



### **What is 3D concrete printing?**

3D printing is basically a manufacturing process in which material is applied layer by layer to create three-dimensional objects. The origins of the technology go back to the 1980 s. Nowadays, 3D printing is widely used mainly in industry, medical and dental technology as well as in research, for example to produce models, prototypes, tools or components with a special geometry.

Finally, around 25 years ago, the first attempts were made to also “build” houses with a 3D printer. With 3D concrete printing, we are talking about an innovative technology that opens up new dimensions in house construction. The technology shapes concrete without the use of formwork – quickly, cost-effectively and with great design freedom.

The process is ideally suited for use in residential construction and for the production of individual prefabricated parts.

At PERI, we have developed the technology into a fully comprehensive construction process in 2020 and are now printing houses. Our 3D-printed houses are the first to be regularly rented and occupied and are not just for demonstration purposes.

### **Why 3D concrete printing?**

The world is in a state of change. Every day we are confronted with global developments such as labour and housing shortages. This is also having an impact on the construction industry: labour is becoming scarce, there are fewer and fewer applicants to choose from and the demands of construction

# Building rethought

3D concrete printing is revolutionising the construction industry

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At PERI, we are passionate about what we do. Our 3D concrete printing team made a major breakthrough in 2020. In summer 2020, the go-ahead was given for Germany's first residential building from the 3D concrete printer. Further success occurred soon after: the largest printed apartment building in Europe. In the following article you will learn more about the innovative technology as well as the technical and design possibilities of 3D concrete printing.



► Discover how 3D printing is revolutionising the construction industry in the B1M Video.

site personnel are changing. At the same time, digitalisation poses new challenges for the construction industry.

3D concrete printing technology as an automated manufacturing process addresses precisely these issues and offers completely new possibilities in the construction industry, for example in residential construction or in the manufacture of prefabricated parts. This goes hand in hand with our vision at PERI: to build houses faster, at lower costs and in an environmentally-friendly way. To offer construction site personnel a workplace that is both sustainable and health-friendly. Another bonus: thanks to the optimised use of materials, 3D concrete printing contributes to a more sustainable environment.

## **3D concrete printing at PERI**

Why are we at PERI involved with 3D concrete printing at all? With a technology that competes with our proven products and could replace our formwork? The answer is simple: we are not competing with ourselves or our customers. Because the houses we make with the help of a 3D concrete printer do not normally use concrete formwork – they are built with bricks or wood.

Because we see ourselves as 3D concrete printing experts and technology suppliers, we also do not stand in the way of our customers' business. We sell and rent out the 3D concrete printers and then support our customers with an extensive service portfolio in the implementation of their projects. ►



# Advantages of 3D concrete printing



## Time and cost reduction

The 3D concrete printer is called the BOD2. It is the only second generation concrete printer on the market and is used in residential construction and the production of precast parts. It is also the fastest of its kind. For example, the production of 1 m<sup>2</sup> of double-skin wall takes only about five minutes.

The construction process with the BOD2 is automated and saves valuable time as well as personnel costs. Two people are sufficient to operate it. One person controls the printer with a laptop, tablet or smartphone. For this purpose, the 3D building model has already been converted into specific instructions for the BOD2 via software before the start of construction. The second person makes sure that the printer has adequate printing material. Any locally sourced, 3D-printable mortar or concrete – up to a grain size of 8 mm – can be used for this.

## Recruitment of skilled workers

For construction companies, the issue of personnel is of immense importance, especially in view of the often difficult search for suitable skilled workers. This is where 3D concrete printing offers new possibilities: The printer is an innovative

machine that is gentle on the body as well as being clean and safe. And above all, it is simply fun to be among the first to have the opportunity to work with such a machine.

In a 3D concrete printing project, the final planning is already available before the start of the project. Costly adjustments that are generally the norm in construction are now a thing of the past. Instead, all parties involved benefit from a high degree of planning reliability.

## Reduced coordination effort

The use of the 3D concrete printer significantly reduces the coordination effort on the construction site and thus optimises the construction processes. How does that work? Various trades are integrated directly into the printing process.

