EMERGENCY REMEDIAL INTERVENTION ON THE SECONDARY RUNWAY AT THE EAST LONDON AIRPORT - NOT HIGH TECH, BUT HIGH RISK.

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The East London Airport, in terms of passenger movements, is the second largest “domestic” airport in South Africa (not counting the three (3) “international” airports) and is the origin and destination of travellers and freight to and from East London and, further the north eastern portion of the Eastern Cape Province.

Due to the fact that the area has four (4) distinct prevailing winds, which can have a gale force velocity at times, the airport has two runways i.e. a “main” runway and a “secondary” runway which are aligned at an angle of approximately 50 degrees to each other. The main runway was originally constructed in 1953, with the secondary runway being opened in 1961. Both runways have received various re-surfacing actions between their opening and the present.

At some point in time, the runways were overlaid with a “porous” asphalt wearing course. Subsequently, the centre portion of the main runway has been inlaid with modified asphalt whilst the centre portion of the secondary runway received an application of bituminous sealing agent. Arcus GIBB engineer’s undertook an inspection of the respective runways in mid 2007 and found that the porous asphalt in outer portions of the runways was in an advanced stage of oxidization and exhibiting indications of ravelling (disintegration / aggregate loss) of the surfacing medium. Further inspections were undertaken on a six (6) monthly basis and it was discovered that the ravelling of the two (2) 20 metre shoulders of the secondary runway was deteriorating at an accelerating rate.

Ravelling of a road surfacing, whilst not good, is considered a minor defect which, (dependant on the surfacing type) can be rectified easily and for a comparatively low cost. When this distress mechanism manifests on an airport runway however, the situation is regarded as being extremely serious (more so than cracking) due to the risk of Foreign Object Damage (F.O.D.) to aircraft engines and, more significantly, the risk that an aircraft could skid on the loose aggregate if it veered onto the shoulders (particularly under braking on landing).

The skidding resistance of the centre portion of the runway is measured annually (as per C.A.A. license requirements) with the latest data indicating that it is above the minimum threshold.

The full rehabilitation of the runways at the East London Airport was programmed to commence in 2011 however, due to the potential risk that the condition of the shoulders of the secondary runway presented, ACSA appointed Arcus GIBB to undertake the design and construction management for short term remedial measures to this runway i.e. to maintain the runway in a safe and serviceable condition until such time that the full rehabilitation would be carried out. The project was carried out over two phases between October 2008 and April 2010.

This Paper discusses the background to the project, the design rationale (which was undertaken to ensure that the remedial measures could form part of the future rehabilitation actions and avoid any “abortive” or sacrificial” work) and, more particularly, presents an account of the construction process which, as the title of the Paper states, was not high tech, but was certainly high risk.
INTRODUCTION AND PROJECT BACKGROUND

The East London Airport, in terms of passenger movements, is the second largest “domestic” airport in South Africa (not counting the three (3) “international” airports) and is the origin and destination of travellers and freight to and from East London and, further the north eastern portion of the Eastern Cape Province.

Due to the fact that the area has four (4) distinct prevailing winds, which are gale force at times, the airport has two runways i.e. a “main” runway and a “secondary” runway which are aligned at an angle of approximately 50 degrees to each other. The main runway was originally constructed in 1953, with the secondary runway being opened in 1961. An illustration of the layout of the various runways and taxiways is presented in Figure 1 below.

The 1,940 metre long main runway (11/29) is depicted from lower left to upper right in the photograph, whilst the secondary runway (06/24), of 1,590 metres, is aligned, as discussed previously, at a 50 degree angle to the main runway, with the 24 threshold being at the lower right of the photograph.

Figure 1 : Arial View of the Runways and Taxiways at the East London Airport

At some point in time, both runways were overlaid with a “porous” asphalt wearing course. Subsequently, the centre portion of the main runway has been inlaid with modified asphalt whilst the centre portion of the secondary runway received an application of bituminous sealing agent.

