

	Density (kg/m ³)	Embodied energy	
		MJ/kg	MJ/m ³
Primary structure			
Steel, virgin	7,850	27	212,000
Steel, 100% recycled	7,850	7.3	57,300
Steel, typical 42% recycled content	7,850	18.7	147,000
Aluminum, virgin	2,700	210	567,000
Aluminum, 43% recycled content	2,700	131	354,000

Exercise: find the embodied energy of fully recycled aluminum

Solution:

$$H_m(100\% \text{ recycled}) = H_R ?$$

$$H_m(f\%) \sim (1-f/100) \cdot H_m + (f/100) \cdot H_R$$

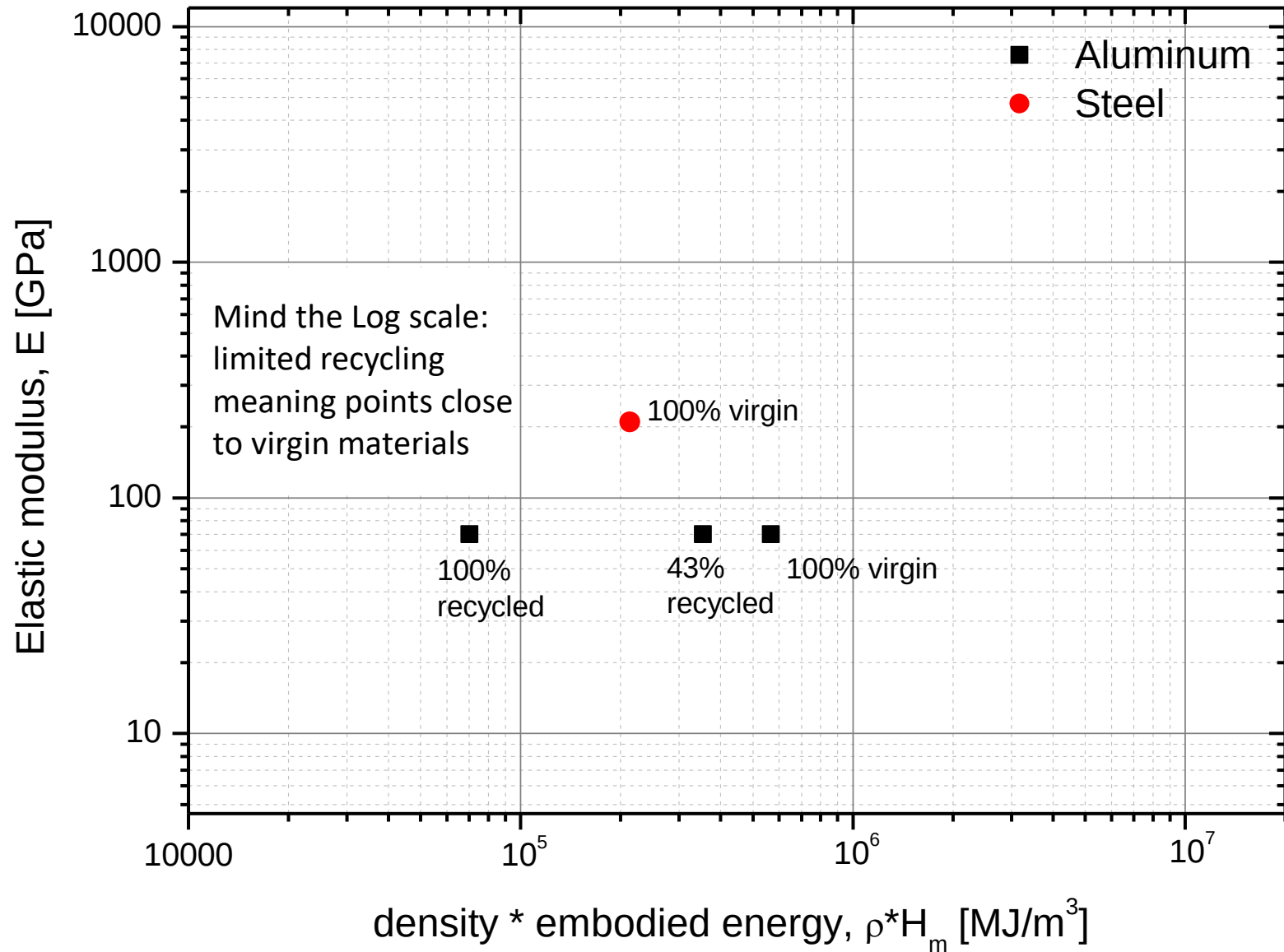
$$H_m(43\%) = (1-0.43) \cdot H_m + 0.43 \cdot H_R$$

