Technical Report Documentation Page

1. REPORT No.

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE

A Factfinding Study OnThe Effects Of Grooved And Textured Pavements On Motorcyclists

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

Summary:

Motorcyclists find some sections of grooved and textured pavements uncomfortable riding. They insist that such pavements are hazardous and want advance warning signs and alternatives to grooving and textured pavements.

The Department of Public Works has conducted rideability studies and finds grooved and textured pavements can cause uncomfortable riding with some combinations of motorcycles and tires, but certainly not to the point of being hazardous.

Accident statistics support the rideability tests. The increase in motorcycle accidents on grooved sections has been 10% per 30-month study period, while motorcycle registrations statewide and motorcycle accidents on ungrooved freeways have increased an average 22% during corresponding study periods.

The Department of Public Works has undertaken research to find means of strengthening and lengthening the surface life of pavements and thus lessen the need for grooving and heavily textured pavements.

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STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS

A FACTFINDING STUDY ON THE EFFECTS OF GROOVED AND TEXTURED PAVEMENTS ON MOTORCYCLISTS

73-37
DND

1972 Regular Session

March 1973

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
1120 N STREET
SACRAMENTO, CALIFORNIA 95814

March 1, 1973

Honorable Darryl R. White
Secretary of the Senate
State Capitol

Honorable James D. Driscoll
Chief Clerk of the Assembly
State Capitol

Gentlemen:

Assembly Concurrent Resolution No. 101 of the 1972 Regular Session by Assemblyman Eugene Chappie requested the Department of Public Works to conduct and submit, in conjunction with the Department of the California Highway Patrol and motorcycle riders, a study of the effects of serrations and pavement texture on motorcycles.

Attached are two copies of a report on the results of that study.

Sincerely,

JAMES A. MOE
Director of Public Works

Howard C. Ullrich
Chief Deputy Director

Attachments

Assembly Concurrent Resolution No. 101—Relative to the effect of highway surfaces on motorcycles.

LEGISLATIVE COUNSEL'S DIGEST

ACR 101, Chappie. Highway surfaces.

Requests the Department of Public Works to conduct, in conjunction with the Department of the California Highway Patrol and motorcycle riders, a study of the effects of serration and texture of highway pavements on motorcycles, and to make a report thereon to the Legislature on or before March 1, 1973.

WHEREAS, Motorcyclists have reported that variations in the texture of the surface of highways have an effect on the handling of motorcycles; and

WHEREAS, The Department of Public Works uses rain-grooving and other techniques in highway construction to increase traction of motor vehicles in wet weather; and

WHEREAS, It is important to determine if such techniques constitute a hazard to motorcycles; now, therefore, be it

Resolved by the Assembly of the State of California, the Senate thereof concurring, That the Legislature hereby requests the Department of Public Works to conduct, in conjunction with the Department of the California Highway Patrol and motorcycle riders, a study of the effects of serration and texture of highway pavement on motorcycles, and to make a report thereon to the Legislature on or before March 1, 1973; and be it further

Resolved, That the Chief Clerk of the Assembly transmit copies of this resolution to the Director of Public Works and to the Commissioner of the California Highway Patrol.

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SUMMARY

Motorcyclists find some sections of grooved and textured pavements uncomfortable riding. They insist that such pavements are hazardous and want advance warning signs and alternatives to grooving and textured pavements.

The Department of Public Works has conducted rideability studies and finds grooved and textured pavements can cause uncomfortable riding with some combinations of motorcycles and tires, but certainly not to the point of being hazardous.

Accident statistics support the rideability tests. The increase in motorcycle accidents on grooved sections has been 10% per 30-month study period, while motorcycle registrations statewide and motorcycle accidents on ungrooved freeways have increased an average 22% during corresponding study periods.

The Department of Public Works has undertaken research to find means of strengthening and lengthening the surface life of pavements and thus lessen the need for grooving and heavily textured pavements.

Warning signs are to be posted in advance of grooved sections that prove difficult to ride.

INTRODUCTION

Pursuant to Assembly Concurrent Resolution No. 101, a study was conducted to obtain opinions, suggestions, and guidelines for future action with regard to motorcycle rideability on State highways. An effort was made to obtain a broad base of opinion, and to this end the following groups were contacted:

1. Members of the California Motorcycle Industry Council at their annual meeting in Ontario, California.

2. Mr. Russ Sanford, representative for "Motorcycle Owners, Riders, Enthusiasts", and spokesman for "International Four Owners Association". The latter group has been very outspoken against grooving.

3. Private individuals and riders' representatives who have written letters of complaint.

4. The Commander, Safety Services, of the California Highway Patrol, who is cooperating in the joint study, and engineers of the CHP who have assisted in previous studies.

5. Members of the CHP motorcycle patrol in Sacramento County (7 officers representing 40 years of riding experience).

RIDEABILITY STUDIES

The Department of Public Works and the California Highway Patrol have conducted rideability studies on previous occasions and they have indicated that grooving does not create hazardous conditions for motorcycles. The tests were objectively designed and based on the subjective opinion of professional riders. The findings of these studies were included in the Legislative Report "A Study of the Effects of Grooving on Motor Vehicle Accidents". (See Reference on page iv.)

In addition to the grooves which are cut into older pavement surfaces, there have been complaints by motorcyclists that the broomed texture which is applied to new pavements results in the same problem of rideability. The findings of a study on this were similar to those rideability studies on grooving; namely, there is some wiggle but not to the point of being hazardous.

