

Dynamic analysis: RC open frame bridge

High speed dynamic analysis is performed using method of interactive modal dynamics. Method allows the definition of a constant moving load across a pre-specified path (track) and obtains the results for a specified range of travelling speeds.

1. Generate static model.
2. Perform *eigenvalue* analysis in frequency range 0 → 35 Hz.
3. Determine *participation factors*.
4. Determine *mass participation factors*.
5. Determine *sum mass participation factors*.
6. Define discrete point load Unit Axle load ($P = 1 \text{ kN}$).
7. Define HSLM- A1 using *vehicle configuration*.
8. Perform *moving dynamic load generation* for Unit Axle
9. Perform *modal force calculation* for Unit load.
10. Chose location for results. Centre of deck is chosen (0 m; 0 m; 5.75 m).
11. Perform dynamic *moving load analysis* for vehicule HSLM – A1

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Appendices	Date	Rev. Date	Rev.
1. Input Receipt 2. Results			

	Part A – CALCULATION ASSUMPTIONS Dymnic analysis: Open RC frame bridge	Status :	Page: A1:1
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1. GENERAL / MEASUREMENT

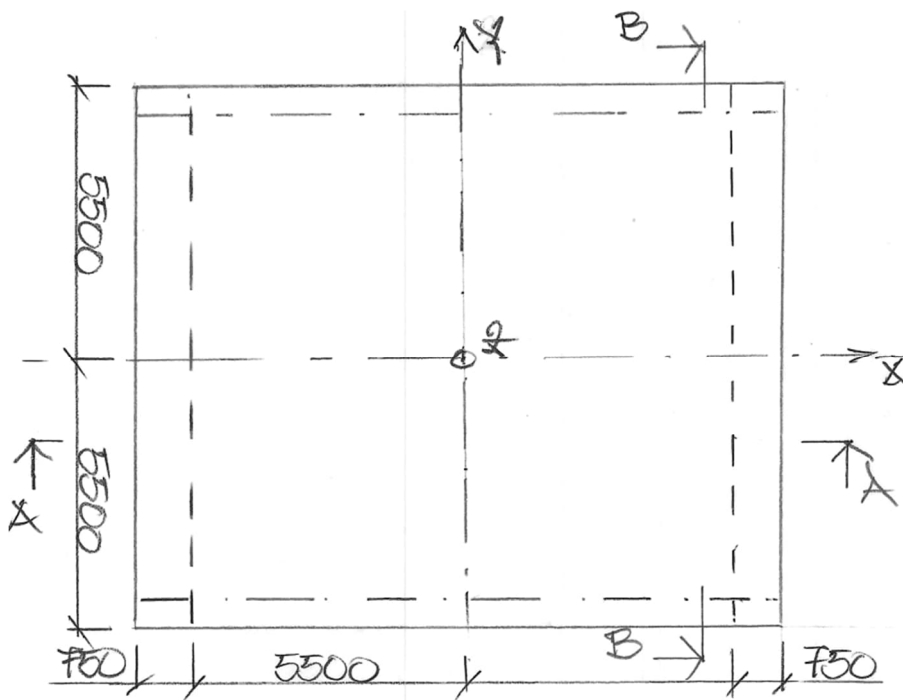
1.1	CONSTRUCTION TYPE	page 1:2
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1.1 CONSTRUCTION TYPE

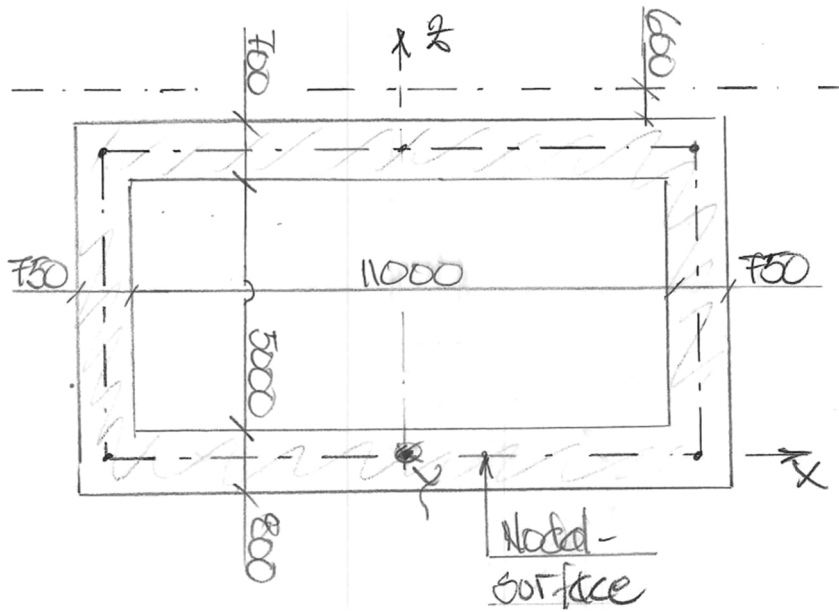
Closed bridge frame constructed using reinforced concrete.

1.2 MEASUREMENTS

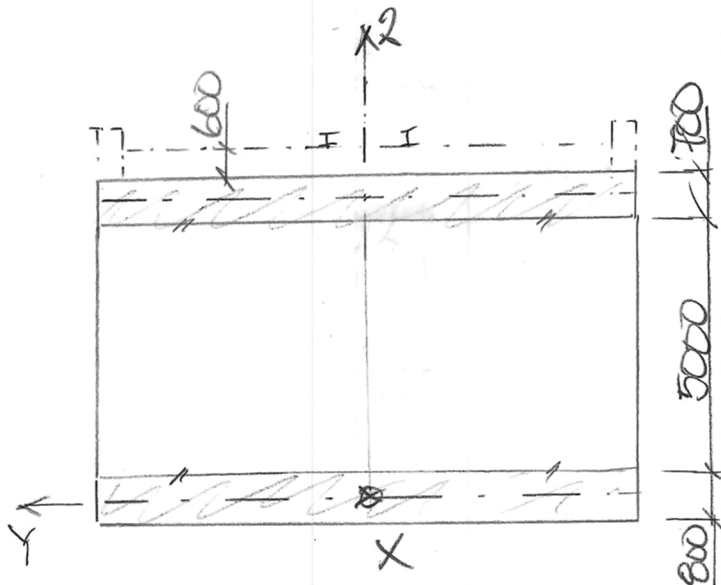


PLAN

	Part A – CALCULATION ASSUMPTIONS	Status :	Page: A1:3
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SECTION A-A
Longitudinal direction.



SECTION B-B
Transversal direction.

	Part A – CALCULATION ASSUMPTIONS Dymnic analysis: Open RC frame bridge	Status :	Page: A1:4
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1.3 FOUNDATION

Bottom slab is a 0.5 m blasted rock rock on top 4.5 m natural natural soil consisting of non cohesion material.

Equivalent vertical spring modulus: 50 MN/m³

1.4 FILLING

Filling against abutment consists of compacted blasted rock.

Equivalent hoizontal sping modulus: 4 MN/m³

1.5 MATERIAL

C40/50 → $E_{ck} = 35\text{GPa}$

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:1
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2. SYSTEM ANALYSIS

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2.2	SKETCH SYSTEM ANALYSIS	page 2:3-4
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	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:2
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2.1 GENERAL

The bridge is built using reinforced concrete.

The bridge is designed as frame bridge.

Abutments are defined by using shell elements applied to nodal surface in abutments.

Superstructure is defined by using shell elements applied to nodal surface in superstructure.

Entire structure is modelled using isotropic material.

Bridge foundation consists of compacted gravel.

System analysis is performed using 3D FEM-program.

Wingwalls are not modelled statically since considered inactive in vertical direction. This is due cracking and the use of only minimal reinforcement in this direction.

Edge beams are not modelled statically since considered inactive. This assumption is considered on safe side. The assumption will facilitate future replacement of edge beams.

Foundation stiffness in vertical direction is modelled using equivalent vertical springs corresponding to foundation modulus.

The bottom slab has a point support in horizontal plan at centre corresponding to friction between soil. This fictive support is modelled against translation in X-Y plane.

The horizontal stiffness between backfill and abutments are modelled using equivalent springs in X plane.

Appendices:

Appendix	Name
1	Input receipt
2	Results

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2.2 SKETCH SYSTEM ANALYSIS

To describe geometry LUSAS first defines POINTS.

Beam elements are defined by applying attributes to LINES.

