MINISTERUL EDUCATIEI CERCETARII SI TINERETULUI
UNIVERSITATEA TEHNICA "GH. ASACHI" IASI
FACULTATEA DE CONSTRUCTII

Bd. Prof. dr. Dimitrie Mangeron 43, cod 700050 ,IASI, tel: (0232)278683*, 254638, fax: (0232)233368

TEORY OF ELASTICITY AND PLASTICITY

1. The system of equations $\begin{matrix} \dfrac{\partial \sigma_x}{\partial x} + \dfrac{\partial \tau_{yx}}{\partial y} + X = 0 \\ \dfrac{\partial \tau_{xy}}{\partial x} + \dfrac{\partial \sigma_y}{\partial y} + Y = 0 \end{matrix}$ represents:

a) the static equilibrium equations for an infinitesimal element detached from a body subjected to a plane stress state;
b) the dynamic equilibrium equations for an infinitesimal element detached from a body subjected to a plane stress state;
c) the boundary conditions in plane elasticity;
d) the continuity condition in plane elasticity.

2. The stress tensor at a point of a deformable loaded is:

$$T_\sigma = \begin{bmatrix} \sigma_x & \tau_{yx} & \tau_{zx} \\ \tau_{xy} & \sigma_y & \tau_{zy} \\ \tau_{xz} & \tau_{yz} & \sigma_z \end{bmatrix} = \begin{bmatrix} 20 & 0 & 4 \\ 0 & 10 & 0 \\ 4 & 0 & -12 \end{bmatrix} N/mm^2$$

What is the tensor element that represents a principal stress?

a. 4 N/mm^2 b. 10 N/ mm^2 c. -12 N/ mm^2 d. 20N/ mm^2

3. The system of equations $\begin{matrix} p_x = \sigma_x l + \tau_{yx} m \\ p_y = \tau_{xy} l + \sigma_y m \end{matrix}$ represents:

a) the static equilibrium equations for an infinitesimal element detached from a body subjected to a plane stress state;
b) the dynamic equilibrium equations for an infinitesimal element detached from a body subjected to a plane stress state;
c) the boundary conditions in plane elasticity;
d) the continuity condition in plane elasticity the continuity.

4. The system of equations $\varepsilon_x = \dfrac{\partial u}{\partial x}, \quad \varepsilon_y = \dfrac{\partial v}{\partial y}, \quad \gamma_{xy} = \dfrac{\partial u}{\partial y} + \dfrac{\partial v}{\partial x}$, represents:

a) the constitutive law of the material in plane elasticity;
b) the geometric equations in plane elasticity;
c) the constitutive law of the material in three-dimensional elasticity;
d) the boundary conditions in plane elasticity.

5. The strain tensor at a point of a homogeneous and isotropic body is:

$$T_\varepsilon = \begin{bmatrix} \varepsilon_x & \frac{1}{2}\gamma_{yx} & \frac{1}{2}\gamma_{zx} \\ \frac{1}{2}\gamma_{xy} & \varepsilon_y & \frac{1}{2}\gamma_{zy} \\ \frac{1}{2}\gamma_{xz} & \frac{1}{2}\gamma_{yz} & \varepsilon_z \end{bmatrix} = 10^{-4}\begin{bmatrix} 8 & 3 & 0 \\ 3 & -4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$$

A principal direction of deformation at this point coincides to:

a.	direction of axis Ox	b.	direction of axis Oy	c.	direction of axis Oz	d.	bisector of angle $x\hat{O}y$

6. Condition $\Delta(\sigma_x + \sigma_y) = 0$ represents:

a) a static equilibrium equation in plane elasticity;
b) the continuity condition expressed in terms of stresses, in plane elasticity;
c) the continuity condition expressed in terms of stresses, in three-dimensional elasticity;
d) a boundary condition in plane elasticity.

7. The solution of a plane elasticity problem in terms of stresses, by considering a Cartesian coordinate system, consists in solving the differential equation (notation $\nabla^2\nabla^2 \equiv \Delta\Delta$):

a.	$\nabla^2\nabla^2 w(x,y) = \frac{p(x,y)}{D}$	b.	$\nabla^2\nabla^2 F(r,\vartheta) = 0$	c.	$\frac{d^4 w}{dx^4} = \frac{p(x)}{D}$	d.	$\nabla^2\nabla^2 F(x,y) = 0$

8. The stress function F(x,y) generates the following stresses:

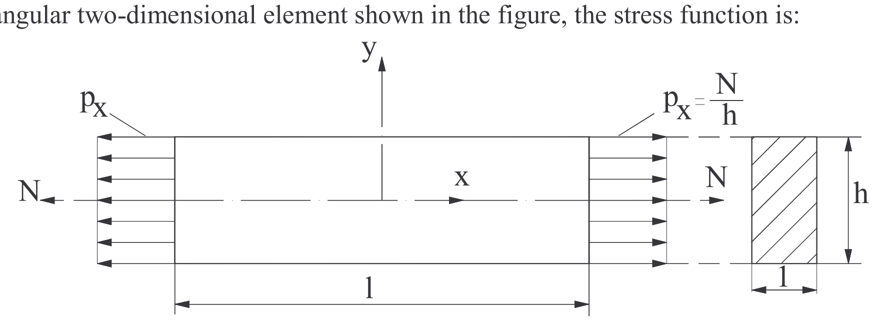
a) $\sigma_x = \frac{\partial^2 F}{\partial x^2}$; $\sigma_y = \frac{\partial^2 F}{\partial y^2}$; $\tau_{xy} = \frac{\partial^2 F}{\partial x \partial y}$;

