UNIVERSITÀ DEGLI STUDI DI PADOVA

Dipartimento Territorio e Sistemi Agro-forestali
Corso di Laurea Magistrale in Scienze Forestali e Ambientali

Tesi di Laurea Magistrale

Use of smartphone technology for non-destructive evaluation of the mechanical properties of wood

Relatore: Prof. Gianluca Tondi
Correlatore: Prof. Michela Nocetti

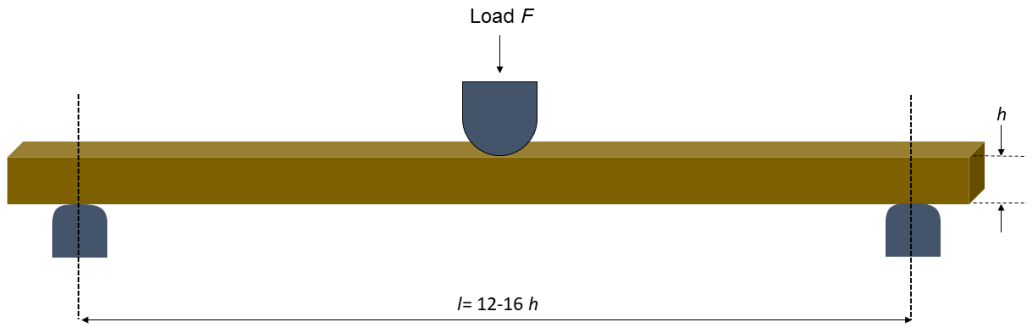
Laureando: Matteo Pol

N° di matricola: 1241236

Anno Accademico 2020/2021

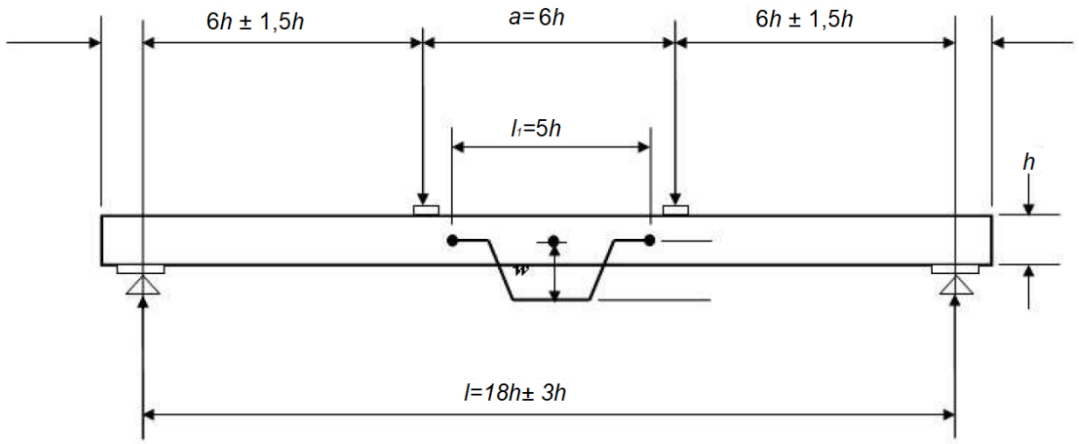
MOE = MODULO DI ELASTICITA’

MOE_{3P} (ISO 13061)



MOE 4 PUNTI (EN 408)

- **Globale (MOEG)**
- **Locale (MOEL)**



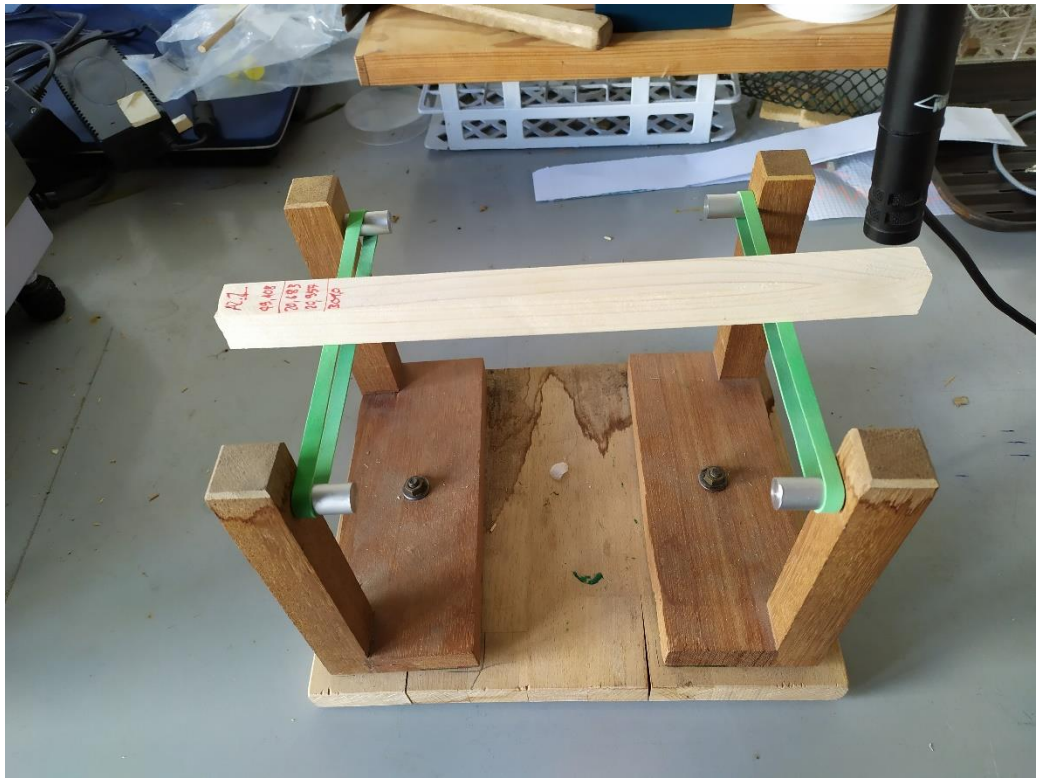
DMOE= MODULO ELASTICO DINAMICO

Metodo vibrazionale trasversale

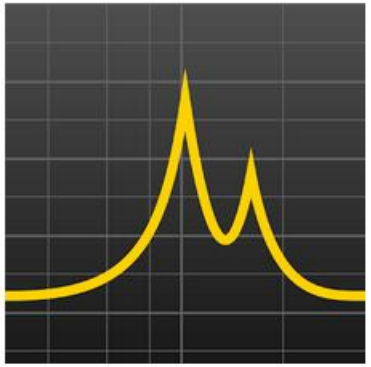
Metodo vibrazionale longitudinale

DMOE: dispositivi professionali

BING-metodo trasversale (microfono)



ViSCAN- metodo longitudinale (laser)



