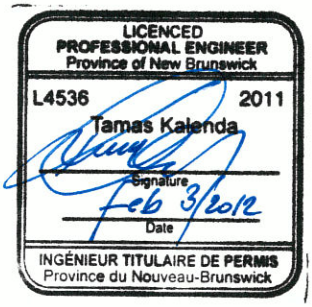
KGM | ENGINEERING

ONE M[illegible]HOUSE V[illegible]CT BRIDGE – SAINT JOHN, NB

DECK FORMW[illegible]ORK[illegible] – S[illegible]RUCTURE A & B ADDITIONAL V[illegible]RTIC[illegible]L ME[illegible]ER DESIGN – OVERH[illegible]NG B[illegible]ACKE[illegible]

Prepared by KGM Engineering Corporation for Concreate USL Limited P[illegible]artnershi[illegible]its General Partner, Concreate USL (GP) Inc:



Date: Febriary 3, 2012

Design of lumber member to prevent the deflection of web of girder

The calculation was carried out according to CAN/CSA-O86-01 Engineering Design in Wood

1. St cture A

1.1. L ds

Horiz reacti of the bracket: (ULS) $H := 12.23kN$

Resista factor: $\phi := 0.9$

web: $d_{web} := 2m$

Distanc tion force m the lower flange: $x := 0.55m$

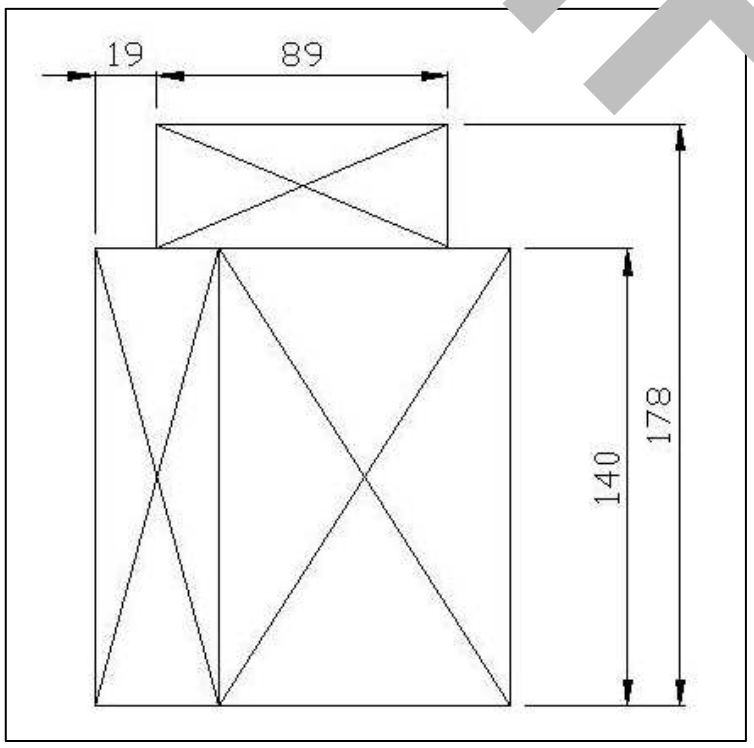
Reaction at upper flang $R_{upper} := \frac{H \cdot x}{d_{web}} = 3.36 \cdot kN$

Reaction at lower flan $R_{lower} := H - R_{upper} = 8.87 \cdot kN$

Factored bending moment wer $\cdot x = 4.88 \cdot kN \cdot m$

Factored shear force $= R_{lowe}$ kN

1.2. Cross section



The cross ction consists of a flat 2x4, a 4x6 and 6.

All the three me rs are nailed together.

1.3. Bending moment resistance

Unsupported length: $l_u := 2m$

Effective length: (Table 6.4.6.4.3) $L_e := 1.92 \cdot l_u = 3.84\,m$

Depth of member: $d_1 := 140mm + 38mm = 178 \cdot mm$

$d_2 := 140mm$

Width of member: $b_1 := 89mm$

$b_2 := 19mm$

Section modulus: $S := \left(\frac{b_1 \cdot d_1^{\,3}}{12} \cdot \frac{2}{d_1} \right) + 2\left(\frac{b_2 \cdot d_2^{\,3}}{12} \cdot \frac{2}{d_2} \right) = 594.11 \cdot cm^3$

Slenderness ratio: (Cl. 6.6.4.3) $C_B := \sqrt{\frac{L_e \cdot d_1}{b_1^{\,2}}} = 9.29$ (Conservatively)

