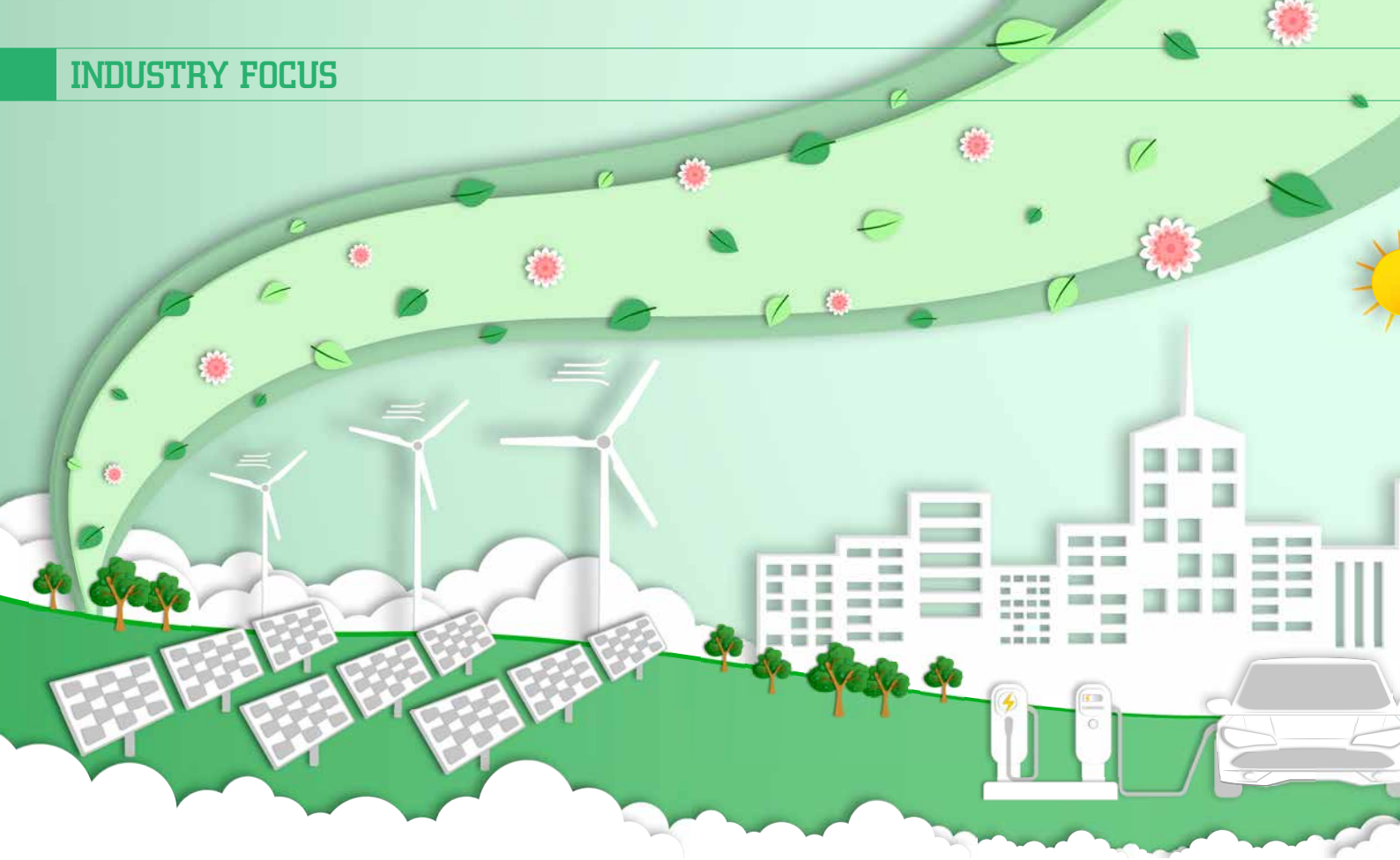


Impact of Global Key Industry Demand on Germany's Fastener Industry (Part 1): Wind Power Industry as a Case Study

Introduction

The global energy transition and net-zero policies are driving growth in the wind power market. The trend toward larger wind turbines, offshore installations, and the replacement of aging equipment is further increasing demand for high-strength, fatigue-resistant, and corrosion-resistant fasteners. Germany holds an important position in the global wind power supply chain, supported by its strengths in precision manufacturing, materials processing, and quality assurance. However, rising production costs, intensifying international competition, and the regionalization of supply chains are placing increasing pressure on Germany's fastener industry to transform. This article examines how developments in the global wind power market are affecting Germany's fastener industry, with a focus on its competitive advantages, technical challenges, and future growth opportunities.

