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REPAIR AND STRUCTURAL STRENGTHENING OF RIGID PAVEMENT OF ZIA INTERNATIONAL AIRPORT

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SUMMARY

The original runway at the Zia International Airport (ZIA), Dhaka was a rigid pavement made from plain cement concrete (PCC). The runway and other traffic areas were reportedly not designed for the operations of wide body aircrafts although it was opened to such traffic in the mid eighties. Again, in 1971, the runway was subjected to heavy bombing operation. As a result of these and other causes, the pavement underwent heavy cracks and were also broken into a number of pieces. It was decided to provide, after completion of the repair work, a flexible (bituminous) overlay of 200 mm thickness over the existing concrete pavement. The present paper deals with the repair and strengthening technology adopted for rehabilitating the pavement at the ZIA.

INTRODUCTION

The runway at the ZIA, Dhaka, made from PCC, underwent severe cracking throughout its whole length even before it was actually opened to routine service in 1980. The paved runway at

ZIA is 10,500 ft.(3,200 m) long with 900 ft. (275 m) long stopway (overrun) strips at both ends. The runway width is 150 ft. (45.7 m) with 25 ft. (7.6 m) paved shoulders on both sides. The pavement subgrade was a compacted fill of thickness ranging from 3 ft. (0.9 m) to 14 ft. (4.25 m). A 6 inch (150 mm) lean concrete sub-base underlying a PCC slab thickness of 10 inch (250 mm) to 13 inch (325 mm) at locations was used. Whereas details of the crack survey and joint condition survey data is available in Civil Aviation Authority of Bangladesh (CAAB) [1], a typical account of cracked pavement (between chainage 4000 ft. to 4500 ft.) can be gathered from Fig. 1. The poor performance of the PCC runway pavement was mainly due to improper spacing of the longitudinal and transverse joints, existence of high temperature gradient across the depth, large plan dimensions as well as thickness and due to the fact that the pavement was not actually designed and constructed for wide bodied aircrafts, although these type of aircrafts regularly operate at ZIA (Ahmed, et al. [2]). In view of the deteriorated condition of the pavement and anticipating increased air traffic in the future, CAAB decided to repair the existing rigid concrete pavement and also provide 8 inch (200 mm) thick flexible overlay to further strengthen it.

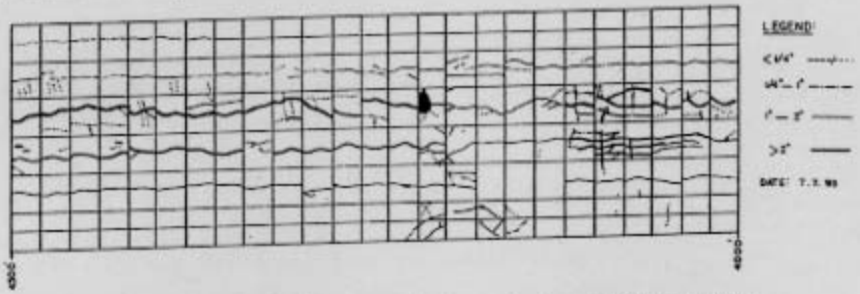

Fig. 1 Cracked pavement between chainage 4000 and 4500 ft.

PREPARATION OF PAVEMENT FOR OVERLAYS

Careful and thorough preparation of the existing pavement prior to the construction of overlays is essential for good construction and better overlay performance. Various preparatory works prior to the overlay operation are discussed here.

Removal of rubber and paint markings from the runway

The rubber deposits on the runway pavement were removed using high pressure water jets, chemicals, high velocity particle impact or mechanical grinding following Federal Aviation Administration (FAA) [3]. In the same way, paint markings were also removed from the runway.

Seating slabs using heavy rollers

It was recommended to use heavy rollers having a minimum weight of 50 tons for seating of the slabs up to 50 ft. on either side of the centre line of the runway. Where visible movement of the slab could be noticed, during the movement of rollers at a speed of 4-8 km per hour, the slab was to be undersealed using asphalt meeting the requirements of ASTM Specification D 3141 following the specification for Undersealing Portland Cement Concrete Pavements with Asphalt (CL-13) of the Asphalt Institute, USA.

