

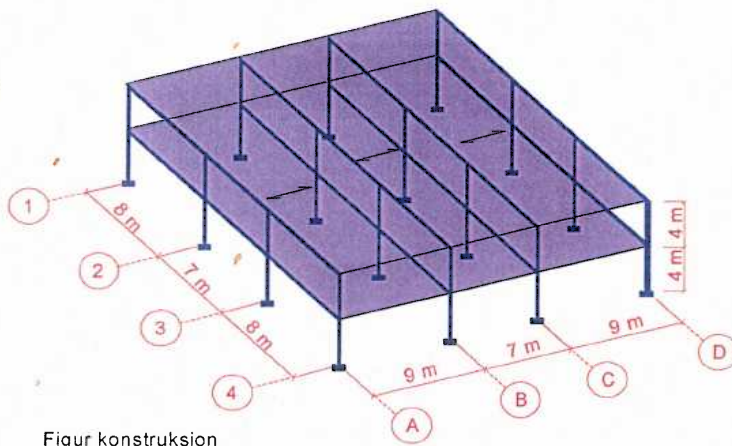
1
Høgskolen i Østfold
Avdeling for ingeniørfag

EKSAMENSOPPGAVE

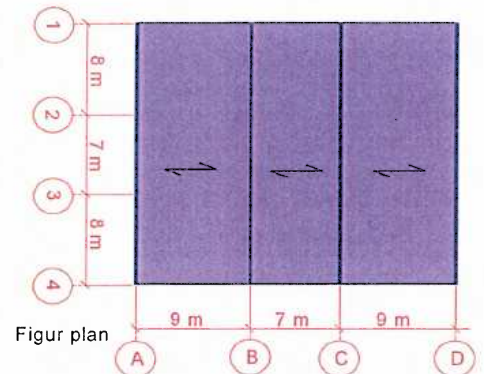
Emne: IRB21512 - Konstruksjonsteknikk 1
Lærer/telefon: Geir Flote / 46832940

Grupper: 2. bygg	Dato: 15.12.2014	Tid: 09:00-13:00
Antall oppgavesider: 3	Antall vedleggsider: 6	
Sensurfrist: 19.01.2015		
Hjelpemidler: NS-EN 1990, NS-EN 1991-1-1, NS-EN 1991-1-3, NS-EN 1991-1-4, utdelt lommekalkulator		
KANDIDATEN MÅ SELV KONTROLLERE AT OPPGAVESETTET ER FULLSTENDIG		

Oppgave 1: Lastkombinasjoner (25 %)



Figur konstruksjon



Figur plan

Et næringsbygg skal bygges i Eidsberg kommune i Østfold fylke.

Byggeplassen ligger på 75 moh. Bygget har flatt tak.

Bygget oppføres i to etasjer (4 m etasjehøyde) med søyler innspent i bunnen, bjelker med ledd mot søylene (8 m og 7 m spenn) og hulldekker som bærer som enveisplater mellom bjelkene (9 m og 7 m spenn). Dekkene er fritt opplagt på bjelkene. Se figurene over.

Bruk de oppgitte systemmålene. Det er ikke nødvendig å ta hensyn til at søylene blir kortere på grunn av dekkene.

Taket skal beregnes for snølast samt egentyngheden fra takoppbygging (tekking og isolasjon) over hele taket i tillegg til hulldekkets egentynghede.

Det skal beregnes nyttelast for kontorarealer i 2. etasje.

Gulvet i 1. etasje utføres som støpt gulv direkte på grunnen, og vil ikke belaste konstruksjonen.

