



bringing materials to *life*

# Best Practical Case Studies : Building & Innovation

Bertrand Collomb

Honorary Chairman of LAFARGE, Governing Board Member of EIT

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## Why innovation and why now ?

- The current crisis requires visionary innovation to address the world's challenges : energy, climate change, health and security issues, bio-sciences and bio-diversity...we need to prepare ourselves to a new **sustainable world**, beyond short-term adjustments.
- Innovation is both a way to help restart the economy, and a way to make it different (ex. "green" cars or buildings).
- Innovation is as much a matter of mindset as a matter of scientific and technological knowledge. It can come in incremental ways or in step-changes. It can be directed by market needs or by a visionary approach.
- We need to revisit the role of markets, financial incentives, and standards ; some innovation objectives will not be dictated by the market, but by political and/or environmental objectives (ex. CO2 emission quotas, prescriptive performance standards for concrete)

# Lafarge : a world leader in construction materials

- Sustainable construction is one of Lafarge's top priorities.
  - Cement and concrete
    - Energy efficiency
    - CO2 and other GHG reduction
    - Durability
    - Recycling
    - Noise-free use
    - Building methods
  - Gypsum and plasterboards
    - Water reduction in drying process
    - Acoustic performance
    - Ease of use, lightweight boards
- A few illustrative examples of innovation in **concrete**, respecting sustainable construction challenges, will be presented.

# Why is concrete the 2<sup>nd</sup>, after water, mostly used product in the world ?

- Intrinsic qualities of concrete
  - Mechanical performance
  - Durability
  - Thermal inertia
  - Acoustic values
  - Fire resistance
  - Health risk-free
  - Easy to use
  
- Extrinsic qualities of concrete
  - Incontrovertible, everlasting social value
  - Excellent “Value/Price” ratio
  - Wide polyvalence : worldwide accessibility, applications
  - Standardized performance
  - Sustainability and environmental value

# Major Lafarge innovations over the past 15 years in concrete

**DUCTAL®** : no-rebars, mechanical performance, durability, aesthetics, self-healing, environmental performance

**AGILIA®** : self-flowing and self-compacting, no vibration required in placing

**ARTEVIA®** : a range of decorative concretes

**EXTENSIA®** : crack-free over large surfaces (20mx20m)

**CHRONOLIA®** : adjustable, rapid set Ready Mix Concrete (4hr formworks removal)

**SENSIUM®** : dust-free cements and mortars, perf. OPC like

**THERMEDIA® 0.6 B** : insulation concrete, reduces thermal conductivity factor by 3

**AETHER®** : cement with reduced (by ~25%) CO2 content, requiring 15% less energy to produce

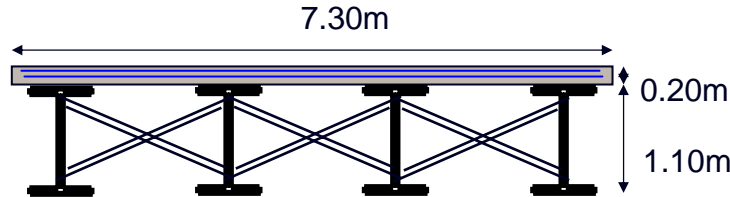
# Concrete answers sustainable construction challenges



## Environment and natural resources

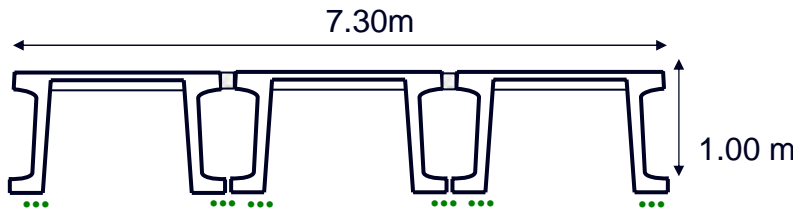
- Concrete production is less energy intensive than other construction materials
  - Steel 43 MJ/kg (when produced from RM)
  - Wood 27 MJ/kg
  - Brick 3 MJ/kg
  - Concrete <1 MJ/kg
- Carbon content of concrete is low
  - Steel 1-2 t CO<sub>2</sub>/t
  - Brick 0.2 t CO<sub>2</sub>/t
  - Concrete <0.1 t CO<sub>2</sub>/t
  - Wood -1 t CO<sub>2</sub>/t
- Concrete can be fully recyclable ; aggregate recovery is frequent
- Concrete can be made from recyclable materials
- Concrete can be produced everywhere

