

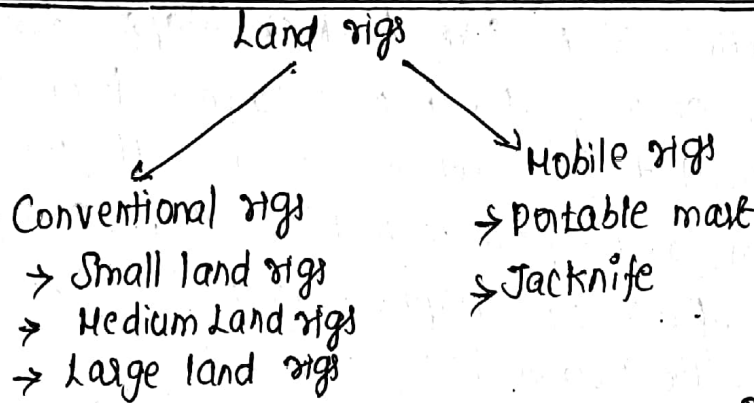
# PE 8601 / WELL DRILLING EQUIPMENT AND OPERATIONS.

①

## Unit-I Part B & C

Year: III year  
Sem: VI sem

① Give an account on the land types of drilling operation:



\* Land type rig also called as onshore rig, it refers to drilling deep holes under the earth's surface.

### Custom Terrain series:

- The custom terrain rigs are purpose-built to perform in specific terrains and environments and continue drilling downhole no matter the conditions above ground.

### Arctic Rig:

- The arctic rig can sustain temperatures dropping to more than 40° below freezing.
- The rig was intricately constructed into five transportable modules with great attention to safety and environmental factors.
- Rig up time is reduced from well to well as there are fewer components to move.
- Transportation time is significantly reduced while moving the equipment from well to well. All separate modules were constructed to be sealed and warmed to mitigate freezing conditions.

### Desert Rig:

The desert rig is a fast-moving desert rig designed specifically for the hostile desert environment and to withstand high ambient temperature while maintaining peak drilling performance.

- The 1000 HP Desert rig is designed to take on the challenges of quick moving desert operations, high ambient temperatures, and difficult transportation logistics.
- The rig employs the use of a primary mover maximizing road sizes in the desert. The modification of traditional rig equipment allows it to fold, bend or collapse, reducing its footprint and allowing for a more compact load size.
- Structural design elements include the use of pin connections in the place of bolt connections and the incorporation of drilling equipment during transit, including integration of the Bop in the rig substructure.
- The 1000 HP Desert rig incorporates all the safety features and reliability you expect from national oilwell valco in one fastmoving configuration.

### Features / Benefits

- Fast moving Desert rig
- Ruggedness - designed to handle high ambient temperatures
- Compact rig design for quicker rig-up/down times

### Helicopter Rig

- The heli rig is specially designed to meet logistical needs when road transportation to a remote location.
- Living up its name, the heli rig is transportable by helicopter and is ideal for isolated jungle locations.

### Train Rig

- The Russian 320 MT train rig from NOV rig systems operates in extreme arctic conditions.
- Key aspect of the rig is the safe working environment with an echelon configuration capable of moving 350 m.

2. Explain the Marine types of drilling operations

offshore rigs (Marine rigs)

Bottom anchored rigs

- artificial island.
- TLP
- submersible
- Jackup
- concrete-structured, etc,

Floating rigs

- drillships
- semi submersible
- barge.

Movable offshore drilling rigs:

- There are two basic types of offshore drilling rigs: those that can be moved from place to place allowing for drilling in multiple locations.
- and those rigs that are permanently placed. Mobile rigs are often used for exploratory purpose because they are much cheaper to use than permanent platforms. Once large deposits of hydrocarbons have been found, a permanent platform is built to allow their extraction.

Drilling Barge

- Drilling barges are used mostly for land, shallow water drilling. This typically takes place in lakes, swamps, rivers and canals.
- drilling barges are not able to withstand the water movement experienced in large open water situations.

Jackup rigs

- Jackup rigs are similar to drilling barges, with one difference. once a jack-up rig is towed to the drilling site to rest above the surface of the water, as opposed to a floating barge.

compliant platform

• complaint towers are much like fixed platforms. They consist of a narrow tower, attached to a foundation on the seafloor and extending up to the platform.

