TVORBA MECHANICKÉHO MODELU CHRBTICE

MPM seminár

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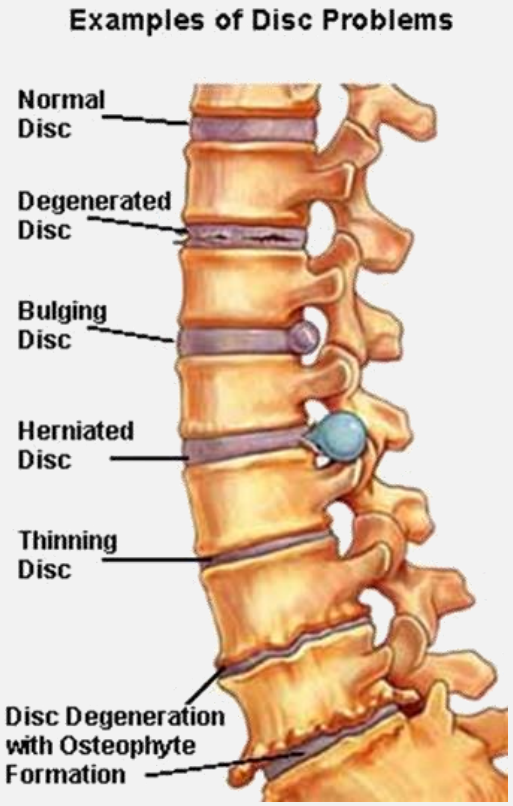
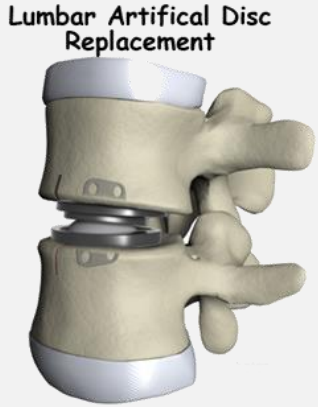
Slovenská technická univerzita

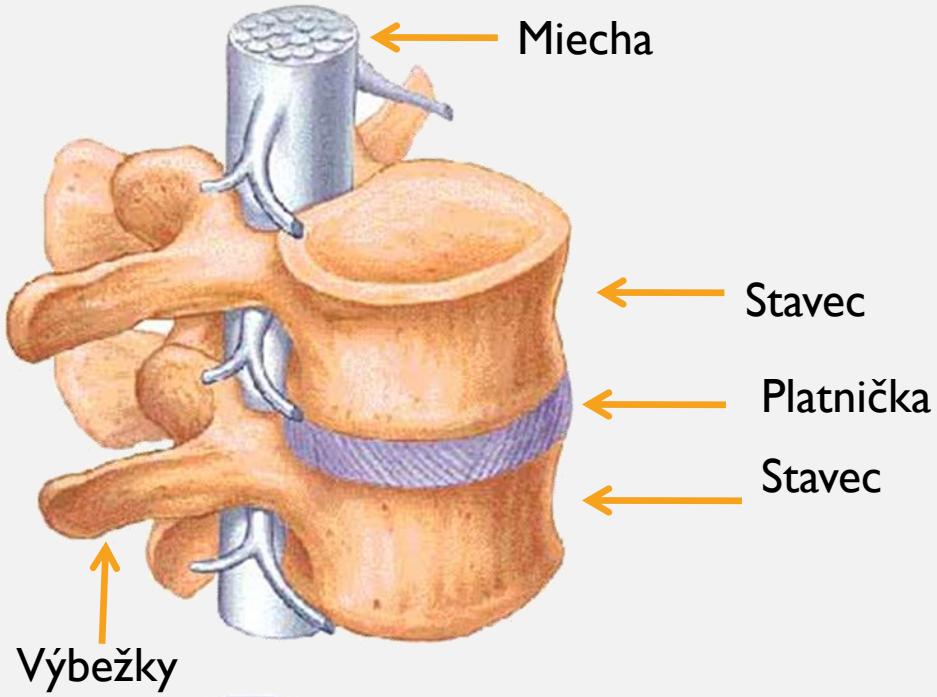
Katedra matematiky a deskriptívnej geometrie

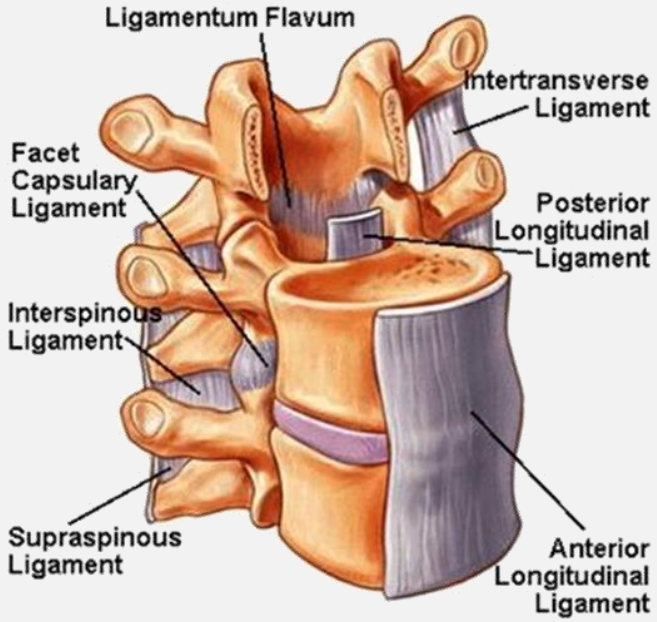
MOTIVÁCIA


Examples of Disc Problems
Normal Disc
Degenerated Disc
Bulging Disc
Herniated Disc
Thinning Disc
Disc Degeneration with Osteophyte Formation

