In earlier attempts to measure pavement roughness, the highway engineer utilized a roller-type straightedge to detect surface irregularities and took this as a measure of the riding quality of the surface. Many roughness measuring devices used today are patterned after the same principle of measuring displacement from a floating datum line. Devices which measure the displacement or acceleration of a sprung mass, or the slope variance between two closely spaced wheels, have also been introduced. In Kentucky, as in most other states, a roller-type straightedge is still used to control construction tolerances simply because an accurate, rapid method of profile measurement is not available.

Accelerometer measurements of a passenger’s torso, utilizing the Automatic Roughness Measuring System, has been used by the Department for several years. The resultant roughness index denotes the ride quality of the pavement, and it can be used to judge construction practices, paving and grading equipment, and general workmanship of the contractor. Many thousands of lane-miles of newly constructed and older roads have been roughness tested and periodically retested.

The commercial introduction of the Surface Dynamics Road Profilometer, a profile measuring device that operates within a broad wavelength spectrum, has opened new doors to research efforts relative to pavement irregularities and the resultant riding quality. The highway engineer is finally able to view the true profile of a pavement, analyze it, and put the results to good use in a variety of ways.

The pavement profile contains useful information in analog form when recorded on a strip chart. Visual inspection of the recording quickly pinpoints localized roughness and permits the engineer to 1) locate the pavement area in question, 2) measure the amplitude and wavelength of the surface irregularities, and 3) make judgments concerning possible remedial action. The profile analog on magnetic tape lends itself to further evaluation in the laboratory. A Swept Spectrum Analyser was chosen as a tool to make direct analog analysis of pavement profiles. The instrument offers the greatest flexibility and control in selecting operating modes and parameters. Results are readily available in graphical form. The analysis will be two-fold: 1) to obtain wavelength spectral information about the pavement and 2) to quantify the profile to yield a single number or index. Spectral information would characterize the pavement for comparison with similar or unlike surfaces and to note changes in the profile with time. The index would permit rating of the profiles as to pavement roughness and serviceability, from construction to retirement of the wearing surface.

A special purpose analog computer, known as the Quarter Car Simulator, has been recently developed for the Surface Dynamics Road Profilometer and is being fabricated for the Department. The simulator is an electrical analogy of a vehicle suspension, which includes the tire, wheel mass, suspension spring, shock absorber, and vehicle mass. Two vehicle simulations will be available — the Bureau of Public Roads Roughometer and a 1969 Chevrolet. The simulator uses advance analog simulation techniques and was designed to reduce a rather complicated vehicle simulation to a routine data processing procedure. The electrical signals representing the pavement profile taken directly from the profilometer computer, or the magnetic tape recorder, can be processed by the simulator to yield in analog or digital form the displacement between the sprung and unsprung masses; the velocity, acceleration and jerk of the vehicle body; and the vehicle tire force on the pavement. Also, the device can be used as peak signal detector and to simulate any driving speed, regardless of the velocity at which the profile measurement was made.

The acquisition and adaptation of the Surface Dynamics Road Profilometer, Swept Spectrum Analyzer, and Quarter Car Simulator to the measurement and processing of pavement profiles should be regarded as significant steps toward meaningful progress in the field of roughness measurement. There is nothing more fundamental to the highway engineer who is concerned with pavement serviceability, riding quality, dynamic pavement loading, etc., than the road profile. Only with such knowledge can he advance in a scientific manner in the direction of studying and understanding pavement-vehicle-passenger interactions.
Figure 33. Surface Dynamics Road Profilometer