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2025 SPRING CONVENTION

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Solving Complex Repair Problems with Geo Hybrid Mortars

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GEO HYBRID MORTARS

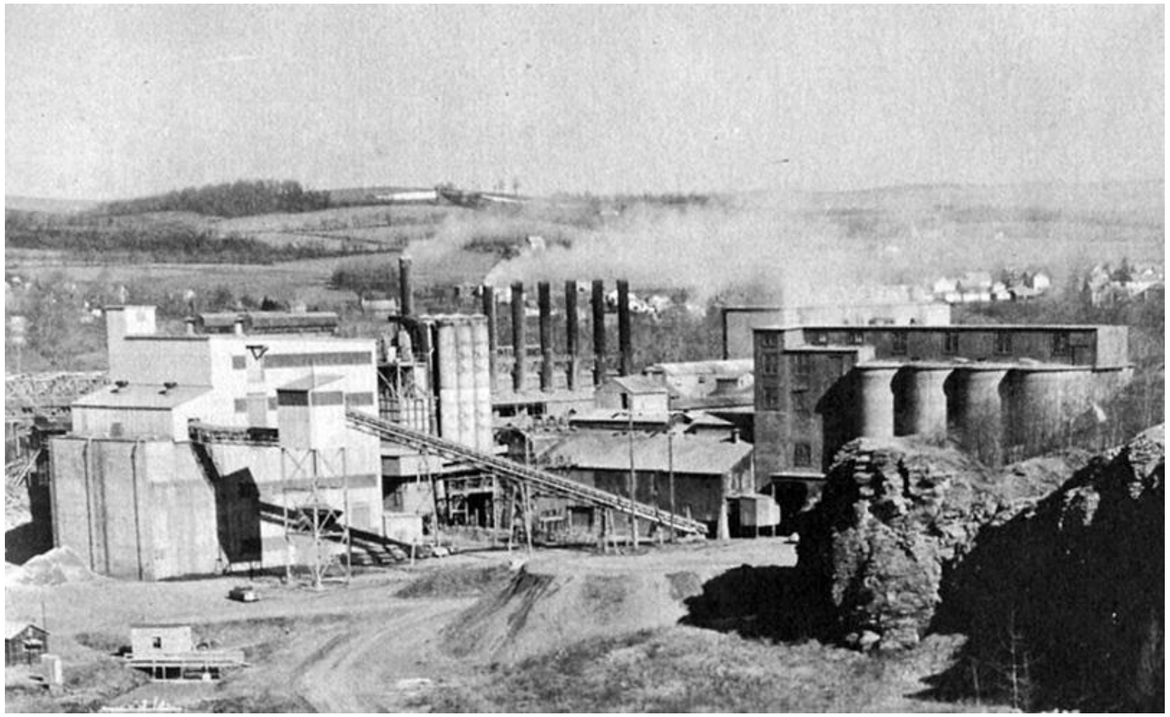
OVERVIEW

- **Sustainability**
- What is a ***Geopolymer***?
  - What is a ***Geo Hybrid***?
- **Advantages**
- **Applications**

GEO HYBRID MORTARS

SUSTAINABILITY

- Sustainability, reduced carbon footprint, green are heard every day in the news cycle
- Concrete and most concrete repair materials are based on Portland cement
- Portland cement production accounts for 8% of global CO_2 emissions*
- 1 ton of cement products results in ~1 ton of CO_2 emissions+

