midas NFX-CFD

CFD_線上課程

土木建築橋樑-CFD 2D基礎課程

台灣邁達斯

2025/01/17 10:00~11:30
Google會議室 https://meet.google.com/sgo-hhbz-qiy

註:範例相關參數使用假設條件。

Subject

- 基礎觀念介紹
  - 斯特勞哈爾數
  - 風廓線
  - 壓力係數
  - 建築風場數值模擬

- 案例操作
  - 2D斯特勞哈爾數
  - 2D風廓線
  - 2D壓力係數

斯特勞哈爾數
(Strouhal number)

斯特勞哈爾數(Strouhal number) ，是流體力學中用來描述周期性非定常流動的一個無量綱數。

斯特勞哈爾數

$$\mathrm{St} = \frac{fL}{U}$$

St:斯特勞哈爾數
F:旋渦脫落頻率
L是特徵長度
U是流速

Reference
https://en.wikipedia.org/wiki/Strouhal_number

風廓線
(Wind Speed Profile)

風廓線即風速隨高度的變化曲線，以研究大氣邊界層內的風速規律。常用邊界層風速剖面的有兩定律，一為指數律(power law)，另一則為對數律(logarithmic law)。

指數律風廓線
(Wind profile power law)

$$u = u_r \left(\frac{z}{z_r} \right)^{\alpha}$$

u:is the wind speed(m/sec) at height z (m)
u_γ:is the known wind speed(m/sec) at a reference height z_γ (m)
α : is an empirically derived coefficient that varies dependent upon the stability of the atmosphere.For neutral stability conditions , α is approximately 1/7 。

對數風廓線
(Log wind profile)

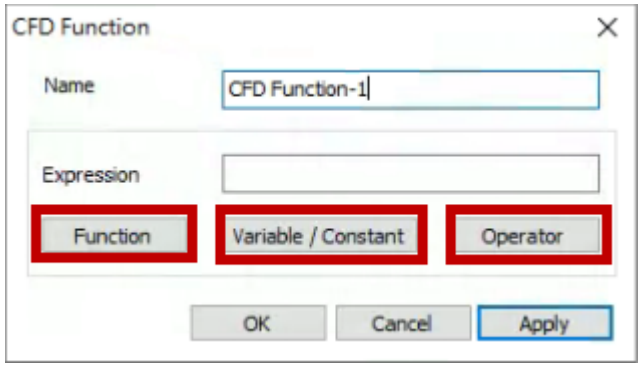
$$u_z = \frac{u_*}{\kappa} \left[\ln \left(\frac{z-d}{z_0} \right) \right]$$

u_z:is the wind speed(m/sec) at height z (m)
u_* : is the friction velocity (m/s)
k: is the Von Kármán constant (~0.41)
d : is the zero plane displacement (m)
Z_0:is the surface roughness (m)

Reference
https://en.wikipedia.org/wiki/Wind_profile_power_law
https://en.wikipedia.org/wiki/Log_wind_profile

CFD函數

NFX CFD提供複雜函數和矩陣計算，它還包括一些幫助插入函數的工具：變量列表和運算符列表。



函數

變量/常量

運算式

風廓線CFD函數定義
(指數律風廓線)

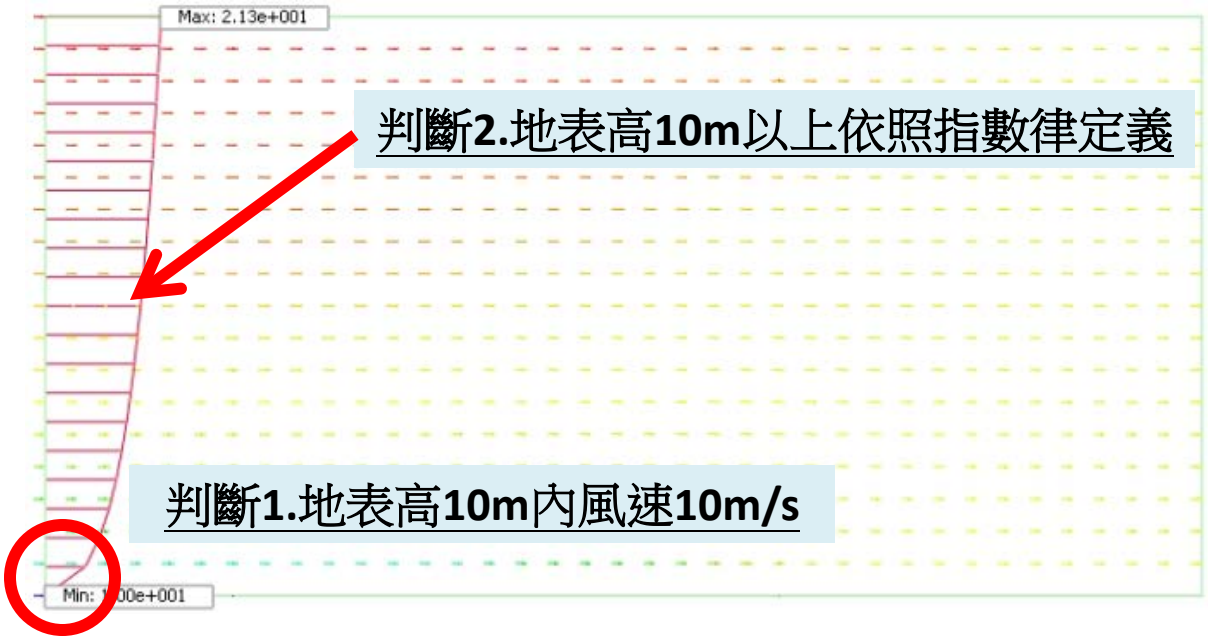
$$u = u_r \left(\frac{z}{z_r} \right)^{\alpha}$$

u:相對高度風速(m/s)
Z_γ:地表高度(10m)
u_γ:地表高度Z_γ風速(假設10m/s)
α :0.143

CFD IF Function格式

if(expression)then(elif_expression)else(next_expression)endif

=>if(y<10)then(10)else(10*(y/10)^(0.143))endif



註:2D空間高度座標為y軸。

壓力係數
(Pressure Coefficient)

壓力係數是描述流體動力學中整個流場的相對壓力的無量綱數，壓力系數應用於空氣動力學和流體力學，流體流場中的每一點的壓力系數不同。該無量綱係數與維數關係如下：

$$C_p = \frac{p - p_\infty}{\frac{1}{2}\rho_\infty V_\infty^2} = \frac{p - p_\infty}{p_0 - p_\infty}$$

P: is the static pressure at the point at which pressure coefficient is being evaluated.

P_∞ : is the static pressure in the free-stream.

P_0: is the stagnation pressure in the free-stream.

ρ_∞ : is the free-stream fluid density.

V_∞ :is the free-stream velocity of the fluid, or the velocity of the body through the fluid.

The free-stream(自由流)

自由流是指飛機前未經擾動的來流，也即沒有飛機等干擾時，空氣的自然流動現象。

Reference

https://en.wikipedia.org/wiki/Pressure_coefficient

CAARC建築風場數值模擬-1

$$C_P = 2(P - P_0)/\rho U_0^2$$

C_p:風壓係數
P:觀測點平均壓力(通用標準測點取2/3H)
P_0:參考高度處的靜壓
ρ：空氣密度
U_0:建築物高度初始風速
H:建築物高度(m)

計算流域取1800m×600m×1000m
(建築物置於流域沿流向前1/3處)

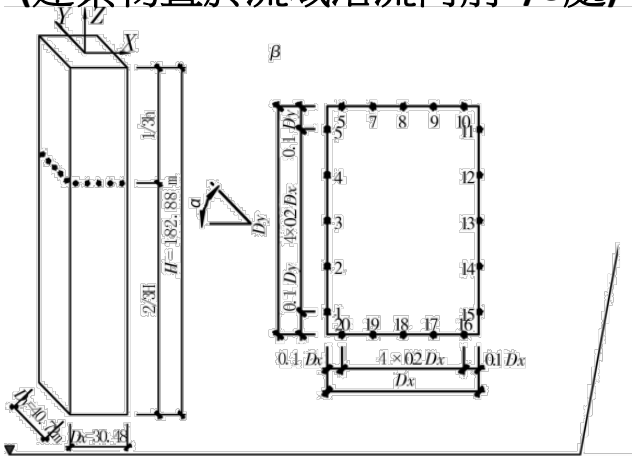


图 1　CAARC 几何尺寸及压力测点布置图

Reference

聶少鋒,周緒紅.CAARC標準高層建築三維鈍體繞流風場數值模擬.土木建築與環境工程,2009,Vol.31 No.6

CAARC建築風場數值模擬-2

$$U = U_0 \left(\frac{Z}{Z_0}\right)^{\alpha}$$

U:相對高度風速(m/s)
Z:地表相對高度(m)
Z_0:參考高度(常見取地表10m高)
U_0:參考高度風速(m/s)
α :地面粗糙度指數

类别	描述	Z_G/m	α
A	指近海海面、海岛、海岸、湖岸及沙漠地区	300	0.12
B	指田野、乡村、丛林、丘陵及房屋比较稀疏的乡镇和城市郊区	350	0.16
C	指有密集建筑群的城市市区	400	0.22
D	指有密集建筑群且房屋 较高的城市市区	450	0.30

Reference
聶少鋒,周緒紅.CAARC標準高層建築三維鈍體繞流風場數值模擬.土木建築與環境工程,2009,Vol.31 No.6

CFD_標準教學系列

強制對流分析10-2D斯特勞哈爾數

台灣邁達斯

註:範例所需計算時間較長

斯特勞哈爾數
(Strouhal number)

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斯特勞哈爾數

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St:斯特勞哈爾數
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U是流速

Reference
https://en.wikipedia.org/wiki/Strouhal_number

分析說明

Re:150 U:0.2 (m/s)

動力黏度計算(雷諾數:150)

層流Laminar Flow Re:150

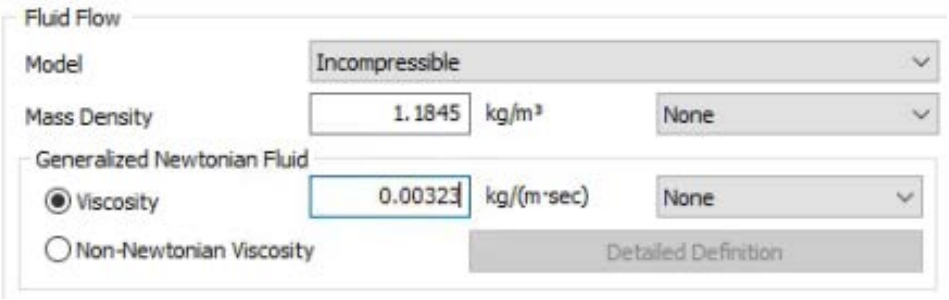
ρ:1.1845 (kg/m^3)=>(AIR_25℃)

U:0.2(m/s)

D:2.05(m)=>橋面截面積4.205m^2，特徵長度取面積開根號。

μ: ρ × U ×D/Re=0.00323 (kg/m-s)=>動力黏度

$$\mathrm{Re} = \frac{\rho V D}{\mu} = \frac{V D}{\nu} = \frac{Q D}{\nu A}$$



動能和渦長標度計算

Eddy Kinetic Energy(m^2/sec^2)

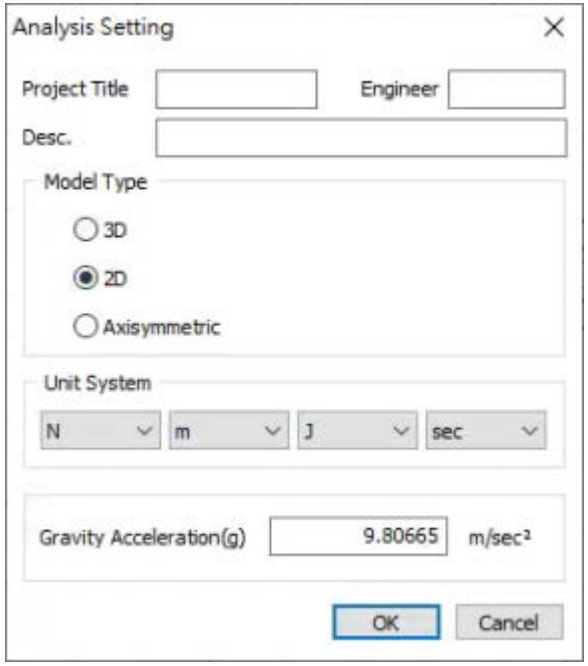
$$k = \frac{3}{2}(UI)^2 \qquad I = 0.16Re^{-\frac{1}{8}}$$

I :is the initial turbulence intensity [%]
U: is the initial velocity magnitude
Re=150
U=0.2(m/s)
$I=0.16 \times 150^{-1/8}=0.16 \times 0.5345=0.08552$
$K=(3/2) \times (0.2 \times 0.08552)^2= 0.0004388$

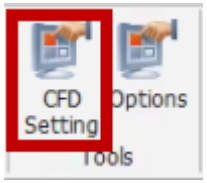
Eddy Length Scale or turbulent length scale

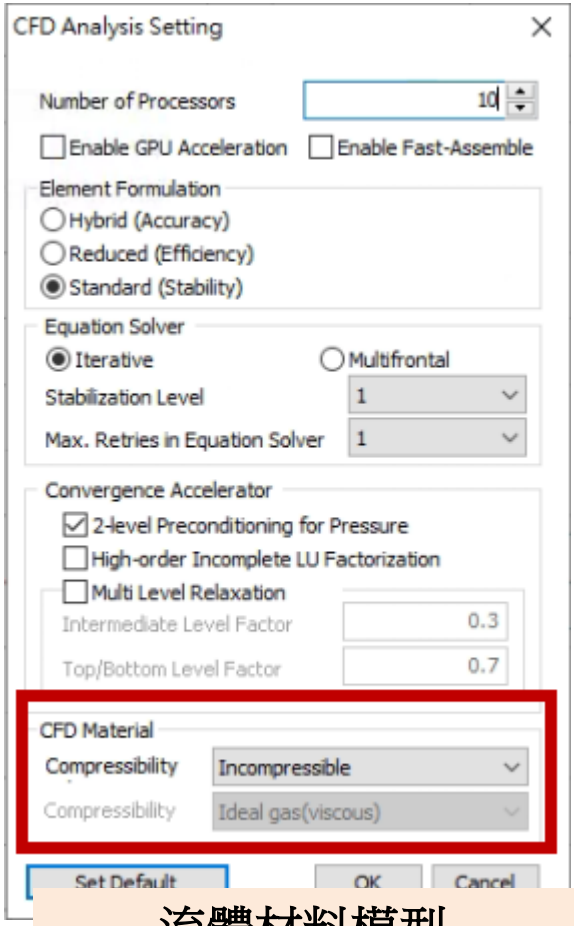
l:0.07L=0.07 ×2.05=0.1435
L:2.05(m) ， is a characteristic length.
(橋面截面積4.205m^2，特徵長度L取面積開根號)

環境



單位使用N/m/J/sec

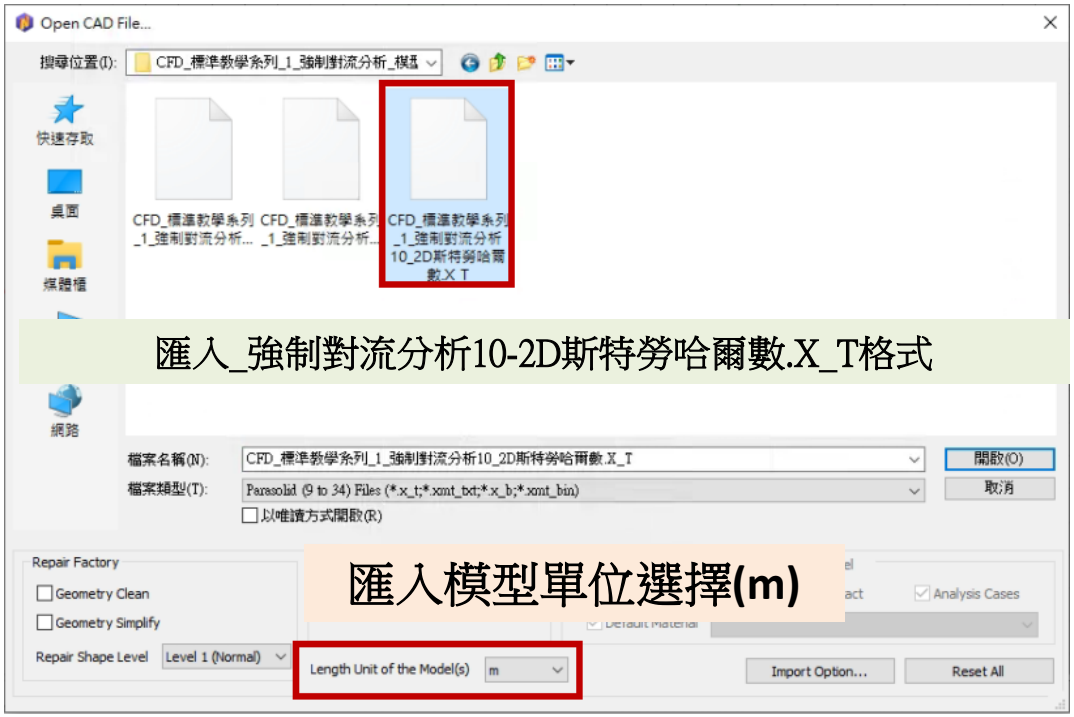


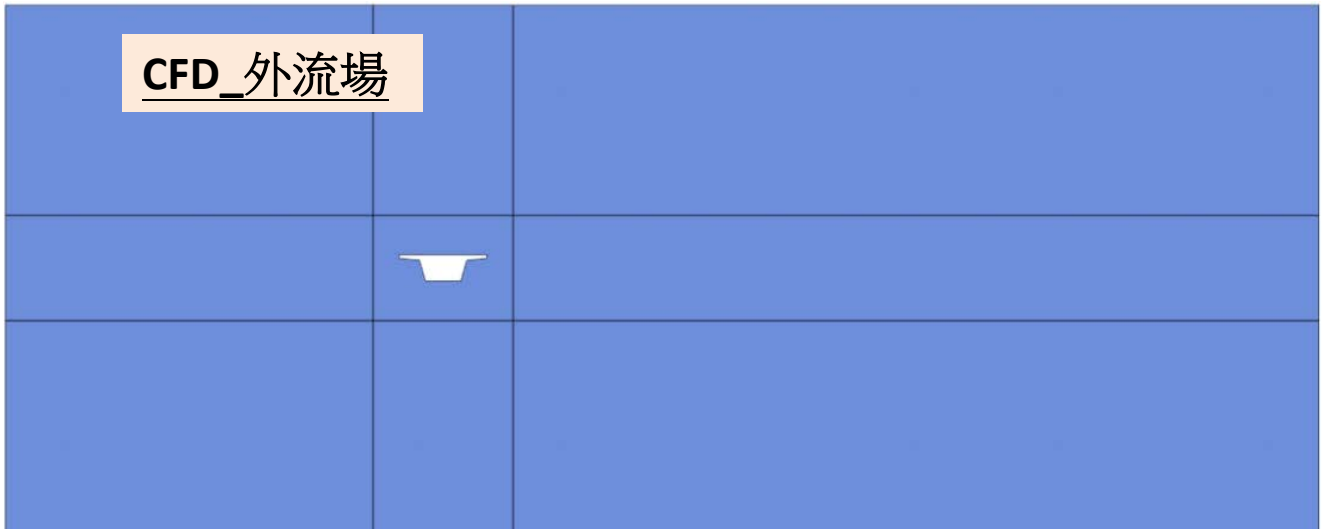


流體材料模型
不可壓縮流

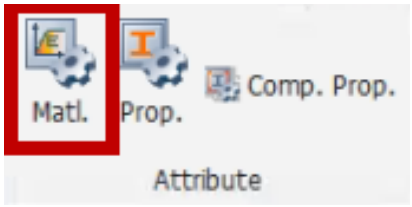
匯入模型

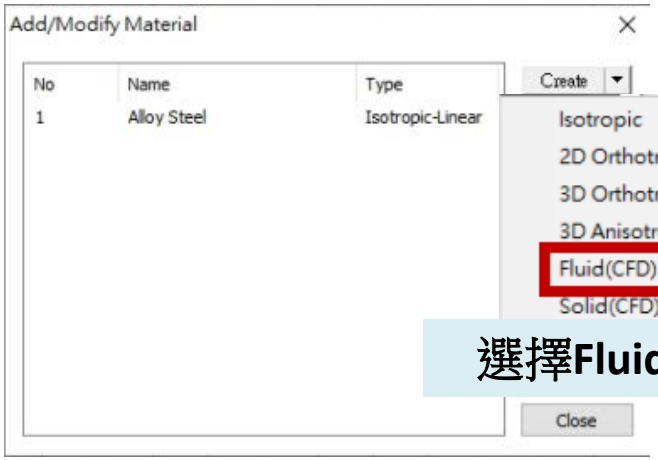

CAD
Import
CAD
Export
CAD File


Open CAD File...
搜尋位置(I):
CFD_標準教學系列_1_強制對流分析_模型
快速存取
桌面
媒體櫃
網路
CFD_標準教學系列_1_強制對流分析...
CFD_標準教學系列_1_強制對流分析...
CFD_標準教學系列_1_強制對流分析10_2D斯特勞哈爾數.X_T
檔案名稱(N):
CFD_標準教學系列_1_強制對流分析10_2D斯特勞哈爾數.X_T
檔案類型(T):
Parasolid (9 to 34) Files (*.x_t;*.xmt_txt;*.x_b;*.xmt_bin)
以唯讀方式開啟(R)
開啟(O)
取消
匯入_強制對流分析10-2D斯特勞哈爾數.X_T格式
匯入模型單位選擇(m)
Repair Factory
Geometry Clean
Geometry Simplify
Repair Shape Level
Level 1 (Normal)
Length Unit of the Model(s)
m
Analysis Cases
Import Option...
Reset All


