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OFFSHORE PLATFORM DEVELOPMENT. FOCUS ON SEMISUBMERSIBLES DESIGN

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Abstract: *All available resources lead to economic development. Because advancement in drilling and offshore exploration technologies, oil and gas energy systems are the common energy source in the world. The semisubmersibles are available for wind and wave energy extraction and projects like WindFloat are developed to respond to our high energy demand. Wind and waves are sources of green energy and the EU countries are strongly ask for inexpensive and green energy solutions.*
Keywords*: Semi-submersible; WindFloat; Wind energy, Ansys mesh.*

INTRODUCTION

Offshore platforms are floating or fixed large marine structures which is used to house machinery needed to wind and wave energy extraction (WindFloat) or for drilling /extracting oil or natural gas.

The semisubmersibles are available for any kind of energy extraction and the present paper is focused on WindFloat structures.

The offshore platforms can be classified on the basis of operating water depths:

- shallow water offshore platforms,
- deep water offshore platforms.

Also, the offshore platforms can be classified on the basis of their energy type:

- Green energy: waves and wind,
- Conventional energy: oil or natural gas.

TYPES OF SEMI-SUBMERSIBLES

Tourist semi-submersible

Tourist semi-submersibles are a type of semi-submersible made for marine fauna and flora turism.

Tourist semi-submersibles compete with tourist submarines and have the advantage of less costs of production and less equipement required onboard. All tourist volumes are low, tourist semi-submersibles are preferred to tourist submarines because of the construction complexity of the latter. All tourist semi-submersibles can place its passengers below water and have windows for a clear view around the semisubmersible.

(a) A typical view of a tourist semi-submersible

Fig. 1 Tourist semi-submersible

(b) A typical seating arrangement for tourist semi-submersible

Fig.2 Tourist semi-submersible

c) An artistic image of a tourist semi-submersible catamaran

PARTICULARS		
	Feet	Meters
Length	44	13.5
Breadth	16	4.9
Draft	5	1.52
Speed	Up to 40 Knots	

Deep-sea ocean research semi-submersible

A deep-sea ocean research semi-submersible has been designed to support a wide range of marine activities and applications including film making and documentaries.The design requirement is to form a stable platform in rough seas.

Fig. 3 Ocean research semi-submersible [Source:http://subseaworldnews.com/2012/05/24/uk-qinetiq-provides-test-facilities-for-innovative-semi-submersible-msv-explorer/]

Military semi-submersible

A military semi-submersible is used by defense forces. Semi-SubmersibleVehicles (SSVs) can provide stealth profile

The small water plane area of small Waterplane Area Twin Hull -SWATH ships at the design waterline ensures a very stable vessel for military use and stealth capabilities.

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Fig. 4 Military semi-submersible
[Source: http://gcaptain.com/wp-content/uploads/2011/10/snorkle-class-usv.jpg]

PARTICULARS		
	Feet	Meters
Length	22	7
Breadth	9	3
Draft	7	2.3
Speed	Up to 15 Knots	

Heavy-lift semi-submersible

A heavy-lift semi-submersible, presented below, can be used for salvage of large vessels, carrying of damaged vessels and transportation of offshore steel structures, platforms and so on.

Fig. 5 Heavy-lift semi-submersible
[Source http://worldmaritimenews.com/wp-content/uploads/2012/01/China-CMHI-Delivers-Semi-submersible-Heavy-Lift-Vessel-HUAHAILONG.jpg]

Offshore drilling semi-submersible

An offshore drilling semi-submersible is used for drilling at deeper sea depths. Initial early designs of offshore drilling semi-submersibles were with jack-up rigs and four columns submersibles. The weight of columns and rigs is high, but without sufficient buoyancy in themselves. The extra buoyancy support is provided by pontoons (flatbottomed boat or the floats). Additionally, pontoons are used as buoyancy tanks which can be ballasted or de-ballasted. The pontoons and columns that constitute the hull are of sufficient weight proper weight distribution to cause the structure to float and also remain upright. Because of high weight of the columns, pontoons, rig and its consumables, the offshore drilling submersible is towed from one location to another at a draft mid way between the top of the pontoons and the underside of the deck. The hydrodynamic motions at this draft are very small, and this has promoted the use of semi-submersible as a stable platform for exploration drilling for offshore oil and gas. They can be towed into position by a tugboat and anchored, or moved by and kept in position by their own 'azipod' propellers with dynamic positioning system. Semi-submersibles are custom built for specific requirements for the drilling industry and the critical design issues for this type of semi-submersible are subsequently discussed in details.

