Draft 7.3
Nov 14, 2008

CONCRETE SUSTAINABILITY

A VISION FOR SUSTAINABLE CONSTRUCTION WITH CONCRETE IN NORTH AMERICA

Initiated by the Strategic Development Council (SDC), this document is the result of efforts by a diverse group of concrete industry volunteers who have contributed their time and experience throughout 2007 and 2008. The SDC also thanks the many Concrete and Masonry-Related Associations (CAMRA) who supported the SDC's efforts with financial and in-kind support (a list of those supporters can be found at www.concreteSDC.org).

Without a renewed mandate or additional financial resources from the concrete industry, this initiative is on hold. However, this document is made available to be used in whole or in part by the various segments of the concrete community as they seek to construct a vision and plan of action for their own unique segments. In using the material and background information from these documents, the SDC trusts that individuals or organizations will acknowledge the source and their use of such information and the leadership of the SDC as part of this effort.

The Strategic Development Council, again, thanks all who participated in this effort.

November 14, 2008

Learn more at www.concreteSDC.org

DOCUMENT PURPOSE

This vision document has been produced by and for the concrete industry under the auspices of the Strategic Development Council. The goals outlined in this statement will help align the initiatives of the different segments of the industry and their associations, thus enabling the industry to speak with one voice on sustainable construction with concrete.

CONCRETE AND SUSTAINABLE DEVELOPMENT

The concrete industry is proud of its progress to date and is committed to improving the sustainability of the built-environment, and, within the industry, to improving concrete's environmental footprint. Society is widely adopting accepted holistic definitions of "sustainable development" and "the built-environment". The potential for concrete to have a more beneficial impact on the built-environment is great. The way forward requires determination and widespread cooperation.

VISION

> **The vision of the North American concrete industry is to transform the built environment by improving the way concrete is designed, specified, produced, transported, installed, maintained, and recycled to ensure an optimum balance between environmental, social, and economic conditions for the industry and the world.**

APPROACH

To achieve this vision the approach includes three key objectives:

- **Lead society in achieving a built-environment** that will one day make a net environmental contribution to the planet,
- **Work as a team** to achieve the vision, and
- **Improve the environmental footprint of concrete.**

OBJECTIVE: THE BUILT-ENVIRONMENT

In this broad context, the concrete industry will be a leading player in helping society build infrastructure to support its desired standard of living, and achieving a built-environment that will make a net sustainable contribution to the planet. The industry will work as a team with every involved party to improve the sustainability of our communities for future generations. The industry has already made important advances. The industry is committed to continuously

improving its contribution to the sustainable building community and to invoking sweeping changes, if proved necessary, to achieving the vision.

Consequently the concrete industry's initial objectives are:

> **By 2010: Create and adopt action plans with all relevant parties for achieving significant improvements in the sustainability of the built-environment, to include measurable process objectives.**
>
> **By 2020: Improve the sustainable characteristics of the built-environment through the efficient and effective use of concrete in green building, improving design to take full advantage of concrete's attributes, and adopting specifications that facilitate innovation in product design.**

OBJECTIVE: TEAMWORK AND AN INDUSTRY SUSTAINABILITY CHARTER

The concrete industry recognizes that appropriate governance structures and teamwork are essential if it is to succeed on its sustainability journey. The industry has developed a Concrete Industry Sustainability Charter (refer to attached). The Charter articulates the industry's values and team-focused operating principles, and will form an integral part of all future plans and protocols.

OBJECTIVE: REDUCED ENVIRONMENTAL FOOTPRINT OF CONCRETE

The concrete industry has made significant progress reducing the environmental footprint of its product. For example, since 1990, the US concrete industry has reduced the amount of CO_2 to produce a cubic yard of concrete by over 20%. The industry is committed to setting similar aggressive targets to continue this trend, both in the immediate future and over the longer term.

– near term

The concrete industry is determined to set specific targets for all key environmental performance indicators of its product. Industry leaders recognize that time is of the essence, and that ambitious targets will help mobilize the industry to adopt the changes necessary to make real progress in reducing concrete's environmental footprint. The industry is adopting objectives to immediately drive baseline research to enable the setting of CO_2 reduction targets, and to enable the setting of targets in other sustainability areas, by or before 2010. These targets are as follows.

> **Reduce by 2030 the carbon footprint per unit of concrete and concrete product produced.**

Reduce by 2030 the total annual carbon footprint for all concrete and concrete put in place.

Reduce substantially by 2030 the environmental footprint of concrete with regards to embodied energy, water conservation, water quality, air quality, recycling, and reuse.

Improve substantially by 2030 the sustainable characteristics of new structures through the efficient and effective use of concrete in construction to take full advantage of concrete's attributes, and adopting specifications that facilitate innovation in product design.

– to 2050

The attainment of its targets for 2030 will challenge the industry, given the boundaries of existing technologies. But the industry recognizes that to continue improvement at the same pace through 2050 will require major changes to those technologies, as well as substantial changes to our social and regulatory framework. At a 2.5% annual growth rate, demand for concrete will increase by 425% as compared to 1990. To return to 1990 absolute CO_2 levels will require a reduction in CO_2 output per cubic yard of concrete of 85% over current levels.

Given this scenario, and the other longer term uncertainties outlined above, the concrete industry pledges to drive research and monitor developments with a view to setting firm and ambitious sustainability targets for 2050 by 2015.

The industry will reach agreement on new 2050 targets through a North American Concrete Sustainability Protocol, as well as the contribution of each industry segment to the achievement of each target reduction, and will measure and publish its progress on an annual basis.

GOALS AND INITIATIVES

To achieve these targets the industry will pursue the following goals and initiatives.

CONTINUOUS IMPROVEMENT

Goal:

Continuously improve, through technical, process, and other innovations, concrete's environmental, social, and economic impact at every step in the concrete lifecycle; and demonstrate through measurement the reality of concrete's sustainability footprint.

Key initiatives:

- Identify key performance indicators and set targets
- Develop, maintain, and implement a comprehensive plan for improvement in performance
- Create and maintain an inventory of concrete's past and current sustainability performance
- Create and maintain an inventory of global best practices
- Develop tools and approaches to achieve these goals.

ADVOCACY

Goal:

Advocate for public positions, policies, laws, regulations, ordinances, and actions that encourage both sustainable business practices/operations and holistic integration of cement- and concrete-related products in sustainable design and application.

Advocacy is defined as issue management, policy development, and public affairs communication. Public is defined as regulators, legislators, designers, specifiers, planners, owners, and end users.

Key initiatives:

- Engage in national dialogue on policies and positions related to sustainability issues
- Translate technical information
- Make information accessible
- Identify critical issues
- Identify and build relationships with key leadership at all levels
- Influence the development of laws and regulations
- Provide implementation and compliance guidance
- Develop, maintain, and implement an advocacy plan

SPECIFIED CONSTRAINTS

Goal:

Work to remove technical constraints in building codes, standards, and specifications that may prevent concrete and construction from reaching its full sustainability potential.

Key initiatives:

- Catalogue existing technical constraints
- Develop justification for addressing constraints
- Work as appropriate to remove or modify technical constraints
- Develop, maintain, and implement a plan

EDUCATION

Goal:

Provide education that will engage and empower the industry and its partners to understand, develop, and implement best sustainability practices.

Key initiatives:

- Educate the industry internally
- Develop education and tools for specifiers and designers
- Educate the general public
- Educate the educators
- Develop, maintain, and implement a strategic education plan

COMMUNICATIONS

Goal:

Accurately convey at all times, both within the industry and to all interested parties, the positions and actions of the North American concrete industry related to the sustainability of concrete and/or its role in supporting sustainable development in our communities.

Key initiatives:

- Develop, maintain, and implement a plan
- Inventory and track important trends
- Develop, introduce, and maintain appropriate communications tools

MOBILIZATION AND TEAMWORK

Goal:

Through structured, dynamic, and innovative approaches enable the varied and disparate components of the North American concrete industry to work together as a team to ensure optimally sustainable applications of concrete; and that the sustainability imperative becomes anchored in the culture of the whole industry.

Key initiatives:

- Develop, implement, and maintain a plan for the continuity of this industry initiative
- Ensure the endorsement of the various segments of the concrete industry
- Ensure initiatives are adequately resourced
- Ensure the process of developing and implementing the concrete sustainability vision and roadmap are efficient and effective

ACHIEVING THE GOALS

Making this vision a reality is a major undertaking involving all facets of the concrete industry working together as a team. These activities, and their resourcing, would be best coordinated and funded by the industry if led by a dedicated paid staff to avoid reliance on volunteer time. Consequently, the industry will create a new not-for-profit entity to coordinate, track, and help communicate its sustainability initiatives. This organization will facilitate the collective action required to make this vision for the sustainability of construction with concrete a reality across North America.

This organization will adhere to and promote the finalization of the Concrete Industry Sustainability Charter. To ensure the continuity of this vital industry initiative, the organization will undertake the following:

- Seek agreement on industry-wide targets and initiatives, and coordinate the contribution of each industry segment to achieve the effort of the whole
- Review of the vision document and plan framework by as many industry stakeholders as possible with a view to making such adjustments as are necessary to help the industry collectively achieve it
- Consult with other participants who have a stake in the sustainability of the built-environment
- Develop action plans (tactics, workplans, change plans, measurable objectives, etc.) in each goal area
- Identify best sustainability practices and steps industry groups can incorporate into their operations and culture
- Coordinate an integrated industry information base

- Start or continue to pursue and implement this vision wherever a related activity is sufficiently well scoped and resourced
- Create awareness and mobilization of industry efforts
- Track and communicate industry progress
- Embed systems, goals, and initiatives into an organizational culture.

The new association will help industry partners by adopting a model (see example below) for integrating industry input and progress (e.g. for recording the goals each industry segment may have set for itself, its sustainability initiatives, etc.) This model recognizes that different segments of the industry can more effectively affect specific areas of sustainability.

Issues to Address / Organizations	CRSI	NRMCA	PCA	PCI	ACI	ASCC	and others
Reduce CO2							
Reduce Water Use							
Reduce Embedded Energy							
Increase the Use of Recycled Material							
Reduce use of non-recycled material							
Reduce materials to landfill							

Each segment of the concrete industry to participate in goals as they are able, by providing data, setting their own targets, identifying initiatives, coordinating their actions to align with an overall vision for the concrete industry.

This model also will be used to store and track sustainability data and track progress to goals and targets, to ensure coherence of roadmap actions, to facilitate alignment of industry messages, etc.

THE CONCRETE INDUSTRY SUSTAINABILITY CHARTER

While we in the industry recognize the historical improvements in concrete's environmental footprint, we are committed to continue on this path as stewards of our environment. As a diverse industry, we share a common vision to ensure that all processes generating modern concrete and concrete products contribute to fulfill sustainable needs of this and future generations. We will cooperate with integrity and honesty to achieve our goals. Time is of the essence. We the undersigned pledge to affect change to the best of our ability in the areas over which we have responsibility or control.

VISION

The vision of the North American concrete industry is to transform the built environment by improving the way concrete is designed, specified, produced, transported, installed, maintained, and recycled in such a way as to ensure an optimum balance between environmental, social, and economic conditions for the industry and all our communities.

OPERATING PRINCIPLES

We the undersigned agree to abide by these principles, to reinforce them in the behaviour of others, and to act with a common vision when assessing, improving, and promoting how concrete can best contribute to sustainable construction.

To this end we will…

1. Act transparently
2. Be honest with our data
3. Act professionally with, and be respectful of, other members of our industry
4. Leverage our industry's diversity to contribute to sustainable practices
5. Encourage and reward innovation in finding positive solutions to industry challenges
6. Contribute resources to accomplish our common sustainability goals at every opportunity
7. Always consider the impact of our actions on our society, environment, and economy
8. Be tolerant and accepting of change
9. Recognize that there are sustainable construction solutions outside our industry
10. Demonstrate sustainable practices in our own facilities, companies, organizations, and communities
11. Bring a sustainable perspective to all appropriate conversations
12. Assist in making sustainability part of our industry's culture
13. Establish, measure, and report the metrics from our own organization
14. Advocate for sustainability improvement and enable this to happen within our own organization
15. Identify the needs for, and support, research within our industry to support sustainable initiatives
16. Support the verification of all claims made in our annual industry reports through an independent third-party
17. Elevate the awareness and consciousness of sustainability

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Nov 14, 2008

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A VISION FOR SUSTAINABLE CONSTRUCTION WITH CONCRETE IN NORTH AMERICA

BACKGROUND INFORMATION & APPENDICES

Initiated by the Strategic Development Council (SDC), this document is the result of efforts by a diverse group of concrete industry volunteers who have contributed their time and experience throughout 2007 and 2008. The SDC also thanks the many Concrete and Masonry-Related Associations (CAMRA) who supported the SDC's efforts with financial and in-kind support (a list of those supporters can be found at www.concreteSDC.org).

