American Concrete Institute®
Advancing concrete knowledge

ACI Concrete Sustainability Forum
Part 2 of 3

ACI Fall 2009 Convention
Nov. 7, New Orleans, LA

ACI WEB SESSIONS

ACI Web Sessions

The audio for this web session will begin momentarily and will play in its entirety along with the slides.

However, if you wish to skip to the next speaker, use the scroll bar at left to locate the speaker's first slide (indicated by the icon in the bottom right corner of slides 9, 37, 55, and 95). Click on the thumbnail for the slide to begin the audio for that portion of the presentation.

ACI WEB SESSIONS

ACI Web Sessions

ACI is bringing you this Web Session in keeping with its motto of "Advancing Concrete Knowledge." The ideas expressed, however, are those of the speakers and do not necessarily reflect the views of ACI or its committees.

Please adjust your audio to an appropriate level at this time.

ACI WEB SESSIONS

ACI Web Sessions

ACI Web Sessions are recorded at ACI Conventions and other concrete industry events. Each week, a new set of presentations can be viewed on ACI's website free of charge.

After one week, the presentations will be temporarily archived on the ACI website or made part of ACI's Online CEU Program, depending on their content.

ACI WEB SESSIONS

Spring 2010 ACI Seminars

- ACI/PCA Reinforced Concrete Design
- ACI/PCA Simplified Design of Reinforced Concrete Buildings of Moderate Size and Height
- Troubleshooting Concrete Construction
- Concrete Repair Basics
- Concrete Slabs-on-Ground

Locations and Dates:

•San Francisco, CA Apr. 20-21 •New Brunswick, NJ May 25-26

Locations and Dates:

•Chicago, IL May 11-12 •Cincinnati, OH

Locations and Dates:

•Los Angeles, CA June 8-9

•San Diego, CA Mar. 25 •Jacksonville, FL May 6

Locations and Dates:

•Washington, D.C. Apr. 7 •Atlanta, GA May 5

•Miami, FL •Phoenix, AZ May 20

Locations and Dates:

•Philadelphia, PA Apr. 6 •San Antonio, TX May 4

•Seattle, WA •Portland, OR Apr. 14 •Kansas City, MO •Dallas, TX May 19

•Milwaukee, WI •Nashville, TN June 10

•Indianapolis, IN Apr. 13 May 18

•Charlotte, NC Apr. 21 •Chicago, IL

•Baltimore, MD Apr. 15 May 27

Apr. 20

•Boston, MA Apr. 29

Visit www.ConcreteSeminars.org for more information.

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ACI Conventions

ACI conventions provide a forum for networking, learning the latest in concrete technology and practices, renewing old friendships, and making new ones. At each of ACI's two annual conventions, technical and educational committees meet to develop the standards, reports, and other documents necessary to keep abreast of the ever-changing world of concrete technology.

With over 1,300 delegates attending each convention, attendees are afforded ample opportunity to meet and talk individually with some of the most prominent persons in the field of concrete technology. For more information about ACI conventions, visit www.aciconvention.org.

Chicago, IL, Mar. 21-25 Pittsburgh, PA, Oct. 24-28

ACI WEB SESSIONS

ACI Web Sessions

This ACI Web Session includes four speakers presenting at the ACI Concrete Sustainability Forum held in New Orleans, LA, on Nov. 7, 2009, just prior to the ACI Fall 2009 Convention.

Additional presentations from this forum will be made available in future ACI Web Sessions.

Please enjoy the presentations.

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American Concrete Institute®
Advancing concrete knowledge

ACI Concrete Sustainability Forum

Part 2 of 3

ACI Fall 2009 Convention
Nov. 7, New Orleans, LA

ACI WEB SESSIONS

Steve Szoke, P.E., LEED AP, is Director of Codes and Standards for the Portland Cement Association in Skokie, Illinois. He graduated with a Bachelor of Science degree in Civil Engineering from Lehigh University, in his native state of Pennsylvania. He is a registered professional engineer in Virginia and the District of Columbia. His accomplishments and activities related to sustainability include past chair and honorary member of the Sustainable Building Industry Council; International Code Council Sustainable Buildings Technology Committee, which developed the draft version of the *International Green Construction Code*; ASTM Committee E60 on Sustainability; and ACI Committee 122, Energy Efficiency of Concrete and Masonry Systems.

