Appendix D: Structural Analysis of Biodigester Dome

Assumptions

1. Internal gas pressure is low— 0.05-0.10 kg/cm^2— and is ignored.
2. Thickness of dome shell is small in comparison to radius of curvature.
3. Boundary condition of spherical shell is assumed to be flexible.
4. Loads are applied about the polar axis and the shell is assumed to be closed.
5. Combined live, backfill and masonry load is assumed to be 2.500 kg/m^2.

Total load on dome:

1. Average depth of backfill over dome – 1.3m.
2. Surface area of over dome = 4.98m^2.
3. Total load – (1.3m)(5.3m^2)(2,500 kg/m^3) = 17,225 kg, where 5.3 m2 is curved surface of dome.

Critical load on dome[1]

$$P_c = \frac{1}{10} E \left(\frac{h}{R}\right)^2$$

Where:

P_c = Critical load, kg
E = Modulus of elasticity for Malian brick-masonry shell, @ 7.04x10^8 kg/m^2
h = Thickness of shell = 0.06m
R = Radius of curvature, @ 1.5m

$$P_c = \frac{1}{10} * 7.04\text{x}10^8 \frac{kg}{m^2} \left(\frac{0.06m}{1.5m}\right)^2 = 1.13 \ x \ 10^5 \ kg$$

∴ Safety factor is

$$\frac{1.13 \ x \ 10^5 \ kg}{17.225 \ kg} = 6.5$$

---

[1] From Biogas Technology and Utilization, Sichuan Provincial Office of Biogas Development, 1979