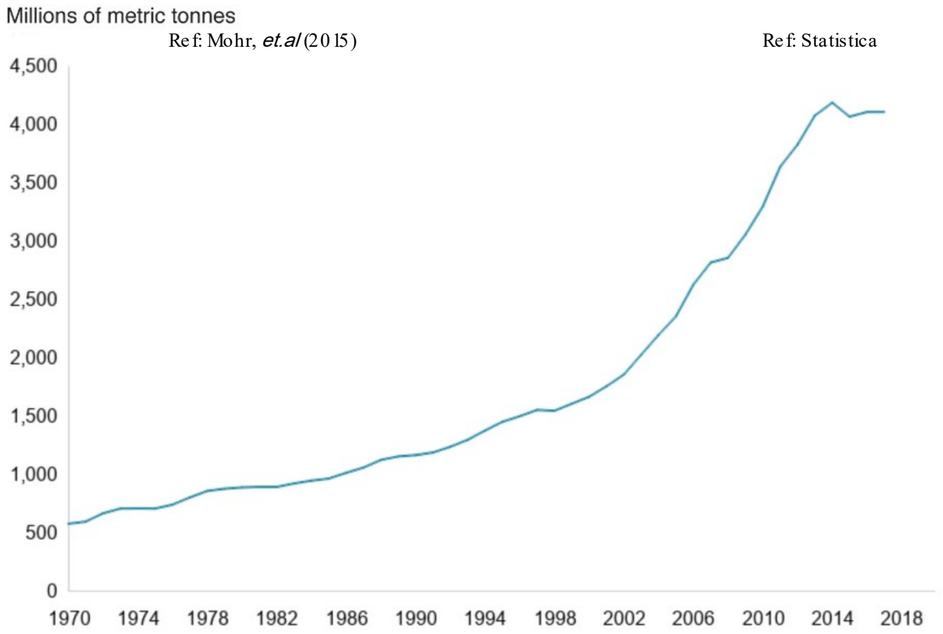


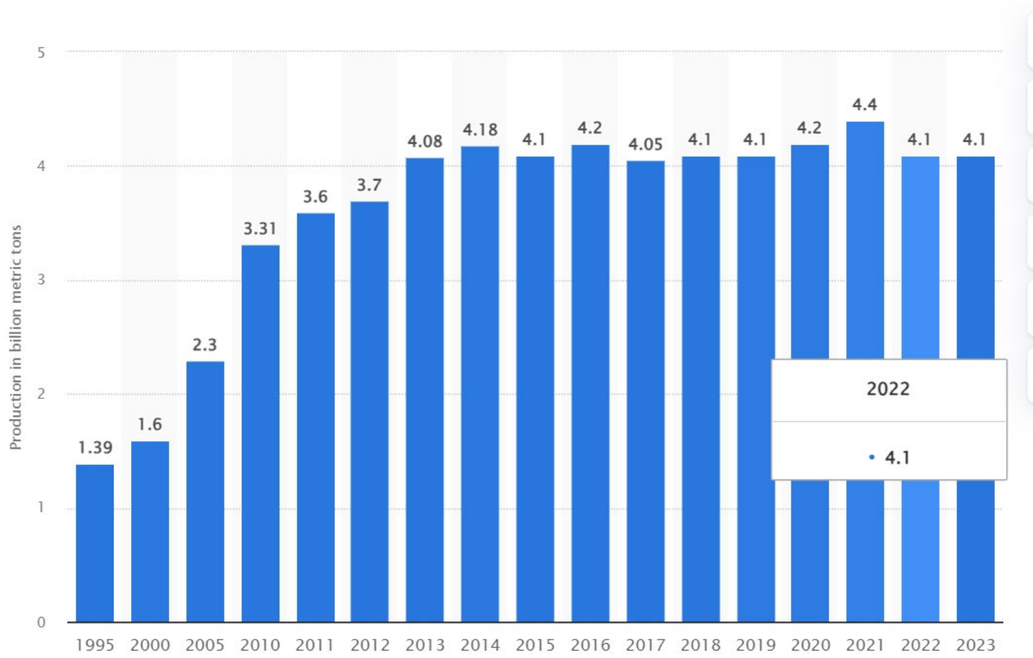
*Ref: Chatham House
+Ref: Scientific American, 2023

GEO HYBRID MORTARS

GLOBAL PORTLAND CEMENT PRODUCTION VOLUME

- Production has leveled off since 2013, likely the result of increased use of SCM's





- Even with Portland cement production leveling off …
  - 4 Billion metric tons of Portland cement results in 4 Billion metric tons of CO_2!

GEO HYBRID MORTARS

WHAT IS A GEOPOLYMER?

- Geopolymer – Portland cement-free binder
- "Geopolymerization" coined by Joseph Davidovits in the later 1970's
- Class of inorganic, polymeric materials that form different chemical units of silicates and aluminosilicates …similar to Portland cement.
- Showed promise as a low/no CO_2 alternative to Portland cement
- Limitations as a result of scale-up and acceptance

In the late 1970's, Joseph Davidovits, the inventor and developer of geopolymerization, coined the term "geopolymer" to classify the newly discovered geosynthesis that produces inorganic polymeric materials now used for a number of industrial applications. He also set a logical scientific terminology based on different chemical units, essentially for silicate and aluminosilicate materials, classified according to the Si:Al atomic ratio:

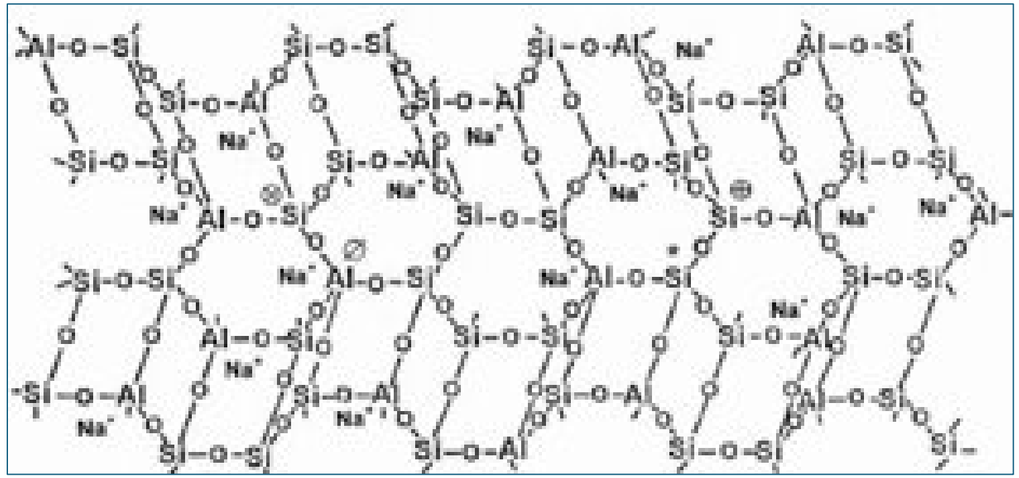
Si:Al = 0, siloxo

Si:Al = 1, sialate (acronym for silicon-oxo-aluminate of Na, K, Ca, Li)

Si:Al = 2, sialate-siloxo

Si:Al = 3, sialate-disiloxo

Si:Al > 3, sialate link.



