EVALUATING CERAMIC MATERIALS

Small-Scale Production

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Gavin Ray

Burn Manufacturing's Jikokoa

- Over 200 000 stoves manufactured each year
- Average lifespan of 3-4 years in the field
- Strive to make each purchase last as long as possible

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Durability Program

- Accelerated Testing (4x)
- Constant Charcoal Burning

SS304 CC before testing

SS304 CC after an equivalent of 3 years' usage

- Oxidation
- Creep Deformation

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Ceramic Combustion Chambers

- Existing cookstoves with a ceramic combustion chamber show this is a viable option
- The most affordable ceramic materials need to be mixed on-site
- How do we verify our ceramic parts' quality and consistency?

Kenya Ceramic Jiko

Philips Stove

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Testing Protocols – Thermal Fatigue

- Make the tests as harsh as possible:
  - Quench the sample in room temperature water
  - Place the sample immediately back into the kiln
  - Repeat until failure

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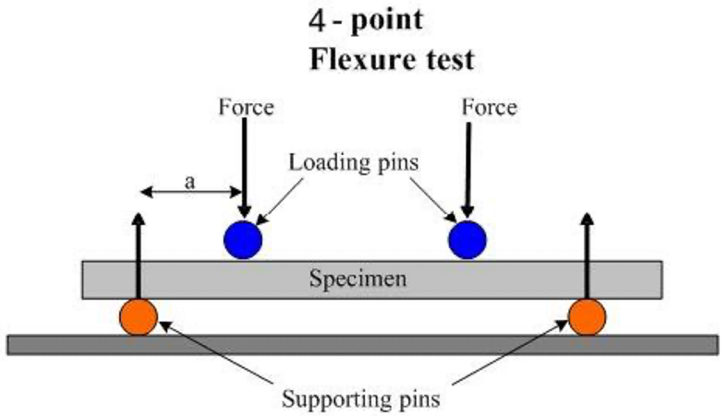
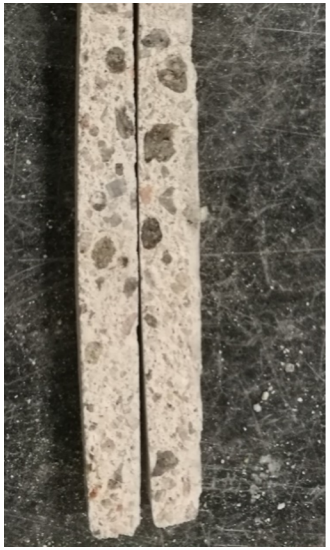
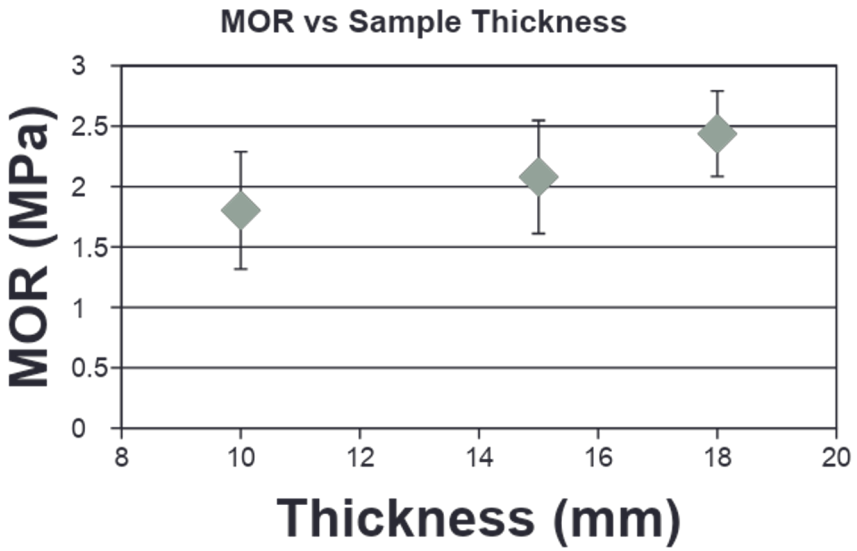
Testing Protocols – Modulus of Rupture (MOR)

- Designed for Brittle Materials
- $MOR = \frac{3 * Force * Length}{4 * Width * Thickness^2}$