An interim report "Effect of Broom Texture on Motorcycle Rideability" dated August 1972 is attached.

ACCIDENT STUDIES

Accident studies of California's initial grooving effort indicated that there was no significant change in motorcycle accidents after grooving. These studies were reported to the Legislature in

answer to House Resolution No. 126, in January 1972. The report is listed under "Reference" on page iv of this report.

A recent follow-up analysis of motorcycle accidents on grooved pavements confirm the earlier findings. There were 123 grooving projects on California highways (almost exclusively freeways) between mid-1966 and mid-1971. 113 of those projects involved grooving only and all lanes were grooved.

In the year prior to grooving there were 81 motorcycle accidents on these 113 sections. There were 90 motorcycle accidents in the year following the grooving, a 10% increase.

To account for the increase in motorcycle accidents during this period an analysiswas made of motorcycle accidents on all California freeways that had not been grooved. It was found that motorcycle accidents on ungrooved freeways increased an average of 22% each period of time corresponding to the before and after study period of the grooved section. It was also found that motorcycle registration increased at the same rate.

In summary, while motorcycle registration and motorcycle accidents on ungrooved freeways increased at a rate of more than 20% per study period, the increase of motorcycle accidents on grooved sections increased only 10%.

MOTORCYCLISTS' VIEWS

Some motorcyclists still insist that grooved and heavily broomed pavements impart an unnerving and potentially dangerous "wiggle", or side-to-side motion, to their cycles. They fear especially for inexperienced riders who may panic.

The heavy brooming on new concrete pavement is considered by most motorcyclists to be more severe in its effect than grooving for the first few months of service. The majority of opinion is that the "zig-zag" pattern of brooming and the lesser undulations of grooving contribute to the severity of the "wiggling". Tire width and tread pattern are also believed to have a significant effect. Riders and riders' groups recommend that the State test motorcycles with tires of various widths and tread patterns and widely publicize the results as a public service.

(It is suspected that narrow, straight-ribbed tires are much more susceptible than wide, random-patterned tires. The interim report in the appendix confirms the influence of tire and tread design and rider experience on broomed pavements.)

Leaving an ungrooved strip through grooved sections was rejected by motorcyclists' representatives. They felt there was no specific two feet of pavement that would be comfortable. In addition, confining oneself to such a strip would be very fatiguing to a rider.

The Department has undertaken a research project to develop new concrete finishing techniques to extend the skid-resistant life of portland cement concrete pavements. The study will include such innovations as seeding the fresh plastic surface with slag and other aggregates. Also, experiments will include placing grooves in the fresh concrete to preclude the future saw cutting of grooves.

It is felt that rideability testing of these new surfaces must include participation of riders' representatives. Motorcycles and riders should be selected by the CHP, the motorcycle industry, and rider's groups. The final evaluation, even though obtained by instrumentation, must be based upon a subjective scale, and public acceptance of test results would be greatly enhanced by public participation.

Oregon now uses a "Grooved Pavement" sign and a similar sign has been recommended to the Federal Highway Administration as a national standard. In the future, California will post warning signs ahead of those grooved sections that prove to cause an uneasy ride for motorcyclists.

Accident statistics will continue to be monitored in a continual measure of the effects of brooming and grooving on accidents.

HIGHWAY RESEARCH REPORT

EFFECT OF BROOM TEXTURE ON MOTORCYCLE RIDEABILITY

INTERIM REPORT

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

RESEARCH REPORT

CA-HY-MR3126-8-72-32

Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration August, 1972

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1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.

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15. SUPPLEMENTARY NOTES

Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration
Study Title - Skid Resistance of Pavement Surfaces

16. ABSTRACT

A study was conducted to determine if the safety of the motorcyclist was impaired by the broom texture of the portland cement concrete roadway surface located on State Highway 50 near Sacramento. Three motorcycles were acquired for the test study. The smallest of the three was 250 cc's, the second was 500 cc's, and the third was a standard Highway Patrol bike. The evaluation was made by three experienced motorcyclists. The broom texture tested in this study did not present a hazardous riding condition to the motorcyclist. In general, the 250 cc bike was more sensitive to the surface texture than the other two bikes. This was even more evident with the addition of semi-knobby tires to both the front and back wheels.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
PCC pavement, broom texture, motorcycle safety	Unlimited

19. SECURITY CLASSIF. (OF THIS REPORT)	20. SECURITY CLASSIF. (OF THIS PAGE)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	22	

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REFERENCE: Woodstrom, J. H., Bailey, S. N., and Spring, R. J. "Effect of Broom Texture on Motorcycle Rideability", State of California Transportation Agency, Department of Public Works, Division of Highways, Materials and Research Department. Interim Research Report No. CA-HY-MR3126-8-72-32, Federal Agreement B-3-1, August 1972.

ACKNOWLEDGMENT

The authors of this report wish to express their appreciation to Mr. Ross Little and Sergeant Larry Piatt of the California Highway Patrol, and Mr. James Smelser of the Materials and Research Department, for their assistance in conducting this study.

Assistance in conducting the project was also provided by Mr. P. E. Mason and E. L. Wilson of the Materials and Research Laboratory.

The project was performed in cooperation with the U.S. Department of Transportation, Federal Highway Administration, Agreement No. B-3-1.

