UH-60 - Flight Dynamics Model

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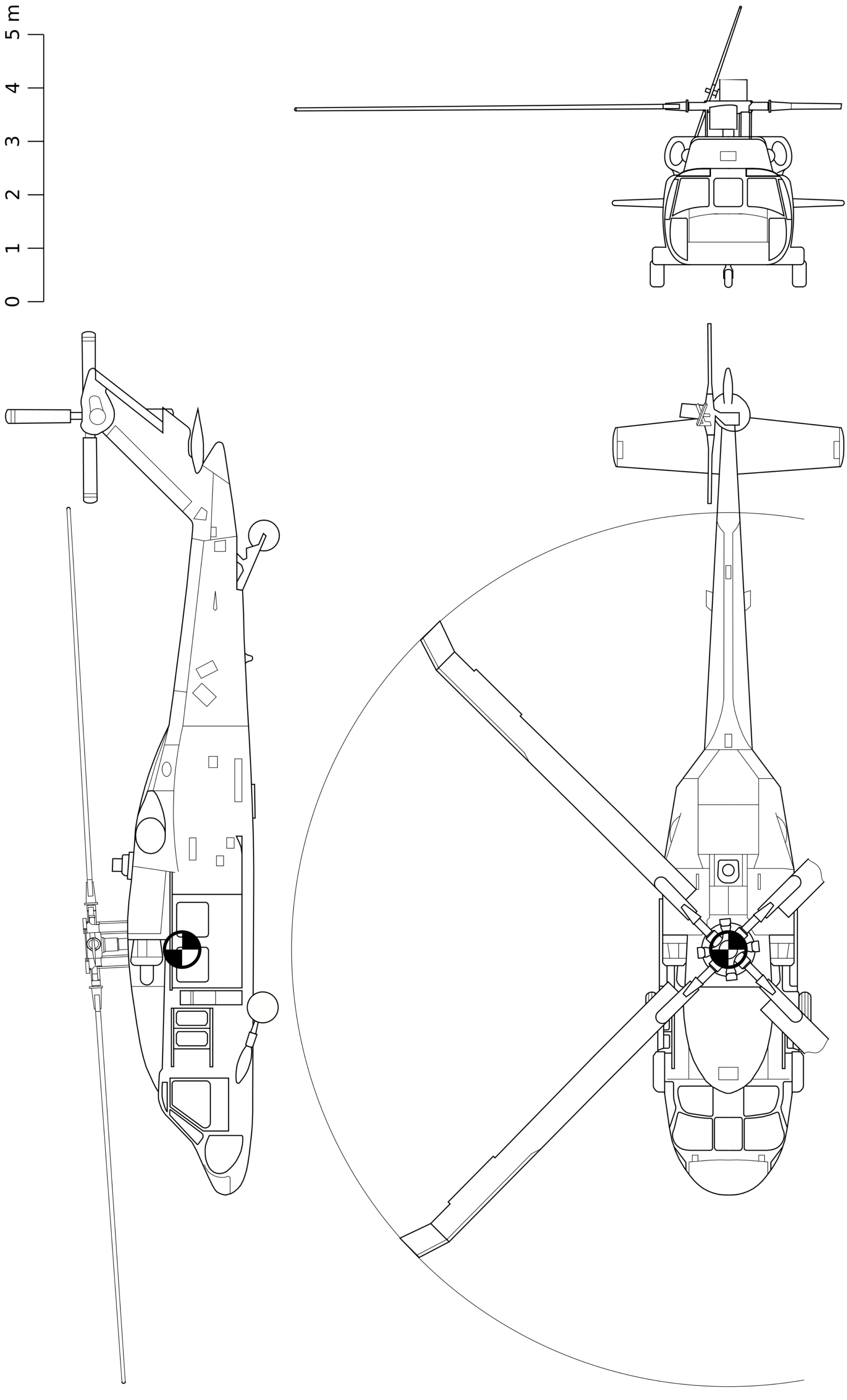

Figure 1: UH-60

Contents

1 Basic Data

Parameter	Value	Reference
Overal length	19.76 m	[1, 2]
Overal height	5.13 m	[1]
Fuselage length	15.26 m	[1, 2]
Fuselage width	2.36 m	[3, 1]
Main rotor diameter	16.36 m	[1, 3]
Tail rotor diameter	3.35 m	[1, 3]
Wheel track	2.71 m	[1, 2]
Wheelbase	8.82 m	[1, 2]
Cockpit floor waterline	5.46 m	[4]
Cabin floor waterline	5.25 m	[4]
Horizontal tail area	4.18 m^2	[1, 2]
Vertical tail area	3.00 m^2	[1, 2]
Empty weight (UH-60A)	5 118 kg	[1]
Empty weight (UH-60L)	5 224 kg	[1]
Internal fuel tanks capacity	1 361 l	[1, 3]
Engine manufacturer	General Electric	[1]
Engine model (UH-60A)	T700-GE-700	[1, 3]
Engine model (UH-60L)	T700-GE-701C	[1, 3]
Engine model (UH-60M)	T700-GE-701D	[1]
Engine maximum power output (T700-GE-700)	1 163 kW	[1]
Engine maximum power output (T700-GE-701C)	1 402 kW	[1]
Engine maximum power output (T700-GE-701D)	1 652 kW	[1]
Engine weight (T700-GE-701C)	207 kg	[5]
Engine specific fuel consumption at maximum continuous power (T700-GE-701C)	279.2 g/(kW·h)	[5]

Table 1: Basic data

2 Performance Data

Parameter	**Value**	**Reference**
Maximum take-off weight (UH-60A/L)	11 113 kg	[1]
Mission take-off weight (UH-60A)	7 708 kg	[1]
Mission take-off weight (UH-60L)	7 907 kg	[1]
Maximum level speed (at SL, mission T-O weight, UH-60A)	160 kts	[1]
Maximum level speed (at max T-O weight, UH-60A)	158 kts	[1]
Never exceed speed (UH-60A/L)	195 kts	[1]
Maximum cruise speed (at 4 000 ft, 35°C, UH-60A)	139 kts	[1]
Maximum cruise speed (at 4 000 ft, 35°C, UH-60L)	152 kts	[1]
Maximum rate of climb (at 4 000 ft, 35°C, UH-60A)	390 ft/min	[1]
Maximum rate of climb (at 4 000 ft, 35°C, UH-60L)	1 550 ft/min	[1]
Service ceiling (UH-60A)	18 700 ft	[1]
Service ceiling (UH-60L)	19 150 ft	[1]
Hovering ceiling (35°C, UH-60A)	5 400 ft	[1]
Hovering ceiling (35°C, UH-60L)	7 650 ft	[1]
Range (with maximum internal fuel, maximum T-O weight, 30 minutes reserves, UH-60A)	319 nmi	[1]
Range (with maximum internal fuel, maximum T-O weight, 30 minutes reserves, UH-60L)	315 nmi	[1]
Endurance (UH-60A)	2 h 18 min ft	[1]
Endurance (UH-60L)	2 h 06 min ft	[1]

Table 2: Performance data

3 Main Rotor

Parameter	Value	Reference
Main rotor diameter	16.36 m	[1, 3]
Main rotor number of blades	4	[2]
Main rotor blade chord	0.53 m	[1, 2]
Main rotor blade airfoil	SC1095/SC1094 R8	[2, 6]
Main rotor solidity	0.0826	[2]
Main rotor total blades area	17.36 m^2	[2]
Main rotor blade tip sweep	20.0°	[2]
Main rotor blade twist	-18.0°	[2]
Main rotor shaft inclination angle	3.0°	[2]
Main rotor nominal rotation speed	27 rad/s (258 rpm)	[2]
Main rotor hinge offset	0.38 m	[2]
Main rotor blade spar lenght	1.17 m	[2]
Main rotor blade tip lift loss factor	0.97	[2]
Main rotor blade section lift curve slope	5.73 rad^{-1}	[7]
Main rotor maximum thrust coefficient	0.1846	[7]
Main rotor single blade weight	116.53 kg	[2]
Main rotor single blade first moment of mass	385.66 kg·m	[2]
Main rotor single blade moment of inertia about flapping hinge	2 050.81 kg·m^2	[2]
Main rotor hub stationline	8.67 m	[4]
Main rotor hub waterline	8.00 m	[4]

Table 3: Main rotor data

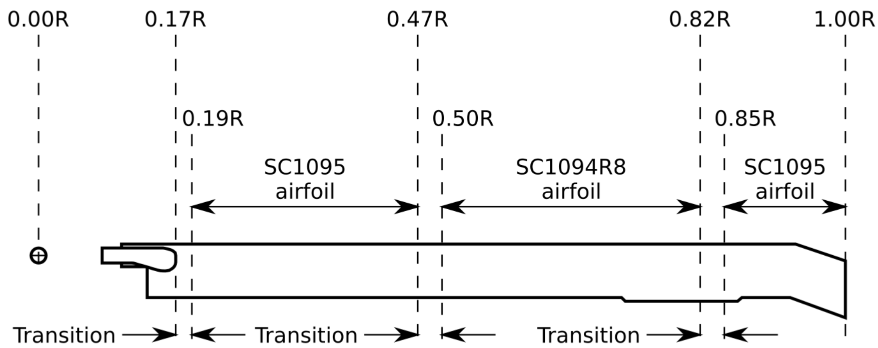

Figure 2: Main rotor blade airfoil section locations [8]

3.1 Symbols

Symbol	Mnemonic	Unit	Description
A_{A0F}	A0FMR	deg	Steady flapping (coning)
A_{A1F}	A1FMR	deg	Longitudinal first harmonic flapping
B_{B1F}	B1FMR	deg	Lateral first harmonic flapping
α_{TRANS}	AFTFMR	deg	Transformed angle of attack for map entry
C_{LY}	CLMR	-	Blade segment lift coefficient
C_{DY}	CDMR	-	Blade segment drag coefficient
$BTLMR$	BTLMR	-	Blade tip lift loss factor
$\dot{L}_{DT}$	LD.MR	m/s	Axial rate of lag damper
F_{δ}	FLD.MR	N	Axial force output from lag damper

Table 4: Main rotor symbols

3.2 Airfoils Ordinates

3.2.1 SC1094 R8

Figure 3: SC1094 R8

Upper surface		**Lower surface**	
x/c	y/c	x/c	y/c
0.00000	0.00000	0.00000	0.00000
0.00013	0.00185	0.00007	-0.00180
0.00090	0.00559	0.00072	-0.00501
0.00218	0.00945	0.00188	-0.00773
0.00427	0.01398	0.00384	-0.01053
0.00686	0.01825	0.00632	-0.01277
0.00944	0.02174	0.00881	-0.01419
0.01252	0.02532	0.01181	-0.01540
0.01867	0.03126	0.01783	-0.01702
0.02245	0.03441	0.02154	-0.01773
0.02857	0.03890	0.02757	-0.01872
0.03468	0.04264	0.03360	-0.01953
0.04077	0.04576	0.03963	-0.02017
0.04686	0.04837	0.04566	-0.02070
0.05294	0.05058	0.05169	-0.02115
0.06104	0.05306	0.05974	-0.02166
0.07115	0.05558	0.06980	-0.02218
0.08125	0.05764	0.07986	-0.02260
0.09135	0.05937	0.08992	-0.02294
0.10145	0.06083	0.09998	-0.02323
0.11154	0.06206	0.11005	-0.02348
0.12666	0.06359	0.12514	-0.02379
0.14179	0.06479	0.14024	-0.02406
0.15691	0.06576	0.15534	-0.02432
0.17202	0.06656	0.17044	-0.02459
0.18714	0.06718	0.18554	-0.02485
0.20225	0.06762	0.20063	-0.02512

Upper surface		Lower surface	
x/c	y/c	x/c	y/c
0.21735	0.06790	0.21573	-0.02538
0.23246	0.06801	0.23083	-0.02564
0.24756	0.06798	0.24593	-0.02591
0.26266	0.06783	0.26103	-0.02617
0.27776	0.06758	0.27612	-0.02643
0.29286	0.06725	0.29122	-0.02665
0.31298	0.06671	0.31136	-0.02687
0.33311	0.06606	0.33149	-0.02701
0.35323	0.06531	0.35163	-0.02708
0.37336	0.06446	0.37176	-0.02709
0.39348	0.06352	0.39190	-0.02702
0.41360	0.06250	0.41204	-0.02690
0.43371	0.06139	0.43218	-0.02671
0.45383	0.06019	0.45232	-0.02647
0.47394	0.05892	0.47246	-0.02616
0.49406	0.05756	0.49261	-0.02580
0.51417	0.05612	0.51275	-0.02537
0.53428	0.05460	0.53290	-0.02489
0.55439	0.05300	0.55304	-0.02435
0.57450	0.05132	0.57319	-0.02375
0.59460	0.04955	0.59334	-0.02309
0.61471	0.04771	0.61349	-0.02237
0.63481	0.04579	0.63364	-0.02159
0.65491	0.04379	0.65379	-0.02075
0.67501	0.04171	0.67394	-0.01985
0.69511	0.03955	0.69409	-0.01889
0.71521	0.03732	0.71425	-0.01788
0.73531	0.03501	0.73440	-0.01682
0.75540	0.03263	0.75456	-0.01572
0.77550	0.03020	0.77472	-0.01458
0.79559	0.02771	0.79487	-0.01340
0.81568	0.02518	0.81503	-0.01220
0.83577	0.02260	0.83519	-0.01097
0.85587	0.01998	0.85535	-0.00972
0.87596	0.01733	0.87551	-0.00845
0.89605	0.01466	0.89567	-0.00718
0.91614	0.01195	0.91583	-0.00589
0.92618	0.01059	0.92591	-0.00524

Upper surface		Lower surface	
x/c	y/c	x/c	y/c
0.93623	0.00921	0.93599	-0.00458
0.94627	0.00782	0.94607	-0.00390
0.95631	0.00641	0.95615	-0.00322
0.96636	0.00498	0.96623	-0.00251
0.97641	0.00398	0.97630	-0.00227
0.98646	0.00301	0.98637	-0.00203
0.99651	0.00205	0.99644	-0.00180
1.00000	0.00171	1.00000	-0.00171

Table 5: SC1094 R8 [6]

