

# MIDAS WEBINAR ON

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PEDESTRIAN STEEL COMPOSITE BRIDGE &  
DYNAMIC ANALYSIS PEDESTRIAN BRIDGES

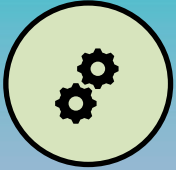
# CONTENTS

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## Introduction

- Steel Composite bridge
- Eurocode consideration in Midas Civil



## Modelling

- Load Application (Static, Moving, Dynamic, Thermal)



## Analysis & Result

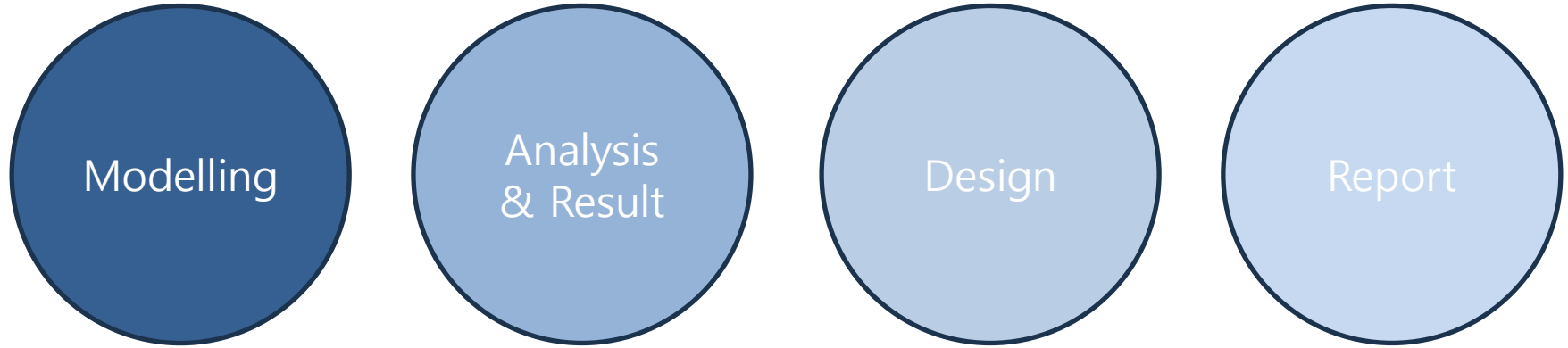
- Deformation
- Forces and Moment



## Design & Dynamic Analysis of Pedestrian Bridge

# 1.1 Introduction

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- **Wizard**
- **Manual Modelling**
- **Drawing Import**

- **Static Load**
- **Moving Load**
- **Thermal Load**
- **Dynamic Load**

- **ULS check**
- **SLS check**

- **Auto-generate design report**

# 1.2 Material and Section Properties

**Material Data**

General  
Material ID: 1 Name: S355

Elasticity Data  
Type of Design: Steel

Steel  
Standard: EN05(S)  
DB: S355

Concrete  
Standard: S420N/NL  
Code: S460N/NL  
DB: S275M/ML

Type of Material  
☒ Isotropic ☐ Orthotropic

Steel  
Modulus of Elasticity: 2.1000e+08 kN/m<sup>2</sup>  
Poisson's Ratio: 0.3  
Thermal Coefficient: 6.6667e-06 1/[F]  
Weight Density: 76.98 kN/m<sup>3</sup>  
☐ Use Mass Density: 7.85 kN/m<sup>3</sup>/g

Concrete  
Modulus of Elasticity: 0.0000e+00 kN/m<sup>2</sup>  
Poisson's Ratio: 0  
Thermal Coefficient: 0.0000e+00 1/[F]  
Weight Density: 0 kN/m<sup>3</sup>  
☐ Use Mass Density: 0 kN/m<sup>3</sup>/g

Steel material specific to EN Standard

**Material Data**

General  
Material ID: 2 Name: C50/60

Elasticity Data  
Type of Design: Concrete

Steel  
Standard:   
DB:

Concrete  
Standard: EN04(RC)  
Code:   
DB: C50/60

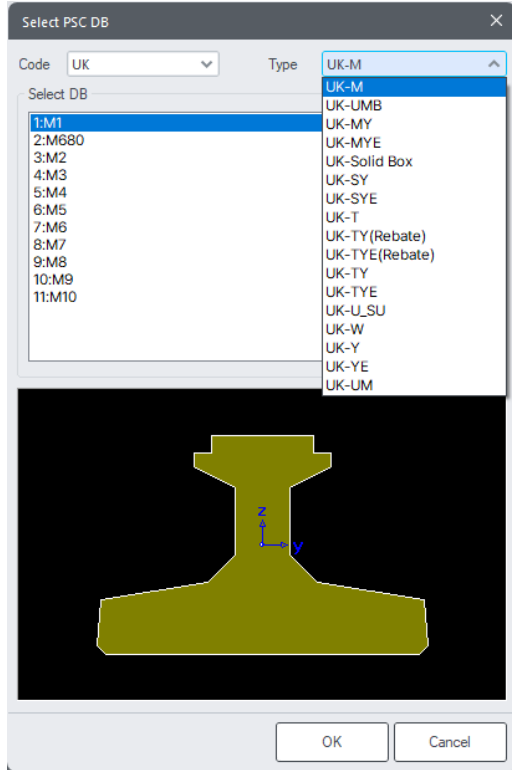
Type of Material  
☒ Isotropic ☐ Orthotropic

Steel  
Modulus of Elasticity: 0.0000e+00 kN/m<sup>2</sup>  
Poisson's Ratio: 0  
Thermal Coefficient: 0.0000e+00 1/[F]  
Weight Density: 0 kN/m<sup>3</sup>  
☐ Use Mass Density: 0 kN/m<sup>3</sup>/g

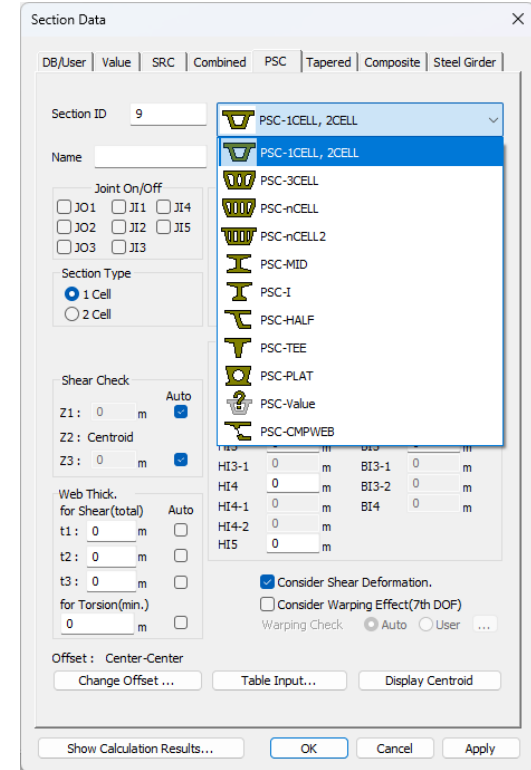
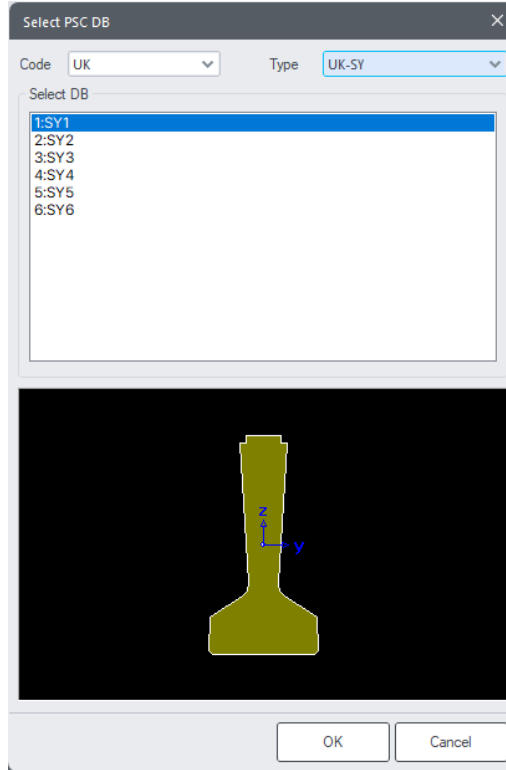
Concrete  
Modulus of Elasticity: 3.7277e+07 kN/m<sup>2</sup>  
Poisson's Ratio: 0.2  
Thermal Coefficient: 5.5556e-06 1/[F]  
Weight Density: 25 kN/m<sup>3</sup>  
☐ Use Mass Density: 2.549 kN/m<sup>3</sup>/g

RC material for EN Standard

# 1.2 Material and Section Properties



EN- Standard Section



And much more...

