BOLTED

A MAGAZINE ABOUT BOLTING TECHNOLOGIES

ISSUE 2 - 2021

THE ONGOING EVOLUTION OF THE

MATERIAL WORLD

HISINGS BRIDGE
A new landmark in the city of Gothenburg

IN THE SPOTLIGHT
Luisa Moralejo shares experience from a career in nuclear power plant safety

A WINNING COMBINATION
A three-product solution to common gas turbine 4-way joint leaks

NORD-LOCK GROUP

www.bolted.com

MANAGING EDITOR
Alexander Wennberg
alexander.wennberg@nord-lock.com

ASSISTANT EDITOR
Kelvin Slesser-Marriott

ART DIRECTION & DESIGN
Gabriel Jacobi

CONTENT PRODUCTION
Nord-Lock Group
Spoon Agency

TRANSLATION
LanguageWire

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Feel free to contact us with any comments at **info@nord-lock.com**

Fredrik Meuller
CEO Nord-Lock Group

Light at the end of the tunnel

A record investment year at Nord-Lock Group saw us upgrading our operational platform and modernizing three out of six factories in 2020. By preparing to meet the rising demand of our customers, through more productive, safe, and sustainable manufacturing, we've certainly 'earned our right to grow' — coming out of the pandemic stronger than ever before.

As the world is gradually recovering from the pandemic, having bridged most of its troubled waters, we look at some remarkable engineering projects that have recently come to fruition, such as the landmark Hisings Bridge here in Sweden. Having learned so much about bridge design, construction and maintenance — we're happy to continue sharing our knowledge with you in this edition of Bolted Magazine.

We also look at the ongoing evolution of the material world, as scientists and engineers continue the elusive search for the perfect balance of physical properties, sustainability, and cost to select materials for industrial applications.

In a previous issue, we highlighted the need for critical infrastructure to be built with greater resilience against natural and man-made disasters.

Now, ten years since the Fukushima disaster, we talk to nuclear safety and inspections expert Luisa Morajelo about maintaining the structural integrity of critical systems in an environment where failure can be catastrophic.

Staying with power generation, we also look at how a recent partnership produced a market-leading solution to 4-way joint leaks in gas turbines. With a combination of multi-jackbolt tensioners, hydraulic closure systems, and alignment tensioners — this is a truly smart example of the Nord-Lock Group's mission to safeguard human lives and customer investments.

Then, travel deep into the South American forest to discover how Log Max handles the demanding process of eucalyptus harvesting. Plus, there's Nord-Lock secured marine fenders bracing South Korean ports for collisions with wayward ships. And finally, a reminder that in an increasingly complex world, joy can be found in the simplest of places with the Spanish game of Spiribol — fastened with Nord-Lock wedge-locking washers!

As always, I wish you a happy reading!

CREATING A LANDMARK BRIDGE

Text
Hanna Klumbies

Photos
Göteborgs Stad
Tomorrow AB
Max Hjalmarsson

In Gothenburg, the new Hisings Bridge — a vertical-lift bridge — will connect the north and south banks of the Göta Älv river while allowing ships to pass. Extraordinary attention to design details and functionality has helped create something larger than the sum of its parts.

In May 2021, the Hisings Bridge (Hisingsbron) in Gothenburg, Sweden, opened to transport across the Göta Älv river. First out were cars, buses, bicycles and pedestrians. The tram rails were finished during the summer.

Commissioned by the Traffic and Public Transport Authority of Gothenburg, the project design started in 2009 and construction in 2016. Reliability and the use of proven technology were vital requirements in their specification for the lift span and its machinery. A joint venture between Skanska and MT Højgaard won the tender and ran the project.

In the 2013 design competition, there were suggestions for different types of movable bridges: bascule bridges, swing bridges and vertical-lift bridges. The winner was a vertical-lift bridge, called Arpeggio, designed by a consortium of architectural firms and project designers. The jury's decision focused on viability, development and functionality.

The bridge will be a symbol of Gothenburg, a landmark associated with the city, in harmony with its character and landscape.

The Arpeggio design is solid, with strong dimensions and a proven technical solution. The open water under the bridge, which will contribute to a vibrant environment of urban sports and boating, was also a positive factor.

Many suggestions before finding the right one

The Hisings Bridge is a 440-meter long vertical-lift bridge where a central lift span, supported by four steel towers (pylons), is raised to 28 meters when a ship needs to pass. After each lift, the lift span must return to the 12-meter level with exact precision so that the lift span tram tracks align perfectly with those on the roadway.

Construction engineers ELU designed the steel pylons and the roadway. They commissioned Tikab Strukturmekanik AB to develop the lift span machinery. Peter Lassfolk, Mechanical Design Engineer and Network Administrator at Tikab, designed the machinery together with his team.

Peter Lassfolk
MECHANICAL DESIGN ENGINEER AND NETWORK ADMINISTRATOR, TIKAB

THE HISINGS BRRIDGE
HISINGSBRON

INAUGURATED	END CUSTOMER
2021	CITY OF GOTHENBURG

TOTAL LENGTH	DESIGN	THE SOLUTION
440 METERS	TIKAB	EXPANDER SYSTEM

BENEFITS
EASY ASSEMBLY, INCREASED SERVICE LIFE AND MINIMAL MAINTENANCE

Lassfolk says that the Hisings Bridge was one of his most demanding assignments:

"The biggest challenge was to develop machinery that could fit the limited space. It was complicated, and we scrutinized quite a few different solutions before deciding on the current one."

Complex system for the lift span

It is vital that the 37-meter-wide lift span, which weighs 800 tons, can be raised and lowered quickly. It is fixed to 16 cables, four in each corner. The cables go up to cable wheels at the top of the pylons, then down to a counterweight. Four thinner cables connect to machinery that pulls the counterweight.

When the lift span is raised, it is actually the counterweight that is pulled down. When the lift span is lowered, the lifting force is removed so that the lift span's weight makes it stay down. In each pylon, there are two large hooks that, through a jack, pull down the lift span, removing the lifting forces. The Expander System is attached to those hooks.

Tikab was in charge of the design, and SH Group manufactured and tested the machinery. Tikab suggested the use of Expander System, and SH Group agreed that this was the best solution. Expander System is a solution to lug wear consisting of three main parts: a pin in the middle and two expansion sleeves, which are installed directly in the existing mounting. When you tighten fasteners from the sides, the expansion sleeves are pressed up the tapered ends of the pin, expanding and conforming to the mounting.

Reliability and long service life

"We're using an extra-large, tailor-made Expander axle," Lassfolk explains.

