Aggregates for Concrete

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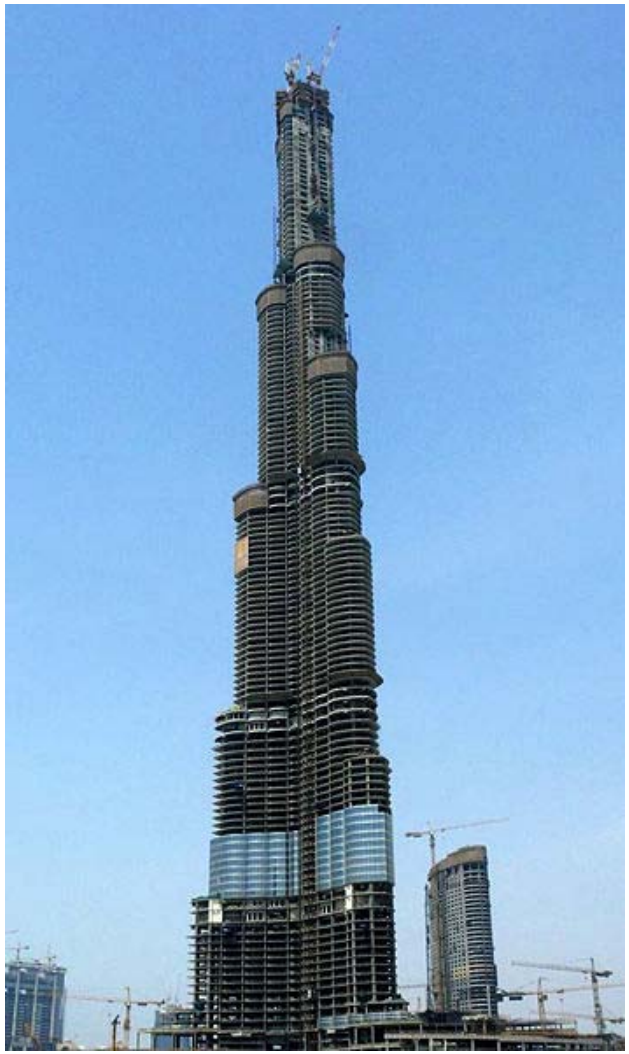
Concrete

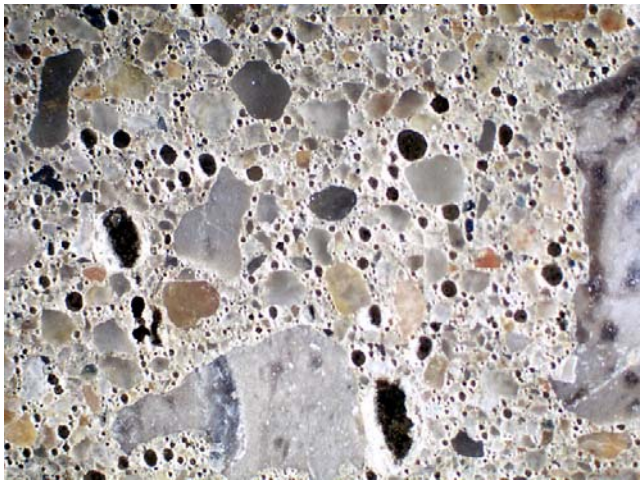
- Civilization would be stunted without it.
- Can be formed to any shape.
- It is fabricated on site.
- Using empirical QC tools.
- There is a lot of it
- Its more complicated than you think

What is Concrete?

