8. PROBLEM AREAS ASSOCIATED WITH THE CONSTRUCTION AND OPERATION OF THE LANDING RESEARCH RUNWAY AT NASA WALLOPS STATION

By Curtis R. Allen and James W. Quillen

NASA Wallops Station

SUMMARY

This report covers the final phases of the construction of a landing research facility at the NASA Wallops Station which was begun late in 1967 and completed early in 1968. The test area had grooved and ungrooved sections of concrete and asphalt with various types of finishes. Also discussed are the problem of finding a suitable method for containing predetermined depths of water and slush required for the various tests and the solution of this problem. Problem areas encountered are cited and some adverse side effects which the tests brought to light are described in detail.

INTRODUCTION

The landing research runway at NASA Wallops Station is unique in that it was constructed for the primary purpose of testing the effectiveness of pavement grooving in increasing aircraft take-off and landing performance on dry, wet, water-flooded, and slush-covered runways having different surface textures. Also, the runway had to be of such configuration that normal aircraft operations could be conducted at other times. A secondary purpose of the landing research runway is to determine the effects of aircraft loading and climatic conditions on the life of grooved runways with both asphalt and concrete surfacing materials.

DISCUSSION

Runway 4-22 is the landing research runway at Wallops Station. The runway is 8750 feet long and 150 feet wide; the test section, which is almost centrally situated, is 3450 feet long and extends 25 feet on either side of the runway center line. Figure 1 shows the test section relative to the overall length and width of the runway.

Test surfaces A, B, C, D, F, G, H, and I are 350 feet long; surface E is 650 feet long. The grooves in sections B, C, G, and H are 1/4 inch deep by 1/4 inch wide and are cut on 1-inch centers. This grooving represents the most effective pattern thus far determined (provides the highest friction coefficient). The various sections of the test area have the following construction and finish (see table I of ref. 1 for detailed description):

Surface A – Ungrooved concrete with canvas belt surface finish (fig. 2)

Surface B – Grooved concrete with canvas belt surface finish (fig. 3)

Surface C – Grooved concrete with burlap surface finish (fig. 4)

Surface D – Ungrooved concrete with burlap surface finish (fig. 5)

Surface E – Ungrooved, smooth rock asphalt (Gripstop) (fig. 6)

Surface F – Ungrooved, smooth, small aggregate asphalt (3/8 inch or less) (fig. 7)

Surface G – Grooved, small aggregate asphalt (3/8 inch or less) (fig. 8)

Surface H – Grooved, large aggregate asphalt (3/4 inch or less) (fig. 9)

Surface I – Ungrooved, smooth, large aggregate asphalt (3/4 inch or less) (fig. 10)

This test area was designed to be as flat and level as possible by using standard construction methods to aid in maintaining the constant depth of water or slush necessary for obtaining reliable data during the tests. The rest of the runway proper is crowned to the standard 1-percent slope to permit water runoff (fig. 1).

When the grooving machine is cutting, it is necessary to continually cool the diamond-tipped cutting blades with water to prevent them from overheating. In the cutting process on concrete, the dust created combines with the water and forms a fine slurry which must be cleaned off the runway by high-pressure washing before it dries and hardens. The reason that the runway must be thoroughly washed was shown in actual tests by both the McDonnell Douglas F-4D and the Convair 990 aircraft. As these aircraft made repeated runs over the grooved concrete sections, large amounts of concrete dust were blown loose by the jet blasts from the aircraft engines and formed huge dust clouds. These clouds were created from the cutting residue which had adhered to the wet runway surface; this indicated that sufficient care had not been exercised in the removal of the slurry. The dust clouds caused some photographic difficulties and resulted in reduced visibility to participating test personnel. This condition might very well pose a serious problem for busy airports where reduced visibility due to such dust could impair the safety of aircraft during landing roll-out and taxiing and also could create a problem for the control-tower operator in the control of air and ground traffic. It is quite conceivable that damage to jet engines could result from ingestion of this dust. Thus, quite a problem is created and it should be given serious consideration in any future grooving on concrete surfaces.

