One Stop Solution
for Bridge and Civil Structures

midas Civil

單跨預鑄合成斷面預力梁橋

台灣邁達斯 技術部製作　www.midasuser.com.tw

目錄

概要

此為單跨 36m 長的預鑄合成斷面預力梁橋分析例題。與車行方向垂直的剖面如下圖所示，為六根間隔 2.75m 的預鑄預力梁組成，預力梁與 20cm 厚現場澆灌的混凝土橋面版形成合成斷面，橋面版上施加靜載重、活載重與衝擊載重。本例將 1.5cm 厚的磨耗層視為 20cm 橋面版的一部分，另有 5cm 厚的磨耗層載重將額外考量。

橋梁尺寸

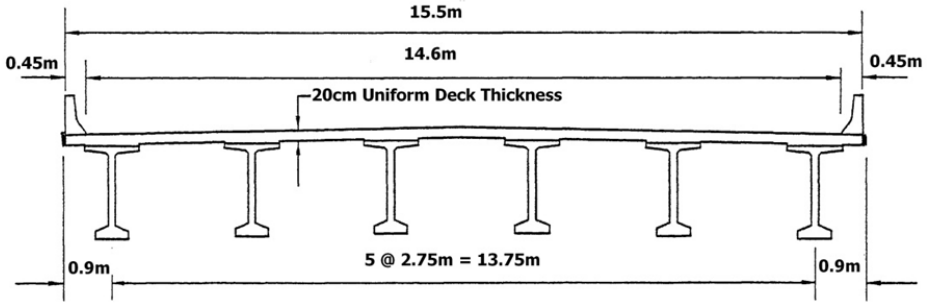


圖 1　橋梁剖面圖

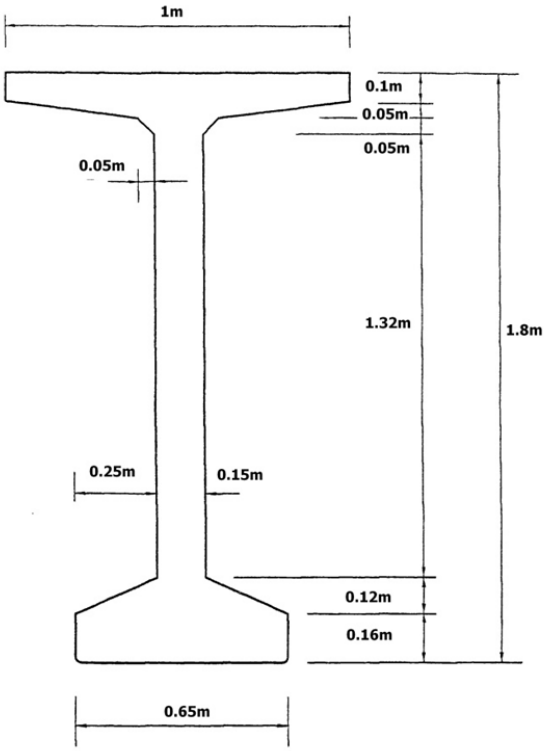


圖 2　預鑄梁尺寸圖

材料

混凝土 – 橋面版(Deck)與橫樑(Cross Beams)

CNS(RC)　C280

Modulus of elasticity　：2.6956 x 10^5 kgf/cm^2
Poisson's ratio　：0.2
Density　：2.4 tonf/m^3
Concrete strength (28-day)：280 kgf/cm^2
Deck total thickness　：20 cm
Deck structural thickness　：18.5 cm
Cross beam depth　：18.5 cm (與橋面版厚度同)
Interior cross beam width　：3 m (鄰接橫樑中心到中心的距離)
End cross beam width　：1.5 m

混凝土 – 預鑄樑(Precast Beams)

CNS(RC)　C420

Modulus of elasticity　：3.4366 x 10^5 kgf/cm^2
Poisson's ratio　：0.2
Density　：2.4 tonf/m^3
Concrete strength (28-day)：420 kgf/cm^2

鋼材 – 預力鋼腱(Prestress Tendons)

12.7mmΦ 7 線絞索，高拉力低鬆弛鋼絞索
Modulus of elasticity　：1.95 x 10^6 kgf/cm^2
Ultimate strength　：190.0 kgf/mm^2　極限抗拉強度
Yield strength　：160.0 kgf/mm^2　降伏強度

載重

靜載重

橋面版

Exterior PC Beam　：(0.2m) (2.275m) (2.4 tonf/m^3) = 1.092 tonf/m
Interior PC Beam　：(0.2m) (2.75m) (2.4 tonf/m^3) = 1.32 tonf/m
Haunch above beam：(0.015m) (1m) (2.4 tonf/m^3) = 0.036 tonf/m

護欄

(2 barriers)(0.45 tonf/m) / (6 beams) = 0.15 tonf/m

新增磨耗層

(0.05m)(2.4 tonf/m^3) (14.6m) / (6 beams) = 0.292 tonf/m , use 0.3

預力

初始應力 = 146.0 kgf/mm^2 (75% of ultimate strength)
因彈性縮短的瞬時損失= 8.9 % (13 kg/mm^2)
假設應力 = 133.0 kgf/mm^2

車輛載重 (Taiwan)　HS 20-44

開啟檔案與偏好設定

> **New Project**
> **Save (PSC Single Span)**

Tools > **Unit System**

Length>**cm** ; Force (Mass)>**kgf**

Temperature > **Celsius** ↵

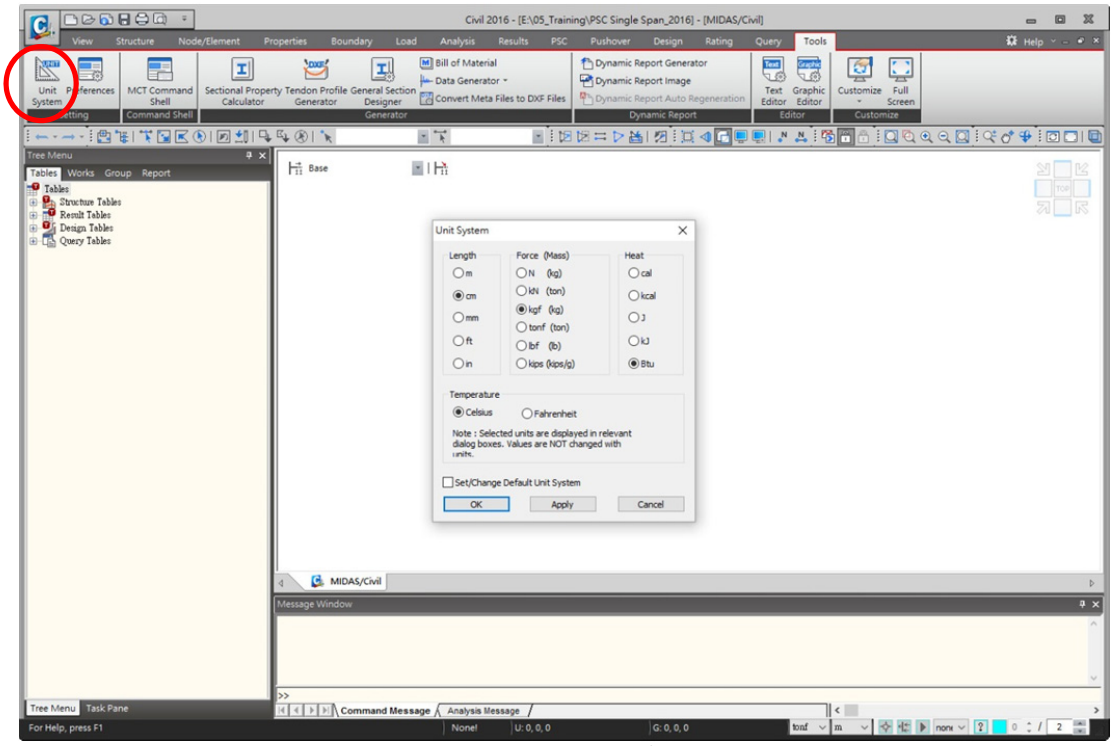


圖 3 開新檔案與單位設定

材料與斷面性質

在此章節將定義模型中須使用到的材料與斷面性質。

材料性質

定義以下材料：**Deck ; Precast Beams ; Tendons ; Cross Beams**.

Properties > **Material Properties** ↵
Properties 對話框 > **Material** 表單 > Add
Name>**Deck**
Type of Design>**Concrete**
Standard>**None**
Modulus of Elasticity>**269560**
Poisson's Ratio>**0.2**
Thermal Coefficient>**1.1 e-005** 1/[C]
Weight Density>**0** ↵
Apply

Note:
本例將橋面版視為梁載重施加，故此處橋面版單位重輸入為零，不要在施工階段生成合成斷面後就自動計算橋面版自重。

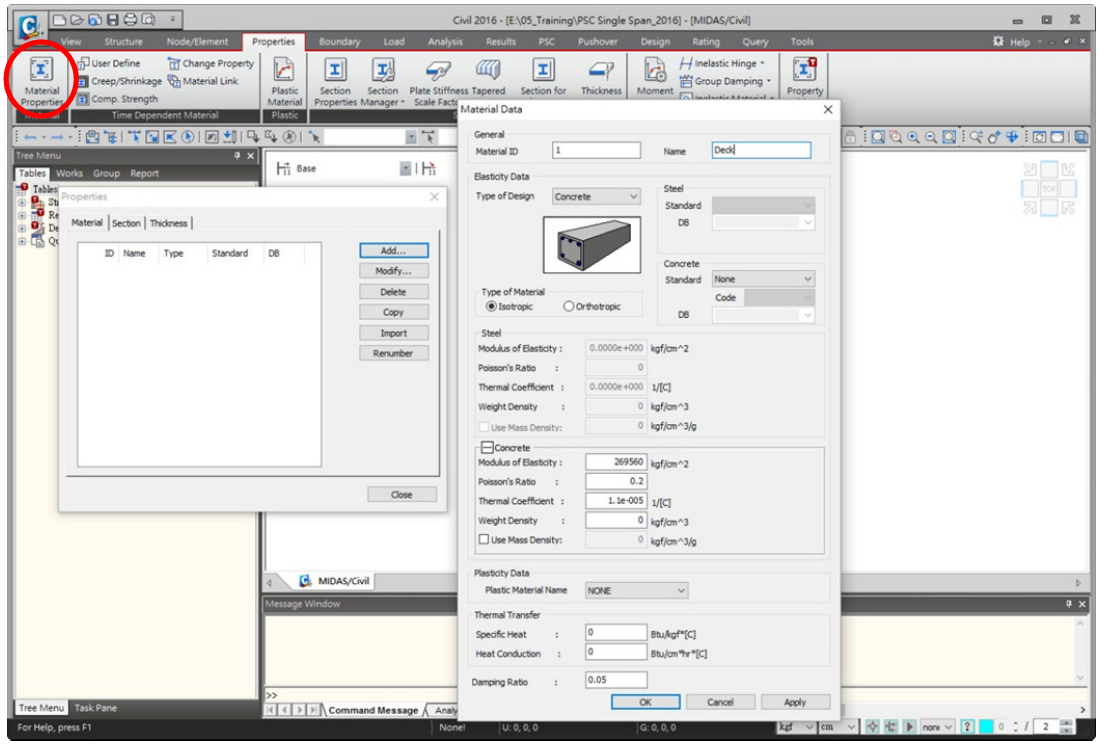


圖 4　設定材料對話框

Name> **Precast Beams**
Type of Design>**Concrete**
Standard>**None**
Modulus of Elasticity>**343660**
Poisson's Ratio> **0.2**
Thermal Coefficient>**1.1 e-005** 1/[C]
Weight Density> **0.0024** kgf/cm^3 (i.e., 2.4 tonf/m^3) ↵
Apply

Name> **Tendon**
Type of Design>**User Defined**
Standard>**None**
Modulus of Elasticity>**1.95e+006**
Poisson's Ratio> **0.3**
Weight Density> **0.0024** kgf/cm^3 (i.e., 2.4 tonf/m^3) ↵
Apply

Note:
在此範例中係將鋼腱的單位重與混凝土的單位重設定為相同，目的是讓使用者易於與其他不考慮鋼腱單位重的模型作比較。

Name> **Cross Beams**
Type of Design>**Concrete**
Standard>**None**
Modulus of Elasticity>**269560**
Poisson's Ratio>**0.2**
Thermal Coefficient>**1.1 e-005** 1/[C]
Weight Density>**0** ↵
OK

Note:
為施加車輛載重而虛設 cross beams，故 cross beams 單位重設為 0。

Close

時間依存材料性質

Properties > Time Dependent Material > **Creep / Shrinkage** ↵

Time Dependent Material (Creep / Shrinkage) 對話框 > Add
Name>**CEB-FIP**
Code>**CEB-FIP(1990)**
Compressive strength of concrete at the age of 28 days>**420**
Relative Humidity of ambient environment (40–99)>**70** %
Notational size of member>**25** cm (此為臨時設定值，此值將於後續步驟讓程式自動計算與替換)
Type of cement**>Normal or rapid hardening cement (N, R)** ↵
Age of concrete at the beginning of shrinkage>**3** day
Show Result... (圖 6)
Close
OK
Close

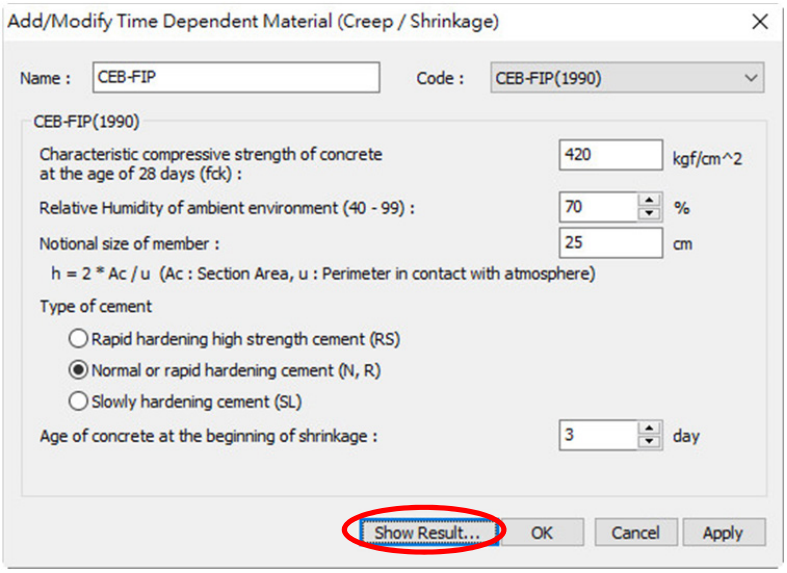


圖 5　設定乾縮潛變對話框

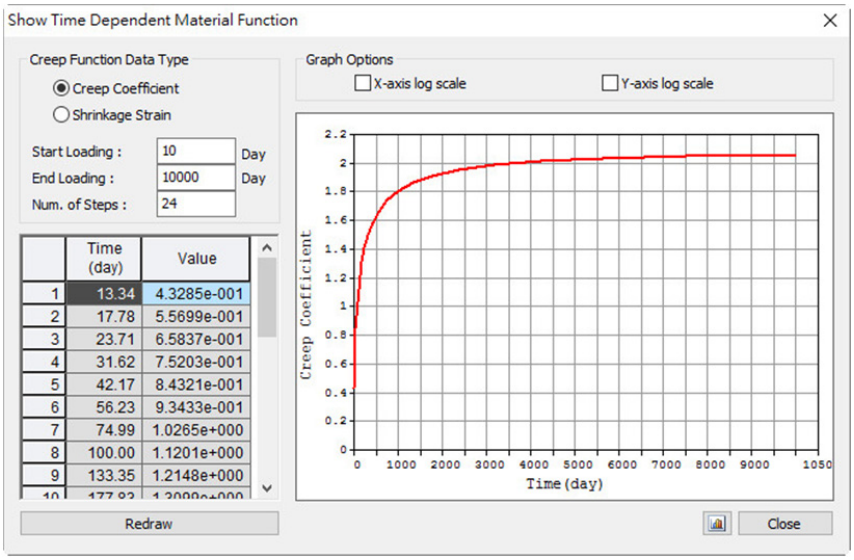


圖 6　乾縮係數圖

Properties > Time Dependent Material **> Comp. Strength** ↵

Time Dependent Material (Comp. Strength) 對話框 > Add
Name>**C420**
Type>**Code**
Development of Strength>Code>**CEB-FIP(1990)**
Concrete Compressive Strength at 28 Days>**420**
Cement Type(s)> **N, R: 0.25**
Redraw Graph
OK
Close

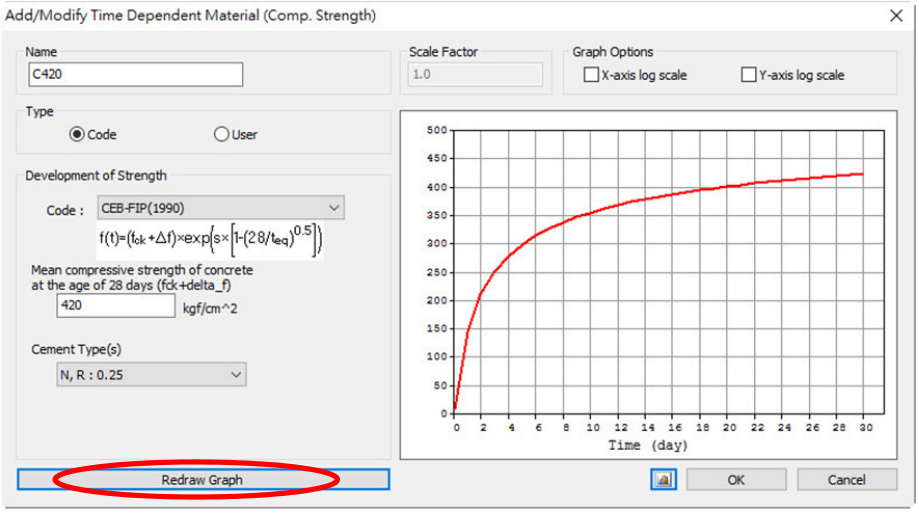
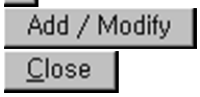


