Fall, 2022

ME 323 – Mechanics of Materials

Lecture 22 – Deflection of beams (cont.)

Reading assignment: Ch.9, Ch.11 lecturebook

PURDUE UNIVERSITY | Mechanical Engineering

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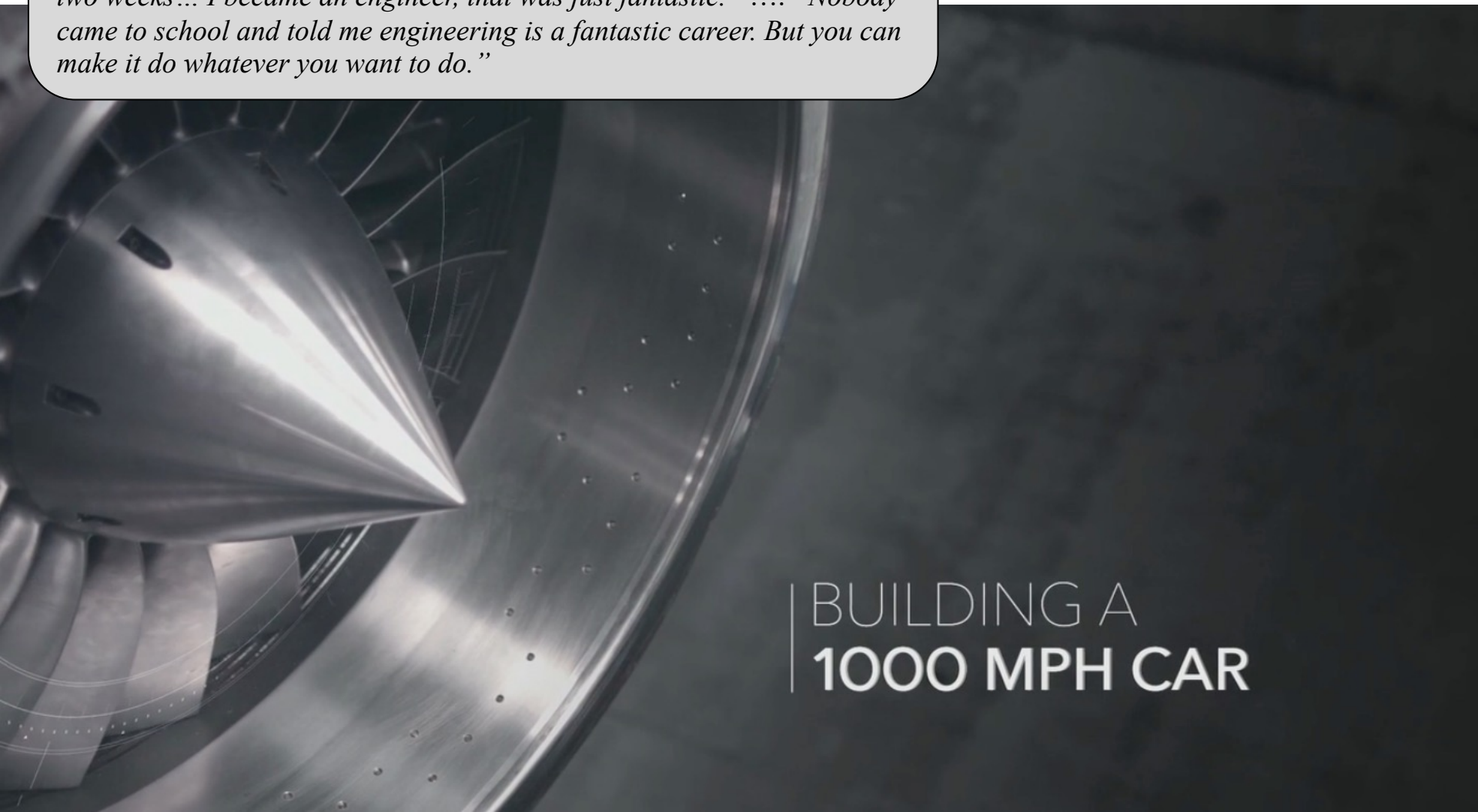
You can make it do whatever you want to do

As a child, Chapman lived below Heathrow Airport's flightpath. His primary-school classroom allowed him a perfect view of the first Concordes in flight. *"To go out into the playground and see the most stunning aircraft you've ever seen in your life above you twice a day for two weeks… I became an engineer, that was just fantastic."* …. *"Nobody came to school and told me engineering is a fantastic career. But you can make it do whatever you want to do."*

