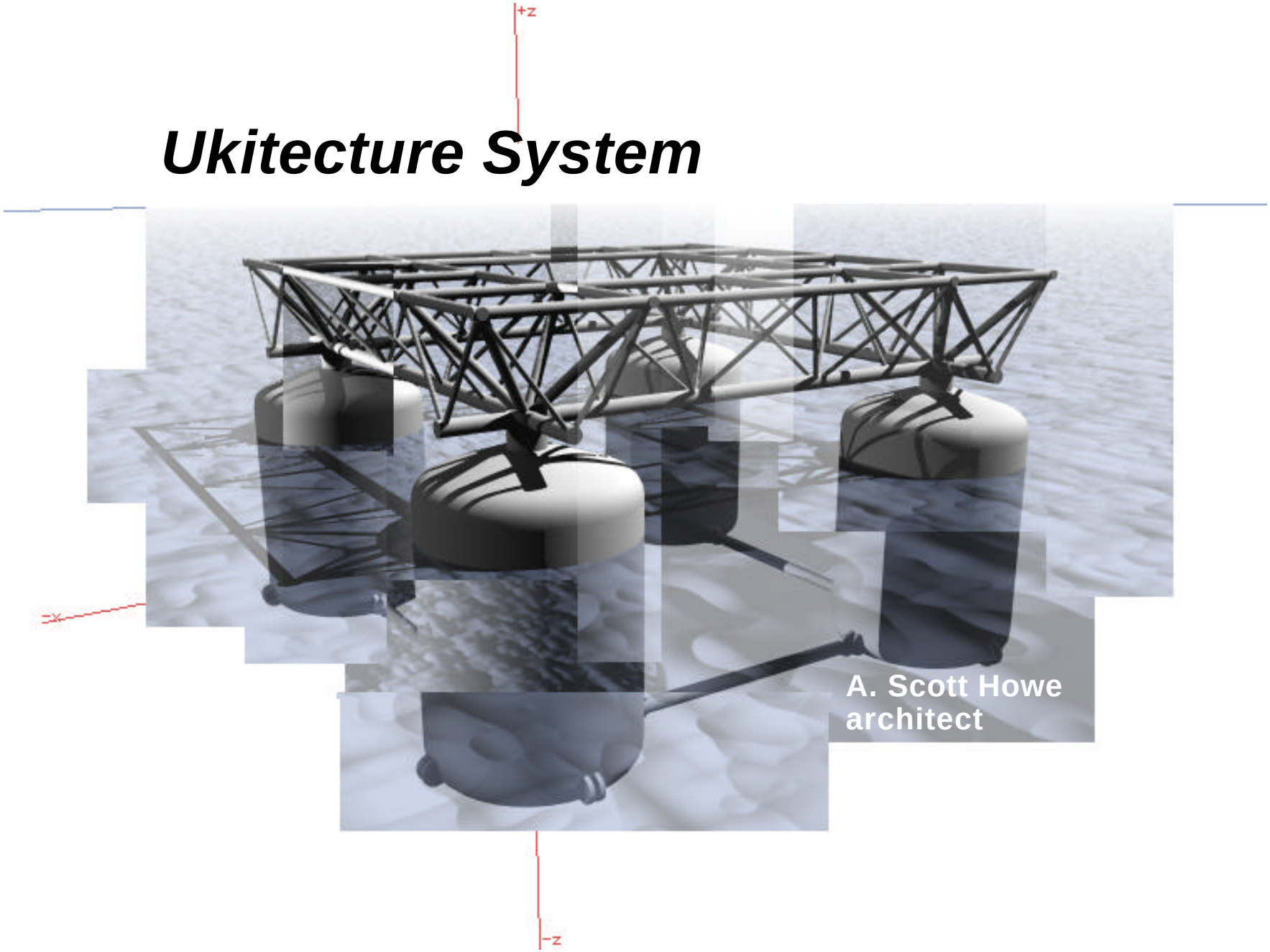
Ukitecture System



Ukitecture System

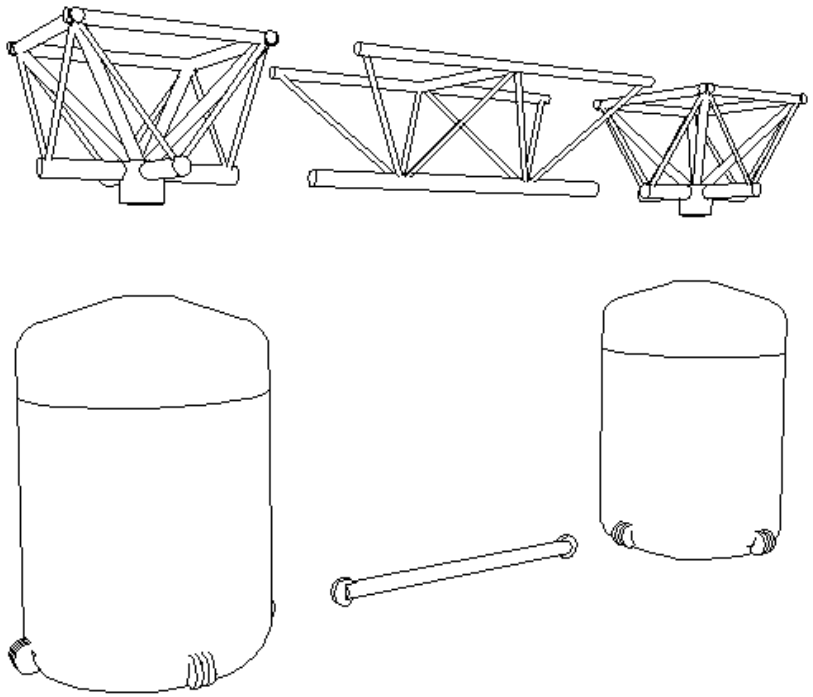
A. Scott Howe, architect
Summer 1996

Introduction

The word “Ukitecture” comes from words in two different languages. The first part, “uki-” comes from the Japanese verb meaning to float or be bouyed up. The second part, “-tecture” comes from the English use of the word “architecture”. The Ukitecture system is essentially a multi-purpose, floating artificial foundation. In the same respect that pile foundations work on boggy soil, the Ukitecture structure would provide a firm foundation on entirely liquid surfaces such as oceans or lakes. The following is a description of the Ukitecture system, followed by an example architectural project utilizing the system.

1. Modular Construction

The Ukitecture system consists of only four simple components that can be assembled into a floating platform of unspecified length and width. The four components are pontoon, node, truss, and brace.



The node is a universal connector which mounts on top of the pontoon. The node consists of four sockets oriented orthogonally from each other, which act as waiting receptacles for the mounting of the trusses. The trusses are triangular in section with a horizontal double upper chord. Combined with the girders that form the top square of the node component, the double upper chord of the truss defines an implied flat surface ready to be built upon. The pontoon is designed to carry a worse-case scenario, which is four trusses plugged into all available node sockets, supporting a maximum load. The brace is an under water girder which connects between pontoons for added lateral structural support.

Using the Ukitecture system, floating platforms can be assembled on site as needed. Due to the modular design of the components, expanding the size can be accomplished by adding new parts on the spot without interupting business or vacating the existing platform.

A likely first-time construction scenario would be to assemble three or four pontoons with their connecting nodes, trusses, and braces, and tow the structure to its final location of anchorage. The minimum would be three pontoons to avoid overturning. Additional pontoons can also be assembled in groups of three or four, towed to the site, and connected to the earlier ones as needed. Repairs and maintenance can also be accomplished without major overhauls.

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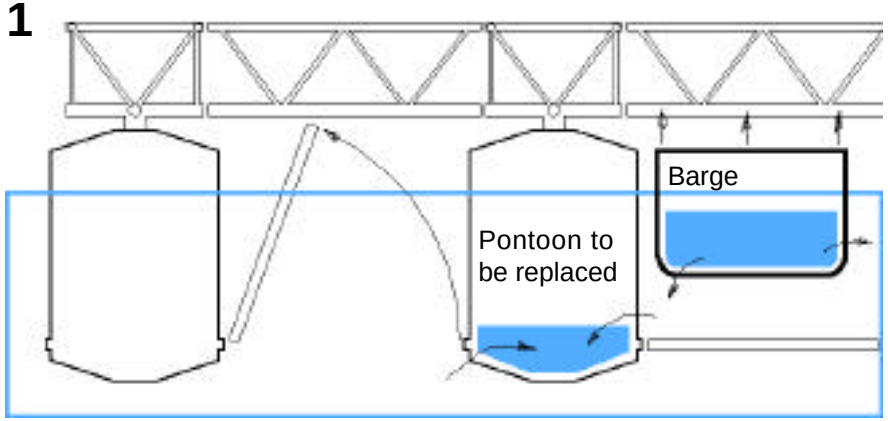

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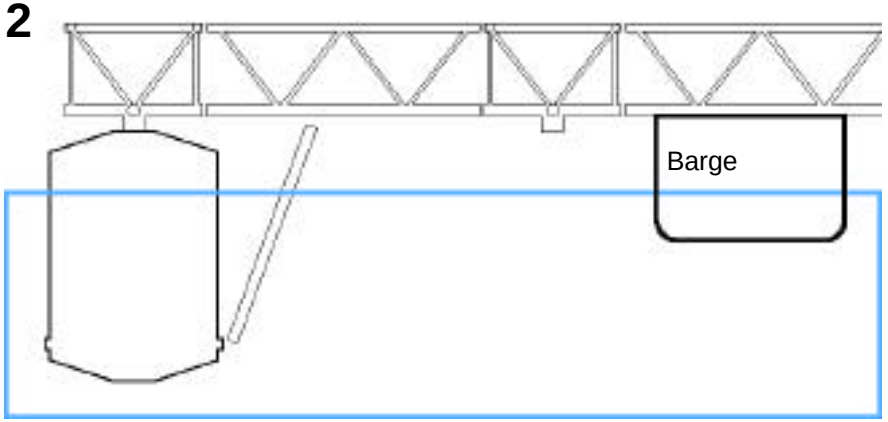

