

Расчетно – проектировочная  
работа № 6  
Энергетический метод расчета  
упругих систем

Задание содержит три задачи.

В задаче № 1 следует определить:  
вертикальное перемещение сечения А, горизонтальное  
перемещение сечения В, угол поворота сечения С.  
Перемещения определяют в виде  $EJ_z \delta = \sum \int M M_i dx$ .

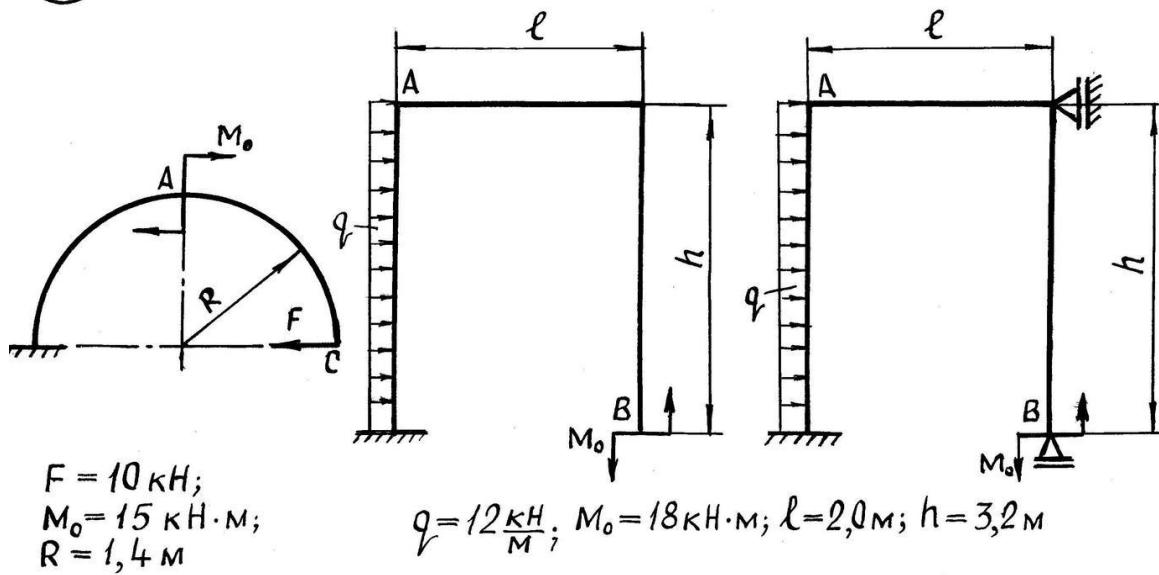
В задачах № 2 и № 3 следует выполнить  
расчет на прочность и определить перемещения в  
указанных сечениях. Расчет на прочность содержит:  
построение эпюр внутренних усилий;  
определение размеров двутавра;  
проверку прочности по касательным напряжениям;  
проверку прочности с учетом осевых усилий.

Допускаемое напряжение  $\sigma_{adm} = 160 \text{ МПа}$ .

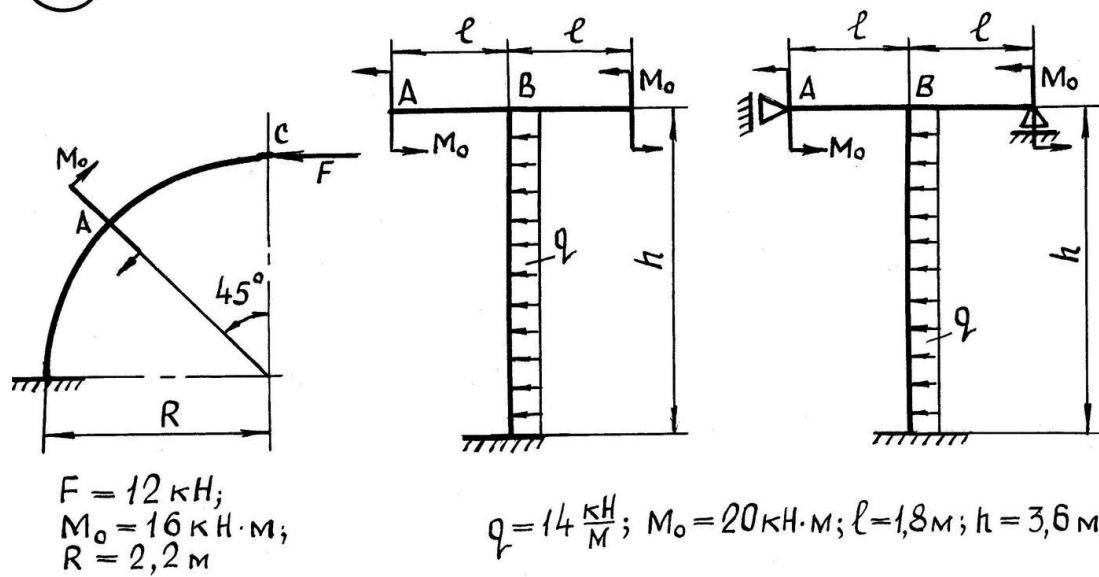
Сравните результаты расчета на прочность и  
определения перемещений при решении задач № 2  
и № 3.

Сравнивая результаты расчетов, сделайте вывод  
о влиянии дополнительных связей на прочность  
и жесткость конструкций.

