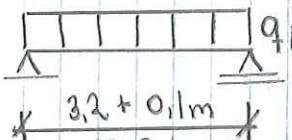


c/c 600mm

Kar. laster

$g_k = 0{,}5\ kN/m^2$

Bygn. kat A

$n_{ic} = 2{,}0\ kN/m^2$

Ref.: NBI 471.031; NS-EN1991 NA.6.1; — " — NA.6.2

Dim. laster

6.10a $q_{Ed} = (1{,}35 \cdot 0{,}5 + 1{,}05 \cdot 2{,}0) \cdot 0{,}6 = 1{,}7\ \frac{kN}{m}$

6.10b $q_{Ed} = (1{,}2 \cdot 0{,}5 + 1{,}5 \cdot 2{,}0) \cdot 0{,}6 = 2{,}2\ \frac{kN}{m}$

Ref.: NS-EN 1990; — " —

Bruker $q_{Ed} = 2{,}2\ kN/m$

Dim. lastvirkninger

$$M_{Ed} = \frac{q_{Ed} \cdot l^2}{8} = \frac{2{,}2\ \frac{kN}{m} \cdot 3{,}3m^2}{8} = 3{,}0\ kNm$$

Ref.: NBI 421.051

Kar. fasthet

C24 → $f_{m,k} = 24\ N/mm^2$

Ref.: NS 338

Dim. fasthet

Lastvarighet: Halvårslast — NS-EN1995 NA2.2

Klimaklasse: 1 — — " — NA.901

$K_{mod} = 0{,}8$ — — " — 3.1

$k_h = 1{,}0$ $h > 148\ mm$ — — " — 3.2

$k_{sys} = 1{,}1$ $l < 6m$ + undergulv — — " — 6.6

$\gamma_M = 1{,}25$ — — " — NA.2.3

$$f_{m,d} = \frac{24 \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 16{,}9\ \frac{N}{mm^2}$$

Ref.

Dim. for moment

Antar b = 48mm

$$h_{nødv.} = \sqrt{\frac{6 \cdot M_{Ed}}{b \cdot f_{m,d}}}$$

$$= \sqrt{\frac{6 \cdot 3{,}0 \cdot 10^6 \, Nmm}{48\,mm \cdot 16{,}9 \, N/mm^2}} = 149\,mm$$

Bruker 48 x 173 mm

FAGSKOLEN INNLANDET

STATISKE BEREGNINGER

Sak: ØV 1 DIM. FOR SKJÆR

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune

Ref.

Dim. laster

Se Øvingsoppgave 1a

$q_{Ed} = 2{,}2\ kN/m$ — NS-EN 1990

Dim. lastvirkninger

$$V_{Ed} = \frac{q_{Ed} \cdot l}{2} = \frac{2{,}2\ \frac{kN}{m} \cdot 3{,}3\ m}{2} = 3{,}6\ kN$$ — NBI 421.051 p. 21

Kar. fasthet

C24 → $f_{v,k} = 4{,}0\ \frac{N}{mm^2}$ — NS 388

Dim. fasthet

$$f_{v,d} = \frac{4{,}0\ N/mm^2 \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 2{,}8\ \frac{N}{mm^2}$$

Dim. for skjær

48x173 fra mom. beregn.

$$f_{v,d} \geq \tau_d = \frac{3 \cdot V_{Ed}}{2bh} = \frac{3 \cdot 3{,}6 \cdot 10^3\ N}{2 \cdot 48\ mm \cdot 173\ mm}$$

$f_{v,d} = 2{,}8\ \frac{N}{mm^2} > \tau_d = 0{,}7\ \frac{N}{mm^2}$

Bjelken er OK mhp. skjær

Ref.

Kar. laster

Se øvingsoppgave 1a

$g_k = 0{,}5\ kN/m^2$ $n_k = 2{,}0\ kN/m^2$

Dim. laster

$g_{Ed} = 1{,}0 \cdot 0{,}5\ kN/m^2 \cdot 0{,}6m = 0{,}3\ \frac{kN}{m}$

$n_{Ed} = 1{,}0 \cdot 2{,}0\ kN/m^2 \cdot 0{,}6m = 1{,}2\ \frac{kN}{m}$

NS-EN 1990 NA.A1.4.1

Dim. for nedbøyning

Klimaklasse 1

$k_{def} = 0{,}6$

$\psi_{2,1} = 0{,}3$ (bolig)

$E_{0,mean} = 11.000\ N/mm^2$

1995 NA.901

1995 3.2

1990 NA.A1.1

NS 338

48 x 173 fra mom/skjær beregn.