"The main advantage is how they facilitated the assembly. We needed to install big components into a rather narrow space, and using Expander System was a smooth process."

Using Expander System also increases service life while minimizing maintenance. Usually, axle movement causes lug wear, which over time makes the holes oval and increases the play.

"If you use Expander System, you remove that play," says Brian Troest, Country Manager Denmark and Sweden, Nord-Lock Group. "The pin must be smaller than the hole to pass through it. However the expansion sleeves adjust this difference between the hole diameter and the pin diameter."

Outlasting other alternatives

When you tighten the bolt or nut on the side, the expansion sleeve is pushed into the hole, where it expands with an outer cone on the shaft and an inner cone in the sleeve. "Then you get a secure fit that doesn't cause any problems and which will outlast any alternative solution," says Troest.

Over the years, Lassfolk has used Expander System in several designs. "It was natural to choose this solution for the Hisings Bridge project. You obviously want to use high-quality products," he concludes.

Brian Troest
COUNTRY MANAGER
DENMARK AND SWEDEN
NORD-LOCK GROUP

This article is taken from Nord-Lock Group's white paper **Bridge Design, Construction & Maintenance: Insights and Best Practices for a Rapidly Changing Sector (2021)**

To read and download the 70-page white paper, go to **nord-lock.com/bridge-construction**

Many European bridges are part of an aging infrastructure built during the mid-20th century. This calls for maintenance, as well as newer bridges that better correspond to rising traffic needs. History, regional preferences and bridge type are all key contextual factors that influence the joining methods used in bridge construction and maintenance.

The following text explores this topic in detail. It is an excerpt from the white paper **Bridge Design, Construction & Maintenance: Insights and Best Practices for a Rapidly Changing Sector**, produced by Nord-Lock Group.

BEST PRACTICES FOR BETTER BRIDGE CONSTRUCTION

Comparing joining methods: welding and bolting

There are many factors to consider when deciding whether to use welding or bolting to join bridge components together. In some instances, existing preferences may dictate this decision, however, it is important to consider each project separately in order to make the best decision.

A hard choice to make

Historically, bridges and other steel structures were riveted such as the Golden Gate Bridge. This process includes heat treating and forging the rivet after which it is cooled through a process called annealing. Individual rivets are not very strong, meaning that many must be used in order to assure the safety of a structure. It is also a cumbersome process and is no longer used within the bridge-building sector. Therefore, although riveted bridges are no longer built, existing bridges that use rivets still need to be maintained. Bolts are often used to replace worn rivets and high-strength bolts in particular are specifically designed to resemble rivets. Welding is not a viable option to maintain the joints on old bridges due to the degradation of the bridge material, which would make it unsafe.

Bolting and welding are currently the two most popular methods to join components together. When it comes to which method to use, the decision can be as controversial and country specific as that of deciding between concrete and steel. It must also be noted that the welding qualification level in some countries is very high and this is an example of how national contexts play a role in the preferred construction methods.

Bridge type

Apart from the influence of national preference, there are a few important factors that can determine whether parts should be welded or bolted. One of these is the type of bridge that is being built — see infographic.

For larger bridges, hollow box cross-sections are often used as they absorb torsional stress very well and only the outside has to be considered when planning corrosion protection. The downside of hollow box cross-sections is that they can only be approached from one side, making it difficult to use a bolted connection. Thus, welding is the most logical method to use. Tolerance and offset compensation are also relevant for larger structures. There is no margin of error for bolted joints as the bolts must fit precisely in the pre-existing holes. Welding is much more flexible as you can compensate offsets if necessary.

Truss bridges, on the other hand, could very well be bolted due to their interlocking triangular sections. However, size must also be taken into account and small truss bridges could potentially be welded together in the production hall and transported as a whole to the construction site. Nevertheless, even if welding is the preferred connection method, bolted joints will still be widely used across the bridge. This is because secondary structures such as railings and noise walls are commonly bolted. These primary structures (e.g. cable clamps, bearings, transition joints structures) are also dynamically loaded to compensate for bridge movement.

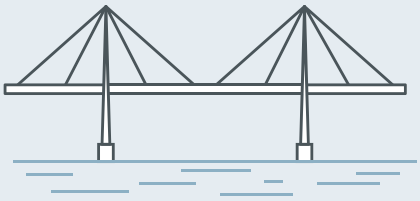
Temporary bridges are almost exclusively bolted due to the fact that they are dismantled every few years and rebuilt elsewhere. Since bolting creates a temporary joint connection, these joints can be easily taken apart and the bolts and washers themselves reused. Since welding creates a permanent joint connection, it is very complicated, costly and time consuming to use it for a temporary bridge. A large amount of effort would have to be put into first creating the welds and then undoing them. In this way, bolting is a much more efficient and advantageous method to use.

Efficiency and ease of use

Efficiency and ease of use are also important factors to consider regarding welding or bolting. Included in this is the decision to make the connection at the factory or on site. Welding often requires a certified welder, advanced tooling and can be considered risky due to the high temperatures involved. Thus, it is quicker and easier to perform this task in a factory where everything is already set up. It is also cheaper to weld in a factory due to the high cost of setting up a welding and testing facility on site, which also contributes to longer bridge erection times.

Indeed, if the connections are to be made on site, bolting is often the easiest and most efficient method to use. This is due to the fact that bolting is a much more controlled operation and does not create any unnecessary risk in a construction environment. The components are also easy to transport and install as they do not require any special equipment to use. Most instances only necessitate a simple handheld torque wrench to operate. Bolting also has the added advantage of not being permanent, unlike welding, which means that unexpected problems are quicker, easier and cheaper to repair.

Text Ariane Osman **Photo** Carlos A Antunes/Shutterstock



CABLE-STAYED

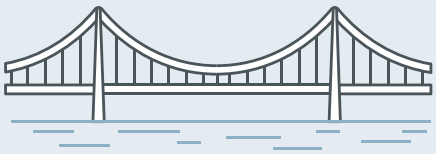
Famous example
Millau Bridge, France

⊕ PROS

+ Attractive bridge.
+ Quicker and cheaper to build than suspension bridges.
+ High level of stiffness.

⊖ CONS

- More expensive than most bridge types.



SUSPENSION

Famous example
Golden Gate Bridge, USA

⊕ PROS

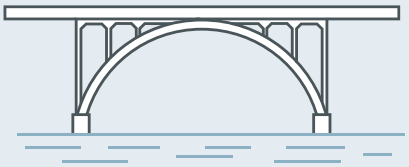
+ Attractive and iconic bridge design.
+ Cover large distances.
+ Large ships can pass underneath.
+ Very strong.