Arcus GIBB engineer’s undertook the initial inspection of the respective runways in mid 2007 and (as part of the “Airside Drainage System” Project) and found that the porous asphalt in outer portions of both runways was in an advanced stage of oxidization and exhibiting indications of ravelling (disintegration / aggregate loss) of the surfacing medium. Further inspections were undertaken on a six (6) monthly basis and it was discovered that the ravelling of the two (2) 20 metre shoulders of the secondary runway was deteriorating at an accelerating rate.
When this distress mechanism manifests on an airport runway, the situation is regarded as being extremely serious (more so than cracking) due to the risk of Foreign Object Damage (F.O.D.) to aircraft engines and, more significantly, the risk that an aircraft could skid on the loose aggregate if it veered onto the shoulders (particularly under braking on landing). Airport runways have strict friction criteria for the “centre portion” in terms of macro and micro texture and, whilst the ravelling surface was outside this area, the reduced friction capability could not be ignored.

The full rehabilitation of the runways at the East London Airport was programmed to commence in 2011 (Arcus GIBB has, in fact, just completed the design and tender stage for this project, with construction programmed to commence in January 2012) however, due to the potential risk that the condition of the shoulders of the secondary runway presented, ACSA appointed Arcus GIBB (Pty) Ltd, in April 2008, to undertake an investigation into the current condition of the runways and taxiways at the East London Airport.

The investigation revealed that the runway and taxiway distresses, previously assessed and logged during the “Airside Drainage System” Project in 2007, was increasing in both extent and severity.

From the analysis, the active aggregate loss / ravelling of the porous asphalt surfacing on the shoulders of the secondary runway (24/06) was identified as being the most serious “short term” problem. The assessment revealed that there was in excess of 32,000 square metres of distressed asphalt in the shoulders of runway 24/06.

Recognising the potential seriousness of the aforementioned, ACSA instructed Arcus GIBB (Pty) Ltd to proceed with the design and documentation for the “Short Term Remedial Repair Measures for Runways and Taxiways” Project: EL09/17/AB. The aim of the Project was to preserve the existing runways and taxiways in a serviceable condition until such a time that the envisaged full rehabilitation Project could be implemented.

The design process identified that milling of the affected areas and replacing with new hot mix asphalt (mill and fill) was the optimal solution in terms of initial cost and future performance.

Approximately 32,000 square metres of oxidized asphalt required replacing. Due to insufficient budget allocation, approximately 50% of the required work could be undertaken during this project. As such, the most serious areas of distress were rehabilitated under this Contract, which was completed in May 2009.

In October 2009, ACSA re-appointed Arcus GIBB (Pty) Ltd to undertake the design, documentation and tender evaluation process for the “Remeil Repair Measures to the Secondary Runway at the East London Airport” Project – Project Number EL10/35/AU.

The object of the project was to arrest the potentially dangerous situation of serious active aggregate loss on the shoulders of the secondary runway (24/06) that could not be repaired during the previous project (EL09/17/AB). Approximately 16,500 square metres were identified for repair under this project which is the subject of this Paper

PROJECT BRIEF

The ACSA Brief to Arcus GIBB was as follows

- Assessment of the condition of the runways and taxiways.
- Identification of the optimal remedial measures with regard to available budget and future performance.
- Design and documentation of the Works
- Other sundry works relating to the project at the discretion of the Employer
- Construction monitoring of the Works on a “full time” basis
PROJECT TIME FRAMES

As the requisite work was considered to be an “emergency” intervention, ACSA were desirous to appoint a Contractor prior to the 2009 Christmas break. In order to meet this very tight deadline the following milestone dates were identified:

- Undertake detailed assessment of runway 24/06 and establish remedial actions required – mid November 2009
- Submit final tender document and drawings to ACSA – end November 2009
- Invite tenders – 8 December 2009
- Tender closure – 15 December 2009
- Submit tender adjudication report – 17 December 2009
- Commence construction mid January 2010

*1 To mitigate possible risk to ACSA It was imperative that the construction works were undertaken as soon as possible and, therefore, ACSA decided that an “invited” tender process would be adopted. The same Contractor’s who tendered on the previous runway repair project were invited to tender on this project.

