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BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING

BACHELOR THESIS - DOCUMENT: REPORT ATTACHMENT

**Project of designing and manufacturing a small wind turbine
using fused deposition modeling technology**

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Contents

List of Figures	2
List of Tables	3
1 Aerodynamic design	4
1.1 Airfoil selection	4
2 Structural design	23

List of Figures

1	SG6040 polar curves.	5
2	SG6041 polar curves.	6
3	SG6042 polar curves.	7
4	SG6043 polar curves.	8
5	S833 polar curves.	9
6	S834 polar curves.	10
7	S835 polar curves.	11
8	S1210 polar curves.	12
9	S1223 polar curves.	13
10	S6063 polar curves.	14
11	S9037 polar curves.	15

List of Tables

1	SG6040 data.	5
2	SG6041 data.	6
3	SG6042 data.	7
4	SG6043 data.	8
5	S833 data.	9
6	S834 data.	10
7	S834 data.	11
8	S1210 data.	12
9	S1223 data.	13
10	S6063 data.	14
11	S9037 data.	15

Chapter 1

Aerodynamic design

1.1 Airfoil selection

In this section the polar curves obtained from XFLR5 will be presented. The data retrieved from each graph will also be shown.

Each value has been obtained using the following criteria:

1. Maximum efficiency E : The mean of the maximum efficiency for each Reynolds.
2. $\Delta\alpha = \alpha_s - \alpha_{opt}$: The mean of difference between optimal and stall angle of attack for each Reynolds.
3. $\frac{d\alpha_{opt}}{dRe}$: The mean of angle of attack variation from $Re = 1.2 \cdot 10^5$ to each other Reynolds.
4. $\frac{dE}{dRe}$: The mean of efficiency variation from $Re = 1.2 \cdot 10^5$ to each other Reynolds.
5. $\frac{dE}{d\alpha}(\alpha = \alpha_{opt})$: The mean of efficiency variation at $\alpha = \alpha_{opt} \pm 2$ for each Reynolds.
6. Thickness t/c : Maximum airfoil thickness.
7. Cl_{opt} : The mean of lift coefficient at maximum efficiency point for each Reynolds.

