

A Study on the Development of Semi-Submersible Drilling Rig with Oil Recovery System

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요약 : 반잠수식 시추선의 주선체(lower hull)를 세 가지 타입으로 설계하여 주선체에 대한 유체정역학적 계산, 조종성능 및 내항성능 계산 그리고 이론계산을 수행하여 wave distribution과 height도 각각 비교 분석하였다. 주선체의 Convention type, Bulbous bow type, 그리고 Ice breaking type 중 Ice breaking type 선형의 성능이 가장 우수하였다. 다음으로는 반잠수식 시추선의 모든 조건(작업, 이동, 생존)에서 주기둥(column) 또는 주선체(Lower)가 손상되어 부력을 상실했을 시 진북 되지 않도록 고안된 예비부력 기능과 기름 유출 사고시 기름을 회수 할 수 있는 기능을 갖춘 유회수 겸용 예비부력 탱크를 개발하였다.

핵심용어 : 반잠수식 시추선, 선형개발, 내항성능, 예비부력 탱크, 유회수 장치

In a concise background

- The sorts and characteristics of Offshore Structure**
 - Offshore Structure was developed with the history of exploring, drilling oil on the ocean floor.
 - In the early days starting with the structure which is installed on the sea bottom, a fixed type structure such as Jacket, Gravity Platform and Jack Up was the mainstream.
 - But as the sea gets deeper, it was developed into Semi-submersible Drilling Rig, TLP(Tension Leg Platform) etc.
 - At the production of oil on the deep sea gets started with a full-fledged operation, large sized it was developed into FPSO(Floating Production System) like SEMI, TLP, FPSO(Floating Production Storage and Off-Loading) and so on.
 - The figure of offshore structure according to the depth of the sea is shown as this Figure.



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Set up of design condition

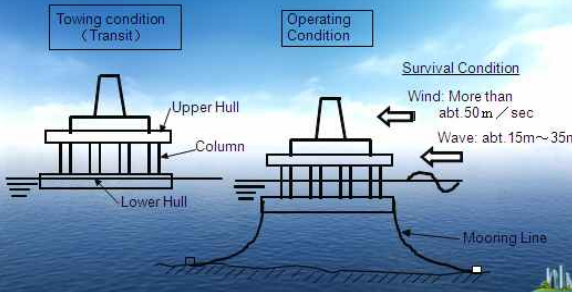
- Working field & environment condition**
 - Depth of water**
 - Bad weather condition(Max. Min) : 400-60meters
 - Normal condition(Max. Min) : 500-90meters
 - Operating condition**
 - Wind speed(average/hour) : 50knot
 - Current : 2knot
 - Significant wave height : 7.62m
 - wave period : 10sec
 - Standby condition**
 - Wind speed(average/hour) : 60knot
 - Current : 2knot
 - Significant wave height : 10.7m
 - wave period : 15sec
 - Survival condition**
 - Wind speed(average/hour) : 110knot
 - Current : 2.5knot
 - Significant wave height : 17m
 - wave period : 15sec
- Structure configuration**

Structures are designed with 4 columns and 2 pontoons considering various design facts. And emergency buoy tank is specially designed to have oil recovery function.

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Semi-submersible drilling rig

- Operating & Transit Condition of Semi-submersible Rig**

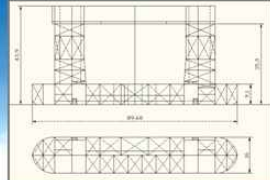


The diagram shows two states: 'Towing condition (Transit)' where the rig is being moved by a tugboat, and 'Operating Condition' where the rig is on the seabed. Labels include Upper Hull, Column, Lower Hull, and Mooring Line. Survival conditions are noted as Wind: More than abt. 50 m/sec and Wave: abt. 15m~35m.

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The existing rig selected as a model of calculation

