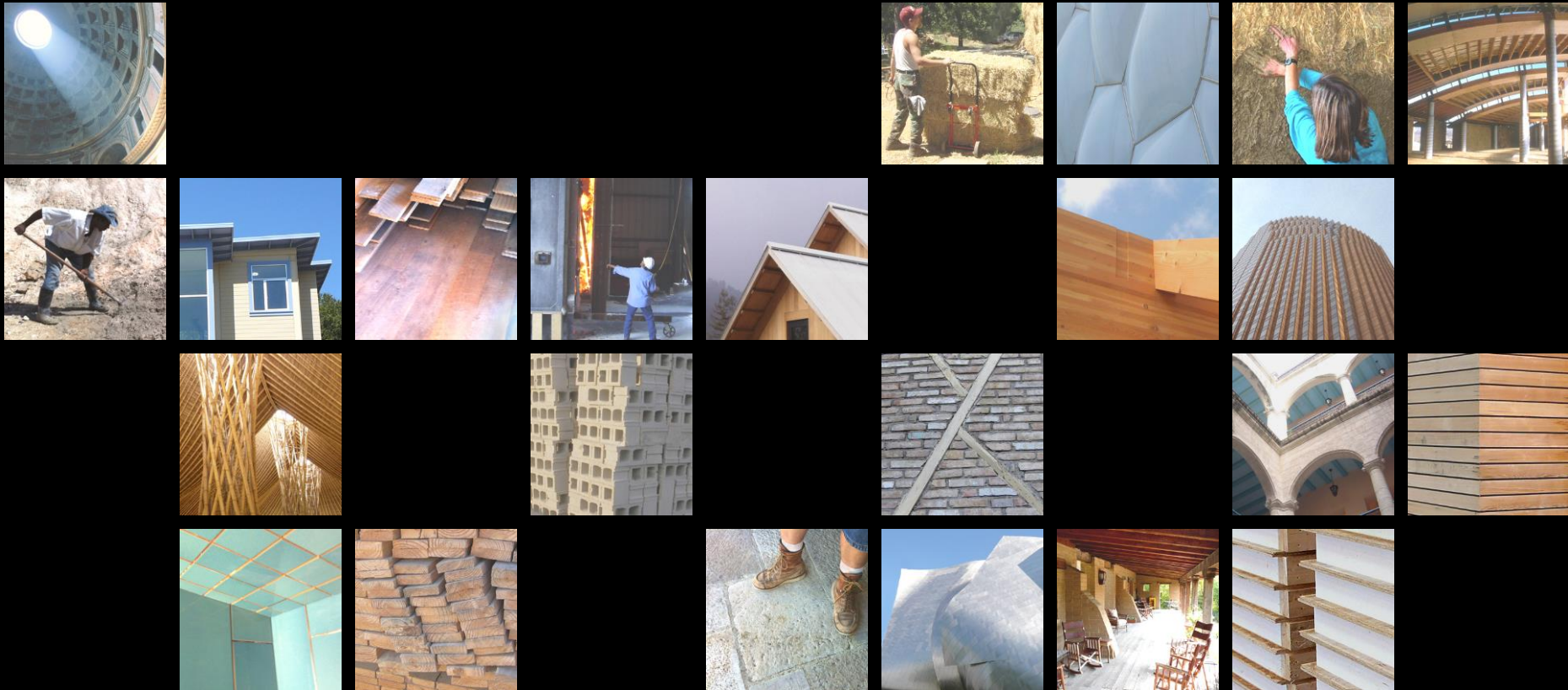


# Engineering with Natural Materials

*some physics, some common sense, and a few myths*



# natural materials

*the state of our knowledge*



## Everyone's an engineer

# natural materials

## *some favorite myths*



Straw bale buildings only cost \$10 a square foot!

With earthen walls you don't need insulation!

Cob buildings are earthquake-proof!

Bamboo is stronger than steel!

Earthbag buildings are *proven* earthquake-proof!

Portland cement is, like, *evil*, man.

# natural materials

*some favorite myths*



It's what everybody else does -- it works!



