

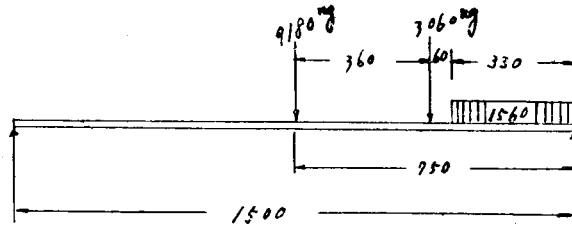
吉林大橋架設工事報告 (其二)

※ 幹 事 渡 部 幸 三 郎
※ 會 員 高 繩 勉 德

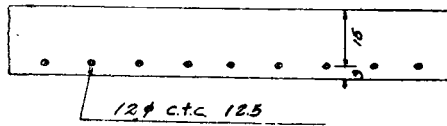
4. 應 力 計 算

第1章 一 般 條 項

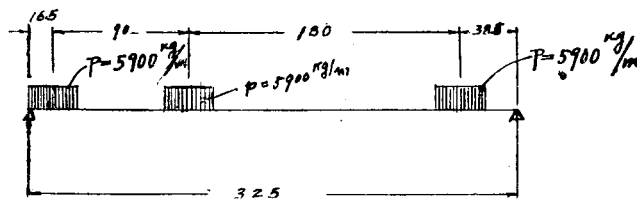
第1項 徑間割り及断面



徑 間 長 23.00—13@31.00—23.00



第2項 荷 重



$$\text{群集荷重 } W = \frac{100000}{170+L} = \frac{100000}{170+31} = 497 \div 500 \text{ kg/m}^2$$

$$\text{衝擊係數 } i = \frac{20}{60+L} = \frac{20}{60+31} = 0.22 \text{ (主桁)}$$

第2章 床 版 の 設 計

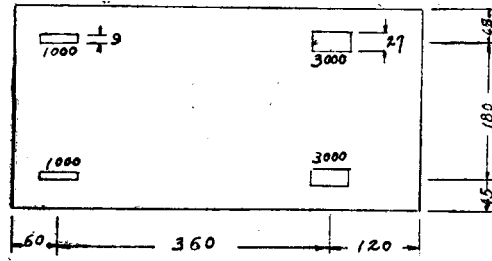
第1項 中 央 床 版

(1) 死 荷 重 鋪 裝 $0.03 \times 2,100 = 63$
 床 版 $0.18 \times 2,400 = 432$ (+

495kg/m²

※ 吉林省公署土木廳工務科長
 ※ 同 上 技 士

(2) 活荷重 車輪荷重分布は下圖の如し



車輪荷重 前輪 $1,000 \times 1.3 = 1,300 \text{ kg}$ (衝撃加算)
 後輪 $3,000 \times 1.3 = 3,900 \text{ kg}$ (//)

床版の有効巾は

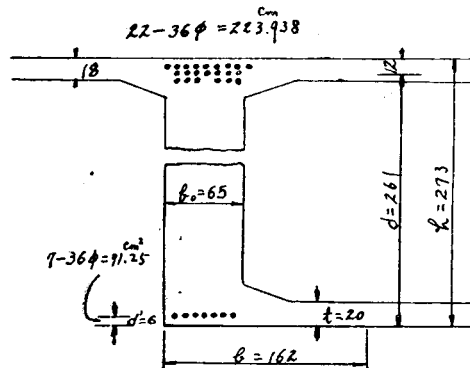
$$l = \frac{2}{3}l + a = \frac{2}{3} \times 3.25 + 0.26 = 2.43 > 2.00$$

$$\therefore l = 2.00 \text{ とす}$$

故に後輪に依る単位荷重は

$$p = \frac{3,900}{2.00 \times 0.33} = 5,900 \text{ kg/m}^2$$

(3) 彎曲率



$$R_a = \frac{1}{3.25} (5,900 \times 0.33 \times 1.625 + \frac{500 \times 1,175^2}{2}) = 1,080 \text{ kg}$$

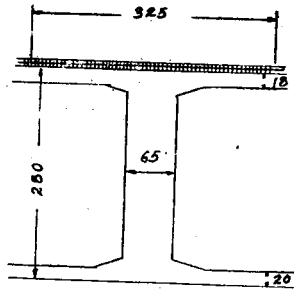
$$M_l = 1,080 \times 1.625 - \frac{5,900 \times 0.33^2}{2} = 1,434 \text{ kg-m}$$

$$M_d = \frac{495 \times 3.25^2}{8} = 654 \text{ kg-m}$$

$$M = M_l + M_d = 1,434 + 654 = 2,088 \text{ kg-m}$$

正負彎曲率は單桁としての2/3をとるものとすれば

$$M_{max} = \frac{2}{3} \times 2,088 = 1,390 \text{ kg-m}$$



(4) 剪 斷 力

$$S_l = \frac{5,900 \times 0.33}{3.25} (3,085 + 2,185 + 0.385) \div 3,390 \text{ kg}$$

$$S_d = \frac{495 \times 3.25}{2} \div 800 \text{ kg}$$

$$S_{max} = 3,390 + 800 = 4,190 \text{ kg}$$

(5) 斷面及應力強度

$$A_s = \frac{1.131 \times 100}{12.5} = 9.05 \text{ cm}^2$$

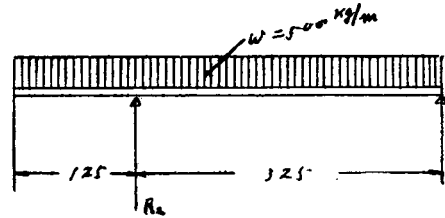
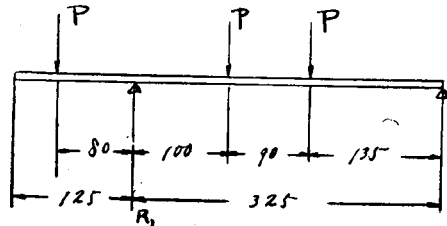
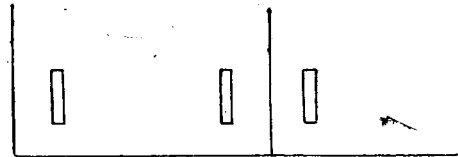
$$P = \frac{A_s}{bd} = \frac{9.05}{100 \times 15} = 0.006$$

$$K = 0.344 \quad j = 0.885$$

$$\sigma_s = \frac{M}{A_s j d} = \frac{139,000}{9.05 \times 0.885 \times 15} = 1160 \text{ kg/cm}^2$$

$$\sigma_c = \sigma_s \frac{k}{n(l-k)} = 1,160 \times \frac{0.344}{15(1-0.344)} = 41 \text{ kg/cm}^2$$

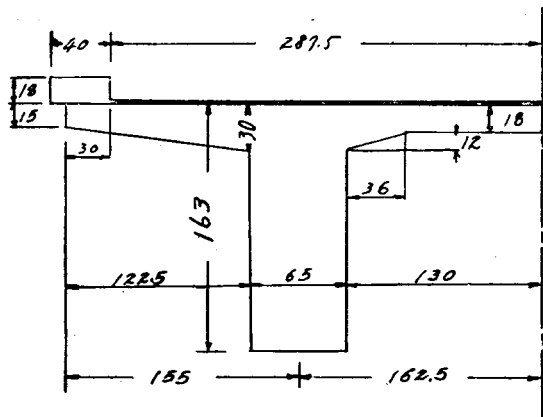
$$t = \frac{S}{b j d} = \frac{4,190}{100 \times 0.885 \times 15} = 3.15 \text{ kg/cm}^2$$



第 3 章 中央桁の設計

第 1 項 荷 重

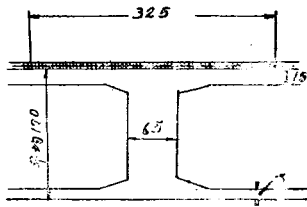
(1) 死 荷 重



㊤~㊦
點

鋪 裝 $0.03 \times 3.25 \times 2,100 = 205$

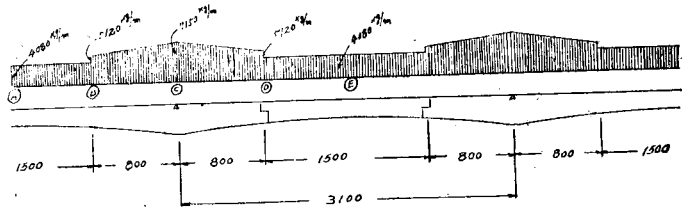
床 版 $3.25 \times 0.18 \times 2,400 = 1404$



