PERFORMANCE OF RUBBERIZED-TAR CONCRETE PAVEMENTS ON AIRFIELD FACILITIES

MISCELLANEOUS PAPER NO. 4-304

February 1959

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
Vicksburg, Mississippi

ARMY-MRC VICKSBURG, MISS.

Preface

The investigation reported herein was authorized by the Office, Chief of Engineers, in letters dated 28 January 1956 and 24 January 1958, subject, "Tar-Rubber Concrete Pavement."

The work was performed by engineers of the Flexible Pavement Branch, Soils Division, U. S. Army Engineer Waterways Experiment Station, with several district offices cooperating in collecting the necessary data. Personnel of the Waterways Experiment Station actively concerned with the analysis and report phase of this study were Messrs. W. J. Turnbull, C. R. Foster, A. A. Maxwell, O. B. Ray, J. L. McRae, J. F. Redus (formerly of the WES), Z. B. Fry, A. H. Joseph, and M. J. Mathews. This report was prepared by Messrs. Fry, Mathews, and Joseph.

Special acknowledgment is made to the U. S. Army Engineer Districts, Seattle, Los Angeles, Albuquerque, Jacksonville, Philadelphia, Boston, Eastern Ocean, and Honolulu, for their cooperation and assistance in providing information and pavement samples for this study.

Previously published reports from which information has been abstracted are listed in the bibliography which follows the text of this report.

Contents

Summary

This report describes visual observations of the behavior of in-place rubberized-tar concrete pavements at fourteen Air Force bases, and results of laboratory tests on core specimens obtained from these pavements to determine their condition after exposure to traffic, jet heat and blast, jet-fuel spillage, and weathering in various climatic zones. The core specimens were subjected to density, stability, extraction, and gradation tests, and void relations were computed. The gradation and extraction tests cannot be considered entirely reliable as it was impossible to separate the binder and aggregate completely.

Surface cracks and open construction joints were found at all of the sites investigated. Types of cracks noted were: (a) reflection, (b) shrinkage, (c) crazing, and (d) overload. The cracking varied from minor hairline to openings 1/2 in. wide. The pavements generally began to crack about the first or second winter after being placed. They usually had received little or no aircraft traffic by this time. At one site the cracking appeared to be retarded somewhat after application of traffic and, although cracking continued, the pavement did not reach a condition considered unsatisfactory for traffic.

Fuel spillage apparently caused only insignificant damage, and the pavements were withstanding the blast from jet aircraft very well.

Visual observations indicated little or no relative difference in performance of the three rubberized-tar binding agents used in the pavements, Flintbinder C-2, Surfa-aero-sealz, and Jetlock.

The major defect in rubberized-tar concrete pavements is their tendency to harden rapidly and crack, apparently as a result of evaporation and sublimation of constituents of the binder. A seal coat applied soon after construction should alleviate this tendency.

PERFORMANCE OF RUBBERIZED-TAR CONCRETE PAVEMENTS ON AIRFIELD FACILITIES

Background and Scope of Study

1. The adoption of the jet engine for aircraft and its effects on flexible pavement durability altered the design requirements for the binder material in bituminous-type surfacing for certain critical areas of airfields. Laboratory tests and field test panels were used to investigate the ability of various binder materials to withstand the heat and blast of jet aircraft as well as jet-fuel spillage, and indicated that blends of tar and rubber should be fairly successful.* As a result, a number of rubberized-tar concrete pavements were constructed at airfields.

2. This report describes the condition and performance of rubberized-tar concrete pavements constructed at fourteen Air Force bases between 1953 and 1957. Most of these pavements were inspected periodically by Waterways Experiment Station personnel, who also obtained pertinent construction data, traffic records, and information on jet-fuel spillage, heat and blast, and weather conditions to which the pavements had been exposed.

Purpose of Study

3. The general purpose of the study is to evaluate rubberized-tar concrete as a surfacing material for airfield facilities, on the basis of the behavior of existing rubberized-tar pavements under aircraft traffic, jet-fuel spillage, heat, blast, and weathering. It was also desired to determine what if any changes in the physical properties of the rubberized mix occur under these conditions.

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* U. S. Army Engineer Waterways Experiment Station, CE, Tar-rubber Test Section at Waterways Experiment Station, Report No. 1, Design and Construction of Test Section, and Report No. 2, Heat and Blast Effects, Technical Memorandum No. 3-372 (Vicksburg, Mississippi, November 1953 and October 1957).

Observations, Sampling, and Testing

Pavement inspections

4. Eleven of the fourteen air bases included in this study (see table 1) are located in the continental United States, and these bases have generally been visited periodically. Visits usually were started during or soon after construction and have been continued to the present time. The three air bases located outside the United States were inspected by WES representatives during a visit to the sites in connection with other projects. Even though these bases were visited only once, the information obtained is included in table 1 as it adds to the over-all picture of the performance of rubberized-tar pavements.

Data collected

5. During the visits to the sites, the following information was obtained: date of construction, climatic conditions, unusual construction problems, traffic history, and, if available, the physical properties of the mix. Requests were made that in-place pavement samples consisting of cored specimens 4 in. in diameter, or large chunk samples if cores could not be obtained, be forwarded to the WES for laboratory testing.

Laboratory tests

6. The cored specimens were subjected to density, stability, and extraction tests, and the gradation of the aggregate was determined. The results of extraction tests on the rubberized tar cannot be considered accurate as the aggregate could not be washed entirely clean. Nevertheless, the voids were computed from this information. When chunk samples were submitted in lieu of cores, the sample was heated, broken apart, recompacted in a standard Marshall mold, and subjected to stability tests. Extraction and aggregate gradation tests were also performed on the chunk samples. Results of the gradation tests are not presented in this report as they are not pertinent. The results of all other tests are shown in table 1.