ACI WEB SESSIONS

High-Performance Building Requirements for Sustainability

Energy Efficiency
Sustainability
Disaster Resistance
Durability

Presentation for the Concrete Sustainability Forum
November 7, 2009

Scope

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality

Functional Resilience

High-Performance Buildings

Functional Resilience

ACI WEB SESSIONS

High-Performance Buildings

IBC Minimum Code

\+ Sustainability

\+ Resilience

= High Performance

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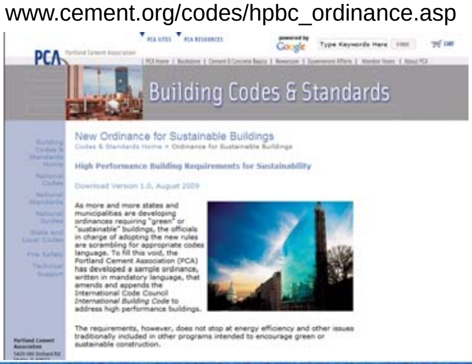
High-Performance Buildings

www.cement.org/codes/hpbc_ordinance.asp



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High-Performance Buildings

Service Life Plan

- Design Service Life
- Construction Material
- Maintenance Costs

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High-Performance Buildings

High Performance Fire Safety

- Mandatory Sprinklers
  - Except F-2 & S-2
- Structural fire resistance
  - Emphasis on I-1 & R
- Redundant fire safety

Sprinkler Trade-offs

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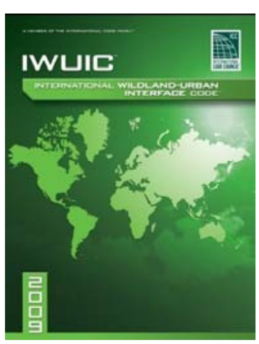
High-Performance Buildings

Wildland-Urban Interface Code

Mandatory



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High-Performance Buildings

Storm Shelters

- ICC 500, *Standard on the Design and Construction of Storm Shelters* in 2009 IBC
  - Covers shelters in high wind regions
  - Specifies which occupancies in hurricane regions

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High-Performance Buildings

Interior Finishes

- VOC restrictions for carpets, adhesives, and paints
- Urea-formaldehyde restrictions for composite woods and agrifiber products

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High-Performance Buildings

Interior Environment

- Minimum requirements for health for ventilation, temperature, light, sound
- Improved air quality
- Improved living environment
- Carbon dioxide (CO^2) detectors
- Minimum Efficiency Reporting Values (MERV) of filters
- No-smoking policies and reserved areas

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High-Performance Buildings

Interior Environment – Comfort

Sound Transmission Requirements:

- Expanded to Occupancies A, B, E, I and M
- Include special requirements for classrooms
- Distinguish indoor sound transmission from outdoor sound transmission
- Apply outdoor sound transmission to exterior wall and roof assemblies

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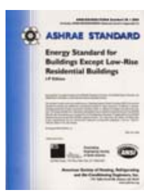
High-Performance Buildings

Energy Efficiency

- Exceeds mandatory requirements based on the IECC, including ASHRAE Std 90.1 by 20%



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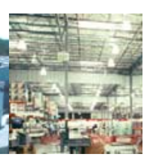
High-Performance Buildings

Energy Efficiency

- Interior daylighting from skylights



- Fenestration area limits for exterior envelope

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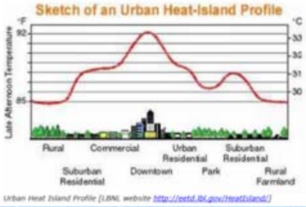
High-Performance Buildings

Energy Efficiency

- Minimum solar reflectance indices (SRI) for exterior walls and roofs



Urban Heat Island Profile (LBNL website http://eetd.lbl.gov/HeatIsland/)

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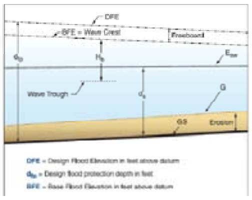
High-Performance Buildings

Structural Design – Flood

- Design flood elevation
- 3 feet above BFE
- 500-year flood



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High-Performance Buildings

Structural Design – Flood

- Revises ASCE 24 to prohibit levees, dams, floodwalls being considered protection

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High-Performance Buildings

Other Sections

- Plumbing – water use reduction
- Plumbing – water metering
- Conveying – stop when not in use
- Indoor Air Quality – filters and flushes

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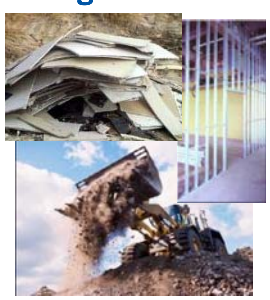
High-Performance Buildings

Construction Waste Management

- Diversion
- Concealment
- Waste limit per 10,000 sf
  - 42 cubic yards
  - 12,000 lbs



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High-Performance Buildings

Reduce, Reuse, Recycle

- Total Material Resource Factor = 10%
  - Recycled – Pre-consumer (0.5 multiplier)
  - Recycled – Post consumer (1.0 multiplier)
  - Reused (1.5 multiplier)
  - Reduced – Manufacture (1.0 multiplier)
  - Reduced – Design (1.5 multiplier)
  - Bio-based (1.0 multiplier)

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High-Performance Buildings

20% Regional Materials

- 55 gals of diesel fuel per ton
- 320 gals of diesel fuel per cu. yd
- 250 miles
- Alternative fuels

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High-Performance Buildings

Pollution Prevention

- Clean Air PLUS
- Clean Water PLUS
- Resource Conservation and Recovery PLUS
- Noise Control