ハウチ $0.36 \times 0.12 \times 2,400 = 104$

桁 $1.52 \times 0.65 \times 2,400 = 2,371 (+)$

$4,084 \div 4,080 \text{ kg/m}$



Ⓑ~Ⓓ 鋪装 205
點

床版 $(0.18 + 0.15) \times 3.25 \times 2,490 = 2,574$

ハウチ $104 \times 2 = 208$

桁 $1.37 \times 0.65 \times 2,400 = 2,137 (+)$

$5,124 \div 5,120 \text{ kg/m}$

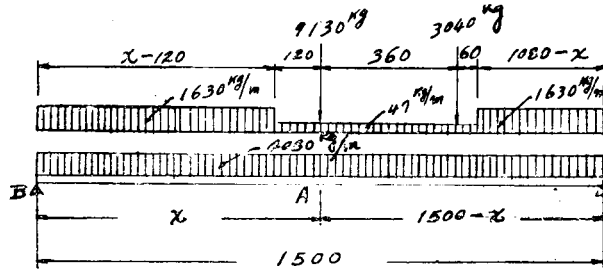
Ⓒ 鋪装 205

床版 $3.25(0.18 + 0.2) \times 2,400 = 2,961$

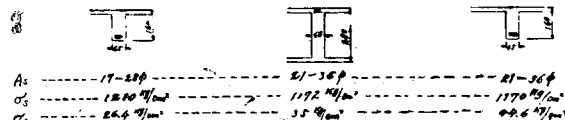
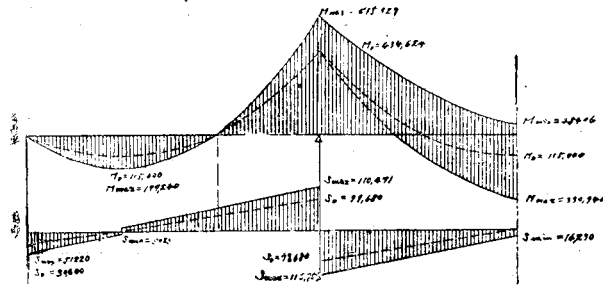
ハウチ $104 \times 2 = 208$

桁 $2.42 \times 0.65 \times 2,400 = 3,780 (+)$

$7,154 \div 7,150 \text{ kg/m}$



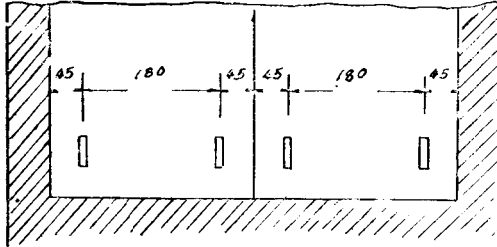
(2) 活 荷 重



$$R_1 = \frac{2P}{3.25}(2.80+1.00)=2.34P$$

∴前輪 $2.34 \times 1,300 = 3,040kg$

後輪 $2.34 \times 3,900 = 9,130kg$



$$R_2 = \frac{2}{3.25}(500 \times 0.55^2 \times 1/2) = 46.5 \div 47kg$$

$$R_3 = \frac{2}{3.25}(500 \times 3.25^2 \times 1/2) = 1,627 \div 1,630kg$$

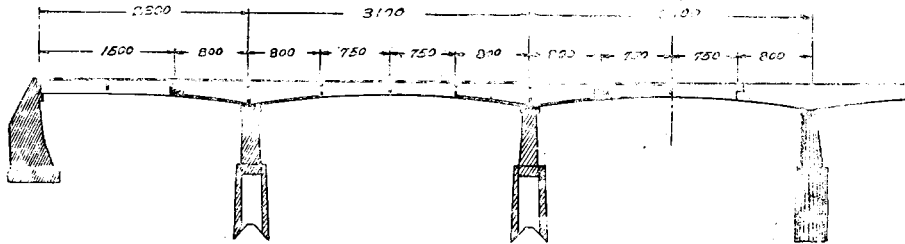
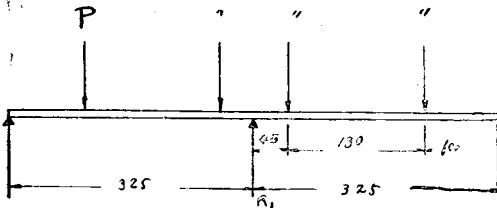
第2項 吊桁 徑間

(1) 彎曲率

(i) 死荷重に依る彎曲率

$$M_d = \frac{4,080 \times 15^2}{8} = 11,500kg-m$$

(ii) 最大彎曲率



$$R_b = \frac{1}{15} \left[1,630(x-1.2) \left(15 - \frac{x-1.2}{2} \right) + 47 \times 5.4 (13.5-x) + \frac{1,630(10.8-x)^2}{2} + 9,130(15-x) \right. \\ \left. + 3,040(11.4-x) \right] + \frac{4,080 \times 15}{2} = \frac{1}{15} (26,406x - 30,514 - 815x^2 + 3,420 - 254x + 95,036 \\ - 17604x + 815x^2 + 136,950 - 9,130x + 34,656 - 3,040x) + 30,600 = -242x + 15,961 \\ + 30,600 = -242x + 46,561$$

$$M_x = (-242x + 46,561)x - 1,630(x-1.2) \left(x - \frac{x-1.2}{2} \right) - \frac{47 \times 1.2^2}{2} - \frac{4080x^2}{2} = -242x^2 \\ + 46,561x - 815x^2 + 1174 - 34 - 2,040x^2 = -3,097x^2 + 46,561x + 1140$$

今最大彎曲率の生ずるXの値を求むるには上式MxをXに就て微分して之を零に等しく置けば

$$\frac{dM_x}{dx} = 6,194x + 46,561 = 0 \quad \therefore x = \frac{46,561}{6,194} = 7.52$$

*の値をMxに代入すれば

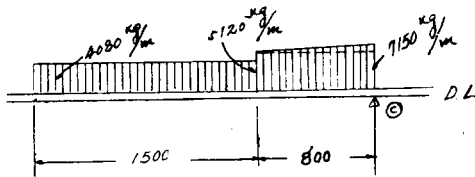
$$M_{max} = -3,094 \times 7.52^2 + 46,561 \times 7.52 + 1140 = -174,900 + 351,000 + 1,140 = 177,240kg-m$$

(2) 剪斷力

(i) 死荷重に依る剪斷力

$$S_d = \frac{\omega l}{2} = \frac{4,080 \times 15.0}{2} = 30,600 \text{ kg}$$

(ii) 活荷重に依る剪斷力



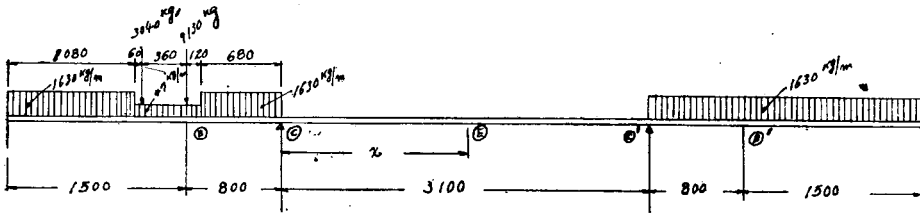
$$l = \frac{1}{15.0} \left(9,130 \times 15.0 + \frac{1,630 \times 13.8^2}{2} \right) + 47 \times 1.2 \times 14.4 = \frac{1}{15.0} (154,100 + 155,000 + 812) = 20,620 \text{ kg}$$