$I_y = \frac{bh^3}{12} = \frac{48 \cdot 173^3}{12} = 2{,}1 \cdot 10^7\ mm^4$

Tekn. tabell

Nedbøyning p.g.a egenlast

Spontan

$u_{inst,G} = \frac{5}{384} \cdot \frac{g_{Ed} \cdot l^4}{EI}$

$= \frac{5}{384} \cdot \frac{0{,}3 \cdot (3300)^4}{11000 \cdot 2{,}1 \cdot 10^7} = 2{,}0\ mm$

NBI 421.051 p.21

Endelig

$u_{fin,G} = u_{inst,G} \cdot (1 + k_{def})$

$= 2{,}0mm \cdot (1 + 0{,}6) = 3{,}2mm$

1995 p.2.2.3

Ref.

Nedbøyning pga. nyttelast

$$u_{inst,Q1} = \frac{5}{384} \cdot \frac{n_{Ed} \cdot l^4}{EI}$$

NBI 421.051 p. 1

Spontan

$$= \frac{5}{384} \cdot \frac{1,2 \cdot 3300^4}{11000 \cdot 2,1 \cdot 10^7} = 8,0 \text{ mm}$$

— " —

Endelig

$$u_{fin,1} = u_{inst,Q1} \cdot (1 + \psi \cdot k_{def})$$

1995 p. 2.2.3

$$= 8,0 \text{ mm} (1 + 0,3 \cdot 0,6) = 9,4 \text{ mm}$$

— " — " —

Total nedbøyning

$$u_{fin} = 3,2 \text{ mm} + 9,4 \text{ mm} = 12,6 \text{ mm}$$

— " — " —

Tillatt nedbøyning

$$y_{tillatt} = \frac{l}{300} = \frac{3300}{300} = 11,0 \text{ mm}$$

Prøver 48x198

$$u_{fin} = \frac{12,6 \text{ mm} \cdot 173^3}{198^3} = 8,4 \text{ mm}$$

$u_{fin} = 8,4 \text{ mm} \leq y_{tillatt} = 11,0 \text{ mm}$

Bruker 48 x 198 C24

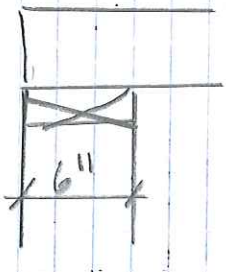
FAGSKOLEN INNLANDET

STATISKE BEREGNINGER

Side: _____

Sak: Øv. 1 Oppleggsflate

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune



Bjelke 48x198

Ref.

Øv. 1b.

NS 338

1995 pkt. 6.1.5

Dim. last

$V_{Ed} = 3{,}6$ kN

Dim. fasthet

C24 → $f_{c,90,k} = 2{,}5\ N/mm^2$

$$f_{c90,k} = \frac{2{,}5\ N/mm^2 \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 1{,}8\ \frac{N}{mm^2}$$

Nødv. oppleggsflate

$\sigma_{c90,d} \leq k_{c,90} \cdot f_{c,90,d}$

$k_{c90} = 1{,}5$

$\sigma_{c90,d} \leq 1{,}5 \cdot 1{,}8\ \frac{N}{mm^2} = 2{,}7\ \frac{N}{mm^2}$

$\sigma_{c90d} = \frac{V_{Ed}}{A_{eff}} \leq 2{,}7\ N/mm^2$

$A_{eff} = \frac{3600\ N}{2{,}7\ N/mm^2} = 1333\ mm^2$

Nødv. oppleggslengde

$l_{eff} = \frac{1333\ mm^2}{48\ mm} = 28\ mm$

6" tilgjengelig > : Ok

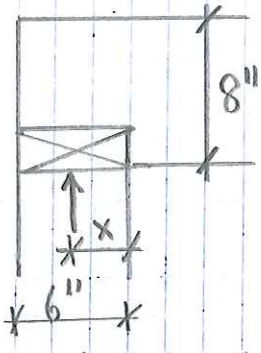
FAGSKOLEN INNLANDET

STATISKE BEREGNINGER

Side: _____

Sak: ØV 1. INNSNITT

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune



b = 4"

Ref.

