

ENERGIZING NORTH CYPRUS EARTHEN ARCHITECTURE: RETHINKING THE FUTURE

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2nd National Civil Engineering Symposium
2. Ulusal İnşaat Mühendisliği Sempozyumu
14-15 Eylül 2022
14-15 September 2022

2nd 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
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INTRODUCTION

- ❖ North Cyprus is mountainous island and they have been used in construction in Cyprus.
- ❖ Cyprus employed a variety of building materials in ancient times.
- ❖ Stone was the primary building material in both the Lusignan (1192-1489) and Venetian periods (1489-1571)
- ❖ During the Ottoman period (1571-1878), stone was only utilized for the ground floor, with adobe being used on the upper floors of residential buildings.
- ❖ Stone was popular throughout the British period (1878-1930).
- ❖ After 1940, reinforced concrete was introduced to Cyprus.



- The construction industry accounts for 23-40% of worldwide greenhouse gas emissions.
- Adobe is a naturally occurring material that has been utilized for a very long time and can be used in a significant way on the island.
- Natural materials should be assessed in order to utilize limited resources for a sustainable environment and contribute to North Cyprus's zero-waste sustainable society.
- Adobe is one of the most important aspects of architecture for resource conservation and maintaining investment sustainability.
- Adobe is also considered to be cost-effective because materials can be simply transported and no specialized labor or equipment is required.



Figure 1: Dervish Pasha Mansion , Nicosia / North Cyprus



Figure 2: The Chamber of Cyprus Turkish Architects Office building



Figure 3:View of the narrow street in the Arabahmet district (Mesda, 2012)

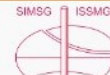
Traditional Buildings in North Cyprus



Figure 4 : Traditional Stone and Earthen Buildings in Northern Cyprus

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ADVANTAGES & DISADVANTAGES

➤ Some of the advantages of using earthen materials in Cyprus include;

- The ability to **adjust the internal environment**
- Its ability to **modify thermal efficiency, heat transfer, and sound transmission properties.**
- They are **cheap** and readily **available** in large quantities.
- They **do not require energy** for production which makes it energy efficient.

➤ Earthen constructions does not meet today's requirements due to certain limitations such as:

- They are **vulnerable to moisture** and can be easily damaged by earthquake .
- **Lower water resistance**
- **Low earthquake resistance .**



ALKER TECHNOLOGY

- ❖ Since 1978, Istanbul Technical University has been researching a technique called Alker technology.
- ❖ Alker is a short name of earth-based stabilized building material produced by the addition of gypsum, lime, and water to earth.
- ❖ Alker as construction material is composed of 10% gypsum, 2% lime and 20-22% water in veneration to the weight of dry soil.



- ❖ The energy usage in buildings constructed with Alker material is negligible.
- ❖ They have a net zero metric ton carbon footprint yearly.
- ❖ Alker buildings are healthier than reinforced concrete structures.
- ❖ According to Ahmad et al. (2022), structures constructed with Alker material are 13% less expensive than those constructed with reinforced concrete.



REVIEW OF ALKER STABILIZATION

- ❖ Waste marble dust in the form of powder and stones of irregular shape and size are deposited in open areas causing threat to environment.
- ❖ Increasing the amount of marble dust in adobe production can be an ideal solution to prevent the excess usage of raw materials.
- ❖ Healthier buildings can be constructed by utilizing marble dust waste combined with adobe.
- ❖ The mechanical properties and the crack propagation in Alker containing 6% clay improved with 0.5%, 1.0% and 1.5% by weight of polypropylene fiber (PPF) content was studied (Onochie and Balkis, 2021) .
- ❖ The mechanical properties of the matrix containing 0.5%PPF showed better results.





Figure 5: Polypropylene Fibers

- ❖ The use of polypropylene fiber reinforced Alker as an alternative building material for sustainable earthen production was investigated by Onochie and Balkis (2021) .
- ❖ The Mechanical properties of adobe–fibers–marble dust mixes with different proportions of polymer fiber as 0.5%, 1.0%, 1.5%, and 2.0% and waste marble dust (by 10% and 20% dry weight of soil) were investigated by Balkis (2017) .
- ❖ Producing adobe with 0.5% polymer fiber and 10% marble dust polymer displays the best results.