Spectroid

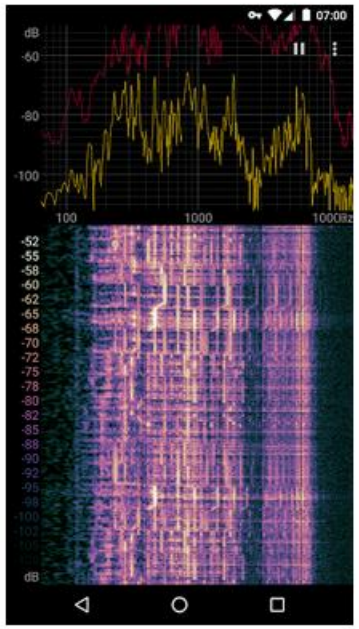
Carl Reinke Strumenti

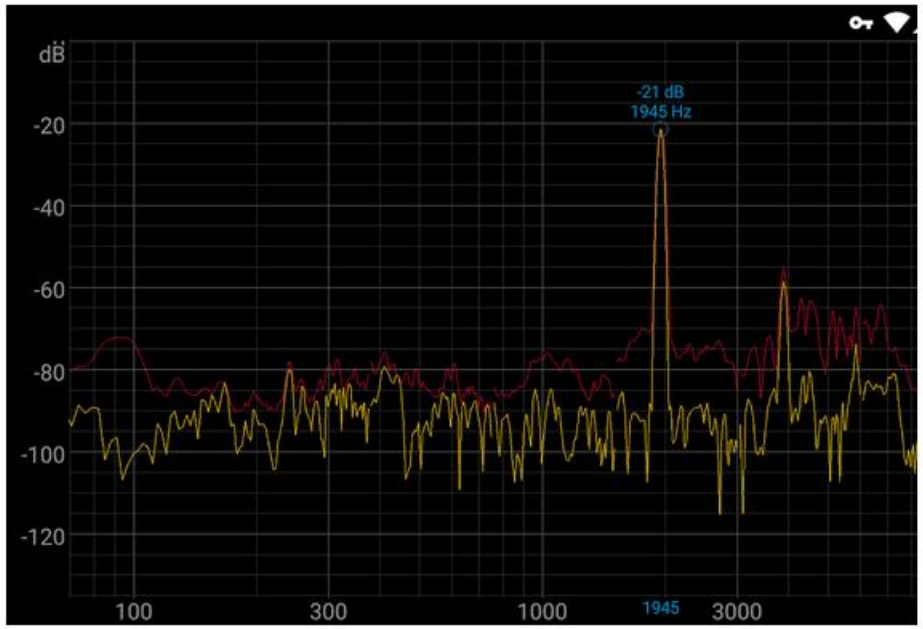
★★★★½ 10.705

Per tutti

Questa app è disponibile per il tuo dispositivo

Installata





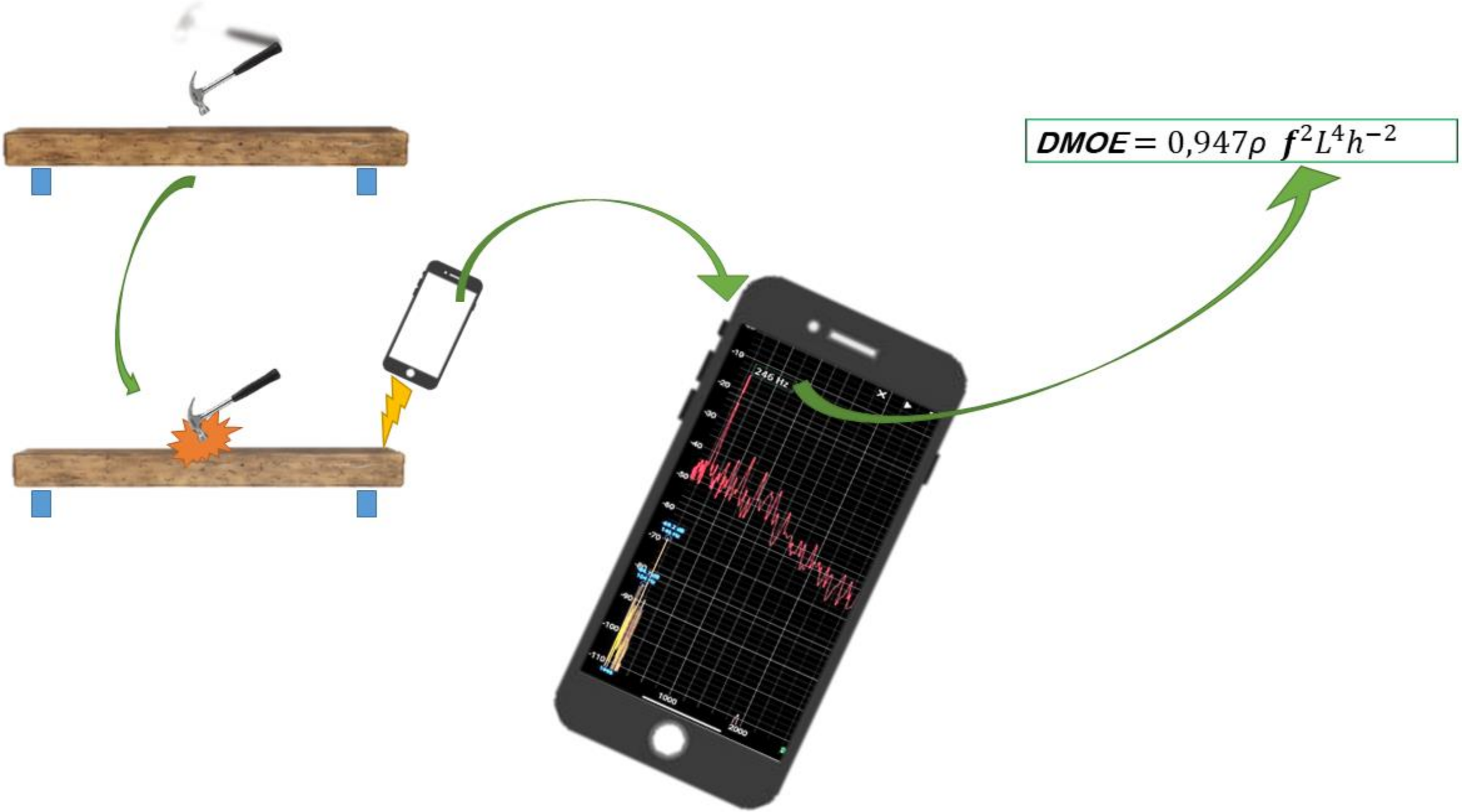
DOMANDE DI RICERCA

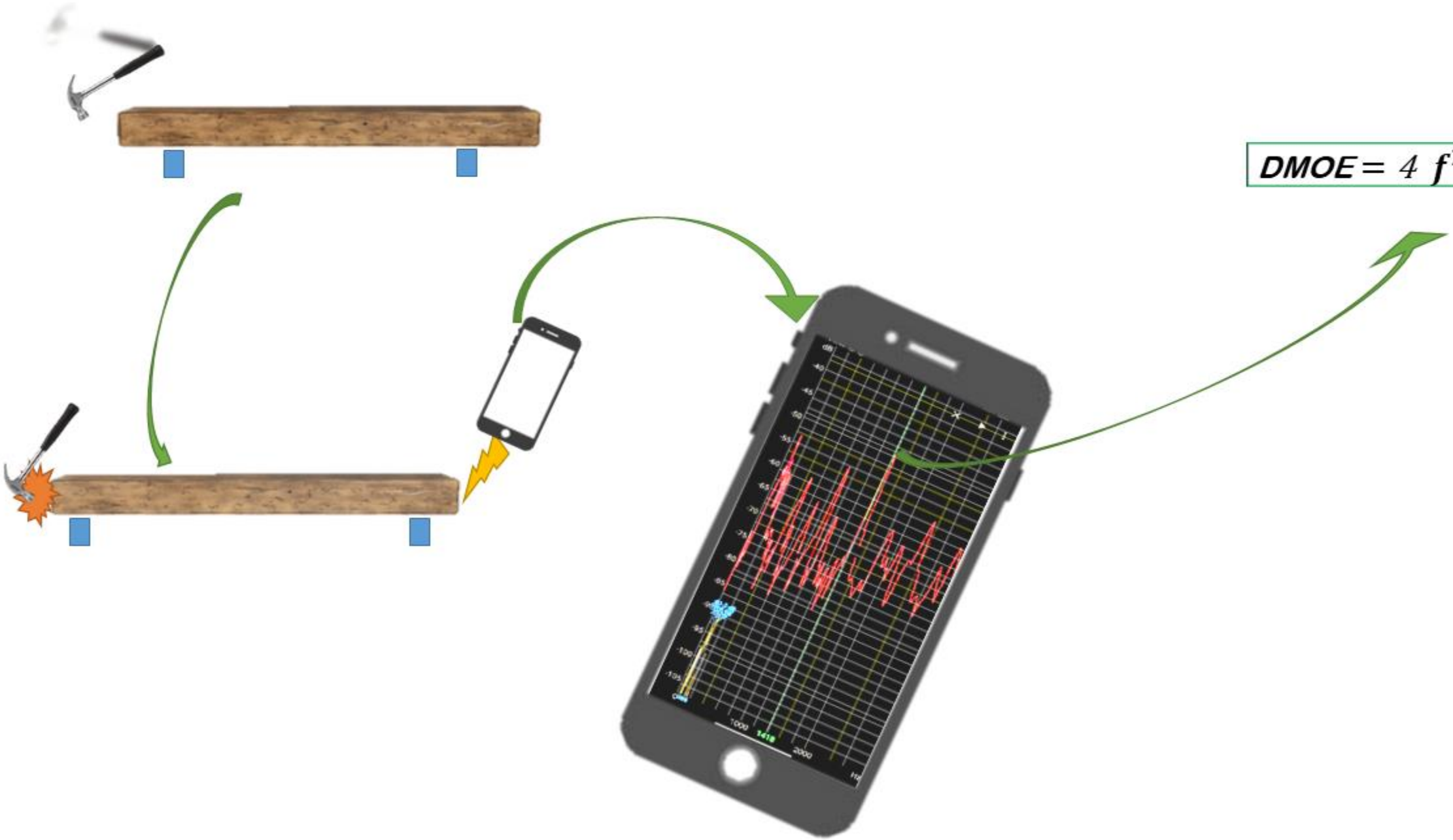
1. Spectroid dà risultati affidabili quanto dispositivi professionali quali Bing e Viscan?
2. La qualità di stima del MOE tramite il DMOE varia tra conifere e latifoglie?
3. Varia tra specie differenti?
4. Varia con le dimensioni del campione?

Materiali e Metodi

TOT. 88 CAMPIONI

Species	Dimensional classes (mm)	Num. Specimens
Pinus sylvestris	40x40x1000	10
Fagus sylvatica	40x40x1000	10
Picea abies	20x20x300	12
	40x40x1000	11
	200x200x4000	9
Castanea sativa	20x20x300	14
	40x40x1000	10
	40x165x3600	12
		88 Tot.


$DMOE = 0{,}947\rho\ f^2 L^4 h^{-2}$
246 Hz
1000
2000



$$DMOE = 4\, f^2 L^2 \rho$$

Spectroid dà risultati affidabili quanto ViSCAN o BING? **Sì**

r= coef. di Pearson

	BING_Trasv_Mic	*Spect_Trasv*	*Spect_Long*	*ViSCAN*	*MOE_G*	*MOE_L*	*MOE_{3P}*
BING_Trasv_Mic	1						
Spect_Trasv	**0,961**	1					
Spect_Long	0,959	0,967	1				
ViSCAN	0,955	0,977	**0,997**	1			
MOE_G	0,952	0,974	0,902	0,897	1		
MOE_L	0,857	0,888	0,787	0,778	0,911	1	
MOE_{3P}	0,946	0,953	0,903	-	-	-	1