## Illustration: LCA of a standard bridge vs. a Ductal<sup>®</sup> bridge. Reduced environmental impact



Standard steel-concrete bridge

Double-lane, 30m span



DUCTAL<sup>®</sup> « Pi » shape bridge  
– developed in collaboration  
with FHWA and MIT

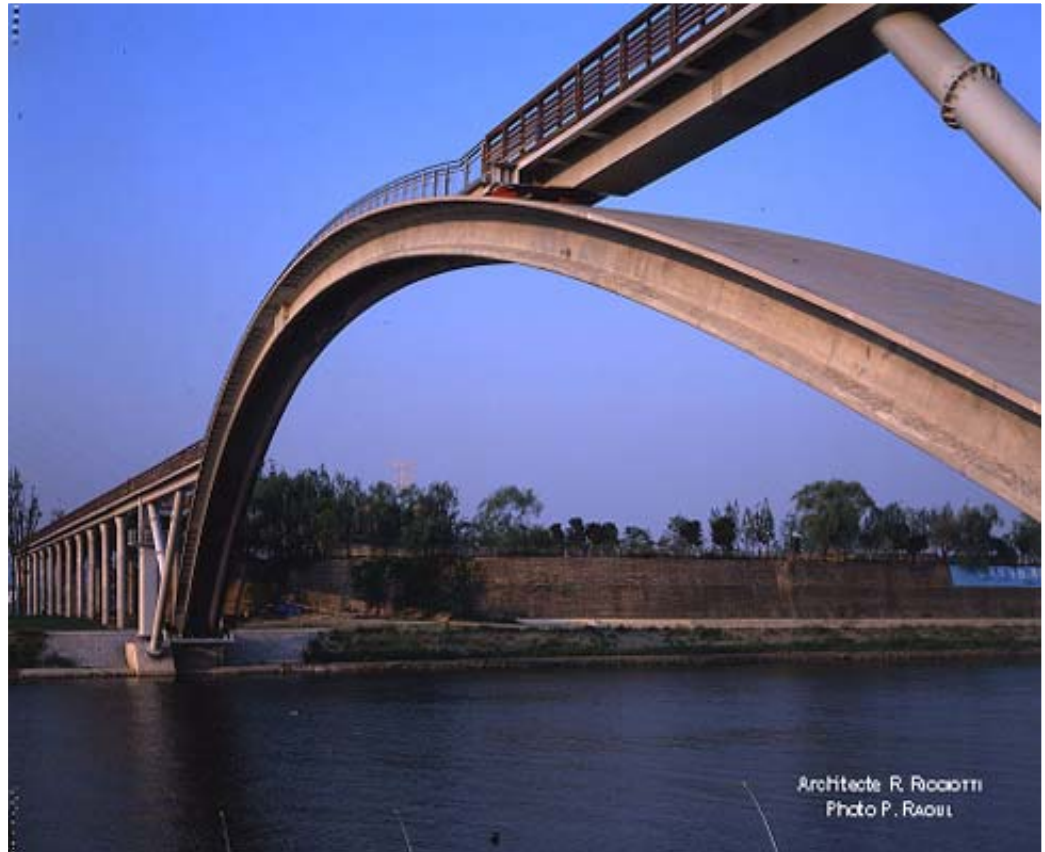
### DUCTAL<sup>®</sup> bridge vs. Standard steel-concrete bridge