Plastics Wastes

➤ In construction, plastics are gaining popularity due to numerous aspects such as :

- Their efficiency
- Strength
- Weather resistance
- Low maintenance
- Cost-effectiveness
- Light weight and
- Flexibility in design.



Figure 6: Plastic Wastes

These features make plastics the ideal construction product and an integral part of a sustainable environment

➤ In 2014 and 2015, the total amount of plastics produced was around 313 and 322 million tons, respectively
(Belmokaddem , 2020)

- ❖ Plastic wastes used in this research were obtained from Hatipoğlu DOĞA GERİ Dönüşüm ; Haspolat Kirli Sanayi
- ❖ They were crushed using an industrial crushing machine to sizes 2.36 mm



Figure 7: Plastic Wastes Used in the Research

Table 1: Physical and chemical properties of shredded plastic wastes

Properties	values
Plastic type	Polyethylene terephthalate
Density (g/cm ³)	0.96
Modulus of elasticity (MPa)	1700
Heat of fusion (J/g)	165
Tensile strength (MPa)	50
Melting temperature (°C)	265
Acid and Alkali resistance	Good

The control sample contained no plastic waste (PW) whereas the modified Alker contained 0.5%, 1.0% and 1.5% plastic waste by weight of soil.

Table 2: Designation of Mixtures

Designation	Specification
K	<u>Alker</u> with <u>Küçük Kaymaklı</u> Soil
K – 0.5% PW	<u>Alker</u> +0.5% Plastic Wastes
K – 1% PW	<u>Alker</u> +1% Plastic Wastes
K – 1.5% PW	<u>Alker</u> +1.5% Plastic Wastes



- Alker mixes for control and modified samples were three each.
- The molded samples are shown below:



Figure 8 : Molded Samples

Mechanical Tests Conducted on Samples

- The samples compressive and flexural strength tests were conducted at the 7 and 28-day and the specimens average strength were obtained .
- The flexural strength test was performed according to ASTM C348.



Figure 9 : Flexural strength test of the samples

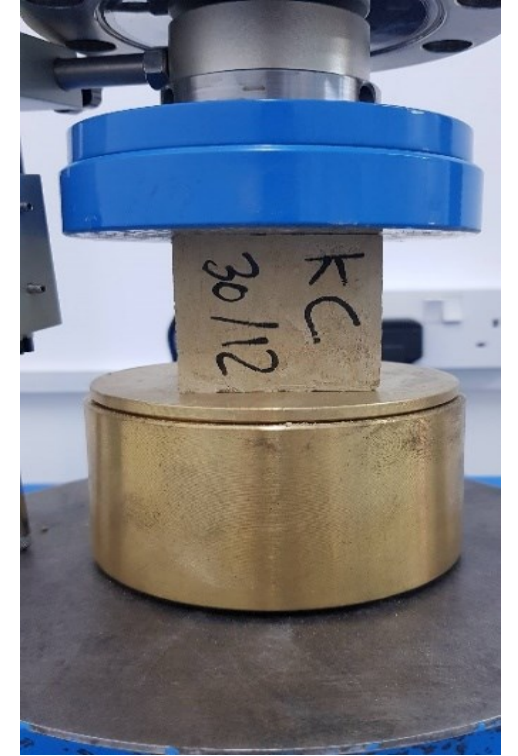


Figure 10 : Compressive strength test of samples

Experimental Results

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Mechanical Properties Results of Alker

