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Limit Handling Performance as Influenced by Degradation of Steering & Suspension Systems

Volume 2 of 2
Vehicle Response Data

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APPENDIX X

LIMIT HANDLING PERFORMANCE AS INFLUENCED BY DEGRADATION OF STEERING AND SUSPENSION SYSTEMS

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APPENDIX X

FULL SCALE TEST PROGRAM DATA

This appendix contains the data plots representing the O.E. and degraded limit maneuver performance of both the American Motors Ambassador and Dodge Coronet test vehicles. Each vehicle was subjected to six test maneuvers in the O.E. condition and in each of the degraded conditions defined in Table X-1.

The mechanical characterization of each degradation mode has been presented in Volume 1, Section 5.

Data plots are arranged in this appendix by maneuver number (as identified at the bottom of Table X-1). For each maneuver category, the O.E. or baseline performance of the Ambassador is placed first followed by the various degraded condition plots for that vehicle. Next, the O.E. plot for the Dodge is presented, followed by its corresponding degraded system plots. Note that the Dodge driver series data (VHTP's 1, 2, and 3) include <u>two</u> sets of O.E. plots, labelled O.E.-A and O.E.-B. The O.E.-A plots are considered to represent the reference condition for degradations D1 and D2 only. The occurrence of a complete change of test tires, following D2, was felt to constitute a sufficient alteration of condition as to merit the conduct of the O.E.-B set of tests. The O.E.-B plots are considered to represent the reference (baseline) condition for degradations D3, D4, and D5.

The various response numerics which are plotted are described ahead of each test set, while a mathematical definition of each numeric is presented in Appendix VIII.

TABLE X-1

DEGRADATION CODES—FULL SCALE TESTS

Degradation Code	Description	Applicable Tests
D1	Shock absorber degradation-both rear wheels	VHTP #3
D2	Shock absorber degradation-all four wheels	1, 2, 3
D3	Two steering system elements degraded (ball joints and tie rod ends)	1, 2, 3
D4	Four steering system elements degraded (ball joints, tie rod ends, steering gear box, and wheel bearings)	1, 2, 3
D5	Front end misalignment	1, 2, 3
A1	Shock absorber degradation-all four wheels	VHTP #4, 5, 6
A2	Four steering system elements degraded (ball joints, tie rod ends, steering gear box, and wheel bearings)	4, 5, 6
A3	Front end misalignment	4, 5, 6
A4	Front end misalignment combined with shock absorber degradation at all four wheels	4, 5, 6

Test Procedure Identification

VHTP #1 - Straight Line Braking

VHTP #2 - Braking In A Turn

VHTP #3 - Roadholding In A Turn

VHTP #4 - Trapezoidal Steer

VHTP #5 - Sinusoidal Steer

VHTP #6 - Drastic Steer and Brake

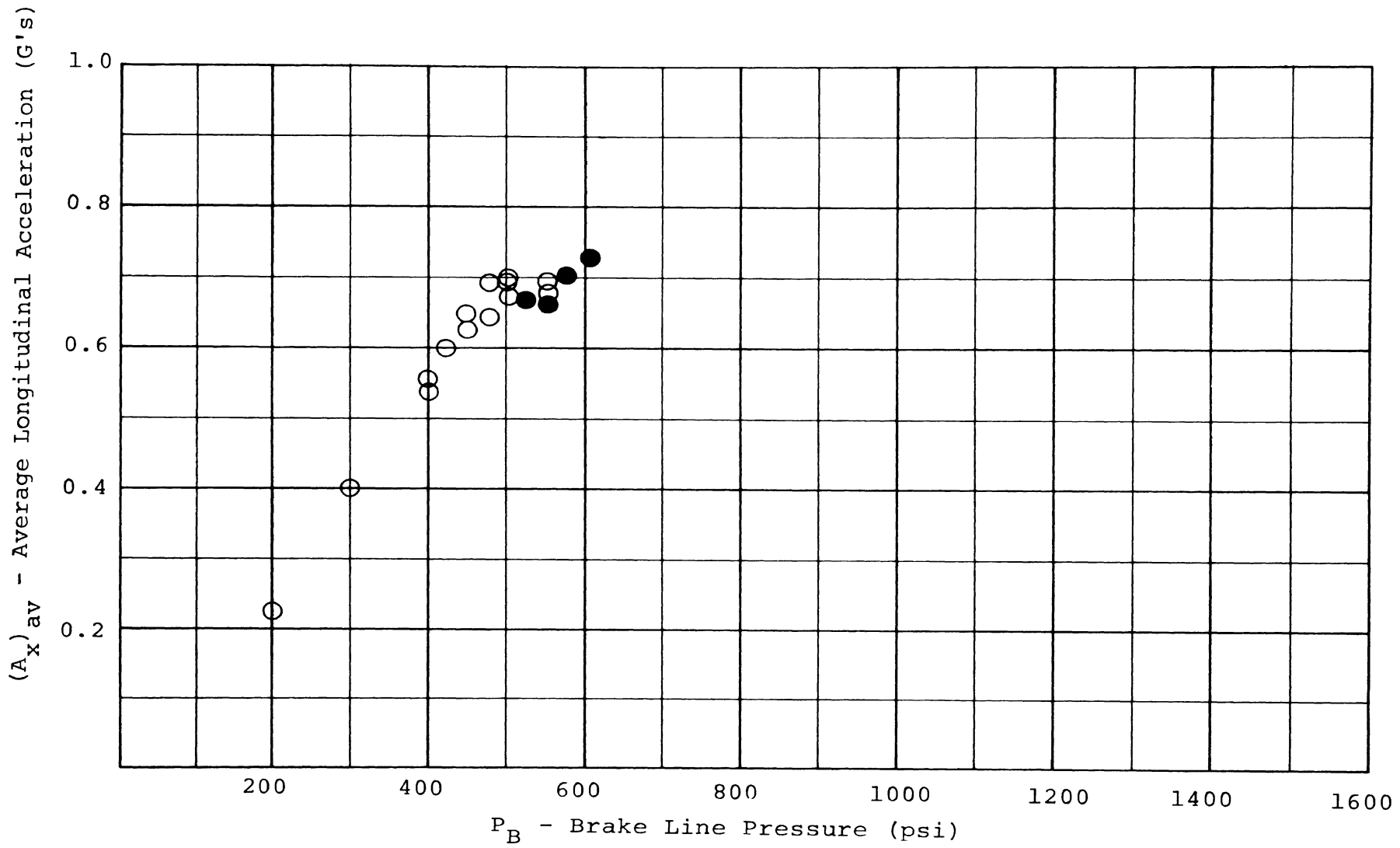
VHTP #1 - STRAIGHT LINE BRAKING

$(A_x)_{ave}$ - Average Deceleration from 35 mph to 10 mph

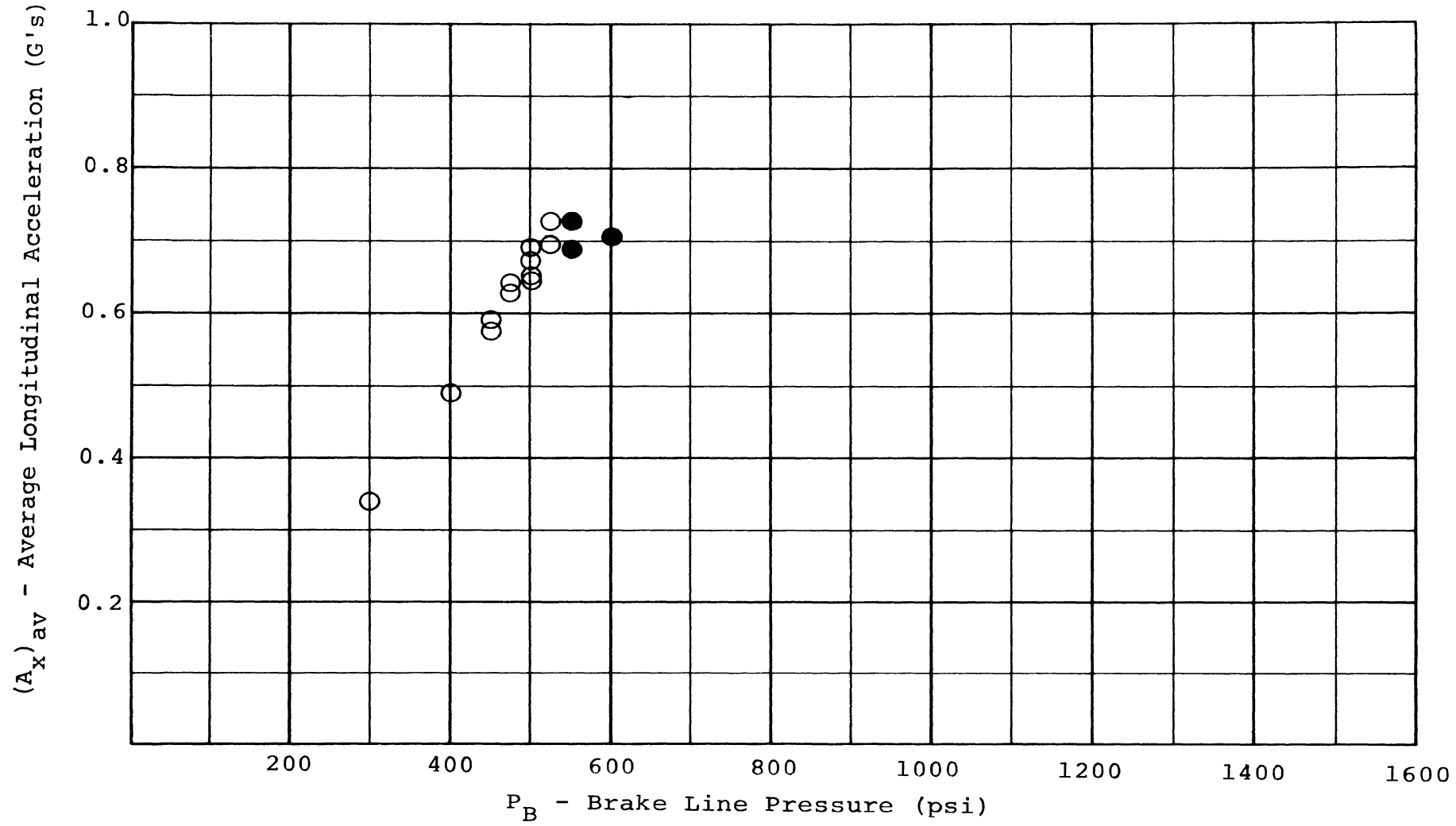
P_B - Brake Line Pressure

● - Indicates 2 Wheels Locked on the Same Axle

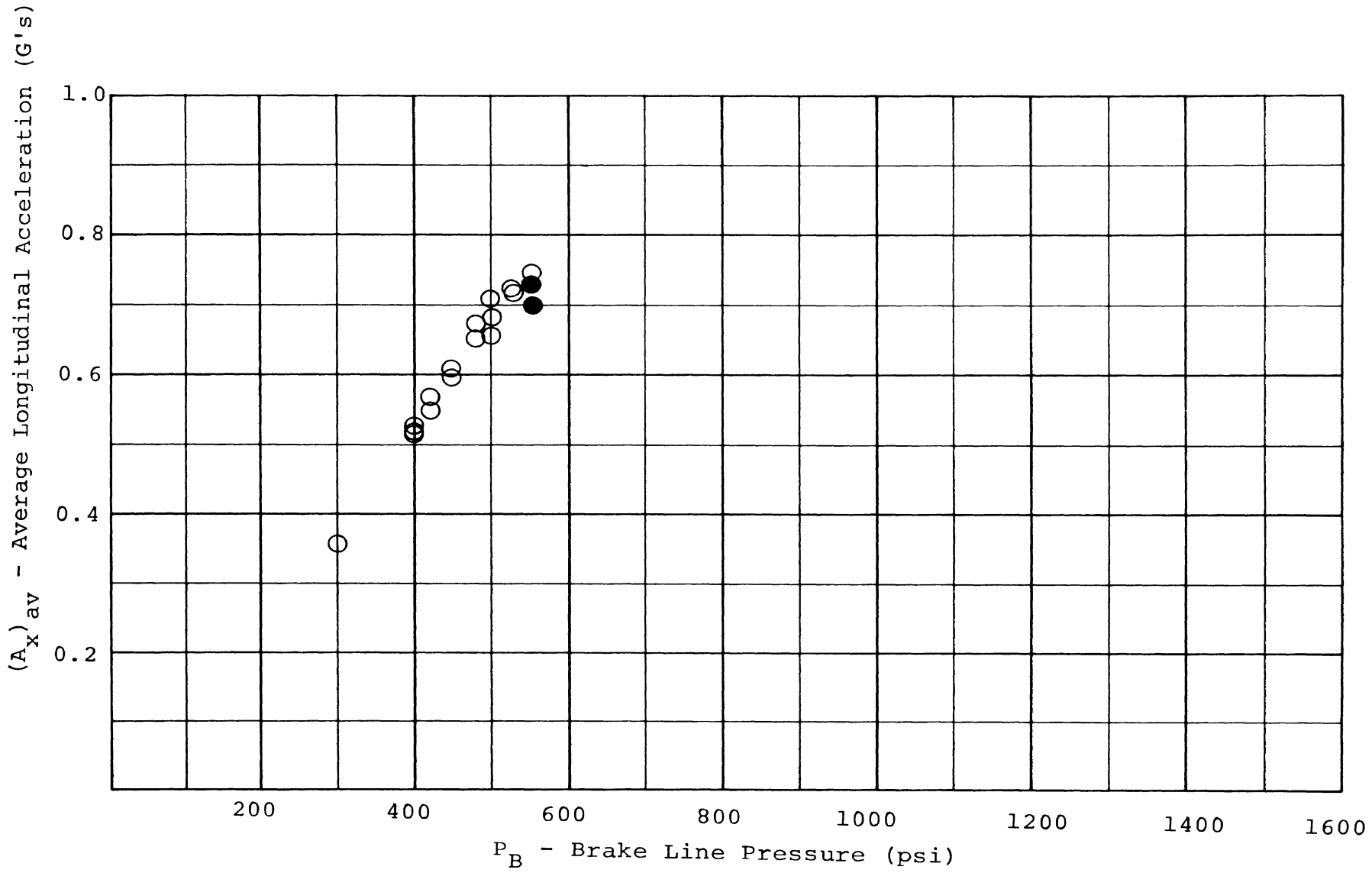
○ - Indicates Fewer Than 2 Wheels Locked on Either Axle



STRAIGHT LINE BRAKING - AMBASSADOR [CONDITION - OE]



STRAIGHT LINE BRAKING - AMBASSADOR [CONDITION - D-2]



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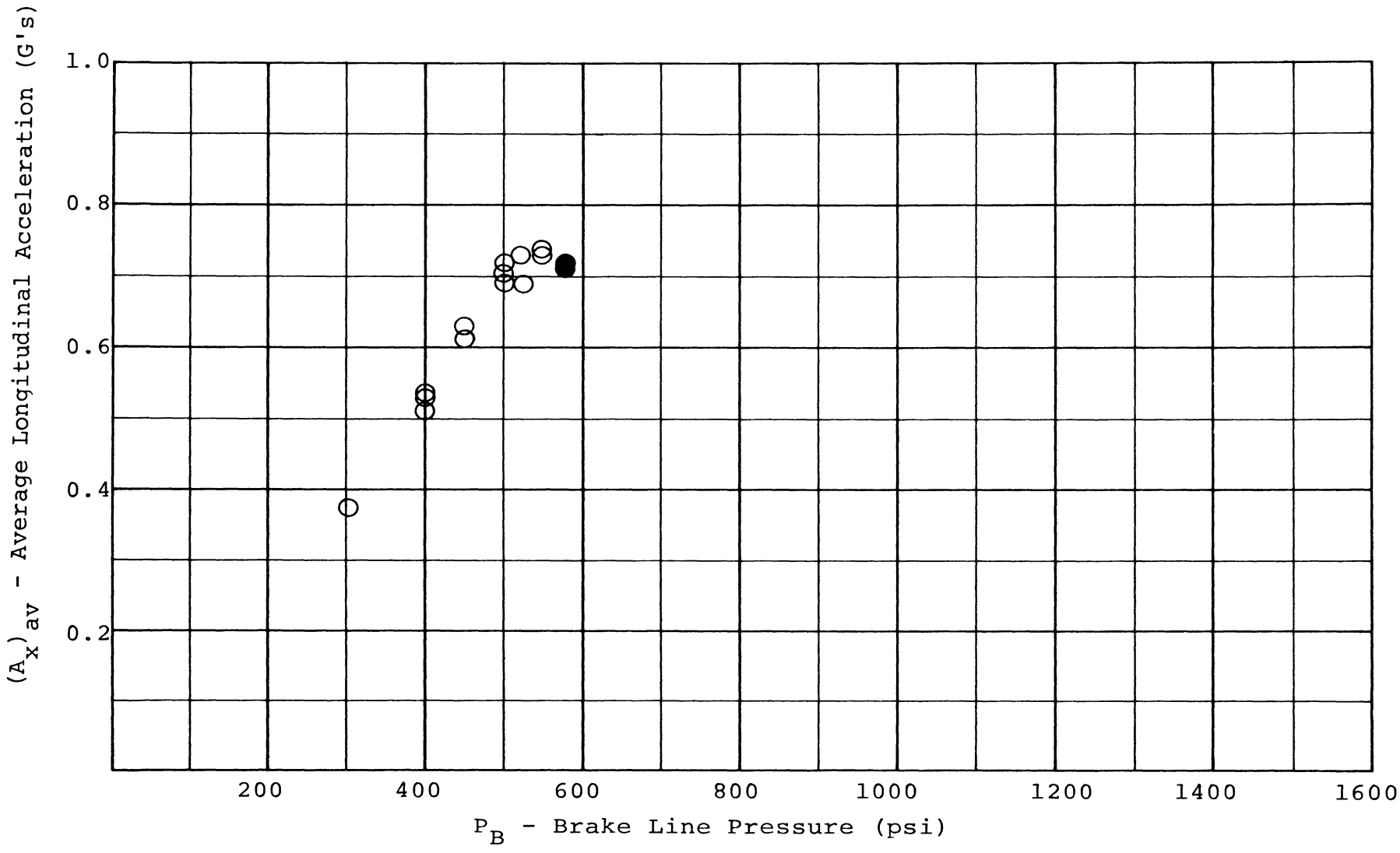
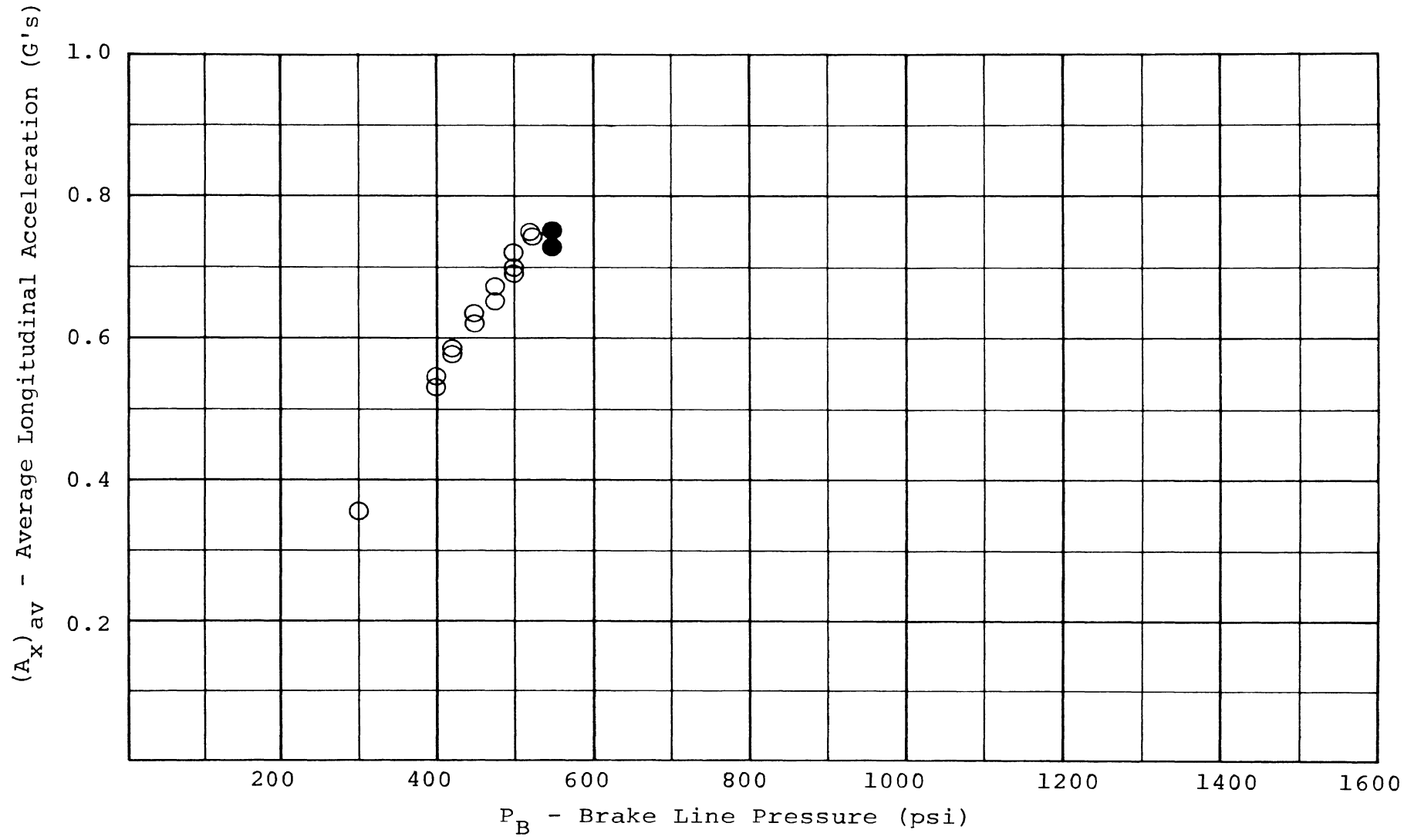


STRAIGHT LINE BRAKING - AMBASSADOR [CONDITION - D-4]



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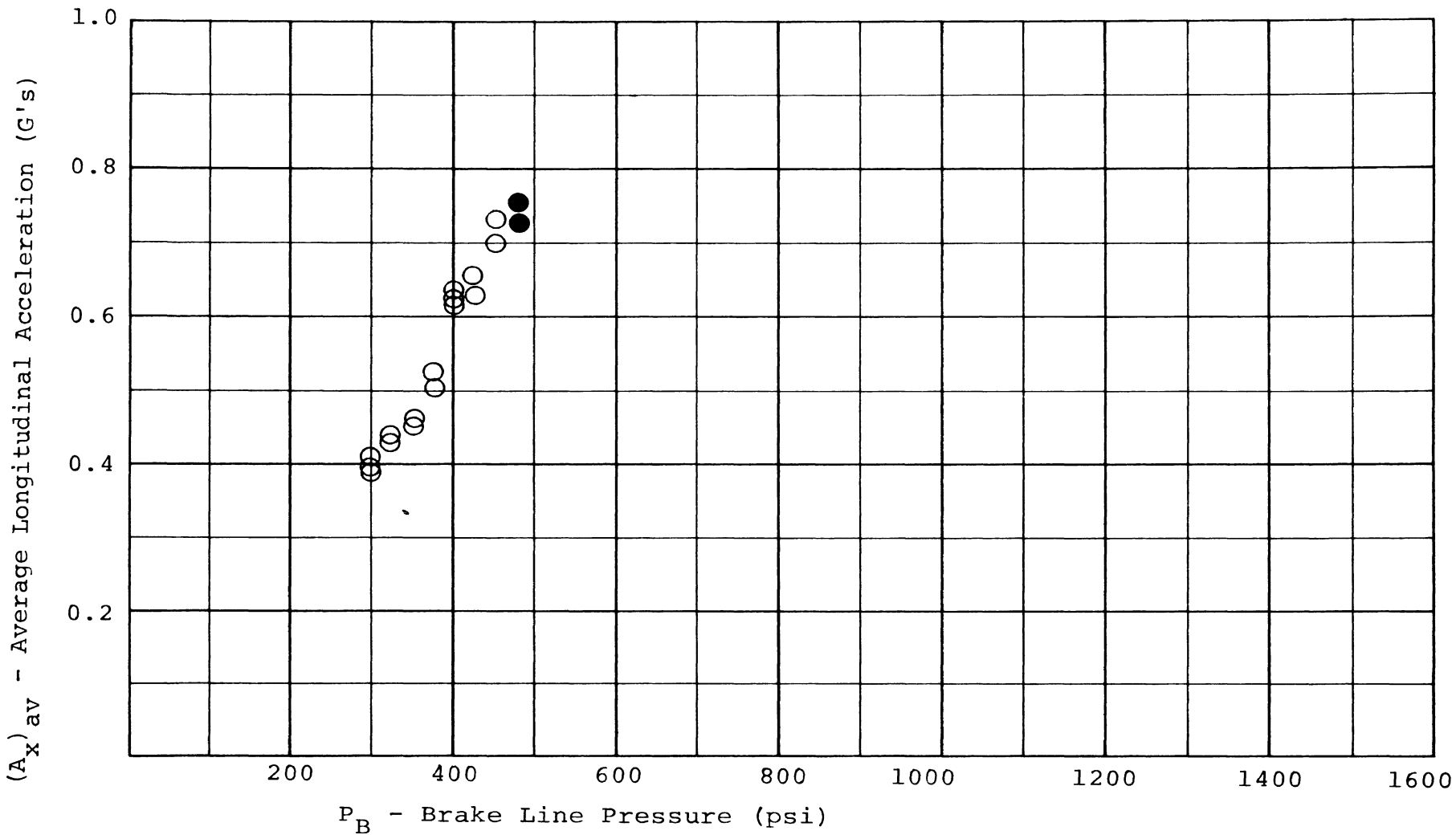

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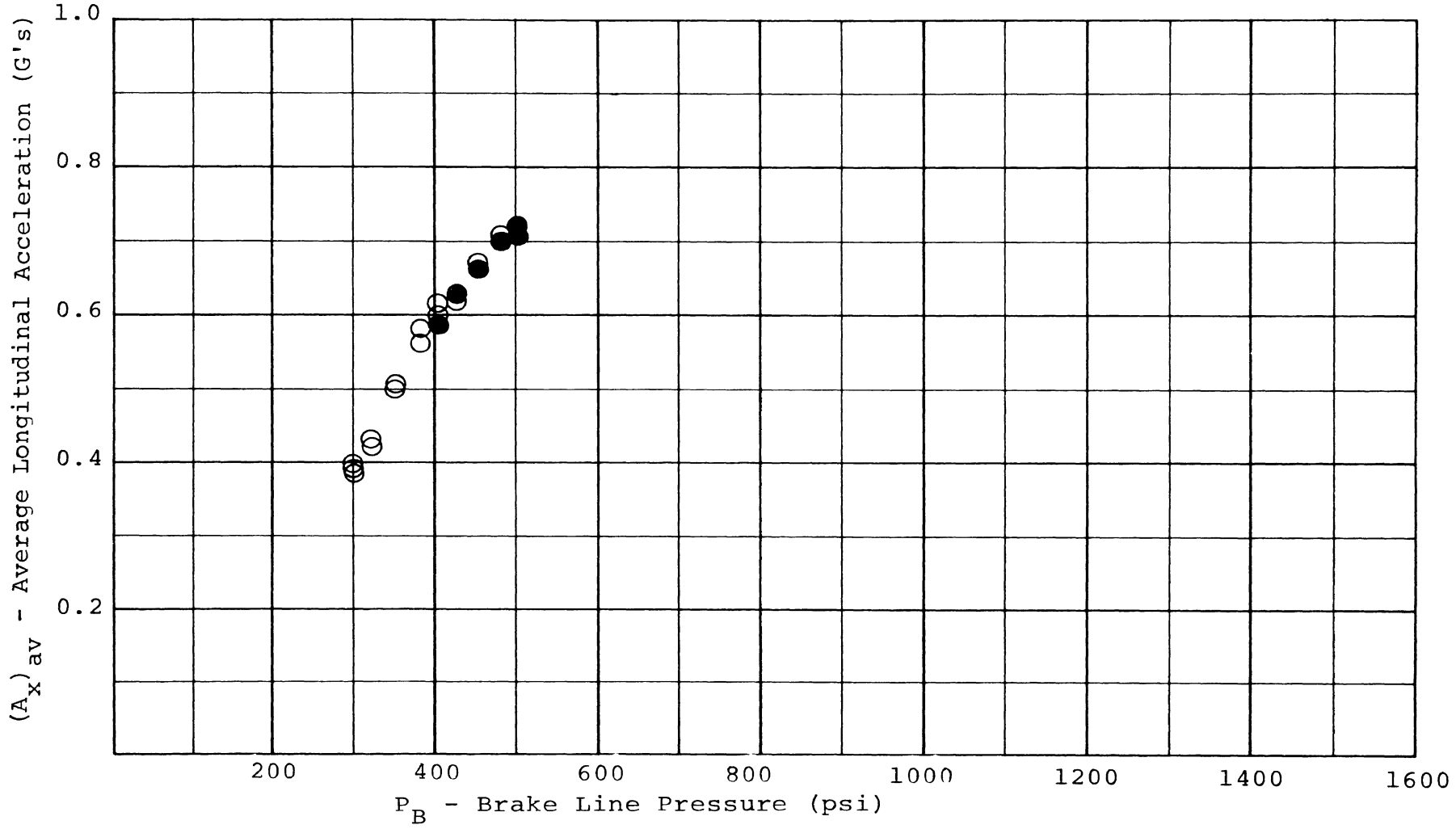

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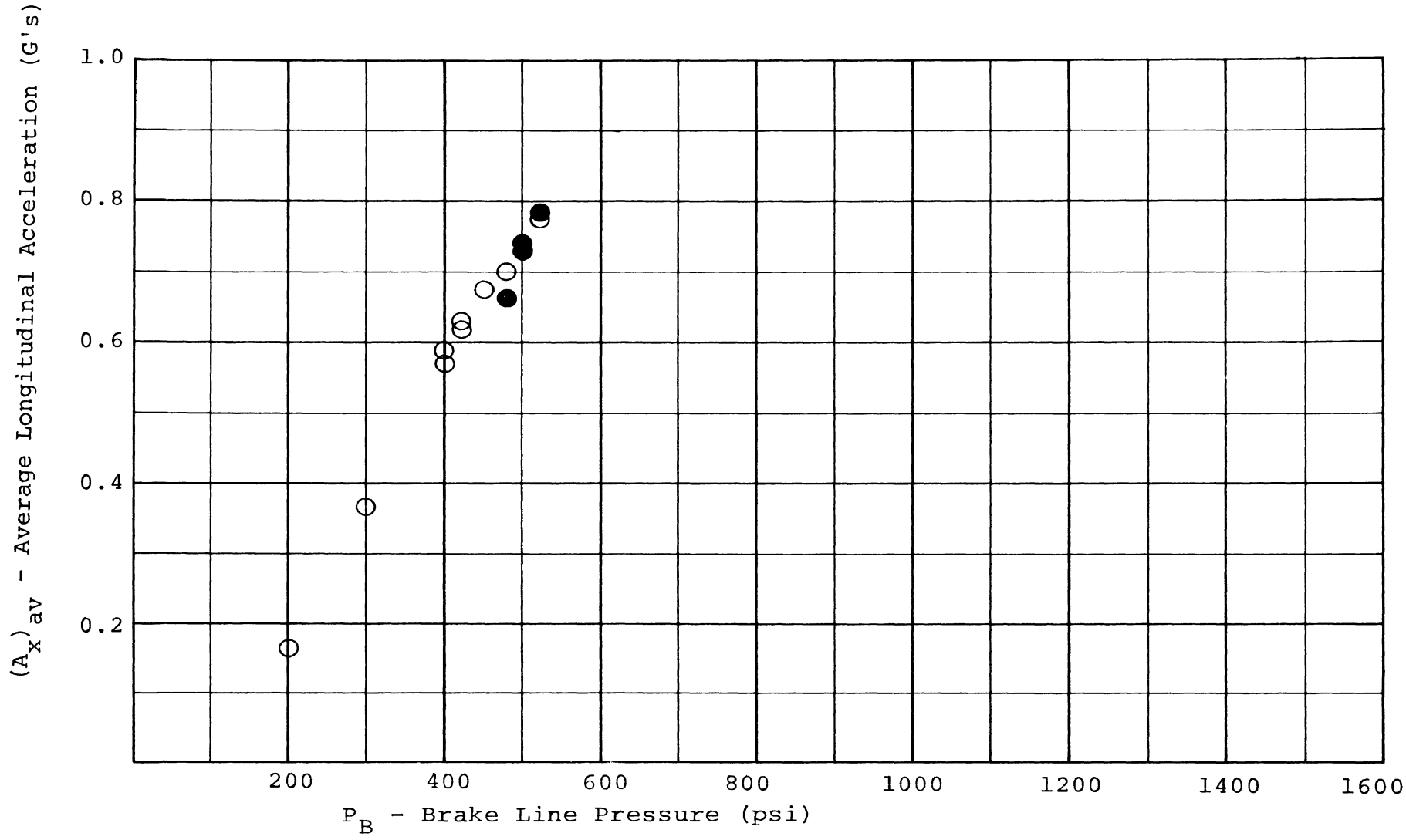

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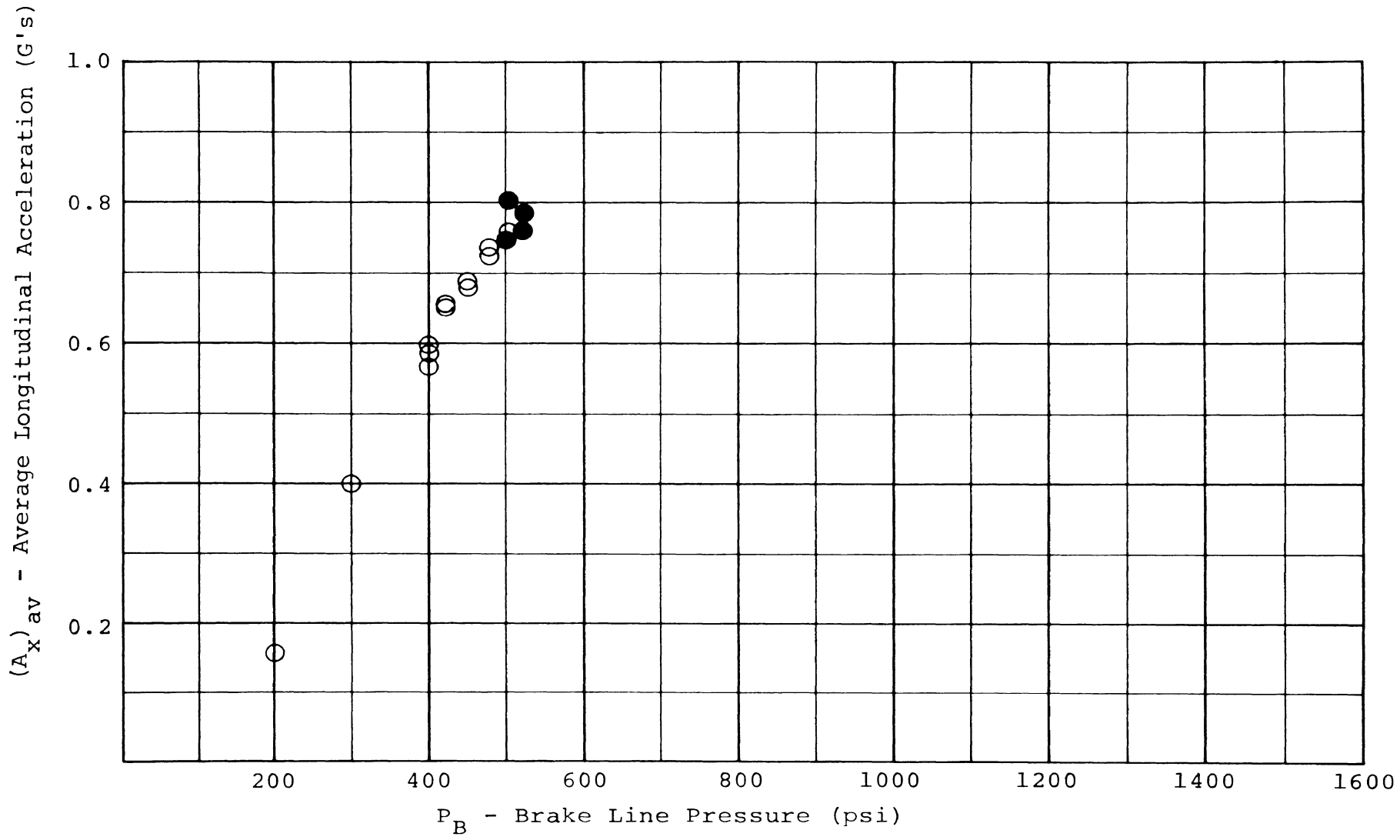