STATE OF CALIFORNIA—TRANSPORTATION AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

August 1972

Interim Report
M&R No. 633126-8
Fed. No. B-3-1

Mr. R. J. Datel
State Highway Engineer

Dear Sir:

Submitted herewith is an interim report on research on skid resistance of pavement surfaces, entitled:

EFFECT OF BROOM TEXTURE ON
MOTORCYCLE RIDEABILITY

D. L. Spellman
Principal Investigator

J. H. Woodstrom
Co-Investigator

Report Prepared by

J. H. Woodstrom
S. N. Bailey
R. J. Spring

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

Attachment

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EFFECT OF BROOM TEXTURE ON MOTORCYCLE RIDEABILITY

Introduction

The problem of producing a PCC riding surface which provides a safe, durable skid resistance surface, has been an area of great concern to the highway engineers in recent years. In order to meet initial skid resistance requirements as well as maintain an adequate skid resistance coefficient over a long period of time, California has investigated several different types of PCC surface textures. As a result of the emphasis placed on this subject and the problems contractors have had in achieving specified friction levels on some projects, a large percentage of California pavements now receive a broomed texture. The striations thus formed are normally oriented in a longitudinal direction.

There is some variability in the characteristics of the longitudinal broomed texture in that (1) the alignment of the striations is not perfectly parallel with the roadway alignment, and at times the roadway surface presents a wavy appearance to drivers, and (2) striations may be deeper in some areas than they are in others. Generally, broomed texturing provides excellent initial skid resistance and good drainage in wet weather.

The heavy appearing texture produced by some brooming operations has prompted reports by motorcyclists that the pavement surface produces an uneasy feel while riding. The interaction between the tire and the pavement texture apparently causes minute lateral movements that can produce a startling sensation to operators of the smaller bikes. There have been no known accidents to cyclists that have been attributed to this condition; however, it was desired to obtain information as to the seriousness of the problem.

Shortly after a recently completed portion of U.S. Highway 50 in Sacramento was opened to public traffic, scattered complaints were received from motorcyclists on the effect of the surface texture on riding characteristics. A test site was selected on Contract 03-100844, between 65th Street and Mayhew Road, for study. From Station 84+00 to 109+00, which is in the

vicinity of Occidental Avenue O.C., the No. 4 (right hand) Eastbound lane was selected for concerted evaluation. This particular area had a heavy broom texture with deep wavy striations (see Figures 1 and 2) and represented a section of the more severe texture. In addition, a cursory evaluation was made of the portion of freeway from Watt Avenue to Stockton Boulevard in the outer lane, both directions.

Three motorcycles and three drivers were used in conducting the study. The motorcycles included a 250 cc, 500 cc, and a standard California Highway Patrol bike. The drivers selected for the study consisted of two experienced street riders and an experienced dirt rider, who has not ridden on freeways. It was felt that possibly the uneasy feeling expressed in the original complaints was due to a lack of experience in street or freeway riding and not as a result of the pavement texture. Therefore, it was decided to include a cyclist not experienced in freeway riding in order to compare his evaluation with that of the other two riders.

CONCLUSIONS

1. When related to other normal conditions, such as the transition from an AC shoulder to a PCC pavement, the effect of a crosswind or the effect of freeway traffic, the heavy broom texture studied in this report did not present a hazardous riding condition.

2. The 250 cc motorcycle, when equipped with semi-knobby tires, was most sensitive to the surface texture and a general "uneasiness" was expressed by riders.

These conclusions are necessarily limited to the findings obtained on one section of a recently opened freeway in which a specific mode of construction and texturing techniques were employed.

EVALUATION PROCEDURE

A series of skid resistance measurements were made on the broom texture prior to the motorcycle test. Skid measurements were made in the right lane every 250 feet in both the right and left wheel tracks using the California Portable Skid Tester (see layout in Figure 11), and the test results are shown in Table A. From these values, it can be seen that the pavement in general had excellent skid resistance characteristics. No significant difference could be established between the right and left wheel tracks.

In addition to the skid measurements, photographs of the surface texture were made at each skid test location in order to evaluate the texture depth. Typical conditions of surface texture are shown in Figures 1 and 2.

Observations

A 250 cc bike was selected as the smallest bike to be used for this study. Although the law in California now allows bikes of slightly smaller size, the 250 cc bike was selected as the most common "small" bike using freeways. A change in the law has been proposed to effectively limit the size of motorcycle to 250 cc minimum displacement. A 500 cc bike was selected as a medium size, and a fully equipped California Highway Patrol 1200 cc bike, as the largest (see Figures 3 through 8). All three of the motorcycles used in this study had moderate mileage and were in reasonably good condition.

In addition to the three sizes of motorcycles with standard street tires, evaluations were made with the 250 cc and 500 cc bikes equipped with semi-knobby tires on both the front and rear wheels (see Figures 9 and 10).

The three test drivers consisted of a uniformed California Highway Patrolman, a nonuniformed employee of the California Highway Patrol, and an employee of the Materials and Research Department. The latter was not experienced in freeway riding, but had considerable experience in dirt, or off-pavement riding.

The three riders were of different size and stature. The uniformed Highway Patrolman was 6'0" in height and weighed 200 pounds. The second Highway Patrol employee was 5'7" in height and weighed 155 lbs. The third rider was 6'1" and weighed 180 lbs. All three of the cyclists rode the 250 cc

and 500 cc bikes, but only the experienced street riders participated in the evaluation using the Highway Patrol bike.

