

Carbon Steel Fasteners: Grades, Coatings, and Industrial Applications

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Key Takeaways

118 - Hex Bolt — GB/T 6173 ISO 8675 (Series 057) — GB/T 6173 ISO 8675

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- Carbon steel fasteners offer a wide strength range from property class 4.8 to 12.9, enabling use from general hardware to high-stress automotive and structural applications.
- Coating selection critically influences corrosion life: zinc flake and hot-dip galvanizing provide robust protection for outdoor and harsh environments, while zinc plating works for indoor use.
- International standards such as ISO 898-1, SAE J429, and ASTM A307 ensure consistent mechanical properties and interchangeability across global supply chains.
- Successful procurement requires clear specification of grade, thread, finish, quantity, and applicable standards to avoid delays and ensure compliance.

Why Material, Grade, and Finish Selection Matters for Fasteners

120 - Hex Nut — GB/T 6170 ISO 4032 (Series 059) — GB/T 6170 ISO 4032

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The single most important decision in specifying a fastener is choosing the right material, grade, and surface finish. For carbon steel fasteners, this choice directly impacts mechanical performance, corrosion resistance, installation behavior, and total cost of ownership. A mismatched grade can lead to shear failure under load, while an inadequate coating invites rust in mildly corrosive environments. Proper selection ensures the joint maintains clamping force over its intended service life without over-engineering or excessive spend.



► Watch video: <https://www.youtube.com/watch?v=PCIPBkHOzng>

The entire process of manufacturing Carbon Steel Anchor Bolts Foundation Bolts for Equipment— by Ningbo Weifeng Fastener Co., Ltd on YouTubeA foundation bolt (or anchor bolt) is a heavy-duty fastener used to anchor structural steel, industrial machinery, and equipmentu00a0...

Available Materials and Grades as Labelled Options

Carbon steel forms the backbone of industrial fasteners, categorized by carbon content and heat treatment. The most recognized inch-series grades under SAE J429 are:

- **Grade 2:** Low carbon steel, no heat treatment, for non-critical applications.
- **Grade 5:** Medium carbon steel, quenched and tempered, offering higher tensile strength.
- **Grade 8:** Medium carbon alloy steel, quenched and tempered, for high-stress joints.

Metric **property classes** (ISO 898-1) include 4.6, 4.8, 5.8, 8.8, 10.9, and 12.9. The first digit indicates nominal tensile strength in hundreds of MPa; the second represents yield ratio. For example, **carbon steel fasteners** in class 8.8 deliver good ductility with strength, while 10.9 and 12.9 progressively increase strength at the cost of reduced elongation and notch sensitivity. **Alloy steel** fasteners, such as ASTM A193 B7, bring added chrome-molybdenum for elevated temperature service, often used in pressure vessels and flanges.

While carbon and alloy steels dominate, other materials appear in specialty roles:

- **Stainless steel A2 (304) / A4 (316):** inherently corrosion-resistant, non-magnetic in annealed state, lower strength than hardened carbon grades.
- **Brass:** decorative, conductive, corrosion-resistant in water, but low tensile strength.
- **Titanium:** highest strength-to-weight ratio, fully immune to chlorides, but significantly higher cost.

Properties and Trade-offs of Each Material

Each material and grade presents clear trade-offs that guide selection:

- **Tensile / proof strength:** A Grade 2 bolt provides modest clamp load at minimal cost, while a **steel fastener** in Grade 8 or class 12.9 approaches 150,000 psi tensile strength, suitable for critical structural joints. However, very high strength grades become brittle and may fail without warning if over-tightened or subjected to impact.
- **Corrosion resistance:** Bare carbon steel will rapidly oxidize; stainless grades inherently resist corrosion but can still suffer pitting in chloride environments. Brass and titanium offer superior galvanic compatibility in specific settings.
- **Cost:** Fastener cost escalates from basic carbon steel through alloy steel and stainless to titanium. Plating can close the gap for corrosive environments when mild steel is acceptable.
- **Weight:** Titanium is about 40% lighter than steel; for weight-critical assemblies (aerospace, motorsport), this can justify the premium.
- **Magnetic / temperature behavior:** Carbon steel is ferromagnetic and suitable up to around 200°C (dependent on coating). Stainless A2 is usually non-magnetic; A4 offers better high-temperature strength. Alloy steels maintain strength at elevated temperatures better than plain carbon grades.