Airfoil 1: SG6040

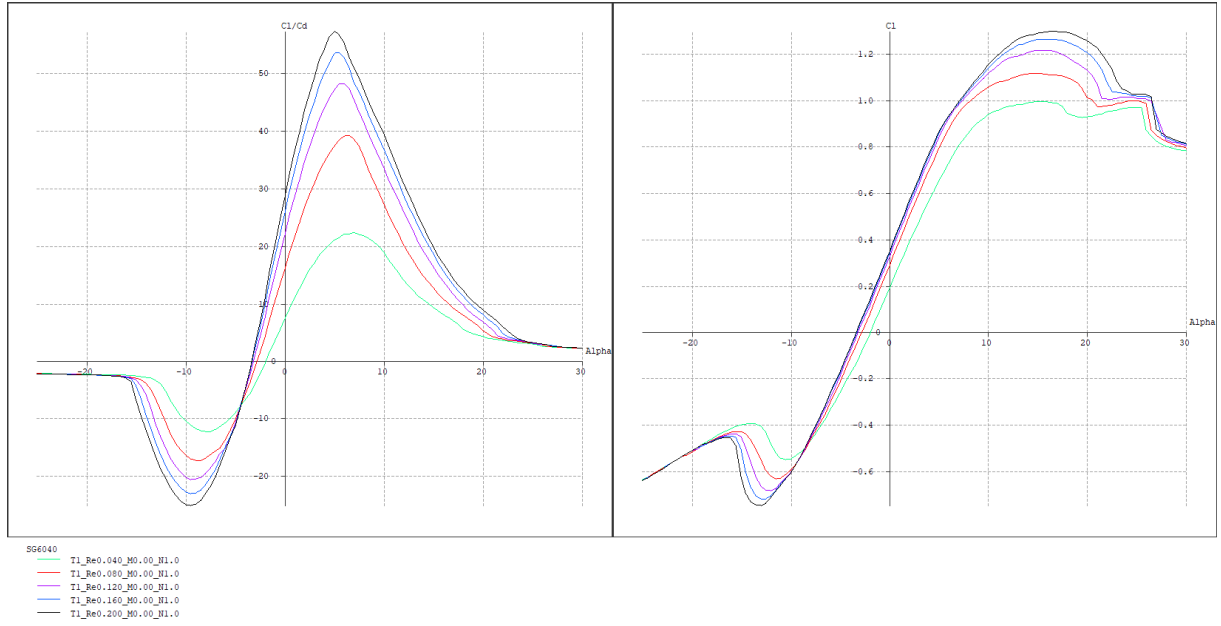


Figure 1: SG6040 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	44.11
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	10.81
3	$d\alpha_{opt}/dRe$	0.55
4	dE/dRe	9.86
5	$dE/d\alpha(\alpha = \alpha_{opt})$	4.66
6	Thickness t/c	16.00
7	Cl_{opt}	0.87

Table 1: SG6040 data.

Airfoil 2: SG6041

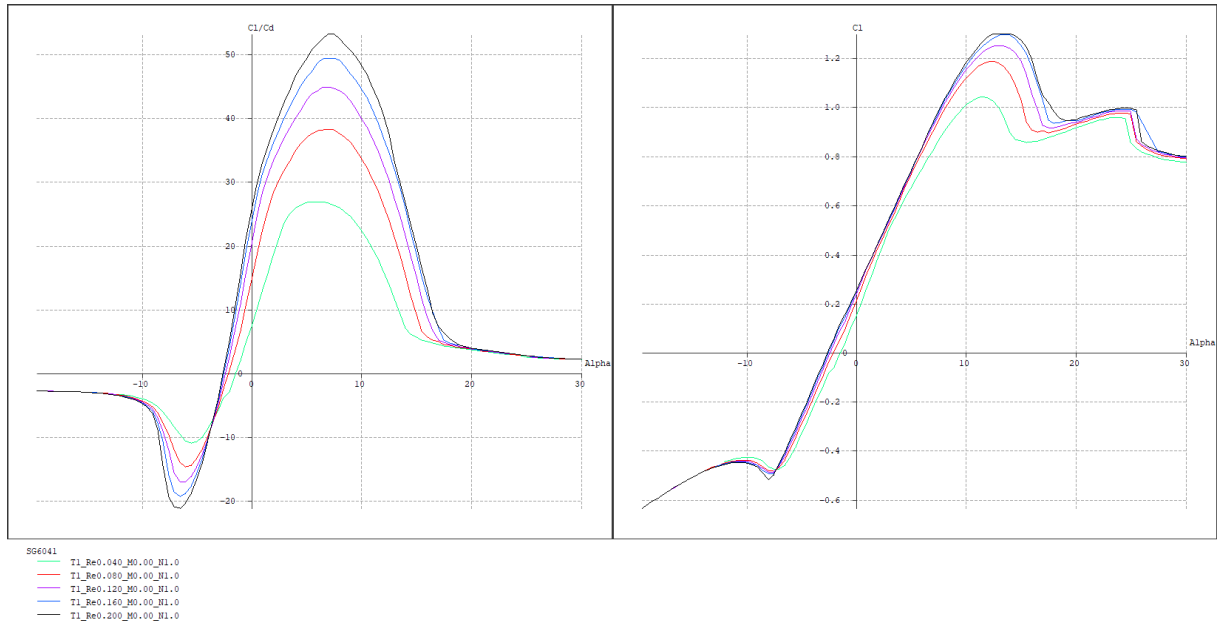


Figure 2: SG6041 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	42.46
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	6.02
3	$d\alpha_{opt}/dRe$	0.36
4	dE/dRe	7.50
5	$dE/d\alpha(\alpha = \alpha_{opt})$	2.14
6	Thickness t/c	10.00
7	Cl_{opt}	0.89

Table 2: SG6041 data.