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High-Performance Buildings

Parking Areas & Drives – Serviceability

Concrete Pavement

- 4-in. concrete
- ACI 330 – *Design and Construction of Concrete Parking Lots*

Asphalt Pavement

- 1-in. wearing / 3-in. asphalt base
- 1-in. wearing / 2-in. asphalt base / 3 in. aggregate
- TAI – *Asphalt Pavement Thickness Design*

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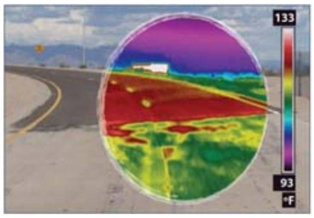
High-Performance Buildings

Heat Island Effect — 50% of Parking Area

- Shaded
  - Structures
  - Planting
- Solar Reflectance
  - 29 (18 for 100%)
- Pervious Pavement



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High-Performance Buildings

Lighting — Level

- Reduced lighting levels jeopardize
  - Safety
  - Security
- Alternate
  - Reflective surfaces
  - Lower lighting loads
  - Requirement lighting levels for safety and security

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High-Performance Buildings

Thank you!

High-Performance Building Requirements for Sustainability

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Lionel Lemay, PE, SE, LEED AP, CAE, is Senior Vice President, Sustainable Development, for the National Ready Mixed Concrete Association (NRMCA). He manages programs to assist producers, contractors, and designers in transforming concrete manufacturing and construction, to improve overall sustainability of the concrete industry. He has written numerous articles on construction and is co-author of the McGraw-Hill book *Insulating Concrete Forms for Residential Design and Construction*. Mr. Lemay holds a bachelor's and master's degree in Civil Engineering and Applied Mechanics from McGill University in Montreal, Canada.

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NRMCA Footprint Reduction Strategies

Lionel Lemay, PE, SE, LEED AP
Sr. VP, Sustainable Development

NRMCA

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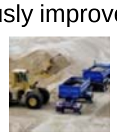
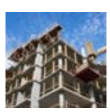
Best Practice:

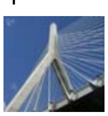
- Continuously improve process



- Continuously improve product



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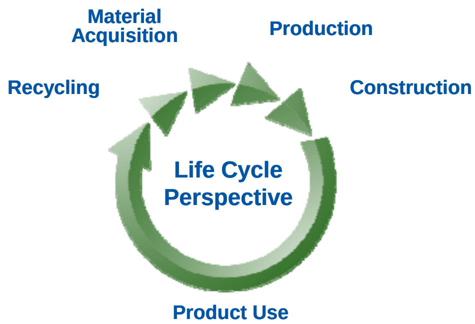
"The discipline of writing something down is the first step toward making it happen."

Vision

The vision of the ready mixed concrete industry is to transform the built environment by improving the way concrete is manufactured and used in order to achieve an optimum balance among environmental, social and economic conditions.



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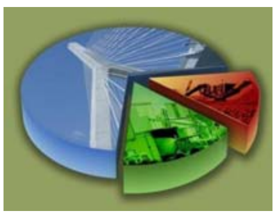
Objectives

- Minimize Energy Use
- Reduce Emissions
- Conserve Water
- Minimize Waste
- Increase Recycled Content



Measure Progress

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Targets Per Unit of Concrete Produced*

- Embodied energy:
  - 20% reduction by 2020
  - 30% reduction by 2030
- Carbon footprint:
  - 20% reduction by 2020
  - 30% reduction by 2030
- Potable water:
  - 10% reduction by 2020
  - 20% reduction by 2030
- Waste:
  - 30% reduction by 2020
  - 50% reduction by 2030
- Recycled content:
  - 200% increase by 2020
  - 400% increase by 2030

** From 2007 Levels*

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Strategies

- Research
- Education
- Advocacy
- Measurement

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“It is not fair to ask of others what you are not willing to do yourself.”

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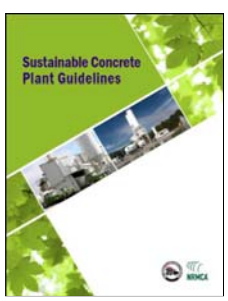
Rating system for concrete plants

- Voluntary program
- Positive image to community
- Energy and cost savings
- Increase productivity
- Contribute to company’s profits



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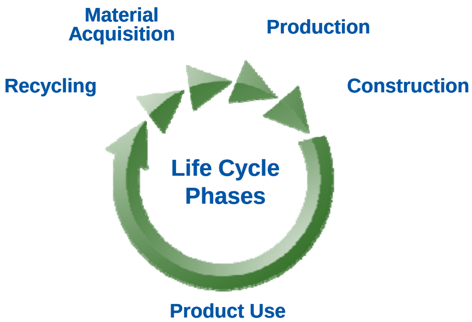
Credit Categories



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Impact Categories

- Embodied Energy
- Carbon Footprint
- Water Use
- Waste
- Recycled Content
- Social Concerns and Human Health

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Concrete Sustainability Hub

Funding

- $10M total industry investment over 5 years
- $2M annually
- Cost 50/50 between RMCREF and PCA

Work Plan

- Lifecycle Investigation of Concrete and Concrete Structures
- Green Concrete Science

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CONCRETE SUSTAINABILITY CONFERENCE

APRIL 13-15, 2010 - TEMPE, AZ

- Topics include
  - Sustainable Concrete Construction
  - Sustainable Concrete Manufacturing
- Call for Abstracts
  - November 20

NRMCA

ASU Ira A. Fulton School of Engineering, Arizona State University

www.SustainabilityConf.org

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"The problems of the world cannot possibly be solved by skeptics or cynics whose horizons are limited by the obvious realities. We need men who can dream of things that never were."