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The Strategic Development Council, again, thanks all who participated in this effort.

November 14, 2008

Learn more at www.concreteSDC.org

BACKGROUND INFORMATION AND APPENDICES

BACKGROUND INFORMATION

Many people from various sectors of the concrete industry have devoted considerable time and effort in the creation of this vision. Appendix A outlines the process engaged and acknowledges those individuals who participated in specific work groups or general sessions.

This background information can assist in further completion of a roadmap by which the industry can move toward its vision.

APPENDICES

Appendix A: Purpose, Scope, and Process

Appendix B: Achieving the Vision: A Preliminary Roadmap Framework

Appendix C: Assumptions Relating to the Industry's CO_2 Targets, 2005 to 2020

Appendix D: Concrete and Sustainable Development – Stars to Steer By

Appendix E: Sustainability and the Concrete Industry Today

Appendix F: Purpose, Targets, Objectives, and Goals

Appendix G: Table of Contents and Foreword retained from Draft 5

APPENDIX A

PURPOSE, SCOPE, AND PROCESS

PURPOSE, SCOPE AND PROCESS

PURPOSE

The vision has been produced by the concrete industry for the concrete industry. It is intended to help align the initiatives of the different parts of the industry and their associations, and enable the industry to speak with one voice on sustainable construction with concrete.

This document lays out the vision, and the strategy of the North American concrete industry to fully realize the sustainability potential of concrete. It sets goals and strategies to reduce the industry's own environmental footprint and that of the built-environment in general. The document is addressed primarily to concrete industry stakeholders, but is available to all interested parties.

The common industry perspective accepts the definition of sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". . For the North American concrete industry this definition includes:…

- continuous reducing concrete's own environmental footprint
- continuous improving concrete's contribution to the sustainability of all construction
- educating of the concrete industry and other stakeholders
- advocating the benefits to sustainability of concrete
- seeking appropriate changes in codes and standards for the use of concrete that will enable the built-environment to become fully sustainable
- developing and implementing a communication strategy.

This vision statement confirms the common goals of industry stakeholders, including those involved in design and specification, materials, cement and reinforcing steel manufacture, admixtures, design, cast-in-place construction, precast, operations, maintenance, repair, demolition, recycling, equipment supply, and others. The statement proposes an approach, goals, and key initiatives to facilitate the teamwork that will be needed between these stakeholders to achieve the concrete industry's sustainability goals and planned initiatives. The industry will pursue a course defined by a detailed Roadmap, identified here on a preliminary basis[1] that the industry will pursue.

While the industry's vision is characterized by a dedication to the three pillars of sustainability (environmental, social, economic), its initial focus is on environmental stewardship. The vision statement focuses on the industry's accelerated work to bring about product improvements, while further researching and planning its potential contributions to the built-environment.

[1] See Appendix B, "Achieving the Vision. A Preliminary Roadmap Framework".

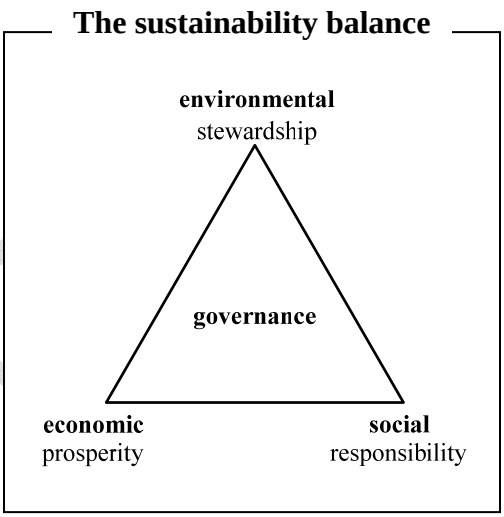
SCOPE

There are four key definitions that define the scope of this vision.…

Concrete

Concrete is a "composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate, usually a combination of fine aggregate and coarse aggregate; in portland-cement concrete, the binder is a mixture of portland cement and water, with or without admixtures."[2]

Sustainability



Sustainability is a characteristic of a process or state that can be maintained at a certain level indefinitely. The term, in its environmental usage, refers to the potential longevity of vital human ecological support systems, such as the planet's climatic system, systems of agriculture, industry, forestry, fisheries, and human communities

Sustainable development focuses on more than environmental issues. Sustainable development policies encompass three general policy areas: economic sustainability, environmental sustainability, and social sustainability. Several United Nations texts refer to the "interdependent and mutually reinforcing pillars" of sustainable development as economic development, social development, and environmental protection.

This terminology is expected to become clearer as the concrete industry's journey towards adopting this statement. But for the moment and for greater clarity, this document frequently uses "sustainable" as a qualifier in a specific rather than general sense. Thus for the concrete industry:

sustainable development	development at the overarching (global and community) societal change level
sustainable construction	construction of the built-environment and infrastructure
sustainable consumption	consumption of lower footprint (GHG(?), EE(?), water, waste, etc.) concrete
sustainable concrete industry	concrete industry working together in a sustainable business model

[2] http://www.concrete.org/technical/CCT/flashhelp/ACI_terminology.htm

North America

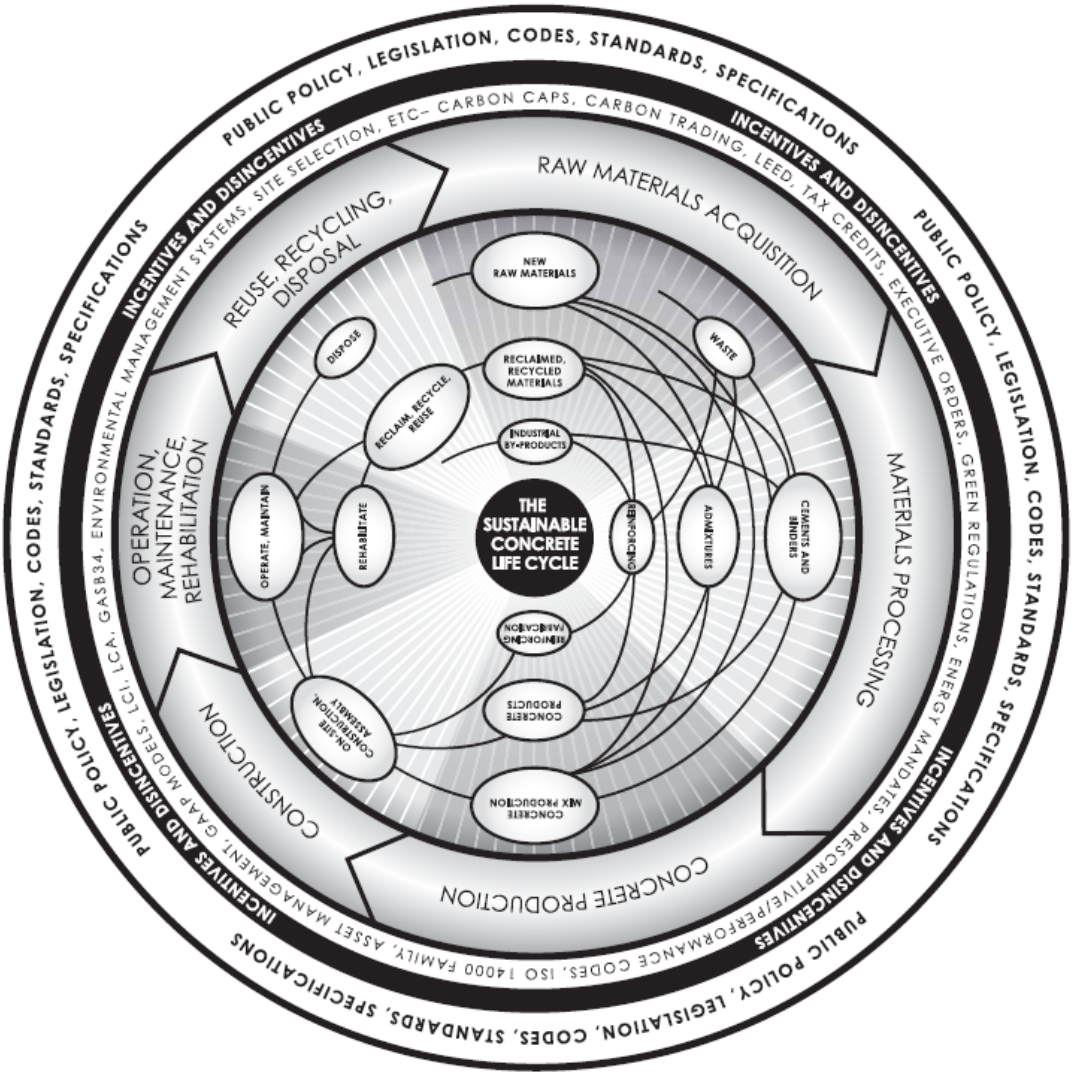
For the purposes of this vision statement, industry representatives from the USA and Canada, (countries comprising most of the industry in North America) have come together as one voice. The industry invites participation from other countries, especially in the Americas.

Concrete Industry

Defining the boundaries of the concrete industry for the purposes of this sustainability vision is a greater challenge. Stakeholders not traditionally considered part of the core industry have a major impact on the sustainability of concrete applications in the built-environment.

This dynamic can be summarized in a "Sustainable Concrete Life Cycle Flowchart" below[3].Accordingly, this vision for sustainable concrete construction encompasses all activities that affect the sustainability of concrete and of the built-environment.

[3] A more detailed linear version appears at the end of this Appendix



The significance of the "public policy, legislation, etc." ring and its affect on the sustainability of concrete applications are explored in the main text. Constraints from these sources often require concrete to be less sustainable than it could be.

The chart depicts the entire process of building with concrete rather than simply the lifecycle of the product. While concrete as a product needs to continue improving its sustainability (and particularly its environmental manufacturing) footprint, the greater gains for society probably lie in the leverage that concrete can provide (for example through its thermal mass qualities, its reflective qualities, its ability to be pervious to water, etc.) to enable all construction in the built-environment to be more sustainable.

PROCESS

This document has been developed over a period of about a year, beginning with an industry summit in Washington, DC in summer 2007 and continuing through a series of workshops and working sessions as the approach was firmed up.

The approach, targets, and thrust have been developed by about seventy participants working in seven workgroups, each comprised of representatives of a wide cross-section of the industry. These workgroups worked together for the duration of the development phase of the project. Most of these groups were formed in September 2007, and addressed vision, values and principles, continuous improvement, education, industry advocacy, codes and standards, communications, mobilization, and teamwork. Each group was led by at least one industry champion ("member") and one facilitator drawn from a US or Canadian industry association. This, combined with wide industry representation on each Workgroup, provided broad input.

The Strategic Development Council of the American Concrete Institute provided the platform for the facilitation of the North American industry's development of this vision. As the industry moves forward to implement this vision, leadership and coordination will be provided by a new entity representing the whole industry.

Participants in the workgroups and plenary workshops included the following.