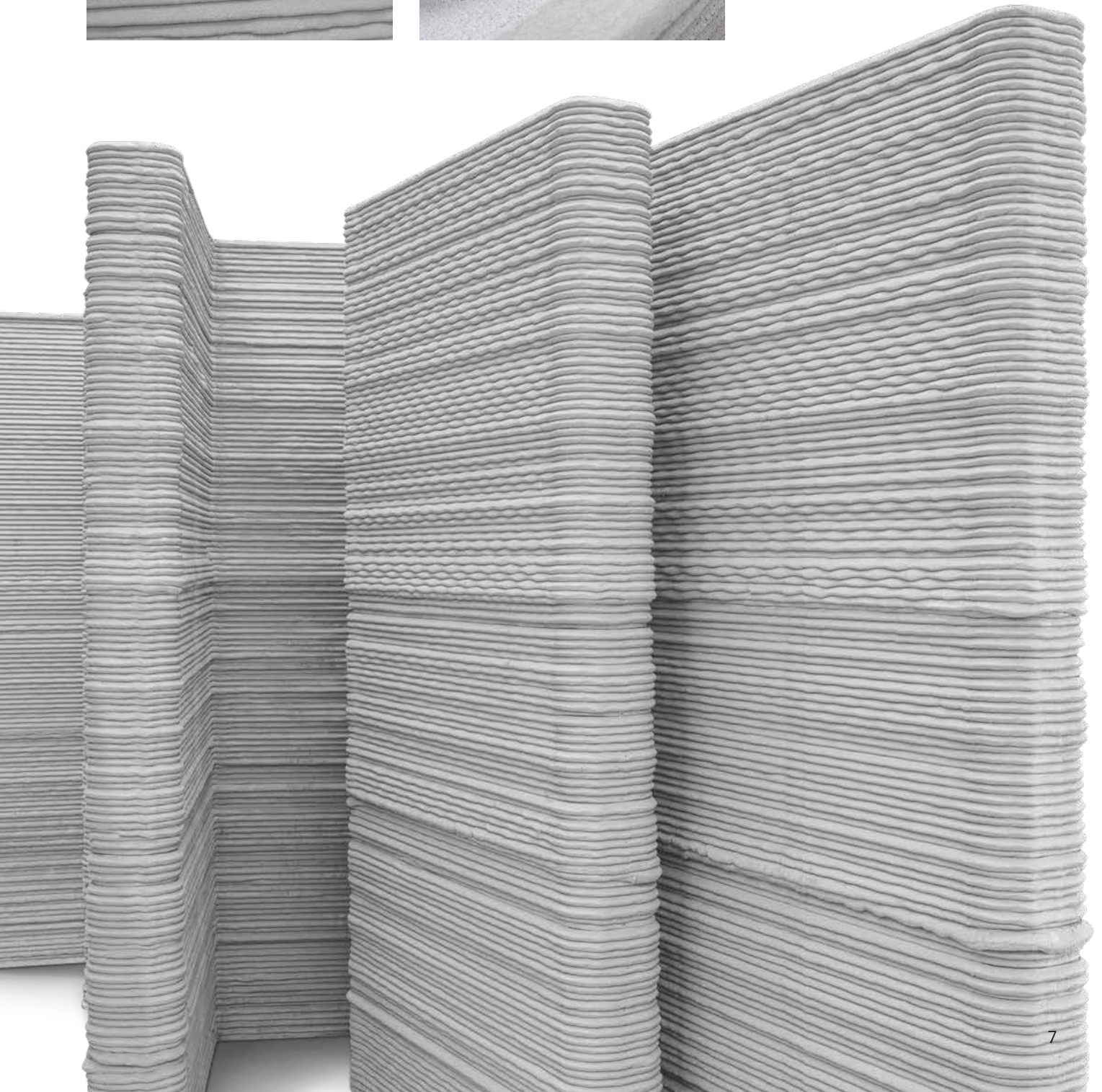
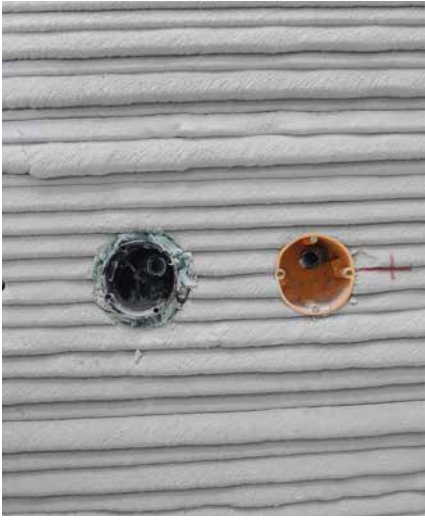
For example, empty pipes can be inserted during the printing process and cable ducts for the electricians can also be printed. The printing of the stopend formwork for concreting the slabs also allows optimisation of this work step. In addition, other trades can be eliminated, such as facade work. The work of surveyors is also reduced in the case of buildings with free geometries.

## High degree of design freedom

With the BOD2, the design possibilities are almost endless – from individual shapes to special surfaces and colours, almost anything is possible. It makes no difference to the printer what it prints. The BOD2 enables the realisation of straight, curved and even rounded shapes, which would not be possible with formwork or only with a lot of work and using special solutions, at no extra cost.

Architects can be creative thanks to 3D concrete printing and realise innovative forms in residential construction. As the first and only buildings of their kind, they thus become a real eye-catcher.

A characteristic feature of BOD2 buildings is the 3D print optics of the surfaces. Apart from pulsating structures, surfaces with a smooth look are also easily possible. A terrace structure is a good choice for easier plastering. There are hardly any other limits for the printer – showers, fireplaces, kitchen substructures can be printed without any problems. Further design possibilities are offered by playing with overhangs as well as different heights and widths of the print layers. ►





# The BOD2

has successfully proven that it is ready for series use on the construction site. This is a portal printer with a portal system consisting of several modules. Each module is 2.50 m long and can be extended at any of the three axes – the maximum dimensions are 15 m in width, 10 m in height, and there is no limit to the length. Thus, the number of modules and the dimensions can be individually configured for different applications and projects. The largest BOD2 built to date has done an impressive job, successfully printing a building with a footprint of 300 m<sup>2</sup> and three storeys.

