285

MICHIGAN
STATE HIGHWAY DEPARTMENT
JOHN C. MACKIE, COMMISSIONER

MICHIGAN'S SKID TESTING PROGRAM

By

M. G. Brown and E. A. Finney

Supplement to "Measurement of Pavement Skidding Resistance by Means of a Simple 2-Wheel Trailer," by Paul C. Skeels, General Motors Proving Ground.

Presented at the 37th Annual Meeting,
Highway Research Board
January 6-10, 1958
Washington, D. C.

Research Project 54 G-74

Research Laboratory
Office of Testing and Research
Report No. 283
January 2, 1958

MICHIGAN'S SKID TESTING PROGRAM

The Michigan State Highway Department began its research on the skidding properties of pavement surfaces with an investigation in 1947-48. This study concerned a number of portland cement concrete projects in Michigan's Upper Peninsula on US-2 between St. Ignace and Escanaba which were constructed in the late 1930's and early '40's. With the increase in postwar traffic, a rash of skidding accidents developed on the 140 miles of this trunkline, especially when wet. The wet sliding coefficients of friction were measured on these projects, using the stopping distance method from an initial velocity of 20 mph. The average coefficient for the projects in question was only 0.28, and was caused by the highly polished condition of the concrete surface which contained fine and coarse limestone aggregates from a local quarry. As a result of this investigation, use of manufactured limestone sand in portland cement concrete was banned in 1948, and these slippery projects have since been resurfaced with bituminous concrete.

Because of the mutual interest of the automotive industry and highway builders in the performance of pavement surfaces and the vehicles using them, a cooperative skid testing program was undertaken in September, 1954 with General Motors Proving Ground and the Michigan State Highway Department as participants.

About 160 skid tests were performed in one day using a 1954 Buick Special sedan and a tow truck, as described in Mr. Skeels' paper. The vehicles and instrumentation were developed and assembled by the General Motors Proving Ground. The Michigan State Highway Department cooperated by furnishing data on mix, design, age, traffic, and materials for the specific pavements tested. Most of the projects in this program were bituminous concrete, but several portland cement concrete pavements were included for comparison. Results of this cooperative venture indicated the need for a comprehensive skid resistance survey of Michigan highways.

Actual testing on this statewide program started in May, 1957. This investigation was initiated with three main objectives: 1) to determine the skid resistance level of all highway surface types now existing in Michigan, 2) from this information to develop methods for increasing the friction level on future pavement surfaces, and 3) to study ways and means of de-slicking existing pavement surfaces found to be below a safe standard.

Michigan's skid testing equipment was designed and built concurrently with that of the General Motors Proving Ground, in close cooperation with Mr. Skeels. The two skid testing machines are basically the same, with differences in axle weight, manner of recording skidding drag force, and control of the skid cycle.

The Highway Department's skid trailer was made from a junked 1949 Buick frame, altered at the front end to connect with a tow truck by means of a regular trailer hitch, as shown in Figures 1 and 2. A concrete weight was cast and attached above and behind the axle to give an axle weight of 1,550 pounds. The two trailer tires are of a standard brand, size 7.60 x 15 which can be easily duplicated, and are mounted on rims with wire spokes to allow for better brake cooling. The hydraulic brakes are air actuated at 40 psig. by an electric valve, delivering a total force of about 1100 pounds to the master cylinder.

The tow truck is a two-ton, 1950 Ford dump with two 200-gallon water tanks, air pressurized at 40 psig. Approximately six gallons of water are used for each test and 50 to 55 tests can be run with one loading of the water tanks.

A typical skidding trace is shown in Figure 3. The trace paper speed is 25 mm. per second. The recording instruments in the right side of the truck cab are a Brush strain analyzer and recording oscillograph as shown in Figure 4. Electrical power for the recording and operating mechanism is furnished by a 3.5 kw., 110 v. AC generator mounted on the truck. Strain is measured by two SR-4, type A-1, strain gages mounted on the top and bottom of the torque tube just ahead of the differential housing and connected for temperature compensated double output. When running the field skidding tests, the strain analyzer is left on constantly and calibration is checked about every hour. The recorder is turned on and off manually for each test cycle.

