DRILLSTRING DESIGN
PGE 471
Oil and Gas Well Drilling Engineering –I-

Rig Components:
1- Power system, 2- Derrick and substructure 3- Hoisting system
4- Rotary equipment 5- Circulation system 6- Pressure control system (BOP)

The main components of a drill string include:
Kelly, Drillpipe, Drill collars, Accessories and Drill bit.

The SWIVEL:
The functions of the swivel:
1- supports the weight of the drill stem during drilling,
2- permits the drill stem to rotate (more than 200 rpm), and
3- provides a passageway for the drilling mud to get into the drill stem

The KELLY
The Kelly is a flat-sided, heavy steel pipe that attached to the bottom of the swivel. Kellys are manufactured from high grades of chrome molybdenum steel and heat-treated.
The Kelly is usually 40 feet (12.2 meters) and 54 feet (16.5 meters) long and has either four (square) or six (hexagonal) flatted sides. The attachments to the Kelly include upper Kelly cock, lower Kelly cock (drill pipe safety valve), and the Kelly saver sub.
Functions of the kelly:
1- Transmits the rotation of the rotary table to the drill string
2- Conducts drilling fluid from the swivel to the drill stem.

Upper Kelly cock: is installed between the swivel and the Kelly. It protects the equipment above the Kelly in emergencies and stops the flow of fluids up the drill stem.
Lower Kelly cock: installed below the Kelly and is like a standby safety valve for blowout prevention.
Kelly saver sub: is short threaded pipe that fits below the Kelly. It minimizes the wear on the Kelly’s threads.

The master bushing performs two jobs:
1- During drilling, it connects the rotary table to the Kelly bushing and transfers rotation from one to the other.
2- When drilling stops, the master bushing holds the slips.

DRILLPIPE
The main functions of drillpipe are to transmit rotary motion and drilling mud under high pressure to the drill bit.
The drillpipe must be capable of withstanding all types of imposed loading, such as axial loading, radial forces due to well-bore pressure, torque due to rotation and cyclic stress (dog-legged hole).

Drill pipes are manufactured according to API specifications concerning *Yield and Tensile strengths*. 

*Minimum yield strengths* refer to the specific value at which the pipe will permanently distort.

*Minimum tensile strength* refers to specific value at which the pipe will snap, or pull apart.

Most of drill pipes fall into four or five API grades:

**E-75**, with minimum yield strengths of 75,000 psi, a maximum yield strengths of 105,000 psi, and minimum tensile strength of 100,000 psi.

**X-95**, with minimum yield strengths of 95,000 psi, a maximum yield strengths of 125,000 psi, and minimum tensile strength of 105,000 psi.

**G-105**, with minimum yield strengths of 105,000 psi, a maximum yield strengths of 135,000 psi, and minimum tensile strength of 115,000 psi.

**S-135**, with a minimum yield strengths of 135,000 psi, a maximum yield strengths of 165,000 psi, and minimum tensile strength of 145,000 psi.

Each grade and size is specified by: a) nominal weight per foot, b) Internal diameter, c) collapse resistance, d) internal yield pressure and e) pipe body yield strength.

For H2S use E and G but not S

In addition to *yield and tensile strength*, the drill pipes are subjected to *torsional yield strength, burst strength, and collapse strength*.

The torsional yield strength is the amount of twisting force a pipe can withstand before twisting off.

The burst strength is the amount of internal pressure that a pipe can withstand before it bursts.

The collapse strength is the amount of external pressure that a pipe can withstand before it collapses.

Upset:

  Thickness forged to the end of a tubular to give the end extra strength.

  Upsetting is usually performed to provide the thickness needed to form threads so that the tubular goods can be connected.

Types of upsets: (upsets give the drill pipe extra strengths on the ends)

- Internal (IU): the bore of the drill pipe is reduced (viewing the pipe from outside reveals no thickened areas).
- External (EU): These pipes have an external upset and the internal diameter is not reduced (smaller pipes have an EU)
- Internal and External (IEU): Most of the pipes come with both internal and external upsets.

Drillpipe ranges:
- Range one 18-22 ft, Range two 27-30 ft, Range three 38-45ft.

Class one: New drillpipe
Class Premium: Pipe having a uniform wear and a minimum wall thickness of 80%
Class Two: Pipe having a wall thickness of 65%
Class Three: Pipe having a wall thickness of 55%

**DRILL COLLARS:**

The drill collars perform the following functions:
1. It provides weight on bit for drilling
2. It maintains weight to keep the drill string from being subjected to buckling forces (keep the drill pipe in tension).
3. It helps provide the pendulum effect which causes the bit to drill a more nearly vertical hole.
4. It helps support and stabilize the bit so that it will drill new hole that is aligned with the hole already drilled.

**Drill string Auxiliaries:**

- Heavy weight, thicker wall than DP, used just above the drill collars in the transition zone between stiffer collars and the more limber drill string, and can replace some drill collars to provide WOB.
- Drilling Jar, mechanical, hydraulic and mixed, or hydromechanical Jars.
- Bit sub,
- Crossover sub (connect the last joint of drillstring to the first drill collar in the drill stem, because of the threads.
- Lifting sub, it provides the drill collar an elevator shoulder to lift it.
- Stabilizers, to keep the hole straight or intentionally cure it from vertical. Rotating and Non-rotating stabilizers
- Reamer, to minimize undergauge hole, holes with diameter less than 1/4” Bit diameter.
- Shock subs or Shock absorber, to absorb vibrations.
- Monel

**Drill String Design:**

- Tension,
- Collapse,
- Shock loading and
- Torsion