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Application, Science and Sustainability of Coal Ash

HIGH VOLUME FLY ASH IN CONCRETE

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2003 CCP PRODUCTION AND USE SURVEY

CCPs AND MINING RECLAMATION IN PENNSYLVANIA



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WINTER/SPRING 2005



Application, Science and Sustainability of Coal Ash

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WORKING TOGETHER TOWARD THE SAME GOALS

By Thomas Jansen

ears ago, I toured a boathouse and had an opportunity to get into a rowing scull. I was amazed to learn that the sleek boat was extremely fragile and unstable. The long oars were awkward and difficult to maneuver. I wondered how nine men, in a boat slightly wider than their hips, managed to move quickly through the cold, choppy lake, without tipping, and held a straight line. The solution was simple: It takes practice, hard work, skill and cooperation.

In many ways ACAA is similar to a crew team. We have an efficient organization and a group of people who work hard for the advancement of our industry. We have skilled professionals who have their oars in competitive, rough waters. At times, it may even be awkward for us to embark on new projects and to work with new members as well as new leadership. We have many common goals and strive to win. ACAA succeeds when we are in sync with our fellow members and customers.

Over the last 10 years, I witnessed ACAA propel our industry forward with the help and involvement of only a portion of the total number of U.S. coalburning utilities. And there is still work to do. With full industry participation and cooperation, we can continue to accomplish even more success. Certainly, we will be closer to 100 percent utilization of a highly valued product. Our companies will save more money, earn more revenue and serve its customers better. Plus, our communities and the environment will reap the benefits of CCP utilization and resource conservation. The quicker we accelerate wider cooperation and more active participation of our industry, the sooner we will have the strength and momentum to achieve greater success.

In order to concentrate our efforts, ACAA recently developed a strategic plan which has five goals with respective strategies. Each strategy will have action items developed and prioritized on the committee level. Necessary resources to execute priorities will be provided by the annual budget. The plan will help to focus our efforts, put us on a straight line toward achieving our goals and provide an opportunity for all members to participate and to use their skills to advance our industry.

Our membership continues to grow. We collaborate with more industries and government agencies. The CCP industry utilization rates are increasing annually. The ACAA staff does an outstanding job to serve you. And that's just the beginning. ACAA committees have a multitude of activities that need your talents to execute the strategic plan and there are roles for all stakeholders. Find an area of interest and participate. For non-members, join ACAA or enroll in EPA's Coal Combustion Products Partnership (C²P²). It's tough to get a boat moving, but it gets easier when we all work together so jump in and grab an oar.





Thomas Jansen, Chairman, American Coal Ash Association, P.E., We Energies, CCP Group Supervising Engineer

ACAA Mission Statement

The mission of the American Coal Ash Association is to advance the management and use of coal combustion products (CCP) in ways that are environmentally responsible, technically sound and commercially competitive.

ACAAVision

ACAA will continue to be a world leader in advancing beneficial use of coal combustion products (CCP) and resource conservation through utilization.

ACAA Goals

- Increase annual utilization of fly ash and bottom ash as a supplementary cementitious material and cement clinker raw feed to 18 million tons by 2010.
- Increase the annual total beneficial use of CCP to 58 million tons by 2008, and to 64 million tons by 2010 (this is 45 percent and 50 percent respectfully, compared to 2002 survey results).
- 3. Proactively anticipate, assess and respond to issues that impact the CCP industry.
- Develop stronger relationships with stakeholders and influencers of CCP utilization and resource conservation.
- Increase ACAA membership to 100 by 2008, including at least 40 Class U (utility) members.

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GREETINGS FOR 2005

By Dave Goss

CAA is beginning its 38th year with enthusiasm and a justifiably earned pride for its 2004 successes. The New Year offers exciting opportunities and challenges for the association to continue its unparalleled growth, and increased membership participation in a wide-range of new CCP activities.

By the end of November 2004, ACAA was comprised of 73 organizational members and six individual members. That was an increase of 27 members, more than 33 percent over 2003.

an economic study being conducted by the American Coal Council, ACI/CAN-MET 2004 International Conference on the Use of Fly Ash in Concrete; and a Polish doctoral candidate study of CCP utilization conducted at Penn State.

In 2005, ACAA will participate in two more C^2P^2 workshops and will be a sponsor of both Electric Power 2005 and Coal Gen 2005. We have been invited to work with the U.S. Army Corps of Engineers on dredge material use in mine reclamation activities in the Great Lakes Region. We continue to work closely with the

ACAA expanded its involvement in other environmental and recycling organizations by joining the Great Lakes Byproducts Management Association, the Sub-bituminous Energy Coalition and the Chicago Climate Exchange.

ACAA expanded its involvement in other environmental and recycling organizations by joining the Great Lakes Byproducts Management Association, the Sub-bituminous Energy Coalition and the Chicago Climate Exchange. The ACAA Educational Foundation increased its visibility by becoming a member of the U.S. Green Building Council and being a Gold Sponsor for the EPA's 2004 Byproducts Beneficial Use Summit in Kansas City.

The Association sponsored (or co-sponsored): four C^2P^2 workshops with the EPA and other groups; Coal Gen 2004; the Coal Ash Professional's course conducted by the Energy and Environmental Research Center; a workshop conducted by the Center for Byproduct Utilization at the University of Wisconsin-Milwaukee; Recycled Materials Resource Center, the EPA, the Department of Energy, the Federal Highway Administration, the Environmental Council of Concrete Organizations (ECCO), the Portland Cement Association, and several organizations and specifiers involved in the use of coal ash and industrial byproducts in large construction projects. We are confident that these relationships and cooperative efforts will lead to increased awareness and utilization of CCPs. This will help further distinguish coal ash as a valuable product that conserves resources.

Not only do we get involved, we often are the leader in many of these activities. ACAA's Strategic Plan implementation and its ever-growing involvement in collaborative CCP utilization



"(ACAA)... continue(s)

its unparalleled growth

and ... membership

participation..."

Dave Goss, ACAA Executive Director

initiatives provide the resources for ACAA to take a leadership role with the utility and construction industries. For example, we have a key role in the development of the "green highway" concept that was presented to the FHWA and EPA in December and will be discussed at the 2005 ACAA Annual meeting in San Diego. Working with the FHWA and other organizations, we hope to increase the awareness of using CCPs in proportionately higher amounts (alone and with other industrial waste streams) in highway construction. This helps our industry to be recognized as a leader in resource conservation and sustainable business practices.

These activities demonstrate the breadth of ACAA's involvement and leadership, which could not be accomplished without the ongoing support of our members and the many volunteers who make these projects and events a success. I thank all of you who are helping make ACAA a significant force in the CCP industry and respected by government agencies and coal ash organizations around the world.



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A Place in Time...

