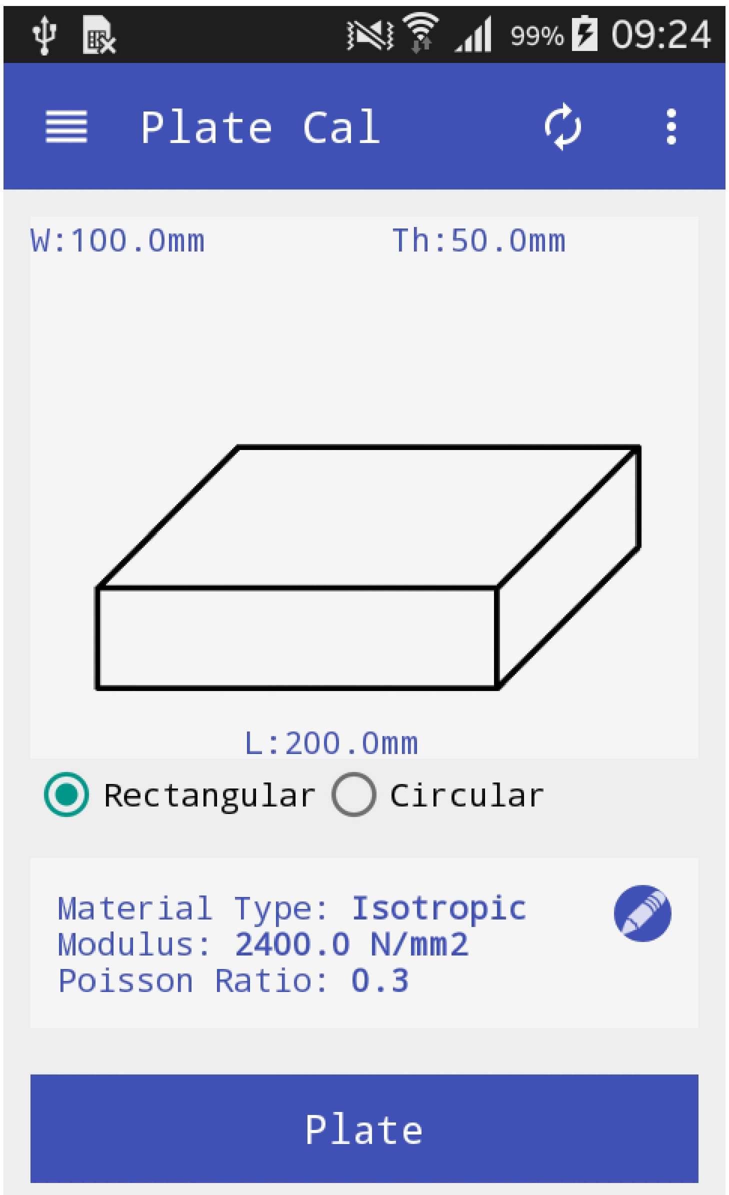
Plate Calculator –Lite

Plate Calculator is used to predict the deflection and stress of plates for various load, boundary and materials. You can use this app for plate design or performance prediction.

