

Relazione per la prova finale:

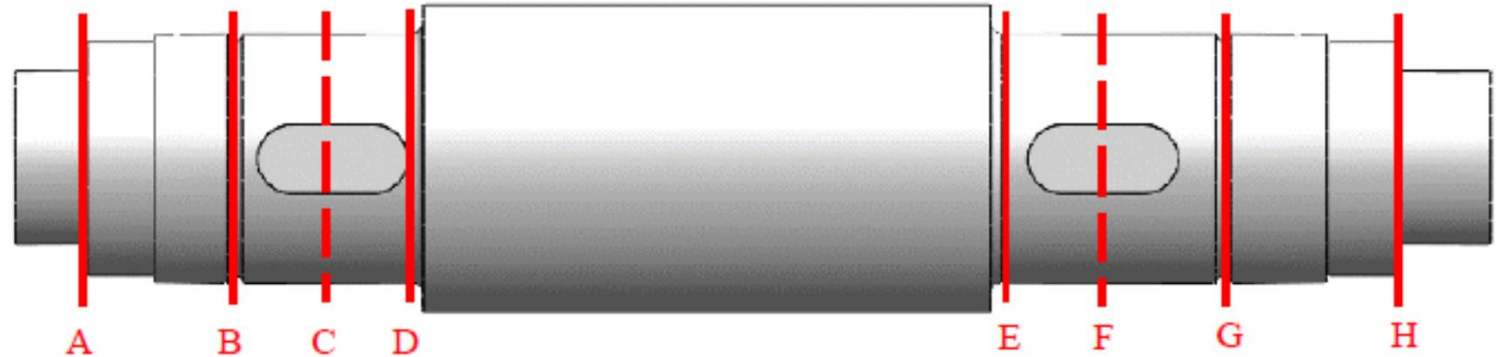
***ANALISI FEM DI UN RIDUTTORE  
BISTADIO MEDIANTE  
SOLIDWORKS SIMULATION***

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Tutor universitario: prof. Alberto Campagnolo

## OBIETTIVI:

- Verifica a fatica flessionale
- Verifica a deformabilità

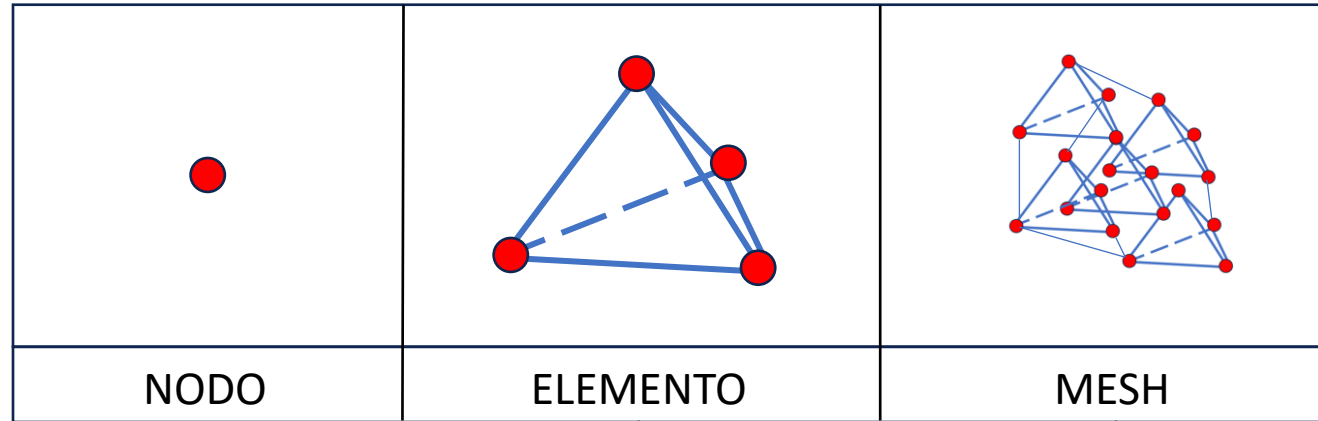


## MATERIALE ALBERO:

- 35CrMo4
- Res. a trazione: 600MPa
- Tens. di snerv.: 290MPa
- E: 206000 MPa

## SVOLGIMENTO:

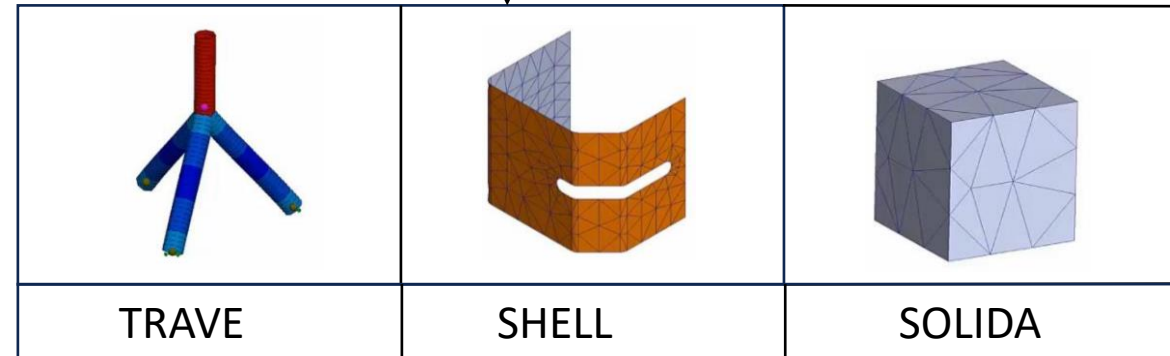
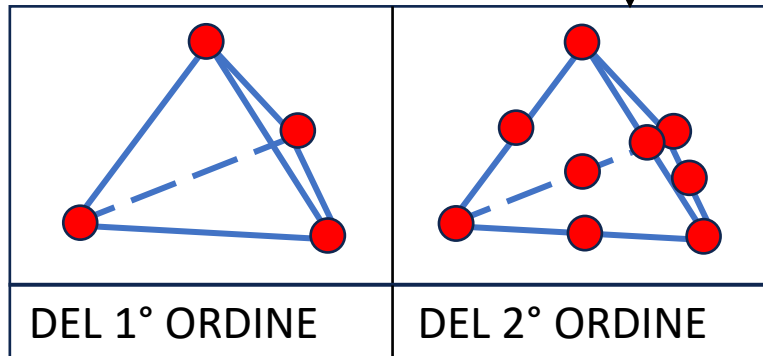
- Introduzione al metodo degli elementi finiti;
- Addestramento a Solidworks Simulation, analisi di un telaio piano e di una piastra forata;
- Calcolo del  $K_t$  dell'albero intermedio nelle tre sezioni critiche A, B e D;
- Verifiche a deformabilità dell'albero intermedio e confronto tra il modello tridimensionale, monodimensionale e teorico.



