Preservation of Modern Materials

27 April 2016

Brian Rich
APTNW President

APT NORTHWEST

Keeping the northwest region embraced in preservation and technology for our built heritage

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Figure __: The Bacardi Building in Miami, FL. by Cuban architect Enrique Gutierrez in 1963 Credit: Wikimedia

Introduction

Figure __: The Bacardi Building in Miami, FL. by Cuban architect Enrique Gutierrez in 1963 Credit: Wikimedia

Introduction

Modern design and construction brought us innovative…

- Design philosophies and methods
- Building materials
- Construction techniques

Modern Design Philosophy

Figure __: The Cleveland Greyhound Station exhibits the Art Moderne style of modern architecture. Credit: Colin Rose - Wikimedia

Modern Design Philosophy

Figure __: The Cleveland Greyhound Station exhibits the Art Moderne style of modern architecture. Credit: Colin Rose - Wikimedia

"Modern buildings acquire their interest through their style and innovation."

– Sir Bernard Feilden

Celebrate the "abstract intellectual achievement of modern buildings, and not focus on tangible steel and glass, concrete or plastic…"

- Alan Baxter

But what if it's the materials themselves which are the innovation….

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Modern Design Philosophy

Figure __: A traditional brownstone residence in downtown Philadelphia sandwiched between modern. Credit; Brian Rich, 2013.

Figure __: The Lyceum theater in New York is sandwiched between modern skyscrapers. Credit: Brian Rich, 2013.

Modern Design Philosophy

Figure __: The Manufacturers Trust Hanover Building in New York exemplifies the extension of the exterior envelope into the interior ceilings, floors, and walls. Credit: wikiwand.com

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Modern Design Philosophy

Figure __: Left: The Barcelona Pavilion – is reconstruction considered historic preservation? Credit: wikimedia. Right: the Parthenon in Nashville TN – is a copy of a copy of the original considered historic preservation? Credit: wikimedia.

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Modern Design Philosophy

Modern design and construction brought us:

- Innovation in building design
  - Engineering
  - Purpose built structures
  - Standard details
- Innovation on construction techniques
  - Rationalization, Standardization, Modularization, Prefabrication
  - Increased efficiency, accuracy, consistency, and uniformity
- Innovation in building materials
  - Materials are smaller, thinner, more efficient
  - Materials are increasingly man-made
  - Quicker availability and higher quality

Modern Materials – Glulam Timbers

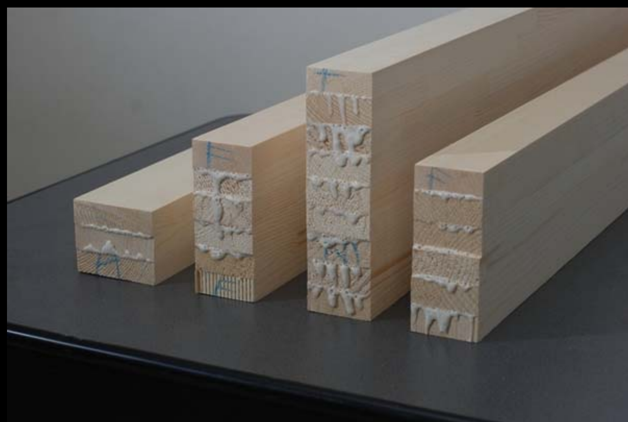


Figure __: Glu laminated timbers in various configurations.

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Modern Materials – Plastic Laminate

Figure __: Two different kinds of plastic laminate. Credit: surfaceandpanel.com

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Modern Materials – Richlite

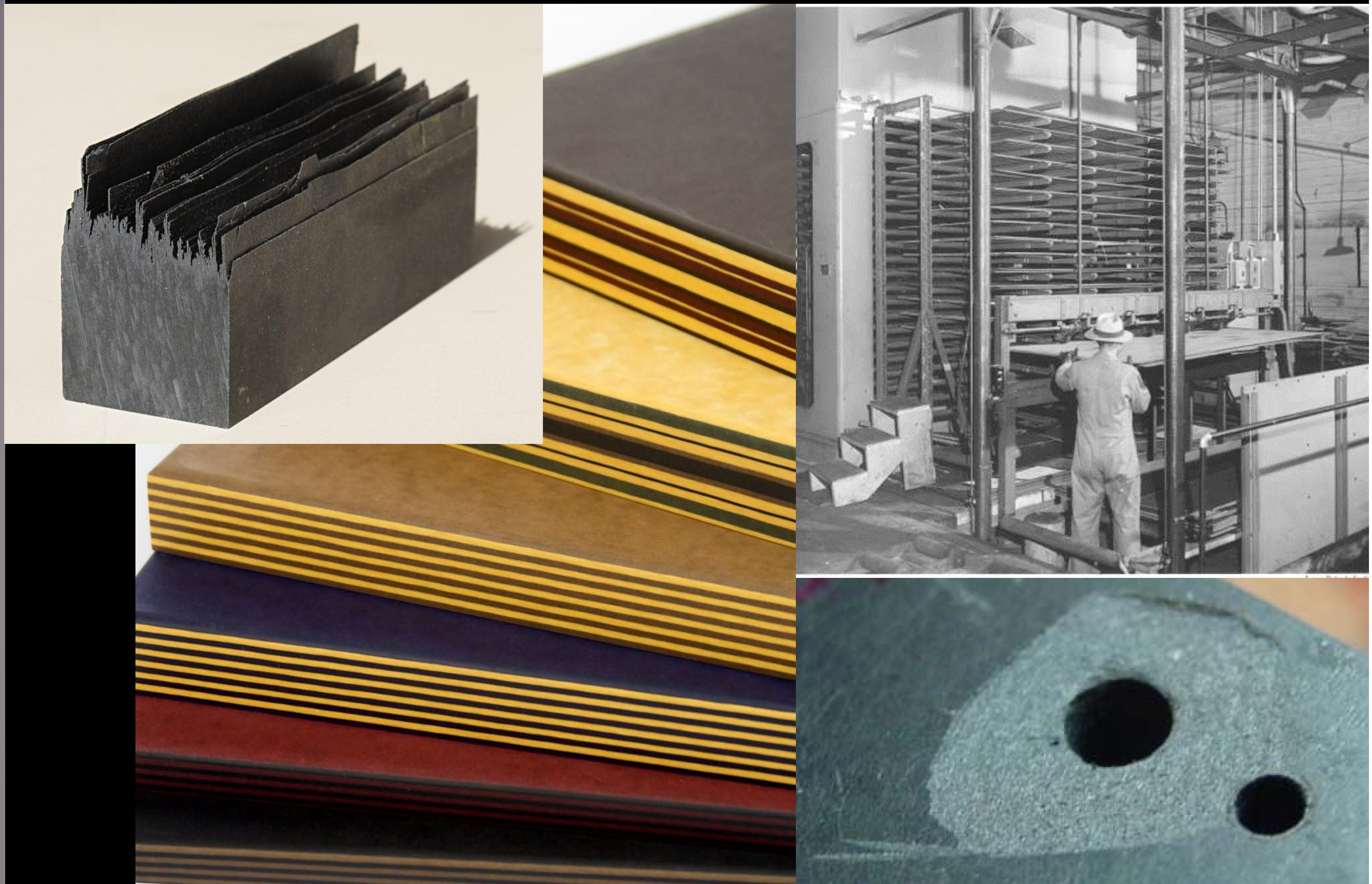

Figure __: Richlite is cellulose paper sheets layered with resin and compressed under high temperature and pressure to create a solid wood-like material. Credit: richlite.com

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Modern Materials – Plywood

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Modern Materials – OSB

Figure __: The thick pile of carefully sized wood chips is compressed with resin into OSB panels. Credit: wikimedia

Modern Materials – Plastics

Figure __: Several different forms of fiber reinforced plastic.

Curtainwall Systems

Figure __: Walter Gropius' Fagus Shoe Factory, **Alfeld an der Leine, Germany, 1911. Credit: Wikimedia**

