Concrete's Role in Sustainable Development Course and Certification

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Sr. VP, Sustainable Development

Purpose of the Course

- Concrete's eco-friendly features
- Take full advantage of the green building movement
- Understanding of LEED 2009
- Can benefit the environment and your business
- **Certified Concrete Sustainability Specialist**

Lesson 1: January 17, 2011 12:00 PM to 2:00 PM eastern (U.S.)

- Introduction
- The Current State of Green Building
- The Environmental Attributes of Concrete
- Follow-up assignments

Lesson 2: January 18, 2011 12:00 PM to 2:00 PM eastern (U.S.)

- LEED 2009 NC Part 1
- Follow-up assignments

Lesson 3: January 19, 2011 12:00 PM to 2:00 PM eastern (U.S.)

- LEED 2009 NC Part 2
- Follow-up assignments

Lesson 4: January 20, 2011 12:00 PM to 2:00 PM eastern (U.S.)

- Strategies for Promoting Sustainable Development
- Follow-up assignments

Certification Exam: Any time prior to February 20, 2011

NRMCA Certified Concrete Sustainability Specialist

- Demonstrate basic knowledge of:
  - Sustainability principles
  - Green building practices
  - The environmental attributes of concrete
  - Concrete's contribution to LEED 2009
  - Strategies for promoting sustainable development
- Requirements:
  - 80% or more on NRMCA Concrete Sustainability Specialist Certification exam

Today's Lesson

- Lesson 1 – Unit 1 (Part 1)
  - The Current State of Green Building
- Lesson 1 – Unit 1 (Part 2)
  - The Environmental Attributes of Concrete

Lesson 1 – Unit 1 (Part 1)

The Current State of Green Building

How DID We Got Here?

- History of the Green Movement
  - Earth Day
  - Founding of EPA
  - Hole in the Ozone Layer
  - IPCC Report on Climate Change
  - Kyoto Protocol
  - Inconvenient Truth
  - USGBC

Green movement has a long history

1824 Jean-Baptiste Fourier: Credited with discovering the “greenhouse effect”

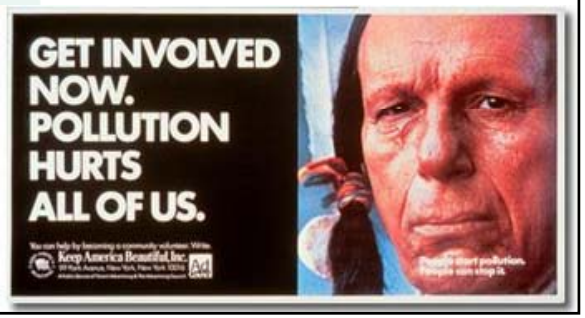
1896 Svante Arrhenius: Formulated the Greenhouse Law : $\Delta F = \alpha \ln(C/C_0 2)$

History of "green" movement

- 1970 – First Earth day

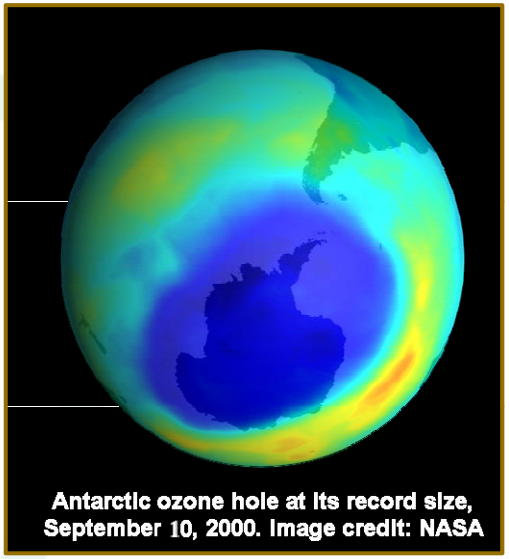
History of the "green" movement

- 1970 – EPA Founded
  - Mission: to protect human health and to safeguard the natural environment
- 1970's – Clean Air Act, Safe Drinking Water Act, Clean Water Act, phase out of leaded gas, Ban on DDT, etc.
- 1979 -U.S. National Academy of Science Report



History of the "green" movement

- 1985 – The British discover a hole in the ozone layer over Antarctica
  - Montreal Protocol - 1987
- 1988 – The Intergovernmental Panel on Climate Change (IPCC) is created by the United Nations



Antarctic ozone hole at its record size, September 10, 2000. Image credit: NASA

IPCC | INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

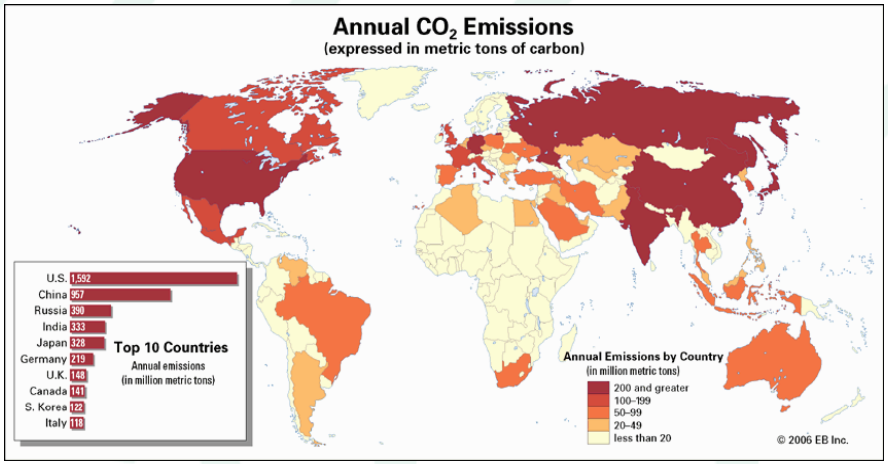
WMO UNEP

History of "green" movement

- 1990 – First IPCC report
  - Suggests that emissions resulting from Human activity are substantially increasing the concentrations of greenhouse gases
  - Concludes that the earth has warmed 0.45º C in the last century
- 1995 – 2nd IPCC Assessment Report
- 2001 – 3rd IPCC Assessment Report
  - Humans are impacting global warming
  - Global Temps and Sea levels are expected to rise
- 2007 – 4th IPCC Assessment Report
  - Warming of the climate is unequivocal (Temps 2º-11.5 º F)
  - Sea levels will probably rise 7.08"-23.22"
  - **Most** temperature increase is **very likely** due to human causes of greenhouse gases.

History of "green" movement

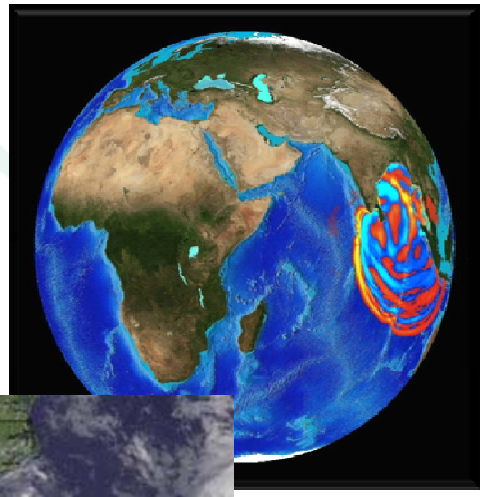
- 1997 – The Kyoto Protocol is proposed



- The Asia-Pacific Partnership on Clean Development and Climate

History of "green" movement

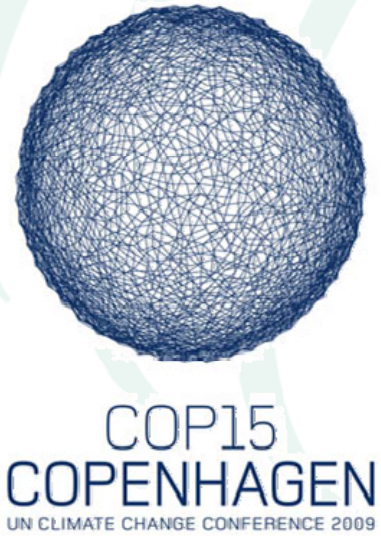
- 2004 Indian Ocean Tsunami
- 2005 – Hurricane Season
  - Dennis
  - Emily
  - Katrina
  - Rita
  - Wilma



History of “green” movement

History of "green" movement

- 2009- UN Climate Change Conference - Copenhagen



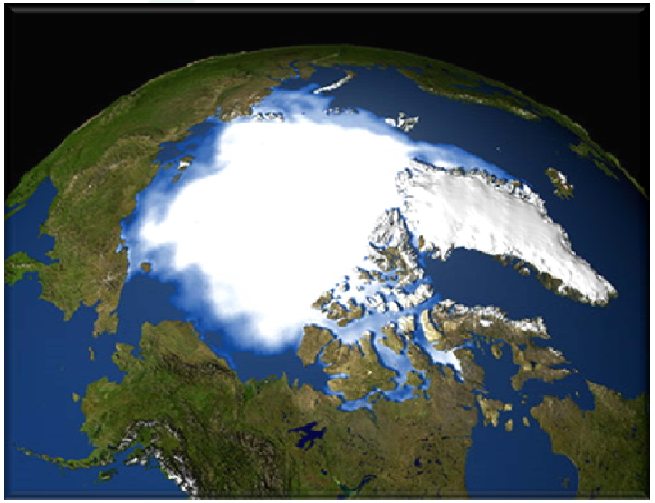
LEED®

- Leadership in Energy and Environmental Design
  - LEED® 2009 (Current Version)
  - Green Building Rating System
  - Developed by U.S. Green Building Council (USGBC)

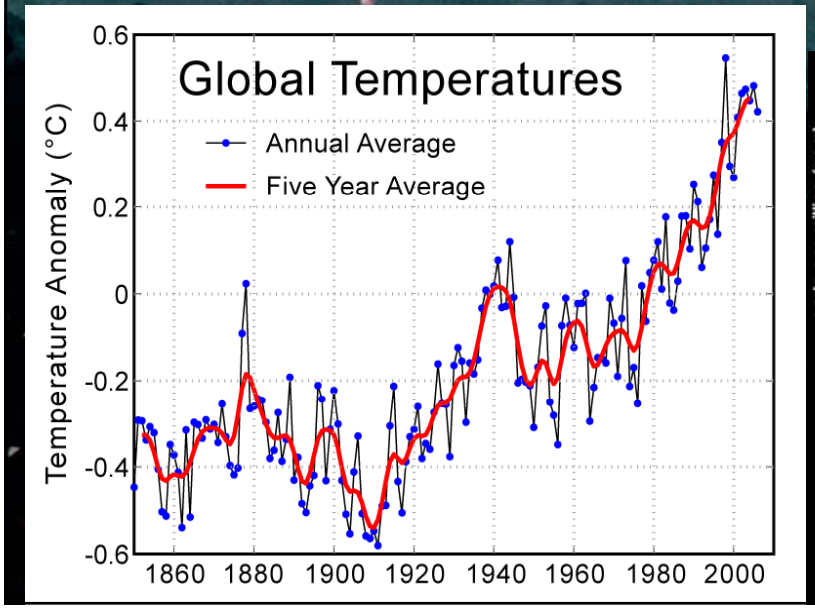
Global Warming? Do YOU believe?

