REPORT

학과: 항공기계공학과

과목: 전산유체해석실습

학번: 2023010586

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교수: 임동균 교수님

제출날짜: 10/14 (화)

CHEONGJU UNIVERSITY

2DN00: 2D NACA 0012 Airfoil Validation Case

[0deg]

```
% -------------------- COMPRESSIBLE FREE-STREAM DEFINITION -------------------%
%
% Mach number (non-dimensional, based on the free-stream values)
MACH_NUMBER= 0.15
%
% Angle of attack (degrees, only for compressible flows)
AOA= 0.0
%
% Side-slip angle (degrees, only for compressible flows)
SIDESLIP_ANGLE= 0.0
%
% Init option to choose between Reynolds (default) or thermodynamics quantities
% for initializing the solution (REYNOLDS, TD_CONDITIONS)
INIT_OPTION= REYNOLDS
%
% Free-stream option to choose between density and temperature (default) for
% initializing the solution (TEMPERATURE_FS, DENSITY_FS)
FREESTREAM_OPTION= TEMPERATURE_FS
%
% Free-stream temperature (288.15 K by default)
FREESTREAM_TEMPERATURE= 288.15
%
% Reynolds number (non-dimensional, based on the free-stream values)
REYNOLDS_NUMBER= 6.0E6
%
% Reynolds length (1 m by default)
REYNOLDS_LENGTH= 1.0
```
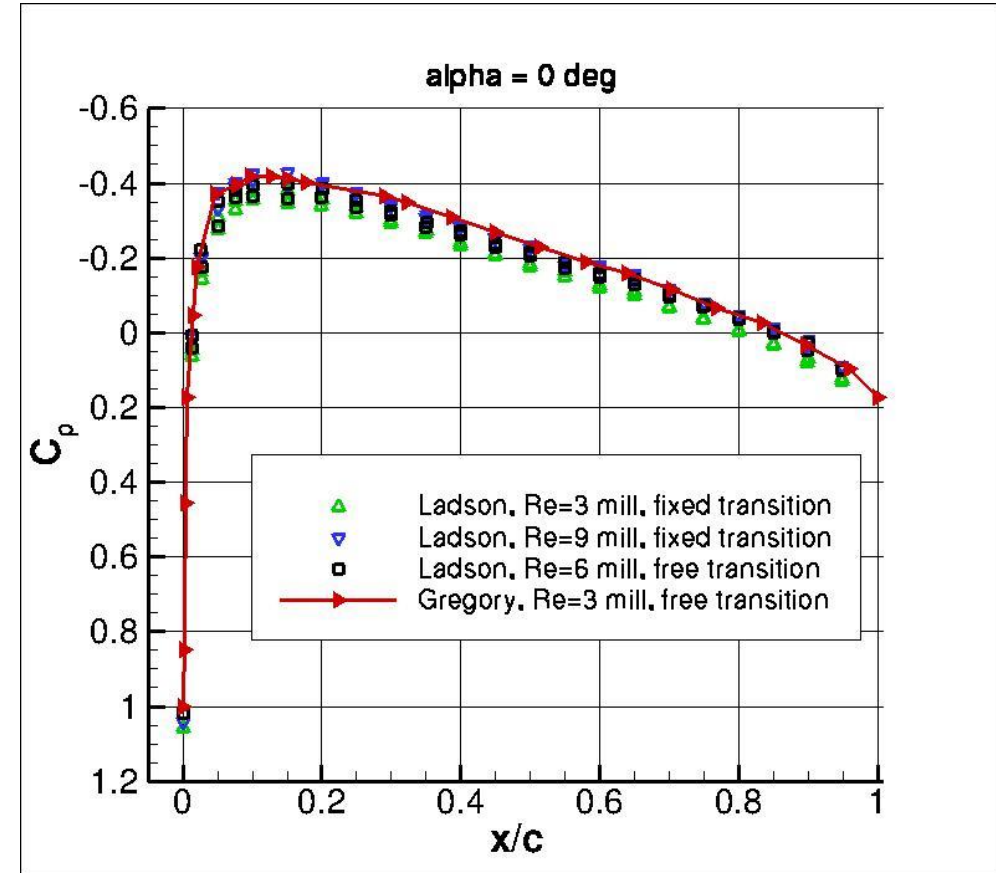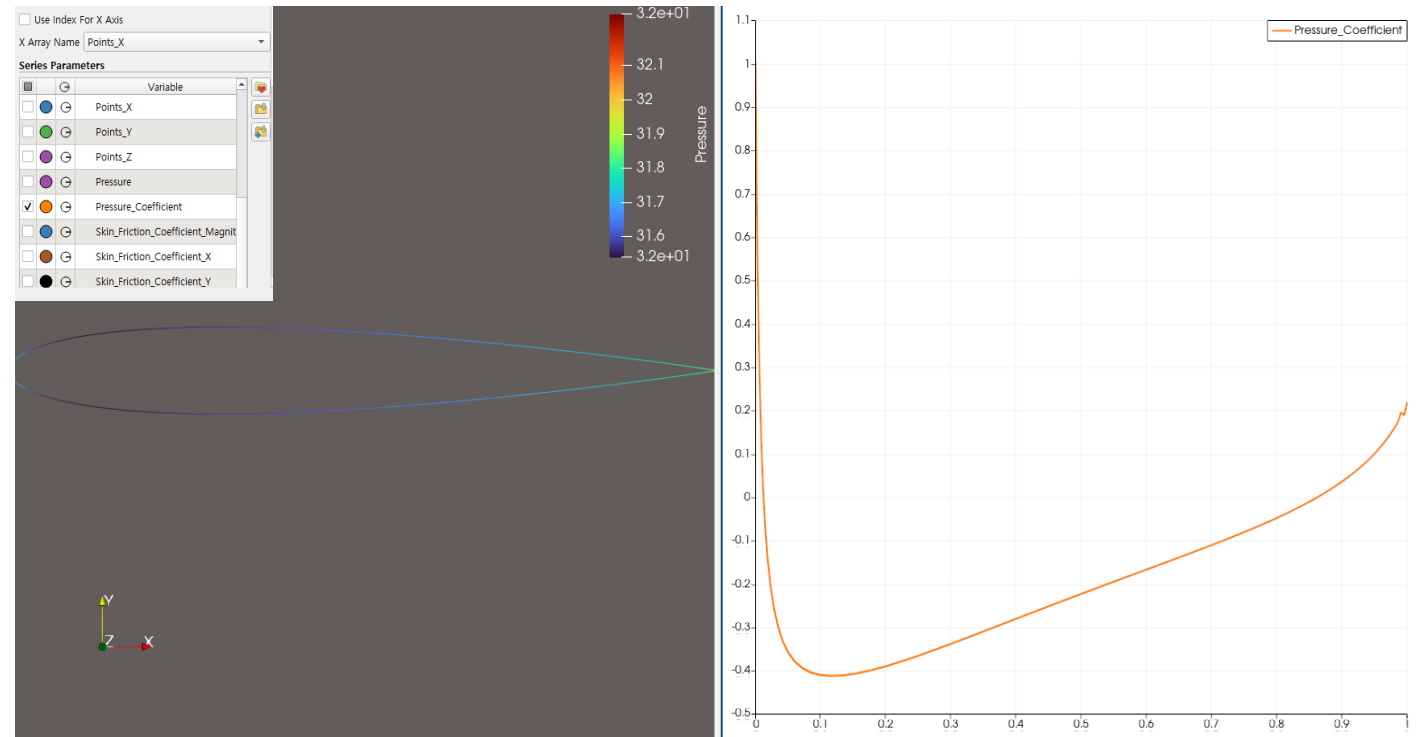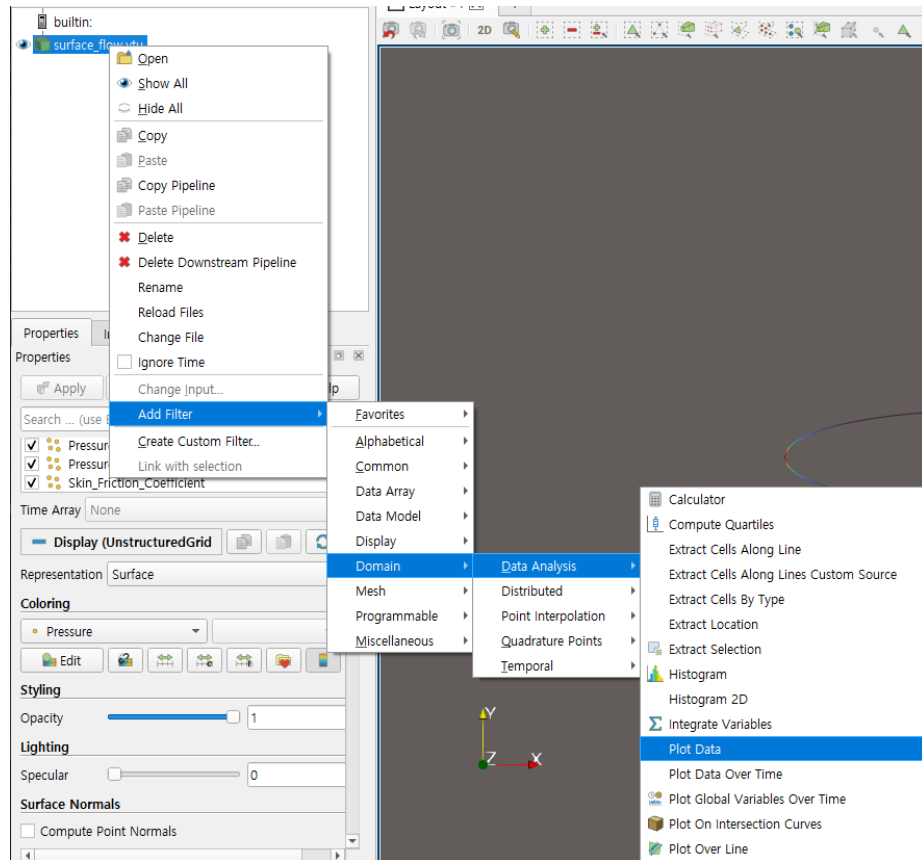