3 Major Components:

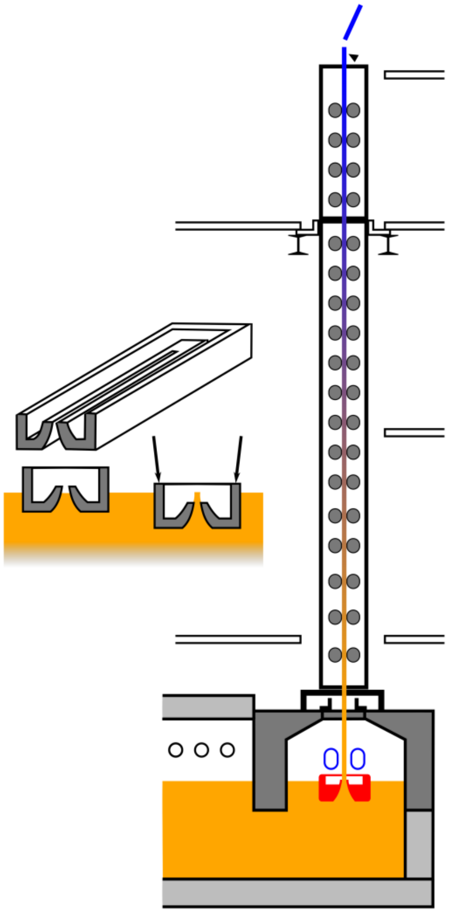
1. Glass
2. Framing
3. Gaskets or seals

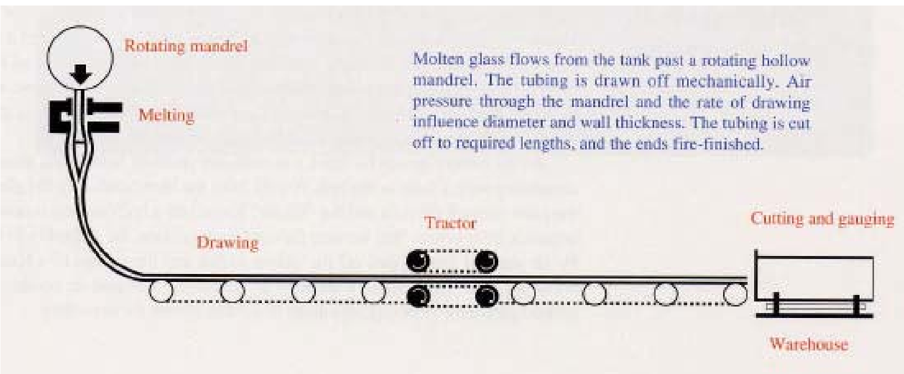
Curtainwall Systems: Glass

Plate glass

Vs

Drawn down glass





Figure

Curtainwall Systems: Glass

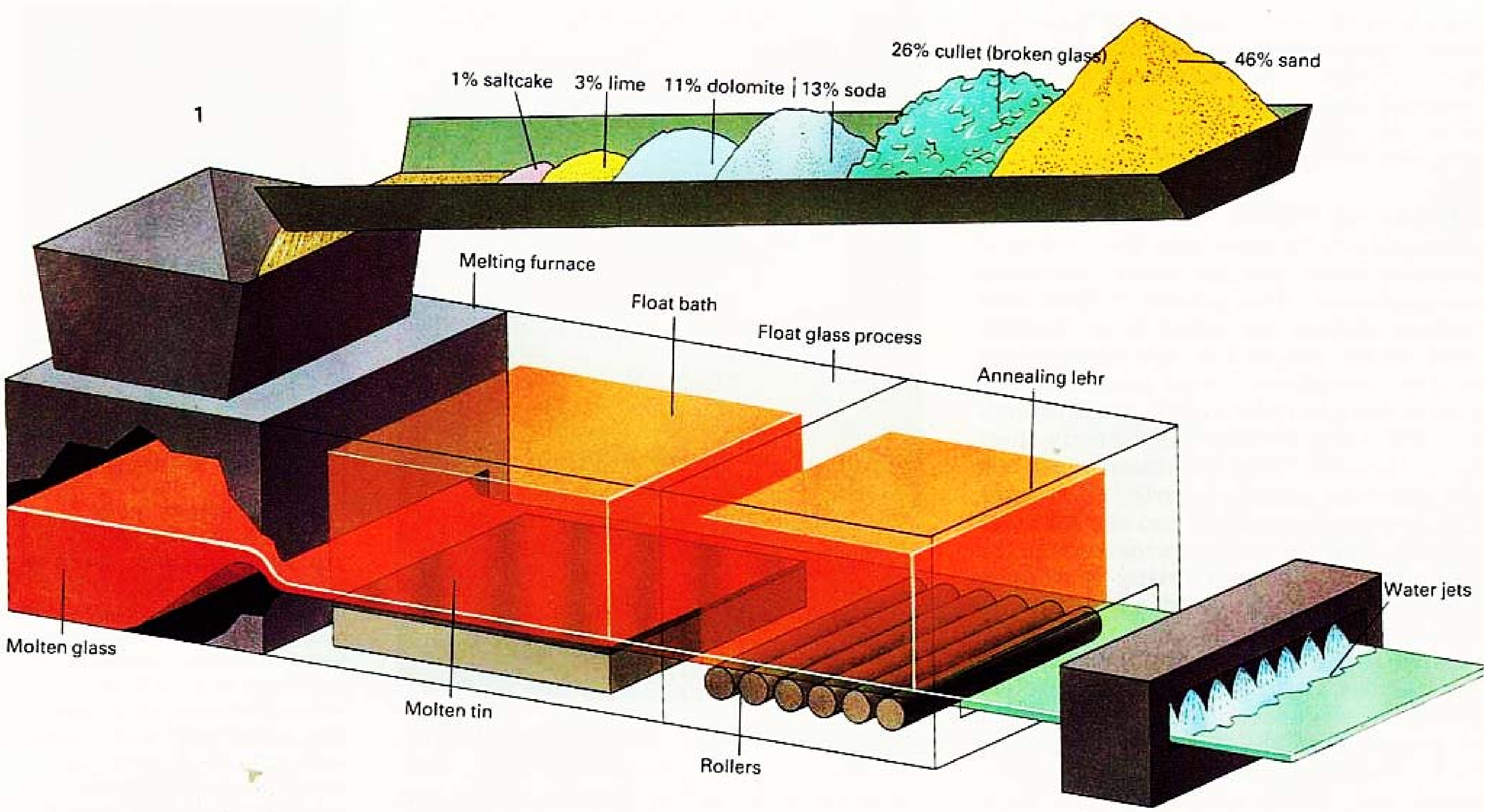


Figure __: The float glass manufacturing process. Credit: yvy4.myblog.arts.ac.uk

Curtainwall Systems: Glass

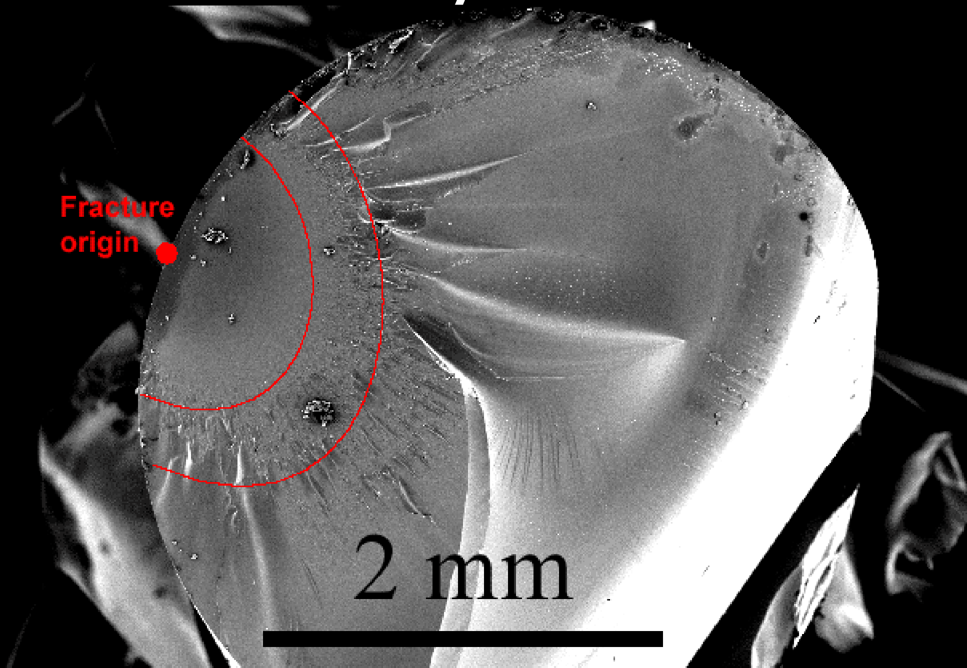


Figure __: Griffiths Flaws are micro-cracks in the surface of glass. Credit: doitpoms.ac.uk

Figure __: Repairing fractured glass can virtually eliminate the apparent damage, but the technology does not have a long history. Credit: mswindshield.com

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Curtainwall Systems: Glass

Insulated Glass Units (IGUs)

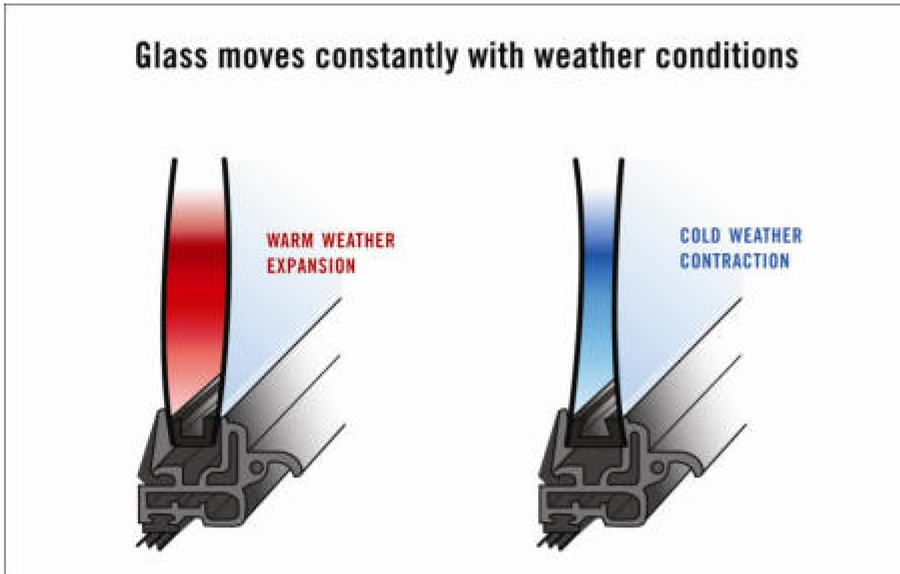


Figure __: Movement of insulated glass panels forces fractures over time in the sealant at the perimeter. Credit: windowgenie.com

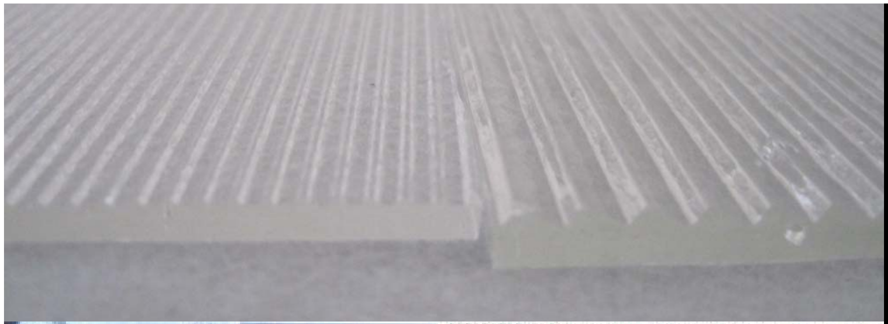
Figure __: The window on the left is an example of a failed insulated glass unit. Credit: lakelandglassmirror.com