# natural materials

*how do you know?*



**Choosing materials and systems –**

***How do you know?***

*How do you know?*

## anecdotal knowledge



*can be very, very useful*

*or can be*

*very, very misleading / wrong*

*How do you know?*

## laboratory testing



*can be very, very useful*

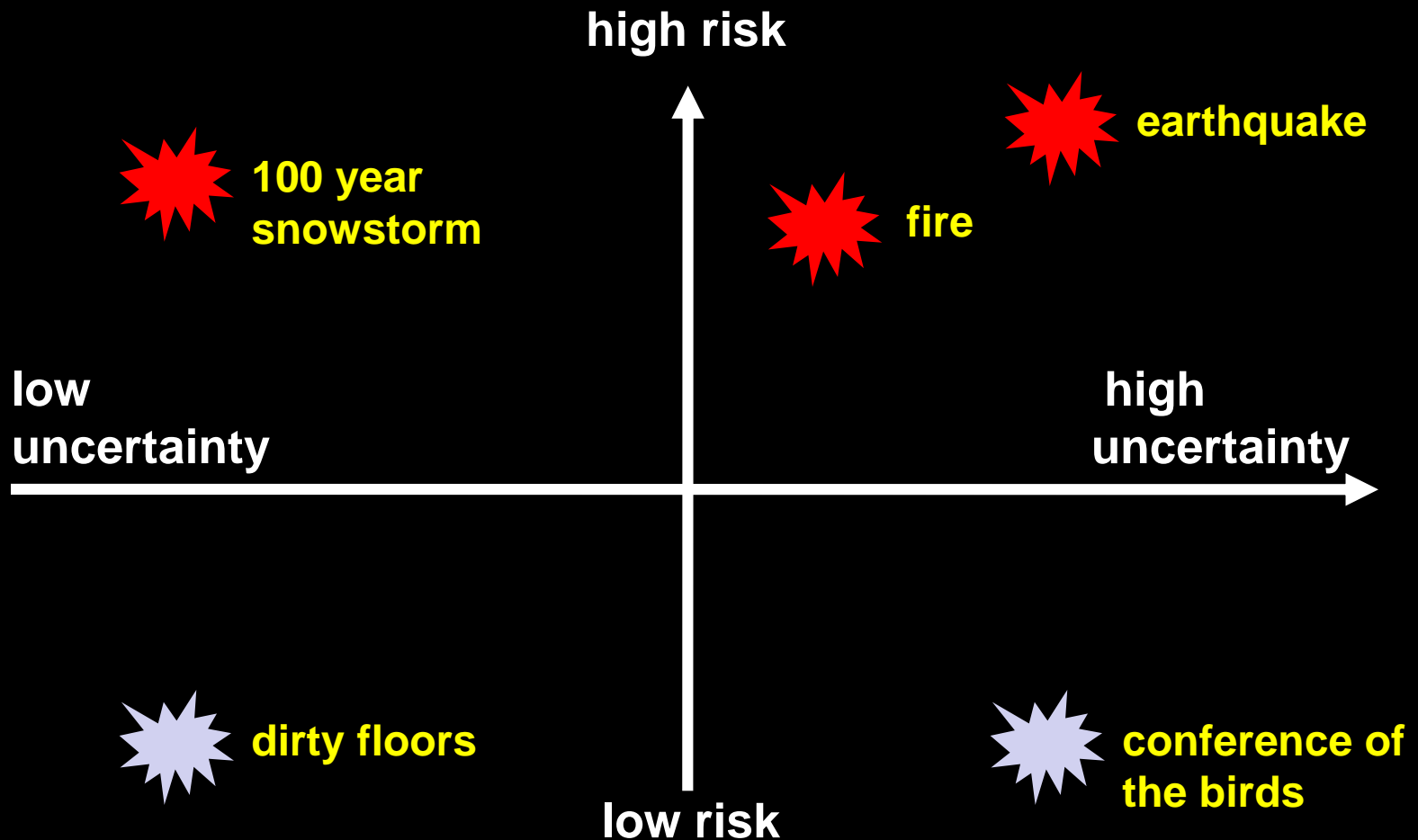
*or can be*