Airfoil 3: SG6042

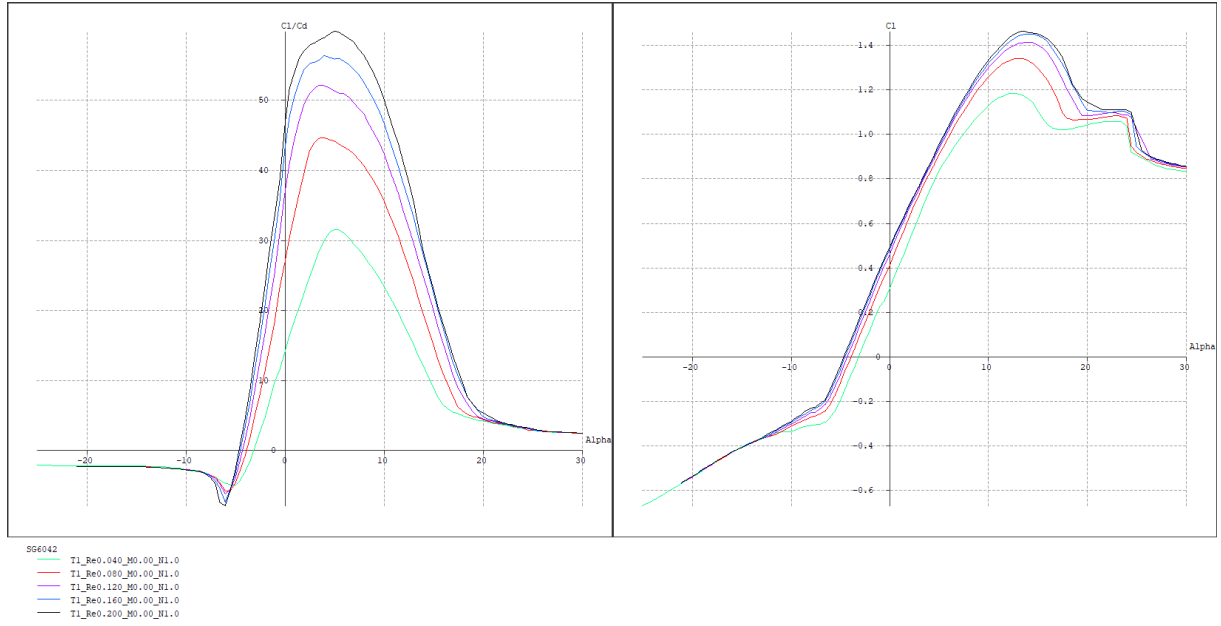


Figure 3: SG6042 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	48.89
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	9.24
3	$d\alpha_{opt}/dRe$	0.64
4	dE/dRe	8.01
5	$dE/d\alpha(\alpha = \alpha_{opt})$	2.57
6	Thickness t/c	10.00
7	Cl_{opt}	0.85

Table 3: SG6042 data.

