Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Permanent taxes	Version:	F1.0

Tax case **8: Other permanent taxes**

There are various permanent loads on the bridge. A distinction is made between the permanent loads on the flank side, the inspection path next to the bridge and the inspection path o / d bridge.

Ramp edge (BG8a)
For the main span, the asphalt load is extended to the edge of the steel deck. There is no grazing edge, only a guardrail.

For the side span, the flank side is split into a UDL load on the deck and a line load due to the edge element.

$q_{guardrail}$ $q_{guardrail}$ p_{edge} $p_{scratch\ side}$

Edge
(h = 500 mm)

Main span *Side span*

Height of the cut edge	$d_{scratching\ side}$ =	235	mm	(based on [A.23315-I, average height)
Concrete deck edge height	d_{edge} =	500	mm	(based on [A.23315-I])
Concrete deck edge width	b_{edge} =	150	mm	(based on [A.23315-I])
Guardrail weight	$F_{guardrail}$ =	1258	kN	(based on [Renovation States 1906 folder 22A]
Total length of guardrail	$l_{guardrail}$ =	2160	m	

Taxes Schampkant

Schampkant concrete deck	$\mathbf{p_{scratch\ side}} = d_{scratch\ side}$	*	$\gamma_{concrete}$	=	**5.88 kN / m 2**	***BG8a***
Edge concrete deck	$\mathbf{p_{edge}} = d_{edge}$	*	$\gamma_{concrete}$	=	**12.50 kN / m 2**	
Guardrail	$\mathbf{q_{guardrail}}$ = $F_{guardrail}$	/	$l_{guardrail}$	=	**0.60 kN / m**	***BG8a***

The load on the edge has been translated into a line load and a moment on the edge of the (structural) concrete deck

Line load edge concrete deck	$\mathbf{q_{edge}} = p_{edge}$	*	0.15	m =	**1.88 kN / m**	***BG8a***
Line moment edge concrete deck	$\mathbf{m_{edge}} = q_{edge}$	*	0.075	m =	**0.14 kNm / m**	***BG8a***

Inspection path next to the bridge deck (BG8b)
The consoles are loaded by the handrail, the grid floor and the cable tray. The loads are determined based on the specifications and are entered as point or line load in the calculation by multiplying the load by the center-to-center distance of the console.

$q_{handrail}$ $q_{handrail}$ $p_{inspection\ path}$ $p_{inspection\ pa}$

705 mm $F_{cable\ tray}$ 470 mm $F_{cable\ tray}$

Main span *Side span*

Handrail weight	$F_{handrail}$ =	243	kN	(based on [Renovation States 1906 folder 22A]
Inspection path weight	$F_{inspection\ path}$ =	479	kN	(based on [Renovation States 1906 folder 22A]
Length inspection path br	$l_{inspection\ path}$ =	960	m	(4 pieces)
Width inspection path br	$b_{inspection\ path}$ =	0.60	m	
Length inspection path hfdbr	$l_{inspection\ path}$	1200	m	(4 pieces)
Inspection path width hdbr	$b_{inspection\ path}$	0.84	m	
Surface inspection path	$A_{inspection\ path}$ =	1580	m²	
Console	$q_{console}$ =	0.11	kN / m 1	(based on drawing A.50928-C, IPE120 profile)
Length console bracket	$l_{console}$ =	0.60	m	(based on drawing A.50928-C)
Length console bridge	$l_{console}$ =	0.86	m	(based on drawing A.50928-C)
Cable tray lighting	$q_{cable\ tray}$ =	0.75	kN / m 1	(estimate based on drawing [A.50928-C]

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Tax case **8: Other permanent taxes**

Loads Inspection path (normal console)

Handrail	$q_{handrail}$ =	$F_{handrail}$	/	$l_{inspection\ path}$ =	0.30 kN / m 1
Inspection path	$p_{inspection\ path}$ = $F_{inspection\ path}$		/	$A_{inspection\ path}$ =	0.40 kN / m²
Console	$q_{console}$ =				0.11 kN / m 1
Cable tray lighting	$q_{cable\ tray}$ =				0.75 kN / m 1

Loads Inspection pad (normal console) on bridges

The load is translated into a point load on the edge of the (structural) concrete deck, based on the center-to-center distance of the consoles

Heart to heart hoh 2000 mm (based on drawing [A.50937]

Handrail	$F_{handrail}$ =	$q_{handrail}$	*	2.00	m =	0.60 kN	
Inspection path	$F_{inspection\ path}$ = $p_{inspection\ path}$		*	2.00	m * $b_{inspection\ path}$ =	0.48 kN	
Console	$F_{console}$ =	$q_{console}$	*	0.60	m =	0.07 kN	
Cable tray lighting	$F_{cable\ tray}$ =	$q_{cable\ tray}$	*	2.00	m =	1.50 kN +	
						2.65 kN	***BG8b***

In addition to a point load, a moment also occurs through the arm relative to the edge of the structural deck

Armrest to deck edge	$a_{handrail}$ =	841	mm
Arm inspection path	$a_{inspection\ path}$ =	462	mm
Arm console	$a_{console}$ =	450	mm
Arm cable tray	$a_{cable\ tray}$ =	620	mm

Handrail	$M_{handrail}$ =	$F_{handrail}$	*	0.84	m =	0.50 kNm	
Inspection path	$M_{inspection\ path}$ =	$F_{inspection\ path}$	*	0.46	m =	0.22 kNm	
Console	$M_{console}$ =	$F_{console}$	*	0.45	m =	0.03 kNm	
Cable tray lighting	$M_{cable\ tray}$ =	$F_{cable\ tray}$	*	0.62	m =	0.93 kNm +	
						1.69 kNm	***BG8b***

Loads Inspection pad (normal console) on main span

The load is translated into a point load on the edge of the (structural) concrete deck, based on the center-to-center distance of the consoles

Heart to heart hoh 1800 mm (based on drawing [A.50937]

Handrail	$F_{handrail}$ =	$q_{handrail}$	*	1.80	m =	0.54 kN	
Inspection path	$F_{inspection\ path}$ = $p_{inspection\ path}$		*	1.80	m * $b_{inspection\ path}$ =	0.60 kN	
Console	$F_{console}$ =	$q_{console}$	*	0.86	m =	0.09 kN	
Cable tray lighting	$F_{cable\ tray}$ =	$q_{cable\ tray}$	*	1.80	m =	1.35 kN +	
						2.59 kN	***BG8b***

In addition to a point load, a moment also occurs through the arm relative to the edge of the steel deck

Armrest to deck edge	$a_{handrail}$ =	926	mm
Arm inspection path	$a_{inspection\ path}$ =	429	mm
Arm console	$a_{console}$ =	432	mm
Arm cable tray	$a_{cable\ tray}$ =	705	mm

Handrail	$M_{handrail}$ =	$F_{handrail}$	*	0.93	m =	0.50 kNm	
Inspection path	$M_{inspection\ path}$ =	$F_{inspection\ path}$	*	0.43	m =	0.26 kNm	
Console	$M_{console}$ =	$F_{console}$	*	0.43	m =	0.04 kNm	
Cable tray lighting	$M_{cable\ tray}$ =	$F_{cable\ tray}$	*	0.71	m =	0.95 kNm +	
						1.75 kNm	***BG8b***

Tax cases

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Description:	Permanent taxes	Version:	F1.0

Tax case **8: Other permanent taxes**

Reinforced console with lighting (BG8c)

At the location of the light poles mounted in a "reinforced" console which is longer than the other consoles. There is a light pole on this extension. There is also a heavier console applied. The other taxes are equal to the normal consoles.

$q_{handrail}$ $F_{lighting}$ $p_{inspection\ path}$ 705 mm $F_{cable\ tray}$

$q_{handrail}$ $F_{lighting}$ $p_{inspection\ path}$ 470 mm $F_{cable\ tray}$

Main span *Side span*

Lighting weight	$F_{lighting}$ =	3	kN	(based on calculation [BBV-0010-00])
Console	$q_{console}$ =	1.00	kN / m	(based on [A.50939] tube 260 * 260 * 11)
Length console bracket	$l_{console}$ =	1104	mm	(based on [A.50939])
Length console bridge	$l_{console}$ =	1359	mm	(based on [A.50939])

Loads Inspection pad (reinforced console) on bridges

Handrail	$F_{handrail}$ =				0.60 kN	
Inspection path	$F_{inspection\ path}$ =				0.48 kN	
Console	$F_{console}$ =	$q_{console}$	*	1.104 m =	1.10 kN	
Cable tray lighting	$F_{cable\ tray}$ =				1.50 kN	
Lighting	**$F_{lighting}$ =**				3.00 kN +	
					6.68 kN	***BG8c***

In addition to a point load, a moment also occurs through the arm relative to the edge of the structural deck

Arm lighting	$a_{lighting}$ =	1029	mm	(based on [A.50939])
Arm console	$a_{console}$ =	702	mm	(based on [A.50939])

Handrail	$M_{handrail}$ =	$F_{handrail}$	*	0.84 m =	0.50 kNm	
Inspection path	$M_{inspection\ path}$ =	$F_{inspection\ path}$	*	0.46 m =	0.22 kNm	
Console	$M_{console}$ =	$F_{console}$	*	0.70 m =	0.78 kNm	
Cable tray lighting	$M_{cable\ tray}$ =	$F_{cable\ tray}$	*	0.62 m =	0.93 kNm	
	$M_{lighting}$ =	$F_{lighting}$	*	1.029 m =	3.09 kNm +	
					5.52 kNm	***BG8c***

Loads Inspection pad (reinforced console) on main bridge

Handrail	$F_{handrail}$ =				0.54 kN	
Inspection path	$F_{inspection\ path}$ =				0.60 kN	
Console	$F_{console}$ =	$q_{console}$	*	1.359 m =	1.36 kN	
Cable tray lighting	$F_{cable\ tray}$ =				1.35 kN	
Lighting	**$F_{lighting}$ =**				3.00 kN +	
					6.85 kN	***BG8c***

In addition to a point load, a moment also occurs through the arm relative to the edge of the steel deck

Arm lighting	$a_{lighting}$ =	1114	mm	(based on [A.50939])
Arm console	$a_{console}$ =	680	mm	(based on [A.50939])

Handrail	$M_{handrail}$ =	$F_{handrail}$	*	0.93 m =	0.50 kNm	
Inspection path	$M_{inspection\ path}$ =	$F_{inspection\ path}$	*	0.43 m =	0.26 kNm	
Console	$M_{console}$ =	$F_{console}$	*	0.68 m =	0.92 kNm	
Cable tray lighting	$M_{cable\ tray}$ =	$F_{cable\ tray}$	*	0.71 m =	0.95 kNm	
	$M_{lighting}$ =	$F_{lighting}$	*	1.114 m =	3.34 kNm +	
					5.98 kNm	***BG8c***

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
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Description:	Permanent taxes	Version:	F1.0

Tax case **8: Other permanent taxes**

Inspection path under the bridge (BG8d)

The inspection path under the bridge is taken into account as 2 point loads on the cross beams, center to center 700 mm, symmetrical with respect to the center of the crossbars.

700 mm

$F_{inspection\ path}$ $F_{inspection\ path}$

Inspection path

	Number	Length	Width	Weight	Total
Cross beam (L50 * 6)	0.50 x	0.88 mx		0.04469 kN / m 1 =	0.02 kN
Pendants (L50 * 6)	1.00 x	1.407 mx		0.04469 kN / m 1 =	0.06 kN
Bottom rail (L50 * 6)	1 x	1.8 mx		0.04469 kN / m 1 =	0.08 kN
Handrail (L50 * 6)	1 x	1.8 mx		0.04469 kN / m 1 =	0.08 kN
Grate (25 mm)	0.5 x	1.8 mx	0.75 mx	0.40 kN / m² =	0.27 kN
Surcharge for confirmations				10%	0.05 kN +
				$F_{inspection\ path}$ =	**0.60 kN (BG8d)**

Source: Drawing [A.85343], [A.85401]

Hot water pipe (BG8e)

The NUON hot water pipes (two pieces) are only present under the western bridge, under the main bridge (1st to 4th spans). The tax case is therefore introduced as a separate tax case, so that if necessary, a distinction can be made for the eastern and western bridges.

Leadership

Outer diameter	$Ø_{outside}$ =	450 mm
Wall thickness	$t_{outside}$ =	7.11 mm
Specific weight	ρ_{sample} =	7850 kg / m 3
Inner diameter	$Ø_{inside}$ =	300 mm
Wall thickness	t_{inside} =	10 mm
Specific weight PE	ρ_{PE} =	1000 kg / m 3
Specific weight PE	ρ_{PUR} =	60 kg / m 3

680 1220 680

$F_{ww, dw}$ $F_{ww, dw}$ $F_{ww, dw}$ $F_{ww, dw}$

Frame

Point loads due to weight of hot water pipe and suspension frame

Tube 100x100x8	$q_{profile}$ =	0.21 kN / m	
Length A	L =	1670 mm	2 pieces
Length B	L =	580 mm	2 pieces
Length C.	L =	1800 mm	2 pieces
Shaft around 35 mm	$q_{profile}$ =	0.08 kN / m	
Length	L =	580 mm	1 piece
Surcharge for connections		20%	

NUON hot water pipe	$q_{WW\ leadership}$ =	0.50 kN / m 1
Frame	F_{frame} =	2.1 kN

Heart to heart size frame hoh = 10.71 m

Total force per suspension frame F_{ww} = $q_{WW\ management}$ * 10.71 m + F_{frame} = 7.4 kN

Force on cross beam **$F_{ww, dw}$ =** F_{ww} / 4 = **1.86 kN** ***BG8e***

Creep and shrinkage according to Eurocode 2

Project:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Shrinkage load	Version:	v0.5 Beta

Tax case 9 : Shrinkage load

Shrinkage

The shrinkgage strain is determined in correspondence with NEN-EN1992-1-1 art. 3.1.4 (6)

ε_{cs} = $\varepsilon_{cd} + \varepsilon_{approx}$ formula 3.8

ε_{cd} = drying shrinkage

ε_{approx} = autogenous shrinkage

Drying shrinkage

$\varepsilon_{cd,\infty}$ = $k_h\ \varepsilon_{cd,0}$ shrinkage at t = ∞

$\varepsilon_{cd}(t)$ = $\beta_{ds}(t, t_s) * k_h * \varepsilon_{cd,0}$ shrinkage at t = t formula 3.9

Environment:	Out	
Relative humidity:	80	%
Concrete class:	C32 / 40	
Type of cement	CEM 32.5 N	(Portland is rapid and blast furness is normal)
Cement class	S	

α_{ds1} = 3

α_{ds2} = 0.13

f_{cm} = 40 N / mm²

f_{cmo} = 10 N / mm²

RH = 80%

RH_0 = 100%

β_{RH} = 0.756

$\varepsilon_{cd,0}$	=	0.21 ‰			
h	=	200 mm			
w	=	1000 mm			
you	=	2000 mm			
h_0	=	200 mm			
k_h	=	0.85			
$\varepsilon_{cd,\infty}$	=	0.85	X	0.21 ‰ =	0.18 ‰
t	=	36500 days			
t_s	=	1 days	(age at the beginning of the drying shrinkage)		
$\beta_{ds}(t, t_s)$	=	0.997		formula 3.10	
$\varepsilon_{cd}(t)$	=	0.178 ‰		formula 3.8	

Creep and shrinkage according to Eurocode 2

Project:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Shrinkage load	Version:	v0.5 Beta

autogenous shrinkage

ε_{approx}	=	autogenous shrinkage		
$\varepsilon_{ca}(t)$	=	$\beta_{axis}(t)\ \varepsilon_{ca}(\infty)$	shrinkage at t = t	formula 3.11
$\varepsilon_{ca}(\infty)$	=	$2.5\ (f_{ck} - 10) * 10^{-6}$	shrinkage at t = ∞	formula 3.12
f_{ck}	=	32 N / mm²		
$\varepsilon_{ca}(\infty)$	=	0.055 ‰		

long term

$\beta_{axis}(t)$	=	$1 - \exp(-0.2t^{0.5})$	formula 3.13
t	=	36500 days	
$\beta_{axis}(t)$	=	1	
$\varepsilon_{ca}(t)$	=	0.055 ‰	

Shrinkage

ε_{cs}	=	$\varepsilon_{cd} + \varepsilon_{approx}$
ε_{cd}	=	0.178 ‰
ε_{approx}	=	0.055 ‰
ε_{cs}	=	0.233 ‰

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Prestressing losses according to RVB 1962

Quality prestressing steel QP105 $\sigma ar := 105 \cdot \frac{kgf}{mm^2}$ $\sigma ar = 1029.7\ MPa$

$fpu.rep := \sigma ar$

Elasticity modulus prestressing steel $Ep := 2.06 \cdot 10^6 \cdot \frac{kgf}{cm^2}$ $Ep = 202.0\ GPa$

Cable cross-section $Ap := 531mm^2$

Initial prestressing force $Fpo := 1.1 \cdot 0.538 \cdot \sigma ar \cdot Ap$ $Fpo = 33.0\ tf$ $Fpo = 324\ kN$

$\sigma po := \frac{Fpo}{Ap}$ $\sigma po = 62.14 \cdot \frac{kgf}{mm^2}$ $\sigma po = 609\ MPa$

Average cube compressive strength (rib 20 cm) after 28 days K450 $\sigma'w28 := 450 \cdot \frac{kgf}{cm^2}$

Modulus of elasticity (art. 7.3.2 RVB) $E'b := \left(200 \cdot \frac{kgf}{cm^2} + \frac{1}{3} \cdot \sigma'w28\right) \cdot 10^3$ $E'b = 350.0 \cdot \frac{tf}{cm^2}$

$E'b = 34323\ MPa$

Half cable length $\frac{L}{2} = 6.0\ m$

Assumption of angular displacement over half cable length $\phi = 0.0\ deg$ $\phi = 0.0000\ rad$

Friction coefficient $\mu := 0.25$

Wobble factor $\phi_1 := 0.01 \cdot \frac{rad}{m}$

$-\mu \cdot \left(\phi + \phi_1 \cdot \frac{L}{2}\right) = -0.0150$

$\Delta Fp.friction(x) := Fpo \cdot \left[1 - e^{-\mu \cdot (\phi(x) + \phi_1 \cdot x)}\right]$ $e^{-0.0150} = 0.985$

$\Delta Fp.friction.max := Fpo \cdot (1 - 0.985)$ $\Delta Fp.friction.max = 0.5\ tf$

$\Delta Fp.friction.max = 4.9\ kN$

$\Delta\sigma p.friction.max := \frac{\Delta Fp.friction.max}{Ap}$ $\Delta\sigma p.friction.max = 93 \cdot \frac{kgf}{cm^2}$

$\Delta\sigma p.friction.max = 9\ MPa$

$\tan(\gamma) := \frac{\Delta\sigma p.friction.max}{\frac{L}{2}}$ $\tan(\gamma) = 0.155 \cdot \frac{\frac{kgf}{mm^2}}{m}$

wedge setting $w := 1\ mm$

Influence length wedge setting $a := \frac{w \cdot e \cdot p}{\tan(\gamma)}$ $a = 11.5\ m$

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$\Delta\sigma p.wigetting.max := 2 \cdot a \cdot \tan(\gamma)$ $\Delta\sigma p.wigetting.max = 358 \cdot \frac{kgf}{cm^2}$

$\Delta\sigma p.wigetting.max = 35\ MPa$

$\Delta Fp.wigetting.max := \Delta\sigma p.wigetting.max \cdot Ap$ $\Delta Fp.wigetting.max = 1.9\ tf$

$\Delta Fp.wigetting.max = 18.6\ kN$

$\Delta\sigma po := \frac{\Delta\sigma p.wigset.max + 2 \cdot \Delta\sigma p.friction.max \cdot \frac{L}{2} \cdot \Delta\sigma p.friction.max}{4}$ $\Delta\sigma po = 19.8\ MPa$

$\sigma pi := \sigma po - \Delta\sigma po$

Relative humidity $R := 80$

Amount of cement paste (in percent by volume) $p := 27.5$

Shrinkage reduction $\varepsilon'k.oo := 3 \cdot 10^{-7} \cdot p \cdot (100 - R)$ $\varepsilon'k.oo = 16 \cdot 10^{-5}$ (art. 8.1.1. RVB)

$t := 21$ $\sigma'w := 375 \cdot \frac{kgf}{cm^2}$

At the time of tension (t days) $\varepsilon'kt := 0.005 \cdot t \cdot \varepsilon'k.oo$ $\varepsilon'kt = 1.73 \cdot 10^{-5}$

$(\varepsilon'k.oo - \varepsilon'kt) = 14.8 \cdot 10^{-5}$

$\Delta\sigma p.k.oo := (\varepsilon'k.oo - \varepsilon'kt) \cdot Ep$ $\Delta\sigma p.k.oo = 304.2 \cdot \frac{kgf}{cm^2}$ $\Delta\sigma p.k.oo = 29.8\ MPa$

Shrinkage Voltage drop $2.8 \cdot \frac{kgf}{mm^2} = 27.5\ MPa$

Surface concrete section $Ab := 0.2 \cdot 0.215 \cdot m^2$

$\sigma'bag := 2 \frac{N}{mm^2}$

Creep shortening $\varepsilon'kt.oo := 100 \cdot \frac{\sigma'bag}{(40 - 0.30 \cdot R) \cdot \sigma'w} \cdot (\varepsilon'k.oo - \varepsilon'kt)$ $\varepsilon'kt.oo = 5.02 \cdot 10^{-5}$

$\Delta\sigma p.kt.oo := \varepsilon'kt.oo \cdot Ep$ $\Delta\sigma p.kt.oo = 103.4 \cdot \frac{kgf}{cm^2}$ $\Delta\sigma p.kt.oo = 10.1\ MPa$

Shrinkage + creep shortening after tensioning

$(\varepsilon'k.oo - \varepsilon'kt) + \varepsilon'kt.oo = 20 \cdot 10^{-5}$

Relaxation $:= 10\%$

$\Delta\sigma p.r := Relaxation \cdot 1.1 \cdot 0.538 \cdot \sigma ar$ $\Delta\sigma p.r = 6.2 \cdot \frac{kgf}{mm^2}$ $\Delta\sigma p.r = 60.9\ MPa$

$\Delta\sigma pk.kr := \Delta\sigma p.k.oo + \Delta\sigma p.kt.oo + \Delta\sigma p.r$ $\Delta\sigma pk.kr = 10.3 \cdot \frac{kgf}{mm^2}$ $\Delta\sigma pk.kr = 100.9\ MPa$

$\Delta Fpk.kr := \Delta\sigma pk.kr \cdot Ap$ $\Delta Fpk.kr = 5.5\ tf$ $\Delta Fpk.kr = 53.6\ kN$

$\sigma pw := \sigma pi \; \Delta\sigma pk.kr$

Position

Anchoring (x = 0 m)	Fpo ΔFp.wigetting.max = 31.1 tf ·
End wedge setting (x = a = 18.2 m)	Fpo - $\frac{a}{30\ m}$ · ΔFp.friction.max = 32.8 tf ·
Half cable length (x = L2 = 35 m)	Fpo ΔFp.friction.max = 32.5 tf ·
Anchoring (x = 0 m)	Fpo ΔFp.wigetting.max - ΔFpk.kr = 25.6 tf ·
End wedge setting (x = a = 18.2 m)	Fpo - $\frac{a}{30\ m}$ · ΔFp.friction.max - ΔFpk.kr = 27.3 tf ·
Half cable length (x = L2 = 35 m)	Fpo ΔFp.friction.max - ΔFpk.kr = 27.0 tf ·

Losses in a row

Initial preload	σpo = 609 MPa	
Lose wedge + friction	Δσpo = 19.8 MPa	$\frac{\Delta\sigma po}{\sigma po}$ = 3.3%
Initial pretension	σpi 590 MPa ·	

Elastic losses

Shrinkage	Δσp.k.oo = 29.8 MPa	$\frac{\Delta\sigma p.k.oo}{\sigma pi}$ = 5.06%
Crawl	Δσp.kt.oo = 10.1 MPa	$\frac{\Delta\sigma p.kt.oo}{\sigma pi}$ = 1.72%
Relaxation	Δσp.r 60.9 MPa ·	$\frac{\Delta\sigma p.r}{\sigma pi}$ = 10.3%
Shrink creep + relaxation	Δσpk.kr 100.9 MPa ·	$\frac{\Delta\sigma pk.kr}{\sigma pi}$ = 17.1%

Completely delayed

Work preload	σpw = 488.6 MPa

Appendix

Appendix F - Traffic taxes

IJssel Bridge

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Traffic taxes BG 100-299

Tax case **100-109: BM1 - UDL - V1 - Normal situation - Main spar**

For the main beams, the loads of BM1 are placed in the middle of the lanes. The load is split lengthwise into separate load cases per span. A checkerboard tax is applied for the local models. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

Lane 1	$p_{udl.1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.2}$	=	2.5 kN / m 2	width	3.00 m

Actual lane layout V1 - Normal situation - Main beam load

Tax case **110-199: BM1 - TS - V1 - Normal situation - Main spar**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration is applied at the location of each cross beam up to the symmetry line from the bridge. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **200-219: BM1 - UDL - V1 - Normal situation - Cross beam**

Within this load case, the load is as far as possible towards the center of the crossbar. For the normal situation (V1), the UDL load is divided into 2 lanes 1 and lane 2. The loads on lanes 1 and 2 outside the main beams and on the residual lanes are omitted because they work favorably. The load is applied alternately in the odd and even fields. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length

Lane 1	$p_{udl. 1}$	=	9 kN / m 2	width	2.85 m
Lane 2	$p_{udl. 2}$	=	2.5 kN / m 2	width	2.85 m

Actual lane layout V1 - Normal situation - Load cross section field

Tax case **220-249: BM1 - TS - V1 - Normal situation - Cross beam**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	

Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration is provided locally for the bridging at the location of some determinative placed crossbars (at fields and supports). For the main bridge, the load is applied in the local model. The axle loads between the two lanes are center to center 0.5 m instead of the usual 1.0 m (local assessment) see 4.3.2 (5) of NEN-EN 1991-2. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **250-269: BM1 - UDL - V1 - Normal situation - Steel deck with bulbs between cross beams**

For the maximum field and support moment in the steel deck with bulbs between the cross bars, the UDL load is as much as possible towards the center of the placed crossbeam. For the normal situation (V1), the UDL load is divided into 2 parts, lane 1 and lane 2. The load is split lengthwise in separate load cases per field (odd and even fields). The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length

Lane 1	$p_{udl.\,1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.\,2}$	=	2.5 kN / m 2	width	3.00 m

Actual lane layout V1 - Normal situation - Load of steel deck with bulbs between cross beams

Tax case **270-299: BM1 - TS - V1 - Normal situation - steel deck with bulbs between cross bars**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The load configuration above is placed in such a way that the maximum voltage in the field and at the support point is found in the steel deck and the bulbs. For this the load in SCIA has been moved in steps of 0.1 m, up to that the maximum load has been found (see separate Excel spreadsheet at the end of this appendix). Only the positions with the maximum stresses are stored in the model due to calculation time. The axle loads between the two lanes is center to center 0.5 m instead of the usual 1.0 m (local assessment) cf 4.3.2 (5) of NEN-EN 1991-2. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **250-269: BM1 - UDL - V1 - Normal situation - Concrete deck between cross members**

For the maximum field moment in the concrete deck between the crossbars, the UDL load is placed as far as possible towards the center of the crossbeam. For the In normal situation (V1), the UDL load is divided into 2 parts, lane 1 and lane 2. The load is split lengthwise into separate load cases per field (odd and even fields). The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length

Lane 1	$p_{udl.\,1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.\,2}$	=	2.5 kN / m 2	width	3.00 m

Actual lane layout V1 - Normal situation - Concrete deck load between cross members

Tax case **270-299: BM1 - TS - V1 - Normal situation - Concrete deck between cross members**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.74 m	
Length wheel dim	L_{wheel}	=	0.74 m	
Distributed wheel load	p_{Q1}	=	273.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.74 m	
Length wheel dim	L_{wheel}	=	0.74 m	
Distributed wheel load	p_{Q2}	=	182.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration is positioned so that the maximum voltage in the field is found in the concrete deck. For this, the load in SCIA has been moved in steps of 0.1 m, up to the maximum load found (see separate Excel spreadsheet at the end of this appendix). Only the positions with the maximum voltages are stored in the model due to calculation time. The axle loads between both lanes are center to center 0.5 m instead of the usual 1.0 m (local assessment) cf 4.3.2 (5) of NEN-EN 1991-2. The tax becomes multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

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Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **300-319: BM1 - UDL - V1 - Normal situation - Console / cantilever concrete deck**

For the consoles / cantilever of the concrete deck, the loads of BM1 are placed on the edge of lane 1. Lane 2 loading is not for the console relevant and has therefore been omitted. The load is applied alternately in the odd and even fields. The tax is multiplied by one reduction factor for LM1, 30 years, depending on the influence length.