*very, very misleading / wrong*



# *How do you know?*

## **risk vs. uncertainty**



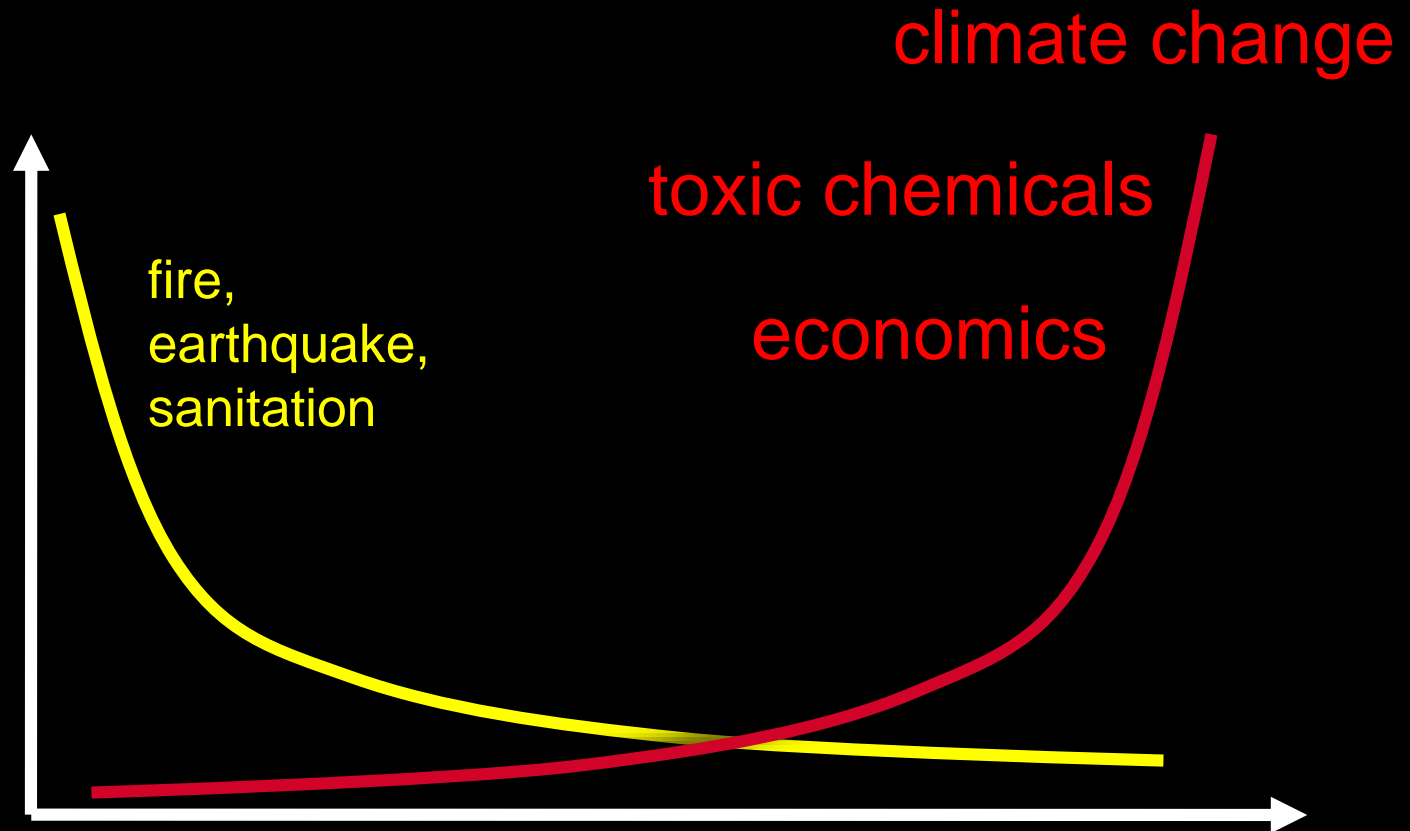
*How do you know?*

# risk aversion



*How do you know?*

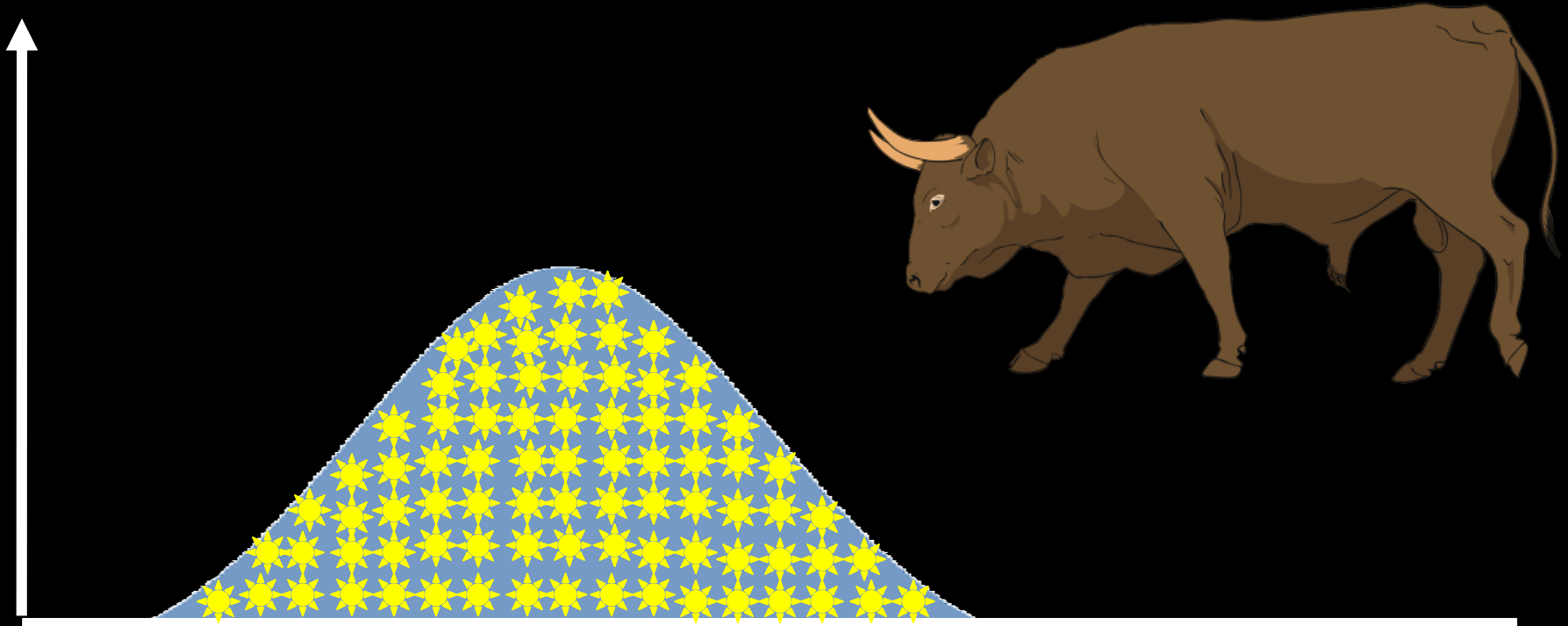
# risk **abatement**



*How do you know?*

**Probabilities --**

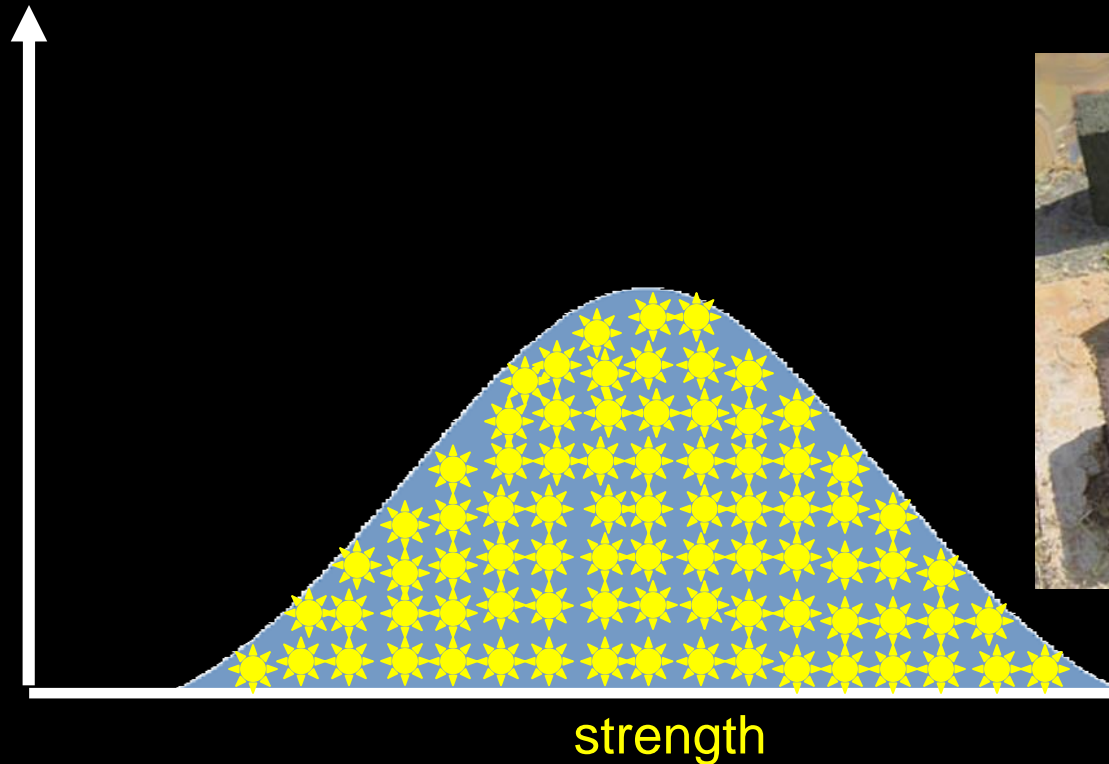
*the bell curve*



*How do you know?*