$$131 = (1-0.43) \cdot 210 + 0.43 \cdot H_R$$

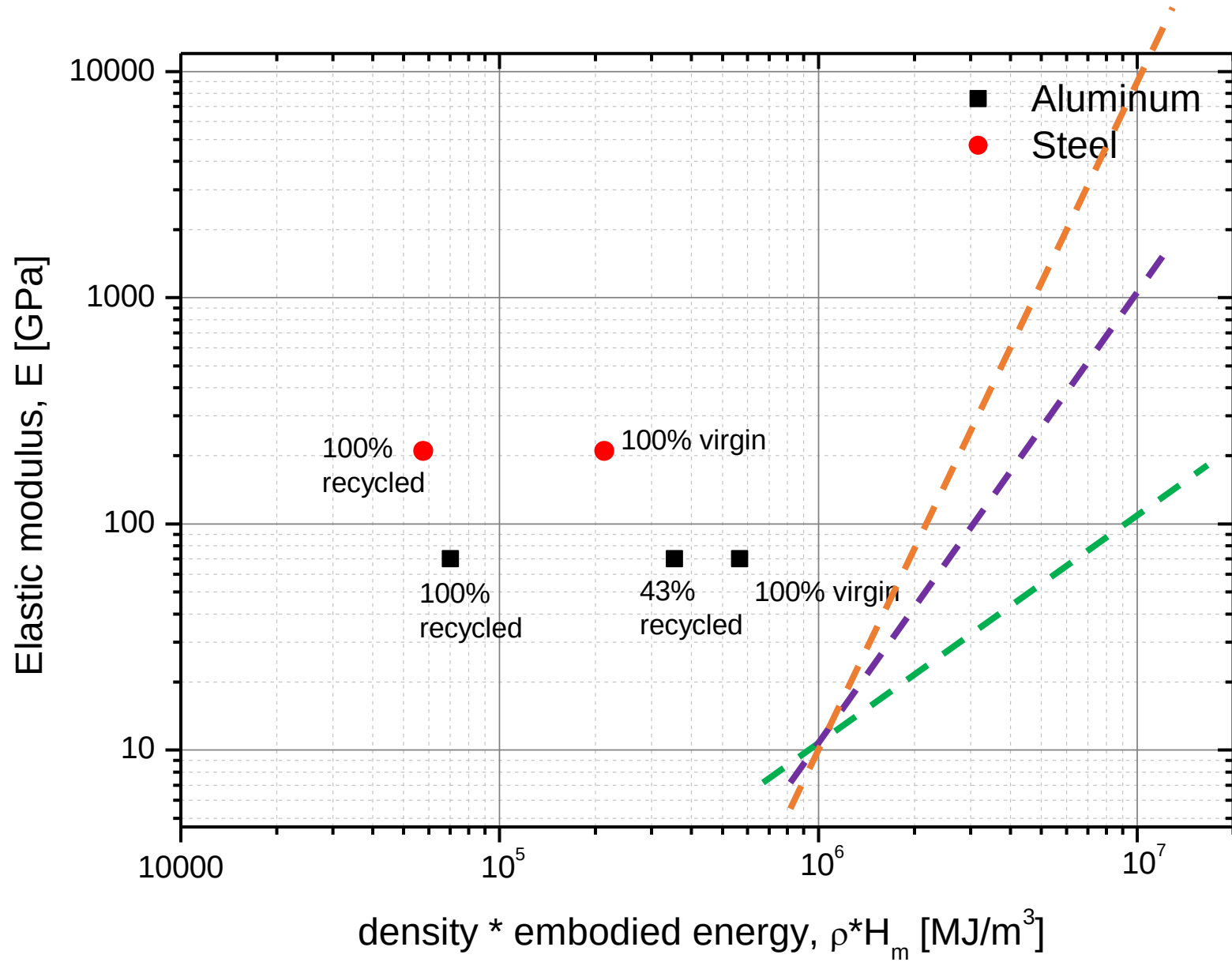
$$H_R = 26 \text{ MJ/kg}$$

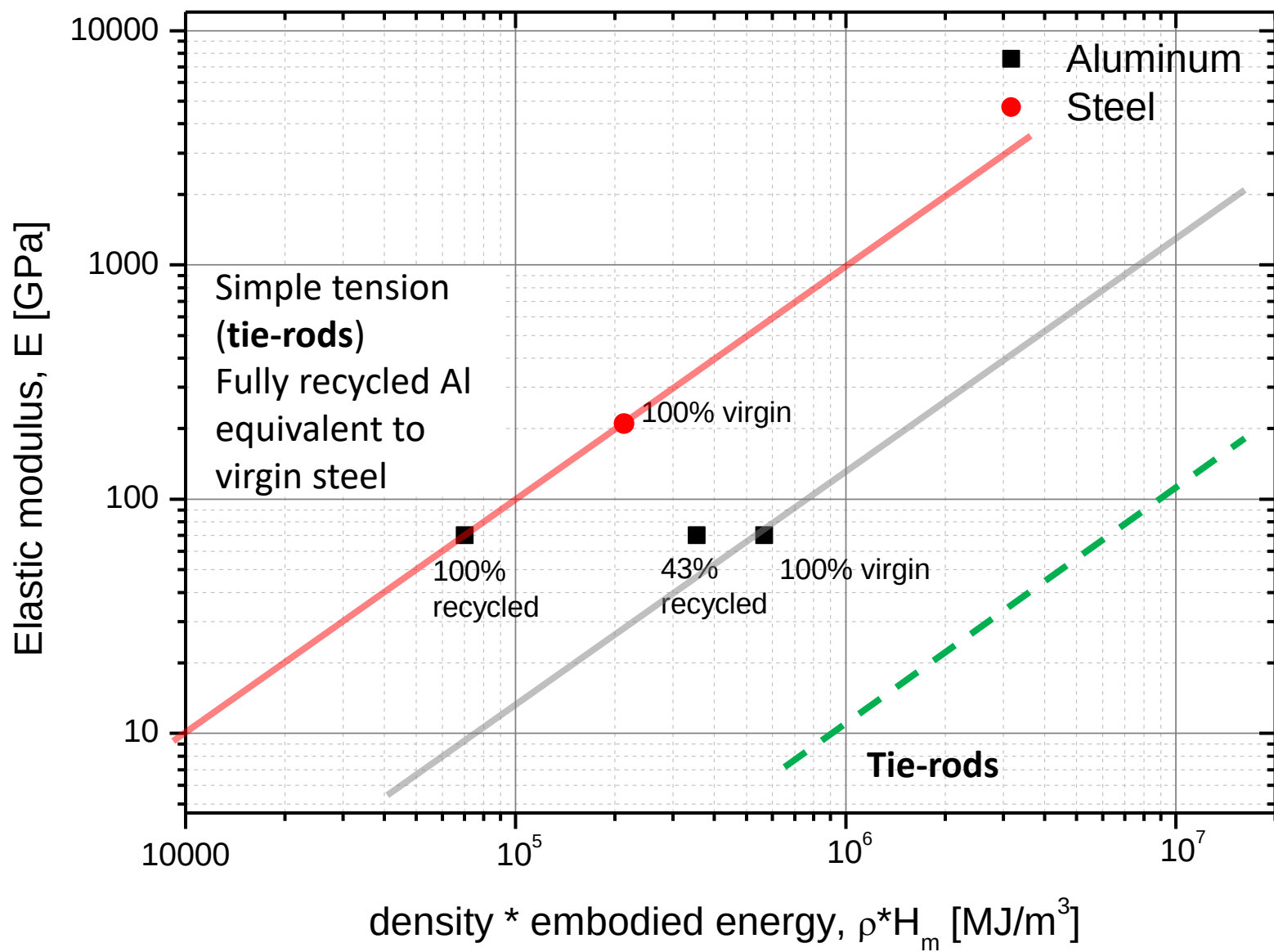
Nearly one order of
magnitude lower than H_m