# 1.2 Material and Section Properties

Add/Modify Time Dependent Material (Creep / Shrinkage)

Name:  Code:

European

Characteristic compressive cylinder strength of concrete at the age of 28 days ( $f_{ck}$ ):  kN/m<sup>2</sup>

Relative Humidity of ambient environment (40 - 99):  %

Notional size of member:  m

$h = 2 \cdot A_c / u$  ( $A_c$ : Section Area,  $u$ : Perimeter in contact with atmosphere)

Type of cement

☐ Class S ☒ Class N ☐ Class R

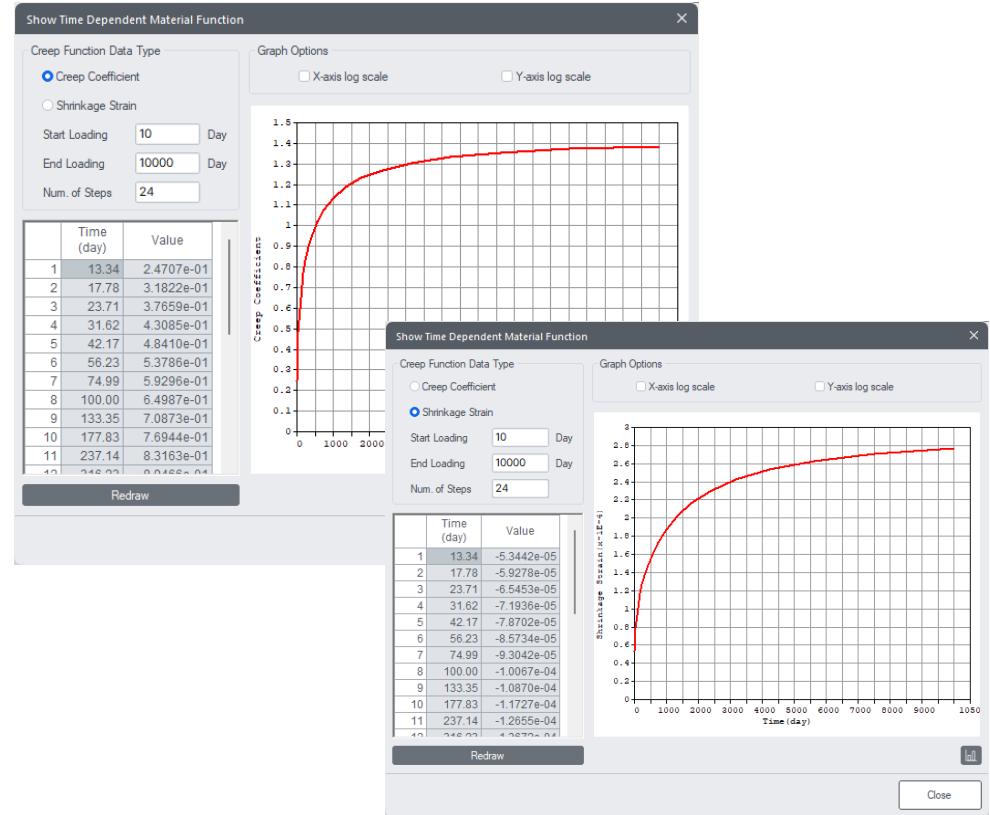
Type of code

☐ EN 1992-1 (General Structure) ☒ EN 1992-2 (Concrete Bridge) ☐ Use of silica-fume

Age of concrete at the beginning of shrinkage:  day

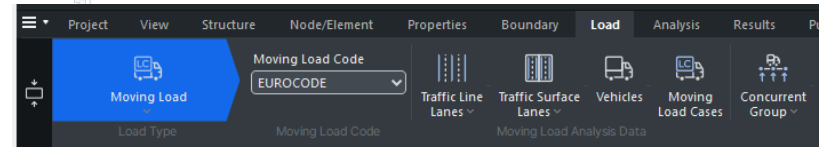
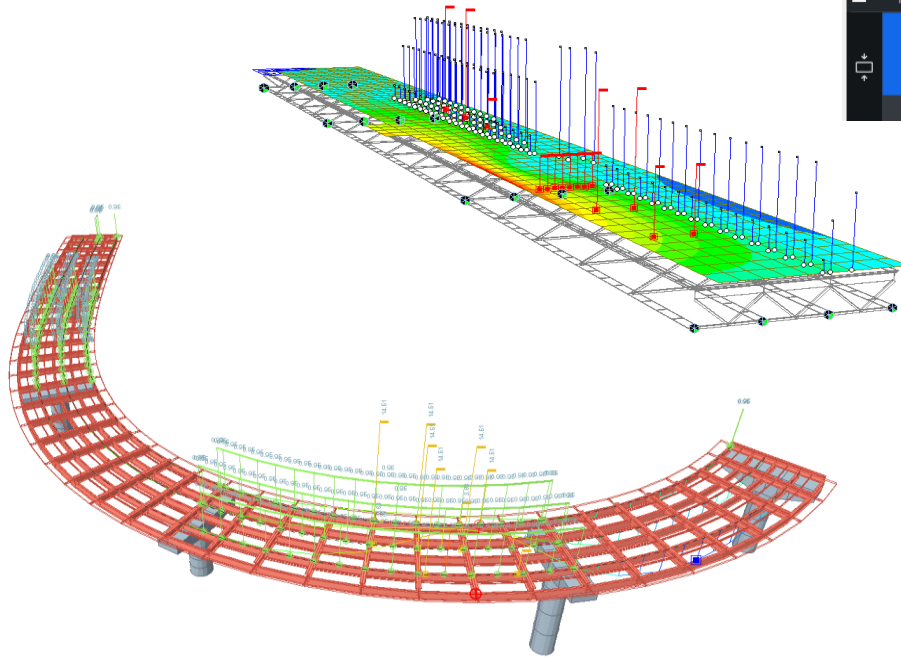
Show Result... OK Cancel Apply

Creep & Shrinkage input based on EN Code



Autogenerated creep & shrinkage curves

# 1.3 Loading (Moving Load)



Define Standard Vehicular Load

Standard Name  
EN 1991-2:2003 - RoadBridge

Vehicular Load Properties  
Vehicular Load Name  
Vehicular Load Type

Load Model 1  
Load Model 1  
Load Model 2  
Load Model 3  
Load Model 3 (UK NA)  
Load Model 4

$\sigma_{01} Q_{ik}$   $\sigma_{01} Q_{ik}$

1.2m

$\sigma_{01} Q_{ik}$  : Tandem System,  $Q_{ik}$   
 $\sigma_{01} Q_{ik}$  : UDL System,  $q_{ik}$

Dynamic amplification factor included

Location	Tandem System		UDL System	
	Adjustment Factor	Axle Loads (kN)	Adjustment Factor	Uniformly Dist. Loads (kN/m²)
Lane Number1	1	300	1	9
Lane Number2	1	200	1	2.5
Lane Number3	1	100	1	2.5
Other Lanes & Remaining Area	0	0	1	2.5

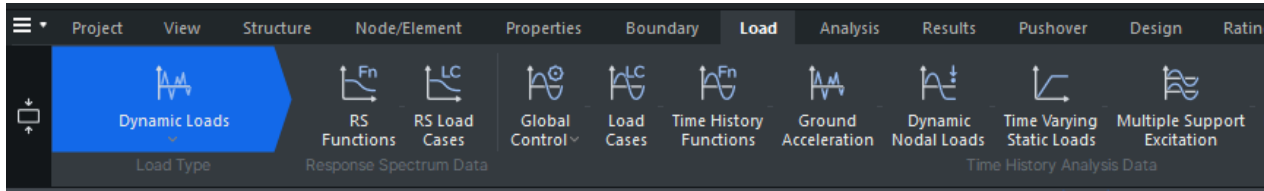
$\psi$  factor for Tandem System 0.75  
 $\psi$  factor for UDL System 0.4