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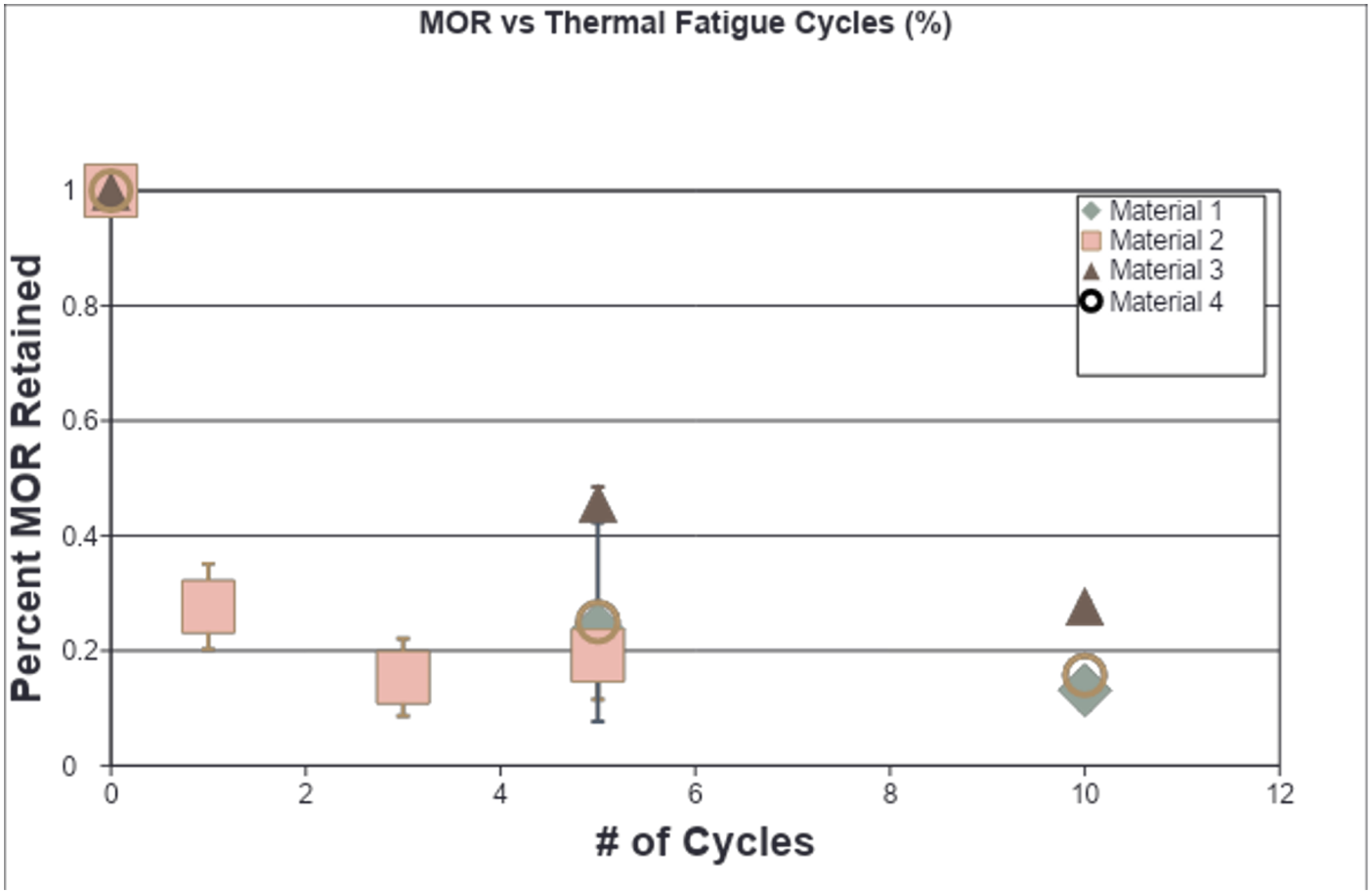
Testing Protocols – Loss of Strength

