Future Concrete Solutions for Sustainable Construction

Future Concrete 2015, Dbayeh, Lebanon
Purpose of today’s presentation

Describe

• What are global and local drivers for sustainable construction?

• What are the resulting customer needs?

• How to deliver on those needs?

NOT

• Come up with one-size-fits-all-answers
Who we are
One of the world’s leading suppliers of Cement, aggregates and ready-mix concrete
History shows earliest engagement in the Middle East

- **1912**: Holcim was founded in 1912 in the village of Holderbank, Canton Aargau, Switzerland.
- **1920-1945**: investments in cement companies in Europe, Egypt, Lebanon and South Africa.
- **1945-1960s**: development of holdings network in North and Latin America.
- **1970-1990s**: continued expansion in Asia-Pacific emerging markets and Central & Eastern Europe. Greater focus on aggregates and ready-mixed concrete production.
- **2001**: The name of the Group was changed from “Holderbank” to Holcim.
Success is based on a global network of good people

- Some 68,000 people in around 70 markets and ~1,500 operations
- Business success depends on the working environment:
  - Multicultural management teams
  - Local management and global standards
  - Performance and rewards culture
  - Best practice and experience multiplication
  - Skilled and motivated workforce
  - Continuous training and development
The Situation
The trend for sustainability in general is a function of energy price and climate change – true since ~2000
Pressure comes from society, and it is affecting corporate governance

Porsche building climate bastards

Source: Greenpeace campaign blaming Porsche for lamentable SUV's mileage
Pressure comes from the tenants’ side, Pressure comes from the developers and building owners

Starbucks only renting LEED® certified stores
Pressure comes from pure, basic needs
Urbanization, resource scarcity, climate disasters

By 2050, about 70% of the global population will be living in cities.
(World Bank)

Source: Michael F. Ashby, Materials and the Environment;
Global population growth over the last 2’000 years
Needs
The 3rd Holcim Forum issued the Mexico City Manifesto, a distinct definition of sustainable construction

- Maximize renewable resources: ‘Zero fossil energy’
- Maximum environmental restoration: ‘Zero emissions’
- Maximize recycling: ‘Zero waste’

One could add:
- Minimize water consumption: ‘Zero water’
- Maximize safety: ‘Zero risk’

Signatories of the ‘2010 Mexico City Manifesto’:
- Sheila Kennedy
- Hansjürg Leibundgut
- Forrest Meggers
- Mengho Qin
- Mike Schlaich
- Masanori Shukuya
- Werner Sobek
… will require integrated thinking on multiple levels, in various life cycles – adapted to different regions

- **Smart buildings**
  - Efficiency & flexibility
  - Health and safety
  - Energy consumption

- **Smart materials**
  - Resource efficiency
  - Cradle to cradle
  - Multiple use & hybrid construction

- **Smart cities**
  - Value creation
  - Wellbeing & safety
  - Mobility & utilities
  - Resiliency
  - Resources management
For the concrete business the needs synthesize on the levels of materials, products and integrated solutions

Municipalities
Neighbors
Employees

Responsible Sourcing

Upstream

Material

Contractors
Engineers
Users

Performance & Efficiency

Future Concrete, 2015-06-11

Idea: Ian Cox, Aggregate Industries
Solutions
1. Climate protection
On the material level carbon emissions and resource consumption are our main drivers

Sources of Green House Gas emissions

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Cement Industry</td>
<td>6%</td>
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Direct and indirect sources; excluding emissions from forestry and agriculture, Source: IPCC

Examples of Holcim MIC (Mineral Components) products
The beauty of slag concrete are its performance features, which come along with significant environmental benefits.

Mass and durable concrete

- Gotthard base tunnel: 57 km, CH, CEM III/B in areas of sulfate attack
- Beirut Sea Port, Lebanon: 120,000 m³ Slag Cement Concrete
- The Shard, London, UK: Tallest in Europe, height of 310m, 70% ggbsfs in foundation

High performance concrete

- Rio Antirio, GR: CEM II/B-M, CEM III/A
- Strength, Durability

Architectural, Arts

- Statue „Beethoven” Bonn, GER: CEM III/A
- Statues: bright

Future Concrete, 2015-06-11
Holcim has always led the effort to reduce emission and remains the most CO₂ efficient company in the sector.
2. Resource efficiency
Public perception:
Sand is an almost unlimited natural resource… really?
Sand in fact has become a scarce resource and a billion $ business!