Dim. last

$V_{Ed} = 3,6\ kN$ — Øv 1b

Dim. fasthet

$f_{v,d} = 2,8\ N/mm^2$ — Øv. 1b

Kontroll innsnitt

$k_n = 5,0$ (konstr. virke) — 1995 pkt. 6.5.2

$\alpha = \frac{h_{eff}}{h} = \frac{148}{198} = 0,75$

$x = \frac{148\ mm}{2} = 74\ mm$

$$k_v = \frac{k_n}{\sqrt{n}\cdot\left(\sqrt{\alpha(1-\alpha)} + 0,8\cdot x\cdot\sqrt{\frac{\alpha^{-1}-\alpha^2}{h}}\right)}$$

$$= \frac{5}{\sqrt{198}\cdot\left(\sqrt{0,75\cdot(1-0,75)} + \frac{0,8\cdot 74\cdot\sqrt{0,75^{-1}-0,75^2}}{198}\right)}$$

$= 0,51$

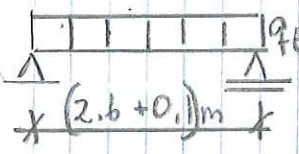
$\tau_d = \frac{1,5\cdot 3600\ N}{48\ mm\cdot 148\ mm} = 0,8\ N/mm^2$ — 1995 pkt 6.5.2

$k_v\cdot f_{v,d} = 0,51\cdot 2,8\ N/mm^2 = 1,4\ N/mm^2$

$k_v\cdot f_{v,d} > \tau_d$ ⇒ OK

Sak: ØV. 2 DIM FOR MOMENT

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune



c/c 300mm

Ref.

Kar. Laster

$g_k = 0,5\ kN/m^2$ — NB471.031

Bruks. kat B — 1991-1 NA.6.1

$n_k = 3,0\ kN/m^2$ — 1991-1 NA.6.2

Dim. Laster

6.10a $q_{Ed} = (1,35 \cdot 0,5\ \frac{kN}{m^2} + 1,05 \cdot 3\ \frac{kN}{m^2}) \cdot 0,3_m = 1,1\ \frac{kN}{m}$ — 1990

6.10b $q_{Ed} = (1,2 \cdot 0,5\ \frac{kN}{m^2} + 1,5 \cdot 3\ \frac{kN}{m^2}) \cdot 0,3_m = 1,5\ \frac{kN}{m}$ — 1990

Dim. Lastvirkninger

$$M_{Ed} = \frac{q_{Ed} \cdot l^2}{8} = \frac{1,5\ \frac{kN}{m} \cdot 2,7^2\ m}{8} = 1,4\ kNm$$ — NB1 421.051

Kar. fasthet

C18 → $f_{m,k} = 18\ N/mm^2$ — NS 338

Dim fasthet

Lastvarighet : Halvårslast — 1995 NA 2.2

Klimaklasse : 1 — — " — NA.901

$k_{mod} = 0,8$ — — " — 3.1

$k_h = 1,0$ $h \geq 148mm$ — " — 3.2

$k_{sys} = 1,1$ $l < 6m$, underguls — " — 6.6

$\gamma_M = 1,25$ — " — NA 2.3

$$f_{md} = \frac{18\ \frac{N}{mm^2} \cdot 0,8 \cdot 1,1 \cdot 1,0}{1,25} = 12,7\ \frac{N}{mm^2}$$

Antar
$b = 36\,mm$

Dim. for moment

$$h_{nødv.} = \sqrt{\frac{6 M_{Ed}}{b \cdot f_{m,d}}}$$

$$= \sqrt{\frac{1{,}4 \cdot 10^6\,Nmm}{36\,mm \cdot 12{,}7\,\frac{N}{mm^2}}} = 55\,mm$$

Velger $36 \times 73\,mm$ C18

Her kunne k_h økt noe da $h < 148\,mm$. Dropper dette da $k_h = 1{,}0$ er mer på den sikre siden.

Ref.

Dim. laster

Se øvingsoppgave 2a

$q_{Ed} = 1{,}5\ kN/m$ — NS-EN 1990

Dim. lastvirkninger

$$V_{Ed} = \frac{q_{Ed} \cdot l}{2} = \frac{1{,}5\frac{kN}{m} \cdot 2{,}7\,m}{2} = 2{,}1\,kN$$ — NBI 421.051 p.21

Kar. fasthet

C18 $\rightarrow f_{v,k} = 3{,}4\frac{N}{mm^2}$ — NS 338

Dim. fasthet

$$f_{v,d} = \frac{3{,}4\frac{N}{mm^2} \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 2{,}4\frac{N}{mm^2}$$

Dim. for skjær

36×98 fra mom. beregn.

$$f_{v,d} \geq \tau_d = \frac{3 \cdot V_{Ed}}{2bh} = \frac{3 \cdot 2{,}1 \cdot 10^3\,N}{2 \cdot 36mm \cdot 73mm}$$

$$f_{v,d} = 2{,}4\frac{N}{mm^2} > \tau_d = 1{,}2\frac{N}{mm^2}$$

Bjelken er OK. mhp. skjær

Ref.

