

Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria Meccanica

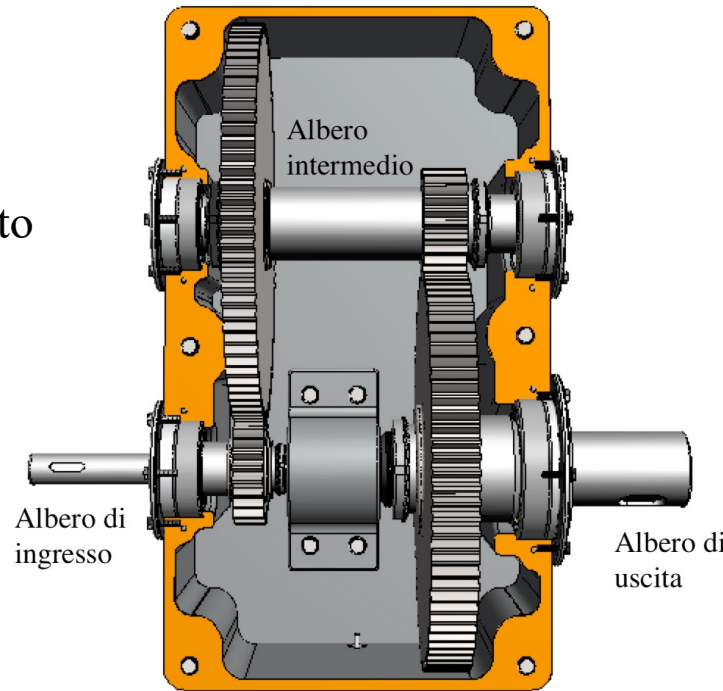
***Relazione per la prova finale
«Analisi strutturali di un riduttore
bistadio mediante modelli FEM su
Solidworks Simulation»***

Tutor universitario: Prof. Alberto Campagnolo

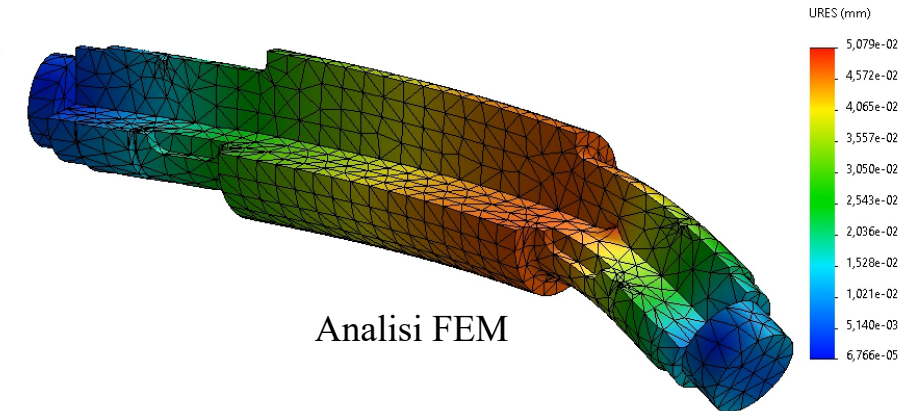
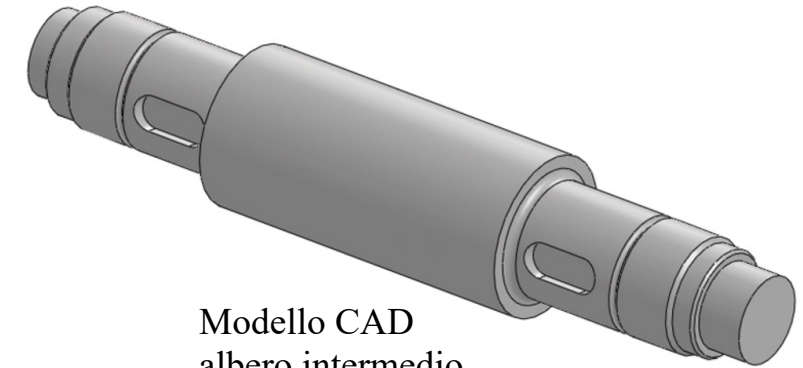
Laureando: *Dalla Pozza Pietro*

Padova, 14/7/2022

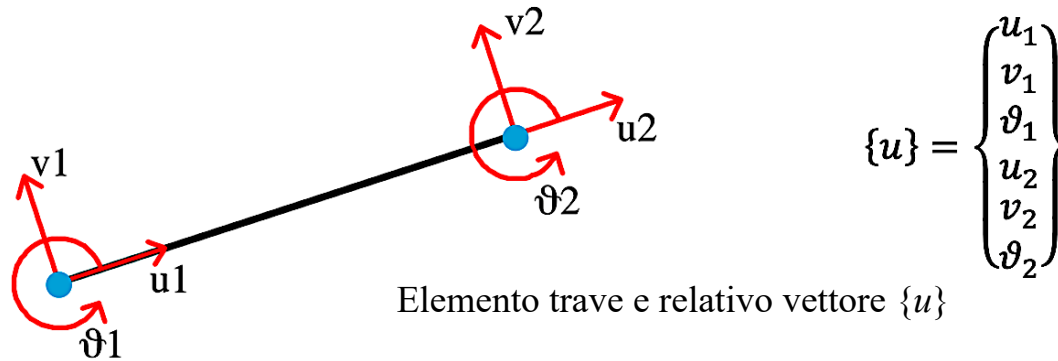
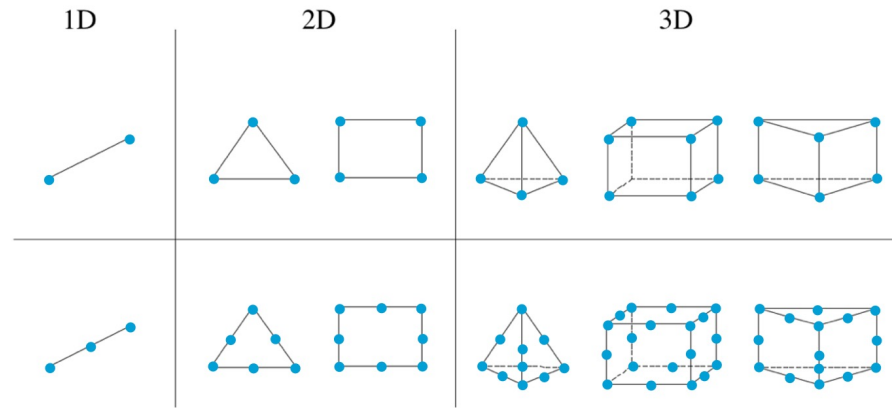
- **Fattore teorico di concentrazione delle tensioni** in corrispondenza di intagli e spallamenti dell'albero
- **Freccia dell'asse**, garantire il corretto ingranamento delle ruote
- **Angolo di inclinazione dell'asse**, verificare i limiti imposti dai cuscinetti
- **Confronto finale tra i modelli adottati per le verifiche a deformabilità**



Interno del riduttore



Tipologie di elemento

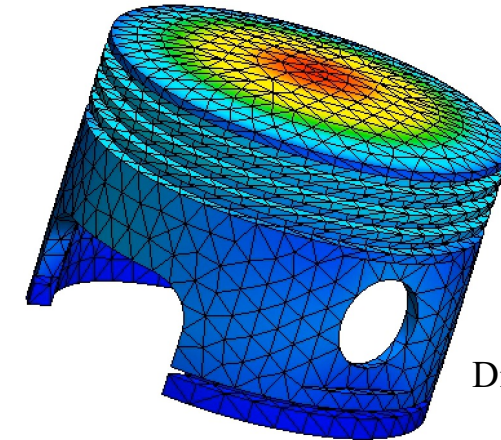


Vettore dei carichi $\{f\}$

$$\begin{Bmatrix} f_{x1} \\ f_{y1} \\ m_1 \\ f_{x2} \\ f_{y2} \\ m_2 \end{Bmatrix} = \begin{bmatrix} k_{11} & k_{12} & k_{13} & k_{14} & k_{15} & k_{16} \\ k_{21} & k_{22} & k_{23} & k_{24} & k_{25} & k_{26} \\ k_{31} & k_{32} & k_{33} & k_{34} & k_{35} & k_{36} \\ k_{41} & k_{42} & k_{43} & k_{44} & k_{45} & k_{46} \\ k_{51} & k_{52} & k_{53} & k_{54} & k_{55} & k_{56} \\ k_{61} & k_{62} & k_{63} & k_{64} & k_{65} & k_{66} \end{bmatrix} \begin{Bmatrix} u_1 \\ v_1 \\ \vartheta_1 \\ u_2 \\ v_2 \\ \vartheta_2 \end{Bmatrix}$$