**Probabilities --**

*the bell curve*

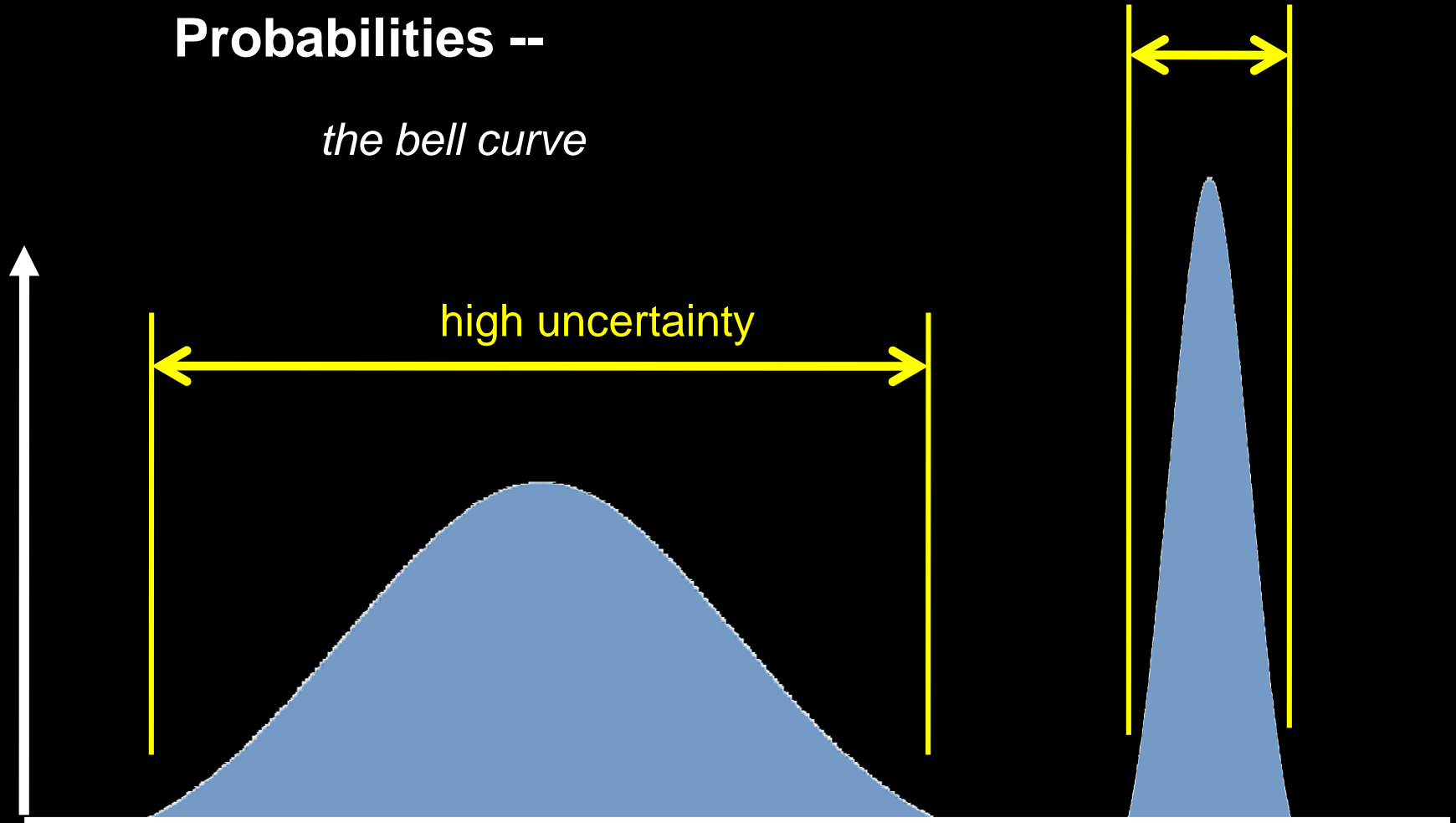




*How do you know?*

**Probabilities --**

*the bell curve*

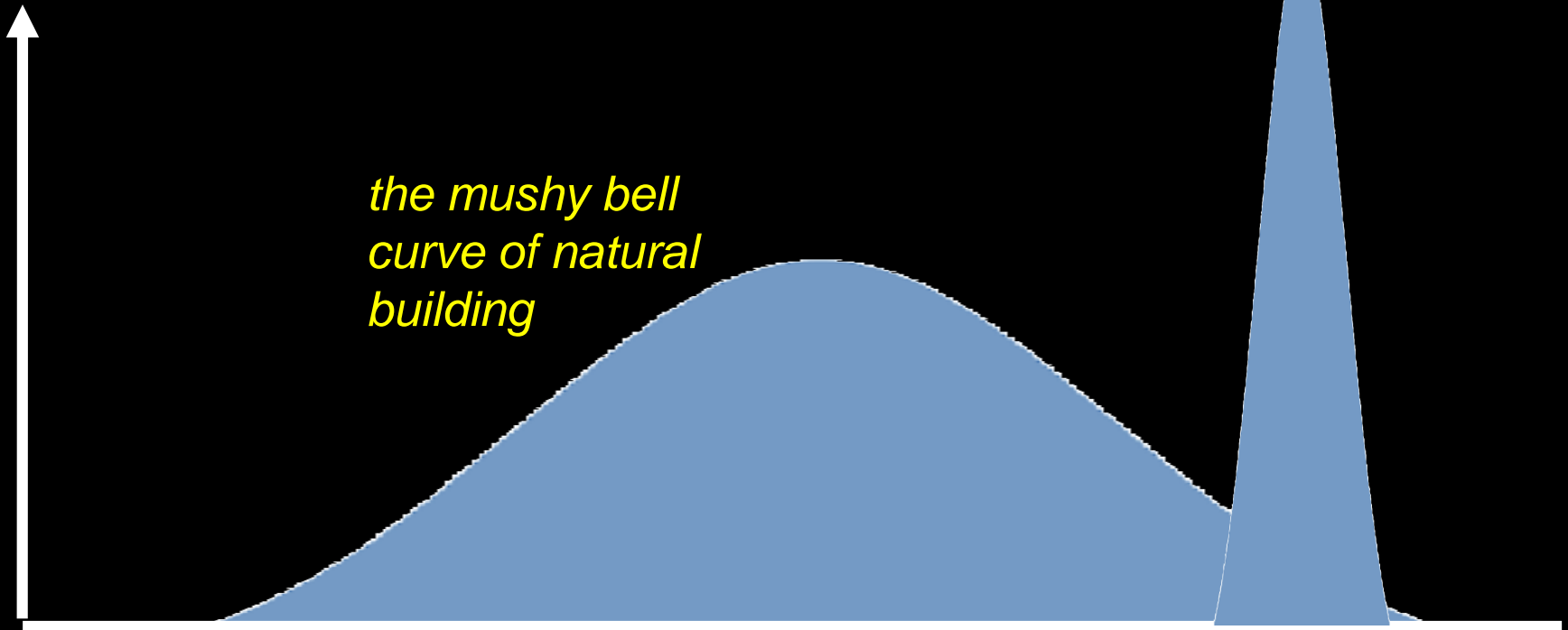


*How do you know?*

**How sure are you?**

*the mushy bell  
curve of natural  
building*

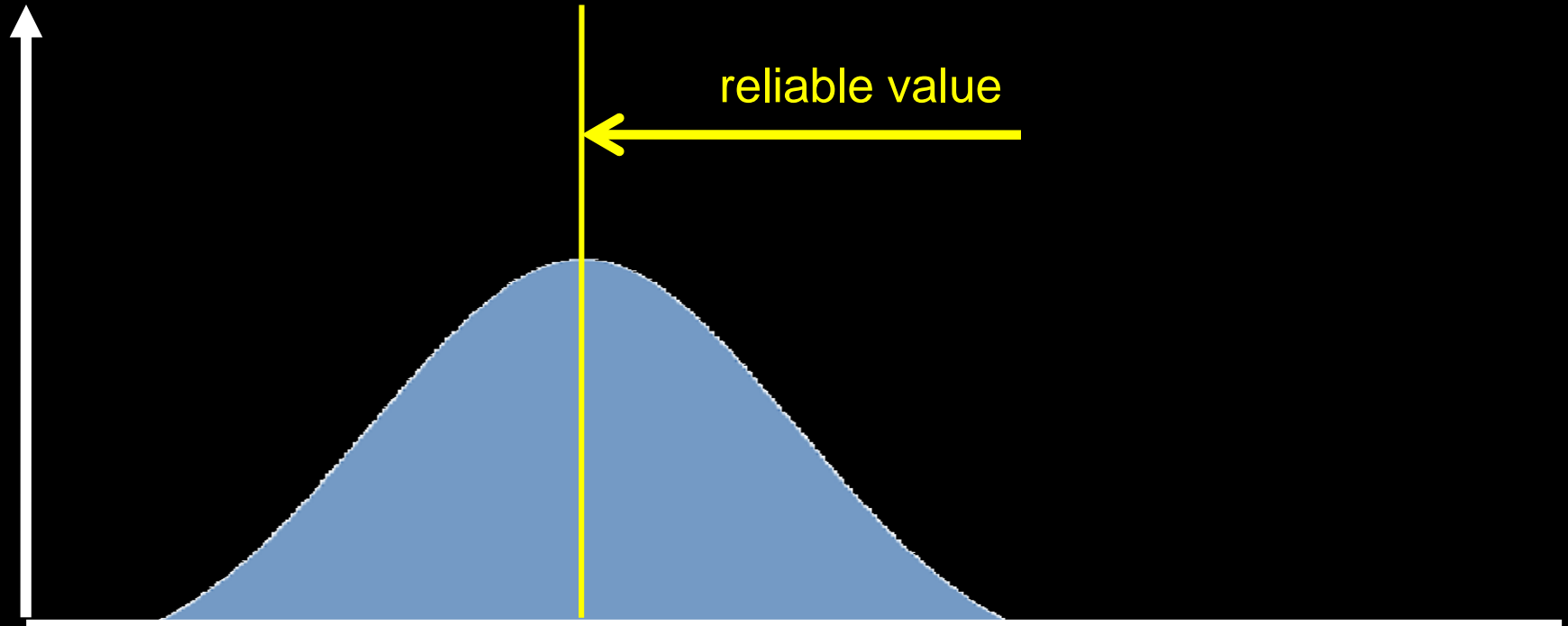
*the **manly** bell  
curve of  
mainstream  
building*



