Experimental characterization of Aucoumea Klaineana Pierre (AKP) specie under cyclic compressive loading at different Internal Moisture Content (IMC)

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CONFERENCE : HYGROTHERMAL PERFORMANCE OF BUILDINGS AND THEIR MATERIALS
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Tree of AKP (Okume)

logs of AKP

Frame in AKP

Timber structures of Aucoumea Klaineana Pierre

Plywood of Aucoumea Klaineana Pierre

- Gabonese forest represented more than 80% of the territory in 2009
- In 2004, Gabon produced more than 1.4 millions m^3 of timber, 61 % was AKP (Okume)
- In 2009, Gabonese government has forbidden the exportation of logs
- Since 2009, we note important studies on wood and its exploitation
- The main objective of this study is the valorization of Gabonese forest in particular and the Congo Basin forest in general

- Study the mechanical characterization of AKP under a monotonous loading at different moisture content rates

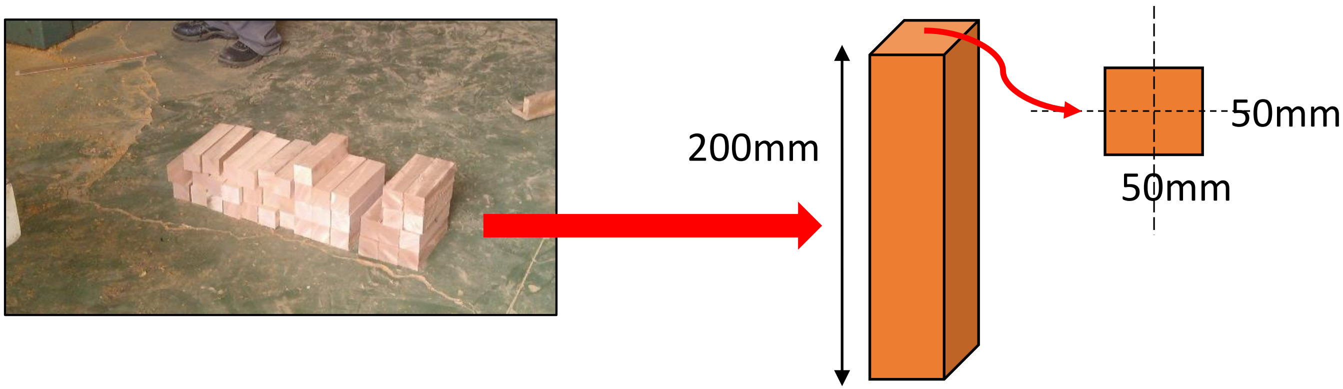
- Study the mechanical characterization of AKP under a cyclic loading at different moisture content rates

- To know the impact of variation of Internal Moisture Content (IMC) in monotonous and cyclic loadings

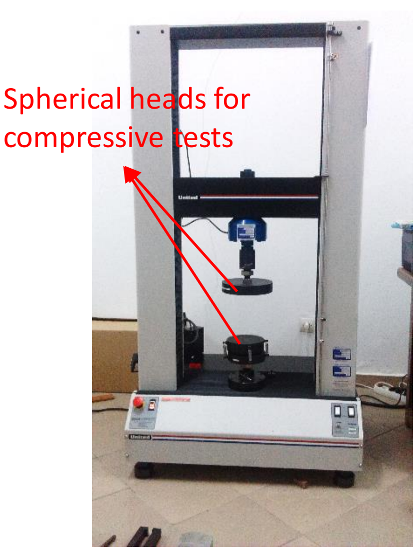
Outline

- Scientific context
- Experimental setup
- Result and analysis
- Conclusion and perspectives

