

PEIKKO WHITE PAPER



IN SEARCH OF A BRIGHT, CIRCULAR FUTURE!

PEIKKO AND THE CIRCULAR ECONOMY, PRACTICAL CONSIDERATIONS

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AUTHORS



Topi Paananen, M.Sc. (Econ.) has been Peikko Group's CEO since 2010. He has worked at Peikko since 2005 in various positions. His interest in the circular economy has developed only recently. However, he believes that the concepts are no longer just mere talk but a real business opportunity.



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EDITORIAL

The building industry is responsible for major societal impact, with 40% of total energy use and 30% of the global amount of waste. The concrete business has a particularly great responsibility as we account for a large proportion of this.

That is why now have chosen to focus on the environment by converting our products and company strategy to the circular economy. We want the building industry to be part of the solution and not the problem.

This white paper aims to describe what Peikko has already done, what Peikko is currently involved in, and what Peikko's long-term aims are in terms of the circular economy. This will be described through technical and practical solutions, concrete strategies and actions, and company analysis and goals.

The circular economy will enable us to create a sustainable business and solutions that can be scaled and adapted. That is why circular construction is one of our stated goals in Peikko's 2020 targets.

Topi Paananen CEO, Peikko Group Corporation

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**BEING IN THE FRONT,
IS NOT AMBITIOUS ENOUGH.**

Topi Paananen
Peikko Group Corporation

INTRODUCING THE CIRCULAR ECONOMY

Towards a new building system

The building industry is known to be responsible for up to 40% of global energy consumption¹ as well as 30–40% of all waste creation². Furthermore, over the next 10 years, the demand for global construction is expected to increase by 70%³. In the light of these numbers, many are looking for ways to move the industry in a more sustainable direction.

The sustainability discourse has in recent years mainly focused on energy consumption, but currently, a more holistic focus on the life cycle and material perspective of buildings is emerging.

Concepts such as Cradle to Cradle[®] 4 and the circular economy are gaining traction as new ways of understanding and dealing with issues of sustainability.

THE LINEAR ECONOMY

The current economy is called an 'open ended economy', a 'linear economy' and, within the Cradle to Cradle[®]4 framework, the 'Cradle to Grave'. It is based on a 'take, make, waste' model of production. A concept where precious and finite raw materials are claimed, made into products and at the end of their use to be disposed of as waste in landfills or to be incinerated.

In this economy, all materials will at some point end up with very little or no value and consume huge amounts of the World's natural resources — This is inherently not sustainable.

CIRCULAR ECONOMY

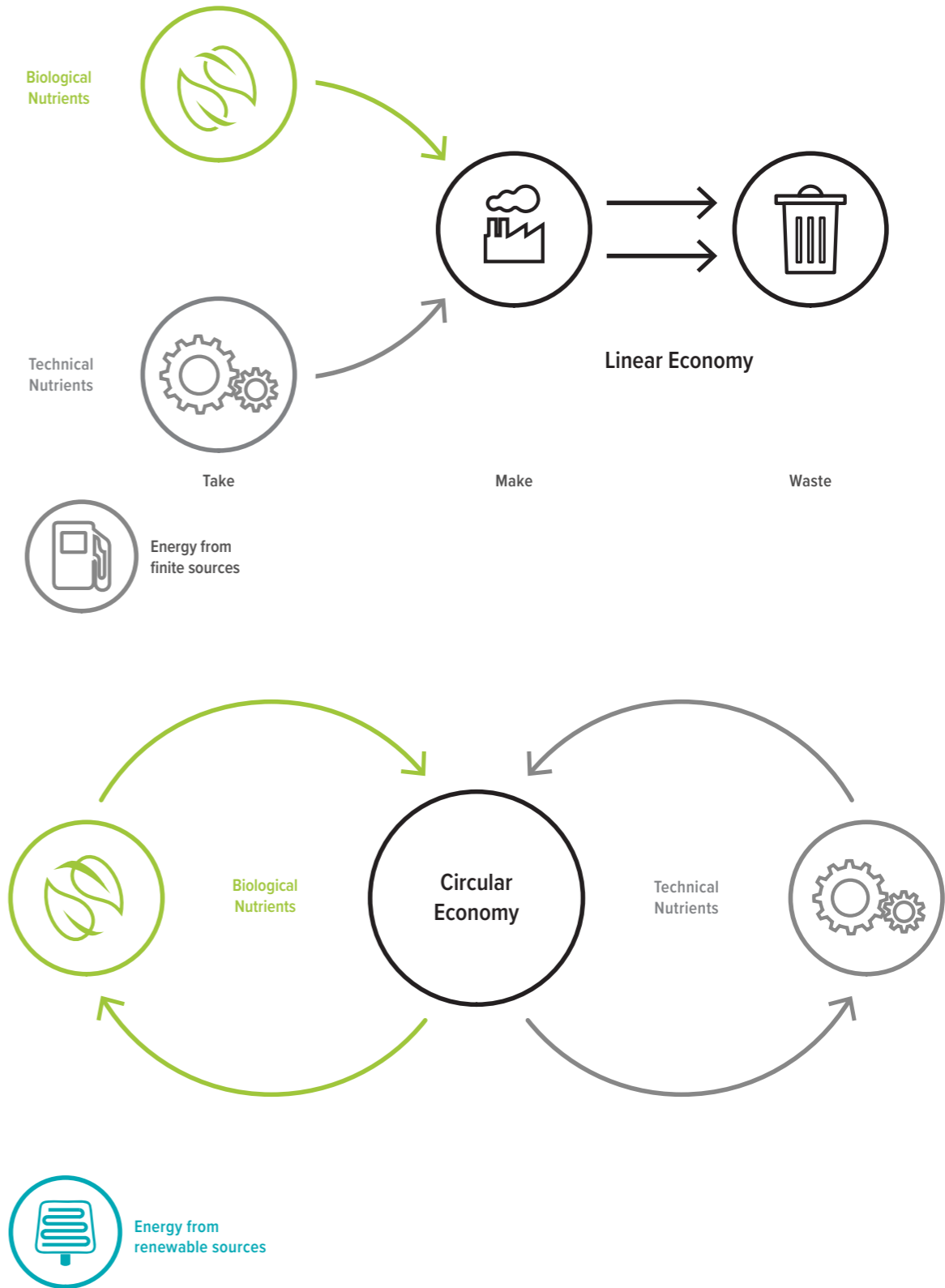
Some call the circular economy sustainability 2.0, others call it the materials economy.

