MATES

MICHIGAN DEPARTMENT OF TRANSPORTATION

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MICHIGAN'S PAVEMENT FRICTION PROGRAM

Michigan motorists traveling the trunklines of our State are enjoying a greater degree of safety, thanks to a program devised and conducted by our Bureau of Highways. The big orange truck with the little orange trailer that travels around the State all summer spraying water on the pavement (and, alas, on the windshields of following motorists) is conducting pavement friction studies. As we discussed in our article in MATES Issue No. 27, pavement friction, or more accurately, the friction between pavement and tire, is what makes it possible to accelerate, steer, or stop a motor vehicle.

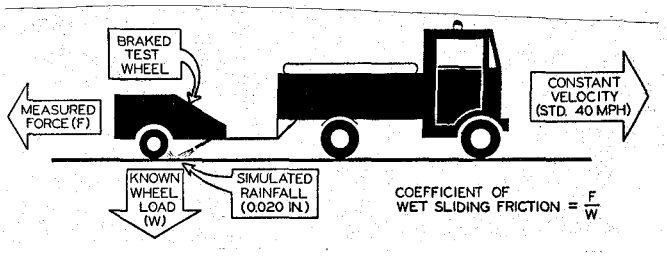
Michigan first began measuring pavement friction in 1947. Initially, it was measured by the stopping distance method; that is, wetting the pavement over an area of several hundred feet and then locking the brakes of a vehicle moving at 25 mph and measuring the distance required to come to a complete stop. There were four major problems with that method, 1) the entire lane to be tested was wetted and this required large quantities of water, 2) the vehicle, after locking wheels, could not be steered and sometimes spun around or slid sideways causing safety problems, 3) time required to make a test was so long that it would be impossible to run tests on the mass production scale considered necessary today, and 4) the section of roadway being tested had to be closed to traffic. Imagine the consequences of such a test method today on, say, the Lodge or Ford Freeways in Detroit.

Development and fabrication of a friction measurement trailer began in 1954. The first MDOT trailer, built by M&T's Research Laboratory, was constructed from a salvaged 1949 Buick automobile chassis and was the real pioneer in pavement friction research in the country. The tester utilized electrical strain gages mounted on structural members of the trailer to measure braking drag forces generated by the system under full lock-up of both trailer wheels. Large water tanks in the tow truck supplied water to spray nozzles ahead of the trailer tires to allow testing under specific wet pavement conditions. Incidently, the first tow vehicle used by MDOT was a dump truck that had been salvaged after being hit by a train. Early experimentation resulted in the development of the associated electronic instruments and calibration procedures, as well as standardized methods for testing. Results of these experiments showed variation of results with speed, temperature, type of surface, time of year, type of tire, etc. Continuing development of the equipment led to a more versatile, accurate, and dependable system, with newer and better trucks to pull the trailer.

One of the significant findings of the early work was the influence of tire type on results. This led to adoption of a standard test tire in 1963. All design features and rubber compounds to be used were established by the American Society for Testing and Materials (ASTM). This was followed in 1965 by adoption of a standard test method also established by the ASTM. Equipment specifications, test and calibration methods, and reporting procedures were established based on the early work done by our own staff, that of General Motors, and several other sources.

Basically, the standard procedure involves bringing the test vehicle to speed (usually 40 mph), applying water in a specified volume and pattern ahead of the test tire to wet the surface, locking the wheel or wheels, and measuring the resulting torque or drag applied to the system by the friction force created between the sliding tire and the wet pavement surface. Measurements are made by calibrated strain gages, drag links, or complex load cells in the trailer. Controls, electrical power, computer circuits, recording devices, and water supply are contained in the tow vehicle.

The first system was used extensively for testing on the statewide trunklines until 1977 when it was replaced by a new system, also designed and built by the Research Laboratory. This new equipment was required because of increasing difficulty in procuring repair parts for the old Buick chassis, as well as by the severely corroded condition of the old rig. The replacement system operated in a manner similar to the older unit, but utilized instrumented drag links to measure the forces developed during testing. It also incorporated the more effective disc brakes, a more durable design, an improved water distribution system, an improved control system, variable weight, one-wheel braking, and more accurate speed control.



Pavement friction tester – Towed trailer type

Pavement Friction Research

Recognizing a need to conduct friction-related research and the fact that the current test system was being used intensively for the high priority inventory testing on our state trunkline system, an additional friction test system was purchased for research use in 1971. This new test system possessed considerable versatility not available in the other system, and provided back-up when the other unit needed servicing.

The major advantages of the research system were the ability to conduct high-speed tests with either wheel individually or combined, the ability to measure both the vertical and horizontal loads on the wheel during the test, and the ability to measure impending friction levels (the maximum friction level attained just before sliding begins). This latter capability is becoming important because of current trends to provide non-locking braking systems on motor vehicles. Significant research in pavement friction has been accomplished through the use of this system, including better information on the effects of tire type and tread design, pavement surface texture, polishing characteristics of various aggregates under varying traffic conditions, variations in friction levels due to seasonal effects and surface weathering, and relationships between speed and friction levels.

