AugerBot Calculations

```
Quit
```

Trial 1: 9/19 - 9/26

Modified Francisco Calculations : 10/18 (Do not use!)

Plotting Fx to find U which Balances Forces: 11/1

Plotting Fx to find U which Balances Forces 2 : 11/9

```
Quit;
```

- Corrected packing factor chart measurements
- Checked behavior of Fx equation
- Non-dimensionalized Fx equation

Finding Possible Case

Parameters

For Helix

In[1]:=
```
(*Current param: R = 1.8cm, n = 3.5*)
R = 0.018; (*Screw radius, m*)
n = 3.5; (*Number of helix turns*)
```

For Material

In[3]:=
```
(*S5 and S6:
   az(β,γ) = az(0,sgn(zdot)*π/2)*|Cos[β]|, Approx Fz on horiz projection
   ax(β,γ) = ax(π/2,0)*|Sin[β]|, Approx Fx on vert projection
*)

(*NOT SURE IF ZDOT IS + OR -, IF - THEN ALL Z VALUES UNDER AROUND 0*)
zlpPoppy = 0.35;
zcpPoppy = 0.55;
zlpGlass = 0.3;
zcpGlass = 0.4;
zcpGLASS = 0.3;(*az(0,sgn(zdot)*π/2), N/cm^3*)
xlpPoppy = 0.0625;
xcpPoppy = 0.2/3;
zlpGlass = 0.075;
zcpGlass = 0.1;
zcpGLASS = 0.0625;(*ax(π/2,0), N/cm^3*)

β = (Pi/2) - ϕ; (*ϕ is symbolic, radians*)
αz = zlpPoppy*Abs[Cos[β]]*(100^3); (*Vertical stress per unit depth, N/m^3*)
αx = xlpPoppy*Abs[Sin[β]]*(100^3); (*Horizontal stress per unit depth, N/m^3*)

d = 0.05;(*Depth robot buried, m*)

(*Friction coefficients, expressed in terms of ϕ*)
Cn = αz*d; (*N/m^2*)
Ct = αx*d;
```

For Motor

In[11]:=
```
w = 2*1000*(2*Pi)/3584;(*Angular velocity with 12V source, rad/s*)
```

- (2 ticks/ms)*(1000 ms/s)*(2*Pi rad/rev)*(1 rev/3584 ticks)

Thrust Equation

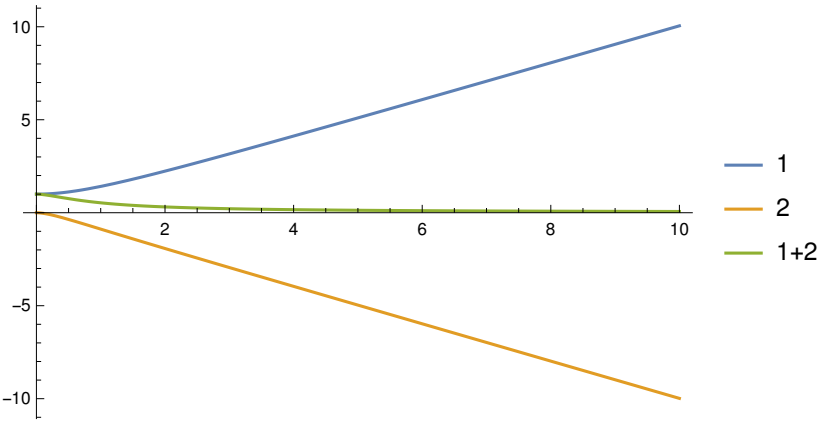
In[12]:=
```
Thrust[U_] := (2*Pi*n/Cos[ϕ])*
    (((Cn - Ct)*w*Sin[ϕ]*Cos[ϕ])*(((R/(2*w^2))*Sqrt[(R*w)^2 + U^2]) +
          ((U^2/(2*w^3))*(Log[U] - Log[R*w + Sqrt[(R*w)^2 + U^2]])))) -
      (U*(Ct*Sin[ϕ]^2 + Cn*Cos[ϕ]^2)*(Sqrt[(R*w)^2 + U^2] - U)/w^2));
```

In[13]:=
```
NDThrust[u_] := (2*Pi*R^2*n/Cos[ϕ])*
    (0.5*(Cn - Ct)*Sin[ϕ]*Cos[ϕ]*(Sqrt[1 + u^2] + u^2*Log[u/(1 + Sqrt[1 + u^2])]) -
      u*(Ct*Sin[ϕ]^2 + Cn*Cos[ϕ]^2)*(Sqrt[1 + u^2] - u));
```

Behavior Plots

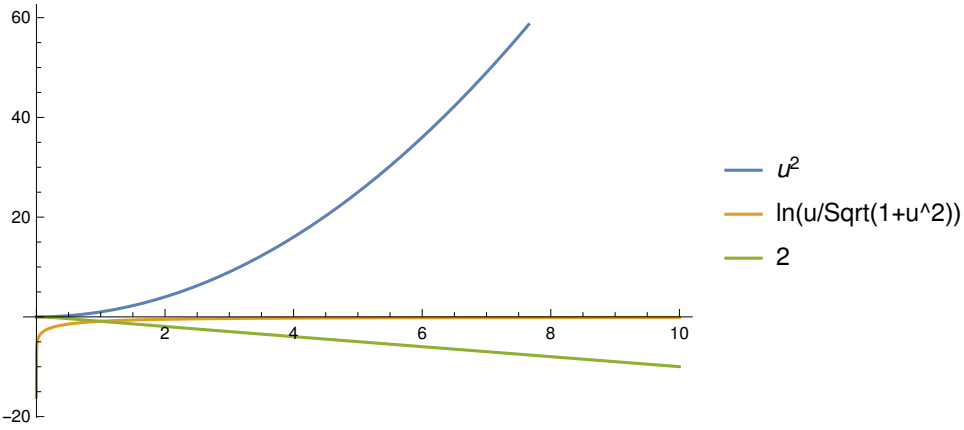
In[14]:=
```
(*Term 1*)
test1 = Sqrt[1 + u^2]; test2 = u^2 * Log[u / (1 + Sqrt[1 + u^2])];
Plot[{test1, test2, test1 + test2}, {u, 0, 10}, PlotLegends → {"1", "2", "1+2"}]
```

Out[15]=



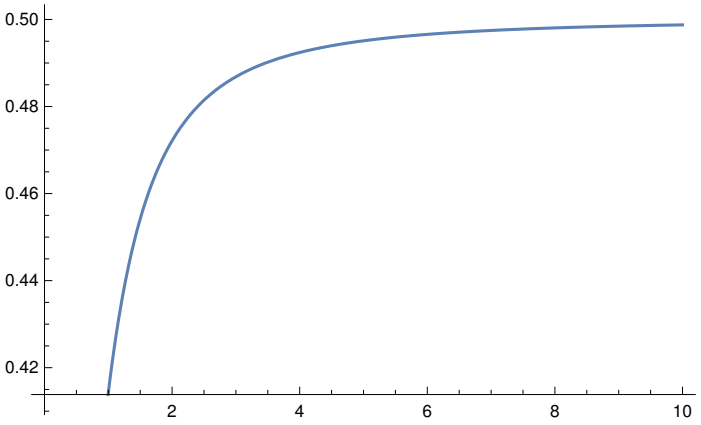
In[16]:=
```
Plot[{u^2, Log[u / (1 + Sqrt[1 + u^2])], test2},
 {u, 0, 10}, PlotLegends → {"u²", "ln(u/Sqrt(1+u^2))", "2"}]
```

Out[16]=



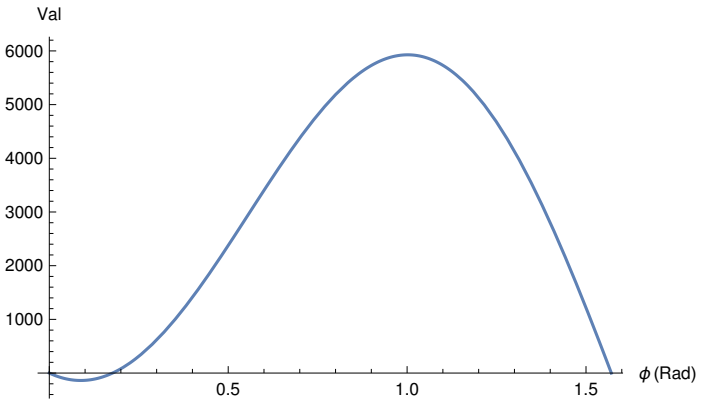
In[17]:=
```
(*Term 2*)
test3 = u * (Sqrt[1 + u^2] - u);
Plot[test3, {u, 0, 10}]
```

Out[18]=



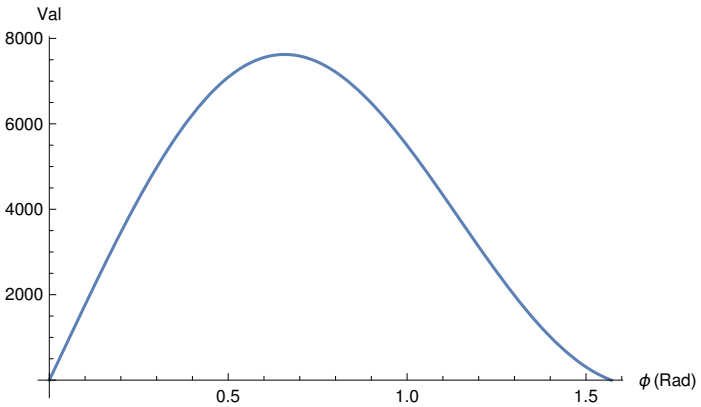
In[19]:=
```
(*Friction coefficient terms: Quit and just run material parameters section*)
test4 = (Cn - Ct) * Sin[ϕ] * Cos[ϕ];
Plot[test4, {ϕ, 0, Pi / 2}, AxesLabel → {"ϕ (Rad)", "Val"}]
```

Out[20]=



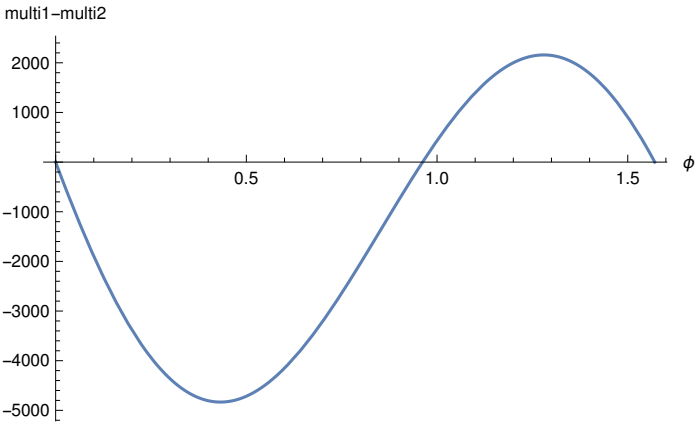
In[21]:=
```
test5 = Ct * Sin[ϕ]^2 + Cn * Cos[ϕ]^2;
Plot[test5, {ϕ, 0, Pi / 2}, AxesLabel → {"ϕ (Rad)", "Val"}]
```

Out[22]=



In[23]:=
```
Plot[test4 - test5, {ϕ, 0, Pi/2}, AxesLabel → {"ϕ", "multi1-multi2"}]
```

