Cast Thicket

Kenneth Joseph Tracy
Amerian Univeristy of Sharjah

Christine Yogiaman
Amerian Univeristy of Sharjah

Cast Thicket is a prototypical instillation that furthers earlier research into tensile concrete molds through the use of plastic formwork and a layered structural network. This research projects beyond this prototypical installation to address current issues in creating tall concrete structures. Cast Thicket presents one spatial outcome from a flexible system that can be multiplied and scaled. The flexibility inherent in the system allows for a new type of porosity while the casting process creates a novel tectonic outcome.

The 12’x8’x8’ white concrete structure provides a proof-of-concept model testing the software workflow, logistics, materiality and details of the system.

Dynamic Tensile Network

Leveraging the fluid materiality of concrete and the machinability of polypropylene, Cast Thicket creates a lacy network of thin members that disperse and coalesce to address structural and spatial needs. Constructed within an external, compressive scaffold the tensile network is designed and optimized to act as the centerline for both concrete mass and steel reinforcing. An initial grid is derived from a diagonal subdivision of the bounding scaffold. The grid is converted into a network of virtual springs to create an optimization scheme similar to a game of cat’s cradle. Played out over a series of iterations the virtual spring simulation is trained into an interlaced, stable network. Using two types of nodes, fixed and dynamic, allows the framework to be moved either directly by positioning fixed nodes or more subtly by changing the tension on the springs thus repositioning the dynamic nodes. This nuanced, haptic design process sets up an interface that adjusts to the structural concerns while creating a formation that demonstrated maximum flexibility of the system.

Steel Frame

Replacing the rebar used in typical concrete construction a precise steel frame serves as a tensioning device and holding the concrete in compression. The steel frame is composed of a series of struts and nodal joints, and is assembled node-by-node. The nodal joints are radially notched steel pipes accepting corresponding struts at specified angles. Further calibration of the joint is achieved using an angle-finding jig to ensure the precise welding of each node and its corresponding strut component. The struts are fabricated with male and female components which, when assembled, produce a T-shaped cross section and allowing for a cold assembly with zip ties to be positioned prior to final welding.

Plastic Formwork & Casting

A formwork of polypropylene, ruled surface panels wraps the steel frame. Refined from optimized, relaxed surfaces these hexagonal tubes simultaneously direct the flow of concrete and create a free-flowing system of load paths. This .02” thin membrane of polypropylene replaces typical plywood and steel forms. The individual pieces of plastic formwork are hand assembled along their seams through a system of interlocking tabs. Each tab changes its shape and width to respond to the curvature of each piece. Once completely stitched together the mold accommodates a specially developed low-viscosity, lightweight concrete mixture. Poured in sequential lifts the hand-operable seams allow access to any part of the mold not yet full of concrete.

Cast Thicket is a prototypical instillation that furthers earlier research into tensile concrete molds through the use of plastic formwork and a layered structural network. This research projects beyond this prototypical installation to address current issues in creating tall concrete structures. Cast Thicket presents one spatial outcome from a flexible system that can be multiplied and scaled. The flexibility inherent in the system allows for a new type of porosity while the casting process creates a novel tectonic outcome. The 12'x8'x8' white concrete structure provides a proof-of-concept model testing the software workflow, logistics, materiality and details of the system.

Dynamic Tensile Network

Leveraging the fluid materiality of concrete and the machinability of polypropylene, Cast Thicket creates a lacy network of thin members that disperse and coalesce to address structural and spatial needs. Constructed within an external, compressive scaffold the tensile network is designed and optimized to act as the centerline for both concrete mass and steel reinforcing. An initial grid is derived from a diagonal subdivision of the bounding scaffold. The grid is converted into a network of virtual springs to create an optimization scheme similar to a game of cat's cradle. Played out over a series of iterations the virtual spring simulation is trained into an interlaced, stable network. Using two types of nodes, fixed and dynamic, allows the framework to be moved either directly by positioning fixed nodes or more subtly by changing the tension on the springs thus repositioning the dynamic nodes. This nuanced, haptic design process sets up an interface that adjusts to the structural concerns while creating a formation that demonstrated maximum flexibility of the system.