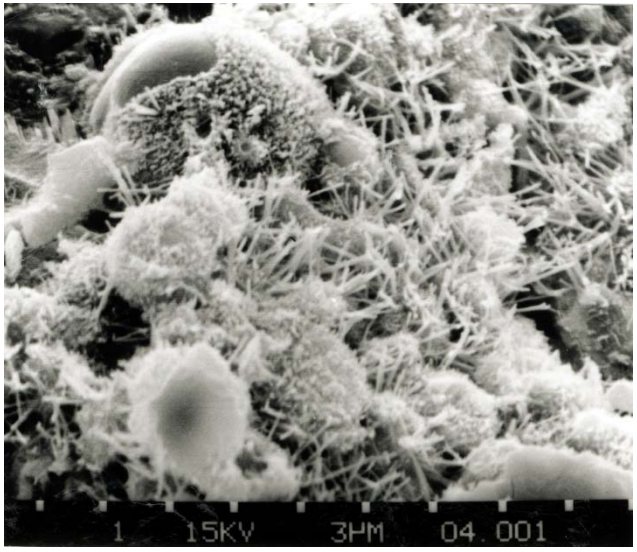


640 m

30 mm

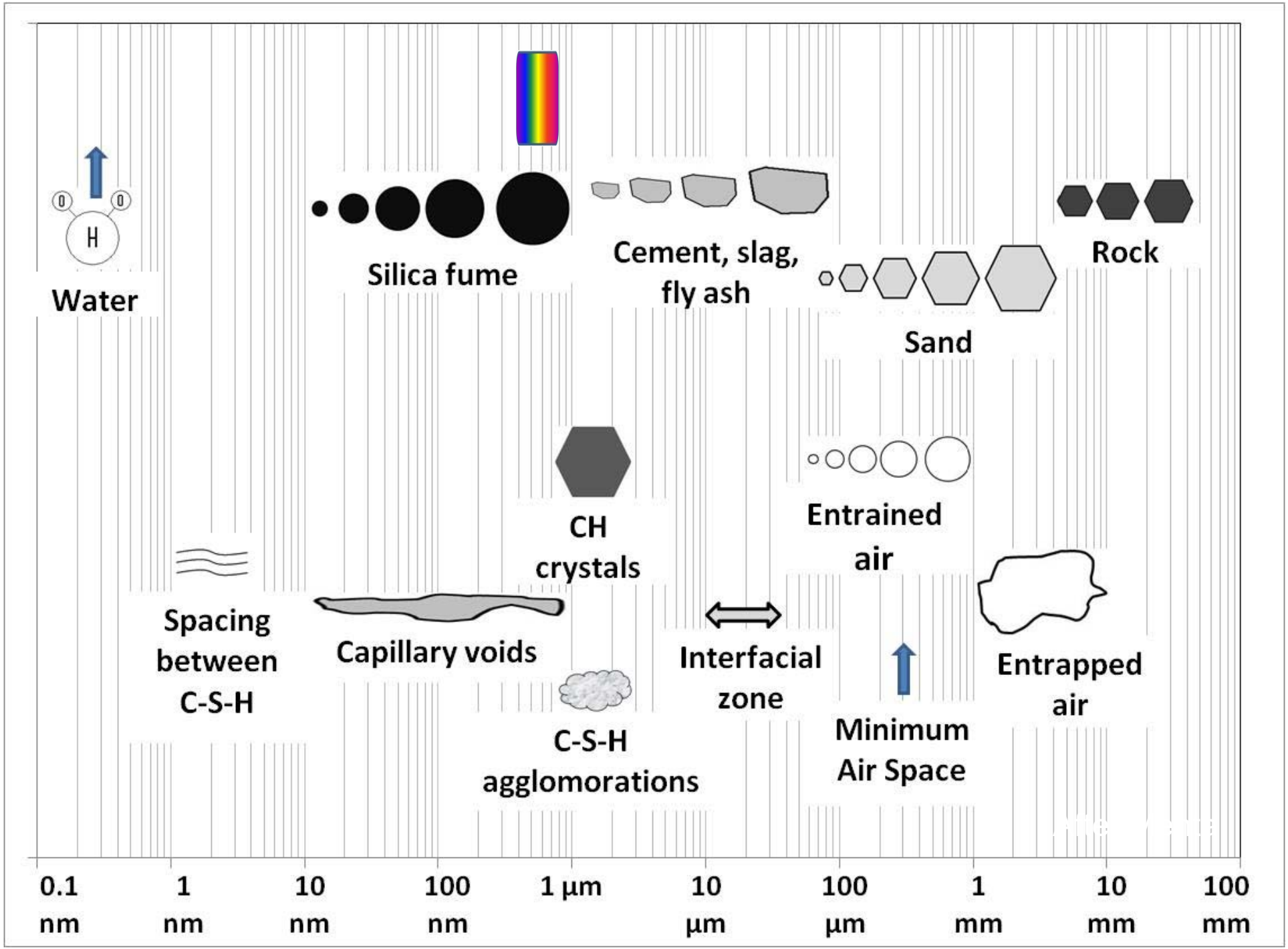


20 µm



The Perfect Material for Pavements

- Cost effective
- Easy to build with
- Get traffic on it fast
- Unbreakable
- Weather-proof
- Sustainable
- Resilient