Evaluation of the 1/2-mile test section was made at speeds of about 50 mph and 60 mph.

Three specific courses were set up so as to have the different riders evaluating the same area. Course 1 was a straight run along the right wheel track approximately 2'6" in from the right edge of the pavement. Course 2 was a straight run down the left wheel track approximately 8'6" from the right edge of the pavement. Course 3 was a curved run which required the rider to change from the left wheel track to the right wheel track, and back again two times during the 1/2-mile course (see Figure 12). This weaving action was designed to simulate lane changing in traffic. It was felt that the weaving action might create greater effect on the rideability of the motorcycles than the straight runs.

After running each course at speeds of about 50± mph and 60± mph with "standard" tires, the 250 cc and 500 cc bikes were equipped with semi-knobby tires both front and rear.

Courses 1 and 2 were run with these two bikes at both the 50 and 60 mph speed ranges, and Course 3 run at the lower (50± mph) speed range only.

After each run, the motorcyclists were asked for comments relating to such items as the overall feel of the roadway, steering problems, front wheel wobble, difficulty in controlling the bike, corrective measures if taken to adjust for riding surface, and if they limited speed for any reason.

In addition to the normal runs through the test section, the three motorcyclists drove over an additional 4-mile section of the freeway in both the eastbound and westbound directions. This additional run was used to evaluate the test section with respect to the entire freeway. For this purpose only one circuit was made with each bike and there was no exchange of riders. All of the cyclists were in agreement that there were no sections of the 4-mile run which could be considered a problem area with respect to being dangerous. However, the cyclist riding the 250 cc machine did notice two locations when some sensitivity to the texture could be felt. He did not feel that the condition was serious. The texture at these two locations was no different in appearance than the texture of the test location.

It was also noted by one of the cyclists that the most severe movement of the bike occurred when he passed over the joint between the asphalt shoulder and the pavement.

DISCUSSION

The data collected from questioning the riders was evaluated for each of the three bike sizes. The motorcyclists were usually in agreement as to their comments concerning the roadway.

The difference in the two speed runs of 50 mph and 60 mph had little if any effect on increasing the feeling of the roadway.

The weaving from one wheel track to the other presented no problems for any of the cyclists. None of the riders expressed any problems with steering using the standard street tires; however, one rider expressed feeling a slight effect due to the semi-knobby tires on the 500 cc machine.

There was some slight oscillation with the semi-knobby tires on the 500 cc bike, and a moderate amount with the 250 cc bike. Although this oscillation was more apparent using the 250 cc bike, it presented no problems in controlling the machine at the test speeds.

Generally speaking, the semi-knobby tires resulted in a somewhat rougher ride on this broom textured pavement; however, this would be expected on any type of PCC pavement surface.

TABLE A

Test No.	Station Location	Coefficient of Friction Left Wheel Track	Coefficient of Friction Right Wheel Track
1	85+25	37	37
2	87+75	39	38
3	90+25	36	40
4	92+75	37	35
5	95+25	36	37
6	97+75	36	34
7	100+25	38	36
8	102+75	36	36
9	105+25	36	37
10	107+75	37	37

