Dynamic analysis: Pedstrian bridge

CONTENTS

1. GENERAL / MEASUREMENT

1.1 CONSTRUCTION TYPE

Bridge is a steel arch bridge.

1.2 DAMPNING

Mass Rayleigh dampning konstant: 0.0028 1/s

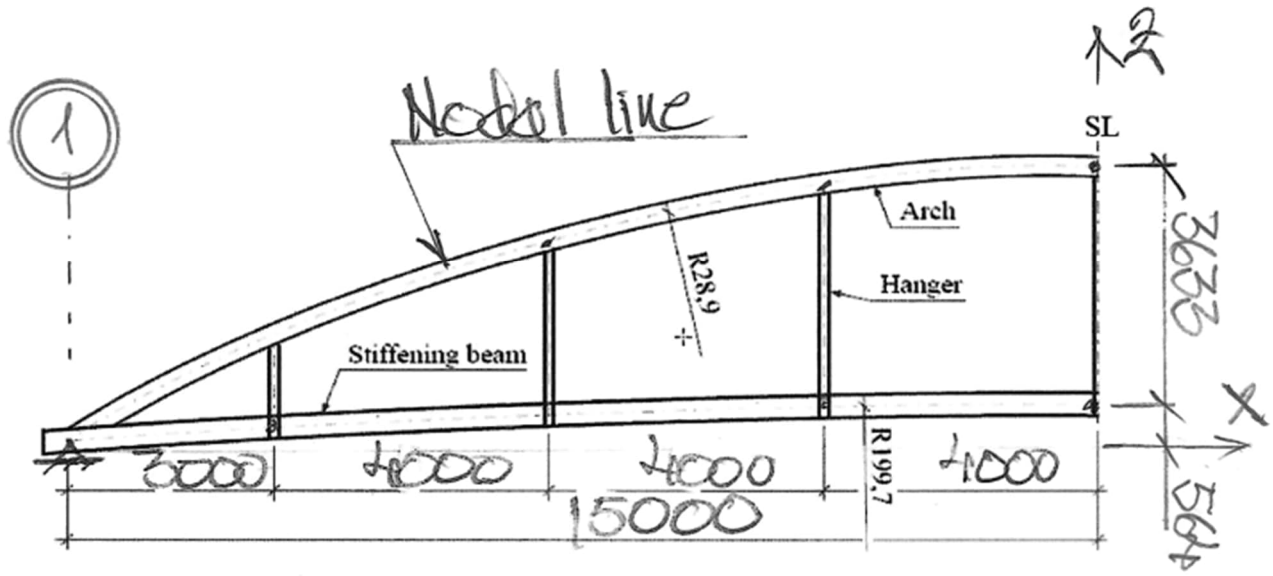
Stiffness Rayleigh dampning constant: 0.0002 s

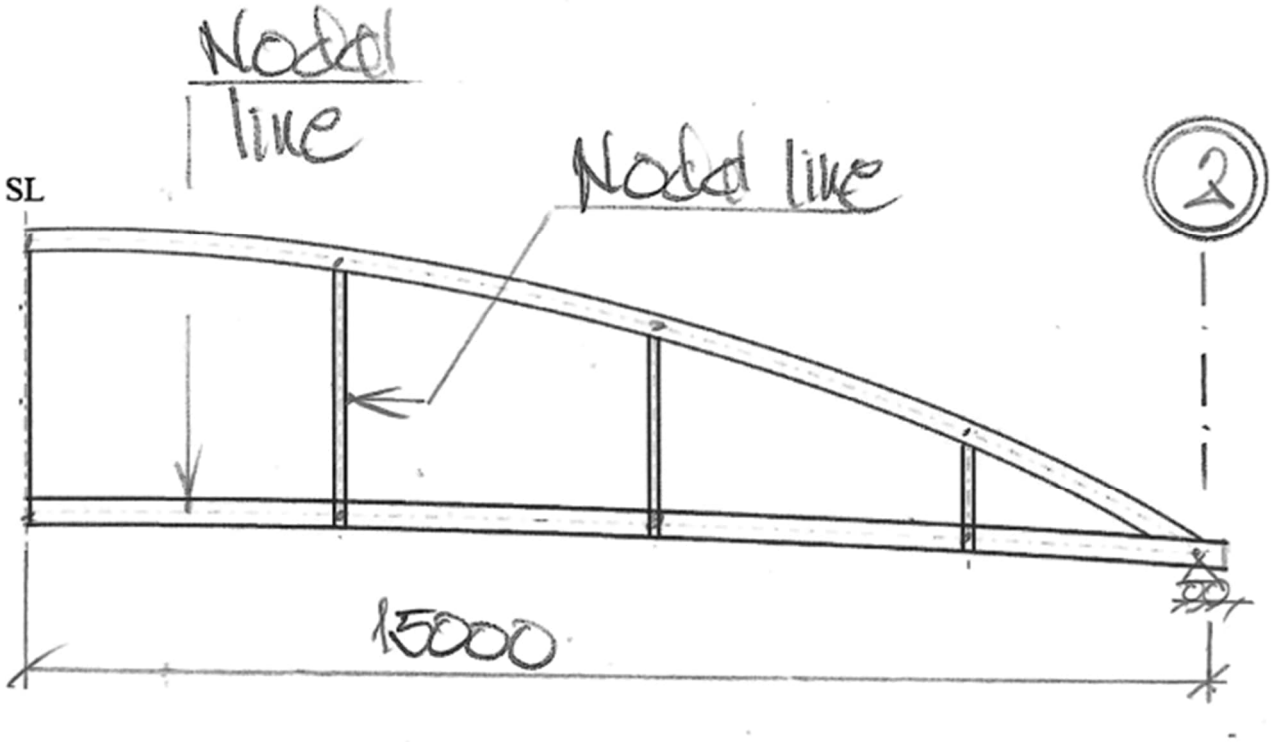
1.3 MATERIAL

Steel $\Rightarrow$ E_{sk} = 210 GPa & v = 0.30.

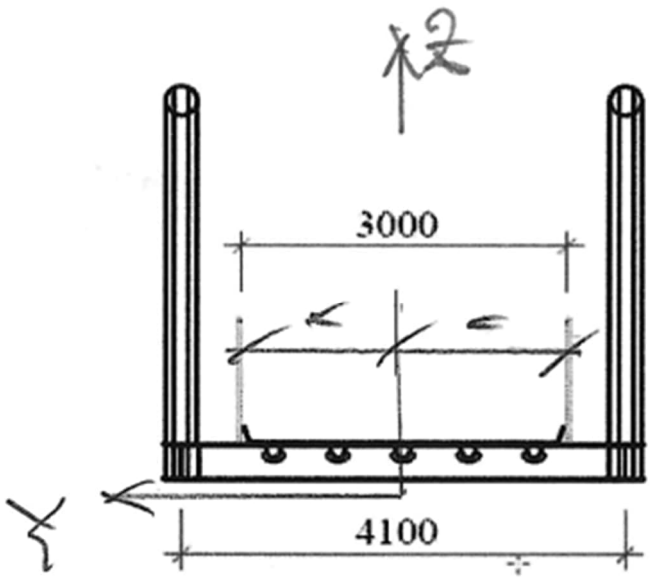
1.4 MEASUREMENTS

PLAN


1
Nodal line
SL
Arch
Hanger
R28.9
Stiffening beam
3633
X
R199.7
3000
4000
4000
4000
15000
564


Nodal line
SL
Nodal line
2
15000

ELEVATION



Cross section

.

1.5 FOUNDATION

Not included in modell.

1.6 CODE OCH TENDER DOCUMENTS

Documents	Version	Name
SS-EN 1990-1997	-	Svensk Standard Eurokod 1-7
TRVINFRA-00226	2.0	KRAV, Bro och broliknande konstruktion, Allmänna krav
TRVINFRA-00227	2.0	KRAV, Bro och broliknande konstruktion, Byggande
TRVINFRA-00228	2.0	KRAV, Bro och broliknande konstruktion, Brounderhåll
TRVINFRA-00331	2.0	KRAV, Bro och broliknande konstruktion, Bärighetsberäkning
TSFS 2018:57		Transportstyrelsens föreskrifter och allmänna råd om tillämpning av eurokoder
TDOK 2013:0667	2.0	Trafikverkets tekniska krav för geokonstruktioner. TK Geo 13
TDOK 2013:0668	2.0	Trafikverkets tekniska råd för geokonstruktioner. TR Geo 13
AMA Anläggning 23		AMA, Svensk Byggtjänst
TDOK 2023:0125	2.0	TRVAMA Anläggning 23
SS 137006:2015	-	Betongkonstruktioner – Utförande – Tillämpning av SS-EN 13670:2009 i Sverige

2. SYSTEM ANALYSIS

2.1 GENERAL

The bridge is a steel arch bridge.

The bridge is modelled in 3D using beam elements

The deck is only modelled with mass but no structural stifffness.

In total 4 different analysis are peformed as seen below.

Analysis 1 (Base analyis):

Linear static analysis of bridge

Analysis 2 (Inherits properties from Base analysis unless changed):

Eigenvalue analysis.

Analysis 3 (Inherits properties from Base analysis unless changed):

Transient analysis of moving cylic pedestrian load (point load).

Analysis 4 (Inherits properties from Base analysis unless changed):

Transient analysis of moving cylic pedestrian load (point load).

Appendices:

Appendix	Name
1	Input receipt
2	Results

2.2 SKETCH SYSTEM ANALYSIS

To describe geometry first POINTS are defined.

Beam elements are defined by applying attributes to LINES.

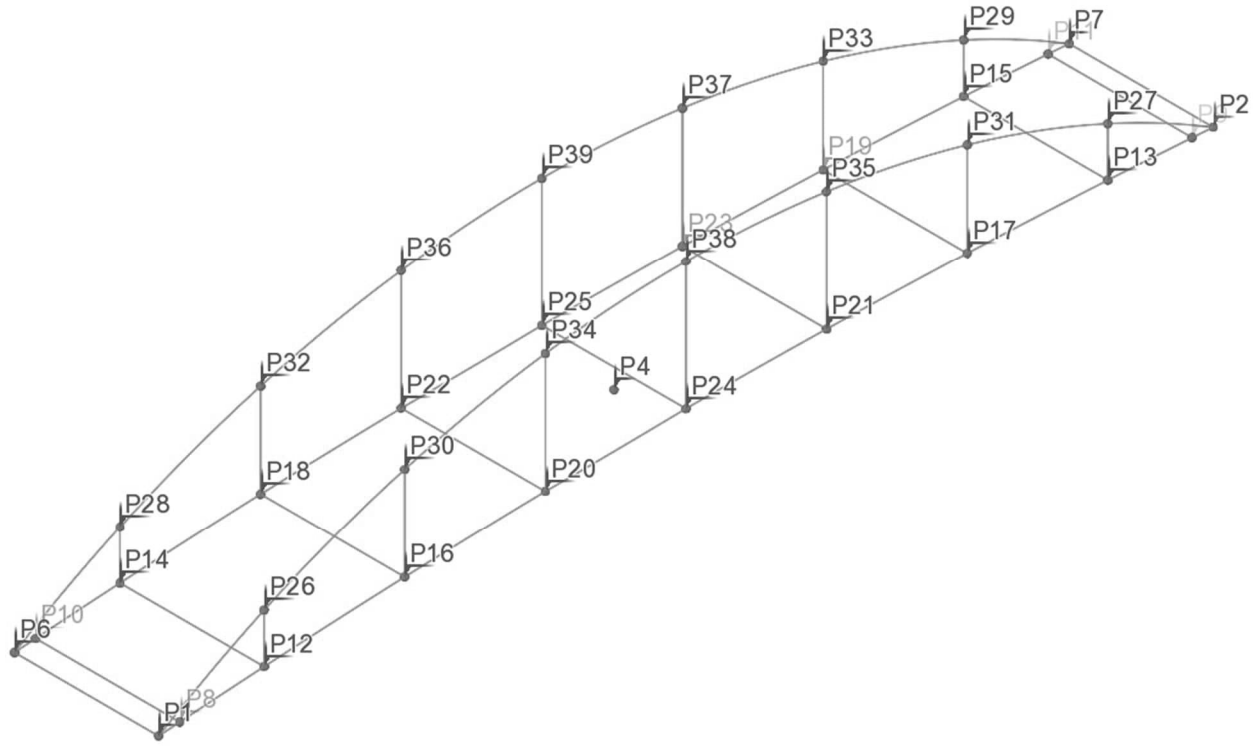
Shell elements are defined by applying attributes to SURFACES.

Attached pictures are retrieved from graphical sketches generated by FEM program using POINT and LINES.

All coordinates needed to describe POINTS are found in appendix 1.

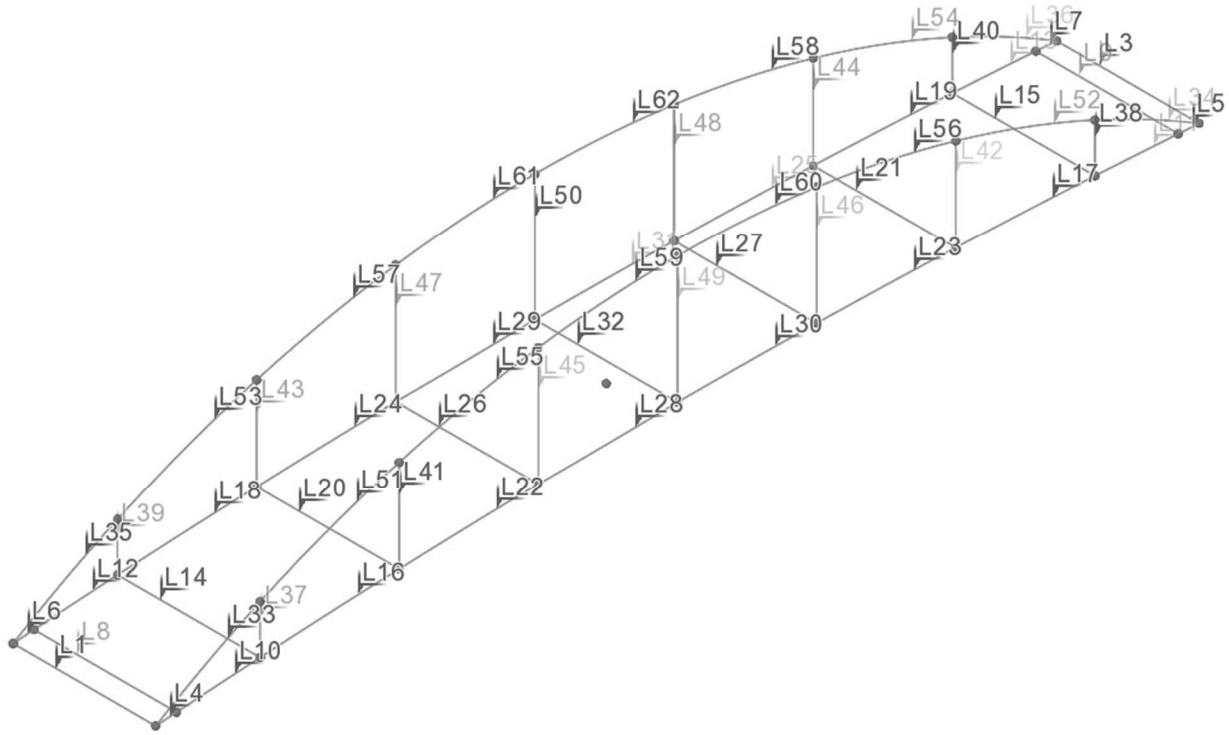
All POINTS needed to describe LINES are found in appendix 1.

