Arch 3690 | Spring 2019
Intermediate Computation and Fabrication

Wed: 10:30am - 12:35pm V-834B | Fri: 10:30am - 12:35pm V-817

Prof. Ravi Raj (rraj@citytech.cuny.edu)
CLT: Henry J Aguilar (haguilar-morales@citytech.cuny.edu)

Department of Architectural Technology
New York City College of Technology
City University of New York
300 Jay Street, Brooklyn, NY 11201

ASSIGNMENT 02: SCAFFOLDING STRUCTURE

You are challenged with developing a parametric model of a structural scaffolding system through Grasshopper and applying this system to a given site. Both macro- and micro-level constraints informing your design will be further developed through 3D printed models at both scales.

CONCEPT:

Fig. 1 - Clockwise from top left corner: a) striped bass scales, b) Venus flower basket sponge, c) broad leaf of a tree, d) araneid spider web, e) staghorn coral, f) tortoise shell.

Many structural forms found in nature can offer insight into new methods of design and construction. For example, the natural branching system of staghorn coral protects against compression loading using scaled struts joined in a common lattice. Other hierarchical structures like the web of an araneid spider absorb impacts through a stacked arrangement of of silk nanocrystals that help resist stress. These as well as many other examples are to be explored as a means of defining your overall biomimetic concept.

Your research will focus on these structural forms found in nature that build strength through their material form. Through research online combined with selective readings, you will explore your concept at multiple levels, drawing from both the formal and functional aspects of your chosen design. In particular, the study of the history of dendriform structures, or structures having the shape or form of a tree, will be helpful in developing your idea from concept to built form.

Please refer to the Page 4 for further resources to help aid your research.

Fig. 2 - Hanging model of Frei Otto's depicting branching systems.

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STRUCTURE & MATERIALS:

Fig. 3 - View of World Trade Center viewing platform designed by Rockwell Group in collaboration with Diller Scofidio + Renfro. Made from standard metal scaffolding supporting rough decking and plywood boards, this platform provided visitors with 180-degree views of Ground Zero, soon after 9/11.

Scaffolding serves many functions within the building industry, ranging from supporting work crews to sheltering pedestrians from falling debris during construction. Due to its inherent flexibility, modularity and ephemerality, designers have also utilized scaffolding as a tool for other uses, such as to provide temporary housing and to stage demonstrations.

There are five major types of scaffolding used in the contemporary world: tube & coupler components, prefabricated modular system scaffolding components, H-frame / facade modular system scaffolds, timber scaffolds, and bamboo scaffolds. For the purposes of this project, we will be focusing on tube & coupler systems composed of standard pipe & custom joints / connections.

A tube & coupler scaffold consists of steel or aluminum pipe that serves as posts, bearers, braces, ties and runners; a base supporting the posts; and special couplers (clamps) used to connect uprights and join various other members.

In this project, you will be using 1 1/2" diameter standard pipe to develop a structural system that is held together by custom 3D printed couplers. Your design may use a series of unique couplers, a standardized coupler that adapts to different orientations / conditions, or a combination of both.

Please refer to Page 4 for further resources on the materials.

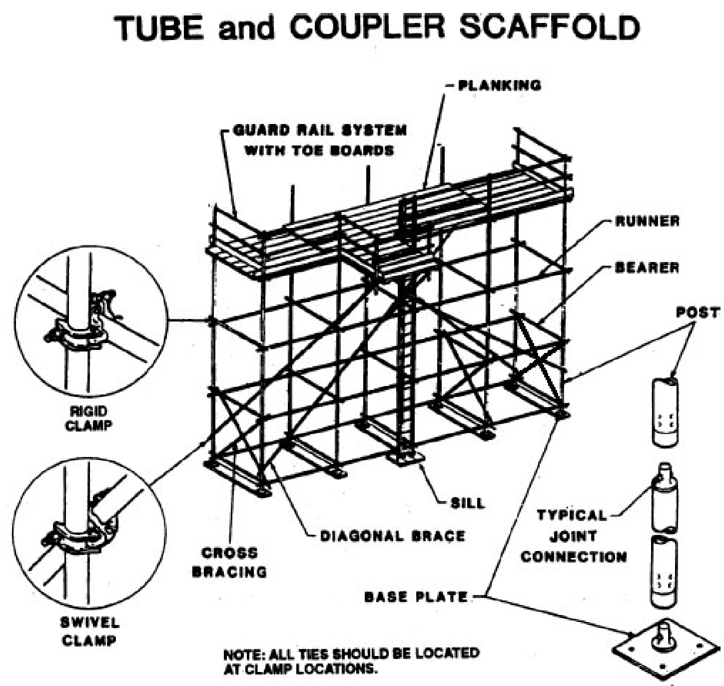
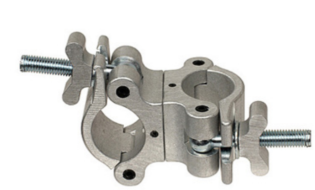


Fig. 4 - Diagram of tube & coupler scaffolding system (OSHA).



