CONNECTIONS

Peikko guides you towards a faster, safer and more efficient way to design and build.

1*2019

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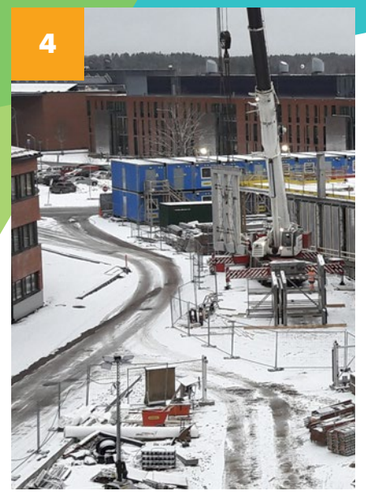

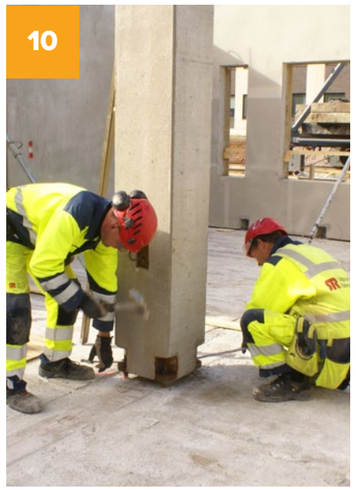

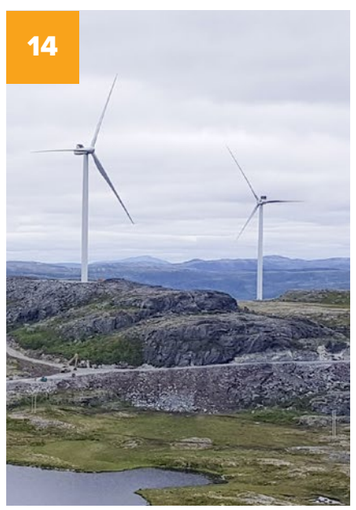

HIGHLIGHTS

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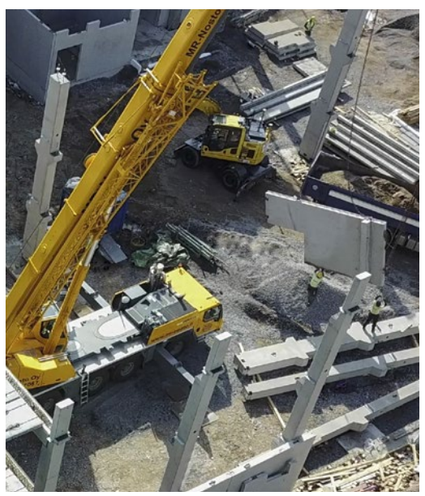
ON THE COVER:

Standardization in Finland enabled efficient production of precast elements. It also created a new, thriving market for subcontractors and companies such as Peikko, allowing them to specialize even further.



HAVE WE MET OUR PROMISES?

Peikko's aim is to provide good technical service and meet the required deliveries with our products. With this year's high growth environment this has been at times a challenge – what is your view?

In 2018, the European construction market has experienced a positive swing with fast growing economies. Peikko has shown strong growth, too. In terms of output, our projected 15% growth for 2018 is equivalent to a very large factory. Or EUR 30 million worth of deliveries.

If construction continues to grow in 2019, Peikko is ready to fulfill the coming needs. We have developed our business with a clear focus on customer needs, investing in our production facilities, introducing new products, product features and services, as well as strengthening our local presence in new areas.

Numerous important actions and improvements have once again been implemented at Peikko. But, our customers are the ones who decide how we have succeeded. So what do you think? Have we been able to keep what we have promised? Have we delivered? Have we been able to give the technical service you need?

We would really like to hear your comments. Feel free to give feedback, either directly to me or to one of my colleagues.

Looking forward to hearing from you,

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COLD FACTS OF WINTER

Since 2004, Jussi Lahti has worked as a Site Manager in many challenging winter projects in the greater Helsinki area. Currently he's waiting for winter to come at Aalto University School of Business site.

Those who have experienced the grip of winter on a construction site know that dealing with it requires skills that fair weather builders never need.

Site Manager **Jussi Lahti** of SRV Construction Ltd. is a veteran of many Finnish winter projects. He has a strong opinion on the subject and doesn't really look forward to winter.

"I think that you should avoid building in winter. It's a pain regardless of the project phase."

With pain he doesn't mean only subzero temperatures but also hail, sleet, and snow.

"Of course, we have learned to make things work in winter. However, there are often extra costs which are seldom taken into account beforehand."

DEALING WITH TEMPERATURE AND COSTS

So for Lahti, building in winter requires no witchcraft. You just need to take care of a few seemingly simple things.

"Keep everything clear of snow and don't let anything freeze."

But even something as elementary as keeping the excavation for foundation dry and unfrozen can be problematic. If the excavation freezes, it needs to be melted again as you cannot cast concrete on frozen soil. It all costs a lot.

"Keeping things unfrozen is the reason why you can expect to pay up to 20% more in winter compared to building in summer months."

To illustrate the fact, Lahti recounts what happened some years ago when they couldn't use district heating on site as planned.

"We had to rent three additional oil heater containers, which made a huge, unexpected hole in the budget."

So Jussi Lahti calls for careful planning, but he reminds that the cold season can wreck even the best-laid plans.

"If frame erection is postponed to winter for some reason, you will surely get problems. If the frame is delayed, it's next to impossible to catch up the schedule," he says.

WHAT ABOUT THE BUILDING METHODS?

The jury is still out on the building methods as both cast-in-situ and precast have their virtues and challenges. Jussi Lahti has no clear favorite.

"Of course, building with precast is quicker and you can get longer spans than with cast-in-place. But I have to admit that I love the smell of fresh concrete in the morning. And casting concrete is always manly," Lahti laughs.

He's quick to remind the cast-in-place advocates that concrete always has a price premium in winter.

"Compared to summer, concrete has to be much warmer when poured. The temperature can be as high as 35 degrees Celsius (95 Fahrenheit). You need to have a higher strength class to facilitate faster reaction and more heat to avoid freezing," Lahti says.

HIGHLIGHTS

If concrete freezes before a compressive strength of around 500 psi is attained, it can lose up to 50% of its ultimate strength.

"With faster setting concrete, you can also dismantle the forms earlier."

Even pumping the concrete can be a challenge.

"The boom pipes have to be insulated so that the mass doesn't lose heat too quickly. Also heating cords need to be installed in the reinforcement. All this affects costs and schedules."

On the other hand, large amounts of concrete develop exothermic heat.

"When you're casting a wall, you normally have around 10 m^3 (14 cu yd) of concrete. It generates a lot of heat even in low ambient temperatures."

With precast, all the large concrete pours have already been done and there is one less thing to worry about. But according to Lahti, precast has its own challenges in low temperatures as well. Interestingly, it has to do with the small amount of mortar between the precast elements.

"Let's take a foundation, for example with a temperature close to zero. The prefabricated element is in ambient temperature and the mortar has to stay over 5 degrees Celsius (41 Fahrenheit). It freezes pretty quickly if you are not paying attention as there is precious little mass to generate reaction heat. One way to deal with the problem is to install heating cords in the foundation base."