CFD_外流場

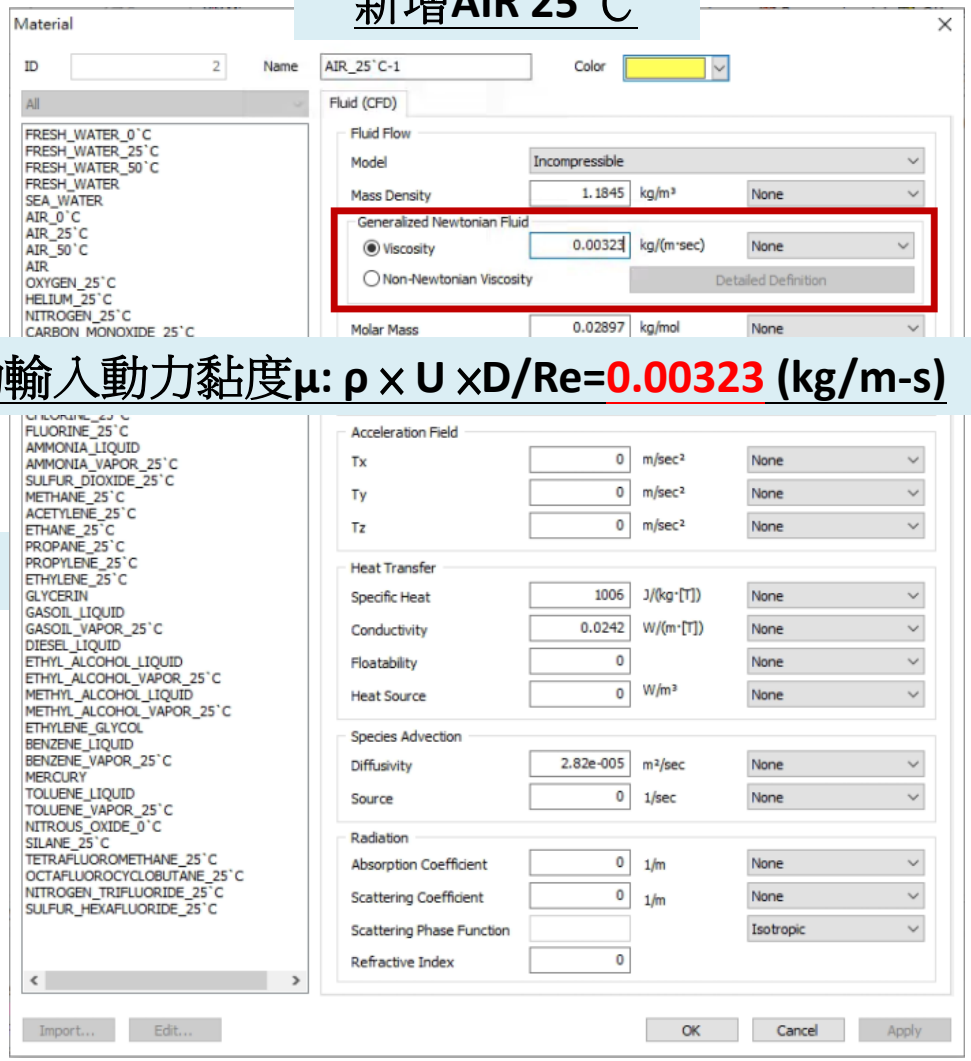
材料





選擇Fluid(CFD)

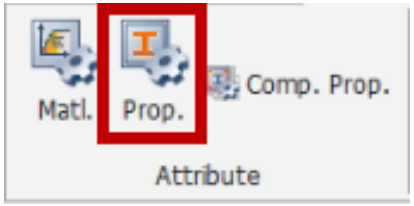
新增AIR 25 ℃



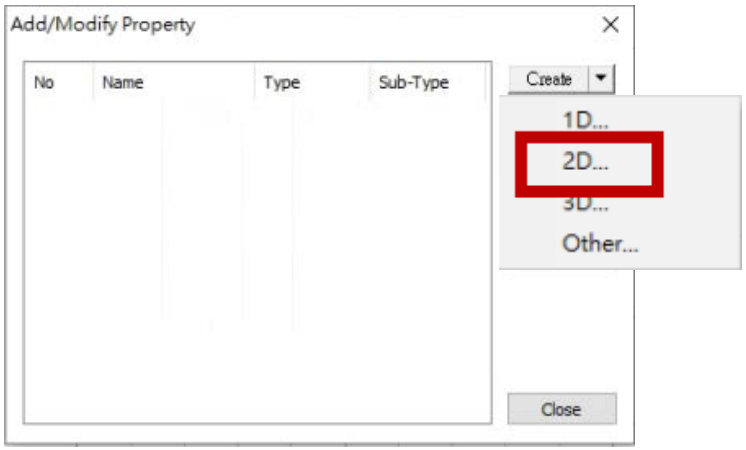
手動輸入動力黏度μ: ρ x U xD/Re=0.00323 (kg/m-s)

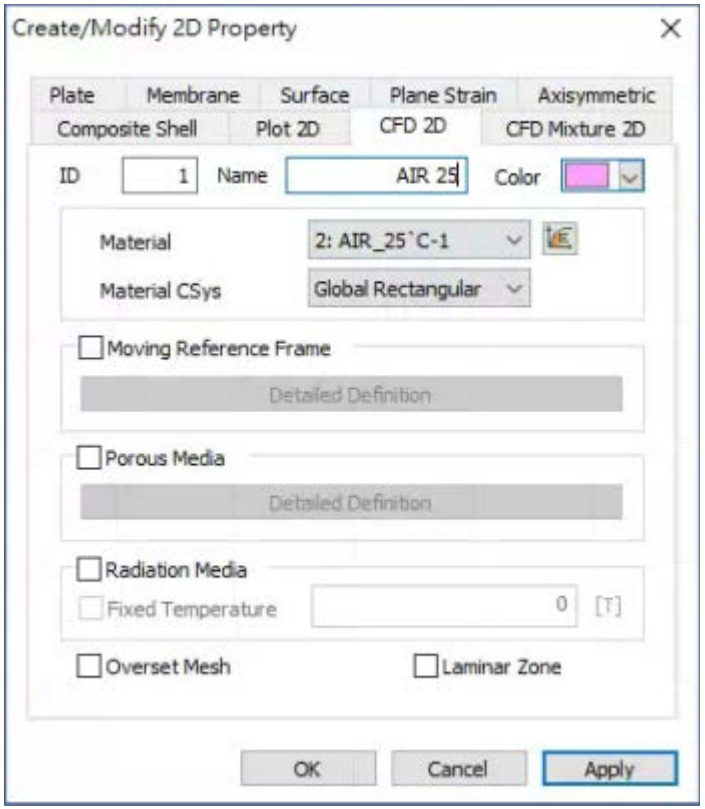
註:NFX CAE/CFD是整合性軟體,材料和屬性包含結構/熱/流場。

屬性



新增AIR 25 ℃ Property



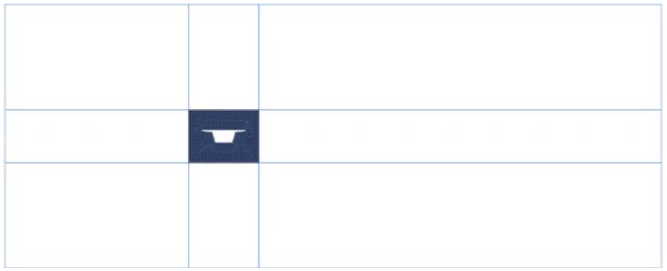


midas NFX-CFD

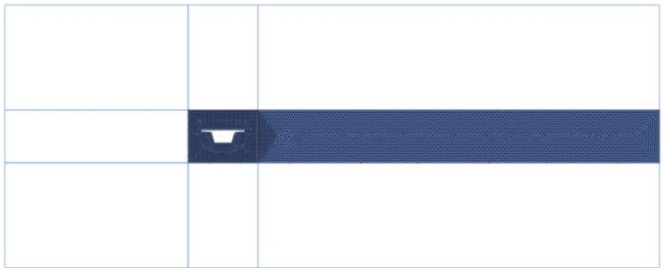
2D網格

三邊形網格/合併節點

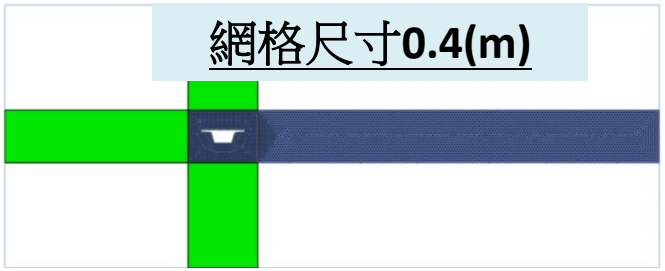
網格尺寸0.2(m)

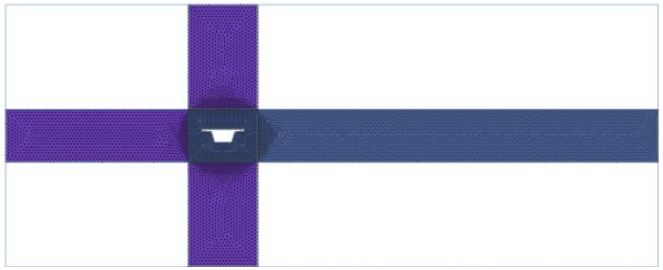


網格尺寸0.3(m)

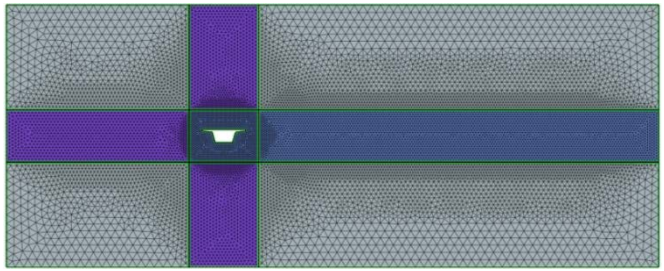


網格尺寸0.4(m)

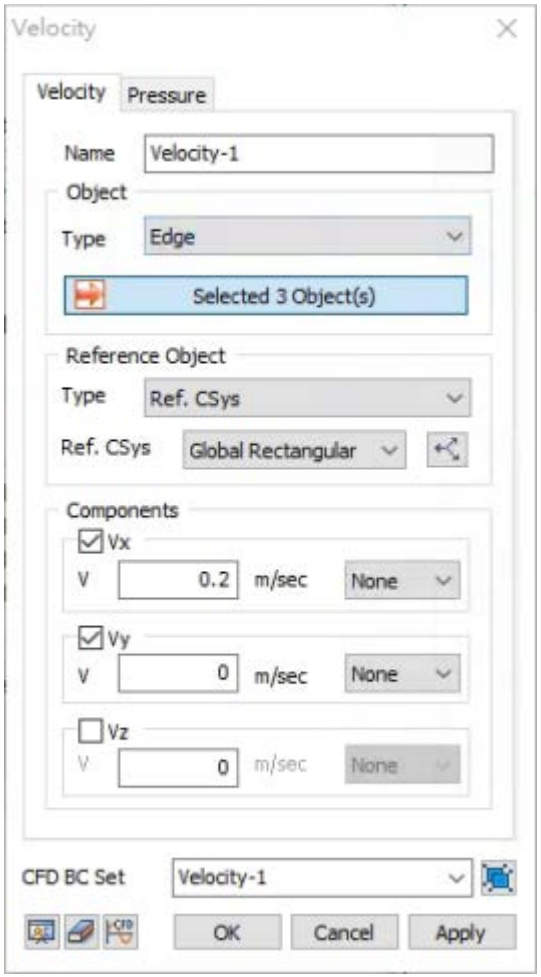




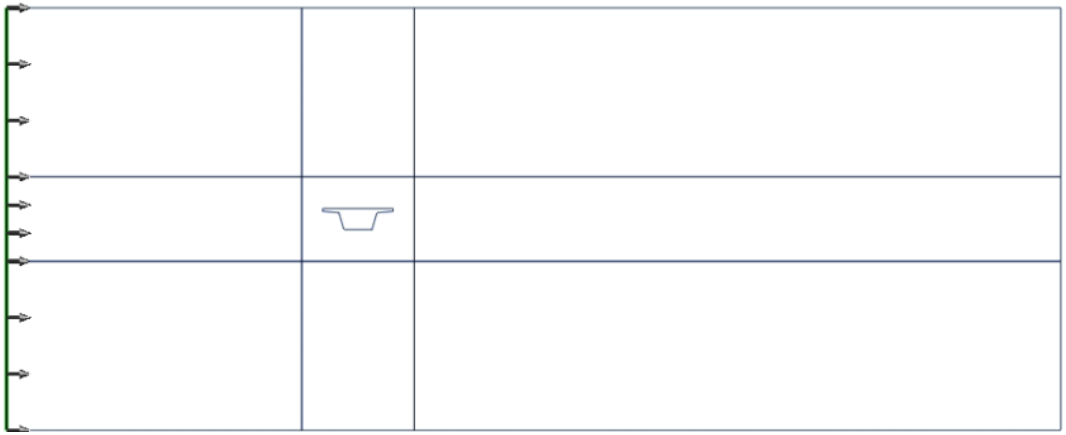
網格尺寸1(m)



入流

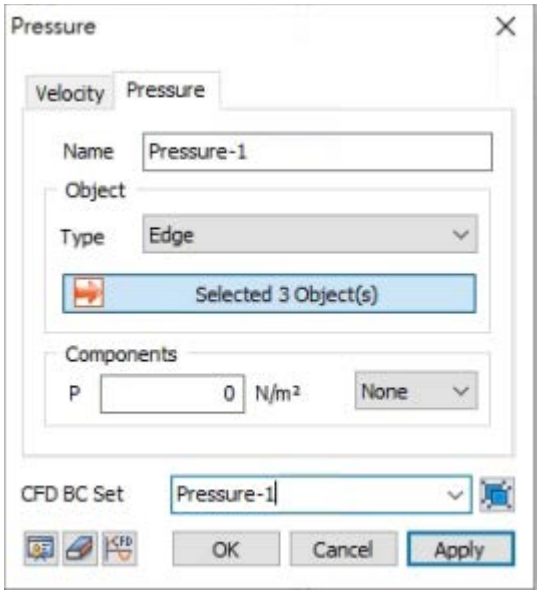


Vx=0.2 (m/s)　Vy=0 (m/s)

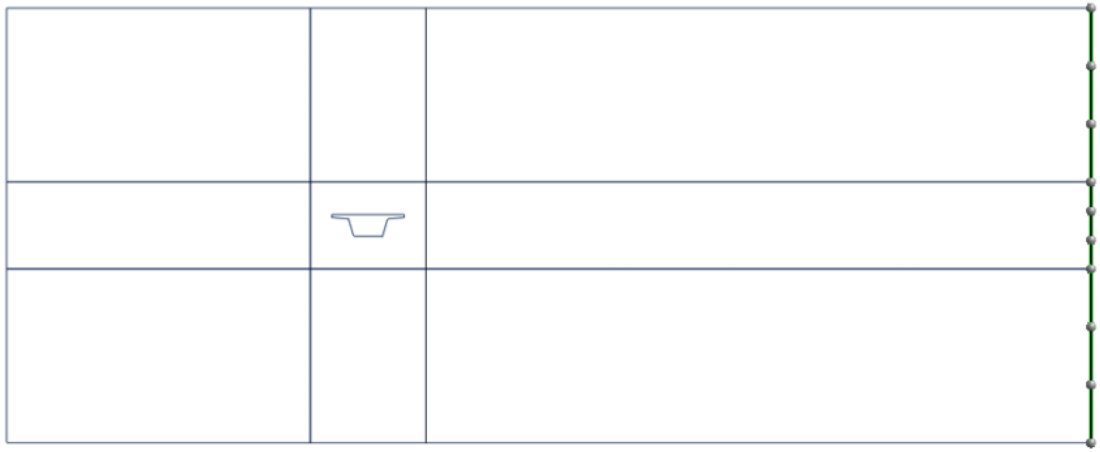


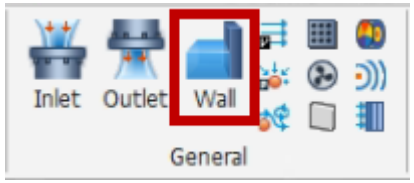
출류口


Inlet
Outlet
Wall
General


Pressure
Velocity
Pressure
Name
Pressure-1
Object
Type
Edge
Selected 3 Object(s)
Components
P
0
N/m²
None
CFD BC Set
Pressure-1
OK
Cancel
Apply

P=0 (N/m²)

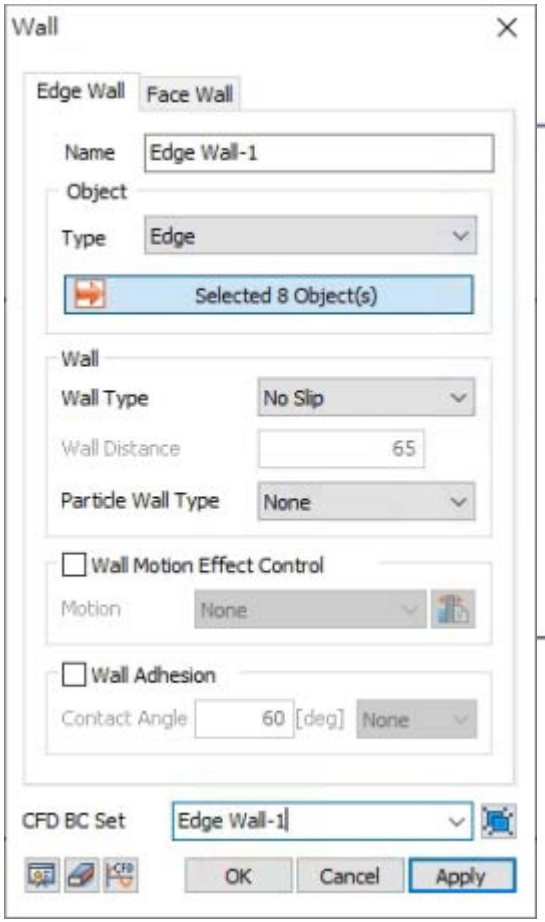


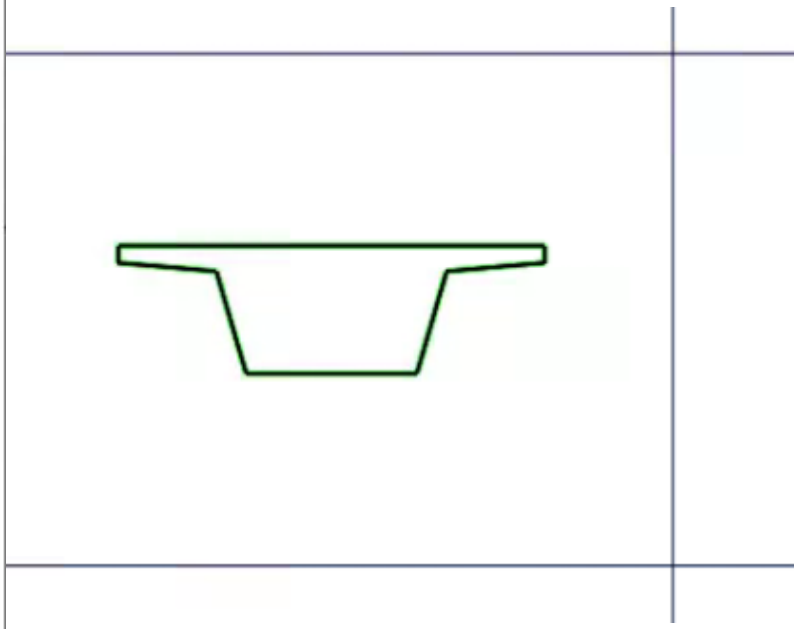


壁函數(No Slip)

No Slip(Wall Function)

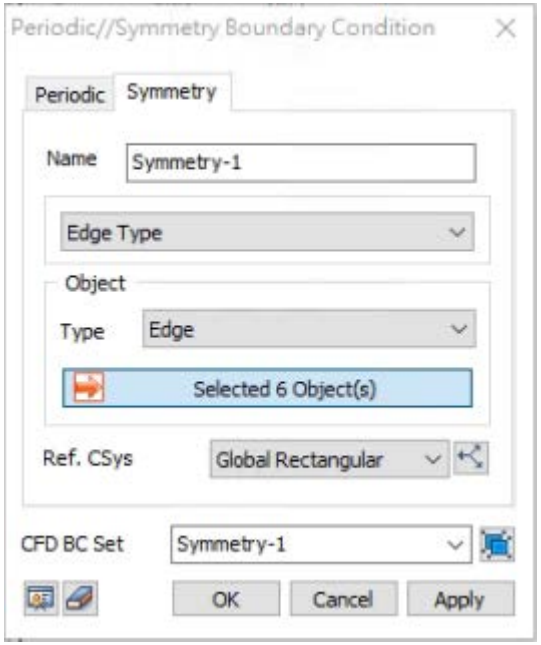
邊界處的速度為 0 , 適用於低或中雷諾數的問題。





對稱(Symmetry)


Inlet
Outlet
Wall
General


Periodic//Symmetry Boundary Condition
Periodic
Symmetry
Name
Symmetry-1
Edge Type
Object
Type
Edge
Selected 6 Object(s)
Ref. CSys
Global Rectangular
CFD BC Set
Symmetry-1
OK
Cancel
Apply

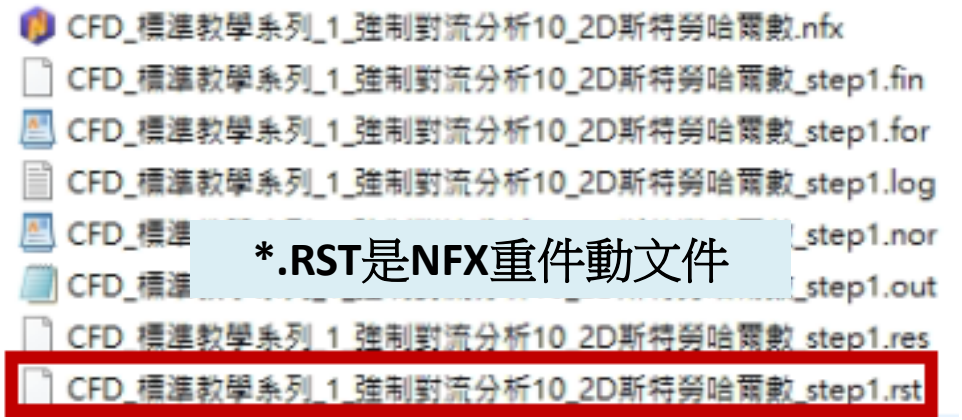
分析說明
(重啓動)

