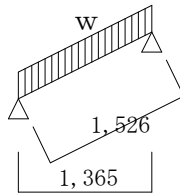


# 1 垂木の設計

## ◇ 垂木 1



屋根勾配 .....	$\theta = 26.57^\circ$
垂木スパン .....	$L1 = 1.365 / 0.8944 = 1.526\text{m}$
垂木ピッチ .....	$B = 0.455\text{m}$
水平投影面屋根荷重(固定)	
一般部 .....	$G = 380\text{N/m}^2$
軒先部 .....	$G = 380\text{N/m}^2$
積雪荷重 .....	$S = 876\text{N/m}^2$
風圧力(正圧) .....	$W1 = +323\text{N/m}^2$
(負圧) .....	$W2 = -474\text{N/m}^2$
軒先部風圧力(負圧) .....	$W3 = -1380\text{N/m}^2$

$$(\text{長期}) w = G \cdot B \cdot \cos 26.57^\circ = 380 \times 0.455 \times 0.8944 = 154.65\text{N/m} \text{ ——①}$$

$$(\text{積雪時}) w = (G + S) \cdot B \cdot \cos 26.57^\circ = (380 + 876) \times 0.455 \times 0.8944 = 511.15\text{N/m} \text{ ——②}$$

$$(\text{風圧時}) \text{正圧 } w = G + (W1 \cdot B) = 154.65 + (323 \times 0.455) = 301.61\text{N/m} \text{ ——③}$$

$$\text{負圧 } w = G - (W2 \cdot B) = 154.65 - (474 \times 0.455) = -61.02\text{N/m} \text{ ——④}$$

①/1.1 < ②/1.6 > ③/2 > ④/2より (積雪時)にて決定する。

$$M = w \cdot L1^2 / 8 = 511.15 \times 1.526^2 / 8 = 148.81\text{N} \cdot \text{m}$$

$$Q = w \cdot L1 / 2 = 511.15 \times 1.526 / 2 = 390.04\text{N}$$

使用材料 4.5cm × 6.0cm (甲種3級 すぎ)

$$A = 27.0\text{cm}^2 \quad Z_x = 27.0\text{cm}^3 \quad I_x = 81.0\text{cm}^4$$

$$\text{曲げ基準強度 } F_b = 22.2\text{N/mm}^2 \quad \text{せん断基準強度 } F_s = 1.8\text{N/mm}^2 \quad \text{ヤング係数 } E = 7000\text{N/mm}^2$$

$$\sigma_b = M / Z = 14881 / 27.0 = 551.15\text{N/cm}^2$$

$$\sigma_b / sfb = 551.15 / \{0.8 \times (2220 \times 2/3)\} = 0.465 < 1 \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 390.04) / 27.0 = 21.67\text{N}$$

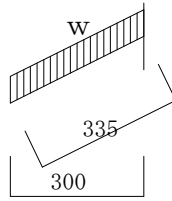
$$\tau / sfs = 21.67 / \{0.8 \times (180 \times 2/3)\} = 0.226 < 1 \therefore \text{O.K.}$$

$$\delta = 5 \cdot W \cdot L1^4 / 384 E \cdot I_x$$

$$= (5 \times 5.11 \times 152.61^4) / (384 \times 70.0 \times 10^4 \times 81.0) = 0.637\text{cm}$$

$$< L1 / 150 = 152.61 / 150 = 1.017\text{cm} \therefore \text{O.K.}$$

・ 軒先部



$$(\text{長期}) w = G \cdot B \cdot \cos 26.57^\circ = 380 \times 0.455 \times 0.8944 = 154.65 \text{ N/m} \quad \text{——①}$$

$$(\text{積雪時}) w = (G+S) \cdot B \cdot \cos 26.57^\circ = (380+876) \times 0.455 \times 0.8944 = 511.15 \text{ N/m} \quad \text{——②}$$

$$(\text{風圧時}) \text{負圧} w = G - (W_3 \cdot B) = 154.65 - (1380 \times 0.455) = -473.25 \text{ N/m} \quad \text{——③}$$

①/1.1 < ②/1.6 > ③/2 より (積雪時)にて決定する。

片持梁として

$$M = w \cdot L^2 / 2 = 511.15 \times 0.335^2 / 2 = 28.75 \text{ N} \cdot \text{m}$$

$$Q = w \cdot L = 511.15 \times 0.335 = 171.44 \text{ N}$$

使用材料 4.5cm × 6.0cm (甲種3級 すぎ)

$$A = 27.0 \text{ cm}^2 \quad Z_x = 27.0 \text{ cm}^3 \quad I_x = 81.0 \text{ cm}^4$$

曲げ基準強度  $F_b = 22.2 \text{ N/mm}^2$  せん断基準強度  $F_s = 1.8 \text{ N/mm}^2$  ヤング係数  $E = 7000 \text{ N/mm}^2$

$$\sigma_b = M/Z = 2875/27.0 = 106.49 \text{ N/cm}^2$$

$$\sigma_b / s f_b = 106.49 / \{0.8 \times (2220 \times 2/3)\} = 0.090 < 1 \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 171.44) / 27.0 = 9.52 \text{ N}$$

$$\tau / s f_s = 9.52 / \{0.8 \times (180 \times 2/3)\} = 0.099 < 1 \therefore \text{O.K.}$$

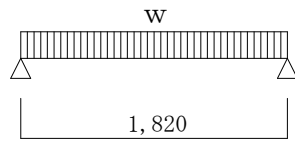
$$\delta = W \cdot L^4 / 8E \cdot I_x$$

$$= (5.11 \times 33.54^4) / (8 \times 70.0 \times 10^4 \times 81.0) = 0.014 \text{ cm}$$

$$< L/150 = 33.54/150 = 0.224 \text{ cm} \therefore \text{O.K.}$$

## 2 母屋の設計

### ◇ 母屋 1



屋根勾配 .....  $\theta = 26.57^\circ$   
 母屋ピッチ .....  $B = 1.1375\text{m}$   
 水平投影面屋根荷重(固定)  
     一般部 .....  $G = 436\text{N/m}^2$   
     けらば部 .....  $G = 436\text{N/m}^2$   
 積雪荷重 .....  $S = 876\text{N/m}^2$   
 風圧力(正圧) .....  $W1 = +323\text{N/m}^2$   
     (負圧) .....  $W2 = -474\text{N/m}^2$   
 けらば部風圧力(負圧) .....  $W3 = -1380\text{N/m}^2$

$$(\text{長期}) w = G \cdot B = 436 \times 1.1375 = 495.95\text{N/m} \quad \text{——①}$$

$$(\text{積雪時}) w = (G + S) \cdot B = (436 + 876) \times 1.1375 = 1492.40\text{N/m} \quad \text{——②}$$

$$(\text{風圧時}) \text{正圧 } w = G + (W1 \cdot B) \cdot \cos 26.57^\circ = 495.95 + (323 \times 1.1375) \times 0.8944 = 824.57\text{N/m} \quad \text{——③}$$

$$\text{負圧 } w = G - (W2 \cdot B) \cdot \cos 26.57^\circ = 495.95 - (474 \times 1.1375) \times 0.8944 = 13.70\text{N/m} \quad \text{——④}$$

①/1.1 < ②/1.6 > ③/2 > ④/2 より (積雪時)にて決定する。

$$M = w \cdot L1^2 / 8 = 1492.40 \times 1.820^2 / 8 = 617.93\text{N} \cdot \text{m}$$

$$Q = w \cdot L1 / 2 = 1492.40 \times 1.820 / 2 = 1358.08\text{N}$$

使用材料 10.5cm × 10.5cm (E110 ベいまつ)

$$A = 110.25\text{cm}^2 \quad Zx = 192.94\text{cm}^3 \quad Ix = 1012.92\text{cm}^4$$

$$\text{曲げ基準強度 } Fb = 30.6\text{N/mm}^2 \quad \text{せん断基準強度 } Fs = 2.4\text{N/mm}^2 \quad \text{ヤング係数 } E = 11000\text{N/mm}^2$$

$$\sigma b = M / Z = 61793 / 192.94 = 320.27\text{N/cm}^2$$

$$\sigma b / sfb = 320.27 / \{0.8 \times (3060 \times 2/3)\} = 0.196 < 1 \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1358.08) / 110.25 = 18.48\text{N}$$

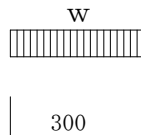
$$\tau / sfs = 18.48 / \{0.8 \times (240 \times 2/3)\} = 0.144 < 1 \therefore \text{O.K.}$$

$$\delta = 5 \cdot W \cdot L1^4 / 384E \cdot Ix$$

$$= (5 \times 14.92 \times 182.0^4) / (384 \times 110.0 \times 10^4 \times 1012.92) = 0.191\text{cm}$$

$$< L1 / 150 = 182.0 / 150 = 1.213\text{cm} \therefore \text{O.K.}$$

・ けらば部



$$(\text{長期}) w = G \cdot B = 436 \times 1.138 = 495.95 \text{ N/m} \quad \text{——①}$$

$$(\text{積雪時}) w = (G + S) \cdot B = (436 + 876) \times 1.138 = 1492.40 \text{ N/m} \quad \text{——②}$$

$$(\text{風圧時}) \text{負圧} w = G - (W \cdot B) \cdot \cos 26.57^\circ = 495.95 - (1380 \times 1.138) \times 0.8944 = -908.08 \text{ N/m} \quad \text{——③}$$

