OPTIMALBEAM

Model Name: Steel beam design example - 30 ft W21X44		**Designer:**
Units: Imperial - (ft), (kip)	**Date:** 2026/11/20	**Sheet No.:** Sheet 1 of 5

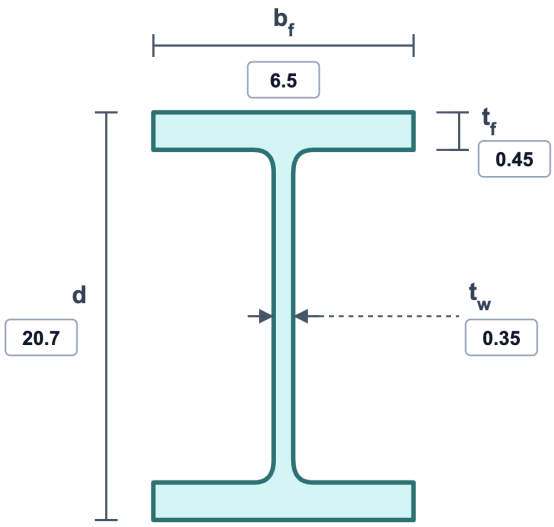
Steel Beam Design

AISC 360-22 | LRFD | A992 | Checked 2026-11-20
Analysis E (deflection) = 29,000 ksi
AISC E (resistance) = 29,000 ksi

W21X44 - Steel section

AISC Shapes Database 16.0

Cross-section dimensions



Section property	Value
Weight (W)	44 lb/ft
Area (A)	13 in^2
Major-axis inertia (Ix)	843 in^4
Elastic section modulus (Sx)	81.6 in^3
Plastic section modulus (Zx)	95.4 in^3
Minor-axis radius of gyration (ry)	1.26 in
Effective radius of gyration (rts)	1.6 in
Flange-centroid distance (ho)	20.3 in
Torsional constant (J)	0.77 in^4
Design fillet dimension (kdes)	0.95 in

Dimensions in in. Schematic not to scale.

Design checks - Selected checks pass

Total deflection governs at 76.7% utilization.

Check	Demand	Available / limit	Utilization	Scenario
Bending	253.44 kip-ft	357.75 kip-ft	70.8% (pass)	LRFD 1.2D + 1.6L
Shear	33.792 kip	217.35 kip	15.5% (pass)	LRFD 1.2D + 1.6L
Total deflection	1.15104 in	1.5 in	76.7% (pass)	Service D + L
Live deflection	0.74549 in	1 in	74.5% (pass)	Live

Scope: selected checks for a uniform catalog section in major-axis bending. Status uses unrounded values.

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Units: Imperial - (ft), (kip)	**Date:** 2026/11/20	**Sheet No.:** Sheet 2 of 5

Design inputs and assumptions

Beam inputs

Input units: ft, kip. Point loads positive downward; moments positive clockwise.

Input	Position	Value	Load case
Length	0 | 30		-
pinned	0		-
roller	30		-
Distributed load	0 | 30	0.5 | 0.5	Dead
Distributed load	0 | 30	1 | 1	Live

Design assumptions

Self-weight: calculated separately for every candidate
Restraint: continuous compression-flange and torsional restraint. Cb = 1.0.
User confirmed lateral restraint and support torsional restraint; cantilever fixed ends restrain warping. Bracing strength and stiffness are separate checks.
Project deflection limits: total L/240; live L/360. Between supports, L is the span length.
Cantilever / overhang criterion: L = projection length. Displacement is relative to the support reference.

Role	Scenario	Case factors	Self-weight factor
strength	LRFD 1.4D	Dead: 1.4	1.4
strength	LRFD 1.2D + 1.6L	Dead: 1.2; Live: 1.6	1.2
total	Service D + L	Dead: 1; Live: 1	1
live	Live	Live: 1	0

Calculation details - W21X44

Catalog: AISC Shapes Database 16.0 | aisc-v16 / w21x44
Section weight: 44 lb/ft | Generated load: 0.044 kip/ft
Material: ASTM A992 | Fy = 50 ksi | Fu = 65 ksi.
Classification: flange compact; web compact.

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W21X44 | Calculation details

Section classification

Equations use in, kip and ksi. Display values are rounded; checks use full precision.

1. Clear web height | B4.1b

h = d - 2 * kdes
h = (20.7) - 2 * (0.95) = 18.8 in

2. Flange slenderness | Table B4.1b, Case 10

lambdaF = bf / (2 * tf)
lambdaF = (6.5) / (2 * (0.45)) = 7.2222222
Flange: compact.

