



# **Geopolymer a New Concrete Binder**

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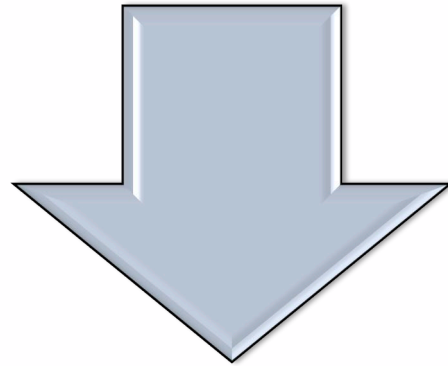
Materials Laboratory

# Outline

- Introduction (Why Geopolymer?)
- Experimental Work
- Results & Discussion
- Conclusion/ Future Work



# Why Geopolymer ?



## Advantages

- Fire resistant
- Chloride and Sulfate Resistant
- Low Carbon Emission
- Sustainable and Durable Concrete



## Disadvantages

- Lack of Standards
- Difficult to create as it requires special handling
- Highly depending on casting and Curing Conditions



# Experimental Work :Material



**Metakaolin**  
Source of Silica & Alumina



**Normalized Sand**  
Well graded aggregates



**Alkali solution:(Activator)**  
Sodium Silicate solution + Sodium Hydroxide pellets

# *Experimental Work :Method*



## Quartering

Evenly distributed Sand  
Particles



## Calcination

Transform Kaolin to  
Metakaolin (MK)

