PCA
Portland Cement Association

REPORT ON SUSTAINABLE MANUFACTURING

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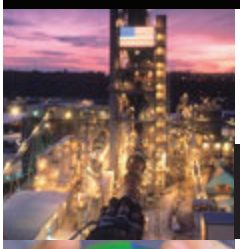
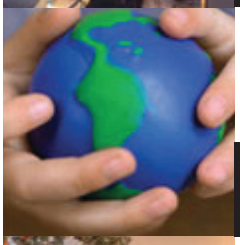
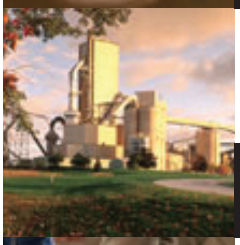
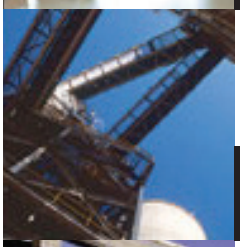
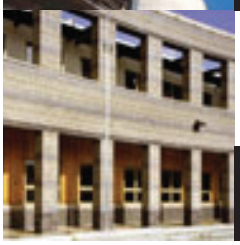
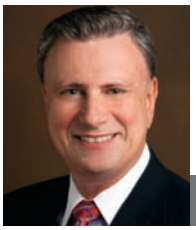












Portland Cement Association

Report on Sustainable Manufacturing

WELCOME

I am pleased to share with you the sixth edition of the U.S. cement industry's Report on Sustainable Manufacturing. The industry has an impressive record of energy efficiency, environmental, and health & safety performance, which is detailed in the report.

In 1999, the Portland Cement Association approved strategic plans for improving the industry's environmental, energy and health & safety performance. To facilitate the plan objectives, the association subsequently adopted a series of voluntary long-term goals for select environment, energy, and heath & safety indicators and created annual award programs to reward superior accomplishments. Progress towards achieving the voluntary goals is tracked by the association through an annual survey of PCA member companies. This information-coupled with data collected in earlier industry surveys-was used to compile the enclosed industry performance trends. As you will see, the industry's efforts speak for themselves.

You will also find information on the winners of the annual PCA energy & environment, and health & safety awards. PCA members are applying cutting edge thinking and approaches to make their manufacturing operations even more sustainable.

I hope that you find this information useful. PCA has updated this document annually and welcomes your thoughts and comments on how the document may be further enhanced. Please forward your suggestions to: sustainablemanufacturing@cement.org.

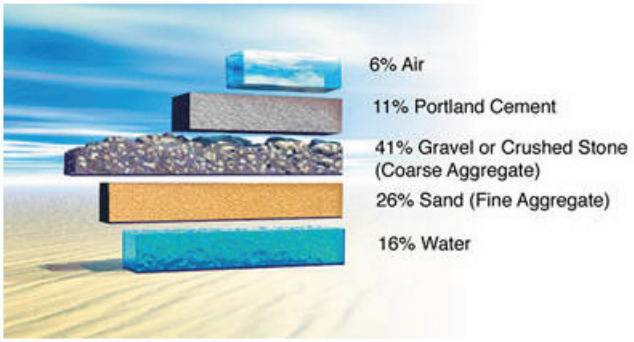
Sincerely,

Aris Papadopoulos
CEO, Titan America
2011 Chairman of the Board
Portland Cement Association

1 CEMENT, CONCRETE & VOLUNTARY GOALS

CEMENT OR CONCRETE?

TYPICAL RATIO OF CONRETE INGERDIENTS BY VOLUME



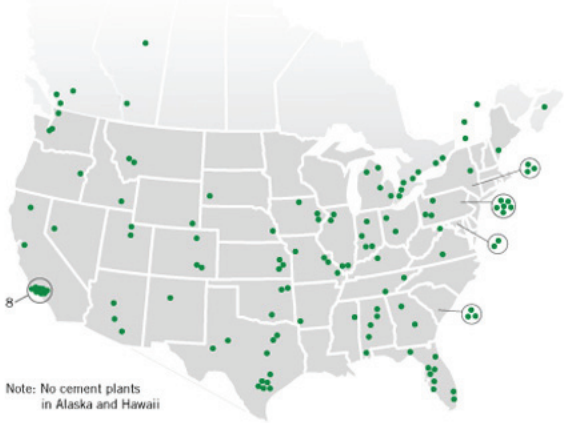
Even construction professionals sometimes incorrectly use the terms cement and concrete interchangeably. Cement is actually an ingredient of concrete. It is the fine powder that, when mixed with water, sand, and gravel or crushed stone (fine and coarse aggregate), forms the rock-like mass known as concrete.

Cement acts as the binding agent or glue. A chemical reaction is triggered called hydration when water and cement are mixed in the right proportions. This reaction causes the cement to harden and bind the aggregate into a solid mass.

The process of hydration is the key to concrete's remarkable strength and versatility. When freshly mixed, concrete can be molded into almost any form. Yet when hardened, its strength and durability often exceed that of natural stone.

CEMENT MANUFACTURING IN THE UNITED STATES

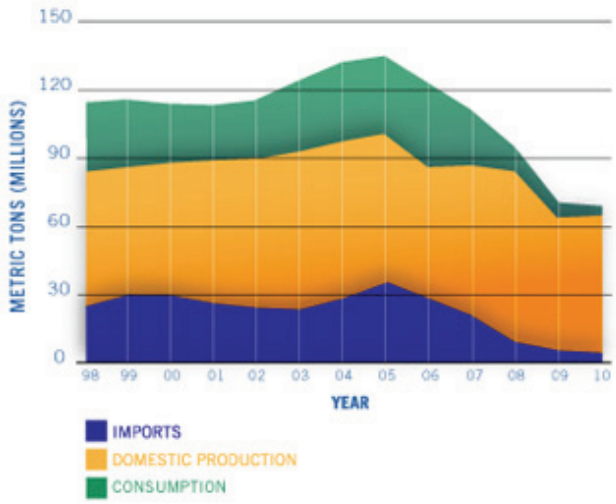
PORTLAND CEMENT PLANT LOCATIONS
UNITED STATES AND CANADA



Cement is a key component of the construction industry. In the United States, 31 companies operate 111 cement plants in 36 states. U.S. cement production is rather widely distributed. The largest company produces approximately 15% of the industry total, with the top five companies collectively producing approximately 54%. Worldwide, the United States ranks third in cement production, behind China—the world's leading producer—and India.

Production and consumption levels of cement are closely tied to trends in the construction sector. Cement consumption is spurred by strong performance in the construction industry as a whole; however, individual sector growth, such as highway construction, affects cement consumption more heavily.

U.S. CEMENT CONSUMPTION

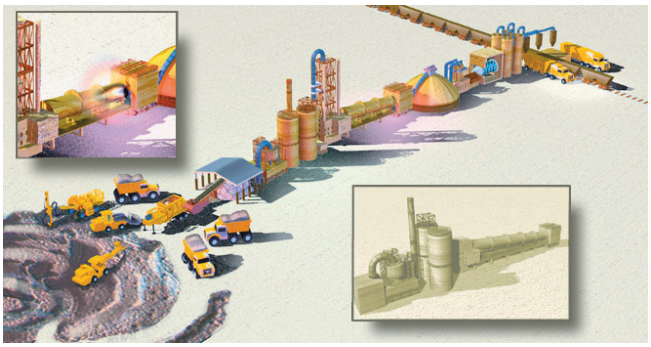


The gap between domestic supply and demand was filled in 2010 by more than 6.8 million metric tons of imported cement and cement clinker. Approximately 85% of cement and clinker imported in 2010 came from four major countries: Canada, Korea, China, and Mexico.