Airfoil 4: SG6043

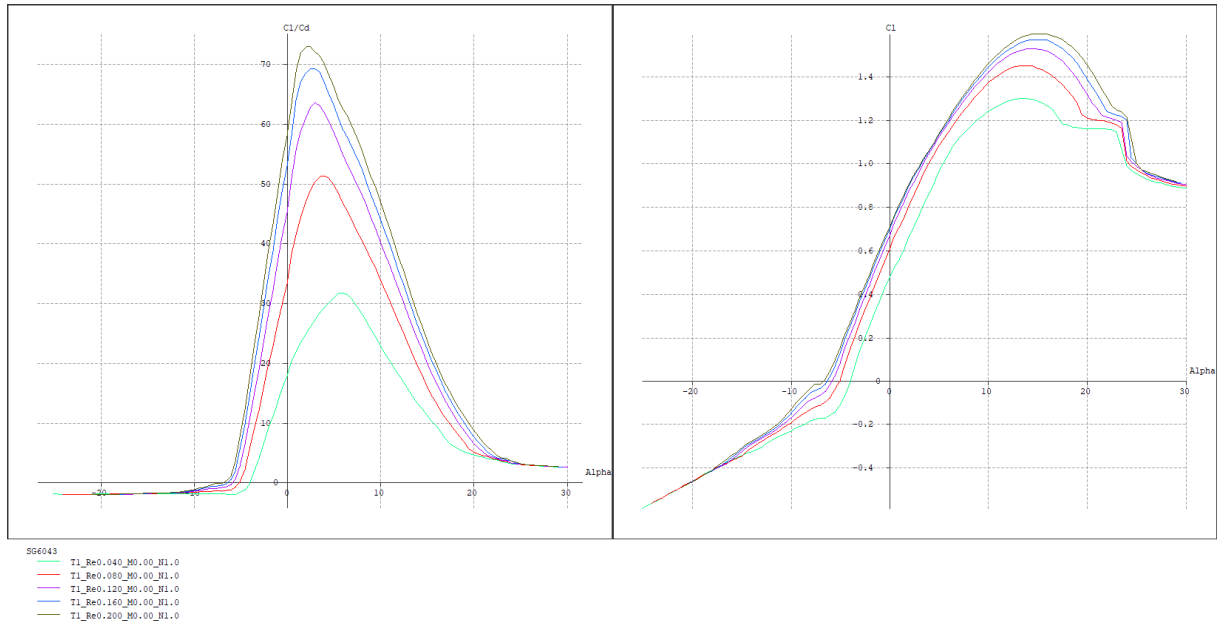


Figure 4: SG6043 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	57.73
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	10.96
3	$d\alpha_{opt}/dRe$	0.94
4	dE/dRe	11.87
5	$dE/d\alpha(\alpha = \alpha_{opt})$	5.59
6	Thickness t/c	10.00
7	Cl_{opt}	0.97

Table 4: SG6043 data.

Airfoil 5: S833

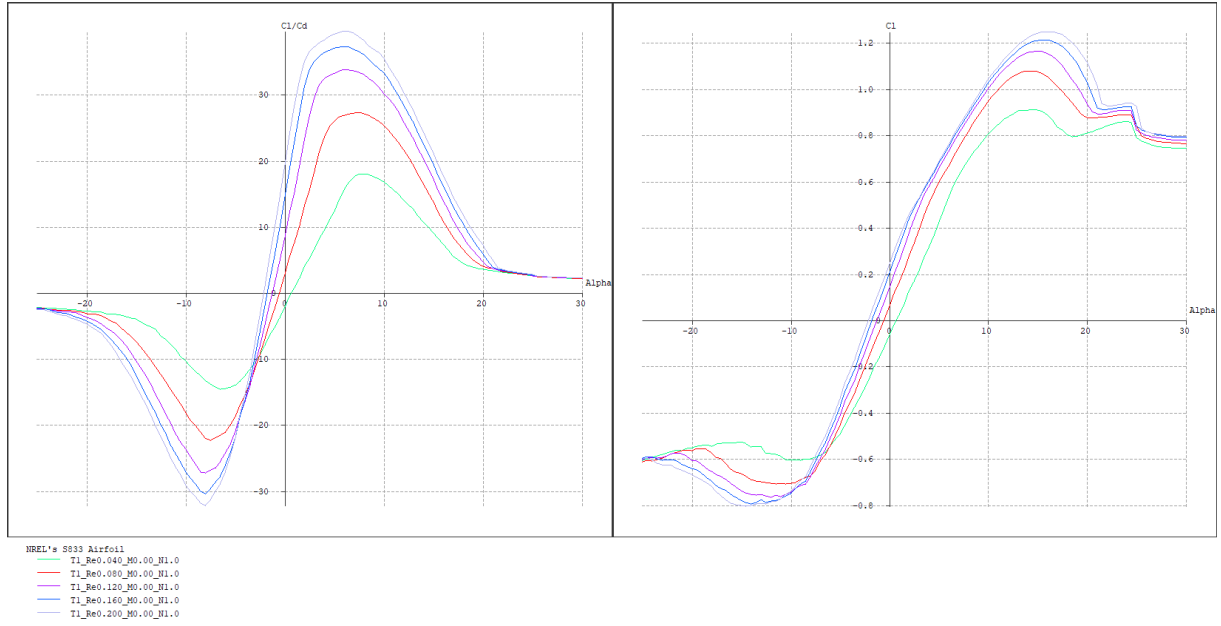


Figure 5: S833 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	31.13
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	8.59
3	$d\alpha_{opt}/dRe$	0.69
4	dE/dRe	6.32
5	$dE/d\alpha(\alpha = \alpha_{opt})$	1.32
6	Thickness t/c	18.00
7	Cl_{opt}	0.75

Table 5: S833 data.