- Specimens of AKP dimensioned according to American standard norm ASTM-D-143



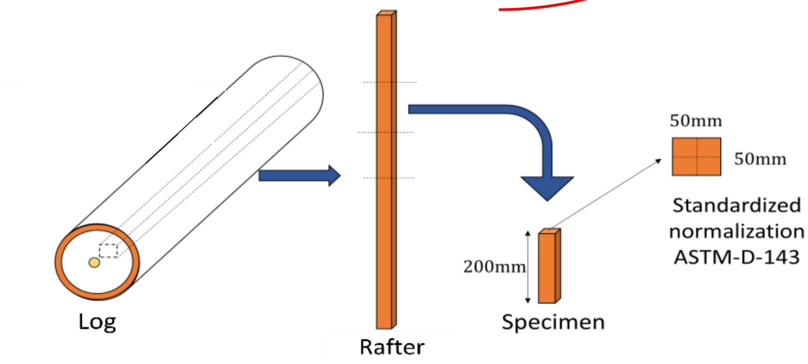
- Electro-mechanical press of 100 kN of static capacity



- Centralizer which ensures the send and the recorded of data during the test

- ❑ Specimens of AKP

- ❑ Sizing of logs of AKP in specimen



- ❑ The specimens of AKP have been each moistened

Physical characteristics of each specimen tested

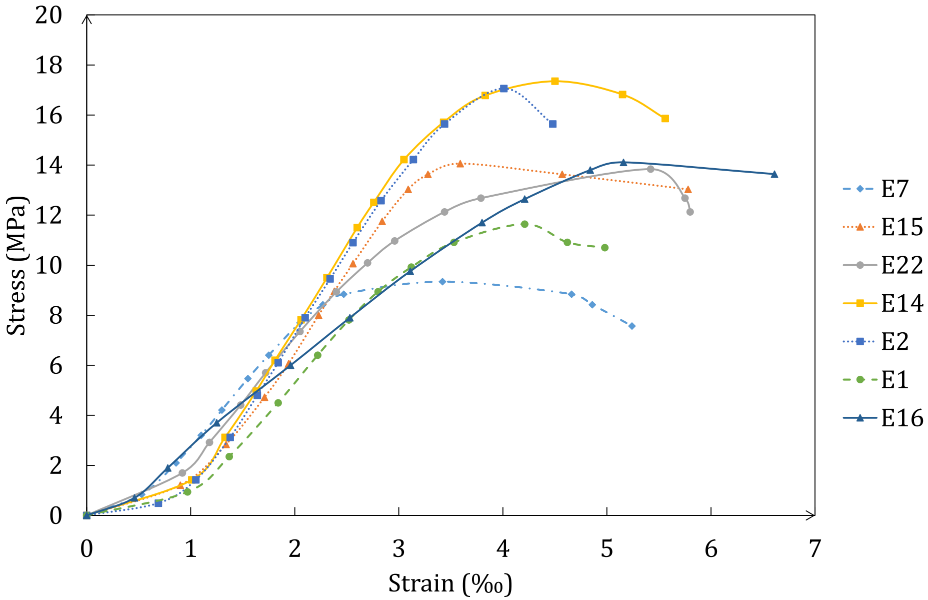
Samples N°	l(mm)	e (mm)	h (mm)	H (%)	M (g)	d (kg/m3)	
E1	49	51	210	52.6	186	0.354	
E2	51	50	210	31.4	179	0.334	
E3	50	51	200	25.2	201	0.394	
E4	49	51	205	30.7	197	0.384	Cyclic loading
E5	50.5	51	210	20.5	240	0.443	
E7	50.5	51	210	39	188	0.347	
E9	50.5	51.5	205	26.2	211	0.395	
E10	50.5	51	210	20.1	211	0.390	
E11	50	50.5	205	40.9	179	0.345	
E12	50.5	50.5	200	27.7	184	0.360	
E13	51.5	51.5	205	36	192	0.353	
E14	51	50.5	210	37.3	182	0.336	
E15	51	50	205	52.2	194	0.371	
E16	51	50	201	82.3	246	0.479	
E18	51	51.5	205	27	183	0.339	
E21	50.5	51.5	205	24	184	0.345	Monotonous loading
E22	50	50	210	40.5	203	0.386	
E24	51	52	210	18	291	0.522	
E25	50	51	205	23.5	202	0.386	
E26	52	50.5	200	28.1	185	0.352	
E27	51	50.5	200	17.2	244	0.473	
E28	50	50	201	24	207	0.412	