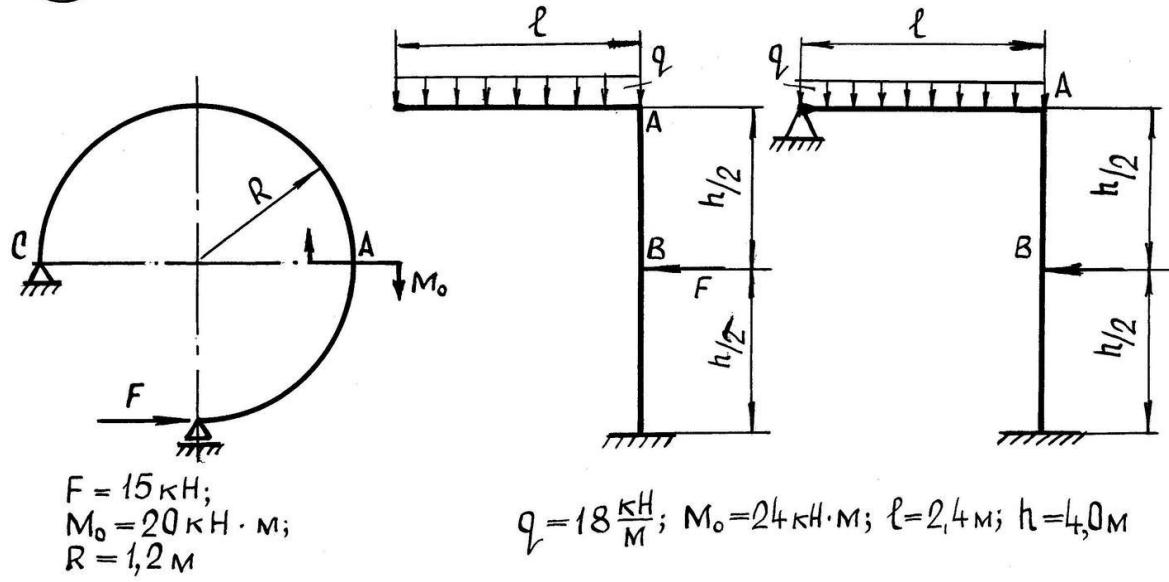
1



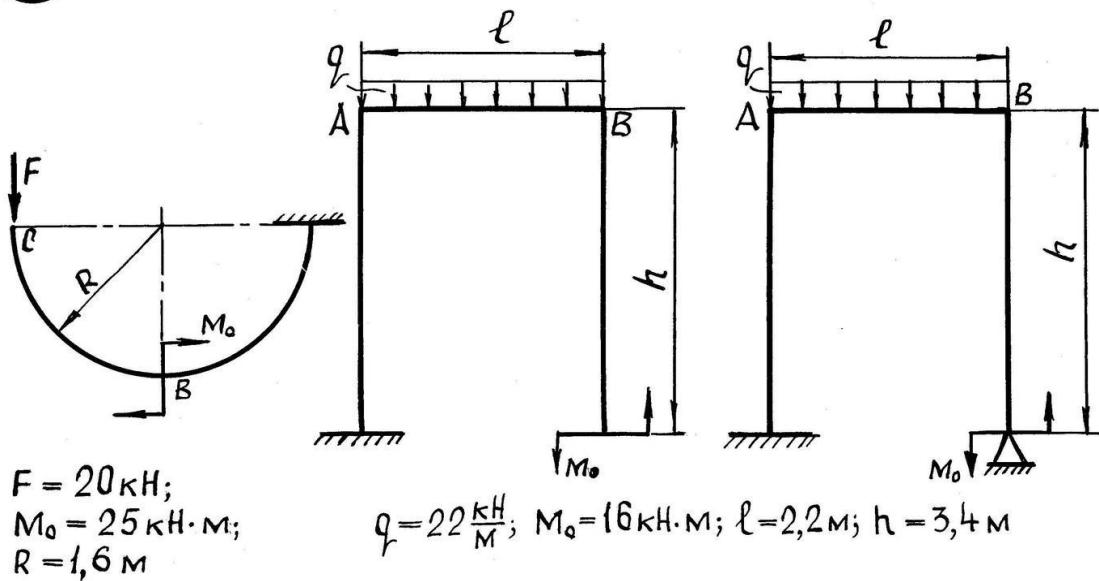
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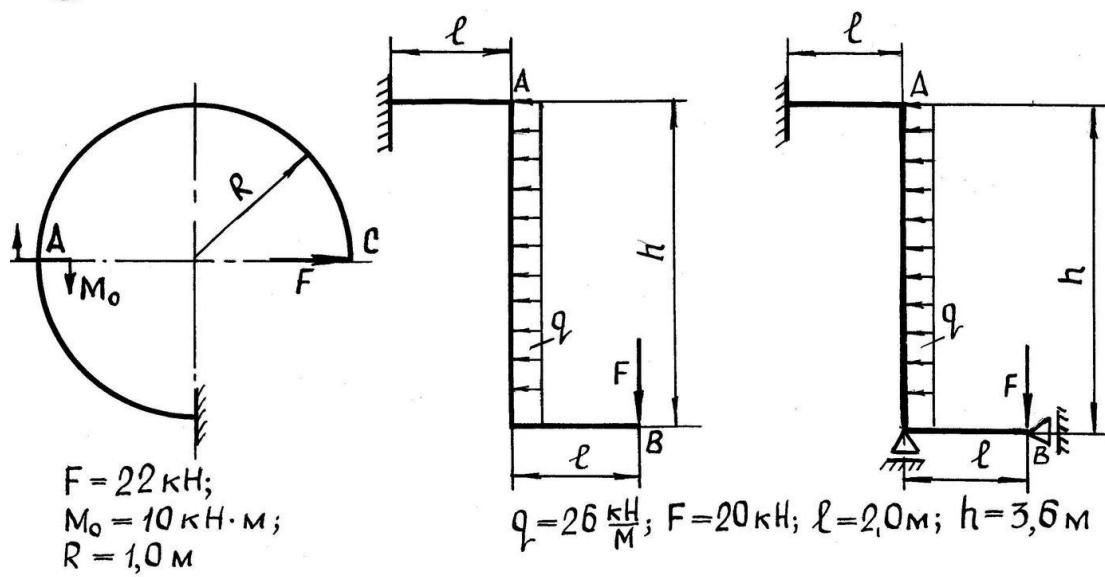
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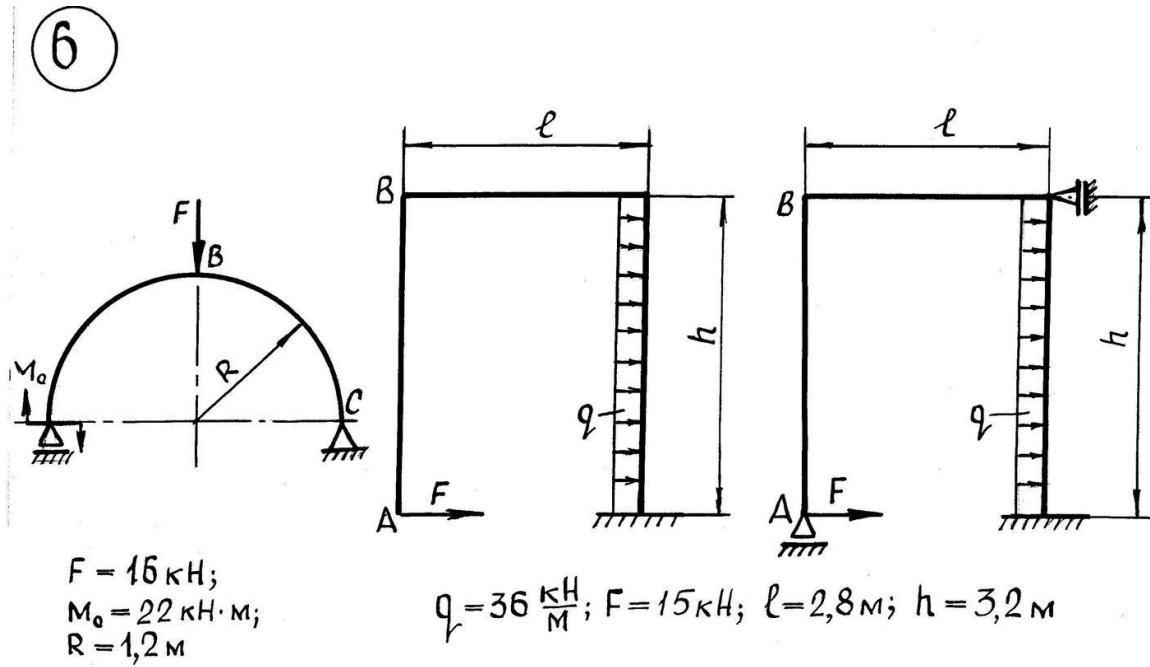
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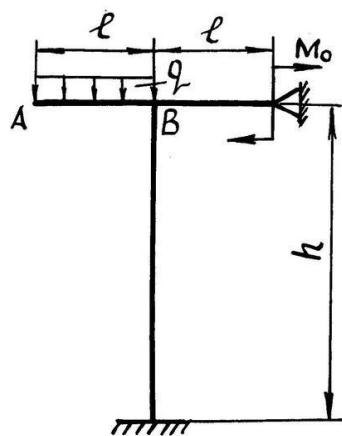
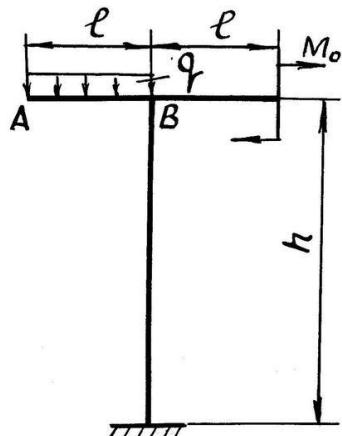
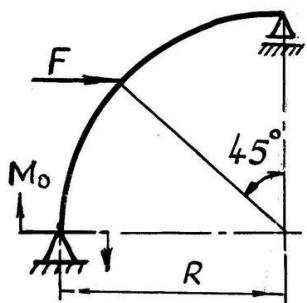
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(6)