Out[23]=



Plotting Thrust as a Function of U

In[24]:=
```
ϕ = 10 * Pi/180 // N (*Local inclination, radians*)
```

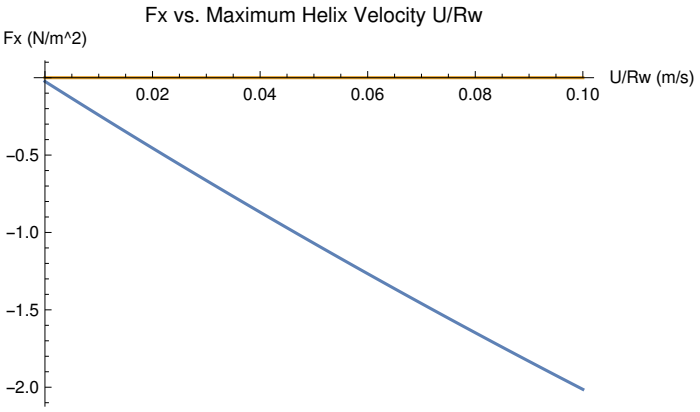
Out[24]=
```
0.174533
```

In[25]:=
```
While[ϕ < 90 * Pi/180,
 Print["Let ϕ = ", ϕ * 180/Pi, " deg"];
 Print["(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = ", (Cn - Ct) * Sin[ϕ] * Cos[ϕ]];
 Print["Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = ", Ct * Sin[ϕ]^2 + Cn * Cos[ϕ]^2];
 Print@Plot[{NDThrust[u], 0}, {u, 0, 0.1},
   PlotLabel → "Fx vs. Maximum Helix Velocity U/Rw",
   AxesLabel → {"U/Rw (m/s)", "Fx (N/m^2)"}, PlotRange → All];
 ϕ = ϕ + (1 * Pi/180) (*Increment by 0.1 deg*)
]
```

```
Let ϕ = 10. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = -6.61486
```

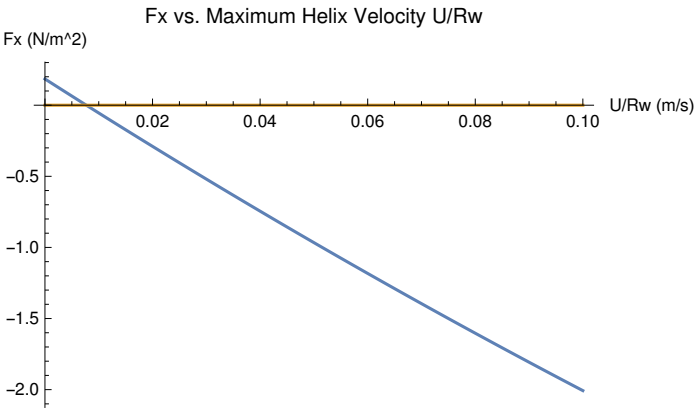
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3040.01
```




```
Let ϕ = 11. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 50.8664
```

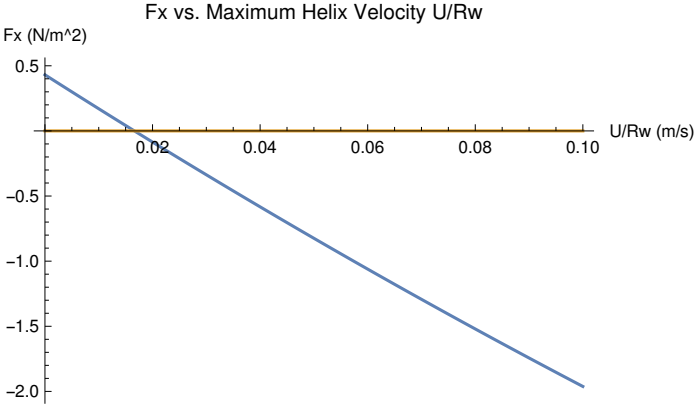
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3329.27



Let ϕ = 12. deg

(Cn−Ct)*Sin[ϕ]*Cos[ϕ] = 118.308

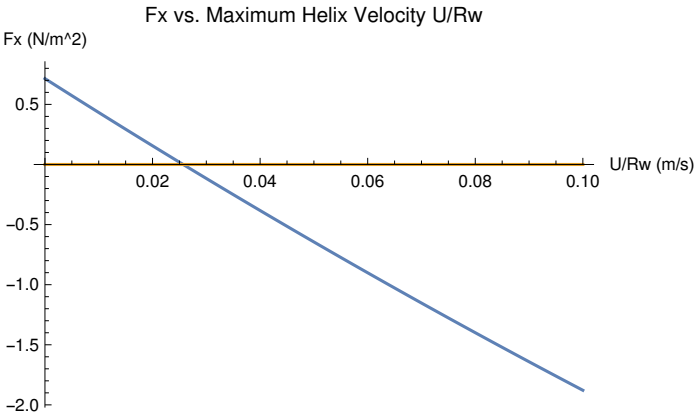
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3613.31



Let ϕ = 13. deg

(Cn−Ct)*Sin[ϕ]*Cos[ϕ] = 195.456

Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3891.52



Let ϕ = 14. deg

(Cn−Ct)*Sin[ϕ]*Cos[ϕ] = 282.025

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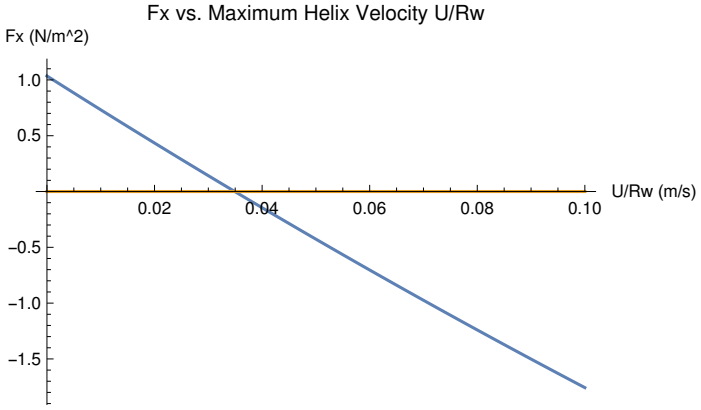
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4163.32
```




```
Let ϕ = 15. deg
```

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(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 377.704
```
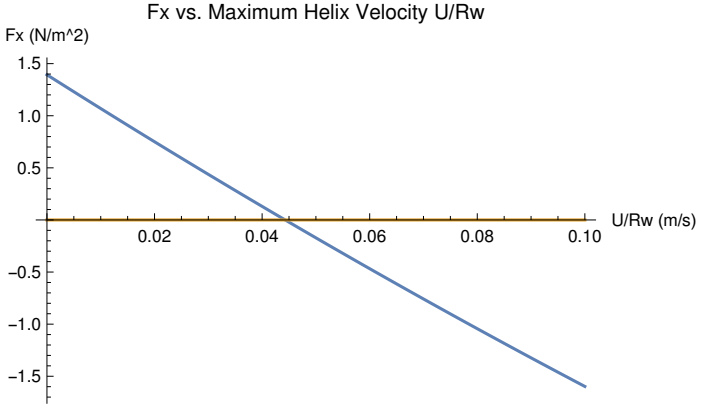

```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4428.13
```




```
Let ϕ = 16. deg
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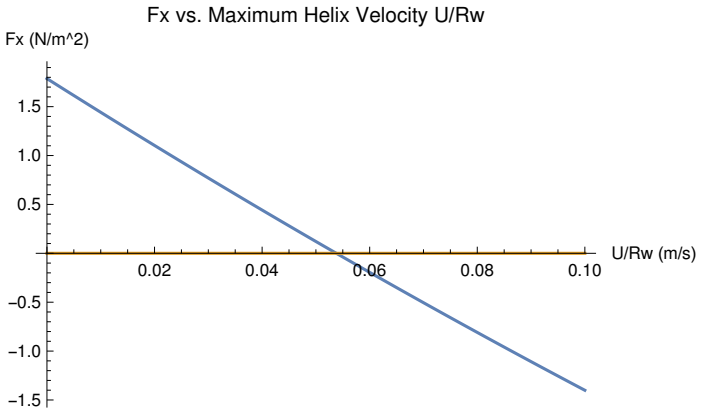
```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 482.15
```

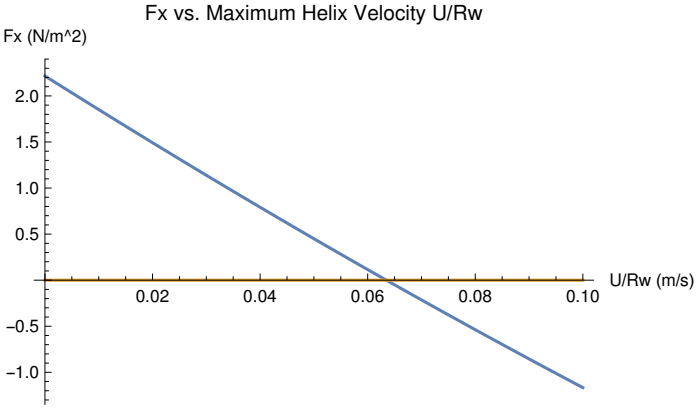
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4685.4
```



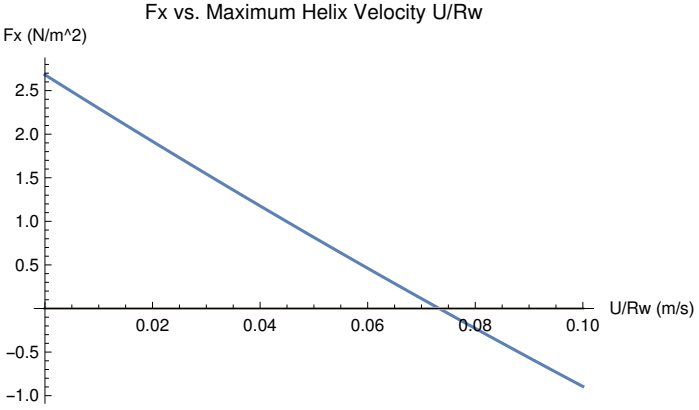

```
Let ϕ = 17. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 594.996
```

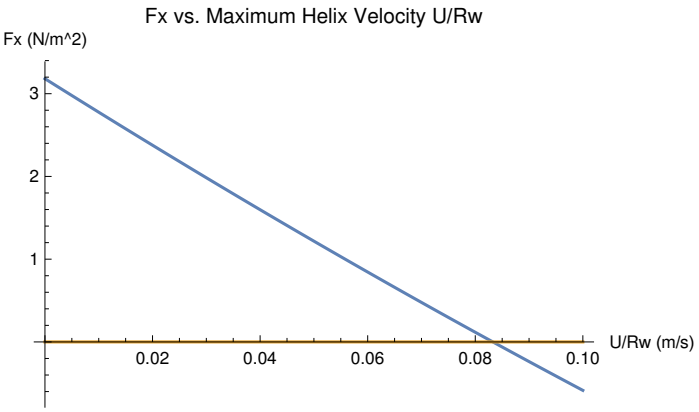
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4934.6
```




```
Let ϕ = 18. deg
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 715.848
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5175.2
```

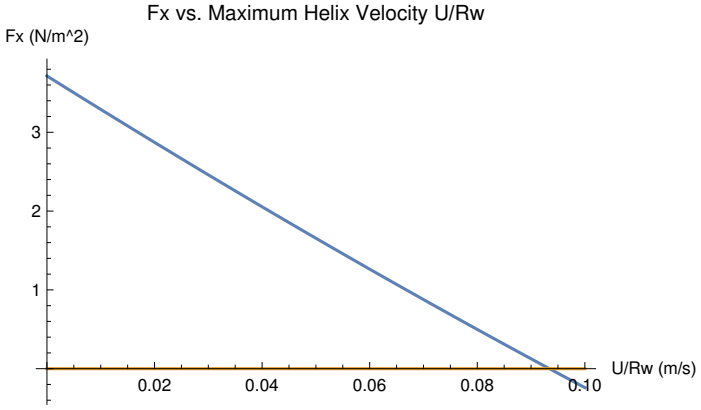



```
Let ϕ = 19. deg
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 844.286
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5406.73
```




```
Let ϕ = 20. deg
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 979.87
```

