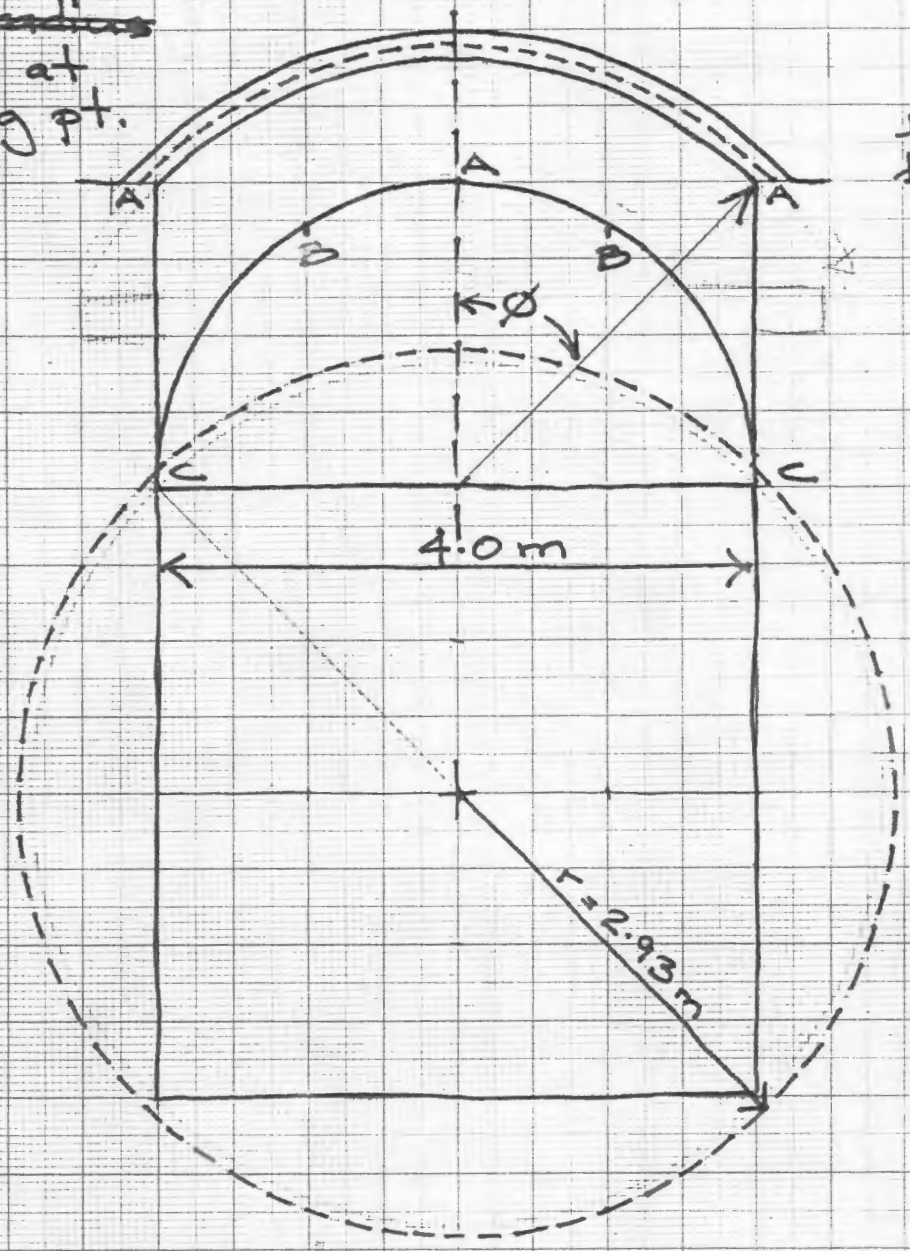
STRUCTURAL ANALSIS OF 4 M. DOME

(A.) W ~~radius~~ focus at spring pt.



1) Assume density of building material = 2600 kg / m³

2) Mass of shell material @ 0.20m thick
q = 400 kg / m²

3) Span of dome = 4.0 m

4) Radius to centre line of shell
R = 2.93 m

Employing shell theory (ref.) we assume:

5) Meridianal force within shell at point X = $N\phi_x$

$$N\phi_x = \frac{-Rq}{1+\cos\phi_x}$$

6) Ring or horizontal force within the shell at point X = $N\theta_x$

$$N\theta_x = -Rq\left(\cos\phi_x - \frac{1}{1+\cos\phi_x}\right)$$

7) Assume positive forces indicate tension.

