MAKING MORE CEMENT WITH LESS BINDER: A SUSTAINABLE WAY TO SUPPLY WORLD DEMAND

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SOCIAL EQUITY DEMANDS A 2.5 TIMES INCREASE IN CEMENT PRODUCTION

DEMAND AND IMPACT

Cement production increasing
- Current production: >2.5x10^6 ton cement
- Estimated to 2050: > 5.5x10^6 ton cement

High environmental impact
- 1 kg clinker – 0.8-1 kg CO₂ released
- 2010: clinker >85% of cement composition

CURRENT STRATEGIES TO DECREASE IMPACTS

1. Clinker replacement
   - No availability of fly ash and slag
   - High impact chains

2. Kiln efficiency
   - Limited

3. Alternative fuel
   - Limited
   - Can double cement final price

4. Carbon capture and storage

Without innovation, the environmental impact will intensify

PROPOSAL – INCREASE BINDER USE EFFICIENCY

BI benchmark literature
- > 50 Mpa: minimum BI = 5 kg.m⁻³.Mpa⁻¹
- < 50 Mpa: minimum BI follow standards minimum cement consumption (~260 kg/m³)
- Market: medium BI = 9 kg.m⁻³.Mpa⁻¹

Strategies for achieving efficiency
- Dispersion of fines
- Packing cement paste with engineered inert fillers
- Fillers with technological aggregate value

Designing low BI concretes
- Paste 40% cement (no additions) + 60% inert fillers
- 126.3kg/m³ of binder / 51 Mpa = BI = 2.5 kg.m⁻³.Mpa⁻¹
- Half than best values found in literature (BI = 5)
- No slag, fly ash or other binder
- A cement with less than a half of total binder is feasible!

Much lower CI for same clinker content
- Same level of lowest CI from literature (~2 kg.m⁻³.Mpa⁻¹), but replacing clinker only with fillers – no other “zero emission” binders such as fly ash or slag
- It is possible to reduce by approximately one-half the CO₂ released by the best concretes from literature with the same binder (only clinker) – higher efficiency with engineered fillers

IMPACT VERSUS PERFORMANCE INDICATORS: BINDER INTENSITY (BI) AND CO₂ INTENSITY (CI)

INNOVATIVE SOLUTION – LOWER BINDER CEMENT FOR SUSTAINABILITY TRIPOD

Increasing binder use efficiency in cement
- It is possible to make cement (and so concrete) with double of binder efficiency...

REPLACING CLINKER BY HIGH QUALITY FILLERS – LARGE WORLD AVAILABILITY

Consequences:
- IT IS POSSIBLE TO PRODUCE TWICE AS MUCH CEMENT WITH THE SAME AMOUNT OF CLINKER
- CO₂ EMISSIONS WOULD NOT INCREASE EVEN WHEN DOUBLING CEMENT PRODUCTION
- CHEAPER CEMENT

SOCIAL
- Increase production for supplying developing countries demand
- Global warming
- Less kilns
- More mills

ECONOMICAL
- Cheaper in medium term

ENVIRONMENTAL

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[Diagram showing social, economical, and environmental aspects of the innovative solution]