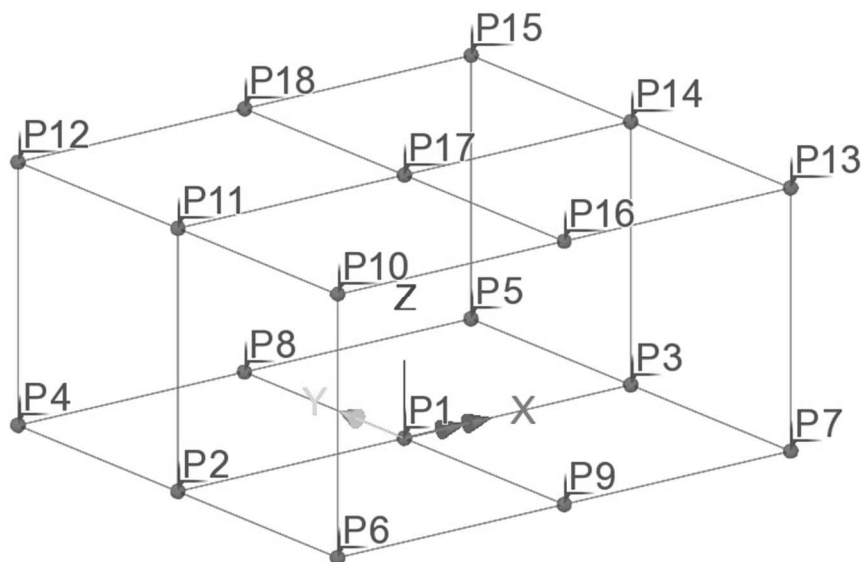
Shell elements are defined by applying attributes to SURFACES.

Attached pictures are retrieved from graphical sketches generated by LUSAS of POINTS, LINES and SURFACES.

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

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

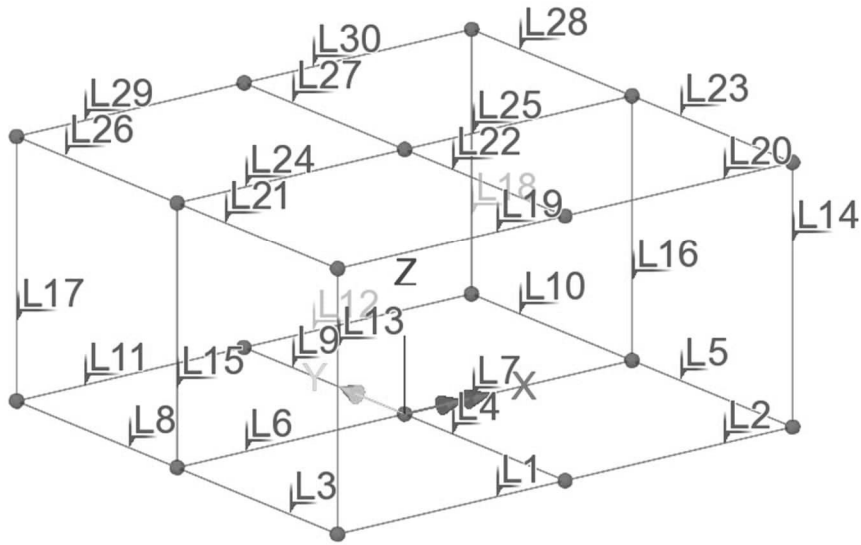
All LINES need to describe SURFACE are found in Appendix 1.



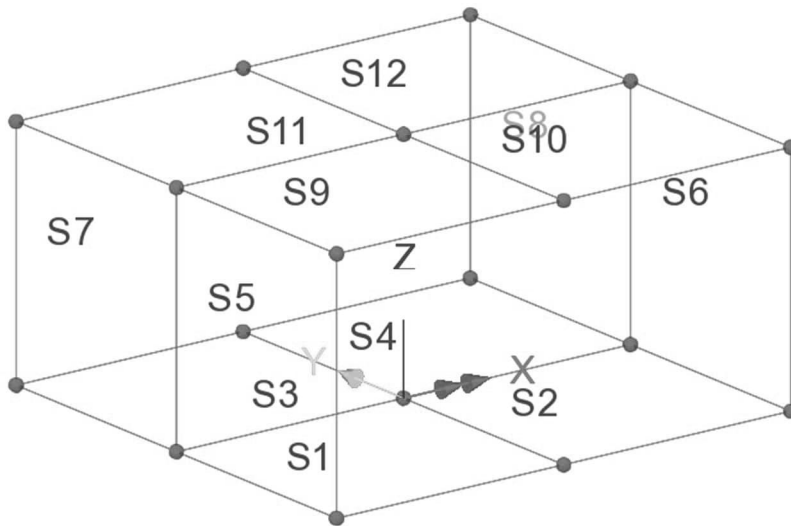
Overview

Points

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Overview
Lines

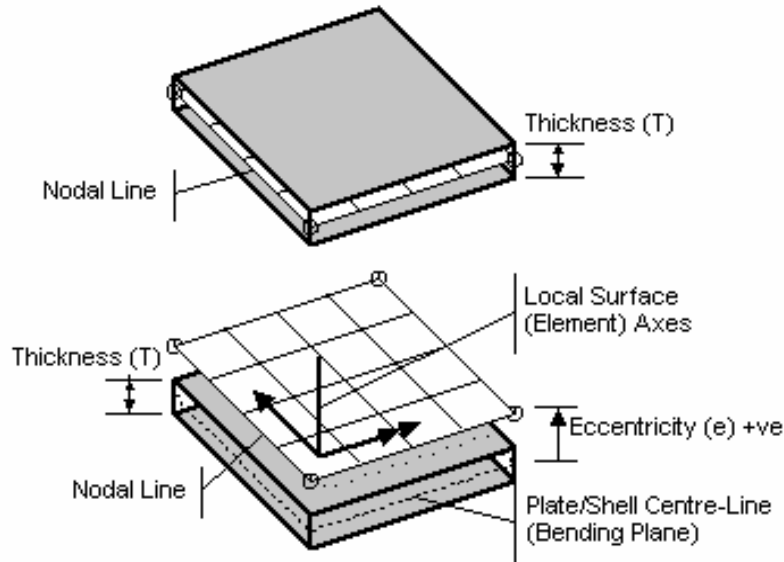


Overview
Surfaces

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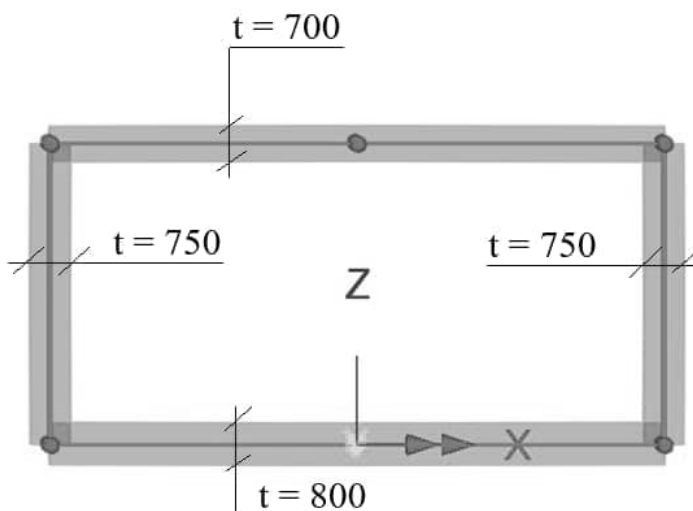
2.3 CROSS SECTION PROPERTIES

Principle figures of geometry associated to shell elements are seen below.

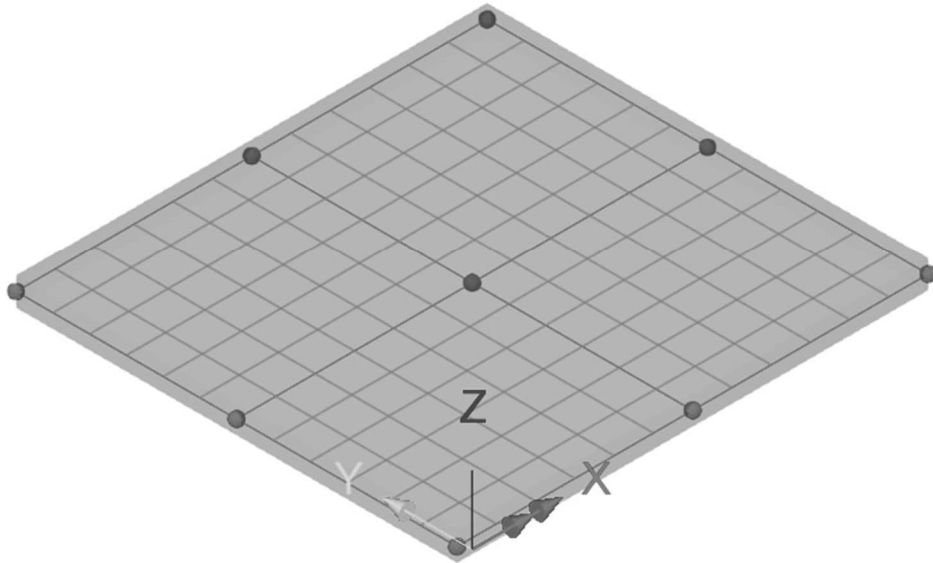


Surface geometry...:

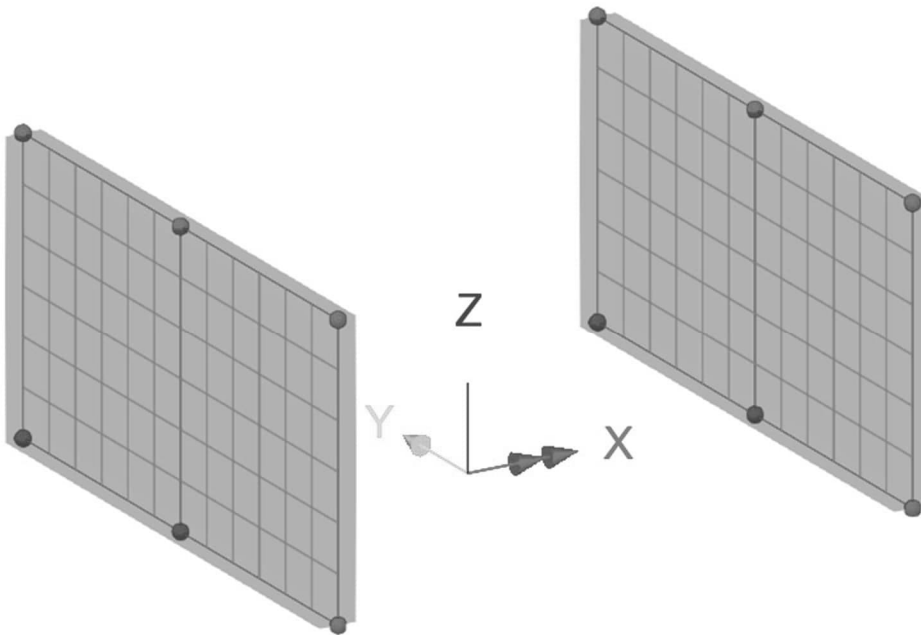
Attribute	t	ez	Remark
t = 800 mm	0.80	0	Bottom slab at support 1
t = 750 mm	0.75	0	Bottom slab at support 2
t = 700 mm	0.70	0	Bottom of abutment 1
-	m	m	-



	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:6
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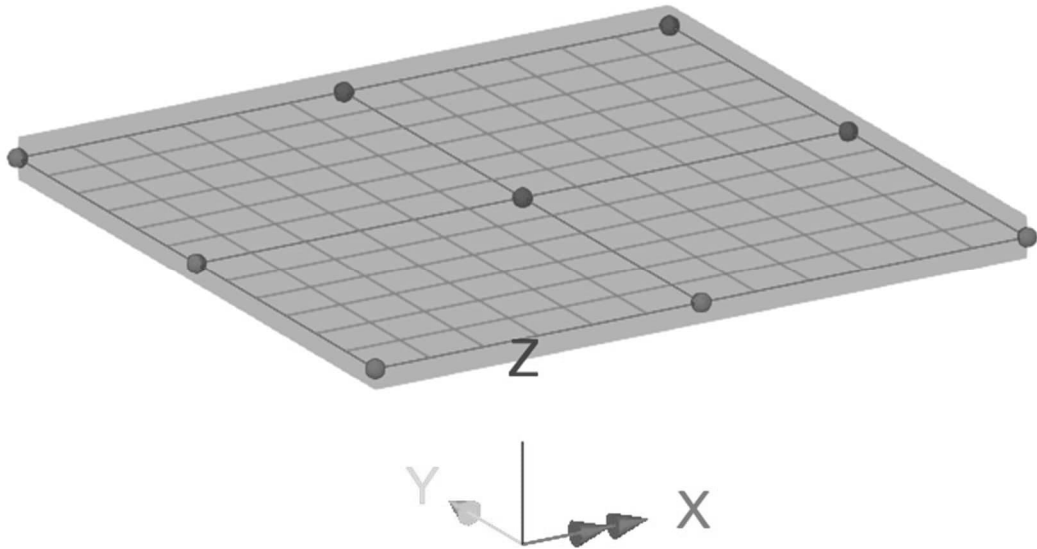


Overview
Bottom slab



Overview
Bottom slab

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:7
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Overview
Deck

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:8
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2.4 MATERIAL

Material properties seen below are to be used.

Concrete C40/50 : $E_{ck} = 35 \text{ GPa}$

Dynamic E-modulus ($\therefore 1.1E_{ck}$) : $E_{dyn} = 38.5 \text{ GPa}$

2.4.1 Material properties: Bottom slab & abutements

$$\gamma_c = 25 \frac{kN}{m^3} \therefore 2.5 \frac{tons}{m^3}$$

Isotropic ✕

Plastic
 Creep
 Damage
 Shrinkage
 Viscous
 Two phase
 Ko Initialisation

Elastic

Dynamic properties
 Thermal expansion

	Value
Young's modulus	38.5E6
Poisson's ratio	0.2
Mass density	2.5
Coefficient of thermal expansion	10.0E-6

Name (1)

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:9
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2.4.2 Material properties: Deck

Mass density is adapted to include 0.6 m ballas. Below is used equivalent mass density.

$$\gamma'_c = \frac{0.7m \cdot 25 \frac{kN}{m^3} + 0.6m \cdot 20 \frac{kN}{m^3}}{0.7m} = 42 \frac{kN}{m^3} \therefore 4.2 \frac{tons}{m^3}$$

Isotropic ✕

Plastic
 Creep
 Damage
 Shrinkage
 Viscous
 Two phase
 Ko Initialisation

Elastic

Dynamic properties
 Thermal expansion

	Value
Young's modulus	38.5E6
Poisson's ratio	0.2
Mass density	4.2
Coefficient of thermal expansion	10.0E-6

Name (2)

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:10
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2.5 BOUNDARY CONDITIONS

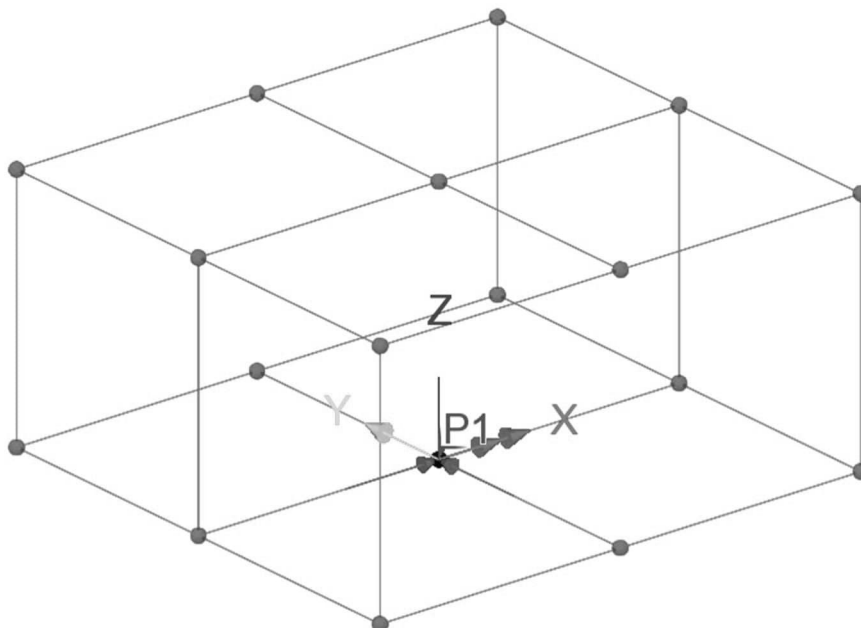
2.5.1 Point support: bottom slab

Structural Supports

Analysis category

		Free	Fixed	Spring	Spring stiffness
Translation in	X	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="text"/>
	Y	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="text"/>
	Z	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Rotation about	X	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
	Y	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
	Z	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Hinge rotation		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Torsional warping		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Pore pressure		Closed Seepage Drainage Open			Pressure
		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Name (3)



Overview

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:11
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2.5.2 Vertical support: bottom slab

Equivalent vertical stiffness soil under bottom slab.

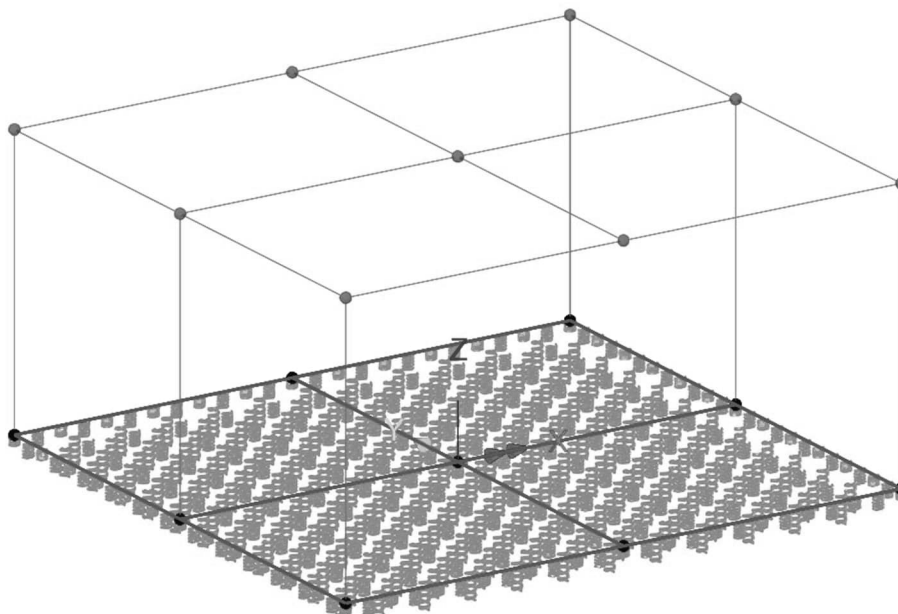
Structural Supports ✕

Analysis category

		Free	Fixed	Spring	Spring stiffness
Translation in	X	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
	Y	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
	Z	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="text" value="50.0E3"/>
Rotation about	X	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
	Y	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
	Z	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Hinge rotation		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Torsional warping		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="text"/>
Pore pressure		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
		Closed	Seepage	Drainage	Open

Spring stiffness distribution
 Stiffness/unit area

Name (1)



Overview

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A2:12
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2.5.2 Horizontal support: abutments

Equivalent horizontal stiffness filling against abutments.