## ANALISI STATICA LINEARE

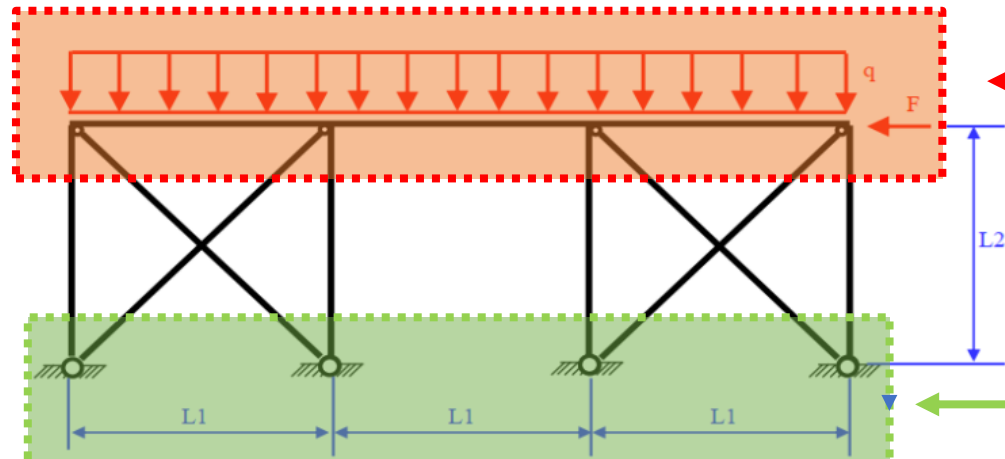
### IPOSTESI:

- Carichi costanti nel tempo
- Risposta lineare del materiale
- Piccoli spostamenti