Mobilization and Teamwork

Jean-Claude Roumain, Corporate Product Manager, Holcim (US)
Claude Bedard, Vice-President & General Manager, The Euclid Chemical Co
John Hull, President, Ready Mix Concrete Association of Ontario
Bob Risser, President, Concrete Reinforcing Steel Institute
Chris Cooper, Cooper/Johri Management Consulting
Dave Shepherd, Director, Sustainable Development, Portland Cement Association
Doug Sordyl, Managing Director, Strategic Development Council

Vision, Values, and Principles

Peter Emmons, CEO, The Structural Group
Emily Lorenz, Editor-in-Chief, Precast/Prestressed Concrete Institute
Chris McColl, Market Manager-Special Binders, St. Lawrence Cement Co.
Bethany Walker, Western Region Manager, Concrete Reinforcing Steel Institute
Dave Shepherd, Director - Sustainable Development, Portland Cement Association

Communications

Tareq Ali, Manager-Strategic Marketing, St. Lawrence Cement Co
Ashley Baker, Baker Concrete Construction Co.
Tom Adams, Executive Director, American Shotcrete Association
Kevin Cail, Director of Marketing, Lafarge NA
Bev Garnant, Executive Director, American Society of Concrete Contractors
Fred McGee, President, Architectural Precast Association
Mike Tholen, Concrete International

Codes & Standards

Terry Holland, Consulting Engineer
Aimee Pergalsky, Technical Support Representative, The Euclid Chemical Company
Lionel Lemay, Vice President-Technical Services, National Ready Mixed Concrete Association
John Archer, Director - Sustainable Development, Cement Association of Canada
Rich Kuchnicki, National Organizations Liaison, International Code Council
John Ries, President, Expanded Clay, Shale, and Slate Institute
Stephen Szoke, Director Codes and Standards, Portland Cement Association

Continuous Improvement (Footprint / Metrics)

Richard Stehly, Principal, American Engineering & Testing
Alan Sparkman, Executive Director, Tennessee Concrete Association
John Archer, Director - Sustainable Development, Cement Association of Canada
Keith Bargaheiser,
American Coal Ash Association
Bruce Chattin, WA Aggregates & Concrete Assn
Caesar Constantino, Titan America LLC
David Darwin, ACI President/Professor, Kansas University
Paul Fredrickson, CMC
Rich Gibson, Recycled Materials of California
Tom Klemens, Senior Editor, Hanley-Wood
Rich Klingner, Professor, University of Texas - Austin
Steve Kosmatka, Staff VP - Research and Technical Services, Portland Cement Association
Chris McColl, Market Manager-Special Binders, St. Lawrence Cement Co.
Kevin MacDonald, Cemstone Concrete Products Co
Tarun Naik, Professor, University of Minnesota
Melissa Perry, Destiny
Dennis Phillips, VP Operations, Baker Concrete Construction Co
Tom Pounds, Calstar Cement
Julie Rapoport, Calstar Cement
Jan Prusinski, Executive Director, Slag Cement Association
Ken Rear, Lehigh Cement Co
David Stokes, Manager-Concrete Technology, FMC Lithium
Larry Sutter, Ph.D., Professor and Director, Michigan Tech Transportation Institute
Director, University Transportation Center for Materials in Sustainable Transportation Infrastructure
Arezki Tagnit-Hamou, Professor/Industrial Research Chair, University of Sherbrooke
Rusty Winters, Engineering Services Manager, Propex Industries

Education

Bob Law, Chief Estimator, Charles Pankow Builders
Rich Bohan, Portland Cement Association
John Arroyo, Executive Director, Northwest Cement Producers Association
Erin Ashley, Director - Codes & Sustainability, National Ready Mixed Concrete Association
Michael Fletcher, Regional Sales Manager, Essex Cement
Chuck Soeder, VP, BASF Construction Chemicals
Bruce Strickland, National Marketing Manager, SIKA Corp
Bob Thomas, VP - Engineering & Research, National Concrete Masonry Association

Advocacy

Anne Ellis, Vice President, EarthTech
Linda McKinley, Sustainable Development Specialist, Lehigh NW Cement
Angela Burton, Senior Advisor-Sustainable Construction, St. Lawrence Cement
Thomas Carter, Staff Vice President, Portland Cement Association
John Sullivan, Director--Federal Infrastructure Markets, Portland Cement Association
Kristin Cooper Carter, Concrete Industry Management Program, CSU, Chico College of Engineering

Financial Committee

JC Roumain - Project "Champion"; Holcim (US)
Claude Bedard – Strategic Development Council; Euclid Chemical
Joe Sanders – Concrete Research Council; Charles Pankow Builders
Donna Halstead - ACI Foundation
Julie Luther- RMC Research & Education Foundation
Steve Kosmatka – Portland Cement Association

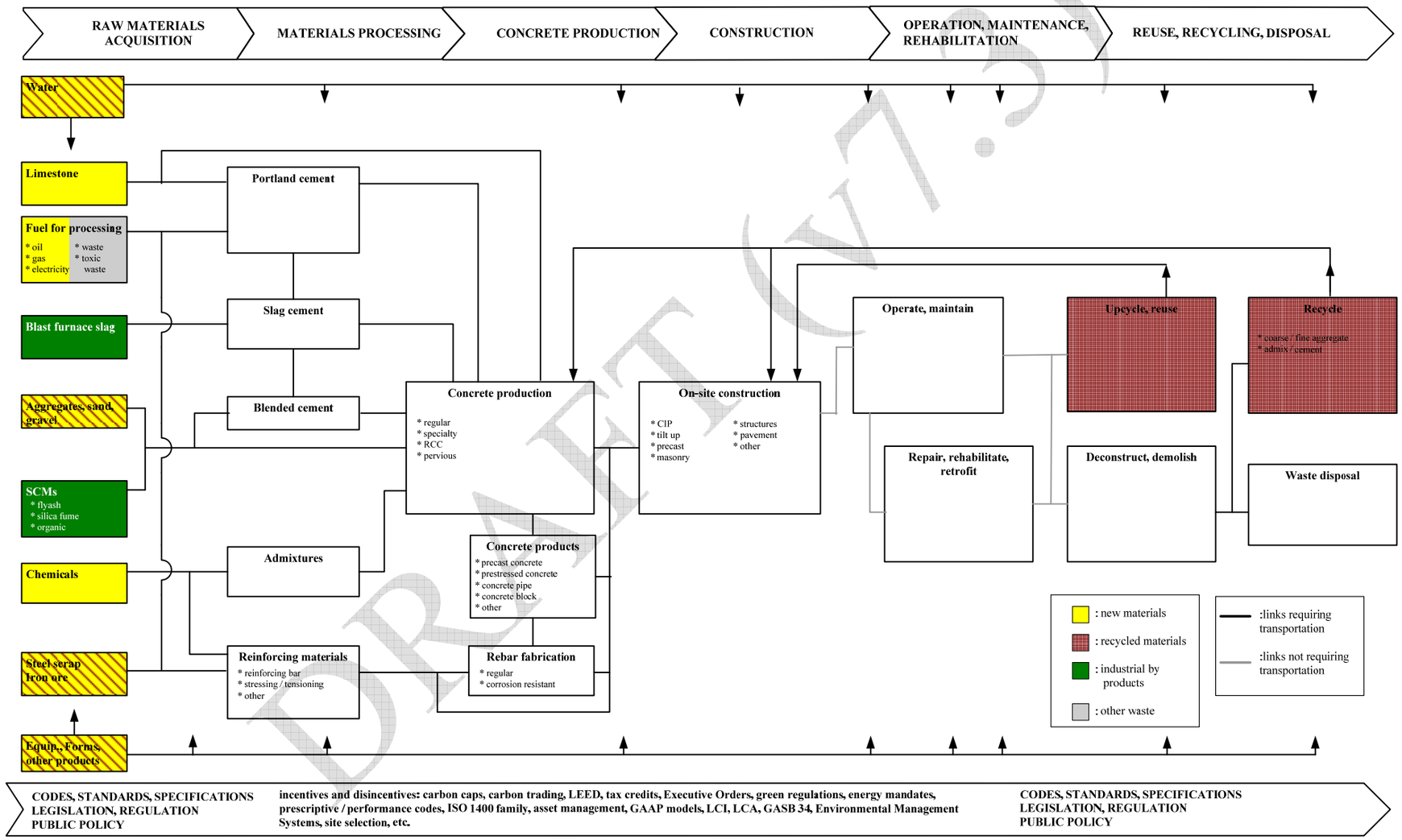
Other participants

Antonio J Aldykiewicz, Research Manager, WR Grace & Co., (MA)
Daniel L Baker, Baker Concrete Construction Inc
Florian Barth
Michael W Beacham, Director of Government Relations, American Concrete Pipe Association
Mark Bury, BASF Admixtures Inc
Brent Constantz, Calera Corporation
Ron Eldridge, Division Manager - Concrete, Sundt Construction Inc
Thomas Finn, Western Regional Engineer, American Concrete Pipe Association
Michael R Fletcher, Regional Sales Manager, Essex Cement Company LLC
David C Goss, Executive Director, American Coal Ash Association
Scot Horst, Horst Inc
Jason Krohn, Technical Director, PCI
Richard E. Lawhun, President, American Concrete Pressure Pipe Association
Susan McCraven, Precast/Prestressed Concrete Inst
David T McKay, ERDC US Army Corps of Engineers
Theodore L Neff, Executive Director, Post-Tensioning Institute
Kelly M. Page, International Concrete Repair Institute
James Posadny, Continental Cement Co
Louis B. Reinwasser, Miller Canfield Paddock
Robert D Thomas, VP - Engineering & Research, National Concrete Masonry Assoc
William R Tolley, Executive Vice President, American Concrete Institute

Other participants (Cont'd)

Debra Van Holst, NOVA Chemicals Inc
Richard Yelton, Hanley-Wood LLC
Ashish Dubey, USG Corporations
Manny Sinha, Parsons Corporation
Michel de Spot, Ecosmart
David Weber, Slag Cement Association
Bob Tlumak, Propex Concrete Systems
Tom Phillips, Miller, Canfield Attorneys
Neal Berke, WR Grace
Brian Lutey, Ozinga Bros.
Per Fidjestol, Elkem Materials
Tony Johnson, CRSI
Harvey Haynes, Haynes & Associates
P. Kumar Mehta, Professor Emeritus, University of California
Ken Slattery, Cement, Concrete & Aggregates Australia
Michael Gartner, Degenkolb SEAOSC SDC
Larry Church, Walker Parking Consultants
Brad Nesset, Thermomass
Laila Raki, National Research Council of Canada
Kurt Bargaheiser, American Coal Ash Association
Tom Van Dam, Michigan Tech University
Paul Kocirajian, Molin Concrete Products
Jussara Tenesi, FHWA/Global
Jenn-Chuan Chern, Taiwan Concrete Institute
Julie Buffenbarger, Lafarge
Nick Horeczko, ICC-Evaluation Services
Rex Donahey, ACI
Sara Steptoe, ACI

THE SUSTAINABLE CONCRETE LIFE CYCLE



APPENDIX B

ACHIEVING THE VISION: A PRELIMINARY ROADMAP FRAMEWORK

ACHIEVING THE VISION

To achieve the vision and strategy outlined in this document, the industry has agreed on a number of sustainability goals, and for each goal a number of key initiatives and preliminary likely tactics or action-plans. These initiatives and preliminary tactics, and necessary next steps, are as follows.

GOAL: CONTINUOUS IMPROVEMENT

Continuously improve, through technical, process, and other innovations, concrete's environmental, social, and economic impact at every step in the concrete lifecycle, and demonstrate through measurement the reality of concrete's sustainability footprint.

Key initiatives	Preliminary tactics
• Develop, maintain and implement comprehensive plan, with measurable objectives, for continuously improving the concrete industry's sustainability performance in North America, including a plan for research	– create and implement the continuous improvement plan, to include detailed roadmap and measurable objectives – create, maintain, and begin the implementation of a plan for technical and business-process research into concrete-related areas promising the most sustainability gains
• Create and maintain a transparent and credible inventory of concrete's past sustainability (environmental, social, economic) performance, and periodically report its current performance	– gather and maintain information and statistics on the sustainability performance of concrete, concrete in construction, and the concrete industry, to serve as a fact base – develop and implement a credible and respected system for the annual monitoring and reporting of the sustainability performance of concrete
• Create and maintain an inventory of global best-practices and cutting-edge technologies capable of improving concrete's sustainability performance	– gather and maintain an inventory of global best practices – publish a guide to best practices and their sustainability impact

• Identify key performance indicators throughout the concrete lifecycle, and set targets for continuous improvement	– create an analysis of potential metrics to measure progress to the various performance drivers and targets, and periodically improve the scope and ambition of industry targets
• Develop tools and approaches (e.g.: technical and process support, rating systems, certification, "concrete sustainability calculator") to promote and facilitate industry achievement of improvement targets	– identify and implement the most worthwhile tools and approaches

GOAL: ADVOCACY

Advocate for public positions, policies, laws, regulations, ordinances, and actions that encourage both sustainable business practices/operations and holistic integration of cement- and concrete-related products in sustainable design and application.

Advocacy is defined as issue management, policy development, and public affairs communication. Public is defined as regulators, legislators, designers, specifiers (AIA COTE, Architecture 2030, etc.), planners, owners, and end users."

Key initiatives	Preliminary tactics
• Engage in national dialogue on policies and positions related to sustainability issues and the assessment of competing products/applications	– stay current on national/state and local legislative initiatives regarding "green" building requirements – be a recognized source for sustainability policy issues at NGA (National Governor's Association), ALEC (American Legislative Exchange Council), US Council of Mayors, etc. – provide a voice for the industry on sustainability and be ready to engage and respond to public issues on sustainability and set the record straight – be influential at USGBC, GBI, Athena Institute, etc. – develop a network of industry advocates to engage in these activities – participate in local green building chapters (USGBC, Home Builders, etc.)