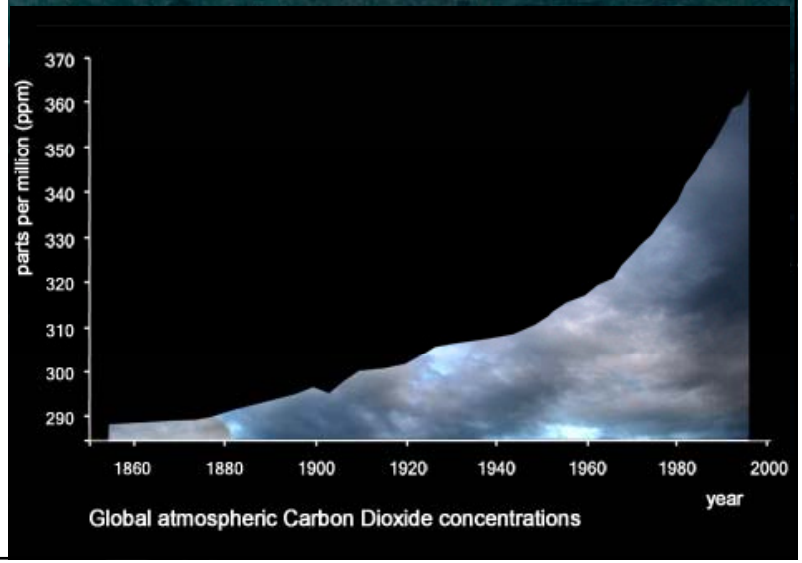
Evidence of Global Warming

- Warming Temperatures
- Carbon Dioxide Increasing in Atmosphere
- Extreme Weather
- Disappearing Glaciers
- Melting Sea Ice
- Greenland's Ice Sheet Melting
- Tropical Diseases Spreading
- Oceans Warming

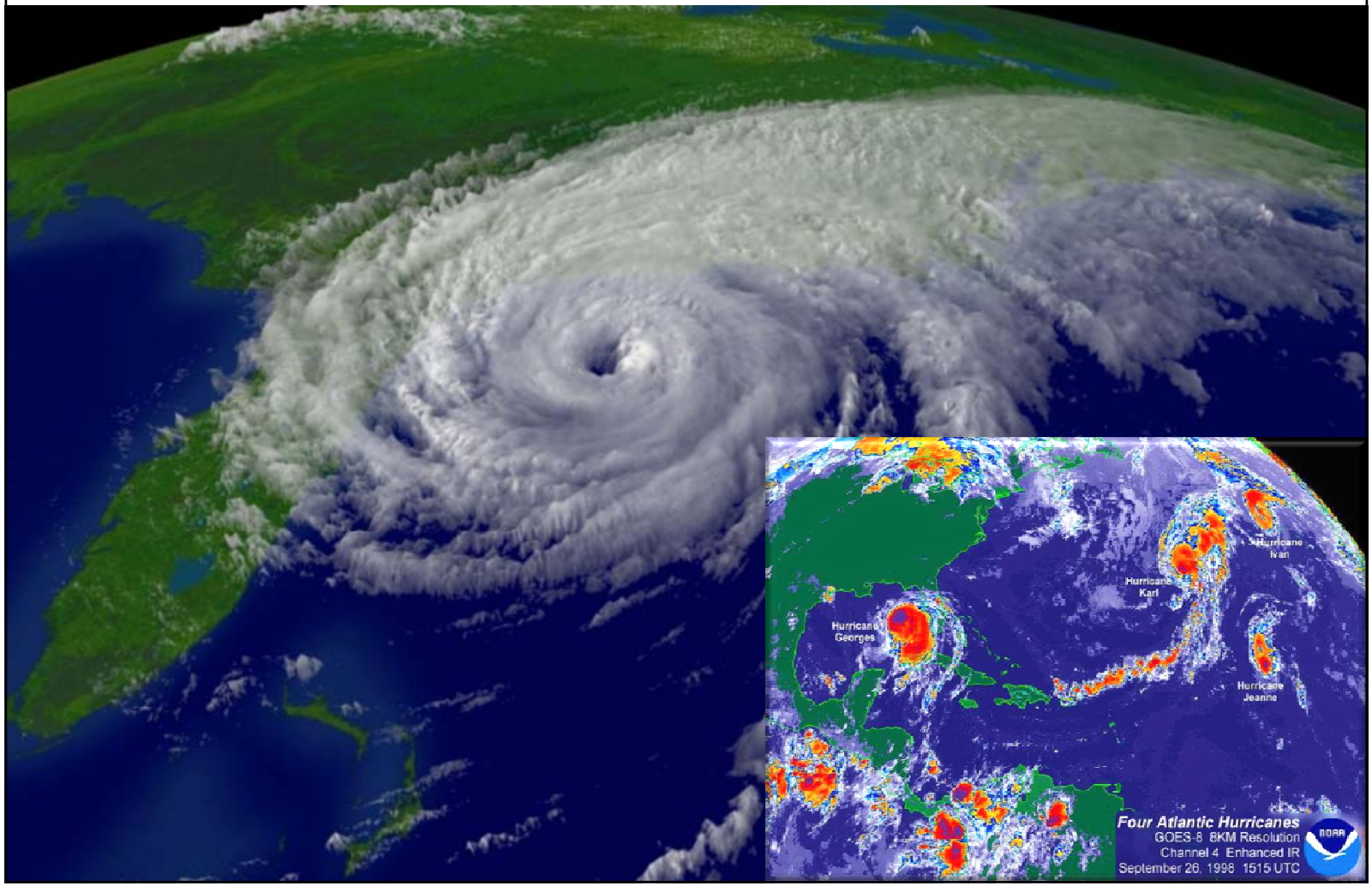


Increased Temp and CO_2 levels





Severe Weather



Heat waves


PORTAGE GLACIER AK, 1914 • NOAA


PORTAGE GLACIER AK
© 2004 GARY BRAASCH
(AERIAL ESTIMATION OF 1914)


North Cascades National Park in 1973

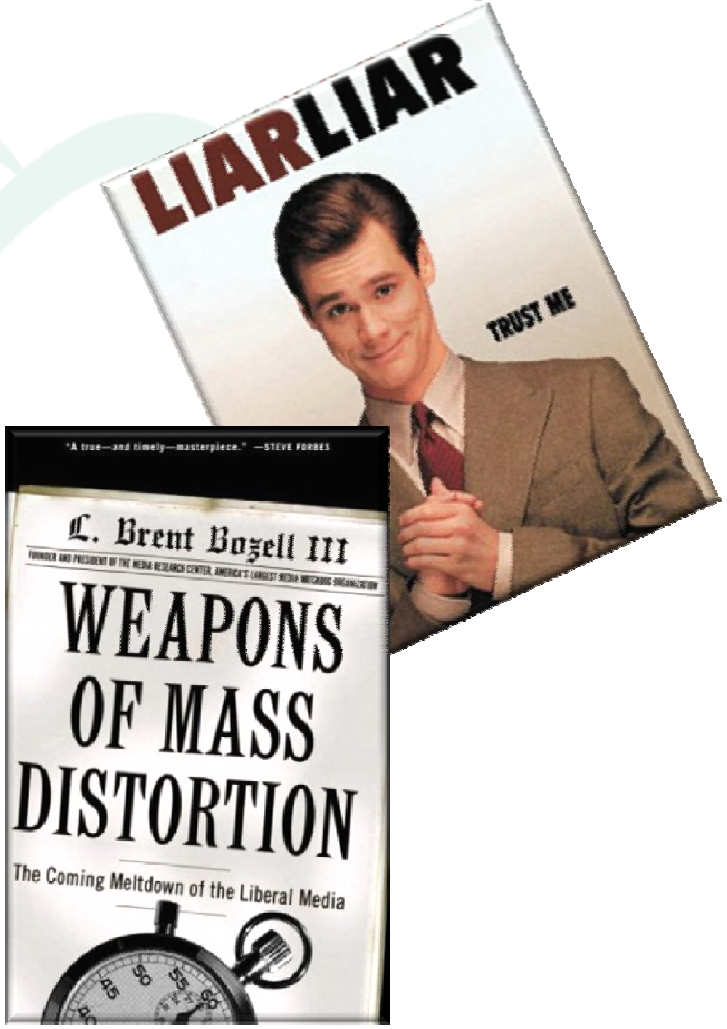

North Cascades National Park in 2006

Global warming is REAL and human activity is related.

