

# NEM LINEÁRIS RUGÓ

$E \neq$  állandó

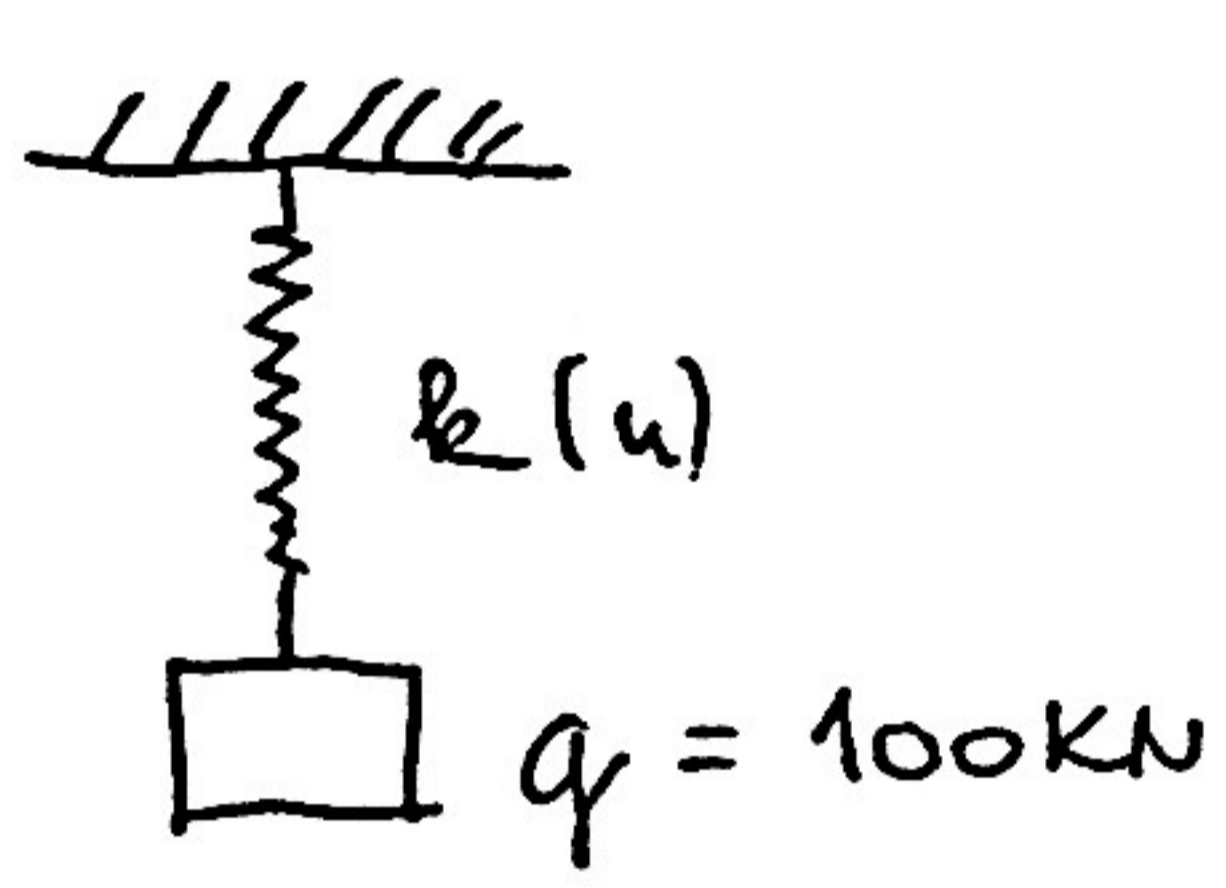