7. Acceptance tests had been performed on the rubberized-tar binding agent used at ten of the fields, prior to construction, to determine if the material met the criteria given in the interim guide specifications dated 4 August 1954, revised 5 November 1954 and 1 February 1956. Results of

these tests are stated in table 1 in the column headed "Interim Specifications for Tar-rubber Binders." Materials used at two bases, Davis-Monthan and Williams, were subjected to specification tests after the pavements had been constructed and were showing distress.* Acceptance tests were not performed on the materials used at McChord AFB and Hanscom AFB.

Analysis of Data

8. The ages of the rubberized-tar pavements at time of inspection ranged from a few months to five years. As shown in table 1, Surfa-aero-sealz (SAS) rubberized-tar binding agent was used in the surface course at 12 of the 14 locations, Flintbinder C-2 at six, and Jetlock at two of the locations. At six fields both SAS and C-2 were used, and at one field (Walker AFB) all three binders were used.

Laboratory tests

9. Pavement cores were obtained from eight of the fields and were tested in the Flexible Pavement Laboratory at WES. Other physical property data were obtained from the previously published reports listed in the bibliography. Table 1 summarizes available data on the rubberized-tar surface courses and asphaltic concrete binder courses from each of the fields under observation, except MacDill and Thule for which no data were available. Data on the asphaltic concrete binder course are not considered in this analysis as there is no evidence that the binder course had any part in the distress of the surface course.

10. Stability values from cores obtained during construction ranged from about 1350 to 3000 lb; cores taken at later dates, from untraveled areas, showed stability values ranging from about 1700 to 6000 lb; corresponding cores taken from within traveled areas show stability values ranging from about 1700 to 6800 lb. The stability values of all the rubberized-tar pavements are rather high and show a trend to increase with age. Stability values of the recompacted specimens of the rubberized tar obtained during construction at Williams and Davis-Monthan Air Force Bases

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* See Waterways Experiment Station Miscellaneous Paper 4-292, Laboratory Study for Improvement of Rubberized-tar Specifications, dated November 1958.

averaged about 2300; after 1-1/2 to 2 years, the stability values of recompacted samples from these bases averaged about 10,000. Data obtained from cores taken from areas of fuel spillage and cracked areas at Hickam AFB indicated no loss of stability in these areas. The core data of all fields tested show a range in voids total mix of about 2 to 8.5 per cent, and an average of about 5 per cent with a trend to decrease with traffic.

11. The rubberized-tar binding agents tested for 10 bases in accordance with the interim guide specifications were accepted as satisfactory. Tests on the material from Davis-Monthan and Williams AFB made after the pavement had been constructed and showed distress indicated that the material would not have met the requirements of the interim specifications. Although the pavements at these two bases probably exhibited distress at an earlier age, the 10 locations where the binding agent was considered satisfactory also began to show signs of distress after a period of one to two years. Pavements at two of the bases, West Palm Beach and Homestead, that contained acceptable binding agents are still in fair condition with only a few areas of distress. As a result of the distress observed in these pavements, the interim guide specifications for binding agents were revised in June 1956 in an attempt to improve the quality of the tar. As of May 1958, no pavements had been constructed with material meeting the revised specifications.

Fuel spillage, and
heat and blast effects

12. Although considerable fuel spillage has occurred on most of the rubberized-tar pavements, the pavements do not appear to have been weakened. Damage has been noted only where fuel ponds in depressed areas or penetrates through a surface crack to the underlying asphalt binder. In areas subjected to jet heat and blast, no definite pattern of erosion was visible; however, the surface of the aggregate appeared to be stripped of tar, and erosion to about 1/4-in. depth was measured at some locations. Photograph 1 shows typical results of jet blast on rubberized-tar and asphaltic concrete. In general, jet blast caused only minor pavement surface flaking, and damage is considered to have been insignificant.

Weathering

13. Brittleness of the rubberized-tar pavement surfaces tended to

increase with time and amount of fuel spillage. These pavements also tended to age more rapidly than asphaltic concrete pavements, and a thin, hard crust was found at the surfaces of the rubberized-tar pavements within the first year after placement.

Texture

14. Texture of the pavements was generally fair at all of the fields; however, at many fields the construction joints between paving lanes showed more segregation and open texture than the other portion of the pavement. Photograph 2 shows the typical surface texture of rubberized-tar pavement.

Cracking

15. The pavements generally began to crack in the first or second winter after construction, and usually had received little or no aircraft traffic. The usual trend was for either longitudinal construction joints to open or cracks to appear within the paving lanes parallel to the direction of laying (see plate 1). Transverse cracking usually accompanied or closely followed the longitudinal cracking. As cracking progressed, small cracks also appeared, forming a rectangular block pattern of varying sizes (see photograph 3). This formation and pattern did not always occur, for cracks appeared in some pavements in a random fashion, forming crowfoot-, map-, or even alligator-type patterns. The cracks ranged in width from hairline to 3/8 in. Some construction joints were open as much as 3/8 to 3/4 in., and this appeared to be the most serious type of crack or opening. The following general types of cracks were observed:

- a. Reflection cracks in the case of overlays (photograph 4).
- b. Shrinkage cracks within the lanes (photograph 5).
- c. Cracks from excessive loads (photograph 6).
- d. Crazing in areas of fuel spillage (photograph 7).
- e. Open longitudinal and transverse construction joints (photograph 8).