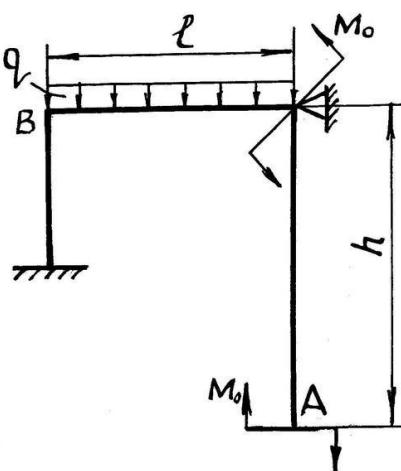
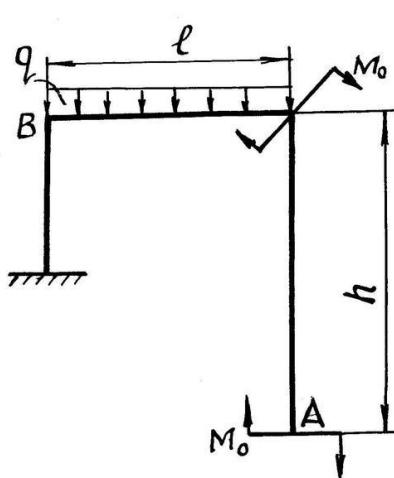
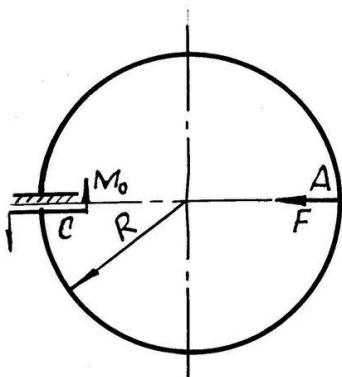
7



$$F = 24 \text{ kN}; \\ M_0 = 18 \text{ kN} \cdot \text{m}; \\ R = 2,0 \text{ m}$$

$$q = 24 \frac{\text{kN}}{\text{m}}; \quad M_0 = 14 \text{ kN} \cdot \text{m}; \quad l = 1,2 \text{ m}; \quad h = 2,8 \text{ m}$$

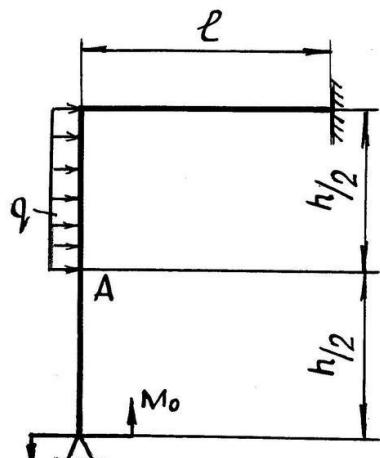
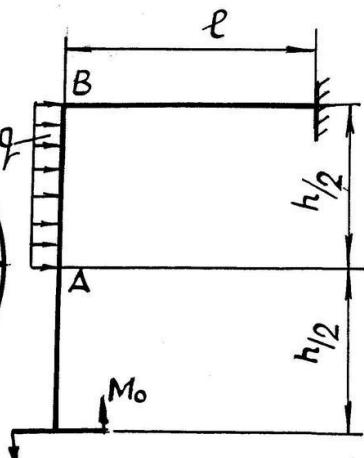
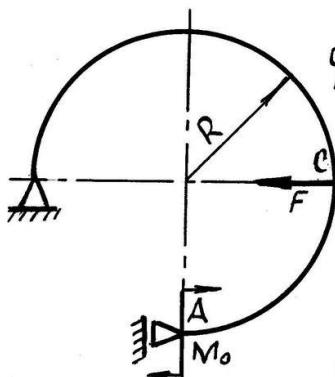
8



$$F = 26 \text{ kN}; \\ M_0 = 14 \text{ kN} \cdot \text{m}; \\ R = 1,0 \text{ m}$$

$$q = 20 \frac{\text{kN}}{\text{m}}; \quad M_0 = 18 \text{ kN} \cdot \text{m}; \quad l = 2,2 \text{ m}; \quad h = 4,0 \text{ m}$$

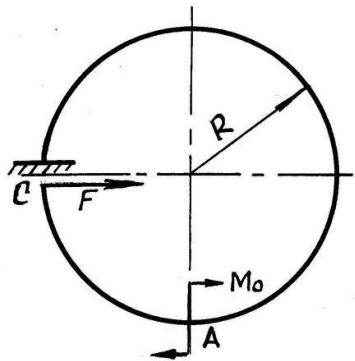
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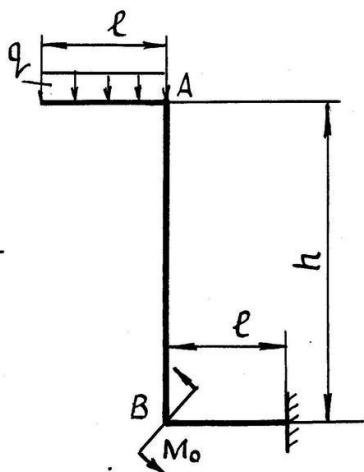
$$F = 20 \text{ kN}; \\ M_0 = 22 \text{ kN} \cdot \text{m}; \\ R = 1,4 \text{ m}$$

$$q = 32 \frac{\text{kN}}{\text{m}}; \quad M_0 = 12 \text{ kN} \cdot \text{m}; \quad l = 2,4 \text{ m}; \quad h = 4,2 \text{ m}$$

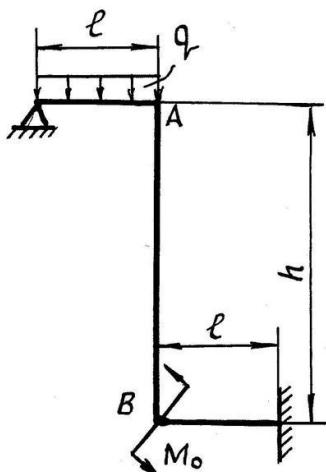
(10)