Karakteristiske egentyngder for konstruksjonselementer:

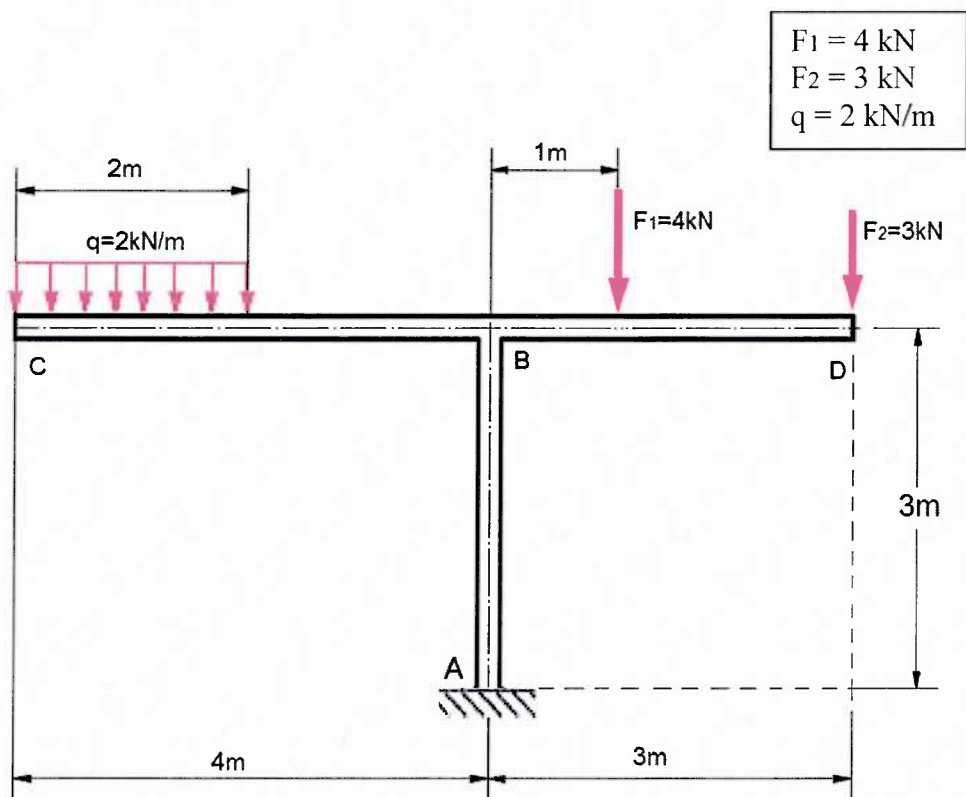
Bjelker:	0,4 kN/m
Søyler:	0,35 kN/m
Hulldekker:	2,50 kN/m ²
Takoppbygging:	0,5 kN/m ²

- Bergen snølast på taket. Anta $C_e = 1,0$ og $C_t = 1,0$. (5 %)
- Beregn dimensjonerende moment for både karakteristisk og ofte forekommende bruksgrensetilstand for bjelken i akse B /2-3 i 2. etasje. (11 %)
- Beregn dimensjonerende moment i bruddgrensetilstand for bjelken i taket i akse D/1-2. (9 %)

Oppgave 2: Statisk bestemt system (22 %)

Gitt en ramme med statisk system og påførte laster, som vist på figuren under.

- Beregn reaksjonskreftene og momentet i punkt A. (10 %)
- Tegn M-, V,- og N- diagrammene for rammen. (12 %)

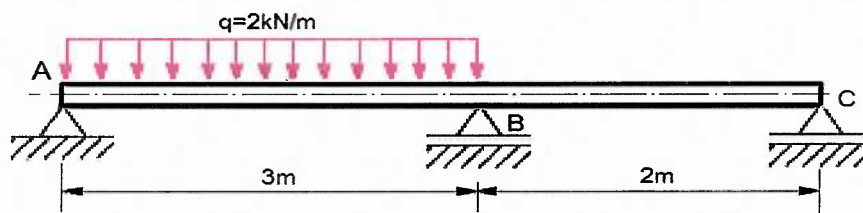


Oppgave 3: Kraftmetoden (30 %)

Gitt en kontinuerlig bjelke med statisk system og jevnt fordelt last $q = 2 \text{ kN/m}$ mellom punktene A og B, som vist på figuren under.

EI er konstant.