Curtainwall Systems: Glass

Figured Glass

Prismatic Glass

Sidewalk Vault Lights



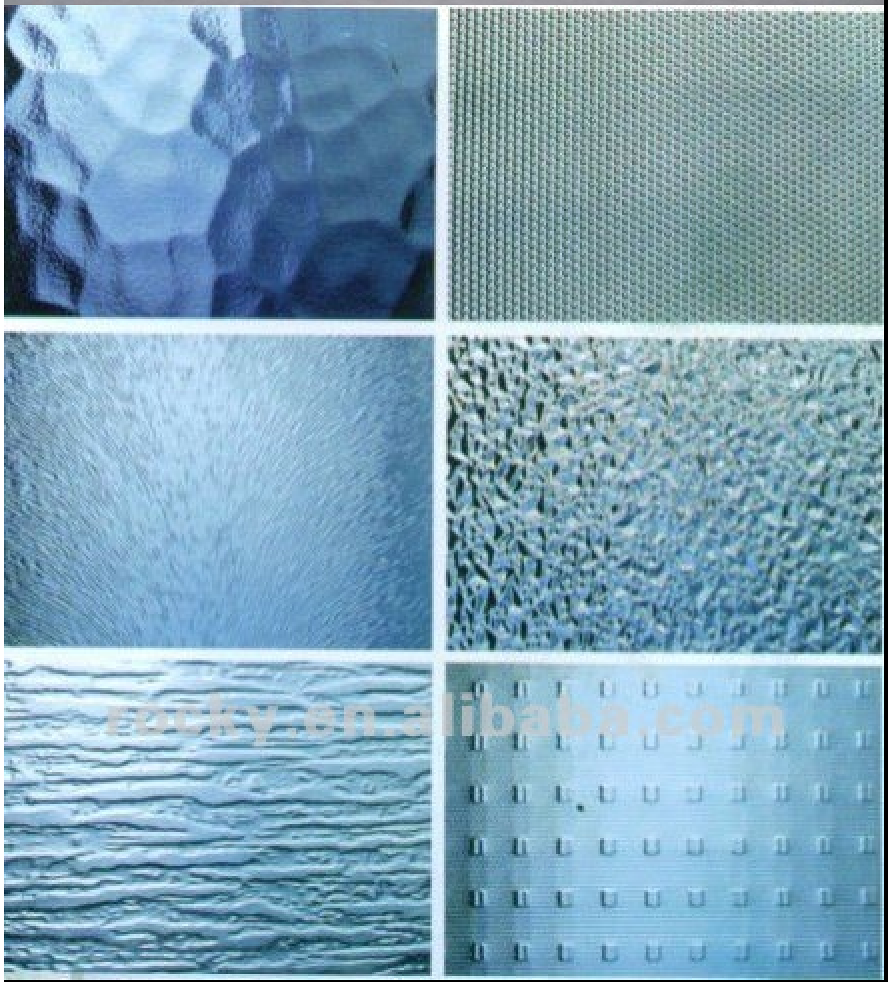


Figure __: Top: Prismatic Glass directs natural light further into an interior space. Credit: idlecreativity.files.wordpress.com Bottom: Figured Glass obscures the view, but not the light. Credit; Alibab.com. Right: Sidewalk vault lights with glass pieces set into cast iron frames in NY. Credit: Brian Rich, 2013

Curtainwall Systems: Metals

Figure __: Left: The Hallidie Building in San Francisco by Willis Polk, 1918. Credit: wikimedia. Right: Crown Hall at the IIT campus in Chicago by Mies van der Rohe, 1956. Credit: wikimedia

Curtainwall Systems: Metals

x

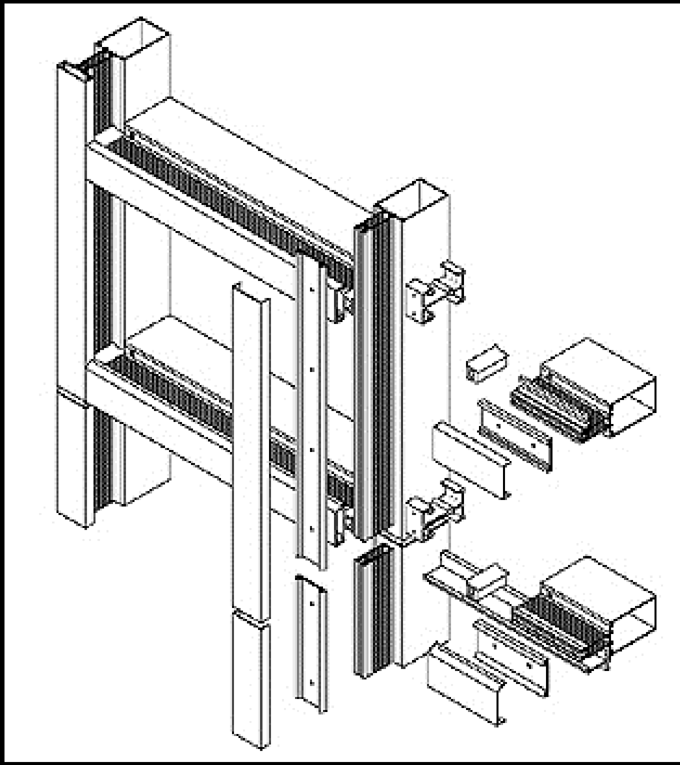


Figure __: The Lever House by Gordon Bunshaft of SOM is one of the earliest aluminum curtainwalls in New York. Credit: Brian Rich, 2013

Figure __: A diagram of a stick built curtainwall system and its component pieces. Credit: Kawneer.com

Curtainwall Systems: Sealants

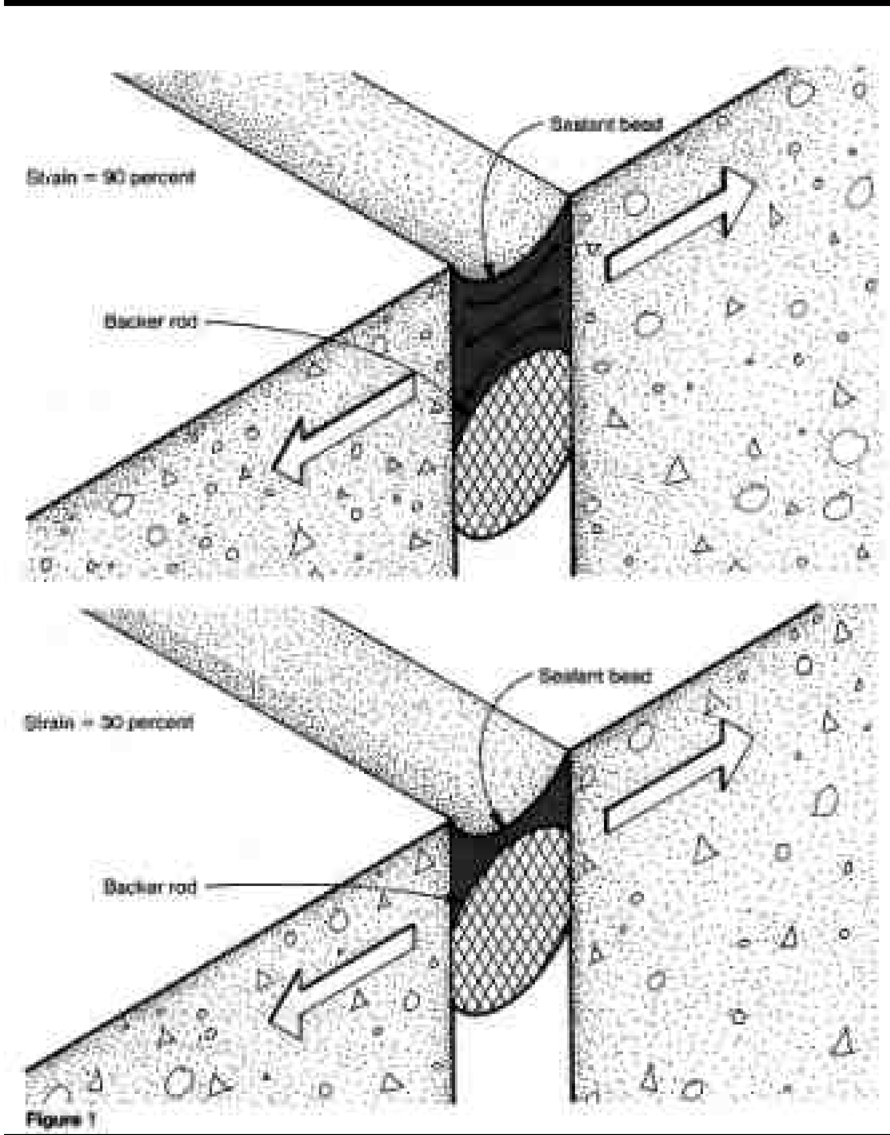


Figure __: Typical Sealant joint installation adheres to both sides but not the back of a sealant joint. Credit: buildingdiagnostics.com