Visit Calendar of Events at www.ACAA-USA.org

To locate upcoming meetings

San Diego, California 24—26 January 2005

Lexington, Kentucky 11—15 April 2005

Atlanta, Georgia 12—14 September 2005

New Orleans, Louisiana 23—25 January 2006

Chicago, Illinois June 2006





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BENEFICIAL USE OF COAL ASH AT MINE SITES IN PENNSYLVANIA

By Kathleen A. McGinty

ennsylvanians have been mining coal for more than 250 years, accounting for one-third of America's coal production. Some 2.25 billion tons of coal was mined in Pennsylvania during World War II alone. These resources have helped build a nation, rebuild Europe following two world wars, and made Pennsylvania's economy a leader of the industrial age.

Unfortunately, a legacy of this proud heritage is thousands of miles of poisoned streams and 250,000 acres of scarred, unusable and dangerous abandoned mine lands. The cost of cleaning up this damage is staggering — approximately \$4.6 billion just to reclaim the highest priority sites and address acid mine drainage that degrades three of the largest river basins in the Northeast.

The money Pennsylvania receives each year from the federal Abandoned Mine Lands Fund is not enough and there are no guarantees that we will continue to receive that money, although Governor Edward G. Rendell has been helping in the fight to ensure that Congress reauthorizes the fund and that the Commonwealth secures its fair share of funding.

Governor Rendell has therefore also made it a top priority to generate new resources to tackle the serious problems caused by the state's mining legacy. The governor has proposed an \$800 million bond initiative to expand and enhance *Growing Greener*, including \$100 million over four years to address problems at mine sites that pose significant environmental harms, hamper the state's economy and hinder attempts to revitalize communities.

Pennsylvania is already a leader in restoring abandoned mine sites to safe and productive use. One of the most innovative answers is the use coal ash to fill abandoned mine pits. When used appropriately, this material is an extraordinarily valuable and effective tool in mine reclamation and in the remediation of acidic drainage from abandoned mines



Kathleen A. McGinty, Secretary, Pennsylvania Department of Environmental Protection

that pollute streams throughout the Commonwealth. In fact, our policies and procedures in this regard, in place since the mid 1980s, are the best in the nation and a model for federal rules and policies.

In October 2004, I attended the grand opening of Reliant Energy's Seward power generating station in the Connemaugh River Valley, directly in the middle of some of the worst damage from the coal industry. This state-of-the-art cogeneration plant will remove more than 40 coal refuse piles, with a total of approximately 60 million tons of coal refuse, as fuel.

The coal ash generated at the station then will be used to reclaim sites where the piles are located. The ash generated at the Seward coal-refuse powered generating station will be alkaline, so it will be effective for use to remediate acidic drainage that exists at the refuse piles suffering from leftover pyretic materials. Environmental benefits are expected in the Conemaugh, Allegheny and Loyalhanna watersheds, which feed into the Ohio River, and the West Branch Susquehanna River, which empties into the Chesapeake Bay.

Much of this coal refuse could not have been reclaimed with available government funding. Aside from the beneficial use of coal ash generated by the plant, other benefits of this project include: 1) cleaning the air by eliminating dust sources and, in some cases, the uncontrolled burning of the refuse piles; Pennsylvania is already a leader in restoring abandoned mine sites to safe and productive use. One of the most innovative answers is the use coal ash to fill abandoned mine pits.

2) eliminating unregulated dumping areas as the piles are removed, pits are reclaimed and access roads are eliminated; and 3) improving aesthetics for small mining towns that are often located very close to the piles.

Pennsylvania has also used coal ash to create in-mine barriers to fires, but we are just beginning to experiment with a promising advance in fighting mine fires. In the late 1990s, coal ash was pumped into the Percy Mine in southwestern Pennsylvania in the hopes of creating an in-mine barrier to control and snuff out a stubborn fire that has burned there for more than 30 years. We have been monitoring the fire, and the barrier appears to be holding, but these barriers have failed in the past, often because there are too many voids and holes allowing oxygen to enter and feed the fire.

In September 2004, DEP approved a contract to use a patented product known as low-permeability cementitious fill (LPC) to attempt to isolate and extinguish the Percy Mine fire. LPC is a thin grout-like slurry made of coal ash that will set up like cement after being pumped into the burning mine. It is expected the slurry will extinguish the fire by depriving it of oxygen and filling all the voids, and lowering the temperature in the fire area by introducing wet material. This is the first time LPC has been used to control a mine fire, but it demonstrates the innovation and new approaches that can be applied to our most serious challenges.

We are fully aware that not all coal ash is appropriate for mine reclamation and that only those sources meeting strong environmental standards should be allowed to provide ash for mine reclamation. In order to provide ash to be used in mine reclamation, plants have to receive approval as a source of coal ash expressly for that purpose. This is conducted in order to verify the material is safe and appropriate for use. The reclamation sites themselves will be inspected and water discharges from the sites monitored to ensure no problems develop from the placing of the ash.

Scientists from various government agencies and academic institutions — including Penn State, Virginia Tech and other state universities — have found that coal ash helps reduce polluted mine drainage without contaminating groundwater or harming the environment. The U.S. Environmental Protection Agency also has announced its findings that coal ash is not to be considered a hazardous waste. Evidence clearly shows coal ash is safe and can reduce life-threatening safety hazards to nearby residents and the environment when used to reclaim mine sites. In Pennsylvania, we are conducting or have completed coal ash placement at 90 mine sites, and we are using coal ash for alkaline addition, as a soil additive and for low-permeability material at another 32 sites. DEP continues to collect watermonitoring data from these sites, and the data shows no evidence of groundwater contamination or other problems.

The reclamation of abandoned mine lands is an environmental priority. Pennsylvania mine sites have an array of associated hazards, including underground mine fires, water-filled surface mining pits, dangerous highwalls and open mine entries. Coal ash is a safe and inexpensive method to help us heal the scars of our industrial past and to protect public health and safety.

Where once our Commonwealth led the nation in coal production, now we are leading the way in reclamation, preserving our rich industrial heritage and protecting our bountiful environmental resources. \Box



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HIGH VOLUME FLY ASH FOR EVERY DAY CONCRETE

By Robert Munro

n 2005, the main concrete specification in Canada (CSA A23.1) will have a definition of and requirements for High Volume Supplementary Cementing Material (HVSCM) concrete. This will address one of the obstacles to specifying high fly ash replacement rates in concrete. In addition to the new specification, the rapid increase in the number of projects incorporating "Green Building" or Sustainable Development (SD) principles is creating a demand for HVSCM concrete.

High volumes of fly ash have been used in concrete for many years. Most applications have been in mass concrete where concerns about the potential for thermal cracking led to the use of fly ash and/or slag to reduce the maximum temperature rise due to the heat of hydration. This use of HVSCM in concrete has been well established. Other reasons for using higher volumes of SCMs, such as improved durability due to reduced permeability, sulphate resistance and the control of alkali silica reactivity of aggregates, have been recognized but remain special cases. Fly ash is in common use in many areas of North America for many practical reasons, such as,

- enhanced 28-day and later strengths
- improved workability
- improved pumpability
- improved slump retention
- reduced bleeding
- economy

There are many more reasons for using fly ash in concrete as well. When the replacement levels are raised, these benefits are generally magnified, as are the properties that limit the day to day replacement rates.

Despite the extensive experience with lower replacement rates and the use of HVSCM in specialty concrete, HVSCM is not a currently common practice in day-to-day concrete. In order for higher volumes of SCMs to be used in day to day concrete, current specifying practices and field procedures need to change.