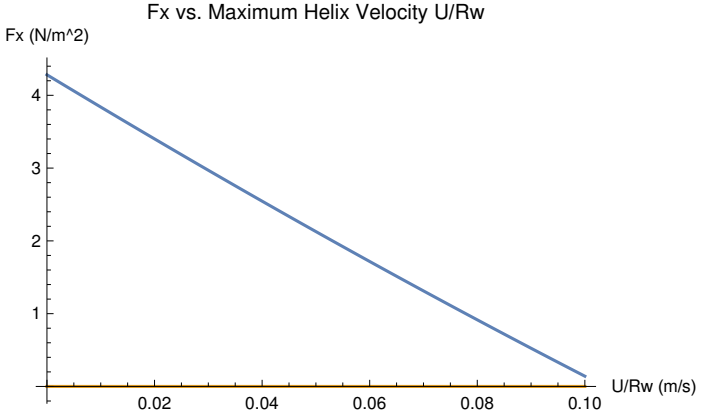
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5628.71



Let ϕ = 21. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1122.13

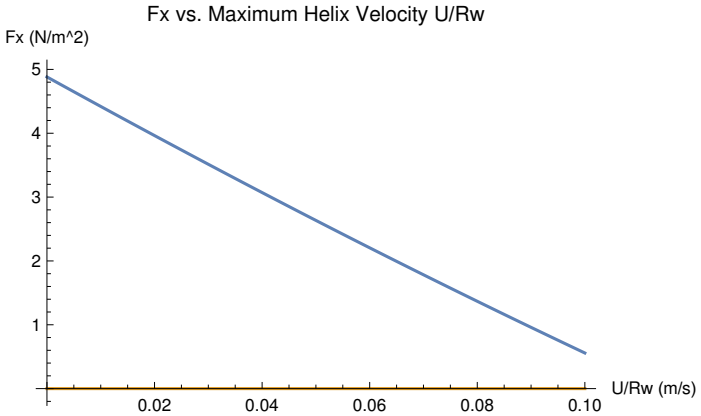
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5840.69



Let ϕ = 22. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1270.59

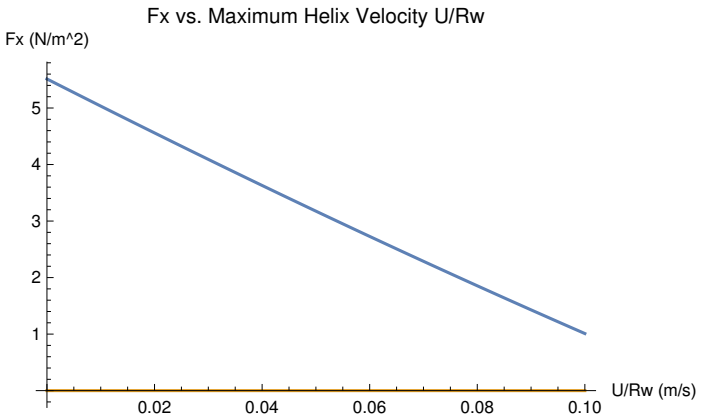
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6042.26



Let ϕ = 23. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1424.73

```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6233.03
```




```
Let ϕ = 24. deg
```

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(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1584.04
```
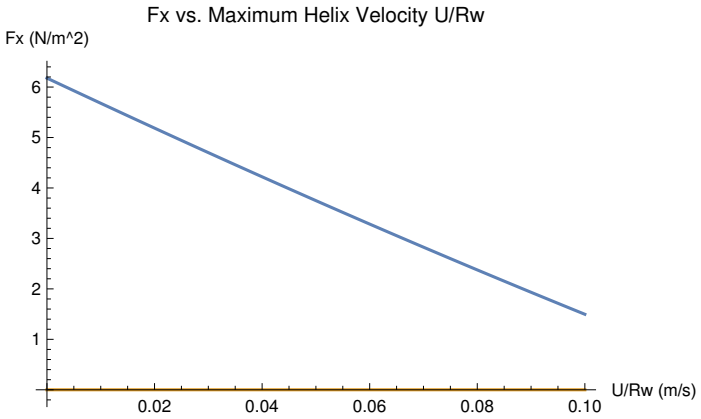
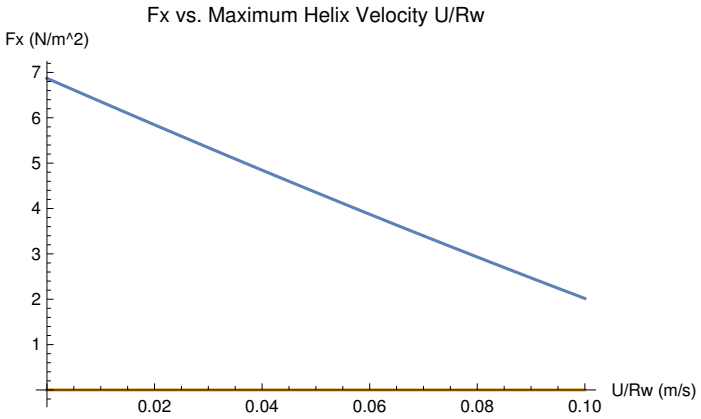

```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6412.63
```




```
Let ϕ = 25. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1747.96
```

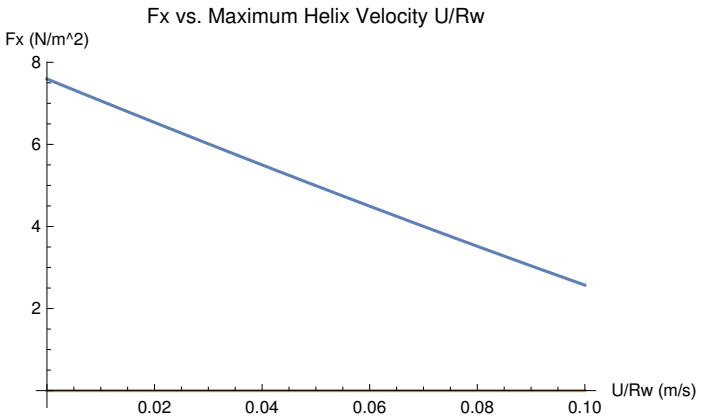
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6580.73
```




```
Let ϕ = 26. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1915.96
```

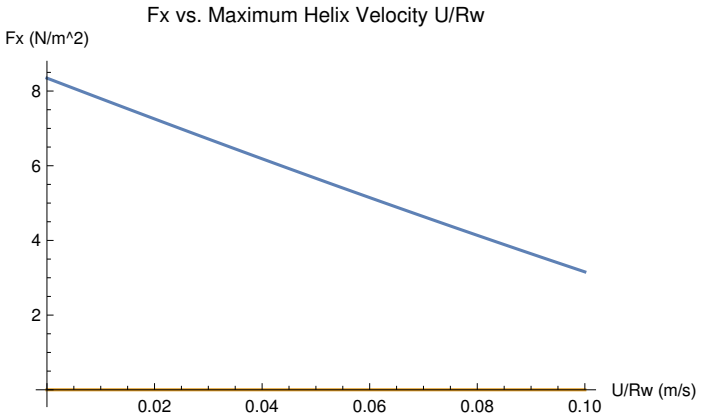
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6737.02



Let ϕ = 27. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2087.44

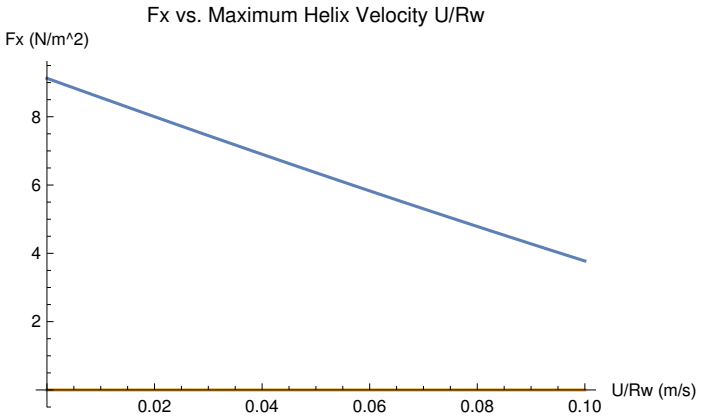
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6881.23



Let ϕ = 28. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2261.84

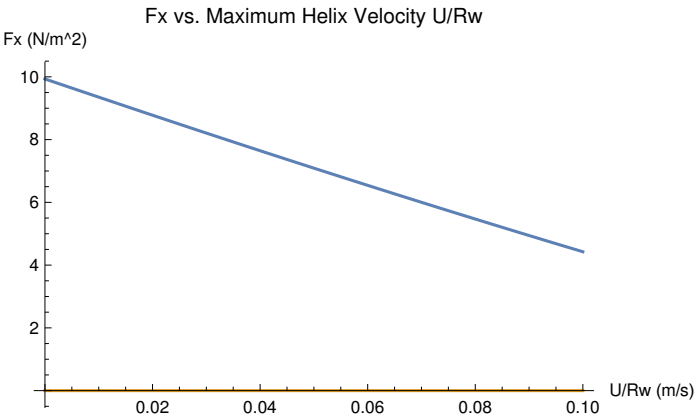
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7013.11



Let ϕ = 29. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2438.55

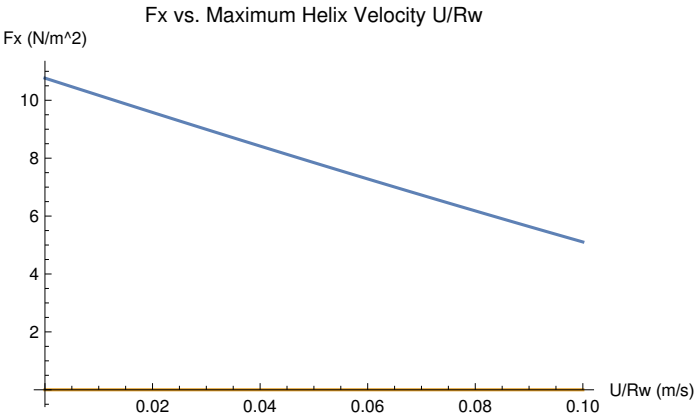
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7132.46



Let ϕ = 30. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2616.99

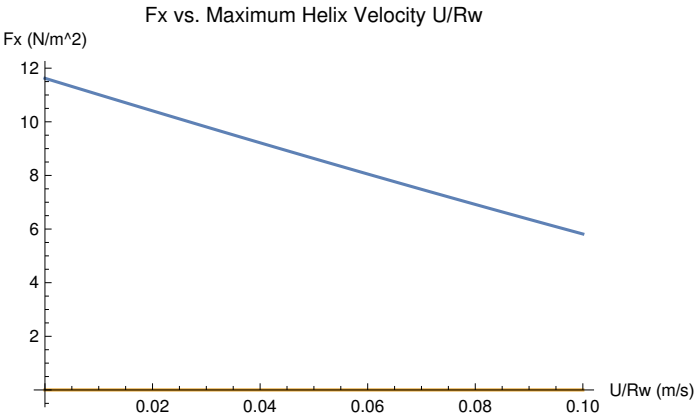
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7239.08