OK Cancel Apply

Influence line based moving load analysis

Standard vehicles for EN Code

# 1.4 Loading (Response Spectrum)



**Generate Design Spectrum**

Design Spectrum: Eurocode-8(2004)  
National Annex: Recommended

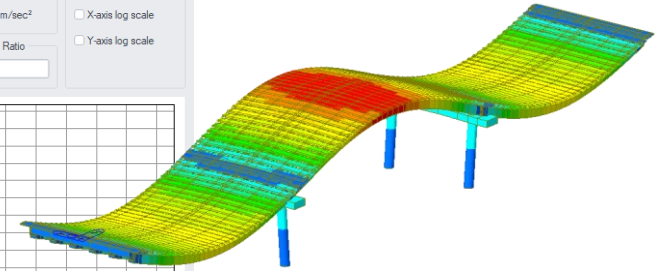
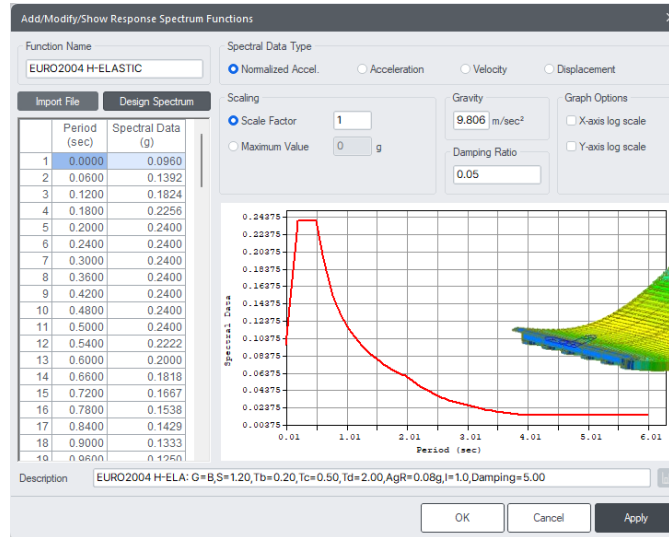
Spectrum Type: Horizontal Elastic Spectrum  
Ground Type: B

Spectrum Parameters  
☒ Type1 ☐ Type2 ☐ User Defined  
Soil Factor (S): 1.2 Tb: 0.2 Tc: 0.5 Td: 2

Ref. Peak Ground Acc. (AgR): 0.08 g  
Importance Factor (I): 1  
Viscous Damping Ratio (xi): 5 %

Max. Period: 6 (Sec)

OK Cancel

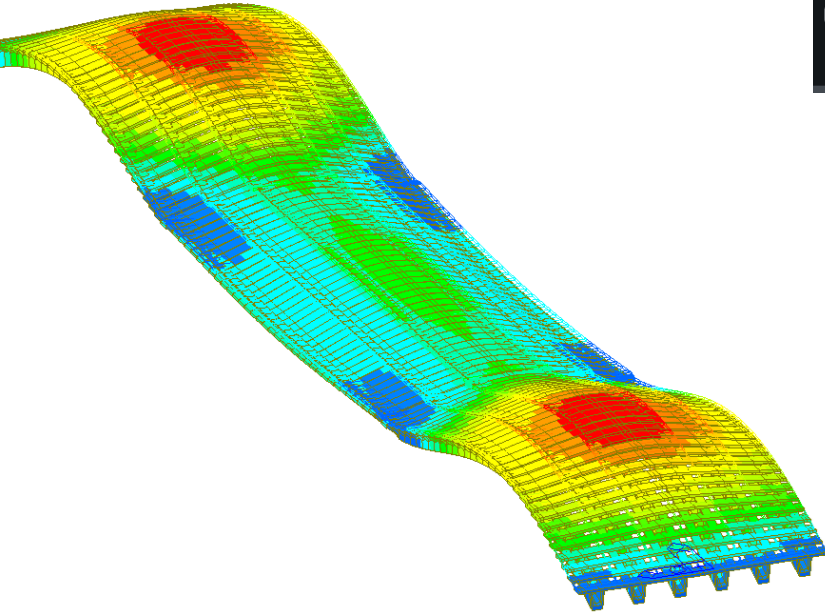


Response spectrum input based on Eurocode

Generated RS curve



# 1.5 Loading (Temperature Gradient)



Software interface showing the 'Load' tab and the 'Define Code Provision' dialog box.

**Load Tab Options:**

- Temperature (selected)
- Element Temp.
- Temp. Gradient
- Beam Section Temp.
- Plate Thickness Temp.
- System Temp.
- Nodal Temp.
- Temp. Loads

**Define Code Provision Dialog:**

Define Code: EUROCODE  
Section Type: Steel Composite

Temperature Gradient:  
☒ Heating ☐ Cooling

Procedure:  
☒ Normal ☐ Simplified

T1: 13 [T] T2: 4 [T]

h: ☒ Auto ☐ User 0.2 m  
h1: ☒ Auto ☐ User 0.12 m  
h2: ☒ Auto ☐ User 0.4 m

Diagram illustrating the temperature gradient input based on Eurocode. The diagram shows a cross-section of a structure with depth  $h$ . The temperature gradient is defined by two points:  $\Delta T1$  at height  $h1$  and  $\Delta T2$  at height  $h2$ . The diagram also indicates the relationship  $h1 = 0.6h$  and  $h2 = 0.4m$ .

h	$\Delta T1$	$\Delta T2$
m	°C	°C
0.2	13	4
0.3	16	4

Temperature gradient input based on Eurocode

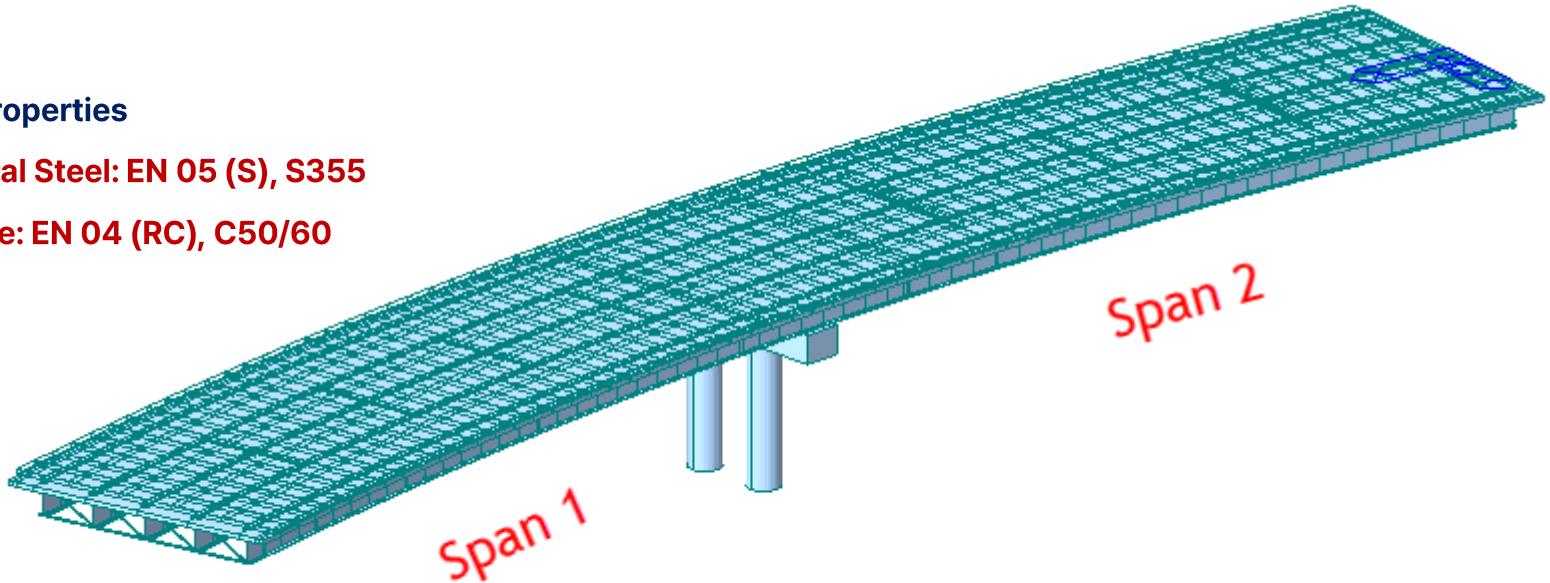
## 2. Specification of Bridge

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- Bridge Type: 2-Span steel composite I girder curved bridge
- Number of main girders: 5
- Curvature Radius: 250'

