

BOLTED

**MAKING WAVES
HUMAN HEART
INSPIRES
RENEWABLE
ENERGY**

**GOING UNDERGROUND
INNOVATIVE BOLTS
SAVE THE DAY
IN NUREMBERG**

**EXPANDER MAGIC
TURNING A RUSTY
NAIL INTO A
BOOMING
BUSINESS**

**HYDRAULIC
TORQUING
VS. TENSIONING**

MAINTAIN YOUR COMPETITIVE EDGE

The Nord-Lock Group believes that no one should ever have to question the integrity of mechanical solutions so critical to our way of life. As a global leader in secure and innovative bolting solutions, we want to share our bolting expertise to increase and strengthen your knowledge in the field.

Education has a major impact on **remaining competitive**. Let our experienced engineers and bolting experts help you to realize safe and efficient bolting.

INTERESTED IN OUR BOLTING SEMINAR / TECHNICAL TRAINING?

Contact us to discuss what agenda best suits your needs:
info@nord-lock.com



Pictures: Haberkorn





Bolted magazine is published by the 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.

For further information visit www.nord-lock.com

Bolted is published twice a year in Chinese, English, Finnish, French, German, Japanese, Korean, Spanish and Swedish. It is free to customers of the Nord-Lock Group worldwide.

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PREPRESS:

Spoon

COVER:

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Printed in Sweden by V-TAB on UPM Finesse Gloss 100 gram and Maxigloss 200 gram.

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The mission continues

This year, the Nord-Lock Group celebrates 35 years of making the world safer through secure bolting solutions. Apart from the original washers, the Group now includes Superbolt multi-jackbolt tensioning (since 2011), Boltight hydraulic tensioning (since 2015) and Expander System pivot technology (2016).

It is a privilege for my colleagues and me – from all parts of the Nord-Lock Group – to have the opportunity to increase our knowledge and learn how our products and technologies overcome challenges to create customer value. It is something we want to share with you. Make sure you read the first Expander System customer case on page 6. Learn all about hydraulic torque and tensioning in the theme article. Don't miss the cool motorcycle application on page 4; and follow us underground on page 12.

Bolted magazine was launched in 2009 to meet the large interest that we saw in bolting knowledge. Seven years down the line, we aim to get even better. That is why we continuously post updates from the world of bolting on social me-

dia. Follow us there to receive relevant and interesting videos and material.

Did you know that, as of November 2016, our most popular film, the Nord-Lock Junker video, had more than 4 million views and 90,000 shares across social media? That makes us very proud and it inspires us to work even harder on our mission of spreading bolting knowledge that helps you. Let us know if you have any specific topics that you wish us to focus on in upcoming articles, videos or seminars.

Thank you for reading!


CARIN LAGERSTEDT
MARKETING MANAGER



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SECURED BY THE NORD-LOCK GROUP

WORDS: LINDA KARLSSON PHOTO: KTM

READY TO RACE

CUSTOMER: KTM SPORTMOTORCYCLE AG	COMPANY SIZE: 2,900 EMPLOYEES, ONE BILLION EURO IN REVENUE	NUMBER OF MODELS: 45
PRODUCTION: >160,000 MOTORCYCLES ANNUALLY (2015)	STRONGEST MOTORCYCLE: KTM 1290 SUPER DUKE R, AKA "THE BEAST" (177 HP, 1,301 CC, 144 NM, 189 KILOS)	
NUMBER OF WORLD TITLES: 270	NORD-LOCK PRODUCTS: NORD-LOCK WASHERS FOR M6, M8, AND A CUSTOMIZED WASHER	

PICK ANY OF THE WORLD'S MOST EXCITING motor races and you will find the orange motorcycles by KTM, Europe's largest manufacturer, among the top contenders.

Located in Mattighofen, Austria, close to both motor-sport-crazy Italy and R&D stronghold Germany, KTM mixes influences from both countries with its own "never give up" attitude. After failing to cross the Dakar finishing line ten times, KTM turned failure into a winning streak that has lasted since 2001.

KTM is the only manufacturer that bolts the gearshift lever axially instead of clamping it, making it easier to access with tools. How-

ever, the bolt that attaches the conic gearshift lever to the shifter shaft was a weak spot on early pre-series bikes. Heavy washers combined with glue couldn't prevent loss of preload during some of the most extreme jumps, where the riders land with their foot on the gearshift lever. The whole lever would come loose.

Standard Nord-Lock washers were either too large or too thick to solve the issue. However, Nord-Lock customized an NL6sp washer, with an outer diameter of 16.6 mm instead of 13.5 mm. Two years later, KTM hasn't seen one single case of gear-lever bolt failure.



KTM MOTORCYCLES WITH NORD-LOCK WASHERS

Nord-Lock washers can be found on all KTM bikes. Partners for 30 years, KTM secures the outer casing of the exhaust system, the centre stand and, most importantly, the gearshift lever with Nord-Lock washers.





CRUSHING THE COMPETITION

CUSTOMER: RAMBOOMS	END-CUSTOMERS: CRUSHER MANUFACTURERS AND MINES	APPLICATIONS: BREAKER BOOM SYSTEMS
RANGE: >40 MODELS FROM 450KG TO 20 TONNE	PRODUCT USED: EXPANDER SYSTEM PIVOT TECHNOLOGY	

RAMBOOMS OY is a global supplier of breaker boom systems to crusher manufacturers and mines. Based in Finland, its products are used to break oversized rocks.

Pivot wear on these applications is a natural occurrence through time and repeated use, and the company had previously been using its own solution to prevent this. This solution, with a basic conical locking, had caused some issues. Rambooms' own pins also arrived at its factory in pieces rather than assembled, which meant extra repacking work for personnel when sending the pins on as spare parts.

