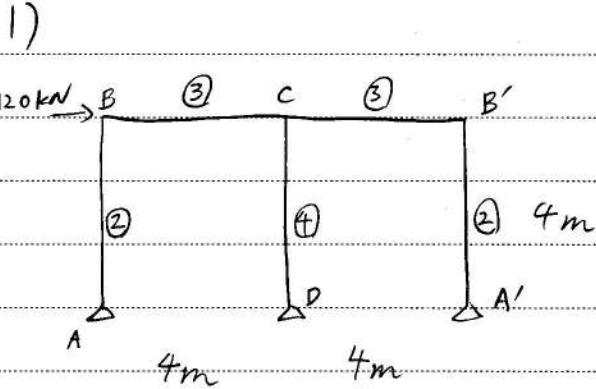


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$$\Leftrightarrow 6\varphi_B + 6\varphi_C + 4\psi = -480$$

①, ②, ③ より

$$\varphi_B = 13.33 \quad \varphi_C = 13.33 \quad \psi = -160$$

$$M_{AB} = 0 \text{ kNm} \quad M_{BA} = -120 \text{ kNm}$$

$$M_{BC} = 120 \text{ kNm} \quad M_{CB} = 120 \text{ kNm}$$

$$M_{CD} = -240 \text{ kNm} \quad M_{DC} = 0 \text{ kNm}$$

$$M_{CB'} = 120 \text{ kNm} \quad M_{B'C} = 120 \text{ kNm}$$

$$M_{B'A} = -120 \text{ kNm} \quad M_{A'B} = 0 \text{ kNm}$$

$$M_{AB} = 0$$

$$M_{BA} = 2\left(\frac{3}{2}\varphi_B + \frac{1}{2}\psi\right)$$

左柱

$$M_{BC} = 3(2\varphi_B + \varphi_C)$$

左梁

$$M_{CB} = 3(2\varphi_C + \varphi_B)$$

$$M_{CD} = 4\left(\frac{3}{2}\varphi_C + \frac{1}{2}\psi\right)$$

中柱

$$M_{DC} = 0$$

$$M_{CB'} = 3(2\varphi_C + \varphi_{B'})$$

右梁

$$M_{B'C} = 3(2\varphi_{B'} + \varphi_C)$$

(∵ 材の一端がピンの場合)

$$M_{BA} = k\left(\frac{3}{2}\varphi_B + \frac{1}{2}\psi\right) + H_{BA}$$

節点方程式より

$$M_{BA} + M_{BC} = 0$$

$$3\varphi_B + \psi + 6\varphi_B + 3\varphi_C = 0$$

$$\Leftrightarrow 9\varphi_B + 3\varphi_C + \psi = 0 \quad \text{--- ①}$$

$$M_{CB} + M_{CD} + M_{CB'} = 0$$

$$6\varphi_B + 3\varphi_C + 6\varphi_C + 2\psi + 6\varphi_C + 3\varphi_{B'} = 0$$

$$\varphi_B = \varphi_{B'} \text{ ため}$$

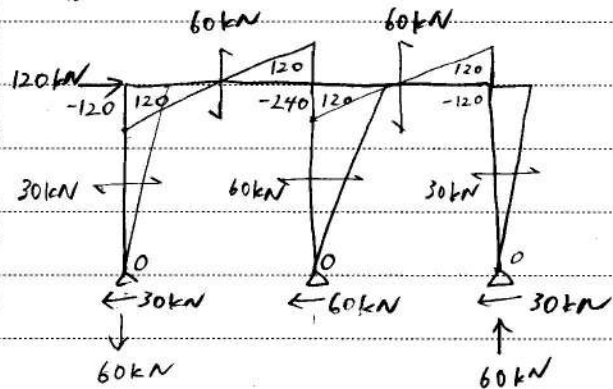
$$9\varphi_{B'} + 15\varphi_C + 2\psi = 0 \quad \text{--- ②}$$

層方程式より

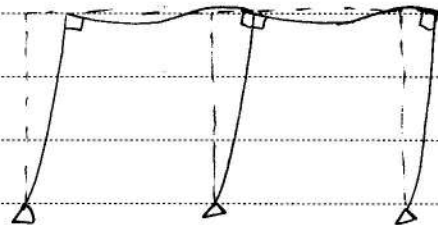
$$(M_{AB} + M_{BA}) + (M_{CD} + M_{DC}) + (M_{A'B} + M_{B'A}) = -120 \times 4$$

$$\Leftrightarrow 3\varphi_B + \psi + 6\varphi_C + 2\psi + 3\varphi_B + \psi = -480$$