CEMENT MANUFACTURING OVERVIEW

The United States cement industry is dedicated to manufacturing a superior product while continuously challenging manufacturing policies and procedures to improve energy efficiency and minimize emissions. The industry's commitment has paved the way for similar efforts around the world.

Portland cement manufacturing is a four-step process:



1. Virgin raw materials, including limestone and small amounts of sand and clay, come from quarries usually located near the cement manufacturing plant.
2. The materials are carefully analyzed, combined and blended, and then ground for further processing.
3. The materials are heated in a very large kiln which is a rotating vessel 60 to over 200 meters (200 to >650 feet) long with a diameter of 3 to 7.5 meters (10 to 25 feet). The kiln reaches temperatures of 1,450 degrees Centigrade (2,650 degrees Fahrenheit). The heat causes the materials to turn into a new marble-sized substance called clinker.
4. Red-hot clinker is cooled and ground with a small amount of gypsum. The end-result is a fine powder called portland cement. This cement is so fine that one pound of cement powder contains 150 billion grains.

Voluntary Code of Conduct

To transform its commitment to sustainable development into consistent, tangible actions, PCA has developed the Cement Manufacturing Sustainability Program. The goal of the program is to balance society's need for cement products with stewardship of the air, land, and water, conservation of energy and natural resources, and maintenance of safe work places and communities. The centerpiece of the CMS Program is a voluntary code of conduct, which is a set of principles, performance measures, and a reporting protocol, designed to guide decision making, business practices, and operating performance in a sustainable fashion.

The PCA Board of Directors in 1991 adopted seven principles that call on member companies in the U.S. to meet market demands while using environmentally responsible practices that minimize emissions, waste, energy consumption, and the use of raw materials. Taken together, these principles help U.S. manufacturers to integrate the economic, social and environmental dimensions of cement manufacturing, and to find a balance between short-term priorities and long-term needs.

I. The safety and health of our employees, our neighbors, and our customers is our first consideration in the production and distribution of a quality product.

II. We will continue to implement effective controls, which reduce or eliminate the release of pollutants to the air, to the land, and/or to the water.

III. We will actively seek ways to manage wastes in a responsible and environmentally sound manner.

VI. We will pursue effective improvements in energy efficiency and promote the conservation of resources.

V. We will seek ways to beneficially and safely utilize recyclable wastes as raw materials, fuels, and product components as part of our overall commitment to waste minimization and recycling.

VI. We will continue to conduct mining operations in a responsible and environmentally sound manner.

VII. We will participate with lawmakers, regulators, and other interested parties in the development of rational and effective health, safety, and environmental laws and regulations.

United States Cement Industry Progress on Voluntary Targets:

Carbon Dioxide Reduction

Carbon dioxide data is being collected and tabulated at this time.

Cement Kiln Dust

Please see the chart on page 7

United States Cement Industry Progress on Environmental Management System Voluntary Target

United States Cement Industry Progress on Environmental Management System Voluntary Target
At the end of 2010, 68% of the U.S. portland cement plants had an Environmental Management System (EMS) which is 7% below the voluntary target of 75% adoption goal by the end of 2010. An additional 20% of the U.S. manufacturers anticipate having an EMS in the next three years. An EMS is defined as a written auditable and verifiable system that identifies the environmental aspects and impacts of the facility's activities and facilitates accomplishment of environmental obligations and continuous improvement of environmental performance by the facility.

Energy Efficiency

Please see the chart on page 7

Environmental Performance Measures

The Environmental Performance Measures translate the Cement Manufacturing Sustainability (CMS) Program Principles into action. A long-term reduction target is identified for each key performance measure and then progress toward that target is measured against a baseline. Currently there are four goals approved by the PCA members:

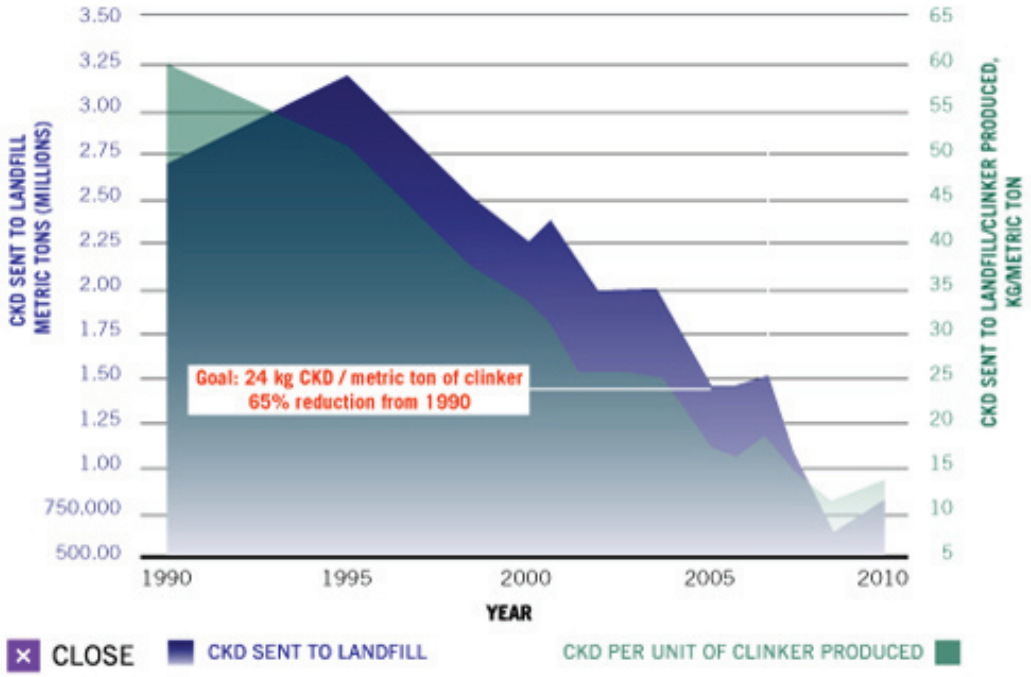
- Carbon Dioxide (CO2)—The U.S. cement industry has adopted a year 2020 voluntary target of reducing CO_2 emissions by 10% (from a 1990 baseline) per ton of cementitious product produced or sold.
- Cement Kiln Dust (CKD)—The U.S. cement industry has adopted a year 2020 voluntary target of a 60% reduction (from a 1990 baseline) in the amount of CKD landfilled per ton of clinker produced.
- Environmental Management Systems (EMS)—The U.S. cement industry has adopted a year 2006 voluntary target of at least 40% of U.S. cement plants having implemented an auditable and verifiable EMS with 75% of the U.S. plants implementing an EMS by the end of 2010, and with 90% by the end of 2020.
- Energy Efficiency—The U.S. cement industry has adopted a year 2020 voluntary target of 20% improvement (from 1990 baseline) energy efficiency—as measured by total Btu-equivalent per unit of cementitious product.

With these ambitious goals, cement manufacturers will reduce their environmental impact and energy burden. As discussed later in this document, additional energy and environmental benefits will be realized by the use of concrete in the construction of buildings and pavements. Portland cement concrete is a durable product that can provide years of benefits.