In the past few years, the circular economy has gained rapid traction from major companies across the World and across industries, as well as in the European Union, which has developed roadmaps and guidelines to move towards a circular production system in Europe.

A circular economy is a closed-loop resource system in which there is no waste — all materials are conserved and are in some way used as inputs for new production. This can be achieved by designing, maintaining, reusing, remanufacturing, refurbishing, and recycling products with appropriate care and thought.

In order to do this, design for disassembly is an important tool. The basic idea is to design each product so it can easily be stripped down to individual components or material fractions, making it easier to reuse either the component in similar products or materials in a new product. This ensures that value and resources are always maintained and kept away from landfills.

Unlike in the traditional linear economy, in circular economy the amounts of renewable and reused non-renewable resources are maximized, thus further minimizing the use of natural resources and negative environmental effects.



Diagrams Illustrating the flow of biological and technical nutrients in the linear versus the circular economy.

Sources: 1. Deutsche Bank Research 2013 2. US Department of Defense 3. PWC Global Construction 2025 4. Cradle to Cradle[®] is a registered trademark of MBDC, LLC 5. Ellen MacArthur Foundation, McKinsey Center for Business and Environment, SUN, Growth Within: A circular economy vision for a competitive Europe 2015

BIG BUSINESS

The Ellen MacArthur Foundation was established in 2010 to accelerate the transition towards the circular economy. The Foundation focuses on insight and analysis, business and government, education and training, and communication.

It collaborates with a number of leading global partners across industries to advance the circular agenda and runs the CE100 network of businesses, universities, governments, cities, and organizations to develop circular business initiatives and build further capacity.

In 2015, the Ellen MacArthur Foundation, the McKinsey Center for Business and Environment, and SUN published the report 'Growth Within: A circular economy vision for a competitive Europe'. The report has increased political awareness and advocacy for the circular economy across sectors.

Sources: 5. Ellen MacArthur Foundation, McKinsey Center for Business and Environment, SUN, Growth Within: A circular economy vision for a competitive Europe 2015

IN THE BUILDING INDUSTRY

The aim of the circular economy is to clearly benefit all individuals living in our globe, and Peikko naturally wants to be part of this development. The circular economy in the building industry has proved to be more challenging than in other industries.

This is due to factors such as variable sizes or low repetition of building projects, complicated investor structures, or the voice of end-consumers hidden in the value chain. The long turnover rate of building is another complicating factor.

Nevertheless, the pressure for new thinking and innovations in the building industry is undeniable, and it is affecting the whole value chain of the industry, from construction companies and designers to building component suppliers such as Peikko.

FACTS

Apple, Google, H&M, IKEA, Nike, Philips, Coca-Cola, eBay, Microsoft, and many more are companies currently involved with the Ellen MacArthur Foundation's CE100.

Europe's resource productivity will grow by up to 3 percent annually thanks to a circular economy and enabled by the technology revolution⁵.

The potential economic benefits are estimated at up to €1,800,000 million annually by 2030 just for Europe's mobility, food and building sectors⁵.

Europe's savings in resource consumption by 2030 are estimated at up to 32 percent or €600,000 million versus today, thanks to a circular economy vision⁵.

CO₂ emissions will drop by as much as 48 percent by 2030 and 83 percent by 2050 compared with 2012 levels. A circular economy would decouple economic growth from resource use⁵.

SETTING THE BASIS

Peikko today

Peikko's products already offer great environmental and economic benefits by making the building process faster, safer, and more efficient, and creating slimmer building floors, thereby reducing the overall material use in buildings.

Peikko's PSB® and ARMATA Punching Reinforcement Systems and the composite beam DELTABEAM® offer the possibility of reduced floor height.

PUNCHING SHEAR REINFORCEMENT

Peikko's Punching Shear Reinforcement can reduce the concrete volume of slabs by 10% to 30% in floor slabs as well as in foundations by allowing thinner structures. In a building with a floor area of 590 m², the slab can be 150 mm thinner (from 450 mm to 300 mm) saving 88 m³, 33 tons of concrete, per floor.

That also means that foundations need less excavation and will save further resources. Savings are multiplied when the lighter slab constructions also allow other structures to be lighter.

The system is available with two- or three-stud elements, which can be used to construct the required reinforcement, or as complete elements with at least 10 studs.

DELTABEAM® SOLUTIONS

Peikko's DELTABEAM® Slim Floor Structure is a flexible solution that is always tailored to the customer's needs. It enables slender and light structural solutions that provide savings in terms of volume and costs.

Its composite action between steel and concrete allows for creative structures with large open spaces. It can be connected to concrete, steel, or composite columns using Peikko's innovative solutions.

DELTABEAM® Slim floor solution saves at least 130 mm of floor height compared to most optimized prestressed precast legdebeams, and a half meter compared to traditional I-steel beams.

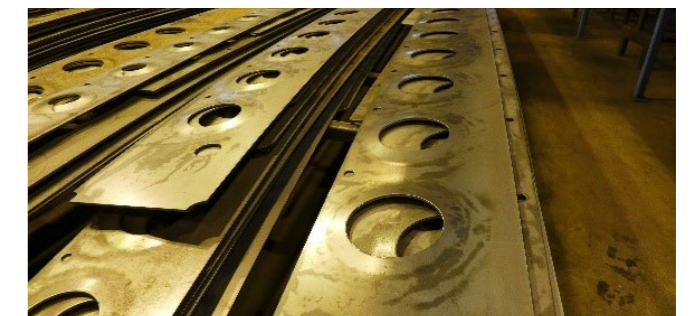
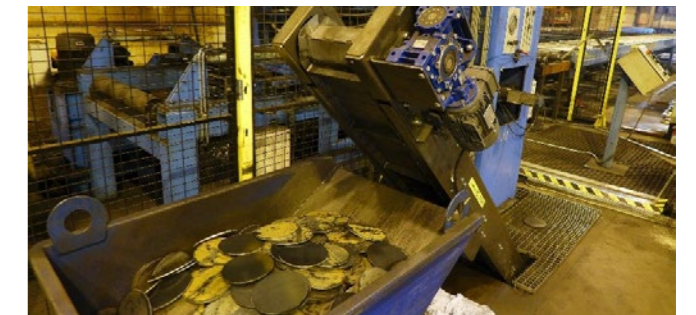
An average saving of 10% in floor to floor height means 10% fewer cubic meters to heat, cool and ventilate. In our example a building with 5 floors with an area of 590 m² has 9.735 m³ of air to be ventilated with traditional beam solutions, and only 8.850 m³ with DELTABEAM® Slim Floor Structure. The difference in numbers is 885 m³, and it equates to the air volume of two decent-sized private houses.

