Use of seagrass fibres in adobe bricks

"Buildings As Material Banks – A Pathway For A Circular Future"
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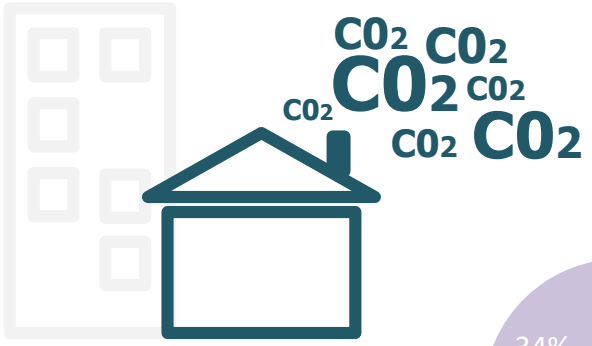
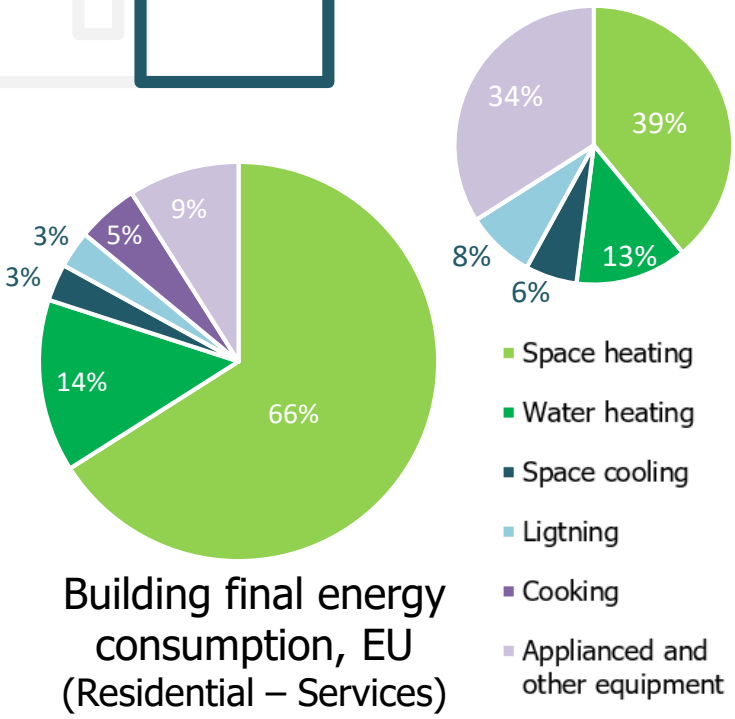
Introduction





Building final energy consumption, EU (Residential – Services)

Source: International Energy Agency. Transition to sustainable buildings. Strategies and Opportunities to 2050, 2013.

transition to **sustainable buildings**

Building envelopes

Low environmental building materials

- ✓Waste by-products
- ✓Locally available
- ✓Improved embodied energy
- ✓Recyclable

Introduction

Earth

- ✓ Locally available traditional building construction material
- ✓ Construction techniques known for over 9000 years
- ✓ Improves indoor climate (heat storage, balances air humidity)

Mosque in Mali, built 1935

Rammed earth house in Germany, built 1828

+ Biomass ?

Europe 2020 target

Rammed earth art museum in China, built 2017

Introduction

seagrass

Posidonia Oceanica

- Biomass by-product fibre
- Distributed along Mediterranean coast
- Economic, hygienic problem

Earth

- Different soil particles distribution

Renewable
low cost material

OBJECTIVES

- Generate a sustainable and value-added building product: **Adobe bricks**
- Analyse Posidonia Ocenaica algae as an adobe reinforcement – **Mechanical** behaviour of the bricks
- **Straw** fibres as reference

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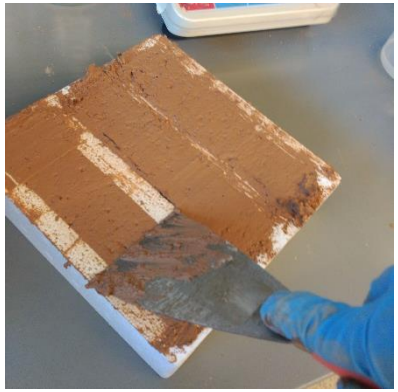
Experimentation