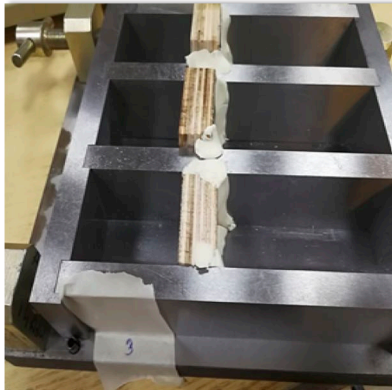


## Solution Preparation

Cooling since Exothermic Reaction

# *Process : Mixing*

Mold Preparation



Metakaolin



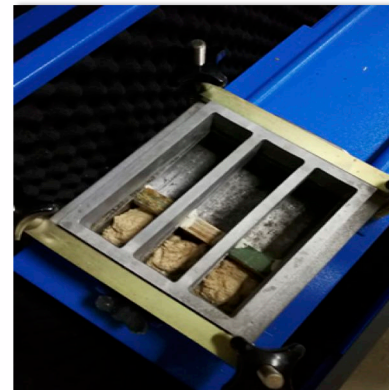
Liquid Added



Workability Test



Vibrating Table



# Process : Curing and Testing

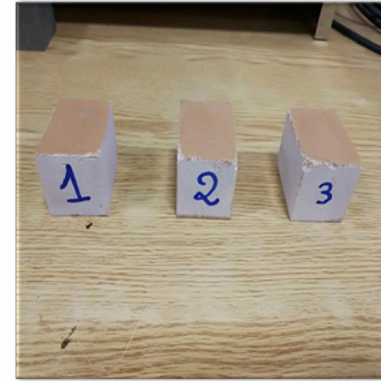
Vibrated Samples



Oven Curing at 40°C



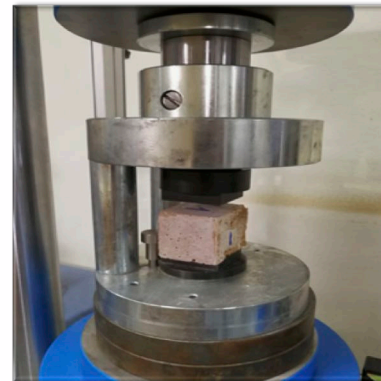
Demolded Samples



Curing at 25°C



F'c Testing



# Laboratory Work

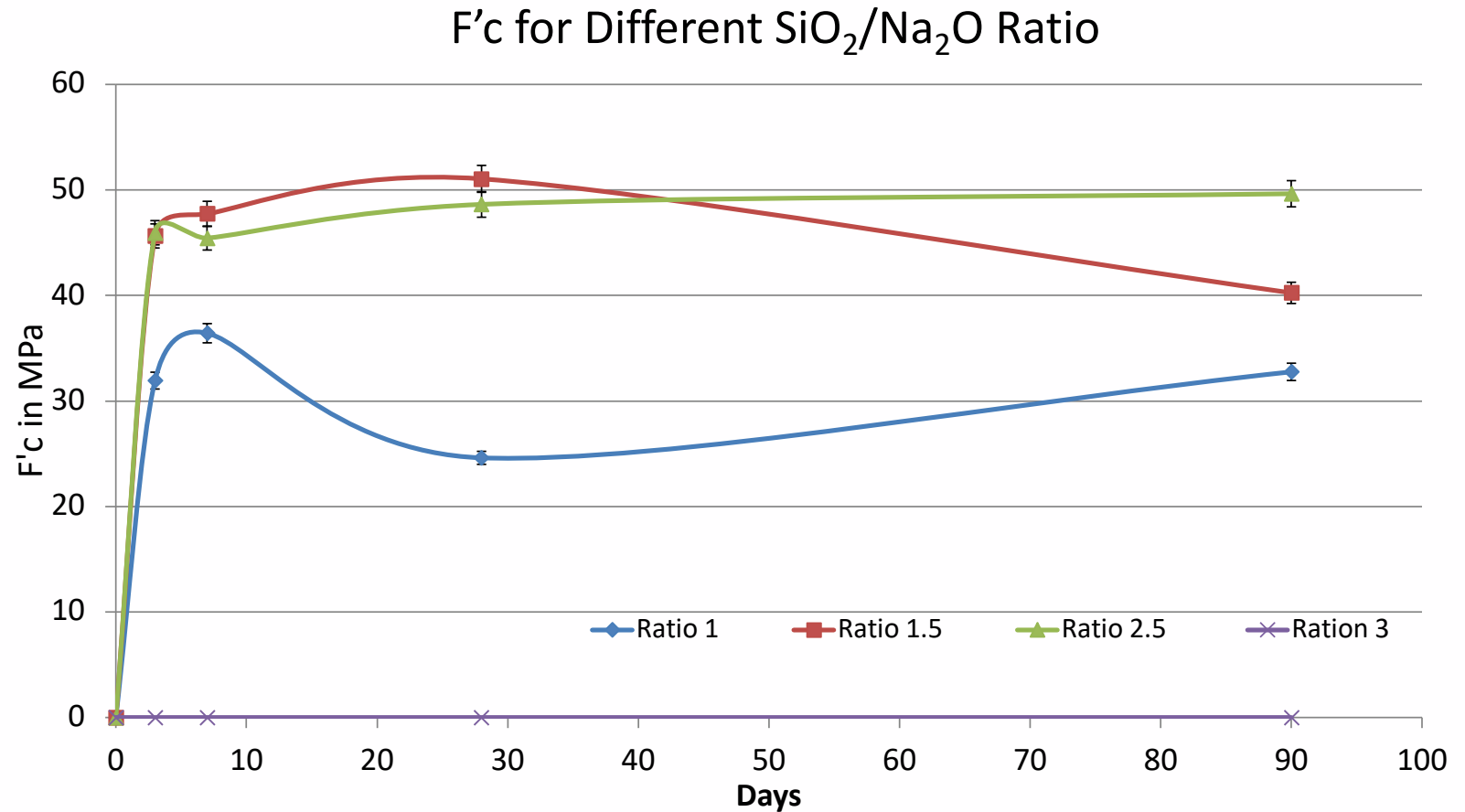
- As a first step, we varied the  $\text{SiO}_2/\text{Na}_2\text{O}$  ratio (1; 1.5; 2.5 & 3) and kept a fixed Liquid/Binder ratio (L/B) = 1.8
- In a second phase we fixed  $\text{SiO}_2/\text{Na}_2\text{O} = 1.5$  and varied the L/B between 1.5 and 1.8
- The third phase was to substitute some of the main raw material MK with materials such as Silica Powder; Silica Fume and MSWBA.
- Results are presented in the slides below.