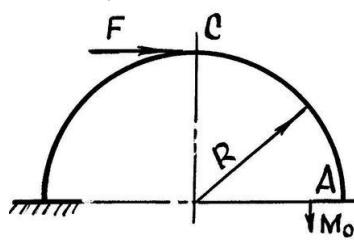
$$F = 22 \text{ kN}; \\ M_0 = 15 \text{ kN}\cdot\text{m}; \\ R = 1,0 \text{ m}$$



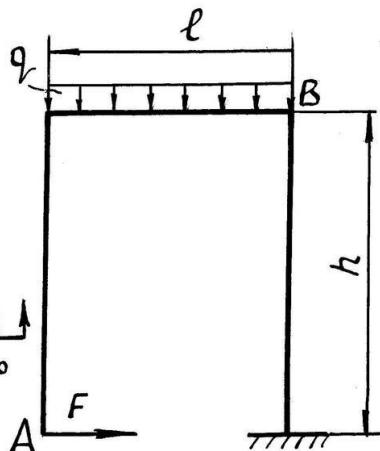
$$q = 10 \frac{\text{kN}}{\text{m}}; M_0 = 18 \text{ kN}\cdot\text{m}; l = 2,4 \text{ m}; h = 3,6 \text{ m}$$



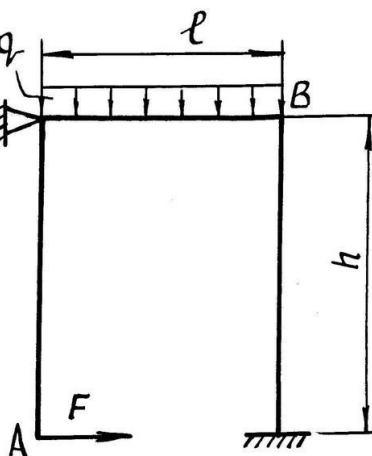
(11)



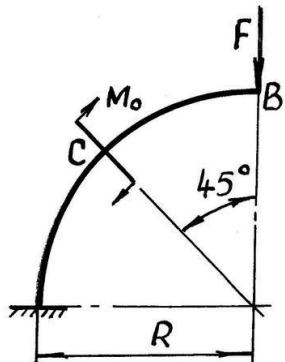
$$F = 10 \text{ kN}; \\ M_0 = 12 \text{ kN}\cdot\text{m}; \\ R = 1,5 \text{ m}$$



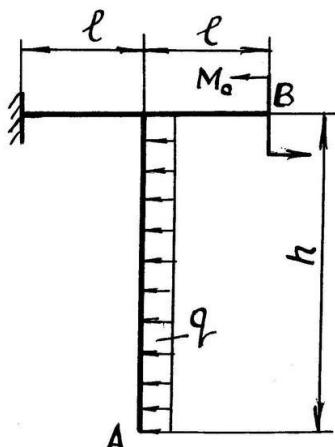
$$q = 28 \frac{\text{kN}}{\text{m}}; F = 24 \text{ kN}; l = 1,8 \text{ m}; h = 3,8 \text{ m}$$



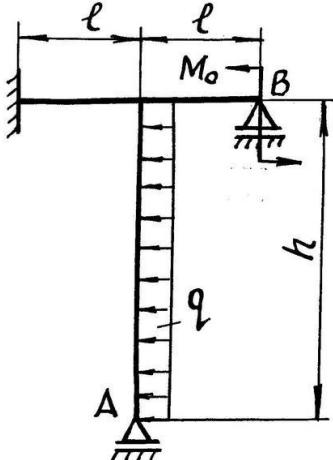
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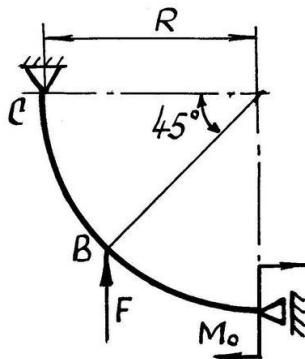
$$F = 24 \text{ kN}; \\ M_0 = 20 \text{ kN}\cdot\text{m}; \\ R = 2,4 \text{ m}$$



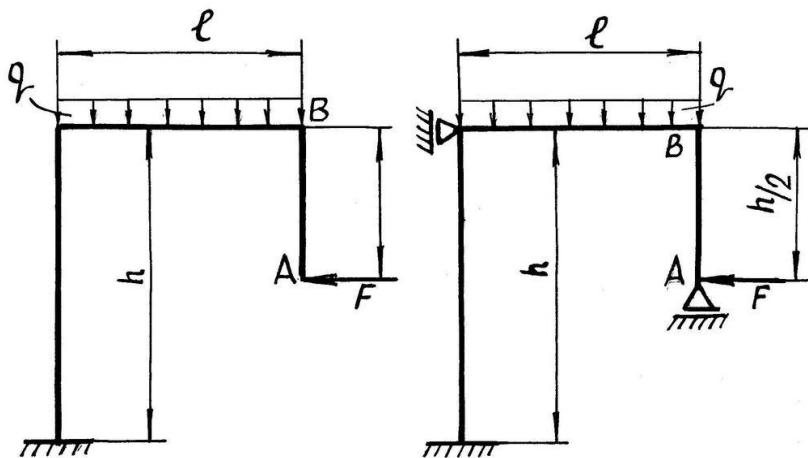
$$q = 30 \frac{\text{kN}}{\text{m}}; M_0 = 10 \text{ kN}\cdot\text{m}, l = 1,0 \text{ m}; h = 3,8 \text{ m}$$



(13)

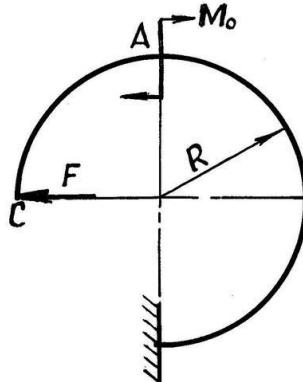


$$F = 15 \text{ kN}; \\ M_o = 25 \text{ kN} \cdot \text{m}; \\ R = 1,4 \text{ m}$$

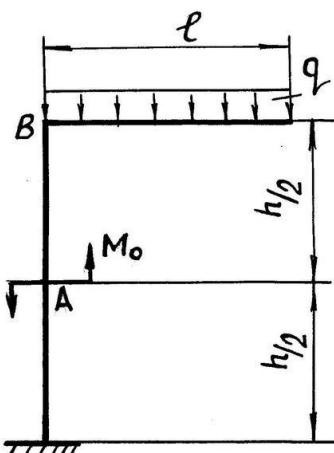


$$q = 22 \frac{\text{kN}}{\text{m}}; F = 14 \text{ kN}; l = 1,4 \text{ m}; h = 2,8 \text{ m}$$