Lane 1	$p_{udl.\,1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.\,2}$	=	0 kN / m 2	width	0.00 m

Actual lane layout V1 - Normal situation - Console load / concrete deck cantilever (BM1)

Tax case **320-349: BM1 - TS - V1 - Normal situation - Console / cantilever concrete deck**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	0 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	0.0 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration will be on site for bridging in line with some determinative crossbars placed (at fields and supports). The load is applied to the main bridge in the local model. The axle loads between the two lanes are center to center 0.5 m instead of the usual 1.0 m (local assessment) see 4.3.2 (5) of NEN-EN 1991-2. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **350-369: BM1 - UDL - V1 - Normal situation - Steel deck with bulbs between consoles**

For the steel deck, the bulbs and the edge strips between the consoles, the loads of BM1 are placed on the edge of lane 1. The load is longitudinal split into separate load cases for the even and odd fields. The load is multiplied by a reduction factor for LM1, 30 years, depending on the influence length.

Lane 1	$p_{udl.1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.2}$	=	2.5 kN / m 2	width	3.00 m

Actual lane layout V1 - Normal situation - Steel deck load with bulbs between consoles (BM1)

Tax case **370-399: BM1 - TS - V1 - Normal situation - Steel deck with bulbs between consoles**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The design positions of the tandem systems for the maximum stresses in the field and at the location of the The support point was determined using SCIA by sliding it in steps of 0.1 m (see Appendix F.3). Only the normative positions are kept in the model because of the calculation time. The tax is multiplied with a reduction factor for LM1, 30 years, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **400-449: BM2 - TS - V1 - Normal situation - Console / cantilever concrete deck**

Load model 2 may be indicative of the moment of support in the consoles (main span) and in the concrete deck (bridging). Below load configuration is used for the bridges as an extension of the crossbars at the supports and the fields. For the main bridge is the load applied to the center consoles. The load is multiplied by a reduction factor for LM2, 30 years, depending on the influence length.

BM2 - Normal situation V1 - Console load / concrete deck cantilever (BM2)

General

Wheel load	F_{Q1}	=	200 kN	(Axle system BM2)
width wheel dim.	B_{wheel}	=	0.75 m	
Length wheel dim	L_{wheel}	=	0.50 m	
Distributed wheel load	p_{Q1}	=	533.3 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$

Tax case **450-499: BM2 - TS - V1 - Normal situation - Steel deck with bulbs between consoles**

Load model 2 may also be indicative of the steel deck between consoles. In Appendix F.3 the normative position is determined for both the steel deck with bulbs between the cross bars and between the brackets and compared to BM1. This shows that BM2 is only indicative of the steel deck between the consoles. The tax is multiplied by a reduction factor for LM2, 30 years, depending on the influence length.

BM2 - Normal situation V1 - Load steel deck with bulbs between consoles (BM2)

General

Wheel load	F_{Q1}	=	200 kN	(Axle system BM2)
width wheel dim.	B_{wheel}	=	0.75 m	
Length wheel dim	L_{wheel}	=	0.50 m	
Distributed wheel load	p_{Q1}	=	533.3 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$

Tax case **500-549: BM1 - UDL - V2 - Emergency - Main spar**

Within this load case, the load is directed to the right main beam as much as possible. The carriageway may be maintained at 0.3 m from the vehicle barrier. The load is split lengthwise into separate load cases per span. A checkerboard tax is applied for the local models. The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Lane 1	$p_{udl.\,1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.\,2}$	=	2.5 kN / m 2	width	3.00 m

Fictitious lane layout V2 - Emergency - Main beam load

Tax case **550-599: BM1 - TS - V2 - Emergency - Main spar**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration is used at the location of each cross beam up to the symmetry line from the bridge (between North and South). The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **600-619: BM1 - UDL - V2 - Emergency - Cross beam**

The position of the UDL load and the axle loads for the field moment in the cross beam has been estimated on the basis of a beam calculation and will be included in the final model. be validated. For this situation, the UDL load on the overhang works favorably and has been omitted. The wheel loads for this situation are 0.5 m apart.
The load is applied alternately in the odd and even fields. The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Lane 1	$p_{udl. 1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl. 2}$	=	2.5 kN / m 2	width	3.00 m

Fictitious lane layout V2 - Emergency - Load crossbar

Tax case **620-649: BM1 - TS - V2 - Emergency - Cross beam**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration is provided locally for the bridging at the location of some determinative placed crossbars (at fields and supports). For the main bridge, the load is applied in the local model. The axle loads between the two lanes are center to center 0.5 m instead of the usual 1.0 m (local assessment) see 4.3.2 (5) of NEN-EN 1991-2. The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Tax case **650-669: BM1 - UDL - V2 - Emergency - Steel deck with bulbs / concrete deck between down carriers**

The load due to BM1 and BM2 in the emergency situation (V2) will not be decisive for the steel deck and the concrete deck between the cross beams relative to the normal situation (V1), due to the higher reduction factor for V2 due to the reduced service life that may be maintained. Because the axes are equal V1 will always be decisive in both situations.

Tax case **670-699: BM1 - TS - V2 - Emergency - Steel deck with bulbs / concrete deck between bearers**

The load due to BM1 and BM2 in the emergency situation (V2) will not be decisive for the steel deck and the concrete deck between the cross beams relative to the normal situation (V1), due to the higher reduction factor for V2 due to the reduced service life that may be maintained. Because the axes are equal V1 will always be decisive in both situations.

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Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **700-719: BM1 - UDL - V2 - Emergency - Console / concrete deck cantilever**

BM1 wheel loads are on the rim for the maximum support moment in the console (main span) and in the cantilever part of the concrete deck (bridging). of the fictional lane, with the rim of the wheel 0.3 m from the vehicle barrier. Assuming a distance from the vehicle barrier of 0.30 m and a wheel width of 0.40 m, the center of the wheel is 0.695 m from the main beam. The load on lane 2 is irrelevant to the cantilever and is omitted left. The load is applied alternately in the odd and even fields. The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Lane 1	$p_{udl. 1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl. 2}$	=	0 kN / m 2	width	3.00 m

Fictitious lane layout V2 - Emergency - Load console / cantilever concrete deck

Tax case **720-749: BM1 - TS - V2 - Emergency - Console / concrete deck cantilever**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The above load configuration will be on site for bridging in line with some determinative crossbars placed (at fields and supports). The load is applied to the main bridge in the local model. The axle loads between the two lanes are center to center 0.5 m instead of the usual 1.0 m (local assessment) see 4.3.2 (5) of NEN-EN 1991-2. The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **750-769: BM1 - UDL - V2 - Emergency - Steel deck with bulbs between consoles**

For the steel deck, the bulbs and the edge strips between the consoles, the loads of BM1 are placed at the edge of the fictional lanes, with the edge of the wheel on 0.3 m from the vehicle barrier. Assuming a distance from the vehicle barrier of 0.30 m and a wheel width of 0.40 m, the center of the wheel is 0.695 m from the main girder. The load on lane 2 is relevant for the bulbs and therefore included. The load is split lengthwise into separate ones load cases for the even and odd fields. The load is multiplied by a reduction factor for LM1, 6 months, depending on the influence length.

Lane 1	$p_{udl.\,1}$	=	9 kN / m 2	width	3.00 m
Lane 2	$p_{udl.\,2}$	=	2.5 kN / m 2	width	3.00 m

Fictitious lane layout V2 - Emergency - Steel deck load with bulbs between the consoles

Tax case **770-779: BM1 - TS - V2 - Emergency - Steel deck with bulbs between consoles**

General

Wheel load	F_{Q1}	=	150 kN	(Axis system lane 1)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q1}	=	495.9 kN / m2	$= F_{Q1} / (B_{wheel} * L_{wheel})$
Wheel load	F_{Q2}	=	100 kN	(Axis system lane 2)
width wheel dim.	B_{wheel}	=	0.55 m	
Length wheel dim	L_{wheel}	=	0.55 m	
Distributed wheel load	p_{Q2}	=	330.6 kN / m2	$= F_{Q2} / (B_{wheel} * L_{wheel})$

Specifically

The design positions of the tandem systems for the maximum stresses in the field and at the location of the The support point was determined using SCIA by sliding it in steps of 0.1 m (see Appendix F.3). Only the normative positions are kept in the model because of the calculation time. The tax is multiplied with a reduction factor for LM1, 6 months, depending on the influence length.

Tax case **780-789: BM2 - TS - V2 - Emergency - Steel deck / concrete deck between cross members**

The load due to BM2 in the emergency situation (V2) will not be compared to the normal situation (V1) for the steel deck and the concrete deck between the cross beams are decisive, due to the higher reduction factor in connection with the reduced service life that may be used.

Tax case **790-799: BM2 - TS - V2 - Emergency - Steel deck / concrete deck between consoles**

For BM2 the wheel loads are placed against the vehicle barrier. Since the load case BM2 - emergency is exactly equal to BM2 - normal situation, it continues not taken into account as the reduction factors for the emergency situation are lower.

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **900-949: Brake load**

In the model, the brake load is entered as a line load along the length of the bridge. A distinction is made for the calculation made in situation V1 (normal situation) and situation V2 (emergency). Taxes take into account the reduction factors.

Main span	$L_{deck.\,1}$	=	295 m	0.6x2x300 + 0.1x9x3x 295 ≤ 800 kN =	800 kN
Side span	$L_{deck.\,2}$	=	120 m	0.6x2x300 + 0.1x9x3x 120 ≤ 800 kN =	684 kN

$q_{brake\,1}$	$= F_{rem.\,1} / L_{deck.\,1}$	=	2.7 kN / m	(excl reduction factors)
$q_{brake\,2}$	$= F_{rem.2.max} / L_{deck.1}$	=	5.7 kN / m	(excl reduction factors)

The load is maintained for the normal situation in the heart of lane 1 or 2. For the fictional situation, the most unfavorable location is chosen, once with lane 1 on the edge and 1 time in the middle of the bridge. This means that a distinction is made between situation V1 (normal situation) and V2 (emergency).

Brake load position

Location	Eccentricity to heart bridge	
V1 - normal use - Main beam cf BG 100-199	1.8125 m	shown in blue
V1 - normal use - Cross beam cf BG 200-249	0 m	shown in green
V1 - normal use - Steel / concrete deck between crossbar cf BG 250-299	0	shown in green
V1 - normal use - Console cf BG 300-349	2.125 m	shown in red
V1 - normal use - Steel deck between console cf BG 350-399	2.125 m	shown in red
V2 - emergency - Main beam cf BG 500-599	2,245 m	shown in purple
V2 - emergency - Cross beam cf BG 600-649	0 m	shown in green
V2 - emergency - Steel / concrete deck between crossbar cf BG 650-699	0 m	shown in green
V2 - emergency - Console cf BG 700-749	2,245 m	shown in purple
V2 - emergency - Steel deck between console cf BG 750-769	2,245 m	shown in purple

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Traffic taxes	Version:	F1.0

Tax case **1200-1299: Tax inspection path**

The inspection path next to the bridge is loaded by a load of 2.0 kN / m². In addition, a point load of 7 kN is applied for local tests. The handrail becomes loaded with 0.8 kN / m. The tax is not charged simultaneously with traffic. Given the size of the load, it is only used for manual calculations of the console itself and the connections on the deck.

UDL inspection paths next to the bridge

UDL	2 kN / m²
Point load	7 kN
Handrail	0.8 kN / m

Tax case **1300-1399 = UDL 2.0 kN / m 2 - Inspection path under the bridge**

The inspection path under the bridge is taken into account as 2 point loads on the cross beams, center to center 700 mm, symmetrical with respect to the center of the crossbars. Given the magnitude of the loads, it is only used for testing the connection to the cross beam.

700 mm

$F_{\text{inspection path}}$ $F_{\text{inspection path}}$

UDL inspection path on the bridge

	Number	Length	Width	Weight	Total
UDL	0.5 x	1.8 mx	0.75 mx	2.00 kN / m² =	1.35 kN

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	5/25/2018
Project number:	BF7387	Name:	EKL
Description:	Reduction factors	Version:	F1.0

Traffic load reduction factors

Main bridge

Axle loads (TS)

Part	L	α Q1 and α q1	LM1 α trend	LM2 α trend	α L	ψ factor (30 yrs)	ψ factor (6 m)	LM1 (30 yrs)	LM1 (6 m)	LM2 (30 yrs)	LM2 (6 m)
Main spar field 1	45 m	0.99	0.96	0.98	1	0.99	0.92	0.94	0.87	0.96	0.89
Main girder field 2 (pos. M)	50 m	0.99	0.96	0.98	1	0.99	0.92	0.94	0.87	0.96	0.89
Main girder field 2 (neg. M)	150 m	0.99	0.96	0.98	1	0.98	0.84	0.93	0.80	0.95	0.81
Main spar field 3	105 m	0.99	0.96	0.98	1	0.98	0.84	0.93	0.80	0.95	0.81
Main beam support point 2	95 m	0.99	0.96	0.98	1	0.98	0.85	0.93	0.81	0.95	0.82
Main beam support point 3	155 m	0.99	0.96	0.98	1	0.97	0.84	0.92	0.80	0.94	0.81
Cross beam / console	12 m	0.99	0.99	0.98	1	0.99	0.93	0.97	0.91	0.96	0.90
Bulb, steel deck	<2.5 m	0.99	1	0.98	1	0.99	0.93	0.98	0.92	0.96	0.90

Evenly distributed load (UDL)

Part	L	α Q1 and α q1	LM1 α trend	LM2 α trend	α L	ψ factor (30 yrs)	ψ factor (6 m)	LM1 (30 yrs)	LM1 (6 m)	LM2 (30 yrs)	LM2 (6 m)
Main spar field 1	45 m	0.99	0.96	0.98	1	0.99	0.92	0.94	0.87	0.96	0.89
Main girder field 2 (pos. M)	50 m	0.99	0.96	0.98	1	0.99	0.92	0.94	0.87	0.96	0.89
Main girder field 2 (neg. M)	150 m	0.99	0.96	0.98	0.90	0.98	0.84	0.84	0.72	0.86	0.73
Main spar field 3	105 m	0.99	0.96	0.98	0.99	0.98	0.84	0.92	0.79	0.94	0.81
Main beam support point 2	95 m	0.99	0.96	0.98	1	0.98	0.85	0.93	0.81	0.95	0.82
Main beam support point 3	155 m	0.99	0.96	0.98	0.89	0.97	0.84	0.82	0.71	0.84	0.73
Cross beam / console	15 m	0.99	0.99	0.98	1	0.99	0.93	0.97	0.91	0.96	0.90
Bulb, steel deck	<2.5 m	0.99	1	0.98	1	0.99	0.93	0.98	0.92	0.96	0.90

Bridge

Axle loads (TS)

Part	L	α Q1 and α q1	LM1 α trend	LM2 α trend	α L	ψ factor (30 yrs)	ψ factor (6 m)	LM1 (30 yrs)	LM1 (6 m)	LM2 (30 yrs)	LM2 (6 m)
Main spar field 1	40 m	0.99	0.97	0.98	1	0.99	0.92	0.95	0.88	0.96	0.89
Main girder field 2 (pos. M)	40 m	0.99	0.97	0.98	1	0.99	0.92	0.95	0.88	0.96	0.89
Main girder field 2 (neg. M)	80 m	0.99	0.96	0.98	1	0.98	0.87	0.93	0.83	0.95	0.84
Main beam support point 2	80 m	0.99	0.96	0.98	1	0.98	0.87	0.93	0.83	0.95	0.84
Cross beam	12 m	0.99	0.99	0.98	1	0.99	0.93	0.97	0.91	0.96	0.90
Concrete deck	<2.5 m	0.99	1	0.98	1	0.99	0.93	0.98	0.92	0.96	0.90

Evenly distributed load (UDL)

Part	L	α Q1 and α q1	LM1 α trend	LM2 α trend	α L	ψ factor (30 yrs)	ψ factor (6 m)	LM1 (30 yrs)	LM1 (6 m)	LM2 (30 yrs)	LM2 (6 m)
Main spar field 1	40 m	0.99	0.97	0.98	1	0.99	0.92	0.95	0.88	0.96	0.89
Main girder field 2 (pos. M)	40 m	0.99	0.97	0.98	1	0.99	0.92	0.95	0.88	0.96	0.89
Main girder field 2 (neg. M)	80 m	0.99	0.96	0.98	1	0.98	0.87	0.93	0.83	0.95	0.84
Main beam support point 2	80 m	0.99	0.96	0.98	1	0.98	0.87	0.93	0.83	0.95	0.84
Cross beam	15 m	0.99	0.99	0.98	1	0.99	0.93	0.97	0.91	0.96	0.90
Concrete deck	<2.5 m	0.99	1	0.98	1	0.99	0.93	0.98	0.92	0.96	0.90

Determining the location of wheel loads for testing bulbs

Project:	Recalculation IJssel Bridge A12	Date:	5/23/2018
Project number:	BF7387	Name:	AKA
Description:	Determining the position of the wheel loads		

Two locations are considered for the testing of the bulbs, one at the location of the bulbs between the cross bars and one at the location of the bulbs between the consoles. For the bulbs between the crossbars is made use of the road layout that was also used for the maximum field moment in the crossbars, however with full lane widths. For the bulbs between the consoles, the load is as far as possible placed to the outside.

The tandem systems have shifted from one crossbeam to another crossbeam in steps of 0.1m determine the position at which the maximum field and support moment occurs. This is for both BM1 and BM2 done, and for BM1 both for the normal situation and the situation in an accident. The effect of one transverse shift has also been controlled.

BM1 V1 Bulbs between cross bars **BM1 V1 Bulbs between consoles**

BG	$\sigma_{x, max}$	$\sigma_{x, min}$
270	150.1	-101.7
270-1	170.5	-103.5
270-2	184.9	-97.7
270-3	187.7	-90.6
270-4	199.4	-93.9
270-5	200.2	-96.5
270-6	193.7	-97.0
270-7	184.2	-97.7
270-8	173.8	91.7
270-9	165.0	-80.1

BG	$\sigma_{x, max}$	$\sigma_{x, min}$
370	96.6	192.9
370-1	114.7	-195.4
370-2	125.9	-187.5
370-3	135.5	-169.7
370-4	144.3	-143.2
370-5	143.0	-118.0
370-6	134.6	-124.4
370-7	126.9	-133.1
370-8	113.5	-133.6
370-9	102.5	-129.1

BM2 V1 Bulbs between cross bars

BG	$\sigma_{x, max}$	$\sigma_{x, min}$
460-0	66.8	-21.8
460-1	86.1	-28.7
460-2	113.3	-36.3
460-3	132.9	-46.4
460-4	141.0	-53.2
460-5	162.5	-62.0
460-6	170.7	-68.9
460-7	185.6	-76.4
460-8	191.4	-80.7
460-9	188.3	-85.6
460-10	190.9	-86.0
460-11	183.4	-86.6
460-12	168.7	-82.2
460-13	158.5	-78.3

BM2 V1 Bulbs between consoles

BG	$\sigma_{x, max}$	$\sigma_{x, min}$
450-0	37.6	-18.6
450-1	57.1	-28.9
450-2	84.4	-33.0
450-3	104.3	-46.2
450-4	116.7	-57.8
450-5	137.8	-71.0
450-6	146.9	-77.0
450-7	163.0	-87.5
450-8	169.5	-94.8
450-9	166.2	-102.6
450-10	169.0	-105.9
450-11	160.9	-109.3
450-12	144.8	-107.3
450-13	134.0	-105.9
450-14	111.4	-95.4
450-15	95.8	-79.8

BM1 V2 Bulbs between cross bars

BG	$\sigma_{x, max}$	$\sigma_{x, min}$
	142.7	-104.9
670-1	163.1	-108.3
670-2	175.7	-101.5
670-3	179.5	-89.8
670-4	189.8	-93.3
670-5	190.6	-96.2
670-6	183.6	-97.0
670-7	175.1	-98.3
670-8	163.8	-92.6
670-9	156.8	-82.1

BM1 V2 Bulbs between consoles

BG	$\sigma_{x, max}$	$\sigma_{x, min}$
770-0	93.0	-169.1
770-1	113.5	-170.9
770-2	123.0	-163.9
770-3	132.3	-148.8
770-4	139.4	-125.5
770-5	139.2	-108.1
770-6	128.8	-133.7
770-7	124.5	-122.0
770-8	109.0	-120.1
770-9	97.4	-116.4

In addition to the above longitudinal variation, the load has also been shifted in the width direction. This has no significant effect on the voltages in the bulbs and deck.

Appendix

Appendix G - Wind loads

IJssel Bridge

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Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Wind load at bridge (5 °)	Version:	D0.1

Wind load

Tax case **950-959** **:** **Wind load**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	120 m
width	10,964 m
free height bottom bridge	11.2 m
1st main beam	2.4 m
bark side	0.225 m
2nd main spar	2.2 m
construction height bridge (d)	2.625 m
inclined windward and slate side (α)	5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	10.1 m + NAP
y	length	Bottom of main beam	21.3 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction **A ref, x**

Separation type	open bridge railing and open safety barrier	
closed or open barrier	On both sides	
handrail / screen height (d_1)	0.85 m	
d_{to} - without traffic	5.29 m	
d_{to} - with traffic	5.97 m	4.22
$A_{ref; x}$ - without traffic	635 m^2	
$A_{ref; x}$ - with traffic	716 m^2	

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	$d + 2d_1$
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.525 m
height of main beams	2.1 m
equivalent construction height	4.03 m

wind in Z direction **A ref, z**

A ref, z 1316 m^2

Wind loads

H4.2 **Basic values**

Design life span = 30 years

C_{prob} = 0.96

Wind area = III

$v_{b;0}$ = 24.5 m / s

v_b = 23.6 m / s

$v^*_{b;0}$ = 23.0 m / s

v^*_b = 23.0 m / s

H4.3.2 **Terrain roughness**

Reference height (z_e) =	12.5 m			
Terrain category =	II	Unbuilt		
height =	17.2			
Distance R =	858 m	Distance R according to table NB. 4		
z_0 =	0.2			
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0, II})^{0.07}$		
roughness factor $c_r(z)$ =	0.866	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$	
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$	

H4.3.1 **Variation with height**

reference height (z_e) =	12.5	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.5 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	19.9 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l =	1
Turbulence intensity $I_v(z)$ =	0.2418

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.70	kN / m 2	2,019
Extreme thrust $q^*_p(z)$ =	0.67	kN / m 2	2,019

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Wind load at bridge (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d to**	**c fx; 0**	**c fx; 0 incl surcharge cross slope line function**	
without traffic	2.07	1.91	1.96	Construction stage, open bridge railings, etc.
with traffic	1.84	1.98	2.04	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	2.07	
angle α of the wind with fly screen.	5 gr	
θ = α + β	6 gr	
figure NB.8 c_{fz} =	0.76	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p rep**
without traffic	F_{wk} =	879 kN	7.3 kN / m1	1.38 kN / m 2
with traffic	F_{wk} =	1029 kN	8.6 kN / m1	1.44 kN / m 2
with traffic, reduced	$\psi_0 F_{wk}$ =	309 kN	2.6 kN / m1	0.43 kN / m 2
with traffic	F^*_w =	975 kN	8.1 kN / m1	1.36 kN / m 2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p rep (about 9.44 m)**
without traffic	F_{wk} =	351 kN	0.31 kN / m 2
with traffic	F_{wk} =	412 kN	0.36 kN / m 2
with traffic, reduced	$\psi_0 F_{wk}$ =	123 kN	0.11 kN / m 2
with traffic	F^*_w =	390 kN	0.34 kN / m 2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p rep (about 10,964 m)**
without traffic	F_{wk} =	709 kN	0.54 kN / m 2
moment with e = b / 4	M_{wk} =	1942 kNm	± 0.81 kN / m 2
with traffic	F^*_w =	671 kN	0.51 kN / m 2
moment with e = b / 4	M^*_w =	1839 kNm	± 0.77 kN / m 2

10,964 m

0.762 m 9.44 m 0.762 m

0.77 kN / m 2 0.66 kN / m2

0.66 kN / m 2 0.77 kN / m 2

0.51 kN / m 2

Scia imports

0,66 kN / m 2 0.16kN / m

0,66 kN / m 2

9.44 m

0.07 kNm / m

0.36 kN / m

0.51 kN / m 2

0.93 kN / m

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Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Wind load at bridge (5 °)	Version:	D0.1

Wind load

Tax case **950-959** **:** **Wind load**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry		Coordinate system				
Type	plate bridge or box bridge	X	width	Ground level	10.1 m + NAP
total length	120 m	y	length	Bottom of main beam	21.3 m + NAP
width	10,964 m	z	height		
free height bottom bridge	11.2 m				
1st main beam	2.4 m				
bark side	0.225 m				
2nd main spar	2.2 m				
construction height bridge (d)	2.625 m				
inclined windward and slate side (α)	2.5 gr				
bridge deck slope (β)	1 gr	NB - cross slope supplement must be included			
Traffic type	road traffic	Traffic band		2	meter

Reference surfaces

wind in X direction	**A ref, x**		**table 1**			
Separation type	open bridge railing and open safety barrier		Separation type		On 1 side	Both sides
closed or open barrier	On both sides		open bridge railing or open safety barrier		d + 0.3m	d + 0.6m
handrail / screen height (d_1)	0.85 m		tight bridge railing or tight safety barrier		$d + d_1$	$d + 2d_1$
d_{to} - without traffic	5.29 m		open bridge railing and open safety barrier		d + 0.6m	d + 1.2m
d_{to} - with traffic	5.97 m	4.22				
			table 2			
$A_{ref;x}$ - without traffic	635 m 2		At deck with main beams	article NB 8.3.1 (4)		
$A_{ref;x}$ - with traffic	716 m 2		number of main beams	2		
			deck height	0.525 m		
			height of main beams	2.1 m		
wind in Z direction	**A ref, z**		equivalent construction height	4.03 m		
A ref, z	1316 m 2					

Wind loads

H4.2 **Basic values**

Design life span =	30 years	
C_{prob} =	0.96	
Wind area =	III	
$v_{b;0}$ =	24.5 m / s	
v_b =	23.6 m / s	
$v^*_{b;0}$ =	23.0 m / s	
v^*_b =	23.0 m / s	

H4.3.2 **Terrain roughness**

Reference height (z_e) =	12.5 m		
Terrain category =	II	Unbuilt	
height =	17.2		
Distance R =	858 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.866	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \le z \le z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \le z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	12.5	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.5 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	19.9 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_I =	1
Turbulence intensity $I_v(z)$ =	0.2418

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.70	kN / m 2	2,019
Extreme thrust $q^*_p(z)$ =	0.67	kN / m 2	2,019

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Wind load at bridge (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d_{to}**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	2.07	1.91	1.96	Construction stage, open bridge railings, etc.
with traffic	1.84	1.98	2.04	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot}	2.07	
angle α of the wind with fly screen.	2.5 gr	
$\theta = \alpha + \beta$	3.5 gr	
figure NB.8 c_{fz} =	0.66	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	879 kN	7.3 kN / m1	1.38 kN / m 2
with traffic	F_{wk} =	1029 kN	8.6 kN / m1	1.44 kN / m 2
with traffic, reduced	$\psi_0 F_{wk}$ =	309 kN	2.6 kN / m1	0.43 kN / m 2
with traffic	F^*_w =	975 kN	8.1 kN / m1	1.36 kN / m 2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about 9.44 m)**
without traffic	F_{wk} =	351 kN	0.31 kN / m 2
with traffic	F_{wk} =	412 kN	0.36 kN / m 2
with traffic, reduced	$\psi_0 F_{wk}$ =	123 kN	0.11 kN / m 2
with traffic	F^*_w =	390 kN	0.34 kN / m 2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about 10,964 m)**
without traffic	F_{wk} =	613 kN	0.47 kN / m 2
moment with e = b / 4	M_{wk} =	1681 kNm	± 0.7 kN / m 2
with traffic	F^*_w =	581 kN	0.44 kN / m 2
moment with e = b / 4	M^*_w =	1592 kNm	± 0.66 kN / m 2

10,964 m

0.762 m 9.44 m 0.762 m

0.66 kN / m 2 0.57 kN / m2

0.57 kN / m 2 0.66 kN / m 2

0.44 kN / m 2

Scia imports

0.57 kN / m 2 0.13 kN / m

0.57 kN / m 2

9.44 m

0.05 kNm / m

0.31 kN / m

0.44 kN / m 2

0.80 kN / m

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	10/19/2018
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **950-951** **:** **Wind load x direction**