The Structure of Europe's Fastener Supply Chain and the Industrial Reshaping Driven by the Wind Power Market

(1) Division of Labor in the Wind Power Fastener Supply Chain and Germany's Industry Position

The wind power fastener supply chain encompasses steel and wire rod supply, forging, thread processing, heat treatment, surface treatment, and inspection and certification. Fasteners are widely used in turbine systems, including towers, foundations, blades, hubs, bearings, gearboxes, and nacelles (Fig. 1). Demand comes not only from original equipment manufacturers but also from suppliers of individual subsystems. Germany's

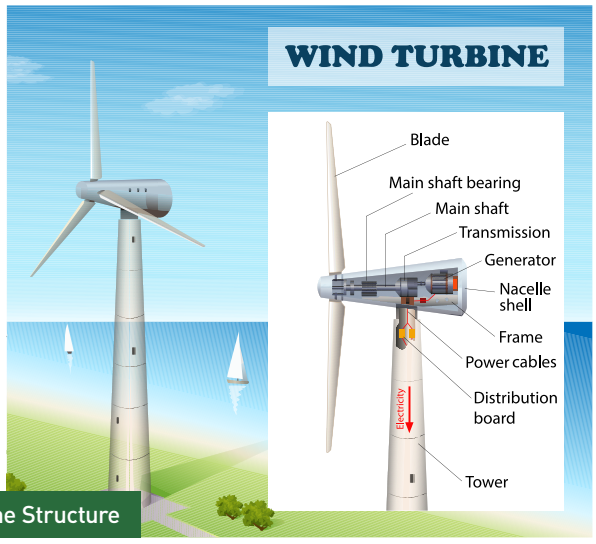
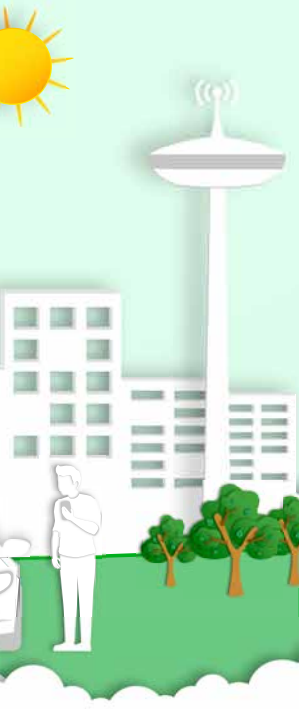


Fig. 1. Wind Turbine Structure



competitive advantages stem primarily from its ability to manufacture products to demanding specifications and its proximity to major wind power markets. By the end of 2025, Germany's installed wind power capacity had reached 77.8 GW, making it the largest single wind power market in the EU.

(2) EU Net-Zero Policies and Supply Chain Cost Challenges

The EU Net-Zero Industry Act sets a benchmark under which the EU's manufacturing capacity for net-zero technologies should reach at least 40% of its annual deployment needs by 2030. It also incorporates sustainability and supply chain resilience criteria into renewable energy auctions, creating potential opportunities for European fastener manufacturers. CBAM entered its definitive phase in 2026, introducing carbon emissions reporting and certificate obligations for imported steel and iron products within its scope. For fastener manufacturers, the impact depends on whether their products fall within the mechanism's coverage and how they source their raw materials. It may also increase the costs associated with carbon data management and supply chain compliance.