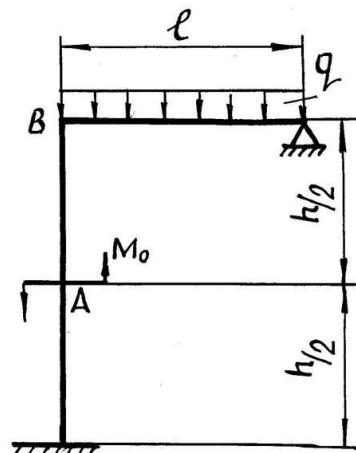
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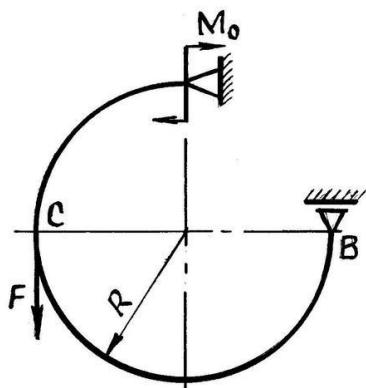
$$F = 28 \text{ kN}; \\ M_o = 12 \text{ kN} \cdot \text{m}; \\ R = 1,2 \text{ m}$$



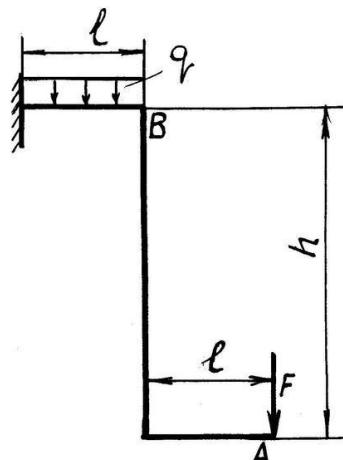
$$q = 16 \frac{\text{kN}}{\text{m}}; M_o = 10 \text{ kN} \cdot \text{m}; l = 2,0 \text{ m}; h = 3,6 \text{ m}$$



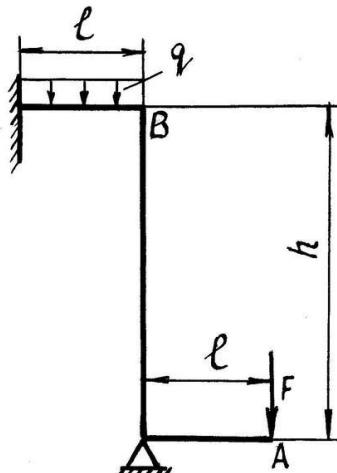
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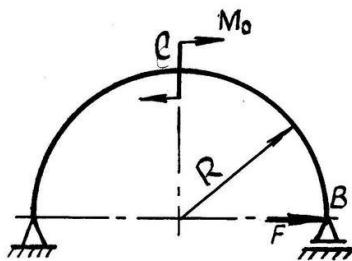
$$F = 30 \text{ kN}; \\ M_o = 10 \text{ kN} \cdot \text{m}; \\ R = 1,4 \text{ m}$$



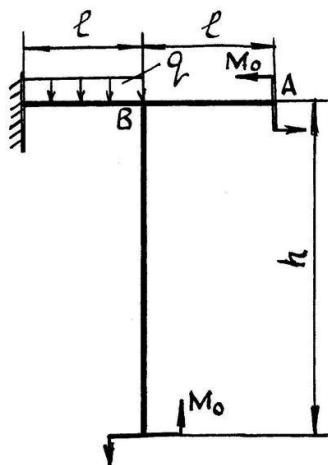
$$q = 24 \frac{\text{kN}}{\text{m}}; F = 18 \text{ kN}; l = 1,5 \text{ m}; h = 3,0 \text{ m}$$



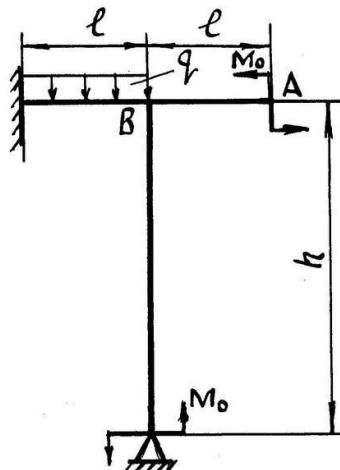
(16)



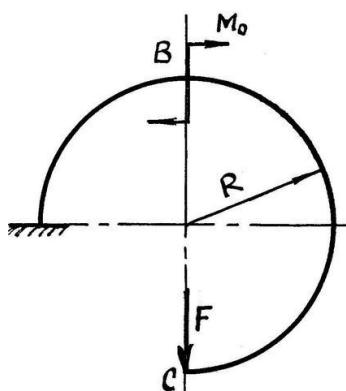
$$F = 10 \text{ kN}; \\ M_0 = 20 \text{ kN} \cdot \text{m}; \\ R = 1,0 \text{ m}$$



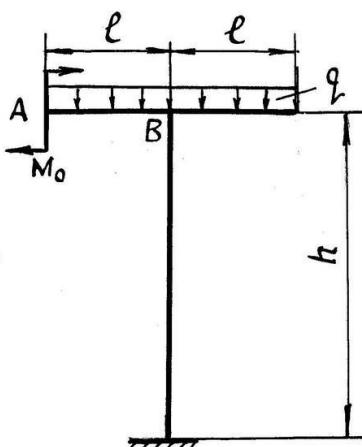
$$q = 30 \frac{\text{kN}}{\text{m}}; M_0 = 20 \text{ kN} \cdot \text{m}; \ell = 1,8 \text{ m}; h = 4,0 \text{ m}$$



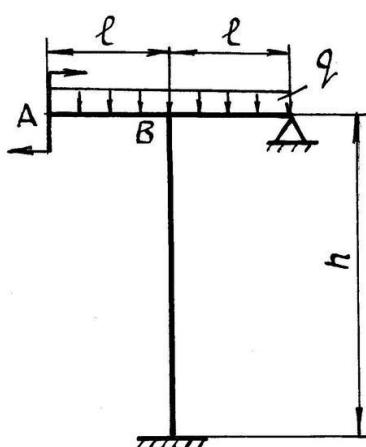
(17)



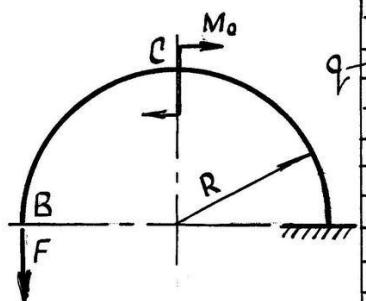
$$F = 12 \text{ kN}; \\ M_0 = 18 \text{ kN} \cdot \text{m} \\ R = 1,4 \text{ m}$$



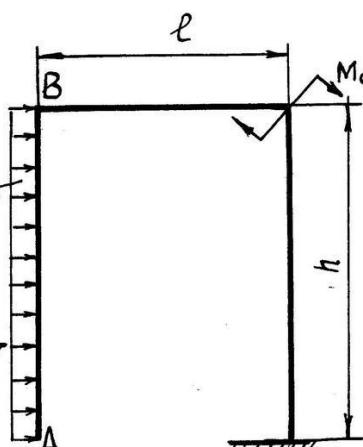
$$q = 20 \frac{\text{kN}}{\text{m}}; M_0 = 10 \text{ kN} \cdot \text{m}; \ell = 1,6 \text{ m}; h = 3,2 \text{ m}$$