John F. Kennedy

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www.nrmca.org/sustainability

NRMCA

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Dr. Kenji Kawai is an associate professor of Civil and Environmental Engineering at Hiroshima University, Japan. His research interests include chemical deterioration of concrete and environmental impact evaluation of concrete. He was a chairman of the Research Subcommittee on Environmental Impact Evaluation of Concrete in the Committee on Concrete, Japan Society of Civil Engineers. He is now a convener of TG3.9: Application of Environmental Design to Concrete Structures of fib Commission 3: Environmental Aspects of Design and Construction. He received his bachelor's, master's and doctoral degrees from the University of Tokyo.

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Environmental Design and Applications of Concrete Structures, from JSCE and fib Activities

Concrete Sustainability Forum
November 7, 2009
ACI Fall Convention - New Orleans

Kenji Kawai
Hiroshima University, Japan

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JSCE Activities

- Subcommittee on Effective Utilization of Resources to Concrete (1997-1999, Chairman: Prof. Ei-ichi Tazawa)
- Research Subcommittee on Environmental Impact Assessment of Concrete (1999-2004, Chairman: Dr. Kenji Kawai)
- Task Force on Environmental Aspects in Subcommittee on Standard Specifications for Concrete Structures (2003-2005, Convener: Prof. Koji Sakai)

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JSCE Activities

- Research Subcommittee on Environmental Impact Assessment of Concrete (1999-2004, Chairman: Dr. Kenji Kawai)
  - Proposal of A Design Method Considering Environmental Performance

    Kawai.K. *et al*. "A Proposal of Concrete Structure Design Methods Considering Environmental Performance," *Journal of Advanced Concrete Technology*, 3(1), 41-51, 2005.
  - Investigation on Inventory Data

    Kawai.K. *et al*. "Inventory Data and Case Studies for Environment-al Performance Evaluation of Concrete Structure Construction," *Journal of Advanced Concrete Technology*, 3(3), 435-456, 2005.

JSCE Activities

- Task Force on Environmental Aspects in Subcommittee on Standard Specifications for Concrete Structures (2003-2005, Convener: Prof. Koji Sakai)
  - Recommendation of Environmental Performance Verification for Concrete Structures

JSCE Guidelines for Concrete No.7 "Recommendation of Environmental Performance Verification for Concrete Structures (Draft)" (2006.6) published by JSCE

fib Activities

- Commission 3:
  Environmental Aspects of Design and Construction
  Chairman: Prof. Koji Sakai

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fib Activities

- **TG3.3** Environmental Design (1999-2002, Convener: Prof. Koji Sakai)
- **TG3.6** Guidelines for Environmental Design (2003-2008, Convener: Prof. Koji Sakai)
- **TG3.7** Integrated Life Cycle Assessment of Concrete Structures (2003-present, Prof. Petr Hajek)
- **TG3.8** Technologies for Green Concrete Structures (2006-present, Convener: Dr. Mette Glavind)

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fib Activities

- **TG3.9** Application of Environmental Design to Concrete Structures (2006-present, Convener: Dr. Kenji Kawai)
- **TG3.10** Concrete with Recycled Materials – Life Cycle Perspective (2009-present, Convener: Dr. Takafumi Noguchi)

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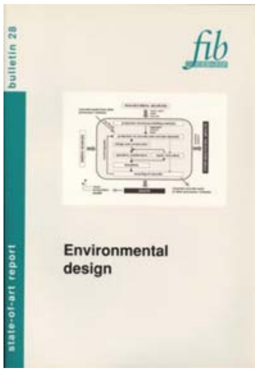

fib bulletin 28 “Environmental design” (2004.2) published by *fib*

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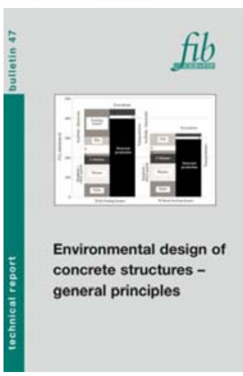

fib bulletin 47 “Environmental design of concrete structures – general principles” (2008.8) published by *fib*

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Environmental Design

- Same as performance-based design

(Ex.) Structural design

Design sectional resistance ↔ Design sectional force

Retaining environmental performance ↔ Environmental performance requirement

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Environmental Performance

- Global warming
  - CO_2
- Acidification
  - SOx
  - NOx
- Resources consumption
  - Coal
  - Oil
  - Natural gas
  - Limestone
- Hazardous substances
  - Hexavalent chromium (Cr(VI))
  - Endocrine-disrupting chemicals (Environmental hormone)

