EXAMPLE CASING DESIGN

A 10 ¾ inch surface casing is to be set at 4500 ft with 10.6 ppg mud in the hoe. Design the casing to achieve minimum cost.

(a) Do not include any section shorter than 1000 ft.
(b) Ignore buoyancy effect on tension.
(c) Ignore effect of tension on collapse.

Burst Design

Assume an injection pressure that is equivalent to 0.4 ppg greater than the fracture gradient and a safety factor of 1.15. Assume the fracture gradient at 4500f is 0.75 psi/ft. Assume the casing is filled with formation gas which has a gradient of -0.1 psi/ft.

Assume the external (backup pressure) outside the casing that resists burst is the normal pore pressure which has a gradient of 0.45 psi/ft.

Collapse Design

Assume a lost circulation zone below the shoe which has zero pore pressure. Assume a safety factor of (1.1).

Tension Design

Assume maximum tension is due to the weight of the casing. Assume a safety factor of 1.6.

SOLUTION

Start with burst.

Burst load at the shoe

P_b = Fracture pressure + incremental injection pressure

- external pressure

$= 0.75\left(\frac{psi}{ft}\right)x\ 4500(ft)$

$+(0.052)x(0.4\ ppg)x(4500\ ft)$

$-0.45(psi/\ ft))x\,4500(ft) =$

$= 3375 + 93.6 - 2025 = 1444\ psi$

Taking SF into consideration $= 1444x1.15 = 1661\ psi$

Burst load at surface

$P_b = 1444 - 0.1(psi/\ ft)x4500 - 0 = 994psi$

Taking SF into consideration $= 994x1.15 = 1143\ psi$

Collapse Load

P_b at surface = $0 - 0 = 0\ psi$

P_c at shoe $= 0.052\,x10.6(ppg)x\,4500 - 0 = 2481\,psi$

Taking SF into consideration = $2481x1.1 = 2729$

After sketching the loads on the graph, we have the following selection:-

Casing	Depth	Length
H-40, 32.7#	0-1350	1350
J-55, 40.5#	1350-2600	1250
C-75, 51#	2600-4500	1900

Tension Design

$WT = 32.7\,x1350 + 40.5\,x(2600 - 1350)$

$+ 51x(4500 - 2600)$

$= 44145 + 50625 + 96900$

$= 191670\ lb$

Pipe body Yield Strength for H-40, 32.75 # from table 7.6 (page 320) is 367,000 lb

$$SF = \frac{367000}{191670} = 1.91 \rangle 1.6$$

Therefore the selected casing grade satisfies the design criteria.

Selection of Couplings

Start with short round coupling (STC):-

Casing	Depth	Coupling Type	Strength (1000)	SF
H-40, 32.7 #	1350	STC	205	1.07
J-55, 40.5#	2600	STC	420	--
C-75, 51#	4500	STC	756	--

For H-40, 32.7# STC joint strength = 205000 lb from table

$$SF = \frac{205000}{191670} = 1.07 \langle 1.6$$

Next select H-40, 40.5 #

$$Wt = 40.5 x 1350 = 54675\ lb$$

$$total\ \ Wt = 54676 + 50625 + 96900 = 202200\ lb$$

$$SF = \frac{314000}{202200} = 1.55 \langle 1.6$$

$\therefore H - 40{,}40.5\#$ is not suitable.

Next select J-55, 40.5#, joint strength from table = 420,000

$$Wt = 40.5 x 1350 = 54675\ lb$$

Total wt = 202200

$$SF = \frac{420{,}000}{202200} = 2.08 \rangle 1.6$$

$\therefore$ We select at the top section Casing type J-55, 40.5#, STC.

Final Selection

Casing	Depth	Coupling
J-55, 405#	2600	STC
C-75, 51#	4500	STC