The skid cycle, which lasts about 4 seconds, is completely automatic, controlled by electrically powered cams and micro-switches as shown in Figure 5. When a single starter button is pushed, the following sequence of events takes place:

1. Two electric valves open, flooding the pavement in each wheel track from water outlets located 10 feet ahead of the trailer wheels.
2. About 1.5 seconds later, the trailer brakes are locked by means of an electric valve and air cylinder linkage on the master cylinder.

3. The brakes are released 1.3 seconds later.

4. About one second later, the water valves close and the cam drive motor shuts itself off.

Individual sliding strain measurements are converted to a coefficient value, corrected for weight shift using the method described by Mr. Skeels. The average coefficients from each project are summarized for evaluation along with the age, total and commercial traffic volumes, materials and mix details. It is planned that these data will be coded on standard IBM cards to facilitate correlation.

Interrelation of skid resistance with project age and traffic volume is accomplished by means of a wear factor, which enables comparison of the projects on a common basis. The wear factor is the product of the average daily traffic volume per traffic lane since construction, weighted for percent of commercial traffic, divided by 1000 and multiplied by the age of the project in years. Characteristics of pavement materials or mix design will be sought which produce the most gradual decrease in skid resistance as the wear factor increases. This relationship was observed in the 1954 survey and is shown graphically in Figure 6.

Approximately 2400 skid tests were performed between June and November, 1957, including about 135 portland cement concrete projects, 240 bituminous aggregate and bituminous concrete, and 37 bituminous surface treatments. The wet sliding coefficients run at 40 mph., ranged from a low of 0.10 on a bleeding bituminous surface treatment to about 0.65 on new portland cement concrete. Usually, about six tests are made on each trunkline project at representative locations selected according to the project's length.

Dynamic and static comparative tests of the two agencies' skid equipment were made in and around the General Motors Proving Ground. In general, the Department's equipment gives sliding coefficients about 20 percent higher than General Motors' at 30 mph. in the same test areas. This difference is being investigated, since the static calibrations of the two trailers have been found to be the same. The Highway Department's static calibration has not changed after four months of use.

The Department's Traffic Division has requested from time to time that certain projects be tested, due to the frequency of skidding accidents on wet surfaces. These critical areas are tested for skid resistance during the regular field test periods, and the measured coefficients are reported. In most cases, this information has substantiated the need for corrective measures.

As a first step in starting corrective measures, two high-accident intersection areas in Detroit were given anti-skid treatments this Fall, utilizing aluminum oxide grain with asphalt and latex emulsions or epoxy resin bond coats. These areas will be retested periodically to determine the effectiveness and permanence of each coating under natural weathering and traffic.

ACKNOWLEDGEMENT

The adaptation of the tow truck, skid trailer and control instrumentation were the work of Mr. Paul Milliman and Mr. Gale Otto of the Electronic Instrumentation Section of the Research Laboratory.

The Department's 1954 cooperative skid test program with General Motors Proving Ground, referred to in this paper, was described in a report titled "Road Surface Friction from the Standpoint of Automotive and Highway Engineers." This report, written by P. C. Skeels, K. A. Stonex, and E. A. Finney, was presented at the technical sessions of the Association of Asphalt Paving Technologists in February 1956, and printed in Vol. 25 of that organization's proceedings.

Figure 1. MSHD skid testing equipment.

Figure 2. Skid testing trailer.

Figure 3. Typical skidding trace on wet bituminous concrete. 30 m. p. h.