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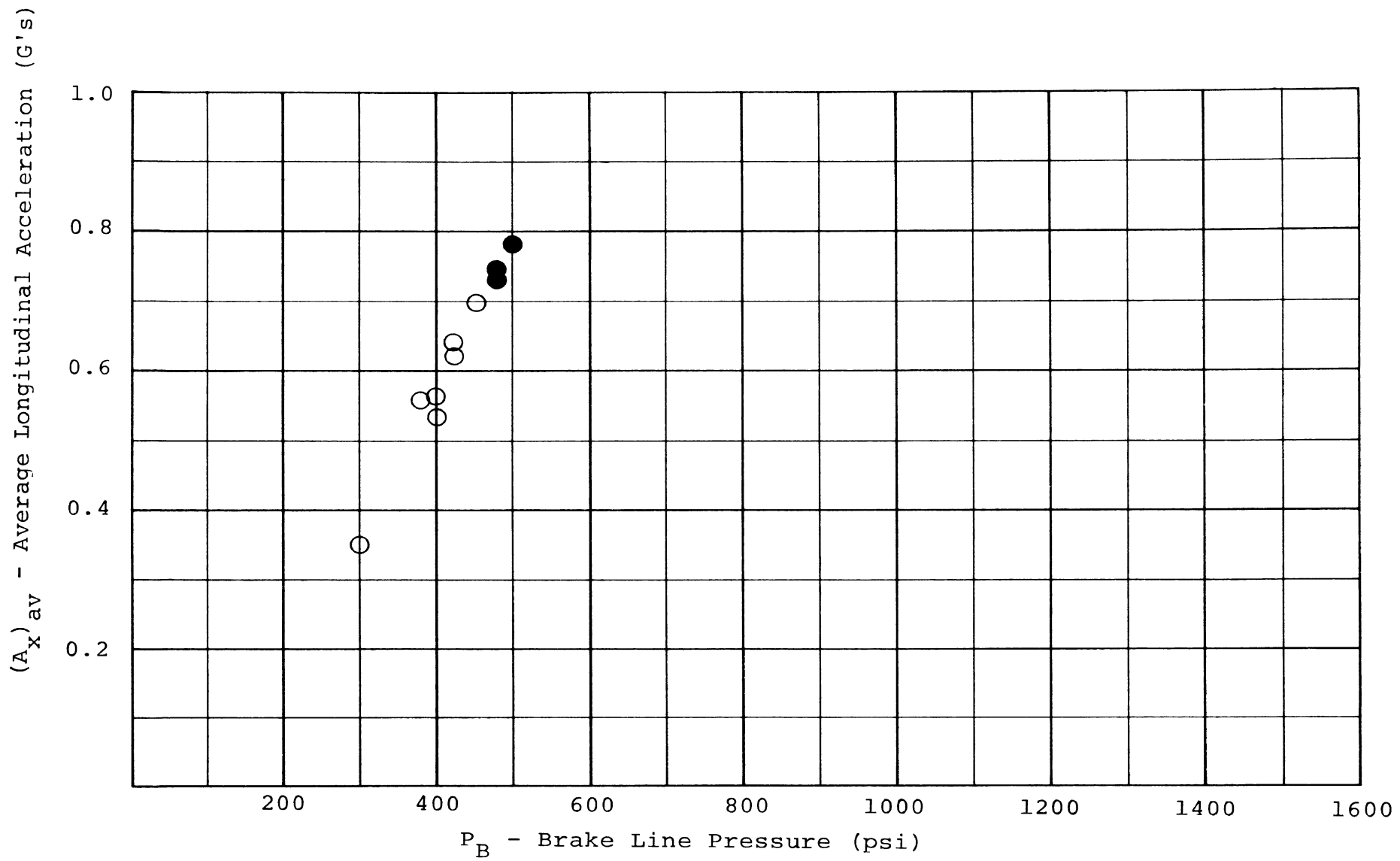

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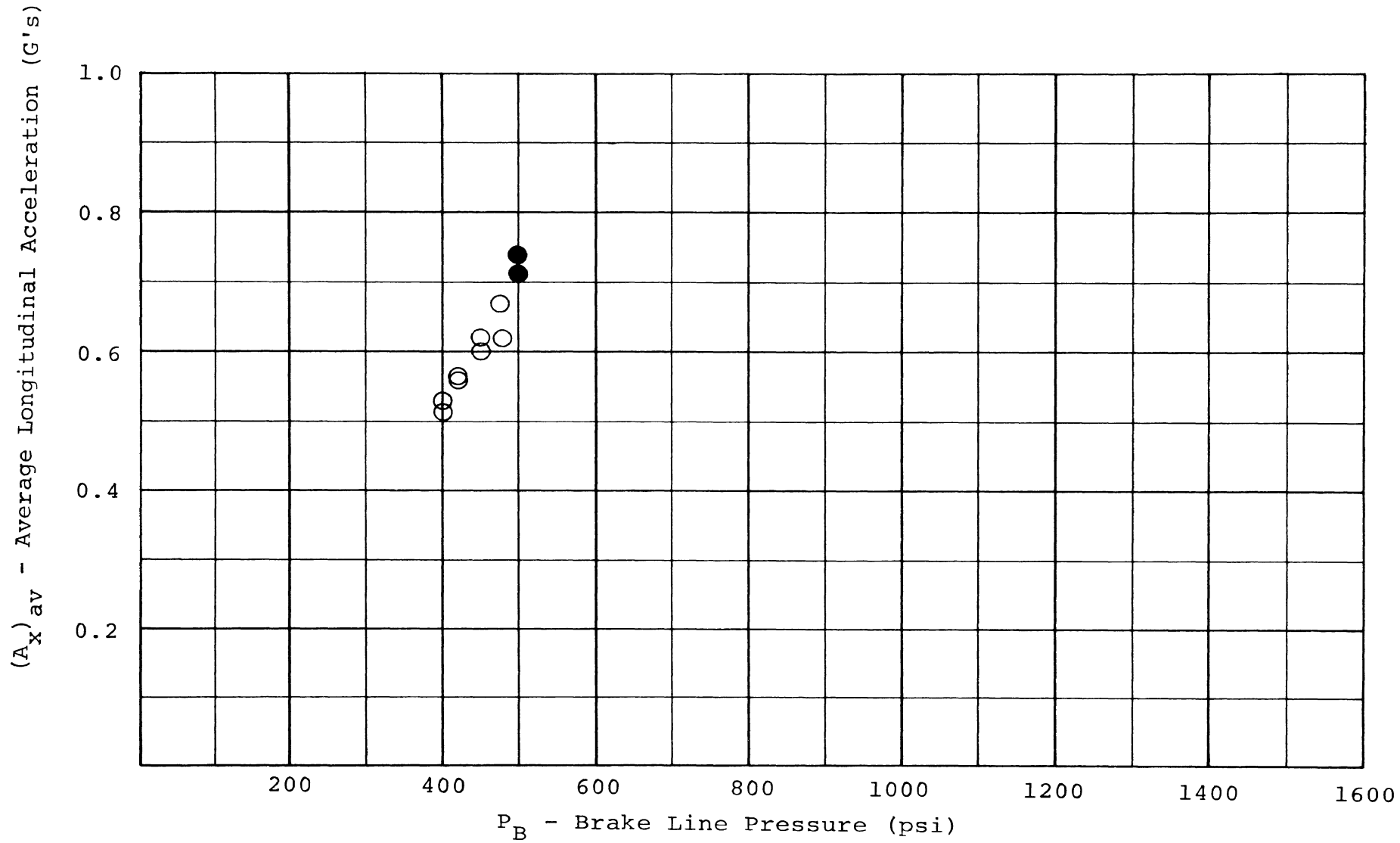


STRAIGHT LINE BRAKING - DODGE [CONDITION - D-5]

VHTP #2 - BRAKING IN A TURN

P_B - Brake Line Pressure

$\dot{\beta}_P$ - Peak Vehicle Sideslip Rate

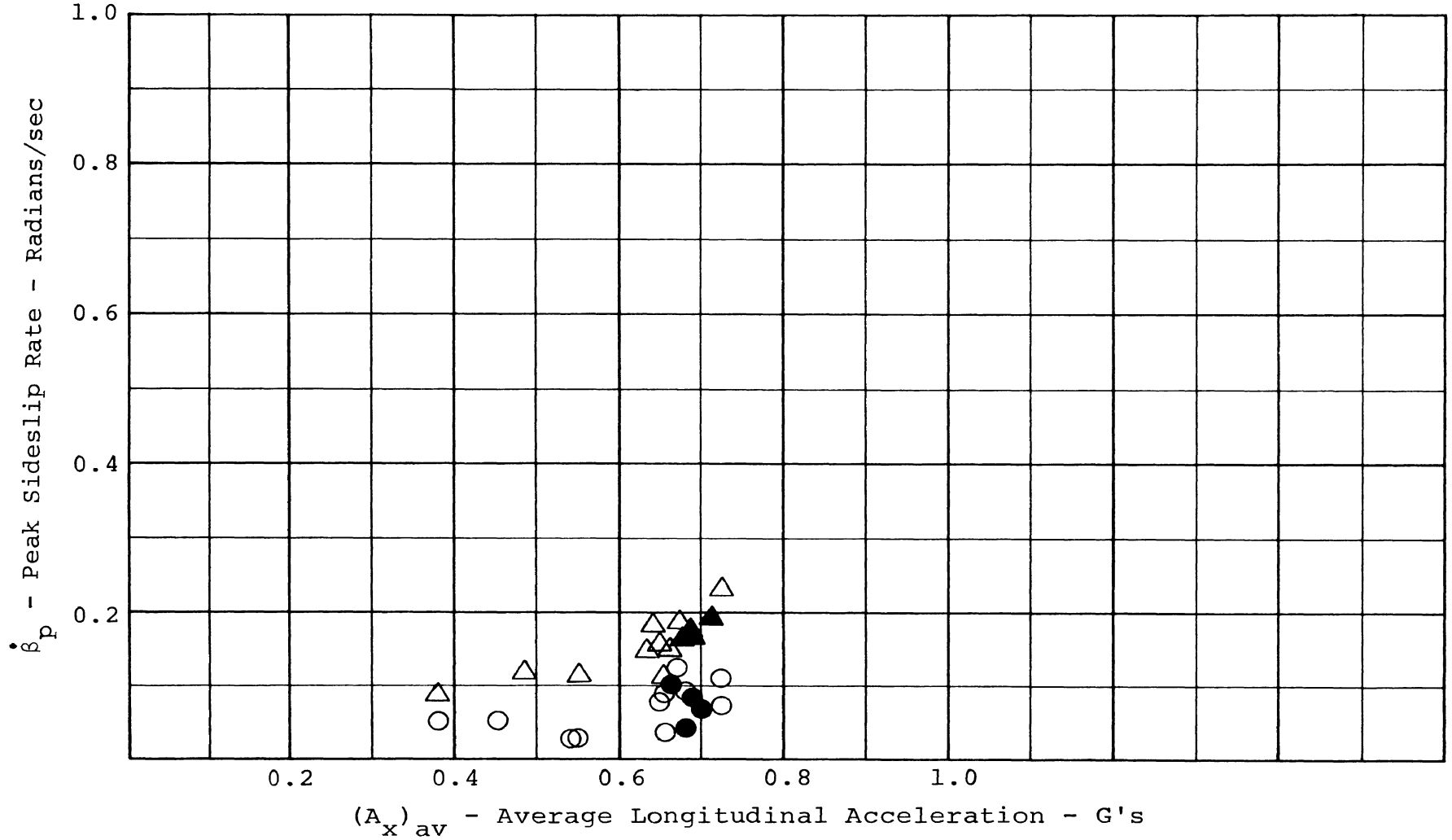
$R_o(1/R)$ - Average Path Curvature Ratio Relative to Initial Turn

○ - Indicates Right Turn - Fewer Than 2 Wheels Locked On Any Axle

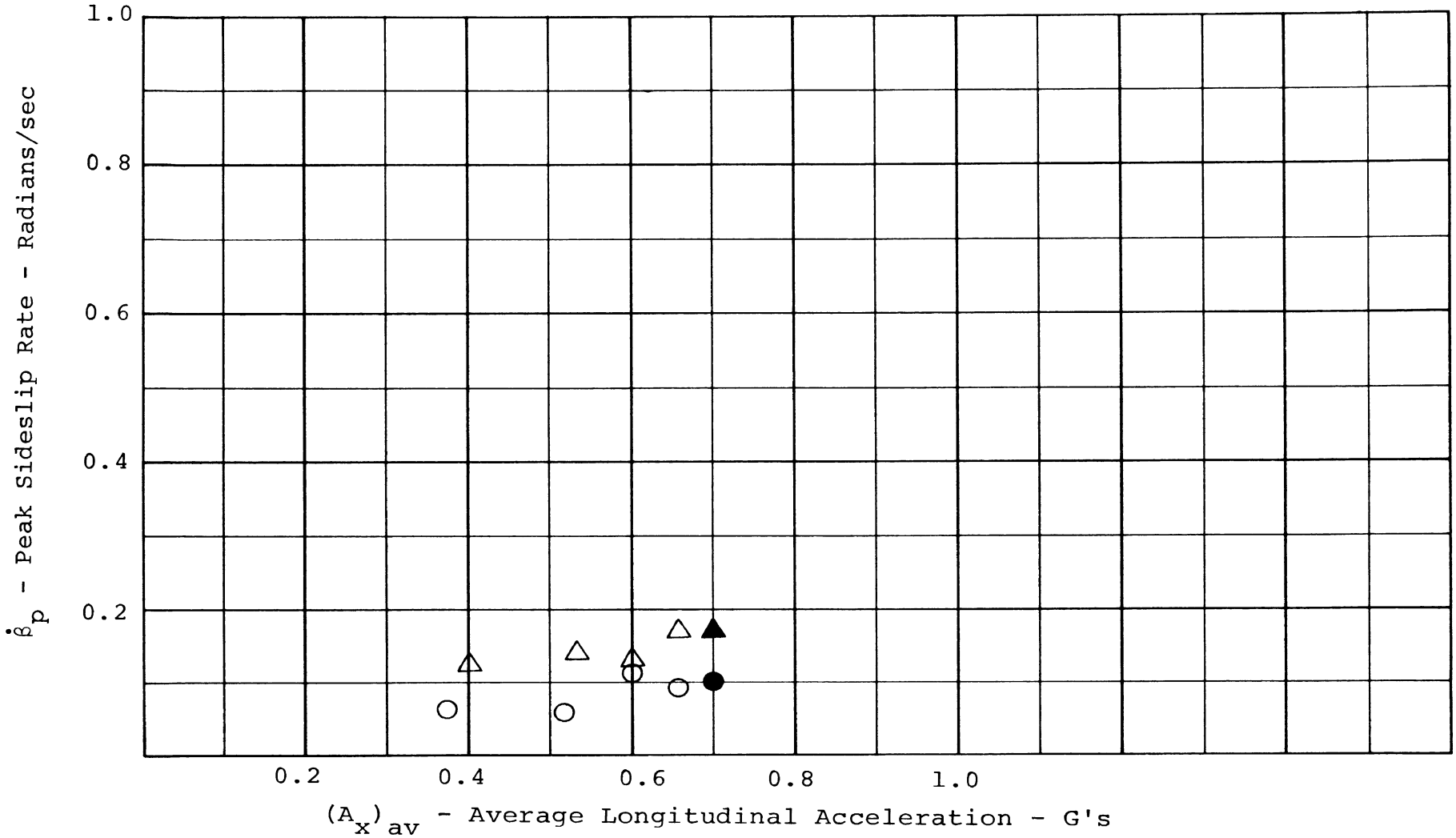
△ - Indicates Left Turn - Fewer Than 2 Wheels Locked On Any Axle

● - Indicates Right Turn - 2 Wheels Locked On One Axle

▲ - Indicates Left Turn - 2 Wheels Locked On One Axle



BRAKING IN A TURN - AMBASSADOR [CONDITION - OE]



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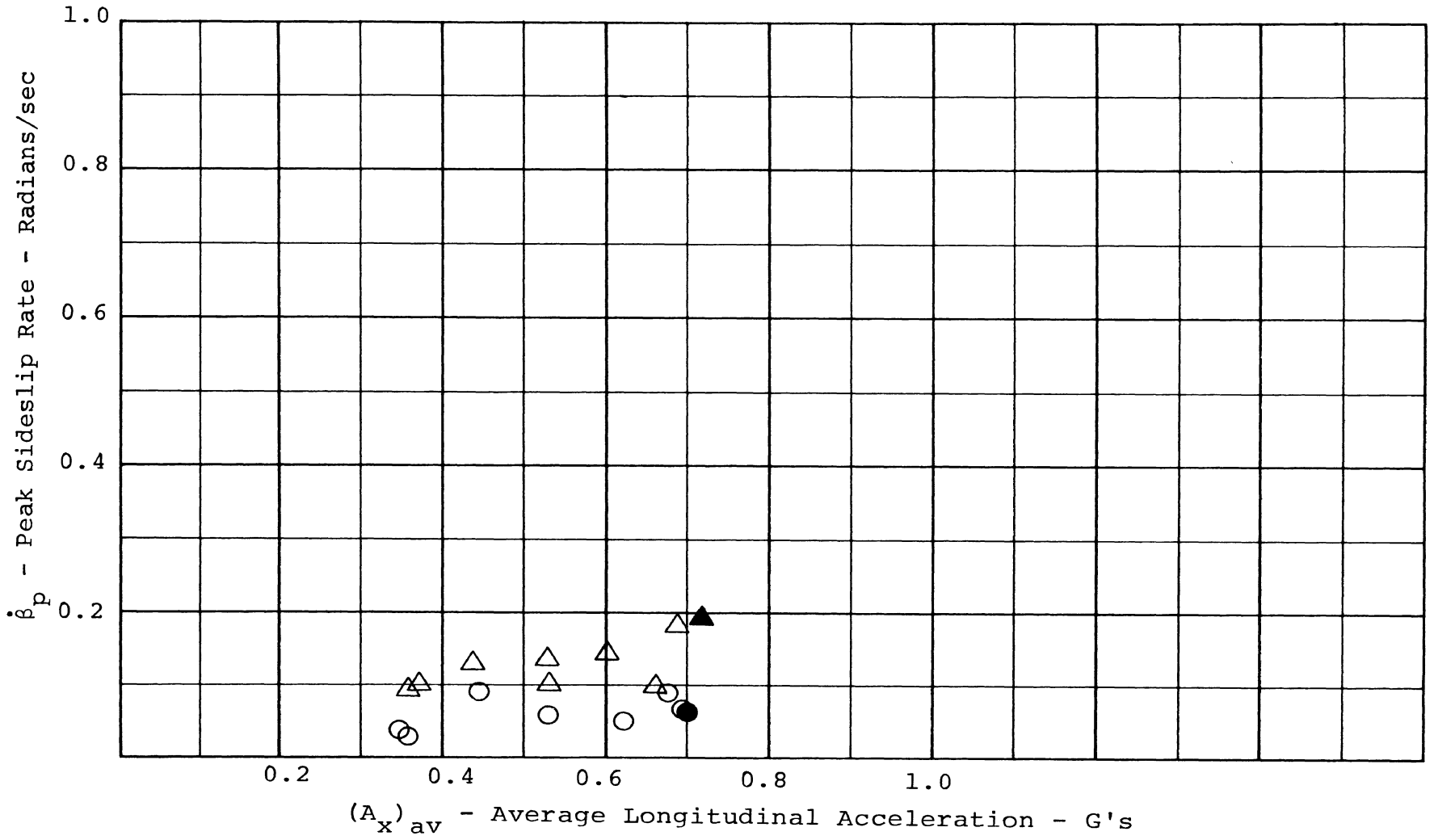

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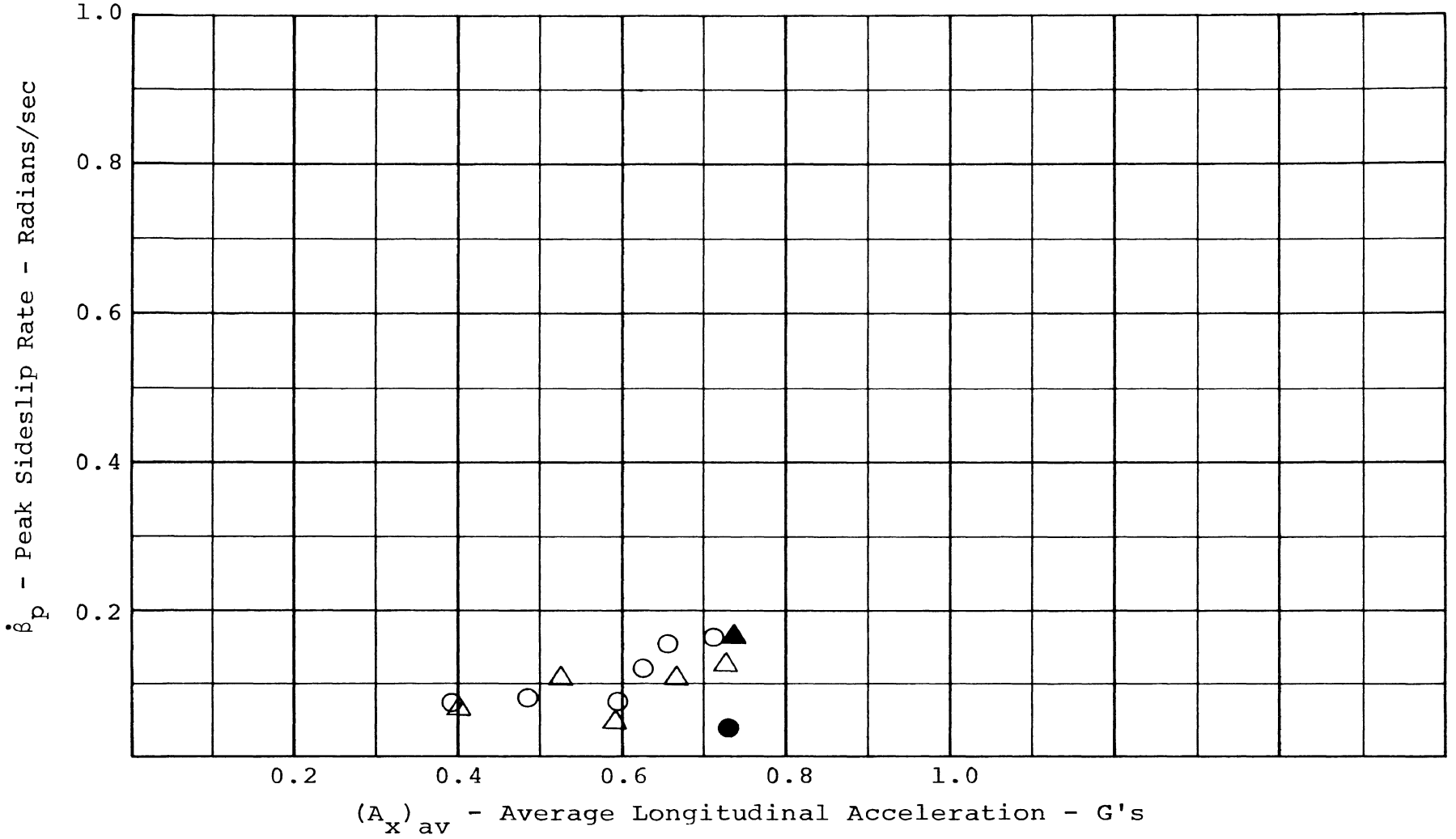

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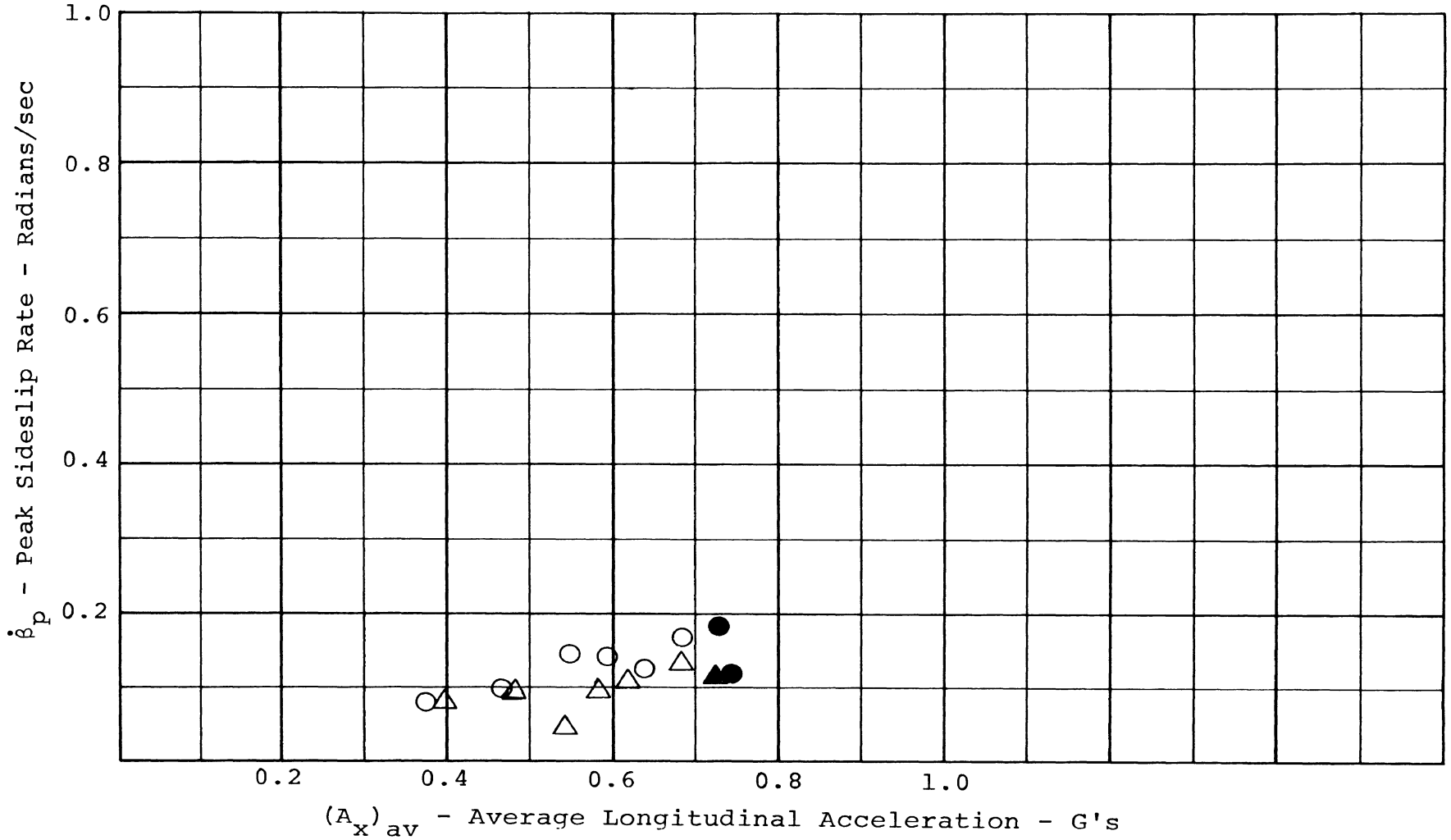

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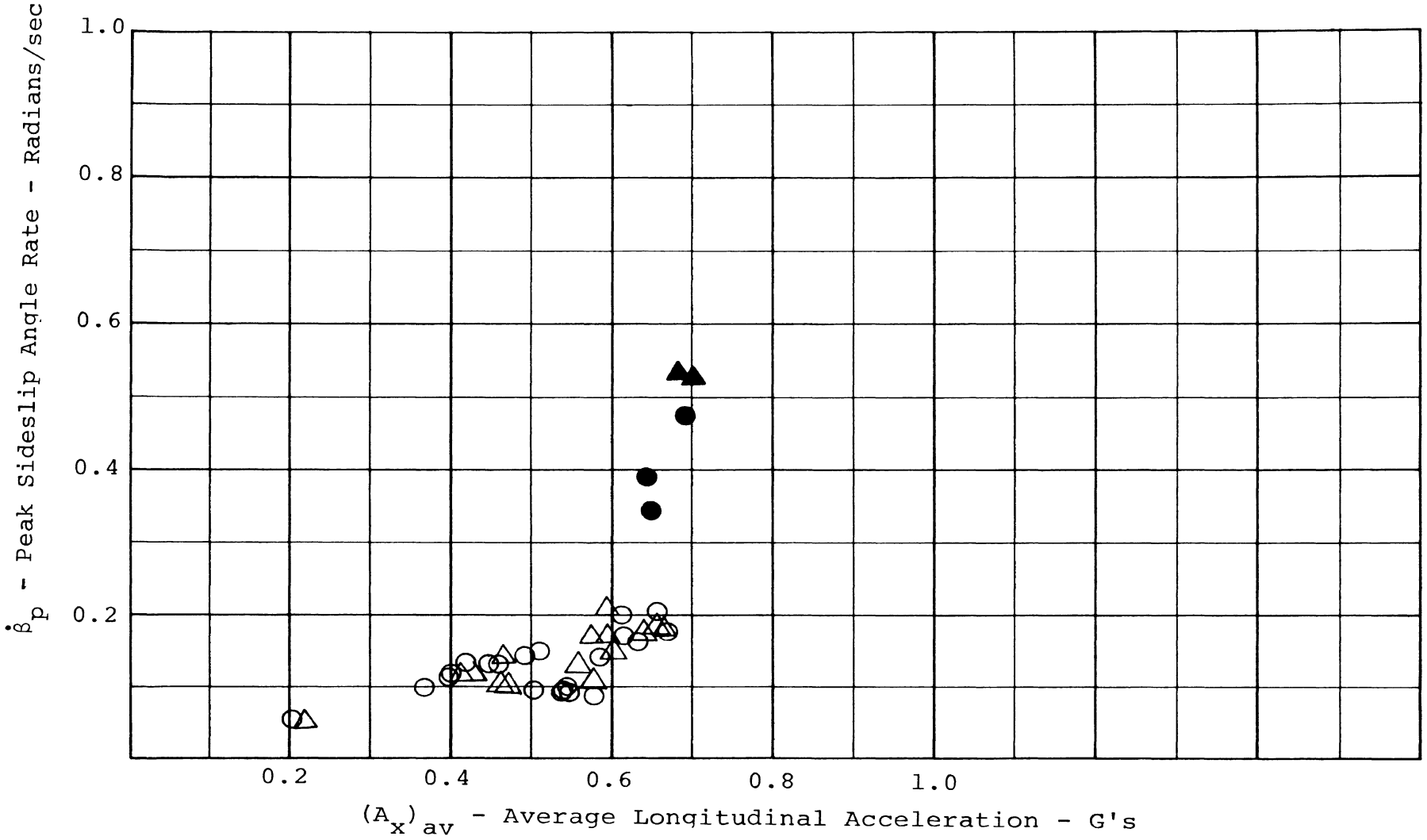

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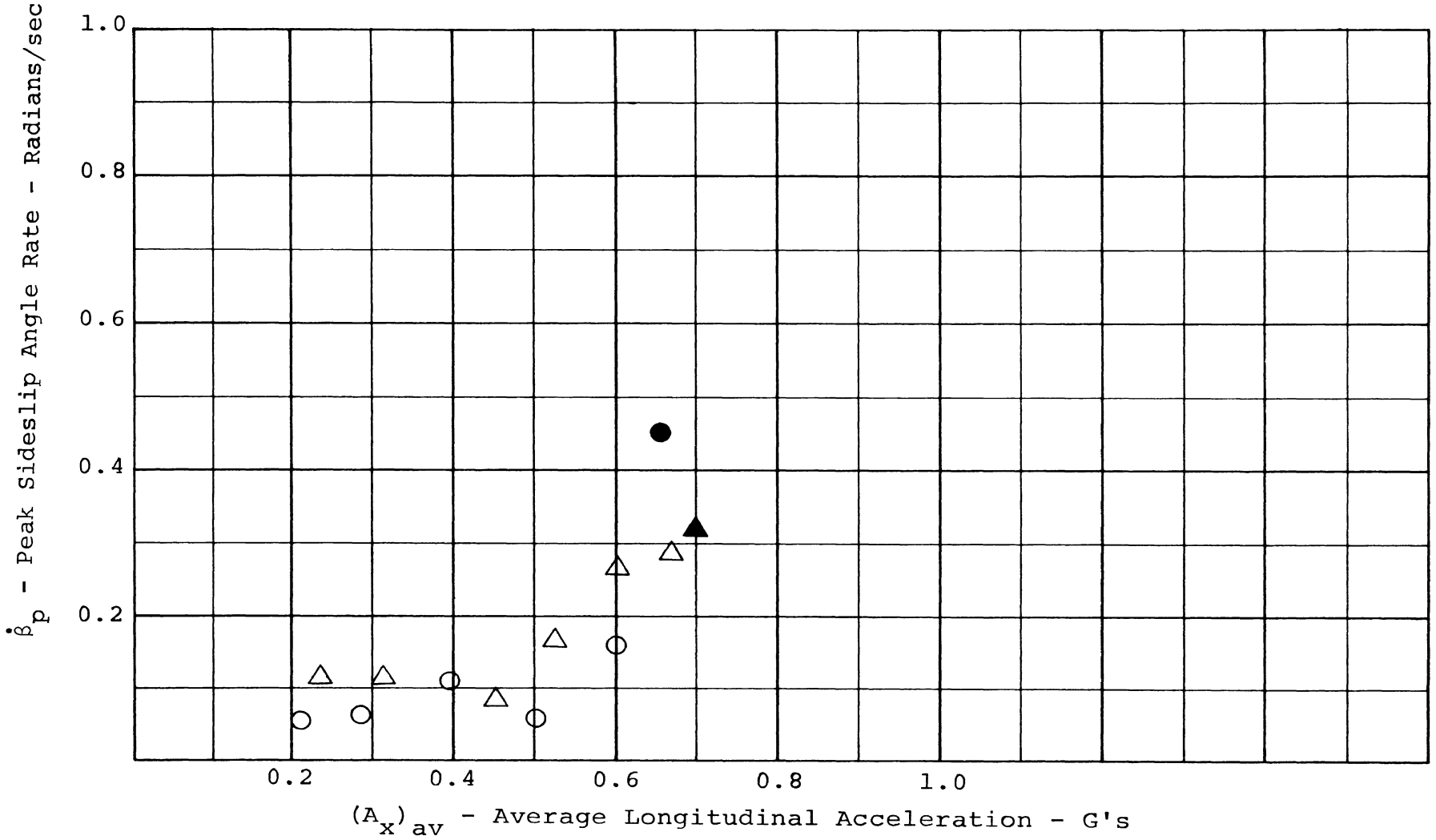

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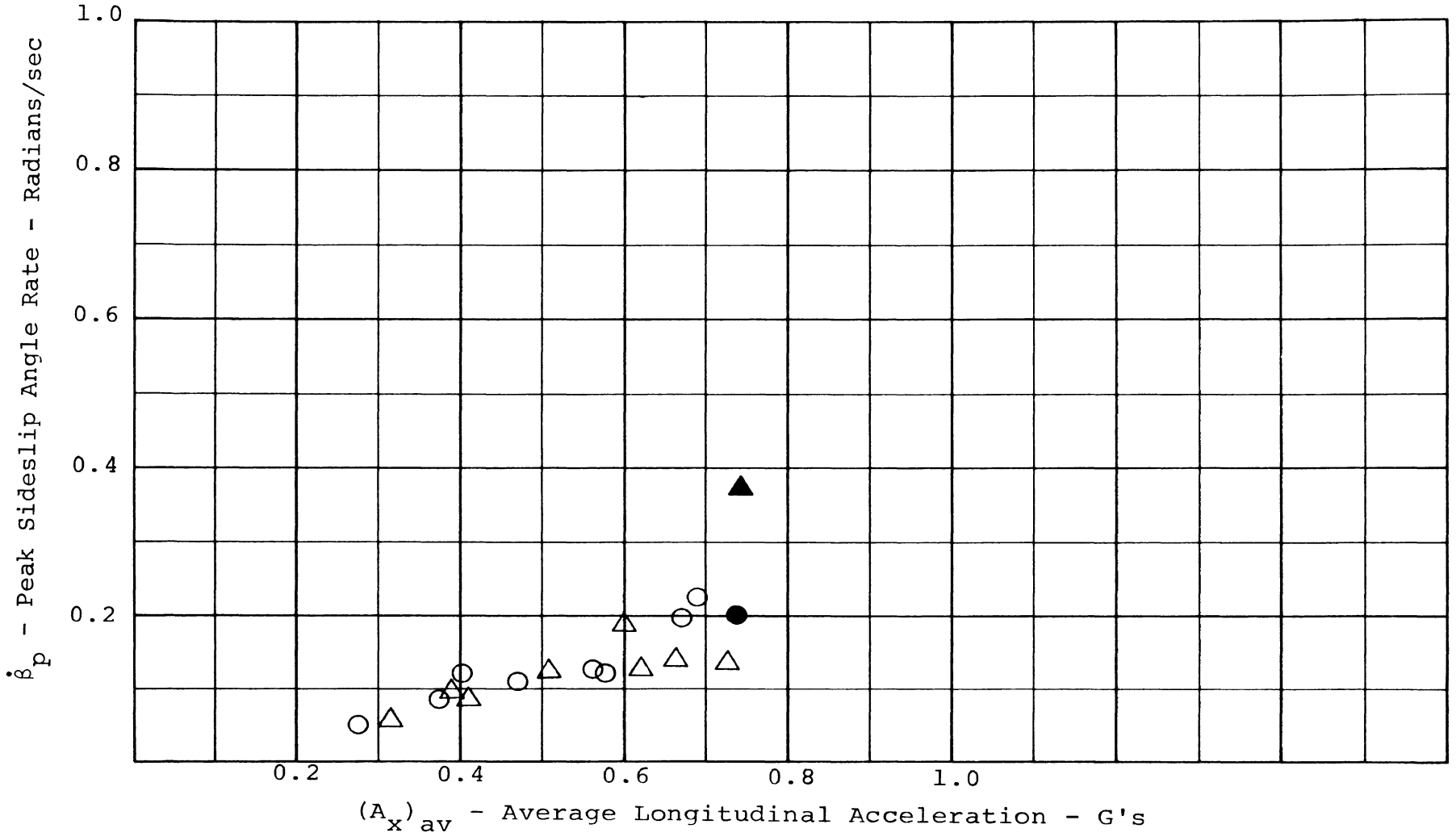

