

BOLTED



COUPLING CHALLENGES

**ARGUABLY THE MOST DEMANDING
OF ALL BOLTING APPLICATIONS**

TIME TRAVEL
GETTING
WIND OF
THE FUTURE

HIGH-SPEED STUDIES
ENGINEERS
RACING THROUGH
UNIVERSITY

CALIFORNIA DREAMING
TEN LANES OF
BRIDGE BUILDING
MAGIC

ON THE RIGHT TRACK
NEW MATERIALS
PICKING UP
SPEED

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Expander System

*the global leader in pivot technology
for first-fit (OEM) & aftermarket*

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- 10 years or 10,000 hours function warranty
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- Quick turnaround for design and delivery

The Nord-Lock Group is a world leader in secure bolting solutions. We are pleased to welcome **Expander System** into our wide range of innovative technologies, which includes Nord-Lock wedge-locking solutions, Superbolt multi-jackbolt tensioning and Boltight hydraulic tensioning.



NORD-LOCK



SUPERBOLT



BOLTIGHT

For more information:

www.nord-lock.com • www.expandersystem.com



Bolted magazine is published by Nord-Lock Group and strives to increase knowledge about bolt assemblies. The Nord-Lock Group is a world leader in bolting technologies and offers a wide product portfolio, including Nord-Lock wedge-locking solutions, Superbolt tensioners, Boltight hydraulic tensioning and Expander® System. These unique solutions withstand vibration and dynamic loads. For further information visit www.nord-lock.com

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EDITOR-IN-CHIEF:

Carin Esberg Lagerstedt
carin.lagerstedt@nord-lock.com

CO-EDITOR:

Ewa Sewerynek
ewa.sewerynek@nord-lock.com

PRODUCTION:

Spoon, Malmö
www.spoonagency.com

EDITORIAL MANAGER:

Ulf Wiman
ulf.wiman@spoon.se

LANGUAGE COORDINATOR:

Kristin Ludvigsson
kristin.ludvigsson@spoon.se

TRANSLATIONS:

Språkbolaget www.språkbolaget.se

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Feel free to contact us with any comments:
bolted@spoon.se

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NORD-LOCK®

Get ahead with our bolting seminars

Recently, I had the pleasure of participating in one of the Nord-Lock seminars on bolted joints at a customer's production site. The interest, learnings and good discussions that these seminars produce never cease to amaze me. There is always valuable knowledge transfer about specific applications and what they require. While our products and technologies are central, the focus is much broader: why do bolted joints come loose? What are the options for bolt securing, and so on.

If you are interested in participating in a seminar, or have a specific challenge or bolting topic you would like to explore, just let us know.

In this issue of *Bolted*, we continue to explore the technology of Boltight. All its products have been developed from scratch, making the design and manufacturing second to none within hydraulic tensioning. Did you know that founder Fred Heaton and his team developed their seal design to exhibit as durable yet frictionless performance as possible? Or that the weight of the bridge has been minimised, and that the design makes all parts easy to use? It is the combination of advantages that provides superior customer

value and makes Boltight the best option within its field. Learn more about Boltight and hydraulic tensioning in the Experts section (page 7) and see how Boltight tools are used for the new eastern span of the San Francisco-Oakland Bay Bridge (page 4).

In the theme article of this issue, you will get interesting and useful insights into bolting couplings, an application that provides a multitude of challenges (page 8). And don't miss the story about how 20 years of wear and tear on wind turbines can be simulated in only six months (page 12).

Thank you for reading!


CARIN LAGERSTEDT
MARKETING MANAGER



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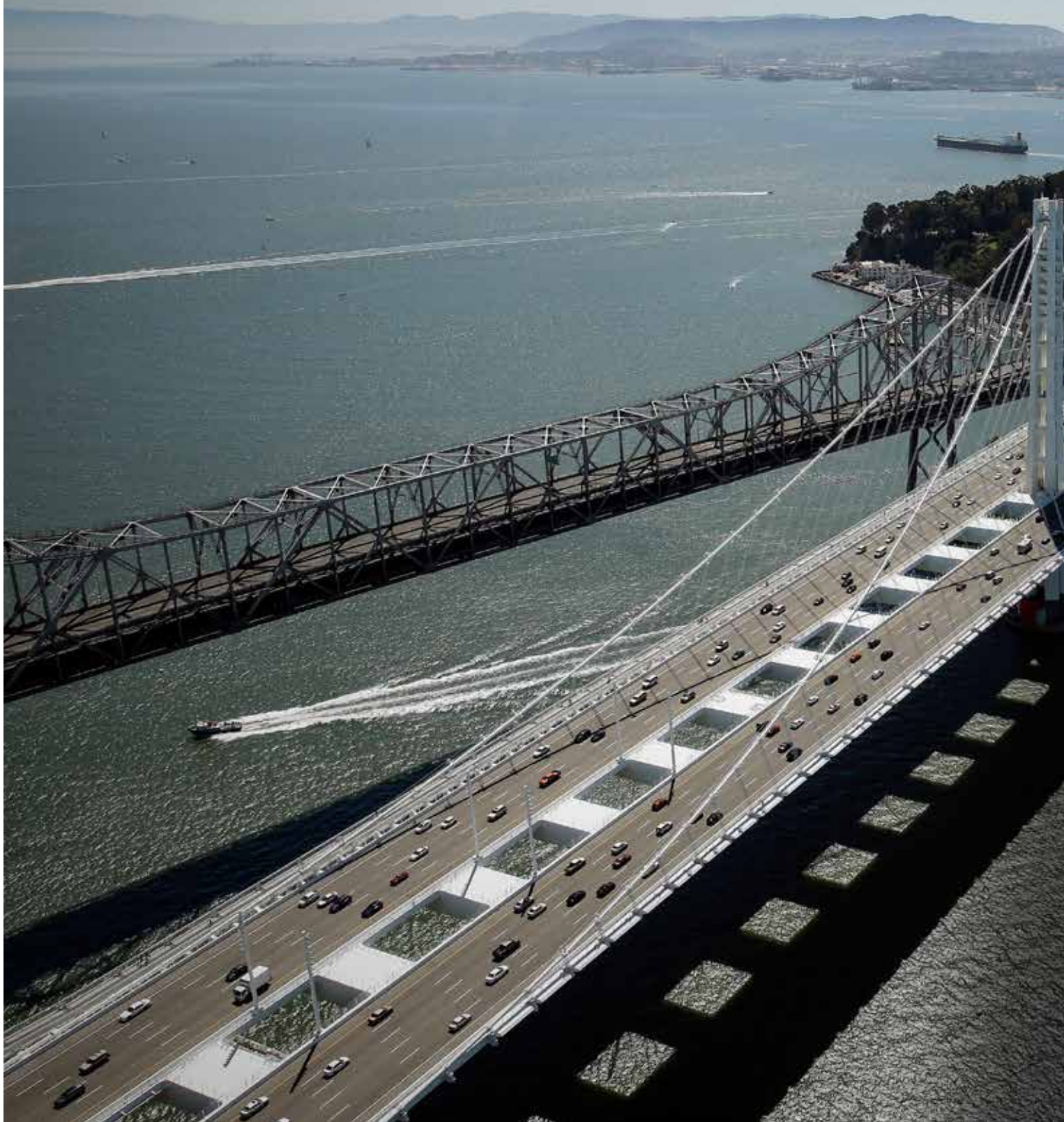
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SECURED BY THE NORD-LOCK GROUP