3. Flange compact limit | Table B4.1b, Case 10

lambdaPF = 0.38 * sqrt(E / Fy)
lambdaPF = 0.38 * sqrt((29000) / (50)) = 9.1516119

4. Flange noncompact limit | Table B4.1b, Case 10

lambdaRF = sqrt(E / Fy)
lambdaRF = sqrt((29000) / (50)) = 24.083189

5. Web slenderness | Table B4.1b, Case 15

lambdaW = h / tw
lambdaW = (18.8) / (0.35) = 53.714286
Web: compact.

6. Web compact limit | Table B4.1b, Case 15

lambdaPW = 3.76 * sqrt(E / Fy)
lambdaPW = 3.76 * sqrt((29000) / (50)) = 90.552791

7. Web noncompact limit | Table B4.1b, Case 15

lambdaRW = 5.70 * sqrt(E / Fy)
lambdaRW = 5.70 * sqrt((29000) / (50)) = 137.27418

Bending calculation

Governing scenario: LRFD 1.2D + 1.6L; position 15 ft (interior).
Demand / available = 253.44 kip-ft / 357.75 kip-ft = 0.70843.
Governing: Yielding. Lb = 0 ft; Cb = 1. Segment: 0 ft to 30 ft.

1. Plastic moment | F2-1

Mp = Fy * Zx
Mp = (50) * (95.4) = 4,770 kip-in

2. Governing nominal strength | F2-1

Mn = Mp
Mn = (4770) = 4,770 kip-in
Yielding; continuous lateral restraint.

3. Available bending strength | F1

Mc = phiB * Mn
Mc = (0.9) * (4770) = 4,293 kip-in
LRFD

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W21X44 | Calculation details

4. Demand / available | Strength comparison

Utilization = abs(demand) / available
Utilization = abs((3041.28)) / (4293) = 0.70842767
Pass requires utilization <= 1.0 using unrounded values.

Shear calculation

Governing scenario: LRFD 1.2D + 1.6L; position 0 ft (right).
Demand / available = 33.792 kip / 217.35 kip = 0.15547.
Governing: Web shear yielding.

1. Web shear area | G2.1

Aw = d * tw
Aw = (20.7) * (0.35) = 7.245 in^2

2. Rolled-section factor limit | G2.1(a)

limit = 2.24 * sqrt(E / Fy)
limit = 2.24 * sqrt((29000) / (50)) = 53.946344
h/tw <= limit; phiV = 1.0, OmegaV = 1.50.

3. Web shear coefficient | G2-2

Cv1 = 1.0
Cv1 = 1.0 = 1
Unstiffened web; kv = 5.34.

4. Nominal shear strength | G2-1

Vn = 0.6 * Fy * Aw * Cv1
Vn = 0.6 * (50) * (7.245) * (1) = 217.35 kip

5. Available shear strength | G2.1(a)

Vc = phiV * Vn
Vc = (1) * (217.35) = 217.35 kip
LRFD

6. Demand / available | Strength comparison

Utilization = abs(demand) / available
Utilization = abs((33.792)) / (217.35) = 0.15547274
Pass requires utilization <= 1.0 using unrounded values.

Total deflection calculation

Governing scenario: Service D + L; position 15 ft (interior).
Demand / available = 1.15104 in / 1.5 in = 0.76736.
User criterion: L/240; span / overhang 0 ft to 30 ft.
Reference length L = 30 ft.
Elastic integration with E = 29,000 ksi, Ix = 843 in4. No shear deformation.

1. Allowable deflection | Project service criterion

Limit = L / denominator
Limit = (360) / (240) = 1.5 in
Demand is the critical elastic displacement relative to the support reference; shear deformation is excluded.

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W21X44 | Calculation details

2. Demand / available | Project service criterion

Utilization = abs(demand) / available
Utilization = abs((-1.1510369)) / (1.5) = 0.76735796
Pass requires utilization <= 1.0 using unrounded values.

Live deflection calculation

Governing scenario: Live; position 15 ft (interior).
Demand / available = 0.74549 in / 1 in = 0.74549.
User criterion: L/360; span / overhang 0 ft to 30 ft.
Reference length L = 30 ft.
Elastic integration with E = 29,000 ksi, Ix = 843 in4. No shear deformation.

1. Allowable deflection | Project service criterion

Limit = L / denominator
Limit = (360) / (360) = 1 in
Demand is the critical elastic displacement relative to the support reference; shear deformation is excluded.

2. Demand / available | Project service criterion

Utilization = abs(demand) / available
Utilization = abs((-0.74549024)) / (1) = 0.74549024
Pass requires utilization <= 1.0 using unrounded values.

Not checked

- Connections and bracing strength/stiffness
- Concentrated-force and local load-introduction checks, including bearing and crippling
- Axial force, torsion, fatigue, holes and composite action
- Automatic live-load patterning; supply required patterns as reviewed combinations

Calculation identification

Engine: aisc-360-22-beam-3 | AISC 360-22 Chapters B, F and G. Gravity D/L presets are a restricted load basis; other loading requires reviewed combinations.