Lahti argues that the same applies for installing wall elements.

"You really have to use all your wits to keep the small amount of mortar in the right temperature. It would be great if the structural designers specified a bit larger seams for winter building. Additional two centimeters in the seam would make things easier on site," he hints.

Even if Jussi Lahti is reluctant to name his favorite winter method, he's pretty sold to the DELTABEAM® and its heating cords.

Aalto University School of Business site.

> **Listen to the guys on site. With their experience, you can avoid many of the pitfalls of winter building.**

Even if Jussi Lahti is reluctant to name his favorite winter method, he's pretty sold to the DELTABEAM® and its heating cords.

"Having heater cords preinstalled helps a lot. It would be much hassle to install them on site. With cords, you can be sure that the beam hardens to the strength it was intended to."

BUT WINTER AFFECTS ALSO DELTABEAM®

"If you connect beams with Gerber joints, it means that there is always a beam between the column joints. This makes for same kind of challenges as with walls and small amounts of mortar."

Lahti says that with hollow-core slabs you have to make sure that the drainage holes aren't blocked – otherwise meltwater can fill the slab and split it when it freezes.

"That's something you definitely don't want to fix."

Finally, Jussi Lahti has a free tip for all the parties involved in designing and scheduling the projects in the warmth of the office.

"Listen to the guys on site. With their experience, you can avoid many of the pitfalls of winter building." ●

CAPELLA LABORATORY, CAMBRIDGE
MINIMIZING BAD VIBES

A 700 mm deep and extremely heavy cast-in-situ floor structure was originally specified to support delicate laboratory equipment sensitive to vibration. With DELTABEAM®, the overall thickness was reduced by 200 mm.

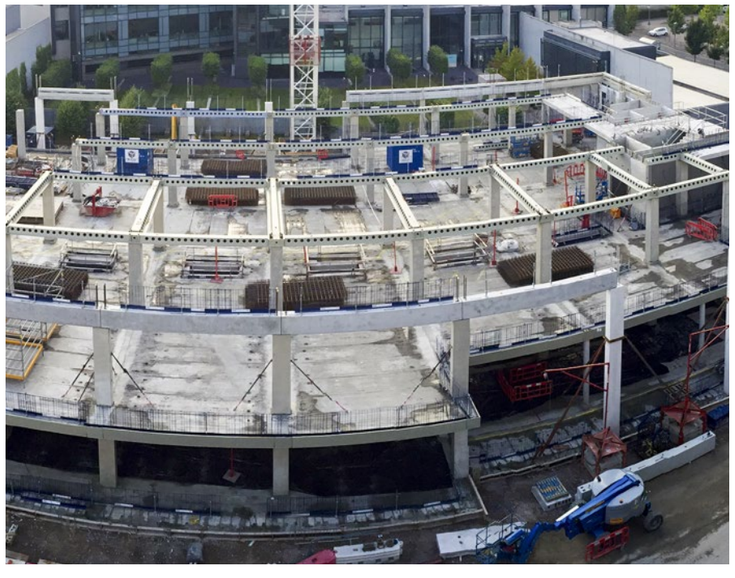
Capella is a new seven-story biosciences laboratory at Cambridge University built at the world-famous Addenbrookes Hospital site. The project brief had a very high demand for a very low response factor – floor vibration in layman's terms.

Normally this would have been achieved by building an extremely rigid cast-in-situ concrete structure. For this project the initial designs resulted in a 700 mm (28 in) overall floor depth. However, it was quickly realized that a fully cast-in-situ solution had significant difficulties due to a shortage of local ready-mixed concrete supply, the number of construction workers, and the amount of construction plant required. The large number of vehicle deliveries as well as the overall program would have caused serious disruption and noise to the already congested hospital area.

During the tender period, Kier Group requested PCE Ltd. to consider options to find a solution that would result in a faster build program and reduced on-site activities, create less need for in-situ concrete works, and be more eco-friendly.

Having successfully used DELTABEAM® in many past projects, PCE asked Peikko if they could be used in combination with hollow-core units and a structural topping. The aim was to achieve the low response factor required with slimmer floors.

"Initial calculations were carried out with various combinations of DELTABEAM®s, hollow-core slabs, and topping depths. The calculations indicated that it was possible to find a structural solution that meets the stringent vibration specification requirements and gives the required construction advantages," says **Michael Scott** of Peikko.



PROJECT FACTS

- **Location: Cambridge, UK**
- **Architect: Fairhursts Design Group**
- **Main Contractor: Kier Group**
- **Specialist Structural Frame Contractor: PCE Ltd.**
- **Consulting Engineers: Arup**

Further design work by Peikko with PCE's structural consultant Curtins and vibration specialist Professor Paul Reynolds of Exeter University was accepted by the project's consultant engineer Arup.

Finally, a detailed FEM analysis revealed that the required low response factors would be achieved with D32-500 DELTABEAM®s, 300 mm (12 in) deep hollow-core slabs, and 200 mm (8 in) of structural concrete topping.

The end result was a hybrid frame, which combined the benefits of both precast and cast-in-situ techniques.

A PROJECT WITH GOOD VIBES

After construction, a full scale vibration test was undertaken on a floor area. It proved compliance with the theoretical design assumptions and the adopted construction solution.

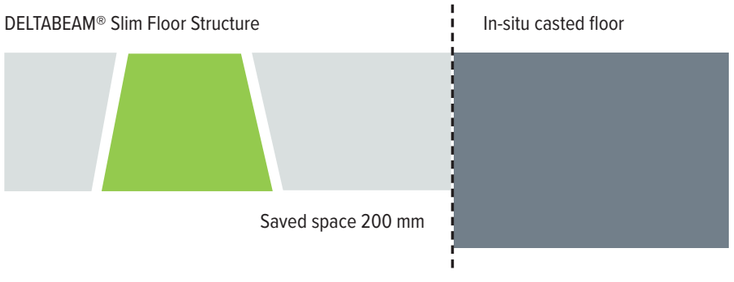
According to the main contractor's estimation, the offsite engineered hybrid solution reduced over 500 truck deliveries to the site and the dead weight of the building was more than 3,000 tons (3,307 US t) lower compared to the original in-situ frame solution.

"Our onsite construction program was 20 weeks faster and saved over 2,500 man weeks in comparison with the envisaged in-situ solution. Additionally, the overall carbon footprint was significantly reduced with fewer truck deliveries and high-quality offsite production of the steel DELTABEAM® and precast concrete units," said **Nickie Brown**, PCE's Managing Director.

"At the time, Capella was the largest DELTABEAM® project in the UK with 2.75 kilometers (1.71 miles) of beams supplied. To make the erection faster, PCE also used Peikko column shoes and anchor bolts," commented Michael Scott.

> **Our onsite construction program was 20 weeks faster and saved over 2,500 man weeks in comparison with the envisaged in-situ solution.**

WITH DELTABEAM®, THE OVERALL THICKNESS WAS REDUCED BY 200 MM



FINLAND, THE SUCCESS STORY OF PRECAST

Success didn’t come by accident. Even in a small country like Finland, you couldn’t just decide that precast would be the preferred building method.