b) $\sigma_x = \frac{\partial F}{\partial y}$; $\sigma_y = \frac{\partial F}{\partial x}$; $\tau_{xy} = -\frac{\partial^2 F}{\partial x \partial y}$;

c) $\sigma_x = \frac{\partial^2 F}{\partial y^2}$; $\sigma_y = \frac{\partial^2 F}{\partial x^2}$; $\tau_{xy} = -\frac{\partial^2 F}{\partial x \partial y}$;

d) $\sigma_x = \frac{\partial^2 F}{\partial x^2} - X \cdot x$; $\sigma_y = \frac{\partial^2 F}{\partial y^2} - Y \cdot y$; $\tau_{xy} = -\frac{\partial^2 F}{\partial x \partial y}$;

9. For the rectangular two-dimensional element shown in the figure, the stress function is:



a.	$F(x) = p_x \frac{x^2}{2}$	b.	$F(x,y) = p_x xy$;	c.	$F(y) = p_x \frac{y^2}{2}$;	d.	$F(y) = p_x \frac{y^3}{6}$

10. The polynomial corresponding to tension along to orthogonal directions is:

a.	$F(x,y)=\frac{ax^2}{2}+bxy$	b.	$F(x,y)=\frac{ax^3}{6}+\frac{cy^3}{6}$	c.	$F(x,y)=bxy+\frac{cy^2}{6}$	d.	$F(x,y)=\frac{ax^2}{2}+\frac{cy^2}{2}$

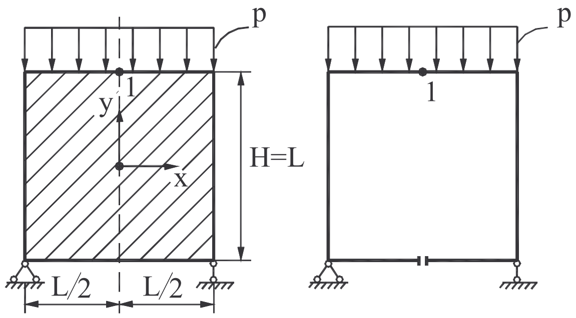
11. The polynomial $F(x,y)=\frac{ay^2}{2}+\frac{dy^3}{6}$ corresponds to:

a.	eccentric tension in y axis direction	b.	eccentric tension in x axis direction	c.	combined shear and bending	d.	tension along two directions

12. The stresses generated by the polynomial $F(x,y)=\frac{ax^2}{2}+bxy+\frac{cy^3}{6}$ have the expressions:

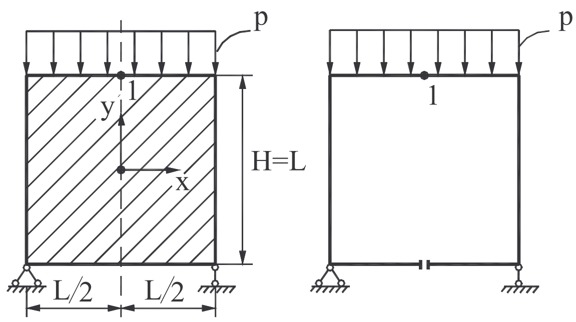
a.	$\sigma_x = cy$; $\sigma_y = a$; $\tau_{xy} = -b$	b.	$\sigma_x = bx + cy$; $\sigma_y = a$; $\tau_{xy} = -b$	c.	$\sigma_x = cy$; $\sigma_y = 0$; $\tau_{xy} = -by$	d.	$\sigma_x = bx + cy$; $\sigma_y = a$; $\tau_{xy} = 0$

13. The stress function at point "1" of the two-dimensional element with unit thickness, shown in the figure, is:



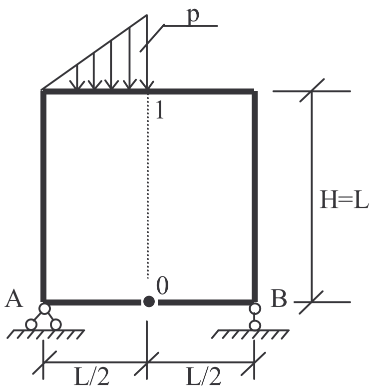
a.	$F_1 = -pL$	b.	$F_1 = \frac{pL^2}{4}$	c.	$F_1 = -\frac{pL^2}{2}$	d.	$F_1 = \frac{pL^2}{8}$

14. The correct values of the stresses σ_y and τ_{xy} at point "1" of the element presented in the figure are:



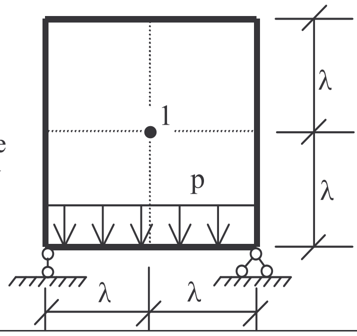
a.	$\sigma_y = p$, $\tau_{xy} = 0$	b.	$\sigma_y = -p$, $\tau_{xy} = p$	c.	$\sigma_y = -p$, $\tau_{xy} = 0$	d.	$\sigma_y = 0$, $\tau_{xy} = 0$