- Measure the MOR after x number of Thermal Fatigue cycles



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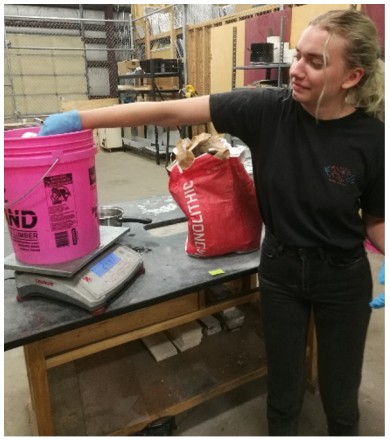
Sample Preparation

- Mixing
  - Water Content
  - Mixing Method
- Moulding
  - Mould Material
  - Mould Shape
  - Release Agent
- Firing
  - Ramp Rate
  - Maximum Temperature
  - Hold Time



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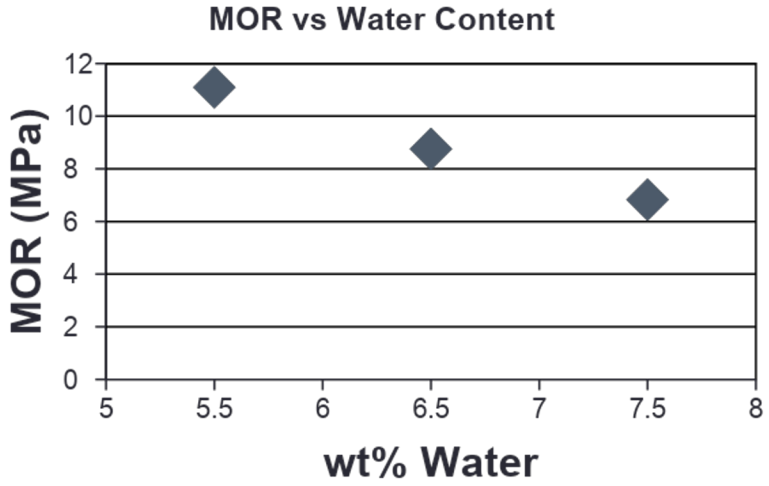
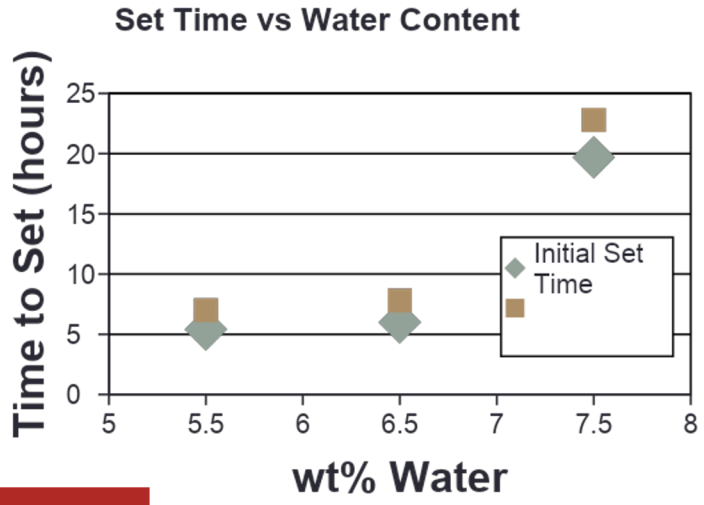
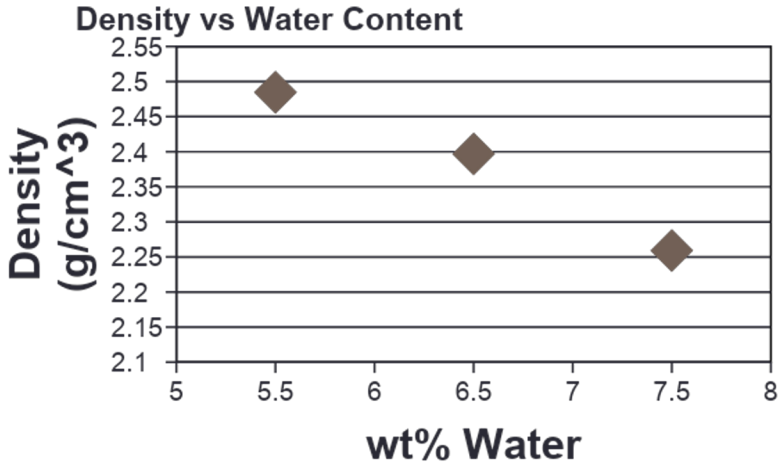
Impact of Water Content