- Sand is the most used natural resource after water. The annual consumption is around 40 billion tons
- Most sand is used for construction
  - Concrete (~800 kg/m$^3$), annual consumption ~30 billion tons
  - Land reclamation
- Trading volume around 70 billion $ per year
- In some areas of the world no sand suitable for construction is remaining (e.g. Singapore, Dubai)

One family house

Highway (1 km)

Burj Khalifa (Dubai)

The World (Dubai)

200 t

30’000 t

257’000 t

300’000‘000 t

Imported from Australia!
The consequences of sand scarcity are manifold for both: Economy and ecology

- Extensive sand dredging on sea floors
  - Erosion of coast line
  - Disappearance and whole islands (e.g. Indonesia)
  - Massive disturbance for marine ecosystem

- Price increase
  - Business risk
  - Allows higher cost solutions for fine aggregates (e.g. substitution, import)

- Illegal activities
  - Uncontrolled sand mining and dredging (e.g. Morocco)
  - “Sand mafia” (e.g. Singapore, India) because of very profitable business
  - Because of illegal sand dredging, in Mumbai it has been prohibited to mine natural sand (needs to be replaced by 100%)

- Challenge for concrete technology
  - More complex mix designs required (higher cement content, admixtures etc.)
  - Issues with product consistency (quality control is key!)
Natural sand has many faces…
…and some are quite useless for concrete production

Glacial

River

Marine

Dune

…and therefore many different properties!

Pictures by K. Ramseyer (Uni Bern) and B. Hofmann (Natural History Museum, Bern)
M-Sand: The solution lies in the use of manufactured sand
The challenge: different characteristics than natural sand

Characterization of crushed sand properties is crucial since it has a major impact on concrete performance!
Holcim has developed a tool set to assess M-Sand properties and their impact on concrete performance

- Gradation
  - Fineness modulus
  - Amount of fines <150µm (Mesh #100)

- Grain shape
  - Flakiness and roughness of grains

- Clay contamination
  - Increase of water demand
  - Admixture incompatibility (mainly PCE)

Standard tests

ASTM C136-05
EN 9330-1, 2

Holcim MeToo box (Measurement Tools) as an application oriented product testing
HTEC Manufactured-sand quality assessment method: Decision tree approach

1. HolcimBlu™
   - High value
     - Negative impact on workability
     - Select admixtures carefully
   - Low value

2. HolcimShape™
   - Difficult shape
     - Blend with other sand
     - Improve shape
   - Good shape

3. Fineness Modulus (FM)
   - Lower FM
     - Good range of fines
   - Higher FM
     - Good range of fines

4. Fines <150 µm
   - Too much fines
     - Blend with other sand
     - Fines correction
   - Not enough fines
     - Blend with other sand
     - Fines correction

Good performance expected
3. Operational excellence
Overall the single biggest lever for efficiency increase are buildings, and here their operational phase.

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ATMI University Building in Jakarta, Indonesia
Indoor climate solutions: The principle of thermal comfort helps to save energy

Temperature we feel
- Is the operative temperature
- Is the average between the radiation temperature and the (convective) air temperature:
  - Air temperature 26°C
  - Radiant temperature 20°C
  - Operative temperature 23°C
Thermal activation and the use of thermal mass can significantly improve a building's energy efficiency

- Takes advantage of a material’s property ‘for free’
- Works even better with night cooling systems

Stabilising effect of thermal mass on internal temperature

- Significant reduction between peak external and internal temperature
- Internal temperatures with high thermal mass
- Internal temperatures with low thermal mass
- External temperatures

Day | Night | Day
Indoor Climate Solution

What is it about?
• Thermal activation of concrete structures (concrete cooling)

Why a sustainable solution?
• Better indoor air quality ➞ Higher office productivity
• Reduced life cycle costs
  ▶ Energy (– 50%)
  ▶ Maintenance
• Lower CO₂ footprint (– 50%)
  ≈ 1’500 cars*

Holcim Indonesia ICS®

* for a 30’000 m² GFA office building
To implement a solution like this you need to involve expertise and partners beyond our core competencies.
Forward thinking
We must move from a ‘Less bad-philosophy’ to an ‘Contribute to good-strategy’

Source: © 2014, Steven Beckers, Lateral Thinking Factory @ Holcim CoP for Sustainable Construction, 28.11.2014
“Building in a way that is socially, economically, environmentally, functionally, and aesthetically balanced to meet today's needs and to conserve resources for future generations.”
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<td>Ethical standards and social inclusion</td>
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<td>Resources and environmental performance</td>
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<td>Economic viability and compatibility</td>
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<td>Contextual and aesthetic impact</td>
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Regional Holcim Awards ceremonies 2014
Total of 6,103 Projects

- Toronto, September 18/19, 2014
- Medellín, October 2/3, 2014
- Jakarta, November 13/14, 2014

Total projects: 6,103
Evergreen City – Beirut, Lebanon
Urban pine forest rehabilitation

Holcim Awards Silver 2014 Africa Middle East for a project in Beirut, Lebanon

A rehabilitation plan to develop the park for opening it to the public and promoting it for cultural, social, sports, and environmental activities while maintaining its natural habitats.

Raëd Abillama, Raëd Abillama Architects, Metn, Lebanon
Urban energy recovery and development concept
Waste to Energy – Beirut, Lebanon

Holcim Awards “Next Generation“ 2014
Africa Middle East for a project in Beirut

from left to right:
• Romy El Sayah
• Yara Rahme
• Marylynn Antaki
• Mira Boumatar
• Christina Attiyeh

American University of Beirut (AUB), Lebanon

The project combines a waste-to-energy plant with public facilities and offers a set of sustainable solutions for reactivating the area.
Raëd Abillama and Christina Attiyeh describing sustainability with their own words