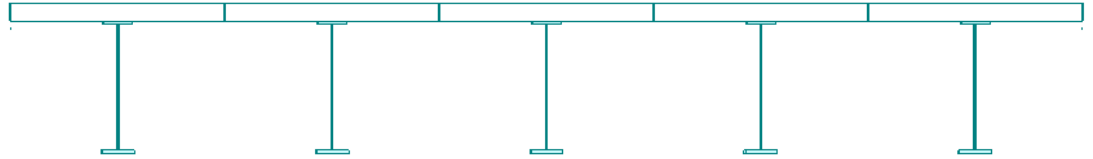
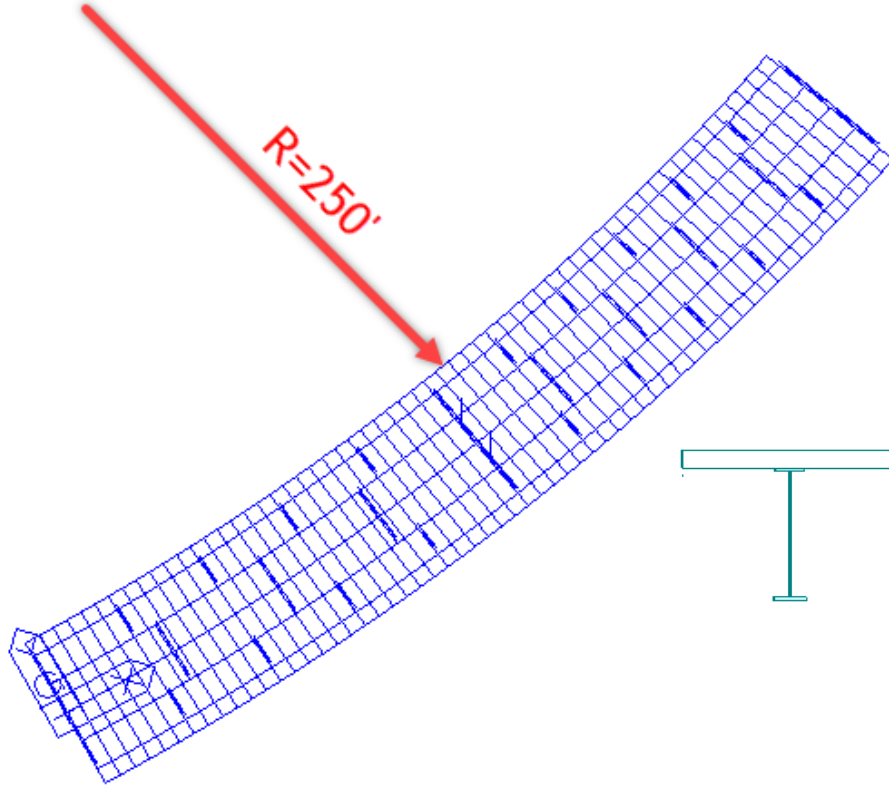
### Material Properties

- Structural Steel: EN 05 (S), S355
- Concrete: EN 04 (RC), C50/60



## 2. Specification of Bridge

---



C/C distance between girder 3m

**Jump into!!**



# CONTENTS

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## Introduction

- Steel Composite bridge
- Eurocode consideration in Midas Civil



## Modelling

- Load Application (Static, Moving, Dynamic, Thermal)



## Analysis & Result

- Deformation
- Forces and Moment



## Design & Dynamic Analysis of Pedestrian Bridge

# 3. Steel Composite Design as per EN 1994-2

Composite Steel Girder Design Code

Code: EN 1994-2 NA Recommended Update by Code

Partial Factor

Concrete(Gamma\_C) 1.5

Reinforcing Steel(Gamma\_S) 1.15

Structural Steel(Gamma\_M0) 1

Structural Steel(Gamma\_M1) 1.1

Shear Resistance of a Headed Stud(Gamma\_V) 1.25

Equivalent Constant Amplitude Stress Range(Gamma\_FF) 1

Fatigue Strength(Gamma\_Mf) 1

Fatigue Strength of Studs in Shear(Gamma\_Mf,s) 1

Stress in Structural Steel(Gamma\_M\_ser) 1

Damage equivalence factors(for Resistance to fatigue)

Design life of the bridge in year(t\_Ld) 100

Stress Limitation

k1 0.6 k2 0.45 k3 0.8

Shear Resistance Reduction Factor of Stud Connector (for SLS)

k\_s 0.75

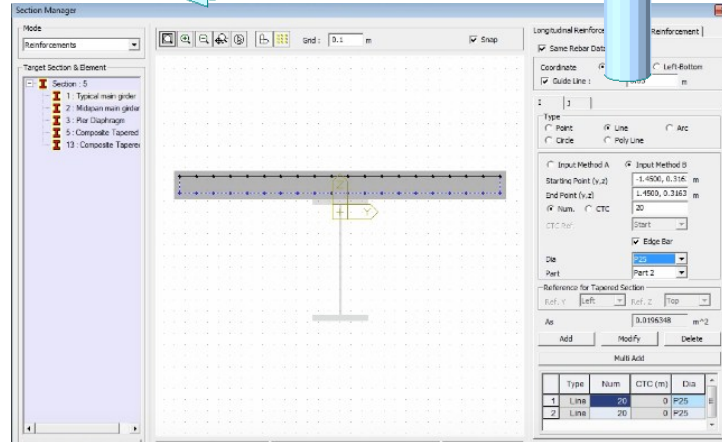
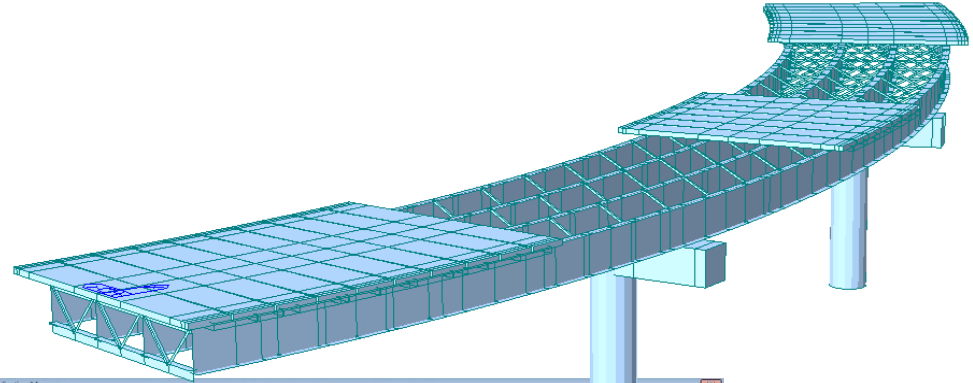
Ultimate Limit States