3.2.2 SC1095

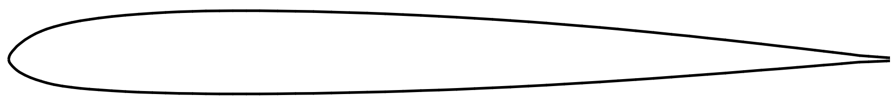

Figure 4: SC1095

Upper surface		Lower surface	
x/c	y/c	x/c	y/c
0.00000	0.00000	0.00000	0.00000
0.00010	0.00147	0.00010	-0.00112
0.00081	0.00396	0.00081	-0.00322
0.00203	0.00626	0.00203	-0.00510
0.00407	0.00913	0.00407	-0.00757
0.00661	0.01215	0.00661	-0.01020
0.00915	0.01473	0.00915	-0.01236
0.01220	0.01748	0.01220	-0.01453
0.01830	0.02220	0.01830	-0.01798
0.02440	0.02608	0.02440	-0.02066
0.03050	0.02934	0.03050	-0.02293
0.03660	0.03208	0.03660	-0.02494
0.04271	0.03443	0.04271	-0.02669
0.05084	0.03707	0.05084	-0.02862

Upper surface		**Lower surface**	
x/c	y/c	x/c	y/c
0.06101	0.03979	0.06101	-0.03048
0.07117	0.04205	0.07117	-0.03191
0.08134	0.04398	0.08134	-0.03304
0.09151	0.04562	0.09151	-0.03397
0.10168	0.04705	0.10168	-0.03476
0.11693	0.04885	0.11693	-0.03580
0.13218	0.05033	0.13218	-0.03666
0.14743	0.05158	0.14743	-0.03737
0.16268	0.05265	0.16268	-0.03795
0.17794	0.05354	0.17794	-0.03841
0.19319	0.05426	0.19319	-0.03876
0.20844	0.05480	0.20844	-0.03903
0.22369	0.05518	0.22369	-0.03923
0.23894	0.05541	0.23894	-0.03935
0.25419	0.05553	0.25419	-0.03941
0.26945	0.05554	0.26945	-0.03941
0.28470	0.05547	0.28470	-0.03937
0.30503	0.05528	0.30503	-0.03924
0.32537	0.05498	0.32537	-0.03903
0.34570	0.05458	0.34570	-0.03874
0.36604	0.05407	0.36604	-0.03839
0.38638	0.05348	0.38638	-0.03797
0.40671	0.05280	0.40671	-0.03749
0.42705	0.05203	0.42705	-0.03695
0.44738	0.05118	0.44738	-0.03635
0.46772	0.05024	0.46772	-0.03569
0.48805	0.04922	0.48805	-0.03497
0.50839	0.04812	0.50839	-0.03419
0.52872	0.04694	0.52872	-0.03335
0.54906	0.04568	0.54906	-0.03245
0.56940	0.04434	0.56940	-0.03149
0.58973	0.04291	0.58973	-0.03047
0.61007	0.04140	0.61007	-0.02938
0.63040	0.03982	0.63040	-0.02824
0.65074	0.03815	0.65074	-0.02703
0.67107	0.03640	0.67107	-0.02577
0.69141	0.03458	0.69141	-0.02445
0.71174	0.03267	0.71174	-0.02308

Upper surface		Lower surface	
x/c	y/c	x/c	y/c
0.73208	0.03070	0.73208	-0.02166
0.75242	0.02865	0.75242	-0.02019
0.77275	0.02655	0.77275	-0.01868
0.79309	0.02439	0.79309	-0.01714
0.81342	0.02218	0.81342	-0.01557
0.83376	0.01993	0.83376	-0.01397
0.85409	0.01764	0.85409	-0.01236
0.87443	0.01532	0.87443	-0.01072
0.89476	0.01297	0.89476	-0.00908
0.91510	0.01060	0.91510	-0.00742
0.92527	0.00939	0.92527	-0.00659
0.93544	0.00818	0.93544	-0.00575
0.94560	0.00695	0.94560	-0.00489
0.95577	0.00570	0.95577	-0.00402
0.96594	0.00443	0.96594	-0.00313
0.97611	0.00360	0.97611	-0.00271
0.98627	0.00281	0.98627	-0.00229
0.99644	0.00201	0.99644	-0.00188
1.00000	0.00173	1.00000	-0.00173

Table 6: SC1095 [6]

3.3 Blade Twist

XSEGMR [-]	TWSTMR [deg]
0.00	0.00
0.05	0.00
0.10	0.00
0.15	0.00
0.20	-0.15
0.25	-0.95
0.30	-1.80
0.35	-2.75
0.40	-3.55
0.45	-4.40
0.50	-5.30
0.55	-6.16
0.60	-7.10
0.65	-7.90
0.70	-8.80
0.75	-9.65
0.80	-10.30
0.85	-10.75
0.90	-12.30
0.95	-13.10
1.00	-10.90

Table 7: Main rotor blade twist [2]

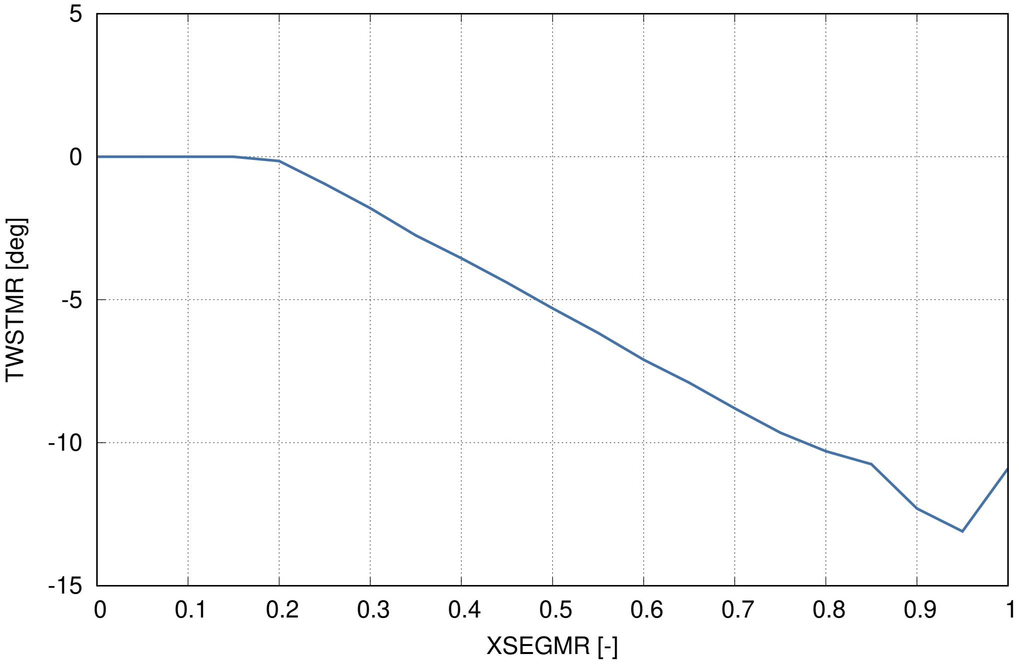

Figure 5: Main rotor blade twist [2]

3.4 Blade Section Aerodynamic Characteristics

α_{TRANS} [deg]	C_{LY} [-]	C_{DY} [-]
-180.0	0.00000	0.00000
-178.0	0.25667	0.36700
-176.0	0.51330	0.73300
-174.0	0.77000	1.10000
-172.0	0.75500	1.06500
-170.0	0.74000	1.03000
-168.0	0.72500	0.99500
-166.0	0.71000	0.96000
-164.0	0.69500	0.92000
-162.0	0.68000	0.88000
-160.0	0.66500	0.84000
-158.0	0.65000	0.80000
-156.0	0.72500	0.76000
-154.0	0.80000	0.72000
-152.0	0.87500	0.68000
-150.0	0.95000	0.64000
-148.0	0.91750	0.68750
-146.0	0.88500	0.73500
-144.0	0.85250	0.78250
-142.0	0.82000	0.83000
-140.0	0.78750	0.87875
-138.0	0.75500	0.92750
-136.0	0.72250	0.97625
-134.0	0.69000	1.02500
-132.0	0.65750	1.07375
-130.0	0.62500	1.12250
-128.0	0.59250	1.17125
-126.0	0.56000	1.22000
-124.0	0.52750	1.26875
-122.0	0.49500	1.31750
-120.0	0.46250	1.36625
-118.0	0.43000	1.41500
-116.0	0.39750	1.46375
-114.0	0.36500	1.51250
-112.0	0.33250	1.56125
-110.0	0.30000	1.61000

α_{TRANS} [deg]	C_{LY} [-]	C_{DY} [-]
-108.0	0.26750	1.66000
-106.0	0.23500	1.71000
-104.0	0.20250	1.76000
-102.0	0.17000	1.81000
-100.0	0.13750	1.85750
-98.0	0.10500	1.90500
-96.0	0.07250	1.95250
-94.0	0.04000	2.00000
-92.0	0.00750	2.02625
-90.0	-0.02500	2.05250
-88.0	-0.05750	2.07875
-86.0	-0.09000	2.10500
-84.0	-0.12250	2.09875
-82.0	-0.15500	2.09250
-80.0	-0.18750	2.08625
-78.0	-0.22000	2.08000
-76.0	-0.25250	2.05500
-74.0	-0.28500	2.03000
-72.0	-0.31750	2.00500
-70.0	-0.35000	1.98000
-68.0	-0.38250	1.92875
-66.0	-0.41500	1.87750
-64.0	-0.44750	1.82625
-62.0	-0.48000	1.77500
-60.0	-0.51250	1.70125
-58.0	-0.54500	1.62750
-56.0	-0.57750	1.55375
-54.0	-0.61000	1.48000
-52.0	-0.64250	1.40750
-50.0	-0.67500	1.33500
-48.0	-0.70750	1.26250
-46.0	-0.74000	1.19000
-44.0	-0.77250	1.11750
-42.0	-0.80500	1.04500
-40.0	-0.83750	0.97250
-38.0	-0.87000	0.90000
-36.0	-0.90250	0.83250
-34.0	-0.93500	0.76500

α_{TRANS} [deg]	C_{LY} [-]	C_{DY} [-]
-32.0	-0.96750	0.69750
-30.0	-1.00000	0.63000
-28.0	-0.99600	0.56200
-26.0	-0.99200	0.48800
-24.0	-0.99800	0.41700
-22.0	-0.98400	0.34000
-20.0	-0.98000	0.26700
-18.0	-0.97600	0.19500
-16.0	-0.97200	0.12000
-14.0	-1.07000	0.04500
-12.0	-0.72400	0.01800
-10.0	-0.37000	0.01200
-8.0	-0.19000	0.00800
-6.0	-0.39000	0.00775
-4.0	-0.45000	0.00750
-2.0	-0.19000	0.00750
0.0	0.03000	0.00750
2.0	0.24300	0.00800
4.0	0.46000	0.00850
6.0	0.67000	0.00900
8.0	0.89000	0.01100
10.0	1.10000	0.01700
12.0	1.25000	0.02600
14.0	1.10000	0.14500
16.0	0.98000	0.23000
18.0	0.98280	0.29300
20.0	0.98560	0.34500
22.0	0.98840	0.40000
24.0	0.99120	0.45500
26.0	0.99400	0.50700
28.0	0.99700	0.56000
30.0	1.00000	0.63000
32.0	0.96750	0.69750
34.0	0.93500	0.76500
36.0	0.90250	0.83250
38.0	0.87000	0.90000
40.0	0.83750	0.97250
42.0	0.80500	1.04500

α_{TRANS} [deg]	C_{LY} [-]	C_{DY} [-]
44.0	0.77250	1.11750
46.0	0.74000	1.19000
48.0	0.70750	1.26250
50.0	0.67500	1.33500
52.0	0.64250	1.40750
54.0	0.61000	1.48000
56.0	0.57750	1.55375
58.0	0.54500	1.62750
60.0	0.51250	1.70125
62.0	0.48000	1.77500
64.0	0.44750	1.82625
66.0	0.41500	1.87750
68.0	0.38250	1.92875
70.0	0.35000	1.98000
72.0	0.31750	2.00500
74.0	0.28500	2.03000
76.0	0.25250	2.05500
78.0	0.22000	2.08000
80.0	0.18750	2.08625
82.0	0.15500	2.09250
84.0	0.12250	2.09875
86.0	0.09000	2.10500
88.0	0.05750	2.07875
90.0	0.02500	2.05250
92.0	-0.00750	2.02625
94.0	-0.04000	2.00000
96.0	-0.07250	1.95250
98.0	-0.10500	1.90500
100.0	-0.13750	1.85750
102.0	-0.17000	1.81000
104.0	-0.20250	1.76000
106.0	-0.23600	1.71000
108.0	-0.26750	1.66000
110.0	-0.30000	1.61000
112.0	-0.33250	1.56125
114.0	-0.36500	1.51250
116.0	-0.39750	1.46375
118.0	-0.43000	1.41500

α_{TRANS} [deg]	C_{LY} [-]	C_{DY} [-]
120.0	-0.46250	1.36625
122.0	-0.49500	1.31750
124.0	-0.52750	1.26875
126.0	-0.56000	1.22000
128.0	-0.59250	1.17125
130.0	-0.62500	1.12250
132.0	-0.65750	1.07375
134.0	-0.69000	1.02500
136.0	-0.72250	0.97625
138.0	-0.75500	0.92720
140.0	-0.78750	0.87875
142.0	-0.82000	0.83000
144.0	-0.85250	0.78250
146.0	-0.88500	0.73500
148.0	-0.91750	0.68750
150.0	-0.96000	0.64000
152.0	-0.87500	0.68000
154.0	-0.80000	0.72000
156.0	-0.72500	0.76000
158.0	-0.65000	0.80000
160.0	-0.66500	0.84000
162.0	-0.68000	0.88000
164.0	-0.69500	0.92000
166.0	-0.71000	0.96000
168.0	-0.72500	0.99500
170.0	-0.74000	1.03000
172.0	-0.75500	1.06500
174.0	-0.77000	1.10000
176.0	-0.51330	0.73300
178.0	-0.25667	0.36700
180.0	0.00000	0.00000

Table 8: SC1095 aerodynamic coefficients [2]