15. The stress function at point "1" of the two-dimensional element shown in the figure (when the origin is located at point O) is:



a. $F_1 = \frac{pL^2}{12}$ b. $F_1 = \frac{pL^2}{24}$ c. $F_1 = -\frac{pL^2}{6}$ d. $F_1 = -\frac{pL^2}{24}$

16. What are the values of the stresses σ_x, σ_y, τ_{xy} at the central point of the deep beam shown in the figure, when their evaluation is performed by using the finite differences method, with the presented grid?



a) $\sigma_x = \frac{1}{8}p, \quad \sigma_y = \frac{1}{3}p, \quad \tau_{xy} = 0$

b) $\sigma_x = -\frac{1}{6}p, \quad \sigma_y = \frac{1}{3}p, \quad \tau_{xy} = 0$

c) $\sigma_x = \frac{1}{2}p, \quad \sigma_y = \frac{1}{4}p, \quad \tau_{xy} = 0$

d) $\sigma_x = \frac{1}{3}p, \quad \sigma_y = \frac{1}{4}p, \quad \tau_{xy} = 0$

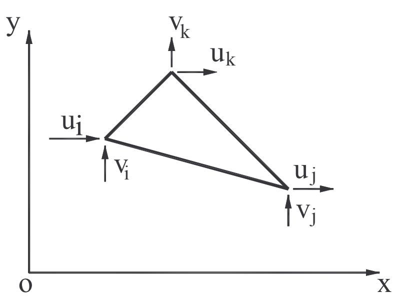
17. Mention the value for the ratio L/H for which a rectangular two-dimensional element, loaded in its middle surface plane, is considered to be a deep beam:

a. $\frac{L}{H} = 10$ b. $\frac{L}{H} < 5$ c. $\frac{L}{H} > 5$ d. $\frac{L}{H} > 10$

18. For the two-dimensional triangular finite element shown in the figure, the displacement field can be expressed as:

$u(x,y) = N_i u_i + N_j u_j + N_k u_k,$
$v(x,y) = N_i v_i + N_j v_j + N_k v_k$

where N_i, N_j, N_k are:

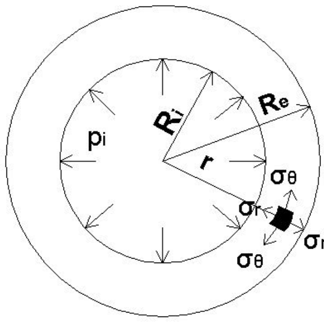


a. stress functions b. axial forces c. Weighting functions d. shape functions

19. The stresses produced by the interior pressure p_i in a cylinder with thick walls are:

$\sigma_r = 2A + \frac{B}{r^2}$; $\sigma_\theta = 2A - \frac{B}{r^2}$;

The constants 2A and B are obtained by using the following boundary conditions:



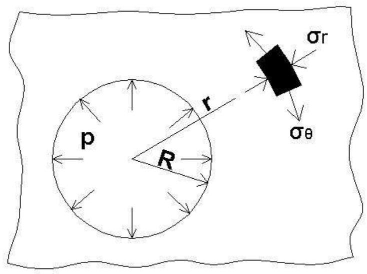
a. $(\sigma_r)_{r=R_i} = p_i$; $(\sigma_r)_{r=R_e} = 0$

b. $(\sigma_r)_{r=R_i} = -p_i$ $(\sigma_\theta)_{r=R_e} = p_i$

c. $(\sigma_\theta)_{r=R_i} = 0$ $(\sigma_r)_{r=R_c} = 0$

d. $(\sigma_r)_{r=R_i} = -p_i$ $(\sigma_r)_{r=R_c} = 0$;

20. The stresses at a point of a infinite plate with a circular hole acted by a constant radial pressure p are:



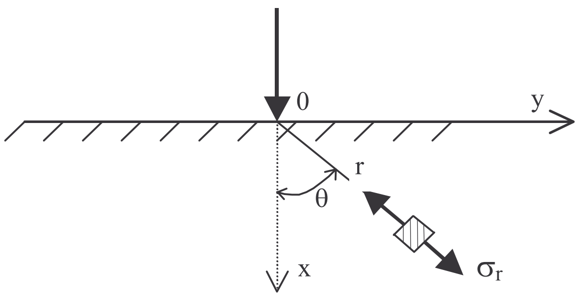
a. $\sigma_r = -p\left(\frac{R}{r}\right)^2$ $(\sigma_\theta) = p\left(\frac{r}{R}\right)^2$

b. $\sigma_r = -p\left(\frac{R}{r}\right)^2$ $(\sigma_\theta) = 0$

c. $\sigma_r = p\left(\frac{R}{r}\right)^2$ $(\sigma_\theta) = 0$

d. $\sigma_r = -\sigma_\theta = -p\left(\frac{R}{r}\right)^2$

21. At a point of an elastic half-plane, loaded by a force that acts normal to the surface, as presented in the figure, the radial stresses are:



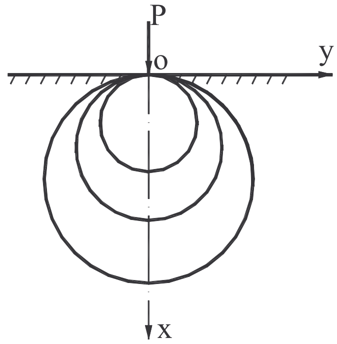
a. $\sigma_r = \frac{2P}{\pi}\frac{\cos\theta}{r}$

b. $\sigma_r = -\frac{2P}{\pi}\frac{\cos\theta}{r}$

c. $\sigma_r = -\frac{3P}{2\pi}\frac{\cos\theta}{r}$

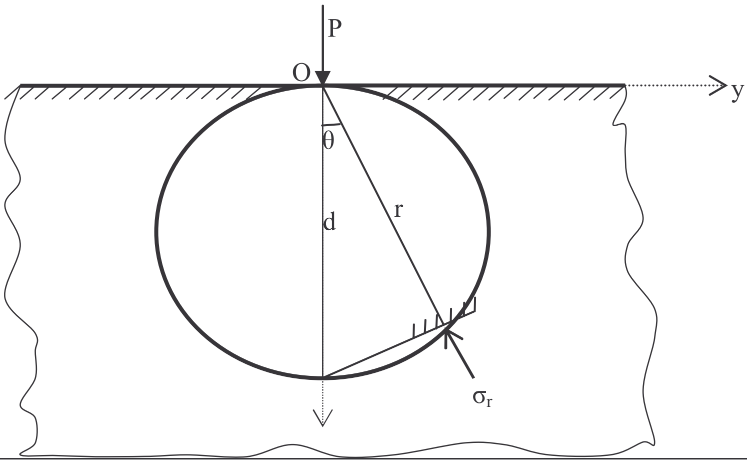
d. $\sigma_r = -\frac{3P}{2\pi}\frac{\cos\theta}{r^2}$

22. For an elastic half-plane, loaded by a force normal to the boundary, as shown in the figure, the circles tangent to the boundary at the origin are called:



a.	isochromatics	b.	isoclines	c.	trajectories of first kind	d.	isobars

23. Knowing $\sigma_r = -\frac{2P}{\pi} \cdot \frac{\cos\theta}{r}$ for a half-plane acted by a force normal to the boundary, mention the values that characterize the isobars:



a.	$-\frac{2P}{\pi r}$	b.	$\frac{2P}{\pi r}$	c.	$-\frac{2P}{\pi d}$	d.	$-\frac{P}{\pi d}$

24. The differential equation of the deformed middle surface in Cartesian coordinates for rectangular plates, acted by normal forces to their middle plane, has the shape:

a) $\frac{\partial^4 F}{\partial x^4} + 2\frac{\partial^4 F}{\partial x^2 \partial y^2} + \frac{\partial^4 F}{\partial y^4} = 0;$

b) $\frac{\partial^4 w}{\partial x^4} + 2\frac{\partial^4 w}{\partial x^2 \partial y^2} + \frac{\partial^4 w}{\partial y^4} = \frac{p(x,y)}{D};$

c) $\frac{d^4 w}{dr^4} + \frac{2}{r}\frac{d^3 w}{dr^3} - \frac{1}{r^2}\frac{d^2 w}{dr^2} + \frac{1}{r^3}\frac{dw}{dr} = \frac{p(r)}{D};$

d) $\frac{d^4 w}{dx^4} = \frac{p(x)}{EI};$

25. The internal forces that occur in rectangular plates, loaded by normal forces to their middle plane, are:

a) the axial forces N_x, N_y ; the shear forces T_x, T_y ;
b) the axial forces N_x, N_y ; the bending moments M_x, M_y ;
c) the bending moments M_x, M_y ; the twisting moment $M_{xy} = M_{yx} = M_t$; the shear forces T_x, T_y;
d) the axial forces N_x, N_y ; the twisting moment $M_{xy} = M_{yx}$;

26. Some of the stresses that occur in a plate subjected to bending have maximum absolute value on the upper surface and the lower surface of the plate. What are these stresses?

a.	$\sigma_x, \tau_{xz}, \tau_{yz};$	b.	$\sigma_y, \tau_{xz}, \tau_{yz};$	c.	$\sigma_x, \sigma_y, \tau_{xy} = \tau_{yx};$	d.	$\tau_{xy}, \tau_{xz}, \tau_{yz};$

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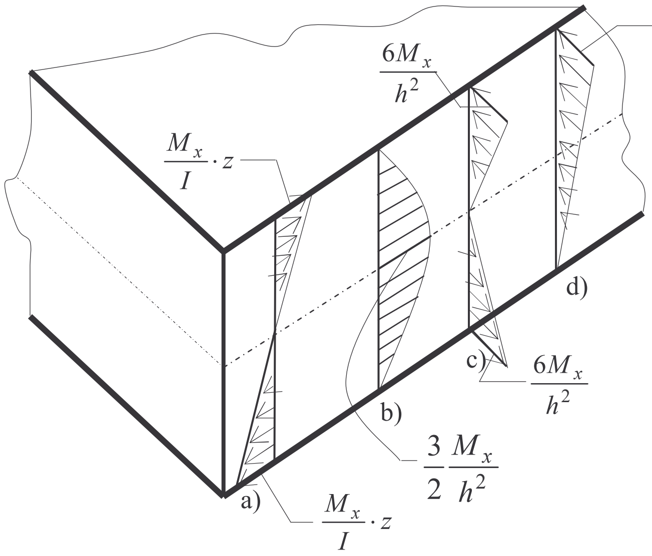
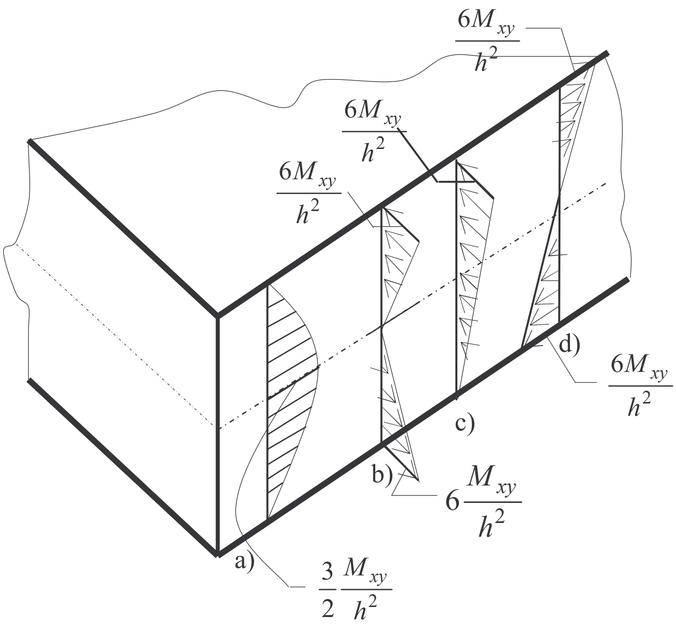
27. For the plates subjected to bending, the distribution of normal stresses σ_x over the thickness and the correct