Repair of spalled areas

The spalled areas along the joints and elsewhere on the runway to be overlaid were removed by sawing the slab approximately 1 inch back of the spalled concrete and to sufficient depth (minimum 2 inches) until sound concrete was reached. The surface should then be cleaned and dried. Emulsified asphalt tack coat (CSS-1 or CSS-1 h) should then be applied on the surface and edges of the groove. The area is then back filled with hot asphalt mixture. The mixture should then be satisfactorily compacted with hand tamper or with hand operated vibrating roller. In case the compacted thickness of the fill is more than 3 inches, the fill is to be placed and compacted in layers of maximum compacted thickness of 3 inches.

Replacement of slabs

Appreciable cracking had taken place on the central slabs on either side of the centre line of the pavement. Some of the slabs underwent multiple cracks. Special treatment method was to be applied for repairing of slabs in the central 50 ft of the runway. Although it was initially conceived that some 50 slab panels showing multiple wide cracks and heavy damages might have to be removed and replaced by precast panels, in the end it was not necessary.

Repair of patched areas

In the past the CAAB, as a part of its routine maintenance, had applied about 10,000 sq. ft. of asphalt concrete patches having thickness between 1 to 3 inches on some slab panels. Considering the poor condition of these patches, the existing bituminous patches were removed and if cracks were found underneath, they were repaired following appropriate methods specified later. A new patch should be placed in advance of the overlay when the average thickness of the patch becomes more than 1.5 inches. It was estimated that it was required to place new patch on a 5,000 sq. ft. (465 sq. m) area. The steps for the placement of a new patch are (i) Cleaning of the surface; (ii) Application of emulsified asphalt of CSS-1 or CSS-1h at tack coat; (iii) Placement of hot asphalt mix, similar to that specified for the surface course of the overlay, on the tack coated surface; (iv) Compaction of the mixture to 98 percent of laboratory density using rollers; and (v) Checking of the level of the compacted patch using a 16-foot straightedge or a stringline.

Repair of corner breaks

These diagonal cracks forming a triangle with a longitudinal edge or joint or a transverse joint or crack should be repaired before the overlay operation. After marking such broken corners, they are usually removed using pavement saw/cutter. The subbase is to be cleaned of all debris and the area should be patched with dense graded asphalt concrete. The asphalt concrete is then placed in layers and compacted (if compacted thickness is more than 3 inches) using rollers.

Resealing of Joints

Detailed survey identified the joints (both longitudinal and transverse) where the joint seal had been damaged and where sealing material protruded above the pavement surface. It was advocated to use the following method of cleaning and resealing of the joints: (i) Plough out the old seal to a depth of 1.5 inches; (ii) Use a joint cleaning machine to clean the vertical faces of the

joint to remove foreign materials and old seal from the pavement surface at least 1.5 inches on each side of joint; (iii) Sandblast vertical faces of joint and the pavement surface at least 1.5 inches on each side of the joint; (iv) Blow out the joints with compressed air; (v) Place the seal material into the joint. A concrete joint sealer satisfying the requirements of ASTM D1190 or a good quality FAA approved joint sealer appropriate for the prevailing environment should be used. The outer ends of transverse joints must be blocked to prevent sealing material from running out on to the shoulder; and (vi) The joint area should be tack coated with AC-20 and a layer of high density fabric/membrane of approved quality and width of 12 in. be placed on the tack coat.

Sealing of cracks and crack repair

Details of crack sealing and repair is given in the next section of the paper.

CRACK REPAIR

Classification of cracks and crack repair techniques

A visual crack survey had been carried out initially for this work. Whereas the crack repair methodology for various types of cracks, classified according to their widths, are given below, Fig. 2 shows some typical activities conducted during the course of the repair of runway at ZIA.