The following key project / contract dates were achieved:

- Compilation and Analysis of Available Data – 03 November 2009
- Field work (Visual Assessment) – 10 November 2009
- Visual and Pavement & Analysis – 17 November 2009
- Submit final tender document and drawings – 04 December 2009
- Invite tenders – 08 December 2009
- Tender closure – 15 December 2009
- Submit tender evaluation report – 16 December 2009
- Domestic tender board approval – 18 December 2009
- Award Contract – 21 December 2009
- Contractual commencement date for construction – 06 January 2010
- Actual commencement date of construction – 08 February 2010
- Contractual construction completion date – 17 March 2010
- Actual construction completion date – 20 March 2010 (Incl. 3 days lost to inclement weather)

DESIGN RATIONALE

Practical Considerations

Aggregate loss / ravelling, particularly when occurring on a porous surfacing, such as the wearing course asphalt on the East London airport runways, is typically addressed (in South Africa) by spraying the affected areas with some form of bituminous sealing agent so as to “rejuvenate” the existing surface and arrest the aggregate loss / ravelling.

This method has been used successfully on major National and Provincial roads in South Africa for a number of years and, as discussed previously, was utilised on the centre portion of runway 06/24 in circa 2004. By 2008, however, the asphalt surfacing on the shoulders of runway 06/24 was in such an advanced stage of ageing that it literally disintegrated when subjected to abrasive rubbing by a boot or shoe. This indicated that there was very little effective binder remaining in the asphalt surfacing and it was considered that the application of a bituminous sealant would not adequately address the aggregate loss / ravelling problem.

The discounting of the aforementioned possible remedial measure meant that there was only one realistic alternative available i.e. milling out the existing surfacing and replacing it with new asphalt –
“mill and fill” and, as such, this option was adopted for both the 2008/9 and 2009/10 projects. A further benefit to this option was that the remedial measures could be incorporated into the “full” rehabilitation design thus avoiding any sacrificial expenditure. For this option to be effective, it was imperative that the existing surfacing was removed in its entirety (to mitigate the risk of delamination),

Cores were drilled at selected locations which indicated that the open textured asphalt was between 40 and 50 mm thick. Figure 2, depicts the typical upper pavement structure of runway 06/24 and clearly illustrates the “friable” porous asphalt wearing course (note the ravelling on the edges of the upper edges of the core sample). Also evident is the previous surfacing of continuously graded asphalt and the base course of large aggregate bitumen bound “Macadam”.

Figure 2 : Typical Core Sample Extracted from Runway 06/24

In order to ensure that the existing surfacing was completely removed and create a good interface between the new and underlying continuously graded asphalt, a nominal 60 mm mill and fill depth was targeted for design and quantification purposes.

Materials Aspects

Whilst the identification of the rehabilitation methodology was a straightforward task (due to there being only one (1) practicable option), the choice of the new surfacing medium, with the exception of it being an asphaltic concrete mix, presented a number of alternatives.

Airport runways, as has been discussed previously, need to maintain minimum friction characteristics in terms of both macro and micro texture, as such a number of “engineered” asphalt mixes have been developed that produce acceptable friction levels over a sustained period. In addition, due to the harsh environment and the need for regular abrasive (normally water jetting) removal of rubber build up, a more “durable” surfacing is also desirable. The possible asphalt types considered for the project were.

- Dual Purpose Semi-Open Graded Ultra Thin Friction Course (UTFC).
- Bitumen Rubber Asphalt Semi-Open Graded (BRASO).
- Antiskid Specialist Friction Course.
The merits and disadvantages of each of the asphalt surfacing alternatives, in terms of the scope and aims of the project are discussed below.

- **Continuously Graded Asphalt (60/70 pen. Binder)**
  
  The compaction specification for the asphalt was 93% of Maximum Theoretical Density, (Rice’s)
RISK MANAGEMENT

Operational and Construction

The undertaking of works to runways at an operational airport is accompanied by a significant risk element – to Client, Contractor and Consulting Engineer. So as to mitigate potential risk, a “Risk Register” was compiled, at design stage. An abridged version of the project risk register is illustrated in Figure 3.

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Figure 3: Abridged Risk Register
The potential risks detailed in the above register were, where appropriate, incorporated into the Contract Documentation e.g. standby major Plant items etc.

