

## Contents

### ▪ What is Tendon Template?

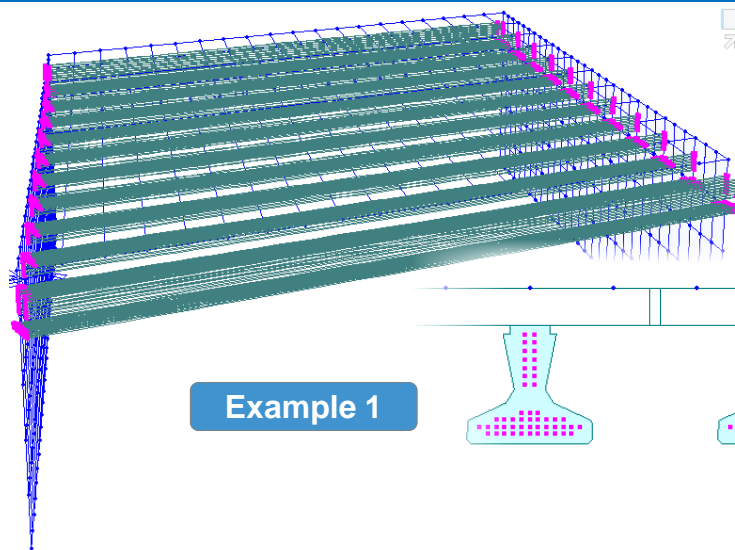
#### ▪ Example 1

- Model: **A single span integral bridge with TY section**
- Unit: **kN, m**
- Section: **Composite-PSC with TY7, TYE7**

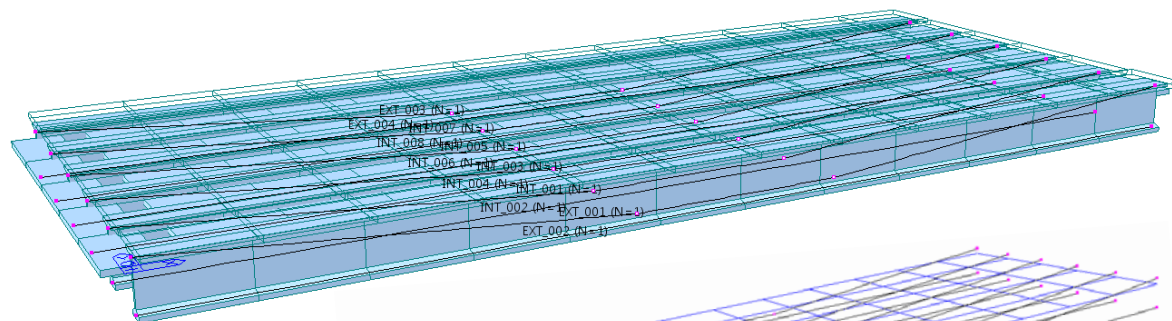
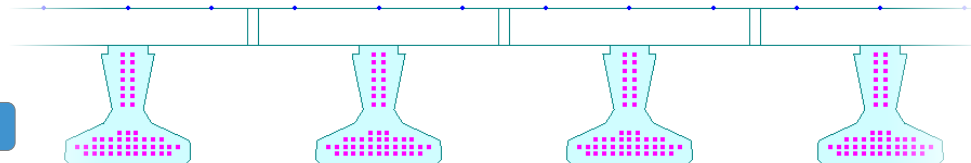
#### ▪ Example 2

- Model: **A single span bridge with AASHTO PCI bulb Tee section**
- Unit: **kips, in**
- Section: **Composite PSC I**

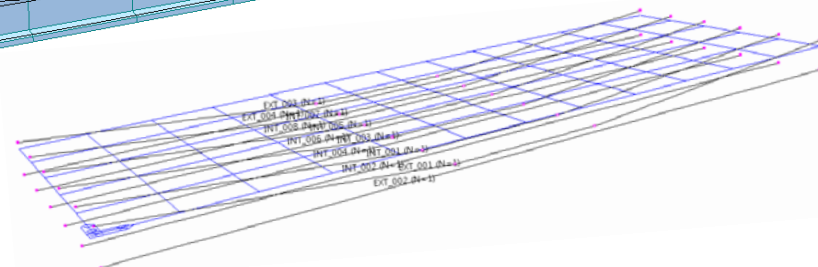
# Tendon Template



Example 1



Example 2



Program Version	Civil 2015 (v1.1)
Release Date	July, 14, 2014
Latest Revision	Dec., 10, 2014

*Tendon Template* is a function to create tendon profile more easily using typical tendon layout and Auto-Generation.

**Add/Modify Tendon Template**

Tendon Name : EXT\_005 Group : Tendon1

Tendon Property : TS

Horiz. Offset(begin) : 0.0000 in ☒ Same span Length

Horiz. Offset(End) : 0.0000 in

Plan(xy)

Tendon Type : Straight

Num. Of Span : 1

Span Length : 1440

(in)	Begin	End
span	t	t
1	45	

Elevation(xz)

Tendon Type : Straight

Num. Of Span : 1








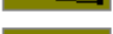
Span Length : 1440

(in)	Begin	End
span	t	t
1	40	40

Reference Axis : ☐ Straight ☐ Curve ☒ Element

## Tendon layout

### Typical tendon layout

-  Straight
-  Straight for Curved tendon
-  Harped 1
-  Harped 2
-  Curved 1
-  Curved 2
-  Curved 3
-  Curved 4

### Auto-Generation

Section database with strands for precast girders

**Auto Generation**

Name prefix : strand

Tendon Property : Tendon

Group : Default

Code : UK

Type : UK-M

Name : M1

Origin Point : 0.000, 0.000 cm

☒ Initialize Tendon Template

OK Cancel

## Tendon Profile

**Add/Modify Tendon Profile**

Tendon Name : L\_008 Group : Default

Tendon Property : Tendon

Assigned Elements : 603 665to966by43 1011 1072 1166 1228

Input Type : ☒ 2-D ☐ 3-D

Curve Type : ☐ Spline ☒ Round

Straight Length of Tendon : Begin : 0 m End : 0 m

☐ Typical Tendon No. of Tendons : 1

Lead Length : User defined Length Begin : 0 End : 0 m

Profile Reference Axis : ☐ Straight ☐ Curve ☒ Element

Y : -0.0538461 -1.05385

	x(m)	y(m)	R(m)	Add	A[deg]	h(m)
1	0.0000	-0.1000	0.0000	None	0.0000	0.0000
2	12.4000	-0.1000	0.0000	None	0.0000	0.0000
3						

Z : -0.818846 -1.81885

	x(m)	z(m)	R(m)	Add	A[deg]	h(m)
1	0.0000	-0.8650	0.0000	None	0.0000	0.0000
2	12.4000	-0.8650	0.0000	None	0.0000	0.0000
3						

Point of Sym. : ☐ First ☒ Last ☐ Make Symmetric Tendon

Profile Insertion Point : ☒ End-I ☐ End-J of Elem. 603

x Axis Direction : ☒ I -> J ☐ J -> I of Elem. 603

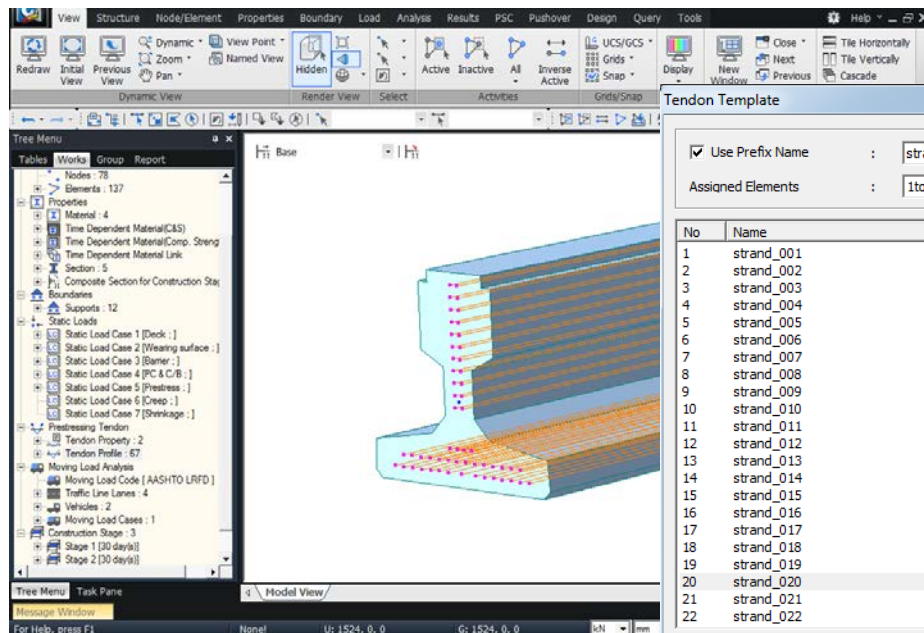
x Axis Rot. Angle : 0 [deg] ☐ Projection

Offset y : 0 m z : 0 m

OK Cancel Apply

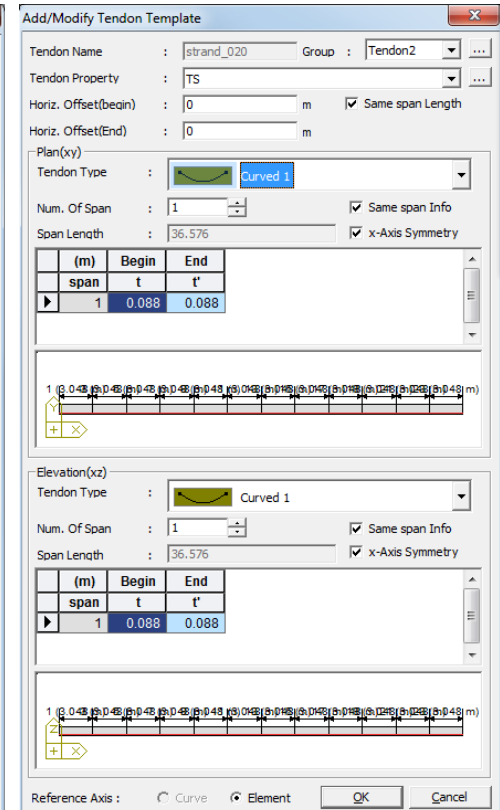
## Structure tab > Wizard > PSC Bridge > Tendon Template

- Various profiles of strands/tendons for the prestressed girders can be created using **Tendon Template** with ease.
- Auto-generation of the UK PSC section database.
- Straight tendons and harped tendons can be defined based on the span and section information.
- The tendon layouts generated in a project can be used to other similar projects which have the same tendon layout but different span lengths by exporting & importing tendon template data.