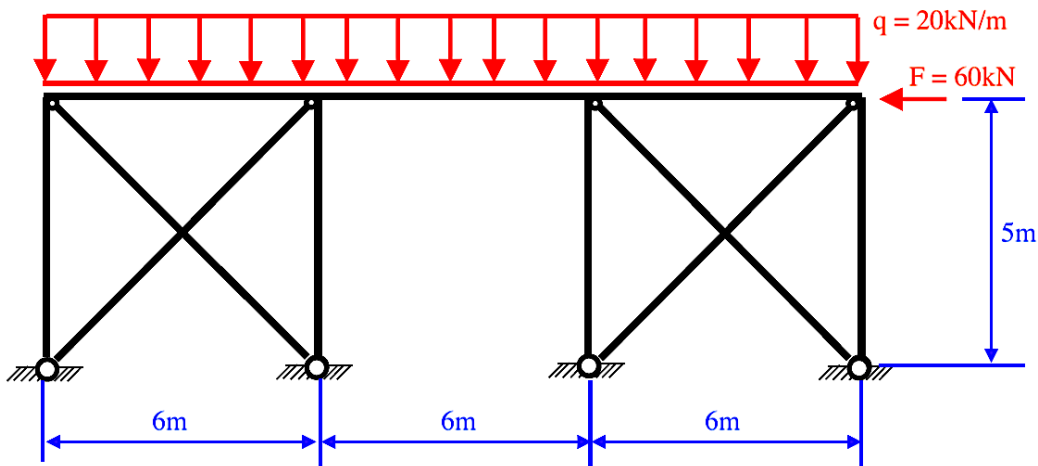
Matrice di rigidezza [K]

Vettore degli spostamenti $\{u\}$



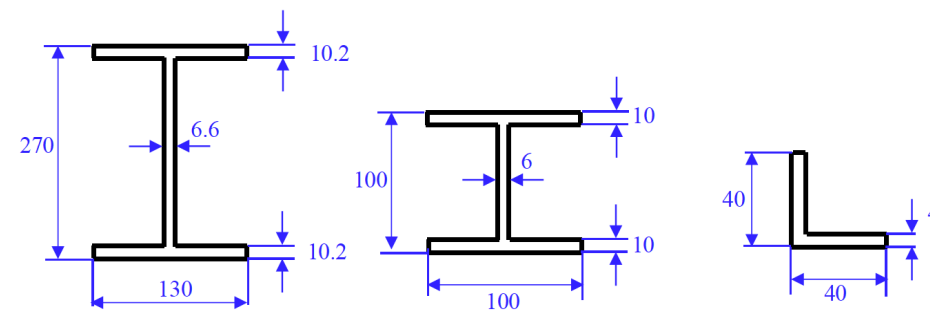
Discretizzazione e risultati

$$\boxed{\{u\} \longrightarrow \{\varepsilon\} = \left\{ \frac{\Delta u}{u} \right\} \longrightarrow \sigma = \sigma(E, \nu, \varepsilon)}$$



Fe430:
 $E = 206000 \text{ MPa}$
 $\nu = 0.3$
 $\sigma_{adm} = 190 \text{ MPa}$
 $\sigma_R = 430 \text{ MPa}$