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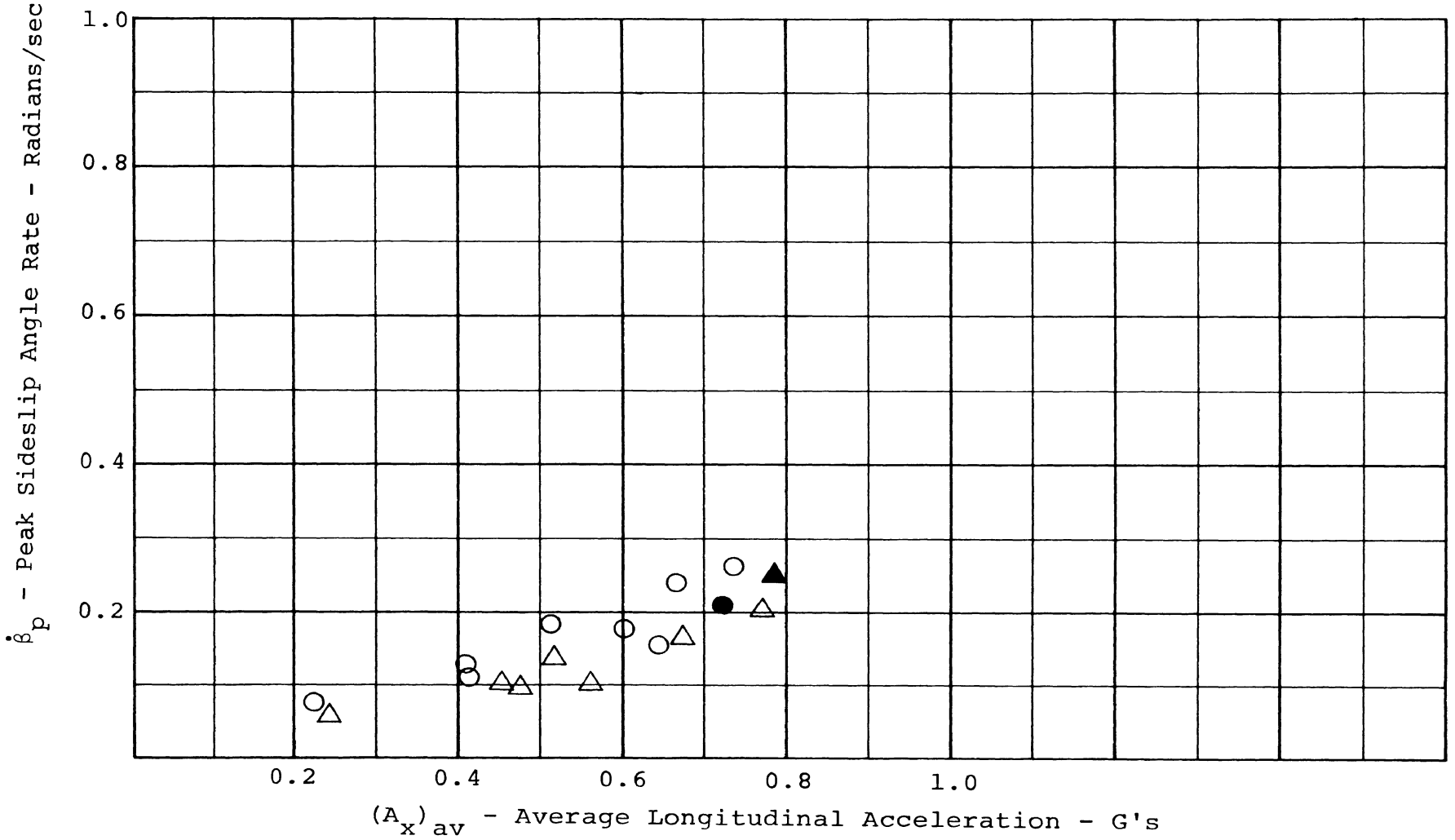

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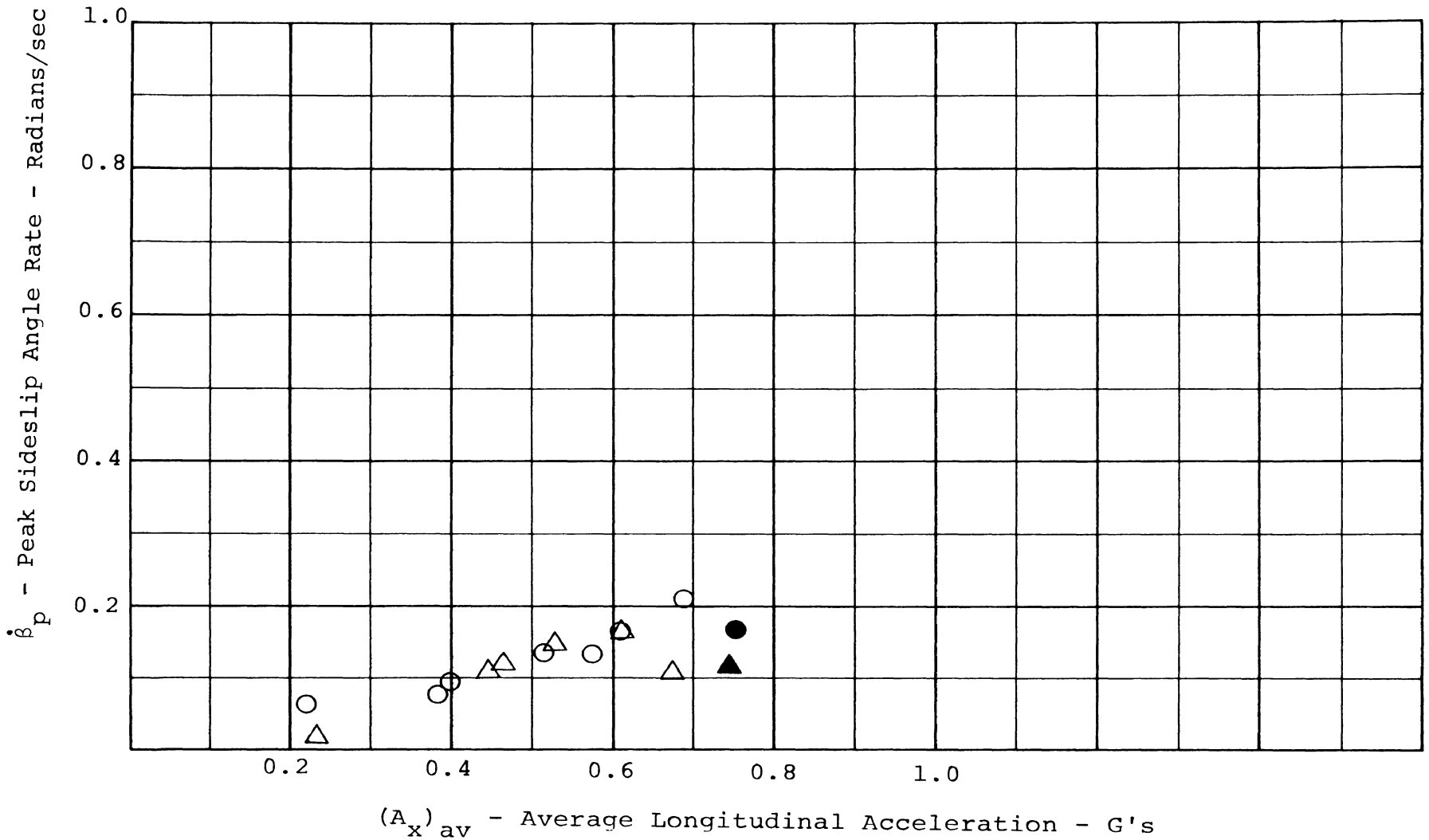

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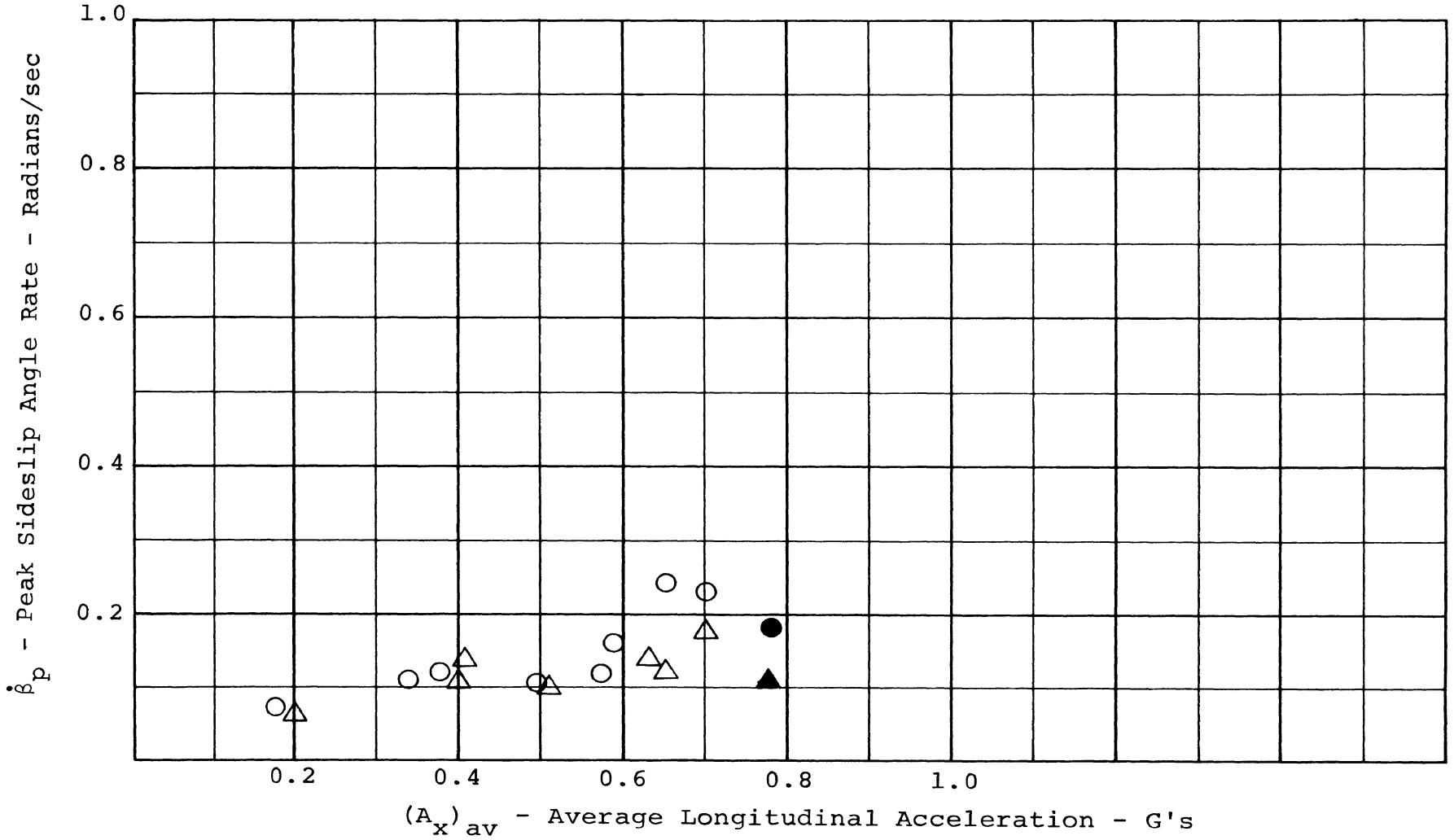

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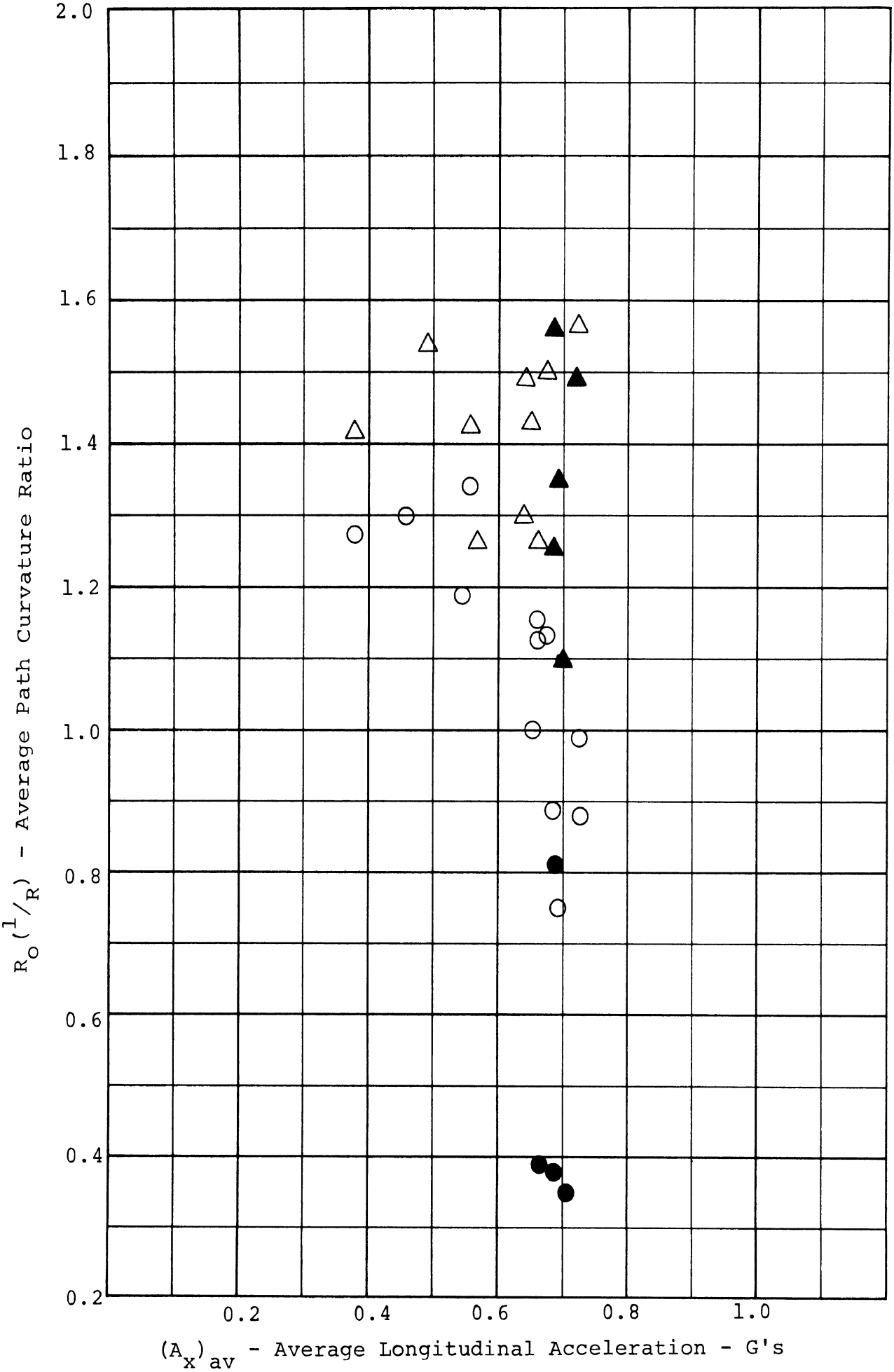
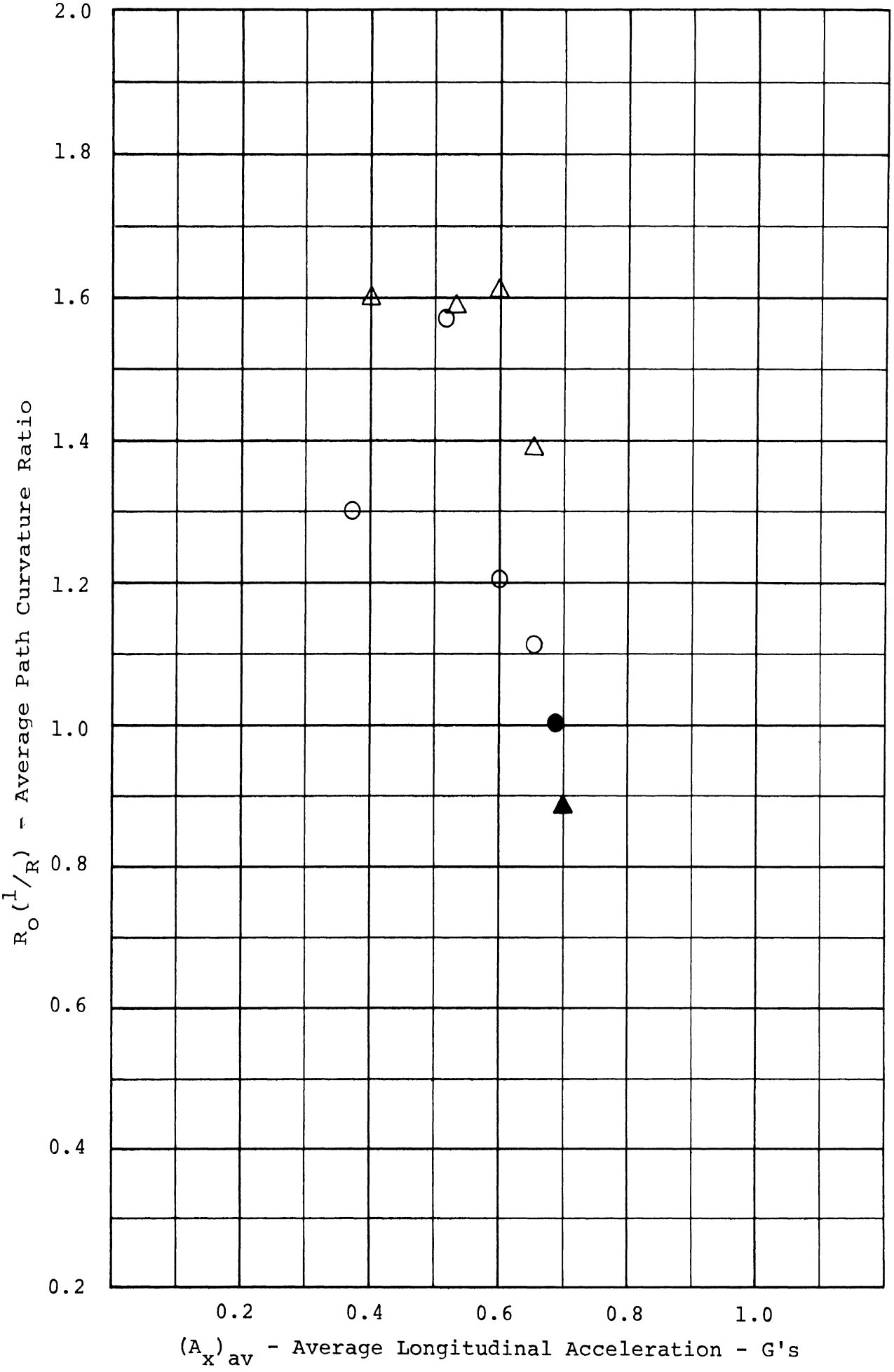
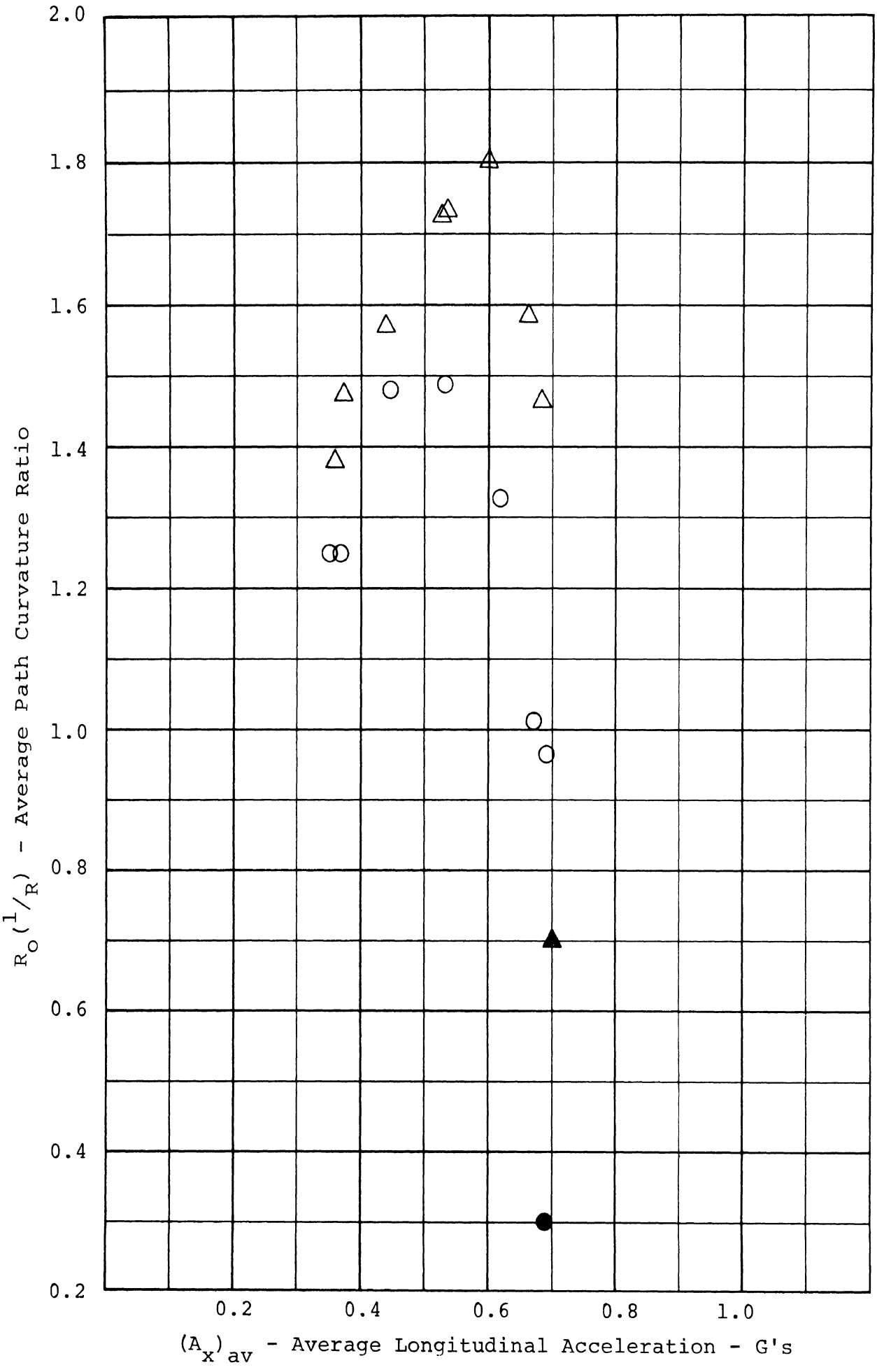


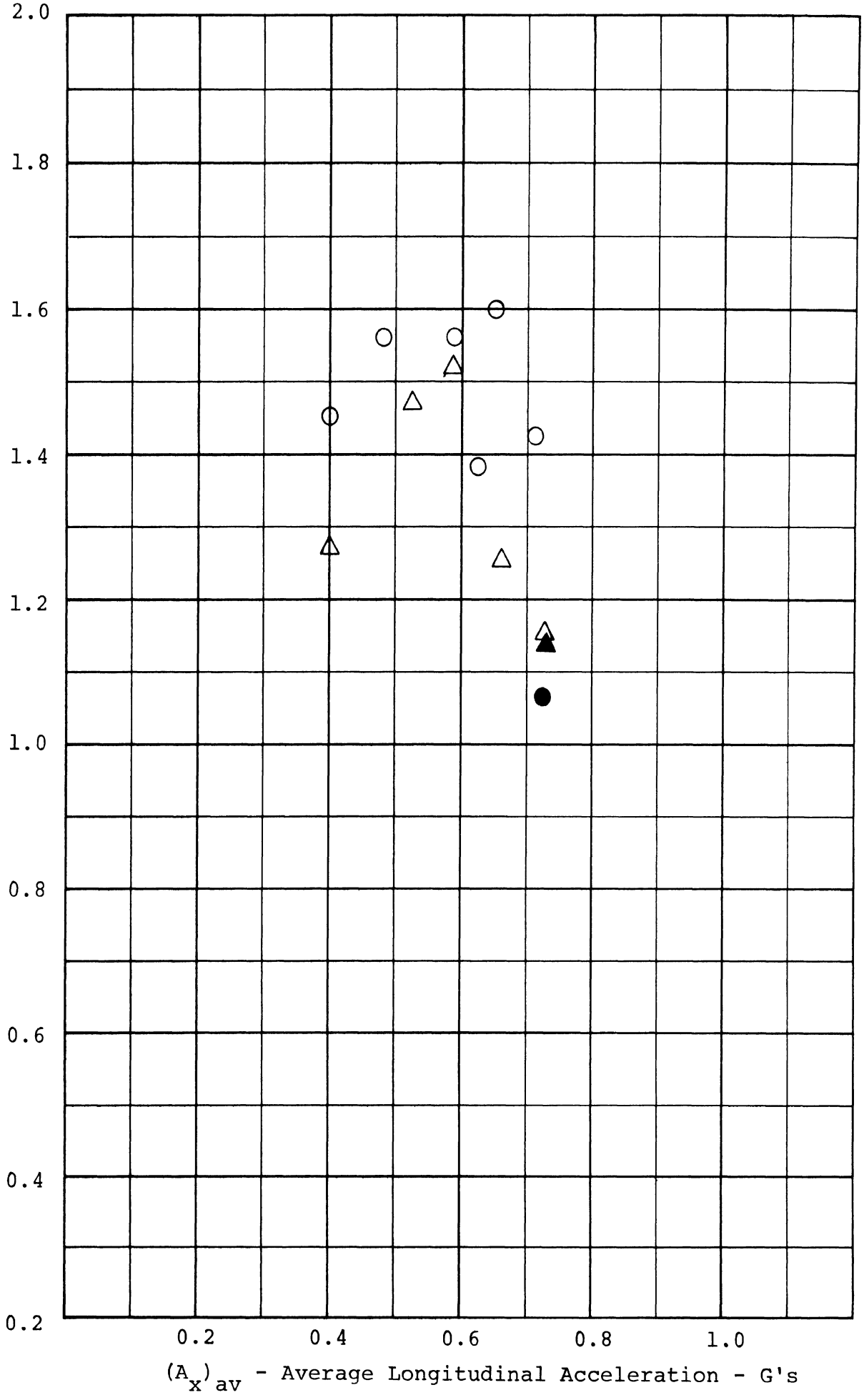
BRAKING IN A TURN - AMBASSADOR [CONDITION - OE]



BRAKING IN A TURN - AMBASSADOR [CONDITION - D-2]



BRAKING IN A TURN - AMBASSADOR [CONDITION - D-3]



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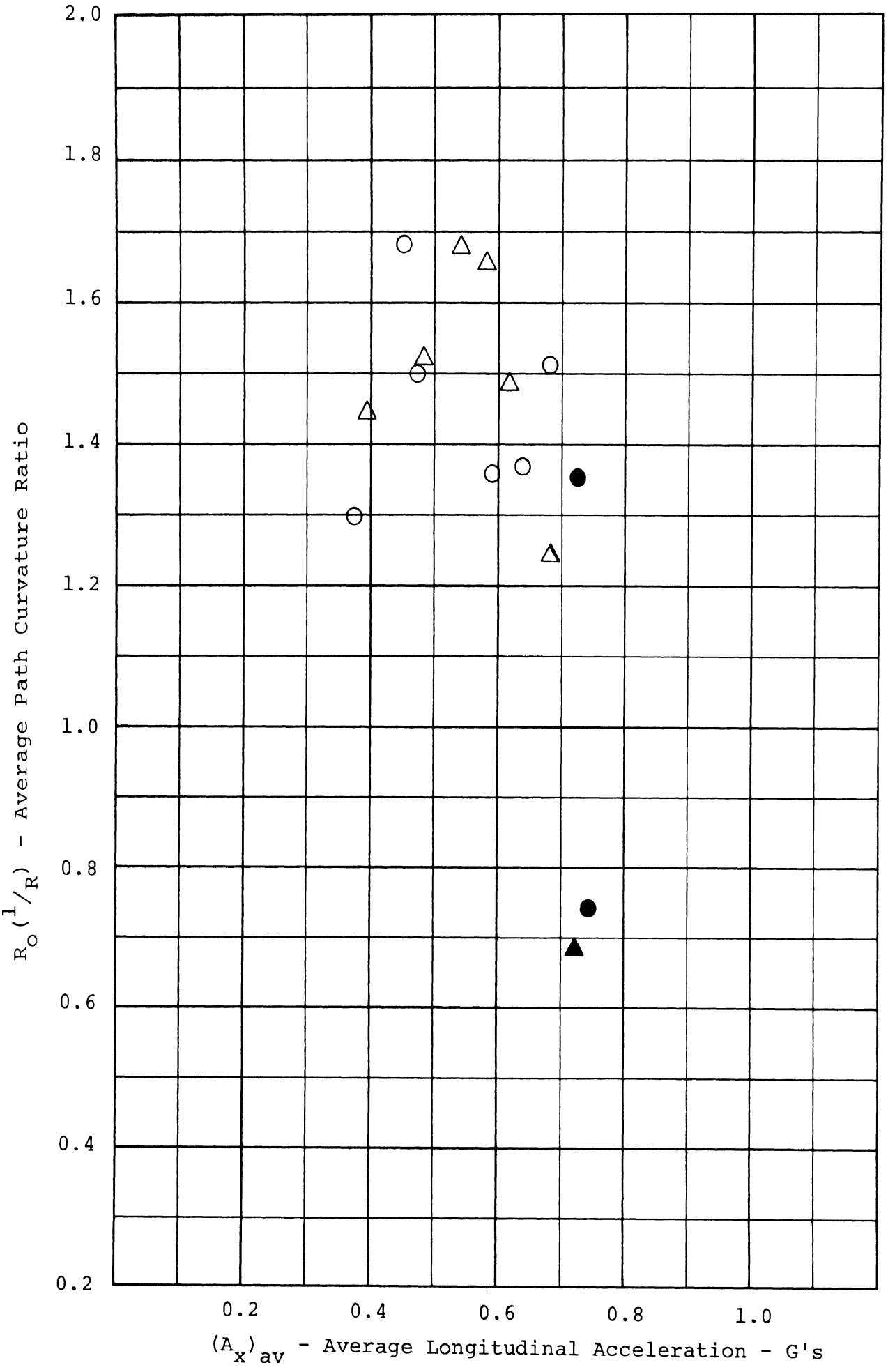

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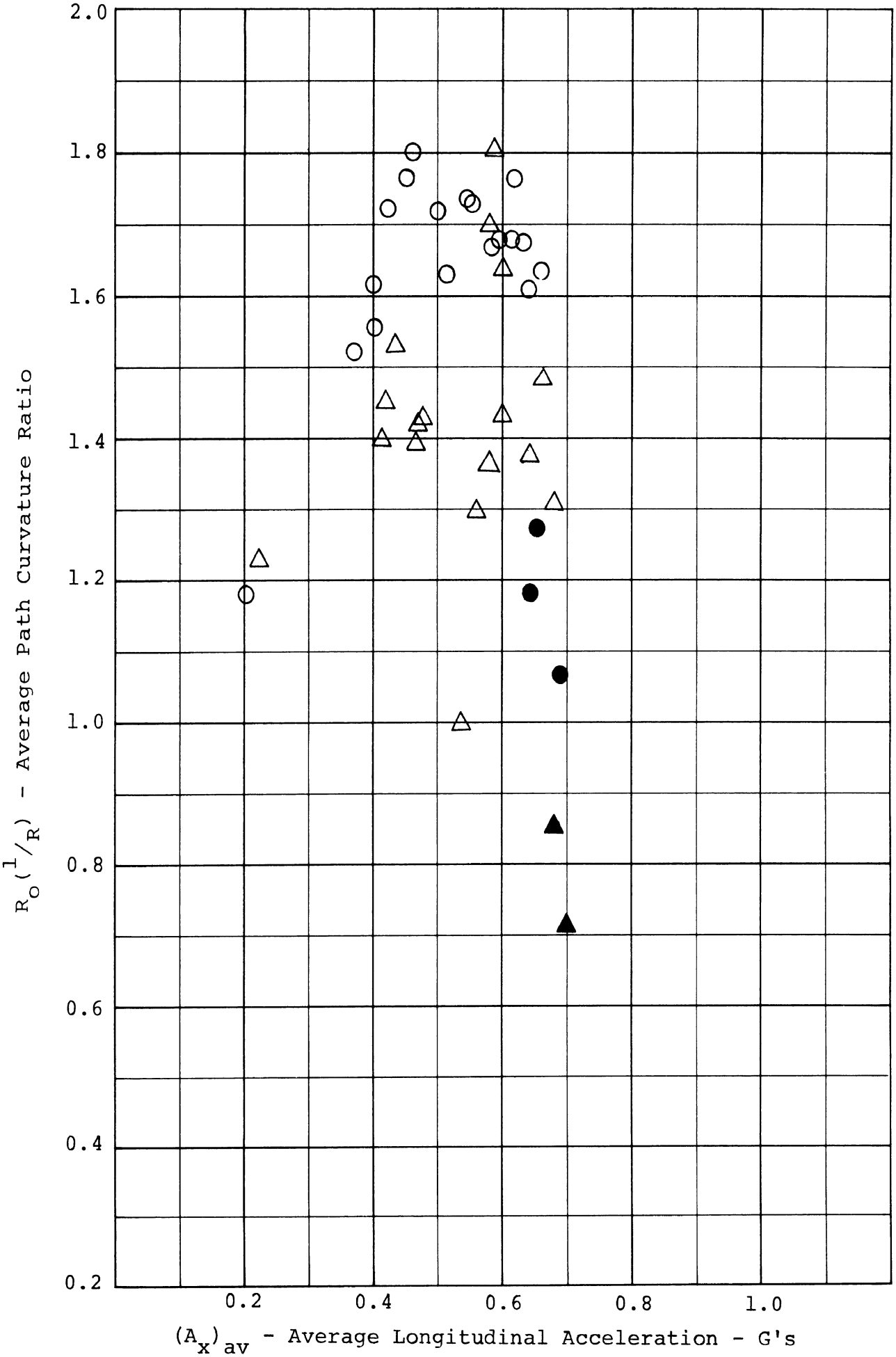
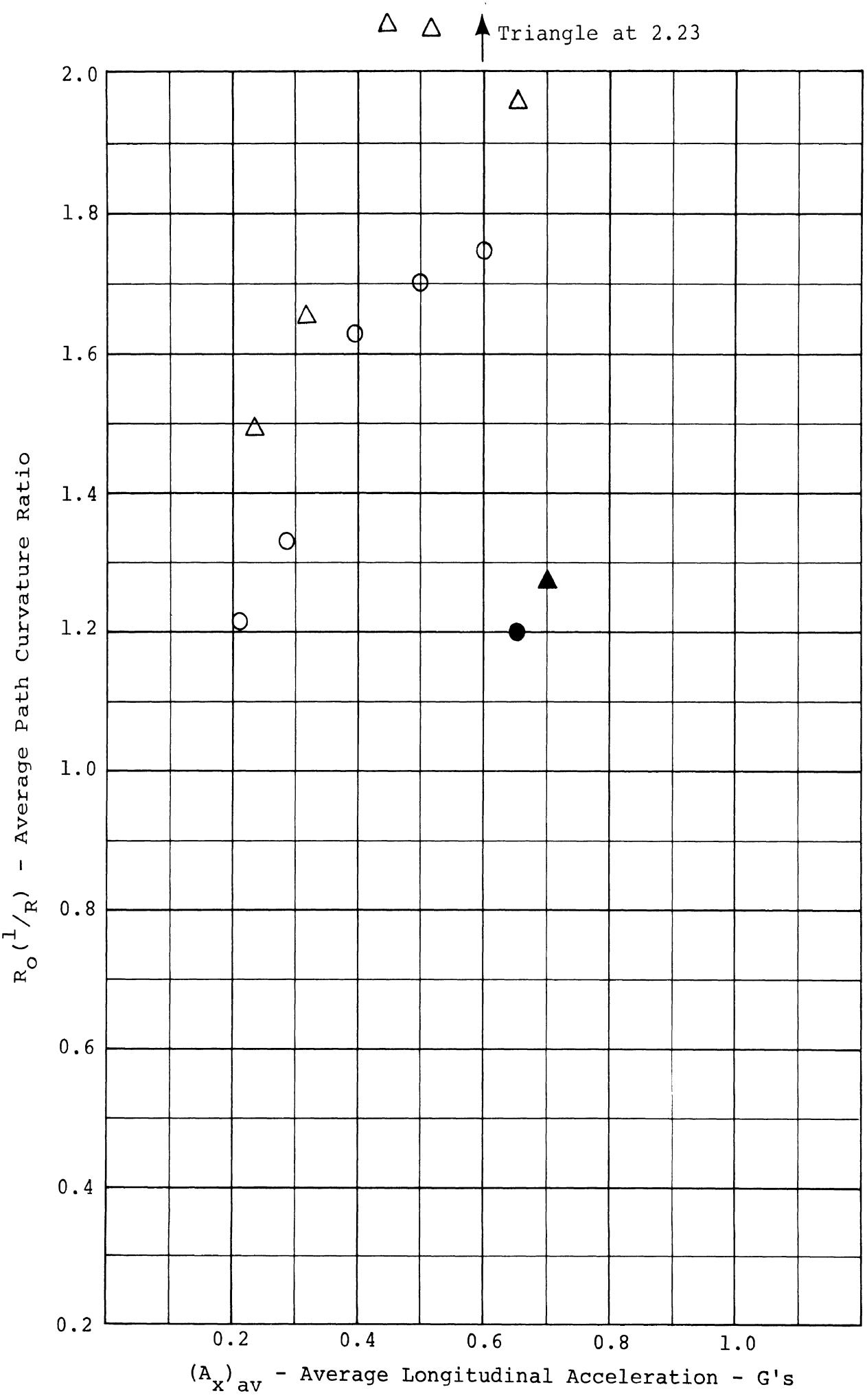