Ili Korander has made a long career in the precast industry since his graduation from Helsinki University of Technology in 1977. Although he was student at the time precast made a revolution in the Finnish construction market, he knows its origins like the back of his hand.

“After a long history as an agricultural country, the Finns started to move to cities in the sixties. This meant that housing was urgently needed, but the decision-makers doubted whether the construction companies could keep up with the demand,” Korander describes the situation all those years ago.

To keep the wheels of economy turning, there was a lot of pressure to lower the price of housing. One way to achieve that was to ramp up the volume of residential construction.

“We needed to build apartments that people could afford. It was a top priority for the society at the time.”

An industrial solution such as precast was quickly seen as the best and most competitive alternative.

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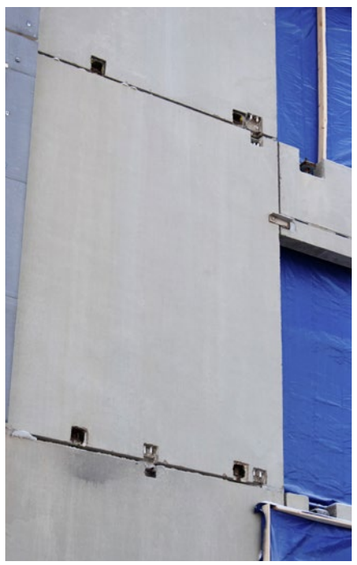


However, there were no precast standards in the country and the precast industry itself was far from being the well-oiled machine it is today.

"The factories manufactured the elements according to the designers' specifications. And these specs could vary a lot from one project to another. This meant that you couldn't manufacture long series of components," Olli Korander explains.

Abroad, precasters had their own standardized systems. For the greater good, that wasn't ideal either. Having proprietary standards meant that nobody else could utilize them and a lot of potential was left unexploited.

"In some ways, our lack of standards was a blessing in disguise. Nobody in the Finnish market had a system to defend and everyone could only win and be more competitive," says Korander.

SYSTEM OWNED BY THE WHOLE COMMUNITY

The aim for the Finnish industry and authorities was to create an open system. It was to be called BES, Concrete Element Standard in English.

"All the stakeholders took part in the project. Investors, government authorities, banks, trade associations, structural designers and above all, contractors. The system was to be owned by the whole precast community."

The first step was to create a common measurement system to ensure the compatibility of components.

"Buildings were to be designed with 30 cm (1 ft) modules. By choosing a small base module, architects and designers could define the building proportions more or less freely and still benefit from the efficiency of precast."

From then on, BES was embraced by both designers and contractors.

"All components were to be based on this common measurement system. It also allowed the standardization of the things that you couldn't see, such as connection and opening details. This lowered the costs of component production and allowed for longer production runs."

BES became a whole ecosystem and an instant success. Exterior and interior walls, hollow-core and staircases were all compatible regardless of which company had manufactured them. Bearing walls were always placed between the apartments. But the dividing walls were lighter and allowed for more flexible interior design compared to cast-in-place techniques.

"The other side of the coin is that some of the housing schemes built in the early seventies were architecturally boring and even ugly. I guess that at some stage aesthetics were pushed aside in order to maximize efficiency. However, the BES system could and still can create also visually pleasing environments," Korander points out.

CONDITIONS FOR SUCCESS

Of all the places, why did BES happen in Finland?

"That's a really good question. Maybe it's because we have a long heritage of consensus, on agreeing on things together. We obviously had a great team of specialists concentrating on the challenge. I personally know some of those who took part in the process and I dare say there were strong personalities involved, too. But they got along well and all of them wanted to get results quickly."

The whole precast industry was born in the Nordics at the same time.

"BES was created out of the need to standardize things that you cannot see, such as connections. In many other markets connection details and other components were produced at the precasters' own workshops."

Standardization enabled efficient production of precast elements. It also created a new, thriving market for subcontractors and companies such as Peikko, allowing them to specialize even further.

"Without BES, the precast industry would have been in a much weaker market position."

It's no wonder that in 1974 the introduction of BES led to the highest volume for residential construction – 74,000 apartments – ever recorded in Finland. Precast products and solutions were presented at an astonishing pace.

"It's a staggering figure if you take the size of the nation into account. Suddenly the industry was full of innovation and drive."

The market share of precast construction in Finland is around 75% in residential building. The basic BES principles from the early seventies still apply. ●

TRENDING IN WIND ENERGY

THE BIG BOYS OPTIMIZE THE TOTAL LIFECYCLE EMISSIONS

The price per megawatt used to be the sole decision-making criteria in sustainable energy sources. Now the tide is beginning to turn – the whole energy value chain needs to be taken into account when assessing feasibility.

Power purchase agreements are on the rise. Most active are those energy intensive players who see sustainability and a low carbon footprint essential for their future business success. Many of them have an ambitious goal to use renewable energy sources only.

You might argue that this is something that is reserved only to the big boys such as Google, Facebook and likes. But be assured, the rest of the business will follow these trailblazers.

Call it good corporate citizenship, call it sound business sense. The fact remains the same, there is a growing demand for low carbon footprint energy solutions.

> **The big boys = energy intensive players who see sustainability and a low carbon footprint essential for their future business success, such as Google and Facebook.**

TOTAL LIFECYCLE EMISSIONS MATTER

The quest for lowering emissions has led to a fierce competition between different technologies. Be it solar, wave or wind, every energy source will need to be more transparent in their overall emissions.

So how green is wind energy after all? You could say, it depends.

For example Facebook has signed a 294 MW wind power purchasing agreement with Vattenfall. The power for their data centers in the Nordics will come from the Norwegian Bjerkreim wind farm.

"Bjerkreim wind farm is built on our rock foundations, which will help Facebook to reach their renewable energy goals", says **Kari Tuominen**, the Business Director for Peikko wind turbine foundations.

Google is also a prime example.

"The 148 MW output of the Lehtirova wind farm is used by Google. These megawatts are also produced on Peikko gravity foundations."

A couple of years ago, Google made another power purchase agreement from the Tellenes wind farm in Norway.

"The fifty 3.2 MW turbines built on Peikko's rock foundations produce more than 500 GWh annually. The recent development is a clear proof of the investors' will to choose the low carbon alternatives. All other things being equal, the low emission option will always prevail", Tuominen predicts.

Another international giant, IKEA, purchases renewable power which is generated on Peikko's low emission foundations.

But to give a more educated answer, you need to take the entire value chain into closer scrutiny by conducting life cycle assessments for all the system components. This will bring to focus the emissions generated during the hardware manufacture, transportation and assembly – in addition to the emissions generated during the day to day energy production.

Peikko is the first player in the market who has made a life cycle assessment for its wind turbine foundations.

Using the Markbydgen wind park in Piteå, Sweden, as a pilot project, Bionova Ltd. has assessed both the construction materials and the transportation on site. The comparison was made between two different gravity designs and Peikko's rock foundation.

"We found out that everything that's done before the actual building of the foundation – the design, the choice of steel and concrete quality – has the biggest impact to CO_2 emissions", Tuominen notes.