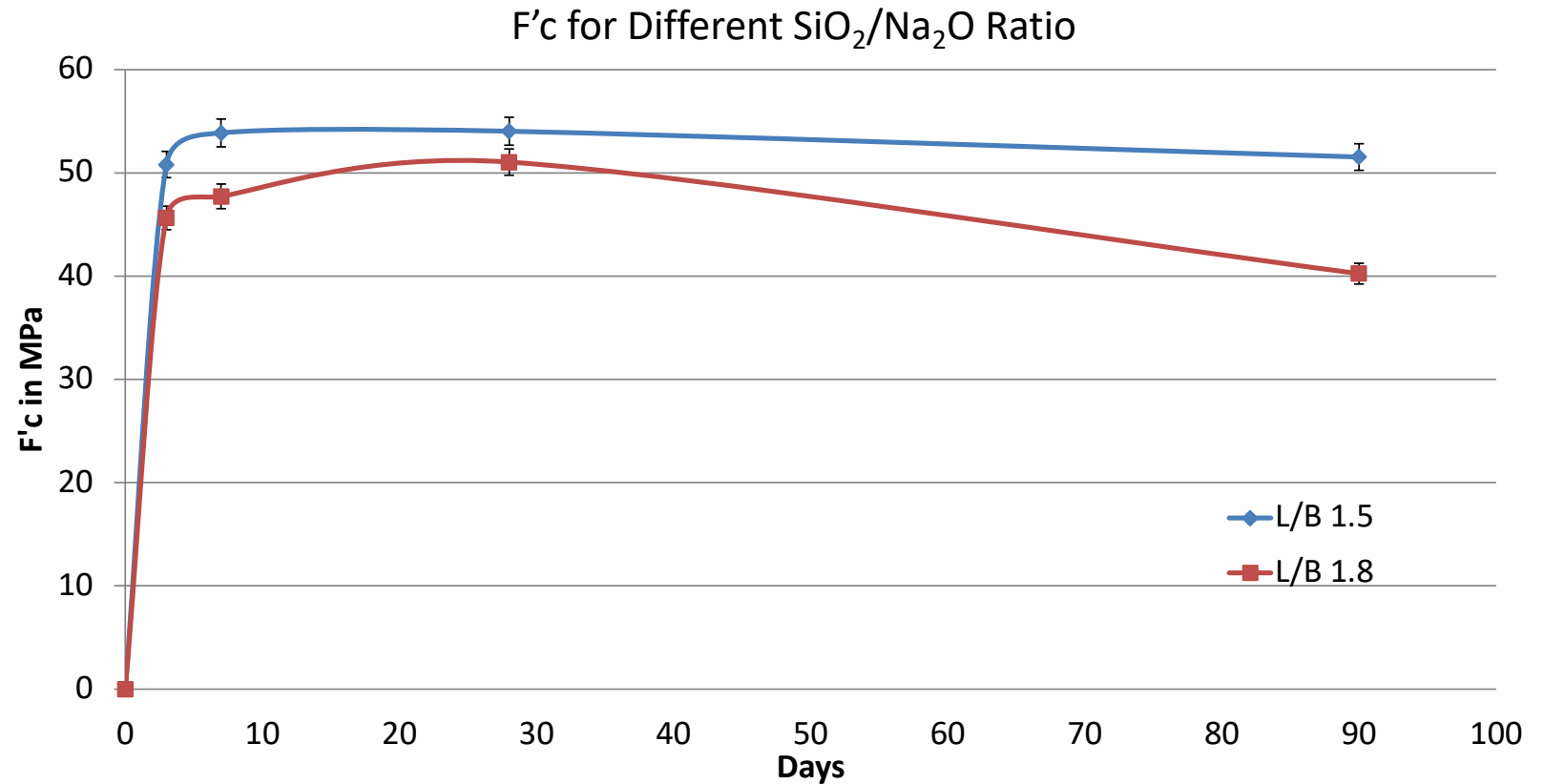
# Results : Compressive Strength $F'_c$

- Fixed Parameters :
  - $L/B = 1.8$
  - Source Material
- Varying Parameter:
  - $\text{SiO}_2/\text{Na}_2\text{O}$  ratio