The internal moisture content is obtained by the following equation

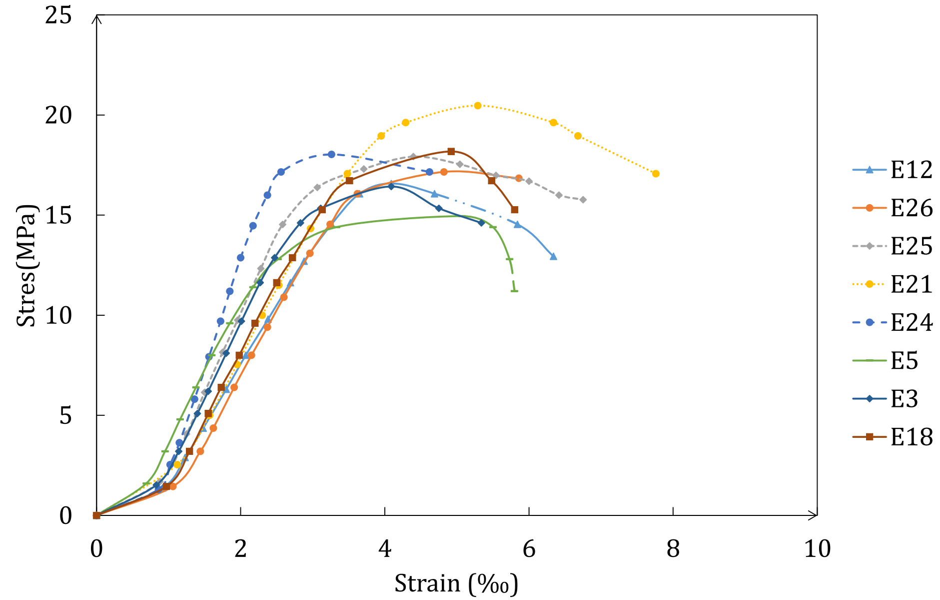
$$H(\%) = \frac{M_H - M_0}{M_0} \times 100$$

Where: M_H represent the bound water content and
M_0 represent the initial bound water content

Monotonous compressive loading:



Relationships between stress-strain of specimens of AKP with IMC more than FSP (30%)



Relationships between stress-strain of specimens of AKP with IMC less than FSP (30%)