Materials and sample preparation





- Biomass fibres (seagrass or straw)
- Different soil particle sizes (clay and sand)
- Water

- 40x40x160 mm prismatic samples
- Samples left to dry in laboratory conditions (21-23°C, 50%RH.)
- 3 repetitions per composition

- Fibre content: 0 – 0.5 – 1.5 – 3%
- Fibres cut at 3 cm length for both seagrass and straw
- Seagrass fibres also in their natural length (up to 19 cm)

- Constant mixture of 60% fine clay, 40% sand and 20% water

Experimentation

Test methods

Biomass fibres

- Density
- Tensile strength
- Water absorption capability

An analytical balance from Mettler Toledo to weight the biomass fibres with precision

Zwick Roell Smart pro testing machine for **testing tensile strength** of seagrass and straw fibres. Maximum capacity load of 200 N. Displacement of 5 mm/min

$$w = \frac{m_2 - m_1}{m_1} \cdot 100$$

Water absorption fibres capability, according to DIN EN ISO 62. The fibres were immersed in water during 18 days and weighted in 24 h. intervals.

w: percentage of water absorption

m1, m2: mass of the fibre before and after immersion in water

Experimentation

Test methods

Adobe bricks
Non fibrous and fibrous reinforced

- Flexural strength
- Compressive strength

40 x 40 x 160 mm

40 x 40 mm

PROETISA Uniaxial testing machine equipment.
For **flexural strength**, a load range of 2000 kg was applied with a velocity of 5 kg/s.
For **compressive strength**, the load cell was 20000 kg with a velocity of 2.40 mm/min.
Resistances calculated from EN 196-1:2005.

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Fibres

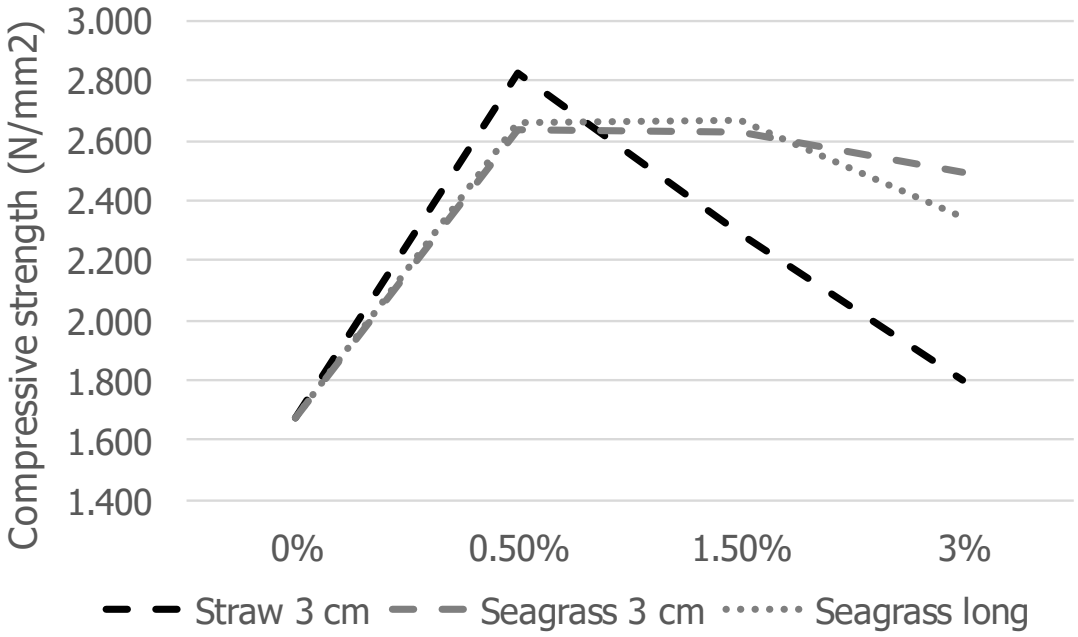
Physical characteristics

Type of fibre	Density (g/m^3)	Water absorption (%)	Break load (N)	Tensile strength (N/mm^2)
Straw	0.312	365	88.18	128.19
Seagrass	0.721	293	23.59	56.01