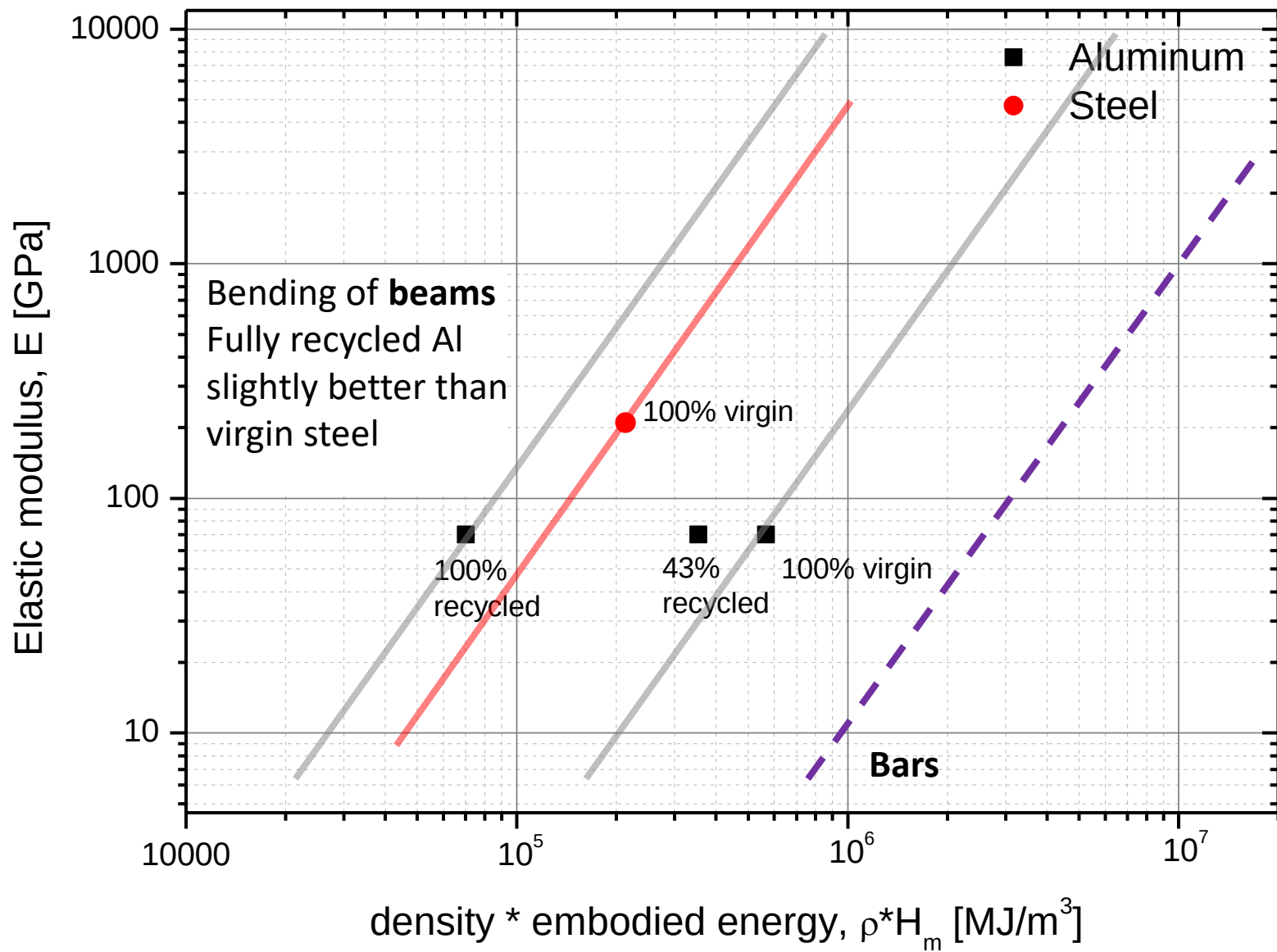
Exercise: Illustrate the environmental benefits of recycling of aluminum, in the comparsion with steel, for the manufacturing of **stiff** components