Solution Type : Step1(Steady CFD)

自動寫出重啓動文件

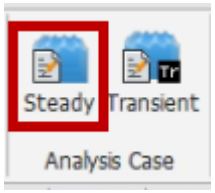
Solution Type : Step2(Transient CFD)

匯入重啓動文件

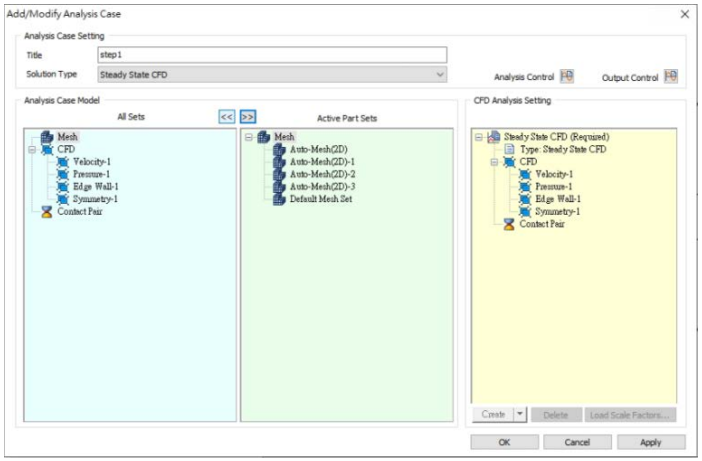


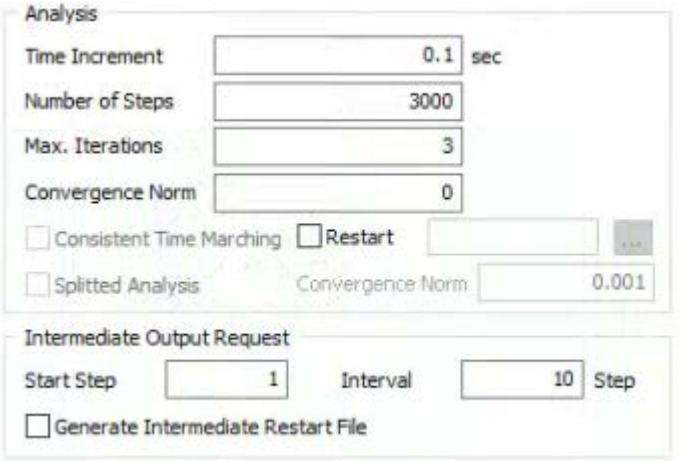
***.RST是NFX重件動文件**

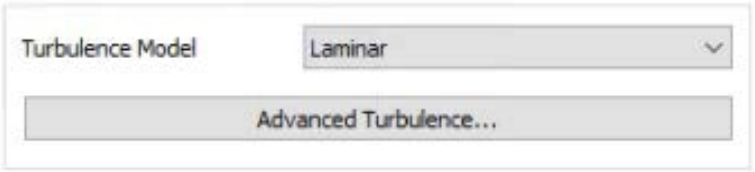
Step1 CFD穩態分析

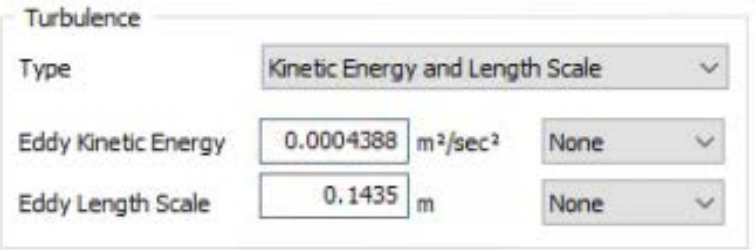


Solution Type : Steady State CFD







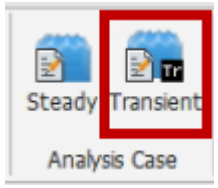


Eddy Kinetic Energy(m^2/sec^2)

K=0.0004388

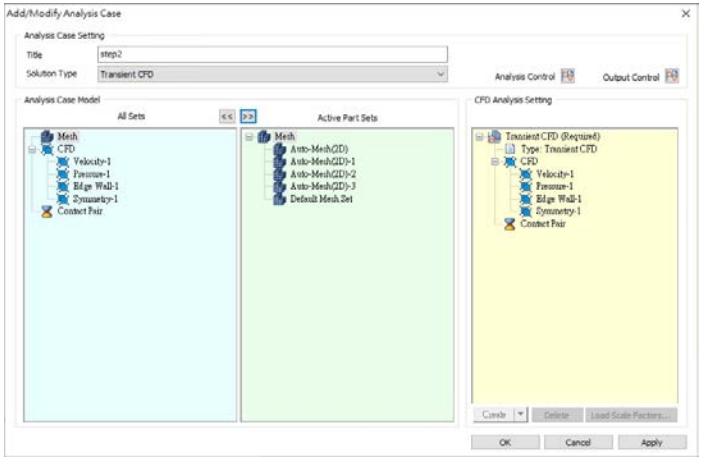
Eddy Length Scale or turbulent length scale

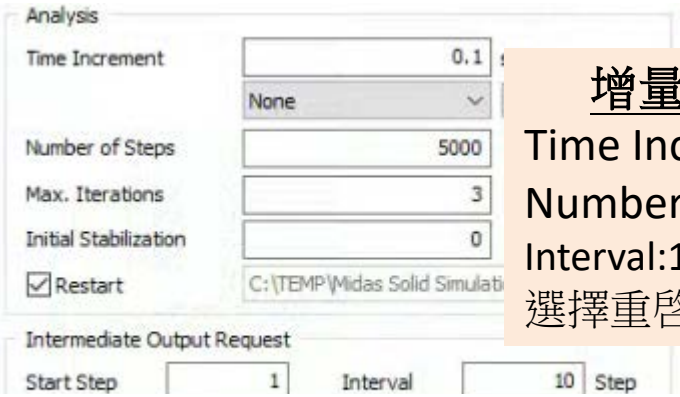
L=0.1435



Step2 CFD瞬態分析

Solution Type : Transient CFD





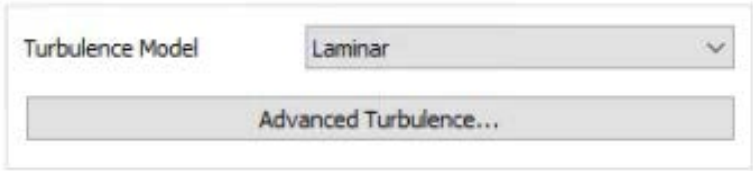
增量步和收斂定義

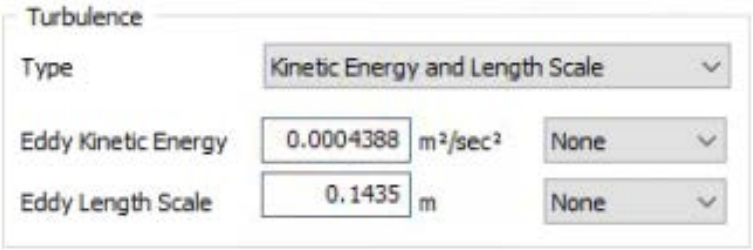
Time Increment :0.1

Number of steps:5000

Interval:10

選擇重啓動文件檔Step1.rst





Eddy Kinetic Energy(m^2/sec^2)

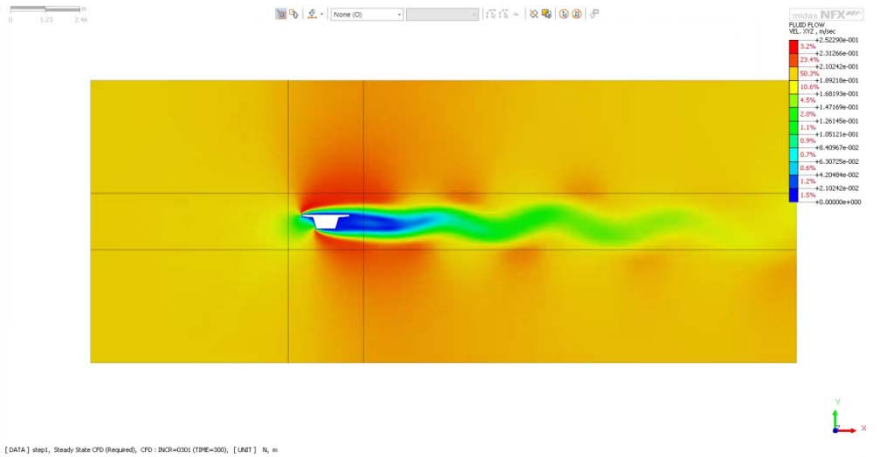
K=0.0004388

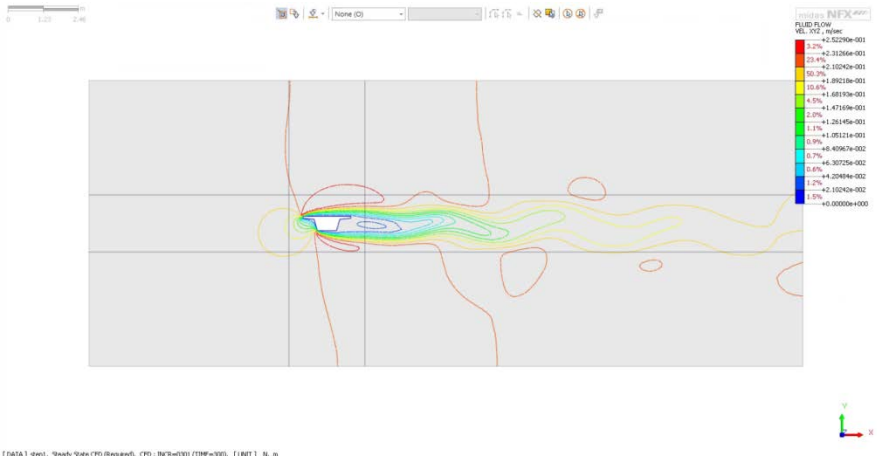
Eddy Length Scale or turbulent length scale

L=0.1435

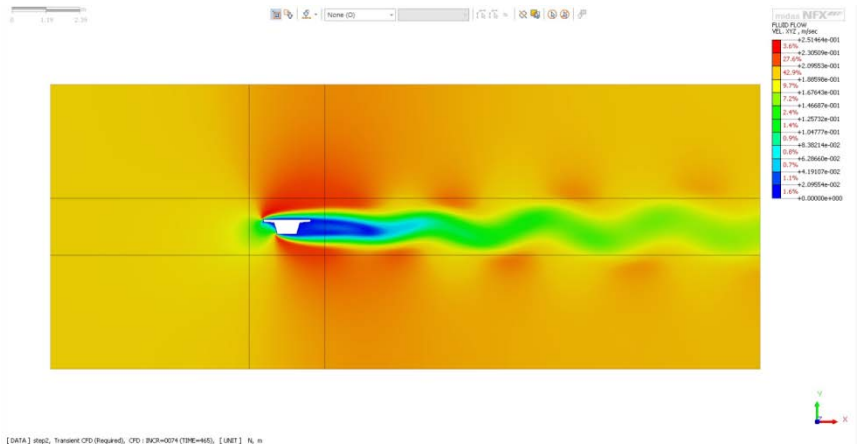
분석결과

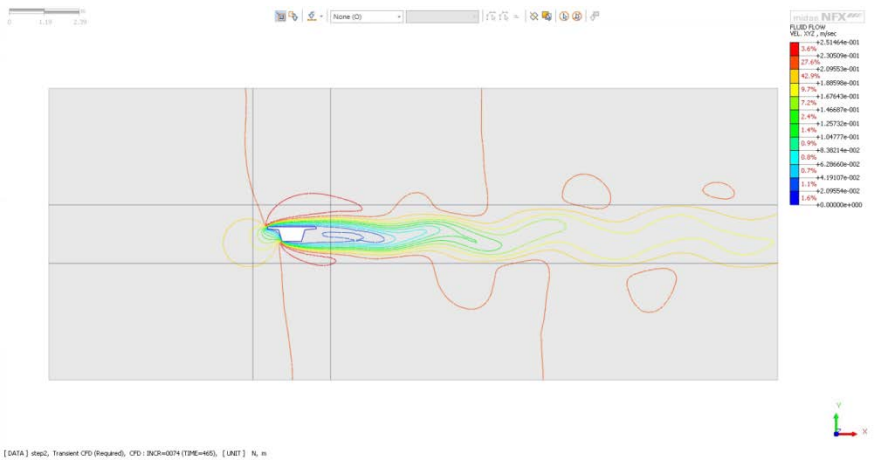
Steday CFD



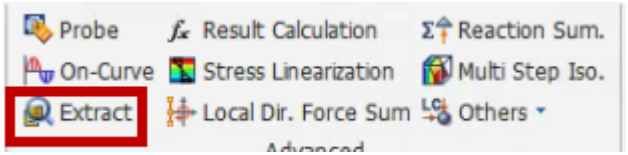


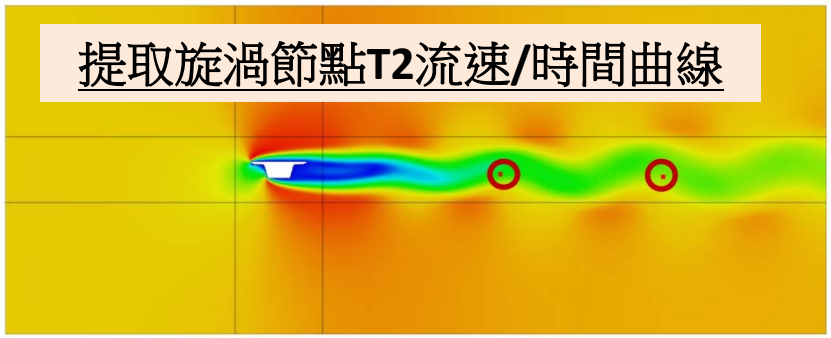
Transient CFD





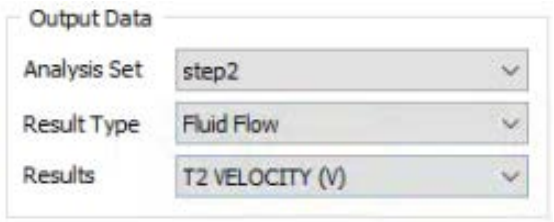
旋渦脫落頻率

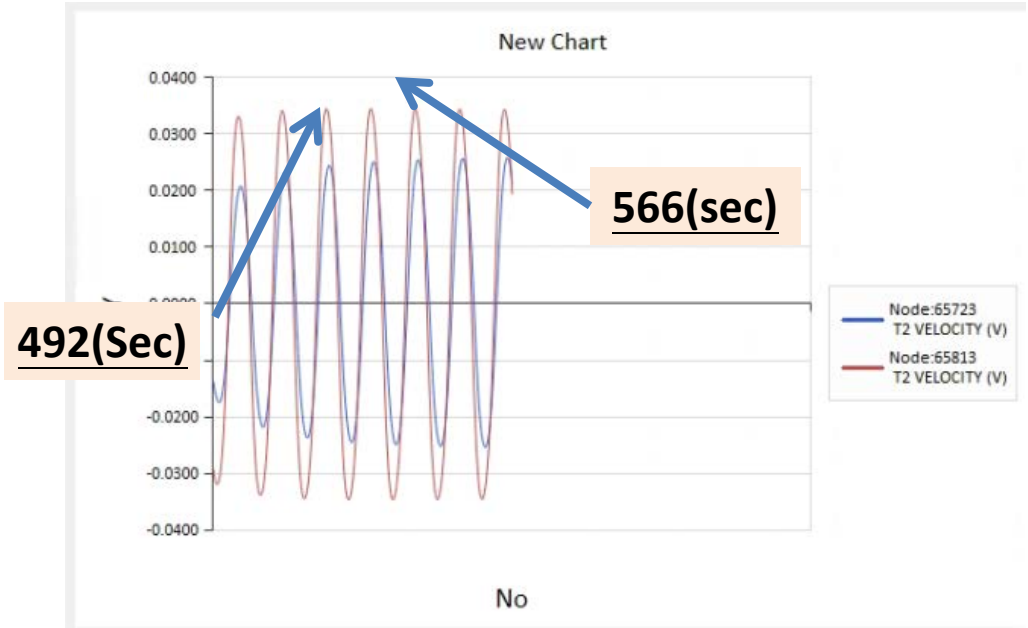




旋渦脫落頻率

Freq=1/(566-492)=0.0135Hz





斯特勞哈爾數
(Strouhal number)

斯特勞哈爾數

$$\mathrm{St} = \frac{fL}{U}$$

St:0.138375=>斯特勞哈爾數
f:0.0135(Hz)=>旋渦脫落頻率
L:2.05(m)=>橋面截面積4.205m^2，特徵長度取面積開根號。
U:0.2(m/sec)=>流速

midas NFX-CFD

CFD_標準教學系列

強制對流分析11-2D風廓線

台灣邁達斯

風廓線
(Wind Speed Profile)

風廓線即風速隨高度的變化曲線，以研究大氣邊界層內的風速規律。常用邊界層風速剖面的有兩定律，一為指數律(power law)，另一則為對數律(logarithmic law)。

指數律風廓線
(Wind profile power law)

$$u = u_r \left(\frac{z}{z_r} \right)^{\alpha}$$

u:is the wind speed(m/sec) at height z (m)
u_γ:is the known wind speed(m/sec) at a reference height z_γ (m)
α : is an empirically derived coefficient that varies dependent upon the stability of the atmosphere.For neutral stability conditions , α is approximately 1/7 。

對數風廓線
(Log wind profile)

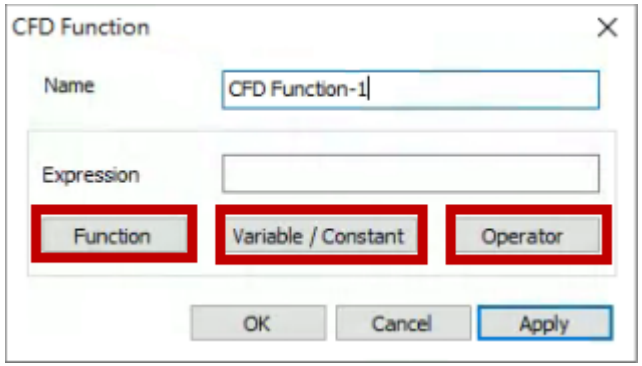
$$u_z = \frac{u_*}{\kappa} \left[\ln \left(\frac{z-d}{z_0} \right) \right]$$

u_z:is the wind speed(m/sec) at height z (m)
u_* : is the friction velocity (m/s)
k: is the Von Kármán constant (~0.41)
d : is the zero plane displacement (m)
Z_0:is the surface roughness (m)

Reference
https://en.wikipedia.org/wiki/Wind_profile_power_law
https://en.wikipedia.org/wiki/Log_wind_profile

CFD函數

NFX CFD提供複雜函數和矩陣計算，它還包括一些幫助插入函數的工具：變量列表和運算符列表。



風廓線CFD函數定義
(指數律風廓線)

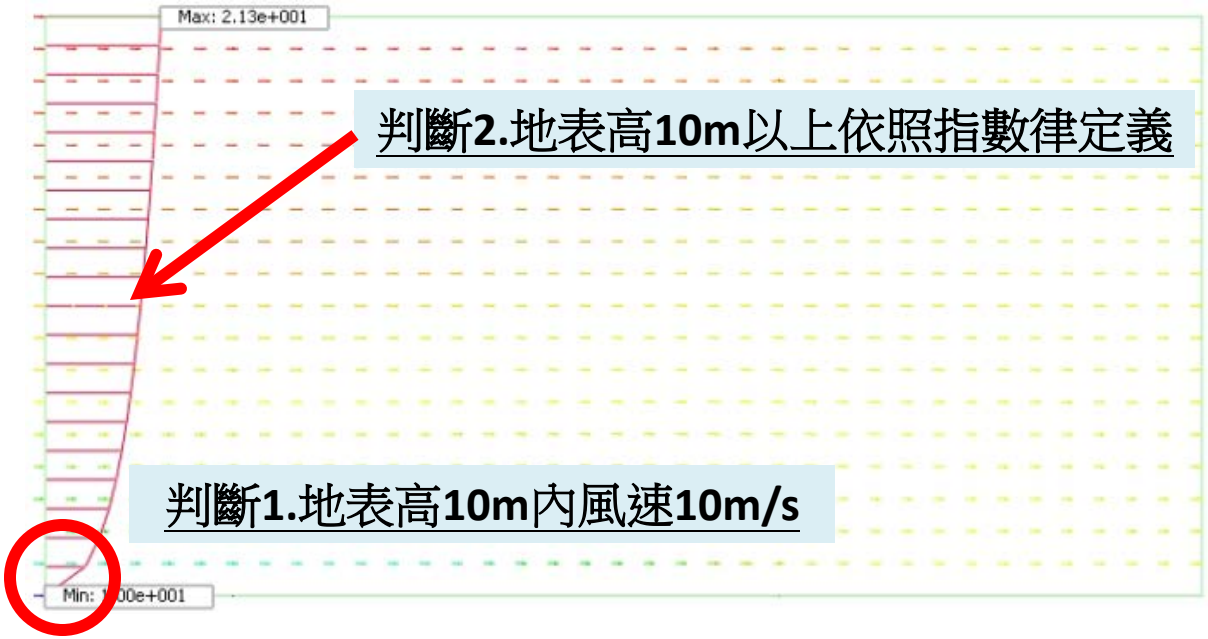
$$u = u_r \left(\frac{z}{z_r} \right)^{\alpha}$$

u:相對高度風速(m/s)
Z_γ:地表高度(10m)
u_γ:地表高度Z_γ風速(假設10m/s)
α :0.143

CFD IF Function格式

if(expression)then(elif_expression)else(next_expression)endif

=>if(y<10)then(10)else(10*(y/10)^(0.143))endif



註:2D空間高度座標為y軸。

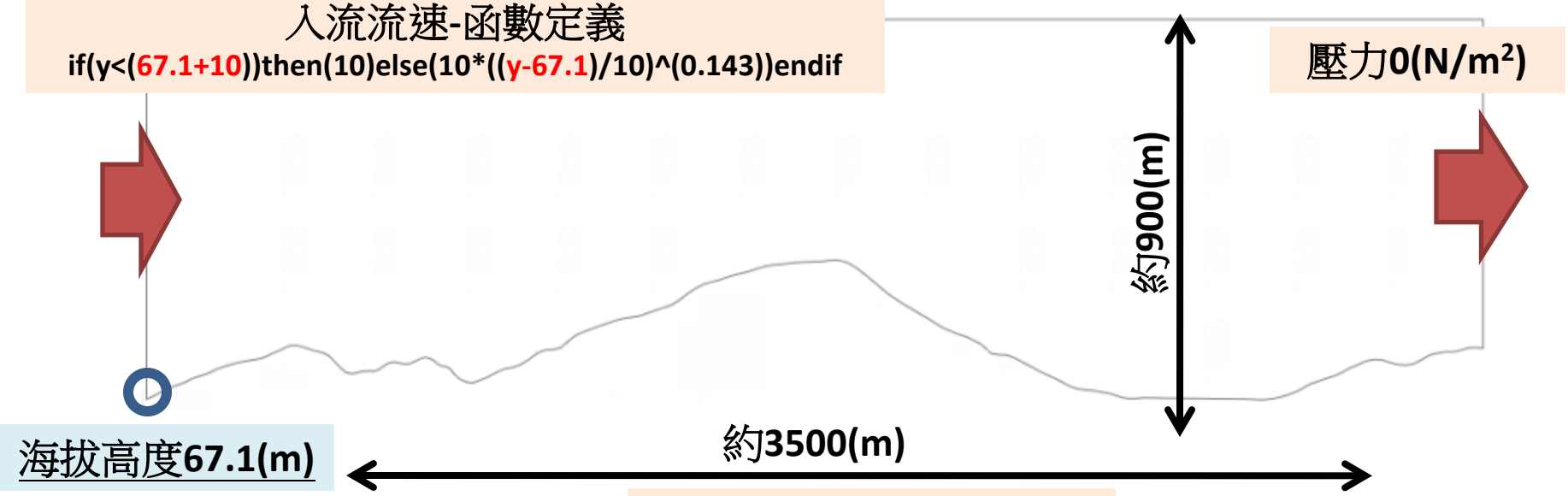
分析說明
(地形風場分析)

