.02527	18.97	1322309	0.566	0.20291	0.008
0.950	2.4	0.481	0.02528	19.02	968336	0.597	0.20151	0.007
1.000	2.4	0.482	0.02529	19.07	484312	0.628	0.20011	0.007

show: **Aerodynamics** | Local Performance | Loads | Wake





☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready.

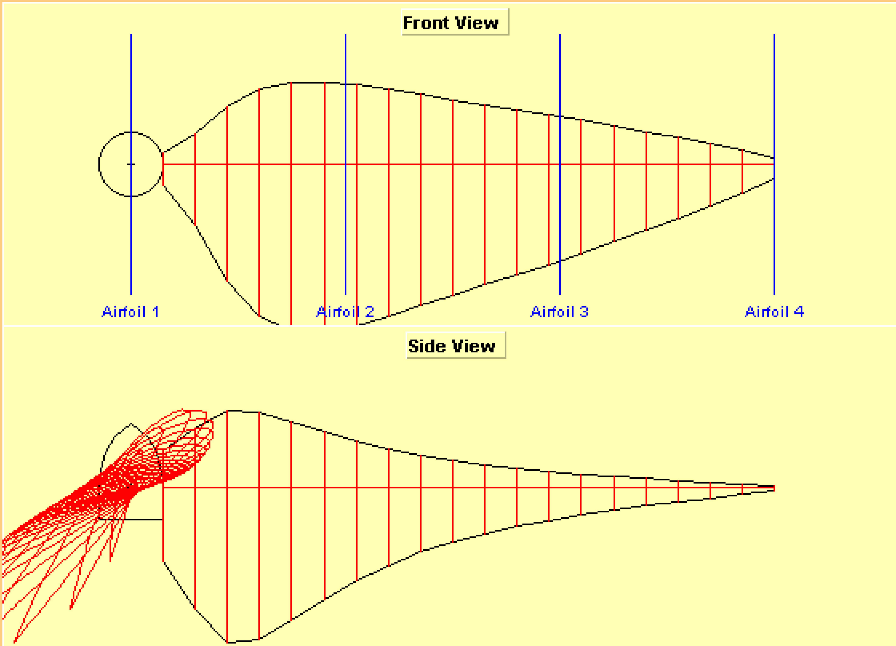
JavaProp

Design | Airfoils | **Geometry** | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Propeller Geometry.

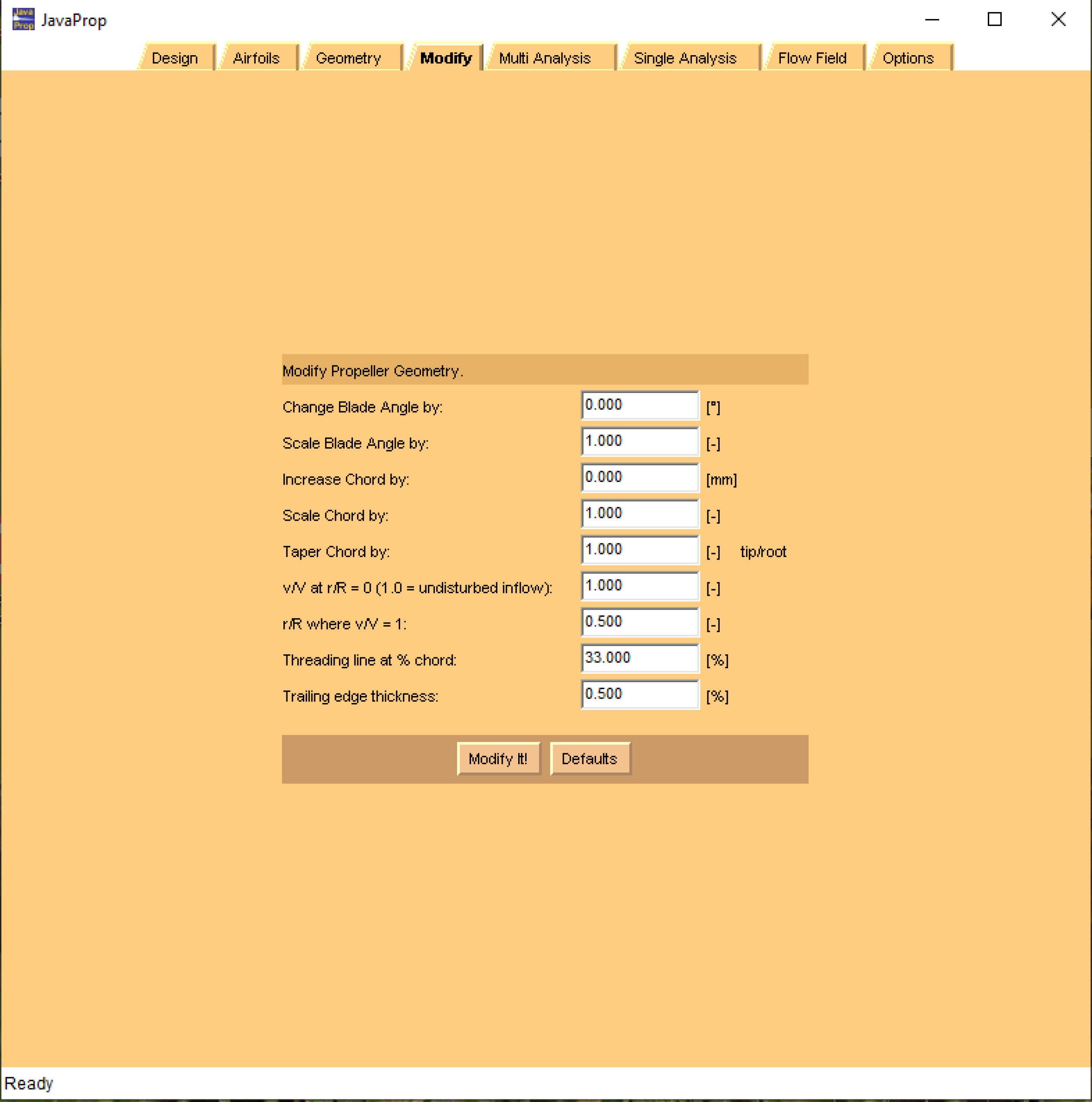
r/R	c/R	β	H/D	r	c	H	t	Airf
[-]	[-]	[°]	[-]	[mm]	[mm]	[mm]	[mm]	[-]
0.0000	Spinner	-	-	-	-	-	-	-
0.0500	0.1777	73.9	0.5	50.0	177.7	1088.4	21.6	interpol
0.1000	0.3138	63.4	0.6	100.0	313.8	1254.7	38.2	interpol
0.1500	0.4499	52.9	0.6	150.0	449.9	1246.2	54.7	interpol
0.2000	0.4969	44.9	0.6	200.0	496.9	1252.3	60.4	interpol
0.2500	0.4924	38.7	0.6	250.0	492.4	1258.4	59.9	interpol
0.3000	0.4653	33.9	0.6	300.0	465.3	1266.6	56.6	interpol

show: **Views** | Pitch/Diameter



Copy Text | Copy (HTML) | Print... | Save... | Import...

Ready


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Modify Propeller Geometry.
Change Blade Angle by: 0.000 [°]
Scale Blade Angle by: 1.000 [-]
Increase Chord by: 0.000 [mm]
Scale Chord by: 1.000 [-]
Taper Chord by: 1.000 [-] tip/root
v/V at r/R = 0 (1.0 = undisturbed inflow): 1.000 [-]
r/R where v/V = 1: 0.500 [-]
Threading line at % chord: 33.000 [%]
Trailing edge thickness: 0.500 [%]
Modify It!
Defaults
Ready

JavaProp

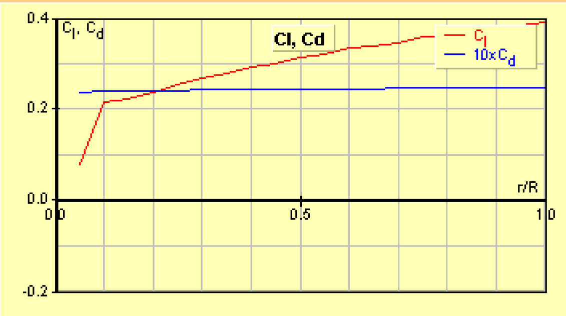
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.544	v/(ΩR)	0.173	Ω*R/v	5.776		Propeller
CT	0.05038	CP	0.04026	PC	0.63717	η	0.68063

r/R	α	Cl	Cd	L/D	Re	Ma	a	a'	Cx	Cy
[-]	[°]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
0.000	Spinner	-	-	-	-	-	-	-	-	-
0.050	-1.3	0.078	0.02355	3.31	402314	0.097	-0.00093	0.08470	0.08129	-0.00287
0.100	-0.0	0.216	0.02403	9.00	787121	0.108	0.02397	0.11301	0.20408	0.07520
0.150	0.0	0.221	0.02405	9.20	1291873	0.123	0.04529	0.08722	0.19090	0.11431
0.200	0.2	0.239	0.02412	9.89	1648235	0.142	0.06567	0.06890	0.18498	0.15250
0.250	0.3	0.254	0.02417	10.49	1879202	0.164	0.08201	0.05449	0.17642	0.18375
0.300	0.5	0.269	0.02424	11.09	2024432	0.187	0.09483	0.04375	0.16839	0.21094

show: **Aerodynamics** | Local Performance | Loads | Wake



☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready.