THE CURRENT PRODUCTION

Peikko's production process has a strong focus on sustainability and recycling. For this reason, Peikko chooses materials with properties that ensure they can be reused.

Peikko receives ready-manufactured steel and concrete from highly qualified and certified producers. Peikko then manufactures its own products itself, ensuring flexible and fast deliveries, as well as high quality products.

Thanks to in-house manufacturing, materials are transformed into concrete connections, composite structures and other solutions, which are ready to be sent to market and ultimately enter the construction process.



Photos showing round steel plates, which are cut outs from the production of the web holes in the DELTABEAM®. The discs are reused as dowels in Floor Joints for ground bearing slabs.

RECYCLING

Optimizing material usage is a step to the closed-loop economy. A computer-based system optimizes the usage of every steel plate sheet used for DELTABEAM® production so that recycled material is minimized.

A very good example of this is the web holes. On average 30 round steel plates are removed from every DELTABEAM® side plate and used as shear dowels in Floor Joints for ground-bearing slabs.

Peikko already recycles all possible waste from its offices to the extent that is possible in the country in question, while measuring its energy consumption and acting to reduce it.

NEXT STEPS

Peikko aims to establish a fully circular product portfolio with the final aim of being able to provide a full circular building system. The system requires design for disassembly elements that can handle heavy elements used in superstructures (for instance, concrete beams, slabs and columns).

Existing Peikko products can form the basis of the system but new product development and third-party testing and verification should also be undertaken.

It is essential that Peikko advance a strong position on recycling issues in order to develop a truly circular system, in which building materials can be reused several times.

At the end of their life cycle, materials from construction sites, especially concrete and steel from Peikko's products together with packaging materials, would be separated and reinserted into the circular process, as raw materials. See the diagram on the opposite page.



Photo showing packaging carton from the received materials waiting to be sent to the carton factory and to become reused circular.



Photo steel scraps from drilling, waiting to be send to a steel mill to become reused circular.

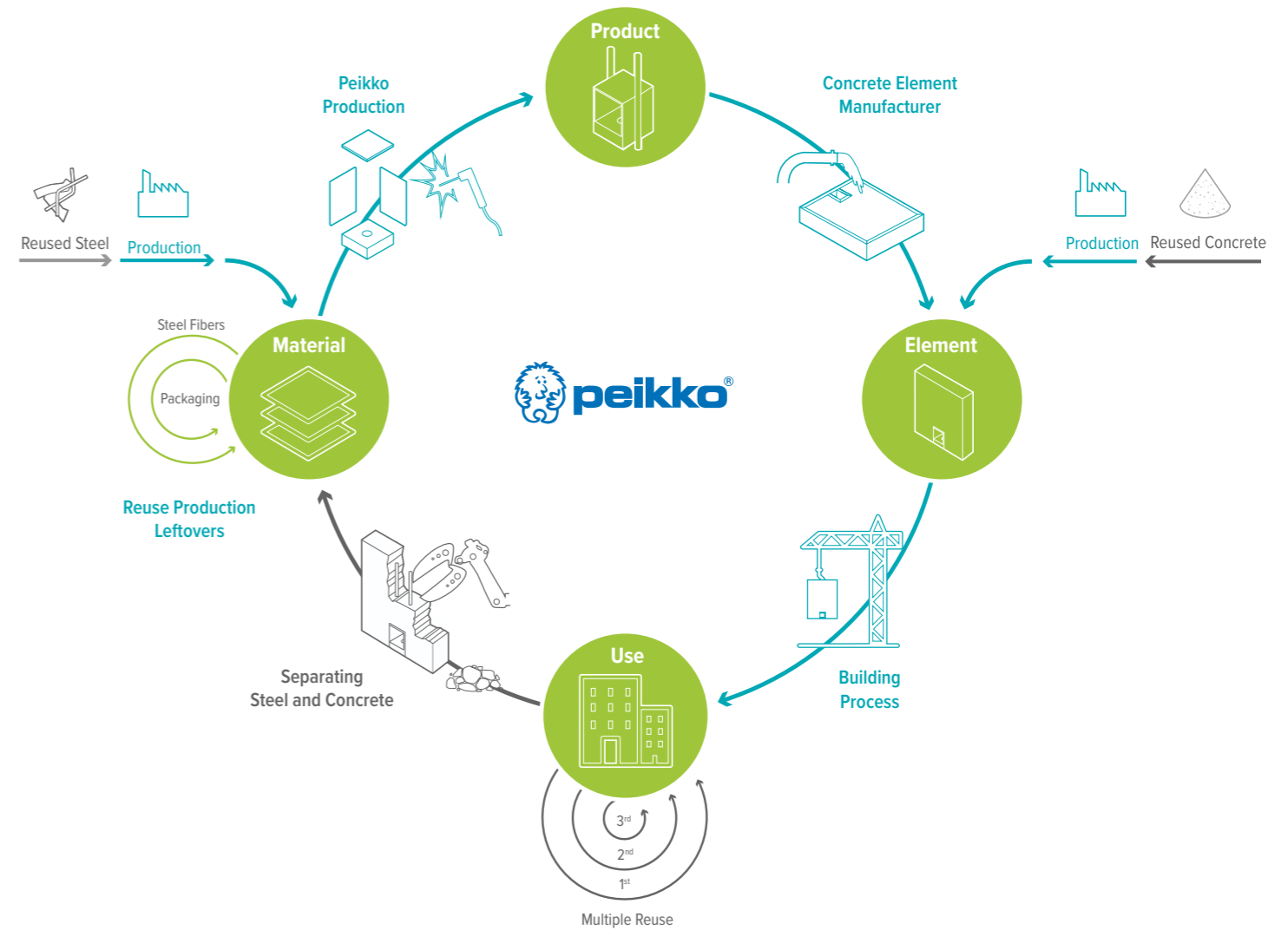


Diagram showing Peikko's current production system and life cycle of the products as well as the missing steps to achieve a complete circular model.