- **35%** saving in raw materials
- **46%** saving in primary energy
- **53%** saving in CO<sub>2</sub> emissions

## 2003: Seonyu Footbridge in Ductal® (Seoul, Korea), architect : Rudy Ricciotti



**Arch span**                      **120 m**  
**Deck thickness**            **30 mm**



## Health and safety protection provided by concrete

- Concrete is a health risk-free construction product (ex. water resources management)
- Its fire resistance exceeds that of other construction materials
- Concrete can be designed to efficiently resist seismic tremors, hurricanes and other natural catastrophes



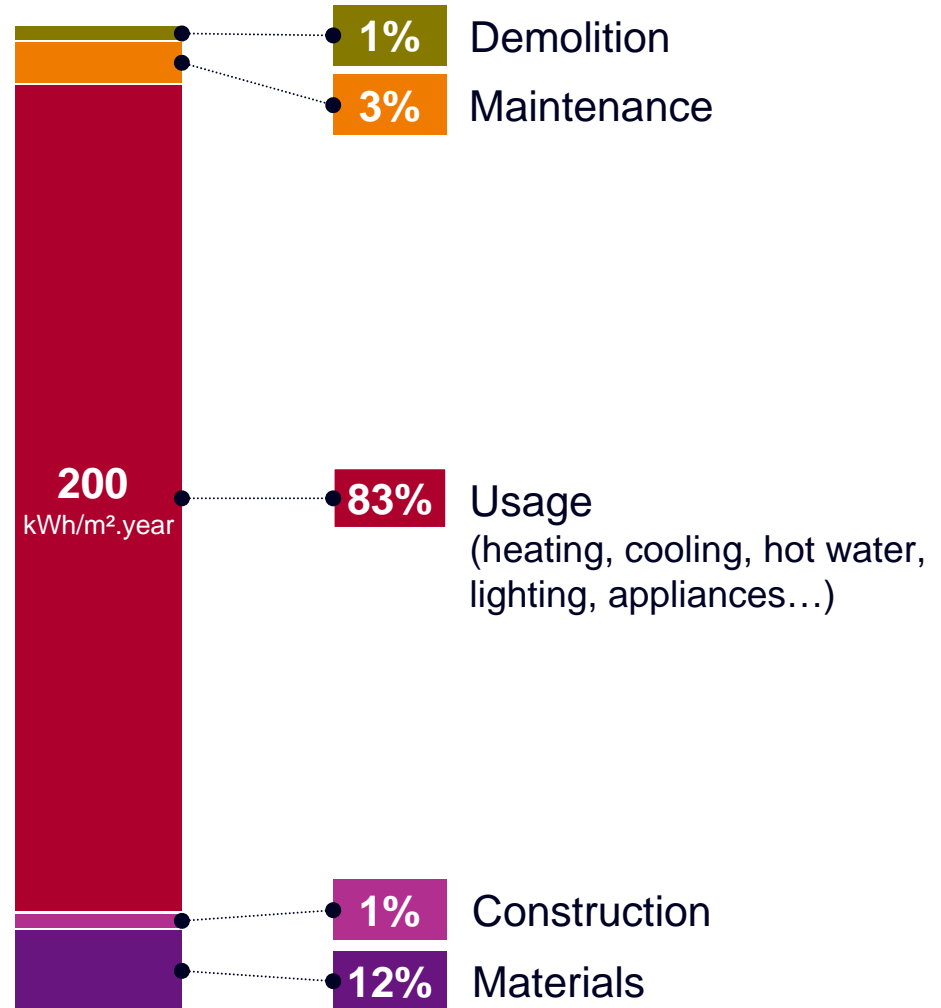
## Illustration: fire resistance of a footbridge in DUCTAL<sup>®</sup>



A normalized 2 hour test...