*How do you know?*

**Probabilities --**     *How much does it matter?*

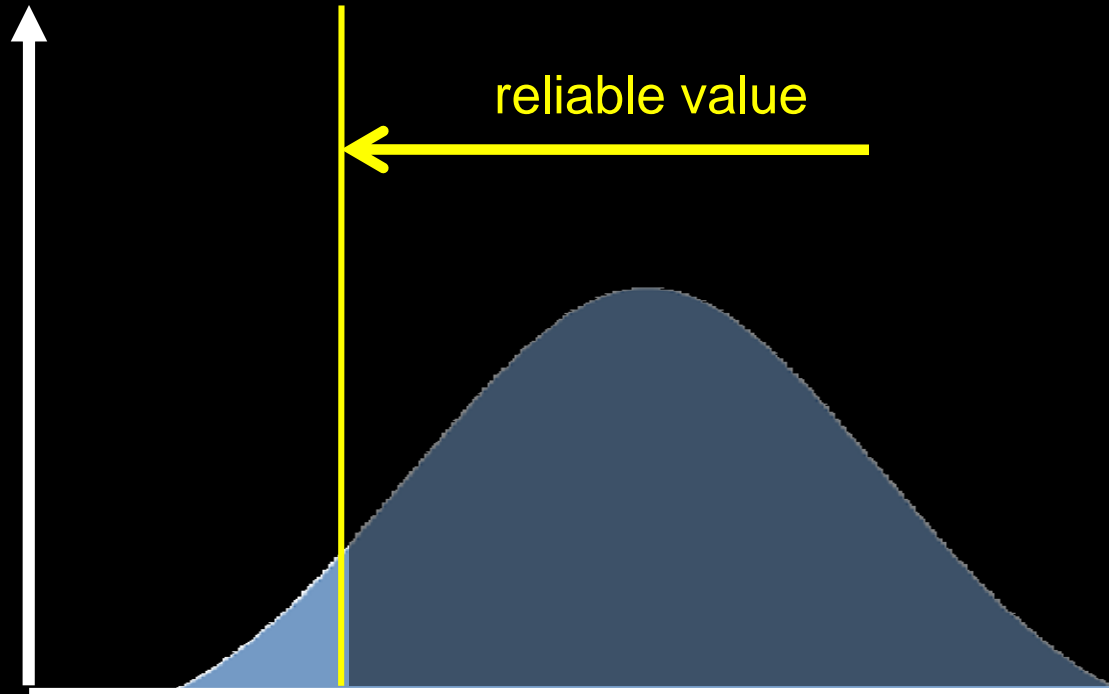
**no risk of life? – take the average**



*How do you know?*

**Probabilities --** *How much does it matter?*

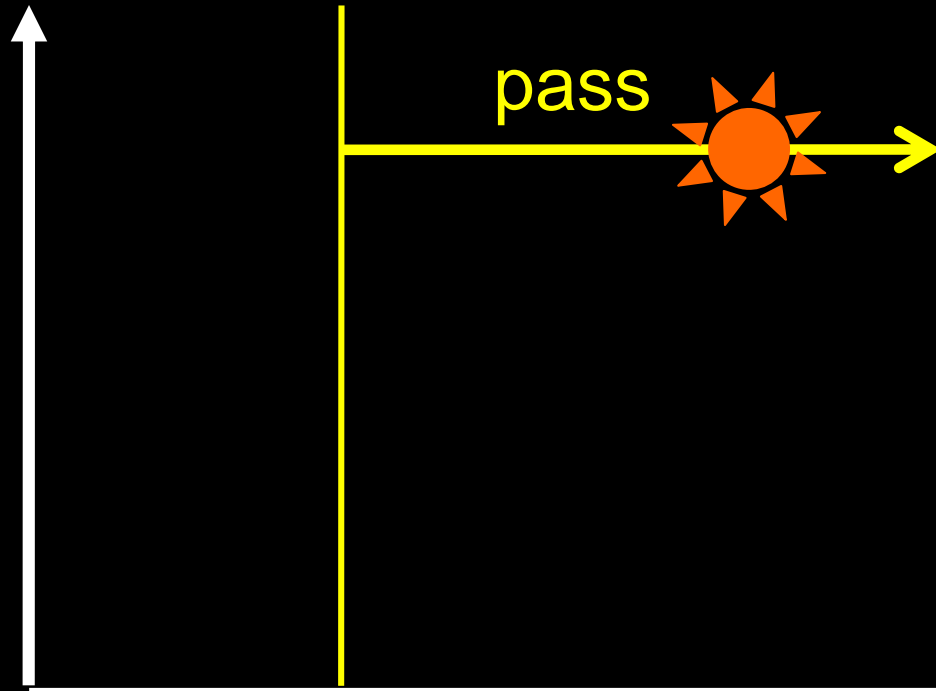
**risk of life? – *be more cautious***



*How do you know?*

**Probabilities --** *How much does it matter?*

**risk of life? – *be more cautious***





*How do you know?*

**Probabilities --** *How much does it matter?*

**risk of life? – *be more cautious***



**News flash:**

**earthen buildings  
are  
concrete buildings  
are  
earthen buildings**





Designation: E2392/E2392M – 10

Standard Guide for  
Design of Earthen Wall Building



Making  
Better  
Concrete

*Guidelines  
to Using  
Fly Ash for  
Higher Quality,  
Eco-Friendly  
Structures*

By Bruce King, P.E.

© 2008 Bruce King

**earthen buildings**  
*are*  
**concrete buildings**  
*are*  
**earthen buildings**



# Concrete and the cult of portland cement

## What is concrete?

**artificial rock:**

*sand  
binder*

*maybe gravel*

*maybe fibers*

*maybe chemical additives*



# Concrete and the cult of portland cement

## What is concrete?

**artificial rock:**

*sand*

*binder*

*maybe gravel*

*maybe fibers*

*maybe chemical additives*

*... but not  
necessarily  
Portland  
cement*



# What is “concrete”?

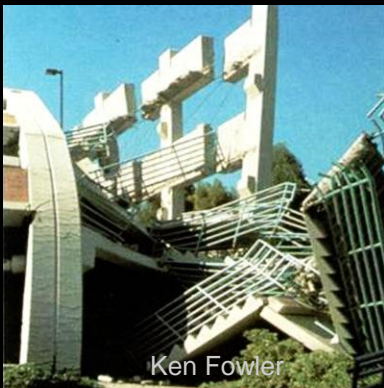


Concrete and the cult of portland cement

# What is “concrete”?

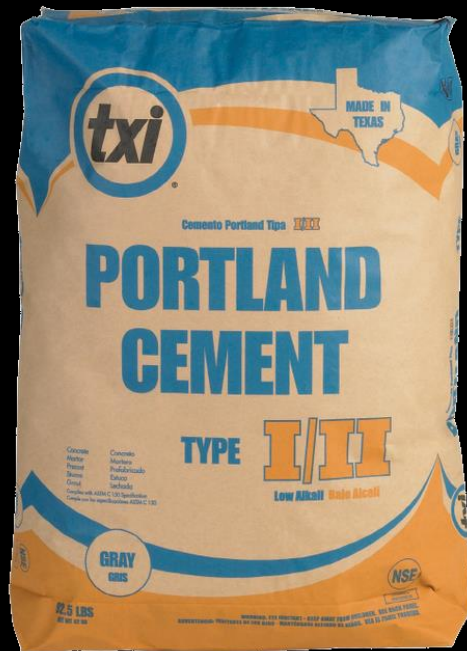


## Concrete and the cult of portland cement





# Concrete and the cult of portland cement



[www.lowes.com](http://www.lowes.com)

6%

# Concrete and the cult of portland cement

*Does it need to be that strong?*



# Concrete and the cult of portland cement

*Does it need to be that strong?*



[www.safran-group.com](http://www.safran-group.com)



