An Overview of the Annual NASA Tire/Runway Friction Workshop and Lessons Learned

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ABSTRACT

This paper summarizes the organization efforts, objectives, scope, agenda, test procedures and results from eleven years of conducting the NASA Tire/Runway Friction Workshop. The paper will also summarize the lessons learned between 1994 and 2004. A description of the various friction, texture and roughness equipment used during these workshops at NASA Wallops Flight Facility on the eastern shore of Virginia will be provided together with the range of test surfaces available for evaluation. The need for friction measuring equipment calibration centers is discussed and plans for future workshops are identified.

KEYWORDS

Tire/pavement friction, pavement texture, surface roughness, test procedures

1. BACKGROUND AND TYPICAL AGENDA

The first annual NASA workshop was held in May 1994 at NASA Wallops Flight Facility on the eastern shore of Virginia near the town of Chincoteague. There were six (6) friction devices and six (6) texture techniques (no roughness measurements were taken) on 18 different surfaces by sixty attendees. At the eleventh annual workshop last year there were 14 friction vehicles, 5 texture and 5 roughness measurement devices evaluating 33 different test surfaces by nearly 100 attendees.

The overall, one week, workshop agenda starts on Monday with technical presentations describing new equipment, test techniques and projects. Prior to start of actual testing on Tuesday, a comprehensive safety briefing is held with all participants to insure operational safety and to emphasize the importance of maintaining communication with the tower at all times when out on the airfield. Tuesday morning is also used to inspect the test equipment and perform necessary pre-test calibrations and check-outs. Special daily data compilation sheets and run number designations are handed out to each operator. Tuesday afternoon through Friday morning, friction, texture and roughness measurements are collected and compiled at the end of each day.

Each test day morning, an overall briefing is held with all participants to review tests conducted the day before as well as the tests planned for that day. In addition, discussion at these morning briefings often provided solutions to problems encountered during the previous day. Everyone was made aware of which vehicles would be testing and at which of three test sites – runway 4/22, taxiway Echo and taxiway Alpha. Often during a workshop, a contractor would demonstrate installing different kinds of surface treatments including overlays, micro-surfacing, shotpeening, grinding, grooving and rubber removal.

For each year, a test procedures document is prepared as well as a test data compilation report. The procedures document lists the test equipment, the workshop attendees and includes copies of Monday's technical presentations. The data compilation report lists all the data collected for each test device in each of the three categories – friction, texture and roughness. All attendees are mailed copies of these documents and copies are made available at next year's workshop. Workshop group photographs are taken each year with prints made available to the individual participants. During most workshops, video coverage is also obtained to further document workshop activities and test operations. An edited, narrated video depicting the scope and objectives of these annual NASA workshops is also available upon request.

2. TEST EQUIPMENT

2.1 FRICTION

Both continuous friction measuring vehicles (CFME) and spot friction measuring devices (SFMD) perform dry, self-wet, water truck wet and rain wet tests on the surfaces at Wallops. Runs are conducted at fixed speeds from 8 to 96 kph (5 to 60 mph). The CFME equipment have included the runway friction tester, the surface friction tester, the IMAG and international reference vehicle, the GripTester, the Mu-meter, the BV-11 and BV-14, the airport surface friction tester, the OSCAR, ROAR, RUNAR and SALTAR. The SFMD equipment have included the NASA diagonal-braked vehicle and instrumented tire test vehicle, the E274 skid trailer, the dynamic friction tester and the electronic recording decelerometer.

2.2 PAVEMENT TEXTURE

Several different laser devices have been used together with a circular texture meter, a British pendulum tester and an outflowmeter. Two volumetric techniques, sand patch and grease test, have also been used to quantify the micro- and macro-texture characteristics of the different test surfaces.

2.3 PAVEMENT ROUGHNESS

Profiler devices, both light weight and high speed, have been used at Wallops along with a laser device, dipsticks and rod and level measurements.

3. TEST PROCEDURE

When aircraft traffic permits, all three test sites at Wallops are occupied with either friction, texture or roughness measuring equipment (see refs. 1-5). The friction devices concentrate on the eight (8), in-line, test surfaces on runway 4/22, test site 1 whereas the roughness equipment measures on taxiway Alpha, test site 3. The texture measuring equipment collect data on these two test sites as well as site 2, taxiway Echo.

Normally, it takes 4 to 8 hours for one test group to finish their evaluation of the different surfaces at a given test site. When appropriate, the friction, texture and roughness teams rotate to another test site and repeat their normal test procedure on a non-interference basis. Most friction and texture measuring equipment make a minimum of three (3) and often six (6) repeat measurements on a given test surface. Since the roughness measurements normally require more time to complete, one or two sets of data are collected on each test surface.

