Technical Report

Tire Slip on the Clayton Dynamometer

by

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Notice

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Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air and Waste Management
U.S. Environmental Protection Agency

I. Introduction

Tire rolling resistance measurements at a steady state 50 mph were conducted on the Clayton dynamometer during a recent tire/dynamometer roll interface effects program. These measurements required the collection of front and rear roll speed data. Analysis of these data indicated that the front roll consistently revolves more slowly than the rear roll. For the purposes of this report, this roll speed difference was defined as "tire slip".

Power from the vehicle is transferred to the dynamometer primarily through the front roll, since the power absorption unit and inertia simulation assembly are connected to this roll. The rear roll remains free to revolve independently and is traditionally used to estimate "true" vehicle speed. The difference in roll speed displayed throughout this experiment may be caused by tire deformation (e.g., different rolling radii), tread creep, tire slippage or some other unidentified phenomenon due to the loading applied by the front roll. Analyses of these difference data were conducted to determine if the tire slip is influenced by dynamometer horsepower setting, tire type, tire size and manufacturer.

II. Summary/Conclusions

As part of the tire/dynamometer roll interface effects project, front and rear dynamometer roll speed data were collected during tire testing. A total of 88 steady-state (50 mph) tests were conducted on radial, bias belted and bias ply tires under five (5) dynamometer horsepower setting conditions. Initial analysis indicated that the front roll consistently revolved at a slower rate than the rear roll. This difference in roll speed may be due to tire deformation, actual tire slip, tread creep or some other unidentified phenomenon and for the purposes of this report is defined as "tire slip".

The basic design of the Clayton dynamometer utilizes the front roll as a conductor of power, transmitted from the vehicle to the dynamometer. The combination of the small surface area of the roll and the relatively small tire-contact-patch, causes an unnatural tire footprint on the roll during load application. These conditions result in the difference in roll speed detected during this experiment.

By expressing the "tire slip" as a percentage of the rear roll speed, the data could be analyzed with respect to dynamometer horsepower setting, tire type, tire size and manufacturer without regard to any speed differences which may have occurred.

Analyses of these data indicated that the percent slip is significantly affected by horsepower setting, tire size and type. It was found that: 1) the percent slip increases with increasing horsepower setting; 2) 14 inch tires slip less than both 13 inch and 15 inch tires and that the 13 inch tire slips more than the 15 inch tires; and 3) that radial tires, in general, have significantly higher slip characteristics than either bias belted or bias ply tires.

It was concluded that "tire slip" causes the dynamometer to underload a test vehicle. The magnitude of this underloading is a function of tire type, tire size, manufacturer and dynamometer horsepower setting. In general, for a vehicle equipped with radial tires travelling at a velocity of 50 mph, it can be estimated that the underloading could be as high as 0.34 Hp. This is based on the premise that the amount of power absorbed by the Clayton dynamometer is proportional to the third power of the front roll speed. The magnitude of the "tire slip" under transient testing conditions is not yet available.

III. Technical Discussion

A. Program Objectives

1. Determine the magnitude of the tire slip during a steady state speed condition.

2. Determine the effects of tire type, tire size, tire manufacturer and dynamometer horsepower setting on tire slip.

B. Program Design

A total of 88 steady state tests (50 mph) were conducted on one twin roll (Clayton) dynamometer utilizing two vehicles. Data were collected on radial, bias belted and bias ply tires under five (5) conditions of dynamometer horsepower setting. The front and rear roll speeds during each test were monitored and recorded on 7-track magnetic tape at a rate of once per second. After tire temperature stabilization, data were collected for approximately five (5) minutes.

C. Equipment

1. Vehicles - Two vehicles were utilized during this study, a 1971 Ford stationwagon and a 1971 Vega stationwagon. Tires with nominal sizes of 14" and 15" were mounted on the Ford for test and those with a nominal size of 13" were mounted on the Vega.

2. Dynamometer - All tests were conducted on one (1) standard Clayton twin roll dynamometer with 8.65 inch diameter rolls which were spaced 17.25 inches apart. Each roll was equipped with a magnetic proximity pick-up and the frequency at which each individual roll revolved was monitored simultaneously. Approximately 300 data points per test were collected.

3. Data Collection - A Kennedy Company 7-track tape recorder was utilized in conjunction with a Datum digital data acquisition system to record front and rear roll speeds, a tire type code, a test identification code, a tire manufacturer code and a tire size code. In addition, initial (cold) tire pressure and dynamometer road load horsepower setting were recorded manually on data sheets. Data recorded on magnetic tape were taken at a once-per-second rate.

D. Analysis

Initially, the mean front and rear roll speeds were computed for each test. The results indicated that the front roll consistently revolved more slowly than the rear roll. The difference, which for the purposes of this report was defined as "tire slip", may be due to tire deformation, tread creep, actual tire slippage or some other unidentified phenomenon caused by the vehicle loading function of the front roll.

The difference between each front and rear roll speed mean value was then expressed as a percentage of the rear roll speed mean. The mean value of the rear roll velocity was selected because it is assumed to be representative of true ground speed. Equation 1 summarizes the computation for each test:

$$\frac{\bar{V}_{rr} - \bar{V}_{fr}}{\bar{V}_{rr}} \times 100\% = \%\ \text{slip} \qquad (1)$$

where $\bar{V}_{rr}$ = mean rear roll speed

$\bar{V}_{fr}$ = mean front roll speed.

The mean front roll speed was subtracted from the mean rear roll speed strictly for convenience.

The percent slip was then statistically tested for effects due to dynamometer road load horsepower setting, tire type, tire size and tire manufacturer.

E. Test Procedure

The data for this report were generated as part of the tire/dynamometer roll interface effects test program for which the power absorbed by the tire was measured on two types of dynamometers, a twin roll Clayton and a large (48") single roll electric. Briefly, a set of test tires was installed on a particular test vehicle and the vehicle was accelerated to a speed of 50 mph and maintained at that speed for 20 minutes. Vehicle transmitted-power and dynamometer received-power data were collected during the entire 20 minute period. The data generated on the twin roll (Clayton) dynamometer were analyzed for roll speed differences in this report. Only roll speed data collected after tire warm-up (15 minutes) were utilized for this analysis.

IV. Results

There were four factors recorded that were either suspected to have or were analyzed to determine if they have an effect on tire slip. These factors are: tire type, manufacturer, tire size and dynamometer horsepower setting. In order to determine if any one of these factors affect tire slip without an interaction with one or more of the remaining factors, two-way frequency tables were generated and Chi-square tests for independence were performed for all possible factor combinations. These tests would determine whether the sample was randomly distributed across the four factors. It was found that both tire type and manufacturer were randomly distributed with respect to dynamometer horsepower setting. Therefore, any effects attributed to horsepower setting would not be influenced by either tire type or tire manufacturer. However, it was found that the other factors (tire type, size and manufacturer) were not randomly distributed with respect to each other. Subsequent analyses investigating the effects of the above factors take this fact into account. The findings of this investigation are presented below for each factor.

A. Dynamometer Horsepower Setting

To more accurately simulate on the dynamometer the experience of the tire on the road, a higher dynamometer road load horsepower setting was applied to the larger tires of the sample, since they are typically installed on larger and heavier vehicles. This practice explains the interaction effects of the sample distribution found in the preliminary analysis. In order to isolate any influence tire size may have on slip, analyses of variance were conducted on the percent slip with respect to horsepower setting for each nominal tire size. Figure 1 is a typical plot of the percent slip versus dynamometer horsepower setting for 14 inch tires (for additional plots see Appendix A).

The results of the analyses indicated that horsepower setting has a significant effect on tire slip. For each tire size, tire slip increases as the dynamometer horsepower setting increases. As an example, Figure 2 shows the mean percent slip with respect to dynamometer horsepower setting by tire size. Individual plots of the percent slip versus dynamometer horsepower setting by tire size and type are provided in Appendix A.

The mean percent slip for each dynamometer horsepower setting and nominal tire size is given in Table 1. The mean percent slip values for the two lowest horsepower settings (5.9 and 6.8) differed significantly from those for the three highest settings (7.4, 8.4 and 10.5).

B. Tire Size

As previously mentioned, tire size is highly correlated with dynamometer horsepower setting due to the experimental technique used (i.e., applying a higher dynamometer load to larger tires). Therefore, to determine if there is any effect due to tire size, there must be some control on dynamometer horsepower setting to assure that the effect the horsepower setting has on tire slip does not confound the results. The method of analysis used to test for tire size effects was the Student's t-test. The mean percent slip values for each tire size were compared at each dynamometer horsepower setting. As can be seen from Table 1, only a limited number of combinations could be tested due to the sample size.

