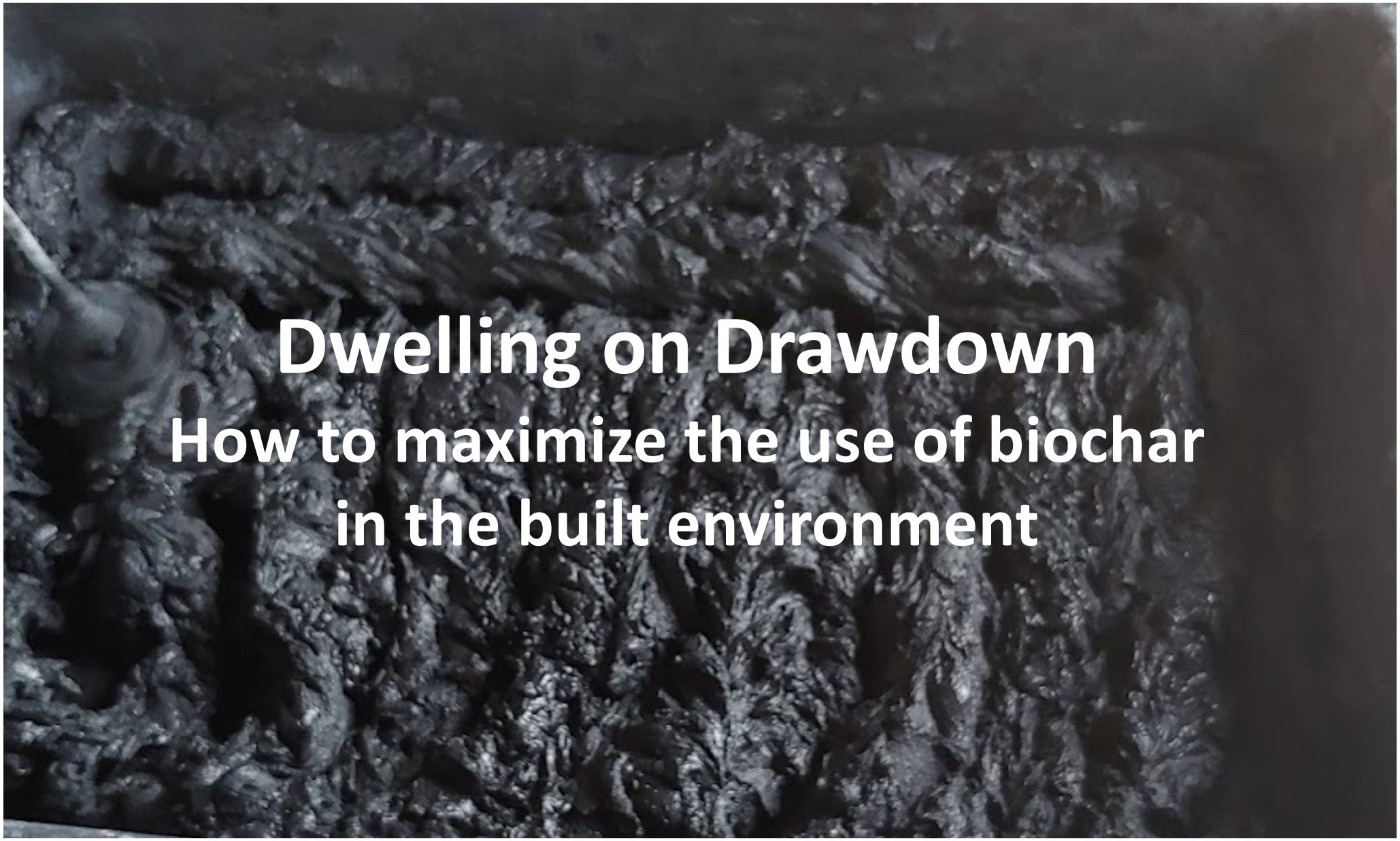

Dwelling on Drawdown

How to maximize the use of biochar in the built environment

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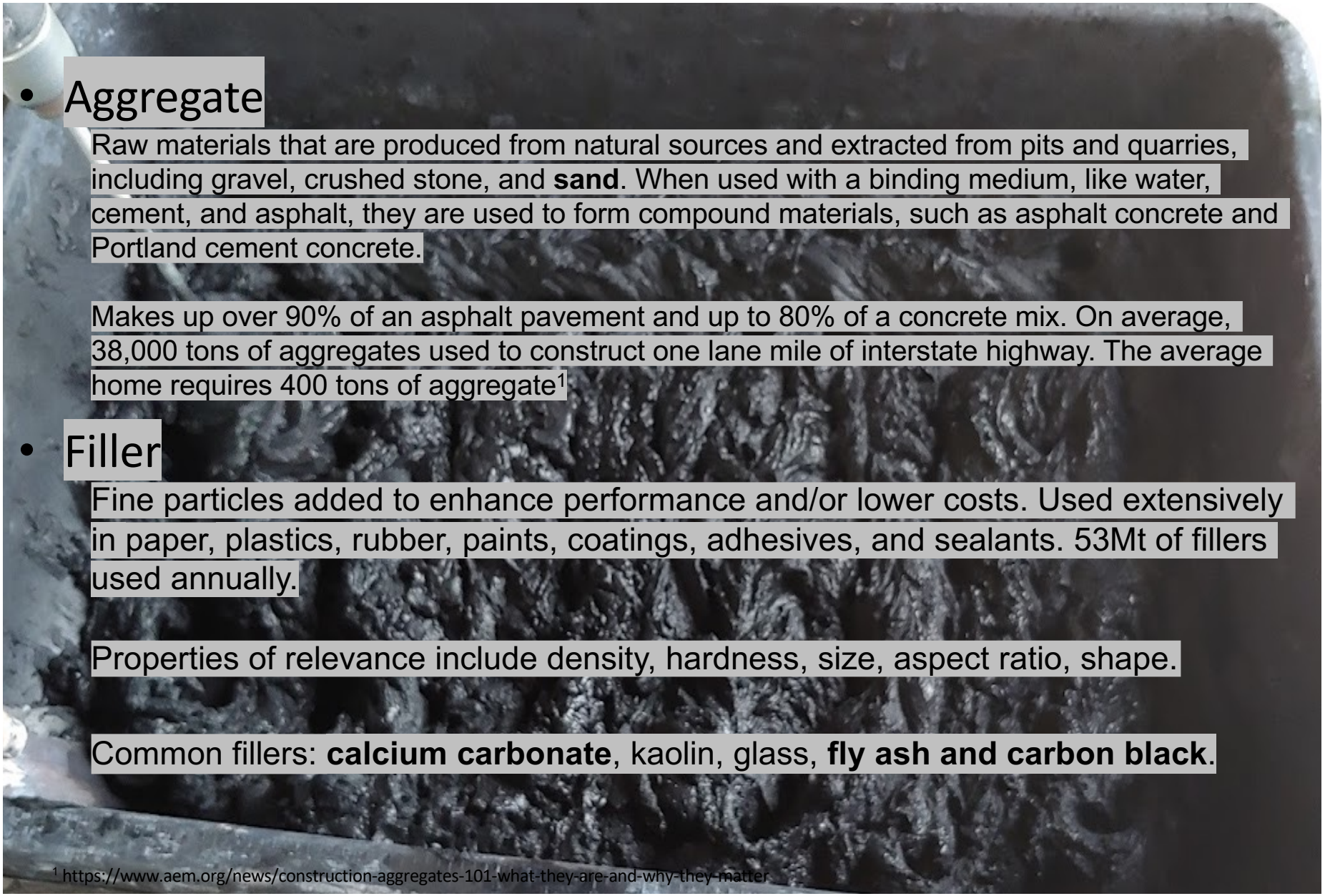
AGENDA