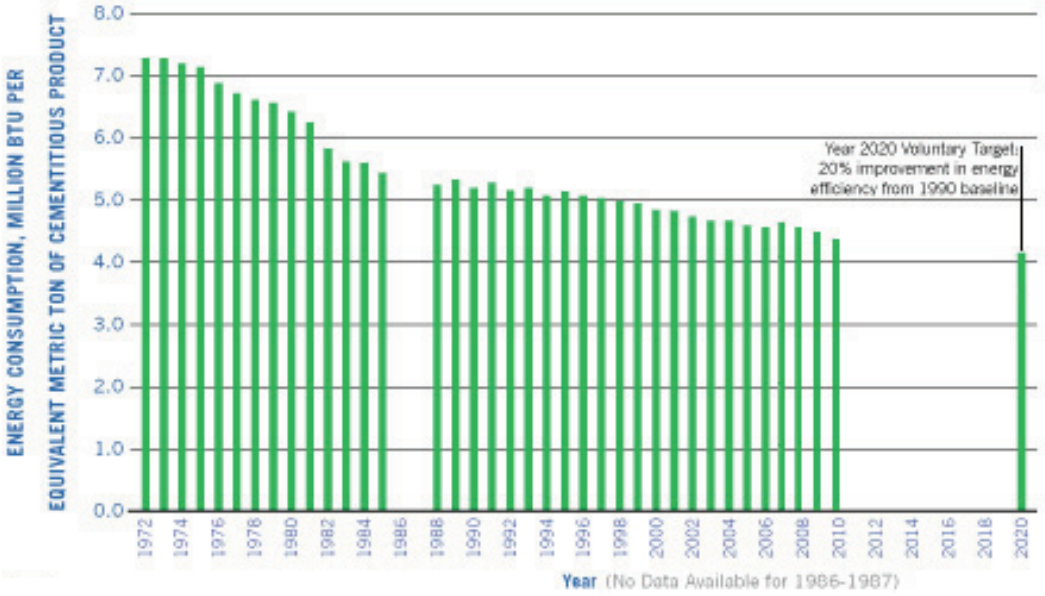
Reporting Protocol

PCA has conducted an annual survey of members since 1970 to collect data and compare it against a baseline to measure performance toward reduction targets on energy use and labor practices. This tool has been modified to collect information on the targets identified above.

CEMENT KILN DUST (CKD) SENT TO LANDFILLS AND CKD PER UNIT OF CLINKER PRODUCED



UNITED STATES CEMENT INDUSTRY PROGRESS ON ENERGY EFFICIENCY VOLUNTARY TARGET



PCA ENERGY & ENVIRONMENT AWARDS

In 2000, as part of PCA's renewed environment and energy strategic plan, the Portland Cement Association initiated a program designed to recognize individual North American facilities that have shown a commitment to continuous environmental and energy efficiency improvement.

PCA and Cement Americas magazine presented the first Cement Industry Environmental Awards in 2002 to the winners for 2001. The awards program is open to any cement manufacturing plant in Canada, United States, and Mexico. The awards honor activities conducted during the previous calendar year. The judges for the awards represent groups within and outside the industry such as the World Resources Institute, the U.S. Environmental Protection Agency, the U.S. Department of State, and the World Wildlife Fund. Additional judges come from PCA, Cement Americas magazine, the Cement Association of Canada, the National Stone Sand and Gravel Association, and the National Ready Mix Concrete Association. Each judge is independent from the cement manufacturers competing for the awards.

Award Categories

Environmental Performance

This category honors those facilities that take steps beyond those contained in environmental laws, regulations, permits, and requirements to minimize their impact on the environment. Recognition for this award is given for pollution prevention, waste minimization, distinctive environmental controls, environmental management systems, and facility recognition.

Land Stewardship

Efforts to protect and enhance the surrounding land through landscaping, species protection, and remediation / rehabilitation of quarries, wetlands, and other features are recognized in this category.

Outreach

Facilities that strive to enhance community, employee, and government relations through communication, partnerships, voluntary efforts, contributions, environmental education, and other measures are honored in this award. The efforts must go beyond public relations to achieve genuine environmental improvements through action and education.

Innovation

This category recognizes the development and application of innovative technologies and techniques relevant to environmental protection or energy efficiency.

Energy Efficiency

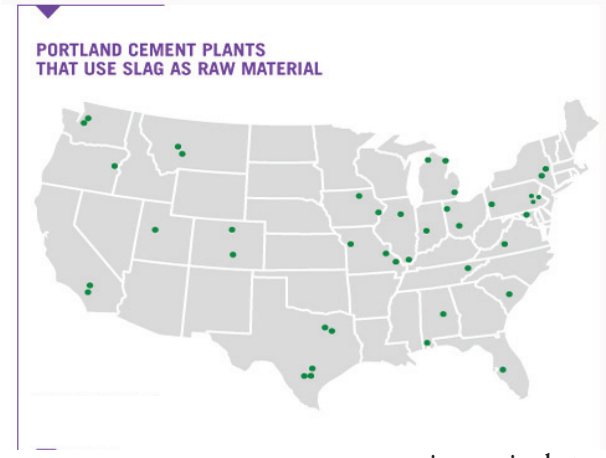
This category focuses on energy planning, applications of efficient technologies and practices, and climate change mitigation efforts.

Overall Environmental Excellence

A facility that demonstrates excellence in several or each of the above categories is recognized with this award.

2 SUSTAINABLE PRACTICES

RAW MATERIALS



Note: No cement plants in Alaska and Hawaii

For its raw material, cement utilizes four elements for its manufacture: calcium, silicon, aluminum, and iron. The most common combination of ingredients is limestone (for calcium), coupled with much smaller quantities of clay, iron ore, and sand (as sources of alumina, iron, and silica, respectively).

So common are these elements that a wide variety of raw materials are suitable. Cement is made with everything from sea shells and shale to industrial byproducts such as blast-furnace slag from steel plants and fly ash from coal-fired electric power plants. Cement plants are increasingly turning to industrial byproducts that otherwise would be discarded. After completing detailed analyses to determine the effects on product chemistry and facility emissions, many cement plants can utilize byproducts in the manufacture of clinker.

From 111 operating plants reporting in the PCA publication: 2010 U.S. and Canadian Portland Cement Industry: Plant Information Summary, 41 plants used blast furnace or iron slag as a raw material and 50 plants used fly ash or bottom ash from electric power plants.

Other alternative materials used by portland cement plants in 2010 included:

- Foundry sand
- Mill scale
- Synthetic gypsum

Use of Iron and Steel Byproducts (from page 9)

Three byproducts of the iron and steel industries can be used in the manufacture of portland cement: foundry sand, mill scale, and slag. Foundry sand can provide silica and possibly iron for the production of clinker. Mill scale contains iron oxides that can replace other iron-bearing materials in the kiln feed. Slag contains high percentages of calcium oxide and silicon dioxide and varying amounts of aluminum oxide and iron oxides. All of these components are needed in the cement manufacturing process. Select slags can be interground with the portland cement to produce a blended cement product. Foundry sand and some slags can replace natural stone as an aggregate in portland cement concrete. From 111 operating plants reporting in the PCA publication: 2010 U.S. and Canadian Portland Cement Industry: Plant Information Summary, 9 plants were using foundry sand and 34 plants were using mill scale as a raw material in the manufacture of clinker. In the U.S., 41 plants were using slag either as a clinker raw material or in blended cements.