Lateral stability factor: (Cl. 6.5.6.4.4) $K_L := \begin{cases} 1.0 & \text{if } C_B < 10 \\ \text{Clause 6.5.6.4.4} & \text{otherwise} \end{cases} = 1$

Specified strength in bending: (Table 5.3.1A) $f_b := 11.8 \cdot MPa$

Size factor in bending: (Table 5.4.5) $K_{Zb} := 1.3$

Load duration factor: (Table 4.3.2.2) $K_D := 1$ (Standard term)

Service Condition Factor: (Table 5.4.2) $K_{SB} := 1$

Treatment factor: (Table 5.4.3) $K_T := 1$

System factor: (Table 5.4.4) $K_H := 1$

$F_b := f_b\left(K_D \cdot K_H \cdot K_{SB} \cdot K_T\right) = 11.8 \cdot MPa$

Factored moment resistance: (Cl. 5.5.4) $M_r := \phi \cdot F_b \cdot S \cdot K_{Zb} \cdot K_L = 8.2 \cdot kN \cdot m$

1.4. Shear resistance

Specified strength in shear: (Table 5.3.1A) $f_v := 1.5MPa$

S[illegible]actor in [illegible]ar: (Table 5.4.5) $K_{Zv} := 1.3$

Loa[illegible]uration fa[illegible]: (Table 4.3.2.2) $K_D := 1$ (Standard term)

Service[illegible]ndition Factor: (Table 5.4.2) $K_{Sv} := 1$

[illegible]t factor: (Tabl[illegible]) $K_T := 1$

System[illegible] ([illegible]e 5.4.4) $K_H := 1$

$$F_v := f_v \cdot \left(K_D \cdot K_H \cdot K_{Sv} \cdot K_T\right) = 1.5 \cdot MPa$$

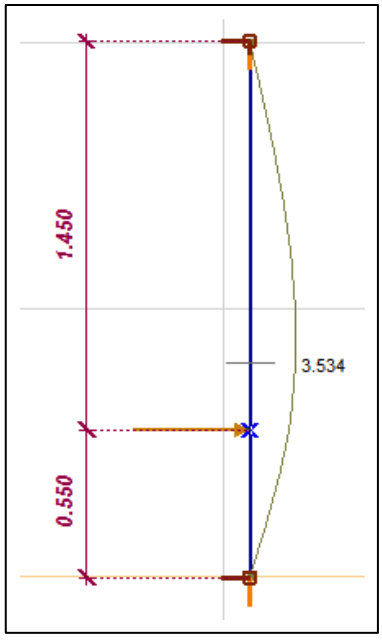
Net area of cross sec[illegible] $A_n := d_1 \cdot b_1 + 2 \cdot d_2 \cdot b_2 = 21162 \cdot mm^2$

Factored shear resistance: ([illegible]. 5.5.5) $V_r := [illegible]v \cdot \frac{2 \cdot A_n}{3} \cdot K_{Zv} = 24.76 \cdot kN$

Efficiency of combined bending and shear: $\frac{[illegible]f}{V_r} + \frac{M_f}{[illegible]} = [illegible]5.27 \cdot \%$ ***Adequate!***

1.5. Deflection

Horizontal deflection of the m[illegible]er: e := [illegible]



2. Structure C

2.1. Loads

Horizontal reaction of the bracket: (ULS) $H := 8.5kN$

Resistance factor $\phi := 0.9$

Depth of web: $d_{web} := 3.3m$

Distance of the reaction force from the lower flange: $x := 1.85m$

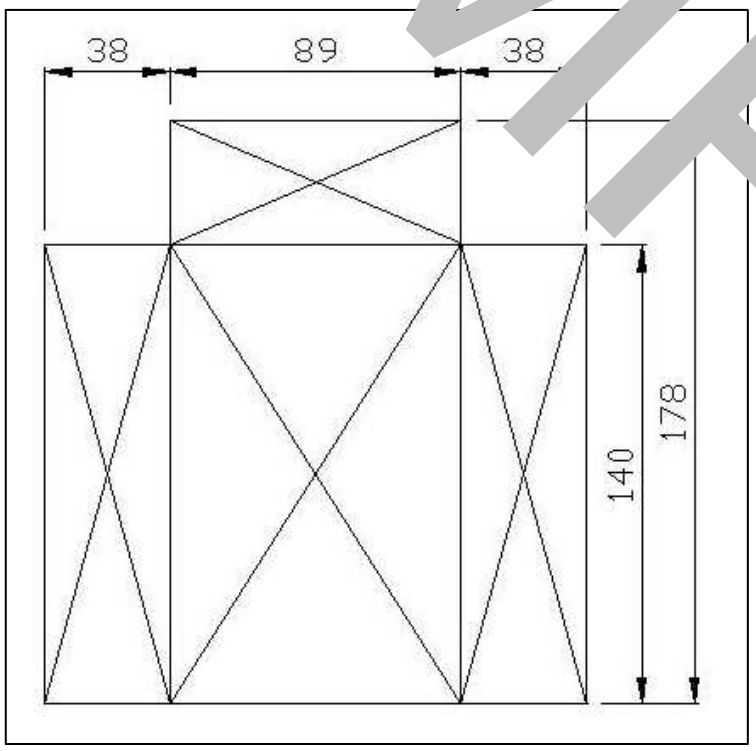
Reaction at upper flange: $R_{upper} := \frac{H \cdot x}{d_{web}} = 4.77 \cdot kN$

