CPT WORLDWIDE
CONSTRUCTION PRINTING TECHNOLOGY

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CPT IS BACK!

Here we are again – in a new format but with old strengths. From now on, CPT Construction Printing Technology continues to inform you about the fascinating developments in the field of digital construction with concrete. Both 3D concrete printing and 3D formwork printing now provide opportunities to the construction industry, which only a few years ago would have been dismissed as utopian.

Let yourself be inspired and get carried away – by what has already been achieved and by the visionary plans for the future of construction. With CPT's new eJournal and our reports on international developments, you are always up to date – bundled and compact on your mobile device! Register now for your regular and free download of the new CPT eJournal. Registration on our homepage is quick and easy: **www.cpt-worldwide.com**

In this issue of the CPT eJournal, we report on exciting and impressive projects and present news and developments of the last few months. This digital edition is thus a bridge to our last printed issue in 2021. Enjoy the reading!

Dipl.-Ing. Mark Küppers
editor in chief
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COBOD 3D PRINTS CONSTRUCTION APPLICATIONS LIVE AT THE WORLD OF CONCRETE 2022 IN LAS VEGAS

NEWS

CLICK
HERE TO WATCH
THE VIDEO

On 18-20 January at the Las Vegas Convention Center during the World of Concrete convention, Cobod International, together with materials provider Quikrete and Arizona 3D builder & developer We Print Homes 3D printed building structures in front of large live crowds for 3 days in a row.

To demonstrate the market readiness of the technology and its widescale applicability in the US, Cobod decided to demonstrate their printing system at a large US construction event. Cobod's printing system is capable of printing with mortars as well as with real concrete. The live printing attracted a crowd of more than 1,000+ people and was very popular. World of Concrete (www.worldofconcrete.com) even labelled the live printing as a "must-see" exhibition, further underlining the increased interest and attraction of the 3D printing technology.

Commenting on the success of the live 3D printing, Philip Lund-Nielsen, Co-founder & Head of Americas at Cobod, said: "Our goal with 3D printing in front of a live audience at World of Concrete was to demonstrate the advantages of our technology in US as our main market, at the same time demonstrating that our technology is reliable and ready to be used in the US. We wanted to show that 3D construction printing is not just a lab idea, but a viable and competitive alternative to traditional construction methods. The massive number of inquiries during and after show tells me that we succeeded with our goals."
As a further sign of the increasing popularity of Cobod's technology, the educational event which Cobod also hosted during the World of Concrete had more than 150+ attendees and the lecture room had to be upgraded twice to accommodate everybody.

©Klaus Peterlin

SOUSA-PHONE

Music amplified by concrete. As a natural successor to the classic Gramophone, the Sousa-Phone combines traditional design language with an innovative production process to create one of the biggest analogue smartphone amplifiers of the world.

Through advanced sound engineering and one of the highest resolution concrete powder bed 3D printing qualities available today, a sensual yet functional music sculpture with extraordinary sound attributes was created.

www.sthar.it

Key data:
- Concrete analogue smartphone amplifier
- 650 x 1050 x 600 mm
- Produced by Concrete Powder Bed 3D Print process by Progress Group
- Production of 35 pieces per print

STRIATUS

CLICK
HERE TO WATCH
THE VIDEO

Striatus is an arched, unreinforced masonry footbridge composed of 3D printed concrete blocks assembled without mortar. The 16x12-metre footbridge is the first of its kind, combining traditional techniques of master builders with advanced computational design, engineering and robotic manufacturing technologies.

The name “Striatus” reflects its structural logic and fabrication process. Concrete is printed in layers orthogonal to the main structural forces to create a “striated” compression-only funicular structure that requires no reinforcement.

A new language for concrete

Proposing a new language for concrete that is structurally informed, fabrication aware, ecologically responsible and precisely placed to build more with less, Striatus optimises the interrelated properties of masonry structures, 3D concrete printing (3DCP) and contemporary design; presenting an alternative to traditional concrete construction.