Forces Acting at point "A"

i) $\phi_A = 45°$

ii) $$N\phi_A = \frac{-(2.93\text{m})\cdot(400\ \text{kg/m}^2)}{1+\cos 45°}$$

$$= \frac{-1172\ \text{kg/m}}{1.707}$$

$$= -686.58\ \text{kg/m}$$

iii) $$N\theta_A = -(2.93\text{m})\cdot(400\text{kg/m}^2)\left(\cos 45° - \frac{1}{1+\cos 45°}\right)$$

$$= -(1172\ \text{kg/m})\left(.707 - \frac{1}{1.707}\right)$$

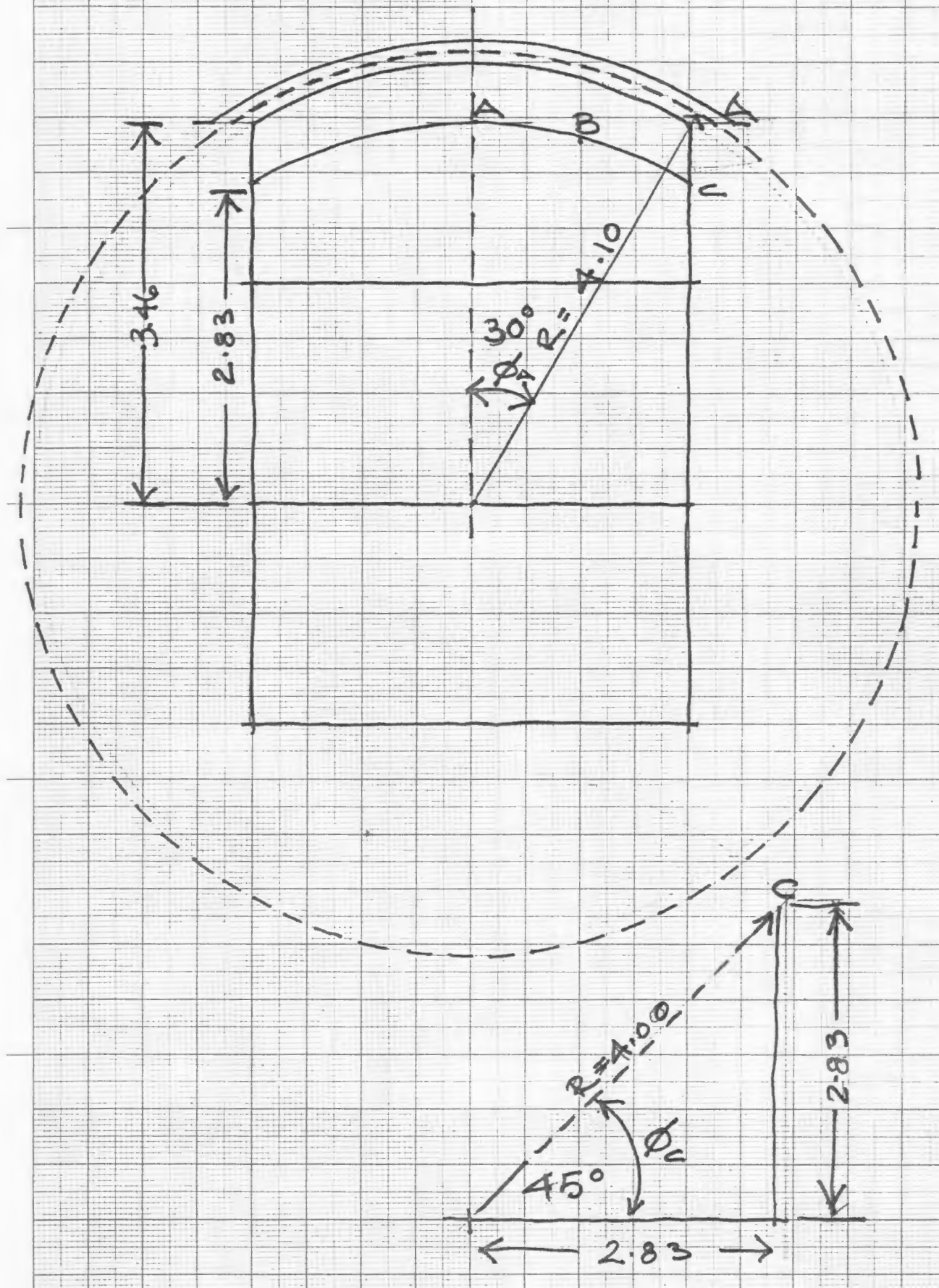
$$= -(1172\ \text{kg/m})(0.707 - 0.5858)$$