표면 압력 계수와 비교하기 위해, Ladson 등의 데이터는 선단 상부 표면 압력 피크를 잘 분해하지 못하는 것으로 보인다.

Gregory와 O'Reilly의 CP 데이터(Re=300만)는 더 잘 분해되는 것으로 보입니다. Gregory와 O'Reilly 데이터는 알파=10과 15에서 에어포일 전면 절반에 걸쳐 Ladson 등의 압력 데이터 수준과 눈에 띄는 차이를 보인다.

이와 같은 선행 결과 데이터를 바탕으로 에이포일의 AOA 치수를 수정하여 스스로 학습하고 결과값을 비교한다.

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CMD에서 추출한 값을 확인 후 surface_flow을 열어 Pressure를 적용한다.

Pressure를 적용 후에는 plot Data를 적용한다.

Plot Data에서 Pressere_Coefficient만 남기고 points_X를 적용한다.

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```
# Data from Ladson, Hill, & Johnson, NASA TM 100526, 1987.
# M=0.3
# Note: may not be sufficiently 2D, because aspect ratio of model only 1.333
variables="x/c","cp"
zone, t="Re=6 million, alpha=.0169, free transition"
 .9483    .1008
 .9000    .0279
 .8503   -.0038
 .7998   -.0378
 .7497   -.0731
 .7003   -.1027
 .6502   -.1428
 .5997   -.1585
 .5506   -.1887
 .5000   -.2152
 .4503   -.2371
 .4000   -.2716
 .3507   -.2958
 .3002   -.3257
 .2501   -.3550
 .2004   -.3854
 .1504   -.3986
 .1000   -.3949
 .0755   -.3815
 .0510   -.3522
 .0251   -.2208
 .0122    .0070
 0.       1.0184
 .0135    .0407
 .0271   -.1745