The wind load in x direction is distributed between the K-bandages and the deck. On the K-beams, the wind load of a half (main) beam height ($d_{k\text{-relation}}$) times the center-to-center distance of the K-relations is charged as a point load ($F^*_{wk,\text{k-connection}}$). On the side of the second main beam, 2/3 of it this tax is charged on the k-connection ($F^*_{wk,\text{k-connection},2}$). The remaining wind load is charged as line load on the steel deck (q_{deck})

						K-bandages				deck
Position	Cross beam	To x vs. 0	$h_{main\ beam}$	p^*_w	$d_{k\ bandage}$	$A_{k\ bandage}$	$F^*_{w,k\ bandage,1}$	$F^*_{w,k\ bandage,2}$	d_{to}	d_{deck}
		[mm]	[m]	[kN / m²]	[m]	[m²]	[kN]	[kN]	[m]	[m]
		-325	2400	1.40	1200				6.37	4.37
Pillar f	**portal A**	**0**	**2400**	**1.40**	**1200**	**3.63**	**5.1**	**3.4**	**6.37**	**4.37**
	1	5400	2400	1.40	1200	6.48	9.1	6.0	**6.37**	4.37
	2	10800	2400	1.40	1200	6.48	9.1	6.0	**6.37**	4.37
	3	16200	2400	1.40	1200	5.40	7.6	5.0	**6.37**	4.37
	4	19798	2400	1.40	1200	4.32	6.0	4.0	**6.37**	4.37
field 1	**5**	**23398**	**2400**	**1.40**	**1200**	**5.40**	**7.6**	**5.0**	**6.37**	**4.37**
	6	28798	2400	1.40	1200	6.48	9.1	6.1	**6.37**	4.37
	7	34198	2400	1.40	1200	6.48	9.1	6.1	**6.37**	4.37
	8	39596	2400	1.41	1200	6.48	9.1	6.1	**6.37**	4.37
Pillar G	**Portal B**	**44996**	**2400**	**1.41**	**1200**	**6.48**	**9.1**	**6.1**	**6.37**	**4.37**
	9	50394	2443	1.42	1222	6.57	9.3	6.2	**6.44**	4.41
	10	55749	2541	1.43	1271	6.80	9.7	6.5	**6.61**	4.49
	11	61104	2720	1.44	1360	7.28	10.5	7.0	**6.90**	4.64
	12	66457	2963	1.45	1482	6.61	9.6	6.4	**7.31**	4.84
field 2	**13**	**70027**	**3159**	**1.46**	**1580**	**5.64**	**8.2**	**5.5**	**7.64**	**5.00**
	14	73597	3374	1.49	1687	7.53	11.2	7.5	**7.99**	5.18
	15	78952	3781	1.53	1891	10.12	15.5	10.3	**8.67**	5.52
	16	84305	4245	1.57	2123	11.36	17.9	11.9	**9.45**	5.91
	17	89660	4766	1.62	2383	12.76	20.6	13.7	**10.31**	6.34
Pillar H	**Portal C**	**95015**	**5300**	**1.66**	**2650**	**14.05**	**23.3**	**15.5**	**11.20**	**6.79**
	18	100265	4880	1.65	2440	12.81	21.1	14.1	**10.50**	6.44
	19	105515	4440	1.64	2220	11.65	19.1	12.7	**9.77**	6.07
	20	110763	4063	1.63	2032	10.66	17.4	11.6	**9.14**	5.76
	21	116013	3725	1.62	1863	9.78	15.8	10.6	**8.58**	5.47
	22	121263	3444	1.61	1722	9.03	14.6	9.7	**8.11**	5.24
	23	126506	3224	1.60	1612	8.46	13.5	9.0	**7.74**	5.06
	24	131756	3034	1.59	1517	7.96	12.7	8.5	**7.43**	4.90
	25	137006	2916	1.58	1458	7.67	12.1	8.1	**7.23**	4.80
	26	142 275.5	2838	1.57	1419	7.46	11.7	7.8	**7.10**	4.74
Field 3	**27**	**147,525.5**	**2800**	**1.56**	**1400**	**7.35**	**11.5**	**7.7**	**7.04**	**4.70**
	26	152775.5	2838	1.57	1419					

Global model:	3318	kN
Local model:	155	kN

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Tax case **952-953** **:** **Wind load 40% xy direction**

For these load cases, a wind force of 40% in x and y direction occurs. This was introduced by multiplying the wind in x direction by 40%. For the y-direction (longitudinal direction) a UDL load is applied to the deck.

Loaded deck width b_{deck} = 9.29 m

				x direction			y direction
		To x vs. 0	d_{to}	$F^*_{w, k\ bandage, 1}$	$F^*_{w, k\ bandage, 2}$	q_{deck}	pdek
Position	Cross beam	[mm]	[m]	[kN]	[kN]	[kN / m]	[kN / m] 2
		-325	6.37			2.44	0.38
Pillar f	portal A	0	6.37	2.0	1.4	2.44	0.38
	1	5400	6.37	3.6	2.4	2.44	0.38
	2	10800	6.37	3.6	2.4	2.44	0.38
	3	16200	6.37	3.0	2.0	2.45	0.38
	4	19798	6.37	2.4	1.6	2.45	0.38
field 1	**5**	**23398**	**6.37**	**3.0**	**2.0**	**2.45**	**0.38**
	6	28798	6.37	3.6	2.4	2.45	0.38
	7	34198	6.37	3.6	2.4	2.45	0.39
	8	39596	6.37	3.6	2.4	2.46	0.39
Pillar G	**Portal B**	**44996**	**6.37**	**3.6**	**2.4**	**2.46**	**0.39**
	9	50394	6.44	3.7	2.5	2.50	0.39
	10	55749	6.61	3.9	2.6	2.56	0.41
	11	61104	6.90	4.2	2.8	2.67	0.43
	12	66457	7.31	3.8	2.6	2.81	0.46
field 2	**13**	**70027**	**7.64**	**3.3**	**2.2**	**2.92**	**0.48**
	14	73597	7.99	4.5	3.0	3.08	0.51
	15	78952	8.67	6.2	4.1	3.38	0.57
	16	84305	9.45	7.1	4.8	3.72	0.64
	17	89660	10.31	8.2	5.5	4.10	0.72
Pillar H	**Portal C**	**95015**	**11.20**	**9.3**	**6.2**	**4.50**	**0.80**
	18	100265	10.50	8.5	5.6	4.25	0.75
	19	105515	9.77	7.6	5.1	3.98	0.69
	20	110763	9.14	7.0	4.6	3.75	0.64
	21	116013	8.58	6.3	4.2	3.55	0.60
	22	121263	8.11	5.8	3.9	3.38	0.56
	23	126506	7.74	5.4	3.6	3.24	0.53
	24	131756	7.43	5.1	3.4	3.12	0.51
	25	137006	7.23	4.9	3.2	3.04	0.49
	26	142 275.5	7.10	4.7	3.1	2.98	0.48
Field 3	**27**	**147,525.5**	**7.04**	**4.6**	**3.1**	**2.94**	**0.47**
	26	152775.5					

Global model: 1327 kN
Local model: 62 kN

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Tax case 954-955 : Wind load z direction

The wind load in Z direction is applied as a UDL load on the deck. The wind load on the inspection paths is used as line load and line moment on the edge from the deck.

Loaded deck width $b_{deck} =$ 9.29 m

Width including inspection paths $b_{deck} =$ 10,964 m

Position	$p^*_{w,z}$ [kN / m²]	$\Delta p^*_{w,z}$ [kN / m²] 2	$p^*_{w,z,left}$ [kN / m²] 2	$p^*_{w,z,right}$ [kN / m²] 22	$q^*_{w,z,left}$ [kN / m]	$q^*_{w,z,right}$ [kN / m]	$m^*_{w,z,left}$ [kN / m] 2	$m^*_{w,z,right}$ [kN / m] 2
field 1	**0.52**	**0.77**	**1.15**	**-0.12**	**1.02**	**-0.16**	**0.43**	**0.07**
field 2	**0.51**	**0.77**	**1.14**	**-0.12**	**1.01**	**-0.16**	**0.43**	**0.07**
Field 3	**0.56**	**0.84**	**1.25**	**-0.13**	**1.11**	**-0.17**	**0.47**	**0.08**
0.837			**9.29**				**0.837**	

$\Delta p^*_{w,z}$

$p^*_{w,z}$

$-\Delta p^*_{w,z}$

Import SCIA

$p^*_{w,z,left}$

$q^*_{w,z,left}$ $q^*_{w,z,right}$

$m^*_{w,z,left}$ $p^*_{w,z,right}$ $m^*_{w,z,right}$

Global model:	1703	kN
Local model:	72	kN

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at pillar F and abutment south**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry Coordinate system

Type	plate bridge or box bridge	X	width	Ground level	10.1 m + NAP
total length	295 m	y	length	Bottom of main beam	21.5 m + NAP
width	10,964 m	z	height		
free height bottom bridge	11.4 m				
1st main beam	2.4				
sheep's edge / deck	0.37				
2nd main spar	2.4				
construction height bridge (d)	2.77 m				
inclined windward and slate side (α)	5 gr				
bridge deck slope (β)	1 gr	NB - cross slope supplement must be included			
Traffic type	road traffic	Traffic band	2	meter	

Reference surfaces

wind in X direction $A_{ref,x}$

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	5.57 m
d_{to} - with traffic	6.37 m
$A_{ref;x}$ - without traffic	1643 m^2
$A_{ref;x}$ - with traffic	1879 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.4 m
equivalent construction height	4.37 m

wind in Z direction $A_{ref,z}$

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span =	30 years	
C_{prob} =	0.96	
Wind area =	III	
$v_{b;0}$ =	24.5 m / s	
v_b =	23.6 m / s	
$v^*_{b;0}$ =	23.0 m / s	
v^*_b =	23.0 m / s	

H4.3.2 **Terrain roughness**

Reference height (z_e) =	12.8 m		
Terrain category =	II	Unbuilt	
height =	17.8		
Distance R =	889 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.870	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	12.8	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.6 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	20.0 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l =	1.00
Turbulence intensity $I_v(z)$ =	0.2405

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.71	kN / m^2	2,033
Extreme thrust $q^*_p(z)$ =	0.67	kN / m^2	2,033

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**c $_{fx;0}$**	**c $_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.97	1.94	2.00	Construction stage, open bridge railings, etc.
with traffic	1.72	2.02	2.08	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	1.97	
angle α of the wind with fly screen.	5 gr	
$\theta = \alpha + \beta$	6 gr	
figure NB.8 c $_{fz}$ =	0.76	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p $_{rep}$**
without traffic	F $_{wk}$ =	2329 kN	7.9 kN / m1	1.42 kN / m ^{2}
with traffic	F $_{wk}$ =	2770 kN	9.4 kN / m1	1.47 kN / m ^{2}
with traffic, reduced	ψ $_0$ F $_{wk}$ =	831 kN	2.8 kN / m1	0.44 kN / m ^{2}
with traffic	F * w =	2624 kN	8.9 kN / m1	1.40 kN / m ^{2}

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p $_{rep}$ (about b = 9.29 m)**
without traffic	F $_{wk}$ =	932 kN	0.34 kN / m ^{2}
with traffic	F $_{wk}$ =	1108 kN	0.40 kN / m ^{2}
with traffic, reduced	ψ $_0$ F $_{wk}$ =	332 kN	0.12 kN / m ^{2}
with traffic	F * w =	1049 kN	0.38 kN / m ^{2}

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p $_{rep}$ (about b = 10,964 m)**
without traffic	F $_{wk}$ =	1753 kN	0.54 kN / m ^{2}
moment with e = b / 4	M $_{wk}$ =	4805 kNm	± 0.81 kN / m ^{2}
with traffic	F * w =	1660 kN	0.51 kN / m ^{2}
moment with e = b / 4	M * w =	4550 kNm	± 0.77 kN / m ^{2}

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at the 1st and 5th span**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	11.55 m
1st main beam	2.4
sheep's edge / deck	0.37
2nd main spar	2.4
construction height bridge (d)	2.77 m
inclined windward and slate side (α)	5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	10.1 m + NAP
y	length	Bottom of main beam	21.65 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction **$A_{ref,x}$**

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	5.57 m
d_{to} - with traffic	6.37 m
$A_{ref;x}$ - without traffic	1643 m^2
$A_{ref;x}$ - with traffic	1879 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6r
tight bridge railing or tight safety barrier	d + d_1	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2r

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.4 m

wind in Z direction **$A_{ref,z}$** equivalent construction height 4.37 m

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2	**Basic values**			
Design life span =	30 years			
C_{prob} =	0.96			
Wind area =	III			
$v_{b;0}$ =	24.5 m / s			
v_b =	23.6 m / s			
$v^*_{b;0}$ =	23.0 m / s			
v^*_b =	23.0 m / s			
H4.3.2	**Terrain roughness**			
Reference height (z_e) =	12.9 m			
Terrain category =	II	Unbuilt		
height =	17.9			
Distance R =	896 m	Distance R according to table NB. 4		
z_0 =	0.2			
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$		
roughness factor $c_r(z)$ =	0.873	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$	
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$	
H4.3.1	**Variation with height**			
reference height (z_e) =	12.9			
orography factor $c_o(z)$ =	1.00			
Avg. wind speed $v_m(z)$ =	20.6 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$		
Avg. wind speed $v^*_m(z)$ =	20.1 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$		
H4.4	**Wind turbulence**			
Turbulence factor k_I =	1.00			
Turbulence intensity $I_v(z)$ =	0.2398			
H4.5	**Extreme thrust**			
ρ =	1.25	kg / m3	$c_e(z)$	
Extreme thrust $q_p(z)$ =	0.71	kN / m^2	2,041	
Extreme thrust $q^*_p(z)$ =	0.67	kN / m^2	2,041	

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d_{to}**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.97	1.94	2.00	Construction stage, open bridge railings, etc.
with traffic	1.72	2.02	2.08	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot} 1.97

angle α of the wind with fly screen. 5 gr

$\theta = \alpha + \beta$ 6 gr

figure NB.8 c_{fz} = 0.76 note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	2338 kN	7.9 kN / m1	1.42 kN / m^2
with traffic	F_{wk} =	2781 kN	9.4 kN / m1	1.48 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	834 kN	2.8 kN / m1	0.44 kN / m^2
with traffic	F^*_w =	2634 kN	8.9 kN / m1	1.40 kN / m^2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	935 kN	0.34 kN / m^2
with traffic	F_{wk} =	1112 kN	0.41 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	334 kN	0.12 kN / m^2
with traffic	F^*_w =	1053 kN	0.38 kN / m^2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1760 kN	0.54 kN / m^2
moment with e = b / 4	M_{wk} =	4823 kNm	± 0.82 kN / m^2
with traffic	F^*_w =	1666 kN	0.52 kN / m^2
moment with e = b / 4	M^*_w =	4568 kNm	± 0.77 kN / m^2

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at pillar G and K**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	11.7 m
1st main beam	2.4
sheep's edge / deck	0.37
2nd main spar	2.4
construction height bridge (d)	2.77 m
inclined windward and slate side (α)	5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	10.1 m + NAP
y	length	Bottom of main beam	21.8 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction $A_{ref,x}$

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	5.57 m
d_{to} - with traffic	6.37 m
$A_{ref;x}$ - without traffic	1643 m^2
$A_{ref;x}$ - with traffic	1879 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6n
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2n

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.4 m
equivalent construction height	4.37 m

wind in Z direction $A_{ref,z}$

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span =	30 years
C_{prob} =	0.96
Wind area =	III
$v_{b;0}$ =	24.5 m / s
v_b =	23.6 m / s
$v^*_{b;0}$ =	23.0 m / s
v^*_b =	23.0 m / s

H4.3.2 **Terrain roughness**

Reference height (z_e) =	13.1 m		
Terrain category =	II	Unbuilt	
height =	18.1		
Distance R =	904 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.875	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	13.1	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.7 m / s	$v_m(z) = c_r(z) x c_0(z) x v_b$
Avg. wind speed $v^*_m(z)$ =	20.1 m / s	$v^*_m(z) = c_r(z) x c_0(z) x v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l =	1.00
Turbulence intensity $I_v(z)$ =	0.2392

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.72	kN / m_2	2,049
Extreme thrust $q^*_p(z)$ =	0.68	kN / m_2	2,049

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.97	1.94	2.00	Construction stage, open bridge railings, etc.
with traffic	1.72	2.02	2.08	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	1.97	
angle α of the wind with fly screen.	5	
θ = α + β	6 gr	
figure NB.8 c_{fz} =	0.76	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	2347 kN	8.0 kN / m1	1.43 kN / m^2
with traffic	F_{wk} =	2792 kN	9.5 kN / m1	1.49 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	837 kN	2.8 kN / m1	0.45 kN / m^2
with traffic	F^*w =	2644 kN	9.0 kN / m1	1.41 kN / m^2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	939 kN	0.34 kN / m^2
with traffic	F_{wk} =	1117 kN	0.41 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	335 kN	0.12 kN / m^2
with traffic	F^*w =	1057 kN	0.39 kN / m^2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1766 kN	0.55 kN / m^2
moment with e = b / 4	M_{wk} =	4842 kNm	± 0.82 kN / m^2

with traffic	F * w =	1673 kN	0.52 kN / m^2
moment with e = b / 4	M * w =	4585 kNm	± 0.78 kN / m^2

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at the 2nd and 4th span**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry		Coordinate system			
Type	plate bridge or box bridge	X	width	Ground level	10.1 m + NAP
total length	295 m	y	length	Bottom of main beam	21.1 m + NAP
width	10,964 m	z	height		
free height bottom bridge	11 m				
1st main beam	3,159				

sheep's edge / deck	0.37				
2nd main spar	3,159				
construction height bridge (d)	3,529 m				
inclined windward and slate side (α)	5 gr				
bridge deck slope (β)	1 gr	NB - cross slope supplement must be included			
Traffic type	road traffic	Traffic band	2	meter	

Reference surfaces

wind in X direction	**$A_{ref,x}$**	**table 1**		
Separation type	open bridge railing and open safety barrier	Separation type	On 1 side	Both sides
closed or open barrier	On both sides	open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
handrail / screen height (d_1)	1 m	tight bridge railing or tight safety barrier	d + d_1	d + 2d
d_{to} - without traffic	6.84 m	open bridge railing and open safety barrier	d + 0.6m	d + 1.2m
d_{to} - with traffic	7.64 m			
		table 2		
$A_{ref;x}$ - without traffic	2016 m^2	At deck with main beams	article NB 8.3.1 (4)	
$A_{ref;x}$ - with traffic	2252 m^2	number of main beams	2	
		deck height	0.37 m	
		height of main beams	3.159 m	
wind in Z direction	**$A_{ref,z}$**	equivalent construction height	5.64 m	
$A_{ref,z}$	3234 m^2			

Wind loads

H4.2 **Basic values**

Design life span =	30 years	
C_{prob} =	0.96	
Wind area =	III	
$v_{b;0}$ =	24.5 m / s	
v_b =	23.6 m / s	
$v^*_{b;0}$ =	23.0 m / s	
v^*_b =	23.0 m / s	

H4.3.2 **Terrain roughness**

Reference height (z_e) =	12.8 m		
Terrain category =	II	Unbuilt	
height =	18.6		
Distance R =	932 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.870	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	12.8	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.6 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	20.0 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l =	1.00
Turbulence intensity $I_v(z)$ =	0.2406

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.71	kN / m^2	2,032
Extreme thrust $q^*_p(z)$ =	0.67	kN / m^2	2,032

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d_{to}**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.60	2.05	2.11	Construction stage, open bridge railings, etc.
with traffic	1.44	2.11	2.17	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot}	1.60	
angle α of the wind with fly screen.	5 gr	
θ = α + β	6 gr	
figure NB.8 c_{fz} =	0.76	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	3025 kN	10.3 kN / m1	1.50 kN / m^2
with traffic	F_{wk} =	3466 kN	11.8 kN / m1	1.54 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	1040 kN	3.5 kN / m1	0.46 kN / m^2
with traffic	F * w =	3283 kN	11.1 kN / m1	1.46 kN / m^2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	1210 kN	0.44 kN / m^2
with traffic	F_{wk} =	1387 kN	0.51 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	416 kN	0.15 kN / m^2
with traffic	F * w =	1313 kN	0.48 kN / m^2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1746 kN	0.54 kN / m^2
moment with e = b / 4	M_{wk} =	4787 kNm	± 0.81 kN / m^2
with traffic	F * w =	1654 kN	0.51 kN / m^2
moment with e = b / 4	M * w =	4533 kNm	± 0.77 kN / m^2

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at pillar H and J**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	12.7 m
1st main beam	5.3
sheep's edge / deck	0.37
2nd main spar	5.3
construction height bridge (d)	5.67 m
inclined windward and slate side (α)	5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	6.5 m + NAP
y	length	Bottom of main beam	19.2 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction **$A_{ref, x}$**

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	10.40 m
d_{to} - with traffic	11.20 m
$A_{ref; x}$ - without traffic	3069 m^2
$A_{ref; x}$ - with traffic	3305 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6r
tight bridge railing or tight safety barrier	d + d_1	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2r

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	5.3 m
equivalent construction height	9.20 m

wind in Z direction **$A_{ref, z}$**

$A_{ref, z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span = 30 years

C_{prob} = 0.96

Wind area = III

$v_{b;0}$ = 24.5 m / s

v_b = 23.6 m / s

$v^*_{b;0}$ = 23.0 m / s

v^*_b = 23.0 m / s

H4.3.2 **Terrain roughness**

Reference height (z_e) =	15.5 m		
Terrain category =	II	Unbuilt	
height =	23.9		
Distance R =	1195 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.911	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	15.5	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	21.5 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	21.0 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l = 1.00

Turbulence intensity $I_v(z)$ = 0.2298

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.76	kN / m^2	2,166
Extreme thrust $q^*_p(z)$ =	0.72	kN / m^2	2,166

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.05	2.23	2.29	Construction stage, open bridge railings, etc.
with traffic	0.98	2.25	2.32	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot}	1.05	
angle α of the wind with fly screen.	5 gr	
θ = α + β	6 gr	
figure NB.8 c_{fz} =	0.76	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	5321 kN	18.0 kN / m1	1.73 kN / m^2
with traffic	F_{wk} =	5791 kN	19.6 kN / m1	1.75 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	1737 kN	5.9 kN / m1	0.53 kN / m^2
with traffic	F^*w =	5484 kN	18.6 kN / m1	1.66 kN / m^2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	2128 kN	0.78 kN / m^2
with traffic	F_{wk} =	2316 kN	0.85 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	695 kN	0.25 kN / m^2
with traffic	F^*w =	2193 kN	0.80 kN / m^2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1852 kN	0.57 kN / m^2
moment with e = b / 4	M_{wk} =	5076 kNm	± 0.86 kN / m^2
with traffic	F^*w =	1754 kN	0.54 kN / m^2
moment with e = b / 4	M^*w =	4807 kNm	± 0.81 kN / m^2

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Wind load

Tax case **800-809** : **Wind load at the 3rd span**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	15.2 m
1st main beam	2.8
sheep's edge / deck	0.37
2nd main spar	2.8
construction height bridge (d)	3.17 m
inclined windward and slate side (α)	5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	6.5 m + NAP
y	length	Bottom of main beam	21.7 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction $A_{ref,x}$

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	6.24 m
d_{to} - with traffic	7.04 m
$A_{ref;x}$ - without traffic	1840 m^2
$A_{ref;x}$ - with traffic	2076 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.8 m
equivalent construction height	5.04 m

wind in Z direction $A_{ref,z}$

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span = 30 years

C_{prob} = 0.96

Wind area = III

$v_{b;0}$ = 24.5 m / s

v_b = 23.6 m / s

$v^*_{b;0}$ = 23.0 m / s

v^*_b = 23.0 m / s

H4.3.2 **Terrain roughness**

Reference height (z_e) = 16.8 m

Terrain category = II Unbuilt

height = 22.2

Distance R = 1112 m Distance R according to table NB. 4

z_0 = 0.2

Terein factor (k_r) = 0.209 $k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$

roughness factor $c_r(z)$ = 0.927 $c_r(z) = k_r \times \ln(z / z_0)$ for $z_{min} \leq z \leq z_{max}$

$c_r(z) = c_r(z_{min})$ for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) = 16.8

orography factor $c_o(z)$ = 1.00

Avg. wind speed $v_m(z)$ = 21.9 m / s $v_m(z) = c_r(z) \times c_0(z) \times v_b$

Avg. wind speed $v^*_m(z)$ = 21.3 m / s $v^*_m(z) = c_r(z)\, x c_0(z)\, x v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_I = 1.00

Turbulence intensity $I_v(z)$ = 0.2257

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.77	kN / m 2	2,219
Extreme thrust $q^*_p(z)$ =	0.73	kN / m 2	2,219

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.76	2.00	2.06	Construction stage, open bridge railings, etc.
with traffic	1.56	2.07	2.13	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot}	1.76	
angle α of the wind with fly screen.	5 gr	
$\theta = \alpha + \beta$	6 gr	
figure NB.8 c_{fz} =	0.76	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	2944 kN	10.0 kN / m1	1.60 kN / m ^{2}
with traffic	F_{wk} =	3425 kN	11.6 kN / m1	1.65 kN / m ^{2}
with traffic, reduced	$\psi_0 F_{wk}$ =	1028 kN	3.5 kN / m1	0.50 kN / m ^{2}
with traffic	F^*w =	3244 kN	11.0 kN / m1	1.56 kN / m ^{2}

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	1177 kN	0.43 kN / m ^{2}
with traffic	F_{wk} =	1370 kN	0.50 kN / m ^{2}
with traffic, reduced	$\psi_0 F_{wk}$ =	411 kN	0.15 kN / m ^{2}
with traffic	F^*w =	1297 kN	0.47 kN / m ^{2}

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1910 kN	0.59 kN / m ^{2}
moment with e = b / 4	M_{wk} =	5234 kNm	± 0.89 kN / m ^{2}
with traffic	F^*w =	1808 kN	0.56 kN / m ^{2}
moment with e = b / 4	M^*w =	4957 kNm	± 0.84 kN / m ^{2}

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	10/19/2018
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **950-951** **:** **Wind load x direction**

The wind load in x direction is distributed between the K-bandages and the deck. On the K-beams, the wind load of a half (main) beam height ($d_{k\text{-}relation}$) times the center-to-center distance of the K-relations is charged as a point load ($F^*_{wk, k\text{-connection}}$). On the side of the second main beam, 2/3 of this will be tax is charged on the k connection ($F^*_{wk, k\ connection, 2}$). The remaining wind load is charged as line load on the steel $_{deck}$ (q_{deck})

						K-bandages				deck
Position	Cross beam	To x vs. 0	h $_{main\ beam}$	p^*_w	d $_{k\ bandage}$	A $_{k\ bandage}$	$F^*_{w, k\ bandage, 1}$	$F^*_{w, k\ bandage, 2}$	d $_{to}$	d $_{deck}$
		[mm]	[m]	[kN / m²]	[m]	[m²]	[kN]	[kN]	[m]	[m]
		-325	2400	1.40	1200				6.37	4.37
Pillar f	**portal A**	**0**	**2400**	**1.40**	**1200**	**3.63**	**5.1**	**3.4**	**6.37**	**4.37**
	1	5400	2400	1.40	1200	6.48	9.1	6.0	**6.37**	4.37
	2	10800	2400	1.40	1200	6.48	9.1	6.0	**6.37**	4.37
	3	16200	2400	1.40	1200	5.40	7.6	5.0	**6.37**	4.37

	4	19798	2400	1.40	1200	4.32	6.0	4.0	**6.37**	4.37
field 1	**5**	**23398**	**2400**	**1.40**	**1200**	**5.40**	**7.6**	**5.0**	**6.37**	**4.37**
	6	28798	2400	1.40	1200	6.48	9.1	6.1	**6.37**	4.37
	7	34198	2400	1.40	1200	6.48	9.1	6.1	**6.37**	4.37
	8	39596	2400	1.41	1200	6.48	9.1	6.1	**6.37**	4.37
Pillar G	**Portal B**	**44996**	**2400**	**1.41**	**1200**	**6.48**	**9.1**	**6.1**	**6.37**	**4.37**
	9	50394	2443	1.42	1222	6.57	9.3	6.2	**6.44**	4.41
	10	55749	2541	1.43	1271	6.80	9.7	6.5	**6.61**	4.49
	11	61104	2720	1.44	1360	7.28	10.5	7.0	**6.90**	4.64
	12	66457	2963	1.45	1482	6.61	9.6	6.4	**7.31**	4.84
field 2	**13**	**70027**	**3159**	**1.46**	**1580**	**5.64**	**8.2**	**5.5**	**7.64**	**5.00**
	14	73597	3374	1.49	1687	7.53	11.2	7.5	**7.99**	5.18
	15	78952	3781	1.53	1891	10.12	15.5	10.3	**8.67**	5.52
	16	84305	4245	1.57	2123	11.36	17.9	11.9	**9.45**	5.91
	17	89660	4766	1.62	2383	12.76	20.6	13.7	**10.31**	6.34
Pillar H	**Portal C**	**95015**	**5300**	**1.66**	**2650**	**14.05**	**23.3**	**15.5**	**11.20**	**6.79**
	18	100265	4880	1.65	2440	12.81	21.1	14.1	**10.50**	6.44
	19	105515	4440	1.64	2220	11.65	19.1	12.7	**9.77**	6.07
	20	110763	4063	1.63	2032	10.66	17.4	11.6	**9.14**	5.76
	21	116013	3725	1.62	1863	9.78	15.8	10.6	**8.58**	5.47
	22	121263	3444	1.61	1722	9.03	14.6	9.7	**8.11**	5.24
	23	126506	3224	1.60	1612	8.46	13.5	9.0	**7.74**	5.06
	24	131756	3034	1.59	1517	7.96	12.7	8.5	**7.43**	4.90
	25	137006	2916	1.58	1458	7.67	12.1	8.1	**7.23**	4.80
	26	142 275.5	2838	1.57	1419	7.46	11.7	7.8	**7.10**	4.74
Field 3	**27**	**147,525.5**	**2800**	**1.56**	**1400**	**7.35**	**11.5**	**7.7**	**7.04**	**4.70**
	26	152775.5	2838	1.57	1419					

Global model: 3318 kN
Local model: 155 kN

Tax case **952-953** **:** **Wind load 40% xy direction**

For these load cases, a wind force of 40% in x and y direction occurs. This was introduced by multiplying the wind in x direction by 40%. For the y-direction (longitudinal direction) a UDL load is applied to the deck.