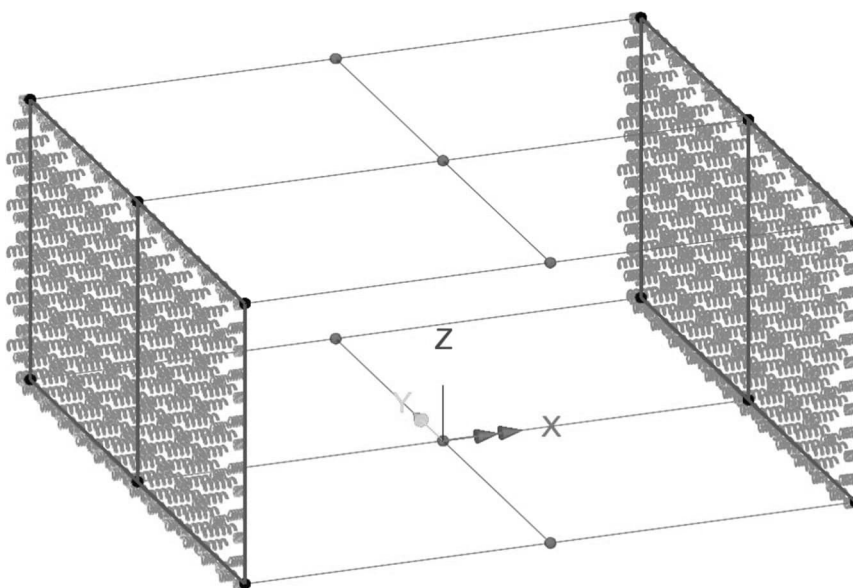
Structural Supports

Analysis category: 3D

		Free	Fixed	Spring	Spring stiffness
Translation in	X	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	4.0E3
	Y	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Z	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Rotation about	X	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Y	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Z	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Hinge rotation		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Torsional warping		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Pore pressure		Closed Seepage Drainage Open			Pressure
		<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Spring stiffness distribution
 Stiffness/unit area

Name: Spring surface: wall (2)



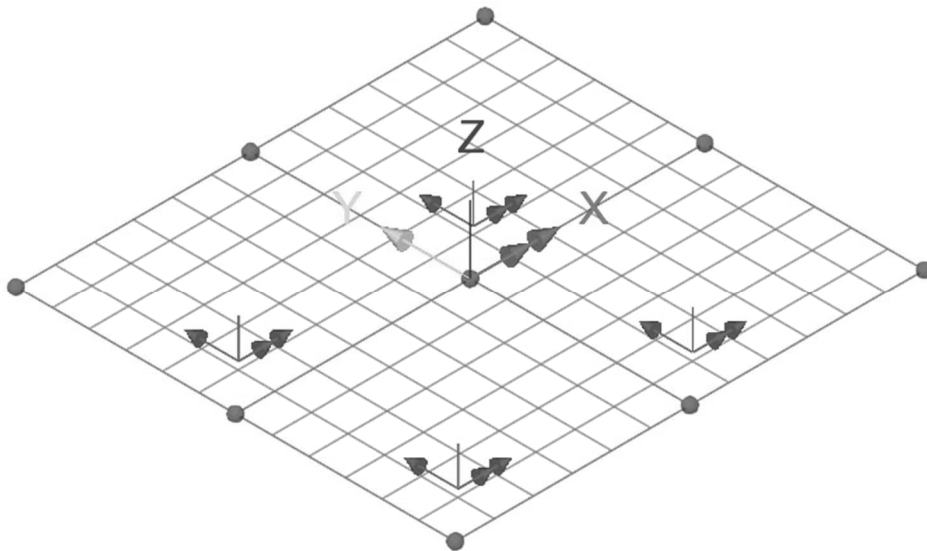
Overview

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2.6 MESH

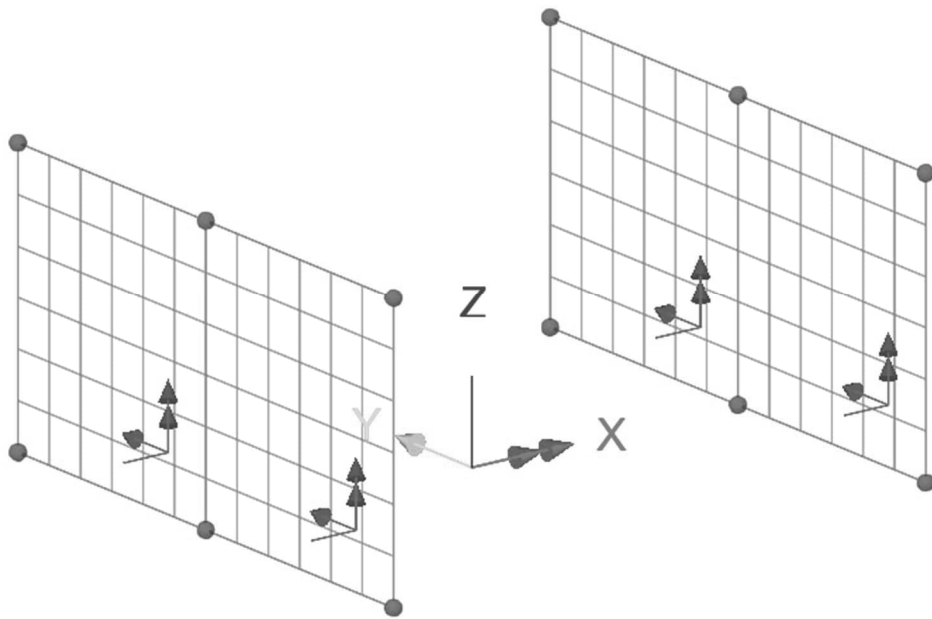
Surface are modelled using hell elements (QTS8) with subdivisions as seen below.

