

Concrete Durability for 2020 and Beyond

Shea Concrete Products- Technical Engineering Seminar ▪ 8/6/2020

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Outline

1. Introduction
2. Ingredients of Durable Concrete
3. Concrete Made Today for the Future
4. Projects

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Lehigh Hanson – Heidelberg Cement

Lehigh Hanson, Inc. is one of the largest construction materials companies in North America with approximately 550 active operations in the U.S. and Canada.

Approx. 9,400 employees in North America

Lehigh Hanson, Inc. is part of HeidelbergCement, one of the world's largest integrated manufacturers of building materials with leading market positions in aggregates, cement and ready mixed concrete. **The company employs some 58,000 people at more than 3,000 locations in around 60 countries.**

Lehigh Hanson – Heidelberg Cement – Company History

- Lehigh Cement Company
 - Founded in 1897 by several prominent businessmen from Allentown, Pennsylvania
 - In 1977, Lehigh was acquired by HeidelbergCement is now a top supplier of cement and related materials in the U.S. and Canada
- Hanson, plc
 - Hanson Trust was formed in 1964
 - Hanson, plc was acquired by HeidelbergCement in August 2007
 - Lehigh Cement and Hanson, PLC were integrated in 2008
- Essroc
 - Started as Coplay Cement in 1872, the company was the first producer of portland cement in North America.
 - Today, the Lehigh Cement Company, Essroc and the Hanson business in North America are collectively known as Lehigh Hanson, Inc

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Our Business Lines

■ Cementitious

- Gray cement
- Cement distribution terminals
- Ground granulated blast furnace slag (GGBFS)
- White and custom color cement

■ Aggregates and asphalt

- Crushed rock, sand & gravel
- Hot-mix asphalt and construction operations
- Recycling operations
- Various other materials

■ Concrete

- Ready mixed concrete
- Concrete block, pipe and other products

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Glens Falls, NY



Ingredients of Durable Concrete

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Slide 7
Concrete for 2020 and Beyond - Femm Singer

Lehigh Hanson
HEIDELBERGCEMENT Group

The Concrete Industry

- Concrete is the most used man-made product in the world
- World Cement production about 4.5 Billion tons in 2018
 - 2018 estimated 97 Million tons produced in the US
 - In 2018 2.6 Billion tons produced in China



Concrete

Mixture Containing:

- **Cementitious Materials**
- **Aggregates**
- **Water**
- **Admixtures**



THE MANUFACTURING OF CEMENT

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How Do We Make Cement?



