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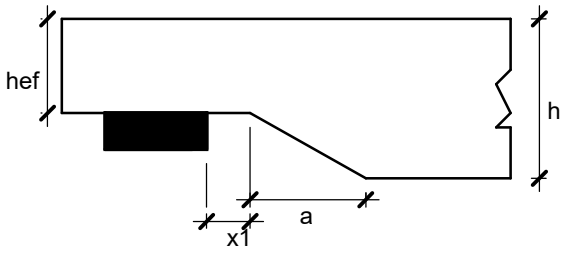
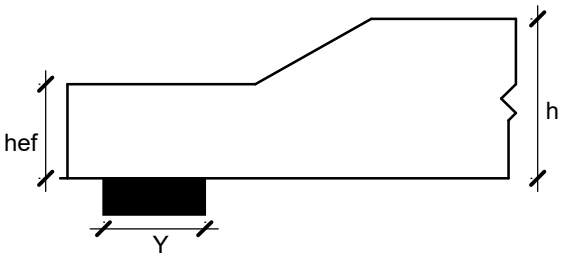
Proj: 2022.98	**Ref :** 1.4 Main Beam
Date: 15/07/22	**Page:** 1
Ponsonby Tarn Footbridge General components	

Joist section design



End notch type (a)



End notch type (b)

Calculations for timber joists are in accordance with BS EN 1995-1-1:2004+A1:2008

Timber size		-	63 mm wide x 200 mm deep
Span of joist	SPAN	=	2.4 m
Number of pieces	np	=	1
End bearing - left hand end	Y,l	=	50 mm
- Right hand end	Y,r	=	50 mm
Strength class from Table 1		-	C16
Service class		-	2 (Covered and heated or unheated)
Variable load duration		-	Medium term
Load sharing		-	No

Notches details

End notches	- left hand end	- none specified
	- right hand end	- none specified

Design effects

Moment due to permanent load	MEdGd	=	0.301 kNm
Moment due to variable load	MEdQd	=	1.296 kNm
Shear due to permanent load at left support	VEdGd,L	=	0.502 kN
Shear due to variable load load at left support	VEdQd,L	=	2.16 kN
Shear due to permanent load at right support	VEdGd,R	=	0.502 kN
Shear due to variable load load at right support	VEdQd,R	=	2.16 kN
Deflection due to permanent load	U,Gk	=	0.439 mm
Deflection due to variable load	U,Qk	=	1.7 mm

Load Description	Type	A	B	C	Gk	Qk
Beam Loading	UDL	0	2.4		0.31	1.2

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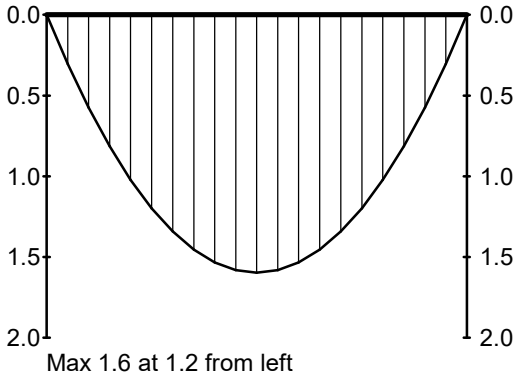
Ponsonby Tarn Footbridge
General components

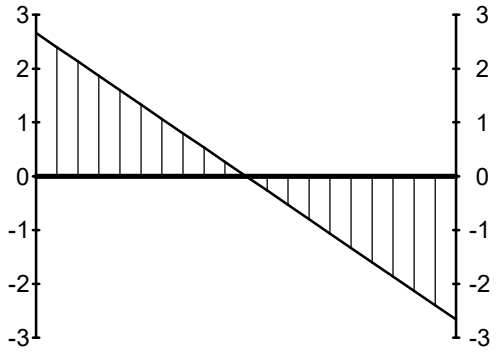
Moment (1.35Gk+1.5Qk) kNm



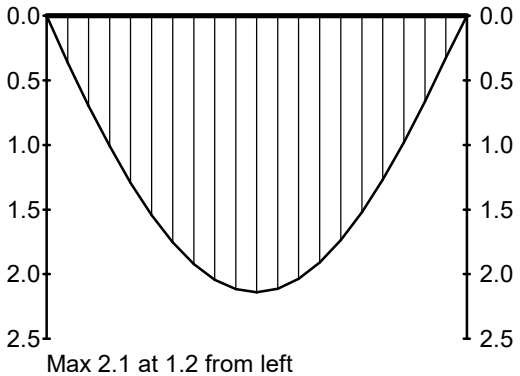
Max 1.6 at 1.2 from left

Shear (1.35Gk+1.5Qk) kN

(2.66) (-2.66)



Deflection (1.0Gk+1.0Qk) mm



Max 2.1 at 1.2 from left

Section properties

Area	A	= 12600 mm^2
Section modulus	Wy	= 420000 mm^3
Second moment of area	Iy	= 42000000 mm^4

Grade stresses - from Table 1 of EN 338:2009

Bending stress	fm,k	= 16 N/mm^2
Tension stress parallel to grain	ft,0,k	= 10 N/mm^2
Tension stress perpendicular to grain	ft,90,k	= 0.4 N/mm^2
Compression stress parallel to grain	fc,0,k	= 17 N/mm^2
Compression stress perpendicular to grain	fc,90,k	= 2.2 N/mm^2
Shear stress	fv,k	= 3.2 N/mm^2
Mean modulus of elasticity parallel	Eomean	= 8 kN/mm^2
5% modulus of elasticity parallel	Eo05	= 5.4 kN/mm^2
Mean shear modulus	Gmean	= 0.5 kN/mm^2
Density	ρk	= 310 kg/m^3