(3) Global Wind Power Capacity Growth and the Outlook for the European Market

According to reports published by organizations such as MRFR, the global wind power market was valued at approximately US$128.5 billion–US$174.5 billion in 2024, covering wind turbine equipment, components, and overall project development. As global demand for renewable energy continues to grow, the market is projected to exceed approximately US$147.8 billion by 2026. Meanwhile, data from the International Energy Agency (IEA) and WindEurope indicate that annual global capital expenditure on wind power has generally remained above US$200 billion. Investment in new wind farms in Europe reached €31 billion (approximately US$33.7 billion) in 2024, rising further to €45 billion (approximately US$52 billion) in 2025. As Europe's largest wind power market, Germany's permits issued for 20.8 GW of onshore wind capacity in 2025 alone are expected to generate €27 billion–€31 billion in project development expenditure, potentially creating procurement opportunities for wind turbine components and high-strength fasteners. However, an accurate assessment of the wind power fastener market requires access to wind turbine bills of materials (BOMs) and actual procurement data. Fasteners vary in specification and application across different structural components, and procurement configurations differ among turbine models. Furthermore, customs tariff codes are not classified according to end use. Consequently, the market value of wind power fasteners cannot currently be calculated directly from installed capacity or project development expenditure alone.

(4) Relevant HS Codes for Steel Fasteners Used in Different Wind Turbine Components

Table 1 estimates the HS codes that may apply to steel fasteners based on their characteristics and the components in which they are used. These estimates should not be interpreted as definitive tariff classifications or dedicated HS codes for specific wind turbine components.

Table 1. Potential HS Codes for Steel Fasteners Used in Major Wind Turbine Components

Wind Turbine Component	Main Fasteners	Potentially Applicable HS Codes
Tower section flanges	Large, high-strength hex bolts, nuts, flat washers, and locking washers	7318.15, 7318.16, 7318.21, 7318.22
Tower and nacelle base	High-strength bolts, nuts, and washers	7318.15, 7318.16, 7318.22
Concrete foundations	Anchor bolts, fully threaded anchor rods, large nuts, and thick washers	7318.15 or 7318.19; 7318.16, 7318.22
Complete anchor bolt cage assembly	Anchor rods, positioning rings, formwork, and structural steel components assembled as a unit	May fall under 7308.90
Blade roots and hub	Blade root bolts, studs, threaded inserts, and nuts	7318.15, 7318.16, or 7318.19
Pitch bearings	High-strength bolts, nuts, and locking components	7318.15, 7318.16, 7318.21
Hub and main shaft	High-strength bolts, nuts, washers, and locating pins	7318.15, 7318.16, 7318.22, 7318.29
Main bearings and bearing housings	High-strength bolts, locating pins, and washers	7318.15, 7318.22, 7318.29
Gearbox and generator	Mounting bolts, self-locking nuts, locking washers, and locating pins	7318.15, 7318.16, 7318.21, 7318.29
Yaw system	Yaw bearing bolts, motor mounting bolts, locking components, and pins	7318.15, 7318.16, 7318.21, 7318.24, 7318.29
Braking system	Caliper mounting bolts, pins, cotter pins, and locking components	7318.15, 7318.21, 7318.24
Nacelle cover and internal sheet metal	Self-tapping screws, standard bolts, rivets, and rivet nuts	7318.14, 7318.15, 7318.16, 7318.23
Electrical control cabinets and cable trays	Self-tapping screws, small bolts, nuts, and washers	7318.14, 7318.15, 7318.16, 7318.22
Offshore platforms, ladders, and guardrails	Corrosion-resistant bolts, nuts, washers, and rivets	7318.15, 7318.16, 7318.22, 7318.23
Lifting and maintenance attachment points	Eye bolts, screw rings, and special fastening components	7318.13 or 7318.15

Analysis of Steel Fastener Export Trends in European Countries

Since customs tariff codes are primarily classified according to product material and form rather than end use, the statistics in this section reflect overall export trends for steel fasteners (HS 7318) across European countries. They do not directly represent export values for fasteners specifically used in wind power applications.

