How the world’s strongest bolt was developed

Swedish premium stainless steel fastener company BUMAX® has drawn on Nobel Prize winning technology that revolutionised how chemists understand solid matter to develop the world’s strongest bolt.

**A premium fastener – far beyond standard**

With their production in central Sweden’s steel belt, premium stainless steel manufacturer BUMAX® produces what is now widely known as the strongest fastener in the world. BUMAX® Ultra has proven itself in various highly-demanding critical fastener applications around the world – providing optimal safety and reliability where standard fasteners are simply inadequate.

BUMAX® Ultra typically offers a yield strength of over 1,350 MPa, which is three times that of standard stainless steel class 70 fasteners (450 MPa) and more than double that of class 80 fasteners (600 MPa). The fact that BUMAX® Ultra can handle more than twice the load of a standard stainless steel fastener is a game changer for critical fastener applications by providing enhanced solutions that simply were not available a few years ago.

**Drawing on Nobel Prize winning technology**

BUMAX® capitalised on its own material technology knowledge and that of its premium stainless steel supplier, as well as its advanced

[Continued ...]
manufacturing techniques, to develop the world’s strongest bolt.

BUMAX® Ultra ensures ultra-high strength and good corrosion resistance by drawing on Nobel Prize winning quasi-crystalline precipitate technology. Materials Science Professor Dan Shechtman won the 2011 Nobel Prize in Chemistry for his work with quasi-crystals, which has fundamentally altered how chemists conceive solid matter.

The BUMAX® technique uses strain hardening followed by precipitation hardening, which significantly increases the yield strength of the stainless steel by ensuring the crystal structure reinforces the material. The entire BUMAX® Ultra range of fasteners are made at the BUMAX® factory in Åshammar, central Sweden.

**The strongest bolt in the world – and it’s stainless**

Stainless steel fasteners are often selected for their corrosion resistance properties, however reduced strength has historically been an accepted compromise of using stainless steel rather than carbon steel. BUMAX® Ultra has changed all that by providing ground-breaking solutions for highly demanding critical applications.

“BUMAX® specialises in the development of high-strength stainless fastener solutions – to ensure superior corrosion resistance, while exceeding the mechanical properties offered by carbon steel, standard stainless products and many high alloy fasteners,” explains Örjan Persson, Business Development Director at BUMAX®, “Our unique stainless steel fasteners such as BUMAX® Ultra have revolutionized the fastener market by far exceeding carbon steel in terms of yield strength.”

**Demanding applications**

Since its launch in 2014, the BUMAX® Ultra range has proven that it is capable of exceeding yield strengths of over 1,350 MPa on various applications, with good corrosion resistance and an operating range of between -50 and 400°C.

BUMAX® Ultra is designed for applications that require ultra-high strength combined with high ductility and fatigue resistance. BUMAX® Ultra applications include security lock systems, aerospace systems, high pressure applications, fueling systems.

**Application example: Lock manufacturer replaces carbon steel screws with BUMAX® Ultra**

A leading European lock and locking system manufacturer originally used a DIN 912, M3x4 8.8 carbon steel screw for the critical latch screw. Following breakages that disabled the entire locking mechanism, the manufacturer tested both 10.9 and 12.9 without solving the problem. The manufacturer then fatigue-tested BUMAX® Ultra, which survived 500,000 strokes without a single breakage – compared with carbon steel screws that only lasted 10,000 strokes. BUMAX® Ultra screws are now a critical lock component that helps avoid lock failure.
and semiconductor manufacturing equipment – all with excellent results. BUMAX® Ultra fasteners are increasingly used to replace high-strength carbon steel fasteners in critical applications with extreme requirements on strength, ductility and fatigue resistance. The very high strength to weight ratio in combination with BUMAX® Ultra’s good formability and ductility also make it a cost-effective fastener alternative to other lightweight materials such as Titanium.