An unsatisfactory occurrence took place on grooved asphalt sections G and H. During routine inspection following each braking run, it was discovered that the asphalt grooves were being completely obliterated during hardover 180° turns by the 990 aircraft. Figure 11 shows the damage produced by a 180° hardover turn made by the 990 aircraft on the grooved asphalt surface. Some damage occurred also on the ungrooved sections.

Another problem associated with grooving occurred on the large aggregate asphalt section H where the 1/2- and 3/4-inch aggregate stones had a marked tendency to break loose from the grooved surfaces. Because of this problem, numerous runway inspections and sweepings were necessary to keep the runway clean. These stones, if left on the runway, would present a most serious hazard to jet aircraft because of possible ingestion into the engines. Therefore, the continual care required to keep this particular type of surface clean is believed to be too extensive to justify grooving on asphalt with aggregate greater than 3/8 inch in diameter.

Probably the most significant problem that had to be resolved before completion of the landing research facility was the method of containing the desired level of water and slush so necessary in the varying nature of the different tests scheduled. Specifically, the problem was to maintain a given depth of water or slush on adjoining grooved and ungrooved sections while maintaining comparatively dry surfaces on the rest of the runway. The following significant requirements had to be kept in mind in the solution of this problem:

(1) Selection of materials with near watertight capabilities yet durable enough to withstand repeated braking and skidding runs

(2) Means for immediate drainage of wet sections with the capability for instant flooding of adjacent sections

(3) Minimum amount of shock to the aircraft landing gear during roll-out and braking runs, which might adversely affect data readings and computations

(4) Simplicity of installation and maintenance

No previously known method or published data were available for the construction of a test facility meeting all the preceding requirements. Therefore, the Contractual and Support Services Branch at Wallops Station was given the task of designing a dam to enclose the test section of the runway and to further subdivide the several sections to provide the varying water and slush depths required.

After numerous methods and plans were discussed, tested, and discarded, the idea of inserting rubber belting into a groove cut into the runway surface was conceived. The procedure used in construction of the prototype of the test model (fig. 12) was as follows: a groove 1 inch deep and 5/16 inch wide was cut in a standard piece of 2- by 4-inch wood framing, and a two-ply canvas-reinforced rubber belting $2\frac{1}{2}$ inches wide and 17/64 inch thick was inserted in the groove. This produced a somewhat snug fit while still allowing the rubber belting to fit fairly easily into the groove. The information gained from this model was then applied to the research runway. A groove 1 inch deep and 10 feet long was cut into one of the concrete sections of the landing research runway. A 10-foot length of rubber belting was inserted into this groove, over which numerous high-speed runs were made with a heavy truck. Some runs were made with locked brakes to determine whether the belting would hold in the grooves, withstand tearing or stretching, and retain its resiliency. It was noted that the passage of the truck wheels over this piece of rubber belting in no way damaged or dislodged the material, nor did it cause the wheels to bounce or swerve. Thus, this system seemed to meet all the test requirements with the exception of providing a constant water level; this requirement still had to be investigated. Therefore, a groove 1 inch deep and 5/16 inch wide was cut around the full perimeter of the 3450-foot-long test area and across each 350-foot section. When these grooves were finished, four men installed the 7400 feet of rubber belting in less than 8 hours. Tests showed that this system did perform the desired function. Hundreds of subsequent tests have proved the durability of both the grooves and the rubber belting. The rubber belting was easy to install and it was a simple matter to lift out selected sections of belting on a previously flooded section for drainage while an adjacent section was being flooded. The consensus of the Project Engineers and all participants of the tests conducted thus far is that the conception, the development, and the final installation of this rubber dam system was perhaps the most important single factor which contributed to the immediate and rapid success in carrying out the actual test operations.

No damage to concrete sections has been experienced thus far in the tests. However, surface damage has resulted from turns on asphalt sections and this alone points to the obvious need for having all aircraft roll free of grooved asphalt surfaces prior to making hard turns on the runway. Furthermore, on the basis of results obtained thus far, aggregate larger than 3/8 inch is not recommended as a wearing course.