CONSTRUCTION STAGE

Constraints

The main constraint that the Contractor faced during the construction of the Works was the need to work during the night and the requirement that the site was vacated, in a safe condition, at a prescribed time (05:00). The Contractor and Engineer (at the start-up meetings before each shift) agreed the production for each shift to ensure that all work was completed and the site vacated before the stipulated “cut-off” time. One (1) incident of late completion occurred and this is discussed in detail later in this Paper.

Night time work obviously impaired vision and great care was required during the paving and milling operations. Of particular importance was the cleaning operation following the final compaction of the inlays. ALL items of Foreign Object Debris (FOD) no matter how small or seemingly insignificant needed to be removed from the runway and verges, this often entailed a final clean, after mechanical and hand sweeping, by literally picking up small stones by hand. In order to improve vision as much as possible, numerous floodlights and associated generator plants were installed before the shift and removed thereafter.

The team faced a number of other constraints but, for the sake of concision, these will not be discussed, needless to say, that undertaking runway works at an operational airport is a high risk operation, often measured in terms of minutes and kilograms as opposed weeks / months / years and tonnes / m³.

Induction Courses

The Contractor’s and Engineer’s site personnel undertook the statutory Airside Induction Safety Course at the East London Airport. This course is obligatory for persons who will be carrying out work within the perimeter fence of an operational airport. In addition vehicle driver’s and plant operator’s attended the Airside driving course to enable them to operate / drive inside the Airport perimeter.

Accommodation of Traffic

Due to the Works being constructed outside operational hours, traffic control was not an issue. The only accommodation of traffic required was that of the Contractor’s own construction Plant and delivery vehicles, which were obliged to adhere to the ACSA safety and security regulations.

The above notwithstanding, the Contractor was responsible for ensuring that construction traffic remained in demarcated areas and also for making sure that the work and surrounding areas were free of F.O.D. prior to vacating the site at the end of each shift.

No accidents involving either the public or the Contractor’s personnel occurred during the construction of the Works.

Scope of the Works

This project involved the construction of new asphalt inlays on the shoulders of the secondary runway (24/06) utilising the “mill and fill” method.

The main work items were:
➢ Milling of areas of distressed asphalt and the disposal of the milled material on the airport security road
➢ Paving of continuously graded, medium textured asphalt
➢ Sealing of the new/existing asphalt interfaces with a bituminous sealing agent
➢ Painting of runway markings

So as to enable the continued use of runway 24/06 during the construction, the Works were undertaken during the night, i.e. between the hours of 21:30 and 05:00 the following day.

**Original Programme**

The original programme for the construction Works was for a 10 week Contract duration, commencing work on 6 January 2010 with completion scheduled for 17 March 2010.

Due to a number of reasons - the Contractor’s inability to establish his plant timeously after the Christmas break, slow obtainment of airside permits etc – the actual construction did not commence until 8 February 2010. The loss this time meant that the construction Works needed to be completed within a 5 week period, 50% of the original duration which required the Contractor to double their originally anticipated production rates. This was obviously a serious problem but, after consultation with the Engineer, it was agreed that, with detailed planning and strict adherence to a new programme (including week ends), the works could be completed by the original completion date

**Methodology**

The areas to be repaired were indicated on layout drawings and the Contractor programmed the work accordingly. As previously discussed, due to the late start of the actual construction works, the programme had to be accelerated by approximately 50%.

The Contractor, in conjunction with the Engineer’s Representative, decided which areas were to be repaired prior to the commencement of each shift with the area being demarcated prior to the milling operation. As will be discussed in the following Chapter, the methods used in the pre-marking of the work areas was amended very early in the Contract

A purpose built self-propelled mechanical milling machine was used to remove the ravelling open textured asphalt wearing course. The depth of the milling was continually adjusted to ensure that the bottom of the excavation was +/- 10 mm below the depth of the existing wearing course, i.e. just into the underlying intact continuously graded asphalt layer. The overall average depth of the milled excavations was 56 mm.