MATERIAL AWARENESS

Transparent value chain management

There are several building project certifications that aim to create more sustainable buildings. Some of the rating systems take aspects of the circular economy into account, although they may also study other factors.

Peikko aims to provide proper information on its products and to guide customers on whether the products are suitable in the given building certification.

The most popular and widespread building certifications in these regards are the US-based LEED and the UK-based BREEAM.

Peikko's products make the building process faster, safer and more efficient, and in many cases they also offer great environmental benefits. Peikko's PSB® or ARMATA Punching Reinforcement Systems and the composite beam DELTABEAM® offer the possibility of reduced floor height, which reduces the amount of heating and cooling. This provides energy savings over the life of the building.

ENVIRONMENTAL PRODUCT DECLARATION (EPD)

In order to support Peikko's customers when they apply the above certifications in their building projects, Peikko can provide Environmental Product Declarations (EPD) for its products.

An EPD is a document that provides information about the environmental impact of a product during its entire life cycle. It is also known by the formal name Type III Environmental declaration.

Peikko has prepared these EPDs together with BIONOVA, and they are freely available at www.peikko.com.

Peikko's EPDs have been created according to European standard EN 15804 "Sustainability of construction works. Environmental product declarations" and international standard ISO14025 "Environmental labels and declarations".

ISO 14001

In addition to the legal minimum requirements, companies demonstrate their proactivity on environmental issues when applying for various certifications, such as ISO14001. Among other quality certifications, Peikko is centrally ISO 14001:2015 certified by DNV-GL, one of the biggest certification bodies headquartered in Oslo, Norway.

This environmental certification ensures that Peikko is committed to thinking about the environment in all its operations. Peikko recycles all its manufacturing process waste, whether the waste is steel scrap, packaging materials or something else, with all the possibilities given in the country in question.

Peikko took the renewed environmental certification of ISO14011:2015 proactively into use on January 1, 2017. The new version of the certification focuses on Peikko's risk and opportunity analysis with regards to environmental issues, including all third parties such as suppliers, customers, personnel and communities.

The environmental certification forces Peikko to act in a responsible and proactive way with regards to the circular economy. The life cycle viewpoint of products is particularly evident, when designing new products and services.

All in all, the laws and the certifications from ISO auditors and customers set the basic minimum for Peikko's actions and requirements.

CE CERTIFICATION

CE (an abbreviation of Conformance Européenne, meaning European Conformity) marking means that a product is produced and controlled in accordance with a harmonized European standard (hEN) or a European Technical Approval/Assessment (ETA). Manufacturers may use CE marking to declare that their construction products meet harmonized European standards or have been granted ETA Approvals. Only CE-marked products can be used in construction in Europe.

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED)

LEED is one of the most popular green building certification programs used worldwide. Developed by the non-profit U.S. Green Building Council (USGBC) it includes a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes, and neighborhoods that aims to help building owners and operators be environmentally responsible and use resources efficiently.

BUILDING RESEARCH ESTABLISHMENT ENVIRONMENTAL ASSESSMENT METHOD (BREEAM)

BREEAM was first published by the Building Research Establishment (United Kingdom) in 1990, is the World's longest-established method of assessing, rating, and certifying the sustainability of buildings. More than 250,000 buildings have been BREEAM certified and over a million are registered for certification in more than 50 countries worldwide.

All in all, there are hundreds of buildings certified by LEED and BREEAM where many of Peikko's products have been successfully used, not only because of their functionality, but also because of their environmental impact for the building.



Project: Skanska Green House - Budapest, Hungary

Certification: LEED certified

Construction system: In the Skanska Green House, the above-ground levels were realized using two-story precast columns provided with Peikko connections. The horizontal structural system was realized with DELTABEAM®s as inner beams while precast beams are set on the edges of the building. The low-weight DELTABEAM®s weigh about 20–30 percent of the weight of concrete beams; for this reason, they can be stored in piles without overloading the slabs underneath. Additionally, as DELTABEAM®s can be lifted with standard crane hooks, no special equipment was needed on the construction site; this also meant less transportation, which was especially important at the Skanska Green House because of the limited space available.

Source: references.peikko.com/reference/green-house/



Project: Lauttasaari Shopping Center - Helsinki, Finland

Certification: BREEAM certified

Construction system: Peikko's DELTABEAM® Frame Solution proved to be a benefit during the construction of the Lauttasaari Shopping Center: it meant a massive saving in time, which meant less space was needed and costs were lower. For these reasons, a decision to change the in-situ frame to Peikko's solution was quickly made. In addition to achieving remarkable time savings in frame construction and wider open spaces, Peikko's DELTABEAM® Frame was found to have a third benefit. No additional fire protection is needed for the frame because the in-built fire protection of the DELTABEAM® Composite Beams makes the frame fire resistant up to R180, which has been proven in several full-scale fire tests.

Source: references.peikko.com/reference/lauttasaari-shopping-center



PEIKKO'S POTENTIAL

How to create impact

Peikko has already started to engage the transformation to a circular economy on many different levels. A lot of Peikko's existing products are inherently designed so they only need minor tweaks and testing to be ready for disassembly, which makes Peikko's move in this direction even more obvious.

PRODUCTS READY FOR DESIGN FOR DISASSEMBLY

Existing Peikko products such as the SUMO® Wall Shoe and Column Shoes are very close to complying with the basic circular economy principles in design for disassembly, but more require testing by independent third parties to ensure viability and guarantee performance.

