Minimize placard's drag force

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발표 장소 : H05-303

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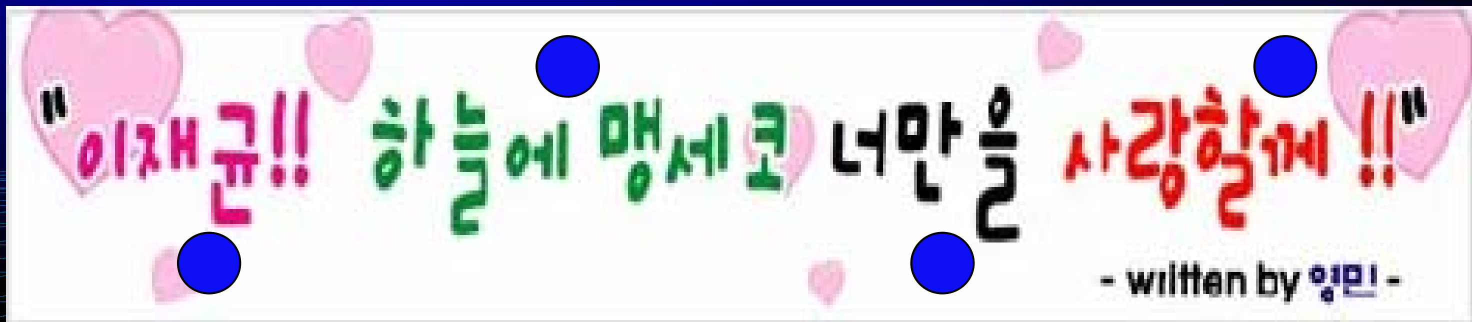
Project statement

❖ Problem of placard

- ✓. Tare in Placard
- ✓. Wire snapped
- ✓. Column broken

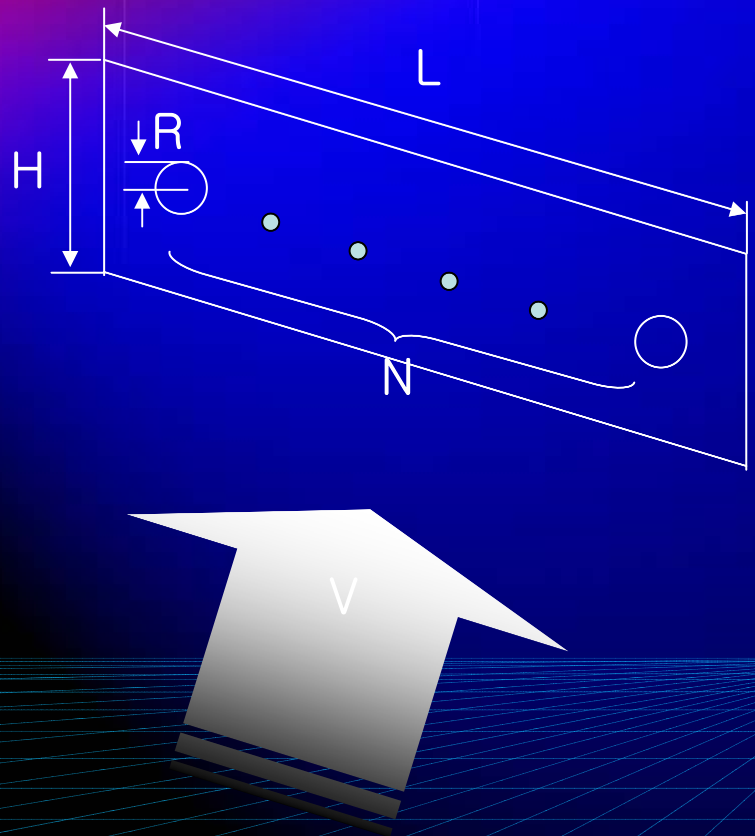
Minimize

Drag force



Reference :http://www.1700.co.kr/

Information collection and Identification of variable



❖ **Data for project**

	Data
L(m)	8
H(m)	0.6
V(m/s)	2.41

❖ **Design variables**

x_1 : Number of hole (N)

x_2 : Radius (R)