- Beregn reaksjonskreftene i punktene A, B, C og støttemomentet i punkt B ved bruk av kraftmetoden. (23 %)
- Tegn / skisser momentdiagrammet for hele bjelken. (7 %)

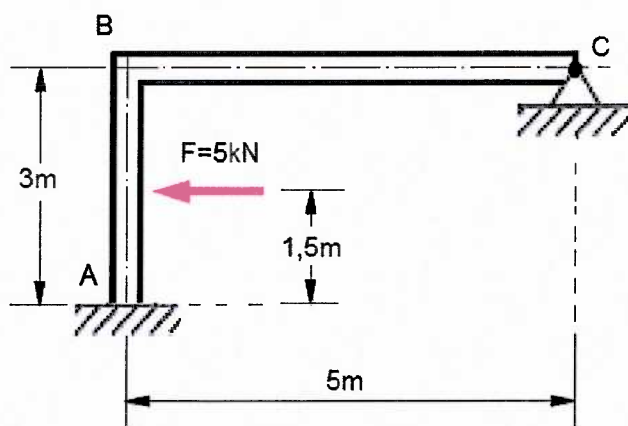


Oppgave 4 : Matrisestatikk (23%)

Gitt en ramme med statisk system og påført kraft $F = 5 \text{ kN}$ midt mellom punktene A og B, som vist på figuren under.

EI er konstant. Forutsett at $EA = \infty$

- Beregn rotasjonen i punkt B ved bruk av matrisestatikk . (12 %)
- Tegn / skisser momentdiagrammet for hele rammen.
Angi på diagrammet verdien på momentet i punktene A, B og C. (11 %)



VEDLEGG 1: Integrasjonstabeller

5.10 Integrasjonstabeller




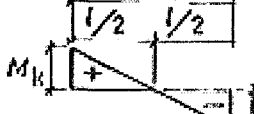
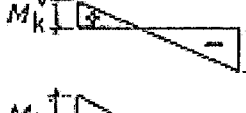

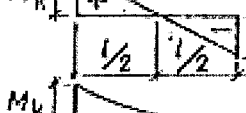
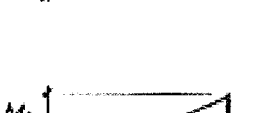


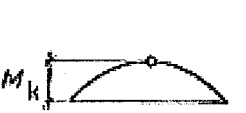

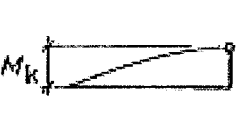
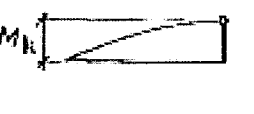




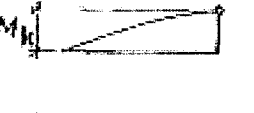
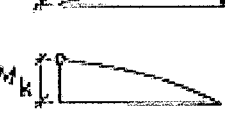
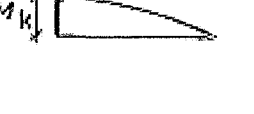

Med konstant treghetsmoment får en:

$$EI \cdot \delta_{ik} = \int_0^l M_i \cdot M_k \cdot dx \quad \text{og} \quad EI \cdot \delta_{ii} = \int_0^l M_i^2 \cdot dx.$$

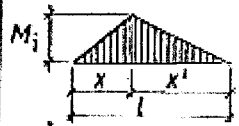
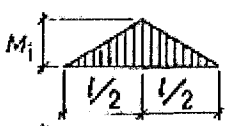
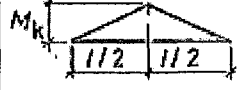
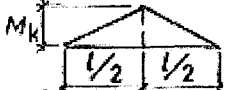


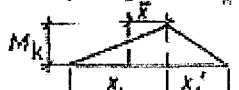
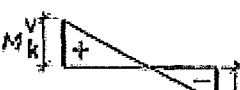
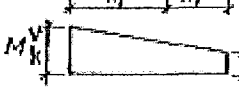
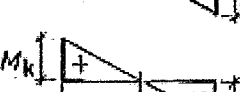
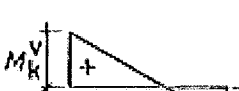
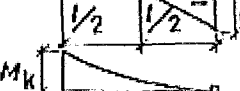