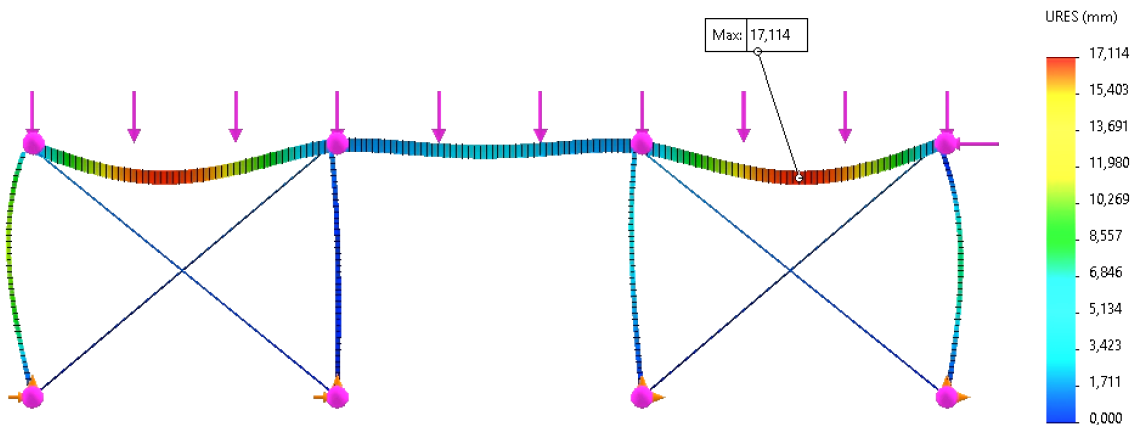
Travi utilizzate nel telaio



Corrente superiore: IPE 270

Colonne: HE 100 B

Controventi: L 40x4



Simulazione della deformata

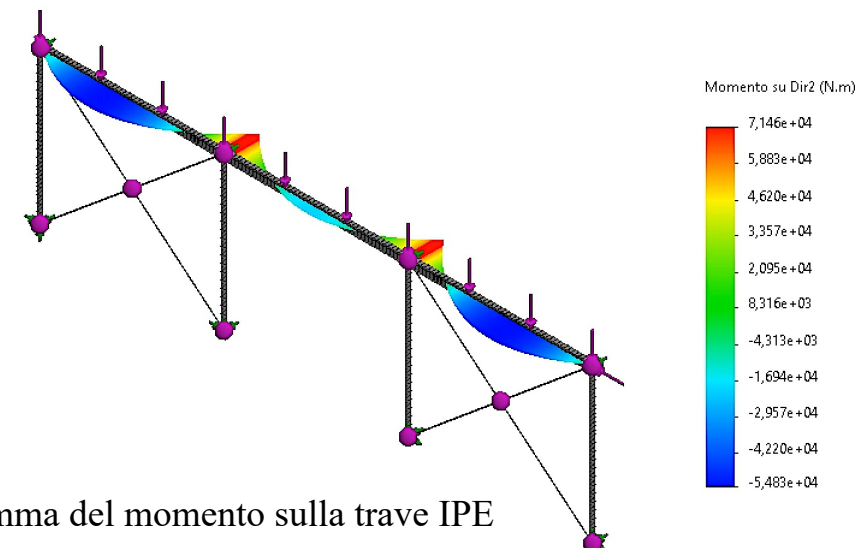


Diagramma del momento sulla trave IPE

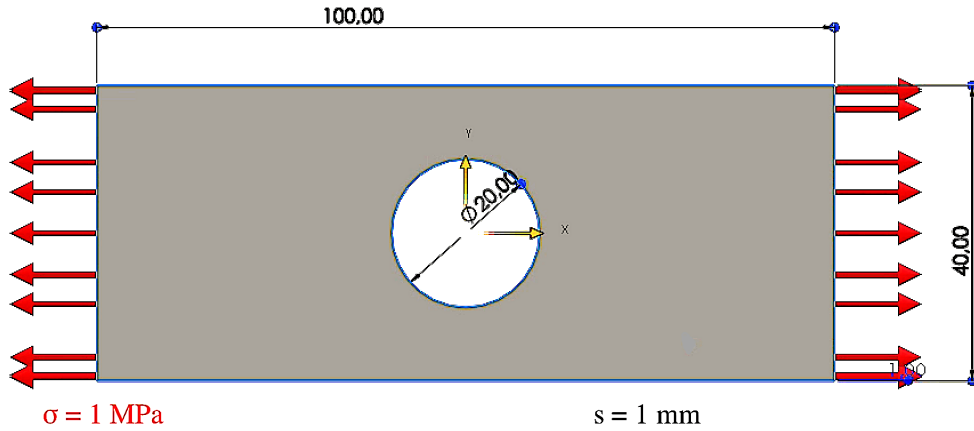
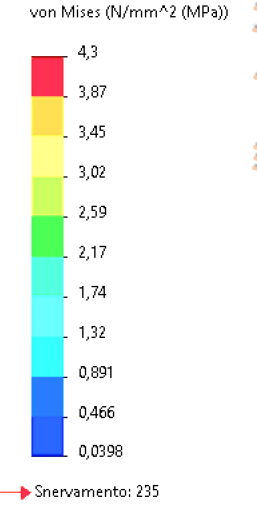
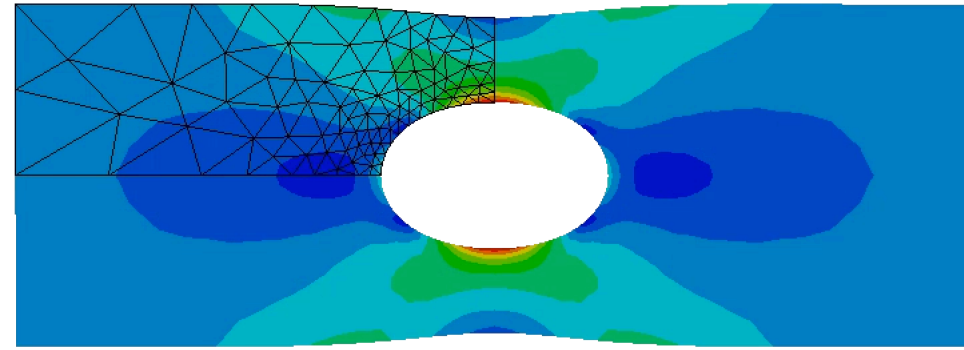
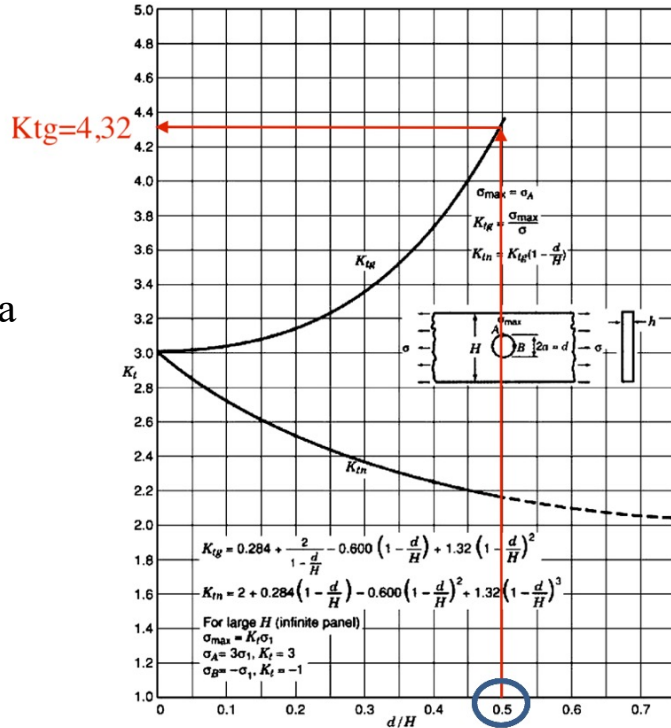


Grafico di sollecitazione

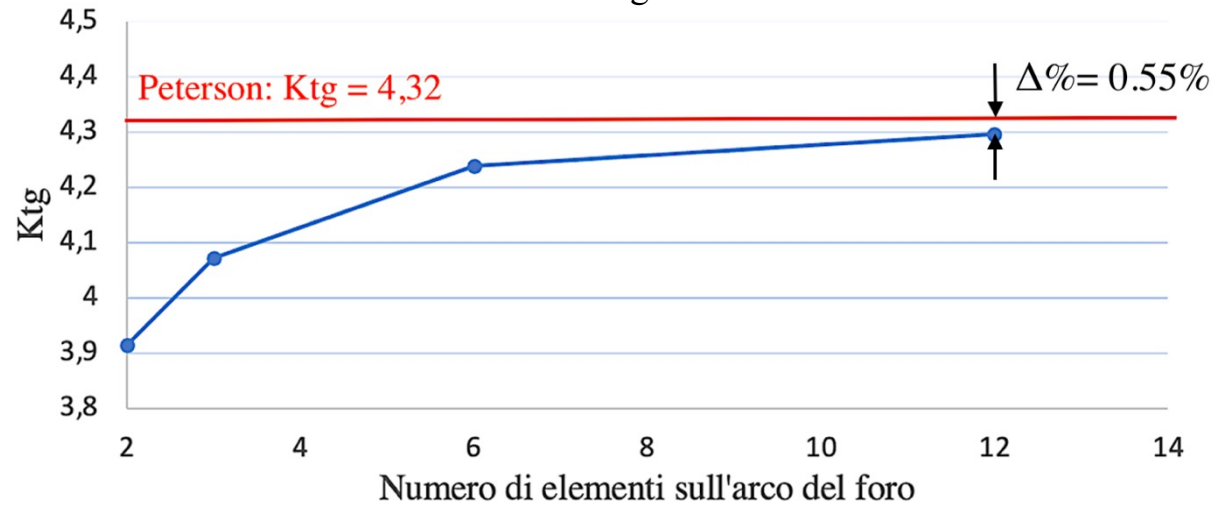


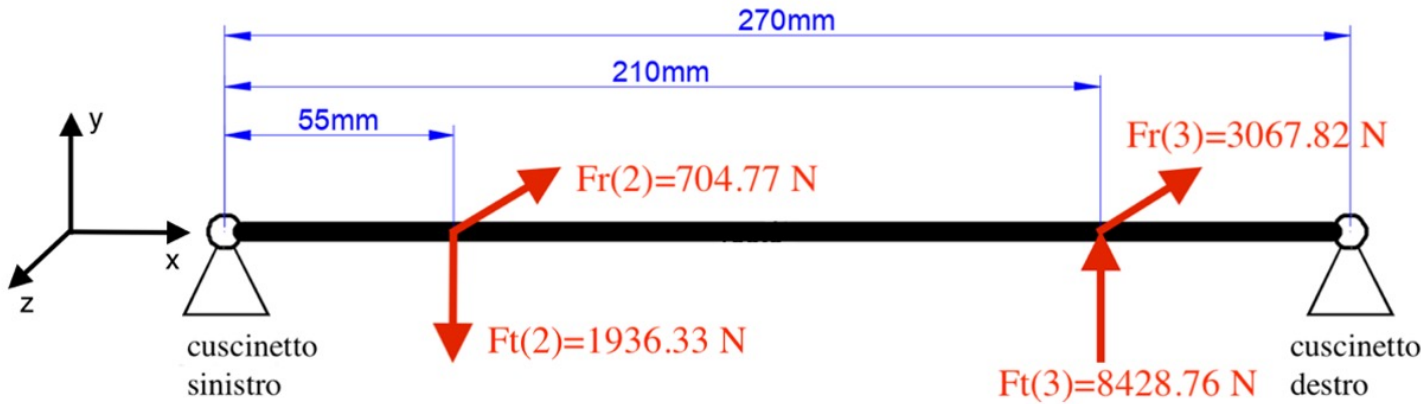
www.dii.unipd.it

Fe360:
 $E = 206000 \text{ MPa}$
 $\nu = 0.3$
 $\sigma_R = 360 \text{ MPa}$
 $\sigma_S = 235 \text{ MPa}$



Convergenza dei risultati



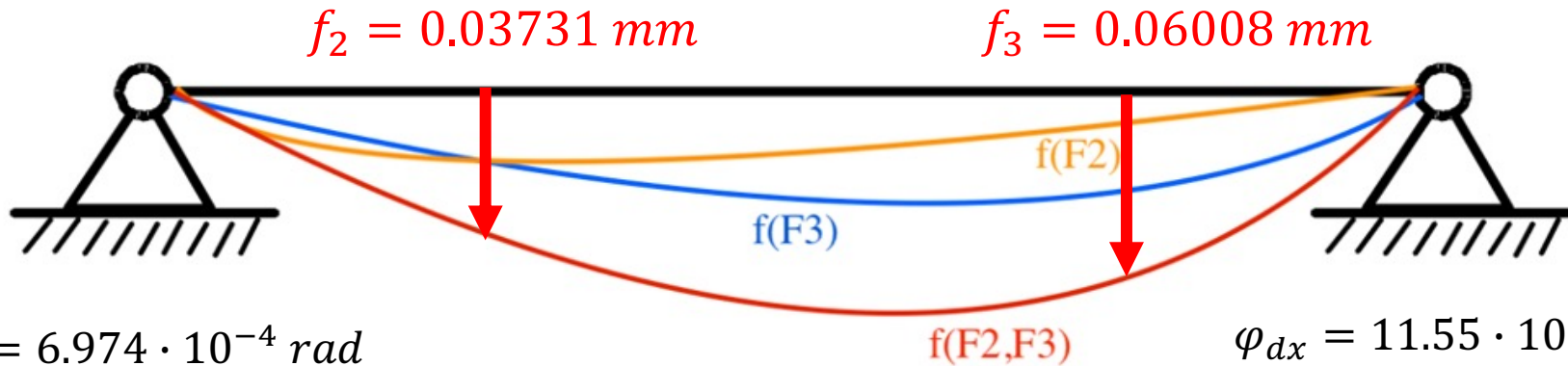


Equazione differenziale della linea elastica

$$\frac{d^2 \eta}{dx^2} = - \frac{M}{EJ}$$

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$$f_{lim} = 0.09 \text{ mm}$$