16. At Walker AFB, some rubberized-tar binder was accidentally spilled over a small area of the rubberized-tar pavement immediately after placement. During an inspection, it was noted that no cracking occurred in this area. This indicates that a seal coat applied immediately after construction might be effective in preventing some of the types of cracking

noted on the preceding page. Another peculiar condition existed at Hickam AFB where within two to four months after placement of the rubberized-tar concrete, small amounts of bitumen were being extruded through pinhole pores on the surface of the pavement. Tests and inspection of samples of this extruded bitumen showed the material to be a mixture of asphalt, tar, and mineral filler forced through the pores and hairline cracks in the rubberized-tar concrete surface course. This extrusion appeared to be the result of a surplus of uncured tack coat material between the asphaltic concrete binder and the rubberized-tar surface course. A cutback tar was used for the tack coat between the two courses; this had a solvent action on the asphaltic concrete binder course which caused the extruded material to contain asphalt. The apparent cause of the tack coat material extrusion was slight pressure due to temperature or load.

Traffic

17. Traffic has been applied on the rubberized-tar pavements by many types of aircraft (T-28, T-33, F-84, F-86, B-36, B-47, B-50, KC-97, and C-124) and has ranged from light to moderate to very intense. The pavement cracking does not necessarily appear to be associated with traffic except, of course, in channelized areas where some other portion of the pavement structure failed. At Presque Isle, cracking appeared to be retarded somewhat after application of traffic; and although some cracks continued to appear, the pavement did not fail. Cracks and open joints were observed in both traveled and untraveled areas.

Climate

18. The rubberized-tar concrete pavements included in this study are located in widely varying climates. The ambient temperatures to which the pavements are subjected range from a high of 120 F at Williams AFB to a low of -47 F at Thule AFB, and the average annual rainfall ranges from 62 in. at Homestead AFB to 8 in. at Williams AFB. It would seem logical for these extremes in temperature and rainfall to affect the physical properties of rubberized-tar concrete pavement mixtures; however, no specific conditions or facts were found in this study that could be related to climatic conditions.

Maintenance

19. Maintenance has consisted principally of sealing cracks around

concrete tie-down plugs and patching depressed areas and weakened areas along construction joints. Extensive maintenance, consisting of filling cracks and sealing the surface of the rubberized-tar pavement, was accomplished at Williams AFB during March 1957. This work was performed under contract by Maintenance, Inc. The seal consisted of a slurry of Jennite (J-16), sand, and water applied in three coats by spray. This seal has been reasonably satisfactory to date and appears to be extending the service life of the pavement. However, in recent studies of maintenance materials and methods of application at WES,* superior emulsion sealers and methods of blending have been developed. On the basis of these studies, tentative guide specifications for both crack-filler and seal-coat materials have been published by the Office, Chief of Engineers.

Discussion

20. The data obtained and observations made in this study indicate that the primary defect of rubberized-tar pavements is their tendency to harden rapidly and crack. This is probably caused by evaporation of some of the more volatile constituents, and sublimation of the less volatile compounds of the binder from the interior of the pavement. It is also possible that the addition of rubber to tar results in a harder, less pliable material which is resistant to change in shape or form, causing cracks to occur to relieve the internal stresses induced when the pavement contracts or is depressed.

21. Fuel-spillage tests conducted on rubberized-tar pavements at WES have indicated that the detrimental effects of jet fuel are considerably greater if the voids in the total mix exceed about 4 per cent. Therefore, it is assumed that a pavement mix with voids total mix in excess of 4 per cent, that will permit the penetration of jet fuel, will also be sufficiently porous to permit the evaporation of some of the more volatile constituents of the tar binder material. This loss of volatiles could result

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* Described in Waterways Experiment Station Technical Report 3-493, Fuel Spillage, Traffic, and Blast Testing of Maintenance Materials for Rubberized-tar Concrete Pavements, Report 1, 1956-1957 Tests (in publication).

in the increase in stability indicated by the results of Marshall tests performed on samples of these pavements, and may eventually result in embrittlement of the binder and decreased flexibility, which can lead to cracking.

22. Mr. Edmund O. Rhodes, tar consultant to WES, stated that his experience has shown that, for maximum durability, the surface of tar pavements should be so completely closed that little or no evaporation and sublimation can take place from the interior of the surface course. This condition can be achieved easily by applying a suitable seal coat to the pavement surface two weeks after construction. Also, the sealing of pavements that have already cracked should tend to close existing cracks, arrest further cracking, and extend the service life of the pavement.

Conclusions

23. The following conclusions are based on results of laboratory tests, and on observations made during inspections of the performance of the various rubberized-tar binding agents.

- a. Stability of rubberized-tar pavements as measured by the Marshall test increases with age.
- b. The rubberized-tar pavements appear to harden more rapidly than asphaltic concrete pavements, which results in a cracked surface. This is probably due to evaporation and sublimation of constituents of the binder.
- c. The rubberized-tar binding agents are considered reasonably satisfactory in resisting the effects of jet-fuel spillage, and the spilled fuel does not appear to weaken the pavement substantially with respect to traffic.
- d. The major distress in the pavements usually consists of shrinkage cracks, closely spaced hairline cracks, and open construction joints.
- e. Sealing of the rubberized-tar pavement at Williams AFB has been effective in improving the surface conditions and appears to have arrested further cracking.
- f. Extremes of climates apparently have no effect on the behavior of tar-rubber pavement.
- g. Performance of the three rubberized-tar binding agents observed, Surfa-aero-sealz, Jetlock, and Flintbinder C-2, is about equal.