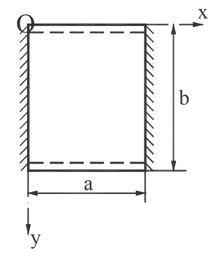
a.	b.	c.	d.

28. What is the distribution of stresses τ_{xy} over the plate thickness?



a.	b.	c.	d.

29. The boundary conditions for the rectangular plate shown in the figure are:



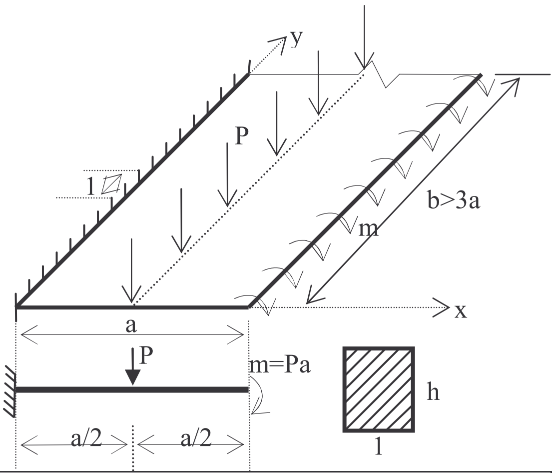
a. on sides x = 0; x = a $\begin{cases} w=0 \\ \dfrac{\partial w}{\partial x}=0 \end{cases}$ on sides y = 0; y = b $\begin{cases} w=0 \\ \dfrac{\partial w}{\partial y}=0 \end{cases}$

b. on sides x = 0; x = a $\begin{cases} w=0 \\ \dfrac{\partial w}{\partial x}=0 \end{cases}$ on sides y = 0; y = b $\begin{cases} w=0 \\ \dfrac{\partial^2 w}{\partial y^2}=0 \end{cases}$

c. on sides x = 0; x = a $\begin{cases} w=0 \\ \dfrac{\partial^2 w}{\partial x^2}=0 \end{cases}$; on sides y = 0; y = b $\begin{cases} w=0 \\ \dfrac{\partial^2 w}{\partial y^2}=0 \end{cases}$

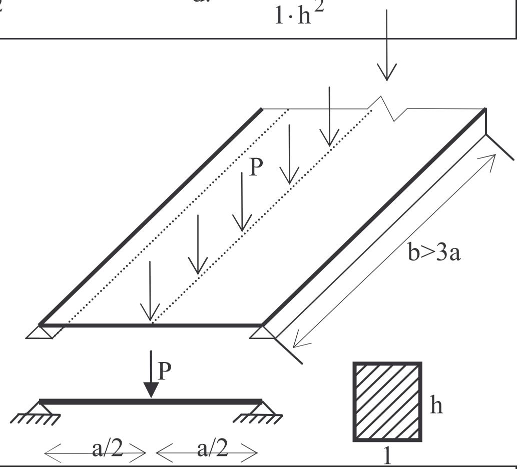
d. On sides x = 0; x = a $\begin{cases} w=0 \\ \dfrac{\partial^2 w}{\partial x^2}=0 \end{cases}$; on sides y = 0; Y = b $\begin{cases} w=0 \\ \dfrac{\partial w}{\partial y}=0 \end{cases}$

30. The extreme normal stresses extreme $\sigma_{x\,\substack{max\\min}}$ for the rectangular plate shown in the figure are:



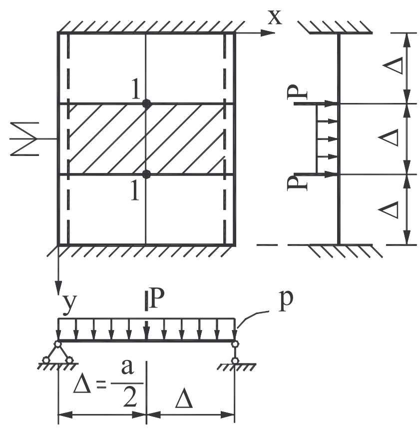
a. $\pm\dfrac{P}{h^2}$ b. $\pm\dfrac{3Pa}{2h^2}$ c. $\pm\dfrac{9Pa}{1\cdot h^2}$ d. $\pm\dfrac{6Pa}{1\cdot h^2}$

31. What is the thickness *h* of the plate presented in the figure and made of a material characterized by the limit normal stress σ_0?



