Bending creep of notched beams in sheltered outdoors conditions: applications on Gabonese and European wooden species

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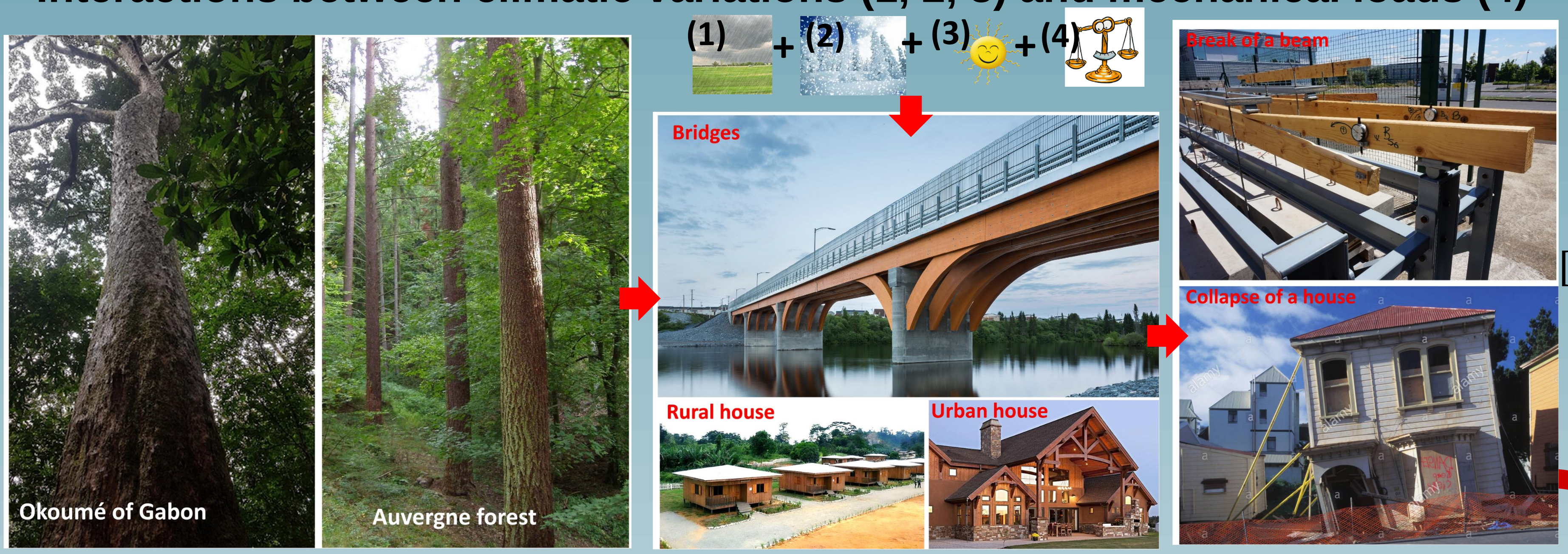
1.Context

Interactions between climatic variations (1, 2, 3) and mechanical loads (4)



[1] and [2]

Interactions between climatic variations (1, 2, 3) and mechanical loads (4) ,coupling with crack process

2.Objective

- **General objective:**
  - Evaluate the influence of initial defects on the structural response and crack propagation, and adapt the design codes to the context of structural use of wood in tropical and temperate environments
- **Specific objectives:**
  - creep tests in 4-point bending of notched beams in sheltered outdoor conditions
  - Characterization of diffusion process
  - Coupling between rupture, creep and sorption

3.Methods

The characterization is done on tropical wood Iroko (Fig.1a) Padouk (Fig.1b) and Okume (Fig.1c). Specimens (L=680 x 40x60 mm) were brought back from Gabon to Clermont-Ferrand.

