

CASE STUDY

East Midlands Airport Taxiway and aircraft parking facilities

Using fly ash / PFA for airport paving

The East Midlands Airport Project required that an area some 15.6 hectares (39 acres) be constructed for the use of various types of aircraft, ranging in size up to and including 747 Jumbo jets. This involved the construction of a large turning apron, incorporating taxiways and some 16 aircraft stands adjacent to the express cargo building, which was constructed under a separate contract. The client for the Project was East Midlands Airport Ltd with Scott Wilson Kirkpatrick & Co. Ltd as their acting consulting engineers.

The contract was awarded to Fitzpatrick Contractors Limited, a company having many years' experience in similar projects worldwide. Burks Green Ltd were engaged as designers for the Project. Construction commenced in October 1998. The paving element of the works started in April 1999 with a completion date of October 1999.

The existing subgrade was mainly a firm clay material and it was decided to lay 22.5mm of dry-lean concrete directly onto this formation.

Following extensive trials, the final mix design for the dry-lean incorporated 30% fly ash as part of the total cementitious content. 20-5mm limestone coarse aggregate, 3mm down limestone dust and medium grade concreting sand were used in conjunction with 91kg/m³ of Portland cement and 30kg/m³ of fly ash to BS EN 450 as supplied from Ratcliffe-on-Soar Power Station near Nottingham. During the mix trials, it was planned

to use a dry-lean concrete (DLC) with a high fly ash content. Compaction of this mix, due to the high fines content contributed by the combined fine aggregate, proved to be problematical and the option was shelved for further investigation at a later date.

The density requirements were 95% of cube refusal density, the strength was in excess of 15MPa at 7 Days. The mix with 30% fly ash easily achieved these parameters.



Laying lean mix concrete



Specialised tipping concrete trucks



Spreading the concrete

vibrating Duo-Tamp on this paver achieved 92-93% of the required compaction. A Bomag 135 tandem roller was used to complete the compaction and close the surface. Curing of the DLC was by conventional bituminous spray.

Placing and compacting the Dry Lean Concrete:

The dry lean concrete was site batched using two mixing plants. The majority of the DLC was produced by an Erie Strayer 9 cubic metre tilting drum mixer, backed up by a 2.5cm Elba ESM 110 plant. The mixed DLC was transported to the point of deposition in Maxon Agitators, each having a capacity of 9 cubic metres. These trucks together with all of the plant used on the project, are part of an extensive fleet of paving plant owned and operated by Fitzpatrick. It was not necessary to use the agitator paddles in the truck bodies with the DLC due to the free flowing nature of the fly ash mix.

The DLC was spread onto the formation using an ABG Titan 423 tracked paver.

Pavement Quality mix design

The Pavement Quality (PQC) mix had to meet stringent flexural strength requirements. The minimum flexural requirement was 4.5 MPa at 28 days. In order to satisfy this requirement a strength of 5.1 MPa at 28 days was required in-situ. Following extensive site mix trials it was concluded that a strength of 6.3 MPa at 28 days in laboratory cured beams would satisfy the desired criteria. The average strength achieved for the contract was 6.9 MPa at 28 days and 8.7 MPa at 56 days. Compressive strength was closely monitored using test cubes throughout the works.



A high quality finish was achieved

Testing was carried out in accordance with the Contract Testing Plan. Cubes for testing at 3, 7, 14, 28, 56 and 91 days were made at regular intervals. Beams for flexural testing at 7, 14, 28 and 56 days were made for every 300m³ produced. The entrained air content required was set at 4.5% \pm 1.5%.

The final mix design, incorporated into the works, was based on total cementitious content of 380kg/m³. 30% BS 3892 Part 1 Pulverised Fuel Ash (PFA) was used in conjunction with Portland cement. Coarse aggregates were single sized limestone 28, 20 and 10mm. Fine aggregate was Zone 2 concreting sand. Water reducing and air entraining admixtures were used.



With PFA a superior quality of finish is possible

Placing and compacting the Pavement Quality concrete

A Gomaco 2800 slipform paver was used to lay the PQC. The concrete was transported from the dedicated site batchers to the point of deposition in the Maxon Agitators. Initial spreading in front of the paver was carried out by a rubber tyred excavator. Compaction was achieved using 24 vibrating pokers mounted on the paver. Following the passage of the conforming plate over the concrete, only minimal finishing by bull float and hand trowel was required. Surface texture and curing membrane were applied by a Wirtgen 850 TCM working directly behind the paver. The completed slab was protected by moveable tentage.

Production achieved throughout the works averaged some 1350m³ per day.



Applying the curing agent

Why specify PFA / fly ash?

Why specify PFA / fly ash in concrete mixes for such applications? There are a number of reasons:

- The extended setting times of PFA in PQ concrete allows the concrete to be properly compacted and finished without problems even in the hottest of weather.
- Excellent surface finishes are possible with no bleeding or segregation of the concrete mix during placing or compacting.
- The reduced temperature rise of PFA concrete reduces thermal movements and the risk of cracking.
- The slower rate of strength gain at early ages assists in the sawing of clean movement joints. These were normally cut about 18 hours after laying. No cracking except at sawn joints has been observed.
- The strength gain characteristics of PFA / fly ash are such that strength gains continue after 28 days resulting in stronger and more durable concrete in the longer term. Durability is paramount for airport applications.
- The risk of alkali silica reaction is minimised as 30% PFA effectively prevents the reaction occurring.
- PFA / fly ash can produce economical concrete.
- There are significant environmental benefits in using a by-product material like PFA / fly ash. The use of 30% PFA in concrete mixes can reduce greenhouse gas emissions by 17% and energy use by 14%.

Some 35,000m³ of dry lean concrete sub-base and 56,000m³ of pavement quality concrete were laid for this contract.

Acknowledgement

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FITZPATRICK

In general usage the term 'fly ash' is used for pulverized coal ash but it can also cover ash from burning other materials. Such 'fly ash' may have significantly differing properties and may not offer the same advantages as ash from burning pulverized coal. UKQAA datasheets only refer to PFA / fly ash produced from the burning of coal in power stations.

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