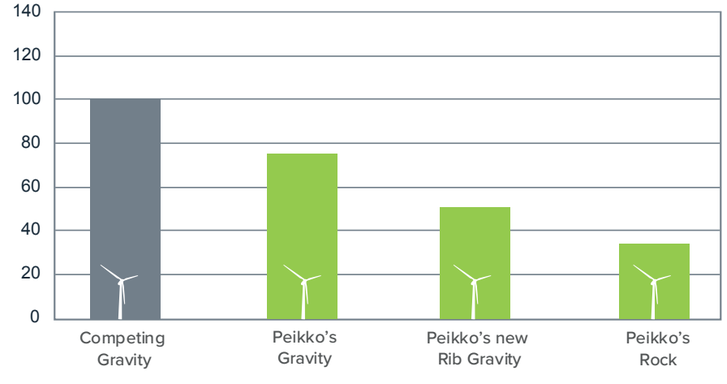
Depending on the design, a traditional shallow gravity foundation can use up to 70 tons (77 US t) of steel and 700 m^3 (916 cu yd) of concrete. With these quantities, the choice of material source and quality can really make a difference to the emissions.

"For the gravity foundations, there was a +28% increase in emissions if you opted for steel which had been manufactured in a polluting factory faraway."

It was no surprise that the rock foundation had the lowest emissions as it uses a minimum amount of concrete.

BIONOVA
Your partner for sustainable performance

Relative CO_2 emissions of different foundation types



DESIGNING FOR LOWER PRICE AND SMALLER CARBON FOOTPRINT

From the CO_2 perspective, the wind turbine foundations have so far been shunned as something that's not very interesting. But anticipating the trend towards reducing the emissions also in wind turbine component manufacturing, Peikko has done methodological research and development work.

"Developed specifically for the Markbydgen wind park in Piteå, Sweden, our current gravity foundation design uses 60 to 80 m^3 (78 to 105 cu yd) less concrete compared to the previous one. On top of that, it needs 6 tons (7 US t) less reinforcing. This is good news for anyone interested in lowering their CO_2 emissions", Kari Tuominen describes.

As the icing on the cake, Peikko has also been able to lower the average foundation price by EUR 20,000. Tuominen argues further that the Peikko gravity foundation designs use up to 20% less concrete and steel than the competing foundations.

A NEW APPROACH IN THE WORKS

Recently Peikko designers have been busy with a totally new approach, which will meet the requirements of the ever increasing turbine sizes and the demand for lower carbon footprint.

"We hope to launch it in autumn 2019. Compared to the more traditional design, the new one will use up to 10,000 kg (1,1 t) less steel and 500 m^3 (654 cu yd) less concrete. That translates into 50 concrete mixer loads."

According to Kari Tuominen, Peikko is the de facto technology leader in the Nordic wind power market with solutions encompassing all the onshore foundation needs.

"We expect that the market will follow the big boys that see low total emissions as a must in their operations. That's why we are continually looking for ways to reduce emissions of our foundation designs."

Peikko's Gravity Foundation

Peikko's Rib Gravity Foundation

Peikko's Rock Foundation

BUIKSLOTERHAM, AMSTERDAM

CIRCULAR WITH DISMOUNTABLE CONNECTIONS

For lot 20E in Buiksloterham, GAAGA Architects have created a concept where sustainability is not a limiting factor. It's rather an enabler that triggers new solutions and unorthodox applications of existing materials and techniques.

While occupying only 3% of land surface globally, urban areas use 75% of resources and produce 60-80% of global greenhouse gases. Cities play a major role in making the global economy more sustainable.

Buiksloterham is an old industrial neighborhood in Amsterdam. Even though it's located only five minutes away from the city center, it has had many empty lots and is almost devoid of monumental buildings. Because of this, Buiksloterham was the perfect candidate for a large-scale test bed for a new kind of a sustainable and circular city.

FROM SCIENCE FICTION TO REALITY

Dismounting and re-using precast buildings has sounded more or less theoretical until now. The two residential buildings at lot 20E in Buiksloterham will turn the theory into reality.

The larger of the buildings has four floors with eight apartments, while the other comprises of three townhouse apartments. The buildings are connected by a roof garden above a shared parking garage.

In order to create a dismountable precast frame, choosing the right kind of connections for the elements is crucial.

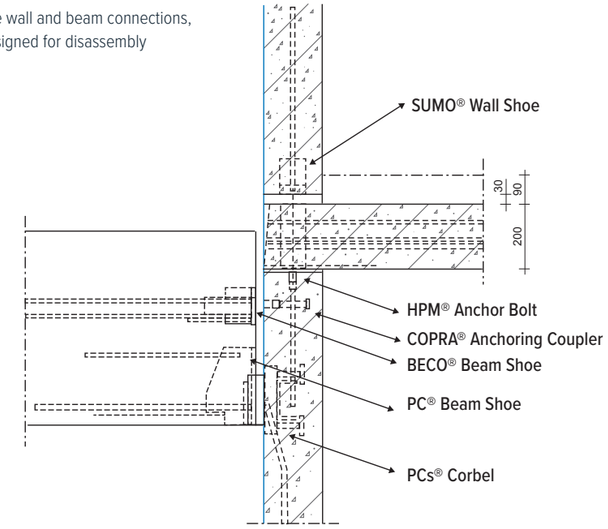
Lievense structural designers suggested a full set of Peikko concrete connections to go with DELTABEAM® Composite Beams. In the finished buildings, HPKM® Column Shoes, HPM® Anchor Bolts, SUMO® Wall Shoes, BECO® Beam Shoes, COPRA® Anchoring Couplers, and PCs® Corbels ensure that the buildings can be easily dismantled when the time comes.

Hot dip galvanized SUMO® Wall Shoe connection.

© GAAGA Architects

HIGHLIGHTS

The wall and beam connections, designed for disassembly



Rockwool and non-shrink mortar are used for protecting the connections from fire. The connections exposed to the environment were hot-dip galvanized. The precaster Bestcon is very satisfied with the installation of Peikko's concrete connections and affirms that this system is very interesting for similar projects in the future.

"Normal grouting would make dismounting next to impossible. But when the time comes, thin layers of non-shrink mortar can be removed to get access to the bolts. After that, it's an easy job to unbolt the connections to separate beams and columns," says Site Manager **Rolf Koper** from Vink Bouw, who is the contractor in this project.

"We are excited to be part of this project as it embodies our emerging circular thinking perfectly," says **Wim Zwaan**, the Managing Director of Peikko Benelux.

The project will be completed in 2019. And in years to come, Buiksloterham will probably be seen as one of the trailblazer areas – a place where the circular building movement took off.

The wall elements ready to be transported.

The rebars connecting the floor slabs through the web holes can be disconnected later on, and then the DELTABEAM® will function as a concrete beam.

The connection at the building site.

PROJECT FACTS

- Location: Buiksloterham, Amsterdam, The Netherlands
- Architect: GAAGA Architecten
- Main structural design: Van Rossum Raadgevende Ingenieurs
- Contractor: Vink Bouw
- Precaster: Bestcon
- Structural design precast frame: Lievense Eindhoven
- Assembly precast elements: Gejamont

In the heart of the village of Wolfurt, an extension to the “RadCult” company’s traditional specialist bicycle factory in timber construction was realized. After barely a year of building work, a four-storey building with a pre-fabricated design construction has been erected.