Loaded deck width b_{deck} = 9.29 m

				x direction			y direction
		To x vs. 0	d_{to}	$F^*_{w,k\ bandage,1}$	$F^*_{w,k\ bandage,2}$	q_{deck}	pdek
Position	Cross beam	[mm]	[m]	[kN]	[kN]	[kN / m]	[kN / m] 2
		-325	6.37			2.44	0.38
Pillar f	portal A	0	6.37	2.0	1.4	2.44	0.38
	1	5400	6.37	3.6	2.4	2.44	0.38
	2	10800	6.37	3.6	2.4	2.44	0.38
	3	16200	6.37	3.0	2.0	2.45	0.38
	4	19798	6.37	2.4	1.6	2.45	0.38
field 1	**5**	**23398**	**6.37**	**3.0**	**2.0**	**2.45**	**0.38**
	6	28798	6.37	3.6	2.4	2.45	0.38
	7	34198	6.37	3.6	2.4	2.45	0.39
	8	39596	6.37	3.6	2.4	2.46	0.39
Pillar G	**Portal B**	**44996**	**6.37**	**3.6**	**2.4**	**2.46**	**0.39**
	9	50394	6.44	3.7	2.5	2.50	0.39
	10	55749	6.61	3.9	2.6	2.56	0.41
	11	61104	6.90	4.2	2.8	2.67	0.43
	12	66457	7.31	3.8	2.6	2.81	0.46
field 2	**13**	**70027**	**7.64**	**3.3**	**2.2**	**2.92**	**0.48**
	14	73597	7.99	4.5	3.0	3.08	0.51
	15	78952	8.67	6.2	4.1	3.38	0.57
	16	84305	9.45	7.1	4.8	3.72	0.64
	17	89660	10.31	8.2	5.5	4.10	0.72
Pillar H	**Portal C**	**95015**	**11.20**	**9.3**	**6.2**	**4.50**	**0.80**
	18	100265	10.50	8.5	5.6	4.25	0.75
	19	105515	9.77	7.6	5.1	3.98	0.69
	20	110763	9.14	7.0	4.6	3.75	0.64
	21	116013	8.58	6.3	4.2	3.55	0.60
	22	121263	8.11	5.8	3.9	3.38	0.56
	23	126506	7.74	5.4	3.6	3.24	0.53
	24	131756	7.43	5.1	3.4	3.12	0.51
	25	137006	7.23	4.9	3.2	3.04	0.49
	26	142 275.5	7.10	4.7	3.1	2.98	0.48
Field 3	**27**	**147,525.5**	**7.04**	**4.6**	**3.1**	**2.94**	**0.47**
	26	152775.5					

Global model: 1327 kN

Local model: 62 kN

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Tax case **954-955** **:** **Wind load z direction**

The wind load in Z direction is applied as a UDL load on the deck. The wind load on the inspection paths is used as line load and line moment on the edge of installed on the deck.

Loaded deck width b_{deck} = 9.29 m

Width including inspection paths b_{deck} = 10,964 m

Position	$p^*_{w,z}$ [kN / m^2]	$\Delta p^*_{w,z}$ [kN / m^2] 2	$p^*_{w,z,left}$ [kN / m^2] 2	$p^*_{w,z,right}$ [kN / m^2] 22	$q^*_{w,z,left}$ [kN / m]	$q^*_{w,z,right}$ [kN / m]	$m^*_{w,z,left}$ [kN / m] 2	$m^*_{w,z,right}$ [kN / m] 2
field 1	**0.45**	**0.67**	**1.00**	**-0.10**	**0.89**	**-0.13**	**0.38**	**0.06**
field 2	**0.46**	**0.69**	**1.02**	**-0.11**	**0.91**	**-0.14**	**0.39**	**0.07**
Field 3	**0.50**	**0.74**	**1.10**	**-0.11**	**0.98**	**-0.15**	**0.42**	**0.07**
0.837			**9.29**				**0.837**	

$\Delta p^*_{w,z}$

$p^*_{w,z}$

$-\Delta p^*_{w,z}$

Import SCIA

$p^*_{w,z,left}$

$q^*_{w,z,left}$ $q^*_{w,z,right}$

$m^*_{w,z,left}$ $m^*_{w,z,right}$ $p^*_{w,z,right}$

Global model:	1512	kN
Local model:	65	kN

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at pillar F and abutment south**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry		Coordinate system			
Type	plate bridge or box bridge	X	width	Ground level	10.1 m + NAP
total length	295 m	y	length	Bottom of main beam	21.5 m + NAP
width	10,964 m	z	height		
free height bottom bridge	11.4 m				
1st main beam	2.4				
sheep's edge / deck	0.37				
2nd main spar	2.4				
construction height bridge (d)	2.77 m				
inclined windward and slate side (α)	2.5 gr				
bridge deck slope (β)	1 gr	NB - cross slope supplement must be included			
Traffic type	road traffic	Traffic band	2	meter	

Reference surfaces
wind in X direction **$A_{ref,x}$**

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	5.57 m
d_{to} - with traffic	6.37 m
$A_{ref;x}$ - without traffic	1643 m^2
$A_{ref;x}$ - with traffic	1879 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.4 m
equivalent construction height	4.37 m

wind in Z direction **$A_{ref,z}$**

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span = 30 years
C_{prob} = 0.96

Wind area = III
$v_{b;0}$ = 24.5 m / s
v_b = 23.6 m / s
$v^*_{b;0}$ = 23.0 m / s
v^*_b = 23.0 m / s

H4.3.2 **Terrain roughness**

Reference height (z_e) = 12.8 m
Terrain category = II Unbuilt
height = 17.8
Distance R = 889 m Distance R according to table NB. 4
z_0 = 0.2
Terein factor (k_r) = 0.209 $k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$
roughness factor $c_r(z)$ = 0.870 $c_r(z) = k_r \times \ln(z / z_0)$ for $z_{min} \leq z \leq z_{max}$
$c_r(z) = c_r(z_{min})$ for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) = 12.8
orography factor $c_o(z)$ = 1.00

Avg. wind speed $v_m(z)$ = 20.6 m / s $v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ = 20.0 m / s $v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_I = 1.00
Turbulence intensity $I_v(z)$ = 0.2405

H4.5 **Extreme thrust**

			$c_e(z)$
ρ =	1.25	kg / m3	
Extreme thrust $q_p(z)$ =	0.71	kN / m^2	2,033
Extreme thrust $q^*_p(z)$ =	0.67	kN / m^2	2,033

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d_{to}**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.97	1.94	2.00	Construction stage, open bridge railings, etc.
with traffic	1.72	2.02	2.08	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot}	1.97	
angle α of the wind with fly screen.	2.5 gr	
θ = α + β	3.5 gr	
figure NB.8 c_{fz} =	0.67	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	2329 kN	7.9 kN / m1	1.42 kN / m^2
with traffic	F_{wk} =	2770 kN	9.4 kN / m1	1.47 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	831 kN	2.8 kN / m1	0.44 kN / m^2
with traffic	F^*w =	2624 kN	8.9 kN / m1	1.40 kN / m^2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	932 kN	0.34 kN / m^2
with traffic	F_{wk} =	1108 kN	0.40 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	332 kN	0.12 kN / m^2
with traffic	F^*w =	1049 kN	0.38 kN / m^2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1528 kN	0.47 kN / m^2
moment with e = b / 4	M_{wk} =	4189 kNm	± 0.71 kN / m^2
with traffic	F^*w =	1447 kN	0.45 kN / m^2
moment with e = b / 4	M^*w =	3967 kNm	± 0.67 kN / m^2

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Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at the 1st and 5th span**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	11.55 m
1st main beam	2.4
sheep's edge / deck	0.37
2nd main spar	2.4
construction height bridge (d)	2.77 m
inclined windward and slate side (α)	2.5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	10.1 m + NAP
y	length	Bottom of main beam	21.65 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction **$A_{ref,x}$**

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	5.57 m
d_{to} - with traffic	6.37 m
$A_{ref;x}$ - without traffic	1643 m^2
$A_{ref;x}$ - with traffic	1879 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6r
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2r

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.4 m
equivalent construction height	4.37 m

wind in Z direction **$A_{ref,z}$**

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span = 30 years

C_{prob} = 0.96

Wind area = III

$v_{b;0}$ = 24.5 m / s

v_b = 23.6 m / s

$v^*_{b;0}$ = 23.0 m / s

v^*_b = 23.0 m / s

H4.3.2 Terrain roughness

Reference height (z_e) =	12.9 m		
Terrain category =	II	Unbuilt	
height =	17.9		
Distance R =	896 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.873	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 Variation with height

reference height (z_e) =	12.9	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.6 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	20.1 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 Wind turbulence

Turbulence factor k_I =	1.00
Turbulence intensity $I_v(z)$ =	0.2398

H4.5 Extreme thrust

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.71	kN / m ^{2}	2,041
Extreme thrust $q^*_p(z)$ =	0.67	kN / m ^{2}	2,041

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.97	1.94	2.00	Construction stage, open bridge railings, etc.
with traffic	1.72	2.02	2.08	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	1.97	
angle α of the wind with fly screen.	2.5 gr	
θ = α + β	3.5 gr	
figure NB.8 c_{fz} =	0.67	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	2338 kN	7.9 kN / m1	1.42 kN / m ^{2}
with traffic	F_{wk} =	2781 kN	9.4 kN / m1	1.48 kN / m ^{2}
with traffic, reduced	$\psi_0 F_{wk}$ =	834 kN	2.8 kN / m1	0.44 kN / m ^{2}
with traffic	F * w =	2634 kN	8.9 kN / m1	1.40 kN / m ^{2}

wind in Y direction	= 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)		
representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	935 kN	0.34 kN / m^2
with traffic	F_{wk} =	1112 kN	0.41 kN / m^2
with traffic, reduced	$\psi_0 F_{wk}$ =	334 kN	0.12 kN / m^2
with traffic	F * w =	1053 kN	0.38 kN / m^2

wind in Z direction	If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction		
representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1534 kN	0.47 kN / m^2
moment with e = b / 4	M_{wk} =	4206 kNm	± 0.71 kN / m^2
with traffic	F * w =	1453 kN	0.45 kN / m^2
moment with e = b / 4	M * w =	3983 kNm	± 0.67 kN / m^2

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **800-809** : **Wind load at pillar G and K**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	11.7 m
1st main beam	2.4
sheep's edge / deck	0.37
2nd main spar	2.4
construction height bridge (d)	2.77 m
inclined windward and slate side (α)	2.5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	10.1 m + NAP
y	length	Bottom of main beam	21.8 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction $A_{ref,x}$

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	5.57 m
d_{to} - with traffic	6.37 m
$A_{ref;x}$ - without traffic	1643 m^2
$A_{ref;x}$ - with traffic	1879 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.4 m
equivalent construction height	4.37 m

wind in Z direction $A_{ref,z}$

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span =	30 years	
C_{prob} =	0.96	
Wind area =	III	
$v_{b;0}$ =	24.5 m / s	
v_b =	23.6 m / s	
$v^*_{b;0}$ =	23.0 m / s	
v^*_b =	23.0 m / s	

H4.3.2 **Terrain roughness**

Reference height (z_e) =	13.1 m		
Terrain category =	II	Unbuilt	
height =	18.1		
Distance R =	904 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.875	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	13.1	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	20.7 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	20.1 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_I =	1.00
Turbulence intensity $I_v(z)$ =	0.2392

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	c_e (z)
Extreme thrust q_p (z) =	0.72	kN / m^2	2,049
Extreme thrust q * $_p$ (z) =	0.68	kN / m^2	2,049

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**c $_{fx;0}$**	**c $_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.97	1.94	2.00	Construction stage, open bridge railings, etc.
with traffic	1.72	2.02	2.08	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	1.97	
angle α of the wind with fly screen.	2.5	
θ = α + β	3.5 gr	
figure NB.8 c $_{fz}$ =	0.67	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p $_{rep}$**
without traffic	F $_{wk}$ =	2347 kN	8.0 kN / m1	1.43 kN / m^2
with traffic	F $_{wk}$ =	2792 kN	9.5 kN / m1	1.49 kN / m^2
with traffic, reduced	ψ $_0$ F $_{wk}$ =	837 kN	2.8 kN / m1	0.45 kN / m^2
with traffic	F * w =	2644 kN	9.0 kN / m1	1.41 kN / m^2

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p $_{rep}$ (about b = 9.29 m)**
without traffic	F $_{wk}$ =	939 kN	0.34 kN / m^2
with traffic	F $_{wk}$ =	1117 kN	0.41 kN / m^2
with traffic, reduced	ψ $_0$ F $_{wk}$ =	335 kN	0.12 kN / m^2
with traffic	F * w =	1057 kN	0.39 kN / m^2

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p $_{rep}$ (about b = 10,964 m)**
without traffic	F $_{wk}$ =	1540 kN	0.48 kN / m^2
moment with e = b / 4	M $_{wk}$ =	4221 kNm	± 0.71 kN / m^2
with traffic	F * w =	1459 kN	0.45 kN / m^2
moment with e = b / 4	M * w =	3998 kNm	± 0.68 kN / m^2

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Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at the 2nd and 4th span**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry		Coordinate system				
Type	plate bridge or box bridge	X	width	Ground level		10.1 m + NAP
total length	295 m	y	length	Bottom of main beam		21.1 m + NAP
width	10,964 m	z	height			
free height bottom bridge	11 m					
1st main beam	3,159					
sheep's edge / deck	0.37					
2nd main spar	3,159					
construction height bridge (d)	3,529 m					
inclined windward and slate side (α)	2.5 gr					
bridge deck slope (β)	1 gr	NB - cross slope supplement must be included				
Traffic type	road traffic	Traffic band		2	meter	

Reference surfaces

wind in X direction	$A_{ref,x}$	**table 1**		
Separation type	open bridge railing and open safety barrier	Separation type	On 1 side	Both sides
closed or open barrier	On both sides	open bridge railing or open safety barrier	d + 0.3m	d + 0.6r
handrail / screen height (d_1)	1 m	tight bridge railing or tight safety barrier	$d + d_1$	d + 2d

d_{to} - without traffic	6.84 m	open bridge railing and open safety barrier	d + 0.6m	d + 1.2m
d_{to} - with traffic	7.64 m			

$A_{ref;x}$ - without traffic	2016 m^2	
$A_{ref;x}$ - with traffic	2252 m^2	

table 2

At deck with main beams	article NB 8.3.1 (4)	
number of main beams	2	
deck height	0.37 m	
height of main beams	3.159 m	
equivalent construction height	5.64 m	

wind in Z direction **$A_{ref, z}$**

$A_{ref, z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span =	30 years	
C_{prob} =	0.96	
Wind area =	III	
$v_{b;0}$ =	24.5 m / s	
v_b =	23.6 m / s	
$v^*_{b;0}$ =	23.0 m / s	
v^*_b =	23.0 m / s	

H4.3.2 **Terrain roughness**

Reference height (z_e) =	12.8 m		
Terrain category =	II	Unbuilt	
height =	18.6		
Distance R =	932 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor c_r (z) =	0.870	$c_r (z) = k_r \times \ln (z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r (z) = c_r (z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	12.8	
orography factor c_o (z) =	1.00	
Avg. wind speed v_m (z) =	20.6 m / s	$v_m (z) = c_r (z) \times c_0 (z) \times v_b$
Avg. wind speed v^*_m (z) =	20.0 m / s	$v^*_m (z) = c_r (z) \times c_0 (z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l =	1.00
Turbulence intensity I_v (z) =	0.2406

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	c_e (z)
Extreme thrust q_p (z) =	0.71	kN / m^2	2,032
Extreme thrust q^*_p (z) =	0.67	kN / m^2	2,032

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**c $_{fx;0}$**	**c $_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.60	2.05	2.11	Construction stage, open bridge railings, etc.
with traffic	1.44	2.11	2.17	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	1.60	
angle α of the wind with fly screen.	2.5 gr	
θ = α + β	3.5 gr	
figure NB.8 c $_{fz}$ =	0.68	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p $_{rep}$**
without traffic	F $_{wk}$ =	3025 kN	10.3 kN / m1	1.50 kN / m ^{2}
with traffic	F $_{wk}$ =	3466 kN	11.8 kN / m1	1.54 kN / m ^{2}
with traffic, reduced	ψ $_0$ F $_{wk}$ =	1040 kN	3.5 kN / m1	0.46 kN / m ^{2}
with traffic	F * w =	3283 kN	11.1 kN / m1	1.46 kN / m ^{2}

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p $_{rep}$ (about b = 9.29 m)**
without traffic	F $_{wk}$ =	1210 kN	0.44 kN / m ^{2}
with traffic	F $_{wk}$ =	1387 kN	0.51 kN / m ^{2}
with traffic, reduced	ψ $_0$ F $_{wk}$ =	416 kN	0.15 kN / m ^{2}
with traffic	F * w =	1313 kN	0.48 kN / m ^{2}

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p $_{rep}$ (about b = 10,964 m)**
without traffic	F $_{wk}$ =	1563 kN	0.48 kN / m ^{2}
moment with e = b / 4	M $_{wk}$ =	4285 kNm	± 0.73 kN / m ^{2}
with traffic	F * w =	1481 kN	0.46 kN / m ^{2}
moment with e = b / 4	M * w =	4058 kNm	± 0.69 kN / m ^{2}

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at pillar H and J**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry

Type	plate bridge or box bridge
total length	295 m
width	10,964 m
free height bottom bridge	12.7 m
1st main beam	5.3
sheep's edge / deck	0.37
2nd main spar	5.3
construction height bridge (d)	5.67 m
inclined windward and slate side (α)	2.5 gr
bridge deck slope (β)	1 gr
Traffic type	road traffic

Coordinate system

X	width	Ground level	6.5 m + NAP
y	length	Bottom of main beam	19.2 m + NAP
z	height		

NB - cross slope supplement must be included

Traffic band 2 meter

Reference surfaces

wind in X direction **$A_{ref,x}$**

Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	10.40 m
d_{to} - with traffic	11.20 m
$A_{ref;x}$ - without traffic	3069 m^2
$A_{ref;x}$ - with traffic	3305 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	5.3 m
equivalent construction height	9.20 m

wind in Z direction **$A_{ref,z}$**

$A_{ref,z}$ 3234 m^2

Wind loads

H4.2 **Basic values**

Design life span = 30 years

C_{prob} = 0.96

Wind area = III

$v_{b;0}$ = 24.5 m / s

v_b = 23.6 m / s

$v^*_{b;0}$ = 23.0 m / s

v^*_b = 23.0 m / s

H4.3.2 **Terrain roughness**

Reference height (z_e) = 15.5 m

Terrain category =	II	Unbuilt	
height =	23.9		
Distance R =	1195 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.911	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	15.5
orography factor $c_o(z)$ =	1.00

Avg. wind speed $v_m(z)$ =	21.5 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	21.0 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_I =	1.00
Turbulence intensity $I_v(z)$ =	0.2298

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.76	kN / m 2	2,166
Extreme thrust $q^*_p(z)$ =	0.72	kN / m 2	2,166

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d_{to}**	**$c_{fx;0}$**	**$c_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.05	2.23	2.29	Construction stage, open bridge railings, etc.
with traffic	0.98	2.25	2.32	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d_{tot}	1.05	
angle α of the wind with fly screen.	2.5 gr	
$\theta = \alpha + \beta$	3.5 gr	
figure NB.8 c_{fz} =	0.70	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p_{rep}**
without traffic	F_{wk} =	5321 kN	18.0 kN / m1	1.73 kN / m ^{2}
with traffic	F_{wk} =	5791 kN	19.6 kN / m1	1.75 kN / m ^{2}
with traffic, reduced	$\psi_0 F_{wk}$ =	1737 kN	5.9 kN / m1	0.53 kN / m ^{2}
with traffic	$F^* w$ =	5484 kN	18.6 kN / m1	1.66 kN / m ^{2}

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p_{rep} (about b = 9.29 m)**
without traffic	F_{wk} =	2128 kN	0.78 kN / m ^{2}
with traffic	F_{wk} =	2316 kN	0.85 kN / m ^{2}

with traffic, reduced	$\psi_0 F_{wk}$ =	695 kN	0.25 kN / m ^{2}
with traffic	F * w =	2193 kN	0.80 kN / m ^{2}

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p_{rep} (about b = 10,964 m)**
without traffic	F_{wk} =	1724 kN	0.53 kN / m ^{2}
moment with e = b / 4	M_{wk} =	4725 kNm	± 0.8 kN / m ^{2}
with traffic	F * w =	1632 kN	0.50 kN / m ^{2}
moment with e = b / 4	M * w =	4475 kNm	± 0.76 kN / m ^{2}

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Wind load

Tax case **800-809** **:** **Wind load at the 3rd span**

NEN-EN 1991-1-4 - H8 wind loads on bridges

Geometry		Coordinate system			
Type	plate bridge or box bridge	X	width	Ground level	6.5 m + NAP
total length	295 m	y	length	Bottom of main beam	21.7 m + NAP
width	10,964 m	z	height		
free height bottom bridge	15.2 m				
1st main beam	2.8				
sheep's edge / deck	0.37				
2nd main spar	2.8				
construction height bridge (d)	3.17 m				
inclined windward and slate side (α)	2.5 gr				
bridge deck slope (β)	1 gr	NB - cross slope supplement must be included			
Traffic type	road traffic	Traffic band	2	meter	

Reference surfaces

wind in X direction	**$A_{ref,x}$**
Separation type	open bridge railing and open safety barrier
closed or open barrier	On both sides
handrail / screen height (d_1)	1 m
d_{to} - without traffic	6.24 m
d_{to} - with traffic	7.04 m
$A_{ref;x}$ - without traffic	1840 m^2
$A_{ref;x}$ - with traffic	2076 m^2

table 1

Separation type	On 1 side	Both sides
open bridge railing or open safety barrier	d + 0.3m	d + 0.6m
tight bridge railing or tight safety barrier	$d + d_1$	d + 2d
open bridge railing and open safety barrier	d + 0.6m	d + 1.2m

table 2

At deck with main beams	article NB 8.3.1 (4)
number of main beams	2
deck height	0.37 m
height of main beams	2.8 m
equivalent construction height	5.04 m

wind in Z direction	**$A_{ref,z}$**
$A_{ref,z}$	3234 m^2

Wind loads

H4.2 **Basic values**

Design life span =	30 years	
C_{prob} =	0.96	
Wind area =	III	
$v_{b;0}$ =	24.5 m / s	
v_b =	23.6 m / s	
$v^*_{b;0}$ =	23.0 m / s	
v^*_b =	23.0 m / s	

H4.3.2 **Terrain roughness**

Reference height (z_e) =	16.8 m		
Terrain category =	II	Unbuilt	
height =	22.2		
Distance R =	1112 m	Distance R according to table NB. 4	
z_0 =	0.2		
Terein factor (k_r) =	0.209	$k_r = 0.19 \times (z_0 / Z_{0,II})^{0.07}$	
roughness factor $c_r(z)$ =	0.927	$c_r(z) = k_r \times \ln(z / z_0)$	for $z_{min} \leq z \leq z_{max}$
		$c_r(z) = c_r(z_{min})$	for $z \leq z_{min}$

H4.3.1 **Variation with height**

reference height (z_e) =	16.8	
orography factor $c_o(z)$ =	1.00	
Avg. wind speed $v_m(z)$ =	21.9 m / s	$v_m(z) = c_r(z) \times c_0(z) \times v_b$
Avg. wind speed $v^*_m(z)$ =	21.3 m / s	$v^*_m(z) = c_r(z) \times c_0(z) \times v^*_b$

H4.4 **Wind turbulence**

Turbulence factor k_l =	1.00
Turbulence intensity $I_v(z)$ =	0.2257

H4.5 **Extreme thrust**

ρ =	1.25	kg / m3	$c_e(z)$
Extreme thrust $q_p(z)$ =	0.77	kN / m^2	2,219
Extreme thrust $q^*_p(z)$ =	0.73	kN / m^2	2,219

Tax cases

Project:	Recalculation IJssel Bridge A12	Date:	#########
Project number:	BF7387	Name:	EKL
Description:	Main span wind load (2.5 °)	Version:	D0.1

Power coefficients

wind in X direction	**b / d $_{to}$**	**c $_{fx;0}$**	**c $_{fx;0}$ incl surcharge cross slope line function**	
without traffic	1.76	2.00	2.06	Construction stage, open bridge railings, etc.
with traffic	1.56	2.07	2.13	Construction stage, open bridge railings, etc.

wind in Z direction

without traffic b / d $_{tot}$	1.76	
angle α of the wind with fly screen.	2.5 gr	
θ = α + β	3.5 gr	
figure NB.8 c $_{fz}$ =	0.67	note also use the negative value for wind in opposite direction

Wind load

wind in X direction

representative tax		**Total**	**per m1**	**p $_{rep}$**
without traffic	F $_{wk}$ =	2944 kN	10.0 kN / m1	1.60 kN / m ^{2}
with traffic	F $_{wk}$ =	3425 kN	11.6 kN / m1	1.65 kN / m ^{2}
with traffic, reduced	ψ $_0$ F $_{wk}$ =	1028 kN	3.5 kN / m1	0.50 kN / m ^{2}
with traffic	F * w =	3244 kN	11.0 kN / m1	1.56 kN / m ^{2}

wind in Y direction = 40% of wind forces in the x direction (in the x direction, the same force as in the y direction occurs simultaneously)

representative tax		**Total**	**p $_{rep}$ (about b = 9.29 m)**
without traffic	F $_{wk}$ =	1177 kN	0.43 kN / m ^{2}
with traffic	F $_{wk}$ =	1370 kN	0.50 kN / m ^{2}
with traffic, reduced	ψ $_0$ F $_{wk}$ =	411 kN	0.15 kN / m ^{2}
with traffic	F * w =	1297 kN	0.47 kN / m ^{2}

wind in Z direction If a load in the Z direction works unfavorably, it occurs simultaneously with the x direction

representative tax		**Total**	**p $_{rep}$ (about b = 10,964 m)**
without traffic	F $_{wk}$ =	1691 kN	0.52 kN / m ^{2}
moment with e = b / 4	M $_{wk}$ =	4634 kNm	± 0.78 kN / m ^{2}
with traffic	F * w =	1601 kN	0.50 kN / m ^{2}
moment with e = b / 4	M * w =	4389 kNm	± 0.74 kN / m ^{2}

Appendix

Appendix H - Temperature load

IJssel Bridge

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.3

Uniform temperature component of steel-concrete deck [deck type 2]

Air temperature

The uniform temperature component depends on the minimum and maximum air temperature and the Lifespan. A distinction is made between the service life of the bridge and the joint transitions.