Kar. laster

Se øvingsoppgave 2a

$g_k = 0{,}5\ kN/m^2$ $\quad n_k = 2{,}0\ kN/m^2$

Dim. laster

$g_{Ed} = 1{,}0 \cdot 0{,}5\ \frac{kN}{m^2} \cdot 0{,}3\ m = 0{,}2\ \frac{kN}{m}$

$n_{Ed} = 1{,}0 \cdot 3{,}0\ \frac{kN}{m^2} \cdot 0{,}3\ m = 0{,}9\ \frac{kN}{m}$

Dim. for nedbøyning

Klimaklasse 1

$k_{def} = 0{,}6$

$\psi = 0{,}3$ (kontor)

1995 NA.901

1995 2.2

1990 NA.A1.1

$E_{0,mean} = 9000\ N/mm^2$

36 x 98 fra mom./skjær

$I_y = \frac{bh^3}{12} = \frac{36 \cdot 98^3}{12} = 2{,}8 \cdot 10^6\ mm^4$

Tekn. tabell

Nedbøyning pga. egenlast

Spontan

$u_{inst,G} = \frac{5}{384} \cdot \frac{g_{Ed} \cdot l^4}{EI}$

NBI 421.051 p.21

$= \frac{5}{384} \cdot \frac{0{,}2 \cdot (2700)^4}{9000 \cdot 2{,}8 \cdot 10^6} = 5{,}5\ mm$

Endelig

$u_{fin} = u_{inst} \cdot (1 + k_{def}) =$

$= 5{,}5\ mm \cdot (1 + 0{,}6) = 8{,}8\ mm$

1995 p. 2.2.3

Ref.

Nedbøyning pga. nyttelast

Spontan

$$u_{inst Q1} = \frac{5}{384} \cdot \frac{n_{Ed} \cdot l^4}{EI}$$

$$= \frac{5}{384} \cdot \frac{0{,}9 \cdot (2700)^4}{9000 \cdot 2{,}8 \cdot 10^6} = 24{,}7 \text{ mm}$$

NBI 421.051 p. 21

Endelig

$$u_{fin Q1} = u_{inst Q1} \cdot (1 + \psi \cdot k_{def})$$

$$= 24{,}7 \text{ mm} \cdot (1 + 0{,}3 \cdot 0{,}6) = 29{,}1 \text{ mm}$$

1995 p. 2.23

Total nedbøyning

$$u_{fin} = 5{,}5 \text{ mm} + 29{,}1 \text{ mm} = 34{,}6 \text{ mm}$$

Tillatt nedbøyning

$$y_{tillatt} = \frac{l}{300} = \frac{2700}{300} = 9 \text{ mm}$$

Bjelken holder ikke

Prøver 36 × 148

$$u_{fin} = \frac{34{,}6 \text{ mm} \cdot 98^3}{148^3} = 10{,}0 \text{ mm}$$

Prøver 48 × 148

$$u_{fin} = \frac{10 \text{ mm} \cdot 36 \text{ mm}}{48 \text{ mm}} = 7{,}5 \text{ mm}$$

$u_{fin} = 7{,}5 \text{ mm} < y_{tillatt} = 9 \text{ mm}$

Bruker 48 × 148 C18

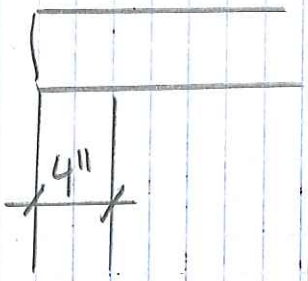
FAGSKOLEN INNLANDET

STATISKE BEREGNINGER

Side: _____

Sak: ØV. 2 Oppleggsflate

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune



Ref.

Dim. last

$V_{Ed} = 2.1\ kN$

Dim. fasthet

C18 → $f_{c90k} = 2.2 \frac{N}{mm^2}$ — NS 338

$$f_{c90d} = \frac{2.2 \frac{N}{mm^2} \cdot 0.8 \cdot 1.1 \cdot 1.0}{1.25} = 1.5 \frac{N}{mm^2}$$

$k_{c90} = 1.5$ — 1995 pkt. 6.1.5

Nødv. oppleggsflate

$$A_{eff} = \frac{V_{Ed}}{k_{c90} \cdot f_{c90d}} = \frac{2100 N}{1.5 \cdot 1.5 N/mm^2}$$

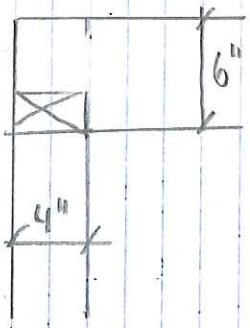
$A_{eff} = 933\ mm^2$

Bjelkebredde $b = 48mm$

Nødv. oppleggslengde

$$l_{eff} = \frac{1867 mm^2}{48 mm} = 19 mm$$

4" tilgjengelig ∴ OK



Ref.