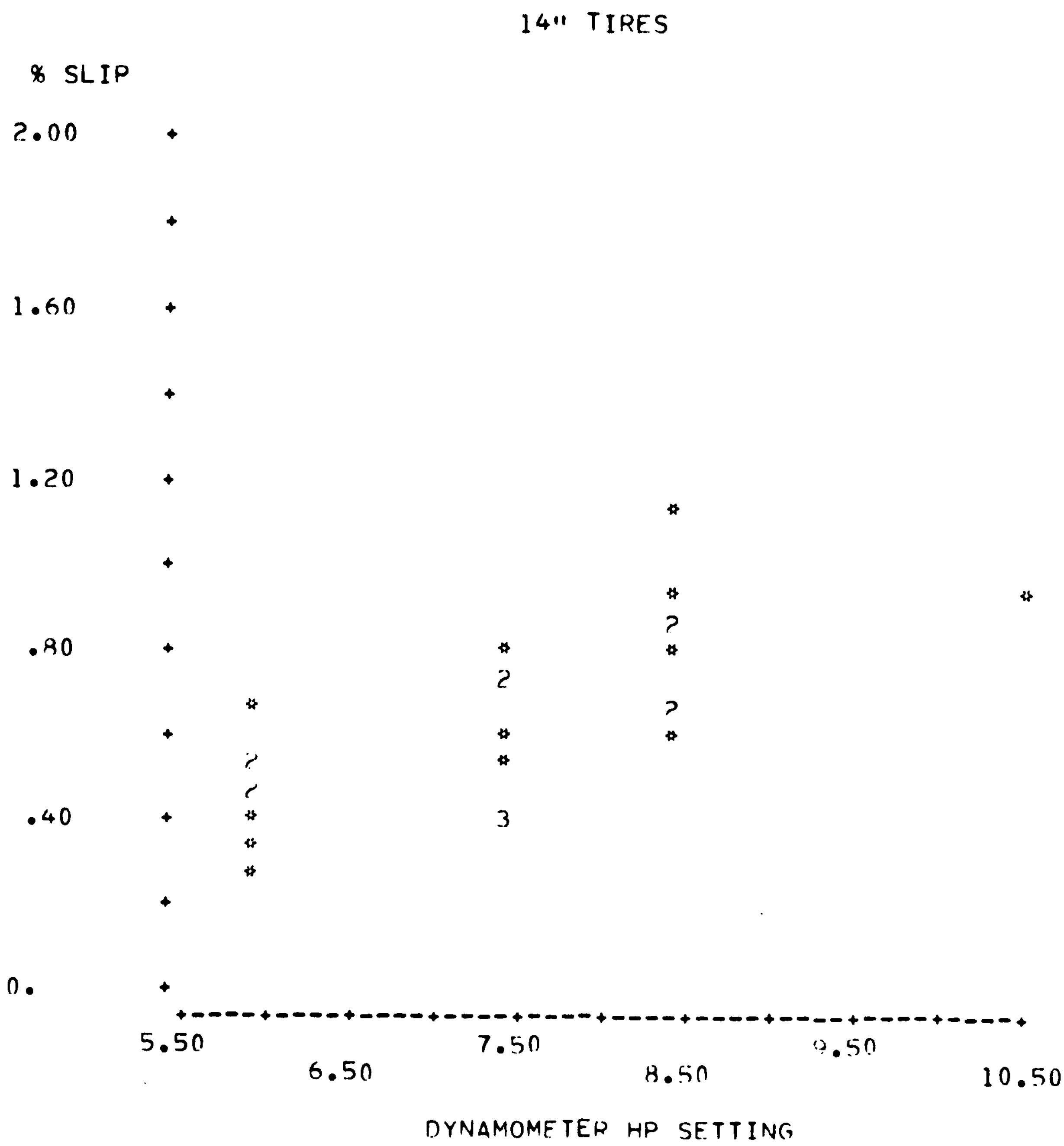

14" TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

Figure 1

Table 1

Average Percent Slip by Dynamometer Horsepower Setting and Tire Size

Horsepower Setting	Nominal Tire Size 13 inch	14 inch	15 inch
5.9	1.00	0.46	—
n	16	8	
6.8	1.34	—	—
n	8		
7.4	1.51	0.58	—
n	9	8	
8.4	—	0.82	1.08
n		8	18
10.5	—	0.91	1.17
n		1	12

n = Sample Size

The results of these analyses were that 13 inch tires differed significantly from 14 inch tires at both the 5.9 and 7.4 horsepower settings. At the 8.4 horsepower setting, 14 inch tires differed significantly from 15 inch tires. It can be seen from Table 1 that 14 inch tires slip less on the average than 13 and 15 inch tires, at each setting, however, it can not be determined using this method of analysis whether 13 or 15 inch tires have the larger percent slip since they were not tested at the same horsepower settings. A comparison of the mean percent slip values for 13 inch and 15 inch tires was conducted by separating the data with respect to tire size and type for all dynamometer horsepower settings. There were consistent results for each type: 13 inch tires had larger mean percent slip than 15 inch tires, however a significant difference could only be detected for the case of bias ply tires. It should be noted that these results are affected by the dynamometer horsepower setting (i.e., slip increases with increasing horsepower setting). Since the 15 inch tires had a higher horsepower setting applied to them during testing than the 13 inch tires, one would expect that the 15 inch tires would have the greater percent slip. This, however, was not the case as can be seen from Table 2. It can therefore be confidently concluded from the data set that 13 inch tires slip more than 15 inch tires. For radial and bias belted tires, 14 inch tires were significantly lower than the other two tire sizes. (Note, due to the lack of data, conclusions may not be drawn with respect to 14 inch bias ply tires.)

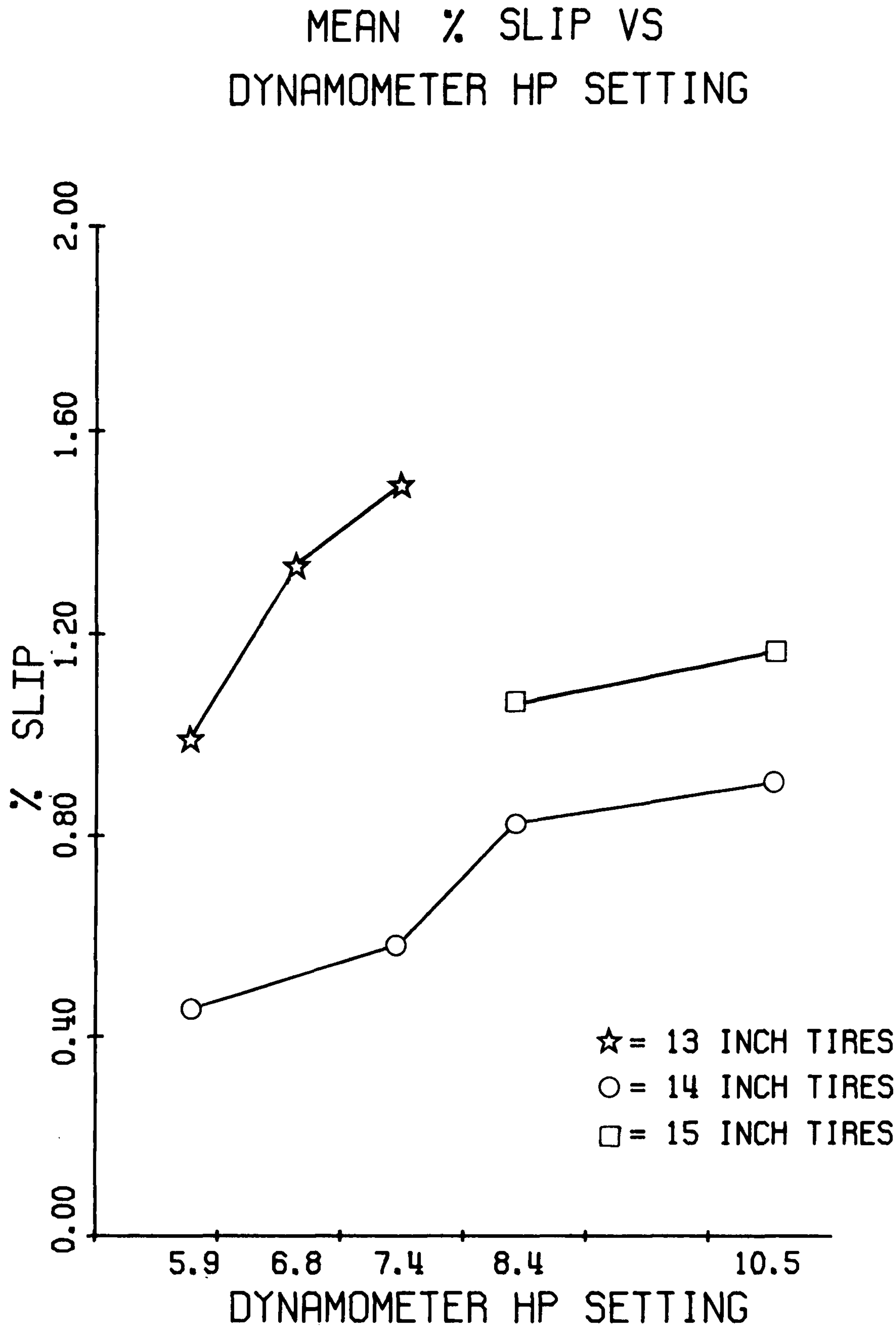

MEAN % SLIP VS
DYNAMOMETER HP SETTING
% SLIP
2.00
1.60
1.20
0.80
0.40
0.00
5.9
6.8
7.4
8.4
10.5
DYNAMOMETER HP SETTING
= 13 INCH TIRES
= 14 INCH TIRES
= 15 INCH TIRES