### Tendon Template

### Add/Modify Tendon Template



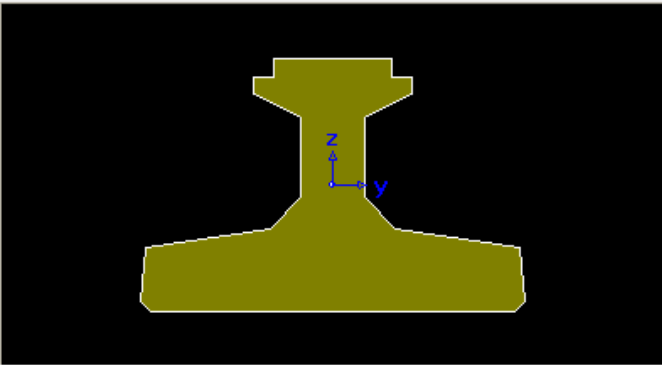
## PSC Value Section DB

Select PSC DB

Code  Type

Select DB

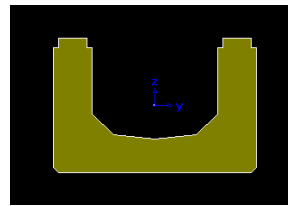
1:M1	UK-M
2:M680	UK-UMB
3:M2	UK-MY
4:M3	UK-MYE
5:M4	UK-Solid Box
6:M5	UK-SY
7:M6	UK-SYE
8:M7	UK-T
9:M8	UK-TY(Rebate)
10:M9	UK-TYE(Rebate)
11:M10	UK-TY
	UK-TYE
	UK-U_SU
	UK-W
	UK-Y
	UK-YE
	UK-UM



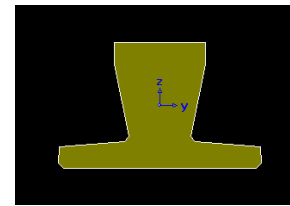
OK Cancel

UK-M

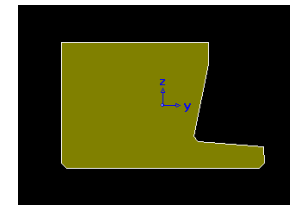
PSC DB in UK Code



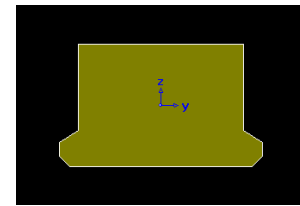
UK-UMB



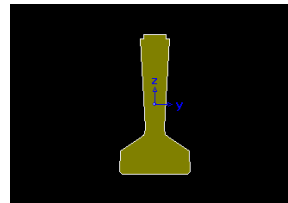
UK-MY



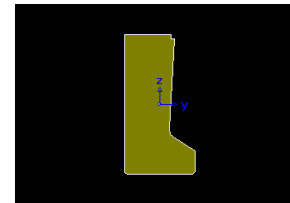
UK-MYE



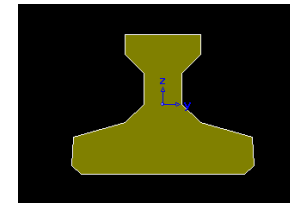
UK-Solid Box



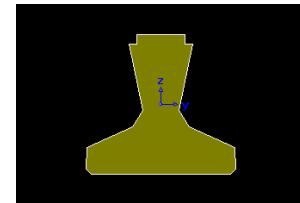
UK-SY



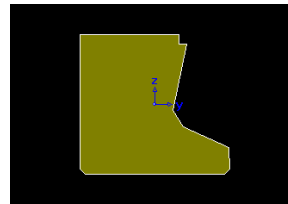
UK-SYE



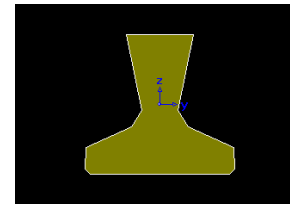
UK-T



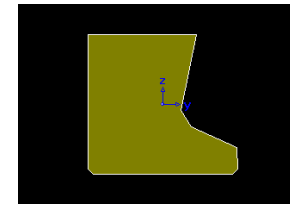
UK-TY(Rebate)



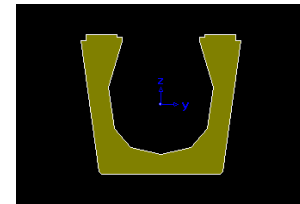
UK-TYE(Rebate)



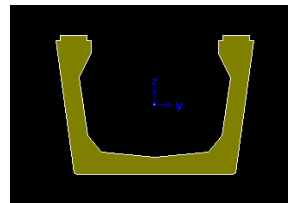
UK-TY



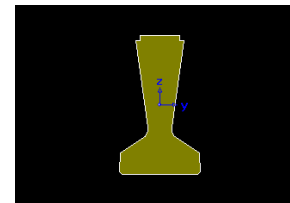
UK-TYE



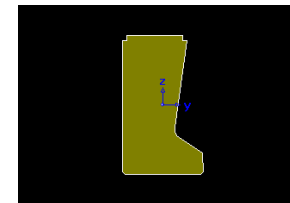
UK-U\_SU



UK-W



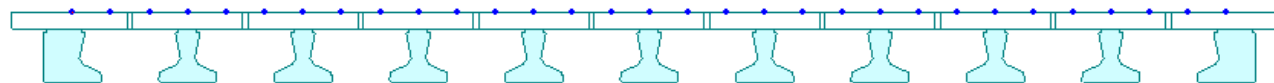
UK-Y



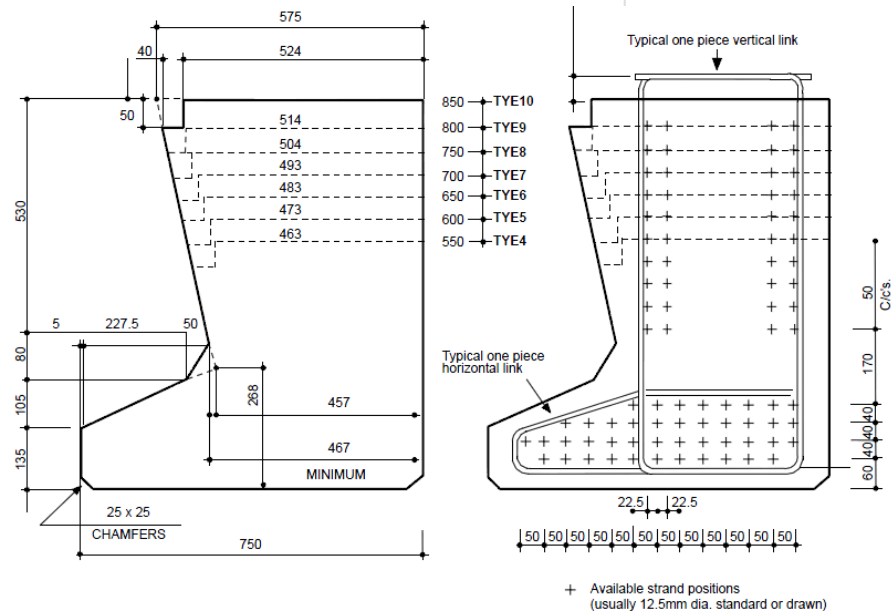
UK-YE

## Bridge overview

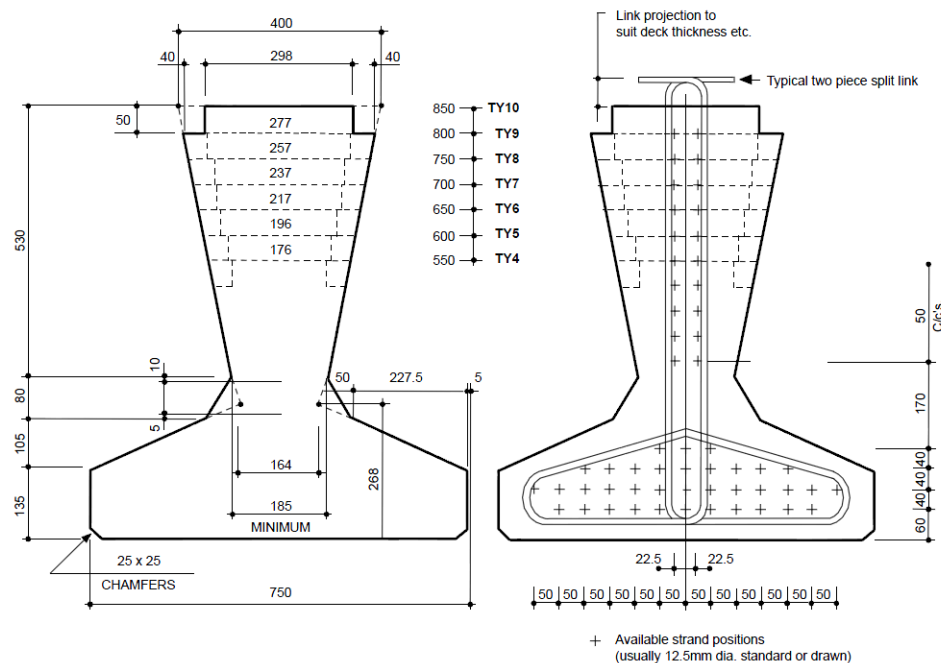
- Bridge type: A single span composite integral bridge with 22 degree skew
- Span length: 12.4 m
- Ten girders spaced at 1.5 m
- Composite section with TY7 beam



## Bridge cross-section




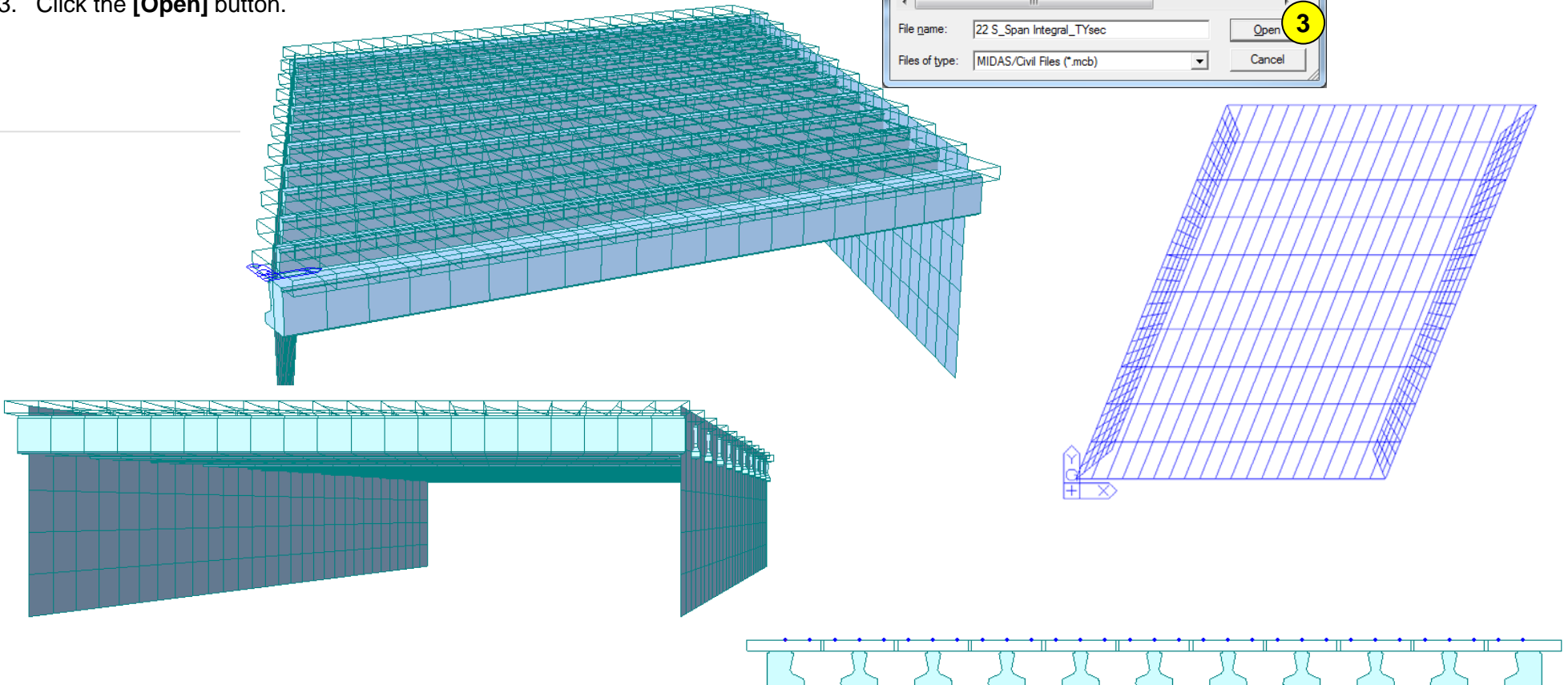
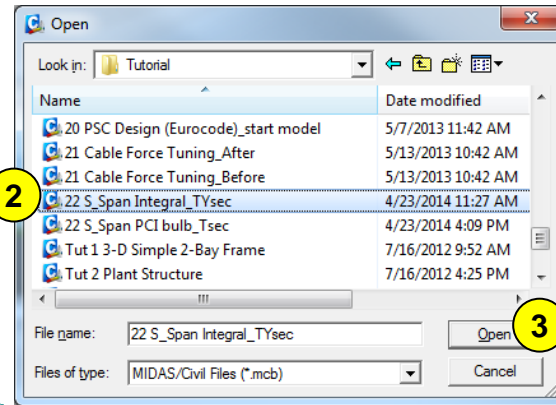
TYE 7 section dimensions