(a). Cracks with width less than 1/4 inch : Cracks which are well defined, easily visible but have very little width fall under this category. Concrete adjacent to these cracks are usually found in good condition. Most of the cracks under this category were not repaired previously by CAAB. Field survey revealed the presence of about 11,000 rft. of cracks of this type. Of these about 9,000 rft. of cracks were not wide enough to receive any sealing material with ease and no attempt was made to seal these cracks. About 2,000 rft. of wider cracks in this category could be sealed by following the steps given below : (i) Using wire brush, stiff bristled brooms and compressed air the pavement surface around the cracks are cleaned of all dirt, dust, loose material and vegetation; (ii) The cracks are then filled with hot asphalt AC-20 by a pressure injection method. The material should comply with the requirements of AASHTO M226.

(b). Cracks having width between 1/4 inch and 1 inch : These cracks are very well defined and many of these had been repaired previously by CAAB without cutting the sides of the cracks. There were about 12000 rft. of cracks in this category. The steps that should be adopted for repairing these cracks are (i) Sandblasting of the vertical faces of the cracks to a depth of at least 25 mm (1 in.) and the pavement surface at least 25 mm to each side of the crack; (ii) Cleaning of the loose debris, dirt, previously placed filler material, vegetation, etc. with wire brushes, shovels and compressed air; (iii) Filling of the cracks using a rubberized asphalt that meets Federal Specification S-SS-1401 and satisfies local environmental conditions. Joint sealers of the hot-poured elastic type meeting the requirements of ASTM D1190 could also be used; and (iv) Application of a tack coat (AC-20) followed by placement of a 20 in. wide high density stress relief fabric of approved specification as shown in Fig. 3a.

(c). Cracks more than 1 inch wide (Type 1): Single non-interconnected cracks which are relatively straight and where cutting of grooves can be done without causing damage to the adjoining areas are included in this type. Total cracks of this type were about 20,000 linear feet.