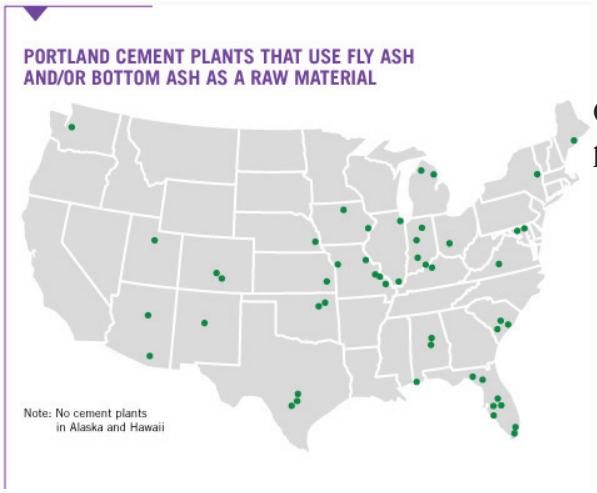
Reclamation of CKD from Existing Landfills (from page 11)

The cement industry has always recognized that CKD was valuable. Due to rising cost of energy and raw material extraction, cement plants have been able to utilize previously landfilled CKD for various beneficial uses. This trend was noted by PCA in 1998 when over 13,000 metric tons of CKD were removed from existing landfills. In 2010, PCA member companies reclaimed over 147,000 metric tons of CKD from on site monofills / landfills. The reclaimed CKD may be returned to the kiln system for the manufacture of clinker or used in a range of off site beneficial applications such as waste stabilization / solidification, soil stabilization / consolidation, and agricultural soil amendment.

Use of Tire-Derived Fuel (from page 12)

Scrap tires contain hydrocarbons like fossil fuels such as coal, oil, and natural gas. Pound for pound, tires have more fuel value than coal. Tens of millions of used tires are generated annually in the United States. By simply disposing of these tires in landfills or junkyards, society misses an important recycling opportunity: the chance to recover energy and conserve fossil fuel resources. Cement making is an ideal process for recovering this energy. The intense heat of the kiln ensures complete destruction of the tires. There are no visible emissions from the tires. In fact, the use of tires as fuel can actually reduce certain emissions.

In 2008, PCA member companies completed a study on the impact of TDF firing on cement kiln air emissions. The study's data set included emission tests from thirty-one of the cement plants presently firing TDF. Dioxin-furan emission test results indicated that kilns firing TDF had emissions approximately one-third of those kilns firing conventional fuels – this difference was statistically significant. Emissions of particulate matter (PM) from TDF-firing kilns were 35% less than the levels reported for kilns firing conventional fuels (not statistically significant due to the low PM emissions reported for essentially all cement plants). Nitrogen oxides, most metals, and sulfur dioxide emissions from TDF-firing kilns also exhibited lower levels than those from conventional fuel kilns. The emission values for carbon monoxide and total hydrocarbons were slightly higher in TDF versus non-TDF firing kilns. However, none of the differences in the emission data sets between TDF versus non-TDF firing kilns for sulfur dioxide, nitrogen oxides, total hydrocarbons, carbon monoxide, and metals were statistically significant. Separate studies conducted by governmental agencies and engineering consulting firms have also indicated that TDF firing either reduces or does not significantly affect emissions of various contaminants from cement kilns.



Other alternative materials used by portland cement plants in 2006 included:

- Copper slag
- Foundry sand
- Mill scale
- Synthetic gypsum

LAND STEWARDSHIP

Reclamation of CKD from Existing Landfills

Over the past several years, CKD placed in landfills has become a valuable commodity.

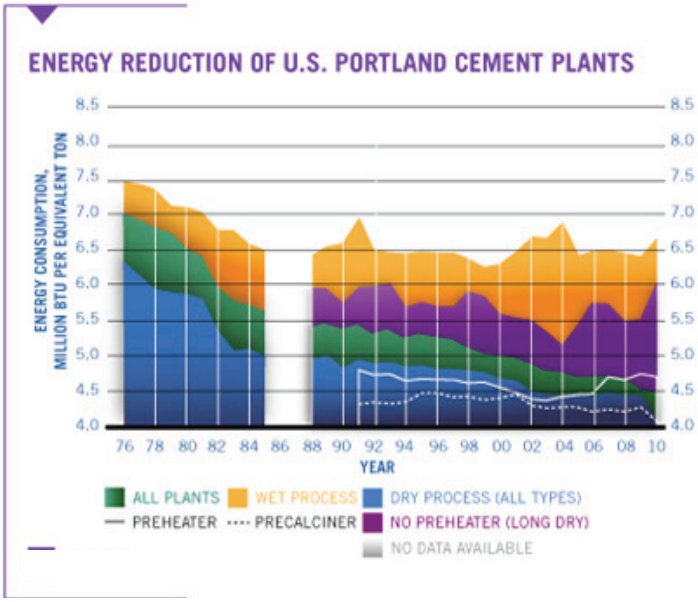
read more on page 10

Extracting any raw material takes a toll on the environment. The cement industry is minimizing the disruption even further with new technologies and a concerted effort to work closely with the communities in which quarries reside.

Limestone usually comes from a quarry at or near the plant while other materials such as clay, shale, iron ore, and sand are usually obtained from other nearby sources. Because these raw materials are among the most common on Earth, cement producers can mitigate environmental impact through careful site selection and operating procedures. Usually these quarries require limited overburden removal and are chemically benign—that is no acid mine drainage.

At the end of their useful life, cement quarries can be reclaimed as parks, recreational areas, or other developments. Many cement companies have developed closure plans for quarries which include careful soil and water contouring to optimize the environmental benefits of the reclaimed areas.

Byproducts generated during cement making are either recycled into the process or used in other beneficial applications. Cement kiln dust (CKD) is the material removed from the kiln exhaust gases by pollution-control devices. Through improvements in the manufacturing process, the industry has greatly reduced the amount of CKD landfilled. Recycling CKD back into the process offsets the use of limestone and other raw virgin materials, conserves energy, and makes good business sense. CKD that cannot be recycled back into the process is either responsibly managed in a monofill on site or sold for a variety of beneficial uses. For those cement plants who use CKD monofills, proper management and closure of them is an integral part of their operations.



The high temperature needed for cement manufacturing makes it an energy-intensive process. The average energy input required to make one ton of cement was 4.45 million Btu in 2010. According to the Department of Energy, U.S. cement production accounts for 2.4% of energy consumption—lower consumption levels than iron and steel mills at 11% and paper mills at 15%. From the PCA publication: U.S. and Canadian Labor-Energy Input Survey 2010, the cement industry has improved energy efficiency by 40.1% from 1972.

To improve the industry's energy efficiency, PCA member companies partnered with the U.S. Environmental Protection Agency (USEPA) in the development of an Energy Performance Indicator (EPI). The EPI allows plants to compare their performance to that of the entire industry. The EPI is an outgrowth of the USEPA's Energy Star Industrial Focus program. The tool is intended to help cement plant operators identify opportunities to improve energy efficiency, reduce greenhouse gas emissions, conserve conventional energy supplies, and reduce production costs.

Use of Tire-Derived Fuel

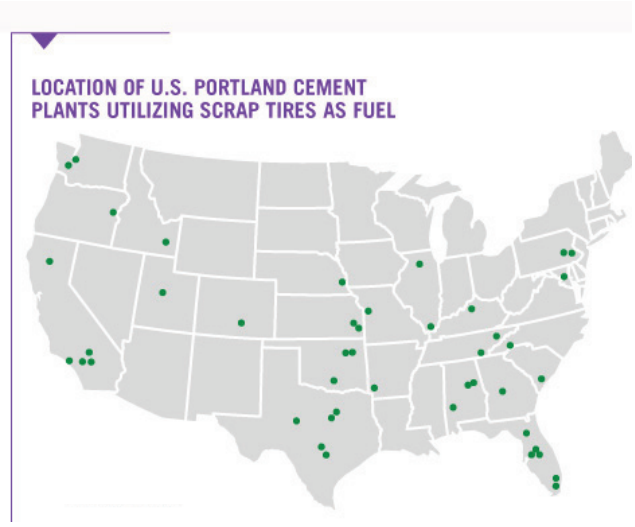
Like fossil fuels such as coal, oil, and natural gas, tires contain hydrocarbons. Pound for pound, tires have more fuel value than coal.

read more on page 10

Finding ways to reduce both energy needs and reliance on fossil fuels is a top priority for cement companies. Although coal, petroleum coke, and other fossil fuels have been traditionally burned in cement kilns, many cement companies have turned to energy-rich alternative fuels. Today, many plants meet 20-70% of their energy requirements with alternative fuels. And many of these alternative fuels are consumer wastes or by-products from other industries. Recovering their energy value in cement making is a safe and proven form of energy recovery.