In 2009, the company took the decision to test the Expander System pivot technology and has been extremely satisfied with the results. The Expander pivot pins are already fully assembled when they arrive. This represents a significant time and cost saving in a competitive industry. Technicians have found fitting and locking much easier than the company's previous solution.

The Expander System has offered Rambooms

significant peace of mind, as it has had no customer issues with pivot wear since the company employed it. A marked improvement in delivery times has also been noted, as Expander always has the stock ready to ship.

"Our customers recognise the fact that the Expander pivot technology means good quality. This reflects well on us and our business," says

Samppa Varhoma, Product Manager at Rambooms Oy.

The Expander System is locked into the pivot on the machinery when fasteners are tightened. The double-sided locking increases safety and stability, while both fitting and dismantling is simple. ■

ALASTAIR MACDUFF



PHOTO: RAMBOOMS

GETTING THEIR TEETH INTO SUSTAINABILITY

CUSTOMER: GYRO-TRAC	LOCATON: FACTORY IN QUEBEC, CANADA. HQ IN SOUTH CAROLINA, USA	APPLICATIONS: MULCHING MACHINES, BIO-ENERGY BALERS
MARKET SHARE, NORTH AMERICA: 60% FOR MULCHING MACHINES	PRODUCTS USED: NL3/8" & NL 20 WASHERS	

THE IMPORTANCE OF SUSTAINABILITY in land clearing is reflected in the product range of North American company Gyro-Trac. With a 21-year history of manufacturing mulching ma-

chines, its focus is now also on creating bio-energy balers for easy packaging, transportation and storage.

As the mulching machines clear unwanted trees, this green technology leaves soil structures intact, eliminates erosion and run-off pollution. The machines can mulch trees to the ground, leaving the roots of neighbouring trees undamaged.

Nord-Lock has provided high-quality washers to Gyro-Trac for around 15 years. The washers maintain the balance of their mulching machines, extending the life cycle and sharpness of the teeth in the process.

The washers also play an important role in Gyro-Trac's Bio-Baling System. The system involves compressing biomass in such a way that no compost is created and no burning is required. For Gyro-Trac's customers, the added costs of hauling and dumping are eliminated, while onsite storage of the one-tonne bales promotes sustainable land use.

Daniel Gaudreault, owner of Gyro-Trac, says: "The teeth are the heart of the machines we produce. We have never had a problem with Nord-Lock washers and their reliability has been vital to our continued success." ■

ALASTAIR MACDUFF



PHOTO: GYRO-TRAC





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Email your questions about bolting technologies to experts@nord-lock.com



ASK THE EXPERTS

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

Optimising a bolted joint through clamped length

Q: What is clamped length?

A: Clamped length – L_k – is the free length of a bolt that is stretched under tension, meaning:

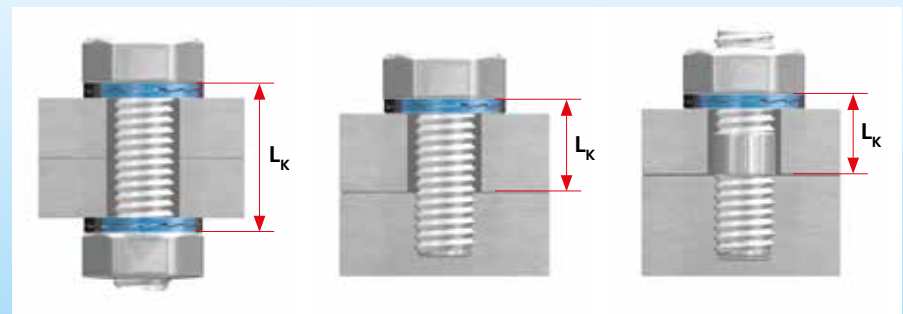
- In a through hole (A), the distance between the bolt head and the nut.
- In a blind hole (B) – or for a stud bolt (C) – the distance between the head (nut) and the first thread engaged in the tapped hole.

It is also called “grip length” as the total thickness of clamped parts under compression.

TO OPTIMISE a bolted joint, it is recommended to design the clamped length to at least 3 or 5 times the bolt diameter. Increasing the elasticity of the fastener greatly improves the properties of the joint, as it:

- Increases the elongation of the bolt, reducing settlement effect.
- Increases the flexibility of the fastener, reducing the risk of self-loosening under vibrations and transverse loads.
- Improves the load factor, reducing the amplitude of dynamic stresses in the bolt and minimising the risk of fatigue failure.
- Minimises the load transfer loss in case of hydraulic tensioning.

The clamped length in different situations



(A) Through hole (bolt)

(B) Blind hole

(C) Stud

FOR STIFF JOINTS that don't permit a long clamped length, it is possible to implement smart and effective solutions to avoid failure. Instead of using expensive and unattractive spacers, you can, for example, use:

- Nord-Lock original washers to prevent spontaneous bolt loosening.

- Nord-Lock X-series washers to prevent spontaneous bolt loosening and compensate settlement and relaxation.
- Superbolt mechanical tensioners, allowing both a direct axial stretching of the bolt with no loss of preload and improving the elasticity of the bolt, hence the load factor.

NB

The effects of lubrication

Q: How does lubrication affect hydraulic tensioning and multi-jackbolt tensioning?

A: With the traditional method of tightening a nut, using a spanner, lubrication is very important, as there are a lot of surfaces moving against each other – the threads of the nut against the threads of the stud and the underside of the nut against the surface of the joint. Overcoming these frictional forces accounts for approximately 90 percent of the work (energy input) applied to generating the load in the joint.

WHEN A HYDRAULIC TENSIONING tool applies a clamping load to a joint, lubrication has no effect as it is applied directly to the stud and joint. A tension force is a linear force applied in an axial direction, so there is no rotation required to generate the load. This allows the nut to be turned down against the joint face under minimal friction.

