TEAM 076

Utilization of Olive Waste Biochar for Sustainable Innovative Interlocking Blocks with Reduced Cement Content

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CHE CEE 3 ME

Problem Statement

Cement production accounts for ~8% of global CO_2 emissions, while Saudi Arabia's Al-Jouf region generates large volumes of olive waste, creating disposal challenges. This project tackles both problems by converting olive pits into biochar through pyrolysis and using it to replace 10–30% of cement in interlocking blocks. The aim is to develop a sustainable, durable, and eco-friendly building material that reduces emissions, manages waste, and supports Saudi Vision 2030.

Constraints

- Reduce cement content by 10–15% in the mix.
- Operate pyrolysis reactor at 400–800°C.
- Ensure mold design achieves precise interlocking dimensions.

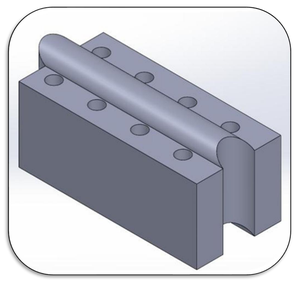
Specifications

- **Furnace ramping rate:** 5°C/min.
- **Max block weight:** 15 kg.
- **Thermal conductivity:** ≤1 W/m·K.
- **Compressive strength:** ≥18 MPa.
- **Must pass durability test:** W/C < 0.4
- **Biochar yield from pyrolysis:** ≥25%.

Prototype Design

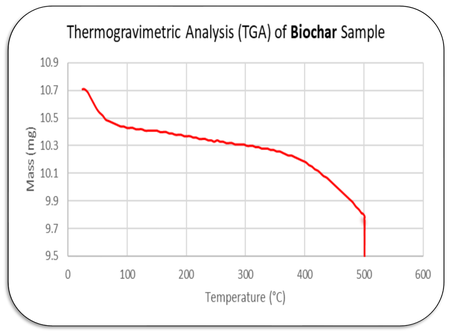
- **Biochar Production (CHE):**
  - Pyrolyzed olive pits at 400-550°C; analyzed with XRF and TGA.
- **Concrete Mix (CEE):**
  - Designed mix with 10–30% biochar; tested for compressive strength.
- **Mold & Block Design (ME):**
  - Created 3D interlocking mold; fabricated using 3D printing.

Mix Design Samples for 50 mm Cubes			
Material	10% Biochar (g)	20% Biochar (g)	30% Biochar (g)
• Water	99.02	99.01	99.01
• Cement	297.02	263.99	213.38
• Biochar	32.99	66.00	94.73
• Sand	742.48	742.48	742.48
• Total	1171.51	1171.48	1149.60



Testing & Validations

- **XRF and TGA for Biochar:**

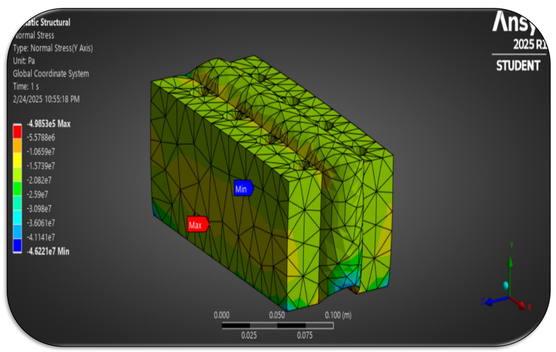


Spectrum: Map

El	AN	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Compound	Comp. C [wt.%]	norm. Comp. C [wt.%]	Error (1 Sigma) [wt.%]
Si	14	K-series	0,75	5,10	5,03	SiO2	10,90	1,60	0,01
O	8		4,22	28,77	49,83		0,00	0,00	0,00
Cl	17	K-series	0,04	0,29	0,23		0,29	0,04	0,00
K	19	K-series	3,35	22,85	16,20	K2O	27,53	4,04	0,01
Ca	20	K-series	5,26	35,86	24,79	CaO	50,18	7,36	0,01
Cr	24	K-series	0,07	0,48	0,26	Cr2O3	0,71	0,10	0,00
Fe	26	K-series	0,68	4,61	2,29	Fe2O3	6,59	0,97	0,00
Zr	40	K-series	0,04	0,30	0,09		0,30	0,04	0,00
P	15	K-series	0,12	0,78	0,70	P2O5	1,80	0,26	0,00
S	16	K-series	0,05	0,31	0,27	SO3	0,77	0,11	0,00
Ti	22	K-series	0,05	0,33	0,19	TiO2	0,55	0,08	0,00
Mn	25	K-series	0,02	0,16	0,08	MnO	0,20	0,03	0,00
Sr	38	K-series	0,02	0,15	0,05	SrO	0,18	0,03	0,00
Rh	45	K-series	0,00	0,00	0,00		0,00	0,00	0,00
		Total:	14,67	100,00	100,00				

- **Average Compressive Strength:**
  - Mix Design with Biochar = **103.967 MPa**
  - Mix Design without Biochar = **100.153 MPa**

- **Finite Element Analysis (FEA):**



Conclusion

This project successfully demonstrated the use of olive pit biochar as a partial cement replacement in interlocking blocks. Among the 10%, 20%, and 30% mixes tested, the 10% biochar mix was selected for its optimal balance of strength, durability, and sustainability. The final blocks met all key specifications and show strong potential as an eco-friendly material supporting Saudi Vision 2030.

Acknowledgment

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