WORDS: CHAD HENDERSON PHOTO: GETTY IMAGES





SELF-ANCHORED SUSPENSION SPAN (SAS)

The new east span of the San Francisco–Oakland Bay Bridge is the world's longest self-anchored suspension span, 620 metres. The main cable – about 1.6 km long – starts at one end of the span, goes up to the tower, down the other side where it wraps around the deck; then goes back up to the tower and down the other side. It is connected to the deck by suspender ropes, which are kept in place by cable bands around the main cable. The bolts for these cable bands were tightened using Boltight hydraulic bolt tensioners.



TIGHTENED JUST RIGHT

PROJECT: SAN FRANCISCO–OAKLAND BAY BRIDGE		APPLICATION: REPLACING THE BRIDGE'S EAST SPAN	CONTRACTORS: AMERICAN BRIDGE/FLUOR
OVERALL PROJECT COST: \$6.4 BILLION	BOLTIGHT SOLUTION: HYDRAULIC BOLT TENSIONING OF CABLE BAND BOLTS		

ENGINEERING PROJECTS don't get much bigger. A suspension bridge with only one tower, on limited bedrock, with ten lanes of traffic that has to be able to withstand the largest earthquake expected over a 1,500-year period.

In a 2006 joint venture contractors American Bridge and Fluor got the assignment to build the new eastern span of the San Francisco–Oakland Bay Bridge, the largest public works project in California's history.

Most suspension bridges have multiple towers, explains Brian A. Petersen, Vice President – Western Region, American Bridge: "This bridge span only had a single tower and is essentially anchored on itself. The main cable is seated in the deck, which is an extremely involved structural engineering design achievement."

A total number of 114 cable bands, secured around the main cable to keep the suspender ropes in place, needed to be bolted with exactly the right amount of tension. High-strength rods, which secured both the main tower as well as the bearings and shear keys at the bridge's east end, required a high-capacity jacking system to obtain the large clamping force that the bolts were required to achieve. Over 2,000 fasteners were tensioned using the Boltight hydraulic bolt tensioners.

"Boltight's system elongates the rod and tightens the nut, but never turns the rod, which was an important design requirement," says Petersen. "Their equipment allowed us to properly tension the high-strength rods and bolts in a very limited space. The equipment had a high level of accuracy, and our workers could easily carry it around. No other manufacturer could meet our requirements." ■

WASHERS SAFEGUARD TRANSPORT SAFETY

CUSTOMER: THE HOYER GROUP	NUMBER OF TANK CONTAINERS: OVER 30,000 WORLDWIDE	NUMBER OF TANK TRAILERS WORLDWIDE: MORE THAN 2,000
PRODUCT USED: NORD-LOCK STAINLESS STEEL AND X-SERIES WASHERS		APPLICATION: TANK CONTAINERS FOR LIQUID TRANSPORT

TO AVOID ACCIDENTS that would put people and the environment in harms way, it is crucial that the transport of liquids is managed safely and efficiently.

Started in Hamburg more than 70 years ago, the Hoyer Group has vast experience in handling chemical products, foodstuffs, gas and mineral oil. Today this global market leader in moving liquids by road, rail and sea operates over 30,000 tank containers and over 2,000 tank trailers worldwide. On the recommendation of a customer, the Hoyer Group has started to employ Nord-Lock stainless steel washers on their tank containers used on the European continent.

Frits Bakker works at the Engineering department at Hoyer Nederland BV in Rotterdam. "We faced a problem with valves on gas containers," he explains. "A customer advised us to try Nord-Lock washers. Using these washers and a different seal material solved the problem. After this, we started to fit them on the bottom valves of our tank containers."

The Hoyer Group will be using the Nord-Lock stainless steel standard washer, as well as the X-series version. They have a standard guideline to fit them on particular parts during maintenance. According to Bakker, the Nord-

Lock washers help the Hoyer Group to avoid critical situations. He says that, "Obviously on tank containers it is vital that leakages don't occur. In this respect, the washers are very reliable."