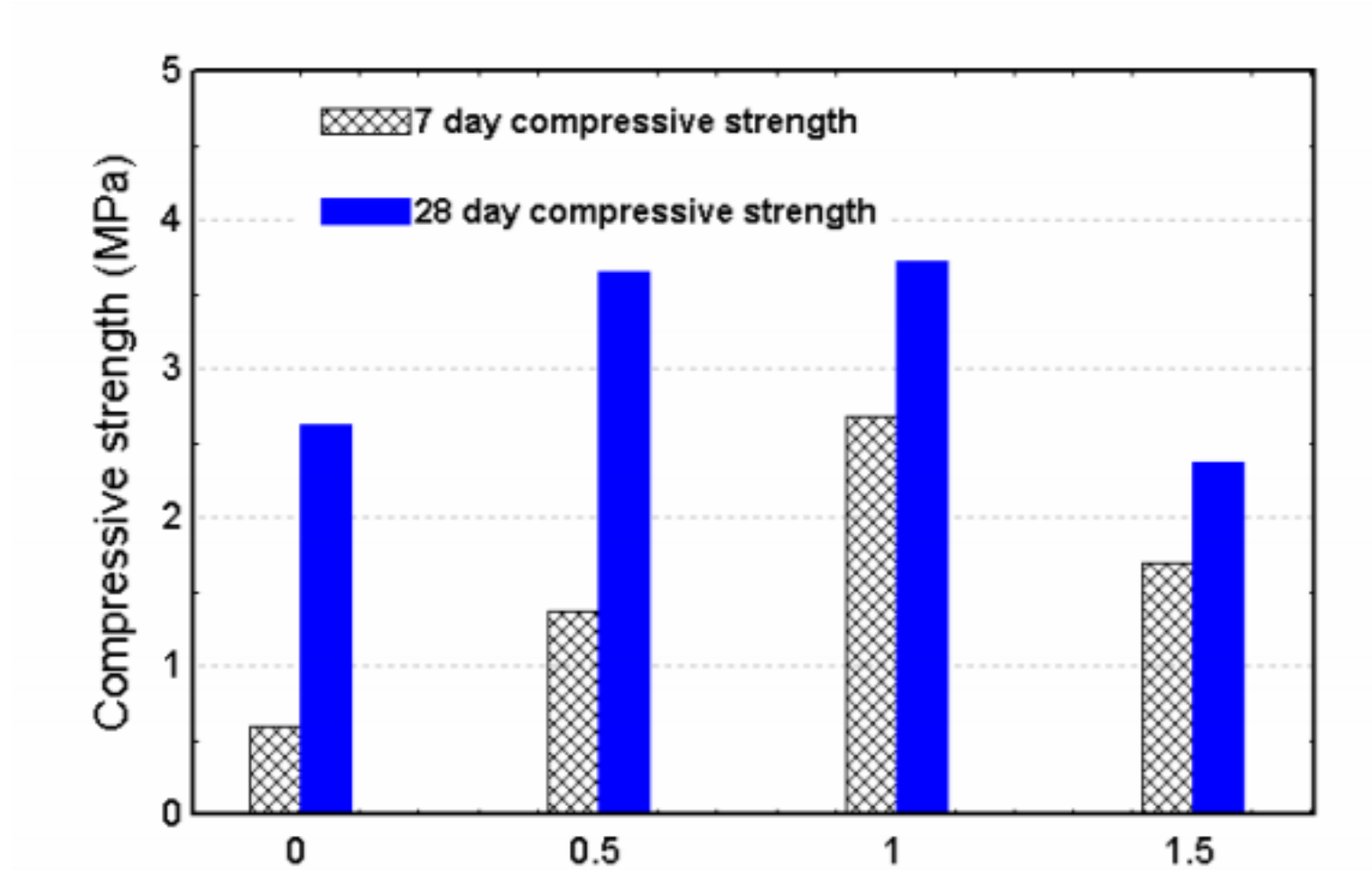


Figure 11: Compressive strength of soil with varying contents of shredded plastic wastes