Identification of a objective function

- Make a Objective Function

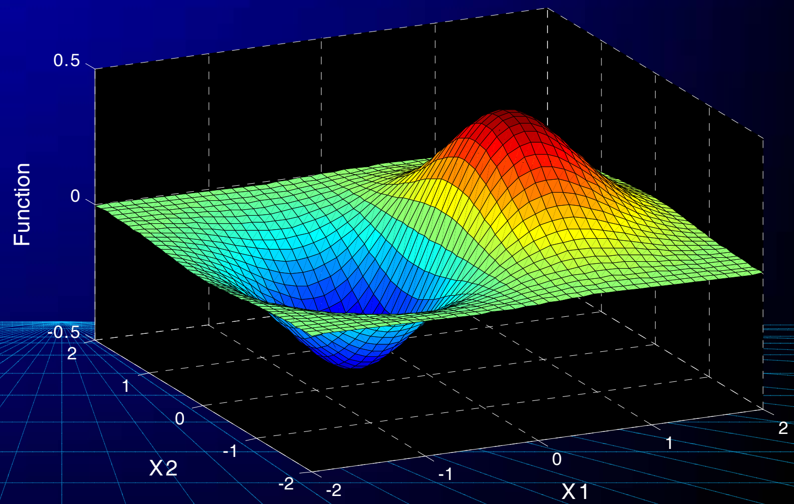
  Calculate Drag force using Simulation

  Create Drag force Function by Curve Fitting

- Minimize f(x1,x2)