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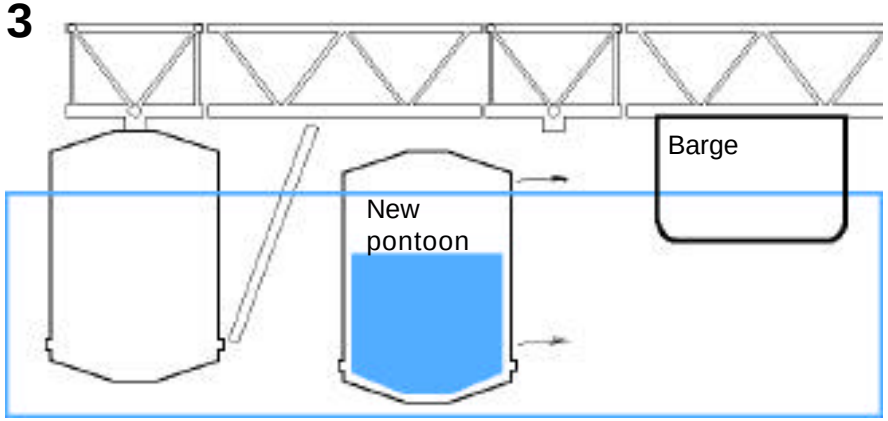


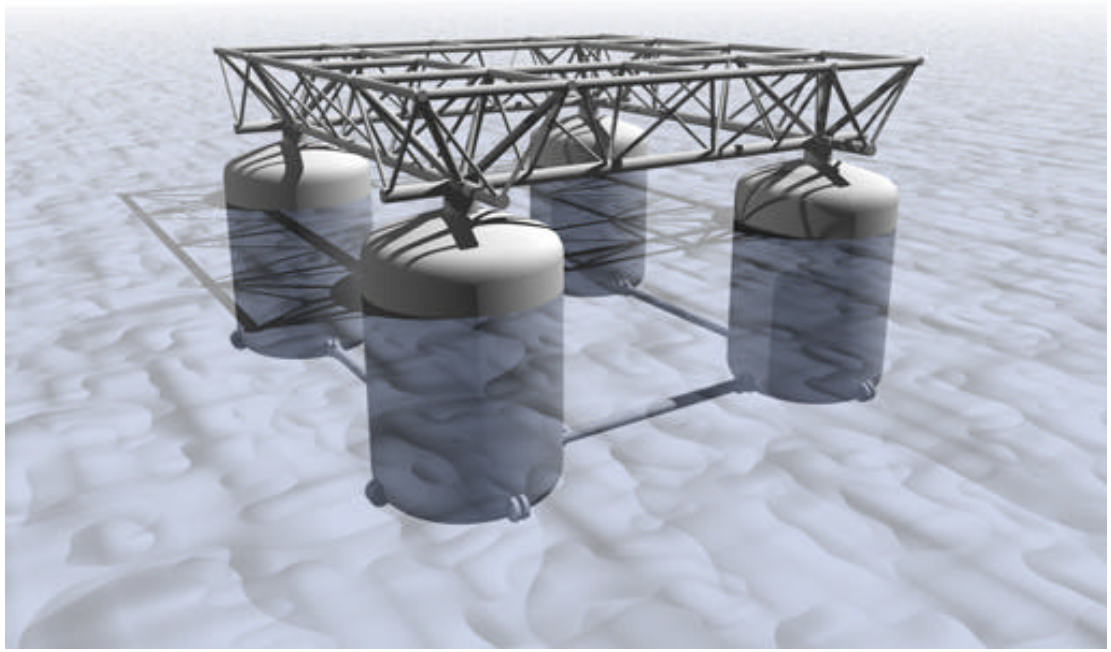
A typical repair scenario would make use of a support barge. 1) First, the barge would be prepared in a ballast condition and placed under a truss adjacent to the pontoon to be replaced. The ballast of the barge would be dumped, and the pontoon to be removed would take on ballast. All connecting braces would be lifted out of the way. 2) The pontoon would be disconnected and floated away, leaving the area under the support of the barge. 3) The new pontoon in ballast condition would be floated into place. The pontoon ballast would be dumped until it could be connected to the structure, and the barge removed.

Each pontoon component would have a machine room on the upper most level, and ballast tanks on the lower levels. The machine room can be fitted with electric generators, bilge pumps, water purification equipment, sewage treatment equipment, water heaters, and other necessary equipment. In addition to plug-in / plug-out structural connections, a generic utility “harness” would be integrated into each component. The utility harness would include power cables, communication wiring, water piping, sewer piping, and other necessary conduit. The harness would be fitted with reversible pumps, transformers, and standard junction points for interface with the construction system intended to be built on the platform. In each pontoon,

the harness would have terminations which could be utilized by equipment installed in the machine room, or capped as required. Through a system of valves and bi-directional pumps, access to anywhere else on the platform can be facilitated through adjustment.

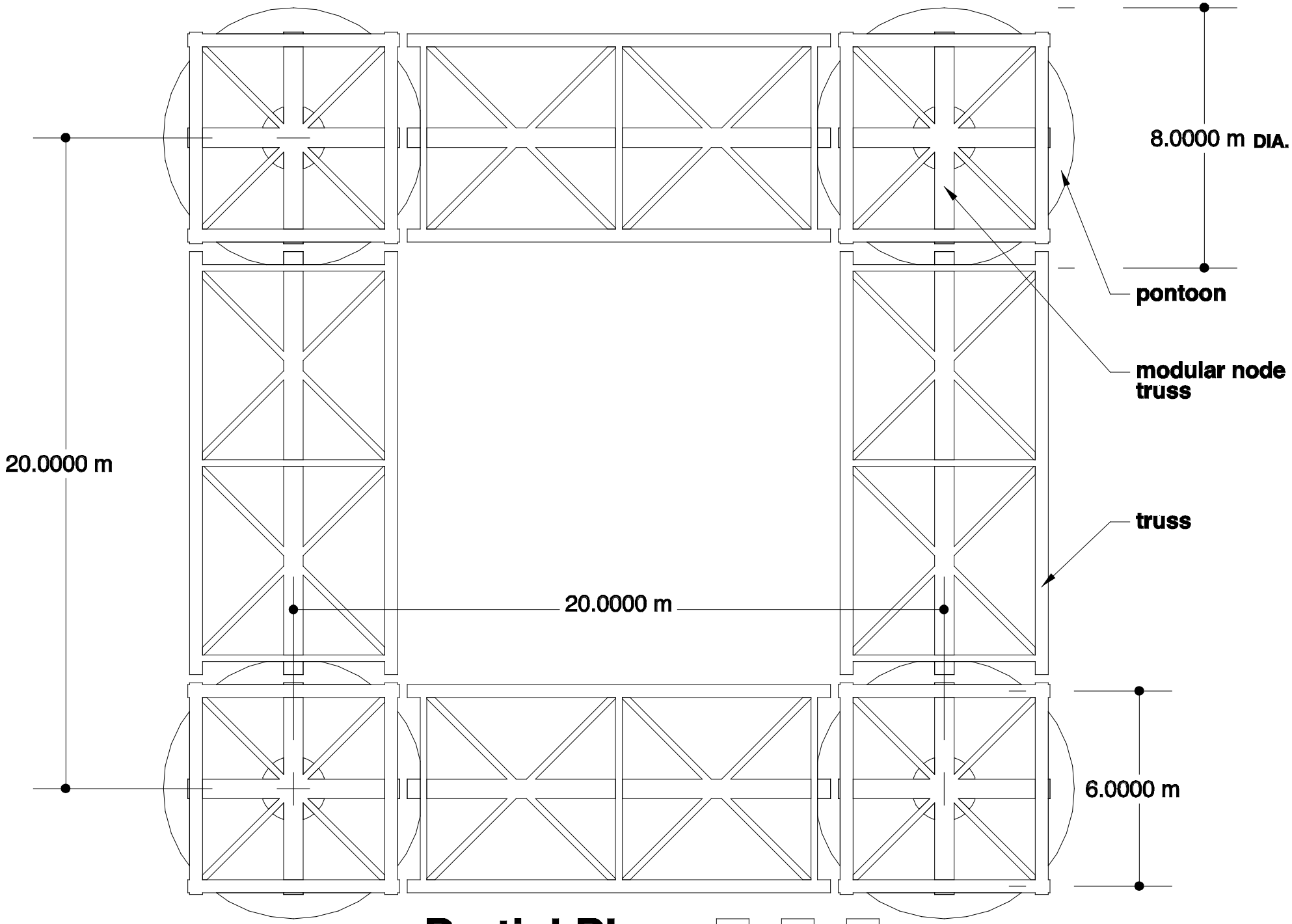
2. Design Capacities

The Ukitecture system is designed on a worse-case scenario for a single pontoon with maximum loading. In the system, the pontoons are placed at 20 meters (78'-9") on center. Half the span of a truss leaves 10 meters on each side of the pontoon, or a total area of 400m^2 (6,241ft^2). This area given certain restrictions to guide the design of the construction system intended to be built on the platform. 400m^2 area was broken up into two zones: a build zone which would include partitions and heavier structure, and a deck zone without partitions. The build zone was situated directly above the truss, coinciding with the 6 meter width of the truss, making a cross-shape. The remainder of the area supported by the pontoon would be the deck zone. In both cases, the live load was estimated at 100lb/ft^2, and structure load at 50lb/ft^2. The build zone would have additional 30lb/ft^2 structure load. The total load in the build zone was thus estimated to be 673,200lbs, and the deck zone was estimated to be 331,200lbs, for a total of 1,004,400lbs (455 tonnes) on one pontoon. The maximum steel weight of the system above a single pontoon is estimated to be 30 tonnes.