AIR 25 ℃

空間特徵-對稱

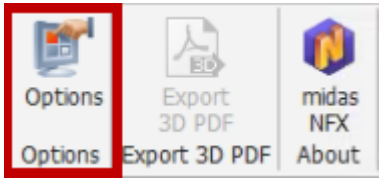
入流流速-函數定義
if(y<(67.1+10))then(10)else(10*((y-67.1)/10)^(0.143))endif

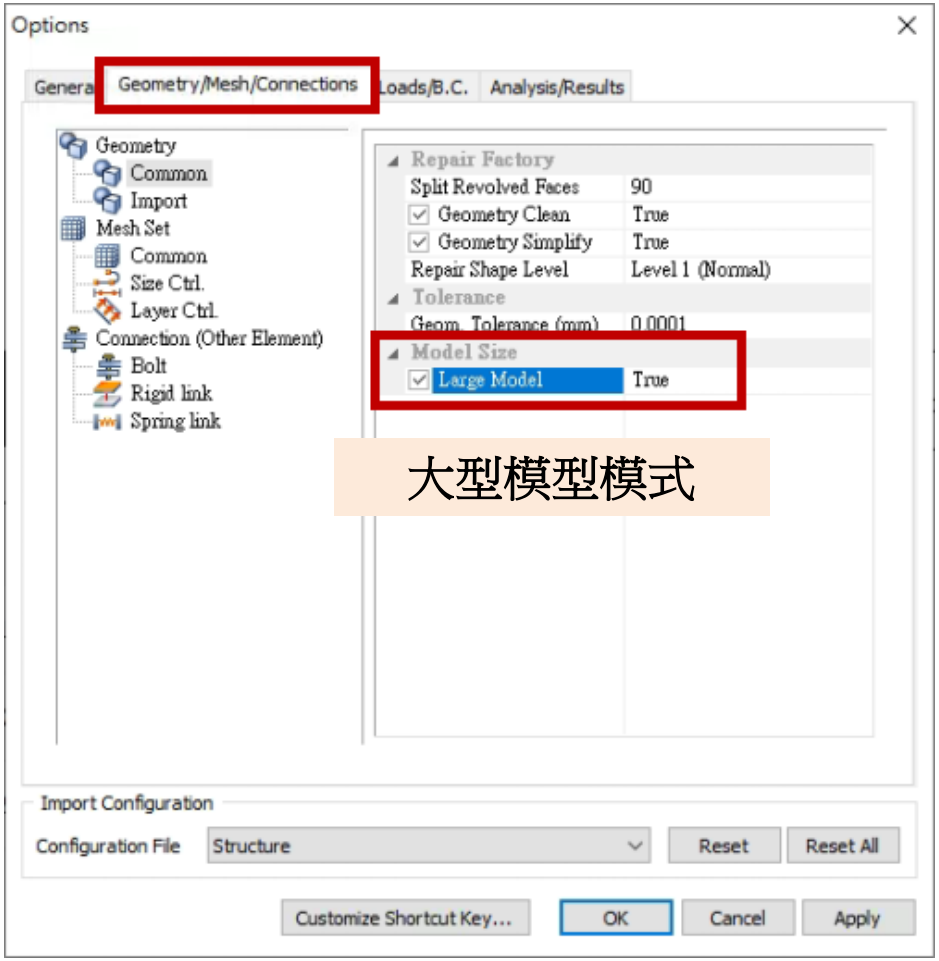
壓力0(N/m²)



地表壁函數
Dimensionless Wall y+=65

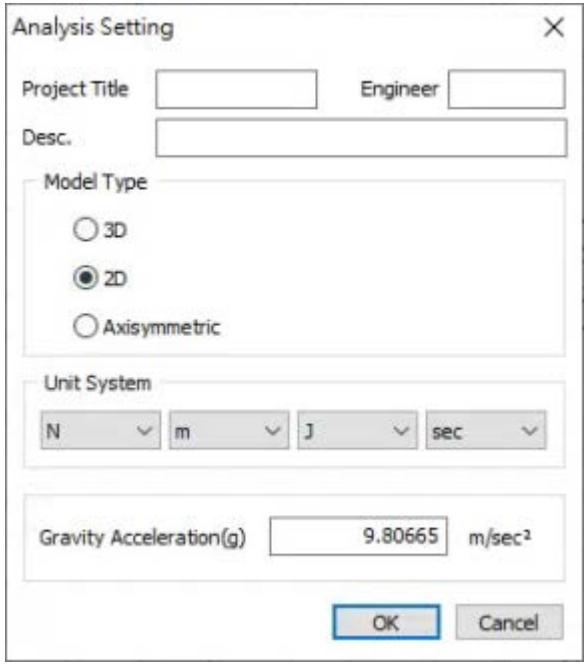
環境-1



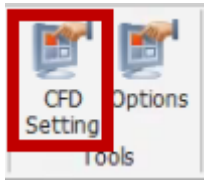


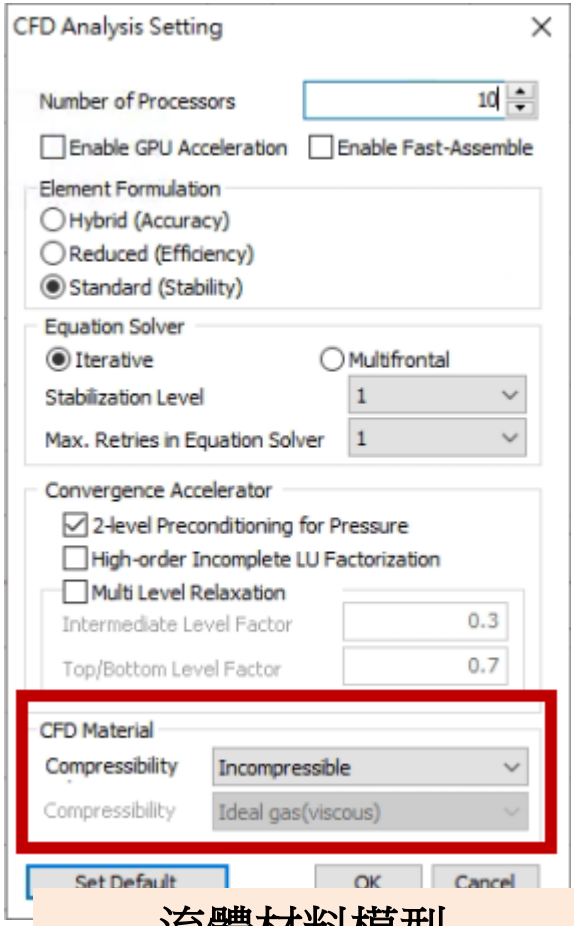
註:標準模型模式1000m ×1000m ×1000m

環境-2



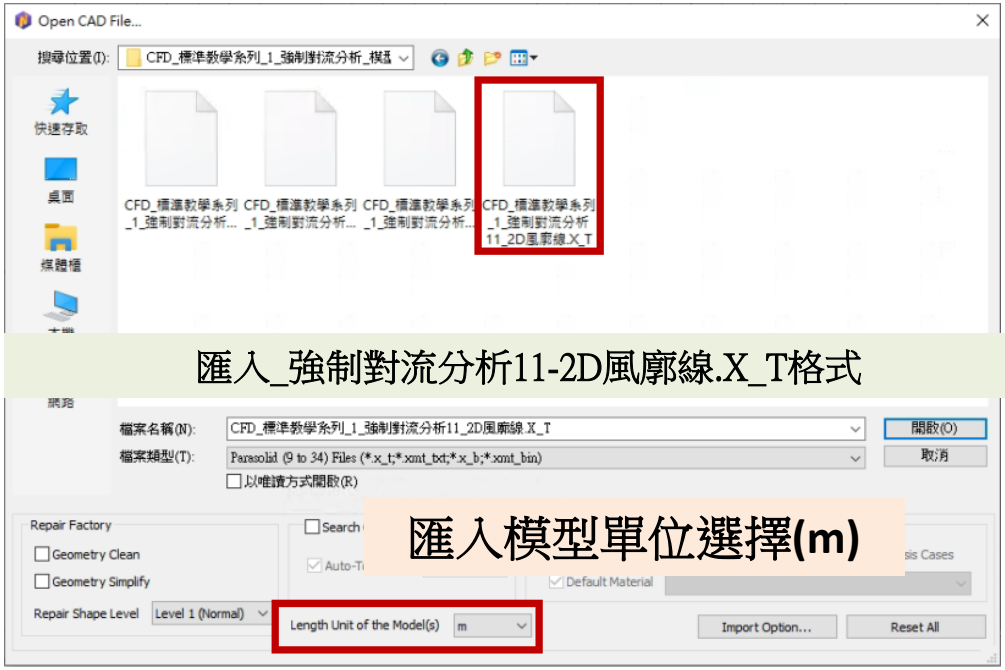
單位使用N/m/J/sec





流體材料模型
不可壓縮流

匯入模型

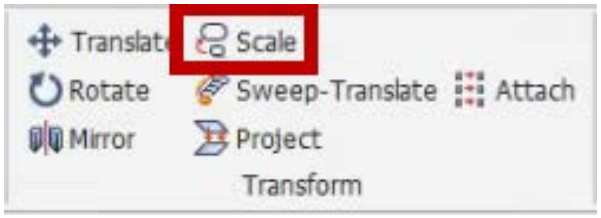


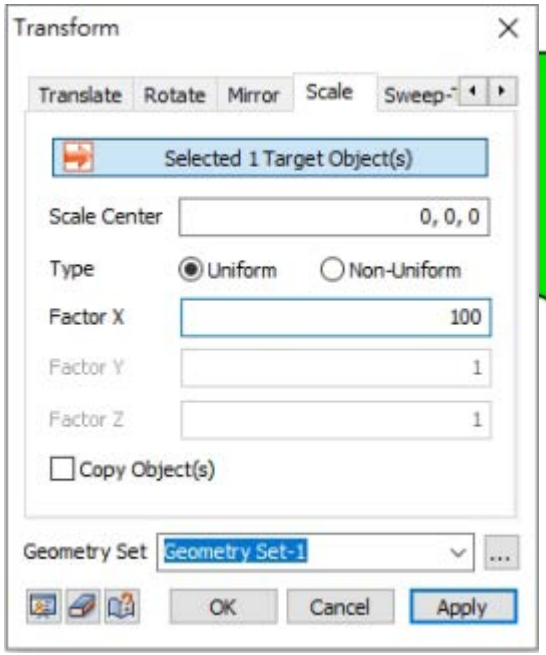
匯入_強制對流分析11-2D風廓線.X_T格式

匯入模型單位選擇(m)

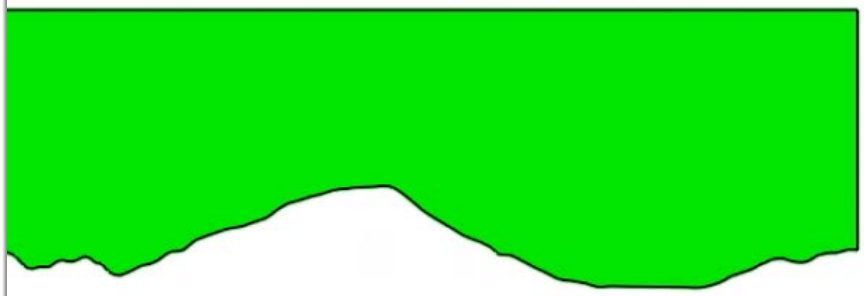
空間地型流場區域

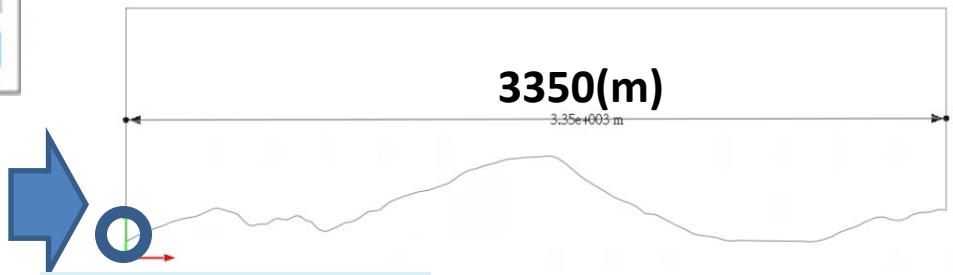
模型放大





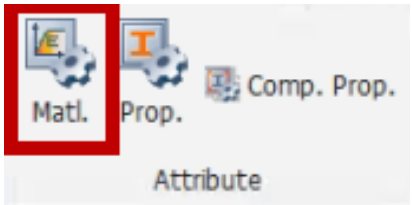
模型放大100倍

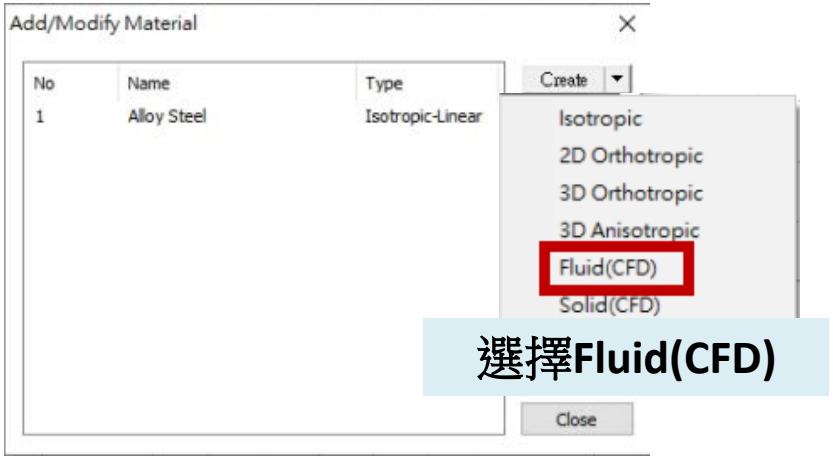




海拔高度67.1(m)

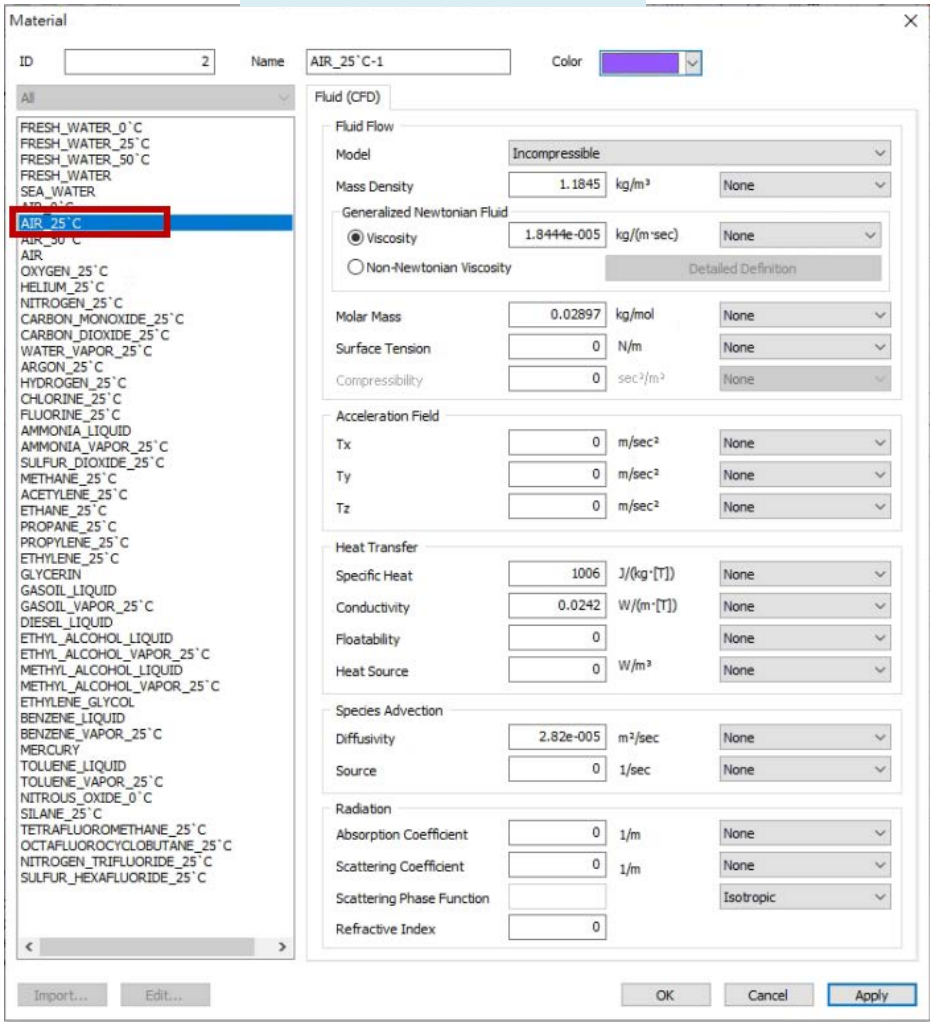
材料





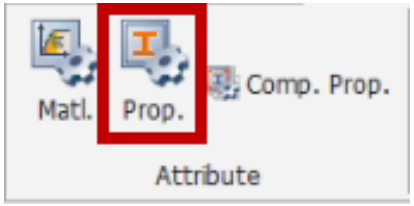
選擇Fluid(CFD)

