The foundation of performance

The transition from prescribed-based cement specifications to performance-based ones is spurring SonoAsh to process off-spec fly ash waste into a raw input material. The goal is to provide a superior, uniform particle size, low-carbon, engineered fly ash product that will uniquely fill the raw materials component of this emerging industry trend.

■ *by **Ian MacKenzie**, SonoAsh LLC, Canada*

The world has an insatiable appetite for cement. There is no better alternative to create our modern built environment than cement and, in turn, concrete. However, how we think and how we create this critical building material will require some new ideas. Striking a balance between building livable and durable cities with the increasingly desired goal of limiting our global CO_2 emissions is a key industry challenge for the coming decades.

As the global population rises and urbanisation grows, global cement production is set to increase by 12-23 per cent by 2050. This fact comes with a high environmental cost. More cement means more emissions. The International Energy Agency's 'Low Carbon Transition in the Cement Industry' report highlights the nexus between mitigating the carbon output and simultaneously creating better, stronger products for the built environment.

The need for performance-based project specifications

The following two recommendations point to a need to increase performance-based project specifications targeting a project outcome as opposed to prescriptive-based formula.

- *Optimising the use of concrete in construction*

  The efficient specification and use of concrete with a lean design can help cut wastage by aligning the lowest carbon option with the optimal technical performance required for the specific application.

- *Maximising design life of buildings and infrastructure*

  The durability of concrete provides opportunities for a long design life.

Performance-based specifications become even more important when the projected structure will be subject to environments of severe environmental aggressiveness, as well as in the case of large constructions whose nature presents large social, financial, or environmental impacts.

SonoAsh explains how changing raw material inputs can impact future construction and how its technology can be the answer to reducing environmental liabilities

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According to the Cement Association of Canada, performance-based specifications, which represent an alternative to current prescriptive specifications, provide details of required results such as strength and other mechanical properties, along with requirements for durability and serviceability. The results are verifiable through measurement or testing to assure the product meets the desired requirements. These performance specifications offer more pathways for innovation and new solutions for materials, mixture proportions that can be supported by data for consistency, and ultimately enables greater cost management.

Beginning the journey

So how do we begin the journey for our new performance-based specification future? We go back to the beginning and ask a different question. What if previously overlooked raw material inputs could be used in the cement making process to better reflect our new, sustainable, performance-based future?

Rewriting the guidelines

ASTM C618 is the governing standard for "coal fly ash and raw or calcined natural pozzolan" use in North American concrete. Its prescriptive and performance-based metrics are meant to ensure suitable fly ash quality for fly ash suppliers and concrete manufacturers. Certain chemical and physical requirements classify fly ashes as Class F (pozzolanic fly ash) and Class C (pozzolanic or latent cementitious fly ash), as well as considering Class N (natural pozzolans).

ASTM guidelines are currently being rewritten to consider the "off-spec" or alternative ashes. These new guidelines will help inform decisions on ashes that would otherwise be excluded because of their source but meet physical, chemical, and strength requirements in ASTM C618 and could be used successfully in concrete.

This is an important development as the

decline in coal power generation in most geographies, except for China and India, is putting pressure on the supply of traditional, compliant fly ash sources necessitating the need to explore ways to fill the supply gap and not compromise safety or durability.

Taking the guess work out of the off-spec equation

It is under these parameters that SonoAsh is anticipating making an impact by engineering off-spec ash into a raw cement input material backed up by data and providing confidence to the market of the physical, chemical and carbon content. In short, taking the guess work out of the off-spec equation. SonoAsh's goal is to provide a superior, uniform particle size, low-carbon, engineered fly ash product that will uniquely fill the raw materials component of this emerging industry trend.

Using the patented sono-chemical process and using waste off-spec fly ash as feedstock, the SonoAsh technology processes impounded fly ash to produce an engineered cementitious material with a significantly reduced CO_2 footprint. The SonoAsh Sonicator reactor can process a broad range of coal ash samples. This engineered coal ash meets ASTM C-618 (AASHTO M295 and European EN-450) requirements for high-value ordinary Portland cement (OPC) displacement. The process creates an engineered <1 per cent loss on ignition (LOI) product from variable coal ash sources with more than 15 per cent LOI and definable particle size and shape specifications, typically 25-100µm.

Table 1 shows SonoAsh data that resulted from extensive testing at a global cement company laboratory, illustrating the reduction in LOI and carbon content. In the years since this testing took place, the market has continued to trend towards the importance of low carbon, uniform particle size, engineered ash product. This cement replacement product is uniquely suited to fill the emerging need for a performance-based construction project, as it forms the very foundation of what is required for maximum strength, durability and sustainability.

The Sonoash Sonicator reactor can process a broad range of coal ash samples

Conclusion

The coming decades will see exponential growth as we work towards a safe, durable, and sustainable built environment. SonoAsh is working to develop a business focused on processing off-spec fly ash waste into high-value engineered product. The construction landscape is facing numerous challenges in the coming decades and will require a level of innovation to meet emerging industry objectives.

We will need to find the optimal starting points to begin to build the necessary infrastructure to protect people and our planet. As we have seen over the course of the past few years, we can expect extreme weather events will become a more frequent occurrence. We will need a built environment that can handle Mother Nature in all its forms. However, in doing so, keeping an eye to the future about how we can be better stewards of our planet.

By removing legacy off-spec ash from its landfills and impoundments, we can accomplish concurrent goals and industry objectives. Firstly, by removing the off-spec ash from impoundments, we mitigate the hazards of these environmental liabilities. Secondly, by using that off-spec ash as a feedstock, we can engineer it into a superior, uniform particle size, low-carbon product. Thirdly, that engineered low-carbon product when used as a cement replacement can help mitigate industry emissions on the raw material input side of the cement making process. Fourthly, that engineered, low carbon product can be used as the raw material foundation for the performance-based specification future that is required to protect our cities and our population from the worst of climate change. ■

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Table 1: SonoAsh data illustrating the reduction in LOI and carbon content

	LOI (mass %)	Rention on a 45µm seive (mass %)	SAI* 28-days (% of control)	Water requirement (% of control)	Overall process yield (mass %)
Unprocessed fly ash	4	57	–	_	100
SonoAsh product	0.8	29.3	93	98.7	72
ASTM C618	6 (max)	34 (max)	75 (min)	105 (max)	–

**SAI = Strength Activity Index of mortar cube tests, 20% replacement of OPC*