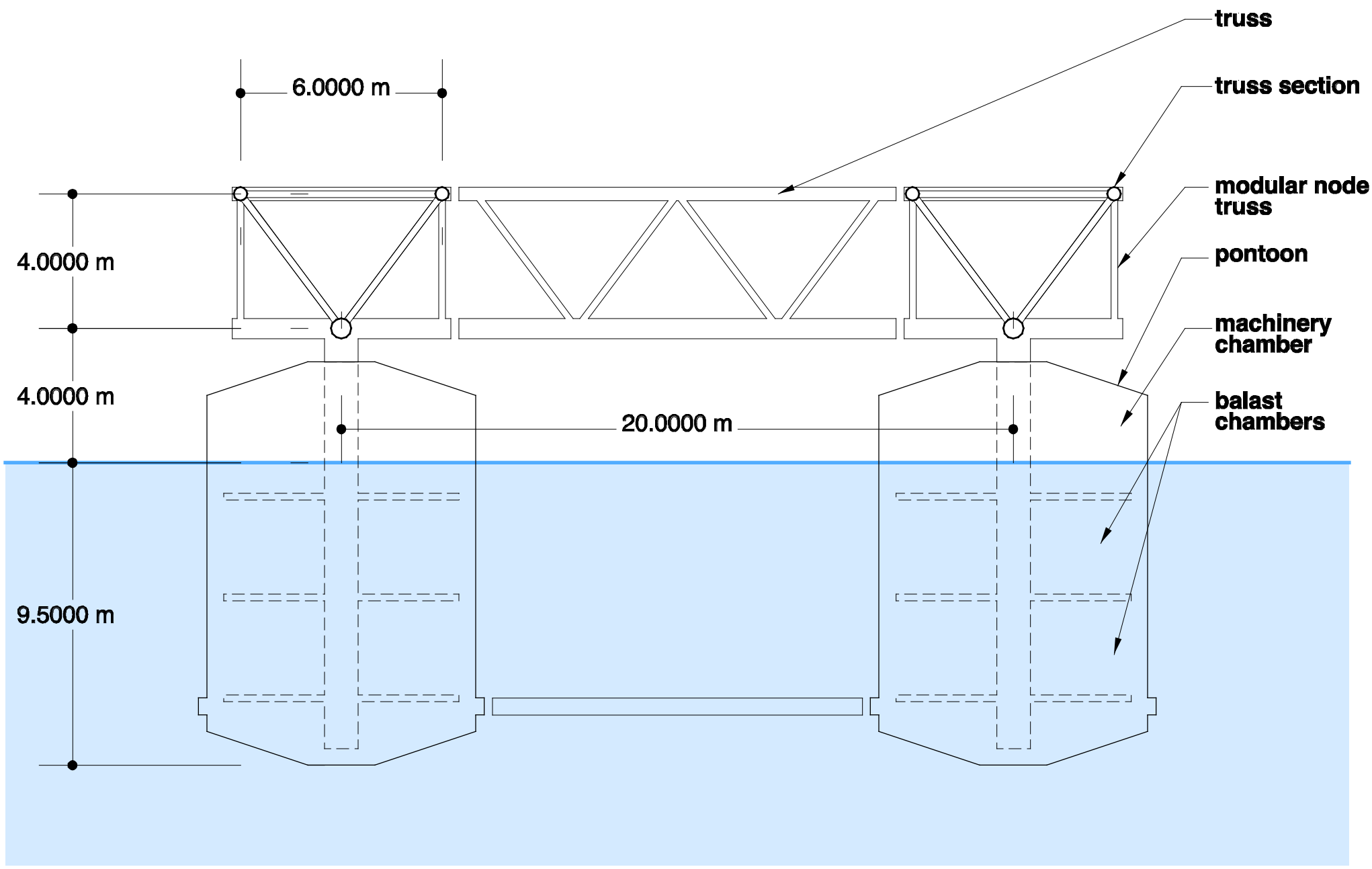
The pontoons are 8 meters (31'-6") in diameter with a design draft of 9.5 meters. Since the Ukitecture system is for construction within protected ports and *NOT* designed for open ocean, 9.5 meters draft was required. This gives each pontoon a maximum displacement of 490 tonnes.

The pontoons extend 3 meters above the water line in the design draft condition. This is to allow more height in the machine rooms without decreasing the ballast capacity. Structurally, a central column extends from the node seat down through the entire depth of the pontoon to distribute the loads.



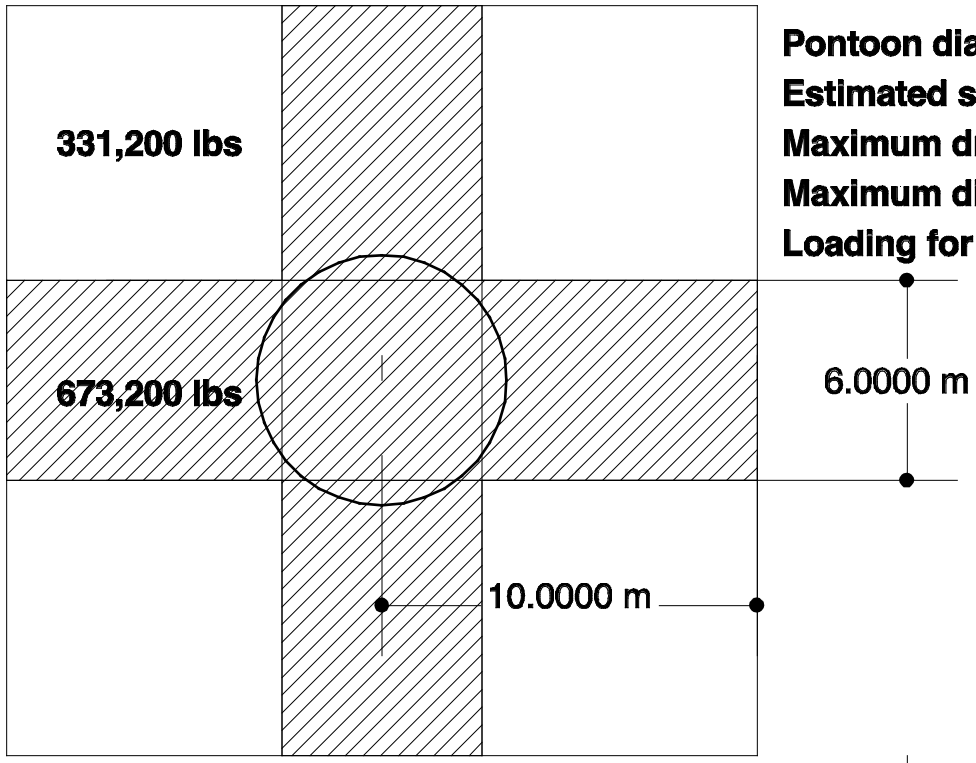
Partial Plan

0 1 2 3 4 5 m

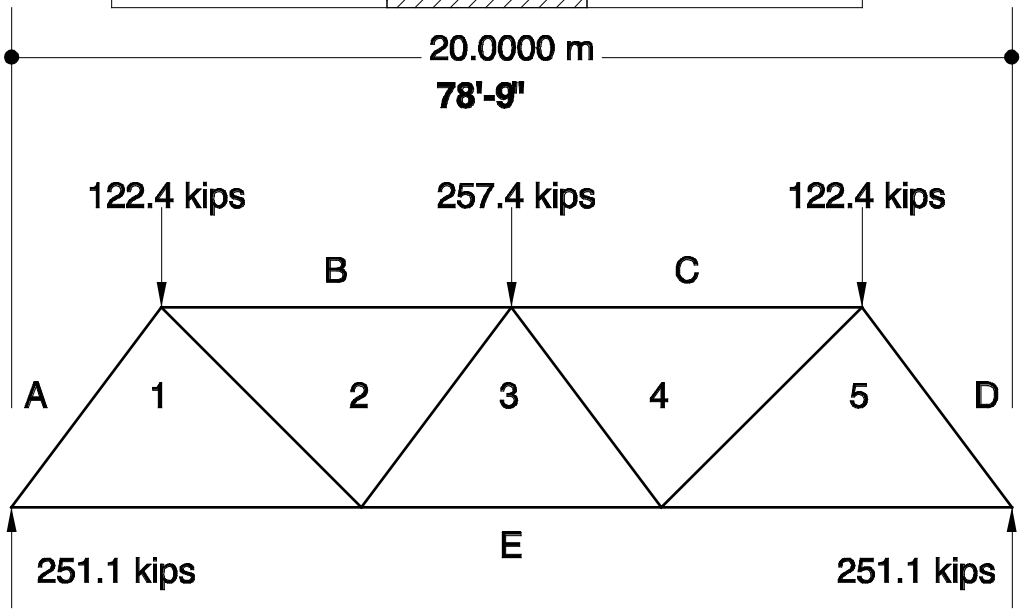


Partial Elevation

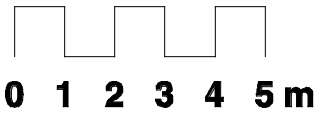
0 1 2 3 4 5 m

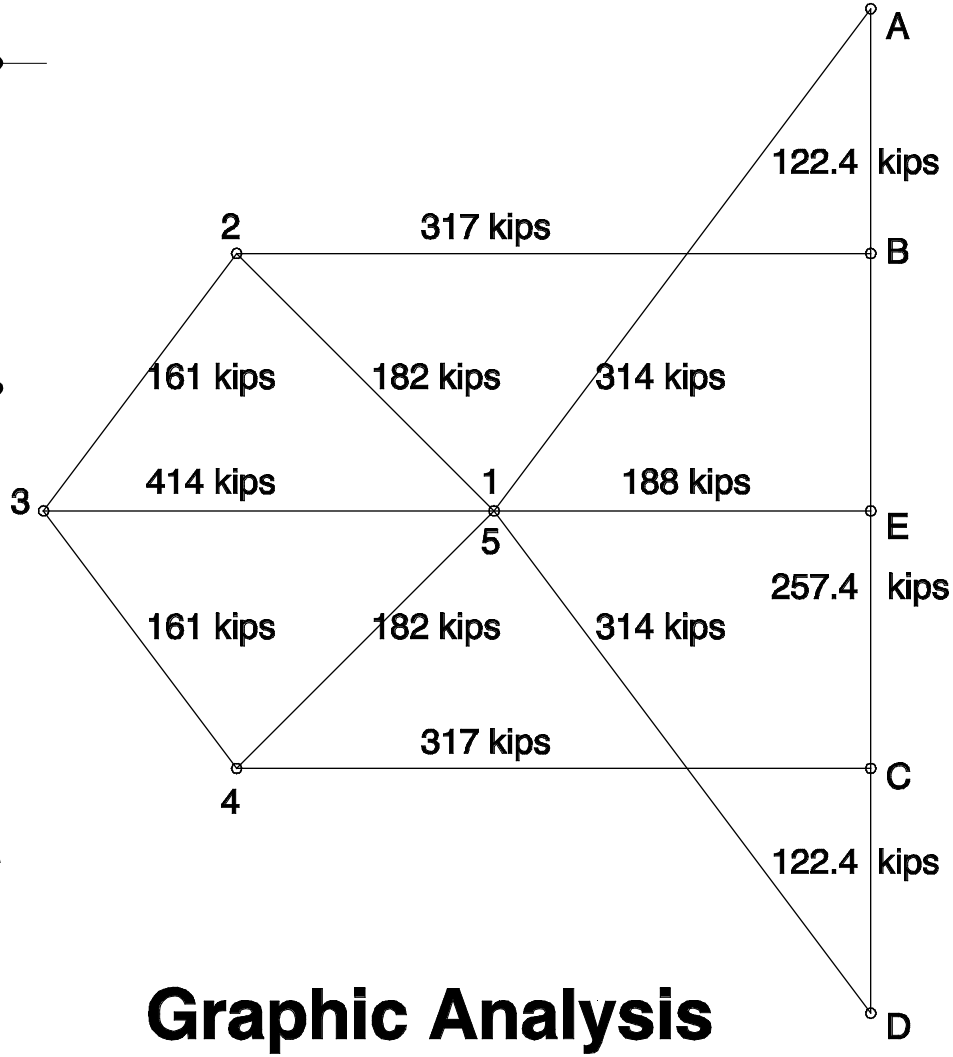


Pontoon diameter: 31'-6" / 8 m
Estimated steel weight: 30 tonnes
Maximum draft: 9.5 m
Maximum displacement: 490 tonnes
Loading for one pontoon: 1004400 lbs / 455 tonnes