- What roles can biochar play in composites
- Why put biochar in composites?
- Properties of relevance
- Durability/end of life
- Examples of biochar in the built environment

What roles can biochar play in composites



- Aggregate

  Raw materials that are produced from natural sources and extracted from pits and quarries, including gravel, crushed stone, and **sand**. When used with a binding medium, like water, cement, and asphalt, they are used to form compound materials, such as asphalt concrete and Portland cement concrete.

  Makes up over 90% of an asphalt pavement and up to 80% of a concrete mix. On average, 38,000 tons of aggregates used to construct one lane mile of interstate highway. The average home requires 400 tons of aggregate[1]

- Filler

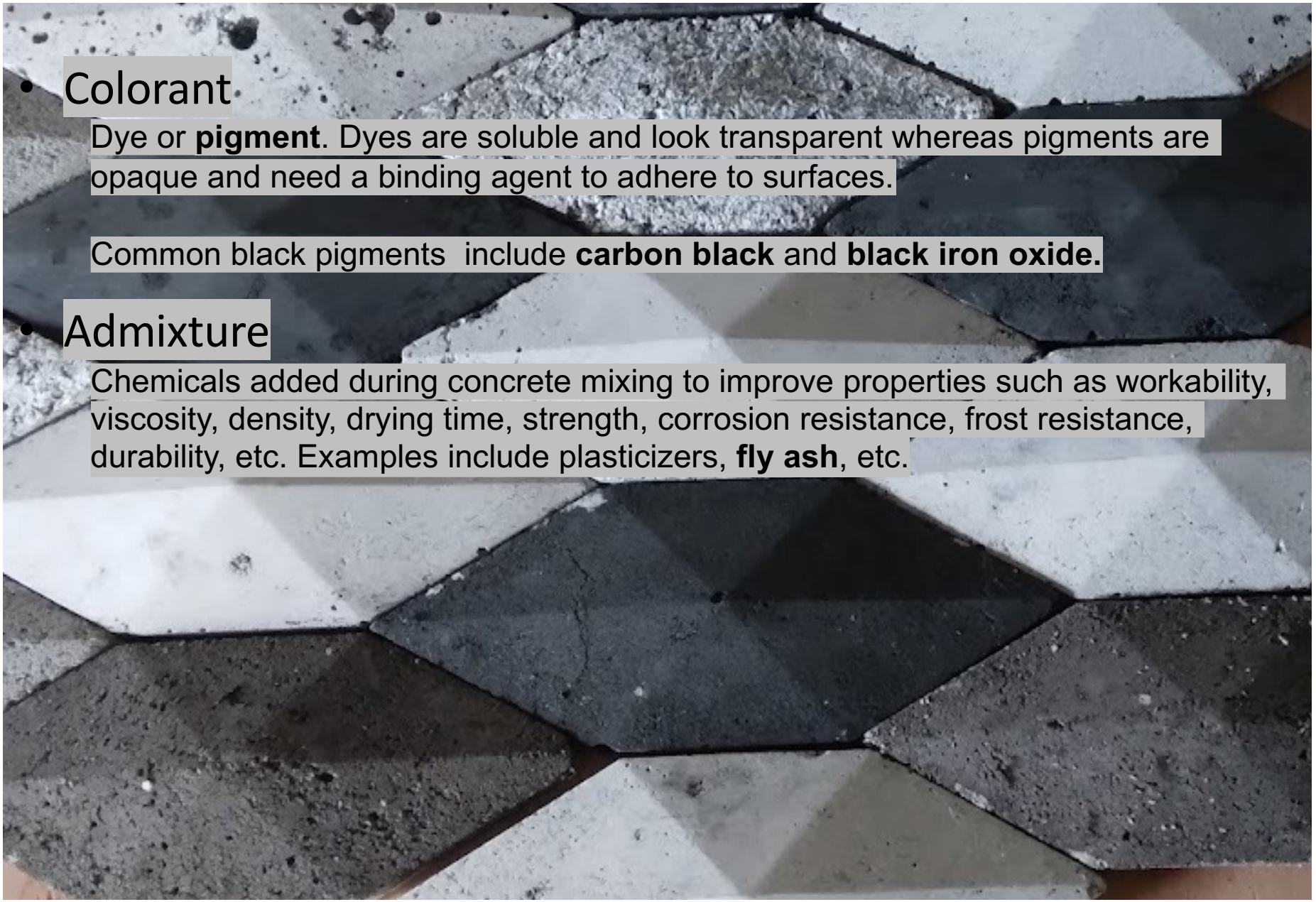
  Fine particles added to enhance performance and/or lower costs. Used extensively in paper, plastics, rubber, paints, coatings, adhesives, and sealants. 53Mt of fillers used annually.