①/1.1 < ②/1.6 > ③/2 より (積雪時)にて決定する。

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片持梁として

$$M = w \cdot L^2 / 2 = 1492.40 \times 0.300^2 / 2 = 67.16 \text{ N} \cdot \text{m}$$

$$Q = w \cdot L = 1492.40 \times 0.300 = 447.72 \text{ N}$$

使用材料 10.5cm × 10.5cm (E110 べいまつ)

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$$A = 110.25 \text{ cm}^2 \quad Z_x = 192.94 \text{ cm}^3 \quad I_x = 1012.92 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 30.6 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 11000 \text{ N/mm}^2$$

$$\sigma_b = M / Z = 6716 / 192.94 = 34.81 \text{ N/cm}^2$$

$$\sigma_b / s_f b = 34.81 / \{0.8 \times (3060 \times 2/3)\} = 0.021 < 1 \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 447.72) / 110.25 = 6.09 \text{ N}$$

$$\tau / s_f s = 6.09 / \{0.8 \times (240 \times 2/3)\} = 0.048 < 1 \therefore \text{O.K.}$$

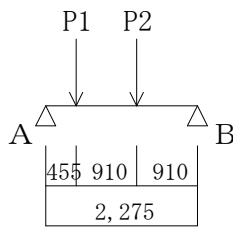
$$\delta = W \cdot L^4 / 8E \cdot I_x$$

$$= (14.92 \times 30.0^4) / (8 \times 110.0 \times 10^4 \times 1012.92) = 0.001 \text{ cm}$$

$$< L^2 / 150 = 30.0 / 150 = 0.200 \text{ cm} \therefore \text{O.K.}$$

### 3 小屋梁の設計

#### ☆小屋梁 1



長期荷重

$$P1 = 0.686 \times 1.138 \times 1.365 = 1.070 \text{ kN}$$

$$P2 = 0.686 \times 0.91 \times 1.365 = 0.850 \text{ kN}$$

積雪時短期荷重

$$P1 = 0.876 \times 1.138 \times 1.365 + 1.070 = 2.430 \text{ kN}$$

$$P2 = 0.876 \times 0.91 \times 1.365 + 0.850 = 1.940 \text{ kN}$$

長期

$$Q_A = \sum P_b / L = (1.070 \times 1.820 + 0.850 \times 0.910) / 2.275 = 1.196 \text{ kN}$$

$$Q_B = \sum P_a / L = (1.070 \times 0.455 + 0.850 \times 1.365) / 2.275 = 0.724 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 = 1.196 \times 1.365 - 1.070 \times 0.910 = 0.659 \text{ kN} \cdot \text{m}$$

積雪時短期

$$Q_A = \sum P_b / L = (2.430 \times 1.820 + 1.940 \times 0.910) / 2.275 = 2.720 \text{ kN}$$

$$Q_B = \sum P_a / L = (2.430 \times 0.455 + 1.940 \times 1.365) / 2.275 = 1.650 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 = 2.720 \times 1.365 - 2.430 \times 0.910 = 1.502 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 10.5cm (E120-E330おうしゅうあかまつ)

$$A = 110.25 \times 0.5 = 55.13 \text{ cm}^2$$

$$Z = 192.94 \times 0.85 = 164.00 \text{ cm}^3$$

$$I_x = 1012.92 \times 0.9 = 911.63 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M / Z_x = 65.9 / 164.00 = 0.4017 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.4017 / (3.30 \times 1.1/3) = 0.332 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1.196) / 55.13 = 0.0325 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0325 / (0.30 \times 1.1/3) = 0.296 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 1.07 \times \sin(180^\circ \times 0.455 / 2.275) + 0.85 \times \sin(180^\circ \times 1.365 / 2.275) = 0.6289 + 0.8084 = 1.437 \text{ kN}$$

$$\delta = 2 \cdot (RE \cdot L^3 / 48 \cdot E \cdot I_x) = 2 \times \{(1.437 \times 227.5^3) / (48 \times 120.0 \times 10^4 \times 911.63)\} = 0.645 \text{ cm}$$

$$< L / 200 = 227.5 / 200 = 1.138 \text{ cm} \quad \therefore \text{O.K.}$$

積雪時短期

$$\sigma_b = M / Z_x = 150.2 / 164.00 = 0.9156 \text{ kN/cm}^2$$

$$\sigma_b / sfb = 0.9156 / \{0.8 \cdot (3.30 \times 2/3)\} = 0.520 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 2.720) / 55.13 = 0.0740 \text{ kN/cm}^2$$

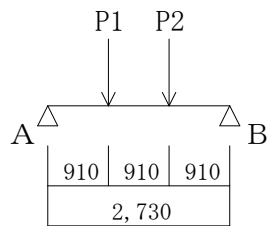
$$\tau / sfs = 0.0740 / \{0.8 \cdot (0.30 \times 2/3)\} = 0.463 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 2.43 \times \sin(180^\circ \times 0.455 / 2.275) + 1.94 \times \sin(180^\circ \times 1.365 / 2.275) = 1.4283 + 1.8451 = 3.273 \text{ kN}$$

$$\delta = RE \cdot L^3 / 48 \cdot E \cdot I_x = (3.273 \times 227.5^3) / (48 \times 120.0 \times 10^4 \times 911.63) = 0.734 \text{ cm}$$

$$< L / 150 = 227.5 / 150 = 1.517 \text{ cm} \quad \therefore \text{O.K.}$$

## ☆小屋梁 2



長期荷重

$$P1 = 0.686 \times (1.035 + 0.414) = 0.990 \text{ kN}$$

$$P2 = 0.686 \times (1.242 + 0.497) = 1.190 \text{ kN}$$

積雪時短期荷重

$$P1 = 0.876 \times (1.035 + 0.414) + 0.990 = 2.260 \text{ kN}$$

$$P2 = 0.876 \times (1.242 + 0.497) + 1.190 = 2.710 \text{ kN}$$

長期

$$Q_A = \sum P_b / L = (0.990 \times 1.820 + 1.190 \times 0.910) / 2.730 = 1.057 \text{ kN}$$

$$Q_B = \sum P_a / L = (0.990 \times 0.910 + 1.190 \times 1.820) / 2.730 = 1.123 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 = 1.057 \times 1.820 - 0.990 \times 0.910 = 1.022 \text{ kN} \cdot \text{m}$$

積雪時短期

$$Q_A = \sum P_b / L = (2.260 \times 1.820 + 2.710 \times 0.910) / 2.730 = 2.410 \text{ kN}$$

$$Q_B = \sum P_a / L = (2.260 \times 0.910 + 2.710 \times 1.820) / 2.730 = 2.560 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 = 2.410 \times 1.820 - 2.260 \times 0.910 = 2.330 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 15.0cm (E120-E330おうしゅうあかまつ)

$$A = 157.5 \times 0.5 = 78.75 \text{ cm}^2$$

$$Z = 393.75 \times 0.6 = 236.25 \text{ cm}^3$$

$$I_x = 2953.13 \times 0.9 = 2657.81 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M / Z_x = 102.2 / 236.25 = 0.4327 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.4327 / (3.30 \times 1.1/3) = 0.358 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1.123) / 78.75 = 0.0214 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0214 / (0.30 \times 1.1/3) = 0.195 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 0.99 \times \sin(180^\circ \times 0.910 / 2.730) + 1.19 \times \sin(180^\circ \times 1.820 / 2.730) = 0.8574 + 1.0306 = 1.888 \text{ kN}$$

$$\delta = 2 \cdot (RE \cdot L^3 / 48 \cdot E \cdot I_x) = 2 \times \{(1.888 \times 273.0^3) / (48 \times 120.0 \times 10^4 \times 2657.81)\} = 0.502 \text{ cm}$$

$$< L / 200 = 273.0 / 200 = 1.365 \text{ cm} \quad \therefore \text{O.K.}$$

積雪時短期

$$\sigma_b = M / Z_x = 233.0 / 236.25 = 0.9861 \text{ kN/cm}^2$$

$$\sigma_b / sfb = 0.9861 / \{0.8 \cdot (3.30 \times 2/3)\} = 0.560 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 2.560) / 78.75 = 0.0488 \text{ kN/cm}^2$$