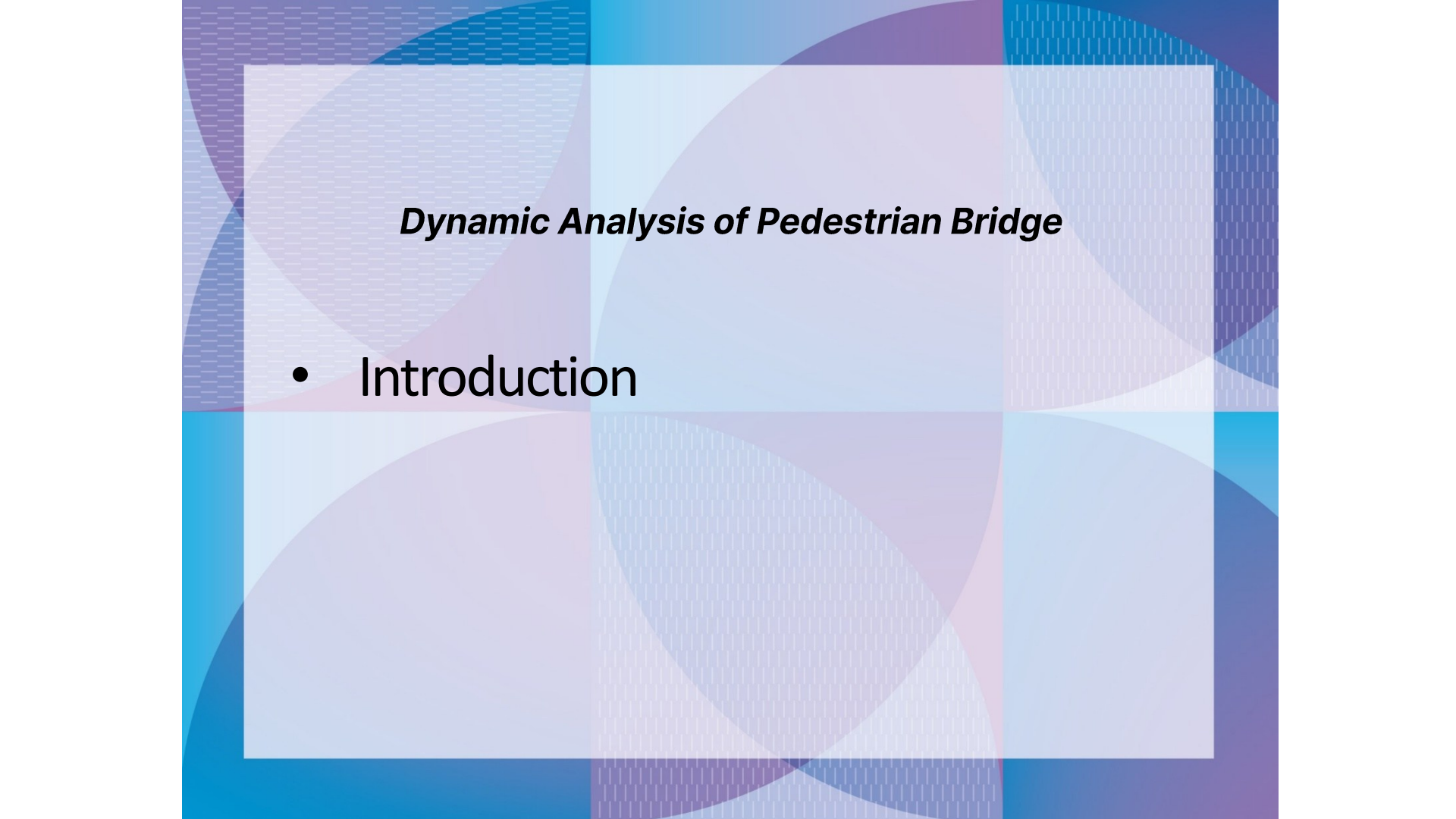
- ☒ Bending Resistance
- ☒ Resistance to Vertical Shear
- ☒ Resistance to Lateral-torsional Buckling
- ☒ Resistance to Transverse force
- ☒ Resistance to Longitudinal Shear
- ☒ Resistance to Fatigue

Serviceability Limit State

- ☒ Stress Limitaion
- ☒ Longitudinal Shear (SLS)

OK Cancel



The background of the slide is a complex abstract design. It features a grid of squares, some of which are filled with a fine, repeating pattern of small, horizontal, slightly wavy lines. Overlaid on this grid are several large, overlapping circles in various shades of blue, purple, and pink. The circles are semi-transparent, creating a layered effect. The overall color palette is cool, dominated by blues and purples, with some warmer pink tones. The text is centered within a white rectangular area that also has a subtle grid pattern.

## ***Dynamic Analysis of Pedestrian Bridge***

- Introduction



# Introduction

---

- **Pedestrian Bridge** are more sensitive to dynamic load generated by moving pedestrian.
- **Walking, running** and **jumping** on footbridges produce dynamic forces which can activate appreciable vibration.
- Vibration can cause **discomfort** to pedestrians.
- Excess vibration can cause deterioration of the footbridge's structure integrity.



- 
- The background features a complex geometric design. It consists of several large, overlapping circles in various shades of blue and purple. A grid of small, light blue squares is overlaid on these circles, creating a textured effect. The overall composition is symmetrical and modern.
- Bridge Layout

# Modelling Data

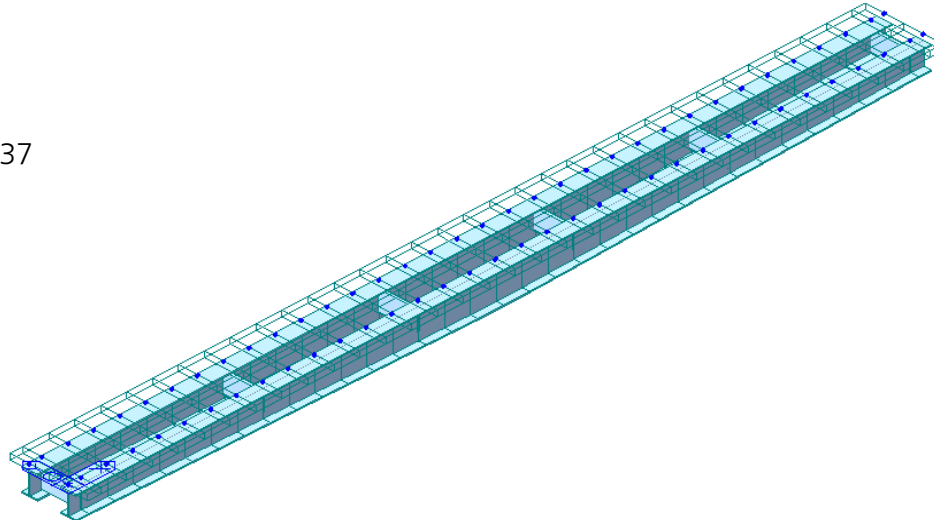
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## Geometric Details

- Bridge Type: Single Span Simply Supported Composite Steel I Girder Bridge
- Span length 33m with 2 main girder

## Material Details

- Girder: S355
- Substructure: C30/37



# Bridge Cross Section

Section ID  Name

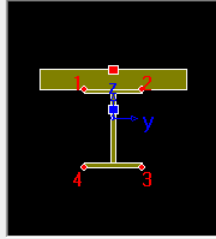
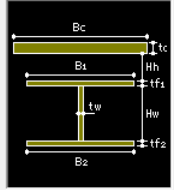
Section Type :

**Slab**

Bc	<input type="text" value="1500"/>	mm
tc	<input type="text" value="200"/>	mm
Hh	<input type="text" value="0"/>	mm

**Girder**

Hw	<input type="text" value="720"/>	tw	<input type="text" value="40"/>	mm
B1	<input type="text" value="600"/>	B2	<input type="text" value="600"/>	mm
Bf1	<input type="text" value="0"/>	Bf2	<input type="text" value="0"/>	mm
tf1	<input type="text" value="40"/>	tf2	<input type="text" value="40"/>	mm
Bf3	<input type="text" value="0"/>	tfp	<input type="text" value="0"/>	mm



Near Support

Section ID  Name

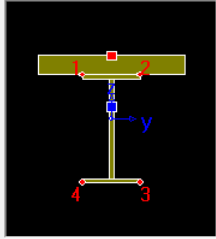
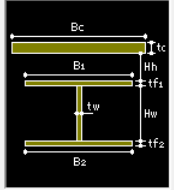
Section Type :

**Slab**

Bc	<input type="text" value="1500"/>	mm
tc	<input type="text" value="200"/>	mm
Hh	<input type="text" value="0"/>	mm