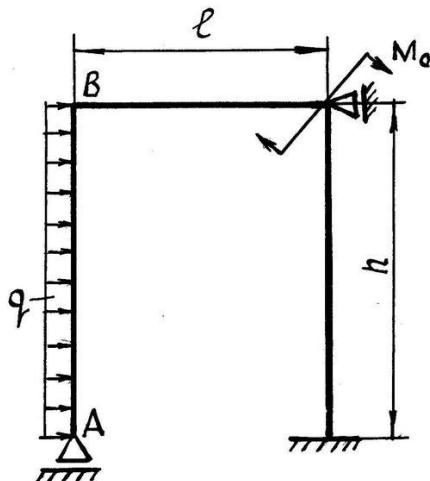
(18)



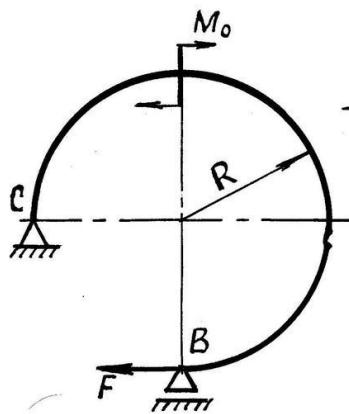
$$F = 14 \text{ kN}; \\ M_0 = 22 \text{ kN} \cdot \text{m}; \\ R = 1,6 \text{ m}$$



$$q = 12 \frac{\text{kN}}{\text{m}}; M_0 = 10 \text{ kN} \cdot \text{m}; \ell = 2,2 \text{ m}; h = 3,8 \text{ m}$$



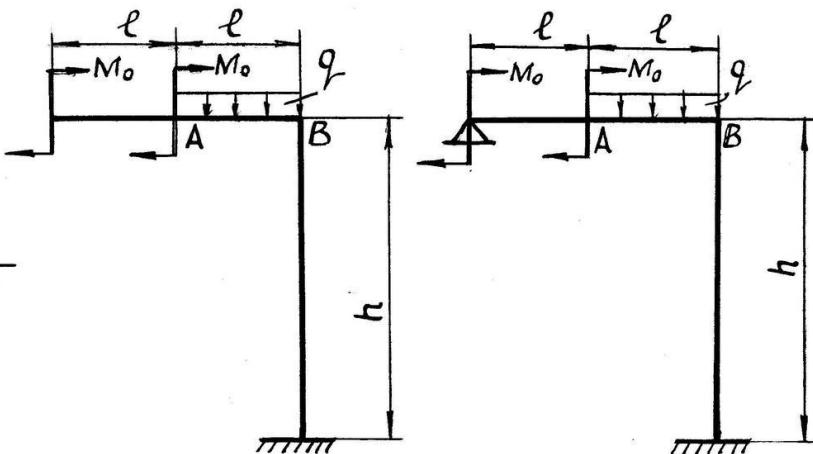
(19)



$$F = 14 \text{ kN};$$

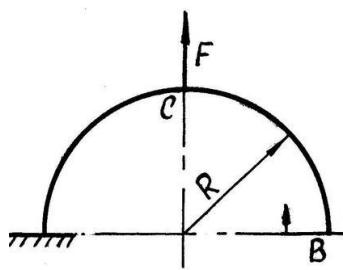
$$M_0 = 24 \text{ kN}\cdot\text{m};$$

$$R = 1,2 \text{ m}$$



$$q = 26 \frac{\text{kN}}{\text{m}}; M_0 = 18 \text{ kN}\cdot\text{m}; \ell = 1,4 \text{ m}; h = 3,4 \text{ m}$$

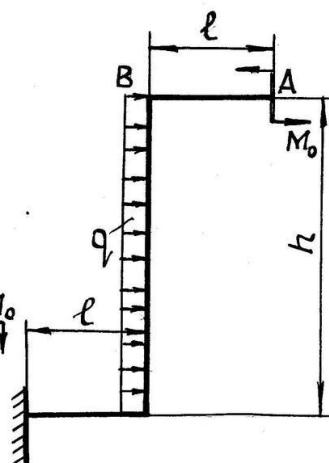
(20)



$$F = 18 \text{ kN};$$

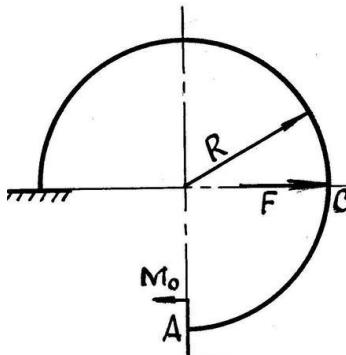
$$M_0 = 16 \text{ kN}\cdot\text{m};$$

$$R = 2,0 \text{ m}$$



$$q = 18 \frac{\text{kN}}{\text{m}}; M_0 = 12 \text{ kN}\cdot\text{m}; \ell = 1,6 \text{ m}; h = 3,8 \text{ m}$$

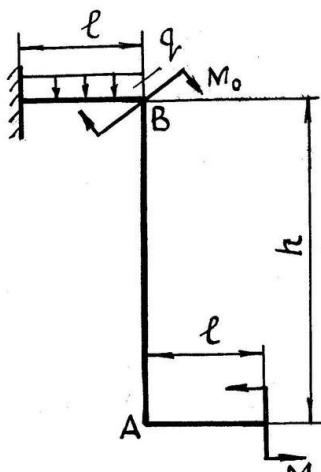
(21)



$$F = 20 \text{ kN};$$

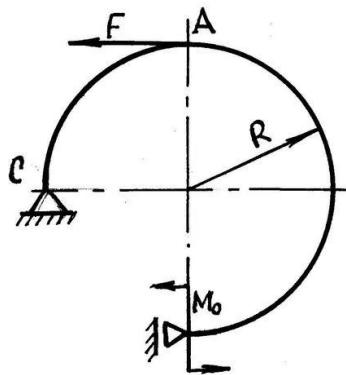
$$M_0 = 26 \text{ kN}\cdot\text{m};$$

$$R = 1,2 \text{ m}$$

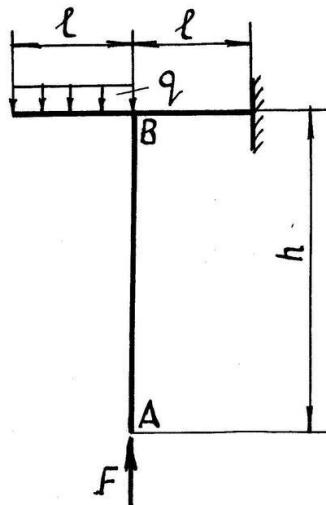


$$q = 28 \frac{\text{kN}}{\text{m}}; M_0 = 12 \text{ kN}\cdot\text{m}; \ell = 1,6 \text{ m}; h = 3,6 \text{ m}$$

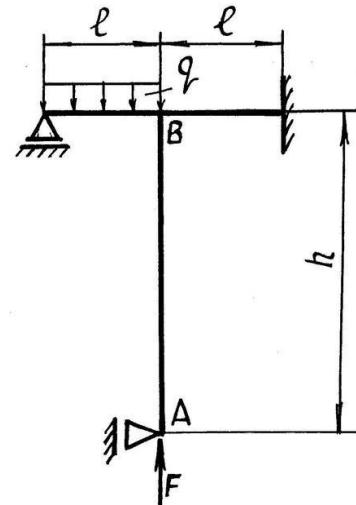
(22)



