Microwave Heating for Concrete Demolition: Experimental and Empirical Study

Mehdi Roshanbin[1], Shahriar Abubakri[1], Gilson Lomboy[1], Benjamin Watts[2], Seth Wagner[2]

[1]Rowan University, [2]US Army Corps of Engineers

Rowan University
CENTER FOR RESEARCH & EDUCATION IN ADVANCED TRANSPORTATION ENGINEERING SYSTEMS

CRREL ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

RESEARCH FRAMEWORK

BACKGROUND

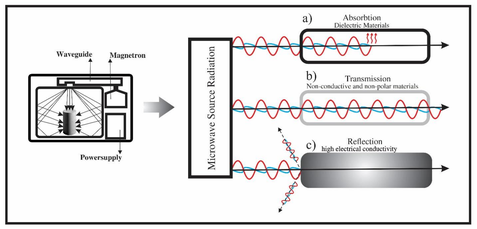
•Traditional demolition (breaking, blasting, chemicals) causes noise, dust, safety risks, and high costs.
•Need for safer, eco-friendly, and efficient methods has led to microwave-based demolition.
•Microwaves create hot spots, cracks, and aggregate separation, enabling selective demolition and recycling.
•Unlike traditional methods, microwaves reduce explosives, dust, and energy use, while improving safety and recycling.
•This study examines key factors (w/c ratio, sample size, power) and develops a predictive model for controlled microwave demolition.

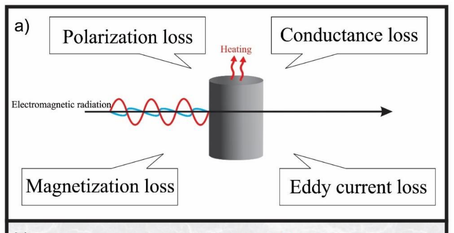
OBJECTIVES

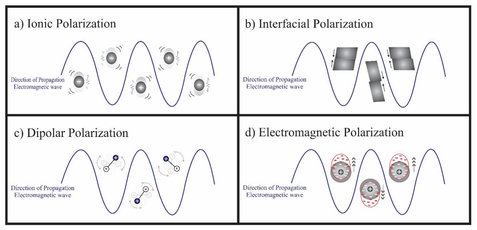
•Establish dataset on microwave–concrete interactions (w/c, size, power).
•Measure penetration depth under moisture and boundary conditions.
•Calibrate thermal imaging with MATLAB correction.
•Develop predictive equation with machine-learning absorption factor (I_m).
•Validate model ($R^2 > 0.94$) across mixes and sizes.
•Provide guidance for selective demolition and recycling

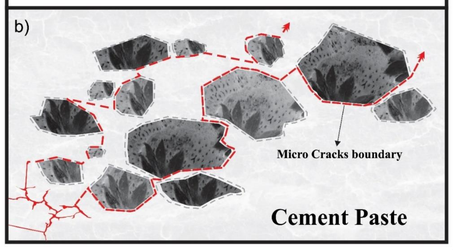
METHODS

•Prepared concrete mixes with w/c = 0.36, 0.43, 0.50.
•Cast cylindrical samples (2×4, 3×6, 4×8 in.) and cured 28 days.
•Exposed specimens to microwaves at 300, 600, 1000 W.
•Recorded temperatures with thermocouples and thermal camera.
•Improve data using MATLAB code for accuracy.
•Developed and validated a predictive equation for heating behavior.