Let ϕ = 31. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2796.52

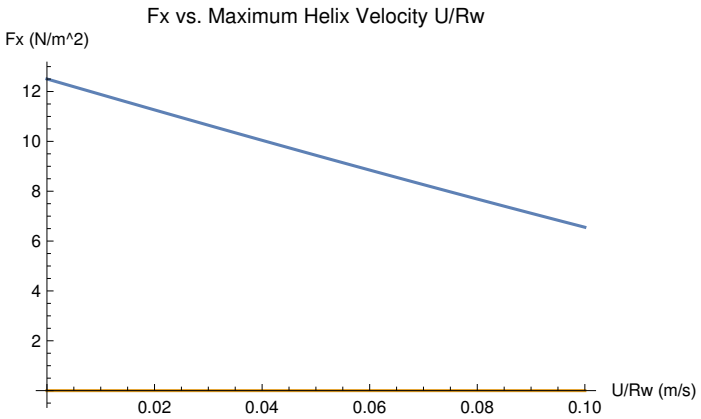
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7332.85



Let ϕ = 32. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2976.55

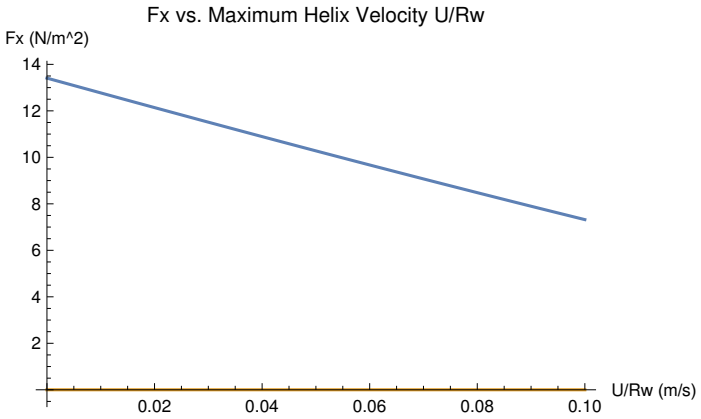
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7413.63



Let ϕ = 33. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3156.45

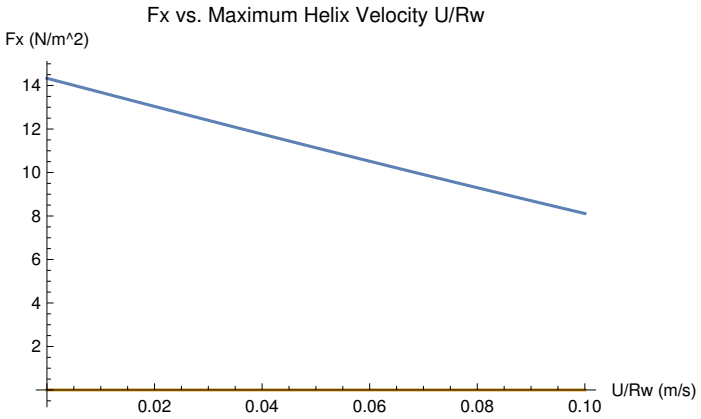
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7481.36



Let ϕ = 34. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3335.61

Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7535.98



Let ϕ = 35. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3513.39

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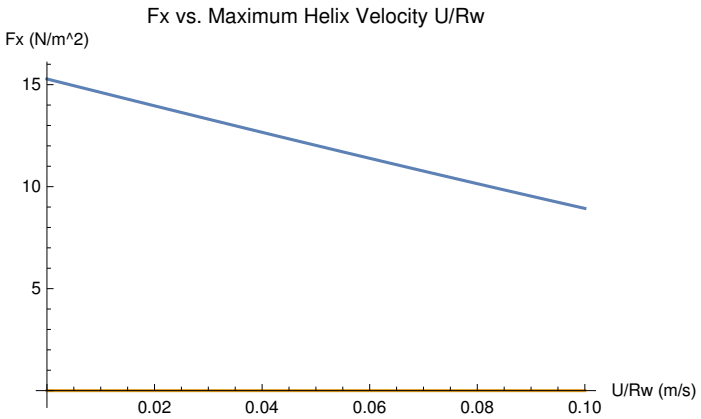
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7577.49
```




```
Let ϕ = 36. deg
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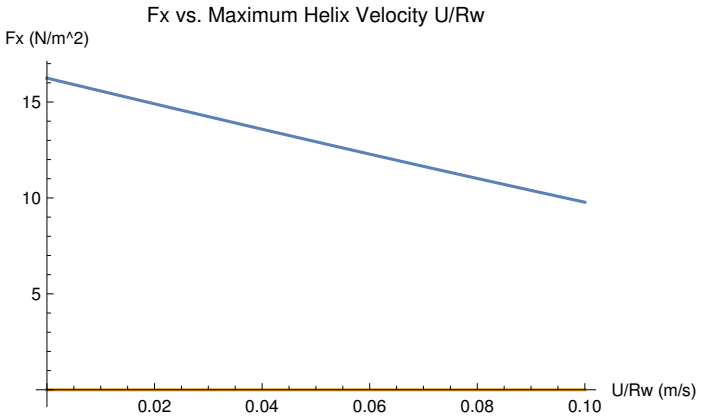
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3689.18
```

```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7605.9
```




```
Let ϕ = 37. deg
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(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3862.36
```

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Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7621.26
```

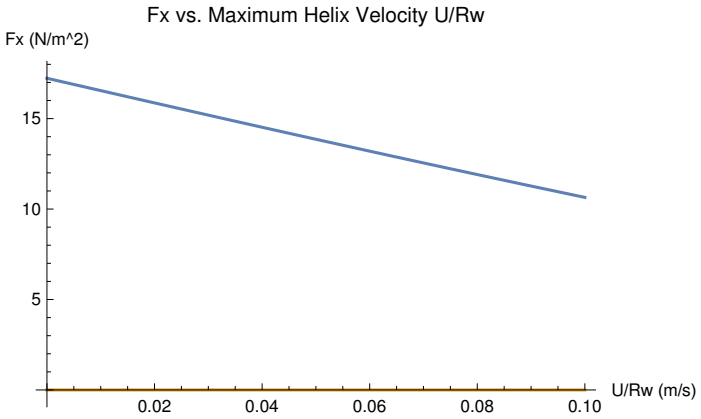


```
Let ϕ = 38. deg
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```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4032.33
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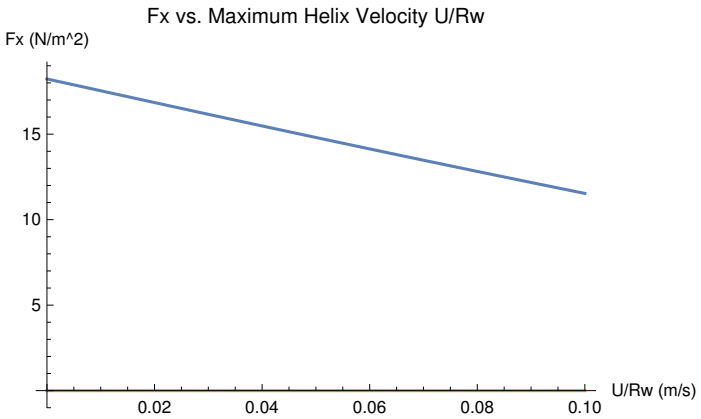
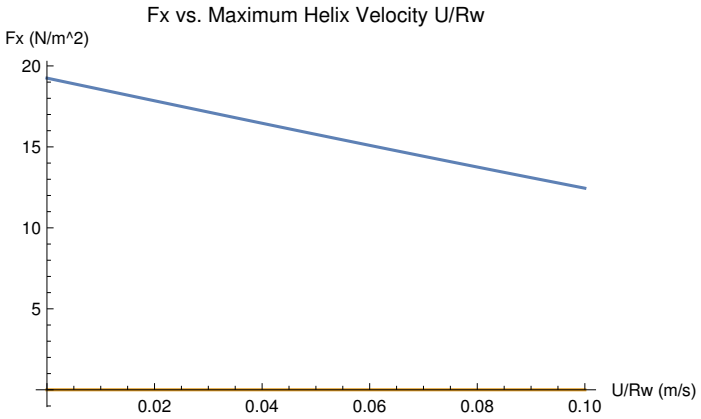
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7623.68



Let ϕ = 39. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4198.47

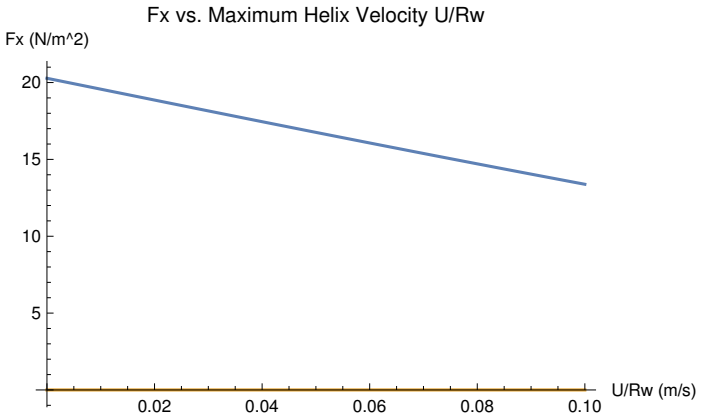
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7613.26



Let ϕ = 40. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4360.18

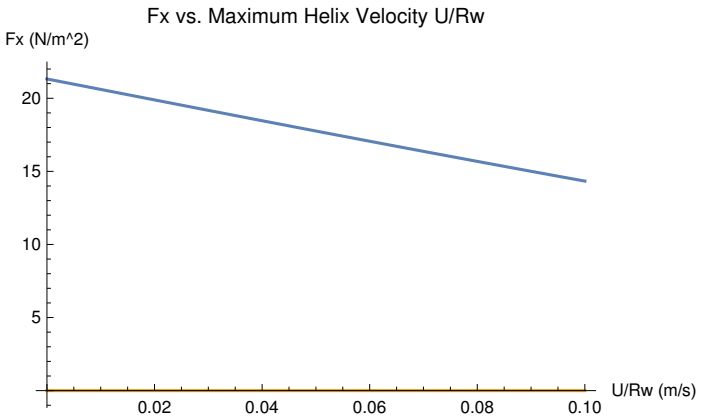
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7590.15



Let ϕ = 41. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4516.89

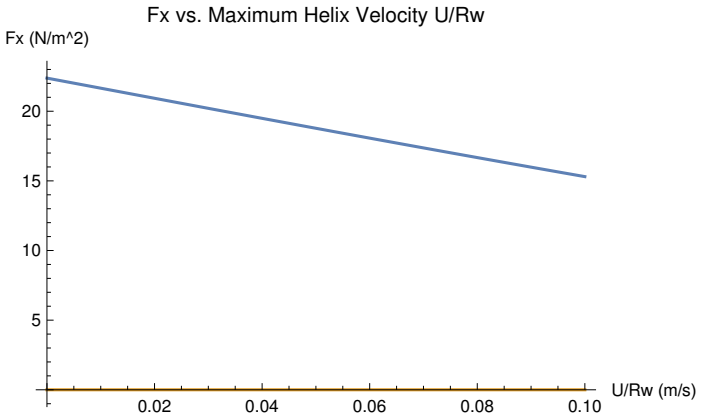
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7554.56
```




```
Let ϕ = 42. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4668.02
```