⊖ CONS

- Expensive to construct.
- Long time to build.
- Susceptible to vibration.

FROM STONE-ARCH TO SPACE-AGE

Bridge type is a critical factor when deciding if you should weld or bolt parts during construction. There are many different bridge types, which in turn can have many variations. The following are six common bridge types with their respective pros and cons.



ARCH

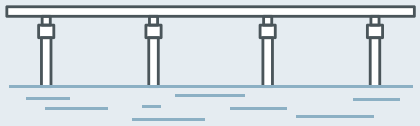
Famous example
Charles Bridge, Czech Republic

⊕ PROS

+ Very strong bridge that can be used for multiple purposes.
+ Can be constructed from many materials.

⊖ CONS

- Expensive to construct.
- Long time to build.
- Susceptible to vibration.



BEAM

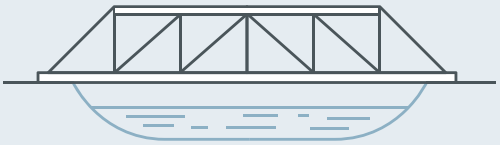
Famous example
Tianjin Grand Bridge, China

⊕ PROS

+ Simple design.
+ Cheaper to build than most bridges.

⊖ CONS

- Viewed as unattractive.
- Only appropriate for small spans.
- Needs columns.



TRUSS

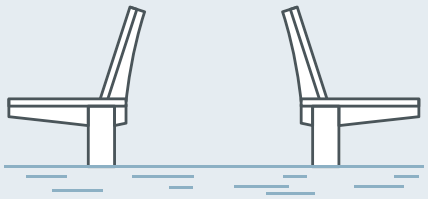
Famous example
Sky Gate Bridge R, Japan

⊕ PROS

+ Very strong.
+ Easy to prefabricate.
+ Low building height.

⊖ CONS

- Difficult to build and maintain.
- Difficult to protect from corrosion due to the many truss sections.



MOVABLE

Famous example
London Tower Bridge, UK

⊕ PROS

+ Provides alternative when fixed bridges cannot be used.

⊖ CONS

- Bridge traffic is stopped while the bridge is open.

More than two decades ago, Luisa Moralejo began her career as a non-destructive testing (NDT) inspector within the nuclear industry.

She has since performed NDT inspections and supervisions in nuclear components both in fabrication and during in-service inspection (ISI). She is also an NDT trainer. These days, Moralejo carries out NDT supervision during ISIs at nuclear power plants in Spain.

What attracted you to the nuclear sector and non-destructive testing (NDT)?

In my first job in the nuclear sector, I assisted the teams who carried out the NDT work during the ISI at the Santa María de Garoña nuclear power plant in Burgos, northern Spain. That first contact lasted a few weeks, but its impact has stayed with me for more than twenty years. I was hooked by my curiosity to understand everything: the operations of the plant, the functioning of each system, the logic of every protocol and the inspection processes.

"Everything was fascinating to me and, even today, it still is."

Nowadays, I work as an NDT supervisor and a staff trainer. Teaching is very gratifying. I find it incredibly satisfying to share my knowledge and awaken the interest of my students in NDT.

What is non-destructive testing? How and why are these tests used in nuclear power plants?

NDT is carried out on welds, components or systems. It enables us to analyze the state of the materials without causing any deterioration. The tests make it possible to identify and evaluate damage such as cracks, wear and tear, loss of thickness, or other flaws, making them an essential part of the predictive and corrective maintenance of a nuclear plant. NDT is performed during plant operation, maintenance outages, or design changes. You might say it's just another feature of the day-to-day running of the plant.

LUISA MORALEJO

What happens during a refueling outage at a nuclear power plant?
Nuclear power plants plan their maintenance work and ISIs during refueling outages. It requires many tasks to be completed in a short space of time, so they are carefully planned to ensure that one does not interfere with the other. There is usually a defined window of time in which to carry out each operation. Personnel are used to working under these circumstances and do the job well and on time. However, unpredicted issues are inevitable and, when they do arise, they upset schedules, so it's necessary to adjust to changes on the go. Aside from all the tension, we also share some hilarious moments. There are countless jokes among us nuclear professionals during the day-to-day running of an outage that wouldn't make sense to anyone else from outside of our world.

Ten years have passed since the Fukushima nuclear disaster. What has changed since then, and what have we learned?
Following the Fukushima accident, all European nuclear power plants were asked to reassess their safety margins through so-called stress tests. The lessons learned from the accident were assessed. This evaluation led to the implementation of a series of measures intended to make plants more robust and able to withstand extreme natural phenomena. It also resulted in the implementation of new Alternative Emergency Control Centers, improved refrigeration systems and the acquisition of portable equipment to mitigate the consequences of accidents, among other things.

The ITER nuclear fusion project has brought together 35 nations collaborating to build the world's largest tokamak. This magnetic fusion device will be the first of its kind to deliver net energy. Why are you excited about it?
The ITER project represents a scientific milestone and an unprecedented technological achievement in our search for clean, safe and inexpensive energy. Years ago, I collaborated in developing the NDT processes for ITER — specifically the ultrasonic testing for the evaluation of the weld joints of the Reactor Vacuum Vessel sectors. That work linked me to ITER, and I continue to follow its progress with great interest.

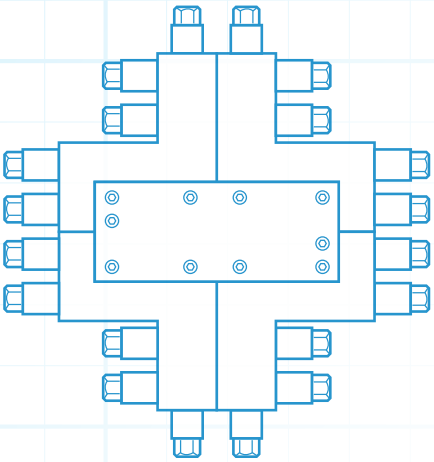
Text Isabelle Kliger **Photos** Manu Ruiz

Name
Luisa Moralejo

Title
Engineer and NDT Level 3

Professional Background
Twenty years in nuclear NDT, including ten years at Santa María de Garoña NPP, ten years at Vandellòs II NPP. Currently working as a freelance NDT supervisor and staff trainer.

Personal qualities
"I believe being a meticulous and methodical person has helped my career development enormously. These are essential characteristics for someone who has to maintain consistency and quality in critical processes such as nuclear inspections."