Slab on grade placement of 50 percent fly-ash concrete. The color and finish of the 50 percent fly-ash concrete was so good that the architect decided to expose the foundation wall concrete rather than cover it with dry wall. Unfortunately, the red chalk lines for installing the dry wall, that can be seen here, were difficult to remove. Current ACI and CSA Specifications have almost no restrictions on the use of SCMs. ACI's only limit is in ACI 318 and only applies for Freeze/Thaw Deicing Chemical Scaling applications. The limits of 50 percent for slag and 25 percent for fly ash do not consider the mix design or the techniques of placing and finishing.

For slip-formed concrete, properly placed and finished and cured, many projects with up to 40 percent fly ash have performed well in the field. For hand-placed and finished concrete there have been many scaling problems with 50-percent slag levels. If concrete is placed in non-freeze/thaw environments, there are currently no limits on replacement levels in ACI or CSA Specifications.

The normal day-to-day SCM replacement levels, in North America, generally range up to 30 percent for fly ash and 35 percent for slag. When the weather is cold and concrete will be significantly retarded, the replacement levels can be as low as zero. When the concrete is heated, the SCM use can be more like summer replacement levels. In hot weather, when 100 percent Ordinary Portland Cement (OPC) concrete tends to set too fast, the highest levels of SCM replacement are typically used. Concrete producers that normally use fly ash have already modified their mix designs to facilitate its use. The main philosophy has been to keep the SCM replacement levels low enough that current field procedures do not have to be modified. This has resulted in typical annual average SCM levels in concrete being fairly low, in the 10 percent to 20 percent range.

There is currently a rapid growth in the number of construction projects using Sustainable Development principles. Sustainable Development has been defined by the United Nations World Commission on the Economy and the Environment in 1987 as "...the ability of humanity to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs..."

In practice, Sustainable Development projects focus on a project's impact on the environment, energy efficiency and pollution reduction. Many of these projects incorporate a lot of natural lighting, recycled material content, water run-off reduction, insulation, efficient ventilation heating and cooling systems, thermal mass and a host of other factors. When all of these factors are considered, concrete has been a frequent choice for the structure and pavements. Once concrete is selected, then further enhancing the green features of concrete can be achieved through the optimum use of fly ash.

A number of "Green Building" check lists have been developed using Sustainable Development principles. The most used check list in North America has been the Leadership in Energy and Environmental Design (LEED) issued by the United States Green



Building Council (USGBC). Canada now has an associated organization, the Canadian Green Building Council (CaGBC). The CaGBC has modified the LEED system to the Canadian market. One of the changes in the Canadian LEED system gives greater credit for HVSCM use in concrete and consideration for improved durability. Many levels of government are adopting green purchasing criteria and several schools and private companies are adopting "Green" criteria for their projects.

By using HVSCM compared to normal SCM levels, there are a number of Sustainable Development benefits:

- Better durability less energy to repair or replace
- Less energy to place reduced labor and or vibrator noise on site
- Lower embodied energy (the total amount of energy associated with placing concrete)
- Reduced Green house gas emissions for the volume of concrete produced
- Use of a recycled material diverted from landfill

Although all of these issues are significant benefits from a Sustainable Development point of view, only some of them receive credit in the LEED system.

The use of recycled materials is one of the Sustainable Development principles. SD project owners usually wish to use higher SCM replacement levels than normal. A major problem with



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incorporating higher SCM levels is the lack of requirements and guidelines in specifications.

To address this need, the main Canadian specification for concrete, CSA A23.1, has developed HVSCM concrete definitions and requirements for the next issue expected to be available at the end of 2004 or the beginning of 2005.

The section facilitates the use of HVSCM in day-to-day concrete a number of ways. First it provides a definition for HVSCM. HVSCM is defined as concrete that "...contains a level of SCM above that typically used in normal construction." This led to two categories of HVSCM being defined:

HVSCM-1: FA/40 + S/45 > 1 HVSCM-2: FA/30 + S/35 > 1

The definition of HVSCM allows two things to happen:

- First, an owner can take credit for using more than the normal SCM replacement level in his project.
- · Second, the specification imposes additional requirements to address concerns about durability.

When the additional requirements were being discussed, it became clear that a moderate increase in SCM level warranted different additional requirements than higher levels, so the intermediate level was also defined.



The additional requirements for the HVSCM concrete are based on the existing durability requirements for different exposure conditions:

- When HVSCM-1 concrete is exposed to freezing and thawing, the water to cementing materials ratio (W/C) required by the main durability table (table 2 in Standard A23.1) is reduced by 0.05.
 - Example for C-1 Exposure the maximum waterto-cementing materials ratio in Table 2 is 0.40, but for HVSCM-1 concrete this maximum value shall be reduced to 0.35.
 - For fly ash concrete, the lower W/C often does not result in an increase in total cementitious content, because fly ash water reduces significantly on its own. It does mean that you cannot take advantage of the strength and water reducing properties of fly ash to reduce cement contents. This requirement is intended to avoid scaling of flatwork which has occurred when mix designs are too lean.
- The minimum compressive strengths required in the main durability table (table 2 in Standard A23.1) shall be specified at 56 days for HVSCM-1 concrete, rather than 28 days.
 - This accommodates the slower strength development that can occur with HVSCMs and recognizes that higher later strength gain usually ensures good long term performance. The 28-day strength requirements usually do not affect the construction schedule.



- For reinforced concrete exposed to moisture and air and/or with depths of cover less than 50 mm, the water-to-cementing material ratio (W/C) should be:
 - not greater than 0.45 for HVSCM-2 concrete
 - and not greater than 0.40 for HVSCM-1 concrete.
 - This clause is intended to minimize the risk of corrosion of embedded steel due to carbonation of the concrete cover. Carbonation induced corrosion of reinforcing steel has been a big problem outside of North America. This clause is intended to ensure that HVSCM concrete does not create a carbonation problem in North America.
- The curing and protection requirements are increased for HVSCM for the following exposure classes C-1, F-1, S-1, S-2:
 - Curing regime 3 for HVSCM-1.
 - And for the following exposure classes A-3, A-4, C-3, C-4, F-2, N, S-3
 - Curing Regime 2 for HVSCM-1 and HVSCM-2
 - These clauses are intended to ensure that no failures occur due to premature exposure of slower strength and permeability developing mixes.

In CSA A23.1 Basic curing (regime 1) is three days at 10°C or for a time necessary to attain 40 percent of the specified strength. Additional curing (regime 2) is seven days at 10°C and for a time necessary to attain 70 percent of the specified strength. Extended curing (regime 3) is wet-curing period of seven days. The curing types allowed for regime 3 are ponding, continuous sprinkling, absorptive mat or fabric kept continuously wet.

For HVSCM and particularly for fly ash, methods of protecting concrete from premature evaporation of surface moisture should be used. Fog spraying or evaporation retardants are particularly effective.