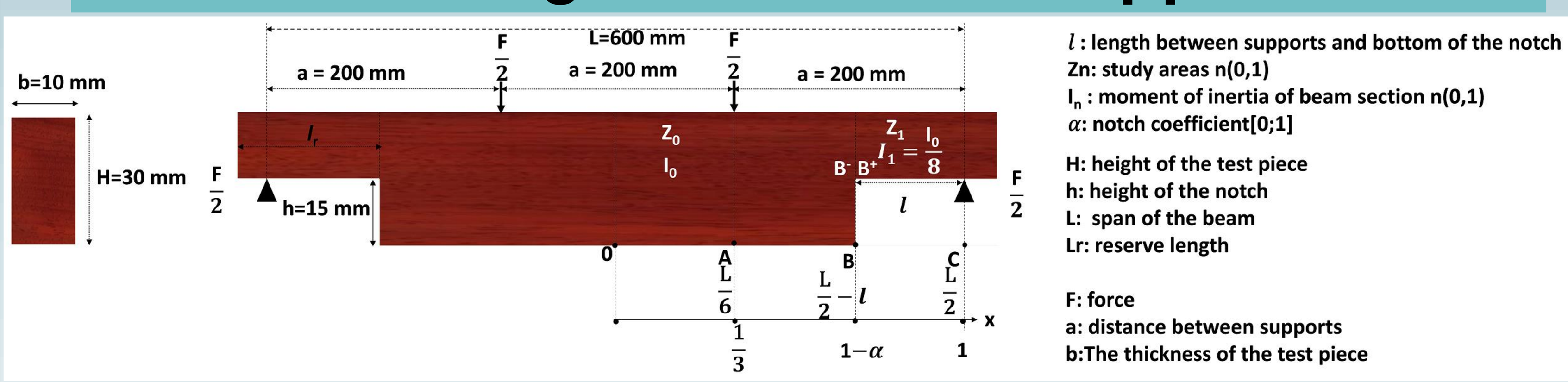
Fig 1: Raw beams of tropical species brought back from Gabon: (a) Iroko (b); Padauk (c); Okume

Determination of specimen geometry:

(9) allowed us to validate the geometry of the beams presented in (Fig. 2) $l = 38{,}3\ mm$ and *Lr = 63,3mm.*

Fig 2. Geometry of test specimens (a); Padauk (b) Iroko (c); okume

3.1. Strength of Materials approach



$$\sigma_0 = \frac{HM_0}{2I_0} \quad (1)$$

$$\sigma_1^{B-} = \frac{3HM_0}{4I_0}\alpha \quad (2)$$

$$\sigma_1^{B+} = \frac{3HM_0}{I_0}\alpha \quad (3)$$

$$\rightarrow \quad \sigma_1^{B-} \leq \sigma_1^{B+} \quad (4)$$

$$\text{if } \sigma_1^{B+} = \sigma_0 \rightarrow \alpha = \frac{1}{6}$$

$$(7) \rightarrow l = \frac{L}{12}$$

with

$$I_0 = \frac{BH^3}{12} \quad (5)$$

$$M_0 = \frac{FL}{6} \quad (6)$$

$$l = C - B = \frac{\alpha L}{2} \quad (7)$$

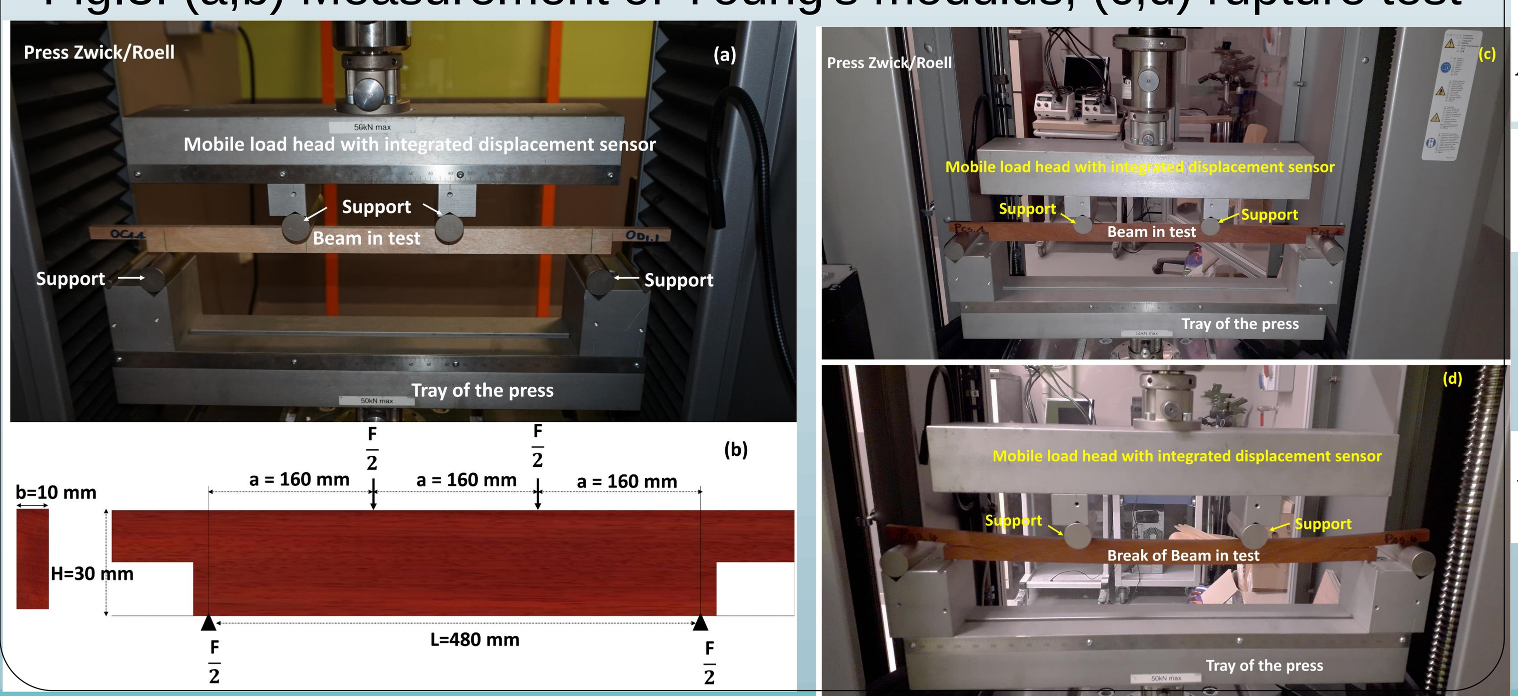
$$\alpha = 1 - \frac{2x(B^+)}{L} \quad (8)$$