Leaks in a gas turbine not only cause forced outages and damage to critical equipment, but can also pose a significant safety hazard. By combining multiple products and technologies, Nord-Lock Group has devised a combination of solutions to solve common 501F gas turbine 4-way joint leaks.

THE 4-WAY JOINT SOLUTION

Text Nic Townsend **Photos** Chris Fogler

4-way joint leaks in gas turbines typically occur over time as extreme thermal variations and startups cause turbine cylinders to warp and distort. Cylinder misalignments compound the problem because flange surfaces don't maintain the maximum contact area needed to ensure a proper seal, allowing leaks to occur.

Leaks can cause significant damage to turbine instrumentation and insulation and may jeopardize operations and workplace safety. Recently, Nord-Lock Group partnered with a 501F gas turbine fleet owner who had experienced such leaks for over 20 years. Together they ran a joint R&D project to find a better solution.

A need for a more permanent solution

"Previous fixes available to fleet owners have been either temporary in nature or consist more of containing the leak rather than stopping it," says Jeremy Hersom, Business Development Manager, Power Generation, at Nord-Lock Group.

A popular type of containment fix is to weld-on leak boxes. However, apart from failing to stop the leak, they also require removal and reinstallation during an outage – adding time and cost to the outage schedule.

Jeremy Hersom
BUSINESS DEVELOPMENT MANAGER, POWER GENERATION, NORD-LOCK GROUP

"Previous fixes also tended to focus on a singular cause to solve the leakage issue," Hersom says. "By contrast, our solution combines multiple products and technologies across our product portfolio to address multiple contributing causes for leaks."

During the project, Nord-Lock Group power generation experts had open access to the fleet owner's turbines so they could study cylinder configurations and leak causes.

"Having open access to the 501F gas turbines proved critical to the successful diagnosis of multiple contributing factors to leakage," says Hersom.

"This was very much a learning process over time, as several solutions were developed and tested."

Ingenious combination of technologies

After comprehensive testing, the most effective solution was a combination of multiple Nord-Lock Group products and technologies. To start, a Boltight Hydraulic Closure System (HCS) is used to quickly and temporarily ensure the cylinders are aligned and that the 4-way joint is tensioned. If, after the cylinder has been squeezed by the HCS, a bolt hole or flange is still misaligned, a CamAlign tensioner system is used to realign the cylinder. This can close an internal gap by 2-4 millimetres, ensuring the smallest possible gap is achieved.

The HCS is pressurized to simultaneously and uniformly squeeze the turbine cylinder around the 4-way joint – thus isolating the area. Multiple hydraulic tensioners maintain the pressure while internal and external gap readings are recorded, and the cylinder alignment is checked.

Once these adjustments are complete and the 4-way joint is correctly aligned, the joint is again squeezed using the HCS, which allows the load to be transferred to the Superbolt mechanical multi-jackbolt tensioners to permanently tension the joint. Rather than tension each bolt one at a time, which can create movement in the load, the HCS immobilizes the entire joint and maintains total stability as each bolt is tensioned.

Boltight's Hydraulic Closure System was essential for alignment

Finally, an internal seal is installed as an added layer of protection in the area where the combustor cylinder and turbine sections meet. This eliminates any leakage not prevented by realigning the cylinders.

The best solution on the market

The combination of Nord-Lock Group solutions – including multi-jackbolt tensioners, hydraulic closure systems, and alignment tensioners – has since been tested and trialled in the fleet owner's operations and has proven effective in preventing 4-way joint leaks. There have been no forced shutdowns due to instrumentation or insulation damage and it has provided a safer working environment inside the turbine enclosure.

The overall feedback from the turbine fleet owner is that "it is the best solution for 4-way joint leaks currently on the market."

While this particular solution is unique to 501F fleet owners and their specific turbines, the knowledge and experience gained will prove valuable for Nord-Lock going forward.

"Turbines share a common principle: a wheel or rotor revolves to produce power through movement," explains Peter Miranda, Regional Sales Director, Nord-Lock Group. "The lessons learned by our Power Generation experts increases our expertise and can be applied to solve similar leakage problems."

Peter Miranda
REGIONAL SALES DIRECTOR, NORD-LOCK GROUP

Superbolt multi-jackbolt tensioners take high preload requirements and break them down into manageable torques using the jackbolts threaded through the nut body. They are easy to install, even on larger sizes, compared to standard hex bolts.

THE ONGOING EVOLUTION OF THE

MATERIAL WORLD

Text Brian Cloughley
Illustration Gabriel Jacobi

For any mechanical or civil engineering project, material selection has always involved trade-offs.

With so many variables — dozens of physical properties, cost, sustainability — there can never really be a perfect material for any job. Still, engineers and scientists keep on searching.

Finding the perfect material for a specific industrial or construction application can be a complex process. Whether you rely on so-called Ashby charts, multi-criteria analyses or even artificial intelligence, the common thread in the decision-making processes is balancing objectives and constraints.

Recent decades have seen an explosion in the variety of materials available to engineers. It hasn't changed the fundamental need to make trade-offs, but it has perhaps led to a subtler change in this balance, with objectives becoming more important than constraints.

Or, to put it another way, you're more likely to choose materials according to what you want — rather than what you're prepared to give up.

Below, we examine how innovations in material design continue to expand the options and possibilities open to engineers.

Fiber-reinforced composites

When thinking about new materials in almost any industry – aviation, transportation, energy, civil engineering, machine-building and many more – you inevitably start with composites. It's more of a category than a material because a composite can be any combination of two or more materials that results in different properties to those of its components. But in general, in most industries, 'composite' refers to a combination of polymers and reinforcing materials.

As a concept, this type of composite isn't new. Fiber-reinforced composites — with glass fibers used to strengthen unsaturated polyester resins — were invented in the 1930s. Over the decades that followed, innovations like carbon fibers and the use of epoxy resins led to this technology being used in military and marine applications. But it was the 1970s when it made a genuinely transformative impact.

With rising oil prices, the high strength-to-weight properties of carbon fiber reinforced polymers (CFRPs) became extremely attractive to the aviation industry. Reducing the weight of aircraft becoming economically compelling, which pushed forward the development and commercialization of CFRPs.

Many advantageous properties

The high strength-to-weight ratio arguably remains the most outstanding quality of these composites, but they can have many more valuable properties. These vary according to which polymers are used, but as a rule, CFRPs have high thermal and electrical conductivity, corrosion resistance, tensile strength, and stiffness. Using different reinforcement materials alters these qualities dramatically. For example, if an aramid (a strong synthetic fiber) is used instead of carbon, then the resulting composite will be more flexible, durable and non-conductive.