The machine's modular design also facilitates assembly, cleaning and maintenance. "The print head moves over three axes on a securely installed metal frame", explains Fabian Meyer-Brötz, Head of 3D Concrete Printing at PERI. "The printer can move in its frame to any position within the design and only needs to be calibrated once, which saves a huge amount of time compared to a 3D printer with a robotic arm. Each calibration process takes several hours", he continues.





### Extremely safe

The BOD2 is the only concrete 3D printer that is already in its second generation. Thanks to a wide range of test series and test projects, the BOD2 is now a mature and particularly safe 3D concrete printer. It is fully CE-certified and has a wide range of safety features such as pinch protection, emergency shutdown mechanisms and weight sensors. In addition, it has an IP67-certified cable system. Furthermore, the print head and print results are continuously monitored by a camera. Due to the high degree of automation, the probability of errors is noticeably reduced.

### Flexible assembly

The installation of the BOD2 is completely flexible. It can therefore be mounted on a foundation or on movable concrete blocks. The assembly time depends on the individual configuration of the printer. A printer measuring 17 m in length, 12 m in width and 8 m in height, requires one working day respectively for assembly and disassembly.

### The printing process

One of the main areas of application for 3D concrete printing is residential construction. During the printing process, the printer takes into account the pipes and connections for water and electricity that will be laid later. Another special feature is that work can be carried out in the printing space during the printing process. Manual work, such as laying empty pipes or connections, are thus easily integrated into the printing process.

### The reinforcement

Reinforcement also becomes unnecessary in residential construction. The printed material carries up to 50 megapascals so the printed cavity wall already meets the static requirements. ►



After being intensively involved with 3D concrete printing technology for years, we acquired a stake in COBOD, the technology leader in 3D concrete printers in 2018. Since then, we have been working together with the Danish start-up to further develop the technology and open up the market.

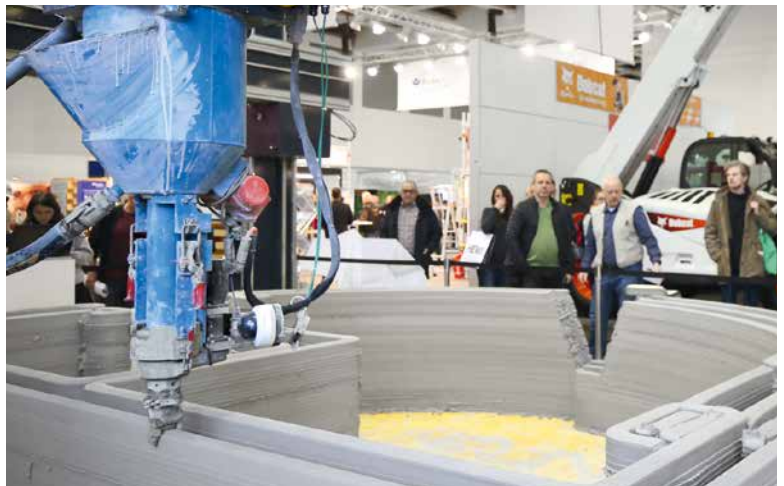
# Milestones

## First live demonstration



► 3D concrete printing is ready for the construction site.

In February 2020, we will show the potential of 3D printing to our customers for the first time at bautec in Berlin, by printing four rooms in just four days.



## We are selling the first concrete 3D printer

In August 2020, our development work of the last few years will pay off. Röser GmbH has ordered a 3D concrete printer for the production of precast concrete parts for its site in Laupheim.





# We print the first residential house in Germany



► Go-ahead for Germany's first 3D-printed residential building.

In the summer of 2020, 3D printing easily goes through all the regulatory approval processes and proves its readiness for the market. The two-storey detached house in Beckum comprises a living area of around 80 m<sup>2</sup> per storey.



# We print the first apartment building in Europe



► Only a short time later we achieve our next success.

After around six weeks of printing, we complete the shell of Europe's first apartment building from the 3D printer in Wallenhausen, Bavaria. The residential building has a full basement and provides space for five flats with a total of around 380 m<sup>2</sup> of living space over three floors.



## Outlook

Our 3D concrete printing team is working flat out to bring this still new technology to the international market. Jan-Peter Graumann, Global Business Development Manager at PERI GmbH proudly states: "3D printing is our baby. One vision resulted in cooperation with the Danish start-up COBOD. Together we have made the technology ready for the construction site. In Germany, we already offer an extensive concrete printing portfolio with a wide range of services. Of course, we also want to make the technology available to customers from all over the world in the near future. We have set our sights on the USA as the next step". ■