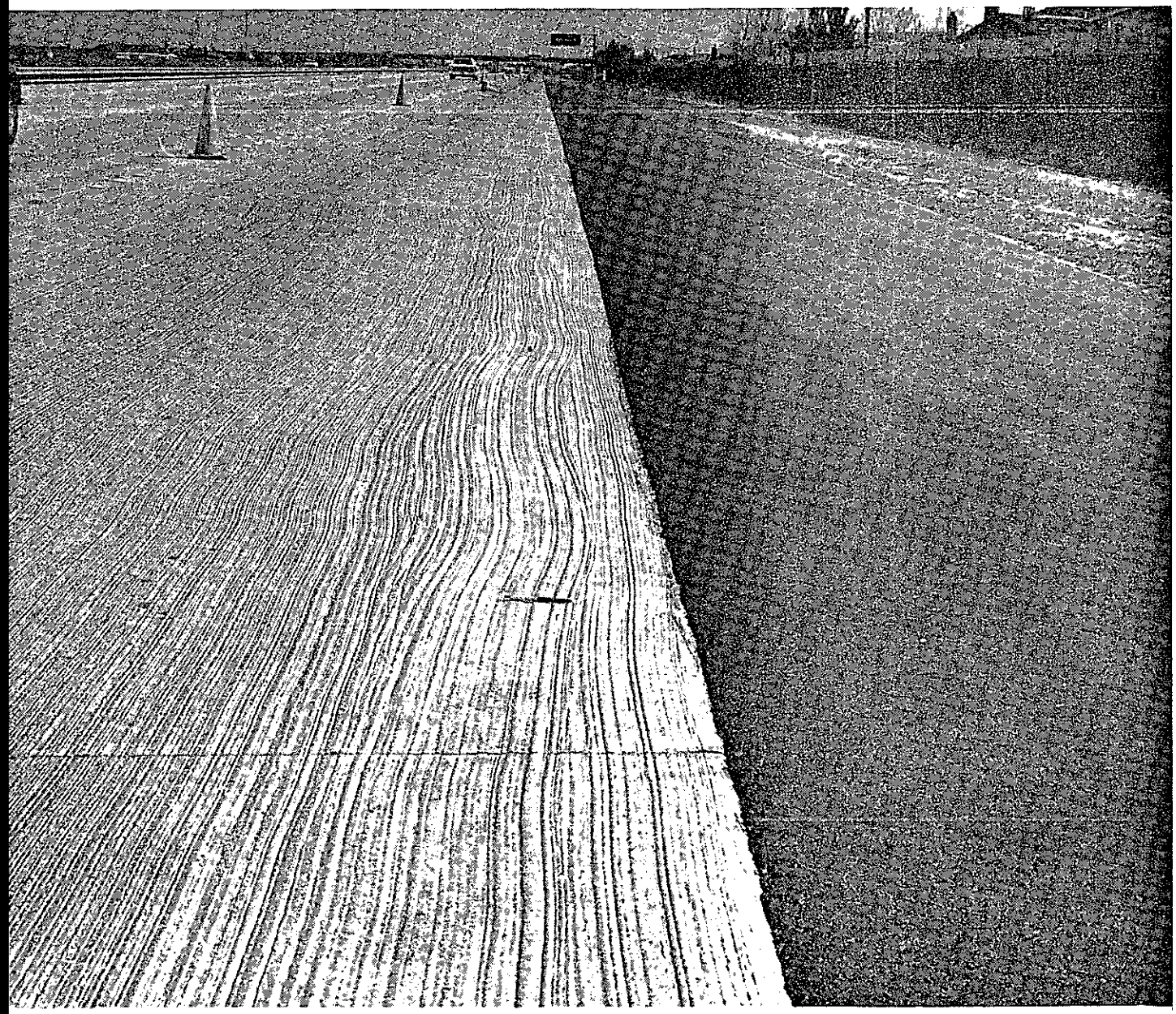


Figure 1. Typical condition of surface texture

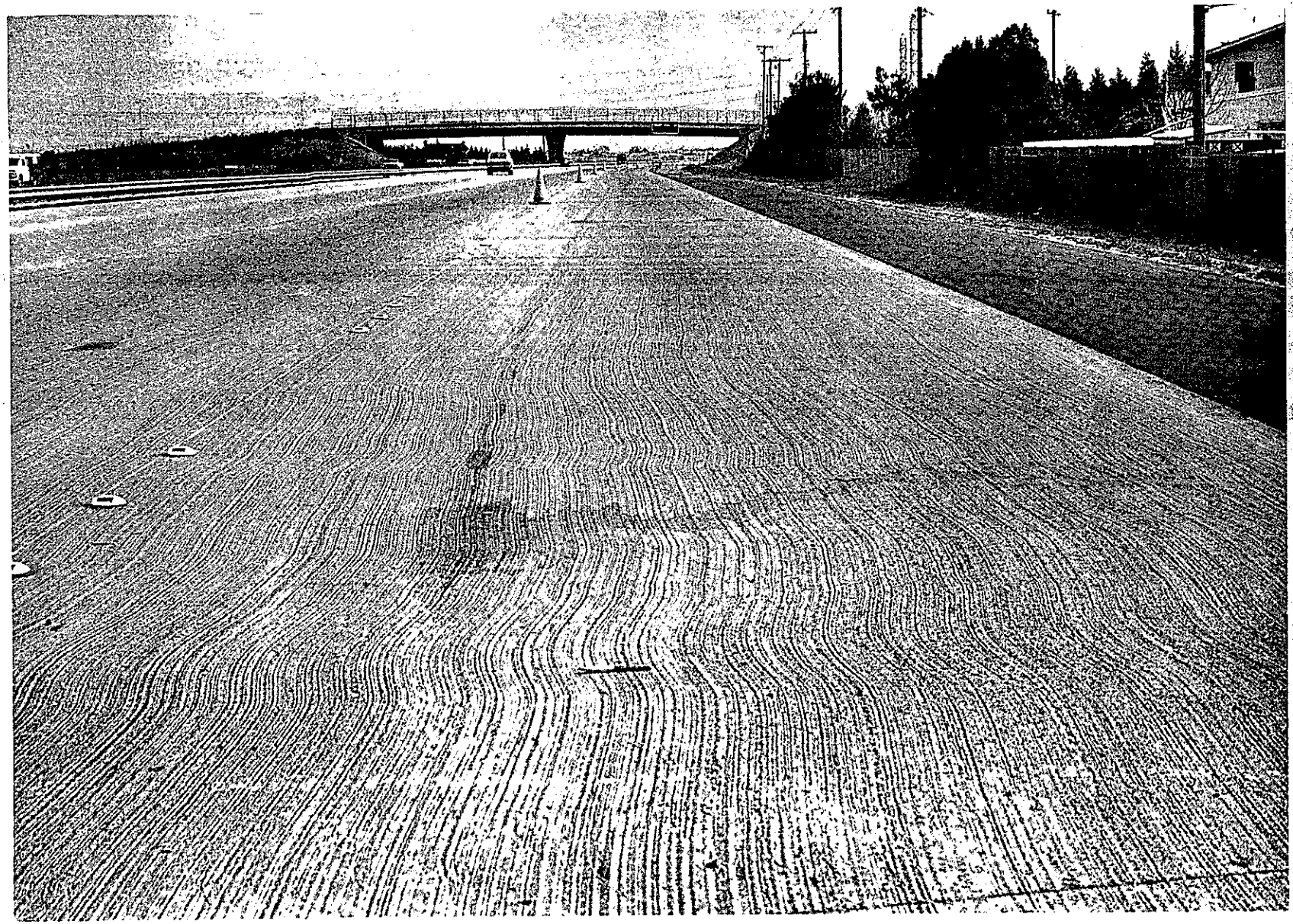


Figure 2. Typical condition of surface texture

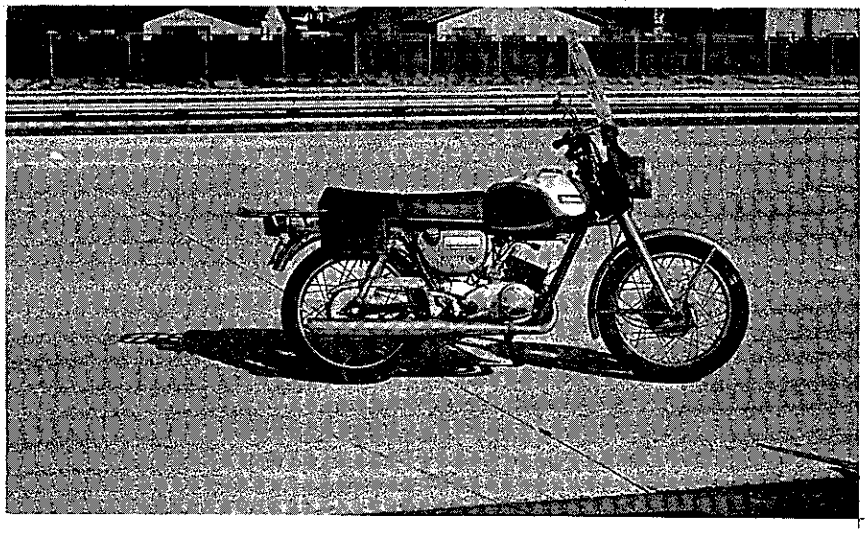