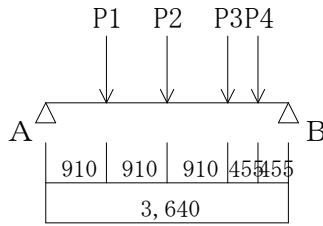
$$\tau / sfs = 0.0488 / \{0.8 \cdot (0.30 \times 2/3)\} = 0.305 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 2.26 \times \sin(180^\circ \times 0.910 / 2.730) + 2.71 \times \sin(180^\circ \times 1.820 / 2.730) = 1.9572 + 2.3469 = 4.304 \text{ kN}$$

$$\delta = RE \cdot L^3 / 48 \cdot E \cdot I_x = (4.304 \times 273.0^3) / (48 \times 120.0 \times 10^4 \times 2657.81) = 0.572 \text{ cm}$$

$$< L / 150 = 273.0 / 150 = 1.820 \text{ cm} \quad \therefore \text{O.K.}$$

☆小屋梁 3



長期荷重

$$P1 = 0.686 \times (0.91 \times 1.365 + 1.365 \times 0.91/2) = 1.280 \text{ kN}$$

$$P2 = 0.686 \times 1.365 \times 1.365 = 1.280 \text{ kN}$$

$$P3 = 0.686 \times 1.365 \times 0.91/2 = 0.430 \text{ kN}$$

$$P4 = 0.686 \times (1.365 \times 0.91 - 0.228^2)/4 = 0.210 \text{ kN}$$

積雪時短期荷重

$$P1 = 0.876 \times (0.91 \times 1.365 + 1.365 \times 0.91/2) + 1.280 = 2.910 \text{ kN}$$

$$P2 = 0.876 \times 1.365 \times 1.365 + 1.280 = 2.910 \text{ kN}$$

$$P3 = 0.876 \times 1.365 \times 0.91/2 + 0.430 = 0.970 \text{ kN}$$

$$P4 = 0.876 \times (1.365 \times 0.91 - 0.228^2)/4 + 0.210 = 0.460 \text{ kN}$$

長期

$$Q_A = \sum P_b/L = (1.280 \times 2.730 + 1.280 \times 1.820 + 0.430 \times 0.910 + 0.210 \times 0.455) / 3.640 = 1.734 \text{ kN}$$

$$Q_B = \sum P_a/L = (1.280 \times 0.910 + 1.280 \times 1.820 + 0.430 \times 2.730 + 0.210 \times 3.185) / 3.640 = 1.466 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P_1 \cdot a_2 = 1.734 \times 1.820 - 1.280 \times 0.910 = 1.991 \text{ kN} \cdot \text{m}$$

積雪時短期

$$Q_A = \sum P_b/L = (2.910 \times 2.730 + 2.910 \times 1.820 + 0.970 \times 0.910 + 0.460 \times 0.455) / 3.640 = 3.938 \text{ kN}$$

$$Q_B = \sum P_a/L = (2.910 \times 0.910 + 2.910 \times 1.820 + 0.970 \times 2.730 + 0.460 \times 3.185) / 3.640 = 3.313 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P_1 \cdot a_2 = 3.938 \times 1.820 - 2.910 \times 0.910 = 4.518 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 18.0cm (E120-E330おうしゅうあかまつ)

$$A = 189.0 \times 0.5 = 94.50 \text{ cm}^2$$

$$Z = 567.0 \times 0.85 = 481.95 \text{ cm}^3$$

$$I_x = 5103.0 \times 0.9 = 4592.70 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M/Z_x = 199.1 / 481.95 = 0.4130 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.4130 / (3.30 \times 1.1/3) = 0.341 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1.734) / 94.50 = 0.0275 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0275 / (0.30 \times 1.1/3) = 0.250 < 1 \quad \therefore \text{O.K.}$$

$$R_E = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 1.28 \times \sin(180^\circ \times 0.910/3.640) + 1.28 \times \sin(180^\circ \times 1.820/3.640) + 0.43 \times \sin(180^\circ \times 2.730/3.640) + 0.21 \times \sin(180^\circ \times 3.185/3.640) = 0.9051 + 1.2800 + 0.3041 + 0.0804 = 2.570 \text{ kN}$$

$$\delta = 2 \cdot (R_E \cdot L^3 / 48 \cdot E \cdot I_x) = 2 \times \{(2.570 \times 364.0^3) / (48 \times 120.0 \times 10^4 \times 4592.7)\} = 0.937 \text{ cm} < L/200 = 364.0/200 = 1.820 \text{ cm} \quad \therefore \text{O.K.}$$

積雪時短期

$$\sigma_b = M/Z_x = 451.8 / 481.95 = 0.9375 \text{ kN/cm}^2$$

$$\sigma_b / s_f b = 0.9375 / \{0.8 \times (3.30 \times 2/3)\} = 0.533 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 3.938) / 94.50 = 0.0625 \text{ kN/cm}^2$$

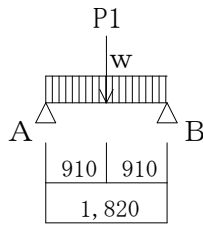
$$\tau / s_f s = 0.0625 / \{0.8 \times (0.30 \times 2/3)\} = 0.391 < 1 \quad \therefore \text{O.K.}$$

$$R_E = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 2.91 \times \sin(180^\circ \times 0.910/3.640) + 2.91 \times \sin(180^\circ \times 1.820/3.640) + 0.97 \times \sin(180^\circ \times 2.730/3.640) + 0.46 \times \sin(180^\circ \times 3.185/3.640) = 2.0577 + 2.9100 + 0.6859 + 0.1760 = 5.830 \text{ kN}$$

$$\delta = R_E \cdot L^3 / 48 \cdot E \cdot I_x = (5.830 \times 364.0^3) / (48 \times 120.0 \times 10^4 \times 4592.7) = 1.063 \text{ cm} < L/150 = 364.0/150 = 2.427 \text{ cm} \quad \therefore \text{O.K.}$$

## 4 軒桁の設計

### ☆軒桁 1



長期荷重

$$w = 0.686 \times 0.755 = 0.520 \text{ kN/m}$$

$$P1 = 0.686 \times (0.91 \times 1.365 \times 1/3 + 0.91 \times 1.365 \times 2/3) = 1.140 \text{ kN}$$

積雪時短期荷重

$$w = 0.876 \times 0.755 + 0.520 = 1.180 \text{ kN/m}$$

$$P1 = 0.686 \times (0.91 \times 1.365 \times 1/3 + 0.91 \times 1.365 \times 2/3) + 1.140 = 2.590 \text{ kN}$$

長期

$$QA = w \cdot L/2 + Pb/L = 0.520 \times 1.820/2 + 1.140 \times 0.910/1.820 = 0.4732 + 0.5700 = 1.043 \text{ kN}$$

$$QB = w \cdot L/2 + Pa/L = 0.520 \times 1.820/2 + 1.140 \times 0.910/1.820 = 0.4732 + 0.5700 = 1.043 \text{ kN}$$

$$M = w \cdot L^2/8 + QA \cdot a1 = 0.520 \times 1.820^2/8 + 0.570 \times 0.910 = 0.2153 + 0.5187 = 0.734 \text{ kN} \cdot \text{m}$$

積雪時短期

$$QA = w \cdot L/2 + Pb/L = 1.180 \times 1.820/2 + 2.590 \times 0.910/1.820 = 1.0738 + 1.2950 = 2.369 \text{ kN}$$

$$QB = w \cdot L/2 + Pa/L = 1.180 \times 1.820/2 + 2.590 \times 0.910/1.820 = 1.0738 + 1.2950 = 2.369 \text{ kN}$$

$$M = w \cdot L^2/8 + QA \cdot a1 = 1.180 \times 1.820^2/8 + 1.295 \times 0.910 = 0.4886 + 1.1785 = 1.667 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 15.0cm (E120-F330おうしゅうあかまつ)

$$A = 157.5 \times 0.5 = 78.75 \text{ cm}^2$$

$$Z = 393.75 \times 0.75 = 295.31 \text{ cm}^3$$

$$Ix = 2953.13 \times 0.9 = 2657.81 \text{ cm}^4$$

$$\text{曲げ基準強度 } Fb = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } Fs = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M/Zx = 73.4/295.31 = 0.2485 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.2485 / (3.30 \times 1.1/3) = 0.205 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1.043) / 78.75 = 0.0199 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0199 / (0.30 \times 1.1/3) = 0.181 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 1.14 \times \sin(180^\circ \times 0.910/1.820) = 1.140 \text{ kN}$$

$$\delta = 5 \cdot w \cdot L^4 / 384 \cdot E \cdot Ix + RE \cdot L^3 / 48 \cdot E \cdot Ix$$

$$= 2 \times \{ (5 \times 5.20 \times 182.0^4) / (384 \times 120.0 \times 10^4 \times 2657.81) \}$$

$$+ (1140 \times 182.0^3) / (48 \times 120.0 \times 10^4 \times 2657.81) = 2 \times (0.0233 + 0.0449) = 0.136 \text{ cm}$$

$$< L/200 = 182.0/200 = 0.910 \text{ cm} \quad \therefore \text{O.K.}$$

積雪時短期

$$\sigma_b = M/Zx = 166.7/295.31 = 0.5645 \text{ kN/cm}^2$$

$$\sigma_b / sfb = 0.5645 / \{0.8 \times (3.30 \times 2/3)\} = 0.321 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 2.369) / 78.75 = 0.0451 \text{ kN/cm}^2$$

$$\tau / sfs = 0.0451 / \{0.8 \times (0.30 \times 2/3)\} = 0.282 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 2.59 \times \sin(180^\circ \times 0.910/1.820) = 2.590 \text{ kN}$$

$$\delta = 5 \cdot w \cdot L^4 / 384 \cdot E \cdot Ix + RE \cdot L^3 / 48 \cdot E \cdot Ix$$