(iii) 最大剪斷力

$$S_{max} = S_d + S_l = 30,600 + 20,620 = 51,220 \text{ kg}$$

(3) 断面及應力強度

$$b = 10t + 2bs + b_0 = 180 + 72 + 65 = 317 \text{ cm} < \text{版中心線間距離} 325 \text{ cm}$$



$$A_s = 17 - 28\phi = 104.68 \text{ am}^2$$

$$X = -\frac{t(b-b_0) + nA_s}{b_0} + \sqrt{\left\{ \frac{t(b-b_0) + nA_s}{b_0} \right\}^2 + \frac{t^2(b-b_0) + 2nA_s d}{b_0}} = \frac{18(317-65) + 15 \times 104.68}{65} + \sqrt{\left\{ \frac{18(317-65) + 15 \times 104.68}{65} \right\}^2 + \frac{18^2(317-65) + 2 \times 15 \times 104.68 \times 150}{65}}$$

$$= -94 + \sqrt{8,836 + 8,500} = 37 \text{ cm}$$

$$Y = \frac{bx^3 - (b-b_0)(x-t)^3}{3nA_s(d-x)} = \frac{317 \times 37^3 - (317-65)(37-18)^3}{3 \times 15 \times 104.68(150-33)} = \frac{16,057,000 - 1,728,000}{532,298} = 27 \text{ cm}$$

$$T = \frac{M}{d-x+y} = \frac{17,724,000}{150-37+27} = 126,500 \text{ kg}$$

$$\delta_s = \frac{T}{A_s} = \frac{126,500}{104.68} = 1,210 \text{ kg/cm}^2$$

$$\delta_c = \sigma_s \frac{x}{n(d-x)} = 1,210 \times \frac{37}{15 \times (150-37)} = 26.4 \text{ kg}$$

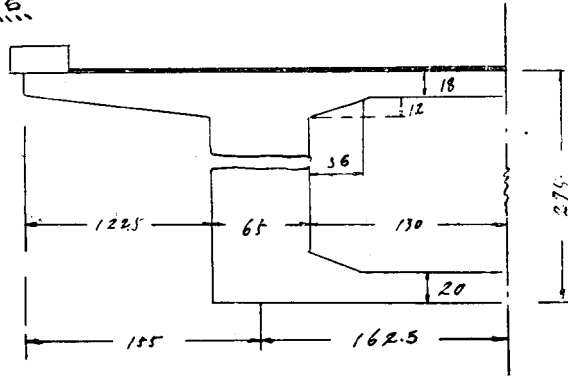
$$T = \frac{S}{bojd} = \frac{51,220}{65 \times \frac{3}{4} \times 184} = 4.9 \text{ kg/am}^2$$

7-28φを使用すれば

$$T_o = \frac{S}{u_o j d} = \frac{25,610}{7 \times 8,796 \times \frac{1}{8} \times 184} = 2.6 \text{ kg/cm}^2$$

(iv) A 點の剪斷力

㉑点

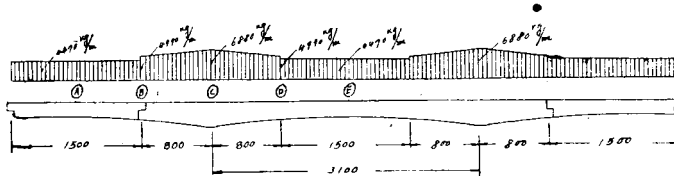


$$S_{max} = R_b = \frac{1}{15.0} (9,130 \times 7.5 + 3,040 \times 3.9 + 47 \times 4.2 \times 5.4 + \frac{1,630 \times 3.3^2}{2})$$

$$= \frac{1}{15.0} (53,475 + 11,856 + 1,066 + 8,875) = 5,025 \text{ kg}$$

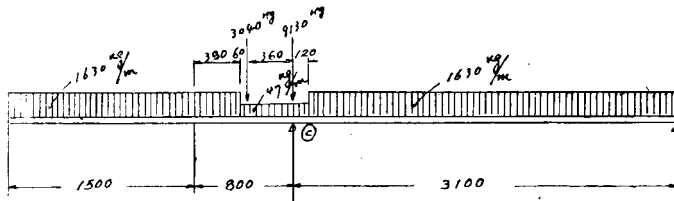
第 3 項 錠 着 徑 間

(1) 彎 曲 率



㉑点の彎曲率

(i) 死荷重に依る彎曲率

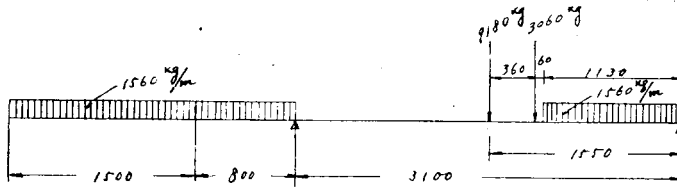


$$R_e = 30,600 + \frac{5,120 + 7,150}{2} \times 8.0 \times 2 + 4,080 \times 7.5 = 159,360 \text{ kg}$$

$$M_d = 159,360 \times 15.5 - 30,600 \times 23.5 - 98,160 \times 15.5 - \frac{4,080 \times 7.5^2}{2} = 2,470,000 - 719,000$$

$$- 1,521,000 - 115,000 = 115,000 \text{ kg-m}$$

(ii) 最大彎曲率

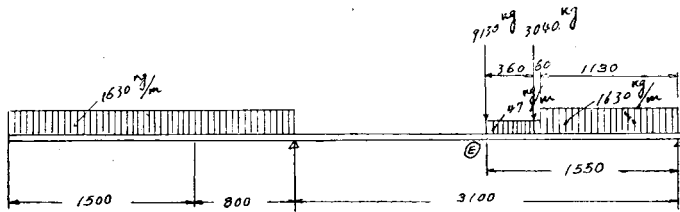


$$R = \frac{1}{31.0} \left[1,630(x-1.2) \left(31.0 - \frac{x-1.2}{2} \right) 47 \times 5.4(29.5-x) + \frac{1,630(26.8-x)^2}{2} \right. \\ \left. + 9,130(31.0-x) + 3,040(27.4-x) \right] + 159,360 = \frac{1}{31.0} \left[52,486x - 815x^2 - 61,810 \right. \\ \left. + 7,487 - 254x - 585,365 - 43,684x + 815x^2 + 283,030 - 9,130x + 83,296 - 3,040x \right] \\ + 159,360 = \frac{1}{31.0} (-3,622x + 897,368) + 159,360 = 117x + 188,260$$

$$Mx = (-177x + 188,260)x - 1,630(x-1.2) \left(x - \frac{x-1.2}{2} \right) - \frac{47 \times 1.2^2}{2} - 30,600(8.0+x) \\ - 98,160x - \frac{4,080(x-8.0)^2}{2} = -117x^2 + 188,260x - 815x^2 + 1,174 - 34 - 244,800 \\ - 30,600x - 98,160x - 2,040x^2 + 32,640x - 130,560 = -2,972x^2 + 92,140x - 374,230 \\ \frac{\sigma Mx}{\sigma x} = -5,944x + 92,140 = 0 \therefore x = \frac{92,140}{5,944} = 15.50$$

$$M_{max} = -2,972 \times 15.5^2 + 92,140 \times 15.5 - 374,230 = -714,000 + 1,428,170 - 374,230 \\ = 339,940 \text{ kg-m}$$

(iii) 最小彎曲率



$$Rb = \frac{1}{15} \left(9,130 \times 15.0 + 3,040 \times 11.4 + 47 \times 4.2 \times 12.9 + \frac{1,630 \times 10.8^2}{2} \right) \\ = \frac{1}{15} (136,950 + 34,656 + 2,546 + 2,546 + 95,062) = 17,900 \text{ kg}$$

$$R'b = 1,630 \times 7.5 = 12,230 \text{ kg}$$

$$Rc = \frac{1}{31.0} \left(17,900 \times 39.0 + 47 \times 1.2 \times 38.4 + 1,630 \times 6.8 \times 34.4 - 12,230 \times 8.0 - \frac{1,630 \times 8.0^2}{2} \right) \\ = \frac{1}{31.0} (698,600 + 2,165 + 386,290 - 97,840 - 52,160) = 30,200 \text{ kg}$$

$$Mx = (159,360 + 30,200)x - 30,600(x+8.0) - 98,160x - \frac{4,080(x-8.0)^2}{2}$$

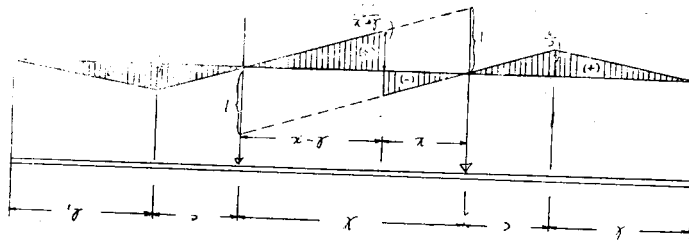
$$\begin{aligned}
 & -17,900(x+8.0) - 47 \times 1.2(x+7.4) - 1,630 \times 6.8(x+3.4) \\
 & = 189,560x - 30,600x - 244,800 - 98,160x - 2,040x^2 + 32,640x - 130,560 - 17,900x - 143,200 \\
 & \quad - 56x - 414 - 11,084x - 37,686 = -2,040x^2 + 64,400x - 556,660
 \end{aligned}$$

$$\frac{\delta Mx}{\delta x} = -4,080x + 64,400 = 0 \quad \therefore x = \frac{64,400}{4,080} = 15.76m \doteq 15.8$$

$$\begin{aligned}
 \therefore M_{min} &= -2,040 \times 15.8^2 + 64,400 \times 15.8 - 556,660 \\
 &= 509,266 + 1,017,520 - 556,660 \\
 &= -48,406kg-m
 \end{aligned}$$