Dim. last

$V_{Ed} = 2{,}1$ kN — ØV 2b

Dim. fasthet

$f_{v,d} = 2{,}4\ N/mm^2$ — ØV. 2b

Kontroll av innsnitt

$k_n = 5{,}0$ (konstr. virke) — 1995 pkt. 6.5.2

$\alpha = \frac{100}{148} = 0{,}68$ — " "

$x = \frac{98\,mm}{2} = 49\,mm$ — " "

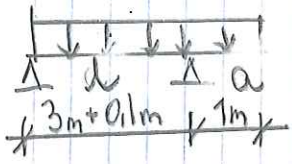
$$k_v = \frac{5}{\sqrt{148 \cdot \left(\sqrt{0{,}68 \cdot (1-0{,}68)} + \frac{0{,}8 \cdot 49 \sqrt{(0{,}68^{-1} - 0{,}68^{2})}}{148}\right)}}$$ — "

$= 0{,}59$

$$\tau_d = \frac{1{,}5 \cdot 2100\,N}{48\,mm \cdot 98\,mm} = 0{,}7\ N/mm^2$$

$k_v \cdot f_{vd} = 0{,}59 \cdot 2{,}4\ N/mm^2 = 1{,}4\ N/mm^2$

$k_v \cdot f_{vd} > \tau_d$ ∴ OK



Kar. Laster

Se øvingsoppgave 1a)

Dim. Laster

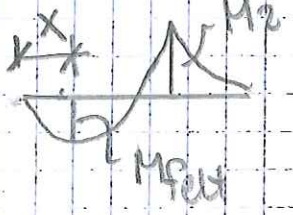
Se øvingsoppgave 1a)

$q_{Ed} = 2,2 \text{ kN/m}$

Ref.

NS-EN 1990

Dim. Lastvirkninger



$$M_2 = \frac{q_{Ed} \cdot a^2}{2} = \frac{2,2 \frac{kN}{m} \cdot 1m^2}{2} = 1,1 \text{ kNm}$$

NBI 421.051 p.51

$$M_{felt} = \frac{q_{Ed}}{8L^2} \cdot (L+a)^2 \cdot (L-a)^2$$

" "

$$= \frac{2,2 \frac{kN}{m}}{8(3,1m)^2} \cdot (3,1m+1m)^2 \cdot (3,1m-1m)^2$$

" "

$$= 3,0 \text{ kNm}$$

Bruker $M_{Ed} = 2,1 \text{ kNm}$

Dim. fasthet

Se øvingsoppgave 1

$f_{m,d} = 16,9 \text{ N/mm}^2$

Dim. for moment

$$h_{nødv} = \sqrt{\frac{6 \cdot 2,2 \cdot 10^6 \text{ Nmm}}{48mm \cdot 16,9 \text{ N/mm}^2}} = 127,6 \text{ mm}$$

Antar $b = 48mm$

Bruker $48 \times 148 \text{ mm}$ C24

Ref.

Dim. laster

Se øvingsoppgave 3a)

$q_{Ed} = 2{,}2\ kN/m$ — NS-EN 1990

Dim. lastvirkninger

$V_2 = \frac{q}{2L} \cdot (L^2 + a^2) = \frac{2{,}2}{2 \cdot 3{,}1} \cdot (3{,}1^2 + 1^2) = 3{,}8\ kN$ — NBI 421.051 p. 51

$V_3 = q \cdot a = 2{,}2\ kN/m \cdot 1\ m = 2{,}2\ kN$ — " —

$V_{Ed} = 3{,}8\ kN$

Kar. fasthet

C24 → $f_{v,k} = 4{,}0\ \frac{N}{mm^2}$ — NS 338

Dim. fasthet

$$f_{v,d} = \frac{4\ \frac{N}{mm^2} \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 2{,}8\ \frac{N}{mm^2}$$

Dim. for skjær

48x148 fra mom. beregn.

$$f_{v,d} \geq \tau_d = \frac{3 \cdot V_{Ed}}{2 \cdot b \cdot h} = \frac{3 \cdot 3{,}8 \cdot 10^3\ N}{2 \cdot 48\ mm \cdot 148\ mm} = 0{,}8\ N/mm^2$$

$f_{v,d} = 2{,}8\ \frac{N}{mm^2} > \tau_d = 0{,}8\ \frac{N}{mm^2}$

Bjelken er OK mhp. skjær

Ref.