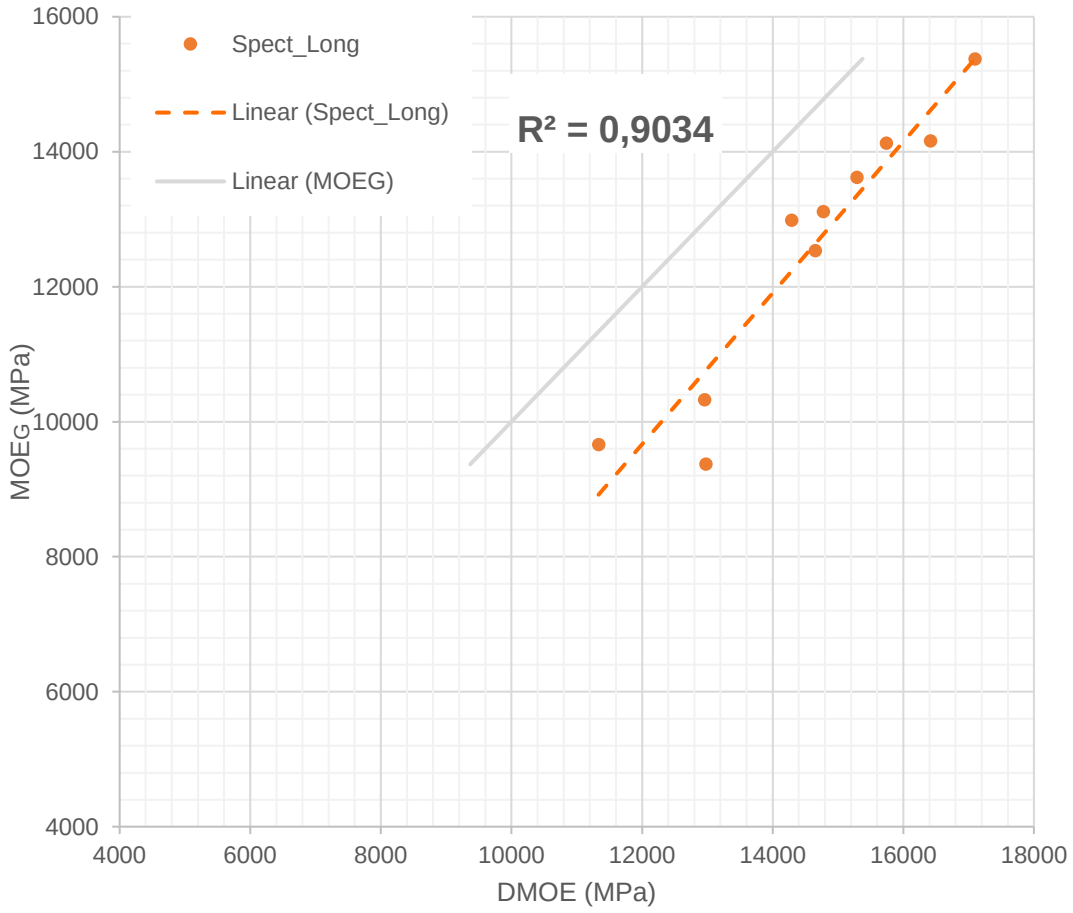
La qualità di stima del MOE tramite il DMOE varia tra conifere e latifoglie? Sì

R^2=Coef. di determinazione

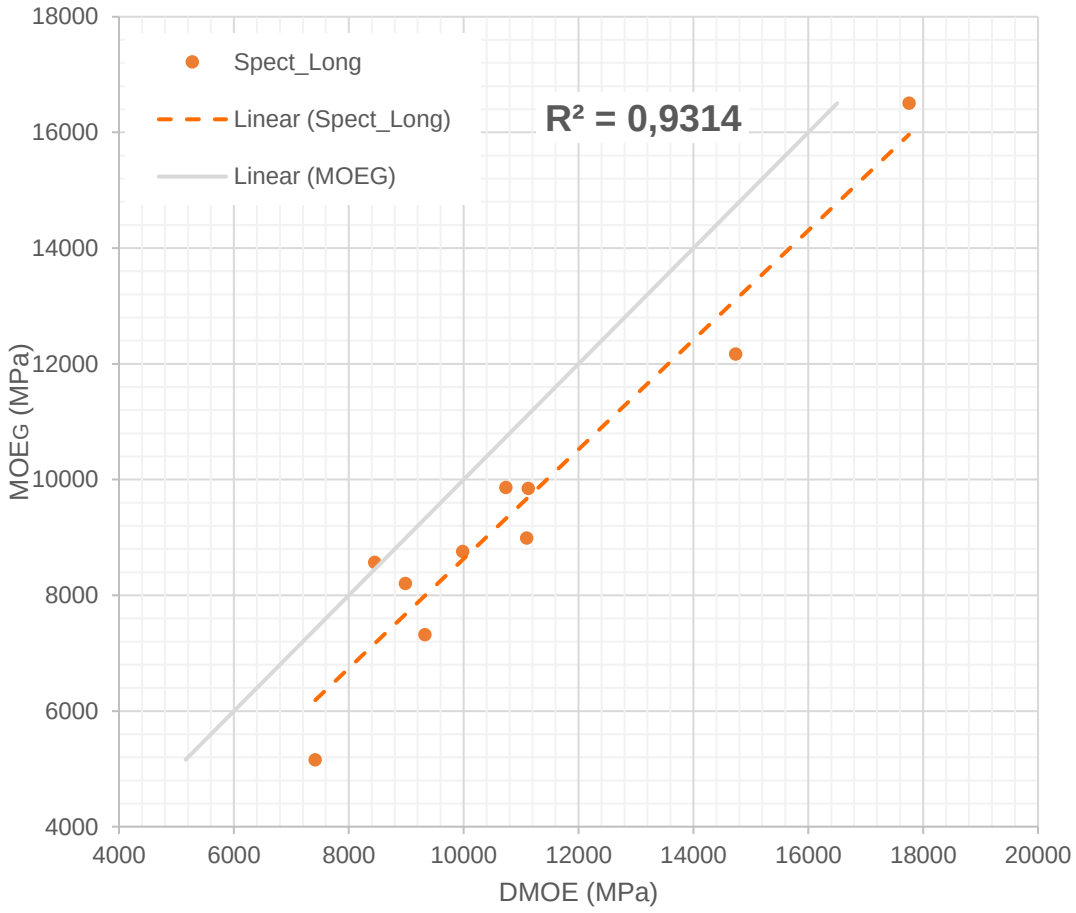
	BING_Trasv_Mic		Spect_Trasv		Spect_Long		ViSCAN	
	C	L	C	L	C	L	C	L
MOE_G	0,94	0,86	0,96	0,94	0,79	0,78	0,78	0,78
MOE_L	0,84	0,73	0,87	0,74	0,71	0,57	0,70	0,57
MOE_{3P}	0,86	0,73	0,87	0,72	0,62	0,72	-	-