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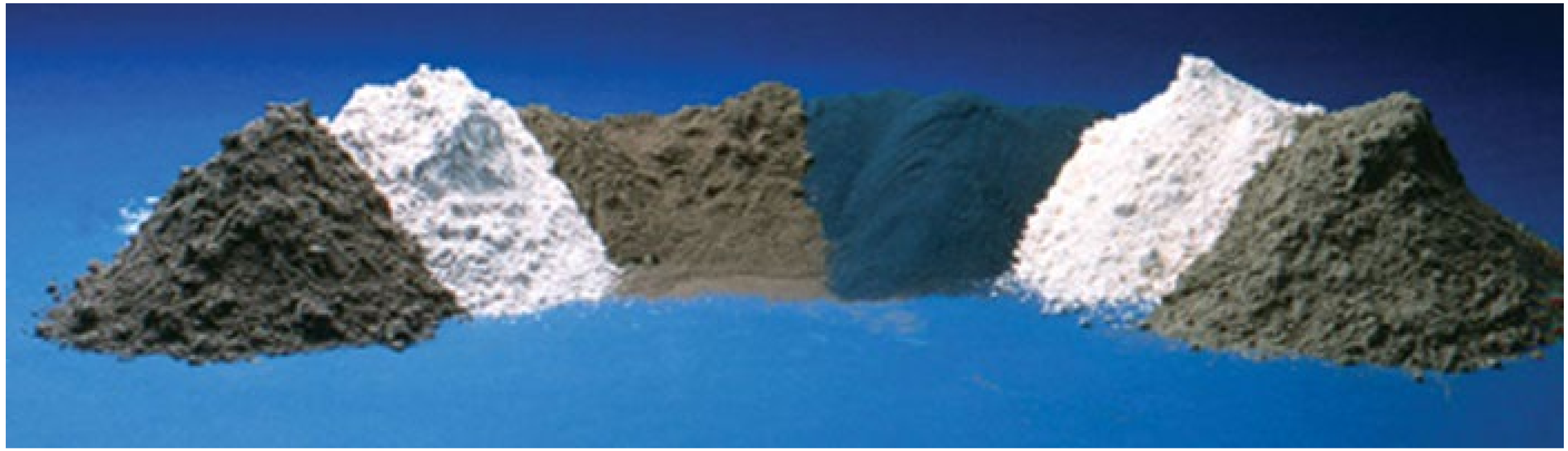
WHAT IS A GEO HYBRID?

- Geopolymer – like
- Utilizes supplementary cementitious materials (SCM's)
- Carbon footprint greatly reduced vs. traditional repair mortars (20-50%)



Ref: Portland Cement Association

GEO HYBRID MORTARS

HOW DO GEO HYBRID MATERIALS WORK?

- The calcium silicates in Portland cement react with water to form hardened cement paste (sometimes called “gel”)