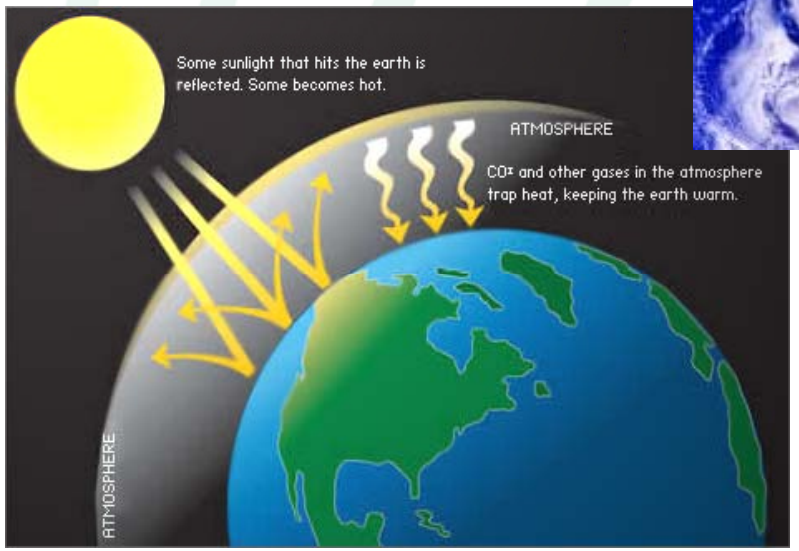
IPCC honored with the 2007 Nobel Peace Prize

The myths about Global Warming

- No Agreement by Scientists
- Global warming is a natural occurrence
- Sea Levels are not rising at an unusual rate
- Some glaciers are melting while others are advancing
- Severe storms are on the decline

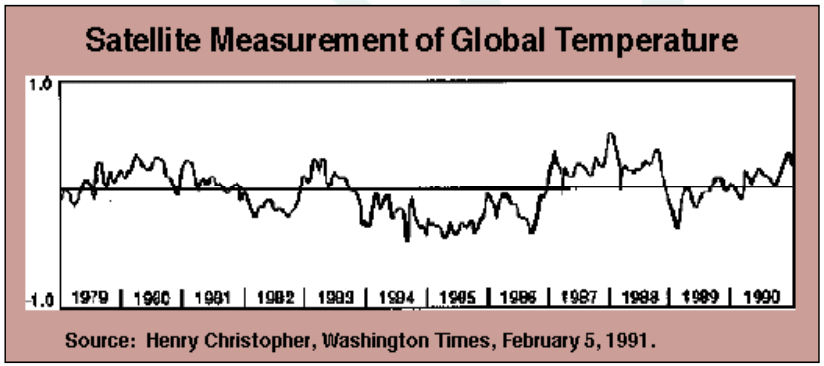


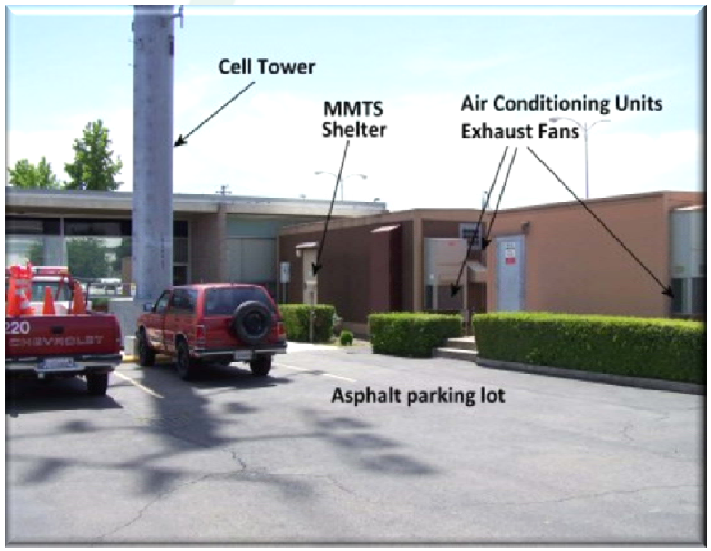
Planet in Crisis? Some say NOT!!



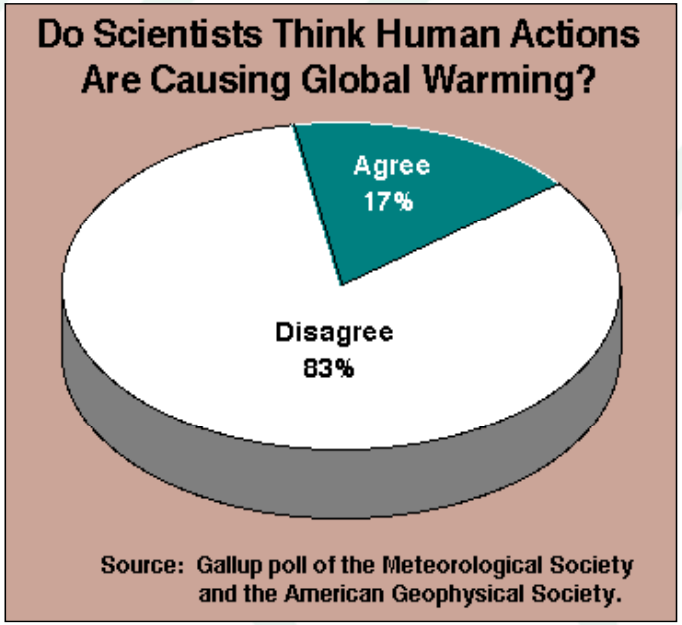
No agreement on global warming!

- No evidence of global warming can be found from 1960 to 1990
- Even if the earth's temperature has increased, it is within the normal range





Global warming is Natural



Climate Changes

- Sea levels have risen more than 300 feet in 18,000 years (prior to human intervention)
- Current rate of increase is less than the average over the last 18,000 years

- The glaciers are melting and reforming
- Natural process
- Mt. Kilimanjaro is melting – Kenya is cooling!

Storms not caused by global warming

- Decrease in intensity and number of storms since the 1940s
- Even 2005 hurricane season did not reverse the downward trend

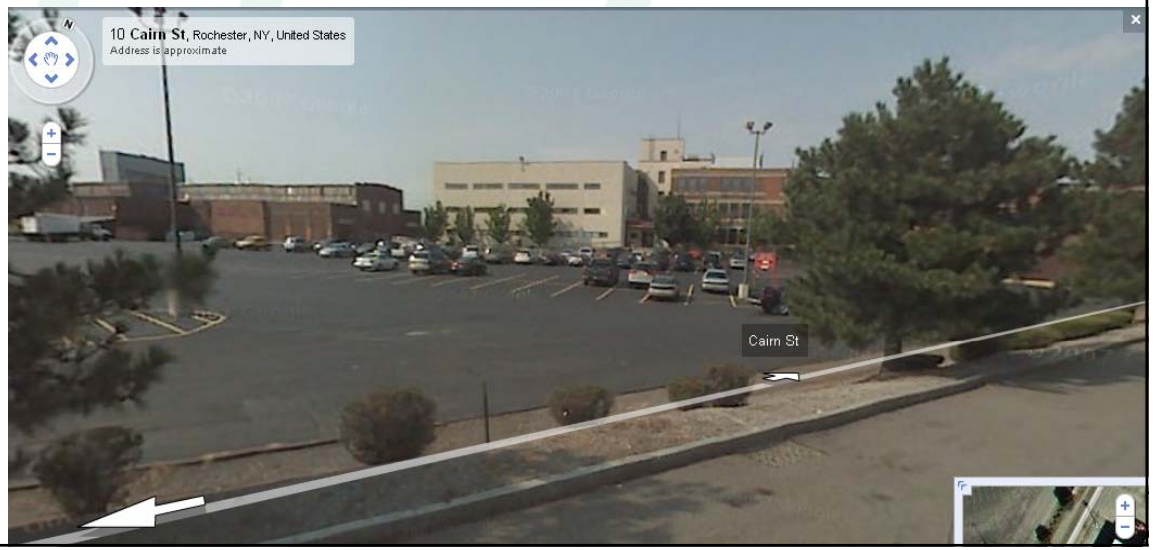
You decide……..

VS

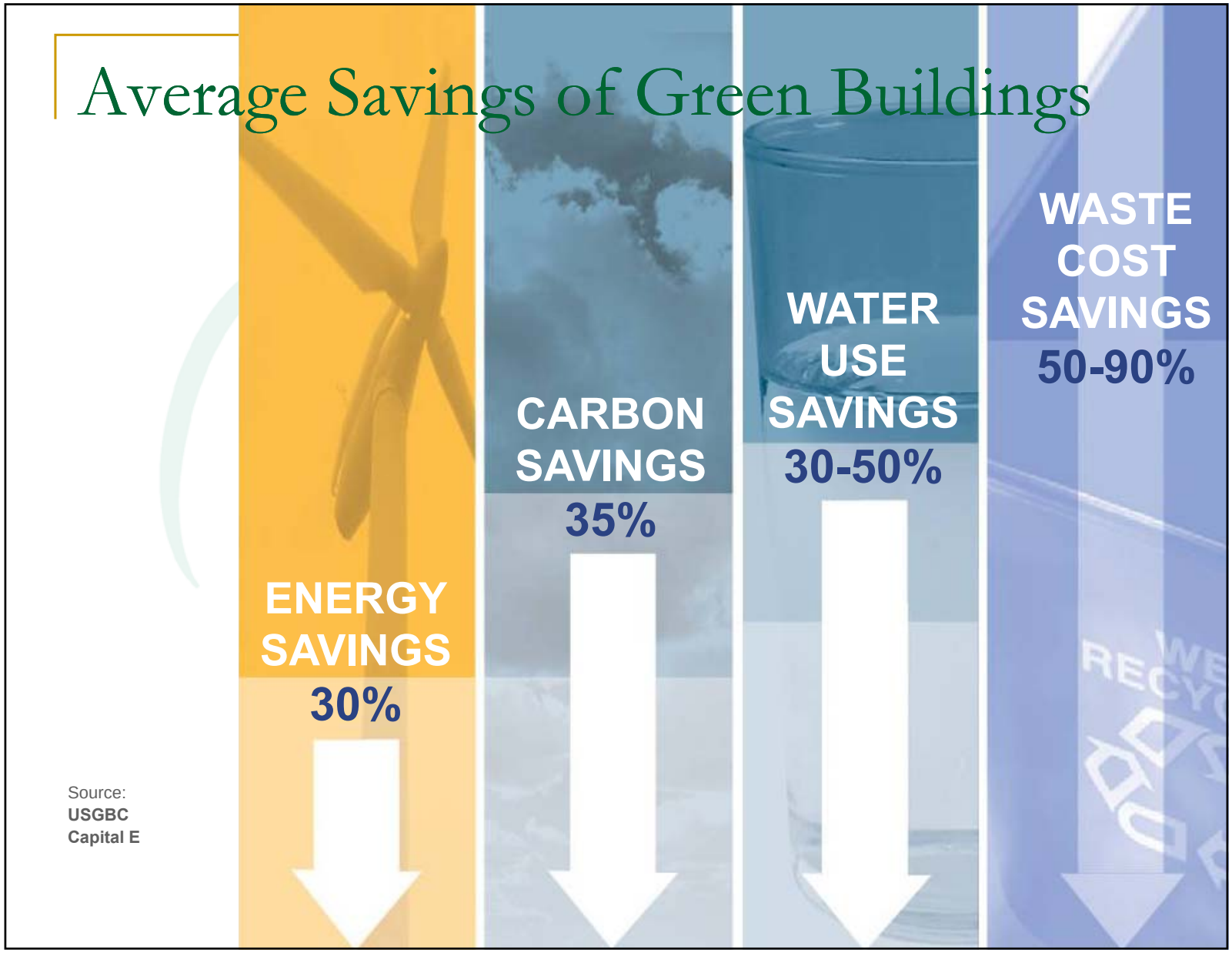
Can't we all just get along?