Water
Silica fume
Cement, slag, fly ash
Rock
Sand
CH crystals
Entrained air
Spacing between C-S-H
Capillary voids
Interfacial zone
Entrapped air
C-S-H agglomorations
Minimum Air Space
0.1 nm
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
10 mm
100 mm

Life is changing

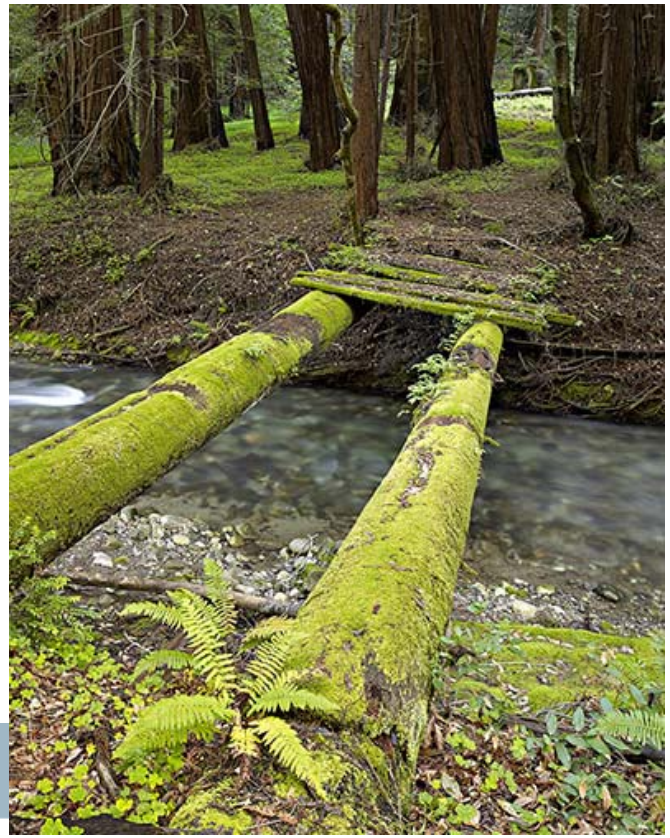
	1977	2017
No. of ingredients	Cement, water, rock, sand, AEA	Add SCMs, admixtures, int. aggregates, limestone…
Opening	Weeks	Days (or hours)
Curing	Weeks	Days
De-icing	Sand, NaCl	Other chlorides, formates, acetates
Design life	20 years	100 years
Knowledge base	In house	Contracted out