  Graphical method

  Numerical method



Identification of constraints

- Area of Holes less than 5% placard's Area

Constraint. 1 $A_h \le 0.05 \times A_p$

$$A_h = x_1 \times \pi x_2^{\,2}, \quad A_p = L \times H$$

- Length of between holes more than 1.5 times radius

Constraint. 2 $2x_2(5x_1 + 3) \le L$

$$x_1 \times 2x_2 + (x_1 + 1) \times 3x_2 \le L$$

Constraint. 3 $0 \le x_1(\text{int}) \le 30, \quad 0.05 \le x_2 \le 0.1$

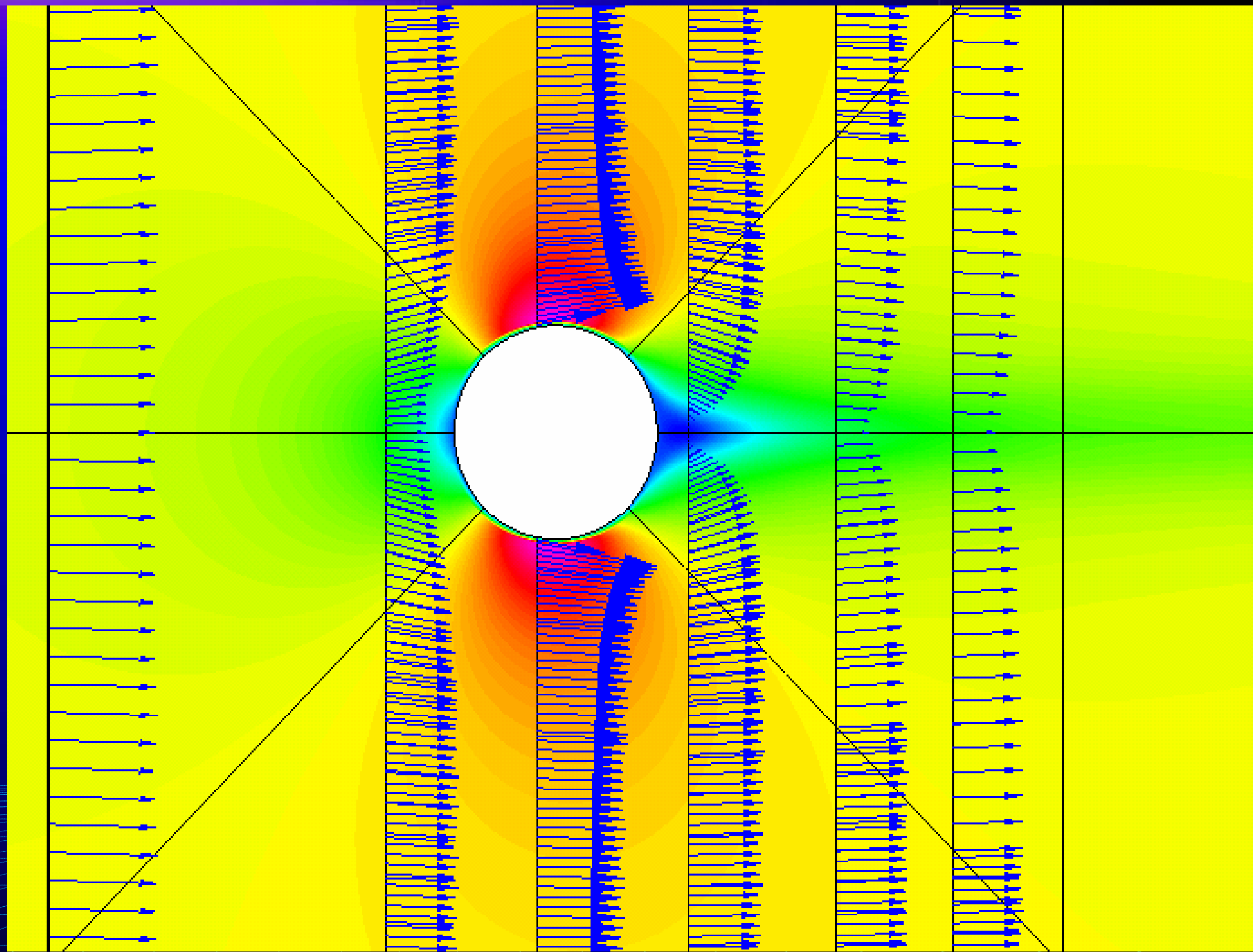
Verification

Cd(ref)=0.71

Cd=0.65

Re=1.4E5

error=8.4%



Reference: Turbulence models and boundary conditions for bluff body flow.