Impact of Buildings

- Buildings accounted for **39%** of total U.S. energy consumption



Average Savings of Green Buildings



Source:
USGBC
Capital E

Improved Bottom Line

- Energy Savings
- Reduced Liability
- Improved Risk Management
- Increased Value
- Verified Performance
- Increased Productivity of Occupants

Triple Bottom Line

PLANET

PEOPLE

PROFITS

What's Happening NOW!

- Global Economy Pushing Energy Independence
- Everyone is on the Bandwagon
  - Media outlets
  - Government
  - General Public
- Concrete Industry Historic Opportunity

Green Building in the Media

- News Stories:
  - WBZ News – Boston
  - Chicago Tribune
  - Idaho Green Living Story
- TV Shows & Networks

HGTV HOME & GARDEN TELEVISION

Discovery CHANNEL

planet green

diy network

The New York Times
ON THE WEB

Concrete Is Remixed With Environment in Mind

Greensburg, KS

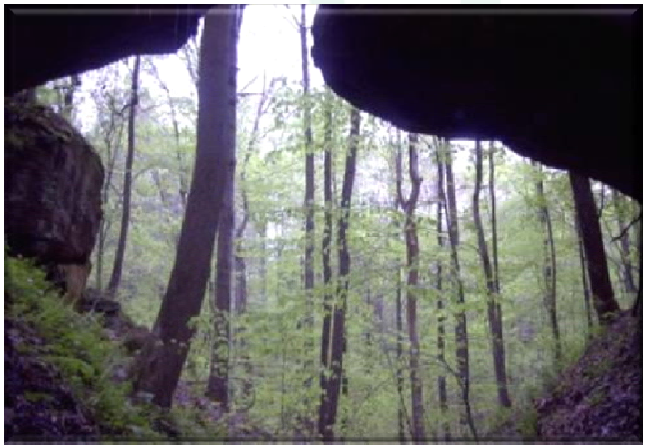
planet green

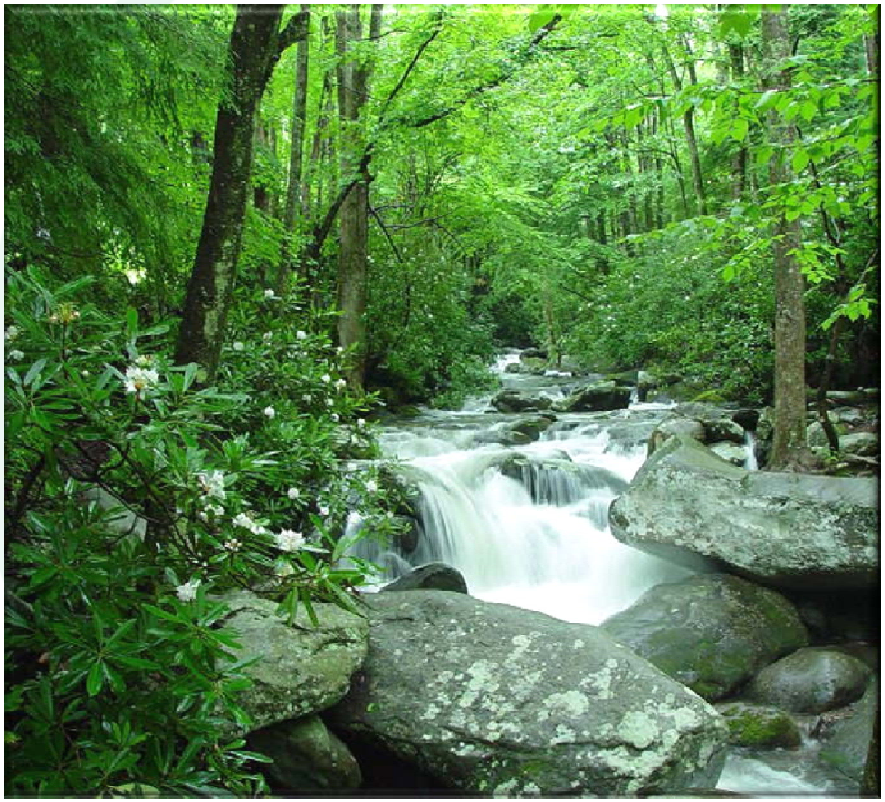
GREENSBURG GreenTown™

YOUR SOURCE FOR EVERYTHING GREEN IN GREENSBURG, KANSAS

CONCRETE offers it ALL

- Versatility
- Sustainability
- Recyclability
- Energy Efficiency
- Durability





Questions?

Lesson 1 – Unit 1 (Part 2)

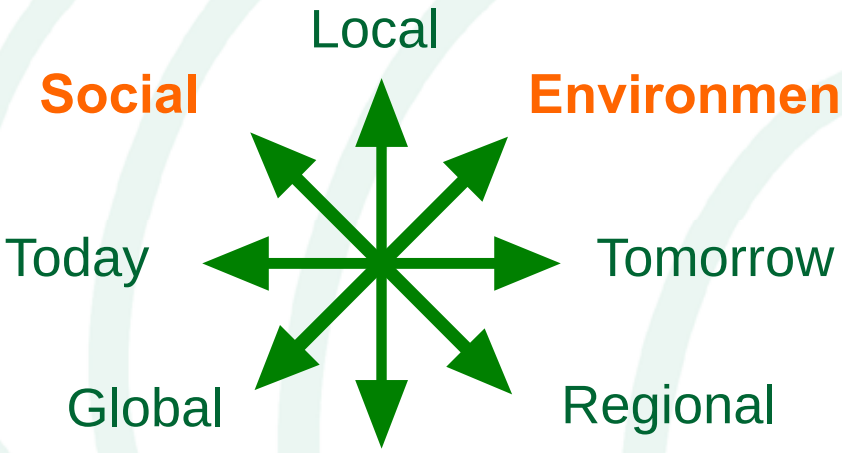
The Environmental Attributes of Concrete


CONCRETE
THE GOOD
THE BAD AND
THE UGLY

Definitions

- What is Sustainable Development?
  - Development that meets the needs of the present without compromising the needs of future generations
  - Encompasses shelter, food, social welfare, health issues, and ecology
- What is Green Building?
  - Focuses on the built environment
  - Minimize environmental impact of buildings
  - A subset of sustainable development

Triple Bottom Line



Cradle to Cradle Perspective

Material Acquisition Phase

The Bad and The Ugly

The Good

Impact of Extracting Materials

- Extraction of any raw material has impact on the environment
- Natural Resources Canada compared impacts in research study
  - Logging (wood)
  - Iron ore mining (steel)
  - Aggregate quarrying (concrete)
- Extracting aggregate for concrete has lower impact than other materials

Impact Index

Resource Impact Index		
Concrete	Aggregate Quarrying Limestone Quarrying	1.00 1.50
Steel	Iron Ore Mining	2.25
Wood	Boreal Timber Harvesting Coastal Timber Harvesting	2.50 3.25

Source: Natural Resources Canada

Logging for Wood

- Disruption per unit of building material is high
- Renewal takes generations
- Stream damage from landslides is common

Source: Natural Resources Canada

Iron Ore Mining for Steel

- Very deep open pit mining
- Mines are rarely restored
- Duration of disruption may be forever

Source: Natural Resources Canada

Aggregate & Limestone Quarrying

- Closely contained and temporary
- Restored within 1 to 2 years
- Most abundant materials on earth

Source: Natural Resources Canada

Manufacturing Phase

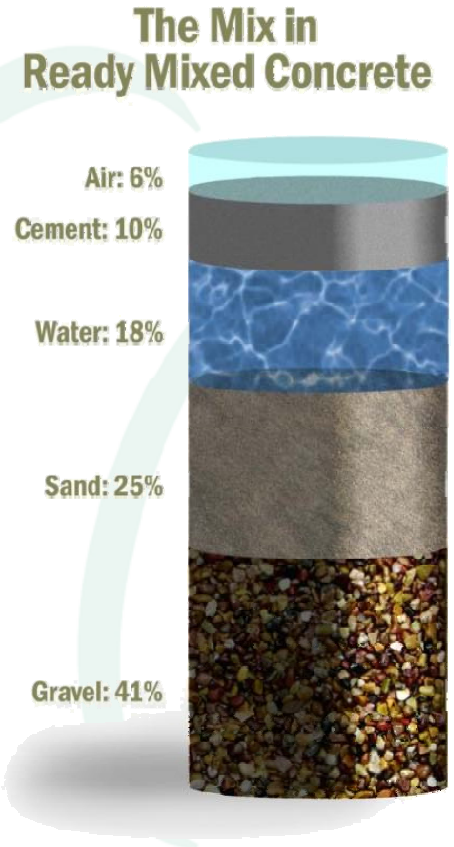
The Bad and The Ugly

The Good

Aesthetics, Noise and Dust

Carbon Dioxide

- Most materials requires little processing
- Low energy of production
- Manufactured and harvested locally
- Low transportation energy
- Contributes to local economy



Does cement manufacturing generate CO_2?