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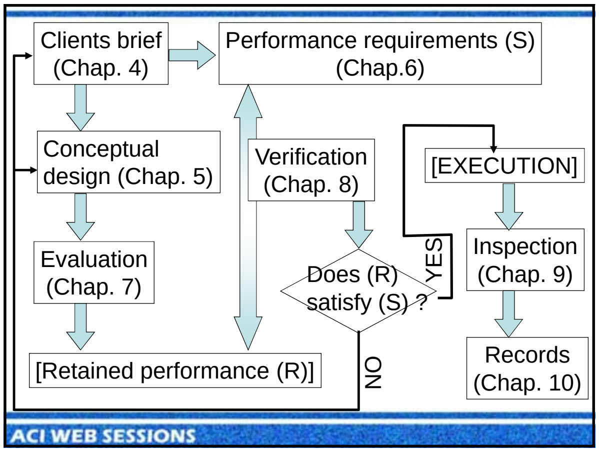

Construction of a leaning-type retaining wall (Outline)

- Retaining wall works accompanying road construction on the slope of a mountain
- Height: 8.0m, Slope: 1:0.5, Length: 120m
- Conventional method
  Use ready-mixed concrete in situ
- Alternative method
  Use precast concrete hollow blocks

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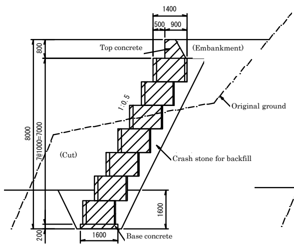
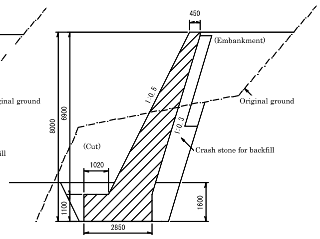


Using hollow blocks



Constructed in situ

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3 months after construction

13 years after construction

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Environmental performance requirement

- 20% reduction of CO_2 emission in the construction compared with a conventional construction method

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Inventory analysis for two methods

	Using hollow blocks	Constructed in situ	Ratio
CO_2 emission ($t\text{-}CO_2$)	171	256	67%
SOx emission (kg-SOx)	73	105	70%
NOx emission (kg-NOx)	671	1181	57%
PM emission (kg-PM)	50	63	79%

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Verification

- CO_2 emission by using hollow blocks can be reduced by approximately **33%** in all, compared with a conventional construction method.
- Therefore, the environmental performance requirement (20% reduction of CO_2 emission) is satisfied!

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Calculation of CO_2 emission

- Total CO_2 emission
  = Σ((amount of constituent material) X (unit-based CO_2 emission))
  + Σ((fuel consumption of transportation) X (unit-based CO_2 emission))
  + Σ((fuel consumption of construction machinery) X (unit-based CO_2 emission))
  + Σ ………

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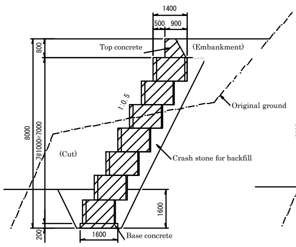
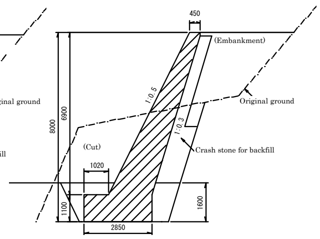


Using hollow blocks (Case-1)



Constructed in situ (Case-2)

Case Study

Materials and works	Unit	Case-1	Case-2
Soil excavation	m^3	1704	1799
Excavation for foundation	m^3	538	904
Backfill of foundation	m^3	241	420
Placing of hollow blocks	m^3	690	---
Embankment	m^3	698	974
Crushed stone for backfill	M^3 (t)	444 (910)	542 (1111)
Hollow blocks	Number (t)	560 (753)	--- (---)
Steel bar	t	3.3	---

Case Study

Materials and works	Unit	Case-1	Case-2
Ready-mixed concrete	m^3	264	1320
Wood form	M^2 (t)	278 (1.7)	2054 (12.3)
Scaffold work	m^2	---	1326
Surplus soil	M^3 (t)	517 (646)	1385 (1731)
Revegetation	m^2	360	---

Inventory Analysis

		Case-1	Case-2	C-1/C-2
Input energy (GJ)		1736	2428	71%
Consump-tion	Oil (kg)	24972	34144	73%
	Coal (kg)	13022	21294	61%
	Natural gas (kg)	943	1594	59%
	Non-metal mineral (t)	2158	3912	55%
	Iron resource (kg)	1557	0	---

