

5C3. Effective Use of Ash in Civil Engineering/Construction and Other Applications

Technology overview

1. Technology overview

Outside of its application in concrete, coal ash is widely used in the civil engineering sector for road construction, foundation improvements, back-filling, or for use in other earthwork and in the construction sector as an artificial light-weight aggregate. On the other hand, in the agriculture/forestry/fisheries sector, it is used as a fertilizer or soil conditioner.

To cope with the anticipated increase in the generation of coal

ash in the future due to such factors as the construction of new coal-fired power plants, utilization technologies are now under active development out of the necessity to expand the utilization of coal ash in the above-mentioned sectors. In order to accomplish this, several challenges, including the diffusion of technology, the exploitation of demand, and the improvement of the distribution mechanism, must be addressed.

2. Utilization for civil engineering

1. Road construction material

The "Outline of Asphalt Pavement"¹ allows fly ash to be used as an asphalt filler material, and clinker ash as a lower subbase material, frost heave depressant, and barrier material.

Fly ash can be used for the upper/lower subbase and subgrade. A cement stabilization treatment construction method adds fly ash to cement to be treated under moderate moisture content for application. This construction method strengthens quickly and is stable over the long-term. Another technology^{2,3,4,5} has also been developed to process coal ash for use as a road construction material.

2. Earthwork material

Fly ash can be effectively used for an embankment or reinforcement material since it is lighter than common earthwork materials. In recent years, therefore, various technology development efforts^{6,7,8} have been made, resulting in a number of applications. Among these is an application using fly ash in its original powder state with cement added as a solidifier to coal ash, as well as fly ash's utilization as a stabilizing material. It is also granulated or processed in other ways for different applications. Review is also underway for the intended commercialization of fly ash as a soil stabilizer or a construction sludge conditioner due to its pozzolanic activation as well as its self-hardening⁹ property.

Meanwhile, basic research of the elution¹⁰ of coal ash's trace elements is continuing since fly ash's use in earthwork must be in harmony with the environment.

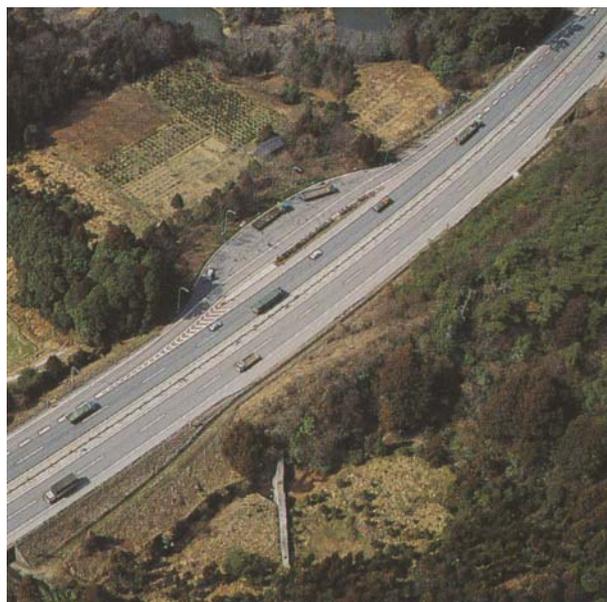


Photo 1 Application for road construction

3. Utilization in the construction sector

1. Artificial light-weight aggregate

Development efforts^{11,12} have successfully produced technology to pelletize/calcine coal ash and cement or the like into artificial light-weight aggregate. Demand, driven by urban development and high-rises, is expected to grow, making it important to further the technological development of artificial light-weight aggregate as well as to reduce production costs.

2. Others

The resemblance of coal ash's elements to the chemical composition of existing construction materials also allows it to be used as a clay-alternative raw material for ceramic products, such as clay roofing, bricks, and tiles, or as a cement mixture for boards (interior/exterior wall material for construction).

4. Utilization in the agricultural/forestry/fisheries sector

1. Fertilizer

Fly ash, from pulverized coal-combustion ash, was designated as a special fertilizer in 1960, as was clinker ash in 1992. Several thousands of tons a year of potassium silicate fertilizer, containing hard-to-dissolve silicic acid contained in coal ash, is also produced.