Strength through geometry

Striatus is an unreinforced concrete structure that achieves strength through geometry. Concrete can be considered an artificial stone that performs best in compression. In arched and vaulted structures, material can be placed precisely so that forces can travel to the supports in pure compression. Strength is created through geometry, rather than an inefficient accumulation of materials as in conventional concrete beams and flat floor slabs. This presents opportunities to significantly reduce the amount of material needed to span space as well as the possibility to build with lower-strength, less-polluting alternatives.

Striatus’ bifurcating deck geometry responds to its site conditions. The funicular shape of its structural arches has been defined by limit analysis techniques and equilibrium methods, such as thrust network analysis, originally developed for the structural assessment of historic masonry vaults; its crescent profile encompasses the thrust lines that trace compressive forces through the structure for all loading cases.
Steel tension ties absorb the horizontal thrust of the arches. Neoprene pads placed in between the dry-assembled blocks avoid stress concentrations and control the friction properties of the interfaces, echoing the use of lead sheets or soft mortar in historical masonry construction.

In plan, the boundaries of the structure form deep arches that transfer horizontal loads (for example, from visitors leaning against the balustrades) to the supports in pure compression. Advanced discrete element modelling (DEM) was used to refine and optimise the blocks’ stereotomy and to check the stability of the entire assembly under extreme loading cases or differential settlements of the supports.

The bridge’s 53 3DCP voussoirs have been produced using non-parallel print layers that are orthogonal to the dominant flow of forces. This avoids delamination between the print layers as they are held together in compression. The additive manufacturing process ensures the structural depth of the components can be achieved without producing blocks with a solid section, hence reducing the amount of material needed compared to subtractive fabrication methods or casting.

A project by the Block Research Group (BRG) at ETH Zurich and Zaha Hadid Architects Computation and Design Group (ZHACODE), in collaboration with incremental3D (in3D), made possible by Holcim.

Striatus follows masonry structural logic on two levels. As a whole, the bridge behaves as a series of leaning unreinforced voussoir arches, with discretisations orthogonal to the dominant flow of compressive forces, following the same structural principles as arched Roman bridges in stone. Locally, on the level of the voussoir, the 3DCP layers behave as traditional brick masonry evident in the inclined rows of bricks within Nubian or Mexican vaulting.

Sustainable digital concrete

Circular by design, Striatus places material only where needed, significantly reducing its environmental footprint. Built without reinforcement and using dry assembly without binders, Striatus can be installed, dismantled, reassembled and repurposed repeatedly; demonstrating how the three R's of sustainability (Reduce, Reuse, Recycle) can be applied to concrete structures.

Reduce

Lowering embodied emissions through structural geometry and additive manufacturing that minimises the consumption of resources and eliminates construction waste.

Placing concrete only there where needed, 3DCP minimises the amount of material required, while the low-stress, compression-only funicular geometry of Striatus proposes the further development of 3DCP that will enable the use of much lower-strength, less-polluting printable materials.

Compared to embedded reinforcement in concrete, Striatus uses external ties to absorb the thrust of its arched shape and dramatically reduce the amount of steel required. A high carbon-intense material, steel reinforcement (100% recycled) per unit mass is more than ten times that of standard concrete.

Reuse

Improving circularity and longevity. Unlike conventional reinforced concrete structures, Striatus is designed to be dry assembled without any binder or glue, enabling the bridge to be dismantled and reused in other locations. Its funicular design ensures the 3DCP blocks experience low stresses throughout their use, resulting in no loss of structural integrity. Striatus separates components in compression and tension, ensuring external ties can be easily accessed and maintained, resulting in a longer lifespan for the entire structure.

Recycle

By ensuring different materials are separated and separable, each component of Striatus can easily be recycled with minimal energy and cost. 3D printing also avoids the waste and costs associated with single-use moulds. Additionally, the component materials within Striatus remain separate and separable with the use of mechanical connections such as simple dry contacts between the voussoirs rather than chemical glues or binders, ensuring a simple, low-energy recycling process at the end of the elements' life, potentially after multiple cycles of reuse.