La qualità di stima varia tra specie? Sì

FAGGIO

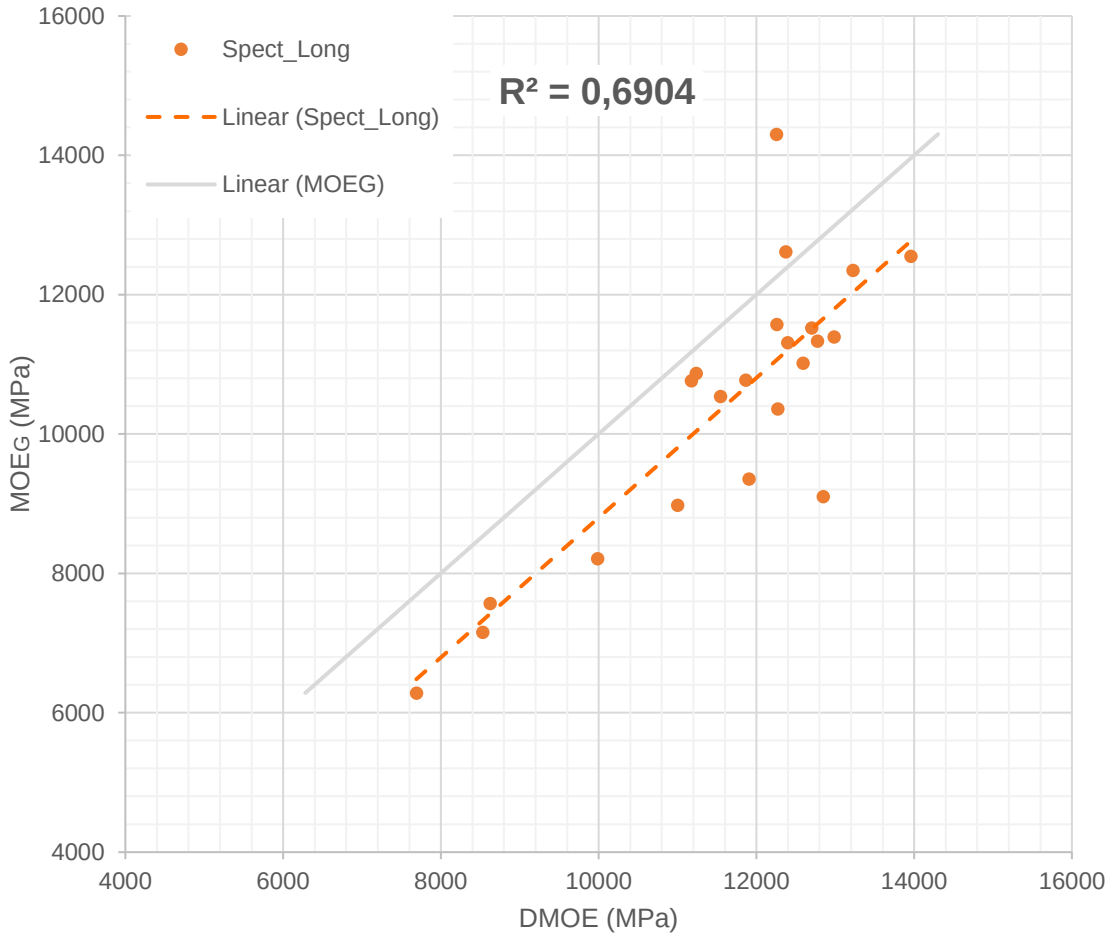


PINO SILVESTRE

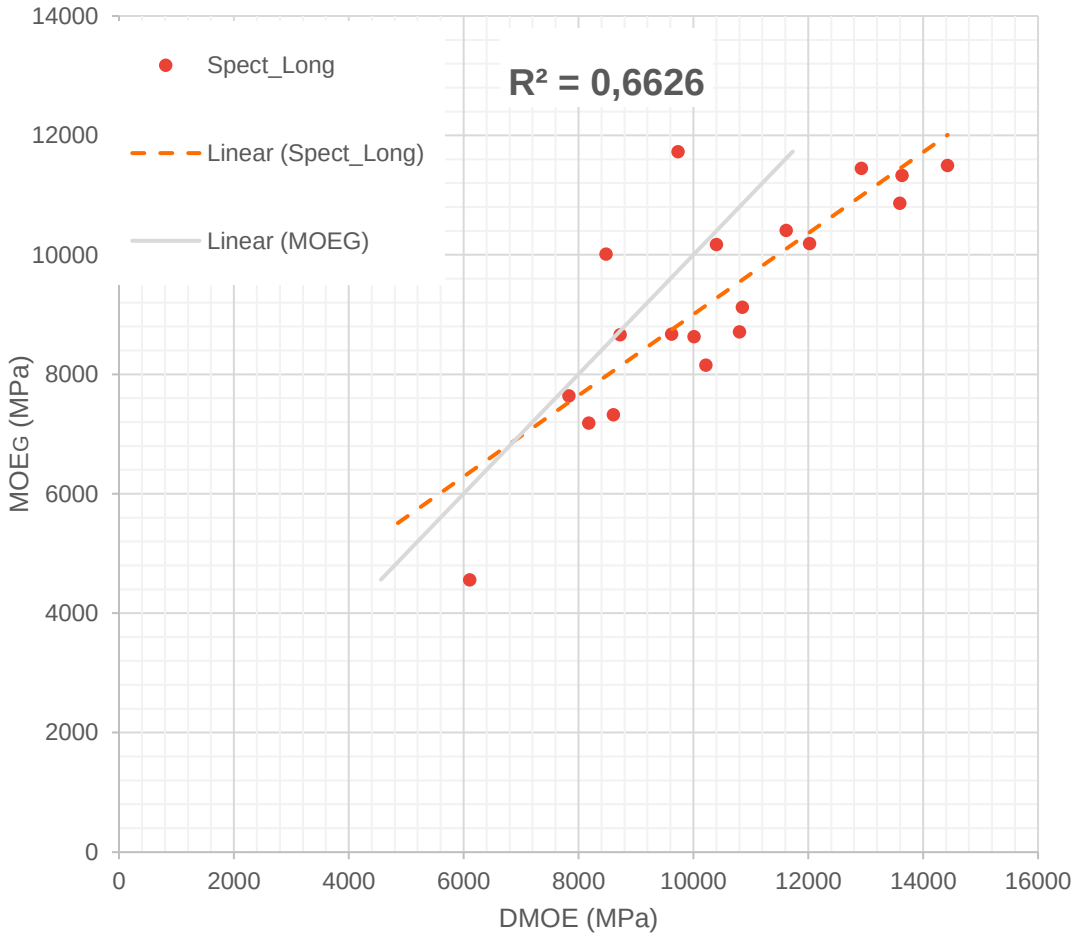


La qualità di stima varia tra specie? Sì

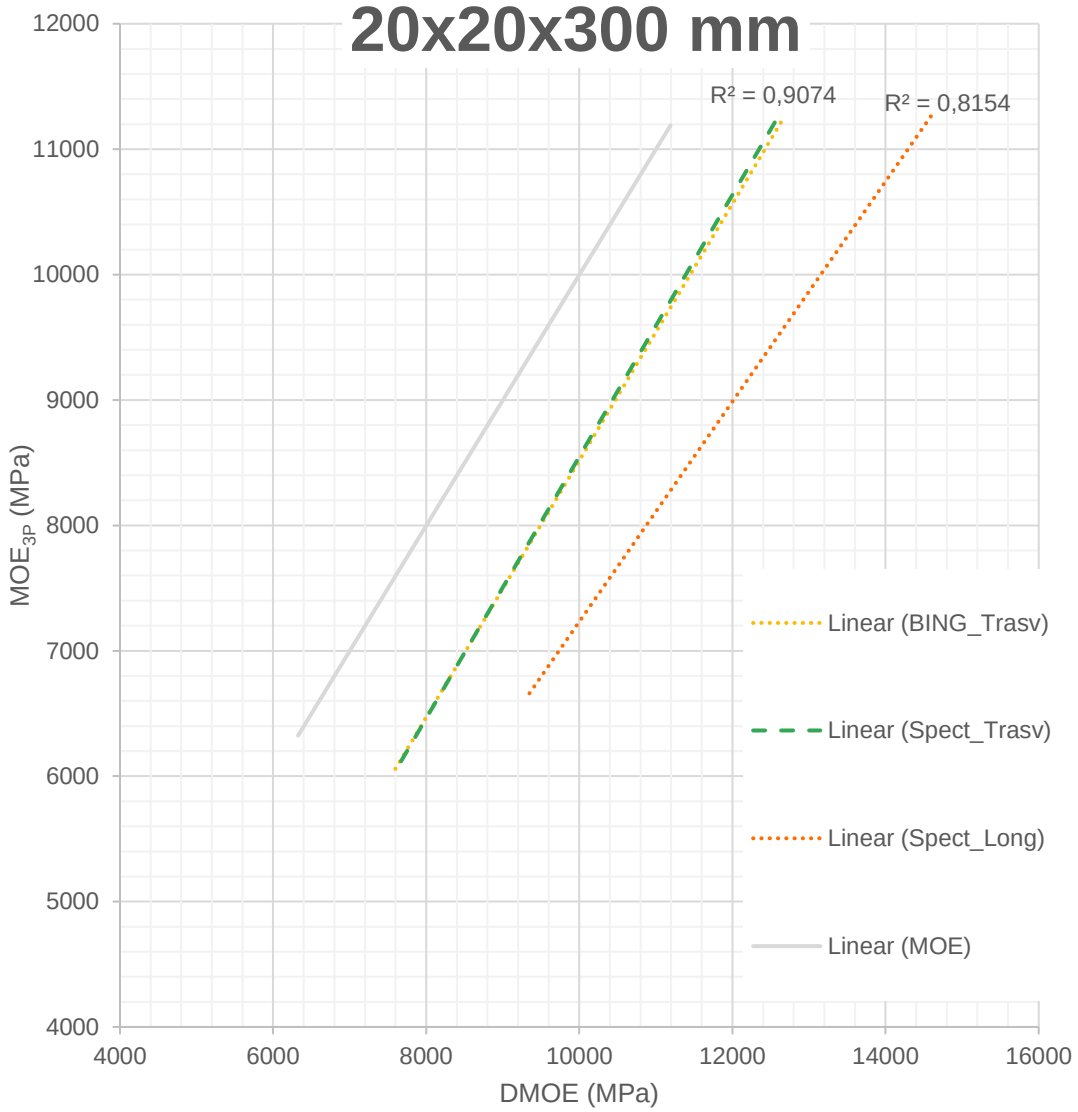
CASTAGNO