2. Soil conditioner

Clinker ash, whose chief components, SiO₂ and Al₂O₃, are almost the same as those of ordinary soil, is suitable for the growth of vegetables. Moreover, it is used to grow sod for golf courses or to improve the soil of poor-drainage areas or arable land since its countless spores retain water well, enabling fertilizers to be effective for a longer duration and, at the same time, its similarity in shape to sand provides comparable water permeability.

3. Utilization in the fisheries sector

There are long-established cases where coal ash has been used for fish breeding reefs and seaweed beds. A recent effort aims to use coal ash as a mounding material for a man-made undersea mountain range to cause artificial upwelling currents.¹³

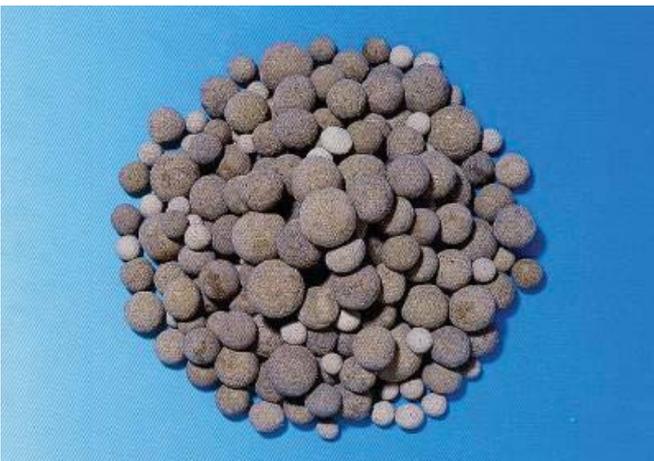


Photo 2 Artificial aggregate fabricated from coal ash (Toughlite)

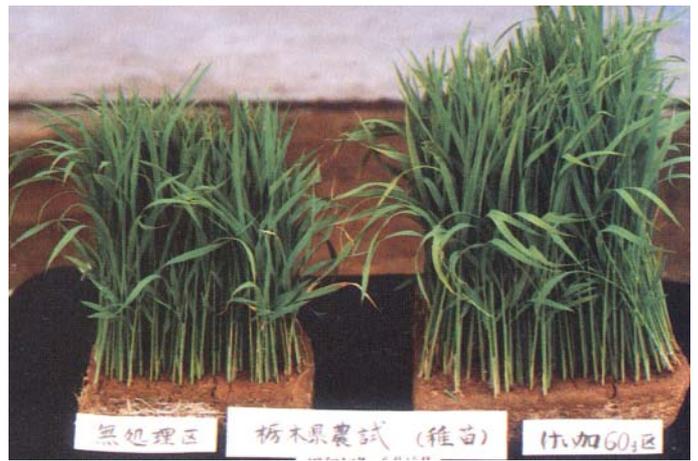


Photo 3 Application as fertilizer

References

- 1) The Japan Road Association: Outline of Asphalt Pavement, 1992.
- 2) Environmental Technology Association/The Japan Fly Ash Association: Coal Ash Handbook 2000 Edition, 2000.
- 3) Public Works Research Institute: Public Works-Related Material Technology/Technical Review Certification Report "Ash-Roban," 1997.
- 4) Public Works Research Institute: Public Works-Related Material Technology/Technical Review Certification Report "Pozzotech," 1997.
- 5) Ohwada et al., 11th Annual Conference on Clean Coal Technology lecture collection, 2001.
- 6) Shintani et al., CCUJ, Civil Engineering 54th Annual Academic Lecture Meeting, collection of summaries, 1999.
- 7) Public Works Research Center: Public Works-Related Material Technology/Technical Review Certification Report "Hard Soil-Break Material," 2000.
- 8) Akira Onaka: The Clean Japan Center's 11th Resources Recycle Technology Research Presentation Meeting, collection of lecture papers, 2003.
- 9) Ozasa et al., CCUJ, 11th Annual Conference on Clean Coal Technology lecture collection, 2001.
- 10) The Japanese Geotechnical Society: Research Committee Report on Utilization of Wastes as Foundations Material, 2000.
- 11) Ishii et al., The "Bulletin of the Chemical Society of Japan," 5, 431, 1992.
- 12) Ozasa et al., CCUJ, 10th Annual Conference on Clean Coal Technology lecture collection, 2000.
- 13) Tatsuo Suzuki, 14th ACAA International Symposium lecture collection, 2001.