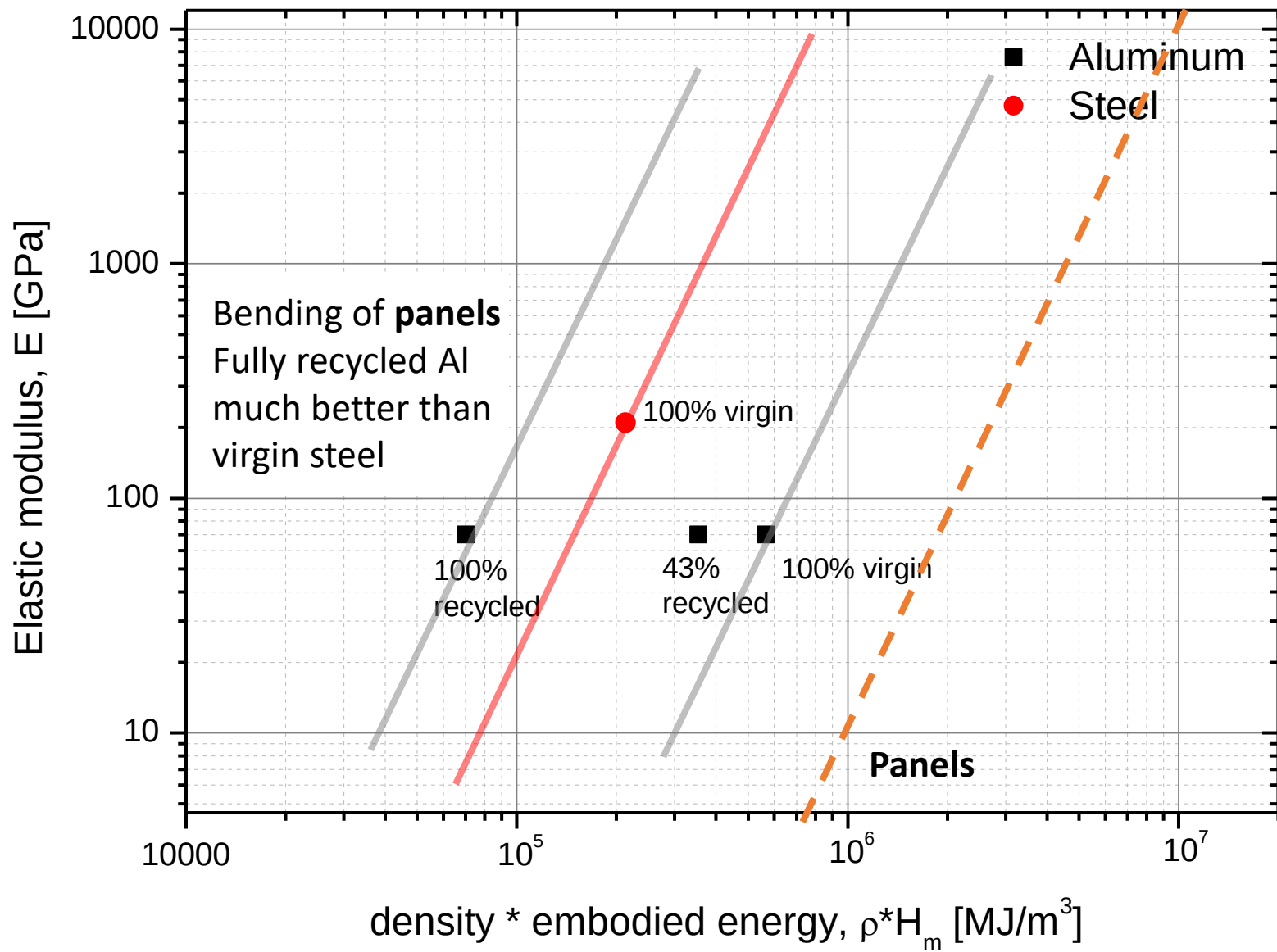


Mind the guidelines: different slopes depending on the context

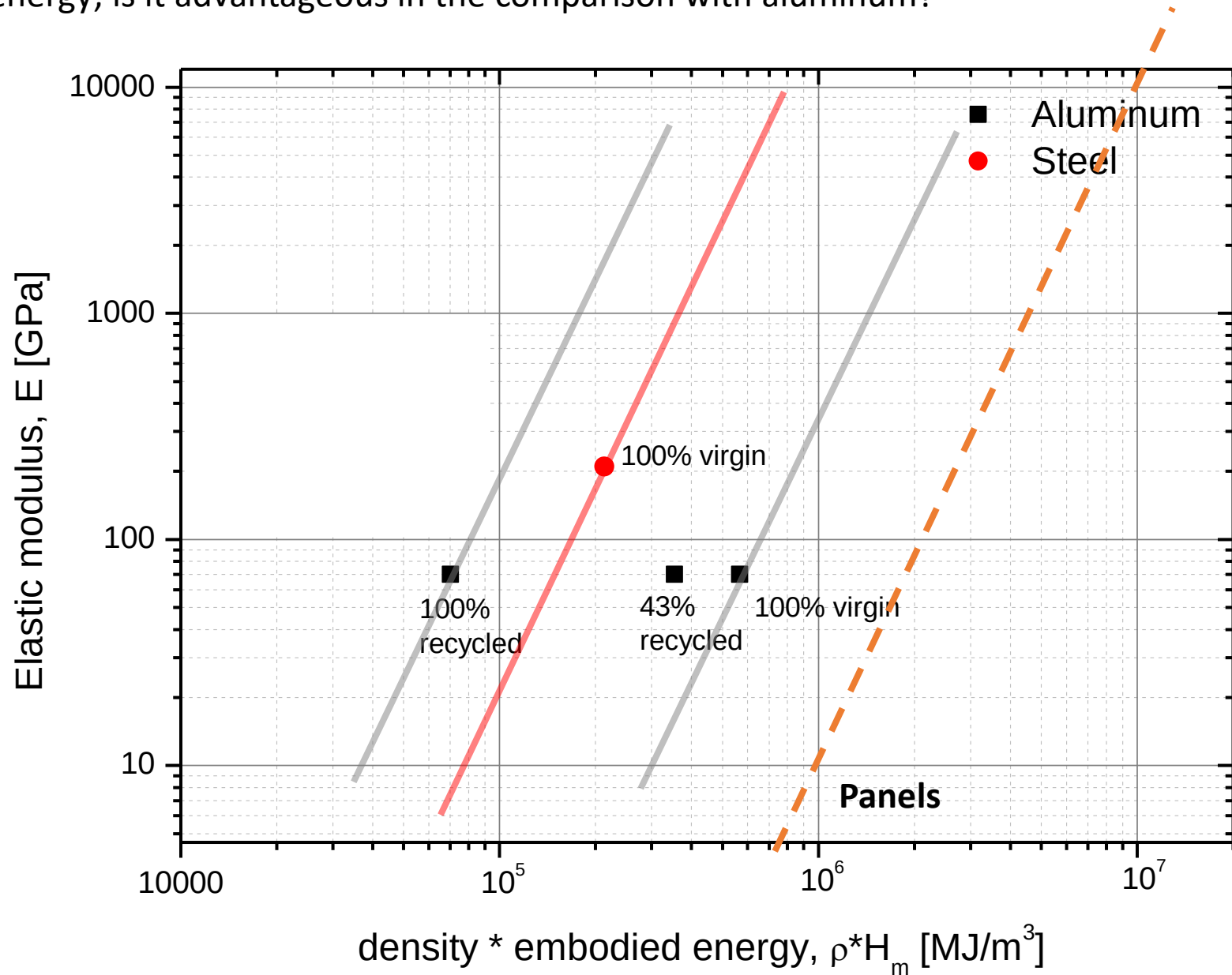






