# Fixed-Ended Beam: Moments and Deflection

End and mid-span moments, reactions and maximum deflection of a beam fixed at both ends under a central point load or a uniformly distributed load.

**Method:** Textbook mechanics (standard beam formulas, Roark's Formulas for Stress and Strain)

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Loading | Uniform load w over the span | |
| Central point load | 10.000 | kN |
| Uniform load per metre | 10.000 | kN/m |
| Span | 4.0000 | m |
| Young's modulus | 200.00 | GPa |
| Second moment of area | 836.00 | $cm^4$ |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Moment at the fixed ends (hogging) | 13,333 | N·m |
| Moment at mid-span (sagging) | 6,666.7 | N·m |
| Reaction at each end | 20.000 | kN |
| Deflection at mid-span | 3.9872 | mm |

**Notes for this case**

- Fully fixed ends are rare in practice; real supports allow some rotation, which moves moment to mid-span.

## Formula and method

$$\text{UDL}: \; M_e = \frac{wL^2}{12}, \; M_c = \frac{wL^2}{24}, \; \delta = \frac{wL^4}{384EI}; \quad \text{point}: \; M_e = M_c = \frac{WL}{8}, \; \delta = \frac{WL^3}{192EI}$$

### Variables

| | | |
|---|---|---|
| $\text{load}$ | Loading | - |
| $W$ | Central point load | N |
| $w$ | Uniform load per metre | N/m |
| $L$ | Span | m |
| $E$ | Young's modulus | Pa |
| $I$ | Second moment of area | $m^4$ |
| $M_e$ | Moment at the fixed ends (hogging) | N·m |
| $M_c$ | Moment at mid-span (sagging) | N·m |
| $R$ | Reaction at each end | N |
| $\delta_{max}$ | Deflection at mid-span | m |

### Method and standards

Elastic beam theory.

### Assumptions and limits

- Prismatic beam, small deflections.
- The point load W is used for the central-load case and the load per metre w for the uniform case, each in its own unit.
- Stresses are not computed (no section modulus input): σ = M/Z with the larger of M_e and M_c. Support rotation, which relieves

the end moments, is not modelled.

### References

• Textbook mechanics (standard beam formulas, Roark's Formulas for Stress and Strain)

## Report details

| | |
|---|---|
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| Calculator | Fixed-Ended Beam: Moments and Deflection |
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| Release checks | 3 reference cases of this calculator, computed independently, are checked on every release |

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

### This calculator online

https://calc.firecad.com/mechanical/strength-of-materials/fixed-beam

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.