2.2.1 Geometry : POINTS



Overview 3D

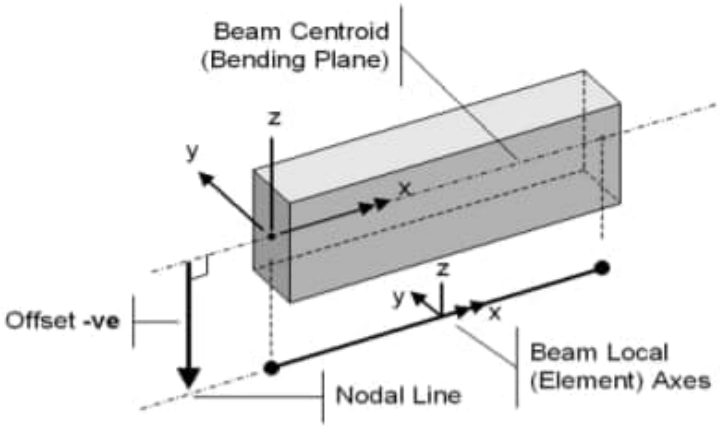
2.2.2 Geometry : LINES

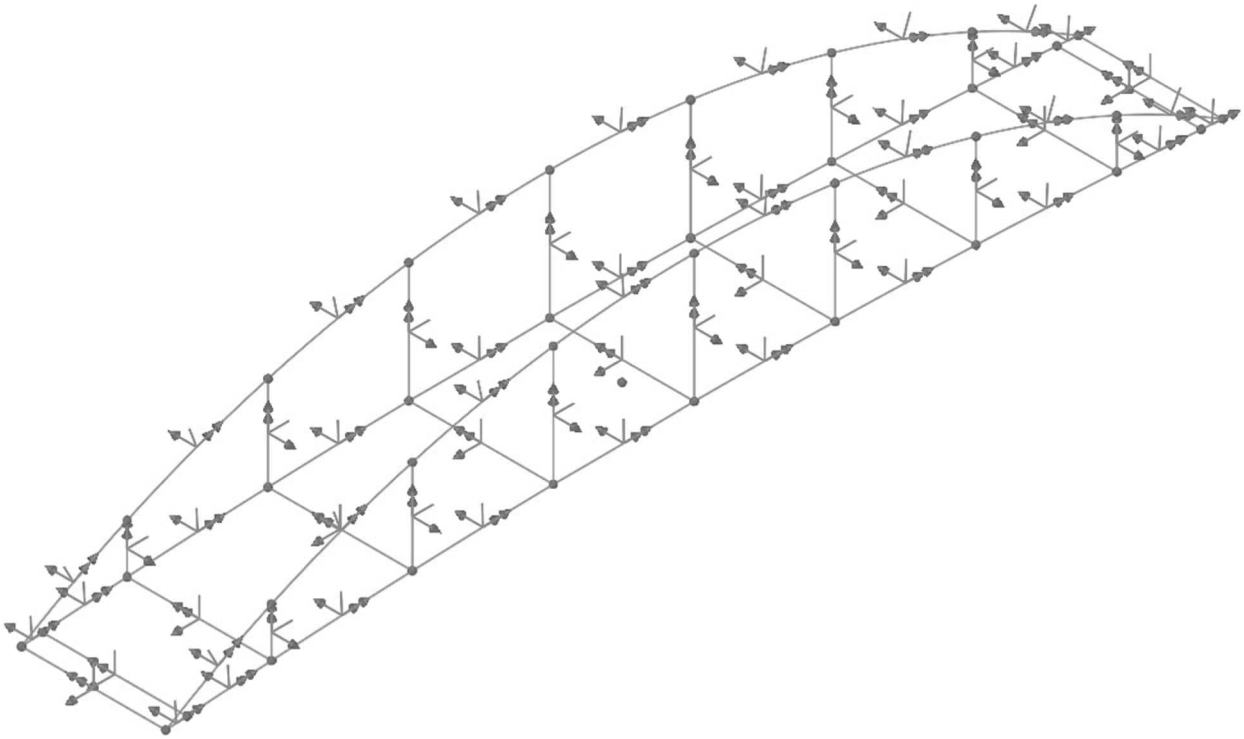


Overview 3D

2.3 CROSS SECTION PROPERTIES

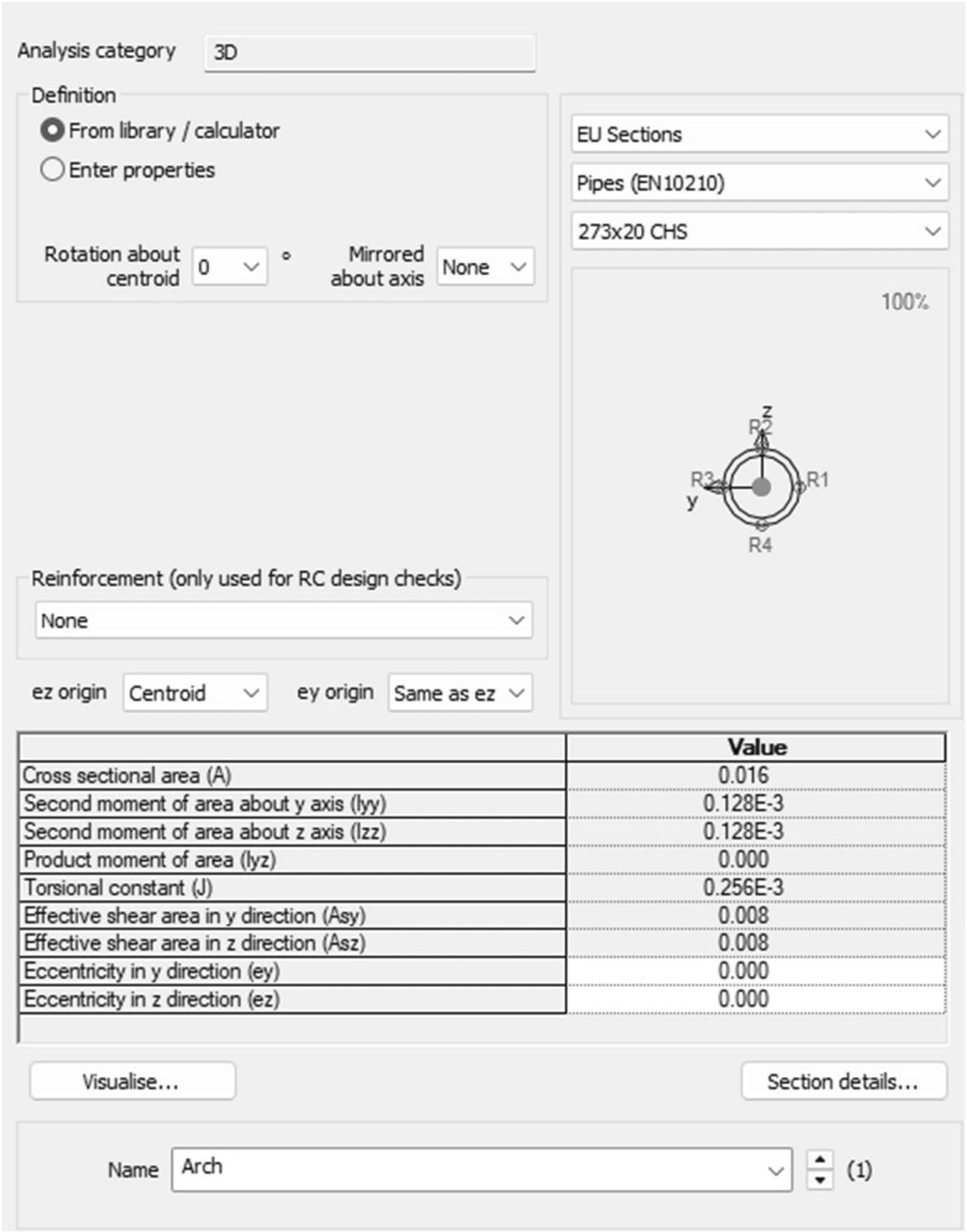
Principal sketch of geometry associated to 3D beam elements are seen below.





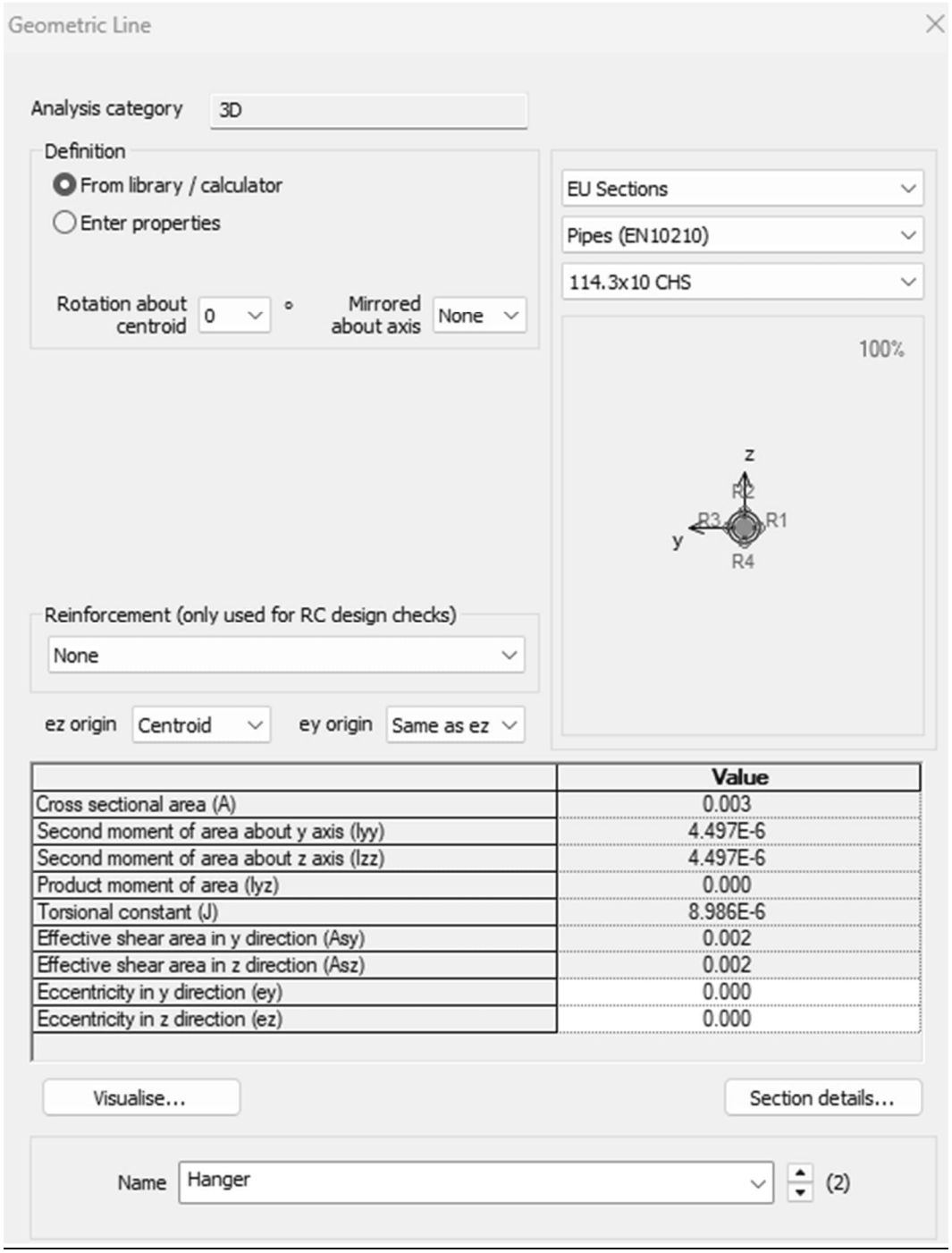
Overview 3D
Local line axis

2.3.1 Arch



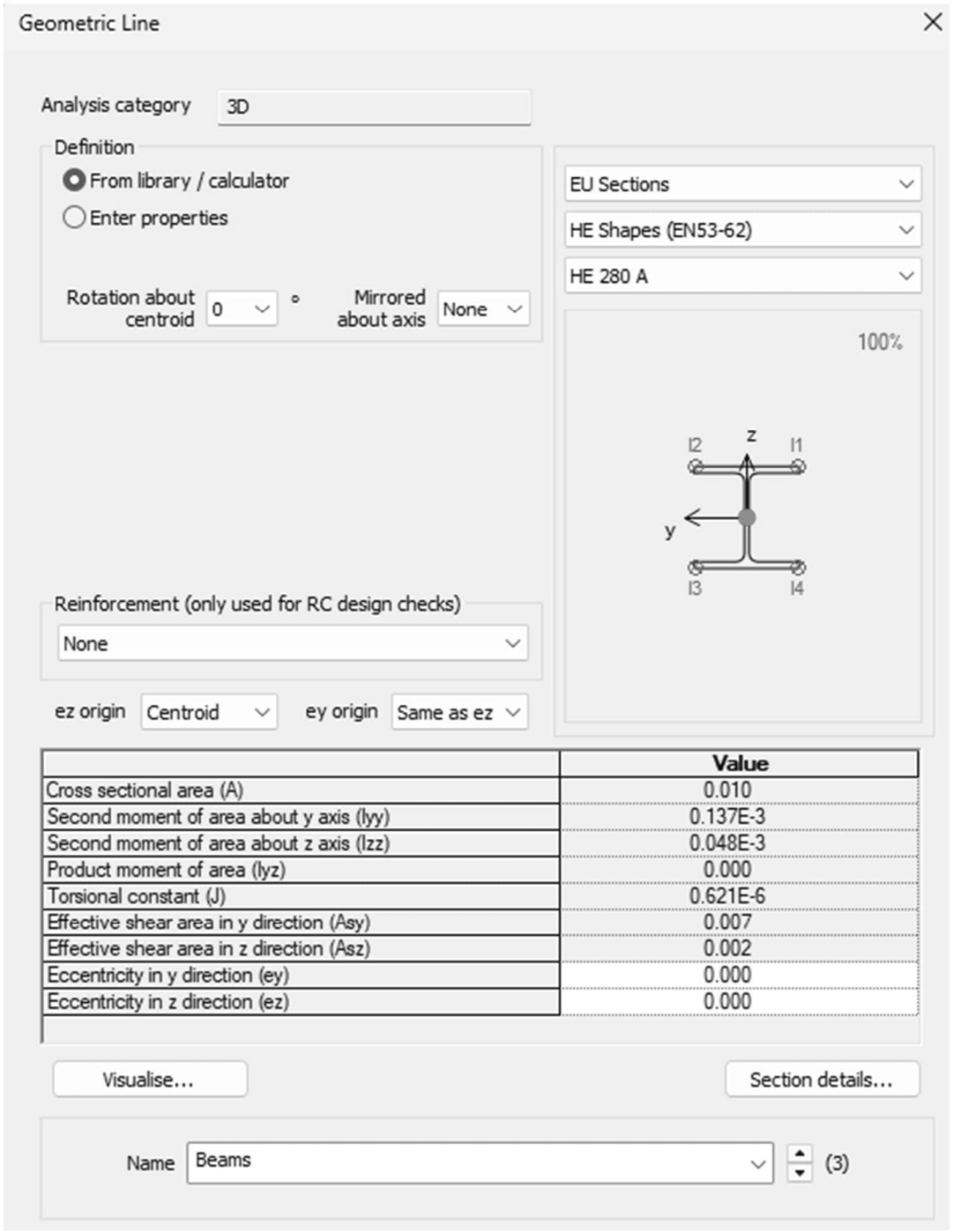
	Value
Cross sectional area (A)	0.016
Second moment of area about y axis (Iyy)	0.128E-3
Second moment of area about z axis (Izz)	0.128E-3
Product moment of area (Iyz)	0.000
Torsional constant (J)	0.256E-3
Effective shear area in y direction (Asy)	0.008
Effective shear area in z direction (Asz)	0.008
Eccentricity in y direction (ey)	0.000
Eccentricity in z direction (ez)	0.000