# Focus on energy efficiency: energy balance in a building's life cycle over 50 years

Basis: multi-family dwelling



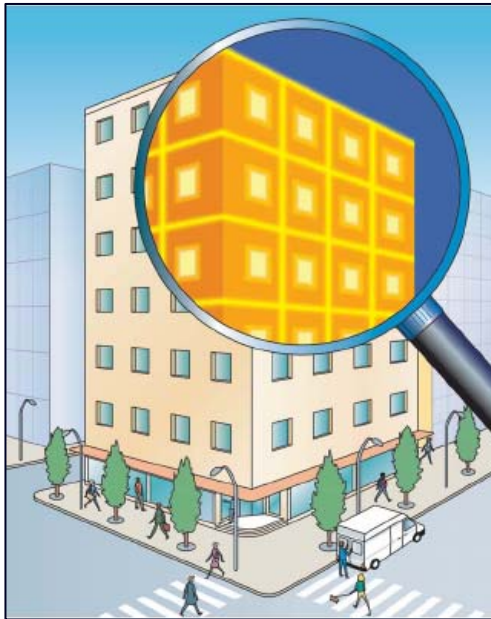
Today's ambition :  
Reduction to 50 kWh/m2/year ←

## Innovation must address the different parts

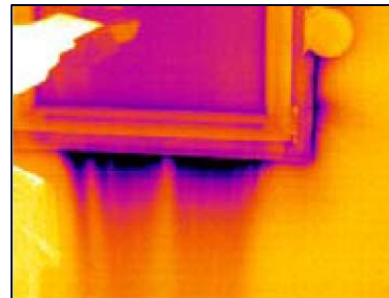
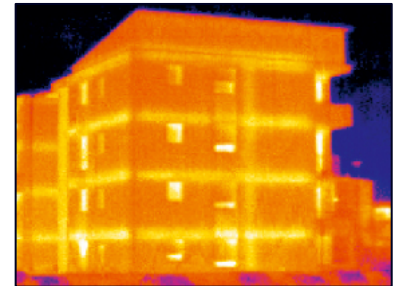
- Most important: reduce CO<sup>2</sup> from building usage
  - optimization of use of products
  - new products/systems
  
- Also: continuous improvement of CO<sup>2</sup> impact of material:
  - A 20% reduction of CO<sup>2</sup> emission per ton of cement between 1990 and 2010
  - A new target for 2020
  
- Breakthrough on the material itself
  - Reduce or eliminate CO<sub>3</sub>Ca ??

## Thermal losses in buildings

- In a classical building, structural envelopes are not particularly designed to avoid thermal conduction losses (through thermal bridges)
- Classical insulators are not designed for mechanical and durability performance