CONCLUDING REMARKS

Tests made on the NASA landing research runway brought to light these adverse side effects of runway grooving on concrete and asphalt surfaces:

(1) The reduced visibility due to the concrete dust

(2) The surface failure of aggregate asphalt materials used in sections G and H

(3) The possibility of foreign object damage that can occur when large aggregate (larger than 3/8 inch) is used as a wearing course in asphalt

All these problems are considered to be easily resolved. It is recommended that airport planners contemplating runway grooving on concrete or asphalt surfaces take into consideration these known adverse effects prior to grooving operations.

Continued surveillance and investigation of all damage, wear, and unsatisfactory occurrences will be noted and documented for publication.

REFERENCE

1. Horne, Walter B.: Results From Studies of Highway Grooving and Texturing at NASA Wallops Station. Pavement Grooving and Traction Studies, NASA SP-5073, 1969. (Paper 26 herein.)

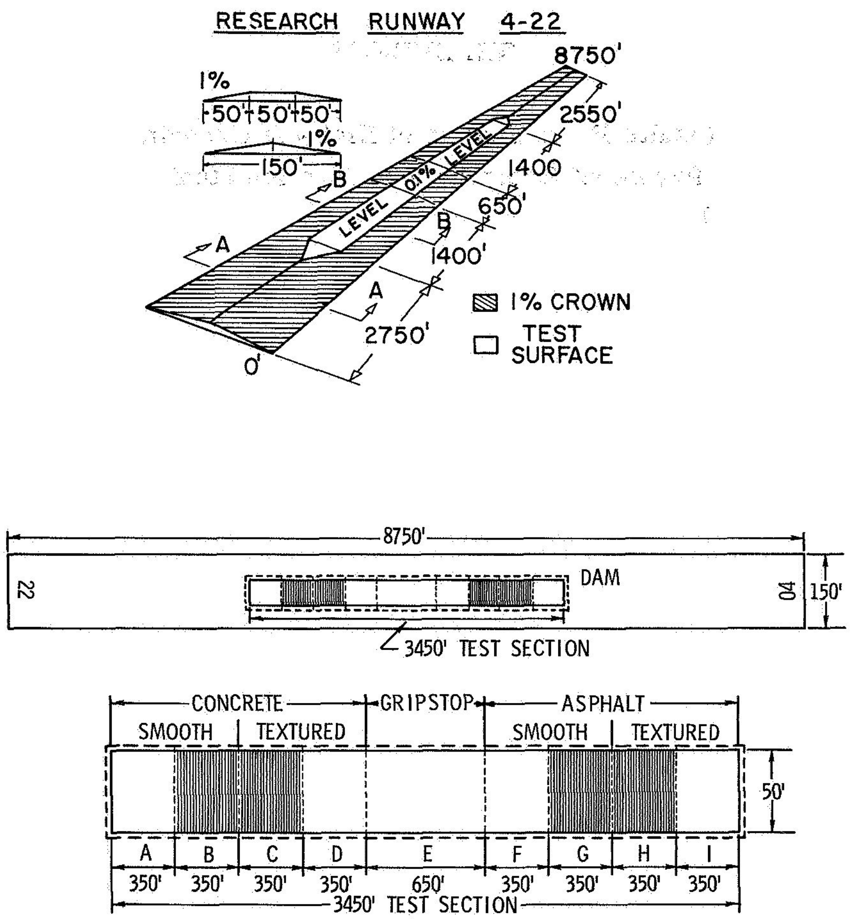

Figure 1.- Landing research runway 4-22 at NASA Wallops Station.