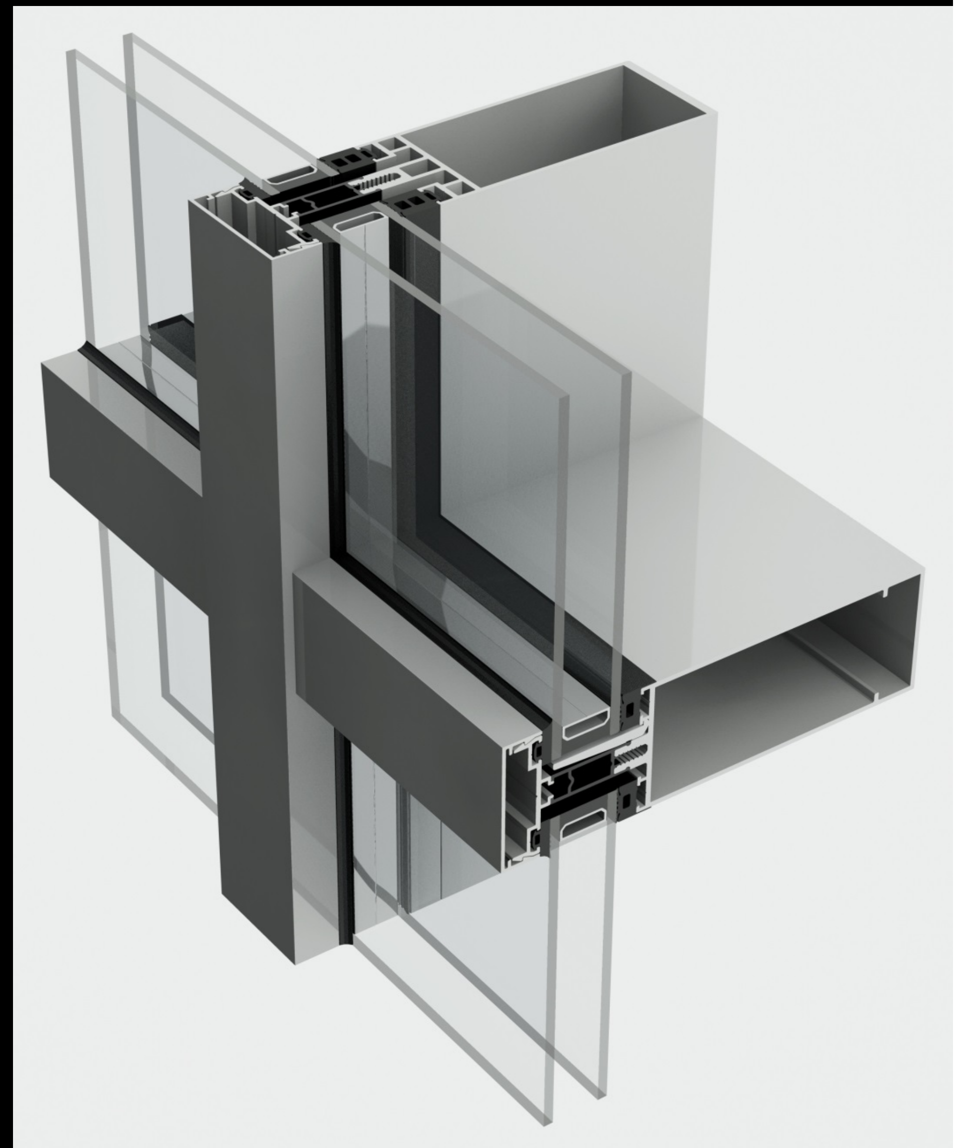


Figure __: This 3-d view shows the different components of a curtain wall system. Credit: http://www.aluk.co.uk/sl52-curtain-walling.php, 2015

Curtainwall Systems: Sealants

Sealants fail – count on it.

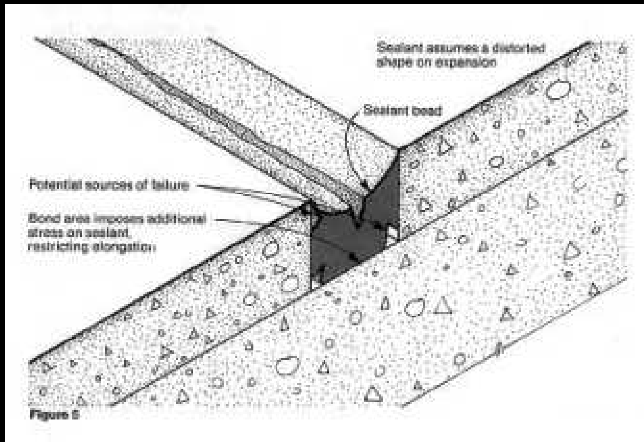


Figure __: Typical sealant joint adhesion failure locations. Credit: buildingdiagnostics.com

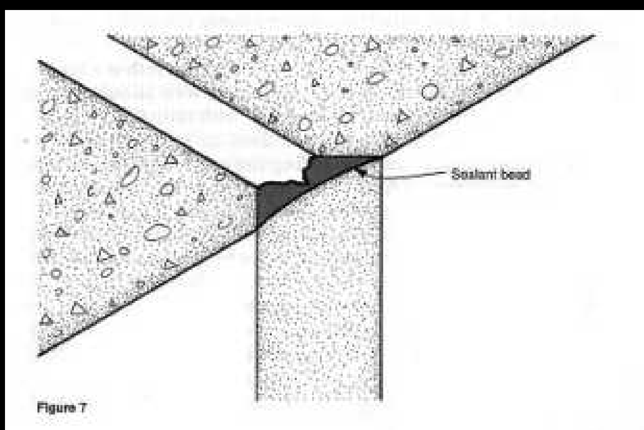


Figure __: Typical sealant cohesion failure in the sealant itself. Credit: buildingdiagnostics.com

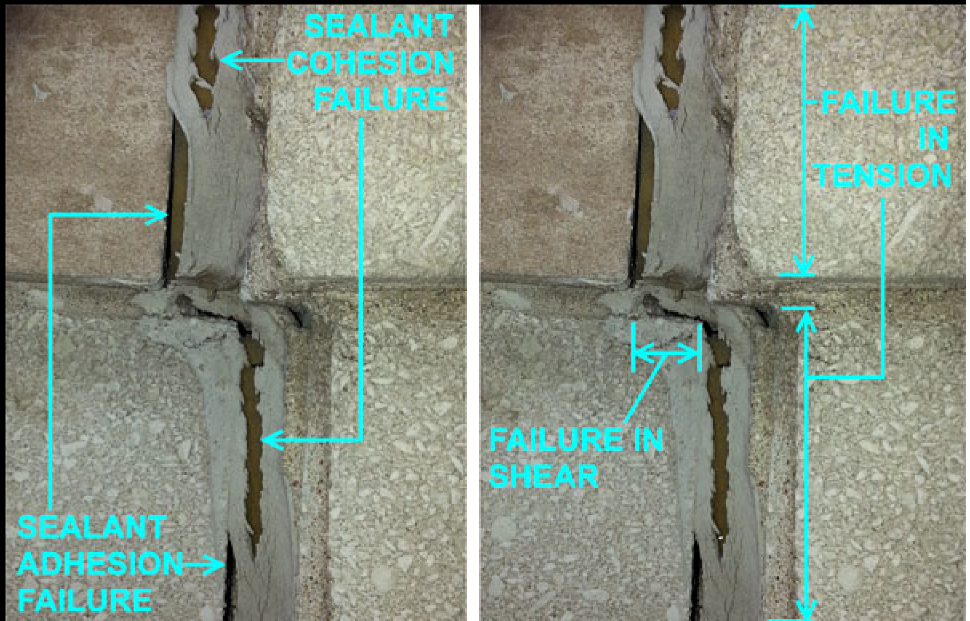


Figure __: Modern sealants fail due to the adhesion to surfaces or internal cohesion of the sealant. Credit: wikimedia

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Water – The Freeze-Thaw Cycle

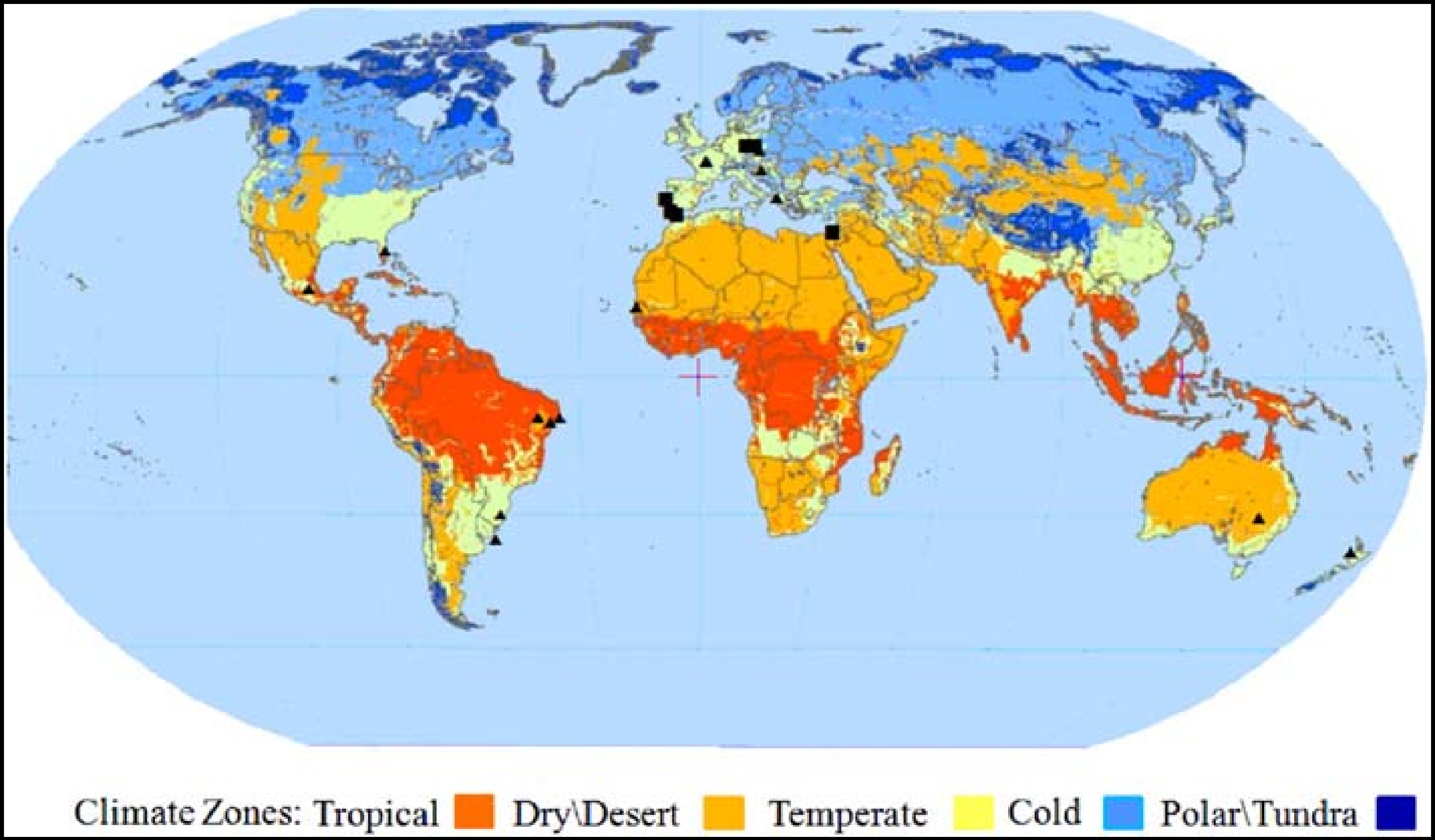

Figure __: A climate zone map showing tropical to polar regions. Regional weather patterns have significant impacts on deterioration of building materials. Credit: www.sedac.ciesin.columbia.edu/place/mapCollection/Climate_Zone