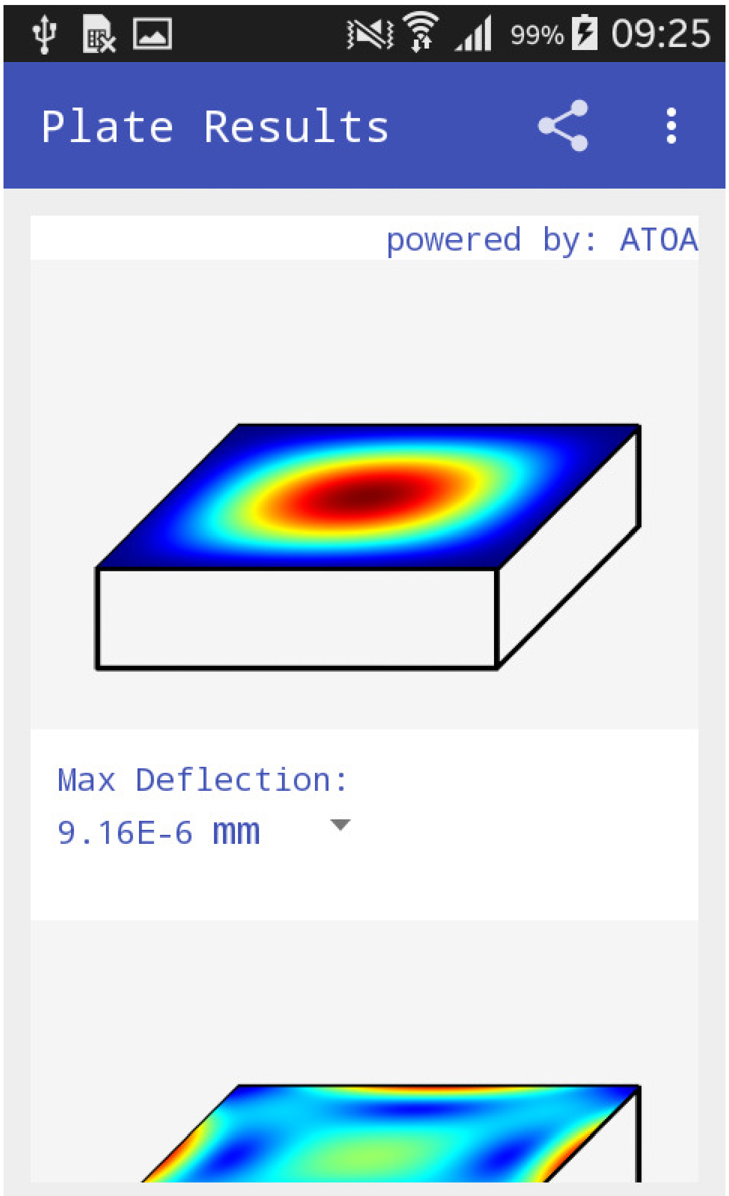
We have Non-Linear analysis with Pro version and many other features .

1) Plate Input for Rectangular



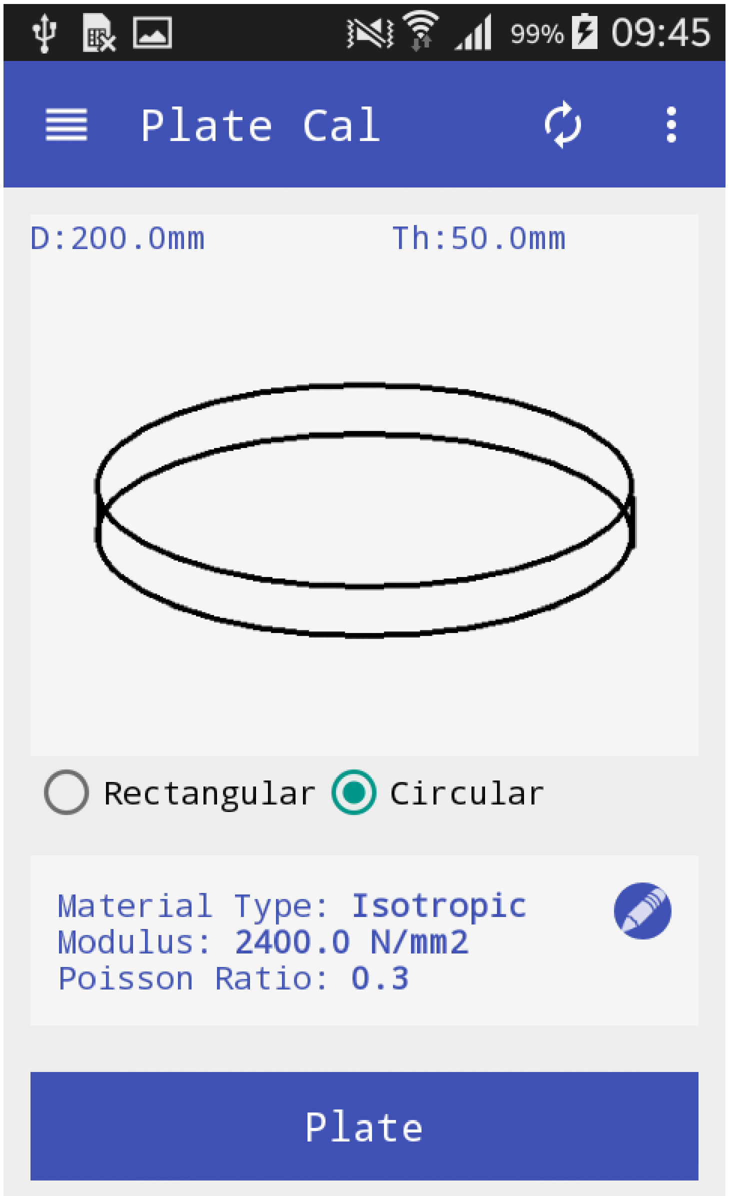
* Select sheet type, Rectangular .