- Translate technical information: guide the development of technical information (e.g., life-cycle analysis) that can develop messages to address decision makers' information needs
  - work in concert with technical advocates to identify the technical and research needs required for sustainability models, tools, industry benchmarking, etc.
  - stay current on "green" building codes and standards
  - stay current on market drivers for sustainable design/green buildings/green lifestyle
  - provide public advocacy messaging for public/legislators/regulators.

- Make information accessible: guide the formation of a central clearing house for key sustainability information
  - collect all legislative and regulatory actions, responses, and associated materials
  - provide industry access for sharing lessons learned and best practices
  - align with an existing credible clearing house and provide the content related to our products.
  - investigate "green labelling" and certification
  - expand the capabilities of ECCO
  - ensure a neutral 3rd party verification of the contents that would give additional credence to the data contained

- Identify critical issues: track emerging issues at the national, state, provincial and local levels and evaluate potential impact on a global scale
  - set-up a national/state/local legislative tracking system with industry access
  - work with allied trade associations to develop/enhance their local political contacts/influence to enable staying abreast of emerging initiatives
  - establish response strategy for engagement in high-risk legislation: risk assessment protocol, coalition building, local lobbyists, grass roots campaigns, etc.
  - develop a program with clear objectives/requirements/measurables for doing this - one that has clear direction from all the Boards or the various associations

• Identify and build relationships with key leadership at the national, state, provincial, and local levels	– encourage allied trade associations networking capabilities at all levels – develop and implement grassroots strategy inclusive of network, tracking of issues, knowledge and communications database ; align strategy with industry priorities – identify allies in efforts (external to industry)
• Influence the development of laws and regulations as they emerge, through advocacy aimed at public decision makers and private influencers	– actively engage in local issues to educate the decision makers – gather the supporting research, and support the need for more research to fill the gaps; ensure credibility critical to advocacy with external audiences – develop the tools (briefing material, technical documents, etc) necessary to validate all statements.
• Help provide implementation and compliance guidance	– develop a two- way network that provides information on what is transpiring at the local, state, and national levels to all concerned – develop communication strategy to ensure industry awareness of laws and regulation promulgated – include "keynote" at all major industry meetings; make attending a requirement for further participation in committees
• Develop, maintain, and implement a plan, with measurable objectives, for advocating positions and actions that will make concrete more sustainable	– create and implement the advocacy plan, to include detailed roadmap and measurable objectives

GOAL: SPECIFIED CONSTRAINTS

Work to remove technical constraints in building codes, standards, and specifications that may prevent concrete and construction from reaching their full sustainability potential.

Key initiatives	Preliminary tactics
• Identify and catalogue existing technical constraints found in building codes, standards, regulations, and specifications.	– identify and prioritize existing technical constraints currently in U.S. and Canadian building codes, standards, regulations, and specifications – tie the analysis into the concrete life cycle flow chart to determine which segments of the concrete industry are affected
• Develop justification for addressing the constraints found building codes, standards, regulations, and specifications.	– review building codes, standards, and specifications from around the world to determine the current state of the art on a worldwide basis to benchmark what other countries are doing to address sustainable development – develop a report providing recommendations on which provisions should be incorporated into U.S. and Canadian codes, standards, regulations, and specifications catalogue and/or conduct research to justify removing constraints.
• Work as appropriate to remove or modify technical constraints found in building codes, standards, regulations, and specifications.	– promote the use of performance based codes, standards, regulations, and specifications to allow for optimization of performance and minimize environmental impact of cement and concrete products – adopt the concrete industry P2P Initiative to provide performance alternatives to prescriptive specifications that restrict the opportunity to use environmentally preferred practices – engage cement and concrete products associations to address constraints (consider enlisting the help of the Alliance for Concrete Codes and Standards (ACCS) and Masonry Alliances for Codes and Standards (MACS)
• Develop, maintain, and implement a plan,	– create and implement the plan to remove

with measurable objectives, to remove specified constraints	constraints, to include detailed roadmap and measurable objectives

GOAL: EDUCATION

Provide education that will engage and empower the industry and its partners to understand, develop, and implement best sustainability practices.

Key initiatives	Preliminary tactics
• Education internal to the industry: develop and deliver training materials and a suggested curriculum to educate the concrete industry on sustainability and the role of concrete in sustainability	Professionals at all levels of responsibility – develop a unified lesson plan that addresses sustainability and its relationship with cement and concrete – compile existing concrete-related sustainability resources – create and maintain an electronic repository for concrete-related sustainability resources – establish an Educational Oversight Committee to aid in implementation – create an educational tool kit for concrete-related sustainability – provide information on how to make individual workplaces more "green" Education unique to each industry sector – develop an AIA-approved distance-learning program – develop a Sustainable Concrete Professional certification program similar to the LEED program – develop a Sustainable Concrete certification program similar to the LEED program for producers and installers – foster industry operational excellence through internal industry award programs – provide a concise message related to the benefit of education related to sustainability, sustainability standards, and the environmental benefits of concrete
• Education of specifiers and designers:	– provide sustainability tools for

develop and deliver tools and a model curriculum highlighting sustainability characteristics of concrete with special emphasis on comparison to other building materials.	designers – develop an AIA-approved distance-learning program on the sustainability footprint of concrete – foster excellence through external award programs
• Education of the general public: saturate the industry with a clear and consistent message on concrete sustainability for delivery to the general public.	– develop a tool-kit for community outreach – provide a website which disseminates information on the sustainable benefits of concrete.
• Educating the educators: develop and deliver a model curriculum to use in building system courses, sustainability courses, concrete design, and materials courses.	– develop and incorporate concrete-related sustainability coursework into all Concrete Industry Management programs. – develop a "train the trainer" program which disseminates information on effective education methods for adults and the sustainable benefits of concrete. – develop educational materials to be used in an undergraduate-level course – develop educational reference materials for educator use to highlight the benefits of various approaches to sustainability
• Develop, maintain, and implement a plan, with measurable objectives, to provide the education needed related to sustainability	– create and implement the education plan, to include detailed roadmap and measurable objectives

GOAL: COMMUNICATIONS

Accurately convey at all times, both within the industry and to all interested parties, the positions and actions of the North American concrete industry related to the sustainability of concrete and/or its role in supporting sustainable development in our communities.

Key initiatives	Preliminary tactics
• Develop, maintain, and implement a plan, with measurable objectives, to communicate the positions and actions of the industry as related to sustainability	– conduct research/situation analysis – develop communications framework – create and implement the communication plan, to include detailed roadmap and measurable objectives – monitor/adjust
• Inventory and track attitudes towards concrete and the concrete industry	(see above)
• Develop, introduce, and maintain appropriate communications vehicles and tools	(see above)

GOAL: MOBILIZATION AND TEAMWORK

Through structured, dynamic, and innovative approaches, enable the varied and disparate components of the North American concrete industry to work together as a team to ensure optimally sustainable applications of concrete, and that the sustainability imperative becomes anchored in the culture of the whole industry.

Key initiatives	Preliminary tactics
• Develop, implement and maintain a plan, with measurable objectives, to enable the continuity of this industry initiative and to enable industry to work as a team and mobilize to achieve the sustainable concrete vision, and to position this sustainability process appropriately	– ensure the continued development of this Vision document – develop and help implement the detailed roadmap, workplans, change-management plan, with measurable objectives, and other plans to enable the achievement of this Vision
• Ensure the endorsement of the various segments of the concrete industry, including gaining acceptance of the need for the industry to address the sustainability issue, for each organization to align its approach with that outlined in the this Vision Document, and to fully support this initiative	– develop and implement a systematic plan to achieve industry endorsement – facilitate the development of a North American Concrete Industry Sustainability Protocol to clarify the contributions of each industry segment

- Ensure that the various initiatives related to sustainable concrete are adequately resourced and that appropriate structures are in place to ensure good governance
  - ensure that an appropriate and well supported entity is chosen (or created) and enabled to coordinate and lead this industry effort
- Work to ensure that the process of developing and implementing the concrete sustainability vision and roadmap are as efficient and effective as possible
  - adopt a branding strategy for the concrete sustainability initiative
  - create a global information base on matters related to concrete sustainability

NEXT STEPS

This plan is a major undertaking involving all parts of the concrete industry working together as a team. Consequently, this activity, and its resourcing, will be coordinated and led by a new not-for-profit 501c6 corporation, funded by the industry and led by full-time paid staff. This will enable the collective action necessary to make an unfolding vision and roadmap for the sustainability of construction with concrete a reality across North America.

To ensure the continuity of this vital industry initiative, the following actions also are planned as soon as this document is released within the industry:

- reviews of this vision and plan framework by as many industry stakeholders as possible with a view to making such adjustments as may help the industry collectively achieve it
- extensive consultation with other actors with a stake in the sustainability of the built-environment
- development of the detailed roadmap (tactics, workplans, change plans, measurable objectives, etc.) in each sustainability goal area
- start or continuation of work to pursue and implement this vision wherever the activity is already sufficiently well scoped and resourced.

APPENDIX C

APPENDIX C: ASSUMPTIONS RELATING TO THE INDUSTRY'S CO_2 TARGETS, 2005 TO 2020

ASSUMPTIONS RELATING TO THE INDUSTRY'S CO_2 TARGETS, 2005 TO 2020

- Per-cubic-yard target is for a typical current cubic-yard in place for a usable structure. This norm needs to be clarified. Without this assumption, the industry's target could be compromised by the environmentally-desirable use of different concrete mixes (for example to respond to performance specifications) in different quantities in the design of structures.

- CO_2 for all-concrete-placed target assumes a growth in demand of 2.5% annually during the period.

- Both targets assume that ways can be found in the period 2005-2020 to further increase the percentage of supplementary cementitious materials in concrete from 12% to 22%, and to reduce the pounds of cementitious materials per cubic yard of concrete from 550 lbs to 500 lbs. The industry should not be unreasonably constrained from making these changes.

- Both targets depend on certain assumptions concerning the 2005 baseline composition of a typical cubic-yard of concrete.

APPENDIX D

APPENDIX: CONCRETE AND SUSTAINABLE DEVELOPMENT - STARS TO STEER BY

STARS TO STEER BY:
CONCRETE AND SUSTAINABLE DEVELOPMENT

NAVIGATION

In fashioning its vision for concrete's contribution to sustainable development and a roadmap for achieving this, the industry faces a number of major challenges. For example, it is no wiser than any other industry when it comes to deciding which holistic framework to adopt for approaching "sustainability" improvement, and has only a limited ability to envision the ways in which our infrastructures and built-environment will need or be able to evolve to meet changing social, economic, and environmental realities. The concrete industry can and does, though, commit to developing a better understanding of the complex systems that determine our effect on our environment that may be critical in meeting the challenges facing society. It will work with all stakeholders to develop, clarify, and support the positive contributions that concrete can make, even though some of these contributions may yet be unclear or may require major research, innovation, or discontinuous change. It also will intensify its work on improving the footprint of the material it provides, a relatively known quantity compared to the broader unknowns related to the built infrastructure and environment. These are the stars by which the industry will steer until what lies over the horizon becomes clearer.

SUSTAINABILITY AND THE BUILT-ENVIRONMENT

Sustainability

Key to the concrete industry's vision is contributing within society's broad definition of sustainability[4]. This is an area where scope and approach are continuing to evolve. Definitions, and particularly approaches to improvement measurement and assessment, vary considerably, and no single accepted framework has yet emerged. These definitions and perceptions as they relate to the built-environment are important to understanding the scope of the industry's commitment.

- ***Sustainability: The Brundtland Report***[5]
  "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In essence sustainable development is a process of change in which exploitation of resources, the direction of investments, the orientation of technological developments and institutional change are all in harmony and enhance current and future

- ***Indicators: United Nations***[6]
  Indicators that can form a framework for sustainable development. **Social**: equity, health, education, housing, security, population. **Environmental**: atmosphere, land, oceans, coasts, seas, fresh water, bio-diversity. **Economic**: economic structure, consumption and production patterns. **Institutional**: institutional framework, institutional capacity.