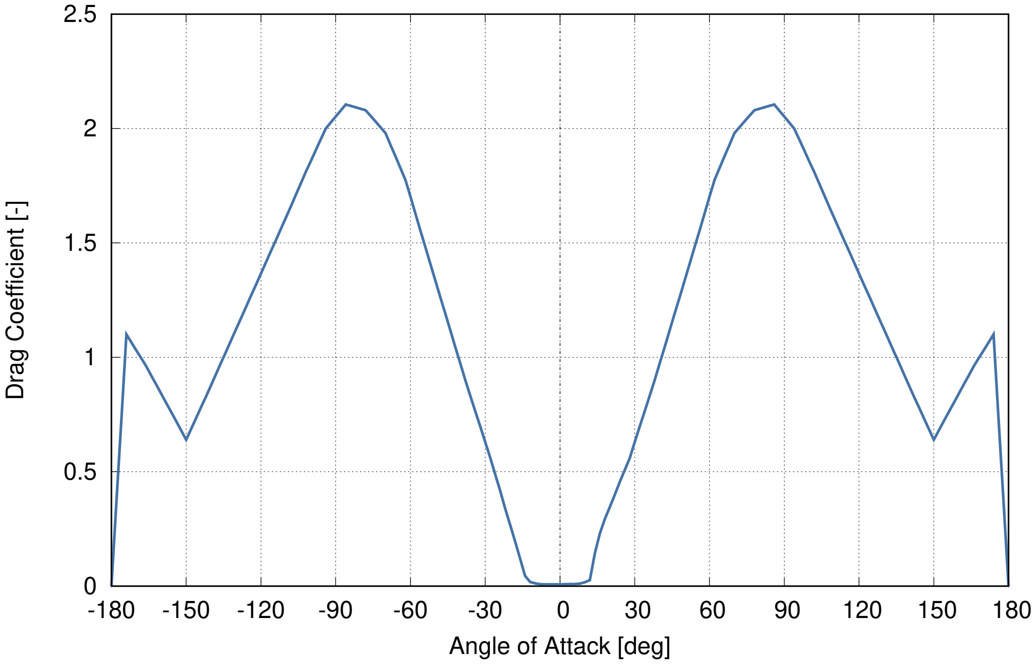

Figure 6: SC1095 drag coefficient [2]

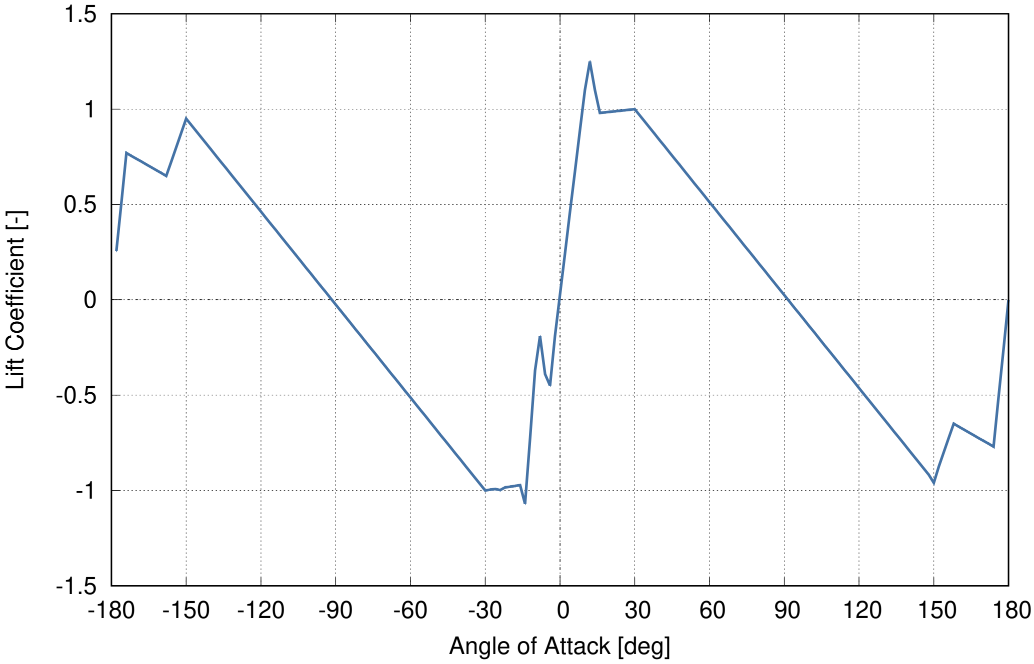

Figure 7: SC1095 lift coefficient [2]

α_{TRANS}						C_{LY}					
[deg]	Ma=0.0	Ma=0.1	Ma=0.2	Ma=0.3	Ma=0.4	Ma=0.5	Ma=0.6	Ma=0.7	Ma=0.8	Ma=0.9	Ma=10.0
-32.0	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675	-0.9675
-30.0	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000
-28.0	-0.9960	-0.9960	-0.9960	-0.9960	-0.9550	-0.9400	-0.9460	-0.9440	-0.9300	-0.9220	-0.9180
-26.0	-0.9920	-0.9920	-0.9920	-0.9920	-0.9600	-0.9300	-0.9420	-0.9380	-0.9100	-0.8940	-0.8860
-24.0	-0.9880	-0.9880	-0.9880	-0.9880	-0.9620	-0.9200	-0.9380	-0.9320	-0.8900	-0.8660	-0.8540
-22.0	-0.9840	-0.9840	-0.9840	-0.9840	-0.9640	-0.9250	-0.9340	-0.9260	-0.8700	-0.8380	-0.8220
-20.0	-0.9800	-0.9800	-0.9800	-0.9800	-0.9660	-0.9300	-0.9300	-0.9200	-0.8500	-0.8100	-0.7900
-18.0	-0.9760	-0.9760	-0.9760	-0.9760	-0.9680	-0.9350	-0.9260	-0.9140	-0.8300	-0.7820	-0.7580
-16.0	-0.9720	-0.9720	-0.9720	-0.9720	-0.9700	-0.9400	-0.9220	-0.9080	-0.9100	-0.7540	-0.7260
-14.0	-1.0700	-1.0700	-1.0700	-1.0700	-0.8200	-0.8000	-0.8050	-0.8800	-0.8000	-0.7260	-0.6940
-12.0	-0.7240	-0.7240	-0.7240	-0.7240	-0.5350	-0.5250	-0.6600	-0.8300	-0.7900	-0.6980	-0.6620
-10.0	-0.3700	-0.3700	-0.3700	-0.3700	-0.2400	-0.4000	-0.6000	-0.7800	-0.8100	-0.6700	-0.6300
-8.0	-0.1900	-0.1900	-0.1900	-0.1900	-0.3000	-0.3000	-0.5500	-0.7350	-0.7500	-0.6650	-0.6200
-6.0	-0.3900	-0.3900	-0.3900	-0.3900	-0.4500	-0.3200	-0.5200	-0.6400	-0.6900	-0.6600	-0.6100
-4.0	-0.4500	-0.4500	-0.4500	-0.4500	-0.4200	-0.4400	-0.4700	-0.5900	-0.4700	-0.5400	-0.4250
-2.0	-0.1900	-0.1900	-0.1900	-0.1900	-0.1850	-0.1950	-0.1950	-0.2550	-0.2500	-0.4100	-0.2400
0.0	0.0300	0.0300	0.0300	0.0300	0.0500	0.0500	0.0750	0.0700	0.0800	-0.1500	-0.0500
2.0	0.2430	0.2430	0.2430	0.2430	0.2800	0.2950	0.3400	0.3950	0.3500	0.1400	0.2000
4.0	0.4600	0.4600	0.4600	0.4600	0.5100	0.5300	0.6130	0.7200	0.5600	0.3900	0.4500
6.0	0.6700	0.6700	0.6700	0.6700	0.7500	0.7800	0.8400	0.8300	0.7050	0.6400	0.7000
8.0	0.8900	0.8900	0.8900	0.8900	0.9800	0.9600	0.9150	0.8770	0.9100	0.7650	0.8000
10.0	1.1000	1.1000	1.1000	1.1000	1.1700	1.0100	0.9470	0.9200	0.8450	0.8100	0.8500
12.0	1.2500	1.2500	1.2500	1.2500	1.1300	0.9600	1.0000	0.9230	0.8450	0.8300	0.8650
14.0	1.1000	1.1000	1.1000	1.1000	1.0300	1.0800	1.0540	0.9300	0.8500	0.8500	0.8800
16.0	0.9800	0.9800	0.9800	0.9800	0.9600	1.0600	1.0800	0.9200	0.8600	0.8700	0.8950
18.0	0.9828	0.9828	0.9828	0.9828	0.9657	1.0700	1.0630	0.8950	0.8800	0.8850	0.9100
20.0	0.9856	0.9856	0.9856	0.9856	0.9714	1.0600	1.0530	0.9000	0.9000	0.9050	0.9250
22.0	0.9884	0.9884	0.9884	0.9884	0.9771	1.0500	1.0420	0.9200	0.9200	0.9250	0.9400
24.0	0.9912	0.9912	0.9912	0.9912	0.9828	1.0350	1.0310	0.9400	0.9400	0.9400	0.9550
26.0	0.9940	0.9940	0.9940	0.9940	0.9885	1.0200	1.0200	0.9700	0.9600	0.9600	0.9700
28.0	0.9970	0.9970	0.9970	0.9970	0.9942	1.0100	1.0100	0.9850	0.9800	0.9800	0.9850
30.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
32.0	0.9675	0.9675	0.9675	0.9675	0.9675	0.9675	0.9675	0.9675	0.9675	0.9675	0.9675

Table 9: SC1095 lift coefficient [2]

α_{TRANS} [deg]	C_{DY} Ma=0.0	Ma=0.1	Ma=0.2	Ma=0.3	Ma=0.4	Ma=0.5	Ma=0.6	Ma=0.7	Ma=0.8	Ma=0.9	Ma=10.0
-32.0	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750
-30.0	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000
-28.0	0.56200	0.56200	0.56200	0.56200	0.57000	0.56400	0.57800	0.59000	0.59300	0.59700	0.60100
-26.0	0.48800	0.48800	0.48800	0.48800	0.51000	0.51000	0.52500	0.54500	0.55500	0.56300	0.57200
-24.0	0.41700	0.41700	0.41700	0.41700	0.44800	0.46500	0.46900	0.50400	0.52000	0.53000	0.54300
-22.0	0.34000	0.34000	0.34000	0.34000	0.39000	0.40800	0.41500	0.46000	0.47800	0.49700	0.51400
-20.0	0.26700	0.26700	0.26700	0.26700	0.33000	0.35300	0.36100	0.41600	0.44000	0.46300	0.48600
-18.0	0.19500	0.19500	0.19500	0.19500	0.26500	0.29600	0.32300	0.37300	0.40300	0.43000	0.45700
-16.0	0.12000	0.12000	0.12000	0.12000	0.20800	0.24000	0.28500	0.32900	0.36400	0.39700	0.42800
-14.0	0.04500	0.04500	0.04500	0.04500	0.16100	0.18300	0.24600	0.28500	0.32500	0.36300	0.39900
-12.0	0.01800	0.01800	0.01800	0.01800	0.02200	0.12000	0.19100	0.24200	0.29000	0.33000	0.37000
-10.0	0.01200	0.01200	0.01200	0.01200	0.01300	0.06700	0.12800	0.17700	0.22500	0.26200	0.29700
-8.0	0.00800	0.00800	0.00800	0.00820	0.00900	0.02100	0.07000	0.11300	0.16000	0.20300	0.24800
-6.0	0.00775	0.00775	0.00775	0.00790	0.00850	0.01000	0.02600	0.06000	0.10000	0.14900	0.20200
-4.0	0.00750	0.00750	0.00750	0.00750	0.00800	0.00800	0.01250	0.03000	0.06500	0.11500	0.15200
-2.0	0.00750	0.00750	0.00750	0.00750	0.00800	0.00750	0.00850	0.01200	0.02900	0.06600	0.11700
0.0	0.00750	0.00750	0.00750	0.00750	0.00800	0.00750	0.00800	0.00800	0.01700	0.05000	0.09000
2.0	0.00800	0.00800	0.00800	0.00800	0.00820	0.00750	0.00850	0.01000	0.04000	0.08000	0.11750
4.0	0.00850	0.00850	0.00850	0.00850	0.00850	0.00800	0.01100	0.03500	0.09000	0.12000	0.15250
6.0	0.00900	0.00900	0.00900	0.00900	0.01100	0.01100	0.02800	0.08200	0.12800	0.16700	0.20300
8.0	0.01100	0.01100	0.01100	0.01100	0.01400	0.02600	0.07300	0.12600	0.17000	0.21000	0.24900
10.0	0.01700	0.01700	0.01700	0.01700	0.02000	0.08000	0.12200	0.16100	0.22500	0.26200	0.29800
12.0	0.02600	0.02600	0.02600	0.02600	0.09800	0.15300	0.17900	0.24000	0.28500	0.32200	0.37000
14.0	0.14500	0.14500	0.14500	0.14500	0.16900	0.21200	0.23100	0.28000	0.32400	0.35600	0.39900
16.0	0.23000	0.23000	0.23000	0.23000	0.23000	0.26200	0.28300	0.32300	0.36100	0.39000	0.42800
18.0	0.29300	0.29300	0.29300	0.29300	0.29300	0.31600	0.32800	0.36500	0.40000	0.42500	0.45700
20.0	0.34500	0.34500	0.34500	0.34500	0.34500	0.36500	0.35800	0.40800	0.43500	0.45900	0.48600
22.0	0.40000	0.40000	0.40000	0.40000	0.40000	0.41600	0.41200	0.45100	0.47000	0.49300	0.51400
24.0	0.45500	0.45500	0.45500	0.45500	0.45500	0.46900	0.46700	0.49300	0.50800	0.52700	0.54300
26.0	0.50700	0.50700	0.50700	0.50700	0.50700	0.52000	0.52100	0.53500	0.54600	0.56200	0.57200
28.0	0.56000	0.56000	0.56000	0.56000	0.56000	0.56900	0.57600	0.57800	0.58300	0.59600	0.60100
30.0	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000	0.63000
32.0	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750	0.69750

Table 10: SC1095 drag coefficient [2]