Fig. 6 Drilling industry semi-submersible
[Source: http://www.offshoreenergytoday.com/wp-content/uploads/2011/10/COSL-Takes-Delivery-of-New-Semi-Submersible-Drilling-Rig.jpg]

PARTICULARS		
	Feet	Meters
Length	383	117
Breadth	344	105
Draft	65	20
Speed	Up to 10 Knots	

Crane semi-submersible

The greater column spacing allows the crane semisubmersible to achieve higher stability and thus lift extreme high loads. A crane semi-submersible can moor the hub facilities at water depth of up to 2500*m*. The recent designs have been able to install flow line at around 2800*m* of water depth.

Fig. 7 Crane semi-submersible
[Source: http://gcaptain.com/wp-content/uploads/2014/03/Huisman.jpg]

Floating dry dock semi-submersible

A floating dry dock semi-submersible is used to repair and maintain ships. The design of a floating dry dock semisubmersible is simple, and consists of either pontoon or barge for dry docking ships.

Furthermore, it possesses floodable buoyancy chambers and a "U or Open Box" shaped cross-section. The box walls provide stability to the dry dock when the pontoon/barge is below the water level. On ballasting the buoyancy chambers, the dry dock sinks to the required draft and allows the vessel to be moved on to the pontoon/barge. The dry dock is raised and the deck is cleared of water by de-ballasting the buoyancy chambers, thus allowing the underside of the hull to be accessible for repair and maintenance.

The basic advantage of floating dry dock semisubmersible is that it can be moved from one location to another throughout the world and also it has a good resale value. The typical design parameters are (for a barge design): L =80~125m, B =25~39m, and Height=21~38 m.

Fig. 8 Floating dry dock semi-submersible

A launching platform semi-submersible is used to provide a launching pad for rocket launches. This is a selfpropelled semi-submersible, which is normally converted from a drilling rig and rebuilt as a mobile spacecraft launch platform. During transit operations, the rockets are stored in a large, weather controlled hangar.

Fig. 9 Launching platform semi-submersible

DESIGN CHOOSING AND SOFTWARE ANALYSYS FOR SEMISUBMERSIBLES

A adequate design is generated based on design parameters (material handling equipments, deck space, motion, stability, operational characteristics, and flotation and safety, ABS standards, API standards and DNV standards).

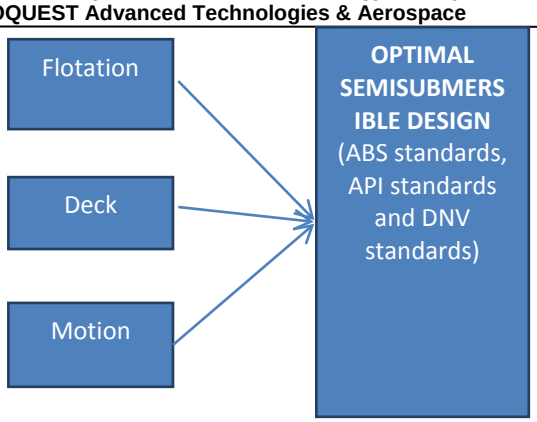
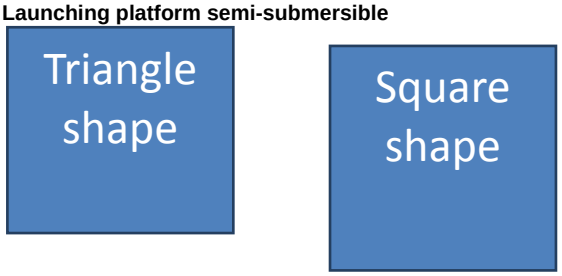


Fig. 10 Design process for semisubmersibles

Windfloat project is a project built to extract wind energy in offshore farms and it does not require deck space or a heavy semisubmersible to carry the wind turbine. The process of optimized design process is based on factors shown in fig 10.

Launching platform semi-submersible



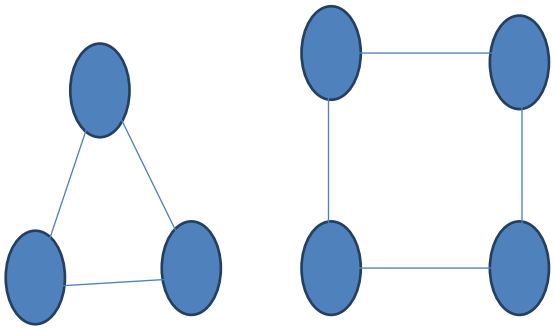


Fig. 11 The geometric shape for semi-submersibles.

