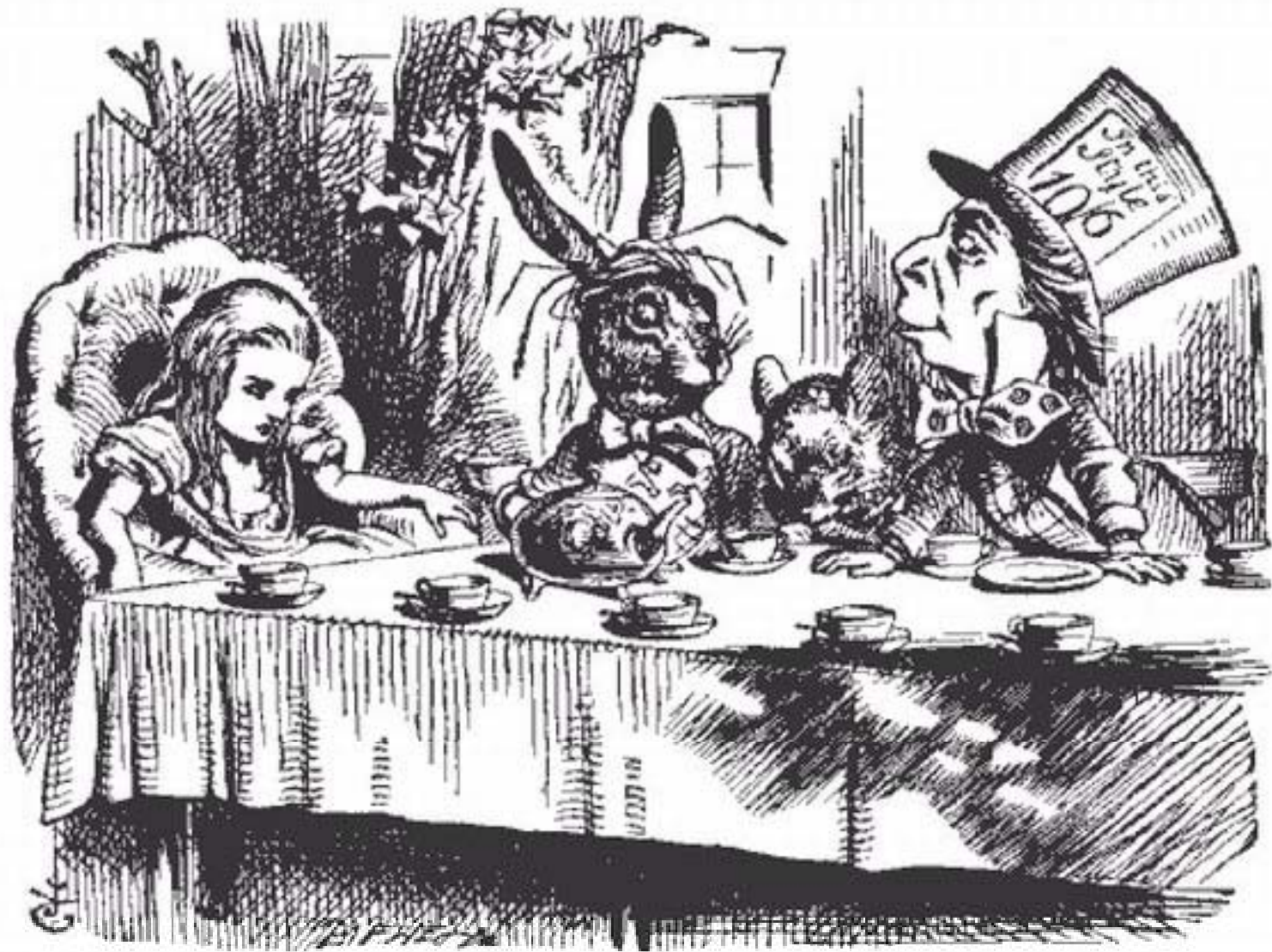


**ANNA MARIA X**

ALICE'S ADVENTURES IN  
WONDERLAND REVISITED:  
“GREEN” CONCRETE VS. THE  
BUILDING CODES

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- Is there some standard definition of “green” or “sustainable” concrete?

“When I use a word,” Humpty Dumpty said..... “it means just what I choose it to mean – neither more nor less.”