Because of strict product quality demands, the cement produced from kilns using alternative materials or fuels must be equal in quality to cement from kilns using conventional materials or fuels. Cement plants carefully utilize these alternative fuels and materials so that all types of cement conform to the rigid specifications of the ASTM International.

Burning alternative fuels in cement kilns offers several environmental benefits. This type of energy recovery conserves valuable fossil fuels for future generations while safely destroying wastes that would otherwise be deposited in landfills. From the PCA publication: 2008 U.S. and Canadian Portland Cement Industry: Plant Information Summary, 20 plants



Note: No cement plants in Alaska and Hawaii

used waste oil, and 44 plants in 20 states used scrap tires. Solvents, unrecyclable plastics, and other materials are used as well.

From the PCA publication: U.S. and Canadian Labor-Energy Input Survey 2008, over 68% of the cement plants reporting used one or more waste fuels in 2010. In 1972, no waste fuels were utilized, and in 2010, the energy from waste fuels was 13% of the energy demand at cement plants.

Solvents, unrecyclable plastics, and other materials are used as well.

From the PCA publication: U.S. and Canadian Labor-Energy Input Survey 2008, over 68% of the cement plants reporting used one or more waste fuels in 2008. In 1972, no waste fuels were utilized, and in 2008, the energy from waste fuels was over 10% of the energy demand at cement plants.

3 ENVIRONMENTAL PERFORMANCE

COMBUSTION EMISSIONS

The cement industry has an enviable record in reducing air pollutants. It is working closely with the Environmental Protection Agency and state regulators to develop new standards and technology to manage air emissions. Investment in new equipment and technology to reduce emissions totals in the millions of dollars per year.

Cement companies also work with state and local officials to meet the National Ambient Air Quality Standards (NAAQS). For example, the industry is conducting ongoing cooperative efforts with federal, state, and local officials to study emissions controls of fine particulates and other pollutants. Further emission reductions are achieved by utilizing waste fuels that would otherwise be burned unproductively in incinerators.

In a perfect world combustion products would be limited to just water and carbon dioxide, but that is not possible with cement manufacturing. Nitrogen oxides can be formed from nitrogen in the fuel or raw materials, or from a reaction of nitrogen with combustion products (prompt NOx). The great majority of NOx in cement plant exhausts are known as thermal NOx which is the conversion of nitrogen in the air around the fuel

combustion flame at temperatures greater than 1200° C. A short hot burning zone can reduce the formation of thermal NOx. Sulfur oxides, or SOx, is formed as sulfur compounds are oxidized at temperatures of 300 to 600° C. Limiting the sources of sulfur or excess oxygen can limit the potential for SOx formation. Carbon monoxide (CO) formation is another concern; it is either formed because of incomplete combustion or the rapid cooling of combustion products below the ignition temperature of 610° C. The particulate matter from the raw materials (cement kiln dust – CKD) can become entrained in the exhaust gas and carried out of the kiln system. The vast majority of the CKD is removed by fabric filters, known as baghouses, or by electrostatic precipitators.

The portland cement industry was among the first to tackle the issue of climate change, and it has remained at the forefront of developing global climate change policies and improving the manufacturing process. Of the several gases which are related to climate change, carbon dioxide (CO2) is the principal emission from the cement industry. CO2 results from the combustion of carbon-based fuels and from raw material calcination, which is the conversion of carbonates in the raw materials into the various compounds which give cement its unique properties. From the PCA publication: U.S. and Canadian Labor-Energy Input Survey 2006, from 1972 to 2006 the cement industry reduced energy consumption by 37.5% which means that the fuel CO2 was reduced by nearly the same amount. In 2000, the industry created a way to measure CO2 emissions, and by the year 2020, the industry plans to voluntarily reduce CO2 emissions per ton of cementitious product by 10% below the 1990 baseline.

The most recent progress involves newly introduced cement guidelines that will allow for greater use of unburned ground limestone as a component in finished cement, which will ultimately reduce calcination CO2 by more than 2.5 million tons per year.

Today, the cement industry fuel CO2 accounts for less than 3% of U.S. industrial CO2 emissions, well below other sources such as the petroleum industry (21.8%), chemical industry (22.2%), and iron and steel mills (9%).

By 2020, the industry aims to reduce CO2 emissions by 10% from the 1990 baseline levels. To achieve this goal, the cement industry has adopted a three-part strategy:

1. Improve the energy efficiency by upgrading plants with state-of-the-art equipment

2. Improve product formulation to reduce manufacturing energy consumption and minimize the use of natural resources

3. Conduct research and develop new applications for cement and

In the 1990's, PCA and its member companies joined the USEPA Climate-WISE program. This voluntary program assisted companies in improving energy efficiency and reducing CO2 emissions. As part of this program, an MS-Excel spreadsheet was developed for the calculation of CO2 cement plant emissions. This farsighted effort was used to develop an international emission calculation spreadsheet (See WBCSD information in the above sidebar). PCA member companies are using this international consensus-developed spreadsheet to calculate current and past CO2 emissions.

The Cement Industry participates in:

Asia-Pacific Partnership on Clean Development and Climate Partners

The Asia-Pacific Partnership (APP) has the goal of accelerating the development and deployment of clean energy technologies. The APP addresses increasing energy needs and associated challenges, including air pollution, energy security, and greenhouse gas intensities. The seven member countries (Australia, Canada, China, India, Japan, Republic of Korea, and the United States) constitute half the world's population and more than half of the world's economy and energy use. In total 61% of global cement production is covered by the APP. PCA joined the U.S. Department of State and the U.S. Environmental Protection Agency in this organization. **Website: www.asiapacificpartnership.org**

USEPA Sector Strategies Program

Through this program, the U.S. Environmental Protection Agency fosters a collaborative approach to address drivers or barriers to better manufacturing performance. Program staffers create partnerships with PCA member companies, state and local officials, and others. Sector strategies include targeted regulatory changes, sector-based environmental management systems, and easier links to assistance services. The Program also tracks performance with a more strategic allocation of resources by all stakeholders. **Website: www.epa.gov/ispd**/

Climate VISION

PCA joined the Cimate Vision program to voluntarily reduce greenhouse gas (GHG) emissions. This program includes the U.S. Department of Energy, U.S. Department of Transportation, U.S. Environmental Protection Agency, and U.S. Department of Agriculture. The program assists industry efforts to accelerate the transition to practices, improved processes, and energy technologies that are cost-effective, cleaner, more efficient, and more capable of reducing, capturing, or sequestering GHGs. Climate VISION links these objectives with technology development, commercialization, and commercial utilization activities supported by the private sector and the government. **Website: www.climatevision.govClimate Leaders**