Water – The Freeze Thaw Cycle

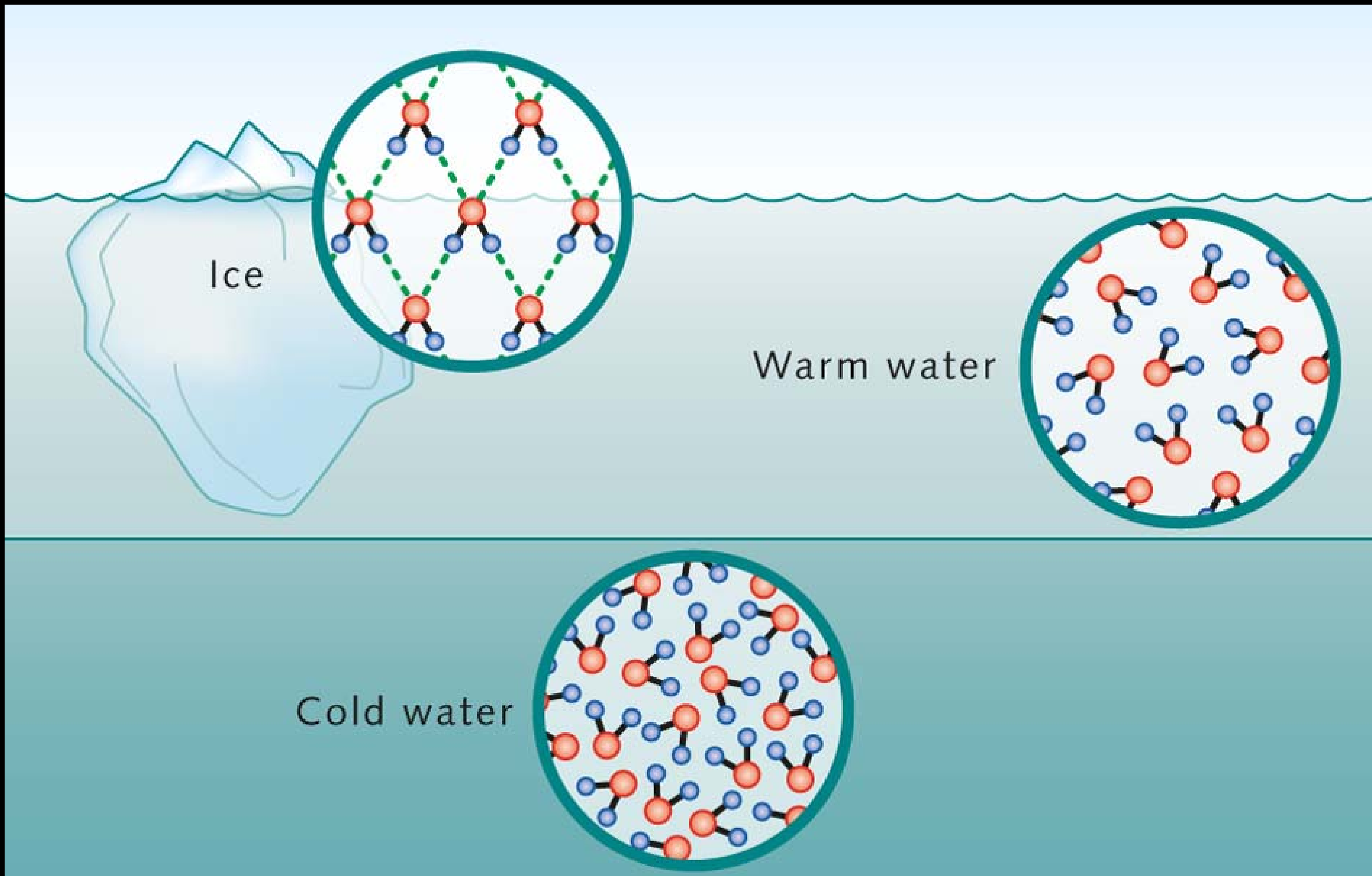

Figure __: as water transitions from warm to cold, it gets denser. As cold water transitions to a frozen state it grows in size as it forms a crystalline lattice which requires more space than randomly oriented molecules. Credit: Lydia Neal, 2015

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Water – The Freeze Thaw Cycle

What's required for freeze-thaw deterioration of materials?

1. A porous, permeable material
2. Water in liquid form
3. A motive force
4. Conducive capillary size (confinement)
5. A brittle solid material
6. Declining temperature

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Reinforced Concrete - History

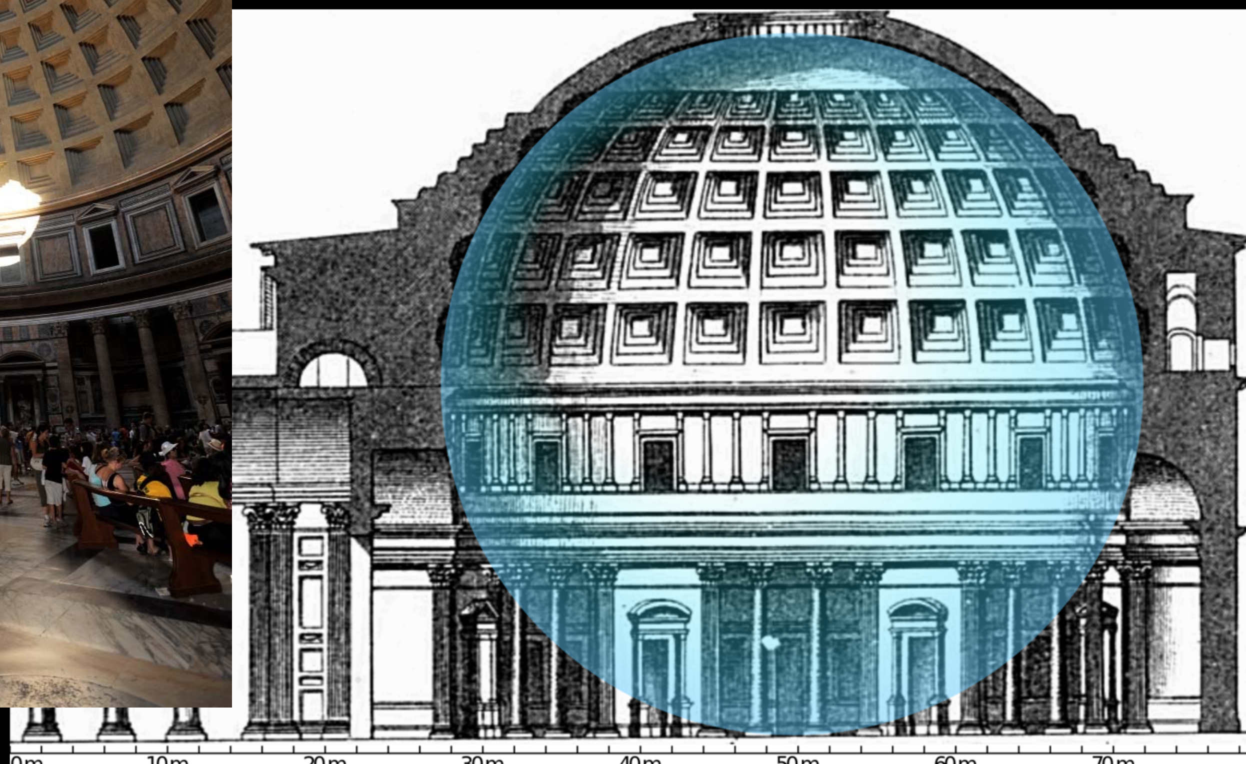

Figure __: The Pantheon in Rome, Italy, circa 128 AD. An unreinforced concrete structure that has endured for centuries. Left: Credit: Emilio Labrador, 2010. Right: credit: Derived from Baukunst Trusker Romer.jpg, modified by cmglee,2012.

Reinforced Concrete - History

Figure __: The Eddystone Lighthouse, England, 1757. This lighthouse was the result of research by John Smeaton in redeveloping hydraulic cement. Credit: Rupert Kirkwood, 2013.

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Reinforced Concrete - History

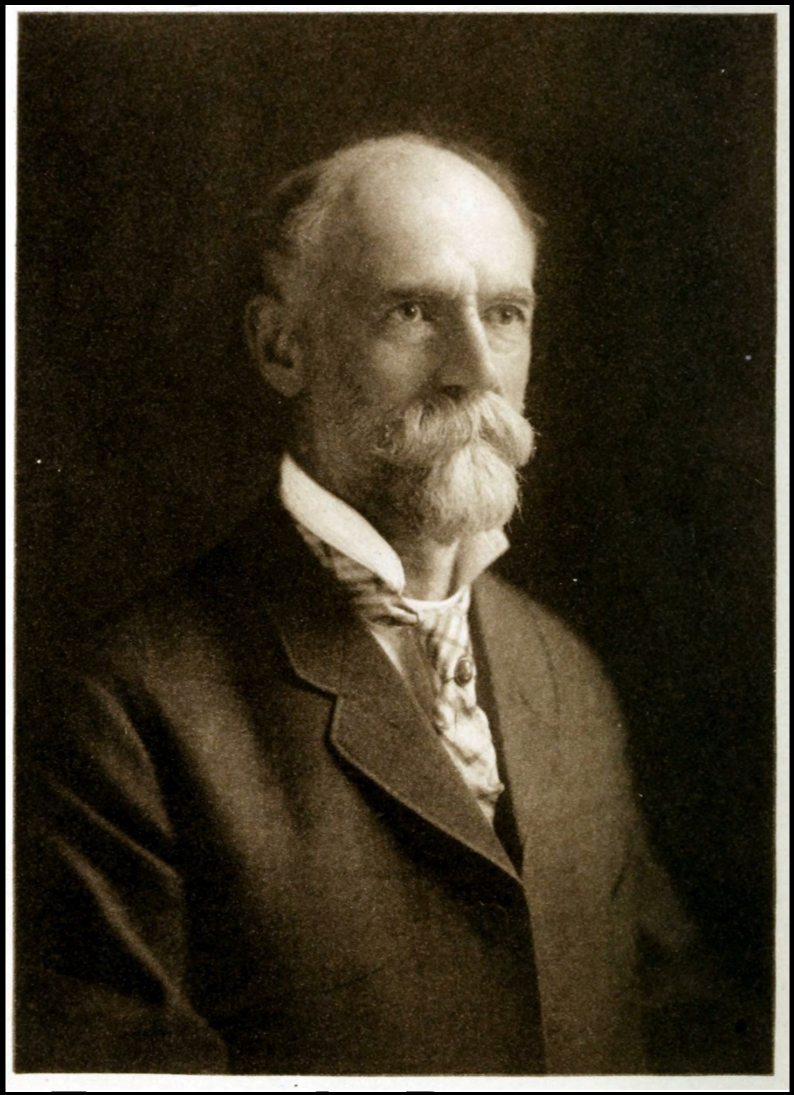

Figure __: Ernest L. Ransome developed refinements in reinforced concrete in the early 1900's using twisted square steel bar to take tensile loads and concrete to take compression loads. Credit: H. Colin Campbell, The Ransome Book: How to Make and Use Concrete, 1917.