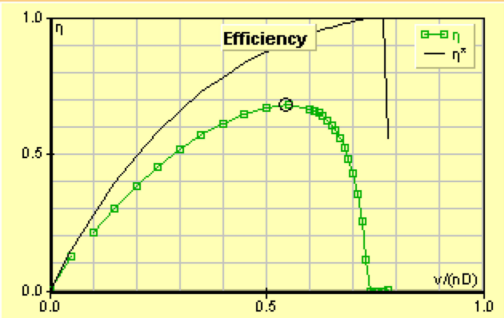
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs [-]	Tc [-]	Pc [-]	η [%]	η* [%]	stalled [%]	v [m/s]	rpm [1/min]	Power [kW]	Thrust [kN]	Torque [Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	1765	62.339	2.4776	337.28
089072	9.999999	9.999999	12.73	15.03	57.00 !	2.94	1765	55.616	2.4065	300.91
172714	9.999999	9.999999	21.29	27.97	2.00 !	5.88	1765	64.927	2.3501	351.28
258904	9.999999	9.999999	30.33	39.38	0.00 !	8.83	1765	65.137	2.2386	352.41
345906	7.880574	9.999999	38.31	49.45	0.00 !	11.77	1765	64.480	2.0995	348.86
434938	4.637481	9.999999	45.35	58.40	0.00	14.71	1765	62.608	1.9305	338.73
525503	2.950149	5.718842	51.59	66.05	0.00	17.65	1765	60.506	1.7684	327.36

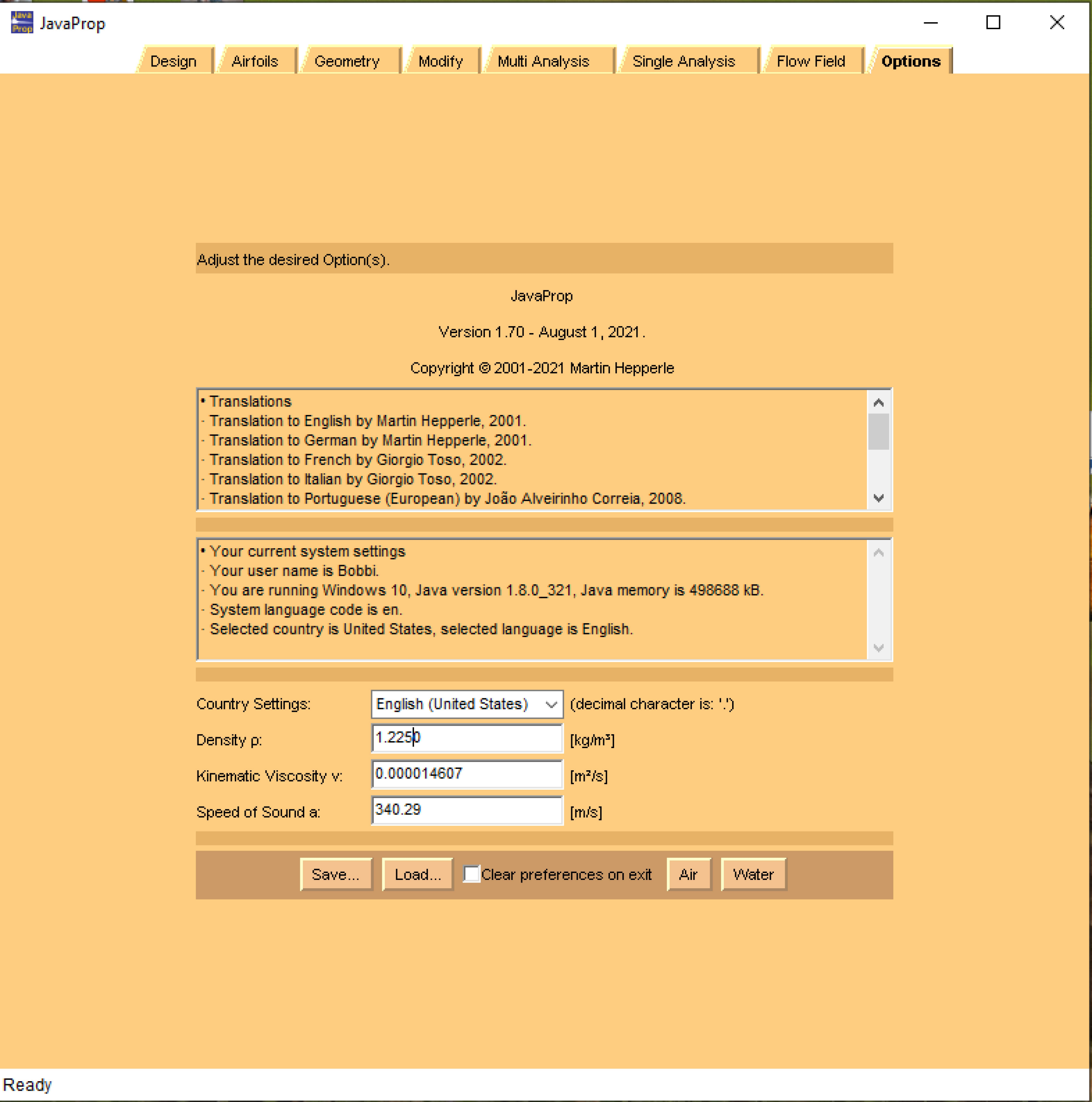
show: **Coefficients Cp, Ct** | Coefficients Pc, Tc | Thrust | Power | rpm | Torque