TY 7 section dimensions

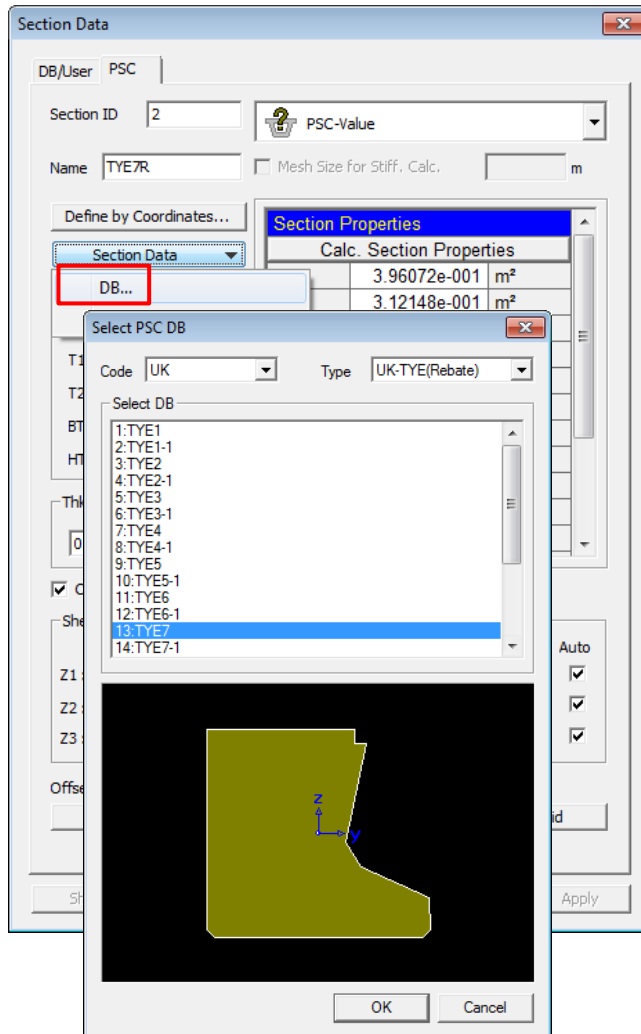
## Open

1. Click .
2. Select [22 S\_Span Integral\_TYsec.mcb].
3. Click the [Open] button.

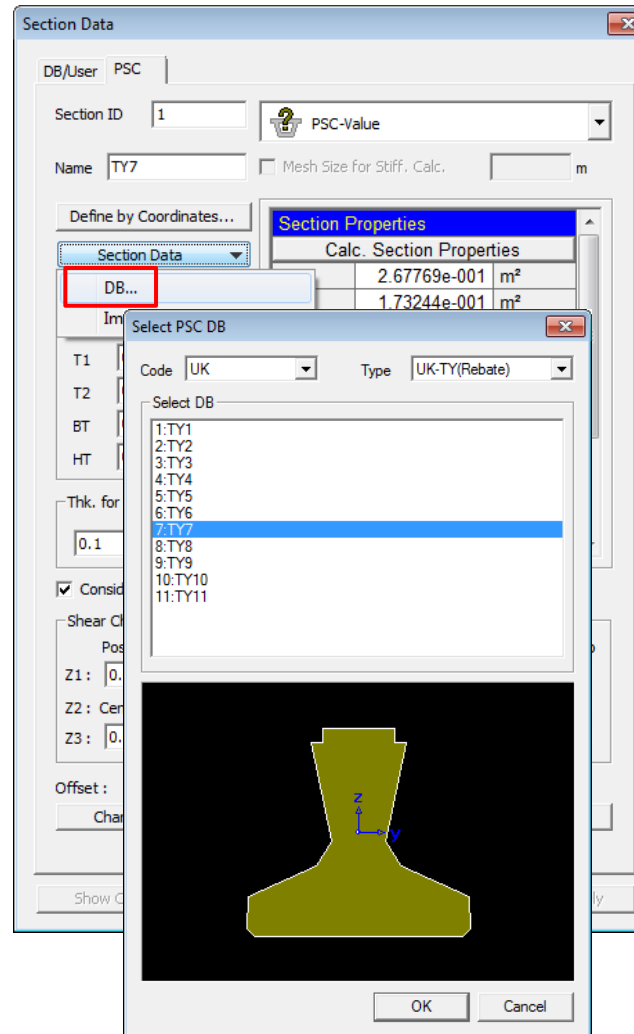


## PSC-Value section

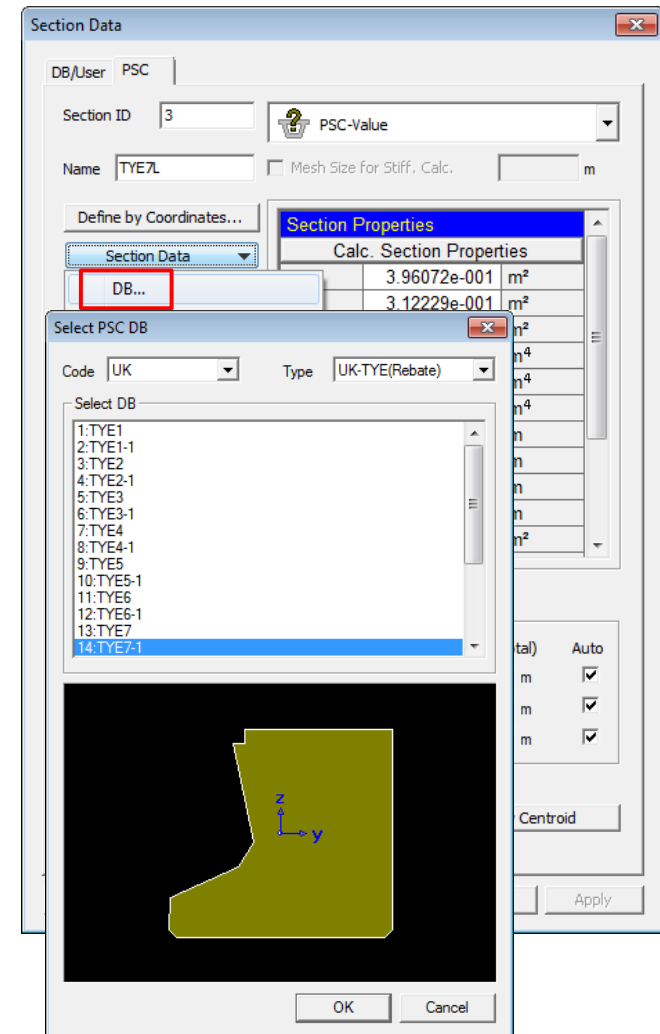
These sections are already defined in the model file.



Standard TYE7



Standard TY7



Standard TYE7-1

## Composite-PSC section type

**Section Data**

DB/User: **Composite**

Section ID: 4 Name: C0mposite TY7

Section Type: Composite-PSC

Slab Width: 1,561 m

Girder : Num 1 CTC 0 m

Slab

Bc	1,561	m
tc	0,225	m
Hh	0	m

Girder

PSC Value Type **Import...**

1: TY7  
2: TYE7R  
3: TYE7L

Material

Select Material

Egd/Esb 1,19524

Pgd 0,2

☐ Multiple Modulus

Es/Ec (Long Term)

Es/Ec (Shrinkage)

☒ Consider Shear Deformation.

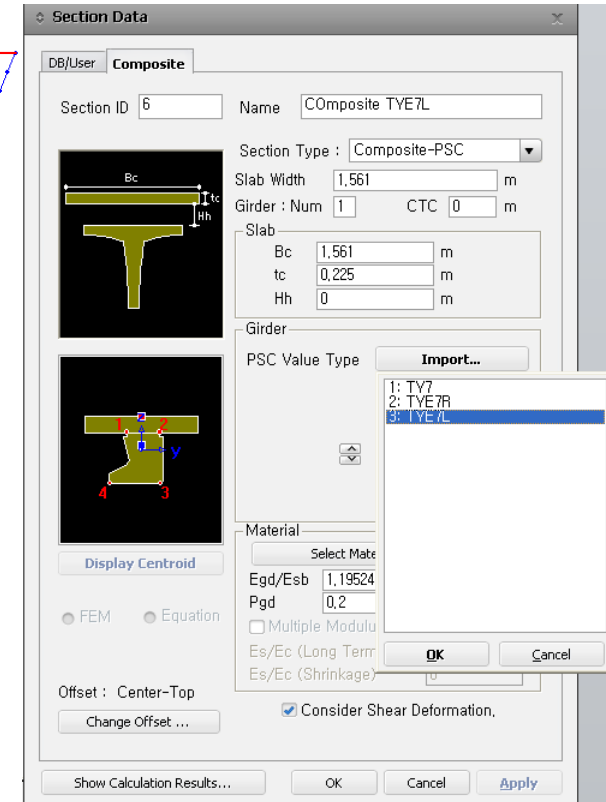
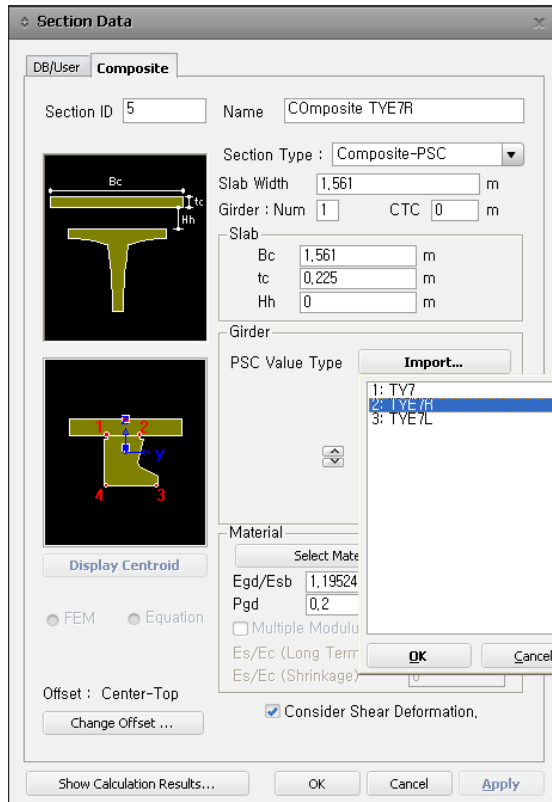
Offset : Center-Top

Change Offset ...