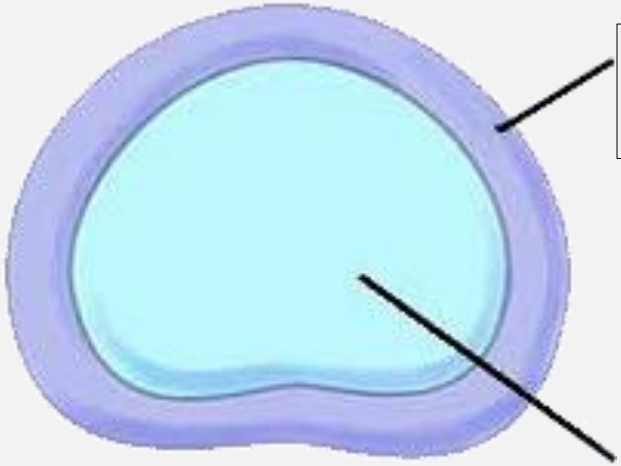

Lumbar Artifical Disc Replacement

ANATÓMIA POHYBOVÉHO SEGMENTU





Väzy

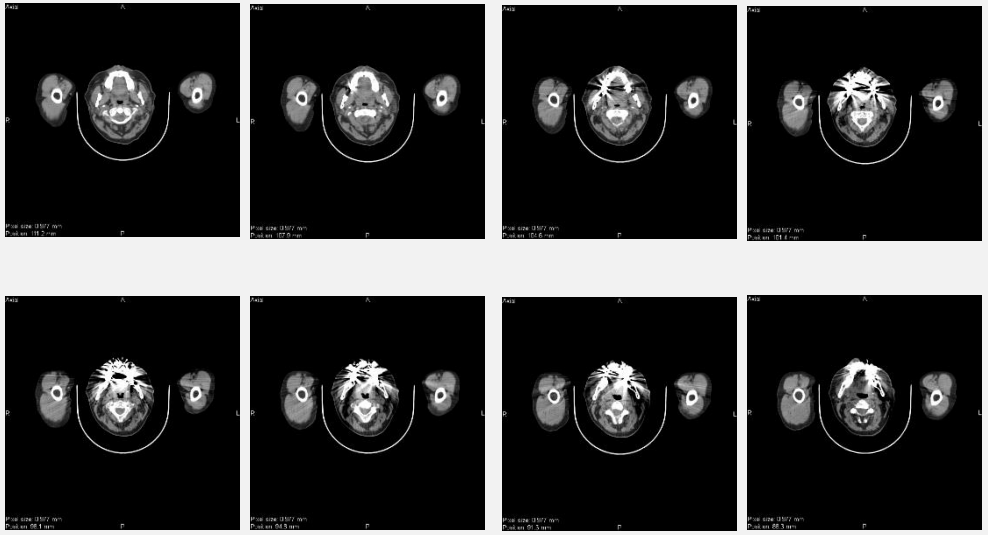


Pružný prstenec

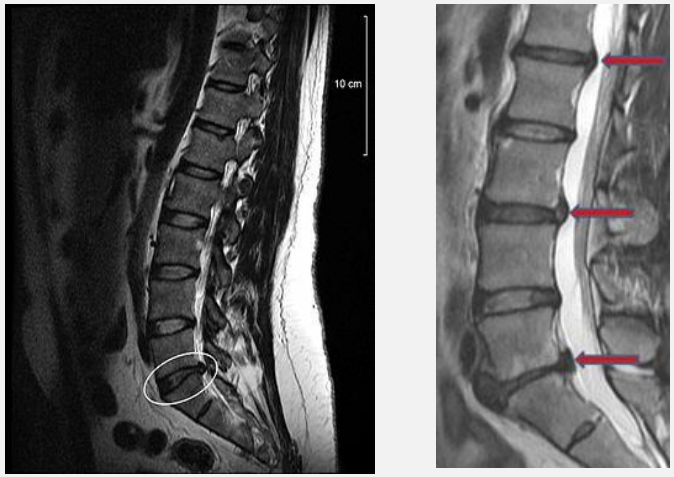
Nestlačiteľné jadro

TVORBA MODELU-GEOMETRICKÉ DÁTA

röntgenové snímky

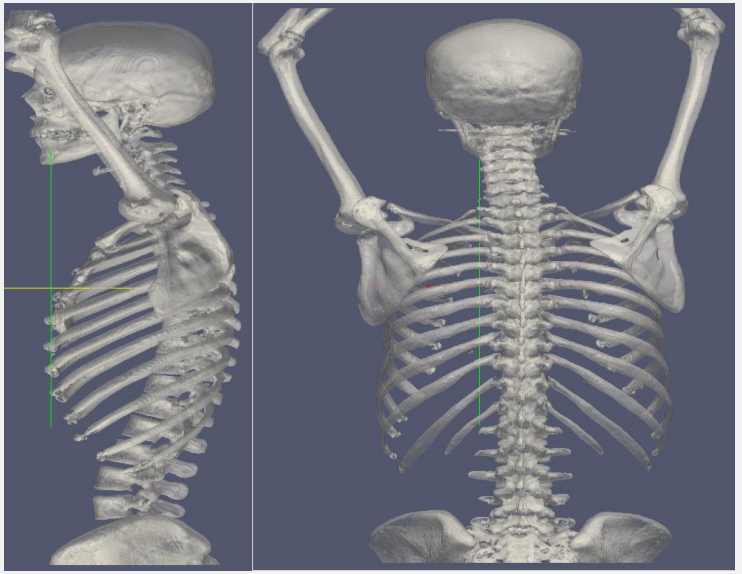


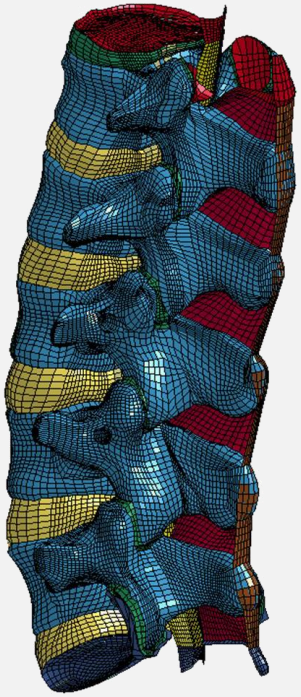
počítačová tomografia



magnetická rezonancia

TVORBA KONEČNOPRVKOVÉHO MODELU CHRBTICE

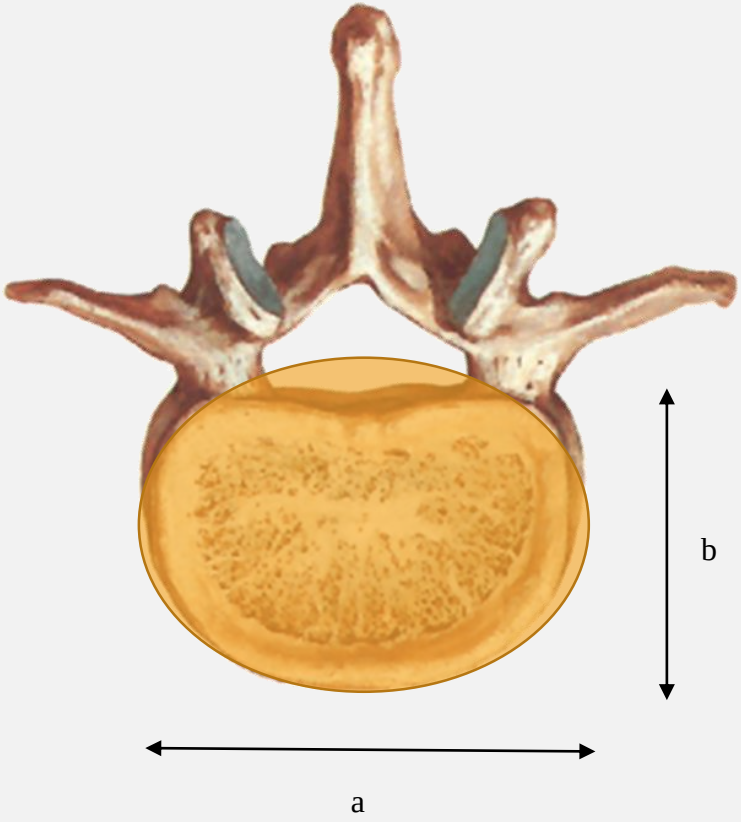


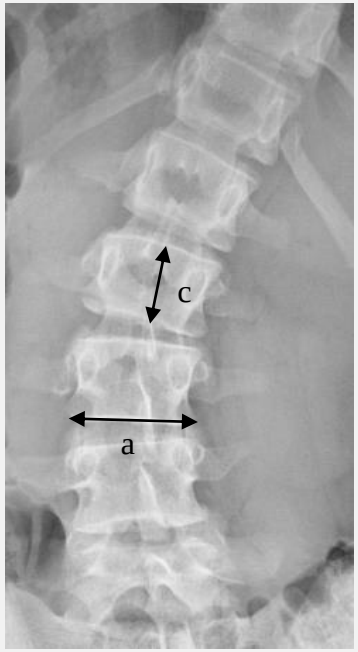


TVORBA KONEČNOPRVKOVÉHO MODELU CHRBTICE

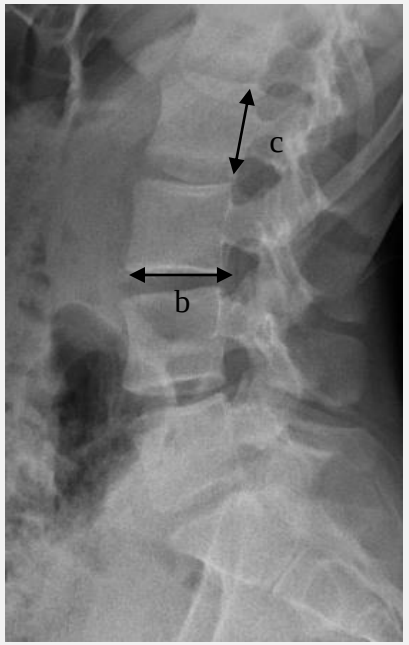
- Tvar podstavy tela stavca môže byť opísaný elipsou