Kar. laster

Se øvingsoppgave 3a

$g_k = 0{,}5\ kN/m^2$ $n_k = 2{,}0\ kN/m^2$

Dim. laster

$g_{Ed} = 1{,}0 \cdot 0{,}5\ \frac{kN}{m^2} \cdot 0{,}6m = 0{,}3\ \frac{kN}{m}$ 1990 NA.A1.4.1

$n_{Ed} = 1{,}0 \cdot 2{,}0\ \frac{kN}{m^2} \cdot 0{,}6m = 1{,}2\ \frac{kN}{m}$ — " — " —

Dim. for nedbøyning

Klimaklasse 1 1995 NA.901

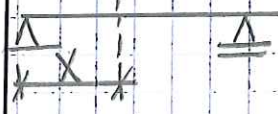
$k_{def} = 0{,}6$ 1995 3.2

$\psi_{2,1} = 0{,}3$ (bolig kat A) 1990 NA.A1.1

$E_{0,mean} = 11000\ N/mm^2$ NS 338

$I_y = \frac{bh^3}{12} = \frac{48 \cdot 173^3}{12} = 2{,}1 \cdot 10^7\ mm$ Tekn. tabell

Max nedb.



Nedbøyning p.g.a egenlast

I feltet $x = \frac{l}{2} \cdot \left(1 - \frac{a^2}{l^2}\right) = \frac{3{,}1}{2} \cdot \left(1 - \frac{1^2}{3{,}1^2}\right) = 1{,}4m = 1400\ mm$

Spontan $u_{inst,G} = \frac{g_{Ed} x}{24 E I \cdot l} \cdot (l^4 - 2l^2x^2 + lx^3 - 2a^2l^2 + 2a^2x^2)$ NBI 421.051 p. 57

$= 0{,}8\ mm$

Endelig $u_{fin,G} = u_{inst,G} \cdot (1 + k_{def})$ 1995 pkt. 2.2.3

$= 0{,}8\ mm \cdot (1 + 0{,}3) = 1{,}0\ mm$

Ref.

Ende utkrager

$y = a$

$$u_{inst,G} = \frac{q_{Ed} \cdot a}{24EI} \cdot (4a^2l - l^3 + 6a^3 - 4a^3 + a^3)$$ NBI 421.051 p. 51

$= \div 0{,}7\,mm$ (bøyer seg opp)

$u_{fin,G} = -0{,}7\,mm \cdot (1 + 0{,}3) = -0{,}9\,mm$ 1995 p. 2.2.3

Nedbøyning pga. nyttelast

Felt

Spontan

$$u_{inst,Q1} = \frac{q_{Ed} \cdot x}{24EI \cdot l} \cdot (l^4 - 2lx^2 \cdot lx^3 - 2a^2l^2 + 2a^2x^2)$$

NBI 421.051 p. 51

$= 5{,}1\,mm$

Endelig $u_{fin,Q1} = u_{inst,Q1} \cdot (1 + \psi \cdot k_{def})$ 1995 pkt. 2.2.3

$= 5{,}1\,mm \cdot (1 + 0{,}3 \cdot 0{,}6) = 6{,}0\,mm$

Endu utkrager $y = a$

Spontan $$u_{inst} = \frac{q_{Ed} \cdot a}{24EI} \cdot (4a^2l - l^3 + 6a^3 + 4a^3 + a^3)$$ NBI 421.051 p. 51

$= -2{,}7\,mm$ (i oppover)

Endelig $u_{fin,a} = u_{inst,Q1} \cdot (1 + \psi \cdot k_{def})$ 1995 pkt. 2.2.3

$= -2{,}7\,mm \cdot (1 + 0{,}3 \cdot 0{,}6) = -3{,}2\,mm$

Total nedbøyning

FELT

$u_{fin} = 1,0m + 6,0mm = 7,0\ mm$

$y_{till.} = \frac{l}{300} = \frac{3100}{300} = 10,3\ mm$

Bjelken er OK

UTKRAGER

$u_{fin} = -0,9 - 3,2 = 4,1\ mm$

$y_{tillatt} = \frac{l}{300} = \frac{1000}{300} = 3,3\ mm$

Holder ikke

Prøver 48x198

$u_{fin} = \frac{(-0,9 - 3,2) \cdot 173^3}{198^3} = -2,7\ mm$

$y_{tillatt} = \frac{l}{300} = \frac{1000}{300} = 3,3\ mm$

$u_{fin\,Q1} < y_{tillatt}$

Bruker bjelke 48x198 C24

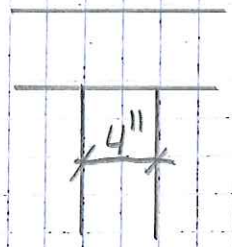
FAGSKOLEN INNLANDET

STATISKE BEREGNINGER

Side: _____

Sak: Øv. 3 Oppleggflate

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune



Bjelke 48×198

Dim. laster

$V_{Ed} = 3{,}8$ kN

Dim. fasthet

C24 → $f_{c90k} = 2{,}5\ N/mm^2$ — NS 3688

$$f_{c90d} = \frac{2{,}5\ N/mm^2 \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 1{,}8\ N/mm^2$$