As there is no friction to consider, there is no need to reduce the coefficient of friction using lubrication. Also, the lack of friction in the application permits much more accurate and repeatable results.

WITH MULTI-JACKBOLT TENSIONERS (MJTs), the use of a lubricant on the main bolt thread does not affect the preload. It is advisable to use a very light film of lubricant with anti-seize characteristics to facilitate tensioner removal.

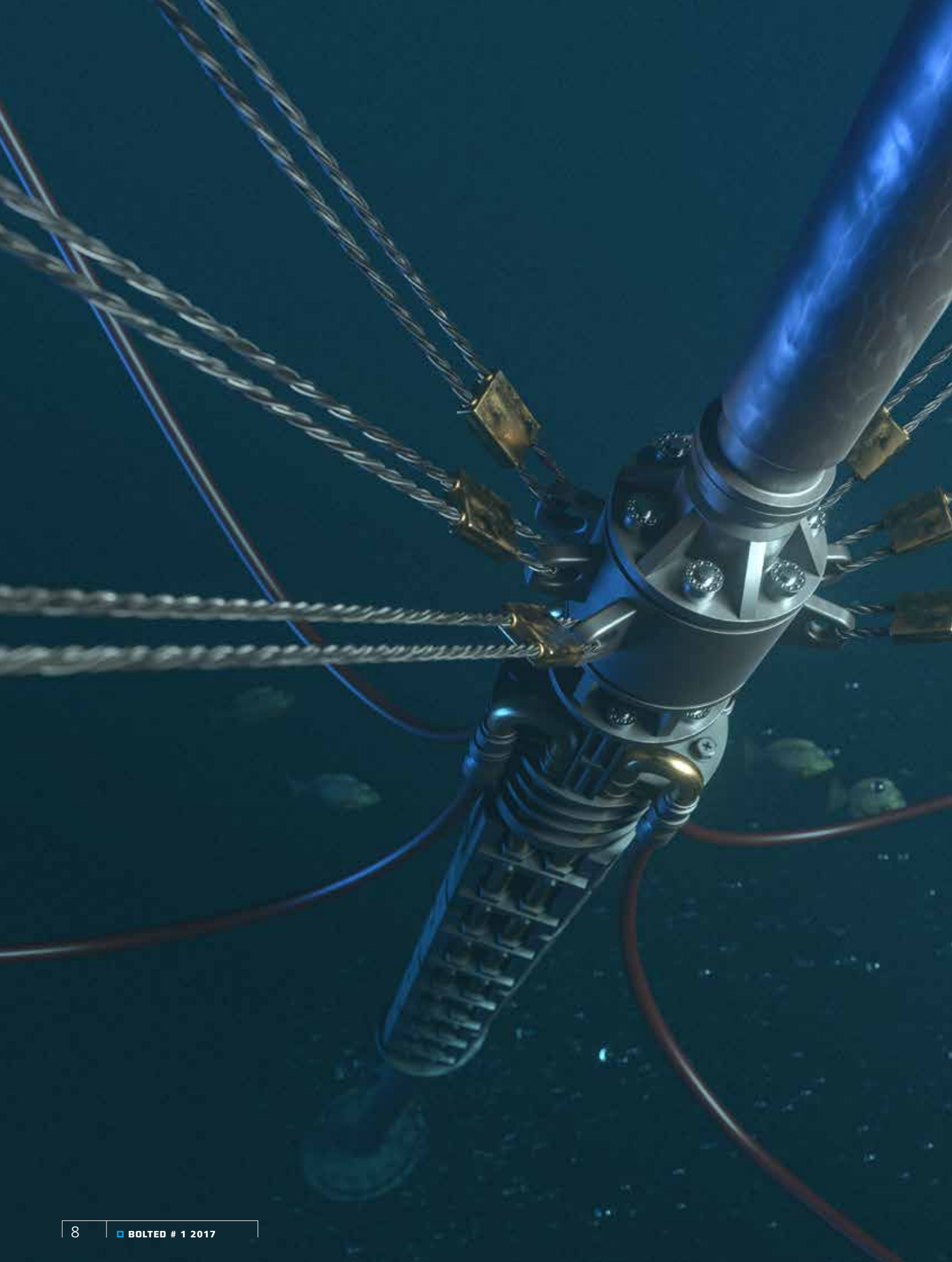
A more tangible effect of lubrication for MJTs is from the required lubricant use on the individual jackbolt threads, jackbolt bottoms of the tensioner, and washer face.


Proper use of lubrication is crucial to safeguarding repeatable and precise preload control in Superbolt installations. Superbolt mainly uses a graphite-based lubricant with a low friction coefficient and steady performance



to achieve a positive impact on the preload. The MJTs are delivered with lubricant pre-applied to the installed jackbolts. Additional lubricant is included for application to the jackbolt bottoms. For subsequent installations, reapplication of lubricant is required to provide the intended performance.

JV & AN





TORQUING VS. TENSIONING

Which is the best method for controlled tightening of a bolted joint?
Bolted plays hydraulic torquing off against hydraulic tensioning.
And the winner is... [→](#)

WORDS:
NIC TOWNSEND

PHOTO:
NORD-LOCK

ILLUSTRATIONS:
DAN HAMBE



→ **N**early everyone has tightened a nut at some point in their lives and can understand the basic concept of torquing. It is the oldest, simplest, and for most non-engineers, the only method of tightening bolted joints.

Whether by hand or hydraulics, compared to other methods, simple to understand basics of torquing make it overall a far more cost-effective option. This does not dismiss the need for training and understanding of the key factors in torque tightening.