2.3.2 Hanger


Geometric Line
Analysis category
3D
Definition
From library / calculator
Enter properties
Rotation about centroid
0
Mirrored about axis
None
EU Sections
Pipes (EN10210)
114.3x10 CHS
100%
z
y
R1
R2
R3
R4
Reinforcement (only used for RC design checks)
None
ez origin
Centroid
ey origin
Same as ez
Value
Cross sectional area (A) 0.003
Second moment of area about y axis (Iyy) 4.497E-6
Second moment of area about z axis (Izz) 4.497E-6
Product moment of area (Iyz) 0.000
Torsional constant (J) 8.986E-6
Effective shear area in y direction (Asy) 0.002
Effective shear area in z direction (Asz) 0.002
Eccentricity in y direction (ey) 0.000
Eccentricity in z direction (ez) 0.000
Visualise...
Section details...
Name
Hanger
(2)

2.3.3 Beams

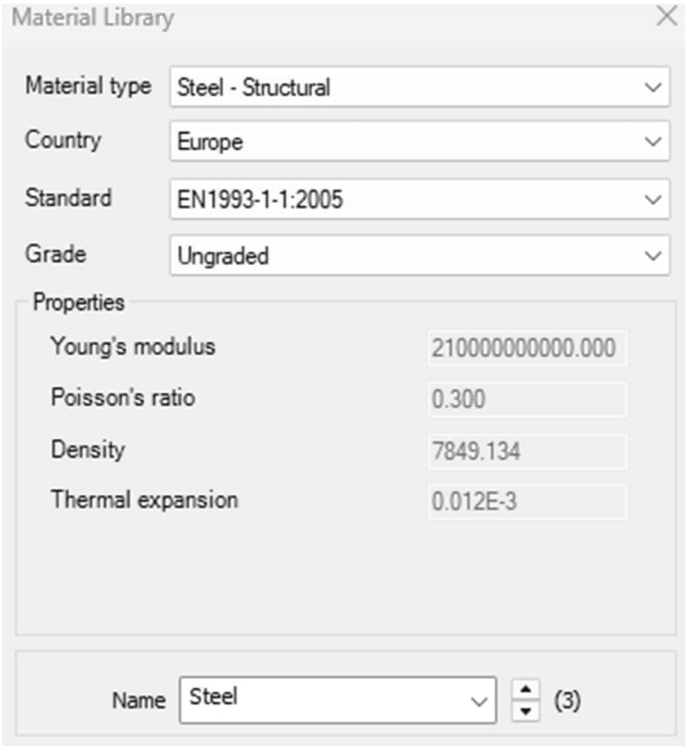
Used for beams at bottom in longitudinal & transversal direction.

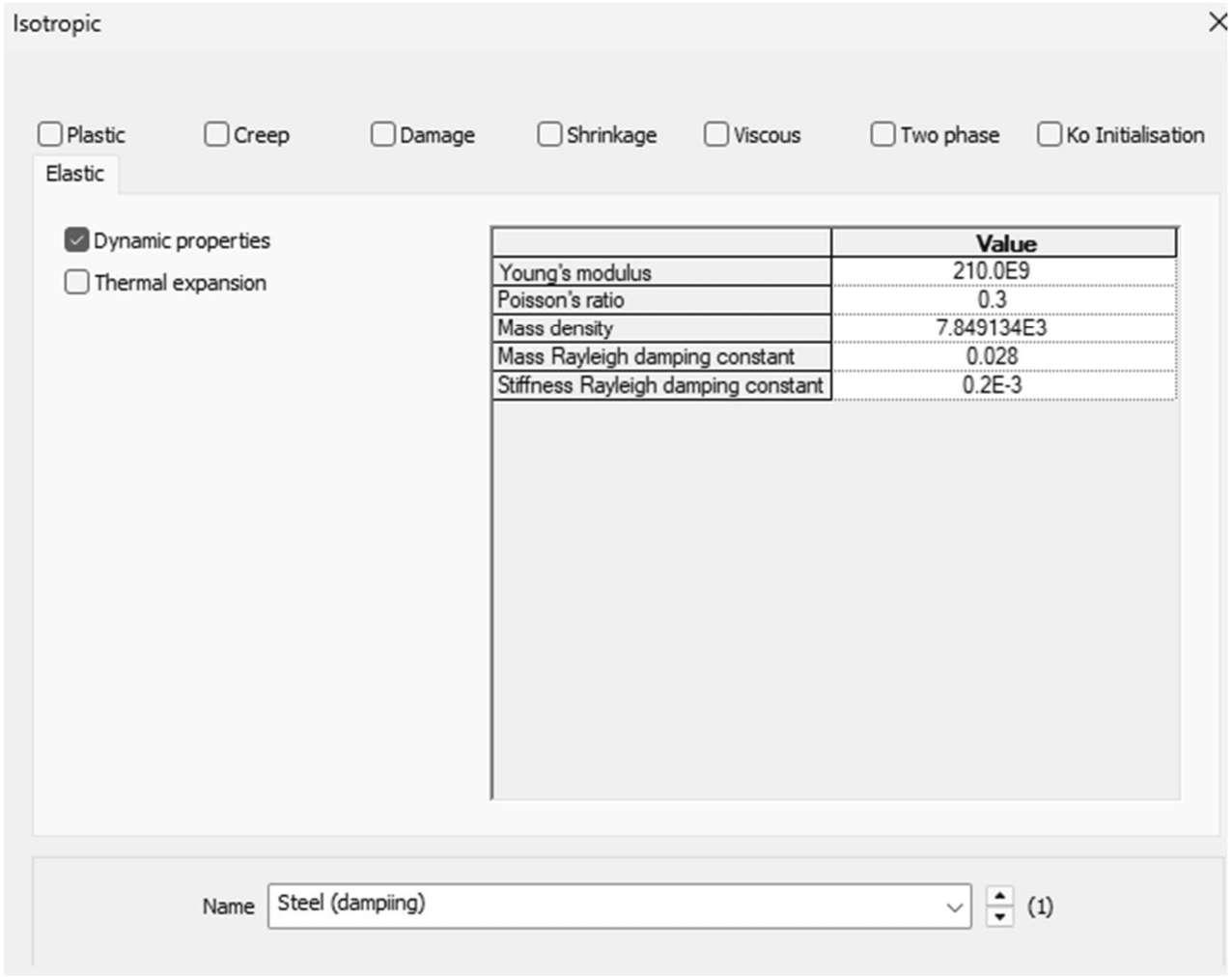


2.4 MATERIAL

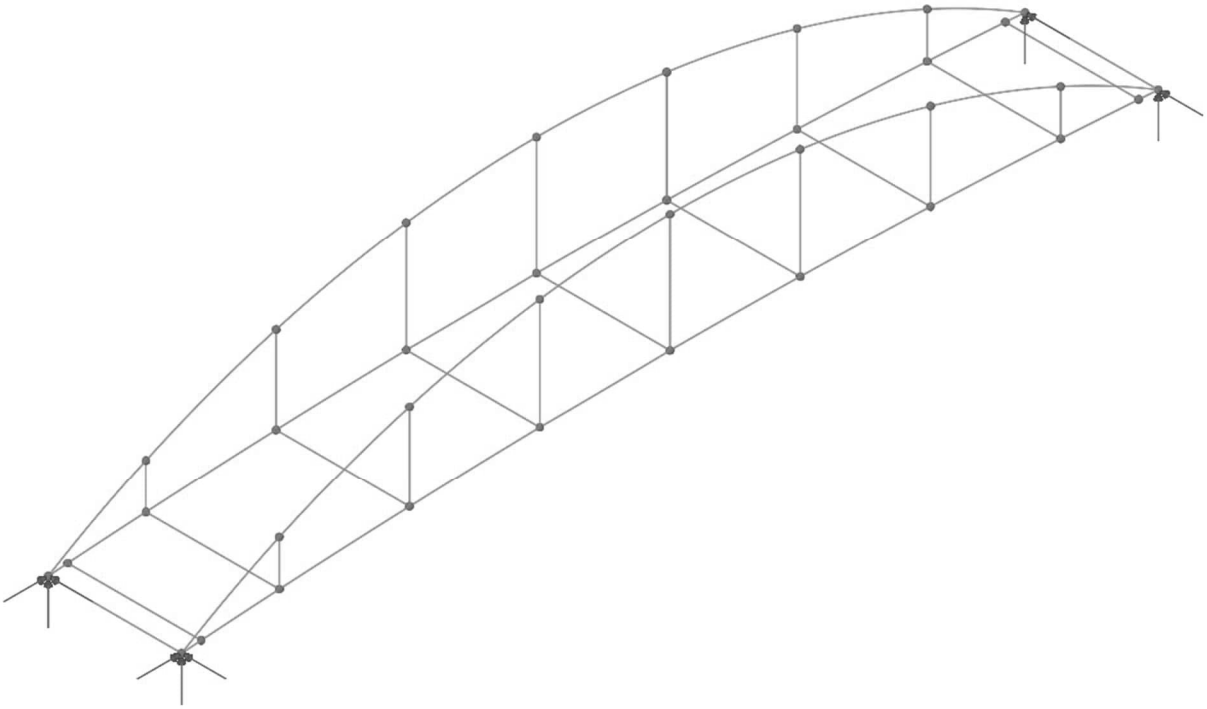
2.4.1 Steel

For analysis 1-2 the properties below are used.



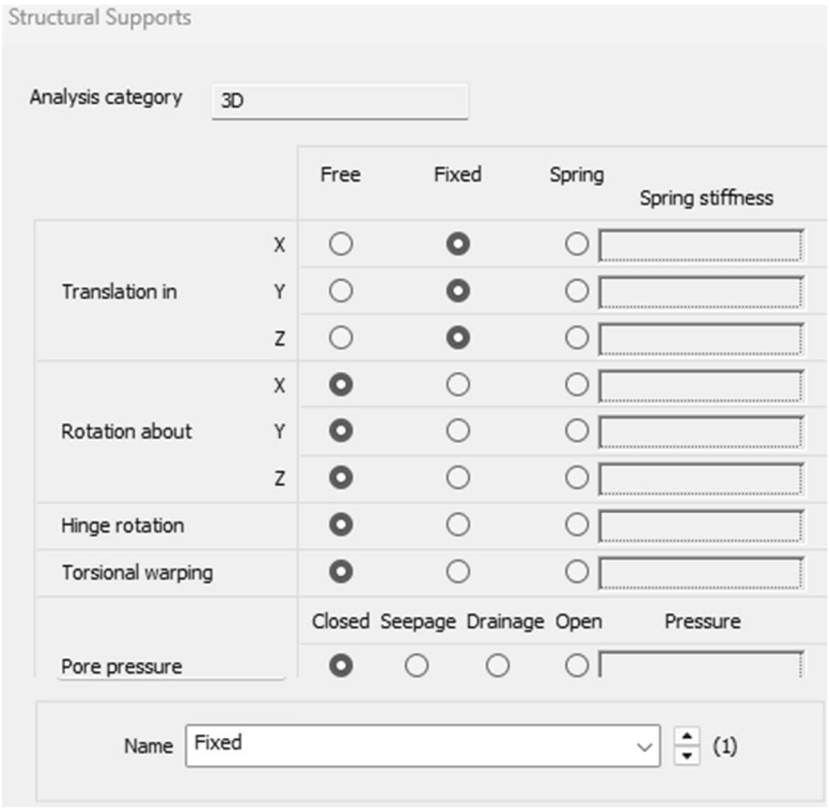

Isotropic
Plastic
Creep
Damage
Shrinkage
Viscous
Two phase
Ko Initialisation
Elastic
Dynamic properties
Thermal expansion
Value
Young's modulus
210.0E9
Poisson's ratio
0.3
Mass density
7.849134E3
Mass Rayleigh damping constant
0.028
Stiffness Rayleigh damping constant
0.2E-3
Name
Steel (dampiing)
(1)