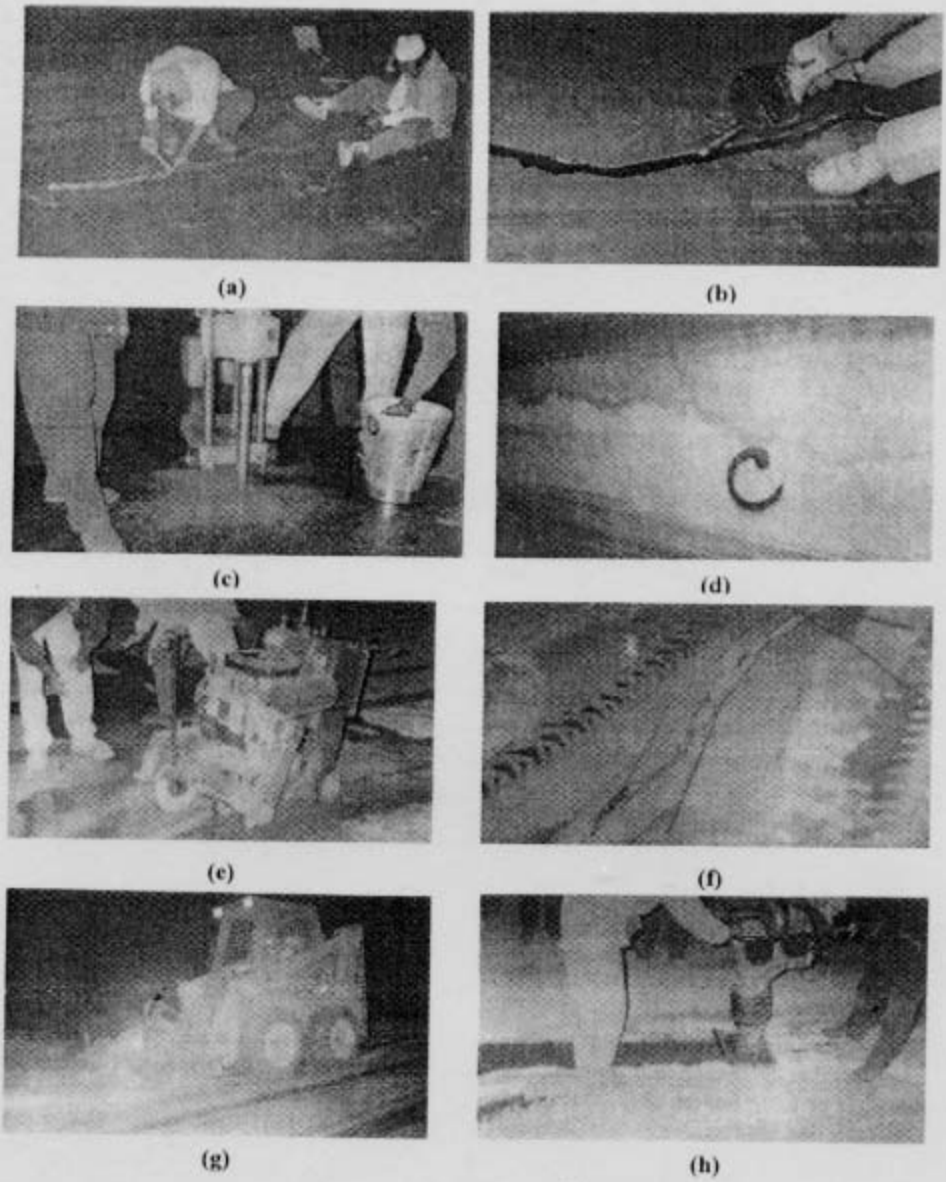

Fig. 2 (a) Removal of joint sealant from joints repaired earlier, (b) resealing of joints using sealant, (c) drilling holes on the runway for repairing cracks, (d) a typical crack on the pavement, (e) sawing operation in progress on one side of a typical crack, (f) cut marks on the pavement after sawing (g) a 6 inch wide by 3 inch deep groove being made at a heavily cracked portion of the runway, and (h) compaction of newly poured hot-mix asphalt using plate compactor.

Repair methodology of cracks of this type includes : (i) Demarcation of the area taking at least 1 in. from the edge of the cracks; (ii) Formation of trenches 12 in. wide and 3 in. deep using concrete cutting wheel/machine of appropriate size (Fig. 3b); (iii) Removal of the loose debris and milled materials; (iv) Blowing of remaining dust using air compressor with hose and nozzle attachment, wire brush, brooms etc. from the trench; (v) Filling of cracks/cavity at the bottom of the trench, if present, using either an approved liquid sealer (as in case of cracks of 1/4"-1") or a hot asphalt mix, for large cracks and cavities. A hand tamper may be used to compact the asphalt mix at the bottom of the trench; (vi) Application of a tack coat (AC-20) on the bottom surface and the edges of the trench. Quantity of tack is to be determined by trials; (vii) Placement of a high density stress absorbing membrane; (viii) Application of additional tack coat using the same material (as in vi) on top of the fabric; (ix) Filling up of the trench with hot-mix asphalt, similar to that specified for surface mix, and compacted to 98% of laboratory density using a roller. The surface of the compacted asphalt mix should be at the same grade as the existing PCC slab; (x) The trench area should be tack coated with AC-20 and another layer of high density fabric similar to that used at the bottom of the trench but of width of 24 in. shall be placed; and (xi) Hot mix asphalt overlay can immediately follow placement of the 2nd layer of fabric. Prior to hot mix overlay, the top of the fabric should be tacked over along with the existing surface.