“With one torque wrench and a range of sockets, you can tighten quite a wide range of nuts and bolt sizes,” says Robert Noble, Technical Director, Asset 55. “It offers quite a bit of flexibility, and it’s easy to explain to a technician how to use torque equipment.”

Given that it will be effective in the majority of applications, it is clear why it is often the default first choice.

HYDRAULIC TORQUING has its limitations, particularly friction, which Noble labels, “the number one enemy of torque.” Typically, friction accounts for 90 percent of the torque applied to the nut, which means only a small portion of torque will translate into useful bolt load. Because torquing is an indirect way of loading, it is difficult to predict the exact bolt load. Many factors should be taken into consideration, in particular the lubricant used, the need to avoid possible contamination and a good surface finish on the nut bearing surfaces. This must be overcome to ensure reasonable accuracy when using torque to produce preload and can be a significant disadvantage in critical joints.

Noble stresses that with good procedures, calibrated equipment and competent personnel, torque tightening can be used successfully on most joints. Much is made of bolt scatter, which

“Blanket policies result in a lot of technical queries and in some cases the need to compromise on bolt load.”

ROBERT NOBLE, TECHNICAL DIRECTOR, ASSET55

will see the achieved preload on an individual bolt within +/- 25 percent of target, but on a flange with multiple bolts the usual result is to achieve an average bolt load within close range of target (providing good practice is followed and the coefficient of friction is assessed). “This

the preferred method for tightening large critical joints in many industries, such as oil and gas, wind, subsea, or power generation.

Compared to hydraulic torquing, it is a more complex procedure that involves more specialised equipment. In certain applications tensioning

can offer greater accuracy and control, as well as speed of assembly. It is particularly advantageous on flanges with multiple bolts. Using conventional torque, each bolt is tightened one-by-one in a pattern, which must be applied carefully to avoid the risk of putting too much load on one side of the gasket or flange. By attaching multiple tensioners, it is possible to tighten a number of bolts simultaneously for an even compression of the gasket.

“This is essentially where hydraulic tensioning came from,” says Nitin Patel, Projects and Commercial Manager, Boltight. “It allowed people to control the clamping force

and if you could do it all in one go, around the whole circumference, that would be much better for the gasket, much better for the joint, and you could actually predict the load that is in that joint.”

ANOTHER PERCEIVED advantage of tensioning is improved accuracy, but as Noble points out, it’s not always that simple. “Unfortunately, the industry tries to use simple one-size-fits-all rules



Whether hydraulic torquing or hydraulic tensioning is the best choice must be decided on a joint-by-joint basis.

is accurate enough for the majority of gasketed flange joints, so torque remains a very viable technique,” Noble says.

HYDRAULIC TENSIONING began in the 1970s, pioneered in part by British engineer Fred Heaton, who would go on to found companies Hydratight and Boltight. Over the next 20 years it gradually became more common and is now becoming

Did you know that...

Friction typically accounts for

90%

of the torque applied to the nut during hydraulic torquing?

JOINT VENTURES

For bolted joints, several factors must be considered before choosing between torquing or tensioning.

- Establish the target assembly load that the application needs.
- Consider any factors that can directly influence your choice. In applications where it would be beneficial to avoid any torsion-

al effect on the bolt, such as foundation bolts in concrete, tensioning would be the best option. Torquing, however, could be a better option if you are dealing with space constraints.

- Don’t underestimate the physical and logistical constraints. For a tensioner to grip properly, at least one diameter of thread needs to be protruding through the nut.

but they do not apply to the torque and tension criteria,” he explains. “Where the conditions are right, tensioning can become very accurate. Typically, that would be for bolts with a high length-to-diameter ratio – long, thin bolts – and where you have high bolt loads. In these applications tensioning is more accurate than torque. But conversely with short, fat bolts and low bolt loads, tensioning becomes less accurate.”

Tensioning also has its disadvantages, namely load loss, which occurs when the tensioner is released and the load transfers to the nut. To compensate for this, the load loss is estimated and the technician applies the expected load loss in advance. This means that the bolt, gasket and flanges are subjected to greater stress than the targeted assembly stress. This has to be taken into consideration either at the joint design stage or prior to using the tooling. An alternative is to repeat the tensioning procedure to compensate for the settlements.

Hydraulic tensioning can also have practical and logistical drawbacks. Since it requires more equipment and specialised tools, it can be significantly more expensive. “Tensioning is not easily understood, other than by those who tension regularly,” says Noble. “You need specific tension tools and it’s difficult to design a tensioner range with the same flexibility as a torque wrench.”

SO THE TRUTH is that there is no simple answer to which one is better, torquing or tensioning. It is best decided on a joint-by-joint basis.

“Blanket policies result in a lot of technical queries and in some cases the need to compromise on bolt load. Instead you need to do what is best for that specific joint,” Noble says and concludes: “Sometimes it comes down to looking at the application with open eyes, considering how you will actually get the equipment out to the site, the location where it has to be used and how it is going to fit into the application.” ■



ROBERT NOBLE

Started as a marine engineer with BP in 1973, before moving onto offshore oil platforms as a mechanical technician. Worked in technical management before specialising in bolted joints in 1998. A member of ASME (American Society of Mechanical Engineers) and has contributed to a number of bolted joint standards and guidelines. Independent consultant since 2012, now as Technical Director at Asset 55, which specialises in bolted joint integrity consultancy and software solutions.

HYDRAULIC TORQUING



H ydraulic pressure is used to apply torque to the nut, turning it down against the flange. This causes the bolt to stretch and

provide clamping force. It also creates friction between the bolt and nut threads, and between the nut and flange.