Airfoil 6: S834

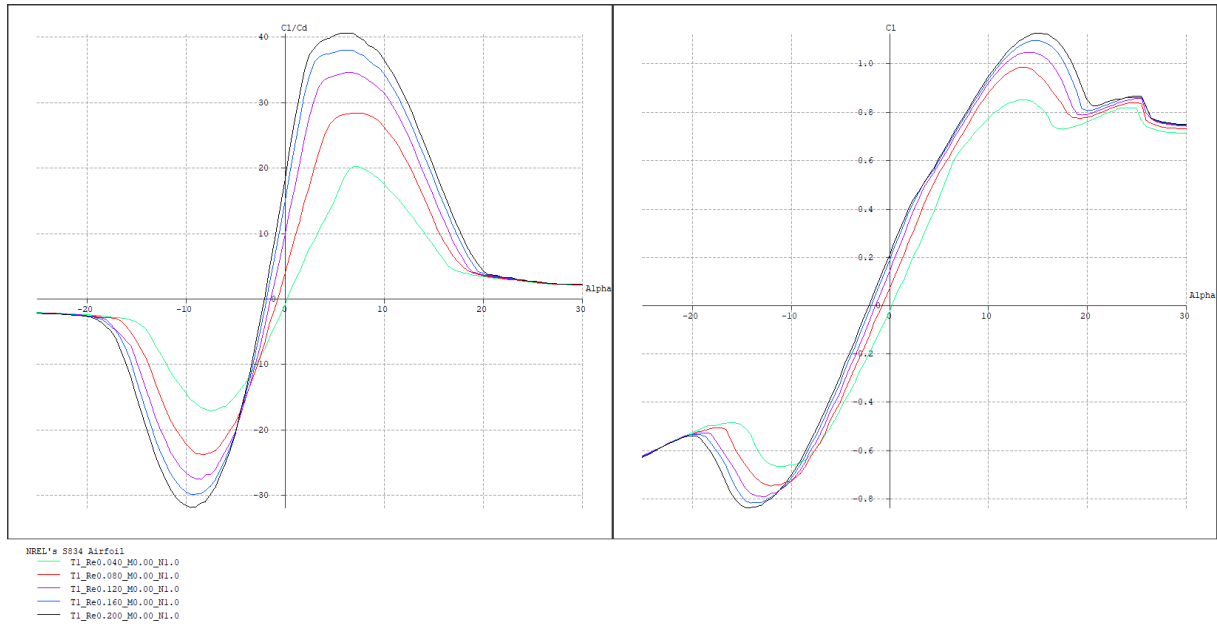


Figure 6: S834 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	32.30
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	7.62
3	$d\alpha_{opt}/dRe$	0.33
4	dE/dRe	5.96
5	$dE/d\alpha(\alpha = \alpha_{opt})$	1.32
6	Thickness t/c	18.00
7	Cl_{opt}	0.69

Table 6: S834 data.