- Principal particulars of referred rig**

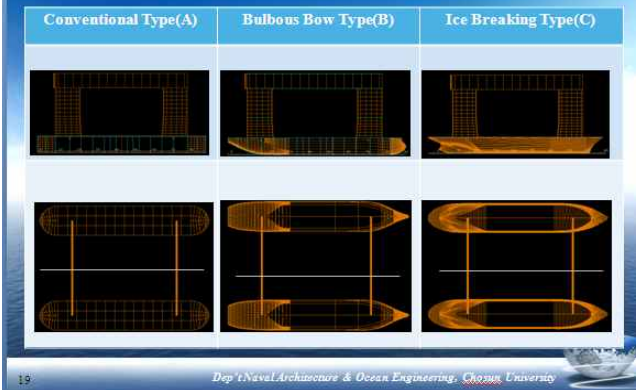


- Length over all (MLD) 99.36m
- Beam over all (MLD) 87.73m
- Height to main deck (MLD) 43.90m
- Height to lower deck (MLD) 35.90m
- Height to drill floor (MLD) 49.90m
- Beam outside pontoons (MLD) 70.72m
- Height to derrick top structure 115.86m
- Pontoon length (MLD) 89.68m
- Pontoon beam (MLD) 16.00m
- Pontoon height (MLD) 9.10m
- Column LxM 13.68x14.5m on pontoon deck
- 12.95x13.77m above 21.93 ab keel
- Transit draft from pontoon bottom (MLD) 8m
- Operation draft (MLD) 24.90m
- Air gap at still water from 24.9m draft 11.09m
- Max. Drilling Depth 7620 m

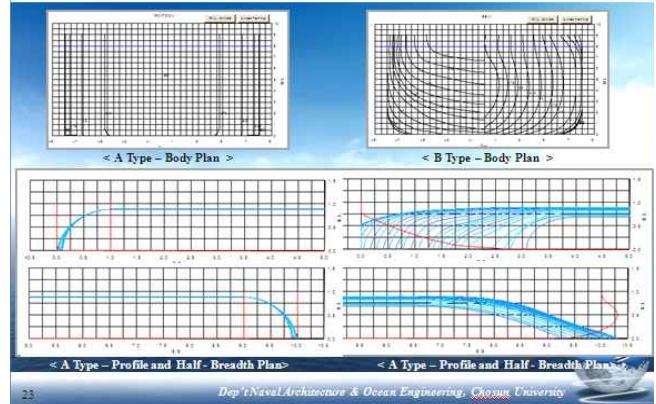
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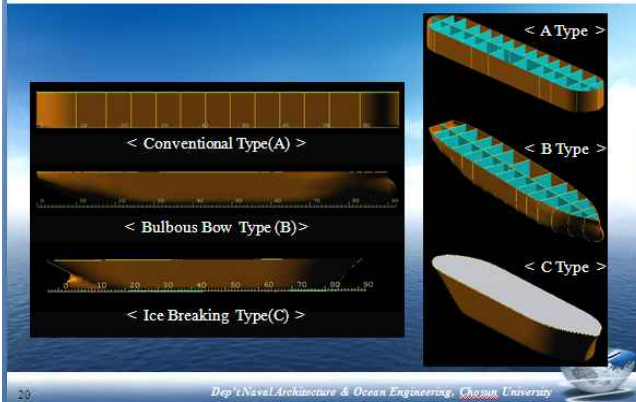
Type of General arrangement