HYDRAULIC TENSIONING

A jack is attached to the bolt, and high-pressure hydraulics is used to stretch the bolt and lift the nut clear of the flange. The nut is then easily turned down back to the

flange surface. When the hydraulic pressure is released, the stretched bolt creates clamping force as it attempts to revert back to shape.



Renovation of underground track beds can be hazardous and lead to operational disruptions. A new, cost-effective concrete bolt solves these problems.

THE LIGHT AT THE END OF THE TUNNEL

How TOGE brought the Nuremberg metro up to date

Renovating an underground railway system without weeks of construction and chaos caused by delays and diversions was previously unheard of. That is, until a unique concrete bolt emerged in Nuremberg.

WORDS:
LINDA KARLSSON

PHOTO:
VAG/PETER ROGGENTHIN, 123RF

THE PEOPLE of Nuremberg are proud of their underground system, which is among the most modern in Europe. The city, located in Bavaria, Southern Germany, has the only underground network in Germany where two of the three lines operate automatically, without train drivers. Nuremberg trains travel the equivalent of the circumference of the earth twice each day, carrying more than one hundred million passengers per year.

After 40 years of continuous use, it comes as no surprise that a renovation of the track beds is required to ensure passenger safety. The main beam, also known as a concrete stringer, which attaches the tracks to the tunnel floor, has simply sustained damage in too many places.

THIS IS A DAUNTING ISSUE for the provider of the Nuremberg metro services, VAG (Verkehrs-Aktiengesellschaft Nürnberg). Normally, metro companies need to completely shut down a track for weeks during the renovation of such concrete stringers. Employing water pressure to remove the concrete, it is a time-consuming and extremely dangerous job, considering the many power lines inside the tunnel. Long delays caused by closed tunnels are costly for the track operators, adversely affecting train traffic and irritating passengers.



Waldemar Gunkel, Technical Director, TOGE, is one of the inventors of the new concrete bolts.

Coming to the rescue, a brand new innovation caught VAG's attention just as they started planning the renovation. Local Nuremberg dowel and concrete bolt manufacturer TOGE Dübel won a railway innovation award for a new concept that enhances the sustainability of existing concrete bridges. Present in the audience, VAG representatives were intrigued and had the idea of trying the concept for the first time in an underground rail environment. Currently, work is under way at the first three stations: Bärenschanze, Gostenhof and Maximilianstrasse. Work on the second largest station in the network, the "Plärrer", with 98,000 passengers daily, is planned for 2017.

Instead of complete reconstruction, concrete bolts measuring 36 centimetres and weighing 1 kilo are utilised as load-bearing components to improve the life span of the overall track bed construction. The bolts are fitted with a patented special thread that cuts into the borehole wall upon application. The force of the bolt is mechanically transferred to the anchor base and the concrete is fixed in place.

"COMPLETELY REMOVING a concrete stringer and installing a new one could never be accomplished without service disruption," says Waldemar Gunkel, Technical Director of TOGE and one of the two inventors of the new generation of concrete bolts.

"In Nuremberg, however, our system is only being installed between the hours of 23.00 and 04.00. By the morning, everything is running normally."

During these working hours, only one track is shut down and trains are redirected via a single track, while the porous areas of concrete on each stringer are chipped away and replaced. Finally, the stringers are fixed into the ground utilising the concrete bolts. Since the bolts need to be drilled into the concrete, there is a risk of inclination as the drilling machine might not be positioned at an exact 90-degree angle. That's why all concrete bolts that are being used in this first project are secured by Nord-Lock X-series →



The rails of the Nuremberg underground are fitted onto longitudinal beams made of reinforced concrete using a rail mounting system, which is, in turn, connected to the tunnel floor. In recent years, the concrete stringers have been repeatedly damaged. The new concrete bolts are fitted with a patented special thread that cuts into the borehole wall upon application.

→ washers. Their conical shape can compensate for the inclination, while the wedge effect prevents spontaneous bolt loosening due to vibration.

THE NORD-LOCK CONNECTION came via Deutsche Bahn – Germany’s national railway operator – where Nord-Lock original wedge-locking technology has long been prescribed as the standard.

Jochen Süßenbach, Nord-Lock Project Account Manager, sees great potential in this new approach to metro renovation. “We’re looking at a huge renovation of the tunnels that virtually doesn’t affect the timetable at all”, he says. “In terms of costs, it’s also a solution that beats any conventional method.”

SO FAR, the renovation is running as planned. The first construction phase has even been completed a week ahead of schedule and the total time for construction carried out at all three metro stations will last six weeks instead of sev-

eral months, which could have been the case with the previous method.

The concrete bolts themselves are designed to last for 50 years. No concrete will last that long, but further renovations will not be necessary for decades.

Describing TOGE’s Innovation Award-winning solution, Bavarian Interior and Transport Minister Joachim Herrmann said the following: “We have our fingers right on the pulse.” He hinted at the billion-dollar losses that Germany faces due to the poor condition of some 120,000 highway bridges and 30,000 railway bridges.

THE UNDERGROUND RAIL SYSTEMS are in a similar state. Just as in Nuremberg, most metro networks in Germany, as well as in the rest of Europe, were established in the 1970s. Gunkel thinks TOGE has found an important application for its concrete bolt: “This project gives us the boost to further drive our product development forward.” ■

FACTS:

THE NORD-LOCK SOLUTION

CLIENT:

TOGE Dübel GmbH & Co.KG.

END CUSTOMER:

Metro services provider, Verkehrs-Aktiengesellschaft Nürnberg (VAG).

LOCATION:

Nuremberg, Germany.

PROJECT:

Renovating concrete stringers under metro tracks without affecting traffic.

SOLUTION:

Using concrete bolts with a patented special thread to reinforce the existing structure.