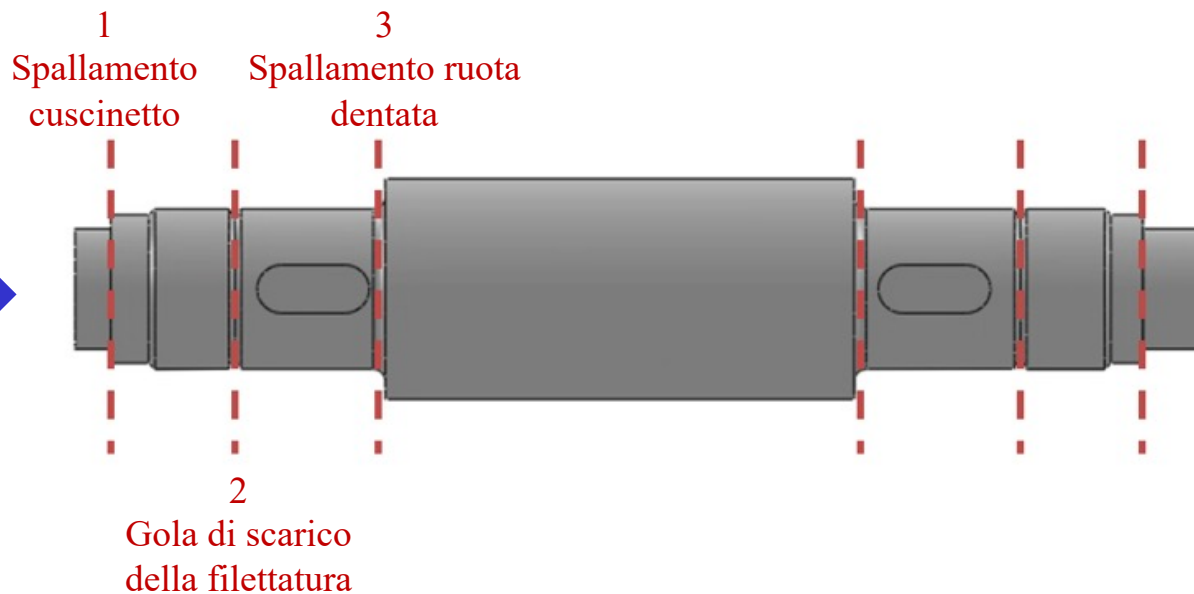
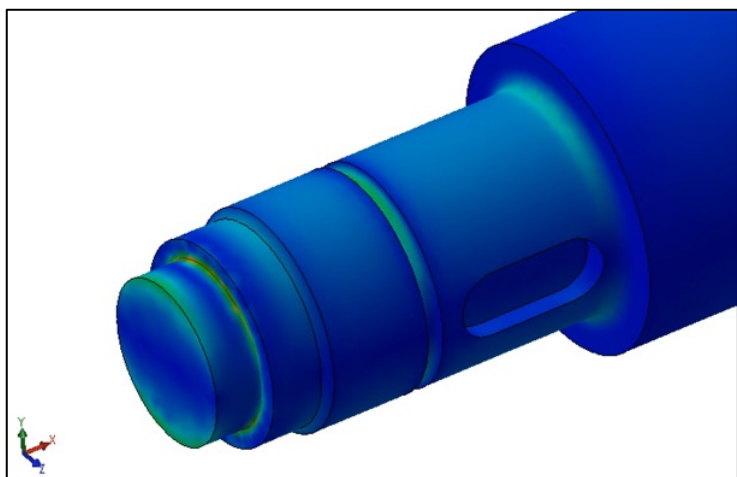


$$\varphi_{sx} = 6.974 \cdot 10^{-4} \text{ rad}$$

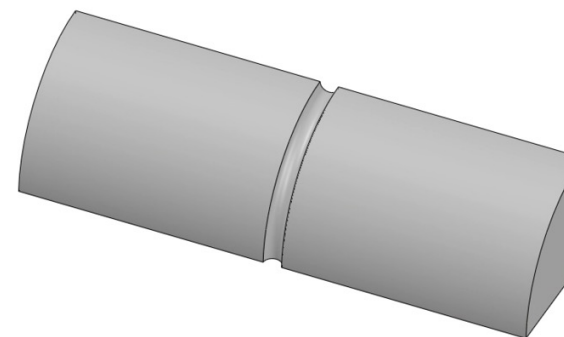
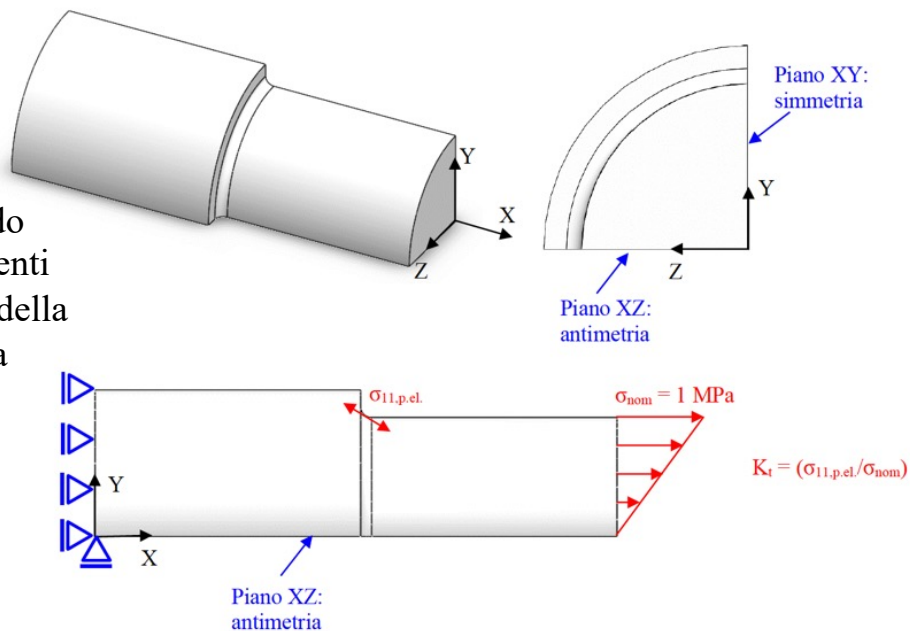
$$\varphi_{lim,sx} = 1.454 \cdot 10^{-3} \text{ rad}$$

$$\varphi_{dx} = 11.55 \cdot 10^{-4} \text{ rad}$$

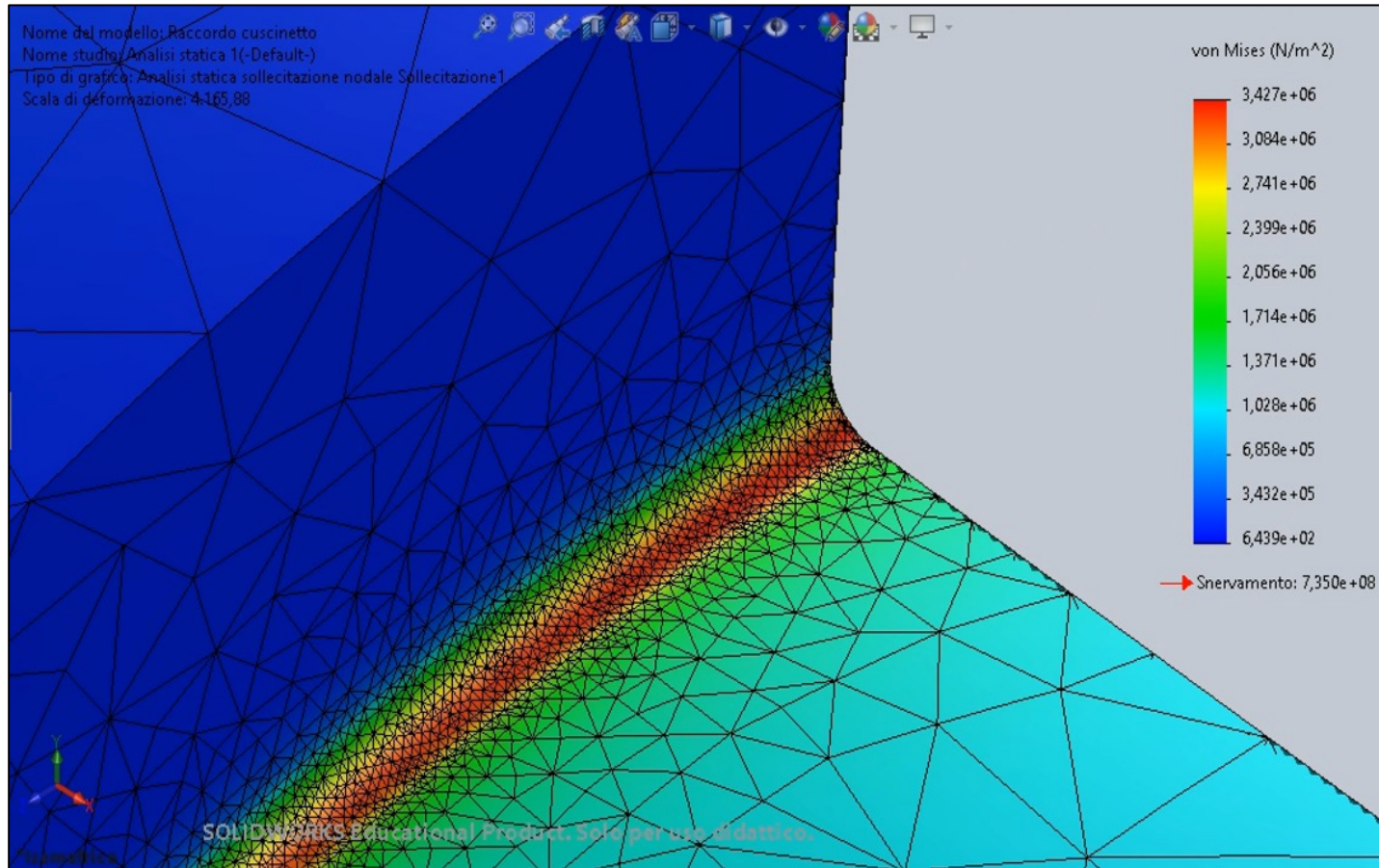
$$\varphi_{lim,dx} = 11.64 \cdot 10^{-4} \text{ rad}$$