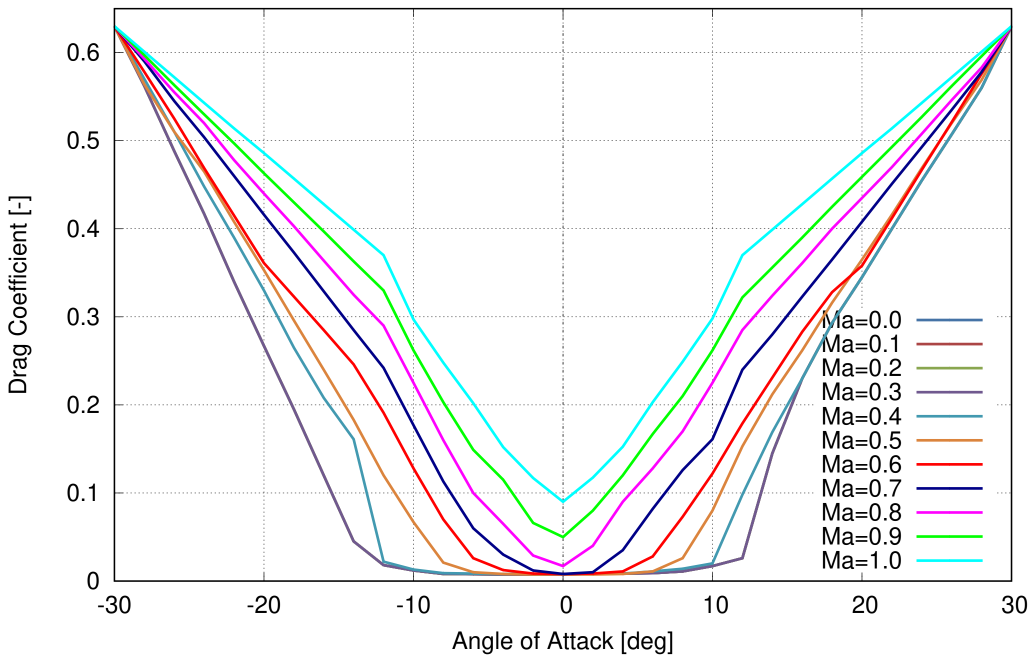

Figure 8: SC1095 drag coefficient [2]

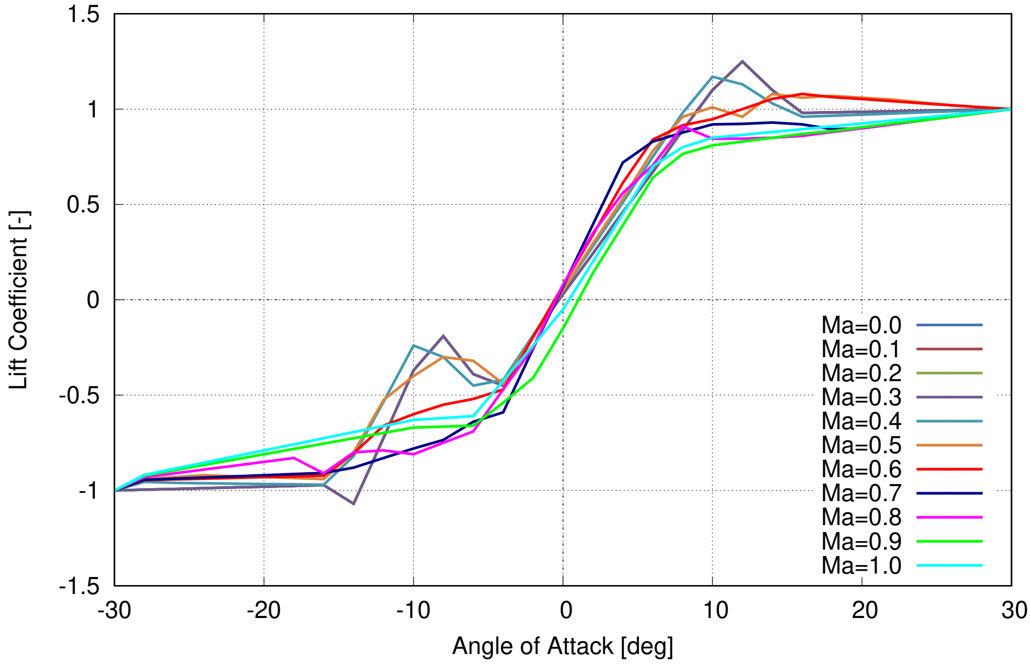

Figure 9: SC1095 lift coefficient [2]

3.5 Lag Damper Force Characteristics

$\dot{L}_{DT}$ [m/s]	F_δ [N]
0.00000	0.00
0.00254	444.82
0.00508	1023.09
0.00762	1690.32
0.01016	2668.93
0.01270	4003.40
0.01524	5782.69
0.01778	7473.01
0.02032	9252.30
0.02286	11031.59
0.02540	13122.25
0.02794	14278.79
0.03048	14946.02
0.03302	15346.36
0.03556	15679.98
0.03810	15857.91
0.04064	15969.12
0.04318	16080.32
0.04572	16147.04
0.04826	16236.01
0.05080	16280.49
0.05080	16280.49
0.07620	16645.25
0.10160	16925.48
0.12700	17236.86
0.15240	17525.99
0.17780	17792.89

Table 11: Lag damper force [2]

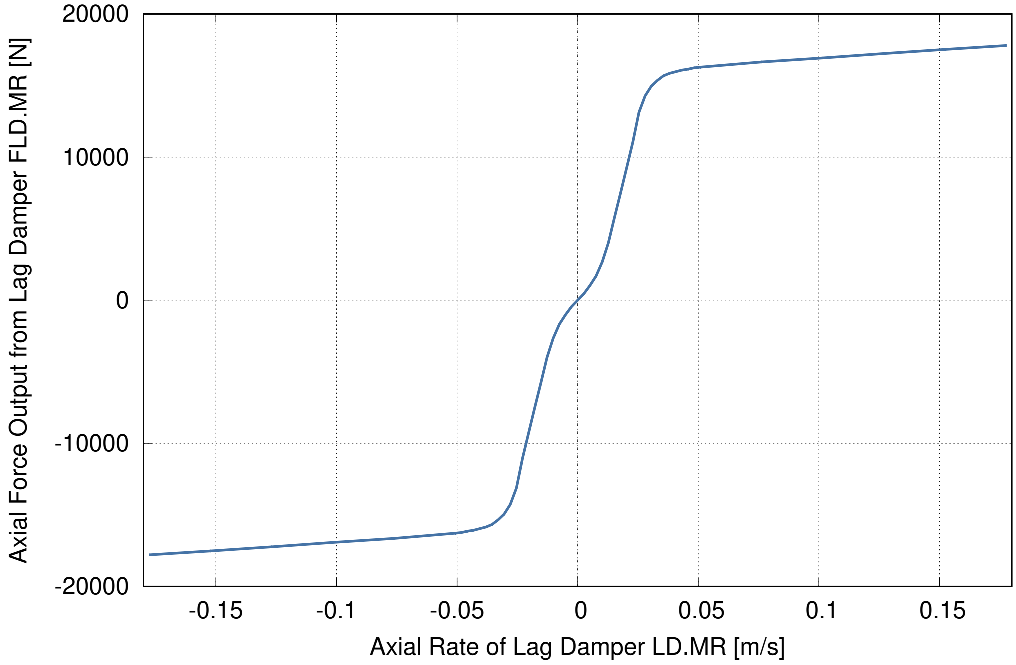

Figure 10: Lag damper force [2]

4 Fuselage

Parameter	**Value**	**Reference**
Fuselage length	15.26 m	[1, 2]
Fuselage width	2.36 m	[3, 1]
Fuselage aerodynamic reference point stationline	8.78 m	[2, 7]
Fuselage aerodynamic reference point waterline	5.94 m	[2, 7]

Table 12: Fuselage data

4.1 Symbols

Symbol	Mnemonic	Unit	Description
EK_{XWF}	EKXWF	-	Rotor wash interference factor (inplane)
EK_{YWF}	EKYWF	-	Rotor wash interference factor (sidewash)
EK_{ZWF}	EKZWF	-	Rotor wash interference factor (downwash)
χ_{PMR}	CHIPMR	deg	Rotor wake skew angle
D_{WO}	DWSHMR	-	Main rotor uniform downwash
Ω_T	OMGTMR	rad/s	Rotor speed
R_T	RMR	m	Rotor radius
q_{WF}	QWF	Pa	dynamic pressure at the body
α_{WF}	ALFWF	deg	angle of attack
β_{WF}	BETAWF	deg	sideslip angle
ψ_{WF}	PSIWF	deg	W/T model yaw angle ($\psi_{WF} = -\beta_{WF}$)

Table 13: Fuselage symbols

4.2 Inplane Component of Rotor Wash on the Fuselage

χ_{PMR} [deg]	EK_{XWF} AA1FMR=-6.0	AA1FMR=0.0	AA1FMR=6.0
0.0	0.08	0.00	-0.12
10.0	0.18	0.10	0.02
20.0	0.30	0.21	0.08
30.0	0.43	0.32	0.18
40.0	0.55	0.42	0.28
50.0	0.66	0.54	0.40
60.0	0.79	0.66	0.53
70.0	0.90	0.80	0.67
80.0	1.03	0.94	0.82
90.0	0.55	0.50	0.40
100.0	0.00	0.00	0.00

Table 14: Inplane component of rotor wash on the fuselage [2]

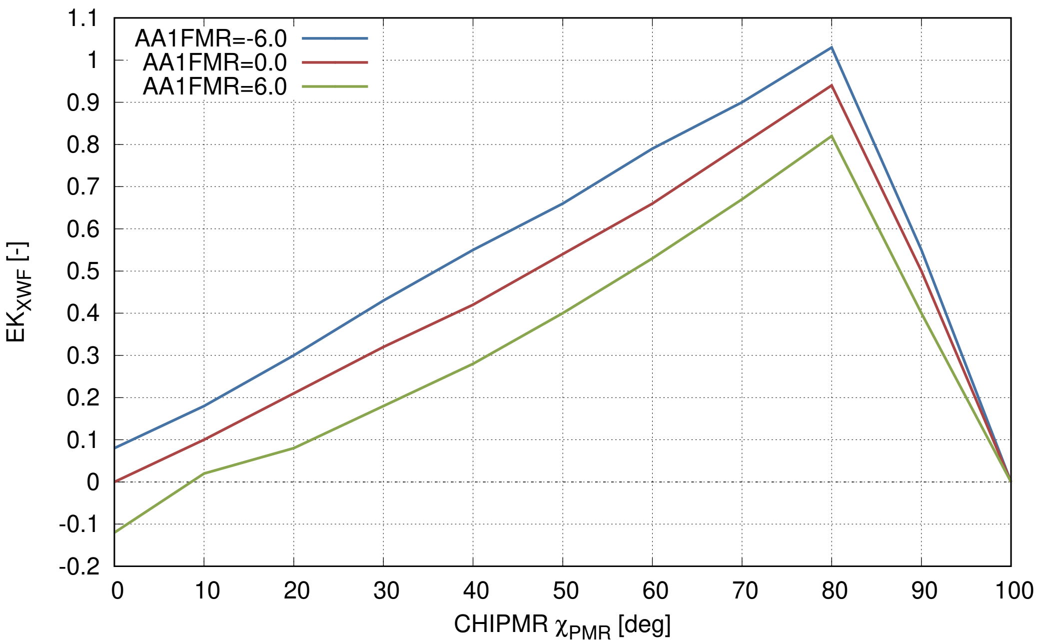

Figure 11: Inplane component of rotor wash on the fuselage [2]

4.3 Downwash Component of Rotor Wash on the Fuselage

χ_{PMR} [deg]	EK_{ZWF} AA1FMR=-6.0	AA1FMR=0.0	AA1FMR=6.0
0.0	1.110	1.120	1.150
10.0	1.090	1.120	1.150
20.0	1.080	1.120	1.150
30.0	1.065	1.120	1.150
40.0	1.050	1.120	1.160
50.0	1.040	1.120	1.170
60.0	1.020	1.120	1.180
70.0	1.010	1.120	1.220
80.0	1.000	1.110	1.160
90.0	0.880	0.960	0.980
100.0	0.600	0.600	0.600

Table 15: Downwash component of rotor wash on the fuselage [2]

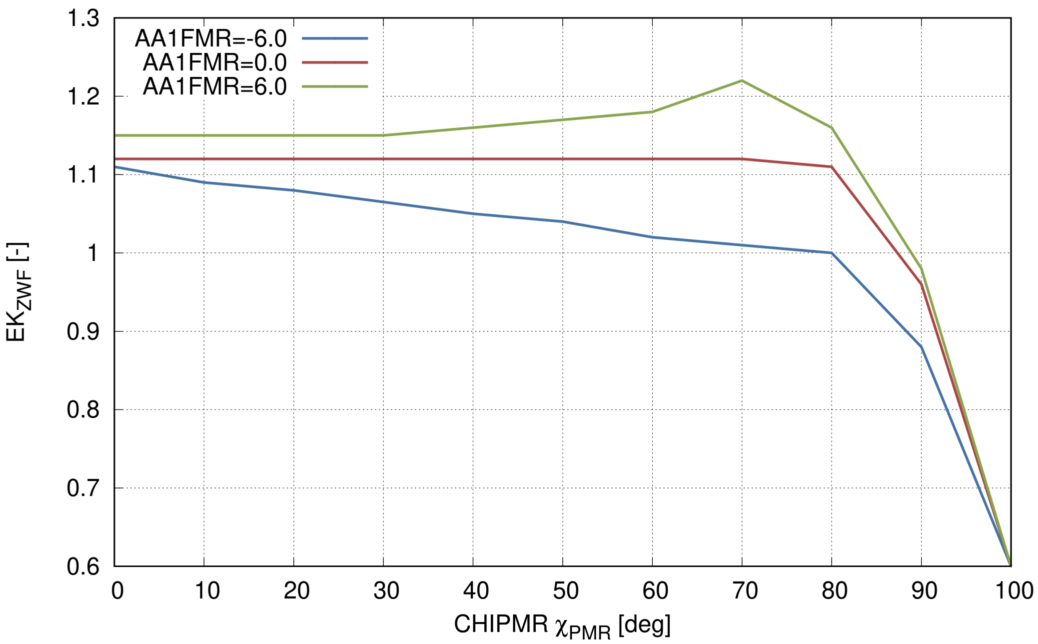

Figure 12: Downwash component of rotor wash on the fuselage [2]