Show Calculation Results... OK Cancel Apply

**Interior composite girders**

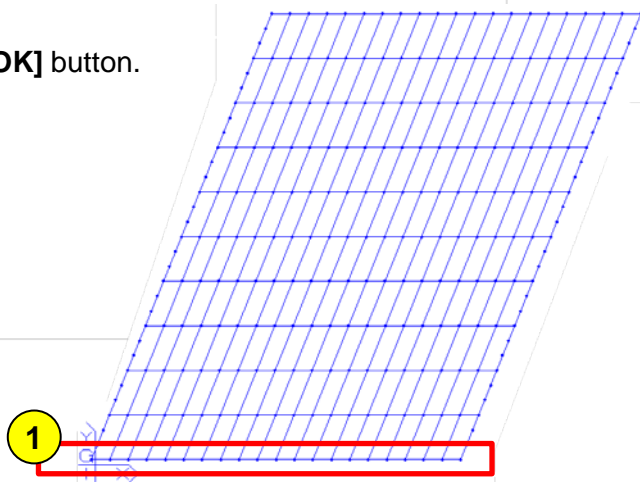
## Composite-PSC section type

Left exterior  
composite girderRight exterior  
composite girder

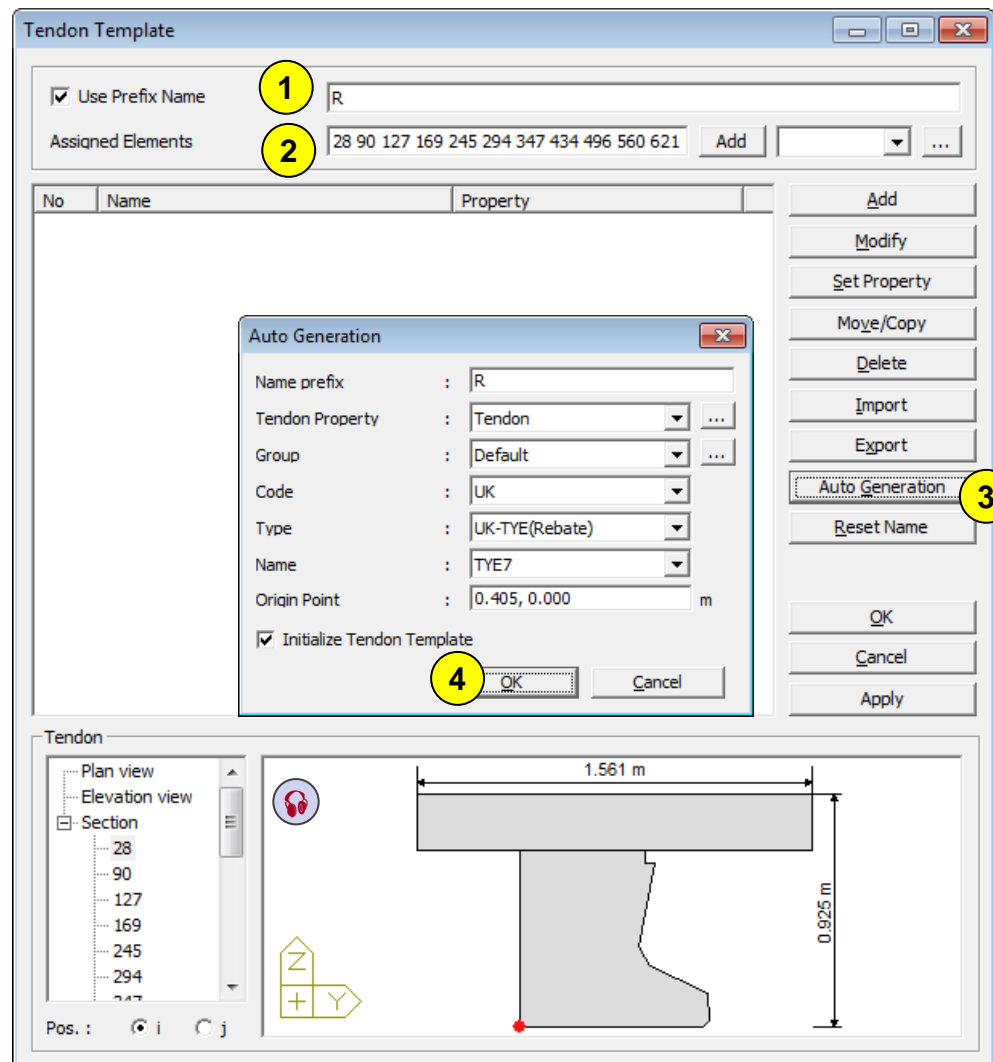
## Define Tendon Template

**Structure > Wizard > PSC Bridge > Tendon Template...**

1. **[Use Prefix Name]: R**
2. Select the right exterior girder for **[Assigned Elements]**.
3. Click the **[Auto Generation]** button.
4. Click the **[OK]** button.



A preview of the tendon profile is viewed from the assigned elements.

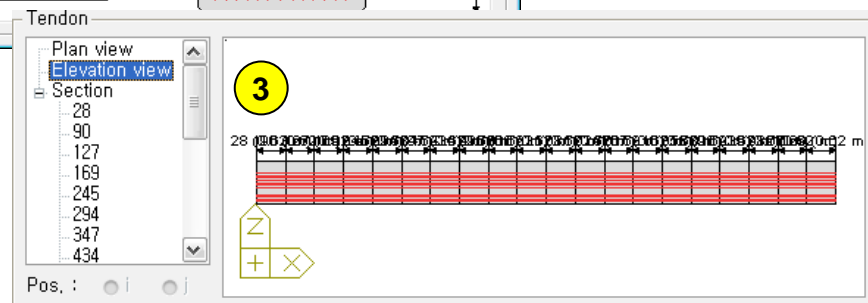
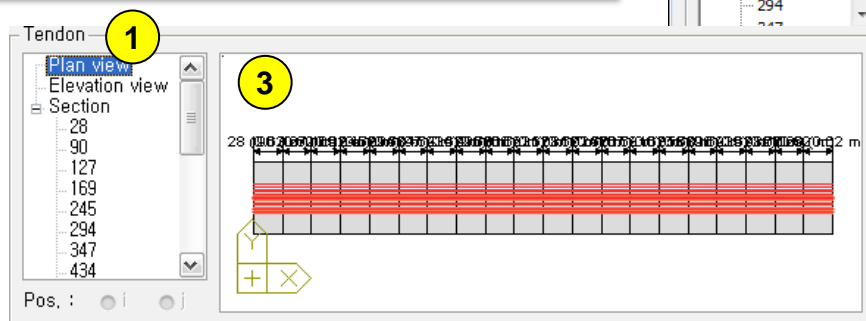
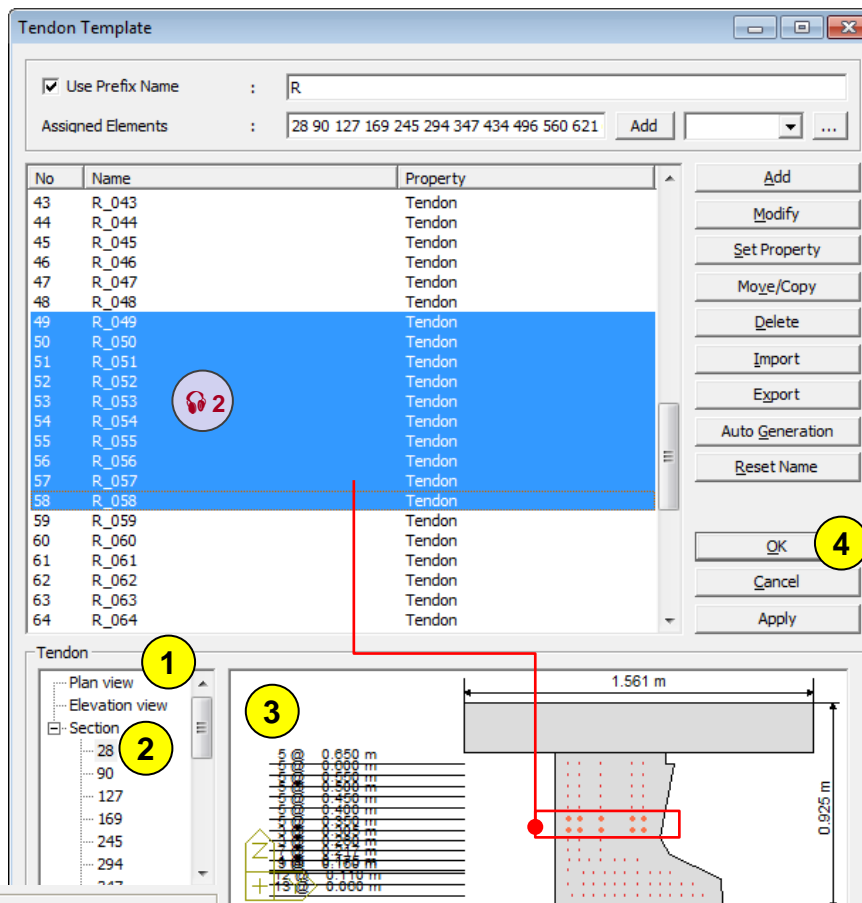


## Define Tendon Template

1. Tendon > Plan view, Elevation view
2. Tendon > Section > 28
3. Check strand arrangement.
4. Click the **[OK]** button.

🔊 1: All the strands defined in Tendon Template are transferred to "Load > Temp./Prestress > Tendon Profile."

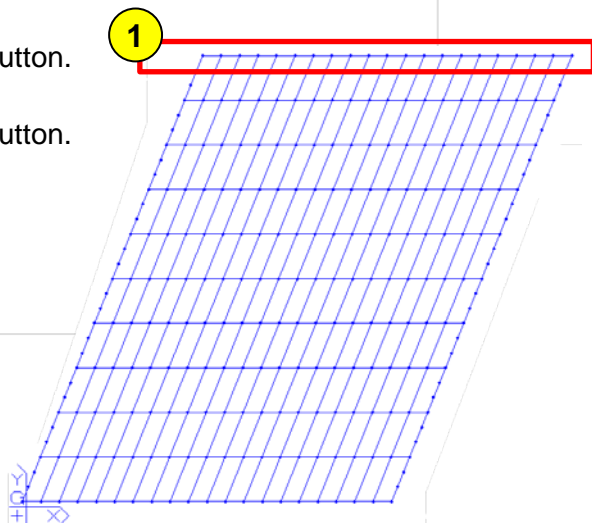
🔊 2: Tendon profile can be selected by clicking in the list or drag the tendon in display view



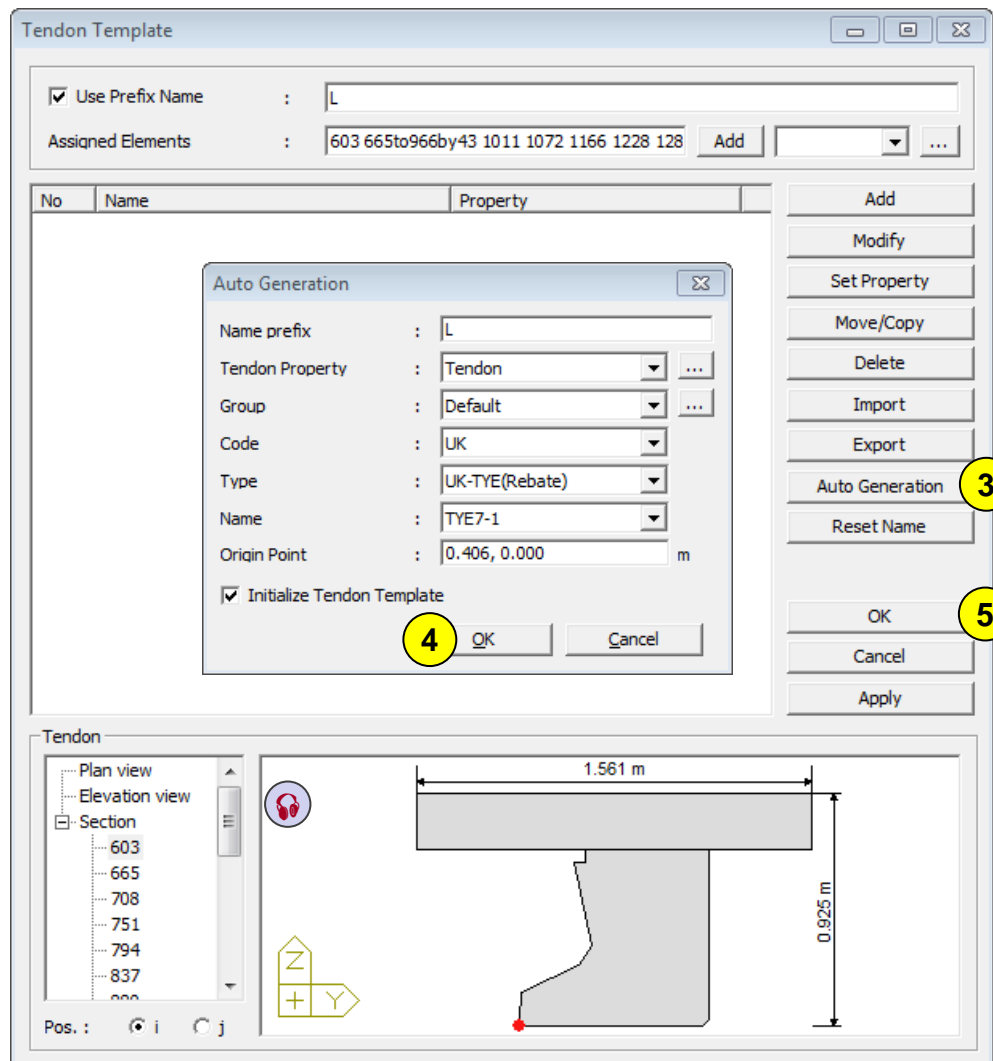
## Define Tendon Template

**Structure > Wizard > PSC Bridge > Tendon Template...**

1. **[Use Prefix Name]:** L
2. Select the left exterior girder for **[Assigned Elements]**.
3. Click the **[Auto Generation]** button.
4. Click the **[OK]** button.
5. Click the **[OK]** button.