  Properties of relevance include density, hardness, size, aspect ratio, shape.

  Common fillers: **calcium carbonate**, kaolin, glass, **fly ash and carbon black**.

[1] https://www.aem.org/news/construction-aggregates-101-what-they-are-and-why-they-matter

What roles can biochar play in composites



- Colorant

  Dye or **pigment**. Dyes are soluble and look transparent whereas pigments are opaque and need a binding agent to adhere to surfaces.

  Common black pigments include **carbon black** and **black iron oxide.**

- Admixture

  Chemicals added during concrete mixing to improve properties such as workability, viscosity, density, drying time, strength, corrosion resistance, frost resistance, durability, etc. Examples include plasticizers, **fly ash**, etc.

Why put biochar in composites?

- **Climate**
  - Lower embodied carbon/global warming impact, carbon sequestration
- **Environment**
  - Reduced mining, reduced reliance on non-renewable resources (e.g., sand)
- **Performance enhancement**
  - Lower density, improved compression strength & fire resistance, humidity control, etc.
- **Cost implications**
  - Currently likely to be higher than some materials it is displacing but not all and biochar prices are poised to fall as production ramps up.
- **Biochar scaling**
  - We need huge, non-seasonal, local & regional markets for biochar, with durability in decades to centuries

[1] https://www.aem.org/news/construction-aggregates-101-what-they-are-and-why-they-matter

Properties of relevance

- ‘Quality’ of biochar depends on end use
- Still very much in discovery phase

- Particle size
- Surface area
- Hydro-philicity/phobicity
- Morphology/aspect ratio
- Pore size distribution

BIOCHAR PROPERTIES

	Soil			Bldg Mat		C
	Farm	Remed.	Storm	Conc.	Insul.	Seques
Chemical properties						
Ash (metals/minerals)	■			■	■	
Carbon (fixed)	■			■	■	■
Volatiles	■					
Elemental comp: C_{org}, H, N, O	■					
CEC (cation exchange capacity)	■					
Degredation during storage	■					
EC (electrical conductivity)	■					
eH (electron activity)/REDOX	■					
H:C ratio	■					■
Liming	■					
Macro/micro nutrients	■					
PAH	■					
ph	■			■	■	
Reactivity						
Structural composition						
Physical properties						
Abrasion						
Agglomeration potential				■	■	
Bulk Density	■			■	■	
Electromagnetic properties						
Hardness (ball pan)				■	■	
Hydrophobicity	■			■	■	
Mechanical Stability				■	■	
Morphology				■	■	
Particle size & distribution	■			■	■	
Porosity: volume, pore size dist., micro, meso, macro	■			■	■	
Surface area	■			■	■	
Thermal Conductivity	■			■	■	
Water Holding Capacity	■			■	■	

ignition potential?

Durability/End of Life

- Durable biochar = C/H ration < .7
- Biochar based product life expectancy
- End of life treatment
  - Landfill
  - Incineration
- Carbon removal market impact

Examples

- In buildings
  - Asphalt
  - Concrete
  - Plaster
  - Drywall
  - Composites
  - Tiles: wall, floor
  - Grout
  - Epoxy
  - Lumber
  - Insulation
- Around buildings
  - Sewage systems
  - Water pipe trenches
  - Lawn, landscape