Figure 2

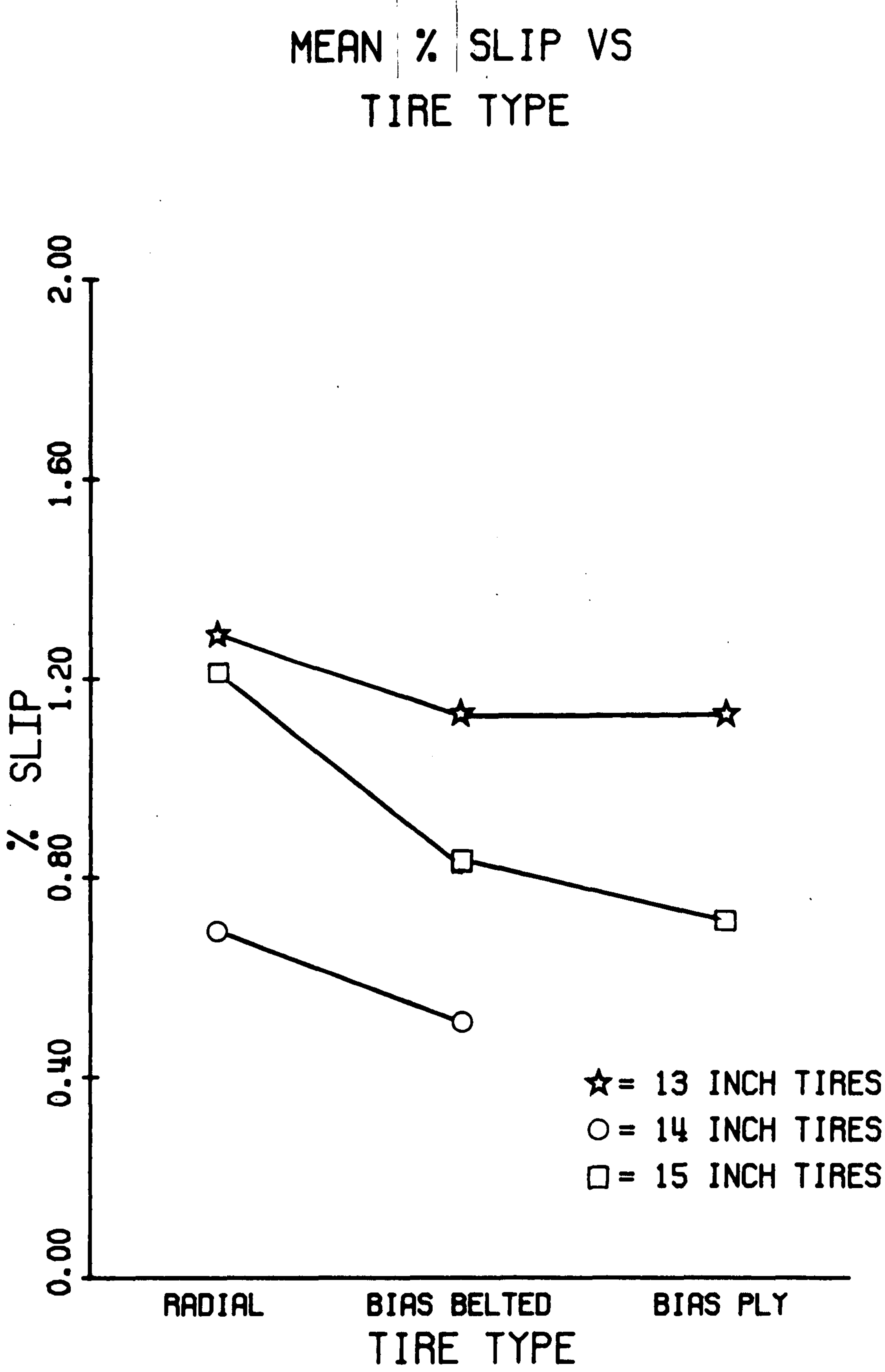

MEAN % SLIP VS
TIRE TYPE
% SLIP
2.00
1.60
1.20
0.80
0.40
0.00
RADIAL
BIAS BELTED
BIAS PLY
TIRE TYPE
☆= 13 INCH TIRES
○= 14 INCH TIRES
□= 15 INCH TIRES

Figure 3

Table 2

Average Percent Slip by Tire Size
and Tire Type

Tire Type	Nominal Tire Size 13 inch	 14 inch	 15 inch
Radial	1.29	0.70	1.22
n	19	15	23
Bias Belted	1.13	0.52	0.83
n	4	10	3
Bias Ply	1.12	—	0.73
n	10		4

n = Sample size

Since there was not a random cross-section between tire size and tire type in the sample, it is possible that the effect due to tire size detected above may have been caused by tire type. Therefore, additional analyses of variance were conducted on the percent slip with respect to tire size for each horsepower setting and tire type. The results for 13 and 14 inch tires were consistent with the previous analyses: 14 inch tires slip significantly less than 13 inch tires. However, the results for the comparison between 14 and 15 inch tires by each tire type were not consistent: for bias belted tires at 8.4 and 10.5 horsepower, significant differences were not detected. In fact, at the 8.4 horsepower setting, the mean percent slip for 15 inch tires was less than that for 14 inch tires. Examination of the data indicated that there was only one 15 inch bias belted tire tested at the 8.4 horsepower setting. Therefore, the latter result was deemed inconclusive. For radial tires at 8.4 horsepower, the results were that 15 inch tires have significantly greater slip characteristics than 14 inch tires, which is consistent with the previous analysis.

The physical cause of the above results is not known at this time. However, it is suspected that the cause may be linked to the dynamometer roll spacing and diameter. A roll spacing of 17.25 inches for the standard twin roll dynamometer may not be the optimum for all tire sizes. Some 'critical distance' from tire center to roll center may exist at which tire slip is minimized. The distance obtained with the use of 14 inch tires may be close to this 'critical distance'. The magnitude of the tire slip may also be dependent upon the total hours-of-operation logged on a particular dynamometer and the roll wear incurred. It has been observed that after many hours of use, the dynamometer roll takes on an "hour glass" type shape. The width of this "hour glassing" is a function of the track width of the variety of vehicles operated on the dynamometer. The effects identified as being due to tire size could be a result of a combination of both these conditions.

C. Tire Type

Analyses of variance were conducted for all the combined data and also by tire size to determine if tire type has any effect on slip. For the combined data, a significant difference due to tire type was detected. A more detailed analysis indicated that this difference was due primarily to a significantly lower slip for bias belted tires.

To assure that the difference detected above was caused by tire type only, the same analysis was conducted by tire size. For 14 and 15 inch tires, this analysis detected a significant difference between the tire type means. Again, more detailed analyses were done and 15 inch bias belted and bias ply tires were found to have significantly less percent slip than the 15 inch radial tires. Therefore, tire type appears to have an effect on percent slip, regardless of tire size, with radial tires slipping the most and bias ply tires slipping the least. Table 2 shows the mean percent slip for each tire type at each tire size and Figure 3 presents these means graphically.

D. Manufacturer

An analysis of variance of all the data indicated that there is a significant effect due to tire manufacturer. A pairwise analysis identified Firestone tires as having a significantly lower mean percent slip than either Goodyear or Goodrich tires. In addition, the mean percent slip for Firestone tires was significantly less than the grand mean value for all the manufacturers combined.

Since the tire type and size data were not randomly distributed across all manufacturers, an analysis was conducted to test manufacturer means taking these factors into account. This was to assure that any effects found were not influenced by either tire type or size.

For radial tires, the analysis indicated that there was a significant difference between the manufacturer means, however, for bias belted and bias ply tires, no significant difference was found. The radial ply tire data were further analyzed by tire size and it was found that Firestone's 15 inch radial tires were the only significantly different tires from the grand mean value for that category of tire. Table 3 shows the mean percent slip for each manufacturer by tire type and Table 4 presents the means by tire type and tire size.

Table 3

Average Percent Slip by Manufacturer and Tire Type

Manufacturer	Radial	Bias Belted	Bias Ply
Goodyear	1.23	0.83	—
n	22	10	
Goodrich	1.31	0.96	0.99
n	7	1	7
Uniroyal	1.06	0.46	0.99
n	15	3	3
Firestone	0.79	0.52	1.06
n	11	3	4
General	1.20	—	—
n	2		

n = Sample Size

Table 4

Average Percent Slip by Manufacturer, Tire Type and Tire Size

	Radial			Bias Belted			Bias Ply	
Manufacturer	13	14	15	13	14	15	13	15
Goodyear	1.36	0.75	1.21	1.13	0.57	0.76	—	—
n	12	3	7	4	4	2		
Goodrich	—	—	1.31	—	—	0.96	1.33	0.74
n			7			1	3	4
Uniroyal	1.31	0.77	1.21	—	0.46	—	0.99	—
n	4	6	5		3		3	
Firestone	1.01	0.62	0.98	—	0.52	—	1.06	—
n	3	6	2		3		4	
General	—	—	1.20	—	—	—	—	—
n			2					

n = Sample Size

V. Conclusions

It is evident from these data that tires slip on the twin small-roll dynamometer. This report has identified three major sources and one minor source of tire slip, namely, dynamometer horsepower setting, tire size, tire type and tire manufacturer, respectively. Although this experiment was not designed to specifically study tire slip, it presents data which may have an impact upon vehicle testing on the twin roll Clayton dynamometer. Typically, tests conducted on EPA dynamometers utilize the rear roll speed to represent vehicle speed and distance travelled. The vehicle is loaded by a power absorber and inertia assembly connected to the front roll. The amount of load the dynamometer applies to the vehicle is based upon the velocity of the front roll. The vehicle's actual road load horsepower at 50 mph is matched on the dynamometer (less dynamometer residual friction) at 50 mph (front roll speed). However, during the actual testing, the front roll may never attain this velocity except if the test requires rear roll speeds greater than 50 mph. As an example, if a vehicle equipped with radial tires requiring a road load of 10 horsepower at 50 mph road speed was operated at a steady state 50 mph rear roll speed on the Clayton dynamometer, the load applied by the front roll could be as low as 9.66 horsepower. (Note: this example neglects any dynamometer frictional forces associated with bearings and inertia weight aerodynamics.) This estimate is based upon a mean steady state slip of 0.55 mph for radial tires and the premise that the amount of power absorbed by the Clayton dynamometer is proportional to the third power of the front roll speed. The extent to which tire slip, as defined, occurs during a transient test, such as the Federal Test Procedure, is not currently available.