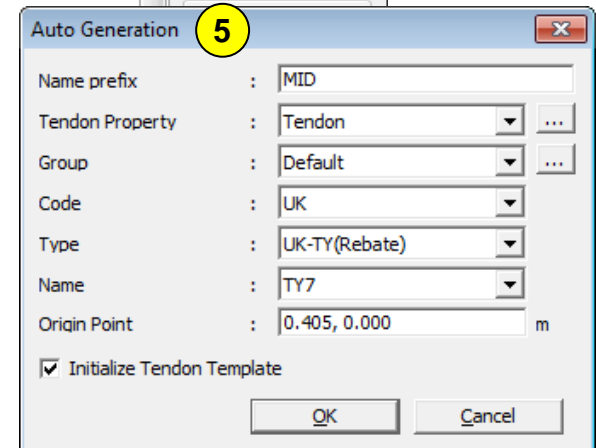
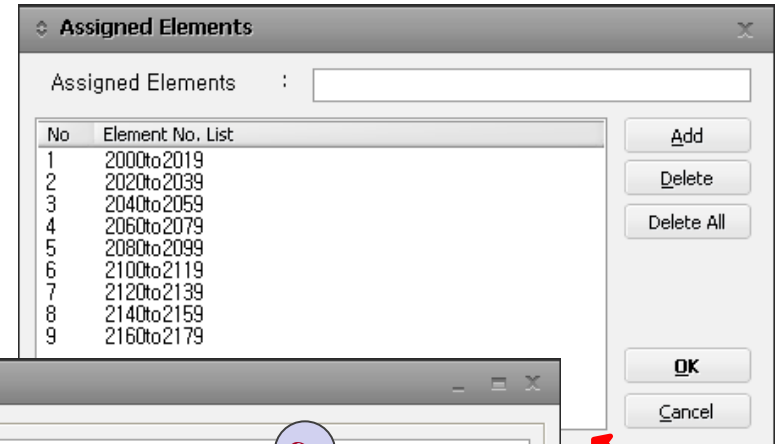
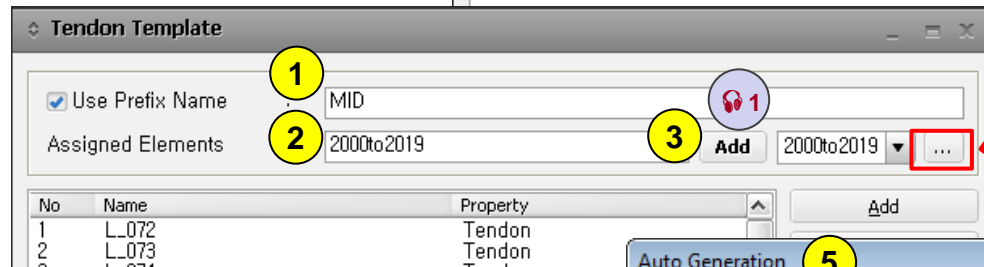
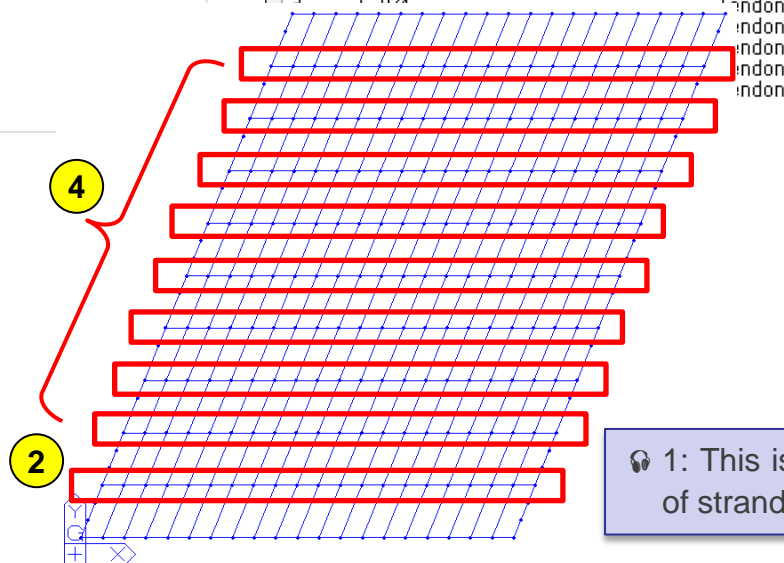


Any generated strand can be selected from Tendon Template List or Tendon Template View (plan view, elevation view and section view).



## Define Tendon Template

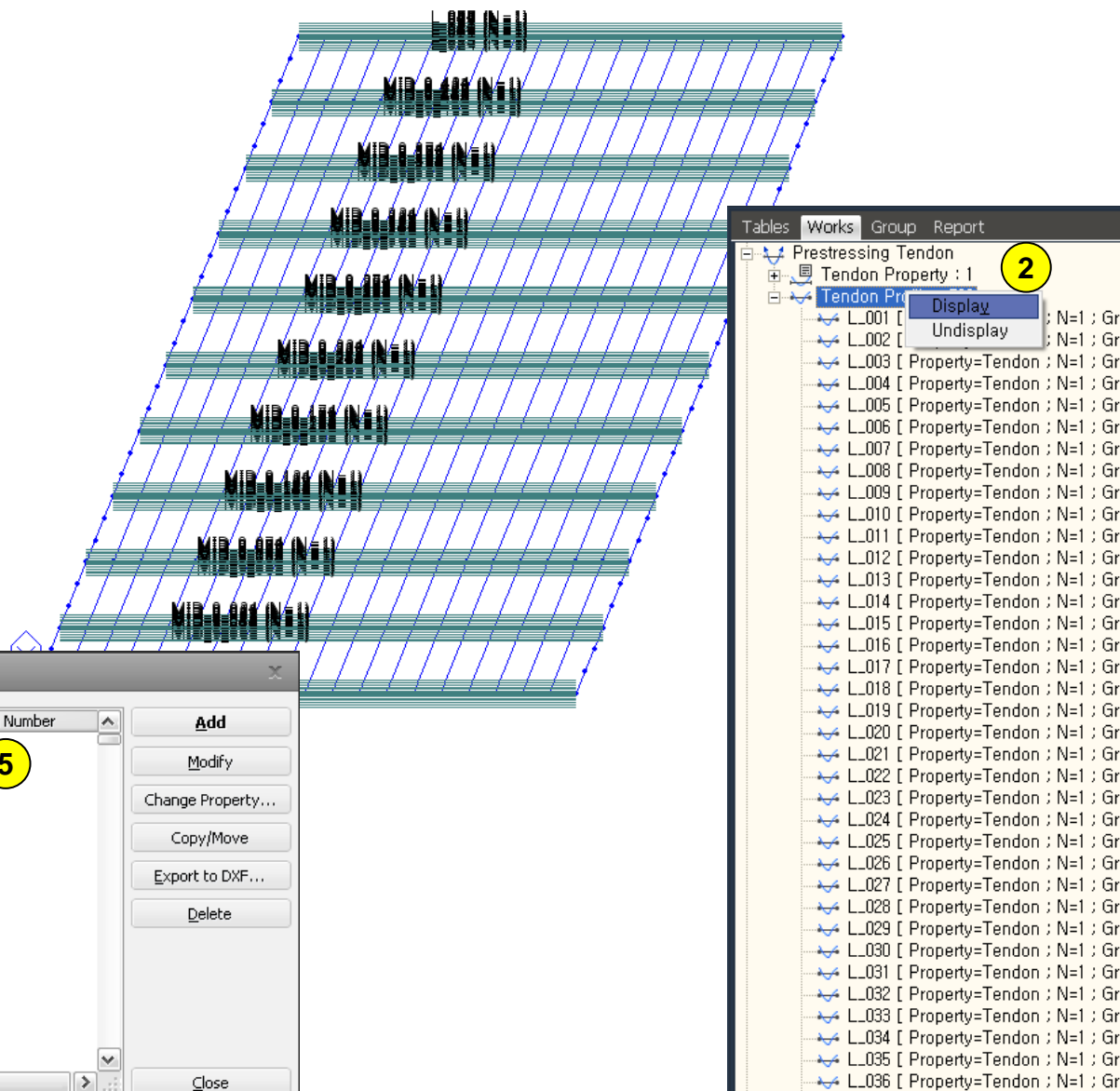
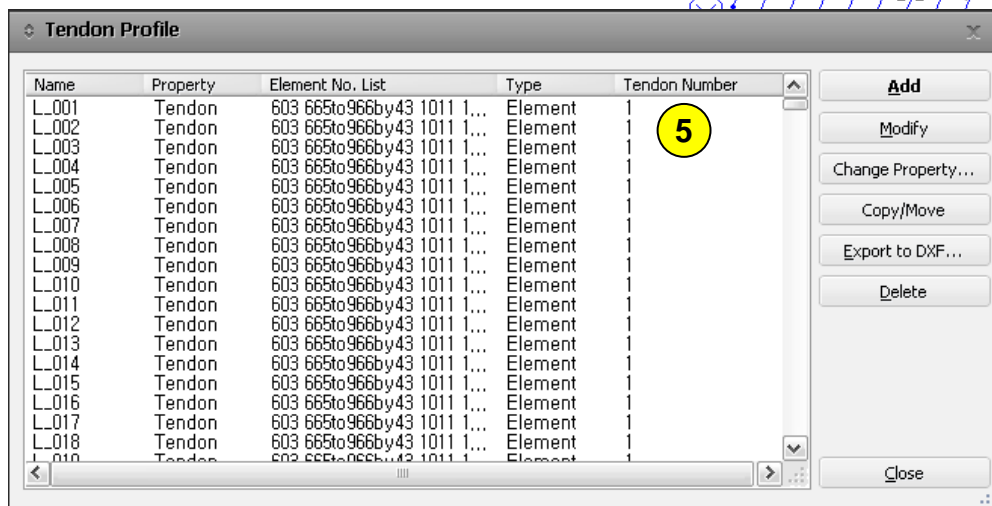
1. **[Use Prefix Name]:** MID
2. Select the elements corresponding to an interior girder for **[Assigned Elements]**.
3. Click the **[Add]** button.
4. Repeat 8 times above process (2 and 3) for the remaining interior girders.
5. Click the **[Auto Generation]** button.
6. Click the **[OK]** button.
7. Click the **[OK]** button.



🔊 1: This is useful when assigning identical arrangement of strands to many girders.

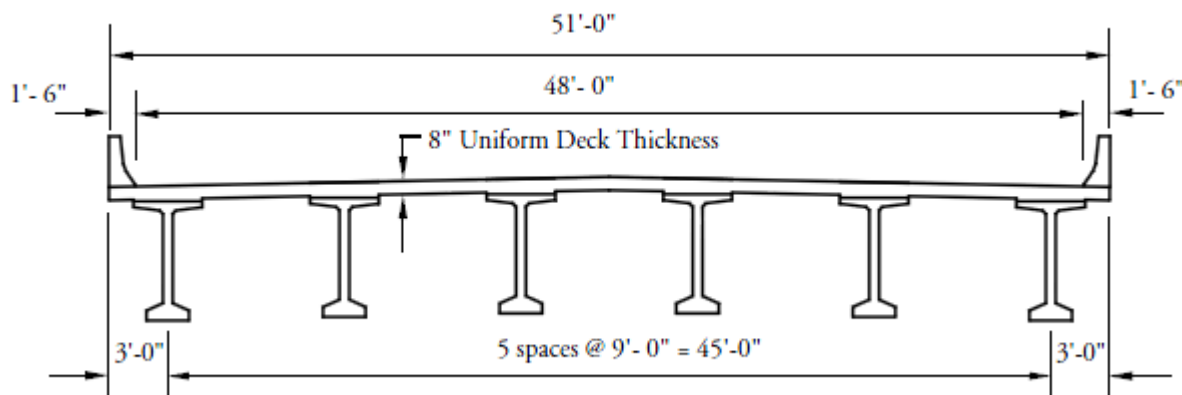
## Check tendon profile

1. Select tendon profile from Works Tree.
2. Display tendon profile by right-clicking and selecting **[Display]**.
3. Load > Load Type > **Temp./Prestress**
4. Select : **[Tendon Profile]**.
5. Check the list of tendon profiles.