M図



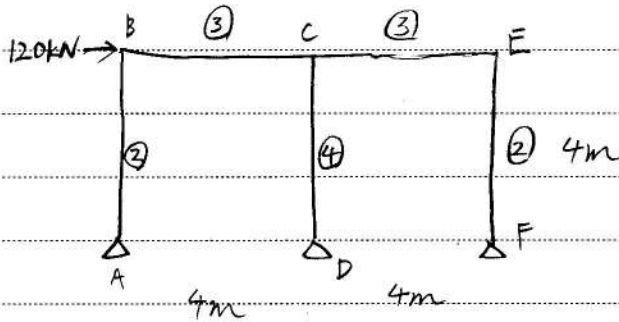
変形



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1) 別解

層方程式より



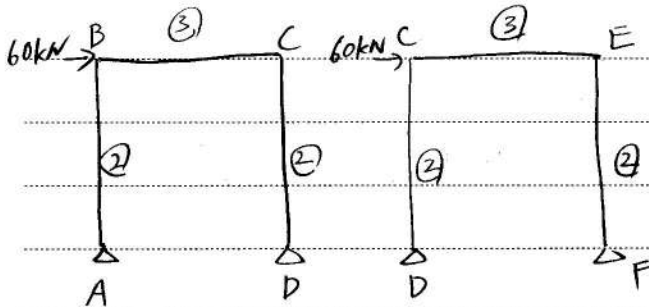
$$M_{AB} + M_{BA} = -30 \times 4$$

$$3\varphi_B + \psi = -120 \dots (3)$$

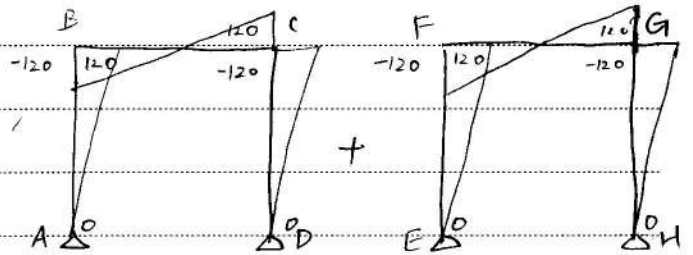
①, ②, ③より

$$\varphi_B = \varphi_C = 13,3$$

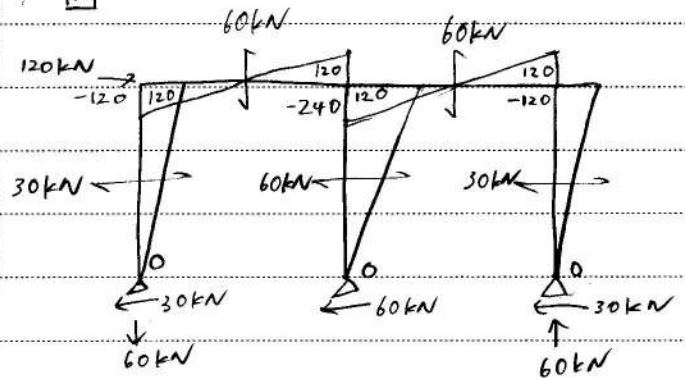
$$\psi = -160$$



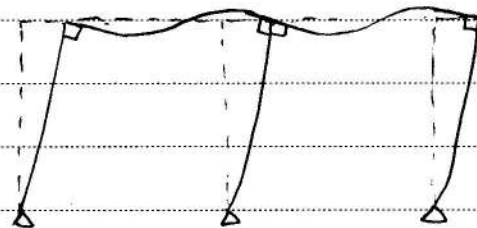
$$\begin{aligned} \sum \rightarrow M_{AB} &= 0 \text{ kNm} & M_{BA} &= -120 \text{ kNm} \\ M_{BC} &= 120 \text{ kNm} & M_{CB} &= 120 \text{ kNm} \\ M_{CD} &= -120 \text{ kNm} & M_{DC} &= 0 \text{ kNm} \end{aligned}$$



M図



変形



$$\begin{cases} M_{AB} = 0 \\ M_{BA} = 2\left(\frac{3}{2}\varphi_B + \frac{1}{2}\psi\right) \\ M_{BC} = 3(2\varphi_B + \varphi_C) \\ M_{CB} = 3(2\varphi_C + \varphi_B) \\ M_{CD} = 2\left(\frac{3}{2}\varphi_C + \frac{1}{2}\psi\right) \\ M_{DC} = 0 \end{cases}$$

ABCDは逆対称より $\varphi_B = \varphi_C \dots (1)$ より

$$M_{BC} = M_{CB} = 9\varphi_B$$

$$M_{BA} = M_{CD} = 3\varphi_B + \psi$$

B点まわりの節点方程式より

$$M_{BA} + M_{BC} = 0$$

$$12\varphi_B + \psi = 0 \dots (2)$$

試 験 用 紙 (年 月 日)