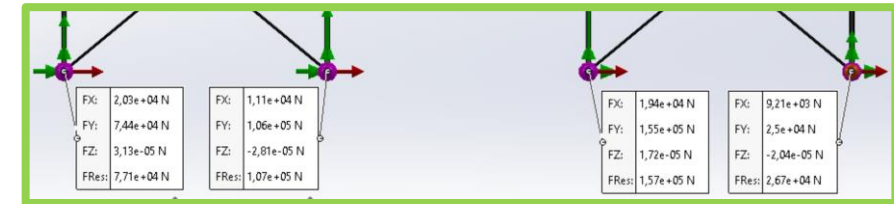
# TELAIO PIANO

## vincoli, carichi e spostamenti



**CARICO APPLICATO E FORZA LATERALE (input)**

**REAZIONI VICOLARI APPLICATE(output):**



**DATI**

F = 60 kN  
q = 20 kN/m  
L1 = 6000 mm  
L2 = 5000 mm

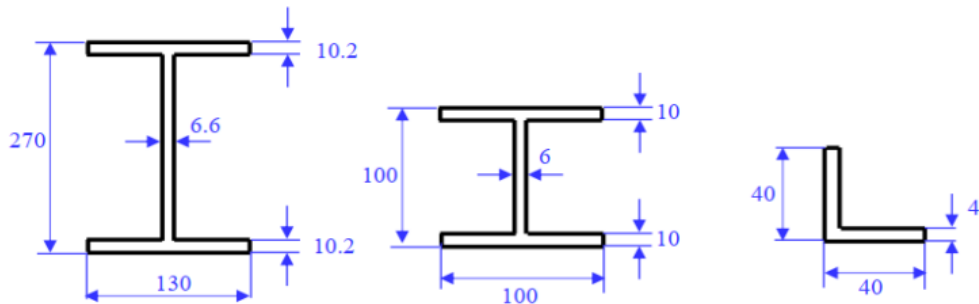
**MATERIALE**

Acciaio Fe 430  
 $\sigma_{adm} = 190$  MPa  
E = 206000 MPa  
 $\nu = 0.3$

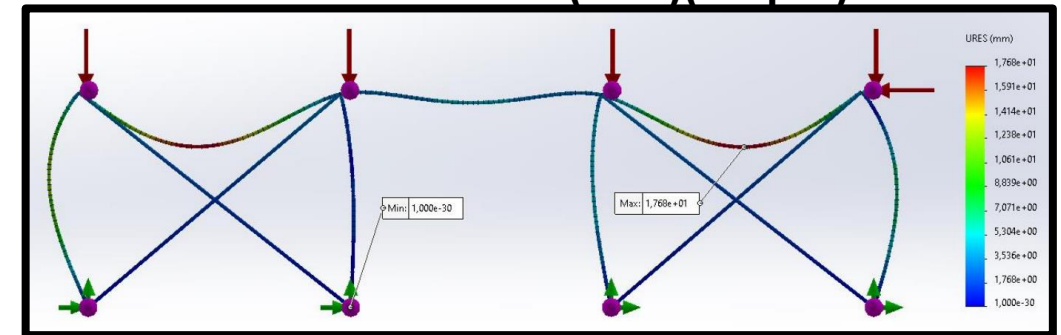
**PROFILI ADOTTATI**

Corrente superiore: IPE 270  
Colonne: HE 100 B  
Controventi: L 40x4

**PROFILI**

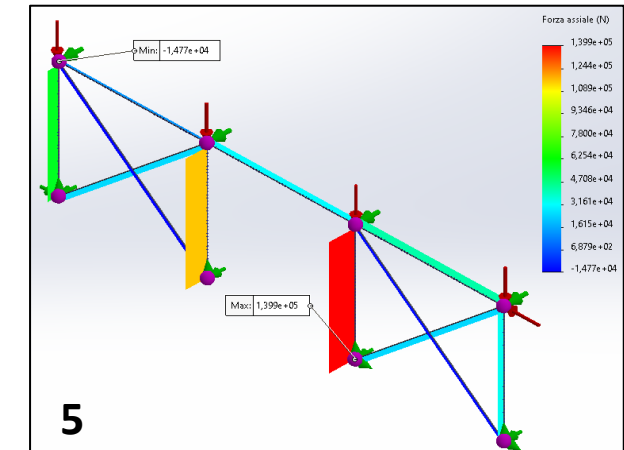
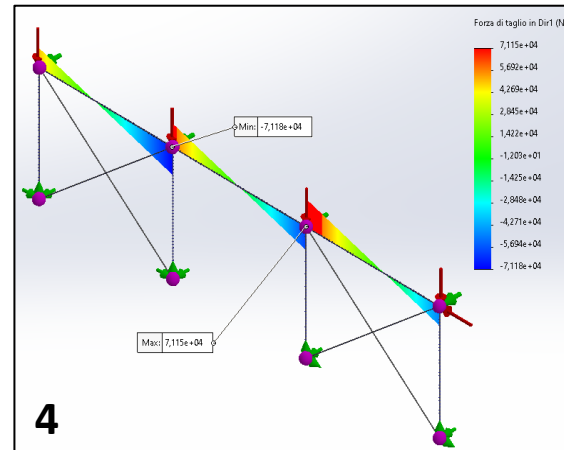
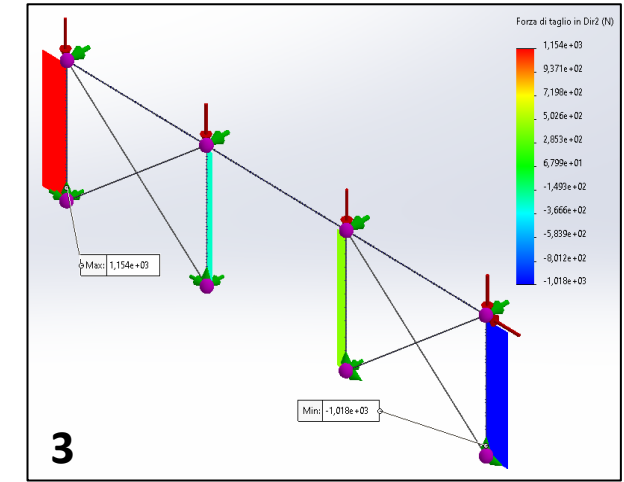
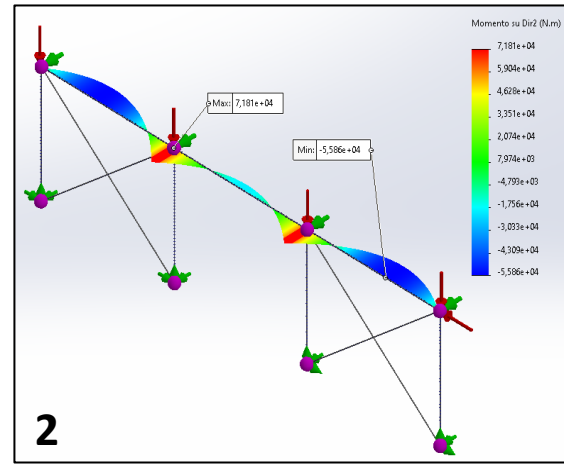
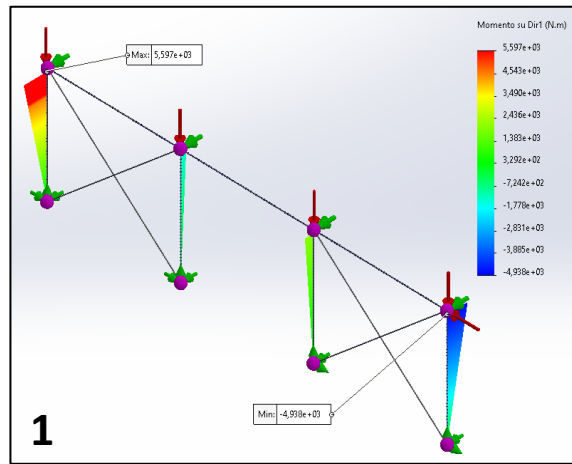


**SPOSTAMENTI DEI NODI (75:1)(output)**



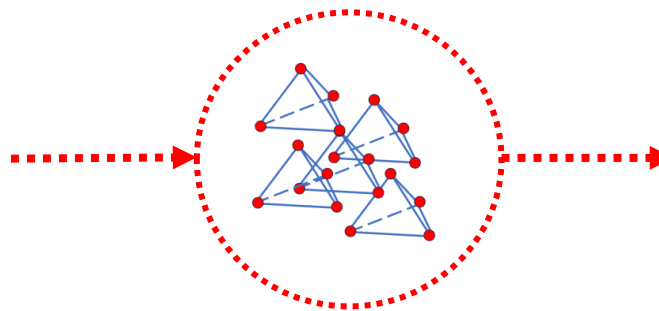
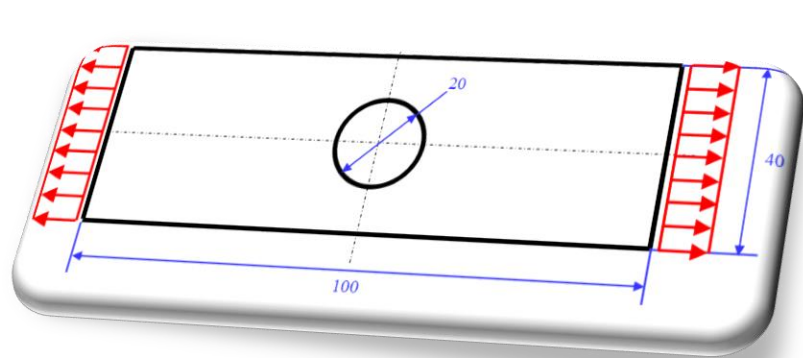
# TELAIO PIANO

## sollecitazioni

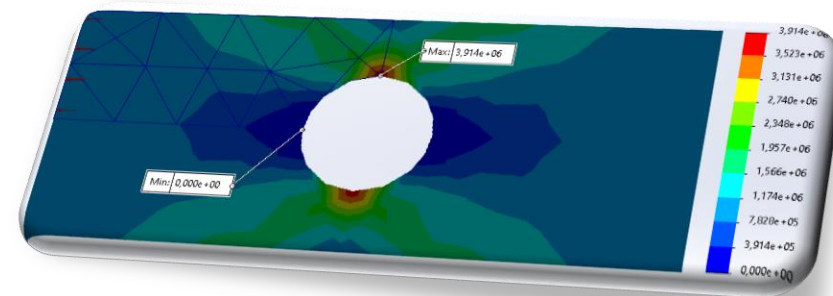


1. momento flettente sulle colonne
2. mom. flet. sul corrente superiore
3. taglio sulle colonne
4. taglio sul corrente superiore
5. sforzo assiale sulla struttura

