Parametric Masonry Textiles

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> An ancient profile will declare in its metrically smallest elements the utmost possibilities of working the material in which it is cut. This declaration rarely corresponds with the real physical qualities of the material. More often, and with the great masters, the level of quality is so exalted as to flood entire building with heroic ideal energies. In such a way do marble lintels three millimeters thick in the Medici chapel resound like steel cuirasses. –Luigi Moretti, "The Value of Profiles"

DESIGN RESEARCH

This ongoing material investigation with Autoclaved Aerated Concrete (AAC) was introduced into an advanced undergraduate studio at Pratt Institute School of Architecture, where innovative post-tensioned screen wall systems were developed to weave a type of mechanical fabric. Students designed assemblies up to four stories tall as an over-cladding strategy for a generic office building using varying unit shapes to be fabricated by a 6-axis robotic milling process. Proposals were modeled using a tight of set of parameters such as block size, reinforcing requirements, span limits, percentage of porosity and a catalog of geometric typologies. The goal of this research was to combine state of the art robotic technology with traditional masonry techniques to create practicable strategies for 21st century stone carving. Parametric design and digital machining processes were harnessed to produce novel tectonics while simultaneously working within the exigencies of a rational construction system with real world applications. The provocation of the work was to walk the line between excess and formal invention on the one hand, and economy and constructability on the other.

Aercon AAC sponsored the studio and donated several pallets of 24-inch x 8-inch x 8-inch blocks with Timbur LLC, a digital fabrication company, contributing the use of an ABB IRB6400 industrial robot equipped with a 10hp milling head. In parallel with analogue modeling using a hot wire cutter, students worked with Grasshopper and RhinoCAM to generate tool paths and simulations for milling models on the school's 3-axis Techno CNC router. Several projects were selected to produce full-scale block details using the robot. As a proof of concept, an engineered 11-feet high by 4-feet wide full-scale prototype was fabricated and installed in the lobby at the School of Architecture as part of a seminar to test the material and assembly processes.

MATERIAL PROPERTIES

AAC is a precast concrete product used widely in other parts of the world but has only been introduced to the US building industry in the last 16 years. Standard components can be combined to create a full building system of floors, walls and roof slabs for low to mid-rise buildings, but the expressive potential of the material remains largely untapped, typically being covered on the exterior in stucco or brick or buried in the building as a rated partition system. A unique quality of the material is that it can be easily cut or carved using conventional power tools – in lieu of custom molds, a range of construction modules and ornamental relief patterns can be produced with CNC 6-axis milling technology economically and quickly. The material is also available in large modules that can be lifted by hand or with the aid of a mini-crane, resulting in greatly reduced assembly time when compared to using traditional masonry sizes. Because the system is lightweight, non-combustible, has insulating properties, and accepts a field applied spray-on finish, it is well suited to be adapted for screen wall or rain screen applications.

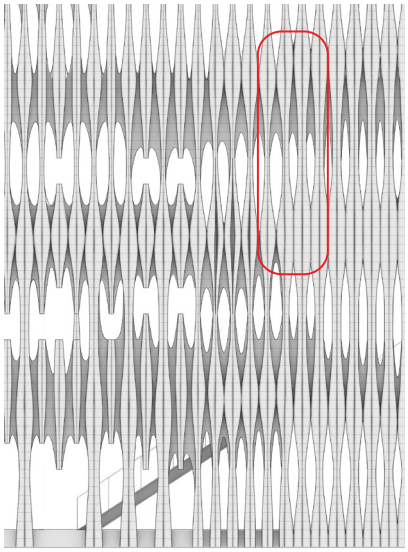
COLLABORATORS

The student design team included Jonathan Cortes, Rena Cukurova, Gary Lee, Alexander Morpurgo, Cameron Reid, and Georgia Reyes. Visiting Assistant Professor Sebastian Misiurek taught the Grasshopper workshops and Visiting Assistant Professor Erik Verboon acted as the façade consultant for the studio. The full-scale prototype was engineered by Visiting Assistant Professor Robert Otani who also worked as the structural consultant for the studio and seminar. Support for the research was provided by the Office of the Dean Pratt School of Architecture.

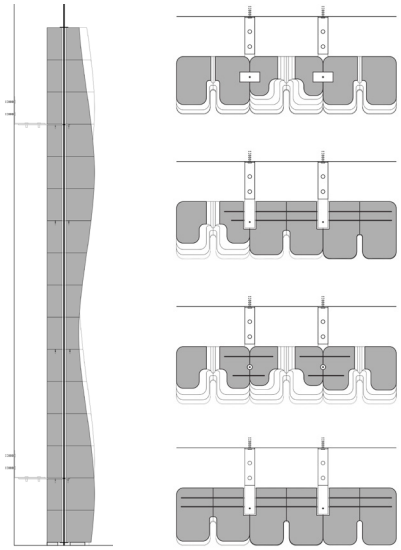
Full-Scale Prototype

Full-Scale Prototype Detail

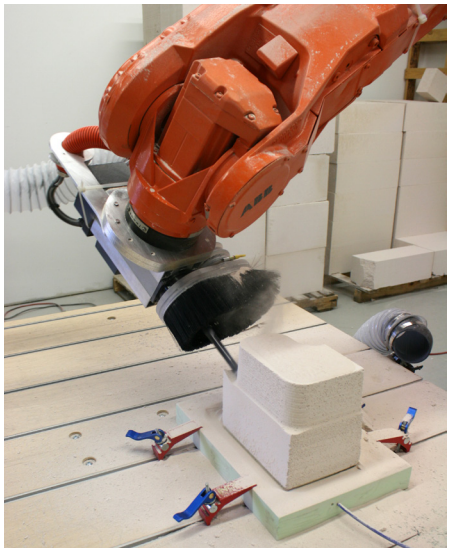
Full-Scale Prototype Detail



Four Story Facade Organization - Sample Area



Prototype Vertical Section and Plan Taxonomy



6-Axis Robotic Block Carving - 96 Blocks / 20 Types