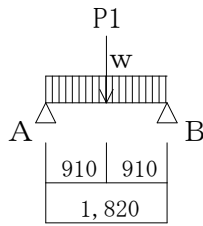
$$= (5 \times 11.80 \times 182.0^4) / (384 \times 120.0 \times 10^4 \times 2657.81)$$

$$+ (2590 \times 182.0^3) / (48 \times 120.0 \times 10^4 \times 2657.81) = 0.0529 + 0.1020 = 0.155 \text{ cm}$$

$$< L/150 = 182.0/150 = 1.213 \text{ cm} \quad \therefore \text{O.K.}$$



## ☆軒桁 2



長期荷重

$$w = 0.686 \times 0.755 = 0.520 \text{ kN/m}$$

P1=小屋梁から受ける荷重 Q=1.800kN

積雪時短期荷重

$$w = 0.876 \times 0.755 + 0.520 = 1.180 \text{ kN/m}$$

P1=小屋梁から受ける荷重 Q + 1.800 = 3.900kN

長期

$$Q_A = w \cdot L/2 + P_b/L = 0.520 \times 1.820/2 + 1.800 \times 0.910/1.820 = 0.4732 + 0.9000 = 1.373 \text{ kN}$$

$$Q_B = w \cdot L/2 + P_a/L = 0.520 \times 1.820/2 + 1.800 \times 0.910/1.820 = 0.4732 + 0.9000 = 1.373 \text{ kN}$$

$$M = w \cdot L^2/8 + Q_A \cdot a_1 = 0.520 \times 1.820^2/8 + 0.900 \times 0.910 = 0.2153 + 0.8190 = 1.034 \text{ kN} \cdot \text{m}$$

積雪時短期

$$Q_A = w \cdot L/2 + P_b/L = 1.180 \times 1.820/2 + 3.900 \times 0.910/1.820 = 1.0738 + 1.9500 = 3.024 \text{ kN}$$

$$Q_B = w \cdot L/2 + P_a/L = 1.180 \times 1.820/2 + 3.900 \times 0.910/1.820 = 1.0738 + 1.9500 = 3.024 \text{ kN}$$

$$M = w \cdot L^2/8 + Q_A \cdot a_1 = 1.180 \times 1.820^2/8 + 1.950 \times 0.910 = 0.4886 + 1.7745 = 2.263 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 18.0cm (E120-F330おうしゅうあかまつ)

$$A = 189.0 \times 0.5 = 94.50 \text{ cm}^2$$

$$Z = 567.0 \times 0.75 = 425.25 \text{ cm}^3$$

$$I_x = 5103.0 \times 0.9 = 4592.70 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M/Z_x = 103.4/425.25 = 0.2432 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.2432 / (3.30 \times 1.1/3) = 0.201 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1.373) / 94.50 = 0.0218 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0218 / (0.30 \times 1.1/3) = 0.198 < 1 \quad \therefore \text{O.K.}$$

$$R_E = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 1.80 \times \sin(180^\circ \times 0.910/1.820) = 1.800 \text{ kN}$$

$$\delta = 2 \cdot (5 \cdot w \cdot L^4/384 \cdot E \cdot I_x + R_E \cdot L^3/48 \cdot E \cdot I_x)$$

$$= 2 \times \{ (5 \times 0.520 \times 182.0^4) / (384 \times 120.0 \times 10^4 \times 4592.7) \}$$

$$+ (1800 \times 182.0^3) / (48 \times 120.0 \times 10^4 \times 4592.7) \} = 2 \times (0.0135 + 0.0410) = 0.109 \text{ cm}$$

$$< L/200 = 182.0/200 = 0.910 \text{ cm} \quad \therefore \text{O.K.}$$

積雪時短期

$$\sigma_b = M/Z_x = 226.3/425.25 = 0.5322 \text{ kN/cm}^2$$

$$\sigma_b / s_f b = 0.5322 / \{0.8 \times (3.30 \times 2/3)\} = 0.302 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 3.024) / 94.50 = 0.0480 \text{ kN/cm}^2$$

$$\tau / s_f s = 0.0480 / \{0.8 \times (0.30 \times 2/3)\} = 0.300 < 1 \quad \therefore \text{O.K.}$$

$$R_E = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 3.90 \times \sin(180^\circ \times 0.910/1.820) = 3.900 \text{ kN}$$

$$\delta = 5 \cdot w \cdot L^4/384 \cdot E \cdot I_x + R_E \cdot L^3/48 \cdot E \cdot I_x$$

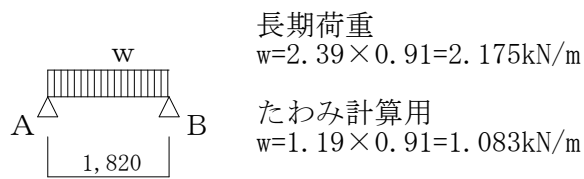
$$= (5 \times 1.180 \times 182.0^4) / (384 \times 120.0 \times 10^4 \times 4592.7)$$

$$+ (3900 \times 182.0^3) / (48 \times 120.0 \times 10^4 \times 4592.7) = 0.0306 + 0.0889 = 0.119 \text{ cm}$$

$$< L/150 = 182.0/150 = 1.213 \text{ cm} \quad \therefore \text{O.K.}$$

## 5 床梁の設計

### ☆床梁 1



長期

$$Q = w \cdot L / 2 = 2.175 \times 1.820 / 2 = 1.979 \text{ kN}$$

$$M = w \cdot L^2 / 8 = 2.175 \times 1.820^2 / 8 = 0.901 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 10.5cm (E110 べいまつ)

$$A = 110.25 \times 0.5 = 55.13 \text{ cm}^2$$

$$Z = 192.94 \times 1.0 = 192.94 \text{ cm}^3$$

$$I_x = 1012.92 \times 1.0 = 1012.92 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 30.6 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 11000 \text{ N/mm}^2$$

長期

$$\sigma_b = M / Z_x = 90.1 / 192.94 = 0.4668 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.4668 / (3.06 \times 1.1/3) = 0.416 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 1.979) / 55.13 = 0.0539 \text{ kN/cm}^2$$

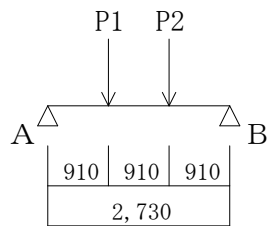
$$\tau / f_s = 0.0539 / (0.24 \times 1.1/3) = 0.612 < 1 \quad \therefore \text{O.K.}$$

$$\delta = 2 \cdot (5 \cdot W \cdot L^4 / 384 \cdot E \cdot I_x)$$

$$= 2 \times \{ (5 \times 10.83 \times 182.0^4) / (384 \times 110.0 \times 10^4 \times 1012.92) \} = 0.278 \text{ cm}$$

$$< L / 300 = 182.0 / 300 = 0.607 \text{ cm} \quad \therefore \text{O.K.}$$

## ☆床梁 2



長期荷重

$$P1 = 1.89 \times 0.91 \times 1.82 = 3.130 \text{ kN}$$

$$P2 = 1.89 \times 0.91 \times 1.82 = 3.130 \text{ kN}$$

たわみ計算用

$$P1 = 1.19 \times 0.91 \times 1.82 = 1.970 \text{ kN}$$

$$P2 = 1.19 \times 0.91 \times 1.82 = 1.970 \text{ kN}$$

長期

$$Q_A = \sum P_b / L = (3.130 \times 1.820 + 3.130 \times 0.910) / 2.730 = 3.130 \text{ kN}$$

$$Q_B = \sum P_a / L = (3.130 \times 0.910 + 3.130 \times 1.820) / 2.730 = 3.130 \text{ kN}$$

$$M = Q_A \cdot a_1 = 3.130 \times 0.910 = 2.848 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 18.0cm (E120-F330おうしゅうあかまつ)

$$A = 189.0 \times 0.5 = 94.50 \text{ cm}^2$$

$$Z = 567.0 \times 0.8 = 453.60 \text{ cm}^3$$

$$I_x = 5103.0 \times 0.9 = 4592.70 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M / Z_x = 284.8 / 453.60 = 0.6279 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.6279 / (3.30 \times 1.1/3) = 0.519 < 1 \quad \therefore \text{O.K.}$$