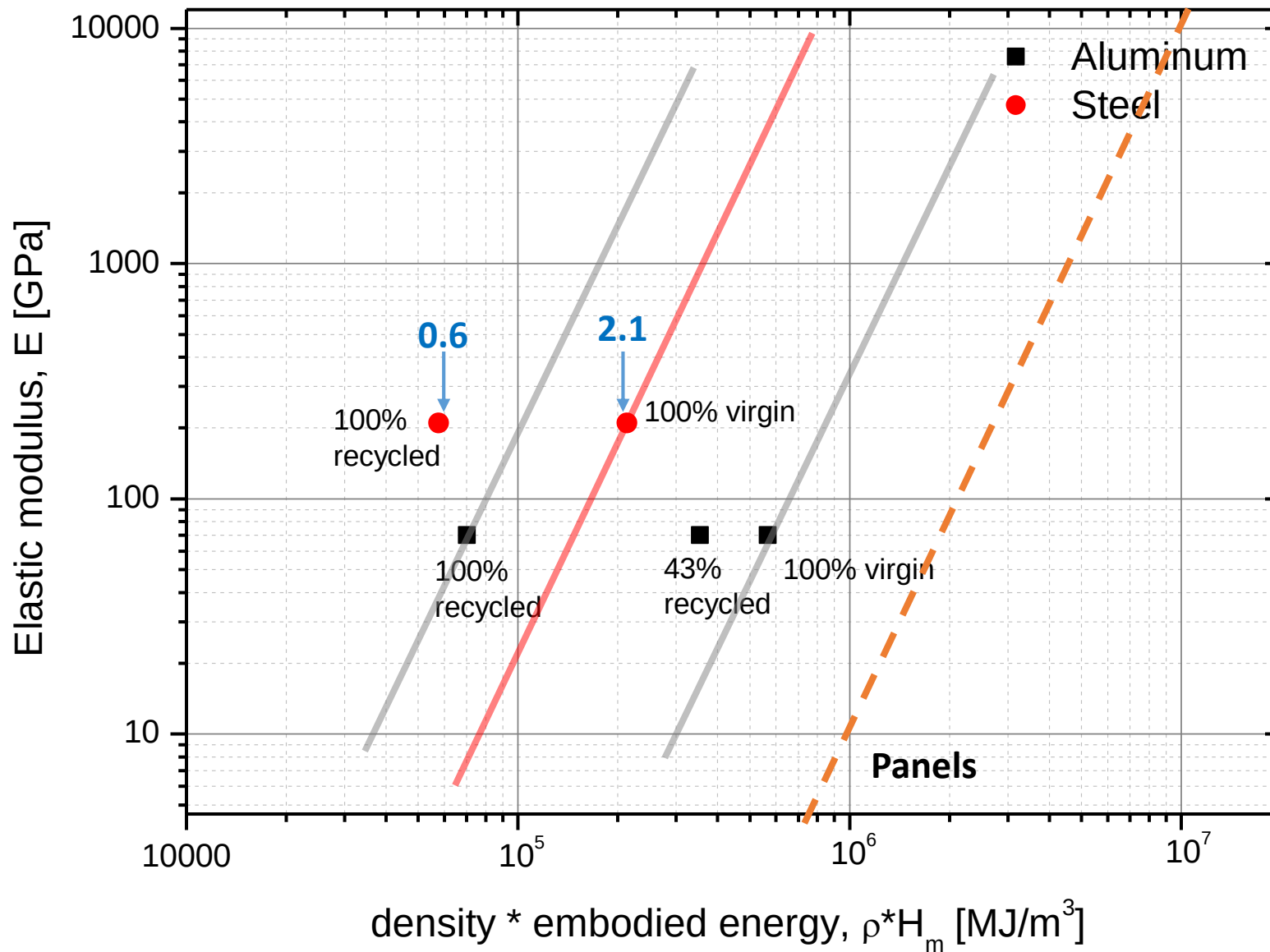


Exercise: Using 100% recycled steel determine a 73% saving of embodied energy; is it advantageous in the comparison with aluminum?