- As with all industrial processes cement generates CO_2
- Made from natural minerals
  - calcium (60%) from limestone
  - silicon (20%)
  - aluminum (10%)
  - iron (10%)
- Heated in large kiln to 1500° C
- Converts raw materials to clinker
- CO_2 generated from two sources
  - Fossil fuels in burning process
  - Calcination - calcium carbonate broken down to calcium oxide with release of CO_2

Cement and CO_2

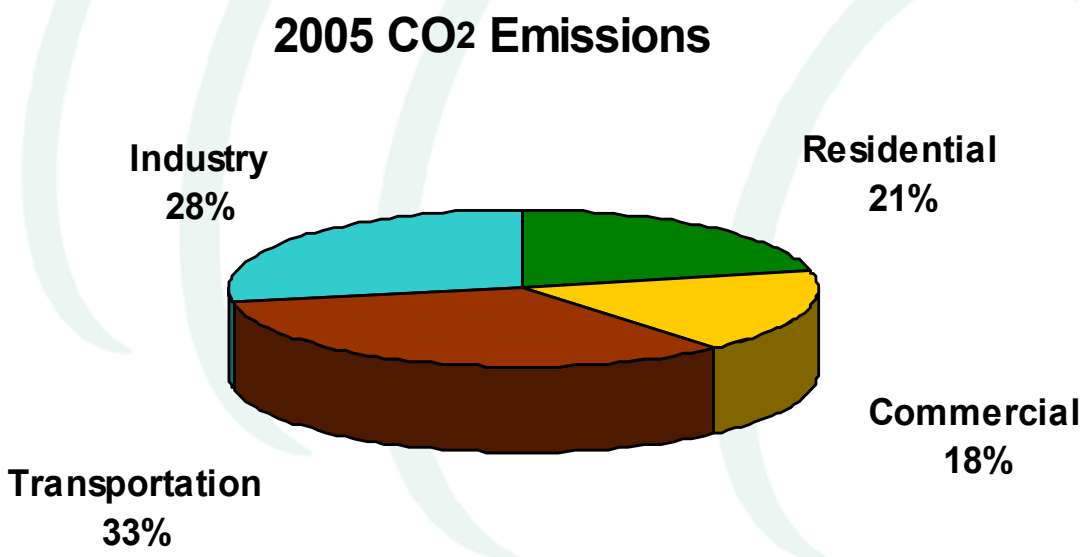
- Most common cement is called portland cement
- Contains about 92% to 95% clinker by weight
- Some companies produce blended cements
  - Incorporate industrial byproducts
  - Reduces amount of clinker in the cement
- Mining equipment and transportation emit relatively small amounts of CO_2
- Energy consumption in the U.S.
  - Petroleum refining (6.5%)
  - Steel production at (1.8%)
  - Wood production at (0.5%)
  - Cement manufacturing (0.33%)

How much CO_2 does cement produce?

- Between 900 and 1100 kg of CO2 emitted for every 1000 kg of portland cement produced
- On average 927 kg of CO_2 emitted for every 1000 kg of portland cement produced
- 50% to 60% is result of calcination
- remaining is result of burning fossil fuels such as coal and natural gas

U.S. Cement CO_2 Emissions

- U.S. cement industry 1.5% of U.S. CO_2 emissions
- Well below other sources



Global CO_2 Production

- Cement accounts for 5% of the global CO_2
- Global cement production in 2005
  - Total: 2300 million metric tons (Mt)
  - China: 1038 Mt
  - India: 145 Mt
  - United States: 96 Mt
- Global emissions will decrease as countries like China replace old kilns

Does concrete manufacturing produce CO_2?

- Water, sand, stone or gravel and other ingredients make up about 90% of concrete
- Mining sand and gravel, crushing stone, combining the materials and transportation concrete requires very little energy
- Emits a relatively small amount of CO_2
- Amounts of CO_2 embodied in concrete primarily function of cement content
- Structures are built with concrete and not cement

How much CO_2 embodied in concrete?

- Small percentage embodied in concrete
- Concrete uses 7% and 15% cement by weight
- The average quantity of cement is around 250 kg/m3
- 100 to 300 kg of CO_2 embodied per cubic meter
- That's 5% to 13% of the weight of concrete
- CO_2 reabsorbed into concrete through carbonation
- 33% to 57% of CO_2 emitted from calcination is reabsorbed through carbonation over 100-year life

How does concrete compare to other building materials?

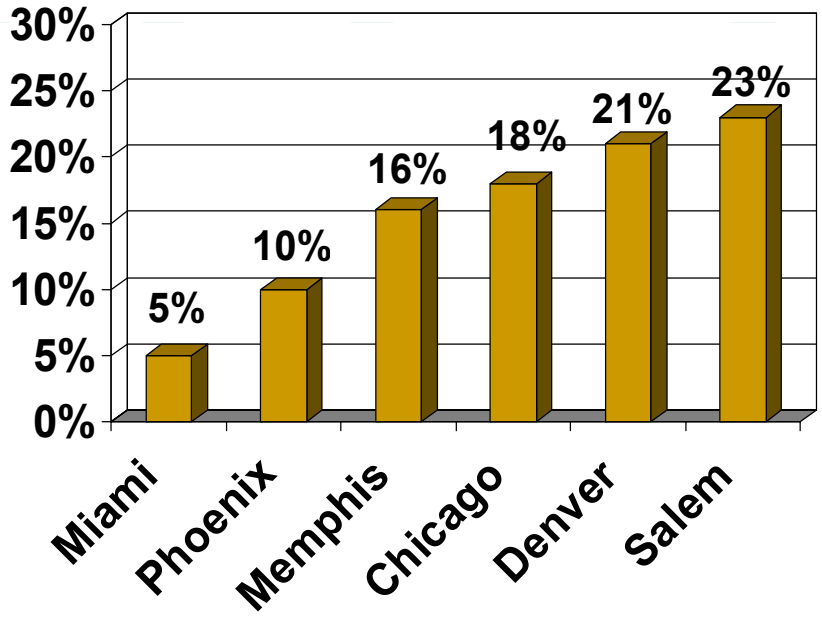
- Concrete has low energy consumption and CO_2 emissions compared to:
  - Steel
  - Wood
  - Asphalt

Concrete vs. Wood Frame

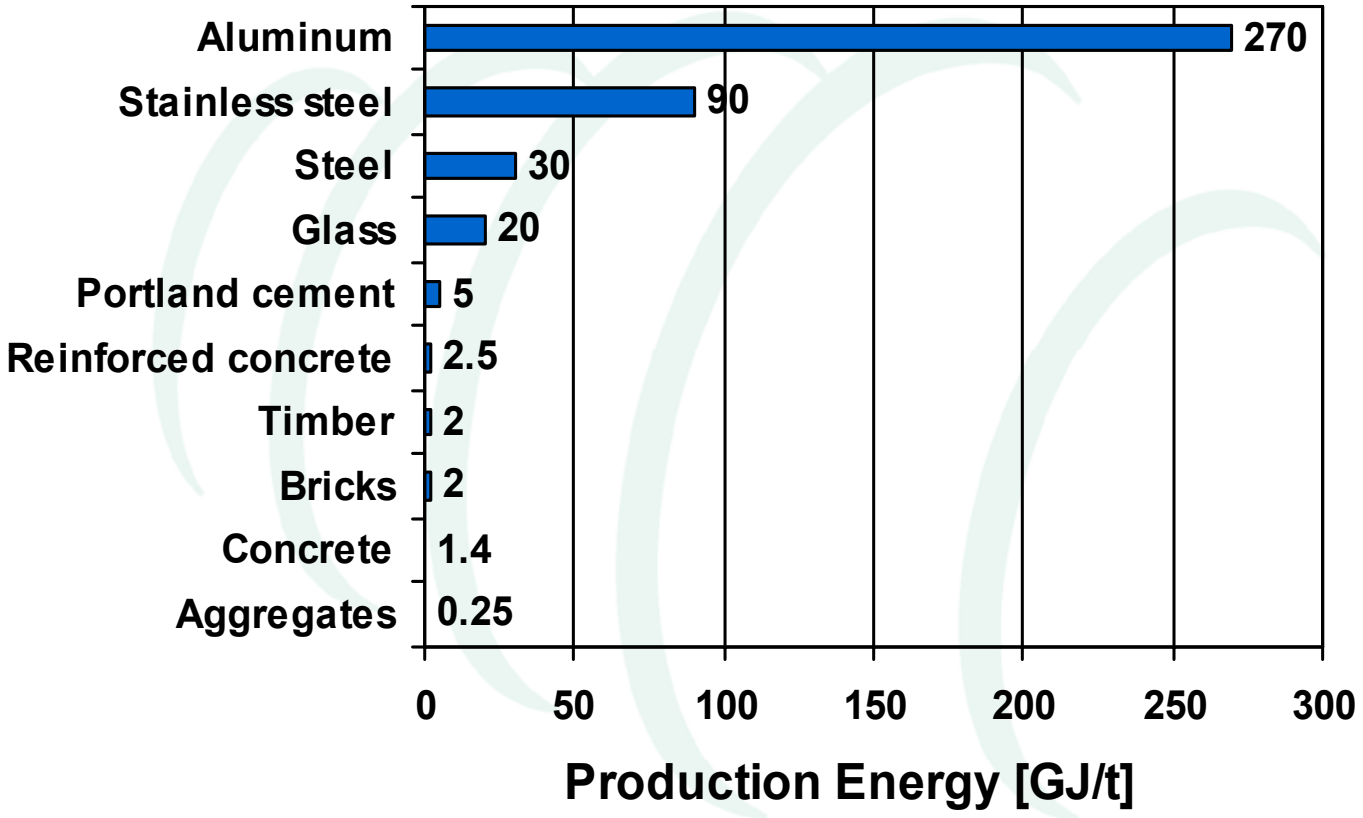
- Thermal mass systems save energy
- Lower CO_2 emissions from building occupancy
- Research study compared energy performance of various concrete wall systems to wood and steel:
  - Concrete systems reduced energy by 17%
  - Stick-frame house must be 2x12 with R-38 insulation to achieve same energy performance as insulated concrete wall comprised of 150 mm of concrete and two layers of 60 mm thick rigid insulation