VI. Recommendations

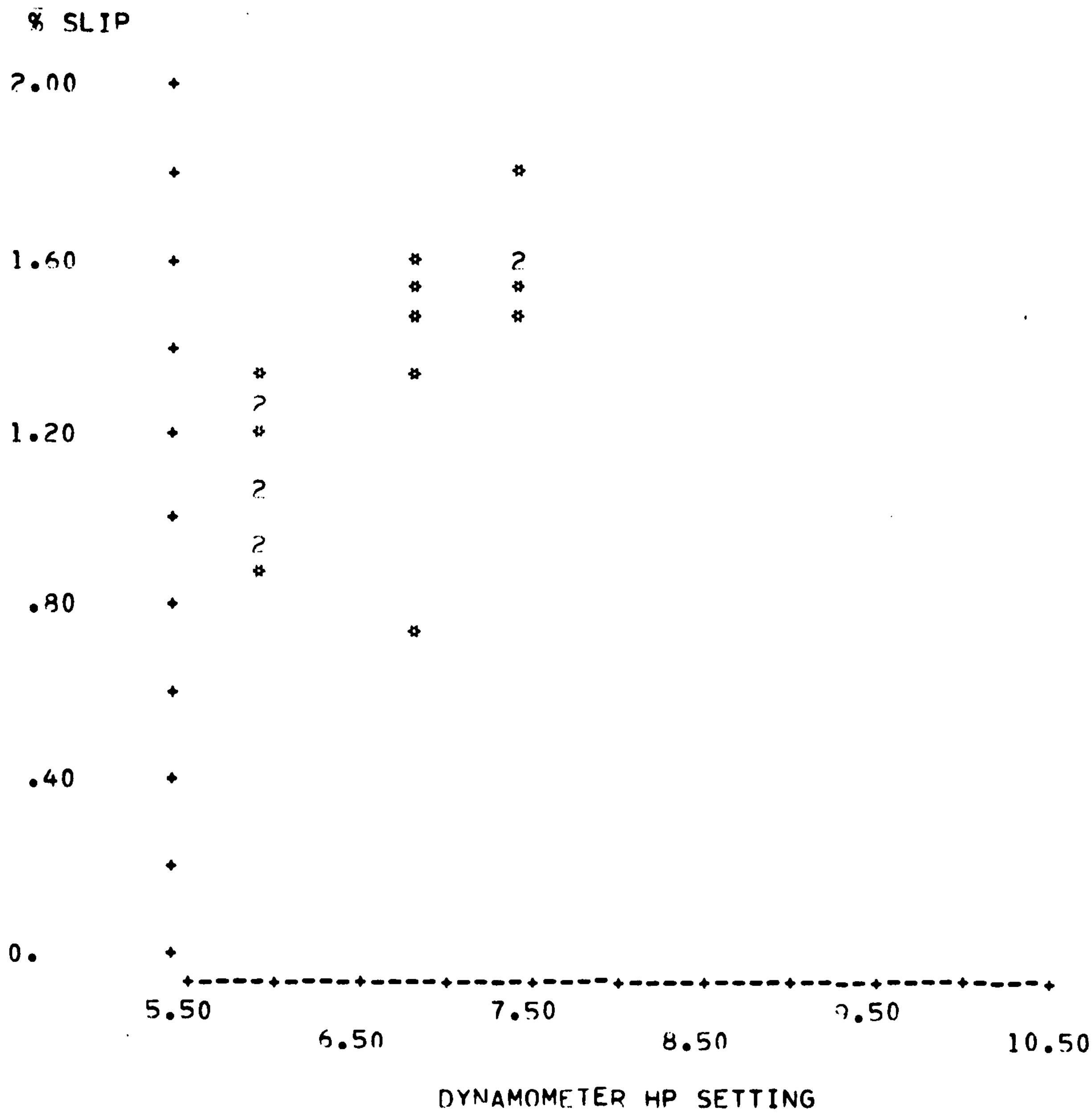
Based on the data presented in this report, it is recommended that further testing be conducted to determine to what extent tire slip occurs both on the road and on the twin small-roll dynamometer during transient vehicle operation. If a definite problem is identified based on that study, steps should be taken to correct the Federal Test Procedure. It is suspected that the magnitude of the tire slip on the dynamometer exceeds that on the road. It may be necessary to install a roll coupling device, in conjunction with some textured material on the front roll, to reduce the slip and make the test speed more representative.

In addition, an in-house study of certification-vehicle tire types and sizes should be conducted to determine possible trends toward tires which slip more on the dynamometer. This study identifies 14 inch tires as having low slip characteristics. A manufacturer may decide to over or under specify the tires on his certification vehicle to avoid this particular tire size.

