

FLEXIBLE CIRCULAR FRAMES SUPPORTED BY A SHELL. MOMENTS IN A FRAME DUE TO CONCENTRATED TANGENTIAL LOADS

1. NOTATION

E	Young's modulus of elasticity for material of frame	N/m ²	lbf/in ²
G	shear modulus for material of shell	N/m ²	lbf/in ²
I	effective moment of inertia of cross section of frame about an axis through its centroid normal to plane of frame and including an allowance for effect of attached skin	m ⁴	in ⁴
L'	effective frame spacing (see Data Sheet 03.06.17)	m	in
M	bending moment in frame at section under consideration, positive if it produces tension on inside of frame	N m	lbf in
R	radius of frame measured to centroid of section	m	in
t	thickness of skin of shell to which frame is attached	m	in
T_a	applied tangential load, positive if tending to rotate frame anti-clockwise	N	lbf
θ	angular displacement of section under consideration from point of application of tangential load, positive if measured clockwise	degree	degree

Both SI and British units are quoted but any coherent system of units may be used.

2. NOTES

In Figure 1 the ratio $M/T_a R$ is plotted against the angle θ for various values of the parameter GtR^4/EIL' . The curves are anti-symmetrical about the $\theta = 180^\circ$ ordinate.

The load T_a is assumed to act in the plane of the frame and to be balanced entirely by tangential shear forces in the shell. These forces arise from the displacement of the frame as a whole in its own plane and from deformation of the frame from its original circular shape. If the frame were not deformed, the displacement alone would give rise to a combined uniform and sinusoidal distribution of shear forces around the frame producing the bending moments given by the curve marked $GtR^4/EIL' = 0$.

3. DERIVATION

1. WIGNOT, J.E. Analysis of circular shell-supported frames. NACA TN 929, 1943.
COMBS, H.
ENSRUD, A.F.

4. EXAMPLE

It is required to find the maximum bending moment in the circular frame described in the example of Data Sheet 03.06.17 when $T_a = 5000$.

From Data Sheet 03.06.17, $GtR^4/EIL' = 8000$.

From Figure 1, at $\theta = 12^\circ$

$$\frac{M}{T_a R} = 0.0069.$$

Hence $M = 0.0069 \times 5000 \times 66 = 2277 \text{ lbf in.}$

Note that there will also be a maximum of $M = -2277 \text{ lbf in}$ at $\theta = 360 - 12 = 348^\circ$.