Monotonous compressive loading

Table 1: Mechanical parameters of specimens loaded monotonously

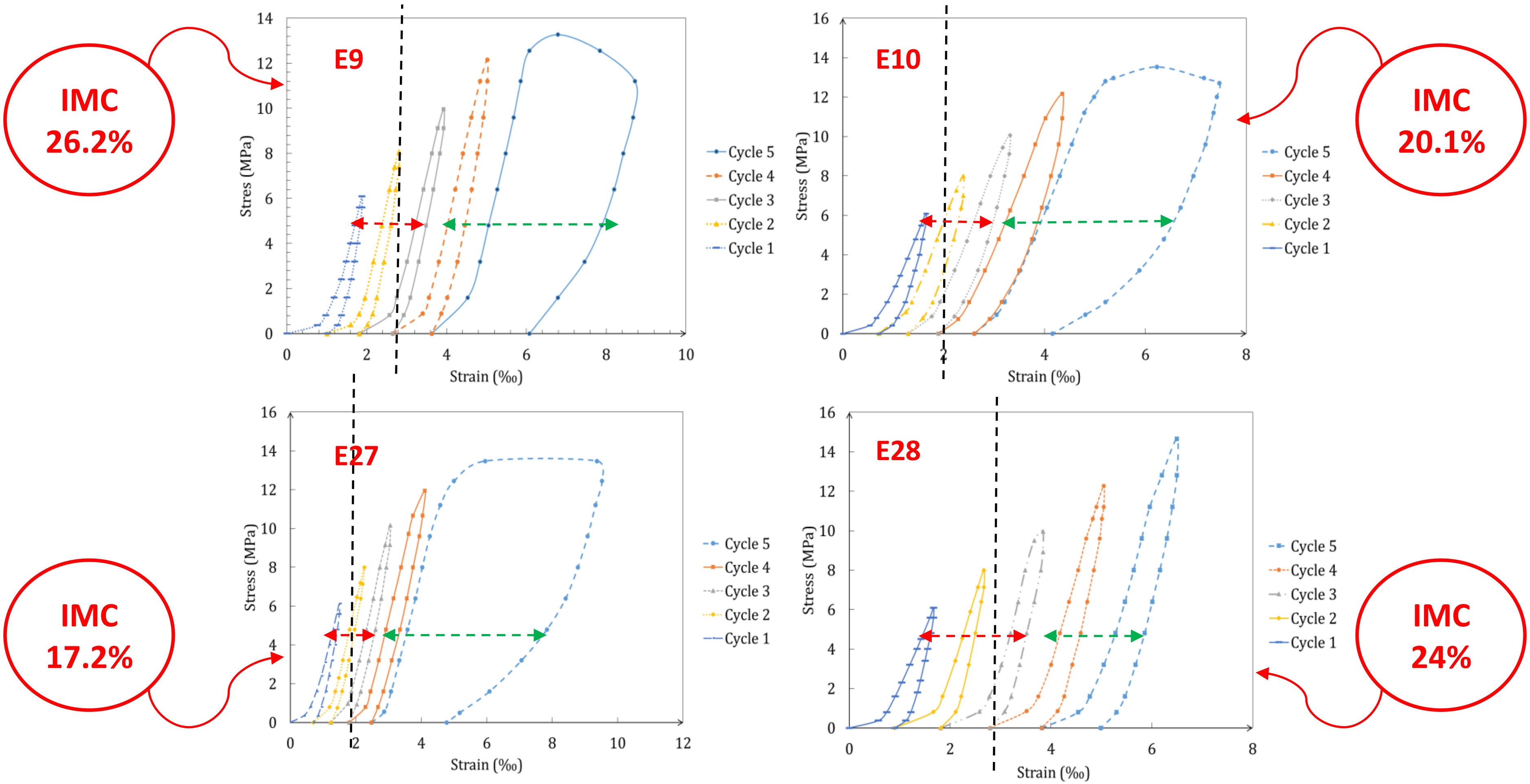
Specimens	MOE (kPa)	RS (MPa)
E1	4.71	11.64
E2	6.5	17.06
E3	7.11	16.43
E5	9.6	14.95
E7	5	9.34
E12	5.98	16.58
E14	6.66	17.35
E15	6.34	14.06
E16	4	14.11
E18	7.03	18.18
E21	6.35	20.47
E22	5.8	13.84
E24	10.66	18.03
E25	8.45	17.92
E26	6.88	17.16