Customized fastener solutions
All BUMAX® Ultra fasteners are custom made to meet the requirements of each specific application and can be delivered with different mechanical properties. “BUMAX® Ultra is an advanced engineering grade and we provide close technical support for customer projects in order to develop the optimal end solution,” says Persson. “Even yield strength exceeding 1,350 MPa is possible with BUMAX® Ultra, together with good corrosion resistance, formability and ductility.”

Application examples for BUMAX® Ultra:
- **Security lock systems**
  - excellent fatigue properties combined with strength.
- **Aerospace systems**
  - good fatigue, corrosion and strength properties and an alternative to titanium fasteners.
- **High pressure applications**
  - high strength requirement, with space limitations.
- **Pump and valve systems**
  - good fatigue properties when compared to high strength carbon steels.
Stainless steel fasteners for the most demanding marine applications

Örjan Persson, BUMAX® Business Development Director and Anders Söderman, BUMAX® Technical Director

High-strength and corrosion-resistant fasteners are essential in a variety of marine applications to promote safe, long-life, low-maintenance and cost-effective solutions – not least in the most demanding environments.

**Stainless steel – the optimal material for demanding marine applications**

Salty marine environments accelerate corrosion for any steel – with greater corrosion caused by increased salt concentrations and temperature. Stainless steel products are particularly useful in marine applications as they offer corrosion resistance.

As high salt concentrations can build up in areas where salt deposits cannot be rinsed away by rain water or maintenance, it is essential to select a suitable stainless steel grade to reduce the risk of corrosion. Stainless steel grades of A4 or 316 with a minimum 2.0% molybdenum content and a Pitting Resistance Equivalent Number (PREN) of approximately 25 or higher are recommended for marine environments. The PREN is a predictive measurement of a stainless steel’s resistance to pitting corrosion in chloride environments based on its chemical composition¹. For critical applications and longer life expectancy, a super austenitic, duplex or super duplex grade should be considered.

Stainless steels can also provide high strength and excellent fatigue properties. These properties can be essential in marine applications subject to vibration and dynamic loads, such as propulsion systems and off-shore wind turbines.

¹The most commonly used formula is PRE=%Cr+3.3x%Mo+16x%N.
In marine environments, cathodic corrosion protection is commonly used. Cathodic protection can cause hydrogen induced stress corrosion cracking (HISC) in ferritic or martensitic material. Crucially, austenitic steels are not sensitive to this type of corrosion phenomena, which is why they are widely used in marine applications.

**BUMAX® – beyond standard fasteners**

BUMAX® offers a wide range of fasteners to cope with any marine application. BUMAX® stainless steel fasteners are already used around the world in a variety of demanding marine applications, from thrusters and sub-sea cable connectors, to seawater filter fastening systems and cleaning equipment for sub-sea oil and gas wells.

BUMAX® fasteners have consistently proved they can deal with the most extreme marine applications – often where standard solutions simply cannot cope. The use of high-strength and corrosion-resistant stainless steel fasteners promotes safety, extends lifespan and reduces the need for maintenance – to reduce lifecycle costs as they simply last longer and require less maintenance than standard solutions.

BUMAX® products commonly used in marine applications include:

- **BUMAX® 88** – a premium A4 fastener with higher strength and better corrosion resistance than a standard A4 due to a minimum 2.5% molybdenum content and a nominal PREN of 27.
- **BUMAX® 109** – offers the same material as BUMAX® 88 but with higher strength.
- **BUMAX® DX 129** – a product with extremely high strength combined with a nominal PREN of 36, which provides very good corrosion resistance.
- **BUMAX® SDX 109** – the optimum choice for extremely demanding marine applications where corrosion resistance is a critical issue with a nominal PREN of 42. The product will never corrode under normal marine conditions. BUMAX® SDX can also be supplied in strength class 129.

BUMAX® fasteners have also proved to have very good fatigue properties compared with standard fasteners in A4-80. This applies to BUMAX® 88 but especially BUMAX® duplex grades that have significantly better fatigue properties compared with both austenitic stainless steel and carbon steel fasteners. The key to higher fatigue resistance is the premium raw materials used for BUMAX® fasteners, with minimal harmful inclusions and excellent surface properties. Rolled threads also enhance fatigue properties because of the compressive stresses created.