Robotic 3D concrete printing

Unlike typical extrusion 3D printing in simple horizontal layers, Striatus uses a two-component (2K) concrete ink with corresponding printing head and pumping arrangement to precisely print non-uniform and non-parallel layers via a 6-axis, multi-DOF robotic arm. This new generation of 3D concrete printing in combination with the arched masonry design allows the resulting components to be used structurally without any reinforcement or post-tensioning.

To prevent misalignment between the direction of structural forces and the orientation of material layers that arises from typical shape-agnostic slicing of explicitly modelled geometry, a custom-developed design pipeline was formulated for Striatus to ensure that its printed layers are wholly aligned with the direction of compression forces throughout the entire bridge and also locally through each 3D-printed block. To address issues and challenges that could prevent in-between stability during printing, the coherence and feasibility of the gradually evolving print paths have been modelled using a Functional Representation (FRep) process.

This process encodes and continuously checks rules of minimum overlap, maximum cantilever between print layers and print length, print speed and the volume of wet concrete extruded. These measures, typically used in horizontally layered 3DCP, have been advanced and refined to work on an inclined-plane setting:

- The angular differences between start and end planes of all 53 printed blocks have been simultaneously adjusted to meet multiple criteria such as an appropriate structural contact and angle between adjacent blocks, and maximum print inclination.

- The careful design and iterative refinement of the hollow cross-sections and infill triangulation have ensured that material is placed corresponding to the precisely analysed, local structural performance of each block. This design and optimisation have been applied to each individual layer of every block (with 500 print layers on average per block), ensuring that all blocks are as hollow and light as possible, and consequently use the least amount of material possible while maintaining structural integrity under all loading conditions.

- The resulting intricate cross-sectional design has been processed into a single, continuous print path meeting various criteria that include appropriate print speed and turning radii, structurally required material width and thickness, and controlled expression of naturally occurring printing artefacts.

A nuanced aspect of robotic 3DCP masonry is the re-introduction of intelligence and highly skilled labour into the manufacturing and construction industry. The digitisation of fabrication and digital augmentation of skilled assembly and construction techniques makes historically-accrued knowledge accessible to younger generations and enables its systematic upgrade towards industrialised construction through the use of computational and robotic technologies. In stark contrast to a brute force, and often materially wasteful economy biased towards automation and assembly line production, 3DCP masonry introduces possibilities of a symbiotic human-machine economy. This promises an environmentally, socio-culturally and economically sustainable alternative to its 20th-century predecessor.

Computational design-to-construction integration

Integrating design, engineering, fabrication and construction, Striatus redefines conventional interdisciplinary relations. The precise manufacturing of the blocks was enabled by well-defined data exchange between the various domain-specific software toolchains involved in the process. This co-development approach was facilitated through the use of COMPAS, an open-source computational framework for collaboration and research in the AEC industry, which enabled the fluent interaction among the key players of the project, working together in five different countries, under a very tight schedule and budget, at a time in which travelling was not possible.

Disruptive outlook

Striatus offers a blueprint for building more with less. Created with the same structural principles and a similar fully-integrated computational design-to-fabrication approach that form the basis of the vaulted, rib-stiffened, unreinforced concrete floors being developed by the Block Research Group in partnership with Holcim, Striatus proposes an alternative to the standard inefficient floor slabs within any building.

Compared to typical reinforced concrete flat floor slabs, this new floor system uses only 30% of the volume of concrete and just 10% of the amount of steel. The very low stresses within the funicular structure also enable the use of low-embodied-carbon concrete that incorporates high percentages of recycled construction waste. Prefabricated and dry-assembled, and therefore fully demountable and reusable, this floor system is easily and cleanly recyclable at end-of-life.

With an estimated 300 billion square metres of floor area to be constructed worldwide over the next 30 years, and floors comprising more than 40% of the weight of most high-rise buildings (10+ storeys), introducing the principles demonstrated by Striatus would truly disrupt the construction industry — transforming how we design and construct our built environment to address the defining challenges of our era.