This diversity of properties helps explain why composites continue to be used in so many industries and applications. Recent innovations have led to CFRPs being used as cables on cable-stayed bridges and, with their damping properties, for fast-moving components in industrial machines.

The primary barrier to using composites even more broadly has been production cost. Besides, using multiple materials and arranging reinforcement fibers in various matrices increases structural complexity and can make it more challenging to predict mechanical behavior and wear. Devising safe and robust joints has also been a challenge in many industries, leading to the development of advanced bolting technologies like Nord-Lock X-Series washers. They employ a spring mechanism to compensate for the slackening that can occur when bolting together two polymers.

Bio-based polymers and composites are promising

Most of the polymers used in industrial applications are still derived from fossil fuels, which raises sustainability issues. In recent years, interest in bio-based polymers, which use renewable resources as a feedstock, has grown rapidly.

Peter Mannberg, a unit manager at independent and state-owned RISE — Research Institutes of Sweden — works in research that tackles polymers and composites' environmental impact.

"Our goal is to find sustainable solutions for lightweight applications," he says. "The most-used composite materials have their origins in fossil oil, both carbon fibers and plastics. We want to replace them with renewable resources. That means using the feedstocks that we have — the available building blocks — to build new materials to replace the ones affecting the environment."

Mannberg's team have looked at forestry and agricultural residues for source materials, but one feedstock in particular seems to have captured his interest. "Reed canary grass grows on marshlands," he says, "so it can be cultivated without using land that would otherwise be used for growing food. That's important. We can use this grass in several different ways to create composites."

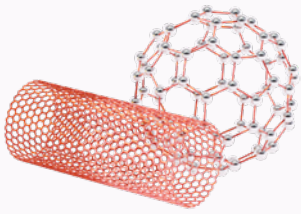
The simplest is to use the stems and wood-like material as reinforcement fiber. The resulting composites, though, have relatively limited applications and are robust enough only for indoor use. A more ambitious method involves using the grass to create carbon fibers.

"For many years at RISE, we've been looking at using lignin to create a fiber, which we then carbonize," Mannberg explains. "You can also do this with cellulose and hemicellulose — the other two basic components in biomass. The lignin from the grass is used to create fibers, which are then carbonized in quite a complicated process."

Carbon fiber

Aramid

Bio-based polymers



Nanocomposites

"The result is carbon fibers, which are the strongest fibers we have at the moment and that can be used for composites in high-level applications."

Replacing fossil-based materials

Of course, this only accounts for one of the components in a carbon fiber composite. Mannberg is optimistic, though, that reed canary grass can also be used for producing polymers.

"Low-quality plastics created from bio-materials are already available on the market, in plastic bags, for instance," Mannberg says. "We're looking to find ways of creating bio-based plastics that can be used in automotive and aeronautic applications, replacing the epoxies and thermosets that are used there. It involves breaking lignin down to a molecular level and building it up to create something that is identical to the materials that are currently derived from oil."

Although some companies are experimenting with using lignin to create carbon fibers, much of the work that Mannberg describes is still at a research stage.

"These are all things that we can do at a lab level," he explains. "At the moment, it's a more expensive process to derive the molecules and create the plastics and fibers than it is to make them from oil. So, it would require a combination of legislation and drive from consumers to get to the point where these products are used commercially."

Peter Mannberg
UNIT MANAGER, RESEARCH INSTITUTES OF SWEDEN

Guan Gong
SENIOR SCIENTIST, RESEARCH INSTITUTES OF SWEDEN

Tailor-made solutions

As an institute that focuses on applied research, RISE is also involved in projects to make it more feasible to work with materials that have for many years been assumed to be the future of engineering materials — nanocomposites.

Nanocomposite is another term that can encompass a wide range of materials. It can describe any composite material where nanoparticles enhance a component part. These are particles that have at least one dimension smaller than 100 nanometers (nm). Incorporating particles of this size can radically alter the physical properties of a material.

Guan Gong is a senior scientist at RISE whose work includes using nanomaterials to modify certain properties of composite materials to suit specific industrial requirements.

"We are interested in using nanomaterials to enhance or modify different properties, according to what the end-users want," she explains.

"For instance, customers could come to us and say, 'I want improved electrical and thermal conductivity, or I just want much better thermal conductivity.' Or, 'I need the composite component to have good barrier properties against oxygen or many other things.' Based on those requirements, we screen nanomaterials to find ones that have those outstanding qualities, then devise and verify a solution. Our general methodology is to first ask, what is required? What is the most critical quality the customer is looking for?"

A demanding and challenging process

Unsurprisingly, it's not quite so simple as looking up a few tables. With the vast range of physical attributes, plus factors like cost, energy efficiency, and ease of production, finding the right combination of nanomaterials, composites and processes is always complicated. Gong explains that this isn't the only barrier to nano-modified composites becoming commonplace:

"The main technical barrier is about dispersion. To convert the outstanding properties of nanomaterials into composite materials, you need to disperse the particles in the composite successfully," Gong says. "You can use different techniques, but it's still very difficult to get the dispersion status that you want, especially when fiber reinforcement is present. Industrial implementation of nano-modified composites is not yet robust.

"Most of the nanomaterials, like carbon nanotubes and graphene, are expensive. The way to get around this is to use very small amounts of nanomaterials, but because we can't reach a good dispersion, you have to use more than is strictly necessary."

Also, following strict safety rules are vital when creating or handling nanomaterial. Otherwise, there may be a threat to human health and the environment.

Nevertheless, Gong's unit has successfully collaborated in this area with many private sector partners, including companies from the aeronautics, marine, automotive, forestry and energy industries.

Titanium
THE PROS AND CONS

Polymers, composites and nanomaterials might command more headlines in science magazines, but innovative applications continue to be devised for more traditional materials. Titanium and titanium alloys have been used for decades because of their high strength-to-weight ratio and corrosion resistance. They even have an advantage over polymer composites in that they have a very high melting point.

One of the main drawbacks of using titanium parts is that they can be challenging to manufacture. Milling is time-consuming and wasteful while melting and moulding require very high energy input because of the element's high melting point. Recent years, however, have seen titanium 3D printing become a reality.

The US military research group DARPA recognized the potential in titanium 3D printing around 15 years ago, when they started devising new ways to produce titanium powder. As a result of this research, titanium powder is now widely available – albeit expensive – and is already used in real-world applications like high-end sports cars and medical implants. Both Boeing and Airbus now use 3D-printed titanium components in new aircraft.