In addition, thread friction testing by third-party laboratories has demonstrated that BUMAX® products have lower thread friction as well as less variation in friction compared to competitor products. This significantly reduces the risk of galling, which can be an issue with standard stainless steel fasteners. Less variation in the friction coefficient also ensures correct clamping force, as incorrect clamping force is a major reason why standard fasteners fail.
Application example

**Vessel thrusters**

BUMAX® 88 bolts are used by a leading propulsion system manufacturer to fasten thruster propeller blades. The manufacturer tested various fastener solutions and found that BUMAX® 88 provide the best corrosion resistance, excellent fatigue resistance, improved assembly (less friction and galling) and overall premium quality. The thruster is also protected against corrosion by sacrificial anodes. The bolts are critical as a fastener failure would potentially result in high repair costs and safety risks.

Application example

**Cleaning equipment for oil and gas wells**

BUMAX® DX 129 is used to fasten sub-sea equipment for cleaning oil and gas wells. Regularly using such equipment to clear wells of debris is essential in optimising production and avoiding potentially costly issues. BUMAX® DX 129 fasteners were selected as they are the only fastener solution capable of dealing with the extreme sub-sea environments – including very high temperatures and pressures, combined with exposure to salt water and hydrogen sulfide. DX 129 also ensures a strength class of 12.9, which is essential in this extreme environment.

Application example

**Sub-sea cable connectors**

BUMAX® SDX 109 bolts are used to fasten the cable fiber optic connectors on the sea bed that are used to regulate sub-sea oil and gas wells. As the connectors are at a depth of up to 3,000m, it can be expensive to repair or replace critical elements such as fasteners, which simply cannot be allowed to fail. BUMAX® SDX 109 was selected as the very best option for corrosion-resistant and maintenance-free fasteners in such demanding marine environments. Some customers have previously used titanium fasteners for such applications, although as these are expensive, BUMAX® SDX 109 make significant cost savings.

Application example

**Seawater filter fastening systems**

BUMAX® LOCK in duplex material and bolts in BUMAX® SDX 109 have been used to fasten two seawater filter fastening systems, 22 metres and 15 metres in diameter respectively, for a European nuclear power plant. Following customer tests on various high security wedge locking systems on the market, BUMAX® LOCK, which is a full metallic lock nut, together with BUMAX® SDX bolts were chosen. The high-strength and low-corrosion BUMAX® solution will meet the strength requirements and cope with the corrosive seawater environment throughout each of the filter’s 30-year design lifespan.

The BUMAX® solution also reduced the number of individual components required, and the free-spinning nature of BUMAX® LOCK allows a quicker and more simplified installation process. BUMAX® LOCK has a special thread design that will not cause it to disassemble when subjected to vibration and provides a constant preload. This ensures that the filter will continue to provide critical cooling to the nuclear reactor to safeguard its safe operation.
What is 410 Stainless Steel and what makes it different to 304 & 316?

From the desk of Peter Hobson

What is 410 Stainless Steel and what makes it different to 304 & 316?

Stainless steel 410 is a basic martensitic grade (hard crystalline structure). Unlike austenitic grades such as 304 & 316 its properties can be altered by heat treatment.

Grade 410 stainless steels are resistant to hot gases, steam, food, mild acids and alkalines, fresh water and dry air. These steels obtain maximum corrosion and heat resistance through hardening. However, grade 410 steels are less corrosion resistant than austenitic grades. They are not recommended for use in salt environments such as coastal and marine applications.

Grade 410 is used mainly for self drilling & tapping screws where the higher hardness assists in the drilling action. Bi-metallic screws (Our part number prefix “T4X” & “T6X”) where the drilling point is a high carbon steel “friction welded” to the 304/316 shank are recommended in coastal and marine environments. These are priced at a higher price point than screws manufactured from 410 stainless steel.

Although 304 & 316 stainless steel fasteners can be mildly magnetic, 410 stainless fasteners are highly magnetic. The force of attraction of a magnet is easily differentiated between the grades.