COMBINING ADVANTAGES AND ELIMINATING DISADVANTAGES ARE HYBRID STRUCTURES THE FUTURE?

The first DELTABEAM® project with wooden slabs was completed in 2010. Since then, the demand in Central Europe has been increasing.

Climate change is a growing concern and many investors want to minimize the CO_2 emissions of their projects. One option is to reduce the amount of concrete used.

“If you are looking for a simple way to get the Green Building certificate, one alternative is to consider using wood in the structure,” says **Reinhard Ertl**, the Managing Director of Peikko Austria GmbH.

But according to Ertl, the demand for wood composite structures is growing in the Alpine region. This has led to a situation where the companies specializing in wooden structures are booked for months in advance.

“However, wood opens the door for hundreds of small subcontractors and contractors, as manufacturing wooden elements can be easier than concrete elements.”

CHOICE BETWEEN CAST-IN-SITU AND PREFABRICATED

In the Central European market, the investors often consider a cast-in-situ structure first, says Ertl. But he’s quick to remind that cast-in-situ always requires a lot of expensive labor on site.

“That’s one of the main reasons prefabrication is becoming more and more popular. It also seems like wood and wood-concrete composites are more often considered by customers”.

Wooden slabs can be used for different kinds of buildings, be it residential, office or retail.

“Of course, using wooden slabs in combination with DELTABEAM® can be a bit more expensive than cast-in-situ, but the difference is mitigated by faster installation.”

One of Peikko’s recent projects was already specified as hybrid structure with a 6 x 6 meter (20 x 20 ft) grid. Along the way, the structure was re-designed for DELTABEAM® and wooden slabs.

“We achieved a 9 x 9 meter (30 x 30 ft) grid with almost the same price, but less time used for installation. So increasing the span doesn’t have to automatically mean higher prices and significantly thicker slabs.”

CONFLICT OF INTERESTS, IS THERE ANY?

Reinhard Ertl sees the material question as a philosophical one. His take is that different systems should be seen as a way of developing the market further by cooperation.

“We should rather look for possibilities than threats. Different materials and building styles can and will co-exist. I see the hybrid structures as an integral part of the future. Of course you hear objections, but I think they are more myths and rumors than reality.”

Ertl reminds us that there are plenty of wooden houses that have stood the test of time for hundreds of years.

“Composite slabs allow using the best properties of both materials. You can have wood where there’s tension and concrete in the pressure areas. Adding a layer of concrete on top of a wooden slab also enhances sound proofing and frequency properties. You can combine the advantages and eliminate the disadvantages of different materials,” Reinhard Ertl concludes.

WELDA® ANCHOR PLATES INCREASED RESISTANCES WITH LESS REINFORCEMENT

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PEIKKO GROUP
CORPORATION

Avoiding supplementary reinforcement means saving time and money in all phases of a construction project from design to erection.

During the past four years, Peikko has invested a significant amount of resources to a research focused on the assessment of the structural performance of WELDA® Anchor Plates with supplementary reinforcement. The research program involved a basic research which identified the basic behavior patterns of WELDA® anchored in reinforced concrete and an applied research that allowed us to formulate new design recommendations for WELDA® under tensile or shear loading alone as well as under tensile and shear load combined.

The research challenged the current way of calculating the effect of supplementary reinforcement used to increase resistance of anchor plates. It proved that the current standards are very conservative.

First of all, the test results show that when the plate is located close to the edge of concrete member, a shear crack develops from the last row of anchors. Current standards assume that it develops from the first row of studs that are closest to the edge of concrete. The practical implication of this is larger concrete cone resistance increasing shear resistance.

The current assumption is that in case of interaction of shear and tensile forces, it is either concrete or steel resistance, whichever is lower, that sets the limit. This is very conservative. The new analytical approach demonstrates that load can be shared between steel and concrete even at failure load. As a result of this the interaction, the action factor of 0.66 as defined by CEN/TS 1992-4-2 can be increased up to 1.2 for WELDA® Anchor Plates.

The research benefits the construction industry. Thanks to work at the test bench, the new design recommendations allow for significantly greater resistances to WELDA® Anchor Plates in comparison to those that can be assessed in accordance with current European design standards. Both the amount and diameter of supplementary reinforcement can be reduced while increasing resistances compared to current standards.

In practice, this significantly reduces time used to design supplementary reinforcements. Also installing the supplementary reinforcement is quicker. Especially in heavy reinforced structures with big WELDA® and WELDA® Strong Anchor Plates, there is limited space for any additional reinforcement. Being able to use less stirrups and with smaller diameter rebars, the efficiency is significantly increased.

The new design concept of WELDA® Anchor Plates makes them easy, safe and fast to design and install. Thanks to this you can move on to other tasks earlier.

The first approval validating such research-based resistances has already been issued by the Finnish Concrete Association (BY) in 2018.

Let's take a closer look at our thinking!

BACKGROUND

The tensile and shear resistance of WELDA® Anchor Plates is often limited by the anchorage capacity of concrete. The simplest way to improve the resistances of WELDA® in case the concrete capacity is not sufficient is to increase the length of anchors or to place the plate far away from the concrete member's edge. However, this is not always possible for different practical reasons. Alternatively, the anchorage capacity can be increased by using supplementary reinforcement. However, designing, approving and executing of supplementary reinforcement is a time-consuming process.

The structural design of WELDA® Anchor Plate is usually done with Peikko Designer®. It refers to resistances approved in the European Technical Assessment ETA 16/0430 in accordance with the latest European design standards. These standards typically limit the performance of WELDA® by the load-bearing capacity of concrete surrounding the anchor plate. Under such assumptions, the contribution of the concrete member's reinforcement to the resistance of an anchorage provided by WELDA® is significantly underestimated, if not neglected.

CURRENT DESIGN METHOD

The European Technical Assessment ETA 16/0430 provides information about essential characteristics of WELDA® Anchor Plates. In ETA 16/0430, the structural performance of WELDA® is assessed using methods of the technical specification CEN/TS 1992-4-2. The resistance of concrete is typically limited by the development of a concrete crack between the heads of the anchors and the free edge of the concrete member (Figure 1) and calculated as follows:

$$N_{Rd} = k_{cr} \cdot \sqrt{f_{ck}} \cdot l^{1,5} \qquad (1)$$

where

$\sqrt{f_{ck}}$ represents the tensile strength of concrete

k_{cr} represents the state of concrete (cracked or uncracked)

l is the distance between the loaded anchors and the edge or the concrete member

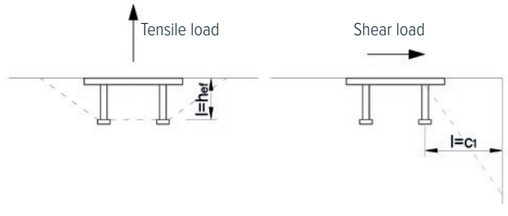


Figure 1. Examples of concrete failure under a) Tensile b) Shear load.