$$\frac{x^2}{(a/2)^2} + \frac{y^2}{(b/2)^2} = 1$$



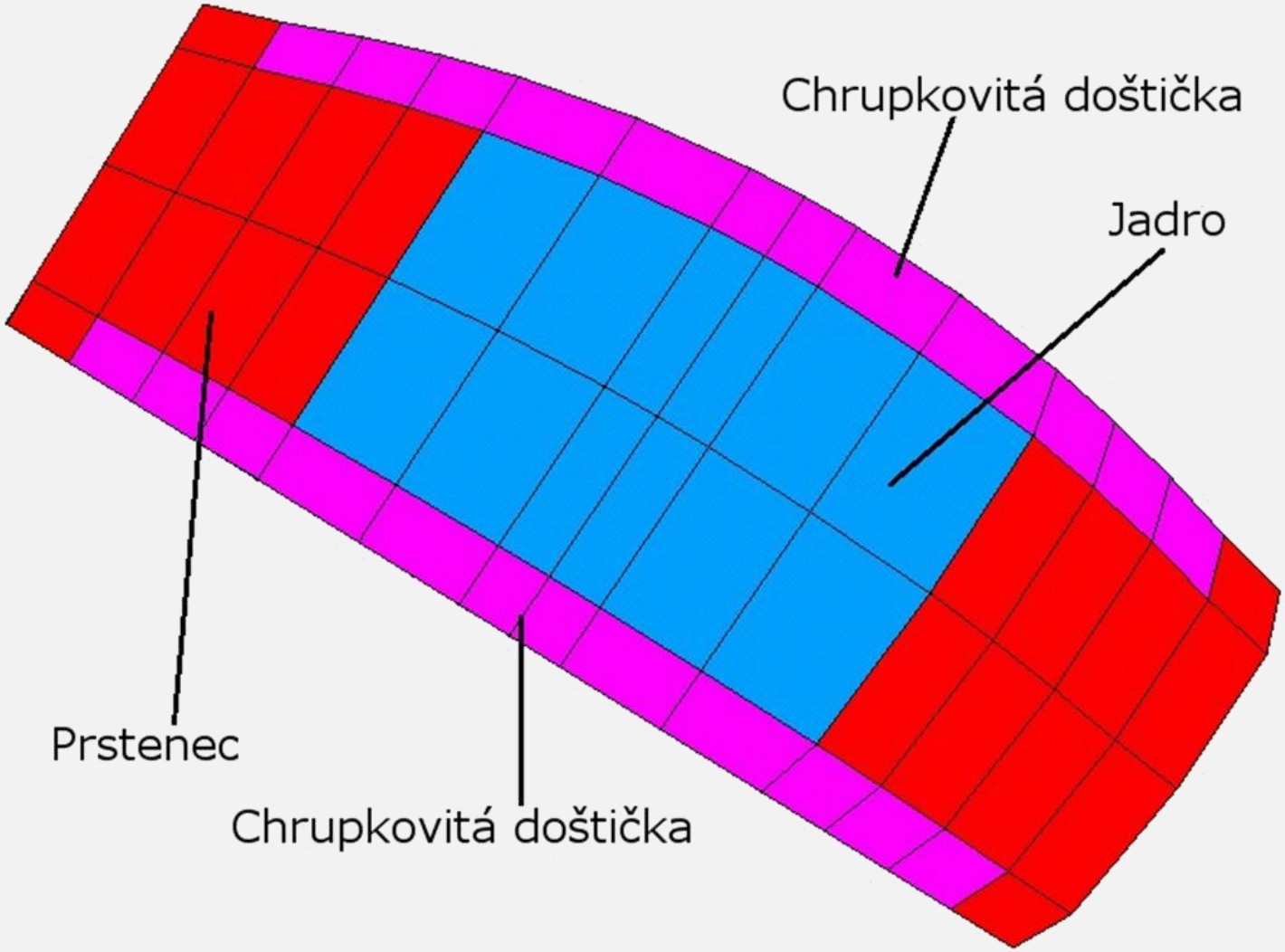


pohľad zozadu

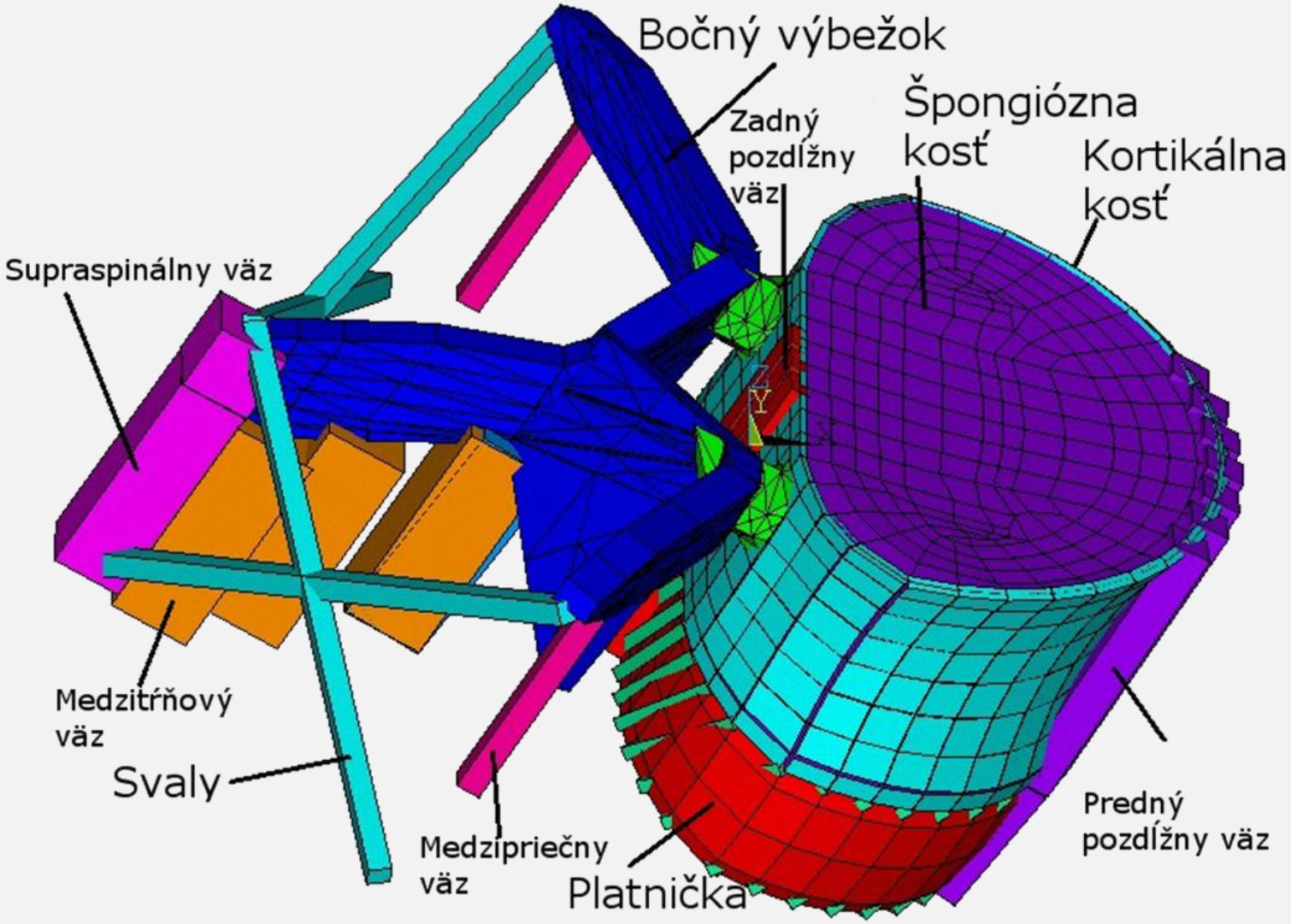


pohľad z boku

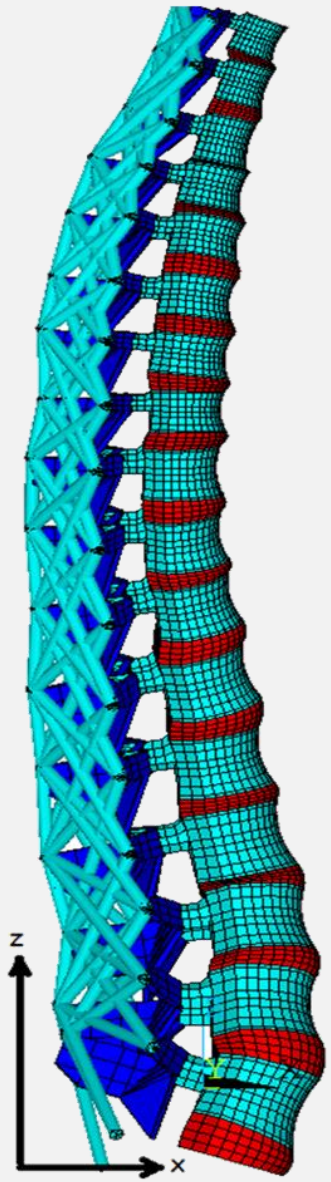
BIOMECHANICKÝ MODEL STAVCA

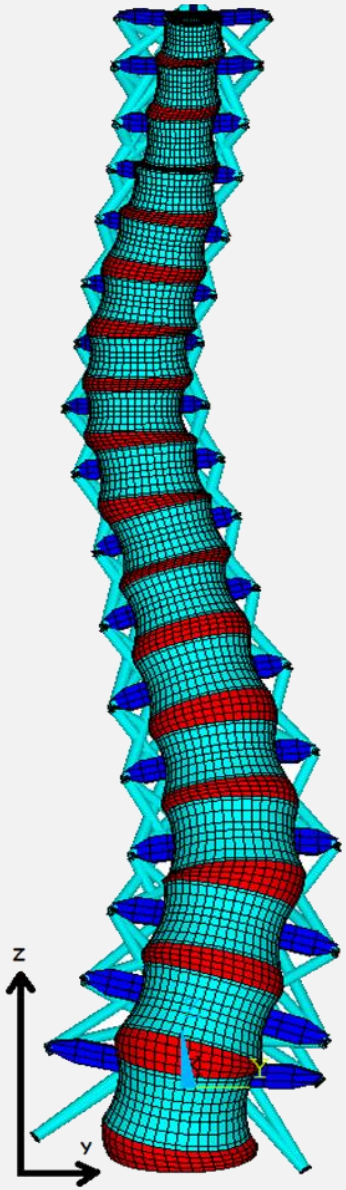


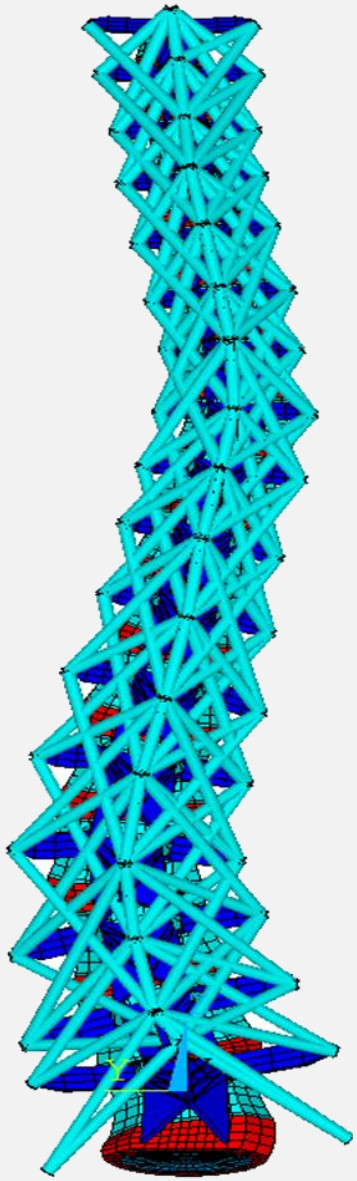