Sustainability

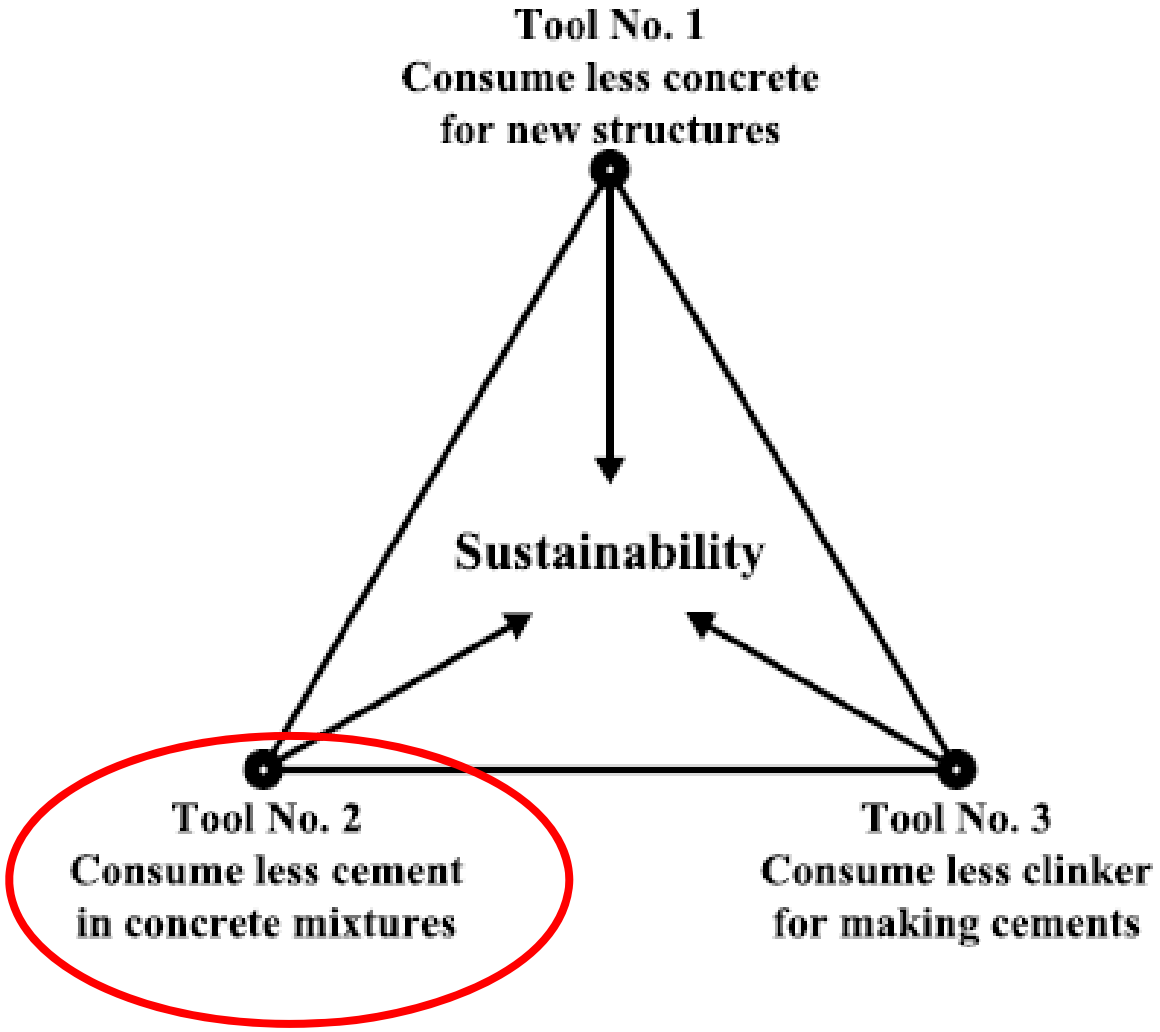
Getting what we need
- Capacity and Longevity

for the minimum :
- Cost
- Energy & resources
- Pollutants
- Negative impact to society

Simply good engineering
(Getting more for less)