It is a common practice to use supplementary reinforcement in order to increase the capacity of concrete in the anchorage zone. The supplementary reinforcement is typically provided in the form of stirrups that are intended to tie the potential breakaway cone to the rest of the concrete body (Figure 2). The stirrups are continuous inside the concrete cone and anchored outside it. The resistance of a headed anchorage combined with supplementary reinforcement is determined by CEN/TS 1992-4-2 as:

$$N_{Rk,a} = \sum \frac{l_1 \cdot \pi \cdot d_s \cdot f_{bd}}{\alpha} \qquad (2)$$

Where:

l_1 = Anchorage length of supplementary reinforcement
d_s = Diameter of reinforcement bar
f_{bd} = Design bond strength of concrete
α = Influencing factor

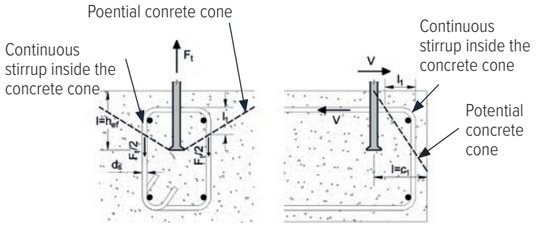


Figure 2. Headed bar coupled with supplementary reinforcement.

Practical experience shows that Eq. (2) provides only a very modest increase to the resistance of WELDA®. At the same time, recent research demonstrated that the Eq. (2) tends to severely underestimate the structural performance of WELDA® Anchor Plates combined with supplementary reinforcement (see references [4]-[7]).

EXPERIMENTAL RESEARCH

An extensive research project was carried out from 2015 to 2018 in cooperation between Peikko Group and the research institute IWB Stuttgart in Germany. The motivation of the research was to develop a detailed understanding of the behavior of WELDA® Anchor Plates combined with supplementary reinforcement and subsequently to develop reliable recommendations for a cost-efficient design of such plates. The project included about 100 laboratory tests of WELDA® anchored in concrete under tensile, shear and combined loading. For each of the load types, specimens with low, moderate and high amount of supplementary reinforcement were tested. These covered all possible failure modes that might occur in practice. Detailed measurements of the test specimens' load deformation behavior allowed to develop, analyze and validate a new analytical approach for the design of WELDA® Anchor Plates combined with supplementary reinforcement.

NEW ANALYTICAL APPROACH

The new analytical approach has been developed by the consulting office IEA (Ingenieurbüro Eligehausen und Asmus) in Stuttgart (see reference [6] and [7] for further details). Within this analytical approach, the resistance of the anchorage is formulated as:

$$N_{Rm} = 0,5 \cdot N_{Rm,c} + N_{Rm,re} \leq \Psi \cdot N_{Rm,c} \qquad (3)$$

where

$N_{Rm,c}$ is the resistance of concrete
$N_{Rm,re}$ is the resistance of supplementary reinforcement (limited ether by the steel or anchorage capacity of the reinforcement bars)
Ψ is an empirical factor

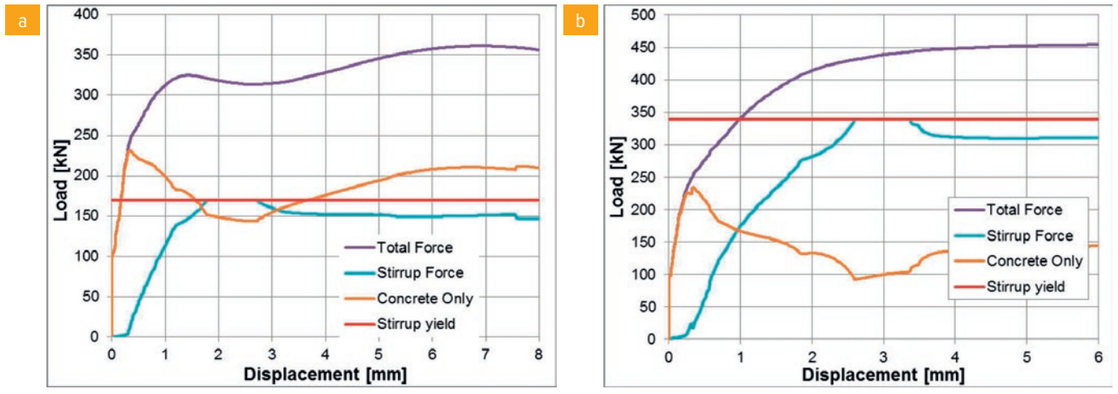
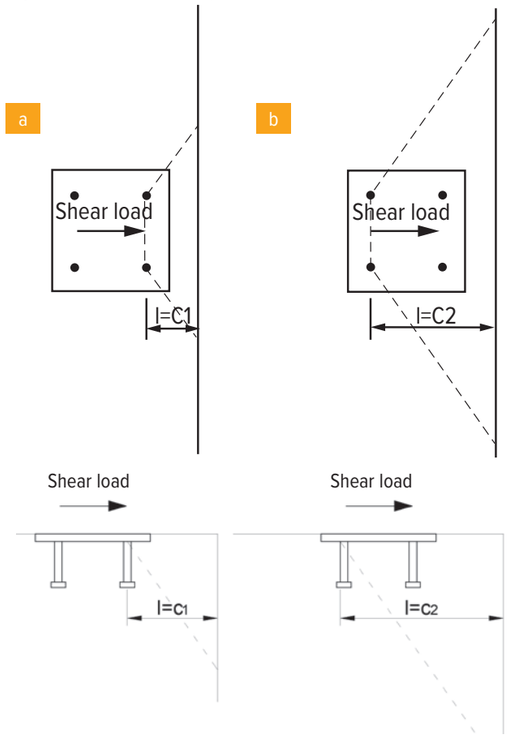


Figure 3. Measured contribution of concrete and steel to the total load-bearing capacity of the anchorage in WELDA® Anchor Plate with a) low b) high amount of steel supplementary reinforcement.

Figure 4. Shear crack acc. to a) CEN/TS 1992-4-2 and b) research.



Contrary to the current design concepts that assume the resistance of the anchorage as the lower of the concrete (Eq. 1) or steel (Eq. 2) resistance, the new analytical approach assumes that these two resistances can be combined. This is justified by experimental measurements (Figure 3) that clearly demonstrate that load can be shared between steel and concrete even at failure load. An upper limit of resistance is defined as a multiple of the concrete resistance, where the factor Ψ has been calibrated in tests with large amount of reinforcement.

The model in Eq. (4) is also applicable for the shear resistance of a plate located close to the edge of a concrete member. However, while ETA 16/0430 assumes that the shear crack develops from the first row of studs that are closest to the edge of concrete, the tests allowed to validate that if supplementary reinforcement is provided, the crack develops from the last row of anchors.

Another improvement yielding from the research is the verification of the resistance of the plate under combined tensile and shear loads. The verification is performed analogous to CEN/TS 1992-4-2 as:

$$\left(\frac{N_{Ed}}{N_{Rd}}\right)^{\alpha} + \left(\frac{V_{Ed}}{V_{Rd}}\right)^{\alpha} \leq 1.0 \qquad (4)$$

However, while the interaction factor defined by CEN/TS 1992-4-2 is α=0.66, the present research allowed to justify the α factor with value up to 1.2 for WELDA® Anchor Plates combined with supplementary reinforcement. →

NEW DESIGN METHOD APPROVED BY AUTHORITIES

The extensive experimental research allowed to create a statistical database of test results that was sufficient to develop reliable design recommendations for WELDA® Anchor Plates. These design recommendations have been used to validate tensile, bending and shear resistances of standard models of WELDA®.