### Composition

<table>
<thead>
<tr>
<th>Grade</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
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<tbody>
<tr>
<td>410</td>
<td>min.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.5</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>max.</td>
<td>0.15</td>
<td>1</td>
<td>0.04</td>
<td>0.03</td>
<td>13.5</td>
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### Grade Specification Comparison

<table>
<thead>
<tr>
<th>Grade</th>
<th>UNS No</th>
<th>Old British</th>
<th>Euronorm</th>
<th>Swedish SS</th>
<th>Japanese JIS</th>
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<tbody>
<tr>
<td>410</td>
<td>S41000</td>
<td>410S21</td>
<td>56A</td>
<td>1.4006</td>
<td>X12Cr13</td>
</tr>
</tbody>
</table>

Our current range of fasteners in 410 stainless steel:
On Location

Island in the sun
FRASER ISLAND, QLD

Not a bad view HEC!
Hobson Engineering are the trusted fastener for this pier with Stainless Screws and Class 4.6 bolts.

Norwest Private Hospital
BELLA VISTA, NSW

Only the most reliable quality fasteners are used in the Maternity Ward of Norwest Private Hospital.
On Location

La Trobe University Bendigo Campus
BENDIGO, VIC

Newly installed deck at the Latrobe University Bendigo. This is part of the Library Upgrade.
The deck was installed using 30,000 Hobson vmaX® Self Drilling Stainless Steel Decking screws.
The end user was very impressed with the performance of vmaX® screws and believes by using vmaX® screws, they saved many hours of labour, due to not having to pre-drill any holes, even in Turpentine Hardwood decking boards.

Mooloolaba Beach
MOOLOOLABA, SUNSHINE COAST, QLD

Yet another deck, decked out in Hobson quality fasteners.
SAFETY WASHERS
EXPERTISE & TECHNOLOGIES

Advantages

- High resistance to vibration due to positive locking of the serrations.
- Concentrical force transmission and uniform axial load eliminate bending torques and deformation of the bolt stem.
- The design of the serrations prevents friction and damage to components when tightening.
- Extremely high safety against loss of pretension force and loosening.
- Wide variety for materials and different finishes.
- The closed ring form results in high degree of pretensioning, while avoiding burst-open effect.
- Development and design of the washers take place on the basis of the screw geometrics, tightening torque as well as the constructive circumstances.
- Also applicable for clearance holes (safety washer is necessary on both sides).
- Applicable for elongated holes (using type VS).
- Equivalent locking effect like wedge-locking washers.
- DIN EN 16984 – Calculation

Characteristics Summary

<table>
<thead>
<tr>
<th>Type S</th>
<th>Type VS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Sizes</td>
<td>M 1.6 to M 36</td>
</tr>
<tr>
<td>Property Classes</td>
<td>up to 8.8</td>
</tr>
<tr>
<td>Standard Materials</td>
<td>C60S (1.1211) X5CrNi18-10 (1.4301)</td>
</tr>
<tr>
<td>Standard Surfaces (C60S)</td>
<td>blackened Gal.Zn8 + passivation Zn8M + passivation</td>
</tr>
<tr>
<td>Tolerances</td>
<td>h14/H14 acc. to DIN 286-2</td>
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</tbody>
</table>