Thermal conduction losses

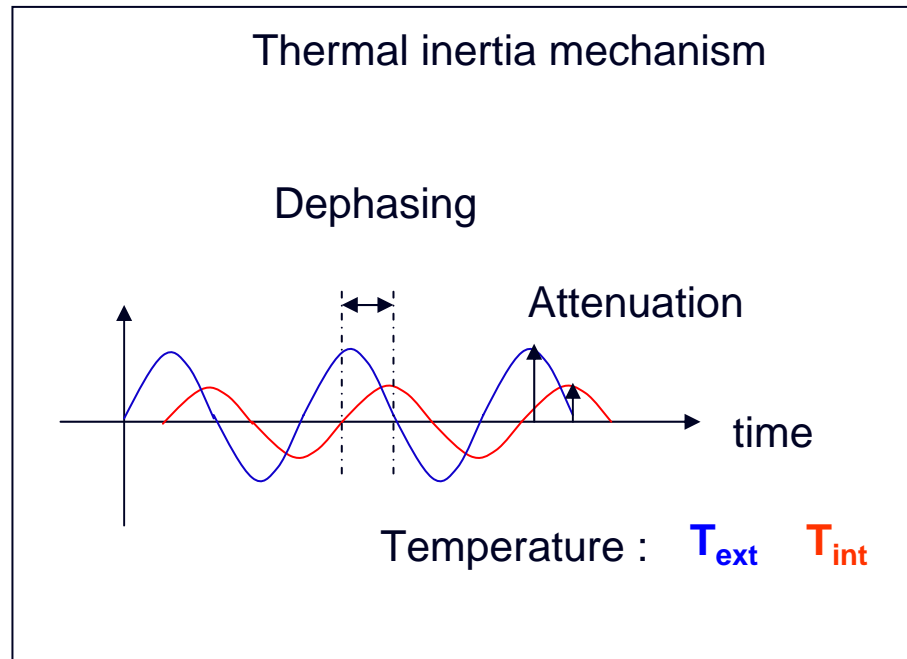


Ventilation and air tightness

Air leakage around the window frame by thermographs

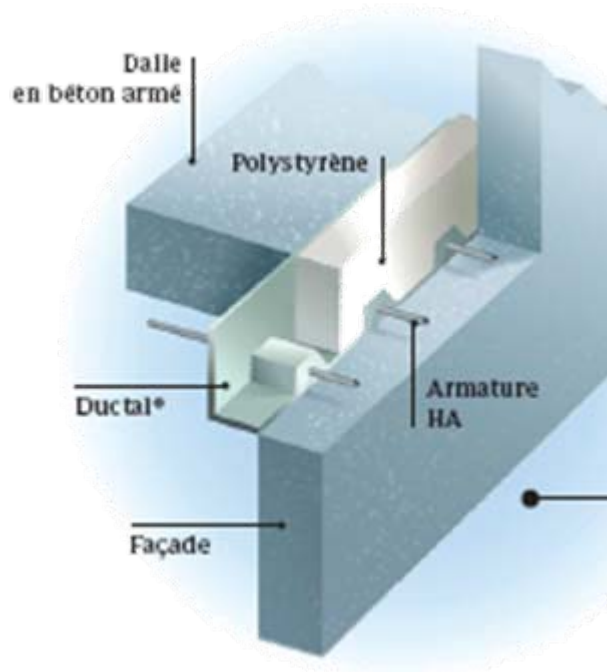
## Concrete's contribution to thermal comfort

- Standard concrete exhibits a helpful thermal inertia and a low thermal conductivity (1.7 W/m°K vs. 60 W/m°K for steel)