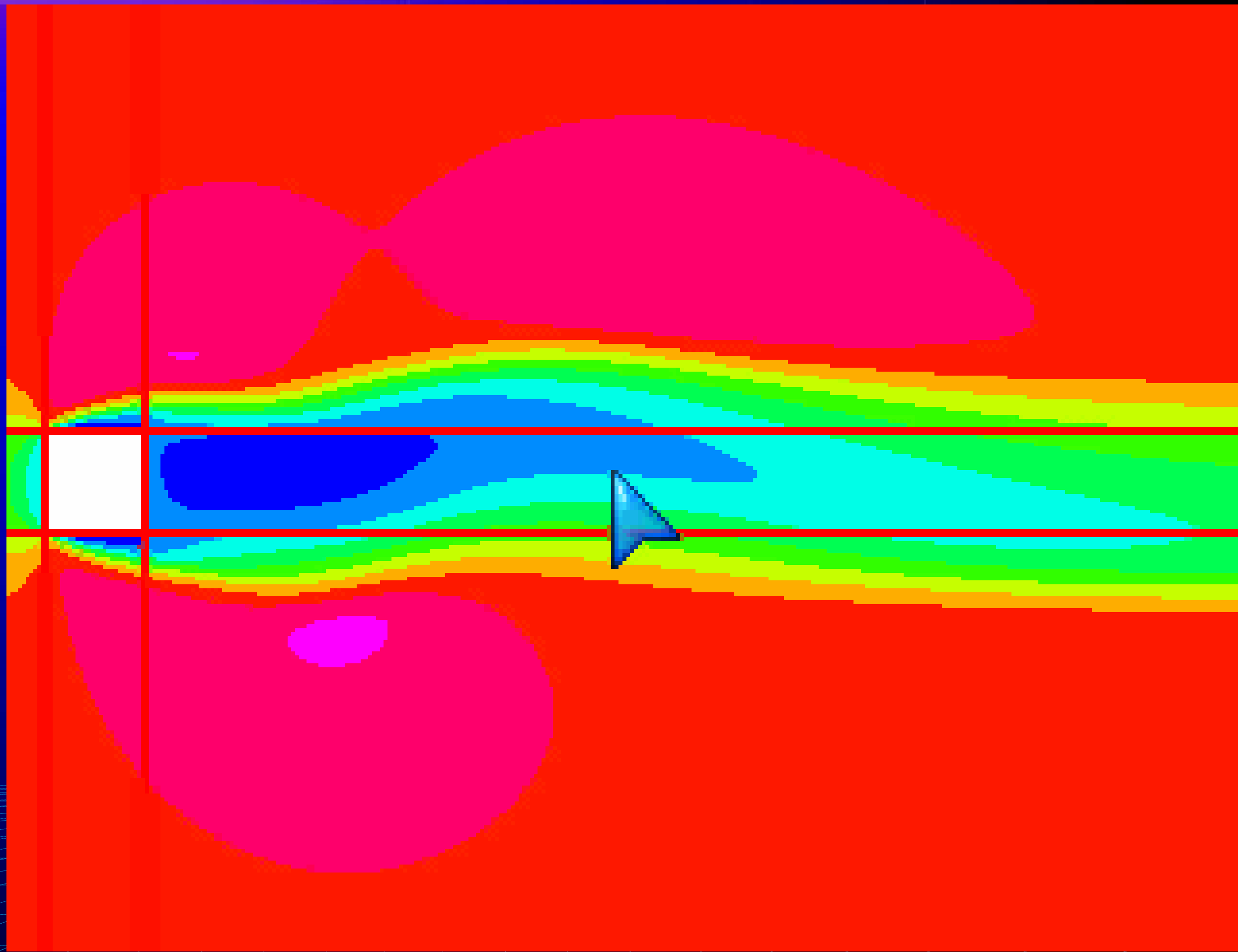
Verification

Cd(ref)=1.618

Cd=1.62

Re=2.2E4

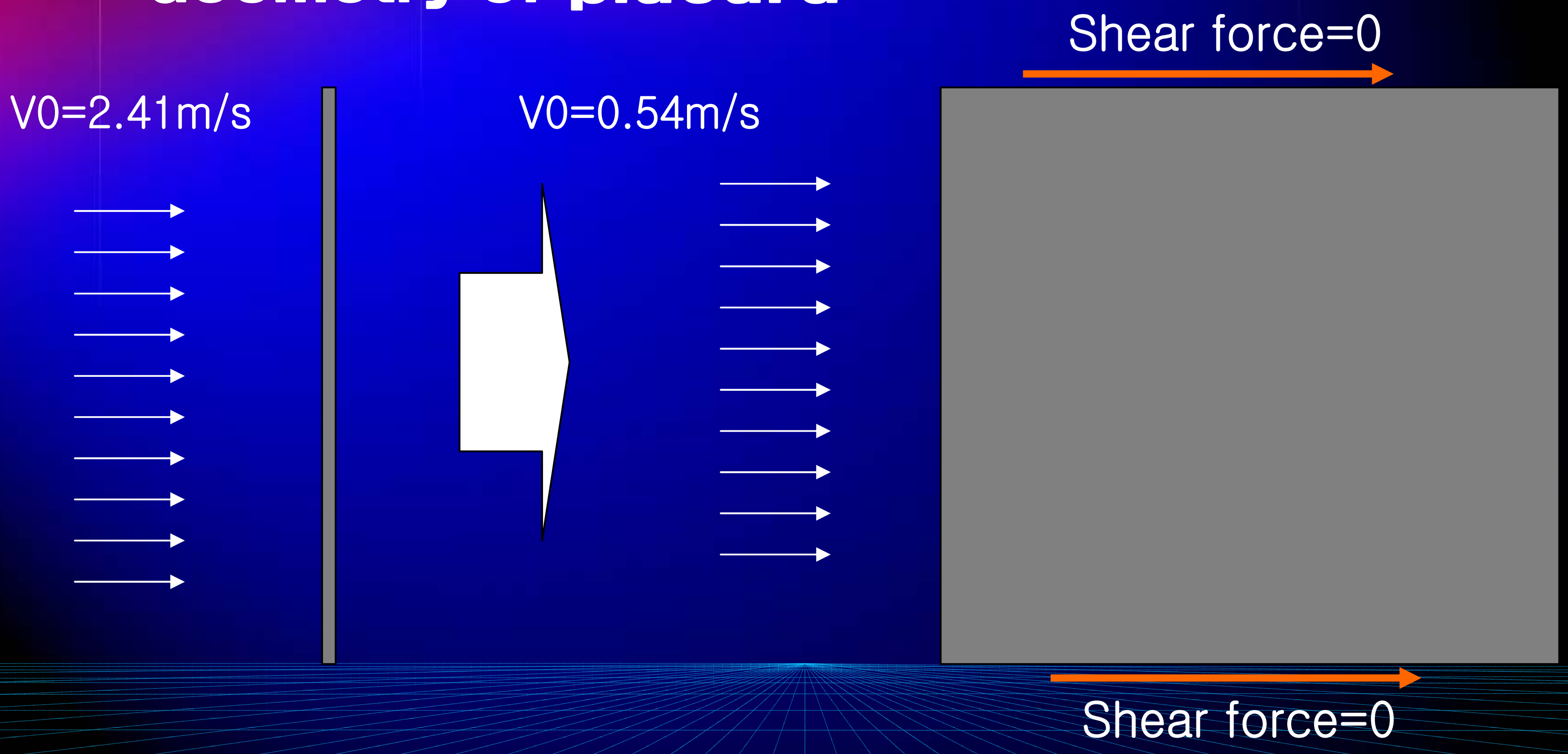
Error=0.1%



Reference : simulation of vortex shedding past a