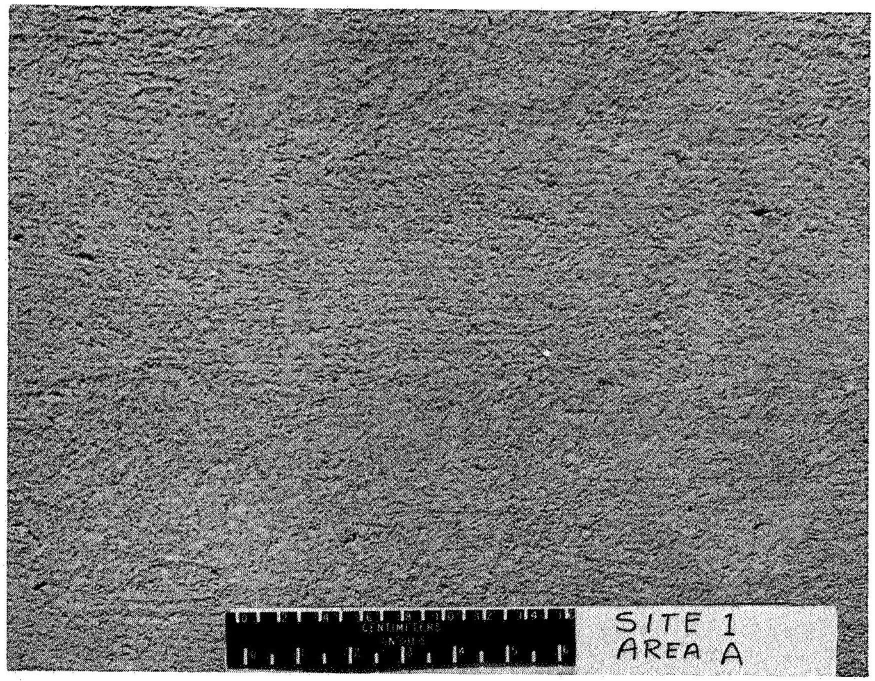

Figure 2.- Surface A.

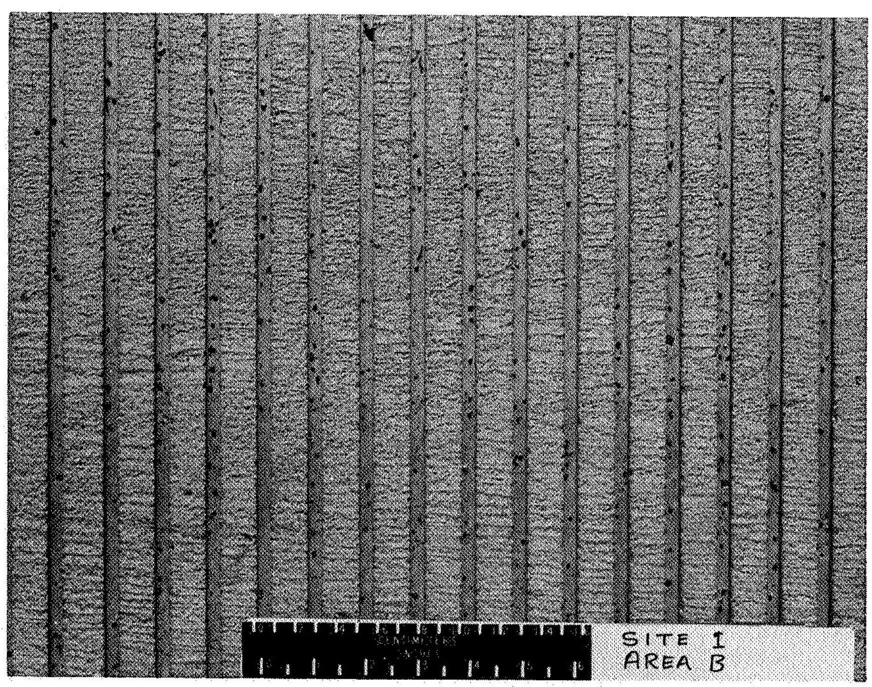

Figure 3.- Surface B.