$$C_3S + H_2O \rightarrow C\text{-}S\text{-}H\ gel + CH$$

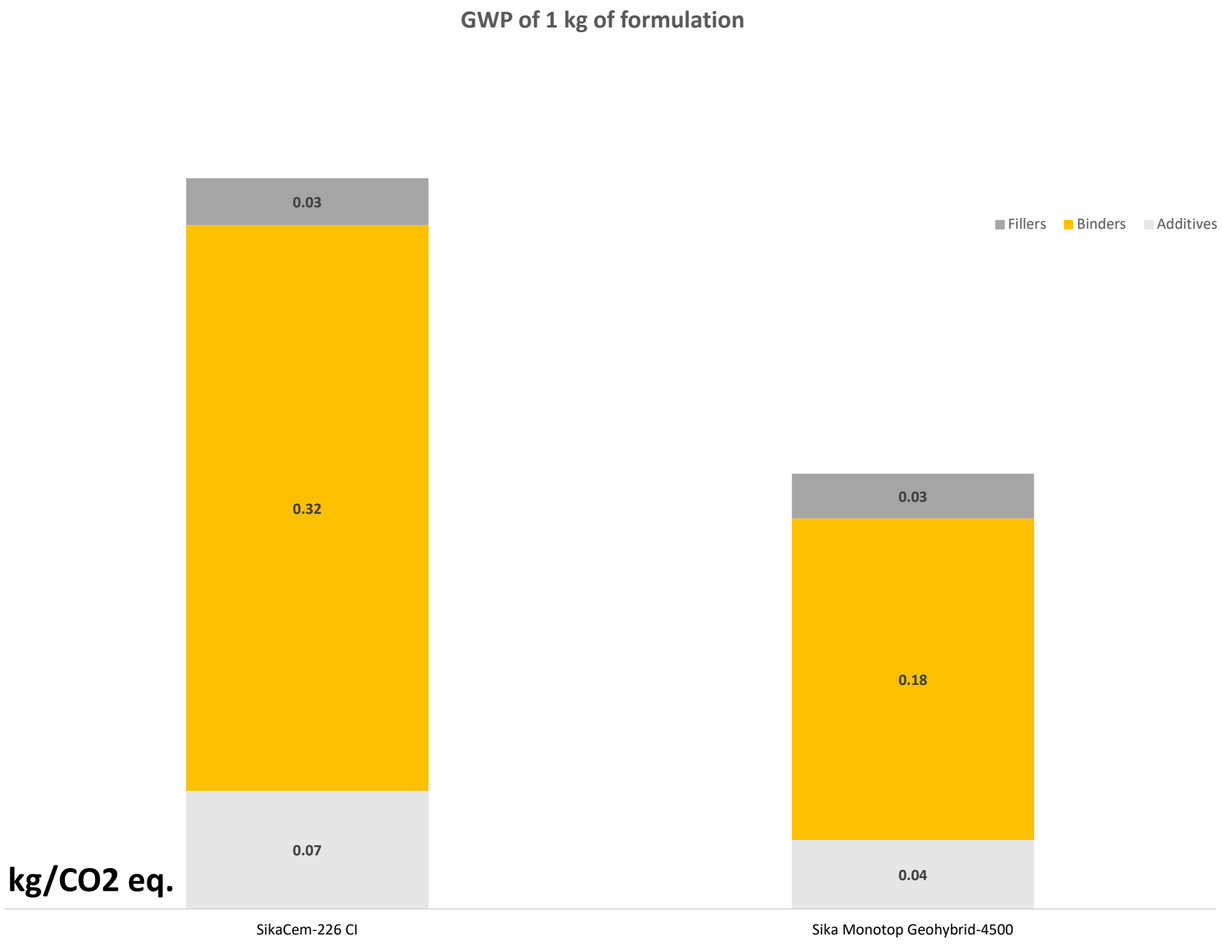
- CH (calcium hydroxide) is a by-product of the reaction, provides no strength and results in porosity

$$SCM + CH + H_2O \rightarrow C\text{-}S\text{-}H\ gel$$

- SCM’s react with water and CH to form more “gel” in the micropores, resulting in lower permeability and increased late-age strength