Airfoil 7: S835

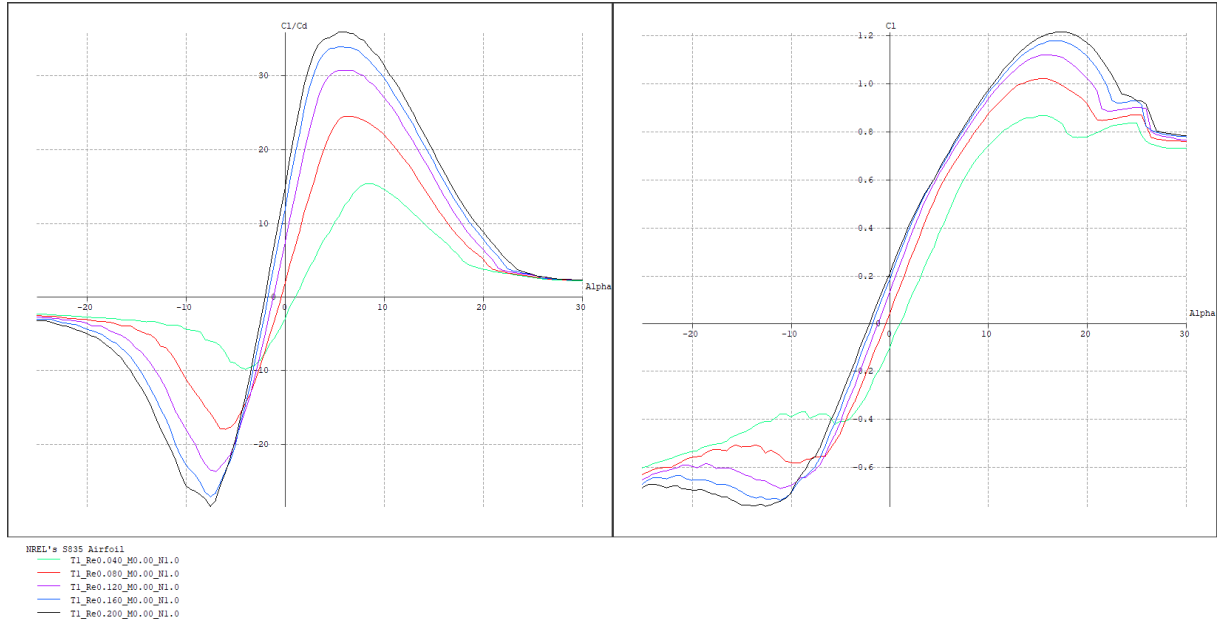


Figure 7: S835 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	27.96
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	10.03
3	$d\alpha_{opt}/dRe$	0.60
4	dE/dRe	6.00
5	$dE/d\alpha(\alpha = \alpha_{opt})$	1.97
6	Thickness t/c	21.00
7	Cl_{opt}	0.67

Table 7: S834 data.

Airfoil 8: S1210

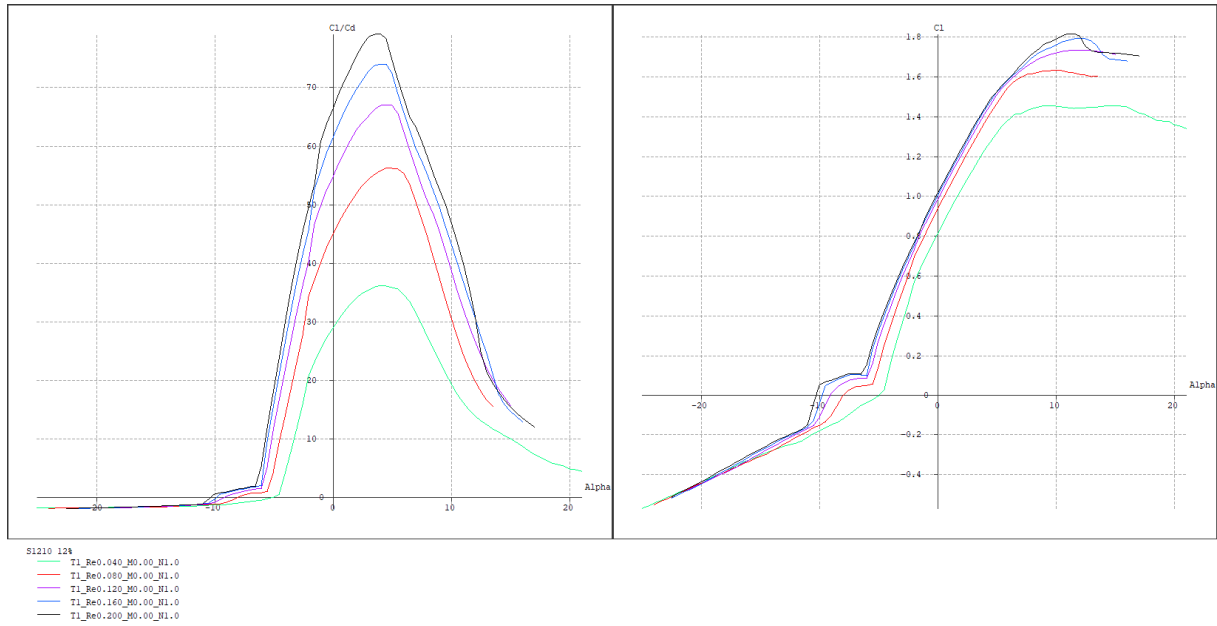


Figure 8: S1210 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	62.47
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	6.32
3	$d\alpha_{opt}/dRe$	0.31
4	dE/dRe	12.13
5	$dE/d\alpha(\alpha = \alpha_{opt})$	4.80
6	Thickness t/c	12.00
7	Cl_{opt}	1.40

Table 8: S1210 data.