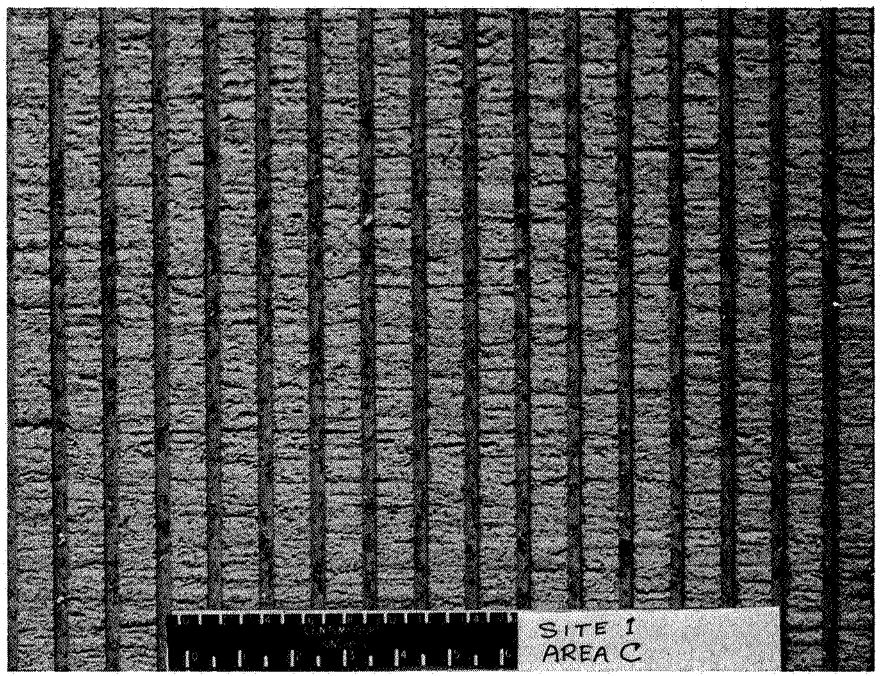

Figure 4.- Surface C.

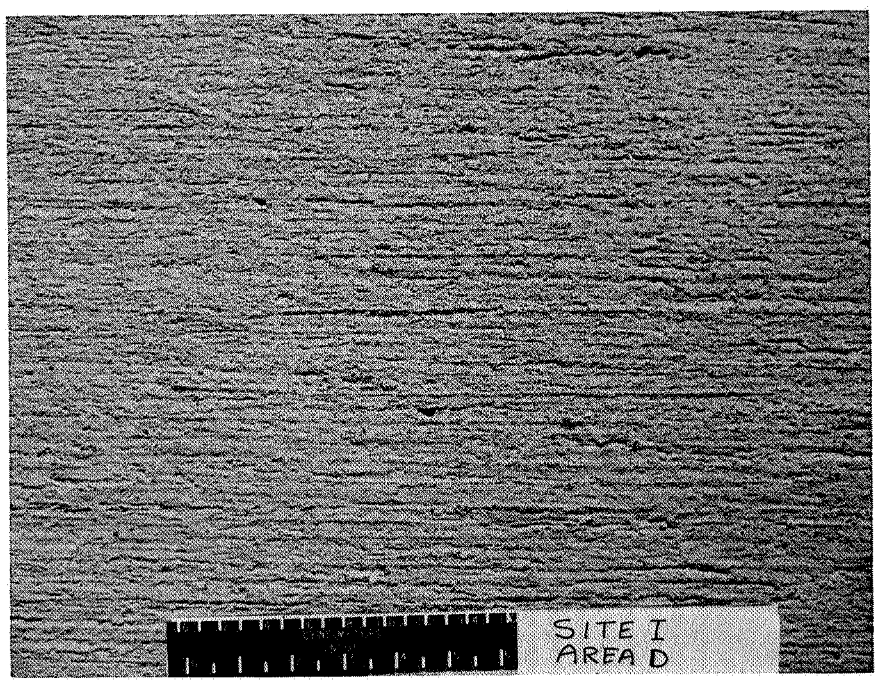

Figure 5.- Surface D.