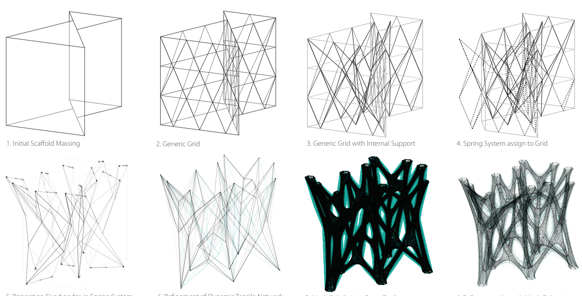
Steel Frame

Replacing the rebar used in typical concrete construction a precise steel frame serves as a tensioning device and holding the concrete in compression. The steel frame is composed of a series of struts and nodal joints, and is assembled node-by-node. The nodal joints are radially notched steel pipes accepting corresponding struts at specified angles. Further calibration of the joint is achieved using an angle-finding jig to ensure the precise welding of each node and its corresponding strut component. The struts are fabricated with male and female components which, when assembled, produce a T-shaped cross section and allowing for a cold assembly with zip ties to be positioned prior to final welding.

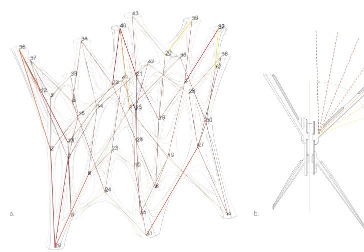
Plastic Formwork & Casting

A formwork of polypropylene, ruled surface panels wraps the steel frame. Refined from optimized, relaxed surfaces these hexagonal tubes simultaneously direct the flow of concrete and create a free-flowing system of load paths. This .02" thin membrane of polypropylene replaces typical plywood and steel forms. The individual pieces of plastic formwork are hand assembled along their seams through a system of interlocking tabs. Each tab changes its shape and width to respond to the curvature of each piece. Once completely stitched together the mold accommodates a specially developed low-viscosity, lightweight concrete mixture. Poured in sequential lifts the hand-operable seams allow access to any part of the mold not yet full of concrete.

CAST THICKET



1. Initial Scaffold Massing
2. Generic Grid
3. Generic Grid with Internal Support
4. Spring System assign to Grid
5. Reposition Fixed nodes in Spring System
6. Refinement of Dynamic Tensile Network
7. Mesh Subdivision Form Finding
8. Refinement through Mesh Relaxation



a.

b.

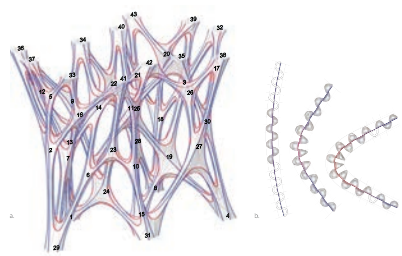
STEEL CONFIGURATION AND ASSEMBLY

a. Color diagram of angle variations connecting at nodes in assembly
b. Detail of node to accomondate vertical steel connection range

cut sequence at 78"

cut sequence at 72"

Steel Assembly



a.

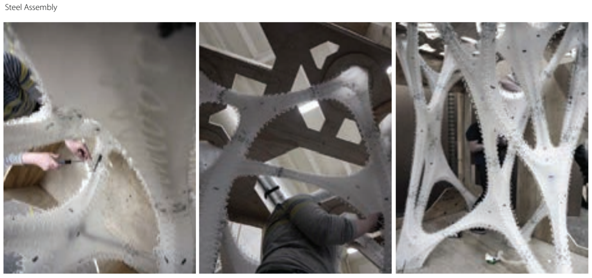
b.

PLASTIC FORMWORK PANELS AND ASSEMBLY

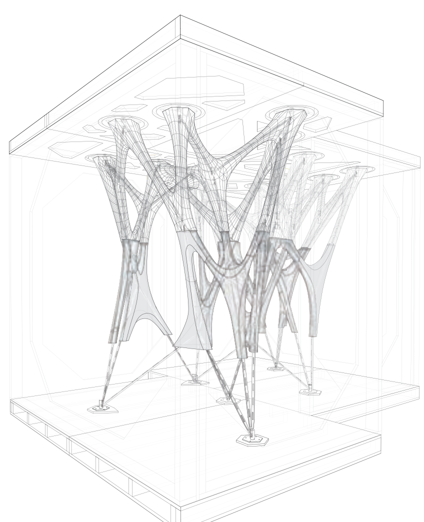
a. Color diagram of various Seam curvature
b. Spacing and thickness of tabs calibrated through difference in Seam curvature

cut sequence at 66"

cut sequence at 54"



Plastic Assembly



Peel Away Axonometric drawing
exposing the steel, plastic and concrete assembly

cut sequence at 42"

cut sequence at 24"

cut sequence at 12"
Plan cut of concrete assembly at various height

Concrete Assembly

Materials