* Enter sheet length, width and Thickness dimensions. The plate graphics will reflect your changes to input.
* Select material type and enter material properties.
* Select Load type and enter loading details.
* Select Boundary conditions type and enter boundary details **(more in Pro)** .
* Select type or analysis Linear v/s Nonlinear **(Pro feature).**
* Click plate to calculate the deflection and stresses.

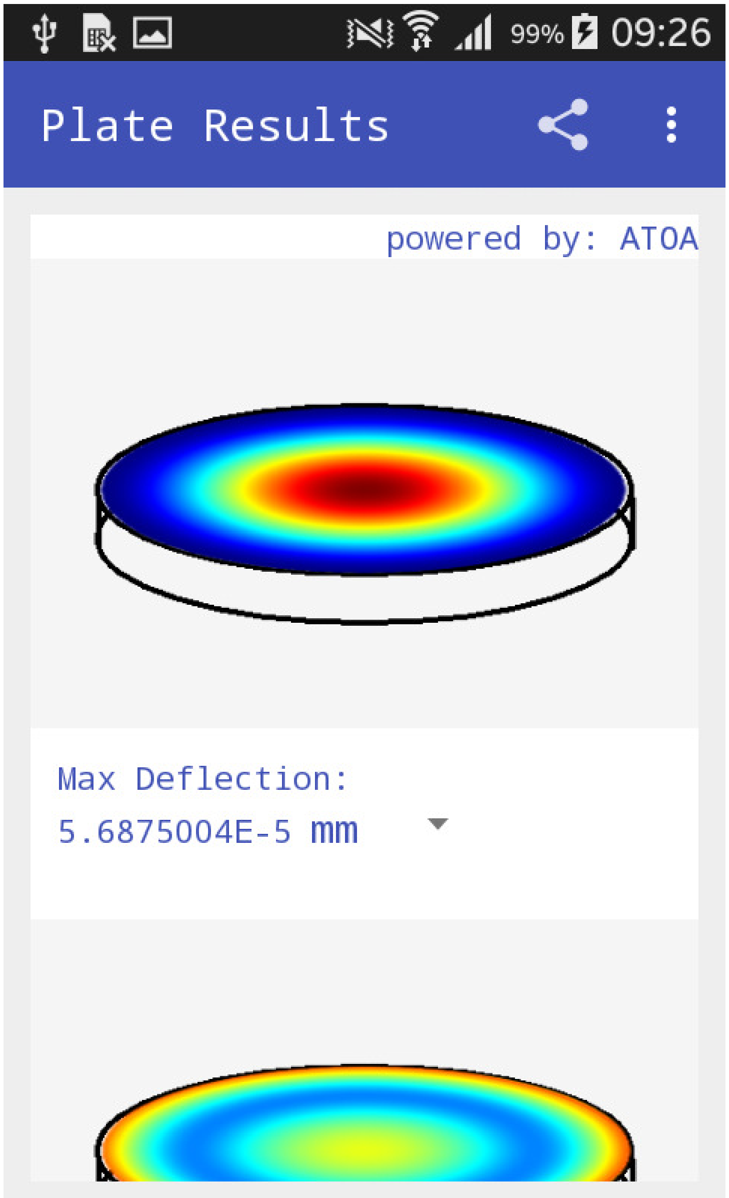


* The results window will display the plate, deflection, stress and along with material, load, and boundary and analysis details.