Limestone: Quarry



Silica: Sand

Raw
Materials



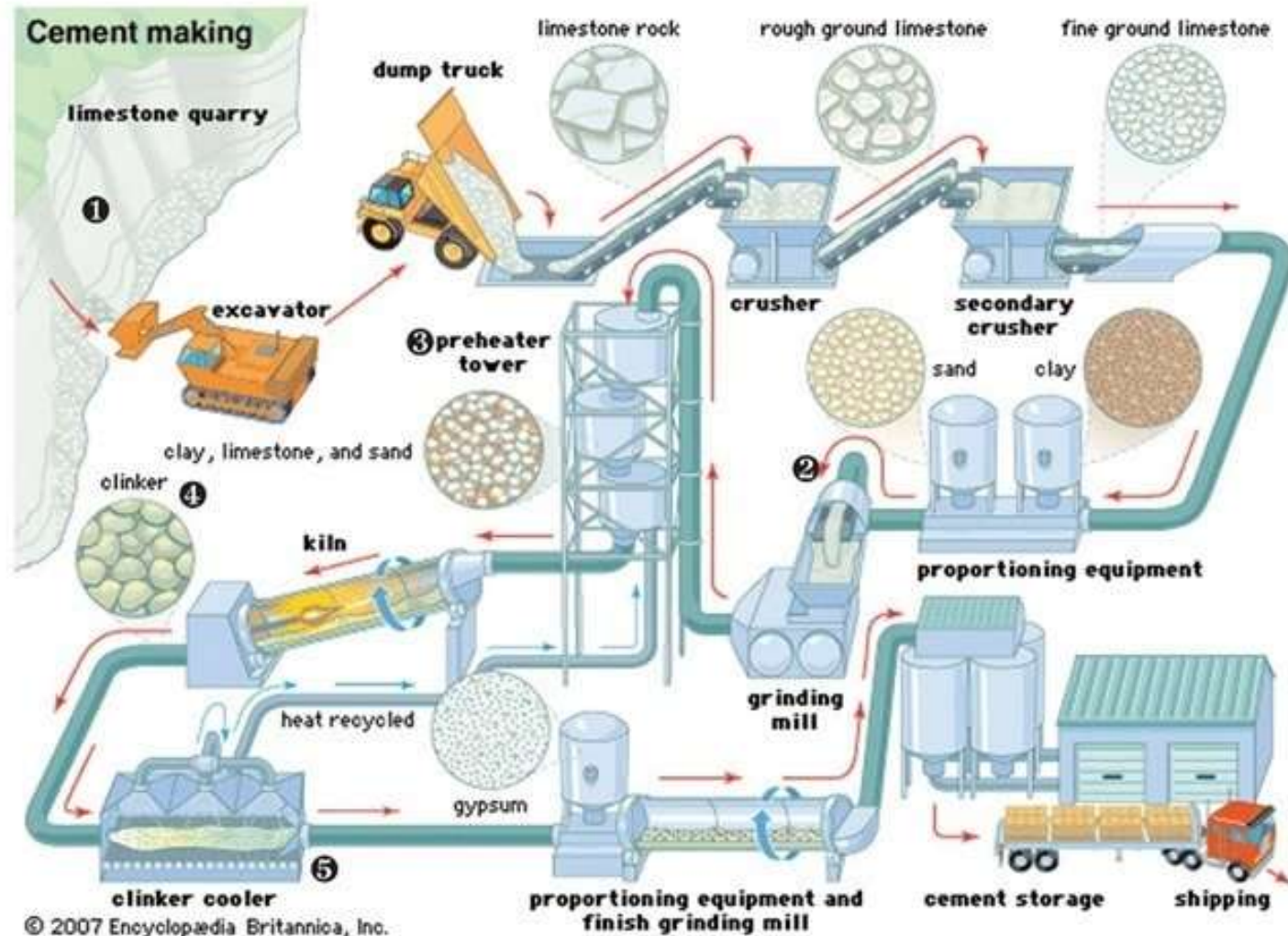
Alumina: Ash



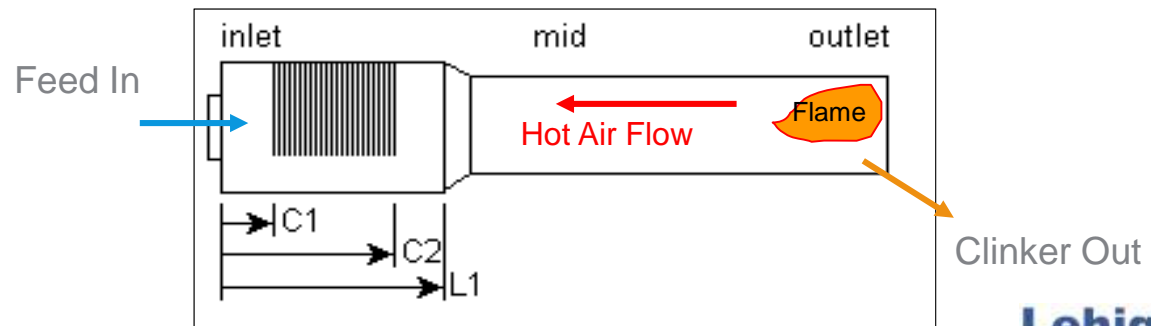
Iron: Steel slag

Cement



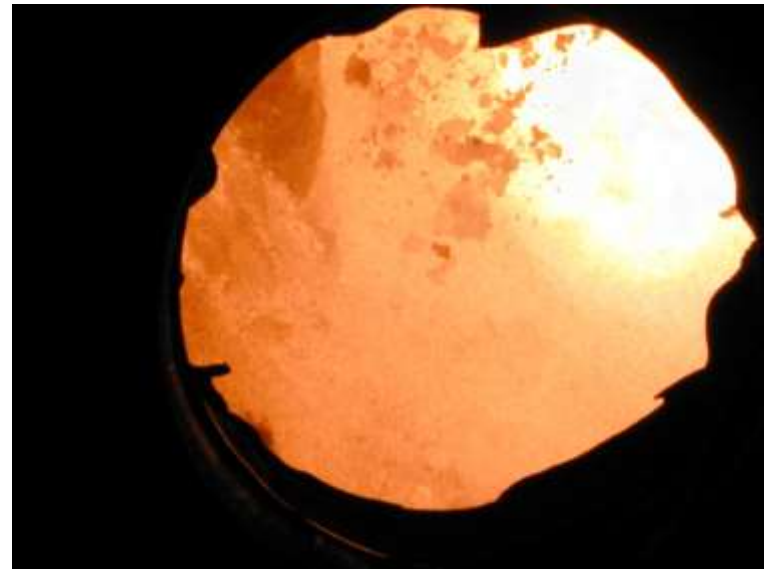
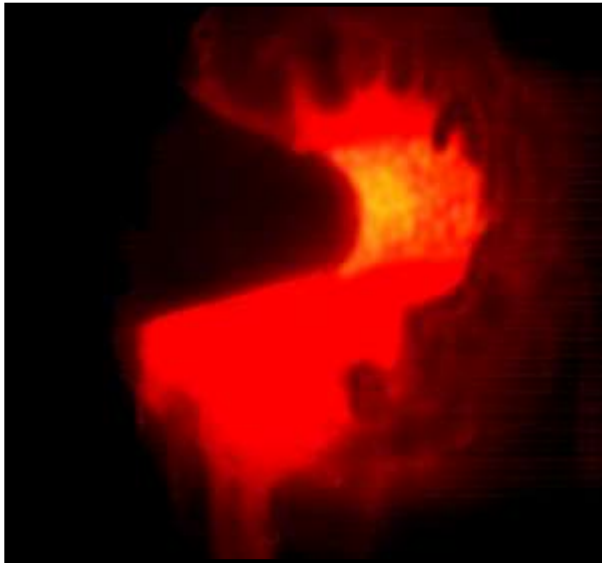


Kiln



Kiln

Flame temperature is 4150 °F/ 2640 °C.



Cement Clinker



Clinker is ground in ball mills to produce the cement



Types of Cement

Portland Cement

ASTM C150 Standard Specification for Portland Cement

- **Type I** **Normal**
- **Type II** **Moderate Sulfate Resistance**
- **Type III** **High Early Strength – Often used in precast**
- **Type IV** **Low Heat of Hydration**
- **Type V** **High Sulfate Resistance**