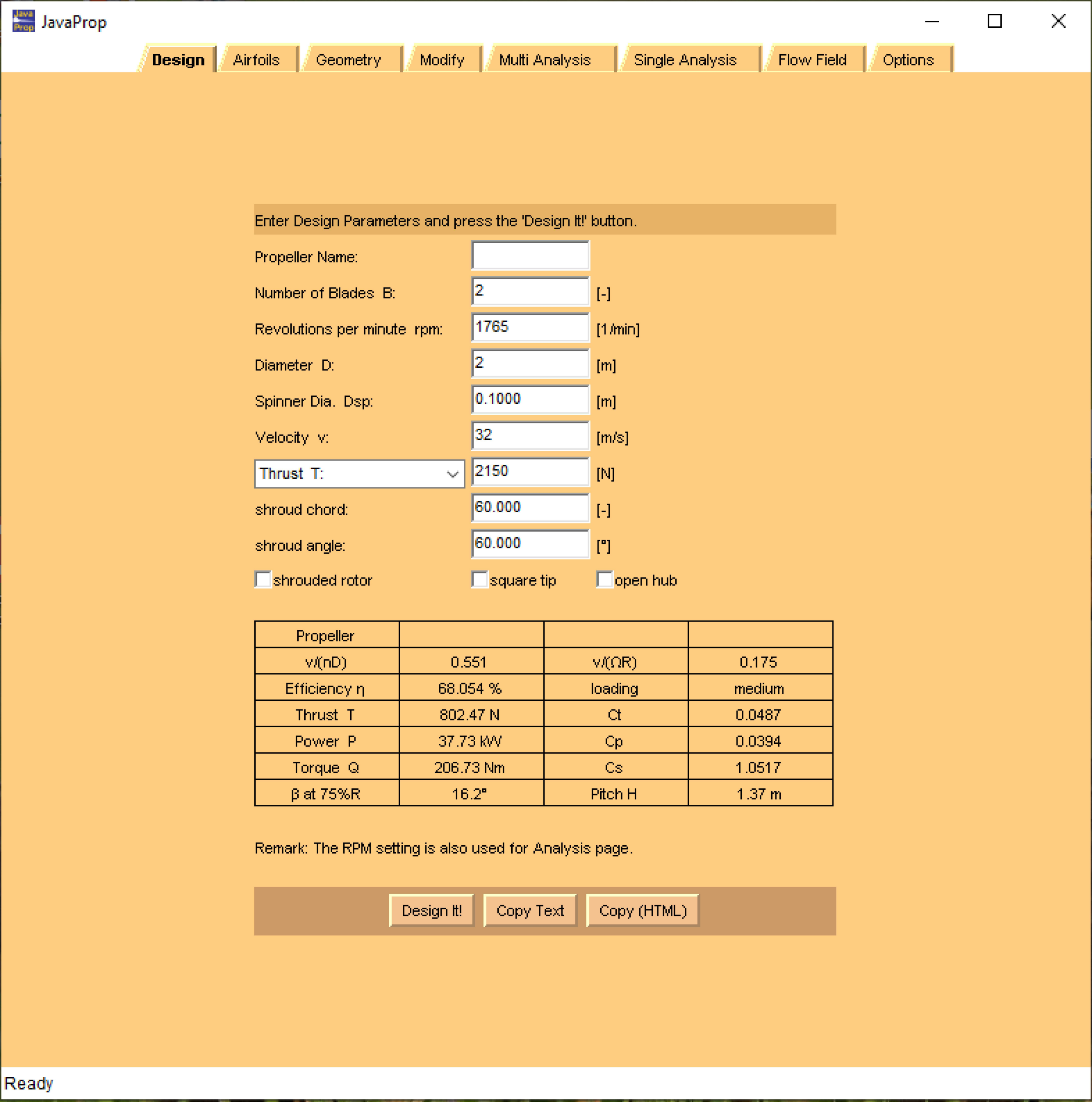


☐ Add to existing plots | Analysis with rpm=prescribed | (Results are valid for B, rpm, D, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Adjust the desired Option(s).
JavaProp
Version 1.70 - August 1, 2021 .
Copyright © 2001-2021 Martin Hepperle
• Translations
- Translation to English by Martin Hepperle, 2001.
- Translation to German by Martin Hepperle, 2001.
- Translation to French by Giorgio Toso, 2002.
- Translation to Italian by Giorgio Toso, 2002.
- Translation to Portuguese (European) by João Alveirinho Correia, 2008.
• Your current system settings
- Your user name is Bobbi.
- You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
- System language code is en.
- Selected country is United States, selected language is English.
Country Settings:
English (United States)
(decimal character is: '.')
Density ρ:
1.2250
[kg/m³]
Kinematic Viscosity ν:
0.000014607
[m²/s]
Speed of Sound a:
340.29
[m/s]
Save...
Load...
Clear preferences on exit
Air
Water
Ready


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Enter Design Parameters and press the 'Design It!' button.
Propeller Name:
Number of Blades B: 2 [-]
Revolutions per minute rpm: 1765 [1/min]
Diameter D: 2 [m]
Spinner Dia. Dsp: 0.1000 [m]
Velocity v: 32 [m/s]
Thrust T: 2150 [N]
shroud chord: 60.000 [-]
shroud angle: 60.000 [°]
shrouded rotor
square tip
open hub
Propeller
v/(nD) 0.551 v/(ΩR) 0.175
Efficiency η 68.054 % loading medium
Thrust T 802.47 N Ct 0.0487
Power P 37.73 kW Cp 0.0394
Torque Q 206.73 Nm Cs 1.0517
β at 75%R 16.2° Pitch H 1.37 m
Remark: The RPM setting is also used for Analysis page.
Design It!
Copy Text
Copy (HTML)
Ready

JavaProp

Design | **Airfoils** | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Select the desired airfoils and angle of attack for each station.

r/R = 0.00: Clark Y, Re=100,000

angle of attack: 3.0 [°]

r/R = 0.333: Clark Y, Re=100,000

angle of attack: 3.0 [°]

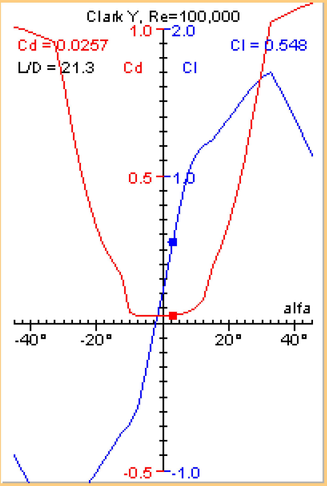
r/R = 0.667: Clark Y, Re=100,000

angle of attack: 3.0 [°]

r/R = 1.00: Clark Y, Re=100,000

angle of attack: 3.0 [°]

☐ suppress airfoil drag



Ready

JavaProp

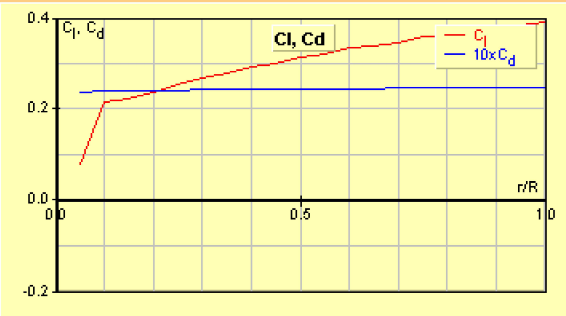
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.544	v/(ΩR)	0.173	Ω*R/v	5.776		Propeller
CT	0.05038	CP	0.04026	PC	0.63717	η	0.68063

0.600	1.0	0.334	0.02451	13.62	2132306	0.338	0.13693	0.01652	0.12893	0.30890
0.650	1.1	0.337	0.02453	13.76	2083015	0.364	0.13922	0.01447	0.12279	0.31526
0.700	1.2	0.346	0.02457	14.07	1966385	0.390	0.14012	0.01264	0.11861	0.32566
0.750	1.3	0.359	0.02463	14.59	1806395	0.417	0.14095	0.01112	0.11634	0.34089
0.800	1.3	0.363	0.02465	14.74	1636347	0.443	0.13891	0.00970	0.11176	0.34675
0.850	1.4	0.374	0.02470	15.12	1432394	0.470	0.14021	0.00866	0.10931	0.35810
0.900	1.5	0.381	0.02474	15.42	1159650	0.497	0.13685	0.00755	0.10621	0.36721
0.950	1.5	0.386	0.02476	15.59	848811	0.523	0.13703	0.00685	0.10304	0.37277
1.000	1.6	0.390	0.02478	15.75	424343	0.550	0.13721	0.00616	0.09986	0.37833

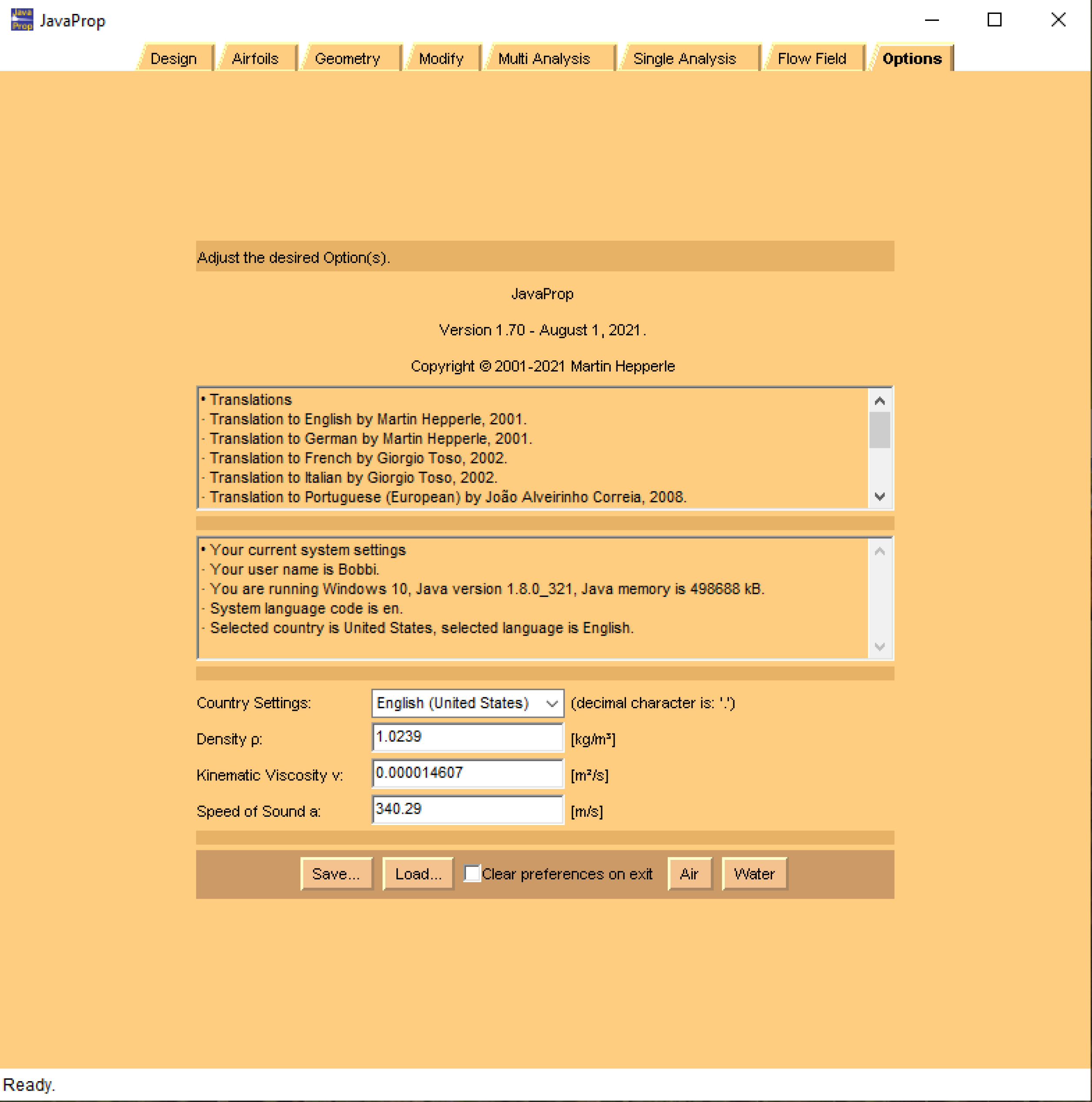
show: **Aerodynamics** | Local Performance | Loads | Wake



☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready.