# Three types of concrete:

Type 1: “ordinary” concrete –

- mild strength & durability
- very low carbon

# Three types of concrete:

Type 1: “ordinary” concrete –

- mild strength & durability
- very low carbon

Type 2: insulating concrete –

- low density / entrained air

# Three types of concrete:

Type 1: “ordinary” concrete –

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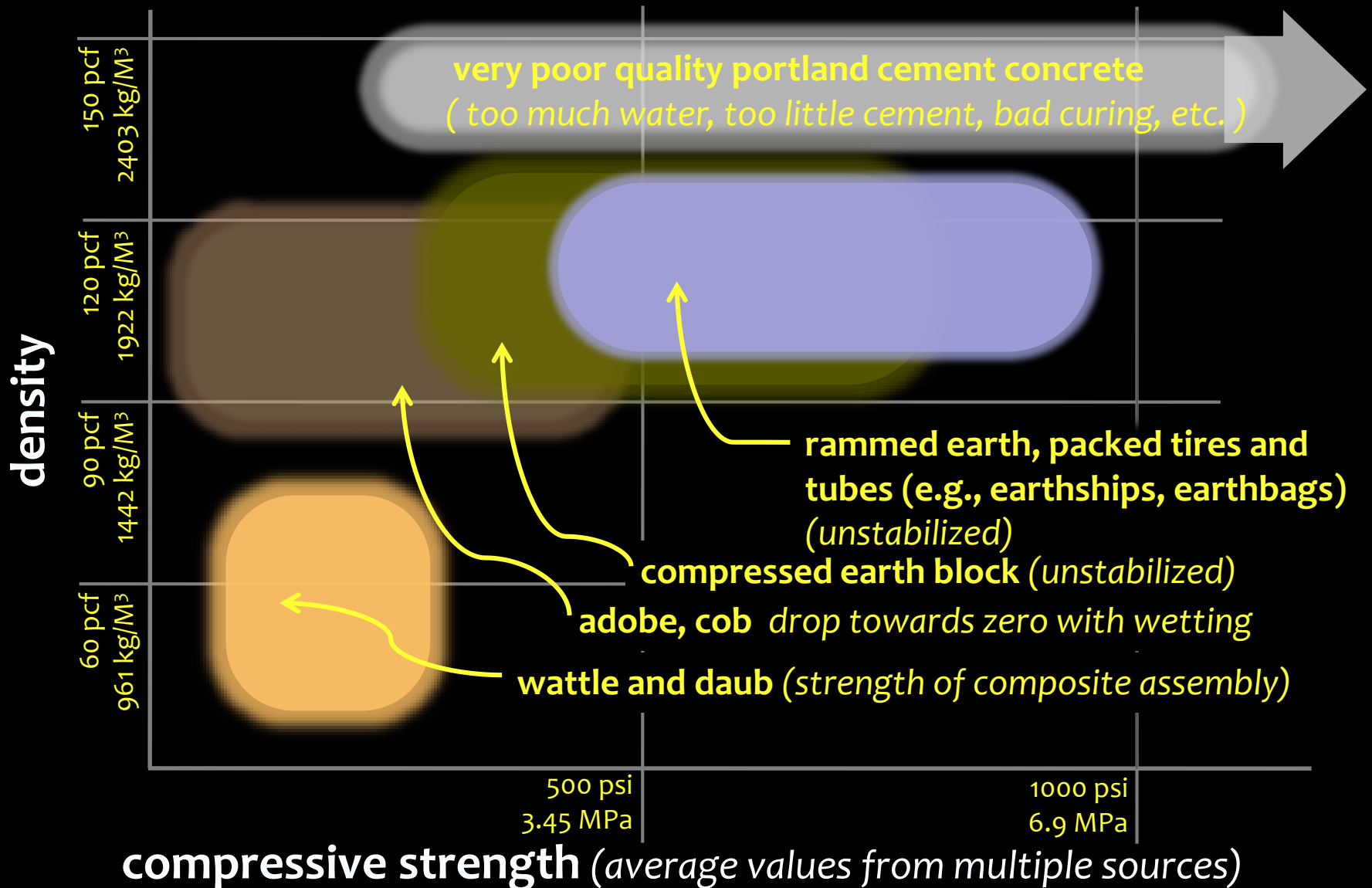
Type 2: insulating concrete –