BIOMECHANICKÝ MODEL STAVCA



MODEL CELEJ CHRBTICE

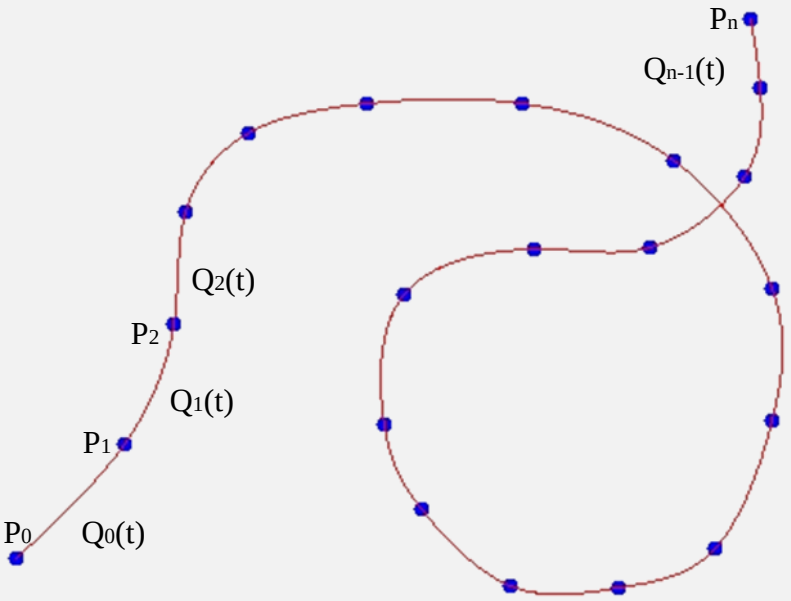




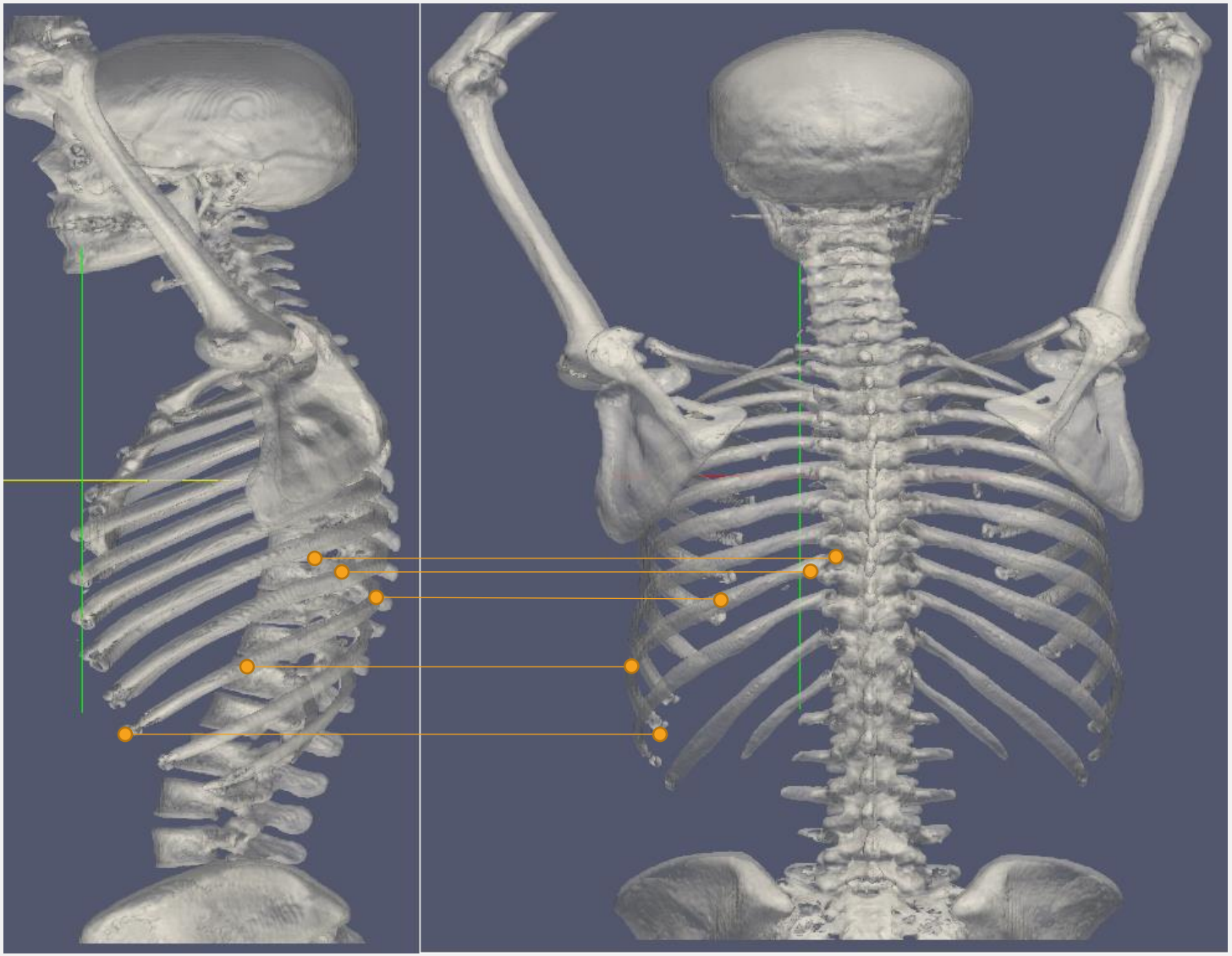


TVORBA MODELU HRUDNÉHO KOŠA

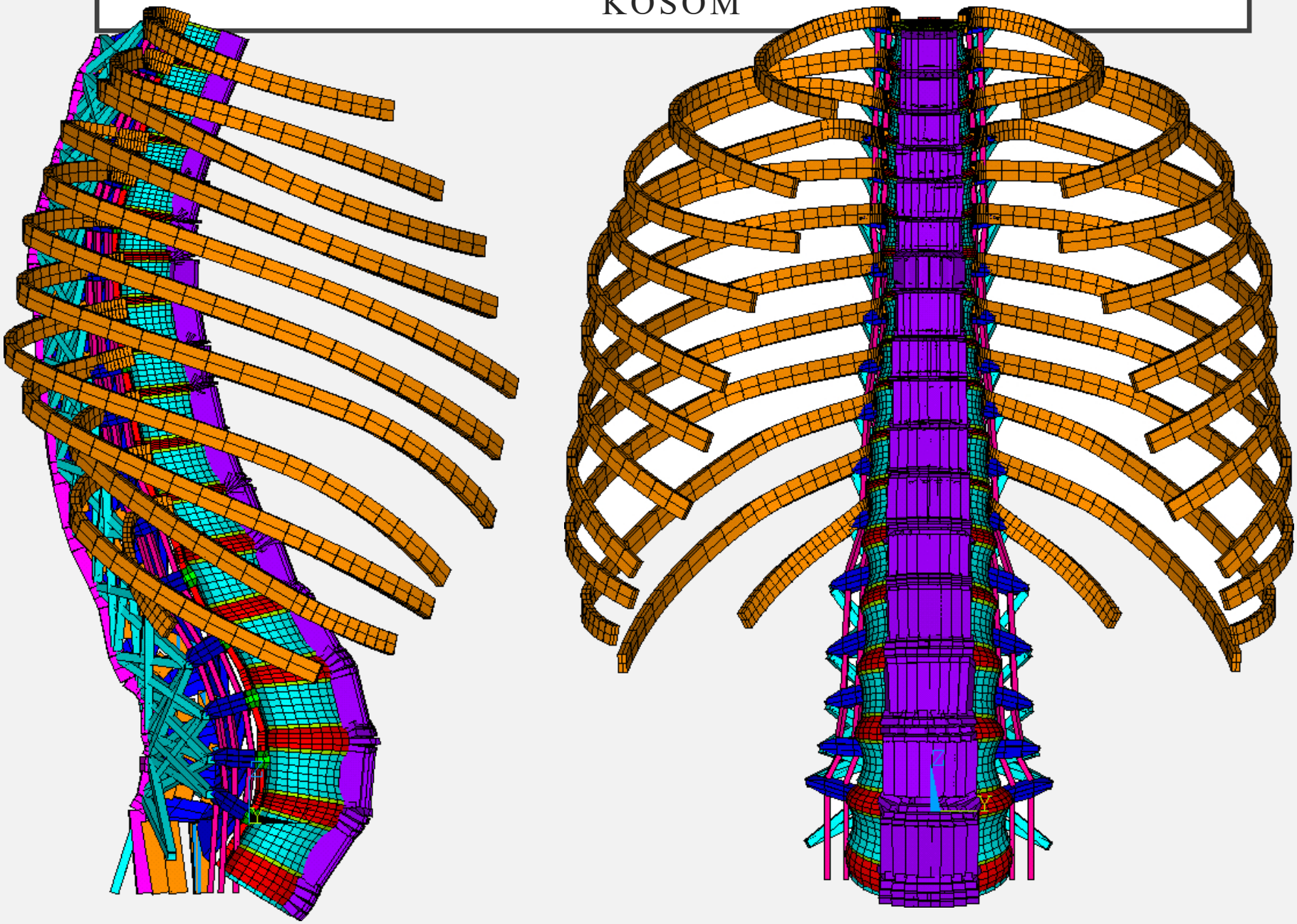
- Prirodzený kubický spline je **interpolačná C^2 spojitá krivka skladajúca sa z úsekov 3. stupňa.**
- Majme dané body $P_0,P_1,...,P_n$. i-ty úsek krivky (i=0...n-1) je daný takto:
  $Q_i(t)=a_it^3+b_it^2+c_it+d_i$
- Chceme, aby krivka prechádzala danými riadiacimi bodmi. Úsek Q_i teda bude začínať v bode P_i a končiť v bode P_{i+1}. Teda:
  $Q_i(0)=d_i=P_i$
  $Q_i(1)=a_i+b_i+c_i+d_i=P_{i+1}$