BRAKING IN A TURN - DODGE [CONDITION - OE-A]



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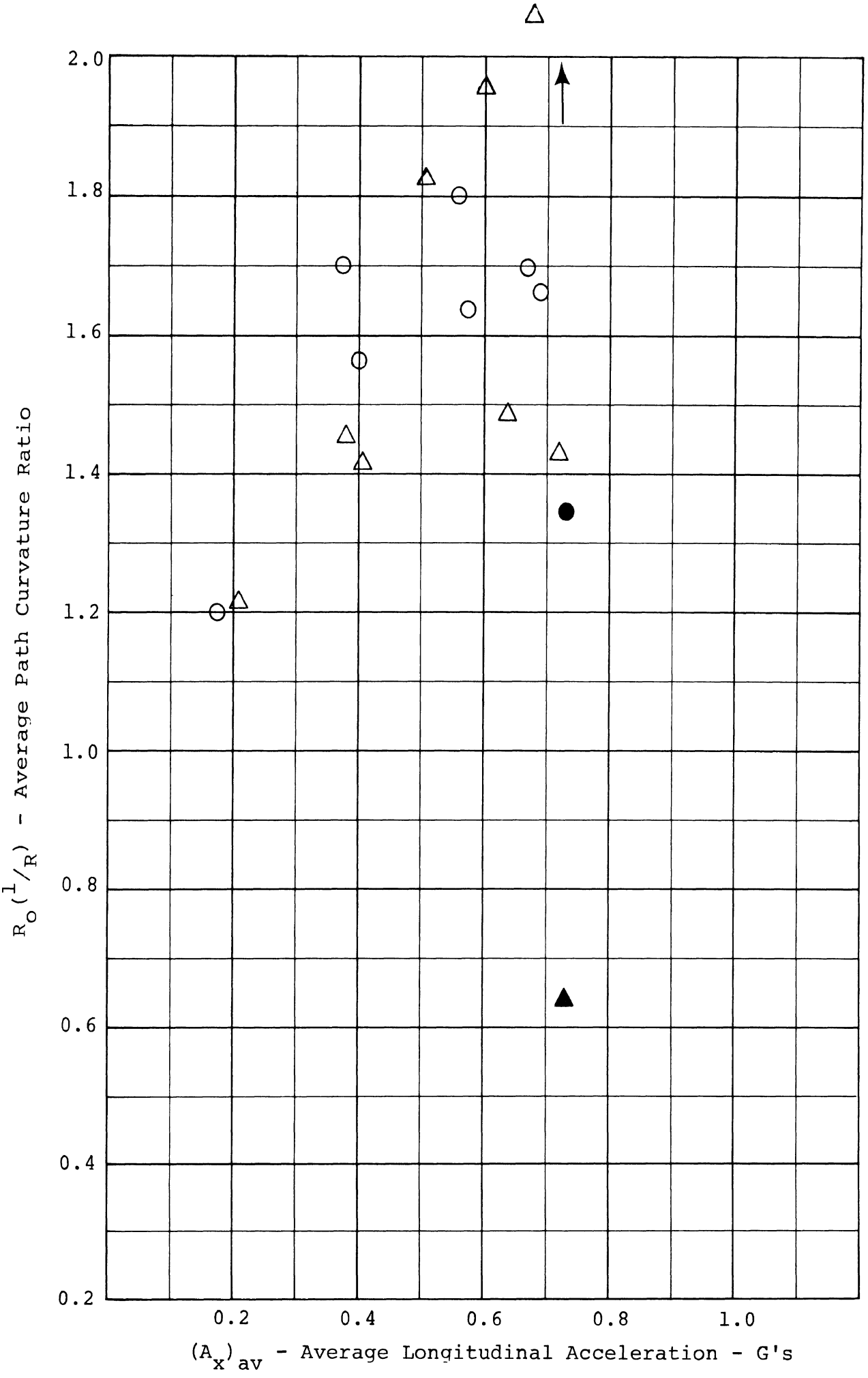

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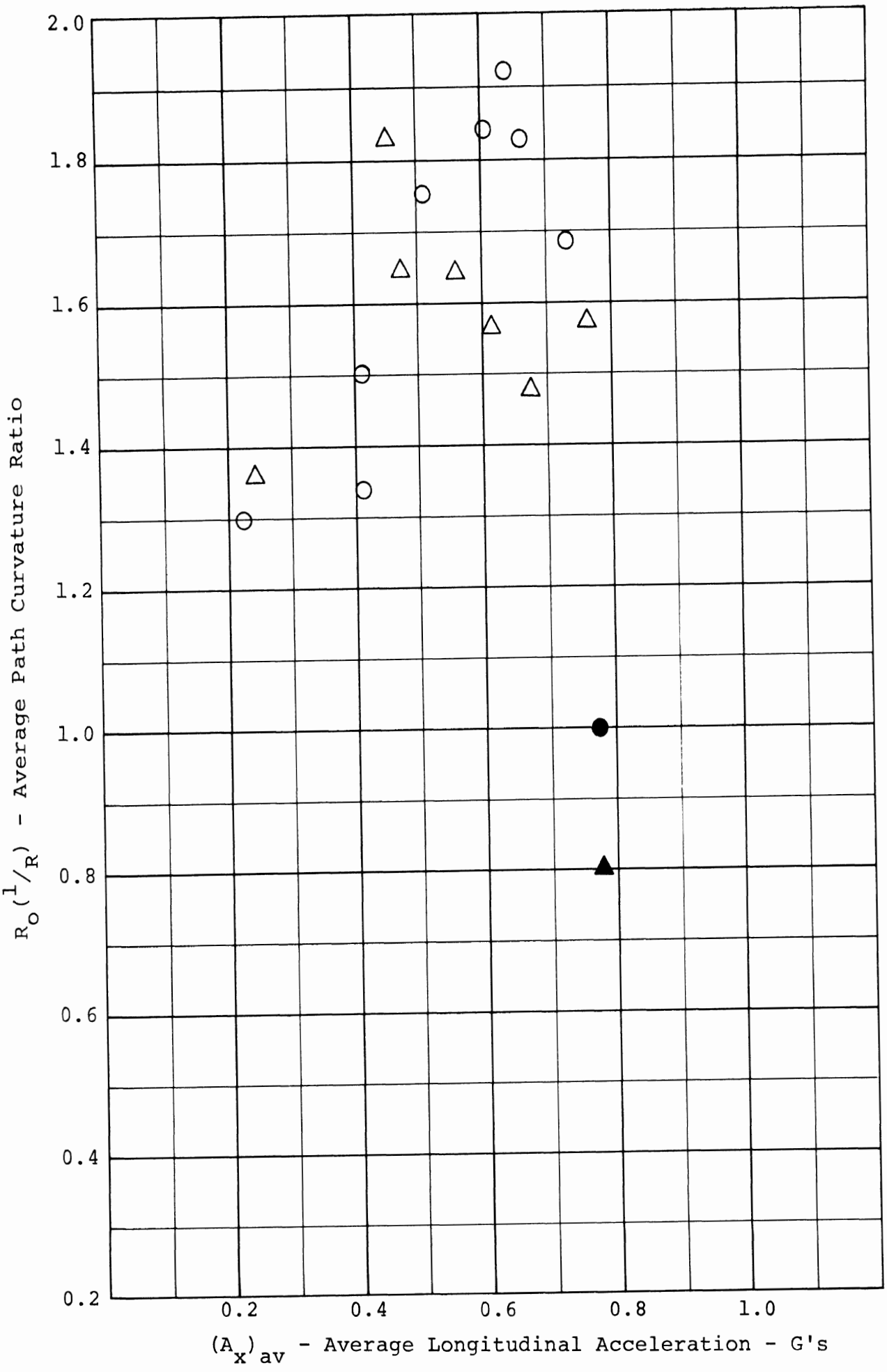

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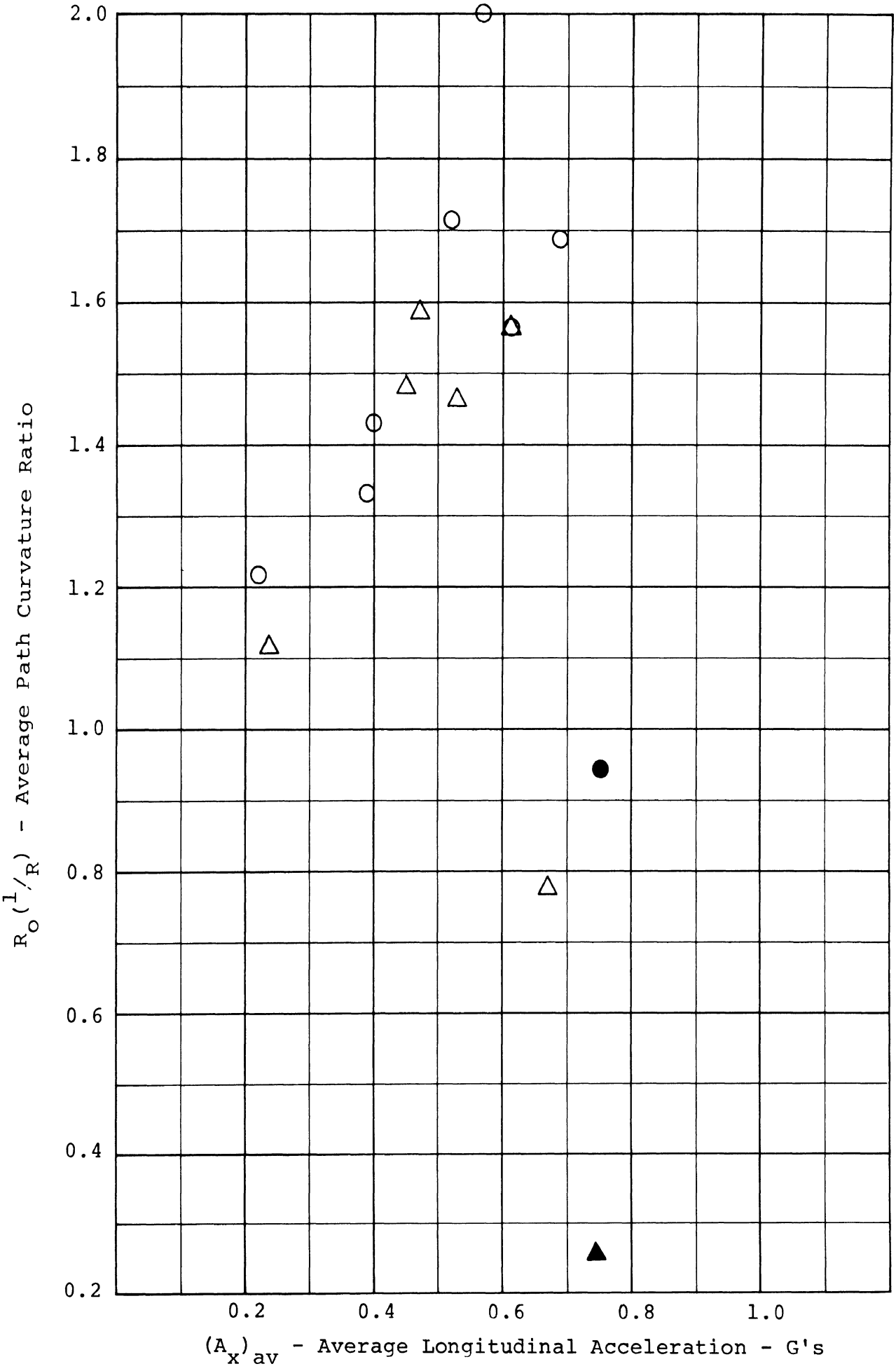

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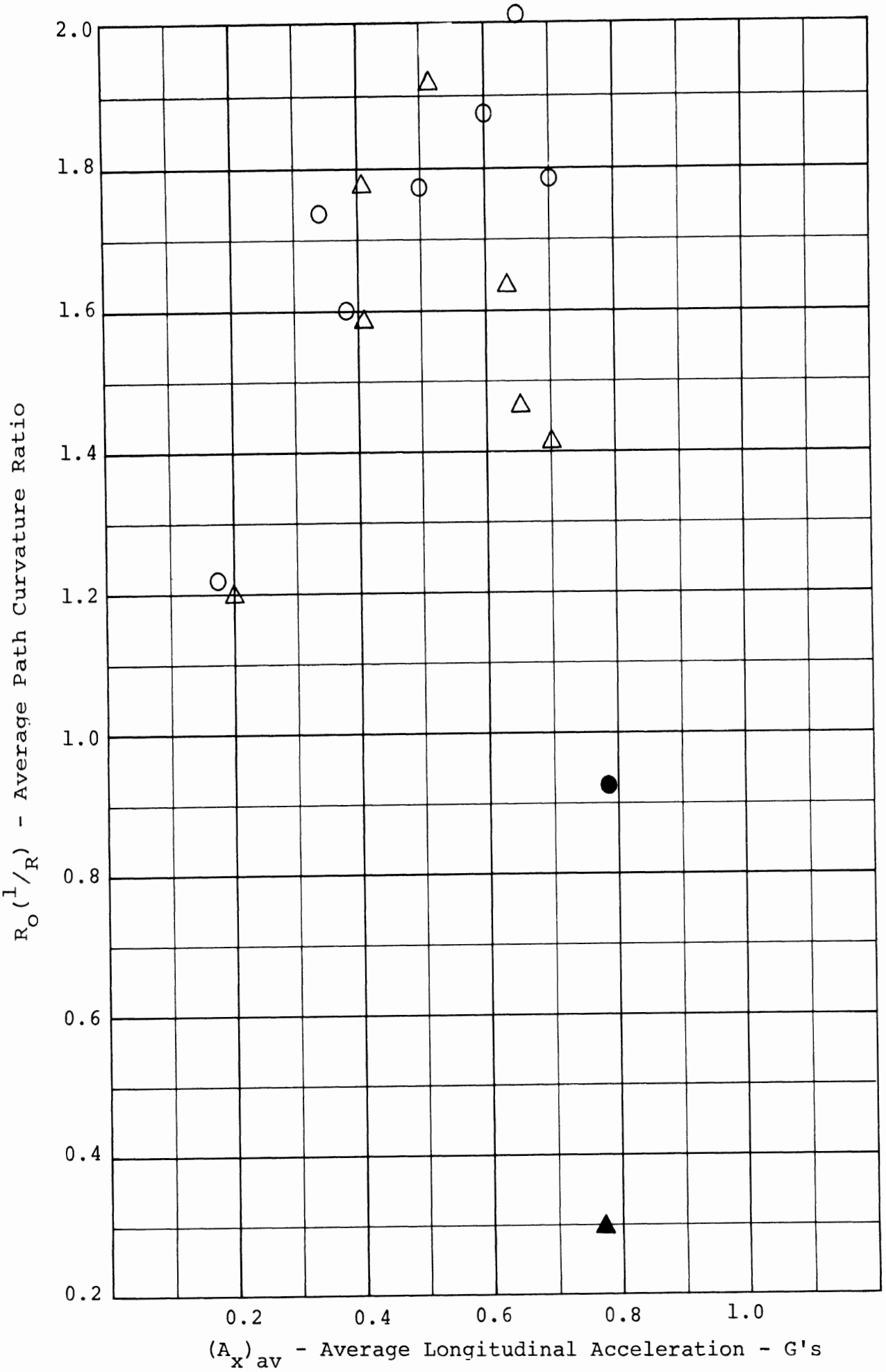


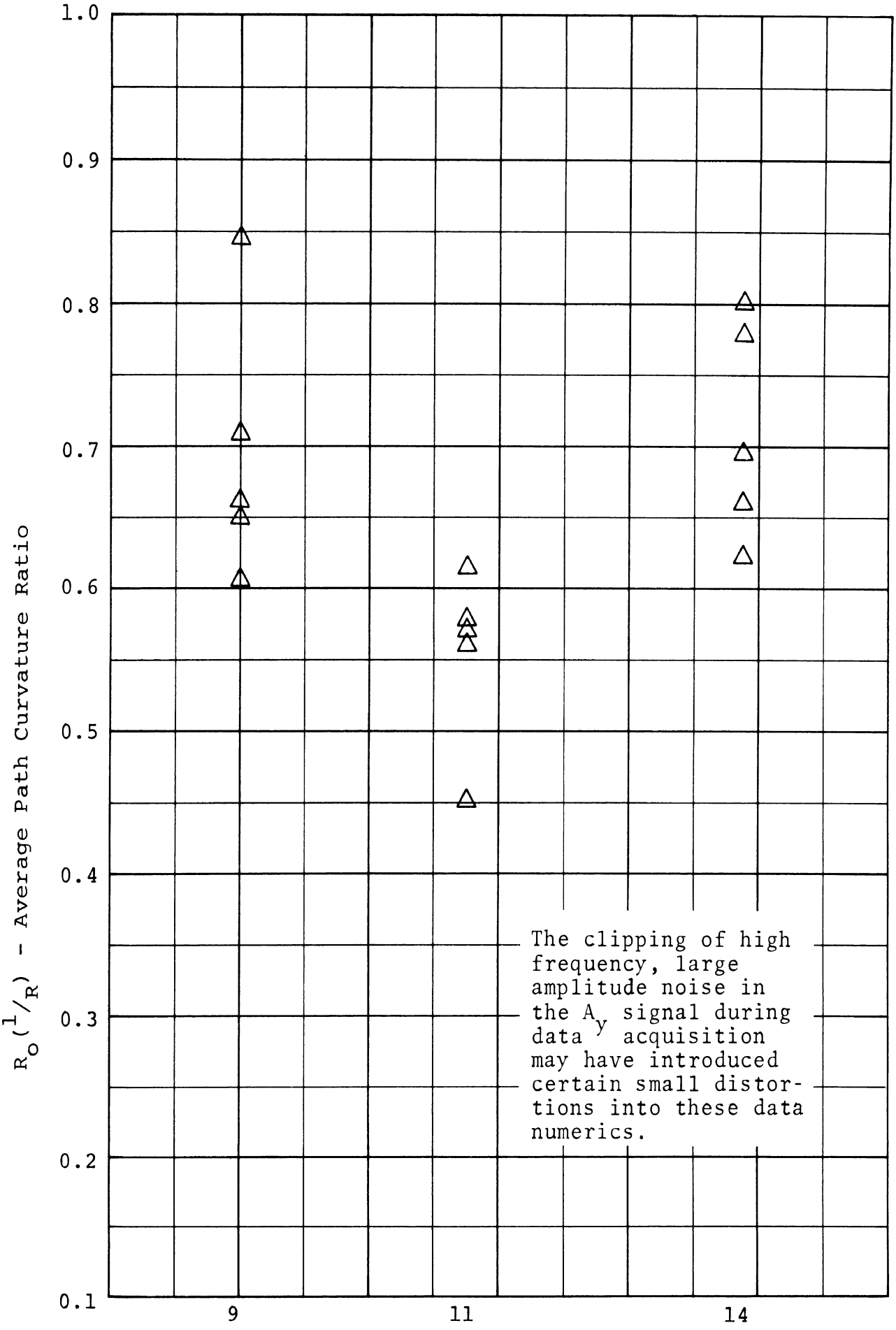
BRAKING IN A TURN - DODGE [CONDITION - D5]

VHTP #3 - ROADHOLDING IN A TURN

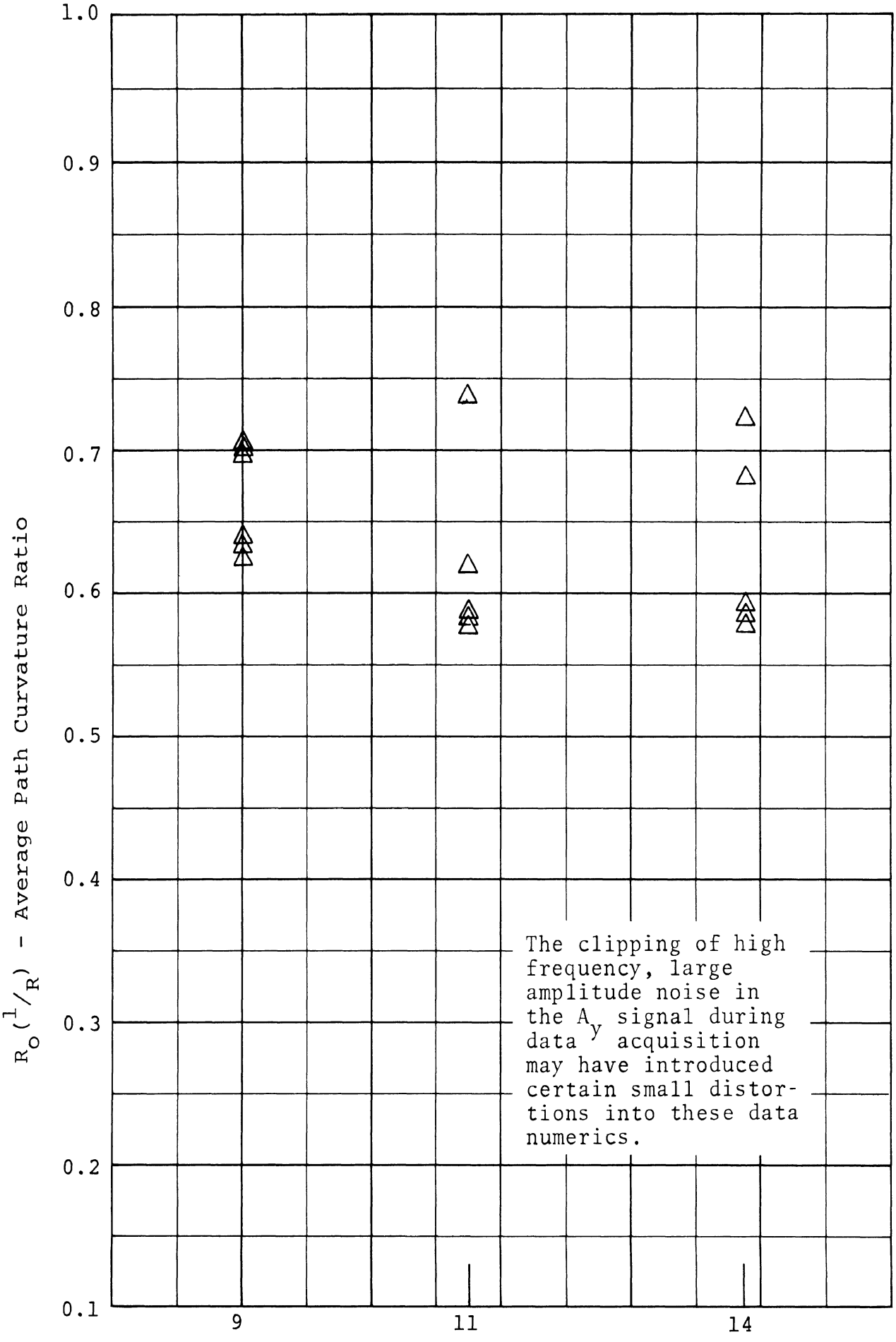
f - Roadroughness Fundamental Frequency—Determined by the Spacing of the Disturbance Elements in Each Grid

$R_o(1/R)_{ave}$ - Average Path Curvature Ratio Relative to the Initial Turn

$\dot{\beta}_p$ - Peak Body Sideslip Rate



ROADHOLDING IN A TURN - AMBASSADOR [CONDITION - OE]



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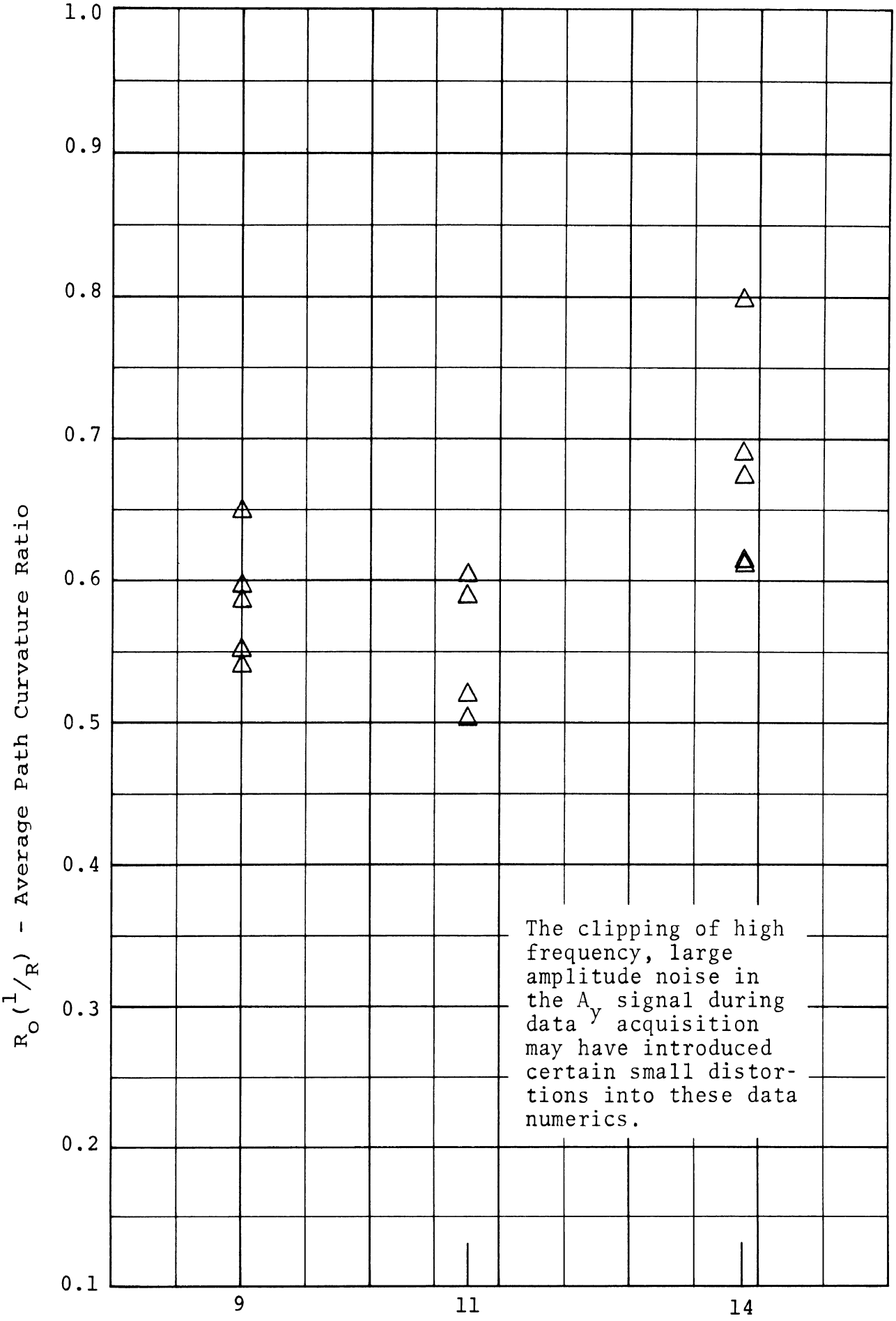

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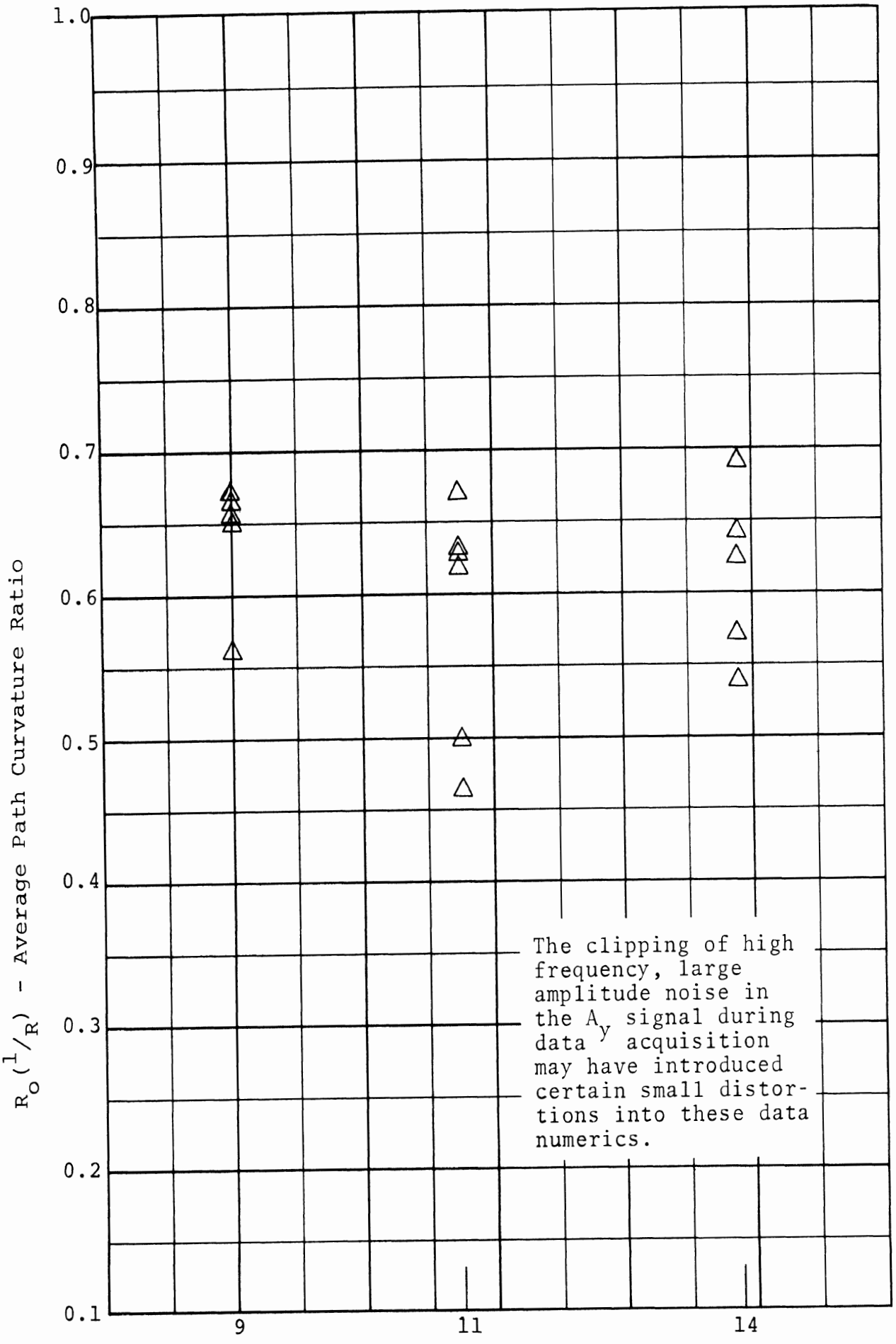