SITE:

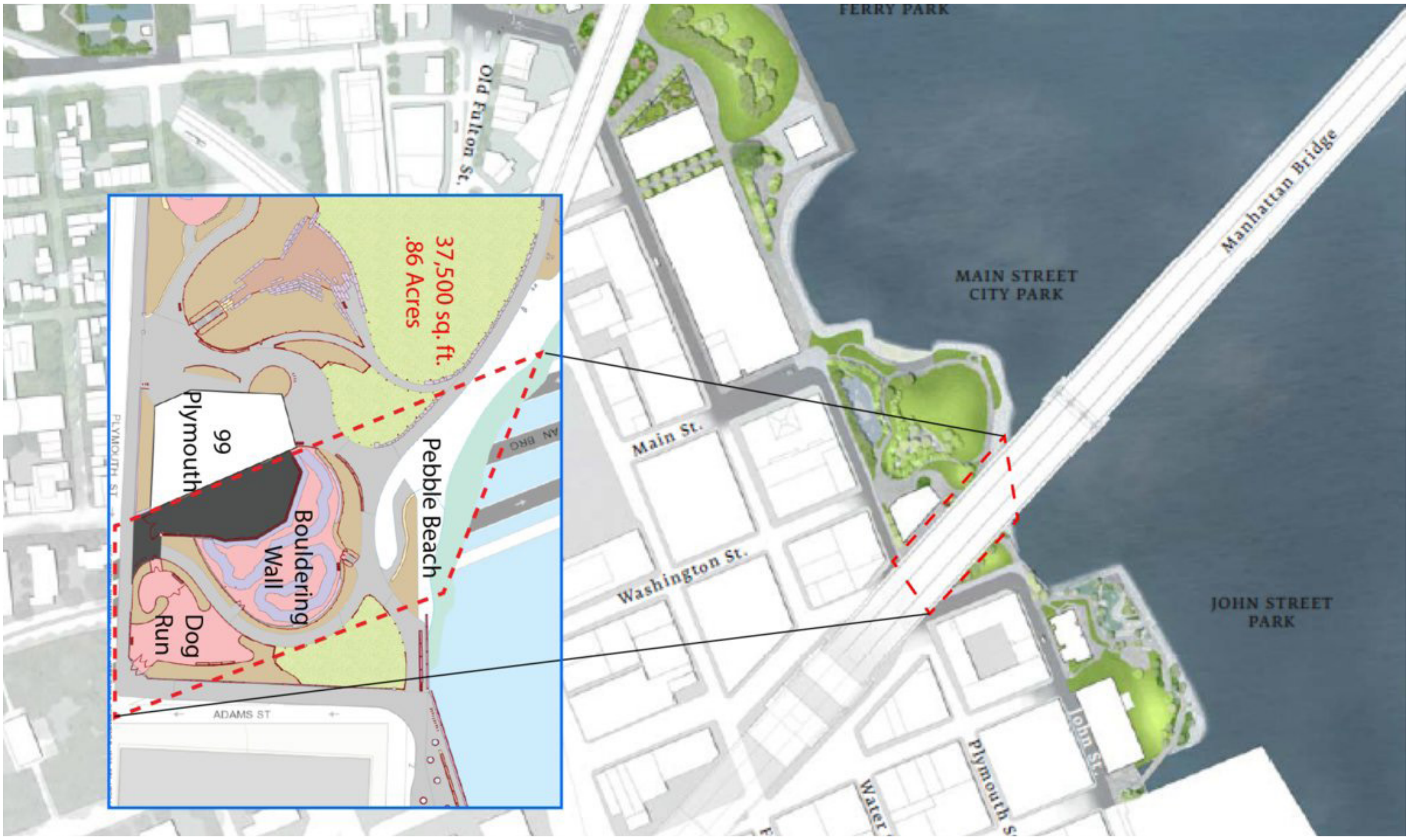


Fig. 5 - Illustrative map of Brooklyn Bridge Park indicating area under Manhattan Bridge to be protected.

In the spring of 2018, a portion of Brooklyn Bridge Park directly under the Manhattan Bridge was closed to install temporary scaffolding protection from falling debris from the bridge. Two pieces of subway infrastructre on the bridge had fallen in May, causing the DUMBO Boulders gym to close for serveral days. Erik Landau, president of Brooklyn Bridge Park has stated that they are working with city agencies to come up with a more permanent solution to protect visitors, one that fits with the “desired aesthetic” of the park.