ALASTAIR MACDUFF



PHOTO: THE HOYER GROUP

SUPERBOLT SOLUTION SAVES THE DAY IN OMAN

CUSTOMER: AMPEGON ANTENNA SYSTEMS	END CUSTOMER: BRITISH BROADCASTING CORPORATION (BBC)	PRODUCT USED: SUPERBOLT CY-M36 X 4/W MULTI-JACKBOLT TENSIONERS
APPLICATION: GEARBOX IN ROTATABLE ANTENNA	LOCATION: BBC RADIO TRANSMITTING STATION, A'SEELA, OMAN	



PHOTO: AMPEGON ANTENNA SYSTEMS

NORD-LOCK SUPERBOLT tensioners came to the rescue when a windstorm damaged a broadcasting antenna structure in the Oman desert. German company Ampegon Antenna Systems were responsible for fixing the drive of a rotatable antenna, which is owned by the BBC.

Ampegon have over fifty years experience in providing high-performance antenna and mast systems for radio broadcasting. Their speciality is a rotatable short wave antenna system with a steel structure weight of 200 tonnes. One of these 80 metres high and 80 metres wide structures was installed on the BBC facility in Oman in 2000. In June 2010, a cyclone destroyed one of the gearwheels in the rotatable joint, which facilitates the rotation of one of the upper parts of the structure.

The antenna is an important part of the BBC's broadcasting capabilities in Oman, allowing worldwide radio transmissions. How-

ever, a quick fix was to be delayed by lengthy legal and budgetary discussions. After finally starting the repairs, Ampegon looked to a solution for pre-tensioning the bolts, fixing the gearboxes to the tubular shaft without the temporary import of hydraulic tensioning equipment. It was then that they turned to Nord-Lock in Switzerland, who supplied Superbolt CY-M36x4/W multi-jackbolt tensioners. These were installed into replacement gearboxes at the site in May 2015.

According to Christoph Fischer, Ampegon's Project Manager in Oman, the BBC are extremely happy with the Superbolt solution. "It was a complicated process to lift the gearboxes out of the steel tower and replace them. However, the Superbolt tensioners are high strength, reliable and were easy to install. The results of the project have been to everyone's satisfaction."

ALASTAIR MACDUFF



JOHN RICHARDSON
FIELD APPLICATIONS
ENGINEER



DAVID WALKER
SENIOR PROJECTS
ENGINEER



ASK THE EXPERTS

Do you have a question about bolt securing? Put the Nord-Lock Group experts to the test.

Getting the most out of fasteners

Q: Can I re-use bolts?

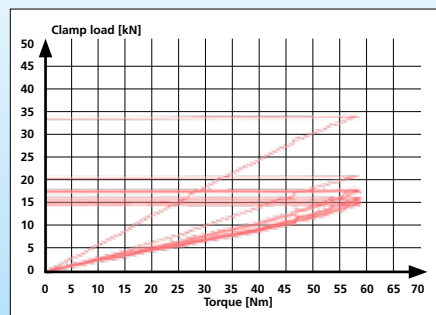
A: Before you re-use bolts, you should always consider the security level of the assembly and economic factors. Operators often lack important information, such as if the assembly working load or working temperature have been exceeded. As fatigue cracks are difficult to detect, the use of a new bolt (screw, nut and washer) is often recommended for security and legal reasons. You can re-use bolts:

- If re-usability has been specified by the assembly designer
- If a bolt failure does not endanger its environment, for example the full structure, the safety of operators or others. The assembly is not critical.
- For temporary/emergency use. A periodic control is recommended.

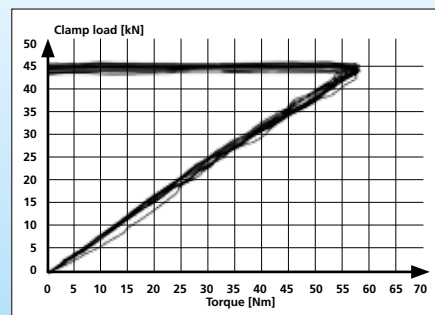
Before re-using threaded fasteners, always make a visual inspection of the head and/or nut for signs of damage or corrosion. Check that the coating on coated fasteners is not damaged or worn away. Ensure that there is no permanent deformation of the threads by running a new nut over the thread engagement length of the screw. Inspect the fastener shank for signs of reduction in diameter "waisting", indicating that the yield strength of the fastener has been exceeded.

Clean the internal and external threads and

Unlubricated



Lubricated



The diagrams show the relationship between Torque and Clamp Load, an M12x1.75 Property Class 8.8 bolt and a Grade 8 nut, tightened to 58Nm 10 times. The lubricated installation (right) was lubricated before the first test only. The average clamp load for the un-lubricated installation was 18.2kN with a deviation of +/- 40.3 %. The result for the lubricated fastener has an average clamp load of 44.9kN with a deviation of +/- 2.5%.

all contact areas. Using the same or similar tightening condition as on the initial installation – such as torque level, tool class or lubricant type – ensures that the same clamp load is achieved.

If the fastener is initially assembled unlubricated, the surfaces of the bearing area and threads will degrade under pressure when untightening, increasing the coefficient of friction

between these surfaces. Tightening on re-use to the initial torque value will result in a reduced clamp load, because of the higher coefficient of friction of these surfaces. Subsequent re-use will progressively reduce the clamp load and then be consistent at a low preload and a lot of problems could take place, such as fatigue, vibration or joint separation.

JR

Hydraulic bolt tensioning tools

Q: What are the key advantages of hydraulic tensioners?

A: A hydraulic bolt tensioning tool provides a quick, easy and safe method for tightening large diameter bolts to high and accurate preloads. It does not use torque or require forceful turning of the nut or bolt, like impact wrenches, flogging spanners or hydraulic torque wrenches, where friction is a common enemy.