**Girder**

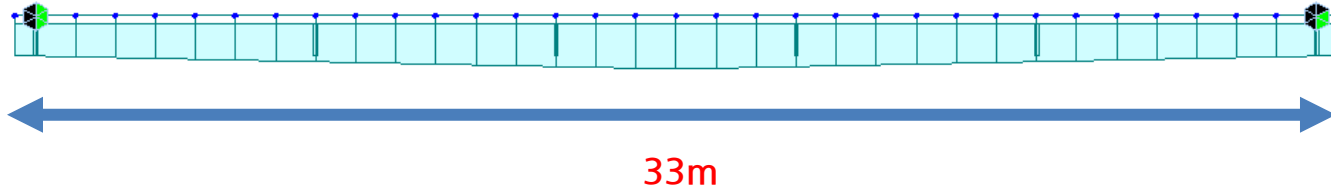
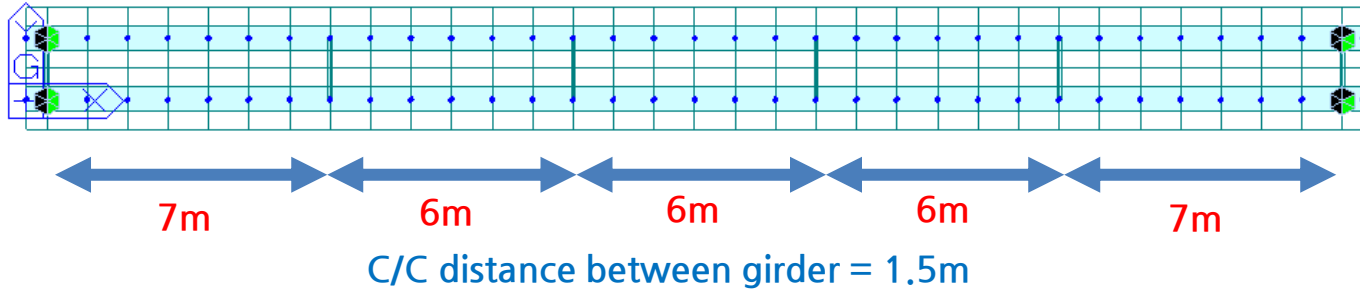
Hw	<input type="text" value="1020"/>	tw	<input type="text" value="40"/>	mm
B1	<input type="text" value="600"/>	B2	<input type="text" value="600"/>	mm
Bf1	<input type="text" value="0"/>	Bf2	<input type="text" value="0"/>	mm
tf1	<input type="text" value="40"/>	tf2	<input type="text" value="40"/>	mm
Bf3	<input type="text" value="0"/>	tfp	<input type="text" value="0"/>	mm



Near Mid Span

**Note:** All Dimensions are in mm unless mentioned otherwise

# Bridge Geometry



- Height @ Support = 1000mm
- Height @ Mid = 1300mm

- 
- The background of the slide is a complex abstract design. It features a central white square divided into four quadrants by a thin black cross. Overlaid on this are several large, semi-transparent circles in shades of blue and purple. A fine, repeating grid pattern is visible within the circular areas. The overall color palette is cool, dominated by blues and purples.
- Loadings

# Loading Details

---

## Self Weight

### Parapet

$$\begin{aligned}\rightarrow \text{Load on Each Girder} &= \text{Area} * \text{Density of Concrete} \\ &= (1 * 0.4) * 25 \\ &= 10 \text{ kN/m}\end{aligned}$$

## Services (50mm thk, density 22 kN/m<sup>3</sup>)

$$\begin{aligned}\rightarrow \text{Load on Each Girder} &= \text{Area} * \text{Density of Wearing Surface} \\ &= (0.05 * 1.5) * 22 \\ &= 1.65 \text{ kN/m}\end{aligned}$$

- 
- Modelling Steps

# Defining Material Properties

Properties

Material | Section | Thickness

ID	Name	Type	Standard	DB
1	C30/37	Concrete	EN04(RC)	C30/37
2	S355	Steel	EN05(S)	S355

Add...

Modify...

## Material

→ C30/37: EN04(RC)

→ S355: EN05(S)

Material Data

General

Material ID: 2 Name: S355

Elasticity Data

Type of Design: Steel

Steel

Standard: EN05(S)

DB: S355

Concrete

Standard:

Code:

DB:

Type of Material

☒ Isotropic ☐ Orthotropic

Steel

Modulus of Elasticity : 2.1000e+02 kN/mm<sup>2</sup>

Poisson's Ratio : 0.3

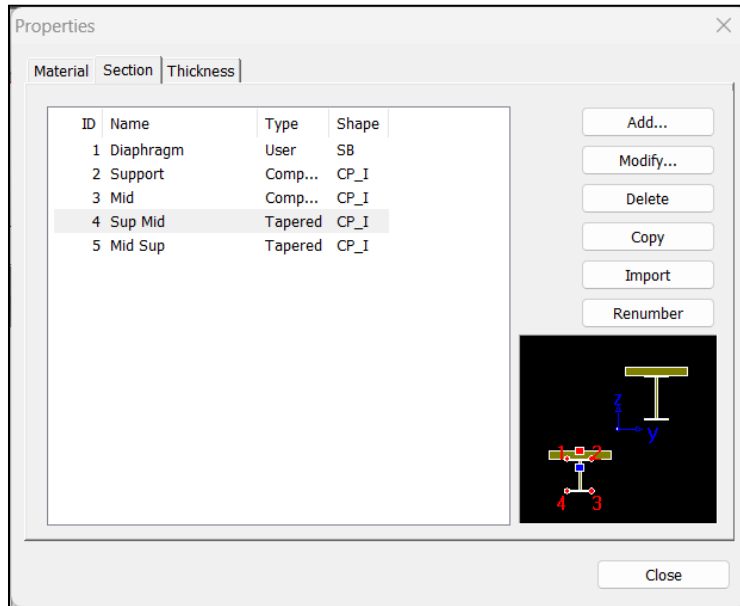
Thermal Coefficient : 1.2000e-05 1/[C]

Weight Density : 7.698e-08 kN/mm<sup>3</sup>

☐ Use Mass Density: 7.85e-12 kN/mm<sup>3</sup>/g



# Defining Section Properties



→ Diaphragm : 800 x 100 mm

→ Support Section

→ Mid Section

→ Tapered Section: Sup-Mid

→ Tapered Section: Mid-Sup

# Define Static Load Cases and Add Loads

Static Load Cases

Name : Services

Case : All Load Case

Type : Dead Load of Wearing Surfaces and Utilities (DW)

Description :

No	Name	Type	D
1	Self Weight	Dead Load (D)	
2	Parapet	Dead Load of Component and Attachments (DC)	
3	Services	Dead Load of Wearing Surfaces and Utilities (DW)	
*			

Close

## Add Static Load Case

→ Self Weight

→ Parapet

→ Services

# Define Static Load Cases and Add Loads

Static Load Cases

Name : Services

Case : All Load Case

Type : Dead Load of Wearing Surfaces and Utilities (DW)

Description :

No	Name	Type	D
1	Self Weight	Dead Load (D)	
2	Parapet	Dead Load of Component and Attachments (DC)	
3	Services	Dead Load of Wearing Surfaces and Utilities (DW)	
*			

Close

## Add Static Load Case

→ Self Weight

→ Parapet

→ Services

# Workflow for Vibration Analysis of Pedestrian Bridges

---

1

Perform Modal analysis to determine natural frequencies

2

Determine pedestrian time forcing functions

3

Apply time forcing function along the length of the bridge while maintaining constant pedestrian velocity

4

Check for acceleration time response and determine peak acceleration

5

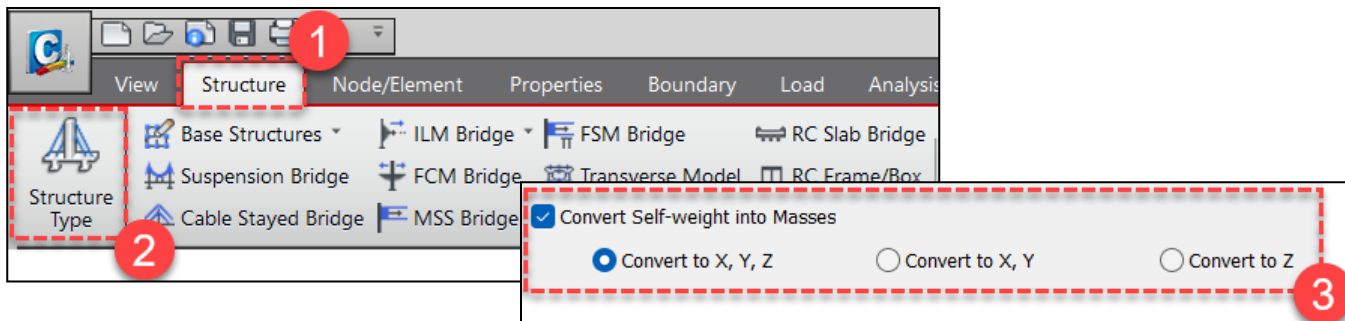
Code checks for peak acceleration limit

6

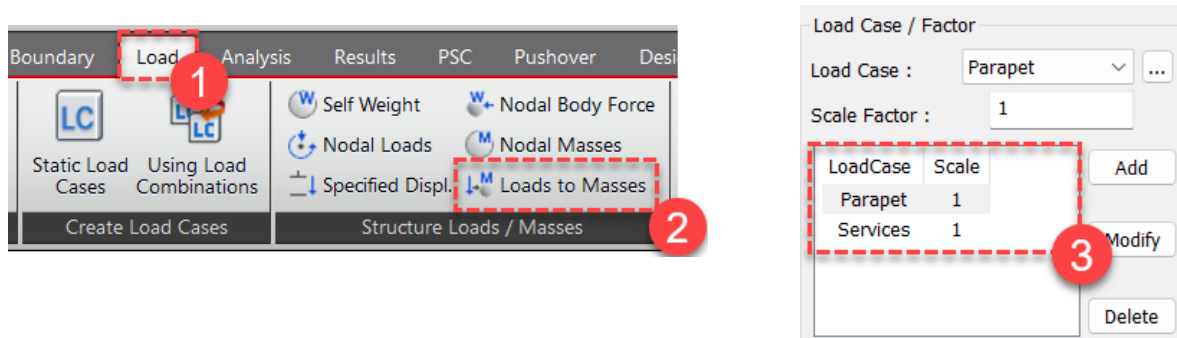
Vibration Control if necessary (Stiffening of the bridge; Dampers etc.)