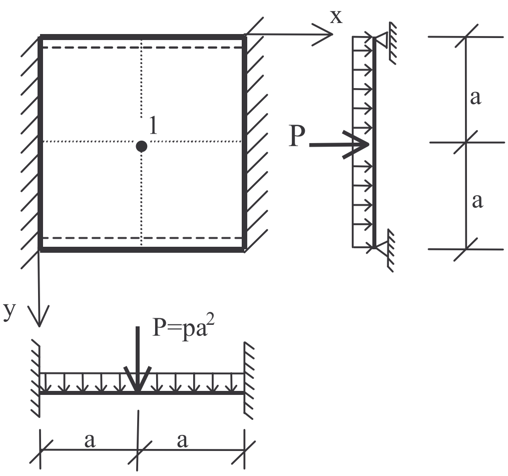
a. $\sqrt{\dfrac{Pa}{\sigma_0}}$ b. $\sqrt{\dfrac{3Pa}{2\sigma_0}}$ c. $\sqrt{\dfrac{6Pa}{\sigma_0}}$ d. $\sqrt{\dfrac{Pa}{2\sigma_0}}$

32. For the plate loaded as shown in the figure, indicate the correct value of the free term p_1, resulted from the transcription into finite differences of equation $\nabla^2\nabla^2 w(x,y)=\frac{p(x,y)}{D}$, at point 1.



a. $p_1 = p + \frac{P}{\Delta^2}$; b. $p_1 = \frac{p}{2} + P$; c. $p_1 = \frac{p}{2} + \frac{P}{\Delta^2}$; d. $p_1 = p + P$;

33. The deflection and bending moments at the central point of the plate presented in the figure, determined by using the finite differences method for the indicated grid, are:



a. $w_1 = \frac{pa^4}{10D}$, $M_{x1} = M_{y1} = \frac{1+\nu}{5} pa^2$

b. $w_1 = \frac{pa^4}{5D}$, $M_{x1} = \frac{1+\nu}{5} pa^2$, $M_{y1} = \frac{1+\nu}{10} pa^2$

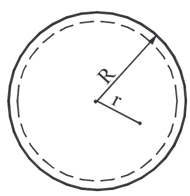
c. $w_1 = \frac{pa^4}{4D}$, $M_{x1} = \frac{pa^2}{5}$, $M_{y1} = \frac{pa^2}{10}$

d. $w_1 = \frac{pa^4}{20D}$, $M_{x1} = \frac{pa^2}{10}$, $M_{y1} = \frac{pa^2}{5}$

34. In the axial-symmetric circular and annular plates, the following internal forces occur:

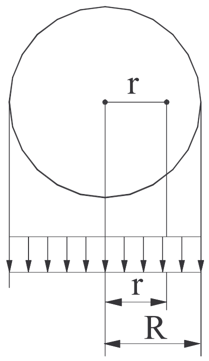
a. M_r, $M_{r\theta} = M_{\theta r}$, T_r; b. M_θ, $M_{r\theta} = M_{\theta r}$, T_θ; c. M_r, M_θ, $M_{r\theta} = M_{\theta r}$ d. M_r, M_θ, T_r;

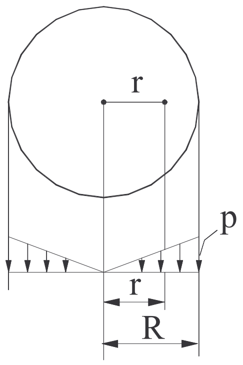
35. For a circular solid plate, the solution of equation $\nabla^2\nabla^2 w(r)=\frac{p(r)}{D}$, has the form: $w = A_1 + B_1 r^2 + w_p$. Mention the boundary conditions corresponding to a plate simply supported along the whole contour, needed to determine the integration constants A_1 and B_1:
For r = R

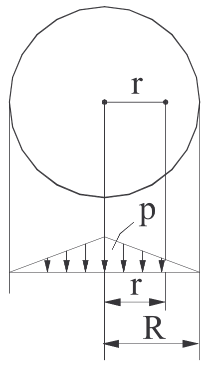


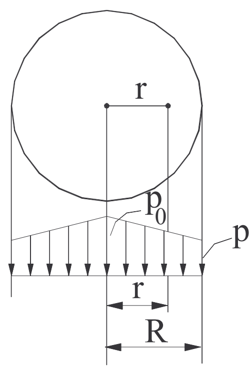
a. $w = 0;\ \frac{dw}{dr} = 0$ b. $w = 0;\ \frac{d^2w}{dr^2} + \frac{\nu}{r}\frac{dw}{dr} = 0$ c. $w = 0;\ \frac{d^2w}{dr^2} = 0$ d. $w = 0;\ \frac{d^2w}{d\theta^2} = 0$

36. Indicate the loading case for the circular plate, knowing that the corresponding particular solution is $w_p = \dfrac{pr^4}{64D}$:

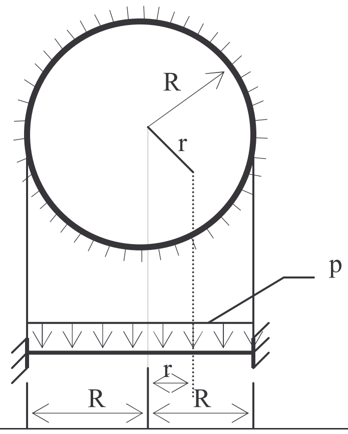
a.


b.


c.


d.


