Marine Innovation & Technology
2610 Marin Ave.
Berkeley, CA 94708
USA
Tel: 1-510-931-6135
Fax: 1-415-665-6045

Client:
The SeaStead Institute

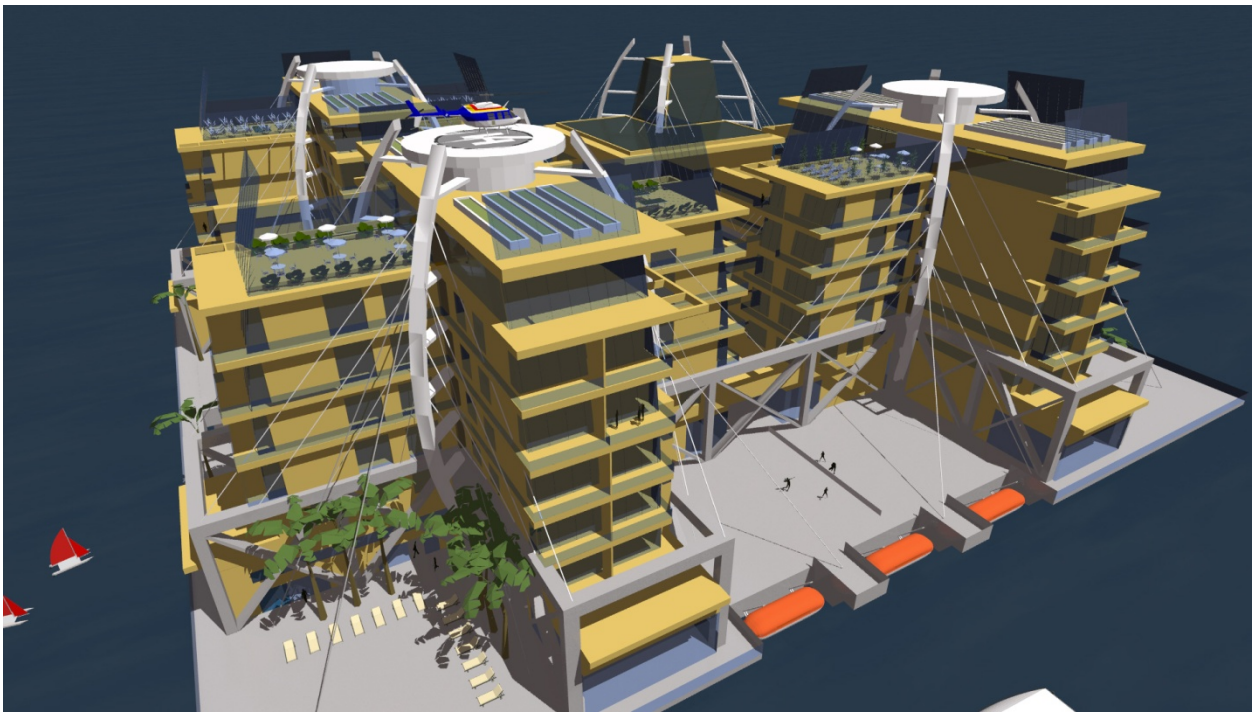
Title:

ClubStead Preliminary Analysis:

Project#:	Revision:	
MI&T040-08_R2	0	

Title:

ClubStead Preliminary Analysis



04.01.09	*0*	*AA*	*DGR*	*For Review doc*
04.01.09	*0a*	*DGR*		*For Internal Review doc*
Date	Rev.	Written by	Checked by	Status/Comments

Marine Innovation & Technology
2610 Marin Ave.
Berkeley, CA 94708
USA
Tel: 1-510-931-6135
Fax: 1-415-665-6045

Client:
The SeaStead Institute

Title:

ClubStead Preliminary Analysis:
Executive Summary

Marine Innovation & Technology (MI&T) was contracted in July 2008 by The Seasteading Institute (TSI) to design a floating residential center with living quarters and working facilities for a community on the high seas. The ClubStead, as it was later named, was initially designed as a tourist destination with a casino and resort. The design may be easily adapted to a range of other business functions. The ClubStead in its present configuration is designed to provide housing and activities to 270 residents and/or visitors.

The ClubStead is a comfortable, spacious and safe community residential center off the coast of San Diego, CA. Due to the intrinsic nature of the ClubStead hull and buildings, the architectural design and the naval architecture / engineering studies are closely related. . Iterations were necessary between the architectural and engineering studies to determine the global characteristics of the ClubStead. An executive summary released in January 2009 [8] summarizes the initial design iterations. The present preliminary analysis lays out the final design after convergence between architectural and engineering data.

To control the cost, the submerged volume of the floating structure is minimized. The submersible-type hull of the ClubStead, which consists of four columns, provides an optimal stability at sea with a minimum submerged volume. A footing at the base of the column lowers the center of gravity and increases the natural heave period for maximum stability of the platform in waves. Cable stayed light-weight surfaces are suspended from the top of towers at the deck level to maximize the available surface area. The dual use of cable stays is inspired from modern bridges where a design element is associated with the lightweight tension supports. This is an innovative solution in the design of floating platforms. When surfaces are supported by cable stays, the primary structure of the deck is lighter. This is critical to keep the weight of the submerged structure small and contributes to lower the construction cost. The cable-stayed platform design was the object of a patent filed by TSI in December 2008.