square cylinder with different turbulence models

Assumption

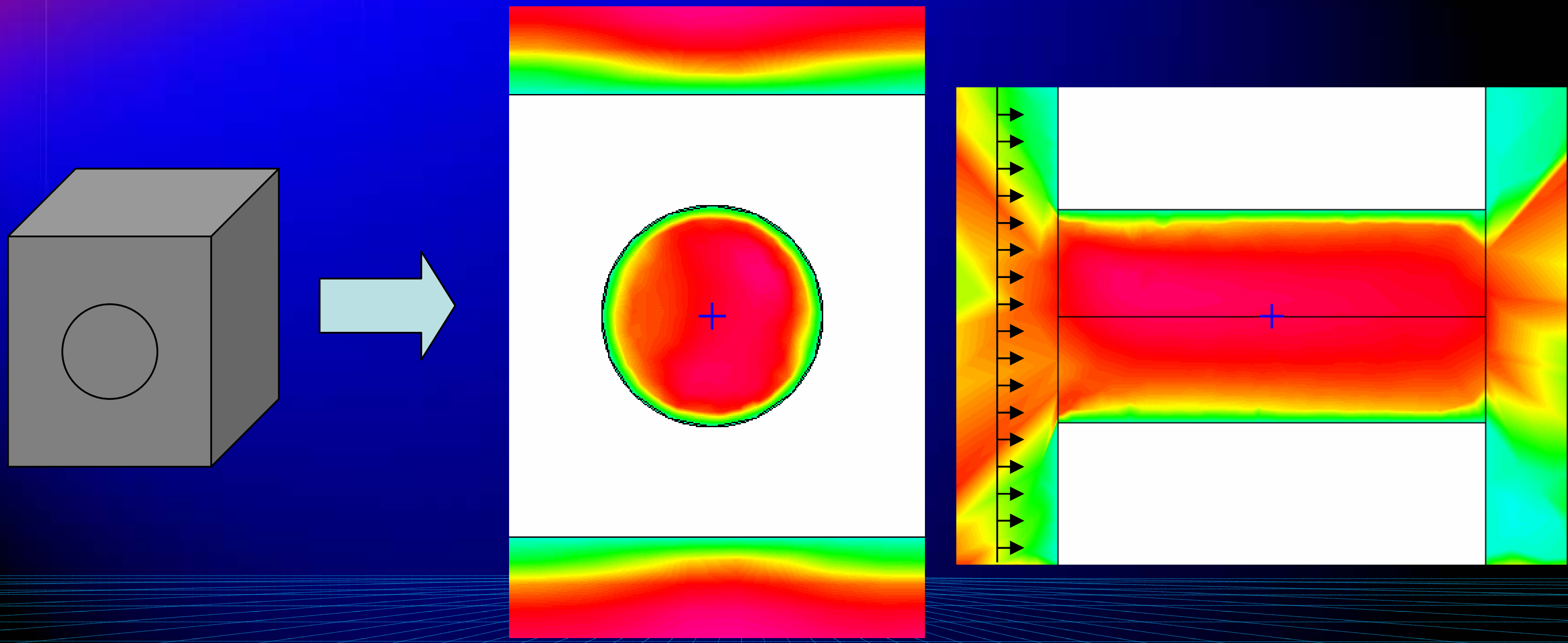
❖ **Geometry of placard**



Pressure force=1.89E-1 N Shear force=1.99E-4 N

Result (CFD-ace)