$$-(1172\ \text{kg/m})\ (0.1212)$$

$$= -142.0\ \text{kg/m}$$

B-1

(B) w focus at 2·83 m below spring point. & Radius → 4.00 m.
→ centre → 4.10 m
line



Forces Acting at point A

i) $\phi_A = 30°$ $\quad q = 400 \text{ kg/m}^2$

$R = 4.10 \text{ m}$

ii) $N_{\phi_A} = \dfrac{-Rq}{1+\cos\phi_A}$

$= \dfrac{-(4.10)(400)}{1+\cos 30°}$

$= \dfrac{-1640}{1.866}$

$= -878.89 \text{ kg./m}$

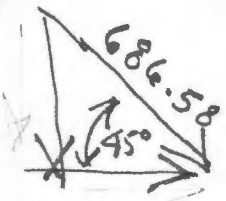
iii) $N_{\theta_A} = -Rq\left(\cos\phi_A - \dfrac{1}{1+\cos\phi_A}\right)$

$= -1640\left(0.866 - \dfrac{1}{1.866}\right)$

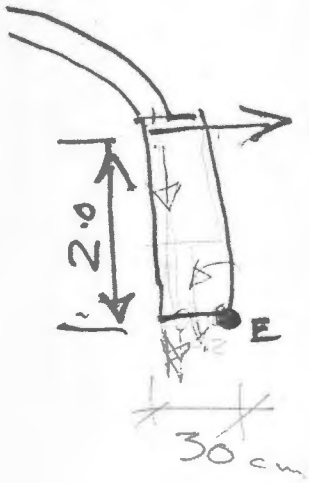
$= -1640\left(\dfrac{0.866 - 0.5359}{0.33}\right)$

$= -541.36 \text{ kg/m}$

A



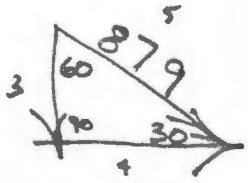
Horizontal component of thrust = 485.5 kg/m