2.5 BOUNDARY CONDITIONS

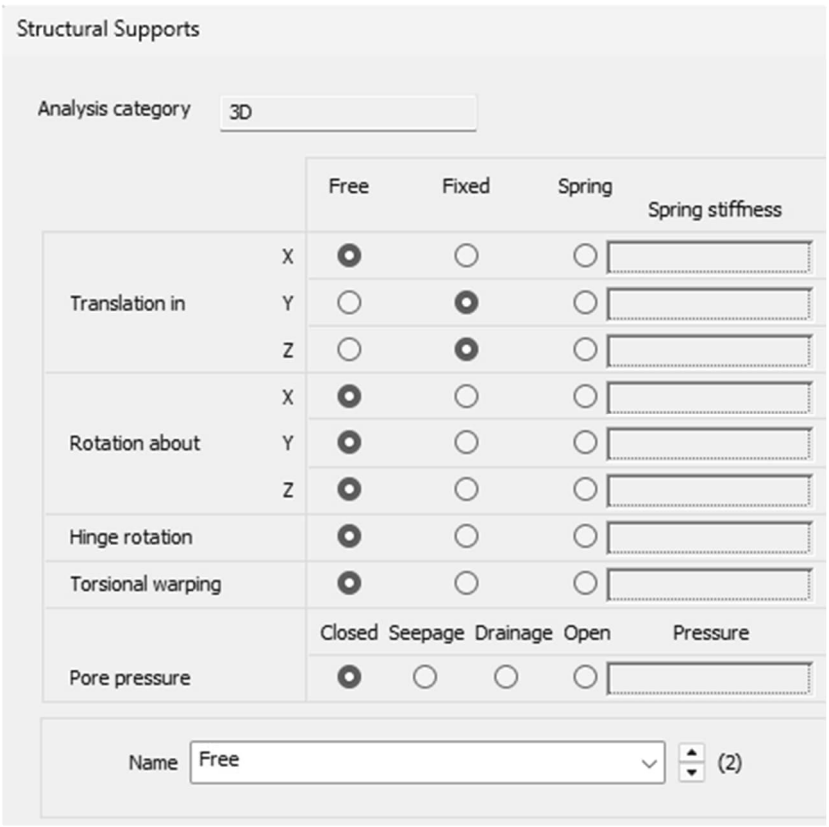


Overview 3D

2.5.1 Support 1



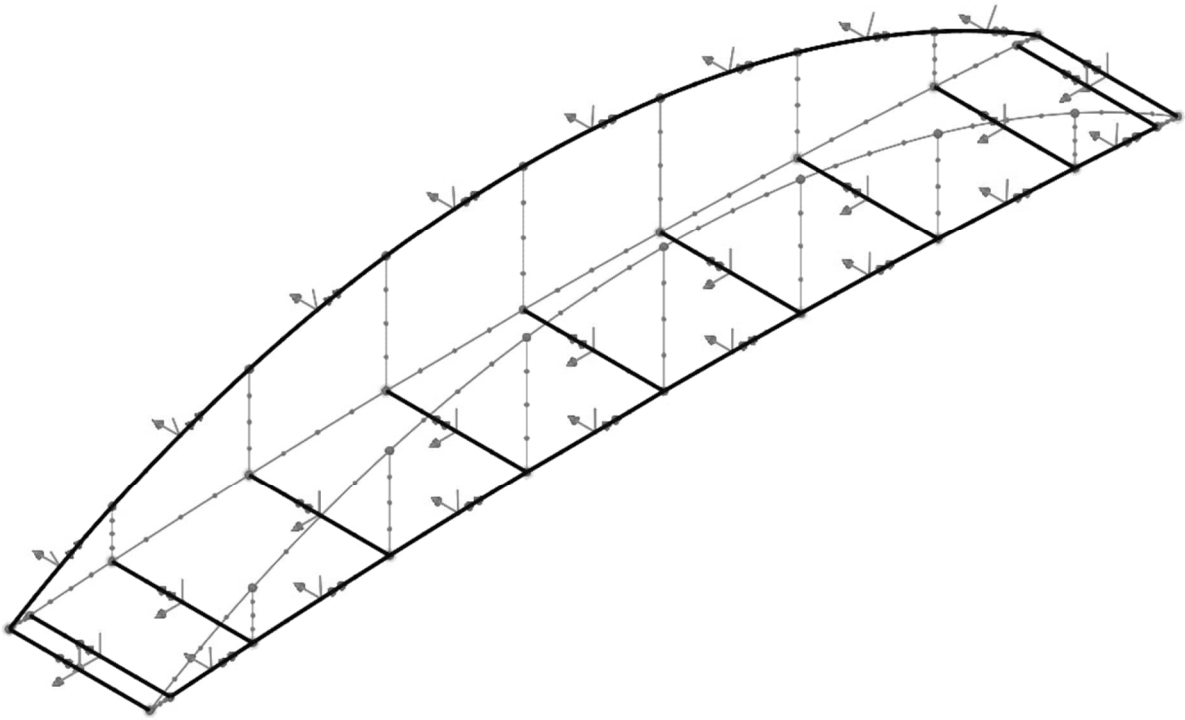
2.5.2 Support 2



2.6 MESH

Studied bridge uses beam elements (" Beam element" / BMI21) for support beam..

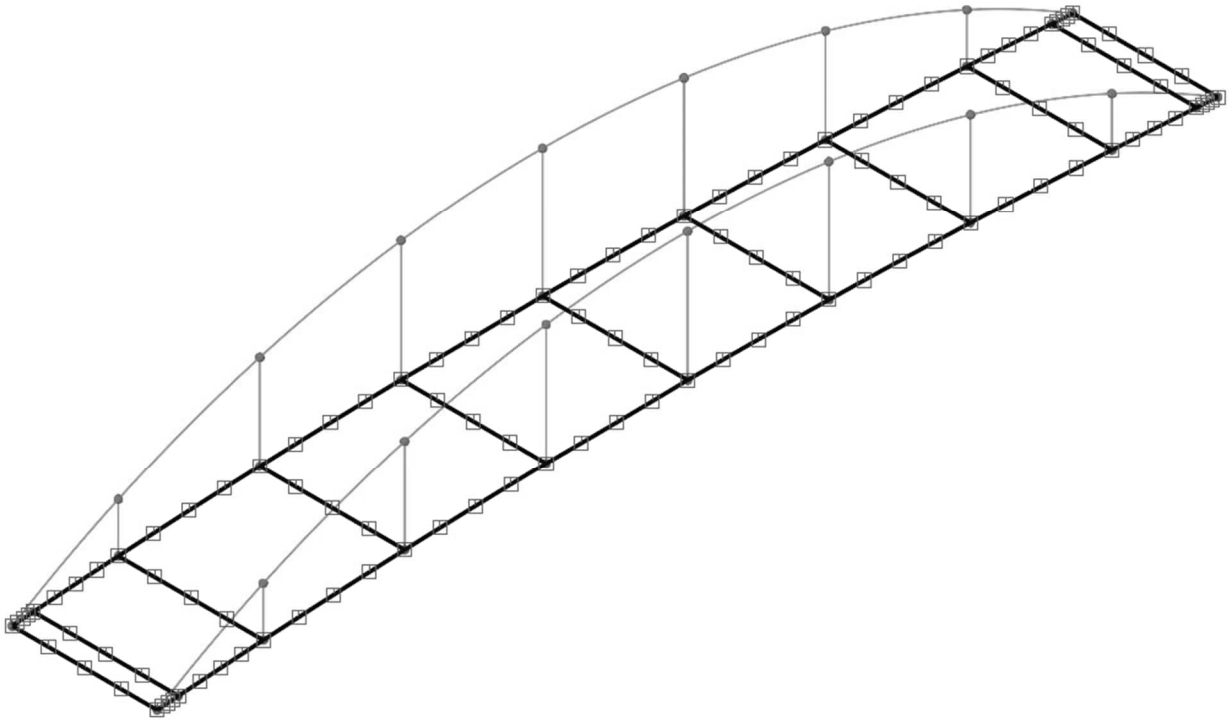
Type	Divisions	End release: Start	End release: End	Structure
Element 4	4	None	None	All structure



3D overview
Local element axles are visualized.

2.7 SEARCH AREA

Discrete load can be applied to structure as chosen structural load area, termed Search Area.



3D overview
Search Area : Deck

3. LOADS

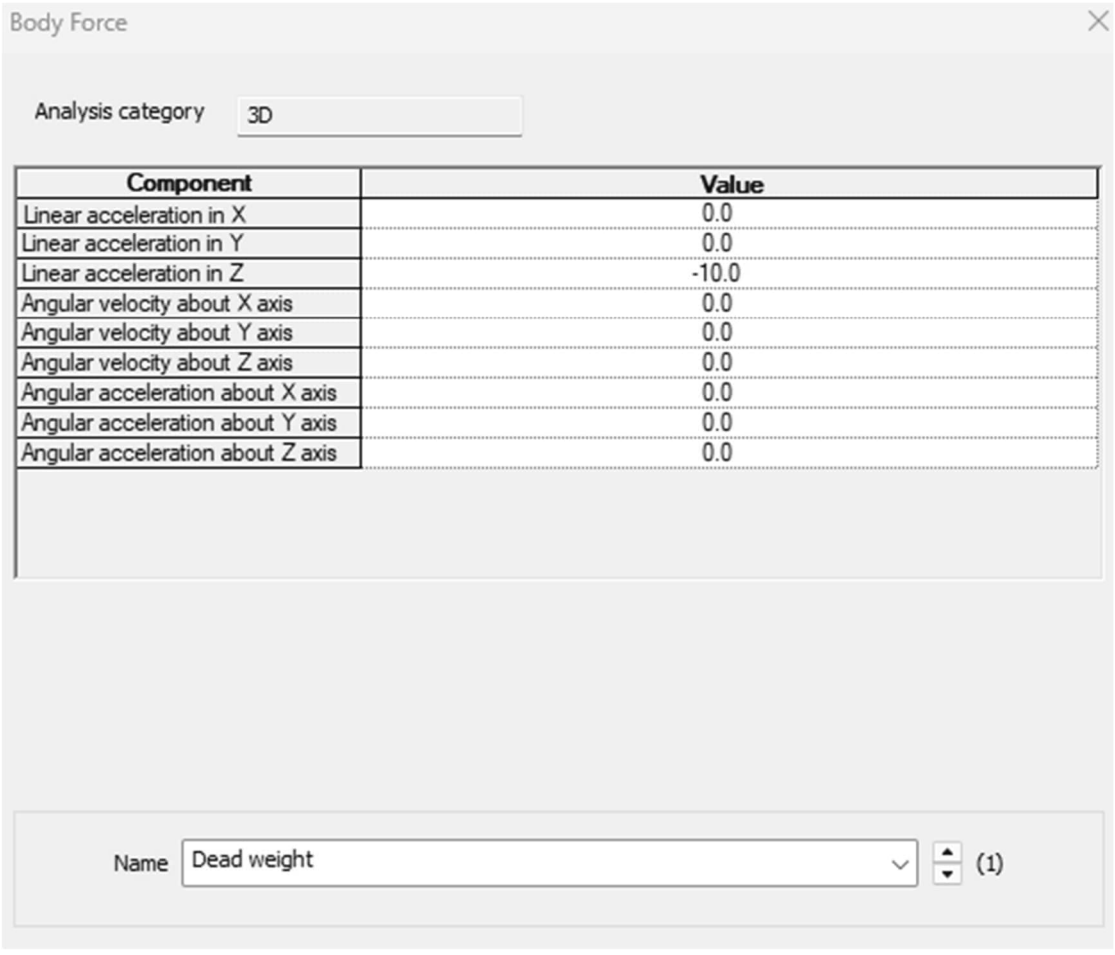
3.1 DEAD WEIGHT

Load case is defined using cross section properties of structural elements.

Load case : Dead weight

Structural loading : Body force

Linear acceleration in Z (a_z) : -10 $\frac{m}{s^2}$

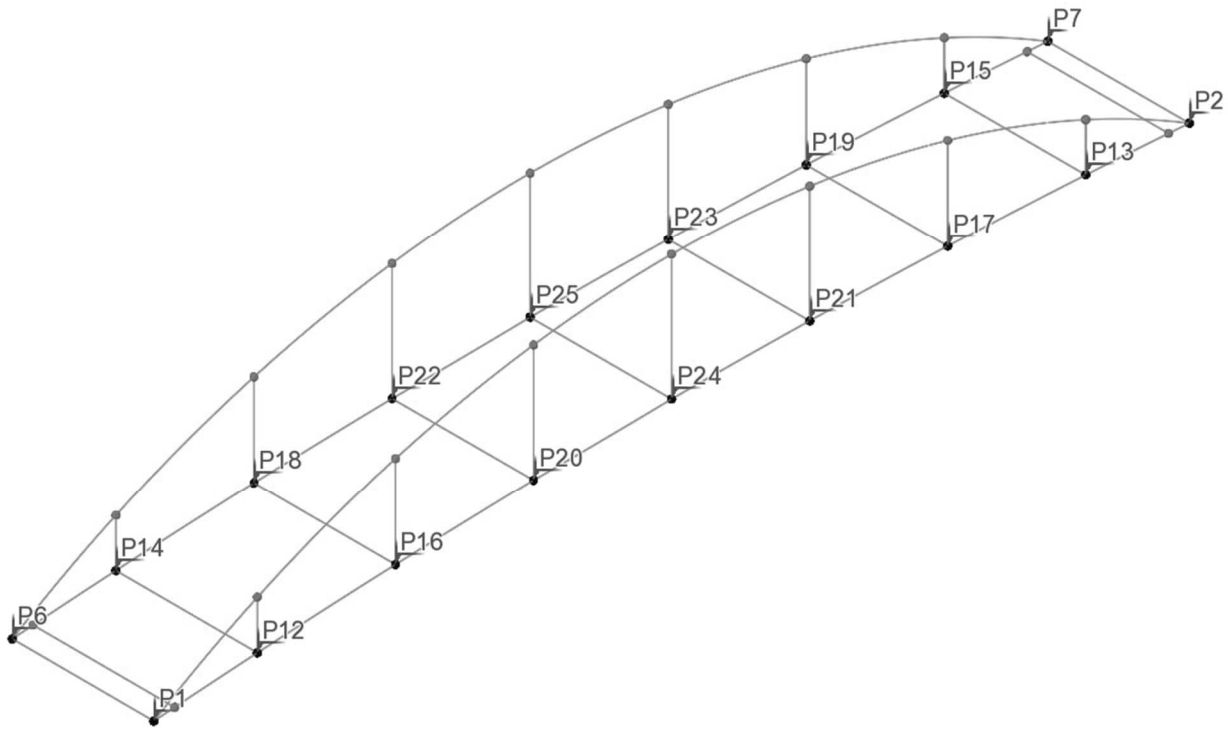


3.2 MASS WEIGHT

Since railing, deck and surfacing is not included as structural element their weight is not includes in structural model, thus dead weight is not considered in load “Dead weight”

Instead, these loads are handled using point mass weights. The are defined as “Point Mass elements” (PM3). Theses non-structural elements are applied a points seed below.

Every mass element has a weight of 500 kg. The mass weight is included into structure a point element with material properties corresponding to it weight.



3D Overview

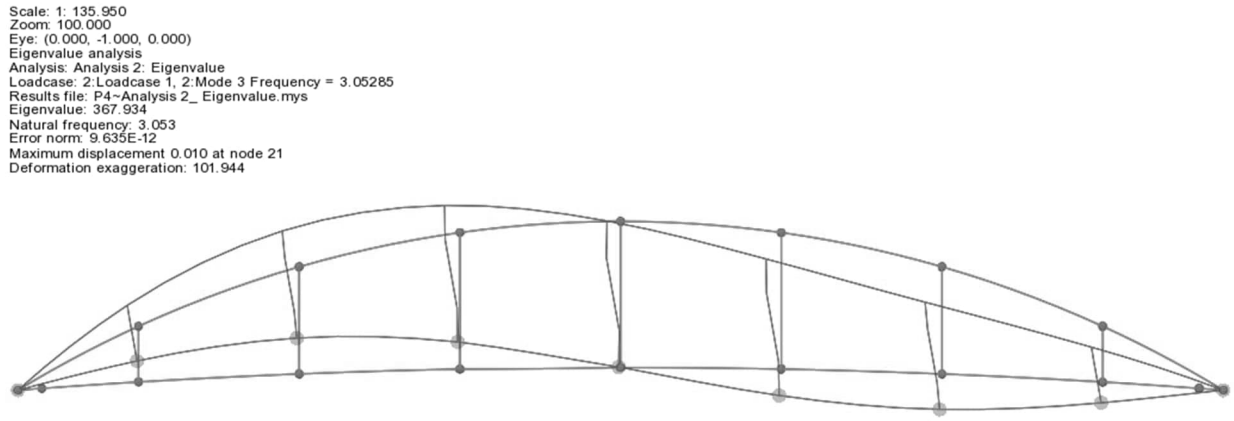
3.3 CYCLIC CROWD LOAD

The general document Eurocode 1991-2 does not contain definition of dynamic pedestrian loads-I this analysis national annex NA to BS EN 1991-2 is used.