Curing and protection from drying before curing is applied, is one of the most neglected and most important site procedures. Due to its slower setting and strength gaining nature, HVSCM is even more susceptible to poor curing and initial protection than normal concrete. All rich concrete mixes, especially when air entrained, have very little bleed water coming to the surface of slabs. In order to protect concrete from premature drying, the use of fog spray or an evaporation retardant, spray on product, is highly recommended. When cured properly, HVSCM generally produces better final properties than regular concrete.

YORK UNIVERSITY COMPUTER SCIENCES BUILDING

An excellent example of the use of High Volume Fly Ash concrete, is the new Computer Sciences building at York University in Toronto. The project was designed from start to finish using Sustainable Development criteria and is one of the most energy efficient buildings in North America. All

For HVSCM and particularly for fly ash, methods of protecting concrete from premature evaporation of surface moisture should be used. Fog spraying or evaporation retardants are particularly effective.

of the interior concrete (approximately 80 percent), used 50 percent Type CI fly ash concrete. The fly ash was from Ontario Power Generation. In the Canadian standards, Type C fly ash is divided into two categories:

- Type CI fly ash with intermediate calcium oxide content (8 20 percent)
- Type CH fly ash with high calcium oxide content (over 20 percent)

Ontario Redemex, which supplied the concrete, worked closely with the contractor, Ellis Don, to address all issues with regard to the use of the HVSCM concrete. A pre-pour meeting was held to address all concerns with regard to the HVSCM. The following site procedures and mix-design adjustments were made in order to facilitate the use of 50 percent fly ash:

- Evaporation retardant was applied after initial floating and again after final finishing ensuring that the slabs did not dry out prior to the application of the wet burlap and plastic curing. This is an excellent practice for all concrete subjected to drying conditions. Rich mixes and air entrained mixes are particularly susceptible to rapid dehydration. The slabs cast with these measures had no premature cracking and an excellent finish.
- A retarder was used in the mix during hot weather to maintain strengths and control slump loss in the ready mix truck
- Extra heat was provided during curing in cold weather to ensure adequate strength.

The quality of the final concrete finish was so good that the architect decided to expose more of it than the original plans called for.

The project, in general, was a great success and won the 2002 Governor General of Canada, Award for Architecture and the 2002 World Architecture, International Green Building Award.

The fly ash or SCM used should be reviewed prior to each project and the replacement rates developed with input from all parties. All SCMs do not provide the same finishability, early strengths and final strengths and must be accommodated in the mix design and site procedures to avoid problems. It is important that the use of HVSCM does not develop a reputation of being problematic, too expensive from a construction schedule point of view, or a durability concern. The expertise is now available to identify the components in structures that can use HVSCM concrete. Although all concrete is green relative to other building materials for most applications, the "greenness" of concrete can be further enhanced through the use of HVSCMs.

Now that credit can be given for Sustainable Development measures taken, and there are specifications with definitions and guidelines, it is easier to specify and use HVSCM concrete. HVSCM can also contribute to points for Green certification of a project.

Simply put, using HVSCM concrete when used properly, is not just doing the right thing, it typically makes better, longer lasting concrete and contributes to solving current environmental problems. Owners and specifiers who are concerned about the environmental impact of their projects should consider using HVSCM concrete.

Robert Munro is with LaFarge-NA in Ontario, Canada. He can be reached at Robert.munro@lafarge-na.com.



NORTH DAKOTA COLLEGE ERECTS NEW BUILDING MADE LARGELY FROM BYPRODUCTS OF COAL COMBUSTION

By Vicki Voskuil, BSC Public Information Specialist

The \$10 million Career and Technology Institute at Bismarck State College (BSC) will be the first campus structure in the North Dakota University System designed to use products such as FlexCrete concrete, which has a 70 percent fly ash content.

two-year North Dakota college with a national reputation for energy education and workforce training will soon erect a building made largely from materials derived from byproducts of coal combustion in power plants. Planned for three stories and situated high on Bismarck's "greenway" overlooking the Missouri River, the building is set for occupancy in January 2007.

The \$10 million Career and Technology Institute at Bismarck State College (BSC) will be the first campus structure in the North Dakota University System designed to use products such as FlexCrete concrete, which has a 70 percent fly ash content. Other construction and finishing materials derived from bottom ash and flue gas desulfurization material will also be integrated to impress upon students the value of recycling and to show how these products reduce the cost of building materials.

"This proves that BSC continues to work with and be on the cutting edge of the energy industry," says Gordon Binek, who heads the BSC Foundation as vice



Gordon Binek heads the Bismarck State College Foundation as vice president for college advancement.

president for college advancement. "We have an opportunity to turn fly ash into an economic engine."

Like the Fort Mandan Visitors Service Center near Washburn, N.D., the institute will be a demonstration site for coal byproducts and how their use saves natural resources and provides environmental benefits. Cultured stone, stucco, wallboard, shingles, floor coverings, ceiling tile, paint, and a host of other materials containing coal byproducts will be integrated into the design, which could earn "green" or Leadership Environmental Engineers Design certification for its "human friendly" construction.

"For years, BSC has taught students how to generate electricity. Now we will also teach them how to use coal combustion products resulting from that generation," Binek says.

In addition, the world-class institute, fashioned with state-of-the-art wireless technology, will help define how energy training and education is delivered. Using Web labs and simulators, BSC will be able to offer learning to students anywhere in the world.

"Our vision is to become a national energy center that provides educational and training opportunities to learners anytime, anywhere," says BSC President Donna S. Thigpen. BSC is the only degree-granting institution in the United States that offers online instruction to the energy industry. Students can earn degrees and certificates in five energy specialties developed largely through partnerships with utilities and energy associations across the country.

"The Power Plant Technology program has certainly been very important to us in our long relationship with BSC," explains John Weeda, manager of Great River Energy's Coal Creek Station in Underwood, N.D. "Many of our employees are graduates of that program. The Career and Technology Institute's three facilities will further enhance BSC's focus on the energy industry."

Besides energy technology, two other fastgrowing programs will be housed in the Career and Technology Institute: workforce training and cooperative education. Regional training needs for energy and other employees will be addressed by the Workforce Training Center managed by BSC Corporate and Continuing Education. The Higher Education Center will consolidate current and future cooperative programs with four-year colleges that offer advanced degrees on the BSC campus.

The National Energy Technology Training and Education Center, the linchpin of the 75,000 square-foot facility, will have advanced technology laboratories, "smarter" classrooms with holographic presentation options, a resource library, media center, think tank area, energy museum, visitor center with hands-on demonstrations, and laptop computers for all students. With the CTI building, BSC will increase its ability to respond to the rapidly changing education and training needs in North Dakota and address the demand for skilled employees by national and international energy companies.

Mike Hummel, president and general manager of BNI Coal Inc. in Bismarck, N.D., says North Dakota's skilled worker turnover between 2008 and 2018 will be staggering. An additional 250,000 are expected to leave the industry nation-wide during that time. With a huge retirement facing the industry, BSC's energy programs are expected to expand rapidly with an enrollment of 1,500 expected by 2010. Since 1999, growth has been dramatic, with an enrollment increase



The \$10 million Career and Technology Institute at Bismarck State College (BSC) will be the first campus structure in the North Dakota University System designed to use products such as FlexCrete concrete, which has a 70 percent fly ash content.

of more than 350 percent. Four-fifths of approximately 500 energy students are studying online. This upsurge has made the Energy Technology Department the largest on campus.