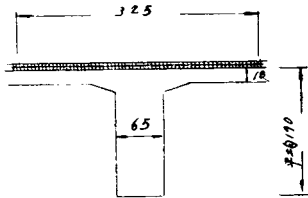
◎ 點の彎曲率

(i) 死荷重に依る彎曲率



$$\begin{aligned}
 -Md &= 30,600 \times 8.0 + \frac{5,120 + 8.0^2}{2} + 2,030 \times \frac{8.0}{2} \times \frac{8.0}{3} \\
 &= 244,800 + 163,840 + 25,984 = 434,624kg-m
 \end{aligned}$$

(ii) 活荷重に依る彎曲率

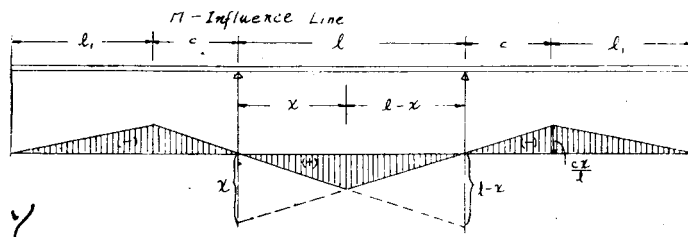


$$\begin{aligned}
 -Ml &= 17,900 \times 8.0 + 47 \times 1.2 \times 7.4 + \frac{1,630 \times 6.8^2}{2} \\
 &= 143,200 + 417 + 37,686 = 181,303kg-m
 \end{aligned}$$

(iii) 最大彎曲率

$$-M_{max} = 434,624 \times 181,303 = 615,927kg-m$$

(2) 剪 斷 力

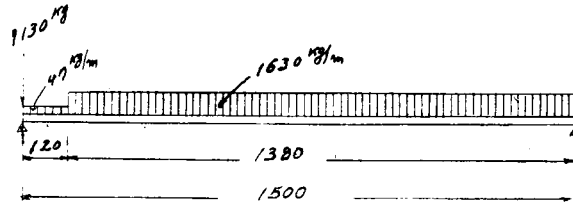


◎ 點の剪斷力 (31m 徑間側)

(i) 死荷重に依る剪斷力

$$Sd = 4,080 \times 7.5 + \frac{5,120 + 7.150}{2} \times 8.0 = 30,600 + 49,080 = 79,680kg$$

(ii) 活荷重に依る剪斷力



$$R_c = \frac{1}{31.0} (1,630 \times 7.5 \times 39.0 + 1,630 \times 3.8 \times 37.1 + 47 \times 5.4 \times 32.5 + 3,040 \times 34.6 + 9,130 \times 31.0 + \frac{1,630 + 29.8^2}{2})$$

$$= \frac{1}{31.0} (476,970 + 229,797 + 8,249 + 105,184 + 283,030 + 723,720) = 58,934 \text{ kg}$$

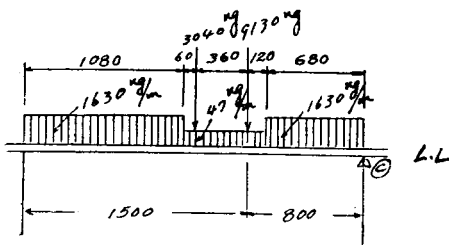
$$S_l = 58,934 - 12,230 - 1,636 \times 3.8 - 47 \times 4.2 - 3,040 = 37,273 \text{ kg}$$

$$S_{max} = 79,680 + 37,273 = 116,953 \text{ kg}$$

㊦点の剪斷力

(i) 死荷重に依る剪斷力は影響線に依り、明かなる如く零である。

(ii) 活荷重に依る剪斷力



$$R_c = \frac{1}{31.0} (12,230 \times 39.0 + 1,630 \times 8.0 \times 35.0 + 9,130 \times 15.5 + 3,040 \times 11.9 + 47 \times 4.2 \times 13.4 + \frac{1,630 \times 11.3^2}{2})$$

$$= \frac{1}{31.0} (476,970 + 456,400 + 141,515 + 36,176 + 2,645 + 104,067) = 39,500 \text{ kg}$$

$$S_{min} = 39,500 - 12,230 - 1,630 \times 8.0 = 14,230 \text{ kg}$$

㊦点の剪斷力 (突桁側)

(i) 死荷重に依る剪斷力

$$S_d = 79,680 \text{ kg}$$

(ii) 活荷重に依る剪斷力

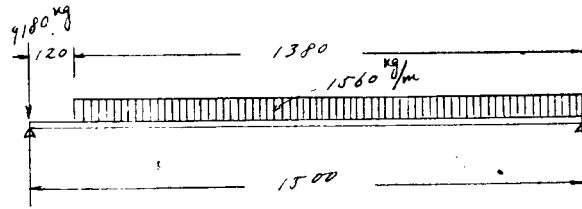
$$S_l = 12,230 + 1,630 \times 3.8 + 47 \times 4.2 + 3,040 + 9,130 = 30,791 \text{ kg}$$

(iii) 最大剪斷力

$$S_{max} = 79,680 + 30,791 = 110,471 \text{ kg}$$

(3) 断面及應力強度

㊦点



$$A_s = 21 - 36\phi = 21 \times 10.179 = 213.759 \text{ cm}^2$$

$$X = \frac{t(b-b_0) + nA_s}{b_0} + \sqrt{\left\{ \frac{t(b-b_0) + nA_s}{b_0} \right\}^2 + \frac{t^2(b-b_0) + 2nA_s d}{b_0}}$$

$$= \frac{18(317-65) + 15 \times 213.759}{65} + \sqrt{\left\{ \right\}^2 + \frac{18^2(317-65) + 2 \times 213.759 \times 147}{65}}$$

$$= -119 + \sqrt{14,161 + 15,900} = -119 + 173 = 54 \text{ cm}$$

$$Y = \frac{bx^3 - (b-b_0)(x-t)^3}{3nA_s(d-x)} = \frac{317 \times 56^3 - (317-65)(54-18)^3}{3 \times 15 \times 213.759(147-54)}$$

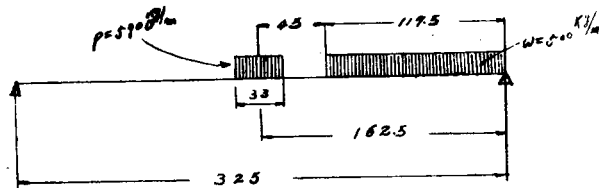
$$= \frac{49,916,088 - 11,757,312}{894,581} = \frac{38,158,776}{894,581} = 42.6 \div 43 \text{ an}$$

$$T = \frac{M}{d-x-y} = \frac{33,994,000}{147-54+43} = 250,000 \text{ kg}$$

$$\sigma_s = \frac{T}{A_s} = \frac{250,000}{213,759} = 1170 \text{ kg/am}^2$$

$$\sigma_c = \sigma_s \frac{x}{n(d-x)} = 1,170 \times \frac{56}{15(147-54)} = 44.6 \text{ kg/cm}^2$$