GEO HYBRID MORTARS

BENEFITS - SUSTAINABILITY



Reduction of Portland cement by > 25% and addition of SCM's

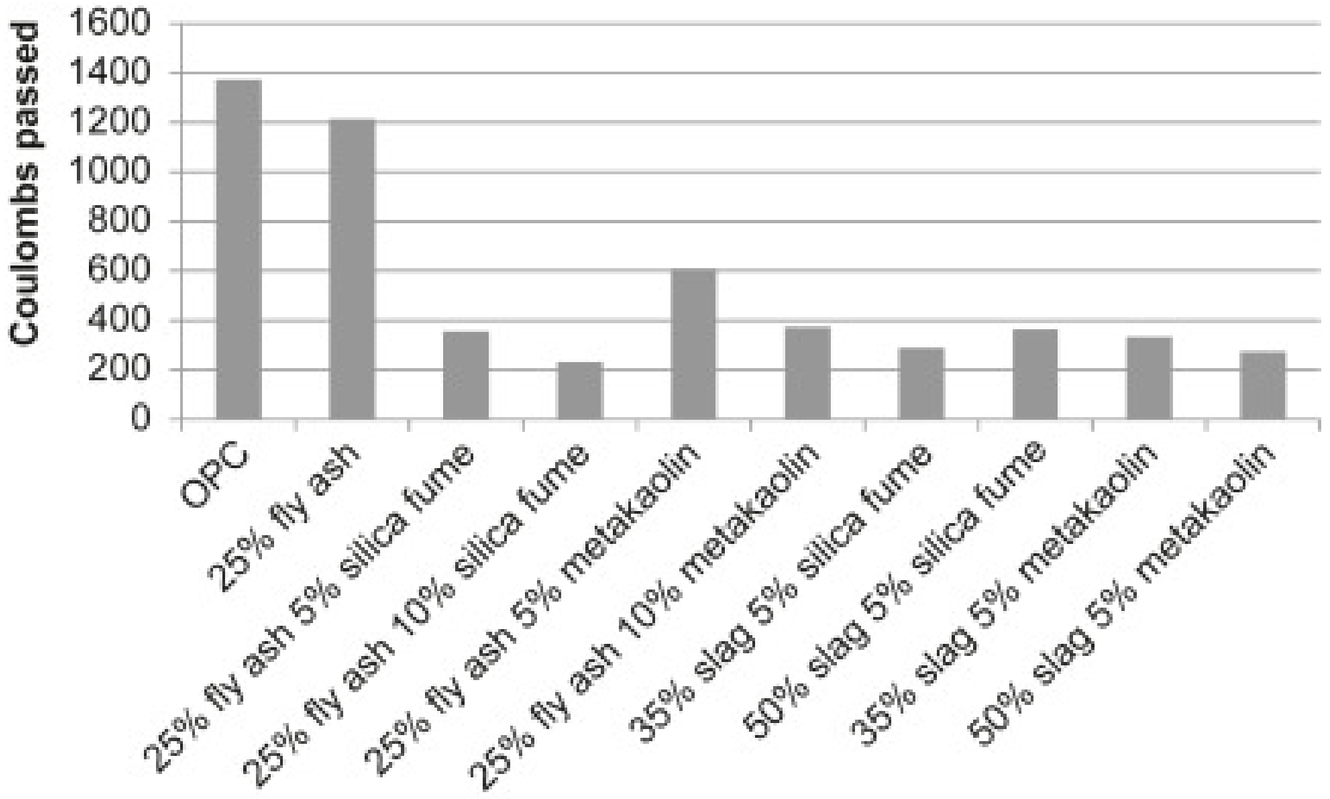
40% REDUCTION IN GWP WHEN COMPARED TO SIKACEM-226 CI

*GWP – Global Warming Potential

GEO HYBRID MORTARS
BENEFITS – REDUCED PERMEABILITY

- Lower permeability
  - Longer service life
  - Reduced corrosion of embedded reinforcement

ASTM C 1202 – Rapid Chloride Permeability



ASTM C 1202 Results (56 days) – Holland (2012)

GEO HYBRID MORTARS
BENEFITS – REDUCED EXOTHERM

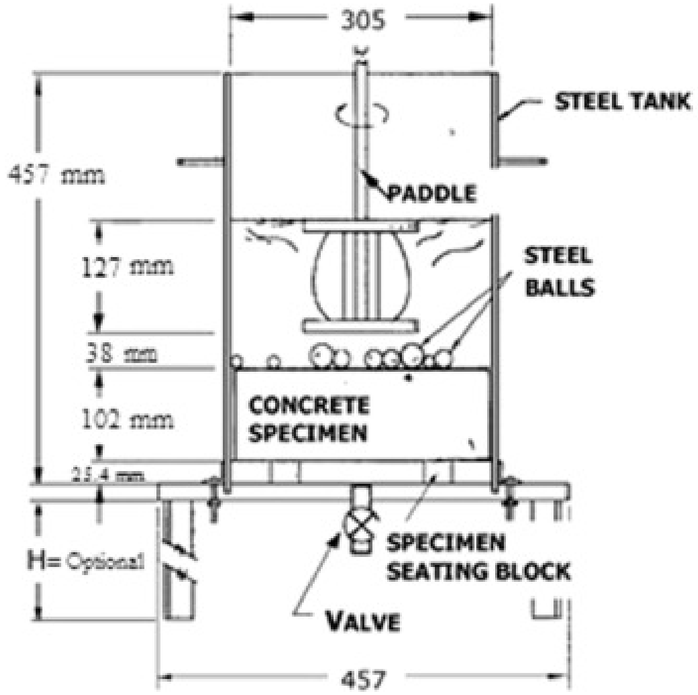
- Lower exotherm
  - Deeper applications
  - Up to 36” thickness in one application without aggregate extension

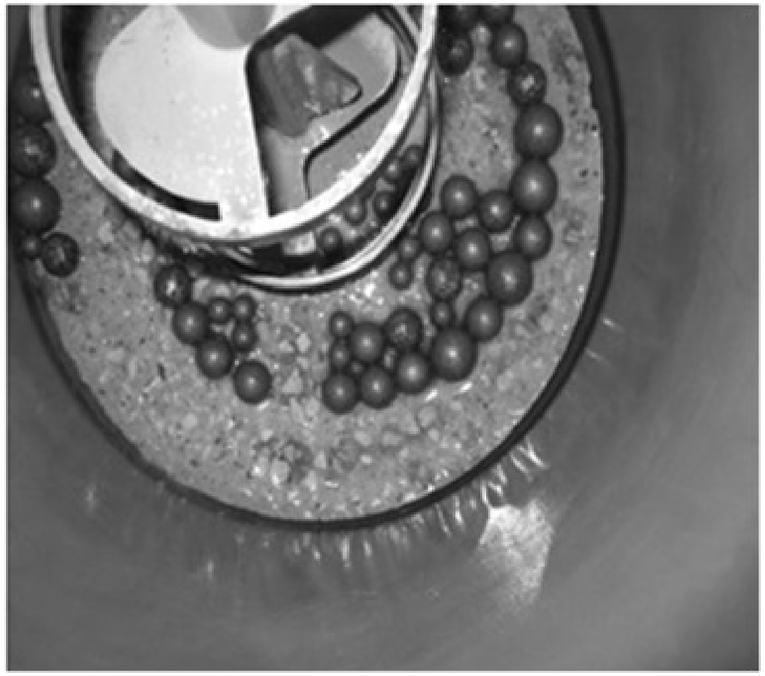
GEO HYBRID MORTARS
BENEFITS – IMPROVED CHEMICAL RESISTANCE

- Improved chemical resistance
  - Acids – sulfuric acid (pH = 1)
    - All inorganic acids
  - Biogenic corrosion – H_2S