新增AIR 25 ℃

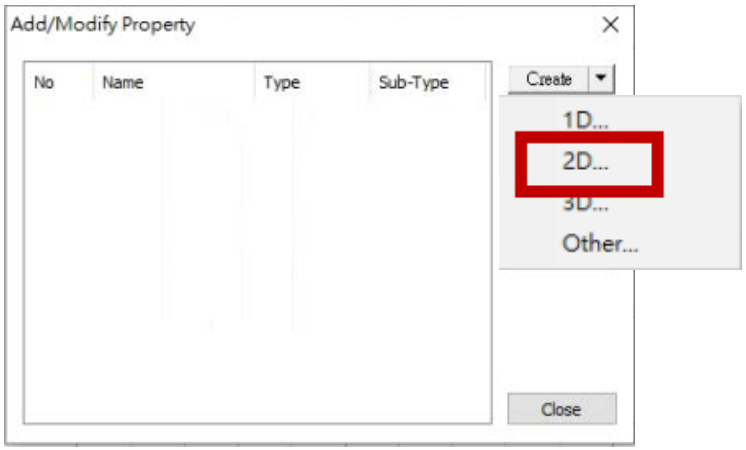


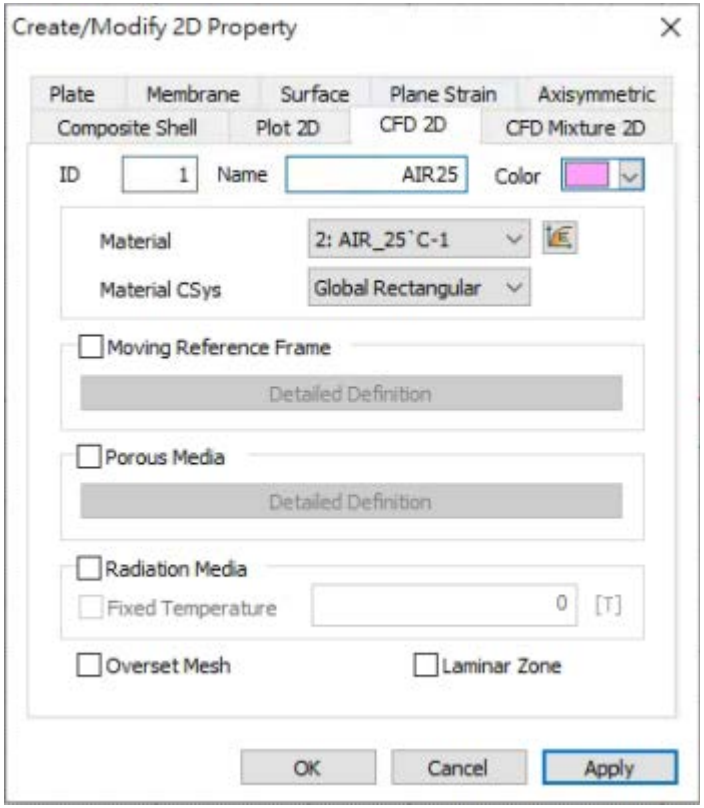
註:NFX CAE/CFD是整合性軟體,材料和屬性包含結構/熱/流場。

屬性

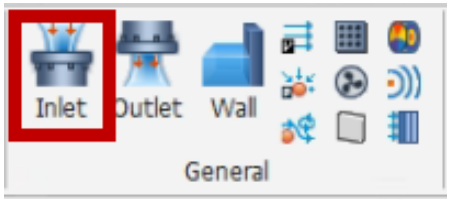


新增AIR 25 ℃ Property



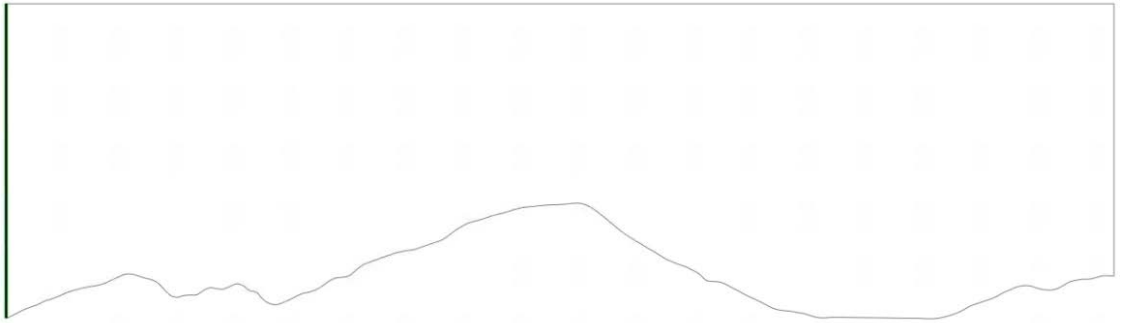


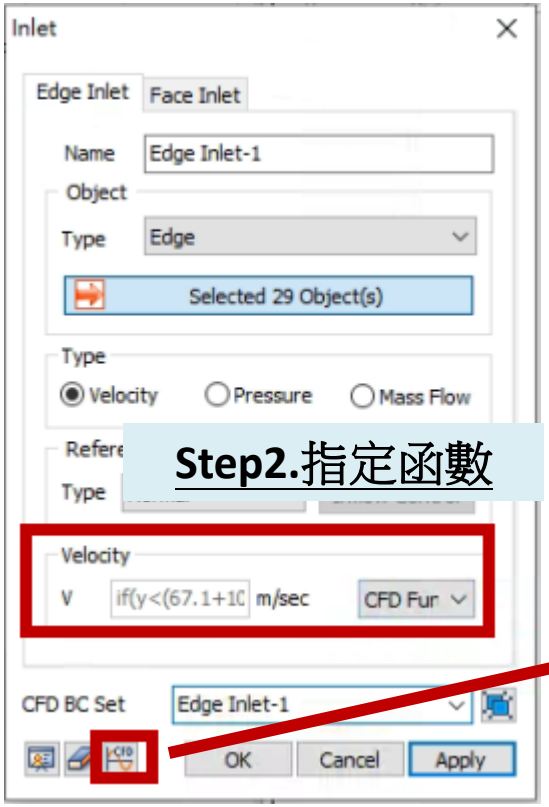
入流



入流流速-函數定義

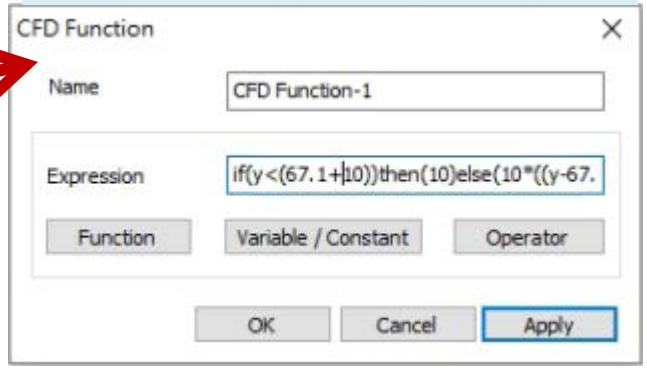
if(y<(67.1+10))then(10)else(10*((y-67.1)/10)^(0.143))endif





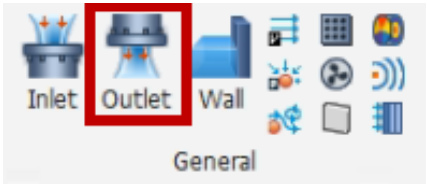
Step2.指定函數

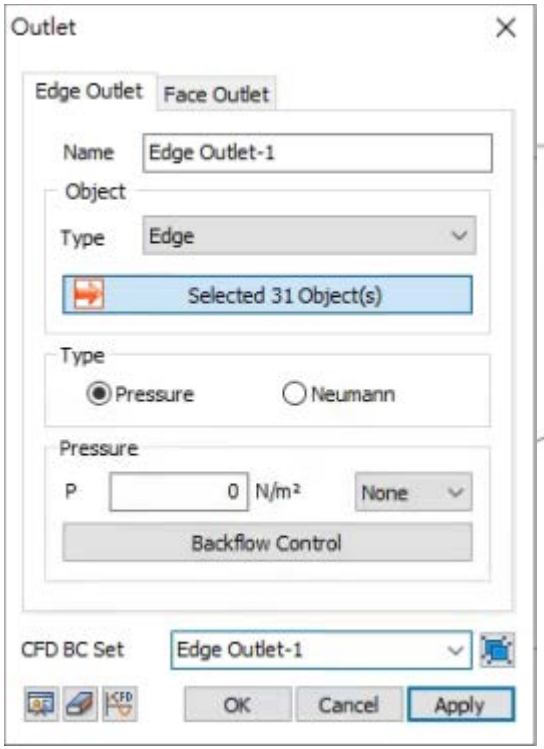
Step1.新增風廓線入流函數



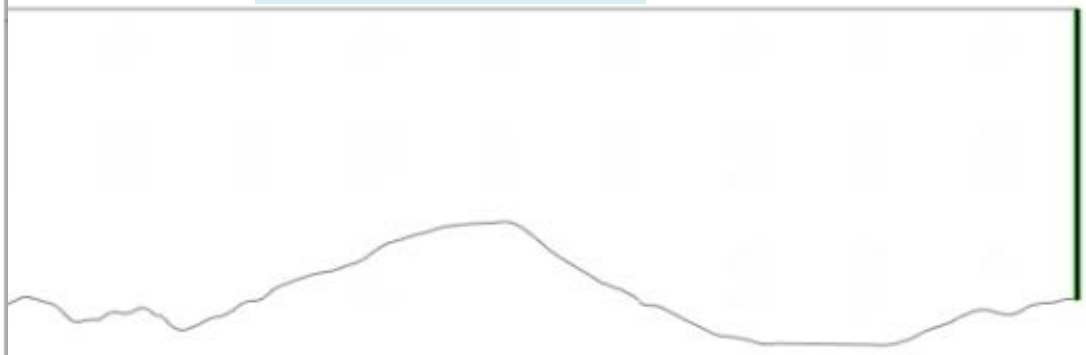
註:不同邊界&載荷建議使用不同集合名稱。

出流



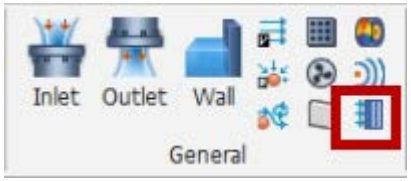


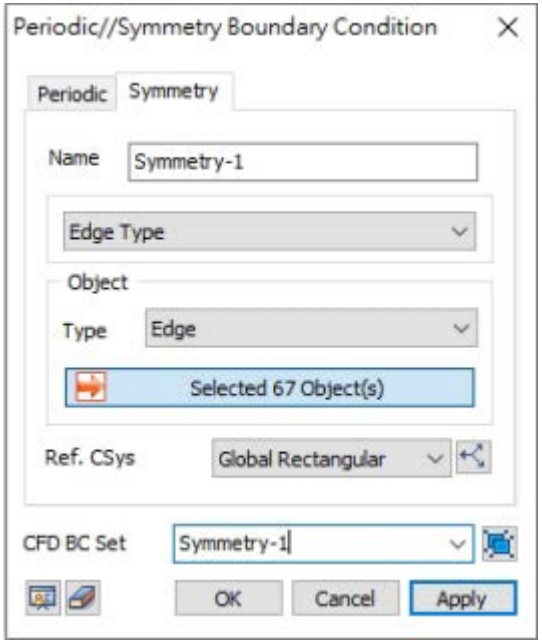
壓力0(N/m²)

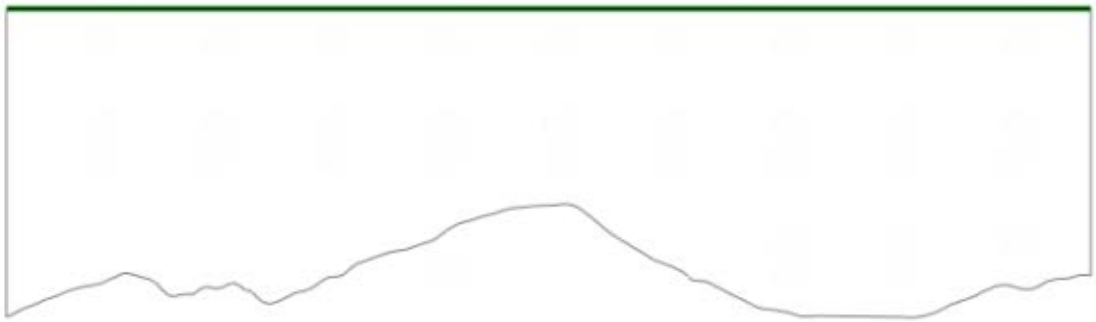


註:不同邊界&載荷建議使用不同集合名稱。

對稱

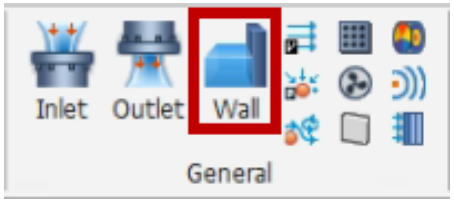


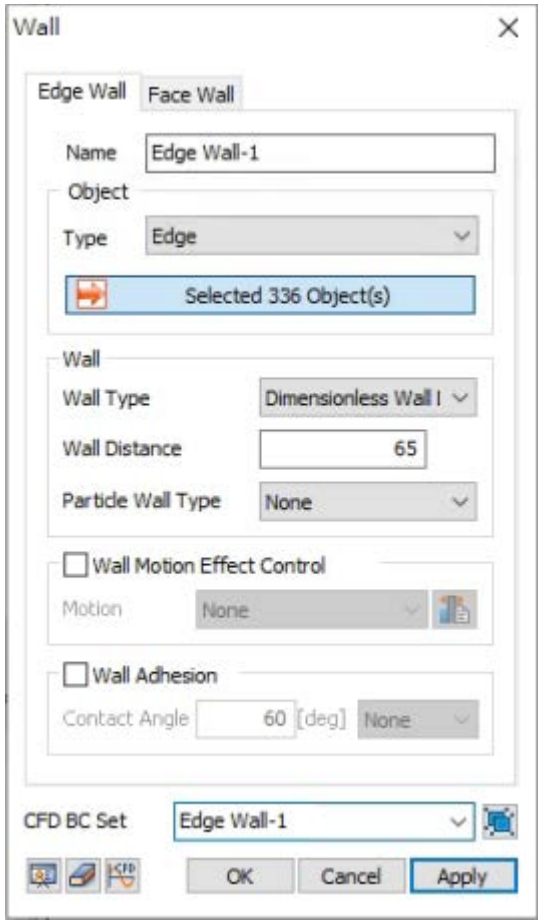




註:不同邊界&載荷建議使用不同集合名稱。

壁



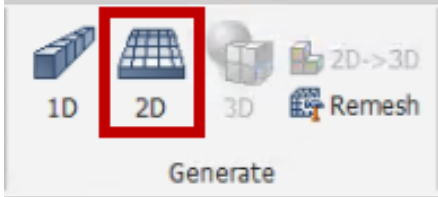


選取地表線特徵

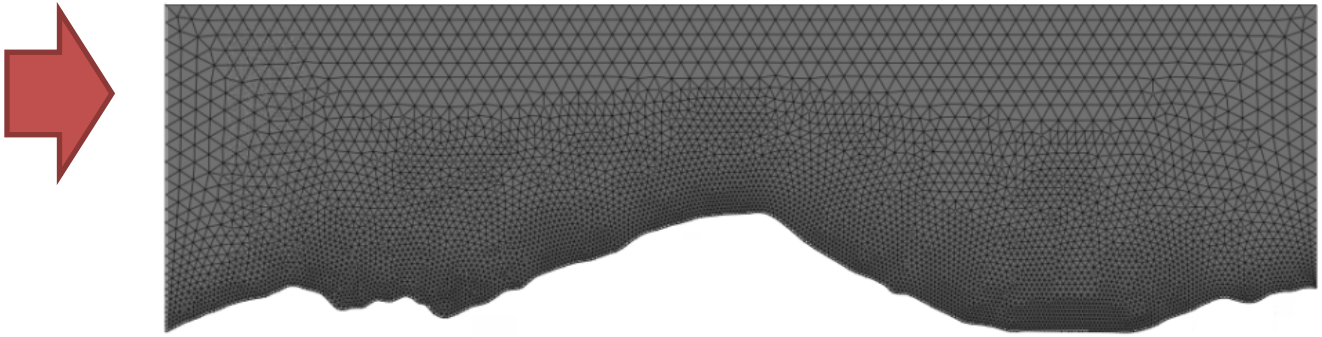
地表壁函數使用預設
Dimensionless Wall y+=65

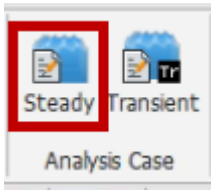
註:不同邊界&載荷建議使用不同集合名稱。

2D網格



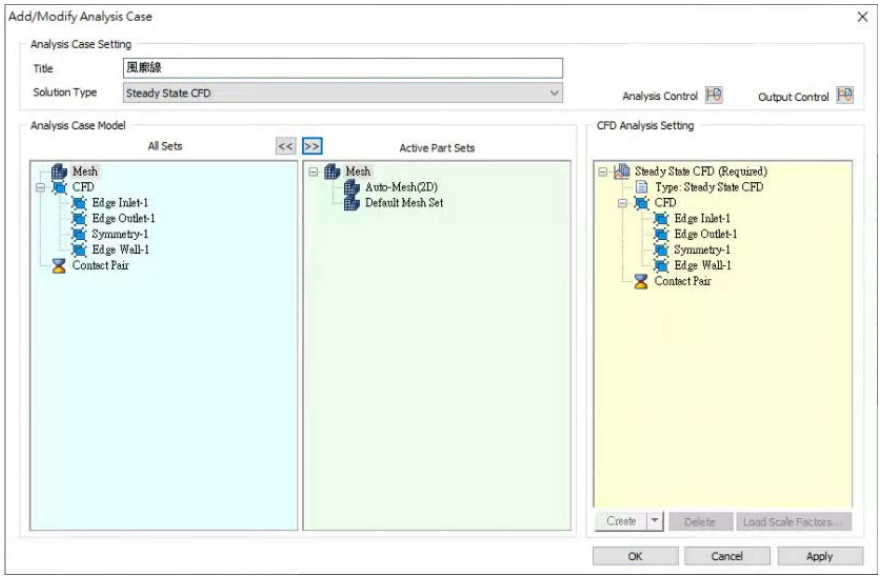
三邊形網格/合併節點/網格尺寸40(m)

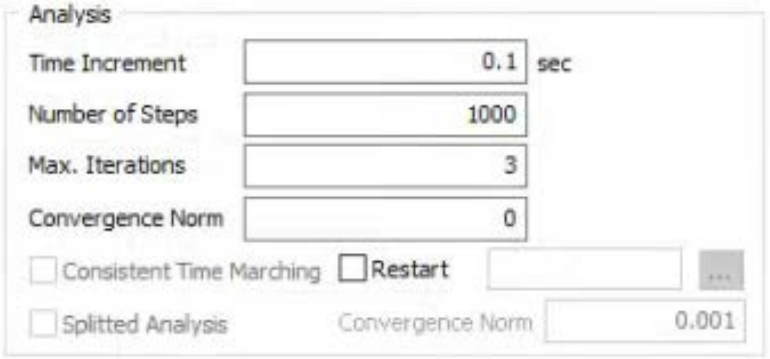


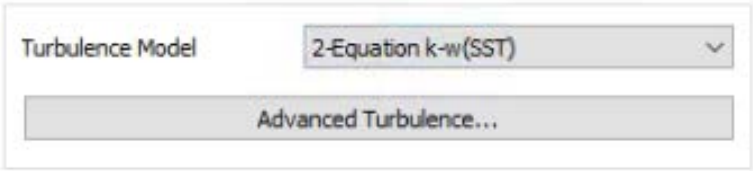


CFD穩態分析
(自訂函數-風廓線)

Solution Type : Steady State CFD

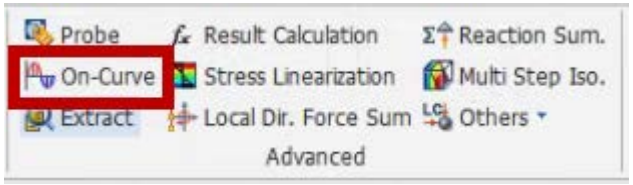


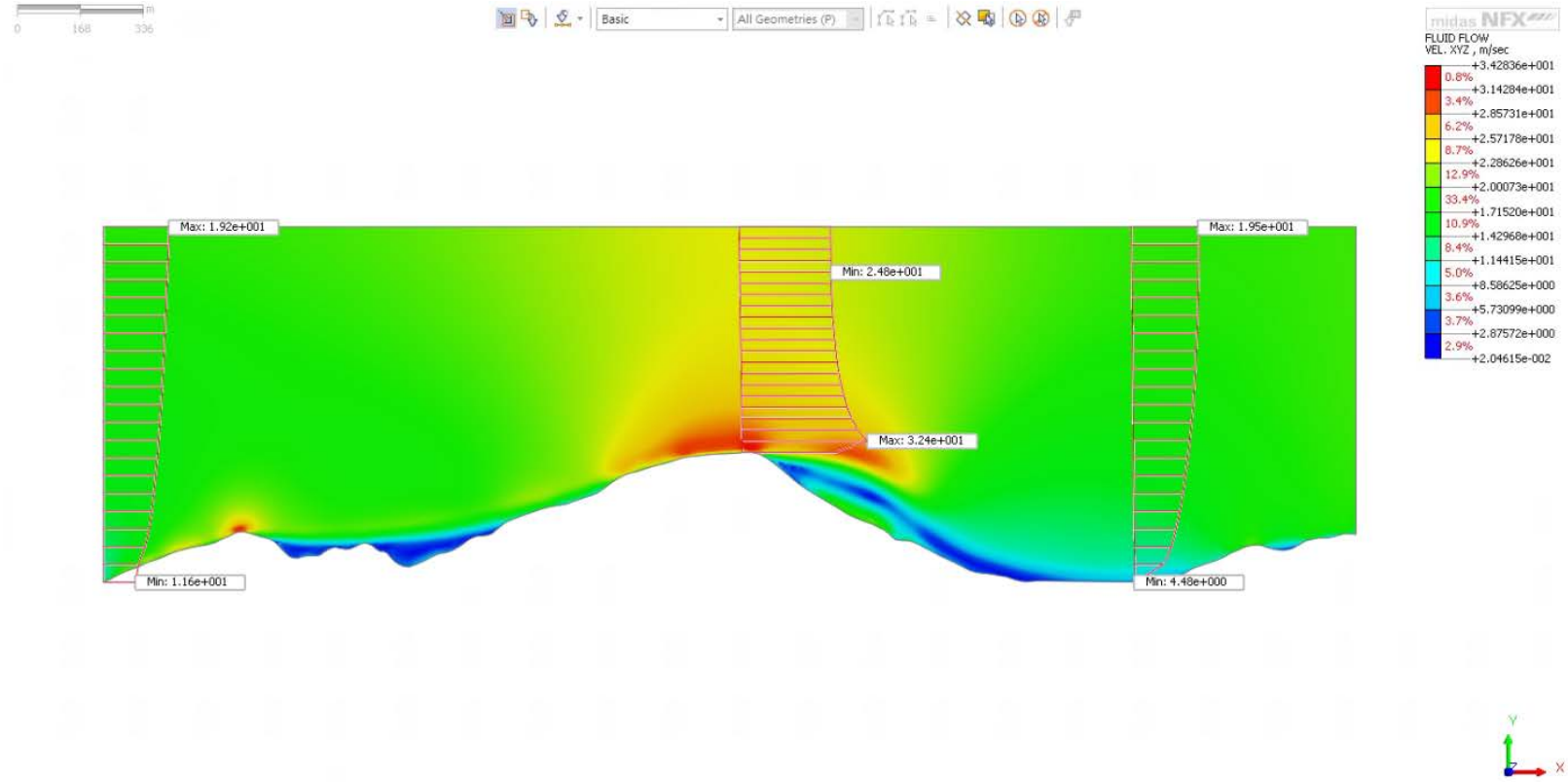




分析結果

(最後1増量)


Probe
Result Calculation
Reaction Sum.
On-Curve
Stress Linearization
Multi Step Iso.
Extract
Local Dir. Force Sum
Others
Advanced


Basic
All Geometries (P)
midas NFX
FLUID FLOW
VEL. XYZ , m/sec
+3.42836e+001
0.8%
+3.14284e+001
3.4%
+2.85731e+001
6.2%
+2.57178e+001
8.7%
+2.28626e+001
12.9%
+2.00073e+001
33.4%
+1.71520e+001
10.9%
+1.42968e+001
8.4%
+1.14415e+001
5.0%
+8.58625e+000
3.6%
+5.73099e+000
3.7%
+2.87572e+000
2.9%
+2.04615e-002
Max: 1.92e+001
Min: 2.48e+001
Max: 1.95e+001
Max: 3.24e+001
Min: 1.16e+001
Min: 4.48e+000
Y
Z
X
[DATA] 風圧線, Steady State CFD (Required), CFD : INCR=0101 (TIME=100), [UNIT] N, m

CFD_標準教學系列

強制對流分析13-2D壓力係數

台灣邁達斯

註:範例所需計算時間較長

壓力係數
(Pressure Coefficient)

壓力係數是描述流體動力學中整個流場的相對壓力的無量綱數，壓力系數應用於空氣動力學和流體力學，流體流場中的每一點的壓力系數不同。該無量綱係數與維數關係如下：

$$C_p = \frac{p - p_\infty}{\frac{1}{2}\rho_\infty V_\infty^2} = \frac{p - p_\infty}{p_0 - p_\infty}$$

P: is the static pressure at the point at which pressure coefficient is being evaluated.