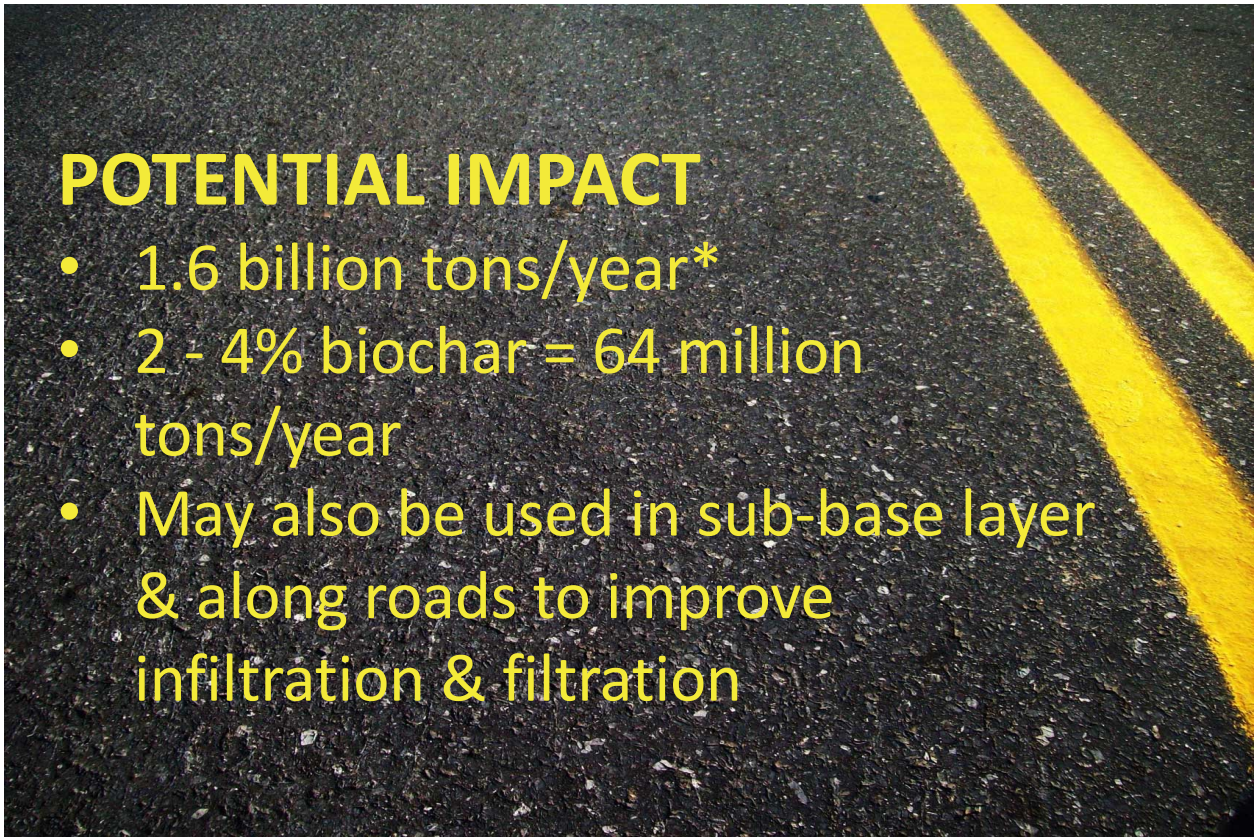
Example: Asphalt

Biochar as a modifier for asphalt binder and mixes

Potential Benefits

- Improved Rutting resistance
- Better fatigue cracking resistance
- improves high-temperature properties
- recommended for subtropical and tropical regions

❖ Finer may be better than courser particles



[1] https://www.aem.org/news/construction-aggregates-101-what-they-are-and-why-they-matter

Example: Concrete

Potential Benefits

- Curing accelerator
- Lighter weight
- Compression strength
- Flexural strength (MOR)
- Absorber of CO2/NOX
- Electromagnetic shielding
- Fire resistance
- Insulation
- Humidity Control

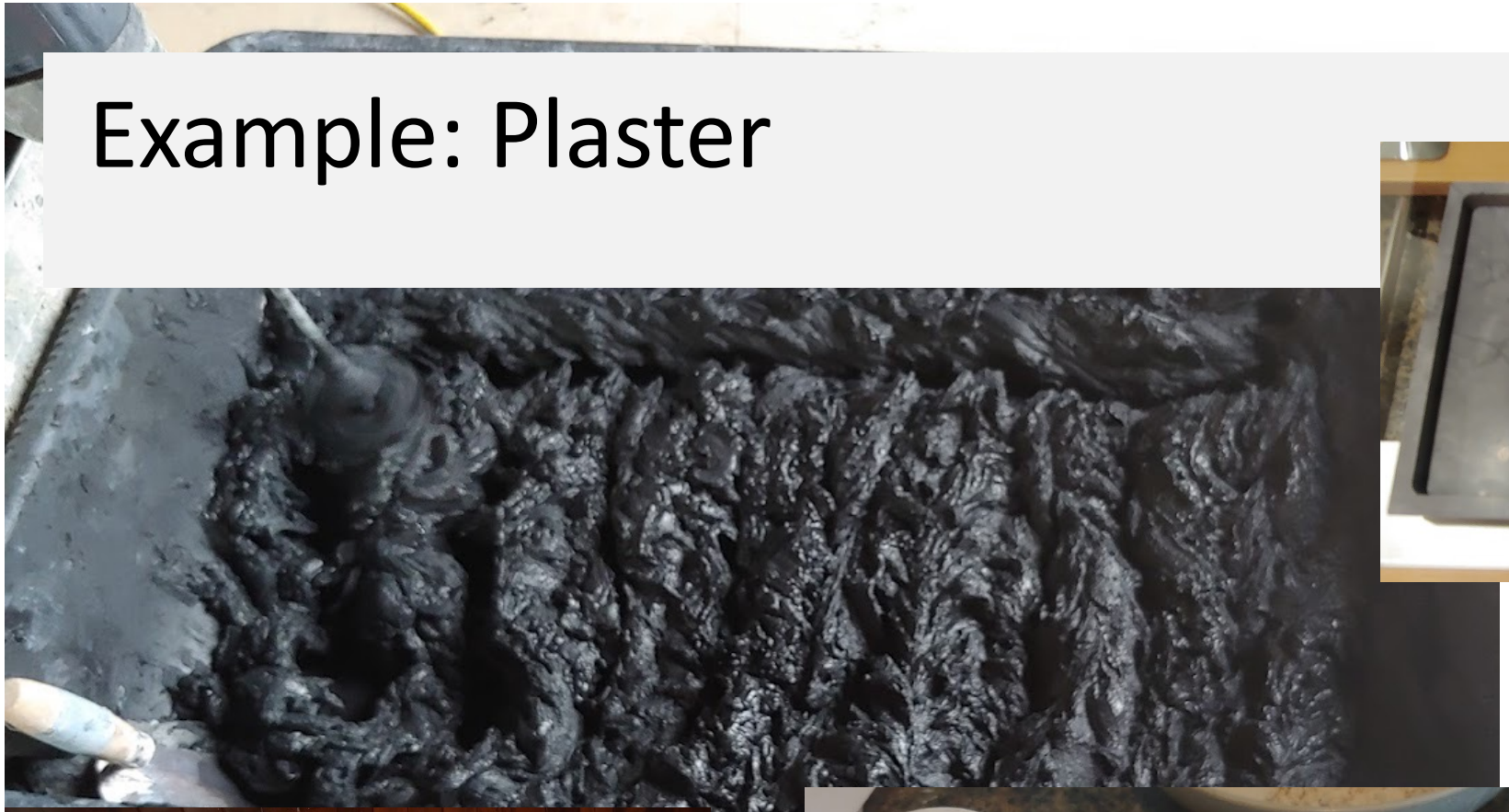
❖ Finer may be better than courser particles