Video



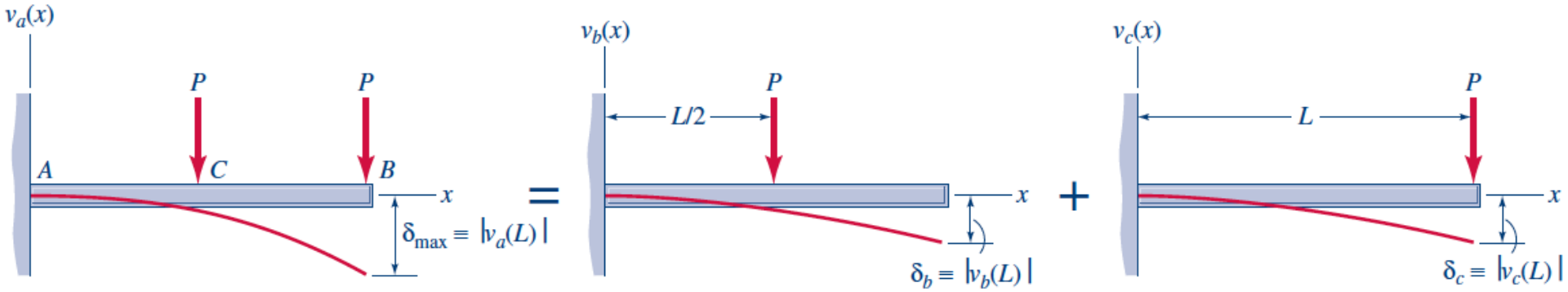
Deflection of beams

Method of superposition

The slope, deflection, reactions, internal shear and bending moment of a beam that simultaneously supports several different loads can be obtained by linear superposition, that is, by addition of the effect of the loads acting separately.

Recall: the principle of superposition can be used for linear elastic materials under small deformations.

Note: each individual sub-problem is in equilibrium, then their superposition is in equilibrium.

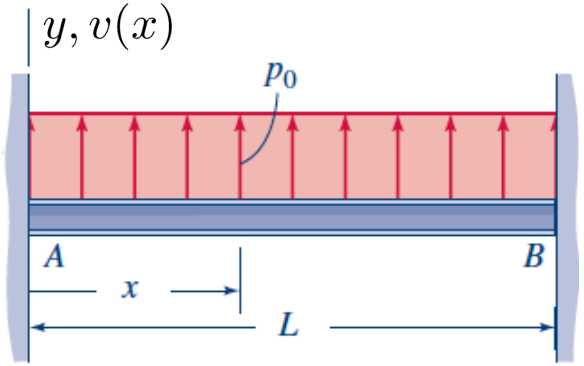


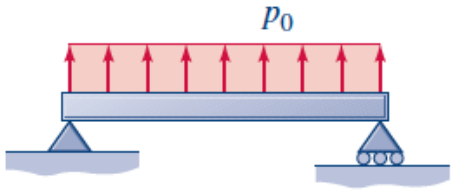
$$v_a(x) = v_b(x) + v_c(x)$$

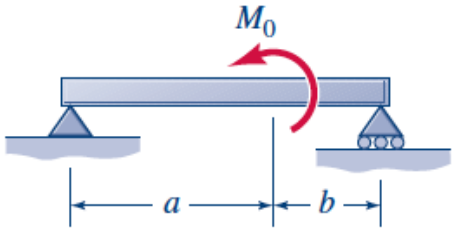
Deflection of beams

Example 38:

The uniformly loaded beam shown in the figure is completely fixed at ends A and B. Determine an expression for the deflection curve $v(x)$ using the superposition method.

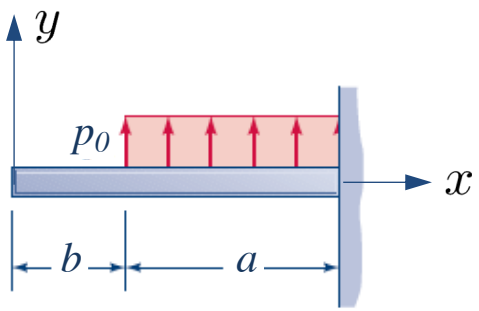






Deflection of beams

Method of superposition (food for thought …)



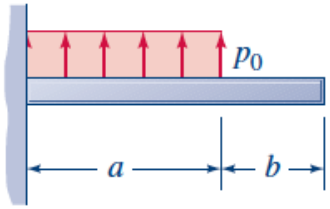
If our configuration is the mirror image of one of the provided solutions.-

We know: $\bar{v}(\xi)$

We need: $x = L - \xi$, i.e., $\xi = L - x$

$$v(x) = \bar{v}(L - x)$$

$$\bar{\theta}_B = \bar{\theta}(\xi_B) = \frac{d\bar{v}}{\xi_B} d\xi = -\frac{dv(x_B)}{dx} = -\theta_B$$



$$v = \frac{p_0 x^2}{24EI}(6a^2 - 4ax + x^2) \qquad 0 \le x \le a$$

$$v' = \frac{p_0 x}{6EI}(3a^2 - 3ax + x^2) \qquad 0 \le x \le a$$

$$v = \frac{p_0 a^3}{24EI}(4x - a) \qquad v' = \frac{p_0 a^3}{6EI} \qquad a \le x \le L$$

$$\delta_B = \frac{p_0 a^3}{24EI}(4L - a) \qquad \theta_B = \frac{p_0 a^3}{6EI}$$

Deflection of beams

Any questions?