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Types of Cement

Blended Cements

ASTM C595 - Standard Specification for Blended Hydraulic Cement

- Type IL Portland-Limestone Cement
- Type IS Portland-Slag Cement
- Type IP Portland-Pozzolan Cement
- Type IT Ternary Blended Cement

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Beside Cement.....

Supplementary Cementitious Materials (SCM)

Type of SCM's- Pozzolans and Other Cementitious Materials

- Fly Ash
- Slag Cement
- Silica Fume



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Do As The Romans Do!

Roman Pantheon (ca. 120 AD)



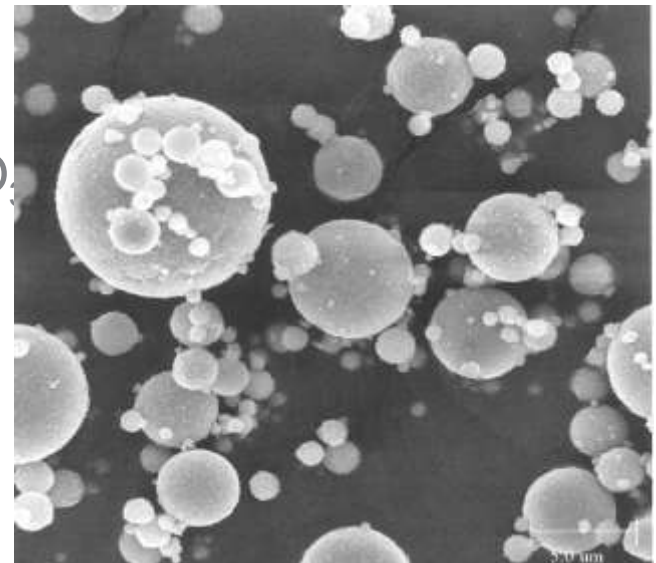
Early SCM's!