圖 7　設定抗壓強度對話框

Properties > Time Dependent Material > **Material Link** ↵

Time Dependent Material Type>Creep/Shrinkage>**CEB-FIP**
Time Dependent Material Type>Comp. Strength>**C420**
Select Material to Assign>Materials>**2:Precast Beams**



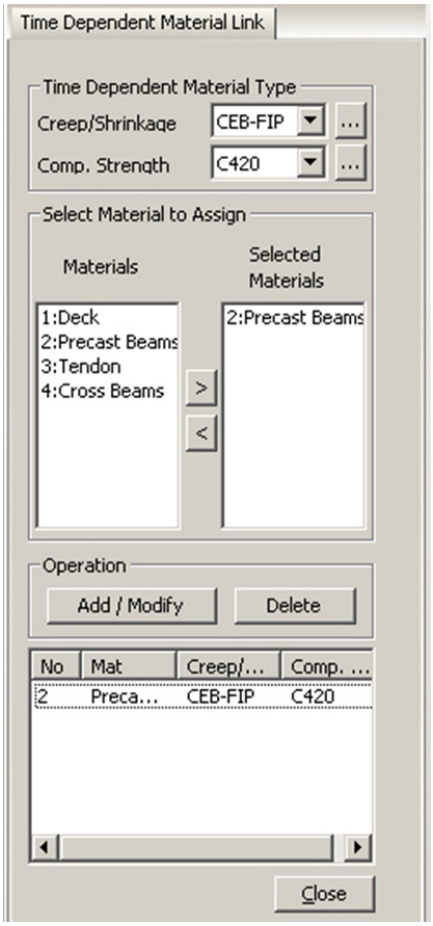


圖 8　時間依存材料連結對話框

斷面性質

定義以下斷面：**Interior Precast Beams**、**Exterior Precast Beams**、**End Cross Beams**、**Interior Cross Beams**

內側與外側的預鑄梁彼此間的有效橋面版寬度不同。
內側與端部橫梁的寬度不同。

Properties > **Section Properties** ↵
Properties 對話框 > **Section** 表單 > Add
選擇 **Composite** 表單
Section ID > **1**
Name>**Interior Precast Beams**
Section Type**>Composite-I**
Slab>Bc>**275** cm
Slab>tc>**18.5** cm
Slab>Hh>**1.5** cm

比對 **PSC Viewer** 的斷面示意圖，輸入 Interior PC Beams 對應的點位尺寸(J1, JL1…JL4, JR1…JR4) 。

Girder>**J1, JL1** (on)
Girder>**Symmetry** (on)

下拉 **Girder** 視窗並輸入
表 1 的斷面幾何資料:

H1	180
HL1	10
HL2	10
HL2-1	5
HL3	132
HL4	12
HL5	16
BL1	7.5
BL2	50
BL2-1	37.5
BL4	32.5

表 1　Interior Precast Beams 斷面幾何資料

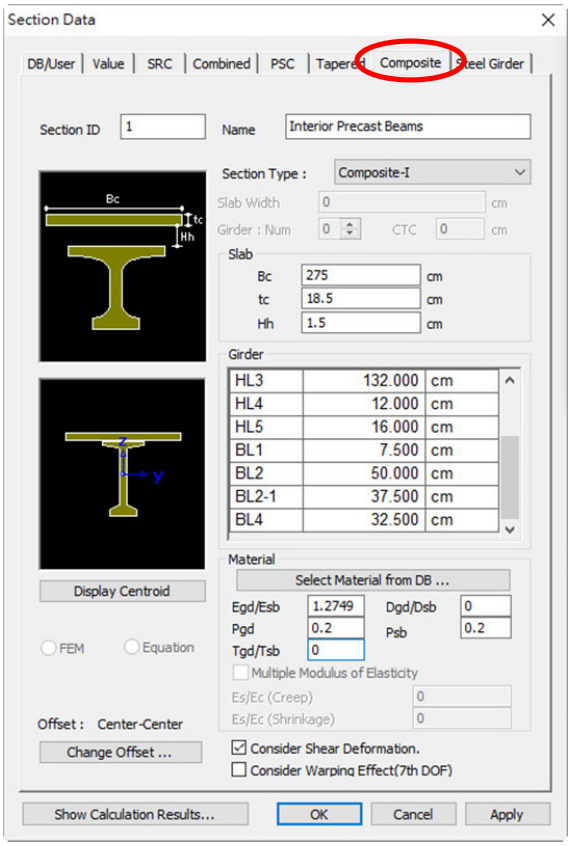


圖 9　斷面資料對話框

Note:

Egd/Esb 代表梁(girder)與橋面板(slab)的彈性模數比，Egd/Esb = 343660/269560 = 1.2749.

Dgd/Dsb 代表梁(girder)與橋面板(slab)的單位密度比，在此處設定為 0 代表想將橋面版重視為梁荷重，不要自動計算橋面版自重。

Properties 對話框 **> Section** 表單 **> ID 1 (Interior Precast Beams)**

Copy

ID 2 (Interior Precast Beams)

Modify...

Name>**Exterior Precast Beams**

Slab > Bc > **227.5** cm (此為兩斷面唯一的不同).

OK

Properties 對話框 **> Section** 表單 > Add
DB/User 表單
Name>**End Cross Beams**
選 **User**

Select **Solid Rectangle** (

)
H>**18.5** cm
B>**150** cm
OK

Properties 對話框 **> Section** 表單 > Add
DB/User 表單
Name>**Interior Cross Beams**
選 **User**

Select **Solid Rectangle** (

)
H>**18.5** cm
B>**300** cm
OK
Close

Note:
Cross Beams 的深度取為橋面板厚度，寬度則取為 Cross Beams 間的中心距。

結構模型

Tools > **Unit System**
Length>**m** ; Force (Mass)>**tonf** ↵

Top View

Node/Element > Nodes > **Create Nodes** ↵
Coordinates (x,y,z)>**0,0,0**
Copy>Number of Times>**5**
Copy>Distances (dx,dy,dz)**>0,2.75,0** m
Apply
Close

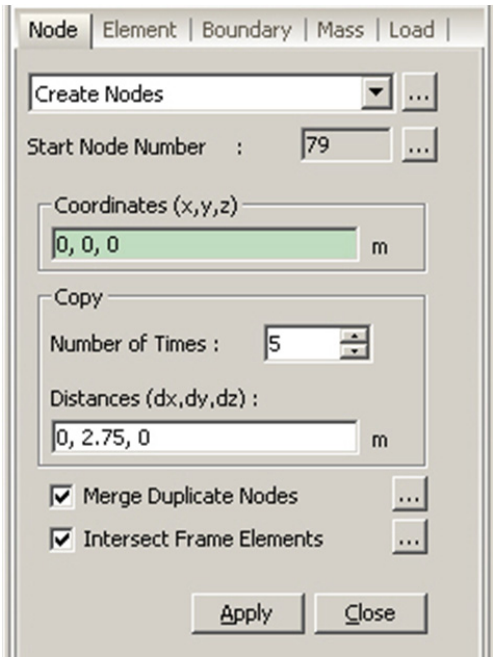


圖 10 建立節點對話框

預鑄梁

Auto Fitting
Node Number

Node/Element > Elements > **Extrude** ↵
Select Window >Nodes 1 , 6
Extrude Type>**Node→ Line Element**
Element Attribute>Element Type>**Beam**
Material>**2: Precast Beams**
Section>**2: Exterior Precast Beams**
Generation Type>**Translate**
Translation>dx,dy,dz>**3, 0, 0** m
Number of Times>**12**
Apply

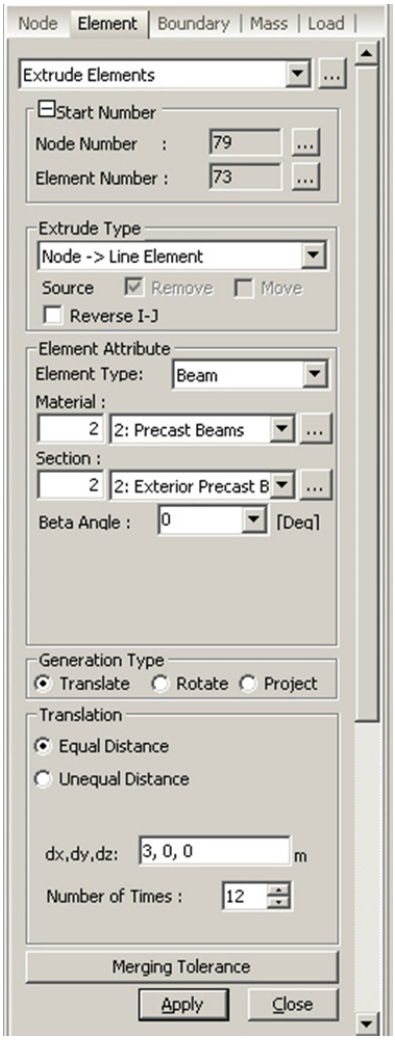


圖 11　擠出元素對話框

Select Window>Nodes 2to5
Extrude Type>**Node→ Line Element**
Element Attribute>Element Type>**Beam**
Material>**2: Precast Beams**
Section>**1: Interior Precast Beams**
Generation Type>**Translate**
Translation>dx,dy,dz>**3, 0, 0** m
Number of Times>**12**
Apply

橫梁

Select Window>Nodes 1 , 29
Extrude Type>**Node→ Line Element**
Element Attribute>Element Type>**Beam**
Material>**4: Cross Beams**
Section>**3: End Cross Beams**
Generation Type>**Translate**
Translation>dx,dy,dz>**0, 2.75, 0** m
Number of Times>**5**
Apply

Select Window>Nodes 7to27by2
Extrude Type>**Node→ Line Element**
Element Attribute>Element Type>**Beam**
Material>**4: Cross Beams**
Section>**4: Interior Cross Beams**
Generation Type>**Translate**
Translation>dx,dy,dz>**0, 2.75, 0** m
Number of Times>**5**
Apply
Close

打開 **Element Number** 桿件編號以檢視模型幾何關係、節點編號與桿件編號，重新編號後關閉之。

Y 向桿件重新編碼

Node/Element > Elements > **Renumber Element ID** ↵

Select Window 選取所有 Y 向 Elements

New Start Number > **Element > 73**

Apply

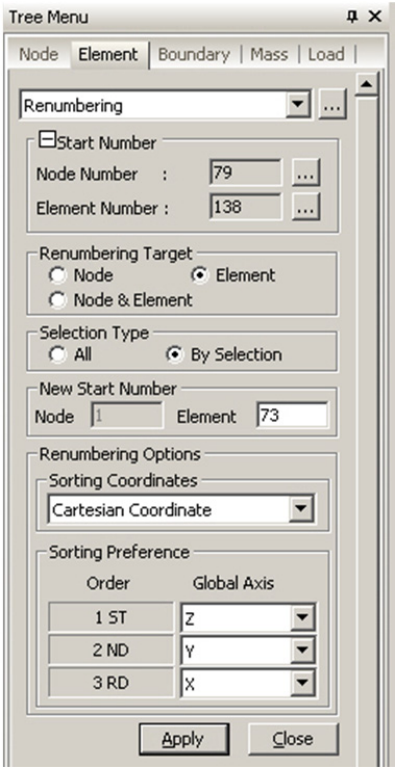


圖 12　桿件重新編號對話框

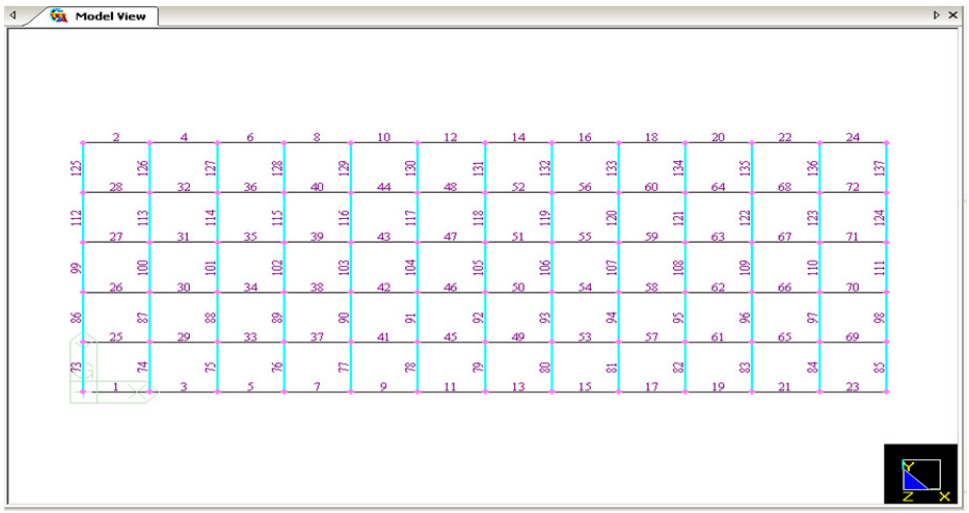


圖 13　Y 向桿件新編號

修改時間依存材料特性值

此功能用於將修正已建立桿件的乾縮潛變形狀參數。

Properties > Time Dependent Material > **Change Property** ↵

Select All
Element Dependent Material>**Notational Size of Membe**r
Select **Auto Calculate**
Apply
Close

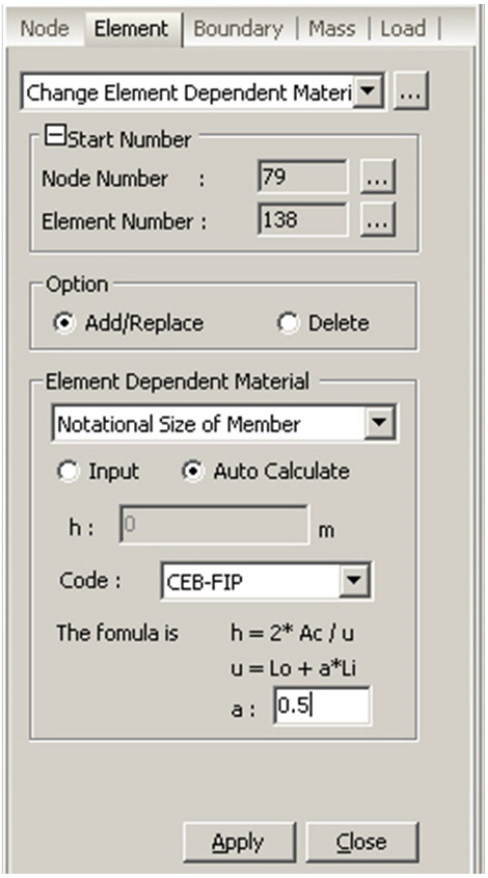


圖 14　修改構件之時間依存材料特性值

邊界條件

Boundaries > **Supports** ↵
Select Window>Node 1
Options>**Add**
Support Type (Local Direction)>**D-ALL**
Apply

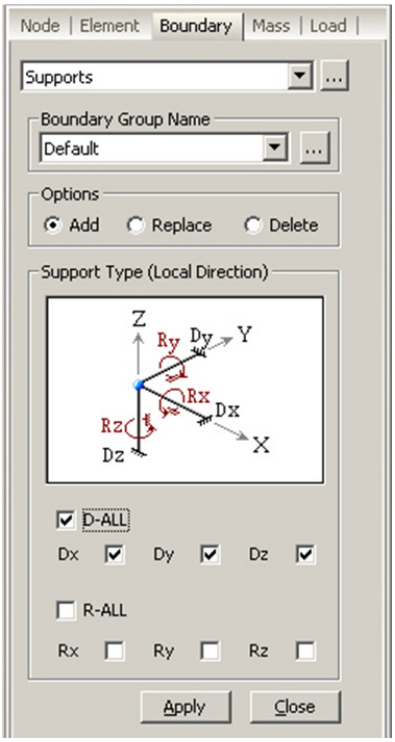


圖 15　支承設定對話框

Select Window>Node 29
Support Type (Local Direction)> **Dy, Dz**
Apply

Select Window>Nodes 2to6
Support Type (Local Direction)> **Dx, Dz**
Apply

Select Window>Nodes 30, 75to78
Support Type (Local Direction)> **Dz**
Apply
Close

