# Low Carbon Waste-Based Geopolymer Pavements

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## Summary:

**Rigid and flexible pavements have:**

-High $CO_2$ footprint[1]

-Generate high levels of mineral waste[1]

-Limited capacity to incorporate high amount of waste materials[2]

Current methods impose limitations on the use of reclaimed asphalt pavement (RAP) and recycled aggregates into rigid pavement structures, keeping waste levels and carbon emissions high.


## Motivation & Desired Outcome

**Motivation:** to reduce waste and carbon emission in pavement construction by producing rigid geopolymer-based pavements and binder containing high amounts of RAP.

**Overall Objectives:**

-Reduce carbon emission

-maximize RAP and waste clay use

-Enhance pavement performance and strength

## Research Summary

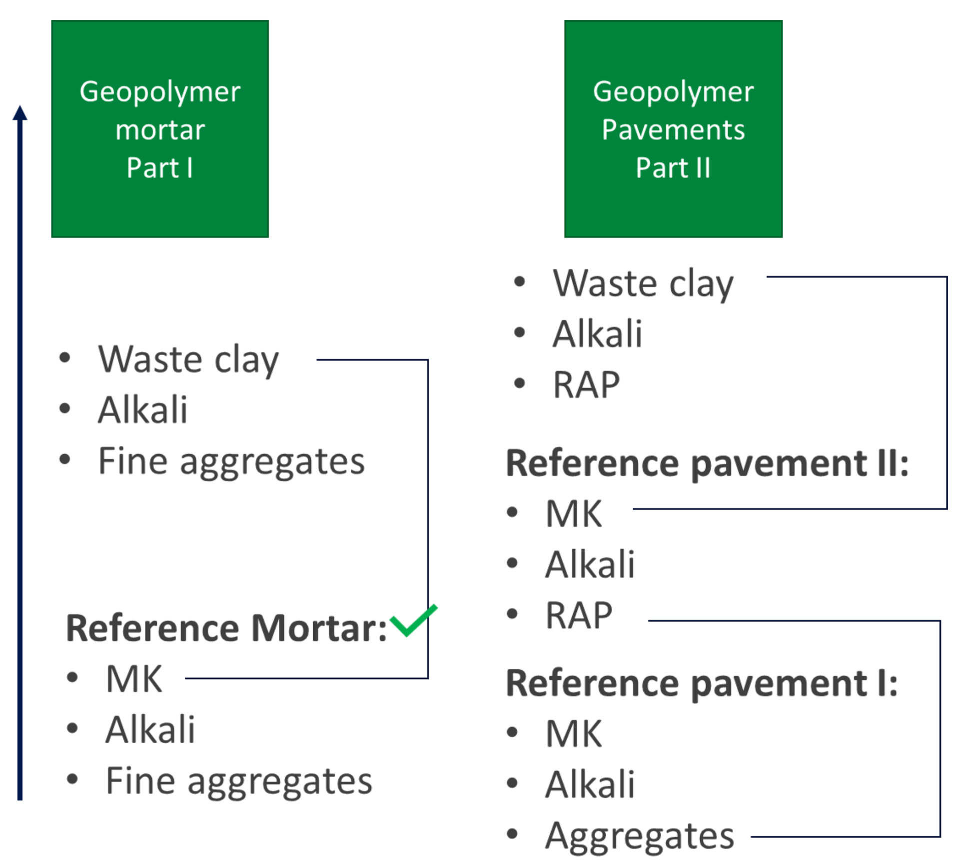


**Figure 1.** Overall workflow for geopolymer mortar and concrete production.

The first step involves producing geopolymer mortars with natural aggregates and pure kaolin, followed by substituting kaolin with waste calcined clay. In the concrete phase, reclaimed asphalt pavement (RAP) will replace natural aggregates, and kaolin will again be substituted with waste calcined clay to create the final geopolymer pavement. Currently, the reference mortar has been successfully produced.