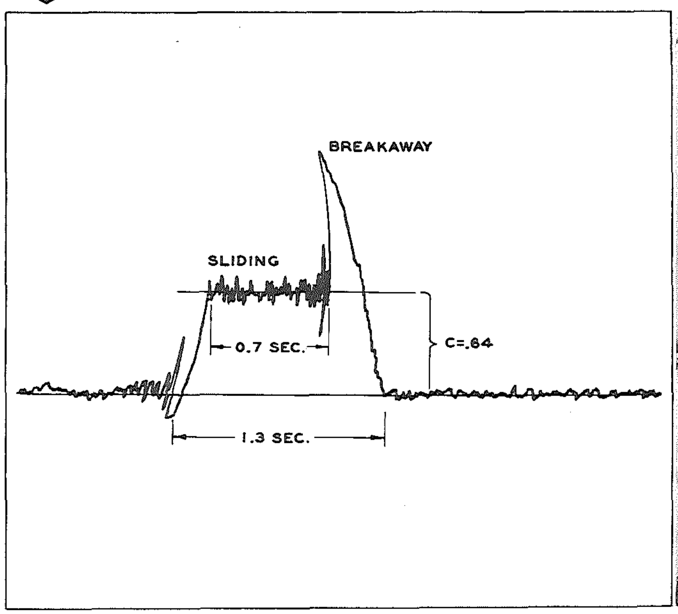


Figure 4. Skid cycle control panel, oscillograph, and strain analyzer.

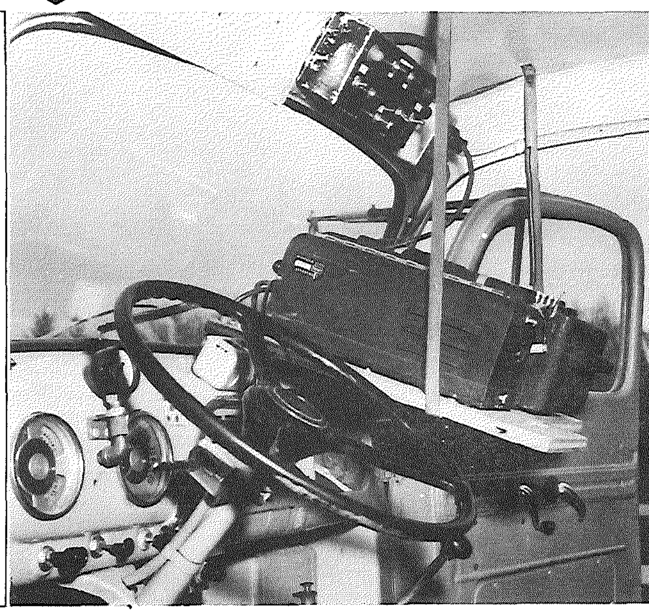
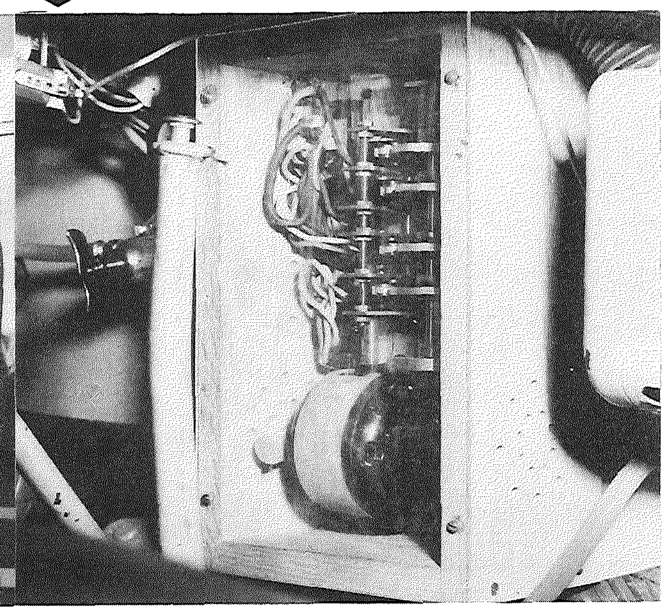


Figure 5. Cycle control cams and motor drive.