◎點



$$A_s = 21 - 36\phi = 21 \times 10.179 = 213.759 \text{ cm}^2$$

$$X = -\frac{t(b-b_0) + nA_s}{b_0} + \sqrt{\left\{ \frac{t(b-b_0) + nA_s}{b_0} \right\}^2 + \frac{t^2(b-b_0) + 2nA_s d}{b_0}}$$

$$= -\frac{18(317-65) + 15 \times 213.759}{65} + \sqrt{\left\{ \right\}^2 + \frac{18^2(317-65) + 2 \times 15 \times 213.759 \times 267}{65}}$$

$$= -119 + 202 = 83 \text{ cm}$$

$$Y = \frac{bx^3 - (b-b_0)(x-t)^3}{3nA_s(d-x)} = \frac{317 \times 83^3 - (317-65)(83-18)^3}{3 \times 15 \times 213.759(267-83)}$$

$$= \frac{181,256,479 - 69,205,500}{1,779,924} = 63 \text{ cm}$$

$$T = \frac{M}{d-x+y} = \frac{61,592,700}{267-83+63} = 249,000kg$$

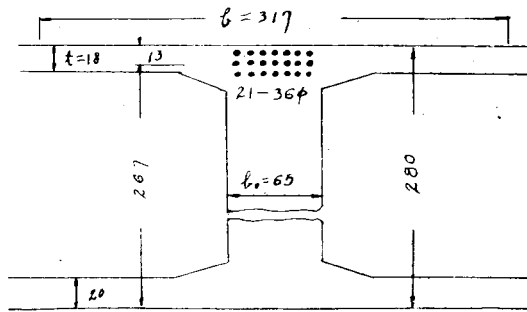
$$\sigma_s = \frac{T}{As} = \frac{249,000}{213,759} = 1,172kg/cm^2$$

$$\sigma_c = \sigma_s \frac{X}{n(d-x)} = 1,172 \times \frac{83}{15(267-83)} = 53.2 \div 35kg/cm^2$$

$$T = \frac{S}{bojd} = \frac{116,953}{65 \times \frac{7}{8} \times 267} = \frac{116,953}{15,150} = 7.8kg/cm^2$$

$$T_o = \frac{S}{ujd} = \frac{58,477}{21 \times 11.31 \times \frac{7}{8} \times 267} = \frac{58,477}{54,650} = 1.07kg/cm^2$$

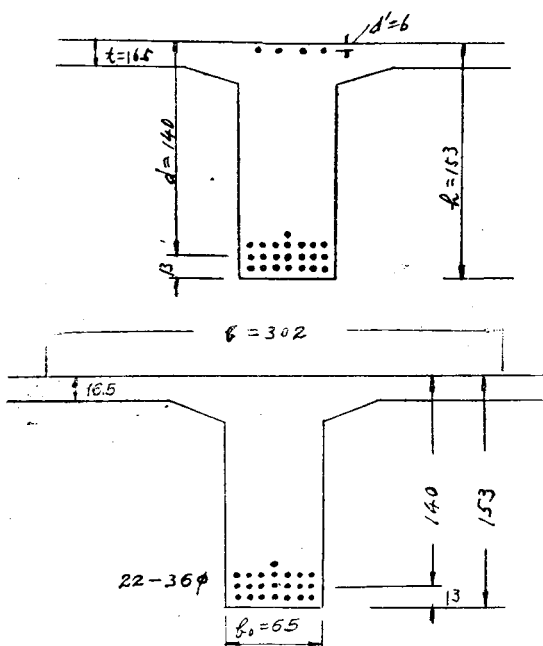
以上の結果を總括すれば



第 4 章 側 桁 の 設 計

第 1 項 荷 重

(1) 死 荷 重 計算を簡單にする爲次の如く假定す

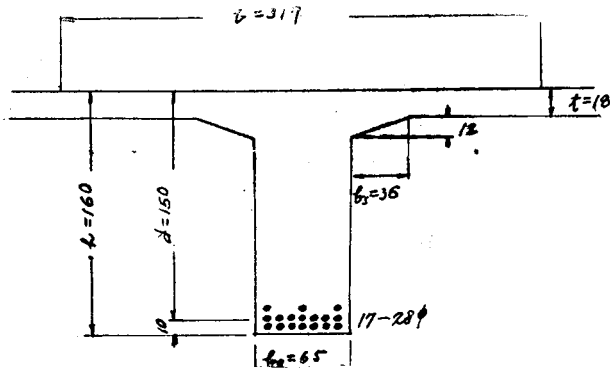


㊦㊦點

高 欄	250
地 覆	$0.40 \times 0.18 \times 2,400 =$	173
鋪 裝	$2.875 \times 0.03 \times 2,100 =$	181
床 版	$1.30 \times 0.18 \times 2,400 =$	562
〃	$1.225 \times 0.225 \times 2,400 =$	662
ハウレチ	$0.12 \times 0.36 \times \frac{1}{2} \times 2,400 =$	52
添架物	50
桁	$1.63 \times 0.65 \times 2,400 =$	2,543

計 = 4,473

$\div 4,470kg/m$

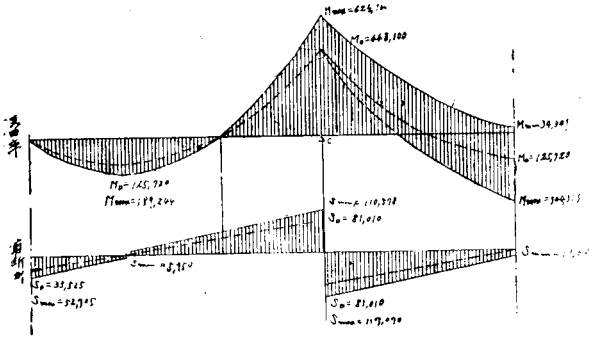


④ ~ ⑤断面.....4,470
 底版 $0.15 \times 1.30 \times 2,400 = 468$
 ハウレチ52

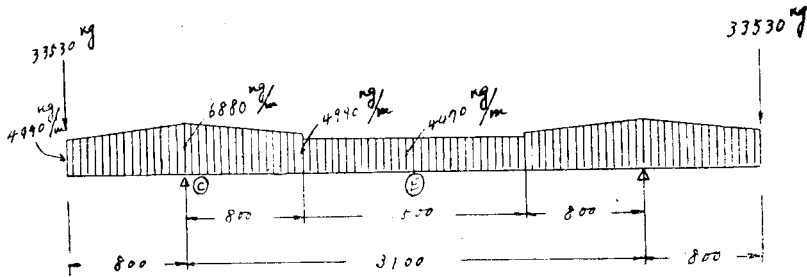
計 = 4,990 kg/m

高欄 250
 地覆 170
 舗装 181
 床版 562
 " 662
 ハウレチ 52
 添架物 50
 桁 $2.74 \times 0.65 \times 2,400 = 4,274$
 底版 $1.30 \times 0.20 \times 2,400 = 624$
 ハウレチ 52

計 = 6,880 kg/m



(2) 活荷重



$$R_1 = \frac{P}{3.25} (4.05 + 2.25 + 1.35) = \frac{7.65}{3.25} P = 2.354P$$

$$\therefore \begin{cases} \text{前輪} & 2.354 \times 1,300 = 3,060 \\ \text{後輪} & 2.354 \times 3,900 = 9,180 \end{cases}$$

$$R_2 = \frac{500 \times 4.50^2}{3.25 \times 2} = 1,558 kg \doteq 1560 kg$$

第2項 吊桁 徑間

(1) 彎曲力率

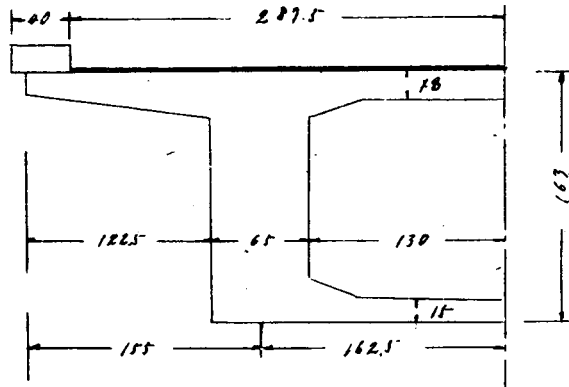
(i) 死荷重に依る彎曲率

$$M_d = \frac{4,470 \times 15,0^2}{8} = 125,719 = 125,720 \text{ kg-m}$$

(ii) 最大彎曲率

$$\begin{aligned} R_b &= \frac{1}{15,0} \left[1,560(x-1,2) \left(150 - \frac{x-1,2}{2} \right) + 1,560 \frac{(10,8-x)^2}{2} + 9,180(15,0-x) \right. \\ &\quad \left. + 3,060 \times (11,4-x) \right] + 4,470 \times 7,5 = \frac{1}{15} \left[25,740x - 780x^2 - 29,203 + 90,979 - 16,848x \right. \\ &\quad \left. + 780x^2 + 137,700 - 9,180x + 34,884 - 3,060x \right] + 33,525 \\ &= \frac{1}{15,0} \left[-3,348x + 234,360 \right] + 33,525 = -223,6x + 15,624 + 33,525 \\ &= -223,6x + 49,149 \end{aligned}$$