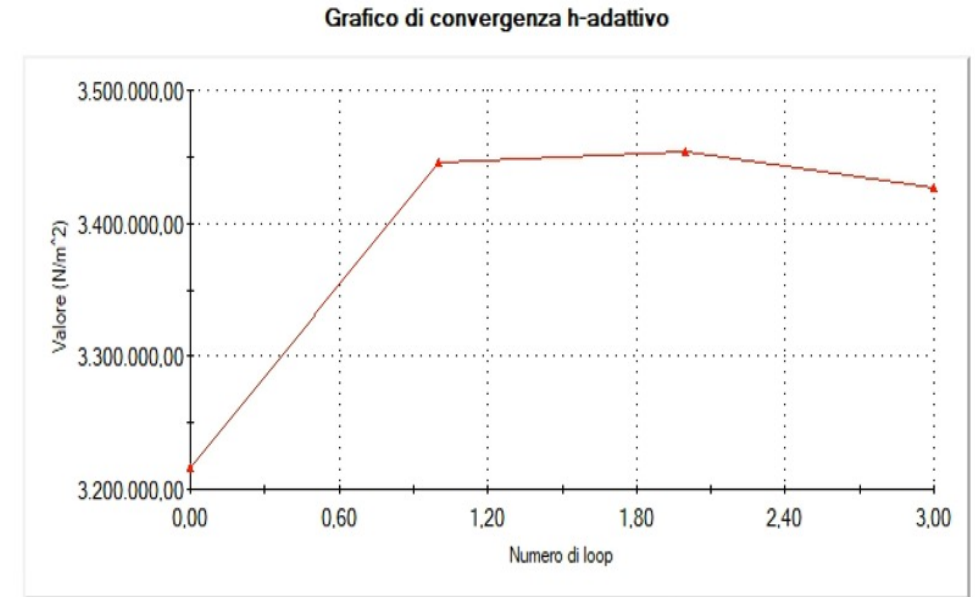
Modello solido per gli spallamenti del cuscinetto e della ruota dentata



Modello solido per la gola di scarico



Campo di sollecitazione sullo spallamento del cuscinetto sinistro

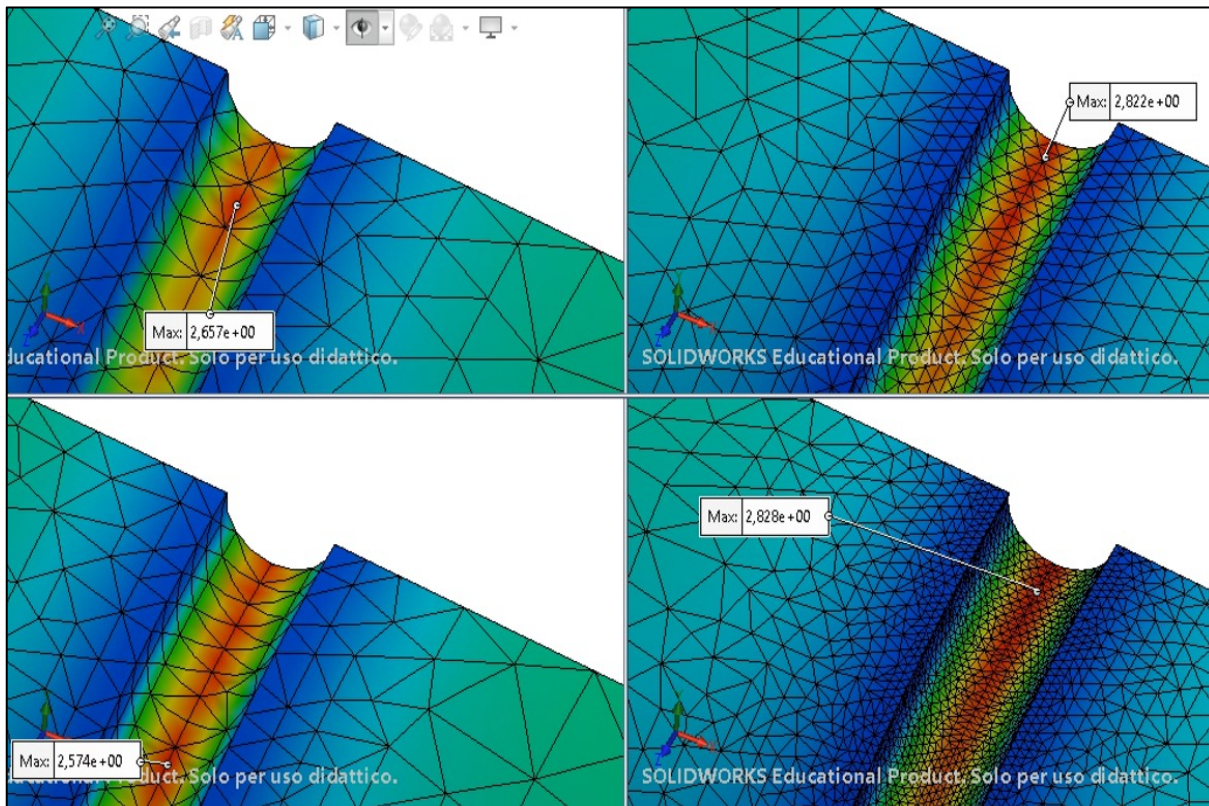


Criterio globale: errore di norma per l'energia di deformazione totale < 2.29267%

—●— Sollecitazione massima von Mises

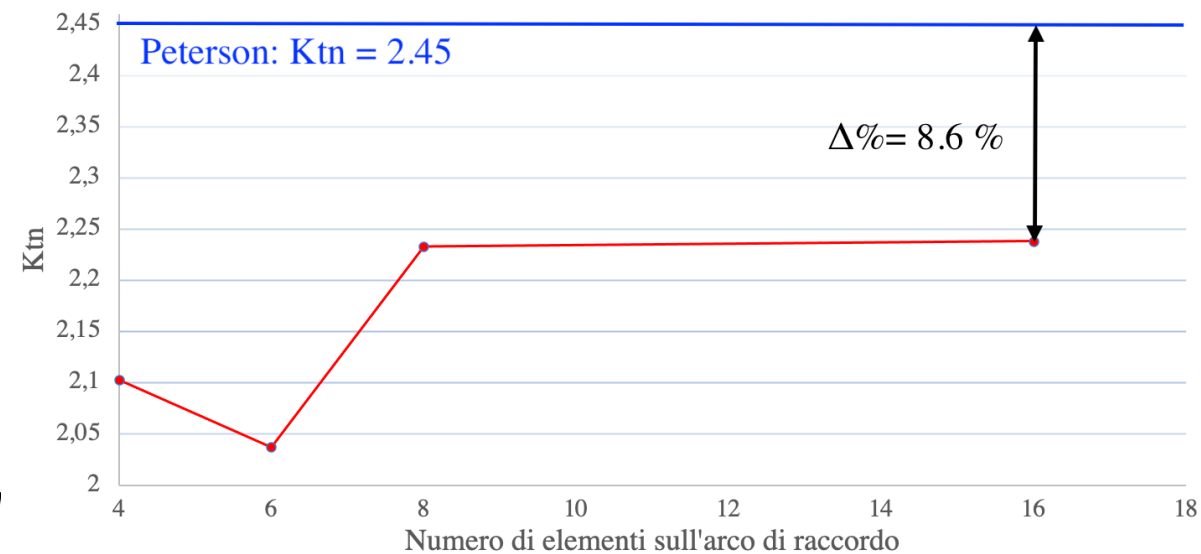
<i>K_{tn} Peterson</i>	<i>K_{tn} FEM</i>	$\Delta\%$
3.43	3.427	0.08%