The global design of the ClubStead is described in an attached document [3]. The column stabilized platform has a displacement of 20,908 short tons, with 5,233st of water ballast. Design criteria are based on a metocean analysis [2] which uses NOAA archived data to define the operational and extreme environmental conditions of San Diego, CA. Both operational and

extreme sea-states are obtained from the wave scatter diagram. The architectural layout, integrates the spatial program with the mechanical and safety components necessary to the autonomous community life onboard. The "Architecture" report [4] summarizes the design philosophy and highlights the main components of the space. A total of 368,200 ft^2 is available indoor or outdoor for residential, business and recreational use. The design of the buildings is integrated in the engineering of the overall structure because it uses the allocated payload of 7,705 short tons and the weight repartition on the 400ft by 400ft square deck.

In the preliminary design phase, a structural analysis is carried out to estimate the weight of the primary deck structure to support the payload and wave loading on the hull. The "Structural Analysis" report [5] describes the methodology used to size the main and secondary trusses on the deck and the supports of cable-stayed areas. The dynamic behavior of cable stays is not included in this preliminary analysis and should be the object of a specific study in the next level of detail design.

The minimization of steel weight is not the only way to control the costs. The installation and commissioning methods can generate significant costs overruns. Few shipyards are equipped to build and launch such large platforms. A modular approach to the construction and installation of the ClubStead is described in the "Construction and Installation" report [7]. The assembling and installation process, in a deep and protected basin near the shipyard, is expected to minimize commissioning costs. Further analysis is needed though to identify the technical challenges that may rise due to welding and assembling of floating modules.

The behavior of the ClubStead in operational and extreme sea-states is studied extensively in the "Hydrodynamic Analysis" [6]. The diffraction-radiation software WAMIT is used to compute the hydrodynamic characteristics of the ClubStead in regular waves. MI&T's proprietary code TimeFloat adds the effects of wind, viscous (vortex shedding) damping and propulsion to calculate the rigid-body motions of the ClubStead. In the 100-year return storm, the integrity of the deck is ensured by keeping a 5ft clearance between the wave crest and the bottom of the deck. In operational conditions, the standard deviation of the vertical acceleration on the deck is calculated to assess the level of passenger comfort. The ClubStead provides comfort more than 90% of the time according to the International Standard ISO 2631. The design may be optimized in further stages by increasing the heave period to reduce the effect of swell on discomfort. The heave period of the ClubStead is 17 seconds and it mostly depends on the ratio of the column diameter at the water line to the column diameter at its footing.

References

[1] “The ClubStead Preliminary Analysis: Design Basis”, MI&T, April 2009

[2] “The ClubStead Preliminary Analysis: Metocean Analysis”, MI&T, April 2009

[3] “The ClubStead Preliminary Analysis: Global Design”, MI&T, April 2009

[4] “The ClubStead Preliminary Analysis: Architectural Design”, MI&T, April 2009

[5] “The ClubStead Preliminary Analysis: Structural Analysis”, MI&T, April 2009

[6] “The ClubStead Preliminary Analysis: Hydrodynamic Analysis”, MI&T, April 2009

[7] “The ClubStead Preliminary Analysis: Construction and Installation”, MI&T, April 2009

[8] “SeaStead Design and Feasibility Study: Executive Summary”, MI&T040-08_R1, MI&T, January 2009

Marine Innovation & Technology
2610 Marin Ave.
Berkeley, CA 94708
USA
Tel: 1-510-931-6135
Fax: 1-415-665-6045

Client:
The SeaStead Institute

Title:

ClubStead Preliminary Analysis:
Design Basis

Project#: MI&T040-08_R2

Revision: 0

This document is the design basis for the ClubStead concept. It describes the functions and capabilities of the ClubStead floating facility.

Residential and business function:

The ClubStead is a mixed residential and business locale. It has a residential capacity of 270 people. Residential areas consist of quarters for 70 staff members and a mixed of economic to luxury rooms and apartments for an additional 200 “clients”. Although the ClubStead was first conceived as a resort, the final design is not specific to any particular business use. Independently of the business purpose of the ClubStead, the program layout is optimized to include recreational outdoor surfaces as well as indoor community spaces, such as dining hall, shopping areas, fitness facilities and offices.

Mobility and location

The ClubStead is located all year long about 100 miles off the coast of San Diego, California, in the Pacific Ocean. The platform is not permanently moored to avoid permitting issues. Instead it is dynamically positioned, keeping station using a diesel electric propulsion system. It is allowed to drift within a defined zone.

Passenger comfort and safety:

The ClubStead available square footage for living facilities is maximized and the architecture intends to convey an impression of ample space. Because the ClubStead passengers may not be professional or even recreational mariners, the level of discomfort, measured by the proportion of sea-sick passengers, must be minimized in all operational conditions.

The ClubStead is designed to withstand extreme environmental conditions on site without affecting the integrity of the platform. It must also ensure the safety of the passengers and equipment in case of damage to the hull. It must be equipped with fire fighting and emergency medical material. Emergency and evacuation procedures follow international standards for passenger vessels. Access to the platform must be possible by boat and helicopter.

Autonomy:

The ClubStead community is not fully self-sufficient and relies on some goods and services such as food, medicine and diesel to be imported every month via a supply boat. The platform is however fitted with systems such as water making, waste and garbage treatment and utility power production to minimize the complete dependency of a land-based station.

Cost:

Since the ClubStead revenues are still unclear and most likely limited, it is critical to minimize all costs, including those related to the construction, commissioning and operation of the platform. This cost minimization philosophy must be applied at all levels of design. A careful economic viability study is recommended at this stage.