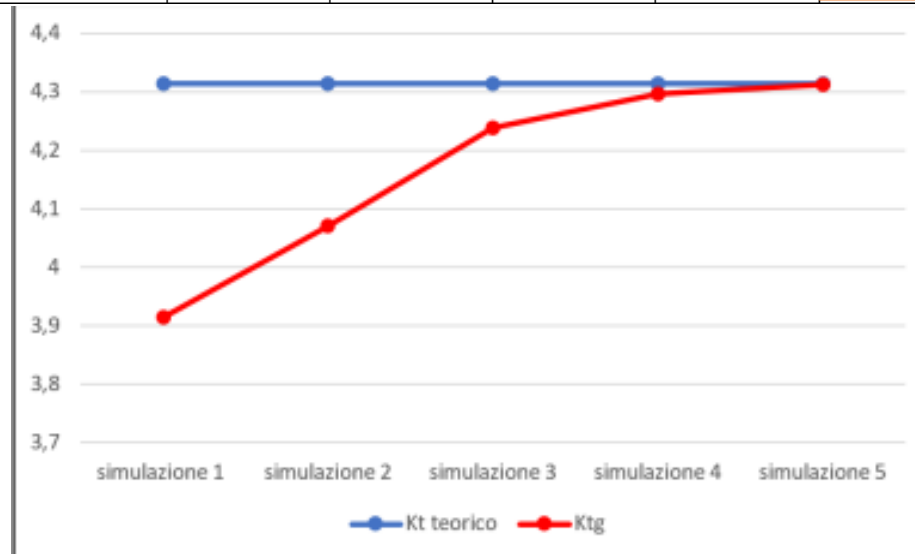
# PIASTRA FORATA



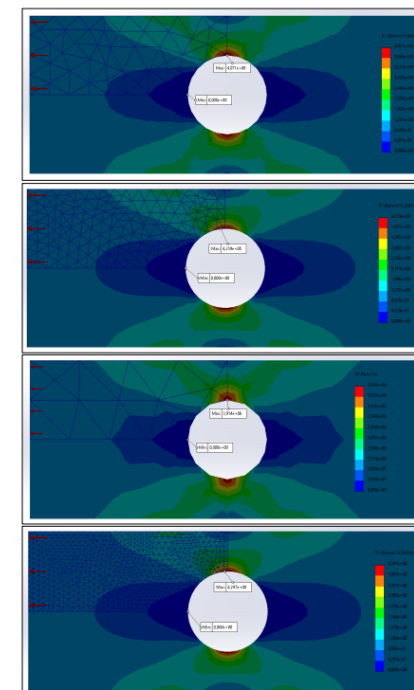
ANALISI F.E.M.



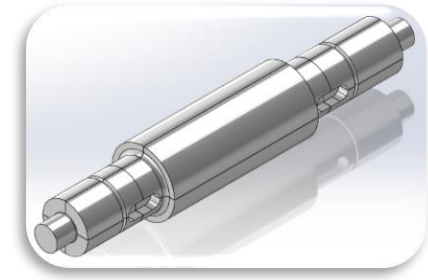
	Simulazione 1	Simulazione 2	Simulazione 3	Simulazione 4	Simulazione 5
Spigolo cella (mm)	10	5	2.5	1.2	/
'controllo mesh'	NO	NO	NO	NO	SI
Kt teorico	4.314	4.314	4.314	4.314	4.314
Ktg	3.914	4.071	4.239	4.297	4.312
Δ% col Kt teorico	9.272%	5.633%	1.738%	0.394%	0.046%