4.4 Basic Fuselage Aerodynamic Characteristics

α_{WF} [deg]	D/q [m^2]	L/q [m^2]	M/q [m^3]
-90.0	150.00	-24.00	-200.00
-80.0	145.00	-54.00	-470.00
-70.0	133.00	-72.00	-645.00
-60.0	114.00	-81.00	-730.00
-50.0	88.00	-85.00	-760.00
-40.0	61.00	-83.00	-760.00
-30.0	45.00	-70.00	-740.00
-25.0	37.58	-52.00	-700.00
-20.0	31.68	-35.00	-630.00
-15.0	27.48	-25.00	-520.00
-10.0	25.06	-13.00	-380.00
-5.0	23.58	-5.00	-230.00
0.0	23.58	1.00	-90.00
5.0	25.08	10.00	10.00
10.0	27.58	20.00	100.00
15.0	31.28	25.00	290.00
20.0	36.58	30.00	450.00
25.0	43.08	34.00	600.00
30.0	51.08	37.00	750.00
40.0	66.00	43.00	810.00
50.0	84.00	48.00	825.00
60.0	110.00	50.00	780.00
70.0	132.00	48.00	650.00
80.0	145.00	39.00	470.00
90.0	150.00	22.00	200.00

Table 16: Fuselage aerodynamic characteristics due to angle of attack [2]

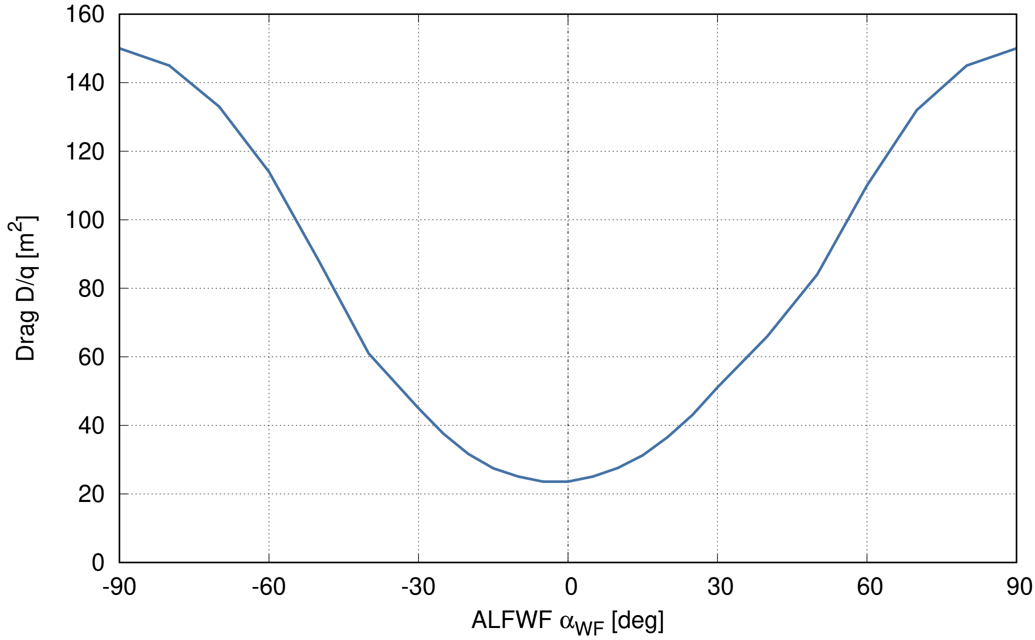

Figure 13: Fuselage drag due to angle of attack [2]

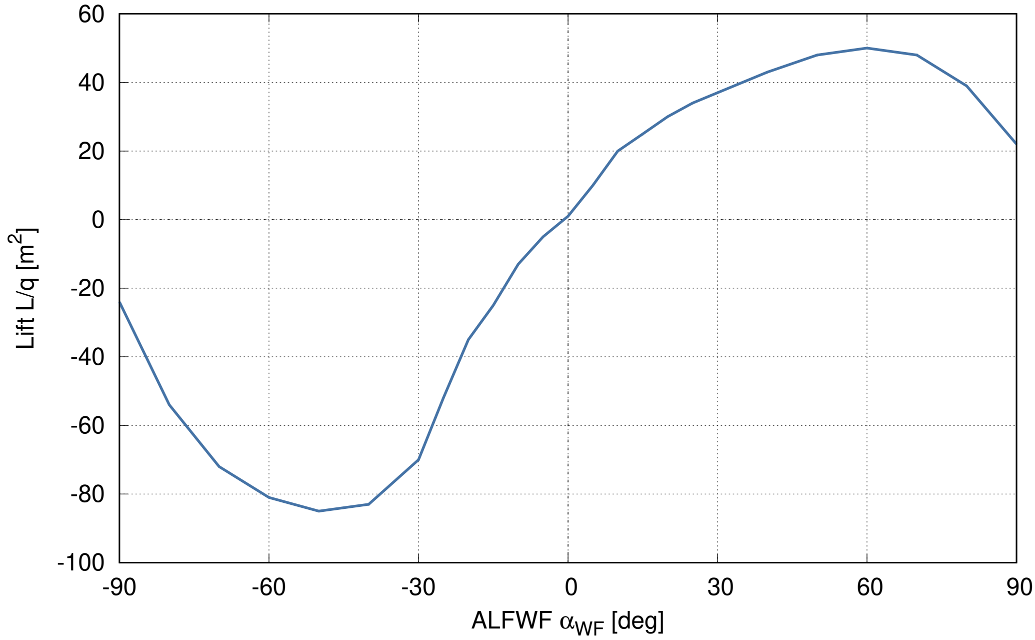

Figure 14: Fuselage lift due to angle of attack [2]

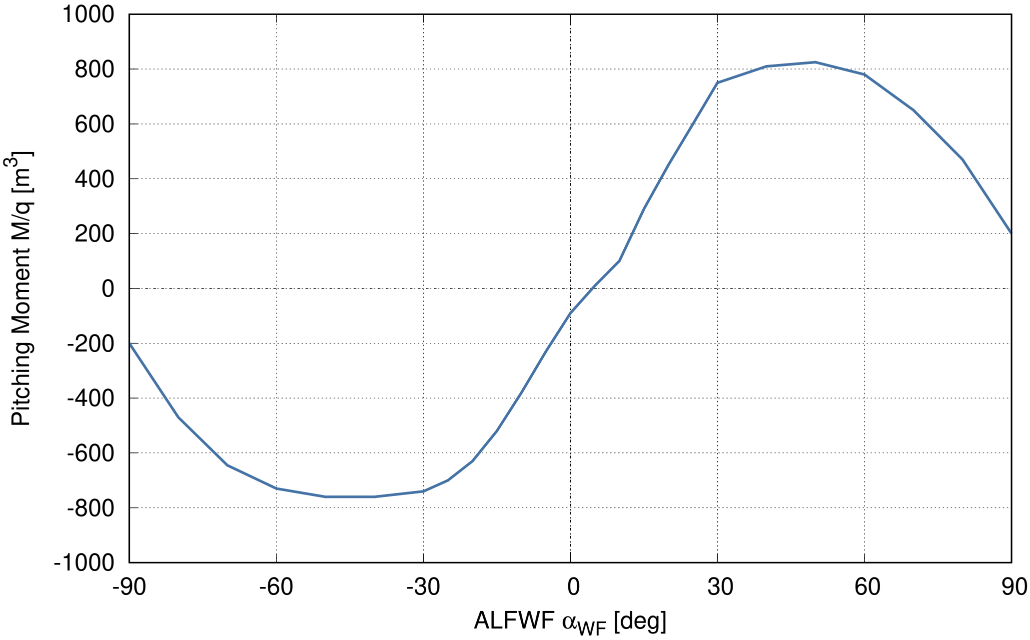

Figure 15: Fuselage pitching moment due to angle of attack [2]

ψ_{WF} [deg]	Y/q [m^2]	R/q [m^3]	N/q [m^3]
-90.0	-37.0	100.0	440.0
-80.0	-64.0	100.0	392.0
-70.0	-84.0	100.0	332.0
-60.0	-100.0	101.0	259.0
-50.0	-103.0	103.0	160.0
-40.0	-92.0	106.0	40.0
-30.0	-72.0	110.0	-140.0
-25.0	-65.0	120.0	-190.0
-20.0	-50.0	75.0	-240.0
-15.0	-35.0	30.0	-220.0
-10.0	-23.0	0.0	-180.0
-5.0	-11.0	0.0	-100.0
0.0	0.0	0.0	0.0
5.0	11.0	0.0	100.0
10.0	23.0	0.0	180.0
15.0	35.0	-30.0	220.0
20.0	50.0	-75.0	240.0
25.0	65.0	-120.0	190.0
30.0	72.0	-110.0	140.0
40.0	92.0	-106.0	59.0
50.0	103.0	-103.0	-30.0
60.0	100.0	-101.0	-125.0
70.0	84.0	-100.0	-220.0
80.0	64.0	-100.0	-320.0
90.0	37.0	-100.0	-420.0

Table 17: Fuselage aerodynamic characteristics due to sideslip [2]

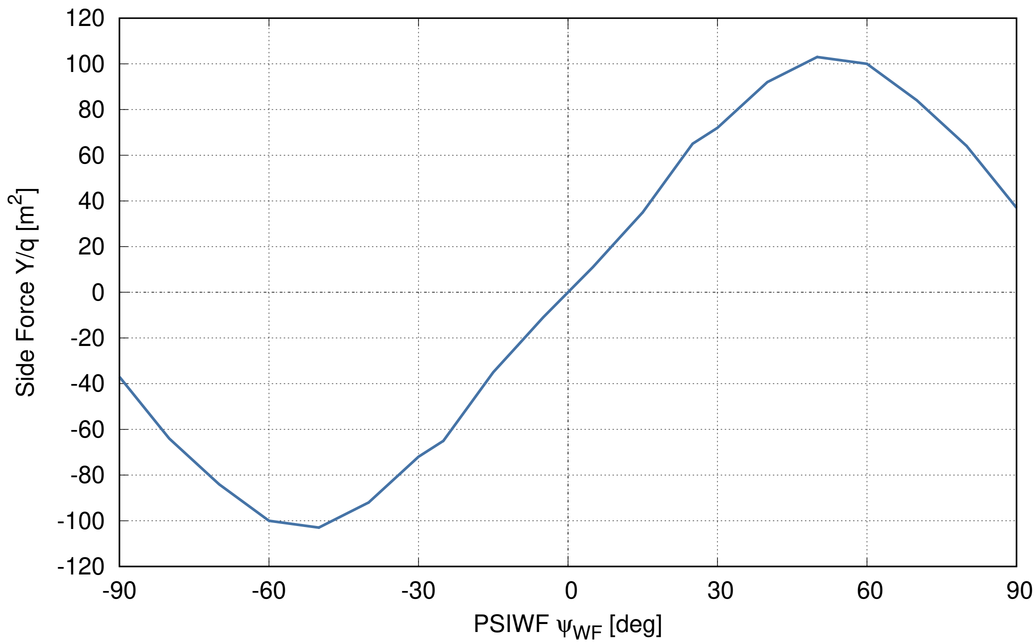

Figure 16: Fuselage side force due to sideslip [2]

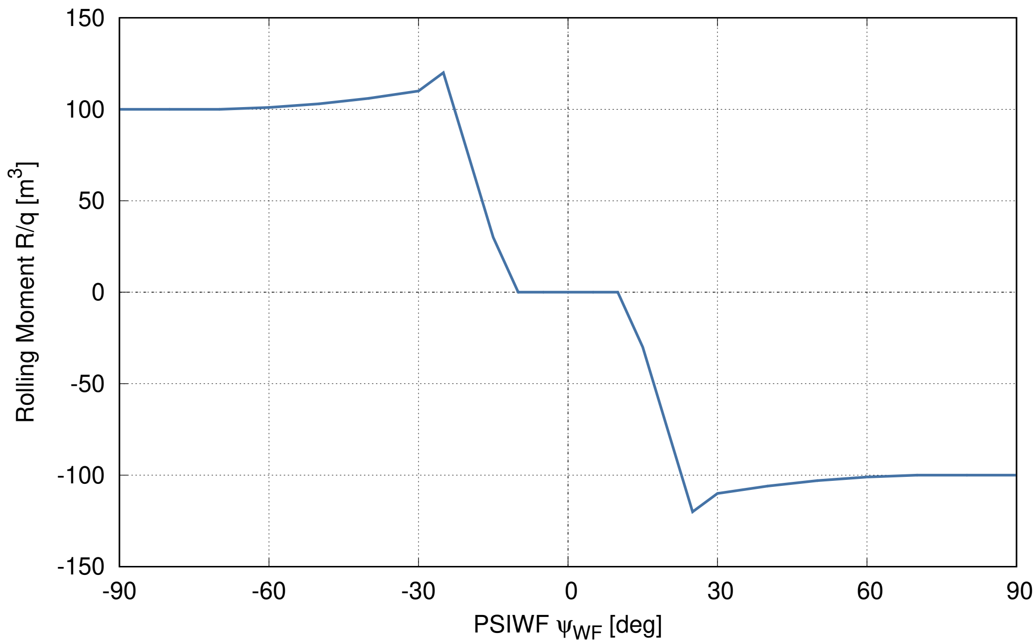

Figure 17: Fuselage rolling moment due to sideslip [2]