 .0515   -.2864
 .0763   -.3605
 .1012   -.3644
 .1503   -.3592
 .1994   -.3618
 .2501   -.3346
 .2999   -.3139
 .3499   -.2805
 .3994   -.2606
 .4496   -.2300
 .4997   -.2065
 .5492   -.1737
 .5994   -.1494
 .6495   -.1278
 .6996   -.0967
 .7489   -.0698
 .8003   -.0371
 .8500    .0011
 .8993    .0477
 .9489    .0973
```

[Ladson et al pressure data]

|	A	B	C	D	E
1	Points_0	0deg		X/C	Ladson
2	0	1.00659		0.9483	0.1008
3	5.82E-06	1.00477		0.9	0.0279
4	5.82E-06	1.00466		0.8503	-0.0038
5	2.72E-05	1.00132		0.7998	-0.0378
6	2.72E-05	1.00112		0.7497	-0.0731
7	7.18E-05	0.991687		0.7003	-0.1027
8	7.18E-05	0.991367		0.6502	-0.1428
9	0.00015	0.974898		0.5997	-0.1585
10	0.00015	0.974443		0.5506	-0.1887
11	0.000276	0.948771		0.5	-0.2152
12	0.000276	0.948162		0.4503	-0.2371
13	0.000469	0.910654		0.4	-0.2716
14	0.000469	0.909878		0.3507	-0.2958
15	0.000753	0.85787		0.3002	-0.3257
16	0.000753	0.856918		0.2501	-0.355
17	0.001159	0.78836		0.2004	-0.3854
18	0.001159	0.787227		0.1504	-0.3986
19	0.001725	0.701456		0.1	-0.3949
20	0.001725	0.700152		0.0755	-0.3815
21	0.002493	0.598646		0.051	-0.3522
22	0.002493	0.597189		0.0251	-0.2208