37. The deflection expression for the circular plate presented in the figure is $w(r) = A + Br^2 + \dfrac{pr^4}{64D}$.
The maximum deflection is:



a. $\dfrac{pR^4}{24D}$	b. $\dfrac{pR^2}{32D}$	c. $\dfrac{pR^4}{16D}$	d. $\dfrac{pR^4}{64D}$

38. What is the condition that does not correspond to membrane state for shells?:

a) the shell thickness, constant or slow variable, is small;
b) the shell surface is continuous (without holes or stiffnings etc.);
c) the shell is continuously supported in the tangent plane to the middle surface;
d) the loads (forces or moments) are concentrated and can have any sense.

→

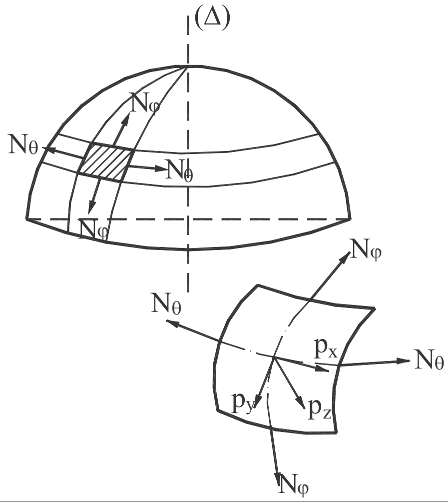
39. For axial-symmetric rotation shells, in the membrane theory, the internal force in the meridian direction, N_φ, at a section defined by the angle φ is expressed by using the relation $N_\varphi = -\dfrac{R_{\Delta\varphi}}{2\pi r \sin\varphi}$, where $R_{\Delta\varphi}$ is:

a) the radius of curvature;
b) the reaction along the boundary;
c) the resultant of the afferent gravitational loads;
d) the resultant of reactions along the boundary.

40. Over the thickness of the shells that work in membrane state, the stresses are:

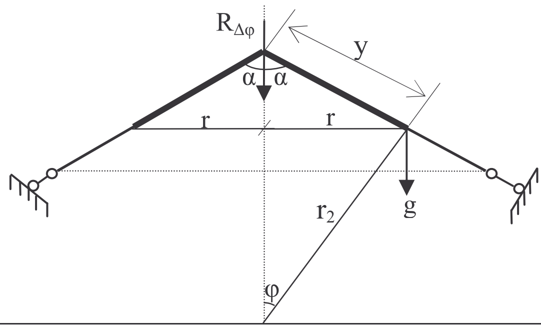
a. zero	b. uniform distributed	c. linear distributed	d. parabolic distributed

41. The circumferential internal force N_θ , in axial-symmetric rotation shells, according to membrane state theory, is obtained from an algebraic equilibrium equation that has the form: (r_1, r_2 – the principal radii of curvature at a point of the surface)



a. $\frac{N_\varphi}{r_1}+\frac{N_\theta}{r_2}+p_x=0$ b. $\frac{N_\varphi}{r_1}+\frac{N_\theta}{r_2}+p_z=0$ c. $\frac{N_\varphi}{r_1}+\frac{N_\theta}{r_2}+p_y=0$ d. $\frac{N_\varphi}{r_2}+\frac{N_\theta}{r_1}+p_z=0$

42. The resultant $R_{\Delta\varphi} = R_{\Delta y}$ of the load given by the own weight (g – the weight per unit surface), at a current section of the conical dome shown in the figure is:

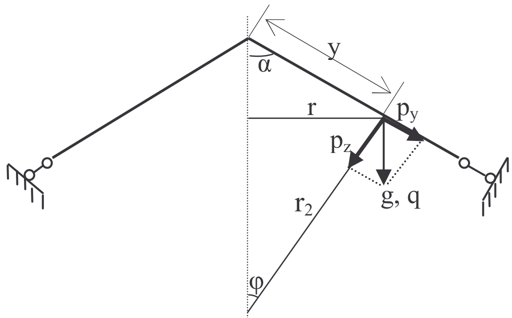


a. $g \cdot \pi r^2$ b. $g \cdot \pi rl$ c. $g \cdot \pi ry$ d. $g \cdot 2\pi ry$

43. The components of the load produced by snow on axial-symmetric rotation shells are:

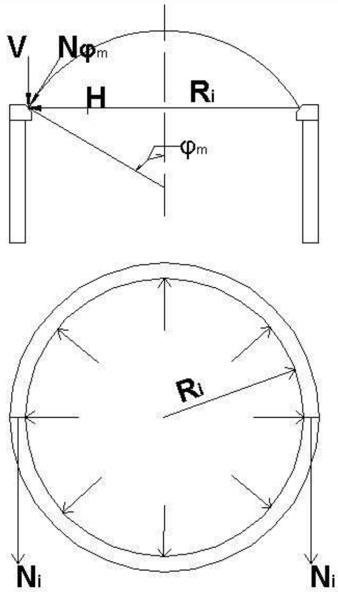
a. $p_x=0$, $p_y=g\cdot\sin\varphi$, $p_z=g\cdot\cos\varphi$ b. $p_x=0$, $p_y=0$, $p_z=\gamma\cdot H_\varphi$ c. $p_x=0$, $p_y=q\cdot\cos\varphi\cdot\sin\varphi$, $p_z=q\cdot\cos^2\varphi$ d. $p_x=0$, $p_y=0$, $p_z=p\cdot\sin\varphi\cdot\cos\theta$.