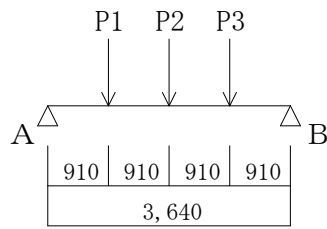
$$\tau = (1.5 \cdot Q) / A = (1.5 \times 3.130) / 94.50 = 0.0497 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0497 / (0.30 \times 1.1/3) = 0.452 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 1.97 \times \sin(180^\circ \times 0.910 / 2.730) + 1.97 \times \sin(180^\circ \times 1.820 / 2.730) \\ = 1.7061 + 1.7061 = 3.412 \text{ kN}$$

$$\delta = 2 \cdot (RE \cdot L^3 / 48 \cdot E \cdot I_x) = 2 \times \{(3.412 \times 273.0^3) / (48 \times 120.0 \times 10^4 \times 4592.7)\} = 0.525 \text{ cm} \\ < L / 300 = 273.0 / 300 = 0.910 \text{ cm} \quad \therefore \text{O.K.}$$

### ☆床梁 3



#### 長期荷重

$$P1 = 1.89 \times 0.91 \times 1.82 = 3.130 \text{ kN}$$

$$P2 = 1.89 \times 0.91 \times 1.82 = 3.130 \text{ kN}$$

$$P3 = 1.89 \times 0.91 \times 1.82 = 3.130 \text{ kN}$$

#### たわみ計算用

$$P1 = 1.19 \times 0.91 \times 1.82 = 1.970 \text{ kN}$$

$$P2 = 1.19 \times 0.91 \times 1.82 = 1.970 \text{ kN}$$

$$P3 = 1.19 \times 0.91 \times 1.82 = 1.970 \text{ kN}$$

#### 長期

$$Q_A = \sum P_b / L = (3.130 \times 2.730 + 3.130 \times 1.820 + 3.130 \times 0.910) / 3.640 = 4.695 \text{ kN}$$

$$Q_B = \sum P_a / L = (3.130 \times 0.910 + 3.130 \times 1.820 + 3.130 \times 2.730) / 3.640 = 4.695 \text{ kN}$$

$$M = Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 = 4.695 \times 1.820 - 3.130 \times 0.910 = 5.697 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 24.0cm (E120-F330おうしゅうあかまつ)

$$A = 252.0 \times 0.5 = 126.00 \text{ cm}^2$$

$$Z = 1008.0 \times 0.8 = 806.40 \text{ cm}^3$$

$$I_x = 12096.0 \times 0.9 = 10886.40 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

#### 長期

$$\sigma_b = M / Z_x = 569.7 / 806.40 = 0.7064 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.7064 / (3.30 \times 1.1/3) = 0.584 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 4.695) / 126.00 = 0.0559 \text{ kN/cm}^2$$

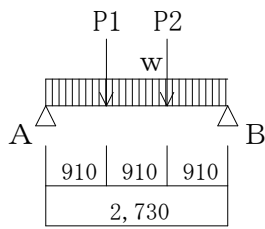
$$\tau / f_s = 0.0559 / (0.30 \times 1.1/3) = 0.508 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 1.97 \times \sin(180^\circ \times 0.910 / 3.640) + 1.97 \times \sin(180^\circ \times 1.820 / 3.640) + 1.97 \times \sin(180^\circ \times 2.730 / 3.640) = 1.3930 + 1.9700 + 1.3930 = 4.756 \text{ kN}$$

$$\delta = 2 \cdot (RE \cdot L^3 / 48 \cdot E \cdot I_x) = 2 \times \{(4756 \times 364.0^3) / (48 \times 120.0 \times 10^4 \times 10886.4)\} = 0.732 \text{ cm}$$

$$< L / 300 = 364.0 / 300 = 1.213 \text{ cm} \quad \therefore \text{O.K.}$$

# ☆床梁 4



## 長期荷重

$$\begin{aligned} w &= 1.43 \times 1.40 = 2.000 \text{ kN/m} \\ P1 &= 2.10 \times 0.91 \times 0.455 = 0.870 \text{ kN} \\ P2 &= 2.10 \times 0.91 \times 0.455 = 0.870 \text{ kN} \end{aligned}$$

## たわみ計算用

$$\begin{aligned} w &= 1.43 \times 1.40 = 2.000 \text{ kN/m} \\ P1 &= 1.40 \times 0.91 \times 0.455 = 0.580 \text{ kN} \\ P2 &= 1.40 \times 0.91 \times 0.455 = 0.580 \text{ kN} \end{aligned}$$

## 長期

$$\begin{aligned} Q_A &= w \cdot L / 2 + \sum P_b / L \\ &= 2.000 \times 2.730 / 2 + (0.870 \times 1.820 + 0.870 \times 0.910) / 2.730 = 2.7300 + 0.8700 = 3.600 \text{ kN} \\ Q_B &= w \cdot L / 2 + \sum P_a / L \\ &= 2.000 \times 2.730 / 2 + (0.870 \times 0.910 + 0.870 \times 1.820) / 2.730 = 2.7300 + 0.8700 = 3.600 \text{ kN} \\ M &= w \cdot L^2 / 8 + Q_A \cdot a_1 = 2.000 \times 2.730^2 / 8 + 0.870 \times 0.910 = 1.8632 + 0.7917 = 2.655 \text{ kN} \cdot \text{m} \end{aligned}$$

使用材料 10.5cm × 18.0cm (E120-F330おうしゅうあかまつ)

$$\begin{aligned} A &= 189.0 \times 0.5 = 94.50 \text{ cm}^2 \\ Z &= 567.0 \times 0.9 = 510.30 \text{ cm}^3 \\ I_x &= 5103.0 \times 0.9 = 4592.70 \text{ cm}^4 \\ \text{曲げ基準強度 } F_b &= 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2 \end{aligned}$$

## 長期

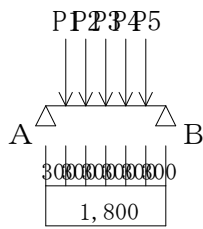
$$\begin{aligned} \sigma_b &= M / Z_x = 265.5 / 510.30 = 0.5203 \text{ kN/cm}^2 \\ \sigma_b / f_b &= 0.5203 / (3.30 \times 1.1/3) = 0.430 < 1 \quad \therefore \text{O.K.} \end{aligned}$$

$$\begin{aligned} \tau &= (1.5 \cdot Q) / A = (1.5 \times 3.600) / 94.50 = 0.0571 \text{ kN/cm}^2 \\ \tau / f_s &= 0.0571 / (0.30 \times 1.1/3) = 0.519 < 1 \quad \therefore \text{O.K.} \end{aligned}$$

$$\begin{aligned} R_E &= \sum \{P \cdot \sin(\pi \cdot a / L)\} = 0.58 \times \sin(180^\circ \times 0.910 / 2.730) + 0.58 \times \sin(180^\circ \times 1.820 / 2.730) \\ &= 0.5023 + 0.5023 = 1.005 \text{ kN} \end{aligned}$$

$$\begin{aligned} \delta &= 2 \cdot (5 \cdot w \cdot L^4 / 384 \cdot E \cdot I_x + R_E \cdot L^3 / 48 \cdot E \cdot I_x) \\ &= 2 \times \{ (5 \times 20.00 \times 273.0^4) / (384 \times 120.0 \times 10^4 \times 4592.7) \\ &\quad + (1005 \times 273.0^3) / (48 \times 120.0 \times 10^4 \times 4592.7) \} = 2 \times (0.2625 + 0.0773) = 0.679 \text{ cm} \\ &< L / 300 = 273.0 / 300 = 0.910 \text{ cm} \quad \therefore \text{O.K.} \end{aligned}$$

☆ 2 階床梁 5



長期荷重

$$P1=2.00 \times 2.00 \times 2.00=8.000\text{kN}$$

$$P2=2.00 \times 2.00 \times 2.00=8.000\text{kN}$$

$$P3=2.00 \times 2.00 \times 2.00=8.000\text{kN}$$

$$P4=2.00 \times 2.00 \times 2.00=8.000\text{kN}$$

$$P5=2.00 \times 2.00 \times 2.00=8.000\text{kN}$$

たわみ計算用

$$P1=1.30 \times 2.00 \times 2.00=5.200\text{kN}$$

$$P2=1.30 \times 2.00 \times 2.00=5.200\text{kN}$$

$$P3=1.30 \times 2.00 \times 2.00=5.200\text{kN}$$

$$P4=1.30 \times 2.00 \times 2.00=5.200\text{kN}$$

$$P5=1.30 \times 2.00 \times 2.00=5.200\text{kN}$$

長期

$$QA=\sum Pb/L=(8.000 \times 1.500+8.000 \times 1.200+8.000 \times 0.900+8.000 \times 0.600+8.000 \times 0.300)/1.800=20.000\text{kN}$$

$$QB=\sum Pa/L=(8.000 \times 0.300+8.000 \times 0.600+8.000 \times 0.900+8.000 \times 1.200+8.000 \times 1.500)/1.800=20.000\text{kN}$$

$$M=QA \cdot (a1+a2+a3)-P1 \cdot (a2+a3)-P2 \cdot a3=20.000 \times 0.900-8.000 \times 0.600-8.000 \times 0.300=10.800\text{kN} \cdot \text{m}$$