(1) Global Export Trends for Steel Fasteners from European Countries

Table 2 summarizes recent changes in global steel fastener exports from major European countries. The table shows that Europe continues to enjoy a competitive position in international markets. Germany ranked first, with exports valued at US$7.57 billion. Although its growth rate was only 0.7%, its export value remained significantly higher than that of Italy, Europe's second-largest exporter. France, Poland, and the UK, meanwhile, demonstrated stronger export growth momentum. These trends indicate that **while Germany remains Europe's leading fastener exporter, it is facing increasing competitive pressure from other European suppliers.**

(2) Global Export Trends for German Steel Fasteners

Table 3 summarizes recent changes in the major export markets for German steel fasteners. Germany remains Europe's leading steel fastener exporter, although its export growth has been relatively limited and its share of total European exports has declined. **This reflects the gradual strengthening of other European countries' competitiveness, even as Germany retains its position as the region's leading exporter.**

Table 2. Global Export Trends for Steel Fasteners from Major European Countries in Recent Years (Unit: US$100 Million; %)

Exporting Country/Region	2021	2022	2023	2024	2025	Share in 2025	CAGR
Germany	73.6	72.4	77.3	74.3	75.7	15.1%	0.7%
Italy	22.1	22.8	24.5	23.9	25.3	5.1%	3.5%
France	14.4	14.9	17.0	18.9	20.5	4.1%	9.3%
United Kingdom	8.8	9.5	10.5	11.9	12.4	2.5%	8.9%
Netherlands	9.0	8.6	9.4	8.9	9.3	1.9%	1.0%
Spain	6.2	6.3	7.3	6.9	7.8	1.6%	5.8%
Poland	2.9	6.6	7.2	7.1	7.4	1.5%	26.7%
Austria	5.8	6.2	6.5	7.0	7.2	1.4%	5.8%
Czech Republic	6.0	6.6	7.2	6.7	7.2	1.4%	4.5%
Belgium	5.4	5.7	5.5	5.8	6.4	1.3%	4.0%
Top 10 European exporters – subtotal	154.2	159.5	172.6	171.4	179.3	35.8%	3.8%
Other European countries – subtotal	16.4	16.6	17.1	16.8	18.5	3.7%	3.0%
Total exports of steel fasteners from 28 European countries to global markets	170.6	176.1	189.7	188.1	197.8	39.5%	3.8%
Global steel fastener exports	462.4	505.2	485.0	488.7	500.7	100.0%	2.0%
Share of global steel fastener exports accounted for by 28 European countries	36.9%	34.9%	39.1%	38.5%	39.5%	0.1%	1.7%

Table 3. Trends in Germany's Major Steel Fastener Export Markets in Recent Years (Unit: US$100 Million; %)

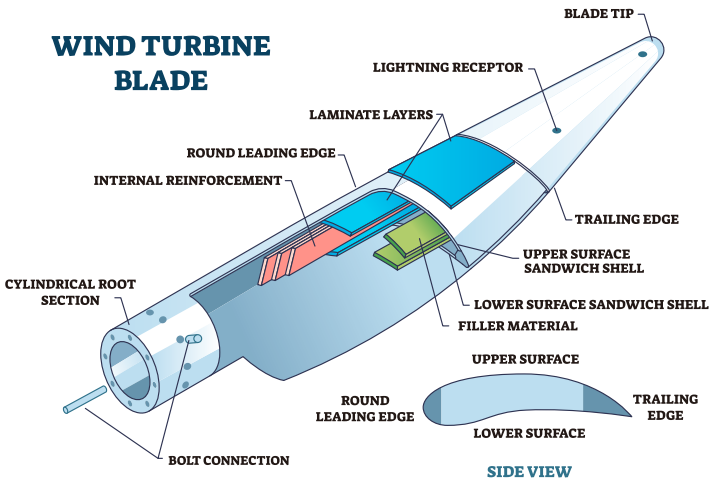
Major Export Market	2021	2022	2023	2024	2025	Share in 2025	CAGR
France	5.6	5.4	6.1	5.8	6.3	8.3%	2.9%
China	8.4	7.3	7.1	7.1	6.0	7.9%	-8.2%
United States	5.6	5.6	5.9	6.1	6.0	7.9%	1.5%
Poland	4.6	4.5	5.1	4.8	4.9	6.5%	1.7%
Czech Republic	4.5	4.4	5.1	4.8	4.8	6.4%	1.8%
Austria	4.6	4.6	4.8	4.2	4.5	5.9%	-0.8%
Netherlands	4.0	4.0	4.2	3.7	3.8	5.0%	-1.7%
Italy	3.1	3.1	3.3	3.1	3.3	4.4%	2.0%
Switzerland	3.0	3.1	2.9	2.8	2.9	3.8%	-1.2%
Spain	2.4	2.5	2.8	2.6	2.8	3.7%	4.3%
Top 10 export markets – subtotal	45.8	44.7	47.1	45.0	45.2	59.7%	-0.3%
Other European countries – subtotal	27.8	27.7	30.2	29.2	30.5	40.3%	2.4%
Total German steel fastener exports worldwide	73.6	72.4	77.3	74.3	75.7	100.0%	0.7%
Total steel fastener exports from 28 European countries to global markets	170.6	176.1	189.7	188.1	197.8	100.0%	3.8%
Germany's share of European exports	43.1%	41.1%	40.8%	39.5%	38.3%	---	-2.9%

