# FLY ASH

## WHAT IS FLY ASH?

Fly ash (FA) is a by-product of combusting coal in power plants. When pulverised coal is combusted in the furnace, ash with different particle sizes is generated. The lightweight ash that is collected by electrostatic precipitators is called FA and constitutes about 90% of the total generated ash. FA can be generated through other sources such as waste-to-energy (WtE) incineration facilities (at about 10–30% of total generated ash), although on a much smaller scale currently. FA is usually grey in colour and has spherical particles. The type of coal and mode of operation does impact the particle size distribution of fly ash and to meet the Australian standard, fly ash must have 75% particles passing the 45 µm.

## WHAT ARE THE BENEFITS OF USING FLY ASH?

The benefits of using fly ash in road and rail infrastructure are as follows:

- **Environmental benefits**
  - Reduced use of natural resources, energy savings and reduced $CO^2$ emissions.
- **Performance benefits when used as a binder for concrete**
  - As a replacement for Portland cement, fly ash offers increased durability, strength and workability.
- **Performance benefits when used as an asphalt filler**
  - As a replacement for natural mineral fillers, fly ash offers higher rut resistance, improved stability and moisture resistance.

## WHERE IS IT USED?

Fly ash can act as a replacement for Portland cement in concrete manufacturing, as a binder or supplementary cementitious material (SCM) for pavement or subgrade stabilisation and as a source of alumina and silica in geopolymeric binders for stabilisation and geopolymer concrete. It can also be used in flowable fill, as an SCM in foamed bitumen stabilisation, and as a filler in asphalt in place of natural mineral fillers.

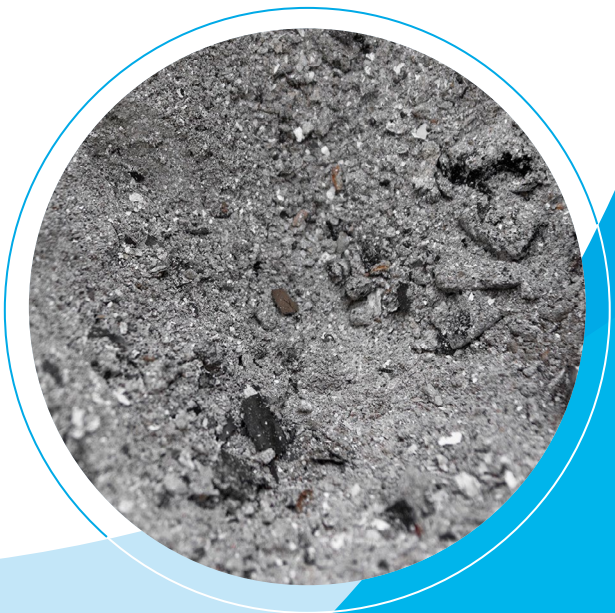
## HOW MUCH CAN BE USED?

Different jurisdictions have various specifications for the use of fly ash, covering its use as an SCM, as cementitious binders for stabilisation, as cementitious material for grout and as a filler in asphalt. The limits vary across applications and some applications do not have specified limits.

In pavement, up to 3% and 5% by mass is allowed for stabilisation of pavement materials and subgrade respectively. Up to 8% by mass of total mix can be used in concrete works, and fly ash may be used as an asphalt filler up to 1.2%.

## WHAT OPPORTUNITIES ARE THERE FOR IMPROVING ADOPTION?

Fly ash is a mature market, with the material being used in concrete manufacture and as a cementitious binder since 1975. However, of the total generated ash in 2018–19 in Australia (12.5 Mt), only 47% was recycled, with several fly ash stockpiles around the country, presenting a need for more widespread use of fly ash. It will be key for jurisdictions to continue optimising the use of fly ash, up to existing specified limits, and explore new options. For example, while only 5% is specified for subgrade stabilisation, ground improvement (stabilisation) projects have explored the use of up to 30%. Jurisdictions with more conservative limits should look to others that have employed higher limits, to increase their capabilities. It should be noted, however, that with a push towards more renewable forms of energy it will be critical to align the use of fly ash with projected volumes in future, should Australia shift its focus from coal power.



# FLY ASH: SOUTHEAST QLD

Foamed bitumen stabilisation (FBS) is a common process for rehabilitating pavement structures and improving the resistance of granular materials' properties to permanent deformation and moisture ingress. It is particularly helpful for making granular pavements more resistant to flooding events.

Queensland Department of Transport and Main Roads have applied the FBS technique considerably on state-controlled arterial roads in Southeast Queensland utilising 50:50 hydrated lime/fly ash blends as the secondary binder. Typically, the granular materials are stabilised to a depth of 250–300 mm, using 3–3.5% foamed bitumen and 1.25–2% secondary binder by total mass of materials. This means between 35 and 70 tonnes of fly ash are being used per kilometre of stabilisation for granular pavements.