23	0.003515	0.483897		0.0122	0.007
24	0.003515	0.482318		0	1.0184
25	0.004845	0.363153		0.0135	0.0407
26	0.004845	0.361489		0.0271	-0.1745
27	0.006539	0.243067		0.0515	-0.2864
28	0.006539	0.241358		0.0763	-0.3605
29	0.008661	0.129571		0.1012	-0.3644
30	0.008661	0.127856		0.1503	-0.3592
31	0.011275	0.026852		0.1994	-0.3618
32	0.011275	0.025163		0.2501	-0.3346
33	0.014452	-0.06298		0.2999	-0.3139
34	0.014452	-0.06462		0.3499	-0.2805
35	0.018269	-0.1394		0.3994	-0.2606
36	0.018269	-0.14097		0.4496	-0.23
37	0.022809	-0.20316		0.4997	-0.2065
38	0.022809	-0.20466		0.5492	-0.1737
39	0.028167	-0.2555		0.5994	-0.1494
40	0.028167	-0.25691		0.6495	-0.1278

[진행한 데이터 & Ladson 데이터 비교]

위의 데이터를 추출하여 NASA 랭글리 연구 센터에서 난류 모델링 리소스의 선행 데이터를 이용하여 비교한다.

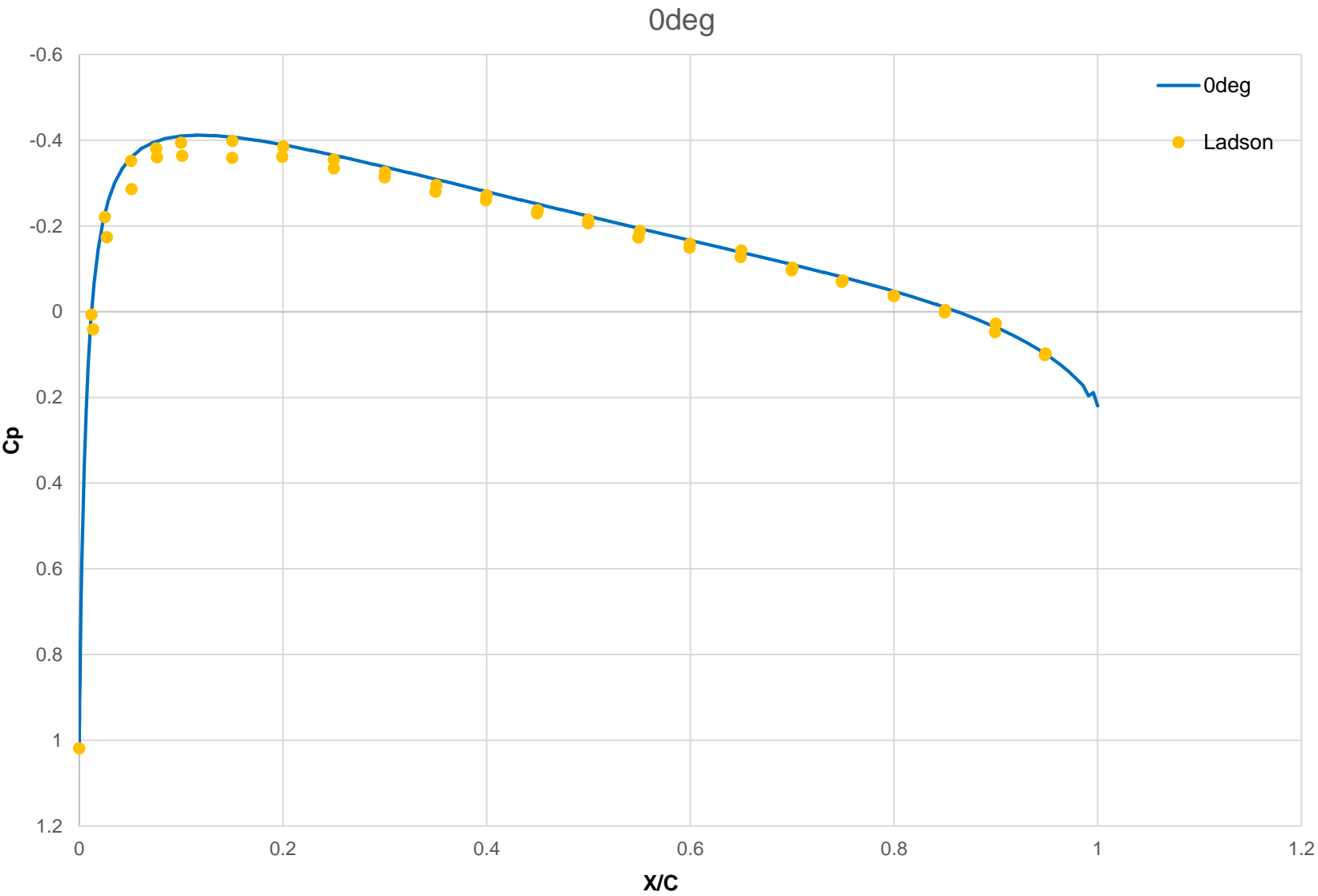# 2DN00: 2D NACA 0012 Airfoil Validation Case
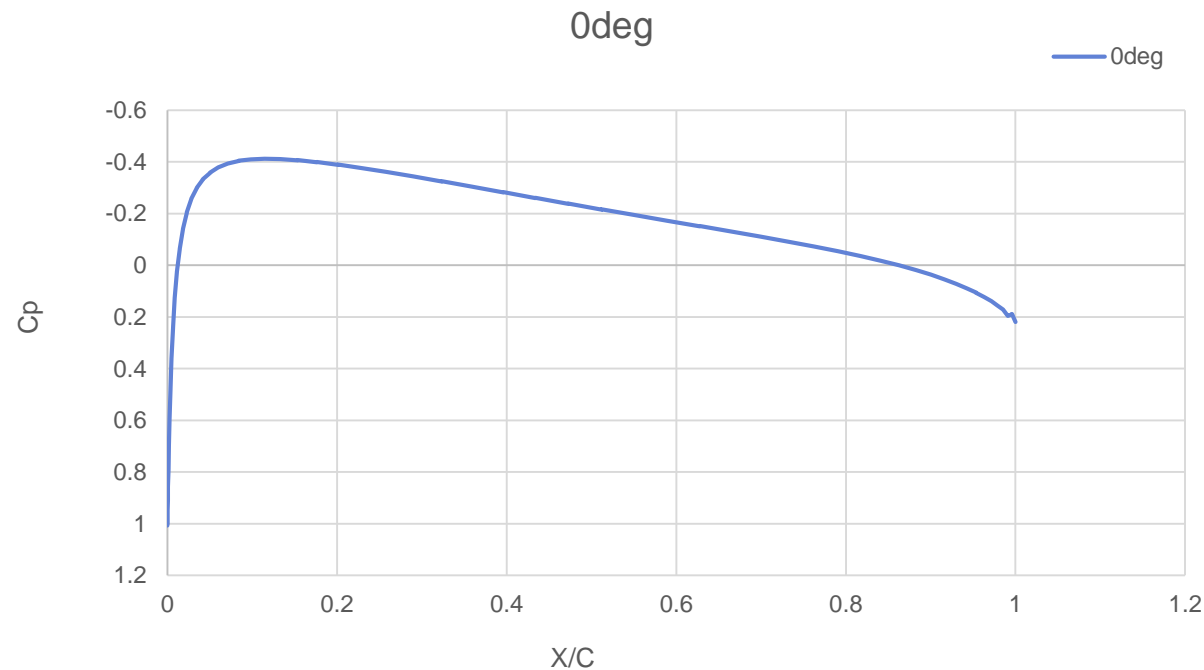
[진행한 데이터 그래프]
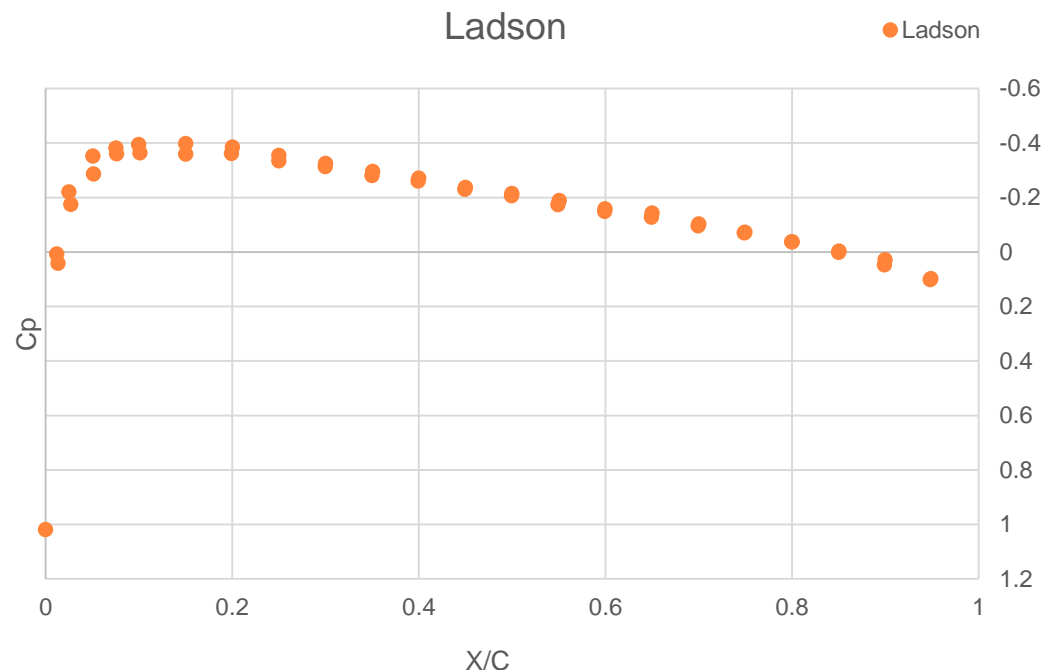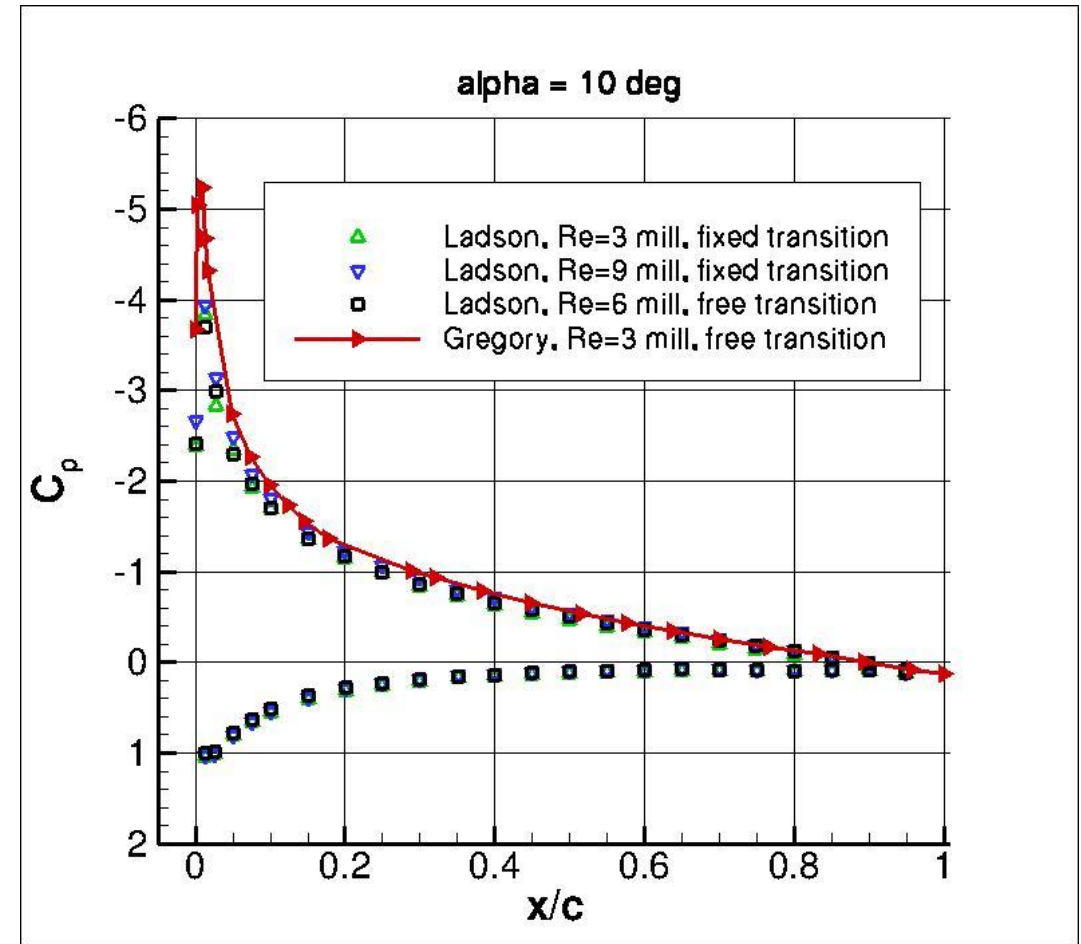
[Ladson 데이터 그래프]

2DN00: 2D NACA 0012 Airfoil Validation Case

[비교 데이터 그래프 결과]

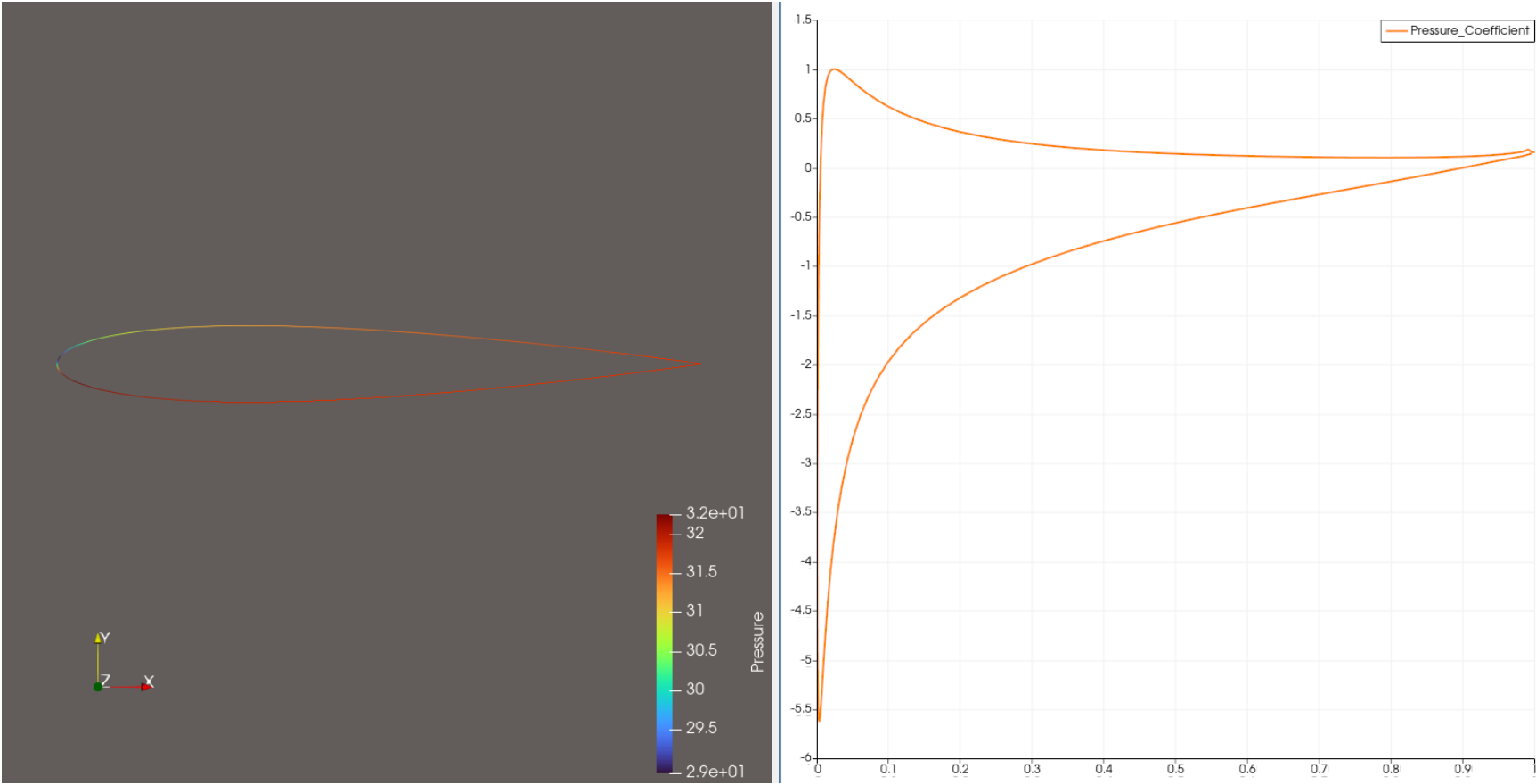# 2DN00: 2D NACA 0012 Airfoil Validation Case

[10deg]