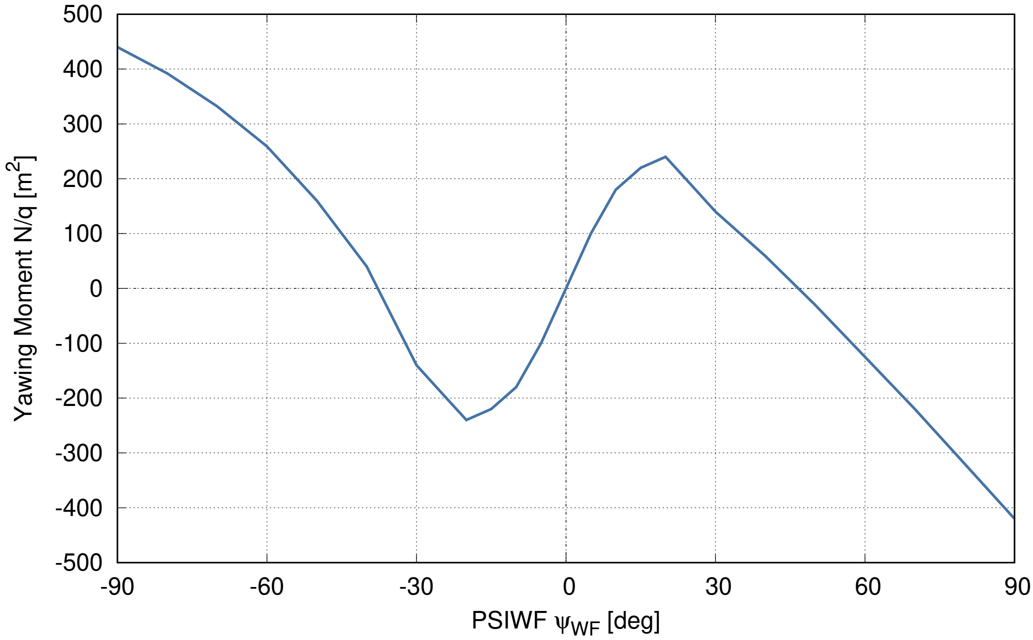

Figure 18: Fuselage yawing moment due to sideslip [2]

4.5 Fuselage Incremental Aerodynamic Characteristics

ψ_{WF} [deg]	$\Delta D/q$ [m^2]	$\Delta L/q$ [m^2]	$\Delta M/q$ [m^3]
-90.0	170.5		
-80.0	169.5		
-70.0	164.5		
-60.0	141.5		
-50.0	113.5		
-40.0	76.5		
-30.0	38.5	30.0	180.0
-25.0	28.0	20.0	130.0
-20.0	16.3	12.0	90.0
-15.0	9.0	7.0	50.0
-10.0	4.0	3.0	20.0
-5.0	1.0	2.0	10.0
0.0	0.0	0.0	0.0
5.0	1.0	2.0	10.0
10.0	4.0	5.0	20.0
15.0	9.0	10.0	50.0
20.0	16.3	15.0	90.0
25.0	28.0	22.0	130.0
30.0	38.5	30.0	180.0
40.0	76.5		
50.0	113.5		
60.0	141.5		
70.0	164.5		
80.0	169.5		
90.0	170.5		

Table 18: Fuselage incremental aerodynamic characteristics [2]

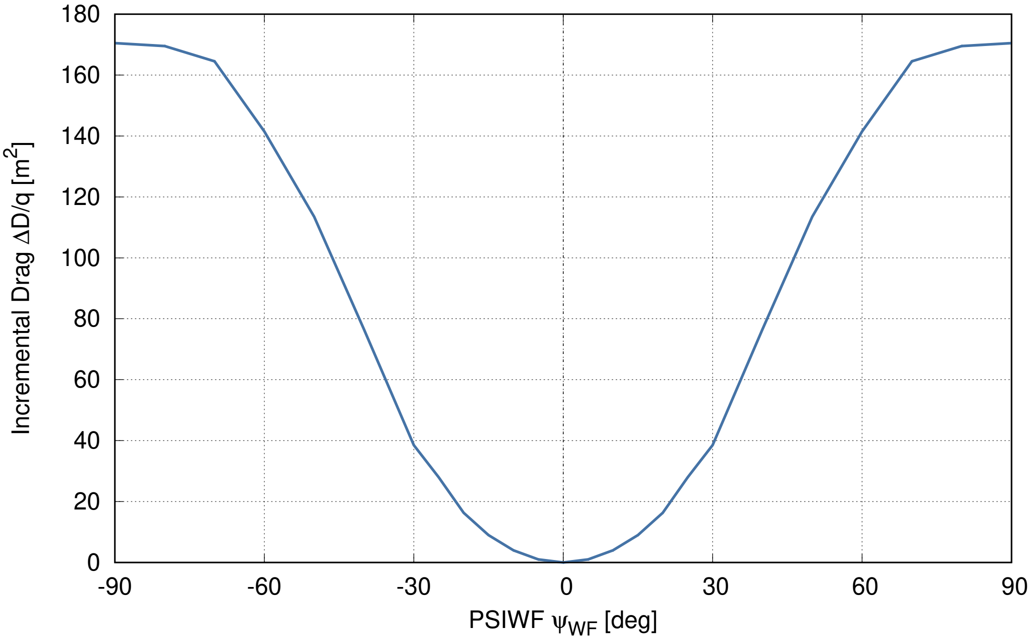

Figure 19: Fuselage incremental drag due to sideslip [2]

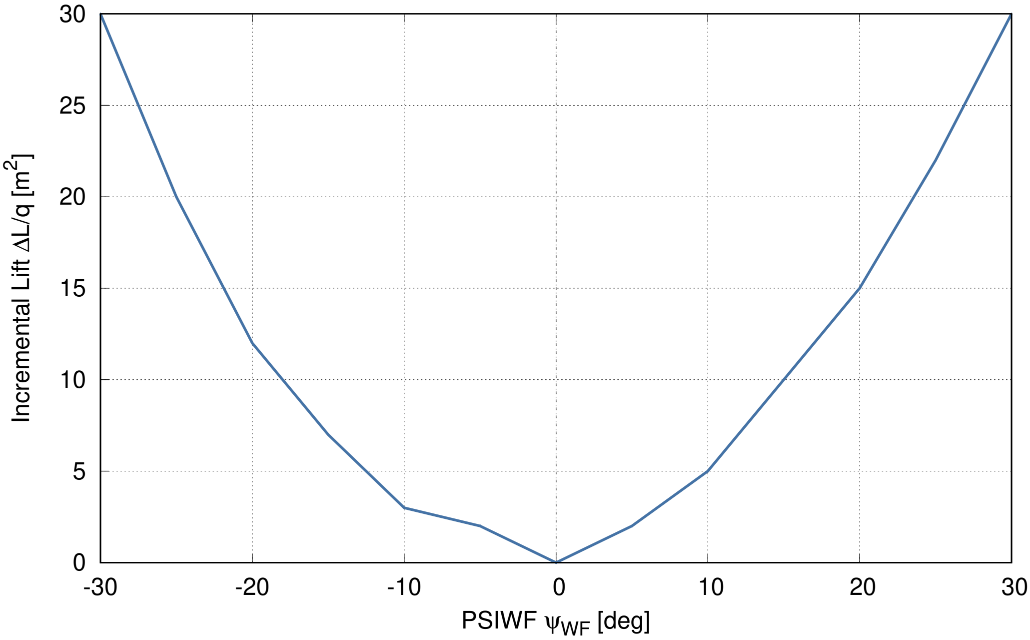

Figure 20: Fuselage incremental lift due to sideslip [2]

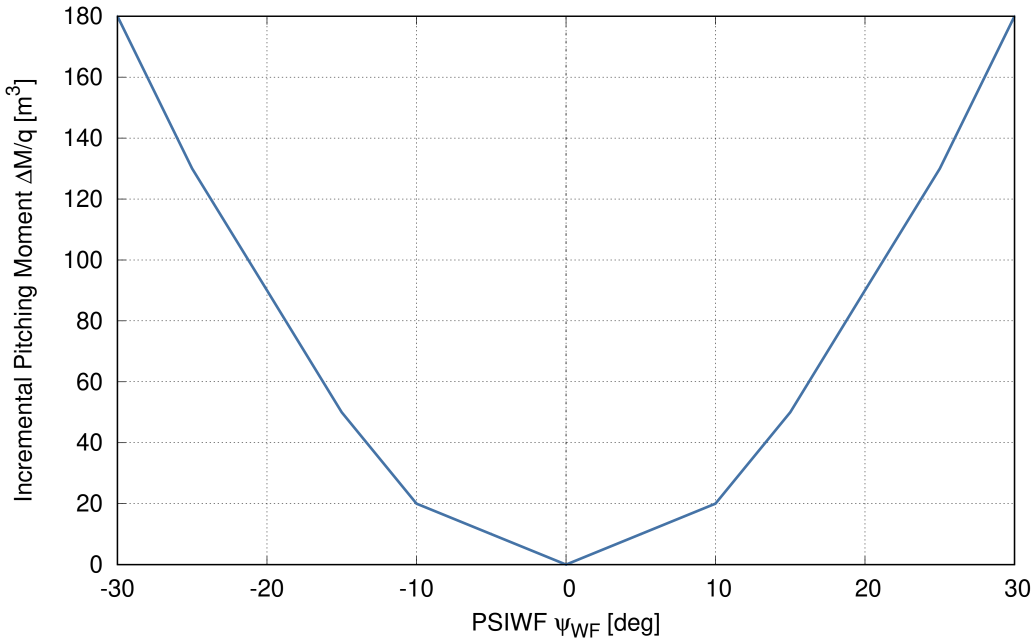

Figure 21: Fuselage incremental pitching moment due to sideslip [2]

5 Empennage

Parameter	Value	Reference
Horizontal tail span	4.38 m	[2]
Horizontal tail area	4.18 m^2	[1, 2]
Horizontal tail root chord	1.12 m	[2]
Horizontal tail tip chord	0.77 m	[2]
Horizontal tail sweep (0.25MAC)	0.0°	[2]
Horizontal tail aspect ratio	4.6	[2]
Horizontal tail airfoil	NACA 0014	[2]
Horizontal tail stationline	17.79 m	[2, 7]
Horizontal tail waterline	6.20 m	[2, 7]
Horizontal tail deflection limit	up -30°, down +35°	[3]
Vertical tail span	2.49 m	[2]
Vertical tail area	3.00 m^2	[1, 2]
Vertical tail root chord	1.83 m	[2]
Vertical tail tip chord	0.86 m	[2]
Vertical tail sweep (0.25MAC)	41.0°	[2]
Vertical tail aspect ratio	1.92	[2]
Vertical tail airfoil	NACA 0021 (Mod)	[2]
Vertical tail stationline	17.65 m	[2, 7]
Vertical tail waterline	6.93 m	[2, 7]

Table 19: Empennage data

5.1 Main Rotor Inplane Wash at the Horizontal Tail

χ [deg]	EKXH1 AA1FMR=-6.0	AA1FMR=0.0	AA1FMR=6.0
0.0	0.00	-0.40	-0.56
10.0	-0.20	-0.60	-0.80
20.0	0.05	-0.20	-0.74
30.0	0.30	0.12	-0.32
40.0	0.54	0.36	0.04
50.0	0.80	0.60	0.32
60.0	1.04	0.83	0.60
70.0	1.30	1.06	0.86
80.0	1.55	1.30	1.12
90.0	0.80	0.66	0.54
100.0	0.00	0.00	0.00

Table 20: Main rotor inplane wash at the horizontal tail [2]

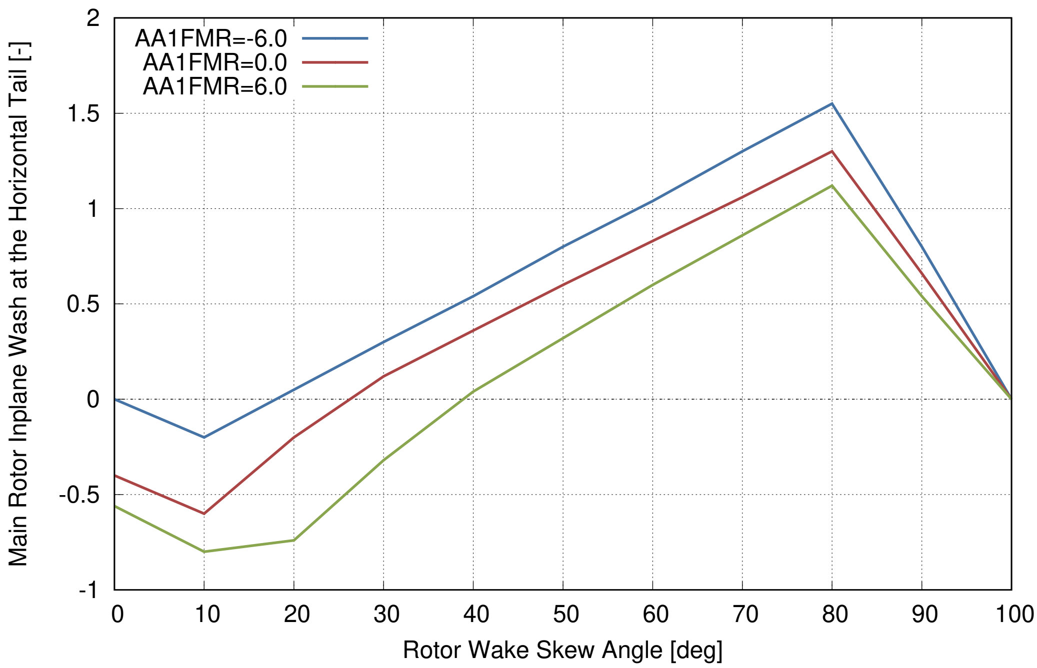

Figure 22: Main rotor inplane wash at the horizontal tail [2]

5.2 Main Rotor Downwash at the Horizontal Tail

χ [deg]	EKZH1 AA1FMR=-6.0	AA1FMR=0.0	AA1FMR=6.0
0.0	-0.130	0.400	0.780
10.0	0.800	0.940	1.360
20.0	1.800	1.840	1.910
30.0	1.820	1.910	1.980
40.0	1.860	1.980	2.060
50.0	1.880	2.040	2.140
60.0	1.910	2.080	2.210
70.0	1.940	2.140	2.280
80.0	1.690	1.890	2.160
90.0	1.420	1.620	1.960
100.0	1.140	1.350	1.560

Table 21: Main rotor downwash at the horizontal tail [2]