“The question is,” said Alice, “whether you *can* make words mean so many different things.”

“The question is,” said Humpty Dumpty, “which is to be master – that’s all.”

# WHAT IS GREEN CONCRETE?

Concrete with significantly reduced greenhouse gas emissions, using supplementary cementing materials to improve both durability and service life.

- What is the current state-of-the-art in California with regard to sustainable concrete practice?

# TYPICAL DECISION MAKERS



# Engineering manager, precast

- “I do not believe it is in the best interest of.....the Environment to use a concrete mix with a high volume of fly ash in a precast structure.”
- “Our mix (700 lb cement, 130lb fly ash) is the most efficient combination of raw materials and admixture technology available.”



Curiouser and curiouser

# City Engineer Mentality

- The best way to bring about changes in the Greenbook is through pilot projects demonstrating the suitability of the new mix designs.
- However, we will not permit pilot projects that do not conform to the Greenbook.

# Caltrans Specifications??!!

- Minimum cementitious content: 675 lb/yd<sup>3</sup>
- Minimum Portland cement: 75%
- Maximum fly ash: 35% **????**
- Silica fume: 10% *minimum?*
- No provision for use of recycled concrete aggregate

# Southern California Edison

- Fly ash: 10-15%
- Silica fume: not permitted
- Recycled concrete aggregate: no

# Florida DOT

- Precast concrete:  
maximum 25% fly ash
- Structural concrete:  
maximum  $20 \pm 2\%$  fly ash  
 $8 \pm 1\%$  silica fume
- Minimum cementitious: 611 lbs/yd<sup>3</sup>

# BASF CONSTRUCTION CHEMICALS

- Max fly ash: 25%
- Max silica fume 10%
- Max SCM: 35%



- It is not possible to educate structural engineers about the properties of concrete; their minds are completely closed in this regard. To them, concrete is a “black box”, completely defined by  $f'_c$  and  $E$ .



- Since it is the structural engineer who is the “engineer of record” on most projects, this is a huge impediment to the introduction of more modern concrete mixes that do not conform exactly to the often regressive concrete specifications.

- We need to better characterize the properties of the available raw materials. If their quality is low, we should look at ways of beneficiating them, or finding better sources of materials.

# Consider these mixes

units in kg/m<sup>3</sup>

•	<u>RRM010</u>	<u>RRM019</u>	<u>RRM020</u>
Water	172	155	121
Cement	272	246	246
Fly Ash (Type F)	126	106	106
Silica fume	21	26	26
Coarse Aggregate	1005	1055	1104
Fine aggregate	785	806	840
Water reducer			
(ml/100kg)	230	230	230
Superplasticizer (L/m <sup>3</sup> )	1.5	4.6	8.0
Unit weight	2381	2400	2453
w/c	0.41	0.41	0.32
Slump (mm)	140	160	185
Air content (%)	1.5	1.6	2.0

# Concrete Strengths (MPa)

LAFARGE	<u>RM010</u>	<u>RM019</u>	<u>RM020</u>
7 day	43.4	49.9	59.8
28 day	63.0	72.1	88.5
56 day	69.9	80.3	97.3
ROBERTSON'S			
7 day	28.1	26.7	33.7
28 day	44.9	41.0	53.7

# Chloride permeabilities

(Coulombs)

Lafarge	<u>RM010</u>	<u>RM019</u>	<u>RM020</u>
7 day	2715	3180	2310
28 day	690	575	345
56 day	374	329	208

## Robertson's

7 day	4792	4596	3275
28 day	1581	2009	1430



“Would you tell me, please, which way I ought to go from here?”

“That depends a good deal on where you want to get to,” said the Cat.

“I don’t care where-----” said Alice.

“Then it doesn’t matter which way you go,” said the Cat.