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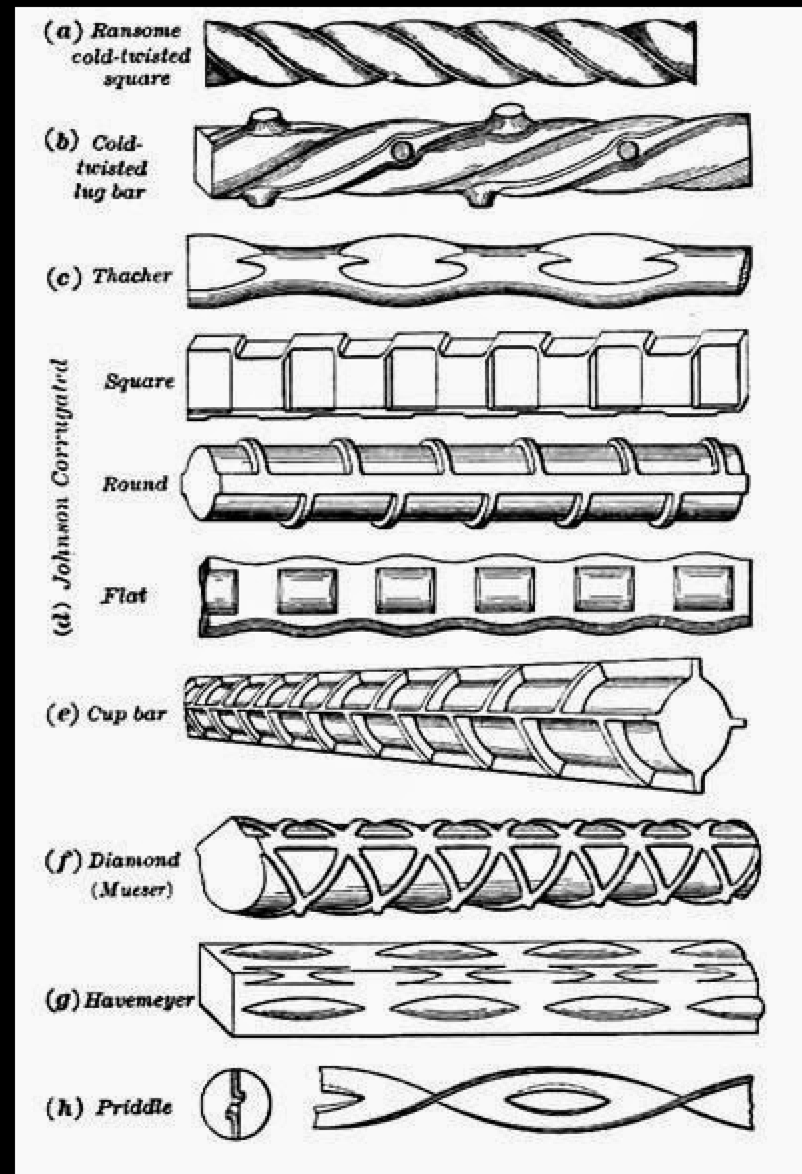
Concrete – What's It Made Of?



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Concrete – Foundations

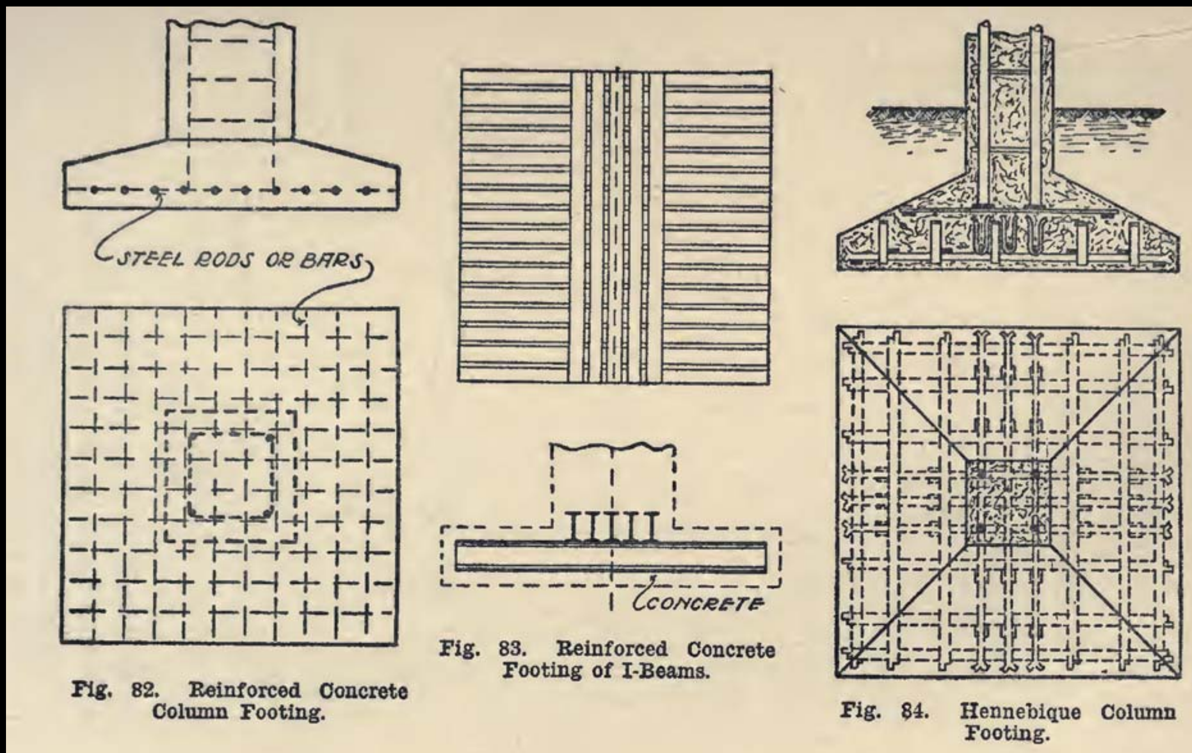
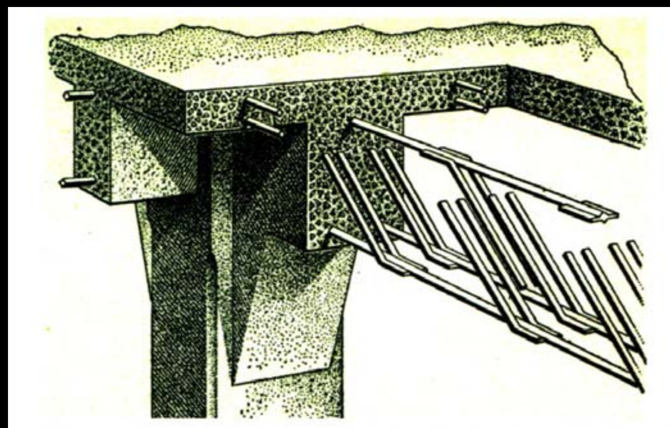


Figure __: Foundations often have crossing layers of steel beams (top left, credit: Hennebique-Radfords cyclopedia of construction, 1909) forming a “grillage,” as at the south tower of World Trade Center (bottom right, credit: howdoyoumeasure525600minutes.com, 2001)

Concrete – Beams and Columns



The Kahn system, showing the bars bent at 45° for shear reinforcement. International Library of Technology, vol 34D, *Stone & Brick, &c* (Scranton Pennsylvania) 1922 [1906-1912] 45, p 15.

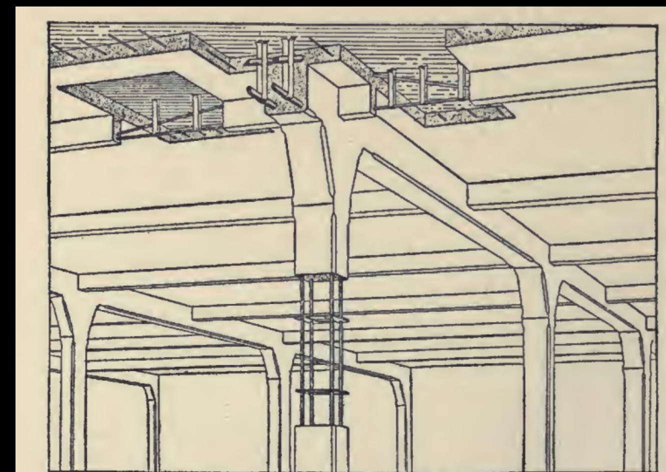


Fig. 73. Hennebique System.