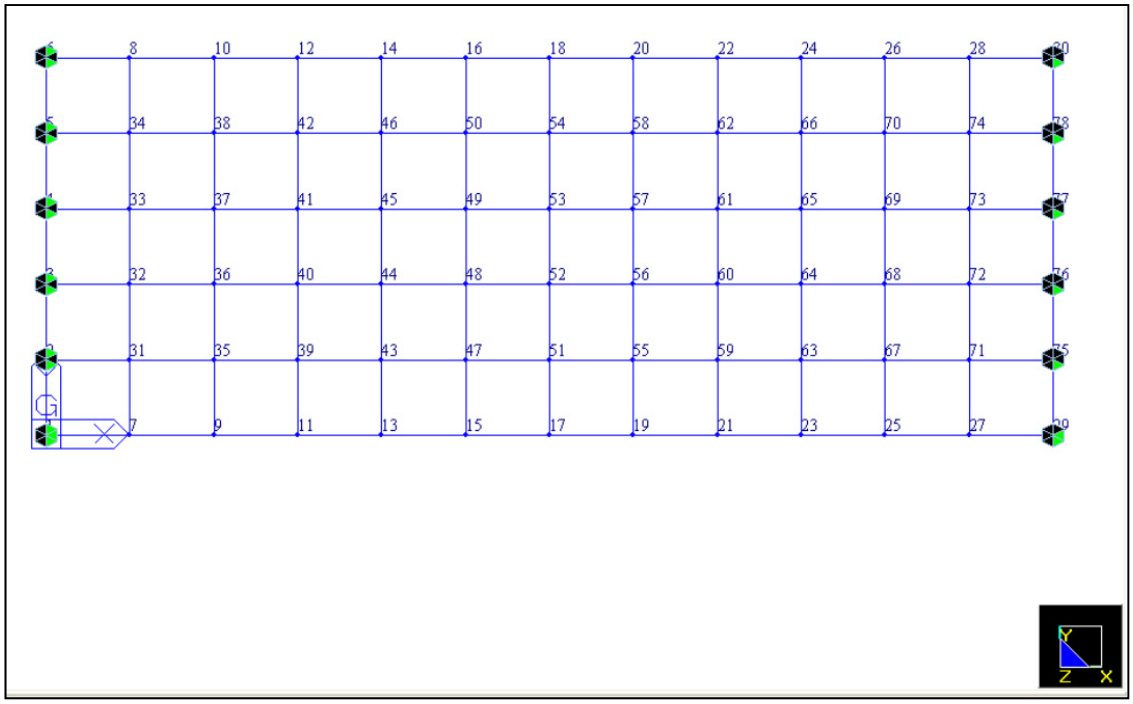

8 10 12 14 16 18 20 22 24 26 28
34 38 42 46 50 54 58 62 66 70 74
33 37 41 45 49 53 57 61 65 69 73
32 36 40 44 48 52 56 60 64 68 72
31 35 39 43 47 51 55 59 63 67 71
7 9 11 13 15 17 19 21 23 25 27
Y
Z
X

圖 16　模型邊界條件

載重資料

接下來將定義以下載重資料：載重群組、靜載重、預力鋼腱、車輛載重。

載重群組

執行施工階段分析前，必須先定義結構群組、邊界群組、載重群組。在此定義的載重群組名稱是為了方便將各載重群組化。

Structure > Group > B/L/T > **Define Load Group**↵
Select **New…**
Name>**PC & C/B**
Add
Name> **Deck**
Add
Name> **Barrier**
Add
Name> **Wearing surface**
Add
Name> **Prestress**
Add
Close

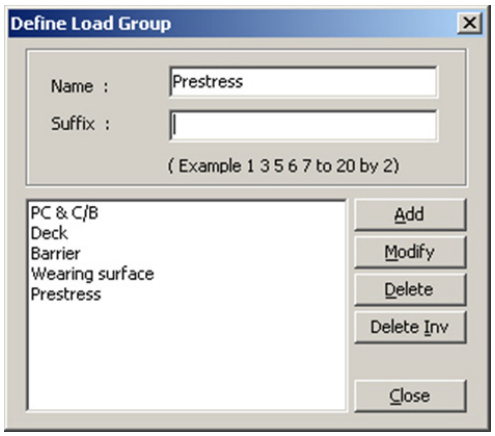


圖 17　設定載重群組名稱

靜載重

Load > Static Loads > **Static Load Cases** ↵
Name>**Deck**
Type>**Dead Load of Component and Attachments (DC)**
Add
Name>**Wearing surface**
Type>**Dead Load of Wearing Surfaces and Utilities (DW)**
Add
Name>**Barrier**
Type> **Dead Load of Wearing Surfaces and Utilities (DW)**
Add
Name>**PC & C/B**
Type> **Dead Load of Component and Attachments (DC)**
Add
Name>**Prestress**
Type>**Prestress (PS)**
Add
Close

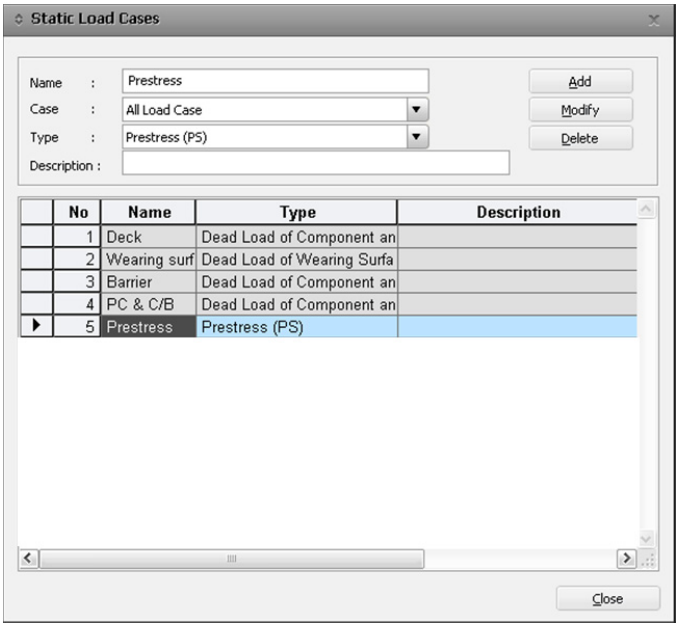


圖 18　設定靜載重名稱對話框

Iso View
Select Identity-Elements
Select Identity 對話框 > Select Type > **Section**
"**1: Interior Precast Beams**"
Add
Close

Load > Beam Loads > **Element Beam Loads** ↵
Load Case Name>**Deck**
Load Group Name>**Deck**
Direction>**Global Z**
Projection>**No**
Value>**Relative**
w>**-1.356** tonf/m (1.32 deck + 0.036 haunch)
Apply

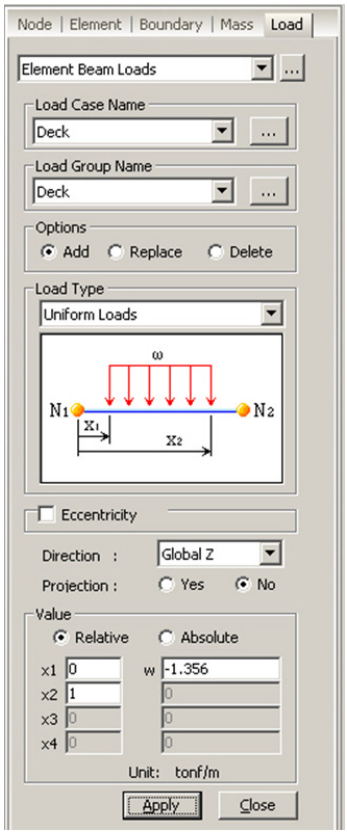


圖 19　設定梁荷重對話框

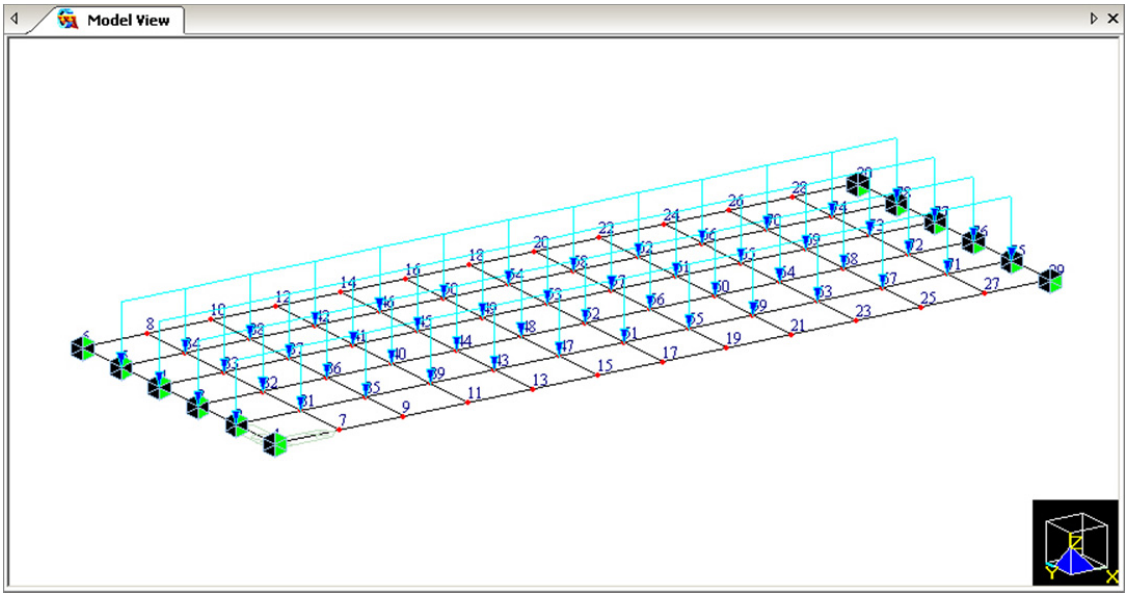


圖 20　於 Model View 顯示梁荷重

Select Identity-Elements
Select Identity 對話框>Select Type>**Section**
"**2: Exterior Precast Beams**"
Replace
Close

Load Case Name>**Deck**
Load Group Name>**Deck**
w>**-1.128** tonf/m (1.092 deck + 0.036 haunch)
Apply

Select Identity-Elements
Select Identity 對話框>Select Type>**Section**
"**1: Interior Precast Beams**"
Add
"**2: Exterior Precast Beams**"
Add
Close

Load Case Name>**Wearing surface**
Load Group Name>**Wearing surface**
w>**-0.3** tonf/m
Apply

Select Previous
Load Case Name> **Barrier**
Load Group Name> **Barrier**
w>**-0.15** tonf/m
Apply
Close

Load > Static Loads> **Self Weight** ↵
Load Case Name> **PC & C/B**
Load Group Name> **PC & C/B**
Self Weight Factor>Z>**-1**
Add
Close

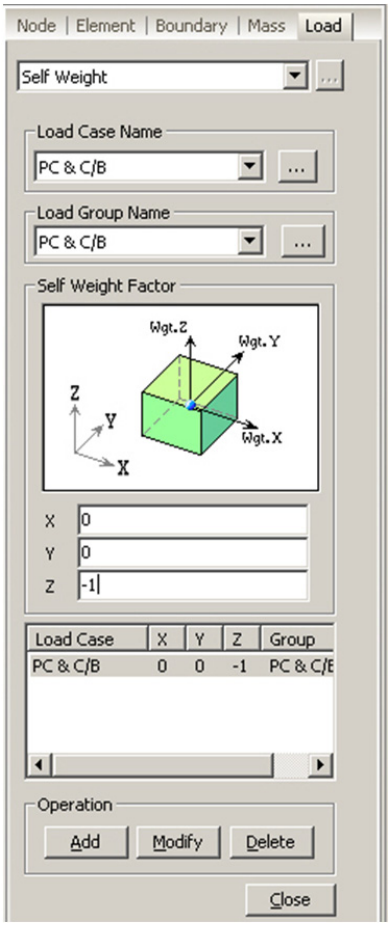


圖 21　設定自動計算材料自重對話框

預力鋼腱

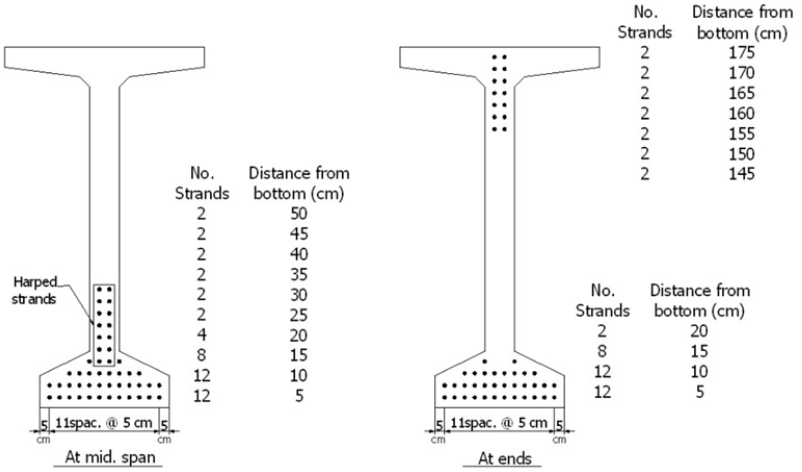


圖 22　鋼腱標準配置

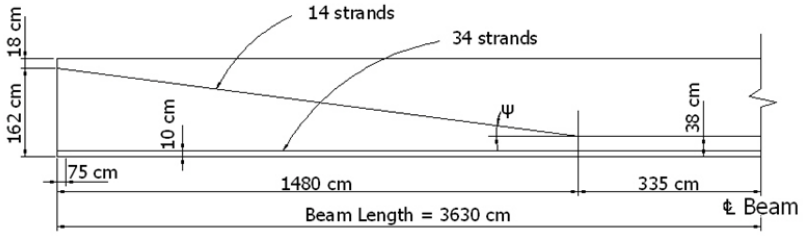


圖 23　鋼腱縱向標準配置

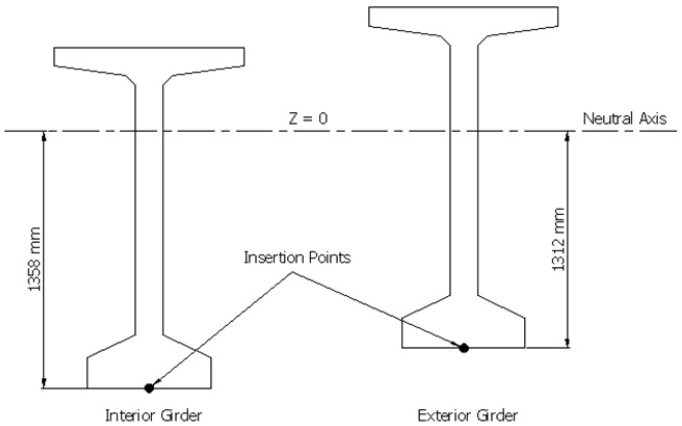


圖 24　鋼腱起始點配置

Tree Menu > Group 表單 > **Tendon Group**
右鍵選單選 **New…**
Name>**Tendon**
Suffix>**1to12**
Add
Close

Tools > **Unit System**
Length>**mm**; Force (Mass)>**kgf** ↵

Load > Temp./Prestress > Prestress Loads> **Tendon Property** ↵
Tendon Property 對話框> Add
Tendon Name>**TH**
Tendon Type>**Internal (Pre-Tension)**
Material>**3: Tendon**
按 … 輔助計算 **Total Tendon Area**
Tendon Area 對話框> Strand Diameter**>12.7mm (0.5")**
Number of Strands>**14**
OK
Select **Relaxation Coefficient**
Relaxation Coefficient>Magura>**45**
Ultimate Strength>**190** kgf/mm^2
Yield Strength>**160** kgf/mm^2
OK

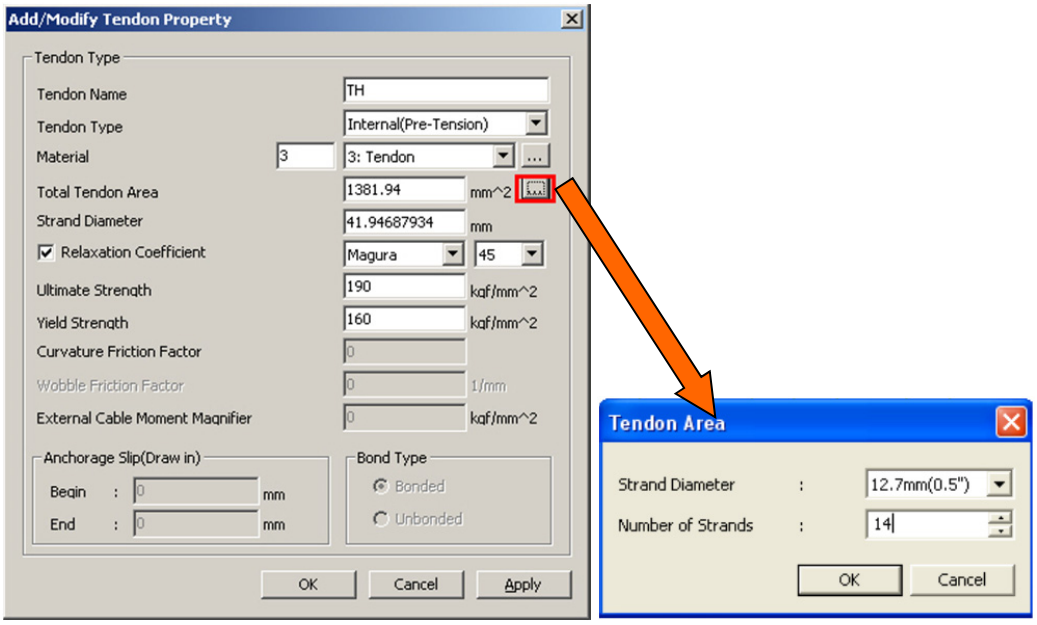


圖 25 設定鋼腱性質對話框

Tendon Property 對話框> Add
Tendon Name>**TS**
Tendon Type>**Internal (Pre-Tension)**
Material>**3: Tendon**
按 ... 輔助計算 **Total Tendon Area**
Tendon Area 對話框> Strand Diameter**>12.7mm (0.5")**
Number of Strands>**34**
OK
Select **Relaxation Coefficient**
Relaxation Coefficient>Magura>**45**
Ultimate Strength>**190** kg/mm^2
Yield Strength>**160** kg/mm^2 OK
Close