Surface Finish and Coating Options

Protective coatings are essential for carbon steel fasteners destined for anything but dry, indoor conditions. Each system offers distinct advantages:

- **Zinc plating (electrogalvanized):** economical, thin layer (5–25 µm), with sacrificial corrosion protection. A chromate conversion coating (clear, yellow, black) adds modest resistance; typical white rust appears after 12–24 hours in salt spray.
- **Zinc-nickel alloy electroplating:** provides significantly longer corrosion protection—often exceeding 500 hours to red rust—without hexavalent chromium. Increasingly specified in automotive and heavy equipment for its durability and environmental compliance.
- **Hot-dip galvanizing (HDG):** a thick metallurgical bond (50–100 µm) offering robust barrier and cathodic protection, ideal for outdoor structural steel, utility, and marine environments. The matte gray finish may affect thread fit; oversize tapping is required.
- **Black oxide:** minimal dimensional build-up, low friction, decorative dark appearance, but negligible corrosion resistance without supplementary oil or wax.
- **Geomet / Dacromet (zinc flake) coatings:** chrome-free, thin-film coatings delivering high corrosion resistance (typically 500+ hours to red rust) with excellent hydrogen embrittlement resistance—critical for high-strength fasteners.
- **Phosphate (manganese or zinc):** porous crystalline layer that holds oil for lubrication; often used as a pre-treatment for painting or as a break-in coating for engine fasteners.

How to Match Material and Finish to Application and Environment

Selection begins with the service environment and mechanical demand. **Carbon steel fasteners** with zinc plating suffice for indoor machinery, HVAC, and general assembly where humidity is controlled. For outdoor exposure or periodic wetting, hot-dip

galvanized or zinc flake coatings are standard. Highly corrosive conditions—chemical processing, coastal salt spray—often require stainless steel A4 or coated alloy steels with Geomet. Structural bolting to AISC/RCSC specifications typically demands Grade 8 or 10.9 with a mechanically galvanized or HDG finish, or weathering steel. Automotive under-hood fasteners favor zinc-nickel for thermal stability and corrosion resistance. Elevated temperature service (above 200°C) rules out electroplated zinc due to liquid metal embrittlement risk; phosphate or bare alloy steel with anti-seize may be appropriate.

Compliance and Environmental Considerations

Global regulations increasingly restrict hazardous substances. Many legacy coatings contained hexavalent chromium (Cr6+) for passivation, a known carcinogen. Today, RoHS and REACH compliant, Cr6+-free alternatives are the default for any manufacturer shipping into the EU and most industrial markets. Zinc flake technologies (Geomet, Delta) and trivalent chromium passivates meet these requirements while preserving high corrosion performance. When ordering **steel fasteners**, procurement teams should specify “hex-chrome-free” in their material callouts to ensure compliance and avoid end-of-life disposal issues.

Customization of Materials and Finishes on Request

Beyond standard catalog items, qualified fastener suppliers can tailor materials and finishes to unique specifications. This may include non-standard property classes, custom plating thicknesses, duplex coatings (e.g., zinc flake plus topcoat), thread locking patches pre-applied, or even selective plating on specific surfaces. Such customization is often economical for mid-to-large volume production runs and serves specialized sectors like oil & gas, renewable energy, and heavy transport. Lead times and MOQs vary, so early-stage collaboration with the supplier ensures feasibility and cost control.