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Fly Ash – Class F

- Combustion by-product from coal burning furnace
- Made up of anthracite and bituminous coals
- High percentage of SiO_2 , Al_2O_3 , and Fe_2O_3 (more than 70%)
- Lower percentage of Calcium Oxide
- Amorphous silica combines with Calcium Hydroxide to form CSH
- Concrete with Class F Ash
 - Lower early strength
 - 95% - 105% of the ultimate strength of a straight portland mixture



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Plastic Properties

- Reduced water demand
- Better slump retention
- Enhanced workability
- Easier consolidation
- Improved pumpability
- Good finishability

Hardened Properties

- Improved Compressive Strengths
- Improved Flexural Strengths
- Reduced Permeability
- Improved Corrosion Resistance
- Increased Resistance to Sulfate Attack and Alkali-Silica Reaction

ADD FOR LONGER LASTING DURABLE CONCRETE

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Slag Cement (GGBFS)

- **Definition:** Finely ground granulated material originating from an iron blast furnace and consisting of primarily calcium and aluminum silicates, used as a partial replacement for portland cement in concrete



Plastic Properties

- Reduced water demand
- Better slump retention
- Enhanced workability
- Easier consolidation
- Improved pumpability
- Superior finishability
- Consistent air content

Hardened Properties

- Improved Compressive Strengths
- Improved Flexural Strengths
- Reduced Permeability
- Improved Corrosion Resistance
- Increased Resistance to Sulfate Attack and Alkali-Silica Reaction
- Lower Heat for Mass Concrete
- Increased SRI Value

ADD FOR LONGER LASTING DURABLE CONCRETE

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Silica Fume

- Silica fume is a by-product of the reduction of high purity quartz in an electric arc furnace during the production of silicon metal or ferrosilicon alloys. Silica fume has a very high content of amorphous silicon dioxide and consists of very fine spherical particles.



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Plastic Properties

- Increases water demand
- Lower slump retention
- Easier consolidation
- Decreased pumpability
- Consistent air content