Recommendation

24. Based on the findings of this report and additional studies of maintenance of rubberized-tar pavements, it is recommended that a seal coat, as specified in the interim Guide Specification "Pavement: Flexible, Bituminous Seal Coat for Rubberized-Tar Pavements," be applied to new pavements, and that existing pavement cracks be repaired following the procedures outlined in the interim Guide Specification "Pavement: Flexible, Bituminous Crack Filler for Rubberized-Tar Pavements," followed with a seal coat as specified in the guide specification mentioned above.

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Table 1

Summary of Test Results and Condition of Rubberized-tar Pavements

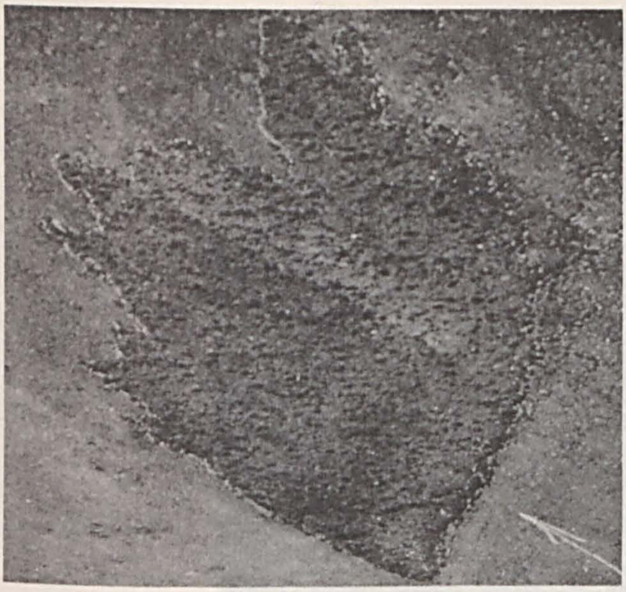
Facility	Year Const	Approx Age mo*	Physical Properties: Surface Course Type **	Surface Course Thick. in.	Surface Course Stability lb	Surface Course Density lb/cu ft	Surface Course VTM %	Binder Course Type	Binder Course Thick. in.	Interim Spec for Tar-rubber Binders†	Traffic††	Fuel Spillage	Condition as of Date Shown	Maintenance	Climatological: Temperature Mean Max Deg F	Temperature Mean Min Deg F	Annual Avg Precip	Remarks
													Davis-Monthan AFB, Tucson, Ariz.					
Aprons (maint and alert) taxiway	1953	0 25 0 25	C-2 C-2 SAS SAS	1-1/2 1-1/2 1-1/2 1-1/2	2,712(a) 6,400(a) 1,774(a) 11,300(a)	--- --- --- ---	3.7 5.4 --- ---	AC AC	1-1/2 1-1/2	Was not tested until after distress occurred. Did not meet interim specifications	Only vehicular type first year. Small number jet-fighter type during 1956	Considerable spillage on apron but no apparent damage	4/55 - Shrinkage cracks and open joints 1/4 in. wide, 1/2 in. deep. 6/55 - Numerous shrinkage cracks and open joints. 10/55 - No traffic to date. More than 50% SAS section contains cracks. Lesser amount in C-2 area. 10/56 - Progressively worse cracking in SAS paving. Still only minor cracks in C-2 pavement. 3/57 - C-2 now cracked. Considerable cracking in both types.	Cracks and open joints sealed in summer of 1956	82.8	56.4	11	(a) Data from recompacted cores
													Dover AFB, Dover, Del.					
Apron	1955	16	SAS	1-1/2	3,209(b) 3,052(b) 3,743(c) 3,569(c)	153 151 151 150	6.8 7.7 7.6 8.1	AC	2-1/2	Tested, met interim specifications	Very minor amount. None in most areas	Considerable spillage during servicing but no apparent damage	10/56 - Surface appears to be in good condition. Construction joints are rough. 7/57 - Many shrinkage cracks and open joints in areas of no-traffic, although some no-traffic areas have no cracks. Similar condition in trafficked areas. 6/58 - Cracking had not progressed to any great extent since last inspection. Some joints had closed and cracks had healed, but most remained open. No definite crack pattern. Still areas with no cracks in both trafficked and untrafficked areas. A seal coat was proposed for the apron surface.	None	64.9	45.4	45	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas
													Dow AFB, Bangor, Maine					
Apron	1954	12	SAS	1-1/2	1,930(b)	150	4.5	AC	2-1/2	Tested, met interim specifications	KC-97 and F-86 types, moderate to intense	Considerable spillage in all areas. No serious damage. Aircraft wheels have caused some minor depressions in soft areas	6/55 - National Guard apron, no cracking or softening in spillage areas. 10/56 - National Guard apron has few cracks but nearly all joints are open slightly. Main apron has few cracks in older portions and joints are generally open. Some cracking appears to be from overload. 7/57 - 1956 pavement appeared in good condition. 1955 construction had many shrinkage cracks and open joints. 1954 pavements had wide cracks and joints open as much as 3/4 in. Most serious distress was in KC-97 traffic lane. 6/58 - It was believed that additional cracking had occurred since the last inspection and that the cracks definitely opened and closed with changes in temperature. No apparent difference in two types, cracking was as severe in one as the other. The newer (1956) pavements contained as many cracks as the older ones. A seal coat was proposed for the apron surface.	Only minor sealing of cracks	58.8	35.5	40	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas
Apron addn's	1955	12	SAS	1-1/2	1,857(c)	149	5.2											
Apron addn's	1956	--	---	-----	---	---	---											
National Guard	1954	--	---	-----	---	---	---											
													Goose Bay AFB, Labrador					
Apron	1954 1955	+36 +24	SAS SAS	1-1/2 1-1/2	2,271 1,756	160 151	3.9 6.3	AC AC	2-1/2 3-1/2	Tested, met interim specifications	Light to moderate intensity by MATS type	None observed	6/57 - Surface texture was good. No open joints. Very few shrinkage cracks. More cracks in overlay on portland-cement concrete than other areas.	None	54.0	20.0	27	
													Hanscom AFB, Bedford, Mass.					
E-W runway (1000 ft each end)	1955	18	SAS	1-1/2	---	149(b)	4.1	AC	1-3/4	Not tested	Moderate to intense on runway and connecting taxiway	Some isolated areas but no damage	10/56 - All areas in good condition. Occasional open joint observed. Joint separation between portland-cement concrete and tar-rubber pavement. 7/57 - Appreciable shrinkage cracks have developed in SAS, only a few in C-2. Joints are open in both types. 6/58 - Shrinkage cracks and open joints have continued to develop since the last inspection. Cracks were both transverse and longitudinal but in no definite pattern. Cracks had been sealed but had reopened. Flintbinder C-2 appeared in better condition than the SAS.	None	55.7	43.2	38	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas
Taxiway (alert)		18	SAS	1-1/2	---	147(c)	5.7	AC	1-3/4									
Apron		18	C-2	1-1/2	---	148(b)	5.3	AC	1-1/2									
Taxiway (connecting)		18	C-2	1-1/2	---	146(c)	6.2	AC	1-1/2									
													Hickam AFB, Hawaii					
Apron	1956 and 1957	0 5	SAS	1-1/2	3,144(d) 2,822(e) 3,207(f) 3,358(g) 3,460(h) 3,564(i)	153 153 153 155 154 153	2.1 5.9 2.9 2.9 2.4 2.6	AC	2-1/2	Tested, met interim specifications	Moderate intensity from MATS type aircraft	Some damage from spillage in parking areas. Fuel is penetrating surface, causes soft areas	10/57 - Random cracks 5-10 ft in length by 1/8 in. wide. Network of hairline cracks in spillage areas. Map cracking and some bleeding in traffic lanes.	Surface cracks sealed with rubberized-tar emulsion, but did not prove satisfactory	76.0 (avg annual)		26	(d) From spillage area (e) Hairline cracked areas (f) Open cracked areas (g) Crazed areas (h) From cold joint (i) From areas of bleeding
													Homestead AFB, Homestead, Fla.					
Parking apron taxiway 1000-ft runway ends	1955	12	SAS	1-1/2	6,829(b) 5,993(c)	137 137	8.6 8.5	AC	2-1/2	Tested, met interim specifications	Very intense traffic by B-47 and KC-97 since opened for operations	Extensive fuel spillage on apron. Only damage is to AC binder where fuel penetrates through cracks in surface course	3/56 - Rubberized-tar pavements in very good condition. 7/56 - Pavements remain in good condition. Jet blast eroded surface on runway ends. 10/56 - Cracks appear in depressed areas caused by channelized traffic. 5/57 - Channelized traffic continues to produce deformation and cracks in pavement. 4/58 - Cracks parallel to joints and in interior of lane and severe localized map and alligator cracks are beginning to appear on apron. Runway ends still remain in good condition.	None to rubberized-tar pavements other than patching depressed areas on taxiway	84.6	62.6	62	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas

(Continued)

* Age shown is that at which samples were obtained for test results shown or if no tests performed the age at which the pavement condition was last observed.
** SAS, Surfa-aero-sealz rubberized-tar binder; C-2, Flintbinder rubberized-tar binder; Jetlock rubberized-tar binder.
† Waterways Experiment Station laboratory tests performed for rubberized-tar binding agent only.
†† MATS, Military Air Transport Service type aircraft generally include C-54, C-97, C-119, C-121, C-123, C-124, and C-135.

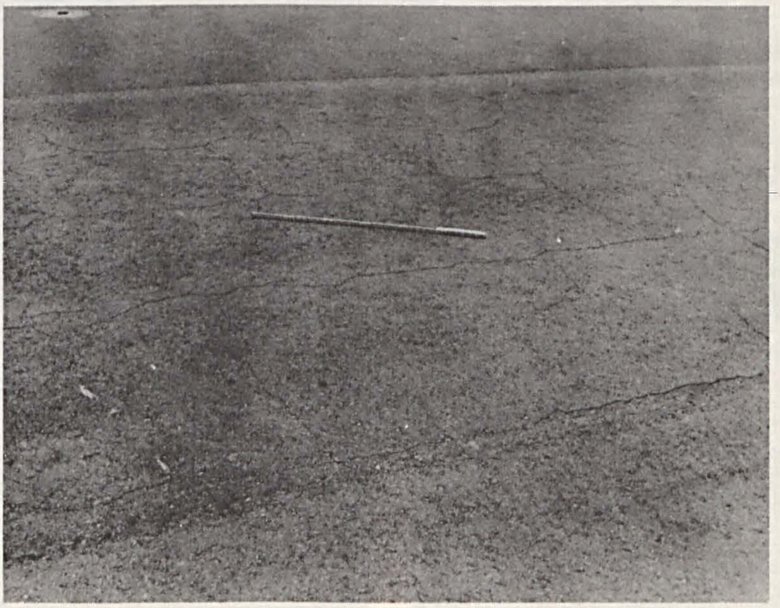
Table 1 (Concluded)