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Inventory Data Collection

- Energy

	Unit (*)	CO_2 (kg/*)	SO_X (kg/*)	NO_X (kg/*)	PM (kg/*)
Electricity	kWh	0.407	0.13×10^{-3}	0.16×10^{-3}	0.03×10^{-3}
LPG for fuel	kg	3.53	3.04×10^{-3}	2.27×10^{-3}	No data
LNG (imported)	kg	3.32	0.78×10^{-3}	1.07×10^{-3}	No data
Light oil	L	2.82	3.59×10^{-3}	60.53×10^{-3}	3.67×10^{-3}
Gasoline	L	2.67	2.31×10^{-3}	1.29×10^{-3}	No data
Heavy oil (A)	L	3.01	14.67×10^{-3}	3.64×10^{-3}	3.0×10^{-3}
Kerosene	L	2.65	1.53×10^{-3}	1.13×10^{-3}	No data
Acetylene gas	m^3	3.38	No data	No data	No data

PM: Particulate matter

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Inventory Data Collection

- Material

		Unit (*)	Material recycling (wet-kg)	Waste emission (wet-kg)	CO_2 emission (kg-CO_2/*)	SO_x emission (kg-SO_x/*)	NO_x emission (kg-NO_x/*)	PM emission (kg-PM/*)
Cement	Normal portland cement	t	148	0	765.5	0.122	1.55	0.0358
	Blast furnace slag cement (Type B)	t	85	0	457.7	0.0809	0.919	0.0218
	Fly ash cement (Type B)	t	120	0	622.8	0.0984	1.25	0.0289
	Normal eco-cement	t	765	0	774.9			
Aggregate	Coarse aggregate (Natural, crashed)	t	0	0	2.8	0.00607	0.00415	0.00141
	Fine aggregate (Natural, crashed)	t	0	0	3.4	0.00860	0.00586	0.00199
	Limestone aggregate	t	0	0	2.8	0.00607	0.00415	0.00141
	Waste aggregate (Melted using fuel)	t	1,238	141	2,284.9	0.0309	0.0376	0.00624
	Waste aggregate (Melted electronically)	t	1,238	141	395.7	0.123	0.150	0.0249
	Recycled aggregate (Type III)	t	1,000	0	2.8	0.00127	0.0108	0.000655
	Recycled aggregate (Type I)	t	1,000	0	16.3	0.00628	0.0289	0.00218

ACI WEB SESSIONS

Inventory Data Collection

- Material

		Unit (*)	Material recycling (wet-kg)	Waste emission (wet-kg)	CO_2 emission (kg-CO_2/*)	SO_x emission (kg-SO_x/*)	NO_x emission (kg-NO_x/*)	PM emission (kg-PM/*)
Mineral admixture	Blast furnace slag	t	0	0	24.1	0.00836	0.0102	0.00169
	Fly ash	t	0	0	17.9	0.00620	0.00754	0.00125
	Limestone powder	t	0	0	14.8	0.0112	0.0103	0.00244
	Coal ash	t	1,000	0		0	0	0
Steel	Electric furnace steel	t	No data	7	755.3	0.134	0.124	0.0101
	Basic oxygen furnace steel (Shapes)	t	No data	7	1,246.6	1.18	1.80	0.00781
	Basic oxygen furnace steel (Bars)	t	No data	7	1,203.9	1.18	1.80	0.00759
	Basic oxygen furnace steel (Wire rods)	t	No data	7	1,311.1	1.18	1.81	0.00898

ACI WEB SESSIONS

Inventory Data Collection

- Energy
  - Electricity
  - LPG for fuel
  - LNG (imported)
  - Light oil
  - Gasoline
  - Heavy oil (Type A)
  - Kerosene
  - Acetylene gas

ACI WEB SESSIONS

Inventory Data Collection

- Transportation
  - Truck
    - Gasoline (2t), Diesel (2t), Diesel (4t), Diesel (10t), Diesel (20t)
  - Dump truck
    - Diesel (10t)
  - Agitator truck
    - 0.8-0.9m^3, 1.6-1.7m^3, 3.0-3.2m^3, 4.4-4.5m^3
  - Freight car
  - Ship
    - 500t class, 1000t class, 2000t class, 5000t class, 10000t class

ACI WEB SESSIONS

Inventory Data Collection

- Materials
  - Cement
    - Normal portland cement, blast furnace slag cement, fly ash cement, normal eco-cement
  - Aggregate
    - Coarse aggregate (Natural, crushed), Fine aggregate (Natural, crushed), Limestone aggregate, Waste aggregate (Melted using fuel), Waste aggregate (Melted electrically), Recycled aggregate (Type III), Recycled aggregate (Type I)
  - Mineral admixture
    - Blast furnace slag, Fly ash, Limestone powder, Coal ash

Inventory Data Collection

- Materials
  - Steel
    - Electric furnace steel, Basic oxygen furnace (Shapes), Basic oxygen furnace (Bars), Basic oxygen furnace (Wire rods)

Inventory Data Collection

- Construction works
  - Ready-mixed concrete
    - Concrete plant, Concrete mixers
  - Concrete placing
    - Agitator trucks, Boom pumps, Truck mounted concrete pump, Concrete pump
  - Compaction
    - Flexible shaft vibrator, Form Vibrator, Direct drive surface vibrator
  - Curing
    - Steam curing, Autoclave curing, Jet heater, Normal curing

