TABLE 3.1 - MTC INPUT DATA.

GEIPOT - EMPRESA BRASILEIRA DE PLANEJAMENTO DE TRANSPORTES

PESQUISA ICR   SISTEMA DE TRAFEGO
PROGRAMA MTC - MODELO DE TEMPO E COMBUSTIVEL - VERSAO 2.1 (JULHO 1980)

LISTAGEM DOS CARTOES DE ENTRADA

```
NUMERO          1         2         3         4         5         6         7         8
CARTAO   12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1     XXXX   VERIFICACAO DO  SOFOT VERSAO 01  -   TRECHO-TESTE 568
   2     11100
   3        8   1   0   1  13   6   6
   4     123456
   5          0.0     +1.4      0.3     +2.5      0.4     +3.5      0.5     +5.1     1.5     +5.0
   6          1.6     +2.0      1.7     -1.0      1.9     -2.5      2.0
   7         80.3     65.3     72.8     69.6     59.6     50.2
   8         63.7     54.9     60.1     57.3     51.4     54.3
   9          1.3      1.6    680.0
  10          0.01     2.0
  11          0.0     36.0      0.1     37.0      0.2     38.0      0.6     39.0     0.7     40.0
  12          0.8     39.0      0.9     38.0      1.0     27.0      1.1     36.0     1.2     37.0
  13          1.3     38.0      1.4     39.0      1.8     40.0      2.0
  14     111   100.0      1.0    100.0
  15     211   100.0     10.0    100.0
  16     311   100.0      1.5    100.0
  17     411   100.0      2.5    100.0
  18     531   100.0     73.0    100.0
  19     631   100.0     73.0    100.0
```

TABLE 3.1 - MTC INPUT DATA (Cont'd).

GEIPOT - EMPRESA BRASILEIRA DE PLANEJAMENTO DE TRANSPORTES

PESQUISA ICR   SISTEMA DE TRAFEGO
PROGRAMA MTC - MODELO DE TEMPO E COMBUSTIVEL - VERSAO 2.1 (JULHO 1980)

VERIFICACAO DO SOFOT VERSAO 01 - TRECHO-TESTE 56B

DADOS FORNECIDOS AO PROGRAMA

```
 6 CLASSES DE VEICULOS
 6 COMBINACOES DE CLASSES E TIPOS
 8 GREIDES
 1 CURVAS
 0 SECOES DE CONTROLE DE VELOCIDADE
 1 SECOES DE PAVIMENTO
13 SECOES DE IRREGULARIDADE
```

MATRIZ DE VELOCIDADES INICIAIS

CLASSE	SENTIDO PRIMARIO	SENTIDO SECUNDARIO
1	80.300	63.700
2	65.300	54.900
3	72.800	60.100
4	69.600	57.300
5	59.600	51.400
6	50.200	54.300

CLASSE	TIPO	PERCEN-TAGEM	PESO BRUTO	PERCEN-TAGEM	PESO BRUTO	PERCEN-TAGEM	PESO BRUTO	PERCEN-TAGEM	PESO BRUTO	PERCEN-TAGEM
1	1	100.0	1.000	100.0						
2	1	100.0	10.000	100.0						
3	1	100.0	1.500	100.0						
4	1	100.0	2.500	100.0						
5	3	100.0	73.000	100.0						
6	3	100.0	73.000	100.0						

TABLE 3.1 - MTC INPUT DATA (Cont'd).

GEIPOT - EMPRESA BRASILEIRA DE PLANEJAMENTO DE TRANSPORTES

PESQUISA ICR   SISTEMA DE TRAFEGO
PROGRAMA MTC - MODELO DE TEMPO E COMBUSTIVEL - VERSAO 2.1 (JULHO 1980)

VERIFICACAO DO SOFOT VERSAO 01 - TRECHO-TESTE 568

GEOMETRIA VERTICAL

DISTANCIA	GREIDE	DISTANCIA	GREIDE	DISTANCIA	GREIDE
0.0	1.400	0.300	2.500	0.400	3.500
0.500	5.100	1.500	5.000	1.600	2.000
1.700	-1.000	1.900	-2.500		
2.000	(FIM DO TRECHO)				

GEOMETRIA HORIZONTAL

INICIO (KM)	RAIO DA CURVA (M)	SUPER-ELEVACAO	FINAL (KM)	INICIO (KM)	RAIO DA CURVA (M)	SUPER-ELEVACAO	FINAL (KM)
1.300	680.	0.0	1.600				

TIPOS DE SUPERFICIE

DISTANCIA	PAVTO.	DISTANCIA	PAVTO.	DISTANCIA	PAVTO.
0.0	1				
2.000	(FIM DO TRECHO)				

SECOES DE IRREGULARIDADE

DISTANCIA	IRREG.	DISTANCIA	IRREG.	DISTANCIA	IRREG.
0.0	36.0	0.100	37.0	0.200	38.0
0.600	39.0	0.700	40.0	0.800	39.0
0.900	38.0	1.000	27.0	1.100	36.0
1.200	37.0	1.300	38.0	1.400	39.0
1.800	40.0				
2.000	(FIM DO TRECHO)				

TABLE 3.2 - MTC ANALYSIS RESULTS.