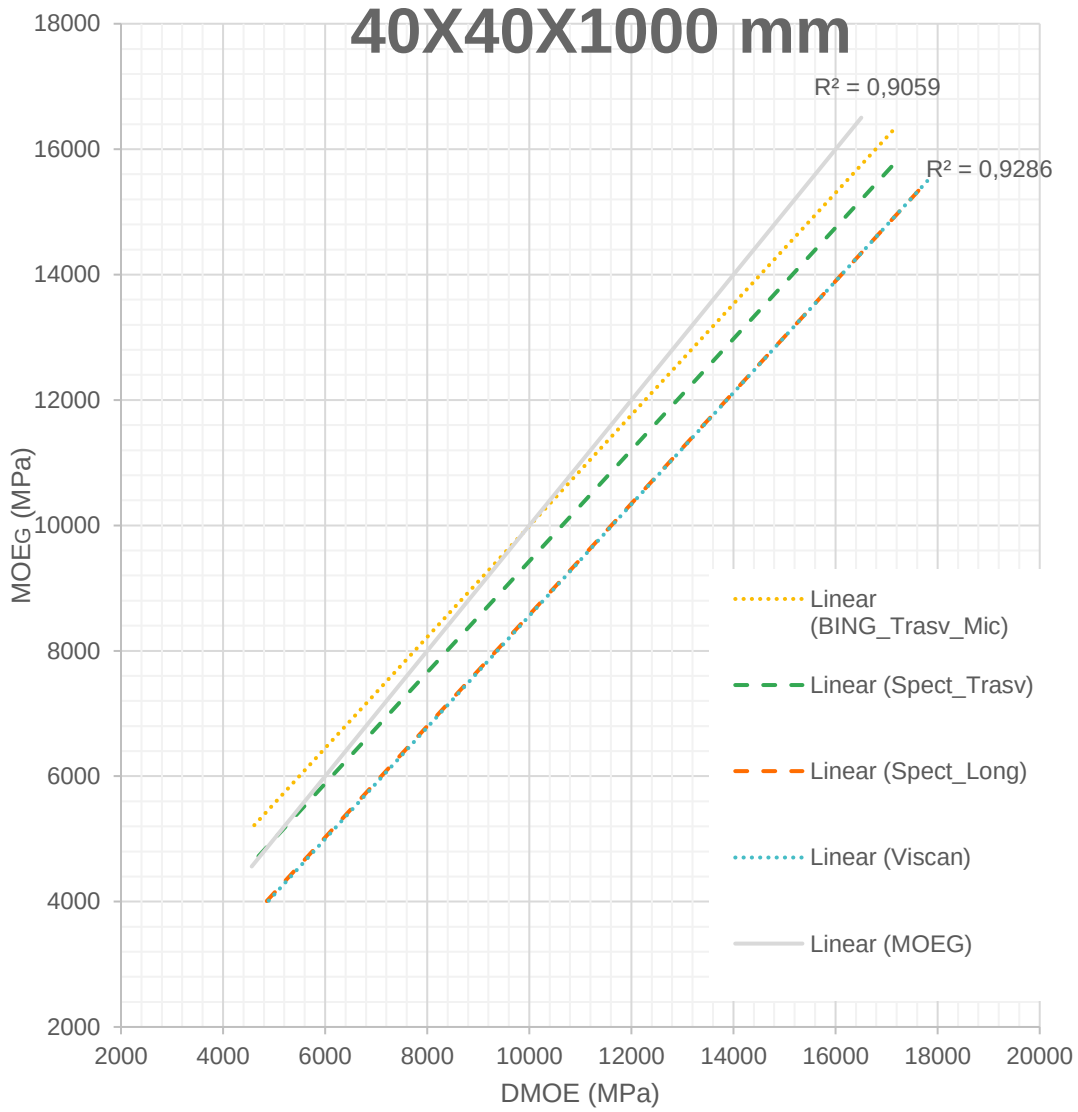


ABETE ROSSO



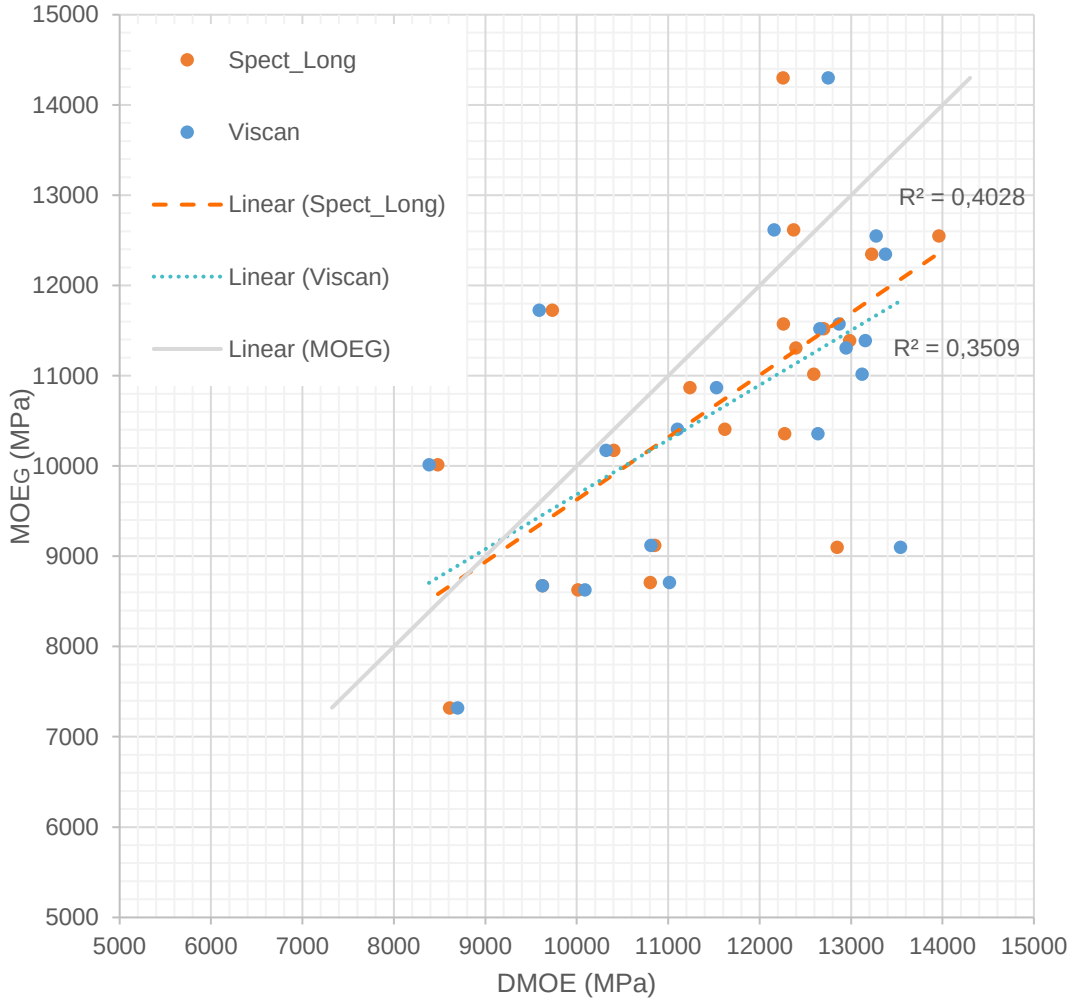
La qualità di stima varia con le dimensioni del campione?

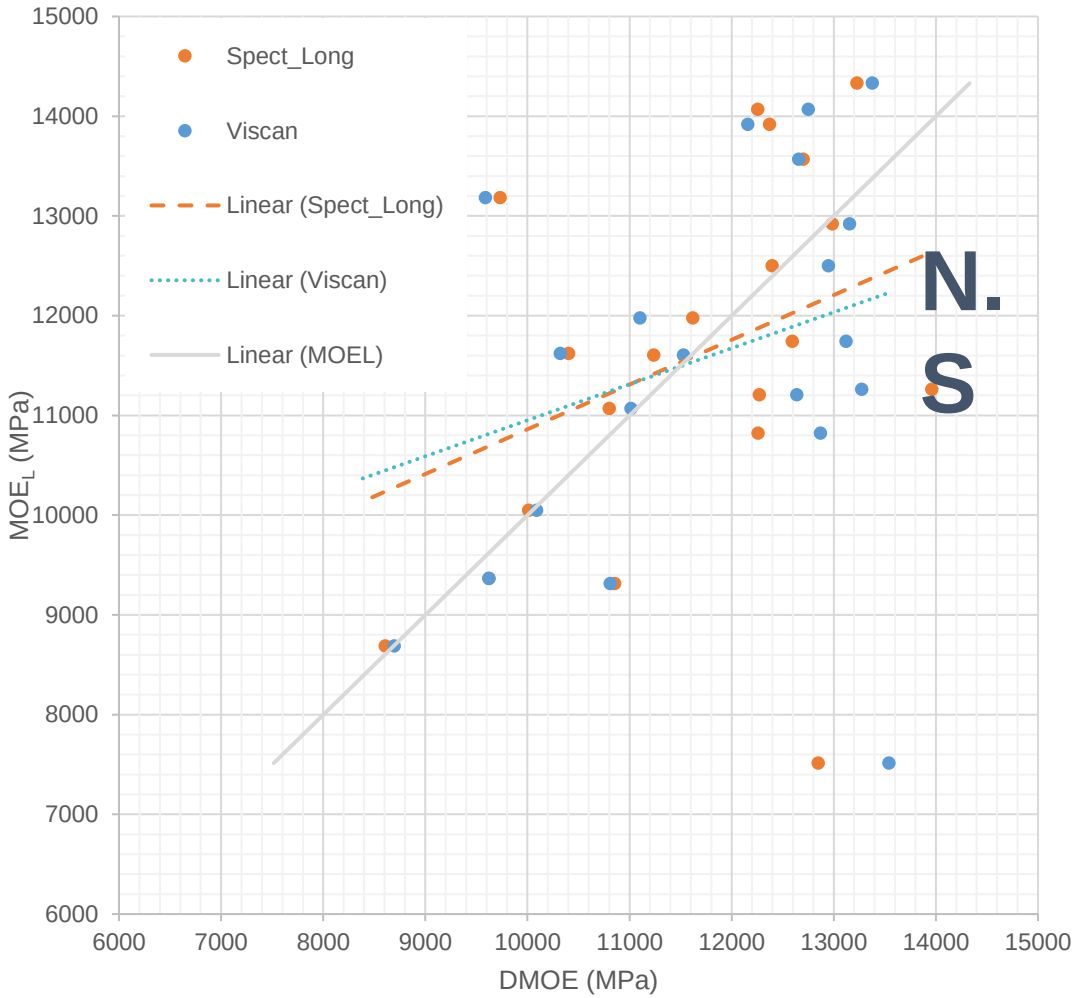




Varia con le dimensioni del campione?