Specimens with IMC more than FSP in blue

Specimens with IMC less than than FSP in white

MOE: Module Of Elasticity
RS: Rupture stresses

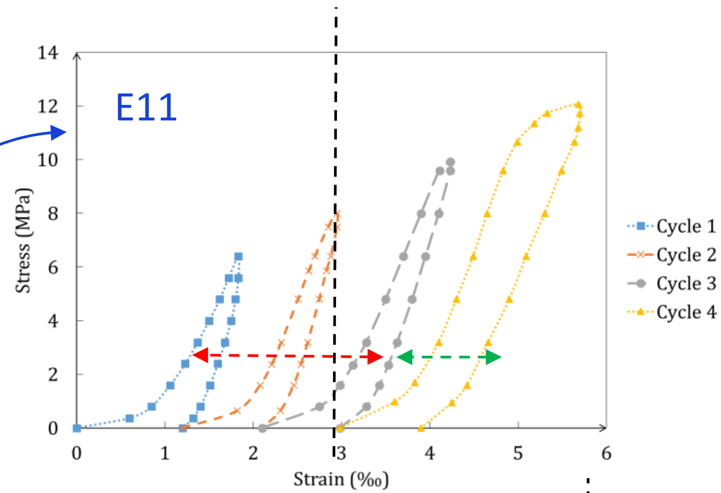
Cyclic compressive loading

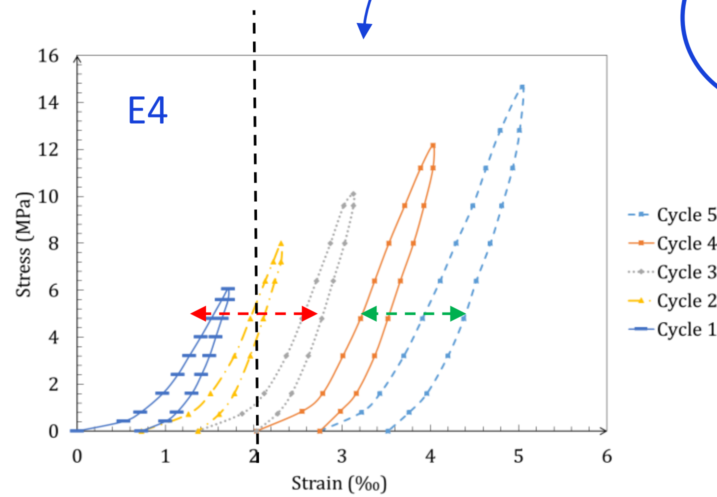