關閉顯示 **Node Number**
開啟顯示 **Element Number**
Top View
Select Identity-Elements
Select Identity 對話框>Select Type>**Section**
選 "**1: Interior Precast Beams**"
選 "**2: Exterior Precast Beams**"
Add
Close
Activate

Loads > Temp./Prestress > Prestress Loads> **Tendon Profile** ↵
Tendon Profile 對話框> Add
Tendon Name>**TH1**
Group>**Tendon1**
Tendon Property>**TH**
滑鼠移到 **Assigned Elements** 欄位
Select Window > Elements 1to23by2
Input Type>**3-D**
Curve Type>**Spline**
Profile>Reference Axis>**Straight**
在 **Profile** 輸入以下鋼腱局部座標點資料：

	x(mm)	y(mm)	z(mm)	fix	Ry[deg]	Rz[deg]
1	0.0000	0.0000	1620.0	☐	0.00	0.00
2	14800.	0.0000	380.00	☑	0.00	0.00
3	21500.	0.0000	380.00	☑	0.00	0.00
4	36300.	0.0000	1620.0	☐	0.00	0.00
5				☐		

圖 26　鋼腱 TH 的局部座標資料

Profile Insertion Point>**-150, 0, -1312** mm
x-Axis Direction>**X**
OK

Note:
插入點為鋼腱在整體座標系(GCS)的參考點，即便一根預鑄梁並非僅為一個單元所組成，但只需要設置一個鋼腱座標(Profile)即可模擬鋼腱位置。

依圖 24 所示，外側梁與內側梁的鋼腱插入點都設於梁底部，但插入點的高程(Z-軸)並不相同，這是因為其各自之混凝土版的有效寬度不同，導致中性軸至梁單元底部的距離不同。

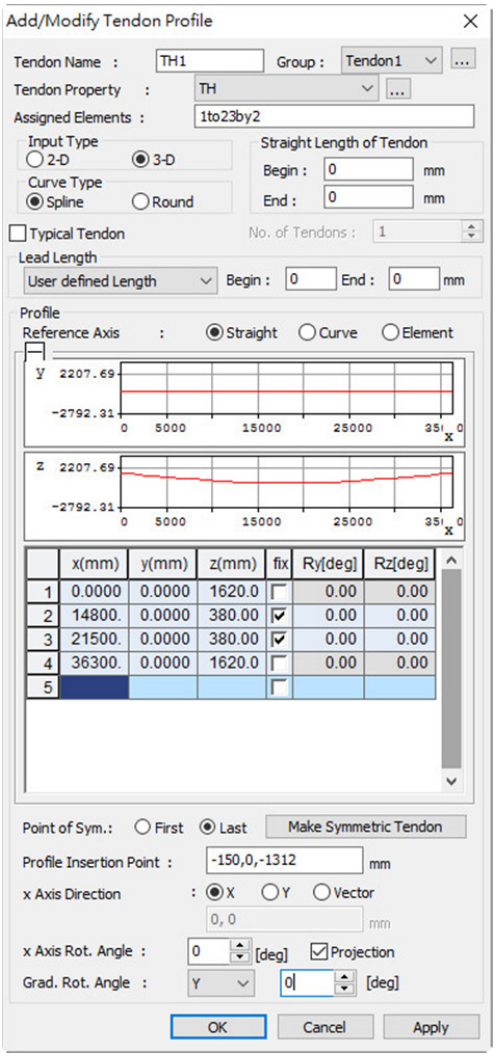


圖 27　設定鋼腱 TH 位置對話框

Tendon Profile 對話框>選 **TH1**

Copy / Move

Mode > **Copy**

Equal Distance > dx, dy, dz : **0 ,2750, 0** mm　OK

選 **TH1-Copy**

Modify

Tendon Name>修改為 **TH2**

Group> 修改為 **Tendon2**

Assigned Elements> **25to69by4** (複製後程式會自動抓)

Profile Insertion Point> 修改為 **-150, 2750, -1358** mm

OK

Tendon Profile 對話框> 選 **TH2**
Copy / Move
Mode > **Copy**
Equal Distance > dx, dy, dz : **0 ,2750, 0** mm OK
選 **TH2-Copy**
Modify
Tendon Name> 修改為 **TH3**
Group> 修改為 **Tendon3**
Assigned Elements > **26to70by4**
OK

以同樣的方法，建立鋼腱 TH4 與 TH5，個別將其設定為鋼腱群組 **Tendon4** 與 **Tendon5**

Tendon Profile 對話框>選 **TH5**
Copy / Move
Mode > **Copy**
Equal Distance > dx, dy, dz : **0 ,2750, 0** mm OK
選 **TH5-Copy**
Modify
Tendon Name> 修改為 **TH6**
Group> 修改為 **Tendon6**
Assigned Elements > **2to24by2**
Profile Insertion Point>修改為 **-150, 13750, -1312** mm
OK

Tendon Profile 對話框> Add
Tendon Name>**TS1**
Group>**Tendon7**
Tendon Property>**TS**
滑鼠移到 **Assigned Elements** 欄位
Select Window > Elements 1to23by2
Input Type>**3-D**
Curve Type>**Spline**
Profile>Reference Axis>**Straight**
在 **Profile** 輸入以下鋼腱局部座標點資料：

	x(mm)	y(mm)	z(mm)	fix	Ry[deg]	Rz[deg]
1	0.0000	0.0000	100.00	☐	0.00	0.00
2	36300.	0.0000	100.00	☐	0.00	0.00
3				☐		

圖 28　鋼腱 TS 的局部座標資料

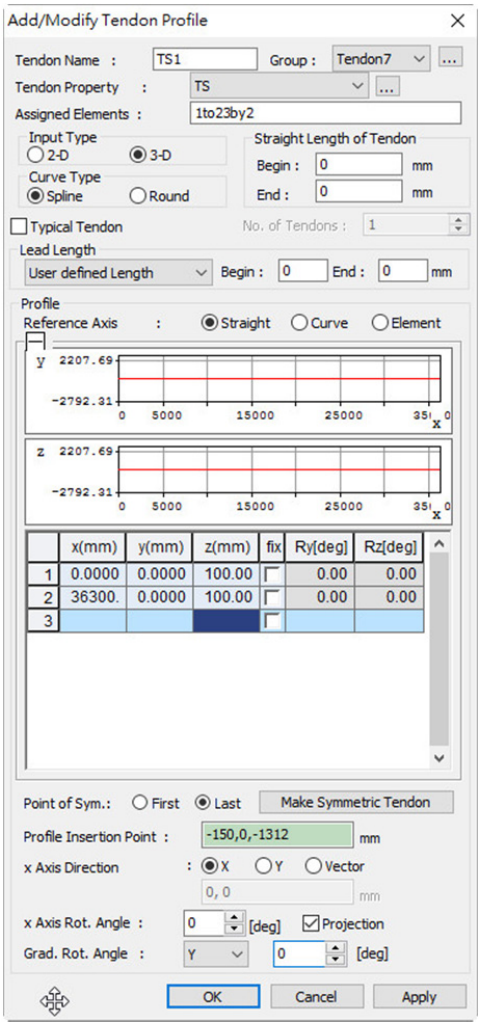


圖 29　設定鋼腱 TH 位置對話框

Profile Insertion Point>**-150, 0, -1312** mm
x-Axis Direction>**X**
OK

Tendon Profile 對話框>選 **TS1**
Copy / Move
Mode > **Copy**
Equal Distance > dx, dy, dz : **0 ,2750, 0** mm　OK
選 **TS1-Copy**
Modify
Tendon Name>修改為 **TS2**
Group> 修改為 **Tendon8**
Assigned Elements> **25to69by4**
Profile Insertion Point>修改為 **-150, 2750, -1358** mm

OK

Tendon Profile 對話框>選 **TS2**

Copy / Move

Mode > **Copy**

Equal Distance > dx, dy, dz : **0 ,2750, 0** mm OK

選 **TS2-Copy**

Modify

Tendon Name> 修改為 **TS3**

Group> 修改為 **Tendon9**

Assigned Elements> **26to70by4**

OK

以同樣的方法，建立鋼腱 TS4 與 TS5，個別將其設定為鋼腱群組 **Tendon10** 與 **Tendon11**

Tendon Profile 對話框>選 **TS5**

Copy / Move

Mode > **Copy**

Equal Distance > dx, dy, dz : **0 ,2750, 0** mm OK

選 **TS5-Copy**

Modify

Tendon Name> 修改為 **TS6**

Group> 修改為 **Tendon12**

Assigned Elements> **2to24by2**

Profile Insertion Point>修改為 **-150, 13750, -1312**

OK

Close

在 Model View 中查看鋼腱位置是否正確

Iso View

到工作數 **Tree Menu: Works** 選單

Prestressing Tendon>**Tendon Profile**

Right- mouse and select **Display**

Initial View

設定鋼腱所施拉的預力量

Load > Temp./Prestress > restress Loads> **Tendon Prestress Loads** ↵

Load Case Name>**Prestress**

Load Group Name>**Prestress**

Select Tendon for Loading>Tendon>選所有鋼腱 **(TH1~TH6, TS1~TS6)**

Selected

Stress Value>**Stress**
1st Jacking>**Begin**
Begin>**133** kgf/mm^2
End>**0**
Add
Close

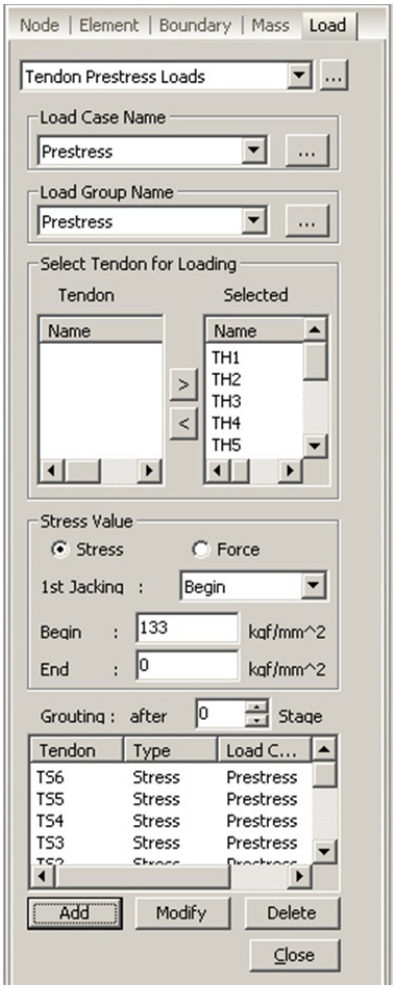


圖 30　設定鋼腱預力對話框

車輛載重

Initial View； **Top View**
Activate All； **Element Number**

Tree Menu > Group 表單 > **Structure Group**
右鍵選單點 **New…**
Name>**Cross Beam**
Add

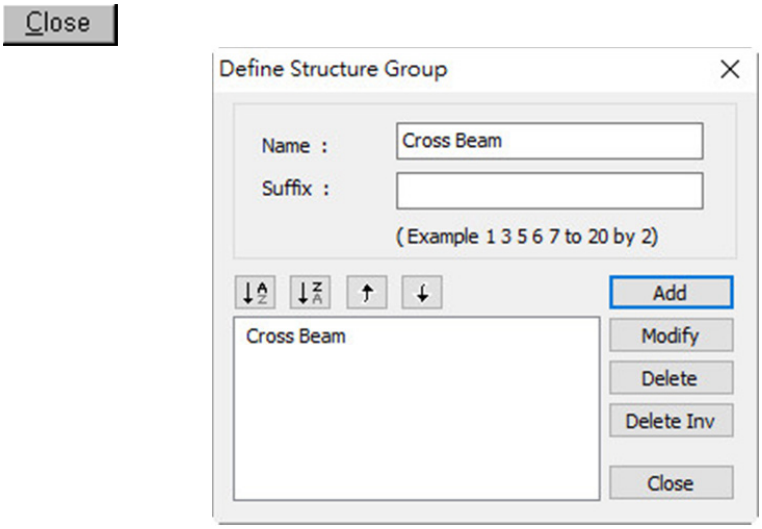


圖 31　設定結構群組對話框

Select Intersect > Elements 73to137 選取所有 Cross Beam
從 Tree Menu 拖拉 “Cross Beam” 至 Model View 中完成群組指派。

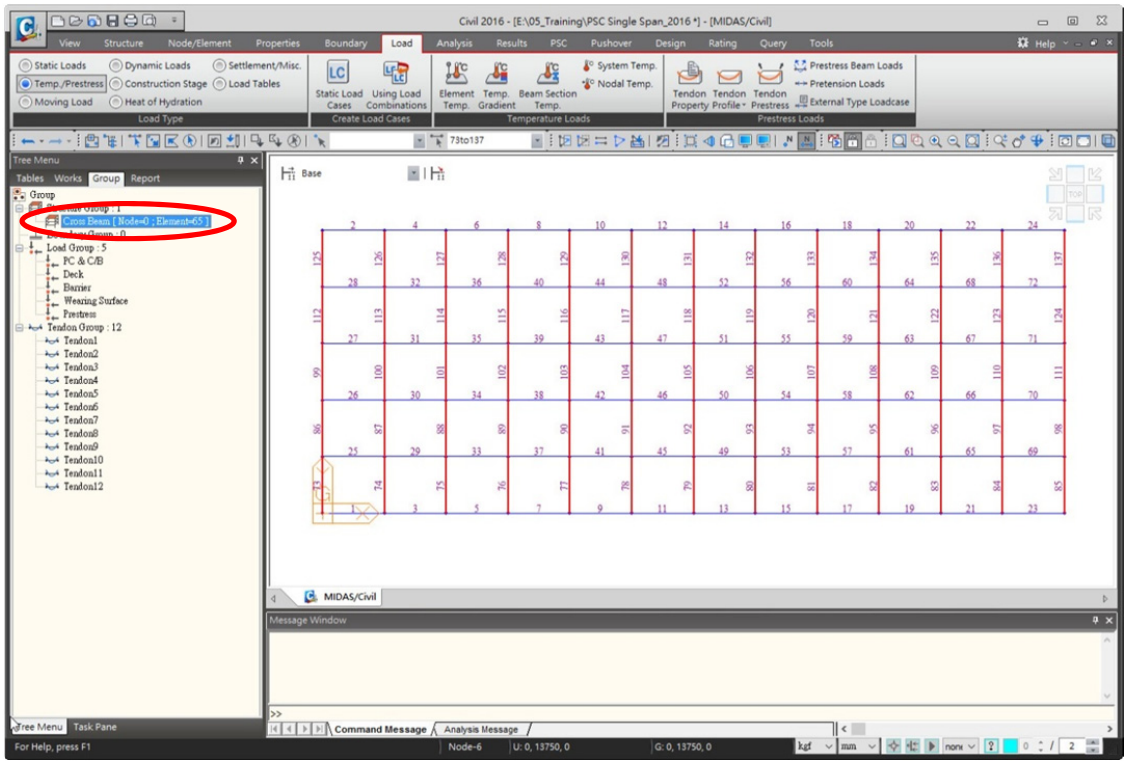


圖 32　設定結構群組“Cross Beam”

Note:
為增加車輛載重分析的正確性，橫梁的數量也需要隨之增加，可於橫向虛設許多根等間距且單位重為 0 的橫梁“Cross Beams”，這些橫梁的深度與寬度相當於橋面版厚與橫梁間的中心距。

Tools > **Unit System**
Length>**m** ； Force (Mass)>**tonf** ↵

開啟顯示 **Node Number**
關閉顯示 **Element Number**

Load > Moving Load > **Moving Load Code** ↵
Select Moving Load Code 對話框>Moving Load Code>**Taiwan**

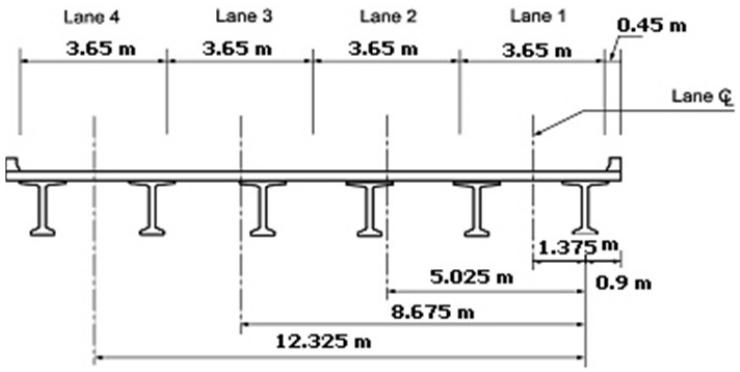


圖 33 車道線與車道梁偏心距示意圖

Load > Moving Load > **Traffic Line Lanes** ↵
Traffic Line Lanes 對話框> Add
Lane Name>**Lane 1**
Eccentricity>**-1.375** m
Vehicular Load Distribution>**Cross Beam**
Cross Beam Group>**Cross Beam**
Moving Direction>**Both**
Selection by>**2 points**
點擊第一個輸入座標點的欄位
Model View > 模型視窗中點擊 Nodes 1 與 29
Lane 資料自動寫入下方表格中
OK