Cultured stone, stucco, wallboard, shingles, floor coverings, ceiling tile, paint, and a host of other materials containing coal byproducts will be integrated into the design, which could earn "green" or Leadership Environmental Engineers Design certification for its "human friendly" construction. Support from major utilities, such as Great River Energy, has advanced the institute project and provided incentive to build a \$4.5 million automated FlexCrete plant in North Dakota by 2005-06. The company has developed a market for fly ash and other byproducts that has propelled it into the top four distributors in the country. Having a processing plant in North Dakota would furnish the state with a value added business, new jobs and entire new enterprise within the energy industry.

Headwaters Resources of Utah and its subsidiary ISG Resources Inc. buys most of Great River Energy's fly ash, which is used as a replacement for cement in concrete. Fly ash is also used to produce FlexCrete, a product that minimizes energy needed to heat and cool a building and supplies more sound insulation than other building materials. Fly ash replaces some of the



Students can earn degrees and certificates in five energy specialties developed largely through partnerships with utilities and energy associations across the country.

cement in the concrete mixture and makes the building more fire-resistant.

Al Christianson, Great River Energy business representative, says the Career and Technology Institute will be a showcase of the newest technology for turning industry byproducts into marketable uses. "The Career and Technology Institute will be a monument to the fact that North Dakota leads in the type of environmental uses of byproduct."

BSC President Thigpen adds that support from the state and federal level and the community demonstrates a high level of recognition that such a facility is needed and will benefit the area and state.

The college recently received a \$1.5 million grant from the federal Economic Development Administration. Basin Electric Power Cooperative in Bismarck gave a lead gift of \$2 million to the capital campaign, which is 70 percent complete, Binek says. In addition to contributions from other energy companies, the CTI project has also gained financial support from the North Dakota Legislature with a \$500,000 appropriation, plus contributions from BSC employees and other individuals and organizations. □



For years, BSC has taught students how to generate electricity. Now they will be taught how to use coal combustion products resulting from that generation.

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CEMENT SHORTAGE AND PERFORMANCE-BASED SPECIFICATIONS: WHAT IT MEANS FOR CCP PRODUCERS

By Carol Carder (on behalf of ACAA)

n Flash Reports on May 13 and again on June 6, 2004, the Portland Cement Association (PCA) announced a short supply of cement in several parts of the United States, particularly the Southeast, Southwest, and the New York/New England regions. Factors affecting the shortage included heightened demand in residential construction, and factors affecting imports such as the booming Asian economies and the skyrocketing rates and tight availability in shipping. Construction is a cyclical industry and the United States depends on imported cement to fill the gap between domestic production and fluctuating demand. According to figures from the U.S. Geological Survey, 2003 U.S. Portland cement consumption was 107.5 million metric tons. Of that total, 23.2 million tons or 21.6 percent was imported cement.

In May and June, 2004, 23 states accounting for 48 percent of cement consumption reported a shortfall in cement supply. According to a PCA August survey, an additional six states were also experiencing a cement shortage. The situation was worse by the October survey, according to Ed Sullivan, PCA chief economist. As October ended, 35 states were experiencing a shortage.

"In our fourth quarter forecast, we expected mortgage rates would rise to 6.5 percent, the tripping rate where housing starts would decrease," Sullivan explains. "Instead, the rate is still hovering below six percent, so we don't see a lessening demand until the first quarter of 2005."

In the long term, cement companies have announced plans to expand manufacturing capacity by 19 million tons by 2009, roughly a 20 percent increase in domestic capacity. However, the companies will experience regulatory roadblocks in zoning and permits that have to be in place by 2006 for the 2009 expansion to happen, according to Sullivan.

The American Coal Ash Association (ACAA) is encouraging more replacement of Portland cement in concrete products as a way to address the cement shortage. Many producers for highway applications are already following the ASTM standards and replacing 20 percent of the cement with Class F fly ash, according to Craig Plunk of Boral Materials Technologies Inc., San Antonio, Texas, who is the ACAA communications and marketing committee chair.



Research at the University of Wisconsin suggests a substitution of up to 40 percent of cement with Class C fly ash may achieve the same performance in concrete as 20 percent Class F fly ash. In some cases, fly ash can replace cement in geotechnical applications such as stabilizing subgrades or embankments or in flowable fill.

INDUSTRY SUPPORT OF PERFORMANCE-BASED SPECIFICATIONS

The National Ready Mixed Concrete Association is spearheading a transition from the traditional prescriptive specifications to performance-based specifications. NRMCA created the P2P (Prescriptive to Performance) initiative to challenge architects and engineers to address concrete specifications in terms of functional requirements as opposed to controlling the specifics of concrete mixtures and construction means and methods.

Ken Rear, vice president of research and support at Heidelberg Cement Group Technology Center in Atlanta, Georgia, and chair of NRMCA's P2P steering committee, says of the prescriptive specs, "It's difficult to make a blanket statement and say 15 percent fly ash, for instance, is good for every application as each application is unique, and a ready mix producer should be prepared to use the appropriate amount for that application."

The Canadians have had a performance-based specification for concrete as an alternative for bids for the last 20 years, according to Rear. The recently revamped Canadian code, published in December, allows prospective bidders to bid the job on either prescriptive specifications or performance-based specifications.

Historically, every state department of transportation (DOT) has developed a prescriptive mix design for concrete. Many states looked at their weakest links and produced a mix design that would make an acceptable concrete with these inferior materials, according to Jimmy Knowles, SEFA Group, Columbia, South Carolina.

"Actually, ready-mix producers following these prescriptive mixes have been producing concrete that outperforms the specified strengths because most of the concrete isn't made with the worst of materials, so many times the state is performing unnecessary over design," Knowles stresses. "What the industry wants is moving to a performance-based specification that would allow each concrete producer to look at his set of concrete making materials and design his recipe to optimally utilize the materials available to him."

Rear adds: "What we are advocating is an alterative to prescriptive mixes. We're saying, 'You tell us how you want the concrete to perform and don't worry about what we put in it. We will guarantee the performance based on your requirements."

Many times the prescriptive specifications conflict with the performance requirements, so the concrete producer is working with a double standard. If he follows the prescriptive mix, he may not attain the strength the specifications dictate, yet if he changes the mix, he doesn't meet the prescriptive specification. If the concrete producer, as a knowledgeable professional, has the option to use 50 percent fly ash and it's appropriate for the required performance, with performance specifications, he could change the mix to 50 percent fly ash replacement of cement content.

The P2P initiative recommends a parallel track of performancebased specifications alongside the current prescriptive specifications to improve the way business is accomplished. NRMCA believes performance-based specifications will foster innovation and result in new technologies coming sooner to the marketplace.

A change to performance-based specifications requires a higher level of trust on the part of the architects and engineers and proof of technical knowledge and quality-control methods on the part of the producer and contractor. Producers and contractors will need to better educate their work force as well as providing excellent quality control.