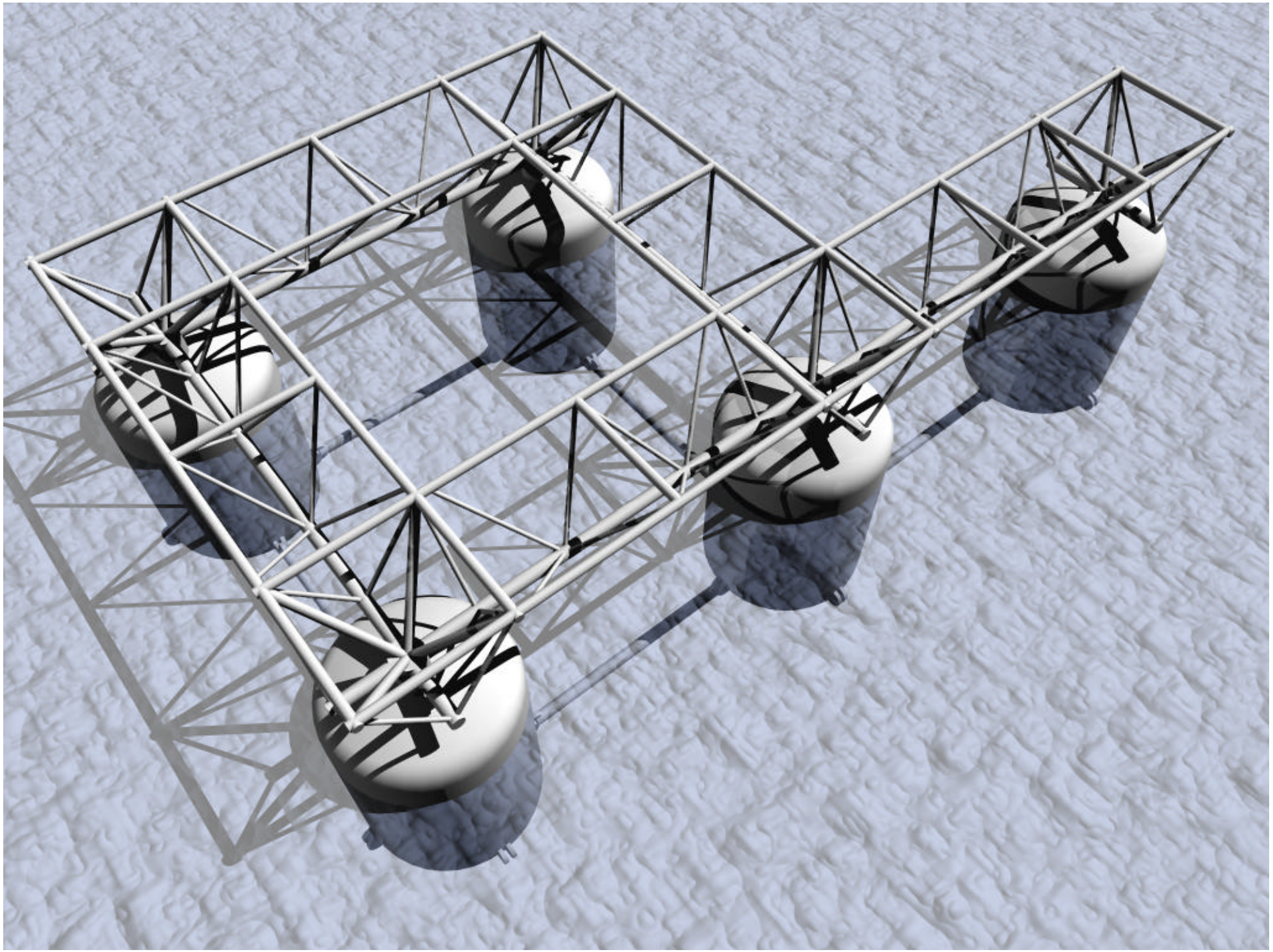


Truss Diagram





Graphic Analysis



Floating Restautant Facility

Introduction

Using the Ukitecture system, a plug-in building system was designed for the top of the platform. A restaurant facility is proposed, which would function as a stop on the Sea Bass shuttle boat system in Yokohama Harbor, Japan. It must be noted that the example system presented here is only *ONE POSSIBILITY OF MANY* that can be designed to interface with the Ukitecture platform system.

1. Kit-of-parts System

A series of components were designed as a kit-of-parts building system that can bolt onto the Ukitecture platform, and interface with its utility harness junction points. The components are mainly heavy timber construction partially supported by a steel moment frame. For the design of the kit-of-parts system, a shape grammar was devised which provided a set of rules for space planning, connection, and interface. The shape grammar follows the rules set up by the Ukitecture system, including the use of build zones and deck zones. For space planning, five main components were conceived: two node components (A, B), and three space components (C, D, E). In addition, five roof elements (F, G, H, J, K), two stairway components (L, M), one landing component (N), four deck components (P, Q, S, T), two catwalk components (U, V), and four special wall elements (W, X, Y, Z) were conceived. A second plug-in modular building system was also conceived which interfaces with both the first kit-of-parts and the Ukitecture system. This system has six special removable modules (sizes up to 6m x 7m) containing complex plumbing or electrical fixtures. These modules are easily removable and accessible for maintenance purposes.

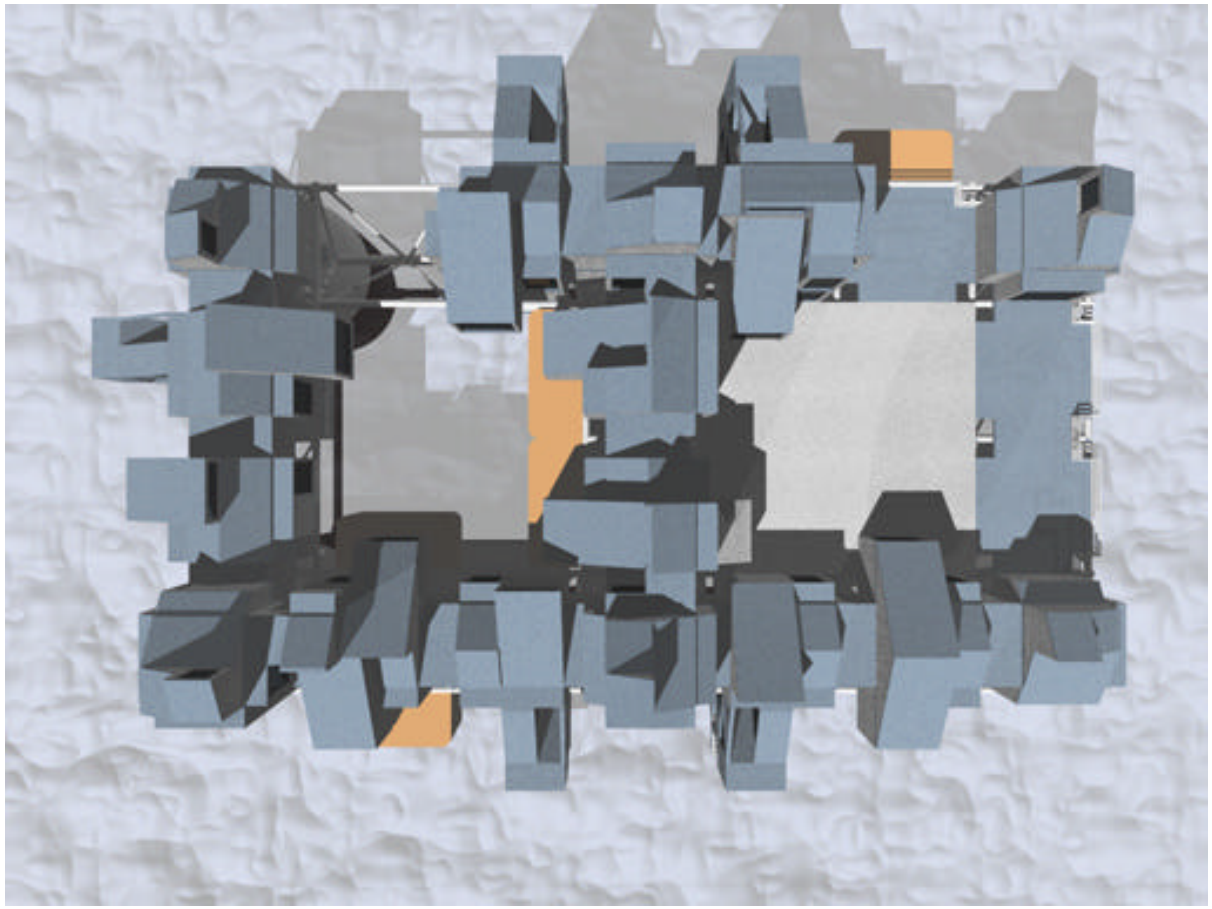
The space components are reversible (R) and have possible variations, which are actually sub-components which plug into the main component. A systematic notation was devised for the space components where a decimal point followed by 0-5 would denote element type (0 = no wall, 1 = solid wall, 2 = window wall, 3 = window wall with a door, 4 = floor opening, 5 = solid floor), and a second digit 2-3 would denote span units. The node components (A, B) are roughly 3m x 4m, and the space components are (C) 3m x 3m, (D) 3m x 4m, and (E) 4m x 5m. Node component (A) has no variations. Node component (B) has four possible variations: one (.02.02), one (.22.22), one (.22.32), and one (.32.32). Space component (C) has eight possible variations: one (.02), one (.12), two (.22)'s, two (.32)'s, one (.40), and one (.50). Space component (D) has seven possible variations: one (.02), one (.22), one (.32), one (.03), one (.13), one (.23), and one (.33). Space component (E) has three variations: one (.13), one (.23), and one (.33). A typical notation for a space component with its attached sub-components could be "C.12.22" or "ER.13", etcetera.

