

What is Beam Deflection?

Worksheet

Beam deflection is how much a beam bends under load. For a simply supported beam with a point load at midspan, the maximum deflection is $= PL/(48EI)$, where P is the load, L the span, E the material's stiffness, and I the cross-section's moment of inertia.

$$\frac{PL^3}{48EI}$$

Questions

1. What does $= PL/(48EI)$ calculate for a simply supported beam?
 - A) Maximum bending stress
 - B) Maximum deflection at midspan under a center point load
 - C) Shear force at the supports
 - D) Column buckling load
2. If the span L of a beam doubles (all else equal), the maximum deflection:
 - A) Doubles
 - B) Stays the same
 - C) Increases 4
 - D) Increases 8
3. Which change would REDUCE beam deflection?
 - A) Decreasing the moment of inertia I
 - B) Increasing the span L
 - C) Increasing the modulus of elasticity E
 - D) Increasing the load P
4. A beam has a computed deflection of 20 mm over a 6000 mm span. Does it meet a common L/360 serviceability limit?
 - A) Yes, 20 mm < 16.7 mm limit
 - B) No, 20 mm > 16.7 mm limit
 - C) Yes, exactly at the limit
 - D) Cannot be determined
5. A simply supported beam has a 4000 mm span with a 5000 N point load at midspan. $E = 200,000 \text{ MPa}$, $I = 60,000,000 \text{ mm}^4$. Find the maximum deflection.
6. If the same beam's span is increased to 8000 mm (all else equal), what is the new deflection?
7. A beam with a 6000 mm span has a computed deflection of 12 mm. Does it meet a common L/360 serviceability limit?
8. Define: What does the beam deflection formula $= PL/(48EI)$ calculate?
9. Define: How does span length affect deflection?
10. Define: What does 'E' represent in the deflection formula?

Answer Key

1. B) Maximum deflection at midspan under a center point load - This formula gives the maximum downward deflection at midspan for a center point load.
2. D) Increases 8 - Deflection L , so doubling L increases deflection by $2^3 = 8$.
3. C) Increasing the modulus of elasticity E - Deflection is inversely proportional to E , so a stiffer material reduces deflection.
4. B) No, $20 \text{ mm} > 16.7 \text{ mm}$ limit - $L/360 = 6000/360 = 16.7 \text{ mm}$; 20 mm exceeds this limit, so it fails serviceability.
5. $= PL/(48EI)$ $P = 5000 \text{ N}$, $L = 4000 \text{ mm}$, $E = 200,000 \text{ MPa}$, $I = 60,000,000 \text{ mm}^4$ $L = 4000 = 6.410 \text{ mm} = (5000 \cdot 6.410) / (48 \cdot 200,000 \cdot 60,000,000) = 3.210 / 5.7610 = 0.56 \text{ mm}$
6. Deflection is proportional to L^3 , so doubling the span multiplies deflection by $2^3 = 8$. Original ($L = 4000 \text{ mm}$) = 0.56 mm New ($L = 8000 \text{ mm}$) = $0.56 \cdot 8 = 4.48 \text{ mm}$ - beams get dramatically more flexible as spans grow.
7. Allowable deflection limit (typical live-load serviceability) = $L/360$ $L = 6000 \text{ mm}$ limit = $6000/360 = 16.7 \text{ mm}$ Actual computed = 12 mm $12 \text{ mm} < 16.7 \text{ mm}$, so the beam satisfies the serviceability deflection limit.
8. The maximum downward deflection at the center of a simply supported beam under a point load at midspan.
9. Deflection is proportional to L^3 - doubling the span multiplies deflection by 8 , so long spans need much stiffer beams.
10. The modulus of elasticity - a measure of the material's stiffness (e.g., steel $200,000 \text{ MPa}$, timber $11,000 \text{ MPa}$).

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