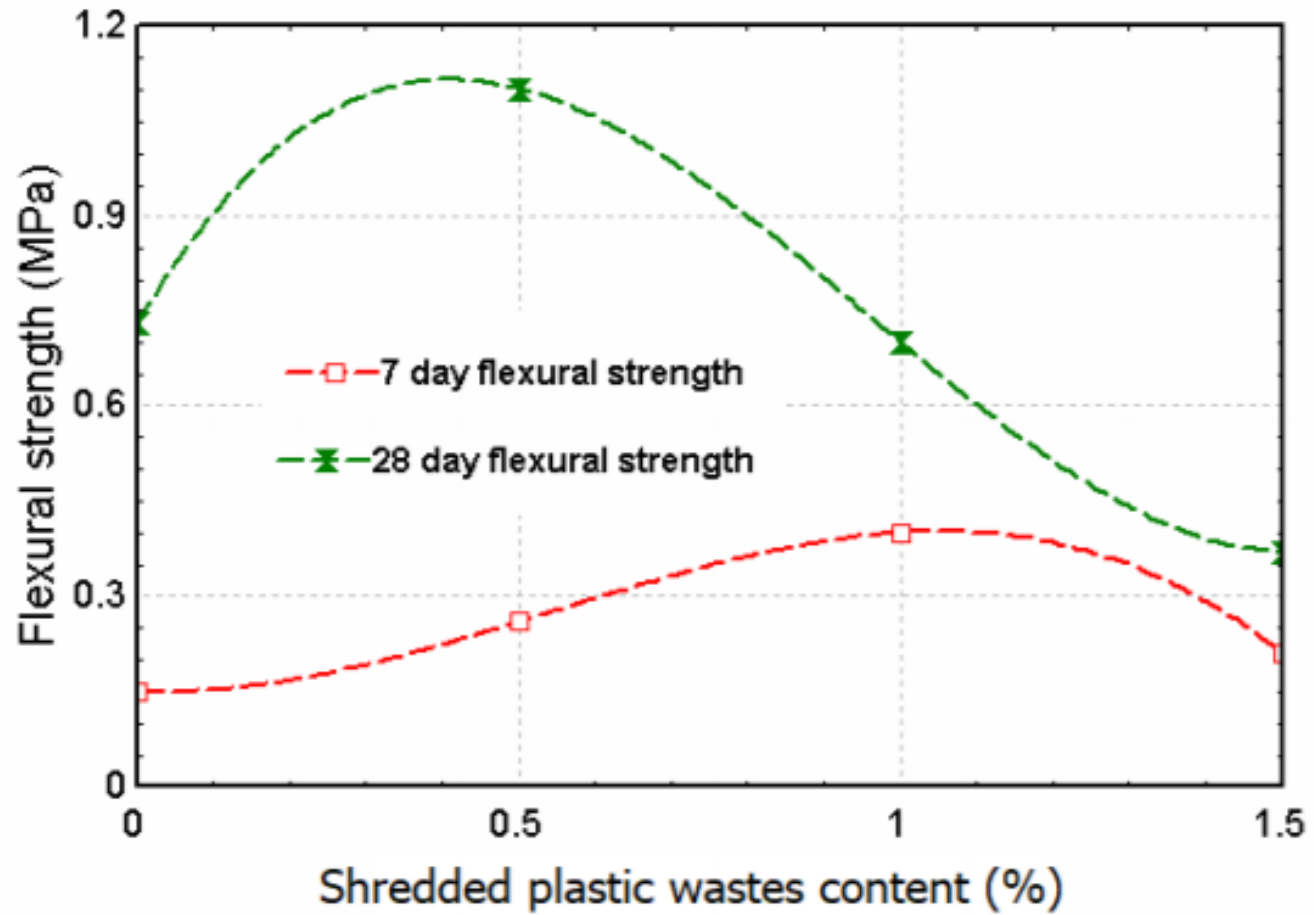


Figure 12: Flexural strength of soil with varying contents of shredded plastic wastes

CONCLUSION

- ✓ Large amounts of plastic waste are created each year as a result of the manufacture of plastics that are utilized on a daily basis in all aspects of life.
- ✓ Alker production is relatively simple and inexpensive compared to conventional building techniques. This lowers carbon emission and makes it a sustainable building production technique.
- ✓ The compressive, flexural and shrinkage properties of the design mixes had a positive effect on the sustainability as a result of the utilization of shredded plastic wastes, lime and gypsum in the production of control and modified Alker samples



- ✓ The use of shredded plastic wastes in Alker and the results obtained provides data on the use of SPW modified Alker as an alternative construction material for sustainable production of earthen buildings.
- ✓ The utilization of plastic wastes in this research also contributed to protecting the environment and it's utilization for building purposes will considerably increase environmental sustainability

THANK YOU FOR YOUR ATTENTION

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