GEO HYBRID MORTARS
BENEFITS – IMPROVED ABRASION RESISTANCE

- Improved abrasion resistance
  - Specifically, underwater





ASTM C 1138 – Underwater abrasion resistance

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BENEFITS – IMPROVED SERVICE TEMPERATURE

- Higher in-service temperature resistance
  - Up to 1000°F (537 °C)
  - Temperature limitations are a result of sand / quartz aggregate

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LIMITATIONS

- Early-age strength development
  - Remember: Portland cement must first react with water for the calcium hydroxide (by product) to form C-S-H gel
- Not rapid set
- Very slow or no cure at cold temperatures

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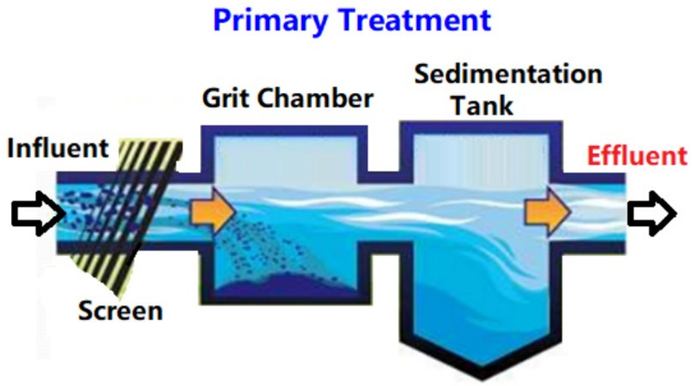
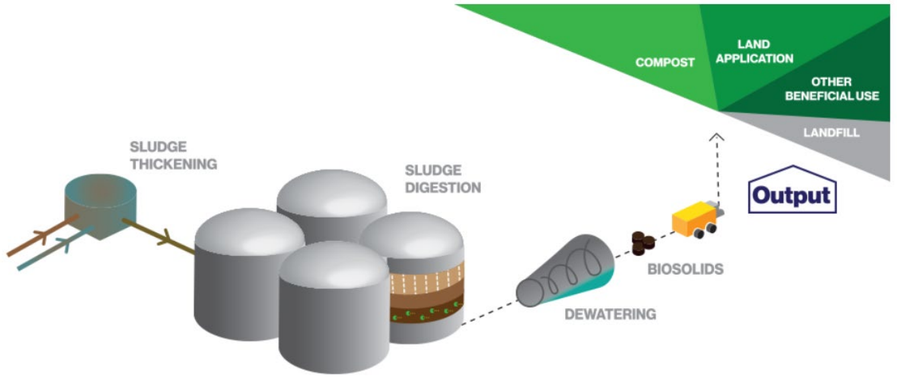
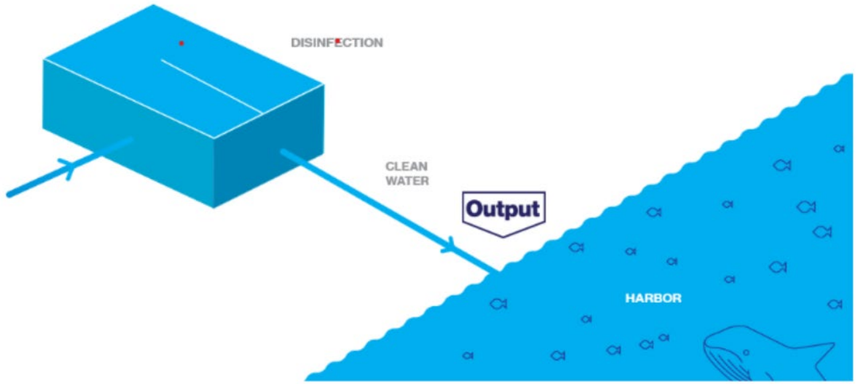
CHALLENGING APPLICATIONS - WASTEWATER







Ref – ChemTech Int'l

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CHALLENGING APPLICATIONS – SEWERS

Source - MCSP

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CHALLENGING APPLICATIONS – SLUICE GATES