A hydraulic bolt tensioner is an annular jack, which fits over the bolt and nut to be tightened. The jack pushes against the bolted joint and pulls on the end of the bolt. Because the force produced by the jack is applied directly to the end of the bolt, a tension equal to the load generated by the jack is developed in the shank of the bolt. With the jack applying tension, it is possible to rotate the nut with zero torque until it is tight. The load applied by the

jack is then relaxed and a high percentage, depending on the length of the bolt and its diameter, is retained in the shank of the bolt.

Hydraulic bolt tensioning provides:

- **Accuracy** – very high bolt load tolerance accuracies, often 5% or better. No frictional losses to consider nor need for lubrication. Easy to calculate load transfer and to prevent overload.
- **Speed** – the tools are remarkably fast to install and operate.
- **Simultaneous tensioning** – multiple bolt tensioners can be hydraulically actuated at the same time.
- **Uniformity** – tensioning several bolts at the same time guarantees the same applied load to each bolt.
- **Safety** – no pinch points or reaction issues. The



safety engineered into Boltight systems surpasses the industry safeguards.

- **Versatility** – using adaptor kits, one tensioning kit can often be used to cover a large variety of bolting sizes.
- **Cost efficiency** – combining the factors above, hydraulic bolt tensioning provides operational value for the customer.

DW



COUPLING



CHALLENGES & THE EVOLUTION

Couplings can be found in many critical applications and represent one of the most challenging bolted joints to secure. And as machines continue to become bigger and more powerful, the demands on couplings become even greater. →

WORDS:
NIC TOWNSEND

PHOTO:
NORD-LOCK, GETTY

ILLUSTRATIONS:
JUSTUS HULTGREN



COUPLINGS ARE AS OLD as industrialisation itself with even early simple machines, such as cotton mills and windmills, needing some way of connecting shafts. However, ever since the invention of the steam turbine back in 1884, shaft couplings have become essential in the power generation and shipping industries. As both turbines and shipping vessels have increased in size, so too has the amount of power and torque that needs to be transmitted. This in turn has greatly increased the demands on shafts and couplings, and in the case of bolted couplings, on the bolts themselves.

"In the power generation and marine industries, couplings have always been there and they really haven't evolved much," says Martin Walsh, an engineer with over 30 years experience working with large-scale bolted couplings. "If you look at a coupling from 60-70 years ago, it is pretty much the same design and concept as today. However, the engineering behind them has evolved a lot. Bolts in particular is an area where couplings have become a lot more sophisticated and this has allowed smaller couplings to transmit more torque."

ONE OF THE MOST important functions of a bolted coupling is to maintain shaft alignment. In marine applications, where shafts typically turn at low speed, any misalignment will cause vibration, which in turn puts unnecessary loading on the bearings. In power generation applications, where rotation can be as high as 3,600 rpm, even the slightest vibration or uneven loading is unacceptable and would severely limit the turbine's ability to run at full power. For this reason, a lot of time and resources are invested in optimising shaft alignment.

"The expanding sleeve bolt has probably been the biggest single advance in accuracy over the past 30 years."

STEVE BROWN, GLOBAL PRODUCT MANAGER – EXPANSION BOLTS, NORD-LOCK GROUP



"Once you've achieved the alignment, then the bolts need to hold it as it was set and maintain that alignment in service," says Walsh. "At some point in the future, you will take those bolts out and disconnect the shaft. When you put it back together, you want it back to exactly where

connection. But the amount of torque that can be transmitted through friction is severely limited and excessive torque can lead to slippage and misalignment. The resulting micro movements and uneven loading can then lead to damaged bolts and bores. The coupling therefore needs to be rebuilt and shaft alignment re-established.

In theory, fitted bolts, which fill the bore, can offer greater torque capacity, since torque is then driven through direct shear across the cross-section of the bolt. In practice it is difficult to achieve a truly fitted bolt, since the bolt's diameter will reduce as it is tightened. This creates a gap between the bolt and the bore, leading to the same problems of slippage and bolt failure.

This need to establish and maintain shaft alignment, even after a coupling has been disassembled and reassembled again, has led to the increased use of expanding sleeve bolts. Since expanding sleeve bolts

expand into the bore, they can ensure a truly fitted bolt and a far more even load distribution. This eliminates movement and slippage, so that shaft alignment should automatically be re-established once the expanding sleeve bolts are reinstalled.

"The expanding sleeve bolt has probably been the biggest single advance in accuracy over the



Expanding sleeve bolts ensure a truly fitted bolt.

it was before because you've already invested a lot in getting the alignment right."

FOR MANY YEARS the most common bolting solution was standard through bolts, which are relatively cheap and readily available. A bolt is simply inserted through the bore and tightened with nuts on either end to create a friction con-



C.A. PARSONS "TURBINIA"

In 1884, British engineer Sir Charles Algernon Parsons invented the first steam turbine.

His first model only generated 7.5 kW of electricity, but it demonstrated huge potential for generating electricity and for powering ships. In 1893, the Parsons Marine Steam Turbine Company was set up and in order to demonstrate the capabilities of the new technology, began developing the experimental vessel Turbinia.

The new ship was equipped with three axial-flow turbines fitted to three shafts, with each shaft driving three propellers. On completion in 1894, the Turbinia was the fastest ship in the world reaching speeds of up to 34 knots (63 km/h) – in comparison the Royal Navy's fastest vessels could only reach 27 knots.

In 1897, the Turbinia turned up unannounced to the Navy Review for Queen Victoria's Diamond Jubilee, and in front of royalty and senior Navy figures, it was able to clearly demonstrate its superior-

ity in speed and power. Within two years, Parson's turbines were adopted by the Royal Navy and shortly afterwards used to power transatlantic passenger ships.