TVORBA MODELU HRUDNÉHO KOŠA



MECHANICKÝ MODEL CELEJ CHRBTICE S HRUDNÝM KOŠOM



LAMÉHO ROVNICE

$$\mu \Delta v_i + (\lambda + \mu) \frac{\partial}{\partial x_i} div\bar{v} + b_i = 0$$

v – vektor premiestnení

b_i - zložky vektora sily pôsobiacej na jednotku objemu

σ - Poissonovo číslo

E – Youngov modul pružnosti

Lamého konštanty:

$$\mu = \frac{E}{2(1+\sigma)}$$

$$\lambda = \frac{E}{(1+\sigma)(1-2\sigma)}$$

	E [Mpa]	σ
kortikálna kosť	12 000	0.3
spongiózna kosť	10	0.2
Endplate – kosť	12 000	0.3
Endplate - chrupavka	24	0.4
Jadro	1	0.49
prstenec	10	0.4

OKRAJOVÉ PODMIENKY

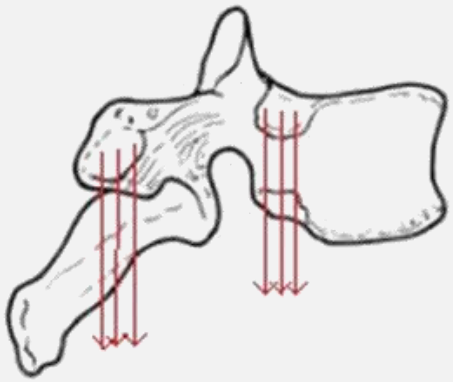
Rovnomerné zaťaženie:

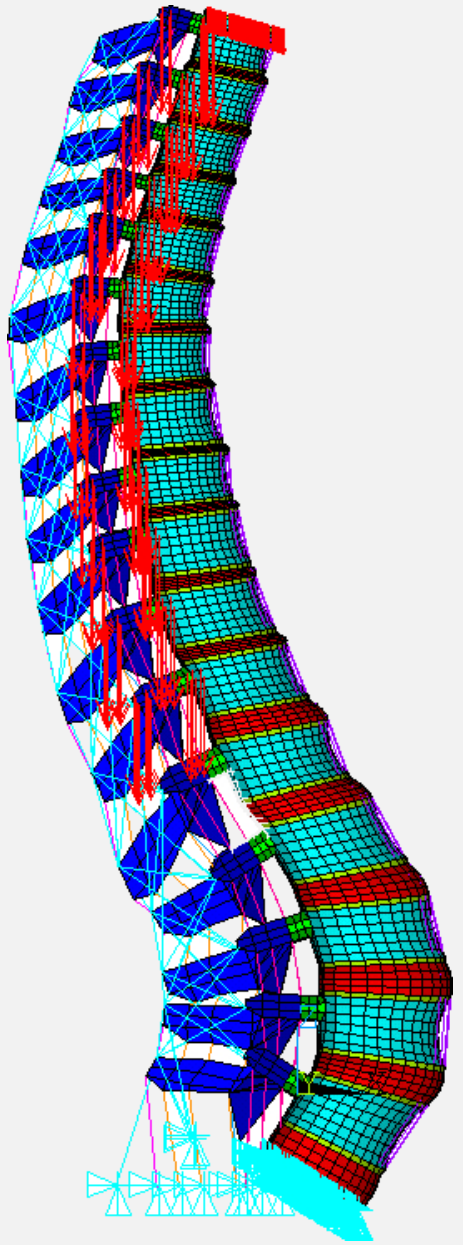
- Sedenie alebo státie vzpriamene

Okrajové podmienky:

$v_x(x,y,z) = 0$
$v_y(x,y,z) = 0$ } $z = 0$
$v_z(x,y,z) = 0$

p=F/plocha (horná podstava stavca)