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$$2) I = \frac{30 \times 40^3}{12}$$

$$= 160000 \text{ cm}^4$$

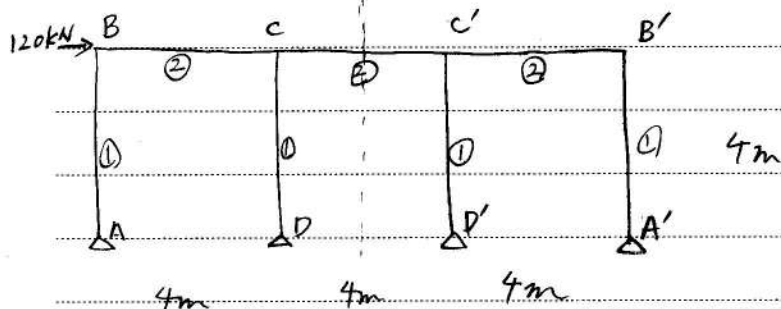
$$Z = \frac{I}{y} = \frac{160000}{20}$$

$$= 8000 \text{ cm}^3$$

$$\sigma = \frac{M}{Z} = \frac{12000}{8000} = 1.5 \text{ kN/cm}^2 < 1.8 \text{ kN/cm}^2$$

I, Z OK

2.1)



層方程式より

$$\begin{cases} M_{AB} = 0 \\ M_{BA} = \frac{3}{2}\varphi_B + \frac{1}{2}\psi \\ M_{BC} = 2(2\varphi_B + \varphi_c) \\ M_{CB} = 2(2\varphi_c + \varphi_B) \\ M_{CD} = \frac{3}{2}\varphi_c + \frac{1}{2}\psi \\ M_{DC} = 0 \\ M_{cD} = 2(2\varphi_c + \varphi_{c'}) \\ M_{c'c} = 2(2\varphi_{c'} + \varphi_c) \end{cases}$$

$$\begin{aligned} (M_{AB} + M_{BA}) + (M_{DC} + M_{CD}) &= -60 \times 4 \\ \frac{3}{2}\varphi_B + \frac{1}{2}\psi + \frac{3}{2}\varphi_c + \frac{1}{2}\psi &= -240 \\ \frac{3}{2}\varphi_B + \frac{3}{2}\varphi_c + \psi &= -240 \dots (3) \end{aligned}$$

①, ②, ③より

$$\varphi_B = 23.03 \quad \varphi_c = 8.485 \quad \psi = -287.27$$

$$\begin{aligned} M_{AB} &= 0 \text{ kNm} & M_{BA} &= -109 \text{ kNm} \\ M_{BC} &= 109 \text{ kNm} & M_{CB} &= 80 \text{ kNm} \\ M_{CD} &= -131 \text{ kNm} & M_{DC} &= 0 \text{ kNm} \\ M_{cD} &= 50.9 \text{ kNm} & M_{c'c} &= 50.9 \text{ kNm} \end{aligned}$$

節点方程式より

$$M_{BA} + M_{BC} = 0$$

$$\frac{3}{2}\varphi_B + \frac{1}{2}\psi + 4\varphi_B + 2\varphi_c = 0$$

$$\frac{11}{2}\varphi_B + 2\varphi_c + \frac{1}{2}\psi = 0 \dots (1)$$

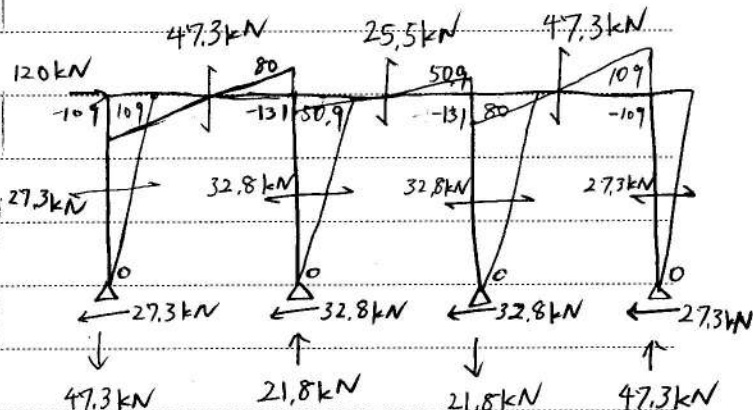
$$M_{CB} + M_{CD} + M_{cD} = 0$$

$$4\varphi_c + 2\varphi_B + \frac{3}{2}\varphi_c + \frac{1}{2}\psi + 4\varphi_c + 2\varphi_{c'} = 0$$

$$\varphi_c = \varphi_{c'} \text{ (より)}$$

$$\frac{1}{2}\varphi_B + \frac{23}{2}\varphi_c + \frac{1}{2}\psi = 0 \dots (2)$$

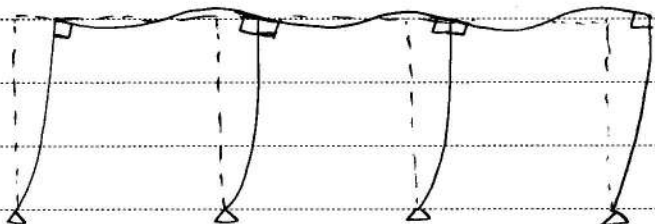
M図



試 験 用 紙 (年 月 日)

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変形



$$2) \psi = 2EK_0(-3R)$$

$$R = -\frac{\psi}{6EK_0}$$

$$= \frac{287,27 \times 100}{6 \times 20000 \times 50}$$

$$= 0,00479 < \frac{1}{200}$$

よ, 2 ok