Concrete Frame Energy Cost Savings

- Compared 5-story office building
  - Steel frame with light frame exterior walls
  - Concrete frame with solid concrete exterior walls



Energy of Production



Concrete Frame vs. Steel Frame

- Study compared the CO_2 emissions of concrete and steel framed buildings
  - Concrete frame accounted for **550 kg** of CO_2 per square meter of floor area
  - Steel frame accounted **620 kg** of CO_2 per square meter of floor area

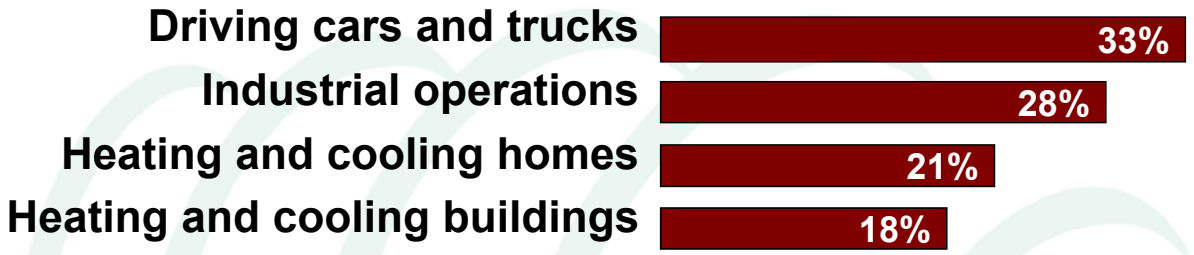
Concrete vs. Asphalt Pavements

Annual Savings and Reductions for Major Urban Arterial Highway			
	Results based on driving on concrete vs. asphalt pavement		
	Minimum 0.8%	Average 3.85%	Maximum 6.9%
Fuel Savings (liters)	377,000	1,813,000	3,249,000
Dollar Savings ($)	338,000	1,625,000	2,912,000
CO_2 Reductions (t)	1,039	5,000	8,950

Concrete vs. Asphalt

- Life cycle analysis on concrete and asphalt roadways
- Compared embodied energy and global warming potential for construction and maintenance over a 50-year life cycle
- For a high volume highway
  - Asphalt pavement required 3 times more energy than concrete pavement
  - Asphalt generated global warming potential of 738 t/km of CO_2 equivalents compared to 674 t/km for concrete

What other human activities generate CO_2?



- Heating, air conditioning, and appliances generate most of the CO_2 throughout a structure's lifetime
- 100-year life-cycle of home
  - 98% CO_2 emissions from the use of natural gas appliances
  - 2% from manufacturing and construction

What is the cement industry doing?

- 33% reduction in CO_2 since 1972
- Additional 10% reduction by 2020 from 1990 levels
- Limestone additions
  - Saves 11.8 Trillion Btus
  - Eliminates 2.5 million tons of CO_2
- Reduce waste by 60%

What is concrete industry doing?

- Committed to continuous environmental improvement
- P2P Initiative (Prescriptive to Performance Specifications for Concrete)
- The P2P Initiative removes limits on materials
- Allows producers to meet performance requirements
- Minimize environmental impact

www.nrmca.org/P2P

Recycled Industrial Byproducts

- Uses of industrial byproducts
  - Fly ash
  - Blast furnace slag
  - Silica fume
- Supplement a portion cement
- Otherwise end up in landfills
- Called supplementary cementitious materials (SCMs)
- Improves strength and durability
- Reduces CO_2 embodied in concrete
  - Typical values 15% to 40%
  - As much as 70%

Environmental Best Practices

- Reuse and recycling of waste from concrete manufacture
  - Wash water
  - Returned concrete
  - Industrial waste water
  - Foundry sands
  - Glass and other
- Materials would otherwise landfilled

Conclusion

- Concrete industry dedicated to continuous environmental improvement
- Through process and product innovation
- Performs well when compared to other building materials
- However, there is always room for improvement
- CO_2 produced is relatively small
- One of the lowest carbon footprints

Construction Phase

The Bad and The Ugly

The Good


TRASH
METAL
PATENT PENDING
CONCRETE WASHOUT SYSTEMS,
1-877-2-WASHOUT

Concrete Construction

- Made specifically for each order
- Little to no waste is generated
- Short transport
- No shipping carton or wrapping
- Leftovers
  - landscaping blocks
  - Traffic barriers