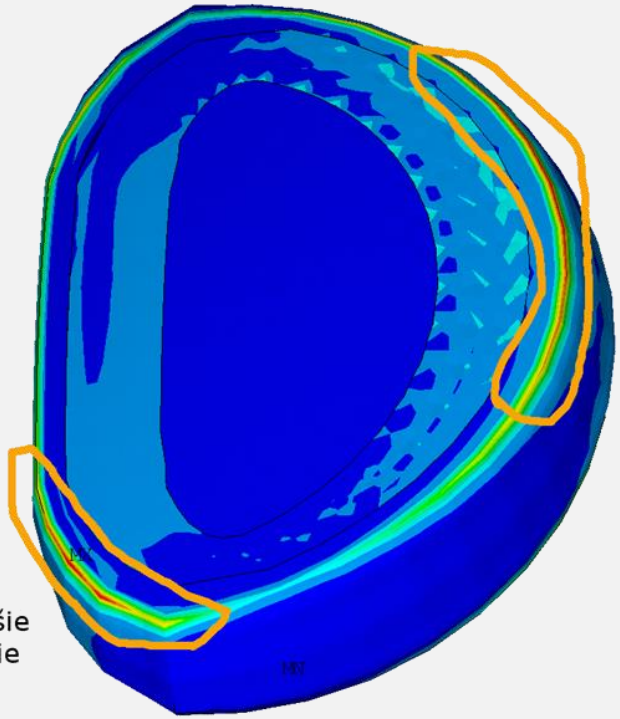


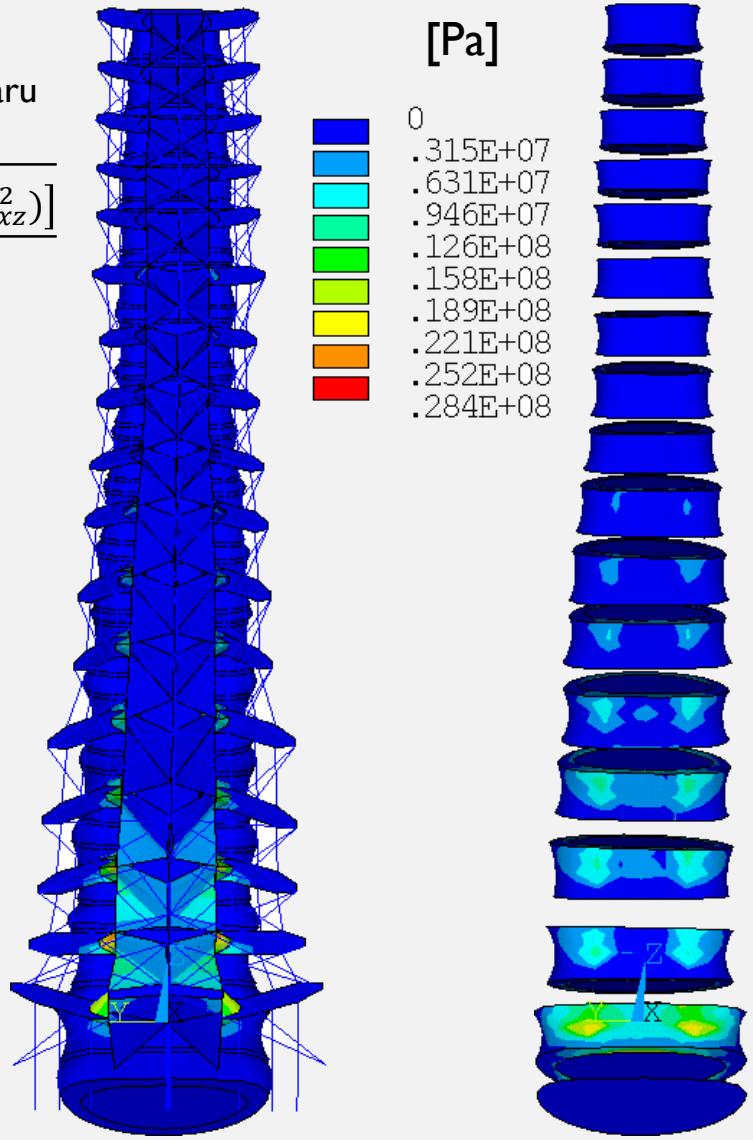


- Napätia

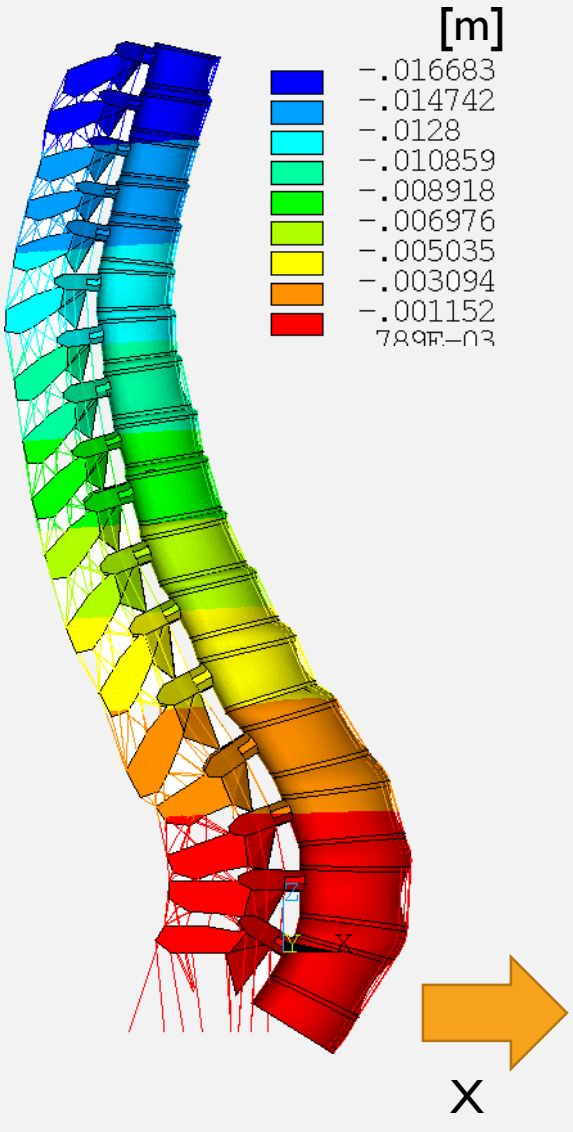
- Vnútorné sily generujú mechanické napätie.
- **von Missesove napätia** – napätia potrebné na zmenu tvaru

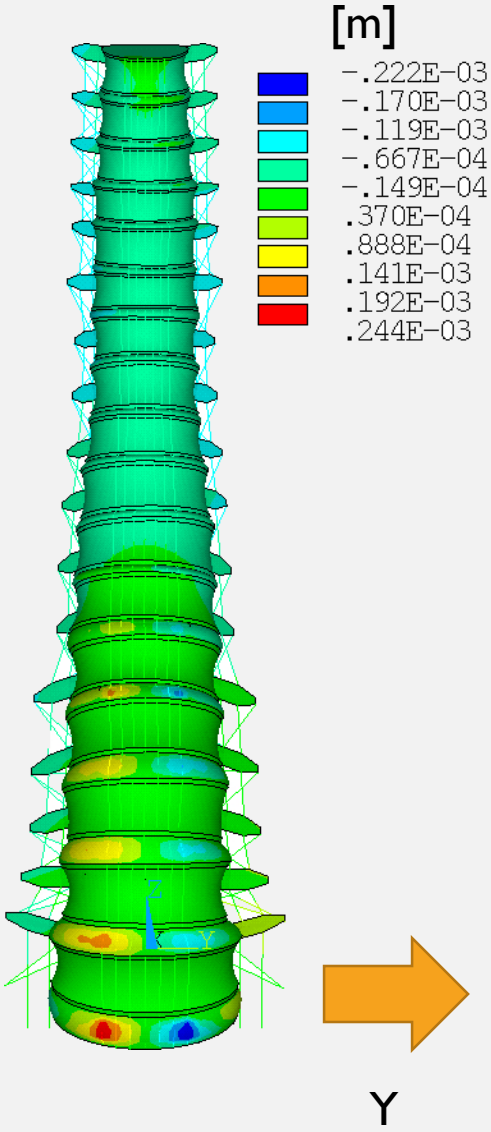
$$\sigma_{eqv} = \sqrt{\frac{\left[(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2 + 6(\tau_{xy}^2 + \tau_{yz}^2 + \tau_{xz}^2)\right]}{2}}$$