Type	x-divisions	y-divisions
Element 6 x 6	6	6

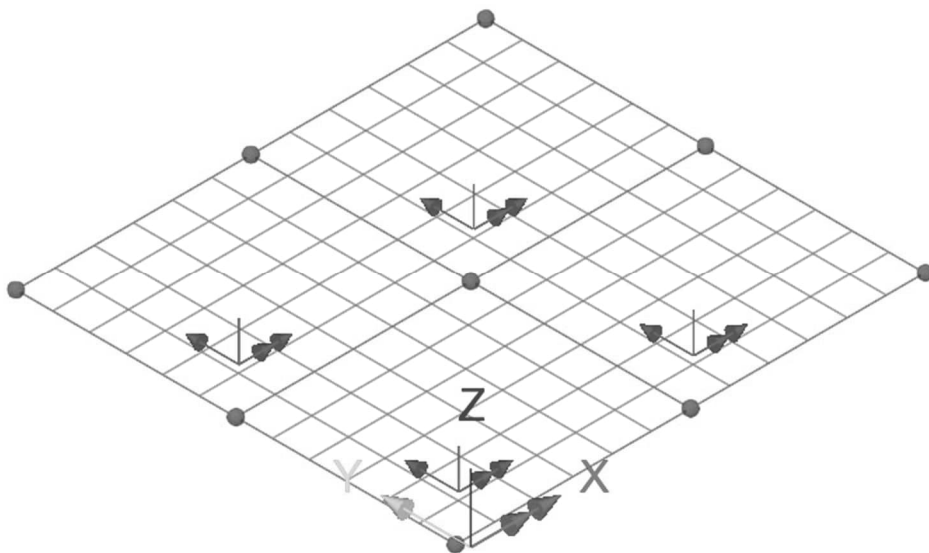


Overview
Bottom slab

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Overview
Abutments

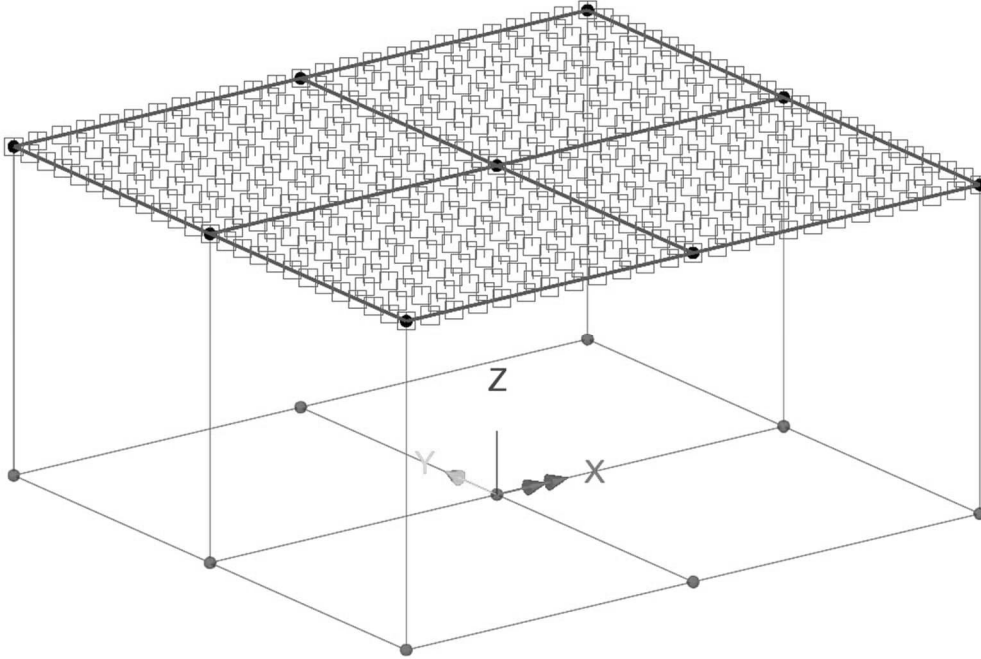


Overview
Superstructure

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2.7 SEARCH AREA

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



Overview

Search Area: Deck

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3. LOADS

- 3.1 DEAD WEIGHT
- 3.2 BALLAST
- 3.2 TRAIN LOAD

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page 3:3
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3.1 DEAD WEIGHT

$$\gamma_c = 25 \cdot \frac{kN}{m^3} \quad : \text{ bottom slab \& abutments}$$

$$\gamma_c = 42 \cdot \frac{kN}{m^3} \quad : \text{ deck \& ballast}$$

Loadcase : Dead weight

Structural loading : Body force

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

Body Force ✕

Analysis category

Component	Value
Linear acceleration in X	0.0
Linear acceleration in Y	0.0
Linear acceleration in Z	-10.0
Angular velocity about X axis	0.0
Angular velocity about Y axis	0.0
Angular velocity about Z axis	0.0
Angular acceleration about X axis	0.0
Angular acceleration about Y axis	0.0
Angular acceleration about Z axis	0.0

Name (1)

	Part A - CALCULATION ASSUMPTIONS	Status :	Page: A3:3
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3.2 BALLAST

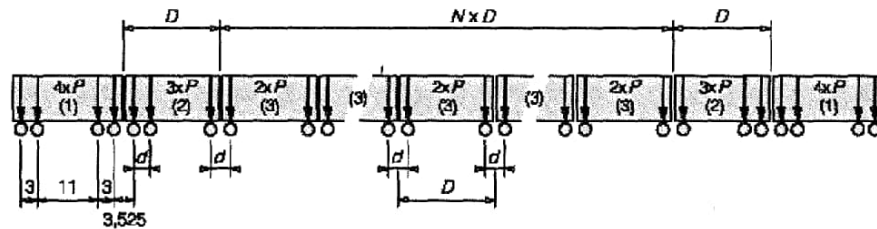
Ballast with thickness 0.6 m is included into load case deadweight.

$$\gamma_{\text{ballast}} = 20 \text{ kN/m}^3$$

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3.3 TRAIN LOAD

Train load HSLM A1- A10 according to SS-EN 1992-2 tabell 1.



- (1) Motorvagn (första och sista motorvagn är identiska)
- (2) Vagnar anslutande till motorvagn
- (3) Mellanliggande vagnar

Figur 1 Fördelning av laster för HSLM-A
(SS-EN 1991-2)

Tabell 1 Lastmodeller för HSLM-A (SS-EN 1991-2)

Lastmodell	Antal mellanliggande vagnar (N)	Vagnlängd (D) m	Hjulavstånd inom boogie (d) m	Axellast (P) kN
A1	18	18	2,0	170
A2	17	19	3,5	200
A3	16	20	2,0	180
A4	15	21	3,0	190
A5	14	22	2,0	170
A6	13	23	2,0	180
A7	13	24	2,0	190
A8	12	25	2,5	190
A9	11	26	2,0	210
A10	11	27	2,0	210

	Part A - CALCULATION ASSUMPTIONS	Status :	Page: A3:5
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3.3.1 Speeds

Speed in interval 140 – 300 km/h (39 – 83 m/s) are considered with interwall 4.4 m/s.

3.3.2 Dampening

$\Delta_{damp} = 1.5 \%$: dampening

3.3.3 Distance between rails (including unit load)

$r = 1425 \text{ mm}$: distance between rails

Definition of unit load Axle load (P = 1 kN):

Point ✕

Analysis category

<input checked="" type="radio"/> Arbitrary <input type="radio"/> Grid x <input type="text" value="1"/> y <input type="text" value="1"/>	Untransformed load direction <input type="radio"/> X <input type="radio"/> Y <input checked="" type="radio"/> Z <input type="radio"/> Surface normal <input type="radio"/> XYZ global <input type="radio"/> XYZ transformable	Projection vector <input checked="" type="checkbox"/> Project in load direction X component <input type="text" value="0.0"/> Y component <input type="text" value="0.0"/> Z component <input type="text" value="1.0"/>
--	---	--

	X	Y	Z	Load
1	0.0	0.7125	0.0	-0.5
2	0.0	-0.7125	0.0	-0.5
3				

Name (2)

	Part A - CALCULATION ASSUMPTIONS	Status :	Page: A3:6
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3.2.4 Track

Track length centre of bridge ± 50 m with stepping length 0.1 m.

Loading options

Moving load dataset:

Search area ID:

Project onto line (2D line beam and frame models)

Project over area (grillages, slabs and 3D space frames)

NOTE: All existing loading will be removed and the moving loads will start from loadcase 1 Advanced...

Load path options

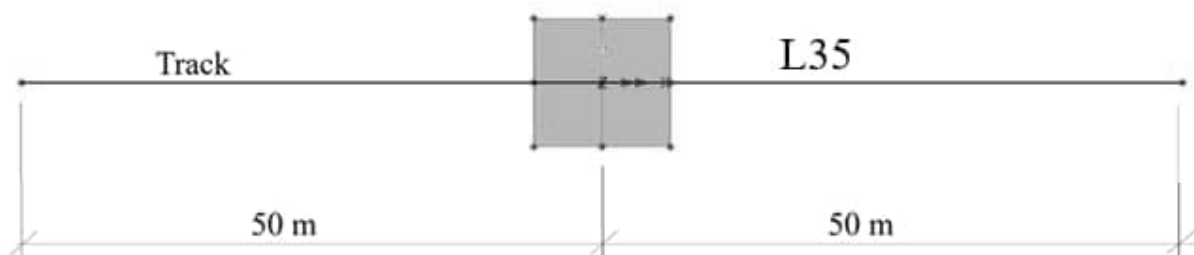
Incremental distance for moving load along path:

Direction: Forwards Backwards

Start of path: X= Y= Z=

Finish of path: X= Y= Z=

Number of divisions/increments to define full path:



PLAN

	Part A - CALCULATION ASSUMPTIONS	Status :	Page: A3:7
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3.2.5 Train load HSLM - A1

s	P	Train vehicle
0	170	Locomotive 1
-3.000	170	"-
-14.000	170	"-
-17.000	170	"-
-20.525	170	Locomotive 1
-22.525	170	"-
-35.7625	170	"-
-37.7625	170	Carriage 1
-53.7625	170	"-
-55.7625	170	Carriage 2
-71.7625	170	"-
-73.7625	170	Carriage 3
-89.7625	170	"-
-91.7625	170	Carriage 4
-107.763	170	"-
-109.763	170	Carriage 5
-125.763	170	"-
-127.763	170	Carriage 6
-143.763	170	"-
-145.763	170	Carriage 7
-161.763	170	"-
-163.763	170	Carriage 8
-179.763	170	"-
-181.763	170	Carriage 9
-197.763	170	"-
-199.763	170	Carriage 10
-215.763	170	"-
-217.763	170	Carriage 11
-233.763	170	"-
-235.763	170	Carriage 12
-251.763	170	"-
-253.763	170	Carriage 13
-269.763	170	"-
m	kN	-

s	P	Train vehicle
-271.763	170	Carriage 14
-287.763	170	"-
-289.763	170	Carriage 15
-305.763	170	"-
-307.763	170	Carriage 16
-323.763	170	"-
-325.763	170	Carriage 17
-341.763	170	"-
-343.763	170	Carriage 18
-359.763	170	"-
-361.763	170	Locomotive 3
-375	170	"-
-377	170	"-
-380.525	170	Locomotive 4
-383.525	170	"-
-394.525	170	"-
-397.525	170	"-
m	kN	-

	Part A - CALCULATION ASSUMPTIONS Dynamic analysis: Open RC frame bridge	Status :	Page: A3:8
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Moving load input

Vehicle configuration (Composite axle)

Mode/damping control

Included modes:

Default damping %

Total participating mass

X-Direction %

Y-Direction %

Z-Direction %

Solution control

Advanced solution options

Minimum speed Quiet time after passage of load

Maximum speed IMDPlus automatic time step (Nyquist)

Speed increment Solution time step

	Part A - CALCULATION ASSUMPTIONS	Status :	Page: A3:9
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3.2.6 Train load HSLM A2-A10.