Returned Concrete Options

Batch fresh materials

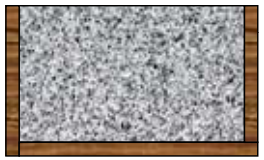
Reship

Paving at plant

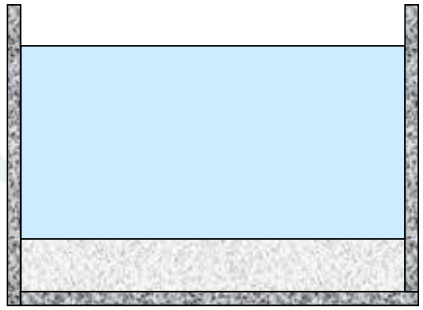
Reclamation

Windrow & Crush

Blocks



Settling pond

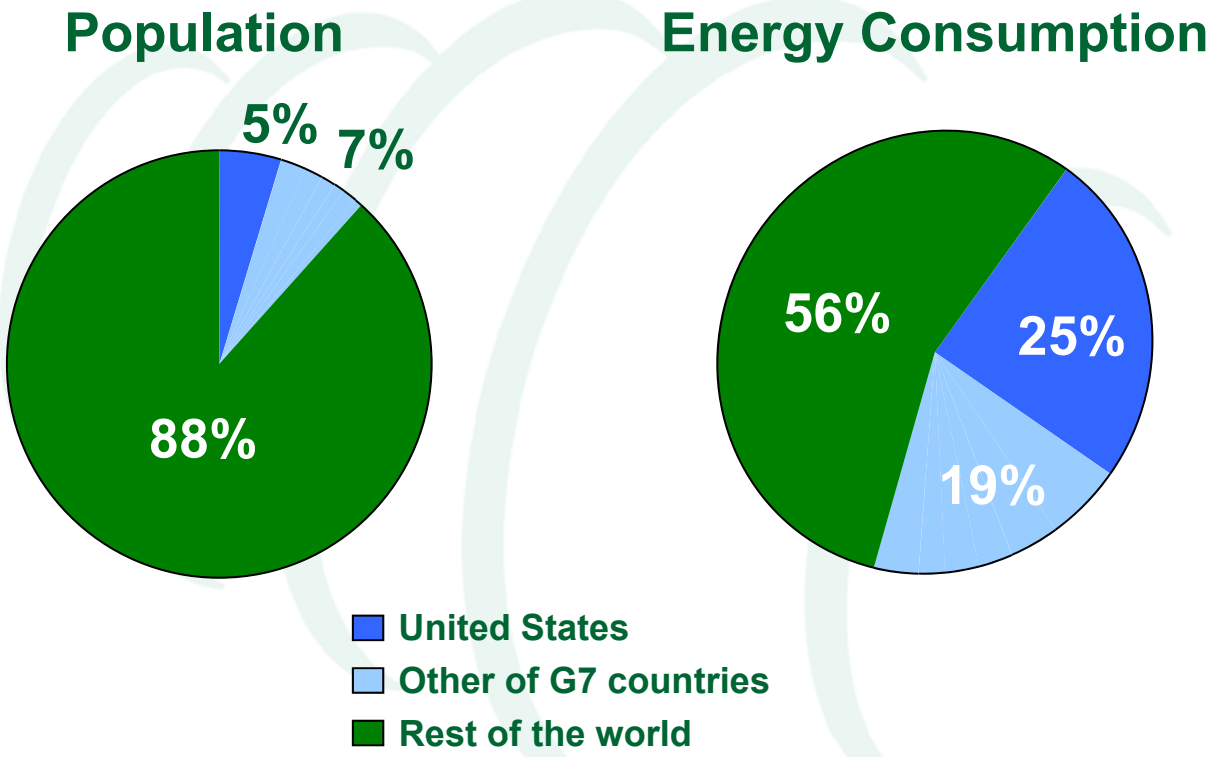


Truck wash, batch plant or discharge after treatment

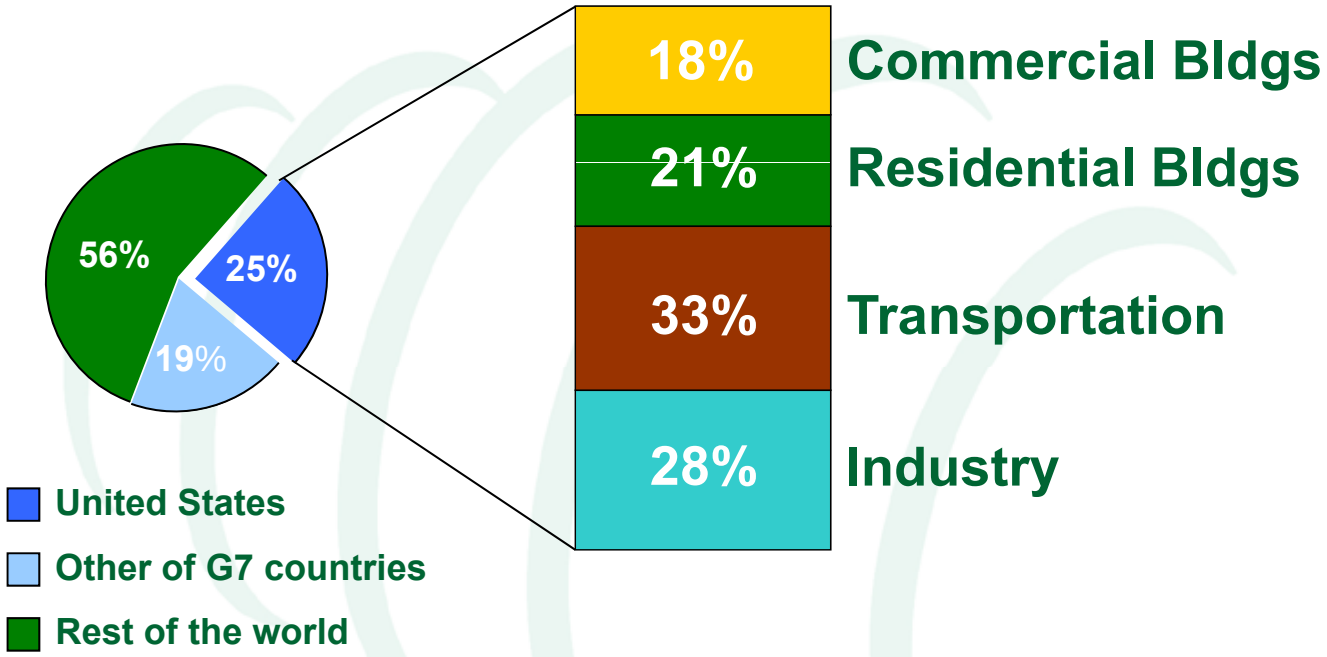
Solids to landfill

Operational Phase

The Bad and The Ugly



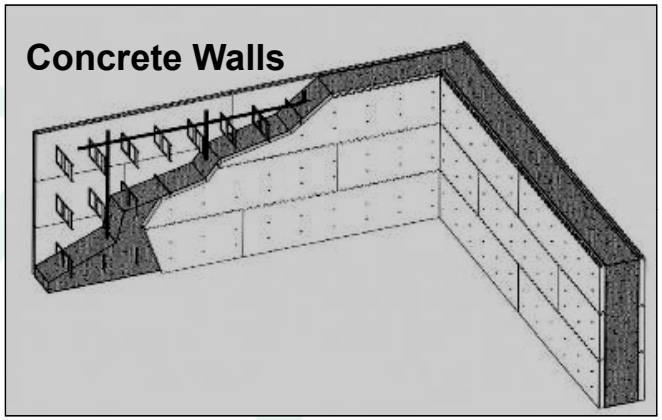
Operational Energy

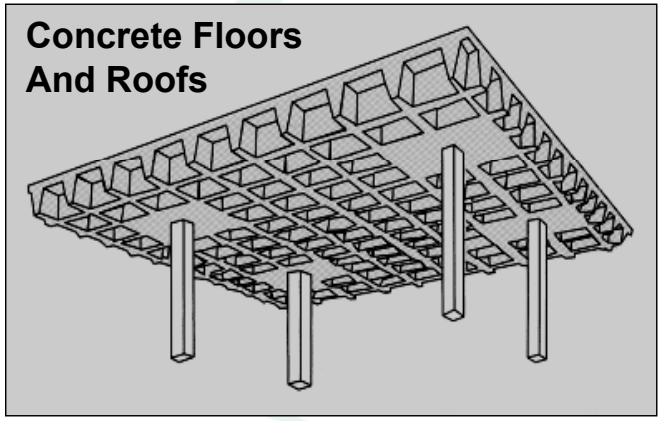


US buildings alone use almost 10% of the world's energy!

The Good

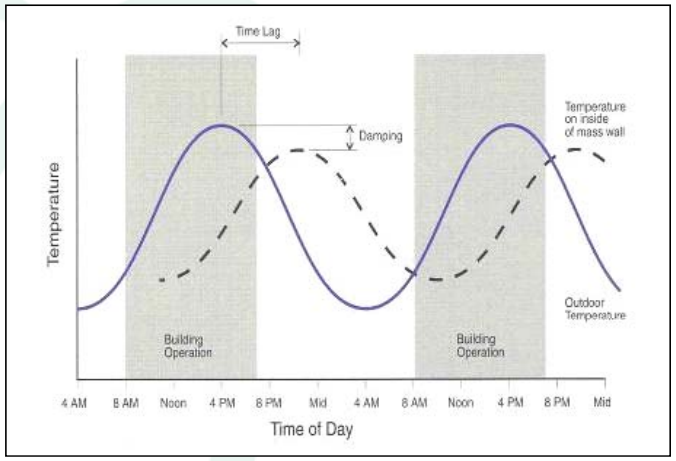
- High Performance Envelopes
  - Insulation on the outside of wall or roof
  - Mass in contact with interior space
  - Superior building envelope





Thermal Mass

- Increase thermal lag
  - Off peak demand
  - Lower energy costs
- Lower peak energy
  - Smaller, more efficient HVAC equipment
- Reduce temperature swings
  - Less heating and cooling energy required



High Performance Wall Systems

Tilt-up Concrete Walls

Insulating Concrete Forms

Removable Form Systems

Passive Solar Design

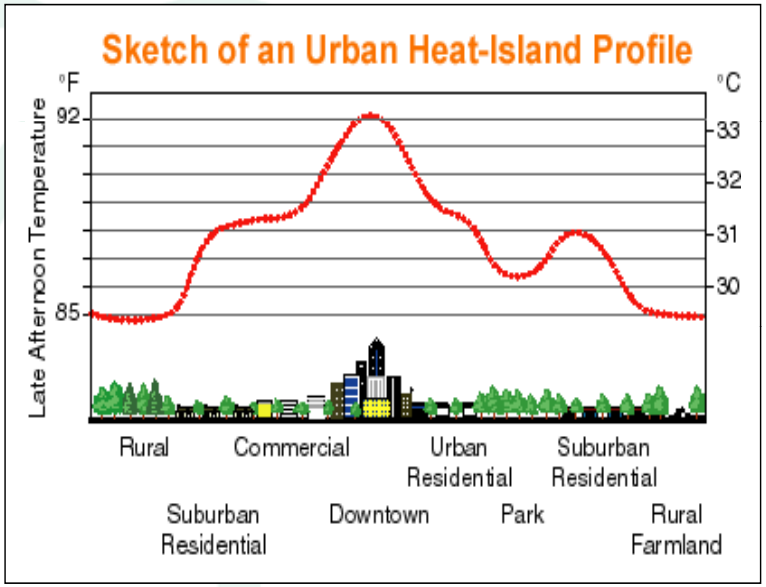
- Daylighting
  - Reduces lighting requirements
  - Heat spaces in winter months
- Solar Shades
  - Reduces solar gain in summer
  - Reflect natural light deep into interior
- Natural Ventilation
  - Provides cooling in summer

Energy Standards

- Thermal mass addressed in building codes
- Buildings
  - ASHRAE 90.1
- Low-rise residential
  - ASHRAE 90.2
- One- and two-family
  - ICC International Energy Conservation Code

Urban Heat Island Effect

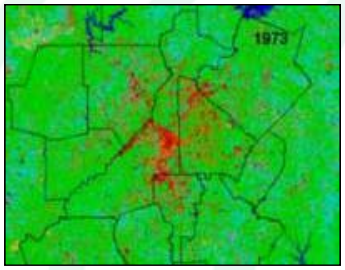
- Residential zones are 3° warmer
- Downtown areas are 7° warmer
- Due to dark-colored roofing and pavement



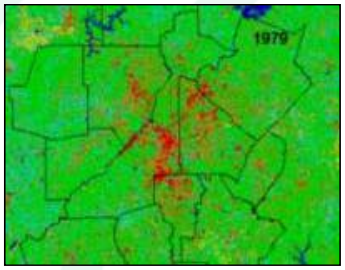
Source: Lawrence Berkeley National Laboratory

Urban Sprawl

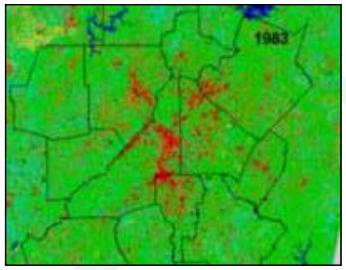
- NASA Thermal Images of Atlanta



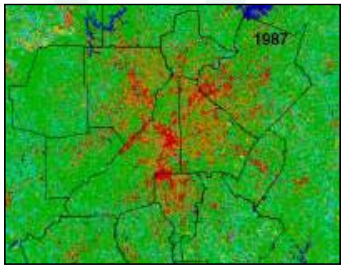
1973



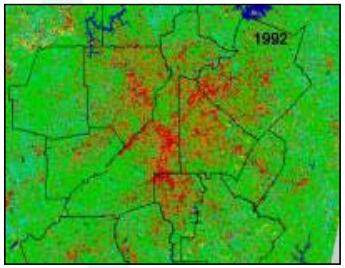
1979



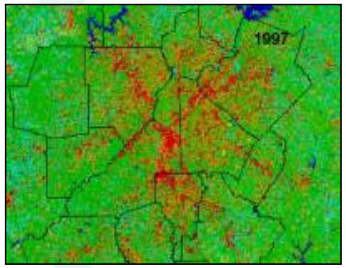
1983



1987

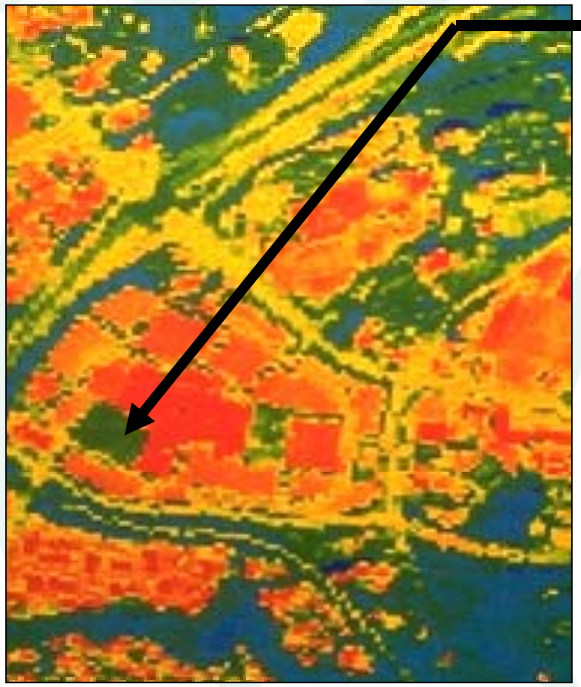


1992



1997

Concrete Parking



Cool Communities

- Use light colored roofing and cladding
- Use light colored pavements
- Landscape shading
- Reduce air temperatures by 5°
- Reduce air conditioning by 18%

Roofing and Cladding

- Concrete roofing and cladding
  - Light colored
  - Highly reflective
- Research shows 40% reduction in cooling energy

Pavement and Landscaping

- Concrete pavement and landscaping
- Article in MIT Technology Review
  - "…blacktopping should be discontinued…"
  - Use light-colored pavements
  - Concrete costs slightly more but has a lower life cycle cost

Reduced Lighting Requirements

- 30% fewer fixtures can produce the same level of lighting on concrete compared to asphalt

Source: Road Surface's Reflectance Influences Lighting Design" RP269.01P, R. E. Stark, Portland Cement Association, April 1986.