Standard WELDA® models have now been approved by the approval BY:13 M2 issued by the Finnish concrete association. The approval also allows to use the factor α=1.2 for the verification of the WELDA® Anchor Plates under combined load in accordance with Eq. (4).

A comparison of resistances of a WELDA® plate without supplementary reinforcement, with supplementary reinforcement acc. to CEN/TS 1992-4-2 and with supplementary reinforcement acc. to the new research based approval BY:13 M2 is in Figure 5 and Figure 6.

Figure 5. Comparison of resistances of WELDA® Anchor Plates calculated using standard and research-based design concepts.

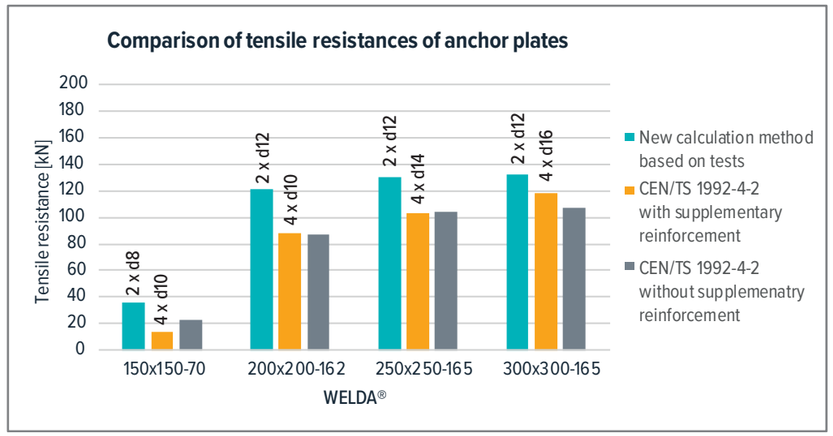
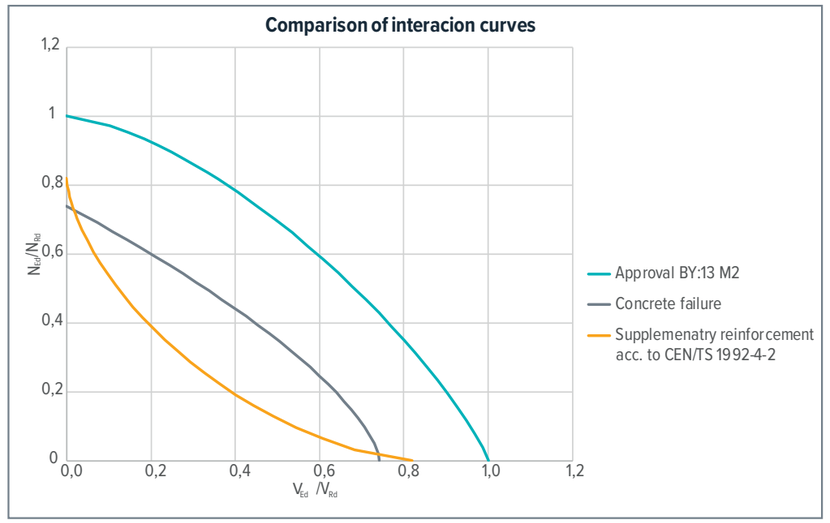


Figure 6. Comparison interaction curves for anchor plates with supplementary reinforcement.



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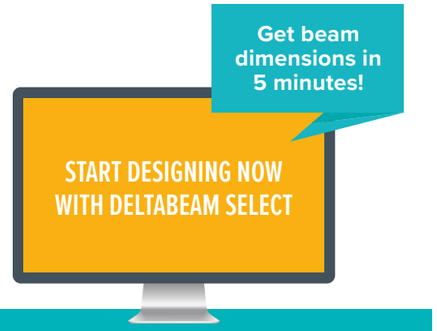

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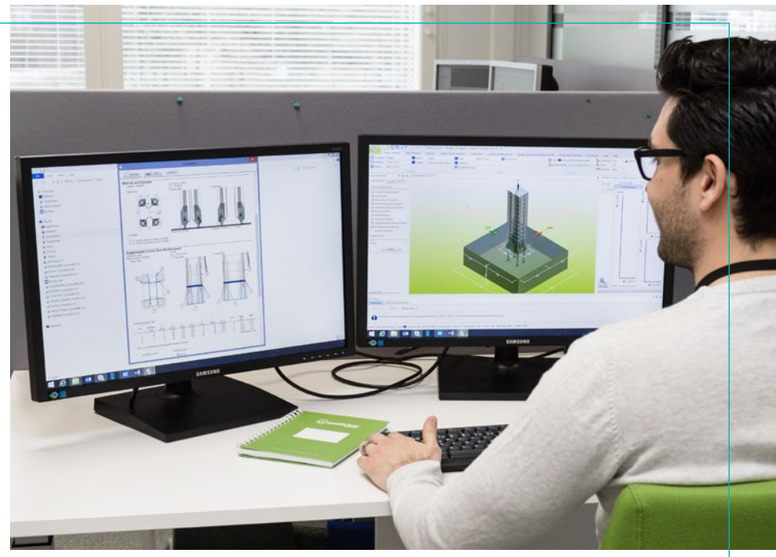

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ACI DESIGN FOR PEIKKO DESIGNER® COLUMN CONNECTION

The Peikko Designer® Column Connection module has a new design code: ACI 318-14. The new design code is available for connection calculation and for checking Peikko Column Shoe and Anchor Bolt capacities. The design is in metric units.

TEKLA, REVIT AND AUTOCAD TOOLS

In addition to Peikko Designer®, we also offer 3D modeling tools for designs made with ACI code. Peikko Anchor Bolts and Column Shoes are available for Tekla, Revit, and AutoCAD.

DESIGN TOOL SECTION ON OUR WEBSITES

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NEW DELTABEAM® GERBER CONNECTION

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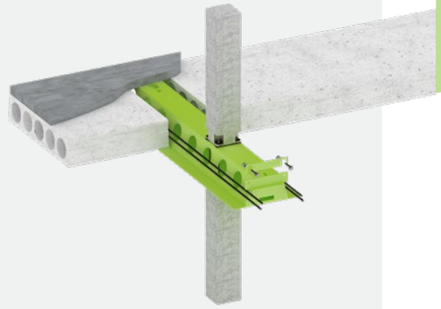
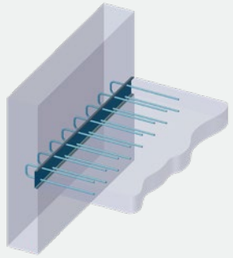
After listening to customer feedback, we have now modified the Gerber connection used to connect continuous DELTABEAM®s. The renewed Gerber connection makes the ring rebar assembly easier and concreting smoother. Both the end plate and the bearing block have been modified.

1. Assembly of ring rebars is now simple, as the gap between the hollow-core slab and the DELTABEAM® is bigger in the Gerber area. The ring rebars pass the Gerber connection without collision to Gerber end plate and/or the hollow-core slabs.