CAMPIONI Più LUNGHI DI 2 M





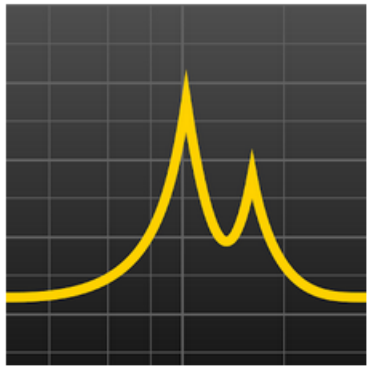
EQUAZIONI CONSIGLIATE PER L'UTILIZZO DI SPECTROID PER LA PREVISIONE DEL *MOE*

METODO TRASVERSALE

- MOE_G
- MOE_L
- MOE_{3P}

METODO LONGITUDINALE

- MOE_G
- MOE_L



Spectroid

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★★★★½ 10.705

Per tutti

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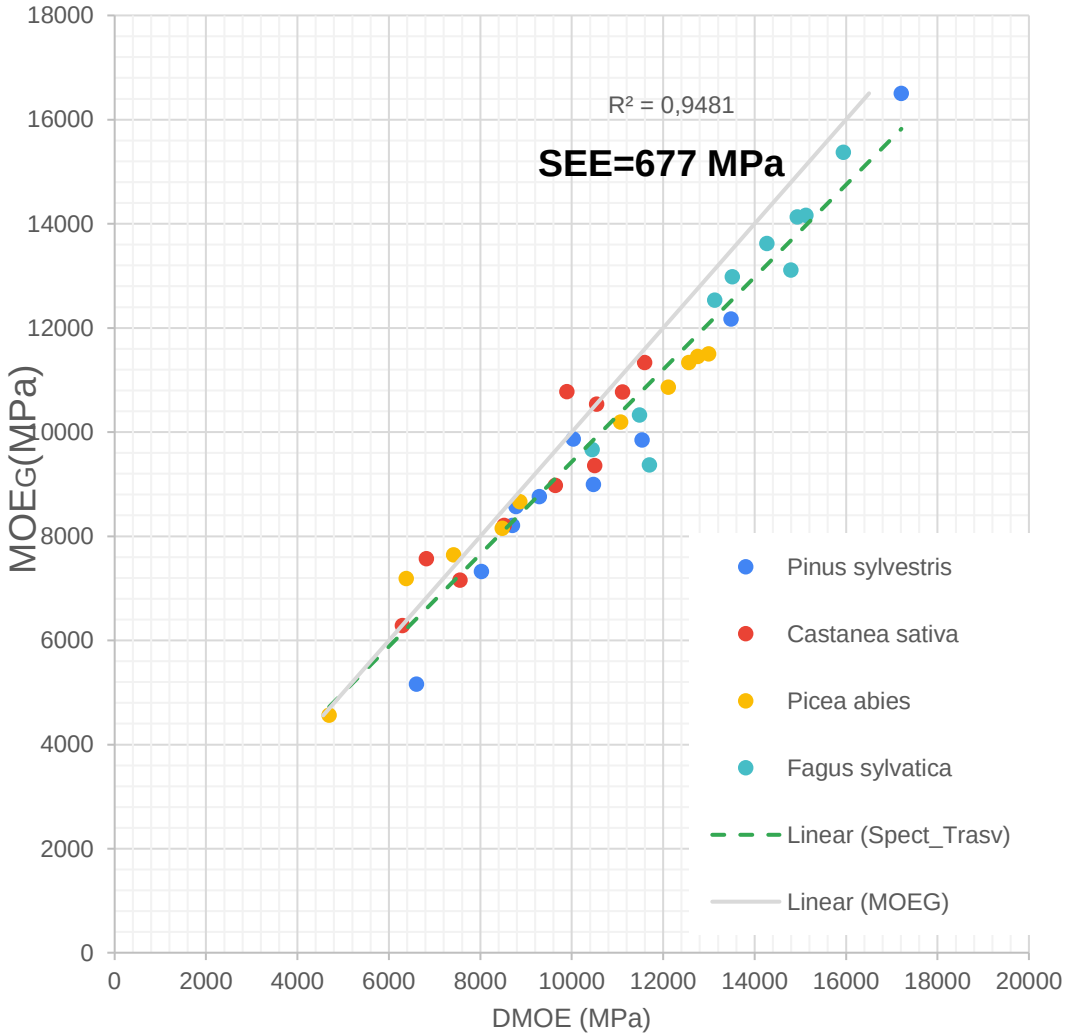
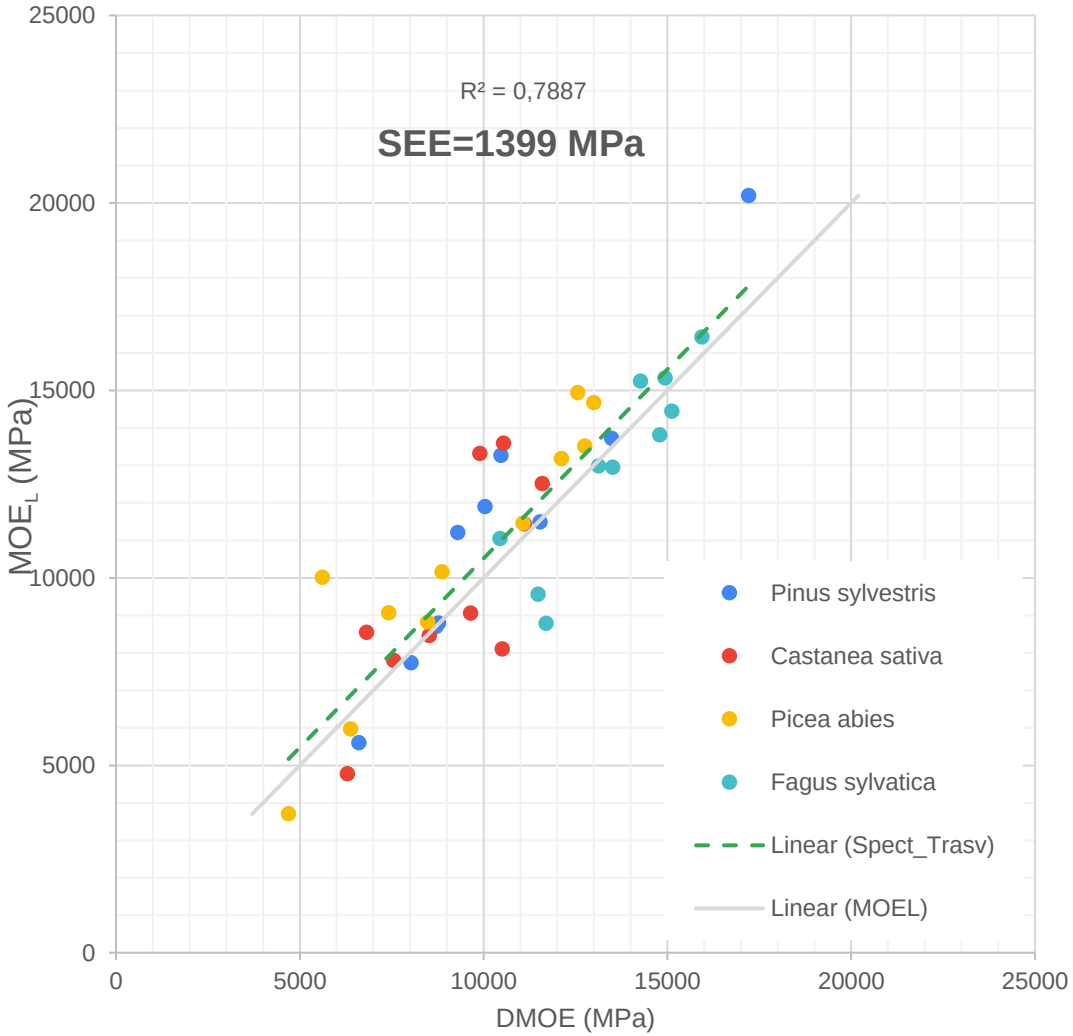
Installata