[4] See Appendix A "Purpose, Scope and Process"
[5] World Commission on Environment and Future Development, "Our Common Future", 1987
[6] http://www.un.org/esa/sustdev/natlinfo/indicators/isdms2001/table_4.htm

potential to meet human needs and aspirations"

- ***System Conditions: Natural Step*** [7]
  An organization can derive its ultimate sustainability objectives through responding to four system conditions. Eliminate our contributions to systematic…
  1. increases in concentration of **substances from the earth's crust**
  2. increases in concentrations of **substances produced by society**
  3. physical **degradation of nature** through over harvesting, introductions and other forms of modifications

  Contribute as much as we can to…
  4. **meeting human needs** in our society and worldwide, over and above all the measures taken in meeting the first three objectives

- ***Community Capital: Hart*** [8]
  Sustainable community indicators reflect community capital. ***Built and financial capital***: goods, equipment, buildings, roads, water systems, jobs, information resources, the credit or debt of a community. ***Human and social capital***: people in society, skills, education health, their ability to work together. ***Natural capital***: the natural environment, renewable and non-renewable resources, and the services the eco-system provides the life-enhancing qualities of nature. All of these must function in balance for a society to sustain itself.

- ***Sustainable Design: Gordon*** [9]
  Key considerations for sustainable design.
  Long life. Will this structure last longer than previous structures?
  Loose fit. Will this structure be adaptable to change in the future to avoid using non-renewable resources?
  Low energy. Will this structure use less energy in extraction, construction and operation than similar structures?

- ***Teamwork: Brandon and Lombardi*** [10]
  "It is worth noting that a **focus on working and learning together** is thought to be beneficial to organizations and, as the built-environment is an organization of a sort, there may well be lessons to be learnt for achieving sustainable development. If we do not do this the [improve / decline] cycles described are likely to continue and we can expect failure on a regular basis"

- ***Dimensions of sustainability: Alberta*** [11]
  "The AUMA encourages communities to consider five dimensions when thinking through the sustainability of their communities: **social, cultural, environmental, economic, and governance**…Of the five dimensions, two are necessary throughout the journey towards sustainability starting today: these are governance structures that are participative and inclusive, and economic sustainability"

- ***Sustainability and ethics: ASCE*** [12]
  Guidelines to Practice under the Fundamental Canons of Ethics. Canon 1: "Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their duties". Note 3: "Sustainable Development is **the challenge of meeting human needs** for natural resources, industrial products, energy, and the natural resource base essential for future development."

While the emphasis varies from viewpoint to viewpoint, most perspectives emphasize the very broad socio-economic scope of the concepts associated with sustainability, along with an

[7] www.naturalstep.ca/sustainability-objectives.html: accessed (date)
[8] Hart, M., *Guide to Sustainable Community Indicators* (Hart, 1999)
[9] Gordon, A., (1974) The Economics of the 3 Ls Concept. *Chartered Surveyor B&QS Quarterly*, RICS, Winter1974
[10] Brandon, P.S., Lombardi, P. (2005) *Evaluating Sustainable Development in the Built-environment*, Blackwell, Oxford: this chapter owes much to this work.
[11] Alberta Urban Municipalities Association, Municipal Sustainability Planning Guide (2006, URL)
[12] www.asce.org/inside/codeofethics.cfm

essential emphasis on holistic, long-term, life-cycle considerations. Similarly, most approaches emphasize the importance of appropriate governance structures and teamwork.
There are contrary views. Bjorn Lomborg's work, for example, suggests that spending extra resources to try and blunt climate change (through carbon taxes, Kyoto-type initiatives, etc.) should not be a priority as compared to spending on health and nutrition, sanitation, water, government, trade, and migration.[13]

The concrete industry will participate fully in the debate to reach consensus on the key variables affecting the sustainability of the built-environment. It considers that, in principle, the broadest possible connotations should be given to the definition of sustainability to follow.

Built-environment

Within the broad societal context sits the built-environment, the infrastructure that concrete helps to shape. This environment is also generally broadly defined. "…the built-environment…by definition is concerned with humankind's activity in creating shelter and accommodation for itself, an act which inevitably changes the environment in some way. In particular the development of cities, and the underlying social cohesion and culture which is created through cities has a big impact on the use of resources, the way people behave, their interaction with nature and the waste products that ensue from this type of living."[14]

More specifically the Presidential Climate Action Project[15] lists a number of features of the vision for America's urban and peri-urban areas, including "zero-emission buildings, rooftop gardens, open space, bike lanes and walking paths, public transport and congestion control. They will be powered by a smart, clean, robust, resilient, and self-healing electric grid with on-site, regional and central power generation, improved storage, cogeneration and computer-derived identification of critical loads within buildings and cities, which will help them adapt to heat waves, storms, and grid interruptions. The result will be fewer vehicle miles traveled, better local air quality, cooler inner-city areas, fewer greenhouse gas emissions, and a boost for local and regional economic growth as energy dollars are retained in their economies."

The influencers over the built-environment are many. France[16], for example, has identified 42 actors in 6 groups (poles) as follows…

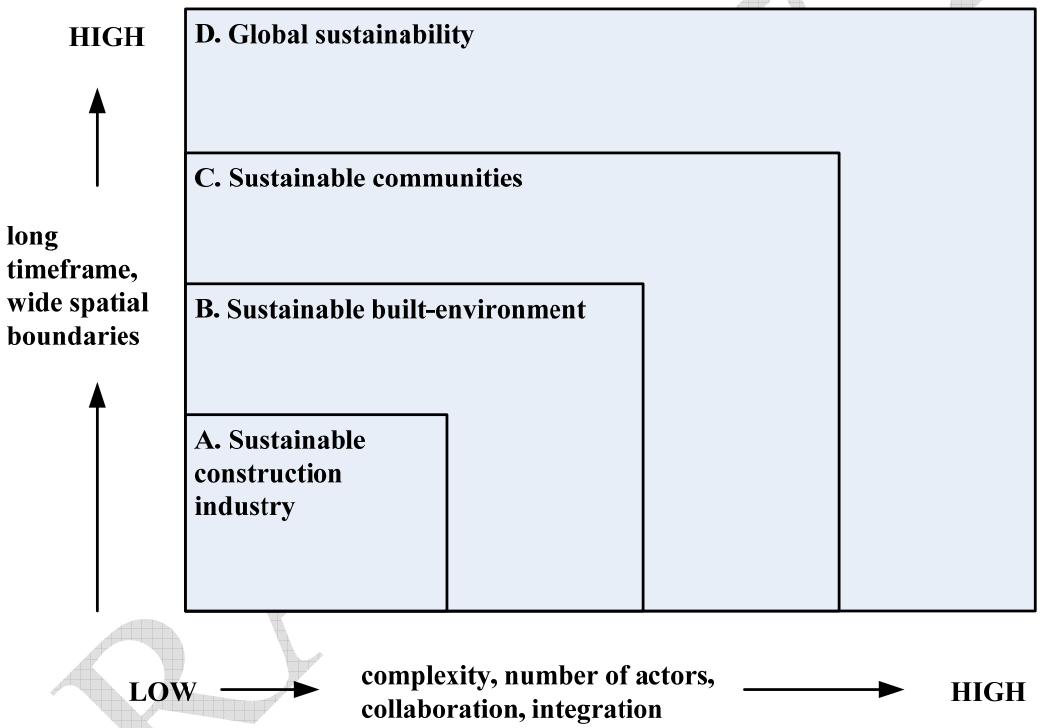
- **civic service:** 10 actors (government, R&D, training, NGOs, standards organizations, etc.)
- **private service: operations:** 7 actors (owners, financiers, developers, etc.)
- **private service: design:** 10 actors (designers, architects, planners,
- **private service: production:** 6 actors (materials producers, contractors, components, equipment, etc.)
- **public / private:** 5 actors (transportation, facilities management, insurers, etc.)
- **citizens:** 6 actors

[13] Lomborg, Bjorn., *Cool It. The Skeptical Environmentalist's Guide to Global Warning* (2007, London, Marshall Cavendish)
[14] Brandon, P.S., Lombardi, P. (2005) *Evaluating Sustainable Development in the Built-environment*, Blackwell, Oxford: this chapter owes much to this work.
[15] Presidential Climate Action Project, 2007: www.climateactionproject.com
[16] Intelcity Roadmap (EU-1st 2001-7373) from the ATEQUE classification

consultants, etc.) (users of space and services)

The main actors in the North American concrete industry as it has historically been thought of are heavily concentrated in the "production" category above, whereas all six groups are major stakeholders in the built-environment. Owners and design practitioners, for example, have a major impact on concrete's use in construction The industry realizes that it must work increasingly with all these actors if there are to be visionary improvements to the sustainability of the built-environment, and to further develop this vision and initial roadmap.

The place of the construction industry (and the concrete industry that is a component of it) in this big picture of sustainability has already been recognized[17].



The industry understands these complexities and the challenges they represent to bringing about widespread change.

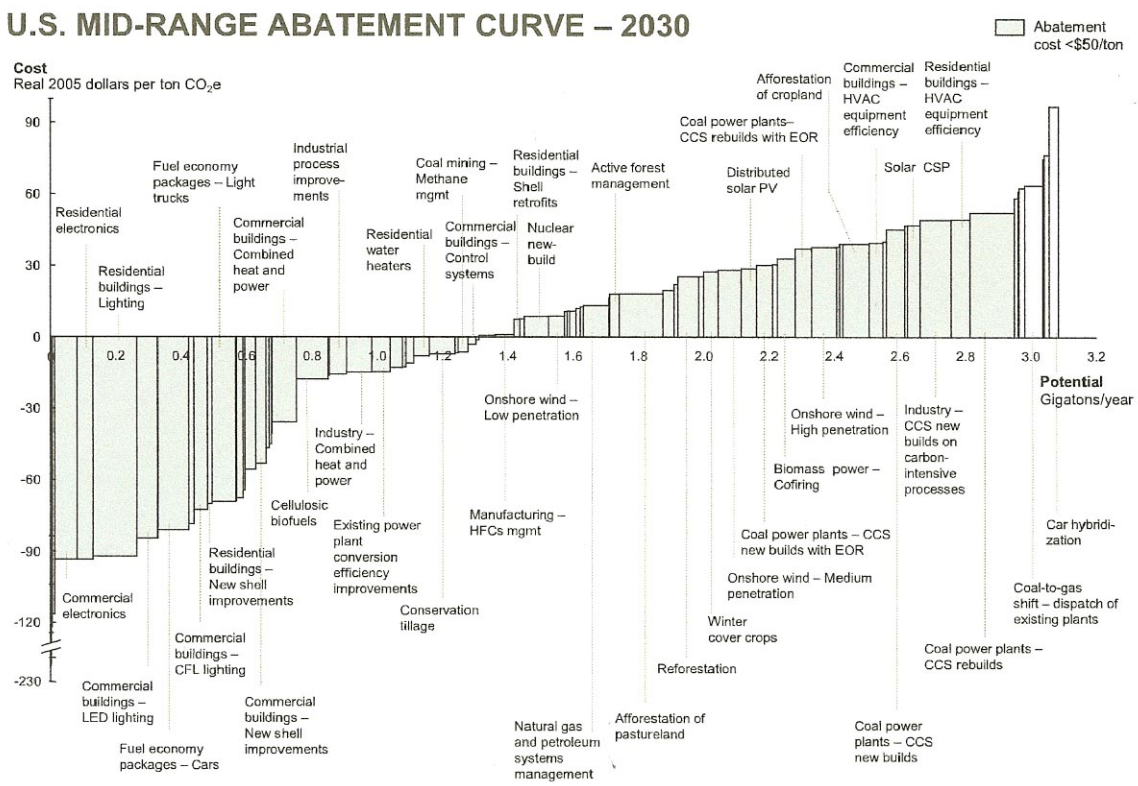
CONCRETE AND THE BUILT-ENVIRONMENT

The British retailer Boots, as part of its carbon reduction and labelling strategy, has been able to reduce the carbon footprint of its Botanics shampoo product by 20% through the greater use of

[17] (Source: Construction Research and Innovation Panel Report: Sustainable Construction: Future R&I Requirements: Analysis of Current Position, 23 March 1991.)

recycled plastics and some adjustments to raw materials. But their research has shown "…that by far the greatest portion of the shampoo carbon footprint was within the consumer use phase. This resulted from the amount of hot water used to wash hair, the frequency of washing and the efficiency of methods used to generate hot water in the home."[18] Concrete is in a similar situation. Advances have been and will be made in the environmental footprint of concrete the product, but the greatest potential contribution to a sustainable society lies in how concrete is designed and used in our infrastructures and built-environment.

In a cost-benefit study of how to cut greenhouse gases in the USA as cheaply as possible, McKinsey and Co[19] looked at the costs of effecting various possible changes as compared to the benefits in CO_2 reduction. This resulted in the following assessment.