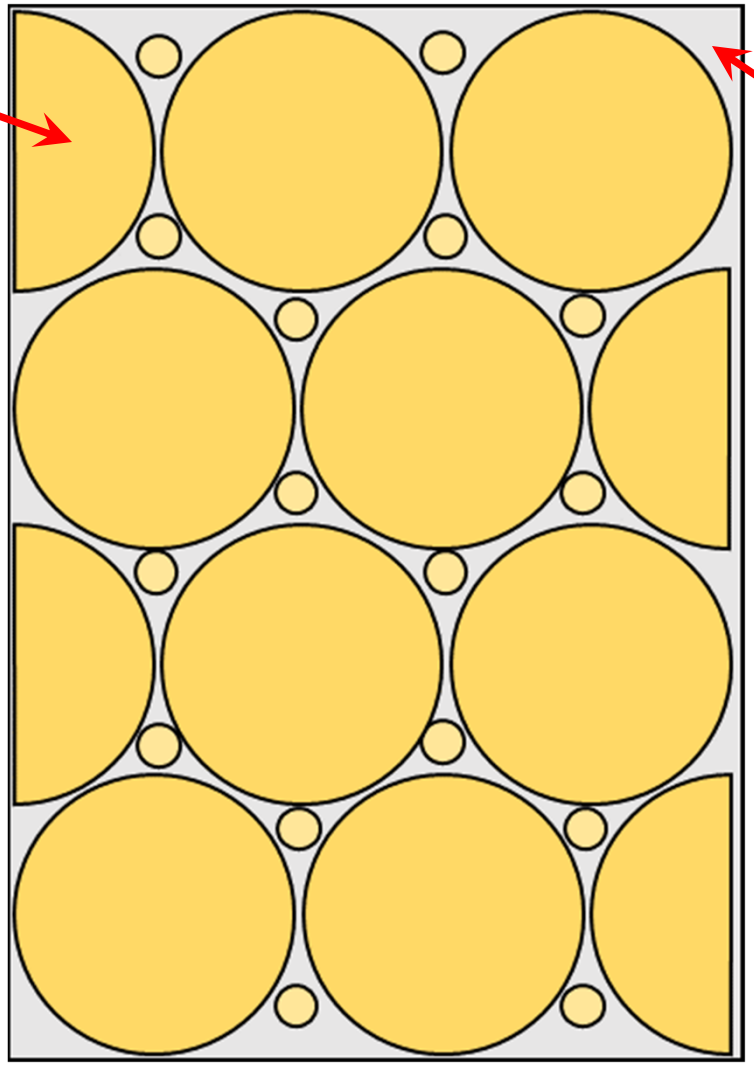


Sustainability



Proportioning

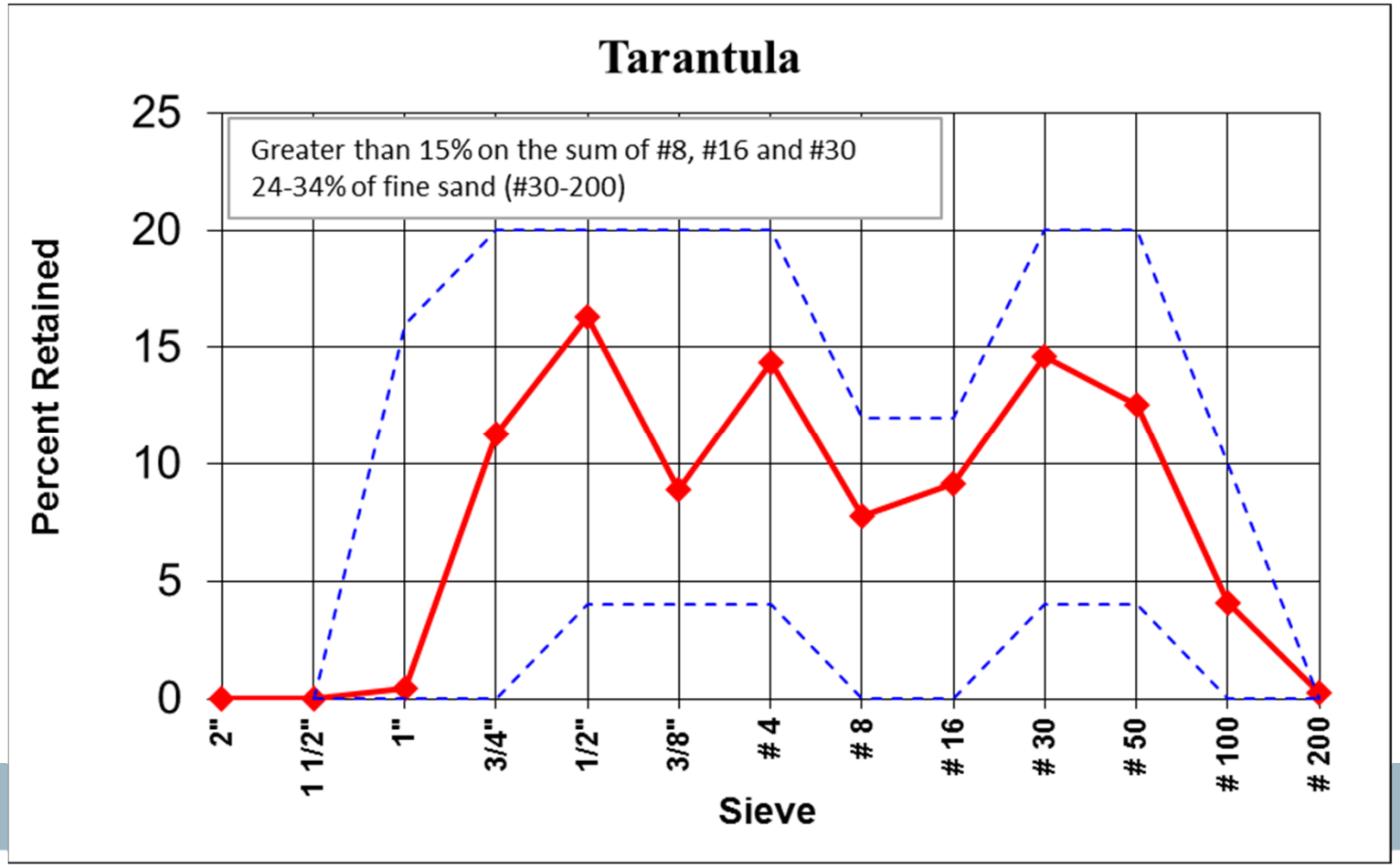
Filler
Gradation



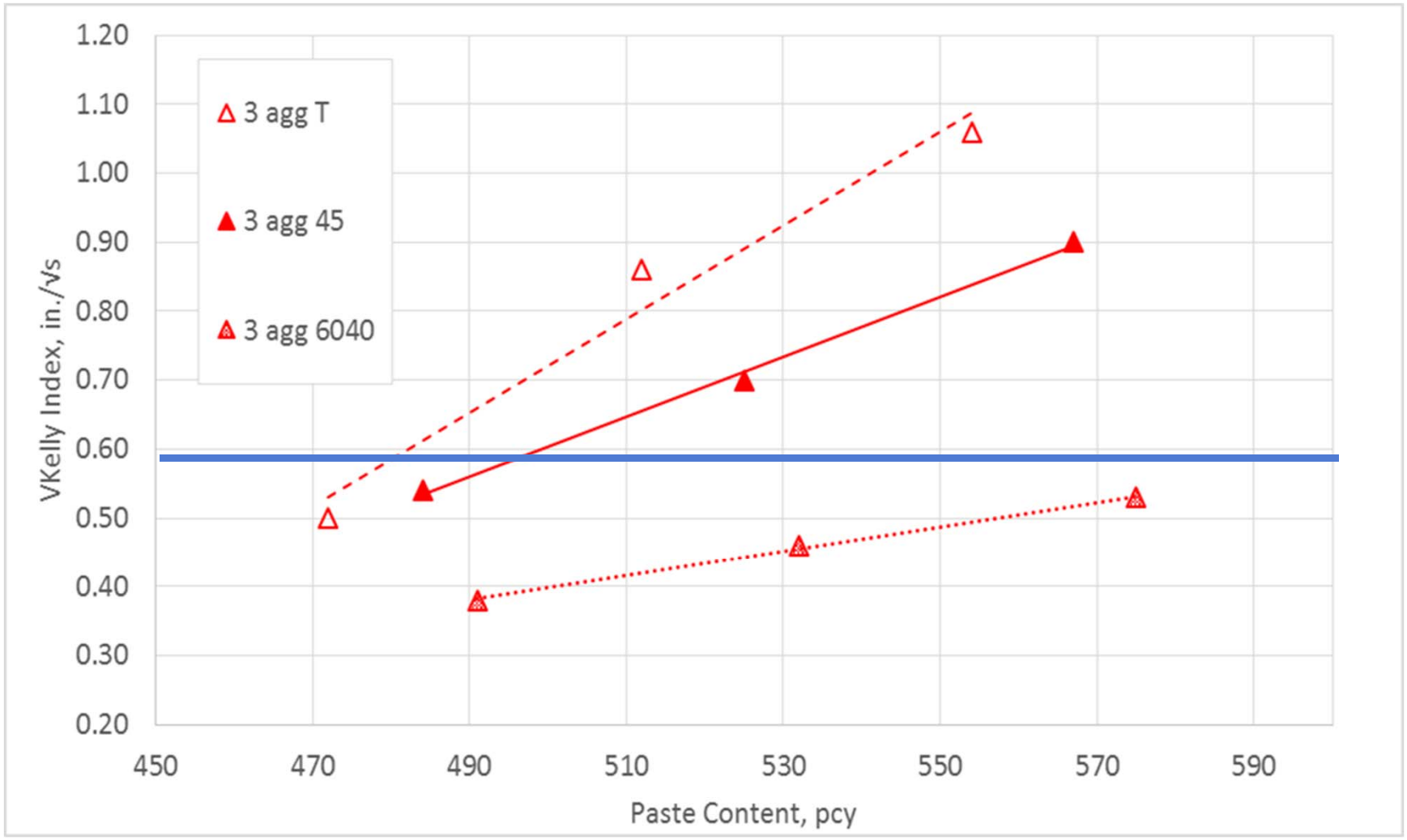
Glue
What sort
How much