Relationship between stress-strain of AKP with IMC less than FSP

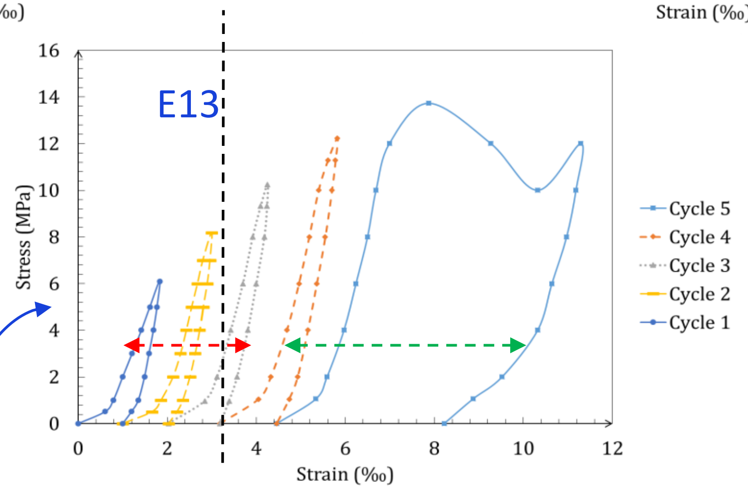
Cyclic compressive loading

IMC 30.7%





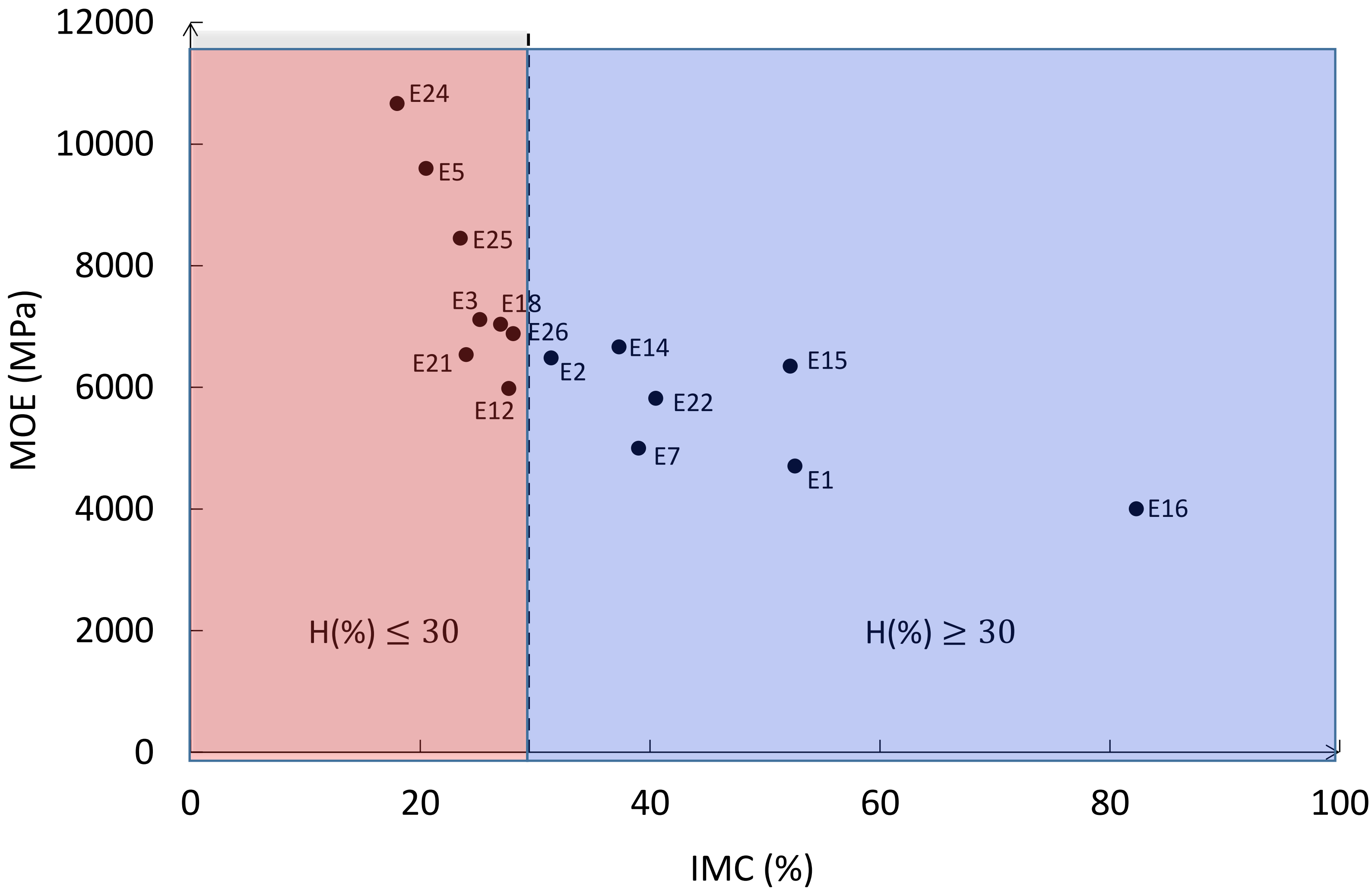
IMC 40.9%



IMC 36%