Stormwater Management

- Pervious Concrete
  - 15-25% voids
  - Rainwater percolates through the slab
  - Minimizes runoff to surrounding streams and lakes
  - Functions like retention basins
  - Recharges groundwater supplies

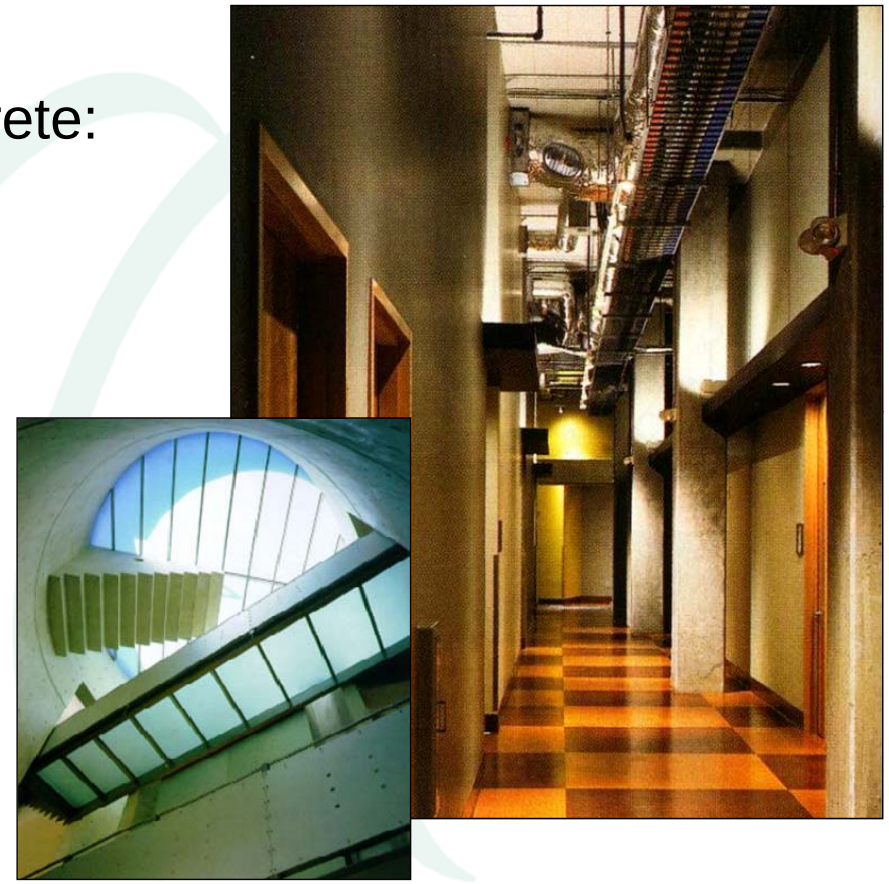
Indoor Air Quality

Building Material	*VOC Emission (mg/m^3h)*
Vinyl flooring	2.3
Particle board	2.0
Plywood	1.0
Acrylic Latex Paint	0.43
Linoleum	0.22
Carpet	0.080
Gypsum board	0.026
Concrete	0.003

Source: University of Western Ontario

Reduce VOC Emissions

- Use exposed concrete:
  - Decorative floors
  - Textured walls
  - Exposed ceiling



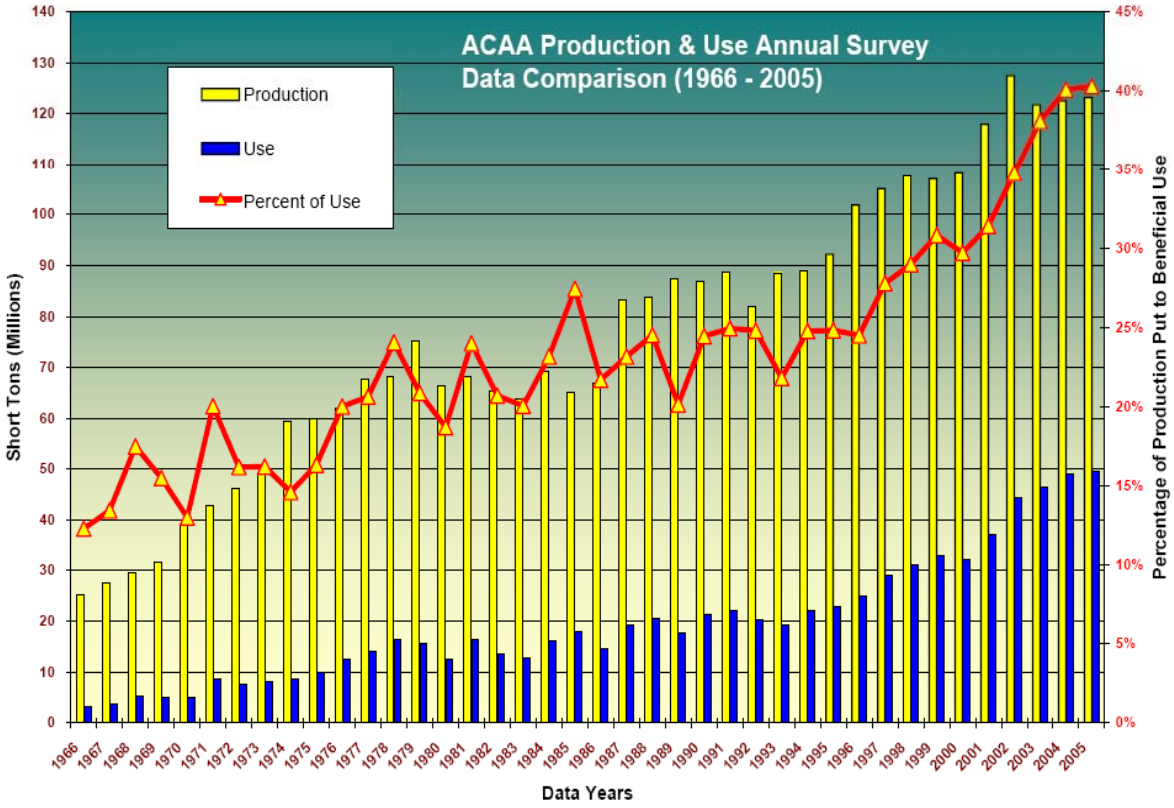
Durability and Versatility

- Most widely used building material
- Extremely durable
  - Doesn't rot
  - Doesn't rust
  - Doesn't burn
- Low maintenance
- 2000 year track record of performance

Reuse/Recycling Phase

The Bad and The Ugly

Aggr
ASTI
to 1M
22%
retai
NoF
c



e 8%
% to
the

The Good

- Committed to continuous environmental improvement
- P2P Initiative (Prescriptive to Performance Specifications for Concrete)
- The P2P Initiative removes limits on materials
- Allows producers to meet performance requirements
- Minimize environmental impact

Supplementary Cementitious Materials

- Fly ash
  - From coal-fired electrical power plants
- Blast furnace slag
  - From steel manufacturing
- Silica Fume
  - From silicone manufacturing

Specifying SCMs

- Concrete:
  - Reference ASTM C 94
  - Permits the use of SCMs
- Fly ash:
  - Reference ASTM C 618
  - Replace from 5 to 65 percent
- Blast furnace slag:
  - Reference ASTM C 989
  - Replace from 20 to 70 percent
- Silica fume:
  - Reference ASTM C 1240
  - Replace from 5 to 12 percent,

Key to high performance

- High Performance
  - Improves durability
  - Increases strength
  - Improves constructability
- Environmental Benefits
  - Reduces waste
  - Reduces raw material extraction
  - Reduces energy of production
  - Reduces CO_2

Recycled concrete

- Fills and bases
- Roadways and parking areas
- Driveways and sidewalks
- Shoulders, curbs, gutters
- Landscaping features
- Foundations
- Some Concrete Structures

Summary

Concrete Feature	Environmental Benefit
Most ingredients require little processing	Minimizes energy of production
Most materials harvested and manufactured locally	Minimizes transportation energy
Building systems combine insulation and thermal mass	Homes and buildings more energy efficient
Long service life	Minimizes reconstruction, repair and maintenance
Pavement and exterior cladding are light in color	Minimizes urban heat island effect
Incorporates recycled industrial byproducts	Reduces the energy required for manufacturing
Absorbs CO_2 throughout its lifetime through carbonation	Reduces carbon footprint

Questions?

Take Remainder of the Course

- Use registration form provided
- 20% discount for conference attendees
- Could skip Lesson 1 – Unit 1
- Must complete Lesson 1 – Unit 2 and 3 online
- Must complete Lesson 2, 3, and 4 online

NRMCA Course Schedule

- Design of Concrete Pavements Online Course
  - January 10-14, 3:30 – 5:00 pm
- Concrete's Role in Sustainable Development Online
  - January 17-20, 12:00-2:00 pm eastern
- Building Green with Concrete Online
  - February 14-18, 12:00 – 2:00 pm eastern
- Pervious Concrete: A Stormwater Solution Online
  - February 28 – March 3, 3:00 – 4:30 pm eastern
- Life Cycle Assessment of Concrete Structures Online
  - March 7-10, 12:00 – 1:30 pm eastern
- LEED Green Associate Exam Study Course Online
  - April 4, 8, 11, 15, 18, 22, 25, 29, May 2, 6, 9, 13, 16, 20, 23, 27
  - 12:00 – 2:00 eastern
- 2011 International Concrete Sustainability Conference
  - August 9-11, Boston

Thank you

Feel free to contact me with questions or comments at:

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