CHAPTER 3

INFLUENCE OF ROAD RIDING QUALITY

The Maysmeter, described in Volume 3 of this report, was adopted to measure the different states of maintenance of paved or unpaved roads. This instrument was used to measure road roughness, defined by a statistic called *roughness index*, or QI.

Based on the analysis of the results of the roughness measurements taken since 1976 by the Pavement Performance and Maintenance Study Team on 48 test sections with gravel and on 74 with asphaltic surfacing, located on the highway network of São Paulo, Minas Gerais, Goiás and the Federal District, the QI values for different levels of maintenance were established, as presented in Table 3.1 (Gontijo, 27/06/80).

However, it is necessary to emphasize that recent studies carried out in the United States by Gillespie, Sayers and Segel(12/80), and studies carried out in Brazil by the ICR Research (Alckmin, et al., 10/81), have raised doubts about the capability of this equipment for discriminating among highways as to their state of maintenance and type of surfacing. These studies show that highways with the same type of surfacing and submitted to the same maintenance standard can present different QI values, depending on a number of not fully explained factors which can occur during roughness measurements.

The ICR Research continues to study the problem, both theoretically and empirically, and it is possible that in a short time the PICR will have a satisfactory answer to this question. However, in the meantime it is necessary to be extremely careful, when measuring roughness, to avoid using QI values not correlated to those obtained at the time of the tests in the prediction equations for vehicle speed and fuel consumption.

TABLE 3.1 - CHARACTERIZATION OF THE STATE OF MAINTENANCE OF HIGHWAYS

STATE OF ROAD SURFACE	PAVED HIGHWAYS			UNPAVED HIGHWAYS		
	RANGE (QI)	FREQ	%	RANGE (QI)	FREQ	%
VERY GOOD	15 - 29	19	25.7	40 - 79	7	14.6
GOOD	30 - 44	31	42.8	80 - 119	19	39.6
REGULAR	45 - 59	20	27.0	120 - 159	15	31.2
POOR	60 - 74	2	2.7	160 - 199	6	12.5
VERY POOR	> 75	2	2.7	> 200	1	2.1

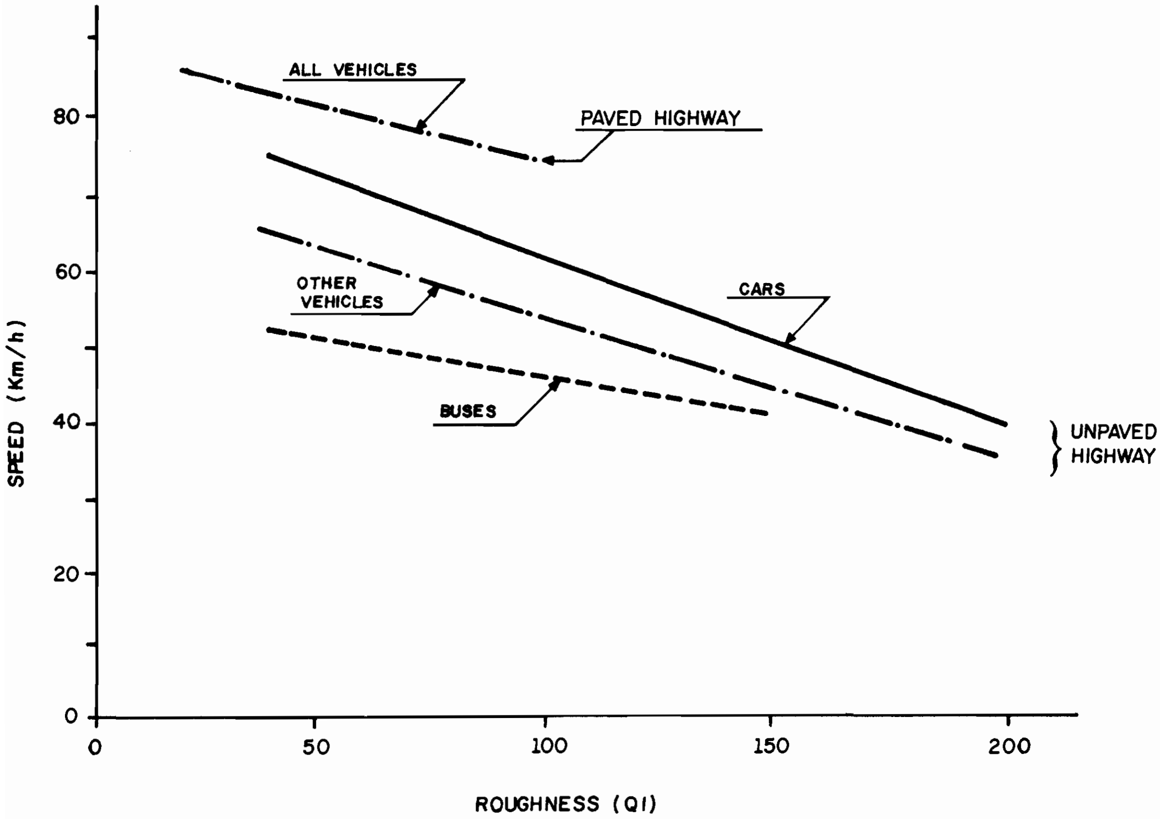

FIGURE 3.1- INFLUENCE OF ROUGHNESS ON FREE - FLOW SPEED (GRADE = 0,2%)

The statistical analysis to verify the influence of roughness on vehicle performance showed that the QI, under the conditions in which it was determined, is a significant variable to explain variations in vehicle speed and fuel consumption.