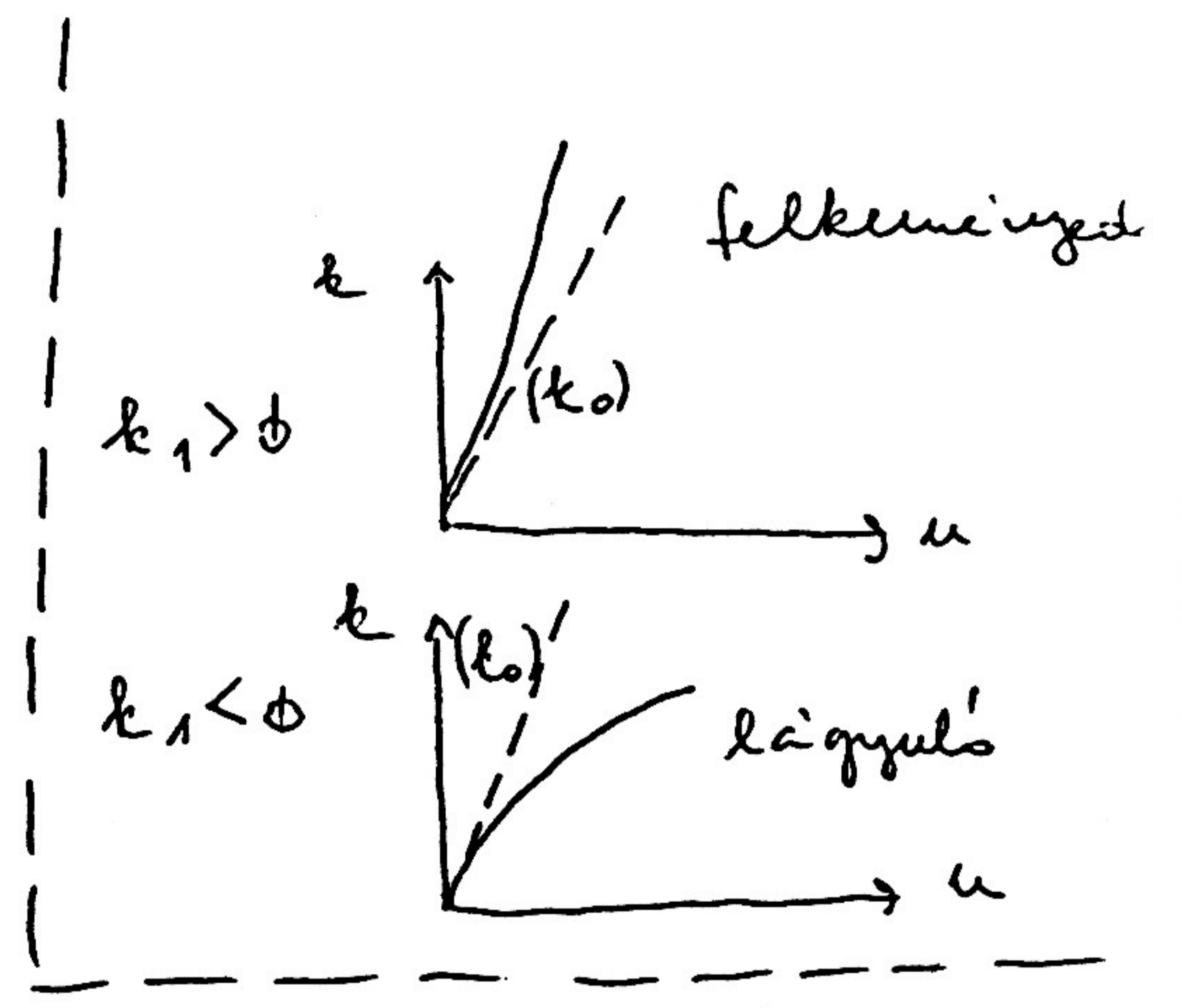
$k = \overset{\text{ráltozó}}{E \cdot A / l}$