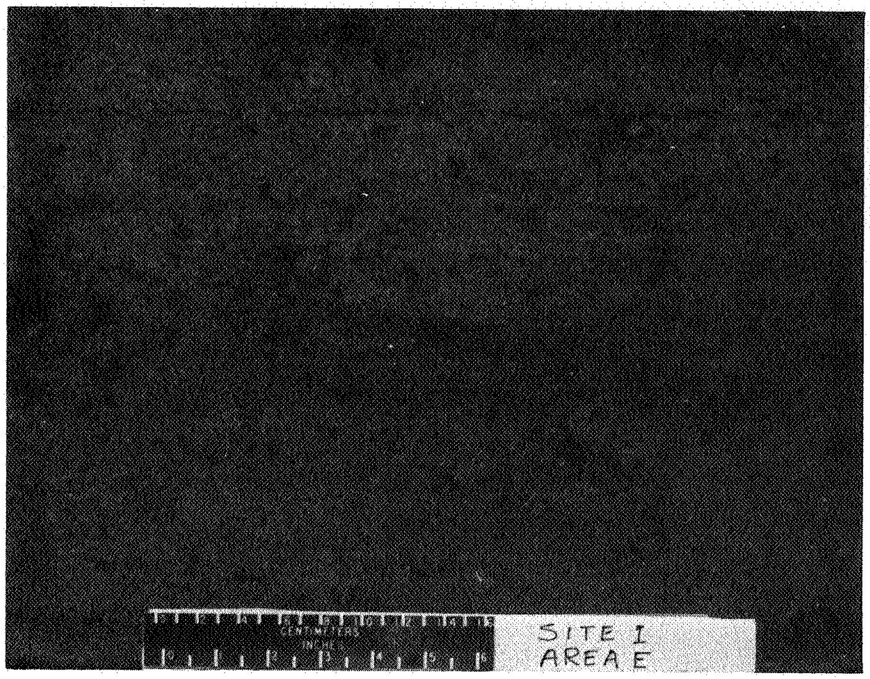

Figure 6.- Surface E.

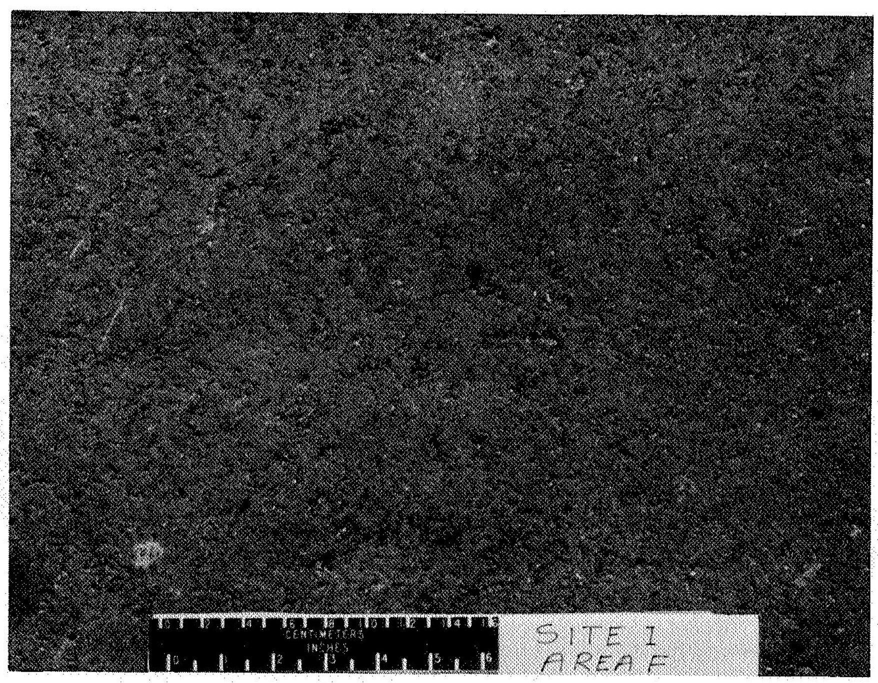

Figure 7.- Surface F.

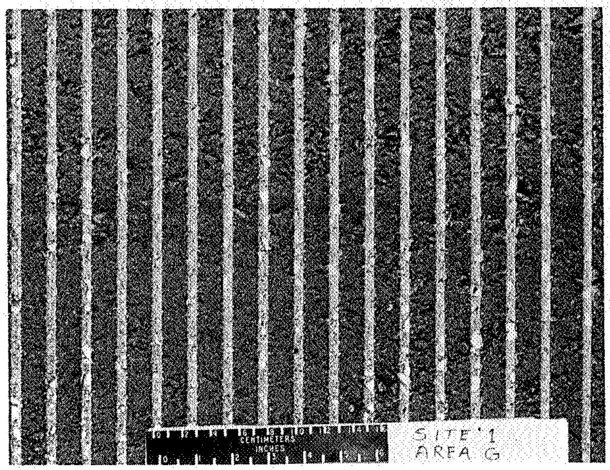

Figure 8.- Surface G.

