Is Fly Ash Going Away?

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Fly ash has become a fundamental ingredient in concrete mixtures. It lowers the cost, improves the durability, and improves the sustainability of concrete. The supply of fly ash is decreasing as society becomes less dependent on coal-fired power plants. This has created shortages of fly ash and many people have started to wonder, "Is fly ash going away?"

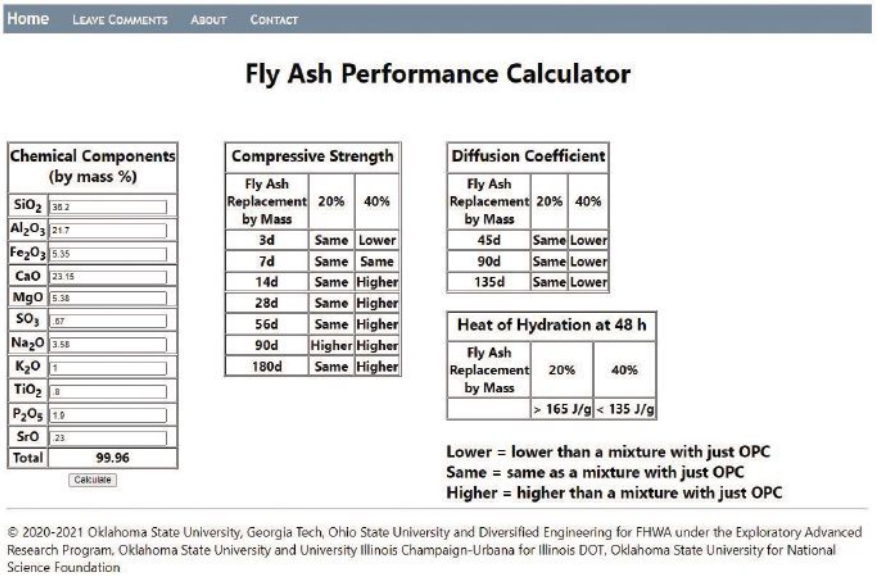
While the supply of traditional fly ash captured from the flue gas of coal-burning power plants is becoming more limited, there is more than a 170-year supply of usable fly ash that has been buried or is in holding ponds, according to the American Coal Ash Association.[1] This reclaimable fly ash has not previously been used due to low demand or because it is slightly out of specification. Although it may not meet the current ASTM C618 *Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*,[2] this material is now being mined, refined, and used in ready-mixed concrete in North Carolina, South Carolina, Texas, and Pennsylvania.

Users are finding that this material has properties that are similar to, and in some cases more consistent than, those of traditional fly ash. Because this material is refined, the producer can control the quality of the fly ash. The companies that sell it use a wide range of proprietary methods to refine the ash. It is not clear whether these refining methods will work on any fly ash source, but satisfactory results are reported for existing sources.

The Federal Highway Administration (FHWA) is sponsoring research project FHWA-PROJ-19-0017, Performance-Based Classification Methods for Reclaimed Fly Ash, to help with the adoption of reclaimed fly ash. Laboratory testing at Oklahoma State University, Georgia Tech, and Ohio State University on 14 different sources of primarily reclaimed Class F fly ash shows that there is little change in the slump or strength gain of concrete with reclaimed fly ash for the first 28 days; however, there is some loss of strength (approximately 10%) at 56 days and 90 days for certain reclaimed fly ash sources. This suggests that, in some cases, concrete with reclaimed fly ash does not achieve the same increase in long-term strength as mixtures with conventional fly ash, but other properties do not seem to be adversely affected. Further work is underway to investigate chloride diffusion and the ability of reclaimed fly ash to suppress the alkali-silica reaction of the concrete, and findings for both seem promising.

One product of the FHWA-sponsored research is a fly ash strength and

Figure 1. A screenshot of the Fly Ash Performance Calculator. When the user inputs the chemical composition of the fly ash, the performance of concrete using the fly ash is predicted relative to a mixture that only contains ordinary portland cement (OPC). Relative performance is indicated for the compressive strength and diffusion coefficient for several ages and two levels of fly ash replacement. An estimate of the heat of hydration is also provided. Figure: Tyler Ley.



Dr. Ley, often with help from his students, has produced many interesting and entertaining YouTube videos on a wide range of topics related to concrete materials and design of concrete structures. In 2019, he posted a YouTube video with the same title as this article (https://www.youtube.com/watch?v=hwtsEUSJ9I0). In the video, he describes fly ash and then discusses fly ash alternatives and the potential for using reclaimed fly ash to continue to improve the durability, constructability, and sustainability of concrete mixtures. For additional information, visit www.tylerley.com/flyashvideos.

permeability calculator, which was developed with machine learning algorithms. This calculator—which is available for free at www.tylerley.com/flyash—uses the oxide content of fly ash from a mill sheet to predict whether a concrete mixture with fly ash will provide performance that is higher than, lower than, or the same as the performance of a concrete mixture that only contains portland cement. This prediction is made for both 20% and 40% fly ash replacement in concrete with ages up to 180 days. **Figure 1** shows a typical data entry screen. The calculator is an outstanding tool that could allow producers or departments of transportation to evaluate a new source of fly ash with a distinctive chemical composition and predict how the concrete will perform. For example, if there were a fly ash shortage on a project, the calculator could be used to help choose a replacement fly ash that maintains the required concrete performance.

This resource also provides much deeper insights than the traditional Class C and F fly ash classifications. The algorithm's accuracy was just over 90% for 35 different fly ashes investigated, and the tool is being extended to use nontraditional fly ash sources.

Several companies are currently investigating the viability of nontraditional fly ash sources. Some of these sources include blended fly ash, ground bottom ash, and natural pozzolans. Blended fly ash combines at least two fly ash sources. Typically, one of the fly ash materials in the blend does not meet the ASTM C618 specification, but the combined material does. Ground bottom ash is a coal-combustion product that is too heavy to be carried up the flue. When this type of ash is ground to a size similar to that of fly ash, the concrete performs well. Natural pozzolans are natural minerals, such as clay and volcanic ash, that are mined, ground, and sometimes heated. These materials have a long history of being used in concrete but have not been used frequently because of cost. All of these materials are being used to make up for the shortfall of fly ash.

With all of these efforts, it is clear that fly ash will not go away, but it will change. New sources of reclaimed or nontraditional fly ash are being brought to the market and will provide new opportunities to improve the durability, sustainability, and cost of concrete.

References

1. American Coal Ash Association. https://acaa-usa.org. Accessed July 17, 2021.
2. ASTM International Subcommittee C09.24. 2019. *Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*. ASTM C618. West Conshohocken, PA: ASTM International. https://doi.org/10.1520/C0618-19.

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