Figure 3. 250 cc Bike

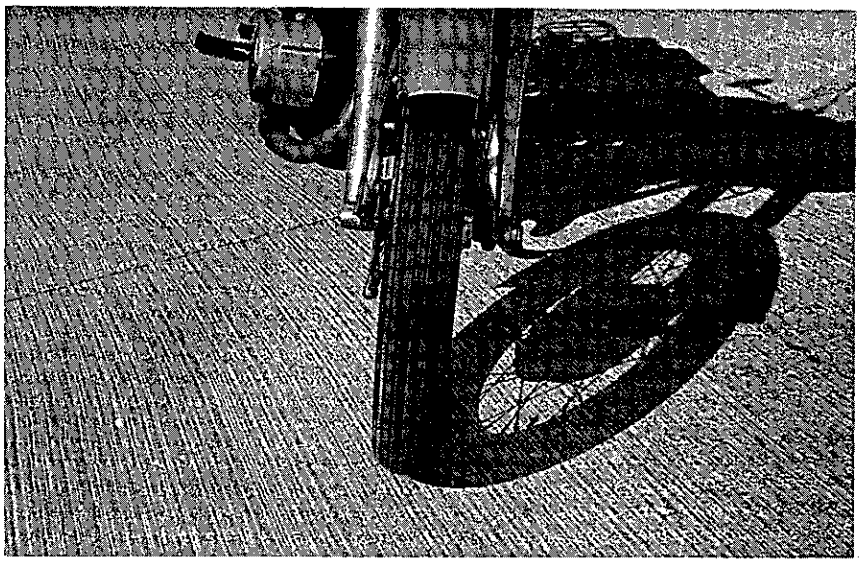


Figure 4. 250 cc Bike with Standard Tire

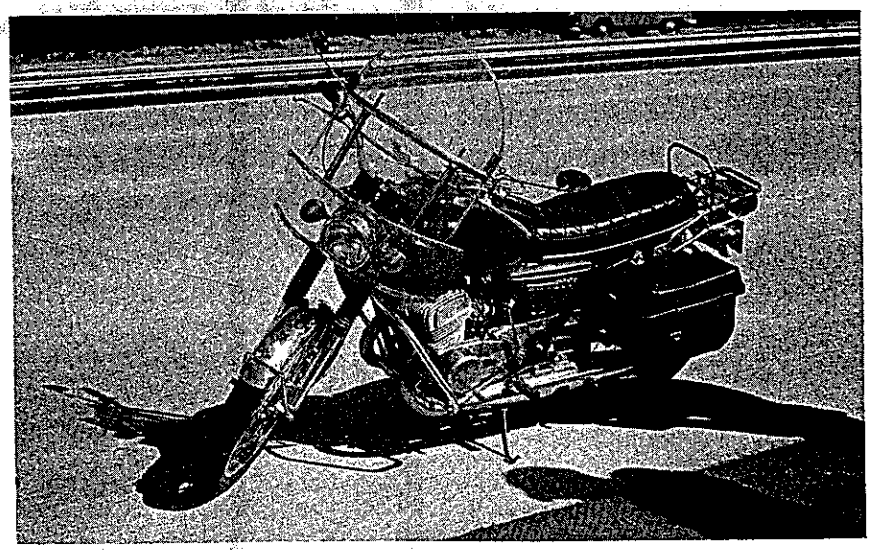


Figure 5. 500 cc Bike

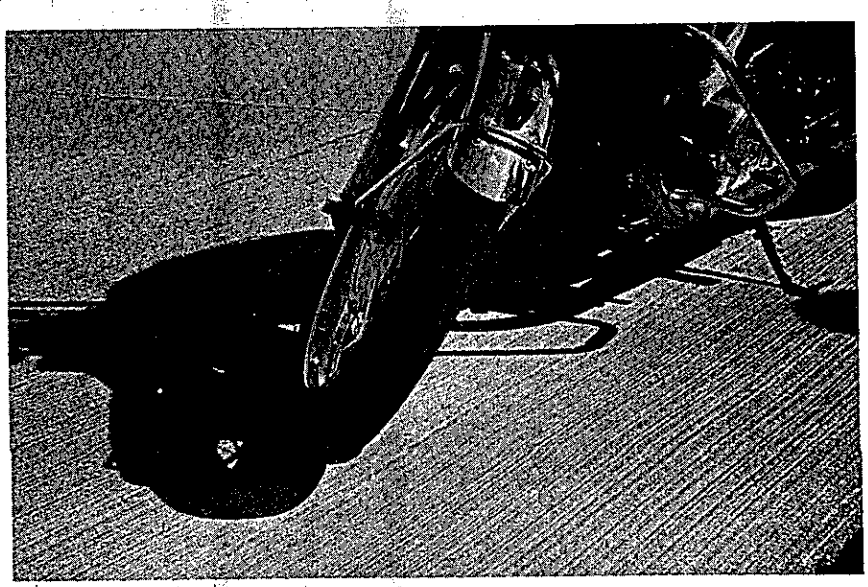