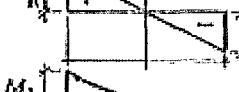






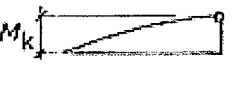
	$M_i^2 l$	$M_i M_k l$	$\frac{1}{3} M_i^2 l$
	$M_i M_k l$	$\frac{1}{2} M_i M_k l$	$\frac{1}{2} M_i M_k l$
	$\frac{1}{2} M_i M_k l$	$\frac{1}{6} M_i M_k l$	$\frac{1}{6} M_i M_k l$
	$\frac{1}{8} M_i M_k l$	$\frac{1}{6} M_i M_k l (1 + \frac{x'}{l})$	$\frac{1}{6} M_i M_k l$
	$\frac{1}{2} M_i M_k l$	$\frac{1}{4} M_i M_k l$	$\frac{1}{4} M_i M_k l$
	$\frac{1}{2} M_i M_k l$	$\frac{1}{8} M_i (2M_k^V + M_k^H) l$	$\frac{1}{8} M_i (2M_k^V - M_k^H) l$
	$\frac{1}{2} M_i (M_k^V + M_k^H) l$	$\frac{1}{8} M_i (2M_k^V - M_k^H) l$	$\frac{1}{6} M_i M_k l$
	$\frac{1}{2} M_i (M_k^V - M_k^H) l$	$\frac{1}{6} M_i M_k l$	$\frac{1}{4} M_i M_k l$
	0	$\frac{1}{6} M_i M_k l$	$\frac{1}{4} M_i M_k l$
	$\frac{1}{3} M_i M_k l$	$\frac{1}{12} M_i M_k l$	$\frac{1}{3} M_i M_k l$
	$\frac{1}{3} M_i M_k l$	$\frac{2}{3} M_i M_k l$	$\frac{1}{3} M_i M_k l$
	$\frac{2}{3} M_i M_k l$	$\frac{2}{3} M_i M_k l$	$\frac{1}{4} M_i M_k l$
	$\frac{2}{3} M_i M_k l$	$\frac{5}{12} M_i M_k l$	$\frac{5}{12} M_i M_k l$

NB! Parablene har sine toppunkter (horisontal tangent) i de punkter som er markert med en ring på figurene.

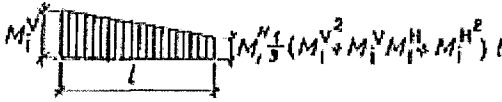

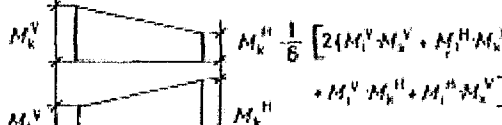
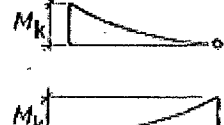
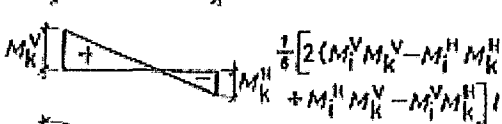
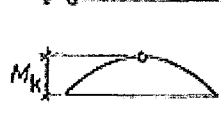
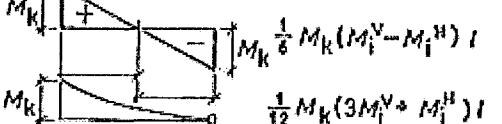
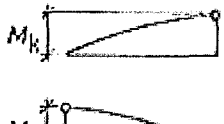
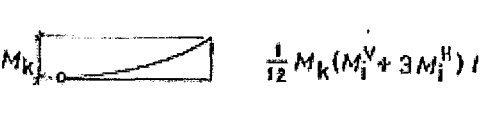