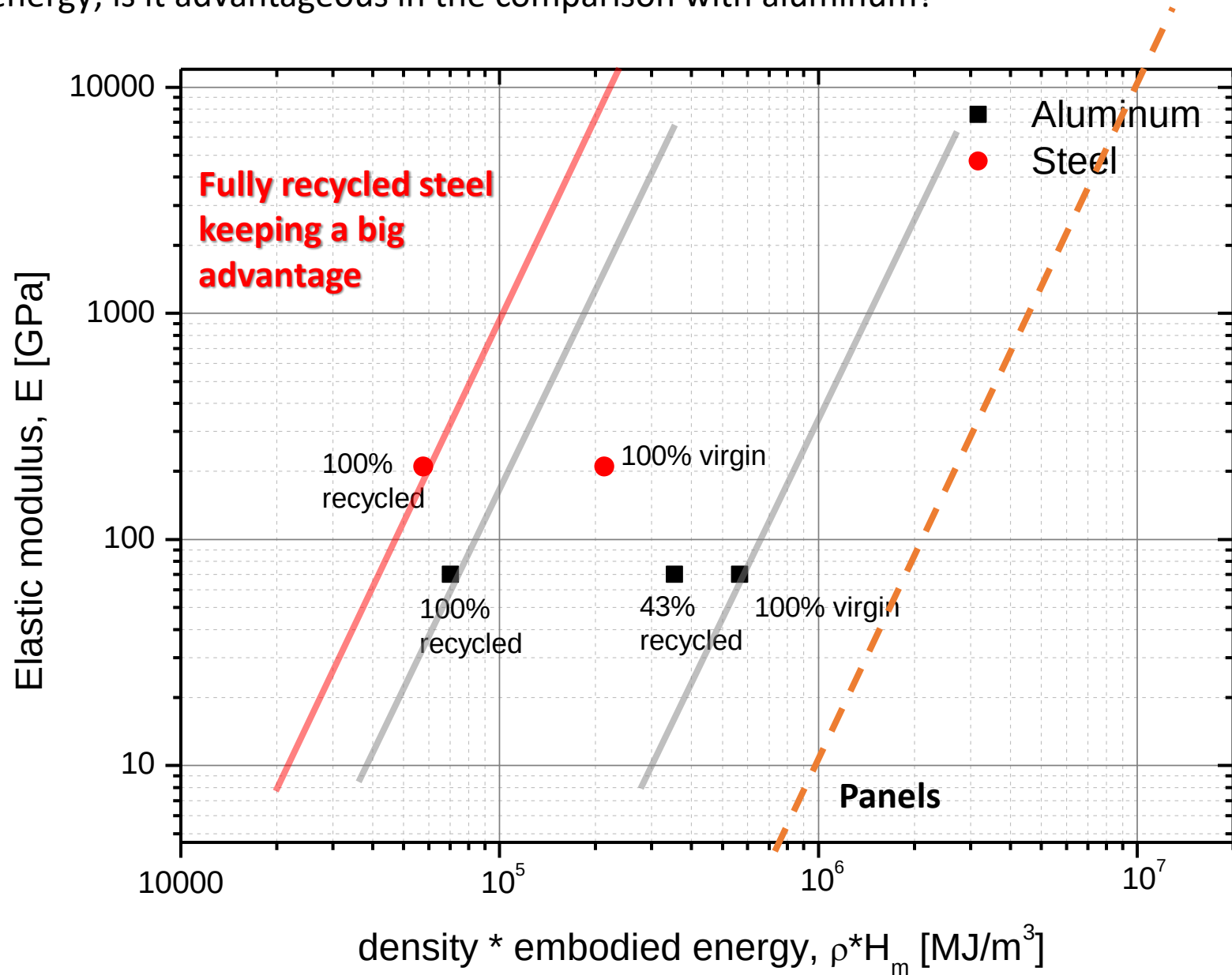


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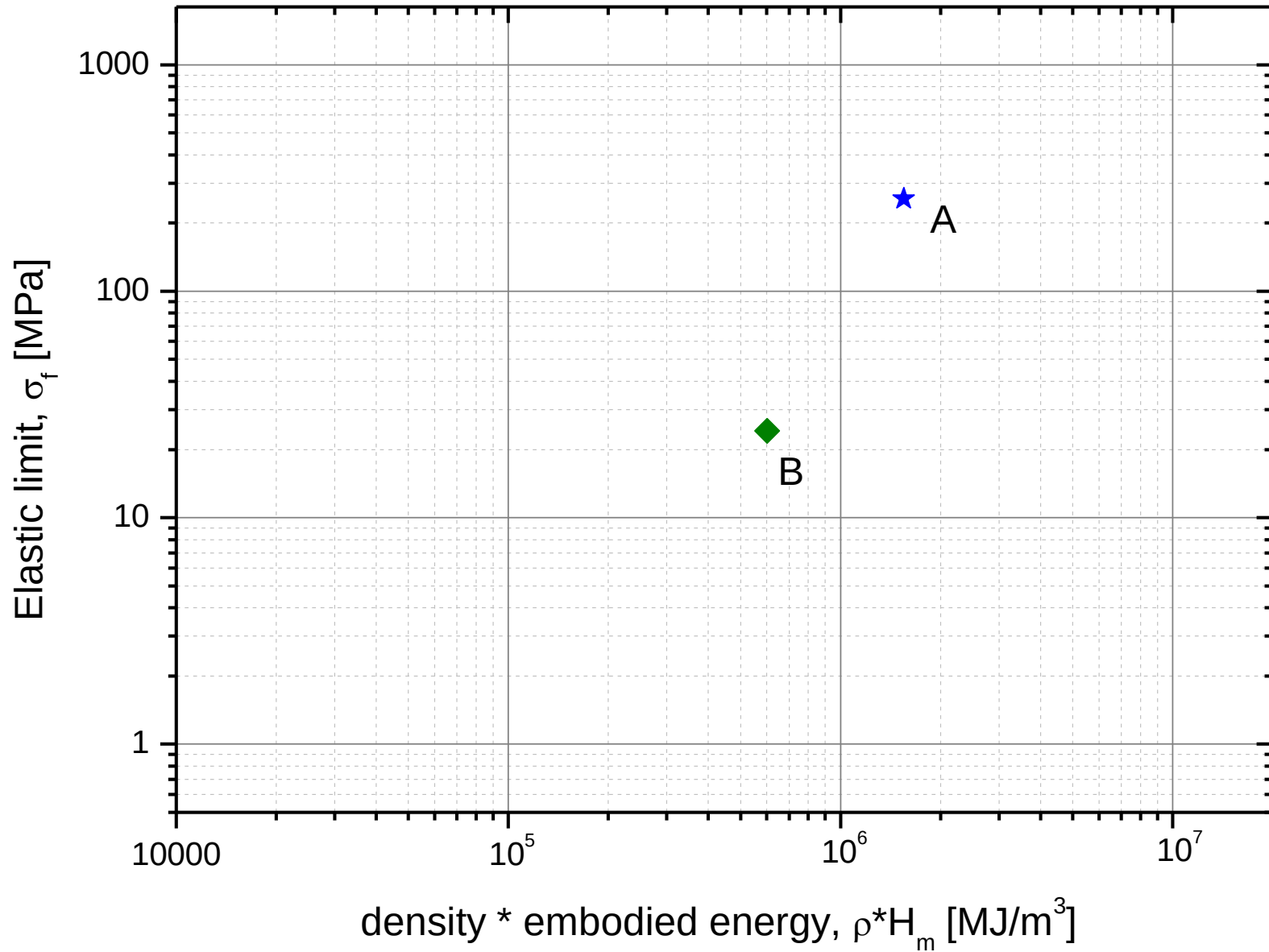
Solution: read the X axis $\rightarrow 2.1 \cdot 10^5 \cdot (1-0.73) = 0.6 \cdot 10^5 = 6 \cdot 10^4$