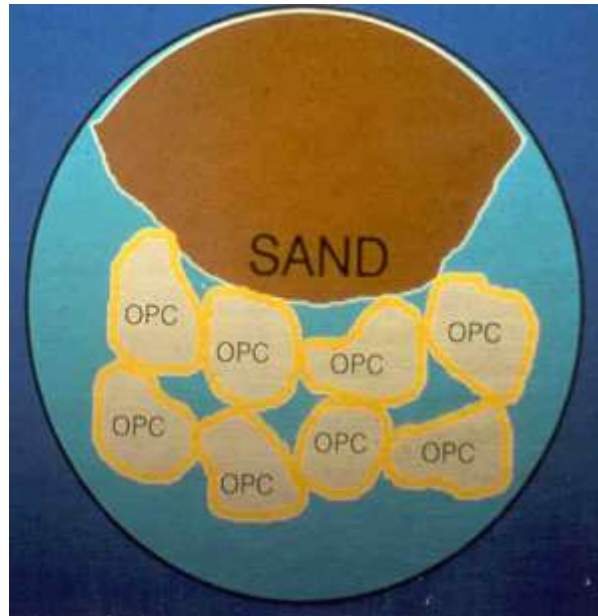
Hardened Properties

- Improved Compressive Strengths
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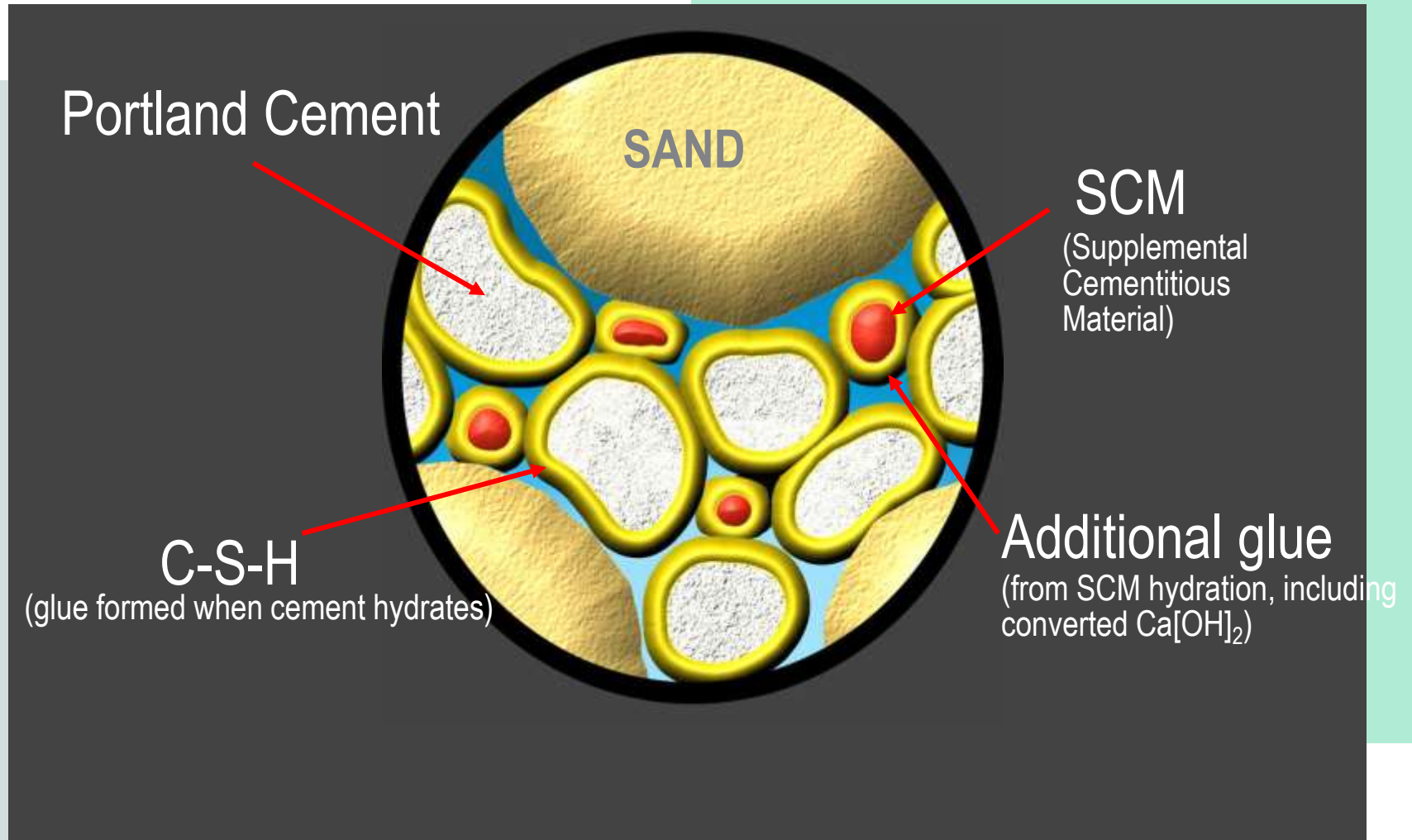
ADD FOR LONGER LASTING DURABLE CONCRETE

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Normal Cement Hydration Process



Hydration with SCM's



Concrete Admixtures

- Air-entraining admixtures
- Water reducing admixtures
- Retarding admixtures
- Accelerating admixtures
- Workability agents
- Waterproofing admixture
- Air-detraining admixture
- Gas forming admixture
- Fibers