使用材料 10.5cm ×42.0cm (まつ)

$$A=441.0 \times 0.8=352.80\text{cm}^2$$

$$Z=3087.0 \times 0.8=2469.60\text{cm}^3$$

$$Ix=64827.0 \times 0.9=58344.30\text{cm}^4$$

$$\text{曲げ基準強度 } Fb=22.2\text{N/mm}^2 \quad \text{せん断基準強度 } Fs=2.4\text{N/mm}^2 \quad \text{ヤング係数 } E=10000\text{N/mm}^2$$

長期

$$\sigma b=M/Zx=1080.0/2469.60=0.4373\text{kN/cm}^2$$

$$\sigma b/lfb=0.4373/(2.22 \times 1.1/3)=0.537 < 1 \quad \therefore \text{O.K.}$$

$$\tau=(1.5 \cdot Q)/A=(1.5 \times 20.000)/352.80=0.0850\text{kN/cm}^2$$

$$\tau/lfs=0.0850/(0.24 \times 1.1/3)=0.966 < 1 \quad \therefore \text{O.K.}$$

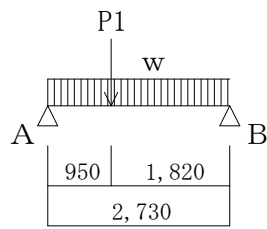
$$RE=\sum \{P \cdot \sin(\pi \cdot a/L)\}=5.20 \times \sin(180^\circ \times 0.300/1.800)+5.20 \times \sin(180^\circ \times 0.600/1.800)+5.20 \times \sin(180^\circ \times 0.900/1.800)+5.20 \times \sin(180^\circ \times 1.200/1.800)+5.20 \times \sin(180^\circ \times 1.500/1.800)$$

$$=2.6000+4.5033+5.2000+4.5033+2.6000=19.407\text{kN}$$

$$\delta=2 \cdot (RE \cdot L^3/48 \cdot E \cdot Ix)=2 \cdot \{(19407 \times 180.0^3)/(48 \times 100.0 \times 10^4 \times 58344.3)\}=0.081\text{cm}$$

$$< L/300=180.0/300=0.600\text{cm} \quad \therefore \text{O.K.}$$

## ☆ 2 階床梁 6



長期荷重

$$w = 1.30 \times 3.00 = 3.900 \text{ kN/m}$$

$$P1 = 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN}$$

たわみ計算用

$$w = 0.60 \times 3.00 = 1.800 \text{ kN/m}$$

$$P1 = 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN}$$

長期

$$Q_A = w \cdot L/2 + P_b/L = 3.900 \times 2.730/2 + 8.000 \times 1.820/2.730 = 5.3235 + 5.3333 = 10.657 \text{ kN}$$

$$Q_B = w \cdot L/2 + P_a/L = 3.900 \times 2.730/2 + 8.000 \times 0.950/2.730 = 5.3235 + 2.7839 = 8.107 \text{ kN}$$

$$M = w \cdot L^2/8 + Q_A \cdot a_1 = 3.900 \times 2.730^2/8 + 5.333 \times 0.950 = 3.6333 + 5.0667 = 8.700 \text{ kN}\cdot\text{m}$$

使用材料 10.5cm × 30.0cm (まつ)

$$A = 315.0 \times 0.8 = 252.00 \text{ cm}^2$$

$$Z = 1575.0 \times 0.8 = 1260.00 \text{ cm}^3$$

$$I_x = 23625.0 \times 0.9 = 21262.50 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 22.2 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 10000 \text{ N/mm}^2$$

長期

$$\sigma_b = M/Z_x = 870.0/1260.00 = 0.6905 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.6905 / (2.22 \times 1.1/3) = 0.848 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 10.657) / 252.00 = 0.0634 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0634 / (0.24 \times 1.1/3) = 0.721 < 1 \quad \therefore \text{O.K.}$$

$$R_E = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 5.20 \times \sin(180^\circ \times 0.950/2.730) = 4.618 \text{ kN}$$

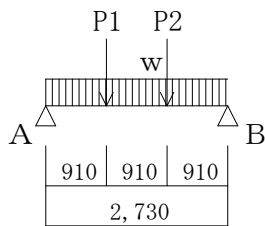
$$\delta = 2 \cdot (5 \cdot w \cdot L^4 / 384 \cdot E \cdot I_x + R_E \cdot L^3 / 48 \cdot E \cdot I_x)$$

$$= 2 \times \{ (5 \times 1.80 \times 273.0^4) / (384 \times 100.0 \times 10^4 \times 21262.5) + (4.618 \times 273.0^3) / (48 \times 100.0 \times 10^4 \times 21262.5) \}$$

$$= 2 \times (0.0612 + 0.0921) = 0.307 \text{ cm}$$

$$< L/300 = 273.0/300 = 0.910 \text{ cm} \quad \therefore \text{O.K.}$$

## ☆ 2階床梁 7



長期荷重

$$w = 1.30 \times 3.00 = 3.900 \text{ kN/m}$$

$$P1 = 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN}$$

$$P2 = 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN}$$

たわみ計算用

$$w = 0.60 \times 3.00 = 1.800 \text{ kN/m}$$

$$P1 = 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN}$$

$$P2 = 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN}$$

長期

$$Q_A = w \cdot L / 2 + \sum P_b / L$$

$$= 3.900 \times 2.730 / 2 + (8.000 \times 1.820 + 8.000 \times 0.910) / 2.730 = 5.3235 + 8.0000 = 13.324 \text{ kN}$$

$$Q_B = w \cdot L / 2 + \sum P_a / L$$

$$= 3.900 \times 2.730 / 2 + (8.000 \times 0.910 + 8.000 \times 1.820) / 2.730 = 5.3235 + 8.0000 = 13.324 \text{ kN}$$

$$M = w \cdot L^2 / 8 + Q_A \cdot a_1 = 3.900 \times 2.730^2 / 8 + 8.000 \times 0.910 = 3.6333 + 7.2800 = 10.913 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 33.0cm (まつ)

$$A = 346.5 \times 0.8 = 277.20 \text{ cm}^2$$

$$Z = 1905.75 \times 0.8 = 1524.60 \text{ cm}^3$$

$$I_x = 31444.88 \times 0.9 = 28300.39 \text{ cm}^4$$

$$\text{曲げ基準強度 } F_b = 22.2 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 10000 \text{ N/mm}^2$$

長期

$$\sigma_b = M / Z_x = 1091.3 / 1524.60 = 0.7158 \text{ kN/cm}^2$$

$$\sigma_b / f_b = 0.7158 / (2.22 \times 1.1/3) = 0.879 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 13.324) / 277.20 = 0.0721 \text{ kN/cm}^2$$

$$\tau / f_s = 0.0721 / (0.24 \times 1.1/3) = 0.819 < 1 \quad \therefore \text{O.K.}$$

$$R_E = \sum \{P \cdot \sin(\pi \cdot a / L)\} = 5.20 \times \sin(180^\circ \times 0.910 / 2.730) + 5.20 \times \sin(180^\circ \times 1.820 / 2.730) \\ = 4.5033 + 4.5033 = 9.007 \text{ kN}$$

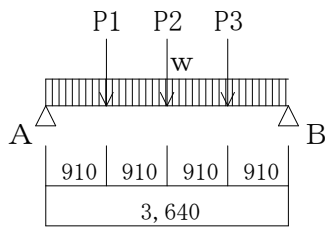
$$\delta = 2 \cdot (5 \cdot w \cdot L^4 / 384 \cdot E \cdot I_x + R_E \cdot L^3 / 48 \cdot E \cdot I_x)$$

$$= 2 \times \{ (5 \times 1.800 \times 273.0^4) / (384 \times 100.0 \times 10^4 \times 28300.39) \\ + (9.007 \times 273.0^3) / (48 \times 100.0 \times 10^4 \times 28300.39) \} = 2 \times (0.0460 + 0.1349) = 0.362 \text{ cm}$$

$$< L / 300 = 273.0 / 300 = 0.910 \text{ cm} \quad \therefore \text{O.K.}$$



## ☆ 2 階床梁 8



### 長期荷重

$$\begin{aligned} w &= 1.30 \times 3.00 = 3.900 \text{ kN/m} \\ P1 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P2 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P3 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \end{aligned}$$

### たわみ計算用

$$\begin{aligned} w &= 0.60 \times 3.00 = 1.800 \text{ kN/m} \\ P1 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P2 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P3 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \end{aligned}$$

