Beam deflection calculator is a powerful tool used by engineers, architects for analyzing the behavior of beams under various loading conditions.

OOK Beam deflection calculator

With the help of Beam Deflection Calculator, you can easily examine how different kinds of beams deflect under various loading scenarios. Beam deflection is an important aspect in structural engineering and construction.

It ensures the structural integrity of the beam and helps to prevent any potential deformation or damage. You can easily find the deflection at any point along the length of the beam by entering parameters like the beam's material, dimensions, and applied loads.

By using this calculator you can easily find the beam's reactions, maximum deflection, bending moment & shear stress.

Inputs parameters:

* Length of the Beam: Deflection is directly proportional to the beam's length.
* Young’s modulus (E): Property that indicates how much a material will deform when subjected to load. Materials having high elastic modulus can resist deformation more effectively, while with a low elastic modulus are more flexible and deform more easily under the same load.

how to calculate young’s modulus?

Young’s modulus is calculated by using this formula:

E= σ​/ε

where:

* σ is the stress
* ε is the strain

what are the units of youngs modulus?

S.I Units of youngs modulus is Pascal (Pa).

Imperial units of young modulus is Pounds per square inch (psi).

* Second moment of area(area moment of inertia): Measure of cross section resistance to bending due to its shape.

Larger second moment of area means greater resistance to bending stress and beam deflection.

How to calculate second moment of area?

Area moment of inertia can be calculated by using this formula

formula: Ix= ∫y2dA & Iy= ∫x2dA

Where y = distance from the x axis to area dA

What are the units of area moment of inertia?

S.I Units of area moment of inertia are millimeter (mm4).

Imperial units of area moment of inertia is inch4 (in4).

* Load: External force or weight acts on a structure that can cause stress and strain in structure.

how to calculate load?

load is calculated by using the formula:

F=σ⋅A

where:

F is the load applied.

σ is the stress.

A is the cross-sectional area.

What are the units of load?

S.I Units of load are Newton.

Imperial units of load is Pound (lb) .

Type of load acting in beams that cause deflection in beams

* Point Load: Applied over a very small area of a structural element but considered to act at a single point.
* Distributed load:

1. Uniform distributed Loads: Constant load along or across the length of beam i.e. the beam experience same load from start and end point of beams.
2. Non-Uniform distributed Loads: Varying load along or across the length of beam i.e. the beam experience different load from start and end point of beams.

* Support Essential components in structure that provide stability and resistance to forces under various load acting on it.

Type of supports:

1. Fixed support: Restrict all translation in horizontal(x) and vertical(y) direction as well as rotational movement of structural member.

Fixed support produce reaction forces in horizontal reaction (Rx), vertical reaction (Ry) and moment (M).

Fixed support used in satiation where complete rigidity is required such as cantilever beams, fixed-end beams, and frame structures.

2. Pin support: Restrict translation in both horizontal(x) and vertical(y) direction but allow rotation of structural member.

Pin support produce reaction forces in both horizontal(Rx), vertical(Ry) reaction.

Commonly used in bridges, trusses, and other structures that require rotation but restrict translational movement.

3. Roller support: Allows rotation and translation in horizontal(x) direction but does not allow translation in vertical(y) direction.

Produce only vertical reaction(Ry). Represented in mechanics with a triangle having circles below it or just a circle.

Used in bridges and large structure which allows thermal expansion and contraction to distribute load.

Output parameter:

* Reaction forces: forces exerted by a structure's supports or connections in response to applied loads. These are the forces that balance the applied loads, ensuring that the structure remains in equilibrium and static.

Reaction forces depend upon the type of support

1. Fixed support produce reaction forces in horizontal reaction (Rx), vertical reaction (Ry) and moment (M). because it restrict translation translation in both horizontal(x) and vertical(y) direction as well as rotational movement.
2. Pin support produce reaction forces in both horizontal(Rx), vertical(Ry) reaction because it restrict translation in both horizontal(x) and vertical(y) direction but allow rotation
3. Roller support: Produce only vertical reaction(Ry) because it allows rotation and translation in horizontal(x) direction but does not allow translation in vertical(y) direction.

* Beam Deflection: Beam bends or sags when subjected to loads such as forces, moments, or even its own weight.

Formula:

how to calculate beam deflection?

beam deflection is calculated by using the formula:

δ = (FL3)/3EI

What are the units of Deflection?

S.I Units of load are millimeter (mm).

Imperial units of load is inche (in) .

δ is the deflection at the center of the beam

F is the applied load

L is the length of the beam

E is the modulus of elasticity of the material

I is the moment of inertia of the cross-sectional area of the beam

Factors affecting Beam Deflection

* Material Properties: young’s modulus (E) of the material affect how much beam will deflect.
* Cross-Sectional Shape: Cross-Sectional Shape with larger moments of inertia are stiffer and deflect less.
* Length of the Beam: Deflection is directly proportional to the beam's length.
* Load type: Amount & distribution of load such as point load, uniformly distributed load, varying load affect the deflection.
* Support Conditions: Support such as Fixed, Roller each have different deflection characteristics due to their support constraints.

Deflection diagram: graphical representation of the displacement or deflection a beam or structure undergoes when subjected to external forces and moments. Provides essential information for engineers about the behaviour of a beam under load or ensure that structural elements can withstand expected loads without experiencing excessive deflection.

* Shear stress: Internal force that acts parallel to the cross-sectional area of the beam. When a beam is subjected to transverse loads causing one layer of the material to slide or deform relative to adjacent layers. Also defined as the force per unit area acting parallel to a plane within the material.

how to calculate shear stress?

* shear stress is calculated by using the formula:

Formula

τ= F/A

what are the unit of shear stress?

​SI unit of shear stress is pascal (Pa) or newton per square meter (N/m²).

Imperial unit of shear stress is pounds per square inch (psi).

Shear force diagram: Graphical representation of the shear force variation along a beam or structural member's length when it is subjected to external loads. Position of the beam plotted along the horizontal axis and the magnitude of shear force plotted along the vertical axis. useful tool for structural analysis and design because it help us to determine the maximum shear force and its location and how shear forces vary along a beam's length.

* Bending moment: Measure of the internal bending forces experienced within a structural member, such as a beam or column, when subjected to external loads or moments.

Sign convention

Sign convention helps to determine the type of bending (sagging or hogging) at a given section of the beam. Bending moments are considered positive when they cause concave bending on the top of the beam called sagging and convex bending on the bottom of the beam called hogging.

how to calculate Bending moment?

Bending moment is calculated by using the formula :

M=∑F×d

where:

M = Bending moment at the point (in units of force times distance)

F = Applied force perpendicular to the beam axis

d = Perpendicular distance from the point to the line of action of the force

​ what are the unit of bending moment?

SI unit of bending moment is newton meter (Nm).

Imperial unit of bending moment is pound-feet (lb-ft).

Bending moment diagram: graphical representation of how the bending moment varies along the length of the structural member. Plotted between the length of the member along the horizontal axis and the magnitude of the bending moment along the vertical axis. Bending moment diagrams are essential for analyzing the behavior of the member under load and for designing structures to resist bending stresses.