Facility	Year Const	Approx Age mo	Surface Course Type	Surface Course Thick. in.	Surface Course Stability lb	Surface Course Density lb/cu ft	Surface Course VTM %	Binder Course Type	Binder Course Thick. in.	Interim Spec for Tar-rubber Binders	Traffic	Fuel Spillage	Condition as of Date Shown	Maintenance	Climatological Temperature Mean Max Deg F	Climatological Temperature Mean Min Deg F	Climatological Annual Avg Precip	Remarks
McChord AFB, Tacoma, Wash.																		
Refueling apron	1953									Not tested	T-33, F-86, and F-89 types have applied very intense traffic	Fuel ponded in some areas and has penetrated through surface. Destroyed bond with binder	4/55 - Severe shrinkage and separation of both longitudinal and transverse construction joints adjacent to refueling hydrants. 12/55 - Distress noted in previous inspection repaired. Joints appear porous, but actually only a few are opening. Absolutely no distinction can be made between C-2 and SAS. 7/56 - Some cracking along longitudinal and transverse joints; more severe around tie-down anchors and refueling pits, but is most severe in areas of fuel spillage. General condition can be considered fair.	Some depressions patched with AC and joints and cracks sealed with jet-fuel resistant joint sealer. All appear satisfactory	58.5	41.6	38	
South half		20	SAS	1-1/2	2,950	145	4.1	AC	1-1/2									
North half		20	C-2	1-1/2	4,300	145	3.9	AC	1-1/2									
MacDill AFB, Tampa, Fla.																		
Apron (transient)	1955	--	SAS	1-1/2	---	---	---	Double surface treatment on 6-in. base course		Tested, met interim specifications	Very light intensity by C-119 and C-123 types	Some slight discoloration	7/56 - Surface in good condition, few shrinkage cracks. 5/57 - Shrinkage cracks within lanes. Numerous open joints. 4/58 - Numerous shrinkage cracks and open joints. Some cracking appears to be from excessive loads.	None	82.1	66.0	49	
Presque Isle AFB, Presque Isle, Maine																		
N-S runway (incl test panels)	1952	0	C-2	1-1/2	1,700	148	4.9	AC	1-1/2	Tested 1955 blend only. Met interim specifications	Moderate to very intense. Many different types. Greatest amount by T-33 and F-89	Some fuel spillage but no apparent damage	4/53 - Few cracks and open joints in C-2 11/53 - Additional open joints and some raveling. Some surface erosion. 4/54 - Several additional full length joint cracks, minor raveling and web cracking. SAS and C-2 withstanding jet blast very well. 10/56 - Test panels, SAS and C-2 appear better than tar but not as good as asphalt. Apron surface appears coarse and rough but no evidence of distress. 7/57 - Considerable cracking and open joints of 1/2 in. on apron. 6/58 - Cracks on old Hi-flight apron had been sealed but generally reopened. Cracks in new (1957) apron were reflection type from underlying portland-cement concrete. The apron extension contained a few shrinkage cracks and open joints. A slurry seal was proposed for the newer parking apron.	Panel of SAS removed after aircraft fire. Replaced with asphalt cement	49.6	28.3	34	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas
		0	SAS	1-1/2	1,348	149	4.2	AC	1-1/2									
		12	C-2	1-1/2	1,697(b)	150	4.5	AC	1-1/2									
		12	SAS	1-1/2	2,181(b)	151	3.4	AC	1-1/2									
		12	C-2	1-1/2	1,724(c)	151	4.1	AC	1-1/2									
		12	SAS	1-1/2	1,797(c)	152	2.4	AC	1-1/2									
Apron	1955		C-2	---	---	---	---	--	-----									
Apron ext	1957		---	---	---	---	---	--	-----									
Thule AFB, Greenland																		
Apron	1956	--	---	---	---	---	---	--	-----	Tested, met interim specifications	Moderate intensity, cargo aircraft	Moderate around refueling pits	6/57 - About three times as many transverse cracks as longitudinal. Joints rough textured.	None	45.0	-27.0	2.5	
Walker AFB, Roswell, N. Mex.																		
Alert apron	1954	0	SAS	1-1/2	2,970	143.2	3.5	AC	2-1/2	Tested 1955 blend only. Met interim specifications	Light to moderate on alert apron. Moderate to very intense on parking apron by B-36, B-47, KB-29, and KC-97	No apparent damage from fuel spillage	8/54 - Coarse and rough surface texture. Some open joints and shrinkage cracks. 11/55 - Alert apron surface is grayish in color. Considerable shrinkage cracks and open joints on apron. No difference in surface of SAS and C-2. 4/56 - Alert apron has open joint between SAS and C-2 sections. Fine hairline cracks in C-2. Parking has open joint between rigid pavement and Jetlock. 10/56 - Extensive cracking in SAS and C-2 on alert apron. Extensive rutting in taxilane on parking apron.	None	76.6	42.0	13	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas
East half		0	C-2	1-1/2	2,494	144.9	3.5	AC	2-1/2									
West half		20	Jet-lock	1-1/2	2,859(b)	149	2.2	AC	2-1/2									
Parking apron	1955	20	Jet-lock	1-1/2	2,894(c)	147	3.5	AC	2-1/2									
West Palm Beach AFB, West Palm Beach, Fla.																		
Aprons (overlay)	1955 and 1956	18	Jet-lock	1-1/2	3,410(b) 3,095(b) 2,835(c) 3,955(c)	139 138 139 139	2.1 3.2 2.9 2.6	AC	4-1/2	Tested, met interim specifications	Moderate to intense by C-124 and B-50 types	Some discoloration of surface. Asphalt in binder extrudes through cracks in surface where fuel has penetrated	3/56 - Joints and cracks in underlying portland-cement concrete are showing through overlay. No cracks in all flexible pavement. 10/56 - Some raveling along cracks over portland-cement concrete joints. Cracks are much wider. Some cracking in interior ~~of lane on apron A.~~ 4/58 - Cracks over joints in portland-cement concrete are wider and pieces of pavement are breaking out. Minor shrinkage cracks in flexible pavement on apron C.	None	81.1	68.6	59	(b) Cores obtained from traveled areas (c) Cores obtained from untraveled areas
Williams AFB, Chandler, Ariz.																		
Parking apron	1954									Not tested until after distress occurred. Did not meet interim specifications	Intense first 18 months by T-33; light to moderate and only transient A/C since 10/57	Some discoloration to surface but no actual softening of pavement	12/54 - Numerous cracks in SAS. C-2 section in good condition. 1/56 - Transverse, longitudinal, and shrinkage cracks in SAS. Few cracks in C-2. Joints appear porous. Surface of both sections has "elephant hide" appearance. 7/57 - Slurry seal applied in spring had cracked and wrinkled over all joints. 10/57 - Cracking through seal coat growing progressively worse. Spillage test conducted by WES. No severe damage to pavement.	Construction joints and cracked areas sealed. Slurry seal coat applied to entire apron surface in March 1957	85.3	54.1	8	(a) Data from recompacted cores
West half		0	C-2	1-1/2	2,300(a)	---	---	AC	3									
		10	C-2	1-1/2	5,400(a)	---	---	AC	3									
		17	C-2	1-1/2	7,500(a)	---	---	AC	3									
East half		0	SAS	1-1/2	2,400(a)	---	---	AC	3									
		10	SAS	1-1/2	9,800(a)	---	---	AC	3									
		17	SAS	1-1/2	14,000(a)	---	---	AC	3									