Aggregate Gradation

- Tarantula Curve



Effect on Binder Content



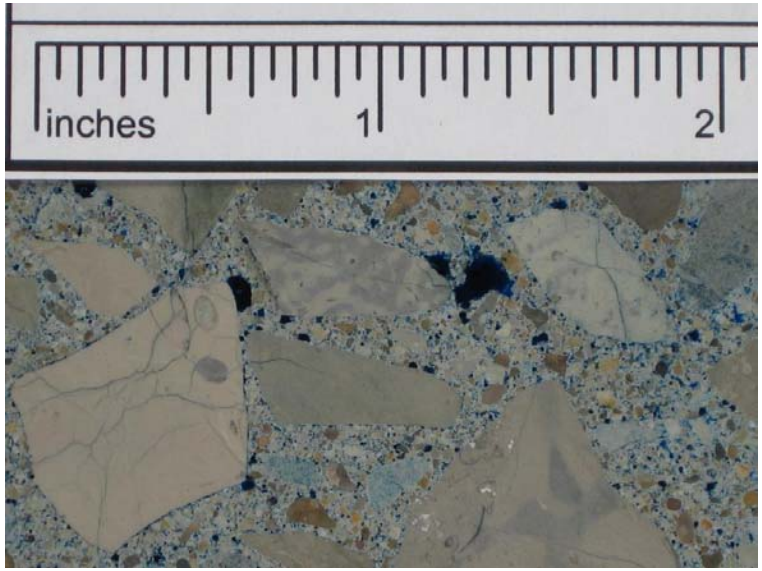
Effect of Proportioning

What Can Go Wrong?

- Alkali Aggregate Reaction
  - Reactive aggregates