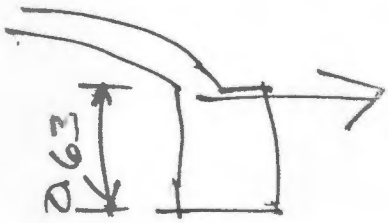
$\overrightarrow{M_E}$ = 485.5 × 2

= 971

B

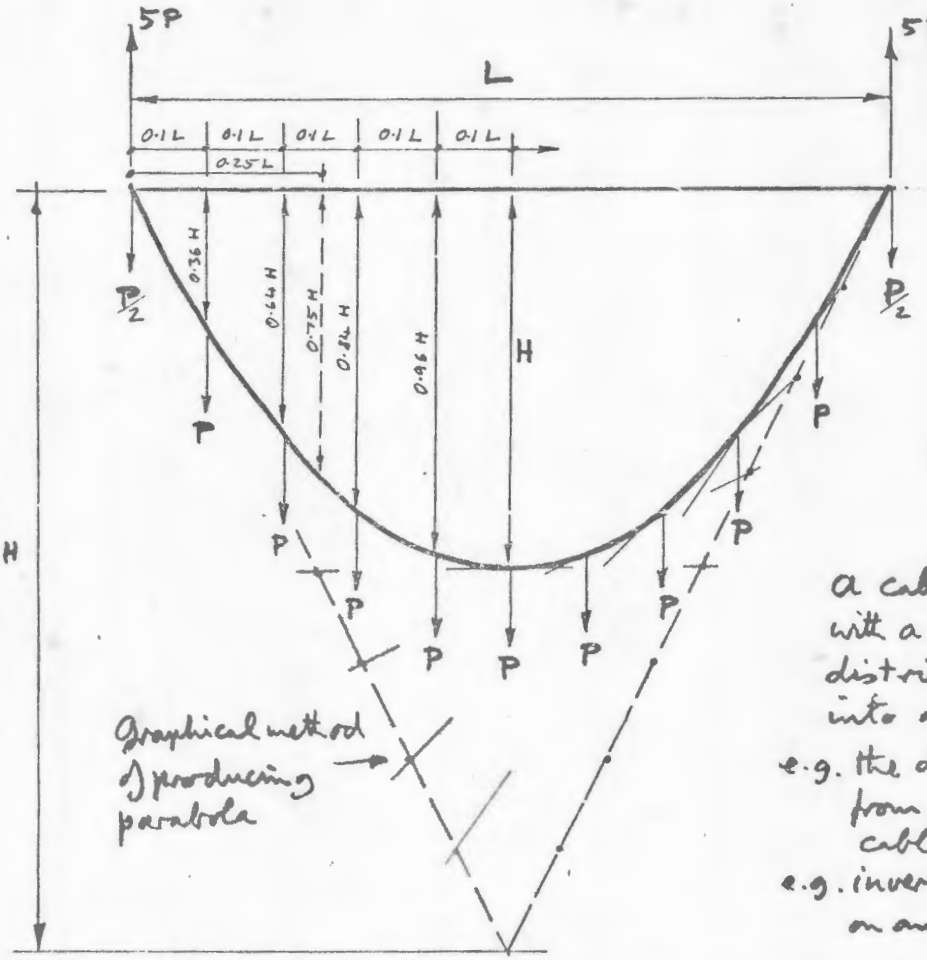


Horizontal component of thrust = 703 kg/m



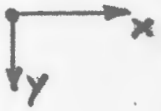
703 kg/m.

PARABOLA



Formula for Parabola

$y = 4H\left(\frac{x}{L} - \frac{x^2}{L}\right)$



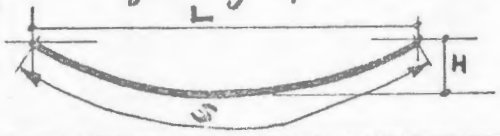
Graphical method of producing parabola →

A cable with equal loads with a uniform horizontal distribution will fall into a parabolic shape.

e.g. the deck loading hanging from a suspension bridge cable.

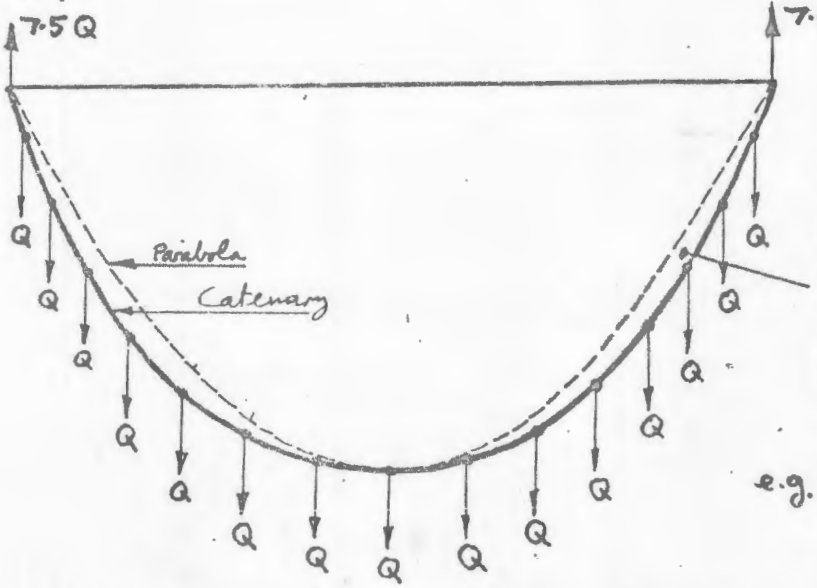
e.g. inverted, the deck loading on an arch.