Request a Material and Finish Recommendation

The array of material grades, property classes, and coating permutations can be daunting. Our application engineers routinely assist buyers and design teams in narrowing the choices based on load requirements, corrosion exposure, assembly method, and budget. Contact us with your operating conditions, applicable standards, and volume needs, and we will provide a tailored material and finish recommendation that balances performance and cost for your **carbon steel fasteners**.

Industrial Applications and Selection Criteria

Carbon steel fasteners serve demanding roles across construction, heavy machinery, automotive, energy, and general industrial assembly. The combination of medium or high carbon content, heat treatment, and protective coatings allows engineers to balance tensile strength, ductility, and corrosion resistance for each operating environment. For example, property class 10.9 hex bolts with zinc-nickel plating are commonly specified for engine mounts and chassis bolting in transport applications, while hot-dip galvanized class 8.8 threaded rods secure structural steel connections in outdoor infrastructure.

Selection hinges on three linked decisions: the base **grade** (e.g., SAE J429 Grade 5, metric 10.9), the appropriate **coating** (zinc flake, galvanizing, etc.), and the **geometry** (head style, thread pitch, tolerance class). Procurement teams should also consider installation torque, preload requirements, and maintenance accessibility when finalizing specifications.

Key Facts for Carbon Steel Fasteners

- Carbon steel fasteners span property classes 4.8 through 12.9 under ISO 898-1, with corresponding SAE J429 Grades 2, 5, and 8 for inch sizes.
- Typical tensile strength ranges from 400 MPa (class 4.8) to over 1200 MPa (class 12.9), depending on heat treatment and alloy content.
- Medium-carbon grades (0.25–0.55% C) are quenched and tempered to achieve the best strength/ductility balance for structural bolting.
- Corrosion protection is mandatory for most environments; popular systems include zinc electroplating, hot-dip galvanizing, and zinc flake (Geomet/Dacromet).
- Carbon steel is magnetic and can be used up to approximately 300°C continuous service, though strength may decrease at elevated temperatures.

Specification Attributes for Procurement

When issuing RFQs or drawings, include these comparable attributes to ensure accurate quoting:

Mechanical and Material Attributes

- **Property class / grade:** State the metric class (e.g., 8.8, 10.9) or SAE grade (e.g., Grade 5, Grade 8). Reference the applicable standard: [Bolt Property Classes — ISO 898-1](#) for metric, or SAE J429 for inch.
- **Thread size and pitch:** Metric coarse (standard) or fine; inch UNC/UNF. Specify tolerance class (e.g., 6g for external threads) if critical.
- **Material sub-type:** Low-carbon (e.g., CHQ1018) for non-heat-treated fasteners, medium-carbon (e.g., C1035–C1045) for quench and temper grades, or specific alloy (e.g., B7 for high-temperature).
- **Finishing and coating:** Choose among zinc plating (trivalent Cr³⁺), zinc-nickel, hot-dip galvanizing, zinc flake (Geomet/Dacromet), or black oxide. Note that hydrogen embrittlement risk applies to high-hardness parts; specify proper baking if required.

Ordering and Logistics Attributes

- **Dimensional standards:** ISO, DIN, ANSI/ASME, or JIS. Common standards include [Hex Bolts — ISO 4014 / ISO 4017](#) and [Hex Nuts — ISO 4032 / ISO 4033](#).
- **Quantity and packaging:** Bulk cartons, palletized, or custom kitting. MOQs typically vary by diameter and finish; consult current schedules.
- **Lead time and origin:** Stock items often ship within days; special finishes or odd sizes may require weeks. Specify port and Incoterms for international shipments.