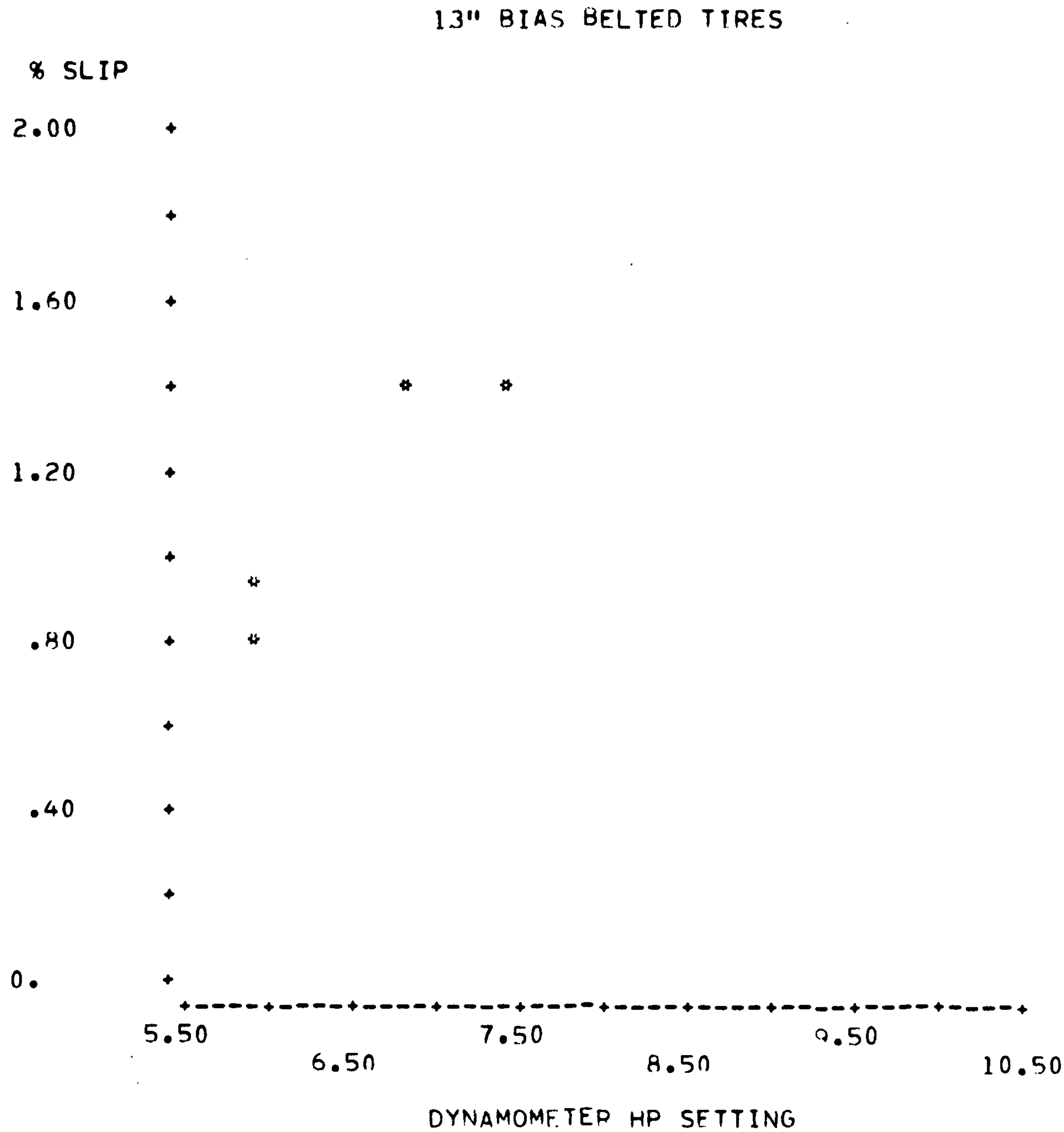
APPENDIX A

Percent Slip versus Dynamometer Horsepower Setting

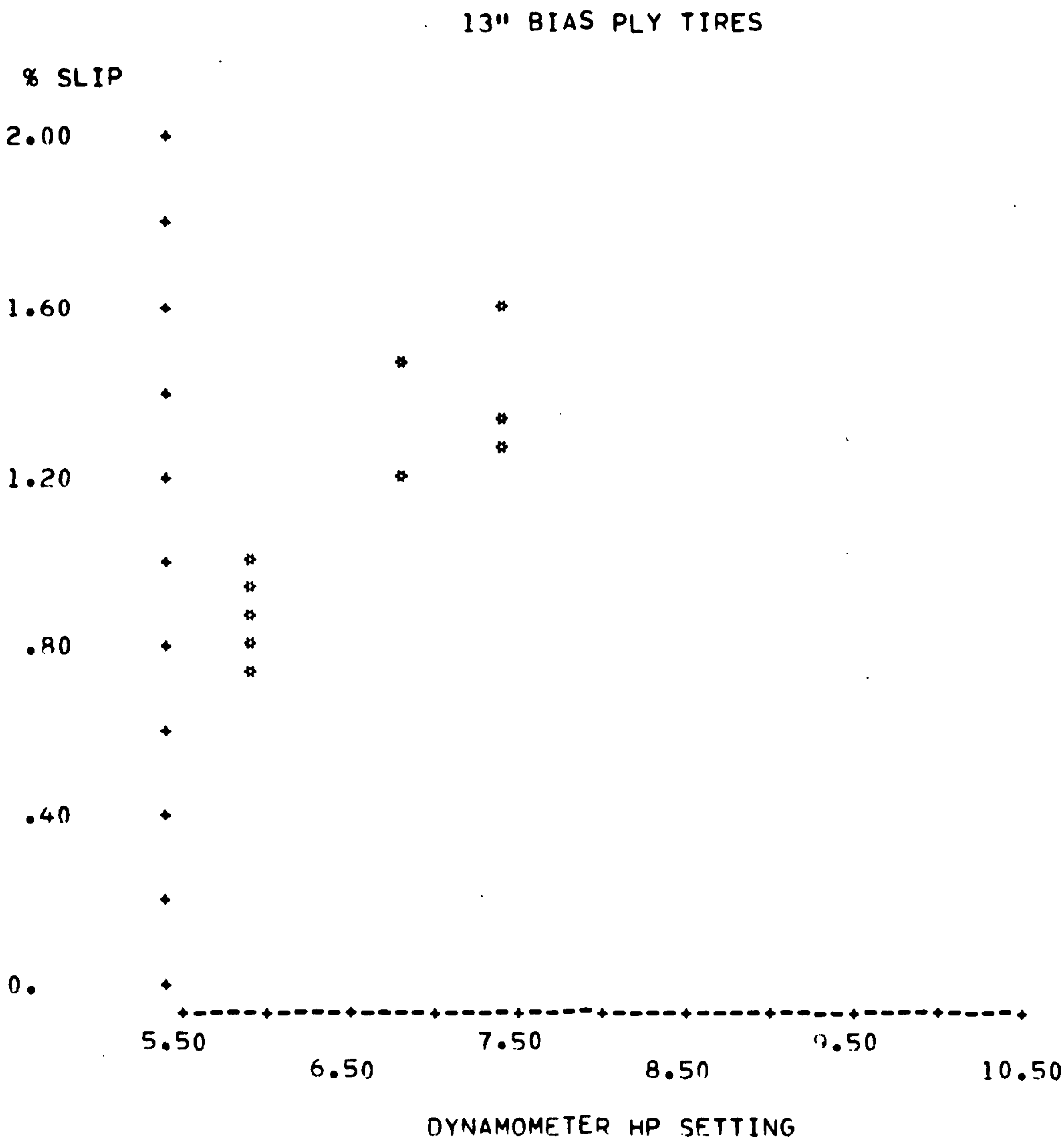
13" RADIAL TIRES



Plot A-1

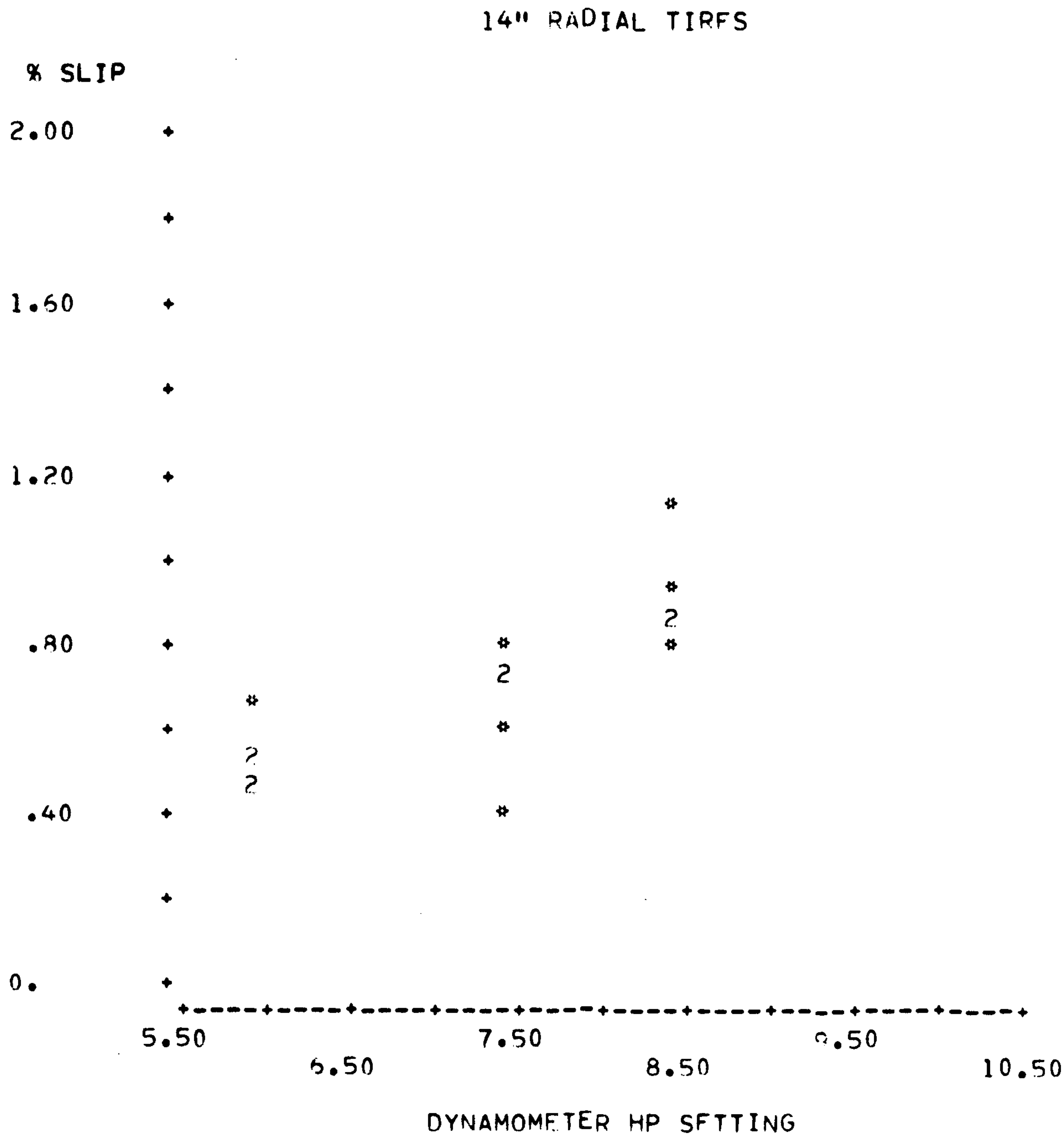

13" BIAS BELTED TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

Plot A-2

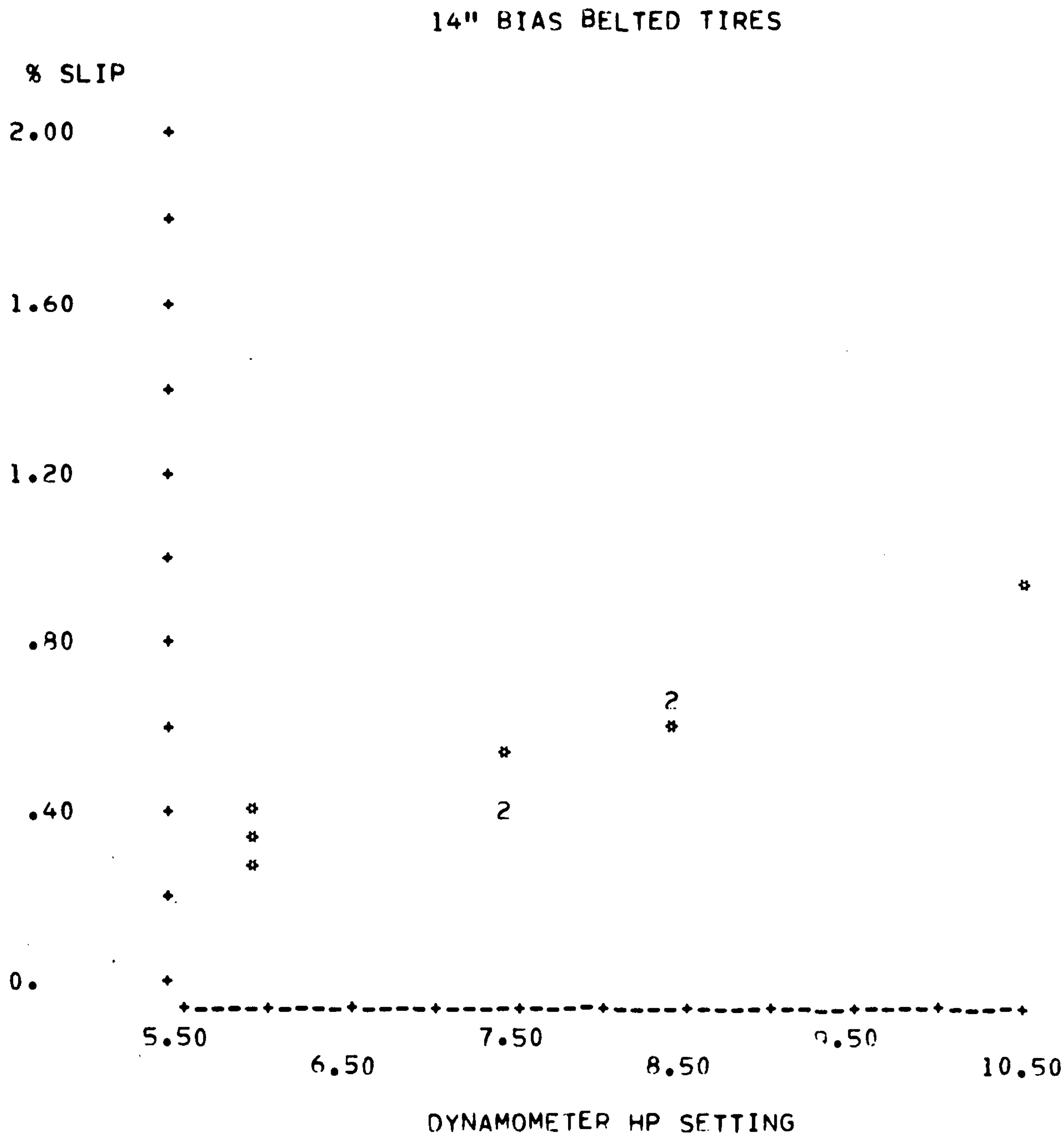