Testing these products will not only build trust with the wider industry but can serve to establish relationships with core technical and research partners. Data from tests can inform the development of circular business cases for these products and the tests themselves can be presented through engaging communication material to signal Peikko's shift and intention to the wider industry.

Peikko's aim is to create connections for a building system that enables a building frame to be ready for design for disassembly.

ORGANIZATIONAL LEVEL

In early 2017, architect Kasper Guldager Jensen from the world renowned Danish practice, 3XN Architects, joined Peikko's Board of Directors.

Kasper leads the internal innovation unit of 3XN, GXN Innovation, a team dedicated to the circular economy. During 2017 Peikko started a research program with GXN Innovation with the goal of brainstorming and developing new solutions that would transform the precast industry.

Peikko aims to create a connections portfolio which enables constructors to use a building frame that can not only be assembled, but also efficiently disassembled at the end of the building's lifetime to provide the ultimate circular economy platform for the precast building frame.

During the initial design phase of the products, all factors related to disassembly of the precast structure are taken into account.

This ideology also needs practical and easy-to-use systems for material passports of the building, where all building parts and the disassembly methods are properly documented in the 3D model of the building or otherwise available for the future use and reuse of the elements and materials.

The benefits for building investors are clear: they ultimately know that they not only own a building, but also a set of construction materials that can be resold, including the individual building frame components, as well as the actual value from this.

In this way, buildings of the future will become material banks where you can harvest materials of high documented value.

PARTNERSHIPS

As a part of Peikko's increasing know-how in the circular economy, Peikko is involved in an External Advisory Group in the PROGRESS consortium. This is a multinational consortium led by the Finnish research institute, VTT, and the work is focused on the reuse of steel structures.

Peikko is also engaging in innovative lighthouse projects. An example of this is the Circle House project in Denmark where 30 different companies have combined to create Denmark's first circular residential development. This project has set out to be a lighthouse project showing it possible to build with concrete superstructure that can be disassembled and reused.

Furthermore, Peikko's most intense activity with regards to the circular economy is developing a connection system that offers possibilities for circular building using precast concrete structures.



” BUILDING CIRCULAR IS NOT ONLY POSSIBLE. IT'S ALSO A GOOD BUSINESS.

Kasper Guldager Jensen
Senior Partner 3XN, Director GXN,
Board Member Peikko Group

PRECAST CONNECTIONS

For the circular economy

The Peikko and GXN collaboration innovation project started in 2017 and has set a target for a concept that is based on the idea of utilizing many of Peikko's existing products, particularly in bolted connections.

It was clear from the beginning that Peikko already has many products and ideas suited to this concept. However, more work was needed to create a fully proven concept.

PROCESS

A connection system suitable for assembly and disassembly was created for all main precast component assemblies.

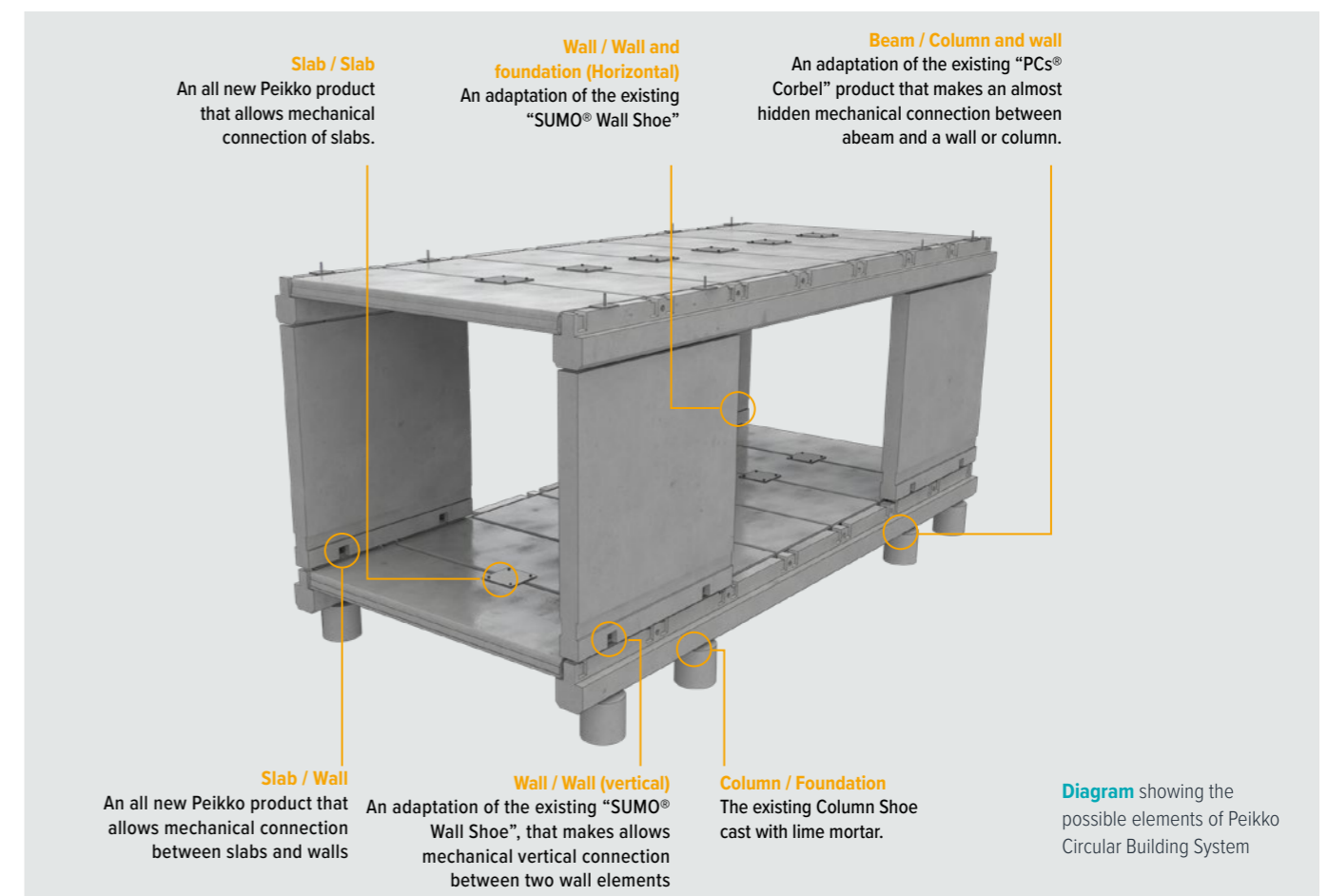
The diagram and the pictures on the following pages show examples of slab/wall connections. The aim was not only to develop suitable connections, but to search for new types of mortar that enable efficient disassembly whenever the building is "taken apart into individual pieces", allowing for the element to be resold to a new location.