NORD-LOCK PRODUCT:

X-series multifunctional wedge-locking washers with enlarged outer diameter (NLX24sp)

BENEFITS GAINED:

- Reliability in different environments.
- Safety under any dynamic load vibrations caused by trains.
- Excellent partnership in which problems are solved quickly.

Nord-Lock – a trusted partner for the railway industry

STARTING WITH ROLLING STOCK some 20 years ago, Nord-Lock wedge-locking washers are now found in all safety-related areas of the railway industry, such as bogies, coupling devices, brake systems, rail dampers, housing, and many more.

Nord-Lock washers ensure the functionality of bolted joints, even at the highest levels of vibration caused by rail traffic. One example is in railway switches, highly complex structures that must be used as long as possible with minimal maintenance, while exposed to the elements and to considerable stress.

Nord-Lock steel construction washers (NLSC) help railway companies avoid operational downtime, thus saving money. When renovating or re-



placing old bridges, small temporary bridges are assembled on site with a bolt preload of 100 percent to achieve secure bolted joints. However, these bolt connections can only be used once. Using Nord-Lock washers, the preload can be reduced.

Overhead line masts and signal masts must

cope with severe dynamic loads caused by passing trains. Given the large number of masts, reliable bolt connections are crucial to reducing maintenance costs. With their special geometry, Nord-Lock X-series washers increase security, including on bolted joints with short clamp length, as well as in softer materials.

A recent application for the Nord-Lock X-series is noise-absorbing walls, which cope with extreme vibrations from passing trains. In Germany alone, 3,000 km of noise-absorbing walls are to be installed by 2030. A combination of concrete bolts and X-series washers is used to attach noise-absorbing barriers on existing bridge decks, many of which were not designed for noise barriers.

“The market potential is huge”

The Expander System Group, the latest Nord-Lock Group acquisition, shares many customers with its new parent company and their history is remarkably similar. Founded in a remote part of Sweden, evolving from an innovative idea. In Expander’s case, a rusty nail was transformed into market-leading pivot technology. Founder and former owner Roger Svensson tells the story.

WORDS:
ULF WIMAN

PHOTO:
STEFAN JERREVÅNG

What is Expander’s business?

“Our patented Expander System is a state-of-the-art, cost-effective solution that permanently ends pivot wear in construction, forestry, mining and other heavy machinery. Fitted in the pivot, a double-locking expanding pivot pin assembly increases stability and safety and eliminates welding and line boring of worn-out pivot ears. The system has been field-tested for over 50,000 hours without failure.”

How did the company start?

“My father, Everth, and his twin brother Gerhard, did road work in the 1950s, starting out with one bulldozer. Machinery joints and pivots are prone to wear and tear, leading to expensive downtime and repairs, but they came up with a makeshift solution, knocking a rusty nail into the lughole to eliminate the gap. This worked surprisingly well, which inspired them to start developing the technology.”

When did you get involved?

“I learned about their ideas and immediately saw the potential. My father and I founded the company in 1986. At quite an early stage we got involved with computer engineers in the development of a parameter-controlled CAD system. This is an invaluable tool, as each Expander System is custom made to fit customer-specific applications.

In the 1990s we expanded geographically. North America is a huge market and in 1997 I moved there to get a business foothold. The launch was successful and in 2006 we established our own production facility in North America.”

Why did you sell the company?

“Enormous markets, such as South America, are starting to develop, but you need local presence. It was about either setting up my own



Roger Svensson says that there are some 60,000 different Expander applications for over 10,000 machine models: “With our proprietary Expander System Online (3D CADEX), we can design new applications within minutes and have the product delivered within a few days.”

network or selling to someone that already had a global subsidiary and distributor network. We already collaborated with Nord-Lock and after several discussions with Ola Ringdahl, CEO, Nord-Lock Group, I was sure that the Nord-Lock Group was a perfect fit.”

What does Expander bring to the Nord-Lock Group?

“There has been a major change in how people view repair and maintenance, which makes the market potential for the Expander System huge. We’ve only scratched the surface.

Also, we and the Nord-Lock Group have often shared customers, but solved different problems. Bringing our solutions together – and cross-fertilising them – will make our portfolio and product range so much stronger, which will benefit the customers.” ■

FACTS:

ROGER SVENSSON

ROLE: Founder and former CEO, Expander System Group.

AGE: 56.

LIVES: Sedona, Arizona, USA.

BACKGROUND: Studied Economics/ Political Science at UCLA (double major). Member of the UCLA team that won the prestigious NCAA swimming championships in 1982. Held a couple of positions with other companies before starting Expander with his father in 1986. “I have always been an entrepreneur.”

PASSION: Music: sings, plays guitar and writes his own songs. Is currently working on his debut album. Also paints and likes to write.



Tunnel cameras must be particularly durable, as the vehicles that constantly pass close by create huge wind pressure. Standard security cameras normally don't last more than a year and a half.

Security in focus

WORDS:
ALASTAIR MACDUFF

PHOTO:
AKKADIA, 06PHOTO

THE CHALLENGE Dutch company Akkadia manufactures specialist CCTV systems for demanding situations in various industries. Its cameras can be found everywhere, from offshore, to polar regions and deserts.

Since 2010, Akkadia has had a contract with the Dutch Ministry of Infrastructure and the Environment (IenM), providing CCTV technology in tunnels throughout the Netherlands. Tunnel cameras must be particularly durable, as the vehicles that constantly pass close by create huge wind pressure. Standard security cameras normally don't last more than a year and a half.

THE SOLUTION Akkadia developed a specific camera for tunnels – the PTZ – as a stainless steel, vibration-resistant application, built to last more

than ten years. To create and maintain such robust technology requires a high-quality locking solution.

The IenM were keen to use its usual self-locking nuts, but Akkadia were already employing a product that would ensure the ability of its cameras to provide long-term, trouble-free traffic surveillance.