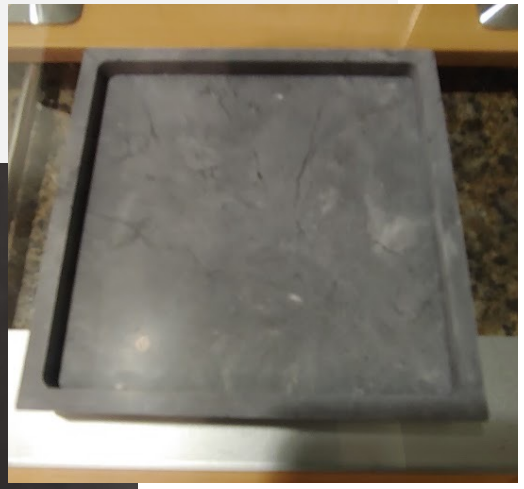
POTENTIAL IMPACT

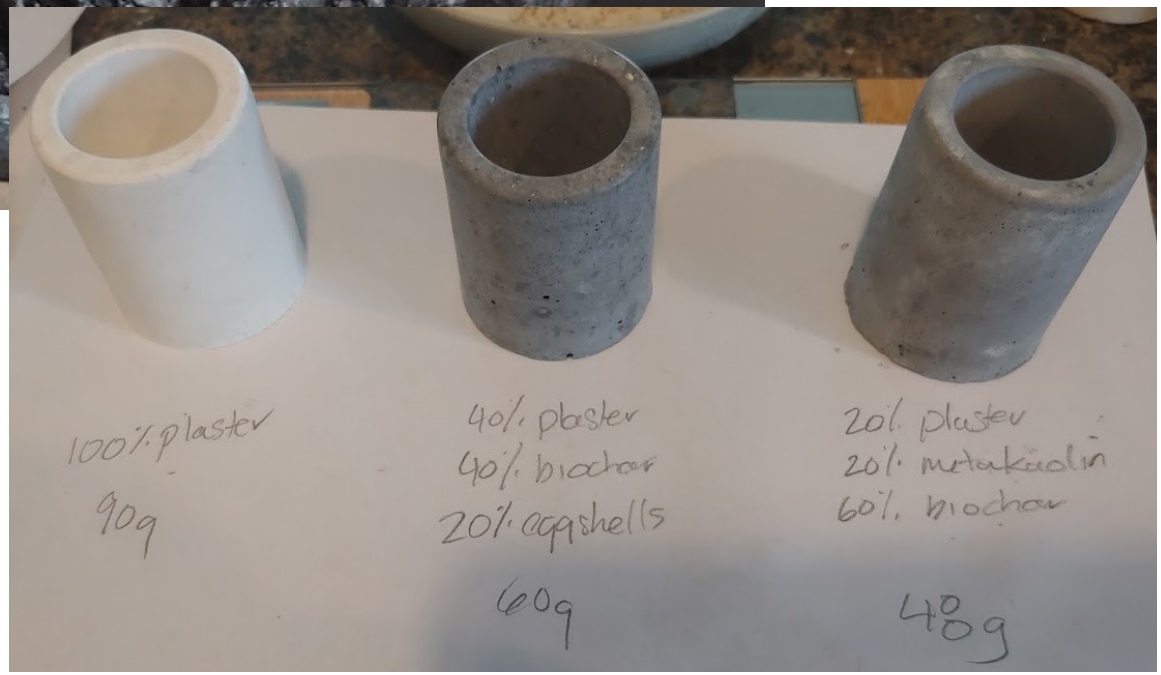
- 25 billion tons/year
- 1% biochar = 250 million tons/year
- With C content of 82% - 98%
  - 205Mt – 245Mt carbon sequestration
  - 738 – 882Mt CO2e