P_∞ : is the static pressure in the free-stream.

P_0: is the stagnation pressure in the free-stream.

ρ_∞ : is the free-stream fluid density.

V_∞ :is the free-stream velocity of the fluid, or the velocity of the body through the fluid.

The free-stream(自由流)

自由流是指飛機前未經擾動的來流，也即沒有飛機等干擾時，空氣的自然流動現象。

Reference

https://en.wikipedia.org/wiki/Pressure_coefficient

CAARC建築風場數值模擬-1

$$C_P = 2(P - P_0)/\rho U_0^2$$

C_p:風壓係數
P:觀測點平均壓力(通用標準測點取2/3H)
P_0:參考高度處的靜壓
ρ：空氣密度
U_0:建築物高度初始風速
H:建築物高度(m)

計算流域取1800m×600m×1000m
(建築物置於流域沿流向前1/3處)

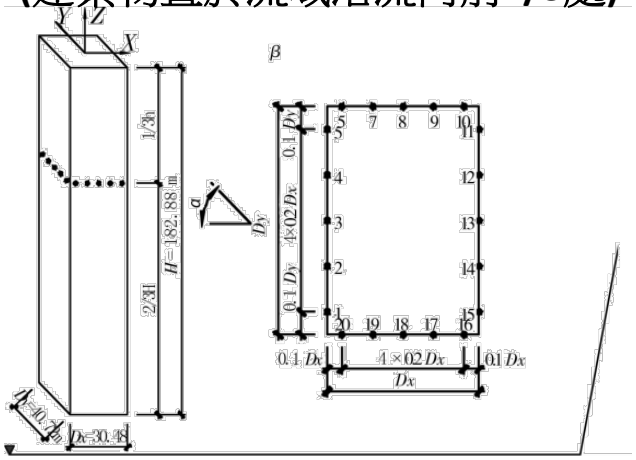


图 1　CAARC 几何尺寸及压力测点布置图

Reference

聶少鋒,周緒紅.CAARC標準高層建築三維鈍體繞流風場數值模擬.土木建築與環境工程,2009,Vol.31 No.6

CAARC建築風場數值模擬-2

$$U = U_0 \left(\frac{Z}{Z_0}\right)^{\alpha}$$

U:相對高度風速(m/s)
Z:地表相對高度(m)
Z_0:參考高度(常見取地表10m高)
U_0:參考高度風速(m/s)
α :地面粗糙度指數

类别	描述	Z_G/m	α
A	指近海海面、海岛、海岸、湖岸及沙漠地区	300	0.12
B	指田野、乡村、丛林、丘陵及房屋比较稀疏的乡镇和城市郊区	350	0.16
C	指有密集建筑群的城市市区	400	0.22
D	指有密集建筑群且房屋 较高的城市市区	450	0.30

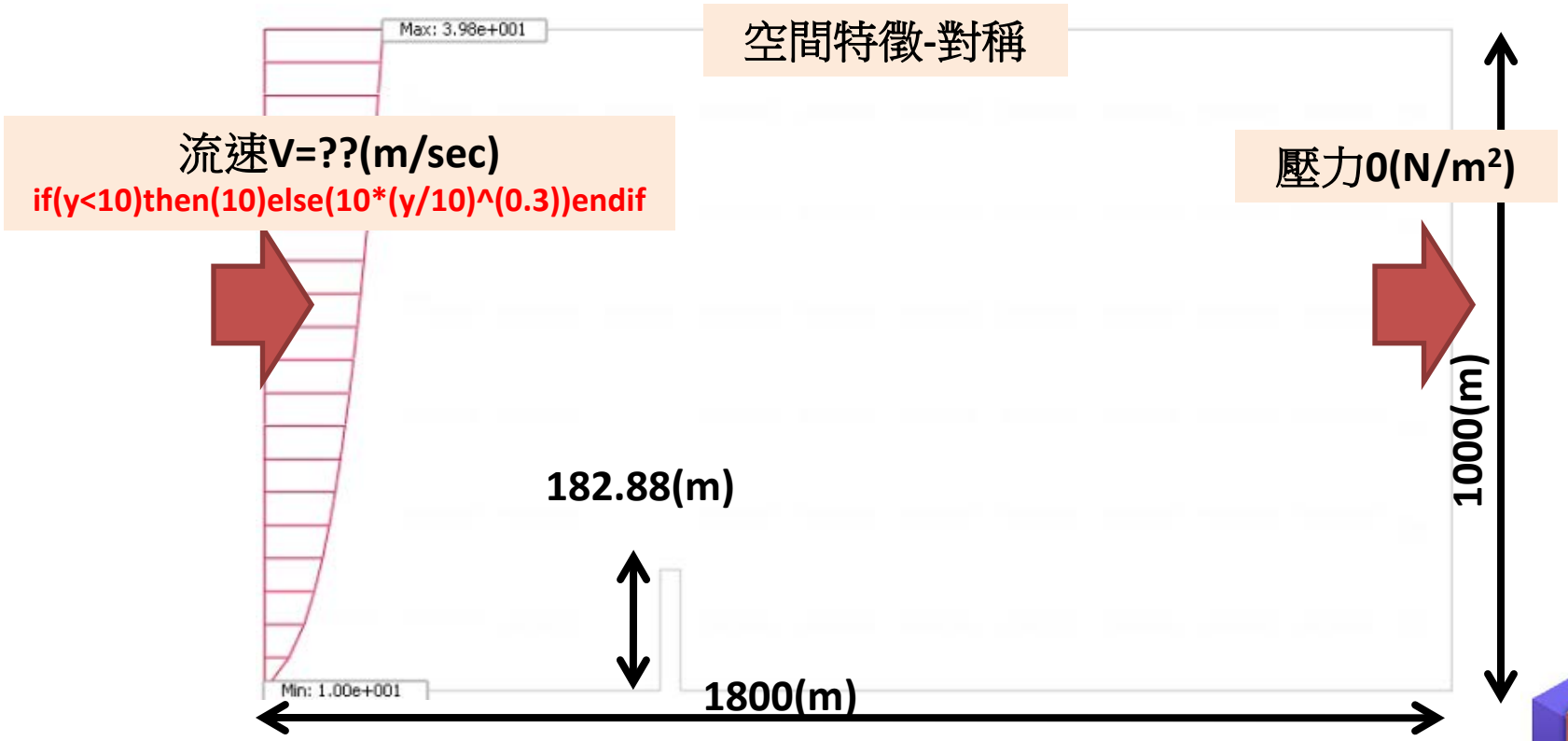
Reference

聶少鋒,周緒紅.CAARC標準高層建築三維鈍體繞流風場數值模擬.土木建築與環境工程,2009,Vol.31 No.6

分析說明

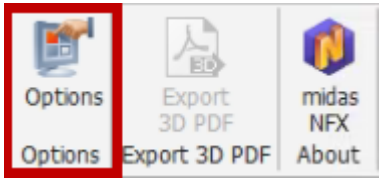
Z_0:參考高度Z_0:10m
U_0:參考高度風速U_0:10(m/s)
地面粗糙度指數α :0.3(市區)

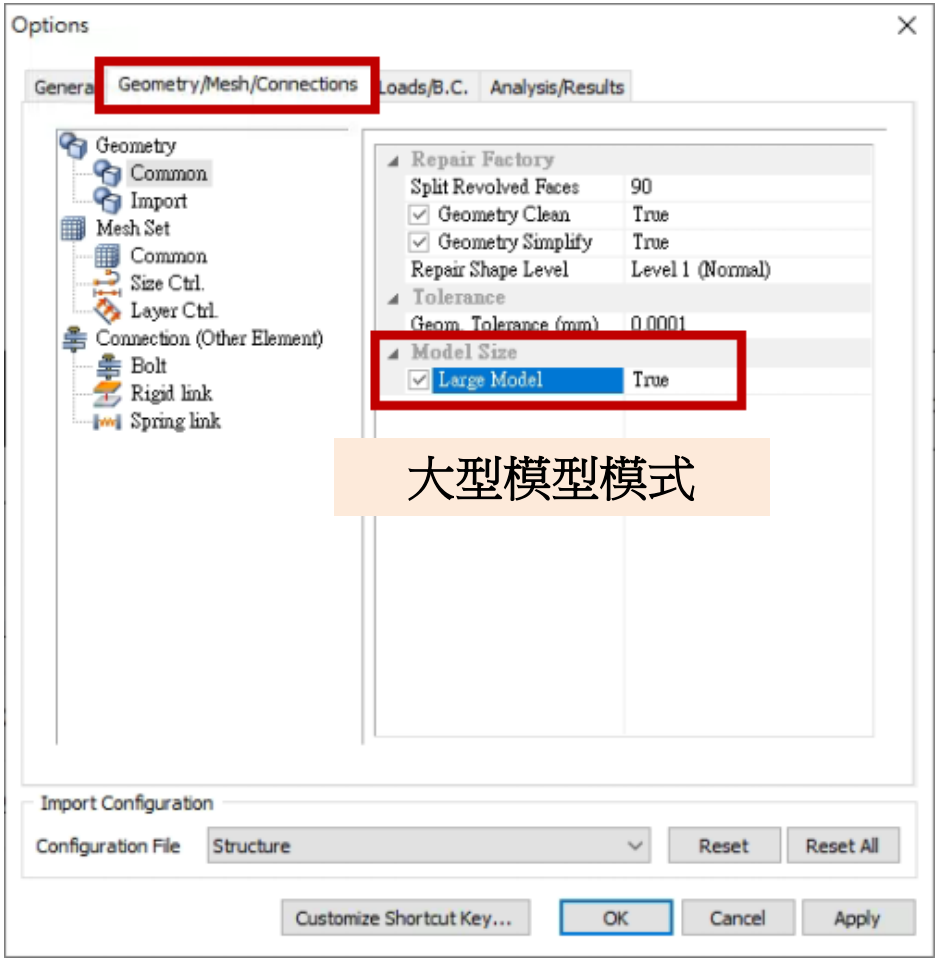
C_p風壓係數 ??
(大樓2/3H高位置)



註:2D空間高度座標為y軸。

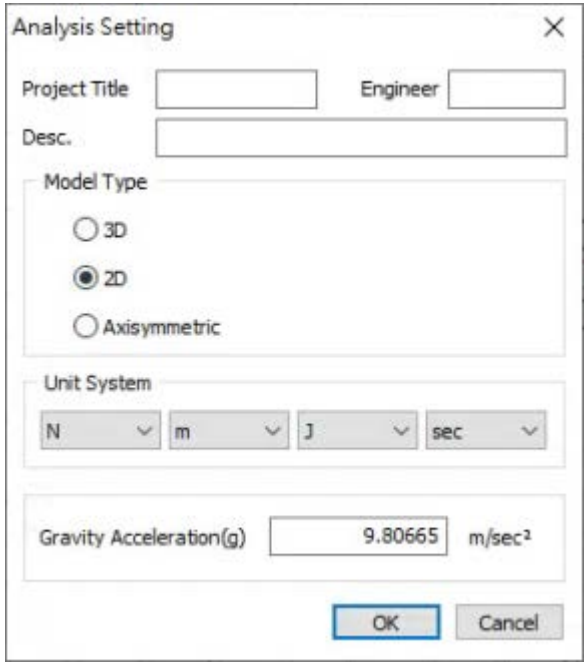
環境-1



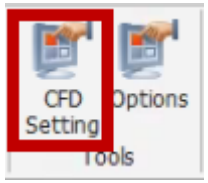


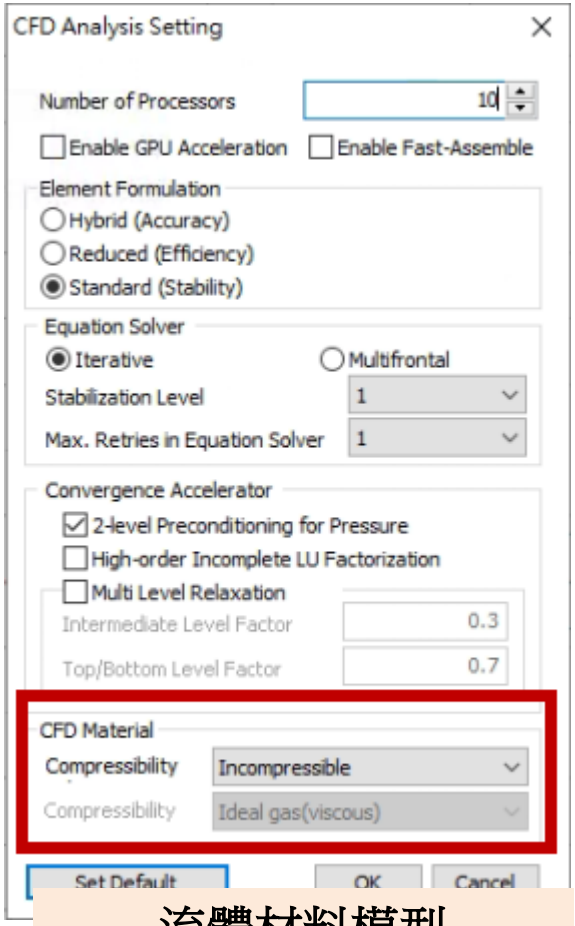
註:標準模型模式1000m ×1000m ×1000m

環境-2



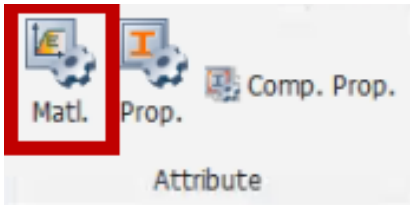
單位使用N/m/J/sec

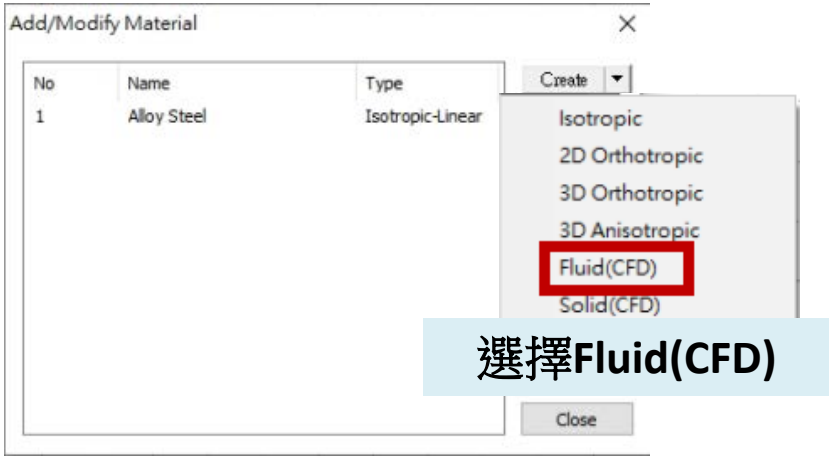




流體材料模型
不可壓縮流

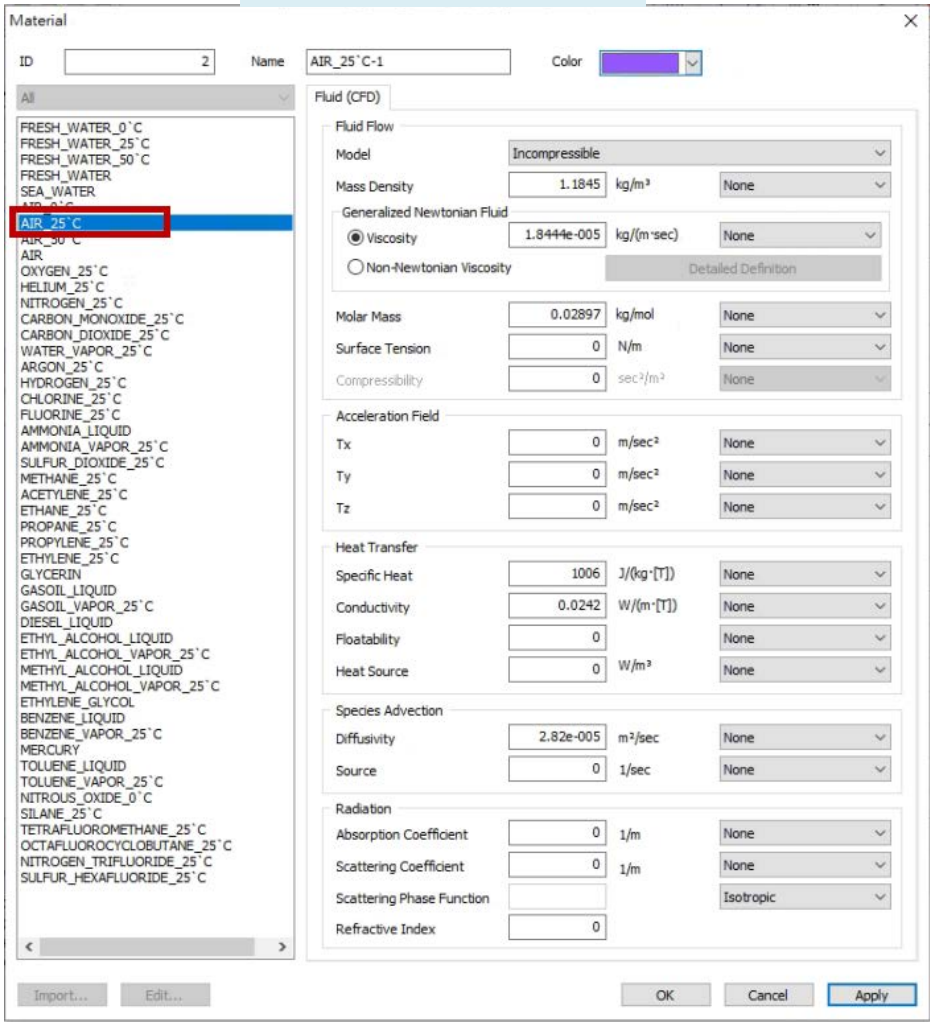
材料





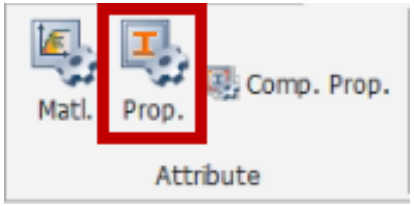
選擇Fluid(CFD)