**Figure 2.** Reference geopolymer mortar preparation containing pure metakaolin and natural fine aggregates

**Figure 3.** Geopolymer mortar reference cubes @ 7 days

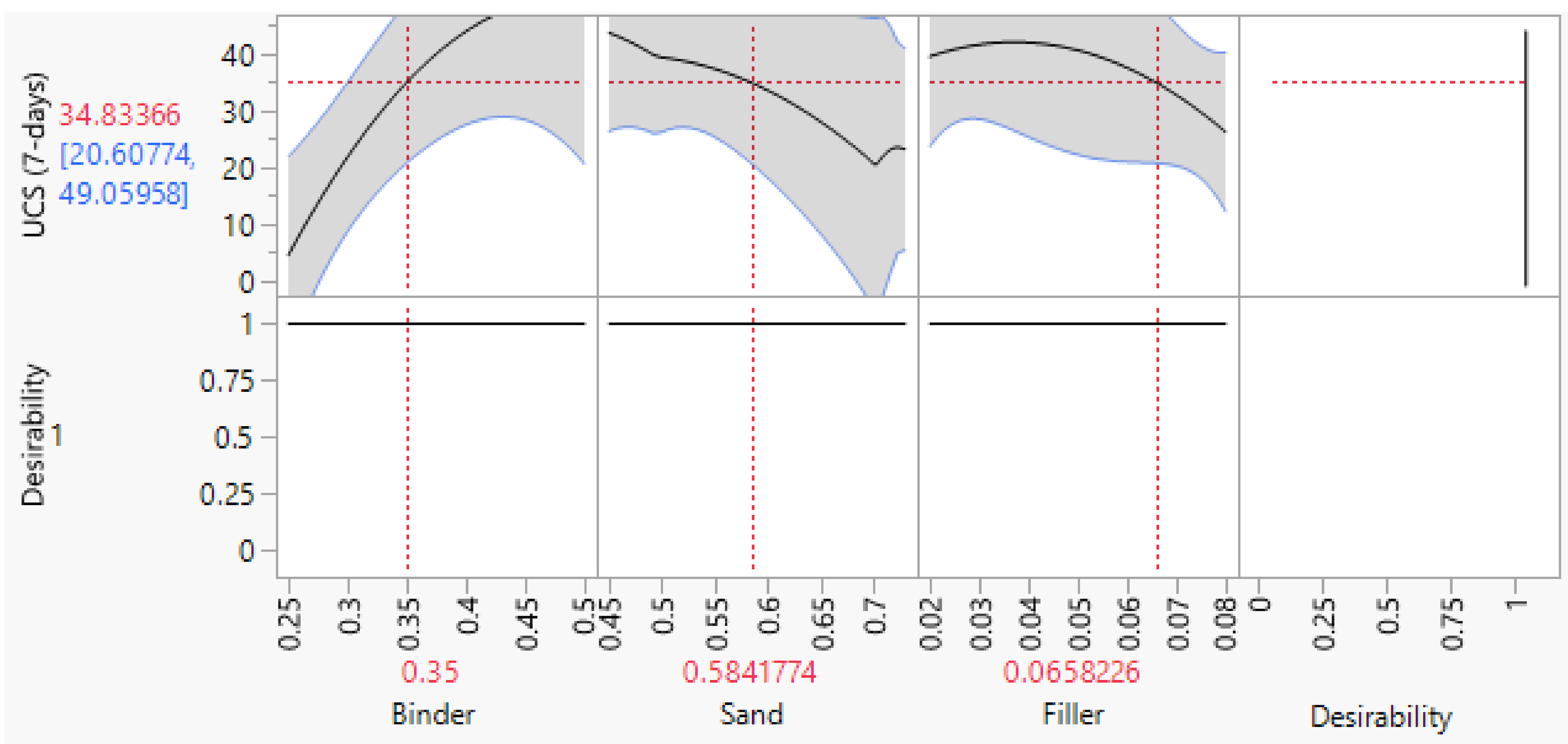


**Figure 4.** Mixture profiler indicating various strengths obtained for different mixture designs. The red dotted lines for instance indicate that a mortar having 35% binder, .58.4% sand and 6.5% filler will have a strength of approximately 35 MPa after 7-days curing.

**Parameter Estimates**

| Term | Estimate | Std Error | t Ratio | Prob>\|t\| |
|---|---|---|---|---|
| (Binder-0.25)/0.28 | 36.461283 | 1.944778 | 18.75 | 0.0339* |
| (Sand-0.45)/0.28 | 23.039009 | 1.398348 | 16.48 | 0.0386* |
| (Filler-0.02)/0.28 | -563.1383 | 120.8948 | -4.66 | 0.1346 |
| Binder*Sand | 44.069442 | 7.016944 | 6.28 | 0.1005 |
| Binder*Filler | 805.32534 | 152.2973 | 5.29 | 0.1190 |
| Sand*Filler | 616.13232 | 153.5176 | 4.01 | 0.1555 |

**Table 1.** Binder and sand amount significantly affect UCS

## What next? (fixed title 44pt bold)

To expand the mortar to concrete and incorporate waste clay and aggregates in the geopolymer mixture

- Finalize reference geopolymer mix designs
- Produce and study sustainable geopolymer concrete and mortar
- Investigate the feasibility of incorporating graphene in geopolymer-based mixtures
- Explore pavement related application of produced mixtures


## Acknowledgements (fixed title 44pt bold)

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## References (36pt)


1-https://doi.org/10.1016/j.trd.2021.102697

2-10.3390/ma13071495