Design
- ZHACODE: Jianfei Chu, Vishu Bhooshan, Henry David Louth, Shajay Bhooshan, Patrik Schumacher
- ETH BRG: Tom Van Mele, Alessandro Dell'Endice, Philippe Block

Structural engineering
- ETH BRG: Tom Van Mele, Alessandro Dell'Endice, Sam Bouten, Philippe Block

Fabrication design
- ETH BRG: Shajay Bhooshan, Alessandro Dell'Endice, Sam Bouten, Chaoyu Du, Tom Van Mele
- ZHACODE: Vishu Bhooshan, Philip Singer, Tommaso Casucci

3D concrete printing
- In3D: Johannes Megens, Georg Grasser, Sandro Sanin, Nikolas Janitsch, Janos Mohacsi

Concrete material development
- Holcim: Christian Blachier, Marjorie Chantin-Coquard, Helene Lombois-Burger, Francis Steiner
- LafargeHolcim Spain: Benito Carrion, Jose Manuel Arnau

Assembly & Construction
- Bürgin Creations: Theo Bürgin, Semir Mächler, Calvin Graf
- ETH BRG: Alessandro Dell'Endice, Tom Van Mele

Logistics
- ETH BRG: Alessandro Dell'Endice, Tom Van Mele
- Holcim Switzerland & Italy: Michele Alverdi
- LafargeHolcim Spain: Ricardo de Pablos, José Luis Romero

Documentation
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- ETH BRG: Tom Van Mele, Alessandro Dell'Endice, Philippe Block
- In3D: Alexander Gugitscher, Sandro Sanin, Nikolas Janitsch
- naaro
- LBS Fotografia

COLORFUL CONCRETE PROJECTS USING AM METHODS

Gray is the predominant color in the relatively young field of 3D printed concrete applications. What is often overlooked is that colorful construction projects can be easily realized by using inorganic pigments. For the reliable coloration of 3D printed concrete, iron oxide pigments are the perfect choice.

Lanxess supports its customers in adding color to their 3D printed concrete products. The specialty chemicals company has created a sample box showing which colors can be realized in additive manufacturing. The box contains concrete samples in 26 different colors, colored with weather-resistant, colorfast, inorganic pigments from the well-known Bayferrox brand. These can be used for reliably adding color to 3D-printed concrete structures, lending users of this highly promising and cost-efficient technology even greater design freedom in projects large and small.

Creating colorful highlights with inorganic pigments

The Bayferrox pigments, which are highly renowned in the construction industry, are available in 100 shades of black, red, yellow, brown and green and are suitable for use in reinforced and non-reinforced concrete. Inorganic iron oxide pigments in particular have proven their suitability for use in various concrete construction materials over many years in extensive tests and weathering tests. Due to their chemical composition and structure, these products are not only insoluble in water and dilute acids, resistant to lime and alkalis, but also absolutely weather- and light-stable and thus ideally suited for coloring building materials.

However, expert advice concerning the use of pigments is essential for colored 3D printing projects. Ensuring that the concrete is of exactly the right shade even after it has cured depends not only on the quality and mixing of the pigments, but also on the application itself. The type of cement used affects the shade – and vice versa. How the pigments react to the concrete additives used also needs to be taken into account. This process requires extensive knowledge of how the concrete and color pigments interact.

Knowing the optimum pigmentation level, for example, is a significant factor in reducing costs. If the amount of pigment in a concrete mix is steadily increased, then the color intensity initially increases linearly with the pigmentation. As the pigment addition progresses, however, the range is reached at which the addition of further quantities of pigment no longer causes any significant intensification of the color shade and is therefore uneconomical. The definition of the saturation range depends, among other things, on the system parameters of the concrete; in general, however, addition rates above five percent (based on the binder quantity) are not necessary for the very strong Bayferrox pigments. In the case of pigments with a weaker color, on the other hand, the saturation range is only reached with much higher pigment additions. The amount of pigment required to achieve a certain color shade can thus become so large that this increase in the amount of fines has a negative effect on the concrete's technological properties.