$k_{c90} = 1{,}25$ (kontinuerlig) — 1995 pkt. 6.1.5

Midtopplegg

Nødv. oppleggsflate

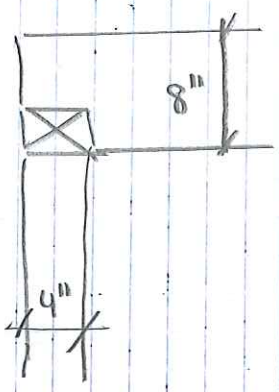
$$A_{eff} = \frac{V_{Ed}}{k_{c90} \cdot f_{c90d}} = \frac{3800\ N}{1{,}25 \cdot 1{,}8\ N/mm^2}$$

$$= 1689\ mm^2$$

$$l_{eff} = \frac{1689\ mm^2}{48\ mm} = 35\ mm$$

4" tilgjengelig ⇒ OK

Ref.



b = 4"

Dim. last

$V_{Ed} = 3{,}8\ kN$

Ref. ØV 3b

Dim. fasthet

$f_{vd} = 2{,}8\ N/mm^2$

Ref. ØV. 3b

Kontroll av innsnitt

$k_n = 5{,}0$ (konstr. virke) — Ref. 1995 pkt. 6.5.2

$\alpha = \frac{148}{198} = 0{,}75$ — " "

$\alpha_i = \frac{98\,mm}{2} = 49\,mm$ — " "

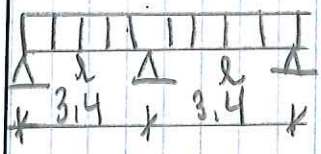
$$k_v = \frac{5}{\sqrt{198 \cdot \left(\sqrt{0{,}75 \cdot (1-0{,}75)} + \frac{0{,}8 \cdot 49}{198} \cdot \left(\sqrt{0{,}75^{-1} - 0{,}75^2}\right)\right)}}$$

$= 0{,}59$

$\tau_d = \frac{1{,}5 \cdot 3800\,N}{48 \cdot 148\,mm^2} = 0{,}8\ N/mm^2$ — " "

$k_v \cdot f_{vd} = 0{,}59 \cdot 2{,}8\ N/mm^2 = 1{,}7\ N/mm^2$ — " "

$k_v \cdot f_{vd} > \tau_d$:) OK



c/c 600

q_{Ed}

Kar. laster

$g_k = 0{,}5\ kN/m^2$

Bygn. kat C1

$n_k = 3{,}0\ kN/m^2$

Ref.

NB! 471.031

1991 NA.6.1

1991 NA.6.1

Dim. laster

6.10a) $q_{Ed} = (1{,}35 \cdot 0{,}5 + 1{,}05 \cdot 3) \cdot 0{,}6 = 2{,}3\ \frac{kN}{m}$ NS-EN 1990

6.10b) $q_{Ed} = (1{,}2 \cdot 0{,}5 + 1{,}5 \cdot 3) \cdot 0{,}6 = 3{,}1\ \frac{kN}{m}$ NS-EN 1990

Dim. lastvirkning

$$M_{Ed} = \frac{q_{Ed} \cdot l^2}{8} = \frac{3{,}1\ \frac{kN}{m} \cdot 3{,}4\ m^2}{8}$$

NB! 421.051 p. 71

$$= 4{,}5\ kNm$$

Dim. fasthet

C24

Se øvingsoppgave 1

$f_{m,d} = 16{,}9\ N/mm^2$

Dim. for moment

$$h_{nødv.} = \sqrt{\frac{4{,}5 \cdot 10^6\ Nmm \cdot 6}{48\ mm \cdot 16{,}9\ N/mm^2}} = 182{,}4\ mm$$

Antar $b = 48\ mm$

Bruker 48 x 198 C24

Ref.