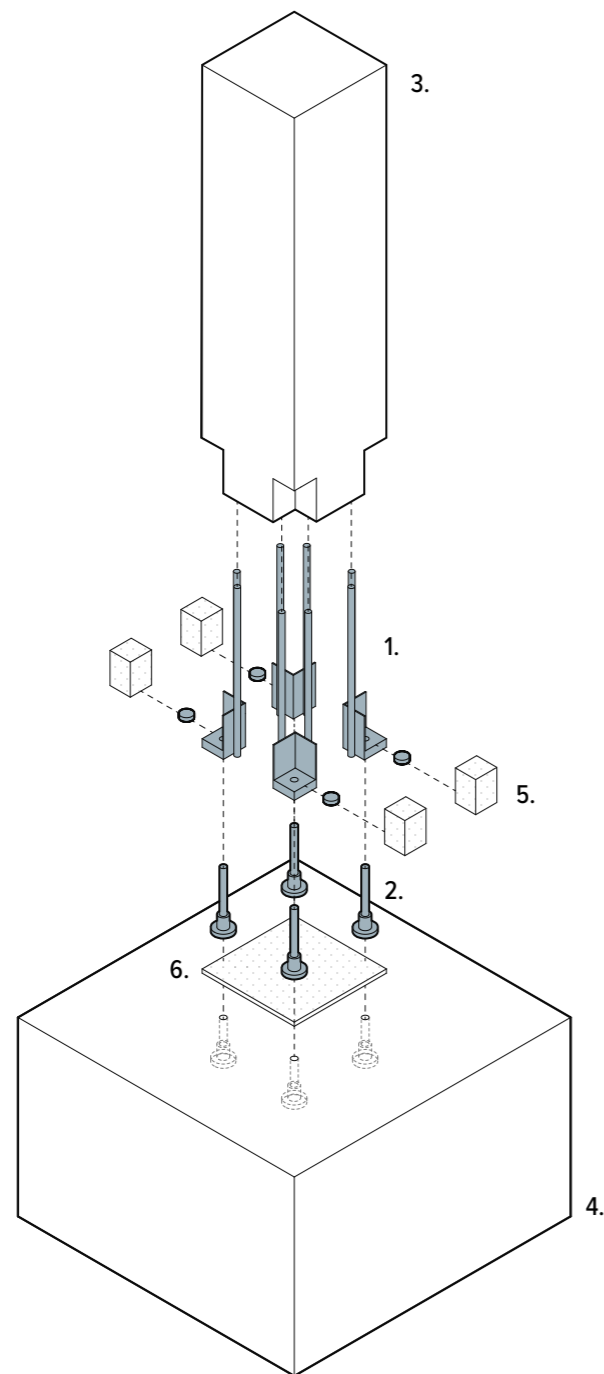
To get to the most suitable connection system, experiments were made with a set of lime mortars. This led to the development of Peikko SUMO® Shoes, which were cast with different strengths of mortar and were allowed to cure for two months.

During drying, no cracks occurred, so the technical properties were maintained. Blasting the lime mortar with a high pressure cleaner exceeded all expectations. It was possible to remove the least dense of the three mortar layers in just 10 seconds. It is not only very simple, but also a very fast process.



Image showing Peikko's SUMO® Wall Shoe application.

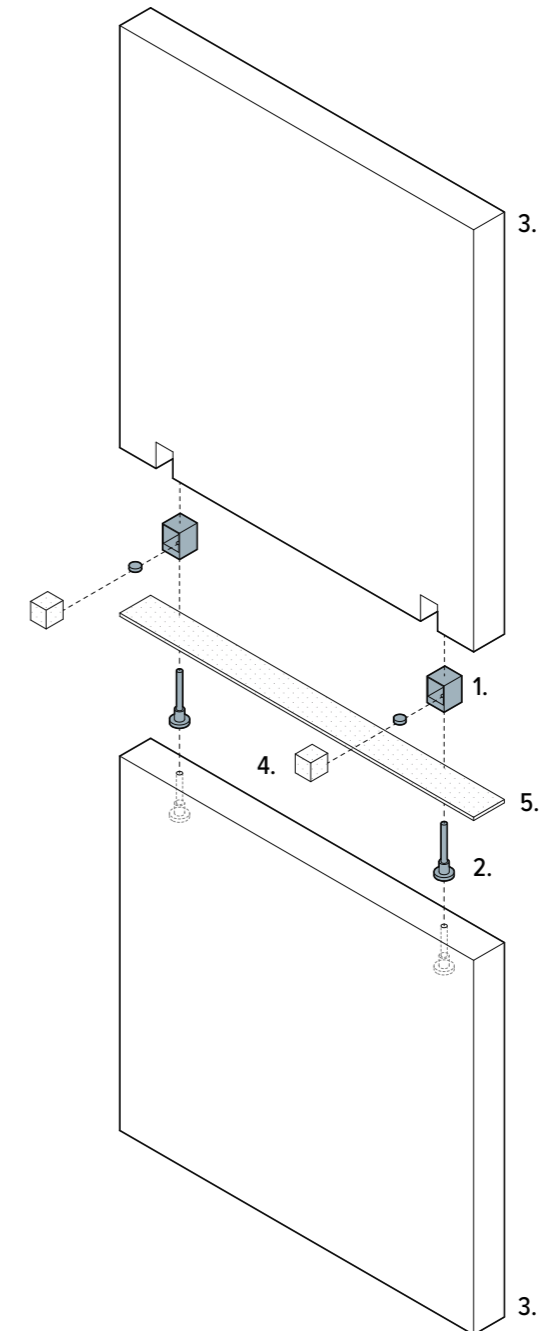




Column / Foundation and column

The current 'Column Shoe' product is very close to being circular and needs only minor adaptation. The protective casting around the connection needs to be easily removable. Examples include lime mortar and cover caps.