		Bridge	Joint transition
Lifespan		30 years	30 years
Min. air temp. in the shadow	$T_{min,p} = T_{min}$ {0.393-0.156 ln [-ln (1-p)]} =	-23.0 ° C	-23.0 ° C
Max. air temp. in the shadow	$T_{max,p} = T_{max}$ {0.781-0.056 ln [-ln (1-p)]} =	29.1 ° C	29.1 ° C

Uniform temperature component

This follows, in accordance with figure NB.1–6.1 from the National Annex, for a steel concrete deck (type 2) the following uniform temperature components:

		Bridge	Joint transition
Minimum even temperature component ($T_{e,min}$)	=	-26 ° C	-26 ° C
Maximum uniform temperature component ($T_{e,max}$)	=	45 ° C	45 ° C

$T_{e,min}$
$T_{e,max}$

Type 1.2 $T_{e,max} = T_{max,p} + 16$

Type 3 $T_{e,max} = T_{max,p} + 2$

70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50

Type 3 $T_{e,min} = T_{min,p} + 8$

Type 1.2 $T_{e,min} = T_{min,p} - 3$

-50 -40 -30 -20 -10 0 10 20 30 40 50

$T_{max,p}$
$T_{min,p}$

Figure 5.2 - Correlation between the minimum / maximum air temperature in the shade ($T_{min,p}$ / $T_{max,p}$) and the minimum / maximum uniform temperature component of the bridge ($T_{e,min}$ / $T_{e,max}$)

Starting temperature

The initial temp. of the bridge (T_0) with regard to the Eurocode has been determined in accordance with appendix A of NEN-EN 1991-1-5.

The initial temp. of the bridge (T_0) with respect to the RTD 1007-2 has been determined on the basis of: measurements

		Bridge	Joint transition
Starting temperature (T_0)	=	10 ° C	10 ° C

Range of the even temperature component

The maximum range of the bridge's uniform temperature components in a shortening ($\Delta T_{N,con}$) and an extension ($\Delta T_{N,exp}$) is:

		Bridge	Joint transition
Shortening ($\Delta T_{N,con}$) = $T_0 - T_{e,min}$	=	36 ° C	36 ° C
Elongation ($\Delta T_{N,exp}$) = $T_{e,max} - T_0$	=	35 ° C	35 ° C
Total range (ΔT_N) = ($\Delta T_{N,con}$) + ($\Delta T_{N,exp}$)	=	71 ° C	71 ° C

Range of the uniform temperature component for the supports and joints

For supports and joints, the maximum expansion and shrinkage range of the bridge is:

Temperature at which the supports and joints are placed is: prescribed

				Bridge	Joint transition
Shortening ($\Delta T_{N, con, add / solve}$) = $\Delta T_{N, con}$ +	10 ° C	(10 ° C conforming to RTD)	=	46 ° C	46 ° C
Elongation ($\Delta T_{N, exp, add / add}$) = $\Delta T_{N, exp}$ +	10 ° C	(10 ° C conforming to RTD)	=	45 ° C	45 ° C
Total range ($\Delta T_{N, add / add}$) = ($\Delta T_{N, con, add / add}$) + ($\Delta T_{N, exp, add}$)			=	91 ° C	91 ° C

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.3

Vertical temperature component with non-linear effects

The vertical temperature component is determined according to approach 2 (article 6.1.4.2), in accordance with the National Annex to NEN-EN 1991-1-5. The table below shows the effect of any different thickness of the wear layer included.

Wear layer: With wear layer

Wear layer thickness Thickness: 70 mm

Steel-concrete deck thickness (h): 200 mm

Construction type — **Temperature difference (Δ T)**: **(a) Global warming** / **(b) Cooling**

Normal procedure

(a) Global warming: $h_1 = 0.6$ h = 120 mm; $h_2 = 0.4$ m = 400 mm

h	Δ T_1	Δ T_2
m	° C	° C
0.2	16.0	4.0
0.3	18.7	4.0

(b) Cooling: $h_1 = 0.6$ h = 120 mm; $h_2 = 0.4$ m = 400 mm

h	Δ T_1	Δ T_2
m	° C	° C
0.2	-4.0	-8.0
0.3	-6.1	-8.0

Simplified procedure

1T 1 = 10 ° C   1T 1 = -10 ° C

NOTE For steel-concrete bridges, the simplified procedure given above may have been used to determine the upper limit of the thermal effects. Values for ΔT in this procedure are indicative.

Vertical temperature component

(normal procedure)

ΔT

0 10 20 -10 -5 0

0 16.0 -4.0 0

120 4.0 120

200 2.9 200

400 0.0 -8.0 600

NOTE The temperature difference ΔT includes ΔT_M and ΔT_E (see NEN-EN 1991-1-5 art 4 (3)) and a small part of component ΔT_N ;

the latter part is contained in the uniform temperature component of the bridge

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.3

Resume

Temperature component — **Temperature difference (Δ T)**

(a) Global warming **(b) Cooling**

Even temperature component
NT_N

0 20 40 -40 -20 0
35 -36

200 35 -36 200

Vertical temperature component
MT_M

0 10 20 -10 -5 0
0 16.0 -4.0 0
120 4.0 120
200 2.9 200
400 0.0 -8.0 600

Combination 1
$MT_M + \omega_N \Delta T_N$ $\omega_N = 0.35$

$\Delta T_1 + \omega_N \Delta T_{N,exp} =$	28.3 ° C	$\Delta T_1 - \omega_N \Delta T_{N,con} =$	-16.6 ° C
$\Delta T_2 + \omega_N \Delta T_{N,exp} =$	16.3 ° C	$HT_{h1} - \omega_N \Delta T_{N,con} =$	-12.6 ° C
$\Delta T_o + \omega_N \Delta T_{N,exp} =$	15.1 ° C	$HT_h - \omega_N \Delta T_{N,con} =$	-12.6 ° C
$\Delta T_s + \omega_N \Delta T_{N,exp} =$	12.3 ° C	$\Delta T_2 - \omega_N \Delta T_{N,con} =$	-20.6 ° C

0 10 20 30 -30 -20 -10 0
0 28.3 -16.6 0
-12.6 120
120 16.3 -12.6 200
200 15.1
400 12.3 -20.6 600

Combination 2
$\omega_M \Delta T_M + \Delta T_N$ $\omega_M = 0.75$

$\omega_M \Delta T_1 + \Delta T_{N,exp} =$	47.1 ° C	$\omega_M \Delta T_1 - \Delta T_{N,con} =$	-39.1 ° C
$\omega_M \Delta T_2 + \Delta T_{N,exp} =$	38.1 ° C	$\omega_M \Delta T_{h1} - \Delta T_{N,con} =$	-36.0 ° C
$\omega_M \Delta T_o + \Delta T_{N,exp} =$	37.3 ° C	$\omega_M \Delta T_h + \Delta T_{N,exp} =$	-36.0 ° C
$\omega_M \Delta T_s + \Delta T_{N,exp} =$	35.1 ° C	$\omega_M \Delta T_2 + \Delta T_{N,exp} =$	-42.0 ° C

0 20 40 60 -60 -40 -20 0
0 47.1 -39.1 0
-36.0 120
120 38.1 -36.0 200
200 37.3
400 35.1 -42.0 600

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.3

Uniform temperature component steel deck [deck type 1b]

Air temperature

The uniform temperature component depends on the minimum and maximum air temperature and the

Lifespan. A distinction is made between the service life of the bridge and the joint transitions.

		Bridge	Joint transition
Lifespan		30 years	30 years
Min. air temp. in the shadow	$T_{min,p} = T_{min}$ {0.393-0.156 ln [-ln (1-p)]} =	-23.0 ° C	-23.0 ° C
Max. air temp. in the shadow	$T_{max,p} = T_{max}$ {0.781-0.056 ln [-ln (1-p)]} =	29.1 ° C	29.1 ° C

Uniform temperature component

This follows, in accordance with figure NB.1–6.1 from the National Annex, for a steel deck (type 1) the following uniform temperature components:

		Bridge	Joint transition
Minimum even temperature component ($T_{e,min}$)	=	-26 ° C	-26 ° C
Maximum uniform temperature component ($T_{e,max}$)	=	45 ° C	45 ° C

$T_{e,min}$
$T_{e,max}$

Type 1.2 $T_{e,max} = T_{max,p} + 16$

Type 3 $T_{e,max} = T_{max,p} + 2$

70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50

Type 3 $T_{e,min} = T_{min,p} + 8$

Type 1.2 $T_{e,min} = T_{min,p} - 3$

$T_{max,p}$

-50 -40 -30 -20 -10 0 10 20 30 40 50

$T_{min,p}$

Figure 5.2 - Correlation between the minimum / maximum air temperature in the shade ($T_{min,p}$ / $T_{max,p}$) and the minimum / maximum uniform temperature component of the bridge ($T_{e,min}$ / $T_{e,max}$)

Starting temperature

The initial temp. of the bridge (T_0) with regard to the Eurocode has been determined in accordance with appendix A of NEN-EN 1991-1-5.

The initial temp. of the bridge (T_0) with respect to the RTD 1007-2 has been determined on the basis of: measurements

		Bridge	Joint transition
Starting temperature (T_0)	=	10 ° C	10 ° C

Range of the even temperature component

The maximum range of the bridge's uniform temperature components in a shortening ($\Delta T_{N,con}$) and an extension ($\Delta T_{N,exp}$) is:

		Bridge	Joint transition
Shortening ($\Delta T_{N,con}$) = $T_0 - T_{e,min}$	=	36 ° C	36 ° C
Elongation ($\Delta T_{N,exp}$) = $T_{e,max} - T_0$	=	35 ° C	35 ° C
Total range (ΔT_N) = ($\Delta T_{N,con}$) + ($\Delta T_{N,exp}$)	=	71 ° C	71 ° C

Range of the uniform temperature component for the supports and joints

For supports and joints, the maximum expansion and shrinkage range of the bridge is:

Temperature at which the supports and joints are placed is: prescribed

				Bridge	Joint transition
Shortening ($\Delta T_{N,con,add/solve}$) = $\Delta T_{N,con}$ +	10 ° C	(10 ° C conforming to RTD)	=	46 ° C	46 ° C
Elongation ($\Delta T_{N,exp,add/add}$) = $\Delta T_{N,exp}$ +	10 ° C	(10 ° C conforming to RTD)	=	45 ° C	45 ° C
Total range ($\Delta T_{N,add/add}$) = ($\Delta T_{N,con,add/add}$) + ($\Delta T_{N,exp,add}$)			=	91 ° C	91 ° C

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.3

Vertical temperature component with non-linear effects

The vertical temperature component is determined according to approach 2 (article 6.1.4.2), in accordance with the National Annex to NEN-EN 1991-1-5. The table below shows the effect of any different thickness of the wear layer included.

Wear layer thickness: 70 mm
Construction height: 2400 mm

Construction type	**Temperature difference (Δ T)**	
	(a) Global warming	**(b) Cooling**
	$h_1 = 0.5$ m	$h_1 = 0.1$ m
	$1T_1 = 15$ ° C	$1T_1 = -6$ ° C

Temperature component	Temperature difference (Δ T) (a) Global warming			(b) Cooling		
Vertical temperature component MT_M		0 2 4 6 8 10 12 14 16		-7 -6 -5 -4 -3 -2 -1 0		
	0		15.0	-6.0	0.0	0100
	500	0.0				
	2400	0.0			0.0	2400

NOTE The temperature difference ΔT includes ΔT_M and ΔT_E (see NEN-EN 1991-1-5 art 4 (3)) and a small part of component ΔT_N ;
this last part is included in the uniform temperature component of the bridge (see previous paragraph)

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.3

Resume

Temperature component	Temperature difference (Δ T) (a) Global warming			(b) Cooling		
Even temperature component NT_N		0 5 10 15 20 25 30 35 40		-40 -30 -20 -10 0		
			35	-36		
	2400		35	-36		2400
Vertical temperature component MT_M		0 2 4 6 8 10 12 14 16		-7 -6 -5 -4 -3 -2 -1 0		
	0		15.0	-6.0	0.0	0100
	500	0.0				
	2400	0.0			0.0	2400

Combination 1		$\Delta T_b + \omega_N \Delta T_{N, exp}$ =	27.3 ° C	$\Delta T_b - \omega_N \Delta T_{N, con}$ =	-18.6 ° C
$MT_M + \omega_N \Delta T_N$	ω_N = 0.35	$\Delta T_1 + \omega_N \Delta T_{N, exp}$ =	12.3 ° C	$HT_{h1} - \omega_N \Delta T_{N, con}$ =	-12.6 ° C

ΔT ₒ + ω N ΔT N, exp = 12.3 ° C

ΔT ₒ - ω N ΔT N, con = -12.6 ° C

0 5 10 15 20 25 30

0 27.3

500 12.3

2400 12.3

-20 -15 -10 -5 0

-18.6 -12.6 0100

-12.6 2400

Combination 2

ω M ΔT M + ΔT N   ω M = 0.75

ω M ΔT 1 + ΔT N, exp = 46.4 ° C

ω M ΔT 2 + ΔT N, exp = 35.1 ° C

ω M ΔT 3 + ΔT N, exp = 35.1 ° C

ω M ΔT 1 - ΔT N, con = -40.5 ° C

ω M ΔT h1 - ΔT N, con = -36.0 ° C

ω M ΔT ₒ + ΔT N, exp = -36.0 ° C

0 10 20 30 40 50

0 46.4

500 35.1

2400 35.1

-50 -40 -30 -20 -10 0

-40.5 -36.0 0100

-36.0 2400

Determination of temperature load on bridge deck

Project name: IJssel Bridge   Date: 5/25/2018
Project number: BF7387   Name: Ernst Klamer
Description: Temperature load Main bridge   Version v1.0

Vertical temperature component with non-linear effects

The non-linear vertical temperature component has been translated for the input in SCIA into a linear vertical temperature component over the height, which results in equal expansion and curvature as the non-linear vertical temperature component. See the underlying Mathcad calculations.
The tables below provide a summary for summer and winter.

Linear vertical temperature component (summer)

Ash	Cross beam	To x vs. 0	h	Plate 1	Plate 2	tpo1	tpo2	tdek	, TN, N	Δ TN, M, above	Δ TN, M, bottom	Column1	Topside deck	Underside deck	Underside strip 8x100	Underside bulb	Underside main beam	Underside crossbeam	Underside End transverse interdental b	Top edge portal
0	Portal A	0	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
	intermediate crossbeam	1800	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
	intermediate crossbeam	3600	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
	1	5400	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	**13.1**	**12.5**	**12.1**	-2.2	9.9	11.2	8.9
	intermediate crossbeam	7200	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
	intermediate crossbeam	9000	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
		10000	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
		10000	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	2	10800	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	intermediate crossbeam	12600	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	intermediate crossbeam	14400	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	3	16200	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
2	intermediate crossbeam	18000	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
2	4	19798	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	intermediate crossbeam	21598	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	5	23398	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	**13.0**	**12.4**	**12.1**	-1.8	10.0	11.2	9.0
	intermediate crossbeam	25198	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	intermediate crossbeam	26998	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	6	28798	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	intermediate crossbeam	30598	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
	intermediate crossbeam	32398	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
		33498	2400	500 * 30	350 * 30	30	30	10	8.1	5.0	-9.9		13.1	13.0	12.4	12.1	-1.8	10.0	11.2	9.0
		33498	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
	7	34198	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	**13.1**	**12.5**	**12.1**	-2.2	9.9	11.2	8.9
		34997	2400	500 * 30		30	0	10	8.8	4.4	-11.0		13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
		34997	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
4	intermediate crossbeam	35998	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
4	intermediate crossbeam	37796	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
	8	39596	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
	intermediate crossbeam	41396	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
	intermediate crossbeam	43196	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
	Portal B	44996	2400	500 * 20		20	0	10	9.2	4.0	-11.7		13.2	13.1	12.5	12.1	-2.5	9.8	11.2	8.8
	intermediate crossbeam	46796	2406	500 * 20		20	0	10	9.2	4.1	-11.7		13.3	13.2	12.6	12.2	-2.5	9.9	11.3	8.9
5	intermediate crossbeam	48596	2416	500 * 20		20	0	10	9.2	4.1	-11.7		13.3	13.2	12.6	12.2	-2.5	9.9	11.3	8.9
5	9	50394	2443	500 * 20		20	0	10	9.1	4.1	-11.7		13.2	**13.1**	**12.5**	**12.1**	-2.6	9.9	11.2	8.8
	intermediate crossbeam	52179	2476	500 * 20		20	0	10	9.1	4.1	-11.7		13.2	13.1	12.5	12.1	-2.6	9.9	11.2	8.9
	intermediate crossbeam	53964	2508	500 * 20		20	0	10	9.1	4.1	-11.7		13.2	13.1	12.5	12.1	-2.6	10.0	11.3	8.9
	10	55749	2541	500 * 20		20	0	10	9.0	4.1	-11.6		13.1	13.0	12.4	12.1	-2.6	9.9	11.2	8.9
	intermediate crossbeam	57534	2593	500 * 20		20	0	10	9.0	4.1	-11.6		13.1	13.0	12.4	12.1	-2.6	10.0	11.2	9.0
	intermediate crossbeam	59319	2657	500 * 20		20	0	10	9.0	4.2	-11.6		13.2	13.1	12.6	12.2	-2.6	10.1	11.4	9.2
	11	61104	2720	500 * 20		20	0	10	8.9	4.2	-11.6		13.1	13.0	12.5	12.1	-2.7	10.1	11.3	9.2
7	intermediate crossbeam	62889	2784	500 * 20		20	0	10	8.8	4.2	-11.5		13.0	12.9	12.4	12.1	-2.7	10.1	11.3	9.2
7	intermediate crossbeam	64672	2865	500 * 20		20	0	10	8.8	4.2	-11.5		13.0	12.9	12.4	12.1	-2.7	10.2	11.3	9.3
		66020	2939	500 * 20		20	0	10	8.7	4.2	-11.5		12.9	12.8	12.3	12.0	-2.8	10.1	11.3	9.3
		66020	2939	500 * 30		30	0	10	8.4	4.6	-10.8		13.0	12.9	12.4	12.1	-2.4	10.3	11.4	9.5
	12	66457	2963	500 * 30		30	0	10	8.4	4.7	-11.1		13.1	13.0	12.5	12.2	-2.7	10.4	11.5	9.5
	intermediate crossbeam	68242	3061	500 * 30		30	0	10	8.3	4.6	-10.7		12.9	**12.9**	**12.4**	**12.1**	-2.4	10.3	11.4	9.5
		68962	3101	500 * 30		30	0	10	8.2	4.5	-10.7		12.7	12.7	12.2	11.9	-2.5	10.2	11.2	9.4
		68962	3101	500 * 30	550 * 30	30	30	10	7.5	5.7	-9.2		13.2	13.2	12.7	12.4	-1.7	10.7	11.7	10.0
	13	70027	3159	500 * 30	550 * 30	30	30	10	7.3	5.4	-9.1		12.7	12.7	12.2	11.9	-1.8	10.4	11.3	9.6
	intermediate crossbeam	71812	3257	500 * 30	550 * 30	30	30	10	7.2	5.4	-9.0		12.6	12.6	12.1	11.9	-1.8	10.3	11.3	9.6
	14	73597	3374	500 * 30	550 * 30	30	30	10	7.2	5.4	-9.0		12.6	12.6	12.1	11.9	-1.8	10.4	11.3	9.7
	intermediate crossbeam	75382	3510	500 * 30	550 * 30	30	30	10	7.1	5.4	-8.9		12.5	12.5	12.1	11.8	-1.8	10.4	11.3	9.8
	intermediate crossbeam	77167	3645	500 * 30	550 * 30	30	30	10	7.0	5.4	-8.9		12.4	12.4	12.0	11.7	-1.9	10.4	11.2	9.8
	15	78952	3781	500 * 30	550 * 30	30	30	10	7.0	5.4	-8.9		12.4	**12.4**	**12.0**	**11.8**	-1.9	10.5	11.2	9.9
9	intermediate crossbeam	80737	3917	500 * 30	550 * 30	30	30	10	6.9	5.4	-8.8		12.3	12.3	11.9	11.7	-1.9	10.4	11.2	9.9
9	intermediate crossbeam	82520	4071	500 * 30	550 * 30	30	30	10	6.8	5.4	-8.8		12.2	12.2	11.8	11.6	-2.0	10.4	11.1	9.9
	16	84305	4245	500 * 30	550 * 30	30	30	12	7.1	5.2	-9.2		12.3	12.3	11.9	11.7	-2.1	10.6	11.3	10.0
	intermediate crossbeam	86090	4419	500 * 30	550 * 30	30	30	12	7.1	5.3	-9.1		12.4	12.4	12.0	11.8	-2.0	10.7	11.4	10.2
	intermediate crossbeam	87875	4592	500 * 30	550 * 30	30	30	12	7.0	5.3	-9.1		12.3	12.3	12.0	11.8	-2.1	10.7	11.3	10.2
	17	89660	4766	500 * 30	550 * 30	30	30	12	6.9	5.3	-9.0		12.2	12.2	11.9	11.7	-2.1	10.7	11.3	10.2
	intermediate crossbeam	91445	4950	500 * 30	550 * 30	30	30	12	6.8	5.3	-9.0		12.1	12.1	11.8	**11.6**	-2.2	10.6	11.2	10.1
	intermediate crossbeam	93230	5134	500 * 30	550 * 30	30	30	12	6.7	5.3	-8.9		12.0	12.0	11.7	11.5	-2.2	10.6	11.1	10.1
	Portal C	95015	5300	500 * 30	550 * 30	30	30	12	6.7	5.3	-8.9		12.0	**12.0**	11.7	11.5	-2.2	10.6	11.2	10.2
	intermediate crossbeam	96765	5182	500 * 30	550 * 30	30	30	12	6.7	5.3	-8.9		12.0	12.0	11.7	11.5	-2.2	10.6	11.2	10.1
	intermediate crossbeam	98515	5026	500 * 30	550 * 30	30	30	12	6.8	5.3	-9.0		12.1	12.1	11.8	11.6	-2.2	10.6	11.2	10.2
	18	100265	4880	500 * 30	550 * 30	30	30	12	6.8	5.2	-9.0		12.0	12.0	11.7	11.5	-2.2	10.5	11.1	10.0
		100953	4822	500 * 30	550 * 30	30	30	12	6.9	5.3	-9.0		12.2	12.2	11.9	11.7	-2.1	10.7	11.3	10.2
		100953	4822	500 * 30		30	0	12	7.6	4.7	-10.5		12.3	12.3	12.0	11.8	-2.9	10.7	11.3	10.2

	intermediate crossbeam	102015	4733	500 * 30		30	0	12	7.6	4.6	-10.6		12.2	12.2	11.8	11.7	-3.0	10.5	11.2	10.0
	intermediate crossbeam	103765	4587	500 * 30		30	0	10	7.5	5.1	-10.3		12.6	12.6	12.2	12.0	-2.8	10.9	11.6	10.3
12	19	105515	4440	500 * 30		30	0	10	7.4	4.8	-10.2		12.2	12.2	11.8	11.6	-2.8	10.5	11.2	9.9
12	intermediate crossbeam	107263	4301	500 * 30		30	0	10	7.4	4.8	-10.3		12.2	12.2	11.8	11.6	-2.9	10.4	11.1	9.8
	intermediate crossbeam	109013	4182	500 * 30		30	0	10	7.5	4.8	-10.3		12.3	**12.3**	11.9	**11.7**	-2.8	10.4	11.2	9.9
	20	110763	4063	500 * 30		30	0	10	7.6	4.8	-10.4		12.4	12.4	12.0	11.8	-2.8	10.5	11.3	9.9
		111064	4042	500 * 30		30	0	10	7.6	4.7	-10.4		12.3	12.3	11.9	11.7	-2.8	10.4	11.2	9.8
		111064	4042	500 * 20		20	0	10	7.9	4.5	-11.0		12.4	12.4	12.0	11.8	-3.1	10.4	11.2	9.8
	intermediate crossbeam	112513	3943	500 * 20		20	0	10	7.9	4.5	-11.1		12.4	12.4	12.0	11.7	-3.2	10.4	11.2	9.7
	intermediate crossbeam	114263	3823	500 * 20		20	0	10	8.0	4.5	-11.1		12.5	12.5	12.1	11.8	-3.1	10.4	11.2	9.7
	21	116013	3725	500 * 20		20	0	10	8.1	4.4	-11.2		12.5	**12.5**	12.0	11.8	-3.1	10.3	11.2	9.7
	intermediate crossbeam	117763	3631	500 * 20		20	0	10	8.2	4.4	-11.2		12.6	12.6	12.1	**11.9**	-3.0	10.4	11.3	9.7
	intermediate crossbeam	119513	3538	500 * 20		20	0	10	8.2	4.4	-11.2		12.6	12.6	12.1	11.9	-3.0	10.3	11.2	9.6
14	22	121263	3444	500 * 20		20	0	10	8.3	4.4	-11.3		12.7	12.7	12.2	11.9	-3.0	10.3	11.3	9.6
14	intermediate crossbeam	123006	3358	500 * 20		20	0	10	8.4	4.4	-11.3		12.8	12.8	12.3	12.0	-2.9	10.4	11.4	9.6
		123357	3345	500 * 20		20	0	10	8.4	4.3	-11.3		12.7	12.7	12.2	11.9	-2.9	10.3	11.3	9.5
		123357	3345	500 * 30		30	0	10	8.1	4.6	-10.6		12.7	12.7	12.2	11.9	-2.5	10.4	11.3	9.6
		124584	3298	500 * 30		30	0	10	8.1	4.6	-10.6		12.7	12.7	12.2	11.9	-2.5	10.3	11.3	9.6
		124584	3298	500 * 30	530 * 10	30	10	10	7.8	4.9	-10.0		12.7	12.7	12.2	11.9	-2.2	10.4	11.3	9.7
	intermediate crossbeam	124756	3291	500 * 30	530 * 10	30	10	10	7.8	4.9	-10.0		12.7	12.7	12.2	11.9	-2.2	10.4	11.3	9.6
	23	126506	3224	500 * 30	530 * 10	30	10	10	7.9	4.9	-10.0		12.8	12.8	12.3	12.0	-2.1	10.4	11.4	9.7
	intermediate crossbeam	128256	3157	500 * 30	530 * 10	30	10	10	7.9	4.8	-10.0		12.7	**12.7**	**12.2**	**11.9**	-2.1	10.3	11.3	9.5
	intermediate crossbeam	130006	3090	500 * 30	530 * 10	30	10	10	7.9	4.8	-10.1		12.7	12.7	12.2	11.9	-2.2	10.2	11.2	9.4
		130284	3081	500 * 30	530 * 10	30	10	10	8.0	4.9	-10.1		12.9	12.9	12.4	12.1	-2.1	10.4	11.4	9.6
		130284	3081	500 * 30	550 * 30	30	30	10	7.4	5.4	-9.1		12.8	12.8	12.3	12.0	-1.7	10.4	11.4	9.6
	24	131756	3034	500 * 30	550 * 30	30	30	12	7.8	5.2	-9.5		13.0	12.9	12.5	12.2	-1.7	10.5	11.5	9.7
	intermediate crossbeam	133506	2995	500 * 30	550 * 30	30	30	12	7.8	5.2	-9.5		13.0	12.9	12.5	12.2	-1.7	10.5	11.5	9.7
	intermediate crossbeam	135256	2955	500 * 30	550 * 30	30	30	12	7.8	5.2	-9.6		13.0	12.9	12.5	12.2	-1.8	10.4	11.5	9.6
	25	137006	2916	500 * 30	550 * 30	30	30	12	7.9	5.1	-9.6		13.0	12.9	12.4	12.2	-1.7	10.4	11.5	9.6
	intermediate crossbeam	138756	2876	500 * 30	550 * 30	30	30	12	7.9	5.2	-9.6		13.1	13.0	12.5	12.2	-1.7	10.5	11.5	9.7
	intermediate crossbeam	140526	2851	500 * 30	550 * 30	30	30	12	7.9	5.2	-9.6		13.1	**13.0**	12.5	**12.2**	-1.7	10.4	11.5	9.6
	26	142276	2838	500 * 30	550 * 30	30	30	12	7.9	5.1	-9.6		13.0	12.9	12.4	12.1	-1.7	10.4	11.4	9.5
	intermediate crossbeam	144026	2825	500 * 30	550 * 30	30	30	12	7.9	5.1	-9.6		13.0	12.9	12.4	12.1	-1.7	10.3	11.4	9.5
	intermediate crossbeam	145776	2813	500 * 30	550 * 30	30	30	12	7.9	5.2	-9.6		13.1	13.0	12.5	12.2	-1.7	10.4	11.5	9.6
17	27	147526	2800	500 * 30	550 * 30	30	30	12	7.9	5.2	-9.6		13.1	13.0	12.5	12.2	-1.7	10.4	11.5	9.6

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Determination of temperature load on bridge deck