### 長期

$$\begin{aligned} Q_A &= w \cdot L / 2 + \sum P_b / L = \\ &= 3.900 \times 3.640 / 2 + (8.000 \times 2.730 + 8.000 \times 1.820 + 8.000 \times 0.910) / 3.640 \\ &= 7.0980 + 12.0000 = 19.098 \text{ kN} \\ Q_B &= w \cdot L / 2 + \sum P_a / L = \\ &= 3.900 \times 3.640 / 2 + (8.000 \times 0.910 + 8.000 \times 1.820 + 8.000 \times 2.730) / 3.640 \\ &= 7.0980 + 12.0000 = 19.098 \text{ kN} \\ M &= w \cdot L^2 / 8 + Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 \\ &= 3.900 \times 3.640^2 / 8 + 12.000 \times 1.820 - 8.000 \times 0.910 = 6.4592 + 14.5600 = 21.019 \text{ kN} \cdot \text{m} \end{aligned}$$

使用材料 10.5cm × 45.0cm (まつ)

$$\begin{aligned} A &= 472.5 \times 0.8 = 378.00 \text{ cm}^2 \\ Z &= 3543.75 \times 0.8 = 2835.00 \text{ cm}^3 \\ I_x &= 79734.38 \times 0.9 = 71760.94 \text{ cm}^4 \\ \text{曲げ基準強度 } F_b &= 22.2 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 10000 \text{ N/mm}^2 \end{aligned}$$

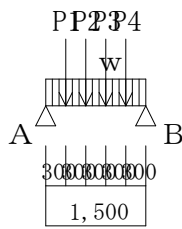
### 長期

$$\begin{aligned} \sigma_b &= M / Z_x = 2101.9 / 2835.00 = 0.7414 \text{ kN/cm}^2 \\ \sigma_b / f_b &= 0.7414 / (2.22 \times 1.1/3) = 0.911 < 1 \quad \therefore \text{O.K.} \end{aligned}$$

$$\begin{aligned} \tau &= (1.5 \cdot Q) / A = (1.5 \times 19.098) / 378.00 = 0.0758 \text{ kN/cm}^2 \\ \tau / f_s &= 0.0758 / (0.24 \times 1.1/3) = 0.861 < 1 \quad \therefore \text{O.K.} \end{aligned}$$

$$\begin{aligned} RE &= \sum \{ P \cdot \sin(\pi \cdot a / L) \} = 5.20 \times \sin(180^\circ \times 0.910 / 3.640) + 5.20 \times \sin(180^\circ \times 1.820 / 3.640) \\ &\quad + 5.20 \times \sin(180^\circ \times 2.730 / 3.640) = 3.6770 + 5.2000 + 3.6770 = 12.554 \text{ kN} \\ \delta &= 2 \cdot (5 \cdot w \cdot L^4 / 384 \cdot E \cdot I_x + RE \cdot L^3 / 48 \cdot E \cdot I_x) \\ &= 2 \times \{ (5 \times 1.80 \times 364.0^4) / (384 \times 100.0 \times 10^4 \times 71760.94) \\ &\quad + (12554 \times 364.0^3) / (48 \times 100.0 \times 10^4 \times 71760.94) \} = 2 \times (0.0573 + 0.1758) = 0.466 \text{ cm} \\ &< L / 300 = 364.0 / 300 = 1.213 \text{ cm} \quad \therefore \text{O.K.} \end{aligned}$$

☆ 2 階床梁 9



長期荷重

$$\begin{aligned} w &= 1.30 \times 3.00 = 3.900 \text{ kN/m} \\ P1 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P2 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P3 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P4 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \end{aligned}$$

たわみ計算用

$$\begin{aligned} w &= 0.60 \times 3.00 = 1.800 \text{ kN/m} \\ P1 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P2 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P3 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P4 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \end{aligned}$$

長期

$$\begin{aligned} Q_A &= w \cdot L/2 + \sum P_b/L = 3.900 \times 1.500/2 + (8.000 \times 1.200 + 8.000 \times 0.900 + 8.000 \times 0.600 \\ &\quad + 8.000 \times 0.300)/1.500 = 2.9250 + 16.0000 = 18.925 \text{ kN} \\ Q_B &= w \cdot L/2 + \sum P_a/L = 3.900 \times 1.500/2 + (8.000 \times 0.300 + 8.000 \times 0.600 + 8.000 \times 0.900 \\ &\quad + 8.000 \times 1.200)/1.500 = 2.9250 + 16.0000 = 18.925 \text{ kN} \\ M &= w \cdot L^2/8 + Q_A \cdot (a_1 + a_2) - P1 \cdot a_2 \\ &= 3.900 \times 1.500^2/8 + 16.000 \times 0.600 - 8.000 \times 0.300 = 1.0969 + 7.2000 = 8.297 \text{ kN} \cdot \text{m} \end{aligned}$$

使用材料 10.5cm × 39.0cm (まつ)

$$\begin{aligned} A &= 409.5 \times 0.8 = 327.60 \text{ cm}^2 \\ Z &= 2661.75 \times 0.8 = 2129.40 \text{ cm}^3 \\ I_x &= 51904.13 \times 0.9 = 46713.71 \text{ cm}^4 \\ \text{曲げ基準強度 } F_b &= 22.2 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 10000 \text{ N/mm}^2 \end{aligned}$$

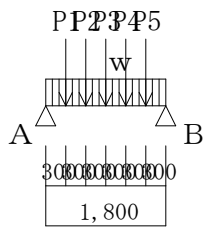
長期

$$\begin{aligned} \sigma_b &= M/Z_x = 829.7/2129.40 = 0.3896 \text{ kN/cm}^2 \\ \sigma_b/lfb &= 0.3896/(2.22 \times 1.1/3) = 0.479 < 1 \quad \therefore \text{O.K.} \end{aligned}$$

$$\begin{aligned} \tau &= (1.5 \cdot Q)/A = (1.5 \times 18.925)/327.60 = 0.0867 \text{ kN/cm}^2 \\ \tau/lfs &= 0.0867/(0.24 \times 1.1/3) = 0.985 < 1 \quad \therefore \text{O.K.} \end{aligned}$$

$$\begin{aligned} RE &= \sum \{P \cdot \sin(\pi \cdot a/L)\} = 5.20 \times \sin(180^\circ \times 0.300/1.500) + 5.20 \times \sin(180^\circ \times 0.600/1.500) \\ &\quad + 5.20 \times \sin(180^\circ \times 0.900/1.500) + 5.20 \times \sin(180^\circ \times 1.200/1.500) \\ &= 3.0565 + 4.9455 + 4.9455 + 3.0565 = 16.004 \text{ kN} \\ \delta &= 2 \cdot \{ (5 \cdot w \cdot L^4/384 \cdot E \cdot I_x + RE \cdot L^3/48 \cdot E \cdot I_x) \\ &\quad + (16004 \times 150.0^3)/(48 \times 100.0 \times 10^4 \times 46713.71) \} = 2 \times (0.0025 + 0.0241) = 0.053 \text{ cm} \\ &< L/300 = 150.0/300 = 0.500 \text{ cm} \quad \therefore \text{O.K.} \end{aligned}$$

☆ 2階床梁10



長期荷重

$$\begin{aligned} w &= 1.30 \times 3.00 = 3.900 \text{ kN/m} \\ P1 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P2 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P3 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P4 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \\ P5 &= 2.00 \times 2.00 \times 2.00 = 8.000 \text{ kN} \end{aligned}$$

たわみ計算用

$$\begin{aligned} w &= 0.60 \times 3.00 = 1.800 \text{ kN/m} \\ P1 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P2 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P3 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P4 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \\ P5 &= 1.30 \times 2.00 \times 2.00 = 5.200 \text{ kN} \end{aligned}$$

長期

$$\begin{aligned} Q_A &= w \cdot L / 2 + \sum P_b / L = 3.900 \times 1.800 / 2 + (8.000 \times 1.500 + 8.000 \times 1.200 + 8.000 \times 0.900 \\ &\quad + 8.000 \times 0.600 + 8.000 \times 0.300) / 1.800 = 3.5100 + 20.0000 = 23.510 \text{ kN} \\ Q_B &= w \cdot L / 2 + \sum P_a / L = 3.900 \times 1.800 / 2 + (8.000 \times 0.300 + 8.000 \times 0.600 + 8.000 \times 0.900 \\ &\quad + 8.000 \times 1.200 + 8.000 \times 1.500) / 1.800 = 3.5100 + 20.0000 = 23.510 \text{ kN} \\ M &= w \cdot L^2 / 8 + Q_A \cdot (a_1 + a_2 + a_3) - P1 \cdot (a_2 + a_3) - P2 \cdot a_3 \\ &= 3.900 \times 1.800^2 / 8 + 20.000 \times 0.900 - 8.000 \times 0.600 - 8.000 \times 0.300 \\ &= 1.5795 + 10.8000 = 12.380 \text{ kN} \cdot \text{m} \end{aligned}$$