### Seastar platforms :-

• Seastar platforms are like miniature tension leg platforms. The platforms consist of a floating rig much like the submersible type discussed above. A lower hull is filled with water when drilling, which increases the stability of the platform against wind and water movement.

### Floating productive systems:

• Floating production systems are essentially semisubmersible drilling rigs. Ships can also be used as floating production systems.

### Tension leg platforms

• Tension leg platforms are larger versions of the seastar platform. The long, flexible legs are attached to the seafloor, and run up to the platform itself.

• As with the seastar platform, these legs allow for significant side to side movement (up to 20 feet), with little vertical movement.

### Spar Platforms

• Spar platforms are among the largest offshore platforms in use. These huge platforms consist of a large cylinder supporting a typical fixed rig platform.

• The cylinder however does not extend all the way to the seafloor.

3. Discuss the composition and roles of various members of drilling crew:-

- (1) Tool pusher
- (2) company man
- (3) Driller
- (4) Derrick Man
- (5) Floor Man
- (6) Mud Engineer, Mud logger.

Tool pusher:

- Tool pusher supervises all drilling operations and is the leading man of the drilling contractor on location.
- Along with this supervision duties, he has to co-ordinate company and contractor affairs.

Company Man

- The Company Man is in direct charge of all the company's activities on the rig site.
- He is responsible for the drilling strategy as well as the supplies and services in need. His decisions directly affect the progress of the well.

Driller:-

- The driller operates the drilling machinery on the rig floor and is the overall supervisor of all floormen.
- He is directly responsible to the toolpusher and is the person who is most closely involved in the drilling process.
- In case of a kick he is the first person to take action by moving the bits off bottom and close the Bop.

### Derrick Man:

- The derrickman works on the so-called monkey board, a small platform up in the derrick, usually about 90 ft above the rotary table.
- During drilling operations the derrickman is responsible for maintaining and repairing the pumps and other equipment as well as keeping tabs on the drilling fluid.