https://snohetta.com/project/558-biocrete-a-carbon-negative-concrete

Example: Plaster

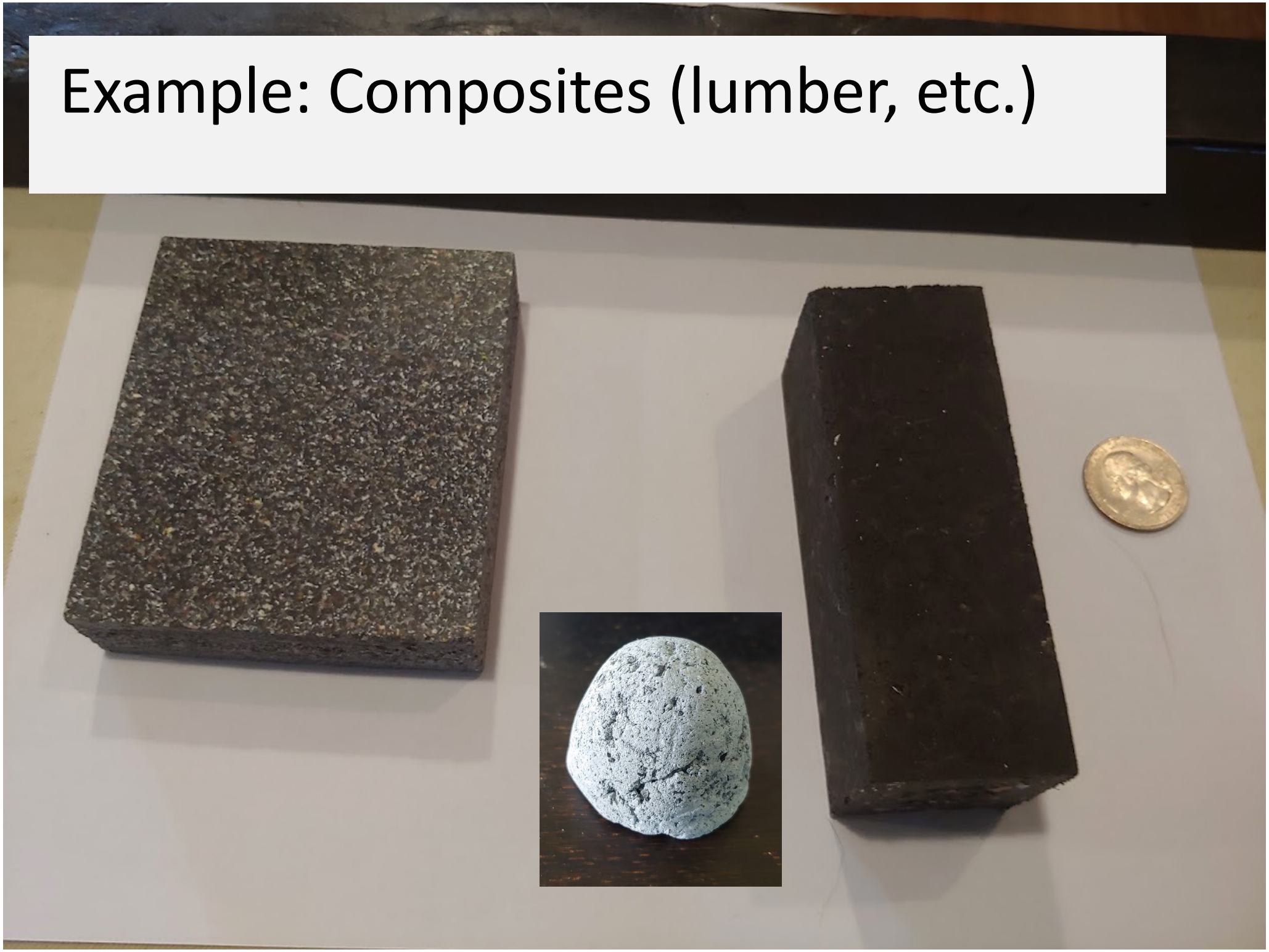




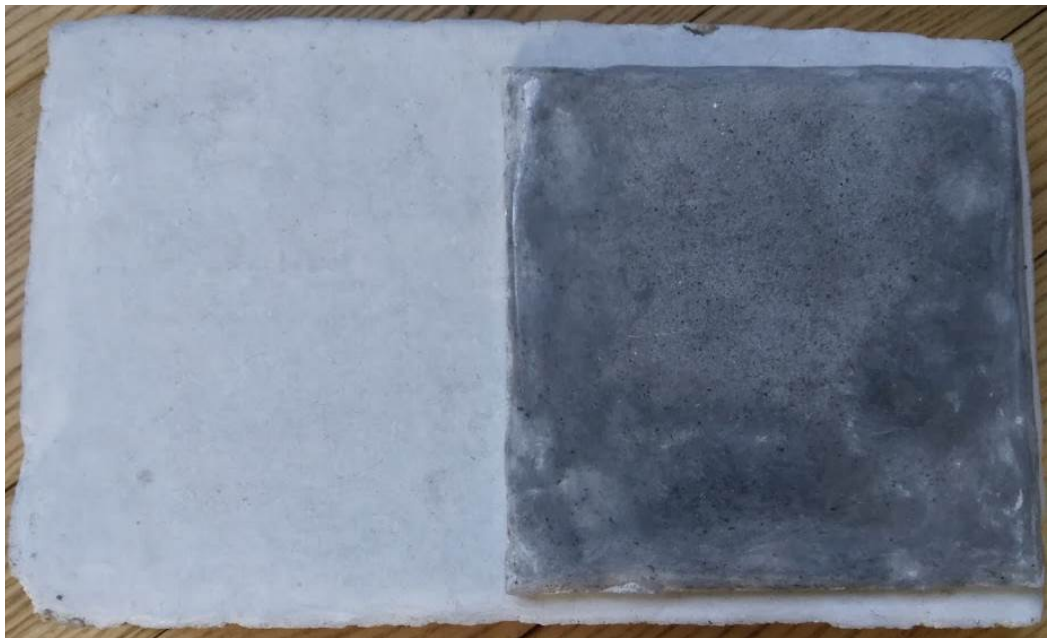


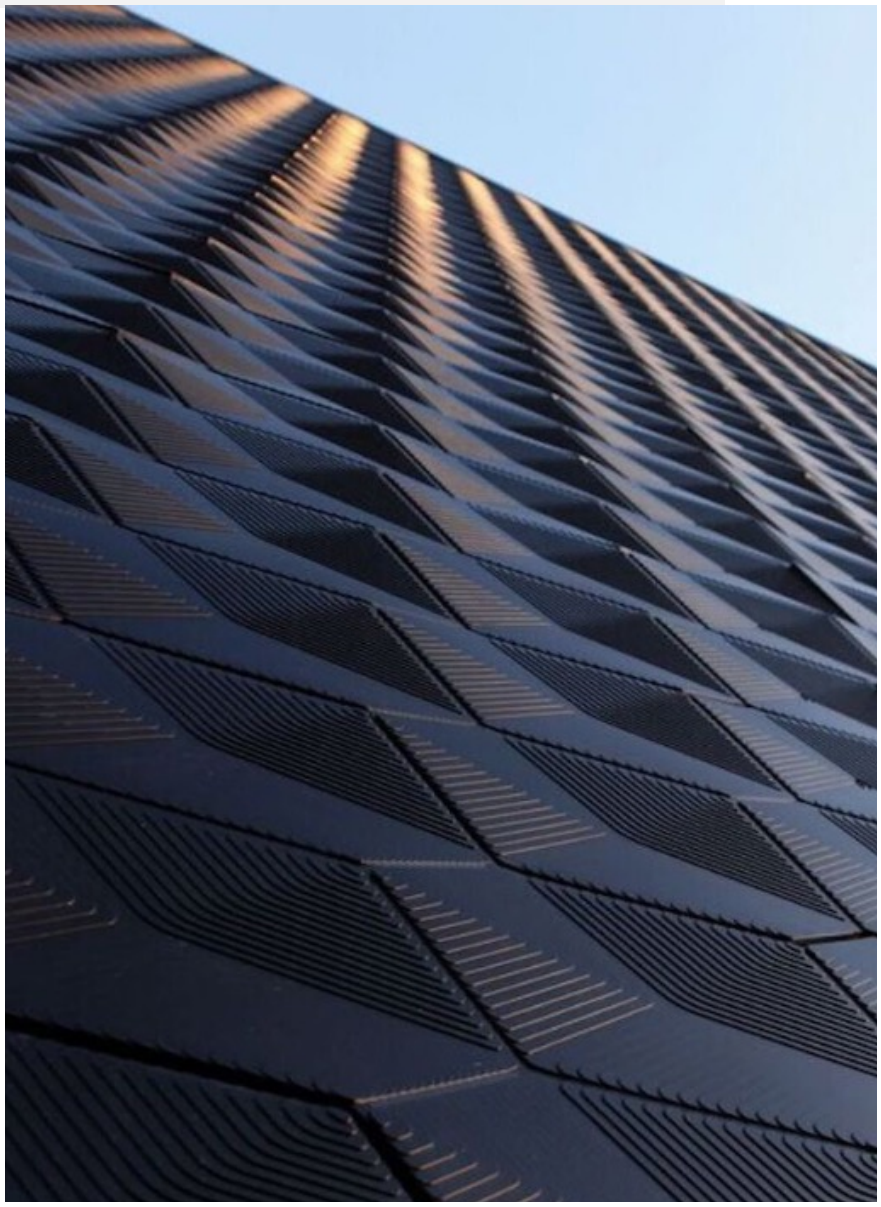
Example: Drywall

Example: Composites (lumber, etc.)