# 1. Perform Modal Analysis

## Convert Self weight into Mass



## Convert Load to Mass



# 1. Perform Modal Analysis

## Eigen Value Analysis

Result > Vibration Mode Shape

Analysis > Eigen Value Analysis

Eigenvalue Analysis Control

Type of Analysis

☒ Eigen Vectors ☐ Ritz Vectors

☐ Subspace Iteration

☒ Lanczos

Eigen Vectors

Number of Frequencies : 15

☐ Sturm Sequence Check

☐ Frequency range of interest

Search From : 0 [cps]

To : 0 [cps]

Remove Eigenvalue Analysis Data

OK

Node	Mode	UX	UY	UZ	RX	RY	RZ					
EIGENVALUE ANALYSIS												
Mode No	Frequency		Period	Tolerance								
	(rad/sec)	(cycle/sec)	(sec)									
1	10.221648	1.626826	0.614694	0.0000e+00								
2	13.425429	2.136723	0.468006	0.0000e+00								
3	29.150874	4.639506	0.215540	0.0000e+00								
4	34.002950	5.411738	0.184784	0.0000e+00								
5	49.059223	7.808018	0.128073	0.0000e+00								
6	70.800871	11.268309	0.088744	0.0000e+00								
7	71.885612	11.440951	0.087405	0.0000e+00								
8	105.598438	16.806513	0.059501	6.5500e-117								
9	113.449011	18.055971	0.055383	1.0776e-109								
10	126.403133	20.117683	0.049708	2.4380e-101								
11	139.969591	22.276852	0.044890	1.1440e-90								
12	141.348723	22.496348	0.044452	2.2882e-89								
13	144.081138	22.931225	0.043609	2.8125e-88								
14	146.110175	23.254157	0.043003	5.7318e-87								
15	157.344056	25.042084	0.039933	8.9576e-83								
MODAL PARTICIPATION MASSES PRINTOUT												
Mode No	TRAN-X		TRAN-Y		TRAN-Z		ROTN-X		ROTN-Y		ROTN-Z	
	MASS(%)	SUM(%)	MASS(%)	SUM(%)	MASS(%)	SUM(%)	MASS(%)	SUM(%)	MASS(%)	SUM(%)	MASS(%)	SUM(%)
1	0.00	0.00	81.55	81.55	0.00	0.00	0.68	0.68	0.00	0.00	0.19	0.19
2	0.51	0.51	0.00	81.55	82.74	82.74	0.00	0.68	0.20	0.20	0.00	0.19
3	0.00	0.51	0.73	82.28	0.00	82.74	81.69	82.37	0.00	0.20	0.00	0.20
4	0.00	0.51	0.00	82.28	0.00	82.74	0.00	82.37	0.00	0.20	59.36	59.56

From A.2.4.3.2 of EN 1990, a verification of the comfort criteria should be performed if the fundamental frequency of the deck is less than:

→ **5 Hz** for Vertical Vibration

→ **2.5 Hz** for Horizontal (lateral) and torsional vibration

# 1. Perform Modal Analysis

## Eigen Value Analysis

Result > Vibration Mode Shape

Analysis > Eigen Value Analysis

Eigenvalue Analysis Control

Type of Analysis

☒ Eigen Vectors ☐ Ritz Vectors

☐ Subspace Iteration

☒ Lanczos

Eigen Vectors

Number of Frequencies : 15

☐ Sturm Sequence Check

☐ Frequency range of interest

Search From : 0 [cps]

To : 0 [cps]

Remove Eigenvalue Analysis Data

OK

Node	Mode	UX	UY	UZ	RX	RY	RZ
EIGENVALUE ANALYSIS							
Mode No	Frequency		Period		Tolerance		
	(rad/sec)	(cycle/sec)	(sec)				
1	10.221648	1.626826	0.614694	0.0000e+00			
2	13.425429	2.136723	0.468006	0.0000e+00			
3	29.150874	4.639506	0.215540	0.0000e+00			
4	34.002950	5.411738	0.184784	0.0000e+00			
5	49.059223	7.808018	0.128073	0.0000e+00			
6	70.800871	11.268309	0.088744	0.0000e+00			
7	71.885612	11.440951	0.087405	0.0000e+00			
8	105.598438	16.806513	0.059501	6.5500e-117			
9	113.449011	18.055971	0.055383	1.0776e-109			
10	126.403133	20.117683	0.049708	2.4380e-101			
11	139.969591	22.276852	0.044890	1.1440e-90			
12	141.348723	22.496348	0.044452	2.2882e-89			
13	144.081138	22.931225	0.043609	2.8125e-88			
14	146.110175	23.254157	0.043003	5.7318e-87			
15	157.344056	25.042084	0.039933	8.9576e-83			
MODAL PARTICIPATION MASSES PRINTOUT							
Mode No	TRAN-X		TRAN-Y		TRAN-Z		ROTN-Z
	MASS(%)	SUM(%)	MASS(%)	SUM(%)	MASS(%)	SUM(%)	
1	0.00	0.00	81.55	81.55	0.00	0.00	0.19
2	0.51	0.51	0.00	81.55	82.74	82.74	0.00
3	0.00	0.51	0.73	82.28	0.00	82.74	0.00
4	0.00	0.51	0.00	82.28	0.00	82.74	0.00

From A.2.4.3.2 of EN 1990, a verification of the comfort criteria should be performed if the fundamental frequency of the deck is less than:

→ **5 Hz** for Vertical Vibration (2.136 Hz < 5 Hz)

→ **2.5 Hz** for Horizontal (lateral) and torsional vibration (1.626 Hz < 2.5 Hz)

# 1. Perform Modal Analysis

## Time History Analysis

Load > Seismic > Time History Analysis Load Case

N.A 2.44 of BS EN1991-2, takes into account the following dynamic load cases for comfort criteria check

General  
Name : Walking Description :  
Analysis Type: ☒ Linear ☐ Nonlinear  
Analysis Method: ☒ Modal ☐ Direct Integration ☐ Static  
Time History Type: ☒ Transient ☐ Periodic  
End Time : 40 sec Time Increment : 0.01 sec  
Step Number Increment for Output : 1  
Order in Sequential Loading  
☐ Subsequent to ☒ Load Case  
☐ Initial Element Forces(Table)  
☐ Initial Forces for Geometric Stiffness  
☐ Cumulate D/V/A Results ☐ Keep Final Step Loads Constant  
Geometric Nonlinearity Type  
☒ None ☐ Large Displacements  
Damping  
Damping Method : Modal  
Direct Specification of Modal Damping  
Damping Ratio for All Modes : 0.04

Walking Pedestrian

General  
Name : Jogging Description :  
Analysis Type: ☒ Linear ☐ Nonlinear  
Analysis Method: ☒ Modal ☐ Direct Integration ☐ Static  
Time History Type: ☒ Transient ☐ Periodic  
End Time : 40 sec Time Increment : 0.01 sec  
Step Number Increment for Output : 1  
Order in Sequential Loading  
☐ Subsequent to ☒ Load Case  
☐ Initial Element Forces(Table)  
☐ Initial Forces for Geometric Stiffness  
☐ Cumulate D/V/A Results ☐ Keep Final Step Loads Constant  
Geometric Nonlinearity Type  
☒ None ☐ Large Displacements  
Damping  
Damping Method : Modal  
Direct Specification of Modal Damping  
Damping Ratio for All Modes : 0.04