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Adjust the desired Option(s).
JavaProp
Version 1.70 - August 1, 2021.
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• Your current system settings
- Your user name is Bobbi.
- You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
- System language code is en.
- Selected country is United States, selected language is English.
Country Settings:
English (United States)
(decimal character is: '.')
Density ρ:
1.0239
[kg/m³]
Kinematic Viscosity ν:
0.000014607
[m²/s]
Speed of Sound a:
340.29
[m/s]
Save...
Load...
Clear preferences on exit
Air
Water
Ready.

JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Enter Design Parameters and press the 'Design It!' button.

Propeller Name:

Number of Blades B: 2 [-]

Revolutions per minute rpm: 1930 [1/min]

Diameter D: 2 [m]

Spinner Dia. Dsp: 0.1000 [m]

Velocity v: 32 [m/s]

Thrust T: 2150 [N]

shroud chord: 60.000 [-]

shroud angle: 60.000 [°]

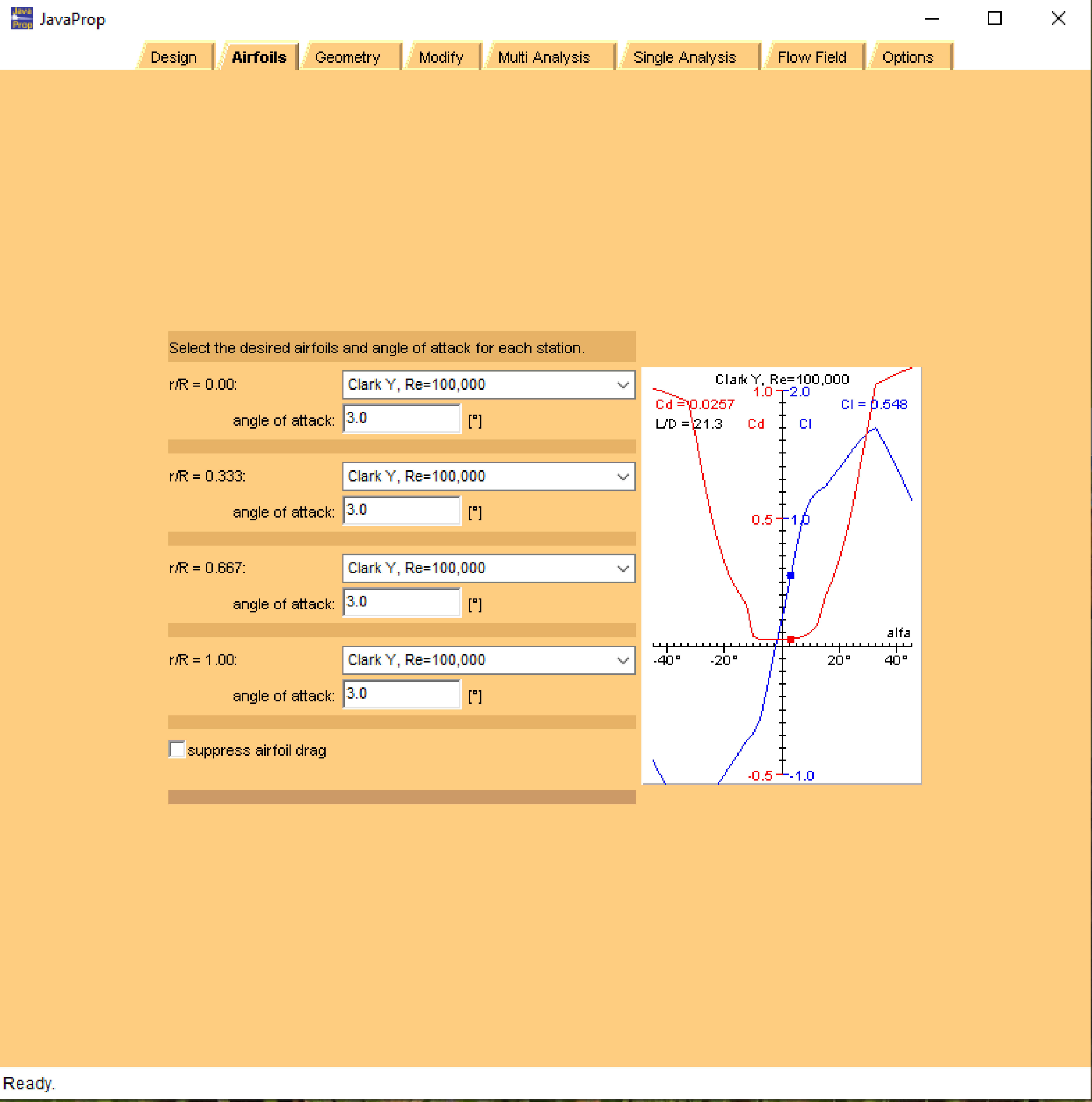
☐ shrouded rotor ☐ square tip ☐ open hub

Propeller			
v/(nD)	0.551	v/(ΩR)	0.175
Efficiency η	68.054 %	loading	medium
Thrust T	802.47 N	Ct	0.0487
Power P	37.73 kW	Cp	0.0394
Torque Q	206.73 Nm	Cs	1.0517
β at 75%R	16.2°	Pitch H	1.37 m

Remark: The RPM setting is also used for Analysis page.

Design It! | Copy Text | Copy (HTML)

Ready.


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Select the desired airfoils and angle of attack for each station.
r/R = 0.00:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
r/R = 0.333:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
r/R = 0.667:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
r/R = 1.00:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
suppress airfoil drag
Clark Y, Re=100,000
Cd = 0.0257
L/D = 21.3
Cl = 0.548
Cd
Cl
1.0
2.0
0.5
1.0
-0.5
-1.0
alfa
-40°
-20°
20°
40°
Ready.

JavaProp

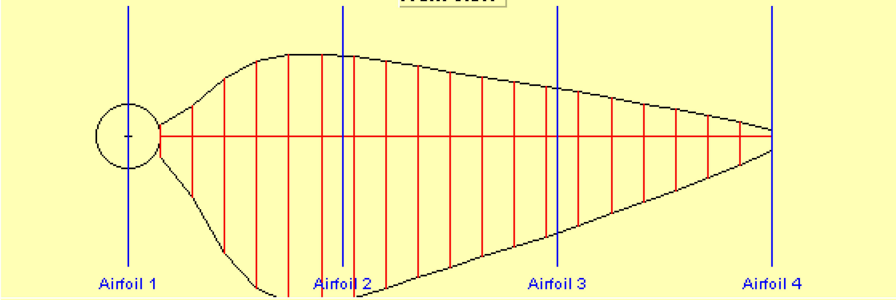
Design | Airfoils | **Geometry** | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Propeller Geometry.

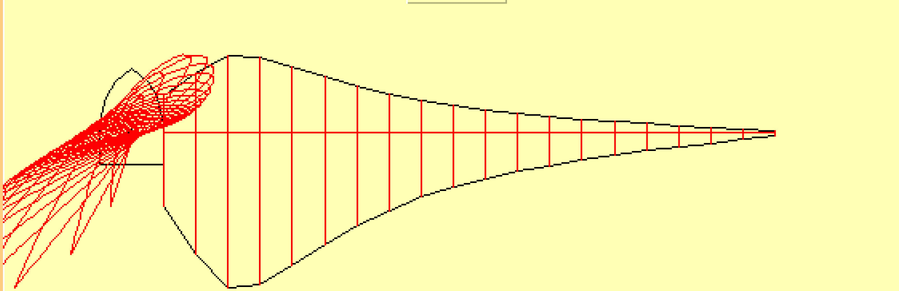
r/R	c/R	β	H/D	r	c	H	t	Airf
[-]	[-]	[°]	[-]	[mm]	[mm]	[mm]	[mm]	[-]
0.0000	Spinner	-	-	-	-	-	-	-
0.0500	0.1777	73.9	0.5	50.0	177.7	1088.4	21.6	interpol
0.1000	0.3138	63.4	0.6	100.0	313.8	1254.7	38.2	interpol
0.1500	0.4499	52.9	0.6	150.0	449.9	1246.2	54.7	interpol
0.2000	0.4969	44.9	0.6	200.0	496.9	1252.3	60.4	interpol
0.2500	0.4924	38.7	0.6	250.0	492.4	1258.4	59.9	interpol
0.3000	0.4653	33.9	0.6	300.0	465.3	1266.6	56.6	interpol