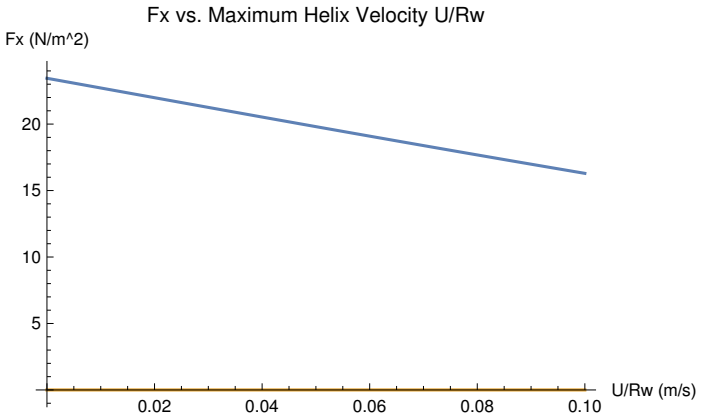
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7506.68
```




```
Let ϕ = 43. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4812.99
```

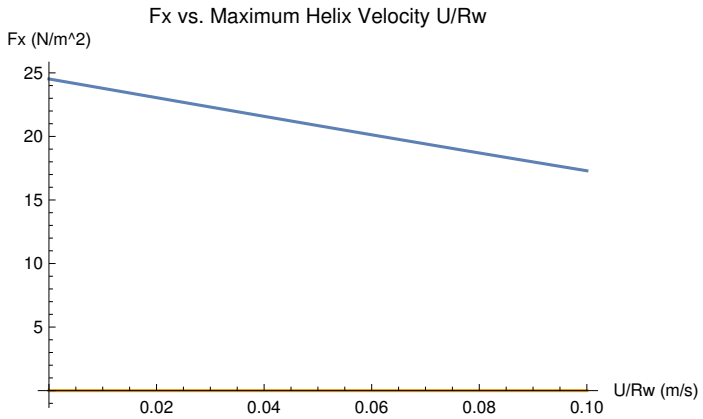
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7446.78
```




```
Let ϕ = 44. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4951.27
```

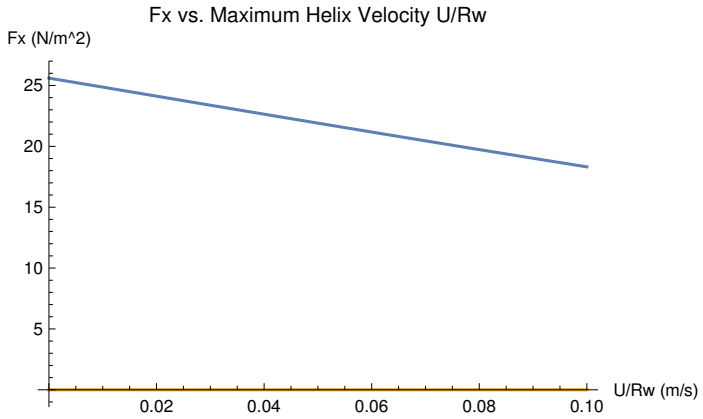
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7375.13



Let ϕ = 45. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5082.33

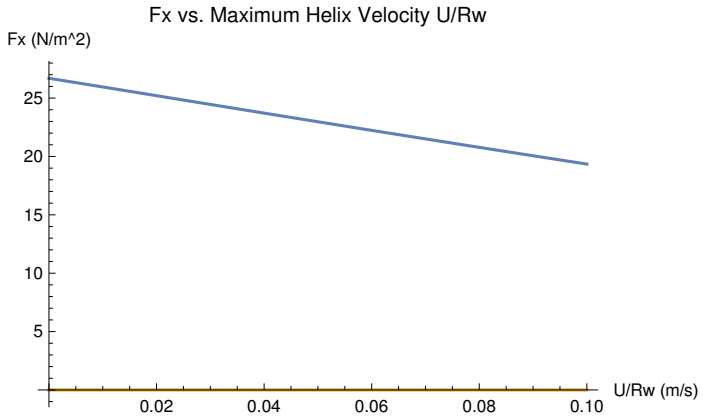
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7292.04



Let ϕ = 46. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5205.65

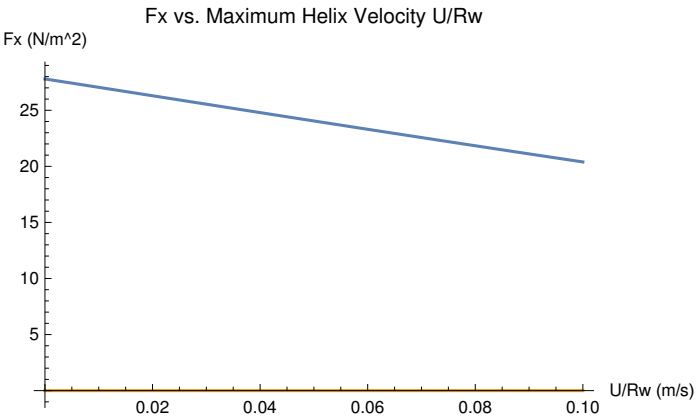
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7197.84



Let ϕ = 47. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5320.73

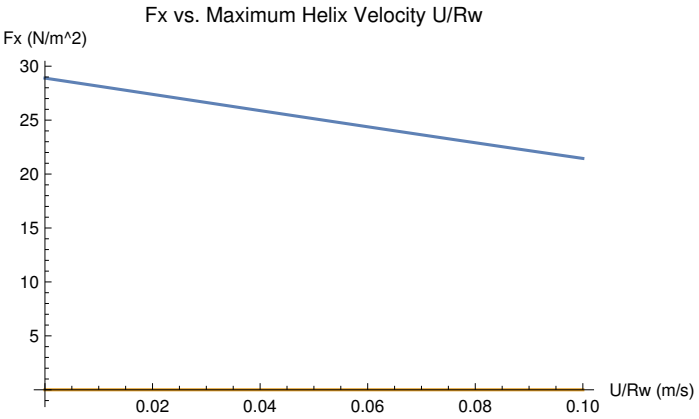
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 7092.91



Let ϕ = 48. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5427.11

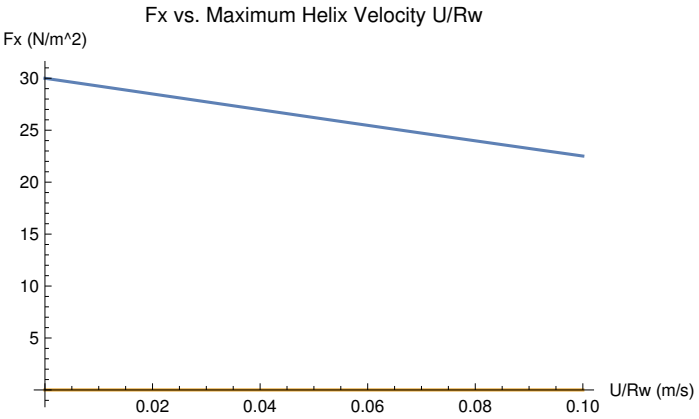
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6977.62



Let ϕ = 49. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5524.33

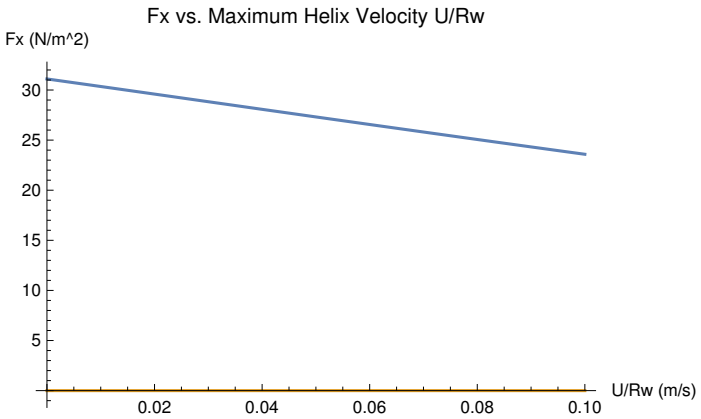
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6852.41



Let ϕ = 50. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5611.96

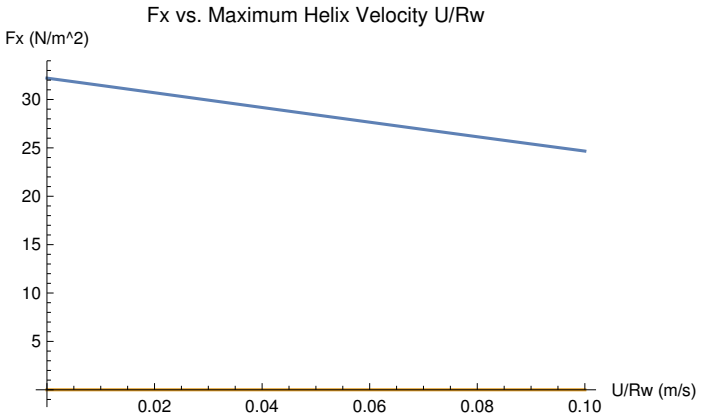
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6717.7



Let ϕ = 51. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5689.6

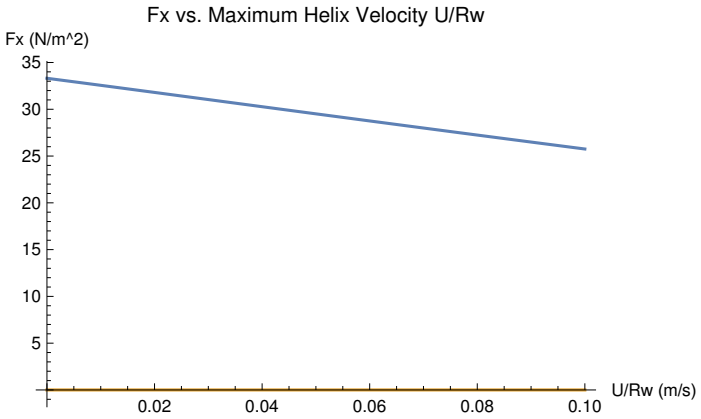
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6573.98



Let ϕ = 52. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5756.88

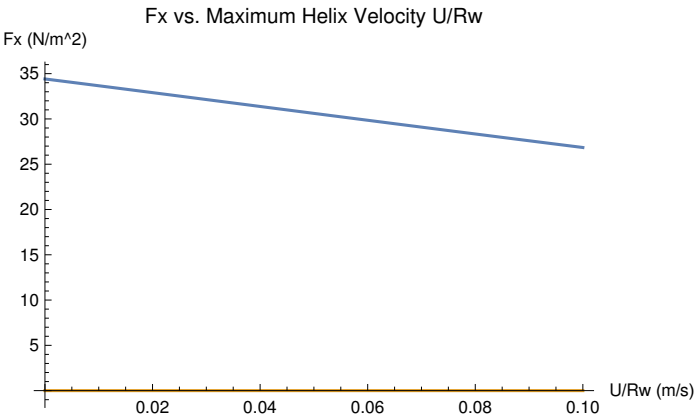
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6421.71



Let ϕ = 53. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5813.45

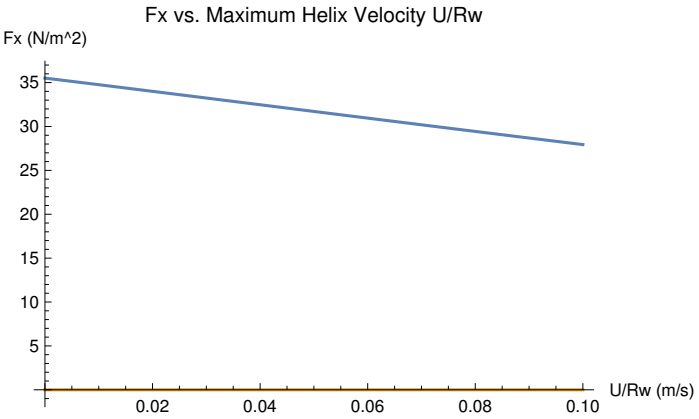
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6261.42