ⓑ ⓓ 点



$$\begin{aligned} M_x &= (-223x + 49,149)x - 1,560(x-1,2) \left(x - \frac{x-1,2}{2} - \frac{4,470x^2}{2} \right) \\ &= -223x^2 + 49,149x - 780x^2 + 1,123 - 2235x^2 = -3,238x^2 + 49,149x + 1,123 \end{aligned}$$

$$\frac{\delta M_x}{\delta x} = -6,476x + 49,149 = 0 \quad 1.x = \frac{49,149}{6,476} = 7.56 \text{ m}$$

$$\begin{aligned} M_{max} &= -3,238 \times 7.56^2 + 49,149 \times 7.56 + 1,123 \\ &= 183,444 + 371,567 + 1,123 = 189,244 \text{ kg-m} \end{aligned}$$

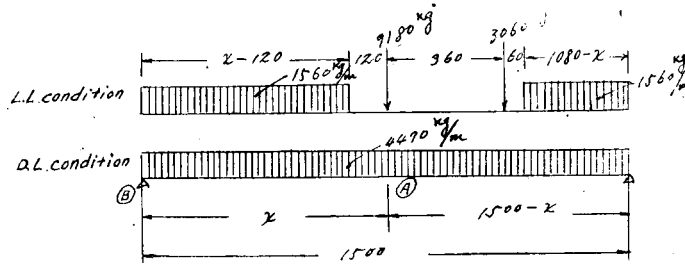
(2) 剪 斷 力

(i) 死荷重に依る剪斷力

$$S_d = \frac{4,470 \times 15,0}{2} = 33,525 \text{ kg}$$

(ii) 活荷重に依る剪斷力

$$S_l = \frac{1}{15,0} \left(9,180 \times 15,0 \times \frac{1,560 \times 13,80^2}{2} \right) = \frac{1}{15,0} (137,700 + 148,543) = 19,180 \text{ kg}$$



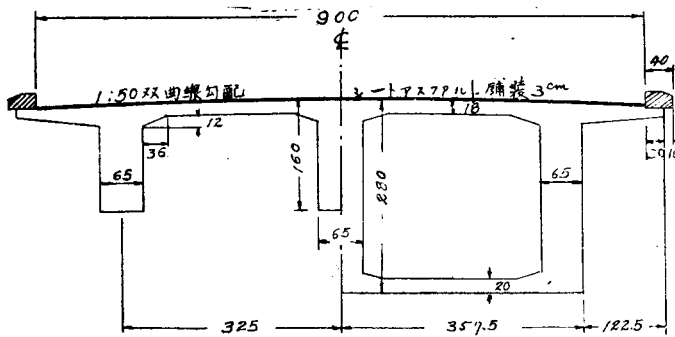
(iii) 最大剪斷力

$$S_{m_0x} = 33,525 + 19,180 = 52,705 \text{ kg}$$

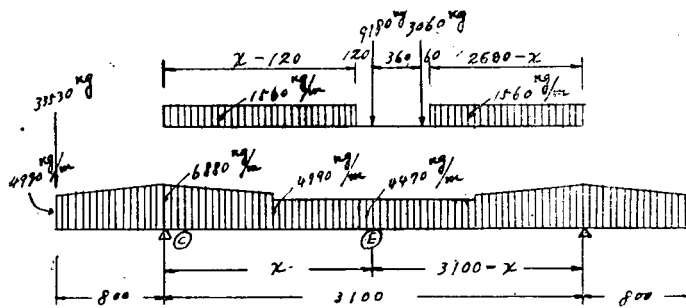
(iv) ㊸ 點の剪斷力

$$S_{min} = \frac{1}{15.0} (9,180 \times 7.5 + 3,060 \times 3.9 + \frac{1,560 \times 3.3^2}{2})$$

$$= \frac{1}{15.0} (68,850 + 11,934 + 8,494) = 5,950 \text{ kg}$$



(3) 斷面及應力強度



$$b = 10t + 2bs + b_0 = 165 + 72 + 65 = 302 \text{ cm} > 317$$

$$A_s = 20 - 28\phi = 20 \times 6.16 = 123.20 \text{ cm}$$

$$X = -\frac{t(b-b_0) + nA_s}{65} + \sqrt{\left\{ \frac{t(b-b_0) + nA_s}{65} \right\}^2 + \frac{16.5^2 \times 237 + 2 \times 15 \times 117.04 \times 142}{65}}$$

$$= -\frac{3,911 + 1,848}{65} + \sqrt{\left\{ \right\}^2 + \frac{64,523 + 524,832}{65}} = -89 + \sqrt{89^2 + 9,060} = -89 + 129 = 40 \text{ cm}$$

$$Y = \frac{bx^2 - (b-b_0)(x-t)^2}{3nAs(d-x)} = \frac{302 \times 40^2 - 237 \times 23.5^2}{3 \times 15 \times 123.2 \times 102} = \frac{19,328,000 - 3,075,756}{565,488} = 29cm$$

$$T = \frac{M}{d-x+y} = \frac{18,924,400}{142-40+29} = 145,000$$

$$\sigma_s = \frac{T}{As} = \frac{145,000}{123.2} = 1,170kg/cm^2$$

$$\sigma_c = \sigma_s \times \frac{X}{n(d-x)} = 1,170 \times \frac{40}{15(14^2-40)} = 30.6kg/cm^2$$

$$T = \frac{S}{bojd} = \frac{52,705}{65 \times \frac{7}{8} \times 179} = \frac{52,705}{10,200} = 5.16kg/cm^2$$

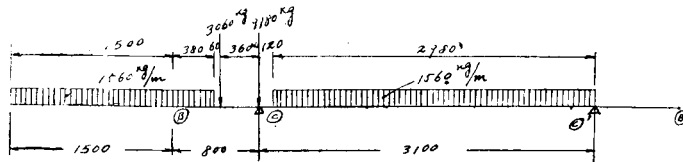
$$T_0 = \frac{S}{u_jd} = \frac{26,353}{7 \times 8.796 \times \frac{7}{8} \times 179} = \frac{26,353}{9,650} = 2.7kg/cm^2$$

第3項 錠着 徑 間

(1) 彎曲力率

㊦點の彎曲率

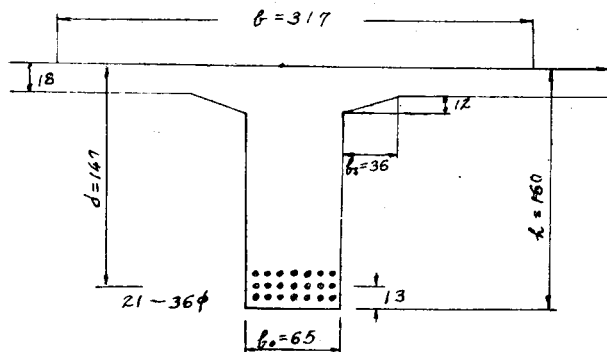
(i) 死荷重に依る彎曲率



$$R_c = 33,530 + \frac{4,990 + 6,880}{2} \times 8.0 \times 2 + 4.470 \times 7.5 = 33,530 + 94,960 + 33,530 = 162,020kg$$

$$M_d = 162,020 \times 15.5 - 33,530 \times 23.5 - 94,960 \times 15.5 - \frac{4,470 \times 7.5^2}{2} = 2,511,310 - 787,955 - 1,471,880 - 125,719 = 125,720kg-m$$

(ii) 最大彎曲率



$$R_c = \frac{1}{31.0} \left[1,560(x-1.2) \left(31.0 - \frac{x-1.2}{2} \right) + \frac{1,560(26.8-x)^2}{2} + 9,180 \times (31.0-x) + 3,060(27.4-x) \right] + 162,020$$