VARIAZIONE  
DIMENSIONE  
DEGLI  
ELEMENTI

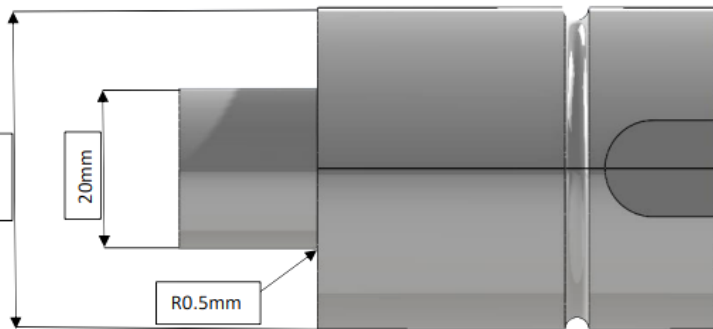


NUMERO DI ELEMENTI FINITI



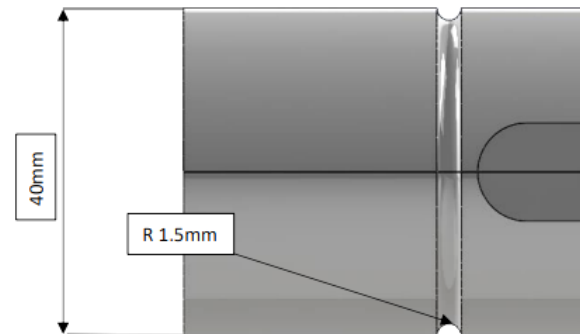
**SEZIONE A:**

spallamento del cuscinetto



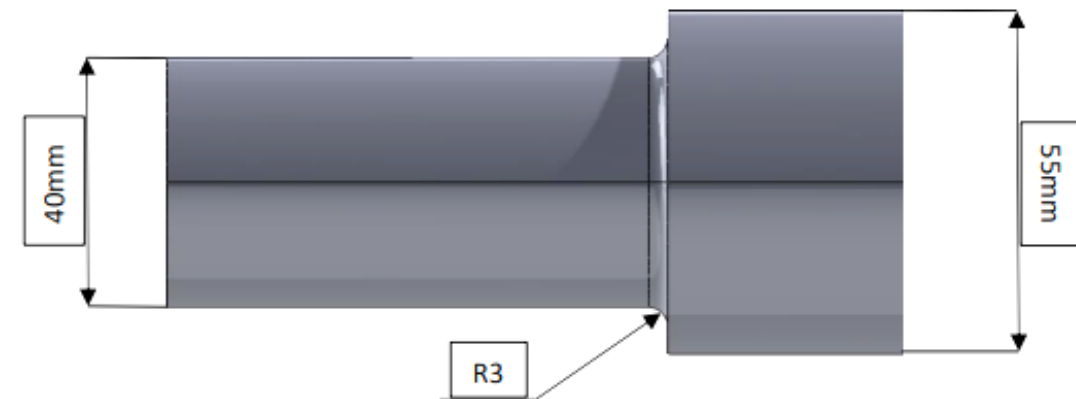
**SEZIONE B:**

gola di scarico della filettatura



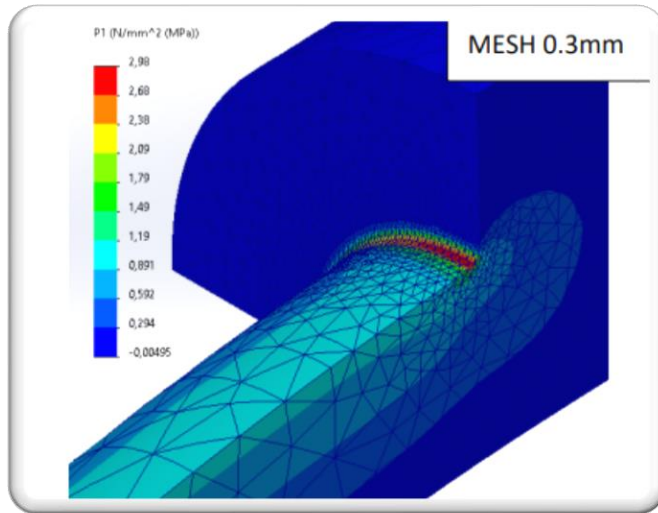
**SEZIONE D:**

spallamento ella ruota dentata

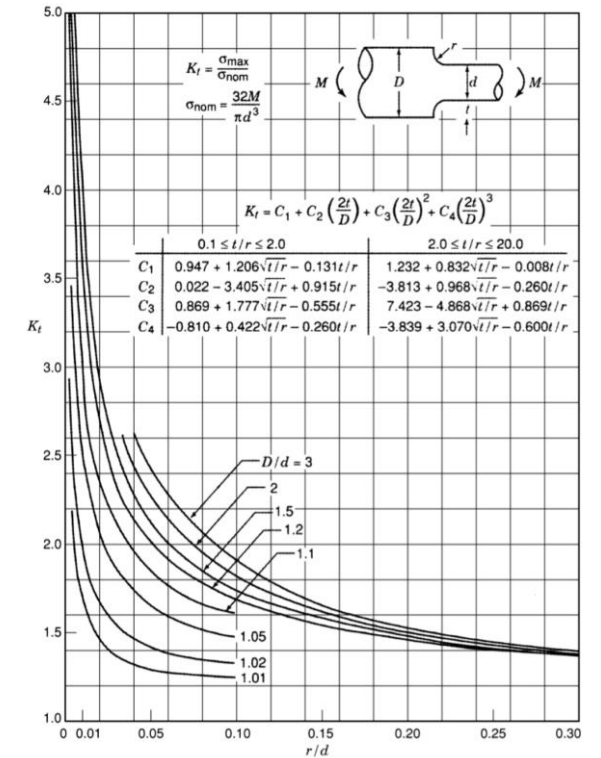
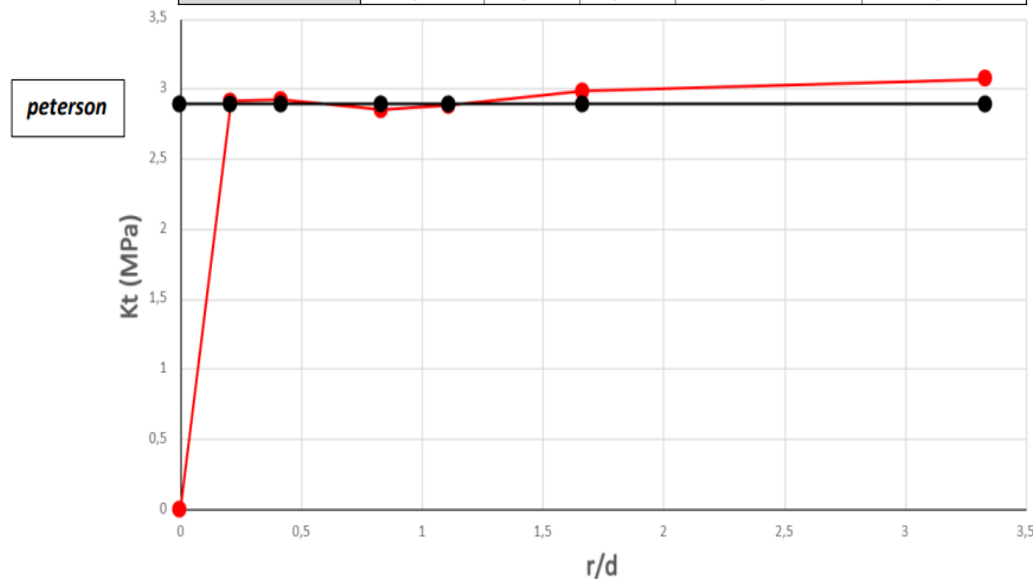


# ALBERO INTERMEDIO

## sezione A - calcolo $K_T$



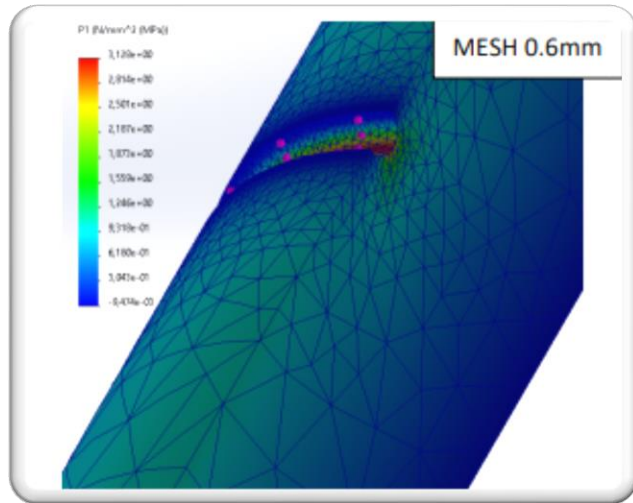
$K_t$ Peterson = 2,89	MESH (mm)	$K_t$	$r/d$	$\Delta\%$ dal precedente	$\Delta\%$ dal Peterson
SIMULAZIONE 1	2,4	2,91	0,208		-2,38
SIMULAZIONE 2	1,2	2,92	0,417	0,34	-2,05
SIMULAZIONE 3	0,6	2,85	0,833	-2,40	-4,39
SIMULAZIONE 4	0,45	2,88	1,111	1,05	-3,39
SIMULAZIONE 5	0,3	2,98	1,667	3,47	-0,03
SIMULAZIONE 6	0,15	3,07	3,333	3,02	2,99