GEIPOT — EMPRESA BRASILEIRA DE PLANEJAMENTO DE TRANSPORTES

PESQUISA ICR   SISTEMA DE TRAFEGO
PROGRAMA MTC - MODELO DE TEMPO E COMBUSTIVEL — VERSAO 2.1 (JULHO 1980)

VERIFICACAO DO SOFOT VERSAO 01 — TRECHO-TESTE 568

SENTIDO 1   CLASSE 1

NOS	XL (KM)	GRD (%)	SUPF	IRREG. (QI)	SPS (KPH)	VEL (KPH)	TEMPO (SEG)	COMBUSTIVEL GASOLINA (ML)	COMBUSTIVEL DIESEL (ML)	FUNCAO DE VEL	FUNCAO DE COMB
1	0.0	1.4	1	36.	150.	80.3	4.48	13.27	0.0	LACC	FCS4P
2	0.100	1.4	1	37.	150.	80.5	4.46	13.24	0.0	LACC	FCS4P
3	0.200	1.4	1	38.	150.	80.7	4.45	13.20	0.0	LACC	FCS4P
4	0.300	2.5	1	38.	150.	80.9	4.45	11.88	0.0	PGSE	FC2P
5	0.400	3.5	1	38.	150.	80.9	4.46	11.92	0.0	PGSE	FC2P
6	0.500	5.1	1	38.	150.	80.5	4.52	12.08	0.0	PGSE	FC2P
7	0.600	5.1	1	39.	150.	78.7	4.63	12.36	0.0	PGSE	FC2P
8	0.700	5.1	1	40.	150.	76.9	4.74	12.65	0.0	PGSE	FC2P
9	0.800	5.1	1	39.	150.	75.1	4.85	12.96	0.0	PGSE	FC2P
10	0.900	5.1	1	38.	150.	73.3	2.39	6.39	0.0	PGSE	FC2P
11	0.948	5.1	1	38.	150.	72.4	2.56	7.15	0.0	CONS	FC1P
12	1.000	5.1	1	27.	150.	72.4	4.96	14.72	0.0	LACC	FCS4P
13	1.100	5.1	1	36.	150.	72.6	2.48	7.34	0.0	LACC	FCS4P
14	1.150	5.1	1	35.	150.	72.7	2.47	6.94	0.0	CONS	FC1P
15	1.200	5.1	1	37.	150.	72.7	4.95	13.90	0.0	CONS	FC1P
16	1.300	5.1	1	38.	150.	72.7	0.83	2.22	0.0	PGSE	FC2P
17	1.317	5.1	1	38.	150.	72.4	4.14	11.54	0.0	CONS	FC1P
18	1.400	5.1	1	39.	150.	72.4	4.97	13.90	0.0	CONS	FC1P
19	1.500	5.0	1	39.	150.	72.4	2.48	7.36	0.0	LACC	FCS4P
20	1.550	5.0	1	39.	150.	72.6	2.48	6.89	0.0	CONS	FC1P
21	1.600	2.0	1	39.	150.	72.6	4.93	14.63	0.0	LACC	FCS4P
22	1.700	-1.0	1	39.	150.	73.4	4.80	10.05	0.0	NGAE	FCS4N
23	1.800	-1.0	1	40.	150.	76.7	4.60	9.82	0.0	NGAE	FCS4N
24	1.900	-2.5	1	40.	150.	79.8	4.35	7.62	0.0	NGAE	FCS4N
25	2.000				150.	85.7					

SENTIDO 1   CLASSE 1

	VELOCIDADE			COMBUSTIVEL			
FUNCAO	% TEMPO	% COMPRIMENTO	FUNCAO	% TEMPO	% COMPRIMENTO	% GASOLINA	% DIESEL
NGSE	0.0	0.0	FC1N	0.0	0.0	0.0	0.0
NGAE	14.6	15.0	FC1P	22.8	21.7	23.7	0.0
NGDB	0.0	0.0	FC2P	32.7	33.3	32.5	0.0
PGSE	32.7	33.3	FCS4N	14.6	15.0	10.8	0.0
LACC	29.9	30.0	FCS4P	29.9	30.0	33.0	0.0
PGDB	0.0	0.0	FCON	0.0	0.0	0.0	0.0
CONS	22.8	21.7	FCOP	0.0	0.0	0.0	0.0

(b) A distance/grade array. As presently structured, the
program considers that a vertical curve with a radius
equal to or less than 100m can be represented by the
continuation of the adjacent grades up to the point of
intersection, and that the vertical curves of more than
100m can be represented by an average grade, as depicted
in the following figure.