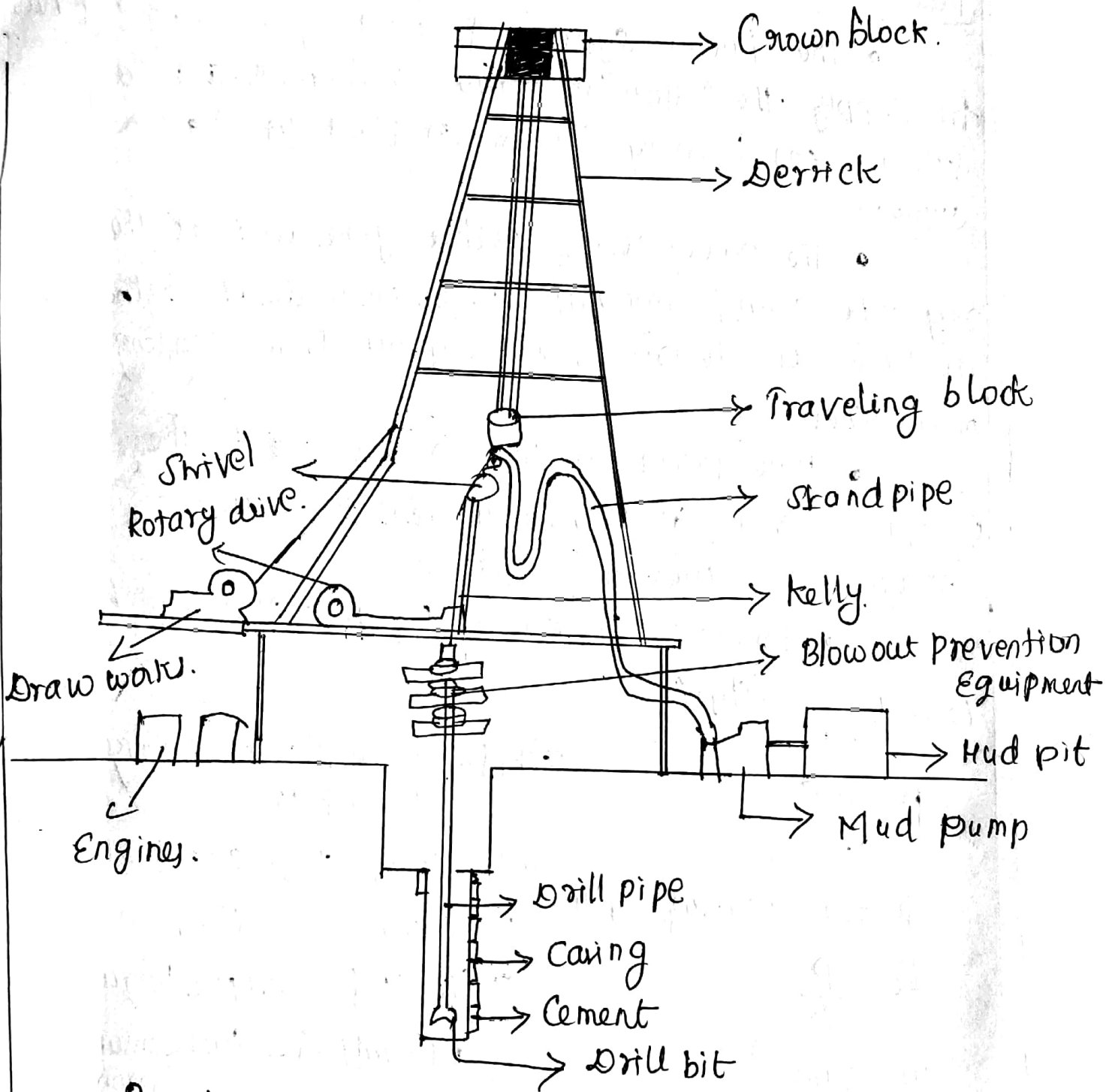
### Floor Men

- During tripping, the rotary helps are responsible for handling the lower end of the drill pipe as well as operating tongs and wrenches to make or break a connection.
- During other times, they also maintain equipment, keep it clean, do painting and in general help where ever help is needed.

### Mud Engineer, Mud Logger

- The service company who provides the mud almost always sends a mud engineer and a mud logger to the rig site.
  - They are constantly responsible for logging what is happening in the hole as well as maintaining the proper mud conditions.
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4. Explain in details about overall drilling rig with a neat sketch. ④



Rig :-

Rig is an integrated system that drills wells such as oil or water wells, to the earth's subsurface.

- Hoisting Capacity
- Power system
- Rotary system

- Circulation system.
- pressure control system.

### Power system

• The power system of a rotary drilling rig has to supply the following main components: (1) Rotary system (2) hoisting system (3) fluid circulation system.

• The power itself either generated at the rig site using internal combustion diesel engines or taken as electric power supply from existing power lines.

• Raw power is then transmitted to the equipment via (i) mechanical drives (ii) direct current (iii) alternating current.

• power requirement for most rigs are between 1000 to 3000 [hp].

$$P = \frac{\omega T}{33,000}$$

$$Q_i = 0.000393 \cdot \omega_f \cdot \rho_d \cdot H$$

$$E_t = \frac{P}{Q_i}$$

$$\omega = 2\pi N$$

$P$  [hp] - shaft power developed by engine

$\omega$  [rad/min] - angular velocity

$N$  [rev/min] - shaft speed

$T$  [ft-lbf] - output torque

$\omega_f$  (gal/hr) - fuel consumption



## Hoisting System:

- The main task of the hoisting system is to lower and raise the drillstring, casings and other subsurface equipment into or out of the well.

- hoisting equipment itself consists of (i) draw works (ii) fast line (iii) crown block (iv) travelling block, (v) deadline (vi) deadline anchor (vii) storage reel (viii) hook & (ix) derrick.

## Circulation System

- The flow of circulated drilling mud can be described as from the mud pit via the mud mixing hopper, where various additives can be mixed.

- At the mud pump the mud is pressurized up to the required mud pressure value.

- From the mud pumps the mud is pushed through the standpipe, rotary hose via swivel in to the drillstring.

- From the bottom of the well the mud rises up the annuli and the mud line which is located above the BOP.

- After cleaning the mud, the circulation cycle is closed when the mud returns to the mud pit.

- it consists of mud pumps (2) flowlines, (3) drillpipes (4) nozzles (5) mud pits.

## Rotary System

- The function of the rotary system is to transmit rotation to the drillstring and consequently rotate the bit.

- During drilling operation, this rotation is to the right.

