"Next Generation" 1st prize Europe

Efficient fabrication system for geometrically complex building elements, London, UK

Project data

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Comment of the Holcim Awards jury Europe

The jury commended this project which innovatively challenges new methods of designing and fabricating geometrically complex building elements and in addition provides efficiency improving elements in terms of materials, storage, and transportation. Overall, the project presents a way that considers simultaneously the design of free and ambitious shapes, as well as the material efficiency and economy of constructions.

Project description by author

The use of complex geometries in contemporary architecture is common nowadays. However, known methods for creating such geometries, at least in the construction industry, are associated with considerable waste of time and materials. This affects the overall costs of a building project and damages the environment. To date, no efficient and sustainable ways of building complex geometries, desired by most of contemporary architectural designs, are known. Can we design a sustainable way of fabricating geometrically complex architecture?

Cast on Cast, efficient and sustainable fabrication process is an investigation on the field of building technology which aims to design an efficient and sustainable manufacturing system of complex geometries in architecture. The research deals with the invention of a parametrisation system of surfaces and its application in a novel efficient fabrication method of components for the construction of geometrically complex shell structures, building envelopes and pavements. Both the parametrisation system and the fabrication method complement each other. The first one is in the brain, the mathematical part, the second one makes the link with material and, therefore, makes possible the development of the research as an architectural project.

1. The parametrisation system consists of a set of mathematical algorithms, which the idea that three-dimensional surfaces can be subdivided into smaller elements, which can be stacked in towers ones on top of the other ones.
2. The fabrication method is a new manufacturing system based on using the previous product as a mold to shape the next product. This fabrication method relies on an additive process of casting components ones on top of the previous ones by using digital fabrication technology. The process requires both parts to operate. First of all, the architect designs a three-dimensional surface and analyses it with the parametrisation system, which subdivides the surface into components capable of being stacked in towers. Secondly, the coordinates of these components are converted to G-code programming language and transferred to the CNC machine, which manufactures the components. Finally, the towers of components are transported to the site where they are detached and assembled into the desired surface.

Cast on Cast, efficient and sustainable fabrication process proposes a new way of designing and building complex geometries, considerably reducing material loss and time involved in designing, manufacturing, transporting and assembling expensive frameworks and scaffolding. An investigation that challenges the sterility of the existing processes and proves that the simplest ideas are the shortest way to achieve sustainability in construction.

Innovation and transferability – Progress

Cast on Cast, efficient and sustainable fabrication process is an investigation of a multidisciplinary nature, which connects the fields of mathematics, architecture, civil engineering and digital fabrication technologies. The research deals with the discovery in mathematics of a new parametrisation system of three-dimensional surfaces, which is based on the idea that any surface can be subdivided into smaller components capable of being stacked in towers. The invention of a logic of production based on using the previous product to shape the next product, which materializes in a fabrication process of customized components for construction without requiring molds, formworks or scaffolding. The combination of these two findings aims to design an efficient and sustainable system for the construction of complex geometries in architecture, in which design and fabrication are naturally welded into one simple process.

Ethical standards and social equity – People

We believe that everyone deserves to enjoy spatially interesting architecture and, therefore, one of the main goals of the project is to design a system that fabricates geometrically complex architecture affordable to anybody. To achieve this, the research intends to improve the existing building practices, rather than replacing them, by helping them to get higher standards in the construction of geometrically complex structures, while using same building materials and similar methods.

Environmental quality and resource efficiency – Planet

Cast on Cast, efficient and sustainable fabrication process has environmental advantages in all the stages of the building industry. Design: Instead of building passively what has been designed by the architect, the system proposes checking during the design process the feasibility of construction under efficiency and sustainability principles. Fabrication: The innovative idea of production, which does not require specific molds and formworks, reduces the use of material resources and minimizes the production of waste. Transportation: The components are stacked in towers using the space in the most efficient way, which reduces time and pollution. Construction: The assembly of the components, which does not require specific scaffolding, reduces time and the use of material resources as well as minimizes the production of waste. Demolition: The system follows the principles of Design for Disassembly (DfD), substituting demolition by disassembly.

Economic performance and compatibility – Prosperity

The system supposes the following economic benefits:

1. The merging of the building stages into one simple process reduces the time of coordination and, therefore, speeds up the building process.
2. The decrease on the need of molds, formworks and scaffolding brings down drastically the production and construction costs.
3. The reduction of waste produced during the fabrication and construction phases minimizes the cost of its transportation and the landfill fees.

Contextual and aesthetic impact – Proficiency

Apart from the unquestionable visual attractiveness and spatial quality of the geometrically complex shell structures, with their folds, double curvatures, openings and textures, the investigation pursues the beauty of those architectural projects which, by their overwhelming simplicity, are able to achieve more with less.