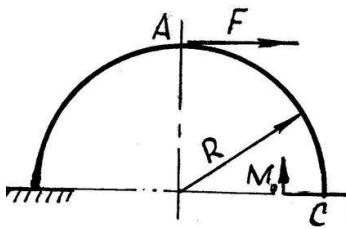
$$F = 22 \text{ kN}; \\ M_0 = 28 \text{ kN}\cdot\text{m}; \\ R = 1,6 \text{ m}$$



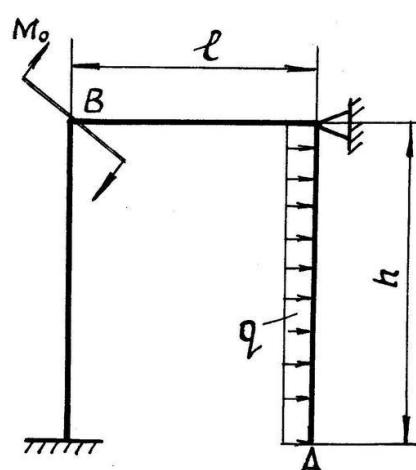
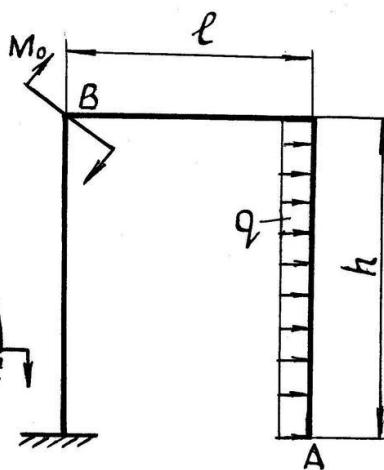
$$q = 20 \frac{\text{kN}}{\text{m}}; F = 10 \text{ kN}; l = 1,2 \text{ m}; h = 3,0 \text{ m}$$



(23)

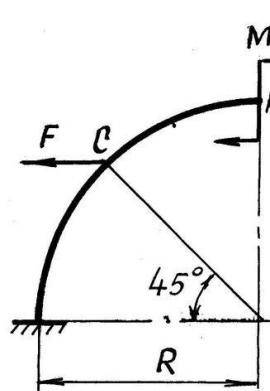


$$F = 24 \text{ kN}; \\ M_0 = 30 \text{ kN}\cdot\text{m}; \\ R = 1,6 \text{ m}$$

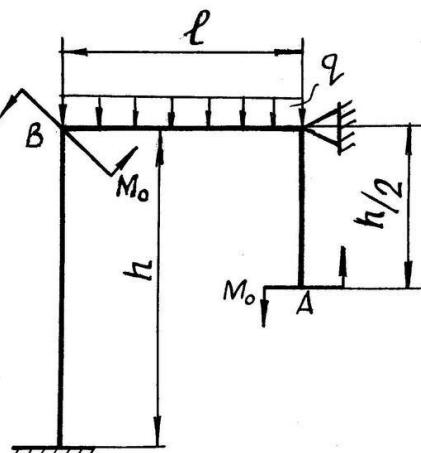
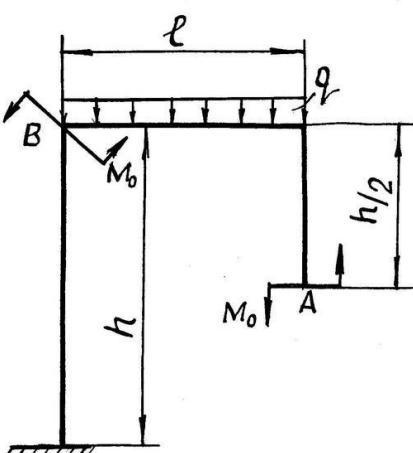


$$q = 20 \frac{\text{kN}}{\text{m}}; M_0 = 10 \text{ kN}\cdot\text{m}; l = 1,5 \text{ m}; h = 3,0 \text{ m}$$

(24)

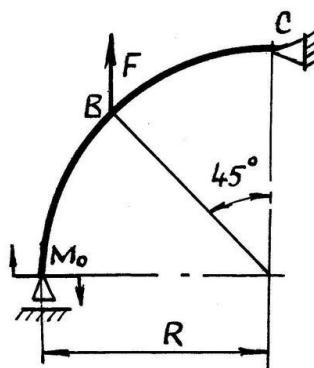


$$F = 26 \text{ kN}; \\ M_0 = 28 \text{ kN}\cdot\text{m}; \\ R = 2,2 \text{ m}$$

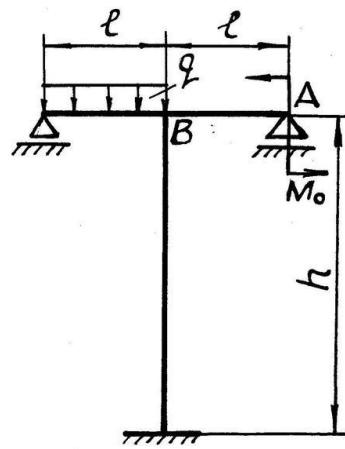
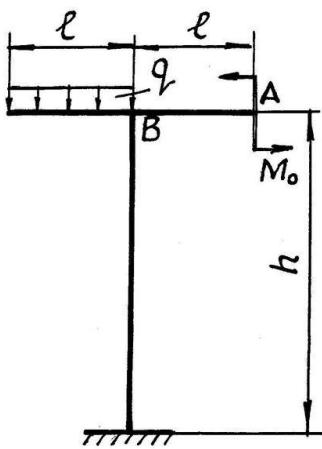


$$q = 18 \frac{\text{kN}}{\text{m}}; M_0 = 22 \text{ kN}\cdot\text{m}; l = 1,8 \text{ m}; h = 3,6 \text{ m}$$

(25)

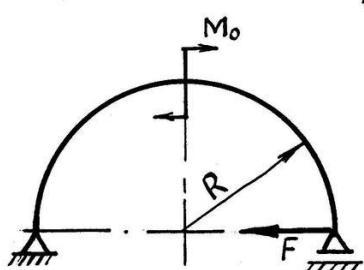


$$F = 28 \text{ kN}; \\ M_0 = 8,0 \text{ kN}\cdot\text{m}; \\ R = 2,4 \text{ m}$$

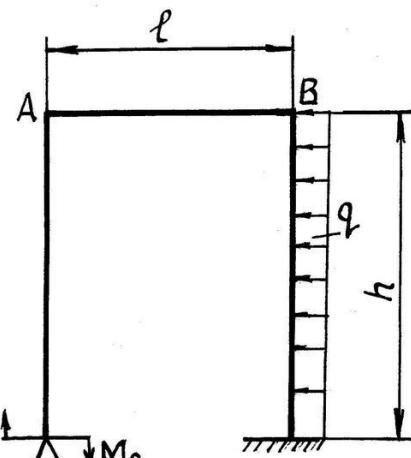
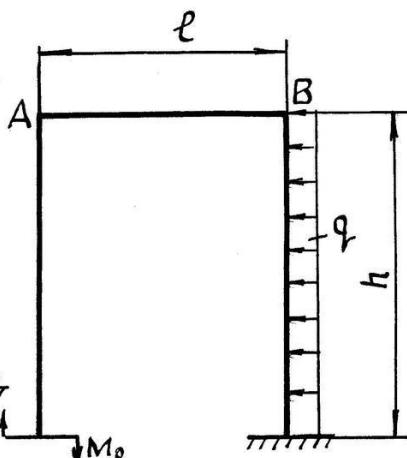


$$q = 25 \frac{\text{kN}}{\text{m}}; M_0 = 30 \text{ kN}\cdot\text{m}; l = 1,2 \text{ m}; h = 2,0 \text{ m}$$

