Anchor Bolt Selection Guide

Tip: Set your PDF viewer to "Actual size" before printing to maintain scale.

Material Selection by Environment

Material	Corrosion Resistance	Best Applications	Cost	Availability
Carbon Steel (Plain)	Poor	Indoor, dry, non-corrosive, temporary	Lowest	Excellent
Zinc Plated Steel	Fair	Indoor, light outdoor (covered), low humidity	Low	Excellent
Hot-Dip Galvanized	Good to Excellent	Outdoor, buried, exposed to weather	Medium	Excellent
Stainless 304	Excellent	Marine (moderate), food grade, chemical (mild)	High	Good
Stainless 316	Superior	Marine (severe), chemical processing, salt water	Highest	Good
Brass	Good	Decorative, electrical, non-magnetic	High	Limited

Application-Based Selection Guide

Application Type	Recommended Bolt Type	Typical Thread Sizes	Material Recommendation	Key Considerations
Deck/Porch Posts	J-Bolt	3/8" to 1/2"	Galvanized	Weather exposure, wood connection
Fence Posts	J-Bolt	3/8" to 1/2"	Galvanized	Outdoor exposure, wind loads
Light Pole Bases	J-Bolt or Foundation Bolt	3/4" to 1"	Galvanized or Stainless	High wind loads, public safety
Machinery Foundations	J-Bolt or Bent Anchor	1/2" to 1"	Carbon Steel or Galvanized	Vibration, weight, precision alignment
Pipe Mounting (Plumbing)	U-Bolt	3/8" to 5/8"	Carbon Steel or Stainless	Corrosion from moisture
HVAC Piping	U-Bolt	3/8" to 3/4"	Galvanized	Temperature cycles, vibration
Marine/Dock	J-Bolt or U-Bolt	1/2" to 1"	Stainless 316	Salt water, submersion
Industrial Equipment	J-Bolt or Heavy-Duty U	5/8" to 1"	Grade 5 or Stainless	High loads, vibration

Load Calculations Overview

Tension Loads (Pull-Out)

- J-bolt capacity depends on embedment depth, concrete strength, and edge distance
- Typical allowable tension load = 1000-3000 lbs for 1/2" bolt in 3000 PSI concrete with proper embedment
- Concrete breakout cone failure mode must be considered for shallow embedment
- Structural applications require engineering calculations per ACI 318 code

Shear Loads (Sliding)

- Shear capacity depends on bolt diameter, material grade, and concrete bearing strength
- Shear capacity is typically 60-70% of bolt's tensile strength for properly embedded anchors
- Edge distance and spacing significantly affect shear capacity
- Combined tension + shear requires interaction formula - consult engineer

U-Bolt Clamping Loads

- Clamping force should be sufficient to prevent movement but not crush the pipe
- Typical clamping pressure: 500-2000 PSI depending on pipe material and application
- Always use backing plates to distribute load and prevent pipe deformation
- For dynamic/vibration loads, use 1.5-2× static load as design load

Recommended Safety Factors

Application Type	Minimum Safety Factor	Preferred Safety Factor	Notes
Static, indoor, light duty	3:1	4:1	Controlled environment

Application Type	Minimum Safety Factor	Preferred Safety Factor	Notes
General structural	4:1	5:1	Building code minimum
Dynamic/vibration	5:1	6:1	Cyclic loading
Outdoor/weather	4:1	6:1	Corrosion consideration
Public safety (signs, lights)	6:1	8:1	Life safety
Seismic/wind zones	5:1	8:1	Code-specific requirements

Note: Safety Factor = Ultimate Strength ÷ Working Load. Higher safety factors provide greater margin for uncertainties, corrosion, impact, and unforeseen conditions.

Step-by-Step Selection Process

1. Define Application Requirements

- What are you mounting? (post, equipment, pipe, etc.)
- What are the loads? (weight, wind, seismic, dynamic)
- What is the environment? (indoor, outdoor, marine, chemical)
- What is the substrate? (concrete strength, wood type, metal)

2. Calculate Design Loads

- Determine dead load (permanent weight)
- Calculate live loads (people, equipment, snow, etc.)
- Add environmental loads (wind, seismic) per local codes
- Apply appropriate safety factor for application type
- For critical applications, consult structural engineer

3. Select Bolt Type

- **J-Bolts:** For anchoring to concrete or masonry
- **U-Bolts:** For clamping pipes, tubes, or round/square objects
- Consider special types (bent anchors, foundation bolts) for unique requirements

4. Determine Size

- Select bolt diameter based on calculated loads and material strength
- For J-bolts: determine embedment depth (deeper = stronger)
- For U-bolts: measure pipe/object OD and select appropriate inside diameter
- Verify adequate thread length for proper nut engagement

5. Choose Material and Finish

- Indoor, dry: carbon steel with zinc plating is usually sufficient
- Outdoor: hot-dip galvanized for good corrosion protection
- Marine or harsh chemical: stainless steel 304 or 316
- Consider galvanic compatibility with attached materials

6. Verify Installation Requirements

- Check edge distance and spacing requirements can be met
- Verify concrete strength meets minimum requirements
- Ensure installation method is practical for site conditions
- Review building codes and permit requirements

Special Considerations

Seismic and High-Wind Zones

- Must comply with local building codes (IBC, ASCE 7)
- Typically require engineered design and calculations
- May need special inspection during installation
- Consider hooked foundation bolts or plate anchors for critical applications
- Use Grade 5 or higher bolts for high-strength requirements

Corrosive Environments

- Salt water or marine: Specify stainless 316 as minimum
- Chemical processing: Consult compatibility charts for specific chemicals
- Buried or encased in soil: Hot-dip galvanized provides long service life

• Consider cathodic protection for long-term critical installations

Vibration and Dynamic Loads

• Use prevailing torque lock nuts or mechanical locking devices
• Consider thread locker for permanent installations
• Increase safety factor to 5:1 or 6:1 for fatigue resistance
• Regular inspection and re-torquing schedule may be required

Temperature Extremes

• High temperature (>500°F): Consider stainless steel or special alloys
• Low temperature (<-20°F): Verify material maintains ductility
• Large temperature swings: Allow for thermal expansion/contraction
• Avoid mixed materials with different expansion rates

When to Consult a Structural Engineer

You MUST consult a licensed structural engineer for:

• Any structural application affecting building safety
• Seismic or high-wind zone installations
• Public safety applications (signs, lights, overhead structures)
• High loads or unusual configurations
• When building codes or permits require engineered design
• Any application where failure could result in injury or property damage

■■ IMPORTANT DISCLAIMER
This guide provides general information only. Actual anchor bolt selection must consider specific site conditions, loads, materials, and local building codes. For structural, seismic, life-safety, or critical applications, always consult a licensed professional engineer. Improper selection or installation of anchor bolts can result in structural failure, property damage, injury, or death.