1. Peikko column shoe.
2. Cast-in threaded rod.
3. Pre-cast concrete column.
4. Concrete foundation.
5. Lime mortar casting or cover cap.
6. Lime mortar grouting.



Wall / Wall and foundation (Horizontal)

The current "SUMO® Wall Shoe" product is very close to being circular and needs only minor adaptation. The protective casting inside the brackets needs to be easily removable. Examples include lime mortar (as shown in the experiment) or cover caps.

1. Peikko SUMO® Wall Shoe.
2. Cast-in threaded rod.
3. Precast concrete wall element.
4. Lime mortar casting or cover cap.
5. Lime mortar grouting.



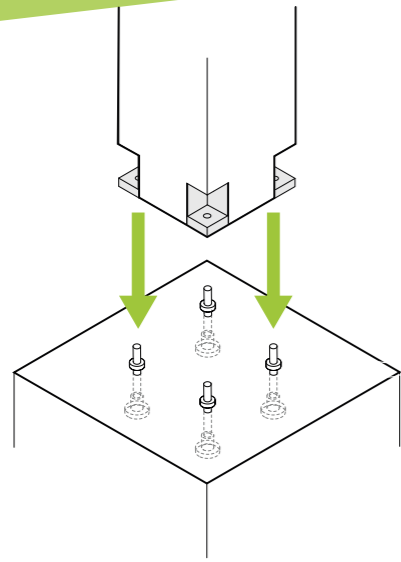
Photo: Baublatt



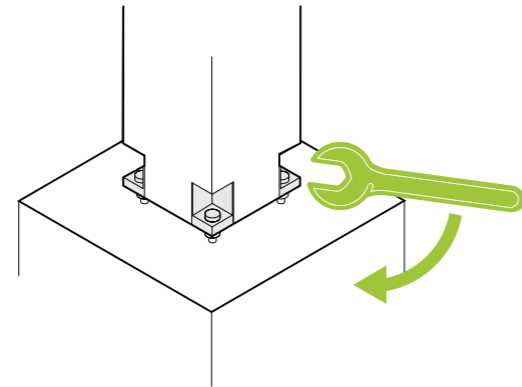
Photos showing the steps in the process of assembling the Peikko Column Shoes.



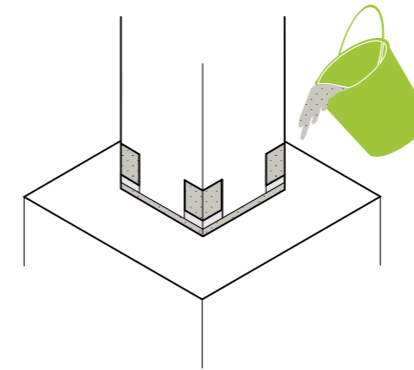
Photos showing the tests for Peikko SUMO® Wall Shoes. These connections were cast with different strengths of lime mortar.



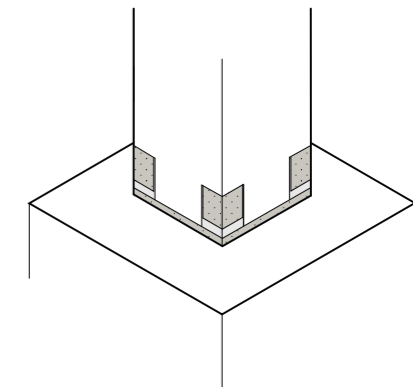
Step 1 – Assembling
The column with the Peikko Column Shoe is mounted to the cast-in Anchor Bolt.



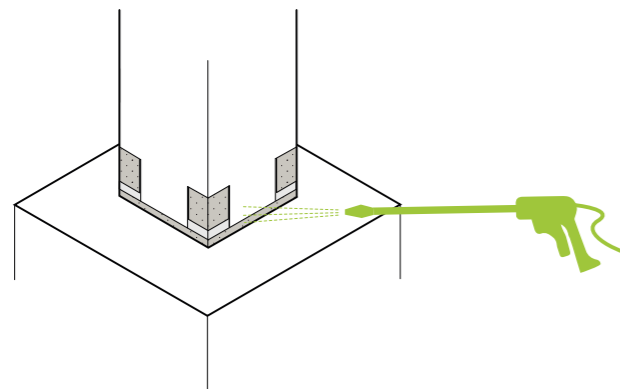
Step 2 – Fastening
The column is bolted, already achieving the stability for the building process to continue



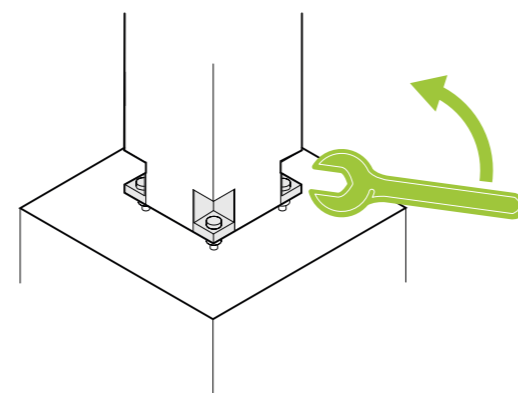
Step 3 – Casting
The Peikko Column Shoes are cast with lime mortar to project the joint from external impacts.



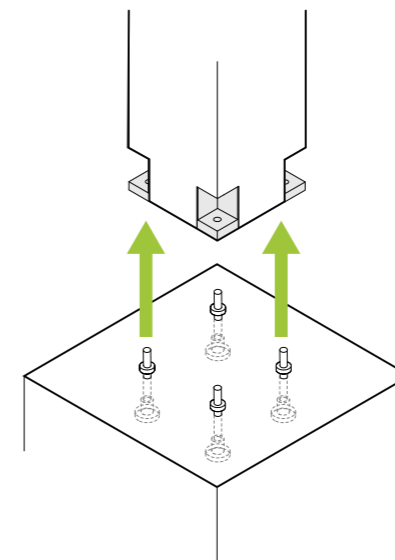
Step 4 – Using
The building is complete and ready to be used.