For α < 1/6, the stress in Z_1 is lower than in Z_0 : $\sigma_1^{B+} \leq \sigma_0$

For this the condition on l is: $l \leq \frac{L}{12}$=50 mm (9)

3.2. Experimental approach

Fig.3: (a,b) Measurement of Young's modulus; (c,d) rupture test



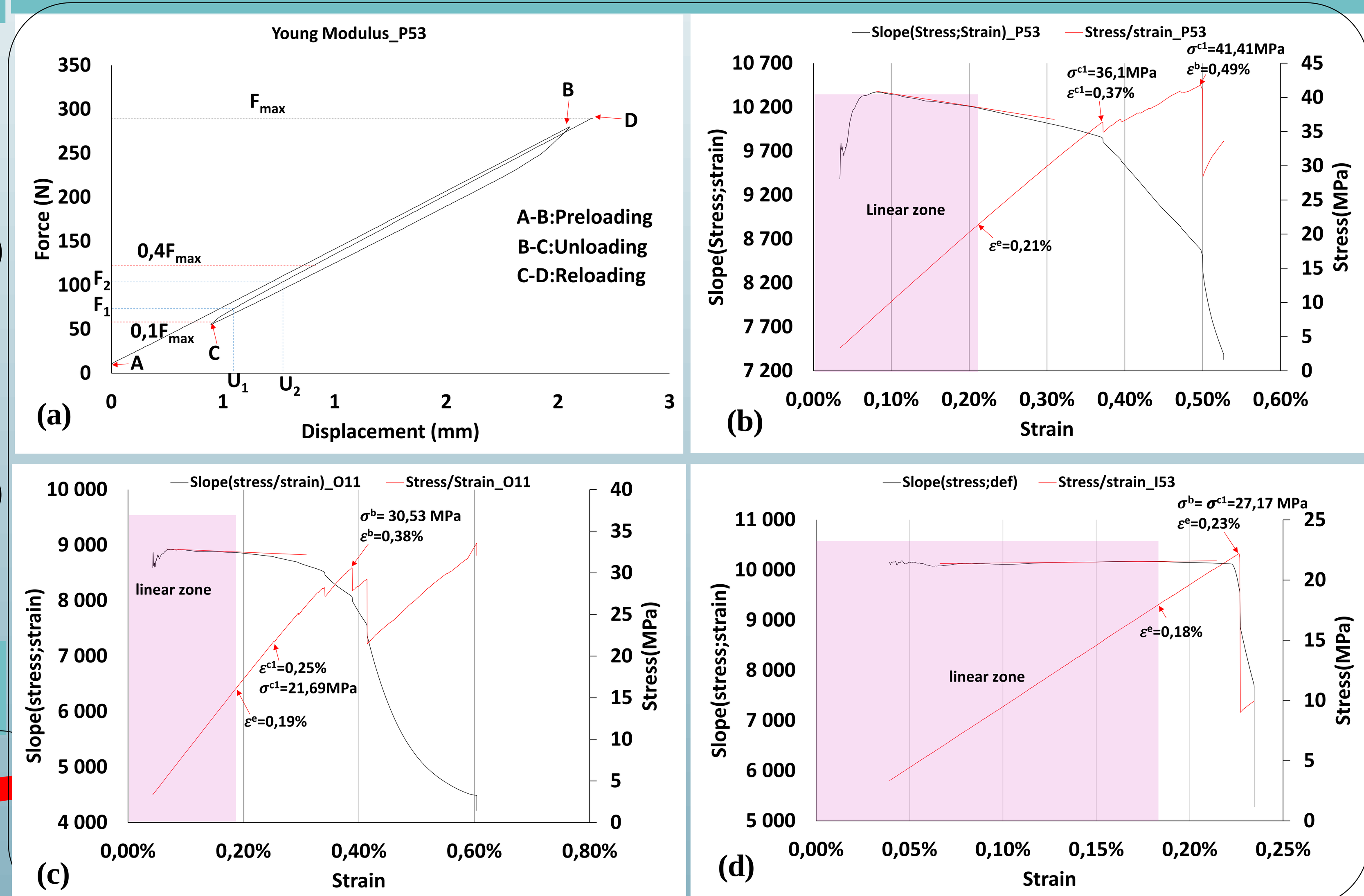
$$E_L = \frac{5L^3}{324I_0}\frac{(F_2 - F_1)}{(U_2 - U_1)} \quad (10)$$