As to vehicle speed, this influence is translated by the following expressions:

Unpaved Roads

cars	$\Delta V = -0.214\ \Delta QI$	(3.1)
buses	$\Delta V = -0.093\ \Delta QI.Gp3$	(3.2)
others	$\Delta V = -0.177\ \Delta QI$	(3.3)

Paved Roads

all vehicles	$\Delta V = -0.154\ \Delta QI$	(3.4)

where: $Gp3 = \begin{cases} (6-G)/6 & \text{if } 0 < G < 6\% \\ 0 & \text{if otherwise} \end{cases}$

ΔV = decrease in speed (in km/h), for an increase ΔQI in road roughness.

G = grade, in per cent.

As an example, if an automobile on a poorly maintained road (with QI=150) travels at a free-flow speed of 50 km/h, after this same road is bladed (QI=50), its speed would tend to increase by 21.4 km/h:

$$V = -0.214\ \Delta QI \quad \text{or}$$
$$-0.214\ (50-150) = +21.4\ \text{km/h}$$

Therefore, the automobile will run at (50 + 21.4) km/h, or at about 71 km/h.

The equations obtained are represented graphically in Figure 3.1.

In the study of fuel consumption, the roughness effect was tested within the range of 90 QI to 110 QI, regardless of the type of surfacing. Within this range, the QI values for poorly maintained paved roads often match those for well maintained unpaved roads.

The influence of roughness was found significant for all vehicle classes. As QI values under 90 generally occur on paved roads, and those over 110 normally occur on unpaved roads this variable was used to represent the combined influence of surfacing type and roughness (Zaniewski, Morais e Moser, 1979).

Figure 3.2 illustrates the effect of roughness on the fuel consumption of a half-loaded utility vehicle running on a level section, by applying the equations of fuel consumption at steady-state speed (Table 8.3). One can see that the fuel consumption increases with the deterioration of the road surface; in other words, the rougher the road surface, the greater will be the fuel consumption per unit of time, independent of the vehicle speed.

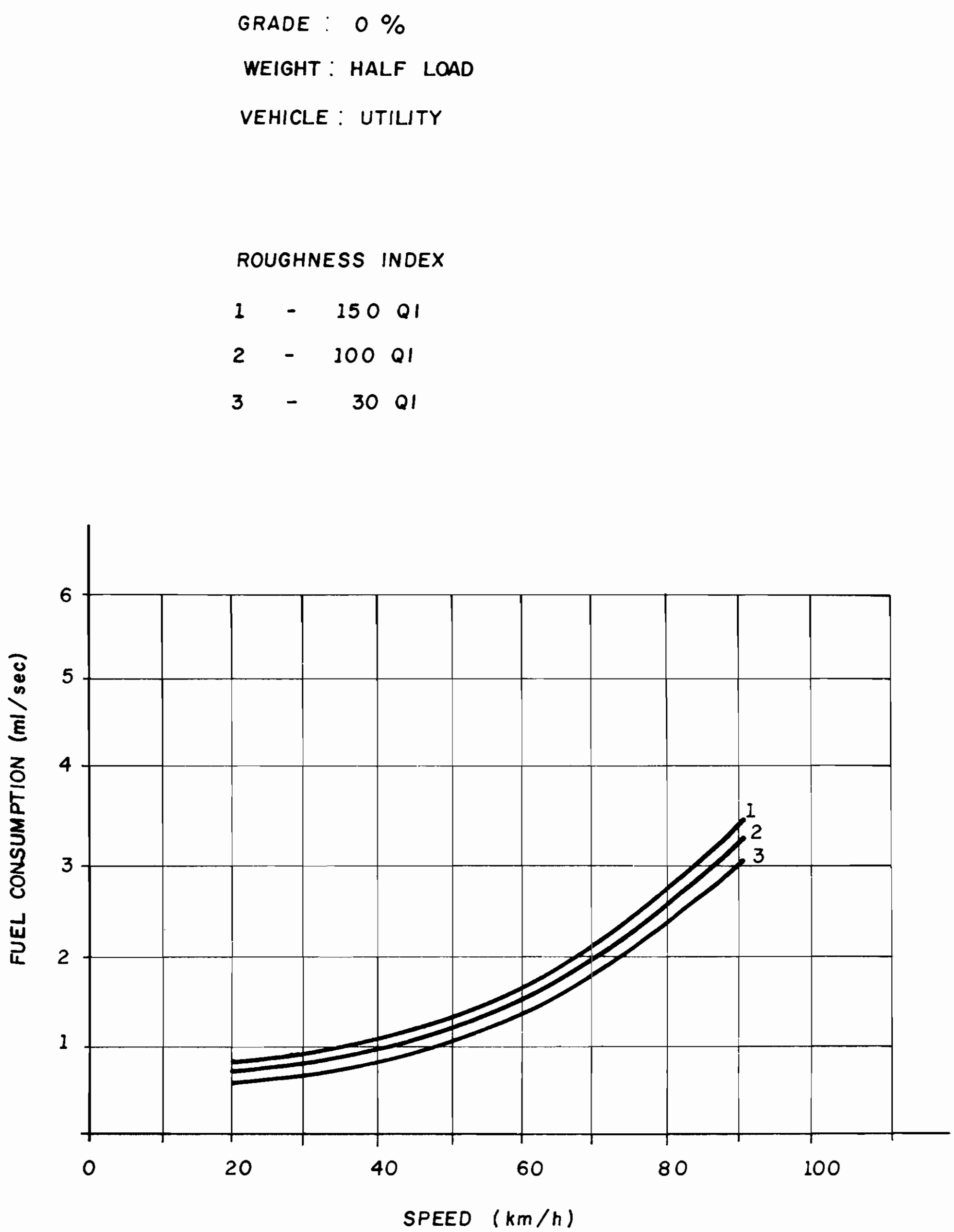

FIGURE 3.2- EFFECT OF ROUGHNESS ON FUEL CONSUMPTION.