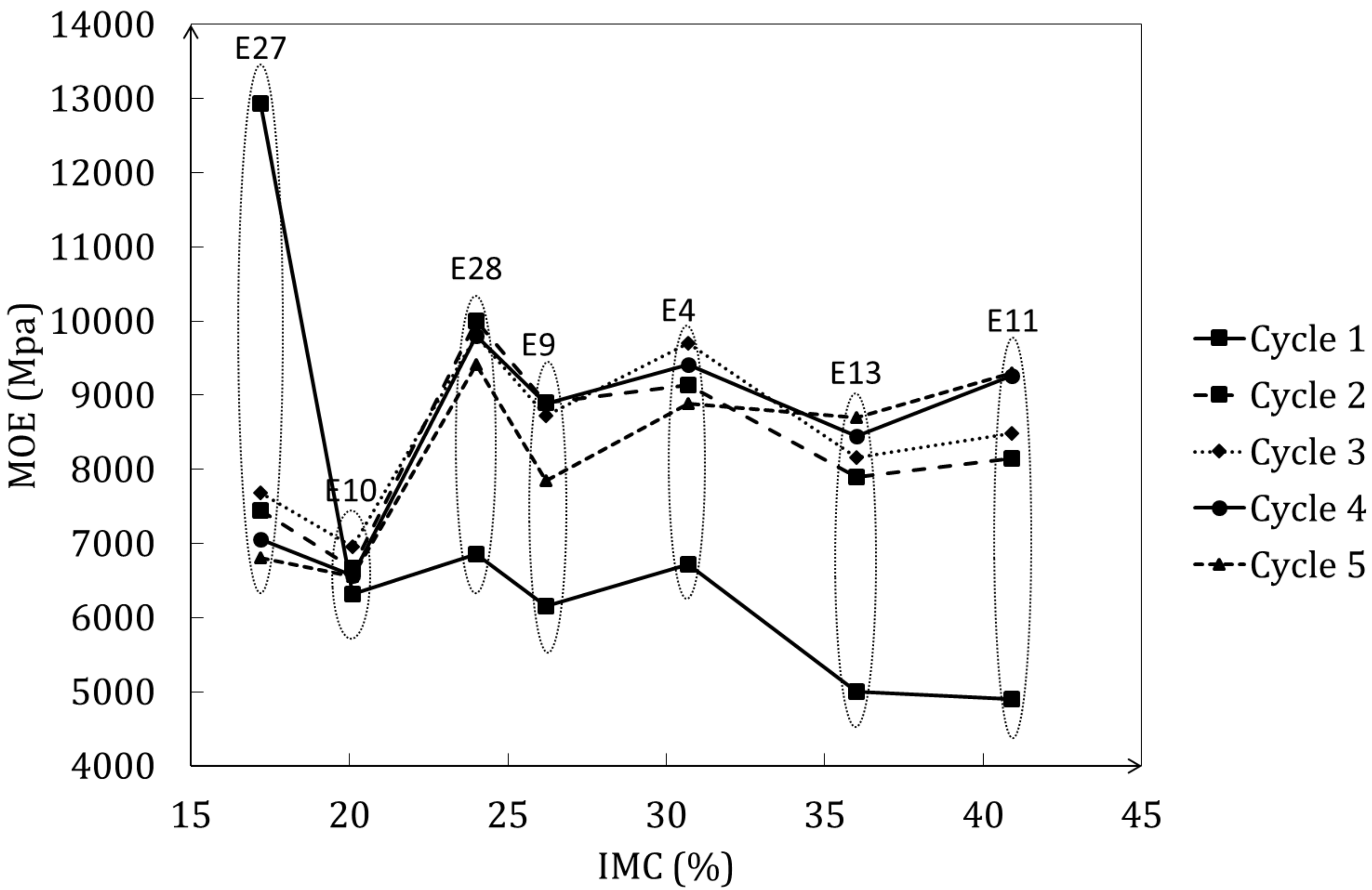
Relationship between stress-strain of AKP with IMC more than FSP

Monotonous compressive loading



Evolution of MOE vs. IMC of the specimens of AKP tested under a monotonous loading

