

# PINE NEEDLES AS NATURAL REINFORCEMENT FOR ADOBE: TOWARDS GREEN BUILDINGS IN LEBANON

ASSOC. PROF. DR. AYSE BALKIS  
CYPRUS INTERNATIONAL UNIVERSITY

AYA AHMAD  
FINAL INTERNATIONAL UNIVERSITY



KTMMOB / UCCTEA  
İNŞAAT MÜHENDİSLERİ ODASI  
CHAMBER OF CIVIL ENGINEERS  
NCE2022.KTIMO.ORG

**2<sup>nd</sup> National Civil Engineering Symposium**  
2. Ulusal İnşaat Mühendisliği Sempozyumu  
14-15 Eylül 2022  
14-15 September 2022

**2<sup>nd</sup> Nature Inspired Solutions For The Built Environment Conference (NISE)**  
2. Uluslararası Yapılar İçin Doğadan İlham Alan Çözümler Konferansı  
16 Eylül 2022  
16 September 2022

**International Workshop on Advances in Laboratory Testing of Liquefiable Soils**  
Sıvılaştan Zeminlerde Laboratuvar Uygulamaları Uluslararası Çalıştayı  
17 Eylül 2022  
17 September 2022

Acapulco Resort Convention SPA Hotel



North Cyprus

14 -17 Eylül 2022  
14 - 17 September 2022

# INTRODUCTION

- Adobe construction has grown in popularity because of its;
  - ✓ *availability,*
  - ✓ *affordability, and*
  - ✓ *ease of workability.*
- Adobe is regarded as a sustainable material due to its minimal energy usage in manufacture and recyclability.
- Several studies nowadays encourage the use of natural materials in construction.





**Figure 1:** The Never Ending Pine Trees in Lebanon

- In Lebanon, pine trees are considered evergreens.
- They keep their needles for about two years.
- When old needles fall, new needles soon replace them.
- Pine needles can range in length from one inch to eleven inches.



- The vegetable fibers help to keep the adobe from cracking throughout the drying process (Jové-Sandoval et al., 2018).
- The vegetable fibers also strengthen its flexo-compression resistance while functioning as microarmour against tensile stresses (Hejazi et al., 2012).
- Pine needles are known to have been widely used by native communities in the Highlands of Chiapas region of southern Mexico (Jiménez et al., 2014).



**Figure 2:** Pine needles

# Previous Studies...

**Table 1:** Characterization of wheat straw and pine needles.

Dimension	straw	pn1	pn2	pn3
Length (mm)	73.5	99	118	127
Long diameter (mm)	4.36	1.42	1.64	2.36
Short diameter (mm)	0.28	1.00	1.30	1.96
Thickness (mm)	0.012	0.62	0.73	1.01

Source: Jové-Sandoval et al. (2018)



(a)



(b)



(c)



(d)

**Figure 3:** Natural fibers used. (a) Straw fibers: ref; (b) Pinus halepensis: pn1; (c) Pinus pinea: pn2; (d) Pinus pinaster: pn3.

Source:





(a)



(b)



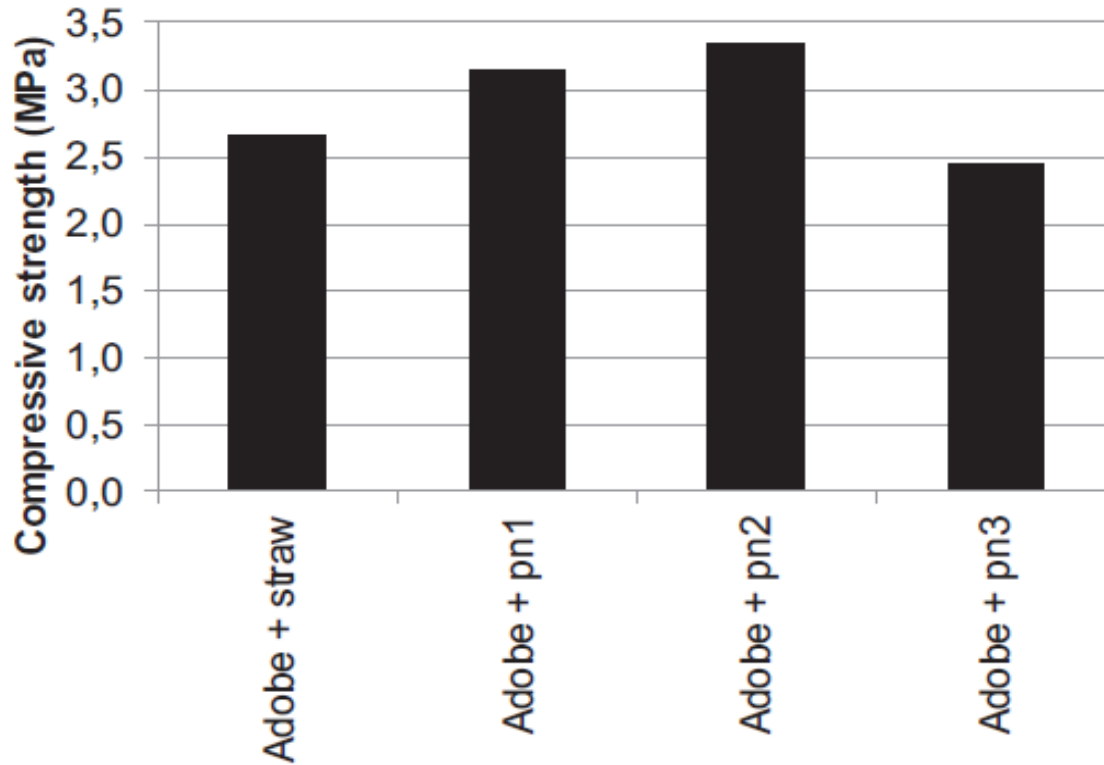
(c)