Figure 6. 500 cc Bike with Standard Tire

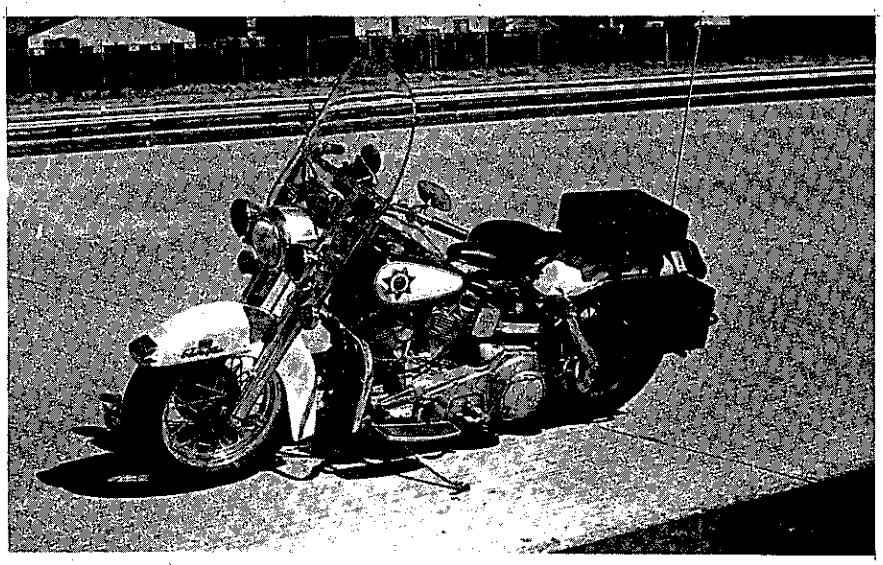


Figure 7. Highway Patrol Bike

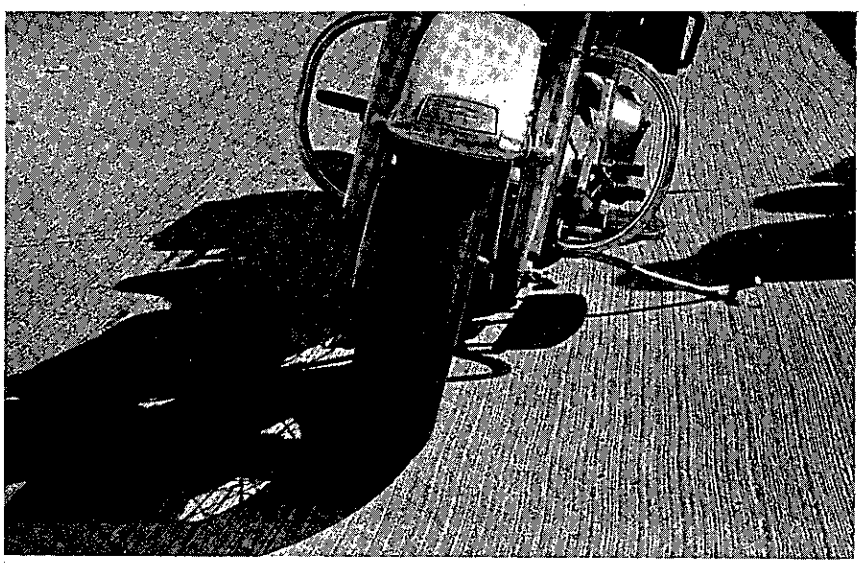


Figure 8. Highway Patrol Bike
with Standard Tire