$k(u) = k_0 + k_1 \cdot u$

rugótevékenység a megnyúlástól is függ

$k_0 = 1,4 \cdot 10^3 \frac{KN}{m} = 1400 \text{ KN/m}$

$k_1 = -0,4 \cdot 10^4 \frac{KN}{m^2} = -4000 \text{ KN/m}^2$



$k(u) \cdot u = q$   
 $(k_0 - k_1 \cdot u) \cdot u = q$

$-k_1 \cdot u^2 + k_0 \cdot u - q = 0$

$u = \frac{-k_0 \pm \sqrt{k_0^2 - 4 \cdot k_1 \cdot q}}{2 \cdot k_1}$

$D = k_0^2 - 4 \cdot k_1 \cdot q \geq 0$

$k_1 \leq \frac{k_0^2}{4 \cdot q}$

$4000 < \frac{1400 \cdot 1400}{4 \cdot 100} = 4900$

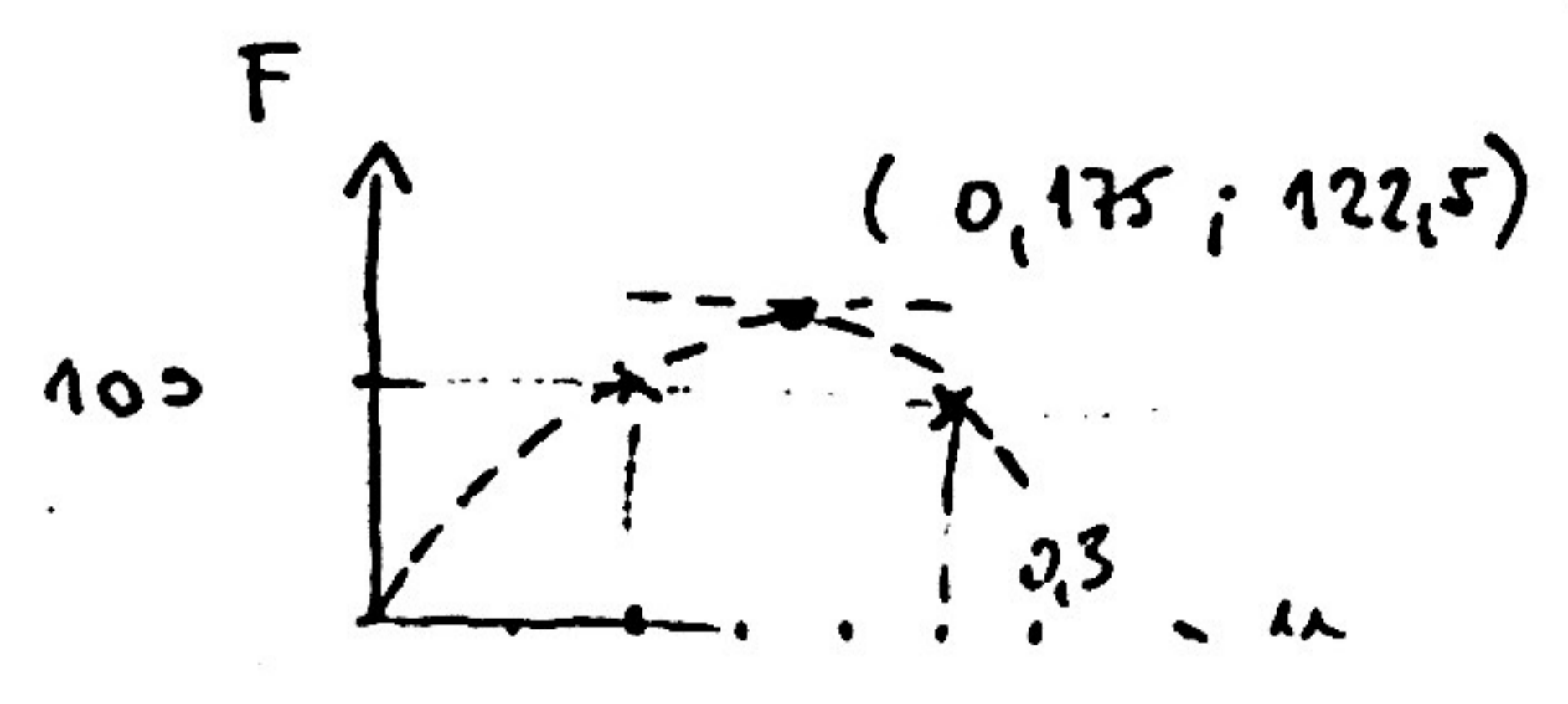
Pontos megoldás

$u_p = \frac{-1400 \pm \sqrt{1400^2 - 4 \cdot 4000 \cdot 100}}{2 \cdot 4000} = \frac{-1400 \pm 600}{-8000} = \begin{cases} 0,25 \text{ m} \\ 0,1 \text{ m} \end{cases}$

behelyettesítés

$(1400 - 4000 \cdot 0,1) \cdot 0,1 = 100$

10 cm-es megnyúlás



## KÖZELTŐ MEGOLDÁSOK

a) kerdesi érintővel másképpen:

$$k_0 = 1400 \text{ KN/m}$$

$$1.) \quad k_0 \cdot u = q \quad \rightarrow \quad \underline{u_1} = \frac{q}{k_0} = \frac{100}{1400} = 0,07143 = \underline{7,143 \text{ cm}}$$

szükség

$$k(u_1) \cdot u_1 = (1400 - 0,07143 \cdot 4000) \cdot 0,07143 =$$

$$= (1400 - 285,72) \cdot 0,07143 =$$

$$= 1114,28 \cdot 0,07143 = 79,583 \text{ KN}$$

$$\text{összesen: } \underline{20,407 \text{ KN}} !$$

$$\underline{100,000 \text{ KN}}$$

2.)

$$1400 \cdot u_2 = 20,407$$

$$\underline{u_2} = \frac{20,407}{1400} = 0,01458 \text{ m} = \underline{1,458 \text{ cm}}$$

$$u_1 + u_2 = 7,143 + 1,458 = \underline{0,086006 \text{ m}}$$

$$k(u_1 + u_2) \cdot (u_1 + u_2) = (1400 - 0,086006 \cdot 4000) \cdot 0,086006 =$$

$$= 1055,9744 \cdot 0,086006 = 90,8201 \text{ KN}$$

$$\text{összesen: } \underline{9,1799 \text{ KN}} !$$

$$\underline{100,000 \text{ KN}}$$

3.)