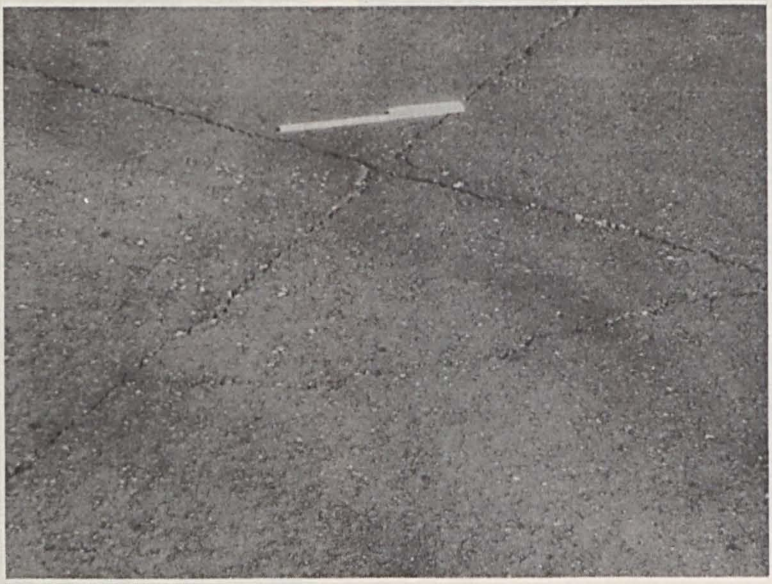


Photograph 1. Effect of jet blast on rubberized-tar surface

Photograph 2. Typical surface texture of rubberized-tar concrete



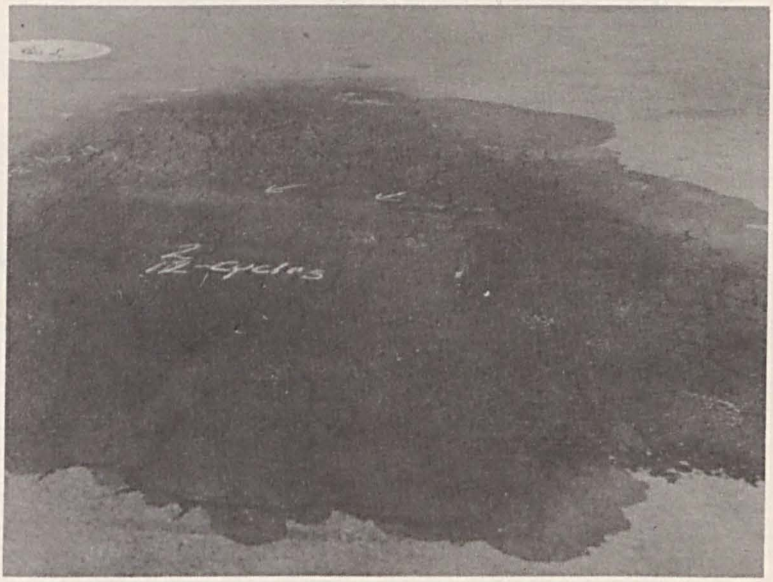
Photograph 3. Rectangular block pattern formed in advanced cracking stage