3.3.1 Vertical cyclic surface load according NA section 2.44.5

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

The is applied to most dangerous eigenvalue frequency in vertical direction (f_v= 3.053).



$$\rightarrow w(t) = 2.542\,\frac{N}{m^2}\cdot \sin\,(2\pi \cdot f_v \cdot t)$$

3.3.2 Definition load curve

The load curve is defined as transient cyclic (see definition below). This load curve is applied to a discrete static surface load.

Name: "Load curve: pedestrian crowd"

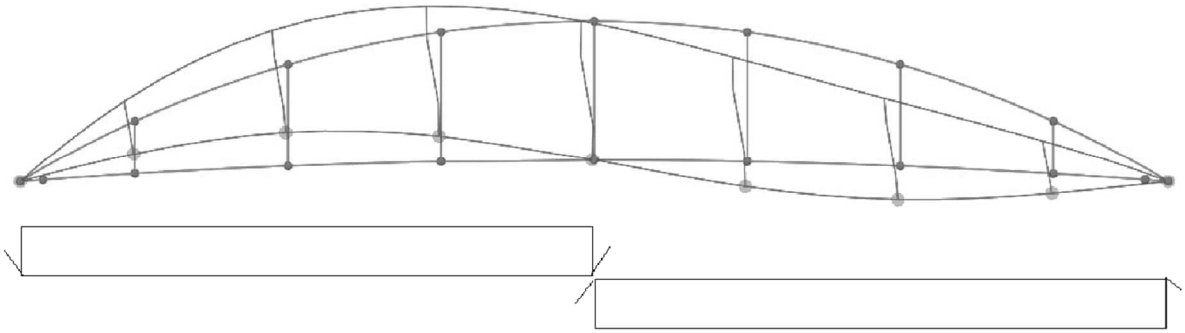
Type: Sine

Amplitude: 2.542

Frequency: 3.053

3.3.3 Definition discrete surface load

The surface load are defined so follows most dangerous eigenvalue frequency, see sketch below. Since intensity is given by load curve only a unit load is applied.



Definition of discrete surface load:

Analysis; “Analysis 3: Pedestrian crowd”

Search area: “Deck”

Analysis: “Analysis 3: Pedestrian crowd”

Load curve: “Load curve: pedestrian crowd”

Discrete surface load: “Unit – Pedestrian crowd-“

Patch

Analysis category 3D

Patch type

8 node patch | 4 node patch | Multi-patch | Straight | Curve | Multi-straight

Load direction

X | Z | Y | XYZ global | Patch x | Patch y | Surface normal | XYZ transformable

Projection vector

Project in load direction

Project for prestress

X component 0.000

Y component 0.000

Z component 1.000

Patch load divisions

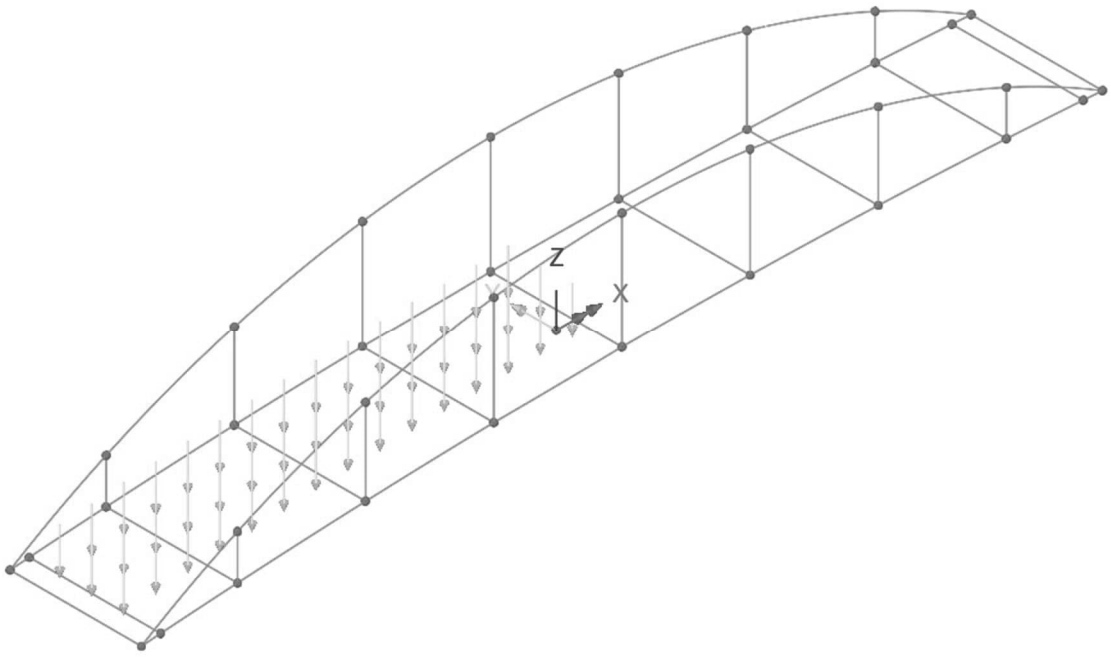
Use default

Number of divisions in x 0

Number of divisions in y 0

	X	Y	Z	Load
1	-15.000	-1.500	0.000	-1.0
2	0.000	-1.500	0.000	-1.0
3	0.000	1.500	0.000	-1.0
4	-15.000	1.500	0.000	-1.0

Name Unit - Pedestrian crowd- (2)



3D Overview

Discrete surface load: “Unit – Pedestrian crowd-“

Patch

Analysis category 3D

Patch type

8 node patch | 4 node patch | Multi-patch | Straight | Curve | Multi-straight

Load direction

X | Z | Y | XYZ global | Patch x | Patch y | Surface normal | XYZ transformable

Projection vector

Project in load direction

Project for prestress

X component 0.000

Y component 0.000

Z component 1.000

Patch load divisions

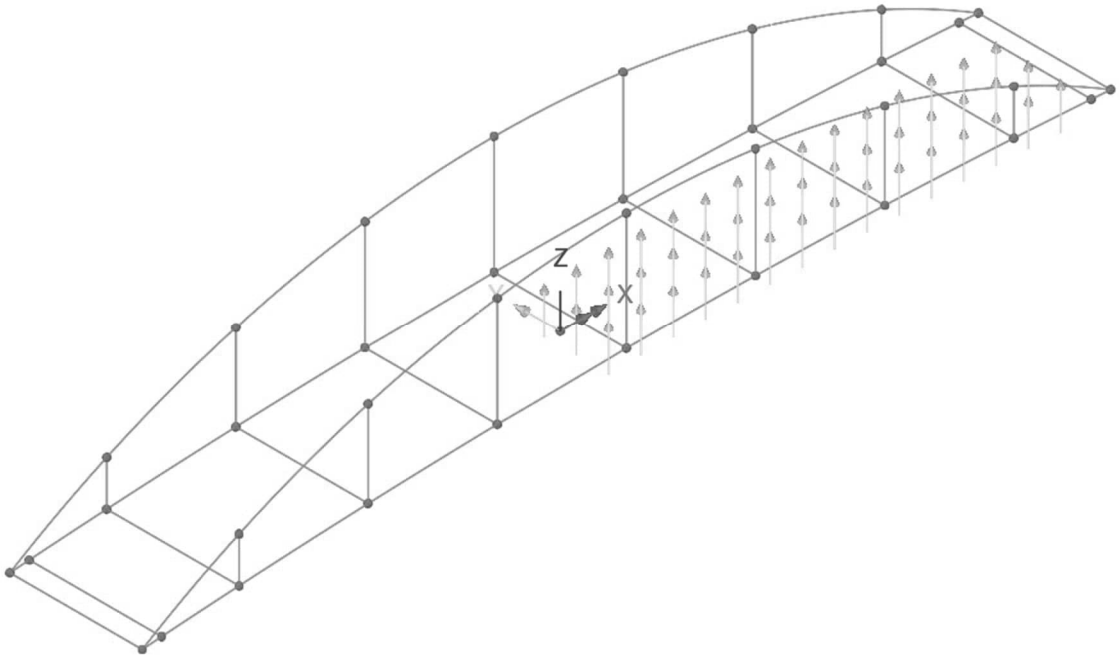
Use default

Number of divisions in x 0

Number of divisions in y 0

	X	Y	Z	Load
1	0.000	-1.500	0.000	1.0
2	15.000	-1.500	0.000	1.0
3	15.000	1.500	0.000	1.0
4	0.000	1.500	0.000	1.0

Name Unit - Pedestrian crowd+ (3)



3D Overview

3.3.4 Definition transient load cases

The surface load are defined so follows most dangerous eigenvalue frequency

Load case t1

Load case:	Load cast t1
Analysis:	Analysis 3: Pedestrian crowd
Load curve:	Load curve: pedestrian crowd
Time domain:	Implicit dynamics
Step time:	0.01 s
Initial time:	0 s
Total time:	10 s
Stored results:	No

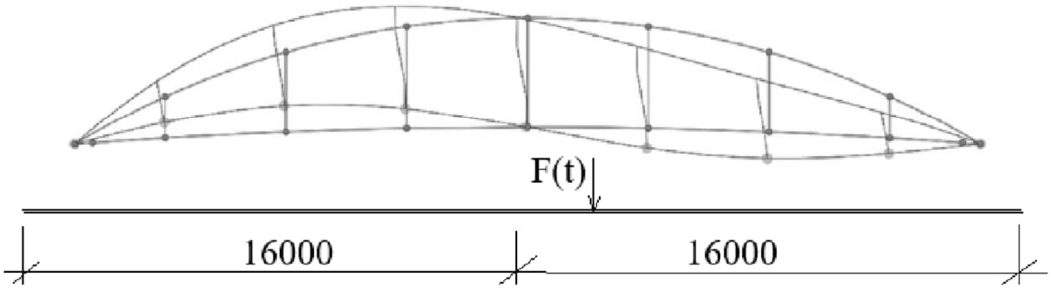
Load case t2

Load case:	Load cast t2
Analysis;	Analysis 3: Pedestrian crowd
Load curve:	Load curve: pedestrian crowd
Time domain:	Implicit dynamics
Step time:	0.01 s
Initial time:	10 s
Total time:	11 s
Stored results:	No

3.4 CYCLIC MOVING VERITICAL LOAD

The general document Eurocode 1991-2 does not contain definition of dynamic pedestrian loads-I this analysis national annex NA to BS EN 1991-2 is used.

The is applied to most dangerous eigenvalue frequency in vertical direction (f_v= 3.053).

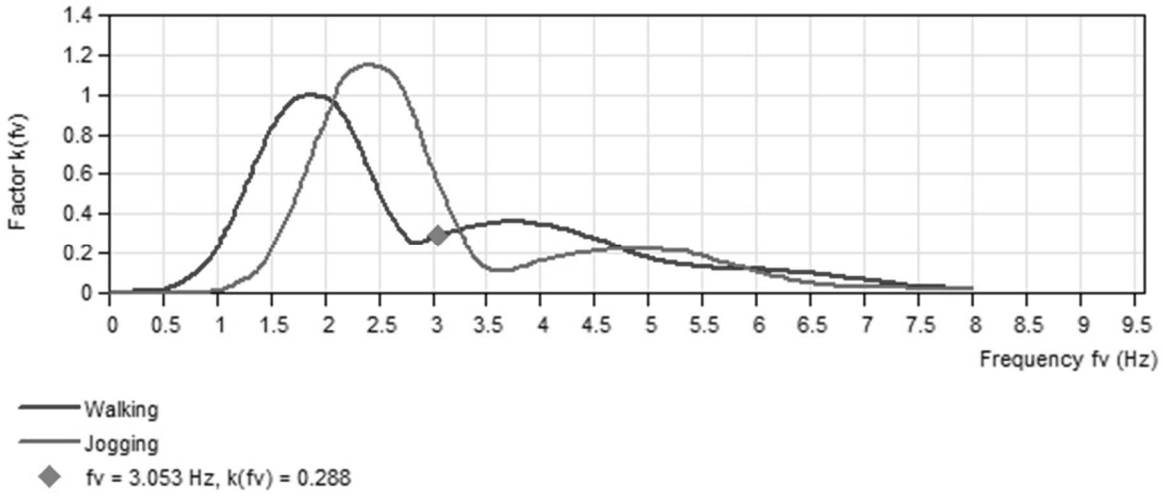


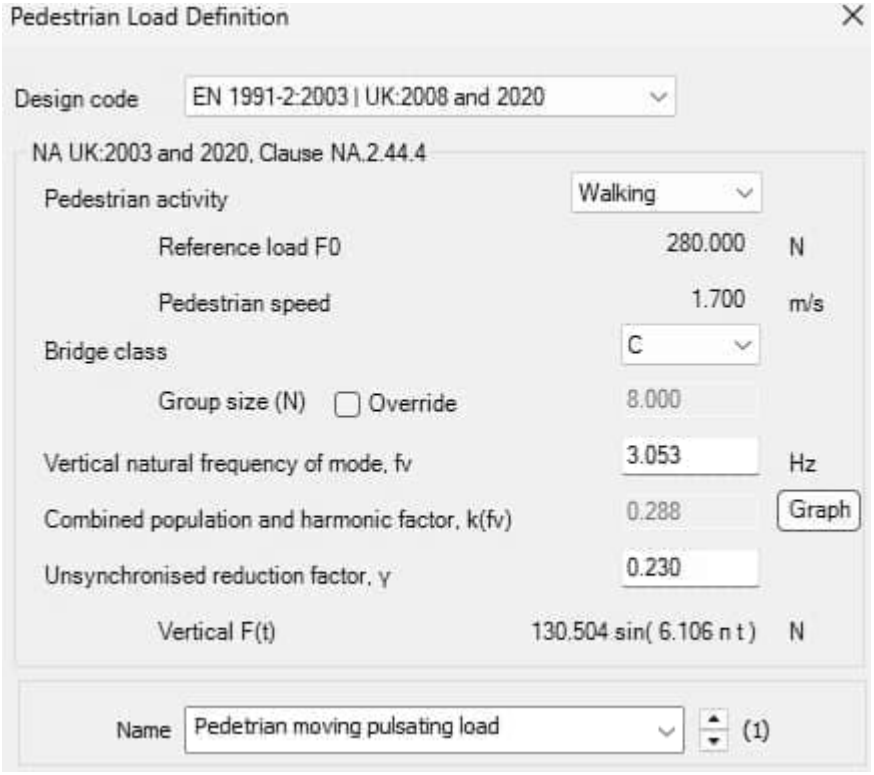
3.4.1 Vertical cyclic moving point load according NA section 2.44.4

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

$F_0 = 280\ N$: table NA.8 (Walking)

$v_t = 1.7 m/s$: table NA.8 (Walking)





$$\rightarrow F(t) = 280\,N \cdot 0.288 \cdot \sqrt{1 + 0.23 \cdot (8-1)} \cdot \sin(2\pi \cdot f_v \cdot t) = 130.5N \cdot \sin(2\pi \cdot f_v \cdot t)$$

3.4.2 Definition load curve

The load curve is defined as transient cyclic (see definition below). This load curve is applied to a discrete static moving point load.