It is striking how many potential initiatives concern the built-environment and infrastructures, and of these how many could be beneficially influenced by the optimum use of concrete. The analysis also serves to illustrate the environmental abatement versus growth paradox for the industry. Much of the new and retrofit construction proposed is likely to increase demand for concrete, compounded potentially by a greater use of concrete per structure. This reinforces the need for the industry to drive down the environmental footprint of its product, but also to work

[18] www.packaging-gateway.com/features/feature1326/

[19] McKinsey and Co., *Reducing US Greenhouse Gas Emissions. How Much at What Cost?* *[check copyright on this]*

urgently with other actors to drive down the future environmental costs of maintaining and operating our infrastructure over cradle-to-cradle life cycles.

There are many applications in the built-environment where investing appropriately in concrete may produce substantial sustainability returns on community capital. These may relate, for example, to the longer life and durability of structures, ways to reduce the energy use of buildings throughout their lifecycles including reuse and recycling, improved ways to manage community water supplies, the reduction of drag (and therefore fuel consumption) on roadways, and the like.

The industry is expanding its research to help quantify the extent of this potential. Some results to date have suggested:…

NRMCA Research

- Quality Management System for Ready Mixed Concrete Companies
- Model Performance Spec Phase II: Guide to Specifying Concrete Performance
- Model Performance Spec Phase I: Preparation of a Performance-Based Specification for Cast-In-Place Concrete
- Experimental Case Study Demonstrating the Advantages of Performance Specifications
- Crushed Returned Concrete as Aggregates for New Concrete
- Recycled Water in Ready Mixed Concrete Operations
- New Technology Based Approach to Advance Higher Volume Fly Ash Concrete with Acceptable Performance
- Effect of Pavement Type on Fuel Consumption and Emissions
- Side-by-Side Comparison of Pervious Concrete & Porous Asphalt
- Performance Assessment of Pervious Concrete and Maintenance Plan
- Air Emissions Testing Program at Ready Mixed Concrete Plants
- Pervious Concrete Mix Design for Wearing Course Applications
- Pervious Concrete Research Compilation
- Long-Term Field Performance of Pervious Concrete Pavements

PCA Research

- Carbonation of pervious concrete
- National Quantitative Survey of Recycled Concrete
- Life Cycle Inventory of Concrete Masonry Units
- LCA Modeling Tool for Sustainable Cities.
- Absorption of Atmospheric Carbon Dioxide by Portland Cement Concrete (SN 2255a)
- Air Emissions Data Summary for Portland Cement Pyroprocessing Operations Firing Tire Derived Fuels SN3050)
- Beneficial Recovery of Waste Heat from Cement Manufacturing (SN 2469) Beneficial Reuse of Materials in the Cement Manufacturing Process (2007)
- Beneficial Reuse of Materials in the Cement Manufacturing Process (2007)
- Carbon Capture Technologies - options and Potentials for the Cement Industry (2007)
- Comparison of the Life Cycle Assessments of a Concrete Masonry House and a Wood Frame House (SN 3042)
- Comparison of the Life Cycle Assessments of an Insulating Concrete Form House and a Wood Frame House (SN 3041)
- Compilation of Cement Industry Air Emissions Data for 1989 to 1996 (SP 125)
- Comparison of Six Environmental Impacts of Portland Cement Concrete and Asphalt Cement Concrete Pavements (SN 2068)
- Concrete Homes Save Energy (IS 300)
- Concrete's Role in the Indoor Air Environment (1998)

- Concrete Pavements Cut Fuel Consumption (SN 2648)
- Controlling the Strength Gain of Fly Ash Concrete at Low Temperature (SN 2146a)
- Effect of Pavement Surface Type on Fuel Consumption (SN 2437)
- Effects of Use of Limestone on Various Properties of Portland Cement (SN 2891)
- Energy Efficiency of Concrete Homes (SN 2518a)
- Energy Use in Residential Housing: A Comparison of Insulating Concrete Form and Wood Frame Walls (SN 2415)
- Energy Use of Single-Family Houses with Various Exterior Walls (Thermal Mass) (SN2518)
- Environmental Considerations Associated with Using Industrial By-Products Such as Fly Ash in Concrete (SN 2636)
- Environmental Life Cycle Inventory of Portland Cement Concrete (SN 2137a)
- Environmental Life Cycle Inventory of Single Family Housing (SN 2582a)
- Environmental Performance of Concrete (SN 2951)
- Fly Ash Fights ASR (SN 2646)
- Fuel Savings of Heavy Trucks on Concrete Pavement (SR 351)
- Guidance of LEED Certification of Concrete Buildings (SN 2880)
- Hydrologic Design of Pervious Concrete (SN 2829, EB 303)
- Influence of Pavement Reflectance on Lighting for Parking Lots (SN 2458)
- LCA of Concrete Masonry House Compared to a Wood Framed House (SN 2572)
- LCA of Lightweight Concrete Masonry House Compared to a Wood Framed House (SN 2573)
- LCA of ICF House Compared to a Wood Framed House (SN 2571)
- Life Cycle Inventory of Portland Cement Manufacture (SN 2095b)
- Life Cycle Inventory of Portland Cement Concrete (SN 3011)
- Modeling Energy Performance of Concrete Bldgs for LEED NC ver 2.2 (Energy and Atmosphere) (SN 2880a)
- Optimizing the Use of Fly Ash in Concrete (SN 3031 IS 548)
- Pervious Concrete Pavements (SN 2828) (EB 302)
- Recycled Aggregates for Reinforced Concrete (SN 2629) (CT 022)
- Recycled Water in Concrete (SN 2774)
- Solar Reflectance of Concretes for LEED (SN 2982)
- Supplementary Cementing Materials (SN 2790) (CD 038)

To know whether these results are typical or atypical, and to better inform the whole debate, the industry and all its partners in the built-environment need to greatly extend their knowledge in these and other areas. The concrete industry is committed to playing a leading role in these efforts, and to work in concert with representatives of other building products to identify the best solutions for our communities.

APPENDIX E: SUSTAINABILITY AND THE CONCRETE INDUSTRY TODAY

SUSTAINABILITY AND THE CONCRETE INDUSTRY TODAY

THE SUSTAINABILITY CONTEXT

Sustainable development, green building, and in particular climate change, are now realities of life. Corporations in every industry are increasingly being shaped by their customers' demands to be more environmentally responsible. Government regulations to limit environmental impact of manufacturing will continue to place pressure on corporations to improve environmental performance, and this will be increasingly monitored and regulated. In the near future, individual companies will compete on lowest environmental impact and most likely on carbon footprint. Companies who do not adapt to these changes will not survive.[20] Those that do will have the opportunity to innovate, build brand trust, and minimize business risk, while behaving ethically and responsibly.

The construction industry is especially affected by these changes since the built-environment has significant impact on the global environment. Operating our buildings and infrastructure consumes enormous amounts of energy which contributes to the deteriorating environment and global warming. The built-environment consumes substantial amounts of fresh water for human consumption, waste, and irrigation. Refuse usually ends up in landfills.

Construction of the built-environment and manufacture of building products also have significant impacts on the environment. These processes consume natural resources and require significant amounts of energy. The manufacture of certain products (e.g.: cement, reinforcing steel) can release significant amounts of greenhouse gases. Transporting building materials and operating on-site machinery for construction projects creates greenhouse gas and other emissions. And at the end of a project's life cycle much demolished material is currently landfilled as opposed to being reused or recycled into new products.

The concept of complete life cycle assessment considers the environmental impacts across all of these phases. Also know as cradle to grave (or cradle to cradle when including re-use), the value of material manufacturing impacts are pro-rated against operational performance and long- term durability. The optimum incorporation of concrete in sustainable construction design can therefore have a major effect over the built infrastructure. It promises savings of, for example, [25%-30%] of lifetime heating and cooling costs through the use of insulated concrete walls, not to mention the additional potential of green roofs, reflective surfaces, and longer building life.

[20] Michael E. Porter and Forest L Reinhardt, Grist: A Strategic Approach to Climate, Harvard Business Review, Cambridge, MA, October, 2007

CONCRETE

Concrete is the most used building product on earth.[21] In general it is comprised of about 41% coarse aggregate (gravel or crushed stone), 26% fine aggregate (sand), 16% water, 11% cementitious materials, 6% air bubbles, and a small amount of chemical admixture. Water and cementitous materials combine chemically to create the 'glue' that binds the materials into an extremely versatile material that can be molded into an infinite variety of shapes while providing a durable, structural material that does not rot, rust, or burn. Currently this traditional concrete mix has an environmental footprint of [between x and y CO_2, x and y other GHGs, x and y embodied energy, and consumes between x and y gallons of fresh water] per cubic yard. Concrete is a unique product that has a number of strong attributes, but also a number of challenges, when it comes to improving the sustainability of construction. These include the following.

Strengths

- typically locally derived and made, locally placed and can be recycled for use as aggregate
- once in place, consumes CO_2 from the atmosphere
- generally reinforced by 100%-recycled steel and generally incorporates other recycled industrial by-products
- resource efficient: the ingredients require little processing and generate little waste
- exceptionally strong in uses where resistance to fire, progressive collapse, seismic disturbance, wind, or blast are concerned
- in roadways, reduces rolling resistance and thus fuel consumption
- can be made to be pervious to water, thus preventing run-off
- reflective, therefore cool, safe, and saves on artificial lighting
- exceptionally durable, will not rot or rust, and can be designed to last a century or more
- provides excellent thermal mass that can enable substantial reductions in heating and cooling costs
- natural beauty in architectural applications
- provides great flexibility in design options, and can fit faultlessly into any surroundings
- provides acoustic attenuation
- provides good indoor air quality

challenges

- typically requires ingredients, such as portland cement and reinforcing steel, whose manufacture requires heat and therefore produces a considerable release of CO_2
- generally owes its strength and durability to cement, whose creation from limestone passes through a natural chemical reaction (pyroprocess) which also releases considerable CO_2
- requires a skilled workforce to place well, particularly in sophisticated structures and applications
- ensuring that designers, architects, engineers, and client-representatives have the information they need to design for optimum infrastructure sustainability with concrete
- prescriptive codes and specifications often inhibit concrete's ability to be an optimally sustainable product, and to achieve its full potential as an enabler of sustainable construction

[21] Reference

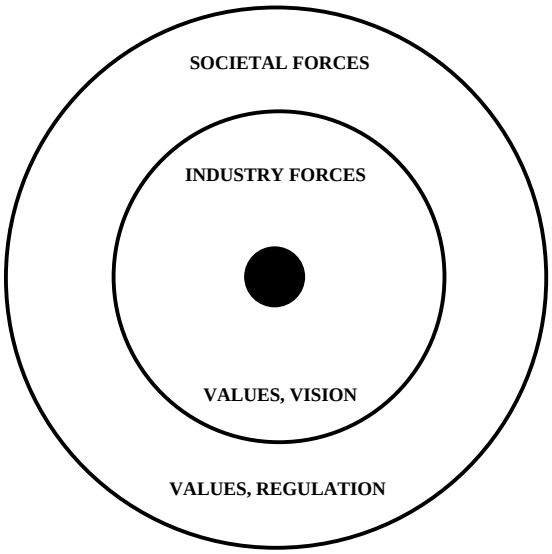
Improving the sustainability of concrete as a product is therefore an opportunity, and one that the industry continues to address.

An avenue that is being actively pursued, for example, is the substitution of other cementitious products for portland cement, domestic production of which is insufficient to meet demand. Not only does this reduce the CO_2 per unit placed, but many of these substitutes are themselves industrial by-products.

FORCES FOR CHANGE

The forces for change are generated both by society in general and by the construction industry. These are each represented on the sustainable concrete life cycle flowchart. Societal forces reflect the emerging community values we all share, but also give rise to specifications and regulation. Industry generated forces reflect community values and regulation, but also the industry's pursuit of its own vision and its determination to be a global leader in sustainable development.

Forces for change in the life cycle



Societal forces

There are a growing number of social initiatives at world, national, and local levels, aimed at promoting sustainability. These have an impact on all industries, and the concrete industry is no exception.

