Working run 1:

Iter Func-count Fval Feasibility Step Length Norm of First-order

step optimality

0 125 9.999998e-01 7.662e-02 1.000e+00 0.000e+00 2.762e-01

1 250 9.869255e-01 2.582e-03 1.000e+00 1.858e-01 1.204e-01

2 376 9.572772e-01 1.806e-03 1.000e+00 2.685e-01 6.214e-02

3 530 9.572759e-01 1.770e-03 4.600e-05 1.754e-05 6.207e-02

4 679 9.572631e-01 1.753e-03 2.737e-04 1.380e-04 6.186e-02

5 847 9.572631e-01 1.753e-03 3.120e-07 3.068e-07 6.197e-02

6 1000 9.572631e-01 1.753e-03 1.688e-12 1.793e-12 6.197e-02

Optimization stopped because the relative changes in all elements of x are

less than options.StepTolerance = 1.000000e-12, but the relative maximum constraint

violation, 1.752996e-03, exceeds options.ConstraintTolerance = 1.000000e-03.

Elapsed time is 6441.759865 seconds.

C\_root: 8.576622 Taper\_1: 0.597235 Taper\_2: 0.352955 Sweep\_LE\_2: 29.244939 b2: 11.572291 Twist\_mid: 0.001000 Twist\_tip: 0.001000

Au\_r: 0.249911 0.085155 0.294455 0.094001 0.305099 0.416696

Al\_r: 0.237030 0.178497 0.050412 0.536985 0.076723 0.348514

Au\_t: 0.143567 0.047758 0.164430 0.054183 0.172458 0.234139

Al\_t: 0.135785 0.099669 0.028135 0.296785 0.044108 0.197802

Cl\_hat: 1.512922 1.613715 1.711559 1.801542 1.883697 1.901575 1.894081 1.914064 1.897278 1.916952 1.891224 1.853250 1.777220 1.553851

Cm\_hat: 0.376677 0.368048 0.359799 0.350567 0.340192 0.295672 0.264785 0.246128 0.233924 0.223549 0.212275 0.197713 0.173201 0.118560

LD\_ratio: 14.821168 W\_wing\_hat: 17189.592601 W\_fuel\_hat: 45401.113665

MTOM: 149801.141622 Normalised objective function:

MTOM: 0.957263 Normalised objective function:

Fmin 0.957263076780740

Note: x was denormalised using x0 instead of abs(x0), needs to be fixed.

X0 init is:

8.57000000000000 0.550000000000000 0.376363630000000 35 14.1600000000000 0.00100000000000000 0.00100000000000000 0.247300000000000 0.0841000000000000 0.284100000000000 0.0935000000000000 0.295300000000000 0.403100000000000 -0.238500000000000 -0.172900000000000 -0.0498000000000000 -0.504700000000000 0.0777000000000000 0.344400000000000 0.141300000000000 0.0482000000000000 0.162000000000000 0.0539000000000000 0.168400000000000 0.230500000000000 -0.136300000000000 -0.0989000000000000 -0.0282000000000000 -0.288700000000000 0.0446000000000000 0.196700000000000 1.45800000000000 1.55000000000000 1.64040000000000 1.72510000000000 1.80320000000000 1.82310000000000 1.84420000000000 1.86810000000000 1.88810000000000 1.90120000000000 1.90250000000000 1.88180000000000 1.80720000000000 1.54100000000000 -0.380600000000000 -0.371700000000000 -0.363200000000000 -0.353700000000000 -0.342900000000000 -0.297600000000000 -0.265800000000000 -0.247300000000000 -0.234900000000000 -0.224400000000000 -0.213000000000000 -0.198300000000000 -0.173600000000000 -0.118700000000000 16 24247.7000000000 45025.5164860000

Settings:

options = optimoptions(@fmincon);

options.Display = 'iter-detailed';

options.Algorithm = 'sqp';

options.DiffMaxChange = 0.1;

options.DiffMinChange = 0.05;

options.TolCon = 1e-3;

options.TolFun = 1e-3;

options.StepTolerance = 1e-12;

% options.UseParallel = true;

% options.OutputFcn = @outfun;

options.FinDiffType = 'central';

options.PlotFcns = {@optimplotfval, @optimplotx, @optimplotfirstorderopt, @optimplotconstrviolation, @optimplotfunccount, @optimplotstepsize};

Initial point:

% ---------- Initial guess ----------

% Airfoil coeffs - Root: whitcomb t/c 14 & Tip: whitcomb t/c 08

Au\_r = [0.2473 0.0841 0.2841 0.0935 0.2953 0.4031];

Al\_r = [-0.2385 -0.1729 -0.0498 -0.5047 0.0777 0.3444];

Au\_t = [0.1413 0.0482 0.1620 0.0539 0.1684 0.2305];

Al\_t = [-0.1363 -0.0989 -0.0282 -0.2887 0.0446 0.1967];

% [Update] Cl and Cm distributions

Cl = [1.458000 1.550000 1.640400 1.725100 1.803200 1.823100 1.844200 1.868100 1.888100 1.901200 1.902500 1.881800 1.807200 1.541000];

Cm = [-0.380600 -0.371700 -0.363200 -0.353700 -0.342900 -0.297600 -0.265800 -0.247300 -0.234900 -0.224400 -0.213000 -0.198300 -0.173600 -0.118700];

% Full vector

x0\_init = [8.57, 0.55, 0.37636363, 35, 14.16, 0.001, 0.001, Au\_r, Al\_r, Au\_t, Al\_t, Cl, Cm, 16, 24247.7, 45025.516486];

Bounds:

% Airfoil coefficients

Cl\_ub = ones(size(Cl)) \* 6;

Cm\_ub = ones(size(Cm)) \* 6;

% ub = [26.5, 1, 1, 50, 17.87, 8.15, 8.15, Au\_r\_ub, Al\_r\_ub, Au\_t\_ub, Al\_t\_ub, Cl\_ub, Cm\_ub, 40, 156489, 156489];

ub = [26.5, 1, 1, 50, 17.87, 0.001, 0.001, Au\_r\_ub, Al\_r\_ub, Au\_t\_ub, Al\_t\_ub, Cl\_ub, Cm\_ub, 40, 156489, 156489];

Cl\_lb = ones(size(Cl)) \* -6;

Cm\_lb = ones(size(Cm)) \* -6;

% lb = [2, 0.05, 0.05, 0.5, 1, -10, -10, Au\_r\_lb, Al\_r\_lb, Au\_t\_lb, Al\_t\_lb, Cl\_lb, Cm\_lb, 5, 4358, 1000];

lb = [3, 0.1, 0.1, 1, 1, 0.001, 0.001, Au\_r\_lb, Al\_r\_lb, Au\_t\_lb, Al\_t\_lb, Cl\_lb, Cm\_lb, 5, 4358, 1000];

Airf coeffs: 1.2, 0.8