How Expanding Global Wind Power Demand Drives Germany's Fastener Supply Chain and Technical Requirements

(1) Wind Power Policies and Project Development Create Supply Chain Opportunities for Germany's Fastener Industry

The global energy transition and renewable energy policies continue to drive wind power development. Demand

Fig. 2.



for high-strength and specialty fasteners is stimulated through a chain of activities: electricity demand → wind farm investment → wind turbine production scheduling → component procurement → fastener orders. Competitive bidding is an important mechanism for advancing large-scale projects. In Germany, improvements in permitting procedures also contributed to an increase in the volume of onshore wind power capacity tendered in the first half of 2025. However, orders are affected by financing, certification, and grid connection schedules, meaning that procurement demand does not necessarily grow in line with installed capacity. **Market opportunities for German fastener suppliers span critical components such as towers, foundations, blades (Fig. 2), and drivetrain systems. While new wind farms prioritize high-volume supply and consistent quality, maintenance, component replacement, and life-extension upgrades for existing turbines also create opportunities for small-batch orders and rapid delivery.** As early-generation wind turbines enter their replacement cycle, suppliers with material qualification capabilities and technical service expertise can expand into full life-cycle services, increasing the share of high-value-added orders and strengthening their competitiveness.

(2) Fastener Applications in Critical Wind Turbine Components and Advanced Technical Requirements

Wind turbines are exposed to cyclic loads, vibration, and environmental corrosion over long operating periods. Consequently, fasteners used in critical areas such as tower flanges, foundation anchors, blade roots, and main shafts must meet stringent requirements for strength, fatigue resistance, and preload stability. Under the International Electrotechnical Commission's IEC 61400-1 standard, wind turbine design must account for loading conditions and structural safety. Fasteners used in critical joints must also be compatible with the overall turbine design to ensure fatigue performance, preload stability, and operational reliability. As wind turbines become larger and offshore installations expand, product qualification, process consistency, and quality traceability are becoming key barriers to entry in the high-end market. Yaw systems, pitch systems, and control equipment are also generating demand for a wider range of functional fasteners, increasing requirements for high-strength alloy steels, specialized coatings, and anti-loosening technologies. For offshore wind turbine support structures and connections, corrosion risks in marine environments must be considered. Corrosion protection design can refer to the offshore structural standards and technical guidance issued by DNV, with the applicability of each standard verified according to the specific component and operating conditions.

How the Trends Toward Larger and Offshore Wind Turbines Affect Technology Upgrade and the Competitive Environment of Germany's Fastener Industry

(1) Larger and Offshore Wind Turbines Raise Technical Barriers and Quality Qualification Requirements for High-End Fasteners in Germany

The global wind power industry is moving toward larger turbines and greater offshore deployment, increasing demand for high-strength, corrosion-resistant, and highly reliable fasteners used in towers, foundations, blades, and drivetrain systems. This is encouraging Germany's fastener industry to upgrade its capabilities in advanced materials, precision machining, and quality qualification. As turbine capacity, blade length, and tower height increase, critical joints must withstand more complex cyclic loads and fatigue stresses. ISO 898-1:2013 specifies the mechanical properties of carbon steel and alloy steel bolts, screws, and studs for defined sizes and conditions, including specified dimensions ranging from M1.6 to M39. However, it does not directly specify fatigue performance, corrosion resistance, or torque–clamp force characteristics. For critical applications such as tower flanges, foundation anchors, and blade roots, ISO 16047 can be used to test torque/clamp force characteristics. Combined with appropriate joint design, tightening procedures, and preload control, these measures can improve the reliability of critical connections.

