

CHAPTER 9  
INFLUENCE OF MOMENTUM  
ACQUIRED BY VEHICLES  
ON NEGATIVE GRADES (FC-2)



In situations where a road has steep negative grades followed by positive ones, the vehicles tend to acquire a momentum on the declivities that helps them climb the subsequent acclivities, with higher initial speeds and less use of low gears. It is expected that this behaviour influences significantly the fuel consumption of vehicles, especially trucks, which normally increase acceleration on a declivity (see experiment TB-2), thus gaining additional kinetic energy for climbing the subsequent acclivity more easily.

In this study, the vehicles were subjected to different accelerations on negative grades in order that different initial speeds (speeds at the beginning of a positive grade) could be obtained. The data thus obtained were used for analyzing the influence of initial speed and the effect on fuel consumption of its interactions with acclivities, grades and vehicle gross weights.

After the data generated by this experiment were screened, it was found that at speeds above 80 km/h the odometer was quite inconsistent. This constituted a difficulty for measuring with the required accuracy the total length of the fuel consumption test section (from the beginning of the acclivity up to the point where the vehicle slowed down to its steady-state speed). Due to this, all measurement results obtained at speeds above 80 km/h were rejected.

This affected the statistical analysis, since the remaining data were not sufficient to determine the influence of any of the variables studied. Therefore, fuel-consumption estimates were determined by averaging data considered reliable, that is, data obtained at speeds under 80 km/h. Thus the influence higher speeds could have on fuel consumption was deleted.

Table 9.1 presents the estimates, for each vehicle type, of the mean and standard deviation of fuel consumption, as well as the number of observations considered and the maximum and minimum consumptions measured.

TABLE 9.1 - FUEL CONSUMPTION DURING GRAVITY-EFFECTED DECELERATION  
(FC-2)

VEHICLE	N° OF OBSERVATIONS	FUEL CONSUMPTION (ml/sec)			
		MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
Car	6	2.45	0.164	2.20	2.70
Bus	17	6.10	0.698	4.70	7.30
Utility	11	3.83	0.380	3.10	4.50
Light Truck (G)	12	10.85	1.072	10.60	14.40
Light Truck (D)	5	4.50	0.339	3.90	4.70
Heavy Truck	31	6.77	1.148	5.30	10.10
Semi-Trailer	15	12.12	1.012	10.60	14.40

With the experience gained from this experiment, a new experiment was designed in which small changes were introduced to allow for more information on speed modes and fuel consumption (see Volume 2, Chapter 4 of this report). The installation of the signal-generating system of the electronic odometer was also modified to make it less sensitive to the test-vehicle speeds.

Fuel consumption on positive grades was recorded at intervals of five seconds in this new experiment. Additional data were thus generated to determine the variation in fuel consumption due to both gear changes and the variation of pressure on the accelerator, in an attempt to maintain stable speed throughout the route. This new procedure represented a considerable advantage over the previous process, which only measured the total volume of fuel consumed from the beginning of the acclivity up to the point of speed stabilization.

This procedure allowed for a better data set to be obtained, as well as more copious information on the influence that the momentum acquired on negative grades can have on the performance of the vehicle on the following positive grade.

After the survey is concluded and the data analyzed, the PICR expects to establish equations which include fuel consumption and independent variables (initial speeds, grades, and gross weights) for each type of vehicle studied.