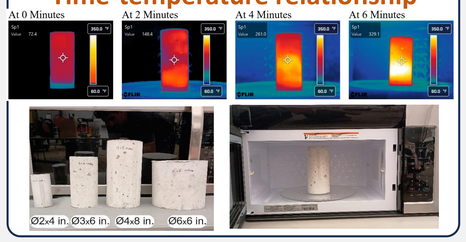




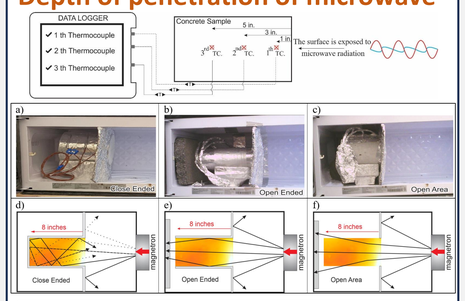


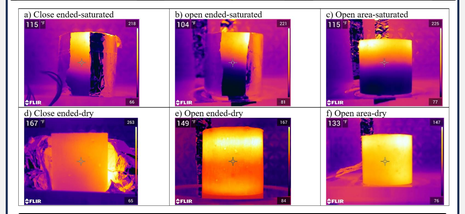
RESULTS

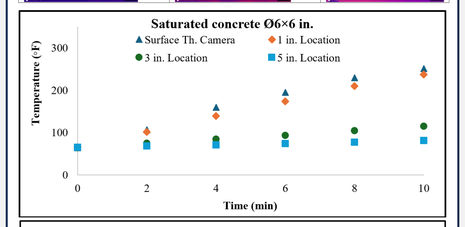
Time-temperature relationship

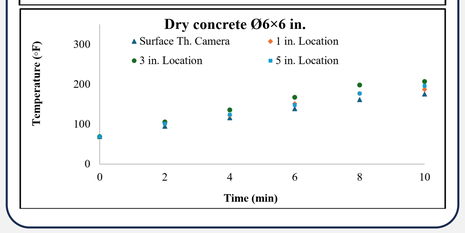


Depth of penetration of microwave



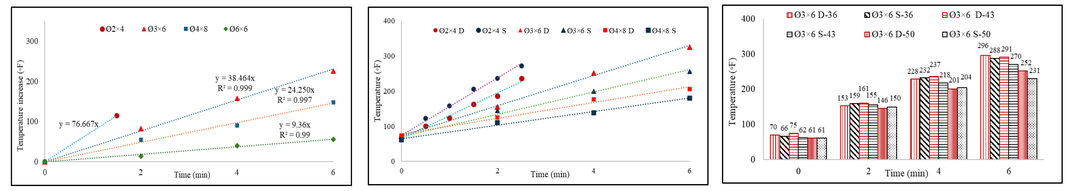




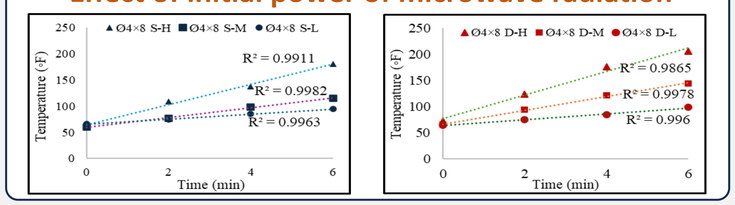


Effect of microwave heating on

1- sample volume | 2-initial moisture Content | 3-water-to-cement ratio (w/c) and cement content



Effect of initial power of microwave radiation

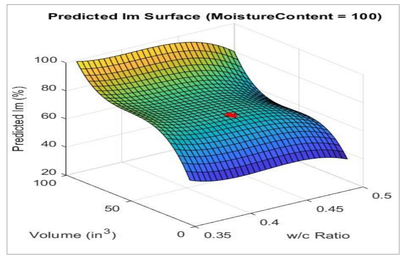


Mix ID	Cement (lb/yd³)	water (lb/yd³)	Sand (lb/yd³)	Gravel (lb/yd³)	w/c ratio	AEA, 90 (fl. oz)	Slump (in)	Air (%)	Compressive Strength (psi)
136	871.6	313.8	1325.2	1291.0	0.36	8.5	4.5	7.6	6090
143	656.7	282.4	1587.1	1291.0	0.43	5.6	3.3	8.9	4510
150	575.1	287.6	1641.9	1291.0	0.50	3.8	5.1	8.5	3940

Temperature Prediction Model and Validation

$$T_2 = T_1 + \frac{P \times t \times I_m}{mc_{concrete} + mc_{water}}$$

•The developed equation predicts the temperature rise in concrete under microwave exposure by combining microwave power, heating time, material mass, and a newly introduced absorption coefficient (I_m). This coefficient captures the effects of w/c ratio, sample size, and moisture, making the model adaptable to different conditions. Validation against experiments ($R^2 > 0.94$) confirmed its accuracy, offering a reliable tool for controlled demolition and recycling applications.



The microwave absorption coefficient (I_m) captures the combined effects of w/c ratio, size, and moisture on heating efficiency. It enables accurate prediction of concrete temperature under microwave exposure.

CONCLUSION

Microwave heating of concrete is influenced by specimen size, w/c ratio, moisture, and power level. Dry samples allowed deeper penetration, while saturated small ones often cracked due to steam pressure. Lower w/c mixes heated faster. A new absorption coefficient (I_m) captured these combined effects, and the model achieved high accuracy ($R^2 > 0.94$) with MATLAB corrections, showing strong potential for selective demolition.

Acknowledgement

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