International Standards and Compliance

Carbon steel fastener specifications are governed by several global standards to ensure interchangeability and mechanical reliability. ISO 898-1 defines mechanical properties of carbon steel and alloy steel bolts, screws and studs with metric threads, while ISO 898-2 covers nuts. In North America, ASTM A307 covers carbon steel externally threaded fasteners up to grade C, and SAE J429 is the primary automotive/industrial grading system. For high-temperature bolting, ASTM A193 Grade B7 (chromium-molybdenum alloy steel) is widely referenced. Surface finish requirements often invoke ISO 4042 for electroplated coatings or ASTM F2329 for hot-dip galvanizing. Compliance with RoHS and REACH is standard for coatings sold into the EU market; hex-chrome-free zinc flake systems are available upon request.

Consolidated Overview of Carbon Steel Fasteners

Summary of material grades, coatings, and typical uses for carbon steel fasteners

Aspect	Options / Values	Key Trade-offs
Material Grade (Metric)	4.8, 5.8, 8.8, 10.9, 12.9	Higher class increases strength and hardness but reduces ductility; 12.9 requires careful coating to avoid hydrogen embrittlement.
SAE Grade (Inch)	Grade 2, Grade 5, Grade 8	Grade 5 offers a balanced mid-range; Grade 8 provides near-alloy-steel tensile strength.
Common Coatings	Zinc plating (Cr ³⁺), zinc-nickel, hot-dip galvanizing, zinc flake (Geomet), black oxide, phosphate	Zinc flake and zinc-nickel give superior corrosion resistance (up to 1000+ hours salt spray) but cost more; galvanizing adds thickness that may affect thread fit.
Corrosion Protection	200-1000+ hours neutral salt spray (depending on coating)	Higher hours usually mean higher cost and thicker coating; HDG may not suit fine threads.
Temperature Range	Typically -50°C to +300°C continuous	Above 300°C, strength degrades; special alloy steels (e.g., ASTM A193 B7) extend temperature limits.
Standards	ISO 898-1/-2, ASTM A307, SAE J429, DIN, JIS, GB	Match standard to regional market and end-use regulatory requirements.

Request a Quote for Carbon Steel Fasteners

Specifying the right combination of grade, coating, and geometry saves costs and ensures reliable field performance. Provide our team with your technical drawings, required quantities, and any test certifications or inspection levels (e.g., PPAP Level 3, 3.1 material certs). We will return a detailed quotation including lead time, packaging options, and documentation. **Contact our sales engineers to start your carbon steel fastener inquiry today.**

Frequently Asked Questions

How do I choose between metric property class 8.8 and 10.9 for structural bolts?

Class 8.8 provides moderate strength with good ductility, suitable for most general structural connections. Class 10.9 offers higher tensile and proof load capacity, beneficial for dynamic loading or weight reduction, but requires more controlled tightening procedures and careful handling to avoid hydrogen embrittlement when coated.

What is the difference between zinc plating and hot-dip galvanizing on carbon steel fasteners?

Zinc plating is an electrochemical process that deposits a thin, uniform coating typically 5–25 µm thick, suitable for indoor or mildly corrosive environments. Hot-dip galvanizing applies a thicker zinc layer (45–85 µm) that provides superior outdoor corrosion resistance but increases dimensional thickness, which may require over-tapping of nuts.

Can carbon steel fasteners be used in high-temperature applications?

Standard carbon steel grades are limited to about 300°C continuous exposure; beyond that, relaxation and oxidation occur. For elevated temperatures, alloy steel fasteners (e.g., ASTM A193 B7) maintain strength up to approximately 500°C.

What certifications are available for carbon steel fastener orders?

Common documentation includes mill test reports (EN 10204 3.1), material certificates, plating certificates (RoHS/REACH compliance), and inspection reports for mechanical properties and dimensional checks. PPAP Level 3 is often available for automotive programs on request.

How does thread tolerance affect assembly with coated fasteners?

Thick coatings like hot-dip galvanizing reduce the effective thread clearance. Nuts are often tapped oversize (e.g., 6AX) to accommodate the coating. Standard thread tolerances (6g/6H) work well with thin coatings such as zinc plating.

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