Reaction at lower flange: $R_{lower} := H - R_{upper} = 3.73 \cdot kN$

Factored bending moment $M_f := R_{lower} \cdot x = 6.91 \cdot kN \cdot m$

Factored shear force $V_f := R_{upper} = 4.77 \cdot kN$

2.2. Cross section



The cross section consists of a flat 2x4, a 4x6 and two 2x6 on both sides.

All the four members are nailed together.

(Alternatively the flat 2x4 nailed to double 4x6 can be used)

2.3. Bending moment resistance

Unsupported length: $l_u := 3.3m$

E[illegible]ive len[illegible] (Table 6.4.6.4.3) $L_e := 1.92 \cdot l_u = 6.34\,m$

De[illegible] of membe[illegible] $d_1 := 140mm + 38mm = 178 \cdot mm$

$d_2 := 140mm$

Width o[illegible]ember: $b_1 := 89mm$

$b_2 := 38mm$

Section modulus: $S := \left(\frac{b_1 \cdot d_1^{3}}{12} \cdot \frac{2}{d_1}\right) + 2\left(\frac{b_2 \cdot d_2^{3}}{12} \cdot \frac{2}{d_2}\right) = 718.25 \cdot cm^{3}$

Slenderness ratio: (Cl[illegible]4.6.4.3) $C_B := \sqrt{\frac{L_e \cdot d_1}{\left(d_1 + 2b_2\right)^{2}}} = 6.44$ (Conservatively)

Lateral stability factor: (Cl. 6.5.6.4.4) $L := \begin{cases} 1.0 & \text{[illegible]} \quad 10 \\ & \text{Clause 6.[illegible]4.4"} \quad \text{otherwise} \end{cases} = 1$

Specified strength in bending: (Table 5.3.1A) 11.8[illegible]

Size factor in bending: (Table 5.4.5) $K_{Zb} := 1.3$

Load duration factor: (Table 4.3.2.2) $K_D := 1$ (Standard ter[illegible]

Service Condition Factor: (Table 5.4.2) $K_{SB} := 1$

Treatment factor: (Table 5.4.3) $K_T := 1$

System factor: (Table 5.4.4) $K_H := 1$

$F_b := f_b\left(K_D \cdot K_H \cdot K_{SB} \cdot K_T\right) = 11.8 \cdot MP$[illegible]

Factored moment resistance: (Cl. 5.5.4) $M_r := \phi \cdot F_b \cdot S \cdot K_{Zb} \cdot K_L = 9.92 \cdot kN \cdot m$

2.4. Shear resistance

Specified strength in shear: (Table 5.3.1A) $f_v := 1.5MPa$

S factor in r: (Table 5.4.5) $K_{Zv} := 1.3$

Loa ration fa : (Table 4.3.2.2) $K_D := 1$ (Standard term)

Service ndition Factor: (Table 5.4.2) $K_{Sv} := 1$

t factor: (Tab 3) $K_T := 1$

Syste : (T 5.4.4) $K_H := 1$

$F_v := f_v \cdot (K_D \cdot K_H \cdot K_{Sv} \cdot K_T) = 1.5 \cdot MPa$

Net area of cross sec $A_n := d_1 \cdot b_1 + 2d_2 \cdot b_2 = 26482 \cdot mm^2$

Factored shear resistance: (Cl. 5.5.5) $V_r := F_v \cdot \frac{2 \cdot A_n}{3} \cdot K_{Zv} = 30.98 \cdot kN$

Efficiency of combined bending and shear: $\frac{V_f}{V_r} + \frac{M_f}{\quad} = 35.06 \cdot \%$ ***Adequate!***

2.5. Deflection

Horizontal deflection of the m er: e := 4mm