Dim. laster

Se øvingsoppgave 4a

$q_{Ed} = 3{,}1$ kN/m

NS-EN 1990

Dim. lastvirkning

$$V_{Ed} = \frac{5 \cdot q_{Ed} \cdot l}{8} = \frac{5 \cdot 3{,}1 \cdot 3{,}4}{8} = 6{,}6 \text{ kN}$$

NB! 421.051 p. 71

Kar. fasthet

C24 → $f_{v,k} = 4{,}0 \frac{N}{mm^2}$

Dim. fasthet

$$f_{v,d} = \frac{4{,}0 \cdot 0{,}8 \cdot 1{,}1 \cdot 1{,}0}{1{,}25} = 2{,}8 \frac{N}{mm^2}$$

Dim for skjær

48x198 fra mom. beregn

$$f_{v,d} \geq \tau_d = \frac{3 \cdot V_{Ed}}{2bh} = \frac{3 \cdot 6{,}6 \cdot 10^3 N}{2 \cdot 48mm \cdot 198mm}$$

$$f_{v,d} = 2{,}8 \frac{N}{mm^2} > \tau_d = 1{,}0 \frac{N}{mm^2}$$

Bjelken er OK mhp. skjær

Ref.

Kar. Laster

Se øvingsoppgave 4a

$g_k = 0{,}5\ kN/m^2$ $n_k = 3{,}0\ kN/m^2$

Dim. Laster

$g_{Ed} = 1.0 \cdot 0{,}5 \frac{kN}{m^2} \cdot 0{,}6\,m = 0{,}3 \frac{kN}{m}$ — 1990 NA.A1.4.1

$n_{Ed} = 1.0 \cdot 3{,}0 \frac{kN}{m^2} \cdot 0{,}6\,m = 1{,}8 \frac{kN}{m}$ — " —

Dim. for nedbøyning

Klimaklasse 1 — 1995 NA.901

$K_{def} = 0{,}6$ — 1995 3.2

$\psi_{2,1} = 0{,}6$ (skole) — 1990 NA.A1

$E_{0,mean} = 11000\ N/mm^2$ — NS 338

$I_y = \frac{48 \cdot 198^3}{12} = 3{,}1 \cdot 10^7$ — Tekn. tab.

Nedbøyning pga egenlast

Spontan $u_{inst,G} = \frac{g_{Ed} \cdot L^4}{185 \cdot E \cdot I}$ — NB1.421.051 p.71

$= \frac{0{,}3 \cdot (3400)^4}{185 \cdot 11000 \cdot 3{,}1 \cdot 10^7} = 0{,}6\,mm$

Endelig $u_{fin,G} = u_{inst,G} \cdot (1 + K_{def})$

$= 0{,}6\,mm \cdot (1 + 0{,}6) = 1{,}0\,mm$

Nedbøyning pga nyttelast

Ref.

Spontan

$$u_{inst\,Q1} = \frac{n_{Ed} \cdot l^4}{185 \cdot E \cdot I}$$

$$= \frac{1{,}8 \cdot 3400^4}{185 \cdot 11000 \cdot 3{,}1 \cdot 10^7} = 3{,}8\ mm$$

NBI 421.051 p.71

Endelig

$$u_{fin\,Q1} = u_{inst\,Q1} \cdot (1 + \psi \cdot k_{def})$$

$$= 3{,}8\ mm \cdot (1 + 0{,}6 \cdot 0{,}6) = 5{,}2\ mm$$

1995 pkt. 2.2.3

Total nedbøyning

$$u_{fin} = 1{,}0 + 5{,}2\ m = 6{,}2\ mm$$

Tillatt nedbøyning

$$y_{till} = \frac{l}{300} = \frac{3400}{300} = 11{,}3\ mm$$

$u_{fin} < y_{till}$ ⇒

Bjelken er OK!

FAGSKOLEN INNLANDET

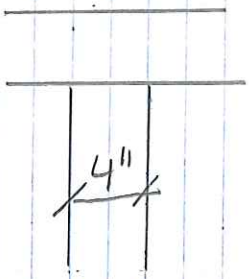
STATISKE BEREGNINGER

Side: _____

Sak: ØV. 4 Oppleggsflate

HEDMARK FYLKESKOMMUNE OPPLAND fylkeskommune

Ref.



Dim. laster

$V_{Ed} = 6.6\ kN$

Dim. fasthet

$C24 \rightarrow f_{c90k} = 2.5\ N/mm^2$ NS 338

$$f_{c90d} = \frac{2.5\ N/mm^2 \cdot 0.8 \cdot 1.1 \cdot 1.0}{1.25} = 1.8\ N/mm^2$$

$k_{c90} = 1.25$ (kontinuerlig) 1995 pkt. 6.1.5

Midtopplegg

$$A_{eff} = \frac{V_{Ed}}{k_{c90} \cdot f_{c90d}} = \frac{6600\ N}{1.25 \cdot 1.8\ N/mm^2}$$

$$= 2933\ mm^2$$

$b = 48\ mm$

$$l_{eff} = \frac{2933\ mm^2}{48\ mm} = 61\ mm$$

Tilgjengelig 4" > OK