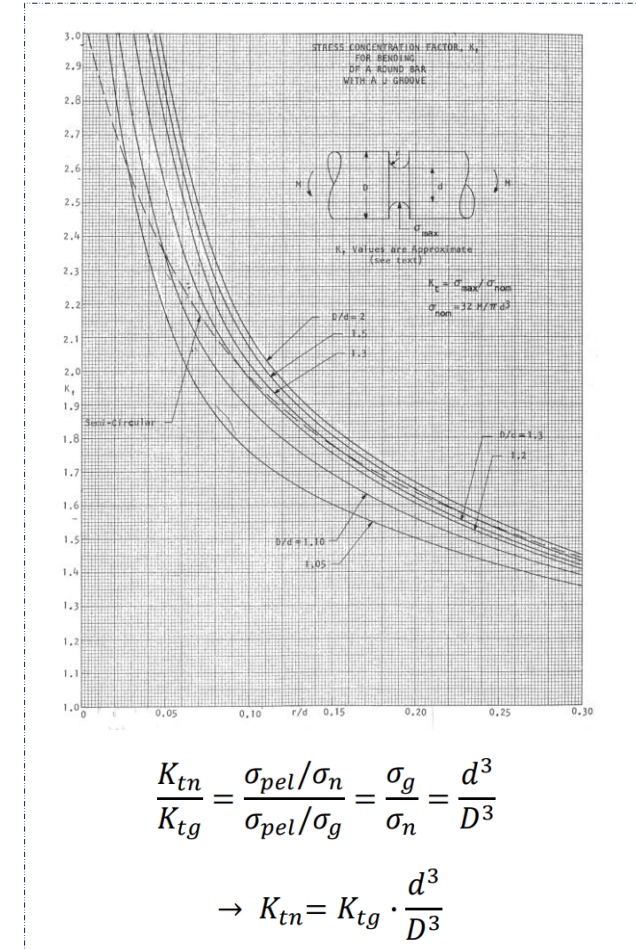
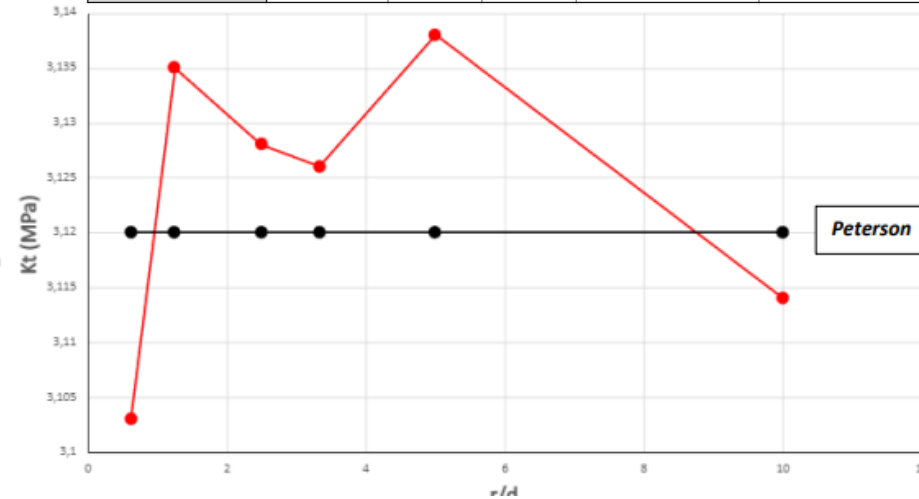


# ALBERO INTERMEDIO

## sezione B - calcolo $K_T$



$K_t$ Peterson = 3,12	MESH (mm)	$K_t$	$r/d$	$\Delta\%$ dal precedente	$\Delta\%$ dal Peterson
SIMULAZIONE 1	2,4	3,103	0,625		-0,54
SIMULAZIONE 2	1,2	3,135	1,25	1,031	0,48
SIMULAZIONE 3	0,6	3,128	2,5	-0,223	0,26
SIMULAZIONE 4	0,45	3,126	3,33	-0,064	0,19
SIMULAZIONE 5	0,3	3,138	5	0,384	0,58
SIMULAZIONE 6	0,15	3,114	10	-0,765	-0,19

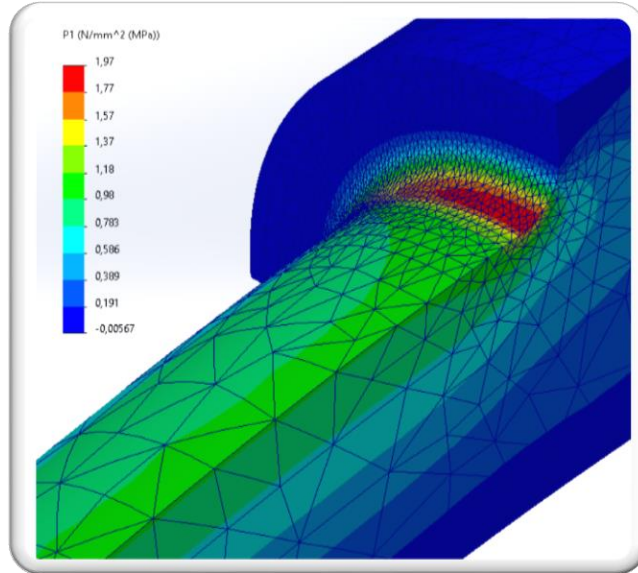


$$\frac{K_{tn}}{K_{tg}} = \frac{\sigma_{pel}/\sigma_n}{\sigma_{pel}/\sigma_g} = \frac{\sigma_g}{\sigma_n} = \frac{d^3}{D^3}$$