show: **Views** | Pitch/Diameter

Front View

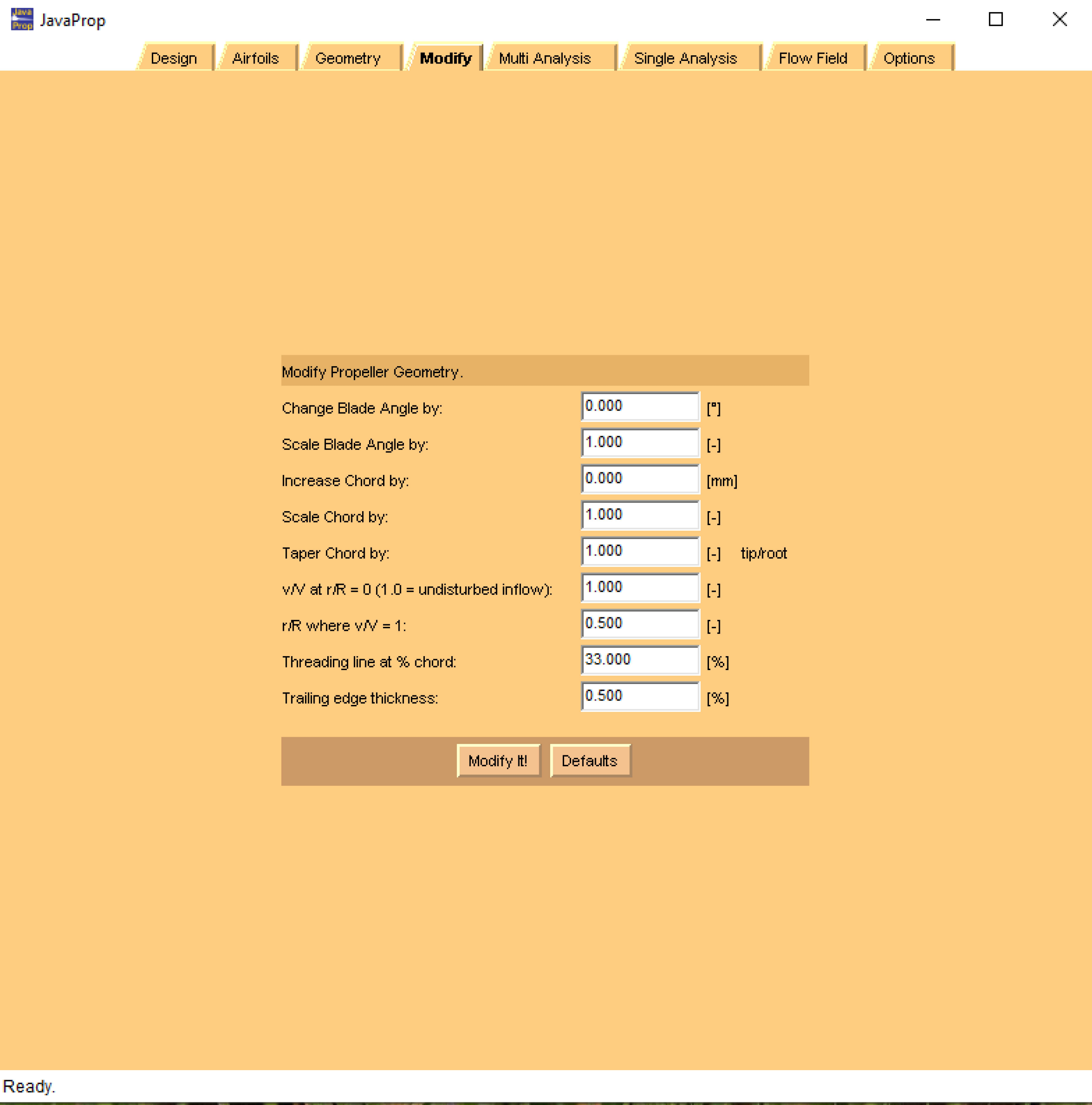


Side View



Copy Text | Copy (HTML) | Print... | Save... | Import...

Ready.


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Modify Propeller Geometry.
Change Blade Angle by: 0.000 [°]
Scale Blade Angle by: 1.000 [-]
Increase Chord by: 0.000 [mm]
Scale Chord by: 1.000 [-]
Taper Chord by: 1.000 [-] tip/root
v/V at r/R = 0 (1.0 = undisturbed inflow): 1.000 [-]
r/R where v/V = 1: 0.500 [-]
Threading line at % chord: 33.000 [%]
Trailing edge thickness: 0.500 [%]
Modify It!
Defaults
Ready.

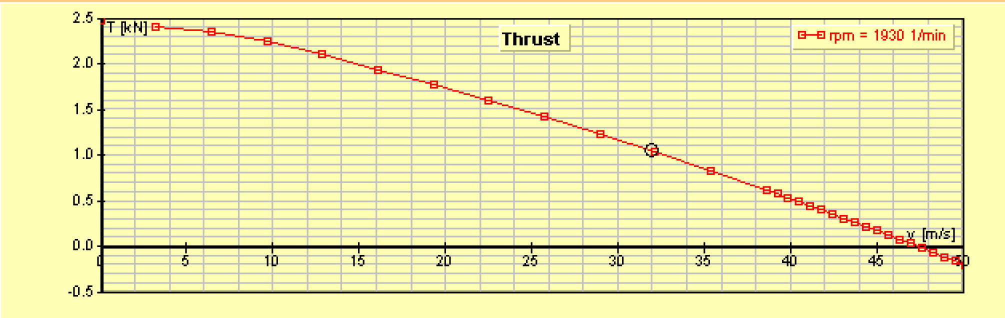
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs	Tc	Pc	η	η*	stalled	v	rpm	Power	Thrust	Torque
[-]	[-]	[-]	[%]	[%]	[%]	[m/s]	[1/min]	[kW]	[kN]	[Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	1930	68.127	2.4761	337.08
089072	9.999999	9.999999	12.73	15.03	57.00 !	3.22	1930	60.780	2.4051	300.73
172714	9.999999	9.999999	21.29	27.97	2.00 !	6.43	1930	70.956	2.3487	351.08
258904	9.999999	9.999999	30.33	39.38	0.00 !	9.65	1930	71.184	2.2373	352.21
345906	7.880574	9.999999	38.31	49.45	0.00 !	12.87	1930	70.467	2.0983	348.66
434938	4.637481	9.999999	45.35	58.40	0.00	16.08	1930	68.421	1.9294	338.54
525503	2.950149	5.718842	51.59	66.05	0.00	19.30	1930	66.124	1.7674	327.17

show: Coefficients Cp, Ct | Coefficients Pc, Tc | **Thrust** | Power | rpm | Torque



☐ Add to existing plots | Analysis with rpm=prescribed | (Results are valid for B, rpm, D, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready.

JavaProp

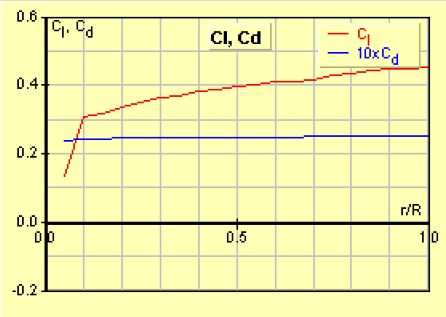
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

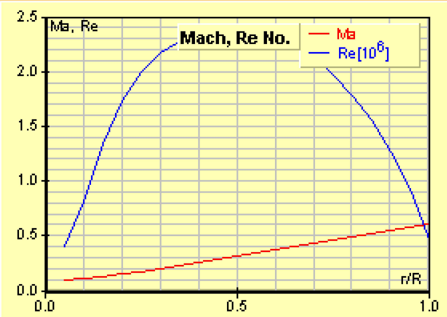
Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.497	v/(ΩR)	0.158	Ω*R/v	6.316		Propeller
CT	0.06161	CP	0.04564	PC	0.94442	η	0.67138

r/R	α	Cl	Cd	L/D	Re	Ma	a	a'
[-]	[°]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
0.000	Spinner	-	-	-	-	-	-	-
0.050	-0.8	0.133	0.02373	5.59	405106	0.098	0.00366	0.129
0.100	0.8	0.306	0.02439	12.54	804551	0.110	0.03909	0.147
0.150	0.9	0.316	0.02444	12.94	1341549	0.128	0.07292	0.115
0.200	1.1	0.335	0.02452	13.67	1733597	0.150	0.10328	0.090
0.250	1.2	0.349	0.02459	14.21	1995203	0.174	0.12651	0.070
0.300	1.3	0.361	0.02464	14.67	2163966	0.200	0.14409	0.056

show: **Aerodynamics** | Local Performance | Loads | Wake





☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready.