Only train load HSLM A1 is considered in this illustration.

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4. SUMMARY RESULTS

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4.3	VERIFICATION DEFORMATIO	page 4:2
4.4	VERIFICATION BENDING MOMENT	page 4:2

	Part A - CALCULATION ASSUMPTIONS	Status :	Page: A4:2
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4.1 WORKFLOW

Workflow for dynamic analysis:

1. Generate static model.
2. Perform *eigenvalue* analysis in frequency range 0 → 35 Hz.
3. Determine *participation factors*.
4. Determine *mass participation factors*.
5. Determine *sum mass participation factors*.
6. Define discrete point load Unit Axle load ($P = 1$ kN).
7. Define HSLM- A1 using *vehicle configuration*.
8. Perform *moving dynamic load generation* for Unit Axle
9. Perform *modal force calculation* for Unit load.
10. Chose location for results. Centre of deck is chosen (0 m; 0 m; 5.75 m).
11. Perform dynamic *moving load analysis* for vehicule HSLM – A1

4.2 VERIFICATION ACCELERATION

Largest vertical acceleration (Z-direction) is $|A_z| = 1$ mm and occurs at train speed $v = 65$ m/s in centre of deck, see appendix 2 page 7.

4.3 VERIFICATION DEFORMATION

Largest vertical deformation (Z-direction) is $|\Delta_z| = 1$ mm and occurs at train speed $v = 57$ m/s in centre of deck, see appendix 2 page 8.

4.4 VERIFICATION BENDING MOMENT

Largest hogging moment in longitudinal direction (X-direction) is $|M_x| = 80$ kNm/m and occurs at train speed $v = 61$ m/s in centre of deck, see appendix 2 page 9.

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 1
		Date :	Created:

Title: Input receipt

Model Units: kN,m,t,s,C
Report Units: kN,m,t,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.

Assignment to Surfaces:
3T17;19T24

This expression means that the assignment occurs to the surfaces S3 → S17 and S19 → S24.

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	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 3
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1. Points

Point	X coordinate	Y coordinate	Z coordinate
1	0.0	0.0	0.0
2	-5.9	0.0	0.0
3	5.9	0.0	0.0
4	-5.9	5.5	0.0
5	5.9	5.5	0.0
6	-5.9	-5.5	0.0
7	5.9	-5.5	0.0
8	0.0	5.5	0.0
9	0.0	-5.5	0.0
10	-5.9	-5.5	5.8
11	-5.9	0.0	5.8
12	-5.9	5.5	5.8
13	5.9	-5.5	5.8
14	5.9	0.0	5.8
15	5.9	5.5	5.8
16	0.0	-5.5	5.8
17	0.0	0.0	5.8
18	0.0	5.5	5.8
19	-50.0	0.0	5.8
20	50.0	0.0	5.8

2. Lines

Line	Points	Line	Points
1	6,9	2	9,7
3	2,6	4	9,1
5	7,3	6	1,2
7	3,1	8	4,2
9	1,8	10	3,5
11	8,4	12	5,8
13	6,10	14	7,13
15	11,2	16	14,3
17	12,4	18	15,5
19	10,16	20	16,13
21	10,11	22	16,17
23	13,14	24	17,11
25	14,17	26	11,12
27	17,18	28	14,15
29	18,12	30	15,18
35	19,20		

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 4
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3. Surfaces

Surface	Lines	Surface	Lines
1	1,4,6,3	2	2,5,7,4
3	6,9,11,8	4	7,10,12,9
5	13,21,15,3	6	14,23,16,5
7	15,26,17,8	8	16,28,18,10
9	19,22,24,21	10	20,23,25,22
11	24,27,29,26	12	25,28,30,27

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 5
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4. MESH:Surface

Attribute: 1 Title: Element 6 x 6

Sub Type = Surface Mesh

Element Type = QTS8

Property

Element size
Number of divisions in x
Number of divisions in y
Transition mesh
Allow irregular mesh
Element defined by name
Single feature joint

Symbol

size
xDivisions
yDivisions
transition
allowIrregular
DefinedByName
isSingleFtrJnt

Value

0.0
6
6
true
true
false
false

Assignment to Surfaces:

1T12

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 6
		Date :	Created:

5. Geometric: Surface

Attribute: 1 Title: Element 6 x 6
Sub Type = Surface Mesh

Element Type = QTS8

Property

Element size
Number of divisions in x
Number of divisions in y
Transition mesh
Allow irregular mesh
Element defined by name
Single feature joint

Symbol

size
xDivisions
yDivisions
transition
allowIrregular
DefinedByName
isSingleFtrJnt

Value

0.0
6
6
true
true
false
false

Assignment to Surfaces:

1T12

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	Dynamic analysis: RC frame bridge	Date :	Created:

6. Isotropic material

Attribute: 1 Title: Dynamic (slab & wall)
Sub Type = Isotropic Material
Assigned in: Analysis 1

Property

Young's modulus
Poisson's ratio
Density
Coefficient of thermal expansion

Symbol

E
nu
rho
alpha

Value

38500000.0
0.2
2.5
0.0

Loadcase ID: 1 Title: Loadcase 1
Assignment to Surfaces:
1T8

Attribute: 2 Title: Dynamic (deck)
Sub Type = Isotropic Material
Assigned in: Analysis 1

Property

Young's modulus
Poisson's ratio
Density
Coefficient of thermal expansion

Symbol

E
nu
rho
alpha

Value

38500000.0
0.2
4.2
0.0

Loadcase ID: 1 Title: Loadcase 1
Assignment to Surfaces:
9T12

	Appendix 1: Input receipt SYSTEM 001	Status :	Page: 8
	Dynamic analysis: RC frame bridge	Date :	Created:

7. Support

Attribute: 1 Title: Spring surface: slab

Sub Type = Structural Support

Assigned in: Analysis 1

Property

Translation in X

Translation in Y

Translation in Z

Rotation about X

Rotation about Y

Rotation about Z

Torsional warping

Moment about hinge

Pore pressure

Spring stiffness distribution

Stiffness in Z

Symbol

U

V

W

THX

THY

THZ

Torsion

L1

pore

springType

Wstiff

Value

"F"

"F"

"S"

"F"

"F"

"F"

"F"

"F"

"C"

"Area"

50000.0

Loadcase ID: 1 Title: Loadcase 1

Assignment to Surfaces:

1T4

Attribute: 2 Title: Spring surface: wall

Sub Type = Structural Support

Assigned in: Analysis 1

Property

Translation in X

Translation in Y

Translation in Z

Rotation about X

Rotation about Y

Rotation about Z

Torsional warping

Moment about hinge

Pore pressure

Spring stiffness distribution

Stiffness in X

Symbol

U

V

W

THX

THY

THZ

Torsion

L1

pore

springType

Ustiff

Value

"S"

"F"

"F"

"F"

"F"

"F"

"F"

"F"

"C"

"Area"

4000.0

Loadcase ID: 1 Title: Loadcase 1

Assignment to Surfaces:

5T8

Attribute: 3 Title: Point: slab

Sub Type = Structural Support

Assigned in: Analysis 1

Property

Translation in X

Translation in Y

Translation in Z

Rotation about X

Rotation about Y

Rotation about Z

Torsional warping

Moment about hinge

Pore pressure

Symbol

U

V

W

THX

THY

THZ

Torsion

L1

pore

Value

"R"

"R"

"F"

"F"

"F"

"F"

"F"

"F"

"C"

Loadcase ID: 1 Title: Loadcase 1

Assignment to Points:

1

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 9
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8. Search Area

**Attribute: 1 Title: Deck
Sub Type = Search Area**

**Assignment to Surfaces:
9T12**

9. Body load

**Attribute: 1 Title: Dead weight
Sub Type = Body Force Load**

Property

Linear acceleration in X
Linear acceleration in Y
Linear acceleration in Z
Angular velocity about X axis
Angular velocity about Y axis
Angular velocity about Z axis
Angular acceleration about X axis
Angular acceleration about Y axis
Angular acceleration about Z axis
Linear acceleration In X fluid phase
Linear acceleration In Y fluid phase
Linear acceleration In Z fluid phase

Symbol	Value
AccX	0.0
AccY	0.0
AccZ	-10.0
AngVelX	0.0
AngVelY	0.0
AngVelZ	0.0
AngAccX	0.0
AngAccY	0.0
AngAccZ	0.0
InFlAccX	0.0
InFlAccY	0.0
InFlAccZ	-10.0

**Assignment to Surfaces:
1T12**

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 10
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10. Discrete point load

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

Attribute: 2 Title: Unite Axle Load
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	0.7125	0.0	-0.5		
0.0	-0.7125	0.0	-0.5		

Search area=Deck
Moving status = Include Full Load

Path discrete longitudinal axes (null)
Assignment to Line: 35

Patch transformation = None Load transformation = None
Search area=Deck

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 11
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11. Load groups: HSLM-A1