MARINE FENDERS

SOFTENING THE BLOWS

Text Ulf Wiman **Pictures** Sung-min Cho/Hwaseung Corporation

Collisions between vessels and port infrastructure can potentially cause serious harm. Marine fenders are the go-to solution to reduce impact forces, but they need to be installed safely. Nord-Lock wedge-locking washers proved to be the perfect fit in South Korea.

Each year, hundreds of vessels collide with jetties or quays while berthing — sometimes spectacularly. Colliding ships are also quite common. These mishaps are generally due to bad planning, such as miscalculations of speed or wind forces. Lack of communication, for example between a ship's bridge team and the pilot, can also be a problem.

Such accidents may be very costly, causing severe harm to vessels and port infrastructure. In the worst case, people may also get injured or even killed. While a zero incidence for human error is desirable, it will undoubtedly be challenging to achieve.

As for berthing, there are just too many variables involved to eliminate collisions. Therefore, it is always a good idea to proactively try to improve safety and reduce the force of impact. The idea of using marine fenders to absorb these forces is probably almost as old as berthing. Today, there is a broad range of marine fenders — in various materials, shapes and sizes — targeting general or more specific requirements.

A shipbuilding giant

South Korea's coastline spans three cardinal points, and the country has some 3,000 ports of all sizes. Given that South Korea is the world's second-largest commercial shipbuilding nation, surpassed only by China, it comes as no surprise that it is also prominent in marine fender manufacturing.

The company Hwaseung Corporation supplies various types of fenders to the South Korean shipbuilding industry. Hyundai Heavy Industry, Samsung Heavy Industry, Daewoo Shipbuilding & Marine Engineering and STX Offshore & Shipbuilding, the four largest shipbuilding companies in the world in 2020, are among their customers.

Hwaseung Corporation develops and manufactures various fenders, such as arch fenders, marine fenders, pneumatic fenders and submarine fenders. The company's rubber department supplies the raw material.

Vibrations cause bolt loosening

The forces that marine fenders have to absorb causes a lot of vibrations. With the plain washers and split-ring washers that Hwaseung Corporation had traditionally used, bolts often loosened. There hadn't been any significant incident, but the problem increased maintenance work time, and end-users complained.

Nord-Lock Group Korea general manager Alex Keum had previously worked at Hwaseung Corporation and was aware of the situation. Using this knowledge, he contacted his old company to introduce them to wedge-locking as a superior solution to secure the fenders.

"I approached Hwaseung and the end-user at the same time," he says. "Eventually, after several visits and promotions, Nord-Lock washers were incorporated into their design. Of course, having a good relationship with my old colleagues at Hwaseung helped."

Unorthodox choice pays off

Mr Sung-min Cho, Deputy General Manager, Hwaseung Corporation, says, "We thought that the washers would be a good solution."

"We now can say that we have adopted one of the best anti-loosening solutions on the market."

The solution included the large NL52ss wedge-locking washers at critical points of a particular fender, the TR fender. Keum says that it might seem an unorthodox product choice. "I was frank with Hwaseung that these washers can be unsuitable for the splash zone and told them about the corrosion risk," he says.

"But it's now one and a half years since they installed the washers, and there is no corrosion problem."

The installation of the Nord-Lock washers practically solved the bolt loosening problem. And as expected, the maintenance efficiency has also improved. "Since we need to check the bolting points less often compared to the split-ring washers, it saves us a great deal of time," Mr Cho says.

Superior to previous solutions

Hwaseung Corporation is generally satisfied with the solution. "Of course, the locking effect lasts longer than past solutions such as split-ring washers," Mr Cho says. "The environment for this application is harsh, and if the Nord-Lock washers can solve the problem perfectly, Nord-Lock Group can potentially enter another large market."

He says that the end-users have also responded positively and that they intend to use Nord-Lock washers in the future, both for marine fenders and for other applications.

"Alex Keum approached our company for the first time in 2018, and this is how we got to know Nord-Lock," Mr Cho says. "He explained our concerns and alleviated our doubts very well. I think we built a mutual trust — so much so that we recommend Nord-Lock washers to our subsidiaries."

Alex Keum
GENERAL MANAGER, NORD-LOCK GROUP KOREA

Mr Sung-min Cho
DEPUTY GENERAL MANAGER, HWASEUNG CORPORATION

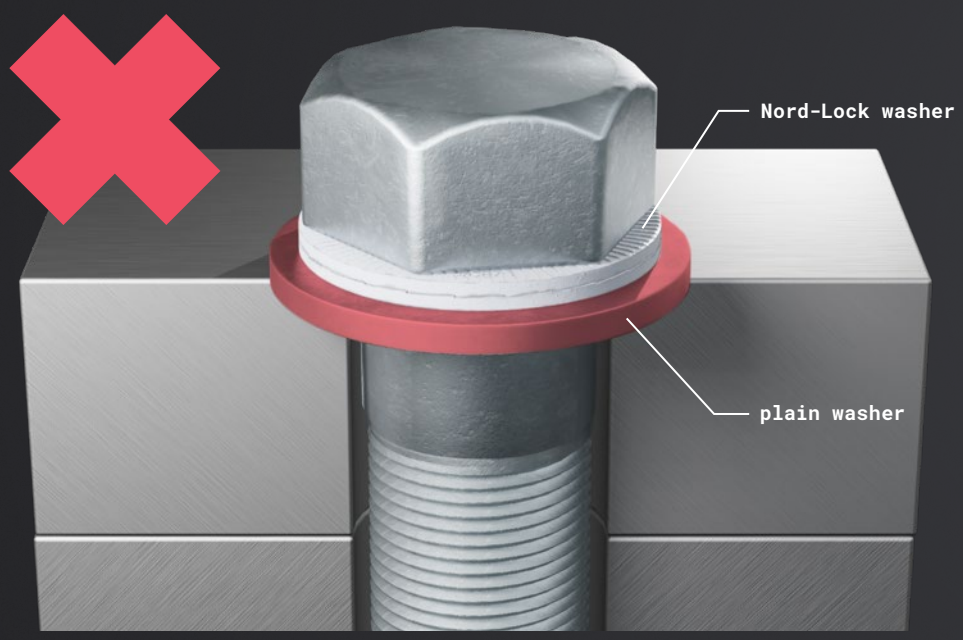
CUSTOMER	ESTABILISHED
HWASEUNG CORPORATION CO., LTD	1978
LOCATION	**APPLICATION**
BUSAN, SOUTH KOREA	PNEUMATIC AND MARINE FENDERS

THE SOLUTION
NORD-LOCK WEDGE-LOCKING WASHERS, NL52ss

Can I use Nord-Lock wedge-locking washers to lock Expander System?