2) Plate Input for Circular



* Select sheet type, Circular.
* Enter sheet Diameter and Thickness dimensions. The plate graphics will reflect your changes to input.
* Input other properties of circular plate
* Click plate to calculate the deflection and stresses.



* The results window will display the plate, deflection, stress and along with material, load, and boundary and analysis details.

Assumptions:

* The plates are flat with uniform thickness.
* The plate thickness is relatively small compared to length and width.
* The length is greater than width.
* All forces, loading and reactions are acting normal to the plate surface.

Theory

The general governing differential equation for an isotropic plate, relating the load, rigidity and deformation is shown below, and is used for linear isotropic plate performance prediction.

$$\frac{\partial^4 w}{\partial x^4} + 2\frac{\partial^4 w}{\partial x^2 \partial y^2} + \frac{\partial^4 w}{\partial y^4} = \frac{q}{D}$$

Where

$$D = \frac{\mathrm{E\,t}^t}{12\,(1-\upsilon^2)}$$

Where, E is elastic modulus, t thickness and n is Poisson's ratio.

Isotropic plate differential equation including the effect of lateral loads and forces in the middle plane of the plate is shown below for geometrical nonlinear performance prediction.

$$\frac{\partial^4 \mathrm{w}}{\partial \mathrm{x}^4} + 2\frac{\partial^4 \mathrm{w}}{\partial \mathrm{x}^2 \partial \mathrm{y}^2} + \frac{\partial^4 \mathrm{w}}{\partial \mathrm{y}^4}$$

$$=$$

$$\frac{1}{D}\left(q + N_x \frac{\partial^2 \mathrm{w}}{\partial \mathrm{x}^2} + 2N_{xy}\frac{\partial^2 \mathrm{w}}{\partial \mathrm{x}\,\partial \mathrm{y}} + N_y \frac{\partial^2 \mathrm{w}}{\partial \mathrm{y}^2}\right)$$

Where

$$D = \frac{\mathrm{E\,t}^3}{12\,(1-\upsilon^2)}$$

$N_x, N_y, N_{xy} = N_{yx},$

are midplane force components.

This equation includes the effect of stress stiffening and geometric nonlinearity.

Similarly, plate governing equation for orthotropic plates is also considered as follows, and used for orthotropic plate performance prediction. The general differential equation for anisotropic plate,

$$Dx\frac{\partial^4 w}{\partial x^4} + 2H\frac{\partial^4 w}{\partial x^2 \partial y^2} + Dy\frac{\partial^4 w}{\partial y^4} = q$$

$$Dx = \frac{E_x\ t^3}{12\,(1 - \nu_x \nu_y)}$$

$$Dy = \frac{E_y\ t^3}{12\,(1 - \nu_x \nu_y)}$$

$$H = D_x \nu_y + 2D_{xy}$$

The Dx and Dy are anisotropic flexural rigidity. Dxy, is torsion rigidity. Where, Ex, Ey, longitudinal and transverse elastic modulus, t thickness and v is Poisson's ratio.

Analytical solution for the above type of plate governing equations was compiled for various type of plate, boundary, loading conditions and is used for the plate performance prediction. The results predicted by Plate Calculator are also compared with numerical simulations. The analytical results predicted by app matches closely with the industry standard numerical finite element analysis solver results.

References

[1] Timoshenko SP and Woinowsky-Kreieger S 1984, Theory of plate and shells, International Students edition, Mc-Graw Hill, New York, 1984.

[2] Warren C Young and Richard G Budynas, Roarkâ€™s Formulaâ€™s for Stress and Strain, 7th Edition, McGraw-Hill, 2002.

[3] Troitsky MS, Stiffened Plates- Bending, stability and vibrations, Elsevier Scientific Publishing company, Amsterdam 1976.