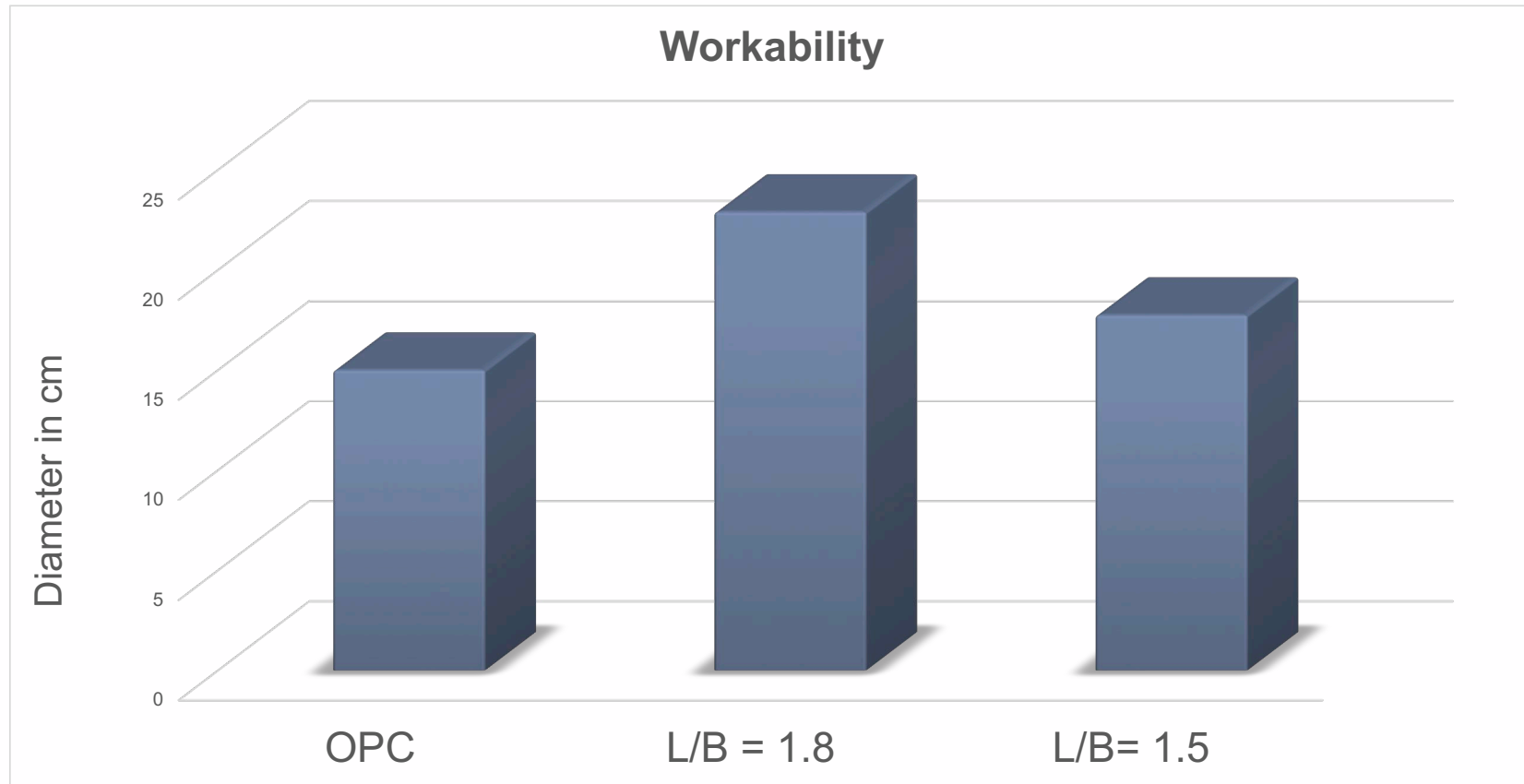


# Con't Results: Compressive Strength

- Fixed Parameters :
  - $\text{SiO}_2/\text{Na}_2\text{O} = 1.5$
  - Source Material
- Varying Parameter:
  - L/B Ratio