JavaProp

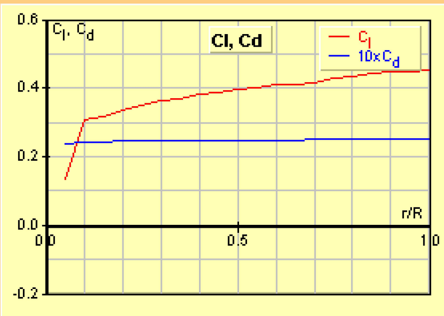
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

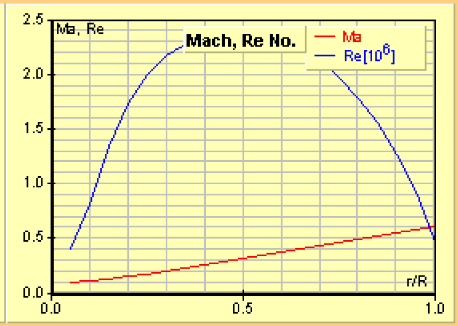
Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.497	v/(ΩR)	0.158	Ω*R/v	6.316		Propeller
CT	0.06161	CP	0.04564	PC	0.94442	η	0.67138

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.600	1.7	0.410	0.02488	16.48	2315420	0.367	0.18959	0.019
0.650	1.7	0.411	0.02489	16.51	2264111	0.396	0.19132	0.016
0.700	1.8	0.417	0.02492	16.74	2139042	0.425	0.19084	0.014
0.750	1.9	0.429	0.02499	17.18	1966286	0.454	0.18993	0.012
0.800	1.9	0.432	0.02500	17.27	1782161	0.483	0.18615	0.011
0.850	2.0	0.442	0.02506	17.63	1560691	0.512	0.18461	0.009
0.900	2.1	0.448	0.02509	17.85	1264001	0.541	0.17828	0.008
0.950	2.1	0.450	0.02510	17.93	925497	0.571	0.17753	0.007
1.000	2.1	0.452	0.02511	18.01	462820	0.600	0.17678	0.006

show: **Aerodynamics** | Local Performance | Loads | Wake





☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready.


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Adjust the desired Option(s).
JavaProp
Version 1.70 - August 1, 2021.
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- Translation to Italian by Giorgio Toso, 2002.
- Translation to Portuguese (European) by João Alveirinho Correia, 2008.
• Your current system settings
- Your user name is Bobbi.
- You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
- System language code is en.
- Selected country is United States, selected language is English.
Country Settings:
English (United States)
(decimal character is: '.')
Density ρ:
1.1210
[kg/m³]
Kinematic Viscosity ν:
0.000014607
[m²/s]
Speed of Sound a:
340.29
[m/s]
Save...
Load...
Clear preferences on exit
Air
Water
Ready.

JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Enter Design Parameters and press the 'Design It!' button.

Propeller Name:

Number of Blades B: 2 [-]

Revolutions per minute rpm: 1845 [1/min]

Diameter D: 2 [m]

Spinner Dia. Dsp: 0.1000 [m]

Velocity v: 32 [m/s]

Thrust T: 2150 [N]

shroud chord: 60.000 [-]

shroud angle: 60.000 [°]

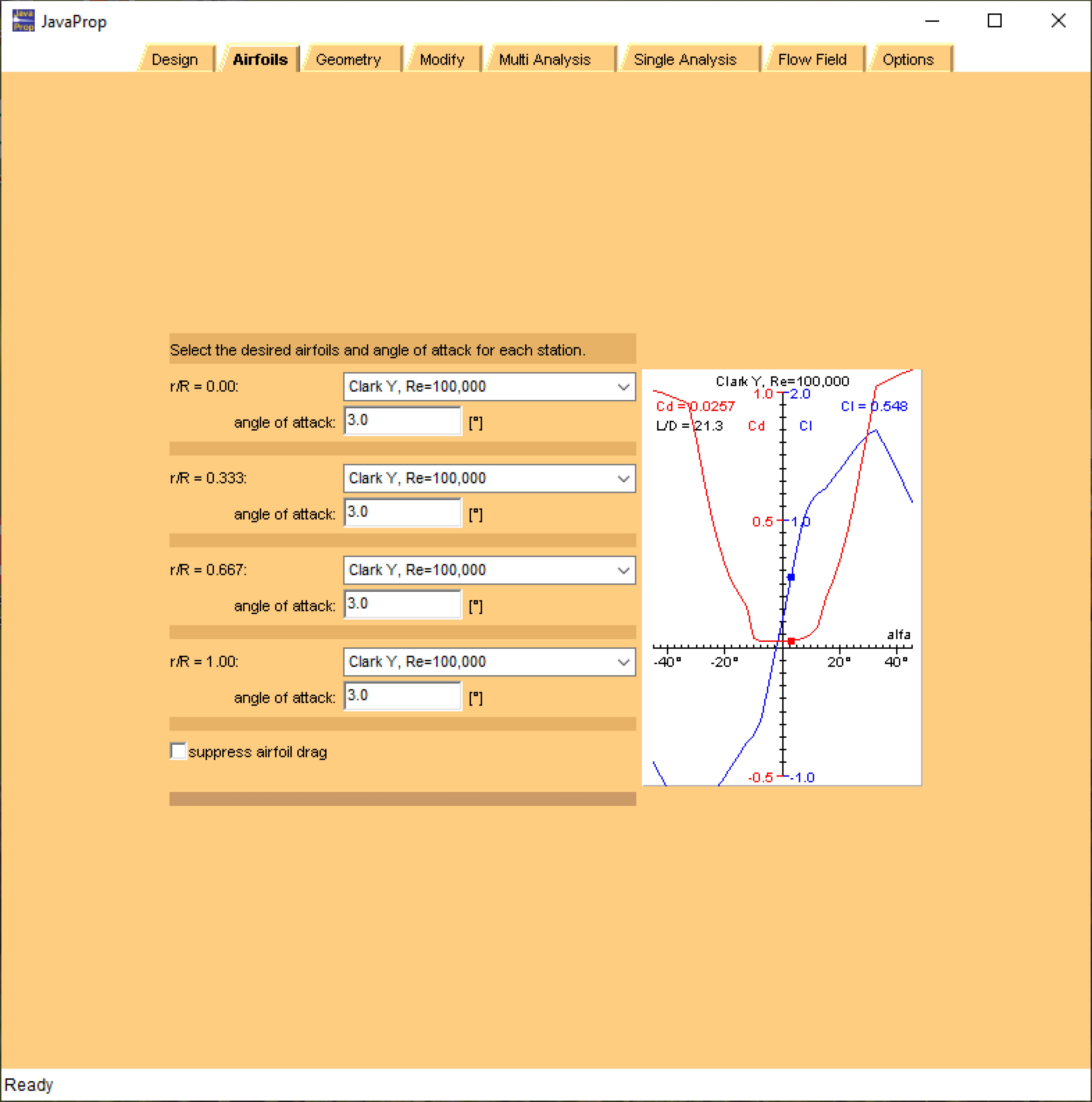
☐ shrouded rotor ☐ square tip ☐ open hub

Propeller			
v/(nD)	0.551	v/(ΩR)	0.175
Efficiency η	68.054 %	loading	medium
Thrust T	802.47 N	Ct	0.0487
Power P	37.73 kW	Cp	0.0394
Torque Q	206.73 Nm	Cs	1.0517
β at 75%R	16.2°	Pitch H	1.37 m

Remark: The RPM setting is also used for Analysis page.

Design It! | Copy Text | Copy (HTML)

Ready


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Select the desired airfoils and angle of attack for each station.
r/R = 0.00:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
r/R = 0.333:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
r/R = 0.667:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
r/R = 1.00:
Clark Y, Re=100,000
angle of attack: 3.0 [°]
suppress airfoil drag
Clark Y, Re=100,000
Cd = 0.0257
L/D = 21.3
Cl = 0.548
Cd
Cl
1.0
2.0
0.5
1.0
-0.5
-1.0
alfa
-40°
-20°
20°
40°
Ready

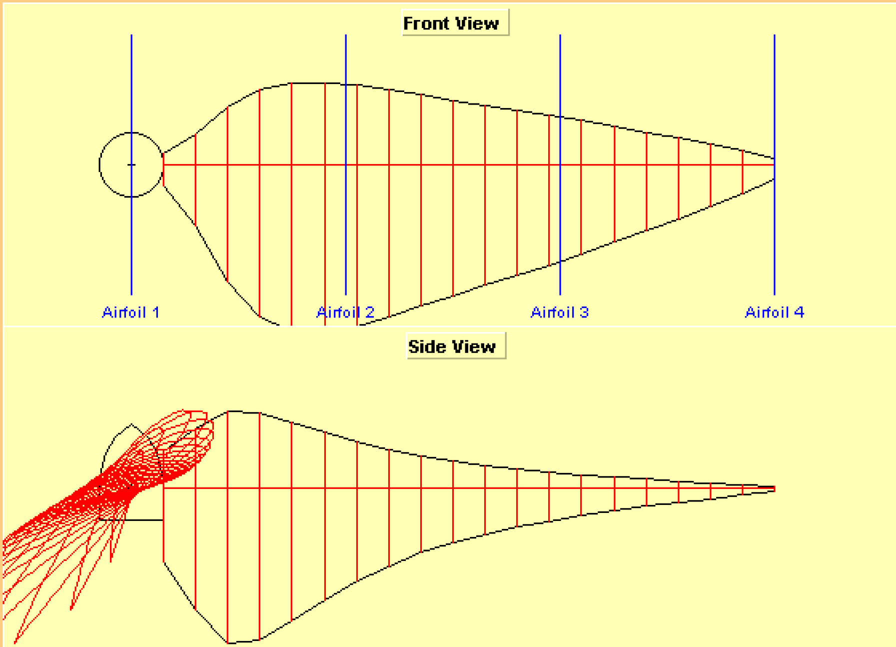
JavaProp

Design | Airfoils | **Geometry** | Modify | Multi Analysis | Single Analysis | Flow Field | Options

Propeller Geometry.