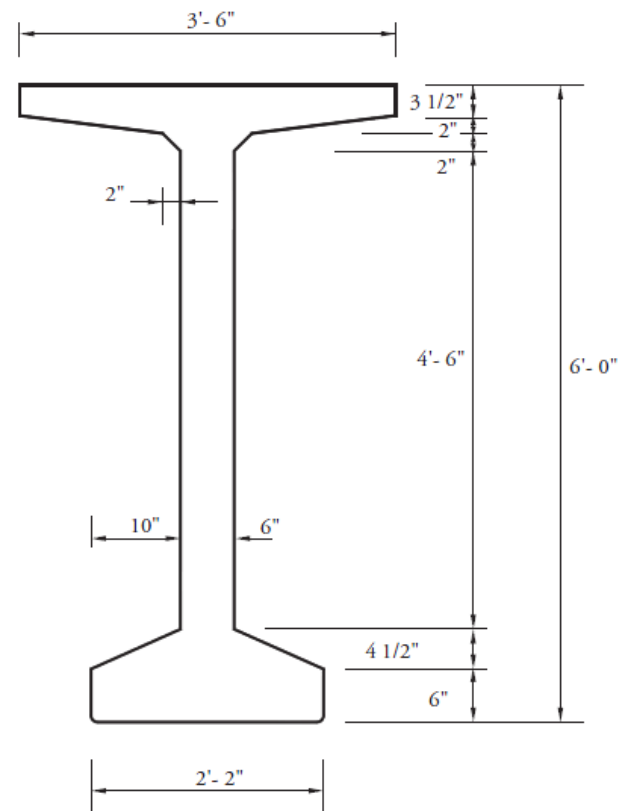


## Bridge overview

- Bridge type: A straight bridge with no skew
- Span length: A single Span 120.0 ft
- Six precast spaced at 9.0 ft
- Total deck width: 51.0 ft
- Precast beams : AASHTO PCI bulb-Tee



Bridge cross-section

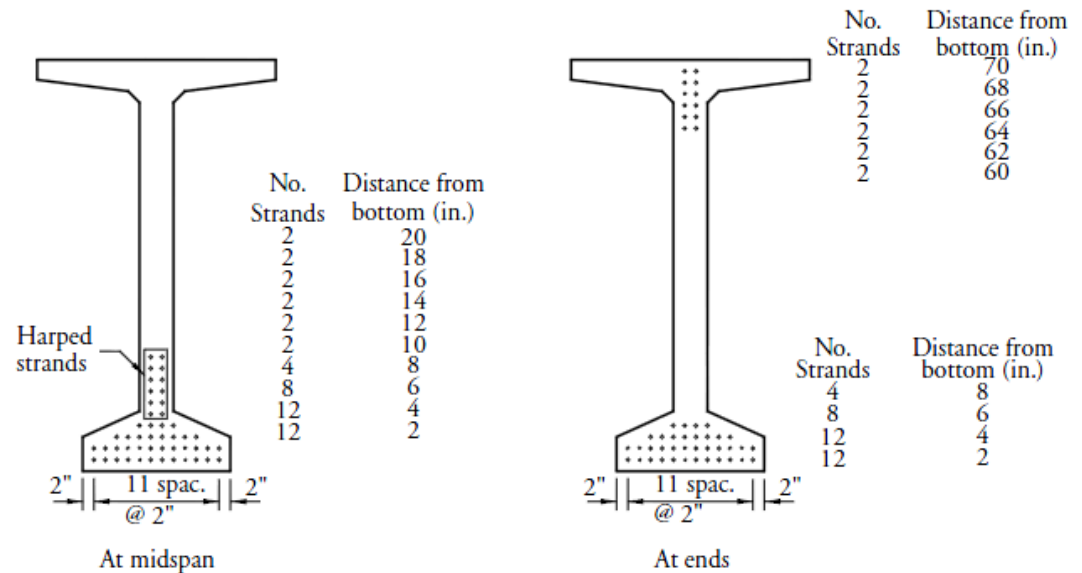


Dimensions

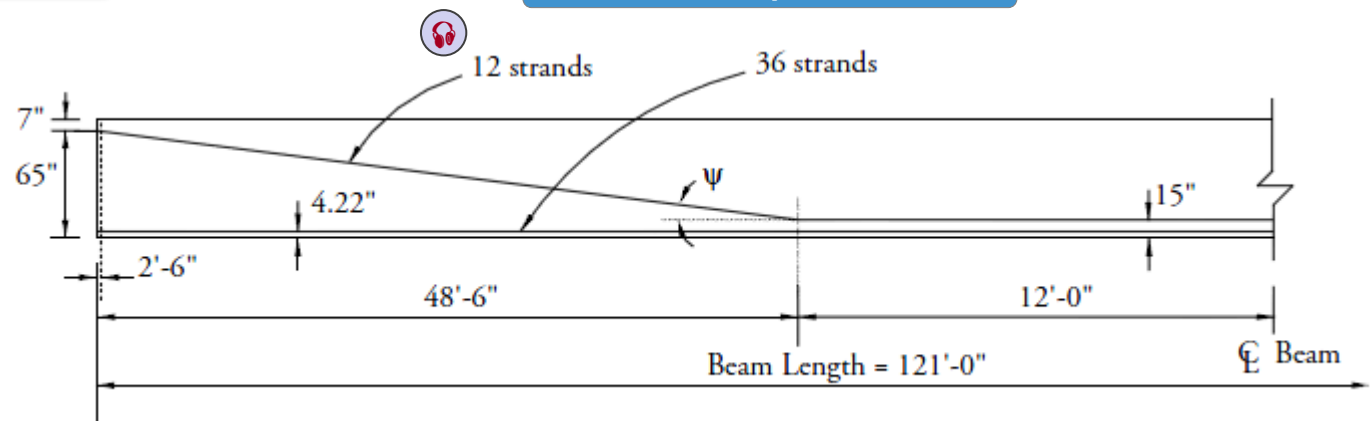
## Strand data

- Area of one strand: 0.153 in<sup>2</sup>
- Ultimate strength ( $f_{pu}$ ): 270.0 ksi
- Yield strength ( $f_{py}$ ): 243.0 ksi

🔊 In this example, 12 harped strands and 36 straight strands will be represented by an equivalent strand separately.




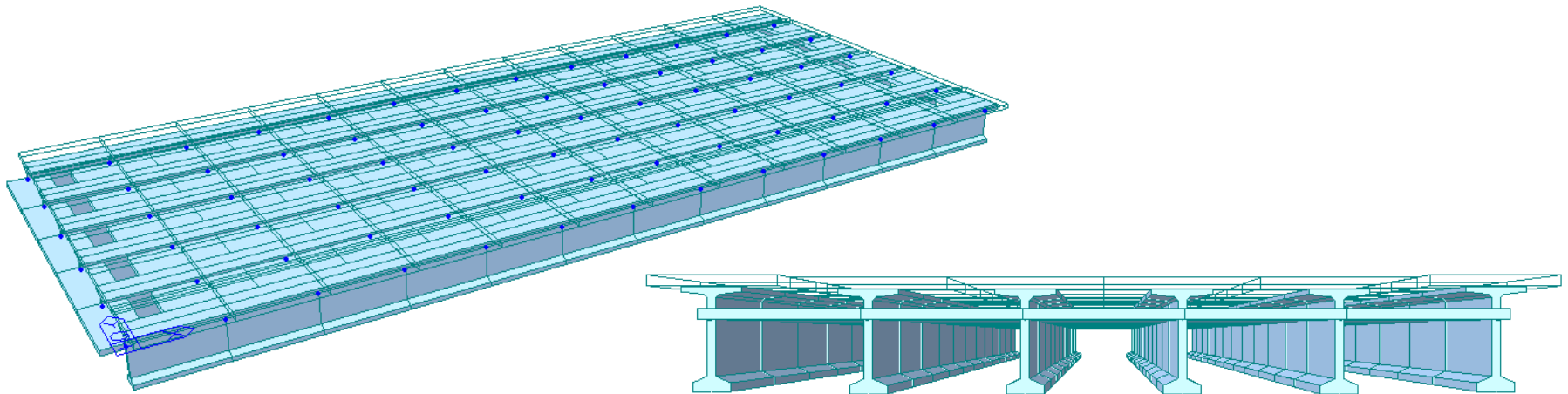
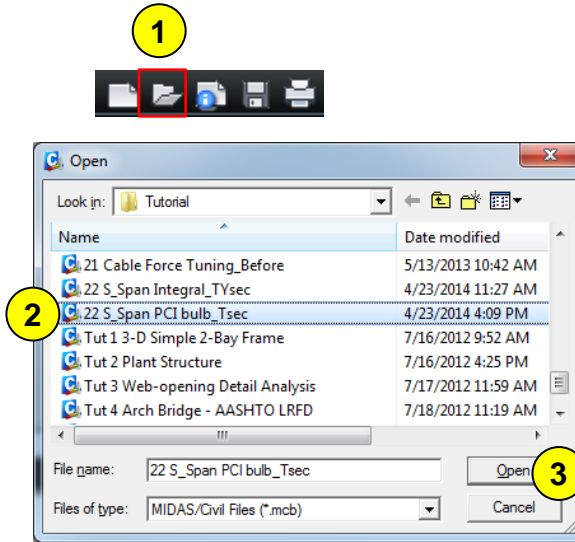
## Strand pattern



## Longitudinal strand profile

## Open

1. Click .
2. Select **[22 S\_Span PCI bulb\_Tsec.mcb]**.
3. Click the **[Open]** button.



## Composite-I section type

These sections are already defined in the model file.

**Section Data**

DB/User **Composite**

Section ID  Name

Section Type: **Composite-I**

Slab Width  in

Girder : Num  CTC  in

Slab

Bc	<input type="text" value="108"/> in
tc	<input type="text" value="7.5"/> in
Hh	<input type="text" value="0.5"/> in

Girder

Size-I	Import...
H1	72.000 in
HL1	3.500 in
HL2	4.000 in
HL2-1	2.000 in
HL3	54.000 in
HL4	4.500 in
HL5	6.000 in

Material

Select Material from DB ...

Egd/Esb  Dgd/Dsb

Pgd  Psb

☐ Multiple Modulus of Elasticity

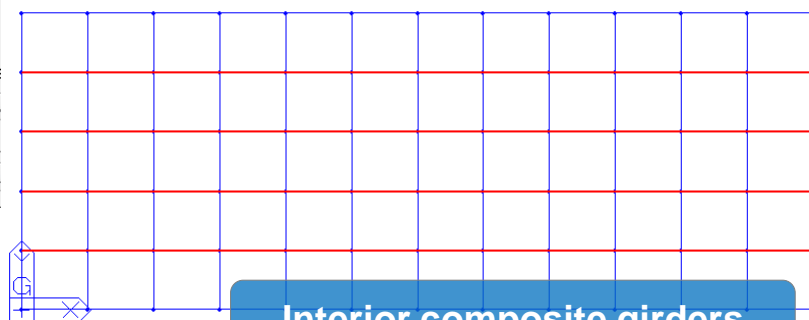
Display Centroid

☐ FEM ☐ Equation

Offset : Center-Ce

Change Offset ...

Show Calculation R



Interior composite girders

**Section Data**

DB/User **Composite**

Section ID  Name

Section Type: **Composite-I**

Slab Width  in

Girder : Num  CTC  in

Slab

Bc	<input type="text" value="90"/> in
tc	<input type="text" value="7.5"/> in
Hh	<input type="text" value="0.5"/> in

Girder

Size-I	Import...
H1	72.000 in
HL1	3.500 in
HL2	4.000 in
HL2-1	2.000 in
HL3	54.000 in
HL4	4.500 in
HL5	6.000 in

Material

Select Material from DB ...