  - Alkali hydroxides
  - Water

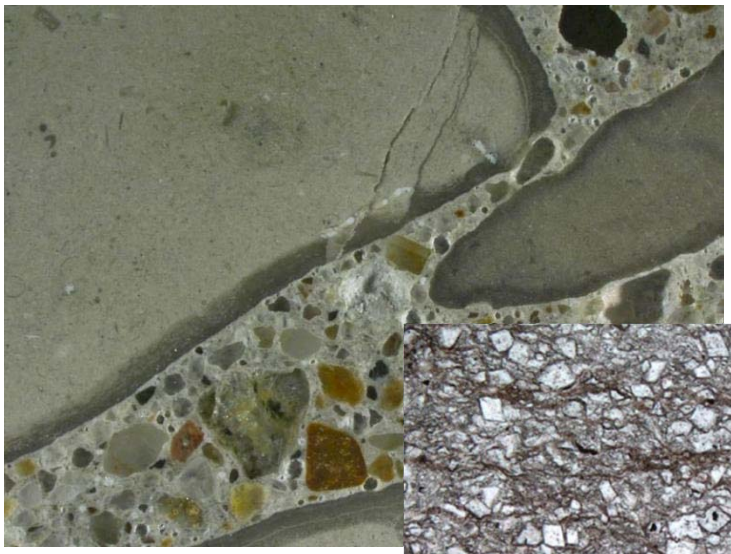
What Can Go Wrong?

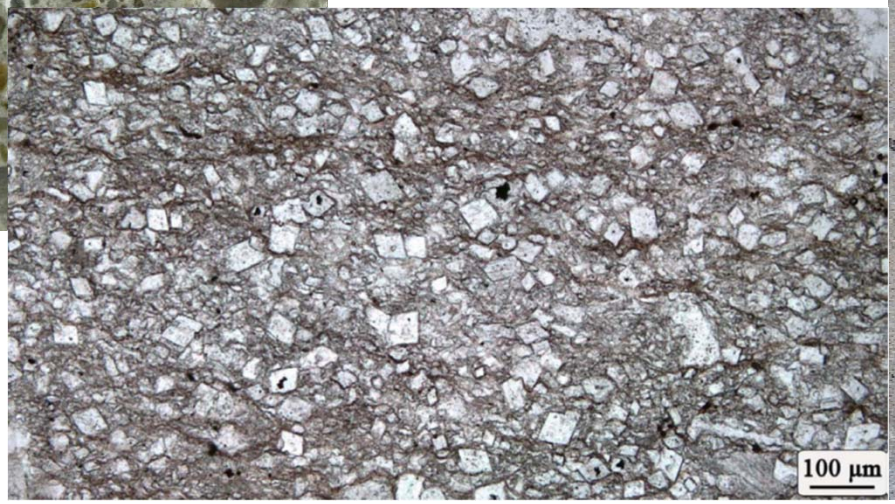
- D-Cracking
  - Some limestone aggregates
  - Cold weather

