

Do cement and concrete have a future? A global perspective

Vanderley M John Copenhagen, 2024

Made in More Sustainable Concrete

Torsdag den 28. november 2024 i Industriens Hus i København





















110 million people 0-



Demand is solid: 1.000.000.000 additional houses

- Housing stock: 1.500.000.000 houses
- Today housing deficit: 400-500 M dwellings (1.6 billion people)
- Future demand : 500 700 M (+ 2 billion people)
- +
 - Infrastructure
 - Extreme climatic events
 - Maintenance & replacement

https://worldpoverty.io/

B. Rajagopal <u>Special Rapporteur on adequate housing.</u> UN General Assembly 2023





Social sustainability will demand more building materials



Image credit: Unsplash / Ritchie Valens

Team Principles Careers Contact Us



We turn plastic waste into lowcarbon buildings

At Kubik, we have a technology that helps countries reduce their carbon and plastic footprint - all while making safe, durable, and affordable buildings that everyone can enjoy.

Learn More



Wood: material of the moment

Mjøstårnet The Tower of Lake Mjøsa, Norway 2019

Voll Arkitekter





Book on Affordable Housing







Alice Palmer

Alice Palmer, MBA, PhD writes about how people impact science, and how science impacts people. Follow her at Sustainable Forests, Resilient Industry.

Forest research and skyrocketing lumber prices: what's the connection?

May 21, 2021 | 4 minute read

A few years ago, I went to my local hardware store and bought a basic 8-foot long "two-by-four" stud to use in a teaching demo. It cost about \$2.50 in Canadian dollars. As I write this article, that same piece of wood is listed online for \$8.59. Yikes! Unprecedented prices like these are currently adding a whopping \$30,000 to the cost of a new 2,500 sq.





Lumber supply is slow to respond to demand

- ~15 years to grow commercial Eucalyptus & pine (Brazil)
- ~ 50-100 years hardwood (Tropics) & conifers cold regions
- Global demand for timber is expected to grow 4x 2050
- 2002 to 2021, US area primary forest decreased by 0.7% (Global Forrest Watch)







Wood Is Not the Climate-friendly Building Material Some Claim it to Be

July 20, 2023 By Tim Searchinger, Liqing Peng, Richard Waite and Jessica Zionts Cover Image by: TFoxFoto/Shutterstock





Wood is not a carbon neutral.

- 1) Most wood (and its stored carbon) is **lost during production**
- 2) Harvesting and processing wood is not carbon-neutral.
- 3) Using wood in construction will most likely increase climate warming for decades.
- 4) Mass timber would have large adverse effects on the world's forests.





Climate change will make wood even scarcer

- Droughts
- Catastrophic wildfires
- Climate effect on Growth and yield
- Deseases (e.g. Canadian Mountain pine beetles)
- Wildlife protection





Mineral binders will still be needed and ceramic, metals, plastics......



















Qualquer forma

























World's Cement per capita consumption







Cement Portland: social inclusive technology

- Abundant raw materials
- Durable, low maintenance, construction
- Concrete: 85% is locally extracted materials
- Low cost
- Low-knowledge barrier.













Bagged cement: 50% of the market a solution of the poor



cement is most needed on markets were bagged cement dominates



World is changing. Fast. And the changes will affect cement market







In many developing countries it is already shrinking



Cics


Temperature change in Brazil since 1911







Outdoor construction more uncertain GaonConnection

YOUR CONNECTION WITH RURAL INDIA

June 27, 2024 Home	e Reportage	Positive Stories	By Invitation	The Slow Interview	Gaon Connection Survey	India's Biggest Rural Media Platform	Q
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Rising heat causing labour losses; 162 lost hours per person per year in India, finds a study

A new study shows India is amongst the most affected countries showing the largest heat exposure impacts on heavy labour, mostly agricultural and construction workers. Midday heat exposure causes productivity losses of upto 20 minutes an hour in the country. Is moving heavy labour to the early morning hours an alternative?



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https://en.gaonconnection.com/global-warming-climate-change-heat-labour-work-health-agriculture-delhi-environment



Carbon pricing will rise all over the world

Carbon pricing instruments around the world, 2024

Cics

Map shows jurisdictions that have implemented Direct Carbon Pricing Instruments - Compliance instruments (Emissions Trading Systems (ETS) and Carbon taxes) and/or domestic carbon crediting mechanisms, subject to any filters applied. The year can be adjusted using the slider below the map.