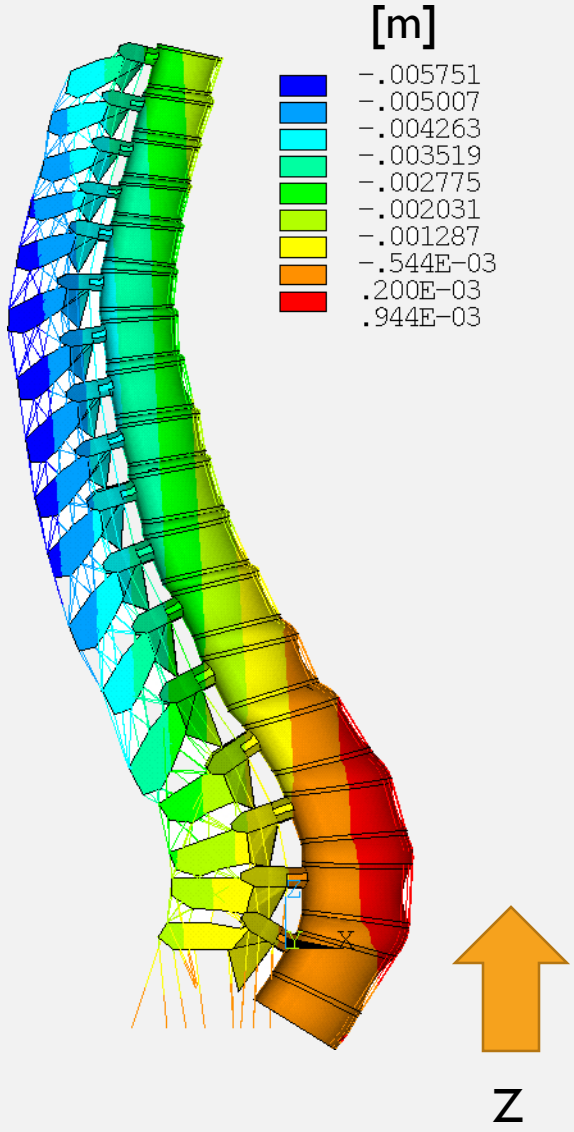




- Premiestnenia







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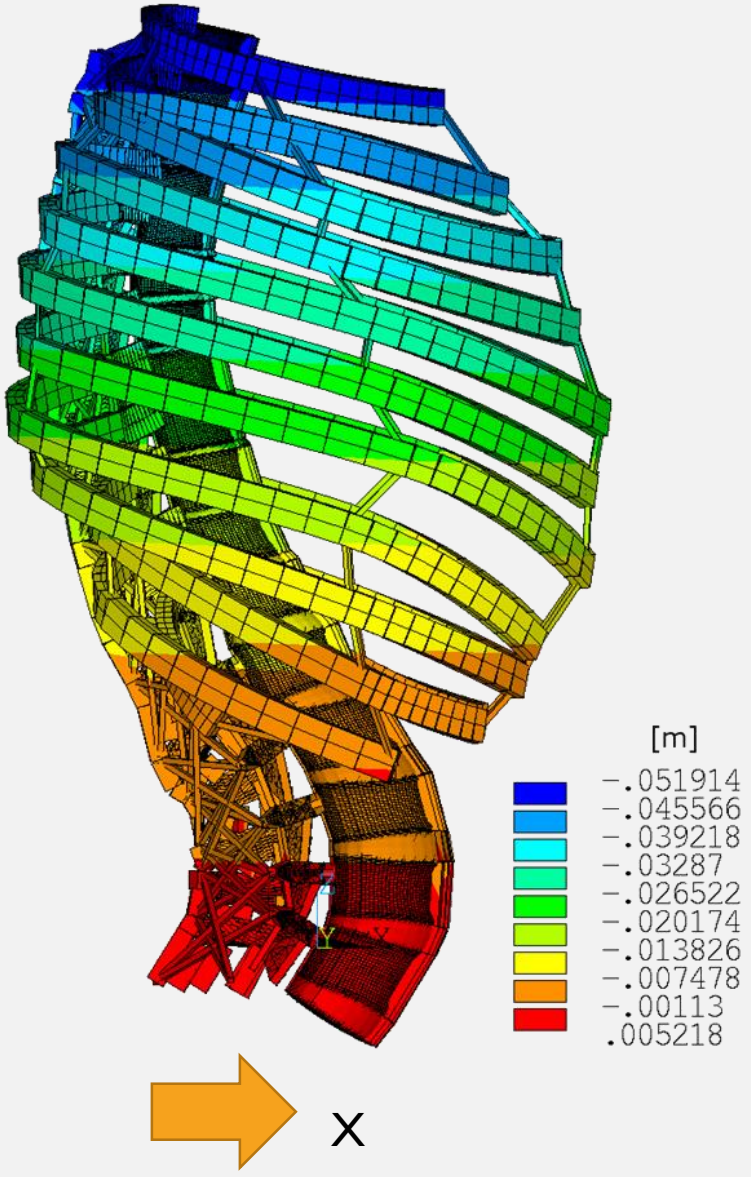

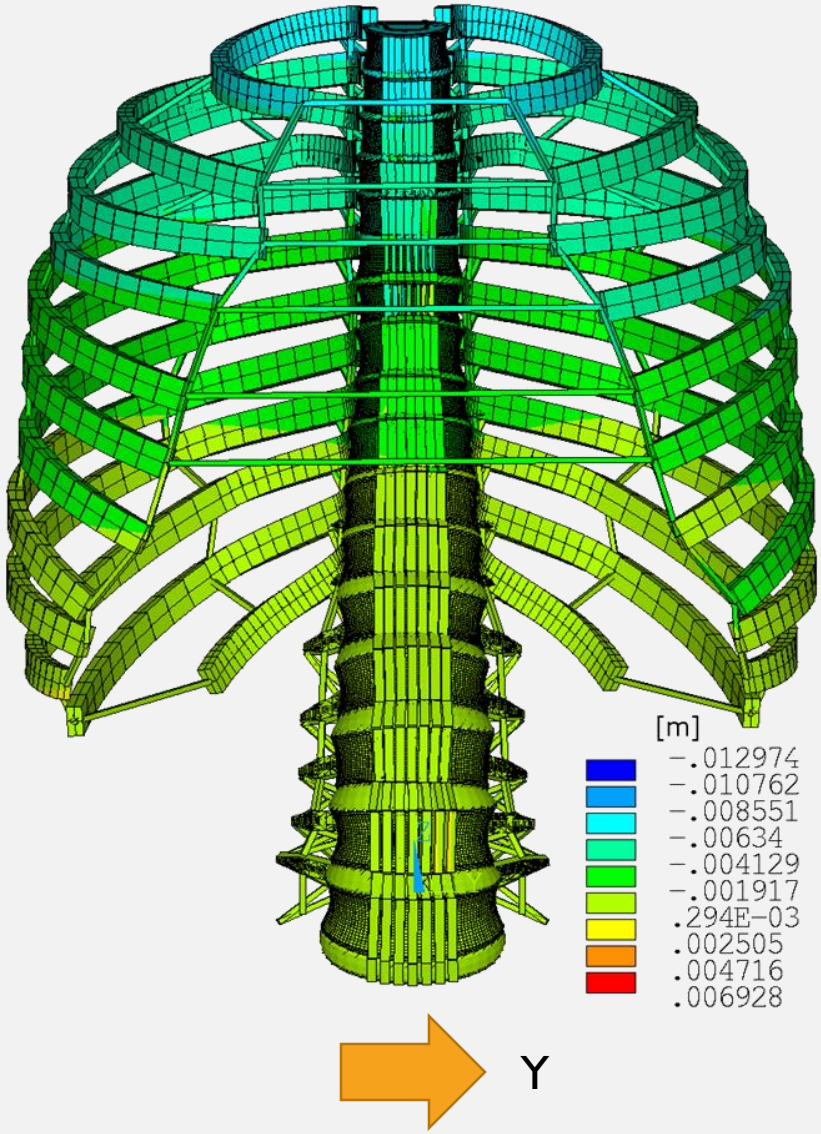

ĎAKUJEM ZA POZORNOSŤ