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

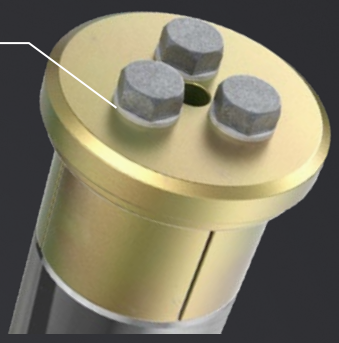
Nord-Lock assembly recommendations advise users to avoid using Nord-Lock washers in combination with a plain washer that can rotate. Here's why:



This is because the Nord-Lock washer will secure the bolt against the plain washer, but it is the friction between the red plain washer and the mating surface that determines the security of the assembly. Since Nord-Lock has no control over that red plain washer, the mating surface nor the friction between them, then Nord-Lock cannot guarantee the locking of the joint. However, some Expander System customers do successfully use Nord-Lock washers in this way to secure Expander System with wedge-locking or increased friction.

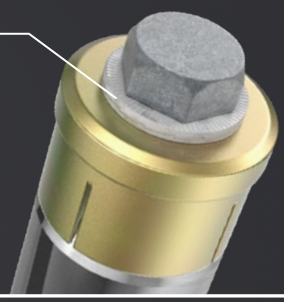
Sonny Halberg
APPLICATION AND SALES ENGINEER, NORD-LOCK GROUP

Jonny Wiberg
ENGINEER, EXPANDER DIVISION NORD-LOCK GROUP



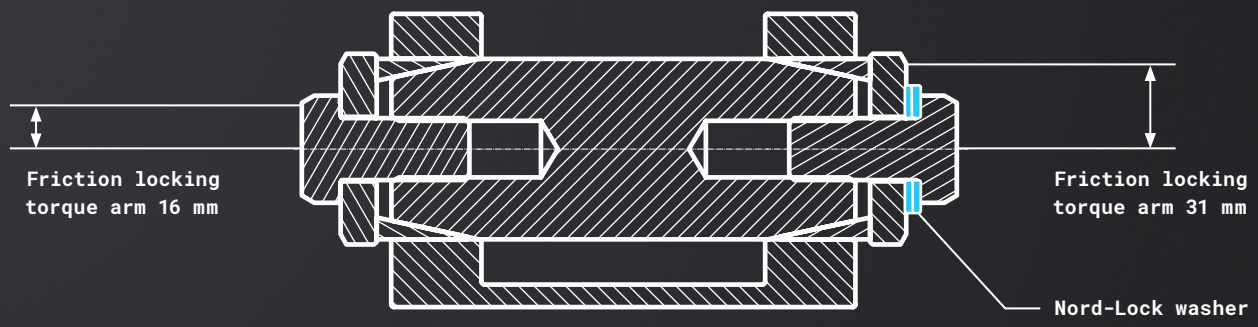
100% wedge locking

For 100% wedge locking there must be no slipping surface under the Nord-Lock washer. For applications with this requirement, the Expander System is typically designed as a multi bolt design that prevents the pressure washer from rotating. In this case, the assembly meets the general mounting recommendations of Nord-Lock washers being assembled against a surface that is not able to rotate. The Nord-Lock washer will provide secure locking of the bolts.



Improved friction locking

If you decide that improved locking is sufficient for your application, then adding Nord-Lock washers to any Expander system will make it harder for the bolts to rotate loose.



Let´s look at an example. The torqued bolt on the left side on the Expander System is held in place by the friction between the bolt head and the pressure washer. The friction force equals preload x friction and the friction force is applied at a torque arm of 16 mm.

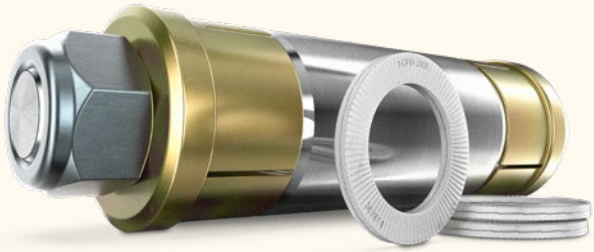
The bolt on the right-hand side includes Nord-Lock washers, resulting in 100% wedge-locking between the bolt and the pressure washer. In this way the bolt is held in place by the friction between the pressure washer and the sleeve. The friction force is applied at a torque arm of 31 mm.

For all friction locking, the mentioned torque arm is an essential parameter. Double the torque arm and it will be twice as hard for the bolt to rotate loose (providing all other parameters are equal). In this example, the torque arm is increased with a factor of 31/16=1,93 and it follows that the friction locking is thereby improved with a factor of about 2.

There is one more advantage of moving the rotation point from between the head of the bolt and the pressure washer to between the pressure washer and the sleeve. The head of the bolt is harder than the sleeve and therefore the friction coefficient between the head of the bolt and the pressure washer is lower than the friction coefficient between the pressure washers and the sleeve. The higher friction and the larger distance from the rotating axis or centreline of the bolt makes it harder for the bolt to rotate loose.

SECURED BY

RELIABILITY IN THE TOUGHEST OF FORESTS



Forest harvesting can be extremely tough on the equipment, and the often-remote workplaces may add days to any production downtime while waiting for machine repairs. Expander System and Nord-Lock washers help Log Max to maintain uptime of key equipment

If you're in the forestry industry, you know the importance of durable, reliable and effective equipment. The forest can be a remote and unforgiving place, and when you're out logging, there is just no scope for machine malfunctions and production downtime. You also want to avoid any incidents or accidents that threaten operator or equipment safety.

You also don't need reminding about the hassle, frustration and waste of time linked to getting broken-down machinery transported from the forest to the workshop, fixed, and returned. These avoidable delays see your productivity — and thus profitability — go up in smoke.

A market-leading forestry manufacturer

The Swedish company Log Max has made its name delivering sturdy and innovative forestry equipment. They provide single grip harvester heads, which are mounted on a carrier, such as a large tractor, an excavator or log loader, or a purpose-built forestry machine.

Working out of the small village of Grangärde in the middle of a Swedish forestry district, Log Max has built a strong position in the global market. Of around 500 harvester heads produced each year, about 70 percent are exported, mainly to Europe, North and South America and Russia. The company is part of the Komatsu Group since 2012.

"We don't provide the carrier, but we're a big, well-known player around the world," says Johan Ericson, head of the design department.