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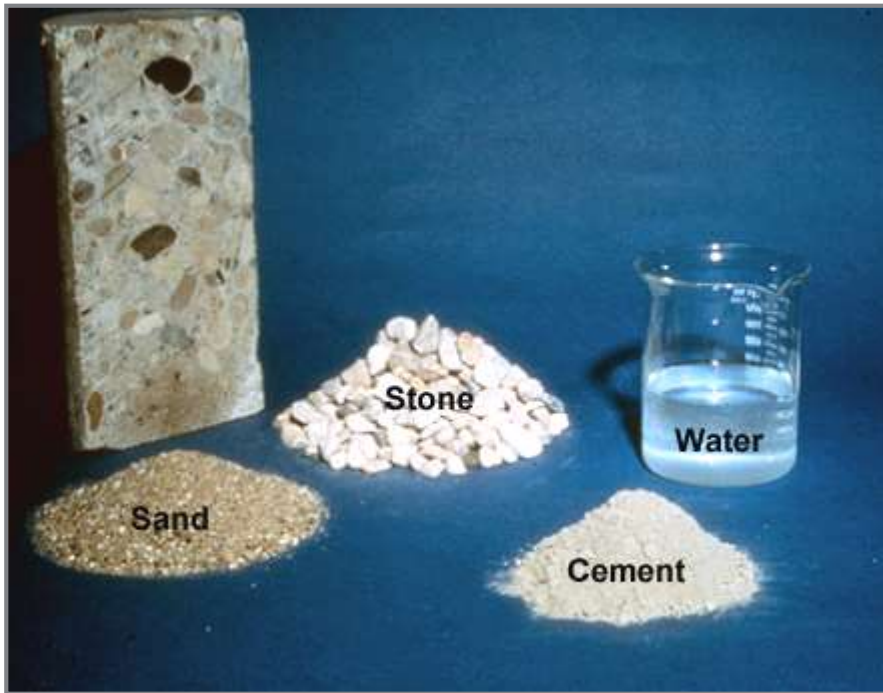
Durable Concrete in 2020

Let's Put It All Together



NPCA Photo

Old School Concrete Mixtures



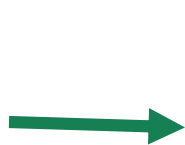
Modern Concrete Mixtures



Cement



Cementitious Materials



Coarse Aggregates



Fine Aggregates



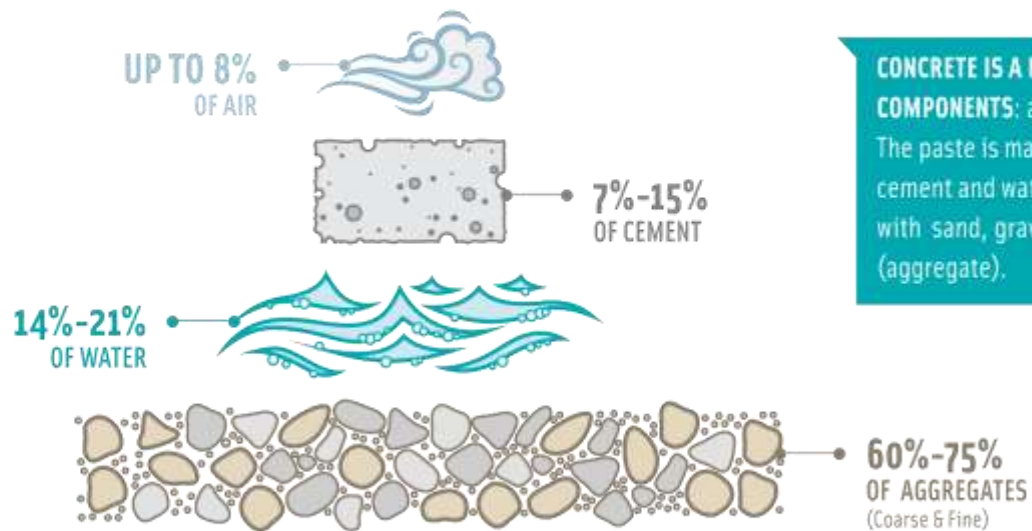
Chemical Admixtures



Water



COMPONENTS OF CONCRETE



CONCRETE IS A MIXTURE OF TWO COMPONENTS: aggregate and paste. The paste is made up of portland cement and water, which then binds with sand, gravel or crushed stone (aggregate).