(d). Cracks more than 1 inch wide (Type 2): Large cracks for which 6 in. wide and 3 in. deep trenches were cut and filled with asphalt concrete previously by the CAAB (about 9,200 linear feet) have been included in this type. Where 12 in. wide trenches may be cut without damaging the adjacent areas, the procedure and materials specified for the repair of Type 1 cracks may be followed. But, where trench cutting similar to that for Type 1 is not possible without damaging the adjacent concrete, the following steps are to be followed: (i) The existing asphalt mix in the trench shall be ploughed out; (ii) The vertical edges and bottom of the trench should be cleaned and all foreign materials removed using a joint cleaning machine, etc.; (iii) All loose materials and debris should be removed from the trench; (iv) (a) If no crack/cavity is found at the bottom of the trench, the trench should be filled up with asphalt concrete (Fig. 3c(i)). The edges and the bottom of the trench should be appropriately tack coated (AC-20) before placement of the hot asphalt mix. The mix should be compacted using vibratory or other suitable rollers. The level of compacted asphalt should be the same as the adjacent PCC slab; (iv)(b) If on completion of step (iii) a large cavity is found at the bottom of the trench, it should be filled up with a surface course hot asphalt concrete mix and compacted to the level of the bottom of the trench. The mixture should be tamped appropriately in place (Fig. 3c(ii)). The vertical edge and bottom of the trench should then be uniformly tack coated using hot AC-20 and the trench should be filled with asphalt concrete and compacted to the level of the PCC slab; (iv)(c) If on completion of step (iii) of this method cracks are found at the bottom of the trench, 2 in. diameter holes are to be drilled along the crack two feet centres up to the bottom of the slab. Dust from the holes should then be removed. An asphalt (AC-40) meeting the requirements of AASHTO M226 / ASTM D3381 shall be then heated to a safe temperature to make it sufficiently fluid suitable for pumping through the holes using a pressure distributor at a pressure of 25 to 60 psi until the cracks up to the bottom of the trench are filled up. Temporary round wooden plugs may be utilised. After the asphalt has hardened the temporary plugs should be removed and the holes filled with an asphalt surface course mixture, thoroughly tamped in place. The vertical edge and bottom of the trench shall then be uniformly tack coated using hot AC-20 and the trench should be filled with asphalt concrete and compacted to the level of the PCC slab; (v) The trench area shall then be tack coated with AC-20 and a 20 in. wide stress absorbing membrane of approved type shall then be placed following the procedure shown in Fig.