```
% -------------------- COMPRESSIBLE FREE-STREAM DEFINITION -------------------%
%
% Mach number (non-dimensional, based on the free-stream values)
MACH_NUMBER= 0.15
%
% Angle of attack (degrees, only for compressible flows)
AOA= 10.0
%
% Side-slip angle (degrees, only for compressible flows)
SIDESLIP_ANGLE= 0.0
%
% Init option to choose between Reynolds (default) or thermodynamics quantities
% for initializing the solution (REYNOLDS, TD_CONDITIONS)
INIT_OPTION= REYNOLDS
%
% Free-stream option to choose between density and temperature (default) for
% initializing the solution (TEMPERATURE_FS, DENSITY_FS)
FREESTREAM_OPTION= TEMPERATURE_FS
%
% Free-stream temperature (288.15 K by default)
FREESTREAM_TEMPERATURE= 288.15
%
% Reynolds number (non-dimensional, based on the free-stream values)
REYNOLDS_NUMBER= 6.0E6
%
% Reynolds length (1 m by default)
REYNOLDS_LENGTH= 1.0
```


alpha = 10 deg

Ladson. Re=3 mill. fixed transition
Ladson. Re=9 mill. fixed transition
Ladson. Re=6 mill. free transition
Gregory. Re=3 mill. free transition

| A	B
Points_0	10deg
1	0.16145
0.995782	0.15854
0.990924	0.191087
0.985337	0.166112
0.978921	0.159813
0.971568	0.150634
0.963157	0.143594
0.95356	0.136492
0.942641	0.130309
0.930255	0.124588
0.916256	0.119545
0.900496	0.115121
0.882836	0.111407
0.863146	0.108428
0.841316	0.106242
0.817266	0.104895
0.790952	0.104426
0.762378	0.104879