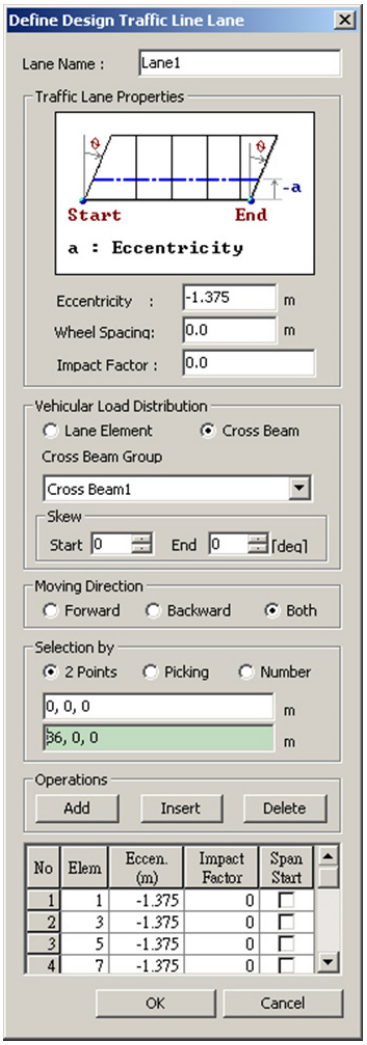


圖 34　定義車道線

Traffic Line Lanes 對話框> Add
Lane Name>**Lane 2**
Eccentricity>**-5.025** m
Vehicular Load Distribution>**Cross Beam**
Cross Beam Group>**Cross Beam**
Moving Direction>**Both**
Selection by>**2 points**
點擊第一個輸入座標點的欄位
Model View > 模型視窗中點擊 Nodes 1 與 29
Lane 資料自動寫入下方表格中
OK

Traffic Line Lanes 對話框> Add
Lane Name>**Lane 3**
Eccentricity>-**8.675** m
Vehicular Load Distribution>**Cross Beam**
Cross Beam Group>**Cross Beam**
Moving Direction>**Both**
Selection by>**2 points**
點擊第一個輸入座標點的欄位
Model View > 模型視窗中點擊 Nodes 1 與 29
Lane 資料自動寫入下方表格中
OK

Traffic Line Lanes 對話框> Add
Lane Name>**Lane 4**
Eccentricity>-**12.325** m
Vehicular Load Distribution>**Cross Beam**
Cross Beam Group>**Cross Beam**
Moving Direction>**Both**
Selection by>**2 points**
點擊第一個輸入座標點的欄位
Model View > 模型視窗中點擊 Nodes 1 與 29
Lane 資料自動寫入下方表格中
OK
Close

Load > Moving Load > **Vehicles** ↵
Vehicles 對話框> Add Standard
Standard Name>**Taiwan**
Vehicular Load Name>**HS20-44 (MS18)**
Vehicular Load Type> **HS20-44 (MS18)**
OK

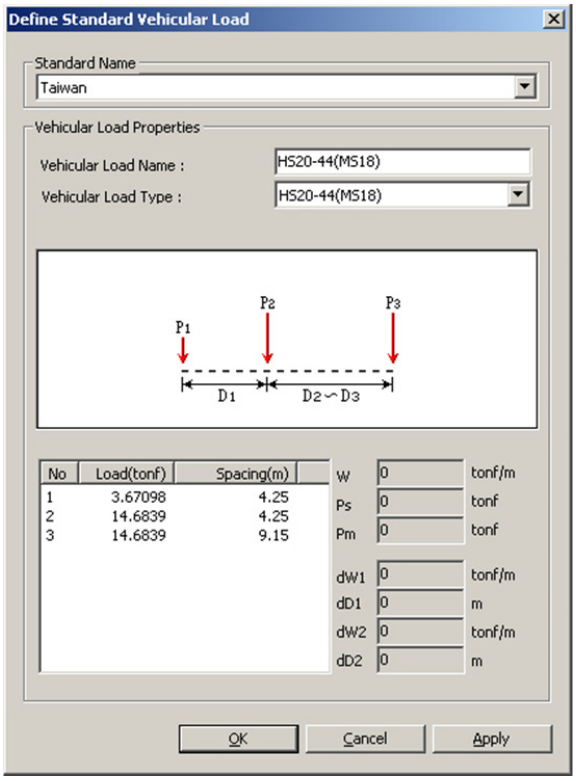


圖 35　設定標準車載重

Vehicles 對話框> Add Standard
Standard Name> **Taiwan**
Vehicular Load Name> **HS-20-44 (MS18)**
Vehicular Load Type> **HS-20-44 (MS18)**
OK
Close

Load > Moving Load > **Moving Load Cases**

Moving Load Cases 對話框> Add

Load Case Name>**MLC**

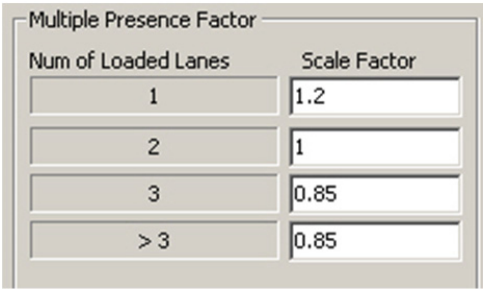


圖 36　輸入多車道折減係數

Sub-Load Cases>Loading Effect>**Independent**

Add

Sub-Load Case 對話框>Vehicle Class>**VL: HS-20-44 (MS18)**

Scale Factor>**1**

Min. Number of Loaded Lanes>**1**

Max. Number of Loaded Lanes>**4**

Assignment Lanes>List of Lanes> **Lane 1, Lane 2, Lane 3, Lane 4**

選所有車道 ->

OK

Define Moving Load Case 對話框> Add

Sub-Load Case 對話框>Vehicle Class>**VL: HS-20-44 (MS18)**

Scale Factor>**1**

Min. Number of Loaded Lanes>**1**

Max. Number of Loaded Lanes>**4**

Assignment Lanes>List of Lanes> **Lane 1, Lane 2, Lane 3, Lane 4**

選所有車道 ->

OK

Close

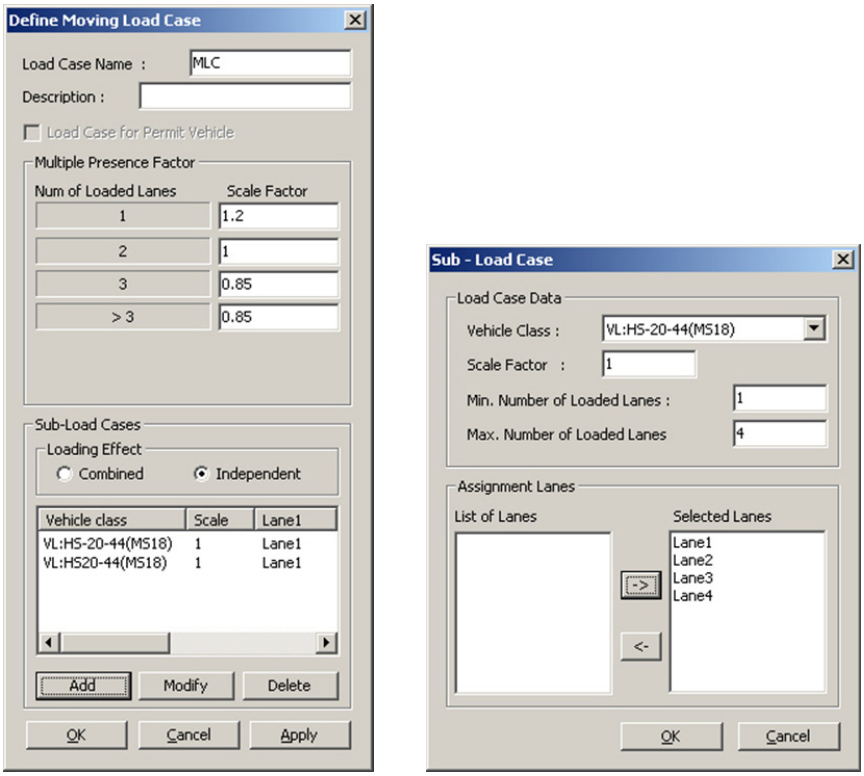


圖 37　定義車輛載重狀況

施工階段資料

此範例以 3 個施工階段模擬橋梁的構築順序，下表為施工階段的細節：

表 2　施工階段

階段	天	說明
Stage 1 (30 天)	1	放置預鑄梁與橫梁並施拉預力
	21	澆鑄橋面版
Stage 2 (30 天)	1	版+梁的合成斷面效應
	1	安裝護欄
	6	鋪設磨耗層
Stage 3 (10000 天)	-	-

Note:
在 Stage 1 的第一天時，設置預鑄構件的初始材齡 (主梁 precast beams & 橫梁 cross beams) 為 7 天 。

群組

Tree Menu > Group 表單 > **Structure Group**
右鍵選單點 **New…**
Name>**All**
Add
Close
Select All
從 Tree Menu 拖拉 “All” 群組至 Model View 中進行指派。

Tree Menu > Group 表單 > **Boundary Group**
右鍵選單點 **New…**
Name> **Supports**
Add
Close
Select All
從 Tree Menu 拖拉 “Supports” 至 Model View 中
勾選 Boundary Type 對話框>**Support**
OK

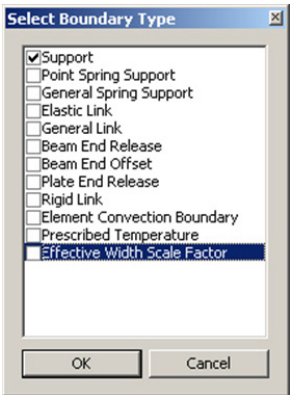


圖 38　設定邊界群組類型

設定施工階段

Load>Construction Stage > **Define Construction Stage** ↵

Construction Stage 對話框> Generate
Stage>Name>**Stage**
Stage>Suffix>**1to3**
Save Result>**Stage, Additional Steps** (on)
OK

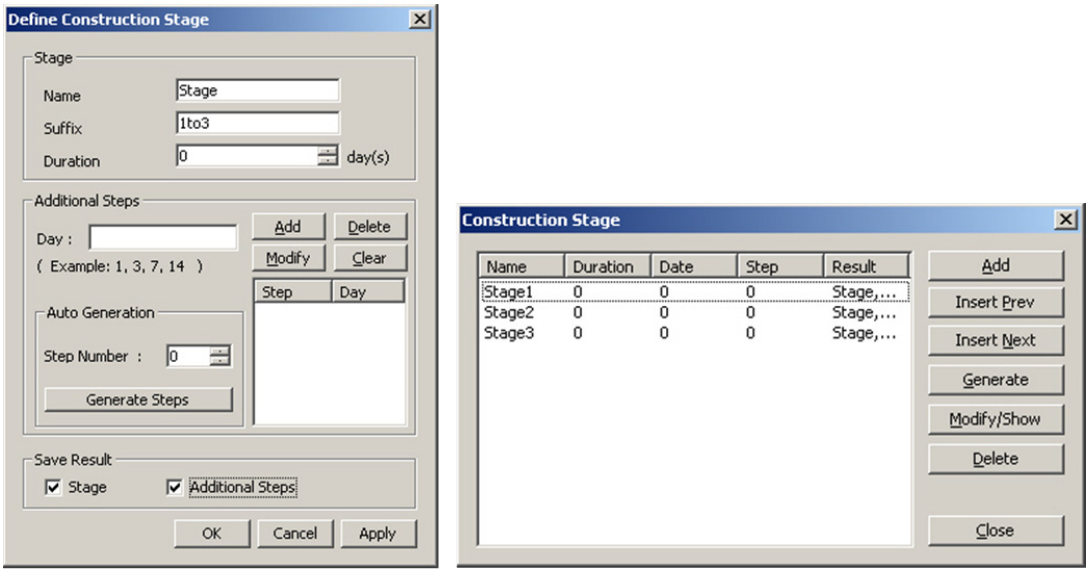


圖 39　設定施工階段

Construction Stage 對話框> 選 **Stage 1** 按 Modify/Show
Stage>**Stage 1**
Name>**Stage 1**
Duration>**30** day(s)
Additional Steps>Day>**21**
按 **Additional Steps** Add 加入

Element 表單
Group List**>All**
Activation>Age>**7** day(s)
按 **Activation** 功能區內 Add 加入

Boundary 表單
Group List**>Supports**
Support/Spring Position>**Deformed**
按 **Activation** 功能區內 Add 加入

Load 表單
Group List>**PC & C/B**
Active Day > **First** day (s)
按 **Activation** 功能區內 Add 加入
Group List>**Prestress**
Active Day > **First** day (s)
按 **Activation** 功能區內 Add 加入
Group List>**Deck**
Active Day>**21** day(s)
按 **Activation** 功能區內 Add 加入
OK

結構群組、邊界群組、載重群組建立後，會一直於後續施工階段保持作用的狀態，直到被撤除 (Deactivation)為止。

Construction Stage 對話框> 選 **Stage 2** 按 Modify/Show
Stage>**Stage 2**
Name>**Stage 2**
Duration>**30** day(s)
Additional Steps>Day>**6**
按 **Additional Steps** Add 加入

Load 表單
Group List>**Barrier**
Active Day > **First** day (s)
按 **Activation** 功能區內 Add 加入
Group List> **Wearing Surface**
Active Day>**6** day(s)
按 **Activation** 功能區內 Add 加入
OK

Construction Stage 對話框>選 **Stage 3** 按 Modify/Show
Stage>**Stage 3**
Name>**Stage 3**
Duration>**10000** day(s)
OK
Close

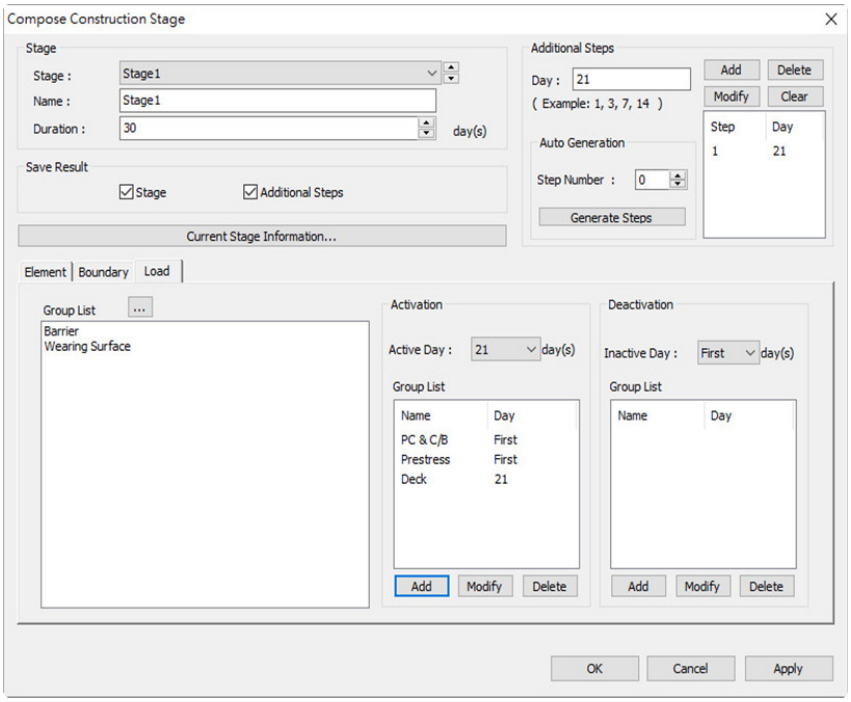


圖 40　定義施工階段 1

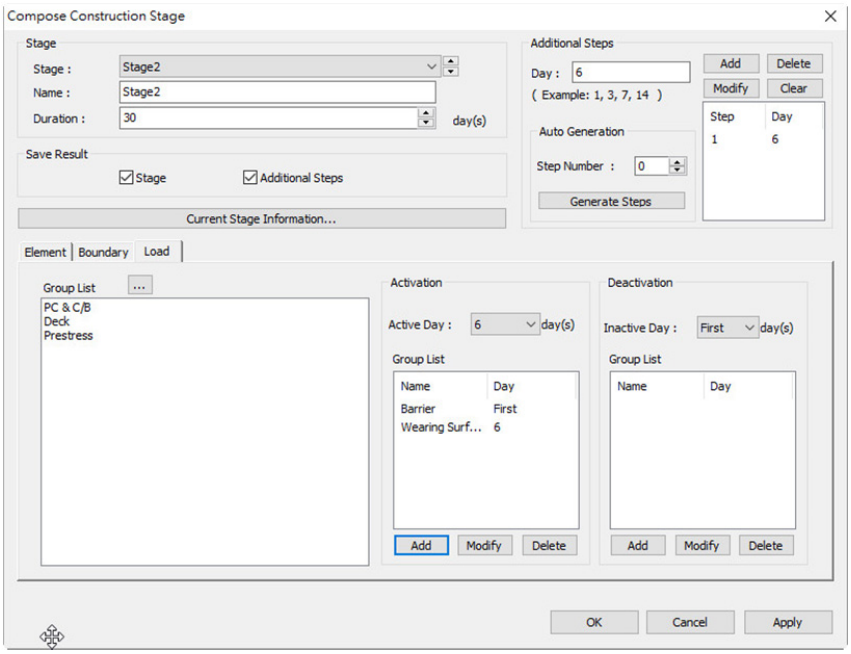


圖 41　定義施工階段 2

Load > Construction Stage > **Composite Section for CS** ↵

Composite Section for Construction Stage 對話框> Add
Active Stage>**Stage 1**
Section>**1: Interior Precast Beams**
Composite Type>**Normal**

Construction Sequence>Part>**1**:
Material Type>**Material**
Material>**2:Precast**
Composite Stage>**Active Stage**
Age>**7**

Construction Sequence>Part>**2**:
Material Type>**Material**
Material>**1:Deck**
Composite Stage>**Stage 2**
Age>**10**
OK