Climate Leaders is an industry-government partnership where companies voluntarily commit to reduce greenhouse gas emissions and report their progress to USEPA. Companies develop comprehensive climate change strategies including a corporate-wide inventory of their GHG emissions. These efforts create a credible record of a company's accomplishments, and the USEPA recognizes outstanding efforts. Currently over 25% of the clinker-producing cement plants are members of this program.
Website: www.epa.gov/stateply/

Energy Star Cement Manufacturing Focus

The U.S. Department of Energy and the U.S. Environmental Protection Agency sponsor the Energy Star Industrial Focus Program. One aspect of this program is to assist businesses in overcoming barriers to energy efficiency by developing industry-specific energy management tools and resources. The Cement Manufacturing Focus began in 2003 and now includes over 65% of the clinker-producing cement plants.
Website: www.energystar.gov/index.cfm?c=in_focus.bus_cement_manuf_focus

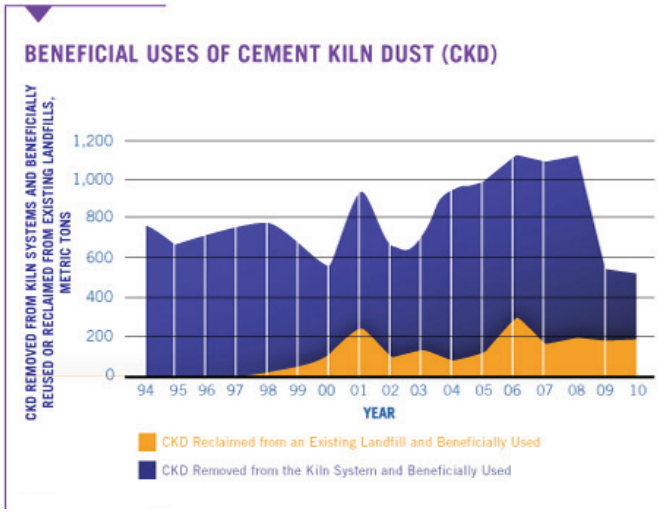
World Business Council for Sustainable Development

The World Business Council for Sustainable Development (WBCSD) is an association of companies dealing exclusively with business and sustainable development. The Council supports companies in the exploration of sustainable development and the transfer of knowledge, experiences and best practices. WBCSD focuses on four areas:

- Energy and Climate
- Development
- The Business Role
- Ecosystems

Approximately 70% of the U.S. clinker-producing cement plants are participating in the WBCSD. PCA also is involved as a communications partner to the organization. **Website: www.wbcsd.org**

The WBCSD member companies with the World Resources Institute developed a methodology for calculating and reporting CO2 emissions. A guidance document and MS-Excel spreadsheet were developed for cement plants so that historic and current emissions **can be calculated** in a concise and transparent manner. This international consensus-based spreadsheet originated from the methodology developed by the USEPA and PCA member companies in the 1990's.
Website: www.ghgprotocol.org/calculation-tools



Beneficial Uses of CKD

Over the last fifteen years, the amount of cement kiln dust (CKD) beneficially reused has increased. In 2008, over 1.13 million metric tons of CKD were removed from the kiln systems and mainly used for soil stabilization / consolidation, waste stabilization / solidification, cement additive / blending, and agricultural soil amendment. Over 163,000 metric tons were removed from existing CKD landfills in 2008 and returned to the kiln system to manufacture more clinker and for other beneficial uses such as waste stabilization / solidification, soil stabilization / consolidation, and agricultural soil amendment.

Solid Waste Production

As raw feed travels through the portland cement kiln system, particulates of the raw materials, partially processed feed, and components of the final product are entrained in the combustion gases flowing countercurrent to the feed. These particulates and combustion gas precipitates are collected in the particulate matter control device (PMCD)—electrostatic precipitators and fabric filters—and are collectively referred to as cement kiln dust (CKD).

In general, CKD is a very heterogeneous mix both by chemistry and particulate size, and these characteristics are dependent on the raw materials, fuels, kiln pyroprocessing type, overall equipment layout, and type of cement being manufactured. It is incorrect to label all dusts collected in the PMCD as waste. Many facilities return all or a major portion of the CKD to the kiln as a feedstock while other facilities sell the dust for numerous beneficial uses, such as soil consolidation, waste stabilization, and other uses. Recycling this byproduct reduces the need for limestone and other raw materials and helps conserve energy. The most common reasons for not returning CKD to the kiln system are equipment limitations for handling the dust and chemical constituents in the dust that would be detrimental to the final cement product. The fraction of CKD that is not returned to the kiln or otherwise beneficially used is placed in landfills.

Beginning in 1990, the Portland Cement Association has tracked the amount of CKD sent to landfills. Over that time period the amount of CKD placed in landfills has decreased dramatically and when compared to the clinker production, the amount of CKD per unit of clinker had decreased at an even greater rate.

Over the last fifteen years, the amount of cement kiln dust (CKD) beneficially reused has increased. In 2010, over 590,000 metric tons of CKD were removed from the kiln systems and mainly used for soil stabilization / consolidation, waste stabilization / solidification, cement additive / blending, and agricultural soil amendment. Over 147,000 metric tons were removed from existing CKD landfills in 2010 and returned to the kiln system to manufacture more clinker and for other beneficial uses such as waste stabilization / solidification, soil stabilization / consolida-

WATER MANAGEMENT

Cement plants generate little or no water effluent. Wet process plants use a large volume of water in the grinding of the raw materials and that water evaporates in the kiln. A large amount of energy is required to accomplish this. For those reasons, U.S. cement manufacturers are closing wet process kilns and installing more energy efficient dry process plants. For both dry and wet process plants, some water is used in the non-contact cooling of machinery and when necessary water is sprayed into hot gas streams to be cooled.

Potential discharges to surface water may result from stormwater runoff, but cement manufacturers take great care to follow strict federal, state, and local regulations and control their water effluents effectively with no impact on the environment.

Because stormwater can carry fine particles of dust, plant operators channel this water into holding ponds where the solid particles settle out. The clean water can then be recycled to cool equipment in the plant or discharge pursuant to permits. Cement plants that discharge any industrial process water or stormwater must comply with the permits, guidelines, and programs under the federal Clean Water Act and state/local environmental agencies.

Stormwater Management and Reuse

The Holcim (US) Inc. facility in Theodore, Alabama received the 2007 Gulf Guardian Award from the U.S. Environmental Protection Agency for its storm water management program. Until Hurricane Ike arrived in 2008, no stormwater was released from the cement manufacturing plant or from the plant's off-site limestone and clay quarries for 36 months. The plant utilizes the stormwater collected at the plant site as cooling or conditioning water in its production process which significantly reduces reliance on local municipality water used in this process. This plant has prevented millions of gallons of stormwater from entering local waterways.

4 COMMUNITY INVOLVEMENT

COMMUNITY OUTREACH PROGRAMS

The portland cement industry has partnered with other stakeholders for many years. Understanding the concerns of the local community allows cement manufacturers to become good corporate citizens. Many cement plants are in smaller towns or rural locations, and many of our neighbors are employees, family members, and friends.

These partnerships take on many forms. Some facilities have community advisory groups that provide feedback on plant operations and proposed changes/ improvements. Other companies join their neighbors in supporting community improvements to schools or wildlife areas and in sponsoring local festivals or charity efforts. Ultimately, the success of all of these programs depends on the dedicated plant employees who keep cement plants operating efficiently, safely, and with limited environmental impact. Those employees take that professionalism from the plant to enrich their local communities as well.