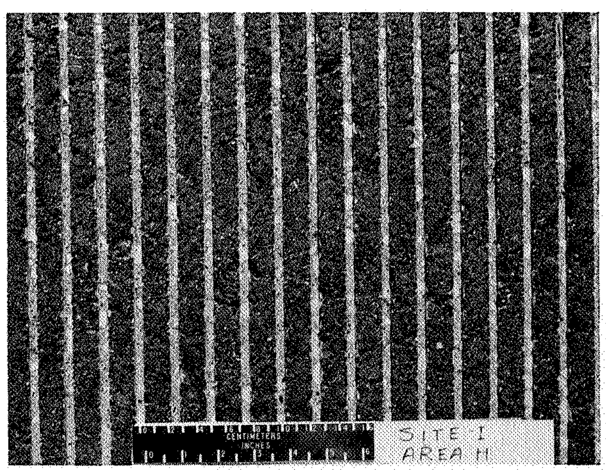

Figure 9.- Surface H.

Figure 10.- Surface I.

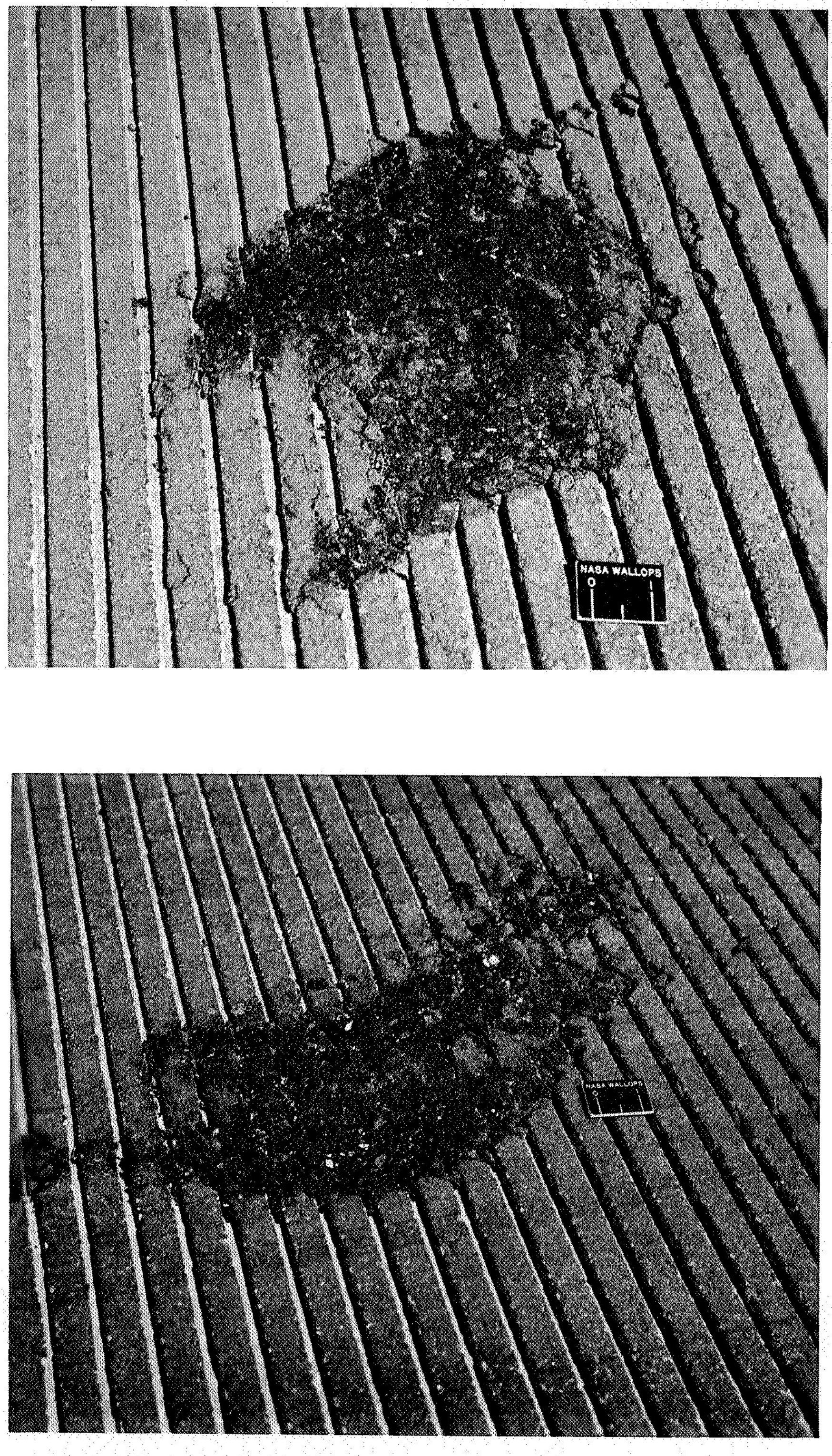

Figure 11.