Tightening torques for original Schnorr® Safety Washers

<table>
<thead>
<tr>
<th>Nominal size</th>
<th>Tightening Torque $M_T$ in Nm</th>
<th>Strength Grade</th>
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<tbody>
<tr>
<td></td>
<td>$\mu_k = \mu_G = 0.14$</td>
<td></td>
</tr>
<tr>
<td>M4</td>
<td>3.6</td>
<td>5.3</td>
</tr>
<tr>
<td>M5</td>
<td>7.20</td>
<td>10.5</td>
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<tr>
<td>M6</td>
<td>12.4</td>
<td>18.2</td>
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<tr>
<td>M7</td>
<td>20.6</td>
<td>30.3</td>
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<tr>
<td>M8</td>
<td>30.0</td>
<td>44.1</td>
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<td>M10</td>
<td>59.4</td>
<td>86.9</td>
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<tr>
<td>M12</td>
<td>102.3</td>
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<tr>
<td>M14</td>
<td>162.8</td>
<td>239.8</td>
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<tr>
<td>M16</td>
<td>253.0</td>
<td>371.8</td>
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<tr>
<td>M18</td>
<td>361.9</td>
<td>515.9</td>
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<tr>
<td>M20</td>
<td>510.4</td>
<td>727.1</td>
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<tr>
<td>M22</td>
<td>697.4</td>
<td>994.4</td>
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<td>M24</td>
<td>877.8</td>
<td>1249.6</td>
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<tr>
<td>M27</td>
<td>1293.6</td>
<td>1841.4</td>
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<tr>
<td>M30</td>
<td>1756.7</td>
<td>2501.4</td>
</tr>
<tr>
<td>M33</td>
<td>2377.1</td>
<td>3385.8</td>
</tr>
<tr>
<td>M36</td>
<td>3055.8</td>
<td>4352.7</td>
</tr>
</tbody>
</table>

All specifications are valid for Original SCHNORR® Safety Washers “S” and “VS” made of C60S (1.1211) and are non-binding approximate values.
Correct usage of safety washers

The Original SCHNORR® Safety Washer is only able to obtain its full effectiveness as a bolt locking device if it is used correctly.

Incorrect usage of safety washers

To obtain the maximum locking effect of the Original SCHNORR® Safety Washers, we recommend:

- Not to use them in combination with a flat washer.
- Not to use them up-side down.
- Not to use them stacked.

FAQ

What are the effects of different initial forces?

Tests, where bolts had been tightened only to 75% instead of 100% of the initial force corresponding to the minimum required bolt tension, produced poorer results. A certain percentage of the joints came loose. This effect was even more evident with only 50% initial force. Hence it can be concluded that fastening up to 100% of the force corresponding to the minimum required bolt tension acc. DIN ISO 898 T1 is essential for a good connection.

What effects do SCHNORR® Safety Washers have for the initial torque?

To reach the same initial force when using a SCHNORR® Safety Washer type “S”, the initial torque has to be about 10% larger than for a bolt without a securing device. The same applies to SCHNORR® Safety Washers type “VS”. For the use of zinc plated safety washers, the initial torque does not have to be raised, because the additional friction induced by the serrated surface of the safety washers, is compensated by a certain lubrication effect from the zinc coating. The variation in initial torque is not greater with use of SCHNORR® Safety Washers than in bolted connections without securing device.

What is the effect of the hardness of the different parts?

With increasing hardness of the base surface in the joint, the “biting” effect of the serration of the safety washers, which results in partially elastic and partially plastic deformation, decreases. The securing performance is directly correlated with this effect. Since the hardness of SCHNORR® Safety Washers is 39–45 HRC (380–450 HV30), this applies only for higher hardness of the contact surface. We recommend to use the high duty type “VS” in combination with hardened surfaces and to tighten the bolt up to 100% of the force corresponding to the minimum required bolt tension.

What is the effect of a surface treatment on the securing effect?

The best securing effect is reached with a safety washer with a black surface. But zinc coated safety washers can also secure bolt joints perfectly if the bolt is tightened with the appropriate initial force. In this case it is necessary to apply no less than 100% of the minimum required bolt tension force.

What happens on a slot?

When tightened up to 100% of the minimum required bolt tension force, bolts without securing device do not loosen, but the bolt head is being damaged considerably, and a relatively high initial torque is required. In combination with a SCHNORR® Safety Washer type “VS”, the required initial torque is about 25% lower, and the damages on the bolt head are minor. The securing effect is high.

Can SCHNORR® Safety Washers be used several times?

When a bolt joint secured with SCHNORR® Safety Washers is being unscrewed and tightened again, the securing effect does not diminish. The initial torque decreases only slightly, i.e. the originally applied momentum produces a slightly higher initial force. Ergo SCHNORR® serrated safety washers can be used two or more times without any restrictions.
Bumax®
THE WORLD'S STRONGEST STAINLESS STEEL BOLT