The milled asphalt is a valuable commodity and should be recycled (either re-batched with fresh asphalt or used in pavement layers) when ever possible. In addition to the economic benefits of recycling the millings, it is much more “environmentally friendly” than merely disposing of such at a land fill or other site. In the case of the airport, the gravel perimeter / security road was in a poor and this was an ideal place to re-use the asphalt milled from the runway. In total, 1060 m³ of the existing oxidized asphalt wearing course had been removed from the shoulders of runway 24/06 and tipped and spread by motor grader enabling approximately 3 kilometres of the perimeter road to be upgraded to a useable condition.

Once the excavation was completed it was thoroughly cleansed by both mechanical and manual brooming and any “biscuit layers” removed. Following approval of the cleaning operation, the tack coat was sprayed. The tack coat used was 30% stable grade emulsion (CAT 60 diluted at 50%) and was, by necessity, sprayed by hand. The target application rate was 0.55 litres / square metre.
Once the tack coat emulsion had achieved an “affective” break (or before if time constraints dictated!) the paving of the asphalt inlays was commenced. The asphalt was placed by a purpose built paving machine with compaction being achieved by two vibrating smooth drum rollers and a pneumatic tired roller (PTR). The temperature of the asphalt and the coverage rates per truck load (based on the weighbridge tickets) was monitored and recorded by the Engineer’s Representative as was the location of the paving of each load of asphalt.

As discussed previously, the target density was 93% of MTD.

All joints between “new” and “existing” asphalt were sealed with a proprietary bituminous sealing agent. The purpose of this work was to waterproof the joint against the ingress of moisture. The sealant was applied by hand at a width of 150mm (75mm either side of the joint).

The milling of the existing surfacing resulted in the removal of some runway markings. All runway markings were re-instated re-painted the same night that they were removed.

At the completion of the Contract, 2,497 tonnes (including 300 tonnes of additional work on the main runway) of asphalt had been placed (17,700 square metres), with an average production rate of approximately 90 tonnes per night shift. Figure 4, below, illustrates the actual production achieved.

![REMEDIAL REPAIR MEASURES TO THE SECONDARY RUNWAY AT THE EAST LONDON AIRPORT : CONTRACT NUMBER EL10/35/AU - “MILL AND FILL” PRODUCTION SCHEDULE](image)

**Figure 4 : Asphalt Paving Production**

As can be seen from Figure 4, significant effort had to be made over the last third of the Contract to complete the works on schedule. The above production model was re-programmed each day with new targets being identified based on previous cumulative production versus time remaining. The blue line indicates a simplistic “straight line” production requirement. It should also be noted that the paving work only commenced when 50% of the Contract period had already expired. Figure 5 shows an aerial
view of the position of the asphalt inlays. The green areas indicate the additional work undertaken on the main runway

Figure 5 : Aerial view of asphalt inlay locations

Quality / Acceptance Control Procedures

A formal method of quality acceptance control was implemented by the Consulting Engineer and is summarised below.

All asphalt delivered to the site was checked for acceptable temperature both in the truck, and in the paving machine.

Each load of asphalt was logged in terms of its paved position, time and end of paving and thickness. On the completion of the shift, the Engineer’s Representative visually inspected the work and, if no problems were encountered, approved the work as being visually acceptable.

Tolerances (deviations under a three (3) metre straight edge) were checked at the joints of the new inlays and also within the area of the inlays.

A professional Civil Engineering laboratory extracted cores from the new asphalt inlays to ascertain in place density and thickness and “hot box” samples were taken to undertake Marshall test procedures to check the asphalt mix against the specified asphalt design.

In total 57 cores and 15 hot box samples were taken

Once all the acceptance aspects for a particular inlay (as discussed above) were submitted and checked for compliance with specification, the section of work was approved as complete. If any of the
acceptance criteria was found to not comply with specifications, the section of work could be rejected and re-constructed.

No work was rejected on the basis of the above.

**Incidents**

On the night of 09/10 February 2010, there was insufficient asphalt to complete the re-instatement of the milled excavations before the “cut-off” time of 05:00.