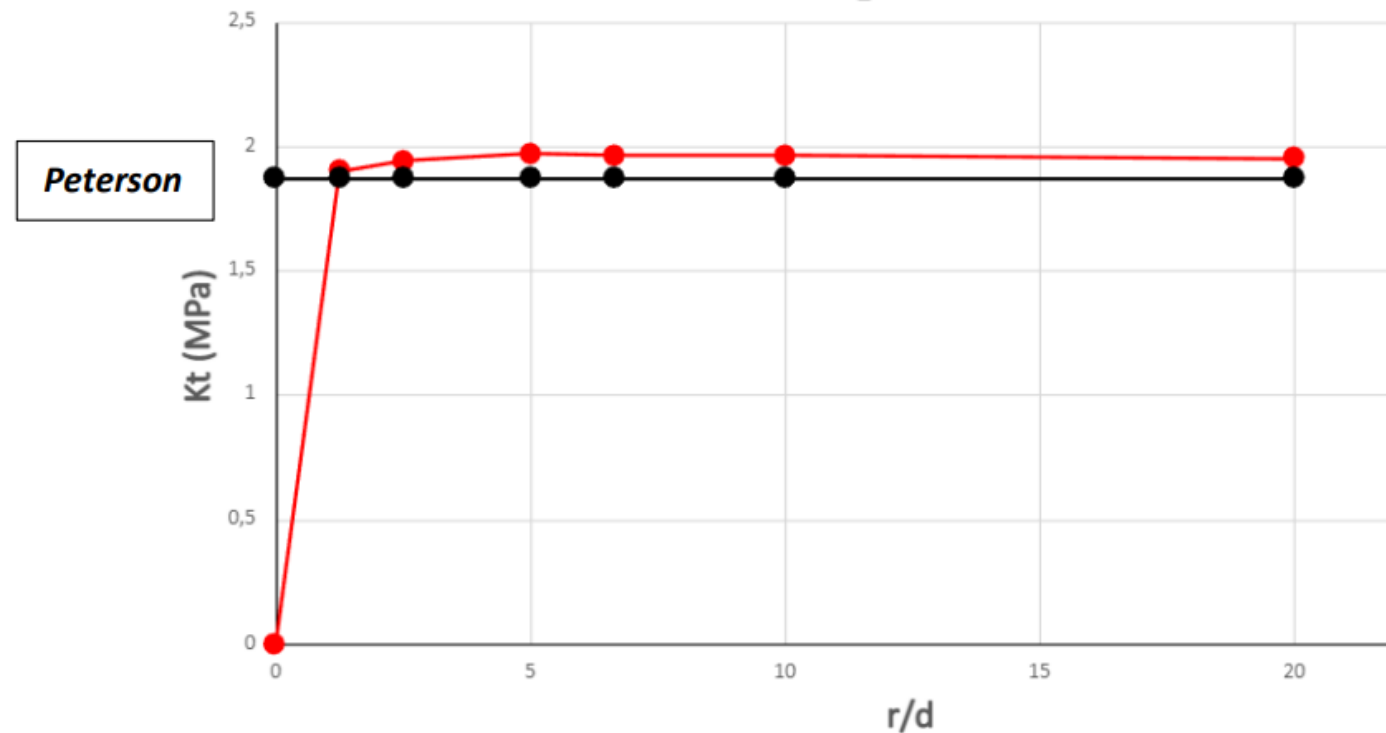
$$\rightarrow K_{tn} = K_{tg} \cdot \frac{d^3}{D^3}$$

# ALBERO INTERMEDIO

## sezione D - calcolo $K_T$

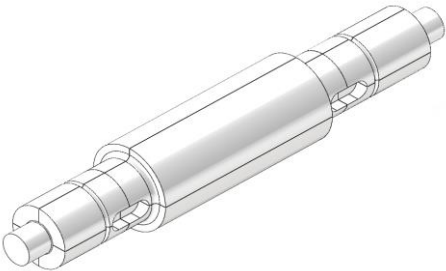
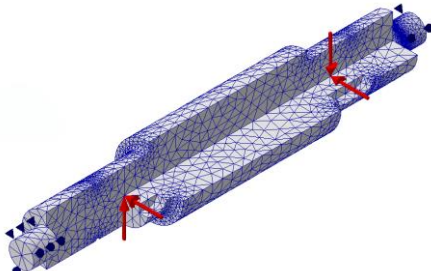
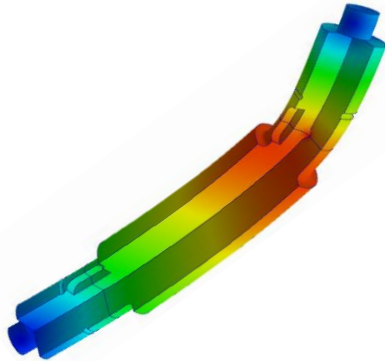

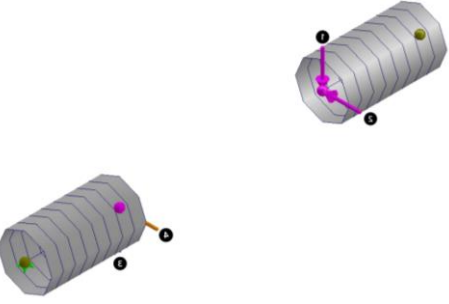
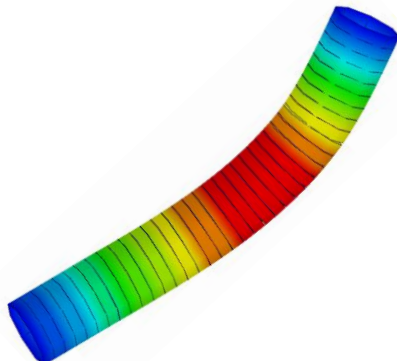


$K_t$ Peterson = 1,87	MESH (mm)	$K_t$	$r/d$	$\Delta\%$ dal precedente	$\Delta\%$ dal Peterson
SIMULAZIONE 1	2,4	1,9	1,25		1,60
SIMULAZIONE 2	1,2	1,94	2,5	2,11	3,74
SIMULAZIONE 3	0,6	1,97	5	1,55	5,35
SIMULAZIONE 4	0,45	1,96	6,66	-0,51	4,81
SIMULAZIONE 5	0,3	1,96	10	0,00	4,81
SIMULAZIONE 6	0,15	1,95	20	-0,51	4,28