Among the resulting initiatives most relevant to the construction and concrete industries are…

- ***United Nations Framework Convention on Climate Change, Kyoto Protocol, and Bali Roadmap***
  the Kyoto Protocol (1990), an international treaty that established targets for greenhouse gas emissions for the world's leading economies: these targets range from -8% to +10% of the countries' individual 1990 emissions levels: commitments vary from nation to nation: the Bali Roadmap (2007), charts the course for a new negotiating process to lead to a post-2012 international agreement on climate change

- ***US State Governments***
  several initiatives, such as the Regional Greenhouse Gas Initiative, a cooperative effort by 9 Northeast and Mid-Atlantic states to design a regional cap-and-trade program: all the Northeast and Mid-Atlantic states are studying or implementing programs to reduce greenhouse gas emissions: the New England governors and Eastern Canadian premiers issued a Climate Change Action Plan calling for reduction of greenhouse gases to 10% below 1990 levels by 2020: Climate Action Team in California charged with implementing global warming emission reduction programs

- ***United States Government***
  has signed the Bali Roadmap: appears to be nearing a cap and trade approach: House Committee on Energy and Commerce has released white papers addressing global climate change legislation: some conclusions include the need for the U.S. to reduce its greenhouse gas emissions by 60% to 80% by 2050: a cap-and-trade program will be the central component of forthcoming legislation

- ***World Business Council on Sustainable Development (WBCSD)***
  a platform for companies to explore sustainable development, share knowledge, experiences and best practices, and to advocate business positions on these issues: within the WBCSD is the *Cement Sustainability Initiative, supported by 17 cement companies producing one third of the world's production.* Their agenda has mapped a 5-year set of task forces and projects dealing with climate protection and CO_2 management, fuel and materials, employee health and safety, emission monitoring and reporting, impacts on land and communities, and reporting and communication

- ***Chicago Climate Exchange***
  the world's first and North America's only active voluntary, legally binding integrated trading system to reduce emissions of all six major greenhouse gases

- ***Green Building Ordinances***
  by late 2007 the number of US cities as compared to 2003 with green building programs had grown from 22 to 92: one out of seven cities surveyed had a green building program: 39% of citizens live in cities with green building programs: various LEED initiatives are to be found in 72 cities, 22 counties, 16 towns, 27 states, 13 federal agencies, 10 public school jurisdictions and 35 institutions of higher education across the United States: in Canada there has been a similar movement at provincial and local level, with approaches varying from modest (Alberta) to more ambitious (Quebec, with its carbon tax)

- ***Al Gore***
  produced the documentary film *An Inconvenient Truth*: awarded the 2007 Nobel Peace Prize "for efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

- ***The Pew Center on Global Climate Change***
  reports from top-tier researchers on key climate-related topics such as economic and environmental impacts and practical domestic and international policy solutions

Internal forces

Forces internal to the construction industry have resulted in a number of initiatives as the industry has steadily improved the sustainable characteristics of its product and its impact on the sustainability of construction.

These initiatives include:…

- ***American Institute of Architects (AIA)***
  AIA Committee on the Environment (AIA COTE): the Environmental Resource Guide

- ***American Concrete Institute (ACI)***
  Strategic Development Council of the ACI Foundation has enabled the development of the industry sustainability vision

- ***United States Green Building Council (USGBC) Canadian Green Building Council (CaGBC)***
  LEED (Leadership in Energy and Environmental Design) green building rating system for new commercial construction: many building owners, cities and other government entities have adopted the LEED standard for their buildings: some cities have adopted ordinances that require all public buildings to be built to a specific LEED certification level: main benefits of green building as outlined by USGBC relate to the environment, economy, health, and community

- ***US and Canadian industry associations***
  most have sustainability committees: initiatives include NRMCA's P2P initiative and Green Star certification, PCA and CAC's Cement Manufacturing Sustainability Program and Voluntary Code of Conduct, PCA's Sustainable Leadership Awards, and many others

- ***Cement Sustainability Initiative***
  a 5-year set of task forces and projects dealing with climate protection and CO_2 management, fuel and materials, employee health and safety, emission monitoring, and reporting, impacts on land and communities, and reporting and communication

- ***Architecture 2030***
  "The 2030 Challenge" to the global architecture and building community to adopt specific targets to reduce the fossil fuel energy consumption of new buildings (e.g.: to the carbon neutral by 2030), and through upgrades to existing buildings: adopted by the US Conference of Mayors, AIA, USGBC, CaGBC, Royal Architecture Institute of Canada, WBCSD, US Environmental Protection Agency, and others

- ***International Organization for Standardization (ISO)***
  continuous development of ISO standards (e.g.: ISO TC71 SC 8) for the environmental management of concrete, sustainability in building construction, etc.

CRITICAL AREAS OF FOCUS

The concrete industry has identified a number of areas critical to the continuous improvement of its sustainability performance. These include:…

- ensuring the continuous improvement of concrete's sustainability footprint, including the measurement, in a credible and transparent manner, of concrete's progress

- extent to which the industry and all interested parties are appropriately educated about the true sustainability characteristics of concrete

- extent to which the industry openly and honestly advocates the true sustainability characteristics of concrete

- impact that applicable codes, standards, legislation and other constraints imposed on the industry have on the sustainability of construction with concrete

- how the concrete industry communicates the industry's approach to sustainable development and sustainable construction, both within the industry and to all interested parties

- how the various components of the North American concrete industry coordinate and collaborate to support optimally sustainable applications of concrete.

The historical trends, and current realities, in each of these areas are broadly as follows.

CONCRETE'S SUSTAINABILITY FOOTPRINT

Concrete has made considerable strides towards sustainability as a product during the past several decades. Progress has also been made towards developing innovative products to improve the sustainability of all construction. Progress has been made in the manufacturing process, along with improvements in the material extraction process. Its ingredient materials also have undergone significant improvements.

As a product, concrete has been steadily improving its carbon footprint, for example, reducing from about [x per cubic yard in 1950 to about y per cubic yard in 2005]. Similarly, heightened awareness, and particularly requirements for LEED certified buildings or other green criteria, have begun to enable concrete to play a more important role in sustainable construction (e.g.: through pervious applications, through greater use of its thermal mass, through its "cool" reflective characteristics, and through materials recycling and reuse).

On the other hand the concrete industry has had no comprehensive approach to tracking these improvements, and consequently only a limited ability to report on them.

While certain segments of the industry have set themselves sustainability improvement targets (e.g.: the cement industries in both the United States and Canada) or adopted focused sustainability initiatives (e.g.: NRMCA's P2P Initiative and Green Star Certification), the industry as a whole does not yet share any common, industry-wide, North America-wide, sustainability improvement targets or programs.

Opportunities for continued improvement

The great versatility of concrete presents a wide range of solutions for sustainable development. Some of these have the potential to further improve the sustainable characteristics of the product, while others of the built-environment, and some to improve both.

These opportunities levers for continuous improvement include:…

> **environmental**: continue to reduce fossil fuel consumption, increase use of waste-derived fuels, reduce use of virgin materials, increase use of industrial or domestic waste, increase use of industrial by-products and supplementary cementitious materials, efficient use of admixtures increase use of recycled concrete and other materials, use new binders and fillers, use new reinforcement approaches, reduce potable water use, reduce transportation, improve the handling of hazardous materials, conduct technical research (CO_2 sequestration, carbonation and recarbonation, bioconcrete, nanoengineering, new binders, etc.), improve business processes (to reduce waste, to reduce air and noise pollution, etc.), sustainability-friendly construction design and specifications (to extend

the life of structures, to permit new mix designs), develop innovative new products and processes

socio-economic: continue to improve employee health and safety, increase local sourcing (and reduce imports) to increase local employment and economic development, improve local community infrastructures (to permit better water management, to enable cleaner electricity generation, to rehabilitate or replace community structures, etc.), rehabilitate raw material extraction sites, continue contributions to community non-profit and charitable initiatives, ensure the continued competitiveness of the industry to safeguard financial contributions to the economy

The industry has continuously used and is using these opportunities to better contribute to sustainable construction but intends to adopt a more systematic and cohesive approach to realize concrete's full potential. Needs include gathering and analyzing available information to identify more precisely the potential of each opportunity, technical research to push current product boundaries, and manufacturing process research to improve environmental performance. This in addition to being a key participant in broader initiatives to improve the sustainability of the built-environment.

EDUCATION AND CONCRETE SUSTAINABILITY

The design community has been tasked with providing direction and solutions for the built-environment. Consequently, there is a great demand by this audience for credible, accessible and fundamentally sound information. Most current educational efforts within the concrete industry focus on disseminating current state-of-the-industry practices for the production, transportation, placement, and application of concrete. These tend to be technical in nature and include a wide variety of educational courses and various certification programs. Environmental issues are consistently addressed within each one of those areas.

The industry also needs to recognize that consumers, legislators, lenders, and other stakeholders are seeking answers to better inform themselves on these issues. Messaging for this audience is more emotionally framed and sustainability has recently been introduced in many educational efforts as one specific subset of the environmental issues that impact concrete. But much more needs to be done.

ADVOCATING CONCRETE'S TRUE SUSTAINABILITY CHARACTERISTICS

There is a great deal to be done to improve the industry's ability to advocate for public positions, policies, laws, regulations, ordinances, and actions that encourage sustainable applications of concrete.

Currently the industry has no unified system for tracking emerging industry drivers, an inadequate regional/local advocacy network, and inconsistent interaction with policy- and decision-makers. The industry tends to be reactive rather than proactive, and frequently fails to

develop relationships with influencers. A knowledge-management clearing house for relevant information is lacking. Partially as a result, there are many advocacy-related issues to be addressed, both internal and external to the concrete industry.

THE IMPACT OF CONSTRAINTS ON CONCRETE SUSTAINABILITY

The actual composition of a concrete mix, how and where concrete is placed and or installed, and the extent to which the full potential of concrete and concrete products are used to optimize the sustainability of a structure, are generally dictated by the codes, standards, and specifications of governments, owners, planners, designers, end users and others.

This often results in overdesign which leads to waste. Many of these codes and standards do not permit optimum use of materials. In the United States, for example, ASTM C 150, *Standard Specification for Portland Cement*, was first created in 1940 and is extensively used today. It received a minor modification in the 2004, after decades of discussion, to permit up to 5% powdered limestone in the cement mix. This level has been permitted in Canada and Europe for decades previously, and represented a change that has subsequently saved substantial energy consumption and CO_2 emissions. ASTM C1157, *Standard Performance Specification for Hydraulic Cement,* is more recent (1992) and permits more sustainable mixes, but is rarely specified. The use of low-alkali portland cement binders is sometimes specified when this is not needed, causing unnecessarily high CO_2 emissions, kiln dust waste, high fuel use, reduce quarry life, and increased waste. In another example, many project specifications place limits on the use of supplementary materials or have minimum cement content requirements which limits the ability for a ready mixed concrete producer to optimize mix designs and minimize environmental impact. High compressive strength specifications and ultimate strength requirements at earlier ages (typically 28 days rather than 56 days or longer) are also sometimes specified when not necessary, causing unnecessary waste and higher cement contents than might be needed. Additionally, the process for changing codes and standards in the industry in the USA has traditionally been very long (more than a decade), though recent improvements have been made. It can then take even longer for governments, owners, and specifiers to adopt the use of the new code or standard. The industry has already taken many steps to improve the situation (for example, NRMCA's P2P initiative to allow performance alternatives to prescriptive codes) but considerably more needs to be done.

In Canada the situation is somewhat different. Material requirements for cement and concrete are specified in the CSA A3000 and A23.1 Standards respectively. These standards are updated on a 5- year timeframe and new editions are released in conjunction with the schedule for the National Building Code of Canada. As a result Canada has long since adopted provisions for the addition of 5% limestone in cement and continues to examine existing provisions being used in Europe to address a variety of climate change issues. Additionally the CSA A23.1 Concrete Materials and Methods of Concrete Construction Standard has already included provisions for high volume SCM mix designs, and has recognized provisions for 56- day strength specifications in place of 28- day specifications where appropriate. This Standard is also developing requirements for alternative SCMs that may appear on the market in the future.

In many other parts of the world, for example Europe, codes are often more sustainable. In the USA standards set many years ago can represent important barriers to the sustainability of concrete and of construction. A more concerted and determined approach, building on current industry initiatives, is needed.

CONCRETE INDUSTRY COMMUNICATIONS

The concrete industry currently lacks a unified voice, and concrete's positioning on sustainability vis-à-vis competing products is unclear.

Today, market studies confirm that concrete is perceived as a good, versatile, building material, but one that is energy intensive and has high initial cost. It is seen as having a significant CO_2 burden, since most people don't distinguish between cement and concrete. There is misunderstanding about the recyclability of concrete and its cradle-to-cradle benefits, both key to sustainability.

The industry needs to better communicate several key facts about the sustainability of its product in a holistic perspective. Our lack of national outreach has left a large information void which is being filled by others. The result is that concrete is often negatively perceived and opportunity for real progress is lost.