ROANOKECEMENT™

A TITAN AMERICA BUSINESS

Spring 2008

Highlights

- Portland Cement Awards
- Baghouse Addition
- Lunchbox Local Newspaper
- Roanoke Valley Cool Cities Coalition
- Roanoke Cement Company Outreach

Community Report

Roanoke Cement Honored by Portland Cement Association

Roanoke Cement Company was honored this month by the Portland Cement Association and *Cement Americas* magazine in the 7th Annual Cement Industry Energy and Environment Awards. RCC was a finalist in two categories: the Overall Environmental Award and the Land Stewardship Award. Judges considered environmental performance, land stewardship, outreach, innovation and energy efficiency as factors in their decisions. Of the hundreds of cement companies throughout the Americas, only three were recognized in each category.

Roanoke Cement Company, approaching Gate 1.

Baghouse Addition Reduces Emissions by Almost 40%

For RCC, the goal is to reduce, reclaim and reuse wastes, thereby minimizing the disposal requirement. For example, Cement Kiln Dust (CKD), produced as a result of bypass systems, which remove elements such as alkali from kiln processes, is one of the primary waste materials produced at the facility.

To minimize the creation of CKD, RCC spent a great deal of time and engineering know-how to change its processes. The culmination of these efforts was the recent addition of the baghouse to the bypass system.

The baghouse replaced an old and inefficient electrostatic precipitator (ESP). This $2.5 million project allowed RCC to greatly reduce the amount of CKD generated – to the extent that now RCC actually reclaims CKD from its landfill. All of the CKD that is created from the baghouse is used in the finish mills for masonry products.

The collection efficiency of the baghouse reduced the visible emissions from the main stack by nearly 40%. The noticeable main stack emission improvement has received favorable comments.

New baghouse addition at RCC

The next Community Report will be published Fall 2008. Please contact Lance Clark, Environmental Engineer (540-966-6854) or Kevin Bond, Plant Manager (540-966-1300) to suggest future articles or comments on the current issue.

Community Outreach Program

The Titan America / Roanoke Cement Company LLC plant in Troutville, Virginia educates their neighbors on plant activities through a biannual newsletter, Community Report. The newsletter is send to homes within a several mile radius of the plant, and includes updates on plant environmental and energy efficiency projects. The plant is also an affiliate of the Roanoke Valley Cool Cities Coalition which educates local residents about energy efficiency and greenhouse gas reduction opportunities. The Coalition has provide over 2,600 compact fluorescent light blubs to local residents.

Interpretive Park

The Lafarge North America Inc., Sugar Creek, Missouri plant completed a wildflower garden in conjunction with the National Park Service historic interpretive displays at the Wayne City Landing Overlook Site. The garden will improve plant and animal biodiversity and compliment the historical information presented. Lafarge worked with the National Park Service, Wildlife Habitat Council, local historical societies, and local business organizations to renovate and improve a historic interpretive site located on the Lafarge property. The location overlooks the former Wayne City Landing on the Missouri River. The former riverboat landing served the City of Independence, Missouri and all points west in the early to mid-1800s. The National Park Service had previously certified the overlook as a historic interpretive site for the Lewis & Clark, Santa Fe, Oregon, and California National Historic Trails.

5 WORKPLACE HEALTH & SAFETY

OCCUPATIONAL HEALTH AND SAFETY PROGRAM

PCA member companies' commitment to health and safety supports the social aspects of the Cement Manufacturing Sustainability Code. By setting high standards for health and safety as well as rewarding companies that install innovative technologies, PCA is encouraging the industry to adopt a better safety culture and infrastructure. The health, safety, and welfare of plant employees and the local community are essential components of economic, environmental, and societal factors by which the sustainability decisions are weighed.

The wellbeing of the cement plant employees
are covered by the U.S. Mine Safety and Health Administration (MSHA).

The PCA and the MSHA signed an alliance agreement in November 2008, and pledged to combine the two organizations' resources to reduce injuries and illnesses that occur to employees in the portland cement manufacturing industry. The two groups will work together to develop safety and health education materials and distribute them among companies and employees in the industry. Going forward, the alliance will continue to work to improve risk and hazard awareness among employees in the industry through education, and will recognize safety excellence in the workforce.

Starting in 2009, the PCA recognized the first group of recipients of the Chairman's Safety Performance Award. The two co-chairmen of the MSHA / PCA Alliance jointly recognized the nine plants that achieved the best accident rates in three categories. Chairman's Awards were distributed to CEMEX (Brooksville, Florida and Lyons, Colorado), Holcim (Artesia, Mississippi and Midlothian, Texas), Keystone Cement Company (Bath, Pennsylvania), Lehigh Cement Company (Delta, British Columbia), Lafarge North America (Paulding, Ohio), St. Mary's Cement Company (Bowmanville, Ontario), and Titan America LLC (Troutville, Virginia).

PCA SAFETY RECORD AWARDS

PCA has a long-standing tradition of honoring exceptional safety performance at cement facilities. The awards program recognizes facilities with strong safety records and includes awards for prevention of lost-time accidents and safety record improvement.

Data are collected from a survey sent to all cement manufacturing facilities at the beginning of the year. In addition to recognizing the industry's safety plants, the information collected is used to determine the safety record for the industry as a whole, and to help individual plants compare their records with others.

Safety Award Categories

- Safety Commendation (One Year without a Lost Time Accident (LTA)
- Safety Honor (2-4 Years without a LTA)
- Safety Excellence (5 or more years without a LTA)
- Safety Excellence (1,000,000 Hours without a LTA)

PCA SAFETY INNOVATION AWARDS

PCA's Occupational Health and Safety Committee looks for examples of how the cement industry is making its plants safer places to work. The goals of the awards are:

- To honor innovative practices, programs, and projects throughout the industry.
- To communicate these ideas to members of the North American cement industry.
- To raise the profile and importance of safety programs both inside and outside the industry.

In 2008, 65 entries were judged by members of the Committee, a representative of MSHA, and a member of the PCA Board of Directors. Winners in four categories— Quarry, Milling/Grinding, Pyroprocessing, and General Facility— received a monetary gift towards a "Celebration for Safety." These awards are co-sponsored by the Portland Cement Association and the Cement Association of Canada.

6 SUSTAINABLE CONCRETE CONSTRUCTION

SUSTAINABLE DEVELOPMENT

In an effort to reduce the overall energy consumption of the country, all industries are embracing the concept of sustainable development––the ability to build the communities we need today without depleting resources for the future. Sustainability seeks to balance the economic, social, and environmental impacts, recognizing that population growth will continue.

Sustainable development is a challenge because it is difficult to determine the appropriate level of energy use. We need to look at a number of environmental, economic, social, and safety issues and take a long-term view on when and how resources should be applied for the common good. Most importantly, society must reach a balance where "environmental debts" are not created and thus ensure that future generations have the same choices with energy usage.

CHALLENGING THE BUILDING TEAM

The manner in which buildings are constructed has changed very little and sustainable development challenges the design and construction industry to create buildings that acknowledge the life cycle of a building. Recognizing that operating a building over time is far more energy intensive than constructing it, demand for durability and energy performance is growing. Innovation in construction that considers the use of the building beyond its construction is integral in determining our nation's energy future.

Using concrete can facilitate the process of obtaining LEED™ Green Building certification. Leadership in Energy and Environmental Design (LEED) is a point rating system devised by the United States Green Building Council (USGBC) to evaluate the environmental performance of a building. The system is credit-based, allowing projects to earn points for environmentally friendly actions taken during construction and use of a building.