Project name: IJssel Bridge Date: 5/25/2018
Project number: BF7387 Name: Ernst Klamer
Description: Temperature load Main bridge Version v1.0

Linear vertical temperature component (winter)

Ash	Cross beam	To x vs. 0	h	Plate 1	Plate 2	tpo1	tpo2	tdek	, TN, N	-1.3	Δ TN, M, bottom	Column1	Topside deck	Underside deck	Underside strip 8x100	Underside bulb	Underside main beam	Underside crossbeam	Underside End transverse interdental beam	Top edge portal
0	Portal A	0	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
	intermediate crossbeam	1800	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
	intermediate crossbeam	3600	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
	1	5400	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
	intermediate crossbeam	7200	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
	intermediate crossbeam	9000	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
		10000	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
		10000	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	2	10800	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	12600	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	14400	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	3	16200	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
2	intermediate crossbeam	18000	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
2	4	19798	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	21598	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	5	23398	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	25198	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	26998	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	6	28798	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	30598	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
	intermediate crossbeam	32398	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
		33498	2400	500 * 30	350 * 30	30	30	10	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.0	-3.4	-2.7
		33498	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
	7	34198	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
		34997	2400	500 * 30		30	0	10	-2.6	-1.4	3.4		-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
		34997	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
4	intermediate crossbeam	35998	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
4	intermediate crossbeam	37796	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
	8	39596	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
	intermediate crossbeam	41396	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
	intermediate crossbeam	43196	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
	Portal B	44996	2400	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.0	-3.5	-2.7
	intermediate crossbeam	46796	2406	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.1	-3.5	-2.7
5	intermediate crossbeam	48596	2416	500 * 20		20	0	10	-2.8	-1.3	3.6		-4.1	-4.1	-3.9	-3.8	0.8	-3.1	-3.5	-2.7
5	9	50394	2443	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.0	-3.4	-2.6
	intermediate crossbeam	52179	2476	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.0	-3.4	-2.7
	intermediate crossbeam	53964	2508	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.0	-3.4	-2.7
	10	55749	2541	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.0	-3.4	-2.7
	intermediate crossbeam	57534	2593	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.0	-3.4	-2.7
	intermediate crossbeam	59319	2657	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.0	-3.4	-2.8
	11	61104	2720	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.1	-3.4	-2.8
7	intermediate crossbeam	62889	2784	500 * 20		20	0	10	-2.7	-1.3	3.6		-4.0	-4.0	-3.8	-3.7	0.9	-3.1	-3.5	-2.8
7	intermediate crossbeam	64672	2865	500 * 20		20	0	10	-2.6	-1.3	3.6		-3.9	-3.9	-3.7	-3.6	1.0	-3.0	-3.4	-2.7
		66020	2939	500 * 20		20	0	10	-2.6	-1.3	3.6		-3.9	-3.9	-3.7	-3.6	1.0	-3.0	-3.4	-2.8
		66020	2939	500 * 30		30	0	10	-2.5	-1.4	3.3		-3.9	-3.9	-3.7	-3.6	0.8	-3.1	-3.4	-2.8
	12	66457	2963	500 * 30		30	0	10	-2.5	-1.4	3.4		-3.9	-3.9	-3.7	-3.6	0.9	-3.1	-3.4	-2.8
	intermediate crossbeam	68242	3061	500 * 30		30	0	10	-2.5	-1.4	3.3		-3.9	-3.9	-3.7	-3.6	0.8	-3.1	-3.4	-2.9
		68962	3101	500 * 30		30	0	10	-2.5	-1.4	3.3		-3.9	-3.9	-3.7	-3.6	0.8	-3.1	-3.4	-2.9
		68962	3101	500 * 30	550 * 30	30	30	10	-2.3	-1.7	2.8		-4.0	-4.0	-3.8	-3.8	0.5	-3.3	-3.6	-3.0
	13	70027	3159	500 * 30	550 * 30	30	30	10	-2.2	-1.7	2.8		-3.9	-3.9	-3.7	-3.7	0.6	-3.2	-3.5	-2.9
	intermediate crossbeam	71812	3257	500 * 30	550 * 30	30	30	10	-2.2	-1.7	2.8		-3.9	-3.9	-3.8	-3.7	0.6	-3.2	-3.5	-3.0
	14	73597	3374	500 * 30	550 * 30	30	30	10	-2.2	-1.7	2.8		-3.9	-3.9	-3.8	-3.7	0.6	-3.2	-3.5	-3.0
	intermediate crossbeam	75382	3510	500 * 30	550 * 30	30	30	10	-2.1	-1.7	2.7		-3.8	-3.8	-3.7	-3.6	0.6	-3.2	-3.4	-3.0
	intermediate crossbeam	77167	3645	500 * 30	550 * 30	30	30	10	-2.1	-1.7	2.7		-3.8	-3.8	-3.7	-3.6	0.6	-3.2	-3.4	-3.0
	15	78952	3781	500 * 30	550 * 30	30	30	10	-2.1	-1.7	2.7		-3.8	-3.8	-3.7	-3.6	0.6	-3.2	-3.4	-3.0
9	intermediate crossbeam	80737	3917	500 * 30	550 * 30	30	30	10	-2.1	-1.7	2.7		-3.8	-3.8	-3.7	-3.6	0.6	-3.2	-3.5	-3.0
9	intermediate crossbeam	82520	4071	500 * 30	550 * 30	30	30	10	-2.0	-1.7	2.7		-3.7	-3.7	-3.6	-3.5	0.7	-3.1	-3.4	-3.0
	16	84305	4245	500 * 30	550 * 30	30	30	12	-2.2	-1.6	2.9		-3.8	-3.8	-3.7	-3.6	0.7	-3.3	-3.5	-3.1
	intermediate crossbeam	86090	4419	500 * 30	550 * 30	30	30	12	-2.2	-1.6	2.8		-3.8	-3.8	-3.7	-3.6	0.6	-3.3	-3.5	-3.1
	intermediate crossbeam	87875	4592	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.5	0.7	-3.2	-3.4	-3.1
	17	89660	4766	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.5	0.7	-3.2	-3.4	-3.1
	intermediate crossbeam	91445	4950	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.5	0.7	-3.2	-3.4	-3.1
	intermediate crossbeam	93230	5134	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.6	0.7	-3.3	-3.4	-3.1
	Portal C	95015	5300	500 * 30	550 * 30	30	30	12	-2.0	-1.6	2.8		-3.6	-3.6	-3.5	-3.5	0.8	-3.2	-3.3	-3.0
	intermediate crossbeam	96765	5182	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.6	0.7	-3.3	-3.4	-3.1
	intermediate crossbeam	98515	5026	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.6	0.7	-3.2	-3.4	-3.1
	18	100265	4880	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.5	0.7	-3.2	-3.4	-3.1
		100953	4822	500 * 30	550 * 30	30	30	12	-2.1	-1.6	2.8		-3.7	-3.7	-3.6	-3.5	0.7	-3.2	-3.4	-3.1
		100953	4822	500 * 30		30	0	12	-2.3	-1.4	3.3		-3.7	-3.7	-3.6	-3.5	1.0	-3.2	-3.4	-3.0
	intermediate crossbeam	102015	4733	500 * 30		30	0	12	-2.3	-1.4	3.3		-3.7	-3.7	-3.6	-3.5	1.0	-3.2	-3.4	-3.0
	intermediate crossbeam	103765	4587	500 * 30		30	0	10	-2.3	-1.6	3.1		-3.9	-3.9	-3.8	-3.7	0.8	-3.4	-3.6	-3.2
12	19	105515	4440	500 * 30		30	0	10	-2.2	-1.5	3.1		-3.7	-3.7	-3.6	-3.5	0.9	-3.2	-3.4	-3.0
12	intermediate crossbeam	107263	4301	500 * 30		30	0	10	-2.2	-1.5	3.1		-3.7	-3.7	-3.6	-3.5	0.9	-3.1	-3.4	-3.0
	intermediate crossbeam	109013	4182	500 * 30		30	0	10	-2.3	-1.5	3.1		-3.8	-3.8	-3.7	-3.6	0.8	-3.2	-3.5	-3.1
	20	110763	4063	500 * 30		30	0	10	-2.3	-1.5	3.2		-3.8	-3.8	-3.7	-3.6	0.9	-3.2	-3.4	-3.0
		111064	4042	500 * 30		30	0	10	-2.3	-1.5	3.2		-3.8	-3.8	-3.7	-3.6	0.9	-3.2	-3.4	-3.0
		111064	4042	500 * 20		20	0	10	-2.4	-1.4	3.4		-3.8	-3.8	-3.7	-3.6	1.0	-3.2	-3.4	-3.0
	intermediate crossbeam	112513	3943	500 * 20		20	0	10	-2.4	-1.4	3.4		-3.8	-3.8	-3.7	-3.6	1.0	-3.2	-3.4	-3.0
	intermediate crossbeam	114263	3823	500 * 20		20	0	10	-2.4	-1.4	3.4		-3.8	-3.8	-3.7	-3.6	1.0	-3.1	-3.4	-2.9
	21	116013	3725	500 * 20		20	0	10	-2.4	-1.4	3.4		-3.8	-3.8	-3.7	-3.6	1.0	-3.1	-3.4	-2.9
	intermediate crossbeam	117763	3631	500 * 20		20	0	10	-2.5	-1.4	3.4		-3.9	-3.9	-3.8	-3.7	0.9	-3.2	-3.5	-3.0
	intermediate crossbeam	119513	3538	500 * 20		20	0	10	-2.5	-1.4	3.5		-3.9	-3.9	-3.7	-3.7	1.0	-3.2	-3.5	-3.0
14	22	121263	3444	500 * 20		20	0	10	-2.5	-1.4	3.5		-3.9	-3.9	-3.7	-3.7	1.0	-3.2	-3.5	-2.9
14	intermediate crossbeam	123006	3358	500 * 20		20	0	10	-2.5	-1.3	3.5		-3.8	-3.8	-3.6	-3.6	1.0	-3.1	-3.4	-2.8
		123357	3345	500 * 20		20	0	10	-2.5	-1.3	3.5		-3.8	-3.8	-3.6	-3.6	1.0	-3.1	-3.4	-2.8
		123357	3345	500 * 30		30	0	10	-2.4	-1.4	3.3		-3.8	-3.8	-3.6	-3.6	0.9	-3.1	-3.4	-2.8
		124584	3298	500 * 30		30	0	10	-2.4	-1.4	3.3		-3.8	-3.8	-3.6	-3.6	0.9	-3.1	-3.4	-2.8
		124584	3298	500 * 30	530 * 10	30	10	10	-2.3	-1.5	3.1		-3.8	-3.8	-3.6	-3.6	0.8	-3.1	-3.4	-2.9
	intermediate crossbeam	124756	3291	500 * 30	530 * 10	30	10	10	-2.3	-1.5	3.1		-3.8	-3.8	-3.6	-3.6	0.8	-3.1	-3.4	-2.9
	23	126506	3224	500 * 30	530 * 10	30	10	10	-2.4	-1.5	3.1		-3.9	-3.9	-3.7	-3.7	0.7	-3.2	-3.5	-2.9
	intermediate crossbeam	128256	3157	500 * 30	530 * 10	30	10	10	-2.4	-1.5	3.1		-3.9	-3.9	-3.7	-3.7	0.7	-3.2	-3.5	-2.9
	intermediate crossbeam	130006	3090	500 * 30	530 * 10	30	10	10	-2.4	-1.5	3.1		-3.9	-3.9	-3.7	-3.7	0.7	-3.1	-3.4	-2.9
		130284	3081	500 * 30	530 * 10	30	10	10	-2.4	-1.5	3.1		-3.9	-3.9	-3.7	-3.7	0.7	-3.1	-3.4	-2.9
		130284	3081	500 * 30	550 * 30	30	30	10	-2.2	-1.7	2.8		-3.9	-3.9	-3.7	-3.7	0.6	-3.2	-3.5	-2.9
	24	131756	3034	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-3.0
	intermediate crossbeam	133506	2995	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-3.0
	intermediate crossbeam	135256	2955	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-3.0

	25	137006	2916	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9
	intermediate crossbeam	138756	2876	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9
	intermediate crossbeam	140526	2851	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9
	26	142276	2838	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9
	intermediate crossbeam	144026	2825	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9
	intermediate crossbeam	145776	2813	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9
17	27	147526	2800	500 * 30	550 * 30	30	30	12	-2.4	-1.6	3.0		-4.0	-4.0	-3.8	-3.7	0.6	-3.2	-3.5	-2.9

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Temperature load Main bridge	Version	v1.0

Vertical temperature component with non-linear effects

For the purpose of the input, the vertical temperature component has been divided into a number of areas with (almost) the same temperature load.
The relevant imports are summarized below, as entered in SCIA (BG 1002 and BG 1003)
In addition, the combinations of the uniform and vertical temperature component are also shown (BG 1004-1007)

BG1002 - Summer vertical temperature component

Plate 1	Plate 2	from	until	Upstairs silk deck	Underside deck	Underside strip 8x100	Underside bulb	Underside head lying r	Underside transverse be there	Underside End transverse interdental b	Top edge portal
500 * 30		Portal A	2	13.2	13.1	12.5	12.1	-2.2	9.9	11.2	8.9
500 * 30	350 * 30	2	7	13.1	13.0	12.4	12.1	-1.8	10.0		
500 * 30		7	7	13.2	13.1	12.5	12.1	-2.2	9.9		
500 * 20		7	12	13.2	13.1	12.5	12.1	-2.6	9.9		
500 * 30		12	13	12.9	12.9	12.4	12.1	-2.5	10.3		
500 * 30	550 * 30	13	16	12.5	12.5	12.1	11.8	-1.9	10.5		
500 * 30	550 * 30	16	18	12.1	12.1	11.8	11.6	-2.2	10.6		10.2
500 * 30		18	20	12.3	12.3	11.9	11.7	-2.9	10.6		
500 * 20		20	22 + 1	12.6	12.5	12.1	11.9	-3.0	10.4		
500 * 30		22 + 1	22 + 2	12.7	12.7	12.2	11.9	-2.5	10.3		
500 * 30	530 * 10	22 + 2	24	12.8	12.7	12.2	12.0	-2.2	10.3		
500 * 30	550 * 30	24	27	13.0	13.0	12.5	12.2	-1.7	10.4		

+1 is one crossbeam after the relevant axle

BG1003 - Vertical temperature component winter

Plate 1	Plate 2	from	until	Upstairs silk deck	Underside deck	Underside strip 8x100	Underside bulb	Underside head lying r	Underside transverse be there	Underside End transverse interdental b	Top edge portal
500 * 30		Portal A	2	-4.0	-4.0	-3.8	-3.7	0.8	-3.0	-3.4	-2.7
500 * 30	350 * 30	2	7	-4.0	-4.0	-3.8	-3.7	0.6	-3.0		
500 * 30		7	7	-4.0	-4.0	-3.8	-3.7	0.8	-3.0		
500 * 20		7	12	-4.0	-4.0	-3.8	-3.7	0.9	-3.0		
500 * 30		12	13	-3.9	-3.9	-3.7	-3.6	0.8	-3.1		
500 * 30	550 * 30	13	16	-3.8	-3.8	-3.7	-3.6	0.6	-3.2		
500 * 30	550 * 30	16	18	-3.7	-3.7	-3.6	-3.5	0.7	-3.2		-3.1
500 * 30		18	20	-3.8	-3.8	-3.6	-3.6	0.9	-3.2		
500 * 20		20	22 + 1	-3.8	-3.8	-3.7	-3.6	1.0	-3.1		
500 * 30		22 + 1	22 + 2	-3.8	-3.8	-3.6	-3.6	0.9	-3.1		
500 * 30	530 * 10	22 + 2	24	-3.9	-3.9	-3.7	-3.6	0.7	-3.1		
500 * 30	550 * 30	24	27	-4.0	-4.0	-3.8	-3.7	0.6	-3.2		

+1 is one crossbeam after the relevant axle

BG1005 - Temperature combination 1 - summer +TM + ωN ΔTN ωN = 0.35 NTN = 35

Plate 1	Plate 2	from	until	Upstairs silk deck	Underside deck	Underside strip 8x100	Underside bulb	Underside head lying r	Underside transverse be there	Underside End transverse interdental b	Top edge portal
500 * 30		Portal A	2	25.5	25.4	24.8	24.4	10.1	22.2	23.5	21.2
500 * 30	350 * 30	2	7	25.4	25.3	24.7	24.4	10.5	22.2		
500 * 30		7	7	25.5	25.4	24.8	24.4	10.1	22.2		
500 * 20		7	12	25.4	25.4	24.8	24.4	9.7	22.2		
500 * 30		12	13	25.2	25.2	24.7	24.4	9.8	22.6		
500 * 30	550 * 30	13	16	24.8	24.8	24.4	24.1	10.4	22.7		
500 * 30	550 * 30	16	18	24.4	24.4	24.1	23.9	10.1	22.9		22.4
500 * 30		18	20	24.6	24.6	24.2	24.0	9.4	22.9		
500 * 20		20	22 + 1	24.9	24.8	24.4	24.1	9.3	22.6		
500 * 30		22 + 1	22 + 2	25.0	24.9	24.5	24.2	9.8	22.6		
500 * 30	530 * 10	22 + 2	24	25.0	25.0	24.5	24.3	10.1	22.6		
500 * 30	550 * 30	24	27	25.3	25.3	24.8	24.5	10.6	22.7		

+1 is one crossbeam after the relevant axle

BG1006 - Temperature combination 1 - winter +TM + ωN ΔTN ωN = 0.35 NTN = -36

Plate 1	Plate 2	from	until	Upstairs silk deck	Underside deck	Underside strip 8x100	Underside bulb	Underside head lying r	Underside transverse be there	Underside End transverse interdental b	Top edge portal
500 * 30		Portal A	2	-16.6	-16.6	-16.4	-16.3	-11.8	-15.6	-16.0	-15.3
500 * 30	350 * 30	2	7	-16.6	-16.6	-16.4	-16.3	-12.0	-15.6		
500 * 30		7	7	-16.6	-16.6	-16.4	-16.3	-11.8	-15.6		
500 * 20		7	12	-16.6	-16.6	-16.4	-16.3	-11.7	-15.6		
500 * 30		12	13	-16.5	-16.5	-16.3	-16.2	-11.8	-15.7		
500 * 30	550 * 30	13	16	-16.4	-16.4	-16.3	-16.2	-12.0	-15.8		
500 * 30	550 * 30	16	18	-16.3	-16.3	-16.2	-16.2	-11.9	-15.8		-15.7
500 * 30		18	20	-16.4	-16.4	-16.3	-16.2	-11.7	-15.8		
500 * 20		20	22 + 1	-16.4	-16.4	-16.3	-16.2	-11.6	-15.8		
500 * 30		22 + 1	22 + 2	-16.4	-16.4	-16.3	-16.2	-11.7	-15.7		
500 * 30	530 * 10	22 + 2	24	-16.5	-16.5	-16.3	-16.2	-11.9	-15.7		
500 * 30	550 * 30	24	27	-16.6	-16.6	-16.4	-16.3	-12.0	-15.8		

+1 is one crossbeam after the relevant axle

BG1007 - Temperature combination 2 - summer ωM ΔTM + ΔTN ωM = 0.75 NTN = 35

Plate 1	Plate 2	from	until	Upstairs silk deck	Underside deck	Underside strip 8x100	Underside bulb	Underside head lying r	Underside transverse be there	Underside End transverse interdental b	Top edge portal
500 * 30		Portal A	2	45.0	45.0	44.5	44.2	33.5	42.5	43.5	41.8
500 * 30	350 * 30	2	7	44.9	44.9	44.4	44.2	33.8	42.6		
500 * 30		7	7	45.0	45.0	44.5	44.2	33.5	42.5		
500 * 20		7	12	45.0	44.9	44.5	44.2	33.2	42.6		
500 * 30		12	13	44.8	44.8	44.4	44.2	33.2	42.8		
500 * 30	550 * 30	13	16	44.5	44.5	44.2	44.0	33.7	43.0		
500 * 30	550 * 30	16	18	44.2	44.2	44.0	43.8	33.5	43.1		42.7
500 * 30		18	20	44.3	44.3	44.1	43.9	33.0	43.0		
500 * 20		20	22 + 1	44.5	44.5	44.2	44.0	32.8	42.9		
500 * 30		22 + 1	22 + 2	44.6	44.6	44.3	44.1	33.2	42.9		
500 * 30	530 * 10	22 + 2	24	44.7	44.6	44.3	44.1	33.5	42.9		
500 * 30	550 * 30	24	27	44.9	44.8	44.5	44.2	33.8	42.9		

+1 is one crossbeam after the relevant axle

BG1008 - Temperature combination 2 - winter ωM ΔTM + ΔTN ωM = 0.75 NTN = -36

Plate 1	Plate 2	from	until	Upstairs silk deck	Underside deck	Underside strip 8x100	Underside bulb	Underside head lying r	Underside transverse be there	Underside End transverse interdental b	Top edge portal
500 * 30		Portal A	2	-39.0	-39.0	-38.9	-38.8	-35.4	-38.3	-38.6	-38.0
500 * 30	350 * 30	2	7	-39.0	-39.0	-38.9	-38.8	-35.6	-38.3		
500 * 30		7	7	-39.0	-39.0	-38.9	-38.8	-35.4	-38.3		
500 * 20		7	12	-39.1	-39.0	-38.9	-38.8	-35.4	-38.3		
500 * 30		12	13	-38.9	-38.9	-38.8	-38.8	-35.4	-38.3		
500 * 30	550 * 30	13	16	-38.9	-38.9	-38.8	-38.7	-35.6	-38.4		
500 * 30	550 * 30	16	18	-38.8	-38.8	-38.7	-38.7	-35.5	-38.5		-38.3
500 * 30		18	20	-38.8	-38.8	-38.8	-38.7	-35.3	-38.4		
500 * 20		20	22 + 1	-38.9	-38.9	-38.8	-38.7	-35.3	-38.4		
500 * 30		22 + 1	22 + 2	-38.9	-38.9	-38.8	-38.7	-35.3	-38.3		
500 * 30	530 * 10	22 + 2	24	-38.9	-38.9	-38.8	-38.7	-35.5	-38.4		
500 * 30	550 * 30	24	27	-39.0	-39.0	-38.9	-38.8	-35.6	-38.4		

+1 is one crossbeam after the relevant axle

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x20 (deck = 10 mm)	Version:	v1.0

Temperature load over the height

Temperature component	Temperature difference (Δ T) (a) Global warming			Temperature difference (Δ T) (b) Cooling		
Vertical temperature component ΔT	0 2 4 6 8 10 12 14 16			-7 -6 -5 -4 -3 -2 -1 0		
	0		15.0	-6.0	0.0	0100
	500	0.0				
	2400	0.0			0.0	2400

ΔT1a := 15gr h1a := 500mm ΔT1b := - 6gr h1b := 100mm

ΔT1az () := max (ΔT1a - z/h1a · ΔT1a , 0gr) ΔT1bz () := min (ΔT1b - z/h1b · ΔT1b , 0gr)

Geometric cross-section properties

Cover plate thickness tdek := 10mm

Cover plate width bdek := 4630mm

Number of bulbs nbulb := 13

Surface bulbs Abulb := 1712mm 2

Height bulbs hbulb := 160mm

Width bulbs tbulb := Abulb / hbulb = 10.7 · mm

Center of gravity bulb from the top zbulb := 98.3mm

The calculation is performed for the following heights

Stiffening strip height hstrip := 100mm

Stiffening strip thickness tstrip := 8mm

Top flange thickness tfb := 20mm

Top flange width bfb := 300mm

Bottom flange thickness tfo := 20mm

Bottom flange width bfo := 300mm

Plate flange thickness tpo1 := 20mm

Bottom flange width bpo1 := 500mm

Plate flange thickness tpo2 := 0mm

Bottom flange width bpo2 := 0mm

Body thickness adv := 12mm

Body height hwh () := h tdek - tfb - tfo ... + - tpo1 - tpo2

Height bottom deck - bottom bottom flange DIN hhl :=	Total height including deck and bottom plate h = · mm
2400	2430
2406	2436
2416	2446
2443	2473
2476	2506
2508	2538
2541	2571
2593	2623
2657	2687
2720	2750
2784	2814
2865	2895
2939	2969
4042	4072
3943	3973

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Function width over the height

bzh(), := bdek if z ≤ tdek

bfbnbulbtbulb · + tstrip if tdek < z ≤ tdek + tfb

bwnbulbtbulb · + tstrip if tdek + tfb < z ≤ tdek + hstrip bwnbulbtbulb if tdekhstrip < z ≤ tdekhbulb

adv if tdekhbulb < z ≤ tdektfb + hwh ()

bfo if tdektfb + hwh () < z ≤ tdektfb + hwh () + tfo

bpo1 if tdektfb + hwh () + tfo < z ≤ h tpo2

bpo2 if h tpo2 < z ≤ h

0 otherwise

Surface $A\,h\,() := \int_0^h bz(h,)\,dz$

Neutral axis $zbh\,() := \frac{1}{A\,h\,()}\left(\int_0^h bz(h,)\,z \cdot dz\right)$

$zoh\,() := h - zbh\,()$

Resistance moment $I\,h\,() := \int_0^h bz(h,)\left(z - zbh\,()\right)^2 dz$

$A\,h_i()$ =	$zbh_i()$ =	$zoh_i()$ =	$I\,h_i()$ =
119357 · mm^2	625 · mm	1805 · mm	100641864842 · mm^4
119695	628	1808	101289006788
119969	632	1814	102250086037
120254	641	1832	104636370948
120583	652	1854	107892732478
120938	663	1875	111000535431
121447	673	1898	114483877526
121974	690	1933	119902738169
122465	713	1974	126609624264
123498	730	2020	132891868709
124254	750	2064	140726283002
125 170	778	2117	150162905869
126398	799	2170	159147054521
139306	1182	2890	330480619681
138312	1146	2827	312136334635

Temperature components Summer Winter

Average temperature $\Delta TN.ah\,() := \frac{1}{A\,h\,()}\int_0^h \Delta T1az\,()\,bz(h,)\,dz$ $\Delta TN.bh\,() := \frac{1}{A\,h\,()}\int_0^h \Delta T1bz\,()\,bz(h,)\,dz$

$\Delta TN.heatz\,h() := \Delta TN.ah\,()$ $\Delta TN.coolz\,h() := \Delta TN.bh\,()$

	$\Delta TN.heat(1mm, h_i)$ =	$\Delta TN.cool(0mm, h_i)$ =
2400	9.2 · gr	-2.8 · gr
2406	9.2	-2.8
2416	9.2	-2.8
2443	9.1	-2.7
2476	9.1	-2.7
2508	9.1	-2.7
2541	9	-2.7

hhl = · mm

2593	9	-2.7
2657	9	-2.7
2720	8.9	-2.7
2784	8.8	-2.7
2865	8.8	-2.6
2939	8.7	-2.6
4042	7.9	-2.4
3943	7.9	-2.4

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Linear temperature component Summer Winter

$$\Delta T_{M.a}(h) := -\frac{h}{I(h)} \int_0^h \Delta T_{1a}(z) \cdot b(z,h) \cdot (z - \bar{z}_b(h)) \, dz \qquad \Delta T_{M.b}(h) := -\frac{h}{I(h)} \int_0^h \Delta T_{1b}(z) \cdot b(z,h) \cdot (z - \bar{z}_b(h)) \, dz$$

$$\Delta T_{M.heat}(z,h) := \frac{-(z - \bar{z}_b(h)) \cdot \Delta T_{M.a}(h)}{h} \qquad \Delta T_{M.cool}(z,h) := \frac{-(z - \bar{z}_b(h)) \cdot \Delta T_{M.b}(h)}{h}$$

hhl = · mm; $\Delta T_{M.a}(h_i) =$ · gr; $\Delta T_{M.b}(h_i) =$ · gr

2400	15.7	-4.9
2406	15.7	-4.9
2416	15.7	-4.9
2443	15.8	-4.9
2476	15.8	-4.9
2508	15.8	-4.9
2541	15.8	-4.9
2593	15.8	-4.9
2657	15.9	-4.9
2720	15.8	-4.9
2784	15.7	-4.9
2865	15.8	-4.9
2939	15.7	-4.9
4042	15.5	-4.8