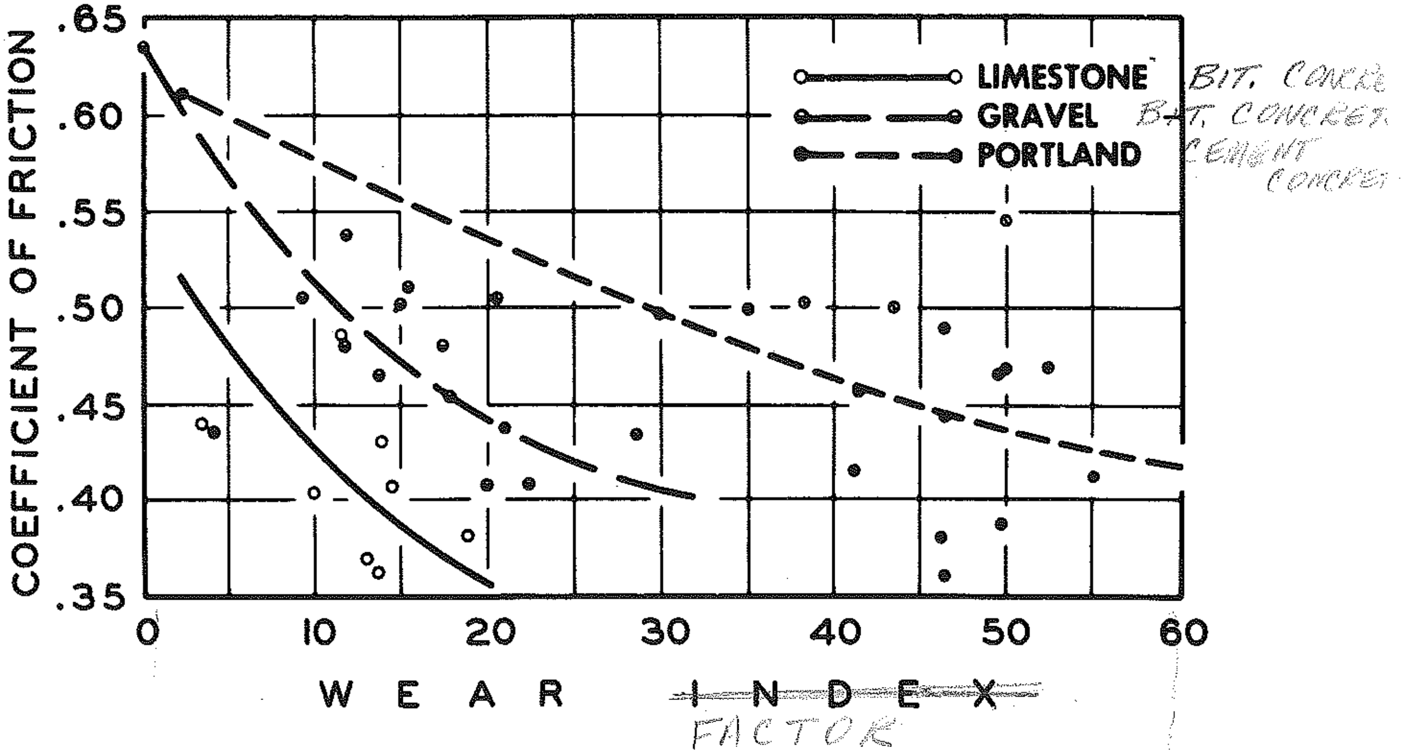


Figure 6. Relation of sliding friction to wear ~~index~~ factor for three types of wet pavement surface in tests run at 40 mph. (Based on 1954 Study).

Bit Conc. - Limestone Agg.
Bit Conc. - Gravel Agg.
Portland Cement Conc.