If $\tau = \frac{H}{L}$ length S of a parabolic cable for a small value of τ is given by:



$$S = L\left(1 + \frac{8}{3}\tau^2\right)$$

CATENARY

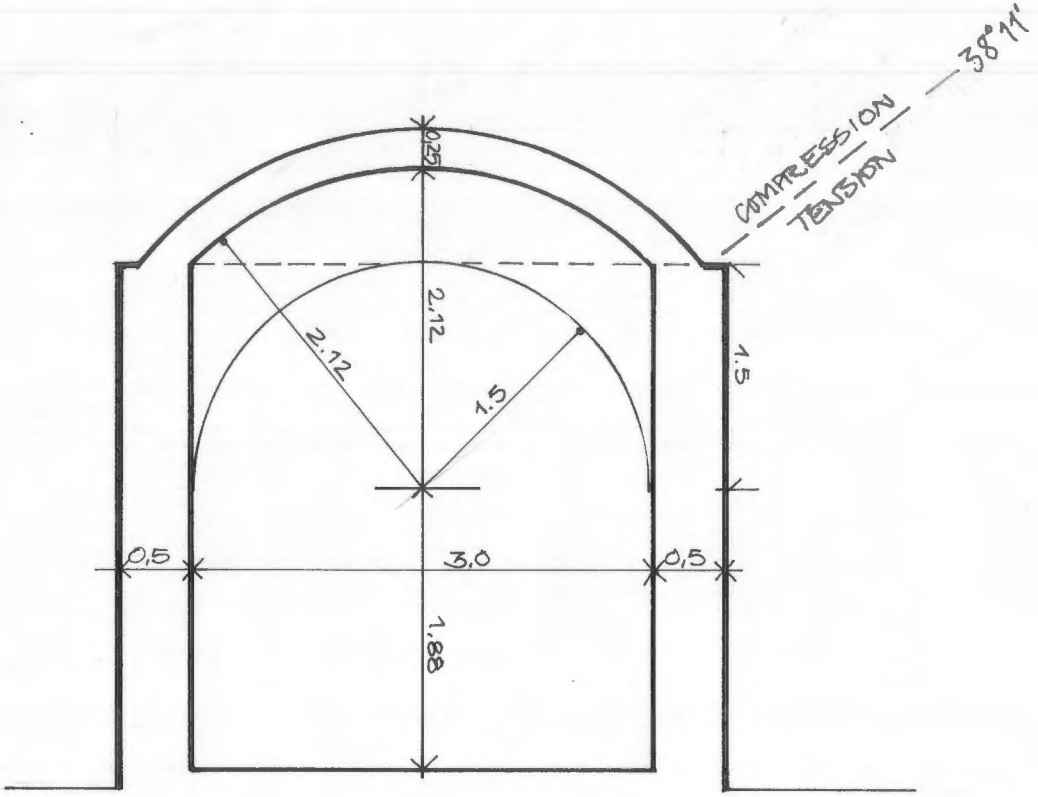


For Catenary the weight per cable unit of horizontal projection is greater towards supports, where cable slope is greater, therefore catenary is lower in this region

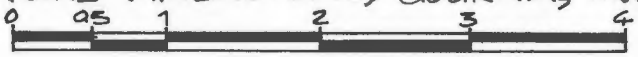
e.g. the curve of a cable or chain due to its own weight only.

For $\tau \leq \frac{3}{10}$ catenary and parabola of equal sag are practically indistinguishable

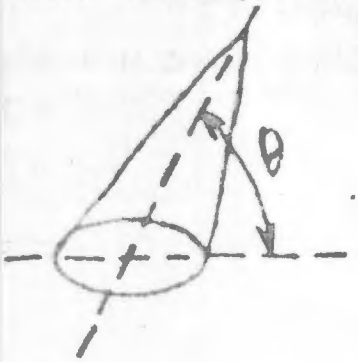
Catenary is approx. $20\tau^2$ per cent longer than equal sag parabola



DOME DIMENSIONS, GOURNA; MUD BRICK



Cône à base circulaire (axe ⊥ à la base)