Let ϕ = 54. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5858.97

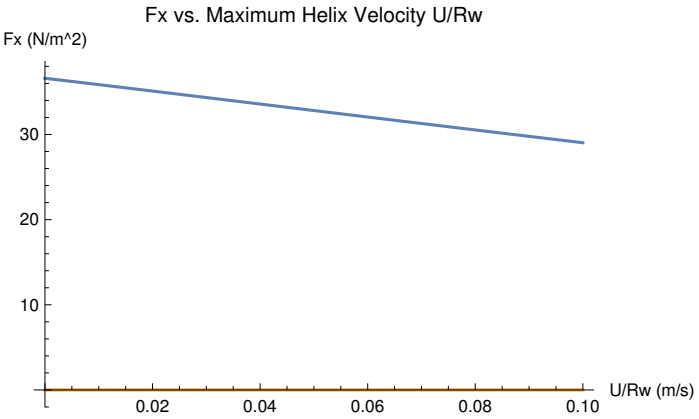
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 6093.62



Let ϕ = 55. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5893.16

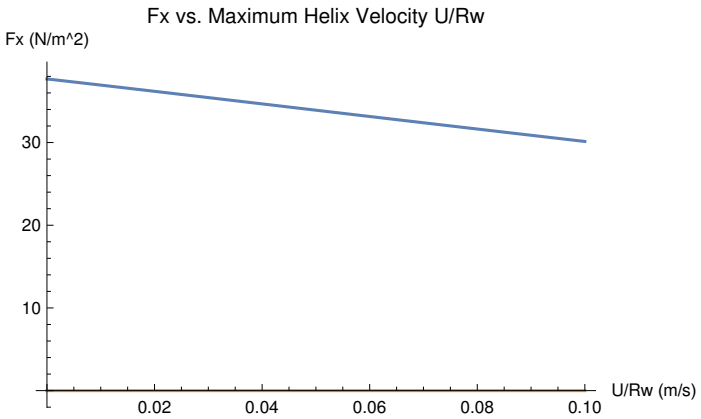
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5918.86



Let ϕ = 56. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5915.75

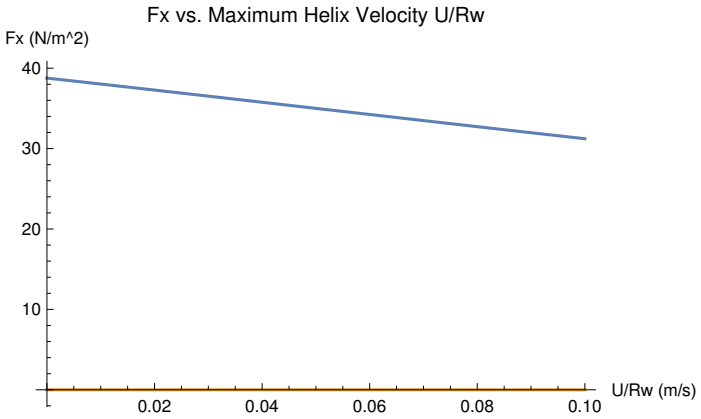
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5737.7



Let ϕ = 57. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5926.51

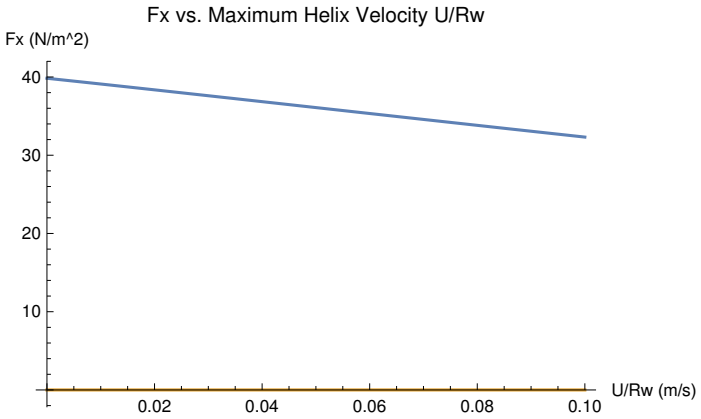
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5550.72



Let ϕ = 58. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5925.23

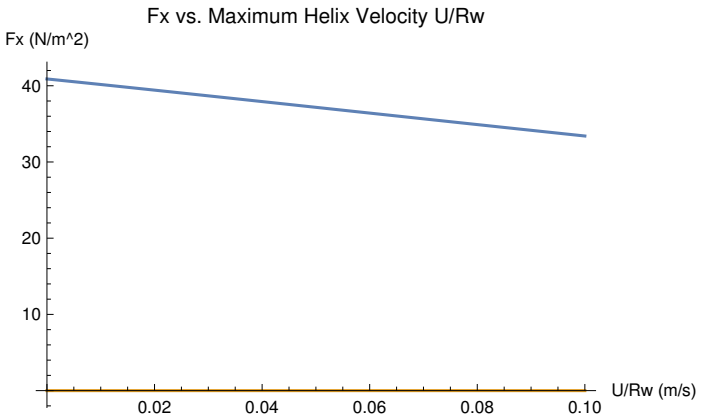
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5358.49



Let ϕ = 59. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5911.75

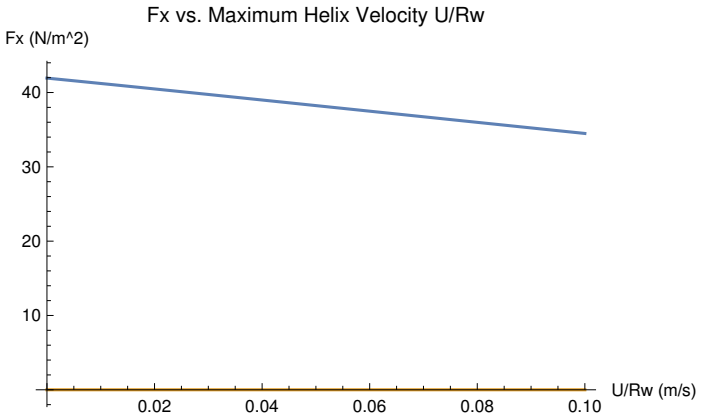
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 5161.63



Let ϕ = 60. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5885.92

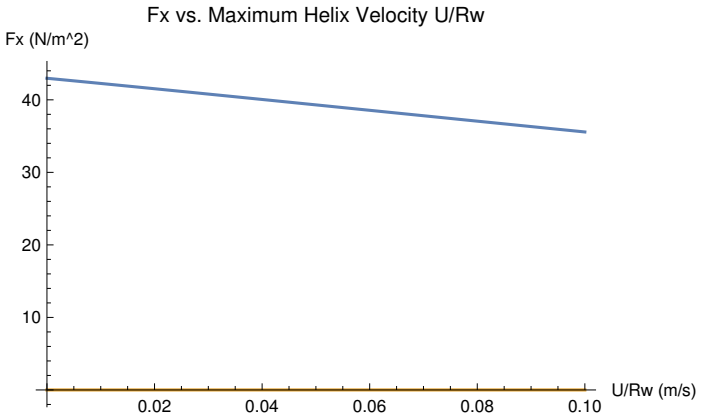
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4960.74



Let ϕ = 61. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5847.64

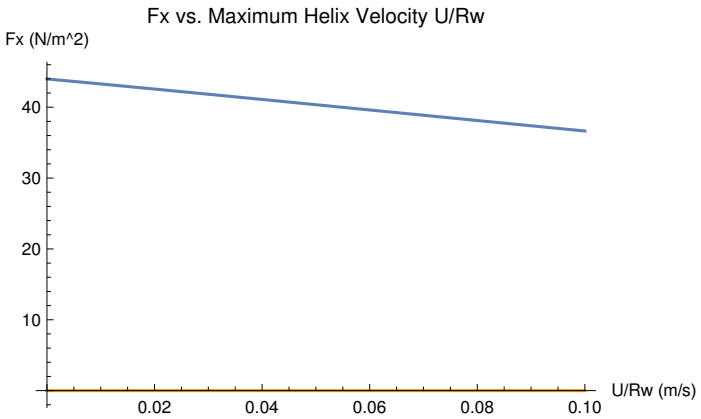
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4756.43



Let ϕ = 62. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5796.83

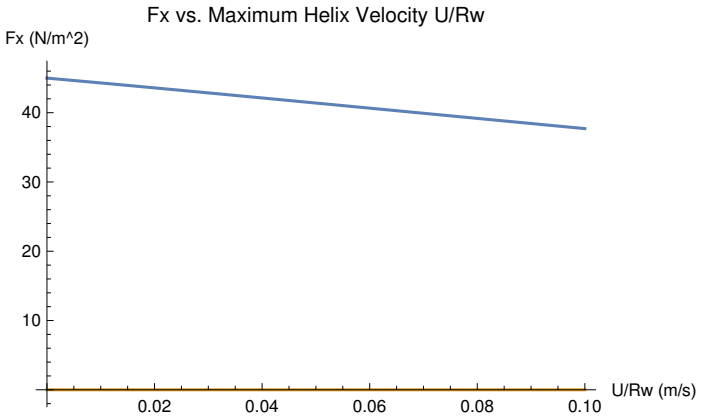
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4549.33



Let ϕ = 63. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5733.46

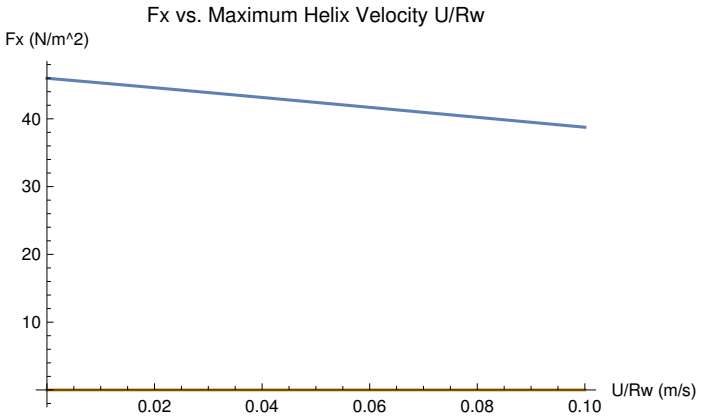
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4340.06



Let ϕ = 64. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5657.52

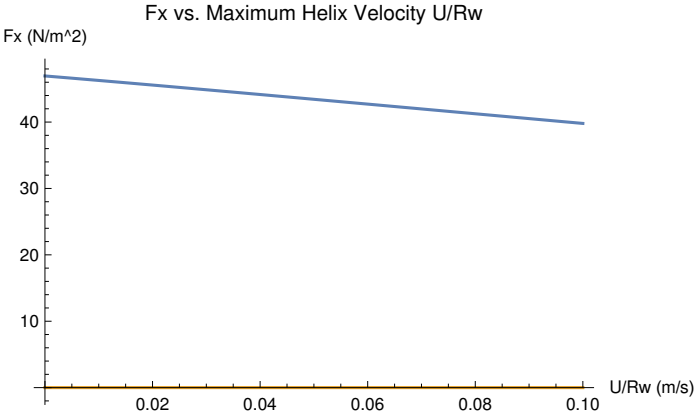
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 4129.27