EQUAZIONI CONSIGLIATE PER L'UTILIZZO DI SPECTROID

$$MOE_G = 0{,}8866 DMOE + 563{,}70$$



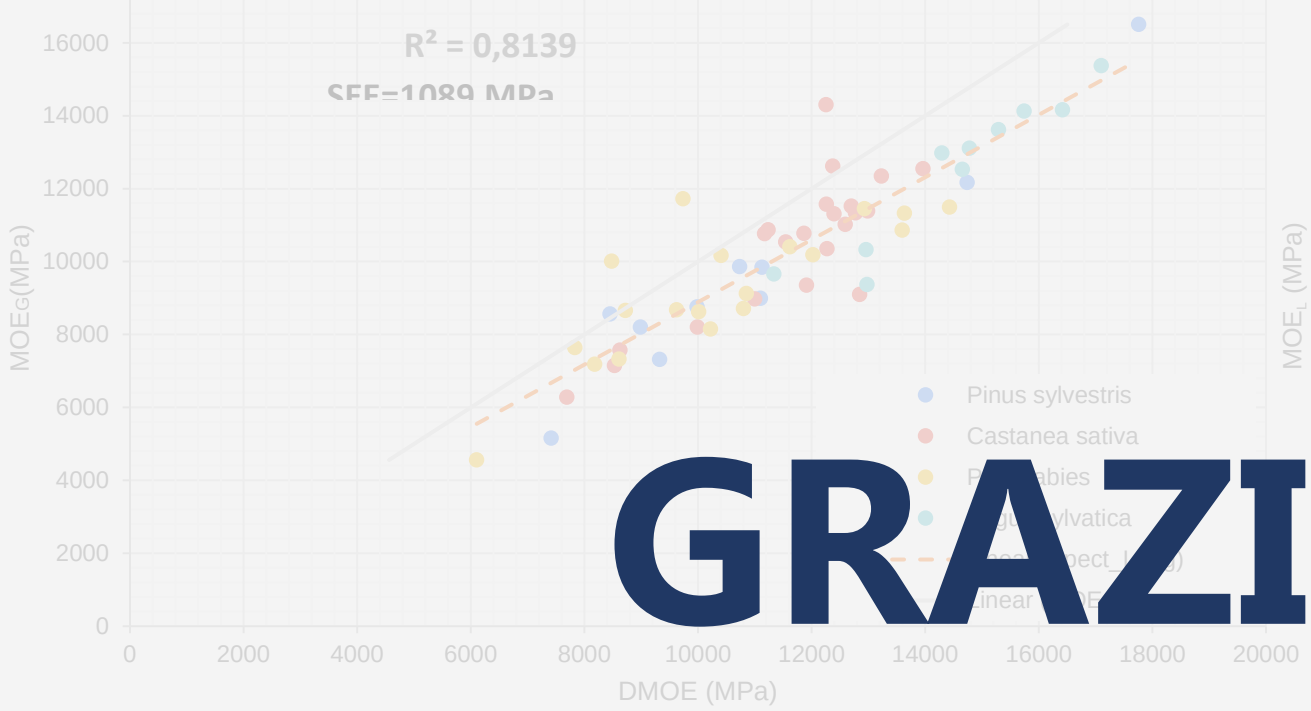
$$MOE_L = 1{,}0082 DMOE + 435{,}79$$

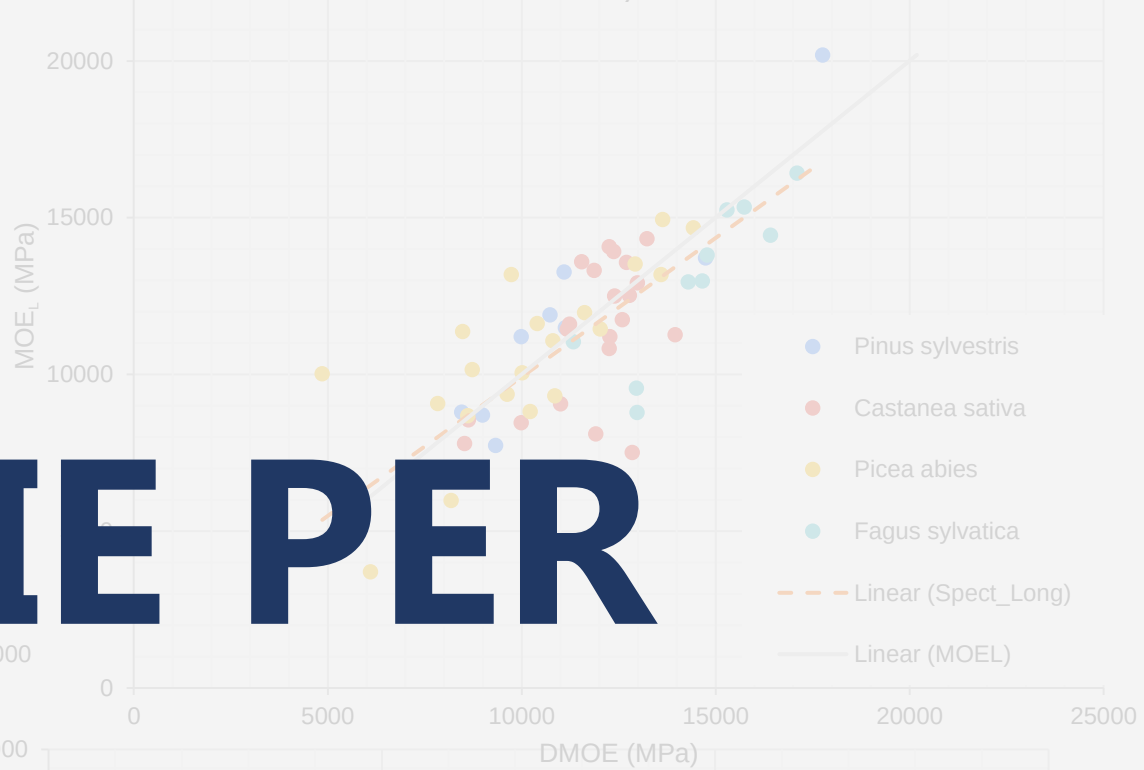


CAMPI DI IMPIEGO DELLA TECNOLOGIA

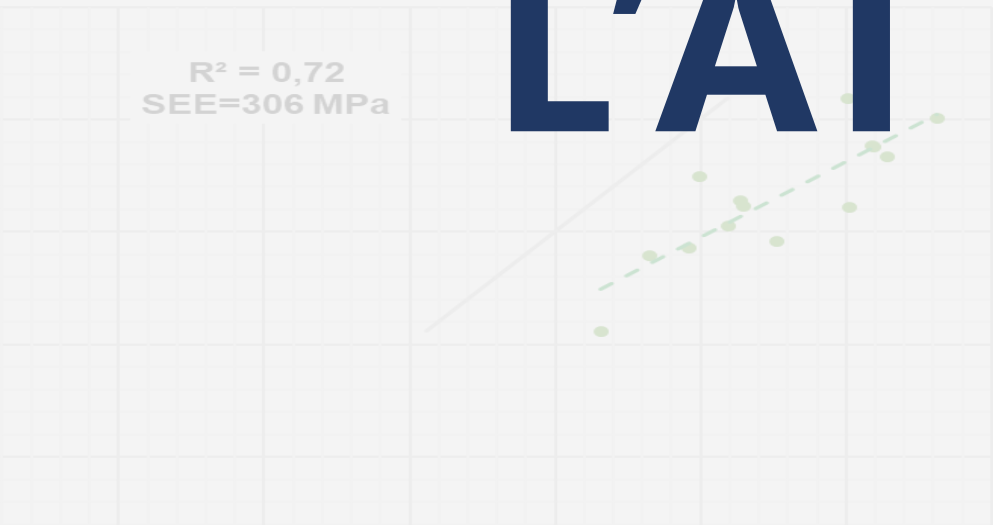
LABORATORI, INSEGNAMENTO

LIBERI PROFESSIONISTI



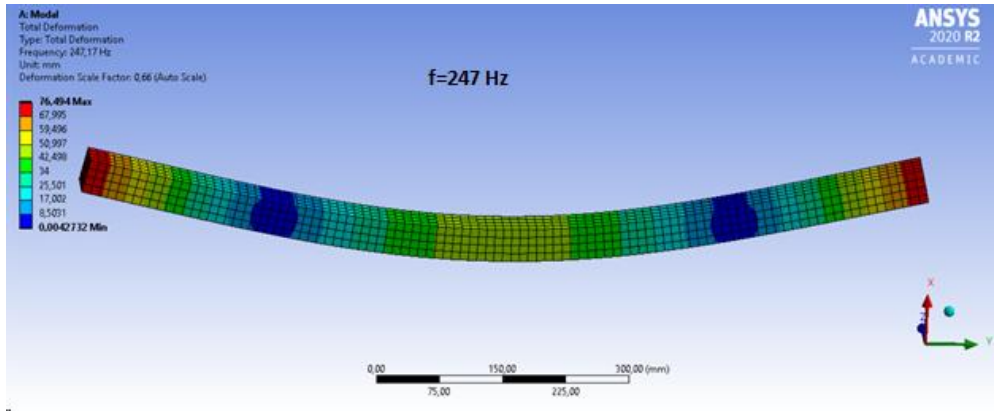


GRAZIE PER L'ATTENZIONE

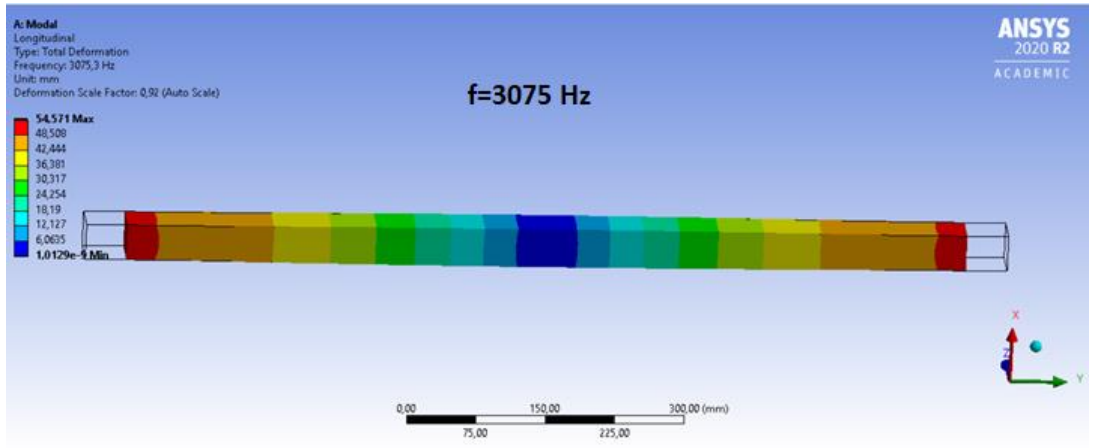


DMOE= MODULO ELASTICO DINAMICO

Metodo vibrazionale trasversale



Metodo vibrazionale longitudinale



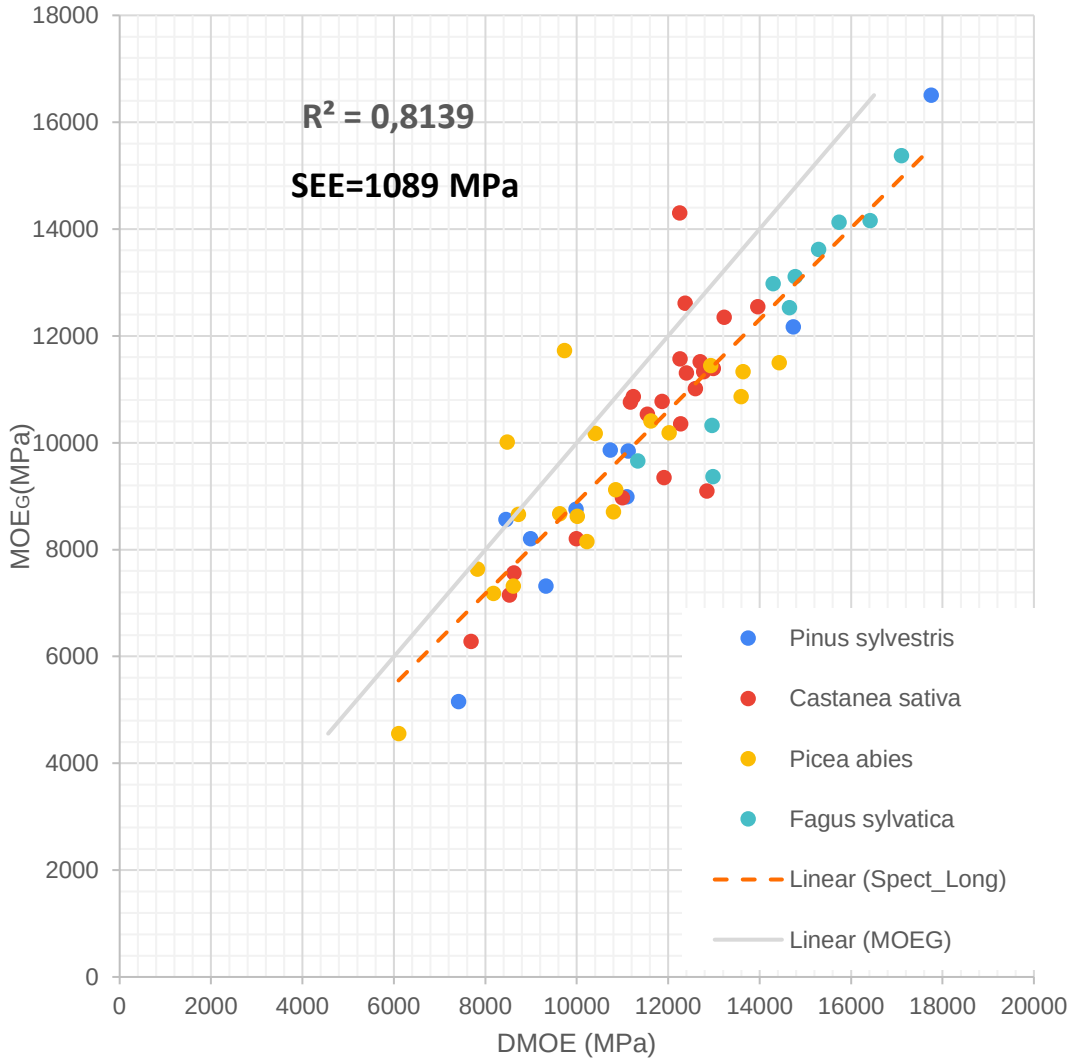
		Dynamic tests				Static tests	
		BING	**Spectroid**		**ViSCAN**	**Bending test machine**	
		Transv.	Transv.	Long.	Long.	3-point bending	4-point bending
Species	Sample (mm)	Microph.	Microph.	Microph.	Laser	-	-
Pinus sylvestris	40x40x1000	X	X	X	X		X
Fagus sylvatica	40x40x1000	X	X	X	X		X
Picea abies	20x20x300	X	X	X		X	
	40x40x1000	X	X	X	X		X
	200x200x4000			X	X		X
Castanea sativa	20x20x300	X	X	X		X	
	40x40x1000	X	X	X	X		X
	40x165x3600			X	X		X

