$Q_5 = \frac{130\times(375-225)}{375} = 52kg$. $S_3 = \frac{130\times225}{375} = 78kg$

$S_1 = \frac{78\times1286}{2010} = 50kg$ $S_2 = \frac{78\times724}{2010} = 28kg$

S_1 og S_2 giver $Q_3 = \frac{(28+50)(2290-375)}{2290} = 65kg$

$Q_8 = \frac{(20+28)(2290-375)}{2290} = 40kg$

2 vægge ved indstigning vejer hver 150 kg.

Paa drager IX falder: $\frac{150\times(1395+65)}{2290} = 96kg$

$W_9 = T_9 = \frac{96\times(440+\frac{1}{2}\times565)}{2932} = 24kg$ $Q_3 = Q_8 = \frac{96\times\frac{1}{2}(565+461)}{2932} =$ 17kg. Passagerer + sofaer med 50% overlast i VIII − IX

(bl. 30.) $\frac{4870\times\frac{1}{2}\times835}{9090} = 224kg$ $W_9 = T_9 = \frac{224(440+\frac{1}{2}\times1026)}{2932} = 73kg$

I: IX − X $\frac{4870\times\frac{1}{2}\times2290}{9090} = 620kg$

$T_9 = W_9 = \frac{620(440+\frac{1}{2}\times565)}{2932} = 152kg$ $Q_3 = Q_8 = \frac{620\times\frac{1}{2}(565+461)}{2932} = 109kg.$

Batterikasse: vægt 850 kg: $S_7 = S_5 = \frac{850(1140+5)}{2\times2245} = 216kg$

$S_4 = \frac{216(565-272)}{565} - \frac{216(461-292)}{565} = 112 - 65 = 47kg$

$S_6 = \frac{216\times272}{565} + \frac{216(464+272)}{565} = 114 + 282 = 396kg$

$Q_8 = \frac{396\times1655}{2290} = 285kg$ $W_9 = \frac{47\times1655}{2290} = 34kg$

Oliebeholder: 670 kg $Q_7 = Q_6 = \frac{670(1300-625)}{2\times1765} = 128kg.$

Hovedluftbeholdere: $2\times80 = 160kg$, $U_4 = V_4 = U_3 = V_3 = \frac{1}{4}\times160 = 40kg$ $T_9 = W_9 = \frac{40(395+1395)}{2290} = 31kg$

A) statiske lodrette tryk.

Her faas ialt: $P = 0{,}31kg/cm$ ∽ 90 kg $Q_8 = 19+80+40+17+109+285 = 550kg$ $Q_7 = 128kg$ $W_9 = 13+25+12+24+73+152+34+31 = 364kg$ $Q_6 = 26+128 = 154kg$ $Q_5 = 26+52 = 78kg$ $T_9 = 13+25+12+24+73+152+31 = 330kg$ $Q_4 = 37kg$ $Q_3 = 19+37+80+65+17+109 = 327kg$

$R_{IX}-1 = \frac{1}{2}\times90 + \frac{550\times461+128\times860+364\times1026+154\times1400+78\times1747}{2932} + \frac{330\times1906+37\times2049}{2932} + \frac{327\times2471}{2932} = 45+86+37+127+74+47+215+26+275 = 932kg$

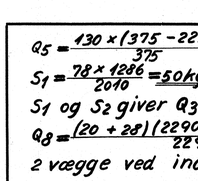
$R_{IX}-2 = \frac{1}{2}\times90 + \frac{550\times2471+128\times2072+364\times1906+154\times1532+78\times1185}{2932} + \frac{330\times1026+37\times883+327\times461}{2932} = 45+464+91+237+80+31+115+11+52 = 1126kg$, Q=0 ved Q_6 (snit A-A)

$M_{xA} = 1126\times140 - 550\times93{,}9 - 128\times54 - 364\times37{,}4 - \frac{90\times1400\times70}{2932}$

(bl. 34) $M_{xA} = 157500 - 51700 - 6900 - 13600 - 3000 = 82300kg\,cm.$

Profilet forstærkes med 2 lameller 57 × 6,5 der begge føres ud til indstigningsdrager.

Snit: A − A og B − B.



□ 140 × 70 × 4: $F = 16cm^2$ J_x 412,3 cm^4 (bl. 23).