2. Concrete cast inside the beam runs out from the rectangular openings into the Gerber connection between two beams.



NEW ARBOX® NOW AVAILABLE



A ready-to-install system for creating stiff concrete casting joints of reinforced concrete elements, the new ARBOX® Joint Reinforcement system increases the shear resistance transverse to joint applications. It can be attached to formwork without having to penetrate or make other adjustments to the formwork. ARBOX® is suitable for creating a wide range of connections, such as wall-to-wall, column-to-wall, and wall-to-slab. ARBOX® is designed according to Eurocode.

INVESTING IN PRODUCTION CAPACITY

Peikko has acquired a new factory close to Bucharest, Romania. The new production capacity will primarily serve the increased demand in the Central European markets. The operations in this 30,000 m² (39 239 sq yd) facility will start in spring 2019.

A new factory and warehouse are being built in Ras Al Khaimah, in the United Arab Emirates. The growth of Peikko's operations in the Middle East has been remarkable in the past years and the demand is constantly increasing. The new factory is estimated to be operational during the third quarter of 2019.

SMOKE-FREE ALL OVER THE WORLD

With sustainability, health and productivity as global megatrends, Peikko decided to get rid of smoking in the workplace once and for all.

Globally operating companies seldom have the exact same policies on all continents. But with careful planning, Peikko managed to become a totally smoke-free working environment in over 30 countries. The plan was put into practice on 31st May 2018. The date was apt as it was the World No Tobacco Day.

"Before the rollout, we formed a work group with representatives from all employee groups to work on the policy. We benchmarked other globally operating industrial companies and learned about best practices. We also conducted internal surveys and gathered feedback from all production and sales units," says **Kjell-Ole Gjestemoen**, Vice President, Human Resources.

The work group made a policy proposal, which was approved by management in no time.

"This decision was really easy! Being a smoke-free workplace aligns with our values as well as with our 5S and safety program," says **Topi Paananen**, CEO of Peikko Group Corporation.

"And our smoke-free initiative is a win-win situation for everyone – except, of course, the tobacco industry. It will have a positive effect on our employees thanks to improved health and saved money. At the same time, Peikko will benefit as the number of sick leaves will likely decline in the long run."

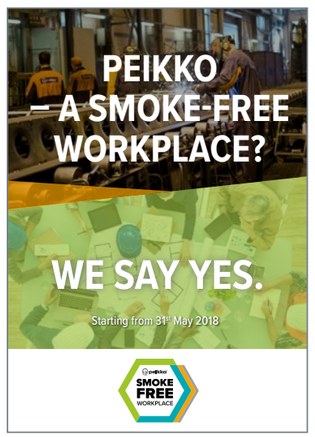
> **Our smoke-free initiative is a win-win situation for everyone – except, of course, the tobacco industry.**

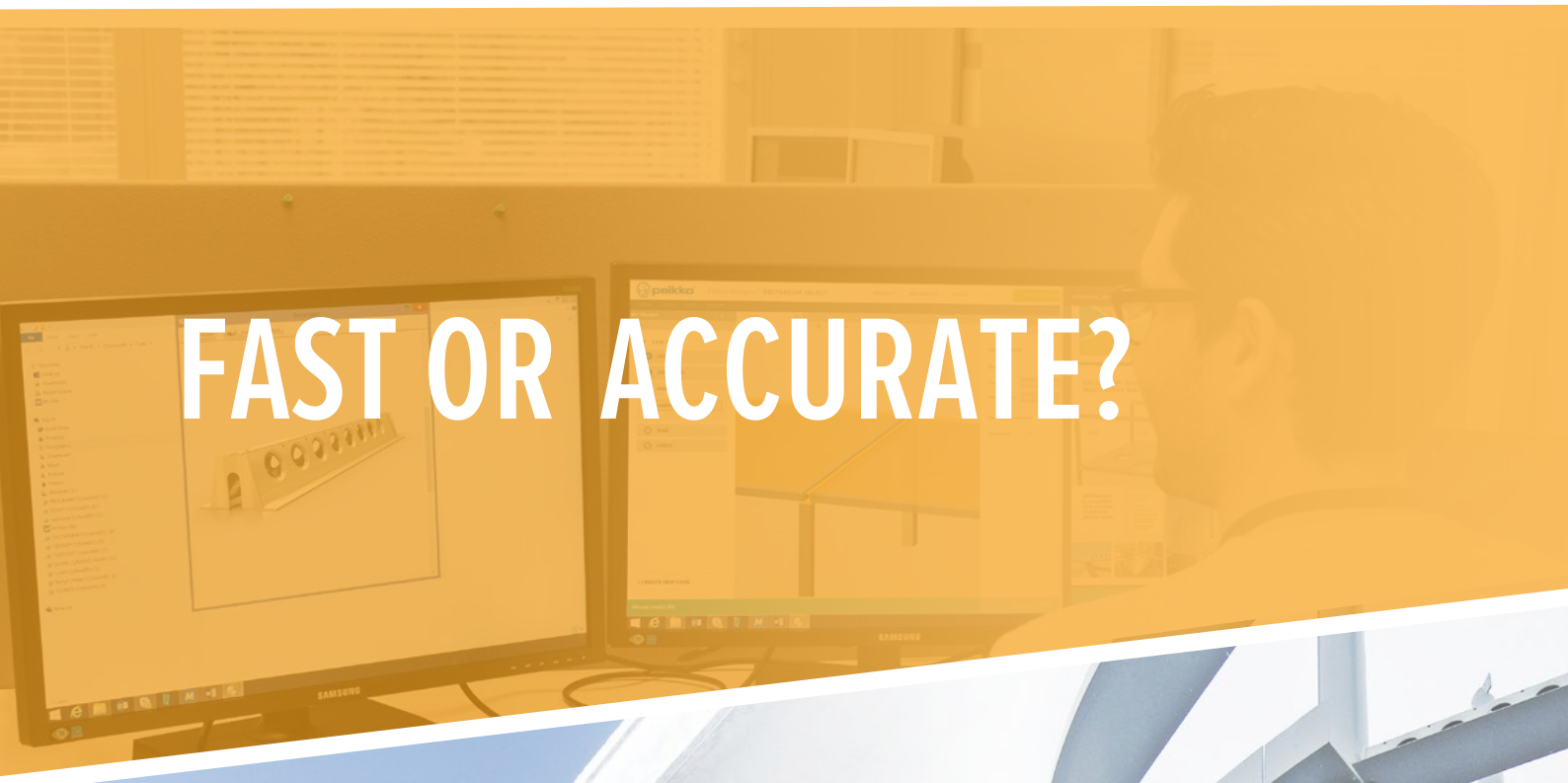
The challenge of being smoke-free concerns everyone, whether you are a company employee, rental worker, student or intern – or even if you are a visitor on Peikko properties.

Employees were supported through several internal activities to help quit smoking. Supportive products, such as nicotine gum and patches, were available for a period of several months. Team leaders were trained to guide their teams through the change and to help to get everyone onboard.

"Our smoke-free policy has been received really well. For me, one of the most rewarding aspects has been when individual employees have told me that having a smoke-free workplace has encouraged them to quit smoking," summarizes **Topi Paananen**, CEO of Peikko Group Corporation.

Posters, stickers and signs reinforce the smoke-free policy.





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