The importance of daily morning check-out of test equipment and careful calibration is stressed in order to minimize data inaccuracies and/or loss. Test equipment that operates at different speeds, such as the friction devices, are never mixed with the stationary texture and roughness devices. Data collection with the texture and roughness equipment also requires a dry surface condition so testing immediately after the self wet friction measurements is not feasible. The stationary, dynamic friction tester usually collects data with the texture measurement team. This friction device and the outflowmeter which both use water, are positioned to collect their data after the other texture measuring equipment. Care is taken not to measure friction or texture by other devices in pavement areas where the grease sample method had been used. This grease sample pavement area is normally not very large since only 1 cu.in. of grease is spread on the surface in a rectangular pattern. Normally, traffic and weathering removes the grease in 3 to 6 months.

For the friction measuring devices testing at 32, 64 and 96 kph (20, 40 and 60 mph) using self wetting, each repetitive run series with more than 4 vehicles is conducted by alternating the test vehicle run order. On the first series, the order would be A, B, C, and D, and then on the second series, D, C, B, and A. This change in order of the test vehicles would continue for all test series on each test surface.

4. LESSONS LEARNED

4.1 GENERAL

These are the major overall lessons that saved time, minimized repeating tests and helped insure safety of test personnel and equipment:

- Do not mix friction, texture and roughness equipment at the same test site
- CFME's should run before spot friction measurement devices
- Conduct most if not all tests in dry weather conditions
- Morning briefings for all test personnel is essential for efficient operation
- Difficult to obtain consistent, uniform wet surface conditions when relying on natural precipitation
- Daily test equipment checkout and calibration is critical to collecting acceptable data
- During tests conducted at active airports, communication is critical
- Document all test activities with video and photographic coverage
- Test time is minimized if different test surfaces are in line with each other

4.2 FRICTION TESTS

These are lessons learned in collecting data with the friction measurement equipment:

- Cannot mix different speeds when conducting tests with more than one device
- Found that self wetting at 1 mm (0.04 in.) provided repeatable and reliable data
- Wet surface evaluation for hydroplaning requires a minimum of three speeds
- For vehicle data comparisons, minimum of six (6) repetitive runs needed
- Normally data from first two runs are found to be outliers
- Test surfaces need to be at least 100m (300 ft) in length and 1m (3 ft) wide
- For vehicle data comparisons, lateral test surface displacement is desired
- If test surface width prevents lateral displacement of the different devices, the vehicle order must be changed for each test run on a given surface
- Vehicle data considered acceptable if within +/- 3 % of other similar vehicles
- Have individual vehicle operators evaluate their recorded data and submit summary report with data CD/floppy submittal

4.3 TEXTURE TESTS

These are lessons learned in collecting data with the pavement texture measuring equipment:

- Requires not only dry pavement surface but also one free of any loose material
- Sand patch texture measurements require wind protection
- A minimum of three (3) texture measurements required for each test surface
- For data comparisons on a given surface, use data average for each technique
- Manual data tabulation sheets on clipboards required for some techniques

- Have individual operators submit summary data compilation and evaluation report

4.4 ROUGHNESS TESTS

These are lessons learned in collecting data with the pavement roughness measuring equipment:

- Need test surface length which meets SAE and ASTM requirements
- Requires not only dry pavement surface but also one free of any loose material
- Conduct high speed vehicle test runs first followed by low speed and/or spot measurements
- Rod and level measurements should be taken at a minimum of 0.3m (1 ft) intervals for data comparison to other devices
- Manual data tabulation sheets on clipboards required for some techniques
- Have individual operators submit summary data compilation and evaluation report

5. FUTURE PLANS

The Twelfth Annual NASA Tire/Runway Workshop at Wallops Flight Facility, Virginia is scheduled for May 16-20, 2005. There is an eight person Russian group, a six person Canadian group and a five person Japanese group planning to be among the approximately 90 attendees. There will be participation by representatives from ten different countries operating friction, texture and roughness devices.

The Thirteenth Annual NASA Workshop will also be at Wallops Flight Facility, Virginia, May 22-26, 2006. New test surfaces will be available for participants evaluation and several improved friction, texture and roughness devices will collect data for comparison with other similar equipment. During the week prior to this workshop, May 15-19, 2006, there will be a meeting of PIARC Committee C1 on tire/pavement interaction and a joint meeting of ASTM E17 and F09 Committees on Vehicle-Pavement Systems and Tires.

For the past year, there has been a lot of discussion in the US and Canada on establishing regional calibration centers for the airport/runway friction measuring devices as well as definition of a practical and acceptable calibration procedure. A minimum of four (4) test surfaces with friction levels varying from 0.1 to 0.9 are suggested. In the US, calibration centers at Tampa, FL, State College, PA, Dallas, TX have been identified with hopes of getting two more on the West coast. Partnerships with small businesses, academia and government are envisioned to cover initial set-up costs with subsequent operational expenses covered by user fees. Efforts are continuing to get ICAO, FAA and Transport Canada support for these calibration centers

6. REFERENCES

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