Qualità della stima in specie differenti

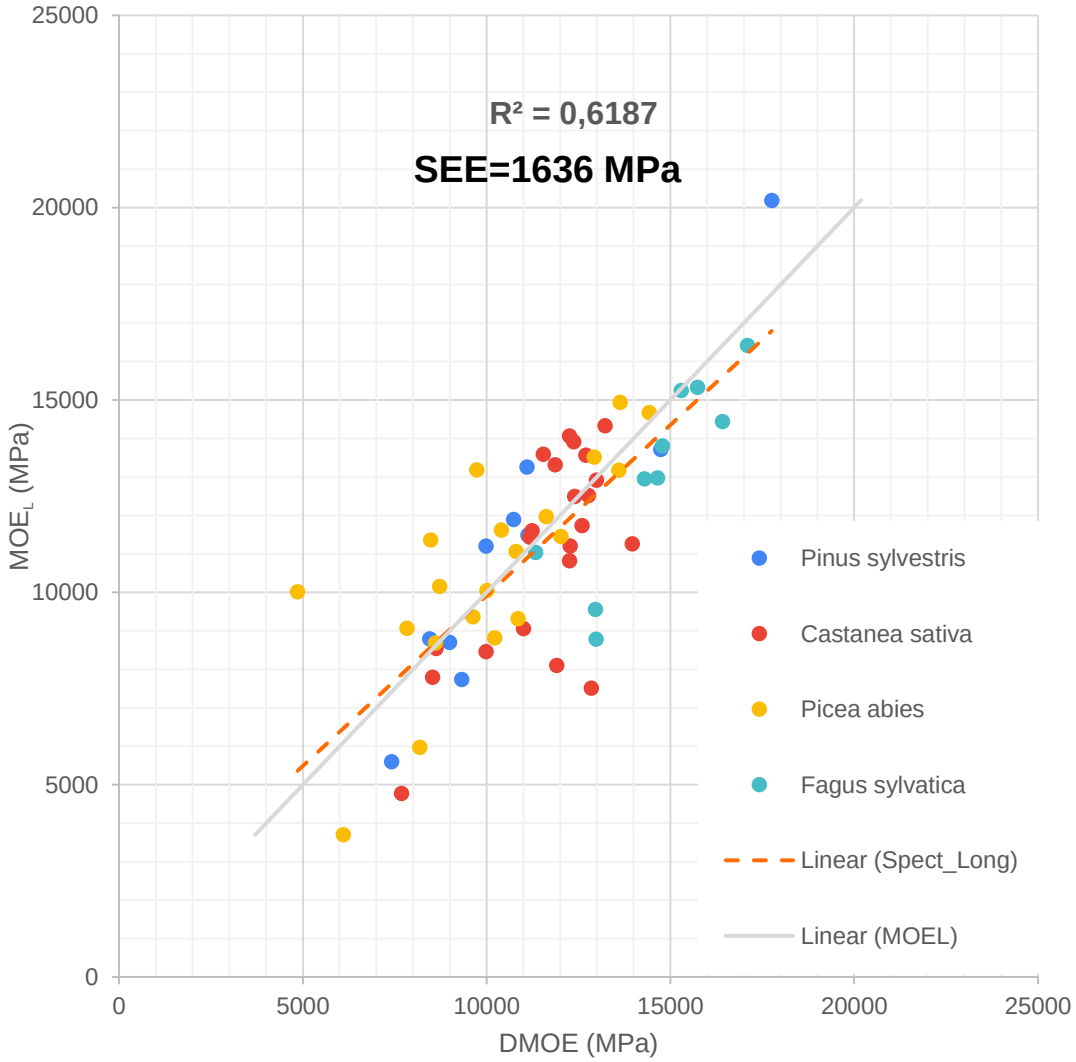
		BING_Trasv_Mic		Spect_Trasv		ViSCAN		Spect_Long	
		R^2	SEE	R^2	SEE	R^2	SEE	R^2	SEE
MOE_G	Scots Pine	0,95	742	0,97	591	0,93	884	0,93	863
	Beech	0,65	1096	0,93	521	0,91	574	0,90	575
	Spruce	0,95	553	0,98	463	0,63	1375	0,66	1327
	Chestnut	0,87	662	0,89	644	0,66	985	0,69	921
MOE_L	Scots Pine	0,92	914	0,92	914	0,89	1104	0,90	1052
	Beech	0,55	1235	0,80	852	0,75	930	0,74	940
	Spruce	0,77	1340	0,84	1318	0,56	1692	0,57	1680
	Chestnut	0,83	379	0,59	1255	0,44	1266	0,48	1198

EQUAZIONI CONSIGLIATE PER L'UTILIZZO DI SPECTROID

MOE_G =0,8562DMOE + 322,51



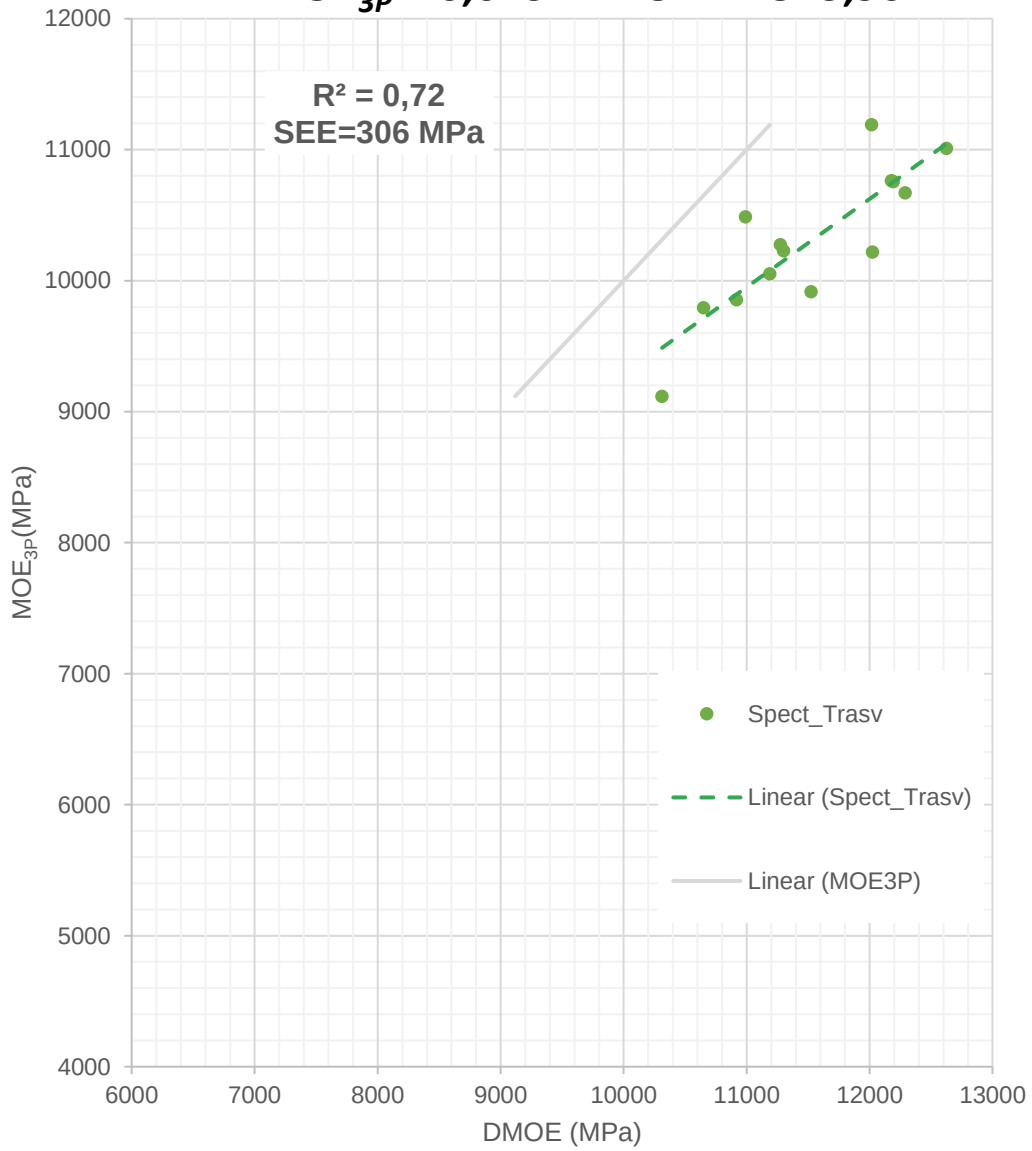
MOE_L = 0,8862DMOE + 1059,40



EQUAZIONI CONSIGLIATE PER L'UTILIZZO DI SPECTROID

CASTAGNO

$MOE_{3P} = 0{,}6734 DMOE + 2543{,}90$



ABETE ROSSO

$MOE_{3P} = 0{,}7707 DMOE + 542{,}97$