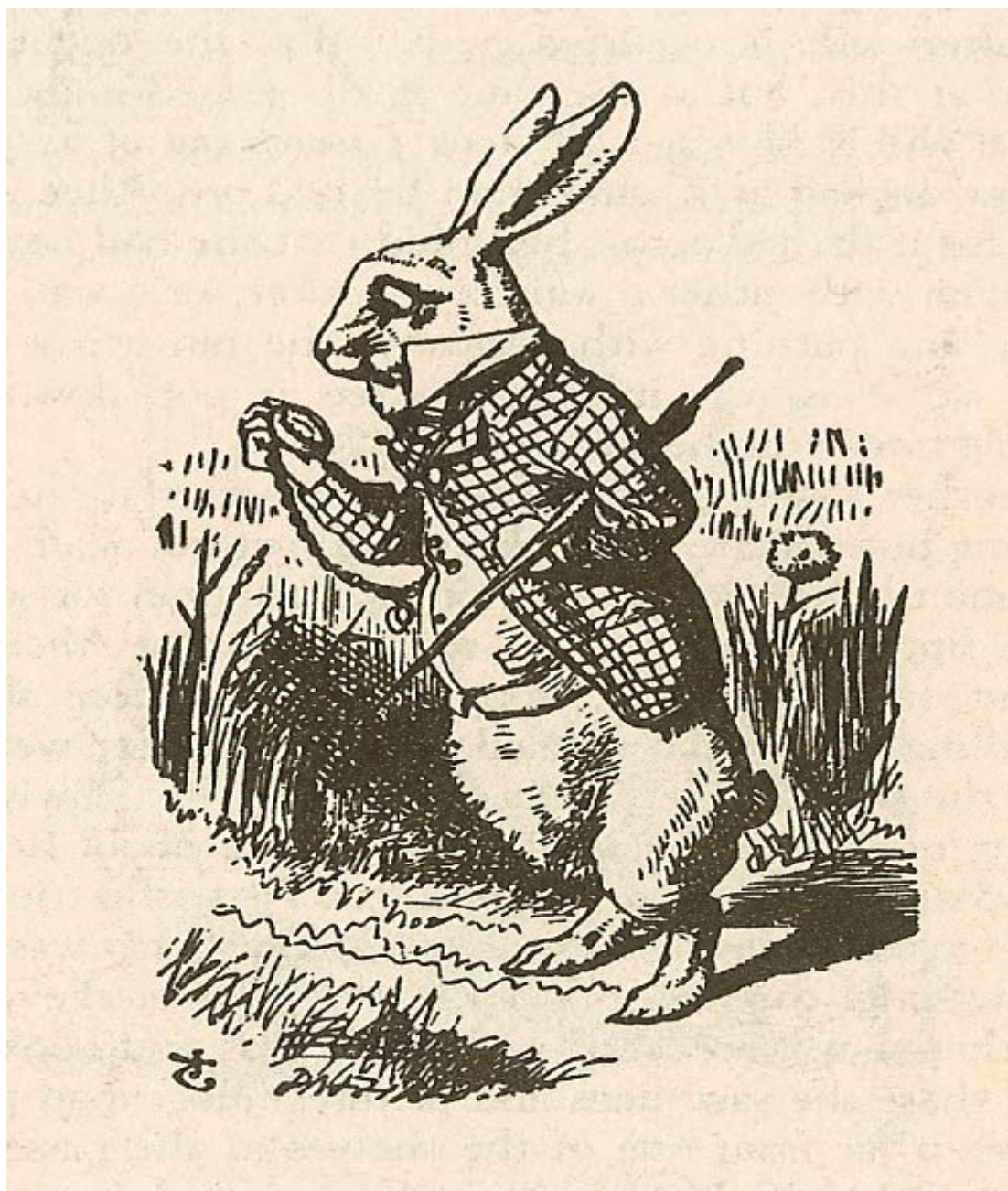
“-----so long as I get *somewhere*,” Alice added.....

“Oh, you’re sure to do that,” said the Cat.....

- What needs to be done to enable the widespread use of sustainable concrete practice?



- Since it is largely impossible to educate structural engineers, it will be necessary to convince architects and asset owners to specify sustainable concrete.



- In order to permit higher cement replacement values for the supplementary cementing materials, and to permit the concrete producers to exercise their creativity and ingenuity, **it is essential to move from prescriptive specifications to performance specifications.**

- We must keep pushing for appropriate changes to the Greenbook, Caltrans specifications, and other rather old-fashioned codes and specifications, all of which are highly prescriptive, and seem to ignore the advances in concrete technology that have taken place over the last 30 years.

- Use more recycled concrete as aggregate

- We must better “market” this new generation HPC; it will no longer be simply a commodity.

- It's not that easy bein' green.

*Kermit the Frog*



# CONCLUSION

- ILLEGITIMI NON CARBORUNDUM !
- (*Don't let the bastards grind you down!*)