Sir Charles Algernon Parsons' designs also saw steam turbines quickly scaled up, making it possible to generate cheap and plentiful electricity. In 1899 the first megawatt turbine was built in a power generation plant in Germany, and within Parsons' lifetime, his invention was adapted by all major power stations in the world. ■



Built in 1894 with three axial-flow turbines, Turbinia was at the time the world's fastest ship.

past 30 years,” says Steve Brown, Global Product Manager – Expansion Bolts, Nord-Lock. “They offer many pros and little in the way of cons – ease of installation, accuracy of fit, ease of removal, regaining of alignment and with correctly prepared holes, regaining of concentricity and re-usability.”

A KEY FACTOR driving the development of bolted couplings has been the evolution in engineering analysis. “70-80 years ago, couplings and bolts were over-engineered and bigger than they needed to be, as engineers erred on the side of caution,” says Walsh. “It was a situation that existed in many industries because the ability to do sophisticated calculations and simulations was not available.”

Now many OEMs have the ability to test the affects of temperature, different materials and operation conditions using computer modelling and simulations. Due to the complexity of rotating couplings, the finite element method (FEM) is becoming increasingly common for identifying weak points and torque tolerance of specific installations. Shear tests have also been used successfully to demonstrate the physical limitations of different bolting solutions.

“THERE IS STILL scope for further analysis and it would be helpful to see exactly how the newer design of bolts with expanding sleeves compare to the older bolts when it comes to transmitting higher torque,” adds Walsh. “Having a full FE analysis could be a significant advantage since it shows the potential for reducing the number of bolts and size of the coupling, particularly in industries such as wind turbines, where they tend to avoid bolted couplings due to space restrictions.”

The need to design smarter and smaller couplings will continue to be important as turbines and shipping vessels keep on growing in size and output, and need to transmit even more torque. ■

EXTREME LEVEL OF TORQUE CAN CAUSE FRACTURES



Choosing the right bolts for hydro power turbine shaft lines can significantly reduce stress concentrations and micromovements.

Due to their sheer size, turbine shaft lines in hydro power plants generally consist of several sections that are bolted together (couplings). Since the level of torque can be extremely high, coupling bolts are critical and often require large and expensive tooling for installation and maintenance. During operation, vibrations, micromovements and even bolt failures, can be costly, dangerous and time consuming.

Recently a hydro power plant in Switzerland asked Nord-Lock for assistance after discovering fractures in the shaft line. After undertaking a finite element (FE) simulation, Nord-Lock was able to identify stress concentrations and micromovements in the couplings.

NORD-LOCK RECOMMENDED expansion bolts as a solution, and conducted another FE simulation in order to determine the effects of the

optimized design. Stress concentrations were reduced and micromovements were virtually eliminated. Having demonstrated significant improvement, the operators decided to test the expansion bolts for one year.

During the testing phase, expansion bolts lived up to the prediction of the FE simulation. At resonance, the stress amplitude was reduced from 170% to 118% nominal torque. Stresses were reduced to below fatigue limit and micromovements reduced to under 0.002mm – well below the allowed limit. In fact the expansion bolts proved so successful that the one-year trial was ended after only three months and expansion bolts were immediately installed on all four shafts lines.

As a result, the hydro power plant has been able to save money from reduced maintenance costs and increased availability of the plant. ■

LET'S STICK TOGETHER



The need to assemble components in bolted joints goes way back. For long the through bolt was the standard threaded fastener. It is inserted through the bore and tightened with nuts on either end to create a friction connection. Excessive torque may lead to slippage and misalignment, which in turn can lead to damaged bolts and bores.

The expanding sleeve bolt is a more recent invention, which overcomes these problems. It expands into the bore and ensures a truly fitted bolt along with more even load distribution. It also simplifies installation and removal as well as retrofitting.





THE WIND TURBINE TIME MACHINE

With the sector growing globally every year, the wind energy industry is looking to use less material for producing big wind turbine parts. A German project is testing new construction methods, simulating 20 years of wear and tear in just a fraction of that time.

WORDS:
ULRICH SCHAMARI

PHOTO:
FRAUNHOFER, 123RF



COST PRESSURE on the growing wind energy industry makes intensive testing necessary. Consistent research on cost reduction methods is also required to strengthen wind power as an alternative, long-term energy source without subsidies.

Helping clients such as manufacturers of wind turbine generators (WTGs), wind farm operators, suppliers and energy supply companies, the German Fraunhofer Institute IWES (The Fraunhofer Institute for Wind Energy and Energy System Technology) provides industry-related research services and cooperation for a wide range of technical wind energy issues.

"The IWES is an industry institute devoted to the field of wind industry," explains Hans Kyling, Research Associate for the current BeBen XXL project, which is researching whether business safety requirements can be met using less material.

RUNNING BETWEEN 2012 and 2017, the project is a collaboration between Fraunhofer IWES, wind turbine manufacturer Suzlon Energy GmbH (which initiated the project) and the Hamburg University of Applied Sciences (HAW). It is funded by the Federal Ministry for Economic Affairs.

The German abbreviation BeBen translates as "accelerated experimental endurance strength verification for large wind turbine components using the example of main shafts."



Hans Kyling, Research Associate for the BeBen XXL project, which could potentially change how wind turbine generators are built in the future.

"The term lightweight construction is a bit exaggerated," Kyling points out, "because we don't really build light, we just build lighter."

All wind industry OEMs (Original Equipment Manufacturers) will potentially benefit from positive project results. If certification guidelines are adjusted accordingly, it will improve cost-effectiveness, as it won't be necessary to oversize WTG components.

IN ADDITION TO THE MAIN PROJECT GOAL, the suitability of high-tensile cast iron as a substitute for expensive forged material is also being investigated and validated. Kyling says: "We are conducting an accelerated service life test by altering some of the parameters, for instance us-

ing a higher rotation speed than during normal WTG operation, thus putting greater stress on the main shaft through a heavier rotor."