- Main parts (1) swivel, (2) rotary hose (3) Kelly (4) Rotary drive (5) Rotary table and (6) drillstring.

5. Draw the neat sketch of wellbore diagram and illustrate the name and function of each part.

### Definition:

- A wellbore is a borehole or a hole drilled in the earth's surface so as to carry out exploration and extraction of natural resources like water, oil or gas.

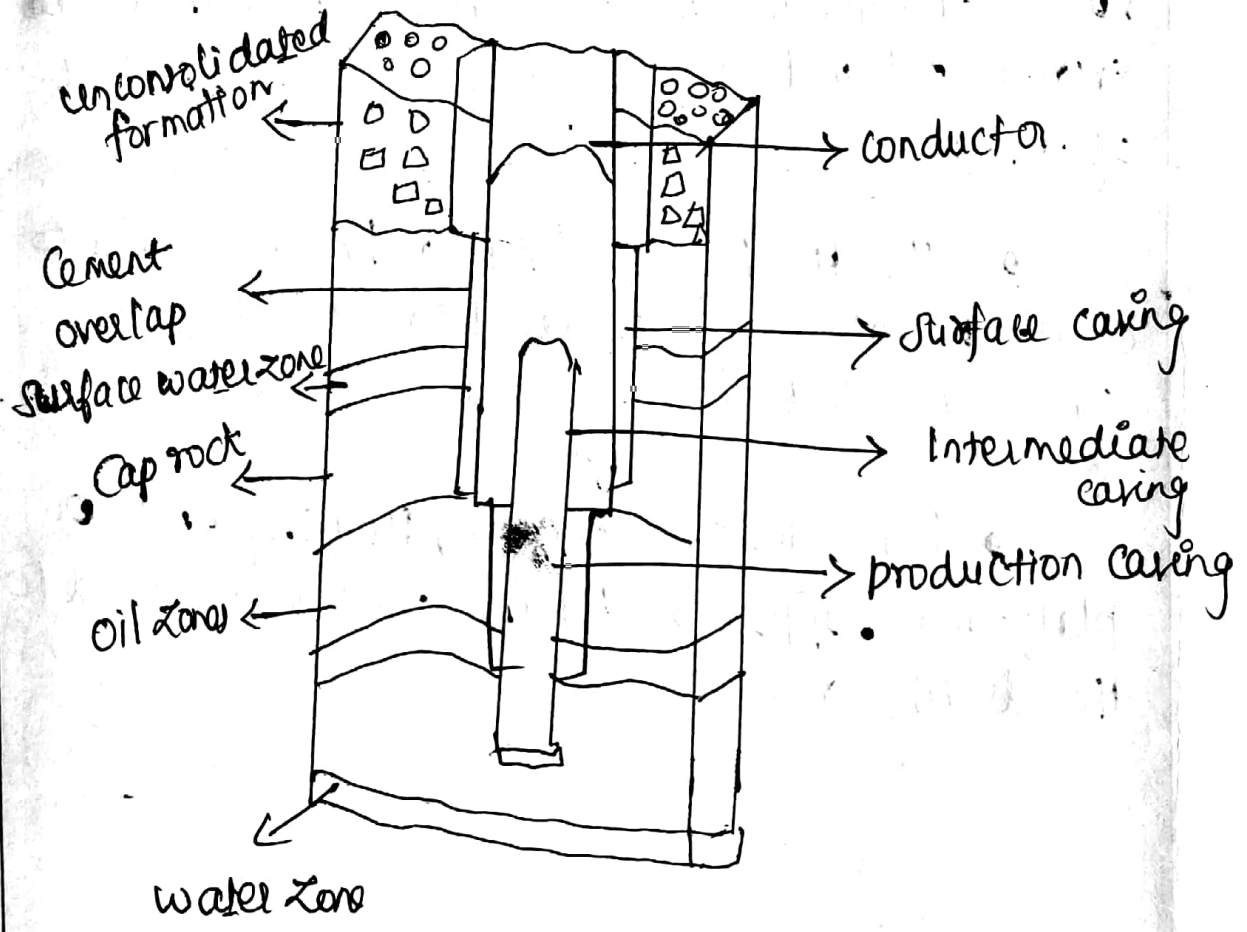
- It is the actual hole that forms the well and it can be uncased or encased by cement and steel.