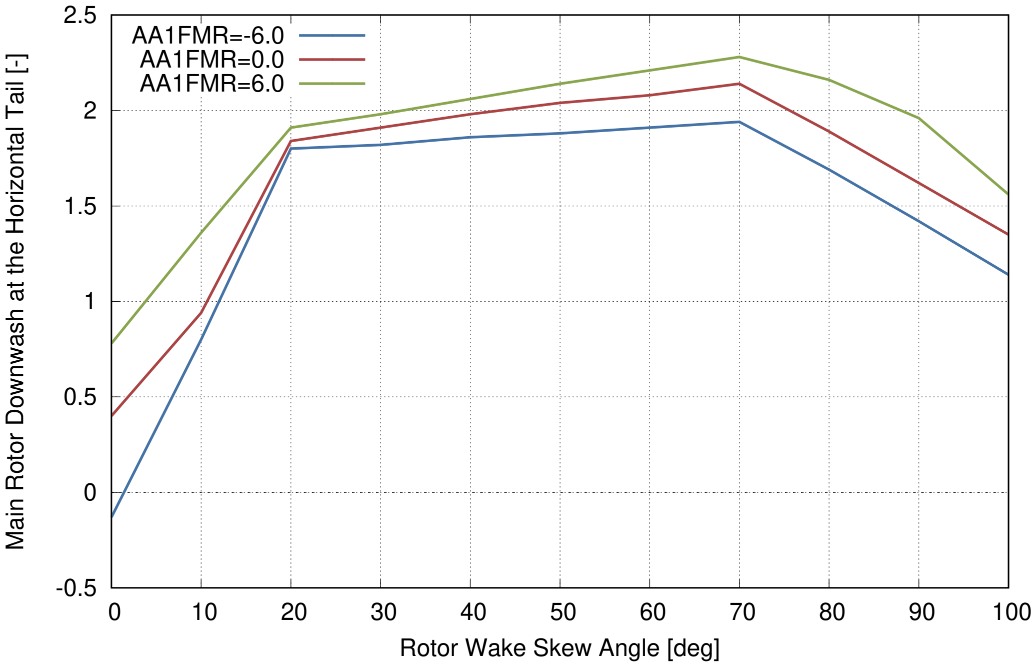

Figure 23: Main rotor downwash at the horizontal tail [2]

5.3 Dynamic Pressure Loss at the Horizontal Tail

α [deg]	QH1QWF [-]
-30.0	1.00
-25.0	1.00
-20.0	0.95
-15.0	0.76
-10.0	0.76
-5.0	0.76
0.0	0.76
5.0	0.76
10.0	0.76
15.0	0.82
20.0	0.91
25.0	1.00
30.0	1.00

Table 22: Dynamic pressure loss at the horizontal tail [2]

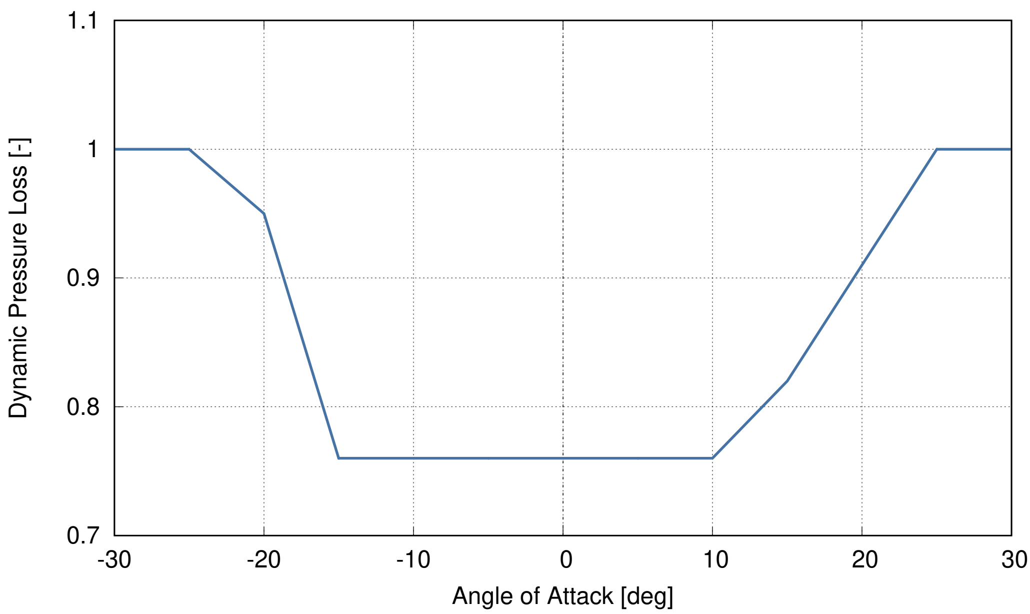

Figure 24: Dynamic pressure loss at the horizontal tail [2]

5.4 Fuselage Downwash at the Horizontal Tail

α_f [deg]	ϵ_h [deg]
-90.0	0.00
-80.0	0.25
-70.0	0.70
-60.0	1.20
-50.0	1.60
-40.0	1.90
-30.0	1.80
-25.0	1.40
-20.0	1.10
-15.0	0.80
-10.0	0.55
-5.0	0.50
0.0	0.45
5.0	0.40
10.0	0.38
15.0	0.33
20.0	0.19
25.0	-0.12
30.0	-0.40
40.0	-0.70
50.0	-0.75
60.0	-0.65
70.0	-0.45
80.0	-0.15
90.0	0.00

Table 23: Fuselage downwash at the horizontal tail [2]

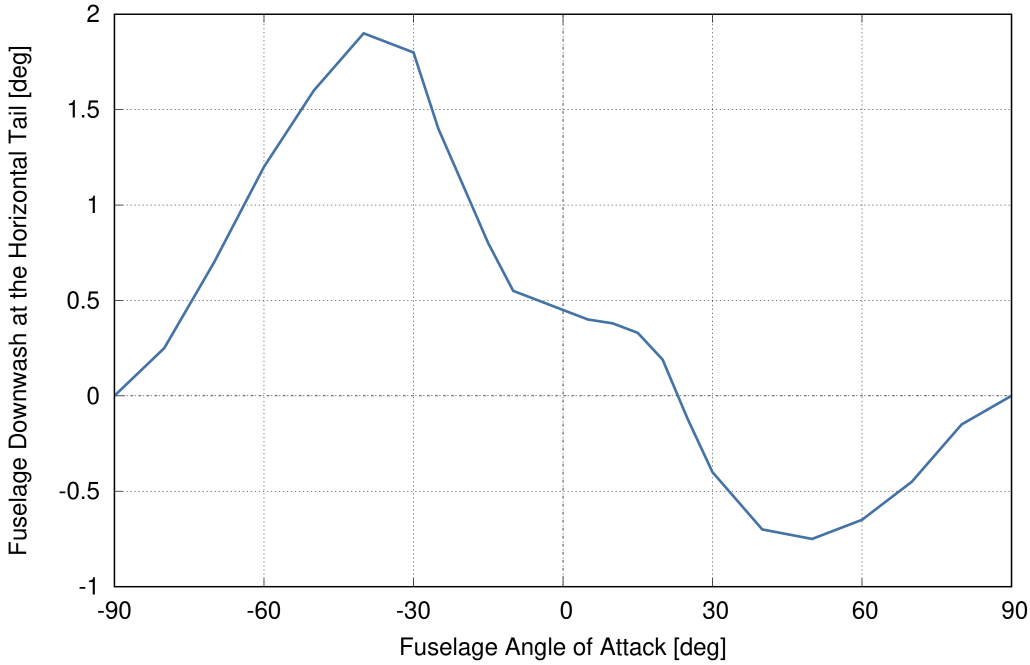

Figure 25: Fuselage downwash at the horizontal tail [2]

5.5 Horizontal Tail Aerodynamic Coefficients

α [deg]	$C_{X,h}$ [-]	$C_{Z,h}$ [-]
-90.0	1.200	0.000
-80.0	1.161	-0.294
-70.0	1.050	-0.558
-60.0	0.888	-0.745
-50.0	0.702	-0.847
-40.0	0.531	-0.847
-30.0	0.430	-0.745
-25.0	0.370	-0.795
-20.0	0.360	-0.950
-15.0	0.190	-1.030
-10.0	0.040	-0.710
-5.0	0.022	-0.356
0.0	0.010	0.000
5.0	0.022	0.356
10.0	0.040	0.710
15.0	0.190	1.030
20.0	0.360	0.950
25.0	0.370	0.795
30.0	0.430	0.745
40.0	0.531	0.847
50.0	0.702	0.847
60.0	0.888	0.745
70.0	1.050	0.558
80.0	1.161	0.294
90.0	1.200	0.000

Table 24: Horizontal tail aerodynamic coefficients [2]

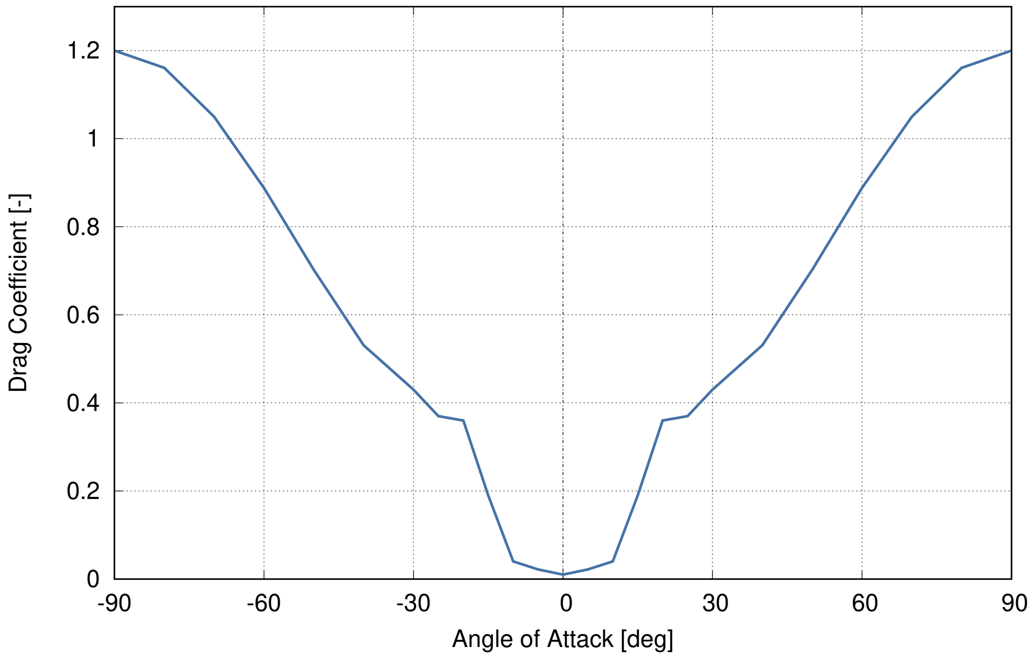

Figure 26: Horizontal tail drag coefficient due to angle of attack [2]

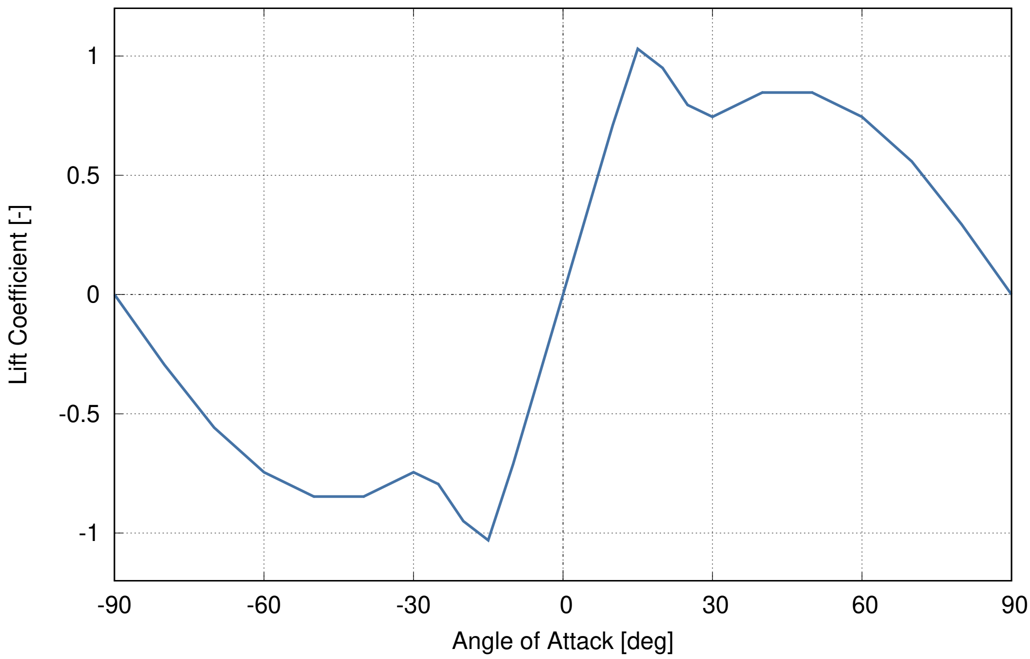

Figure 27: Horizontal tail lift coefficient due to angle of attack [2]

5.6 Dynamic Pressure Loss at the Vertical Tail

β [deg]	QP3QWF [-]
-30.0	1.00
-25.0	0.88
-20.0	0.79
-15.0	0.72
-10.0	0.66
-5.0	0.64
0.0	0.62
5.0	0.64
10.0	0.66
15.0	0.72
20.0	0.79
25.0	0.88
30.0	1.00

Table 25: Dynamic pressure loss at the vertical tail [2]

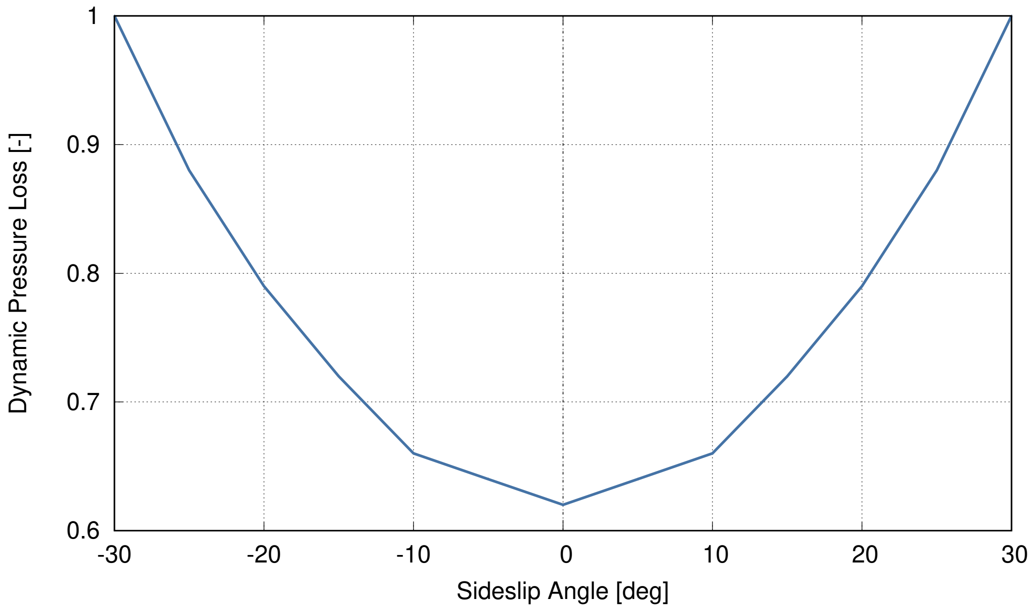

Figure 28: Dynamic pressure loss at the vertical tail [2]