$$1400 \cdot u_3 = 9,1799$$

$$u_3 = \frac{9,1799}{1400} = 0,006557 \text{ m} = \underline{0,656 \text{ cm}}$$

$$u_1 + u_2 + u_3 = \underline{0,092563 \text{ m}}$$

$$k(u_1 + u_2 + u_3) \cdot (u_1 + u_2 + u_3) = (1400 - 0,092563 \cdot 4000) \cdot 0,092563 =$$

$$= 1029,748 \cdot 0,092563 = 95,3166 \text{ KN}$$

$$\text{összesen: } \underline{4,68344 \text{ KN}} !$$

$$\underline{100,000 \text{ KN}}$$

b)

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érintő megállandó minden lépésben

$$1.) \quad -k_0 \cdot u_1 = q \rightarrow u_1 = \frac{100}{1400} = 0,07143 \text{ m} = 7,143 \text{ cm}$$

$$k(u_1) = 1400 - 4000 \cdot 0,07143 = 1400 - 285,72 = 1114,28 \frac{\text{KN}}{\text{m}}$$

$$k(u_1) \cdot u_1 = 1114,28 \cdot 0,07143 = 79,593 \text{ KN}$$

$$\text{hidány, eltérés} \quad \frac{20,407 \text{ KN}}{100,000 \text{ KN}} !$$

$$2.) \quad k(u_1) \cdot u_2 = 20,407 \rightarrow u_2 = \frac{20,407}{1114,28} = 0,018314 \text{ m} = 1,8314 \text{ cm}$$

$$u_1 + u_2 = 0,089744 \text{ m}$$

$$k(u_1 + u_2) = 1400 - 4000 \cdot 0,089744 = 1041,027 \text{ KN/m}$$

$$k(u_1 + u_2) \cdot (u_1 + u_2) = 1041,027 \cdot 0,089744 = 93,426 \text{ KN}$$

$$\text{hidány} \quad \frac{6,5744 \text{ KN}}{100,000 \text{ KN}} !$$

$$3.) \quad k(u_1 + u_2) \cdot u_3 = 6,5744 \rightarrow u_3 = \frac{6,5744}{1041,024} = 0,006315 \text{ m} = 0,6315 \text{ cm}$$

$$u_1 + u_2 + u_3 = 0,096059 \text{ m}$$

$$k(u_1 + u_2 + u_3) = 1400 - 4000 \cdot 0,096059 = 1015,76 \text{ KN/m}$$

$$k(u_1 + u_2 + u_3) \cdot (u_1 + u_2 + u_3) = 1015,76 \cdot 0,096059 = 97,57 \text{ KN}$$

$$\text{hidány} \quad \frac{2,43 \text{ KN}}{100,00 \text{ KN}} !$$

$$100,00 \text{ KN}$$

c)

4.

$$\frac{100 \text{ kN}}{5} = \underline{20 \text{ KN} \cdot \text{m}} \text{ felhúzóerővel számolva}$$

$$k = 1400 - 4000 \cdot u$$

$$1) \quad 1400 \cdot u_1 = 20 \rightarrow u_1 = \frac{20}{1400} = 0,014286 \text{ m} = 1,4286 \text{ cm}$$

$$k(u_1) = 1400 - 4000 \cdot 0,014286 = 1342,86 \frac{\text{KN}}{\text{m}}$$

$$2.) \quad 1342,86 \cdot u_2 = 20 \rightarrow u_2 = \frac{20}{1342,86} = \frac{0,0148}{0,014894} = 1,4894 \text{ cm}$$

$$u_1 + u_2 = 0,0291796 \text{ m}$$

$$k(u_1 + u_2) = 1400 - 4000 \cdot 0,0291796 = 1283,28 \text{ KN/m}$$

$$3.) \quad 1283,28 \cdot u_3 = 20 \rightarrow u_3 = \frac{20}{1283,28} = 0,015585 \text{ m} = 1,5585 \text{ cm}$$

$$u_1 + u_2 + u_3 = 0,0447646 \text{ m}$$

$$k(u_1 + u_2 + u_3) = 1400 - 4000 \cdot 0,0447646 = 1220,94 \text{ KN/m}$$

$$4.) \quad 1220,94 \cdot u_4 = 20 \rightarrow u_4 = \frac{20}{1220,94} = 0,016381 \text{ m} = 1,6381 \text{ cm}$$

$$u_1 + u_2 + u_3 + u_4 = 0,0611453 \text{ m}$$

$$k(u_1 + u_2 + u_3 + u_4) = 1400 - 4000 \cdot 0,0611453 = 1155,42 \frac{\text{KN}}{\text{m}}$$

$$5.) \quad 1155,42 \cdot u_5 = 20 \rightarrow u_5 = \frac{20}{1155,42} = 0,0173097 \text{ m} = 1,73097 \text{ cm}$$

$$u_1 + u_2 + u_3 + u_4 + u_5 = 0,078455 \text{ m}$$

