AM-Sβ1x-24x FOILS: CANDIDATES FOR PRIMARY FOIL

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Design Goals/Constraints

- Primary foil for stall regulated rotor
- $t/c \approx 24\%$
- $c_l \approx 1$
- $Re_c = 7.5 \times 10^6$
- High l/d
- Some thickness at trailing edge to resist singing
- Manage cp,min for cavitation sensitivity
- Minimize performance loss when soiled

General Discussion

Air-/hydro- foil design is a zero-sum game. Within the design space, pursuing a particular design objective often comes at the cost of another. In the AM-Sβ1x-24x candidate foils, achieving good stall behavior at relatively low c_l and high Reynolds number might not be possible within conventional foil design space (i.e., without active flow control devices). However, l/d can be tailored such that stall regulation might still be effectively possible, depending on generator/rotor operation (in particular, the range of variable speed and the availability of other power regulation devices such as electromotive braking).

S818

A NREL/SERI airfoil with t/c=24.2% for stall-regulated wind turbine rotors, provided for comparison. Its l/d performance benefits from its sharp trailing edge.

m240c20b01

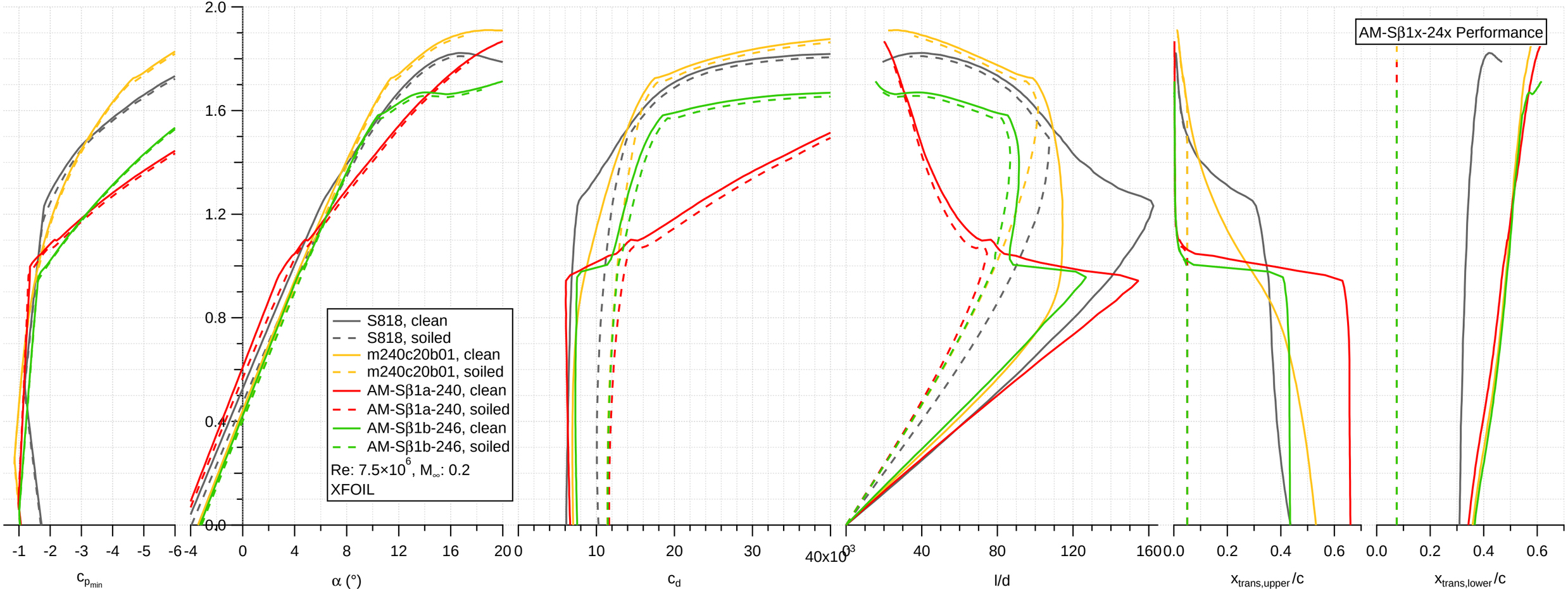
A previous design iteration, presented for comparison.