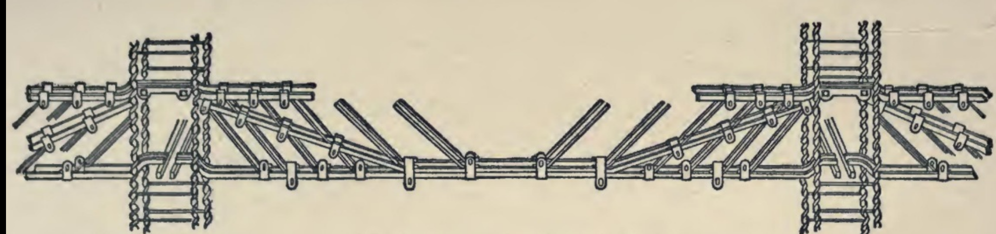


Fig. 67. Pin-Connected Girder Frame.

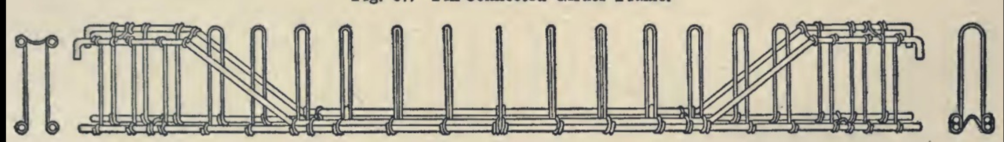


Fig. 68. Unit-Girder Frame System.

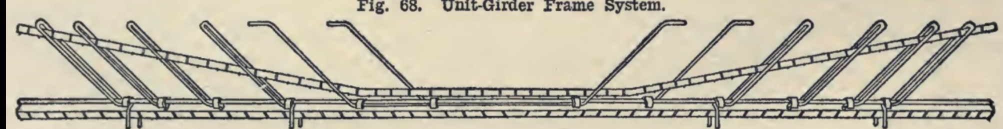


Fig. 69. Herringbone Trussed Bar Used as a Girder Frame.

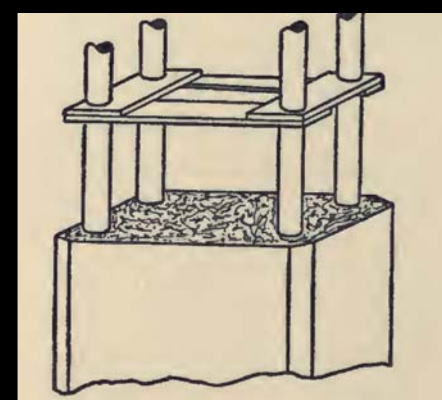


Fig. 112. Hennebique Column.

Figure __: Typical early 20th century concrete reinforcing configurations from: Hennebique-Radfords Cyclopedia of Construction, 1909.

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Concrete – Floors

Figure __: Photos showing concrete "punching" on the bottom right (credit: http://ibeton.epfl.ch/recherche/punching) and two methods for reinforced concrete to prevent punching shear at column to slab connections. The Duluth MN Armory at the left and a "drop cap" at the right.

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Concrete – Precast Elements

Figure __: Examples of pre-cast concrete panels. Credit: top left: Axis Design Lab, 2015 and bottom right: Alfanar Building Systems.

Concrete – Thin Shell

Figure __: Top right: The MIT Kresge Auditorium by Eero Saarinen, 1955 (credit: wikimedia, madcoverboy, 2008.)
Bottom left: The TWA Terminal at JFK Airport, New York, by Eero Saarinen, 1962 (credit: Karen Johnson Photography)

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Concrete - Thin Shell

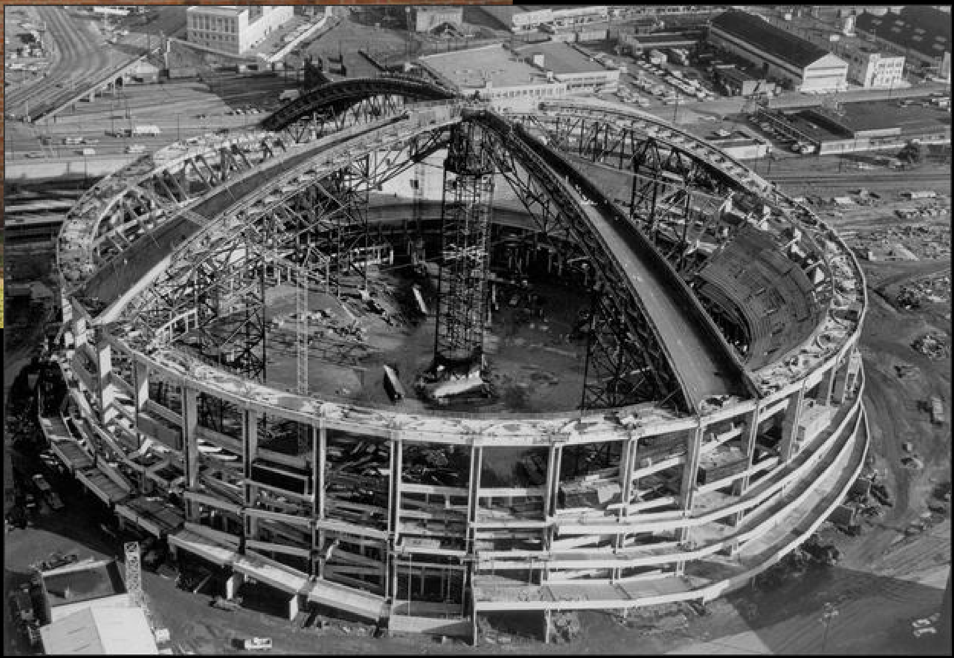

Figure __: Top left: The Cuban School of Ballet by Vittorio Garatti – a Catalan Vault thin shell brick dome (credit: Dieter Janssen, 2015)
Bottom right: The Kingdome under construction in Seattle, WA, 1974 (credit: Seattle Post Intelligencer, 1974)

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Concrete - Surface Textures

Figure __: Left: The main building at the Ballard Locks with exposed aggregate concrete, 1911-1917. (credit: Brian Rich, 2013)
Right: Board formed concrete at the Unite D'habitation by LeCorbusier, 1952. (credit: Piere Janerete, 2014)

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Concrete - Other Forms

Figure __: Shotcrete (air-blown concrete) being installed as part of a shoring wall. Credit: Raimond Spekking, 2013)

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Concrete – Post Tensioned

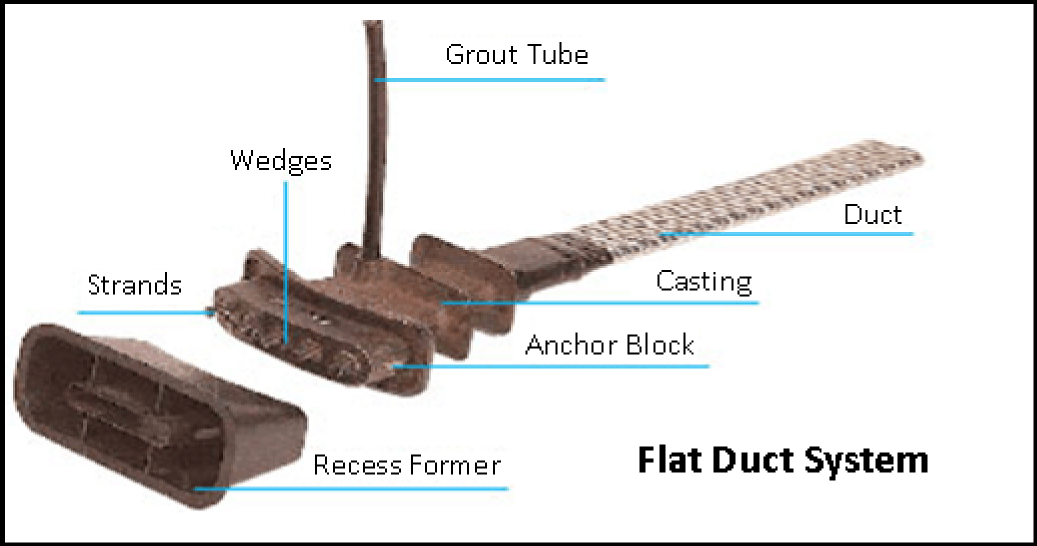

Figure __: Top: Components of a flat duct post-tensioning system (credit: ptsindia.net, 2015). Bottom left: Deteriorating tendons (credit: KJ Rodgers, 2013). Bottom right: Failure of post tensioned tendons can destroy the concrete cover as well (credit: cowleyengineering.com).

Concrete Deterioration

Figure __: Left: Exposed rebar corrodes and loses strength (credit: jenicke.com, 2012)
Right: Air entrainment voids in concrete make space for water to expand into (credit: nist.gov, 2009)

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Concrete Deterioration Mechanisms

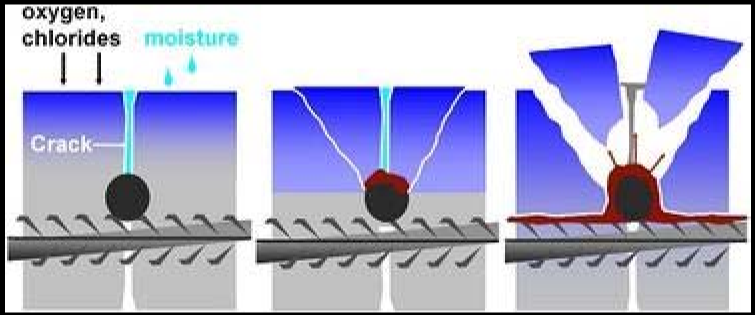
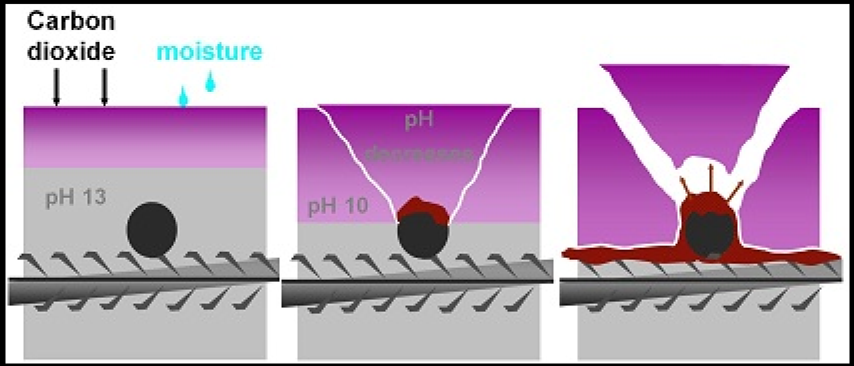


Figure __: Top left: Rebar placed too close to the surface of the concrete at the UW Seattle (credit: Brian Rich, 2014). Bottom left: A diagram of rebar deterioration due to water (credit: Pirro, 2012). Right: Deterioration of rebar placed too close to the surface (credit:).