13" BIAS PLY TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

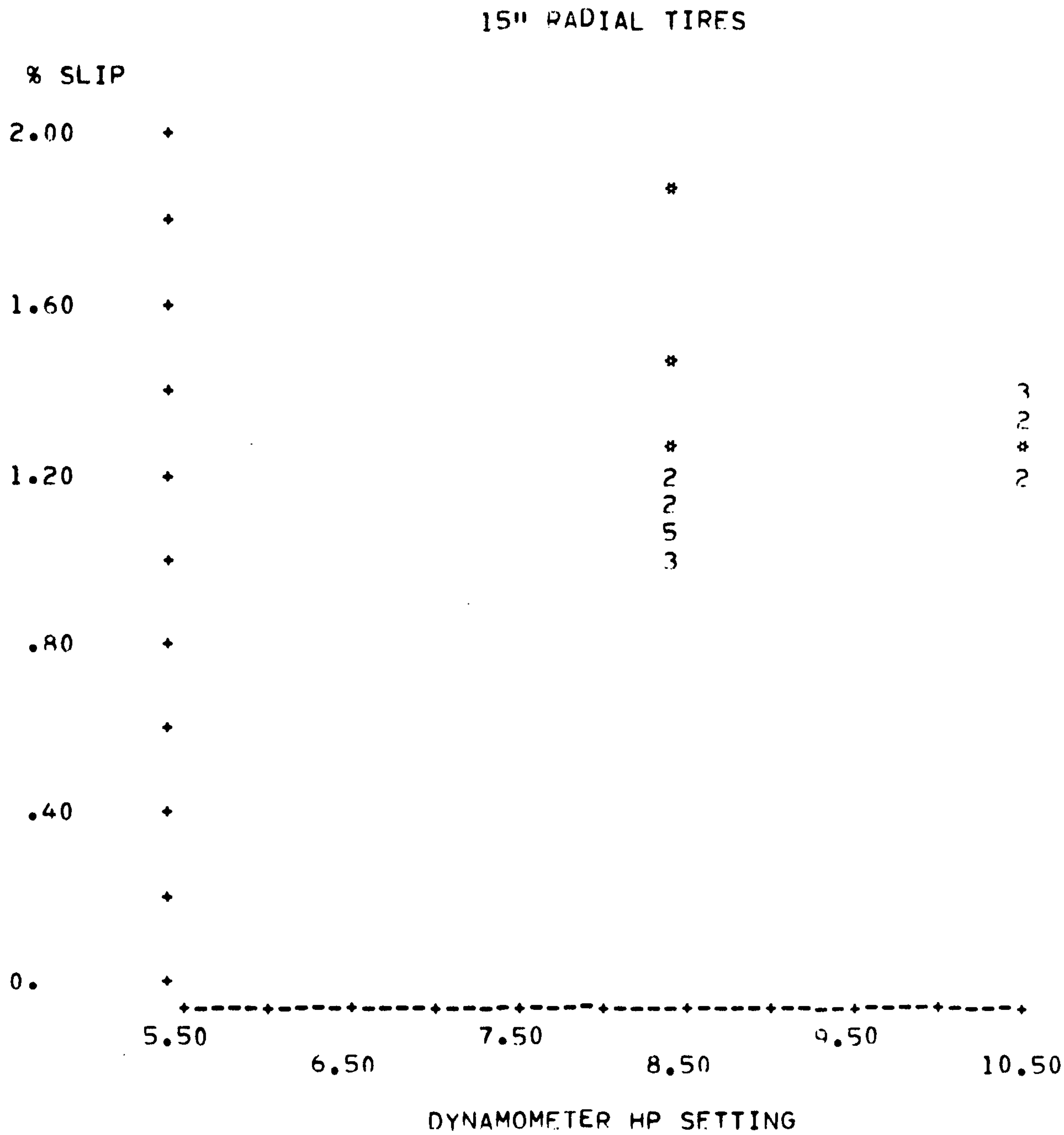
Plot A-3


14" RADIAL TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

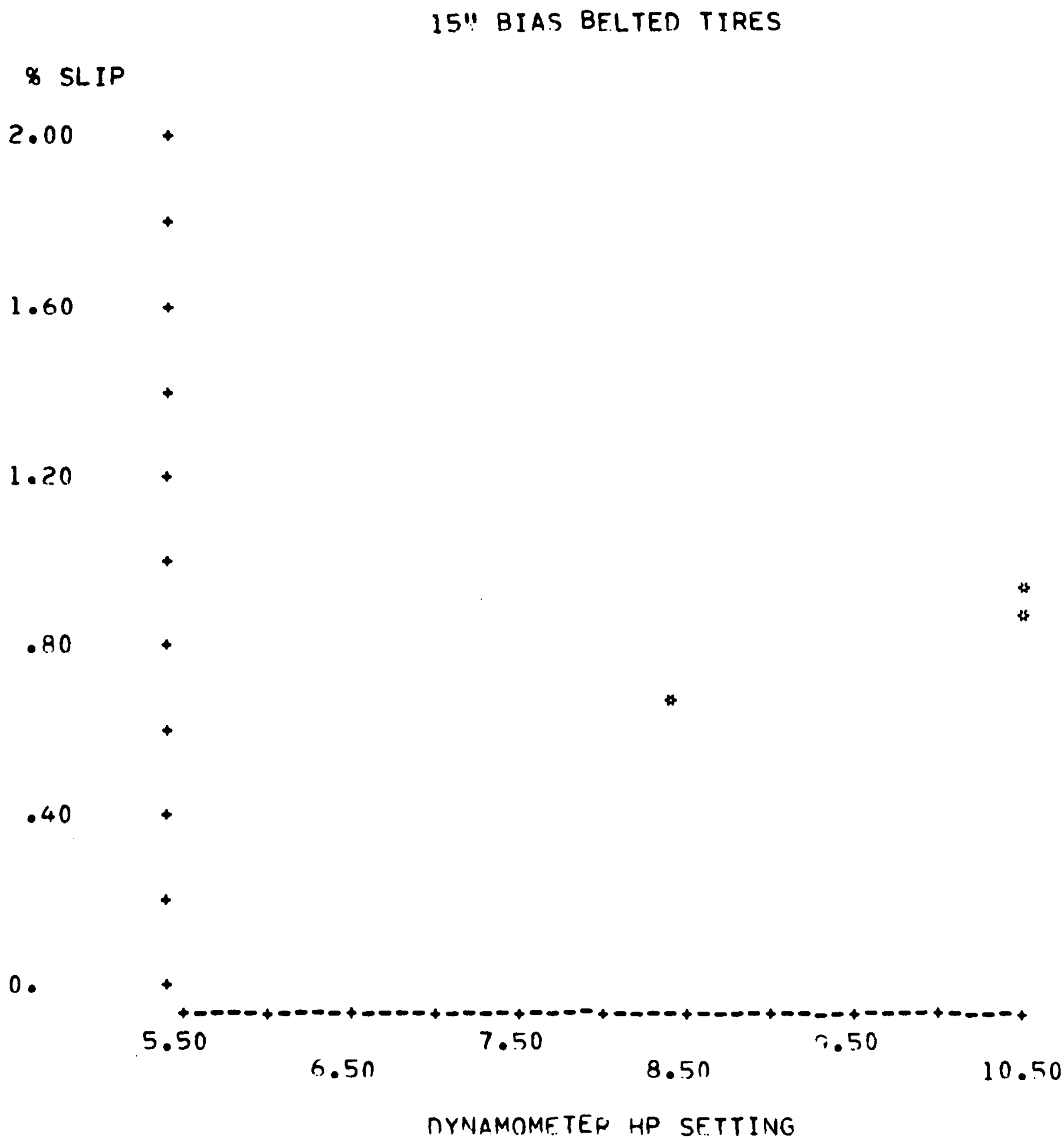
Plot A-4


14" BIAS BELTED TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
2
2
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