$S = \pi R \sqrt{R^2 + h^2 (1 + \cot g^2 \theta)}$ = S totale

$V = \frac{1}{3} \pi R^2 h$

Tronc de cône à base circulaire

$A = \pi \left(\frac{R+r}{2} \right) h$ = S Latérale

$S = \pi \left(\frac{R+r}{2} \right) h + R^2 + r^2$ = S Totale

$V = \frac{1}{3} \pi \left(R^2 + r^2 + Rr \right) h$

Sphère

$S = 4 \pi R^2$

$V = \frac{4}{3} \pi R^3$

Secteur sphérique

$S = \frac{\pi R}{2} (4h + 2r)$

$V = \frac{2}{3} \pi R^2 h = 2,0944 R^2 h$

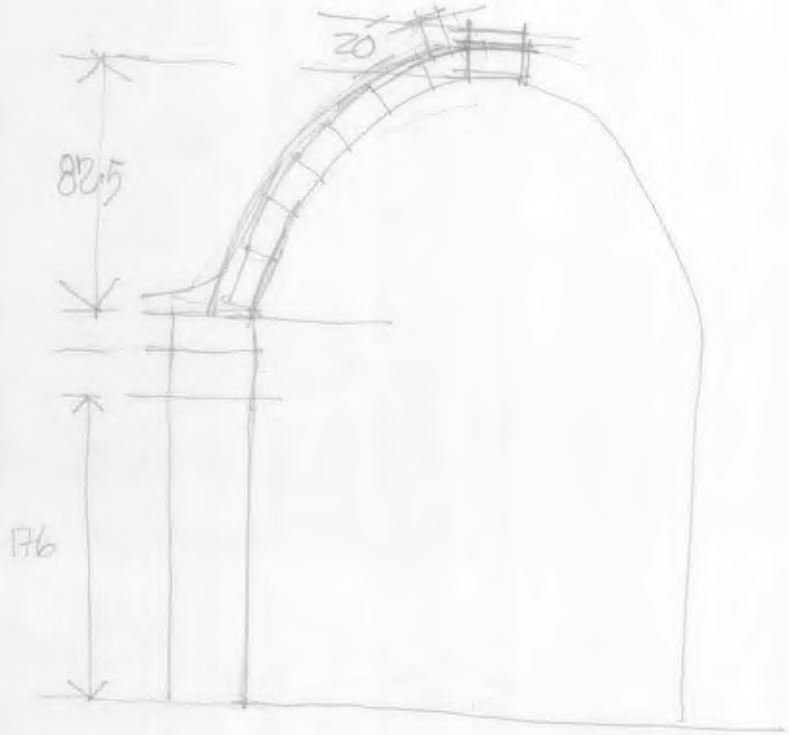
$r = \sqrt{h(2R - h)}$

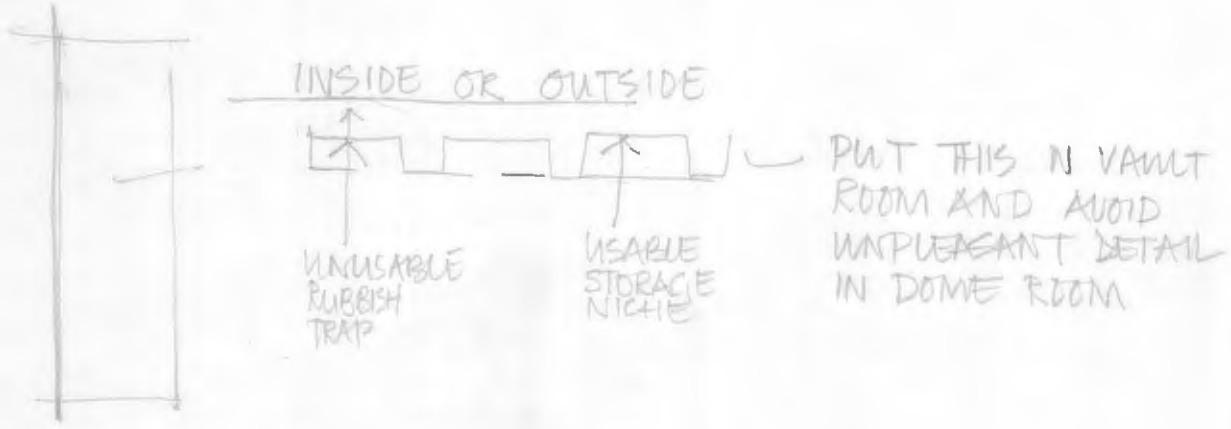
Onglet sphérique

$V = \frac{2}{3} \alpha R^3$ en radians