The high salinity and humidity of offshore environments further increase requirements for corrosion resistance, coating quality, and hydrogen embrittlement risk management. ISO 4042 addresses coating requirements and hydrogen embrittlement risks for electroplated fasteners, while ISO 10683 specifies requirements for non-electrolytically applied zinc flake coatings. The latter can reduce the hydrogen embrittlement risks associated with electroplating, although appropriate material and process controls remain necessary. In addition, by aligning with the IEC's structural safety standards and DNV's offshore corrosion protection guidance, suppliers need to establish comprehensive quality traceability systems covering materials, heat treatment, thread accuracy, coatings, and inspection records. For German fastener manufacturers, these technical requirements increase R&D and equipment costs but also create barriers to market entry. **Companies with integrated capabilities in hot forging, thread rolling, heat treatment, specialized coatings, and product qualification can differentiate themselves through technology, reduce exposure to price competition, and capture greater added value in Europe's high-end wind power supply chain.**

(2) How Global Wind Power Supply Chain Restructuring Affects Germany's Fastener Industry and Its Competitive Position

As global wind power demand expands, Germany benefits from its mature manufacturing base, quality control capabilities, and favorable geographic position. Moreover, **because critical wind turbine fasteners are essential to structural safety, changing suppliers involves requalification procedures and quality risks. This favors established suppliers that have already passed customer qualification and demonstrated reliable delivery performance, helping them maintain long-term customer relationships.** Meanwhile, Germany's fastener industry faces high energy, labor, and environmental compliance costs, placing it under pressure from international price competition. The EU Net-Zero Industry Act incorporates sustainability and supply chain resilience into the evaluation criteria for certain tenders, increasing the importance of low-carbon manufacturing and supply chain transparency. However, it does not exclude suppliers from outside the EU. German manufacturers will therefore need to reduce production costs and international competitive pressures through process automation, digital quality traceability, improved energy efficiency, and the development of higher-value products. Strengthening technological differentiation and supply chain integration will also be essential to converting wind power market opportunities into tangible profits.

Conclusion: The Wind Power Transition Is Driving the Shift Toward Higher Value in Germany's Fastener Industry

Expanding global wind power demand and Europe's energy transition policies are creating potential market opportunities for German fastener manufacturers with advanced manufacturing capabilities, quality qualification expertise, and supply chain integration strengths. As wind turbines become larger, offshore installations expand, and demand for operation and maintenance services increases, high-strength, corrosion-resistant, and highly reliable fasteners are becoming increasingly important. Germany can build on its strengths in precision manufacturing, quality qualification, and industrial clustering to reinforce its position in the high-end wind power supply chain. Nevertheless, the industry continues to face pressure from energy costs, environmental compliance requirements, and international competition. Going forward, the industry's development will depend increasingly on a shift away from price-based competition toward technological innovation, low-carbon manufacturing, supply chain resilience, and full life-cycle services. Through digitalization and the development of higher-value products and services, Germany's fastener industry can turn growth in the global wind power market into sustainable competitive advantages and long-term profitability. ■

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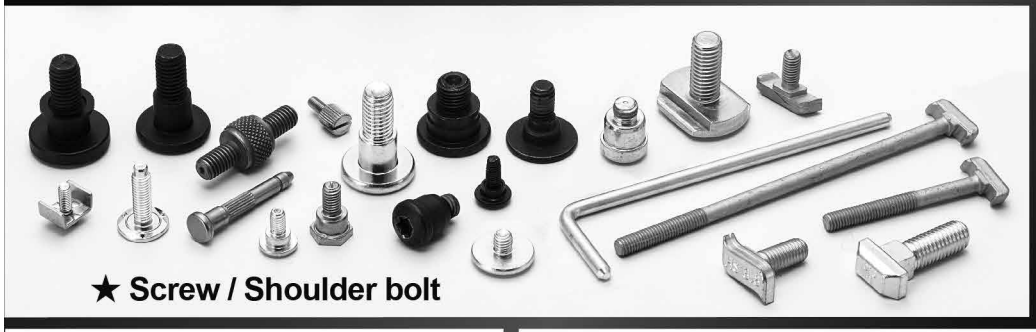
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