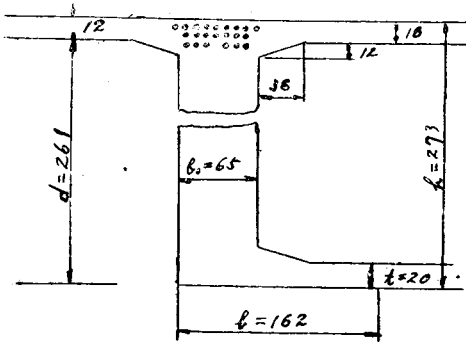
$$= \frac{1}{31.0} \left\{ 50,232x - 780x^2 - 59,155 + 560,227 - 41,808x + 780x^2 + 284,580 \right. \\ \left. - 9,180x + 83,844 - 3,060x \right\} + 162,020 \\ = \frac{1}{31.0} \left\{ -3,816x + 869,496 \right\} + 162,020 = -123x + 28,050 + 162,020 = -123x + 190,070$$

$$Mx = (-123x + 190,070)x - 1,560(x - 1.2)\left(x - \frac{x - 1.2}{2}\right) - 33,530(8.0 + x) - 94,960x \\ - \frac{4,470(x - 8.0)^2}{2} = -123x^2 + 190,070x - 780x^2 + 1,123 - 268,240 - 33,530x - 94,960x \\ - 2,235x^2 + 35,760x - 143,040 = -3,138x^2 + 97,340x - 410,157$$

$$\frac{\delta Mx}{\delta x} = -6,276x + 97,340 = 0 \quad \therefore x = \frac{97,340}{6,276} = 15.50m$$

$$Mmax = -3,139 \times 15.5^2 + 97,330 \times 15.5 - 410,157 \\ = -754,145 + 1,508,615 - 410,157 + 344,313kg-m$$

(iii) 最小彎曲率



$$R = \frac{1}{15.0} \left(3,060 \times 11.4 + \frac{1,560 \times 10.8^2}{2} \right) \\ + 9,180 = \frac{1}{15} (34,884 + 90,979) + 9,180 \\ = 8,330 + 9,180 = 17,560kg \\ R_b = 1,560 \times 7.5 = 11,700kg \\ R_e = \frac{1}{31.0} \left\{ 17,560 \times 39.0 + 1,560 \times 6.8 \times 34.4 \right. \\ \left. - 11,700 \times 8.0 - \frac{1,560 \times 8.0^2}{2} \right\}$$

$$= \frac{1}{31.0} \left\{ 684,840 + 364,915 - 93,600 - 49,920 \right\} = \frac{906,235}{31} = 29,220kg$$

$$Mx = (162,020 + 29,220)x - 17,560(x + 8.0) - 1,560 \times 6.8 \times (x + 3.4) - 33,530(x + 8.0) \\ - 94,960x - \frac{4,470 \times (x - 8.0)^2}{2} \\ = 191,240x - 17,560x - 140,480 - 10,608x - 36,067 - 33,530x - 268,240 \\ - 94,960x - 2,235x^2 + 35,760x - 143,040 \\ = 70,342x - 2,235x^2 - 587,827$$

$$\frac{\delta Mx}{\delta x} = -4,470x + 70,342 = 0 \quad \therefore x^2 = \frac{70,342}{4,470} = 15.72$$

$$Mmin = -2,235 \times 15.72x^2 + 70,342 \times 15.72 - 587,827 \\ = 552,310 + 1,105,776 - 587,827 = -34,361kg-m$$

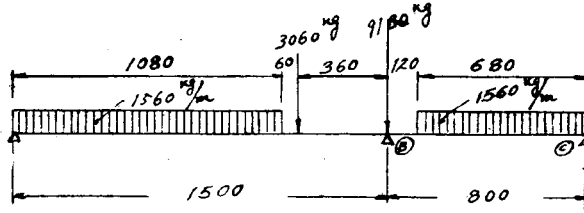
◎ 點の彎曲率

(i) 死荷重に依る彎曲率

$$M_d = 33,530 \times 8.0 + \frac{4,990 \times 8.0^2}{2} + \frac{1,890 \times 8.0}{2} \times 2.67$$

$$= 268,240 + 159,680 + 20,185 = 448,105 \text{ kg-m} \doteq 448,100 \text{ kg-m}$$

(ii) 活荷重に依る彎曲率



$$R_b = 17,560 \text{ kg} \dots\dots (\text{最小彎曲率の項参照})$$

$$M_l = 17,560 \times 8.0 + 1,560 \times \frac{6.8^2}{2} = 140,480 + 36,067 = 176,547 \text{ kg-m}$$

(iii) 最大彎曲率

$$M_{max} = 448,100 + 176,547 = 624,700 \text{ kg-m}$$

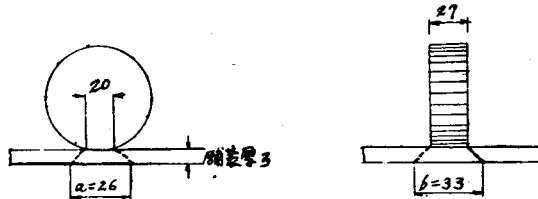
(2) 剪 斷 力

◎ 點の剪斷力 (31米徑間側)

(i) 死荷重に依る剪斷力

$$S_d = 33,530 + \frac{4,990 + 6,880}{2} \times 8.0 = 81,010 \text{ kg}$$

(ii) 活荷重に依る剪斷力



$$R_c = \frac{1}{31.0} \left[11,700 \times 39.0 + 1,560 \times 3.8 \times 3.71 + \frac{1,560 + 298^2}{2} + 3,060 \times 34.6 + 9,180 \times 31.0 \right]$$

$$= \frac{1}{31.0} \left[456,300 + 219,929 + 692,671 + 105,876 + 284,580 \right] \doteq 36,750 \text{ kg}$$

$$S_l = 56,750 - 11,700 - 1,560 \times 3.8 - 3,060 = 36,060 \text{ kg}$$

(iii) 最大剪斷力

$$S_{max} = 81,010 + 36,060 = 117,070 \text{ kg}$$

◎ 點の剪斷力 (突桁側)

(i) 死荷重に依る剪斷力

$$S_d = 81,010 \text{ kg}$$

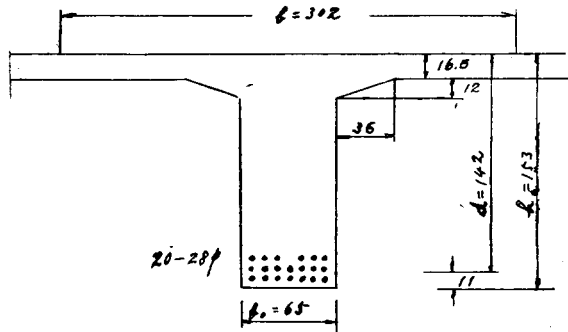
(ii) 活荷重に依る剪斷力

$$S_l = 11,700 + 1,560 \times 3.8 + 3,060 + 9,180 = 29,868 \text{ kg}$$

(iii) 最大剪斷力

$$S_{max} = 81,010 + 29,868 = 110,878 \text{ kg}$$

㊦ 點の剪斷力



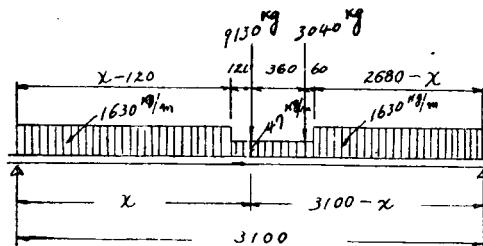
$$R_c = \frac{1}{31.0} \left[11,700 \times 39.0 + 1,560 \times 8.0 \times 35.0 + 9,180 \times 15.5 + 3,060 \times 11.9 + \frac{1,560 \times 11.3^2}{2} \right]$$

$$= \frac{1}{31.0} (456,300 + 436,800 + 142,290 + 36,414 + 99,598) = 37,800 \text{ kg}$$

$$S_{min} = 37,800 - 11,700 - 1,560 \times 8.0 = 13,620 \text{ kg}$$

(3) 斷面及應力強度

㊦ 點



$$A_s = 22 - 36 \phi = 22 \times 10,179 = 223,938 \text{ cm}^2$$

$$X = -\frac{t(b-bo) + nA_s}{bo} + \sqrt{\left\{ \frac{t(b-bo) + nA_s}{bo} \right\}^2 + \frac{t^2(b-bo) + 2nA_s d}{65}}$$

$$= -\frac{16.5 \times 237 + 15 \times 223,938}{65} + \sqrt{\left\{ \right\}^2 + \frac{16.5^2 \times 237 + 2 \times 15 \times 223,938 \times 140}{65}}$$

$$= -\frac{7,270}{65} + \sqrt{\left\{ \right\}^2 + \frac{1,011,781}{65}} = -112 + \sqrt{112 + 15,100} = -112 + 166 = 54 \text{ cm}$$

$$Y = \frac{bx^3 - (b-bo)(x-t)^3}{3nA_s(d-x)} = \frac{302 \times 54^3 - 237 \times 37.5^3}{3 \times 15 \times 223,938 \times 86} = \frac{47,554,128 - 12,498,047}{479,640}$$