Lanxess offers manufacturers of 3D-printed in-situ & precast concrete objects expert technical support to ensure that drab gray does not come to dominate the relatively new world of 3D concrete printing. The company has recently expanded its application technology laboratory for construction materials and the technical center for pigment applications at its production site in Krefeld-Uerdingen, Germany. With an area of roughly 1,000 square meters, the facility is equipped with state-of-the-art technology. This center of excellence offers extensive testing and analysis of the physical properties of the pigments as well as their effects in concrete:

- Color matching to meet customer specifications can be made in existing and new concrete formulations by using modern color measuring technology. Accurate measurement of the precise color coordinates are determined on the basis of the CIELab color system for all cement based applications.

- Colorimetric problems in customer-specific applications can be analyzed reliably under the electronic microscope. The cause of the problem is often determined by analyzing the shape of the primary pigment particles and their distribution in the hardened concrete structure.

- Consistency checks in the usage of iron oxide ensure trouble-free processing of the concrete at the customer as well as reproducible coloring. Lanxess prepares recommended recipes for its customers which take into account the raw materials used and process equipment available.

MATERIALS

Consistency checks in the usage of iron oxide ensure trouble-free processing of the concrete at the customer as well as reproducible coloring. Lanxess develops and recommends tailormade recipes for its customers which take into account the raw materials used and process equipment available.

As part of its extended technical service offering, Lanxess conducts extensive tests of the physical and material-specific pigment characteristics and provides well-founded recommendations for the modification of customer formulations. To this end, the company works together closely with raw material producers, plant manufacturers, architects, and universities.

www.bayferrox.com

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FIRST 3D PRINTED BUILDING IN AUSTRIA

Austria's first 3D printed building was constructed in Hausleiten, Lower Austria. Construction technology group Strabag, together with Peri, realised a roughly 125 m² office building next to its asphalt mixing plant in Hausleiten. The pure printing time for the building extension was approx. 45 hours. The special dry mortar for the construction 3D printing project was supplied by Lafarge.

Klemens Haselsteiner, Strabag board member responsible for digitalization and innovation: "3D construction printing brings an important innovation impulse for the construction industry and is an exciting addition to other construction methods. With this practical test, we want to further develop 3D construction printing together with our partners Peri and Lafarge. In Hausleiten, we were already able to achieve important findings for future use during the joint planning."

Thomas Imbacher, Chief Innovation & Marketing Officer at Peri AG: "At Peri, we see great potential in the still young technology of 3D construction printing. Just under a year ago, we printed Germany's first residential building with a Bod2 printer from our Danish partner Cobod. Now, together with our partners Strabag and Lafarge, we are bringing this new form of construction to Austria and are delighted with the first printed office building in Hausleiten."

Peri used the Cobod Bod2 gantry printer for the printing project in Hausleiten. With this technology, the print head moves over three axes on a permanently installed metal frame. The advantage: The printer can move to any position within the construction and only needs to be calibrated once.

With the printing project in Hausleiten, the Peri 3D construction printing team has successfully completed five printing projects in one year. All these projects are not research projects, but "real" houses that have gone through all the building code approval processes, are rented out and occupied, or in which people work.

www.peri.com

ICON AND LENNAR TO BUILD LARGEST NEIGHBORHOOD OF 3D PRINTED HOMES

Lennar, one of the nation's leading homebuilders, and Icon, a large-scale 3D printing construction technologies company, announced a commitment to build the largest community of 3D printed homes to date using Icon's innovative robotics, software and advanced materials. The 100-home community will be codesigned by the acclaimed architecture firm, BIG-Bjarke Ingels Group.

The announcement deepens a relationship that began with Lennar's investment in Austin-based Icon's recent $207-million financing round and offers a promising path toward delivering affordable, technology-driven homes that meet rising demand.