Load groups : HLML-A1

s	P	s	P
0	170	-271.763	170
-3.000	170	-287.763	170
-14.000	170	-289.763	170
-17.000	170	-305.763	170
-20.525	170	-307.763	170
-22.525	170	-323.763	170
-35.7625	170	-325.763	170
-37.7625	170	-341.763	170
-53.7625	170	-343.763	170
-55.7625	170	-359.763	170
-71.7625	170	-361.763	170
-73.7625	170	-375.000	170
-89.7625	170	-377.000	170
-91.7625	170	-380.525	170
-107.763	170	-383.525	170
-109.763	170	-394.525	170
-125.763	170	-397.525	170
-127.763	170		
-143.763	170		
-145.763	170		
-161.763	170		
-163.763	170		
-179.763	170		
-181.763	170		
-197.763	170		
-199.763	170		
-215.763	170		
-217.763	170		
-233.763	170		
-235.763	170		
-251.763	170		
-253.763	170		
-269.763	170		

	Appendix 1: Input receipt SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 12
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12. IMD Analysis

Type: IMD analysis

Load groups : HSLM-A1

Track: Line 35

Speed : 39, 83

Speed intervall: 4.4

Dampening: 0.015

Influence attributes :

Inf 1 - Deformation

Inf 2 – Acceleration

Inf 3 – Shell forces

	Appendix 2: Results SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 1
		Date :	Created:

Title: Results

Model Units: kN,m,t,s,C
Report Units: kN,m,t,s,C

Model Title: System 001
Model File: System 001

	Appendix 2: Results SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 2
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7.	Design moment (Mx)	9

	Appendix 2: Results SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 3
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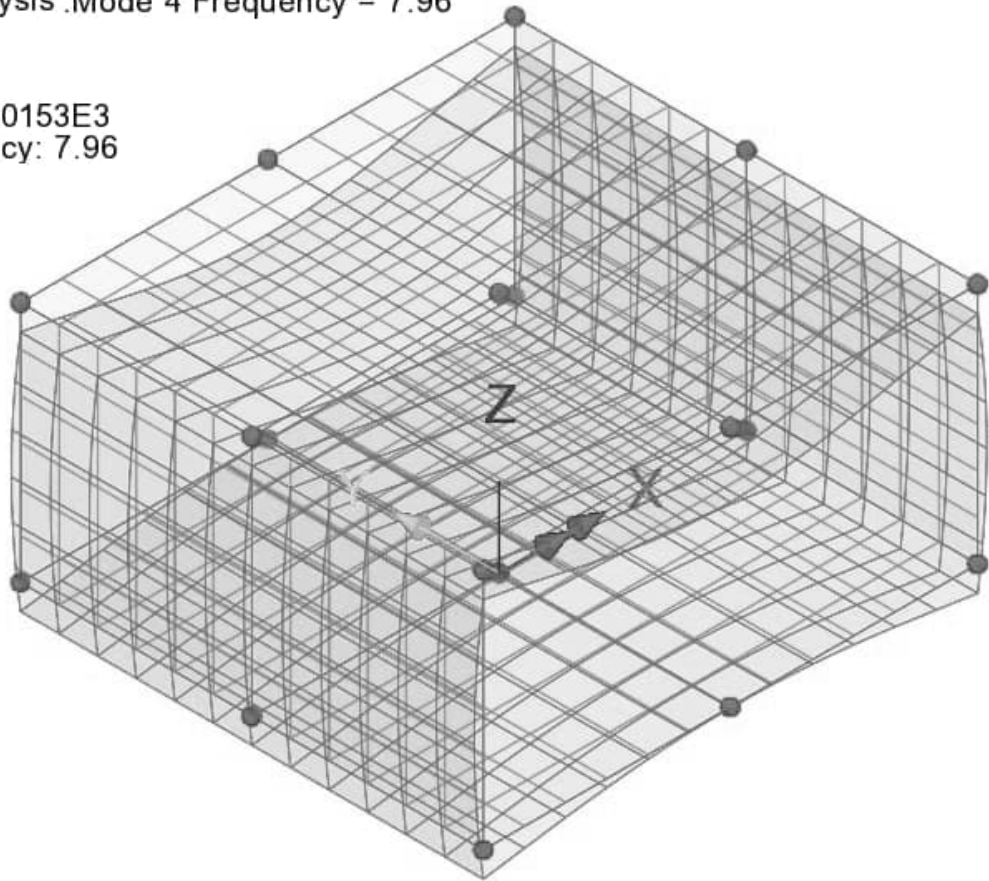
1. Eigenvalues

Nr	Mode	Eigenvalue	Frequency
1	1	207	2
2	2	1156	5
3	3	1458	6
4	4	2502	8
5	5	6003	12
6	6	8084	14
7	7	10490	16
8	8	14252	19
9	9	35097	30
10	10	36963	31
11	11	39049	31
12	12	47531	35

Eigenvalue analysis :Mode 4 Frequency = 7.96

Loadcase: 1

Eigenvalue: 2.50153E3
Natural frequency: 7.96



	Appendix 2: Results SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 4
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2. Participation factors

Mode	P.Factor X	P.Factor Y	P.Factor Z	Frequency
1	0.0	0.0	0.0	2.3
2	-22.4	0.0	0.0	5.4
3	0.0	-19.4	0.0	6.1
4	0.0	0.0	-25.3	8.0
5	6.3	0.0	0.0	12.3
6	0.0	0.0	0.0	14.3
7	0.0	-11.3	0.0	16.3
8	0.0	0.0	13.0	19.0
9	0.0	0.0	1.4	29.8
10	0.0	0.0	-7.9	30.6
11	0.0	11.3	0.0	31.5
12	-8.5	0.0	0.0	34.7

	Appendix 2: Results SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 5
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3. Mass participation factors

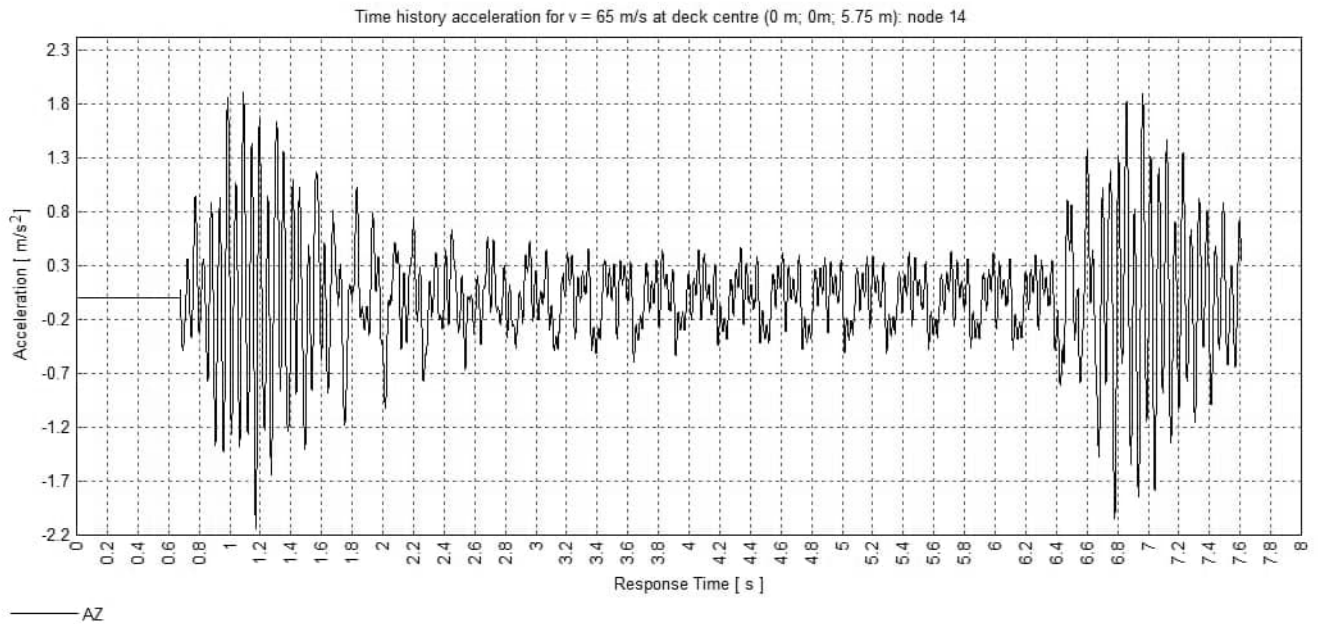
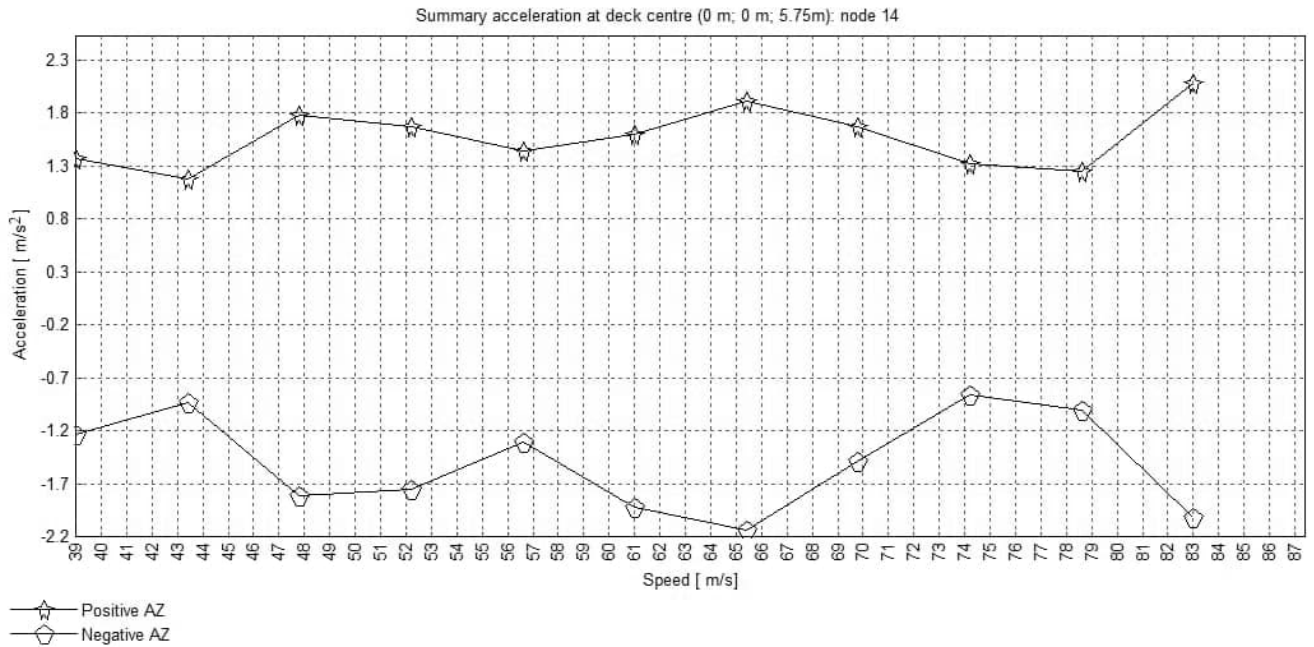
Mode	Mass PF X	Mass PF Y	Mass PF Z	Frequency
1	0	0	0	2.29
2	0.57	0.00	0	5.41
3	0.00	0.43	0	6.08
4	0.00	0.00	0.73	7.96
5	0.05	0.00	0.00	12.33
6	0.00	0.00	0.00	14.31
7	0.00	0.15	0.00	16.30
8	0.00	0.00	0.19	19.00
9	0.00	0.00	0.00	29.82
10	0.00	0.00	0.07	30.60
11	0.00	0.15	0.00	31.45
12	0.08	0.00	0.00	34.70