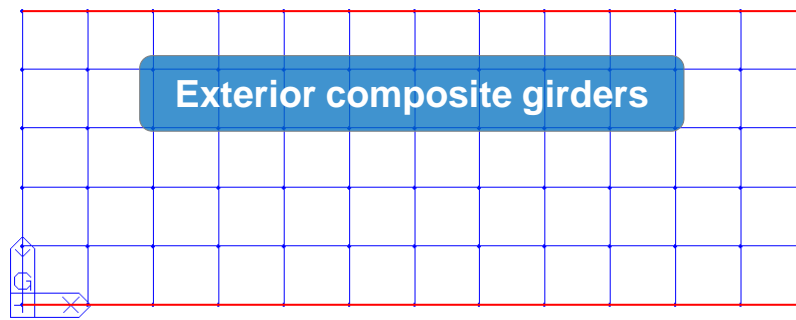
Egd/Esb  Dgd/Dsb

Pgd  Psb

☐ Multiple Modulus of Elasticity

Display Centroid


☐ FEM ☐ Equation




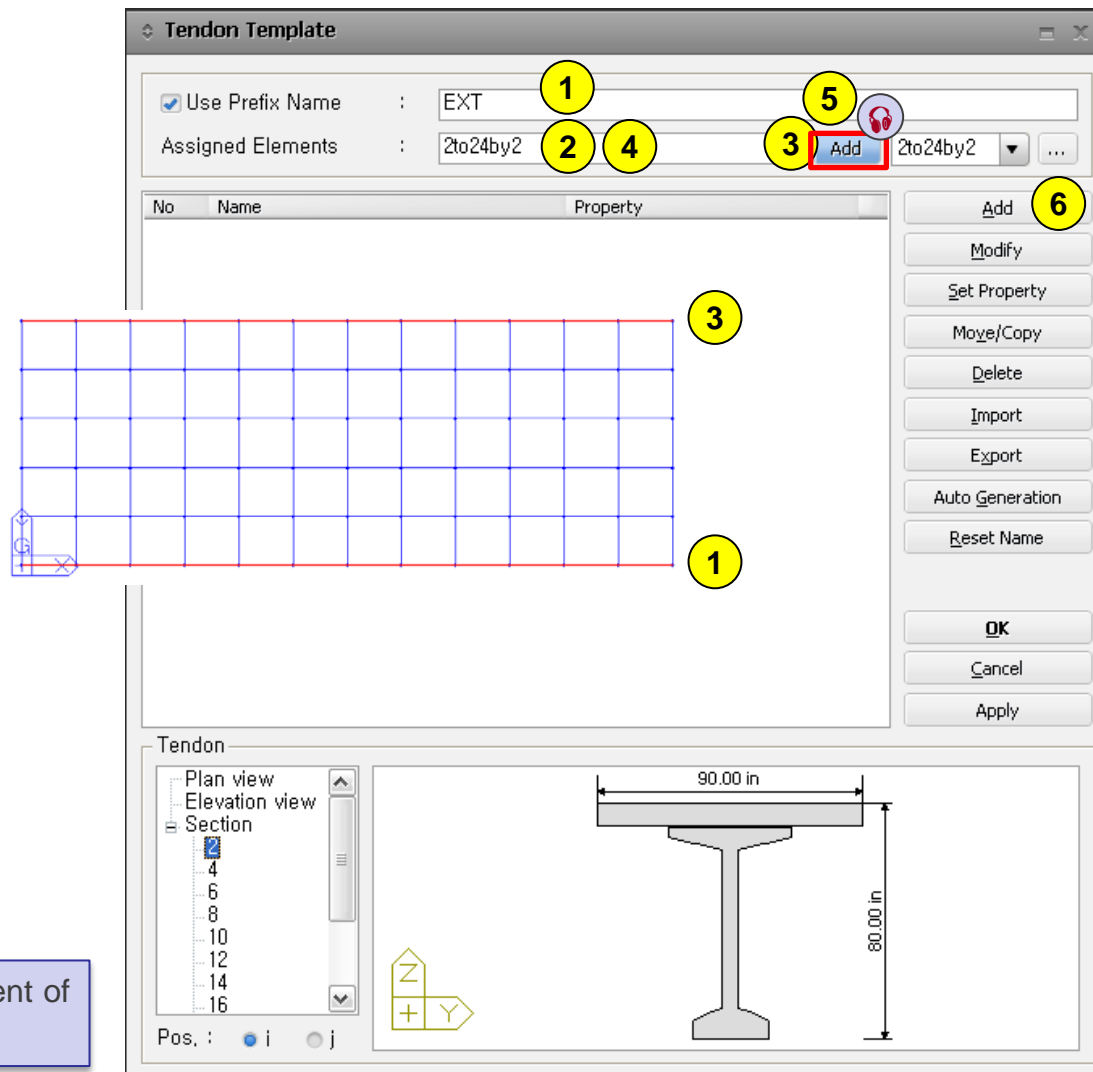
Exterior composite girders

## Define Tendon Template

**Structure > Wizard > PSC Bridge > Tendon Template...**

1. [Use Prefix Name]: EXT
2. Assigned Elements: [1to23by20]
3. Click the [Add] button.
4. Assigned Elements: [2to24by20]
5. Click the [Add] button. 
6. Click the [Add] button.

 This is useful when assigning identical arrangement of strands to many girders.



## Define Tendon Template

1. Group: **[Tendon1]**
2. Tendon Property: **[TH]**
3. Plan(xy), Tendon Type: **[Straight]**
4. Begin t: **[45]**, End t: **[45]**
5. Elevation(xz), Tendon Type: **[Harped 2]**
6. Begin t: **[15]**, h1: **[576]**, b1: **[15]**, h2: **[576]**, b2: **[15]**, End t': **[15]**
7. Reference Axis: **[Element]**
8. Click the **[OK]** button.
9. Click the **[Add]** button.

**Add/Modify Tendon Template**

Tendon Name : EXT\_001 Group : Tendon1

Tendon Property : TH

Horiz. Offset(begin) : 0,0000 in ☒ Same span Length

Horiz. Offset(End) : 0,0000 in

Plan(xy)

Tendon Type : Straight

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

(in)	Begin	End
span	t	t'
1	45	45

Elevation(xz)

Tendon Type : Harped 2

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

(in)	Begin	Middle				End
span	t	h1	b1	h2	b2	t'
1	15	576	15	576	15	15

Reference Axis : ☐ Curve ☒ Element

OK Cancel

**Tendon Template**

☒ Use Prefix Name : EXT

Assigned Elements : 2to24by2 Add 2to24by2

No	Name	Property
1	EXT_001	TH

Add Modify Set Prop

**Tendon Input Guide**

Tendon Profile in the Elements

Horiz. Offset(begin) Horiz. Offset(end)

Tendon Profile per Span

t t'


b1 b2

h1 h2

1: Tendon Input Guide is displayed when entering data.

2: It is a harped strand for exterior girder.

## Define Tendon Template

1. Group: **[Tendon3]**
2. Tendon Property: **[TS]**
3. Plan(xy), Tendon Type: **[Straight]**
4. Begin t: **[45]**, End t': **[45]**
5. Elevation(xz), Tendon Type: **[Straight]**
6. Begin t: **[75.78]**, End t': **[75.78]** 
7. Reference Axis: **[Element]**
8. Click the **[OK]** button.

 It is a straight strand for exterior girder

**Add/Modify Tendon Template**

Tendon Name : EXT\_002 Group : Tendon3

Tendon Property : TS

Horiz. Offset(begin) : 0.0000 in ☒ Same span Length

Horiz. Offset(End) : 0.0000 in

Plan(xy)

Tendon Type : Straight

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

(in)	Begin	End
span	t	t'
1	45	45

Elevation(xz)

Tendon Type : Straight

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

(in)	Begin	End
span	t	t'
1	75.78	75.78

Reference Axis : ☐ Curve ☒ Element

OK Cancel

**Tendon Input Guide**

Tendon Profile in the Elements

Horiz. Offset(begin) Horiz. Offset(end)

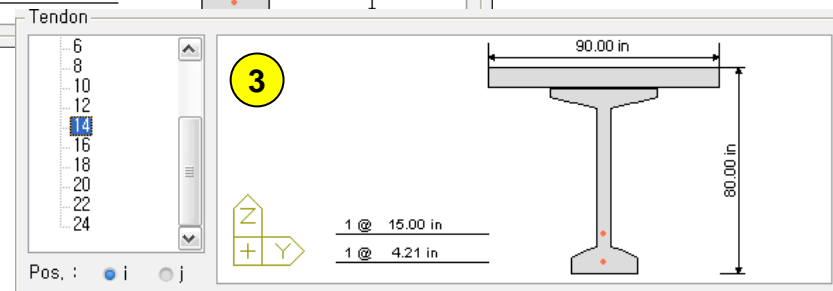
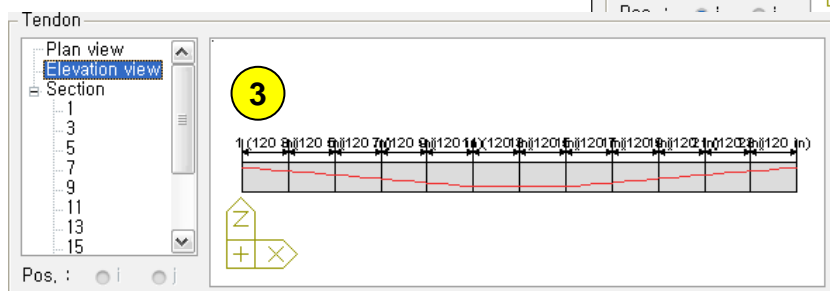
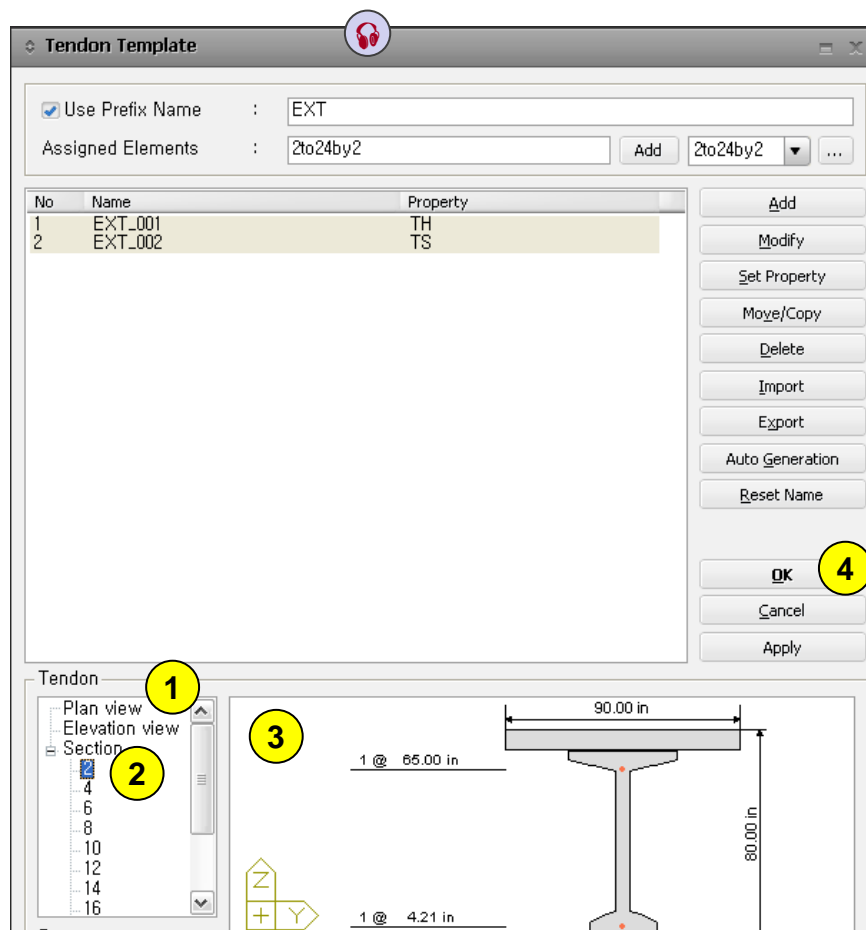
Tendon Profile per Span

t t

## Define Tendon Template

1. Tendon > Plan view, Elevation view
2. Tendon > Section > 2, 8, 14
3. Check strand arrangement.
4. Click the [OK] button.