- low density / entrained air

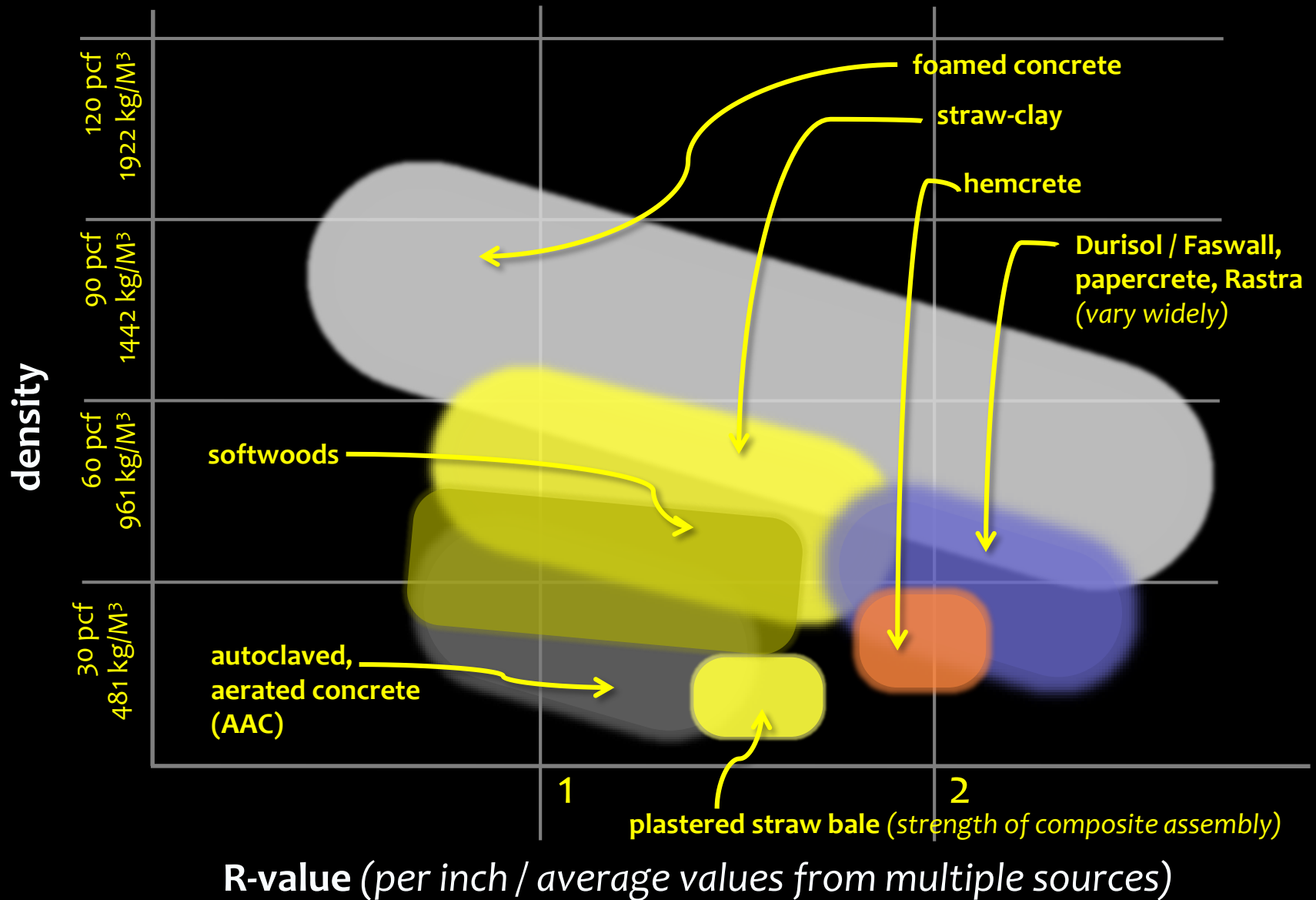
Type 3: strong concrete –

- high strength / durability
- generally high carbon

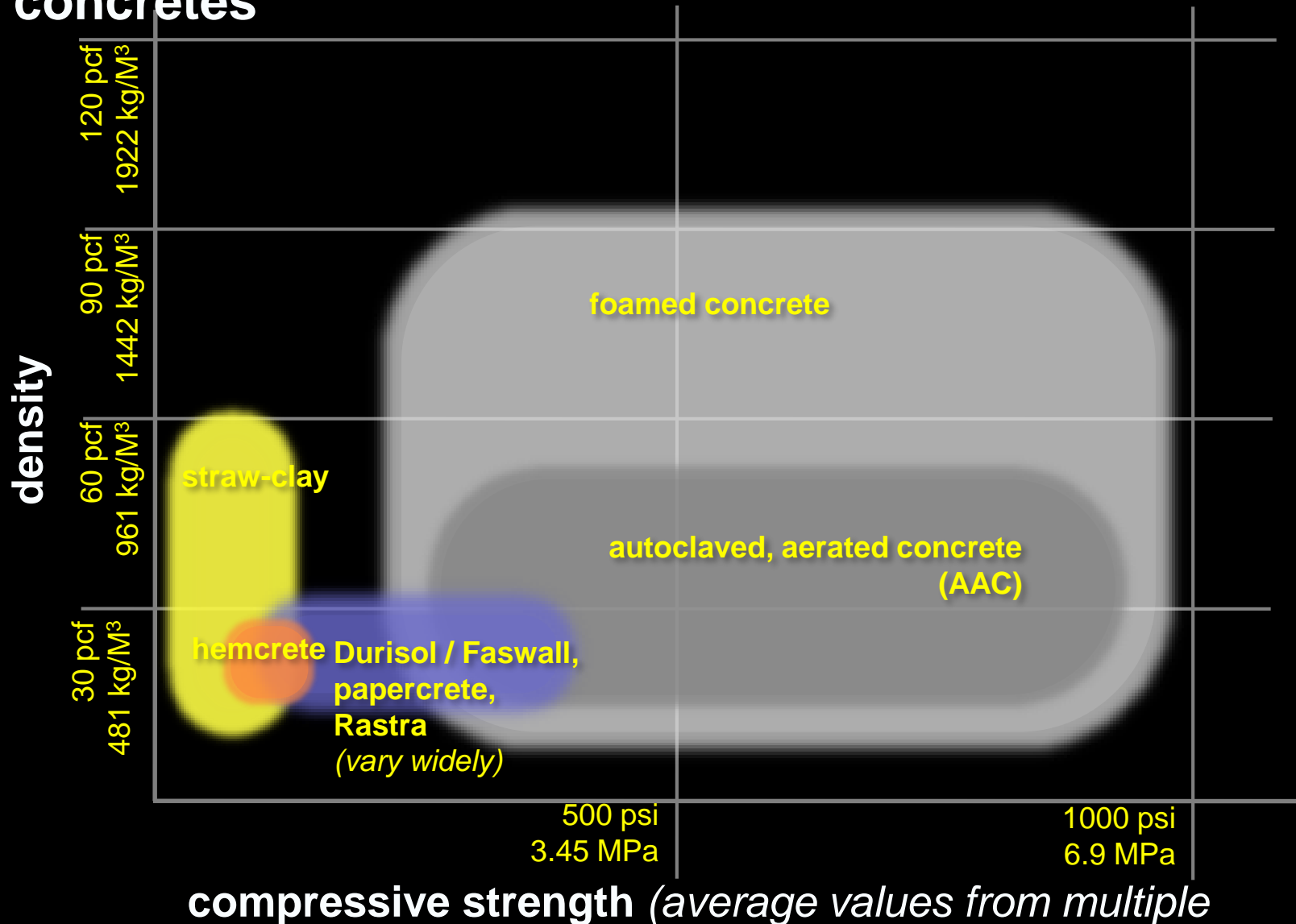
# density and compressive strength of ordinary (Type 1) concretes



# density and R-value of insulating (Type 2) concretes



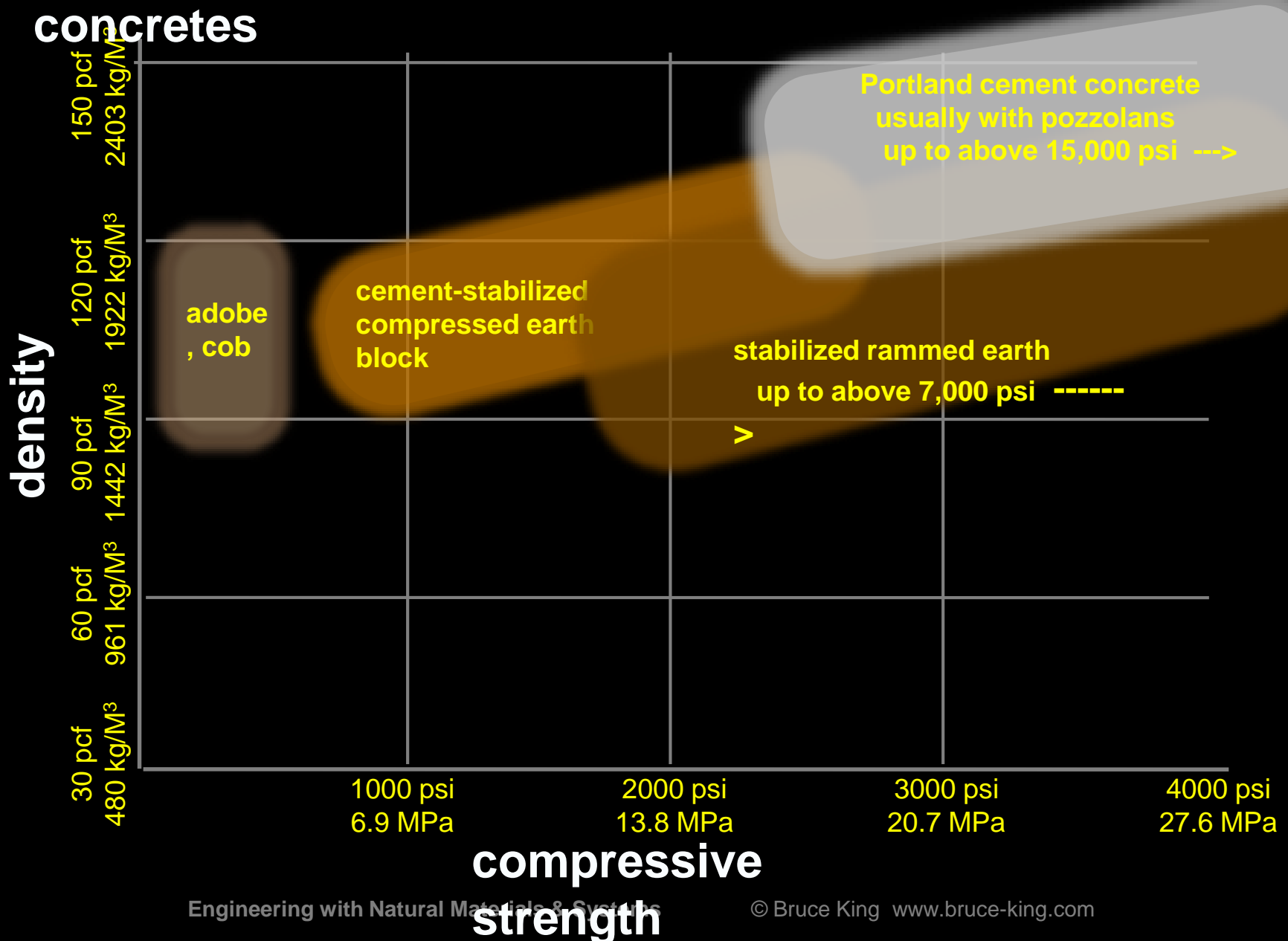
# density and compressive strength of insulating (Type 2) concretes