	Appendix 2: Results SYSTEM 001 Dynamic analysis: RC frame bridge	Status :	Page: 6
		Date :	Created:

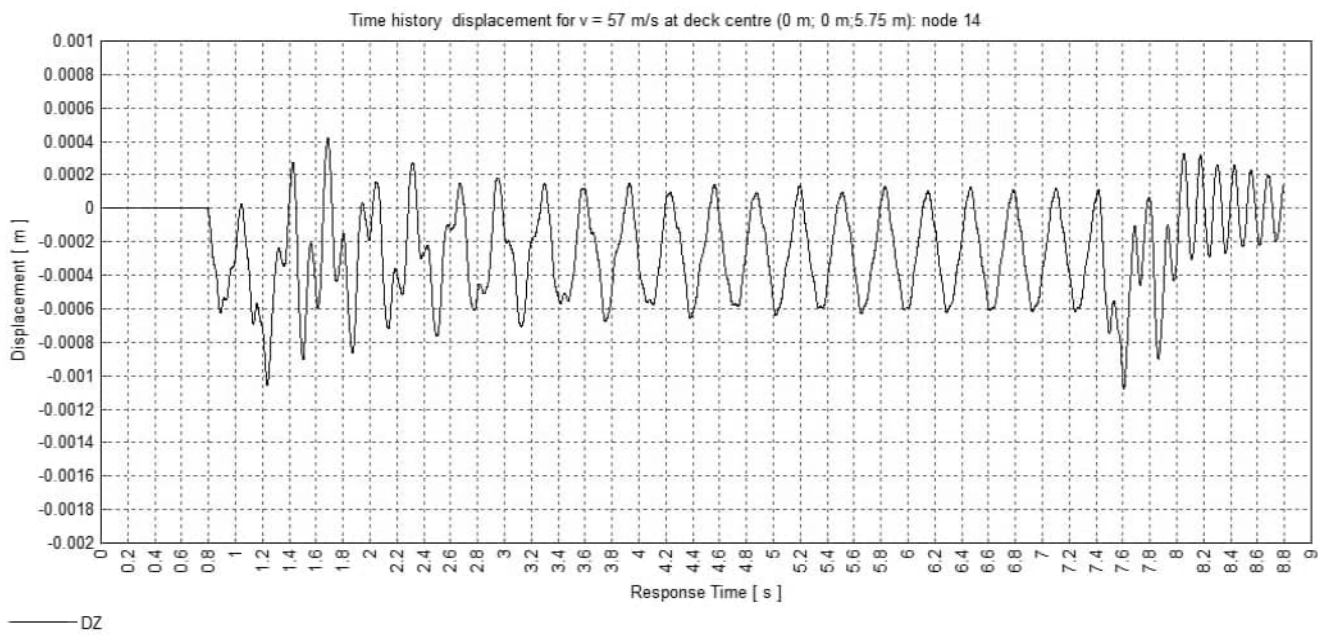
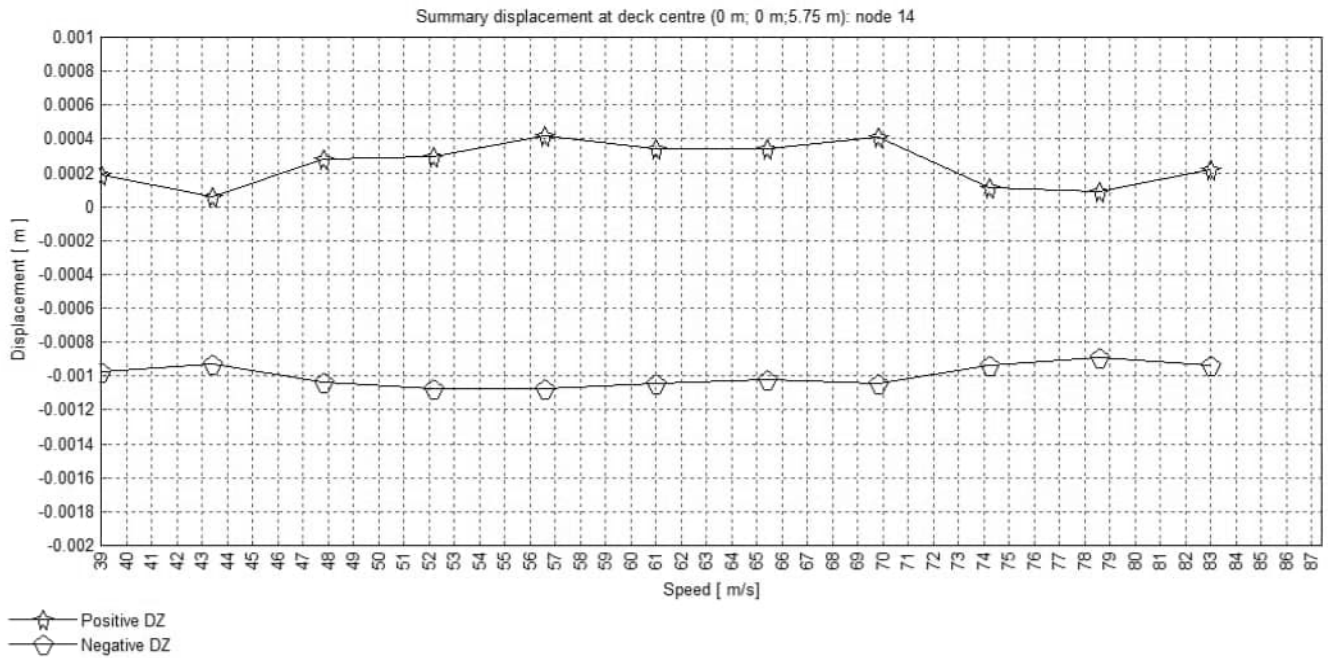
4. Sum mass participation factors

Mode	Sum Mass X	Sum Mass Y	Sum Mass Z	Frequency
1	0	0	0	2.29
2	0.57	0.00	0	5.41
3	0.57	0.43	0	6.08
4	0.57	0.43	0.73	7.96
5	0.62	0.43	0.73	12.33
6	0.62	0.43	0.73	14.31
7	0.62	0.58	0.73	16.30
8	0.62	0.58	0.93	19.00
9	0.62	0.58	0.93	29.82
10	0.62	0.58	1.00	30.60
11	0.62	0.72	1.00	31.45
12	0.70	0.72	1.00	34.70

5. Acceleration (Z-direction)



6. Deformation (Z-direction)



7. Design moment (Mx)