Campo di sollecitazione sulla gola di scarico della filettatura

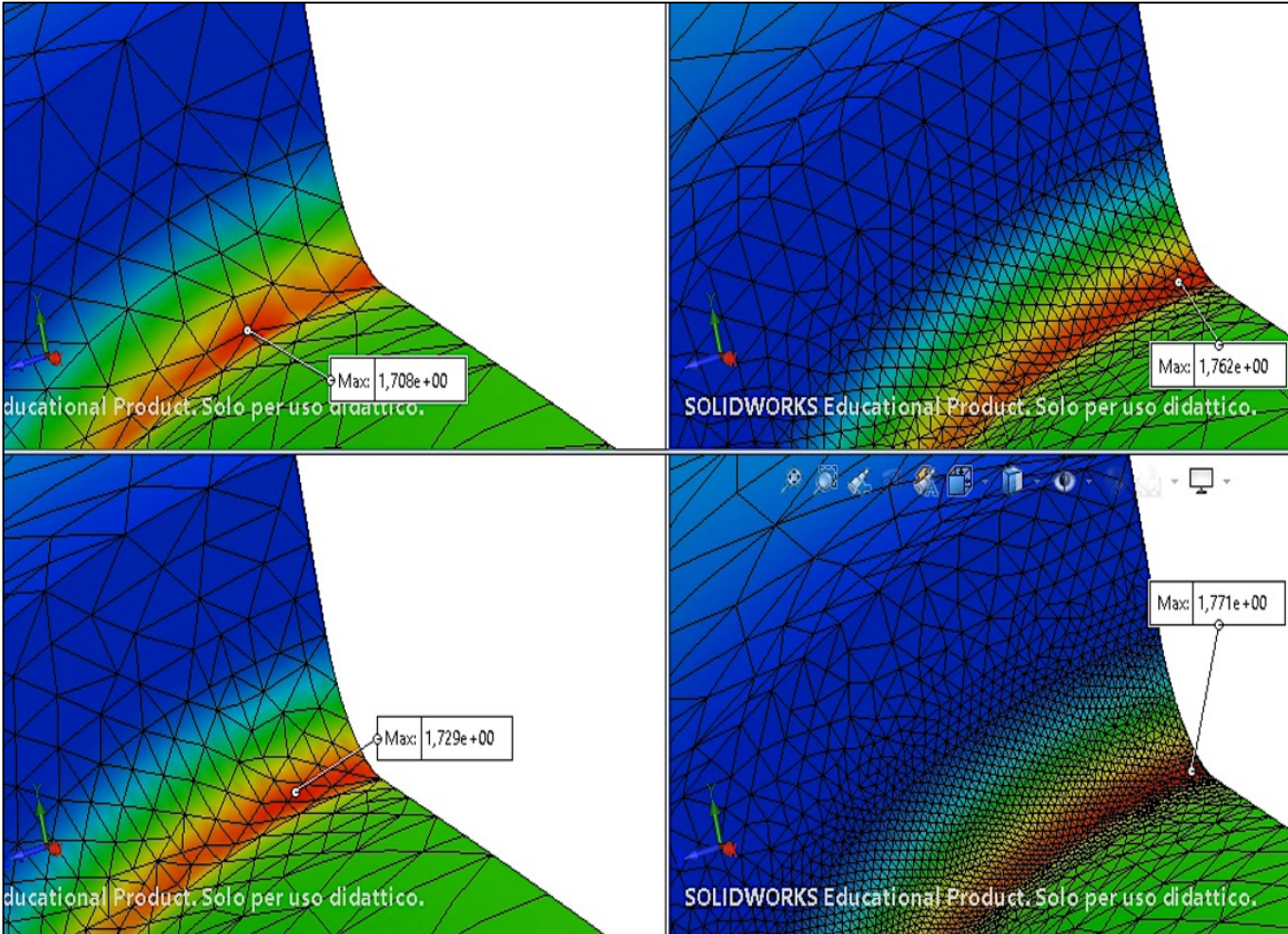


	K _{tg}	K _{tn}
Analisi statica 1	2.657	2.102
Analisi statica 2	2.574	2.037
Analisi statica 3	2.822	2.233
Analisi statica 4	2.828	2.238

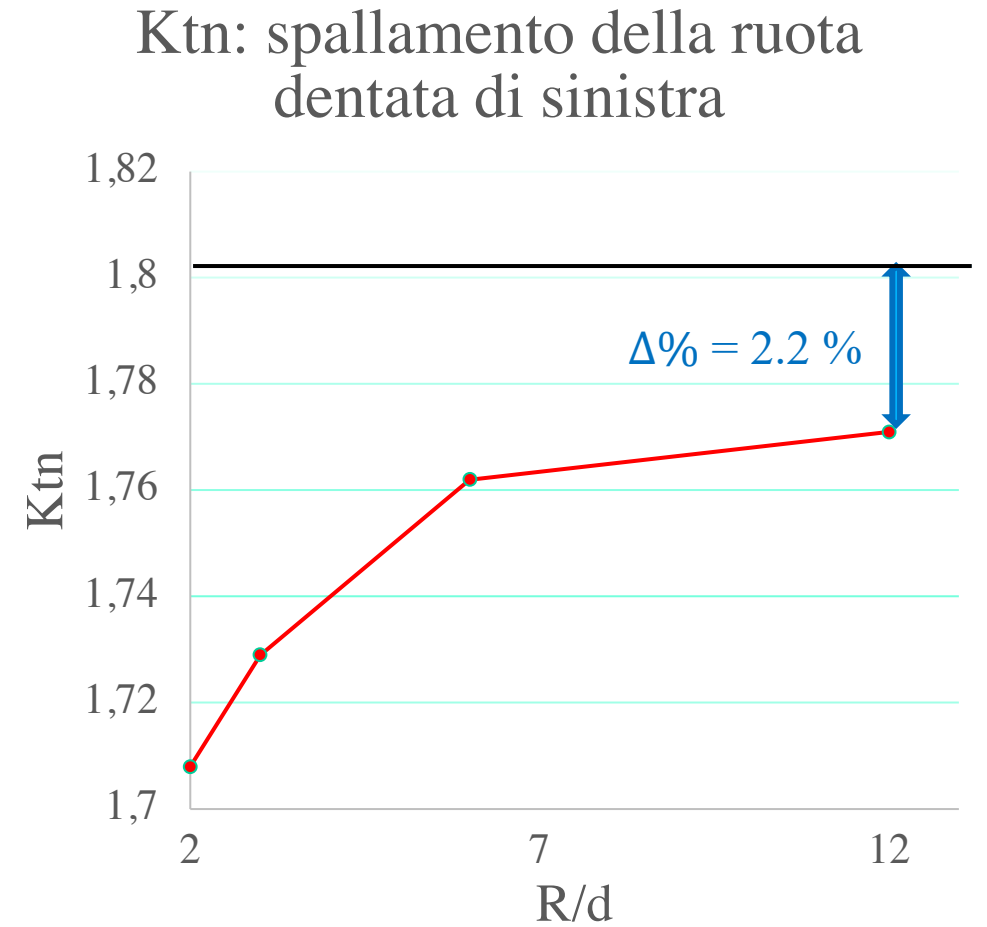
K_{tn}: gola di scarico della filettatura di sinistra