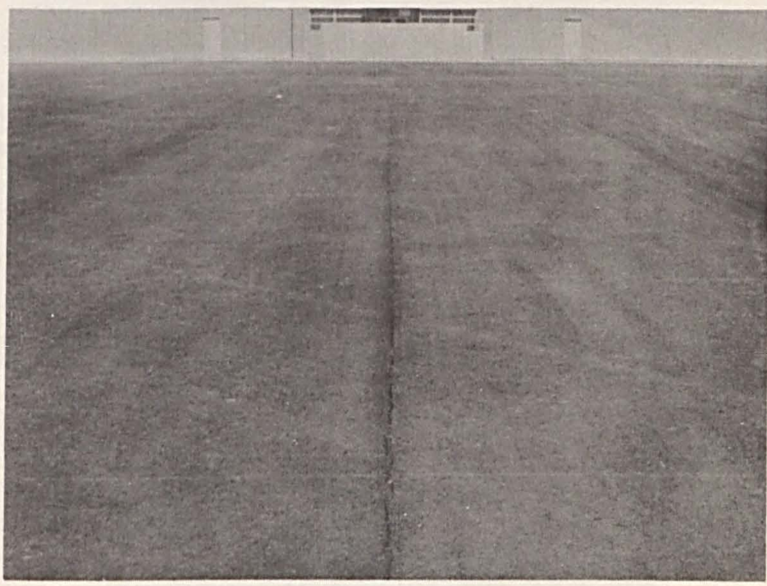
Photograph 4. Reflection cracks

Photograph 5. Shrinkage cracks

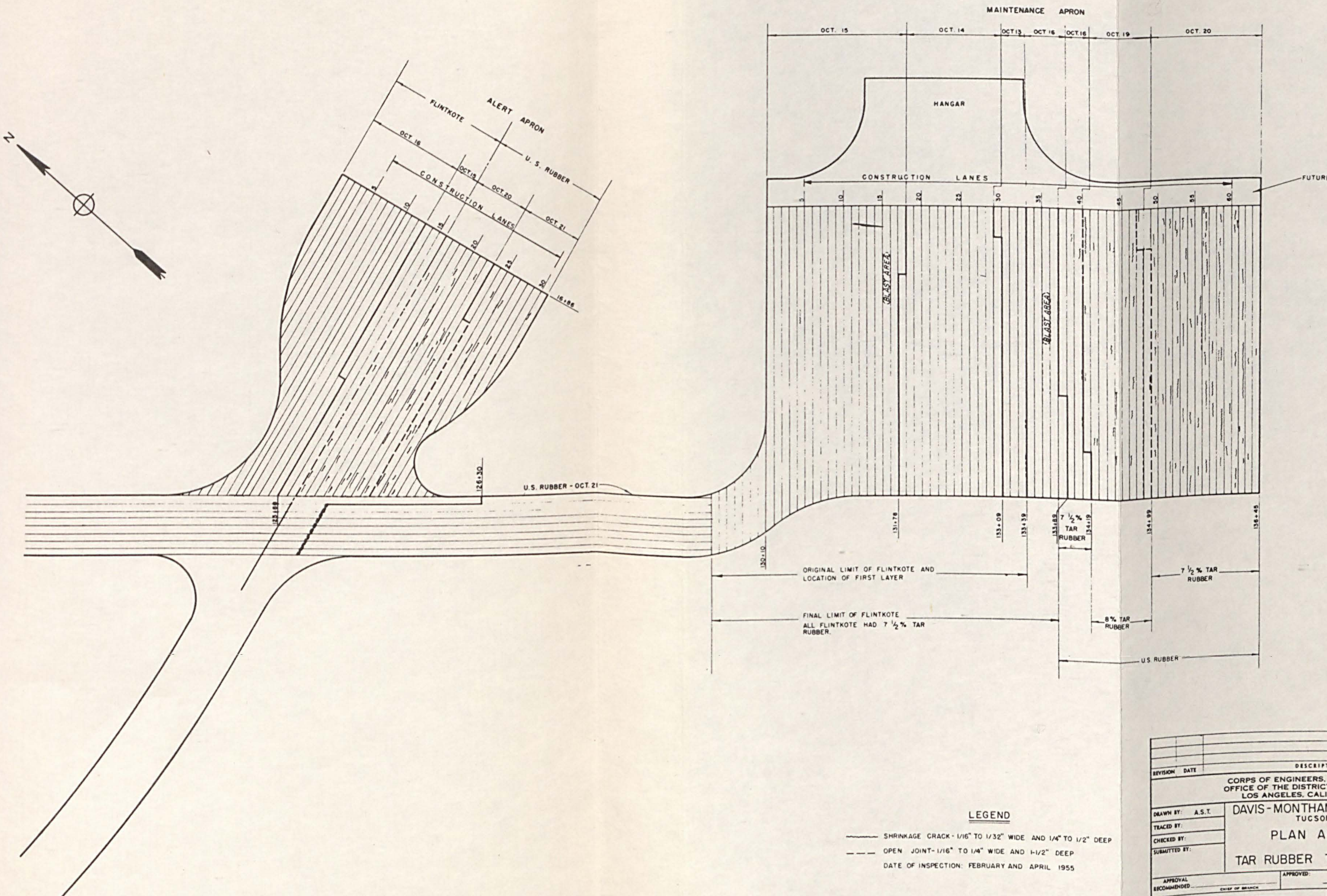
Photograph 6. Cracks from excessive loads



Photograph 7. Cracks in area of jet-fuel spillage



Photograph 8. Open construction joints



LEGEND

SHRINKAGE CRACK - 1/16" TO 1/32" WIDE AND 1/4" TO 1/2" DEEP

OPEN JOINT - 1/16" TO 1/4" WIDE AND 1-1/2" DEEP

DATE OF INSPECTION: FEBRUARY AND APRIL 1955

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
LOS ANGELES, CALIFORNIA

DRAWN BY: A.S.T.
TRACED BY:
CHECKED BY:
SUBMITTED BY:

DAVIS-MONTHAN AIR FORCE BASE
TUCSON, ARIZONA

PLAN AND DETAIL OF TAR RUBBER TEST PAVEMENTS

APPROVAL RECOMMENDED ________ CHIEF OF BRANCH

APPROVED: ________ CHIEF, ENGINEERING DIVISION

DATE: FEB. 1955

PREPARED UNDER THE DIRECTION OF
ARTHUR ... COL. ... DISTRICT ENGINEER

DRAWING NO. AF 45-04-01
SHEET 1 OF 1

SCALE: 1 INCH = 50 FEET

SPECIFICATIONS NO.

D. O. SERIES AF 1342/86

PLATE 1

29683