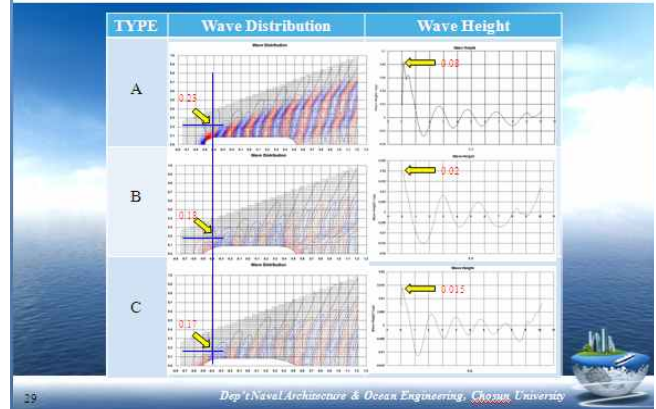
Lines



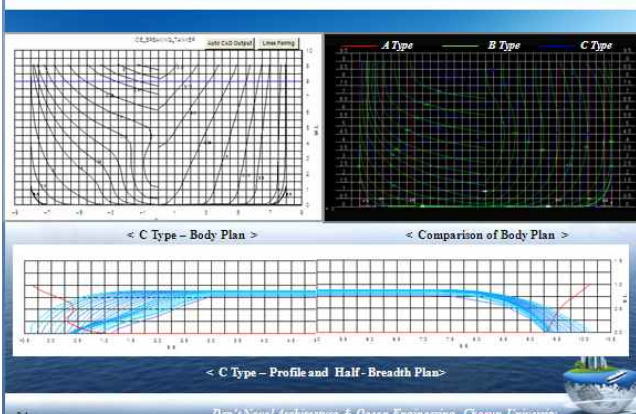
Type of Hull Form



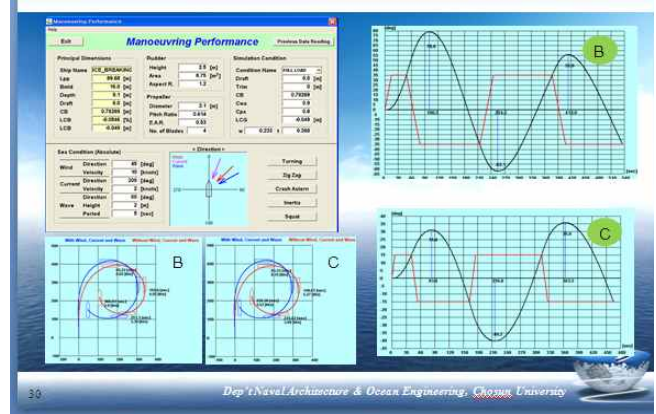
Wave & Flow Simulation



Lines

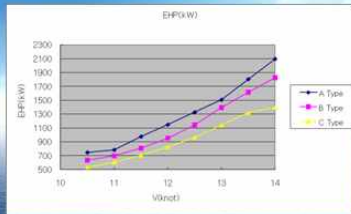


Maneuvering Performance (Turing & Zig Zag)



Effective Horse Power(EHP)

V ₀ [knot]	EHP(kW)		
	A Type	B Type	C Type
10.2	748	853	533
11.0	781	898	568
11.2	876	908	706
12.0	1148	953	823
12.2	1226	1143	964
13.0	1708	1393	1140
13.2	1802	1513	1221
14.0	2092	1823	1399



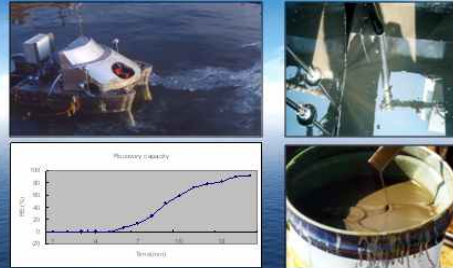
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Sea trial and performance test

High oil recovery efficiency

- High oil recovery efficiency by many circulation steps of oil-water separation
- Expect more efficiency in actual ship than model ship



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Extra Buoyancy



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Hydrostatic calculation

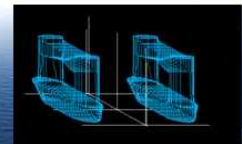
Shipmaster and FORAN system program for conducting hydrostatic calculation and stability calculation was used and applied.

The calculation process

- The hull form about the various structures consisting of a semi-rig/pontoon, lower column, upper column, deck structure, bracing was defined.
- From this process, producing the calculation sections of dense distance made up of polygons, the areas and moments about each calculated section are calculated. By adding the calculation result for the longitudinal direction, the data of hull form for a semi-rig can be gained.

The calculation result

- The calculation result carried on the project rig is shown in Table.
- In this chart, hydrostatic calculation result from the draft 1.0m to 2.0m were calculated at 0.5m intervals.



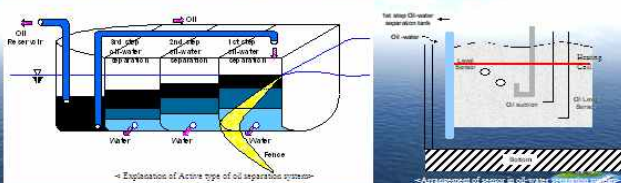
Computing sections of the design rig

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Development of active type oil-water separation system

- The oil which passes through the pipes undergoes active separation in 3 stages and this process is repeated continuously thereby resulting in high filtration effect.
- The sea water is thrown out of the vessel automatically through outlet holes located at the bottom of the vessel in between hulls.
- So the momentum of inflow and outflow is large as a result of which this Oil-Recovery vessel can recover oil at a very high rate compared to the other recovery vessels in operation now a days.
- In last tank of active type oil separation system two water level sensors and one oil level sensor are operating for the collection of denser than 90% oil as shown in Fig.



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Conclusion

1. Ice breaking hull formed semi-submersible rig developed of which resistance and propulsion efficiency improved 15% by applying GA
2. Green rig with multi-purpose oil recovery system has been developed and its efficiency proved
3. Maneuvering and seakeeping performance are satisfied compare with existing rig
4. Intact and damage stability are satisfied with DNV requirement

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