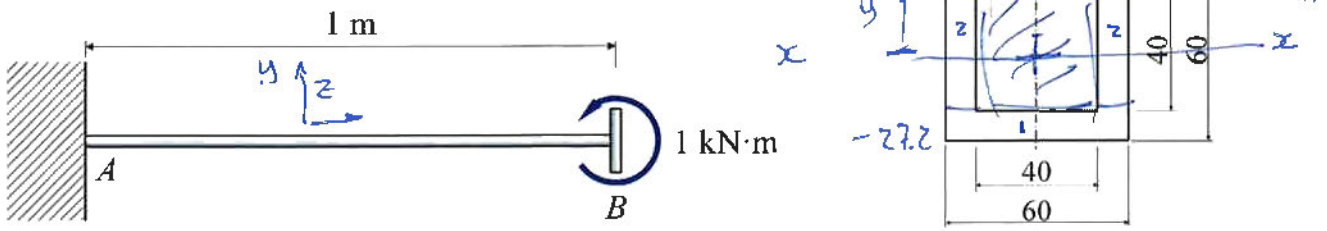
Example 2.2.4

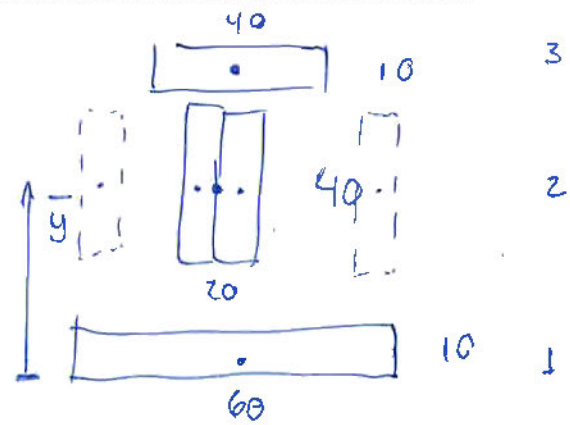
The cantilever beam in Figure 1a is made of aluminium alloy with $E = 70$ GPa and its cross-section is shown in Figure 1b (cross-section dimensions in mm). Calculate the radius of curvature of the neutral line of the beam when it is subjected to a pure bending moment of 1 kN·m as shown.



(a) (b)

Figure 1: (a) A cantilever beam subjected to pure bending, and (b) dimensions of its cross-section in millimetres.

i	1	2	3
b_i	60	20	40
h_i	10	40	10
A_i	600	800	400
$\bar{y}_i$	5	30	55
$A_i\bar{y}_i$	3000	24000	22000
d_i	$-22.\bar{2}$	$2.\bar{7}$	$27.\bar{7}$
I_i	5000	$106\,666.\bar{6}$	$3333.\bar{3}$



$A = 1800\ mm^2$

$\Sigma A_i \bar{y}_i = 49000$

$\bar{y}_{NA} = \frac{49000}{1800} = 27.\bar{2}\ mm$

$I_{\square} = \frac{b h^3}{12}$

$I_{NA} = \Sigma\left(I_i + A_i d_i^2\right)$

$I_{NA} = 726\,111\ mm^4$

$\frac{-\sigma}{y} = \frac{M}{I} = \frac{E}{R}$ $\quad R = \frac{EI}{M}$

1 N.m = 10^3 N.mm

1 N/m = 10^{-3} N/mm

1 m^4 = 10^{12} mm^4

$$R = \frac{(200\,000\ N/mm^2)(726\,111\ mm^4)}{10^6\ N\,mm}$$

Steel $R = 145\ m$ AL $R = 50.75\ m$