Akkadia had entered into partnership with Nord-Lock and fit its washers in the CCTV camera technology. The IenM was subsequently won over by convincing evidence presented by Akkadia about the quality of the Nord-Lock washers, including test reports from TÜV in Germany. The PTZ tunnel camera utilises NL6 and NL8 steel and stainless steel washers on the inside, and NL10 stainless steel washers on the mounting and base.

THE RESULT All moving parts and internal connections on Akkadia CCTV systems are secured by Nord-Lock washers; from the housings to the base plates.

No problems have been reported in the six years that Akkadia has supplied tunnel cameras to the IenM. Akkadia has now manufactured around 800 systems featuring the Nord-Lock solution. Currently, over 400 PTZ tunnel cameras cover two large motorway projects in the Netherlands – the Amsterdam Orbital, and the Maastricht motorway near the Belgian border.

The success of Akkadia's tunnel cameras highlights the importance of total cost of ownership. In thinking long term, the IenM has saved money on the cost of maintenance and replacing broken cameras. ■

Riding the waves

CorPower Ocean harvesting energy in the sea

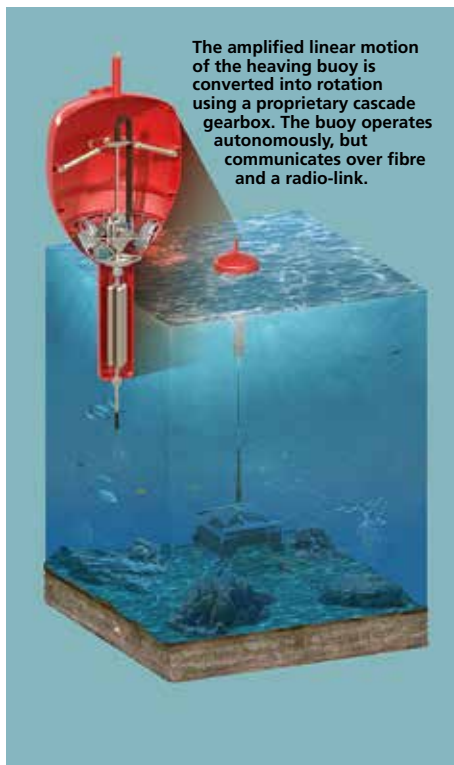


ENERGY. With oceans covering more than 70 per cent of the earth's surface, wave power is potentially a huge untapped source of renewable energy. The problem is that most wave energy converters are too large and costly to be commercially viable. Swedish company CorPower Ocean could have the answer.

The company's compact Wave Energy Converter works by oscillating in resonance with waves, amplifying their motion and then converting that energy into power. CorPower Ocean founder, cardiologist Stig Lundbäck, invented the initial concept based on the pumping principles of the human heart. In the same way that a heart uses hydraulically stored energy to form back in place, the Wave Energy Converter uses a pneumatic pre-tension system to pull down the buoy after it has been lifted by a wave.

THIS ALLOWS FOR a relatively small device to harvest a large amount of energy. It is estimated that one buoy, eight metres in diameter, can generate around 250 kilowatts of power. That is enough electricity for around 200 homes.

"If you look at wave energy potential, somewhere between 10 to 20 percent of global electricity consumption could be provided by wave



The amplified linear motion of the heaving buoy is converted into rotation using a proprietary cascade gearbox. The buoy operates autonomously, but communicates over fibre and a radio-link.

power," says Patrik Möller, CEO, CorPower Ocean. "It has the potential to become the most competitive source of renewable energy. It offers five times more energy density than wind and ten times more than solar power. Waves have fewer variations and are more predictable than sun and wind, so you know a few days in advance what the energy flow will be."

CURRENTLY, THE WAVE ENERGY CONVERTER is undergoing tests with simulated wave loading, while a full-scale demonstration is being set up to begin in 2017. One of the key challenges has been keeping the buoy small and lightweight, while at the same time strong and durable enough to survive the toughest storms at sea.

This has presented a number of fastening challenges. On the mainframe inside the buoy, CorPower Ocean has elected to use Superbolt tensioners due to their lower torque requirements compared to a single bolt, which makes assembly far more manageable. Superbolt can also guarantee reliability over the buoy's intended 20-year lifespan. At the base of the buoy, Nord-Lock washers are used, since they can maintain the correct tension over many load cycles over a long period of time. ■

NIC TOWNSEND

The voice of wisdom

BOLTED GOT A UNIQUE OPPORTUNITY to meet Japan's foremost expert in bolting, Doctor Tomotsugu Sakai. His book *Bolted Joint Engineering – Fundamentals and Applications* continues to receive an enormous amount of support as the definitive work on bolt fastening.

How do you define ideal fastening, which you also covered in your book?

"Ideally, fastening should be based on the use of widely available, standardised fasteners, rather than specially designed parts. More importantly, ideal fastening should ensure a bolt fastening design that won't lead to any kind of failure. The entire product design becomes invalid if a single failure occurs. You must pay attention to every aspect. I consider 'evaluation without any omission' most important."

Is using lubricants an advantage in bolt fastening?

"Yes, if the fastened objects don't slip against each other, lowering the friction coefficient is favourable in all aspects. If fastened objects are in a 'loosening environment', they are more likely to loosen if the friction coefficient is low, but it does not necessarily lead to loosening.

They are in a 'loosening environment' if they are repeatedly subject to slip against each other with a force exceeding a certain threshold.

How do external forces cause slip, based on shear direction, axial direction and torsion?

"If an external force is applied in the shear direction, it would cause slip. If it is applied in the axial direction, the fastened objects would separate from each other – separation. Under these conditions, the lower the friction coefficient, the more likely loosening is to occur.