Cyclic compressive loading



Evolution of MOE vs. IMC of at different cycle for each specimen of AKP tested

Cycles with practically the same length of amplitudes in blue

IMC ≥ FSP

IMC ≤ FSP

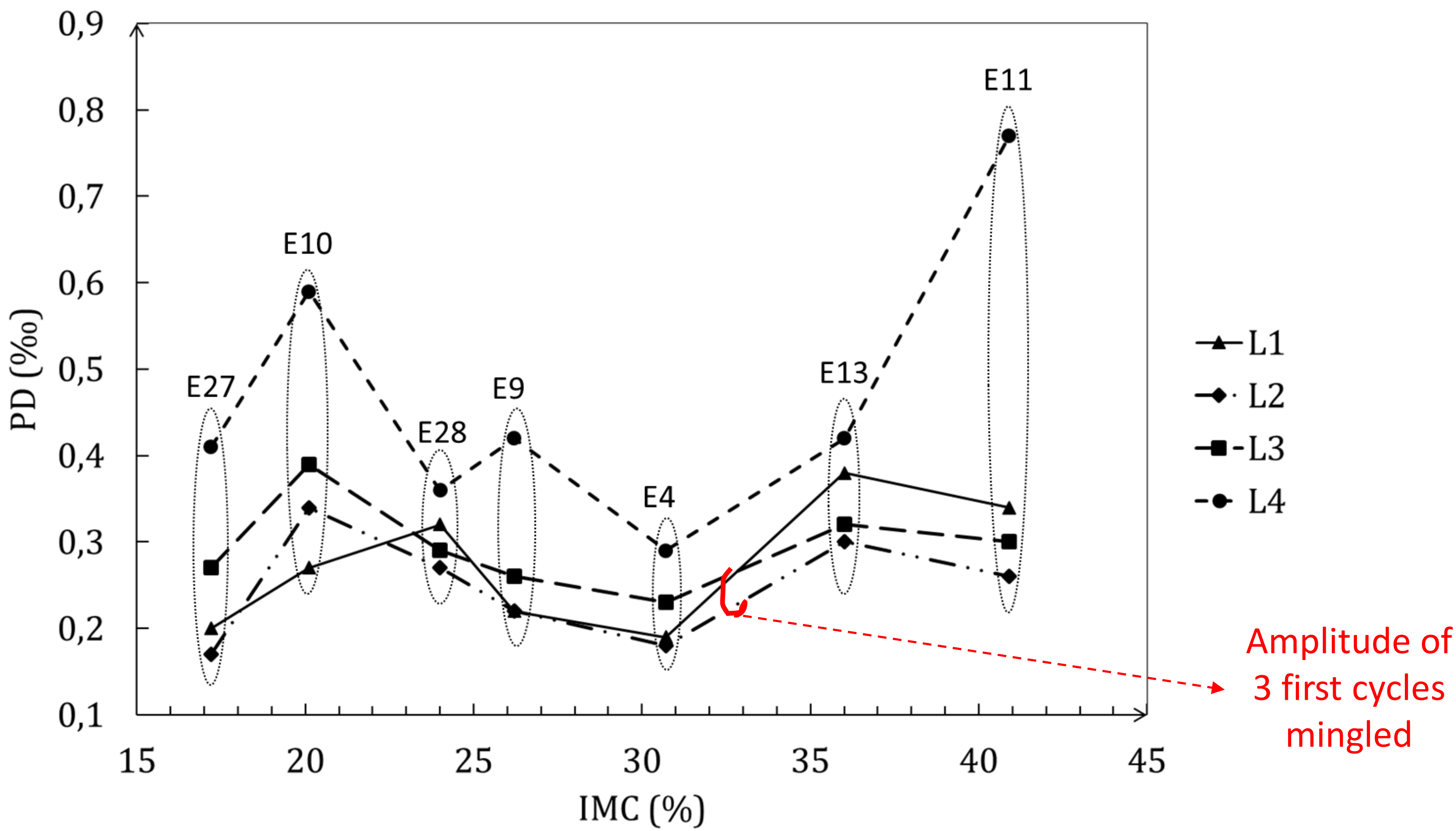
Specimens	L_1/L_2	L_2/L_3	L_3/L_4	L_4/L_5
E4	**0.84**	**0.82**	**0.79**	**0.74**
E9	**1.0**	**0.84**	0.62	0.14
E10	**0.79**	**0.87**	0.66	0.22
E11	**0.76**	**0.86**	0.38	-
E13	**0.78**	**0.93**	**0.76**	0.09
E27	**0.85**	**0.72**	0.65	0.09
E28	**0.84**	**0.96**	**0.80**	**0.70**

L_i represent the amplitude of permanent displacement of each cycle ***i***

If $(L_i/L_{i+1}) \geq 0.70$ the decision is **N.S** difference between the amplitudes (elastic zone)
if $(L_i/L_{i+1}) \leq 0.70$ the decision is **S** differences between the amplitudes (plastic zone)

N.S: Non Significant; S: Significant

Cyclic compressive loading



Evolution of PD (Permanent Deformation) with the variations of IMC and the number of cycles

- Monotonous and compressive cyclic loadings of APK
- In both cases when IMC increases the resistance of AKP decreases
- The rate of aging of APK in cyclic (monotonous) loadings depends also of the FSP
- Impact of number of cycles on the mechanical behaviour of AKP
- Impact is perceptible after a cyclic yield point of AKP

- ❑ Uncouple the intensity of loading with the number of cycle by setting a constant force of loading for each cycle.
- ❑ Reduce the dimensions of the specimens studied
- ❑ To improve a predictive mechano-sorptive behaviour model of load-unload-reload of AKP under a compressive cyclic loading
- ❑ Perform the same tests with other tropical species

THANK YOU FOR YOUR ATTENTION

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