The incident occurred due to the following:

- The Contractor’s paving supervisor unilaterally milled out an area in excess of that agreed by the Engineer and the Site Agent at the start up meeting.
- The paving supervisor miscalculated the asphalt tonnage required to complete the re-instatement of the “over milled” area and, as a consequence, there was shortfall of approximately 15 tonnes of asphalt.
- The Engineer was only informed of the situation at a very late stage, by which time it was not possible to obtain the additional asphalt in time to rectify the situation prior to the 05:00 cut-off time.

The above incident occurred on the second night of the construction and, as such, may have been due to the usual “teething problems” that often occur at the beginning of a construction contract. This notwithstanding, undertaking runway works at an operational airport is a high risk operation and, therefore, immediate and severe actions were required to ensure that such an occurrence was not repeated.

The significant implications of delayed outgoing flights and the re-routing of inbound aircraft are obvious in terms of cost, not to mention negative publicity to the airport authorities.

As such, the Engineer had no option but to instruct the Contractor to remove the paving supervisor from the project and to further instruct that his replacement be pre-approved.

A further requirement was that ALL the asphalt required for the night’s work, PLUS 5% was to be on site prior to any milling operations being undertaken, fortunately the average night time temperatures were around 15 C, so there was little probability of the asphalt losing “paving” temperature in the covered trucks. Barricades were also erected at either end of the work area to negate the risk of over milling.

In addition to the above, the Engineer was “at the site of the works” from pre-marking operations through to the time when the last item of plant vacated the airside area. All asphalt quantity calculations were double checked, milling depths confirmed and the paving spread rates were monitored on a truck by truck basis.

With the above measures in place, no further incidents occurred.

**SUMMARY**

As has often been discussed in this Paper, the “Remedial Repair Measures to the Secondary Runway at East London Airport” project, presented challenges in terms of risk as opposed to technical difficulties.
In terms of “operational risk”, the “late” opening of the runway, as discussed above, could have been very costly if the wind had not been favourable on that early morning – it favoured the main runway – or if the airport did not have two (2) runways. The other obvious risk is that of ensuring a completely safe environment in which aircraft can operate, this aspect encompasses both the issue of FOD at the site of the previous night’s work and also the ability of the asphalt inlays to withstand loading and breaking forces.

The latter, as the inlays were constructed on the shoulders of the runway, should not occur too often, but it is not an occurrence that can be discounted. The former issue of FOD was, perhaps, the most difficult aspect of the entire project to manage and significant time needed to be allowed for this activity. In general, the aim was to complete all paving operations by 03:00 so that two (2) hours were available for cleaning, this equates to over 25% of the night shift hours being dedicated to cleaning the work areas and also the routes that the plant took to get to the site of each night’s work.

The risk of weather interruptions during the milling operations were also a risk, although this was a risk to the Contractor as opposed to the Client. Unlike on road works where an excavation can merely be left open should it rain, on an operational airport runway no such luxury exists.

Any excavations that are opened must be re-instated before the 05:00 cut off time. In the event of “rain damaged” asphalt, this would have to be removed and replaced at the Contractor’s cost and, as such a close eye was kept on long and short range weather forecasts and also on the sky on some nights when it looked as if rain may occur!

The late start of the construction placed an ever increasing stress level on both Contractor and Engineer, particularly as the production got off to a fairly slow start (refer to Figure 4). This notwithstanding, the Contractor, Engineer and Client, worked as a team and by this close association, a common goal was realised.

Constant monitoring and amendments of the programme, improving work methods and the Contractor’s team becoming familiar with the procedural aspects of the Contract (not to mention countless cell phone calls in organising the next nights shift) ensured that this project was a great success. The work ended on the last night of the Contract period and was completed within the Contract value (97% expended) with the balance plus the contingency allowance being used for the additional work on the main runway.

As discussed, the design and tender stages for the full rehabilitation project of the runways and taxiways at the East London Airport is now complete, with work programmed to commence in early January 2012. A 15 month Contract period is envisaged with the pavement designs having been undertaken to provide a 15 year structural and surfacing life. To give an indication of magnitude, the following are some of the more important quantities for this project:

- Tack Coat – 480,000 litres
- Asphalt Base Mix – 32,000 tonnes
- Asphalt Surfacing – 48,000 tonnes
- Line Markings – 55 Km

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