新增AIR 25 ℃

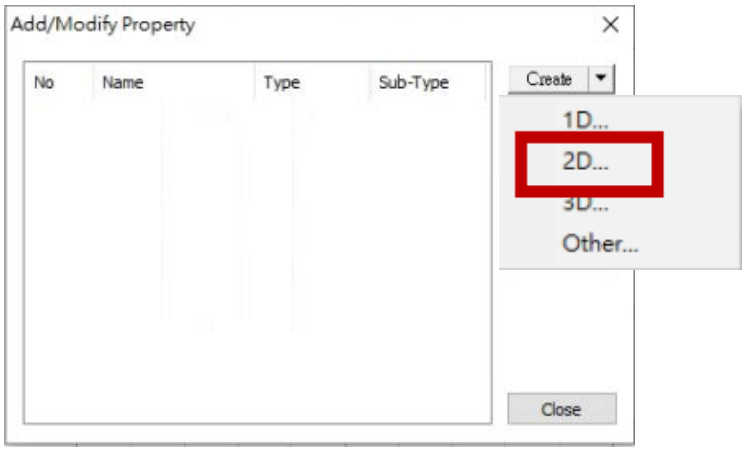


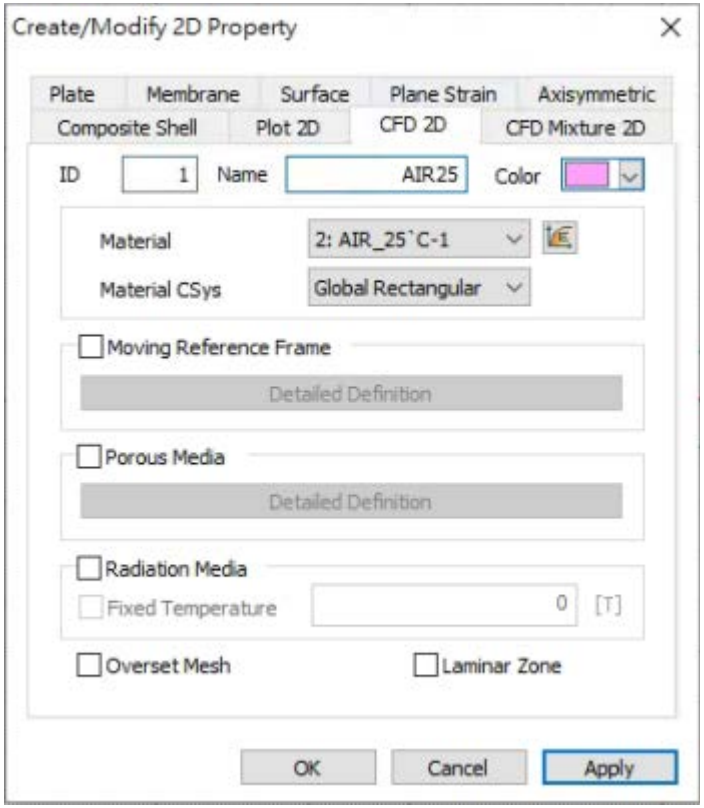
註:NFX CAE/CFD是整合性軟體,材料和屬性包含結構/熱/流場。

屬性

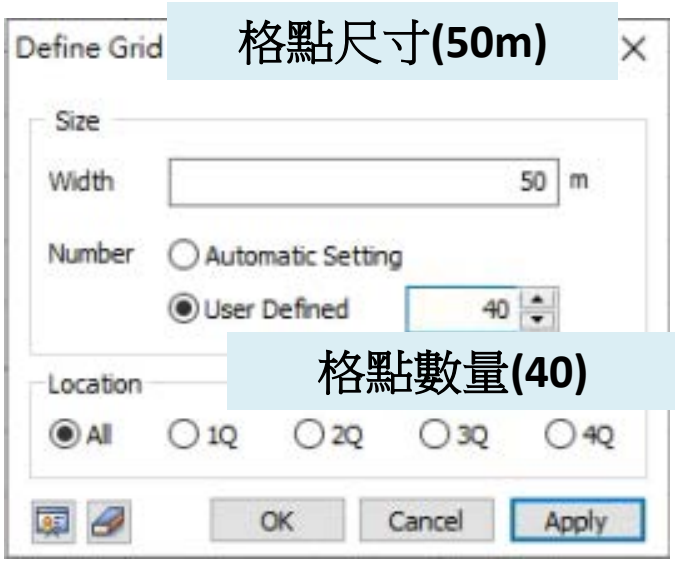


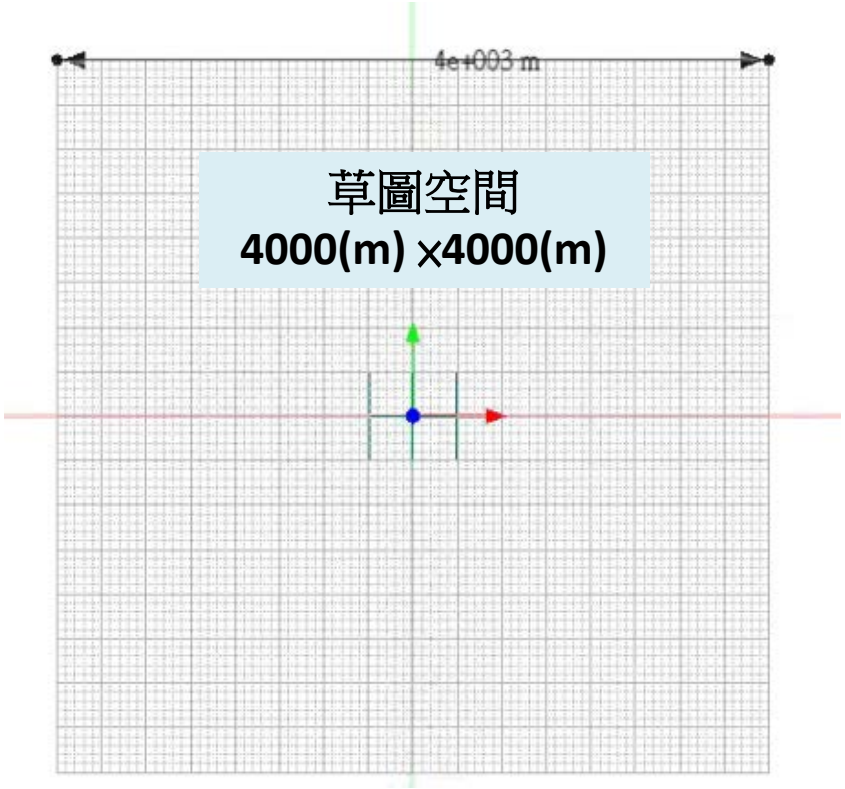
新增AIR 25 ℃ Property





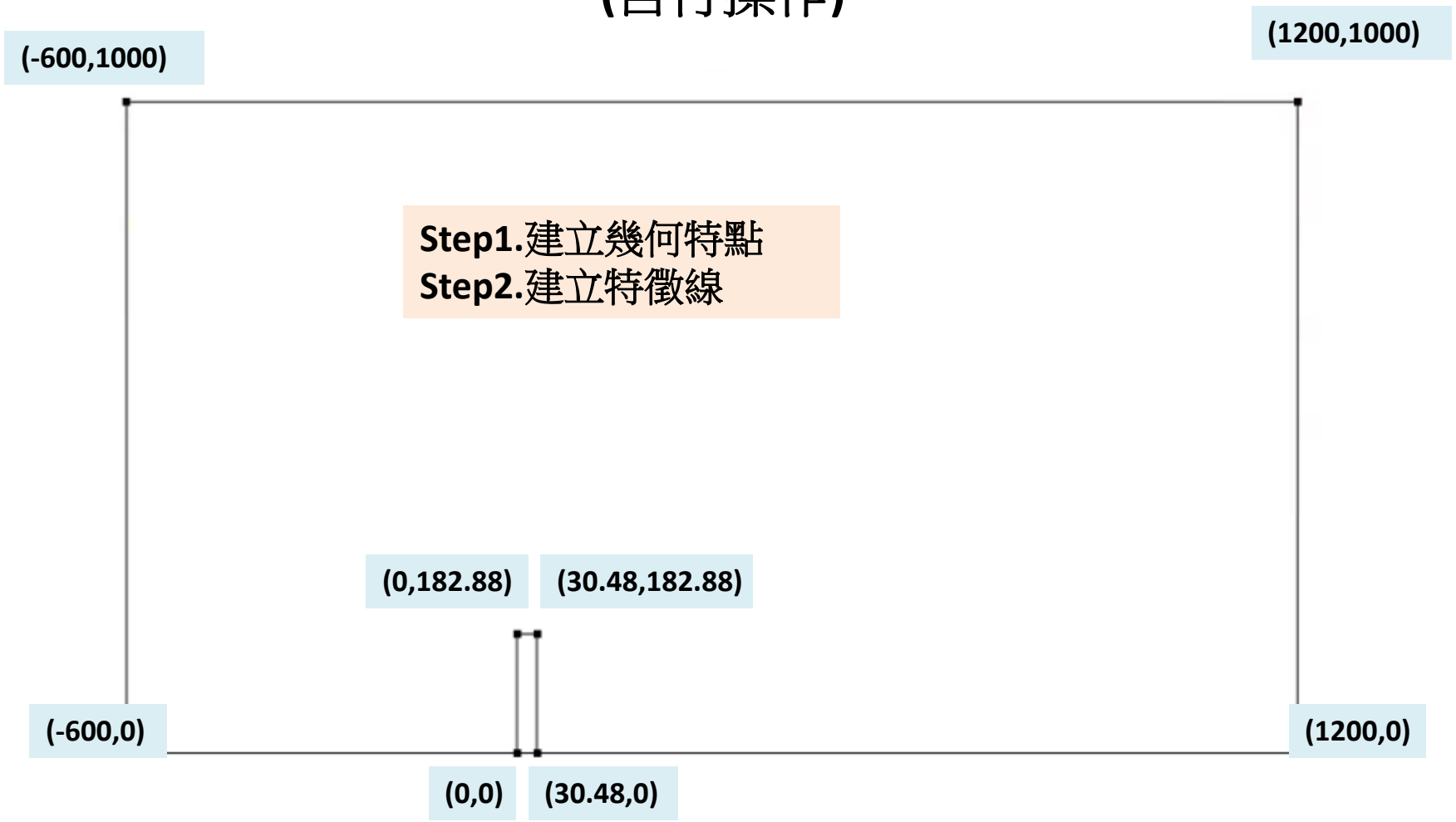
草圖格點


Define Grid
格點尺寸(50m)
Size
Width
50
m
Number
Automatic Setting
User Defined
40
格點數量(40)
Location
All
1Q
2Q
3Q
4Q
OK
Cancel
Apply

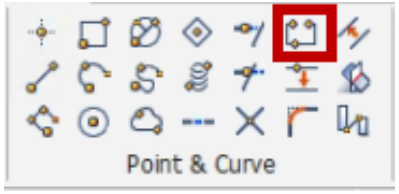

4e+003 m
草圖空間
4000(m) x4000(m)

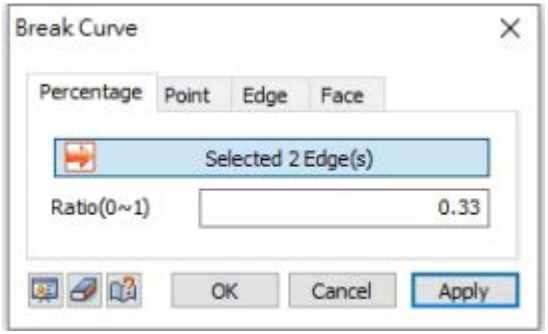
特徵線繪製

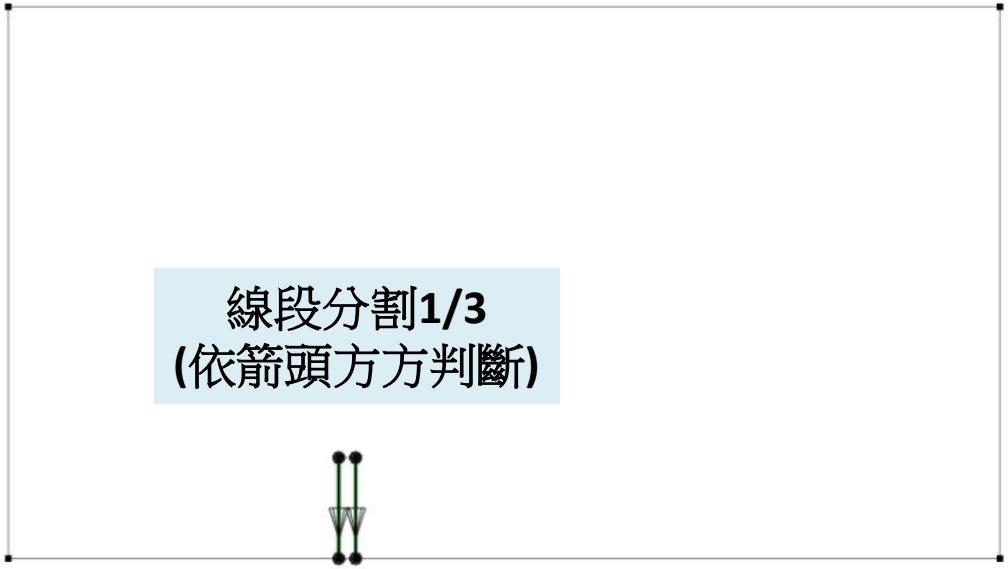
(自行操作)


(-600,1000)
(1200,1000)
Step1.建立幾何特點
Step2.建立特徵線
(0,182.88)
(30.48,182.88)
(-600,0)
(1200,0)
(0,0)
(30.48,0)

特徵線分割

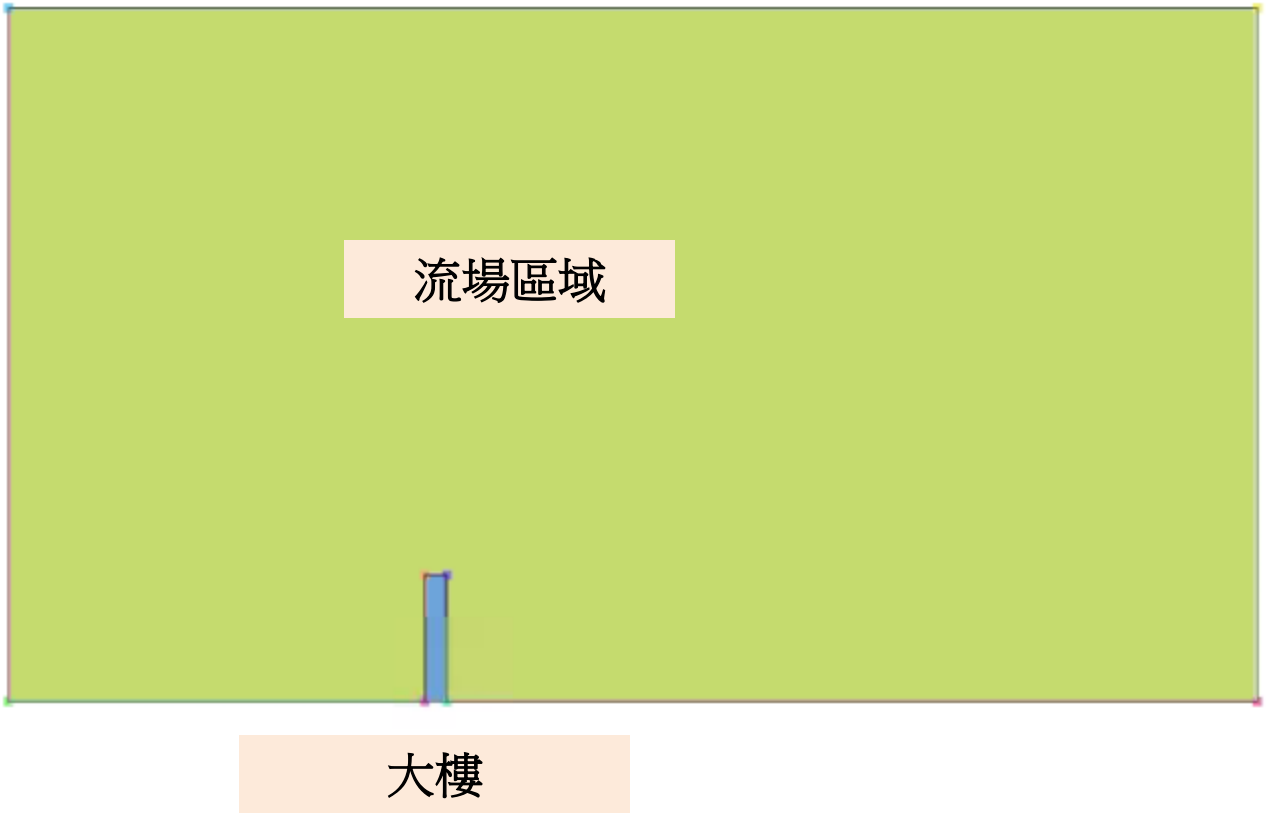

Point & Curve


Break Curve
Percentage
Point
Edge
Face
Selected 2 Edge(s)
Ratio(0~1)
0.33
OK
Cancel
Apply


線段分割1/3
(依箭頭方方判斷)

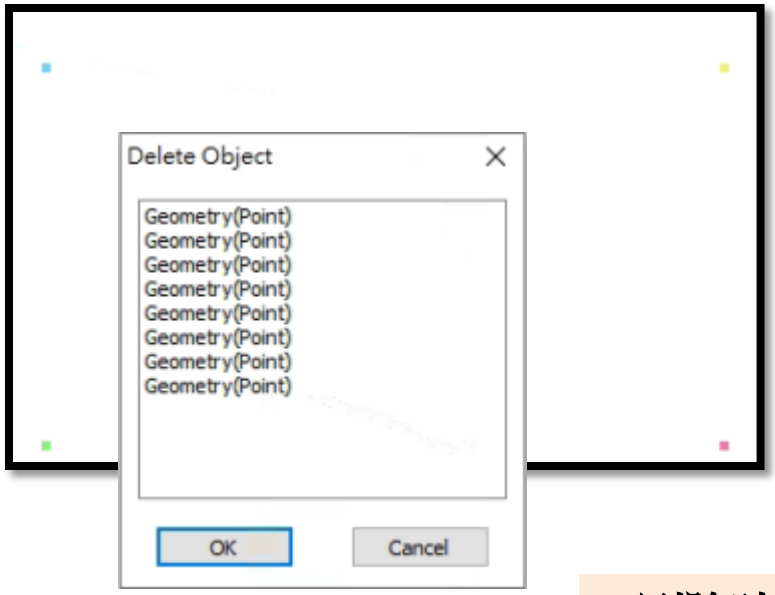
特徵面繪製

(自行操作)

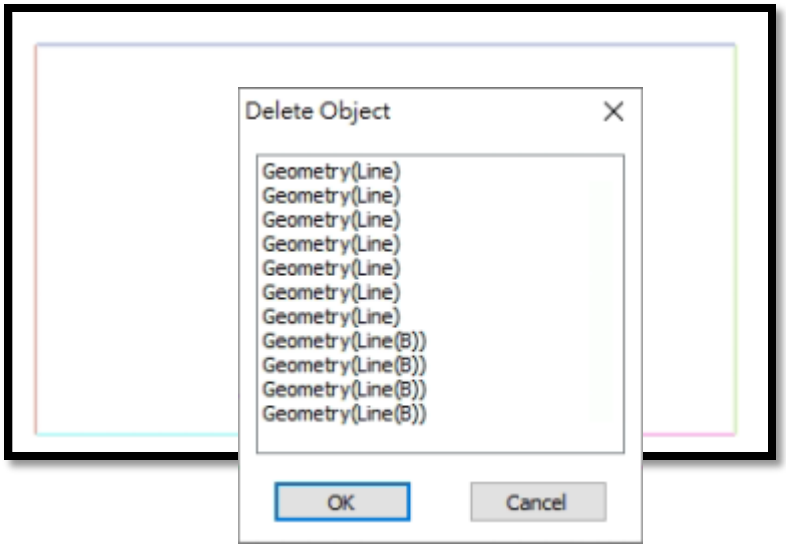


刪除點/線/面特徵

刪除所有點特徵

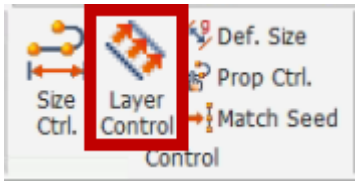


刪除所有線特徵



刪除建物面特徵

邊界層指定



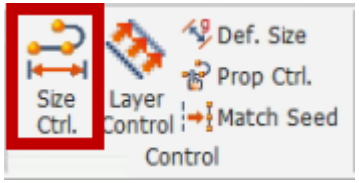
Number of Layers:3
Total Layer Height:0.1(m)
Layer Growth Rate:1

Step1.選取面特徵

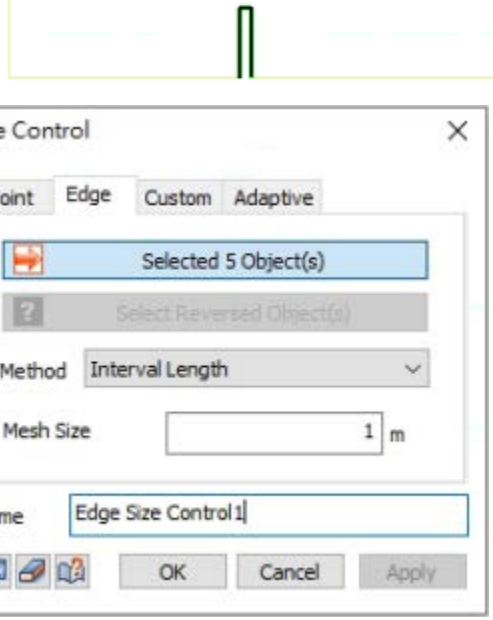
Step2.選取建物和地表線特徵

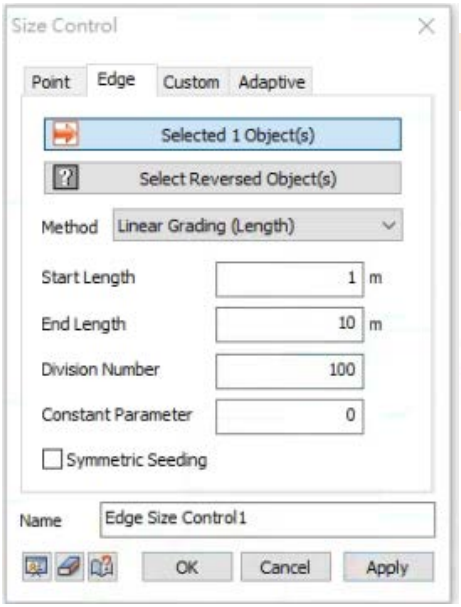
midas NFX-CFD

網格尺寸指定

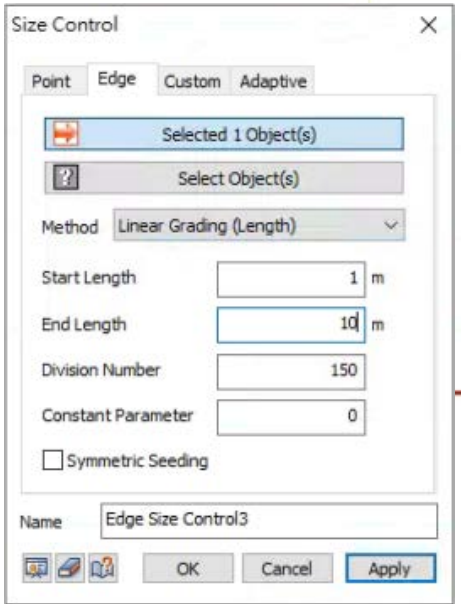


選取建物線特徵





選取地表左側線特徵



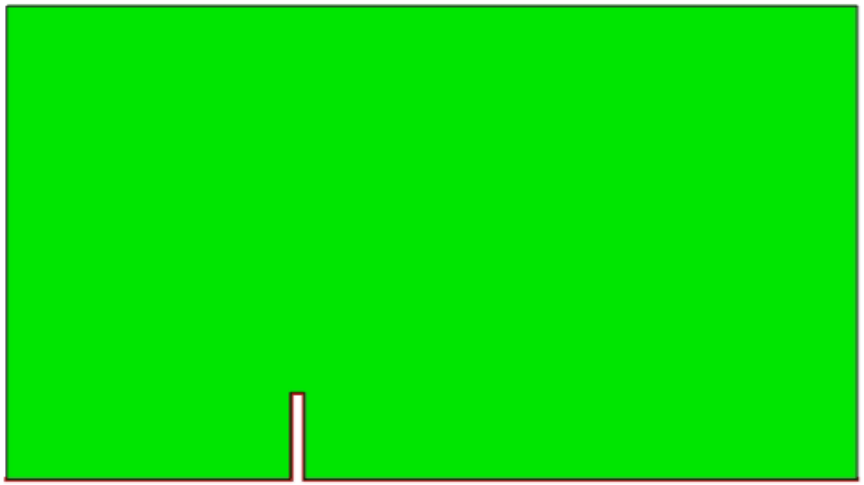
選取地表右側線特徵

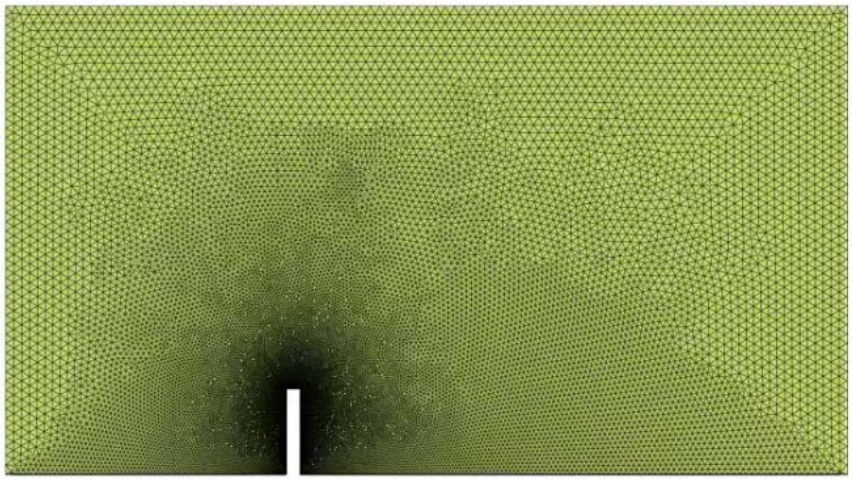
MIDAS

midas NFX-CFD

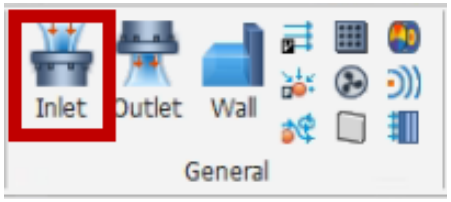
2D網格

三邊形網格/網格尺寸20(m)