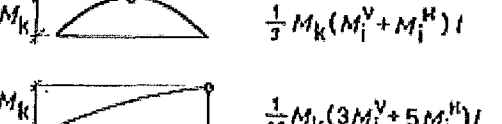

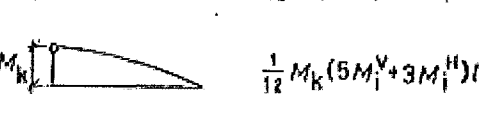







Tabell 19

 $M_i^H \frac{1}{3} (M_i^{H^2} - M_i^V M_i^H + M_i^V M_i^H) l$	 $\frac{1}{3} M_i^2 \cdot l$
 $M_k^H \frac{1}{6} [2(M_i^V M_k^V + M_i^H M_k^H) - M_i^H M_k^V - M_i^V M_k^H] l$	 $\frac{1}{3} M_i M_k l$
 $\frac{1}{6} M_k (M_i^V + M_i^H) l$	 $\frac{1}{6} M_i M_k l$
 $\frac{1}{12} M_k (3M_i^V - M_i^H) l$	 $-\frac{1}{6} M_i M_k l$
 $\frac{1}{12} M_k (M_i^V - 3M_i^H) l$	 0
 $\frac{1}{3} M_k (M_i^V - M_i^H) l$	 $-\frac{1}{6} M_i M_k l$
 $\frac{1}{12} M_k (3M_i^V - 5M_i^H) l$	 $\frac{1}{6} M_i M_k l$
 $\frac{1}{12} M_k (5M_i^V - 3M_i^H) l$	
 $\frac{8}{15} M_i^2 \cdot l$	 $\frac{8}{15} M_i^2 l$
 $\frac{8}{15} M_i \cdot M_k l$	 $\frac{8}{15} M_i M_k l$
 $\frac{7}{15} M_i \cdot M_k l$	 $\frac{11}{30} M_i M_k l$
 $\frac{7}{15} M_i \cdot M_k l$	