Ialt $F = 16+2\times5{,}7\times0{,}65 = 16+7{,}4 = 23{,}4\,cm^2$

$J_x = 412{,}3 + 2\times\frac{1}{12}\times5{,}7\times0{,}65^3 + 2\times3{,}7\times7{,}32^2 = 412{,}3+0{,}2+397 = 809{,}5\,cm^4$

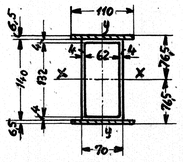
$W_x = \frac{8095}{7{,}65} = 106\,cm^3$

$\sigma_A = \frac{82300}{106} = 775\,kg/cm^2 < 800\,kg/cm^2$

$M_{xB} = 932\times118{,}5 - 327\times72{,}4 - 37\times30{,}2 - 330\times15{,}9 - \frac{90\times1185\times59{,}25}{2932} = 110500 - 23700 - 1100 - 5200 - 2100 = 78400\,kg\,cm$

$\sigma_B = \frac{78400}{106} = 735\,kg/cm^2$

Snit: C-C.



$J_x = 412{,}3 + 2\times\frac{1}{12}\times11\times0{,}65^3 + 2\times11\times0{,}65\times7{,}32 + 412{,}3 + 0{,}5 + 761 = 1173{,}8\,cm^4$

$W_x = \frac{11738}{7{,}65} = 153\,cm^3$

$J_y = \frac{1}{12}\times7^3\times14 - \frac{1}{12}\times6{,}2^3\times13{,}2 + 2\frac{1}{12}\times11^3\times0{,}65 = 400 - 264 + 144 = 280\,cm^4$ $W_y = \frac{280}{5{,}5} = 51\,cm^3$

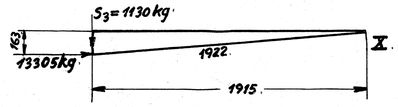
$M_{xC} = 932\times88{,}3 - 327\times42{,}2 - \frac{90\times883\times44{,}15}{2932} = 82300 - 13800 - 1200 = 68800\,kg\,cm$ $\sigma_C = \frac{68800}{153} = 450\,kg/cm^2 < 800\,kg/cm^2$

B) statiske tryk + 30% stød + direkte bremsning

a) bremsning af motorbogie med direkte bremsning + haandbremsning ved samme bogie.

(bl. 32) Tryk i cylinder (18W-1.480) er 2760 kg, der virker 163 mm under X-akse i tværdrager IX, der skal overføre det vandrette tryk til bremsens faste punkt og drager ved indstigning: $Q_3 = Q_4 = \frac{1/2\times2760\times163}{835} = 290kg.$

Tryk i bremselejet ved S_3 bliver fra luftbremse + haandbremse (18W-1.480): $2760+5005+1640+\frac{1640\times655}{283} = 7765+1640+3800 = 13305kg.$



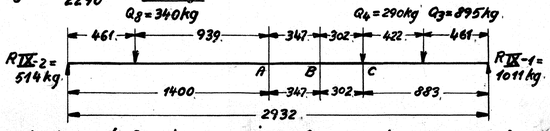
Lodret tryk S_3 paa tværdrager.

$S_3 = \frac{13305\times163}{1915} = 1130kg$ (vandret billede bl. 36).

Ved drager $S_1 - S_3 - S_2$ overføres S_3 til længdedragerne $Q_8 - V_6$ og $Q_3 - V_4$: $S_2 = \frac{1130\times(1005-281)}{2010} = 406kg$

$S_1 = \frac{1130(1005+281)}{2010} = 724kg$ $Q_3 = \frac{724\times1915}{2290} = 605kg$

$Q_8 = \frac{406\times1915}{2290} = 340kg$



Lodret last fra bremsning $Q_8 = 340kg$ $Q_4 = 290kg$

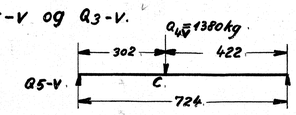
$Q_3 = 290+605 = 895kg$, $R_{IX}-1 = \frac{340\times461+290\times2049}{2932} + \frac{885\times2471}{2932} = 53+203+755 = 1011kg$ $R_{IX}-2 = \frac{340\times2471+280\times883}{2932} + \frac{895\times461}{2932} = 287+87+140 = 514kg.$