Jogging Pedestrian

General  
Name : Crowded Condition Description :  
Analysis Type: ☒ Linear ☐ Nonlinear  
Analysis Method: ☒ Modal ☐ Direct Integration ☐ Static  
Time History Type: ☐ Transient ☒ Periodic  
End Time : 40 sec Time Increment : 0.01 sec  
Step Number Increment for Output : 1  
Order in Sequential Loading  
☐ Subsequent to ☒ Load Case  
☐ Initial Element Forces(Table)  
☐ Initial Forces for Geometric Stiffness  
☐ Cumulate D/V/A Results ☐ Keep Final Step Loads Constant  
Geometric Nonlinearity Type  
☒ None ☐ Large Displacements  
Damping  
Damping Method : Modal  
Direct Specification of Modal Damping  
Damping Ratio for All Modes : 0.04

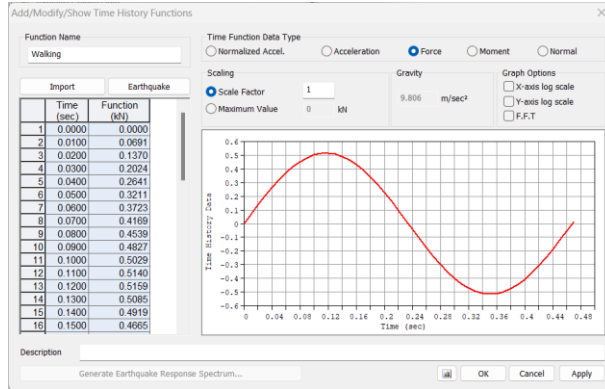
Crowded Steady State

→Damping ratio = 4% as per BC EN 1991-1-4

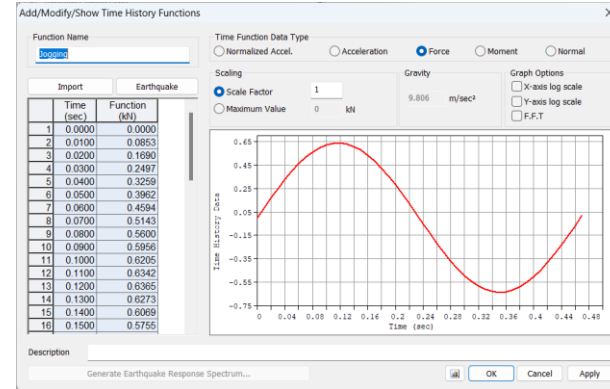


# 1. Perform Modal Analysis

## 2. Add Time History Function Load > Seismic > Time History Function



**Walking Pedestrian**



**Jogging Pedestrian**

→ Forcing function calculated as per NA 2.44.4 BS EN 1991-2

→  $f_v = 2.136 \text{ Hz}$

→  $\gamma = 0.8$

→ Walking,  $N=4$

→ Jogging,  $N=1$

→ Walking,  $k(f_v)=1$

→ Jogging,  $k(f_v)=0.7$

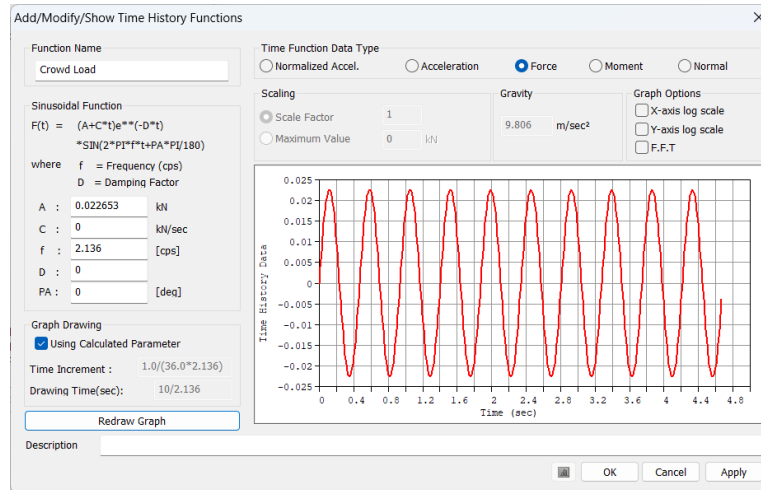
→ Walking,  $F_o = 280 \text{ kN}$

→ Jogging,  $F_o = 910 \text{ kN}$

$$F = F_0 \cdot k(f_v) \cdot \sqrt{1 + \gamma \cdot (N - 1)} \cdot \sin(2\pi f_v \cdot t)$$

# 1. Perform Modal Analysis

## 2. Add Time History Function [Load > Seismic > Time History Function](#)



→  $f_v = 2.136 \text{ Hz}$

→ Area = 99 m<sup>2</sup>

→  $\gamma = 0.2$

→  $k(f_v) = 1$

→  $F_0 = 280 \text{ kN}$

→ Crowd density = 0.4 per/m<sup>2</sup>

**Crowded Steady State**

→ Forcing function calculated as per NA 2.44.5 BS EN 1991-2

$$w = 1.8 \left( \frac{F_0}{A} \right) \cdot k(f_v) \cdot \sqrt{\gamma \cdot N / \lambda} \cdot \sin(2\pi \cdot f_v \cdot t)$$

# 1. Perform Modal Analysis

## 2. Add Time History Function [Load > Seismic > Dynamic Nodal loads](#)

→ Forcing function are applied along the length of bridge as dynamic load with a time gap = 0.615sec (fundamental period) to achieve worst case response due to resonance

→ Dynamic Nodal loads should simulate constant velocity

→ Velocity for walking and jogging are taken from Table NA.8

→ Crowd condition dynamic nodal loads should be applied with zero interval time.

Time History Load Case Name

Walking

Options

☒ Add ☐ Replace ☐ Delete

Function and Direction

Function Name : Walking

Load Type : Force

Direction : ☐ X ☐ Y ☒ Z

Arrival Time : 0 sec

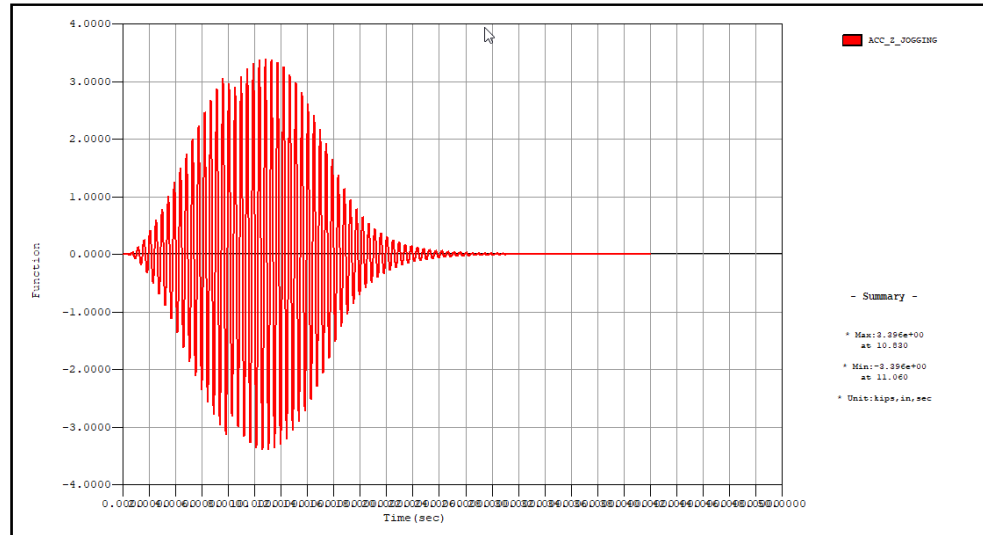
Scale Factor : 1

Apply Close

# 1. Perform Modal Analysis

Check Results

Results > Time History Graph



→As per NA 2.44.6, Peak acceleration limit is given by

→From Table NA.9, K1=1.3

→From Table NA.10, K2=0.7

→From Table NA.11, K3=1

$$\alpha_{limit} = 1.0 k_1 k_2 k_3 k_4 m/s^2$$

$$\text{and } 0.5m/s^2 \leq \alpha_{limit} \leq 2m/s^2$$

# Q & A

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# Thank you!



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For Technical Queries, kindly contact our  
Global Technical Support:

<https://globalsupport.midasuser.com/>