Source – RUD

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CHALLENGING APPLICATIONS – MUNICIPAL SOLID WASTE & RECYCLING

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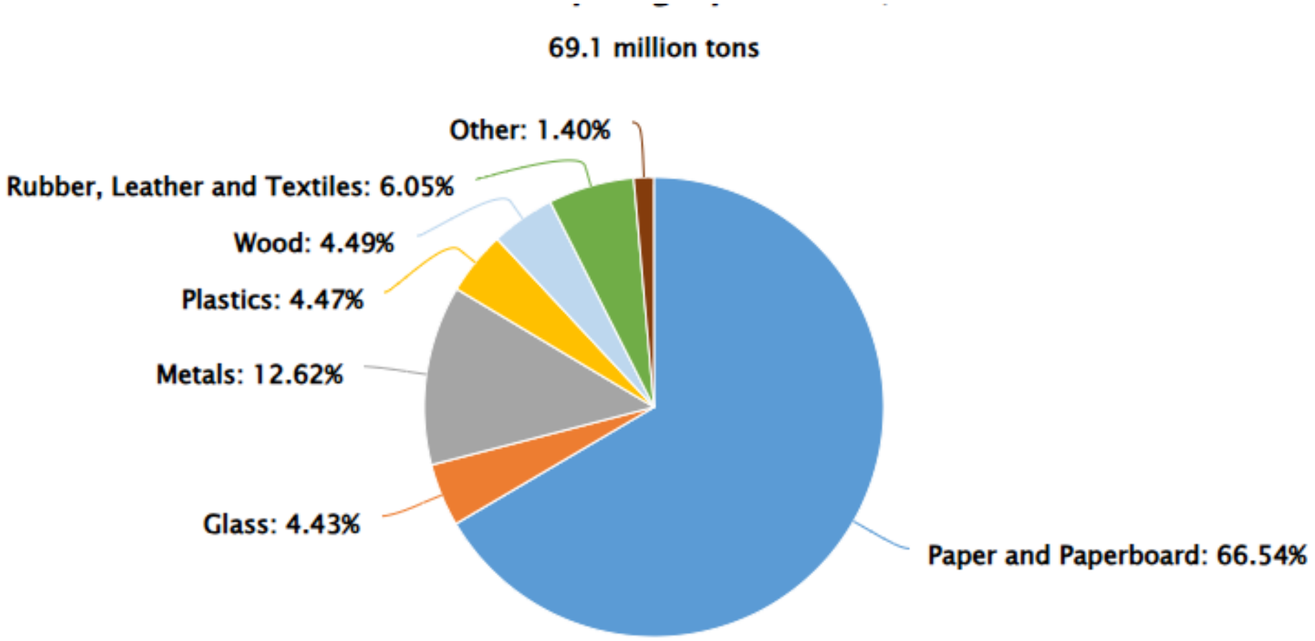
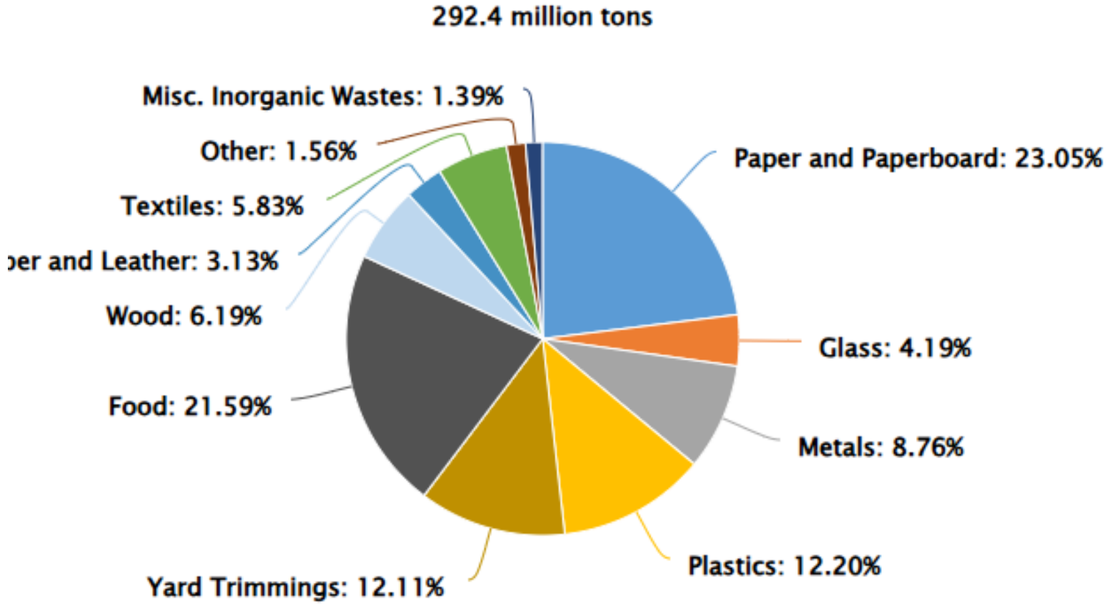
CHALLENGING APPLICATIONS – MUNICIPAL SOLID WASTE





Source - EPA

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CHALLENGING APPLICATIONS – SULFUR PITS