There have been several recent drivers to incorporate fly ash within the secondary binder for foamed bitumen stabilisation. One is that certain aggregate sources, such as the metagreywackes in Southeast Queensland, perform better in FBS when fly ash has been incorporated as part of the secondary binder, especially when they have higher silica contents. Another has been the limited availability of hydrated lime in Australia, which created the necessity to look for alternatives. An additional sustainability benefit to using fly ash in the secondary binder blend is the opportunity to use locally sourced materials, cutting transportation costs and emissions considerably.

This is what has led to widespread usage of the 50:50 hydrated lime/fly ash blend as the secondary binder in FBS in Queensland. In the FBS process, granular materials are stabilised by blending them with a secondary cementitious binder and then foamed bitumen – bitumen with its volume expanded many times by passing steam through it – as a primary binder. The materials are blended with a stabiliser. The foamed bitumen binds the materials with tiny spot welds. The stabilised granular materials are then compacted and over time the secondary binder cures to provide strength to the resultant structure.

Traffic Test for Crumb Rubber Asphalt Mixes

LOCATIONS

NATIONAL TRANSPORT RESEARCH
CENTRE AND HEAD OFFICE:
80A TURNER STREET
PORT MELBOURNE, VIC 3207

OFFICES IN:
BRISBANE, SYDNEY, ADELAIDE, PERTH, CANBERRA

This case study is part of the project Best Practice Expert Advice on the Use of Recycled Materials in Road and Rail Infrastructure. This project has been funded by the Australian Government.

# FLY ASH: YEPPEN SOUTH, QLD

A Triple Blend Stabilisation is a subbase and/or subgrade treatment typically carried out on materials of medium plasticity by incorporating lime, cement and fly ash.

**Triple Blend Stabilisation:**

- Increases the California Bearing Ratio (CBR) value.
- Reduces the plasticity index.
- Reduces permeability (reduces moisture sensitivity).
- Reduces shrink-swell characteristics.

Triple Blend Stabilisation enables the foundation improvement of a larger variety of subbase and subgrade materials in Queensland.

Queensland Department of Transport and Main Roads have developed a process based on the following steps to determine the binder ratio that should be used:

Step 1: Particle Size Distribution

Step 2: Plasticity Index (PI)

Step 3: Linear Shrinkage (LS)

Step 4: Confirm Blend Ratio

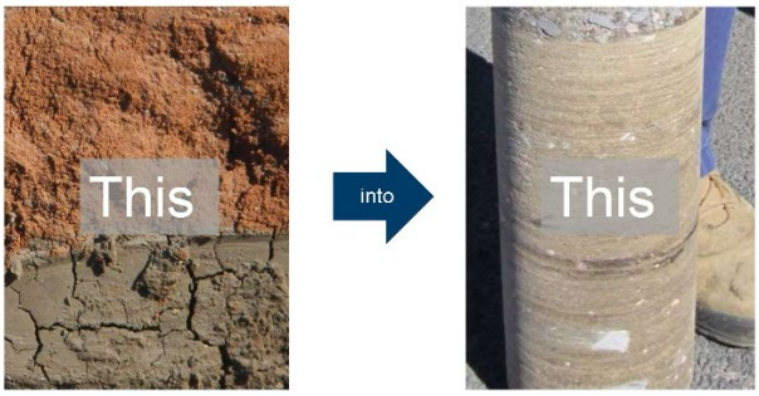
Step 5: UCS and Capillary Rise Tests

Step 6: Working Time Test.

Triple Blend Stabilisations are typically carried out for materials where more than 25% of the material particle size passes the 0.425-mm sieve and the plasticity index (PI) is between 10 and 20.

Linear shrinkage of the materials plays a key role. Where the materials to be stabilised have LS < 6%, the triple blend ratio typically used is 30% lime, 40% cement and 30% fly ash; and where the LS > 6%, the Triple Blend Ratio used is 40% lime, 30% cement and 30% fly ash.

Triple Blend Stabilisation was used during the rehabilitation works on the Bruce Highway at Yeppen South in Queensland. This section of highway had a particularly wet and weak subgrade, which had previously led to block cracks in the cement-treated layer above. A 1.34-km length section was stabilised with a 40% lime, 30% cement and 30% fly ash Triple Blend Binder; 4% binder content by total mass of material was used in the stabilisation, which was to a depth of 350 mm. With a formation width of approximately 10 m, more than 10,000 tonnes of subgrade material was stabilised using approximately 120 tonnes of fly ash.




## LOCATIONS

NATIONAL TRANSPORT RESEARCH
CENTRE AND HEAD OFFICE:
80A TURNER STREET
PORT MELBOURNE, VIC 3207

OFFICES IN:
BRISBANE, SYDNEY, ADELAIDE, PERTH, CANBERRA

This case study is part of the project Best Practice Expert Advice on the Use of Recycled Materials in Road and Rail Infrastructure. This project has been funded by the Australian Government.