5.7 Fuselage Sidewash at the Vertical Tail

β_f [deg]	ϵ_v [deg]
-90.0	0.0
-60.0	0.0
-30.0	0.2
-25.0	0.6
-20.0	1.4
-15.0	0.8
-10.0	-0.6
-5.0	-0.4
0.0	0.0
5.0	0.4
10.0	0.6
15.0	-0.8
20.0	-1.4
25.0	-0.6
30.0	-0.2
60.0	0.0
90.0	0.0

Table 26: Fuselage sidewash at the vertical tail [2]

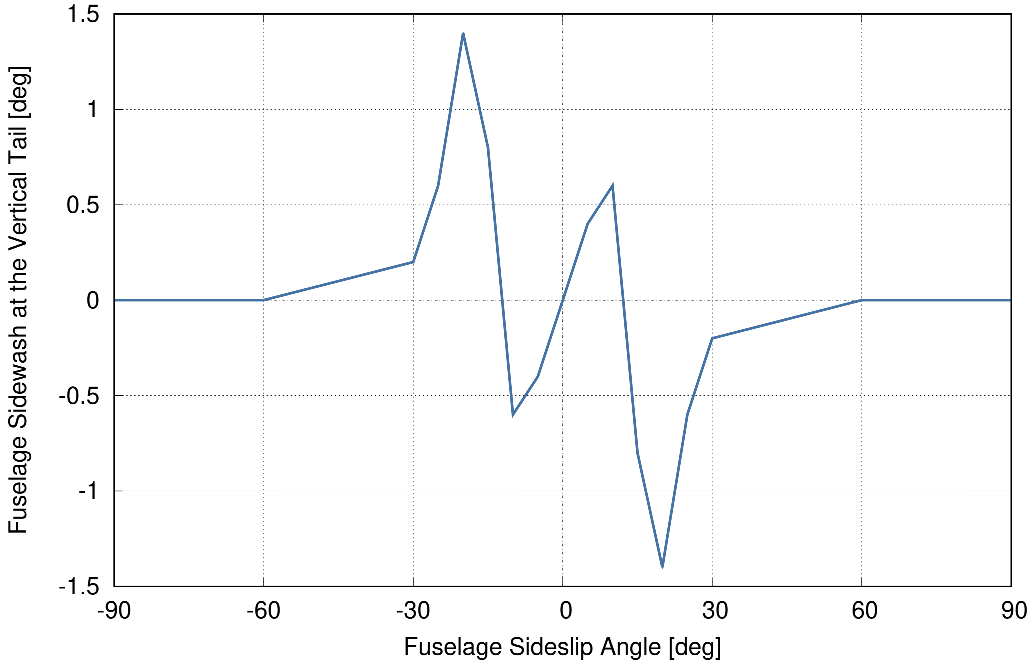

Figure 29: Fuselage sidewash at the vertical tail [2]

5.8 Vertical Tail Aerodynamic Coefficients

β [deg]	$C_{X,v}$ [-]	$C_{Y,v}$ [-]
-90.0	1.100	0.000
-80.0	1.025	-0.120
-70.0	0.965	-0.280
-60.0	0.875	-0.460
-50.0	0.745	-0.660
-40.0	0.575	-0.880
-30.0	0.360	-1.000
-25.0	0.265	-1.000
-20.0	0.174	-0.930
-15.0	0.118	-0.730
-10.0	0.066	-0.500
-5.0	0.033	-0.280
0.0	0.018	-0.060
5.0	0.021	0.160
10.0	0.044	0.380
15.0	0.092	0.610
20.0	0.162	0.820
25.0	0.248	0.890
30.0	0.355	0.890
40.0	0.580	0.800
50.0	0.750	0.630
60.0	0.875	0.480
70.0	0.966	0.320
80.0	1.020	0.170
90.0	1.080	0.000

Table 27: Vertical tail aerodynamic coefficients [2]

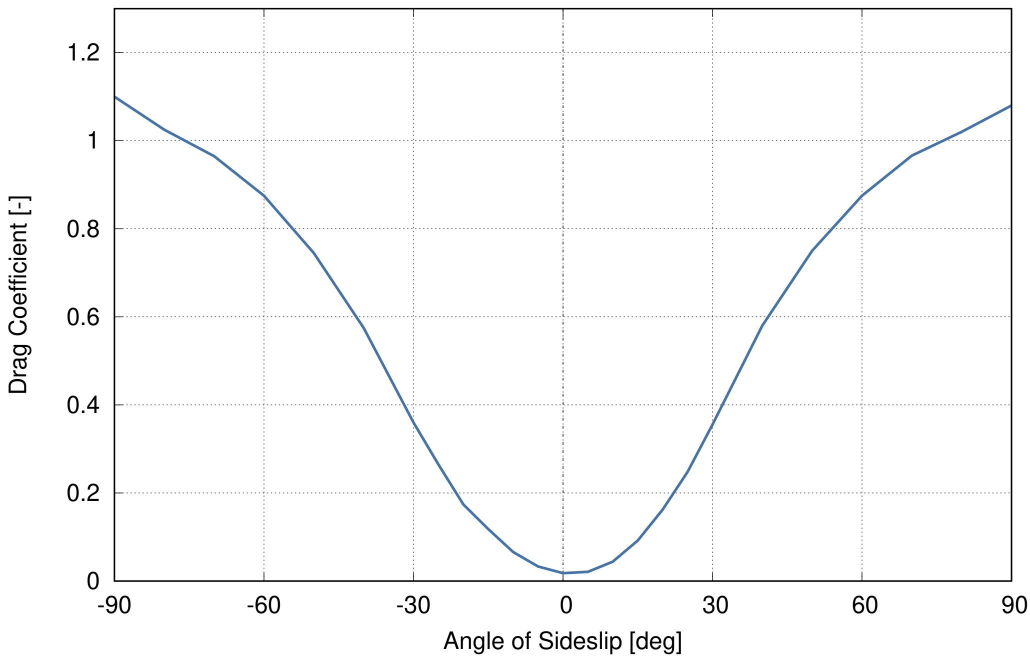

Figure 30: Vertical tail drag coefficient due to sideslip [2]

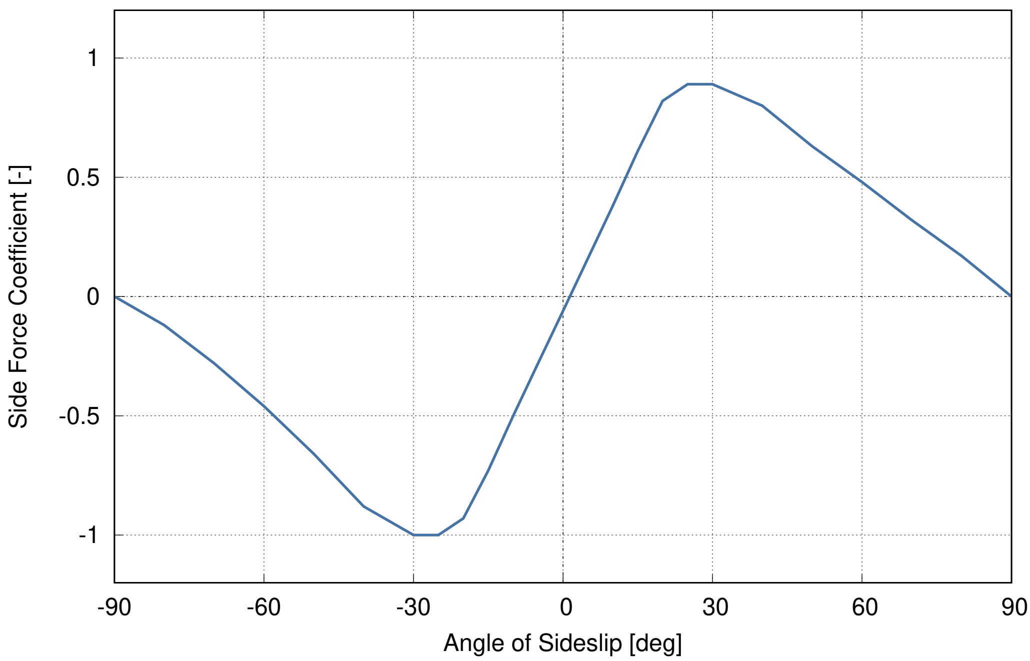

Figure 31: Vertical tail side force coefficient due to sideslip [2]

6 Tail Rotor

Parameter	**Value**	**Reference**
Tail rotor diameter	3.35 m	[1, 3, 2]
Tail rotor number of blades	4	[2]
Tail rotor blade chord	0.25 m	[2]
Tail rotor blade airfoil	SC1095	[2]
Tail rotor solidity	0.1875	[2]
Tail rotor blade twist	-18.0°	[2]
Tail rotor cant angle	20.0°	[3]
Tail rotor nominal rotation speed	124.62 rad/s (1191 rpm)	[2]
Tail rotor blade tip loss factor	0.92	[2]
Tail rotor blade section lift curve slope	5.73 rad^{-1}	[7]
Tail rotor stationline	18.59 m	[2, 4]
Tail rotor waterline	8.25 m	[2, 4]
Tail rotor buttline	0.36 m	[2, 4]

Table 28: Tail rotor data

7 Flight Controls

Parameter	Value	Reference
Lateral cyclic output at rotor	$+/-8.0°$	[2]
Longitudinal cyclic output at rotor	fwd. -12.3°, aft +16.5°	[2]
Collective output at rotor	low 9.9°, high 25.9°	[2]
Pedals output at tail rotor	right 0.1°, left 29.9°	[2]

Table 29: Main rotor data

8 Engine

Parameter	**Value**	**Reference**
Engine manufacturer	General Electric	[1]
Engine model (UH-60A)	T700-GE-700	[1, 3]
Engine model (UH-60L)	T700-GE-701C	[1, 3]
Engine model (UH-60M)	T700-GE-701D	[1]
Engine maximum power output (T700-GE-700)	1 163 kW	[1]
Engine maximum power output (T700-GE-701C)	1 402 kW	[1]
Engine maximum power output (T700-GE-701D)	1 652 kW	[1]
Engine weight (T700-GE-701C)	207 kg	[5]
Engine specific fuel consumption at maximum continuous power (T700-GE-701C)	279.2 g/(kW·h)	[5]

Table 30: Basic data

9 Mass and Inertia

Parameter	**Value**	**Reference**
Empty weight (UH-60A)	5 118 kg	[1]
Empty weight (UH-60L)	5 224 kg	[1]
Internal fuel tanks capacity	1 361 l	[1, 3]
Internal fuel tanks stationline	10.69 m	[3]
Center of mass stationline (for 7 258 kg)	9.09 m	[2]
Center of mass waterline (for 7 258 kg)	6.38 m	[2]
Moment of inertia I_x (for 7 258 kg)	7 406 kg·m^2	[2]
Moment of inertia I_y (for 7 258 kg)	53 513 kg·m^2	[2]
Moment of inertia I_z (for 7 258 kg)	50 012 kg·m^2	[2]
Cross product of inertia I_{xz} (for 7 258 kg)	2 134 kg·m^2	[2]

Table 31: Mass data

9.1 Structure Groups Breakdown

Data given in [3, 2, 4] were used to calculate empty aircraft inertia tensor and center of mass coordinates. Results are given in the following table.

Parameter	**Value**
Center of mass x-coordinate	-0.15 m
Center of mass y-coordinate	0.00 m
Center of mass z-coordinate	-0.25 m
Moment of inertia I_X	6 543.0 kg·m^2
Moment of inertia I_Y	46 293.1 kg·m^2
Moment of inertia I_Z	43 498.3 kg·m^2
Cross product of inertia I_{XY}	0.0 kg·m^2
Cross product of inertia I_{XZ}	-3 753.0 kg·m^2
Cross product of inertia I_{YZ}	0.0 kg·m^2

Table 32: Empty aircraft inertia tensor and center of mass coordinates

Structure group	**Weight** [kg]	**Coordinates** [m]			**First moment of mass** [kg·m]			**Moment of inertia** [kg·m^2]					
	m	x	y	z	S_X	S_Y	S_Z	I_X	I_Y	I_Z	I_{XY}	I_{XZ}	I_{YZ}
Empty aircraft	5118	−0.15	0.00	−0.25	−791.9	0.0	−1274.0	6543.0	46 293.1	43 498.3	0.0	−3753.0	0.0
Pilot (left)	80	2.90	−0.70	0.40	232.0	−56.0	32.0	52.0	685.6	712.0	162.4	−92.8	22.4
Pilot (right)	80	2.90	0.70	0.40	232.0	56.0	32.0	52.0	685.6	712.0	−162.4	−92.8	−22.4
Fuel	1100	−2.02	0.00	0.70	−2222.0	0.0	770.0	539.0	5027.4	4488.4	0.0	1555.4	0.0
Personnel (4th row)	440	0.04	0.00	0.50	15.6	0.0	220.0	110.0	110.6	0.6	0.0	−7.8	0.0
Personnel (5th row)	440	−1.17	0.00	0.50	−514.1	0.0	220.0	110.0	710.7	600.7	0.0	257.0	0.0
Gross weight	7258	−0.42	0.00	0.00	−3048.4	0.0	0.0	7406.0	53 513.0	50 012.0	0.0	−2134.0	0.0

Table 33: Mass data intermediate results

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[2] J. Howlett, *UH-60A Black Hawk Engineering Simulation Program: Volume I - Mathematical Model*. National Aeronautics and Space Administration, CR-166309, 1981.

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