使用材料 10.5cm × 48.0cm (まつ)

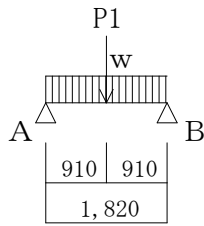
$$\begin{aligned} A &= 504.0 \times 0.8 = 403.20 \text{ cm}^2 \\ Z &= 4032.0 \times 0.8 = 3225.60 \text{ cm}^3 \\ I_x &= 96768.0 \times 0.9 = 87091.20 \text{ cm}^4 \\ \text{曲げ基準強度 } F_b &= 22.2 \text{ N/mm}^2 \quad \text{せん断基準強度 } F_s = 2.4 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 10000 \text{ N/mm}^2 \end{aligned}$$

長期

$$\begin{aligned} \sigma_b &= M / Z_x = 1238.0 / 3225.60 = 0.3838 \text{ kN/cm}^2 \\ \sigma_b / f_b &= 0.3838 / (2.22 \times 1.1 / 3) = 0.471 < 1 \quad \therefore \text{O.K.} \\ \tau &= (1.5 \cdot Q) / A = (1.5 \times 23.510) / 403.20 = 0.0875 \text{ kN/cm}^2 \\ \tau / f_s &= 0.0875 / (0.24 \times 1.1 / 3) = 0.994 < 1 \quad \therefore \text{O.K.} \\ RE &= \sum \{ P \cdot \sin(\pi \cdot a / L) \} = 5.20 \times \sin(180^\circ \times 0.300 / 1.800) + 5.20 \times \sin(180^\circ \times 0.600 / 1.800) \\ &\quad + 5.20 \times \sin(180^\circ \times 0.900 / 1.800) + 5.20 \times \sin(180^\circ \times 1.200 / 1.800) \\ &\quad + 5.20 \times \sin(180^\circ \times 1.500 / 1.800) \\ &= 2.6000 + 4.5033 + 5.2000 + 4.5033 + 2.6000 = 19.407 \text{ kN} \\ \delta &= 2 \cdot (5 \cdot w \cdot L^4 / 384 \cdot E \cdot I_x + RE \cdot L^3 / 48 \cdot E \cdot I_x) \\ &= 2 \times \{ (5 \times 18.00 \times 180.0^4) / (384 \times 100.0 \times 10^4 \times 87091.2) \\ &\quad + (19407 \times 180.0^3) / (48 \times 100.0 \times 10^4 \times 87091.2) \} = 2 \times (0.0028 + 0.0271) = 0.060 \text{ cm} \\ &< L / 300 = 180.0 / 300 = 0.600 \text{ cm} \quad \therefore \text{O.K.} \end{aligned}$$

## 6 胴差の設計

### ☆胴差 1



長期荷重

$$w = 0.89 \times 2.80 = 2.490 \text{ kN/m}$$

$$P1 = 1.89 \times 0.91 \times 0.91 + 2.10 \times 0.91 \times 0.455 = 2.430 \text{ kN}$$

たわみ計算用

$$w = 0.89 \times 2.80 = 2.490 \text{ kN/m}$$

$$P1 = 1.19 \times 0.91 \times 0.91 + 2.10 \times 0.91 \times 0.455 = 1.570 \text{ kN}$$

長期

$$QA = w \cdot L/2 + Pb/L = 2.490 \times 1.820/2 + 2.430 \times 0.910/1.820 = 2.2659 + 1.2150 = 3.481 \text{ kN}$$

$$QB = w \cdot L/2 + Pa/L = 2.490 \times 1.820/2 + 2.430 \times 0.910/1.820 = 2.2659 + 1.2150 = 3.481 \text{ kN}$$

$$M = w \cdot L^2/8 + QA \cdot a1 = 2.490 \times 1.820^2/8 + 1.215 \times 0.910 = 1.0310 + 1.1057 = 2.137 \text{ kN} \cdot \text{m}$$

使用材料 10.5cm × 24.0cm (E120-F330おうしゅうあかまつ)

$$A = 252.0 \times 0.5 = 126.00 \text{ cm}^2$$

$$Z = 1008.0 \times 0.8 = 806.40 \text{ cm}^3$$

$$Ix = 12096.0 \times 0.9 = 10886.40 \text{ cm}^4$$

$$\text{曲げ基準強度 } Fb = 33.0 \text{ N/mm}^2 \quad \text{せん断基準強度 } Fs = 3.0 \text{ N/mm}^2 \quad \text{ヤング係数 } E = 12000 \text{ N/mm}^2$$

長期

$$\sigma_b = M/Zx = 213.7/806.40 = 0.2650 \text{ dN/cm}^2$$

$$\sigma_b / f_b = 0.2650 / (3.30 \times 1.1/3) = 0.219 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (1.5 \cdot Q) / A = (1.5 \times 3.481) / 126.00 = 0.0414 \text{ dN/cm}^2$$

$$\tau / f_s = 0.0414 / (0.30 \times 1.1/3) = 0.377 < 1 \quad \therefore \text{O.K.}$$

$$RE = \sum \{P \cdot \sin(\pi \cdot a/L)\} = 1.57 \times \sin(180^\circ \times 0.910/1.820) = 1.570 \text{ kN}$$

$$\delta = 2 \cdot (5 \cdot w \cdot L^4 / 384 \cdot E \cdot Ix + RE \cdot L^3 / 48 \cdot E \cdot Ix)$$

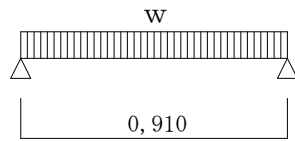
$$= 2 \times \{ (5 \times 24.90 \times 182.0^4) / (384 \times 120.0 \times 10^4 \times 10886.4) \}$$

$$+ (1570 \times 182.0^3) / (48 \times 120.0 \times 10^4 \times 10886.4) \} = 2 \times (0.0272 + 0.0151) = 0.085 \text{ cm}$$

$$< L/300 = 182.0/300 = 0.607 \text{ cm} \quad \therefore \text{O.K.}$$

## 7 根太の設計

### ◇ 根太 1



根太ピッチ B=0.455m

使用材料 4.5cm × 4.5cm (無等級 ひのき)

$$Z_x = 15.19 \text{ cm}^3 \quad I_x = 34.17 \text{ cm}^4$$

$$A = 20.25 \text{ cm}^2 \quad Z_x = 15.19 \text{ cm}^3 \quad I_x = 34.17 \text{ cm}^4$$

$$\text{曲げ基準強度} \quad F_b = 2670 \text{ N/cm}^2$$

$$\text{せん断基準強度} \quad F_s = 210 \text{ N/cm}^2$$

$$\text{長期許容曲げ応力度} \quad f_b = (1.1/3) \cdot F_b = (1.1/3) \times 2670 = 979 \text{ N/cm}^2$$

$$\text{長期許容せん断応力度} \quad f_s = (1.1/3) \cdot F_s = (1.1/3) \times 210 = 77 \text{ N/cm}^2$$

$$\text{ヤング係数} \quad E = 9000 \text{ N/mm}^2$$

$$\text{並列材} F_b \text{ の割り増し} \quad F_{\text{sys}} = 1.25$$

$$\text{長期変形増大係数} = 2$$

$$\text{床荷重(固定+積載) 応力計算用} \quad G+P = 340 + 1800 = 2140 \text{ N/m}^2$$

$$\text{たわみ計算用} \quad G+P = 340 + 600 = 940 \text{ N/m}^2$$

(長期)

$$w = (G+P) \cdot B = 2140 \times 0.455 = 973.70 \text{ N/m}$$

$$M = w \cdot L^2 / 8 = 973.70 \times 0.910^2 / 8 = 100.79 \text{ N}\cdot\text{m}$$

$$Q = w \cdot L / 2 = 973.70 \times 0.910 / 2 = 443.03 \text{ N}$$

$$\sigma_b = M / Z = 10079 / 15.19 = 663.64 \text{ N/cm}^2$$

$$\sigma_b / (F_{\text{sys}} \cdot f_b) = 663.64 / (1.25 \times 979) = 0.542 < 1 \quad \therefore \text{O.K.}$$

$$\tau = (\alpha \cdot Q) / A = (1.5 \times 443.03) / 20.25 = 32.82 \text{ N}$$

$$\tau / f_s = 32.82 / 77 = 0.426 < 1 \quad \therefore \text{O.K.}$$

$$w = (G+P) \cdot B = 940 \times 0.455 = 427.70 \text{ N/m}$$

$$\delta = 2 \cdot \{ 5 \cdot w \cdot L^4 / 384 \cdot E \cdot I_x \}$$

$$= 2 \times \{ (5 \times 4.28 \times 91.0^4) / (384 \times 900000 \times 34.17) \} = 0.248 \text{ cm}$$

$$< L / 300 = 91.0 / 300 = 0.303 \text{ cm} \quad \therefore \text{O.K.}$$