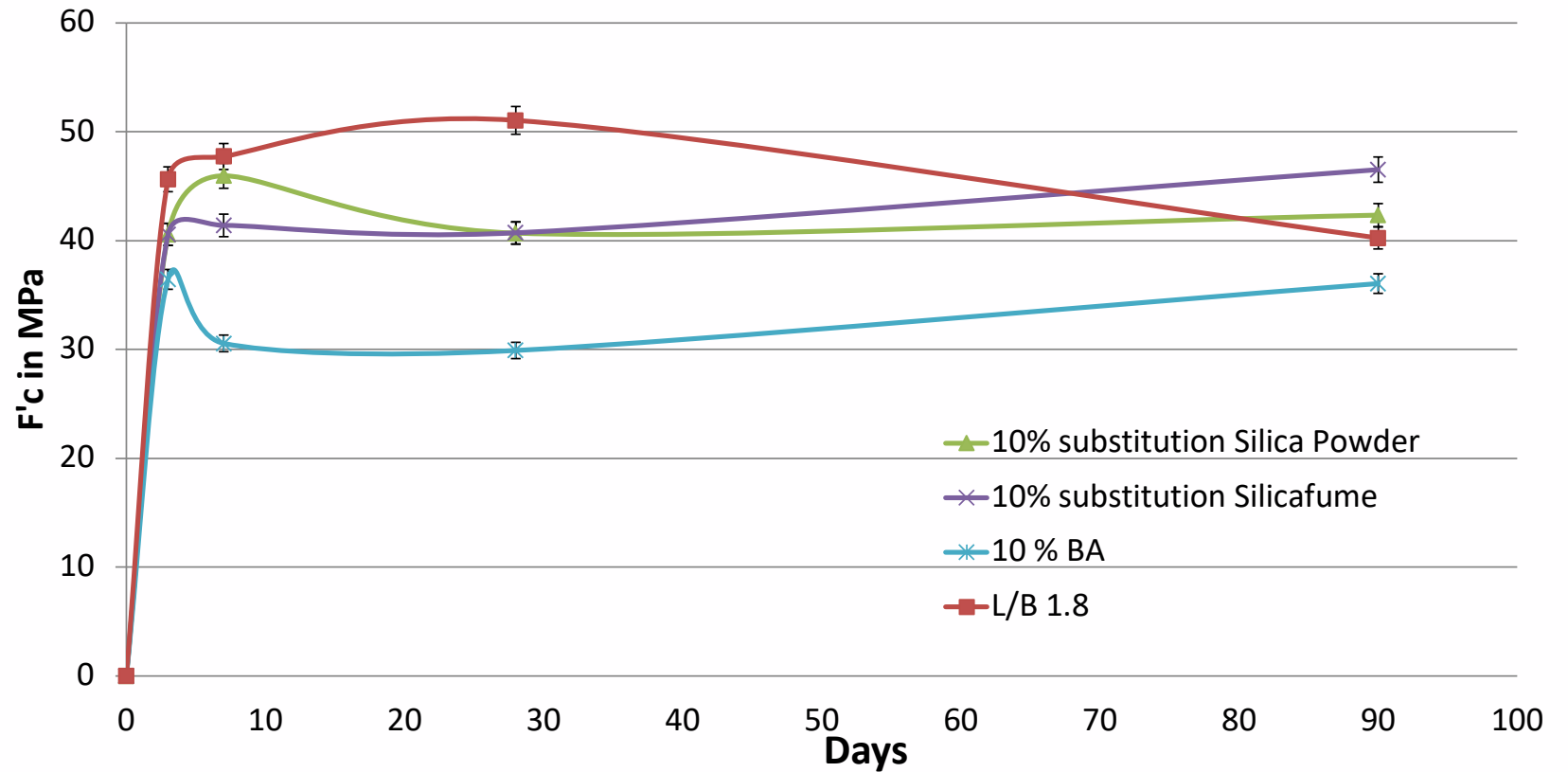
# Con't Results : Workability



# Con't Results: Substitution

F'c for different substitution Silica based Material

- Fixed Parameters :
  - L/B = 1.8
  - $\text{SiO}_2/\text{Na}_2\text{O} = 1.5$
- Varying Parameter:
  - Raw material containing Si



## Conclusion

- $F'c$  for  $L/B = 1.8$  Increases after 3 days up to 28 days , and from heron decreases continuously
  - $F'c$  for  $L/B = 1.5$  Increases after 3 days and maintain a near constant value after 30 days
- The less solution used the higher the  $F'c$
- Replacing Metakaolin (100%) will not give satisfying results

## *Future Work*

- Make the Geopolymer with substitution rates of 10% Silica Fume, Silica Powder and MSWBA with a  $L/B = 1.5$  and compare them with  $L/B = 1.8$
- Try to find a local source of MK to make the production of Geopolymer cheaper .
- Work on the Environmental Assessment of the Geopolymer.
- Work on Solidification/Stabilization of Heavy Metals in Geopolymers.

Thank you for your  
Attention

Any Questions ???