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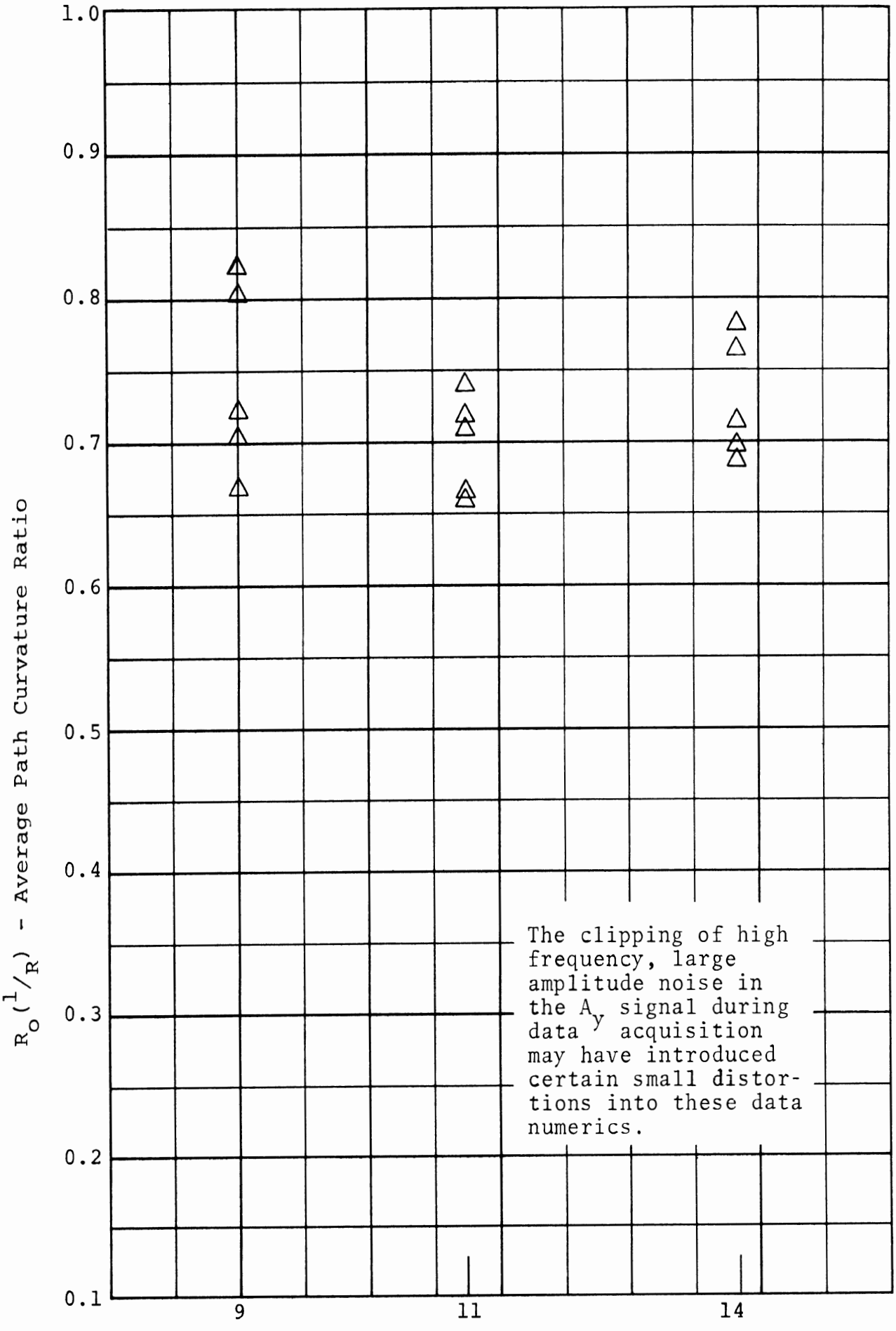
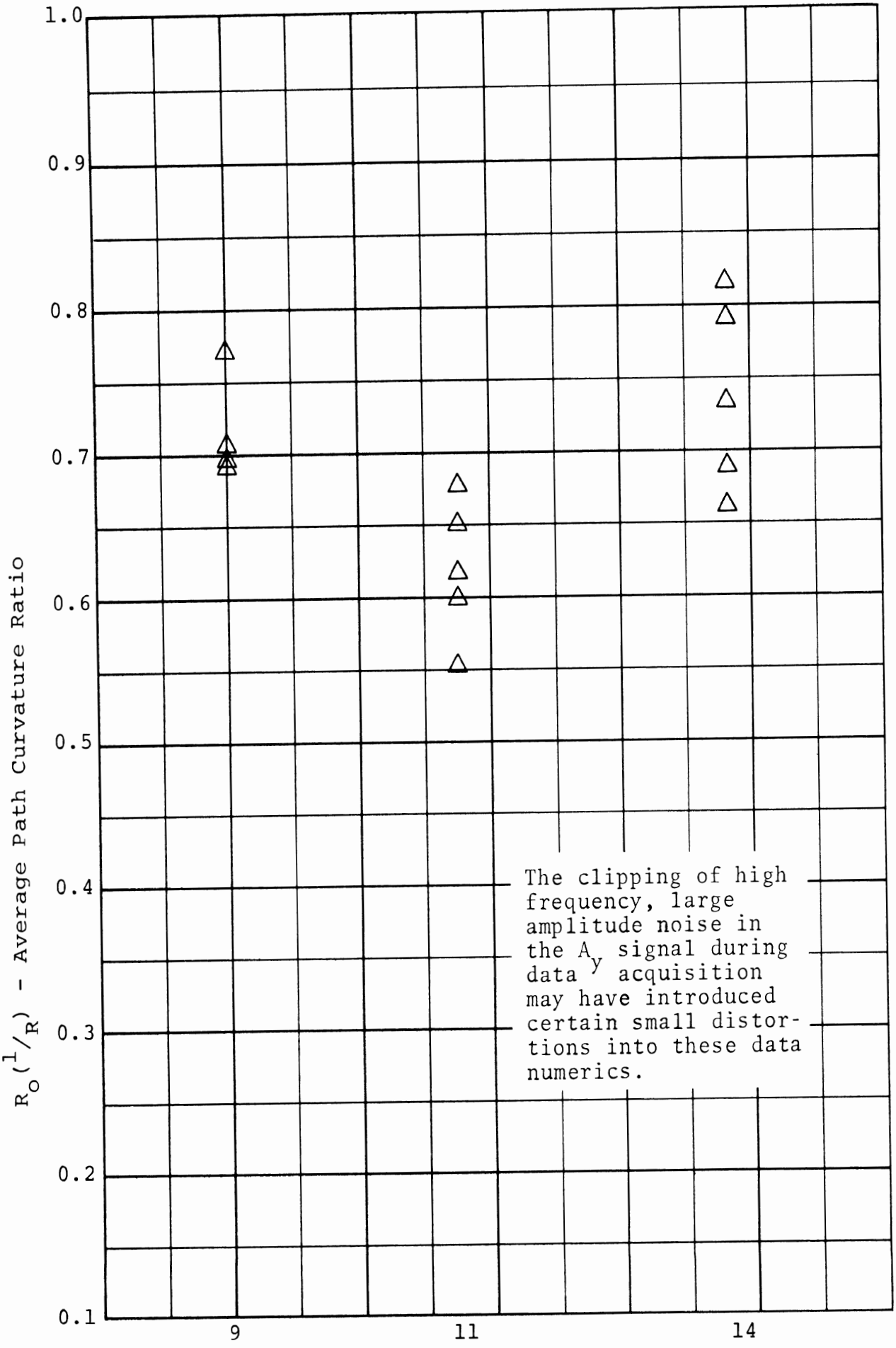
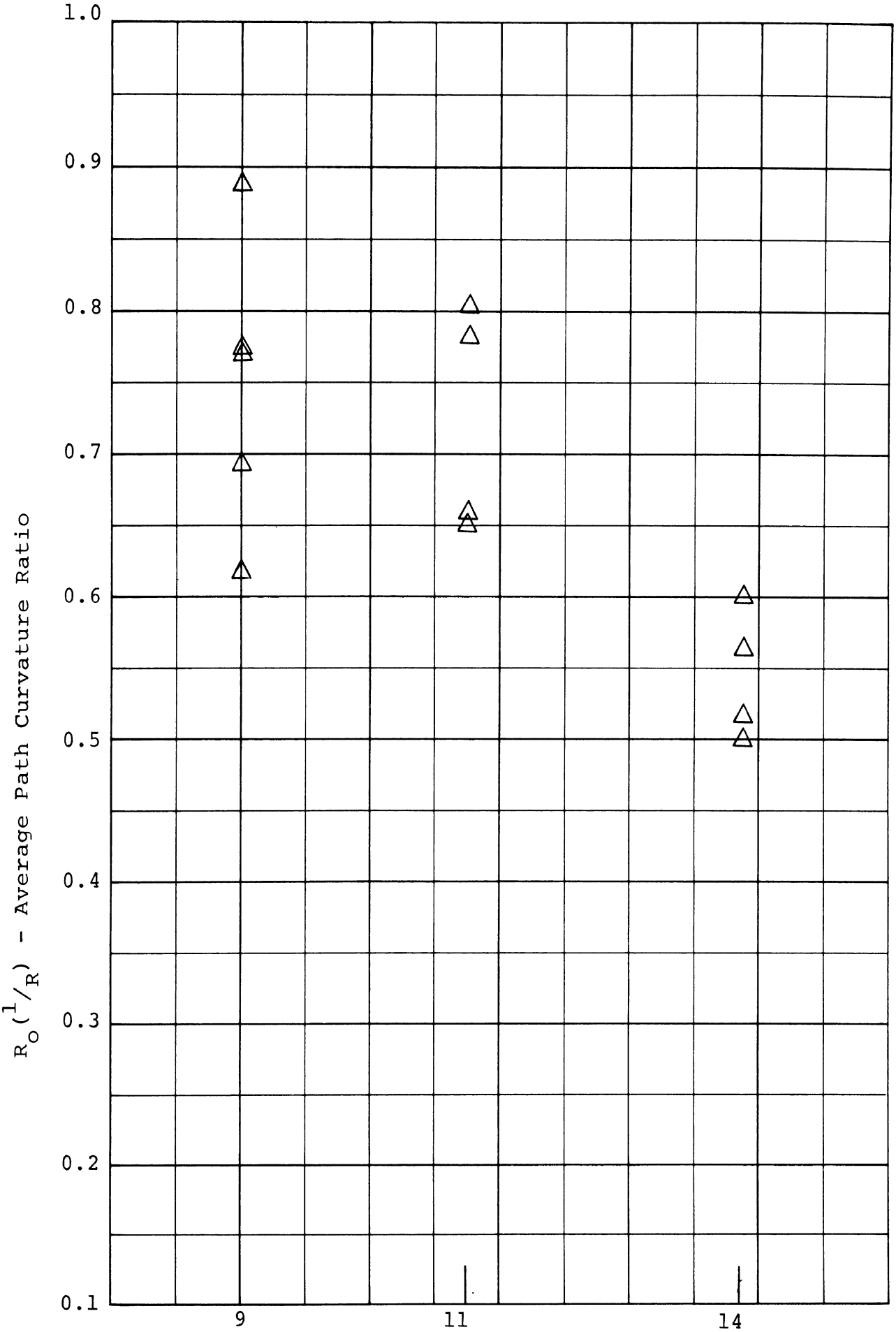


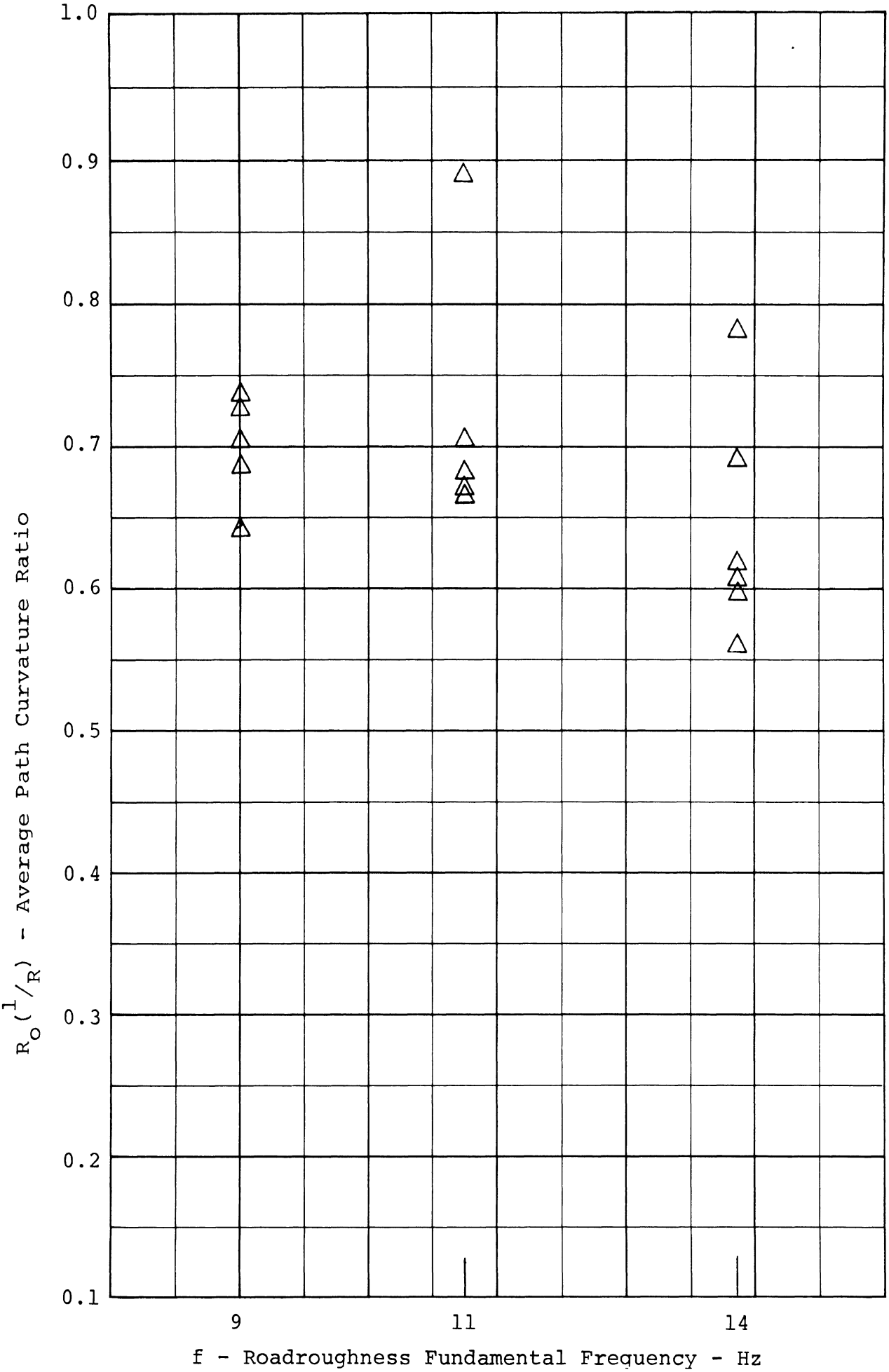
ROADHOLDING IN A TURN - AMBASSADOR [CONDITION - D-4]



ROADHOLDING IN A TURN - AMBASSADOR [CONDITION - D-5]



ROADHOLDING IN A TURN - DODGE [CONDITION - OE-A]



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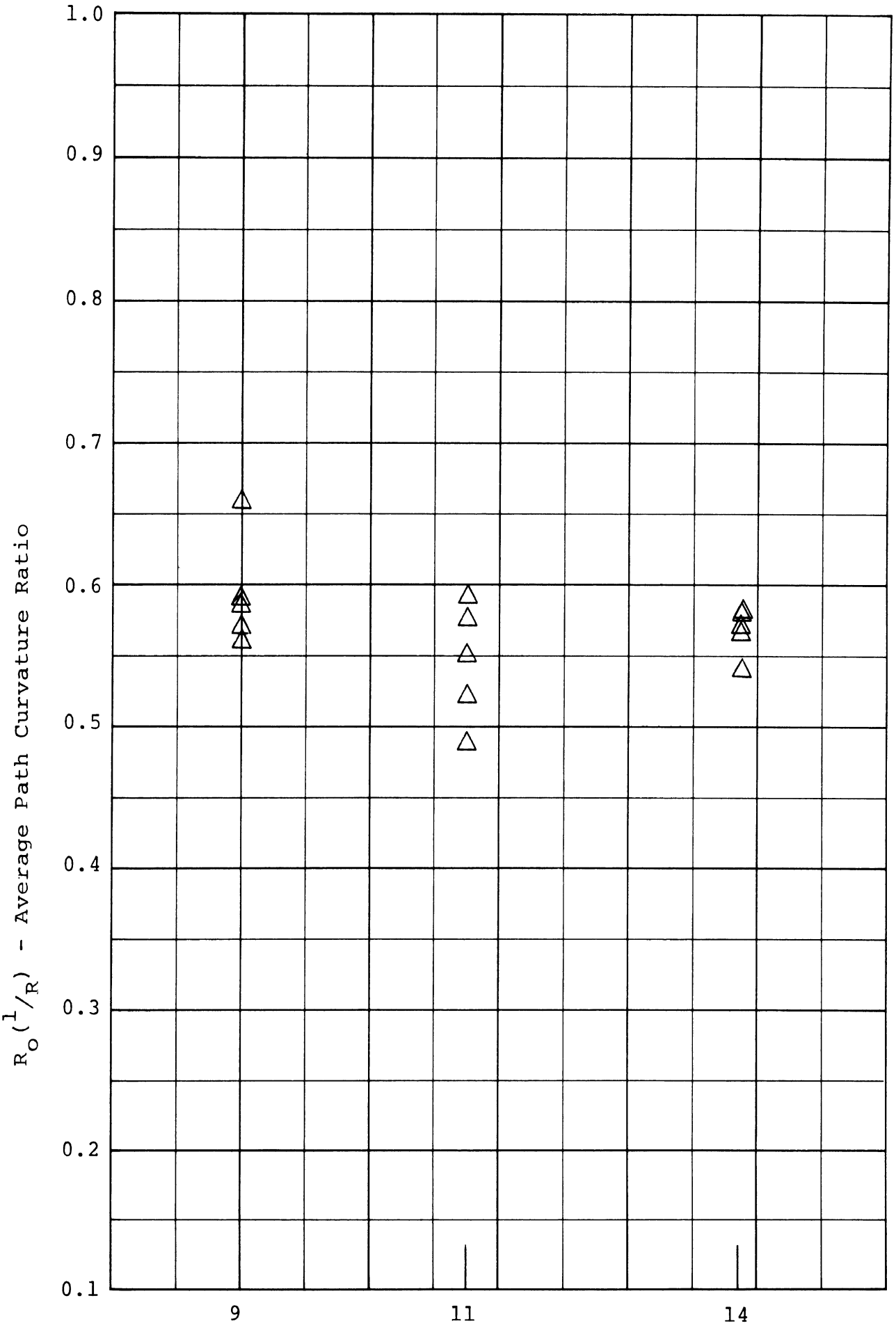

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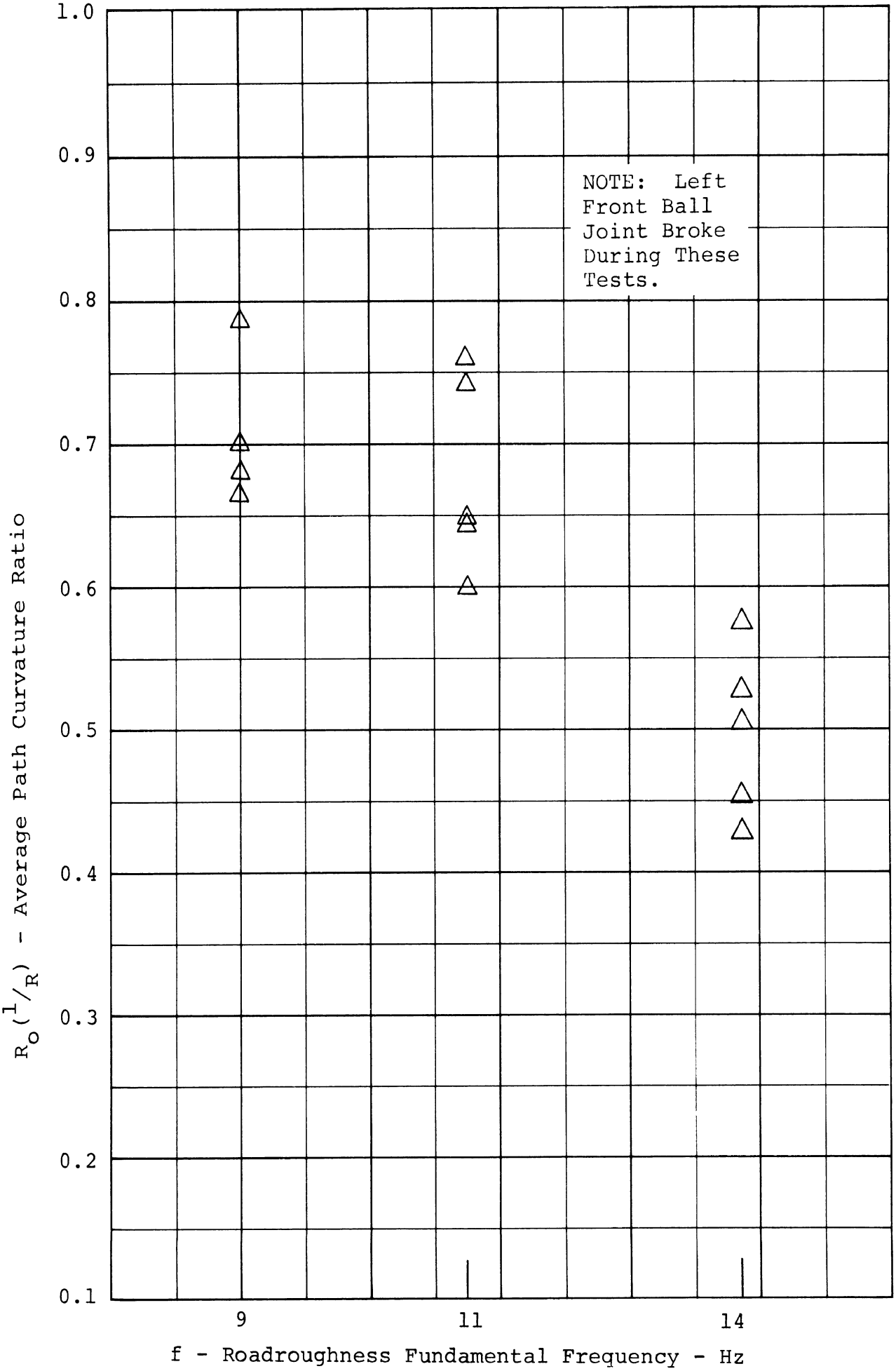
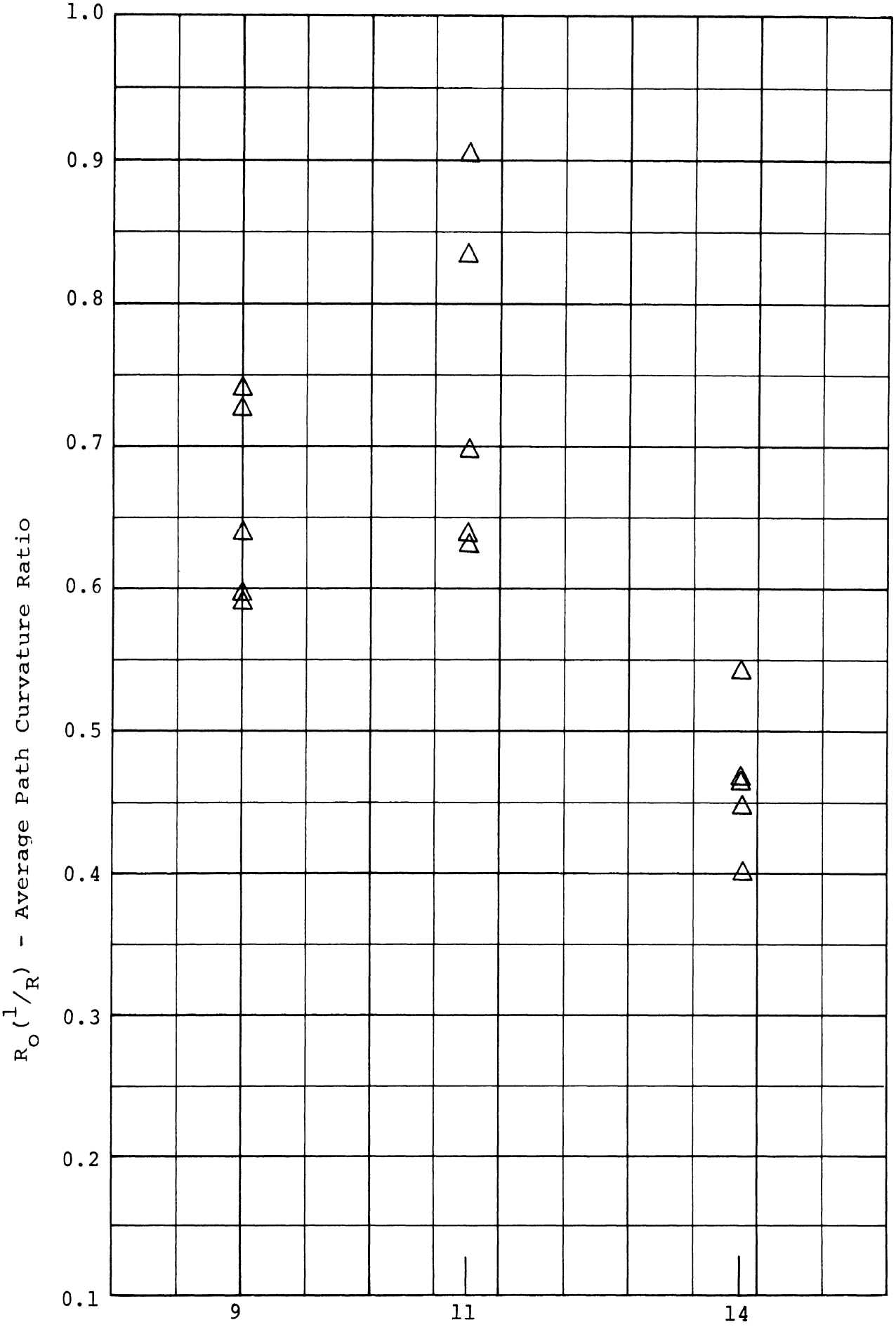


ROADHOLDING IN A TURN - DODGE [CONDITION - OE-B]



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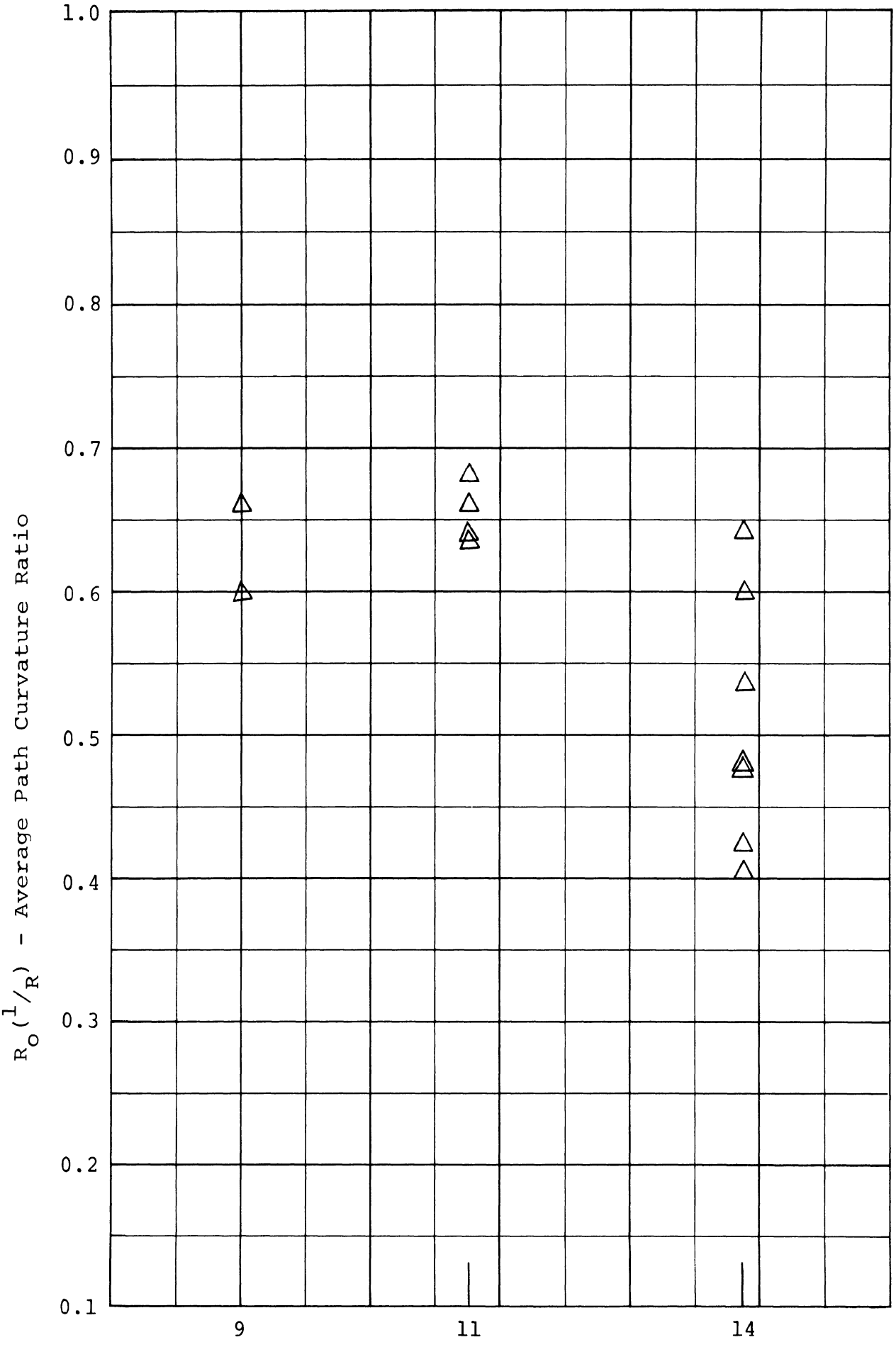
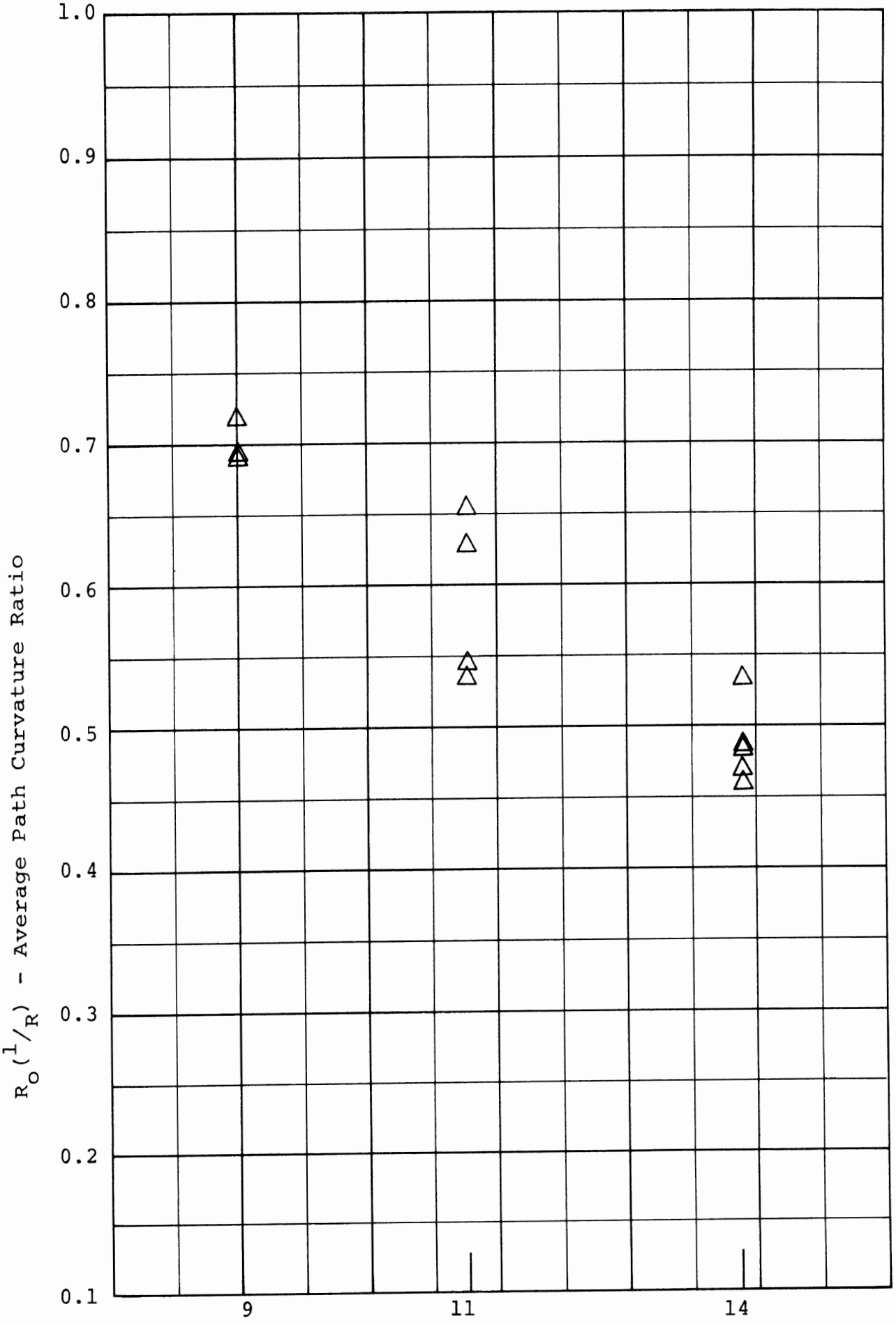
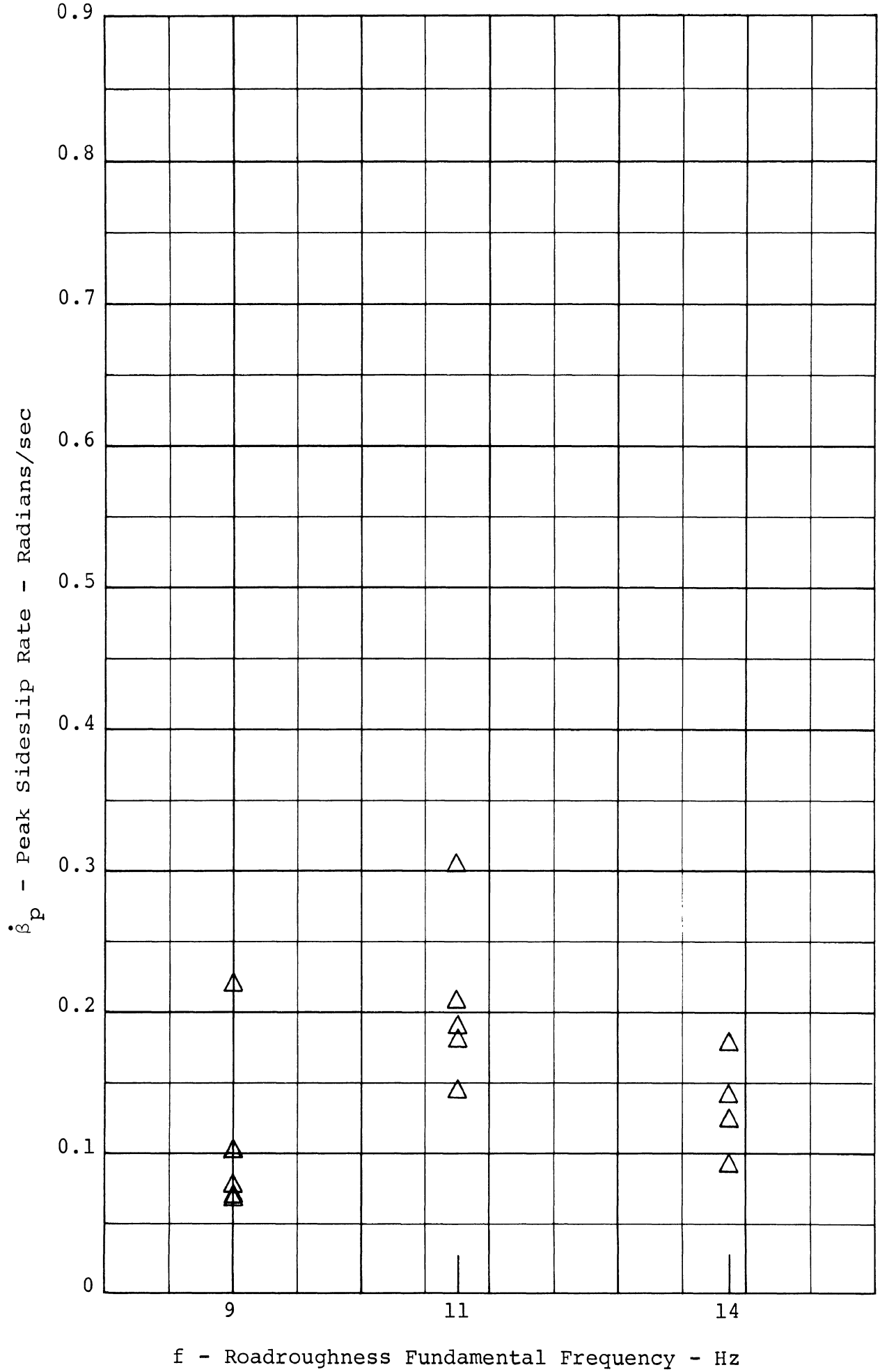


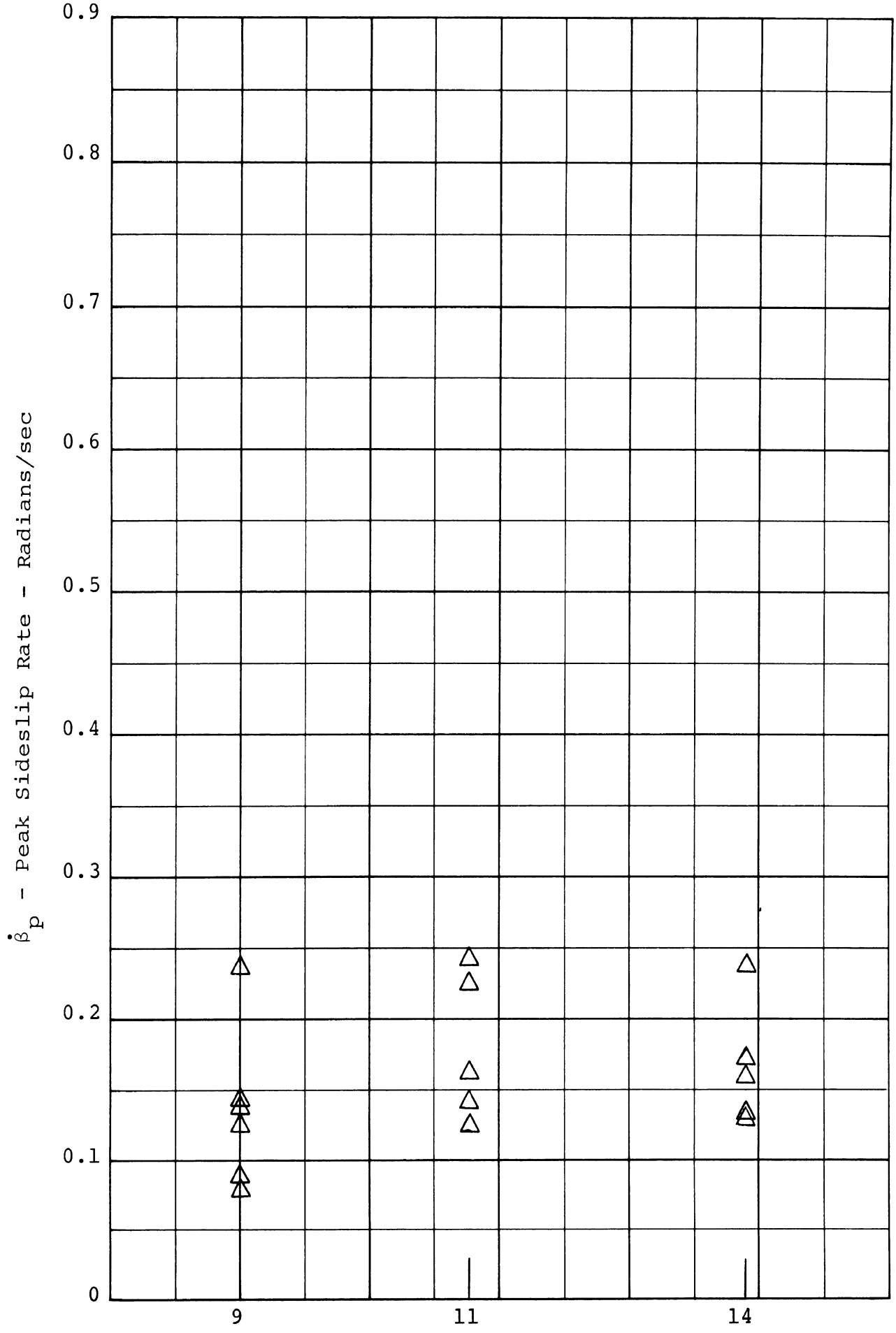
ROADHOLDING IN A TURN - DODGE [CONDITION - D-4]