Typically, individual friction testing systems, even though built to ASTM specifications, measure slightly

different values. Therefore, an effort was begun in 1972 to create a standardized reporting value. This led to the Federal Highway Administration's sponsoring the establishment of regional reference centers. These centers were created to allow individual states to send their units for calibration and correlation with a unit maintained by the reference center as a 'standard.' Michigan has been sending its friction testing units annually to the facility in Ohio (the Field Test and Evaluation Center for Eastern States) since 1975. All friction values reported since July 10, 1980 have been in terms of friction numbers (FN) indicating a value derived through correlation with the reference center 'standard unit,' and, therefore, comparable to values published by other participating states.

Michigan's current program centers around maintaining a computer-based statewide inventory of pavement friction levels for all State trunklines. Inventory tests are conducted at five-year intervals. In addition, numerous special requests and research project evaluation tests are conducted annually. The normal test season generally runs from May through September and involves conducting about 15,000 individual tests. Results of all tests are furnished to the Traffic and Safety Division and the individual District Engineers to be used in establishing priorities for rehabilitation projects. In addition, the data are used to evaluate experimental surfaces, materials, and construction methods being investigated for enhancing the friction and durability of our pavement surfaces. Data are also used in response to litigation against the Department of Transportation resulting from traffic accidents. We believe that the long-term commitment to pavement friction measurement and the associated knowledge and improvement programs have been of considerable value in providing safer travel on Michigan highways.

-Bob Felter

TECHADVISORIES

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

NEW MATERIALS ACTION

CORRECTION - Perma-Loc PVC Storm Drain Pipe PS-10 was not approved.

Perma-Loc PVC Storm Drain conforming to AASHTO Materials Specification M304-891 is approved for use. This specification will become effective in the summer of 1989 and will be included in MDOT projects at that time.

MATERIALS NOTE:

The dust palliative Norlig 58% produced by Daishowa Chemicals, Inc. is approved as an alternate to Flambinder.

SPECIFICATION UPDATE

Preformed Waterproofing Membrane for Concrete Bridge Deck, 5.06(3), dated 10-27-88. This material is an alternate for the polyester-asphalt, hot-mix membrane currently being used on bridge decks. Due to the sometimes remote location of the bridge, the reduction in number of available batch plants, and the longer hauls which are required, the polyester material is getting more and more expensive.

Concrete Mixtures for Prestressed Concrete Beams, 5.05(2), dated 10-27-88. This new specification deletes the maximum cement content requirement and adds a minimum cementitious material (cement plus fly ash, if used) requirement. Obtaining the 7000 psi concrete called for in some recent projects is extremely difficult when restricted by the 7.5 sack cement content limitation.

Field Repair of Damaged Hot-Dip Galvanized Coatings, 5.04(21), dated 12-8-88. This supplemental specification references a new ASTM A 780 specification that lists three methods for repairing damaged zinc coating.

Temporary Concrete Barrier, 6.31(6c), dated 12-15-88. This specification prohibits the use of portable concrete barriers having the "General Motors" configuration on Department projects for which bids are received after January 1, 1989. The specification also contains a requirement that end attachments in temporary concrete barriers withstand a pull-out force of 15,000 pounds.

Disposal of Surplus and Unsuitable Material, 2.08(1d), dated 01-03-89. This supplemental specification replaces the previous edition, 2.08(1c), dated 11-18-87, and includes the latest environmental requirements.

MDOT RESEARCH PUBLICATIONS

Evaluation of Boschung Ice Early Warning System, Research Report No. R-1289, by Frank Spica. This project was conducted in order to determine if the Boschung Ice Early Warning System is capable of detecting the varying surface conditions of a bridge deck and to report them with a reasonable degree of accuracy. This evaluation was conducted over three winters. The results for all conditions were accuracy rates of about 65 percent the first winter, 84 percent the second winter, and 88 percent the third winter. It was concluded that the system is capable of detecting and reporting the condition of a bridge deck with a reasonable degree of accuracy. If it errs, most errors are on the 'safe' side, that is, reporting ice when there is none rather than reporting no ice when some is present.

MARTY O'TOOLE

Martin L. O'Toole is retiring as Assistant Division Engineer for Materials and Technology after 34 years with the Department. Marty was born and raised in Muskegon, and after serving in the U. S. Army, graduated in civil engineering from Michigan Tech in 1954. In June of that year he came to the Department as an engineer-trainee, first in the Design Division, then transferring to the Construction Division. From 1956 to 1963, Marty served as Project Engineer on several freeway bridge construction jobs in western Michigan before becoming Assistant Maintenance Engineer at the Grand Rapids District office. In 1966 he came to the central Maintenance Division office in Lansing, and when he left in 1980 he was the Engineer of Maintenance Operations, directly overseeing the maintenance of the entire State Trunkline System. In June 1980, Marty came to the Materials and Technology Division as Assistant Division Engineer. Because of M&T's contact with him during his service in the Maintenance Division, Marty was no stranger to our technical staff; he did, however, bring some fresh, outside perspectives to the job which proved to be positive contributions. He is liked and respected throughout the Materials and Technology Division for his knowledge, his candor, and his sense of humor and will be sorely missed. Marty is an avid hunter, fisherman and golfer, and plans on relocating somewhere in the western part of the state where he'll have the leisure to expand these pursuits. Retirements are a mixed blessing; we are pleased to see a good friend free to pursue the courses he wishes, but certainly will miss his help and expertise. Marty, have a good one!

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

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