(d)

**Figure 4:** (a) Straw fibers (b) *Pinus halepensis*: pn1, (c) *Pinus pinea*: pn2, (d) *Pinus pinaster*: pn3.

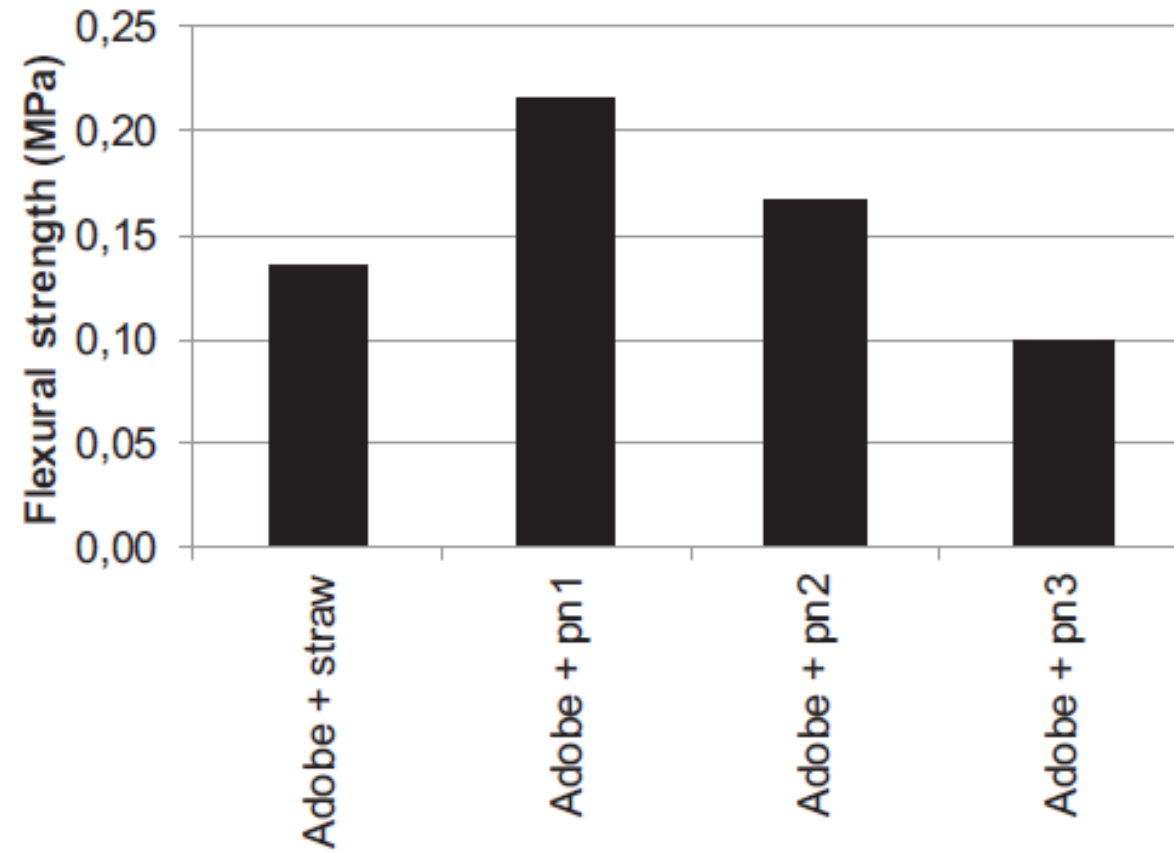
Source: Jové-Sandoval et al. (2018)



**Figure 5:** Compressive strength of adobe bricks

- The compressive strengths of adobes made with the fibres of pine needles are 3.2 MPa (pn1), 3.3 MPa (pn2) and 2.4 Mpa (pn3), compared to 2.7 MPa of straw-adobe.
- The fibres pn1 and pn2 present better mechanical behavior compared to pn3 due to their smaller sections and consequently better bond with the clay matrix.





**Figure 6:** Flexural strength of adobe bricks

# CONCLUSION

- Pine needles can be utilized as a vegetable fiber in the production of adobes.
- Pine needles boost adobe's resistance by up to 24% when compared to straw.
- Pine needles provide significant resistance and longevity to adobes, both in terms of hardness and moisture absorption.
- The needles are thought to contain resins that bind and protect the earth..
- The results obtained show their viability, providing high resistance and ductility to the adobe.



# Thanks for your attention.

North Cyprus

14 -17 Eylül 2022  
14 - 17 September 2022



ULUSLARARASI  
KIBRIS  
ÜNİVERSİTESİ



TECHNICAL  
COMMITTEE  
101



LABORATORY STRESS  
STRENGTH TESTING OF  
GEOMATERIALS