ACAA views the move to performance-specifications as a positive influence that will permit ready-mix producers to use the right amount of fly ash and other coal combustion products in producing superior concrete. Producers who have proven their technical expertise and passed certification programs such as those sponsored by American Concrete Institute and NRMCA have the ability to produce the best concrete for the application following performance-based specifications. \Box

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ACAA ANNOUNCES COAL ASH UTILIZATION INCREASE IN 2003

As in previous years, these 2003 figures are industry-wide estimates based on voluntary data received from electric utilities that are representative of the nearly 500 coal-fueled utility power plants in the U.S.

n October 1, 2004, ACAA released coal combustion product (CCP) production and use data for calendar year 2003. The Association estimates an overall 2003 CCP production total of 121.7 million tons for all of the various CCP types, compared to 128.7 million tons produced in 2002, or a decrease of about a five percent.

As in previous years, these 2003 figures are industry-wide estimates based on voluntary data received from electric utilities that are representative of the nearly 500 coal-fueled utility power plants in the U.S. The reduction in 2003 CCP production is due, in part, to a corresponding reduction in the sampling data that was available to perform estimate calculations. Total CCP production can vary significantly from year to year. Estimated production totals depend on the industry's total amount of coal burned, the ash content of the coal burned, and the extent of air emission controls used.

CCP utilization for 2003 is estimated at about 46.4 million tons, which represents a 38.1 percent overall CCP utilization rate. This compares to 45.5 million tons used and a 35.4 percent utilization rate in 2002. The increase in CCP tonnage use and corresponding increase in utilization are consistent with wider acceptance of CCPs in the building and construction industries. The increases are also testimonials to the environmental, technical and economic advantages that these materials present where each ton of CCPs used is one less ton disposed.

On a tonnage basis, fly ash continues to be the largest contributor of all CCP types produced with 2003 fly ash production estimated at 70.2 million tons. As has been the case in prior years, the predominant use of fly ash in 2003 was as a substitute for Portland cement in concrete products where an estimated 12.3 million tons were used. The total fly ash usage for 2003 is estimated at 27.1 million tons compared to 26.5 million tons reported in 2002, an increase of about 2.3 percent. This increase is consistent with the continued high demand for Portland cement in concrete construction and a cement shortage in some areas of the U.S. In economic terms, continued high demand and prices for Portland cement can cause an upward shift in the fly ash demand due to typically lower prices for fly ash.

Bottom ash production also decreased in 2003 from 2002 with production estimated at 18.1 million tons versus 19.8 million tons in 2002. Bottom-ash utilization increased in 2003 to an estimated 8.2 million tons used versus 7.6 million tons reported in 2002, or an increase of about 7.9 percent. Bottom-ash uses in structural fills, embankments and mining applications were significant contributors to this overall increase. In all, about 45.6 percent of the bottom ash produced in 2003 was used.

Production of gypsum from flue gas desulphurization (FGD) systems increased slightly in 2003 to an estimated 11.9 million tons versus 11.4 million tons reported in 2002. Year-to-year FGD gypsum production is tied to the sulfur content in the coal burned and the resulting SO2 emissions that are "scrubbed" during this air emission control process. The predominant use of FGD gypsum in 2003 continued to be in the manufacturing of wallboard. The 2003 FGD utilization rate is estimated at 69.7 percent with an overall use of 8.3 million tons.

Survey data is compared to other data available reflecting CCP production. The Department of Energy's EIA (Energy Information Agency) database is used to compare data reported to DOE and the voluntary data provided to ACAA. Extrapolations are made to populate missing data to assure that ACAA's information correctly indicates trends and utilization rates.

Next year's survey will revert to a simplified reporting format and will be used by the Environmental Protection Agency to assess the overall success of the Coal Combustion Products Partnership (C²P²). Although the utilization trend continues to increase, both ACAA and the EPA hope to encourage more widespread voluntary reporting in the future, as the industry strives to reach a goal of 50 percent utilization by the year 2010.

The survey is available on ACAA's Web site at www.acaa-usa.org by clicking "CCP Survey" on the homepage list of menu options.

	INTERNATION	Prod	luction and	Use Survey			
Fly Ash	Bottom Ash	FGD Gypsum	FGD Material Wet Scrubbers	Boiler Slag*	FGD Material Dry Scrubbers*	FGD Other*	FBC Ash*
70,150,000	18,100,000	11,900,000	17,350,000	1,836,235	1,444,273	167,345	796,718
							121,744,571
27,136,524	8,247,273	8,299,060	484,412	1,756,004	197,509	0	263,623
							46,384,405
Fly Ash	Bottom Ash	FGD Gypsum	FGD Material Wet Scrubbers	Boiler Slag	FGD Material Dry Scrubbers	FGD Other	FBC Ash
12,265,169	298,181	65,593	0	15,907	34,284	0	
3,024,930	493,765 20,327	420,043	0 0	15,766 0	2,469	0 0	
5,496,948	2,443,206	0	224,100	11,074	12,141	0	0
493,487	1,138,101	0	0	29,800	0	0	0
515,552	67,998	0	704	0	114	0	188,708
52,608	0	0	0	31,402	0	0	0
1,928	683,556	0	0	102,700	0	0	0
0	42,604	0	0	1,455,140	0	0	0
683,925	1,184,927	0	259,608	59,800	130,723	0	11,049
0	0	7,780,906	0	0	0	0	0
3,919,898	30,508	0	0	0	0	0	49,217
12,140	3,534	32,518	0	0	2,295	0	0
137,171	512,769	0	0	31,600	6,299	0	0
396,150	1,327,797	0	0	2,815	0	0	14,649
27,136,524	8,247,273	8,299,060	484,412	1,756,004	197,509	0	263,623
38.68%	45.57%	69.74%	2.79%	95.63%	13.68%	0.00%	33.09%
							38.10%
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PUTTING GREEN CONSTRUCTION USING COAL COMBUSTION PRODUCTS (CCP)

INTRODUCTION

Dependable recreational use of a turfgrass site requires a welldrained root mix. Common mineral soils possess limited macroporosity and do not support heavy traffic and use. For these reasons, sand has become the medium of choice for constructing golf course putting greens. However, there are disadvantages in using sand for green construction. Foremost, sand is chemically inert and lacks internal porosity. Second, sand is dense and expensive to ship long distances. Lastly, all but the finesttextured sands lack water holding capacity and necessitate frequent irrigation to maintain turfgrass vigor.

Researchers have amended sand with coal combustion products (CCP) in attempts to overcome these soil physical and chemical limitations. Recent CCP amendment has increased capillary porosity in sandy soils and total porosity in fine-textured soils. Fly ash amendment of an acidic, excessively drained sand at rates of 128, 254, and 384 tons/acre raised the water-holding capacity, but lowered infiltration rates. Similarly, sizable increases in capillary porosity and exchange capacity of FA-amended fine and coarse sands have been reported, but often at the expense of air-filled porosity and drainage.