PCA Image

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Concrete Made Today For The Future – Projects

Durable Concrete Made Today For The Future

- High Performance Mixes
- Sustainable
- Durable
- Local

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Self-Consolidating Concrete (SCC)



NPCA Web Photo

- **Fluid Mix**
- **Non-segregating Concrete Mix / Admixture binds material**
- **“Cleaner” Smooth Finish**
- **Less Labor**

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Second Severn Crossing, Bristol-Cardiff United Kingdom

- **Project Summary:**
- **Bridge project:** Crossing point for the M4 motorway, over the Severn Estuary
- **Start/finish dates:** 1992/1996
- **Bridge type:** Cable-stayed
- **Length:** 5km (456m main span)
- **Structure:** 150m concrete pylons, precast cross beams, composite deck and twin box girder viaduct
- **Production:** Precast on shore and shipped into position
- **Tidal range:** 14.5m
- **Main Contractor:** Laing-GTM

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Second Severn Crossing, Bristol-Cardiff United Kingdom



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Railway Tunnel Ejpovice, Czechia Completed 2017



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Railway Tunnel Ejovice, Czechia Summary

Precast concrete reinforced with steel fibers.

Construction of two single-track tunnel tubes at Ejovice, with a length of 4,150 meters (2.6 miles) each, which are part of the new railway line.

Trains will then be able to pass through this section of the railway corridor at speeds of up to 99 miles per hour.



Railway Tunnel Ejpovice, Czechia

Summary



The lining of the tunnel is a ring made from concrete with an outer diameter of 9.5 meters (31.2 feet) and internal diameter of 8.7 meters (28.5 feet).

4,000 rings are required for both tubes. Each ring is 2 meters long (6.6 feet), consists of eight segments and weighs 65 tons (US).

The rings are connected by plastic anchors (longitudinal direction) and steel rods (pulled out after injection).



Palazzo Italia Expo 2015 – Milan, Italy

TX Active



Palazzo Italia Expo 2015 – Milan, Italy

TX Active Summary

TX Active Technology allowing the organically latticed outer wall to filter the air, converting pollutants into inert salts.

Rising 35 meters (115 feet) from the foot to the top of the front wall is a tangle of branch-like concrete elements, constructed using environmentally active titanium-oxide mortar.

The sustainable mortar comprised of 80 percent recycled materials.

More than 700 facing precast panels.



Palazzo Italia Expo 2015 – Milan, Italy

Summary

High-performance cement-based mortar offering high flexural strength.

TX Active Technology allowing the organically latticed outer wall to filter the air, converting pollutants into inert salts.



Patricia & Phillip Frost Museum of Science, USA Miami, FL 2016

TX Active - The photocatalytic action eliminates the various pollutants



Patricia & Phillip Frost Museum of Science, USA

Miami, FL 2016



The photocatalytic action eliminates the various pollutants – vehicle exhaust gas, flue gas from domestic heating, industrial discharges of chemicals, pesticides

Museum covers 250,000 square feet (23,226 m²) and is divided into 4 buildings: a planetarium, an aquarium, and 2 separate wings for the science museum

The precast concrete panels cover the museum façade and the planetarium

Patricia & Phillip Frost Museum of Science, USA

Miami, FL 2016



Italian Pavilion - Expo Shanghai 2010, China

i.light®



Italian Pavilion - Expo Shanghai 2010, China

i.light® - Summary

The building was built with transparent cement i.light®.

3,774 transparent panels made of i.light® cover a total area of 1,887 m², the equivalent of about 40 % of the whole architectural structure

The exhibition structure is 18 m high, with an area of about 3,600 m², and is configured as a system of separate parts forming a geometrically unitary object.



i.light® - Summary

i.light®, the innovative material that does not contain fiber optics.

Concrete mix ensures transparency by mixing cement and admixtures. The admixtures bind a matrix of plastic resins inside the cement-based material without generating cracks or weakening the structure.

The resins of different colors react both with natural and artificial light creating a warm and soft light inside the building and an image of bright shininess on the outside.



Resources

Lehigh Cement Co.
www.lehighhanson.com

National Precast Concrete Association (NPCA)
www.precast.org

Northeast Concrete Precast Concrete Association (NEPCA)
www.nepca.com

American Concrete Institute (ACI)
www.concrete.org

ACI New England Chapter
www.aci-ne.org

Portland Cement Association (PCA)
www.cement.org

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Thank you!