3943	15.6	-4.8

		Top temperature		Bottom temperature	
		Summer	Winter	Summer	Winter
		$\Delta TM.heat0mm(h_i,) =$	$\Delta TM.cool0mm(h_i,) =$	$\Delta TM.heath(h_i,) =$	$\Delta TM.coolh(h_i,) =$
hhl =	2400	4 ·gr	-1.3 ·gr	-11.7 ·gr	3.6 ·gr
	2406	4.1	-1.3	-11.7	3.6
	2416	4.1	-1.3	-11.7	3.6
	2443	4.1	-1.3	-11.7	3.6
	2476	4.1	-1.3	-11.7	3.6
	2508	4.1	-1.3	-11.7	3.6
	2541	4.1	-1.3	-11.6	3.6
	2593 ·mm	4.1	-1.3	-11.6	3.6
	2657	4.2	-1.3	-11.6	3.6
	2720	4.2	-1.3	-11.6	3.6
	2784	4.2	-1.3	-11.5	3.6
	2865	4.2	-1.3	-11.5	3.6
	2939	4.2	-1.3	-11.5	3.6
	4042	4.5	-1.4	-11	3.4
	3943	4.5	-1.4	-11.1	3.4

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/24/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x20 (deck = 10 mm)	Version:	v1.0

Temperature load over the height

Temperature component | **Temperature difference (Δ T)**

(a) Global warming | **(b) Cooling**

Vertical temperature component
ΔT

0 2 4 6 8 10 12 14 16

0
500 0.0
15.0
2400 0.0

-7 -6 -5 -4 -3 -2 -1 0

-6.0
0.0 0100
0.0 2400

$\Delta T1a := 15gr$ $h1a := 500mm$

$\Delta T1az() := \max\left(\Delta T1a - \frac{z}{h1a} \cdot \Delta T1a, 0gr\right)$

$\Delta T1b := -6gr$ $h1b := 100mm$

$\Delta T1bz() := \min\left(\Delta T1b - \frac{z}{h1b} \cdot \Delta T1b, 0gr\right)$

Geometric cross-section properties

Cover plate thickness $tdek := 10mm$

Cover plate width $bdek := 4630mm$

Number of bulbs $nbulb := 13$

Surface bulbs $Abulb := 1712mm^2$

Height bulbs $hbulb := 160mm$

Width bulbs $tbulb := \frac{Abulb}{hbulb} = 10.7 \cdot mm$

Center of gravity bulb from the top $zbulb := 98.3mm$

The calculation is performed for the following heights

Stiffening strip height $hstrip := 100mm$

Stiffening strip thickness $tstrip := 8mm$

Height bottom deck - bottom bottom flange DIN

Total height including deck and bottom plate

Top flange thickness	tfb := 20mm	
Top flange width	bfb := 300mm	
Bottom flange thickness	tfo := 20mm	
Bottom flange width	bfo := 300mm	
Plate flange thickness	tpo1 := 20mm	
Bottom flange width	bpo1 := 500mm	
Plate flange thickness	tpo2 := 0mm	
Bottom flange width	bpo2 := 0mm	

hhl :=

3823	3853
3725	3755
3631	3661
3538	3568
3444	3474
3358	3388
3345	3375

h = · mm

Body thickness	adv := 12mm
Body height	hwh(h) := h − tdek − tfb − tfo ... + − tpo1 − tpo2

Function width over the height

bz(h, z) :=
bdek if z ≤ tdek
bfb + nbulb · tbulb + tstrip if tdek < z ≤ tdek + tfb
bw + nbulb · tbulb + tstrip if tdek + tfb < z ≤ tdek + hstrip
bw + nbulb · tbulb if tdek + hstrip < z ≤ tdek + hbulb
adv if tdek + hbulb < z ≤ tdek + tfb + hwh(h)
bfo if tdek + tfb + hwh(h) < z ≤ tdek + tfb + hwh(h) + tfo
bpo1 if tdek + tfb + hwh(h) + tfo < z ≤ h − tpo2
bpo2 if h − tpo2 < z ≤ h
0 otherwise

Surface $A(h) := \int_0^h bz(h,z)\, dz$

Neutral axis $zb(h) := \frac{1}{A(h)} \left(\int_0^h bz(h,z) \cdot z\, dz \right)$

$zo(h) := h - zb(h)$

Resistance moment $I(h) := \int_0^h bz(h,z) \left(z - zb(h) \right)^2 dz$

$A(h_i) =$	$zb(h_i) =$	$zo(h_i) =$	$I(h_i) =$
136783 · mm^2	1106 · mm	2747 · mm	290802869182 · mm^4
135708	1070	2685	273703572618
134477	1036	2625	258133254996
133334	1003	2565	243140375778
132148	973	2501	228596487340
131202	942	2446	215734086520
131109	934	2441	213990303459

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Temperature components Summer

Winter

Average temperature

$$\Delta T_{N.a}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1a}(z) \cdot b(z,h) \, dz$$

$$\Delta T_{N.b}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1b}(z) \cdot b(z,h) \, dz$$

$\Delta T_{N.heat1}(h) := \Delta T_{N.a}(h)$

$\Delta T_{N.cool0}(h) := \Delta T_{N.b}(h)$

$\Delta T_{N.heat1}(\mathrm{mm} \cdot hh_i) =$

$\Delta T_{N.cool0}(\mathrm{mm} \cdot hh_i) =$

hh^T =	0	$\Delta T_{N.heat1}$ (gr)	$\Delta T_{N.cool0}$ (gr)
0	3823	8	-2.4
1	3725	8.1	-2.4
2	3631	8.2	-2.5
3	3538	8.2	-2.5
4	3444	8.3	-2.5
5	3358	8.4	-2.5
6	3345	8.4	-2.5
7			
8			
9			
10			
11			
12			
13			
14			
15			

·mm

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Linear temperature component Summer Winter

ΔTM.ah () : = - h / I h () ∫₀ʰ ΔT1az () bżh,() ·(z z̄bh ()) dz ΔTM.bh () : = - h / I h () ∫₀ʰ ΔT1bz () bżh,() ·(z z̄bh ()) dz

ΔTM.heatz h() : = - (z z̄bh ()) · ΔTM.ah () / h ΔTM.coolz h() : = - (z z̄bh ()) · ΔTM.bh () / h

	ΔTM.ah i() =	ΔTM.bh i() =
3823	15.6 ·gr	-4.8 ·gr
3725	15.6	-4.8
3631	15.6	-4.8
3538	15.6	-4.8
3444	15.7	-4.8
3358	15.7	-4.8
3345	15.6	-4.8

hhl = ·mm

	Top temperature Summer ΔTM.heat0mm h i(,) =	Winter ΔTM.cool0mm h i(,) =	Bottom temperature Summer ΔTM.heath i h i(,) =	Winter ΔTM.coolh i h i(,) =
3823	4.5 ·gr	-1.4 ·gr	-11.1 ·gr	3.4 ·gr
3725	4.4	-1.4	-11.2	3.4
3631	4.4	-1.4	-11.2	3.4
3538	4.4	-1.4	-11.2	3.5
3444	4.4	-1.4	-11.3	3.5
3358	4.4	-1.3	-11.3	3.5
3345	4.3	-1.3	-11.3	3.5

hhl = ·mm

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Determination of temperature load on bridge deck

Project name: IJssel Bridge Date: 5/25/2018
Project number: BF7387 Name: Ernst Klamer
Description: Main beam 500x30 (deck = 10 mm) h = 2400 mm Version: v1.0

Temperature load over the height

Temperature component	**Temperature difference (Δ T)**	
	(a) Global warming	**(b) Cooling**
Vertical temperature component ΔT	0 2 4 6 8 10 12 14 16	-7 -6 -5 -4 -3 -2 -1 0
	0 15.0	-6.0 0.0 0100
	500 0.0	
	2400 0.0	0.0 2400

ΔT1a := 15gr h1a := 500mm ΔT1b := -8gr h1b := 100mm

ΔT1az () := max (ΔT1a - z/h1a · ΔT1a , 0gr) ΔT1bz () := min (ΔT1b - z/h1b · ΔT1b , 0gr)

Geometric cross-section properties

Cover plate thickness tdek := 10mm

Cover plate width bdek := 4630mm

Number of bulbs nbulb := 13

Surface bulbs Abulb := 1712mm ^{2}

Height bulbs hbulb := 160mm

Width bulbs tbulb := Abulb/hbulb = 10.7 mm

Center of gravity bulb from the top zbulb := 98.3mm

Stiffening strip height hstrip := 100mm

Stiffening strip thickness tstrip := 8mm

Top flange thickness tfb := 20mm

Top flange width bfb := 300mm

Bottom flange thickness tfo := 20mm

Bottom flange width bfo := 300mm

Plate flange thickness tpo1 := 30mm

Bottom flange width bpo1 := 500mm

Plate flange thickness tpo2 := 0mm

Bottom flange width bpo2 := 0mm

Height (including cover plate) h := 2400mm + tpo1 + tpo2 + tdek = 2440 mm

Body thickness adv := 12mm

Body height hw := h - tdek - tfb - tfo - tpo1 - tpo2 = 2360 mm

Function width over the height

bz () := bdek if z < tdek

bfb + nbulb · tbulb + tstrip if tdek < z ≤ tdek + tfb

bw + nbulb · tbulb + tstrip if tdek + tfb < z ≤ tdek + hstrip

bw + nbulb · tbulb if tdek + hstrip < z ≤ tdek + hbulb

adv if tdek + hbulb < z ≤ tdek + tfb + hw

bfo if tdek + tfb + hw < z ≤ tdek + tfb + hw + tfo

bpo1 if tdek + tfb + hw + tfo < z ≤ h - tpo2

bpo2 if h - tpo2 < z ≤ h

0 otherwise

Surface $a := \int_0^h b(z)\, dz = 124903 \cdot mm^2$

Neutral axis $zb := \frac{1}{a} \left(\int_0^h b(z) \cdot z \cdot dz \right) = 700 \cdot mm$

$so := h - zb = 1740 \cdot mm$

Resistance moment $I := \int_0^h b(z) \cdot (z - zb)^2\, dz = 1.16 \times 10^{11} \cdot mm^4$

Temperature components

Average temperature $\Delta TN.a := \frac{1}{a} \int_0^h \Delta T1a(z) \cdot b(z)\, dz = 8.8 \cdot gr$ $\Delta TN.b := \frac{1}{a} \int_0^h \Delta T1b(z) \cdot b(z)\, dz = -2.6 \cdot gr$

$\Delta TN.heat(z) := \Delta TN.a$ $\Delta TN.cool(z) := \Delta TN.b$

0 0

z 1000 z 1000

mm mm

0 2 4 6 8 -3 -2 -1

ΔTN.heat z () ΔTN.cool z ()

Linear temp. comp. $\Delta TM.a := -\frac{h}{I} \int_0^h \Delta T1a(z) \cdot b(z) \cdot (z - zb)\, dz = 15.4 \cdot gr$ $\Delta TM.b := -\frac{h}{I} \int_0^h \Delta T1b(z) \cdot b(z) \cdot (z - zb)\, dz = -4.8 \cdot gr$

$\Delta TM.heat(z) := \frac{-(z - zb) \cdot \Delta TM.a}{h}$ $\Delta TM.cool(z) := \frac{-(z - zb) \cdot \Delta TM.b}{h}$

0 0

z 1000
mm

-10 -5 0
ΔTM.heat z ()

z 1000
mm

3 2 1 0 -1
ΔTM.cool z ()

ΔTM.heat0mm () 4.4 gr =

ΔTM.heath () = - gr 1

ΔTM.cool0mm () = - 1.4 gr

ΔTM.coolh () 3.4 gr =

Property temperature

ΔTE.heatz () := ΔT1az () - (ΔTN.heatz () ... + ΔTM.heatz ())

ΔTE.coolz () := ΔT1bz () - (ΔTN.coolz () ... + ΔTM.coolz ())

0

z 1000
mm

-10 -5 0 5 10
ΔTE.heat z ()

0

z 1000
mm

-10 -5 0 5
ΔTE.cool z ()

Total

ΔTheatz () := ΔTN.heatz () ... + ΔTM.heatz () ΔTE.heatz ()

ΔTcoolz () := ΔTN.coolz () ... + ΔTM.coolz () ΔTE.coolz ()

0

z 1000
mm

0 10 20
ΔTheat z ()

0

z 1000
mm

-10 -5 0 5
ΔTcool z ()

Input data in SCIA Engineer

Total

ΔTinput.az () := ΔTN.heatz () ΔTM.heatz () +

ΔTinput.bz () := ΔTN.coolz () ΔTM.coolz () +

0

z 1000
mm

0 10 20
ΔTinput.az ()

0

z 1000
mm

-10 -5 0 5
ΔTinput.bz ()

top side deck	ΔTinput.a0mm () 13.2 gr =	ΔTinput.b0mm () = - 4.0 gr
bottom of deck	ΔTinput.atdek ( ) 13.1 gr =	ΔTinput.btdek ( ) 4.0 = - gr
bottom strip (8x100 mm)	ΔTinput.atdekhstrip (+) 12.5 gr =	ΔTinput.btdekhstrip (+) 3.8 = - gr

underside bulb	ΔTinput.atdek(hbulb +) = 12.1 gr ·	ΔTinput.btdek(hbulb +) = 3.7 · gr
bottom side of main beam	ΔTinput.ah () = - 2.2 · gr	ΔTinput.bh () 0.8 = gr ·
crossbeam	ΔTinput.a512(mm tdek +) = 9.9 gr ·	ΔTinput.b512(mm tdek +) = 3.0 · gr
console (500 mm)	ΔTinput.a500(mm tdek +) = 10.0 g ·	ΔTinput.b500(mm tdek +) = 3.0 · gr
console (250 mm)	ΔTinput.a250(mm tdek +) = 11.6 gr ·	ΔTinput.b250(mm tdek +) = 3.5 · gr

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x30 (deck = 10 mm)	Version:	v1.0

Temperature load over the height

Temperature component **Temperature difference (Δ T)**

(a) Global warming **(b) Cooling**

Vertical temperature component
ΔT

0 2 4 6 8 10 12 14 16

-7 -6 -5 -4 -3 -2 -1 0

0 15.0 -6.0 0.0 0100

500 0.0

2400 0.0 0.0 2400

ΔT1a := 15gr h1a := 500mm ΔT1b := - 8 gr h1b := 100mm

$$\Delta T1az() := \max\left(\Delta T1a - \frac{z}{h1a} \cdot \Delta T1a, 0gr\right) \qquad \Delta T1bz() := \min\left(\Delta T1b - \frac{z}{h1b} \cdot \Delta T1b, 0gr\right)$$

Geometric cross-section properties

Cover plate thickness	tdek := 10mm
Cover plate width	bdek := 4630mm
Number of bulbs	nbulb := 13
Surface bulbs	Abulb := 1712mm²
Height bulbs	hbulb := 160mm
Width bulbs	$tbulb := \frac{Abulb}{hbulb} = 10.7 \cdot mm$
Center of gravity bulb from the top	zbulb := 98.3mm
Stiffening strip height	hstrip := 100mm
Stiffening strip thickness	tstrip := 8mm
Top flange thickness	tfb := 20mm
Top flange width	bfb := 300mm
Bottom flange thickness	tfo := 20mm
Bottom flange width	bfo := 300mm
Plate flange thickness	tpo1 := 30mm
Bottom flange width	bpo1 := 500mm
Plate flange thickness	tpo2 := 0mm

The calculation is performed for the following heights

hhl :=

Height bottom deck - bottom bottom flange DIN	Total height including deck and bottom plate
2400	2440
2939	2979
2963	3003
3061	3101
3101	3141
4587	4627
4440	4480

Bottom flange width bpo2 := 0mm

Body thickness adv := 12mm

Body height hwh () := h tdek - tfb - tfo ... + - tpo1 - tpo2

	h =	
4301	4341	·mm
4182	4222	
4063	4103	
4042	4082	
3345	3385	
3298	3338	

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Function width over the height

bz(h, := bdek if z tdek

bfbnbulbtbulb + tstrip if tdekz < ≤ tdektfb

bwnbulbtbulb + tstrip if tdektfb < z ≤ tdekhstrip

bwnbulbtbulb if tdekhstrip < z ≤ tdekhbulb

adv if tdekhbulb < z ≤ tdektfb + hwh ()

bfo if tdektfb + hwh () < z ≤ tdektfb + hwh () + tfo

bpo1 if tdektfb + hwh () + tfo < z ≤ h tpo2

bpo2 if h tpo2 < z ≤ h

0 otherwise

Surface $A\,h() := \int_0^h bz(h, \; dz$

Neutral axis $zbh() := \frac{1}{A\,h()}\left(\int_0^h bz(h, z \cdot \; dz\right)$

$zoh() := h - zbh()$

Resistance moment $I\,h() := \int_0^h bz(h, z\, (zbh() - \;)^2 dz$

A h() =		zbh() =		zoh() =		I h() =	
124903	·mm²	700	·mm	1740	·mm	116251265736	·mm⁴
131201		886		2093		181787984803	
131462		892		2111		179421993088	
132591		926		2175		198982442285	
133330		937		2204		204821069172	
146393		1534		3093		494568725023	
149148		1433		3047		459298048252	
147427		1381		2960		426939298237	
145810		1337		2885		399998774799	
144609		1293		2810		375440532389	
144414		1283		2799		370921354301	
136032		1026		2359		242646112732	
135440		1007		2331		234930368314	

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Temperature components Summer | Winter

Average temperature

$\Delta T_{N.a}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1a}(z) \cdot b(z,h) \, dz$ $\qquad$ $\Delta T_{N.b}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1b}(z) \cdot b(z,h) \, dz$

$\Delta T_{N.heat}(h) := \Delta T_{N.a}(h)$ $\qquad$ $\Delta T_{N.cool}(h) := \Delta T_{N.b}(h)$

hhl = ... mm	$\Delta T_{N.heat}(1mm \cdot h_i) =$ ... gr	$\Delta T_{N.cool}(0mm \cdot h_i) =$ ... gr
2400	8.8	-2.6
2939	8.4	-2.5
2963	8.4	-2.5
3061	8.3	-2.5
3101	8.2	-2.5
4587	7.5	-2.3
4440	7.4	-2.2
4301	7.4	-2.2
4182	7.5	-2.3
4063	7.6	-2.3
4042	7.6	-2.3
3345	8.1	-2.4
3298	8.1	-2.4

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Linear temperature component Summer | Winter

$\Delta T_{M.a}(h) := -h \int^h \Delta T_{1a}(z) \cdot b(z,h) \cdot (z - \bar{z}_b(h)) \, dz$ $\qquad$ $\Delta T_{M.b}(h) := -h \int^h \Delta T_{1b}(z) \cdot b(z,h) \cdot (z - \bar{z}_b(h)) \, dz$

I h () ⌡0

ΔTM.heatz h() := - (z z̄bh ()) ΔTM.ah ()
h

I h () ⌡0

ΔTM.coolz h() := - (z z̄bh ()) ΔTM.bh ()
h

hhl = ·mm	ΔTM.ah i() = ·gr	ΔTM.bh i() = ·gr
2400	15.4	-4.8
2939	15.3	-4.7
2963	15.8	-4.9
3061	15.3	-4.7
3101	15.2	-4.7
4587	15.4	-4.7
4440	15	-4.6
4301	15	-4.6
4182	15.1	-4.6
4063	15.1	-4.6
4042	15.1	-4.6
3345	15.2	-4.7
3298	15.2	-4.7

	Top temperature		Bottom temperature	
	Summer	Winter	Summer	Winter
hhl = ·mm	ΔTM.heat0mm h i (,) = ·gr	ΔTM.cool0mm h i (,) = ·gr	ΔTM.heath i h i (,) = ·gr	ΔTM.coolh i h i (,) = ·gr
2400	4.4	-1.4	-11	3.4
2939	4.6	-1.4	-10.8	3.3
2963	4.7	-1.4	-11.1	3.4
3061	4.6	-1.4	-10.7	3.3
3101	4.5	-1.4	-10.7	3.3
4587	5.1	-1.6	-10.3	3.1
4440	4.8	-1.5	-10.2	3.1
4301	4.8	-1.5	-10.3	3.1
4182	4.8	-1.5	-10.3	3.2
4063	4.8	-1.5	-10.4	3.2
4042	4.7	-1.5	-10.4	3.2
3345	4.6	-1.4	-10.6	3.3
3298	4.6	-1.4	-10.6	3.3

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	main beam 500x30 (deck = 12 mm)	Version:	v1.0

Temperature load over the height

Temperature component	Temperature difference (Δ T) (a) Global warming	(b) Cooling
Vertical temperature component ΔT	0 2 4 6 8 10 12 14 16 0 15.0 500 0.0	-7 -6 -5 -4 -3 -2 -1 0 -6.0 0.0 0100

2400 0.0 0.0 2400

$\Delta T1a := 15gr$ $h1a := 500mm$ $\Delta T1b := -8gr$ $h1b := 100mm$

$\Delta T1az() := \max\left(\Delta T1a - \frac{z}{h1a} \cdot \Delta T1a, 0gr\right)$ $\Delta T1bz() := \min\left(\Delta T1b - \frac{z}{h1b} \cdot \Delta T1b, 0gr\right)$

Geometric cross-section properties

Cover plate thickness $tdek := 12mm$

Cover plate width $bdek := 4630mm$

Number of bulbs $nbulb := 13$

Surface bulbs $Abulb := 1712mm^2$

Height bulbs $hbulb := 160mm$

Width bulbs $tbulb := \frac{Abulb}{hbulb} = 10.7 \cdot mm$

Center of gravity bulb from the top $zbulb := 98.3mm$

The calculation is performed for the following heights

Stiffening strip height $hstrip := 100mm$

Stiffening strip thickness $tstrip := 8mm$

hhl :=	Height bottom deck - bottom bottom flange DIN	Total height including deck and bottom plate
	4822	4864
	4733	4775

Top flange thickness $tfb := 20mm$

Top flange width $bfb := 300mm$

Bottom flange thickness $tfo := 20mm$

Bottom flange width $bfo := 300mm$

Plate flange thickness $tpo1 := 30mm$

Bottom flange width $bpo1 := 500mm$

Plate flange thickness $tpo2 := 0mm$

Bottom flange width $bpo2 := 0mm$

$h = \cdot mm$

Body thickness $adv := 12mm$

Body height $hwh() := h - tdek - tfb - tfo \cdots$
$+ - tpo1 - tpo2$

Function width over the height

$$b(z,h) := \begin{cases} bdek & \text{if } z \le tdek \\ bfb + nbulb \cdot tbulb + tstrip & \text{if } tdek < z \le tdek + tfb \\ bwh + nbulb \cdot tbulb + tstrip & \text{if } tdek + tfb < z \le tdek + hstrip \\ bwh + nbulb \cdot tbulb & \text{if } tdek + hstrip < z \le tdek + hbulb \\ adv & \text{if } tdek + hbulb < z \le tdek + tfb + hwh() \\ bfo & \text{if } tdek + tfb + hwh() < z \le tdek + tfb + hwh() + tfo \\ bpo1 & \text{if } tdek + tfb + hwh() + tfo < z \le h - tpo2 \\ bpo2 & \text{if } h - tpo2 < z \le h \\ 0 & \text{otherwise} \end{cases}$$

Surface $A h() := \int_0^h b(z,h)\, dz$

Neutral axis $zbh() := \frac{1}{A h()}\left(\int_0^h b(z,h) \cdot z\, dz\right)$

$zoh() := h - zbh()$

Resistance moment $I h() := \int_0^h b(z,h) \cdot \left(z - zbh()\right)^2 dz$

$A(h_i) =$	$z_{bl}(h_i) =$	$z_{ol}(h_i) =$	$I(h_i) =$
$162915 \cdot mm^2$	$1492 \cdot mm$	$3372 \cdot mm$	$575596363904 \cdot mm^4$
161901	1455	3320	551699691150

Temperature components Summer | Winter

Average temperature

$$\Delta T_{N.a}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1a}(z) \cdot b(z,h)\, dz \qquad \Delta T_{N.b}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1b}(z) \cdot b(z,h)\, dz$$

$$\Delta T_{N.heat}(h) := \Delta T_{N.a}(h) \qquad \Delta T_{N.cool}(h) := \Delta T_{N.b}(h)$$

$$\Delta T_{N.heat1}(mm\, h_i,\ ) = \qquad \Delta T_{N.cool0}(mm\, h_i,\ ) =$$

$7.6 \cdot gr$ | $-2.3 \cdot gr$
7.6 | -2.3

$$hhl = \begin{pmatrix} 4822 \\ 4733 \end{pmatrix} \cdot mm$$

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Linear temperature component Summer Winter

ΔTM.ah () := - h / I h () ∫₀ʰ ΔT1az () bżh,() · (z z̄bh ()) d z   ΔTM.bh () := - h / I h () ∫₀ʰ ΔT1bz () bżh,() · (z z̄bh ()) d z

ΔTM.heatz h() := - (z z̄bh ()) ΔTM.ah () / h   ΔTM.coolz h() := - (z z̄bh ()) ΔTM.bh () / h

ΔTM.ah i () =   ΔTM.bh i () =

15.2 ˙gr	-4.7 ˙gr
15.2	-4.7

$hhl = \begin{pmatrix} 4822 \\ 4733 \end{pmatrix} \cdot mm$

Top temperature   Bottom temperature

Summer	Winter	Summer	Winter
ΔTM.heat0mm h i (,) =	ΔTM.cool0mm h i (,) =	ΔTM.heath i h i (,) =	ΔTM.coolh i h i (,) =
4.7 ˙gr	-1.4 ˙gr	-10.5 ˙gr	3.3 ˙gr
4.6	-1.4	-10.6	3.3

$hhl = \begin{pmatrix} 4822 \\ 4733 \end{pmatrix} \cdot mm$

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x30 + 350x30 (deck = 10 mm)	Version:	v1.0

Temperature load over the height

Temperature component	Temperature difference (Δ T) (a) Global warming			Temperature difference (Δ T) (b) Cooling		
Vertical temperature component ΔT	0 2 4 6 8 10 12 14 16			-7 -6 -5 -4 -3 -2 -1 0		
	0	15.0		-6.0	0.0	0100
	500	0.0				
	2400	0.0			0.0	2400

$\Delta T1a := 15gr \quad h1a := 500mm \quad \Delta T1b := -6gr \quad h1b := 100mm$

$\Delta T1az() := \max\left(\Delta T1a - \frac{z}{h1a}\cdot\Delta T1a, 0gr\right) \quad \Delta T1bz() := \min\left(\Delta T1b - \frac{z}{h1b}\cdot\Delta T1b, 0gr\right)$

Geometric cross-section properties

Cover plate thickness	$tdek := 10mm$
Cover plate width	$bdek := 4630mm$
Number of bulbs	$nbulb := 13$
Surface bulbs	$Abulb := 1712mm^2$
Height bulbs	$hbulb := 160mm$
Width bulbs	$tbulb := \frac{Abulb}{hbulb} = 10.7\,mm$
Center of gravity bulb from the top	$zbulb := 98.3mm$
Stiffening strip height	$hstrip := 100mm$
Stiffening strip thickness	$tstrip := 8mm$
Top flange thickness	$tfb := 20mm$
Top flange width	$bfb := 300mm$
Bottom flange thickness	$tfo := 20mm$
Bottom flange width	$bfo := 300mm$
Plate flange thickness	$tpo1 := 30mm$
Bottom flange width	$bpo1 := 500mm$
Plate flange thickness	$tpo2 := 30mm$
Bottom flange width	$bpo2 := 350mm$
Height (including cover plate)	$h := 2400mm + tpo1 + tpo2 + tdek = 2470\,mm$
Body thickness	$adv := 12mm$
Body height	$hw := h - tdek - tfb - tfo - tpo1 - tpo2 = 2360\,mm$

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Function width over the height

bz () := bdek if z tdek

bfbnbulbtbulb + tstrip if tdekz < ≤ tdektfb

bwnbulbtbulb + tstrip if tdektfb < z ≤ tdekhstrip

bwnbulbtbulb if tdekhstrip < z ≤ tdekhbulb

adv if tdekhbulb < z ≤ tdektfb + hw

bfo if tdektfb + hw < z ≤ tdektfb + hw + tfo

bpo1 if tdektfb + hw + tfo < z ≤ h tpo2

bpo2 if h tpo2 < z ≤ h

0 otherwise

Surface $a := \int_0^h bz()\, dz = 135454\, mm^2$

Neutral axis $zb := \frac{1}{a}\left(\int_0^h bz()\, z \cdot dz\right) = 835\, mm$

$so := h - zb = 1635\, mm$

Resistance moment $I := \int_0^h bz()\, (z - zb)^2\, dz = 1.46 \times 10^{11}\, mm^4$

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Temperature components

Average temperature $\Delta TN.a := \frac{1}{} \int^h \Delta T1az()\, bz()\, dz = 8.1\, gr$ $\Delta TN.b := \frac{1}{} \int^h \Delta T1bz()\, bz()\, dz = -2.4\, gr$

a ⌡0

ΔTN.heatz () := ΔTN.a   ΔTN.coolz () := ΔTN.b

0   0

z 1000   z 1000
mm   mm

0 2 4 6 8   - 3 - 2 - 1
ΔTN.heat z ()   ΔTN.cool z ()