Of the other components, only the catwalks (U, V) have variations on handrail configurations 6-7, and continue with the same notation as the space components (6 = no rail, 7 = rail). The stairway, landing, two special wall, and one deck component can also be reversed. All in all, this brings the total number of *DIFFERENT* components (including reversed) in the kit-of-parts system library to only 40 elements.

2. Restaurant Facility

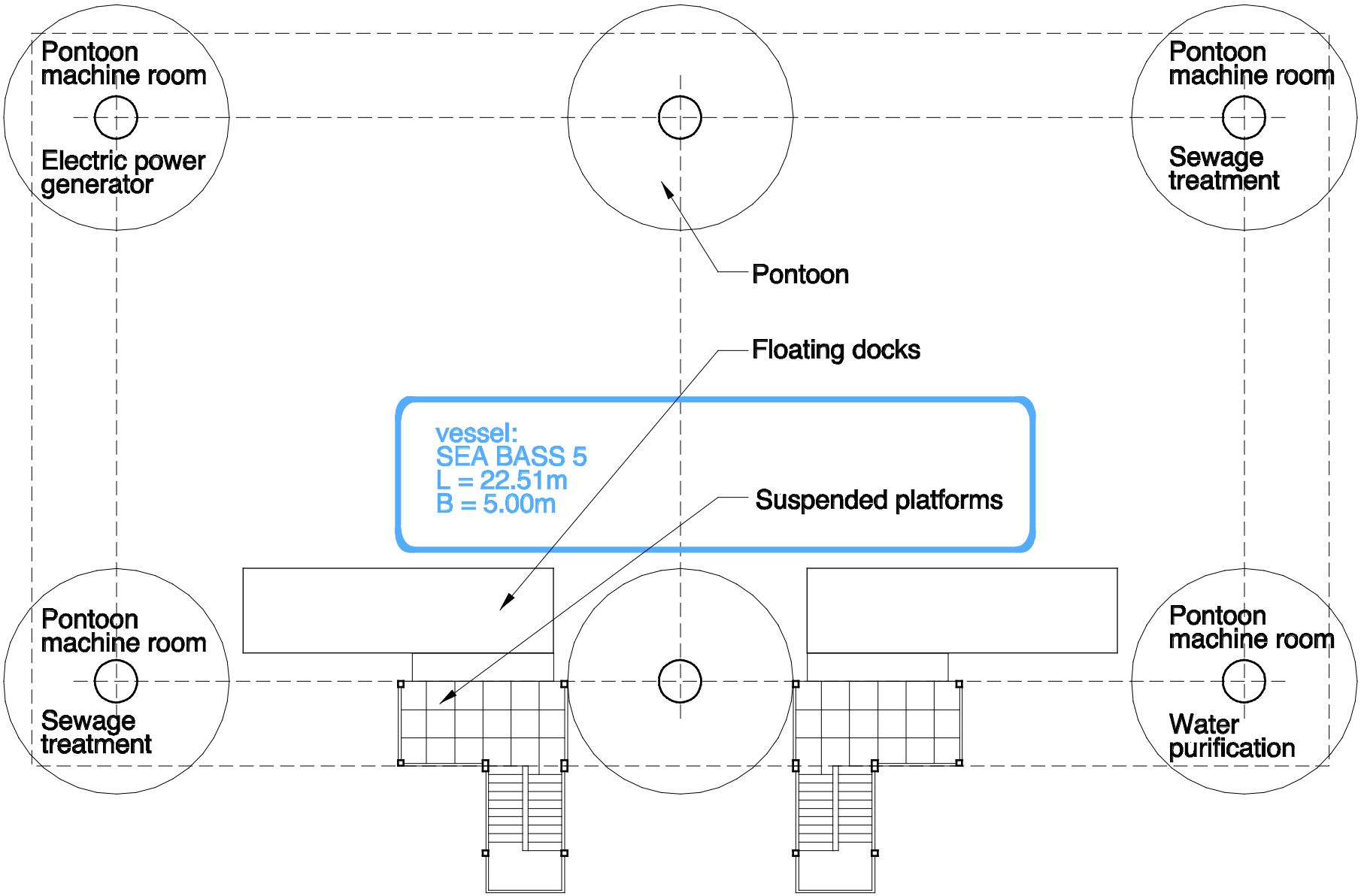
In example, a conceptual restaurant facility is proposed. The facility will include a 474m^2 formal restaurant, an 82m^2 fast-food restaurant, a 32m^2 convenience store, a 32m^2 bar, 44m^2 of small shop space, and 19m^2 of “yattai” space (yattai = a small portable food cart similar to a hot dog or popcorn stand). The facility will also have 297m^2 of deck space for outdoor dining and dancing, and special decks for fishing enthusiasts.

The restaurant facility uses two full bays of the Ukitecture system, which translates into six pontoons, six nodes, seven trusses and seven braces. Four of the pontoons will be used for specialized mechanical equipment, namely electrical power generation, water purification, and sewage treatment.



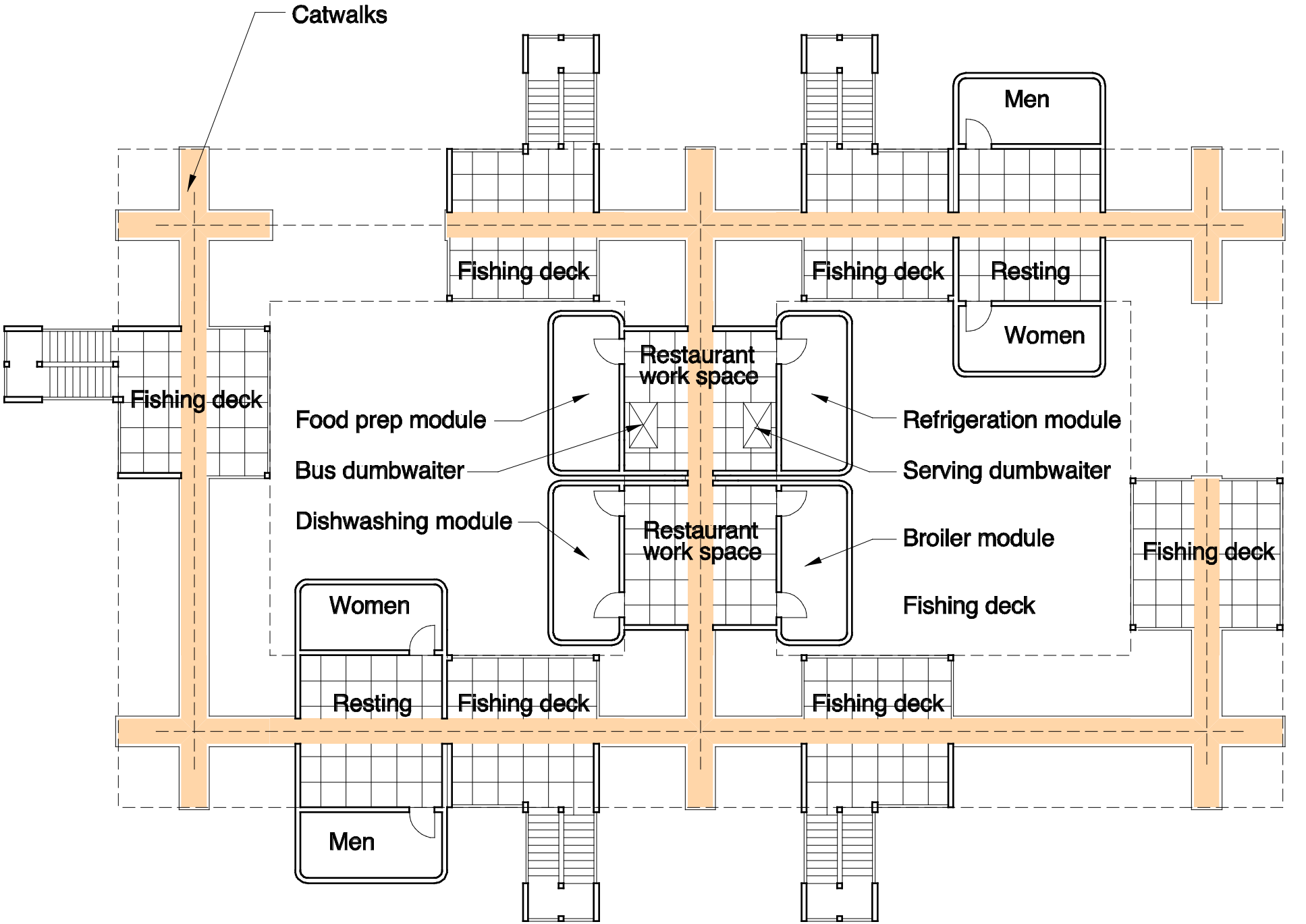
The kit-of-parts system has been assembled in such a way that eye-level views will appear as a seaside townscape consisting of many small buildings. Of the two Ukitecture platform bays, one has been left open to the water surface below, and the other has been filled in for a dining & dancing deck.

The total number of components can easily be calculated. Total space components used was 79, space sub-components were 81, stairways were 9, decks & landings were 21, catwalks were 18, catwalk rails 14, special walls were 12, roofs were 44, toilet modules were 4, and kitchen modules were 4. Excluding tenant improvement work, the total number of components used in this project were 312.