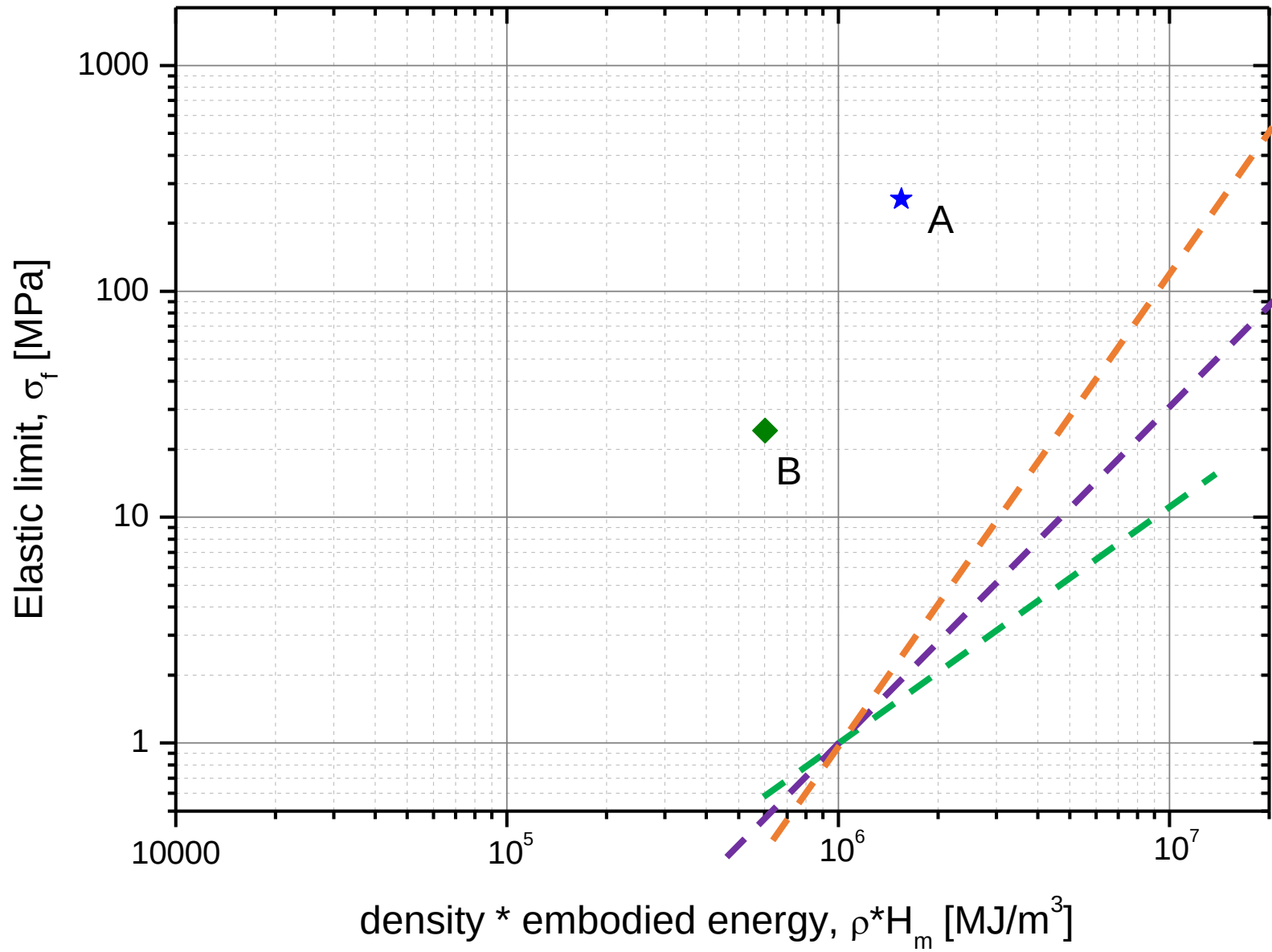
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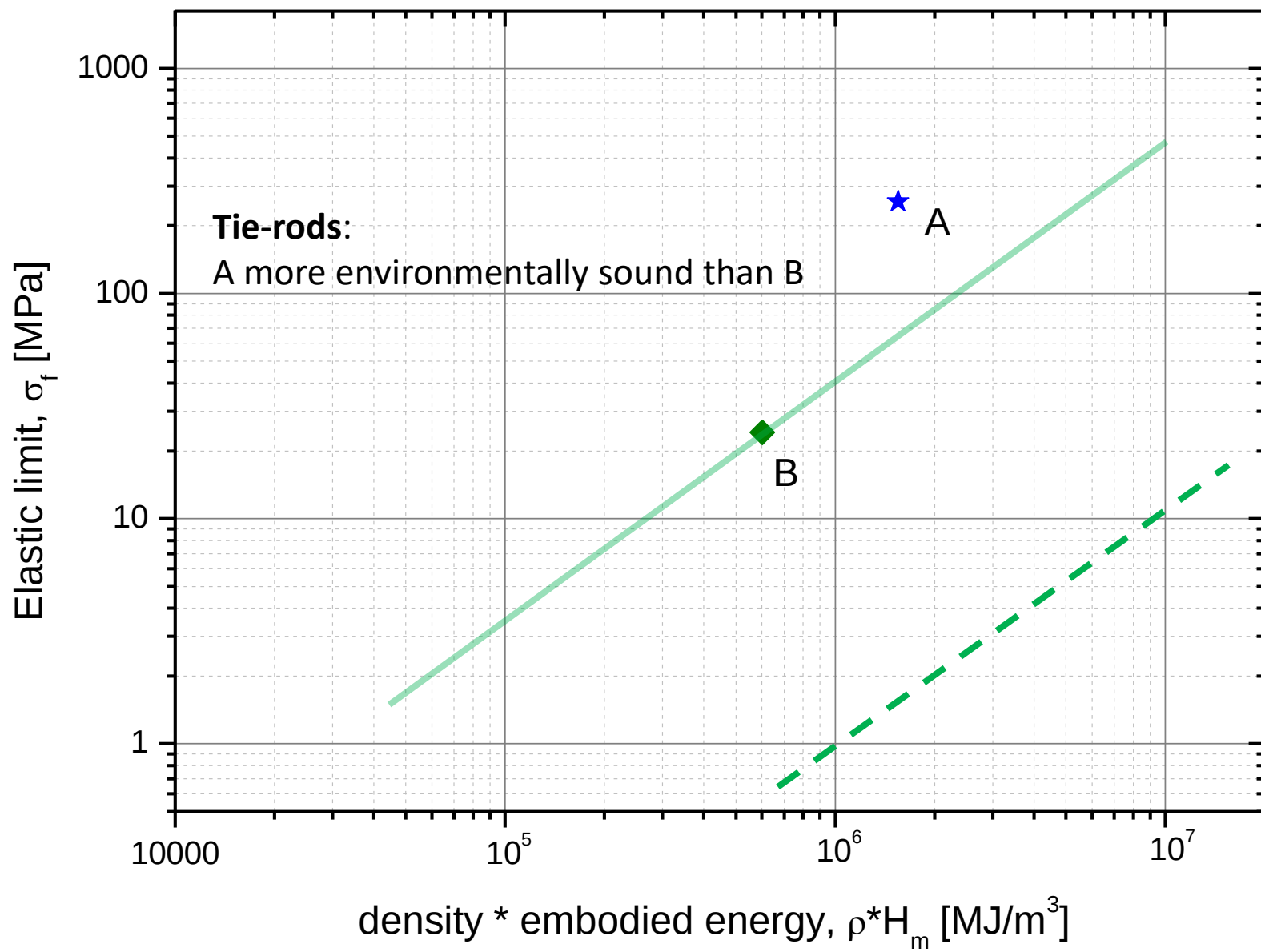


