Reducing CO_2 by Half, in Concrete!

An unavoidable opportunity for our profession; Doing More with Less

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Facts and Figures (per year)

- ± 9 Billion m3 concrete
- > 5 BT CO_2 by concrete (Prof. Sakai)
- ± 2.5 BT clinker produced (in China 1.28)
- ± 1 T Clinker = 1 T CO_2 = 1.6 T raw material (1.5 BT in ozon)
- Without changes, 260% increase by 2050
- When energy is renewable, 1/3 of CO_2 from concrete
- Water demand of OPC is increasing due to new grinding
- Water Cement Ratio is still common tool
- Non clinker binders on big scale operational ± 10 years ?
- Carbon Capture Questionable and CO_2 absorption partial

Double objectives

I. Reducing Carbon Footprint in concrete structures =

II. “Doing more with less” implies Transforming Concrete sector in the most popular High Tech building material technology, at ALL levels

Holistic Approach

- PRODUCTION Change to renewable Energy
  - ✓ ± 70 BTPY aggregates and raw OPC meal (3 to 8 kWh/t)
  - ✓ Concrete, precast and RMC (2 to 20 kWh/m3)
  - ✓ At installation site
  - ✓ Maintenance
  - ✓ At demolition & recycling
- TRANSPORT; Change to renewable Energy
- STRUCTURE; CLINKER CONTENT REDUCTION

Doing More with less Clinker in concrete structures

- *Even if heating of clinker is 100% renewable energy, calcination of limestone remains = loosing 1.5 BT!*

Focus area's of concrete profession;

✓ Optimize material use by engineering (Sakai, Lewis)

✓ Optimize installation with contractors

✓ Awareness creation at owners and legislators

✓ Reduce clinker content per m3 with producers

*London Olympics 2012 success story**

PARTICIPATION PYRAMID

(cost saving) SUSTAINABLE CONSTRUCTION PROCESS

* klhsustainability.com

Reduce Clinker Content per m 3

1. Reduce Paste content of Aggregate > 125µ PSD
2. Reduce clinker content of Paste, by <125µ Particle Size Engineering, understanding that Strength is function of; REACTIVITY, PACKING, ADHESION
3. Use SCM pre-blended with OPC + in Concrete, on equal terms
4. Apply Water POWDER Ratio since DURABILITY is 90% corrosion and related to Permeability, not Strength
5. Design mix for tailor made strength demand at specific time
6. CONSISTANCY; Impose PSD control on incoming materials, Ken Day's CUSUM on outgoing, and NDT on finished product
7. Involve RMC suppliers in installation, curing and monitoring
8. Train All people on All levels (U-tube RSA Animate/Education)

Clinker Replacement Materials

- SCM = Supplementary CEMENTING Materials for lower Permeability (water demand) and Tailor made strength;

I. Recognized SCM by EN 197; Silica Fume, GGBS, PCFA, Natural Pozzolans, Ground Calcium Carbonate, Oil Shale Ash.

II. Scientific proven; Meta Kaolin, APReM (Activated Paper Recycled Minerals) RRiHSil (Reactive Rice Husk Silica), SuCaBM (Sugar Cane Bagasse Minerals),

- NPC (Non Portland) Alkali Activated, Magnesium Silicate, Calcium Magnesium, Sulpho Aluminate etc.

Case story sustainable precast (A)

Water Binder Ratio of Self Compacting Concrete using each 180 kg OPC, GGBS and Ground Calcium Carbonate (GCC)

UK	0.40
NI	0.45
FR	0.66
DE, ES etc	0.92
	0.36 acc. to EN 197 for "cement" recognized SCM

mixed with CEM I = CEM II B LL + CEM III C equivalent binders made by concrete producer on an "equal rights" base

Lesson 1: Water Cement/Binder Ratio is market tool, penalizing the use of environmental friendly SCM's by concrete producer

Case Story Sustainable precast (B)

Lesson 2; “non reactive” GCC stabilizer results in higher strength

Sustainable SCC

1. 190 kg CO_2/m3*
2. Good demoulding strength
3. Noise, from music !
4. Skilled forces, Less errors
5. Homogeneous = durable
6. Smooth light surface
7. Same cost as vibrated c.
8. Higher C 53/65 strength
9. Highest grade OPC (> € !)

** CO_2 and cost can be reduced by less OPC use (= high Q.)*

Former vibration concrete

1. 360 kg CO_2/m3
2. Noise from vibrating
3. Dust from vibration tables
4. Unschooled workers
5. High maintenance
6. Non homogeneous
7. Rough surface
8. C 35/45 strength

Mix design survey

C /35 for a watertight basement

Country	Clinker	SCM kg	Water	WCR	W.Powder R.
China	250	+100 FA or GGBS	170	0.48	0.49
South Africa	260	+110 FA	195	0.75	0.38
Kenia	250	+160 natural pozzolan	195	0.45	0.38
Zambia	± 260	± 70 limestone (not GCC!)	190	0.57	0.35
India, USA, .	400	-	160?	0.40?	-
Netherland PILOT II	68	272 GGBS + GCC	165	2.43	0.48

Dialogue with cement producers

- What is “cement”? OPC or EN 197?
- Concrete is NOT anymore a packaging of “cement”
- Is the steel content of a car important for its performance?
- How much OPC is non hydrated filler?
- No barriers to use environmental friendly SCM by concrete producer
- Is “cement” content + strength or Permeability related to Durability?
- Does packing (matrix) and adhesion contribute to strength and durability?
- Future is “Tailor Made Concrete” = Tailor made binders
- Could we build the PANTHEON in Rome today using EN 197 & 206?
- CO2 reduction in clinker process is more or less engaged
- WBCSD engagement is sincere
- We can not expect cement industry to assist in less clinker/ m3 concrete since
- Industry is bulk oriented
- Cement is distributed, not sold
- More financial contribution with high quality OPC for less volume
- Produce stable CEM I 62.5 R, CEM II C LL, CEM III C 22.5 etc. please
- Promotion of concrete common target; is there a 2000 year old Pantheon in metal or wood?

Better to change to a Win - Win game!

From Prescriptive to Sustainable Performance Verified Concrete

Healthier for our children

6 pillars for concrete progress
moving from prescription to Performance

① EN 206 Art.5.2.5.3 Equivalent Concrete Performance Concept testing protocol

② Validation instead of Certification of innovations

③ L C S A; Sustainability Index – Concrete (CO_2 key)

④ Quality (FSC type) Label “Pantheon Performance”

⑤ STEBAS (Science, Technology, Ethical Board of Advisors and Supervisors)

⑥ Innovation Insurance more on “Real-Crete”

CONCLUSION

By EDUCATION on all levels,

Recognizing we are in a high tech profession,

Engaging all stakeholders, especially engineers,

Removing barriers to use sustainable concrete

Using new credible + dynamic tools for Performance

We prove that we can reduce

CO_2 < 100/m3 in ¾ of concrete

Thank you for your attention
+ the EC for supporting the
Sustainable Performance Concrete
project www.sustcon.org

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