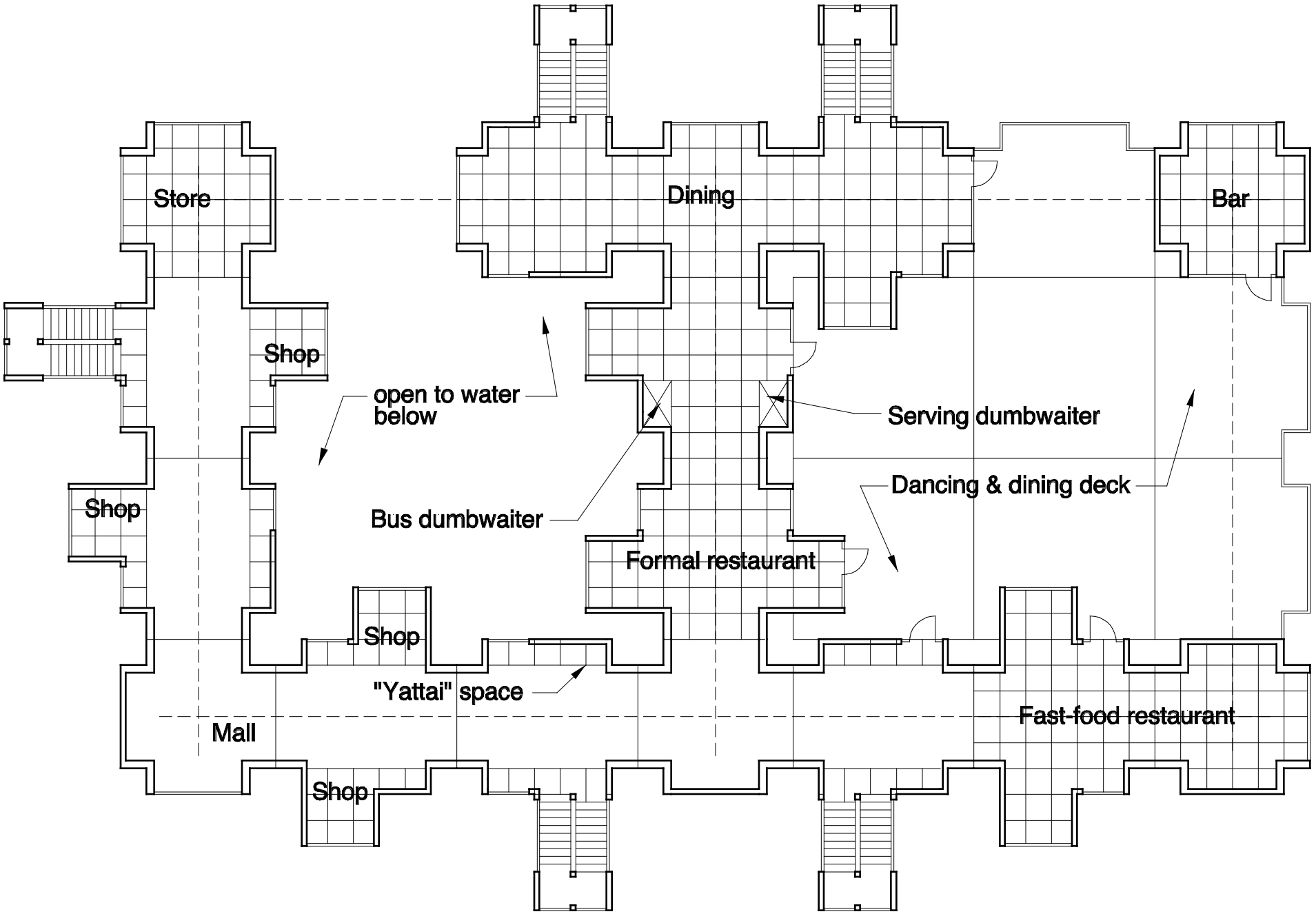


Water Level Plan

0 2 4 6 8 10 m



First Floor Plan



Second Floor Plan

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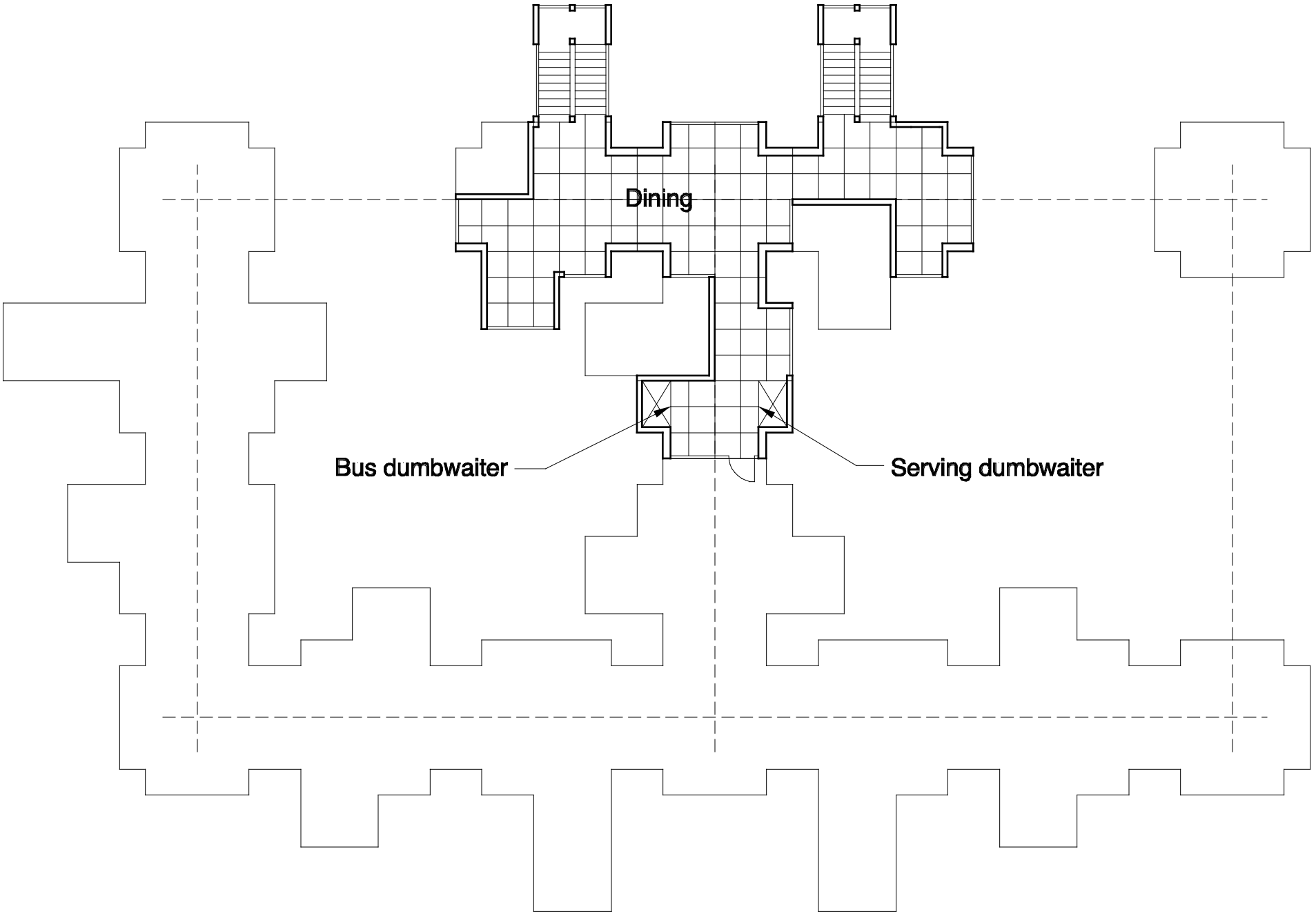
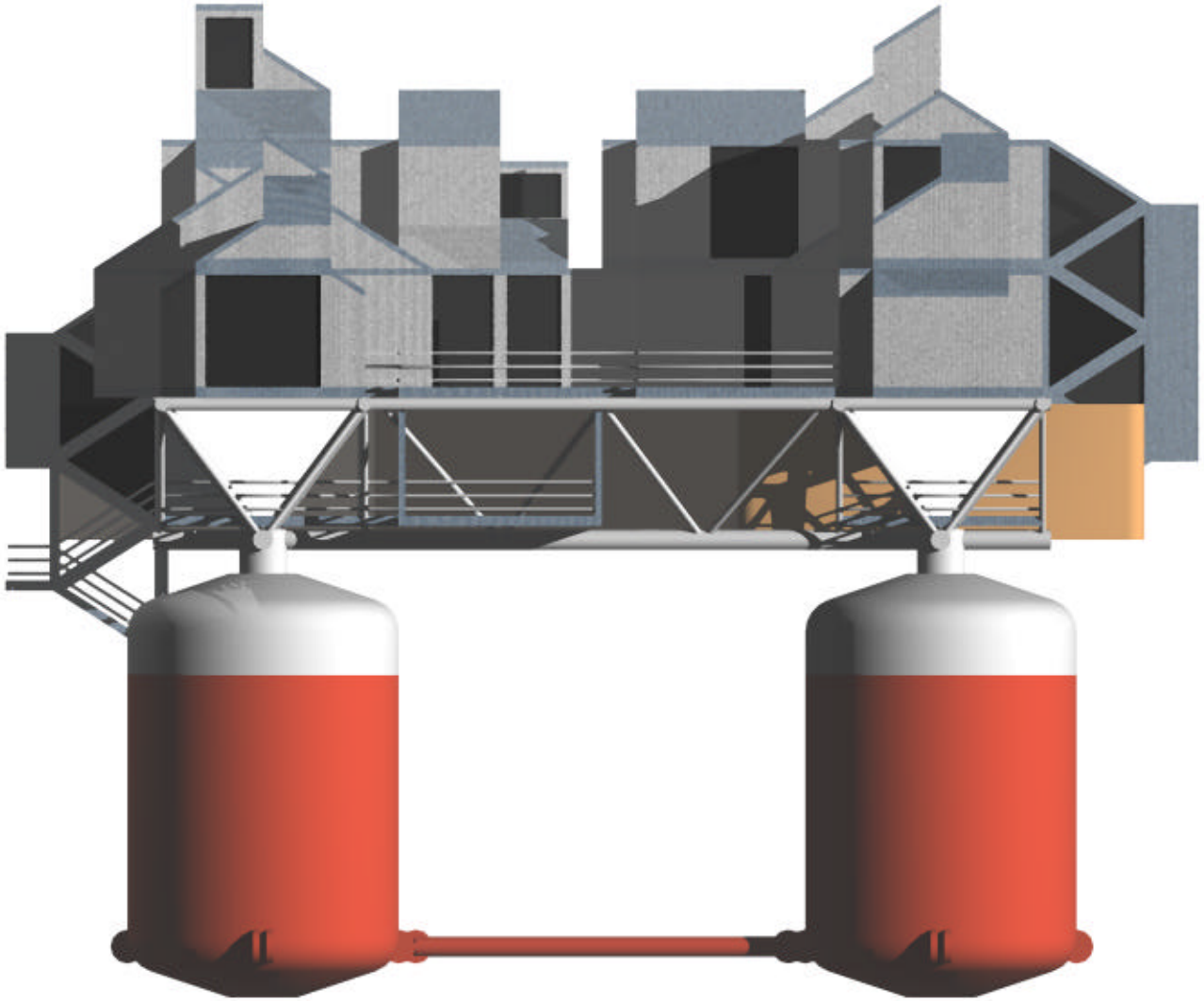
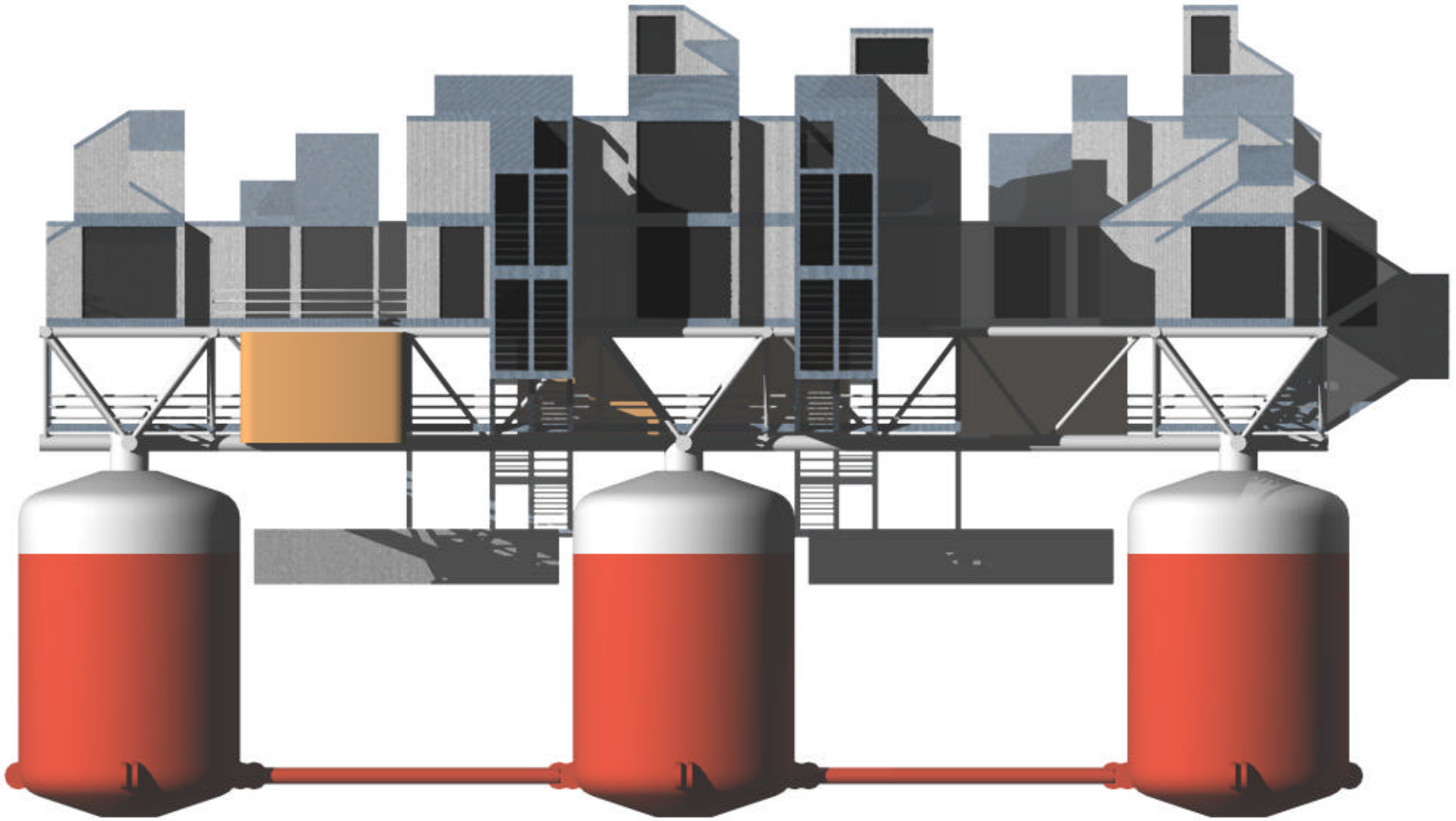