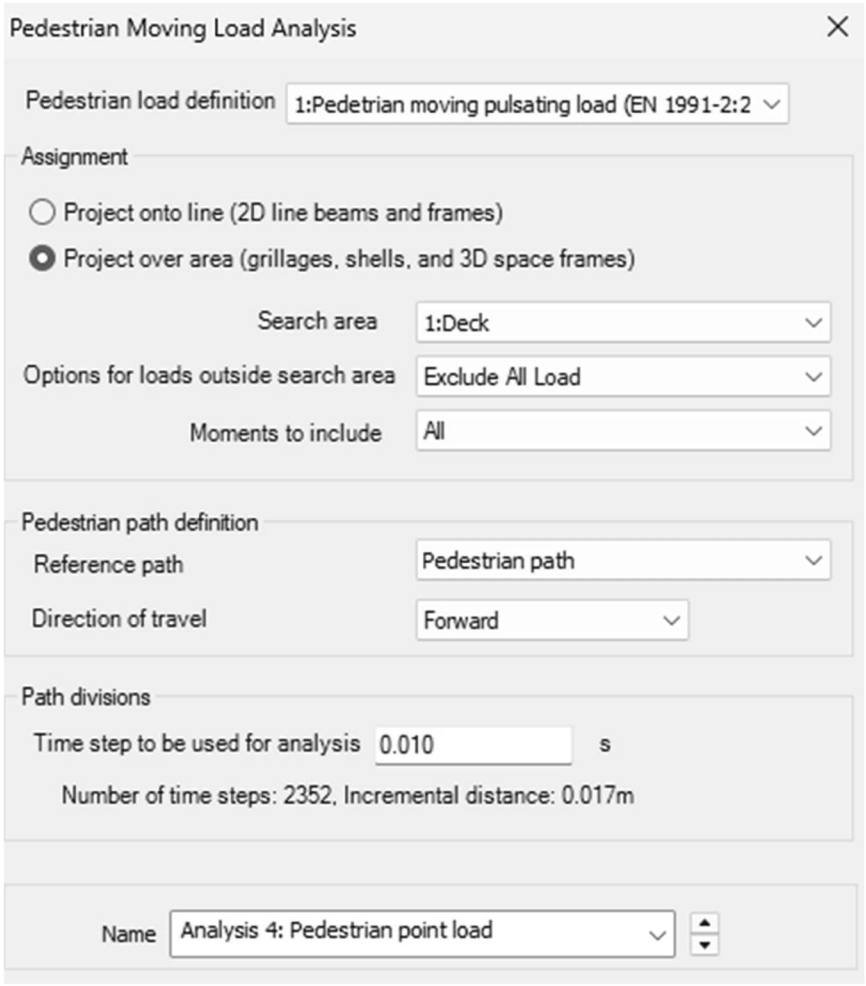
Name: "Load curve: pedestrian vertical load"

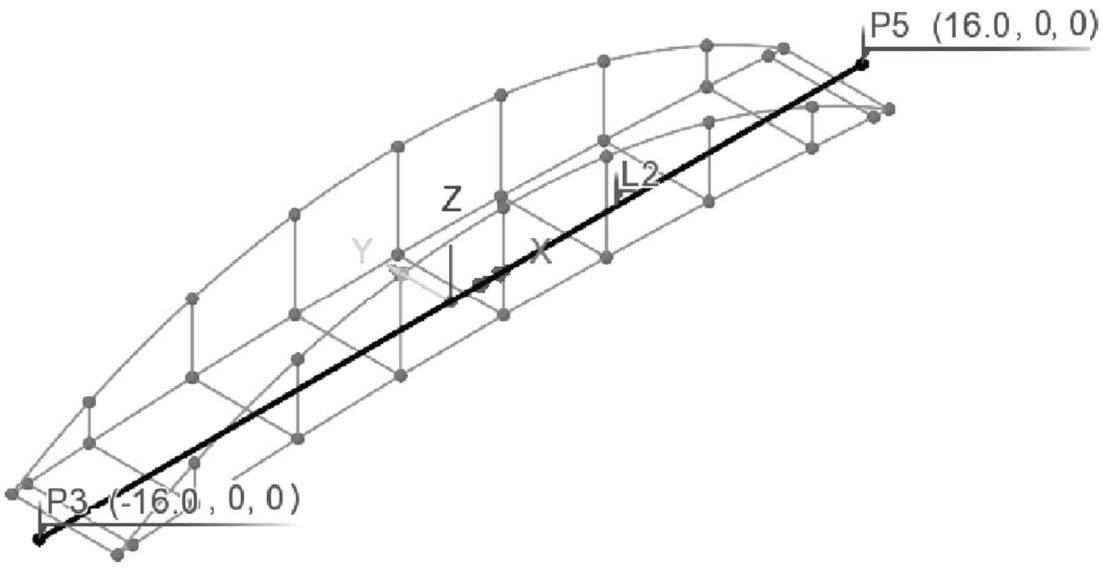
Type: Sine

Amplitude: 130.5

Frequency: 3.053

3.4.3 Definition of path of moving load



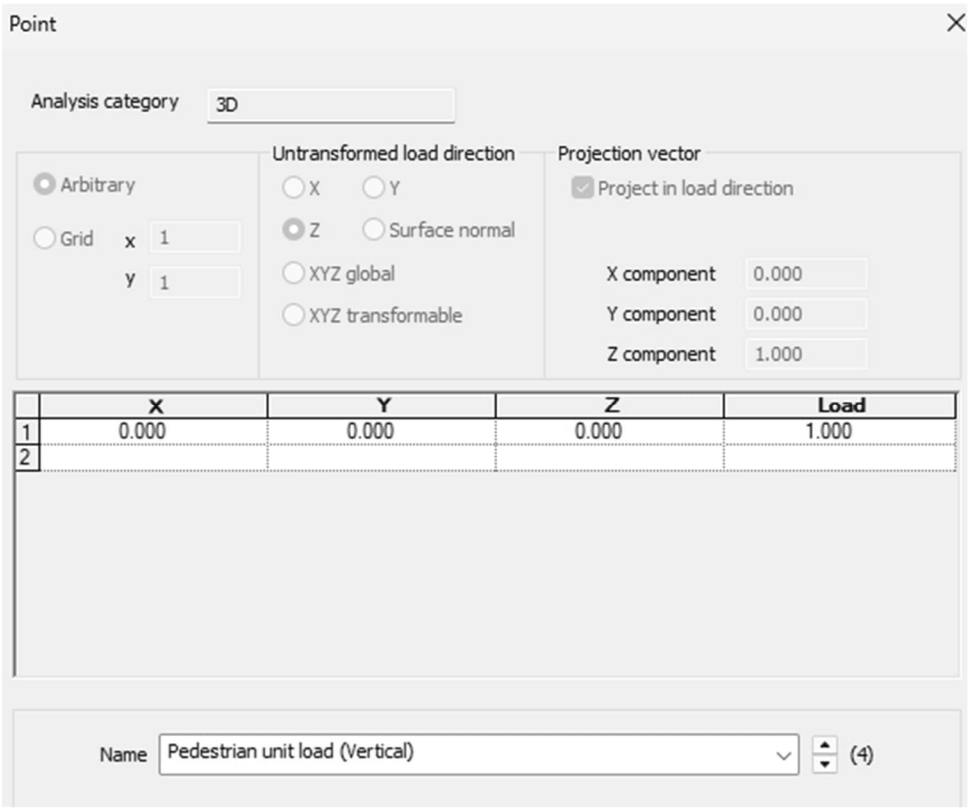


3D Overview

3.4.4 Definition discrete point load

The point load is moved along pedestrian path at speed of 1.7 m/s with step time 0.010 s a discrete point load is generated every 0.017 m → 1765 static load case (∴ 30 m / 0.017 m).

Total time on bridge : 17.65 s (∴30 m ÷ 1.7 m/s).



3.4.5 Definition transient load cases

Transient load cases are generated.

Load case: LC 4716 → LC 4680

Analysis: Analysis 4: Pedestrian moving load

Load curve: Load curve: pedestrian vertical load

Time domain: Implicit dynamics

Step time: 0.01 s

Initial time: 0 s

Total time: 20 s

4. RESULTS

4.1 WORKFLOW

Workflow for dynamic analysis of cyclic crowd load (surface load):

1. Generate static model and perform linear analysis (Analysis 1)
2. Perform *eigenvalue* analysis (Analysis 2)
3. Determine lowest frequency in z-direction.
4. Create unit discrete static surface loads that corresponds to nodal deflection (Analysis 3).
5. Create a transient cyclic load curve (Analysis 3).
6. Perform transient analysis of stationary loads (Analysis 3).

Workflow for dynamic analysis of cyclic crowd load (surface load):

1. Generate static model and perform linear analysis (Analysis 1)
2. Perform *eigenvalue* analysis (Analysis 2)
3. Determine lowest frequency in z-direction.
4. Create unit discrete moving point load along pedestrian track (Analysis 4).
5. Create a transient cyclic load curve (Analysis 4).
6. Perform transient analysis of moving loads (Analysis 4).

4.2 ACCELERATION: CYCLIC CROWD LOAD

Largest vertical acceleration (Z-direction) is $|A_z| = 0.27$ m/s^2, see appendix 2 page 7.

4.3 ACCELERATION: CYCLIC MOVING LOAD

Largest vertical acceleration (Z-direction) is $|A_z| = 0.45$ m/s^2, see appendix 2 page 8.

Title: Input receipt

Model Units: N,m,kg,s,C
Report Units: N,m,kg,s,C

Model Title: System 001
Model File: System 001

Clarification of definitions.

In the report, the letter “T” is used to describe a range. The letter is an abbreviation of “to”.

See example of assignment below.

Assignment to Lines:
105T110;114T119

This expression means that the assignment occurs to the lines L105 → L110 and L114 → L119.

Table of Contents

1. Points

Point	X coordinate	Y coordinate	Z coordinate
1	-15.0	-2.0	0.0
2	15.0	-2.0	0.0
3	-16.0	0.0	0.0
4	0.0	0.0	0.0
5	16.0	0.0	0.0
6	-15.0	2.0	0.0
7	15.0	2.0	0.0
8	-14.4	-2.0	0.0
9	14.4	-2.0	0.0
10	-14.4	2.0	0.0
11	14.4	2.0	0.0
12	-12.0	-2.0	0.2
13	12.0	-2.0	0.2
14	-12.0	2.0	0.2
15	12.0	2.0	0.2
16	-8.0	-2.0	0.4
17	8.0	-2.0	0.4
18	-8.0	2.0	0.4
19	8.0	2.0	0.4
20	-4.0	-2.0	0.5
21	4.0	-2.0	0.5
22	-4.0	2.0	0.5
23	4.0	2.0	0.5
24	0.0	-2.0	0.6
25	0.0	2.0	0.6
26	-12.0	-2.0	1.6
27	12.0	-2.0	1.6
28	-12.0	2.0	1.6
29	12.0	2.0	1.6
30	-8.0	-2.0	3.1
31	8.0	-2.0	3.1
32	-8.0	2.0	3.1
33	8.0	2.0	3.1
34	-4.0	-2.0	3.9
35	4.0	-2.0	3.9
36	-4.0	2.0	3.9
37	4.0	2.0	3.9
38	0.0	-2.0	4.2
39	0.0	2.0	4.2
Moving Load	0.0	0.0	0.0

2. Lines

Line	Points	Line	Points
1	1,6	3	2,7
4	1,8	5	9,2
6	6,10	7	11,7
8	8,10	9	9,11
10	8,12	11	13,9
12	10,14	13	15,11
14	12,14	15	13,15
16	12,16	17	17,13
18	14,18	19	19,15
20	16,18	21	17,19
22	16,20	23	21,17
24	18,22	25	23,19
26	20,22	27	21,23
28	20,24	29	22,25
30	24,21	31	25,23
32	24,25	33	1,26
34	27,2	35	6,28
36	29,7	37	12,26
38	13,27	39	14,28
40	15,29	41	16,30
42	17,31	43	18,32
44	19,33	45	20,34
46	21,35	47	22,36
48	23,37	49	24,38
50	25,39	51	26,30
52	31,27	53	28,32
54	33,29	55	30,34
56	35,31	57	32,36
58	37,33	59	34,38
60	38,35	61	36,39
62	39,37		

3. MESH: Line

Attribute: 1 **Title: Element 4**

Sub Type = Line Mesh **Element Type = BMI21**

Mesh spacing	Nr. of elements	Start node end releases:	End node end releases:
Uniform	4	None	None

Assignment to Lines: Beta angle = 0.000

1;3;4T62

4. MESH: Mass

Attribute: 2 **Title: Mass elements**

Sub Type = Point Mesh **Element Type = PM3**

Property	Symbol	Value
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Points Beta angle = 0.000

1;2;6;7;12T25

5. Geometric: Line

Attribute: 1 **Title: Arch (273x20 CHS)** **Sub Type = Line Geometric**

Assigned in: Analysis 1: Linear static

Property	Symbol	Value
Cross sectional area	A	0.0
Second moment of area about y axis	Iyy	0.0
Second moment of area about z axis	Izz	0.0
Product moment of area	Iyz	0.0
Torsional constant	J	0.0
Eccentricity in local z direction, relative to specified origin	ez0	0.0
Eccentricity in local y direction, relative to specified origin	ey0	0.0
Eccentricity in local z direction, relative to beam centroid	ez	0.0
Eccentricity in local y direction, relative to beam centroid	ey	0.0
Wagner constant 1st moment of square radius about y (Iyr)	Iyr	0.0
Wagner constant 1st moment of square radius about z (Izr)	Izr	0.0
Wagner constant 4th moment of area about origin (Irr)	Irr	0.0
Wagner constant 2nd moment of warping about origin (Iwr)	Iwr	0.0
Effective shear area in local z direction	Asz	0.0
Effective shear area in local y direction	Asy	0.0
Plastic area	Ap	0.0
Plastic modulus for bending about y	Zpy	0.0
Plastic modulus for bending about z	Zpz	0.0
Plastic neutral axis, distance from centroid along y axis	yp	0.0
Plastic neutral axis, distance from centroid along z axis	zp	0.0
Plastic torsional section modulus	Zpt	0.0
Warping torsional constant about shear centre	Cw	0.0
Shear centre about y axis	yo	0.0
Shear centre about z axis	zo	0.0
Monosymmetry constant about y	betay	0.0
Monosymmetry constant about z	betaz	0.0
Radius of gyration about y axis	ky	0.1
Radius of gyration about z axis	kz	0.1
y axis extreme fibre, top	yt	0.1
y axis extreme fibre, bottom	yb	-0.1
z axis extreme fibre, top	zt	0.1
z axis extreme fibre, bottom	zb	-0.1
Shape code identifier	Type	4
Outer diameter of this section	D	0.3
Thickness of this section	t	0.0
Element type	elementType	"3D Thick Beam"
Reinforcement	reinforcement	None