Let ϕ = 65. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5569.03

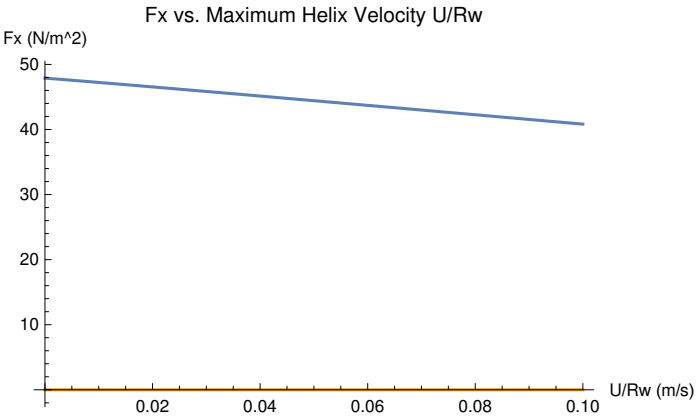
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3917.56
```




```
Let ϕ = 66. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5468.06
```

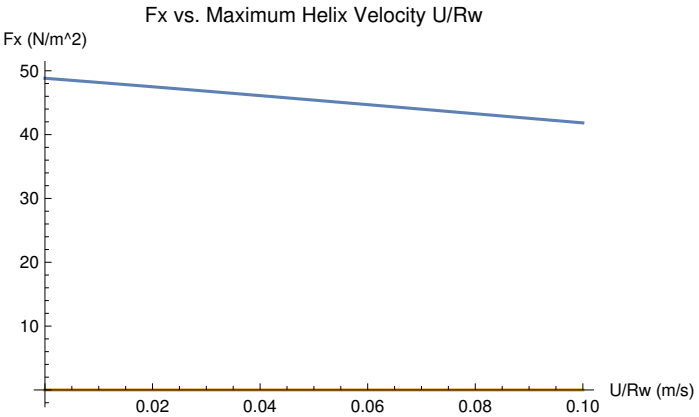
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3705.59
```




```
Let ϕ = 67. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5354.69
```

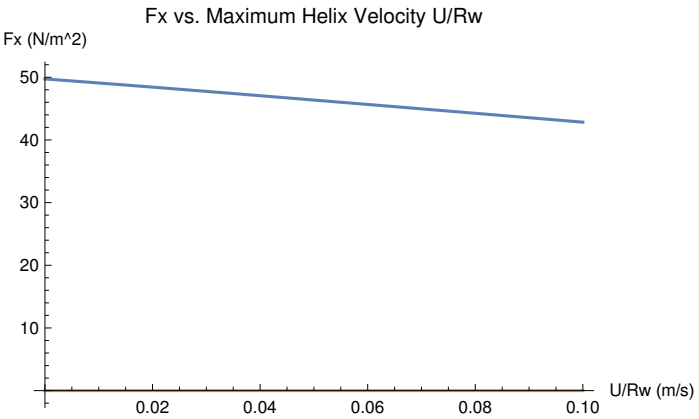
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3493.97
```




```
Let ϕ = 68. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5229.07
```

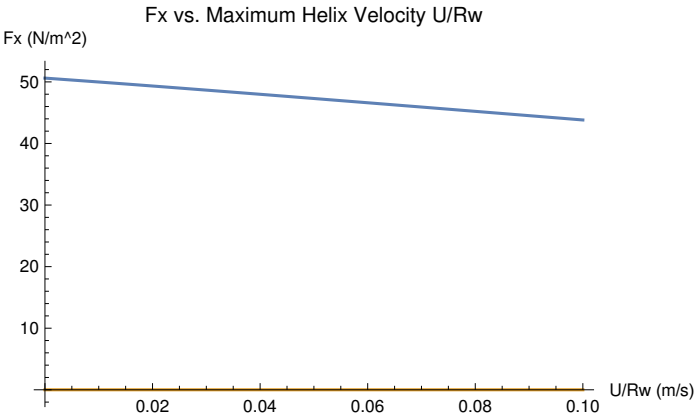
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3283.33



Let ϕ = 69. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 5091.33

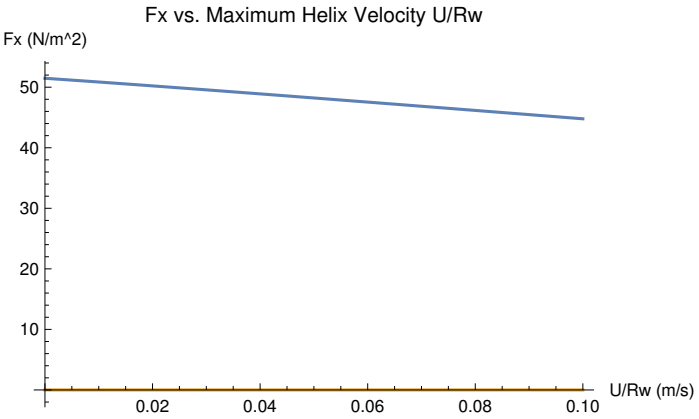
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 3074.28



Let ϕ = 70. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4941.69

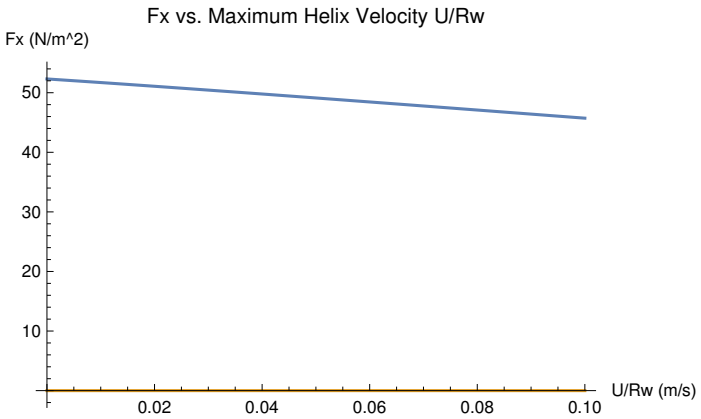
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 2867.44



Let ϕ = 71. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4780.36

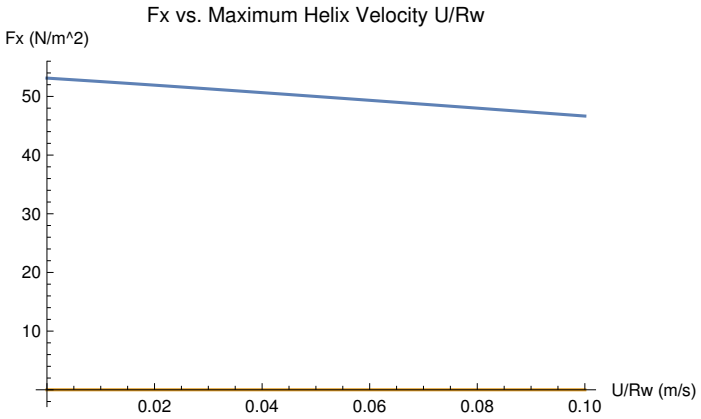
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 2663.41
```




```
Let ϕ = 72. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4607.59
```

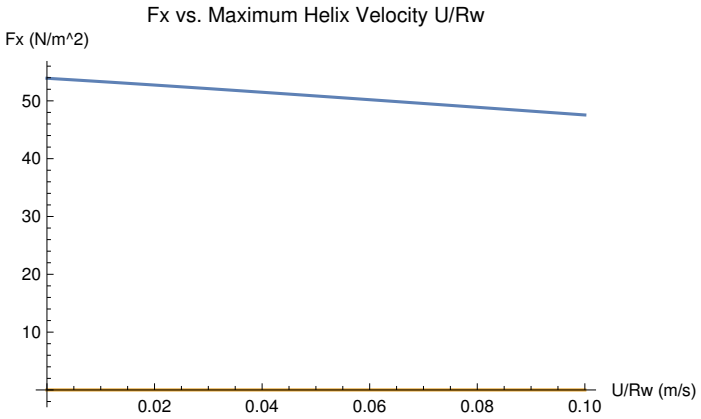
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 2462.78
```




```
Let ϕ = 73. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4423.68
```

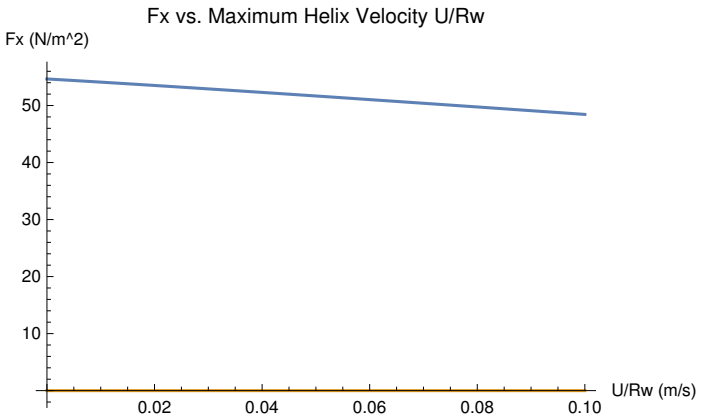
```
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 2266.12
```