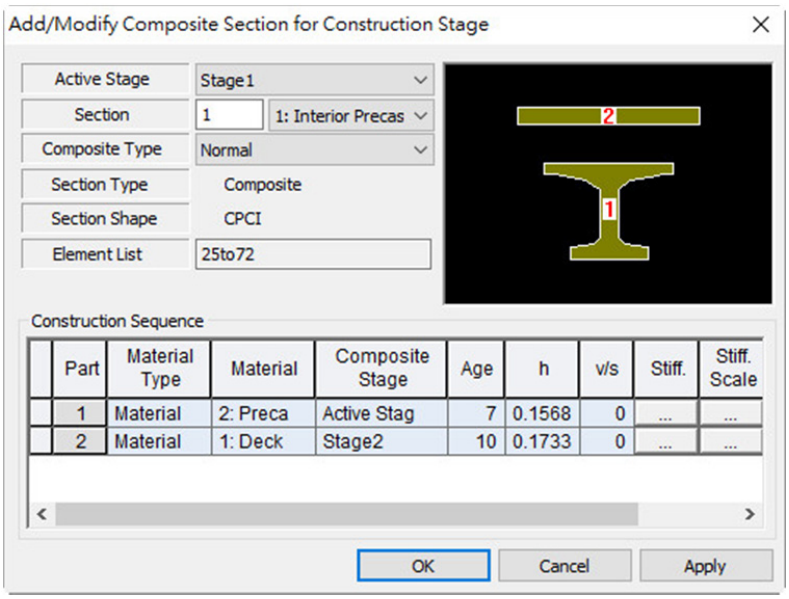


圖 42　設定內側預鑄梁與橋面版於施工階段的合成階段

Composite Section for Construction Stage 對話框> Add
Active Stage>**Stage 1**
Section>**2: Exterior Precast Beams**
Composite Type>**Normal**

Construction Sequence>Part>**1**:
Material Type>**Material**
Material>**2:Precast Beams**
Composite Stage>**Active Stage**
Age>**7**

Construction Sequence>Part>**2**:
Material Type>**Material**
Material>**1:Deck**
Composite Stage>**Stage 2**
Age>**10**
OK
Close

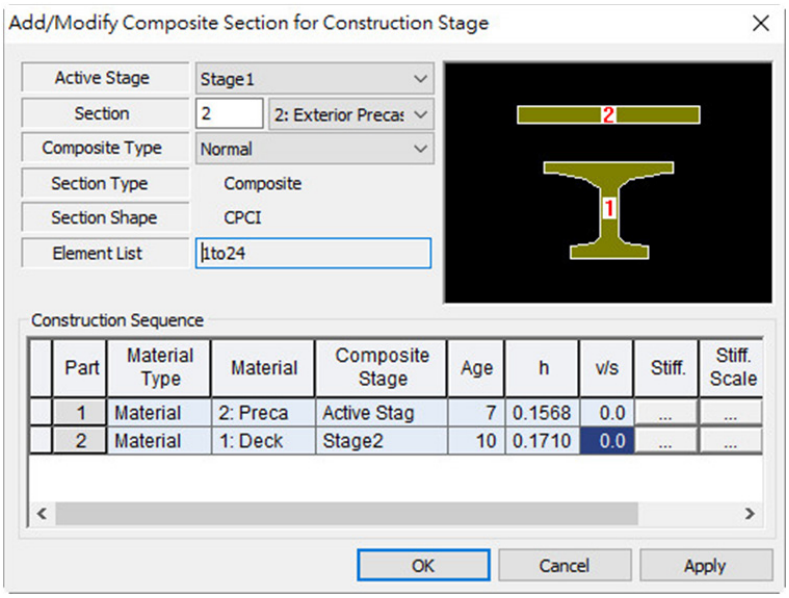


圖 43　設定外側預鑄梁與橋面版於施工階段的合成階段

設定施工階段分析控制項：

Analysis > **Construction Stage Analysis Control**

Final Stage>**Last Stage**

Analysis Option>**Include Time Dependent Effect** (on)

Time Dependent Effect Control >

Time Dependent Effect>**Creep & Shrinkage** (on)
Type>**Creep & Shrinkage**
Auto Time Step Generation for Large Time Gap (on)
Tendon Tension Loss Effect (Creep & Shrinkage) (on)
Variation of Comp. Strength (on)
Tendon Tension Loss (Elastic Shortening) (on)

預設已勾選

Load Cases to be Distinguished from Dead Load for CS Output:
Load Case>**Wearing Surface**
Add
Load Case>**Barrier**
Add
OK

加入

Beam Section Property Changes>**Change with Tendon**

Frame Output>**Calculate Output of Each part of Composite Section** (on)

Save Output of Current Stage (Beam/Truss) (on)

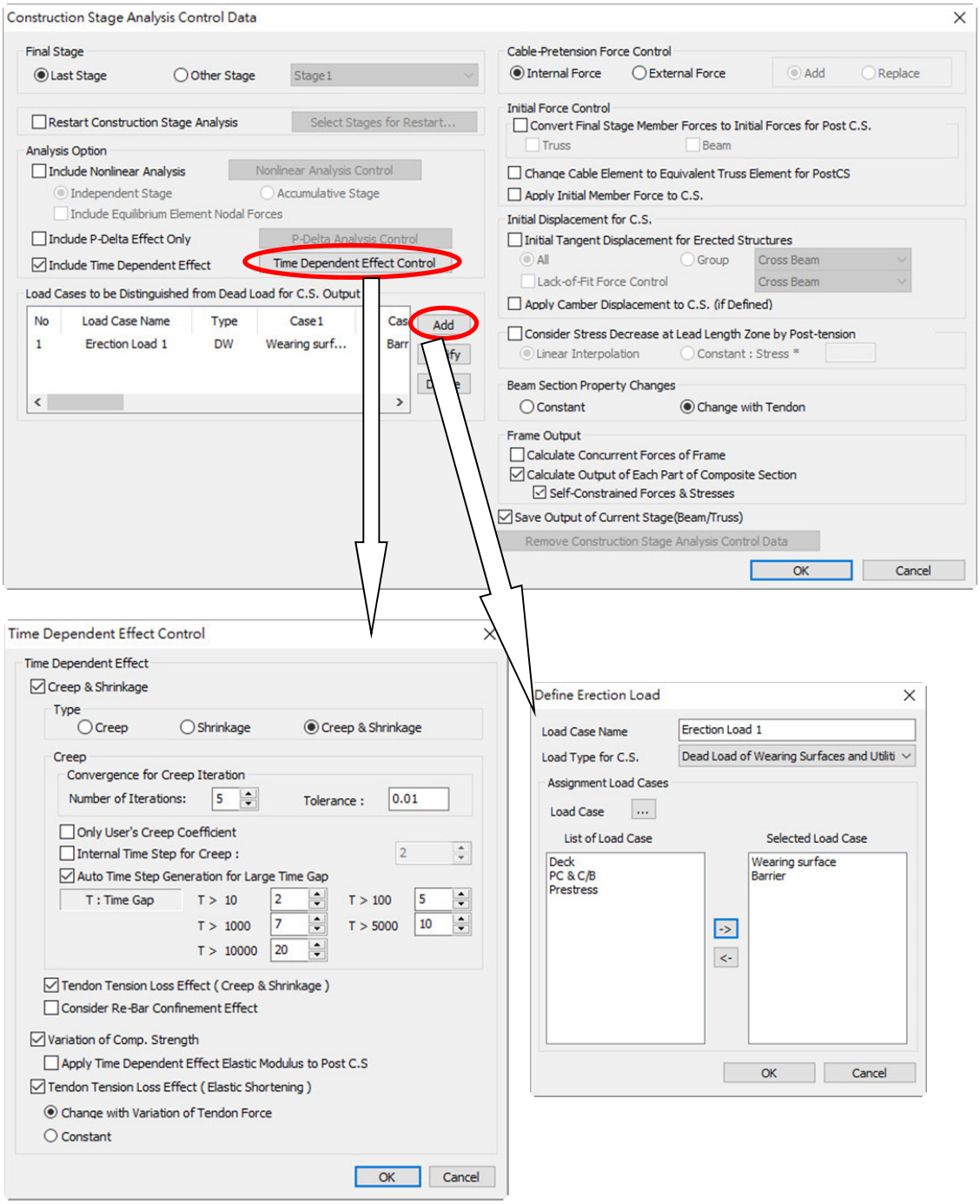


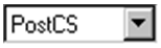
圖 44　施工階段分析控制資料

執行分析

Analysis > **Perform Analysis**

查看結果

載重組合

切換到 Post Construction Stage 

Results > **Combinations** ↵

Load Combinations 對話框>**General** 表單> 

Option>**Add**
Add Envelope (on)
Code Selection>**Concrete**
Design Code>**AASHTO-LRFD02**
Manipulation of Construction Stage Load Case>**CS Only**

Load Modifier>**1**

Load Factors for Permanent Loads (Yp):
Component and Attachments>Load Factor>**Both**
Wearing Surfaces and Utilities>Load Factor>**Both**

Condition for Temperature, Creep, Shrinkage Factor>**Deformation Check**

Note:
勿選“ST+CS” (Static Load + Construction Stage)選項，避免輸出混淆的結果。“Bridge Deck”與“PC & C/B”已經定義為“Dead Load of Components and Attachments (DC)”與“Construction Stage (CS) Loads”，同樣的，“Wearing Surface”與“Barrier” 已經定義為“Dead Load of Wearing Surface and Utilities (DW)”與“Erection Loads (EL)”(參考 Static Load Cases 與圖 44)，若選擇選“ST+CS”，則這些靜載重會重覆出現於輸出結果。

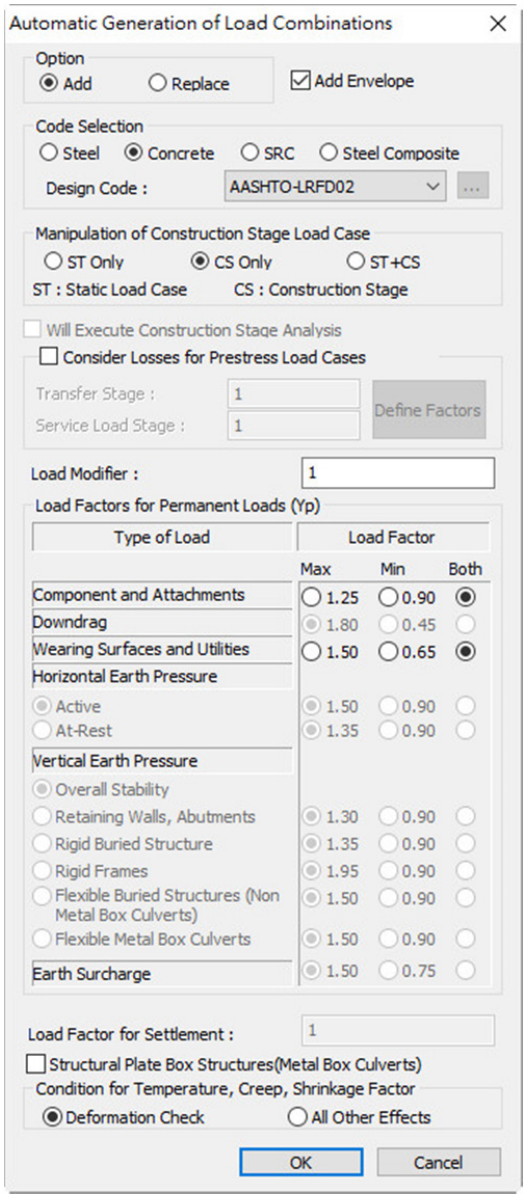


圖 45　依規範進行載重組合設定

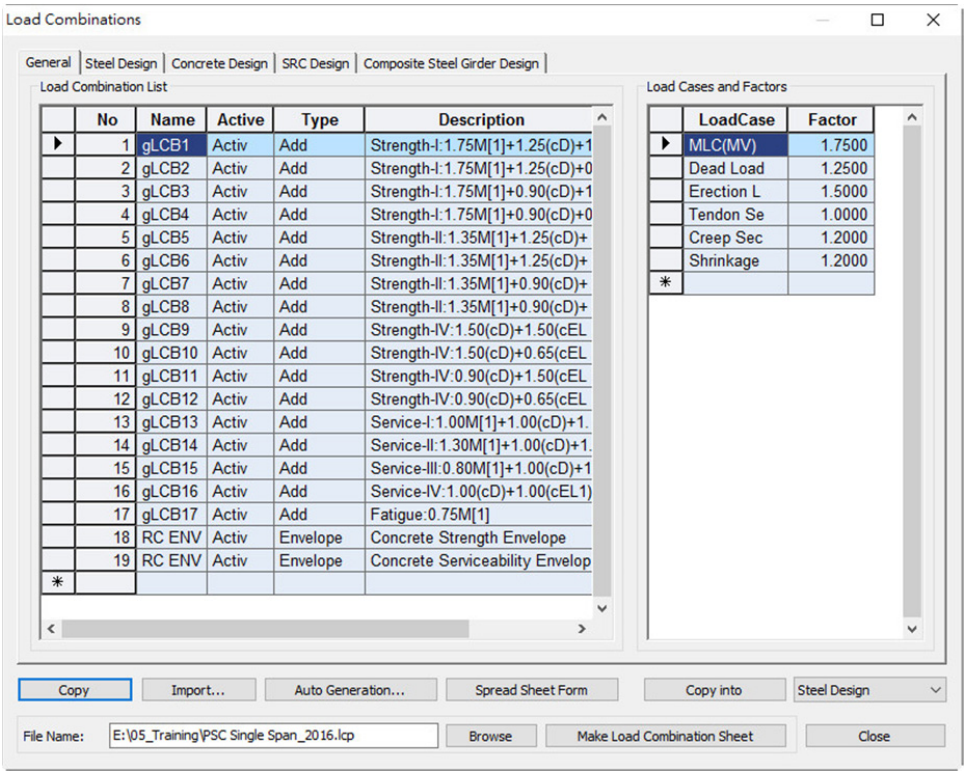


圖 46　依規範產生的載重組合

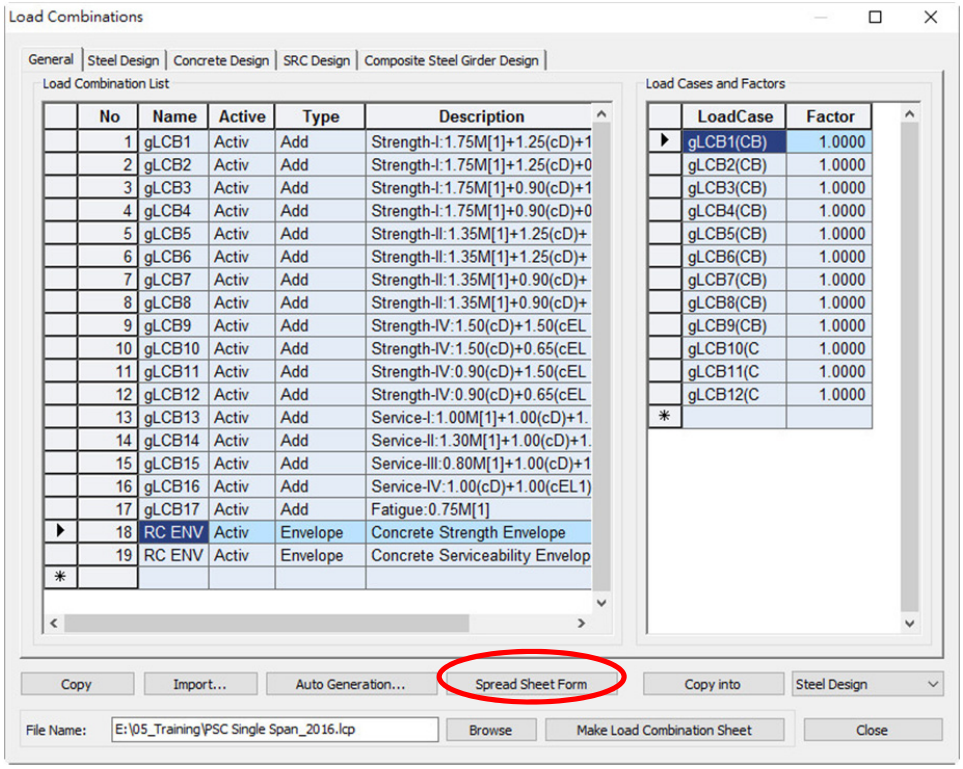


圖 47　定義包絡載重組合

Spread Sheet Form

依表 3 改變 gLCB13、gLCB14、gLCB15 與 gLCB16(Service I, II and III, respectively)載重組合係數。

使用 AASHTO-LRFD02 必須建立合乎該規範的載重組合

表 3 中無描述的載重係數為 0，該格可留白

Close

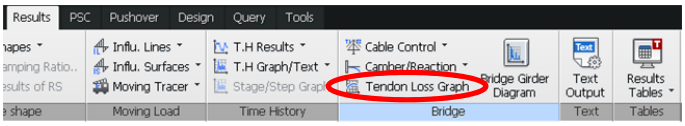
表 3 施工階段結果的載重組合

Load Comb.	MLC	Dead Load	Erection Load	Tendon Primary	Tendon Secondary	Creep Primary	Creep Secondary	Shrinkage Primary	Shrinkage Secondary
gLCB1	1.75	1.25	1.50		1.00		1.20		1.20
gLCB2	1.75	1.25	0.65		1.00		1.20		1.20
gLCB3	1.75	0.90	1.50		1.00		1.20		1.20
gLCB4	1.75	0.90	0.65		1.00		1.20		1.20
gLCB5	1.35	1.25	1.50		1.00		1.20		1.20
gLCB6	1.35	1.25	0.65		1.00		1.20		1.20
gLCB7	1.35	0.90	1.50		1.00		1.20		1.20
gLCB8	1.35	0.90	0.65		1.00		1.20		1.20
gLCB9		1.25	1.50		1.00		1.20		1.20
gLCB10		1.25	0.65		1.00		1.20		1.20
gLCB11		0.90	1.50		1.00		1.20		1.20
gLCB12		0.90	0.65		1.00		1.20		1.20
gLCB13	1.00	1.00	1.00	1.00		1.20		1.20	
gLCB14	1.30	1.00	1.00	1.00		1.20		1.20	
gLCB15	0.80	1.00	1.00	1.00		1.20		1.20	
gLCB16		1.00	1.00	1.00		1.20		1.20	
gLCB17	0.75								