(26)

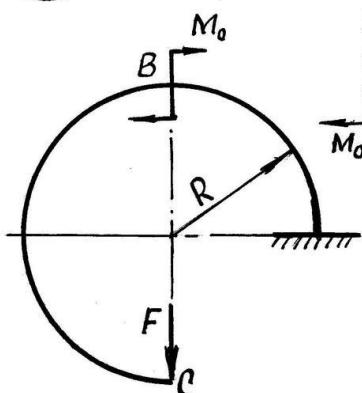


$$F = 30 \text{ kN}; \\ M_0 = 12 \text{ kN}\cdot\text{m}; \\ R = 1,5 \text{ m}$$

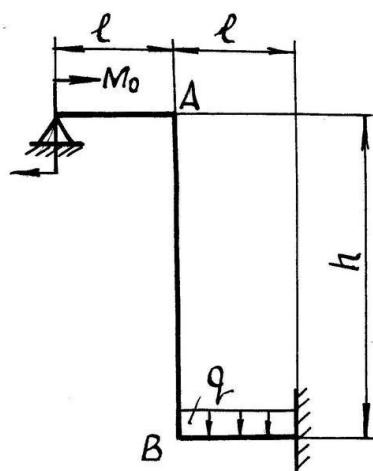
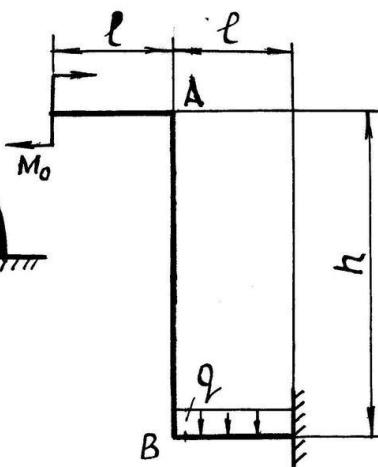


$$q = 22 \frac{\text{kN}}{\text{m}}; M_0 = 10 \text{ kN}\cdot\text{m}; l = 2,0 \text{ m}; h = 4,0 \text{ m}$$

(27)

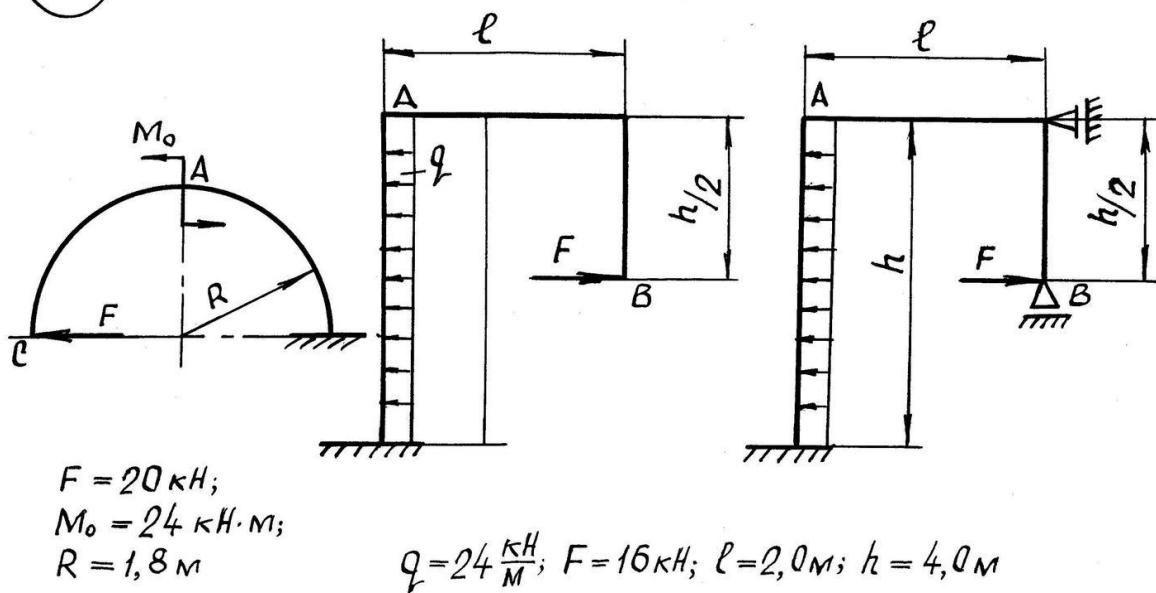


$$F = 25 \text{ kN}; \\ M_0 = 20 \text{ kN}\cdot\text{m}; \\ R = 1,2 \text{ m}$$

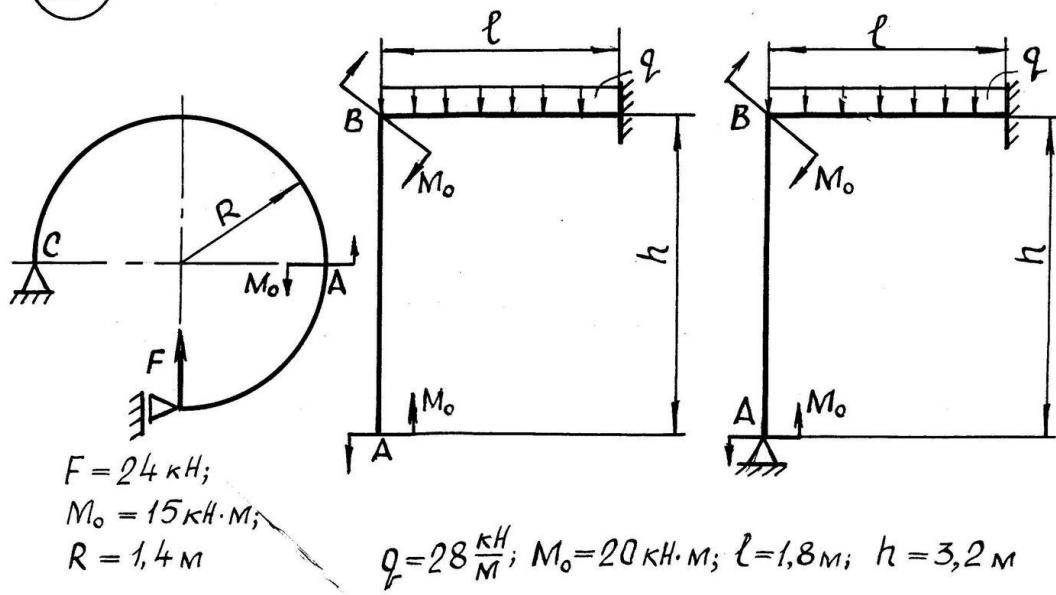


$$q = 30 \frac{\text{kN}}{\text{m}}; M_0 = 15 \text{ kN}\cdot\text{m}; l = 1,0 \text{ m}; h = 2,0 \text{ m}$$

(28)



(29)



(30)