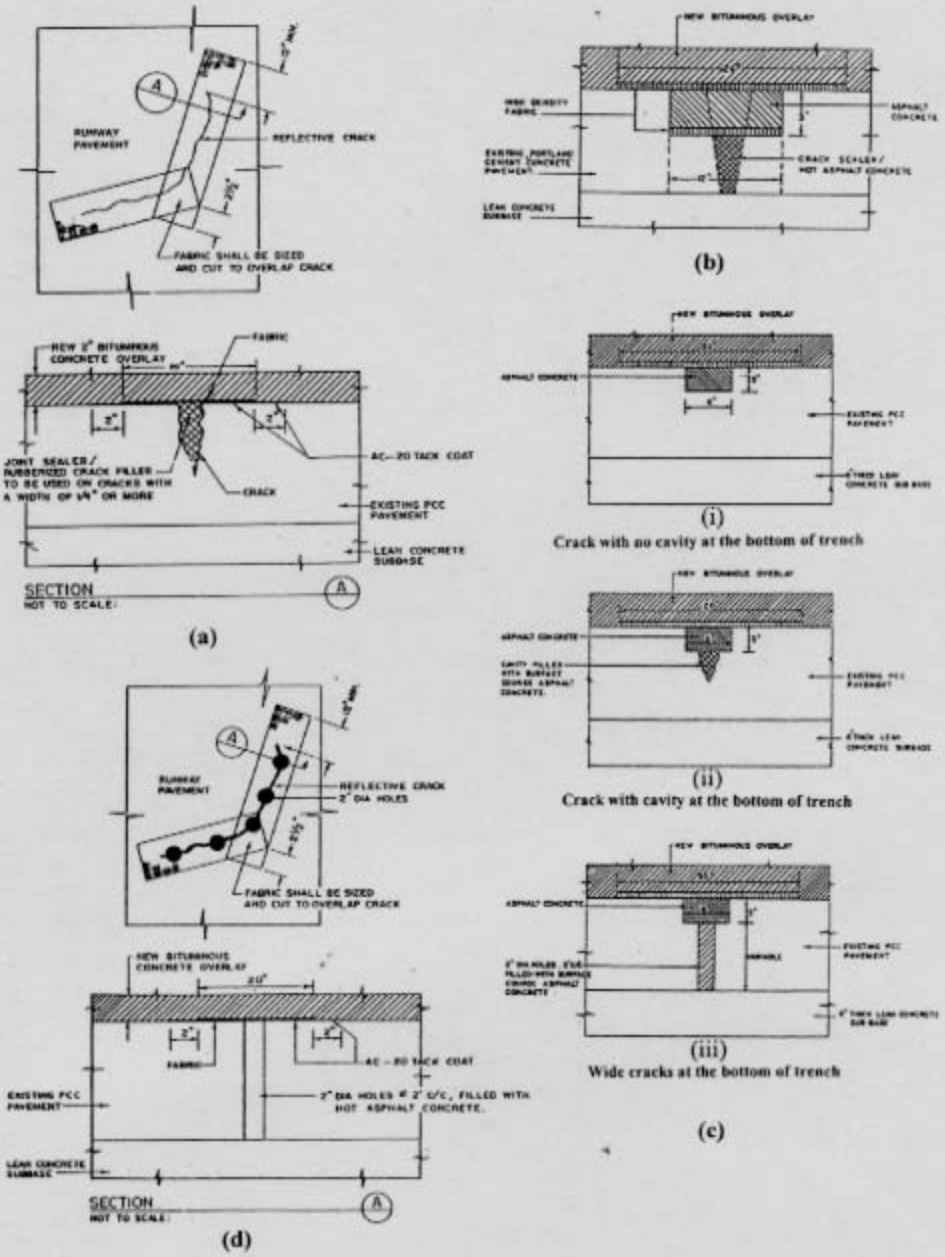

Fig. 3 (a) Typical crack repair (crack width 1/4 - 1 in.) and placement detail of fabric, (b) repair of more than 1 in. wide Type 1 cracks, (c) repair of more than 1 in. wide Type 2 cracks, and (d) repair of more than 1 in. wide Type 3 cracks.

3c(iii); and (vi) Hot mix asphalt overlay should be placed after application of tack coat on the fabric and the existing surface as described in step (xi) for Type 1 cracks.

(e). Cracks more than 1 inch wide (Type 3): Crack survey revealed the presence of many random and interconnected wide cracks where trench cutting similar to that for Type 1 cracks would not be feasible and any attempt of groove cutting would likely to cause extensive damage to the runway slab. It was estimated that there were about 20,000 linear ft. of cracks of this type which might be repaired in the following fashion: (i) Identification of the wide random cracks for repair; (ii) Drilling of 2 in. diameter holes through the entire slab on two feet centres along the crack; (iii) Removal of debris, dust, etc. from the holes; (iv) Filling up of the cracks and the holes using materials as described in iv(c) for Type 2 cracks; (v) Application of tack coat (AC-20) and placement of a high density stress relief fabric (20 in. wide) of approved type following standard procedures as shown in Fig. 3d; and (vi) Application of tack coat on the top of the fabric. The existing surface should be tack coated before the placement of the overlay.

THE OVERLAY

The airport pavement overlay design method of the International Civil Aviation Organization (ICAO) [4], which has been recommended by the FAA, has been followed. A flexible (bituminous) overlay of thickness of 8 inches (200 mm) at the centre was found to be necessary. Reduction of overlay thickness in the interior has not been recommended considering the condition of the existing runway slab. This adopted overlay was aimed at ensuring a PCN of the resultant runway pavement in excess of 59. Details of the materials specified for use in the overlay construction and the construction method is available elsewhere in CAAB [1].

CONCLUSIONS

The repair and structural strengthening methodology described in this paper was advocated for the repair of the heavily cracked rigid (concrete) pavement of the only international runway of Bangladesh at the Zia International Airport, Dhaka. The repair work was followed by the application of a 200 mm thick flexible (bituminous) overlay on the pavement. The whole work was completed at night keeping the runway operational during the day. The overall performance of the work has been reported to be so far satisfactory.

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