Adobe bricks

Compressive strength

- Fibre content: 0 – 0.5 – 1.5 – 3%
- Algae/seagrass fibres: 3 cm length and long natural length
- Straw fibres: 3 cm length



Adobe bricks

Flexural strength

- Fibre content: 0 – 0.5 – 1.5 – 3%
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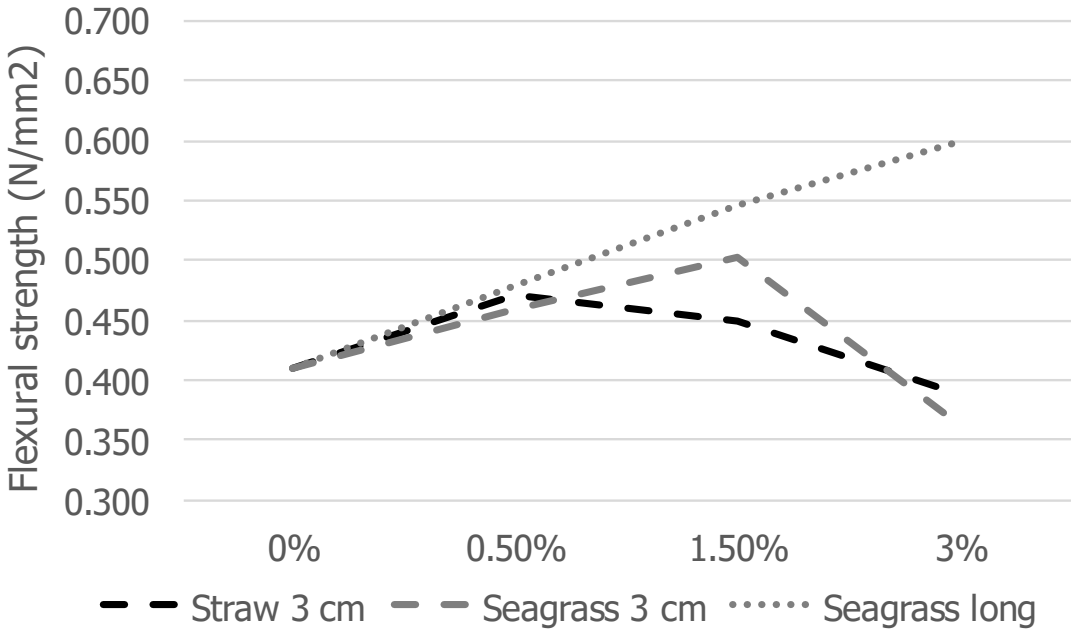

Fibres & Adobe bricks

Comparison: seagrass vs. straw

- Seagrass bricks are better than straw. Generally, adobes with seagrass cut at 3 cm or even with their natural long length present better results when higher percentage of fibres is added.
  - Seagrass has more density and presents curved and flexible aspect → Less quantity of fibres and less fibre interactions with soil → Better resistance of the brick sections
  - Straw fibres have higher ratio of water absorption → voids around the biomass fibres → Decreasing of mechanical behaviour

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Conclusions

Main purpose of the experiment

Evaluating Posidona Ocenaica seagrass as fibre reinforcement in adobe bricks, considering straw fibres as a reference. Three different lengths and percentages of fibres are included.

- According to the analysed **physical properties of the fibres**, straw and Posidonia Oceanica fibres present great differences, where **density** and **water absorption** are determinant in the mechanical behaviour of the bricks.

- Taking into consideration a **fibre reinforcement by weight**, seagrass additives on the bricks seem to be more suitable from mechanical point of view.

- Both flexural and compressive strength are generally **improved** with **higher fibre ratios** when **seagrass** is included in the bricks. Specially, when the leafs are disposed with their **natural length**.

Conclusions

Main purpose of the experiment

Evaluating Posidona Ocenaica seagrass as fibre reinforcement in adobe bricks, considering straw fibres as a reference. Three different lengths and percentages of fibres are included.

- Compared with non-fibrous samples, an **improvement up to 50%** in mechanical strength is reached when **Posidonia Oceanica** is included in 1.50 or 3% content.

- The fact of including seagrass fibres with their natural length without any cutting action, makes that the manufacturing process of the **sustainable adobe brick** be much easier and cheaper.

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Thank you for your attention!

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