# ALBERO INTERMEDIO

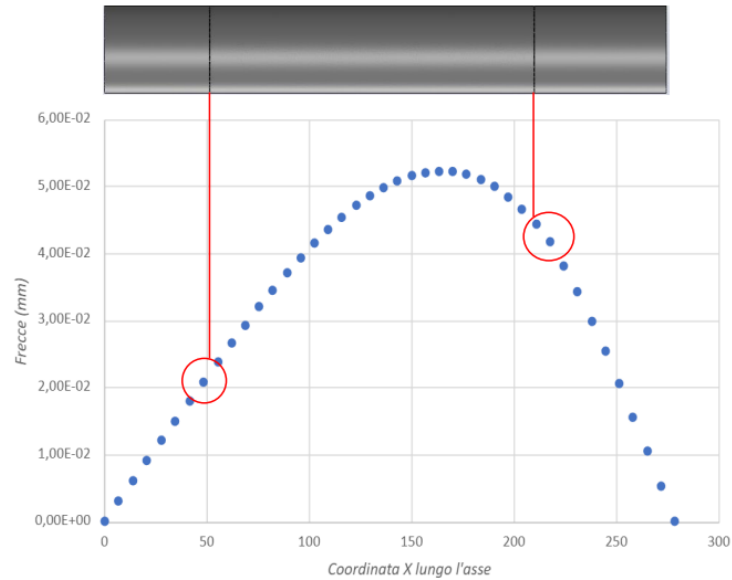
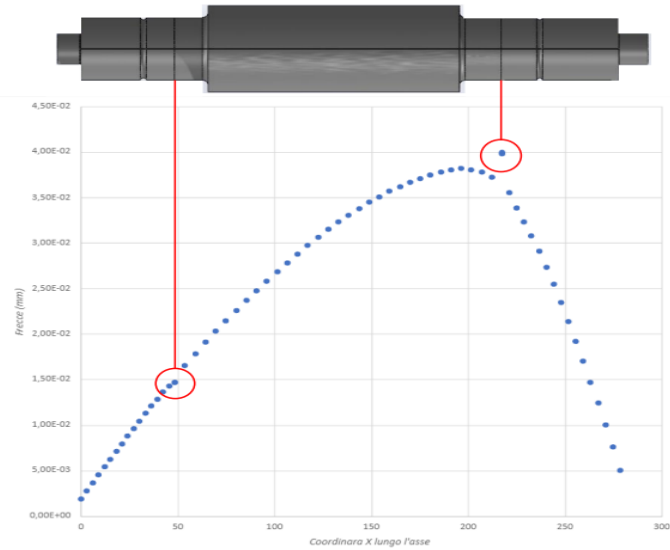
## verifica a deformabilità

 <p>modello tridimensionale</p>	 <p>mesh solida basata su curvatura</p>	 <p>deformata</p>
 <p>modello monodimensionale</p>	 <p>mesh di tipo trave</p>	 <p>deformata</p>

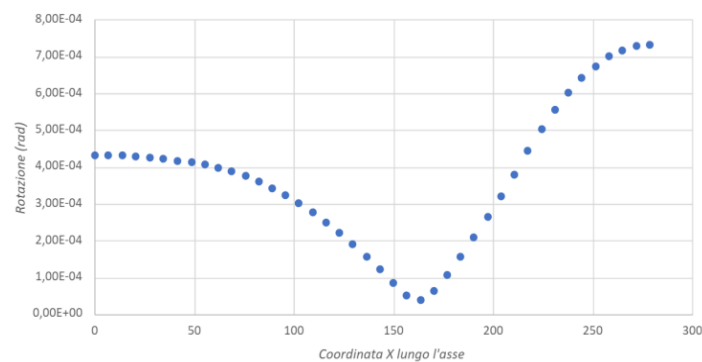
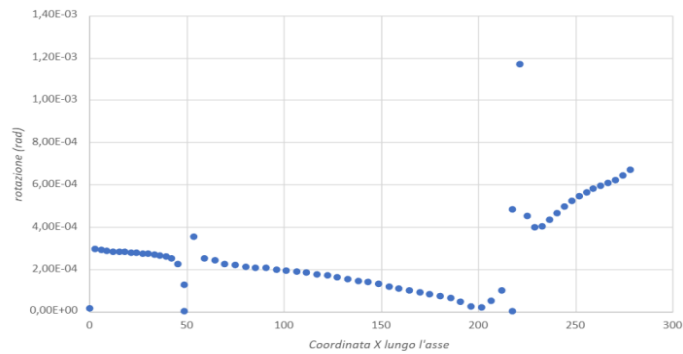
# ALBERO INTERMEDIO

## spostamenti e rotazioni

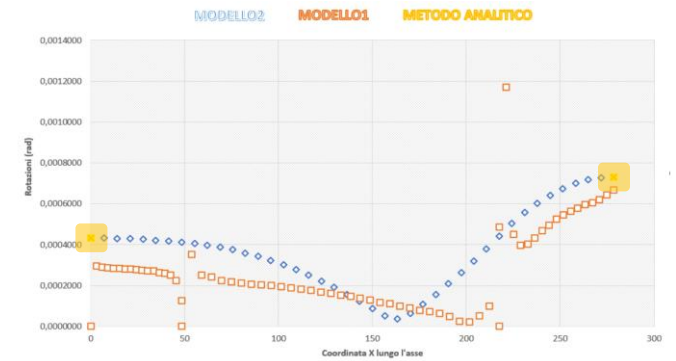
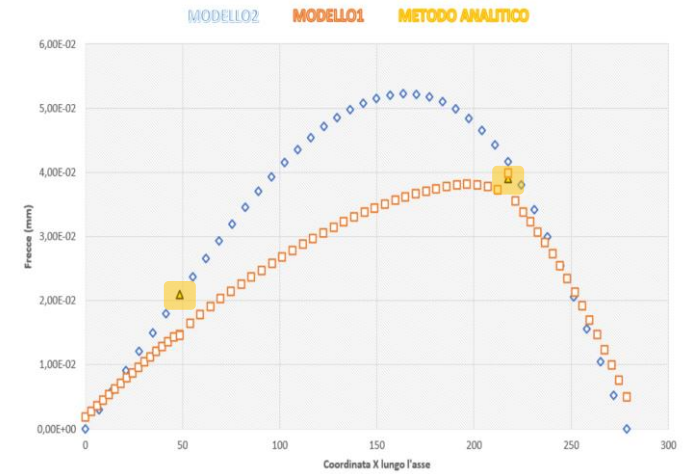
spostamenti



rotazioni



### Sovrapposizione modelli



- **Verifiche a fatica flessionale tramite calcolo del  $K_t$**

SEZIONE	$K_T$	$K_T$ <i>Peterson</i>	Deviazione (%)
A	3,07	2,891	+6,19%
B	3,114	3,12	-0,21%
D	1,95	1,87	+4,28%

- **Verifiche a deformabilità: spostamenti**

MODELLO	$f_2$ (mm)	$f_3$ (mm)
Tridimensionale	0,0147	0,0389
Monodimensionale	0,021	0,0416
Analitico	0,021	0,039

- **Verifiche a deformabilità: rotazioni**

MODELLO	$\varphi_s$ (rad)	$\varphi_d$ (rad)
Tridimensionale	0.00025	0.00049
Monodimensionale	0,00041	0,0004
Analitico	0,000383	0,000719