ANSYS FLUENT MESH CHECK FOR HEAVE AND PITCH.

Computation has been performed with the ANSYS FLUENT solver available in the "Mircea cel Batran" Naval Academy. Turbulent flow is simulated by solving the incompressible Reynolds-averaged Navier-Stokes equations (RANS). The Fluent flow solver is based on finite volume method.

The solver can be updated to certain situations via UDF files written in C++. In this case the solver settings are set to simulate SST model around the hull.

NUMERICAL CONVERGENCE ACCORDING TO MESH

All calculations are set as convergence criterion the reduction of the maximum difference between consecutive iterations of the three velocity components and of the pressure to 10^{-3} . The mesh shown below will interfere in the solution calculus. The solver will exit calculations at the step where we will obtain numerical convergence.

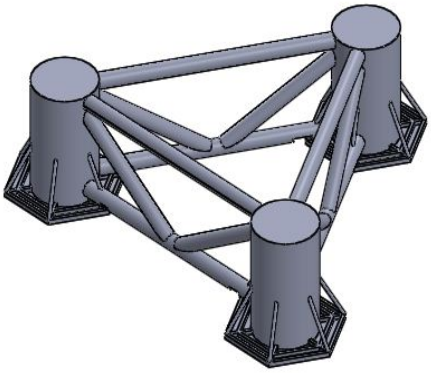


Fig. 12. 3D CAD drawing for ANSYS FLUENT analisys

Ansys Fluent is a part of the Workbench platform and a single setup is shown below for heave and pitch analysis.

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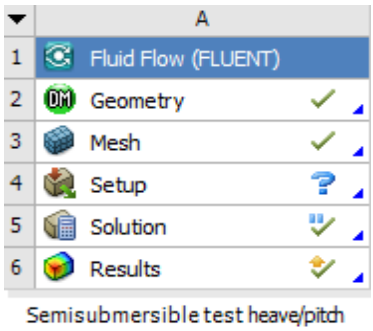

Fig.13. ANSYS FLUENT module

As described before the paper is intended to obtain a mesh for ANSYS Fluent for a computer based on I3 proccesor and 4Gb of memory. The results are shown below and this will not interfere with a good result.

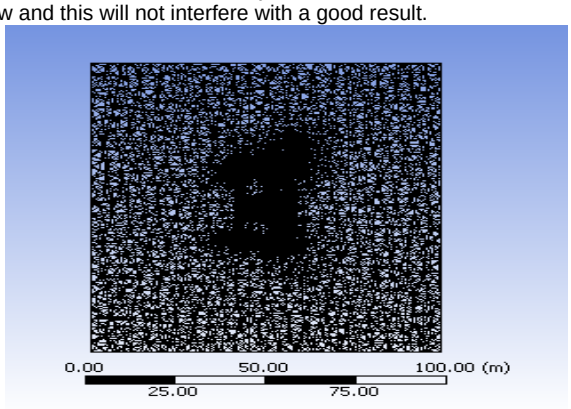

Fig.14. Building section mesh for ANSYS Fluent

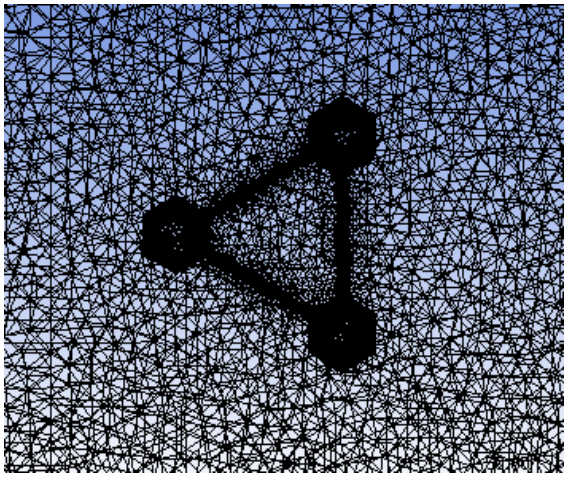

Fig.15. Building geometry and mesh for ANSYS Fluent

CONCLUSIONS

This work has reviewed and reported the state of art in 2014 on the semi-submersible design. In this analysis we have shown that tsemisubmersible design is an evolutionary processed on design parameters and strong software analysis.
This work has presented an mesh analysis that can help in software simulations in ANSYS Fluent and helping to tale a more informed decision in the offshore industry. The analysis reported in this paper can be further explored to develop semisubmerisible related aided design for better understanding and development of the offshore structures.

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