THE GRADE OF THE SEGMENT A̅ B̅ REPRESENTS
THE VERTICAL CURVE BETWEEN A AND B.
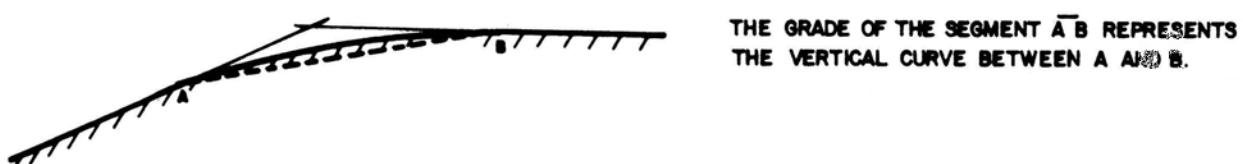
(c) An inventory of road visibility and roughness for each
tenth of a kilometer along the section.

In order to calculate successive free-speed averages along
a section, a functional relation of the acceleration with the speed,
grade, surface type and roughness was chosen (vide Figure 3.2).
This relation has the advantage of including the acceleration and de-
celeration modes in a single equation.
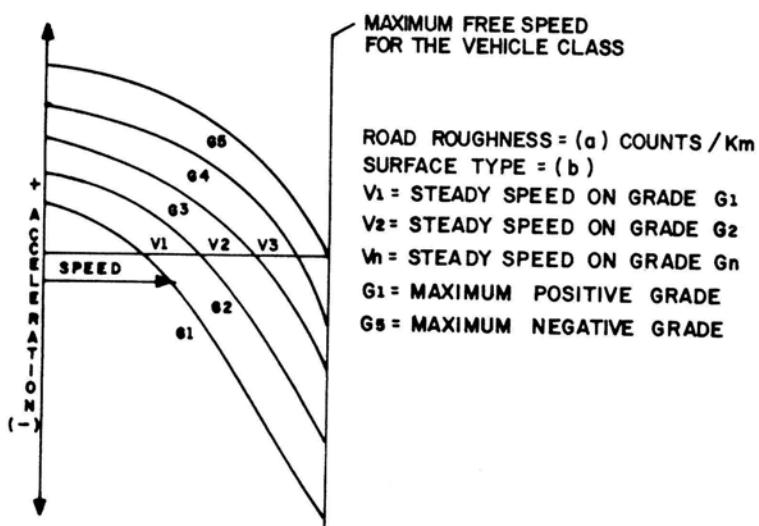
FIGURE 3.2 - ACCELERATION-SPEED RELATIONSHIP.

Aside from this, there is no necessity of knowing the position of the
vehicle on the grade, as in the speed/distance relation (see *Highway
Capacity Manual*, Highway Research Board, 1965, pp. 299-318). Utili-
zing the relations found in Figure 3.2 and the distance/grade array,
the program calculates the mean spot speed, the coefficient of varia-
tion and the accumulated time at each tenth of a kilometer. At each
point the speed is compared to the control speed and, should it be
greater, the spot speed is made equal to the control speed, while
the coefficient of variation and the accumulated time are adjusted
accordingly.

In the subsequent control section, if the spot speed is
greater than the next control speed, the program uses a deceleration
rate that is equal to light braking conditions, until the deceleration
curve intercepts the speed profile previously developed. Should the
interception not occur within the previous control section, an in-
creased rate of deceleration is utilized so as to diminish the speed
at the beginning of the previous link to the control speed of the
next link. This requires a more intense braking.

It has been argued that it is not realistic to return be-
yond the previous control section. The fact of the matter is that
light or intense deceleration comes about on the link immediately
prior to that which requires speed reduction. Earlier deceleration
would only occur if some sort of restriction were already present,
due to a warning sign or as a result of some other event.

In any case, the aspect of visibility takes precedence over
driver attention, since the driver will only act on the brakes when
the condition of restriction is perceived by him. In both cases, visi-
bility will be a restrictive factor; therefore, the driver will be
forced to utilize heavy braking.