```
Let ϕ = 74. deg
```

```
(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4228.94
```

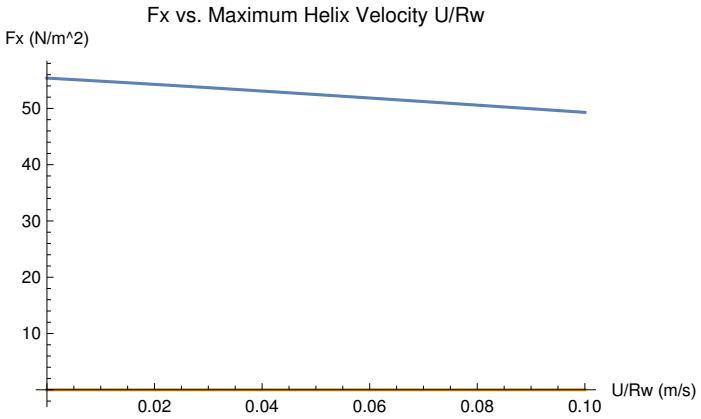
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 2074.



Let ϕ = 75. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 4023.72

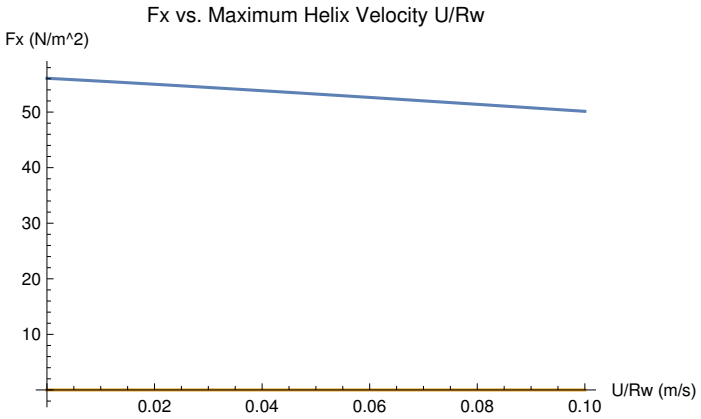
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 1886.96



Let ϕ = 76. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3808.39

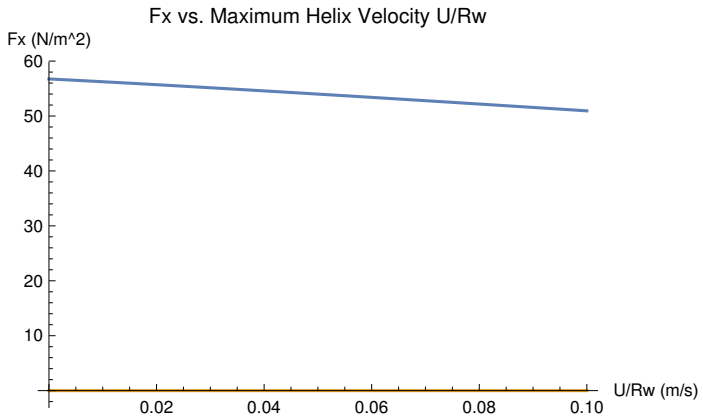
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 1705.54



Let ϕ = 77. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3583.36

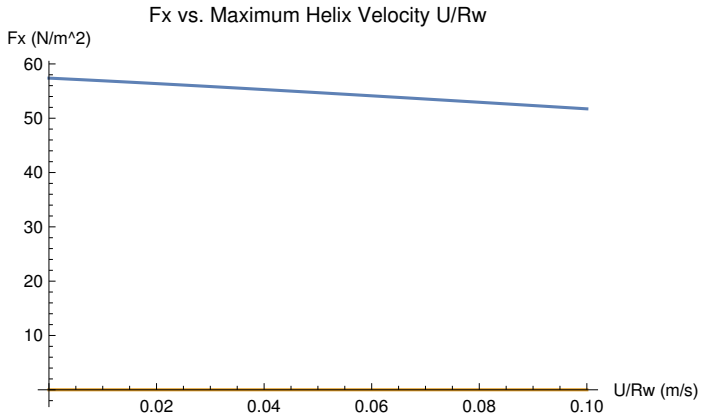
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 1530.26



Let ϕ = 78. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3349.04

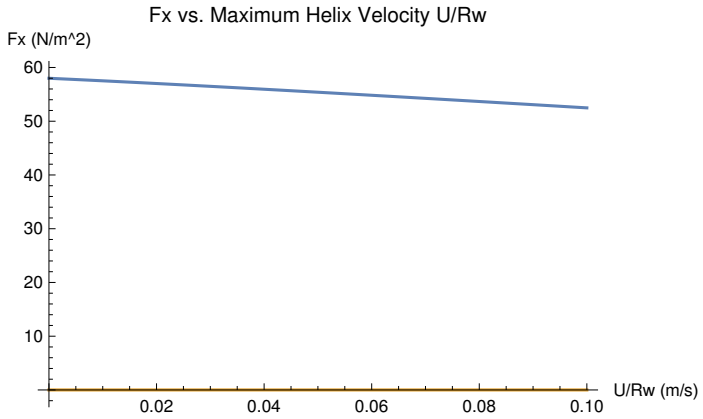
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 1361.58



Let ϕ = 79. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 3105.9

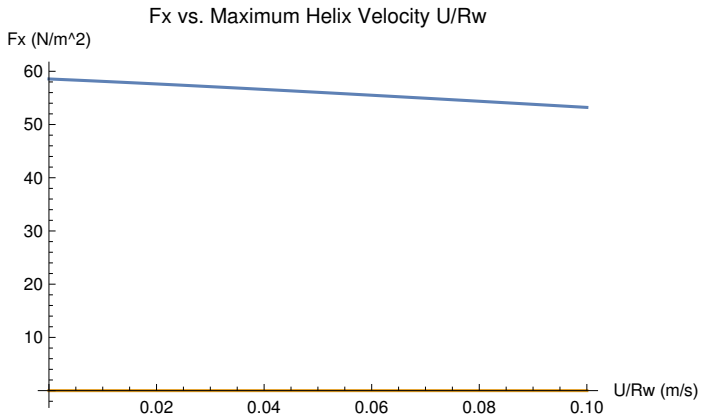
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 1200.



Let ϕ = 80. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2854.41

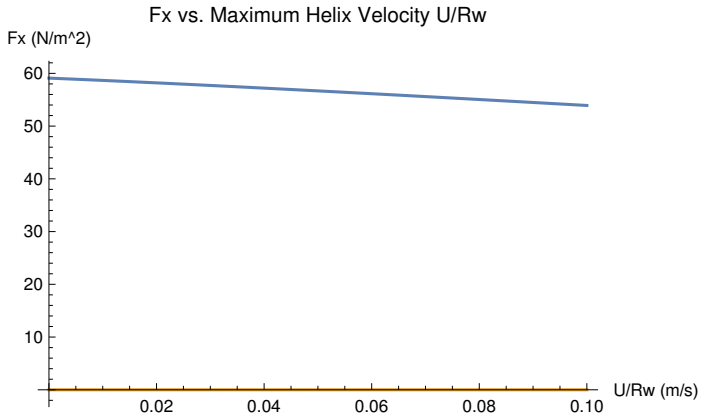
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 1045.96



Let ϕ = 81. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2595.08

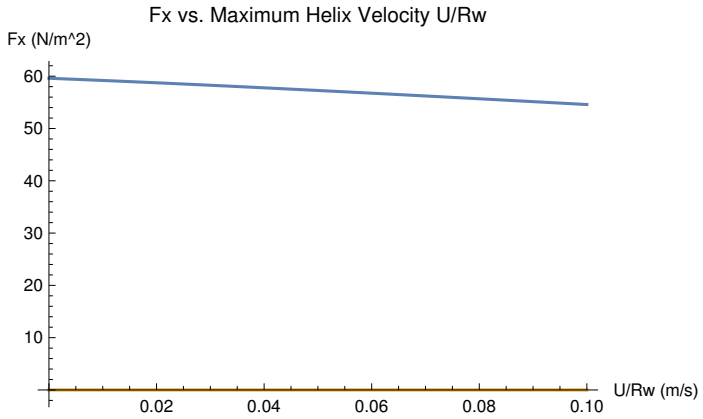
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 899.877



Let ϕ = 82. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2328.42

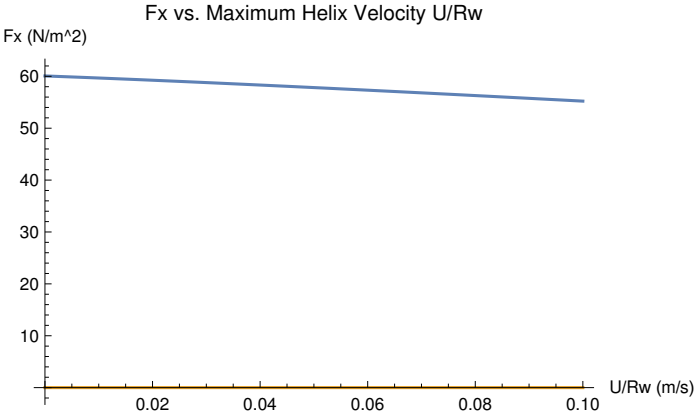
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 762.153



Let ϕ = 83. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 2054.97

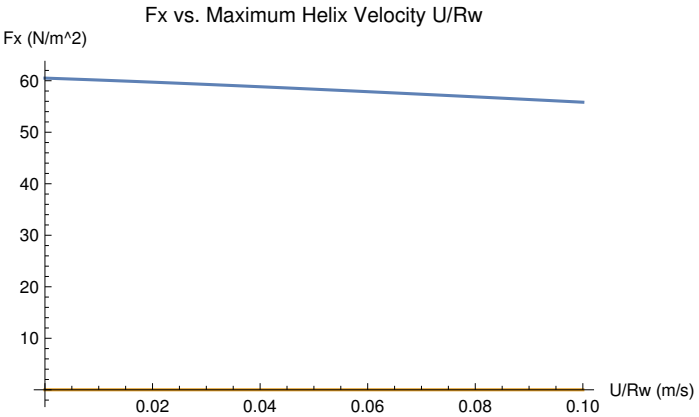
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 633.16



Let ϕ = 84. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1775.3

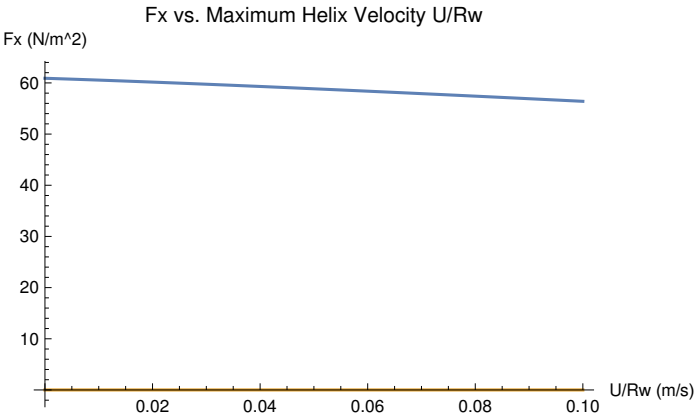
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 513.243



Let ϕ = 85. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1489.99

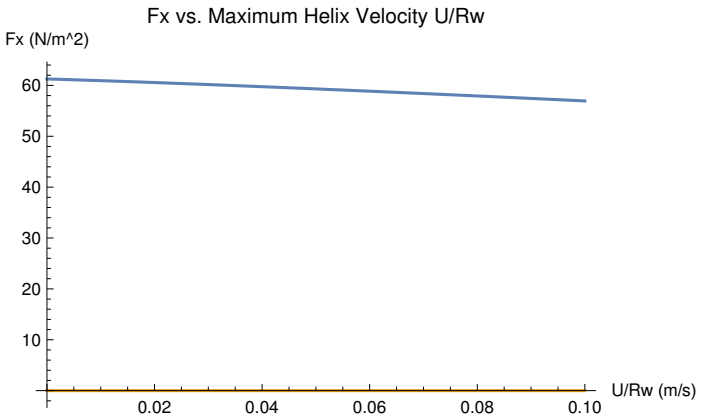
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 402.719



Let ϕ = 86. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 1199.63

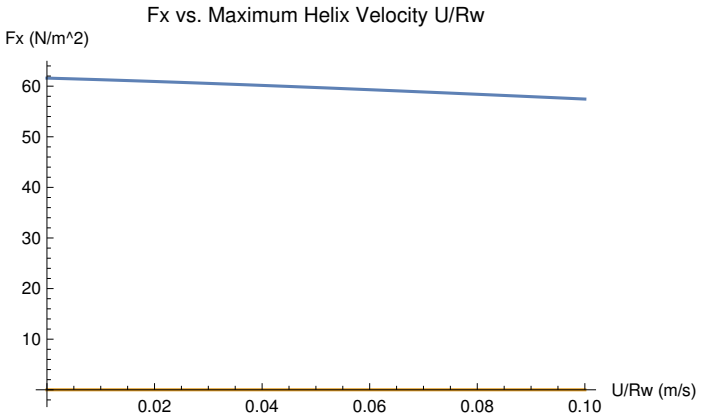
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 301.875



Let ϕ = 87. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 904.823

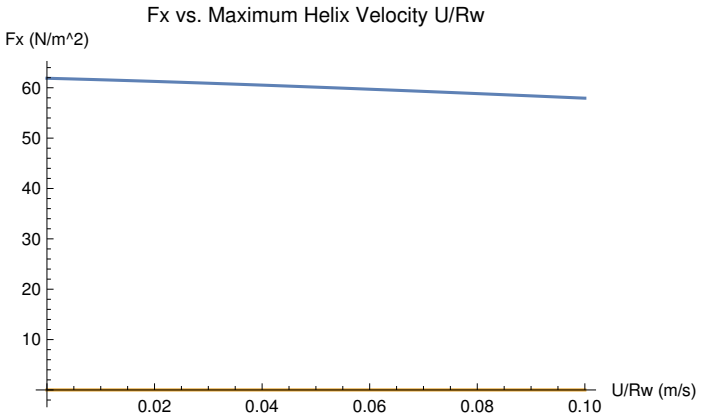
Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 210.97



Let ϕ = 88. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 606.193

Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 130.23



Let ϕ = 89. deg

(Cn-Ct)*Sin[ϕ]*Cos[ϕ] = 304.372

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Ct*Sin[ϕ]^2+Cn*Cos[ϕ]^2 = 59.8516
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