WORKING TOGETHER FOR SUSTAINABILITY

The vitality of the North American concrete industry is evidenced by the great number of long-standing associations representing the different segments of the industry at national, regional, and local level across the United States and Canada. With industry consolidation, the number of major companies belonging to more than one of these associations on both sides of the border has grown. To these industry associations should be added the other key players in the concrete construction business process, such as the many research and testing facilities, education faculties, designer and specifying organizations, and government regulatory bodies.

The industry has a long history of successful partnership between various associations and segments, largely when a particular need (e.g.: code development, product promotion, advocacy) can be more effectively met through collaboration. While this tradition of teamwork is strong it is not universal, and even information transfer (for example, of technical advances from researchers to practitioners) does not always occur as effectively as it should. Compounding the issue is the number of industry organizations in the USA and Canada, which increases the difficulties of maintaining effective communications and coordinated messaging.

It has been previously observed by the industry that "…due to its diversity and fragmentation, it is difficult for the concrete industry to address institutional barriers that prevent concrete from achieving its full potential as the preferred material of construction. Some examples of institutional barriers include difficulty in changing imperfect standards and codes,…a lack of comprehensive course offerings in concrete technology…the slow pace at which technical

societies exploit advances in information technology and the tendency of trade associations to sustain the commodity nature of the industry. Many of the barriers can only be addressed effectively if the industry has a unified voice."[22] This initiative to continuously improve the sustainability of concrete is far broader in scope than any project the industry has sought to undertake collectively in the past. There is a need, therefore, to pay particular attention to the new processes and mechanisms that will best enable the industry to mobilize to achieve the vision outlined in this document.

The principal forces for and against the necessary changes in the industry to meet the challenges of sustainability have been identified as:

forces for change

- new government incentives, legislation, policy
- public perceptions
- attitudes of the younger generation
- resource shortages

forces against change

- industry lack of readiness, lack of cohesion
- costs
- existing government legislation
- risks and fear of change

The majority of forces seen as working for change are societal; the majority working against change come from within the industry. This adds emphasis to the need for careful planning to ensure the teamwork needed for the industry to deliver the full sustainable potential of concrete to our communities.

INDUSTRY CAPACITY

That part of the concrete industry engaged in the production and placing of concrete is a major force in North America, accounting for about [x%][23] of GDP, employing over [x thousand][24] people, and contributing substantially to the economy. In 2005 the industry placed over 456 million cubic yards[25] of ready mixed concrete, [XX] million cubic yards of concrete pavement[26], [XX] million cubic yards of precast concrete[27], and [XX] million concrete masonry units[28], and other concrete products such as concrete pipe and concrete roof tile. It is a diverse industry supplying a product whose use is heavily influenced by owners and specifiers. Because the concrete industry is so large, and the product so versatile, the industry can have a major impact through its potential leverage on the sustainability of all construction. A high-level summary of industry's capacity to further improve sustainability includes the following factors.

[22] "Vision 2030: A Vision for the US Concrete Industry". (Detroit, Strategic Development Council, 2001)
[23] Reference
[24] Reference
[25] http://www.nrmca.org/concrete/07_2007.htm accessed 2-25-08.
[26] Reference
[27] Reference
[28] Reference

internal strengths	internal challenges
• present in every community in North America: a local industry providing local employment • comprises some of the brightest and best minds in construction • offers lasting and well-remunerated careers at all education levels • making great strides in promoting employee health and safety • motor of innumerable small businesses across the continent • provided reasonable economic benefits for most industry member-enterprises • fields substantial paid and volunteer resources for concrete promotion and could field more • tradition of technical innovation through research and development	• could be more successful articulating and communicating industry improvements and the real sustainable characteristics of concrete and concrete products • needs a more cohesive team-approach to the pursuit of sustainability programs and behaviours • need for a coordinated technical research program in support of sustainability through the concrete lifecycle • generally aware of the sustainability imperative, but has not generally integrated this into day-to-day corporate or personal behaviours • increasing productivity and the pace of change through innovation

external opportunities	external challenges
• acknowledged as placing one of the most sustainable building products on earth, and as pursuing an approach to sustainable development that is a model for industries everywhere	• dealing with claims that concrete is not a sustainable product • codes, standards, specifications etc. that restrict the sustainability of concrete: for example related to plant location, domestic / industrial waste disposal, prescriptive codes, short-life design, ordinances restricting times of day for construction work, the recycling of concrete, etc. • continued volatile and expensive supply of raw materials, and increases in overall construction costs • sub-optimum availability of skilled professionals to work in and with the industry • perceptions that many careers in the concrete industry are less desirable than most other career options

The concrete industry is well positioned to continue its recent advances in support of sustainability, both through the inherent sustainability of concrete as a product and through the initiatives of the industry. These advances must, however, be based on a realistic assessment of not only the product but also the industry.

APPENDIX F: PURPOSE, TARGETS, OBJECTIVES, AND GOALS

PURPOSE, TARGETS, OBJECTIVES, AND GOALS

PURPOSE

In the matter of sustainability, the purpose of the North American concrete industry is:

> **to transform the built environment by improving the way concrete is designed, specified, produced, transported, installed, maintained, and recycled in such a way as to ensure an optimum balance between environmental, social, and economic conditions for the industry and all our communities.**

Through critical self examination and continuous innovation in new technologies and applications, the concrete industry is committed to continuously improving the sustainability of its product, and its ongoing contribution to North American society and economic prosperity.

OBJECTIVES: THE BUILT-ENVIRONMENT

The concrete industry has begun its journey to contribute increasingly to the sustainability of the built-environment. But it is in the early stages, and to set targets the industry urgently needs to have better research, envision, and plan its approach in collaboration with others travelling the same road.

Consequently its first objectives are:

> **by 2010: create with all actors an improved vision and roadmap for achieving significant improvements in the sustainability of the built-environment, to include measurable process objectives**
>
> **by 2020: the industry will have helped to substantially improve the sustainable characteristics of the built-environment through the efficient and effective use of concrete in green building, improving design to take full advantage of concrete's attributes, and adopting specifications that facilitate innovation in product design**

TARGETS AND OBJECTIVES: CONCRETE

The North American concrete industry has made strong progress towards product sustainability. In the USA, the amount of CO_2 per cubic yard of concrete has been reduced by over 20% since 1990. The ready mixed concrete industry has increased the amount of industrial by-products used in concrete by [XX%] thus reducing the embodied energy (and associated carbon dioxide emissions) by [XX%] over the same time frame[29]. The industry in general has also reduced solid

[29] Reference

and liquid waste, and has adopted several aggressive sustainability initiatives. Since 1975, the cement industry has reduced the energy required to make a ton of product by 33%, as well as associated combustion emissions and carbon dioxide. While reducing its own solid and liquid waste contribution, it also uses 20 million tons of industrial by-products from other industries. Furthermore, the cement sector has established a voluntary goal of 10% reduction of carbon dioxide by 2020, from a benchmark of 1990 [all US and Canada #s?].

Approach

Through this initiative, the concrete industry has now committed to a more structured and collective approach to consolidate and accelerate these gains, aiming to reduce the environmental footprint of each unit placed while maintaining or increasing the industry's social and economic contribution to our communities. In addition, the industry will work more actively with owners and specifiers to lever the attributes of concrete to improve the sustainability of all construction.

The industry is still lacking a complete picture of its sustainability (environmental, social, and economic) performance. However, it is committed as a matter of urgency to gathering this information and continuing to improve the environmental footprint of its product.

Uncertainties

While the industry has control over the manufacturing and placing of concrete, there are a number of variables that make forecasting and target-setting a challenge.

The demand for concrete is expected to grow by about 2.5% per year from 2005 to 2020, which would result in a 45% increase in total concrete and concrete products placed during the same period. However difficult-to-predict scenarios such as economic slowdowns, growth slowing as the population ages, or government investments in infrastructure being diverted to healthcare, could reduce this demand. Similarly, continued population growth and migration, or possible increases in the amount of concrete placed per construction dollar, could increase this demand. Government policies and regulations, for example carbon cap-and-trade programs, carbon taxes, taxes on energy consumption, or immigration legislation could change competitive realities. Continued world shortages of commodities and fossil fuels could also change competitive realities.

Influences such as these, currently in rapid evolution, could substantially influence demand for concrete, the competitiveness of the product, and construction business models.

Baseline data

In many areas the industry lacks the reliable information necessary to establish past sustainability performance, current trends, and forecasts. The collection of this data forms part of this vision.

Targets and objectives to 2020

NOTE: THE FOLLOWING TEXT ON TARGETS AND OBJECTIVES WERE ORIGINALLY CONTAINED IN DRAFT 5 ver 1, AND SUBSEQUENTLY REVISED TO THAT INCLUDEDIN THE VISION DOCUMENT.

The concrete industry is determined to set itself a number of specific targets with respect to all key indicators of the environmental performance of its product. It recognizes that time is of the essence, and that ambitious targets can help mobilize the industry and drive the changes necessary to make real progress in reducing the footprint of concrete. On the other hand the industry lacks the data it would ideally like to have to set such targets and to measure its progress towards their attainment. In response to this dilemma the industry has immediately set two high-level targets for CO_2 reduction, conditioned at this stage by certain assumptions, and adopted the current EPA target for flyash substitution in the USA. It has also adopted objectives to immediately drive baseline research to validate their CO_2 reduction targets, and to enable the setting of targets in other sustainability areas within a short period. These targets and objectives are as follows.

TARGETS

By 2020 the industry will reduce the CO_2 EMISSIONS associated with in each cubic yard of concrete and concrete products put in place by 40% with respect to 2005 levels*

By 2020 the industry will reduce the total annual CO_2 EMISSIONS associated with all concrete and concrete products put in place by 10% with respect to 2005 levels*

By 2011: increase the use of coal FLYASH in the USA by 3m tons in the period 2008-2011 (EPA target)

OBJECTIVES

by 2010: set new targets to reduce by 2030 the carbon footprint per unit of concrete and concrete products produced, and for all concrete and concrete products put in place.

by 2010: define key environmental impacts (CO_2, embodied energy water, air emissions, solid waste, recycling / reuse etc): establish programs within 90% of the industry sectors for benchmark data collection: set targets to substantially improve by 2030 the environmental footprint of concrete with regards to the above impacts.

by 2010: set targets to substantially improve the sustainable characteristics of new structures through the efficient and effective use of concrete in construction to take full advantage of concrete's attributes, and adopting specifications that facilitate innovation in product design.

by 2010: establish education and outreach goals by market segment, with funded work plans for 75% of industry sectors.

* For assumptions, see Appendix C: Assumptions Relating to the Industry's CO^2 Targets, 2005 to 2020

The industry will reach agreement on new targets through a North American Concrete Sustainability Protocol, as well as the contribution of each segment of the industry to the achievement of each target, and will measure and publish its progress on an annual basis.

APPENDIX G: TABLE OF CONTENTS AND FOREWORD RETAINED FROM DRAFT 5

CONCRETE SUSTAINABILITY
TABLE OF CONTENTS

ORIGINALLY THE FORMAT OF DRAFT 5

This report has been printed on recycled paper. It is also available in Spanish and in French.

This is Table of Contents is preserved from version 2 of Draft 5 of the vision portion of the North American Concrete Sustainability vision and roadmap. Text for review appears in normal (black) typeface.
Elements missing from the text or needing confirmation appear in parentheses in blue.

FOREWORD

RETAINED FROM DRAFT 5

"A vision without a plan is just a dream. A plan without a vision is just drudgery. But a vision with a plan can change the world."[30]

This document is an initial summary of the vision of the concrete industry for sustainable construction with concrete in North America.[31]

It is a first step on a journey to be travelled with others, a first expression of a vision for the future, and an indication of the plan that may result. It is hoped that this document will be a catalyst for urgent and immediate action.

The industry is proud of its progress to date, but approaches this voyage towards sustainability with humility, conscious of the gaps in its knowledge, of the imperfections of some of its institutional frameworks. It knows, though, that it is not alone in its pledge to strive for sustainability and looks forward to continuing working with, and learning from, others on the same quest.

The concrete industry's journey started years ago, but is given direction with this document, and will surely last for many decades. In the short-term the industry will accelerate work on what it knows it can improve - the environmental footprint of its own product. Concrete is an essential thread in the fabric of the built-environment, and the industry will also drive for a better understanding of what is possible when it comes to improving the sustainability of this community infrastructure, and will continuously improve its plan and capacity for achieving this.

This is the vision: this is the plan.

[30] www.naturalstep.ca
[31] See also Appendix A "Purpose, Scope and Process"