Source – Beton LLC

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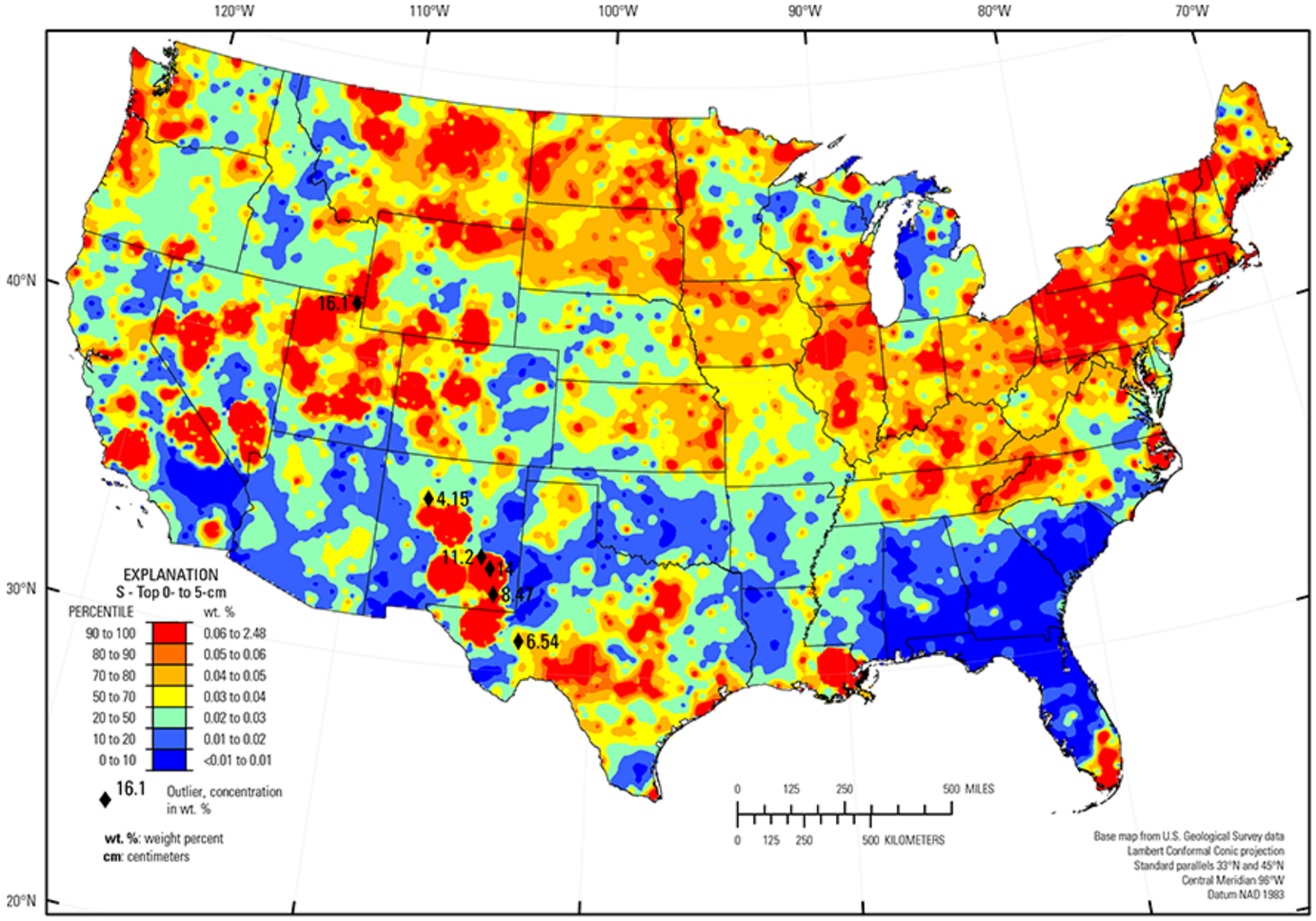
CHALLENGING APPLICATIONS – HIGH SULFATE SOILS



Source – USGS

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CHALLENGING APPLICATIONS – MASS POURS

Source – NYSDOT

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CHALLENGING APPLICATIONS – FOUNDRIES

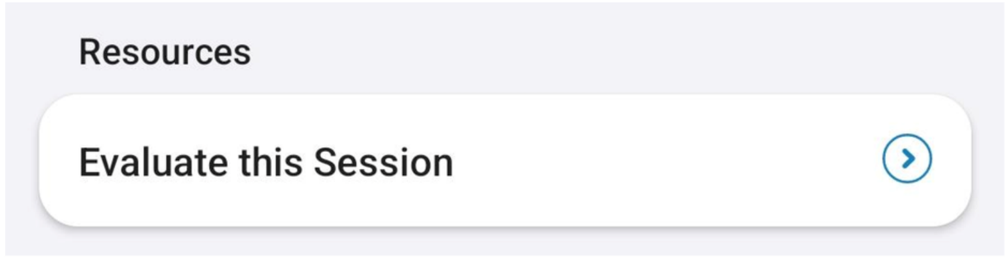
Source – LMM Group

GEO HYBRID MORTARS
CURRENT PRODUCTS

GEO HYBRID MORTARS
SUMMARY

- Portland cement production accounts for 8% of global CO_2 emissions
- Geo Hybrid mortars result in 20 – 50% reduction of GHGs
- Geo Hybrid mortars offer many property improvements of OPC-based mortars
- No special mixing, handling or safety considerations
- Comparable cost to current technology

SESSIONEVALUATION



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ANY QUESTIONS?