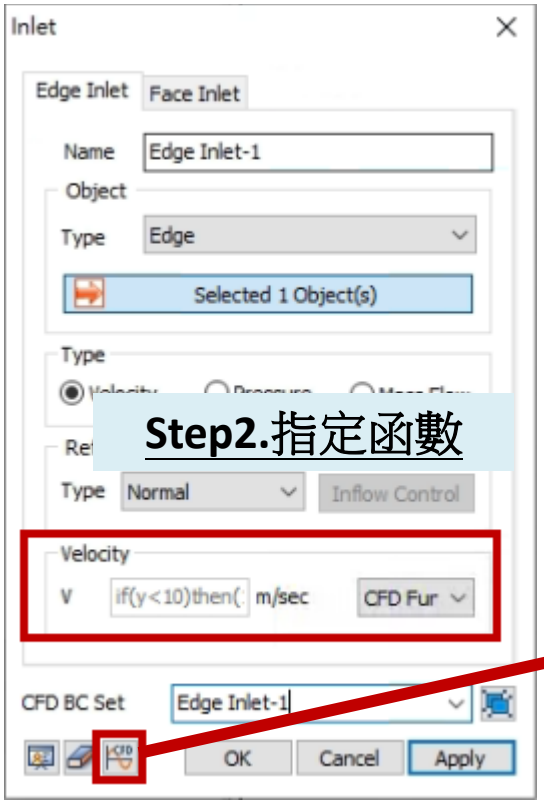


入流



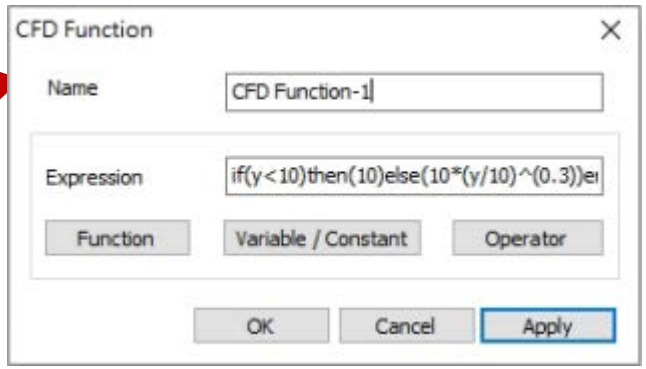
入流流速-函數定義

if(y<(10))then(10)else(10*((y)/10)^(0.3))endif



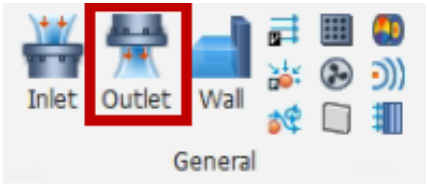
Step2.指定函數

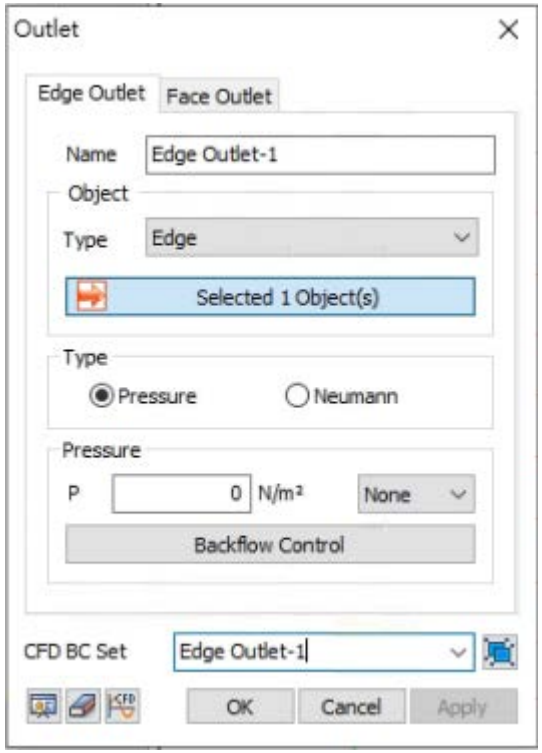
Step1.新增風廓線入流函數



註:不同邊界&載荷建議使用不同集合名稱。

出流

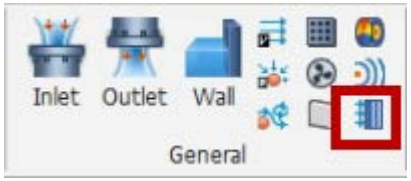


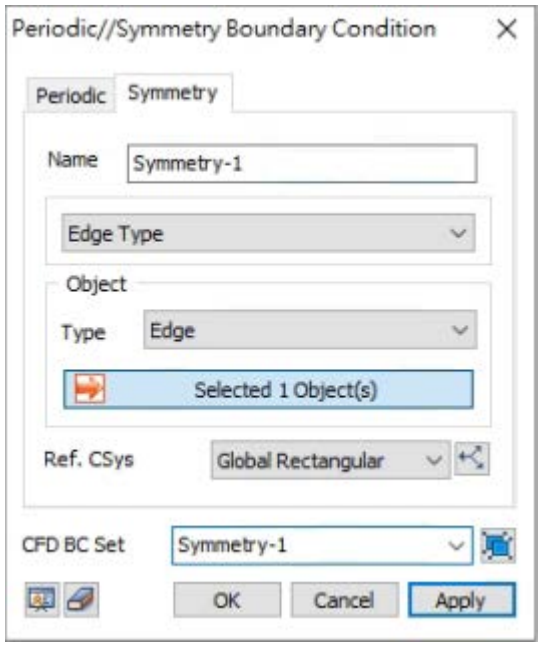


壓力0(N/m²)

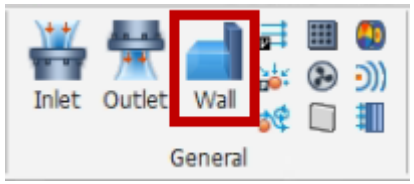
註:不同邊界&載荷建議使用不同集合名稱。

對稱

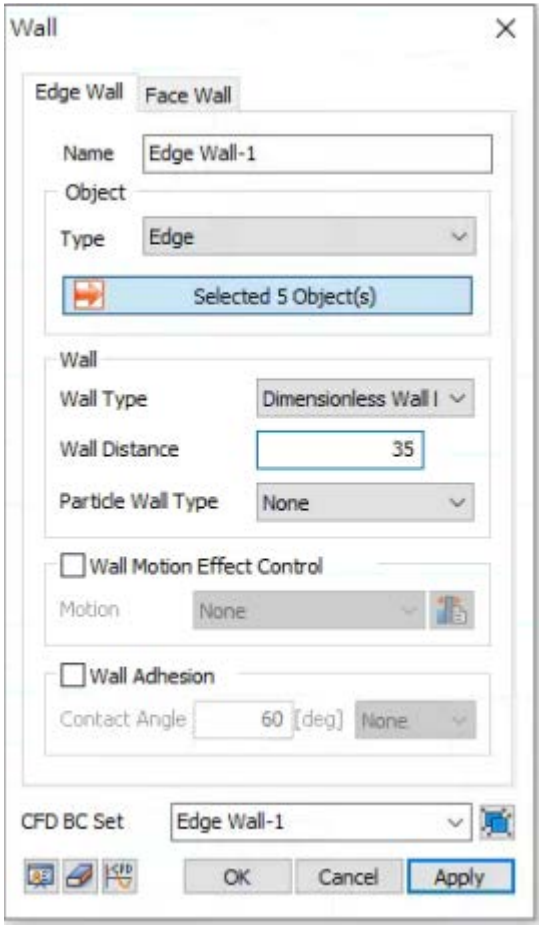




註:不同邊界&載荷建議使用不同集合名稱。

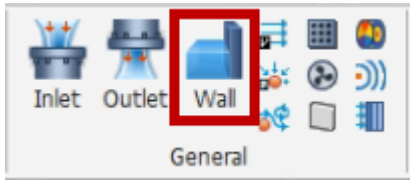


壁函數-1
(Dimensionless Wall Applied)

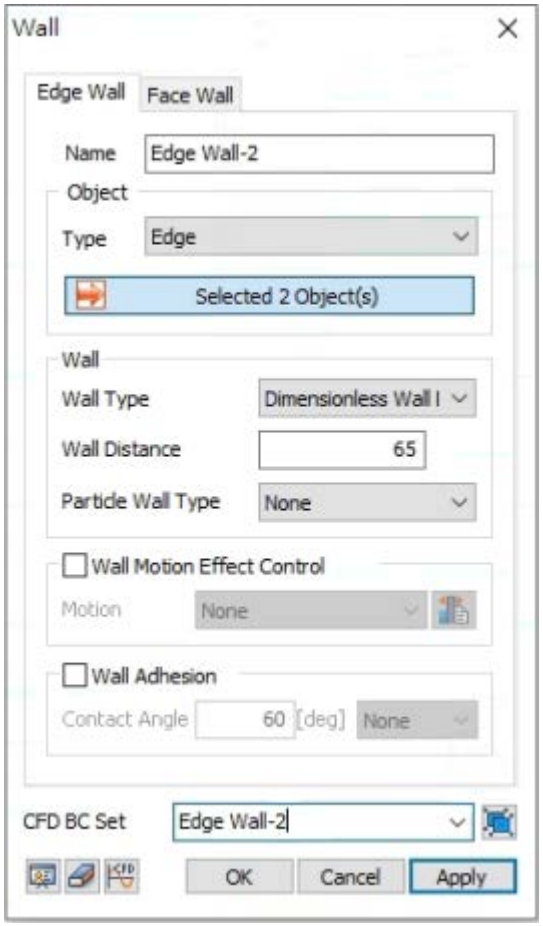


選取建物線特徵

壁函數(Dimensionless Wall Applied)
Y+=35

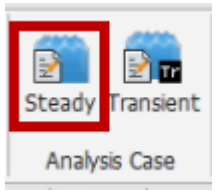


壁函數-2
(Dimensionless Wall Applied)



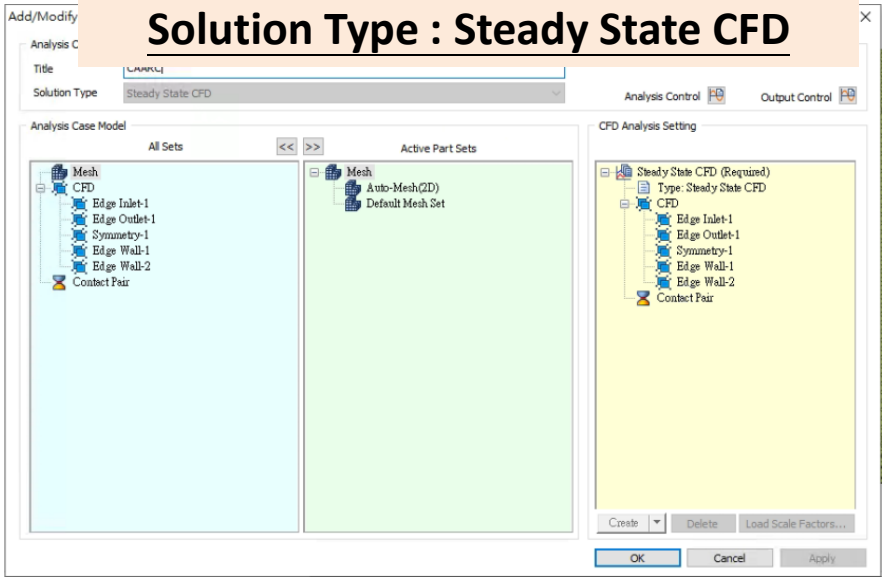
選取地表線特徵

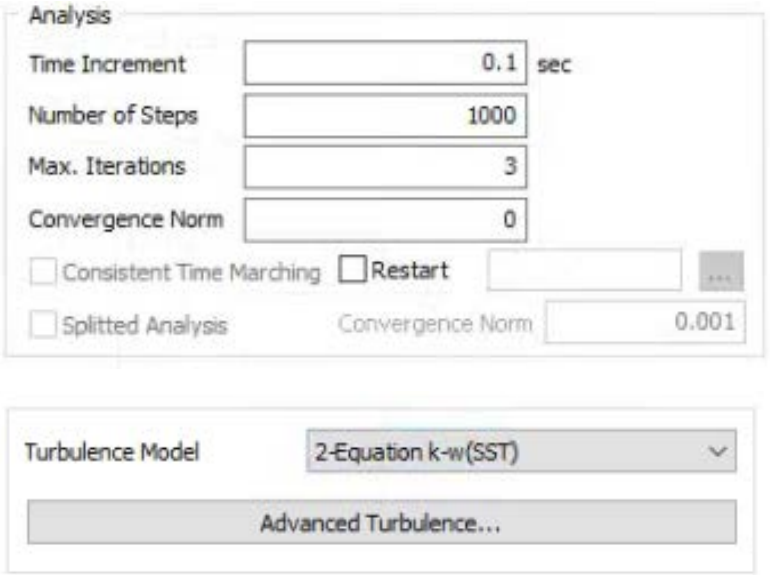
壁函數(Dimensionless Wall Applied)
Y+=65



CFD穩態分析
(CAARC建築風場數值模擬)

Solution Type : Steady State CFD





分析結果
(最後1增量)

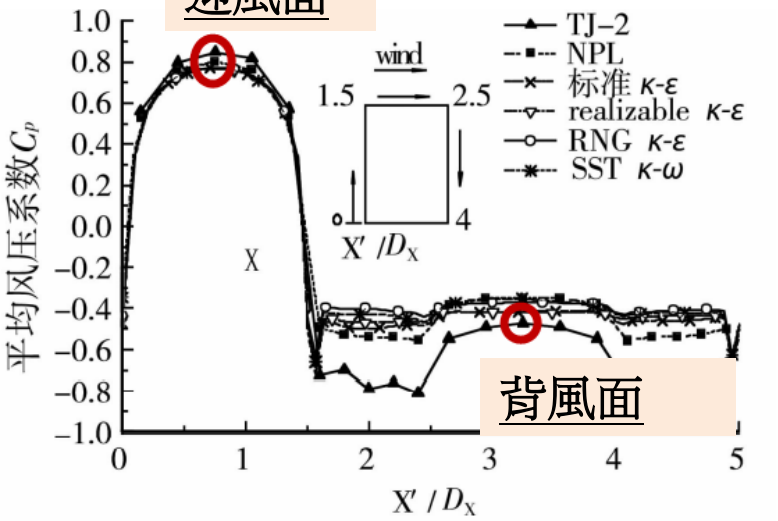
參考
聶少鋒,周緒紅.CAARC標準高層建築三維鈍體繞流風場數值模擬.

$$C_P = 2(P - P_0)/\rho U_0^2$$

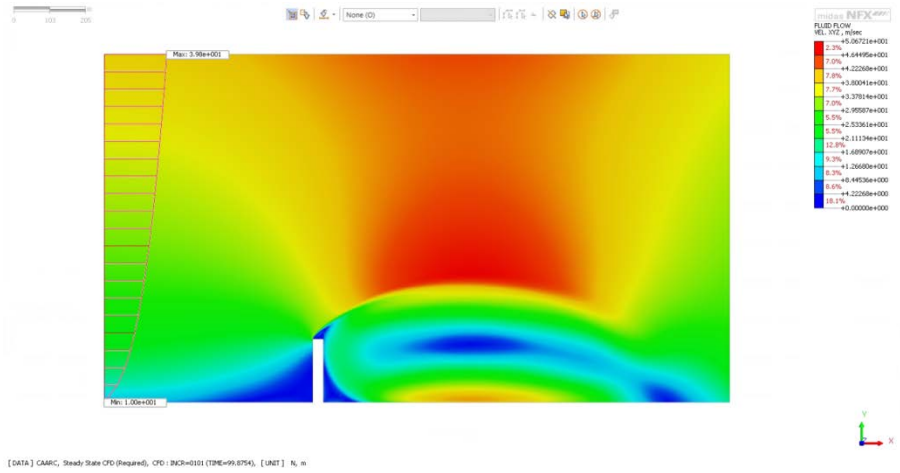
2D迎風面
P:295.7097(N/m²)
P_0:不考慮
ρ : 1.1845(kg/m³)
U_0:24(m/sec)
H:182.88(m)
C_p:0.8668

2D背風面
P:-309.5183(N/m²)
P_0:不考慮
ρ : 1.1845(kg/m³)
U_0:24(m/sec)
H:182.88(m)
C_p:-0.9058

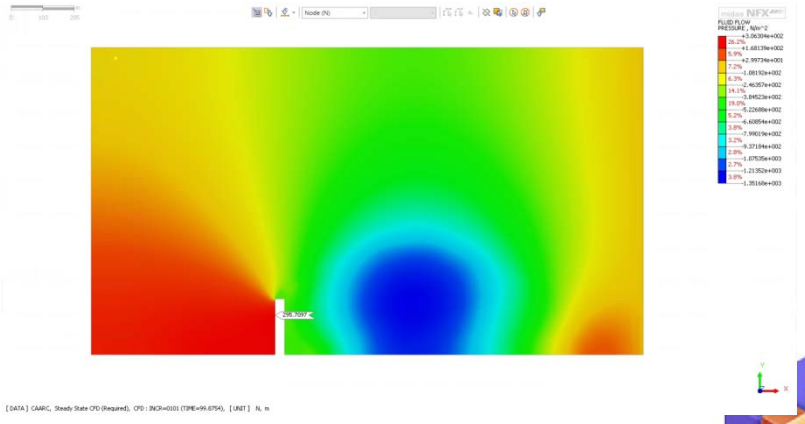
迎風面



流速(m/sec)



壓力(N/m²)



註:2維空間分析流場未考慮側邊流動，風壓係數誤差會偏大。

補充3D CAARC建築風場

(第800增量)

3D迎風面

P:254.1(N/m²)

C_p:0.7449

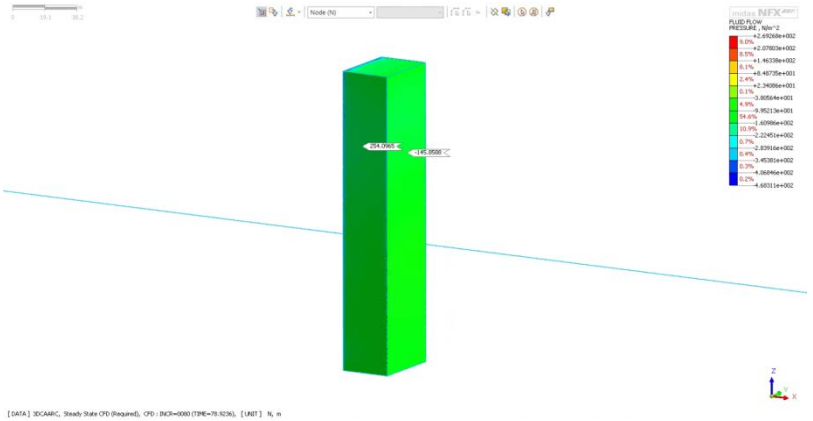
3D背風面

P:-145.9N/m²)

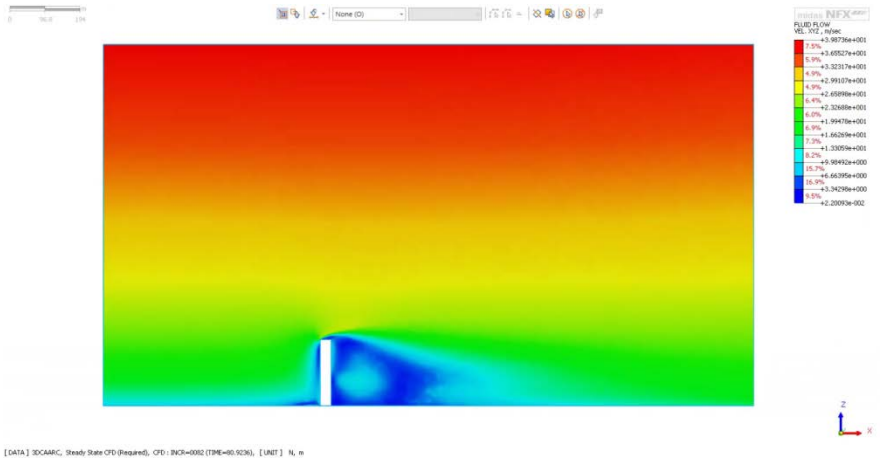
C_p:-0.4277

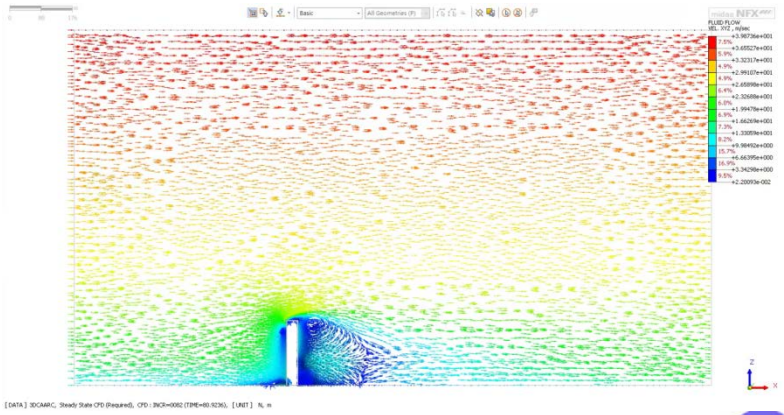
接近文獻結果

壓力(N/m²)



流速(m/sec)





註:3維空間分析計算所需時較長。