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MOMENTLESS SHELLS

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Annotation: In this article, we introduce the definition of geometric shells by defining a certain median surface from which segments of the same length are laid on one side and on the other, the ends of which form the outer and inner surfaces of the shell parallel to the median surface.An example is the calculation of momentless shells, i.e. "Soft shells (membranes) of rotation.
Key words: shell,cylinder, conoid, cone,hyperbolic paraboloid, sphere, ellipsoid, orthogonal plane,membrane,meridian.

Geometrically, shells are defined by defining a certain median surface (linear – cylinder, conoid, cone, hyperbolic paraboloid, nonlinear – sphere, ellipsoid, etc.), from which segments of the same length h/ 2 are laid on one side and on the other, the ends of which form the outer and inner surfaces of the shell parallel to the median surface.

The thickness of the shell h is small compared to its other dimensions and the radii of curvature of its median surface. The shell element, cut by four mutually orthogonal planes perpendicular to its median surface, is exposed to the following internal forces:

1)forces tangential to the median surface, and shear forces,

2)bending moments, shearing forces and torques on the side faces.

The forces of the first group are called membrane forces, and the second group is called bending (momentary) forces.

Consider momentless shells:

1.Rotations of the soft (membranes)

Shells in the form of rotating surfaces subjected to axially symmetrical loads are very well calculated according to the membrane theory (with the exception of edges and supports), which takes into account only the forces of the first group.

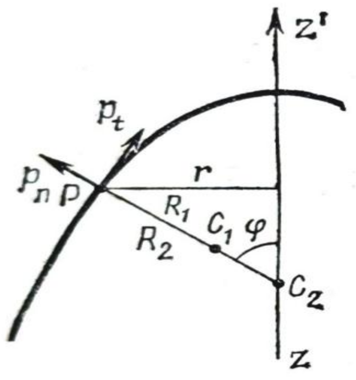

fig -1

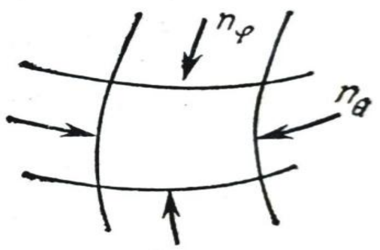

fig-2

Let P be an arbitrary point of the surface of rotation with the zz axis ;
Figure 1. Shows the meridional section of this surface drawn through the point P.

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The radius of curvature of the meridian at point P is denoted by R1, and R2 is the radius of curvature of the line of intersection of the surface with the plane perpendicular to the meridian at point P.

R - is the radius of a small circle or parallel passing through R.

At each point of the parallel, a pressure ρn perpendicular to the surface and a force ρt tangential to the meridian are applied.

The calculations determine the normal forces nQ and n_φ ; due to symmetry, the shear forces are zero.

Let Q be the main vector of the total load applied to the part of the shell above the parallel passing through the point P, then the equation of equilibrium of forces in the vertical projection gives (Fig. 2)

$$2\pi r n_\varphi \sin\varphi + Q = 0 \rightarrow n_\varphi = -\frac{Q}{2\pi R_2 \sin^2\varphi} \quad (1)$$

The equation of equilibrium of forces projected onto the normal to the median surface at point P is written as

$$\frac{n_\varphi}{R_1} + \frac{n_\theta}{R_2} + \rho_n = 0 \quad (2)$$

Which means that

$$n_\theta = \frac{Q}{2\pi R_1 \sin^2\varphi} - \rho_n R_2 \quad (3)$$

In the application, considera:

A spherical dome of radius R under the action of its own weight p , assumed to be constant (per unit surface area) ,

it follows from the formulas obtained that (Fig. 3)

$$n_\varphi = \frac{\rho r}{1+cos\varphi} ; \qquad n_\theta = \rho R \left(cos\varphi - \frac{1}{1+COS\varphi}\right)$$

Power n_φ always compressive n_θ it is compressive when$0 < \varphi < 52$ and stretchable when $\varphi < 52^\circ$

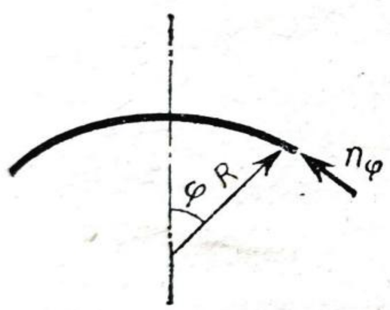

Fig-3

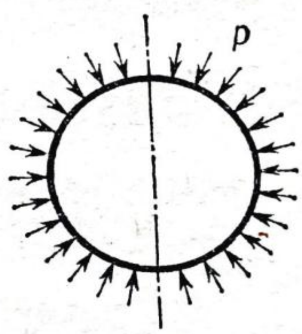

fig- 4

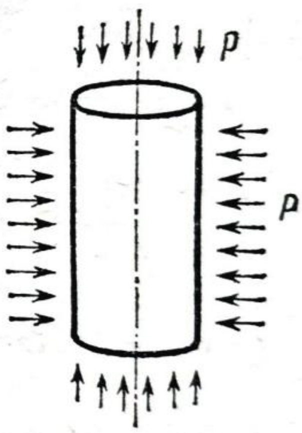

fig-5

b) A spherical shell of radius R loaded with a uniformly distributed external pressure of intensity p (Fig.3.4). In this case

$$n_\varphi = n_\theta = \frac{\rho R}{2}$$

There is always compression. c) A closed cylindrical shell of radius R, loaded with a uniformly distributed external pressure of intensity:

$n_{\varphi} = \frac{\rho R}{2}, \qquad n_{\theta} = \rho R$

-both forces are compressive

The latter formula is the same as the formula for the normal force N in the ring;

$N = \rho R$, where ρ- evenly distributed load on the ring, which is calculated based on the unit length of the ring.

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