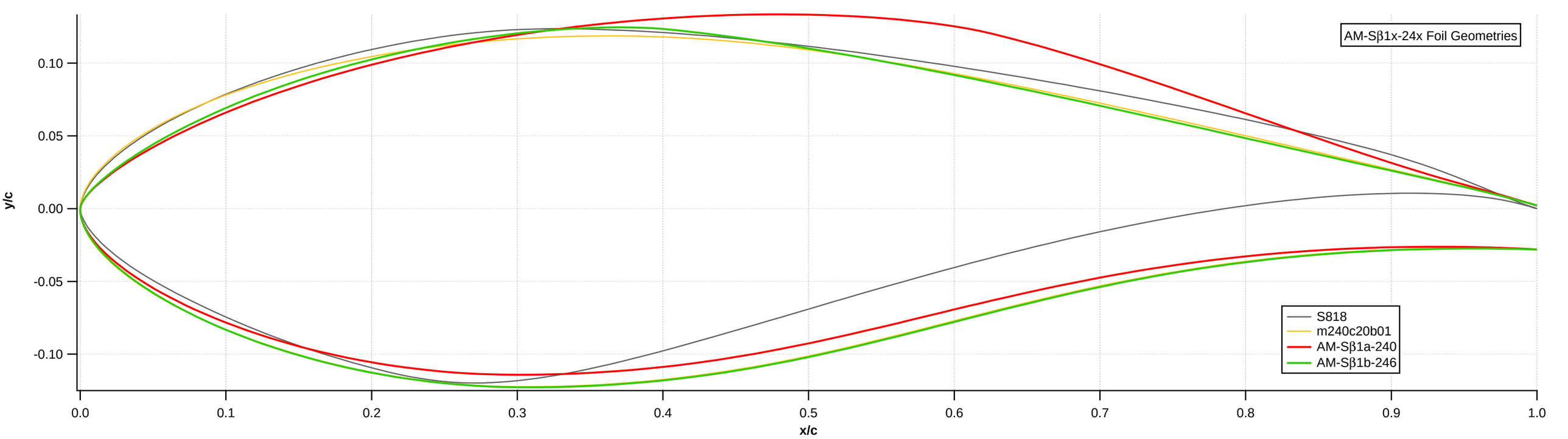
AM-Sβ1a-240

Achieves high l/d in clean conditions, but l/d performance is relatively low in soiled conditions. l/d collapses sharply beyond $c_l \approx 0.9$, but lift continues increasing with only a slight decrease in slope. It should be possible to increase c_l of $(l/d)_{max}$ if desired.

AM-Sβ1b-246

A different design branch with lower l/d in clean conditions and marginal gains in soiled conditions. There is a sharp decrease in l/d beyond $c_l \approx 1$, but stall is not prominent until $c_l > 1.6$.


AM-Sβ1x-24x Performance
S818, clean
S818, soiled
m240c20b01, clean
m240c20b01, soiled
AM-Sβ1a-240, clean
AM-Sβ1a-240, soiled
AM-Sβ1b-246, clean
AM-Sβ1b-246, soiled
Re: 7.5×10^6, M∞: 0.2
XFOIL
-1 -2 -3 -4 -5 -6
cpmin
-4 0 4 8 12 16 20
α (°)
2.0 1.6 1.2 0.8 0.4 0.0
0 10 20 30
40x10^-3
cd
0 40 80 120 160
l/d
0.0 0.2 0.4 0.6
xtrans,upper/c
0.0 0.2 0.4 0.6
xtrans,lower/c


AM-Sβ1x-24x Foil Geometries
S818
m240c20b01
AM-Sβ1a-240
AM-Sβ1b-246
0.10
0.05
0.00
-0.05
-0.10
y/c
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
x/c