Inventory Data Collection

- Construction works
  - Excavator
    - $0.6m^3$ (with and without exhaust emission measures)
  - Crawler crane
    - Mechanical (16t), Mechanical (25-27t), Hydraulic (4.9t)
  - Truck crane
    - Hydraulic (11t), Hydraulic (16t), Hydraulic (22t)
  - Wheel crane
    - 4.8t, 15t, 25t (with and without exhaust emission measures)
  - Motor grader
    - Blade length 3.1m (with and without emission measures)

ACI WEB SESSIONS

Inventory Data Collection

- Construction works
  - Road roller
    - 10-12t (with and without exhaust emission measures)
  - Tire roller
    - 8-20t (with and without exhaust emission measures)
  - Tamper
    - 60-100kg
  - Sprinkler
    - 5500-6500L

ACI WEB SESSIONS

Inventory Data Collection

- Construction works
  - Diesel generator
    - 10kVA, 45kVA, 75kVA

ACI WEB SESSIONS

Inventory Data Collection

- Demolition works
  - PC & RC
    - From the ground, From the roof, Underground, Footing beam, Foundation
  - SRC
    - From the ground, From the roof, Underground
  - Earth floor
  - Plane concrete
    - Less than 0.2m thickness, More than 0.2m thickness
  - Tunnel

ACI WEB SESSIONS

Inventory Data Collection

- Demolition works
  - Pavement
  - Steel cut
    - Welding machine
  - Steel frame cut
    - Crawler crane, welding machine
  - Operation
    - Piling and loading
  - Breaker
    - Hydraulic 600-800kg, Hydraulic 1300kg

ACI WEB SESSIONS

Inventory Data Collection

- Disposal and recycling
  - Landfill site for wastes
    - Leachate-controlled type, Non-leachate-controlled type
  - Recycled aggregate
    - Type III (14-30t/h) treated in situ, Type III (35-85t/h) treated in situ, Type III (47-100t/h) treated in situ, Type III (30t/h) treated outside the site, Type I, Type I with a heating and grinding method

ACI WEB SESSIONS

Inventory Data Collection

- Energy and transportation
  - 13 types 24 detail items
- Materials
  - 4 types 19 detail items
- Construction
  - 14 types 46 detail items
- Demolition
  - 10 types 18 detail items
- Disposal and Recycling
  - 2 types 8 detail items

ACI WEB SESSIONS

Harve Stoeck is Vice President of Environment and Public Affairs at Lafarge in Denver, Colorado. He began his career at Lafarge in 1979 as a pre-cast plant laborer and has held numerous other positions at the company over the past 30 years, including V.P. Technical Services, V.P. Performance, and V.P. Aggregates & Asphalt Manufacturing. Mr. Stoeck holds a B.S., M.S., and Ph.D. in Civil Engineering from the University of Alberta in Edmonton, Alberta, Canada.

ACI WEB SESSIONS

Cement Sustainability Initiative: Recycling & Beyond

Concrete Sustainability Forum
New Orleans, November 7, 2009

Harve Stoeck, VP Environment & Public Affairs

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Lafarge Worldwide Demographics

1. Three Major Product Lines:
   - Cement
   - Aggregates, Concrete and Asphalt
   - Gypsum Wallboard
2. Manufacturing Operations in 79 Countries
3. 84,000 Employees Worldwide
4. 16,000 Employees in North America
5. 2,200 Facilities Worldwide
6. 1,325 Ready-Mix Concrete Plants Worldwide
7. 62 Quarries Worldwide

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Background

- Cement Sustainability Initiative (CSI)
  - CSI Project Initiated Under the Auspices of the World Business Council for Sustainable Development (WBCSD)
  - Leading Worldwide Cement Producers Focused on Understanding, Managing & Minimizing the Environmental and Social Impacts of Cement Production:
    - Lafarge
    - CEMEX
    - Holcim
    - Heidelberg
    - Others—18 Cement Companies are participating today in the CSI Project
  - The WBCSD retained in 1999 Battelle Memorial Institute to Identify the Major Sustainability Topics in order to Position the Cement Industry for a More Sustainable Future

ACI WEB SESSIONS

Background

- Cement Sustainability Initiative:
  - The Participating Companies Responded to the Battelle Scoping Report by Launching in 2002 an “Agenda for Action.” The Core CSI program Included:
    - Climate Protection
    - Fuel & Raw Materials Use
    - Employee Health & Safety
    - Air Emissions Reduction
    - Local Impacts
    - Reporting & Communications
  - Each Agenda for Action Topic is Divided Into:
    - Industry Actions (i.e., a protocol to calculate a CO2 emissions inventory), and
    - Company Specific Actions (i.e., setting CO2 mitigation targets)

ACI WEB SESSIONS

Background

- CSI Progress Report:
  - 2005 Interim Progress Report:
    - Status of implementing "Agenda for Action" top Industry and Company Specific Actions
    - Added "Concrete Recycling" and Stakeholder Relations Management to the Core CSI Program
  - 2007 CSI "Agenda for Action Accomplishments Report Published
    - E.g., 11 Companies have set Company Specific CO2 Emissions Reduction Targets
    - Status of Industry and Company Specific Actions on new Core CSI Topics—Stakeholder Relations Management and Recycling Concrete