預力損失圖

於此範例中，TH 字首的鋼腱為曲線鋼腱，TS 字首的鋼腱為直線鋼腱，可用 Animate 功能查看特定鋼腱於所有階段的鋼腱損失圖。

Results>**Tendon Loss Graph** ↵



鋼腱“**TH1**”於 Stage 1 的圖會自動顯示

Tendon>**TH2**
Stage>**Stage 1**
Step>**Last Step**
Animate

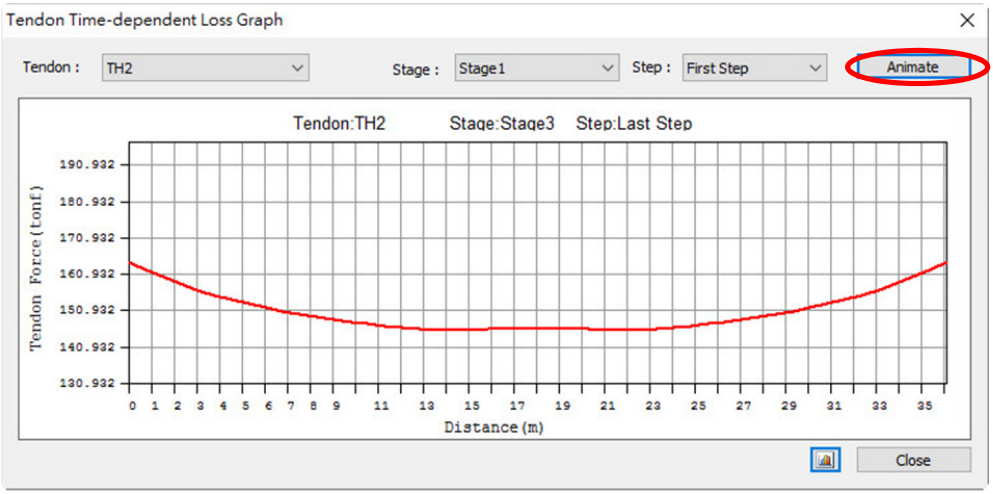


圖 48　鋼腱 TH2 的預力損失圖

Tendon> **TS2**
Stage>**Stage 1**
Step>**Last Step**
Animate

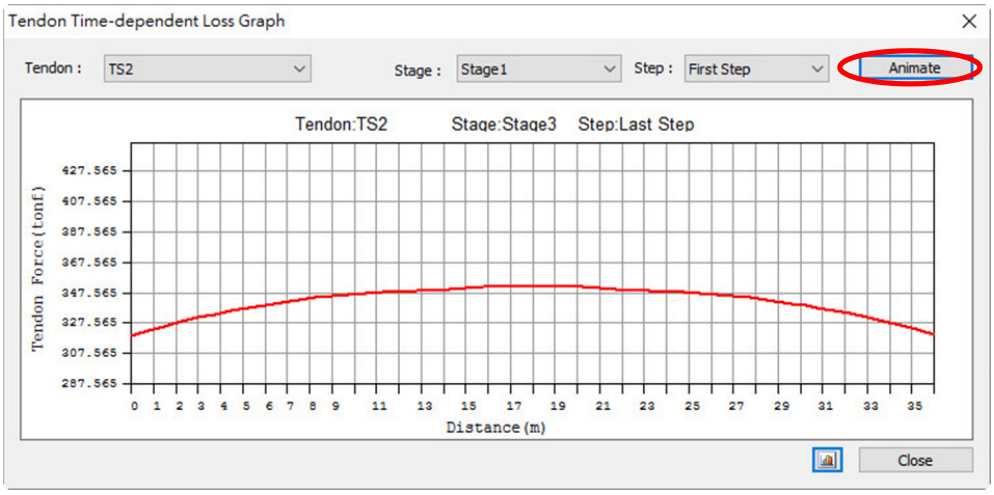


圖 49　鋼腱 TS2 的預力損失圖

預拉力損失表

到 Tree Menu 選 **Table** 表單
Result Tables > Tendon > **Tendon Loss** ↵

Tendon Group > Tendon 1
Stage > Stage 1
Apply

	Elem	Part	Stress (After Immediate Loss) : A (tonf/m^2)	Elastic Deform. Loss : B (tonf/m^2)	Stress(Elastic Loss)/ Stress(Immediate Loss)	Creep/Shrinkage Loss (tonf/m^2)	Relaxation Loss (tonf/m^2)	Stress(After All Loss)/ Stress(After Immediate Loss)	Effective Num.
	The Loss of tendon group [Tendon1] at the stage of [Stage1]								
	Tendon Group		Tendon1	Stage	Stage1	Apply			
▶	1	I	129758.3068	-216.7358	0.9983	-3498.1611	-2104.1443	0.9552	1.0000
	1	J	128369.9815	-1268.5310	0.9901	-4892.2151	-1953.7863	0.9368	1.0000
	3	I	128369.9815	-1292.0953	0.9899	-4891.6329	-1953.0313	0.9366	1.0000
	3	J	126145.4993	-630.6784	0.9950	-5810.1484	-1817.0591	0.9345	1.0000
	5	I	126145.4993	-653.5878	0.9948	-5808.9613	-1816.2909	0.9344	1.0000
	5	J	123266.8782	1218.2124	1.0099	-6411.6257	-1685.4882	0.9442	1.0000
	7	I	123266.8782	1203.9485	1.0098	-6410.4247	-1684.9738	0.9441	1.0000
	7	J	120153.5398	3586.4016	1.0298	-6843.0707	-1561.2190	0.9599	1.0000
	9	I	120153.5398	3581.1743	1.0298	-6842.0844	-1560.9695	0.9599	1.0000
	9	J	118324.4134	5109.9636	1.0432	-7008.0600	-1495.1732	0.9713	1.0000
	11	I	118324.4134	5110.5161	1.0432	-7007.7547	-1495.1148	0.9713	1.0000
	11	J	118324.4134	5229.2745	1.0442	-6934.0669	-1499.9763	0.9729	1.0000
	13	I	118324.4134	5234.6826	1.0442	-6934.3414	-1500.0776	0.9730	1.0000
	13	J	118324.4134	5116.7497	1.0432	-7008.2755	-1495.2296	0.9714	1.0000
	15	I	118324.4134	5127.4347	1.0433	-7009.2121	-1495.4973	0.9715	1.0000
	15	J	120153.5398	3602.6350	1.0300	-6843.3179	-1561.3727	0.9600	1.0000
	17	I	120153.5398	3623.2398	1.0302	-6845.2787	-1561.9084	0.9602	1.0000
	17	J	123266.8782	1252.4347	1.0102	-6412.5755	-1685.9034	0.9445	1.0000
	19	I	123266.8782	1291.8773	1.0105	-6415.9145	-1686.8854	0.9447	1.0000
	19	J	126145.4993	-560.5131	0.9956	-5813.5862	-1818.0974	0.9351	1.0000
	21	I	126145.4993	-495.9637	0.9961	-5820.3572	-1819.6308	0.9355	1.0000
	21	J	128369.9815	-1128.3855	0.9912	-4903.8480	-1956.2374	0.9378	1.0000
	23	I	128369.9815	-1039.6631	0.9919	-4919.8013	-1958.1665	0.9383	1.0000
	23	J	129758.3068	57.3961	1.0004	-3531.6518	-2109.5716	0.9570	1.0000

Tendon Loss (Stress) | Tendon Loss (Force)

圖 50　鋼腱預應力損失

	Elem	Part	Force (After Immediate Loss) : A (tonf)	Elastic Deform. Loss : B (tonf)	Force(Elastic Loss)/ Force(Immediate Loss)	Creep/Shrinkage Loss (tonf)	Relaxation Loss (tonf)	Force(After All Loss)/ Force(After Immediate Loss)	Effective Num.
	The Loss of tendon group [Tendon1] at the stage of [Stage1]								
	Tendon Group		Tendon1	Stage	Stage1	Apply			
▶	1	I	179.3182	-0.2995	0.9983	-4.8342	-2.9078	0.9552	1.0000
	1	J	177.3996	-1.7530	0.9901	-6.7607	-2.7000	0.9368	1.0000
	3	I	177.3996	-1.7856	0.9899	-6.7599	-2.6990	0.9366	1.0000
	3	J	174.3255	-0.8716	0.9950	-8.0293	-2.5111	0.9345	1.0000
	5	I	174.3255	-0.9032	0.9948	-8.0276	-2.5100	0.9344	1.0000
	5	J	170.3474	1.6835	1.0099	-8.8605	-2.3292	0.9442	1.0000
	7	I	170.3474	1.6638	1.0098	-8.8588	-2.3285	0.9441	1.0000
	7	J	166.0450	4.9562	1.0298	-9.4567	-2.1575	0.9599	1.0000
	9	I	166.0450	4.9490	1.0298	-9.4554	-2.1572	0.9599	1.0000
	9	J	163.5172	7.0617	1.0432	-9.6847	-2.0662	0.9713	1.0000
	11	I	163.5172	7.0624	1.0432	-9.6843	-2.0662	0.9713	1.0000
	11	J	163.5172	7.2265	1.0442	-9.5825	-2.0729	0.9729	1.0000
	13	I	163.5172	7.2340	1.0442	-9.5828	-2.0730	0.9730	1.0000
	13	J	163.5172	7.0710	1.0432	-9.6850	-2.0663	0.9714	1.0000
	15	I	163.5172	7.0858	1.0433	-9.6863	-2.0667	0.9715	1.0000
	15	J	166.0450	4.9786	1.0300	-9.4571	-2.1577	0.9600	1.0000
	17	I	166.0450	5.0071	1.0302	-9.4598	-2.1585	0.9602	1.0000
	17	J	170.3474	1.7308	1.0102	-8.8618	-2.3298	0.9445	1.0000
	19	I	170.3474	1.7853	1.0105	-8.8664	-2.3312	0.9447	1.0000
	19	J	174.3255	-0.7716	0.9956	-8.0340	-2.5125	0.9351	1.0000
	21	I	174.3255	-0.6854	0.9961	-8.0434	-2.5146	0.9355	1.0000
	21	J	177.3996	-1.5594	0.9912	-6.7768	-2.7034	0.9378	1.0000
	23	I	177.3996	-1.4368	0.9919	-6.7989	-2.7061	0.9383	1.0000
	23	J	179.3182	0.0793	1.0004	-4.8805	-2.9153	0.9570	1.0000

Tendon Loss (Stress) | Tendon Loss (Force)

圖 51　鋼腱預力損失

鋼腱伸長量

Tools > **Unit System**
Length>**cm**; Force (Mass)>**tonf** ↵

到 Tree Menu 選 **Table** 表單
Result Tables > Tendon > **Tendon Elongation** ↵

	Tendon Name	Stage	Step	Tendon Elongation		Element Elongation		Summation	
				Begin (cm)	End (cm)	Begin (cm)	End (cm)	Begin (cm)	End (cm)
▶	TH1	Stage1	001(first	12.3138	12.3138	0.2171	0.2171	12.5309	12.5309
	TH2	Stage1	001(first	12.3138	12.3138	0.2171	0.2171	12.5309	12.5309
	TH3	Stage1	001(first	12.3138	12.3138	0.2171	0.2171	12.5309	12.5309
	TH4	Stage1	001(first	12.3138	12.3138	0.2171	0.2171	12.5309	12.5309
	TH5	Stage1	001(first	12.3138	12.3138	0.2171	0.2171	12.5309	12.5309
	TH6	Stage1	001(first	12.3138	12.3138	0.2171	0.2171	12.5309	12.5309
	TS1	Stage1	001(first	12.2769	12.2769	0.5274	0.5274	12.8043	12.8043
	TS2	Stage1	001(first	12.2769	12.2769	0.5274	0.5274	12.8043	12.8043
	TS3	Stage1	001(first	12.2769	12.2769	0.5274	0.5274	12.8043	12.8043
	TS4	Stage1	001(first	12.2769	12.2769	0.5274	0.5274	12.8043	12.8043
	TS5	Stage1	001(first	12.2769	12.2769	0.5274	0.5274	12.8043	12.8043
	TS6	Stage1	001(first	12.2769	12.2769	0.5274	0.5274	12.8043	12.8043

圖 52　鋼腱伸長量

影響線

返回 **Model View**
Initial View
Iso View

Tools > **Unit System**
Length>**m**; Force (Mass)> **tonf** ↵

Results > Moving Load >Influence Lines > **Beam Forces/Moments** ↵
Line/Surface Lanes>**LANE all**
Key Element>**13**
Scale Factor>**1**
Parts>**j**
Components>**My**
Type of Display>**Legend** (on)
Apply

梁單元 13 端點(My)彎矩影響線圖顯示如圖 53，此位置恰對應其中一內側梁的跨距中央處。

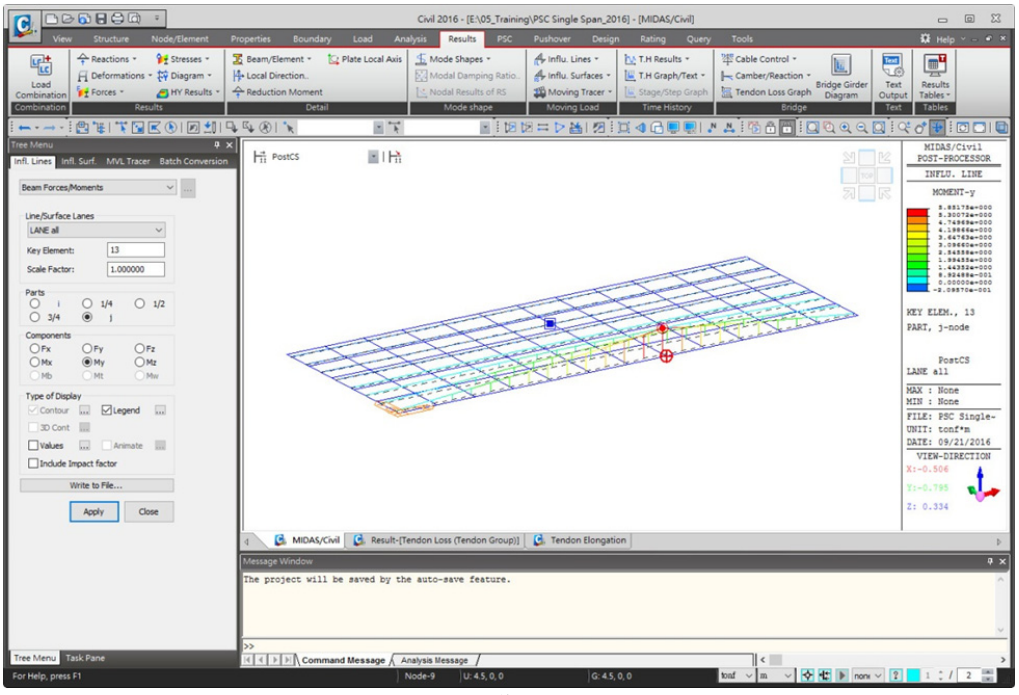


圖 53　影響線圖

車輛載重追蹤器

Results> Moving Load > Moving Tracer> **Beam Forces/Moments**

Moving Load Cases>**MVmax: MLC**
Key Element>**13**
Scale Factor>**1**
Parts>**j**
Components>**My**
Type of Display>**Contour** (on) ; **Legend** (on) ; **Applied Loads** (on)

Apply
Close

造成梁單元 13 端點(My)彎矩最大值的車輛活載重位置顯示如圖 54。

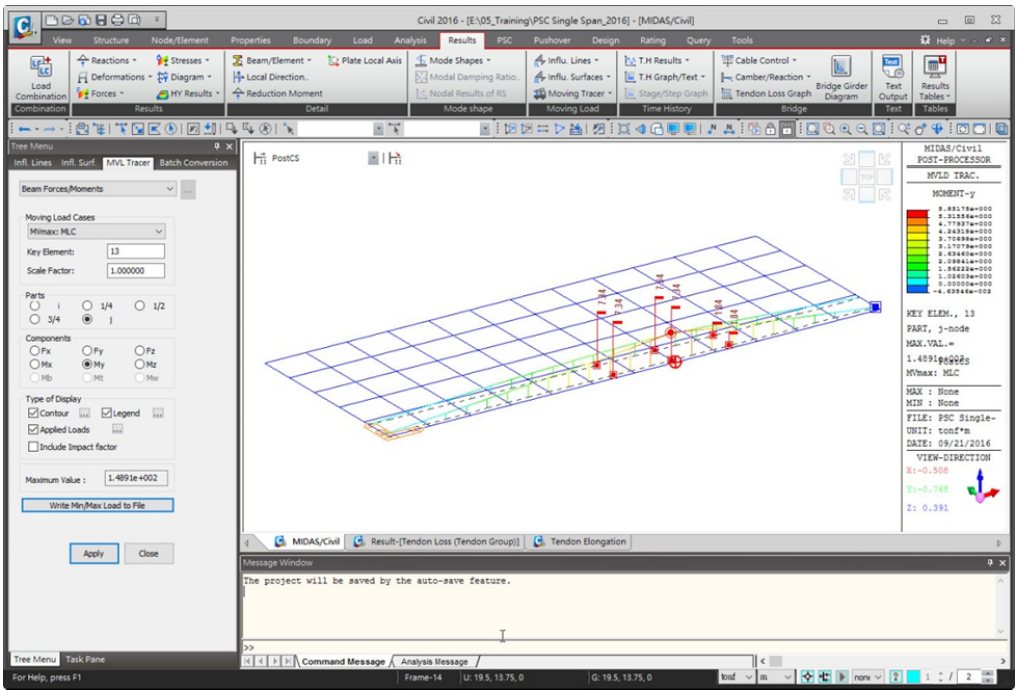


圖 54　Moving Load Tracer

施工階段預力梁應力

Model View > 施工階段工具列 > Stage 1

Result>Result Tables>Composite Section for C.S.> **Beam Stress** ↵

Records Activation 對話框:

Loadcase/Combination>**Summation(CS)**

Stage/Step>**Stage 1:0003(last) (on) ; Stage 2:0003(last) (on)**

Part Number>**Part j**

OK

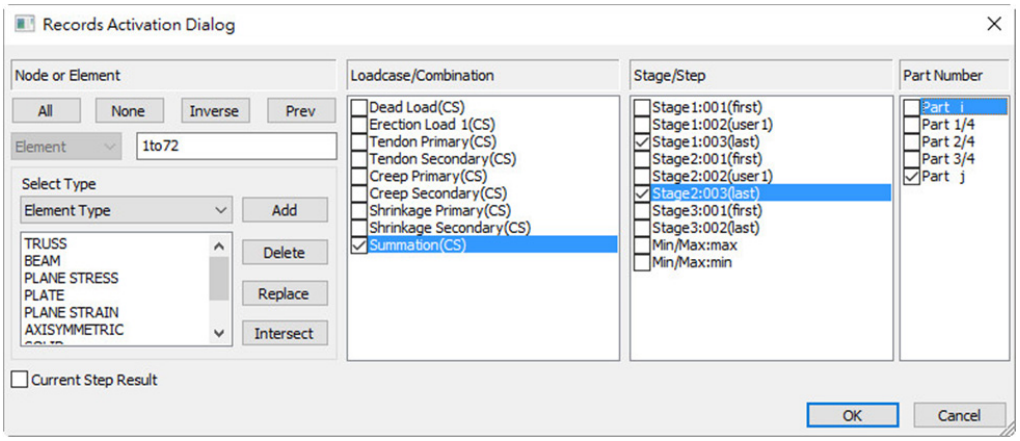


圖 55 設定輸出資料對話框

設定輸出施工階段 1 與施工階段 2 時，桿件 1 至 72 的 J 端軸力、彎矩與組合應力結果。

Elem	Load	Stage	Step	Section Part	Part	Axial (tonf/m^2)	Bend(+y) (tonf/m^2)	Bend(-y) (tonf/m^2)	Bend(+z) (tonf/m^2)	Bend(-z) (tonf/m^2)	Cb(min/max) (tonf/m^2)	Cb1(-y+z) (tonf/m^2)	Cb2(+y+z) (tonf/m^2)
1	Summati	Stage1	003(last)	1	J	-1055.41	-13.15	13.15	432.38	-421.02	-1484.98	-609.88	-636.18
1	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	Summati	Stage2	003(last)	1	J	-978.55	-11.40	11.40	452.50	-440.89	-1426.85	-514.65	-537.44
1	Summati	Stage2	003(last)	2	J	-63.65	-0.07	0.07	6.02	-6.02	-69.74	-57.56	-57.71
2	Summati	Stage1	003(last)	1	J	-1055.35	12.99	-12.99	432.44	-421.07	-1484.87	-635.91	-609.93
2	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Summati	Stage2	003(last)	1	J	-978.85	11.29	-11.29	452.61	-440.99	-1427.18	-537.54	-514.96
2	Summati	Stage2	003(last)	2	J	-64.05	0.38	-0.38	6.02	-6.02	-70.44	-58.41	-57.65
3	Summati	Stage1	003(last)	1	J	-1057.63	-17.76	17.76	244.11	-232.92	-1302.09	-795.75	-831.28
3	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Summati	Stage2	003(last)	1	J	-957.10	-16.07	16.07	254.08	-242.73	-1210.28	-686.95	-719.10
3	Summati	Stage2	003(last)	2	J	-96.60	-0.09	0.09	0.66	-0.66	-97.36	-95.85	-96.04
4	Summati	Stage1	003(last)	1	J	-1057.57	17.59	-17.59	244.16	-232.98	-1301.99	-831.00	-795.81
4	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Summati	Stage2	003(last)	1	J	-957.36	15.92	-15.92	254.17	-242.82	-1210.53	-719.11	-687.28
4	Summati	Stage2	003(last)	2	J	-96.95	0.23	-0.23	0.66	-0.66	-97.84	-96.53	-96.06
5	Summati	Stage1	003(last)	1	J	-1059.14	-14.42	14.42	115.90	-105.85	-1174.37	-928.82	-957.67
5	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Summati	Stage2	003(last)	1	J	-940.89	-13.54	13.54	117.18	-107.17	-1056.86	-810.17	-837.24
5	Summati	Stage2	003(last)	2	J	-121.76	0.18	-0.18	-3.33	3.33	-125.28	-125.28	-124.91
6	Summati	Stage1	003(last)	1	J	-1059.09	14.26	-14.26	115.95	-105.90	-1174.26	-957.40	-928.89
6	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Summati	Stage2	003(last)	1	J	-941.11	13.38	-13.38	117.26	-107.25	-1057.06	-837.23	-810.48
6	Summati	Stage2	003(last)	2	J	-122.07	-0.07	0.07	-3.33	3.33	-125.47	-125.34	-125.47
7	Summati	Stage1	003(last)	1	J	-1059.04	-11.42	11.42	45.01	-35.79	-1102.24	-1002.61	-1025.44
7	Summati	Stage1	003(last)	2	J	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Summati	Stage2	003(last)	1	J	-929.14	-10.94	10.94	38.65	-29.74	-965.99	-879.55	-901.43
7	Summati	Stage2	003(last)	2	J	-138.69	0.49	-0.49	-5.96	5.96	-145.14	-145.14	-144.17
8	Summati	Stage1	003(last)	1	J	-1058.99	11.25	-11.25	45.06	-35.83	-1102.13	-1025.19	-1002.68

Beam Stress

MIDAS/Civil Result-[Beam Stress (Section Part)]

圖 56 梁於施工階段的應力值

預力梁彎矩圖

Top View
開啟顯示 **Element Number**
Select Window > Elements 25to69by4
Activate
Front View

Model View

Results > Forces > **Beam Diagrams** ↵
Load Cases/Combinations>**CS: Summation**
Step > **Last Step**
Components>**My**
Display Options>**5 Points** (on) ; **Solid Fill** (on)
Type of Display>**Contour** (on) ; **Legend** (on)
Apply

顯示施工階段 1，所有施工階段載重作用下，內側主梁的彎矩圖。

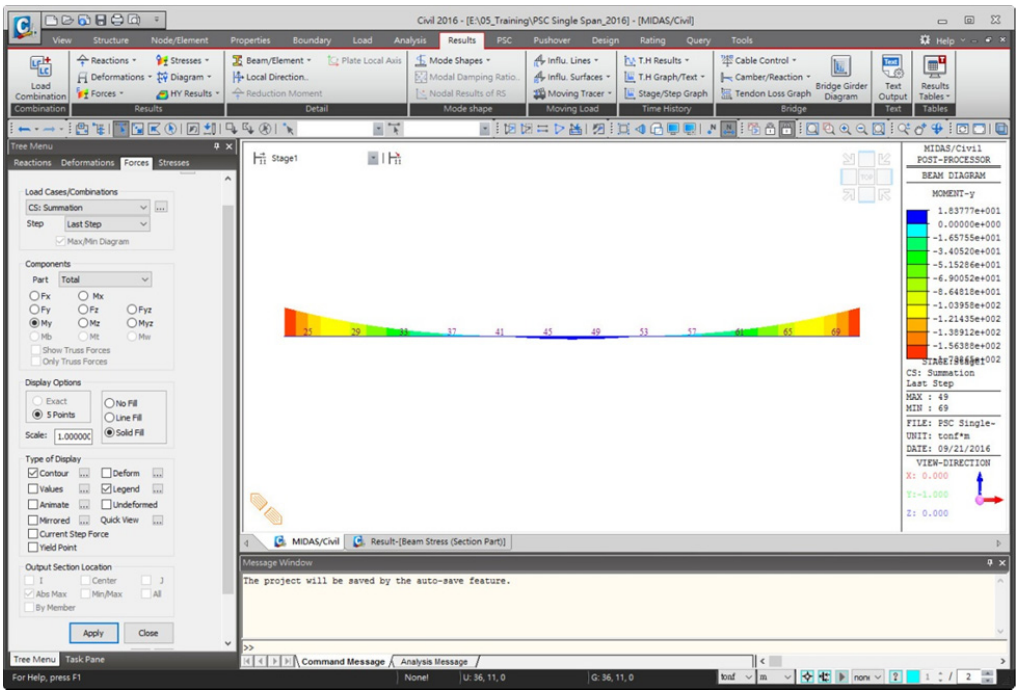


圖 57　主梁於施工階段 1 的彎矩圖

開啟視窗下方 **Status Bar** 狀態列上的 **Active Fix**

施工階段工具列 > **Post Construction Stage** (PostCS).

Load Cases/Combinations> **CBall: RC ENV_STR**
Components>**My**
Apply

顯示完工階段，內側主梁的彎矩包絡圖。

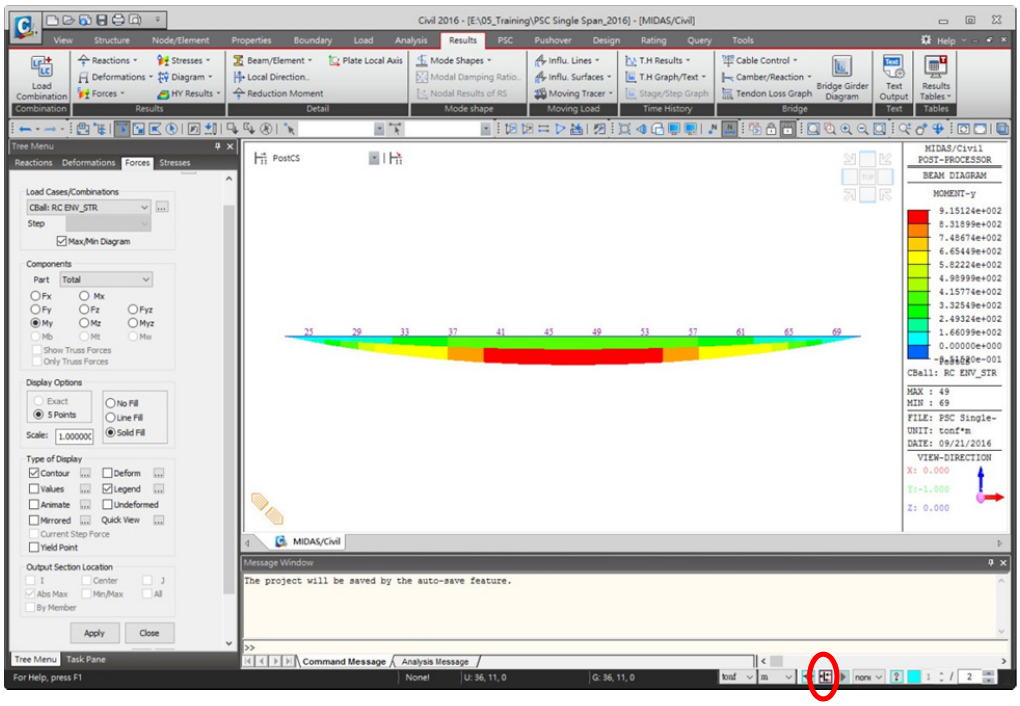


圖 58　主梁於完工階段的彎矩包絡圖

預力梁剪力圖

Load Cases/Combinations> **CBall: RC ENV_STR**
Components>**Fz**

Apply
Close

顯示完工階段，內側主梁的剪力包絡圖。

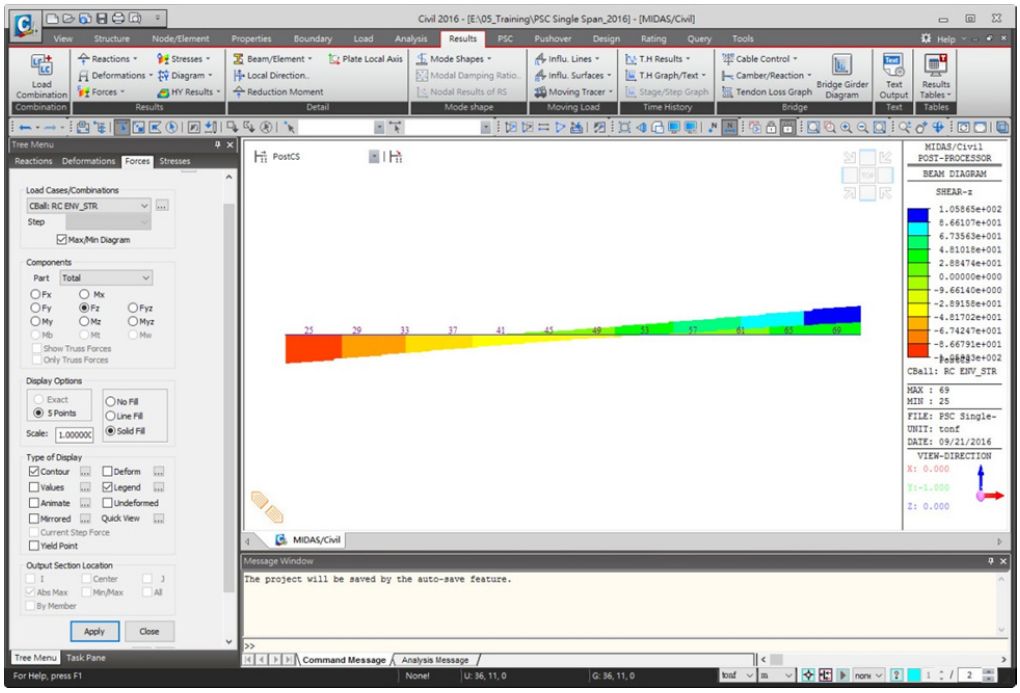


圖 59　主梁於完工階段的剪力包絡圖

反力

Results>Result Tables > **Reaction** ↵
Records Activation 對話框>
Loadcase Combination>**gLCB1(CB:max)**
OK

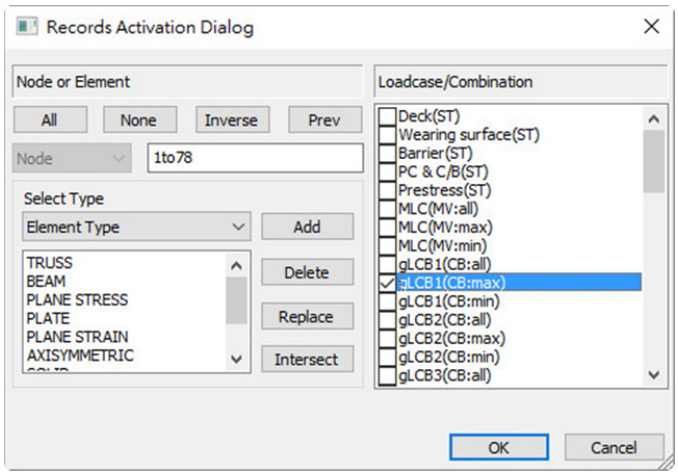


圖 60　設定輸出資料對話框

	Node	Load	FX (tonf)	FY (tonf)	FZ (tonf)	MX (tonf*m)	MY (tonf*m)	MZ (tonf*m)
▶	1	gLCB1(m	-35.103931	0.569277	94.619327	0.000000	0.000000	0.000000
	2	gLCB1(m	22.544699	0.000000	112.825424	0.000000	0.000000	0.000000
	3	gLCB1(m	18.663174	0.000000	113.930523	0.000000	0.000000	0.000000
	4	gLCB1(m	19.035862	0.000000	113.983548	0.000000	0.000000	0.000000
	5	gLCB1(m	23.904161	0.000000	113.017900	0.000000	0.000000	0.000000
	6	gLCB1(m	-32.837370	0.000000	93.611126	0.000000	0.000000	0.000000
	29	gLCB1(m	0.000000	1.830174	94.676792	0.000000	0.000000	0.000000
	30	gLCB1(m	0.000000	0.000000	93.670761	0.000000	0.000000	0.000000
	75	gLCB1(m	0.000000	0.000000	112.779080	0.000000	0.000000	0.000000
	76	gLCB1(m	0.000000	0.000000	113.916212	0.000000	0.000000	0.000000
	77	gLCB1(m	0.000000	0.000000	113.970234	0.000000	0.000000	0.000000
	78	gLCB1(m	0.000000	0.000000	112.973199	0.000000	0.000000	0.000000
	SUMMATION OF REACTION FORCES PRINTOUT							
		Load	FX (tonf)	FY (tonf)	FZ (tonf)			
		gLCB1(m	N/A	N/A	N/A			

圖 61　完工階段，載重組合 LCB1 作用下，各支承點的最大反力