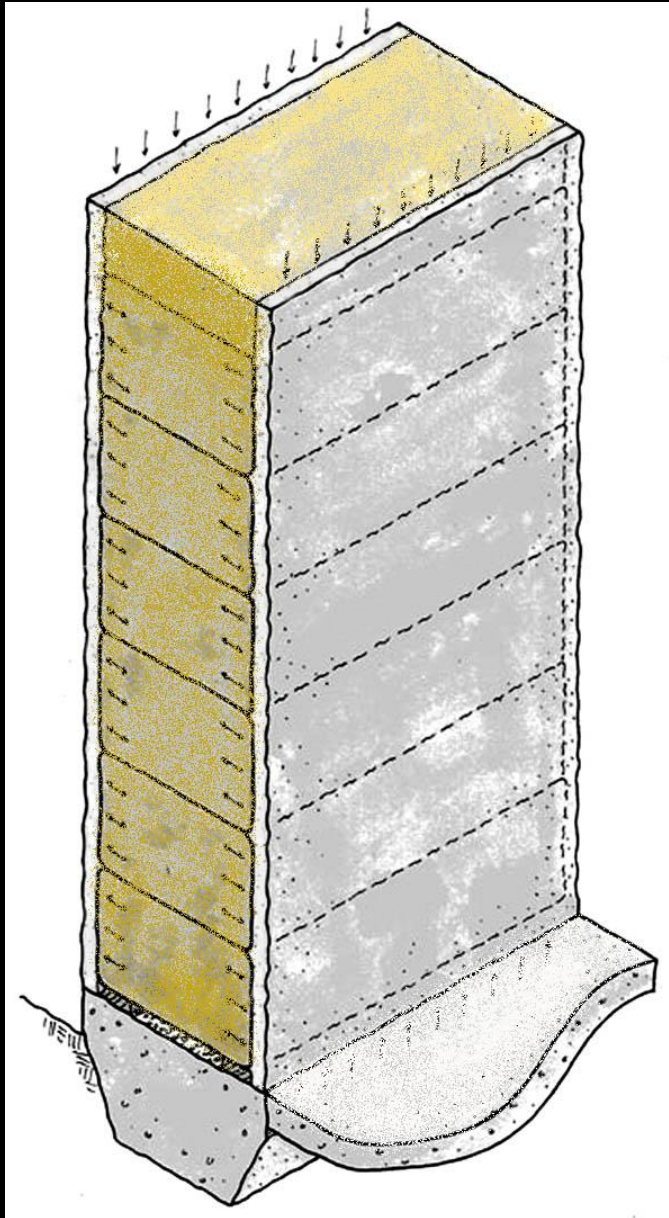


compressive strength (average values from multiple sources)



# density and compressive strength of strong (Type 3) concretes



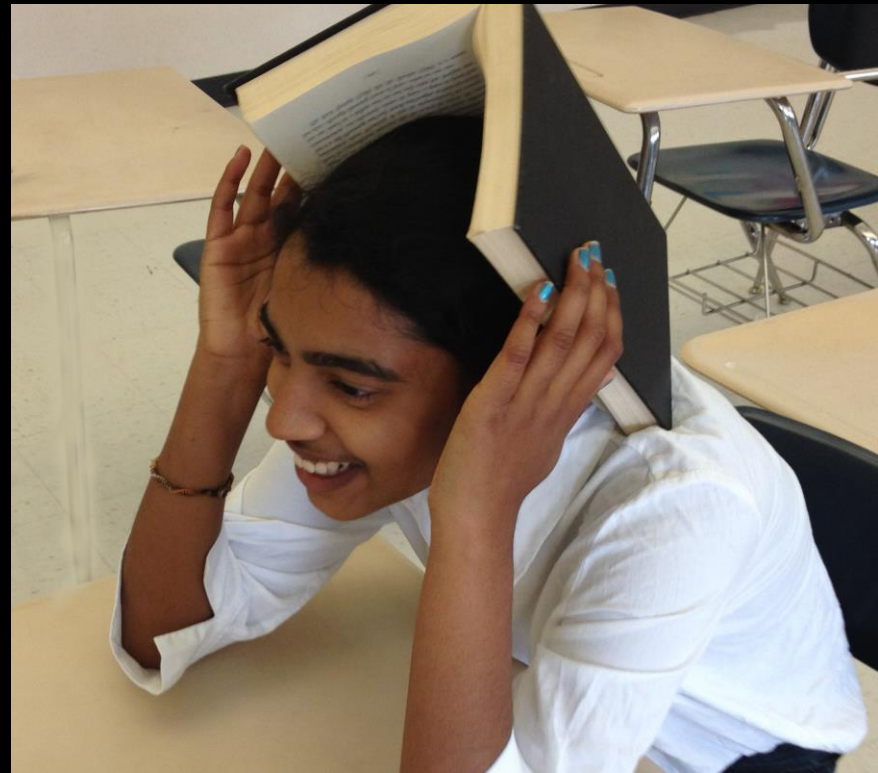


Yikes!

# Natural building research

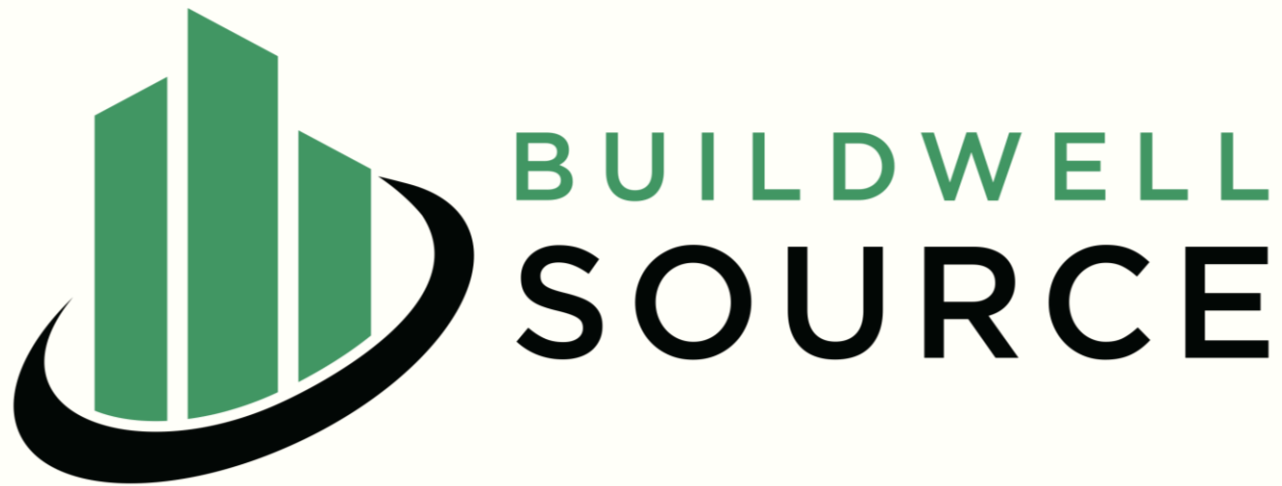


# access to knowledge



**access to knowledge**

**[www.buildwelllibrary.org](http://www.buildwelllibrary.org)**



# BuildWellLibrary.org



- User built
- User reviewed
- Open and free



# BuildWellLibrary.org



professional  
resource

K-12 education

codes & standards

policy

disaster relief

innovation

games & contests



# Questions?