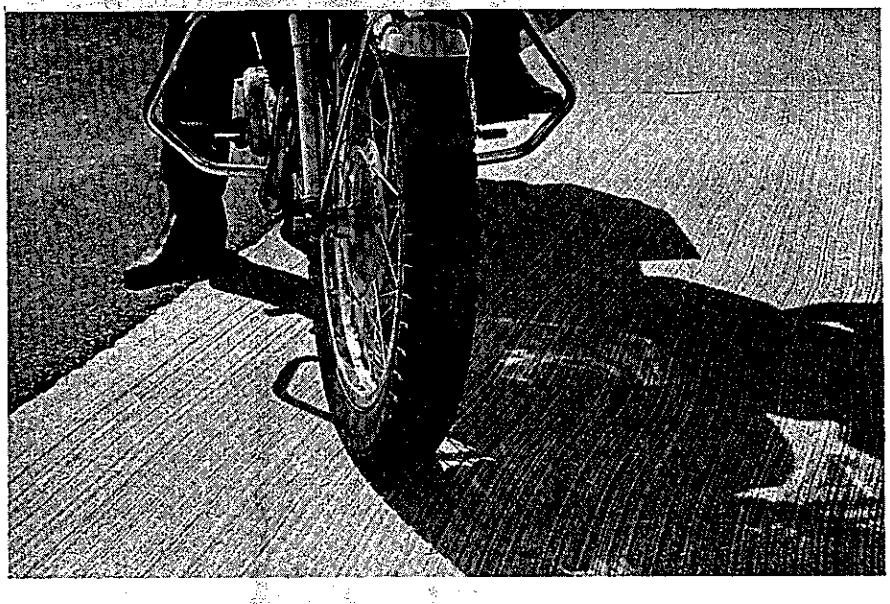
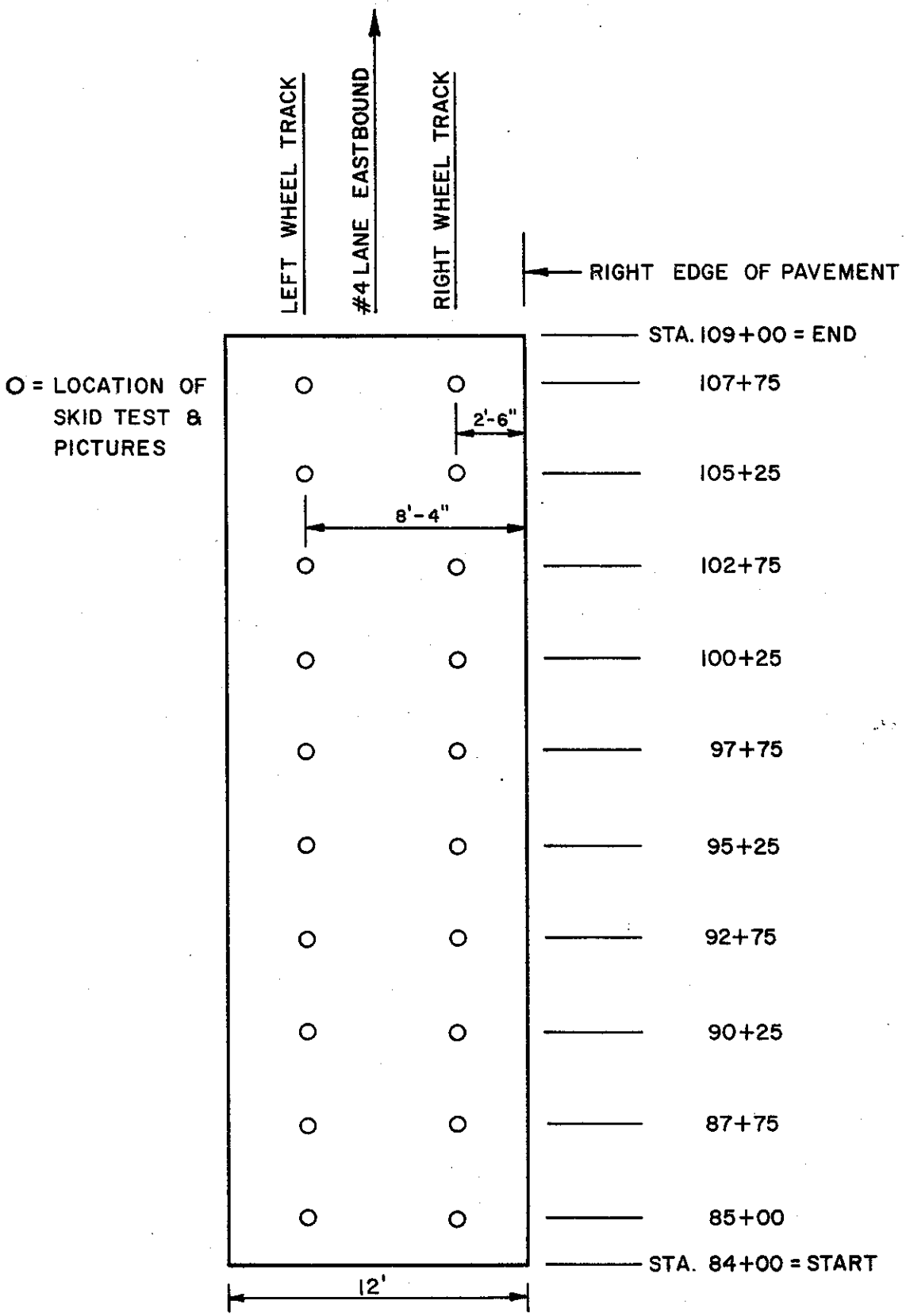


Figure 9. 500 cc Bike with Semi-knobby Tires

Figure 10. 250 cc Bike with Semi-knobby Tires

Figure 11



TEST SECTION

Figure 12