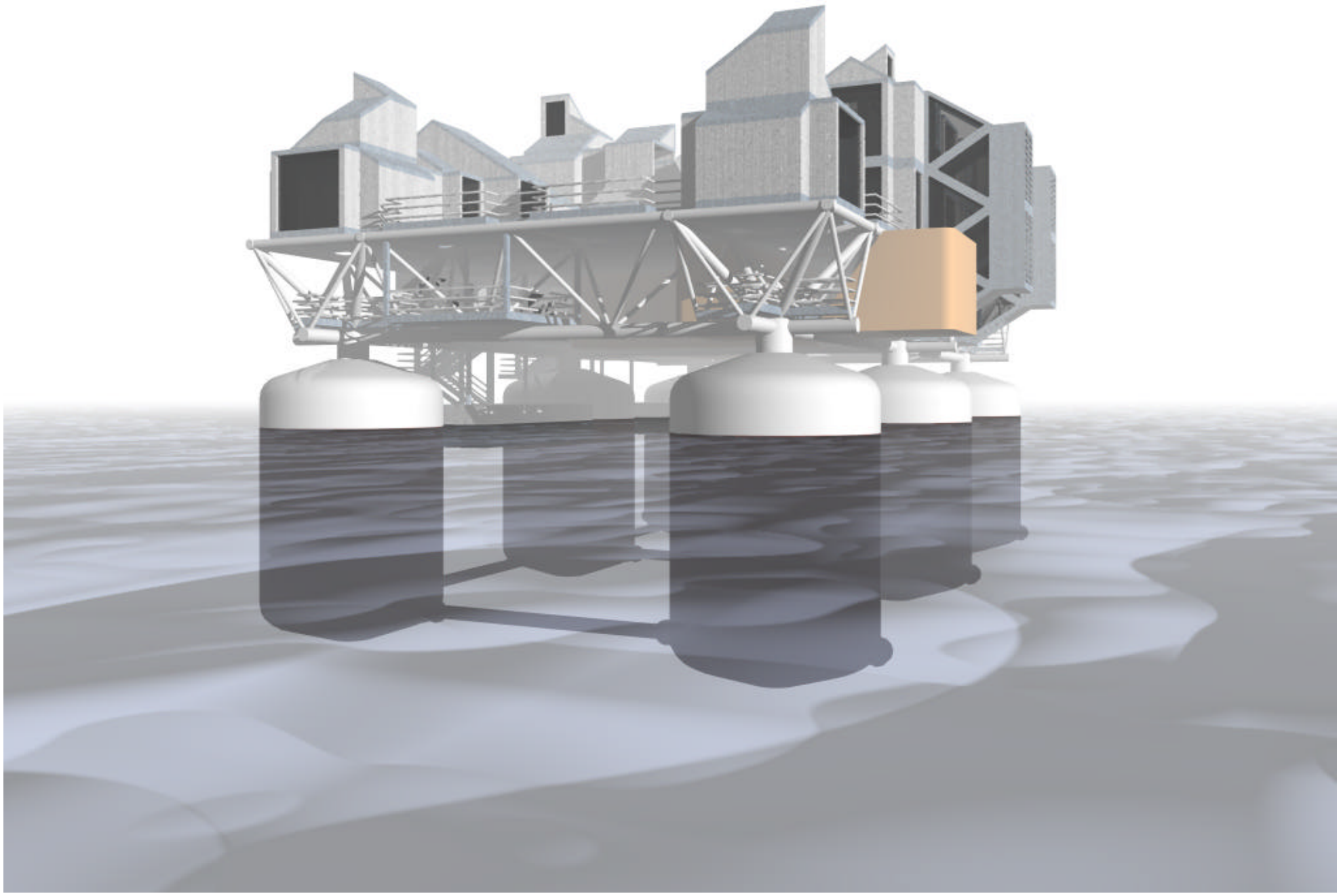
Third Floor Plan

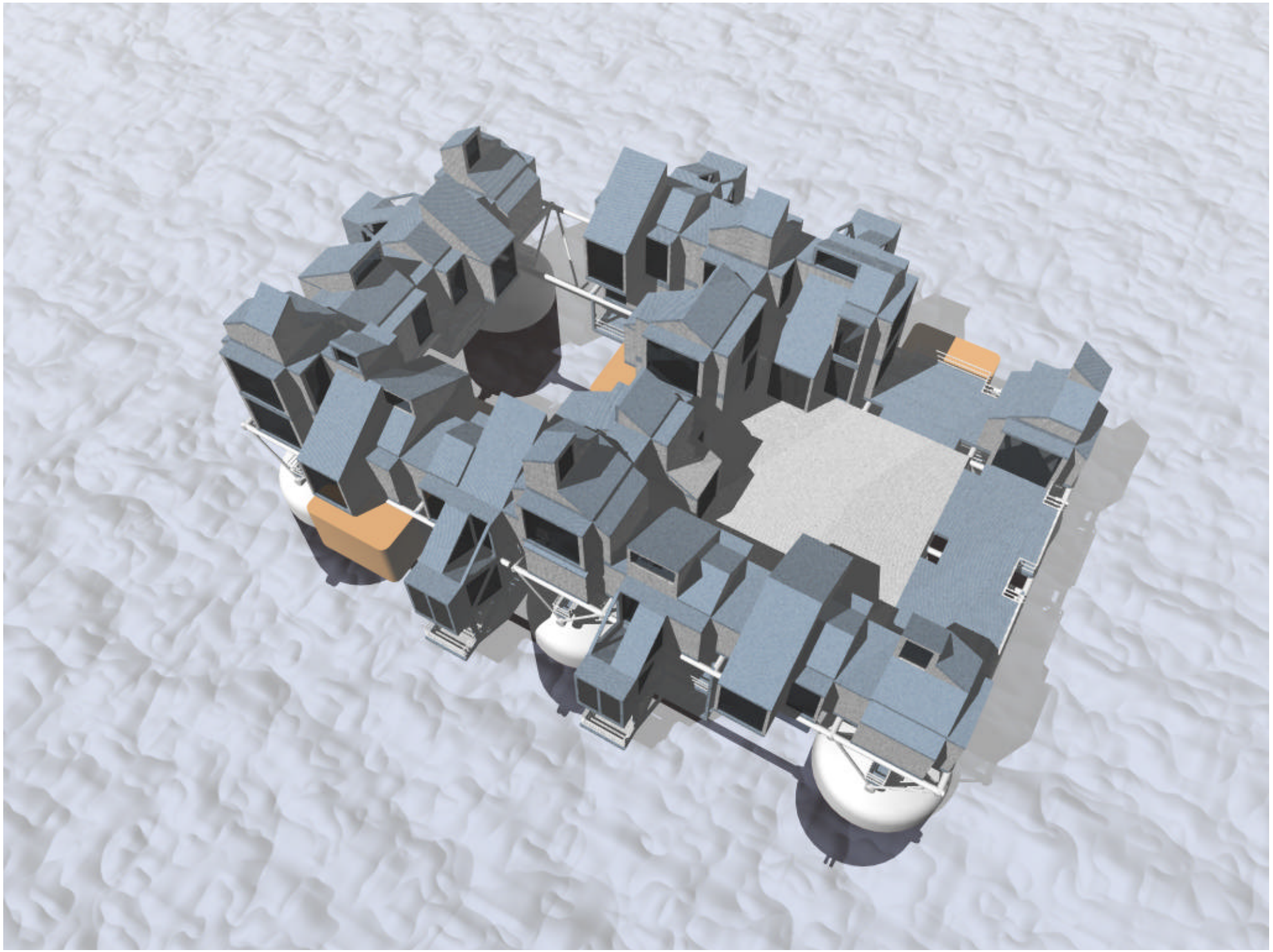
0 2 4 6 8 10 m

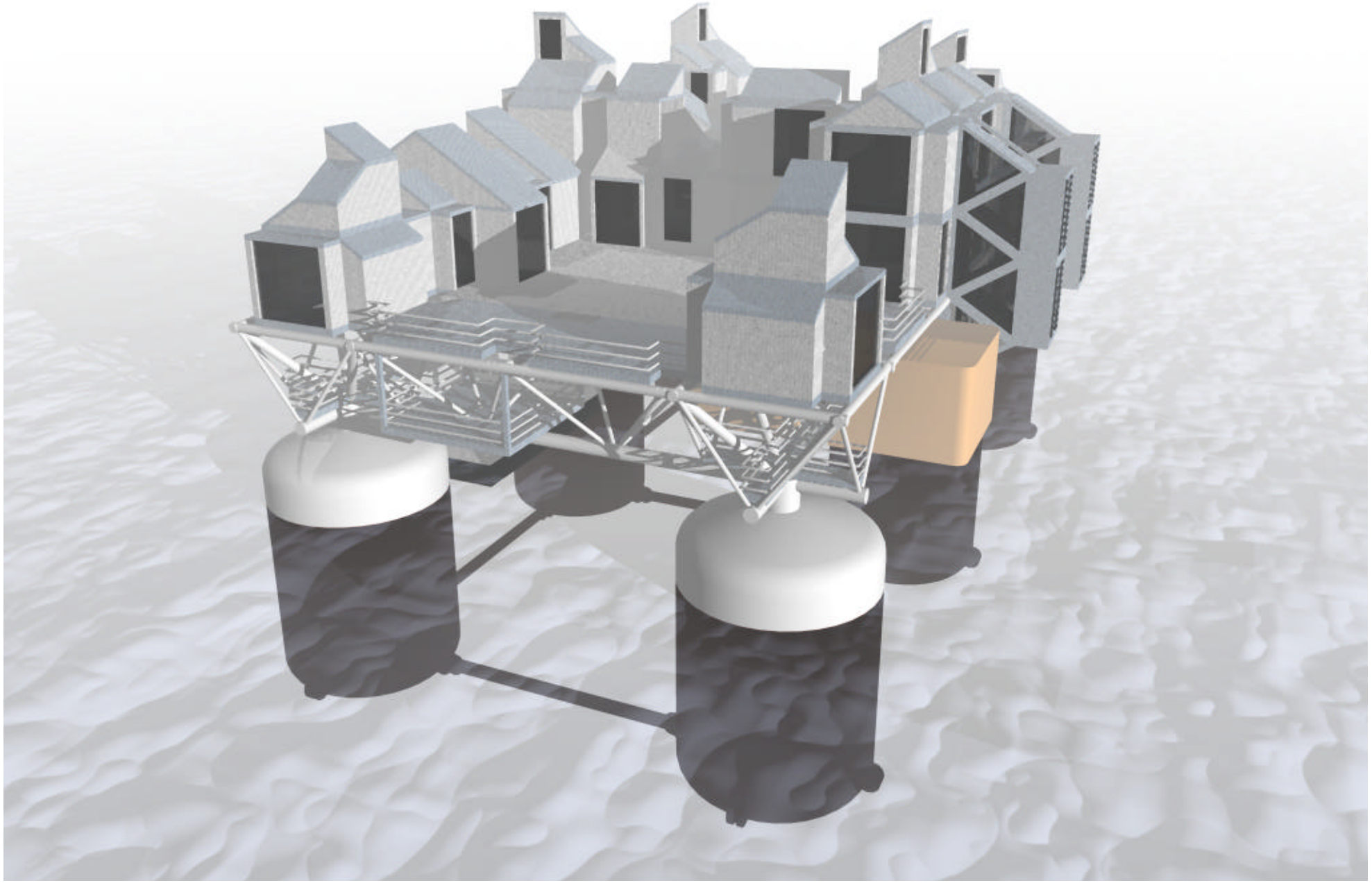
	SPACE NAME	WATER LEVEL	FIRST FLOOR	SECOND FLOOR	THIRD FLOOR	EXTERIOR SPACES	INTERIOR SPACES
Tenant space	Restaurant						474 m^2
	Kitchen		144 m^2				
	Dining			208 m^2	122 m^2		
	Convenience store			32 m^2			32 m^2
	Shops			44 m^2			44 m^2
	Fast-food restaurant			82 m^2			82 m^2
	Bar			32 m^2			32 m^2
	Yattai space			19 m^2			19 m^2
Restrooms	Restrooms		72 m^2				72 m^2
	Resting lobbies		60 m^2				60 m^2