Airfoil 9: S1223

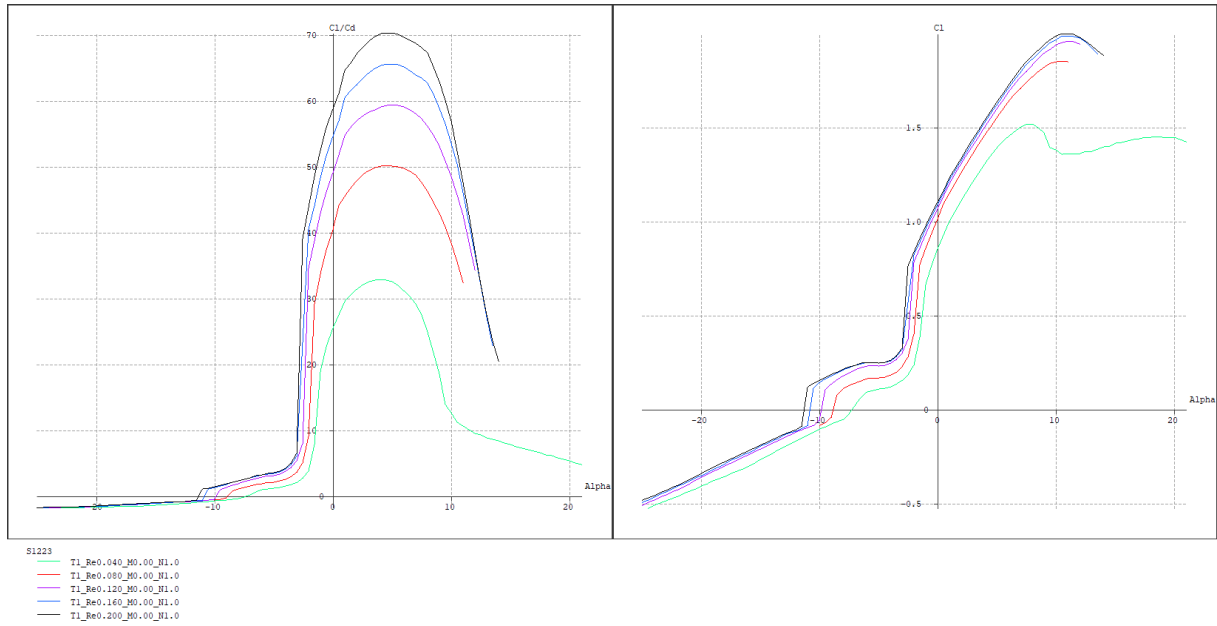


Figure 9: S1223 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	55.67
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	5.63
3	$d\alpha_{opt}/dRe$	0.37
4	dE/dRe	10.55
5	$dE/d\alpha(\alpha = \alpha_{opt})$	1.44
6	Thickness t/c	12.10
7	Cl_{opt}	1.52

Table 9: S1223 data.