- Damage produced by 180° hardover turn by 990 aircraft on grooved asphalt surface.

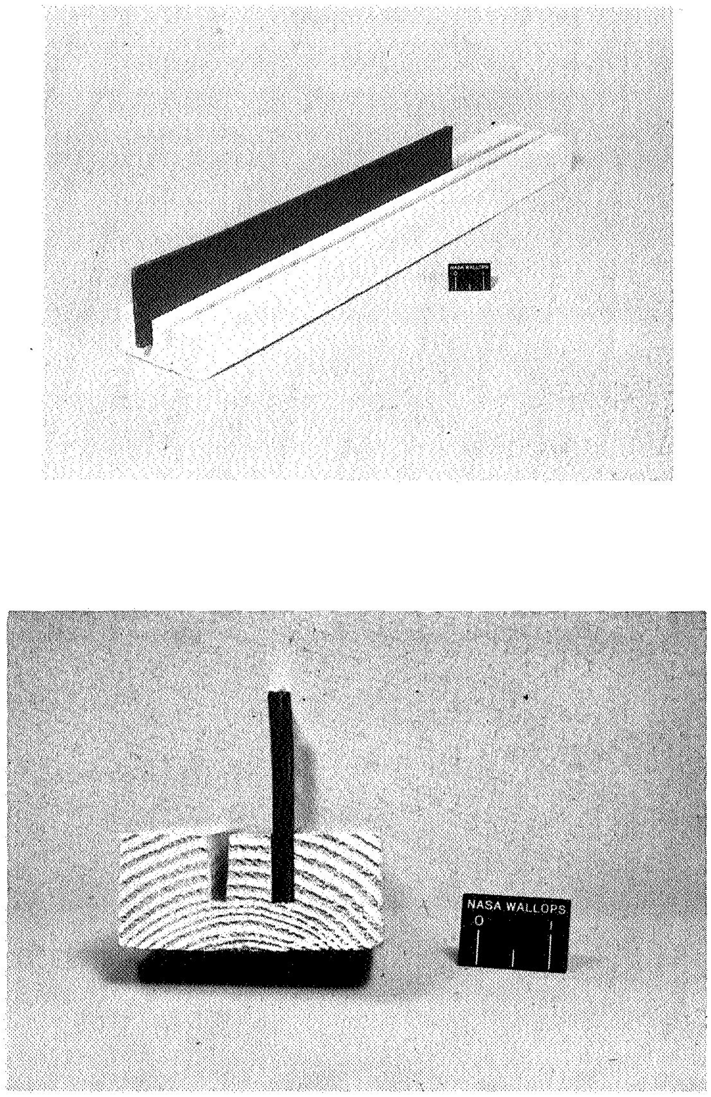

Figure 12.- Model of belting-groove system.