Circulation	Mall			215 m^2			215 m^2
	Stairways	27 m^2	67.5 m^2	67.5 m^2	27 m^2	27 m^2	162 m^2
	Catwalks		150 m^2			150 m^2	
	Other		75 m^2			75 m^2	
Decks	Dancing & dining deck			297 m^2		297 m^2	
	Fishing decks		105 m^2			105 m^2	
Mechanical & service	Electric generator	48 m^2					48 m^2
	Water purification	48 m^2					48 m^2
	Sewage treatment	96 m^2					96 m^2
	Other	48 m^2					48 m^2
Docks	Floating docks	66 m^2				66 m^2	
	Platforms	36 m^2				36 m^2	
	TOTALS	342 m^2	673.5 m^2	781.5 m^2	149 m^2	756 m^2	797 m^2

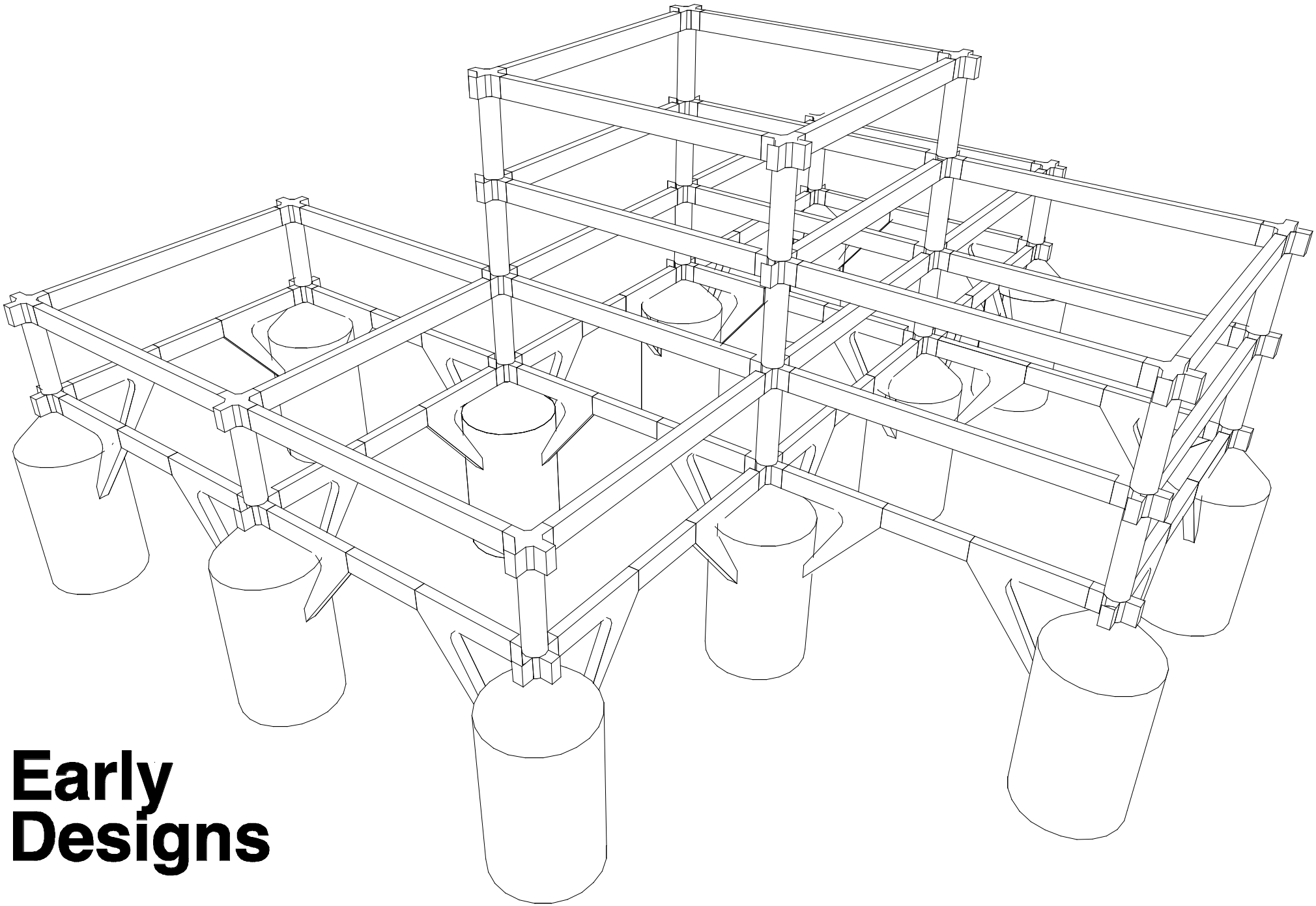












Early Designs