$$F_{load} = \frac{bH^2 E_L \varepsilon_{load}}{L} \quad (11)$$

$$\varepsilon = \frac{864H}{167L^2}y \quad (12)$$

$$y = \frac{FL^3}{E_L I_0}\left(\frac{5}{324} + \frac{7}{48}\left(\frac{1}{\alpha}\right)^3\right) \quad (13)$$

4.Results



Wood	Density	MC (%)	$E_{L(10)}$(MPa)
Okume	0,47(0,03)	13,11(0,58)	7 694(421)
Padauk	0,77(0,09)	10,44(1,12)	10 898(748)
Iroko	0,60(0,06)	10,96 (0,56)	10 194(277)

In ()=Standard deviation; MC =moisture content, $E_{L(10)}$ =Longitudinal Young's modulus given by (10)

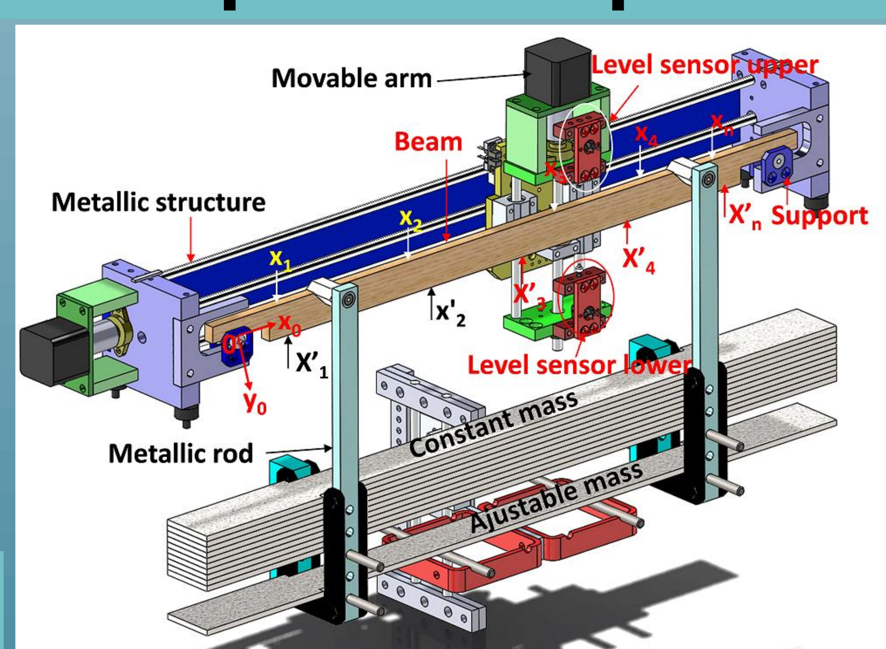
(a): measuring of Young's modulus

(b,c,d) rupture tests

Wood	ε_e(%)	ε_{c1}(%)	ε_b(%)	ε_{load}(%)	F_{load} (daN)	F_{c1} (daN)	F_b (daN)
Okoumé	0,183(0,015)	0,313(0,051)	0,51 (0,096)	0,26	29,64	36,6(39)	51,1(67)
Padouk	0,234(0,023)	0,394(0,064)	0,509(0,062)	0,27	43,42	59,7(97)	68,8(130)
Iroko	0,157(0,017)	0,202(0,026)	0,203(0,024)	0,16	25,34	30,4(30)	30,4(30)

In ()=Standard deviation ;F_{c1} =critical force; F_b =rupture force ; ε_e=elastic limit ε_{c1}=; critical strain ε_b =rupture strain; y=deflection; ε= strain of the beam during the test ; F_{load}=Loading force for creep test; ε_{load}= Loading strain for creep test

5. Experimental setup for creep tests



6. Conclusion

This study presents the dimensioning and the characterization of the beams in outdoor conditions. It is based on strength of materials and experimental approaches. This approaches enabled us to validate the specimens geometry and to estimate the loading strain and the loading forces for the creep test.

Bibliography

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