SPALL REPAIRS IN PCC PAVEMENTS
CONDITION 2 – LOCALIZED SPALLS
TECHNICAL REPORT

1.0 BACKGROUND

Servicios de Aeropuertos Bolivianos, S.A. (SABSA) started its concession contract for the administration of the international airports in Bolivia in March, 1997. Within its responsibilities, SABSA initiated a program to evaluate the existing conditions of the aeronautical pavements to determine the maintenance/replacement needs.

As a result of this evaluation program, a Pavement Management System was developed and implemented, incorporating the following items:

- Inventory of existing pavement
- Preventive/corrective maintenance manual
- Determination of the coefficient of friction resistance
- Determination of the pavement roughness
- Determination of the Pavement Condition Index
- Evaluation/improvement of drainage systems
- Non destructive testing (HWD)

Due to the magnitude and resources needed to undertake all activities previously listed, it was determined that full implementation of the system would demand several years. One of the reasons for the large volume of work involved was an inadequate maintenance of the pavement during many years of administration prior to that of SABSA.

2.0 PREVENTIVE/CORRECTIVE MAINTENANCE MANUAL

Upon completion of the inventory of pavement conditions, the development of this manual was oriented to clearly categorize each slab inspected and to determine the corresponding repair methodologies. For the specific case of rigid pavements, the deterioration processed lead to the characterization of 5 conditions:

- Condition 1: Slab with severe cracking/differential settlements/collapse
- Condition 2: Slab with localized spalls
- Condition 3: Slabs with longitudinal, transverse and/or diagonal cracks
- Condition 4: Slab with joint sealant
- Condition 5: Slab in good conditions

The purpose of this report is to summarize the results achieved during the development of the repair methodologies for slabs under Condition 2; Localized Spalls. The need to undertake the repairs for this kind of deficiency responds to the risk of damage to the tires and the risk of FOD during aeronautical operations that they represent. The pictures in Figure 1 show examples of this pavement condition.

Figure 1: Examples of Condition 2 in slabs of PCC pavement

Based on the result of the pavement conditions inventory, an estimate of the volume of work involved was obtained. Due to its magnitude, the repair activities were prioritized and different repair materials, available in the local market, tested to determine which one would yield the best long term solution. The following sections describe the results obtained for four types of materials used.

2.1 Asphalts

The reason to consider asphalt materials for this specific type of deterioration in the pavement was twofold; first, price wise the option was the most competitive, and second, it allowed a fast return to service in the area where the repair took place. It was determined that this solution durability was in direct relation to its costs, and the repairs resulted only in a temporary patch as opposed to a permanent fix.

Hot asphalt mixtures products have a sealed matrix which, once applied to the PCC pavement, produce an impervious interface. This interface does not allow the underlying concrete to "breathe" when exposed to rains or maintenance activities (such as rubber removal). As a result of these conditions, the surface of concrete in direct contact with the asphalt patch will saturate compromising, eventually, the bond between both materials, and the patch will break loose. Figure 2 shows the results of this kind of incompatibility.

Figure 2: Failure of hot asphalt repairs on PCC pavement

The application of cold asphalts proved to be an excellent alternative for emergency repairs only. These materials allow for their application even in spalls with standing water, and this is the type of flexibility that an emergency repair requires. However, the properties of these materials do not allow proper compaction with standard equipment (especially at the perimeter of the repair) and by no means can the compacting effort simulate the load of a landing gear. In addition, this alternative has virtually no resistance to torsion loads, very common y aeronautical maneuvers. The combination of the two previously described conditions will lead to the eventual disintegration of the patch in pieces of different sized that could represent the risk of FOD.

Figure 3: Failure of cols asphalt repairs; settlement due to heavy traffic loads and tearing of patch due to torsion

2.2 Fast setting cements and high strength grouts

Very encouraging results were obtained during the early stages testing these materials. Light traffic (pick-ups and catering trucks) could be open in the area repaired within the first three hours of application. Unfortunately, the lack of resistance of these materials to the freeze/thaw cycles (El Alto) and to the sudden changes in temperature due to cold fronts (Viru Viru) became evident. It took only three month before the need to replace the repair was obvious. Five materials of similar characteristics and different brands were used with the same results in all cases. Figure 3 shows pictures of patches that failed after being exposed to environmental conditions with temperature changes ranging between 20 and 25 degrees Centigrade.

Figure 4: Deterioration process of cement based materials due to sudden ambient temperature changes

2.3 Epoxy compounds

Due to the results obtained the search to determine the best product for long term repairs continued by the testing of epoxy compounds. It was determined that the high early strengths reached by this kind of materials (three different products were tested) would allow a rapid return to service for the infrastructure repaired. Before the deficiencies previously reported on cement based materials were identified, tests were performed simultaneously with epoxies and cement based materials. The picture in Figure 5 shows a location where adjacent corner spalls where repaired with different materials. After two months in service the cement based materials showed signs of deterioration already.

Figure 5: Comparison of durability between cement based materials and epoxy compounds

Based on the results obtained, it was determined to use epoxy compounds exclusively for the repair of slabs classified under Condition 2. The determination was made even though the cost per cubic meter of epoxies was close to be five times higher that that of cement based materials.

Subsequent monitoring of the epoxy compound repairs showed a clearly defined tendency for cracking within the first four months after the repair was completed. Figure 6 shows the conditions of repairs with epoxy compound when exposed to traffic and environmental conditions for an extended period.

It is evident that epoxy compounds yield not only better durability but also safer operational conditions even after cracking. However, the presence of cracks allows for water to flow under the pavement compromising the sub grade due to saturation. Similarly, non-compressive material accumulating in the cracks, combined with expansion processes due to high temperatures, will result in a continuous deterioration process in the repair.

During the early stages of testing these materials, it was observed that the perimeter between the PCC pavement and the epoxy compound cracked within the first week after the material was poured. In order to eliminate this cracking a joint was established and sealed at the vertical interface between both materials.

Figure 6: Cracking of patches completed with epoxy compounds

3.0 ALTERNATIVE MATERIALS

With the results obtained using repair materials available in the local market, it was determined to explore the possibility to obtain alternatives from the US market to continue searching for the best available option. By attending the pavement management and pavement condition seminar sponsored by ICAO in Lima, in November 2003, it was possible to establish contact with Mr. Don Simmons, sales manager from Ceratech, Inc. A small amount of products was ordered and imported. Tests in the field yielded excellent results, as shown in Figure 7. It can be observed, after four months, that the repair shows no signs of deterioration. The small epoxy compound patch at the adjacent corner shows cracking around the perimeter.

Figure 7: Repair completed using Pavemend

The success achieved in repairs using the Pavemend family of products is the result of the following physical properties they have been engineering with:

- Rapid set
- High early strengths
- Low coefficient of thermal expansion
- Low modulus of elasticity (the repairs “moves” with the pavement repaired)
- Zero shrinkage (repair does not suffer volume changes)
- Temperature tolerant (Pavemend can be applied under below zero temperatures with no need for curing or protection)

In addition to the results obtained, Pavemend has a very competitive cost when compared with the epoxy compounds (approximately 60% cheaper) and it will be used exclusively for this kind of repairs. Due to its properties, this material has been used in applications to correct pavement roughness due to settlements and to improve the skid resistance. The results of theses tests will be subject for independent reports.

Prepared by: Maintenance Department
Servicios de Aeropuertos Bolivianos S.A.
El Alto International Airport
January 2005

Contact: Eng. Jaime Zubieta Q.
Chief of Maintenance
Phone 591-2-281-1916
jaime.zubieta@sabsa.aero