Golf course builders and superintendents have inherent interest in substitutes possessing equivalent stability and size of quartz sand, but improved physicochemical properties. Bottom ash (BA), a relatively inert and stable aggregate, is commonly produced in the sand-sized fraction (0.05–2 mm). Fly ash (FA) is a finer CCP (<0.05 mm) with a more highly-variable chemical makeup. Both BA and FA possess lesser bulk densities than sand (values ranging from 0.7–1.2 tons/m³), and when used as a supplemental root mix aggregate could minimize construction and transport costs.

Thus, considering the positive reports of CCP amendment of sands, and the potential reduction in cost associated with use of ubiquitous and inexpensive CCP, a simple investigation of



Maxim J. Schlossberg, Ph.D. Assistant Professor, Turfgrass Nutrition and Soil Fertility, Center for Turfgrass Science, Penn State University, University Park, PA.

bottom and fly ash as sand-substitutes in golf course putting greens was initiated. The objectives of this study were to determine physical stability and overall 'soil quality' of CCP-amended root mixes receiving compaction forces and culture typical of golf course putting green use.

MATERIAL AND METHODS

Bottom ash (BA) and FA were provided by Georgia Power Inc. Quartz sand and sphagnum peat moss were acquired at local commercial outlets. Four experimental root mixes were formulated: a control rooting mix (CON), containing eight parts quartz sand (coarse, medium, and fine sands in proportions commonly used in putting green construction: Table 1) to 2 parts peat moss (v/v); and three CCP 'experimental mixes'. One root mix contained BA as a substitute for sand and FA for silt/very fine sand (BAFA); another root mix contained BA as a substitute for half of the sand aggregate (v/v) and FA as a substitute for all silt/very fine sand (BASFA). The third root mix treatment contained the control quartz sand with FA as a substitute for the silt/very fine sand sized particles (SFA).

Once homogenized, root mixes were constructed in 42-cm. long sections of schedule 40, polyvinyl-chloride (PVC) pipe, and established with creeping bentgrass (the fine textured lawn grass featured on Wimbledon Centre Court, among others). Putting green columns were maintained in a greenhouse

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(Athens, GA), and half were regularly compacted by dropping a 2.7-lb. cylindrical stainless steel weight onto each cylinder turfgrass surface.

RESULTS AND TECHNICAL CONSIDERATIONS

In 18 months of observation, general measures of turfgrass health indicated no limitations of CCP as described root mix substitutes. All simulated greens demonstrated rapid growth, recuperation from compaction damage, and drought resistance. These attributes are expected from root mixes that follow established general construction guidelines, engineered to foster root growth and drain rapidly.

More discriminative analysis of the CCP mixes revealed some adverse traits and alterations over time, but it must be noted that the conditions and scale of this greenhouse research were hardly representative of a true green construction. Compaction significantly lowered percolation rates of all putting greens compared with those not compacted. However, the root mix containing sand and 10 percent FA (SFA), demonstrated still lower percolation rates than the other mixes and failed to meet accepted thresholds. Due to the spherical shape and small size of FA, dispersion and translocation (causing pore blockage) may limit application of FA in green construction. However, columns containing BA replacement for all sand or half the sand (BAFA and BASFA, respectively), demonstrated acceptable percolation rates over the 18-month study, even when containing 10 percent FA (v/v). Compaction-induced degradation of coarse textured BA was observed at the surface of the putting greens after cumulative compaction events, but this did not significantly affect percolation in mixes having 100 percent substitution of sand by BA (BAFA).

It is important to note that the BA used in this study was a product not benefited by modern sorting/screening technology. Granted, the BA was screened to particle-size classifications shown in Table 1, prior to mix formulation. However, the BA particles used in this study possessed various: mineralogy, degree of crystallization, and inclusions of weakly aggregated FA. A field study, utilizing more recalcitrant BA components and monitored over a greater time period, would likely demonstrate more practical results.

Further differences observed among the control and CCP-root mixes were metal concentrations released into leachate (drainage water). Fortunately, any putting green construction having a root mix today (regardless of CCP use) will possess internal tiles to recover putting green drainage and rout it to a drain field, wetland, or irrigation impoundment. This minimizes potential of ground water degradation, and may even recycle valuable nutrients. Our study implemented unweathered FA with a few trace element concentrations exceeding national FA averages. Statistical analysis showed the FA used to be the major source of trace element efflux, more so than the BA component.



Recent research has shown stockpiled (weathered) CCP to have the most potential for beneficial use.

ECONOMIC CONSIDERATIONS

Successful putting green root mixes that demonstrate functional longevity (>15 years) are nearly always formulated off-site, delivered by truck, and released directly on site. An average 18-hole construction (or renovation) will require three to four acres of putting green surface, equating to approximately 6,500 cubic yards (5,400 m³) of well-compacted root mix. When using sand as the primary aggregate under current convention, this requirement equates to ~10,000 tons of root mix. Because of the high bulk density of sand-based mixes (one to two tons per cubic yard, depending on water content), transport vehicles are often weight-limited rather than volume-limited. Root mixes comprised of BA can possess bulk densities 30 percent to 50 percent less than sand mixes and may reduce transport costs comparatively.

Potential demand for putting green construction materials is difficult to estimate. The National Golf Institute (NGF) tabulated 250 golf course openings (18-hole equivalents) in 2003. A lower 2004 number is expected. However, renovation of established courses boosts potential demand by 200 to 300 percent. This total potential demand represents a significant portion of current annual BA production and handling, but cannot be realized until actual demand for CCP in putting green construction exists.



CONCLUSIONS

The simple connotation 'turfgrass' implies use. Uninterrupted enjoyment of quality turfgrass cover, preventing the need for disruptive renovation procedures, requires a root mix that is compaction-resistant, and continually well-drained with ample air-filled porosity. This attempt to utilize CCP BA and FA as substitute aggregates in golf course putting green construction was novel, but hardly original. Coal cinders have historically been utilized in the construction of golf course putting greens, as well as drainage layers in bunker construction. Bulk density of our BA-amended root mixes was 20 percent to 45 percent less that observed of an 'industry-standard' control mix.

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Over the limited conditions imposed in this study, FA utilization in putting green root mixes at rates investigated in this study showed mixed results. Amendment (of this particular sand) solely with fly ash (SFA) resulted in a slow-draining root mix. More careful selection of both FA and sand can ensure compatibility and minimize the likelihood of pore-clogging. Our results tend to indicate a greater future application of BA to root mix construction than FA, but further research may prove otherwise. Our results did show synergistic attributes of FA and BA combination in putting green root mix formulation. These root mixes maintained rapid infiltration and hydraulic conductivity throughout the 18-month experimental period. Though bottom ash demonstrated minor instability under subjection to compactive forces, it is important to note this BA product was not screened to optimize resiliency. Considering the expected functional period of golf course putting greens exceeds 15 years, our results prompt further investigation of CCP for golf course putting green root mix inclusion.

ACKNOWLEDGEMENTS

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Max Schlossberg is with the Center for Turfgrass Science at Penn State University in University Park, PA. He can be reached at mjs38@psu.edu.