- It is a straight shaft that bores into the surface and allows improvement of the qualities of the natural resources extracted.

- It also includes an open hole or uncased portion of the well.

### Key takeaways

- A wellbore, is a type of borehole that is used to extract oil or gas.
- A borehole can also be used for mineral extraction, environmental assessment and temperature measurement.
- Wellbores are typically vertical shafts that might be uncased or encased.
- Purpose of the wellbore is to extract oil/gas for a protected period of time.



- The drilled hole may refer to the inside dia of a wellbore wall or the rock face that bounds the drilled hole.

- The well bore can then be cased with materials to improve its stability while improving operation and resource recovery.

- Wellbores must be cleaned before and after production because if mud or debris are not removed, it can increase operating costs while increasing safety and environmental risks.

- Drilling wellbores is complex and requires specialized training, tools and equipment. When successful, the wellbore creates a well that can extract oil and gas for a protracted period of time.

- The Machinery and techniques used to create wellbores differ based on geological conditions and the intended purpose of the oil.

- For offshore drilling, floating units or platforms supported by the seafloor are used for the drilling rig.

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6. Explain in details about drilling loads  
On axial:-

- Definition
- Main components
- Bottom hole assembly (BHA)
- Transition pipe
- Drill pipe
- HWDP.

● The drilling constitutes the connection b/w the rig and the drill bit. The Main components are

- Kelly
- Drill pipe
- Drill collar
- Drilling bit
- Heavy weight drill pipe
- Jars, stabilizers, reamers and various sub

(Kelly sub, bit sub, shock sub) are connected to establish a properly designed drilling

functions

- Improves required weight on the bit.
- Transmits rotary motion from the Kelly to the drill bit.
- provides a two way fluid conduit from the rig to the drill bit
- Medium to lower and raise the drill bit in the hole.
- stabilizes the BHA (Bottom hole assembly) and minimizes vibrations.

• Due to geometrical shape of the drillstring it has a tendency to buckle. To reduce this buckling tendency, it is aimed to design the drillstring in such a way that the neutral point is located inside drill collar.

• In the absence of mud

$$L_n = \frac{WOB}{12 \cdot W_S}$$

• In the presence of drilling mud

$$L_n = \frac{WOB}{12 (W_S - \rho_s \cdot A_s)}$$

When differential pressure is considered as well the neutral point is found at,

$$L_n = \frac{WOB}{12 (W_S - \rho_e \cdot A_e + P_i \cdot A_i)}$$

### Tension :

• The total weight, when the drillstring is suspended into the borehole is carried by the top joint of the string.

• The weight is given by

$$P = (L_{dp} \cdot W_{dp} + L_{hw} \cdot W_{hw} + L_{dc} \cdot W_{dc}) BF$$

$L$  [ft] → total length of the individual tubular

$w$  (lb/ft) → nominal weight of the individual tubular.

$BF(\rho)$  → Buoyancy factor.

### Shock loading

• The movement of the drillpipe is suddenly stopped, shock loads develop that compromise an additional tensile force.

$$F_s = 3200 \cdot W_{dp}$$

$$F_s = \text{shock loading force}$$

$$W_{dp} = \text{weight of the drillpipe per unit length}$$

7. Explain about two types of floating rigs their purpose and application.

- Tension-leg platform
- Semi-submersible platform.

Tension-leg platform

- TLP's are floating platforms tethered to the seabed in a manner that eliminates most vertical movement of the structure.
- TLP's are used in water depths up to about 2000 meters (6600 feet). The conventional TLP is a 4-column design which looks similar to a semisubmersible.
- Proprietary versions include the Seastar and MOSES mini TLP's. They are relatively low cost, used in water depths b/w 180 and 1300m.
- Mini TLP's can also be used as utility satellite or early production platforms for larger deepwater discoveries.

Semi-submersible platform:

- These platforms have hulls (columns and pontoons) of sufficient buoyancy to cause the structure to float, but the weight sufficient to keep the structure upright.

- Semi Submersible platforms can be moved from place to place and can be ballasted up or down by altering the amount of flooding in buoyancy tanks.

- They are generally anchored by combinations of chain, wire rope or polyester rope, or both during drilling and/or production operations, though they can also be kept in place by the use of dynamic positioning.

- Semi Submersibles can be used in water depths from 60 to 6000 metres (200 ft to 20000 ft)

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