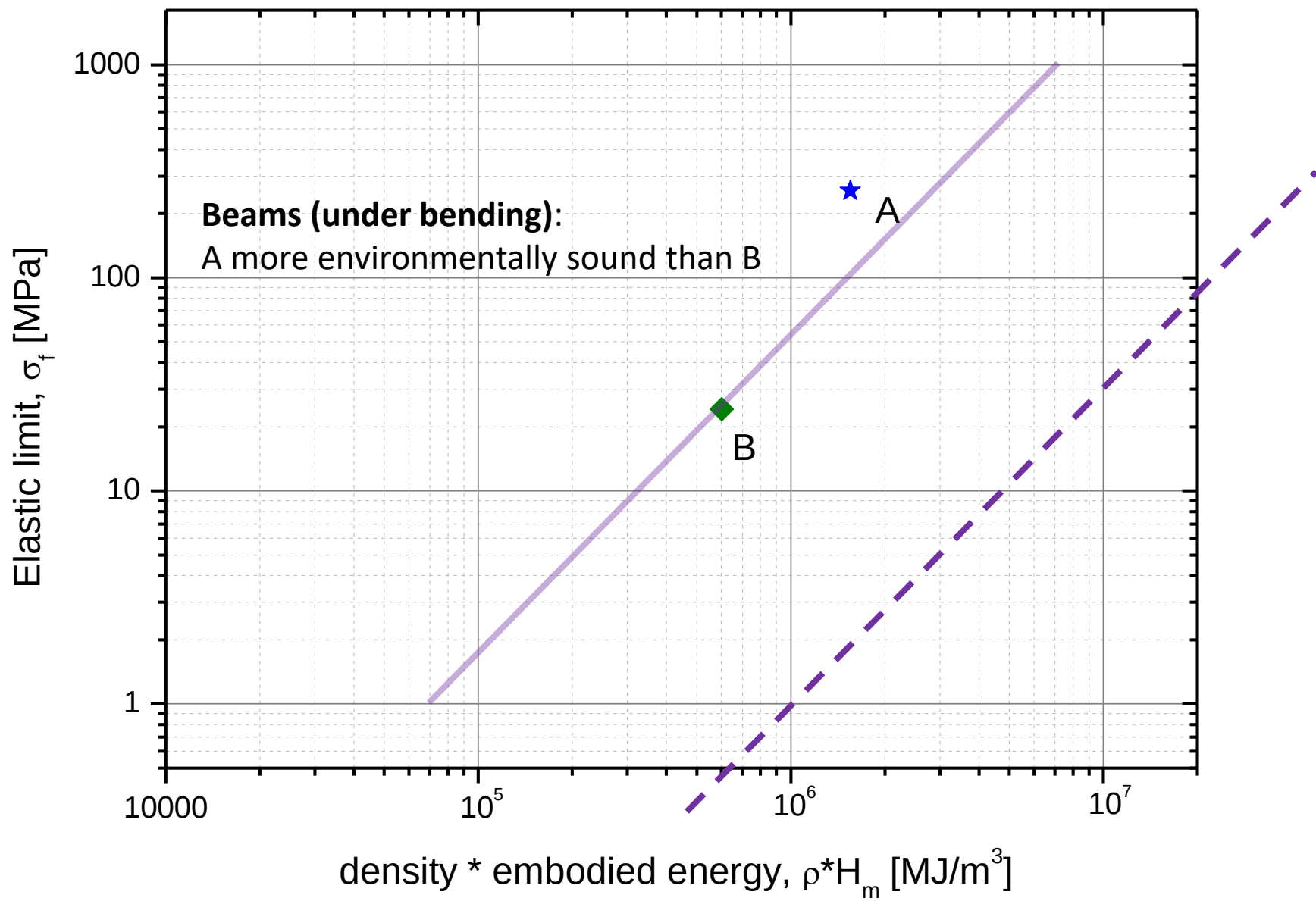
Exercise: Specify the most environmentally advantageous material, between A and B, for the manufacturing of **strong** components

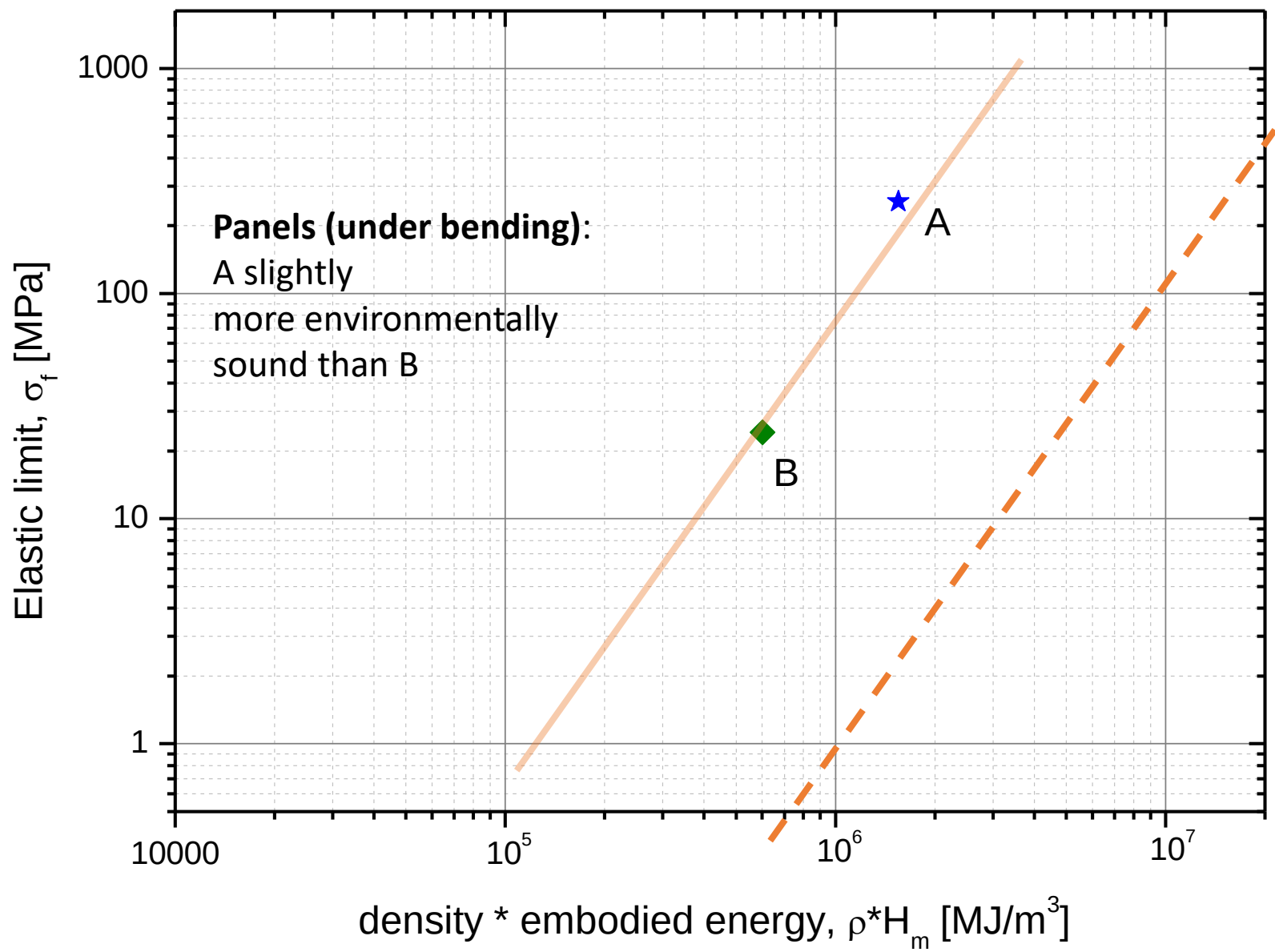


Mind the guidelines: different slopes depending on the context









Exercise: In the manufacturing of **strong** tie-rods and bars, discuss the advantage of a reduction of embodied energy, for B, of 50%