Painstaking development process

Log Max aims to launch at least two new or updated product models each year. Currently, the product range includes 14 models but also a dedicated control system. Log Max holds several patents, such as the Active Friction Control system that adjusts the knife to the application, improving timber quality and reducing fuel consumption.

Ericson explains that a lot of development and testing go into every new model. A long list of continuous product improvements proves it, but it can be a time-consuming business. "Our products go through a lengthy development process," he says.

"We are very thorough because anything that we launch must be of the highest quality."

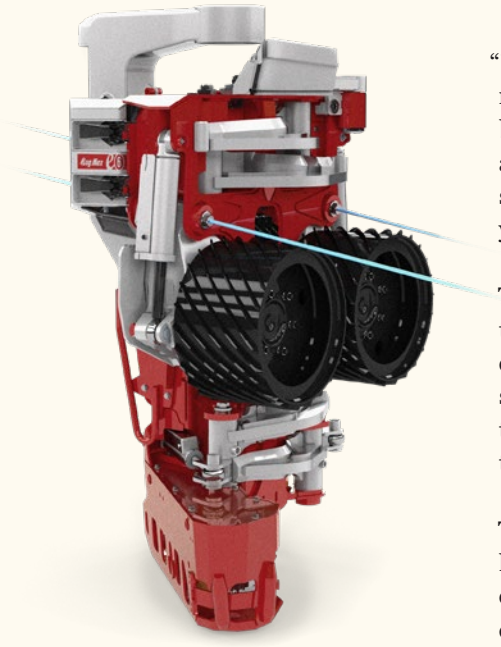
In common with many other manufacturers that produce solutions for harsh environments and demanding applications, Log Max relies on Nord-Lock wedge-locking washers to reduce the risk of failing bolted joints. Mechanical engineer Per Andersson says that Log Max used them when he was hired 20 years ago. Today, they are a given in the design.

"Our steel frames have many threaded holes where there is no nut in the bolted joint," Andersson says. "The Nord-Lock washer design prevents the bolts from loosening."

Expander crucial for very demanding forestry

Log Max uses Expander System extensively as a service and repair method during maintenance. The Expander System is also standard fitted from the factory on Log Max E6 harvesting head for eucalyptus, mainly targeting the South American market.

Logging doesn't come much harsher than eucalyptus tree harvesting. The application is very rough on the equipment, and Log Max developed the E6 head to meet the demands. It features five knives for debarking and delimbing as well as special feed rollers that help rotate the log.



"Unlike traditional harvesting, you also rotate the eucalyptus log while moving it back and forth for more efficient debarking and delimbing," Ericson explains. "There shouldn't be any bark left on the log when you send it for further processing."

The fact that eucalyptus absorbs sand from the ground into the bark further complicates the debarking. In practice, Andersson says, "It's like running sandpaper through the machine, very abrasive, which adds to the wear and tear."

The strains and stresses that the E6 head is exposed to are quite unlike those of Log Max' other harvesting heads. The decision to make the Expander System a standard feature was customer-driven, Andersson says.

"The Expander System is very durable, and you don't need any special tools for maintenance," he says.

"For example, you need to sharpen the knives quite often, and anything that simplifies this and other maintenance will save the customer time and money."

A strong local and global presence

It might seem a long way from a small Swedish village to the South American forests, but Log Max keeps on putting the village on the map. A recent workshop extension has significantly increased the production capacity.

"We're proud of the ways that we contribute to the local environment," Ericson says. "Our headquarters are still in Grangärde, including design and development, production and main sales office but also our main spare parts depot. Most of our subcontractors are also local companies. It's good to know that Komatsu wants us to expand here. I think that means a lot to our long-standing customers."

Text
Ulf Wiman

Pictures
Thanakorn Hongphan/Shutterstock
Thomas Jenkins/Log Max

Johan Ericson
HEAD OF DESIGN, LOG MAX

Per Andersson
MECHANICAL ENGINEER, LOG MAX

CUSTOMER
LOG MAX AB

LOCATION
GRANGÄRDE, SWEDEN

ESTABLISHED
1980

NUMBER OF EMPLOYEES
85

MAIN PRODUCT
GRAPPLE HARVESTERS FOR THE FORESTRY INDUSTRY

MAIN MARKETS
EUROPE, NORTH AND SOUTH AMERICA, RUSSIA

NORD-LOCK GROUP SOLUTIONS
NORD-LOCK WEDGE-LOCKING WASHERS, EXPANDER SYSTEM PIVOT PINS

HAVING A BALL WITH SPIRIBOL

They say the simple things in life are often the best, which certainly rings true for Spiribol. The development of this humble solution, made of a ball, a mast and a rope, currently brings joy to people across Spain.

The story of the "Spiribol" began in Granada, in the south of Spain, back in the 1920s. Baltasar Fábregas created a rudimentary device for his 11 children to play with. He joined a tennis ball to a pole with a rope, and — just like that — a new sport was invented.

Some five decades later, one of Fábregas' grandchildren, Jesús Candel, better known as "Spiriman", commercialized it. A medical doctor, Candel was concerned about the sedentary lifestyles of young people. He recognized the potential of the Spiribol, especially as a game for disadvantaged youths.

Candel created the Spiribol Foundation, which promotes school-based sports and seeks to support young people with social difficulties.

Simple but effective construction

Playing Spiribol involves spinning the ball around the mast. The player who manages to spin the rope all the way so that the ball reaches the yellow mast wins. The base of the Spiribol is joined to the mast mechanism with a pair of Nord-Lock washers positioned between the base and the base-mast connection piece.

"The Nord-Lock washers are an essential part of the current Spiribol model. It's thanks to these components that the mast and base remain stable during the game," explains Chus Hervera, General Coordinator of institutional activities at Spiribol and President of the Spiribol Foundation.

Two worthy objectives

In 2020, Candel was diagnosed with lung cancer. A firm believer in the healing power of physical exercise, he has extended the Spiribol Foundation's work to raise money for Oncology Patient Support Units.

"Spiribol is a solidarity sport with two objectives; to promote physical exercise and make a positive social impact," continues Hervera. "Spiribol can be played anywhere, by people of all ages and fitness levels. As such, the game can bring families closer together and promote social cohesion."

Text Isabelle Kliger **Pictures** Spiribol

COMPANY
SPIRIBOL FOUNDATION

LOCATION
GRANADA, SPAIN

THE SOLUTION
SPIRIBOL CONSISTS OF A BASE, A MAST, A ROPE AND A BALL. THE BASE IS JOINED TO THE MAST MECHANISM USING A PAIR OF NORD-LOCK WASHERS.

PRODUCT
NL18sp WEDGE-LOCKING WASHERS