❖ Velocity profile of placard



<Front view> <Side view>

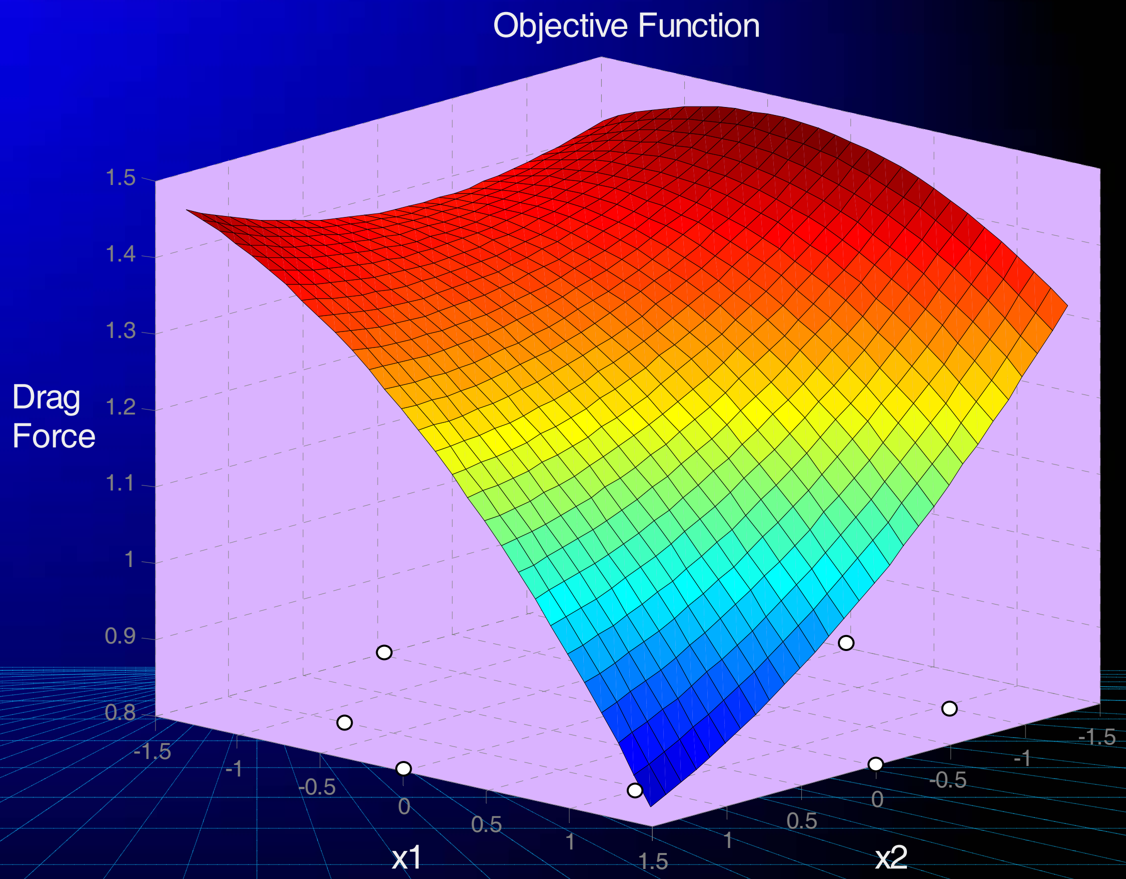
Result (RSM)

❖ Velocity Objective function

Minimize

$$f(x) = 1.298 - 8.42E^{-2}x_1 - 1.37E^{-1}x_2 + 2.98E^{-2}{x_1}^2 - 5.25E^{-2}{x_2}^2 - 6.85E^{-2}x_1x_2$$