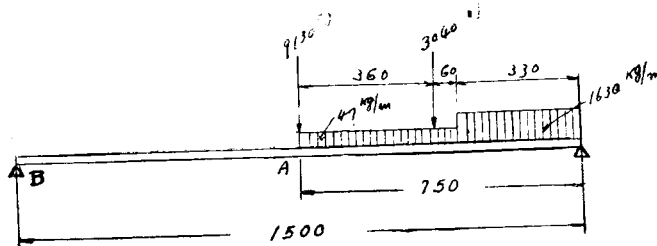
$$= \frac{35,056,081}{866,640} = 41 \text{ cm}$$

$$T = \frac{M}{d-x+y} = \frac{34,431,300}{140-54+41} = \frac{34,431,300}{127} = 271,000 \text{ kg}$$

$$\delta_s = \frac{T}{A_s} = \frac{271,000}{223,938} = 1,200 \text{ kg/cm}^2$$

$$\delta_c = \delta_s \frac{x}{n(d-x)} = \frac{54}{15(140-54)} \times 1,200 = \frac{54}{1,290} \times 1,200 = 50 \text{ kg/cm}^2$$

◎點



$$B = 4t + b_1 + b_s = 4 \times 20 + 65 + 36 = 181 \text{ cm} > \frac{3.25}{2} = 162.5 \text{ cm}$$

$$A_s = 22 - 36 \phi = 22 \times 10.179 = 223,938 \text{ cm}^2$$

$$\begin{aligned} X &= -\frac{t(b-bo+nAs)}{65} + \sqrt{\left\{ \frac{t(b-bo+nAs)}{bo} \right\}^2 + \frac{t^2(b-bo)+2nAsd}{bo}} \\ &= -\frac{20 \times 97 + 15 \times 223,938}{65} + \sqrt{\left\{ \frac{20 \times 97 + 15 \times 223,938}{65} \right\}^2 + \frac{20^2 \times 97 + 2 \times 15 \times 223,938 \times 261}{65}} \\ &= -\frac{5,299.07}{65} + \sqrt{\left\{ \frac{5,299.07}{65} \right\}^2 + \frac{19,400 + 1,753,435}{65}} = -81 + \sqrt{81^2 + 27,300} \\ &= -81 + 184 = 103 \text{ cm.} \end{aligned}$$

$$Y = \frac{bx^3 - (b-bo)(x-t)^2}{3nAs(d-x)} = \frac{162 \times 103^3 - 97 + 83^3}{3 \times 15 \times 223,938 \times 158} = \frac{177,005,574 - 55,463,339}{1,592,199} = 76 \text{ cm}$$

$$T = \frac{M}{d-x+y} = \frac{62,470,000}{261-103+76} = \frac{62,470,000}{234} = 267,000 \text{ kg}$$

$$\delta_s = \frac{T}{A_s} = \frac{267,000}{223,938} = 1,120 \text{ kg/cm}^2$$

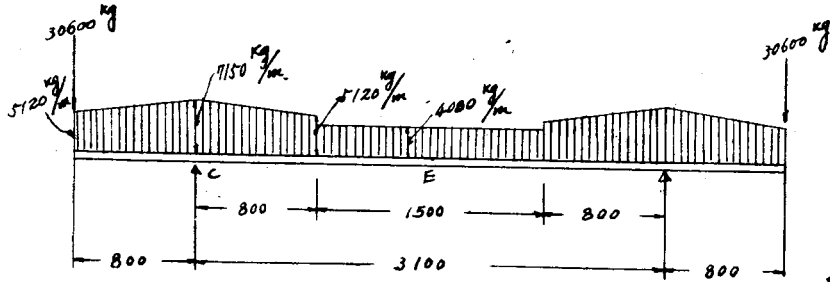
$$\delta_c = \delta_s \frac{X}{n(d-x)} = 1,120 \times \frac{103}{15 \times 158} = 48.6 \text{ kg/cm}^2$$

$$T = \frac{S}{bojd} = \frac{117,070}{65 \times \frac{7}{8} \times 261} = \frac{117,070}{65 \times 229} = 7.8 \text{ kg/cm}^2$$

$$T_o = \frac{S}{ujd} = \frac{58,535}{22 \times 11.31 \times 229} = \frac{58,535}{56,980} = 1.0 \text{ kg/cm}^2$$

組立鐵筋を抗壓鐵筋として考慮すれば

◎點



$$A_s = 22 - 36\phi = 223,938\text{cm}^2 \quad A_s' = 4 - 36\phi = 40,72\text{cm}^2$$

$$X = -\frac{t(b-bo) + n(As + As')}{bo} = \sqrt{\left\{ \frac{t(b-bo) + n(As + As')}{bo} \right\}^2 + \frac{t(b-bo) + 2n(Asd + As'd')}{bo}}$$

$$= -\frac{16.5(302-65)15 \times 264,658}{65} + \sqrt{\left\{ \right\}^2 + \frac{16.5(302-65) + 2 \times 15(223,938 \times 140 + 40,72 \times 6)}{65}}$$

$$= -\frac{3,991 + 3,969}{65} + \sqrt{\left\{ \right\}^2 + \frac{64,523 + 947,880}{65}}$$

$$= -121 + \sqrt{121^2 + 15,550} = -121 + 174 = 53\text{cm}$$

$$Y = \frac{bx^2 - (b-bo)(x-t)^2 + 3nAs'(x-d)^2}{3nAs(d-x)} = \frac{302 \times 53^2 - 237 \times 36.5^2 + 3 \times 15 \times 40,72 \times 47^2}{3 \times 15 \times 87 \times 223,938}$$

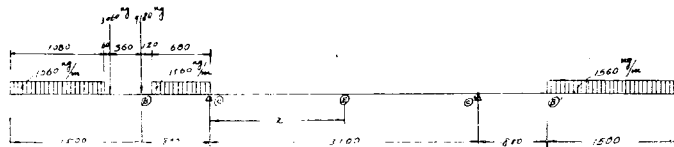
$$= \frac{44,960,854 - 11,524,599 + 4,047,772}{876,717} = \frac{37,484,027}{876,717} = 43\text{cm}$$

$$T = \frac{M}{d-x+y} = \frac{34,431,300}{140-53+43} = \frac{34,431,300}{130} = 265,000\text{kg}$$

$$\delta s = \frac{T}{A_s} = \frac{265,000}{223,938} = 1,110\text{kg/cm}^2$$

$$\delta c = \frac{\sigma_s X}{n(d-x)} = 1,110 \times \frac{53}{15 \times 87} = 45\text{kg/cm}^2$$

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$$A_s = 22 - 36\phi = 223,938\text{cm}^2 \quad A_s' = 7 - 36\phi = 71,25\text{cm}^2$$

$$= -\frac{20(162-65) + 15(223,938 + 71,25)}{65}$$

$$+ \sqrt{\left\{ \right\}^2 + \frac{20(162-65) + 215(223,938) \times 2,61 + 71,25 \times 6}{65}}$$

$$= -\frac{1,940 + 4,428}{65} + \sqrt{\left\{ \right\}^2 + \frac{38,800 + 30 \times 58,876}{65}}$$

$$= -\frac{6,368}{65} + \sqrt{\left\{ \right\}^2 + \frac{1,805,080}{65}}$$

$$= -98 + \sqrt{98^2 + 27,800} = -98 + 193 = 95 \text{ cm}$$

$$Y = \frac{162 \times 95^2 - (162 - 65)(95 - 20)^2 + 3 \times 15 \times 71.25(95 - 6)^2}{3 \times 15 \times 223.938(261 - 95)}$$

$$= \frac{162 \times 853,375 - 97 \times 321,875 + 3,206 \times 3,206 \times 9,025}{10,077 \times 166}$$

$$\times \frac{138,894,750 - 31,221,875 + 28,934,150}{1,662,782} = \frac{136,607,027}{1,662,782} = 82 \text{ cm}$$

$$T = \frac{M}{d - x + y} = \frac{62,470,000}{261 - 95 + 82} = 251,500 \text{ kg}$$

$$\hat{\epsilon} a = \frac{T}{A_s} = \frac{251,500}{223,938} = 1,050 \text{ kg/cm}^2$$

$$\delta c = \frac{\sigma_s X}{n(d - x)} = 1,050 \times \frac{95}{15 \times 166} = 1,050 \times 0,0382 = 40 \text{ kg/cm}^2$$

以上の結果を總括すれば