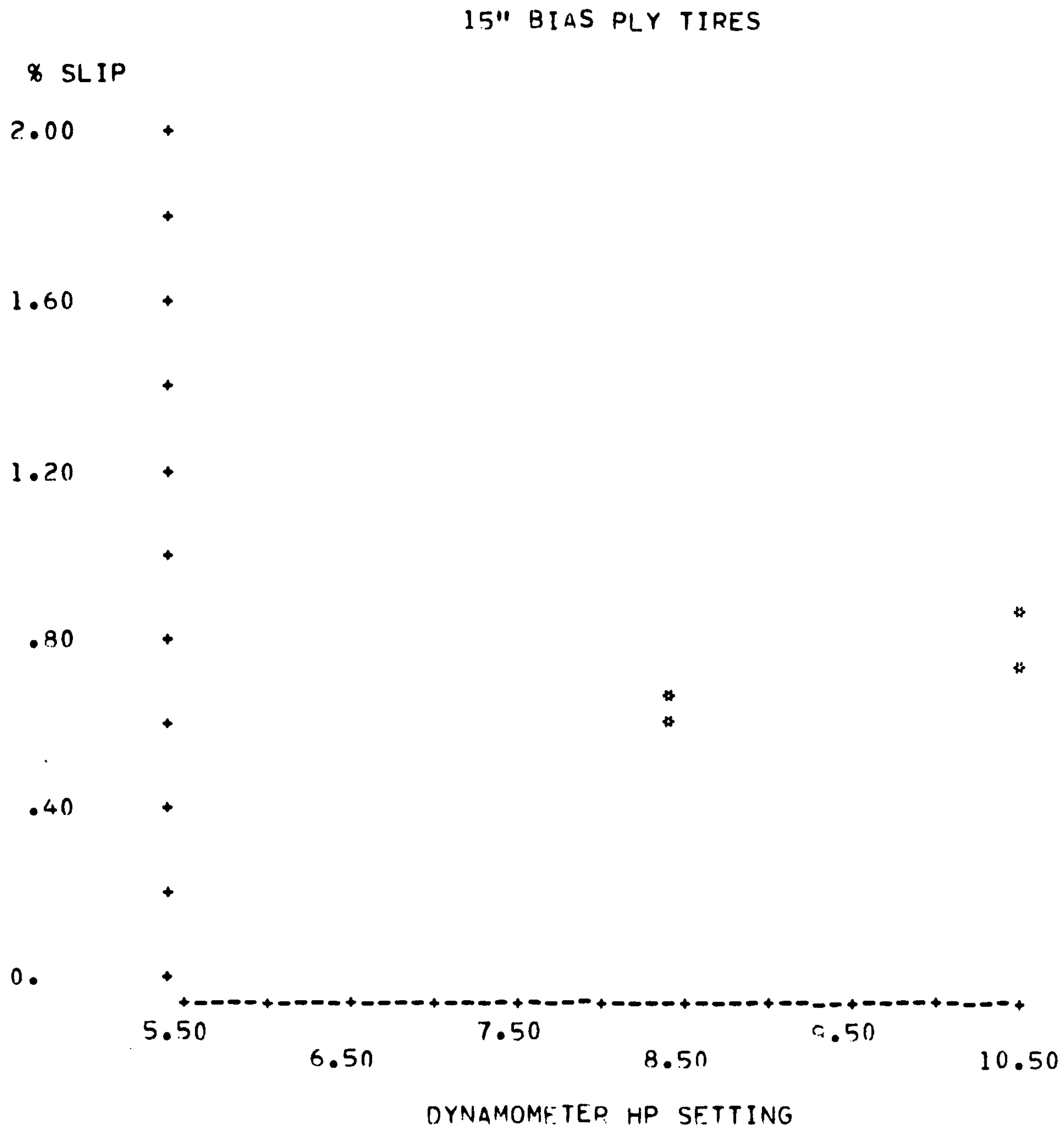
Plot A-5


15" RADIAL TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

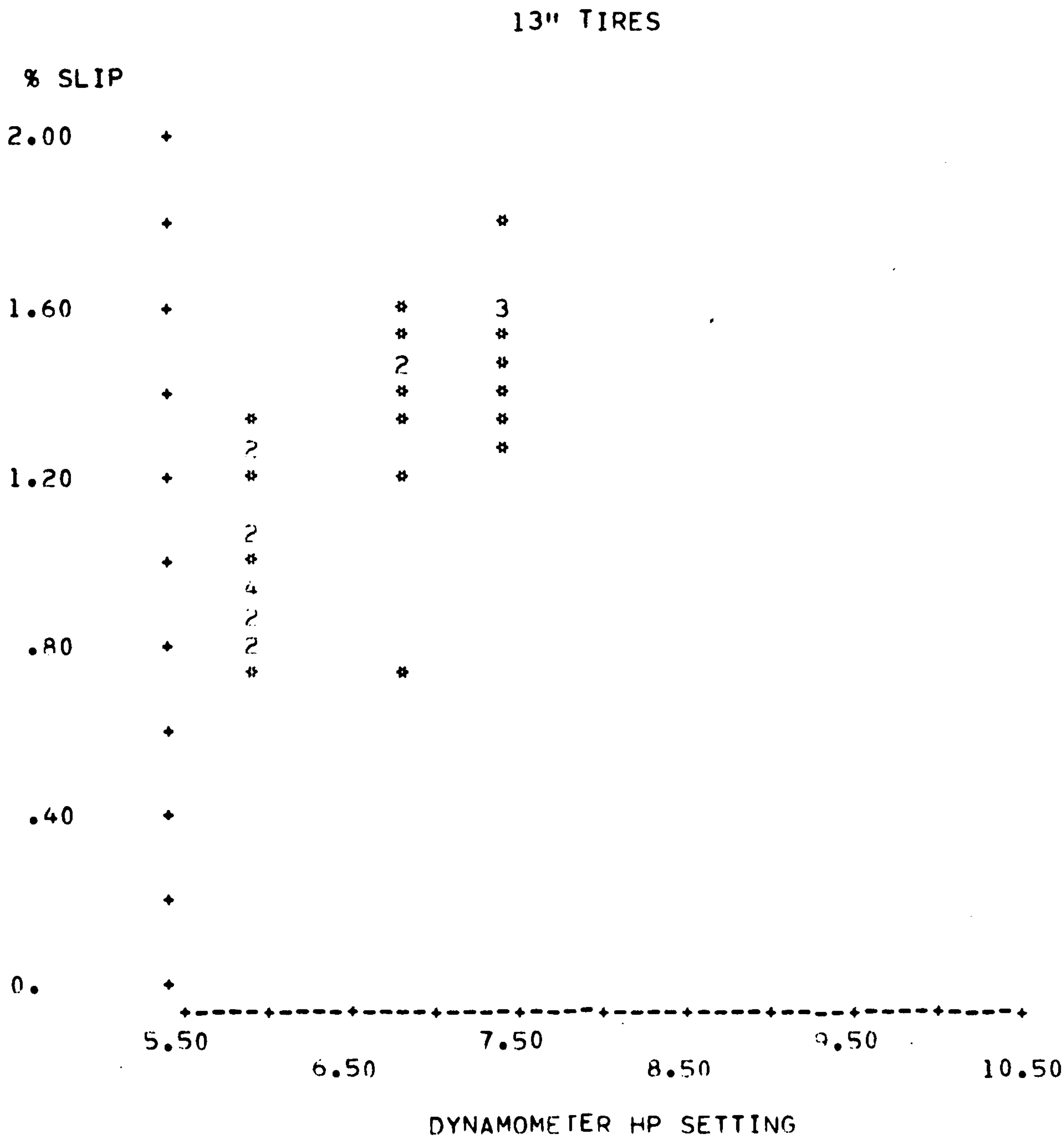
Plot A-6


15" BIAS BELTED TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
.50
10.50
DYNAMOMETER HP SETTING