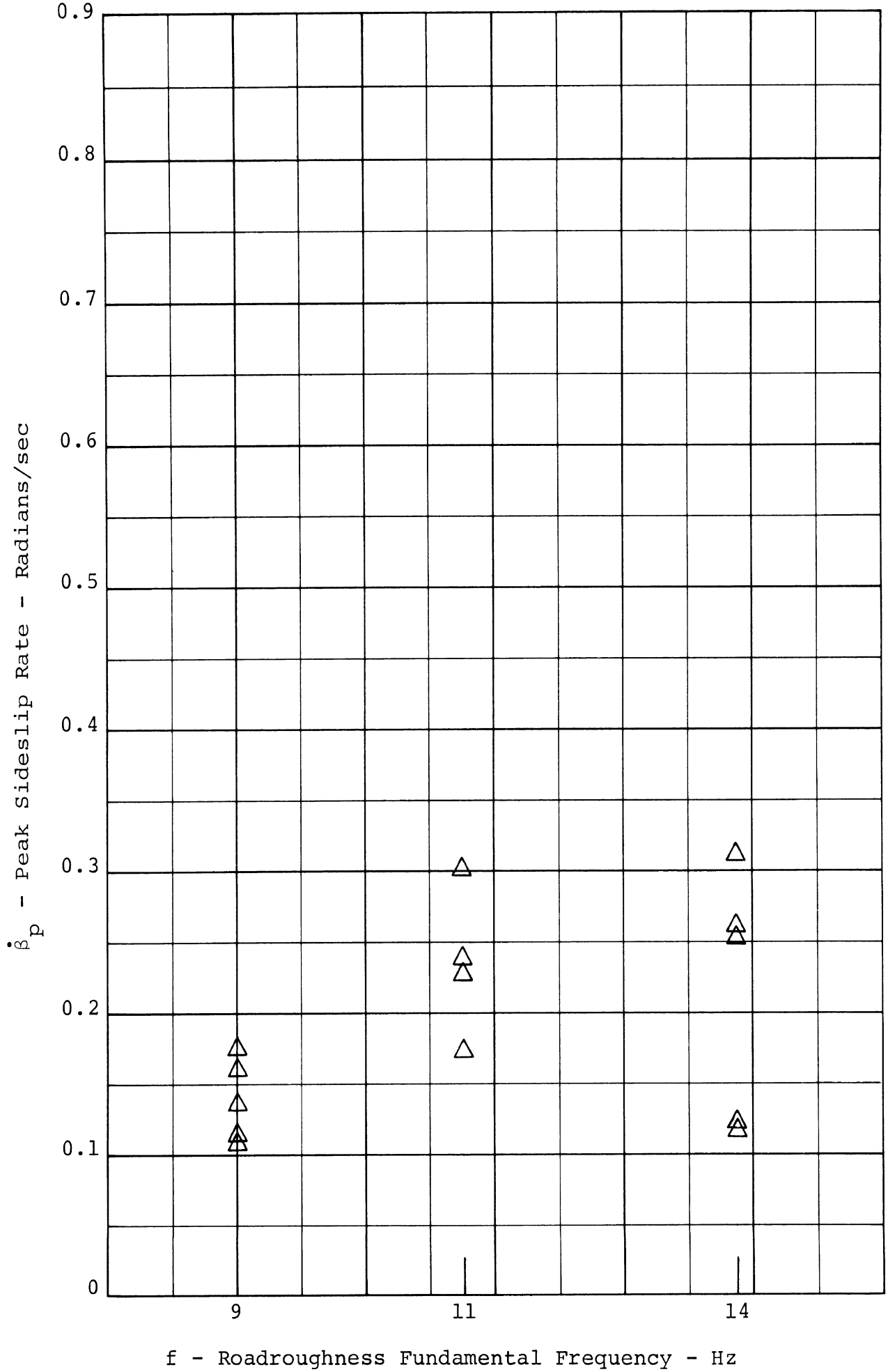
ROADHOLDING IN A TURN - DODGE [CONDITION - D-5]



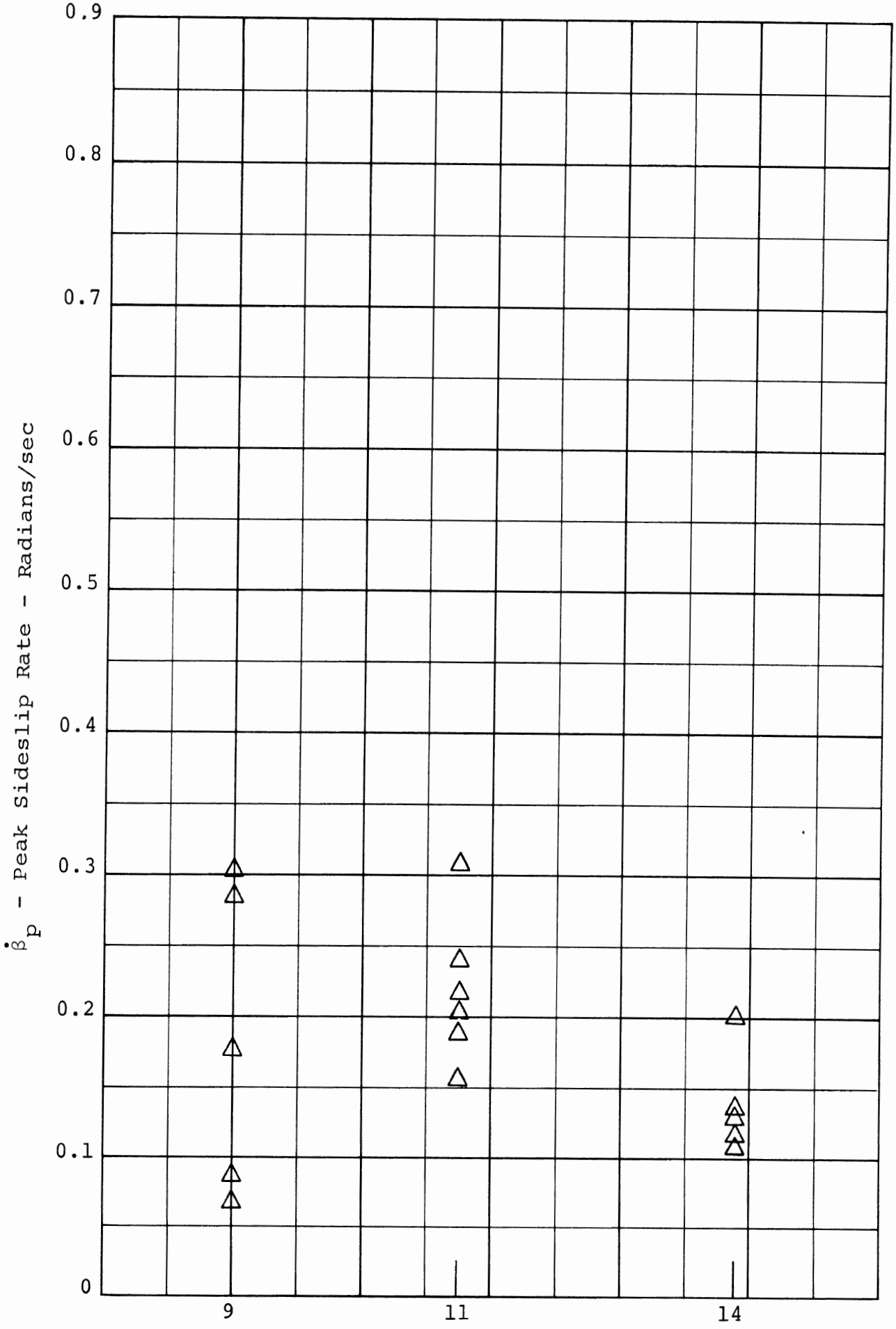
ROADHONDING IN A TURN - AMBASSADOR [condition - OE]



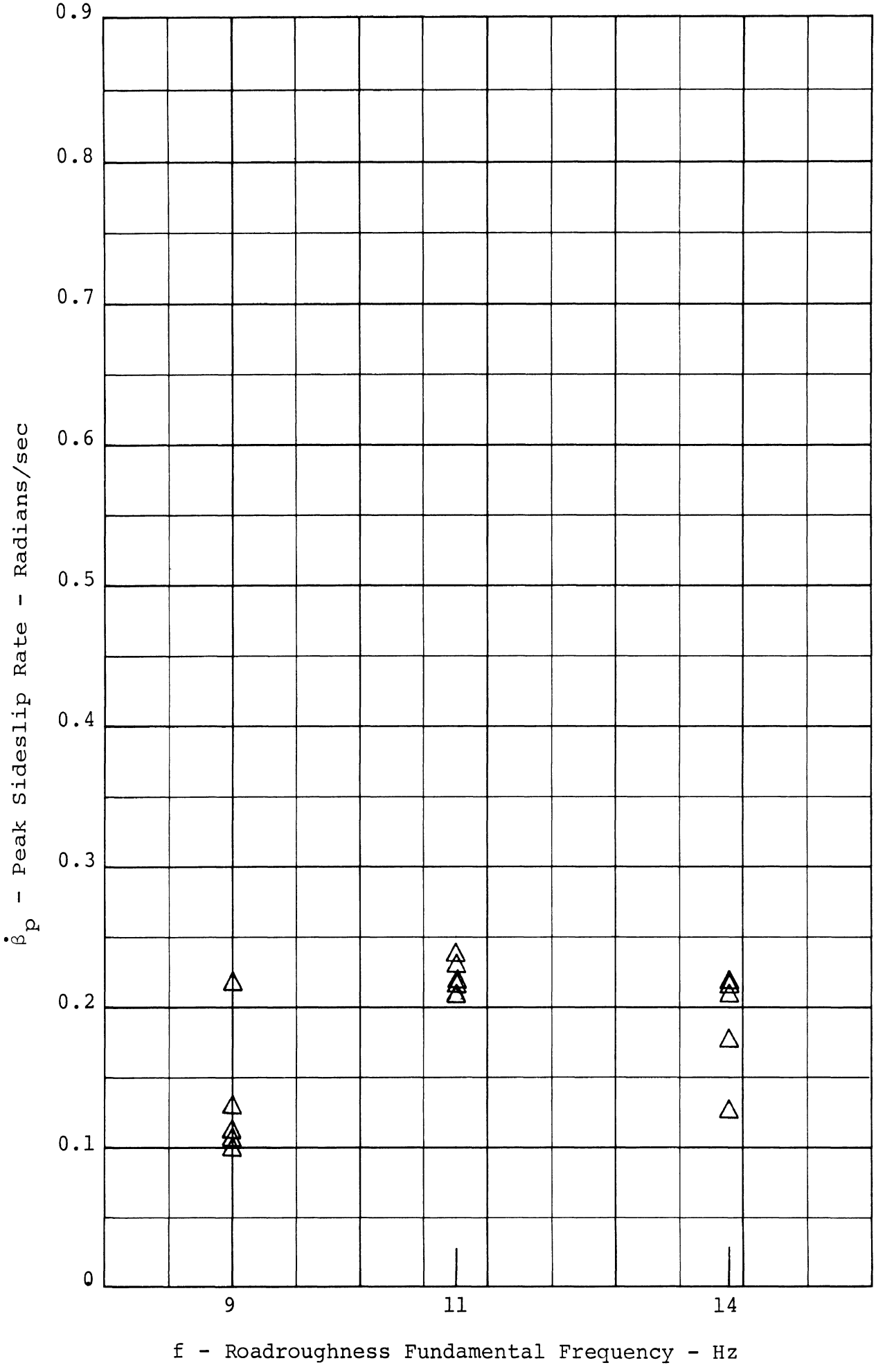
ROADHOLDING IN A TURN - AMBASSADOR [condition - D1]



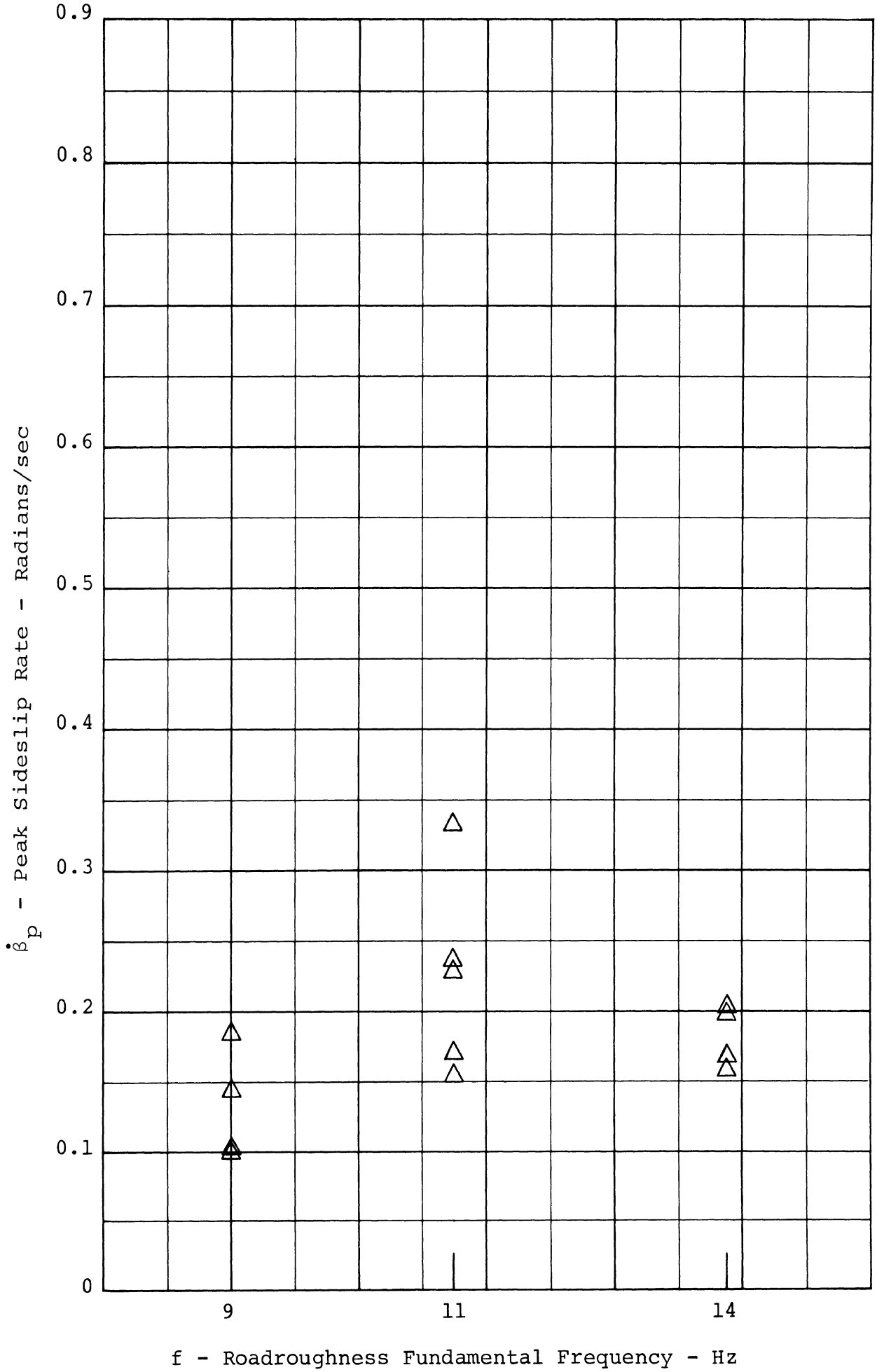
ROADHOLDING IN A TURN - AMBASSADOR [condition - D2]



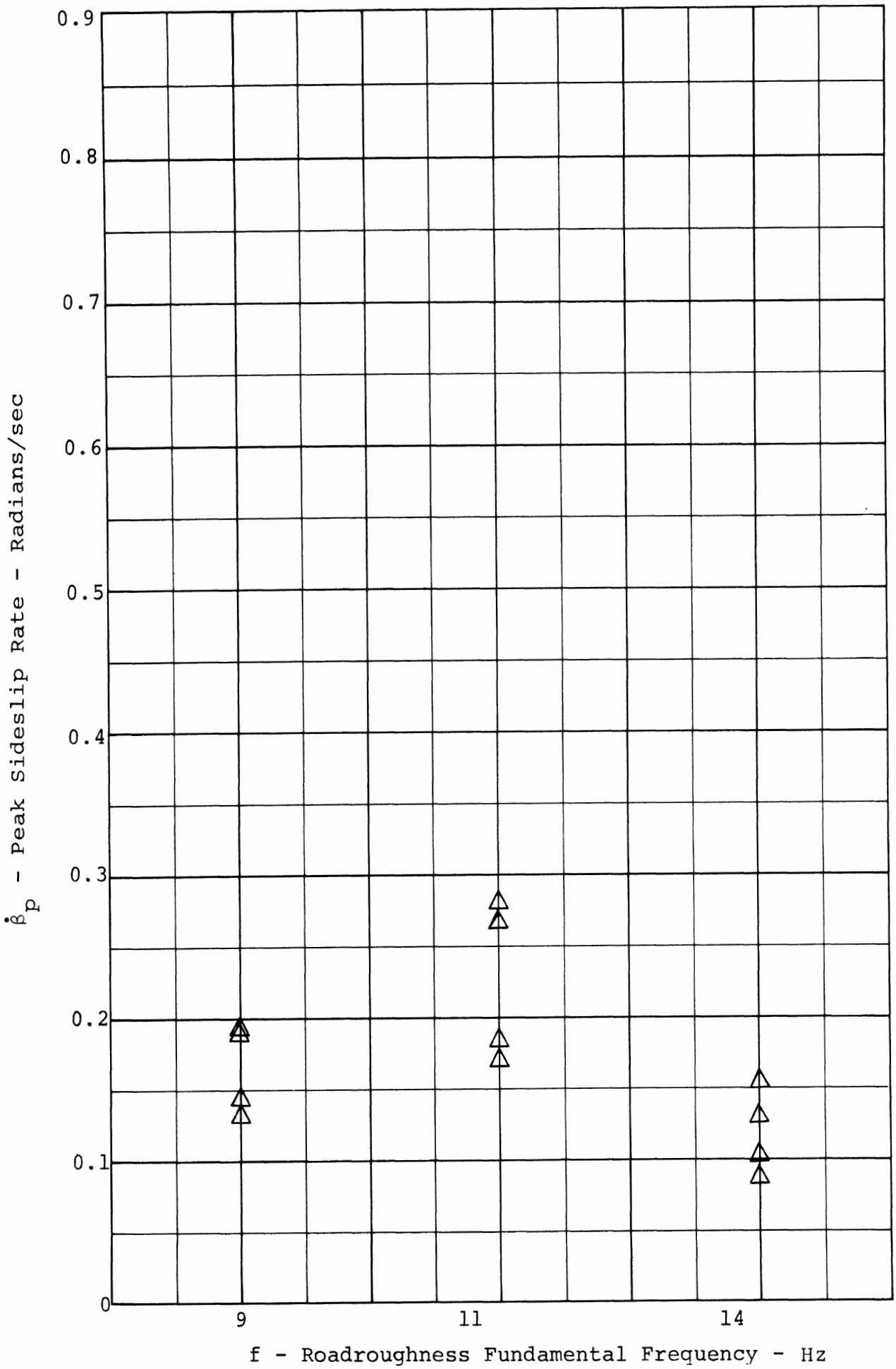
ROADHOLDING IN A TURN - AMBASSADOR [condition - D3]



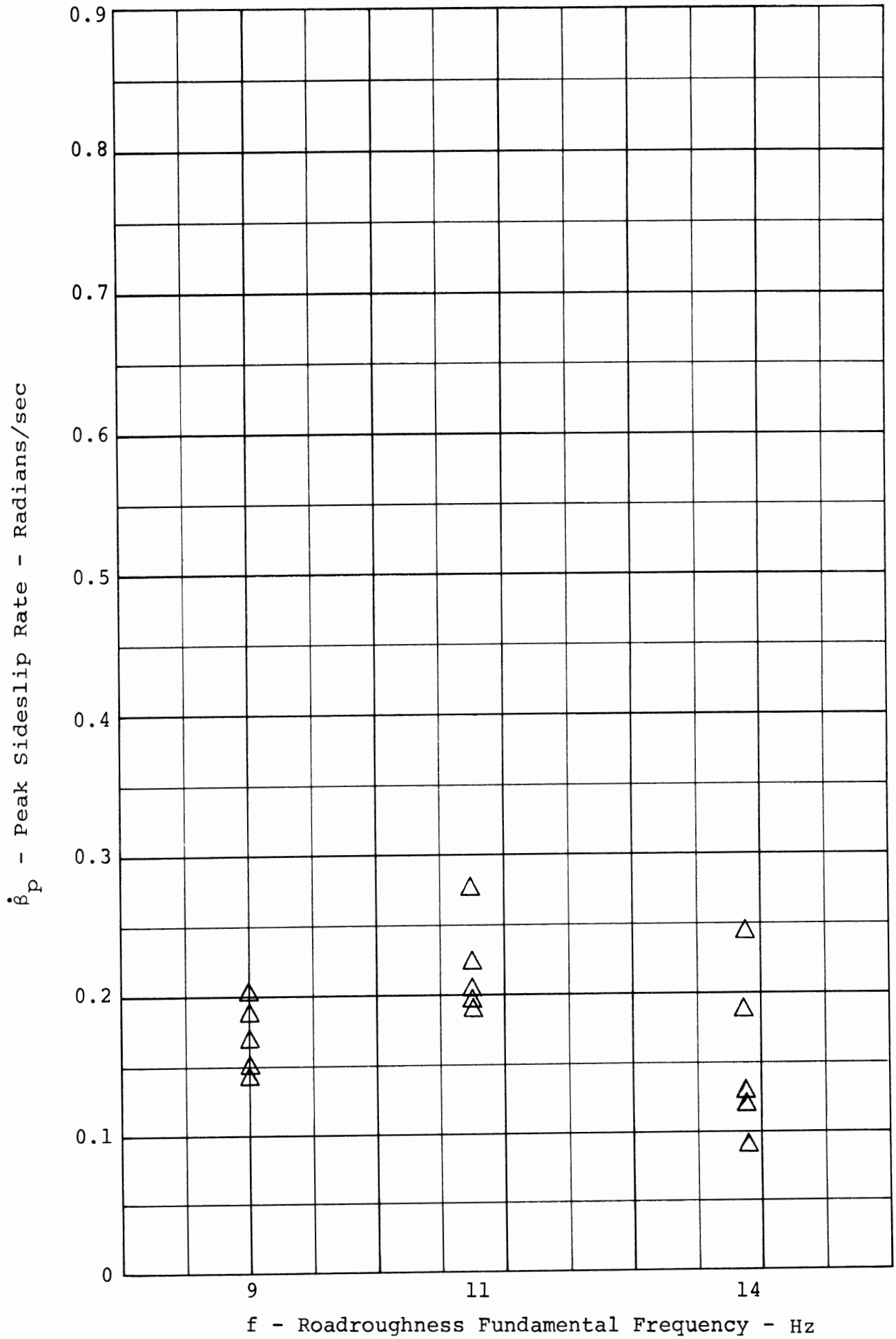
ROADHOLDING IN A TURN - AMBASSADOR [condition D4]



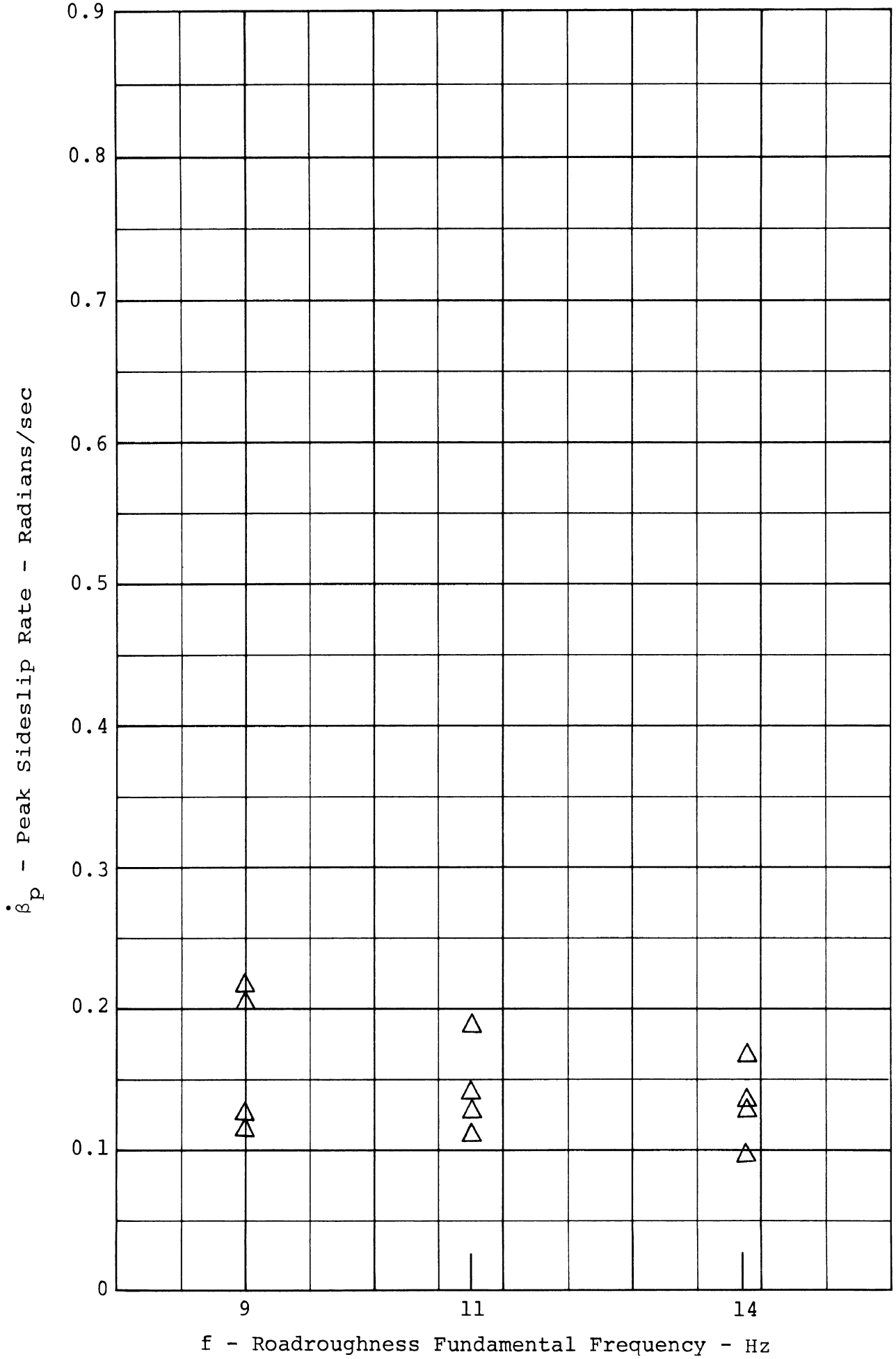
ROADHOLDING IN A TURN - AMBASSADOR [condition D5]



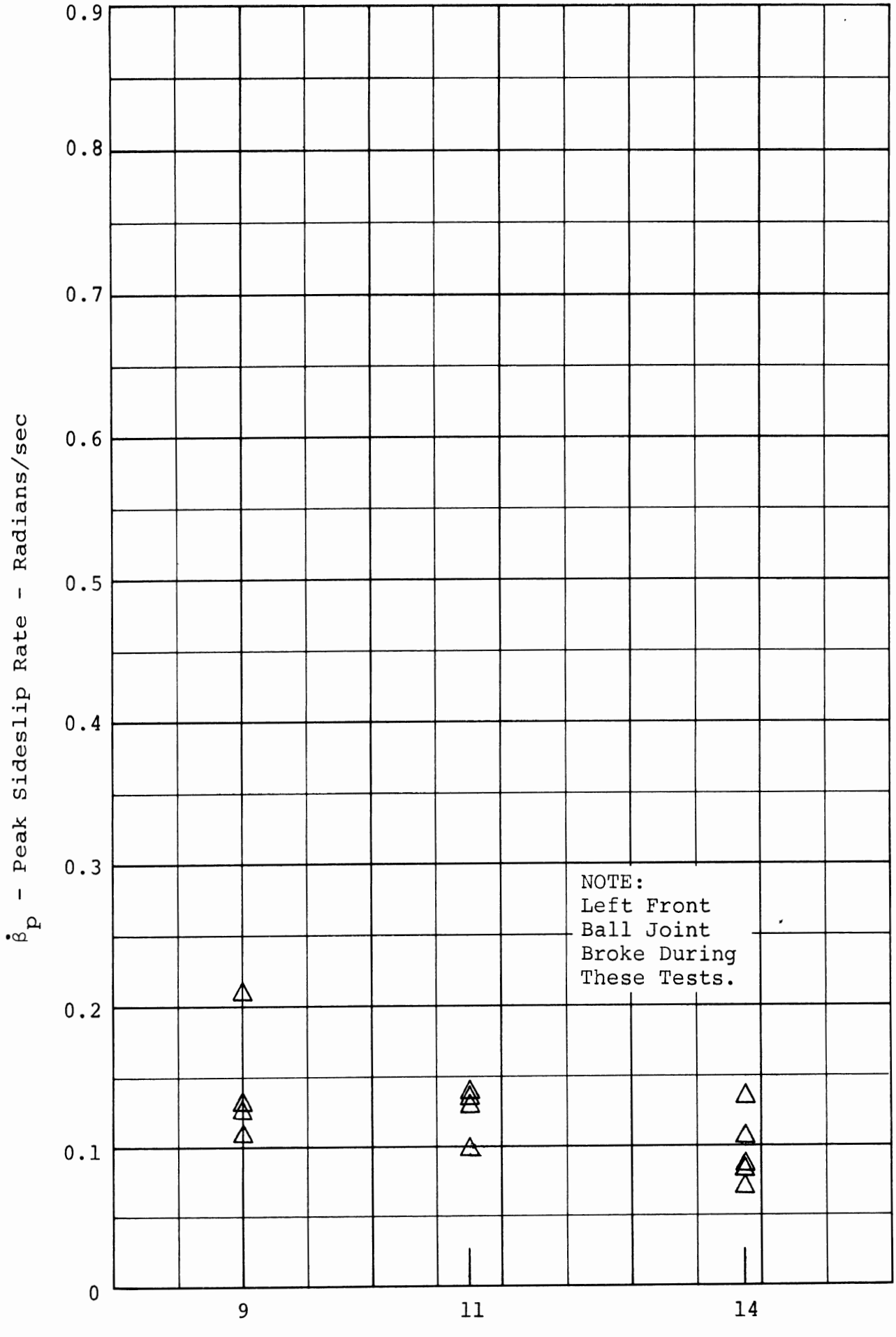
ROADHOLDING IN A TURN - DODGE [CONDITION - OE-A]



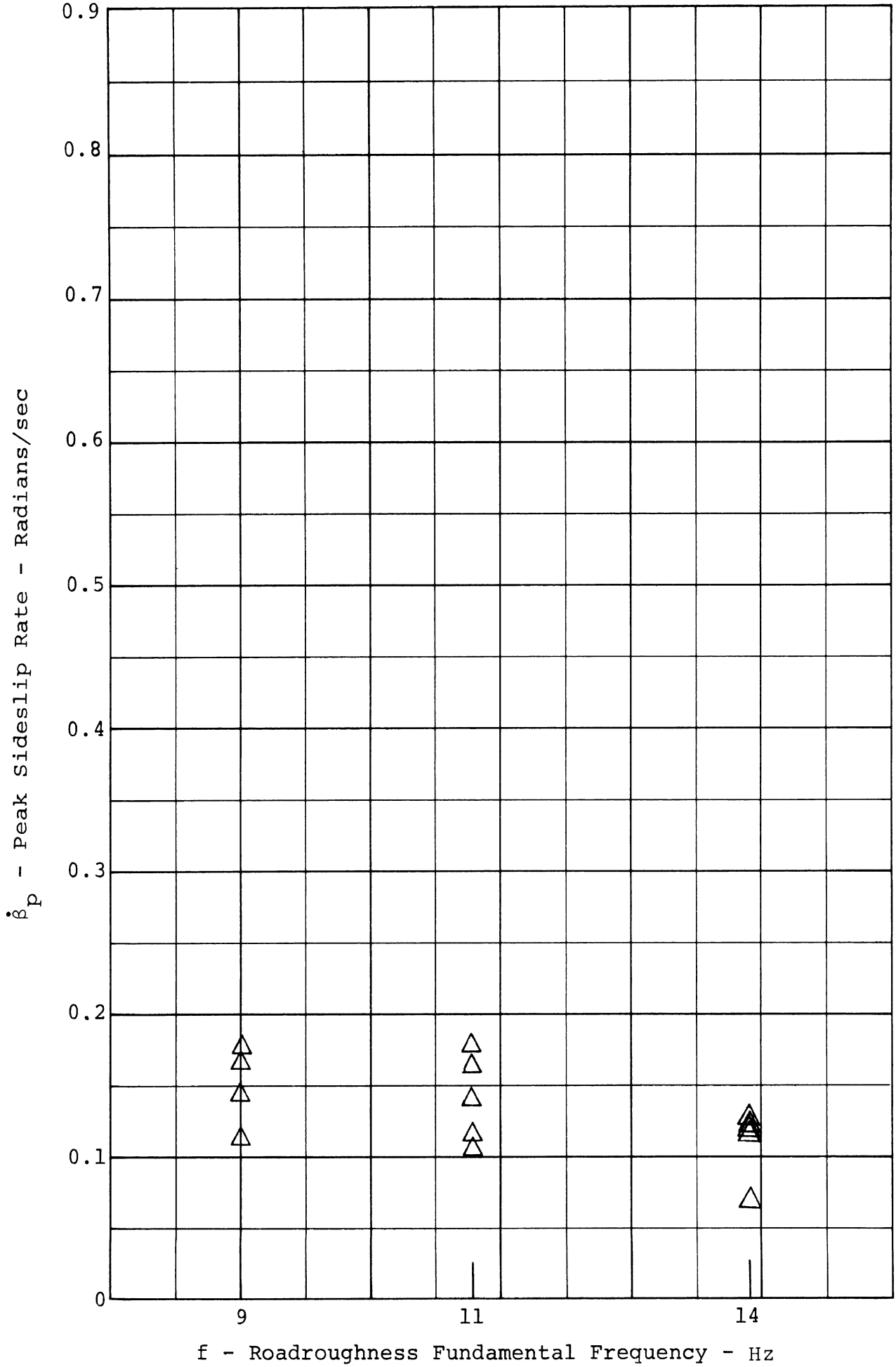
ROADHOLDING IN A TURN - DODGE [CONDITION - D-1]



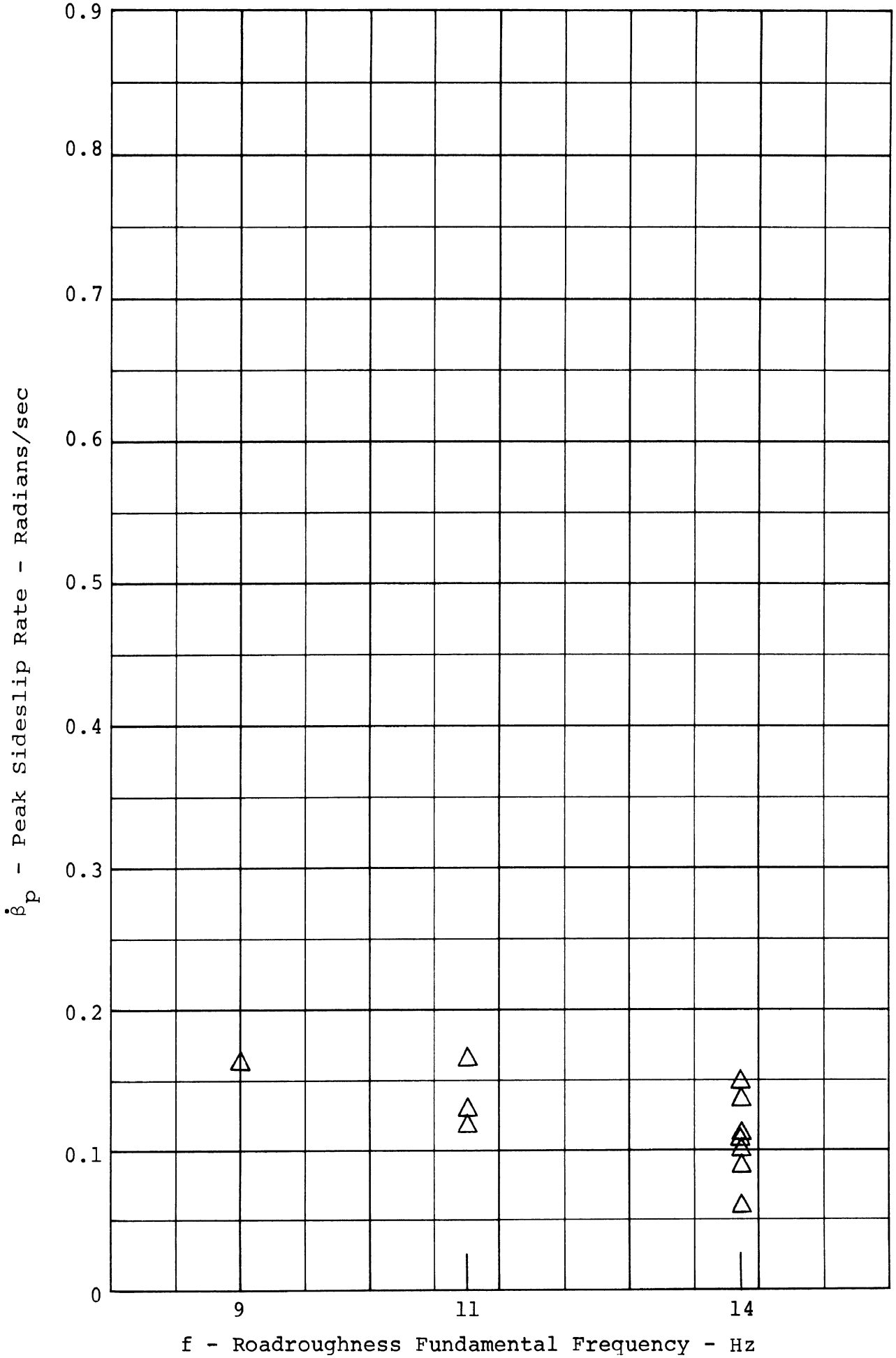
ROADHOLDING IN A TURN - DODGE [CONDITION - D-2]