Casting Water (%)	5.5	6.5	7.5
230°F Density (pcf)	155.3	149.8	141.2
230°F MOR (psi)	1610	1270	990
Initial Set (hours)	5.4	6.0	19.7
Final Set (hours)	7.0	7.8	22.8

Effect of water content on the properties of a general-use castable







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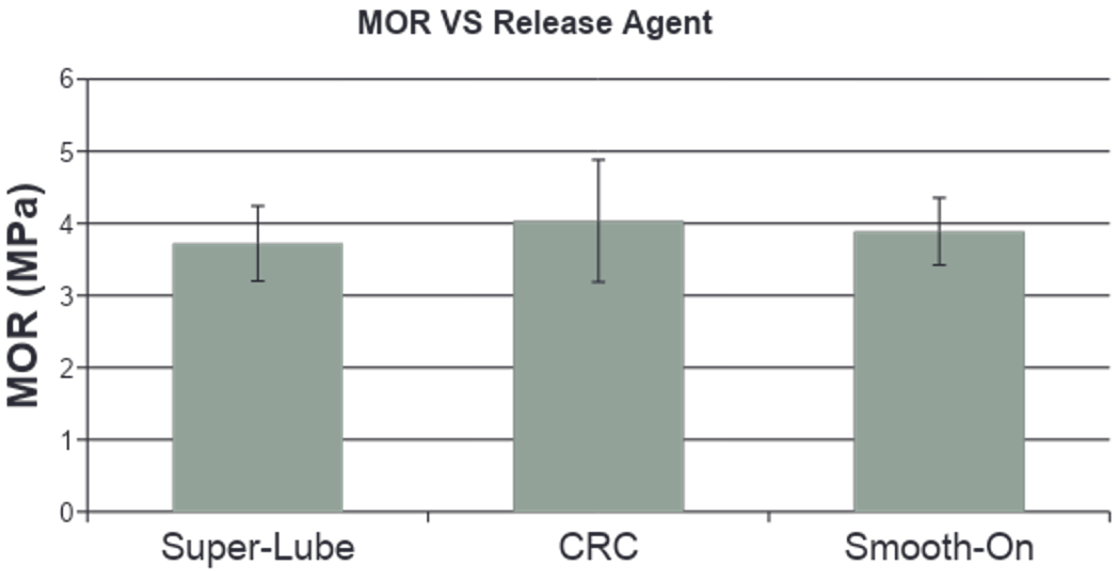
Impact of Release Agent