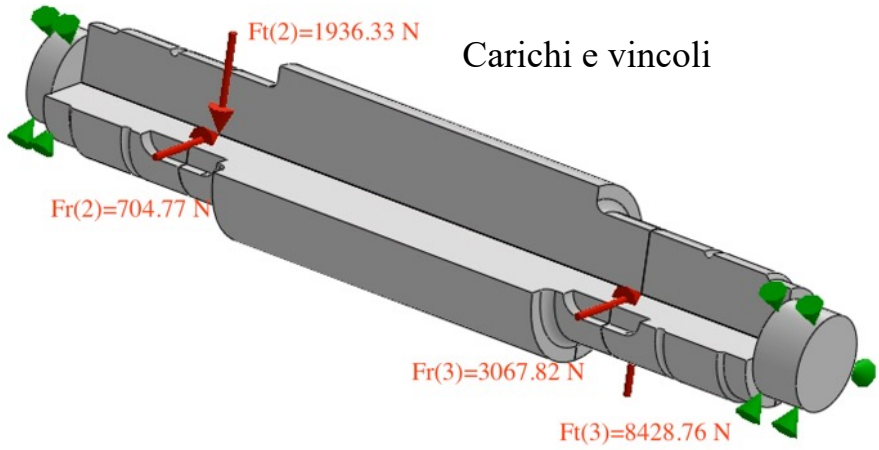


$$\frac{K_{tn}}{K_{tg}} = \frac{\sigma_{ng}}{\sigma_{nn}} = \frac{W_{fn}}{W_{fg}} = \frac{d^3}{D^3} \longrightarrow K_{tn} = \frac{d^3}{D^3} \cdot K_{tg}$$

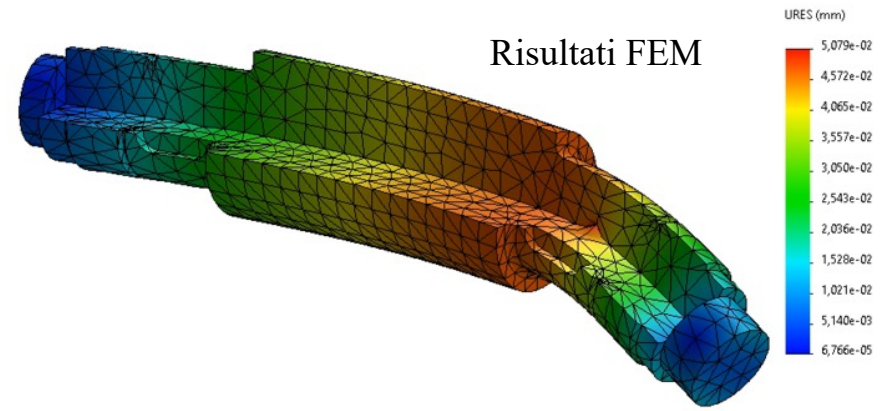


Campo di sollecitazione sullo spallamento della ruota dentata

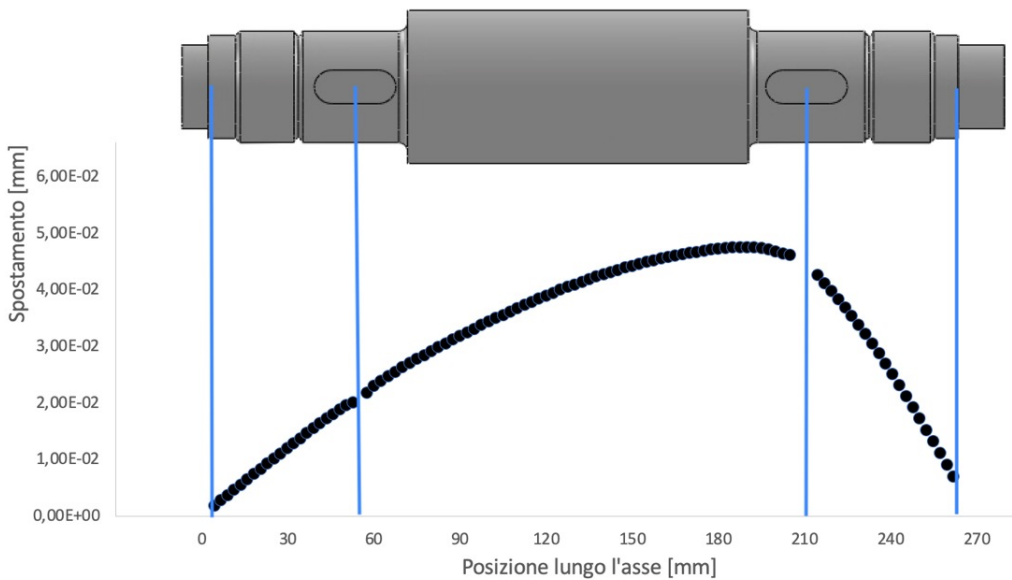




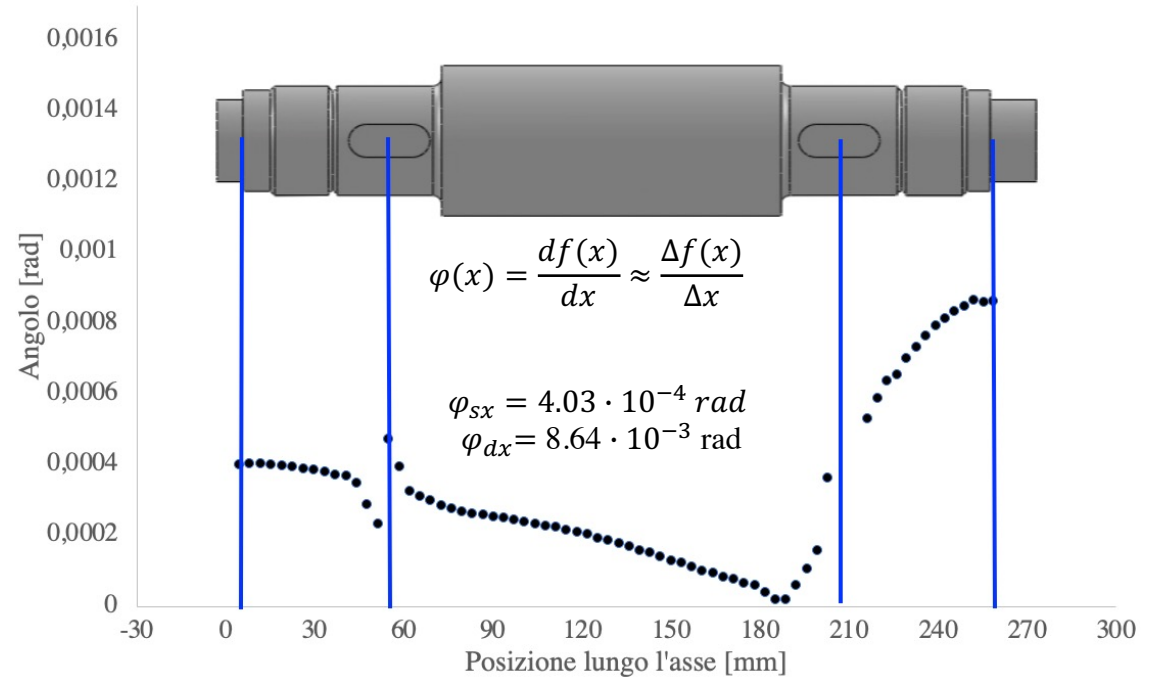
Discretizzazione ed esecuzione dello studio



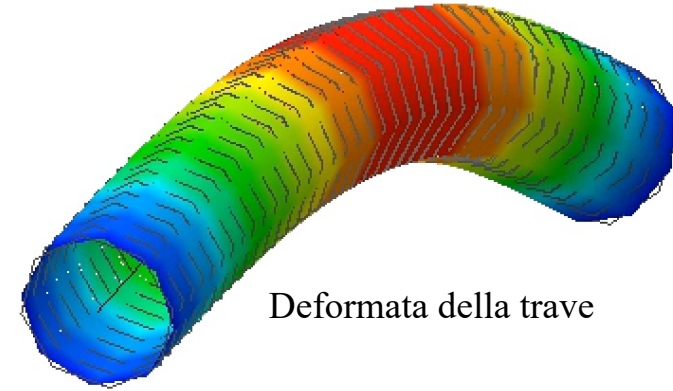
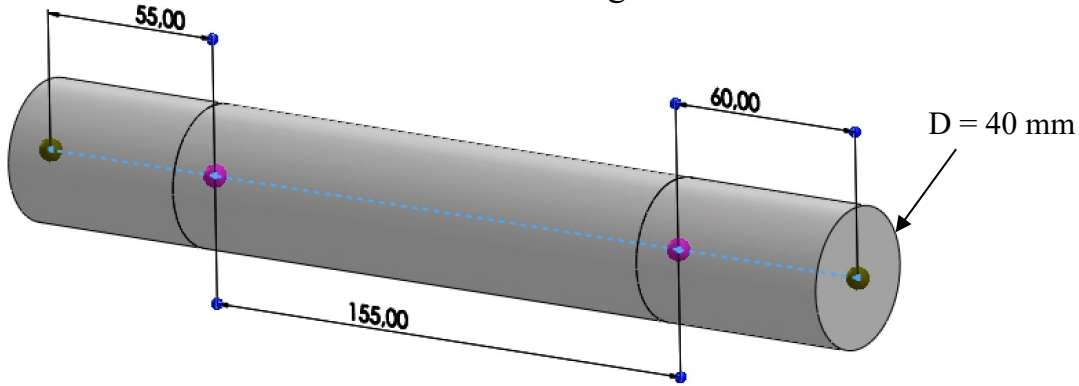
Spostamento risultante dell'asse dell'albero solido