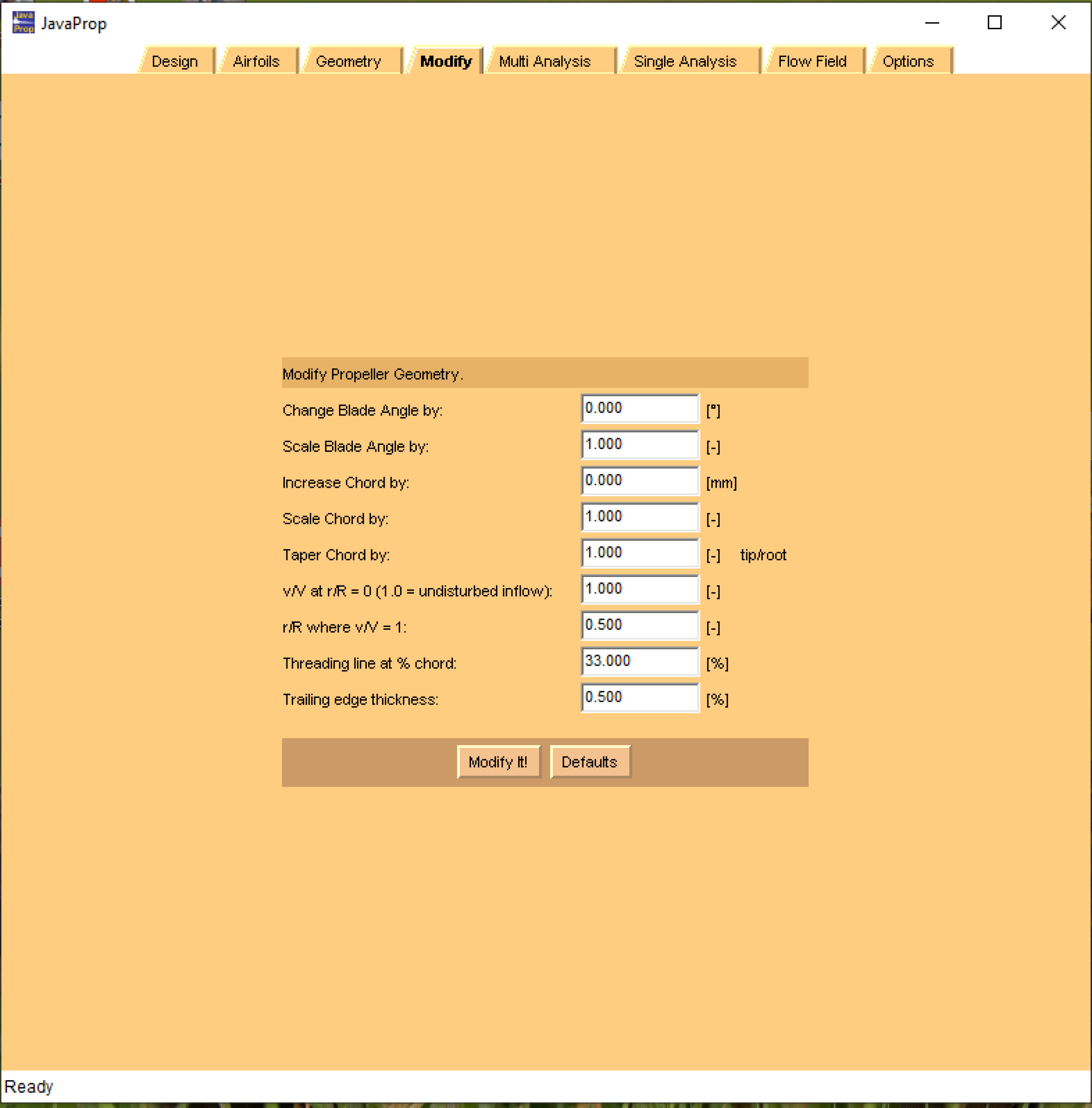
r/R	c/R	β	H/D	r	c	H	t	Airf
[-]	[-]	[°]	[-]	[mm]	[mm]	[mm]	[mm]	[-]
0.0000	Spinner	-	-	-	-	-	-	-
0.0500	0.1777	73.9	0.5	50.0	177.7	1088.4	21.6	interpol
0.1000	0.3138	63.4	0.6	100.0	313.8	1254.7	38.2	interpol
0.1500	0.4499	52.9	0.6	150.0	449.9	1246.2	54.7	interpol
0.2000	0.4969	44.9	0.6	200.0	496.9	1252.3	60.4	interpol
0.2500	0.4924	38.7	0.6	250.0	492.4	1258.4	59.9	interpol
0.3000	0.4653	33.9	0.6	300.0	465.3	1266.6	56.6	interpol

show: **Views** | Pitch/Diameter



Copy Text | Copy (HTML) | Print... | Save... | Import...

Ready


JavaProp
Design
Airfoils
Geometry
Modify
Multi Analysis
Single Analysis
Flow Field
Options
Modify Propeller Geometry.
Change Blade Angle by: 0.000 [°]
Scale Blade Angle by: 1.000 [-]
Increase Chord by: 0.000 [mm]
Scale Chord by: 1.000 [-]
Taper Chord by: 1.000 [-] tip/root
v/V at r/R = 0 (1.0 = undisturbed inflow): 1.000 [-]
r/R where v/V = 1: 0.500 [-]
Threading line at % chord: 33.000 [%]
Trailing edge thickness: 0.500 [%]
Modify It!
Defaults
Ready

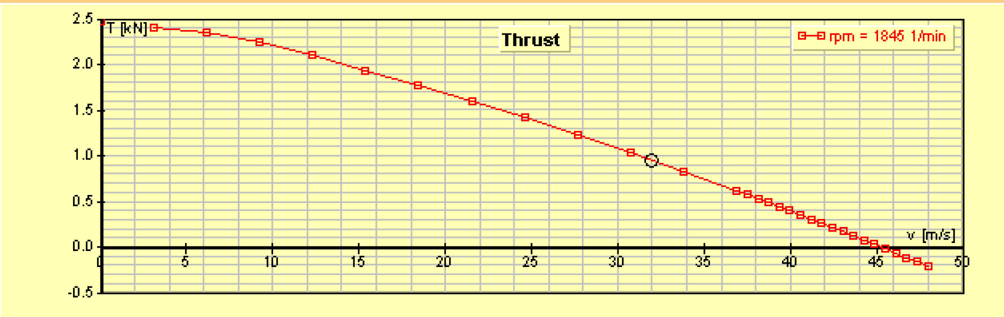
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs	Tc	Pc	η	η*	stalled	v	rpm	Power	Thrust	Torque
[-]	[-]	[-]	[%]	[%]	[%]	[m/s]	[1/min]	[kW]	[kN]	[Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	1845	65.161	2.4774	337.26
089072	9.999999	9.999999	12.73	15.03	57.00 !	3.08	1845	58.134	2.4063	300.89
172714	9.999999	9.999999	21.29	27.97	2.00 !	6.15	1845	67.866	2.3499	351.26
258904	9.999999	9.999999	30.33	39.38	0.00 !	9.23	1845	68.085	2.2385	352.39
345906	7.880574	9.999999	38.31	49.45	0.00 !	12.30	1845	67.399	2.0994	348.84
434938	4.637481	9.999999	45.35	58.40	0.00	15.38	1845	65.442	1.9304	338.71
525503	2.950149	5.718842	51.59	66.05	0.00	18.45	1845	63.244	1.7683	327.34

show: Coefficients Cp, Ct | Coefficients Pc, Tc | **Thrust** | Power | rpm | Torque



☐ Add to existing plots | Analysis with rpm=prescribed | (Results are valid for B, rpm, D, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready

JavaProp

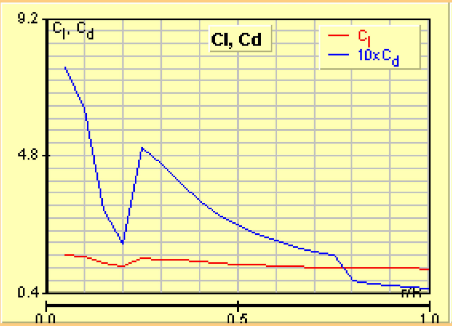
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