Tabell 20

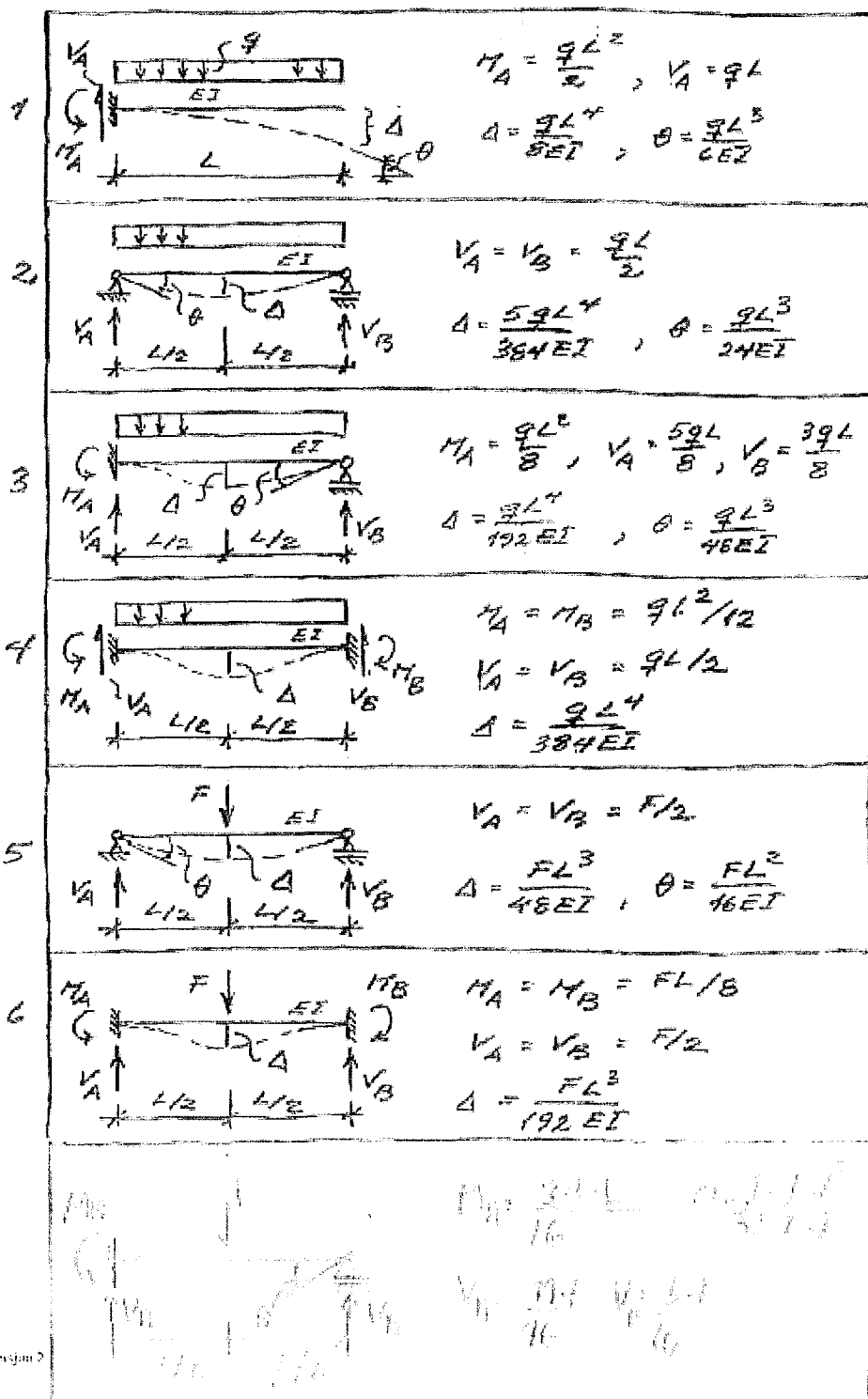
	$\frac{1}{3} M_i^2 l$		$\frac{1}{3} M_i^2 l$
	$\frac{1}{3} M_i M_k l \left(\frac{l}{2} - \frac{2x^2}{3l} \right)$		$\frac{1}{3} M_i M_k l$
	$\frac{1}{3} M_i M_k \cdot l$		$M_k^H \frac{1}{4} M_i (M_k^V + M_k^H) l$
	$\frac{1}{6} M_i M_k l \left(2 - \frac{\bar{x}^2}{x_i \cdot x_i'} \right)$		$M_k^H \frac{1}{4} M_i (M_k^V - M_k^H) l$
	$M_k^H \frac{1}{6} M_i \left[M_k^V \left(1 + \frac{x'}{l} \right) + M_k^H \left(1 + \frac{x}{l} \right) \right] l$		0
	$\frac{1}{6} M_i \left[M_k^V \left(1 + \frac{x'}{l} \right) - M_k^H \left(1 + \frac{x}{l} \right) \right] l$		$\frac{7}{48} M_i M_k l$
	$\frac{1}{3} M_i M_k l \cdot \frac{\bar{x}}{l}$		$\frac{7}{48} M_i M_k l$
	$\frac{1}{12} M_i M_k l \left(\frac{3x'}{l} + \frac{x^2}{l^2} \right)$		$\frac{5}{12} M_i M_k l$
	$\frac{1}{12} M_i M_k l \left(\frac{3x}{l} + \frac{x'^2}{l^2} \right)$		$\frac{17}{48} M_i M_k l$
	$\frac{1}{3} M_i M_k l \left(1 + \frac{x \cdot x'}{l^2} \right)$		$\frac{17}{48} M_i M_k l$
	$\frac{1}{12} M_i M_k l \left(3 + \frac{3x}{l} - \frac{x^2}{l^2} \right)$		
	$\frac{1}{12} M_i M_k l \left(3 + \frac{3x'}{l} - \frac{x'^2}{l^2} \right)$		

Tabell 21

	$M_i^H = \frac{1}{2} (M_i^V + M_i^V) l = M_i^V l$		$\frac{1}{5} M_i^2 l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{5} M_i M_K l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{30} M_i M_K l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{5} M_i M_K l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{2}{15} M_i M_K l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{3}{10} M_i M_K l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{12} M_K (M_i^V + 3M_i^H) l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{9} M_K (M_i^V + M_i^H) l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{12} M_K (3M_i^V + 5M_i^H) l$
	$M_i^H = \frac{1}{6} [2(M_i^V + M_i^H) + M_i^V + M_i^H] l$		$\frac{1}{12} M_K (5M_i^V + 3M_i^H) l$

Tabell 22

VEDLEGG 2: Basistilfeller mht. lastvirkning



Vedlegg 3: Basistilfeller med stivhetstall