(bl. 33) $M_{Ax} = 514\times140 - 340\times93{,}9 = 72000 - 32000 = 40000kg\,cm$

$M_{Bx} = 514\times174{,}7 - 340\times128{,}6 = 89500 - 44000 = 45500\,kgcm$

$M_{Cx} = 1011\times88{,}3 - 895\times42{,}2 = 89000 - 37800 = 51200\,kg\,cm.$

Tryk fra cylinder Q_4-V $= 1/2\times2760 = 1380kg$ overføres til Q_5-V og Q_3-V.



$M_{yC} = \frac{1380\times42{,}2\times30{,}2}{72{,}4} = 24200\,kg\,cm$

Ialt: $M_{Ax} = 82300\times1{,}3 + 40000 = 107000 + 40000 = 147000\,kgcm$

$M_{Ay} = 0$ $\sigma_A = \frac{147000}{106} = 1385\,kg/cm^2 < 1400\,kg/cm^2$

$M_{Bx} = 78400\times1{,}3 + 45500 = 101800 + 45500 = 147300\,kg\,cm$

$M_{yB} = 0$ $\sigma_B = \frac{147300}{106} = 1390\,kg/cm^2 < 1400\,kg/cm^2$

$M_{xC} = 1{,}3\times68800 + 51200 = 89400 + 51200 = 140600\,kg\,cm$

$M_{yC} = 24200\,kg\,cm$ $\sigma_C = \frac{140200}{153} + \frac{24200}{51} = 915+473 = 1388\,kg/cm^2 < 1400$.

b) statiske tryk + 30% stød + direkte bremsning ved maskinbogie. Lodrette tryk $Q_3 = Q_8 = Q_4 = 0$

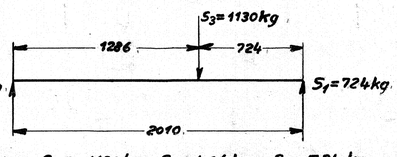
Vandret tryk $Q_{4V} = 1/2\times3860 = 1930kg$

$M_{yC} = \frac{1930\times30{,}2\times42{,}2}{72{,}4} = 34000\,kg\,cm$

$\sigma_A = \frac{82300\times1{,}3}{106} = 1010\,kg/cm^2$ $\sigma_B = \frac{78400\times1{,}3}{106} = 960\,kg/cm^2$

$\sigma_C = \frac{68800\times1{,}3}{153} + \frac{34000}{51{,}0} = 585+666 = 1251\,kg/cm^2 < 1400\,kg/cm^2.$

(bl. 34) 13) beregning af tværdrager $S_1 - S_2$ (18W-22.050).

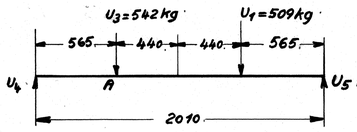


Efter bl. 32 er $S_3 = 1130kg$ $S_2 = 406kg$ $S_1 = 724kg$

$M_{S3} = 724\times72{,}4 = 52400\,kg\,cm$ $\perp NP.10$ $W_x = 41{,}2\,cm^3$

$\sigma = \frac{52400}{41{,}2} \backsim 1270\,kg/cm^2 < 1400\,kg/cm^2$

14) beregning af tværdrager $U_4 - U_5$ (18W-22.050).



Egenvægt af drager 22 kg. Skillerum 150 kg

$U_3 = U_1 = \frac{22(440+\frac{1}{2}\times565)}{2010} + \frac{150\times(440+\frac{1}{2}\times565)}{2932} =$ 8+37 = 45 kg. Luftbeholdere: $U_3 = U_1 = 40 + \frac{40\times395}{1395}$

40+11 = 51 kg. Gulvbærere i IX − X $U_1 = U_3 = 9kg.$

Gulv i IX-X: 214 kg (bl. 28).