Another thing that makes the project innovative is the creation of a so-called Wöhler curve, which determines the vibration resistance of a material or a component – especially a very large one. The automotive industry generally uses vibration resistance tests for much smaller components. For cost reasons, even the aerospace industry usually conducts tests on significantly smaller components.

DESPITE THE HUGE DIMENSIONS of the WTG main shaft, the working space for bolted joints is quite limited, which can make installation and maintenance difficult – even risky.

"We created a split form of test rig," Kyling says. "There is a steel structure, which is connected to the foundation, and an upper steel structure, which is connected to the test specimen."

Typically, both these applications are very hard to access. The structure is designed for load-flow optimisation, which means that the bolts are sometimes placed in hard-to-reach places with little room for maneuvering the tools. Apart from the tight spaces, Kyling stresses other challenges: "The loss in pre-load should be as low as possible, and very high forces must be countered."

These challenges were a major reason for selecting Nord-Lock products. Superbolt tension- ➔



The BeBen XXL projects use Superbolt M80 and M56 Multi-jackbolt tensioners to secure joints in their test rig. The bolts must be able to safely handle very high forces. Despite the huge size of the test rig, many of the spaces for the bolts are cramped, and the bolts have to satisfy this requirement as well.



Technical insights: Products for all conditions



THE NORD-LOCK GROUP'S PREMIUM product range is very attractive to the wind energy industry, as it meets the tough requirements of wind turbine operators. Nord-Lock products are perfect for securing bolted joints in wind turbines that must be able to withstand enormous pressures under extreme conditions. They also provide practically maintenance-free operation.

Nord-Lock washers protect from bolt loosening due to vibration and dynamic loads, using tension instead of friction, thus reducing the risk of production failures or property damage. X-series washers offer extra safety since they, in addition to the same wedge-locking effect as original wedge-locking washers, can compensate for relaxation and settlements. They also handle dynamic loads dependably, especially in new turbines with increasingly high performance.

Superbolt tensioners are a superior choice for wind turbines. Replacing conventional nuts and bolts, they increase the lifespan of bolted joints and require only hand tools to tighten the joints. They are ideally used in the drivetrain, before and after the gearbox, at the housing and footing screws, all of which are continuously subjected to great forces.

Boltight hydraulic tools offer reliable and precise pre-tensioning for all critical bolt connections, both for construction and maintenance. Applications include tower-field connections, as well as frames, bearings, foundations and rotor blades.

→ ers contribute to the safety of the project, not only because they make it possible to work in confined spaces, but also because they allow for use of lighter tools. Handling hydraulic equipment in these situations could compromise the technicians' safety.

SUPERBOLT TENSIONERS are used between the two upper steel components and between the steel structure and foundation. Eight size-M80 tensioners are used in the project, along with 28 smaller M56 tensioners. Even with the large M80 Superbolt tensioners, there are still 2.8 MN (meganewtons) of force to be reckoned with, but Superbolt Multi-jackbolt tensioners can handle it.

Apart from the actual parts, the BeBen XXL project also benefits from the Nord-Lock wind energy industry experience. Positioning is key to success in this market, "Because

there's always the cost pressure," Kyling says.

Nord-Lock sales engineer Tobias Klanck says that, "As a highly qualified supplier for the wind energy industry, we are glad that the growth trend in this segment is continuing. This holds especially true for weak-wind turbines. Making full use of the existing wind, they are well suited to many locations worldwide."

GOING FORWARD, Kyling says about wind turbine construction that, "There are still many challenges to overcome." One of them is the use of increasingly large rotor blades. Regarding the drivetrain, there is the problem of using cast shafts instead of forged ones to keep costs down for large volumes. As there is no general drivetrain concept, bearings are another challenge for WTG manufacturers in order to meet to be competitive. ■

M80 MULTI-JACKBOLT TENSIONER



FACTS:

THE BEBEN XXL RESEARCH PROJECT

CUSTOMER: The Fraunhofer IWES industry institute.

LOCATION: Bremerhaven, Germany.

PROJECT: The BeBen XXL research project, running 2012–2017.

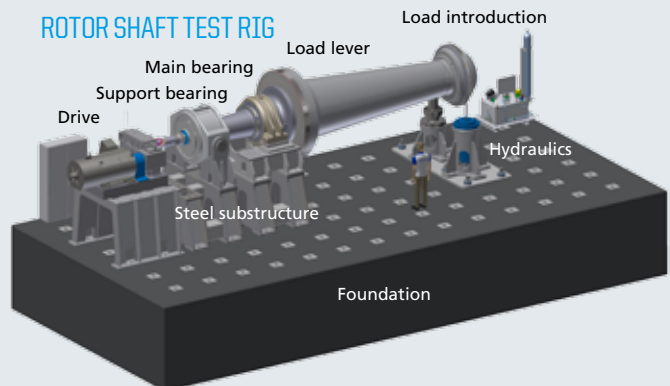
PROJECT GOAL: To determine if it is possible to reduce or change the material use for large wind turbine shafts.

NORD-LOCK PRODUCTS: Superbolt M56 and M80 Multi-jackbolt tensioners

BENEFITS GAINED:

- Superior in confined spaces.
- No pre-tensioning loss.
- Able to handle very high forces.
- Use of lighter tools.

ROTOR SHAFT TEST RIG



"A unique technology is emerging"

WORDS:
ALASTAIR MACDUFF

PHOTO:
LAURENCE CLAUS

LAURENCE CLAUS IS PASSIONATE. With more than 25 years' experience working in the US fastener and automotive part supplier industries, he is driven by a desire to share his knowledge. He now heads his own company, providing training and consultancy in fastener-related topics to businesses in the manufacturing and automotive industries.

