



Analyzing the Fastener Demand from High-Speed Rail Construction in China

中国高铁建设紧固件需求分析

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China's HSR Build-out: Where the Track Miles are Headed

China's HSR network reached ~48,000 km by the end of 2024. China State Railway's public targets indicate ~60,000 km by 2030, embedded in a broader rail network goal of ~180,000 km by that date, while earlier planning set an ambition of ~70,000 km of HSR by 2035.

This pipeline matters because fastener consumption scales directly with track-kilometers (not just route-kilometers). Most Chinese HSR corridors are double-track, so every new route-km usually implies 2 track-km of fastener-intensive rail. A 12,000-km increase in operating HSR mileage from 2025 to 2030 therefore likely translates to ~24,000 track-km of new fastener demand, with additional volumes for turnouts, station throats, and depots.

China's HSR foundation technology is dominated by ballastless (slab) track—CRTS I/II/III variants—engineered for high speed, low maintenance, and tight geometry control. These designs rely on resilient fasteners that clamp the rail to baseplates or directly to concrete slabs; materials and pad stiffness are tuned to speed, axle load, and bridge/tunnel dynamics.

Track Fasteners: the Core of Demand

► **Spacing and unit counts per kilometre:** In slab-track HSR, rail fastening assemblies are typically placed at intervals of ~0.60–0.65 m along each rail. Academic and industry references show common sleeper/rail-seat spacings near 0.60 m for high-speed applications, while Chinese research and tests often use 0.65 m for CRTS II field experiments and modelling.

► **Using 0.65 m as a baseline spacing:**

- Positions per rail-km = $1,000 \text{ m} / 0.65 \text{ m} \approx 1,538$ fastening points.
- Each track-km has two rails, so $\approx 3,076$ fastening assemblies per track-km.
- If we assume double-track construction, a typical route-km then consumes $\approx 6,152$ assemblies (not counting turnouts/special trackwork).
- To show the sensitivity, a 0.60 m spacing would increase counts by ~8%:
- $1,000 / 0.60 = 1,667$ per rail-km, or 3,334 per track-km; 6,668 per route-km.

These densities are directionally consistent with UIC/HSR engineering norms for resilient fastenings in high-speed service.

► **Projecting 2025–2030 new-build demand:** From ~48,000 km (the end of 2024) to ~60,000 km by 2030, net operating HSR increases by ~12,000 km. Treat that as new double-track put into service (the practical reality may include phased openings and upgrades, but the aggregate impact on fastener demand is similar).

- Track-km added $\approx 12,000 \text{ route-km} \times 2 = 24,000 \text{ track-km}$.
- Fastener assemblies (baseline 0.65 m): $24,000 \times 3,076 \approx 73.8$ million assemblies.
- Range (0.60–0.65 m): roughly 73–80 million assemblies for the same build-out.

This excludes turnouts, where special fasteners (switches, crossings, guard rails) have higher density and specialized parts, and station/yard complex geometry. Factoring those in can add several percent to totals depending on corridor design.

Beyond the Rails: Many Other Fastener “Hotspots”

While rail-seating fasteners represent the single largest category by count, high-speed rail projects in China consume vast numbers of additional steel fixings across multiple domains. Bridges and viaducts stand out as particularly intensive consumers, since Chinese HSR networks are heavily elevated on long viaducts and box-girder bridges. For instance, approximately 1,268 kilometers of the Beijing–Shanghai high-speed railway is ballastless, and around 87 percent of that corridor runs on elevated structures. This design choice implies a massive demand for structural connections and embedded anchors. Expansion joints, bearing fixings, parapets, access walkways, noise barriers, inspection gantries, and drainage hardware all rely on bolts and anchors engineered to withstand vibration, thermal cycling, and long-term corrosion exposure.

Tunnels also add significantly to fastener demand. In these underground environments, fixings are essential for anchoring cable trays, emergency systems, track slab dowels, and equipment cabinets. High-speed tunnel aerodynamics present unique challenges, as pressure pulses and crosswinds at portals exert dynamic forces that increase performance requirements for fasteners and their supporting structures.

The overhead contact system (OCS), the backbone of electric traction, is another major consumer of fasteners. Every mast, cantilever, bracket, insulator, steady arm, and sectioning device depends on structural and electrical fixings. Given that typical HSR mainline span lengths range from 50 to 60 meters between supports, each kilometer of double-track line can require 17 to 20 masts, depending on terrain and design. Each of these installations translates into

hundreds of structural fasteners for baseplates and ancillary hardware, with the numbers varying according to wind zones, bridge versus earthwork alignments, and the specific contact wire configuration.

Stations, depots, and mechanical and electrical (M&E) facilities also constitute a vast consumption base. Platform screen doors—where deployed—require precision-engineered fasteners, while HVAC systems, cable trays, fire suppression infrastructure, signaling racks, and traction power equipment demand large volumes of stainless steel or corrosion-protected bolts and anchors to ensure reliability and safety.

In parallel, signaling and communications systems add their own requirements. The deployment of CTCS-3 train control, lineside cabinets, and extensive fiber-optic networks involves mounting hardware and vibration-rated fasteners designed for both stability and longevity under continuous service conditions.

Lifecycle Replacement Demand

Quantitatively, lifecycle replacement is an increasingly significant factor. Under normal operating conditions, elastic fasteners (e.g., WJ-8 family) require inspection every 2–3 years, with partial replacement cycles typically every 8–12 years depending on corridor speed, axle load, and climate. **Assuming an average 10% replacement of assemblies per decade, the existing network of ~45,000 km implies demand for at least 40–45 million replacement fasteners by 2030**—independent of expansion. As the network grows toward 60,000 km, **cumulative replacement needs could reach 60–65 million units per decade**, effectively creating a permanent parallel market alongside new construction. **By 2035, if 70,000 km of HSR is realized, annualized demand could average 8–10 million replacement fasteners per year**, rivaling new-build consumption even if expansion moderates.

Summary

China’s high-speed rail program continues to stand out as a uniquely large, policy-anchored engine for fastener demand.

The near-term bellwether is progress toward the 60,000-kilometer milestone by 2030, which would add an estimated 74–80 million rail-seat fastening assemblies under standard spacing assumptions.

This figure grows substantially when one accounts for turnouts, overhead contact system hardware, and the immense volumes of bridge, tunnel, and station-related fixings. Beyond 2030, the vision of reaching 70,000 kilometers by 2035 remains a credible long-range anchor, provided policy momentum and fiscal support remain steady.

Even if network expansion slows or flexes with broader fiscal realities, the scale of China’s HSR infrastructure ensures that inspection, replacement, and upgrade cycles will sustain a large and durable market for fasteners well into the next decade. By 2035, the interplay of expansion, lifecycle management, and technical evolution positions the fastener sector as both a critical enabler of reliability and a beneficiary of one of the most ambitious transportation programs in modern history. ■

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