44. The membrane internal force N_θ, at a current section of the conical dome presented in the figure, is determined from an algebraic equation that has the form:



a. $\frac{N_\varphi}{r_1}+\frac{N_\theta}{r_2}+p_y=0$ b. $\frac{N_\varphi}{r_2}+\frac{N_\theta}{r_1}+p_z=0$ c. $\frac{N_\theta}{r_2}+p_y=0$ d. $\frac{N_\theta}{r_2}+p_z=0$

45. The internal force in the supporting ring of the dome shown in the figure is:

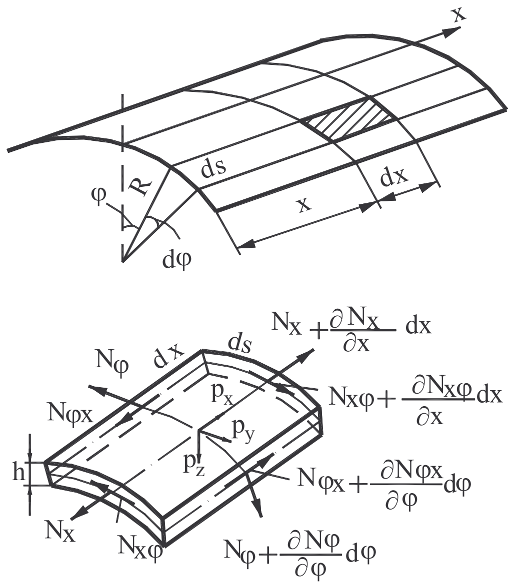


a.	$V \cdot R_i$	b.	$N_{\varphi m} \cdot R_i$	c.	$H \cdot R_i$	d.	$-H \cdot R_i$

46. The equilibrium equations for open cylindrical shells that work in membrane state are:

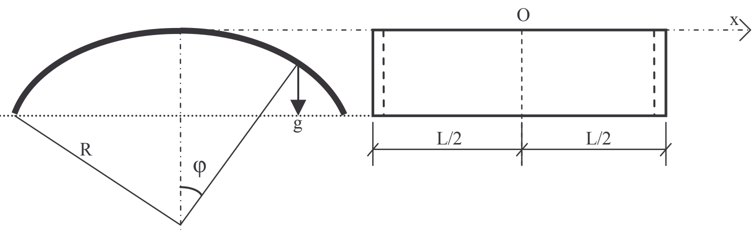
$$\begin{cases} \dfrac{\partial N_x}{\partial x} + \dfrac{1}{R}\dfrac{\partial N_{\varphi x}}{\partial \varphi} + p_x = 0; \\ \dfrac{\partial N_{x\varphi}}{\partial x} + \dfrac{1}{R}\dfrac{\partial N_{\varphi}}{\partial \varphi} + p_y = 0; \\ \dfrac{N_\varphi}{R} + p_z = 0. \end{cases}$$

The internal forces are obtained from this system in the following order:



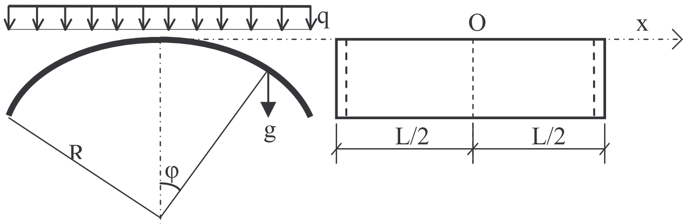
a.	$N_x, N_\varphi, N_{x\varphi}$	b.	$N_x, N_{x\varphi}, N_\varphi$	c.	$N_\varphi, N_{x\varphi}, N_x$	d.	$N_\varphi, N_x, N_{x\varphi}$

47. In the cylindrical shell having one span and one bay, supported on a pediment, the internal force N_φ produced by the own weight has the expression:



a.	$-2gx \cdot \sin\varphi$	b.	$2gR \cdot \cos\varphi$	c.	$-\dfrac{g}{R}\left(\dfrac{L^2}{4} - x^2\right) \cdot \cos\varphi$	d.	$-gR \cdot \cos\varphi$

48. The internal force N_φ, produced by the weight of snow in a cylindrical roof with one span and one bay, supported on a pediment, is determined by using the relation:



a. $-qR\cdot\cos^2\varphi$ b. $qR\cdot\cos\varphi$ c. $-\frac{3}{2}qx\cdot\sin 2\varphi$ d. $-\frac{3}{2}\frac{q}{R}\left(\frac{L^2}{4}-x^2\right)\cdot\cos 2\varphi$

49. The yielding criterion at a point where the stresses σ and τ are known, can be expressed as:

a. $\sigma_1=\sigma_c$ b. $\frac{1}{2}\sqrt{\sigma^2+\tau^2}=\sigma_c$ c. $\sqrt{\sigma^2+4\tau^2}=\sigma_c$ d. $\sqrt{\sigma^2+\tau^2}=\sigma_c$

50. The yielding criterion V*on Mises* for the stress state at a point, expressed by the stresses σ and τ, has the form:

a. $\sqrt{\sigma^2+2{,}6\tau^2}=\sigma_c$ b. $\sqrt{\sigma^2+3\tau^2}=\sigma_c$ c. $\sqrt{\sigma^2+\tau^2}=\sigma_c$ d. $\frac{1}{2}\sqrt{\sigma^2+4\tau^2}=\sigma_c$