- Affects Outer Porosity
- Affects Ease of Removal
- Does not seem to affect MOR



Removal Failure

Difficult to remove

Difficult to remove

Easy to remove

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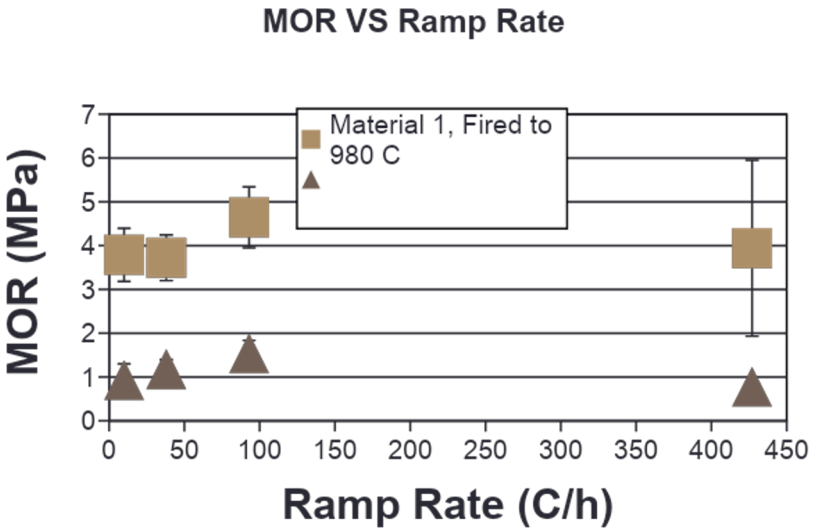
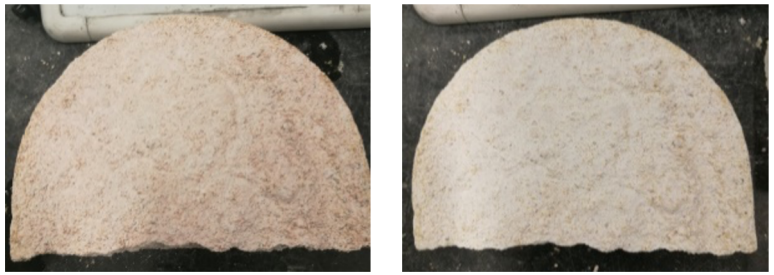
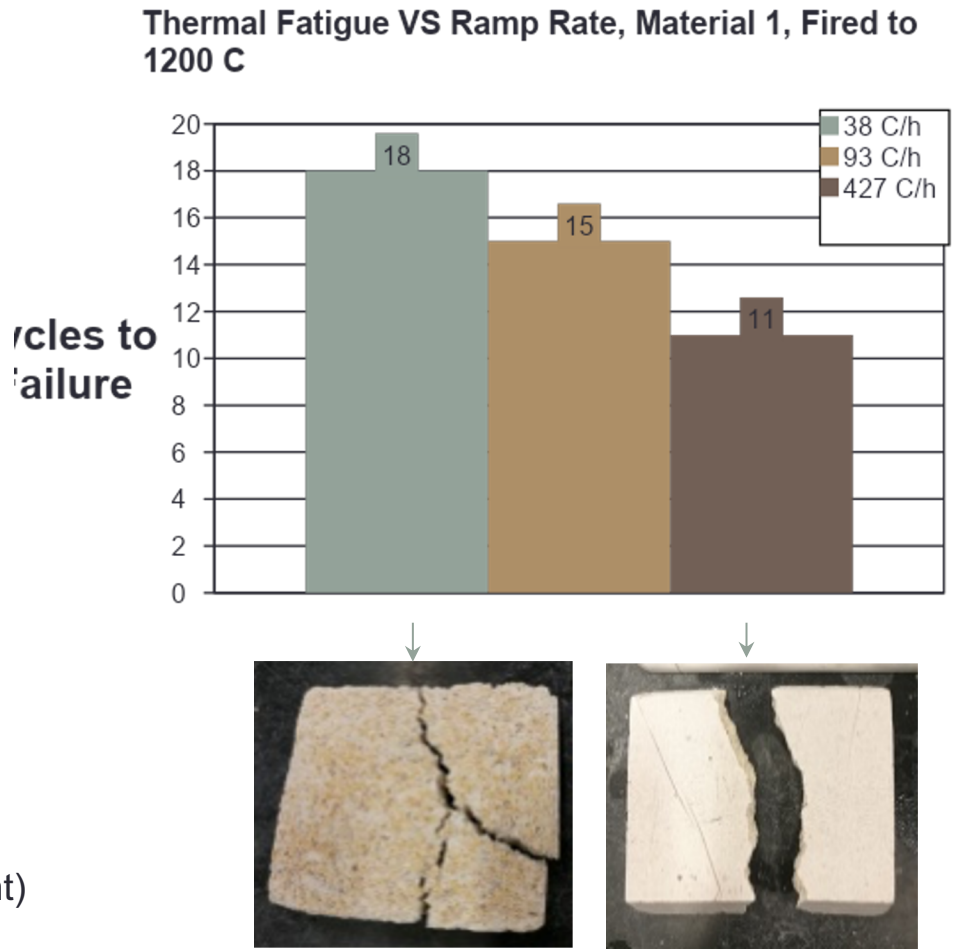
Impact of Firing Protocol





Material 1, Fired to 980 C (Left) and 1200 C (Right)



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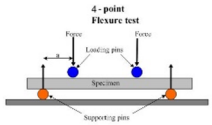
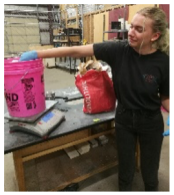
Conclusion

- To extend the customers' use of their Jikokoa, we have begun to explore ceramic materials as a replacement combustion chamber material.

- We have identified tools to evaluate some of these materials' physical properties.



- We have used these tools to monitor the effect manufacturing procedures have on our parts.



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