A new material for pavement and parking area designers is pervious concrete. Carefully controlled amounts of water and cementitious products create a paste that forms a thick coating around aggregate particles. Unlike conventional concrete, the mixture contains little or

no sand, creating a substantial void content – between 15% to 25%. Using sufficient paste to coat and bind the aggregate particles together creates a system of highly permeable, interconnected voids which drain quickly. Both the low mortar content and the high porosity reduce strength compared to conventional concrete, but sufficient strength is readily achieved for many applications. Pervious concrete allows water to pass through the material and seep into the ground. Pervious concrete can be instrumental in recharging groundwater and reducing stormwater runoff. This capability can reduce the need for retention ponds, swales, and other stormwater management devices. Pervious pavement integrates hardscape surfaces with stormwater management.

DURABILITY MEANS LONGER LASTING, MORE EFFICIENT STRUCTURES

Durability is a significant sustainable attribute of concrete because it will not rust, rot, or burn, requiring less energy and resources over time to repair or replace. Concrete builds durable, long-lasting structures including sidewalks, building foundations and envelopes, as well as roadways and bridges. As the most widely used building material in the world, concrete structures have withstood the test of time for more than 2,000 years. Because of its longevity, it can be a viable solution for environmentally responsible design.

When properly designed, concrete buildings can be reused or rebuilt in the future. Although a concrete building may begin its life as an industrial building, it might be renovated into office space or housing, The reuse attributes of concrete may conserve future building materials and reduce the construction time which new structures may require.

New concrete mix designs have been developed that minimize the amount of cement required while maximizing the use of alternative materials. No one concrete mix is applicable to all situations, but with the correct proportions of flyash, recycled aggregate, slag, and other materials, quality concretes can be produced that are more durable than concrete produced in the past.

ENERGY EFFICIENCY OPTIMIZED

Building components constructed of concrete generally are considered "mass" elements. This means they have enough heat-storage capacity to moderate daily temperature swings. Buildings constructed of cast-in-place, tilt-up, precast concrete, insulating concrete forms (ICF), or masonry possess thermal mass that helps moderate indoor temperature extremes and reduces peak heating and cooling loads. In many climates, these buildings have lower energy consumption than non-massive buildings with walls of similar thermal resistance. When buildings are properly

designed and optimized, incorporating thermal mass can lead to a reduction in heating, ventilating, and air-conditioning equipment capacity. Reduced equipment capacity can represent energy and construction cost savings.

Structures built with insulated concrete have optimal energy performance. Homes and buildings constructed from insulated concrete walls are not subject to large daily temperature fluctuations. This means home or building owners can lower heating and cooling bills up to 25% and occupants within these structures are more comfortable. Also heating, ventilating, and air-conditioning can be designed with smaller-capacity equipment.

Additionally, concrete minimizes the effects that produce urban heat islands. Studies have shown that urban environments have higher temperatures in areas where there are few trees, and a multitude of dark colored paved surfaces and buildings. This additional heat causes air conditioning systems to work harder, which uses more energy (up to 18% more) and promotes the formation of smog. Light-colored concrete absorbs less heat and reflects more light than dark-colored materials––thereby reducing heat gain. Light colored pavements also require less site lighting to provide safe night-time illumination levels, whether on parking lots, driveways, or sidewalks.

RECYCLING KEY FOCUS TO IMPROVE MANUFACTURING PROCESS

RECYCLED CONCRETE AGGREGATE

In concrete's life cycle, recycling is present from the beginning. Many wastes and industrial byproducts like fly ash that would otherwise clog landfills can be added to concrete mixes. These by-products also reduce reliance on natural (virgin) raw materials and can improve the concrete products. According to the American Coal Ash Association, in 2009 the cement and concrete industry used 13,500,000 metric tons of coal combustion products such as fly ash and bottom ash.

Concrete is easy to use and can be readily recycled. Delivered and prepared for each specific project, concrete typically produces very little waste.

Finally, when a concrete structure has served its purpose, it can be recycled as aggregate in new concrete paving, backfill, or as road base. Even the reinforcing steel in concrete (which often is made from recycled materials) can be recycled and reused.

For more information please see:

www.cement.org
www.concretethinker.com

The following publications available from PCA on-line bookstore:

www.cement.org/bookstore/index.asp

General Cement Manufacturing Descriptions:

A New Stone Age: The Making of Portland Cement
Item Code: CD052 Date: 2004

A New Stone Age: The Making of Portland Cement
Item Code: PA164 Date: 1992

U.S. Cement Industry Data:

U.S. and Canadian Portland Cement Industry :
Plant Information Summary
Item Code: ER373 Date: 2006

U.S. and Canadian Labor-Energy Survey
Item Code: ER374 Date: 2007

2007 North American Cement Industry Annual Yearbook
Item Code: ER375 Date: 2007

Cement Manufacturing Information:

Innovations in Portland Cement Manufacturing
Item Code: CD400 Date: 2004

Characterizing the Airborne Particulate in Portland Cement Plants
Item Code: SN3117 Date: 2009

Compilation of Mercury Emissions Data
Item Code: SN3091 Date: 2009

Compilation of NOx and SO2 CEM Data
Item Code: SN3092 Date: 2009

Air Emissions Data Summary for Portland
Cement Pyroprocessing Operations
Item Code: SN3048 Date: 2008

Air Emissions Data Summary for Portland Cement Pyroprocessing
Operations Firing Tire-Derived Fuels
Item Code: SN3050 Date: 2008

Beneficial Reuse of Materials in the Cement Manufacturing Process
Item Code: SN2868 Date: 2007

Recommended Guidelines for Solid Fuel Use in Cement Plants
Item Code: EB123 Date: 2007

Use of Waste Plastics as Fuel in Cement Production
Item Code: LB29 Date: 2006

Slag as Raw Material in Cement Manufacture
Item Code: LB18 Date: 2005

A Qualitative Examination of the Control of Major Gaseous Pollutants
Generated in Portland Cement Kilns
Item Code: SN2728a Date: 2004

Use of Waste Tires in Cement Manufacture
Item Code: LB12 Date: 2004

Pet Coke as Fuel in Cement Production: A Bibliography
Item Code: LB16 Date: 2004

Use of Waste Glass in Concrete: Bibliography of Publications
Item Code: LB13 Date: 2004

Cement Kiln Dust: Selected References on Use and Applications
Item Code: LB11 Date: 2003

Sustainability Topics

Design and Control of Concrete Mixtures 2009 Edition
Item Code: CD100 Date: 2009

Concrete: The Choice for Sustainable Design
Item Code: RP444 Date: 2008

The Engineering Guide to LEED-New Construction:
Sustainable Construction for Engineers
Item Code: LT314 Date: 2008

The Thermal and Radiative Characteristics of Concrete Pavements in
Mitigating Urban Heat Island Effects
Item Code: SN2969 Date: 2008

Sustainable Manufacturing Fact Sheet: Tire-Derived Fuel
Item Code: IS325 Date: 2008

Solar Reflectance of Concretes for LEED Sustainable Sites Credit:
Heat Island Effect
Item Code: SN2982 Date: 2007

Exploring the Environmental Attributes of Concrete - 2007
Item Code: RP442 Date: 2007

Exploring the Environmental Attributes of Concrete - 2006
Item Code: RP432 Date: 2006

An Engineer's Guide to: Building Green with Concrete
Item Code: IS312 Date: 2005

Residential Technology Brief: Building Green with Gray Concrete
Item Code: IS311 Date: 2005

Sustainable Manufacturing Fact Sheet: Iron and Steel Byproducts
Item Code: IS326 Date: 2005

Sustainable Manufacturing Fact Sheet: Power Plant Byproducts
Item Code: IS331 Date: 2005

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