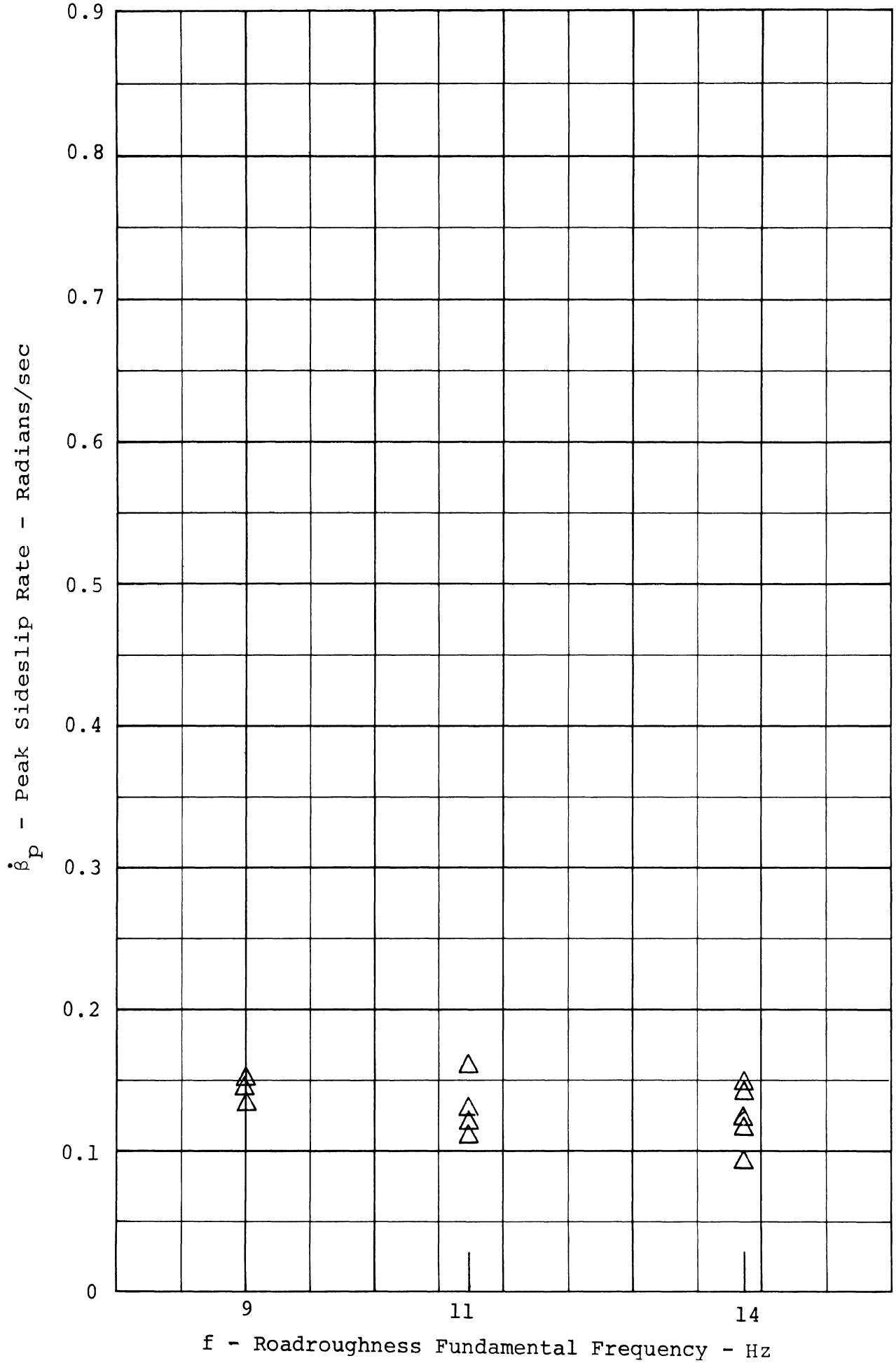
ROADHOLDING IN A TURN - DODGE [CONDITION - OE-B]



ROADHOLDING IN A TURN - DODGE [CONDITION - D-3]



ROADHOLDING IN A TURN - DODGE [CONDITION - D-4]



ROADHOLDING IN A TURN - DODGE [CONDITION - D-5]

VIITP #4 - TRAPEZOIDAL STEER

σ' - Normalized Steer Angle, or Nominal Front Wheel Steer Angle

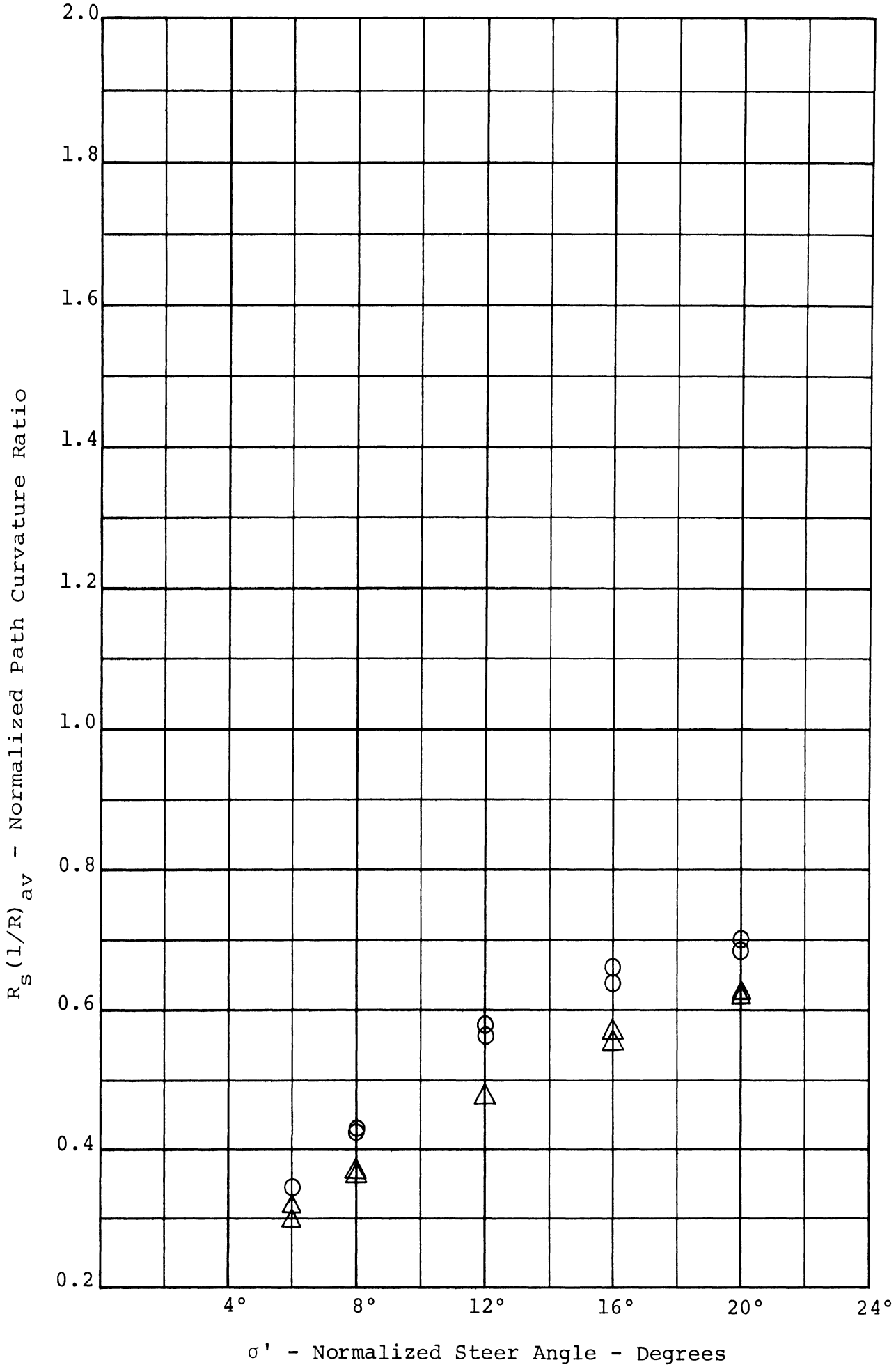
$R_s(1/R)_{ave}$ - Path Curvature Response Averaged Over Two Seconds and Ratioed to a Reference Path Curvature Deriving from a Steady Turn of 40 mph and 1.0g A_y

$\dot{\beta}_p$ - Peak Vehicle Sideslip Angular Rate

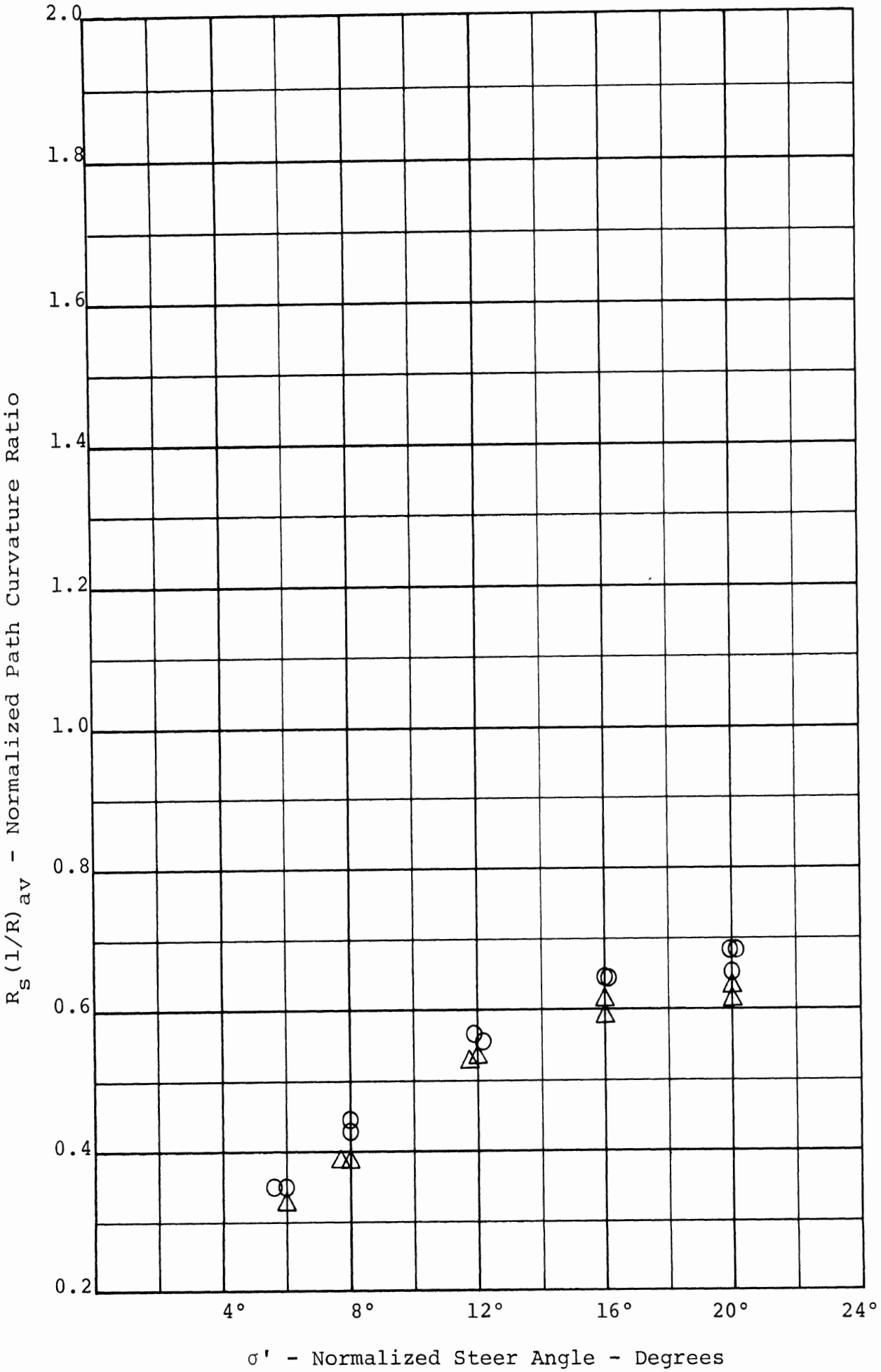
β_p - Peak Vehicle Sideslip Angle

Δ - Indicates Left Turn

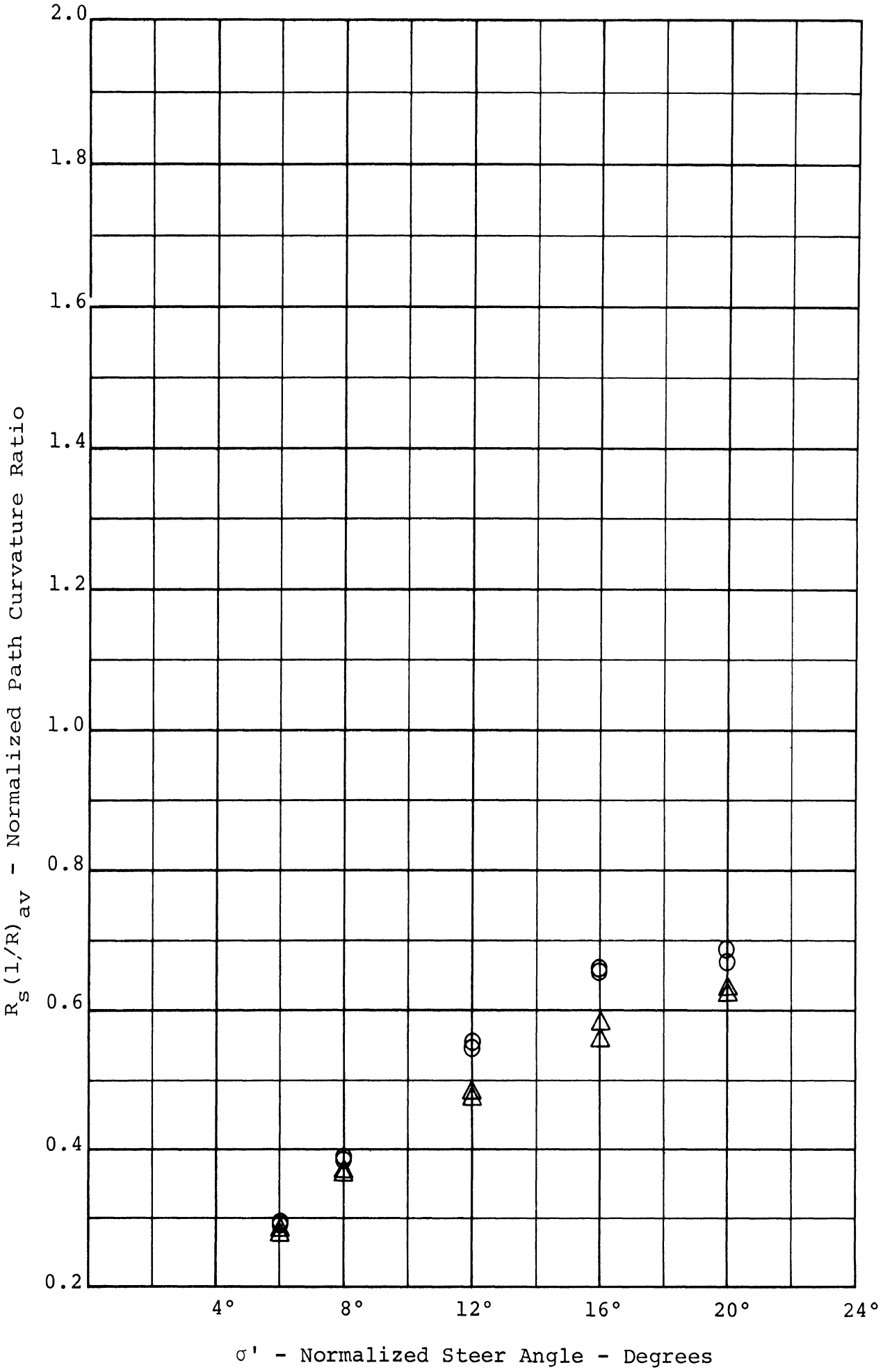
O - Indicates Right Turn



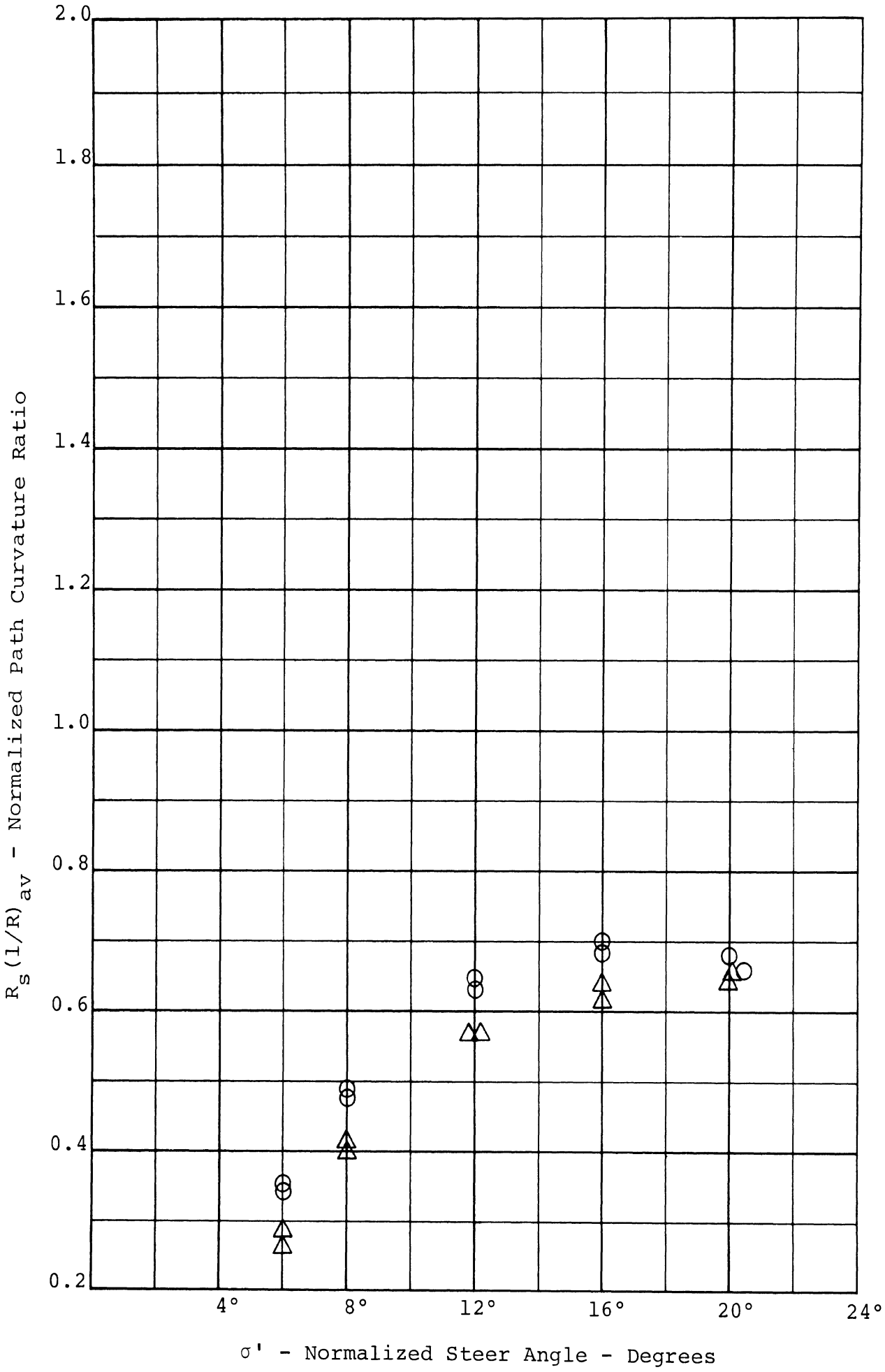
TRAPEZOIDAL STEER - AMBASSADOR [condition OE]



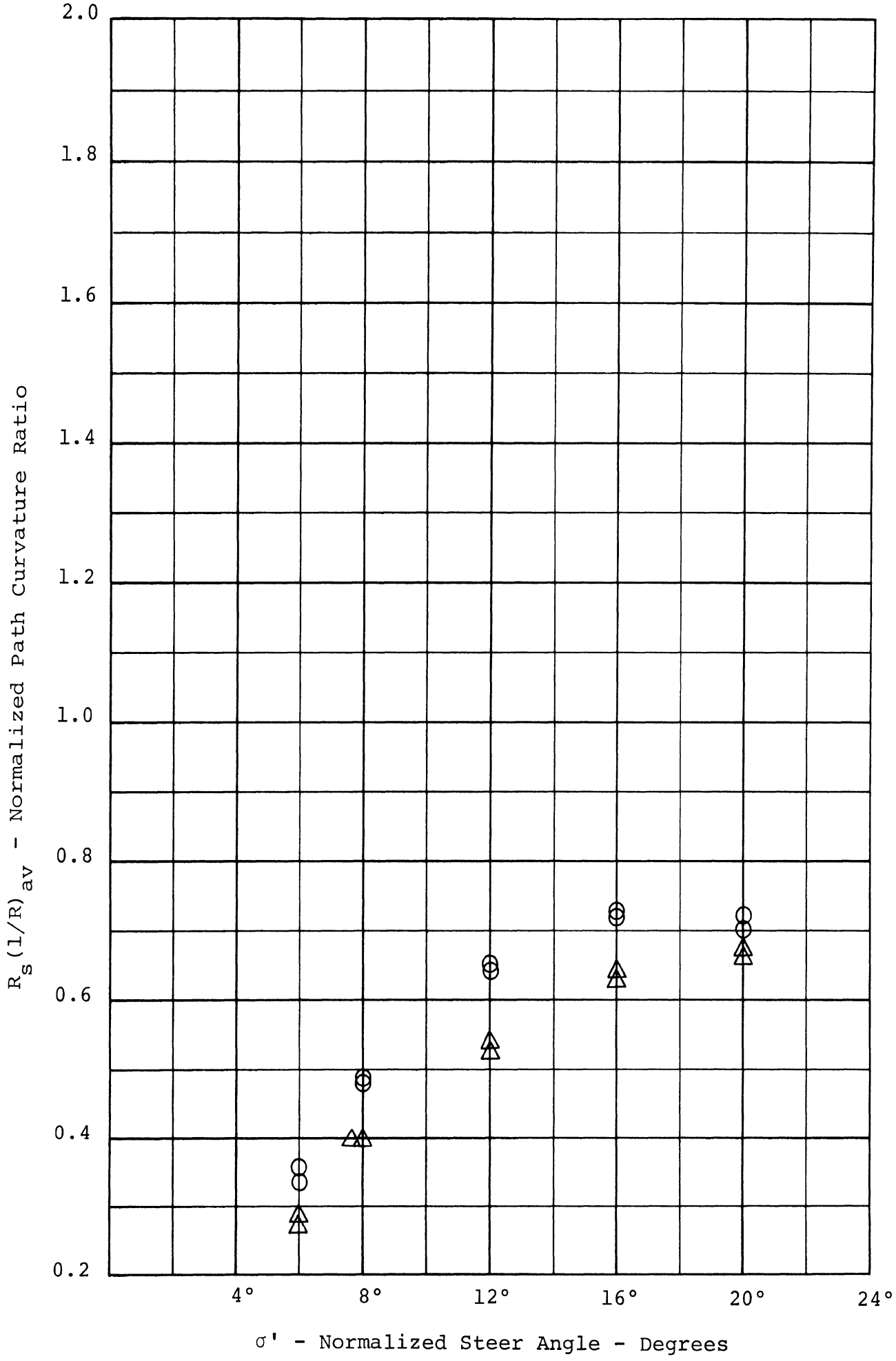
TRAPEZOIDAL STEER - AMBASSADOR [condition A1]



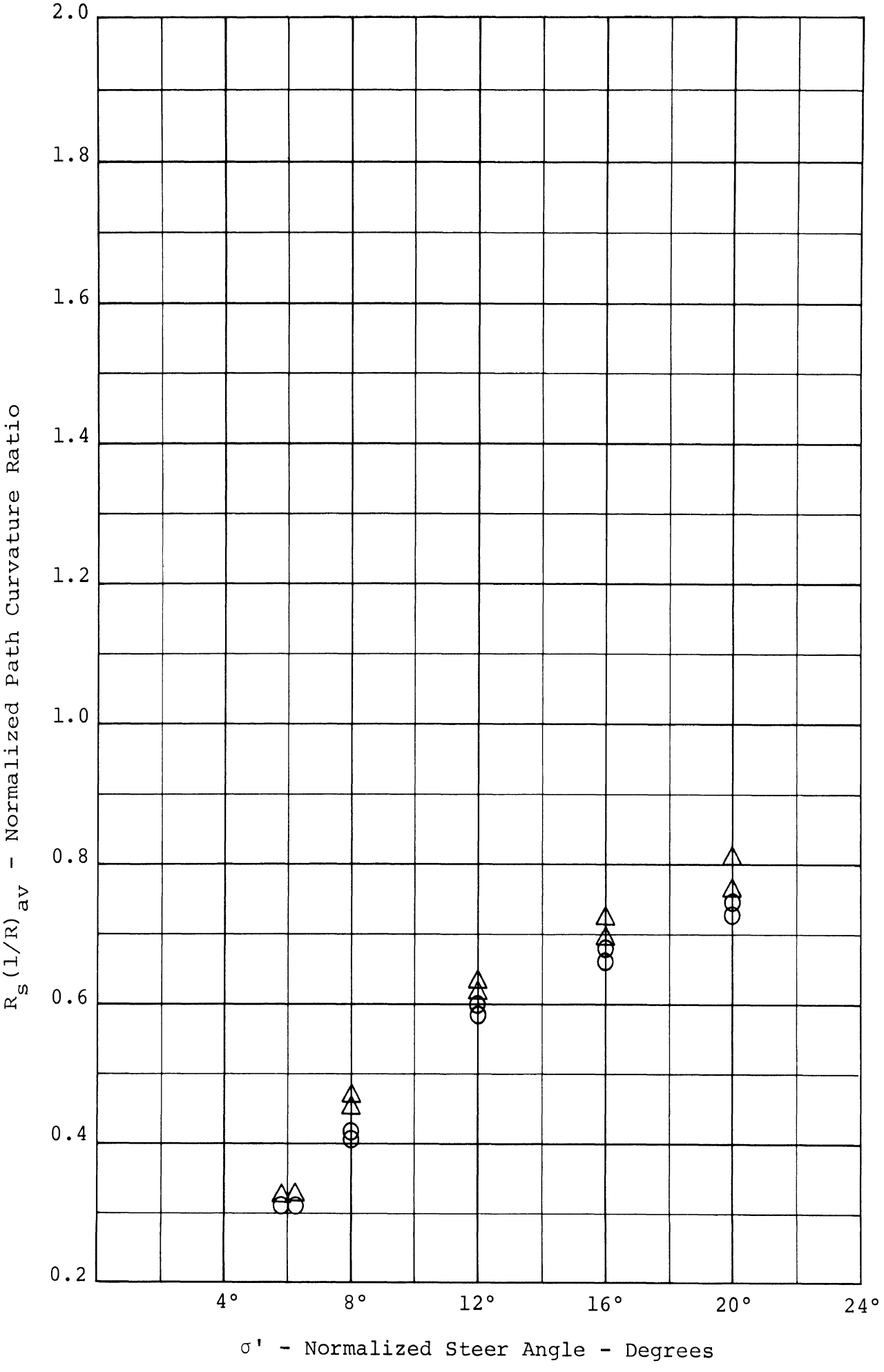
TRAPEZOIDAL STEER - AMBASSADOR [condition A2]



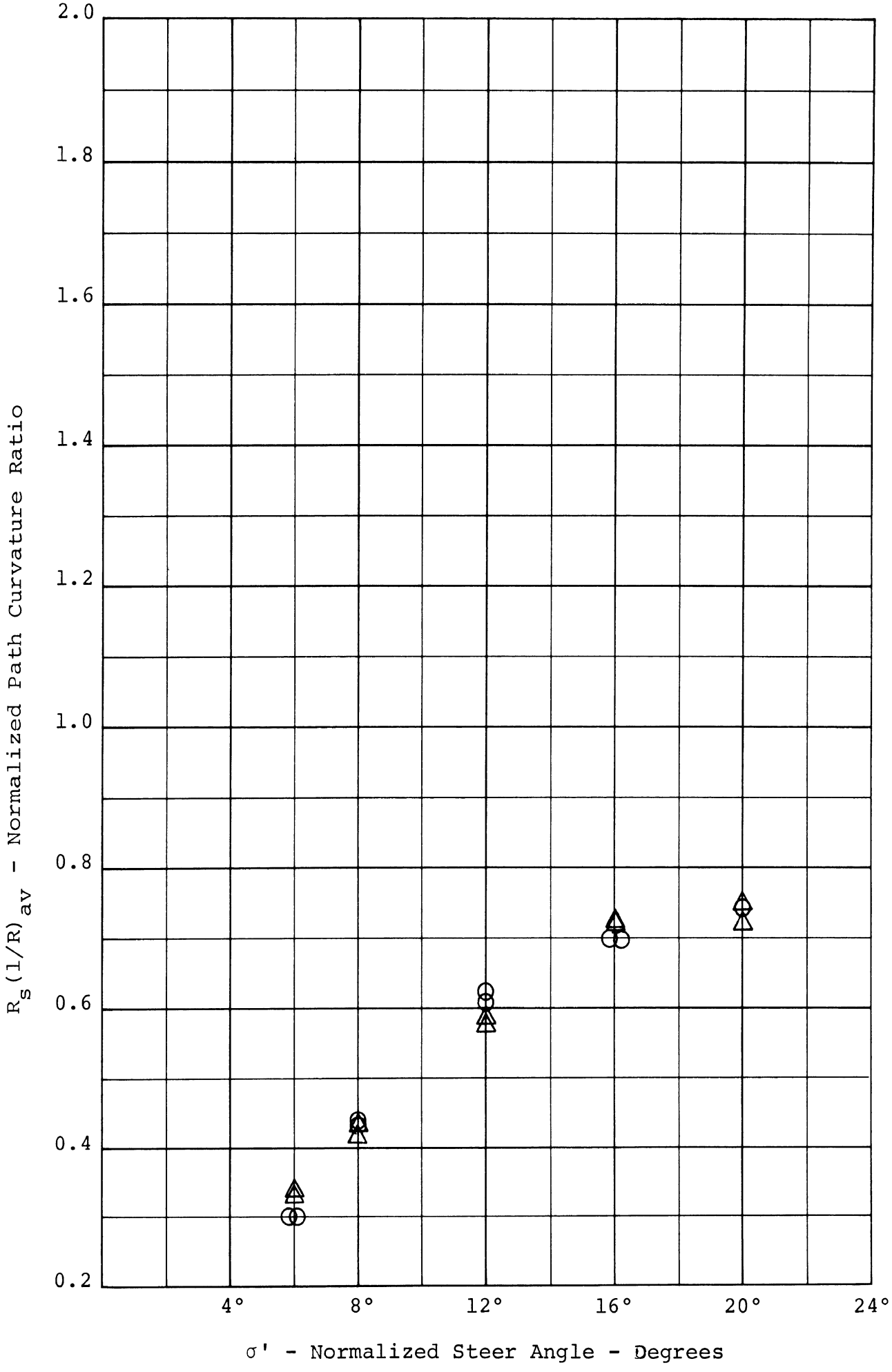
TRAPEZOIDAL STEER - AMBASSADOR [condition A3]



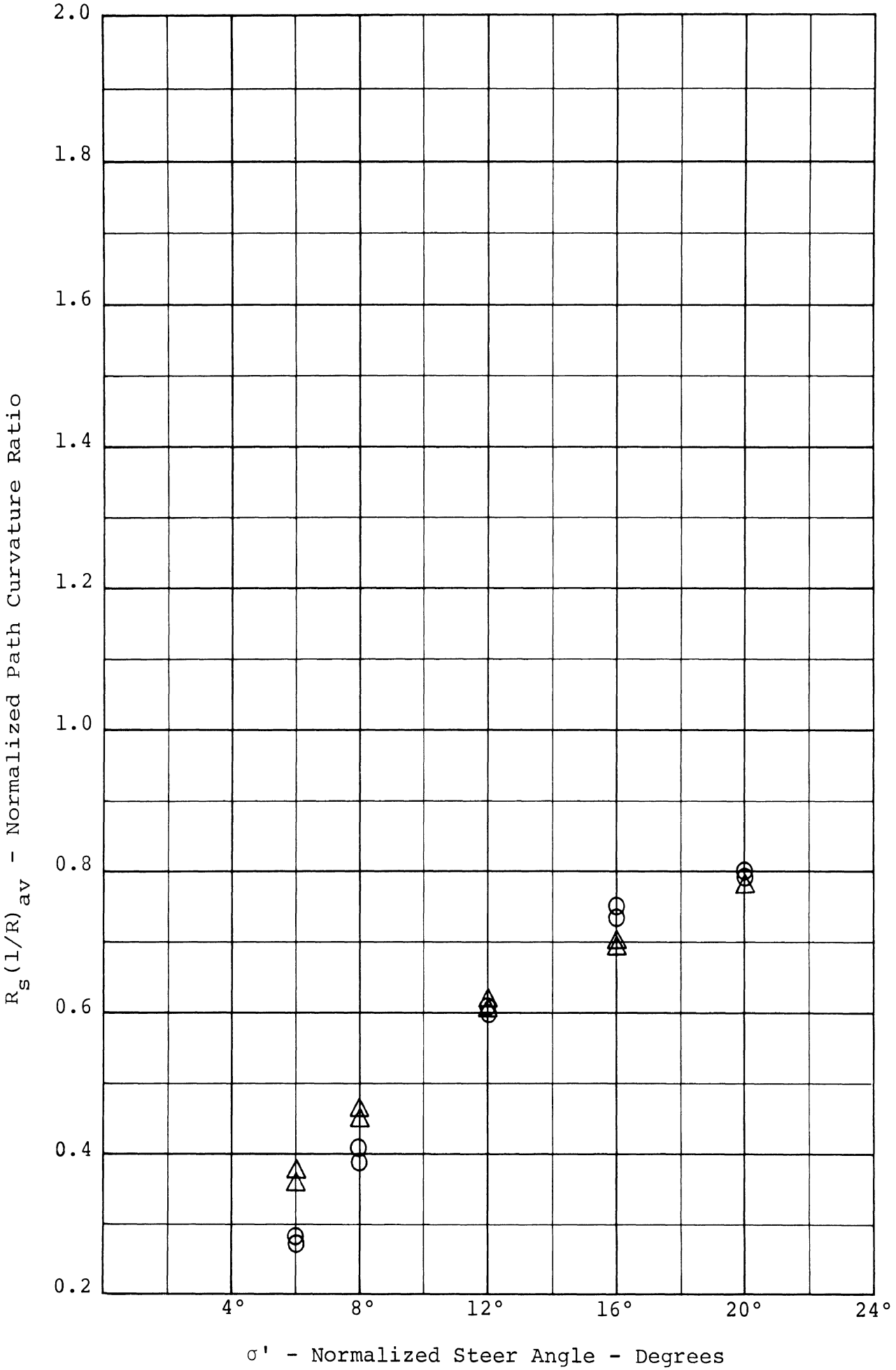
TRAPEZOIDAL STEER - AMBASSADOR [condition A4]