Cement cost will rise f(clinker fraction)



Carbon tax Carbon Capture and Storage Cost Clean energy cost





Cement is more vulnerable to carbon cost

 Steel
 <15%</td>

 Ceramic
 < 5%</td>

 Gypsum
 < 5%</td>

 Wood
 .../

Portland Cement demand will reduced Roadmap GCCA 2021





The size of cement market shrinkage will be defined by the industry





How much can we dematerialize reinforced concrete structures by improving design?



54 Brazilian High-Rise Residential Buildings Beam and Column reinforced concrete structure Prof. Ricardo França (Poli USP, França & Associados)



Design optimization & urban regulation





Belizario-Silva et al. 2024





If low-clinker cement were fast hardening for ready-mix concrete.....



Belizario-Silva et al. 2024





Carbon mitigation by Benchmarking-driven interative design





Fernanda M Kemeid (~2008)

How much cement is really needed to make concrete?

Binder use in conventional concrete Data from 29 countries



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Daminelli et al. 2010



+90% CO2 is in the binder.....





Daminelli et al. 2010



Dispersants Admixtures: for experts only

- Paste volume limits for normal strength concrete
- Up to 20% cement reduction
- Compatibility with cement
- Not an option for bagged cement







Fillers: a must for low-carbon concretes & mortars multiplying the mitigation potential of dispersants

- Water reduction without reducing paste volume
- Super-low carbon (grinding only)
- More complex technology
- Require strict control of water content
- Cheaper than any other option



John et al. 2018





Paste Packaging for flowability (Filer + Dispersant + Minimum binders)



Cics

(Filler interground, no dispersion)



(Filer + Dispersant): Content of fine particles increase







Packing for flowability of paste and aggregates



Cics Dohn et al. Review accepted by Cement and Concrete Research



Packing for flowability of paste and aggregates



John et. All Fillers in cementitious materials - Experience, recent advances and future potential 2018 DOI: 10.1016/J.CEMCONRES.2017.09.013



hubic

Packing for flowability: multi-modal controlled PSD









Separate grinding is the future

- Intergrinding is inefficient (most of the time)
- **Reactive particles**: finely grinded to ensure 100% reaction at 28 d
- Fillers fractions: complete optimum PSD minimizing water
- Performance specified.





Separate griding no (or some) product storage



Continuous (Coriolis) Mixer





Practical Application CICS livingLAB







E. Ma



Industrial Application

• Continuous flight auger (CFA) piles

InterCement

- 180m³ Concrete Used
- Built-in geothermal energy
- 12m steel cage

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• Self-compacting concrete





Less water, less cement, less CO2 No change on aggregates





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How about durability of reinforced concrete?

- 50% of cement is not used in reinforced concrete
- Most reinforced concrete is (or can easily be) protected
 - Painted
 - Indoors permanently dry
- Reinforcements can made corrosion resistant





Low water, low Binder: low shrinkage







And for reinforced concrete exposed to moisture and chlorides

<u>Home</u> > <u>Materials and Structures</u> > Article

Minimum cement content requirements: a must or a myth?

Original Article | Published: 25 October 2008

Volume 42, pages 973–982, (2009) <u>Cite this article</u>







Materials and Structures

Aims and scope \rightarrow

Submit manuscript \rightarrow

There is no reason to increase buildings design life

What is the fraction of buildings that are demolished due to the low durability of concrete structures?

1000 B.C. 110 million people



Minimum carbon concrete = maximum filler. Degree of success of deploying filler technology will decide the size of the cement business

How much is the minimum? Refractory Castable Binder Content Evolution

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Traço de Concreto mais USADO na OBRA em PILARES e VIGAS!!

The challenge: bagged cement market and its universal mix proportion
How to migrate embodied CO2 and improve the quality of life of the poorest?



Brazilian pre-competitive project New cement, filler + admixtures

- Low CO2 footprint < 400 kg/t
- Competitive cost
- High initial strength







How about new cements? contribution limited by market share



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Steel rebar traditional 500MPa







Steel rebar innovation 700MPa







a solution

design construction products to use less material and labour.

up to 70% CO2 reduction up to 50% material cost reduction

CO2 capture during cure & use







a solution

design construction products to use less material and labour.

up to 70% CO2 reduction up to 50% material cost reduction

Conclusions

- Demand is solid: +1 billion new houses and Infrastructure
- Future of cement depends on industry's ability to scale up low-carbon, low-cost, simple new solutions
- Durability cannot be an excuse to inaction: there are options.





Conclusions II

- Fillers, dispersants, packing for flowability
 - Low-cost mitigation
 - Work with any binder (calcined clay included, geopolymer....)
 - Can stabilize cement market size
- Aggregates production must evolve
- Filler and low-water demand may increase cement market
- The technology is not mature yet.





The real challenge is a innovative solution for the bagged cement market.





Thank you!

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