Assignment to Lines:

33T36;51T62

Attribute: 2 Title: Hanger (114.3x10 CHS) Sub Type = Line Geometric
Assigned in: Analysis 1: Linear static

Property	Symbol	Value
Cross sectional area	A	0.0
Second moment of area about y axis	Iyy	0.0
Second moment of area about z axis	Izz	0.0
Product moment of area	Iyz	0.0
Torsional constant	J	0.0
Eccentricity in local z direction, relative to specified origin	ez0	0.0
Eccentricity in local y direction, relative to specified origin	ey0	0.0
Eccentricity in local z direction, relative to beam centroid	ez	0.0
Eccentricity in local y direction, relative to beam centroid	ey	0.0
Wagner constant 1st moment of square radius about y (Iyr)	Iyr	0.0
Wagner constant 1st moment of square radius about z (Izr)	Izr	0.0
Wagner constant 4th moment of area about origin (Irr)	Irr	0.0
Wagner constant 2nd moment of warping about origin (Iwr)	Iwr	0.0
Effective shear area in local z direction	Asz	0.0
Effective shear area in local y direction	Asy	0.0
Plastic area	Ap	0.0
Plastic modulus for bending about y	Zpy	0.0
Plastic modulus for bending about z	Zpz	0.0
Plastic neutral axis, distance from centroid along y axis	yp	0.0
Plastic neutral axis, distance from centroid along z axis	zp	0.0
Plastic torsional section modulus	Zpt	0.0
Warping torsional constant about shear centre	Cw	0.0
Shear centre about y axis	yo	0.0
Shear centre about z axis	zo	0.0
Monosymmetry constant about y	betay	0.0
Monosymmetry constant about z	betaz	0.0
Radius of gyration about y axis	ky	0.0
Radius of gyration about z axis	kz	0.0
y axis extreme fibre, top	yt	0.1
y axis extreme fibre, bottom	yb	-0.1
z axis extreme fibre, top	zt	0.1
z axis extreme fibre, bottom	zb	-0.1
Shape code identifier	Type	4
Outer diameter of this section	D	0.1
Thickness of this section	t	0.0
Element type	elementType	"3D Thick Beam"
Reinforcement	reinforcement	None

Assignment to Lines:
37T50

Attribute: 3 Title: Beams (HE 280 A)

Sub Type = Line Geometric

Assigned in: Analysis 1: Linear static

Property	Symbol	Value
Cross sectional area	A	0.0
Second moment of area about y axis	Iyy	0.0
Second moment of area about z axis	Izz	0.0
Product moment of area	Iyz	0.0
Torsional constant	J	0.0
Eccentricity in local z direction, relative to specified origin	ez0	0.0
Eccentricity in local y direction, relative to specified origin	ey0	0.0
Eccentricity in local z direction, relative to beam centroid	ez	0.0
Eccentricity in local y direction, relative to beam centroid	ey	0.0
Wagner constant 1st moment of square radius about y (Iyr)	Iyr	0.0
Wagner constant 1st moment of square radius about z (Izr)	Izr	0.0
Wagner constant 4th moment of area about origin (Irr)	Irr	0.0
Wagner constant 2nd moment of warping about origin (Iwr)	Iwr	0.0
Effective shear area in local z direction	Asz	0.0
Effective shear area in local y direction	Asy	0.0
Plastic area	Ap	0.0
Plastic modulus for bending about y	Zpy	0.0
Plastic modulus for bending about z	Zpz	0.0
Plastic neutral axis, distance from centroid along y axis	yp	0.0
Plastic neutral axis, distance from centroid along z axis	zp	0.0
Plastic torsional section modulus	Zpt	0.0
Warping torsional constant about shear centre	Cw	0.0
Shear centre about y axis	yo	0.0
Shear centre about z axis	zo	0.0
Monosymmetry constant about y	betay	0.0
Monosymmetry constant about z	betaz	0.0
Radius of gyration about y axis	ky	0.1
Radius of gyration about z axis	kz	0.1
y axis extreme fibre, top	yt	0.1
y axis extreme fibre, bottom	yb	-0.1
z axis extreme fibre, top	zt	0.1
z axis extreme fibre, bottom	zb	-0.1
Shape code identifier	Type	5
Breadth of this section	B	0.3
Depth of this section	D	0.3
Thickness of flange of this section	tf	0.0
Thickness of web of this section	tw	0.0
Radius of fillet of this section		0.0
Element type	elementType	"3D Thick Beam"
Reinforcement	reinforcement	None

Assignment to Lines:

1;3;4T32

6. Isotropic material

Attribute: 1 **Title: Steel (damping)**

Sub Type = Isotropic Material

Property	Symbol	Value
Young's modulus	E	210000000000.0
Poisson's ratio	nu	0.3
Density	rho	7849.1
Mass Rayleigh damping constant	ar	0.028
Stiffness Rayleigh damping constant	br	0.0004

Assigned in: Analysis 3: Pedestrian crowd; Analysis 4: Pedestrian moving load

Assignment to Lines:
1T62

Attribute: 3 **Title: Steel (Steel - Structural | EN1993-1-1:2005)** **Sub Type = Isotropic Material**

Property	Symbol	Value
Young's modulus	E	210000000000.0
Poisson's ratio	nu	0.3
Density	rho	7849.1
Coefficient of thermal expansion	alpha	0.0

Assigned in: Analysis 1: Linear static
Assignment to Lines:
1T62

Attribute: 2 **Title: 500 kg**

Sub Type = Mass

Property	Symbol	Value
Mass in X	massX	500.0
Mass in Y	massY	500.0
Mass in Z	massZ	500.0
3D	is3d	true
Type	type	"point"

Assigned in: Analysis 1: Linear static
Assignment to Points:
1;2;6;7;12T25

7. Support

Attribute: 1 **Title: Fixed**

Sub Type = Structural Support

Property	Symbol	Value
Translation in X	U	"R"
Translation in Y	V	"R"
Translation in Z	W	"R"
Rotation about X	THX	"F"
Rotation about Y	THY	"F"
Rotation about Z	THZ	"F"
Torsional warping	Torsion	"F"
Moment about hinge	L1	"F"
Pore pressure	pore	"C"

Assignment to Points:
1;6

Attribute: 2 **Title: Free**

Sub Type = Structural Support

Property	Symbol	Value
Translation in X	U	"F"
Translation in Y	V	"R"
Translation in Z	W	"R"
Rotation about X	THX	"F"
Rotation about Y	THY	"F"
Rotation about Z	THZ	"F"
Torsional warping	Torsion	"F"
Moment about hinge	L1	"F"
Pore pressure	pore	"C"

Assignment to Points:
2;7

8. Search Area

Attribute: 1

Title: Ddeck

Sub Type = Search Area
Assignment to Lines: 1T32

13. Body load

Attribute: 1

Title: Dead weight

Sub Type = Body Force Load

Property	Symbol	Value
Linear acceleration in X	AccX	0.0
Linear acceleration in Y	AccY	0.0
Linear acceleration in Z	AccZ	-10.0
Angular velocity about X axis	AngVelX	0.0
Angular velocity about Y axis	AngVelY	0.0
Angular velocity about Z axis	AngVelZ	0.0
Angular acceleration about X axis	AngAccX	0.0
Angular acceleration about Y axis	AngAccY	0.0
Angular acceleration about Z axis	AngAccZ	0.0
Linear acceleration In X fluid phase	lnFlAccX	0.0
Linear acceleration In Y fluid phase	lnFlAccY	0.0
Linear acceleration In Z fluid phase	lnFlAccZ	-10.0

Assignment to Lines:

1T62

Property	Symbol	Value
Linear acceleration in X	AccX	0.0
Linear acceleration in Y	AccY	0.0
Linear acceleration in Z	AccZ	-10.0
Angular velocity about X axis	AngVelX	0.0
Angular velocity about Y axis	AngVelY	0.0
Angular velocity about Z axis	AngVelZ	0.0
Angular acceleration about X axis	AngAccX	0.0
Angular acceleration about Y axis	AngAccY	0.0
Angular acceleration about Z axis	AngAccZ	0.0
Linear acceleration In X fluid phase	lnFlAccX	0.0
Linear acceleration In Y fluid phase	lnFlAccY	0.0
Linear acceleration In Z fluid phase	lnFlAccZ	-10.0

14. Discrete point load

Symbol	Property
dirType	Load direction
pDir	Projection vector
nGridX	X Grid size
nGridY	Y Grid size
pos	Coordinates
P	Load

Attribute: 4 **Title: Pedstrian unit load (Vertical)**
Sub Type = Discrete Point Load

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0.0	0.0	1.0	0	0

pos_x	pos_y	pos_z	Pz
0.0	0.0	0.0	1.0

Search area= Deck
Moving status = Yes
Step length: 0.017
Load outside search area = Include
Assignment to Line: L2

15. Discrete pacth load

Symbol	Property
patchType	Patch type
sweptAngle	Swept angle
xDivisions	Number of local x divisions
yDivisions	Number of local y divisions
dirType	Load direction
pDir	Projection vector
nGridX	X Grid size
nGridY	Y Grid size
pos	Coordinates
P	Load

Attribute: 2 Title: Unit pedestrian crowd-
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0	0	1	0	0

pos_x	pos_y	pos_z	Pz
-15.0	-1.5	0	-1
0	-1.5	0	-1
0	1.5	0	-1
-15.0	1.5	0	-1

Search area= Deck
Moving status = No
Load outside search area = Include
Assignment to Point: 4

Attribute: 3 Title: Unit pedestrian crowd+
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0	0	1	0	0

pos_x	pos_y	pos_z	Pz
0	-1.5	0	1
15.0	-1.5	0	1
15.0	1.5	0	1
0	1.5	0	1

Search area= Deck
Moving status = No
Load outside search area = Include
Assignment to Point: 4

16. Load curves

Attribute 1
Title: Load curve: Pedestrian crowd
Type: Sine
Amplitude: 2.542
Mean value: 0
Frequency: 3.053
Activation time: 0

Attribute: 2
Title: Load curve: Pedestrian vertical load
Type: Sine
Amplitude: 130.5
Mean value: 0
Frequency: 3.053
Activation time: 0

17. Transient analysis

Title: Analysis 3: Cyclic crowd load
Loadcase: Loadcase t1
Factor = ”Load curve: Pedestrain crowd”
Assigned in: Analysis 3: Pedestrain crowd
Time domain: Implicit dynamics
Activation time: 0
Step time: 0.01
Total respons time: 10

Title: Analysis 3: Cyclic crowd load
Loadcase: Loadcase t2
Factor = ”Load curve: Pedestrain crowd”
Assigned in: Analysis 3: Pedestrain crowd
Time domain: Implicit dynamics
Activation time: 10
Step time: 0.01
Total respons time: 11

Title: Analysis 4: Cyclic moving load
Loadcases: LC 4716… LC 8480
Factor = ”Load curve: Pedestrain crowd”
Assigned in: Analysis 4: Pedestrain vertical load
Time domain: Implicit dynamics
Activation time: 0
Step time: 0.01
Total respons time: 20