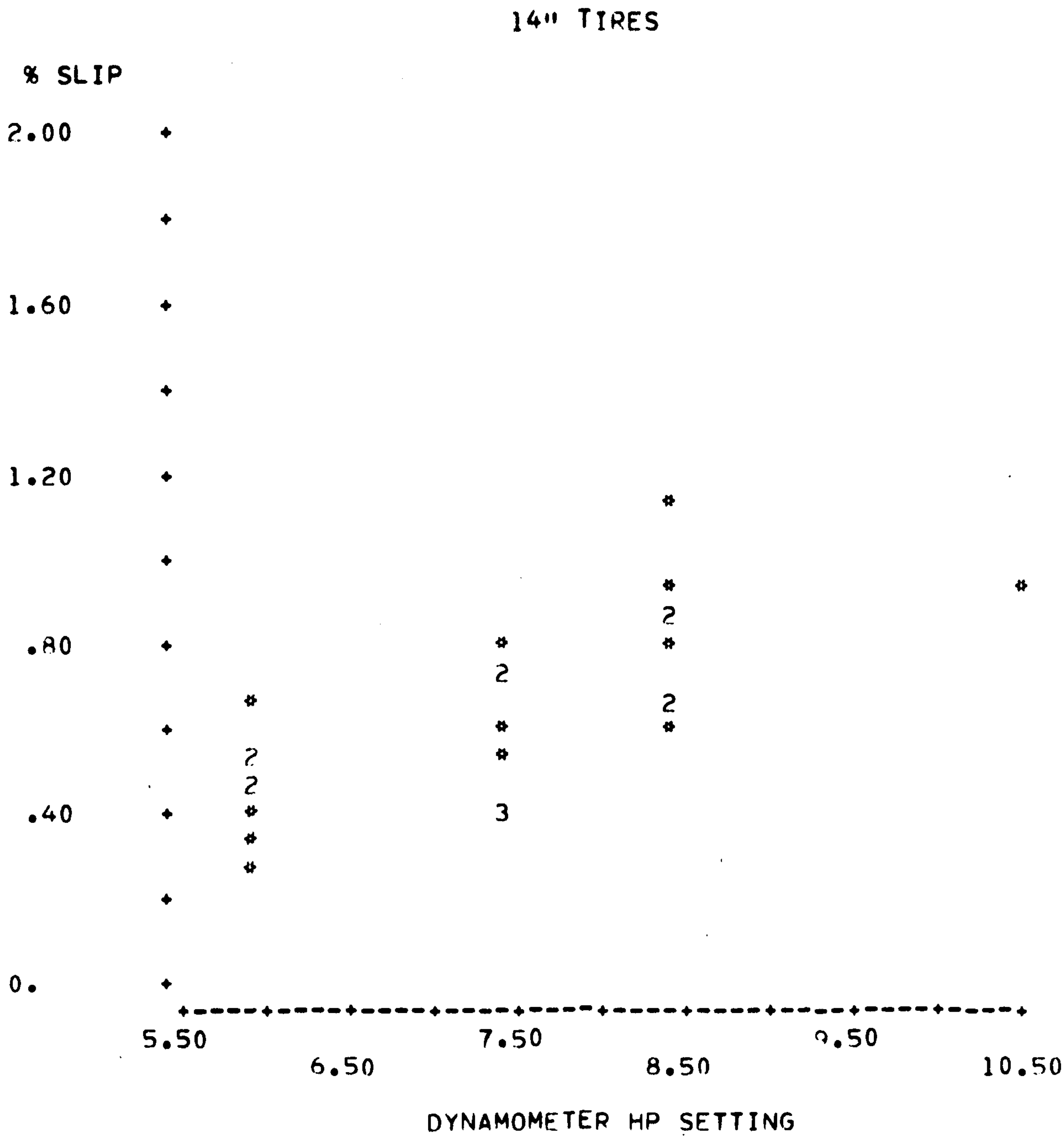
Plot A-7


15" BIAS PLY TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

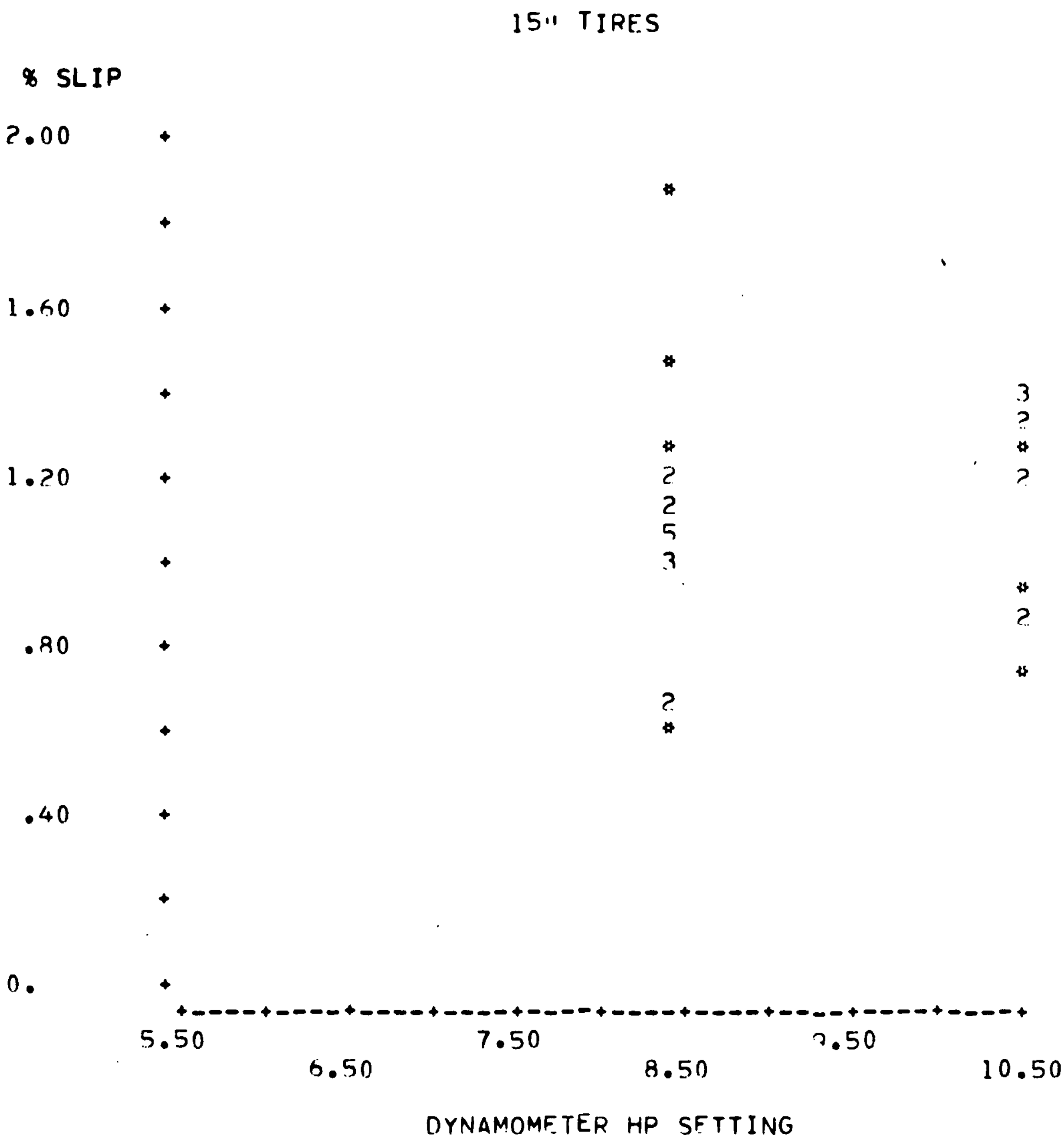
Plot A-8


13" TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

Plot A-9


14" TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

Plot A-10


15" TIRES
% SLIP
2.00
1.60
1.20
.80
.40
0.
5.50
6.50
7.50
8.50
9.50
10.50
DYNAMOMETER HP SETTING

Plot A-11

APPENDIX B

Tire Descriptions and Test Data

Table B-1

Tire Descriptions

Identification Number	Manufacturer	Size	Model/Type
010	Goodyear	BR70X13	Polyglass Radial WT
020	Goodyear	BR78X13	Polyglass Radial
040	Goodyear	HR78X14	Custom Polysteel Radial
060	Goodyear	H78X15	Custom Power Cushion Polyglass
070	Goodyear	HR78X15	Polyglass Radial
080	Goodyear	HR70X15	Polyglass Radial WT
100	Goodyear	B78X13	Cushion Belt Polyglass
110	Goodyear	H78X14	Polyglass Cushion Bias Belted
12B	B.F. Goodrich	HR78X15	Silvertown Steel Radial
13A	B.F. Goodrich	H78X15	Custom Long Miler
13B	B.F. Goodrich	H78X15	Custom Long Miler
15B	B.F. Goodrich	H78X15	Silvertown Belted
16A	B.F. Goodrich	HR70X15	Silvertown Lifesaver XL-100
16B	B.F. Goodrich	HR70X15	Silvertown Lifesaver XL-100
180	Firestone	GR78X15	Steel Belted Radial
200	Goodyear	HR78X15	Custom Tread Steel Belted Radial
210	Uniroyal	GR78X15	Steel Belted Radial PR6
220	Goodyear	GR78X15	Custom Tread Steel Belted Radial
230	General	GR78X15	Dual Steel II Radial
240	Uniroyal	LR78X15	Steel Belted Radial PR6
250	Goodyear	ER78X14	Custom Tread Steel Belted Radial
260	Uniroyal	FR78X14	Steel Belted Radial
270	Firestone	FR78X14	Steel Belted Radial
290	Firestone	HR78X15	Steel Belted Radial
300	Uniroyal	ER78X14	Steel Belted Radial
310	Firestone	ER78X14	Steel Belted Radial
320	Goodyear	E78X14	Custom Power Cushion Polyglass
330	Uniroyal	E78X14	Fastrak Belted
340	Firestone	E78X14	Sup-R-Belted Deluxe Champion
350	Uniroyal	B78X13	Fastrak Belted
360	Goodyear	BR78X13	Steel Belted Radial
370	Firestone	BR78X13	Steel Belted Radial
380	Uniroyal	BR78X13	Steel Belted Radial
390	Firestone	B78X13	Deluxe Champion
400	Uniroyal	HR78X15	Steel Belted Radial
410	B.F. Goodrich	B78X13	Silvertown Bias Ply
420	B.F. Goodrich	GR78X15	Lifesaver 78 Steel Belted Radial

Table B-2

Tire Mean Data

Tire Identification	Hp Set	Nominal Tire Size (inches)	Delta Roll Speed (rev/sec)	Percent Slip
010	5.9	13	10.09	1.26
010	5.9	13	7.47	0.95
010	6.8	13	12.11	1.56
010	7.4	13	14.48	1.79
020	5.9	13	7.40	0.95
020	6.8	13	12.90	1.62
020	7.4	13	12.42	1.58
020	5.9	13	9.96	1.28
040	10.5	15	9.94	1.32
060	10.5	15	7.10	0.88
060	8.4	15	4.94	0.64
070	8.4	15	8.26	1.09
080	10.5	15	9.24	1.20
080	8.4	15	9.74	1.22
100	5.9	13	6.41	0.79
100	5.9	13	7.25	0.92
100	6.8	13	11.47	1.38
100	7.4	13	11.34	1.41
110	10.5	14	7.14	0.91
12B	10.5	15	9.69	1.28
12B	8.4	15	8.02	1.05
13A	10.5	15	5.76	0.76
13A	8.4	15	5.42	0.69
13B	8.4	15	4.74	0.61
13B	10.5	15	6.71	0.86
15B	10.5	15	7.84	0.96
16A	8.4	15	15.05	1.86
16B	10.5	15	10.52	1.37
16B	8.4	15	9.33	1.15
180	8.4	15	7.49	0.97
200	10.5	15	9.35	1.23
200	8.4	15	8.19	1.02
210	8.4	15	7.98	1.07
220	8.4	15	10.94	1.44
230	10.5	15	10.30	1.35
230	8.4	15	7.86	1.04
240	10.5	15	11.02	1.42
240	8.4	15	9.56	1.21
250	5.9	14	3.92	0.56
250	8.4	14	6.39	0.92
250	7.4	14	5.48	0.76

Table B-2 Continued

Tire Identification	Hp Set	Nominal Tire Size (inches)	Delta Roll Speed (rev/sec)	Percent Slip
260	5.9	14	4.65	0.64
260	8.4	14	8.77	1.11
260	7.4	14	5.67	0.79
270	5.9	14	3.49	0.48
270	8.4	14	6.69	0.89
270	7.4	14	3.11	0.43
290	8.4	15	7.38	0.98
300	5.9	14	3.66	0.52
300	8.4	14	6.13	0.87
300	7.4	14	5.15	0.71
310	7.4	14	4.27	0.61
310	5.9	14	3.28	0.48
310	8.4	14	5.58	0.80
320	5.9	14	2.73	0.36
320	8.4	14	4.28	0.59
320	7.4	14	3.07	0.42
330	5.9	14	2.02	0.28
330	8.4	14	5.38	0.68
330	7.4	14	3.16	0.43
340	8.4	14	4.71	0.66
340	5.9	14	2.81	0.38
340	7.4	14	3.73	0.52
350	5.9	13	6.27	0.79
350	5.9	13	6.74	0.85
350	7.4	13	10.34	1.33
360	5.9	13	10.07	1.22
360	6.8	13	11.38	1.44
360	5.9	13	8.20	1.05
360	7.4	13	12.48	1.58
370	6.8	13	5.59	0.73
370	7.4	13	11.51	1.47
370	5.9	13	6.74	0.84
380	5.9	13	8.24	1.05
380	6.8	13	10.19	1.33
380	7.4	13	11.70	1.51
380	5.9	13	10.90	1.35
390	5.9	13	8.15	1.00
390	5.9	13	6.03	0.76
390	7.4	13	9.82	1.25
390	6.8	13	9.70	1.23
400	8.4	15	9.42	1.24
400	8.4	15	8.29	1.09
410	7.4	13	12.75	1.63
410	5.9	13	7.38	0.92
410	6.8	13	11.58	1.45
420	10.5	15	10.13	1.37
420	8.4	15	8.40	1.12