What fastener knowledge gaps do you see in the modern workplace?

"In North America, the general workforce is aging and companies are finding it difficult to replace experienced personnel. In the USA, over 10,000 'baby boomers' retire every day. Following them is a large influx of millennials and, as a result, the workforce needs to be re-educated.

"Millennials think about work very differently than their predecessors, but are especially drawn to employers that show an interest in them. This is positive, but does present a challenge for companies who must invest in training new personnel."

What are some fastener trends in the manufacturing and automotive industries?

"Compared to Europe, the US fastener industry has been slow in updating itself. I believe that companies here are starting to reinvest and reinvent themselves. In recent years it has been very much about lean manufacturing and driving efficiency.

"Today's spotlight in the automotive industry is lightweighting. Auto OEMs are increasingly designing mixed material structures with a focus on aluminium, composites and ultra high strength steel. These are not possible, however, without 'enabling' fastening technology. Hybrid, non-traditional combinations such as aluminium to aluminium, aluminium to steel or magnesium to steel are becoming commonplace."

What are the challenges for end-users surrounding multi-material joints?

"A unique technology is emerging, in which European companies are at the forefront. Cars have traditionally been welded together. However, when mixing materials, this no longer works. Innovative companies have introduced flow drill thread forming screws and friction welding technology to address the challenges of these new multi-material joints."

How important is it to think about life-cycle costs when choosing fasteners?



Laurence Claus says that manufacturing and automotive industry consumers are increasingly searching for companies who offer value, whether it is about product innovation or fastener assistance.

"The automotive industry is very cost-conscious, but one client learned the hard way that price should not be the primary measure when choosing a supplier. Their price-driven 'strategy' has had two negative consequences. They suffered major quality spill – saving money in the short term, but their business lost out in the long term. They also found that suppliers who had previously been happy to help them with technical support were no longer able to assist them. This has had a hugely negative effect on their business.

"I believe that the pendulum is shifting back. Fasteners are not a simple commodity and customers who previously wouldn't pay premium price for a component are now more willing to do so. They are waking up to the bigger picture." ■

FACTS: LAURENCE CLAUS

TITLE: President, NNI Training and Consulting, Inc.

AGE: 49.

LIVES: Northern suburbs of Chicago, Illinois.

BACKGROUND: Graduated as a Mechanical Engineer. Has over 25 years experience in the fastener and automotive supplier industries. Bulk of career spent with an automotive fastener manufacturer, the last six as Vice President of Technology and Engineering. Started NNI four years ago.

PASSION: Family. Has five children, aged between 2 and 10. NNI is named after his first three children – Noah, Nathan and Isaac.



Changing to Superbolt tensioners, Sodick will be able to avoid loose bolts in their moulding machines.

Pressing problem solved with Superbolt

WORDS:
CAROL AKIYAMA

PHOTO:
SODICK

THE CHALLENGE Bolted joints are a key component of most machines, which make them essential to many of Japanese Sodick Corporation's applications. The company manufactures industrial machines and machining tools as well as consumables and other products. Original research and development is a top priority, ensuring high-quality products that improve the customers' manufacturing operations.

Sodick moulding machine engineers recently attended a seminar on solutions to the problem of loose bolts held by Ikeda Metals, a Nord-Lock Japan distributor. It touched upon exactly what they were struggling with.

Together with Ikeda Metals engineers, Nord-Lock engineers started searching for areas where they could help improve Sodick's bolted joint design. They realized that in the Sodick moulding machines, the tie rod bolts were tightened by a traditional method. Tie rods are quite long, so if they are subject to torsion stress, and the ma-

chine is operating for a long time at the end-customer site, it is difficult to guarantee optimal performance. From the customer's perspective, the ability to properly control the force on the joints becomes essential, because it is key to safe operation without costly downtime.



Moulding machines are used to manufacture parts for many of the products and gadgets that we use in our daily life, such as cars and mobile phones.

THE SOLUTION Superbolt was the perfect solution as it just has pure tension. It does not create any friction and therefore can control the force on the joints without giving off torsion stress. The people at Sodick were impressed by how diligently the Nord-Lock engineers worked at finding solutions that catered specifically to their application needs.

THE RESULT Superbolt tensioners are premium products and while there are cheaper alternatives in the market, Sodick firmly believes that the cost performance of the product makes it appealing. About half of Sodick's products are sold overseas, and some big machines cannot be shipped assembled. It is essential that the moulding machine assembly and changing of parts can be carried out easily, quickly and safely at the end-customer site. Sodick is pleased to hear reports that their customers are satisfied with having smooth, speedy operations. ■

New materials increase railway safety



RAILWAY. The development of new materials, for example glass-fibre reinforced plastic (GRP), has set new trends for the infrastructure of railway companies. Materials on the tracks, such as steel and timber, are increasingly being replaced by GRP for grates, walkways, bridge coverings, escape routes and service access ways. GRP makes these elements weather-resistant, slip-proof and thus safer.

THEIR SIMPLE, MODULAR DESIGN, but also their low weight and high strength, make GRP profiles increasingly popular with railway operators for entire structures, such as railings, ladders, suspended stairways and work platforms. Another GRP advantage, compared to steel, is the fact that you don't have to earth the entire structure, as the material is an electrical insulator. It is also resistant to corrosion, which significantly reduces the costs for maintenance.

Deutsche Bahn AG in particular has decided to make greater use of GRP in its infrastructure. This makes DB a trendsetter for Europe, since railway operators in neighbouring countries take cues from the continent's largest railway industry company.

"This is a trend, because Deutsche Bahn has a complete understanding of this material's ad-



GRP is a premium choice for rail infrastructure, such as walkways, platforms and bridge coverings. Other applications include wind energy, plant manufacturing and architecture.