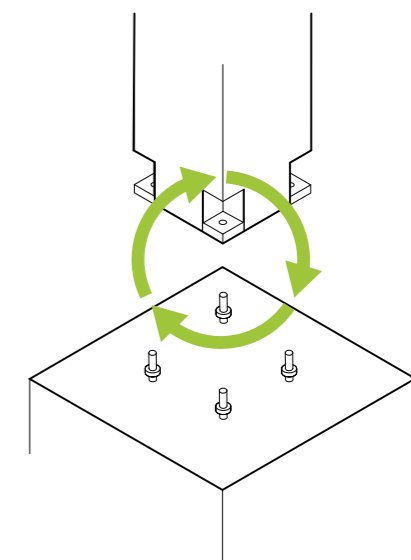
Step 5 – Hydroblasting
The lime mortar in the Column Shoes is removed by hydro-blasting.



Step 6 – Unfastening
The bolt in the Peikko Column Shoe is unfastened from the threaded rod.



Step 7 – Disassembling
The column with the Peikko Column Shoes is disassembled and lifted away.



Step 8 – Reusing
The column with the Peikko Column Shoes is ready to be reused in new buildings.

Diagram showing the possible assembly and disassembly process for Peikko's Column Shoe.

FUTURE WORK

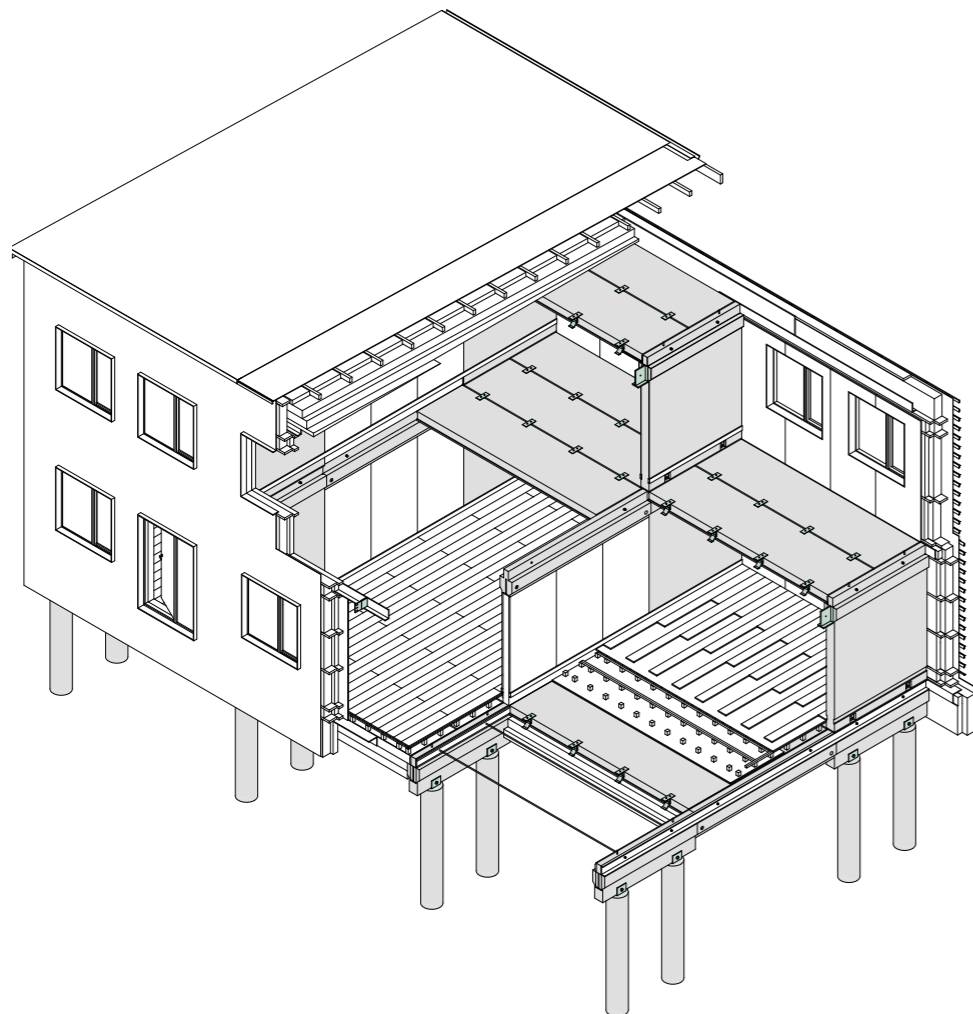
A three-year horizon

Peikko aims to verify the precast circular economy concept via a set of real customer pilot buildings between 2018 and 2020.

The aim is to pilot the connection system in several buildings in at least three countries, so that the concept is practical and detailed, yet generic enough to be accepted in most countries. One of the projects Peikko is actively working on is the Circle House project led by GXN in the city of Aarhus, Denmark. The final "Circle House" will be completed in 2020. This year, the project will build a 1:1 model of the complete circular building system.



Timeline showing the work that will be done over a three-year horizon.



Axonometry showing the Circle House and the Circular Building System.

CONCLUSION

New opportunities

Peikko is at the beginning of its journey in the circular economy. Between 2018 and 2020, Peikko will pilot its connection concepts in real-life buildings.

After successful piloting, Peikko will be ready to provide connection concepts that offer new, circular horizons for investors. The circular economy needs to be and will be fundamentally good business for investors of buildings. Peikko aims to be a forerunner in this development, to provide practical, cost-efficient solutions to change the building industry and help it adapt to the circular economy.



Peikko creates connections and solutions to support the circular economy

EXPERT ADVICE LOCALLY AVAILABLE

Peikko's operations are based on localized and reliable customer service, excellence in R&D and manufacturing. This includes good co-operation with customers, other stakeholders, and within society. Our overall aim is to consistently deliver high quality and to work in an environmentally aware manner.

www.peikko.com



A faster, safer, and more efficient way to design and build

Peikko supplies slim floor structures and connection technology for precast and cast-in-situ applications. Peikko's innovative solutions make your construction process more efficient.