ACI WEB SESSIONS

Concrete Recycling

- Overarching Objective—No Concrete waste to Landfills
- Benefits of Increased Concrete Recycling
  - Reduction of Concrete Waste Land-filled or Dumped and Associated Cost of Site Clean-ups
  - Lower Cost for Raw Materials by Substitution of Virgin Aggregates and Water
  - Longer term aggregates and water sustainability by use of recycled aggregates and water
  - Reduced Transportation Costs
  - Green Construction Benefits

ACI WEB SESSIONS

Concrete Recycling

- Today, global data on waste generation not available
- Estimates for major regions are (millions of metric tonnes / year)

Amount of waste (Mt)	Europe	US	Japan
Construction and Demolition Waste (C&DW)	510	317	77
Municipal Waste	241	228	53

- In some countries, full recovery of concrete is achieved; in others the potential is overlooked, due to low public concern

ACI WEB SESSIONS

Concrete Recycling

The CSI report recommends:

- Collect and publicize construction and demolition waste data and develop reliable statistics
- Set targets for use in both road construction and building industries
- Develop economic incentives and legislation to promote concrete recycling
- Change public misperceptions

www.wbcsdcement.org/recycling

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Concrete Recycling
Methodology & Approach

- Lafarge North America Tracks the Following Recycled Materials:
  - Tonnes Recycled Flyash
  - Tonnes Recycled Slag
  - Tonnes Recycled RAP / MSM
  - Tonnes Recycled Concrete & Aggregates
- Track Quantity on a Recycled Materials on a Quarterly Basis and Publish in our Annual Sustainability Report
- In the Process of Developing Targets for Recycling Concrete and Water for Use in the Coming Years
- Rigorous Policy of:
  - ZERO Return Concrete WASTE
  - ZERO Return WATER Release to the Environment

ACI WEB SESSIONS

Concrete Recycling
Specific Lafarge Examples

- Returned Concrete for Next Day Use
- Returned Concrete for PreCast Application
- “Surry machine” Separating all Constituents for the Production of New Ready Mix Concrete
- Reclaim Old Concrete Into Granular Road Base

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Concrete Recycling

- Future Innovations:
  - Business arrangement at various RMX sites to take "other company's" wastewater and/or demolition wastes
  - Advanced Rainwater Collection and Recycling Techniques
  - Conduct a Water Footprint Analysis to Maximize Collection & Reuse (WBCSD protocol)
  - Other Raw Material Reuse as Substitutes for Aggregates

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Concrete Recycling
Green Building Rating Systems

- Green Building Codes / Systems Provide an Incentive for the Reuse of Return Concrete and/or Recycled Aggregates
- Multiple Programs – LEED, Green Globe, CASBEE, etc.
- The main features of a green building rating system include:
  - Requirements for on-site waste management plans for demolition of existing structures
  - Requirements for use of existing materials made from recycled components

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Concrete Recycling
Green Building Rating Systems

- Most programs consider the following key areas:
  - Sustainable Site Development (including management of C&DW)
  - Water Savings
  - Energy Efficiency
  - Materials Selection
  - Indoor Environmental Quality

(* 8 of 85 available LEEDS points relate to C&DW handling and use of recycled materials)

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Concrete Recycling

- Recommendations:
  - The Ultimate Goal is for "ZERO LANDFILL" of Concrete
  - Considerations:
    - Key Stakeholders Publicity to Change Public Misconceptions
    - Employ Overall Benefits Strategy Analysis to Determine the Best Use of Recovered Concrete in a Given Market
    - Green Building Approaches to Further Encourage Good C&DW Management and use of Recycled Concrete Aggregate

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Comments / Questions?

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Additional Resources

Pervious Concrete
- ACI 522R-06: Pervious Concrete
- ACI 522.1-08: Specification for Pervious Concrete Pavement

Recycled Cementitious Materials
- ACI 232.2R-03: Use of Fly Ash in Concrete
- ACI 233R-03: Slag Cement in Concrete and Mortar
- ACI 234R-06: Guide for the Use of Silica Fume in Concrete
- ACI SP-202: Third CANMET/ACI International Symposium: Sustainable Development of Cement and Concrete
- ACI SP-221: Eighth CANMET/ACI International Conference on Fly Ash, Silica Fume, Slag, and Natural Pozzolans in Concrete
- ACI SP-242 Ninth CANMET/ACI Fly Ash Conference

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Additional Resources

Recycled Concrete

- ACI 555R-01: Removal and Reuse of Hardened Concrete
- ACI SP-219: Recycling Concrete and Other Materials for Sustainable Development

Thermal Mass/Minimizing Energy Use

- ACI 122R-02: Guide to Thermal Properties of Concrete and Masonry Systems

Sustainability of Concrete

- The Sustainable Concrete Guide: Strategies and Examples by Andrea Schokker

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