$< R^2 = 95\% >$



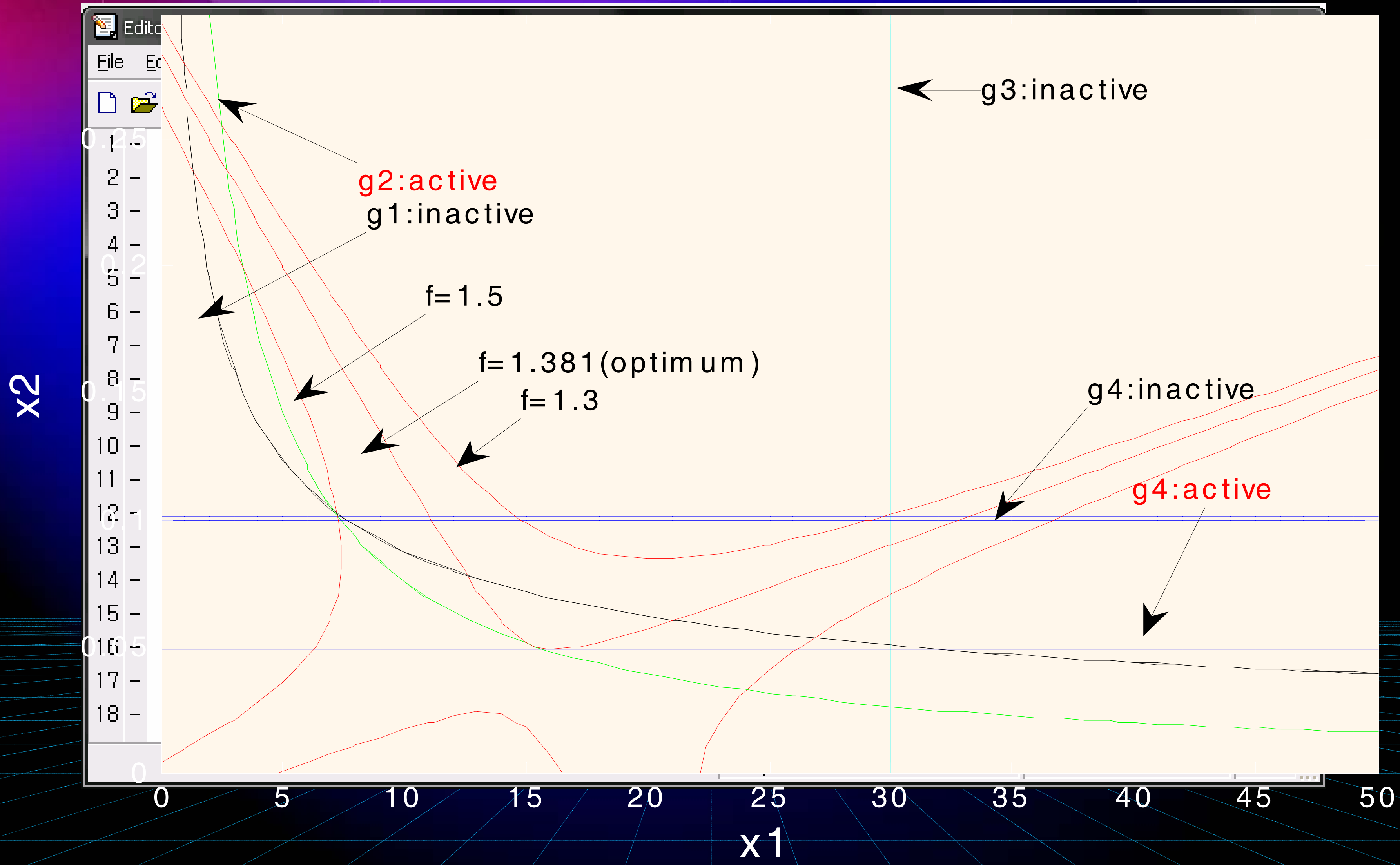
Result (Excel)

Placard 제원					
length	8	[m]	Re	2,20E+04	
height	0,6	[m]	wind V	0,54	[m/s]