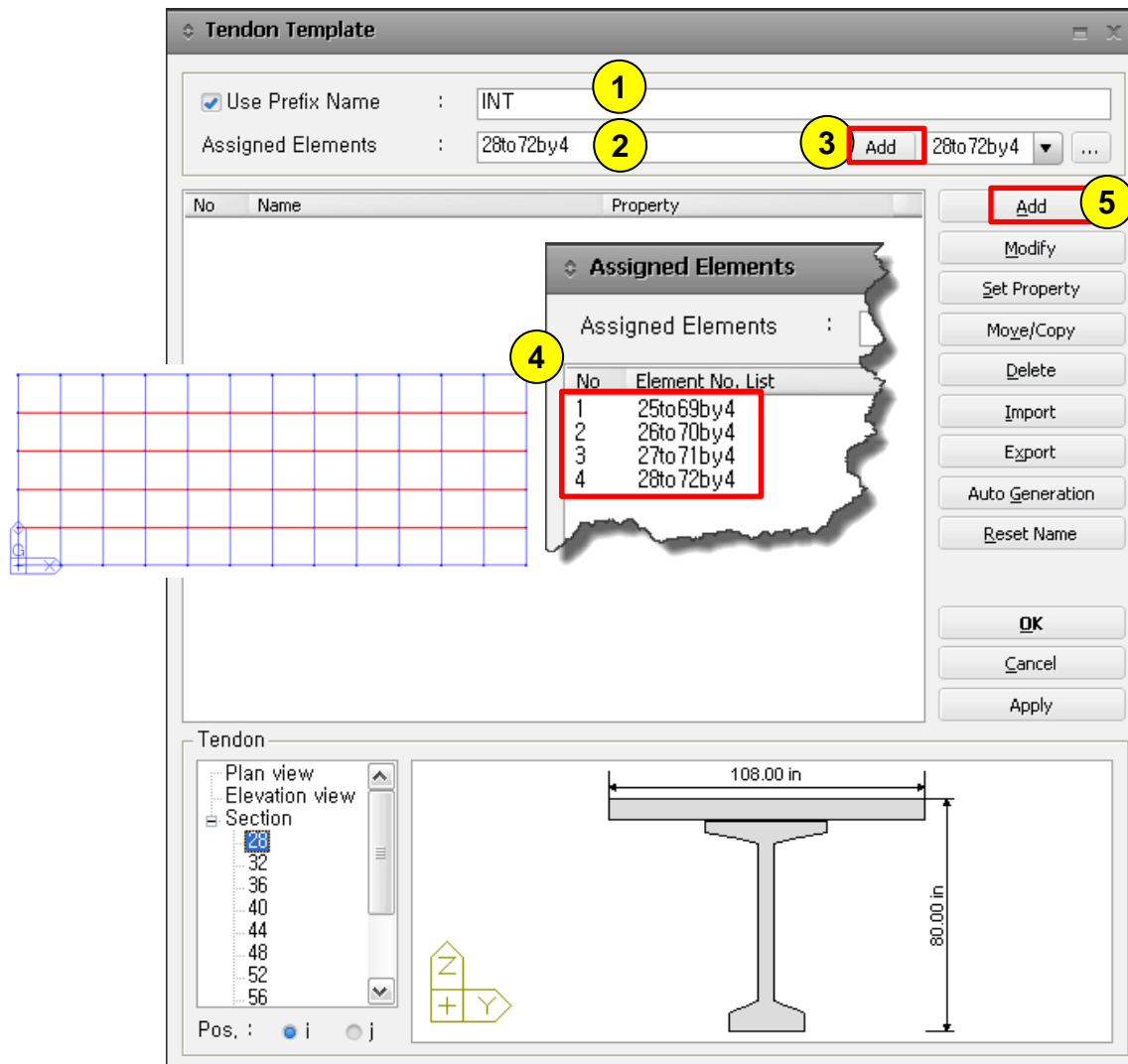
🔊 The size of dialog box can be increased by double-clicking.



## Define Tendon Template

**Structure > Wizard > PSC Bridge > Tendon Template...**

1. **[Use Prefix Name]**: INT
2. Assigned Elements: **[25t69by4]**
3. Click the **[Add]** button.
4. Repeat 3 times above process (2 and 3) for the remaining interior girders.
5. Click the **[Add]** button.



## Define Tendon Template

1. Group: **[Tendon2]**
2. Tendon Property: **[TH]**
3. Plan(xy), Tendon Type: **[Straight]**
4. Begin t: **[54]**, End t: **[54]**
5. Elevation(xz), Tendon Type: **[Harped 2]**
6. Begin t: **[15]**, h1: **[576]**, b1: **[15]**, h2: **[576]**, b2: **[15]**, End t': **[15]**
7. Reference Axis: **[Element]**
8. Click the **[OK]** button.
9. Click the **[Add]** button.

**Add/Modify Tendon Template**

Tendon Name : INT\_001 Group : Tendon2

Tendon Property : TH

Horiz. Offset(begin) : 0.0000 in ☒ Same span Length

Horiz. Offset(End) : 0.0000 in

Plan(xy)

Tendon Type : Straight

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

(in)	Begin	End
span	t	t'
1	54	54

Elevation(xz)

Tendon Type : Harped 2

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

(in)	Begin	Middle				End
span	t	h1	b1	h2	b2	t'
1	15	576	15	576	15	15

Reference Axis : ☐ Curve ☒ Element

**OK** **Cancel**

**Tendon Template**

☒ Use Prefix Name : INT

Assigned Elements : 28to72by4 **Add** **28to72by4** ...

No	Name	Property
1	INT_001	TH

**Add** **Modify**

## Define Tendon Template

1. Group: **[Tendon4]**
2. Tendon Property: **[TS]**
3. Plan(xy), Tendon Type: **[Straight]**
4. Begin t: **[54]**, End t': **[54]**
5. Elevation(xz), Tendon Type: **[Straight]**
6. Begin t: **[75.78]**, End t': **[75.78]**
7. Reference Axis: **[Element]**
8. Click the **[OK]** button.

**Add/Modify Tendon Template**

Tendon Name : INT\_002 Group : Tendon4

Tendon Property : TS

Horiz. Offset(begin) : 0.0000 in ☒ Same span Length

Horiz. Offset(End) : 0.0000 in

Plan(xy)

Tendon Type : Straight

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

	(in)	Begin	End
	span	t	t'
▶	1	54	54

28 (1232) 286 290 294 298 302 306 310 314 318 322 326 330 334 338 342 346 350 354 358 362 366 370 374 378 382 386 390 394 398 402 406 410 414 418 422 426 430 434 438 442 446 450 454 458 462 466 470 474 478 482 486 490 494 498 502 506 510 514 518 522 526 530 534 538 542 546 550 554 558 562 566 570 574 578 582 586 590 594 598 602 606 610 614 618 622 626 630 634 638 642 646 650 654 658 662 666 670 674 678 682 686 690 694 698 702 706 710 714 718 722 726 730 734 738 742 746 750 754 758 762 766 770 774 778 782 786 790 794 798 802 806 810 814 818 822 826 830 834 838 842 846 850 854 858 862 866 870 874 878 882 886 890 894 898 902 906 910 914 918 922 926 930 934 938 942 946 950 954 958 962 966 970 974 978 982 986 990 994 998 1000 (in)

Elevation(xz)

Tendon Type : Straight

Num. Of Span : 1 ☒ Same span Info

Span Length : 1440 ☐ Invert Profile

	(in)	Begin	End
	span	t	t'
▶	1	75.78	75.78

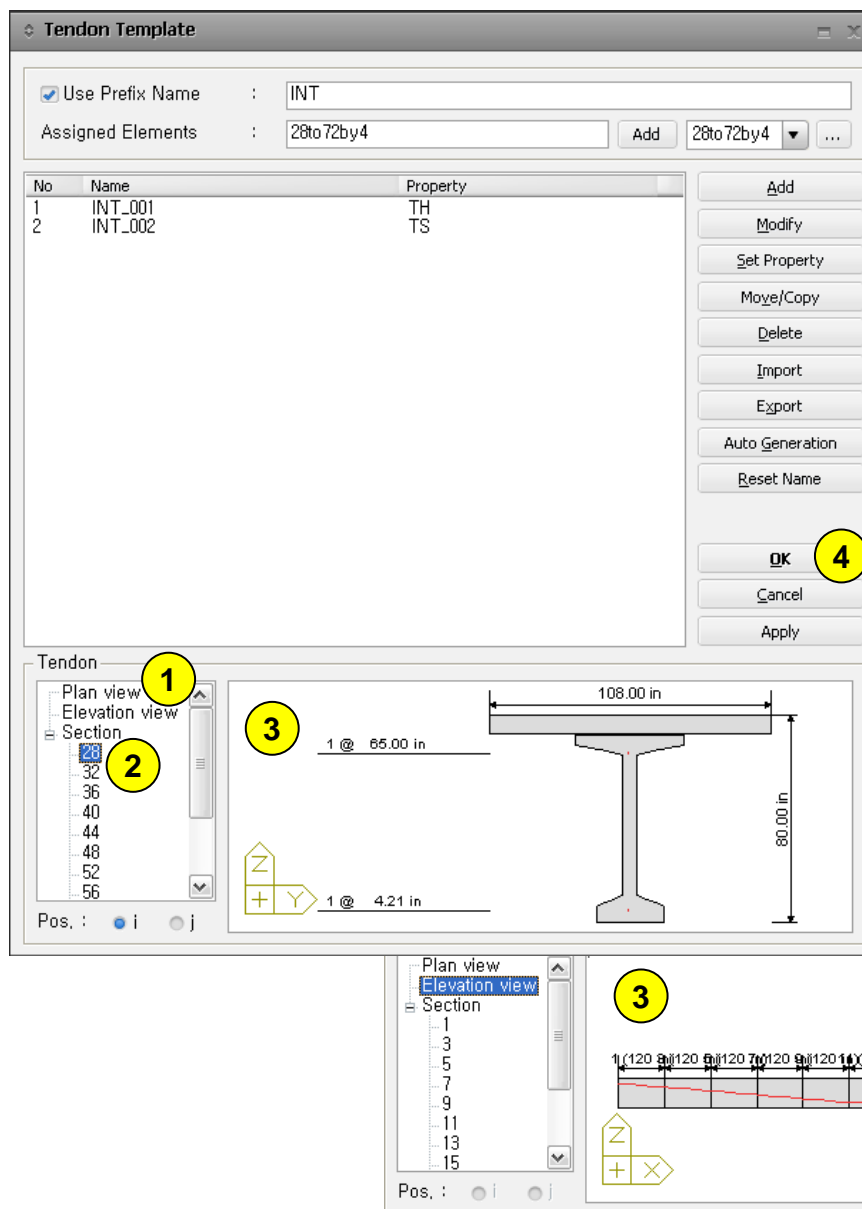
28 (1232) 286 290 294 298 302 306 310 314 318 322 326 330 334 338 342 346 350 354 358 362 366 370 374 378 382 386 390 394 398 402 406 410 414 418 422 426 430 434 438 442 446 450 454 458 462 466 470 474 478 482 486 490 494 498 502 506 510 514 518 522 526 530 534 538 542 546 550 554 558 562 566 570 574 578 582 586 590 594 598 602 606 610 614 618 622 626 630 634 638 642 646 650 654 658 662 666 670 674 678 682 686 690 694 698 702 706 710 714 718 722 726 730 734 738 742 746 750 754 758 762 766 770 774 778 782 786 790 794 798 802 806 810 814 818 822 826 830 834 838 842 846 850 854 858 862 866 870 874 878 882 886 890 894 898 902 906 910 914 918 922 926 930 934 938 942 946 950 954 958 962 966 970 974 978 982 986 990 994 998 1000 (in)

Reference Axis : ☐ Curve ☒ Element

OK Cancel

## Define Tendon Template

1. Tendon > Plan view, Elevation view
2. Tendon > Section > 28, 40, 52
3. Check strand arrangement.
4. Click the [OK] button.



## Check Tendon Profile

1. Select Tendon Profile in Works Tree.
2. Right-click on the mouse and select **[Display]** to view strand profiles.