$U_1 = U_3 = \frac{214\times(440+\frac{1}{2}+565)}{2932\times2} = 26kg.$

Batterikasse giver (bl. 30) $S_4 = 47kg$ $U_3 = \frac{47\times635}{395} = 33kg$

Skillerum ved X: $U_3 = U_1 = \frac{150(440+\frac{1}{2}\cdot565)\times65}{2932\times1395} = 2kg$

6 personer pr. m^2 i IX-X: vægt: $6\times75\times2\times2{,}29$ ∽ 2100 kg. $U_1 = U_3 = \frac{2100(440+\frac{1}{2}\times565)}{2\times2010} = 376kg.$

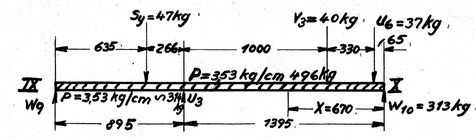
(bl. 35) Ialt $U_3 = 45+51+9+26+2+376+33 = 542kg$

$U_1 = 45+51+9+26+2+376 = 509kg$

$M_{XA} = \frac{542\times56{,}5\times145{,}0}{201} + \frac{509\times56{,}5}{201}\times56{,}5 = 22000+8000 =$ 30000 kg cm. Profil $\perp NP.10$ $W_x = 412\,cm^3$

$\sigma_A = \frac{30000}{41{,}2} = 730\,kg/cm^2 < 800$

15) beregning af gulvbærer $W_9 - W_{10}$



Fra batterikasse faas (bl. 30) $S_4 = 47kg$.

Luftbeholdere $V_3 = 40kg$. Skillerum ved X

$U_6 = \frac{150(440+\frac{1}{2}\times565)}{2932} = 37kg$. Egenvægt drager $W_9 - U_3 = 7kg$

Gulv IX − X 214 kg. I $W_9 - U_3 = \frac{214\times895\times(440+\frac{1}{2}\times565)}{2290\times2932} =$ 21 kg. Egenvægt drager $U_3 - W_{16} = 10kg$.

Egenvægtgulv $U_3 - W_{10} = \frac{214\times1395\times(440+\frac{1}{2}\times565)}{2290\times2932} = 33kg$

Med 6 passagerer pr. m^2 faas ($W_9 - U_3$): $6\times75\times0{,}895\times(0{,}44+0{,}28) =$ 286 kg. Strkn. $U_3 - W_{10} = 6\times75\times1{,}4\times(0{,}44+0{,}28) =$ 453 kg. Ensformig fordelt last $W_9 - U_3$: 7 + 21 + 286 = 314 kg

$p = \frac{314}{89{,}5} = 3{,}53\,kg/cm$ strk. $U_3 - W_{10} = 10+33+453 = 496kg$

$p = \frac{496}{139{,}5} = 3{,}53\,kg/cm.$

Drager $U_3 - W_{10}$ er haardest paavirket

$W_{10} = \frac{1}{2}\times496 + \frac{40\times1000}{1395} + \frac{37\times1330}{1395} = 248+29+36 = 313kg$

Q = 0 X fra $-W_{10}$ $X = \frac{313-(40+37)}{3{,}53} = 67\,cm.$

(bl. 36) $M_{max} = 313\times67 - 37\times60{,}5 - 40\times27{,}5 - \frac{496\times670\times33{,}5}{1395} = 21000 - 2200 - 1100 - 8000 = 10700\,kg\,cm.$

Profil $\perp NP.6\frac{1}{2}$: $W_x = 17{,}7\,cm^3$ $\sigma = \frac{10700}{17{,}7} = 605\,kg/cm^2 < 800\,kg/cm^2$.

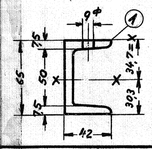
Ved at bore et 9 mm hul i øverste flange som vist på skitsen nedenfor faas: $F = 9{,}03 - 0{,}9\times0{,}75 = 9{,}03 - 0{,}67 = 8{,}36\ cm^2$

$x = \frac{9{,}03\times3{,}25 - 0{,}67\times0{,}38}{8{,}36} = 3{,}50 - 0{,}03 = 3{,}47\ cm$

$J_X = 57{,}5 + 9{,}03\times0{,}22^2 - \frac{1}{12}\times0{,}9\times0{,}75^3 - 0{,}67\times3{,}095^2$