Linear temp. comp. ΔTM.a := - h/I ∫₀ʰ ΔT1az () bz () · (z z̄b) d z = 14.9 gr   ΔTM.b := - h/I ∫₀ʰ ΔT1bz () bz () · (z z̄b) d z = - 4.6 gr

ΔTM.heatz () := - (z z̄b)/h ΔTM.a   ΔTM.coolz () := - (z z̄b)/h ΔTM.b

0   0

z 1000   z 1000
mm   mm

- 5 0 5   3 2 1 0 - 1
ΔTM.heat z ()   ΔTM.cool z ()

ΔTM.heat0mm () 5.0 gr   ΔTM.cool0mm () = - 1.6 gr

ΔTM.heath () = - 9.9 gr   ΔTM.coolh () 3.0gr

Property temperature ΔTE.heatz () := ΔT1az () - (ΔTN.heatz () ... + ΔTM.heatz ())   ΔTE.coolz () := ΔT1bz () - (ΔTN.coolz () ... + ΔTM.coolz ())

0   0

z 1000   z 1000
mm   mm

- 10 - 5 0 5 10   - 10 - 5 0 5
ΔTE.heat z ()   ΔTE.cool z ()

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Total ΔTheatz () := ΔTN.heatz () ... + ΔTM.heatz () ΔTE.heatz ()   ΔTcoolz () := ΔTN.coolz () ... + ΔTM.coolz () ΔTE.coolz ()

0   0

z 1000   z 1000
mm   mm

0 10 20   - 10 - 5 0 5
ΔTheat z ()   ΔTcool z ()

Input data in SCIA Engineer

Total ΔTinput.az () := ΔTN.heatz () ΔTM.heatz () ΔTinput.bz () := ΔTN.coolz () ΔTM.coolz ()

0 0

z 1000 z 1000
mm mm

0 10 20 - 10 - 5 0 5
ΔTinput.az () ΔTinput.bz ()

top side deck	ΔTinput.a0mm () 13.1 = gr ·	ΔTinput.b0mm () = - 4.0 · gr
bottom of deck	ΔTinput.atdek() 13.1 = gr ·	ΔTinput.btdek() 4.0 = - · gr
bottom strip (8x100 mm)	ΔTinput.atdek(hstrip +) = 12.5 gr ·	ΔTinput.btdek(hstrip +) = 3.8 · gr
underside bulb	ΔTinput.atdek(hbulb +) = 12.1 gr ·	ΔTinput.btdek(hbulb +) = 3.7 · gr
bottom side of main beam	ΔTinput.ah () = - 1.7 · gr	ΔTinput.bh () 0.6 = gr ·
crossbeam	ΔTinput.a512(mm tdek +) = 10.0 g ·	ΔTinput.b512(mm tdek +) = 3.0 · gr
console (500 mm)	ΔTinput.a500(mm tdek +) = 10.1 gr ·	ΔTinput.b500(mm tdek +) = 3.0 · gr
console (250 mm)	ΔTinput.a250(mm tdek +) = 11.6 gr ·	ΔTinput.b250(mm tdek +) = 3.5 · gr

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x30 + 530x10 (deck = 10 mm)	Version:	v1.0

Temperature load over the height

Temperature component **Temperature difference (Δ T)**
(a) Global warming **(b) Cooling**

Vertical temperature component
ΔT

0 2 4 6 8 10 12 14 16 -7 -6 -5 -4 -3 -2 -1 0
0 15.0 -6.0 0.0 0100
500 0.0

2400 0.0 0.0 2400

ΔT1a := 15gr h1a := 500mm ΔT1b := - 6 gr h1b := 100mm

ΔT1az () := max (ΔT1a - z/h1a · ΔT1a , 0gr) ΔT1bz () := min (ΔT1b - z/h1b · ΔT1b , 0gr)

Geometric cross-section properties

Cover plate thickness tdek := 10mm

Cover plate width	bdek := 4630mm
Number of bulbs	nbulb := 13
Surface bulbs	Abulb := 1712mm ^{2}
Height bulbs	hbulb := 160mm
Width bulbs	tbulb := $\frac{Abulb}{hbulb}$ = 10.7 mm
Center of gravity bulb from the top	zbulb := 98.3mm
Stiffening strip height	hstrip := 100mm
Stiffening strip thickness	tstrip := 8mm
Top flange thickness	tfb := 20mm
Top flange width	bfb := 300mm
Bottom flange thickness	tfo := 20mm
Bottom flange width	bfo := 300mm
Plate flange thickness	tpo1 := 30mm
Bottom flange width	bpo1 := 500mm
Plate flange thickness	tpo2 := 10mm
Bottom flange width	bpo2 := 530mm
Body thickness	adv := 12mm
Body height	hwh () := h tdek - tfb - tfo ... + - tpo1 - tpo2

The calculation is performed for the following heights

Height bottom deck - bottom bottom flange DIN (hhl :=)	Total height including deck and bottom plate
3298	3348
3291	3341
3224	3274
3157	3207
3090	3140
3081	3131

h = ·mm

Function width over the height

bz(h,) := bdek if z tdek ≤
bfbnbulbtbulb + · + tstrip if tdekz < ≤ tdektfb +
bwnbulbtbulb + · + tstrip if tdektfb + < z ≤ tdekhstrip +
bwnbulbtbulb + · if tdekhstrip + < z ≤ tdekhbulb +
adv if tdekhbulb + < z ≤ tdektfb + + hwh ()
bfo if tdektfb + + hwh () < z ≤ tdektfb + + hwh () + tfo
bpo1 if tdektfb + + hwh () + tfo < z ≤ h tpo2 -
bpo2 if h tpo2 - < z ≤ h
0 otherwise

Surface $A(h) := \int_0^h bz(h, z)\, dz$

Neutral axis $zb(h) := \frac{1}{A(h)} \left(\int_0^h bz(h, z) \cdot z\, dz \right)$

$zo(h) := h - zb(h)$

Resistance moment $I(h) := \int_0^h bz(h, z) \left(z - zb(h) \right)^2 dz$

A(hi) =	zb(hi) =	zo(hi) =	I(hi) =
140739 ·mm ^{2}	1097 ·mm	2251 ·mm	262739162098 ·mm ^{4}
140617	1095	2246	261487545885
139873	1071	2203	249960916711
139142	1041	2166	238738235100
138453	1018	2122	227953614644

138181 1017 2114 225997060959

Temperature components Summer		Winter
Average temperature	$\Delta T_{N.a}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1a}(z)\, b(z,h)\, dz$	$\Delta T_{N.b}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1b}(z)\, b(z,h)\, dz$
	$\Delta T_{N.heat}(z, h) := \Delta T_{N.a}(h)$	$\Delta T_{N.cool}(z, h) := \Delta T_{N.b}(h)$
	$\Delta T_{N.heat}(1mm, h_i) =$	$\Delta T_{N.cool}(0mm, h_i) =$
3298	7.8 ·gr	-2.3 ·gr
3291	7.8	-2.3
3224	7.9	-2.4
3157	7.9	-2.4
3090	7.9	-2.4
3081	8	-2.4

$h_{hl} =$ ·mm

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Linear temperature component Summer Winter

$$\Delta T_{M.a}(h) := -\frac{h}{I(h)} \int_0^h \Delta T_{1a}(z) \cdot b(z,h) \cdot (z - \bar{z}_b(h))\, dz \qquad \Delta T_{M.b}(h) := -\frac{h}{I(h)} \int_0^h \Delta T_{1b}(z) \cdot b(z,h) \cdot (z - \bar{z}_b(h))\, dz$$

$$\Delta T_{M.heat}(z,h) := -\frac{(z - \bar{z}_b(h))}{h} \cdot \Delta T_{M.a}(h) \qquad \Delta T_{M.cool}(z,h) := -\frac{(z - \bar{z}_b(h))}{h} \cdot \Delta T_{M.b}(h)$$

h_i	$\Delta T_{M.a}(h_i) =$	$\Delta T_{M.b}(h_i) =$
3298	14.9 · gr	-4.6 · gr
3291	14.9	-4.6
3224	14.9	-4.6
3157	14.9	-4.6
3090	14.9	-4.6
3081	15	-4.6

$hhl =$ · mm

Top temperature / Bottom temperature

h_i	Top, Summer: $\Delta T_{M.heat}(0mm, h_i) =$	Top, Winter: $\Delta T_{M.cool}(0mm, h_i) =$	Bottom, Summer: $\Delta T_{M.heat}(h_i, h_i) =$	Bottom, Winter: $\Delta T_{M.cool}(h_i, h_i) =$
3298	4.9 · gr	-1.5 · gr	-10 · gr	3.1 · gr
3291	4.9	-1.5	-10	3.1
3224	4.9	-1.5	-10	3.1
3157	4.8	-1.5	-10	3.1
3090	4.8	-1.5	-10.1	3.1
3081	4.9	-1.5	-10.1	3.1

$hhl =$ · mm

Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x30 + 550x30 (deck = 10 mm)	Version:	v1.0

Temperature load over the height

Temperature component — **Temperature difference (Δ T)**

(a) Global warming — **(b) Cooling**

Vertical temperature component ΔT

0 2 4 6 8 10 12 14 16

-7 -6 -5 -4 -3 -2 -1 0

0 15.0 -6.0 0.0 0100

500 0.0

2400 0.0 0.0 2400

$\Delta T1a := 15gr$ $h1a := 500mm$ $\Delta T1b := -6gr$ $h1b := 100mm$

$\Delta T1az() := \max\left(\Delta T1a - \frac{z}{h1a} \cdot \Delta T1a, 0gr\right)$ $\Delta T1bz() := \min\left(\Delta T1b - \frac{z}{h1b} \cdot \Delta T1b, 0gr\right)$

Geometric cross-section properties

Cover plate thickness $tdek := 10mm$

Cover plate width $bdek := 4630mm$

Number of bulbs $nbulb := 13$

Surface bulbs $Abulb := 1712mm^2$

Height bulbs $hbulb := 160mm$

Width bulbs $tbulb := \frac{Abulb}{hbulb} = 10.7 \cdot mm$

Center of gravity bulb from the top $zbulb := 98.3mm$

The calculation is performed for the following heights

Stiffening strip height $hstrip := 100mm$

Stiffening strip thickness $tstrip := 8mm$

Top flange thickness $tfb := 20mm$

Top flange width $bfb := 300mm$

Bottom flange thickness $tfo := 20mm$

Bottom flange width $bfo := 300mm$

Plate flange thickness $tpo1 := 30mm$

Bottom flange width $bpo1 := 500mm$

Plate flange thickness $tpo2 := 30mm$

Bottom flange width $bpo2 := 550mm$

Height bottom deck - bottom bottom flange DIN ($hhl :=$)	Total height including deck and bottom plate ($h = \ldots \cdot mm$)
3101	3171
3159	3229
3257	3327
3374	3444
3510	3580
3645	3715
3781	3851
3917	3987
4071	4141
3081	3151

Body thickness $adv := 12mm$

Body height $hwh() := h - tdek - tfb - tfo \cdots + - tpo1 - tpo2$

Function width over the height

$$
b(z,h) := \begin{cases}
bdek & \text{if } z \le tdek \\
bfb + nbulb \cdot tbulb + tstrip & \text{if } tdek < z \le tdek + tfb \\
bw + nbulb \cdot tbulb + tstrip & \text{if } tdek + tfb < z \le tdek + hstrip \\
bw + nbulb \cdot tbulb & \text{if } tdek + hstrip < z \le tdek + hbulb \\
adv & \text{if } tdek + hbulb < z \le tdek + tfb + hw(h) \\
bfo & \text{if } tdek + tfb + hw(h) < z \le tdek + tfb + hw(h) + tfo \\
bpo1 & \text{if } tdek + tfb + hw(h) + tfo < z \le h - tpo2 \\
bpo2 & \text{if } h - tpo2 < z \le h \\
0 & \text{otherwise}
\end{cases}
$$

Surface $$A(h) := \int_0^h b(z,h)\,dz$$

Neutral axis $$zb(h) := \frac{1}{A(h)}\left(\int_0^h b(z,h)\cdot z\,dz\right)$$

$$zo(h) := h - zb(h)$$

Resistance moment $$I(h) := \int_0^h b(z,h)\cdot\left(z - zb(h)\right)^2\,dz$$

$A(h_i) =$	$zb(h_i) =$	$zo(h_i) =$	$I(h_i) =$
146352 $\cdot mm^2$	1211 $\cdot mm$	1960 $\cdot mm$	276968056448 $\cdot mm^4$
150340	1207	2022	287993279487
151547	1246	2081	307386249421
152916	1295	2149	329698788295
154510	1353	2227	360637096286
156094	1406	2309	390932453763
157571	1465	2386	422604500424
159335	1520	2467	455449717480
161258	1581	2560	495079876955
149320	1174	1977	273055148121

Temperature components Summer Winter

Average temperature $$\Delta TN.ah(h) := \frac{1}{A(h)}\int_0^h \Delta T1a(z)\cdot b(z,h)\,dz \qquad \Delta TN.bh(h) := \frac{1}{A(h)}\int_0^h \Delta T1b(z)\cdot b(z,h)\,dz$$

$$\Delta TN.heat(z,h) := \Delta TN.ah(h) \qquad \Delta TN.cool(z,h) := \Delta TN.bh(h)$$

	$\Delta TN.heat(1mm, h_i) =$	$\Delta T.N.cool(0mm, h_i) =$
3101	7.5 $\cdot gr$	-2.3 $\cdot gr$
3159	7.3	-2.2
3257	7.2	-2.2

	3374	7.2	-2.2
	3510	7.1	-2.1
	3645	7	-2.1
	3781	7	-2.1
hhl =	3917	6.9	-2.1
mm	4071	6.8	-2
	3081	7.4	-2.2

Linear temperature component Summer Winter

ΔTM.ah () := - h / I h () ∫₀ʰ ΔT1az () bżh,() · (z z̄bh ()) dz   ΔTM.bh () := - h / I h () ∫₀ʰ ΔT1bz () bżh,() · (z z̄bh ()) dz

ΔTM.heatz h() := - (z z̄bh ()) ΔTM.ah () / h   ΔTM.coolz h() := - (z z̄bh ()) ΔTM.bh () / h

		ΔTM.ah i() =	ΔTM.bh i() =
	3101	14.8 · gr	-4.5 · gr
	3159	14.5	-4.4
	3257	14.4	-4.4
	3374	14.5	-4.4
	3510	14.4	-4.4
	3645	14.3	-4.4
	3781	14.3	-4.4
hhl =	3917	14.3	-4.4
mm	4071	14.2	-4.3
	3081	14.5	-4.4

		Top temperature		Bottom temperature	
		Summer	Winter	Summer	Winter
		$\Delta TM.heat0mm\left(h_i\right) =$	$\Delta TM.cool0mm\left(h_i\right) =$	$\Delta TM.heath\left(h_i\right) =$	$\Delta TM.coolh\left(h_i\right) =$
	3101	5.7 ·gr	-1.7 ·gr	-9.2 ·gr	2.8 ·gr
	3159	5.4	-1.7	-9.1	2.8
	3257	5.4	-1.7	-9	2.8
	3374	5.4	-1.7	-9	2.8
	3510	5.4	-1.7	-8.9	2.7
	3645	5.4	-1.7	-8.9	2.7
	3781	5.4	-1.7	-8.9	2.7
hhl =	3917 ·mm	5.4	-1.7	-8.8	2.7
	4071	5.4	-1.7	-8.8	2.7
	3081	5.4	-1.7	-9.1	2.8

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x30 + 550x30 (deck = 12 mm)	Version:	v1.0

Temperature load over the height

Temperature component	**Temperature difference (Δ T)**	
	(a) Global warming	**(b) Cooling**
Vertical temperature component ΔT	0 2 4 6 8 10 12 14 16 0 15.0 500 0.0 2400 0.0	-7 -6 -5 -4 -3 -2 -1 0 -6.0 0.0 0100 0.0 2400

$\Delta T1a := 15gr$ $\quad h1a := 500mm$ $\quad \Delta T1b := -8gr$ $\quad h1b := 100mm$

$\Delta T1az() := \max\left(\Delta T1a - \frac{z}{h1a}\cdot\Delta T1a, 0gr\right)$ $\quad \Delta T1bz() := \min\left(\Delta T1b - \frac{z}{h1b}\cdot\Delta T1b, 0gr\right)$

Geometric cross-section properties

Cover plate thickness	$tdek := 12mm$
Cover plate width	$bdek := 4630mm$
Number of bulbs	$nbulb := 13$
Surface bulbs	$Abulb := 1712mm^2$
Height bulbs	$hbulb := 160mm$
Width bulbs	$tbulb := \frac{Abulb}{hbulb} = 10.7\,mm$
Center of gravity bulb from the top	$zbulb := 98.3mm$

The calculation is performed for the following heights

Stiffening strip height	hstrip := 100mm	
Stiffening strip thickness	tstrip := 8mm	
Top flange thickness	tfb := 20mm	
Top flange width	bfb := 300mm	
Bottom flange thickness	tfo := 20mm	
Bottom flange width	bfo := 300mm	
Plate flange thickness	tpo1 := 30mm	
Bottom flange width	bpo1 := 500mm	
Plate flange thickness	tpo2 := 30mm	
Bottom flange width	bpo2 := 550mm	
Body thickness	adv := 12mm	
Body height	hwh () := h − tdek − tfb − tfo ... + − tpo1 − tpo2	

Height bottom deck - bottom bottom flange DIN (hhl :=)	Total height including deck and bottom plate (h = ... ·mm)
4245	4317
4419	4491
4592	4664
4766	4838
4950	5022
5134	5206
5300	5372
5182	5254
5026	5098
4880	4952
4822	4894

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Function width over the height

bz(h, z) := bdek if z ≤ tdek
bfb + bbulb · tbulb + tstrip if tdek < z ≤ tdek + tfb
bwn + bbulb · tbulb + tstrip if tdek + tfb < z ≤ tdek + hstrip
bwn + bbulb · tbulb if tdek + hstrip < z ≤ tdek + hbulb
adv if tdek + hbulb < z ≤ tdek + tfb + hwh ()
bfo if tdek + tfb + hwh () < z ≤ tdek + tfb + hwh () + tfo
bpo1 if tdek + tfb + hwh () + tfo < z ≤ h − tpo2
bpo2 if h − tpo2 < z ≤ h
0 otherwise

Surface $$A(h) := \int_0^h bz(h, z)\, dz$$

Neutral axis $$zb(h) := \frac{1}{A(h)} \left(\int_0^h bz(h, z) \cdot z\, dz \right)$$

$$zo(h) := h - zb(h)$$

Resistance moment $$I(h) := \int_0^h bz(h, z) \left(z - zb(h) \right)^2 dz$$

A(h) = ·mm²	zb(h) = ·mm	zo(h) = ·mm	I(h) = ·mm⁴
172531	1570	2747	566875603447
174639	1640	2851	618408740391
176742	1710	2954	672082815285
178759	1782	3056	728769898768
181023	1856	3166	791479278327
183287	1932	3274	857162266492
185216	2001	3371	918877797481
183931	1951	3303	874838376254
181580	1891	3207	817316731983
180233	1821	3131	766860190906
179478	1802	3092	747378509554

Temperature components Summer | Winter

Average temperature

$$\Delta T_{N.a}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1a}(z) \cdot b(z,h)\, dz \qquad \Delta T_{N.b}(h) := \frac{1}{A(h)} \int_0^h \Delta T_{1b}(z) \cdot b(z,h)\, dz$$

$$\Delta T_{N.heat}(h) := \Delta T_{N.a}(h) \qquad \Delta T_{N.cool}(h) := \Delta T_{N.b}(h)$$

$$\Delta T_{N.heat}(1mm \cdot h_i) = \qquad \Delta T_{N.cool}(0mm \cdot h_i) =$$

hhl = (·mm)	$\Delta T_{N.heat}$ (·gr)	$\Delta T_{N.cool}$ (·gr)
4245	7.1	-2.2
4419	7.1	-2.2
4592	7	-2.1
4766	6.9	-2.1
4950	6.8	-2.1
5134	6.7	-2.1
5300	6.7	-2
5182	6.7	-2.1
5026	6.8	-2.1
4880	6.8	-2.1
4822	6.9	-2.1

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Linear temperature component Summer Winter

ΔTM.ah () : = - h / I h () ∫₀ʰ ΔT1az () bżh,() ·(z z̄bh ()) dz ΔTM.bh () : = - h / I h () ∫₀ʰ ΔT1bz () bżh,() ·(z z̄bh ()) dz

ΔTM.heatz h() : = - (z z̄bh ()) ΔTM.ah () / h ΔTM.coolz h() : = - (z z̄bh ()) ΔTM.bh () / h

hhl = (·mm)	ΔTM.ah i() = (·gr)	ΔTM.bh i() = (·gr)
4245	14.4	-4.5
4419	14.4	-4.5
4592	14.4	-4.5
4766	14.3	-4.4
4950	14.3	-4.4
5134	14.2	-4.4
5300	14.2	-4.4
5182	14.2	-4.4
5026	14.3	-4.4
4880	14.2	-4.4
4822	14.3	-4.4

Top temperature Bottom temperature

hhl = (·mm)	Top temperature Summer: ΔTM.heat0mm h i(,) = (·gr)	Top temperature Winter: ΔTM.cool0mm h i(,) = (·gr)	Bottom temperature Summer: ΔTM.heath i h i(,) = (·gr)	Bottom temperature Winter: ΔTM.coolh i h i(,) = (·gr)
4245	5.2	-1.6	-9.2	2.9
4419	5.3	-1.6	-9.1	2.8
4592	5.3	-1.6	-9.1	2.8
4766	5.3	-1.6	-9	2.8
4950	5.3	-1.6	-9	2.8
5134	5.3	-1.6	-8.9	2.8
5300	5.3	-1.6	-8.9	2.8
5182	5.3	-1.6	-8.9	2.8
5026	5.3	-1.6	-9	2.8
4880	5.2	-1.6	-9	2.8
4822	5.3	-1.6	-9	2.8

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Determination of temperature load on bridge deck

Project name:	IJssel Bridge	Date:	5/25/2018
Project number:	BF7387	Name:	Ernst Klamer
Description:	Main beam 500x30 + 550x30 (deck = 12 mm)	Version:	v1.0

Temperature load over the height

Temperature component	Temperature difference (Δ T) (a) Global warming				(b) Cooling		
Vertical temperature component ΔT	0 2 4 6 8 10 12 14 16				-7 -6 -5 -4 -3 -2 -1 0		
	0		15.0	-6.0		0.0	0100
	500	0.0					
	2400	0.0				0.0	2400

ΔT1a := 15gr   h1a := 500mm   ΔT1b := - 8 gr   h1b := 100mm

ΔT1az () := max (ΔT1a - z / h1a · ΔT1a , 0gr)   ΔT1bz () := min (ΔT1b - z / h1b · ΔT1b , 0gr)

Geometric cross-section properties

Cover plate thickness	tdek := 12mm
Cover plate width	bdek := 4630mm
Number of bulbs	nbulb := 13
Surface bulbs	Abulb := 1712mm 2
Height bulbs	hbulb := 160mm
Width bulbs	tbulb := Abulb / hbulb = 10.7 · mm
Center of gravity bulb from the top	zbulb := 98.3mm
Stiffening strip height	hstrip := 100mm
Stiffening strip thickness	tstrip := 8mm
Top flange thickness	tfb := 20mm
Top flange width	bfb := 300mm
Bottom flange thickness	tfo := 20mm
Bottom flange width	bfo := 300mm
Plate flange thickness	tpo1 := 30mm
Bottom flange width	bpo1 := 500mm
Plate flange thickness	tpo2 := 30mm
Bottom flange width	bpo2 := 550mm
Body thickness	adv := 12mm
Body height	hwh () := h tdek - tfb - tfo ··· + - tpo1 - tpo2

The calculation is performed for the following heights

Height bottom deck - bottom bottom flange DIN hhl :=	Total height including deck and bottom plate h = · mm
3034	3106
2995	3067
2955	3027
2916	2988
2876	2948
2851	2923
2838	2910
2825	2897
2813	2885
2800	2872

Function width over the height

bzh(), := bdek if z ≤ tdek

bfb + nbulb · tbulb + tstrip if tdek < z ≤ tdek + tfb

bw + nbulb · tbulb + tstrip if tdek + tfb < z ≤ tdek + hstrip

bw + nbulb · tbulb if tdek + hstrip < z ≤ tdek + hbulb

adv if tdek + hbulb < z ≤ tdek + tfb + hwh ()

bfo if tdek + tfb + hwh () < z ≤ tdek + tfb + hwh () + tfo

+ + + < ≤ -

bpo1 if tdektfb < z ≤ hwh () tfo z h tpo2
bpo2 if h tpo2 < z ≤ h
0 otherwise

Surface $A(h) := \int_0^h b(z,h)\, dz$

Neutral axis $zb(h) := \frac{1}{A(h)} \left(\int_0^h b(z,h) \cdot z\, dz \right)$

$zo(h) := h - zb(h)$

Resistance moment $I(h) := \int_0^h b(z,h) \left(z - zb(h) \right)^2 dz$

$A(h_i) =$	$zb(h_i) =$	$zo(h_i) =$	$I(h_i) =$
158053 ·mm²	1092 ·mm	2014 ·mm	276130327687 ·mm⁴
157491	1078	1989	268431597611
157013	1062	1965	260922188585
156631	1044	1944	253748057544
156146	1032	1916	246486596179
155814	1027	1896	241627000140
156221	1015	1895	239589706039
155809	1011	1886	237299669142
155068	1009	1876	235162596441
155198	1003	1869	232824248134

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Temperature components Summer — Winter

Average temperature $\Delta TN.ah(h) := \frac{1}{A(h)} \int_0^h \Delta T1a(z) \cdot b(z,h)\, dz$ — $\Delta TN.bh(h) := \frac{1}{A(h)} \int_0^h \Delta T1b(z) \cdot b(z,h)\, dz$

$\Delta TN.heat(z,h) := \Delta TN.ah(h)$ — $\Delta TN.cool(z,h) := \Delta TN.bh(h)$

hhl = ·mm	$\Delta TN.heat(1mm, h_i) =$	$\Delta TN.cool(0mm, h_i) =$
3034	7.8 ·gr	-2.4 ·gr
2995	7.8	-2.4
2955	7.8	-2.4
2916	7.9	-2.4
2876	7.9	-2.4
2851	7.9	-2.4
2838	7.9	-2.4
2825	7.9	-2.4
2813	7.9	-2.4
2800	7.9	-2.4

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Linear temperature component Summer Winter

$$\Delta T_{M.a}(h) := -\frac{h}{I(h)}\int_0^h \Delta T_{1a}(z)\cdot b(z,h)\cdot\left(z-\bar{z}_b(h)\right)dz \qquad \Delta T_{M.b}(h) := -\frac{h}{I(h)}\int_0^h \Delta T_{1b}(z)\cdot b(z,h)\cdot\left(z-\bar{z}_b(h)\right)dz$$

$$\Delta T_{M.heat}(z,h) := \frac{-\left(z-\bar{z}_b(h)\right)\cdot\Delta T_{M.a}(h)}{h} \qquad \Delta T_{M.cool}(z,h) := \frac{-\left(z-\bar{z}_b(h)\right)\cdot\Delta T_{M.b}(h)}{h}$$

$hh_l =$ (mm)	$\Delta T_{M.a}(h_i) =$ (gr)	$\Delta T_{M.b}(h_i) =$ (gr)
3034	14.7	-4.6
2995	14.7	-4.6
2955	14.7	-4.6
2916	14.7	-4.6
2876	14.7	-4.6
2851	14.8	-4.6
2838	14.7	-4.6
2825	14.7	-4.6
2813	14.8	-4.6
2800	14.8	-4.6

Top temperature Bottom temperature

		Summer	Winter	Summer	Winter
		ΔTM.heat0mm h i (,) =	ΔTM.cool0mm h i (,) =	ΔTM.heath i h i (,) =	ΔTM.coolh i h i (,) =
hhl =	3034	5.2 ˙gr	-1.6 ˙gr	-9.5 ˙gr	3 ˙gr
	2995	5.2	-1.6	-9.5	3
	2955	5.2	-1.6	-9.6	3
	2916	5.1	-1.6	-9.6	3
	2876	5.2	-1.6	-9.6	3
	2851	5.2	-1.6	-9.6	3
	2838	5.1	-1.6	-9.6	3
	2825 ˙mm	5.1	-1.6	-9.6	3
	2813	5.2	-1.6	-9.6	3
	2800	5.2	-1.6	-9.6	3

Appendix

Annex I - Other variable taxes

IJssel Bridge