		Sand-sized	Components		_	Coal Combustion Products
	1-2 mm	0.5-1 mm	0.25-0.5 mm	<0.25 mm	Fly Ash	Fly Ash and/or Bottom Ash
			——————————————————————————————————————	volume —		
Mix Type						
CON	7 S†	42 S	21 S	10 S	0	0
BAFA	7 BA	42 BA	21 BA	0	10	80
BASFA	3.5 S + 3.5 BA	21 S + 21 BA	10.5 S + 10.5 BA	0	10	45
SFA	7 S	42 S	21 S	0	10	10
	1-2 mm	0.5-1 mm	0.25-0.5 mm	<0.25 mm		Bulk density (BD)
Mix Type					tons m ⁻³	
CON	15.3 ± 0.4	39.6 ± 2.2	32.1 ± 1.3	23.1 ± 2.0		1.35 ± 0.0
BAFA	4.0 ± 0.2	33.1 ± 0.1	24.3 ± 0.2	38.5 ± 0.6		0.74 ± 0.0
BASFA	5.7 ± 0.2	37.7 ± 0.7	30.8 ± 0.7	25.8 ± 0.8		1.03 ± 0.0
SFA	5.7 ± 0.1	41.9 ± 0.9	34.5 ± 0.5	17.9 ± 1.1		1.34 ± 0.0
Fly Ash	0	0	1.0 ± 0.1	99.0 ± 0.9		1.20 ± 0.1
USGA*	<10%	>	60%	<30%		

Table 1: Formulated Volume Proportions and Particle Size Distributions of Experimental Putting Green Root Mixes.

[†] S, sand; BA, bottom ash; FA, fly ash.

 $\P \mu \pm SE$; means followed by sample standard error (SE).

* Approximate United States Golf Association (USGA) recommended distribution (1993).

REGULATORY UPDATE

Government Agencies Play Important Role In Increasing Coal Combustion Product Utilization

By John N. Ward, Headwaters Resource

Generators and marketers of coal combustion products have many important allies in the effort to increase CCP utilization. Academicians, technology developers and innovative users all play a role in finding new and better ways to use CCPs. But one ally stands out as unique: the Government.

Government agencies at the state and federal levels touch CPP utilization in a variety of ways – as regulators, standards setters, specifiers, and even as users of the material. The influence of these agencies can be profound as shapers of markets.

In fact, the U.S. federal government was one of the earliest adopters of modern fly ash utilization. Beginning in the 1940s and '50s, the U.S. Bureau of Reclamation began using coal fly ash in the construction of dams to moderate the heat of cement hydration and thereby control cracking. Over the years, other federal agencies have followed suit in supporting the use of ash in concrete. The U.S. Army Corps of Engineers has conducted extensive research and developed numerous designs of concrete mixes that utilize fly ash. The Federal Highway Administration has extensively supported ash utilization in concrete for road construction – which currently constitutes one of the largest markets for fly ash sales. (For instance, "Fly Ash Facts for Highway Engineers" – a joint publication of FHWA and the American Coal Ash Association – is a perennial best seller.)

The U.S. Department of Energy, in its role with the nation's fossil fuel infrastructure, also provides substantial support to the CCP industry. And, the most recent high profile government agency to increase promotional support for CCP utilization is the Environmental Protection Agency.

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Dedicated to the promotion of coal combustion by-products (CCBs) within the western United States in applications that are technically proven, environmentally and socially beneficial and commercially viable.

Since 1984, EPA has issued Comprehensive Procurement Guidelines advocating the beneficial use of coal combustion products. But recently, the Agency ratcheted up its efforts through the creation of the Coal Combustion Products Partnership (C2P2). Part of EPA's Resource Conservation Challenge, C2P2 features a challenge program, numerous barrier breaking activities, publications and workshops.

Support from federal agencies can have a significant trickledown effect as state agencies and even private industry looks for guidance. The trickle-down effect becomes even more pronounced at the state level.

State departments of transportation are often key players in CCP utilization. As the managers of most highway construction, these departments determine concrete specifications that are often adopted by counties and municipalities. And because large volumes of concrete are produced according to these state-accepted specifications, many private sector concrete projects often adopt similar approaches.

The result is something of a patchwork of regulation. While all states allow the use of fly ash in concrete, there are differences in the amounts allowed and different limits on various chemical and mechanical performance characteristics of the ash.

Over the past several years, most state departments of transportation have been loosening their specifications, allowing greater amounts and wider varieties of ash to be used. CCP industry representatives work closely individual state departments – as well as through standards setting organizations such as the American Concrete Institute and ASTM (American Society for Testing and Materials) – to promote the effective use higher volumes of CCP materials. It is likely that this effort will continue on a state-by-state basis in order to ensure that specifications conform to the performance capabilities of the coal ash that is locally available.

Government agencies also continue to fulfill their regulatory missions, of course. The most prominent effort currently under way is a study by the National Research Council that is examining the health, safety and environmental risks of using coal combustion products in mine placement and mine reclamation. A panel of independent experts began meeting in late October to conduct the study. The panel's report – to be published in several months or more – is expected to guide on-going decision-making within the Environmental Protection Agency regarding potential regulation of this particular use for CCPs. \Box

John N. Ward is vice president of marketing and government affairs for Headwaters Resources and serves as co-chairman of the American Coal Ash Association's Government Relations Committee. Headwaters Resources is one of America's largest manager and marketer of coal combustion products, serving more than 100 coal-fueled power plants nation wide. He can be reached at (801) 984-9441.

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Thanks to our renewing members for your support and participation during 2004. We look forward to 2005 and greet new members joining the ACAA team in support of its efforts to promote and increase CCP utilization. Welcome!

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further details and website address to be announced Spring 2005

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Unburned Carbon Invited to Join World of Coal Ash

The U.S. Department of Energy's annual Conference on Unburned Carbon on Utility Fly Ash, which is in its tenth year, has been invited to join the World of Coal Ash Conference in Lexington. Its addition to the WOCA conference, along with the American Coal Ash Association, the University of Kentucky Center for Applied Energy Research, and the U.S. Department of Energy's Office of Surface Mining, the Unburned Carbon Conference would complete a comprehensive analysis of coal ash. Pending final DOE approval, the Conference is expected to be held

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on Wednesday, April 13, 2004 in the Kentucky Ballroom of the Lexington Convention Center as a separate track in the World of Coal Ash Conference.

Registration for the one-day Unburned Carbon Conference is \$100 before March 1, 2005 and \$125 after that date, and registrants for the UBC conference will be free to attend any World of Coal Ash Conference presentations for that day. Registration for the full World of Coal Ash Conference, including the UBC conference, is \$425 before March 1, 2005 and \$585 after that date.

For further information on the status of the Unburned Carbon Conference, please contact Gretchen Tremoulet (859-257-0355; gtremoulet@caer.uky.edu).

What is the Unburned Carbon Conference?

The Conference on Unburned Carbon on Utility Fly Ash has become an annual forum for discussing combustion modification as a means to reduce NOx emissions and the consequent increase in carbon content of fly ash. This conference, considered by many to be the premier event in this field, has served for the past nine years to keep attendees abreast of the regulatory, technical, and economic issues surrounding high-LOI fly ash.

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