Modification factors

Depth factor	kh	= 1
Load duration factor (Table 3.1)	kmod	= 0.8
Permanent load duration factor (Table 3.1)	kmodp	= 0.6
System length factor (cl 6.6 of EN 1995)	ksys	= 1
Reduced bending stress factor (cl 6.3.3)	kcrit	= 1
Load configuration factor (cl 6.1.5)	kc,90	= 1.5
Shear crack factor (cl 6.1.7)	kcr	= 0.67
Deformation factor (Table 3.2)	kdef	= 0.8

Partial safety factors

Material safety factor	γM	= 1.3

Bending check

Bending Stresses

Bending stress due to permanent load

σmydGd = MEdGd*10^6/Wy
= 0.717 N/mm^2

Bending stress due to variable load

σmydQd = MEdQd*10^6/Wy
= 3.086 N/mm^2

Total bending stress

σmyd = σmydGd+σmydQd
= 3.803 N/mm^2

Design bending strength

fmd = fmk*kh*kmod*ksys*kcrit/γM
= 9.846 N/mm^2

Bending stress utilisation

Ubm = σmyd/fmd
= 0.386

Bending status - **PASS.**

Shear check

Left support

Shear stress due to total permanent load

$\tau dGdl = 1.5*(VEdGd,L*10^3)/(kcr*b*hef\_L*np)$

$= 0.0892\ N/mm^2$

Shear stress due to total variable load

$\tau dQdl = 1.5*(VEdQd,L*10^3)/(kcr*b*hef\_L*np)$

$= 0.384\ N/mm^2$

Total shear stress

$\tau dl = \tau dGdl+\tau dQdl$

$= 0.473\ N/mm^2$

Design shear strength

$fvdl = fvk*kmod*ksys*KvL/\gamma M$

$= 1.969\ N/mm^2$

Shear utilisation

$Ushl = \tau dl/fvdl$

$= 0.24$

Shear status at left support - **PASS.**

Right support

Shear stress due to total permanent load

$\tau dGdr = 1.5*(VEdGd,R*10^3)/(kcr*b*hef\_R*np)$

$= 0.0892\ N/mm^2$

Shear stress due to total variable load

$\tau dQdr = 1.5*(VEdQd,R*10^3)/(kcr*b*hef\_R*np)$

$= 0.384\ N/mm^2$

Total shear stress

$\tau dr = \tau dGdr+\tau dQdr$

$= 0.473\ N/mm^2$

Design shear strength

$fvdr = fvk*kmod*ksys*KvR/\gamma M$

$= 1.969\ N/mm^2$

Shear utilisation

$Ushr = \tau dr/fvdr$

$= 0.24$

Shear status at right support - **PASS.**

Bearing check

Left support bearing check

Bearing contact length

cl = Y,l+minbear
= 80 mm

Bearing stress due to permanent load

σc90dGdl = VEdGd,L*10^3/(b*cl*np)
= 0.0996 N/mm^2

Bearing stress due to variable load

σc90dQdl = VEdQd,L*10^3/(b*cl*np)
= 0.429 N/mm^2

Total bearing stress

σc90dl = σc90dGdl+σc90dQdl
= 0.528 N/mm^2

Design bearing strength

fc90dl = fc90k*kmod*ksys*kc,90/γM
= 2.031 N/mm^2

Bearing stress utilisation

Ubl = σc90dl/fc90dl
= 0.26

Bearing status at left support - **PASS.**

Right support bearing check

Bearing contact length

cl = Y,r+minbear
= 80 mm

Bearing stress due to permanent load

σc90dGdr = VEdGd,R*10^3/(b*cl*np)
= 0.0996 N/mm^2

Bearing stress due to variable load

σc90dQdr = VEdQd,R*10^3/(b*cl*np)
= 0.429 N/mm^2

Total bearing stress

σc90dr = σc90dGdr+σc90dQdr
= 0.528 N/mm^2

Design bearing strength

fc90dr = fc90k*kmod*ksys*kc,90/γM
= 2.031 N/mm^2

Bearing stress utilisation

Ubr = σc90dr/fc90dr
= 0.26

Bearing status at right support - **PASS.**

Deflection check

Section properties used to calculate bending and shear deflection

Second moment of area

I = 4200 mm^4

Modulus of elasticity

Eomean = 8000 N/mm^2

Area

A = 126 mm^2

Shear modulus

Gmean = 500 N/mm^2

Section factor

F = 1.2 (For rectangular section)

Final deflection due to permanent load,

UfnG = U,Gk*(1+kdef)
= 0.791 mm

Final deflection due to variable load,

UfnQ = U,Qk*(1+(kdef*ψ21))
= 2.109 mm

Total deflection,

	Ufin	= UfnG+UfnQ
		= 2.899 mm

Allowable deflection,

	Uallow	= SPAN*1000/250
		= 9.6 mm

Deflection utilisation,

	Udef	= Ufin/Uallow
		= 0.302

Deflection status - **PASS.**

Vibration check

[Expression 7.5 of BS EN 1995-1-1:2004+A1:2008]

Fundamental frequency

	f1	= 18/sqr(UfnG)
		= 20.243 Hertz

Since f1>8, Vibration status - **PASS.**

The section 63 x 200 mm PASSES all checks