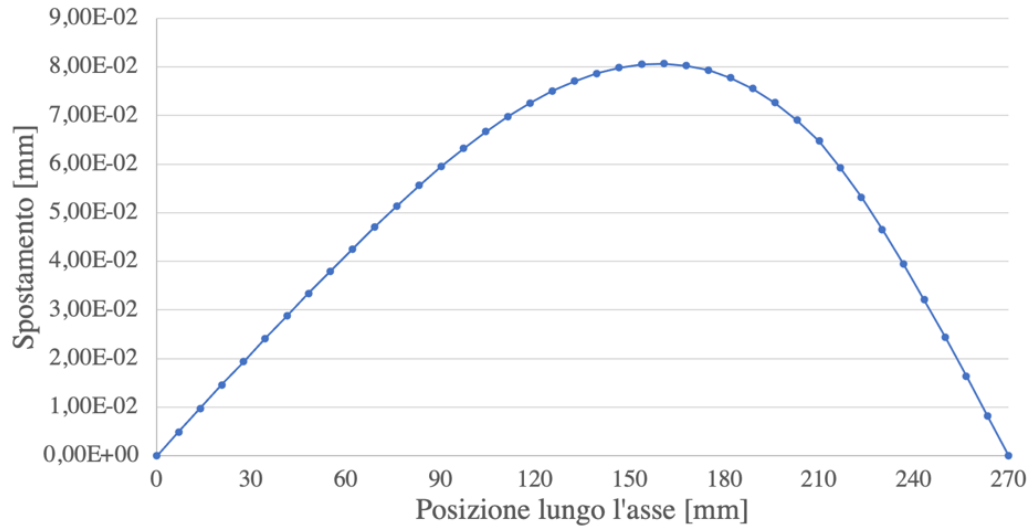
Rotazione asse dell'albero solido



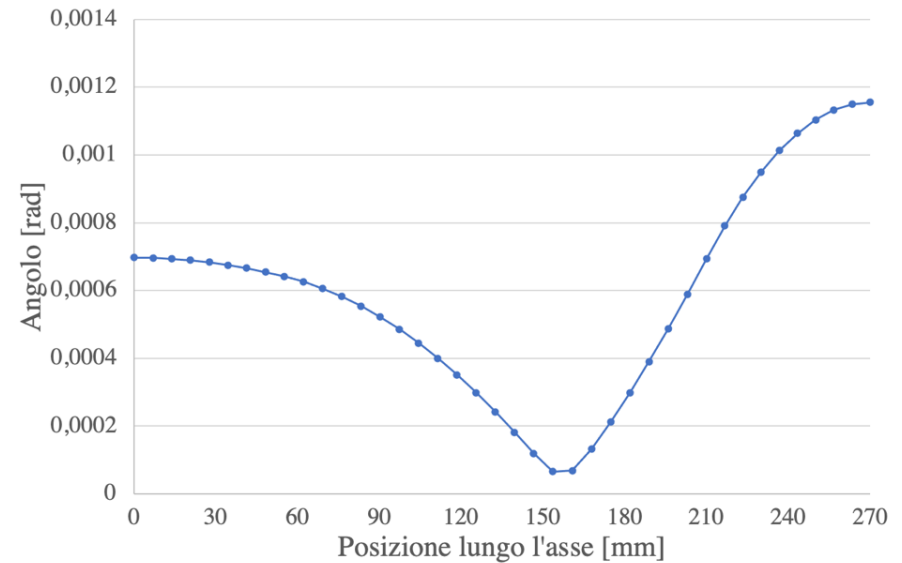
Trave a tre segmenti



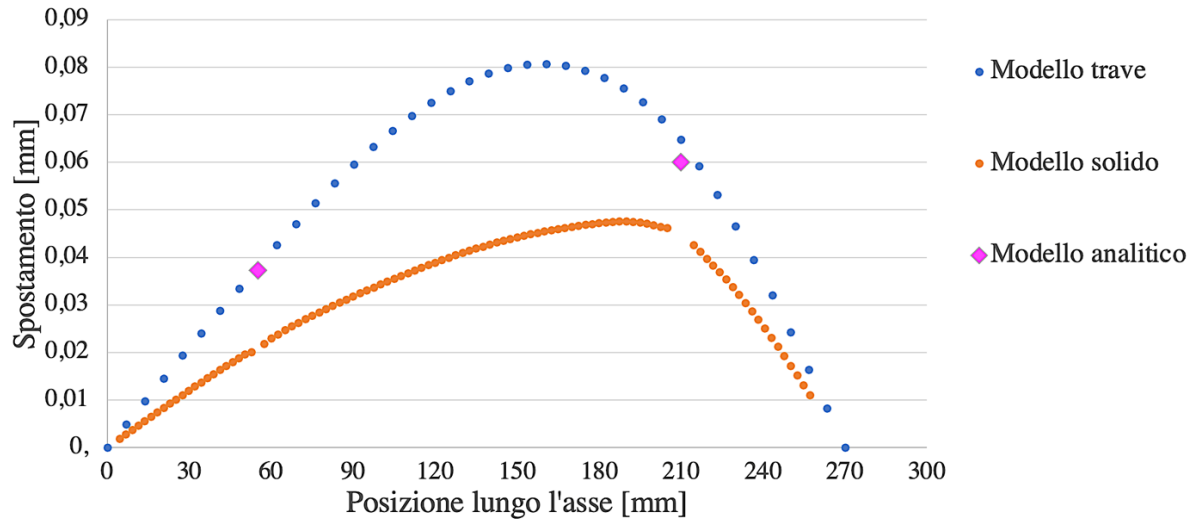
Spostamento risultante dell'asse dell'albero trave



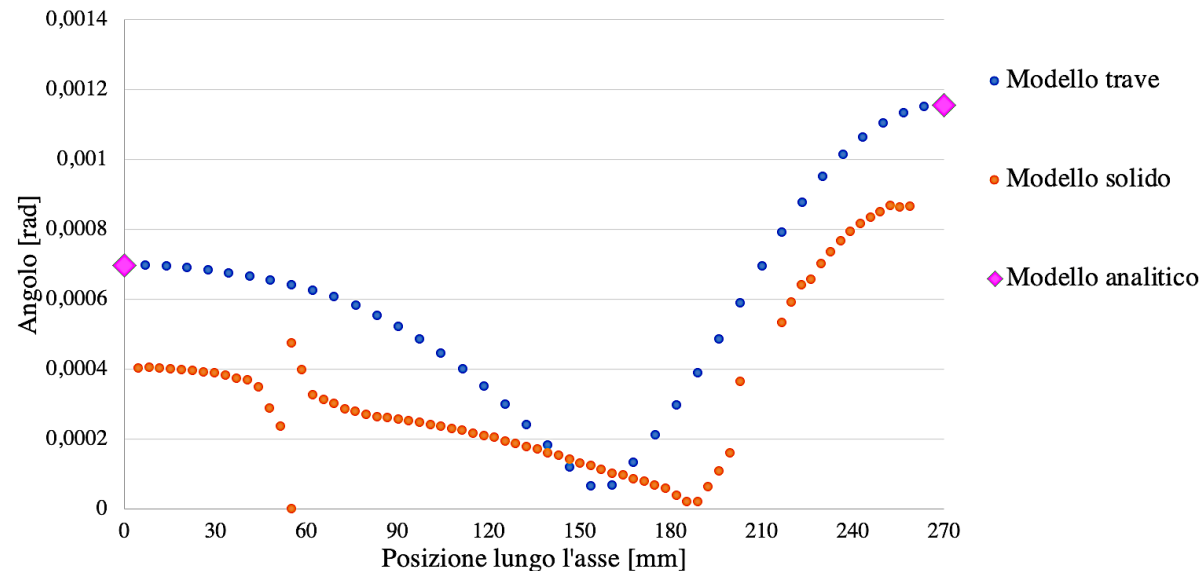
Inclinazione totale dell'asse dell'albero trave



Confronto dei risultati di deformazione



Confronto dei risultati di rotazione



Spostamento:

- Modello trave in favore di sicurezza
- Spostamento dei picchi di deformazione
- Piccole discrepanze tra modello trave ed analitico

Rotazione:

- Concordanza tra modello trave ed analitico
- Andamenti globalmente concordi