Airfoil 10: S6063

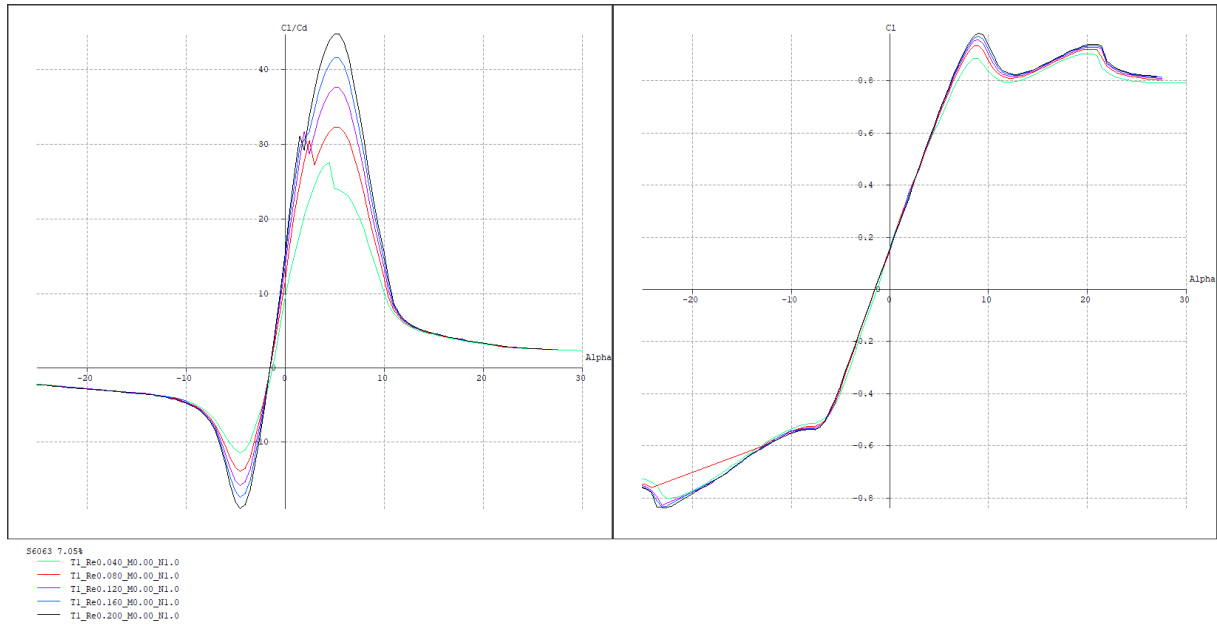


Figure 10: S6063 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	33.78
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	3.89
3	$d\alpha_{opt}/dRe$	0.18
4	dE/dRe	5.36
5	$dE/d\alpha(\alpha = \alpha_{opt})$	5.57
6	Thickness t/c	7.00
7	Cl_{opt}	0.67

Table 10: S6063 data.

Airfoil 11: S9037

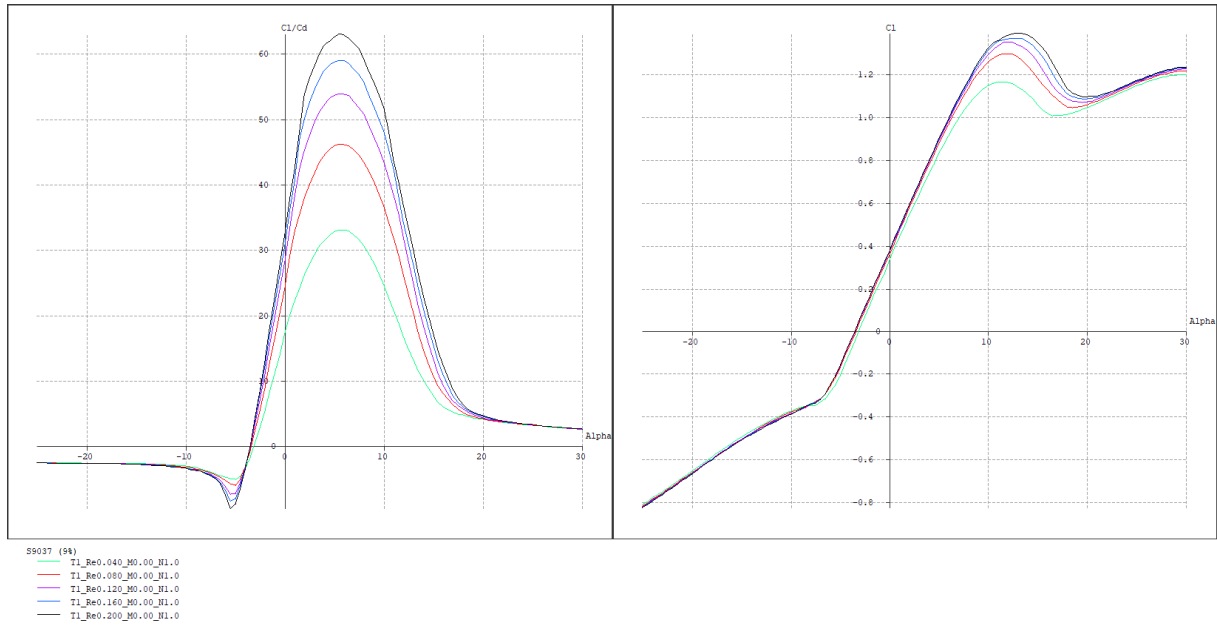


Figure 11: S9037 polar curves.

Code	Parameter	Value
1	Maximum efficiency E	50.95
2	$\Delta\alpha = \alpha_s - \alpha_{opt}$	6.57
3	$d\alpha_{opt}/dRe$	0.09
4	dE/dRe	8.55
5	$dE/d\alpha(\alpha = \alpha_{opt})$	2.33
6	Thickness t/c	9.00
7	Cl_{opt}	0.93

Table 11: S9037 data.



Airfoil 12: S3010



Airfoil 13: SD8000



Airfoil 14: BW3



Airfoil 15: E387



Airfoil 16: E374



Airfoil 17: E62



Airfoil 18: RG15

Chapter 2

Structural design