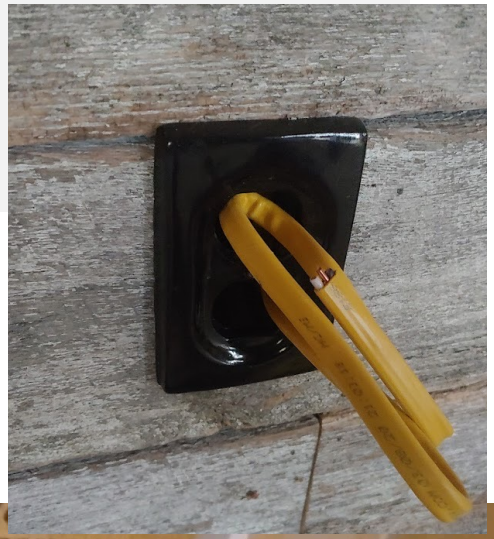
Example: Tiles

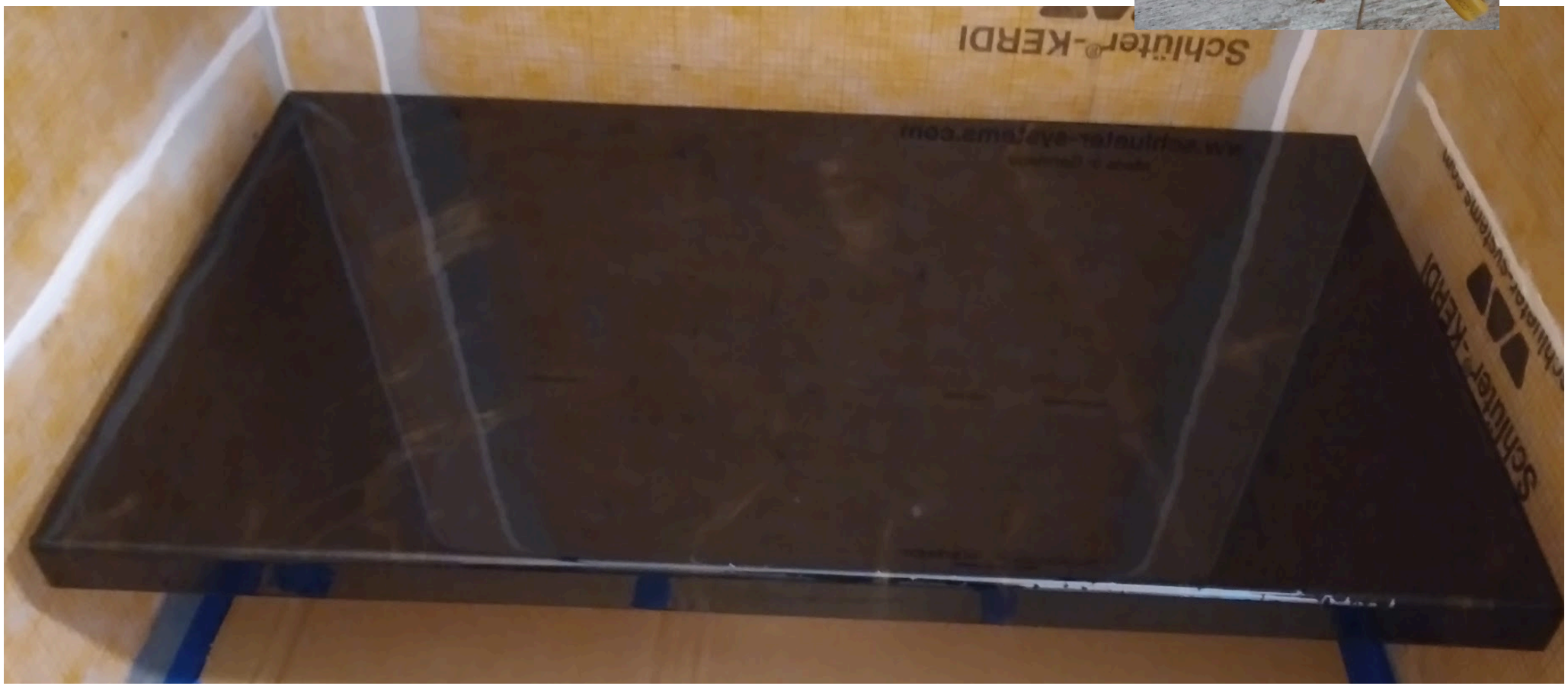




Example: Grout

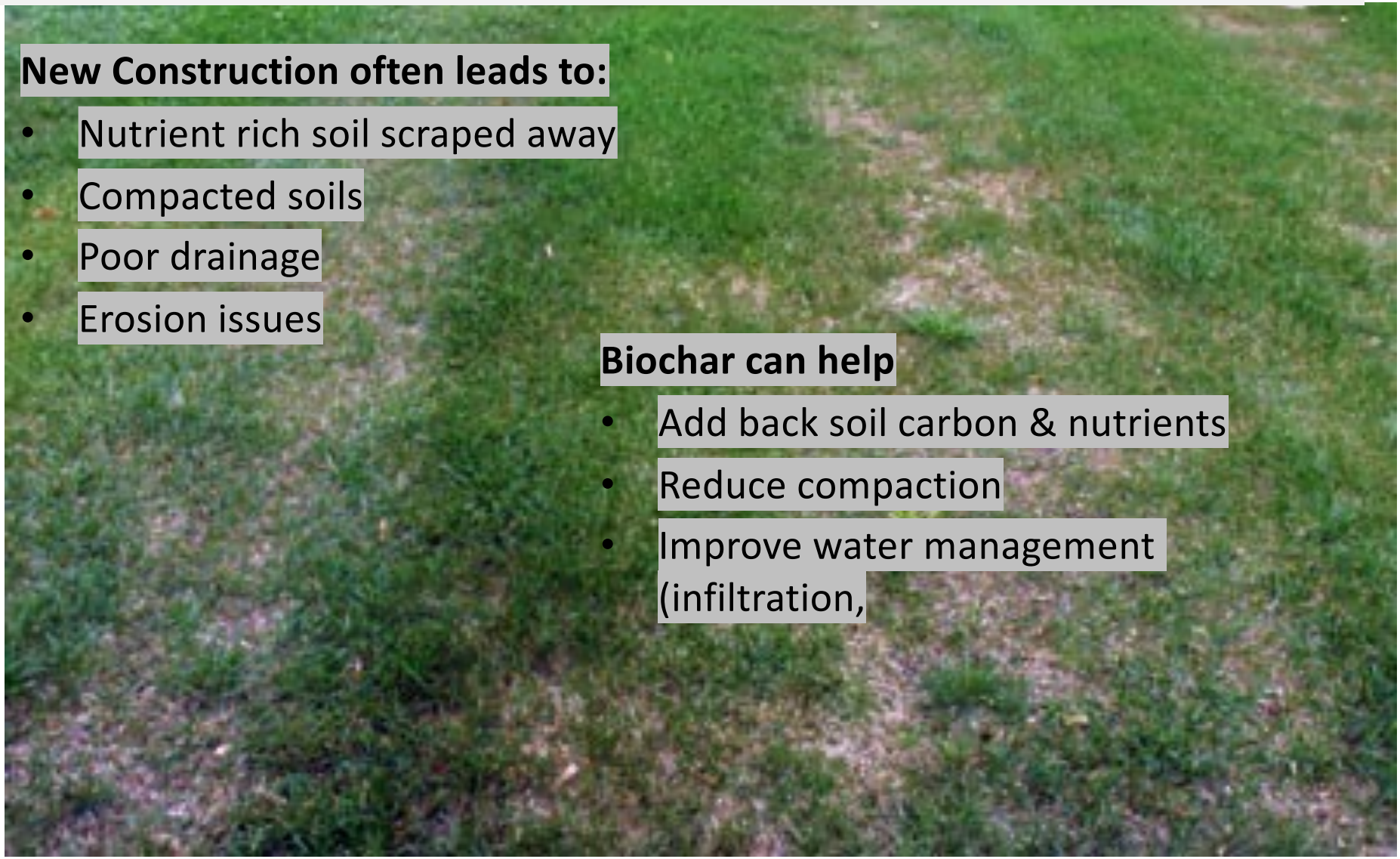
Example: Epoxy





Example: Sewage System

Example: Lawn & Landscape



New Construction often leads to:

- Nutrient rich soil scraped away
- Compacted soils
- Poor drainage
- Erosion issues

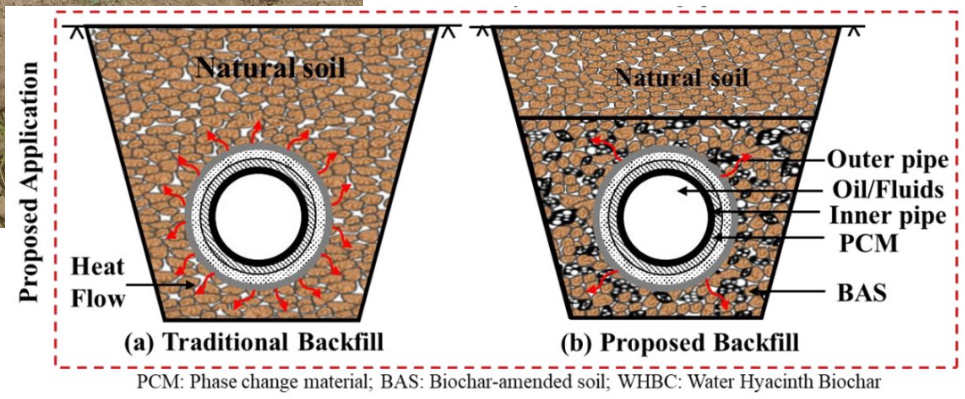
Biochar can help

- Add back soil carbon & nutrients
- Reduce compaction
- Improve water management (infiltration,

Example: Water Pipe trenches

- Engineered thermal backfill
  - May be able to dig shallower trenches in freeze/frost zones
- Damage protection
  - Displace sand

❖ Courser may be better than finer particles



PCM: Phase change material; BAS: Biochar-amended soil; WHBC: Water Hyacinth Biochar

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Questions?

Ichar Events

News and events Ichar

Biochar School 2022