3.4   THE FREE-SPEED PROFILE

An example of the free-speed profile is shown in Tables 3.3
and 3.4. These free speeds were obtained through the use of the MTC,
and represent the free speeds by vehicle class obtained for test sec-

TABLE 3.3 - FREE SPEED ON PRIMARY LANE OF THE BR-381 HIGHWAY, SÃO PAULO-BELO HORIZONTE, TEST SECTION No.568, LENGTH: 2 km

DISTANCE OF FREE SPEED (KM)	AVERAGE SPEED OF EACH VEHICLE CLASS - 6 CLASSES*(km/h)x10^{-1}						COEFFICIENT OF VARIATION OF EACH VEHICLE CLASS x10^{-2}						ACCUMULATED TRAVEL TIME AT AVERAGE SPEED FOR EACH VEHICLE CLASS (IN SECONDS)						GRADE %	TYPE OF SURFACE: 1-PAVED 2-UN-PAVED	ROUGHNESS OF HIGH-WAY (COUNTS/KM)	VISI-BILITY (KM)
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6				
0.0	745	690	625	493	653	480	13	12	12	18	23	17	00	00	00	00	00	00	1.4	1	36	1.5
0.1	753	697	636	508	653	484	13	12	12	18	23	17	48	52	57	72	55	75	1.4	1	37	1.4
0.2	760	703	646	521	652	487	13	12	12	18	23	17	96	103	113	142	110	149	1.4	1	38	1.3
0.3	767	708	655	532	652	490	13	12	12	18	23	17	143	155	169	210	166	223	2.0	1	38	1.2
0.4	770	710	659	539	651	480	13	12	12	18	23	17	190	205	223	278	221	297	3.0	1	38	1.1
0.5	767	705	656	541	642	465	13	12	12	18	23	17	237	258	278	344	277	373	4.5	1	38	1.0
0.6	750	688	638	519	604	432	13	12	12	18	23	17	284	308	334	412	334	453	5.1	1	39	0.9
0.7	732	670	620	499	567	399	13	12	12	18	23	17	333	361	391	483	396	540	5.1	1	40	0.8
0.8	721	666	601	499	530	365	13	12	12	18	23	17	382	415	449	555	462	634	5.1	1	39	0.7
0.9	723	667	596	499	492	332	13	12	12	18	23	17	432	469	510	627	532	737	5.1	1	38	0.6
1.0	724	669	597	503	455	299	13	12	12	18	23	17	483	523	571	699	608	851	5.1	1	37	0.5
1.1	726	670	599	502	417	280	13	12	12	18	23	17	532	577	631	771	691	978	5.1	1	36	0.4
1.2	727	672	600	503	380	280	13	12	12	18	23	17	581	630	691	843	781	1107	5.1	1	37	0.3
1.3	727	672	600	503	361	280	13	12	12	18	23	17	631	684	751	914	879	1235	5.1	1	38	0.2
1.4	724	669	597	500	361	280	13	12	12	18	23	17	680	738	811	987	979	1363	5.1	1	39	0.2
1.5	724	669	597	500	361	280	13	12	12	18	23	17	730	791	871	1058	1079	1492	5.0	1	39	0.2
1.6	726	669	600	503	364	280	13	12	12	18	23	17	780	845	932	1130	1178	1621	3.5	1	39	0.2
1.7	734	676	611	514	384	296	13	12	12	18	23	17	829	899	991	1201	1274	1746	0.5	1	39	0.2
1.8	767	708	645	549	437	349	13	12	12	18	23	17	877	951	1048	1269	1362	1857	-1.0	1	40	0.4
1.9	798	736	677	581	484	397	13	12	12	18	23	17	923	1000	1103	1332	1440	1954	-2.0	1	40	0.3
2.0	857	781	734	640	550	465	13	12	12	18	23	17	966	1048	1154	1391	1510	2037	-2.5	1	40	0.2

* Classes of vehicles:

1 - Automobiles
2 - Utilities
3 - Light Trucks
4 - Medium Trucks
5 - Buses
6 - Heavy Trucks

SOURCE: PICR, Traffic Group, Experiment TB-8, Test Section no. 568.

