5.- STRUCTURE:

5.1. GEOMETRICALS DIMENSIONS:

Tank diameter $D = 31,09$ m. $r = 15,545$ m.

Roof radius $a = 46,635$ m.

Roof height $h = a - \sqrt{a^2 - r^2} = 2,667$ m.

Number of belts $n = 60$

Thickness of roof shell plates $t_D = 5$ mm.

Relation of spherical surface A_c, to surface in projection A_h, on a horizontal plane.

$$\frac{A_c}{A_h} = \frac{2\ a\ h}{r^2} = 1,029$$

5.2. WEIGHT OF STRUCTURE AND OVERLOAD:

Total weight of structure, without shell plates roof, used in calculus, $Q_t = 15.000$ Kg.

Weight concerning its superface in plant:

$$g_R = \frac{Q_t}{A_h} = 19,75 \text{Kg./m}^2$$

Shell plates roof weight.

$$g_H = 8\ t_D\ \frac{A_c}{A_h} = 41\ \text{Kg./m}^2.$$

Overload s/API 650 more 30 mm. column of water:

$$P = 25\ \frac{\text{Lb}}{\text{ft}^2} = 122\ \text{Kg./m}^2 + 29 = 151\ \text{Kg./m}^2$$

Total roof load.

$q = g_H + g_R + P = 212$ Kg./m² < 300

5.3. LOAD DENT OF SHELL PLATES ROOF:

$b_R = \frac{2 \pi r}{n} = 1{,}62$ m. < 1,915 (Max. S/API 650).

$IB = b_R \left(1 - \frac{\pi}{n}\right) = 1{,}535$ m.

$= \frac{10\ t_D}{a} = 1{,}072$

$K = \frac{1.000\ IB^2}{58{,}4 x a x\ t_D} = 0{,}173$

105 ² = 120 Kg./m².

(If K < 1) $P_B = 26{,}3$ ² $\left(K + \frac{1}{K}\right) = 180$ Kg/m² > 105 ²

If < 105 ²
we take PB
= 105 ²

(If K > 1) $P_B = 52{,}6$ ²

$P_B = 180$ Kg/m².

$\frac{P_B}{1{,}71} = 105$ Kg/m².

5.4. CALCULATION OF BELTING:

Stress of belts:

$P_R = g_H + P - \frac{PB}{1{,}71} = 87$ Kg/m².

$P_R = 0{,}5\ (g_H + P) = 96$ Kg/m².

Take the biggest value of P_R

$P_R = 96$ Kg/m² > 75 Kg/m² (In apposite case $P_R = 75$ Kg/m²).

Load of the belt:

$$P_c = \frac{\pi D^2 \; P_R}{4.000 \; n} = 1,21 \; Tn.$$

Structure weight by belt, $G = \beta \times P_c$

$$\beta = \frac{g_R}{P_R} = 0,20 \qquad G = 0,249 \; Tn.$$

Normal stress due to G

$$N_g = 0,513 \frac{r}{h} \times G = 0,744 \; Tn.$$

Normal stress due to P_c

$$N_p = 0,375 \frac{r}{h} \times P_c = 2,644 Tn.$$

Normal stress of 1st order:

$$N = N_g + N_p = 3,388 \; Tn.$$

Maximum moment of 1st order:

$$IMF = 3 \times P_c \times r = 56,42 \; Tn/cm.$$

As the structure isn't weld to shell plate roof , we take $\beta = 1$

Moment of minimun inertia required for the belt.

$$J_x \; min. = \beta \frac{1,71 \; N}{2,07} \times r^2 = 676 \; cm^4$$

We assume a profile: IPN 14

J_x = 573 cm^4 W_x = 81,9 cm^3 F = 18,2 cm^3

g = 14,3 Kg/m. i_y = 1,40 cm.

Maximun moment of 2nd order:

$$II\ M_F = \frac{1\ MF}{1 - \varepsilon} \quad \text{Donde } \varepsilon = \frac{1{,}71\ N}{6\ J_x} r^2 = 0{,}40$$

II M_F = 94,03 Tnxcm.

Maximun normal stress of 2nd order:

II N = N = 3,388 Tn.

$$\sigma = \frac{II\ N}{F} + \frac{II\ M_F}{W_x} = 1{,}334$$ Tn/cm² < Adm. (1,4 S/API 650).

.5. CALCULATION OF BRACING:

We place a polygonal ring from a peak distance of s = 3,9 m.

$$s = \frac{0{,}9\ r}{n_1 + 2} + 0{,}1\ r$$

Also we place n_1 = 4 polygonals rings, from the higher polygonal ring, to top angle of the shell, equally spaced. Total polygonals rings = 5

$$S_{KY} = 100 \frac{r - s}{n_1 + 1} = 233 \text{ cm.}$$

Slenderness of belf:

$$\lambda y = \frac{S\ K_y}{i_y} = 166 < 180$$

Para D < 20 n_2 = 2

Para D ≥ 20 n_2 = 4