$= 57{,}5 + 0{,}43 - 0 - 6{,}38 = 50{,}55\ cm^4$

$W_{x1} = 50{,}55 : 3{,}47 = 14{,}6\ cm^3$

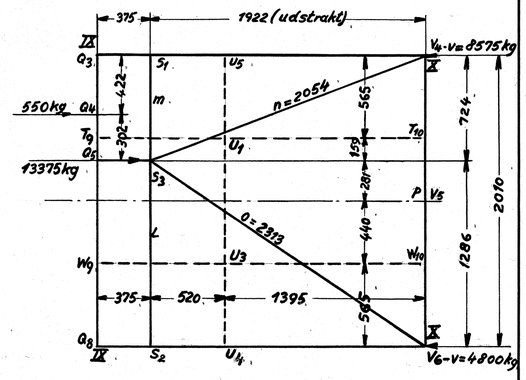


Spændingen bliver således, idet største moment er 10700 kg cm

$\sigma_1 = 10700 : 14{,}6 = 732\,kg/cm^2 < 800\,kg/cm^2$

FRICHS nr. 147

16) beregning af bremsegitter ved motorbogie.



Fra bremsning af motorbogie med direkte bremsning + haandbremse $S_{3V} = 13305kg$ (bl. 32).

Tryk Q_4 fra bremsecylinder: $1/2(3860-2760) = 550kg.$

Ialt: $S_3 = \frac{13305}{724} + \frac{550\times422}{724} = 13305+320 = 13625kg.$

Kraft i gitterets plan $\frac{13325\times1922}{1915} \backsim 13375kg$

$V_{4V} = \frac{13375\times1286}{2010} = 8575kg$ $V_{6-V} = \frac{13375\times724}{2010} = 4800kg$

(bl. 37) $S_m = S_l = 0$ $S_p = +\frac{4800\times1286}{1922} = +3200kg$

$S_o = -\frac{4800\times2313}{1932} = -5770kg$ $S_n = -\frac{8575\times2054}{1922} = -9150kg$

a) stang n

$S = -9150kg$ $l_9 = 1{,}33m$ $L: 75\times75\times8$ $F = 11{,}5\,cm^2$

$\xi = 5{,}42$ $r_0 = 0{,}8\times1400 = 1120\,kg/cm^2$ $F_o = \frac{9150}{1120} = 8{,}2\,cm^2$

$1/3\,\xi l^2 = 1/3\times5{,}42\times1{,}33^2 = 3{,}2\,cm^2$ $F_o + 1/3\,\xi l^2 = 8{,}2+3{,}2 =$ 11,4 $cm^2 < 11{,}5\,cm^2$

b) stang o

$S = -5770kg$ stang holdes fast saa $l_9 = 1{,}55m$

$F_o = \frac{5770}{1120} = 5{,}17\,cm^2$ $L: 75\times75\times8$ $F = 11{,}5\,cm^2$ $\xi = 5{,}42$

$1/3\times5{,}42\times1{,}55^2 = 4{,}33\,cm^2$

$F_o + 1/3\,\xi l^2 = 5{,}17+4{,}33 = 9{,}5\,cm^2 < 11{,}5\,cm^2.$

Lodrette tryk i V_4 og V_6 fra bremsegitter (bl. 32).

$V_4 = -\frac{1130\times1286}{2010} \backsim -724kg$ $V_6 = -\frac{1130\times724}{2010} = -406kg.$

Efter bl. 34 er $S_2 = 406kg$ og $S_1 = 724kg.$

Ialt $V_4 = +724 + \frac{724\times375}{2290} = -605kg$

$V_6 = +406 + \frac{406\times375}{2290} = -342kg.$

Stk.	Betegnelse	Pos.	Materiale kvalitet	Model nr. eller materiale størrelse	rå / færdig Vægt/stk.
5					
4					
3					
2					
1					

Tegn.	M.A.	Rev.	E.U. 22/2-51	Afd.	IV L
Kalk.	B.F. 12/1-50	Norm.		Dato	
Dato	Rettelse	Indeks			
9/1-53	beregn. m. 9 ø hul i gulvbærer tilføjet	a			

Målestok:

FRICHS

Anvendelse: Diesel-el. 500/550 H.K. motorvogn.

Stykliste nr.: —

Tegningens benævnelse: Beregning af dragere i undervogn.

Tegningens nummer: 18W − 1.194.

Indeks: a