"Labor and material shortages are two of the biggest factors pushing the dream of home ownership out of reach for many American families," said Eric Feder, President of Lenx. "Lennar has always expanded the boundaries of technological innovation to keep quality homes affordable and 3D printing is an immensely encouraging approach. We are excited to collaborate with Icon to develop solutions to emerging challenges in the coming years."

Designed and engineered from the ground up for volume 3D printing of homes with precision and speed, Icon's Vulcan construction system can deliver homes and structures up to 3,000 square feet that are built to the International Building Code (IBC) structural code standard and expected to last as long or longer than standard Concrete Masonry Unit (CMU) built homes.

"Icon exists as a response to the global housing crisis and to put our technology in service to the world," said Icon co-founder and CEO Jason Ballard. "Construction-scale 3D printing not only delivers higher-quality homes faster and more affordably, but fleets of printers can change the way that entire communities are built for the better. The United States faces a deficit of approximately 5 million new homes, so there is a profound need to swiftly increase supply without compromising quality, beauty, or sustainability and that

is exactly the strength of our technology. It is an honor and a huge milestone for Icon to partner with Lennar, an elite top-tier homebuilder with a commitment to innovation. We believe this will be a watershed moment in the history of community-scale development and the future breaking into the present."

"Additive manufacturing has the potential to revolutionize the built environment as it gets adopted by the industry at scale," said Martin Voelkle, Partner, BIG-Bjarke Ingels Group. "By partnering with Icon and Lennar, we are able to see this new technology roll out to the widest possible audience. The 3D-printed architecture and the photovoltaic roofs are innovations that are significant steps towards reducing waste in the construction process, as well as towards making our homes more resilient, sustainable, and energy self-sufficient."

www.iconbuild.com

ONE OF THE WORLD'S LARGEST 3D PRINTED CONCRETE BUILDINGS

End of 2021, the German University of Technology in Oman celebrated the finishing of the 3D printing of the walls of the so far largest 3D printed building in the world made with a real concrete. The importance of the event was marked by the presence of His Excellency Sultan Al-Habsi, Minister of Finance of Oman together with more than 200 guests including several ministers and VIPs of Oman, who attended the event in Muscat, the capital of Oman.

The house consists of 190 m² (2,100 SF) and is typical for a social housing unit in Oman. It has 3 bedrooms, three bathrooms, a living room, kitchen, and guest reception area. The house was printed in two stages. While the materials recipe was adjusted and training of the Omani crew took place during the printing of the first part of the house, the second part of the house was done by the Omani crew on their own and it only took five days to complete. A sign of fast learning and productivity improvements occurring in 3D printed projects.

Dr. Hussain, Acting Rector of GUtech said "Today's display of the first 3D printed building is perhaps the first step in the 1,000-mile journey. A step that will not be success without the support of all parties involved. In this regard, I sincerely thank all the local and international parties who contribute to supporting the center and the University. We hope that this center will play its part in supporting Oman's efforts to achieve Oman's Vision 2040."

While the Middle East have seen numerous 3D printed buildings, the 190 m² building in Oman is printed with real concrete instead of the traditional dry mix mortars used in many other 3D printed buildings. To make the concrete 3D printable, GUtech applied the D.fab solution developed by Cobod and Cemex in cooperation where the concrete can have particle sizes up to 10 mm (1/3 inch) and is made from locally available cement, sand, and gravel. In the case of Oman, more than 99.5% of the materials used were local, with less than 0.5% coming from Europe in the form of the D.fab additives.

Henrik Lund-Nielsen, Founder & General Manager of Cobod International stated: "While we have been happy to help various cement and concrete manufacturers develop dry mix 3D printable mortars, we have also insisted on that a solution for making real concrete made from local available materials would be needed for mass application of our technology. We are more than pleased that Cemex took on the challenge, and proud that we in cooperation could develop the new solution, which GUtech has now applied to the first building in Oman.