## High performance structural envelopes in buildings should...

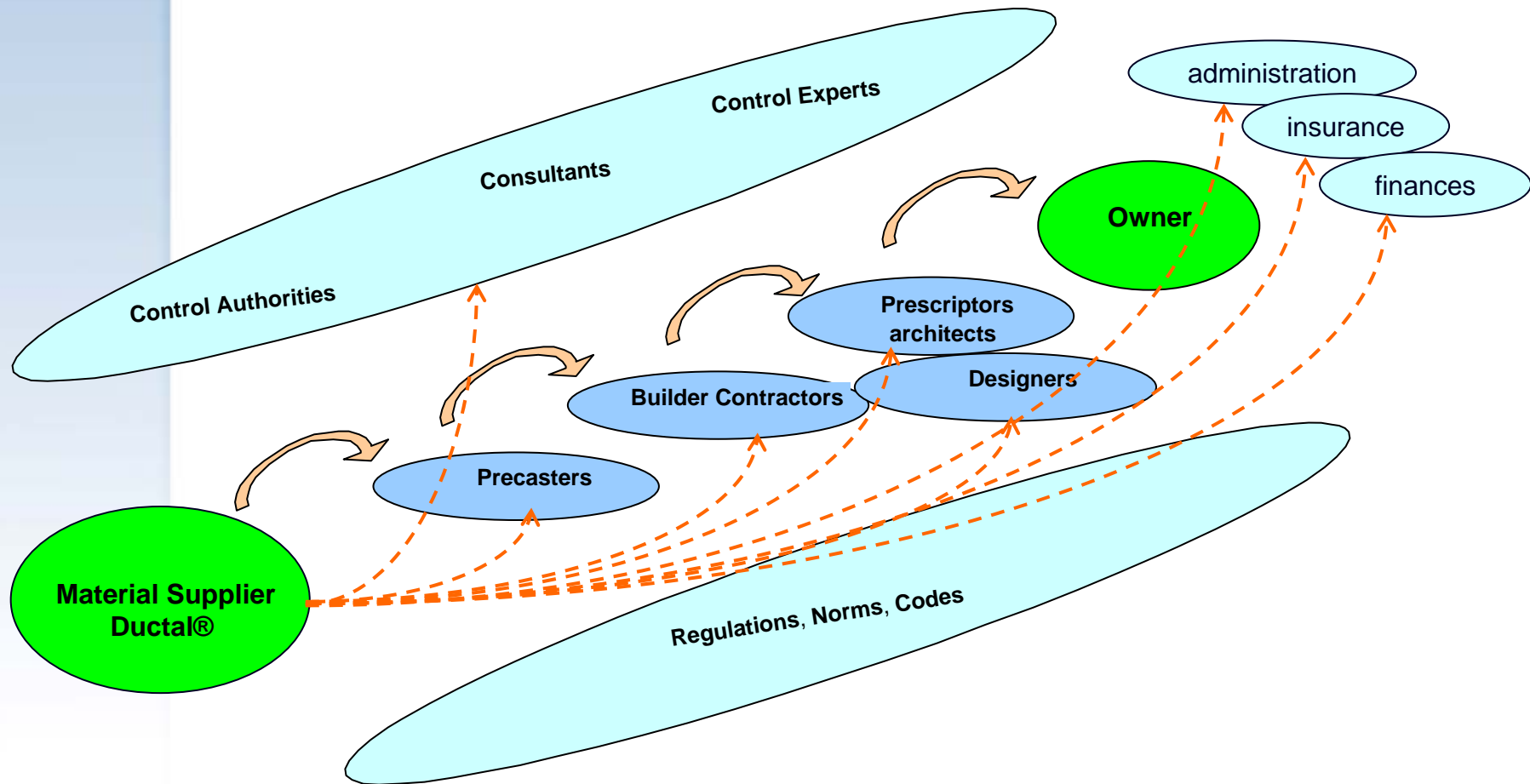
- Minimize thermal bridges and thus thermal conduction losses
- Be air tight



RUPTAL<sup>®</sup>, a Contact Breaker  
in DUCTAL<sup>®</sup>, improves  
thermal bridge losses by 70%

- Lafarge has recently introduced THERMEDIA<sup>®</sup> insulating concrete, reducing thermal conductivity by a factor of 3

# Innovation in construction materials is complex and involves a chain of external development actors



## Using standards, incentives or prices

- Example of the 1974 oil shock: the cement standard in France and the US
- How to align incentives between owner and tenant
- A single CO<sup>2</sup> price across the board: an appealing economic concept but a slow impact

## Breakthrough ideas: the example of micro-algae

- Growing micro-algae to absorb CO<sup>2</sup> emitted by the kiln, and reuse them as biofuel
- A partnership with Salata, a German company specialized in cultivating micro-algae
- A pilot PhotoBioReactor installed in a plant near Lyon in 2009
- The process works but needs to be improved

## A new product: Aether instead of Portland cement

- New chemistry of raw material (30% of limestone replaced by sulfo-aluminates)
- Lower heating temperature
- Similar manufacturing process, but energy saving of 15%
- Similar mechanical, rheological and durability performance
- 25% reduction in CO<sub>2</sub> emissions

## Conclusion

- Resistance to change by existing organizations/businesses is the main obstacle to innovation.
- Often, innovation and entrepreneurship go together. Entrepreneurship can flourish only if there is a reward for success but real entrepreneurship is not driven by the expectation of short-term financial gains.
- Networks and partnerships will be more than ever the key to success.
- Overall, the current crisis creates a need and an opportunity for more innovation. Europe should face the challenge.
- The EIT launching is an excellent opportunity for Europe and Euro-CASE, through its large competencies and networks, can efficiently contribute to its success.