This portion of the park includes a dog run, rock climing walls (DUMBO Boulders), Sandy Beach and several paved paths through the site. The area of the site is about four-fifths of an acre (34,850 SF) and the minumum height ranges from 12ft (sidewalk) to 24ft (bouldering walls). Your solution is to address all of these conditions with one cohesive structural system which can adapt to the many conditions of the site.

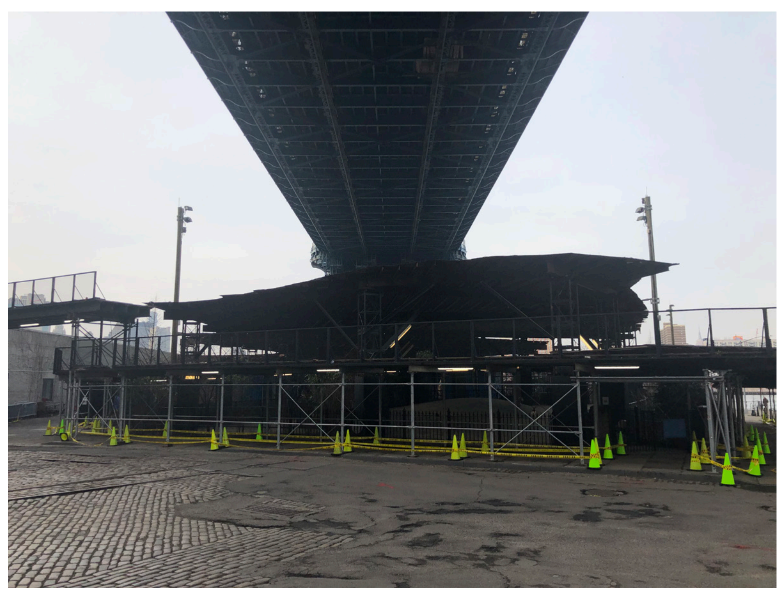


Fig. 6 - Photo of site looking north underneath the Manhattan Bridge.

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ASSIGNMENTS:

Part 1 - Concept / Precedence
Students are to present their biomimetic structural solutions for the project. Each presentation is to be formatted to 11x17 (3 slides minimum) and consist of: a) a 250-word description of the research with reference images, b) a representative architectural precedent, and c) a minimum of three sketched variables to help define your biomimetic structural system.
Due date: Wednesday, March 6

Part 2A - Structural Form
Based on your concept, students are to develop a parametric system using standard scaffolding tubes through Grasshopper. A series of tutorials will aid you in the process of defining the variables of your system. Students will then apply their systems to the site through a macro-scale model, adjusting the structure to meet the site constraints. Final Grasshopper definitions and Rhino models (with site context) are to be uploaded to the Google Drive student folders.
Due date: Wednesday, March 13

Part 2B - Structural Node
Using your macro-model as a framework, students are to further develop the coupler or node that connects the scaffolding tubes. Data trees from Grasshopper will be used to produce the geometry of each node. Adjustments to the macro-model will be informed by material and structural contraints of each node. Final Grasshopper definitions and Rhino models are to be uploaded to the Google Drive student folders.
Due date: Wednesday, March 20

Part 2C - 3D Printed Model/Node
Students will print 3D models of the following scales: a) one comprehensive overall model showcasing your scaffolding structure on the site, and b) at least two full-scale prototypes of the system couplers (nodes) including aluminum tubing. Final models will be presented at the mid-review.

MID-REVIEW
Students will make a comprehensive presentation exhibiting their project concept, parametric system(s), site strategy, & structural prototypes. Specific requirements will be outlined at a later date.
Presentation date: Wednesday, April 3

REFERENCES / SOURCES:

Readings/Sources:
Moheb Sabry Aziz & Amr Y. El Sherif, "Biomimicry as an approach for bio-inspired structure with the aid of computation," Alexandria Engineering Journal, Vol. 55 (2016), pp. 707-714.
Iasef Md Rian & Mario Sassone, "Tree-inspired dendriforms and fractal-like branching structures in architecture: A brief historical overview," Frontiers of Architectural Research, Vol. 3 (2014), pp. 298-323.
Tom McKeag, "Little Things Multiply Up: Hierarchical Structures," Zygote Quarterly, Vol. 9 (Spring 2014), pp. 10-27.

asknature.org

Materials:
Aluminum tubing (alloy 6061) can be purchased on McMaster-Carr >> https://www.mcmaster.com/aluminum-tubing
Note: a pipe-cutter will be provided for students to use in class.

Material for 3D printing is to be purchased by the students as needed.