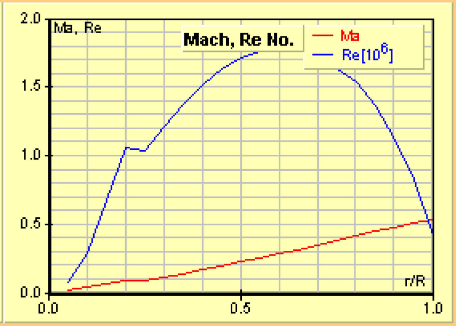
Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.054	v/(ΩR)	0.017	Ω*R/v	57.759		Propeller
CT	0.14398	CP	0.05706	PC	903.05169	η	0.13724

r/R	α	Cl	Cd	L/D	Re	Ma	a	a'
[-]	[°]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
0.000	Spinner	-	-	-	-	-	-	-
0.050	28.4	1.629	0.76132	2.14	81865	0.020	0.49980	0.489
0.100	26.3	1.573	0.62976	2.50	284074	0.039	1.49482	0.429
0.150	19.0	1.361	0.30452	4.47	675786	0.064	2.81977	0.342
0.200	15.1	1.251	0.19884	6.29	1061562	0.092	3.83825	0.267
0.250	23.9	1.507	0.50394	2.99	1036789	0.090	1.45516	0.356
0.300	22.9	1.477	0.45614	3.24	1214847	0.112	1.27563	0.324

show: **Aerodynamics** | Local Performance | Loads | Wake





☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready

JavaProp

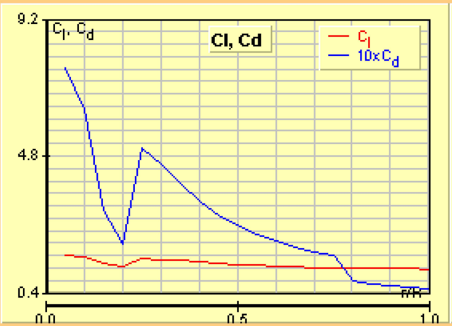
Design | Airfoils | Geometry | Modify | Multi Analysis | **Single Analysis** | Flow Field | Options

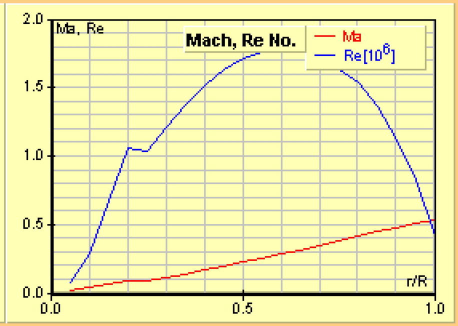
Propeller Off-Design Analysis for single v/nD value.

v/(nD)	0.054	v/(ΩR)	0.017	Ω*R/v	57.759		Propeller
CT	0.14398	CP	0.05706	PC	903.05169	η	0.13724

0.600	15.5	1.260	0.20605	6.11	1791290	0.284	1.12378	0.131
0.650	14.6	1.237	0.18668	6.63	1797557	0.314	1.12223	0.111
0.700	13.8	1.220	0.17180	7.10	1738578	0.345	1.12613	0.093
0.750	13.2	1.207	0.16072	7.51	1631131	0.376	1.13537	0.077
0.800	12.5	1.200	0.07669	15.64	1537312	0.417	1.13926	0.042
0.850	12.0	1.195	0.07040	16.98	1361750	0.447	1.16069	0.033
0.900	11.4	1.186	0.06398	18.53	1114467	0.477	1.20393	0.024
0.950	10.9	1.172	0.05862	20.00	822263	0.507	1.26425	0.018
1.000	10.4	1.155	0.05359	21.56	414202	0.537	1.32457	0.011

show: **Aerodynamics** | Local Performance | Loads | Wake





☐ Add to existing plots (Results are valid for B, rpm, D, v, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready

Basic formulas for hydraulic motors

Flow (q)

$$q = \frac{D \times n}{1000 \times \eta_v} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p \times \eta_{hm}}{63} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p \times \eta_t}{600} \text{ [kW]}$$

D - displacement [cm³/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Basic formulas for hydraulic pumps

Flow (q)

$$q = \frac{D \times n \times \eta_v}{1000} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p}{63 \times \eta_{hm}} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p}{600 \times \eta_t} \text{ [kW]}$$

D - displacement [cm³/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Conversion factors

1 kg .... 2.20 lb
1 N .... 0.225 lbf
1 Nm .... 0.738 lbf ft
1 bar .... 14.5 psi
1 l .... 0.264 US gallon
1 cm^3 .... 0.061 cu in
1 mm .... 0.039 in
1°C .... $^5/_9$(°F-32)
1 kW .... 1.34 hp

Conversion factors

1 lb .... 0.454 kg
1 lbf .... 4.448 N
1 lbf ft .... 1.356 Nm
1 psi .... 0.068948 bar
1 US gallon .... 3.785 l
1 cu in .... 16.387 cm^3
1 in .... 25.4 mm
1 °F .... $^9/_5$°C + 32
1 hp .... 0.7457 kW

Pump and Motor Calculations
Altitude 0 ft Engine @93.8%

ACCELERATE from 0 m/sec to 2.94 m/sec

Total Drone wt =
Drone 2100lbs + 89.4 gal fuel (600lbs) + Payload 500lbs = 3200 lbs
6 Propellers (3200 ÷ 6 = 533 lbs) = 2.37 kN thrust per propeller)

Altitude 0ft Density 1.225 Kg/m^3
Prop: 1765 rpm, 0 m/sec, 62 kW, 2.477 kN, 338 Nm

Motor $\frac{(338)(63)}{(59.5)(0.95)}$ = 376.7 Bar

Motor q= $\frac{(1765)(59.8)}{(1000)(0.95)}$ =111 L/min

111x6 = 666 L/min

Jet Engine @93.8% (6016 rpm)(0.938) = 5643 rpm
(5643)(0.53) = 2990 rpm   (5643)(0.60) = 3385 rpm
Pump Gears ratio 25teeth:45teeth = 0.53   25teeth:40teeth = 0.60

Pump #1 q=$\frac{(110.1)(2990)(0.95)}{1000}$ = 312.7 L/mi

Pump #2 q=$\frac{(110.1)(3385)(0.95)}{1000}$ = 354 L/min

312.7+354= 666.7 L/min

Pump $\frac{(110.1)(376.7Bar)}{(563)(0.95)}$ = 693 Nm

693 x 0.53 = 367.2 Nm
693 x 0.60 = 415.8 Nm

367.2+415.8 = 783 Nm

Engine Max Nm=800 Nm Engine Max kw =485

783 Nm @ 5643 rpm = 462 kW = 620 Hp

Pump and Motor Calculations
Altitude 0 ft Engine @93.8%

ACCELERATE from 0 m/sec to 2.94 m/sec

Total Drone wt =
Drone 2100lbs + 89.4 gal fuel (600lbs) + Payload 500lbs = 3200 lbs
6 Propellers (3200 ÷ 6 = 533 lbs) = 2.37 kN thrust per propeller)

Altitude 0ft Density 1.225 Kg/m^3
Prop: 1765 rpm, 0 m/sec, 62 kW, 2.477 kN, 338 Nm

2.4777 kN per prop x 6 props = 14.862 kN = total lift 3341 lbs

(Total lift 3341 lbs) - (Total Drone wt 3200 lbs) = 141 lbs excess lift

From F=ma formula Force= (mass)x(accel) accel = F÷mass

(141 lbs force)÷(3200 lbs wt) = 1.417 ft/sec^2 = 0.432 m/sec^2

From formula V=at or Velocity= (accel)(time) Time= Velocity÷Accel

(2.94 m/sec)÷(0.432 m/sec^2) = 6.8 sec

0 m/sec velocity to 2.94 m/sec @ 0.432 m/sec^2 accel = 6.8 sec

distance = $(\frac{1}{2})(a)(t)^2 = (\frac{1}{2})(0.432)(6.8)^2$ = 9.98 meters = 33 feet

Thus drone will start at 0 altitude and 0 m/sec
Drone will then rise up by 33 feet and have velocity of 2.94 m/sec

Engine Max Nm=800 Nm Engine Max kw =485

783 Nm @ engine rpm of 5643 = 462 kW = 620 HP

Pump and Motor Calculations
Altitude 0 ft Engine @93.8%

ACCELERATE from 0 m/sec to 2.94 m/sec

Total Drone wt =
Drone 2100lbs + 89.4 gal fuel (600lbs) + Payload 500lbs = 3200 lbs
6 Propellers (3200 ÷ 6 = 533 lbs) = 2.37 kN thrust per propeller)

Altitude 0ft Density 1.225 Kg/m^3
Prop: 1765 rpm, 0 m/sec, 62 kW, 2.477 kN, 338 Nm

2.4777 kN per prop x 6 props = 14.862 kN = total lift 3341 lbs

Disk Loading Considerations:

Disk Loading is (pounds of thrust)÷(area swept by propeller)

Propeller Diameter = 2 meters radius = 1 meter
area = $(\pi)(r)^2 = (\pi)(1)^2 = 3.14\ m^2 = 33.79\ ft^2$
Disk Loading for one propeller includes:
(3200lbs total wt) ÷ (6 propellers) = 533 lbs per propeller

Disk Loading per propeller = (533lbs)÷(33.79ft^2 = 15.77lbs per sq ft
3200 lbs lifted by 620 HP of power = 3200÷620 = 5.16 lbs per HP

Thus drone will start at 0 altitude and 0 m/sec
Drone will then rise up by 33 feet and have velocity of 2.94 m/sec

Engine Max Nm=800 Nm Engine Max kw =485

783 Nm @ engine rpm of 5643 = 462 kW = 620 HP