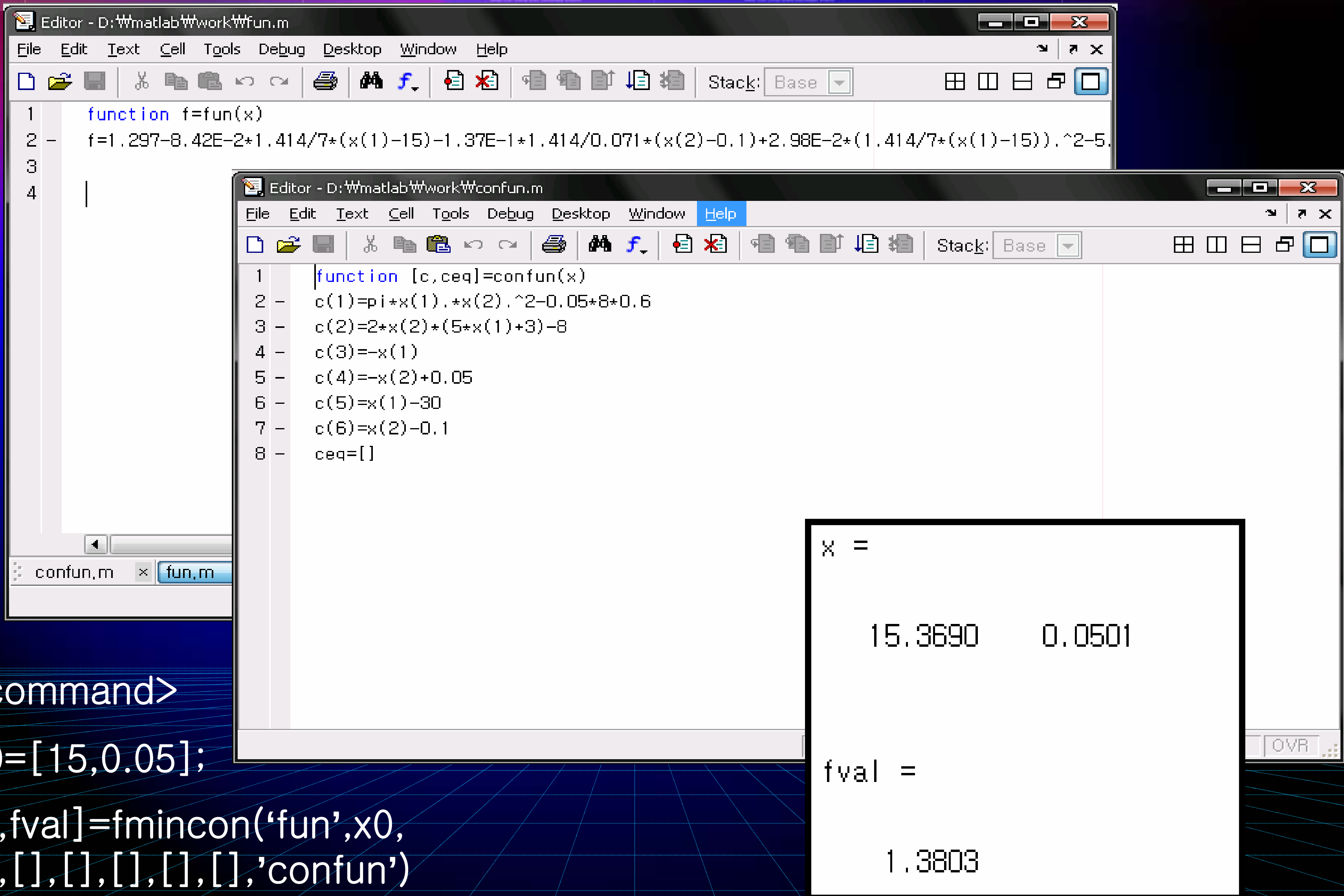
variable	x1	length between circle
	x2	radius
objective	minimize f	=1,297-8,42E-2xx1-1,37E-1xx2 +2,98E-2xx1^2-5,25E-2xx2^2-6,85E-2xx1xx2
subject to	g1	=pi()*x1x2x2^2-0,05*8*0,6=0
	g2	=2x2(5x1+3)-8<=0
	g3	0<x1<30
	g4	0<x2<0,1

x1	15		
x2	0,051282		
f	1,380501		
g1	-0,11607	0	
g2	0	0	
g3	15	0	30
g4	0,051282	0,05	0,1

Result (Matlab-graphical)



Result (Matlab-fmincon)



<command>

X0=[15,0.05];

[x,fval]=fmincon('fun',x0, [],[],[],[],[],[],'confun')

Conclusion

- ❖ Drage force reduction (1.477N => 1.38N)
- ❖ Three method express same result
- ❖ Too many assumptions
- ❖ Uncertainty 3D CFD modeling