When writing *Bolted Joint Engineering – Fundamentals and Applications*, I used the conventional view of the slip phenomenon, explaining the slip of fastened objects on the contact surface – so-called 'macro-slip'. You can observe this with your eye, as this type of slip needs to be only 0.1 mm for visual confirmation. Around 1988, it was found that invisible 'micro-slip' actually occurs before the macro-slip and that it causes rotation, which is so micro that, whether



Dr. Sakai on ideal fastening: "I consider 'evaluation without any omission' most important."

FACTS: MICRO-SLIP

A slip not visible to the naked eye. Gradually diminishing the clamp force, it can ultimately lead to visible rotational loosening (macro-slip). Settlements and relaxation of the material can also decrease the clamp force. Nord-Lock Group has developed X-series washers that deal with both forms of slip. They counteract all kinds of clamp force losses with the spring effect, while the wedge effect prevents spontaneous bolt loosening.

turned in the direction of loosening or not, it can't be confirmed with the naked eye. This phenomenon, 'micro-slip', gradually diminishes the axial force. It was introduced in an article in the *Journal of the Japan Society for Precision Engineering*.

"IF FASTENED OBJECTS are in contact with each other, conventional experiments can't measure the slip amount of a certain section of the contact surface or of other sections. But all of these values can be calculated using the finite element method, FEM. It has been used in the fastener industry since around 2000 and today most research on

threaded fasteners utilises it. An article by Doctor Satoshi Izumi et al. in 2006 announced that gradual rotational loosening was found to occur with micro-slip (invisible minute slip) rather than macro-slip (clear, visible slip). I was shocked when I first read the article, which states that when micro-slip occurs repeatedly, it causes minute rotational loosening as small as 1 degree per 1,000 times or 1/1000 degree each time. A 1/1000-degree rotation is not at all observable to the eye. With the finite element

method, it can be studied perfectly and it was demonstrated that micro-slip causes rotational loosening. I felt I was in trouble! [Laughs] The results drastically shook the concept of critical amount of slip.

I had thought that micro-slip would naturally lead to fretting wear, but didn't consider that it could cause rotational loosening. I had no way of testing that at the time. It was an eye-opening experience." ■

KEISUKE OKADA



Bolted joint engineering – Fundamentals and applications

FACTS: DOCTOR TOMOTSUGU SAKAI

- 1941 – Born in Okazaki City, Japan
- 1979 – After working for Toyota Motor Corporation, receives his doctoral degree in engineering, mainly engaging in the strength and durability testing, research and development of various automobile parts.
- 2001 – Transfers to Toyota Techno Service Corp, engaging in education and technical consultation for threaded fasteners.
- 2007 – Retires and establishes Sakai Consulting Office on Bolted Joint Engineering, where he provides education and technical consultation for bolt fastening to this day.

From A to Z – in a new video

DON'T MISS the new Nord-Lock Bolted video. Following the video about how wedge-locking washers significantly improved safety in a power ascender, the company is now premiering a video about Superbolt Expansion bolts.

This time, the focus is on the hands-on aspects of the product. The video takes you through an entire Superbolt Expansion bolt installation, from preparation and positioning to the fitting of the bolts into the holes when aligned.

The video was filmed on location at the EDF hydro electric power station, Usine Électrique de Malgovert, in the beautiful French Alps, where electricity generator giant EDF joined forces with the Nord-Lock Group to install Superbolt on the Malgovert turbines.

"EDF CHOSE SUPERBOLT Expansion bolts to simplify future maintenance. Ease of installation and removal due to the expanding sleeve technology insures against future damage to coupling bolt and coupling holes. There is no longer a need to re-machine holes or replace bolts," says Steve Brown, expansion bolt specialist with the Nord-Lock Group. "This film is for everyone who wants the optimal bolted coupling, using and making the most of a Superbolt installation." ■

www.nord-lock.com/install-expansion-bolt.



Flying high with Nord-Lock



LOOK UP INTO THE SKY in the coastal city of Miri, in north-eastern Sarawak, Malaysia, and you may see Nord-Lock washers in action: inside a radio-controlled aircraft. These hob-

by airplanes are sold by Beyond Horizon, a business that otherwise uses drones to take aerial photos and videos for companies.

"Unlike our drones, these recrea-

tional aircraft use gasoline-powered engines," says Mr. M. Fadzly of Beyond Horizon. "These engines cause a vibration problem. Since the frame is made of wood, which is soft, and the engine and its mounting are made of steel, the bolts holding them together can come loose after only four or five flights."

Fadzly says that it can be difficult to access the plane's engine, so the loosening is a real problem. A friend of Fadzly's, however, works at Mayura Engineering and is a supplier of Nord-Lock washers.

"I ordered a box, tried them out, and now I recommend them to all of my customers when we are assembling their airplanes," says Fadzly. "The Nord-Lock washers never need to be retightened, and they also

make sure the engine stays in place. It would be quite dangerous if the engine were to fall out during flight."

Fadzly not only sells the radio-controlled airplanes, he flies them himself. "I've been doing it since 1997," he says. "It's a passion, and a fun thing to do on the weekend. It gives you the feeling of flying a real airplane." ■

CHAD HENDERSON



NUMBER ONE AT BEING FIRST

Nord-Lock Group was **the first** to bring you the wedge-locking washer. **The first** to develop the multi-jackbolt tensioner. **The first** to make pivot repairs with line boring and welding obsolete. And **the first** to unite the industry's leading bolting solutions into one comprehensive offer.

Now we can proudly add **being first** in our industry to offer lifetime warranty.

There are a lot of good reasons Nord-Lock Group is **number one** in secure bolting solutions worldwide. Now there's an even better one.

Details coming soon on our website
www.nord-lock.com