PHOTO: CTS

vantages," says Philipp Wilczek, Junior Partner and Sales Director at CTS Composite Technologie Systeme GmbH – a technology leader in the field of glass-fibre reinforced plastics. Products and structures made of GRP must be bolted together and these bolted joints can be problematic. To overcome this, CTS has decided to use the Nord-Lock X-series bolt-securing system. Maik Hartmann, Technical Director at CTS, explains: "Our material is low-maintenance in principle. However, in order to make the entire structure low-maintenance as well, we needed a solution for securing the bolts, so that we could expand the material's advantages to the connecting elements as well."

ON OR CLOSE TO THE TRACKS, shaking and vibrations from train traffic must always be expected. An increased loss of preload due to slackening (settlements and/or relaxation) should be considered when using new materials. Nord-Lock X-series washers combine the wedge-locking principle with a spring effect to prevent loosening caused by settlements and relaxation. This way, they enhance the advantages of CTS's GRP products to offer the railway industry a safe option with many advantages. ■

ULRICH SCHAMARI

Life in the engineering fast lane

ATTRACTING YOUNG TALENT to the manufacturing industry is getting increasingly challenging. Some state that a lack of future engineers is a serious threat to individual companies and the industry as a whole. So what can companies and academia do to attract young talent?

One way is adding excitement to the mix. Several universities are, quite literally, trying to accelerate student interest through extracurricular motorsports projects. Two American projects – Gator Motorsports at the University of Florida, Gainesville, and the Virginia Tech Baja SAE Team in Blacksburg – along with Dutch Forze Hydrogen Racing at Delft University of Technology are sponsored by the Nord-Lock Group.

These projects cover all steps, from design and development to assembly and racing the vehicles. Gator Motorsports highlights how students acquire technical skills while practicing teamwork and project management, which is beneficial for their transition into careers in the industry later on.

GATOR MOTORSPORTS takes part in the yearly Formula Society of Automotive Engineers (FSAE) design competition in Michigan, USA. Here, they compete against more than 100 teams from all over the world with their high-performance Formula-style race car.

Combining motorsport with sustainable technology, Forze Delft focuses on race cars powered by hydrogen fuel cells. Their latest model, the Forze VI, is one of the first fuel cell system race cars globally, and the first and fastest hydrogen-powered race car ever measured on the Nürburgring Nordschleife in Germany. Recently, it broke the electric-lap record on Circuit Park Zandvoort in The Netherlands.

True to its “Fun, fast, dirty” slogan, the Virginia Tech Baja SAE Team has chosen to go off-road. Its single-seat vehicle competes each year in an international competition arranged by the Society of Automotive Engineers (SAE).

THESE STUDENT PROJECTS rely heavily on sponsors, but it is not all about getting free parts. “Networking with industry sponsors exposes us to engineering after college,” says Jess Barton of the VT Baja SAE Team. “We have the opportunity to learn from the companies, including how they operate and what they design and manufacture. Real-world skills and advice from sponsor companies make us great engineers and professionals.” ■

ULF WIMAN



The proud Forze team reaching the finishing line, turning extracurricular fun into long-term practical experience.

PHOTO: FORZE HYDROGEN RACING

3 QUESTIONS

Johanna Persson, Sales and Marketing Director, Nord-Lock Group

1 What kind of student projects does the Nord-Lock Group sponsor?

“The projects that we select should resonate and align with our business and brand strategy. We wish to connect with future engineers, designers and innovators that will play an important part in developing solutions for both current and future challenges within our world.”

2 What are the long-term gains for the students?

“We want to help them to develop their creativ-

ity. We support thoughtful, innovative projects and programmes that build the capacity of students to succeed in a constantly evolving world.”

3 How do I get my student project sponsored?

“All student organisations are welcome to submit an inquiry through our website if they see a use for our products. We can’t support activities asking for a cash contribution, but we will support projects with knowledge and market-leading products.”



Like us on Facebook

DON'T MISS the new Nord-Lock International Facebook page. It is a great way to interact with the company as well as with its customers, suppliers and partners. Keep updated on what is happening at Nord-Lock Group.

Go to: <https://www.facebook.com/nordlockint>. ■



Save time with Expansion Bolts

Heavy machinery requires bolting elements that can be easily installed and removed. This is especially true on large and high-performance flange couplings where the bolting elements produce an interference fit for proper torque transfer.

Superbolt Expansion Bolts replace large fitted or interference fit bolts. Its outer diameter can be expanded to fit the actual bore size.

Easy: Loose fit sleeves are easily inserted even in holes not fully aligned due to rotation. Only hand tools are required for installation and removal.

Fast: Tightening requires only minutes per assembly.

Safe: Eliminates the need for special high-powered tools, bolt deep-freezing, and cumbersome emergency drilling procedures.

Economical: Reusable. Savings in time and tooling. No unplanned downtime due to seized bolts. ■

Download the Expansion Bolt brochure at:
www.nord-lock.com/expansion-bolt

Would you like to read about your company in Bolted?

NORD-LOCK GROUP IS ALWAYS on the lookout for good stories for its customer magazine, Bolted. If you currently use Nord-Lock Group products in a unique product or interesting application, we would love to hear from you. Contact us at: bolted@nord-lock.com. ■



Specially designed for steel construction applications



HV/HR-sets are a type of bolted connection that is frequently used in steel construction applications. The radius under the bolt head is a particular characteristic of these sets. Now you can safely secure these connections with the new **Nord-Lock steel construction washer** specially designed to fit HV/HR bolts and nuts (in accordance with the European standard EN 14399-4 / EN 14399-3).

In order to ensure an optimal contact surface between the bolt and the washer, each SC-washer pair has chamfers on the inner diameter. The proven wedge-locking technology prevents the bolt from rotating loose.

Find out more at www.nord-lock.com/sc



NORD-LOCK®
Bolt securing systems