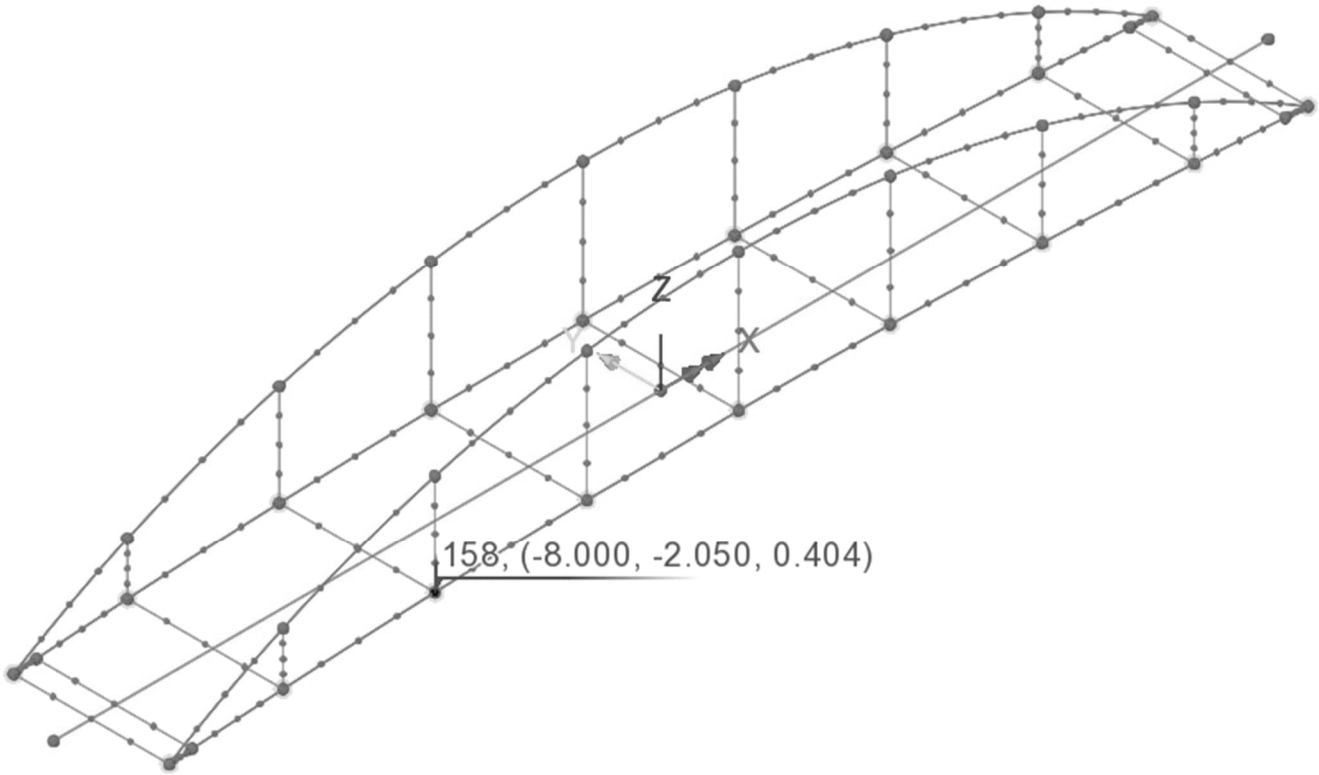
Title: Results

Model Units: N,m,kg,s,C
Report Units: N,m,kg,s,C

Model Title: System 001
Model File: System 001

Table of Contents

1. Result nodes



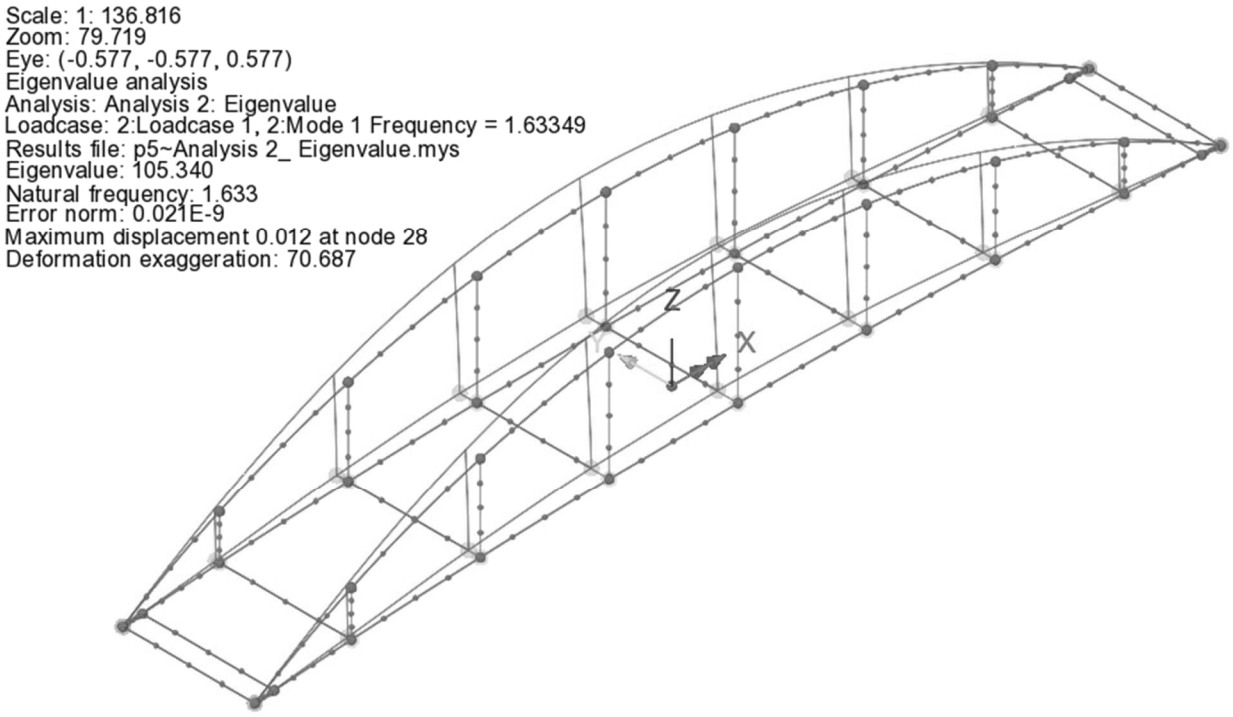
3D Overview
Location N158

2. Analysis 2: Eigenvalues

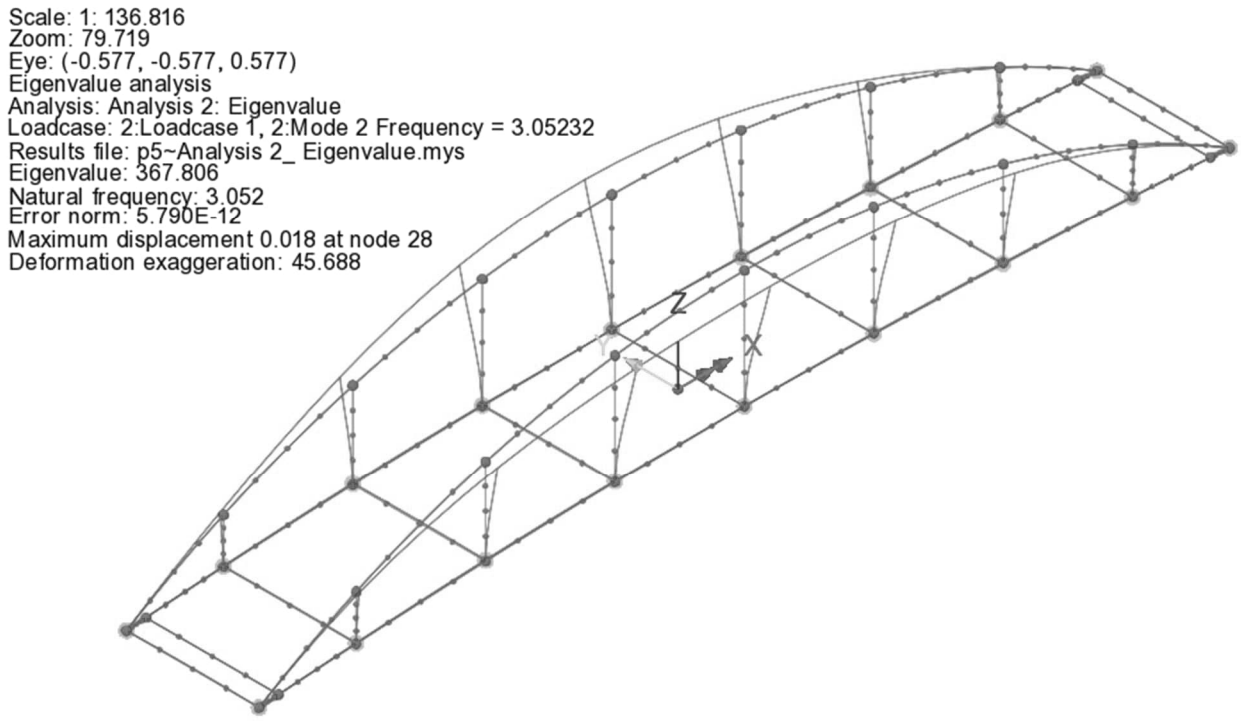
2.1 Table

Mode	Eigenvalue	Frequency
1	105	1.633
2	368	3.052
3	368	3.053
4	463	3.424
5	585	3.851
6	612	3.936
7	1148	5.392
8	1336	5.817
9	1403	5.962
10	1796	6.744
-	-	Hz

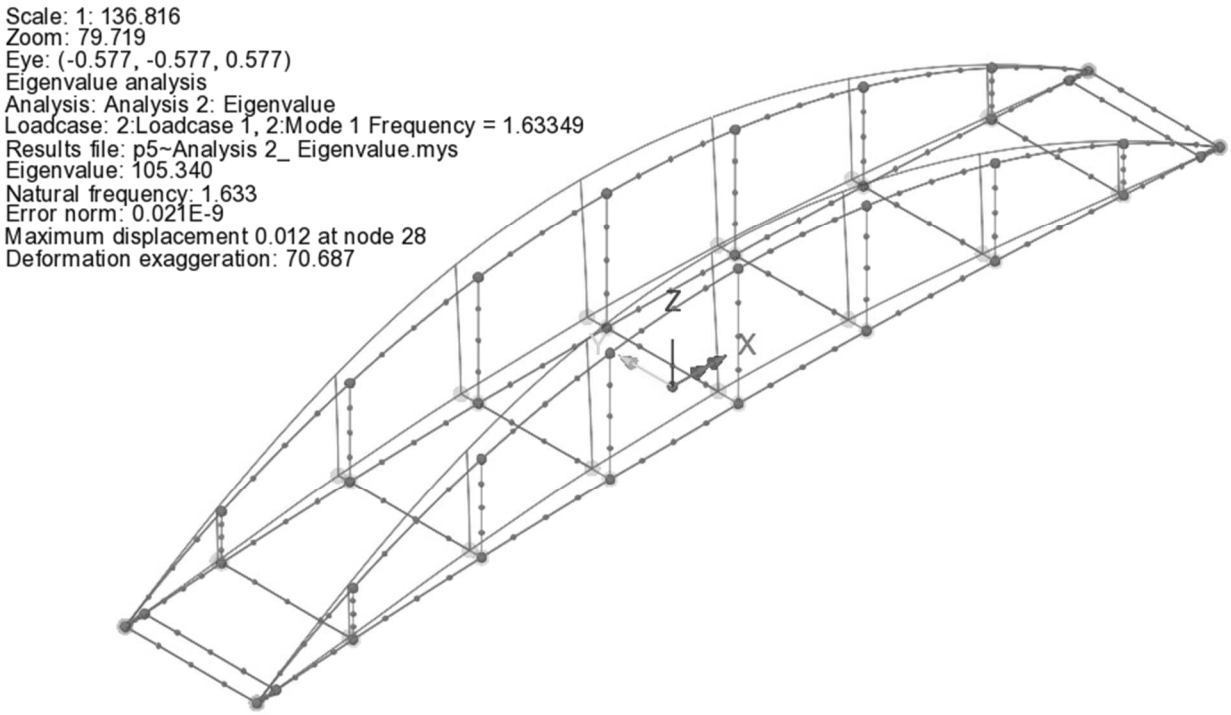
2.2 Deformed mesh



3D view
Mode 1: deformation y-direction



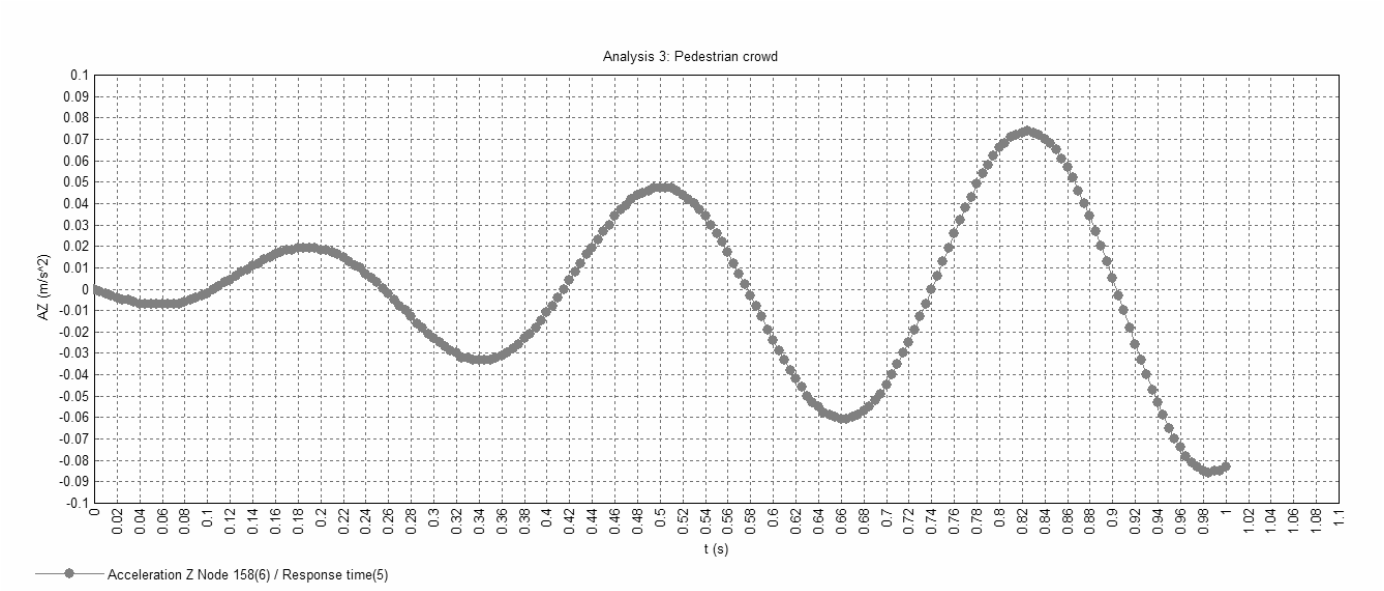
3D view
Mode 2: deformation y-direction



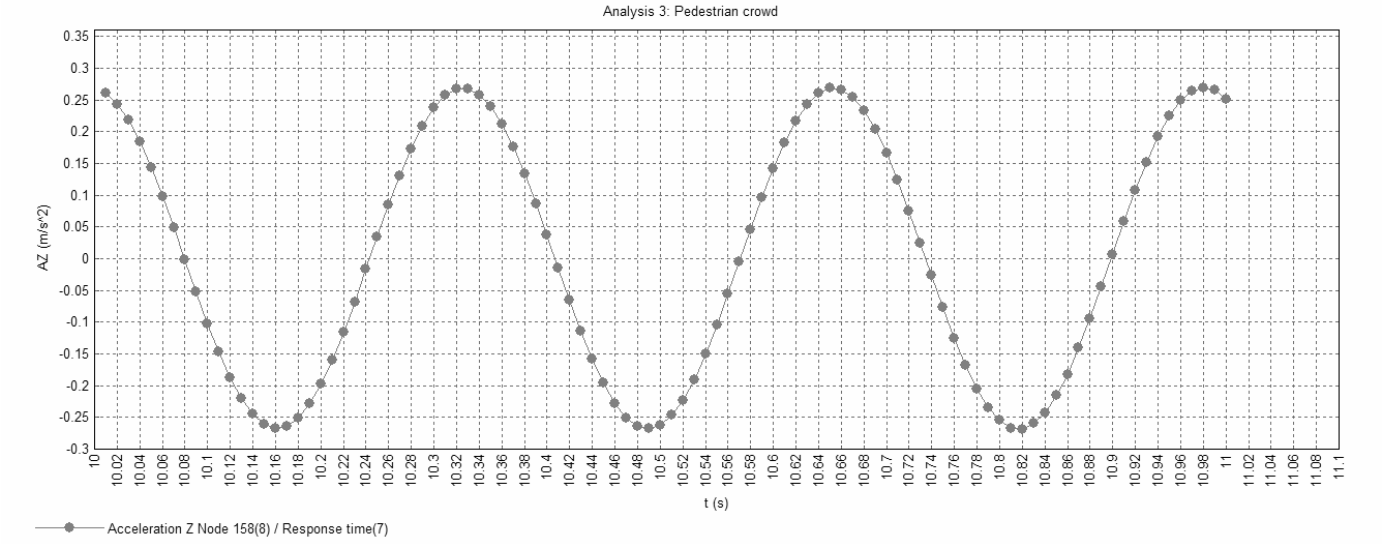
3D view
Mode 3: deformation z-direction

3. Analysis 3: Cyclic crowd load

Time 0 s → 1.0 s (time step 0.005 s):



Time 10.0 s → 11.0 s (time step 0.005 s):



4. Analysis 4: Cyclic moving vertical load

Time 0 s → 20 s (time step 0.005 s):