Concrete Deterioration Mechanisms



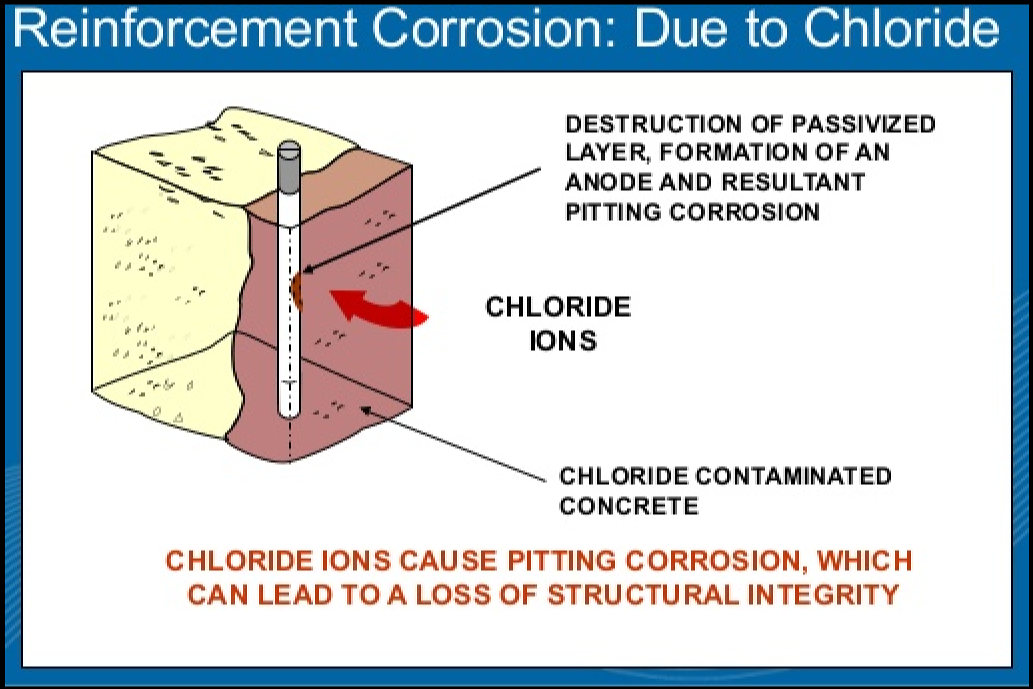


Figure __: Concrete deterioration due to carbonation is very similar to corrosion caused by water. The best way to differentiate the two is to understand the pH level of the concrete. Credit: Top left: Pirro, 2012, and bottom right: Dr. Mohammad Ali, GHD, 2014).

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Concrete Deterioration Mechanisms

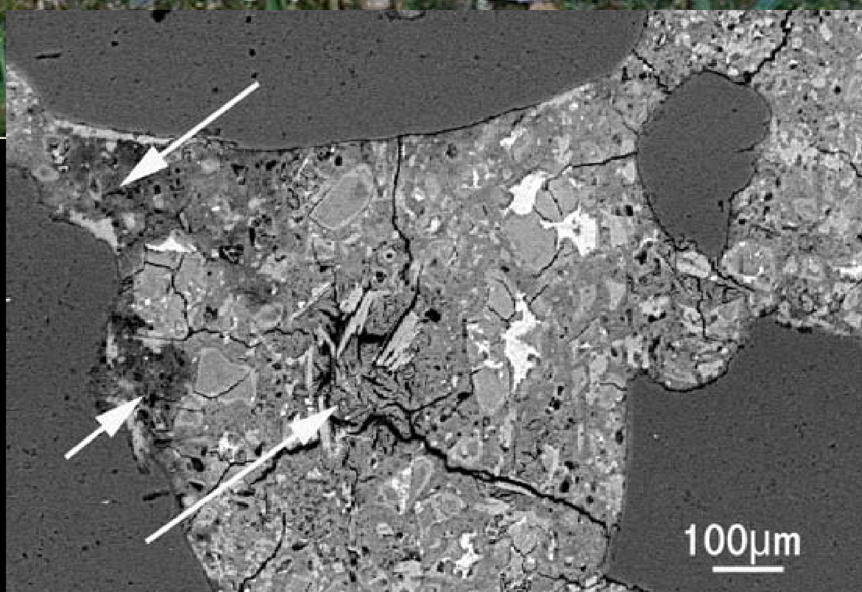

Figure __: Top Left and Right: Sulfate Attack creates gypsum which expands with water causing spalling (credit: top left: Dave Niragik, 2013. right: Ray Deal, 2013). Bottom left: An electron microscope view of ettringite formation (credit: undertanding-cement.com, 2016).

Concrete Deterioration Mechanisms

Figure __: Concrete spalling due to freeze-thaw cycles at the Salt Lake City Public Library by Moshe Safdie, 2003. Credit: Brian Rich, 2015.

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Concrete Deterioration Mechanisms

Figure __: Concrete spalling due to an Alkali-Aggregate Reaction. Petrographic microscope or scanning electron microscope imaging can be used to confirm the formation of a gel due to this chemical process. Credit: Viggo Jensen, NBTL, 2003.

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Concrete Deterioration Mechanisms

Figure __: Concrete deterioration at a concrete wall at the University of Utah, Salt Lake City, Utah. Credit: Brian Rich, 2015

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Concrete Deterioration Mechanisms

Figure __: Concrete deterioration isn't just chemical or corrosion based. It can also be mechanical, such as this damage by a garbage truck that ran into the concrete wall. Credit: Brian Rich, 2015.

Concrete Deterioration Mechanisms

Figure __: High alumina cement deterioration is caused by reactions of the alumina to other components of the concrete leaving voids that become structurally weak points in this concrete joist. Credit: www.sandberg.co.uk, 2014

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Concrete Deterioration Mechanisms

Figure __: Fire damaged concrete can spall, exposing rebar to corrosion and even melting rebar in sustained fires. Credit: www.sandberg.co.uk, 2014

Concrete/Reinforcement Protection

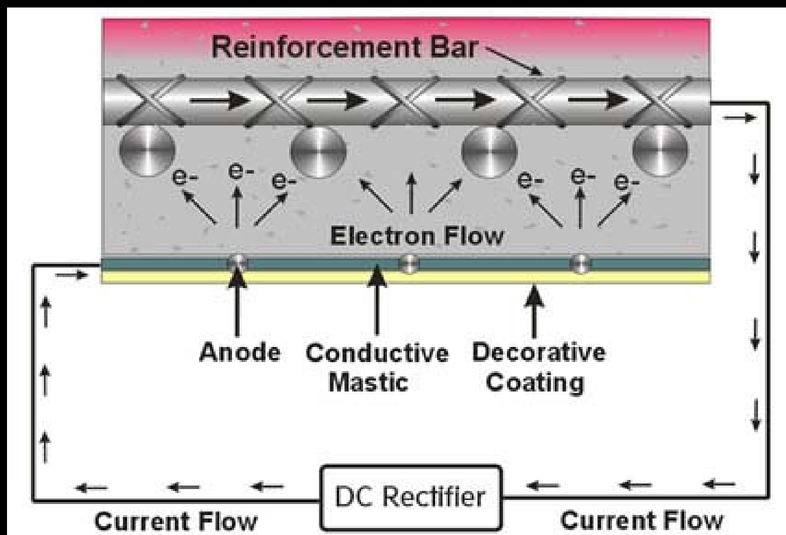

Figure __:

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Concrete – Patching & Repair

Figure __:

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Concrete – Crack Repair

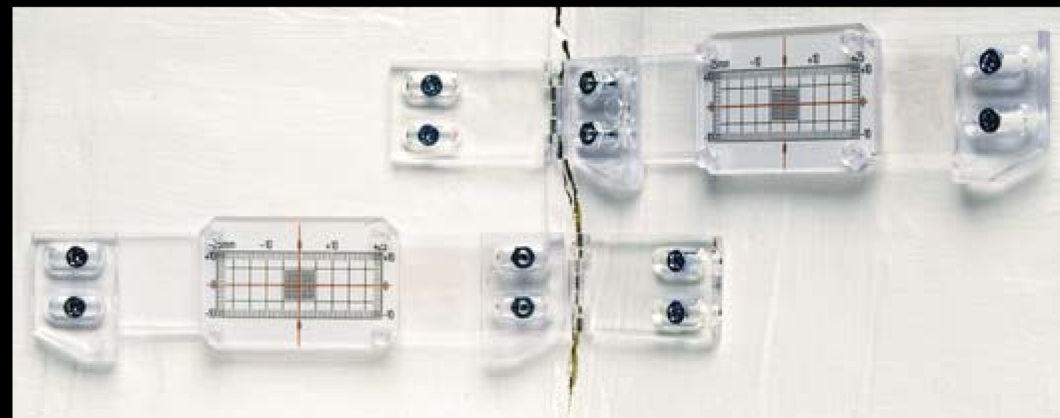

Figure __:

Preservation of Mid-Century Modern Building Materials

cosponsored by APTNW & DoCoMoMo_Oregon

Venue: Central Lutheran Church
1820 NE 21st Avenue, Portland, OR 97212

Date: Saturday, May 21, 2016

Format: Full-day Workshop - 10am to 3pm; 2 hrs / lunch / 2 hrs

Topics: History / Materials / Case Studies

Contact: Brian Rich / 206.909.9866 / brian@richaven.com
Kate Kearney / 503.517.0283 / KateK@pmapdx.com

Registration: https://www.eventbrite.com/e/preservation-of-mid-century-modern-building-materials-workshop-tickets-24523661933

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End

Thanks!

NORTHWEST

Keeping the northwest region embraced in preservation and technology for our built heritage