With the low cost for the printed materials, on top of the savings from not needing formwork and the minimal crew needed to operate our printers, our disruptive technology is now more competitive than ever before in Oman and everywhere in the world".

www.cobod.com

About GUtech

The German University of Technology in Oman (GUtech) is the result of a collaborative agreement between RWTH Aachen University and OES Company (Oman Educational Services) which was signed in December 2006. The main goal behind GUtech is to become a leading university in the region, achieving internationally recognized standards in education, research, and innovation. GUtech mission is to provide a diverse student body with the education required to become highly qualified and socially responsible graduates, guided by German excellence in science and technology and with a firm grounding in Oman's culture and heritage. The University fosters creative and critical thinking to advance research and innovation and, through this, aims at serving society as a whole.

www.gutech.edu.om

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CULTURAL SITE AND PIONEERING CONSTRUCTION

The 23-metre-high tower made of 3D-printed columns is to become a cultural site in Mulegns, a village on the Julier Pass with just 16 inhabitants. The structure is being planned by ETH architects and engineers. Construction is scheduled to start in spring 2022 with robots printing the tower's components on site.

Hansmeyer/Dillenburger

PROJECTS

Michael Walther, ETH Zurich, Switzerland

The village of Mulegns is located on the Julier Pass road, and has just 16 inhabitants. The aim of the project is to bring in culture and revitalise the area. This plan is the brainchild of Giovanni Netzer, theatre director and founder of the Origen cultural festival. To this end, his foundation had an old villa relocated, reopened a hotel and is now having a tower printed using white concrete.

Digital building technology in a mountain village

The White Tower was designed and planned by ETH Professor Benjamin Dillenburger and Michael Hansmeyer from the Digital Building Technologies research group, together with the Origen foundation. Today, the foundation presented the project in Mulegns for the first time. Swiss President Guy Parmelin was also in attendance during the presentation of the project.

Hansmeyer/Dillenburger

The tower is 23 metres in height, and consists mainly of organically shaped, 3D-printed white concrete columns. They support four floors that are each between four and eight metres high. Right at the top, they form a dome and surround a stage where theatre plays, dance performances and concerts will be held.

The project is a fascinating blend of culture and science. ETH aims to use this collaboration to strengthen the association between culture, research and technology development, says Detlef Günther, Vice President for Research at ETH Zurich. "Because new knowledge often emerges where various disciplines meet."

Hansmeyer/Dillenburger

The White Tower will have a prominent position on the Julier Pass, and is intended to be visually reminiscent of the Grisons confectionery tradition. Large numbers of Grisons emigrants made a name for themselves as pâtissiers in Europe's capital cities in the 18th century, with their elaborately decorated creations of small, delicate sugar towers.

Four ETH professorships involved

The tower will be distinctive not only from an artistic perspective, but also in terms of its construction, as it will be one of the tallest 3D-printed, robot-built structures ever. Alongside Benjamin Dillenburger, three other ETH professors from the National Centre of Competence in Research (NCCR) Digital Fabrication are involved in the development process: Robert Flatt is working on the mixing of concrete – the "ink" for the 3D printer, so to speak – while Walter Kaufmann is responsible for the structural integrity and the connections of the printed concrete elements, and Andreas Wieser's area is metrology and inspection.
The 3D printing approach to construction allows complex geometries to be produced, and for the concrete to be used exactly where it is needed for the load-bearing structure. The structure will also need less raw materials overall, as no formwork is needed.

Watching the robot at work

If everything goes according to plan, a public construction site will be set up in April 2022, and everyone will be able to watch as a robot applies the white concrete layer by layer. This robot will need just two hours for a three-metre-high column. And the process of dismantling has also already been planned: the concrete elements can all be taken apart, and the tower can theoretically be rebuilt at another location.

ETH and the Origen foundation already worked together back in 2019, when digitally printed concrete columns were used to create a stage set for dance and theatre performances in the gardens of the Villa Carisch in Riom.

ETH zürich
www.ethz.ch/news

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