0.731603	0.106296
0.69875	0.108728
0.664007	0.112246
0.627628	0.116953
0.589933	0.123001
0.551292	0.130571
0.512117	0.139925
0.472843	0.151356
0.433912	0.165247
0.395749	0.181981
0.358747	0.202003
0.323253	0.22566
0.289554	0.253306
0.257873	0.285159

[파라뷰로 작성한 데이터 그래프]

2DN00: 2D NACA 0012 Airfoil Validation Case
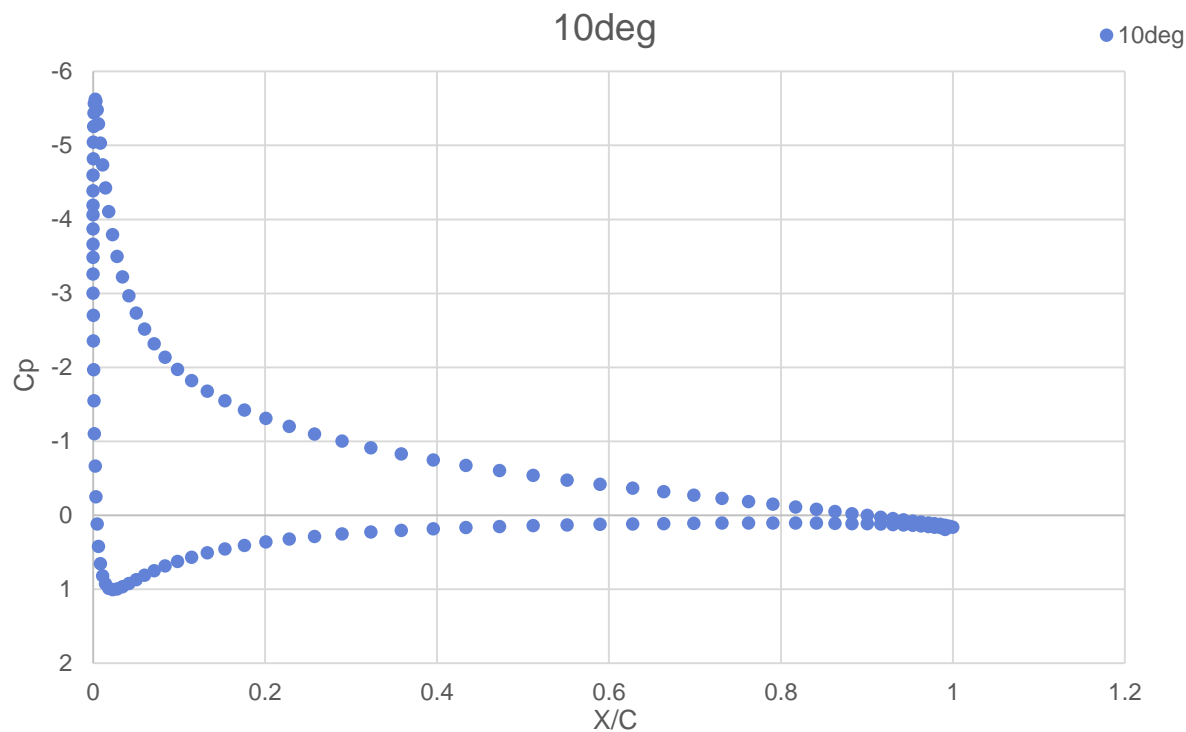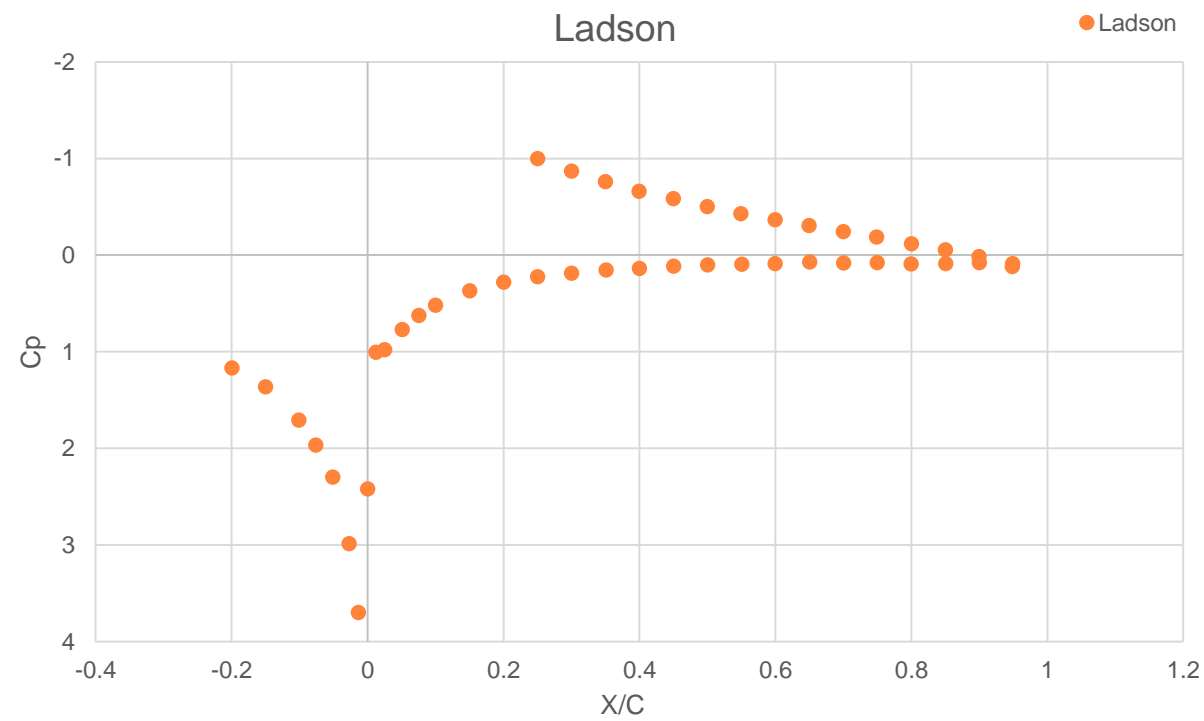
[진행한 데이터 그래프]

[Ladson 데이터 그래프]

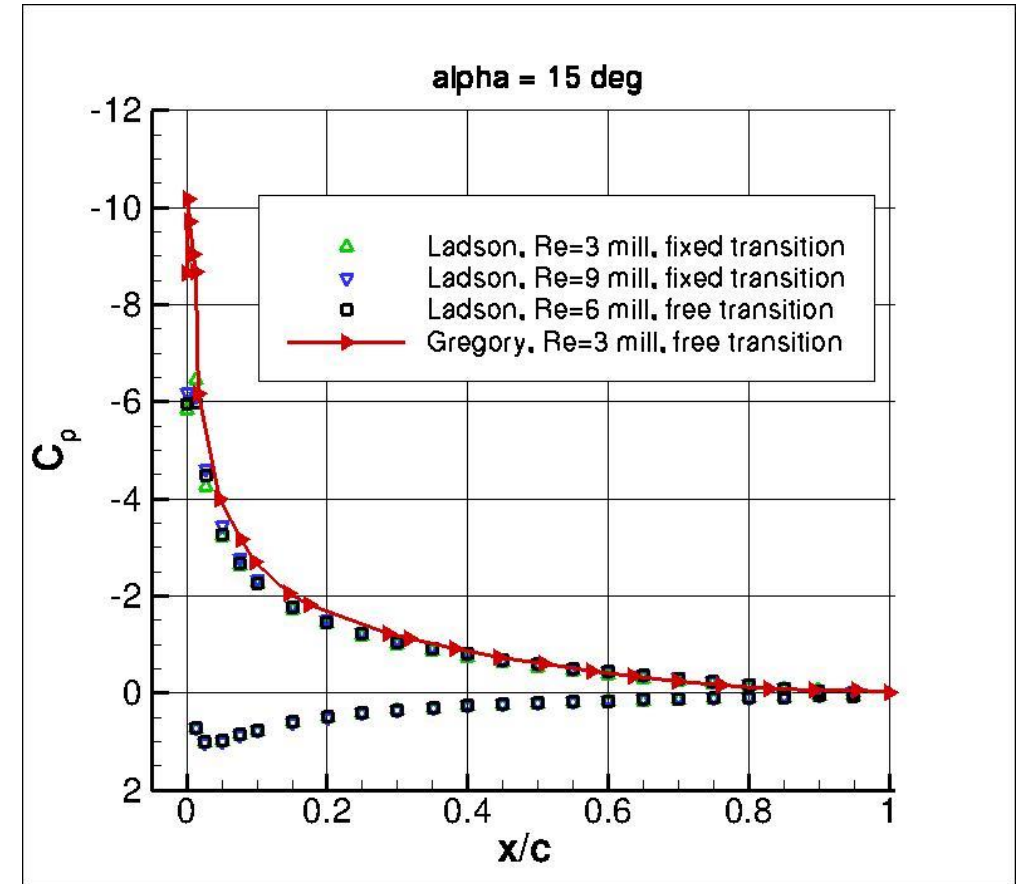# 2DN00: 2D NACA 0012 Airfoil Validation Case

10deg

■ 10deg   ● Ladson
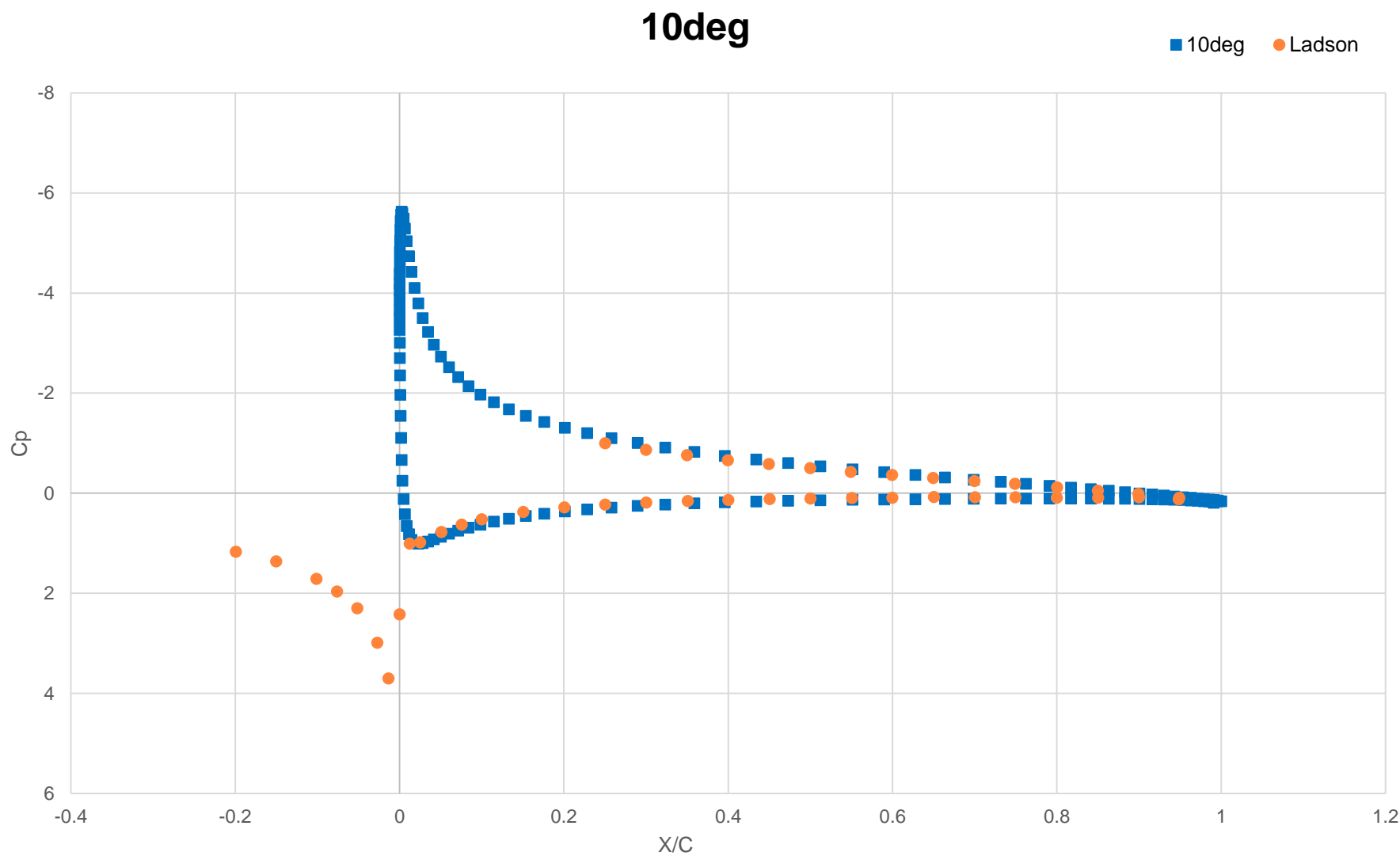
[비교 데이터 그래프 결과]

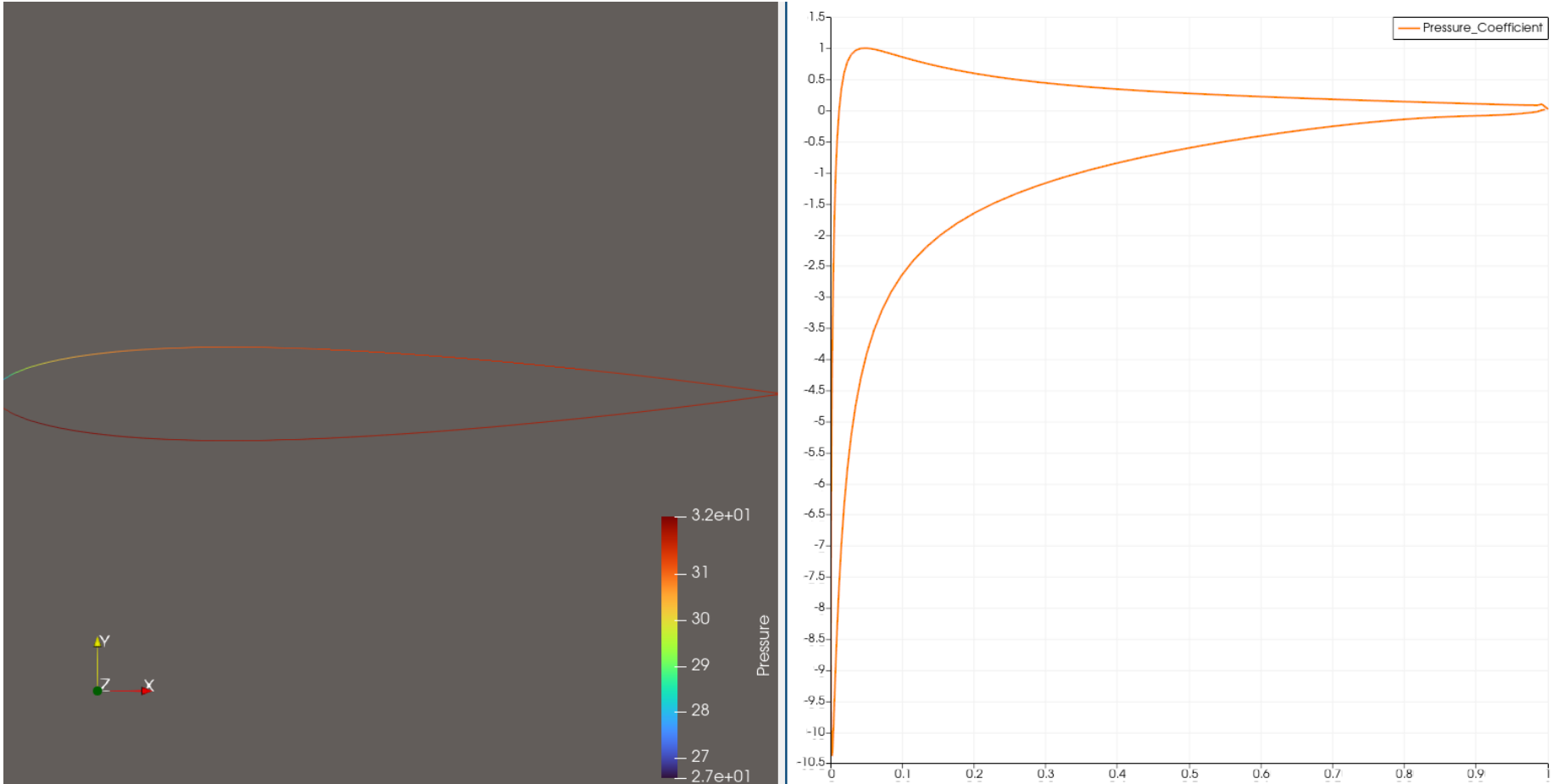# 2DN00: 2D NACA 0012 Airfoil Validation Case

[15deg]