$= \frac{1}{6} \pi R^3 \frac{N}{90}$ en degrés

length vault
P.3 370
P 10 = 376
P 22 380

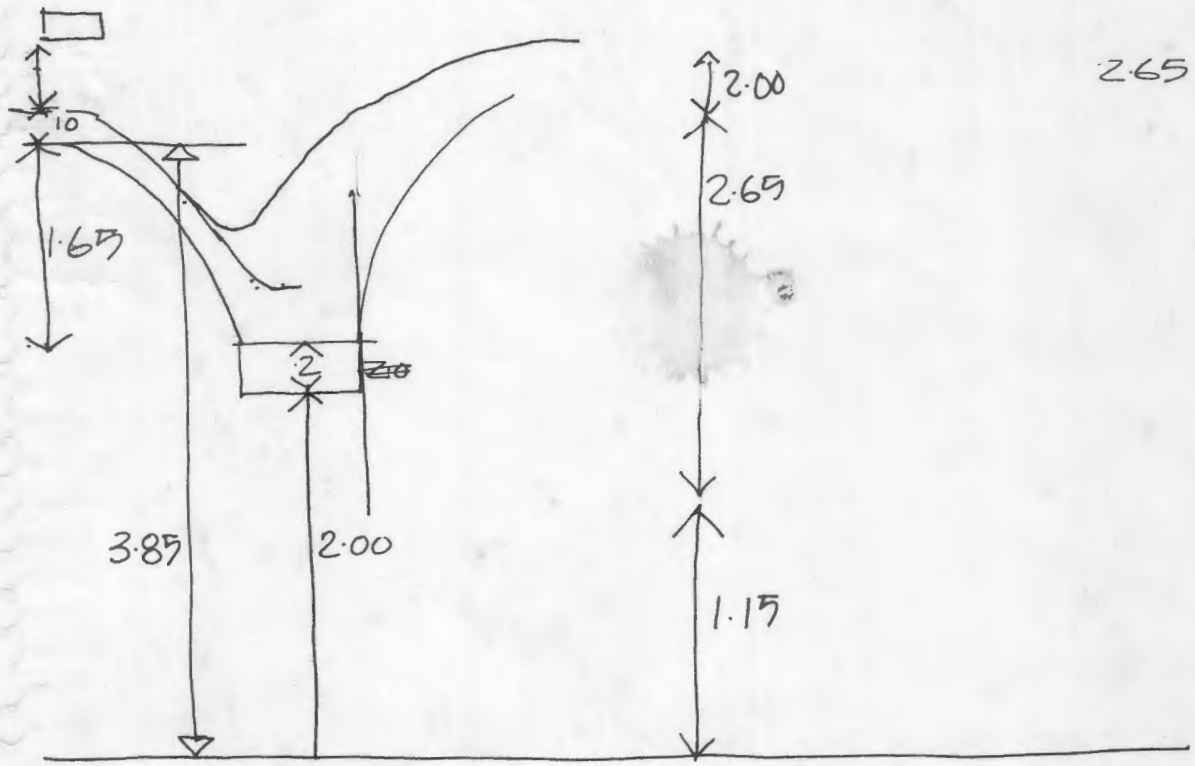




AVOID ~~HAVE~~ AUQUARD DETAIL

REDUCTION OF HEIGHT OF UNITS 1-4 TO SAVE TIME, LABOUR AND MATERIALS.

1) GIVEN RELATIONSHIP BETWEEN vault + dome, in parallel ~~so~~ as it were, much reduction cannot be achieved without complicating needlessly the vault construction. However, the connecting arch way  can be lowered without too much ~~loss~~ effect, as this ~~da can be~~ can come down to 2m top of arch height. Perhaps even 1.95.



3.95

4.00 finish height for vault.

4.00

2.65 + 20 = 2.85

1.15