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LENGTH: 2 KM

DISTANCE OF FREE SPEED (KM)	AVERAGE SPEED OF EACH VEHICLE CLASS - 6 CLASSES*(km/h)x10^{-1}						COEFFICIENT OF VARIATION OF EACH VEHICLE CLASS x10^{-2}						ACCUMULATED TRAVEL TIME AT AVERAGE SPEED FOR EACH VEHICLE CLASS (IN SECONDS)						GRADE %	TYPE OF SURFACE 1-PAVED 2-UN-PAVED	ROUGH-NESS OF HIGH-WAY (COUNTS/KM)	VISI-BILITY (KM)
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6				
0.0	596	550	539	489	538	568	15	18	25	18	25	19	00	00	00	00	00	00	2.5	1	40	0.3
0.1	616	568	554	499	537	559	15	18	25	18	25	19	59	64	66	73	67	64	2.0	1	40	0.2
0.2	637	587	573	514	551	561	15	18	25	18	25	19	117	127	130	144	133	128	1.0	1	39	0.2
0.3	657	604	591	528	564	563	15	18	25	18	25	19	173	187	192	213	198	192	-0.5	1	39	0.2
0.4	719	663	645	581	616	610	15	18	25	18	25	19	225	244	250	278	259	254	-3.5	1	39	0.2
0.5	871	795	758	690	718	710	15	18	25	18	25	19	270	294	301	334	313	308	-5.0	1	39	0.2
0.6	871	795	796	797	821	809	15	18	25	18	25	19	311	339	317	383	360	355	-5.1	1	38	0.5
0.7	871	795	796	853	821	840	15	18	25	18	25	19	353	384	392	426	403	399	-5.1	1	37	1.9
0.8	871	795	796	853	821	840	15	18	25	18	25	19	394	429	437	468	447	441	-5.1	1	36	1.8
0.9	871	795	796	853	821	840	15	18	25	18	25	19	435	475	483	510	491	484	-5.1	1	37	1.7
1.0	871	795	796	853	821	857	15	18	25	18	25	19	477	520	528	552	535	526	-5.1	1	38	1.6
1.1	871	795	796	853	821	857	15	18	25	18	25	19	518	565	573	595	579	568	-5.1	1	39	1.5
1.2	871	795	796	853	821	857	15	18	25	18	25	19	559	611	618	637	622	610	-5.1	1	40	1.4
1.3	871	795	796	853	821	857	15	18	25	18	25	19	601	656	663	679	666	652	-5.1	1	39	1.3
1.4	871	795	796	853	821	857	15	18	25	18	25	19	642	701	709	721	710	694	-5.1	1	38	1.2
1.5	871	795	796	853	821	857	15	18	25	18	25	19	683	747	754	763	754	736	-4.5	1	38	1.1
1.6	871	795	796	853	821	857	15	18	25	18	25	19	724	792	799	806	798	778	-3.0	1	38	1.0
1.7	871	795	796	853	821	857	15	18	25	18	25	19	766	837	844	848	841	820	-2.0	1	38	0.9
1.8	871	795	796	853	821	857	15	18	25	18	25	19	807	882	889	890	885	862	-1.4	1	37	0.8
1.9	871	795	796	853	821	857	15	18	25	18	25	19	848	928	935	932	929	904	-1.4	1	36	0.7
2.0	871	795	796	853	821	857	15	18	25	18	25	19	890	973	980	974	973	946	-1.4	1	36	0.6

* Classes of Vehicles:

1 - Automobiles
2 - Utilities
3 - Light Trucks
4 - Medium Trucks
5 - Buses
6 - Heavy Trucks

SOURCE:PICR, TRAFFIC GROUP,Experiment TB-8, Test Section no. 568.

tion no. 568, located on the Fernão Dias highway.

Table 3.3 presents the free-speed profile of the vehicle classes trafficking on the lane conventionalized as the primary lane, while Table 3.4 presents the free-speed profile of the vehicle classes on the opposite lane. The following explanation with respect to columns is valid for both tables: the first column indicates that the section described is 2 km in length and is subdivided at intervals of 100m each. The six subsequent columns present the speeds at intervals of 100m, measured in (km/h) x 10^{-1}, for each of the 6 vehicle classes. The six vehicle classes are as follows:

1 - Automobiles
2 - Utilities
3 - Light trucks
4 - Medium trucks
5 - Buses
6 - Heavy trucks

The second grouping of six columns presents the coefficients of variation at each 100m, measured in 10^{-2}, for each one of the six vehicle classes. The third grouping of six columns presents the accumulated travel times in average speed, measured in seconds, at each 100m, for each one of the six vehicle classes. The next column indicates the grade at each 100m, measured in percentages. The antepenultimate column indicates the type of road surface: 1=paved, 2=unpaved. The penultimate column indicates the roughness of the highway at 100m intervals, measured in counts/km. The final column indicates visibility at each 100m, measured in km.

3.5   SUMMARY

This chapter described how the free-speed profile is generated. This profile will be utilized in the next chapter for the simulation of the behavior of the vehicles on the sections under study.