```
% ------------------- COMPRESSIBLE FREE-STREAM DEFINITION -------------------%
%
% Mach number (non-dimensional, based on the free-stream values)
MACH_NUMBER= 0.15
%
% Angle of attack (degrees, only for compressible flows)
AOA= 15.0
%
% Side-slip angle (degrees, only for compressible flows)
SIDESLIP_ANGLE= 0.0
%
% Init option to choose between Reynolds (default) or thermodynamics quantities
% for initializing the solution (REYNOLDS, TD_CONDITIONS)
INIT_OPTION= REYNOLDS
%
% Free-stream option to choose between density and temperature (default) for
% initializing the solution (TEMPERATURE_FS, DENSITY_FS)
FREESTREAM_OPTION= TEMPERATURE_FS
%
% Free-stream temperature (288.15 K by default)
FREESTREAM_TEMPERATURE= 288.15
%
% Reynolds number (non-dimensional, based on the free-stream values)
REYNOLDS_NUMBER= 6.0E6
%
% Reynolds length (1 m by default)
REYNOLDS_LENGTH= 1.0
```
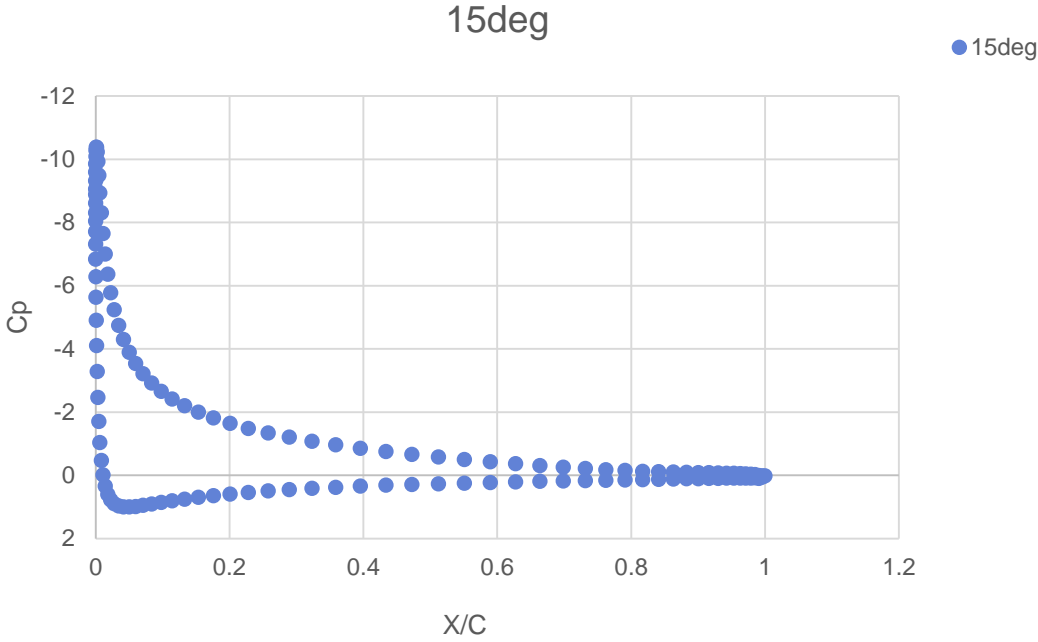
A	B
Points_0	15deg
0	-10.3831
5.82E-06	-10.3743
5.82E-06	-10.2776
2.72E-05	-10.2253
2.72E-05	-10.0903
7.18E-05	-9.92623
7.18E-05	-9.85126
0.00015	-9.58732
0.00015	-9.48721
0.000276	-9.31682
0.000276	-9.058
0.000469	-8.93562
0.000469	-8.88284
0.000753	-8.60916
0.000753	-8.30928
0.001159	-8.30616
0.001159	-8.0449
0.001725	-7.70861
0.001725	-7.65024
0.002493	-7.31395
0.002493	-6.99445
0.003515	-6.84004
0.003515	-6.36493
0.004845	-6.28049
0.004845	-5.77532
0.006539	-5.63047
0.006539	-5.23266
0.008661	-4.8978
0.008661	-4.73939
0.011275	-4.29434
0.011275	-4.10282
0.014452	-3.89381
0.014452	-3.53358
0.018269	-3.2788

[파라뷰로 작성한 데이터 그래프]

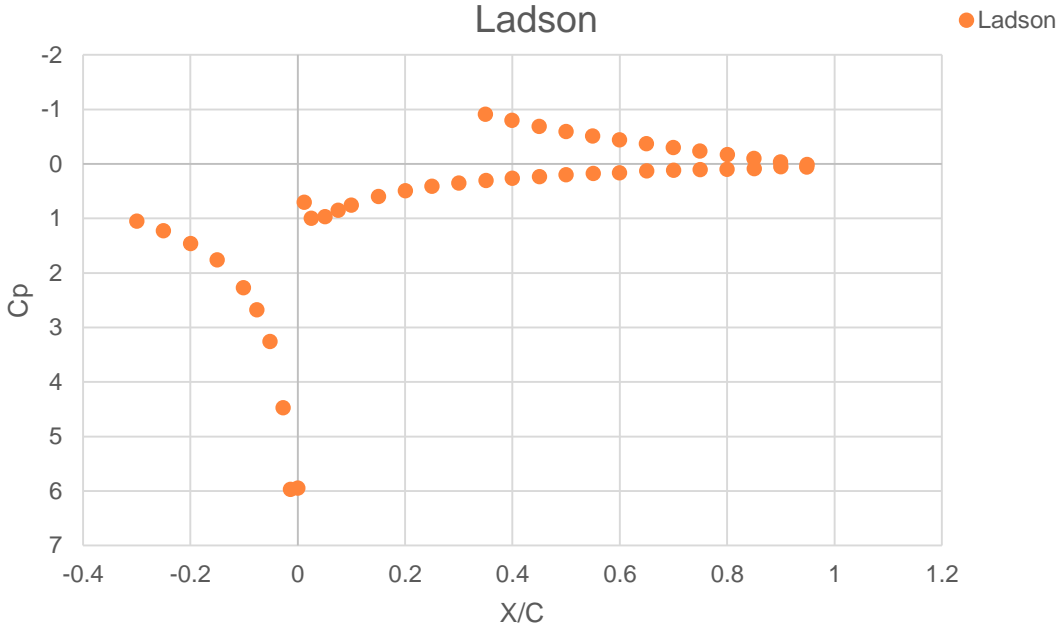# 2DN00: 2D NACA 0012 Airfoil Validation Case
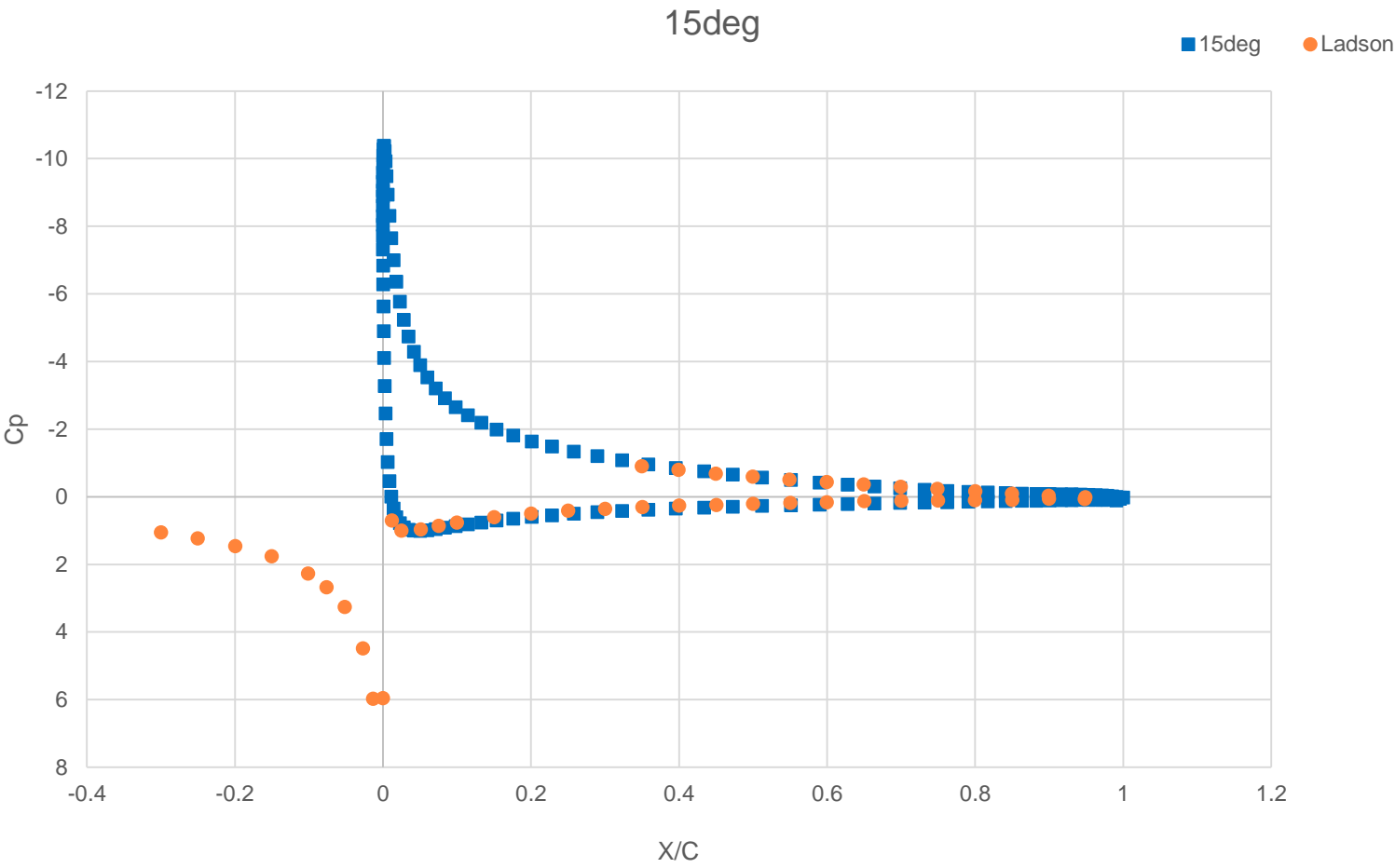

[진행한 데이터 그래프]

[Ladson 데이터 그래프]

2DN00: 2D NACA 0012 Airfoil Validation Case

[비교 데이터 그래프 결과]