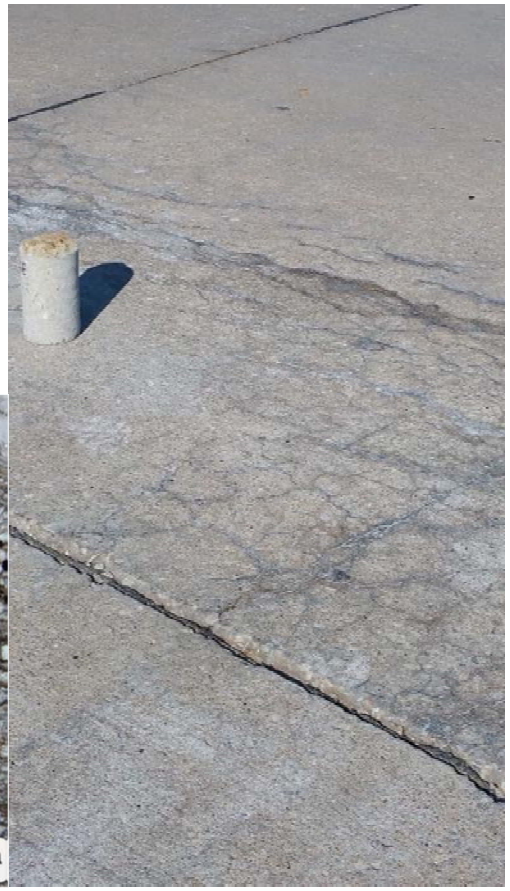


What Can Go Wrong?

- Alkali Carbonate Reaction
  - A mystery







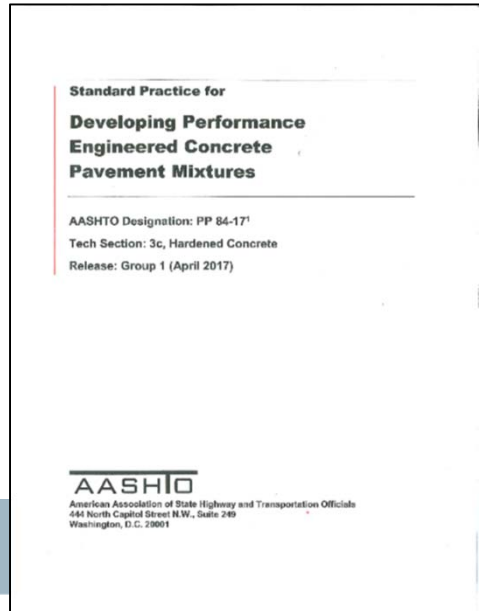
What Can Go Wrong?

- Popouts
  - Porous aggregates

A Better Specification

- AASHTO PP84 published in March
  - Guide Specification
  - “Deemed to satisfy”
  - Avoids bonus discussion – that is local
  - Provisional = meaning we can modify as we learn things

Delivering concrete to survive it’s environment


Standard Practice for

Developing Performance Engineered Concrete Pavement Mixtures

AASHTO Designation: PP 84-17[1]

Tech Section: 3c, Hardened Concrete

Release: Group 1 (April 2017)

AASHTO

American Association of State Highway and Transportation Officials
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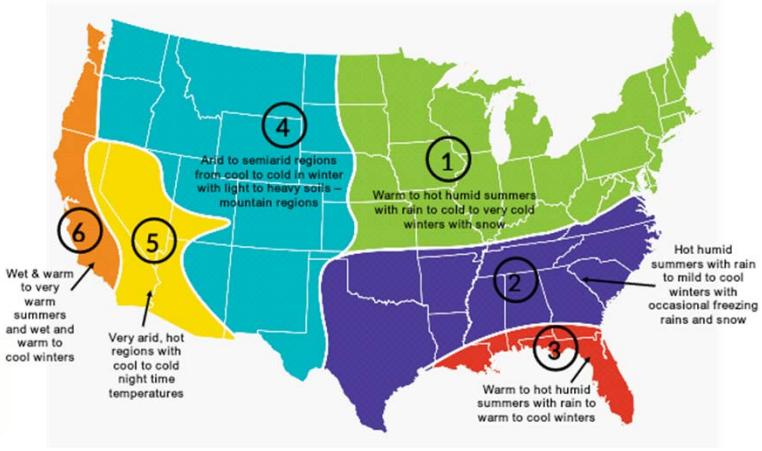
Washington, D.C. 20001

Require the things that matter

- Transport properties (everywhere)
- Aggregate stability (everywhere)
- Strength (everywhere)
- Cold weather resistance (cold locations)
- Shrinkage (dry locations)
- Workability (everywhere)



Closing

- We need to talk…