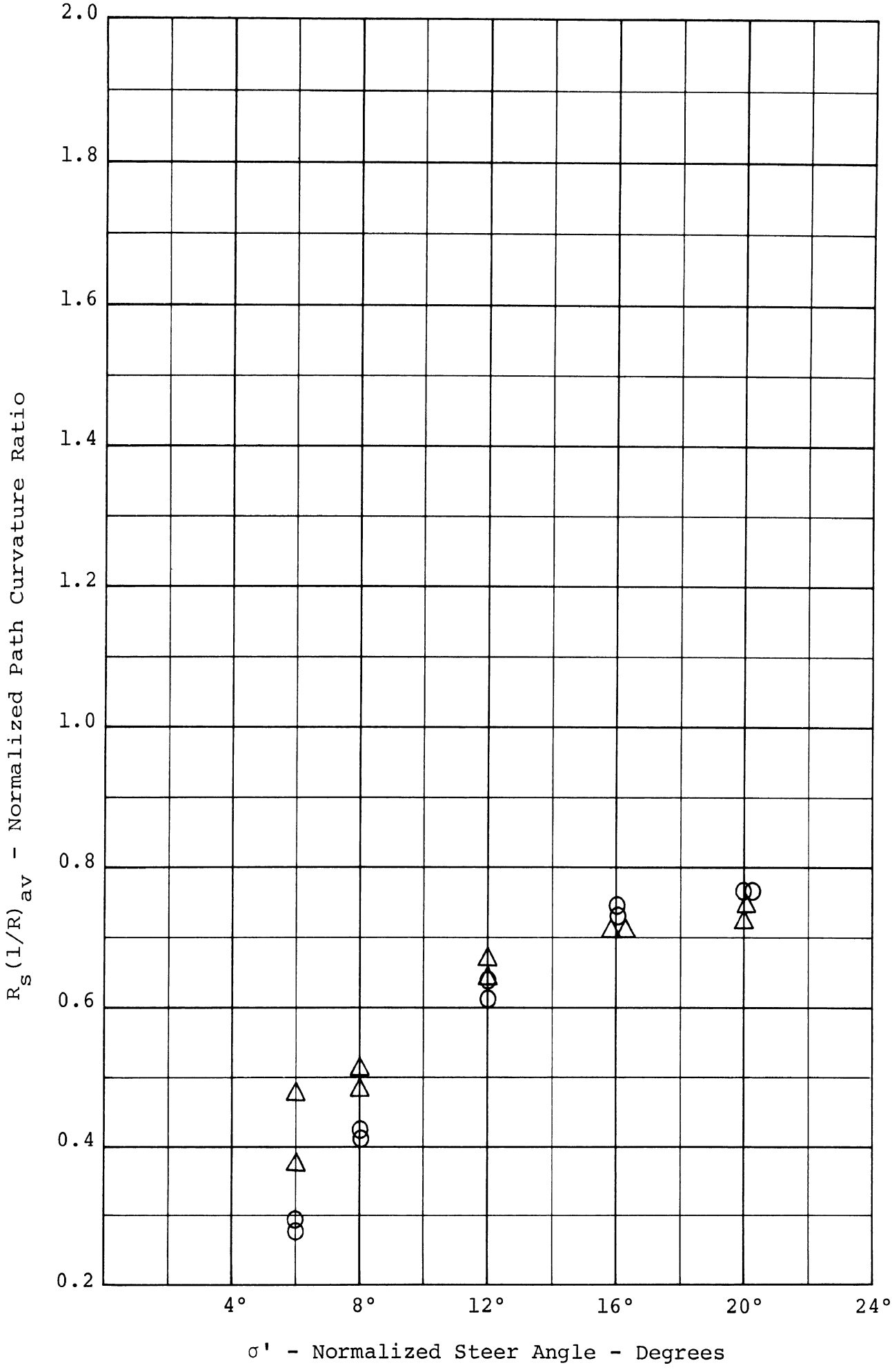
TRAPEZOIDAL STEER - DODGE [condition OE]



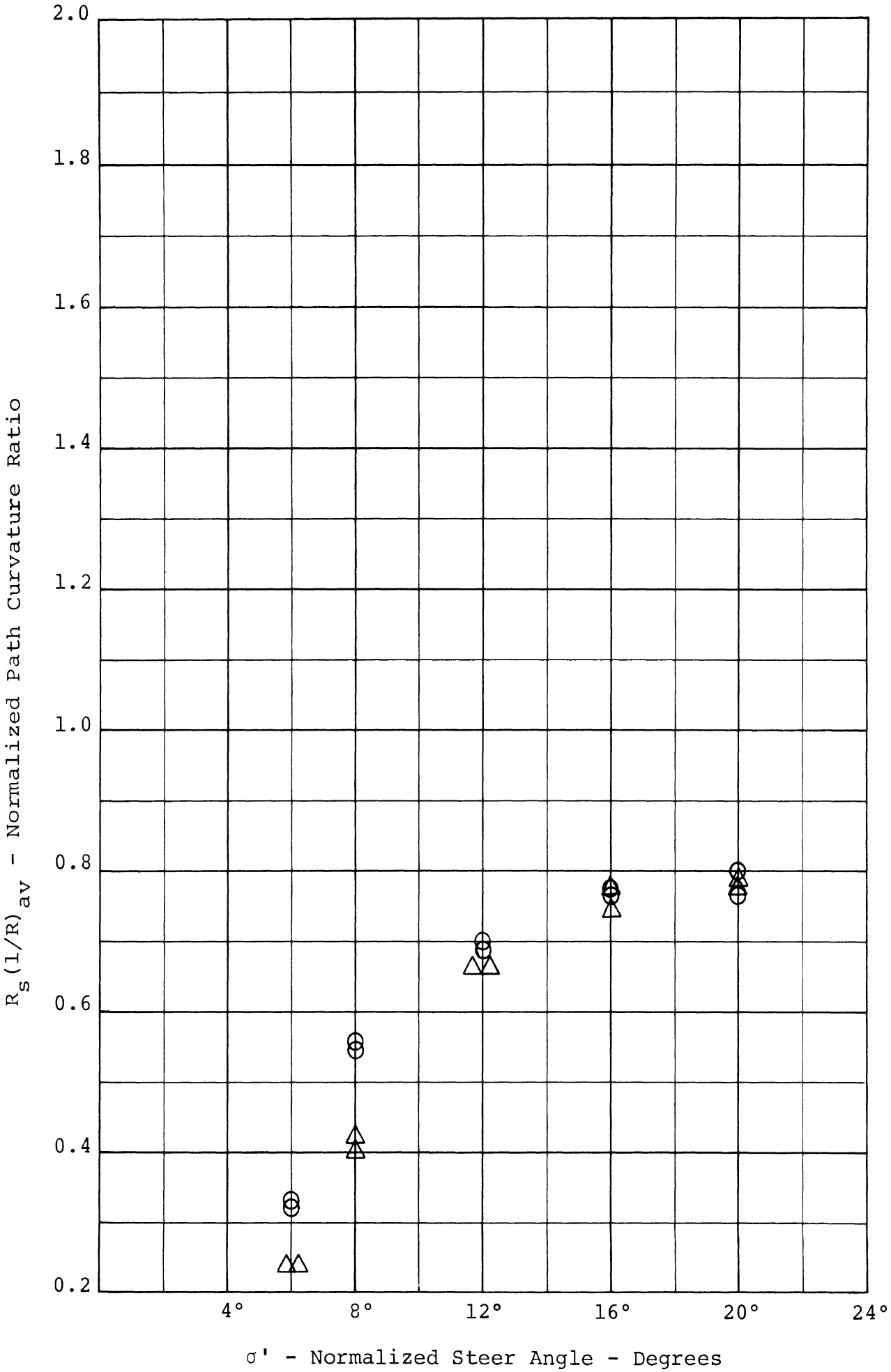
TRAPEZOIDAL STEER - DODGE [condition A1]



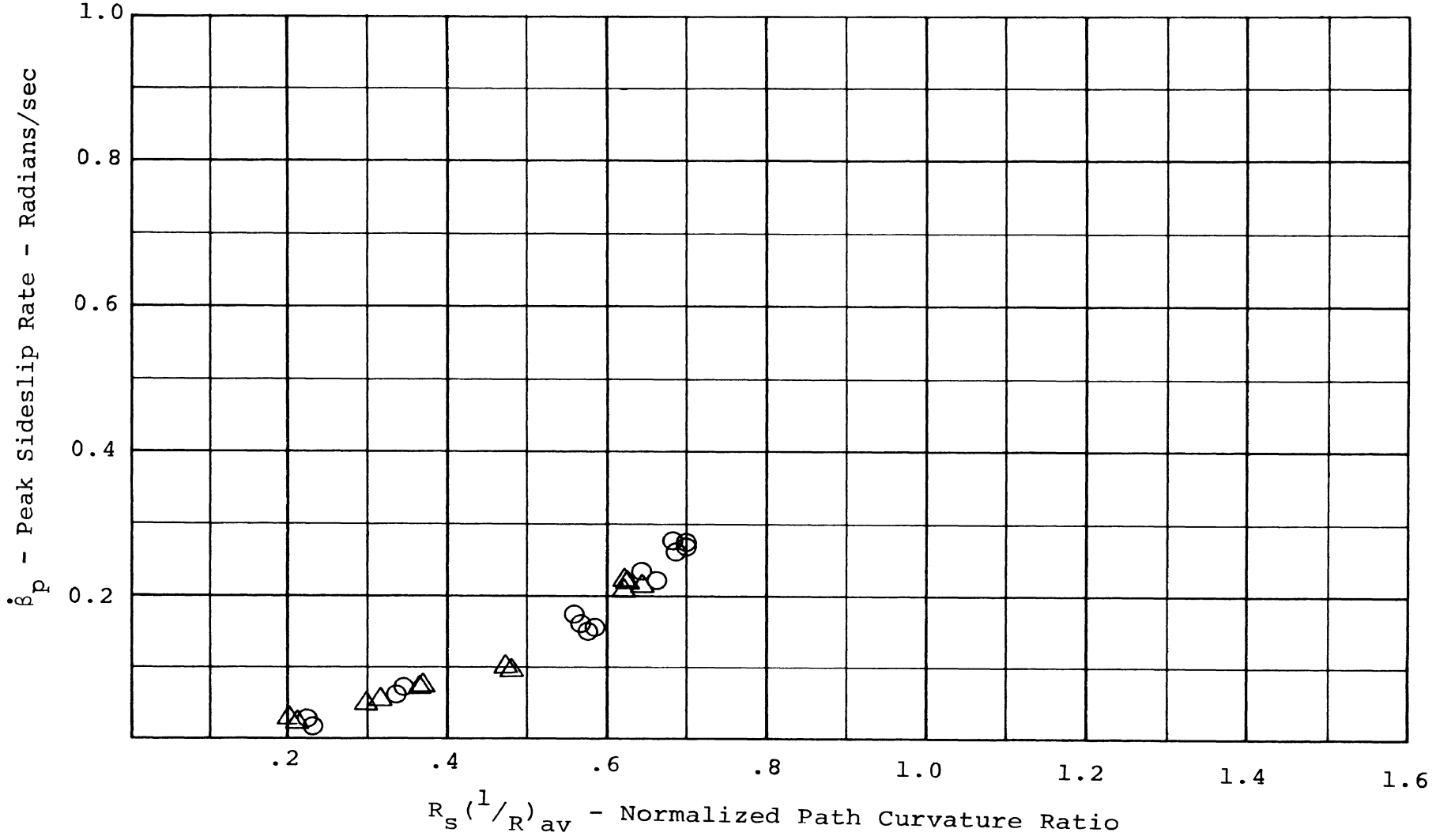
TRAPEZOIDAL STEER - DODGE [condition A2]



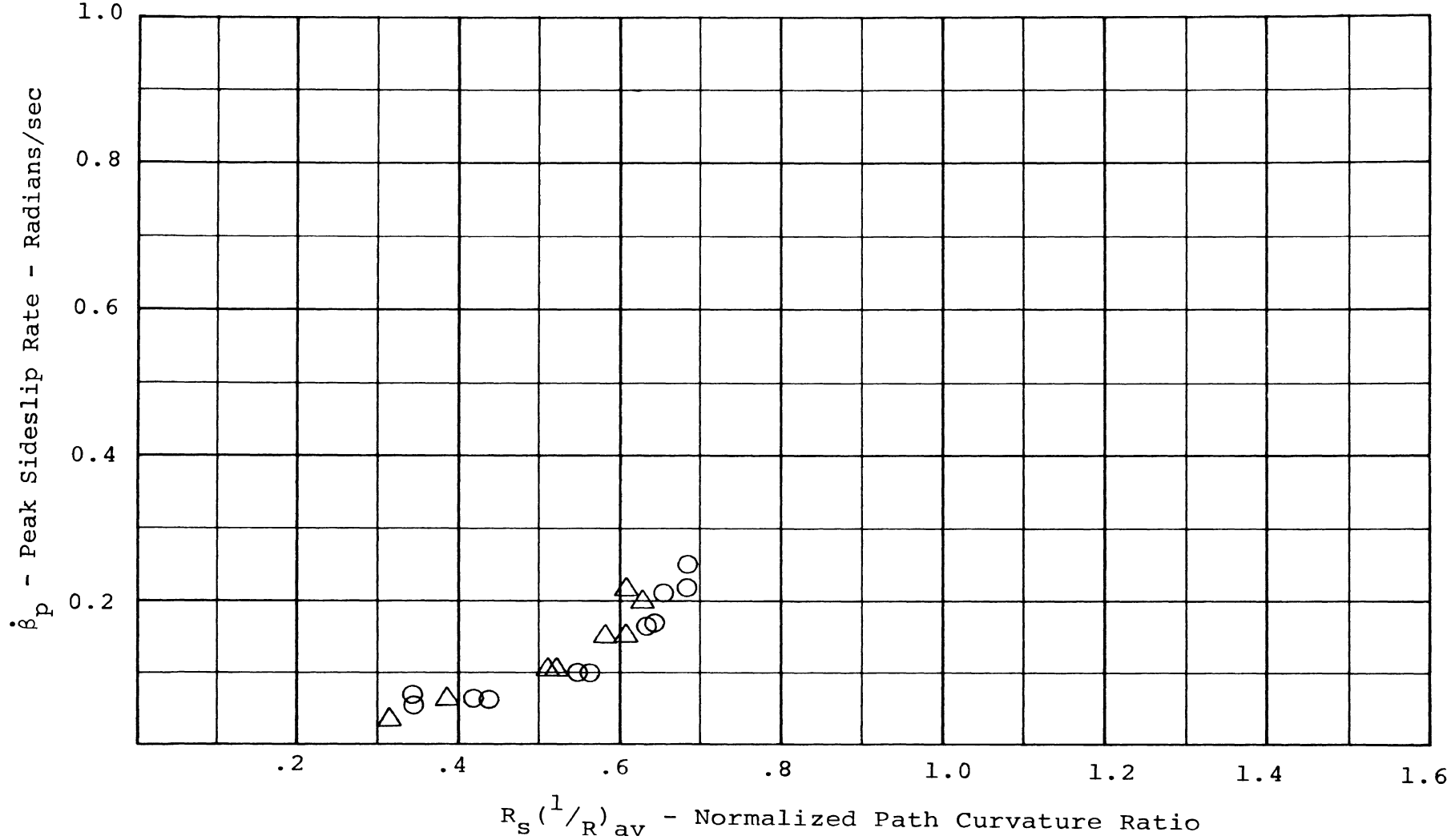
TRAPEZOIDAL STEER - DODGE [condition A3]



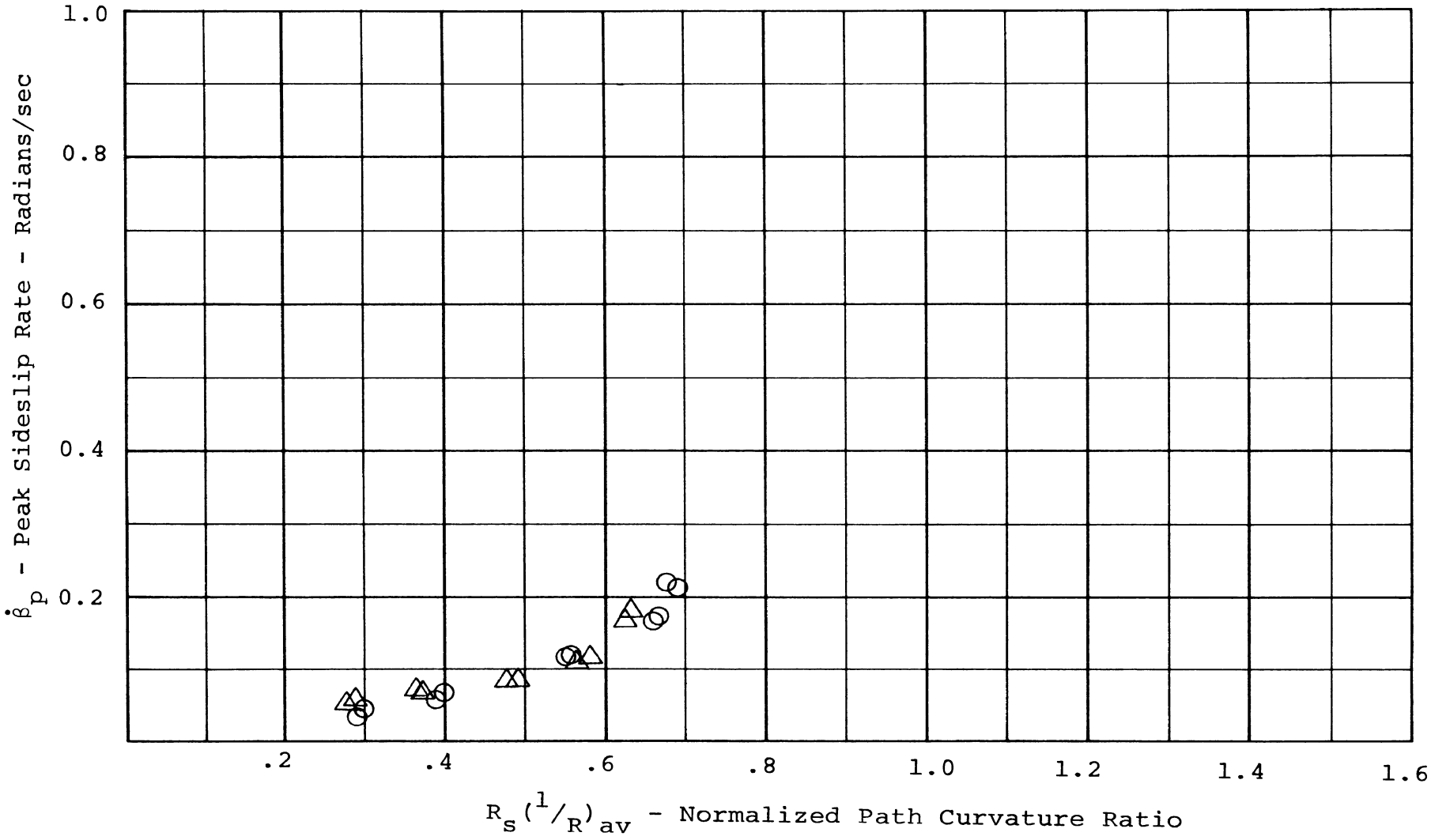
TRAPEZOIDAL STEER - DODGE [condition A4]



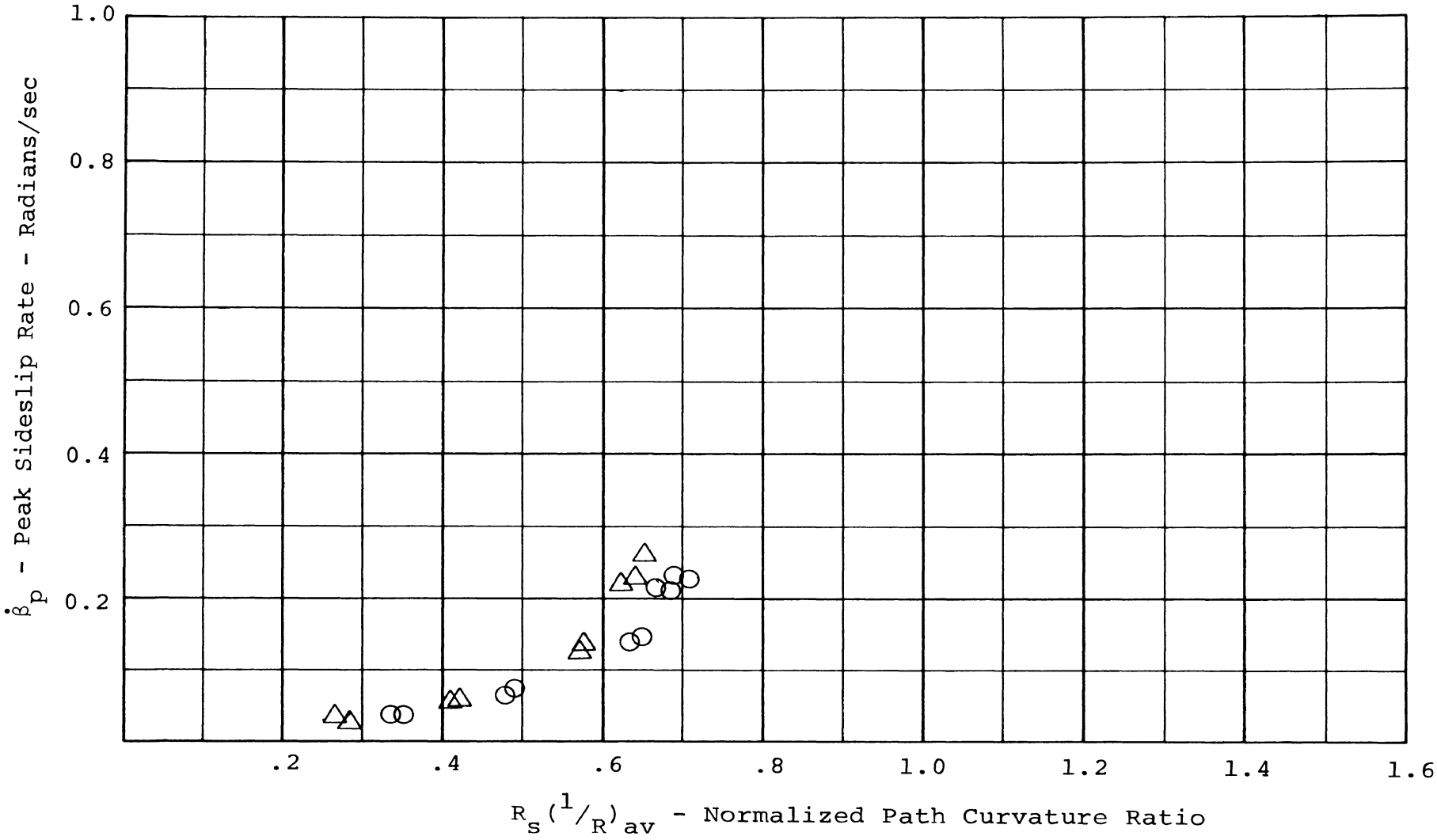
TRAPEZOIDAL STEER - AMBASSADOR [CONDITION - OE]



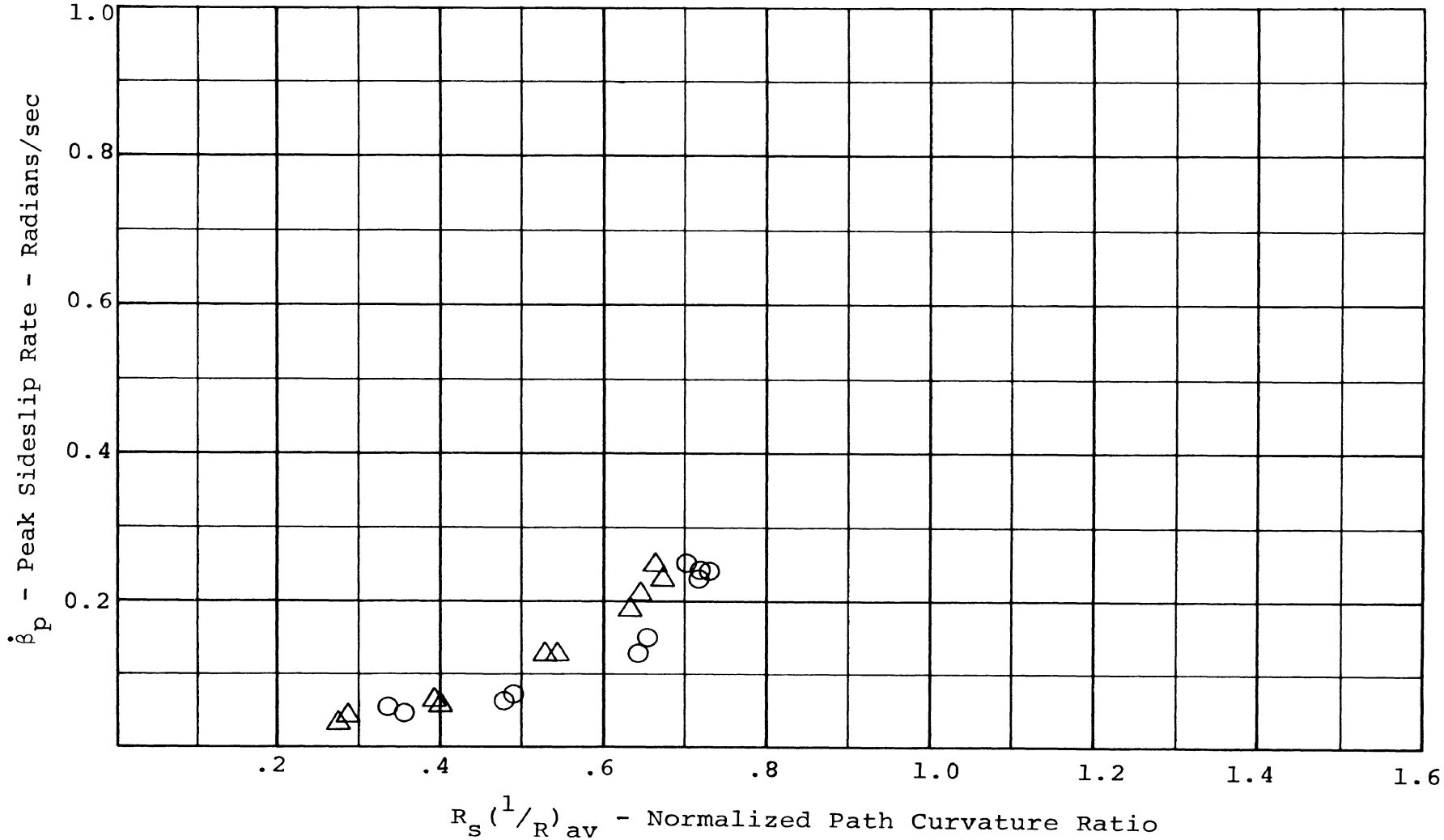
TRAPEZOIDAL STEER - AMBASSADOR [CONDITION - A-1]



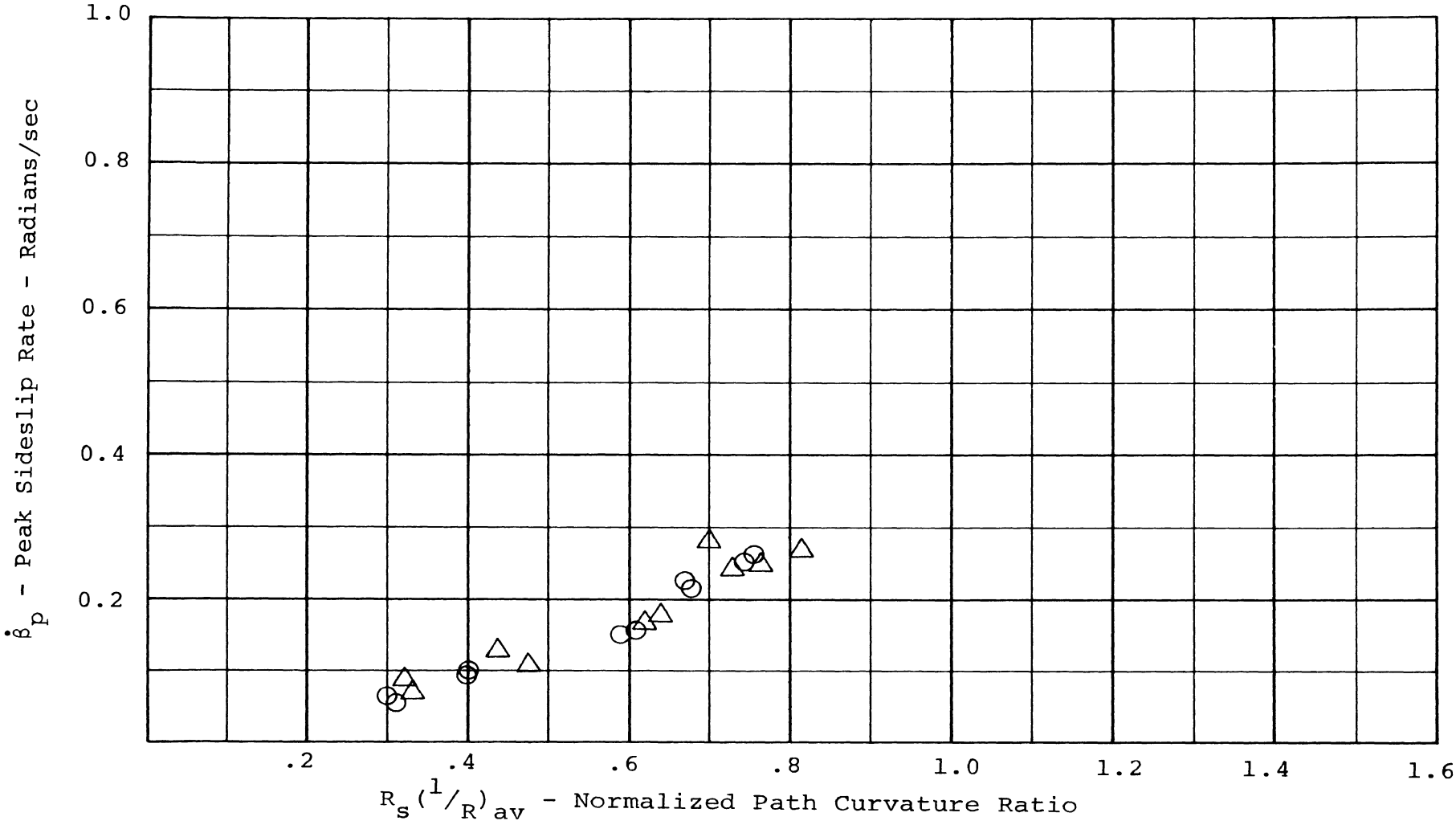
TRAPEZOIDAL STEER - AMBASSADOR [CONDITION - A-2]



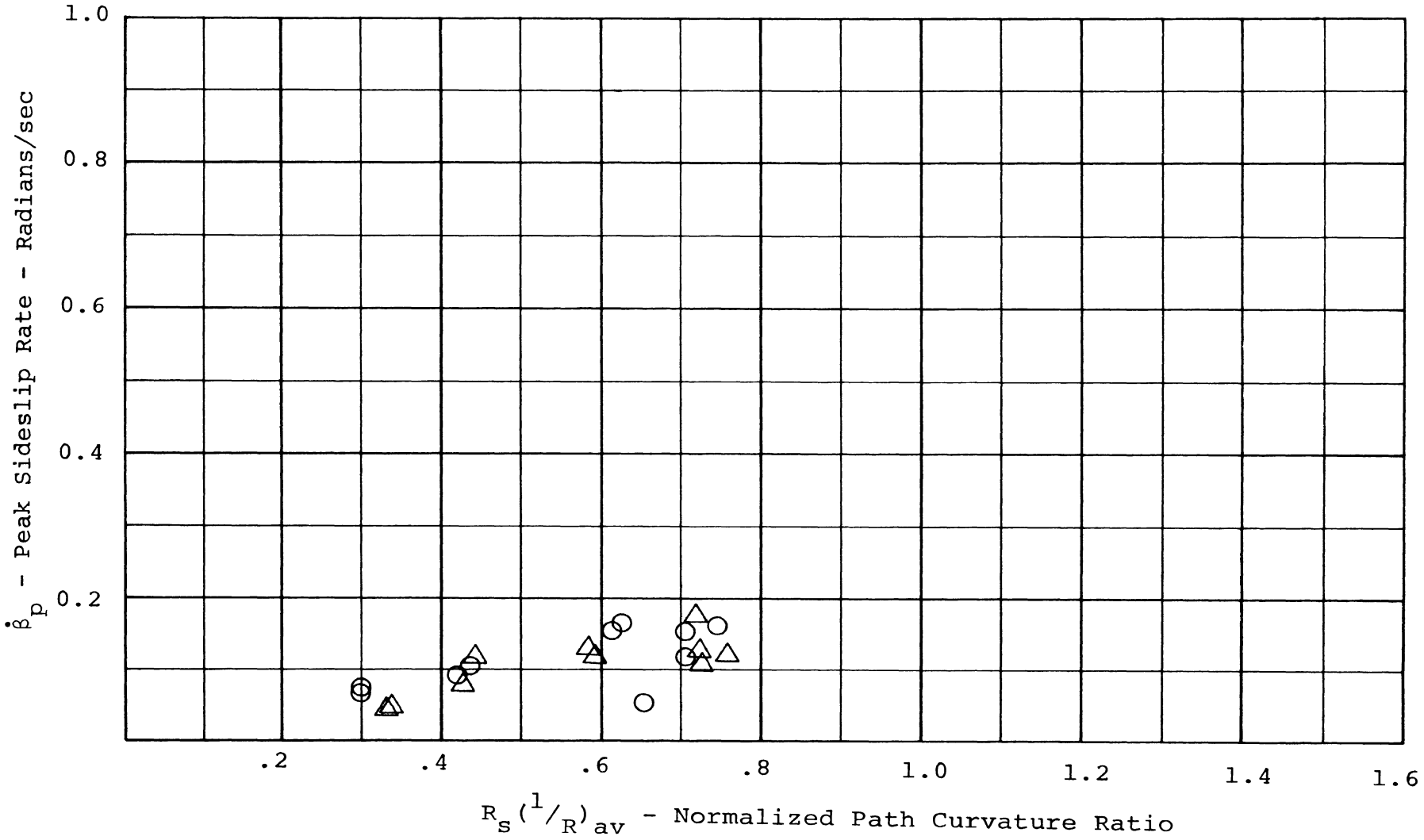
TRAPEZOIDAL STEER - AMBASSADOR [CONDITION - A-3]



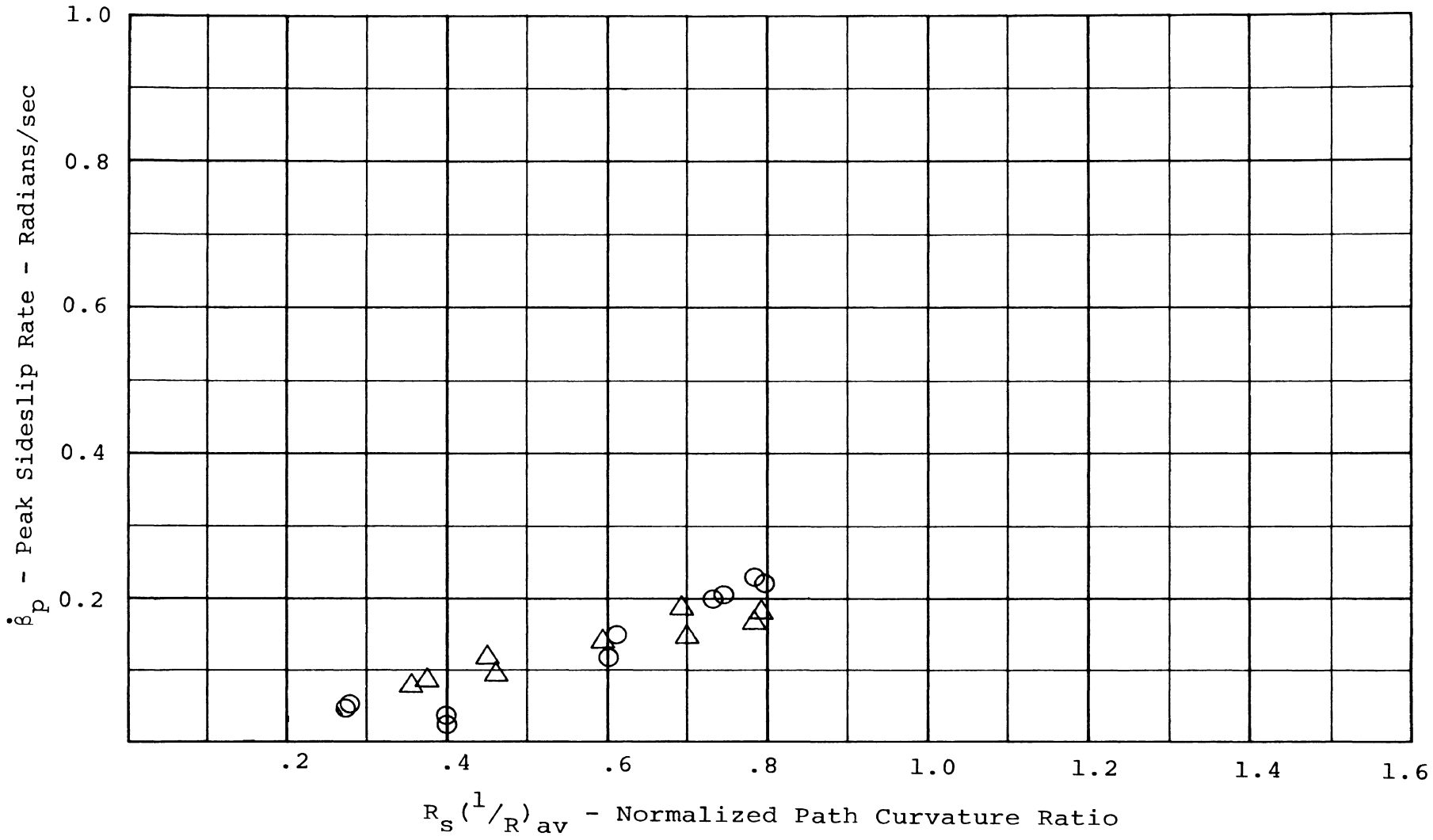
TRAPEZOIDAL STEER - AMBASSADOR [CONDITION - A-4]



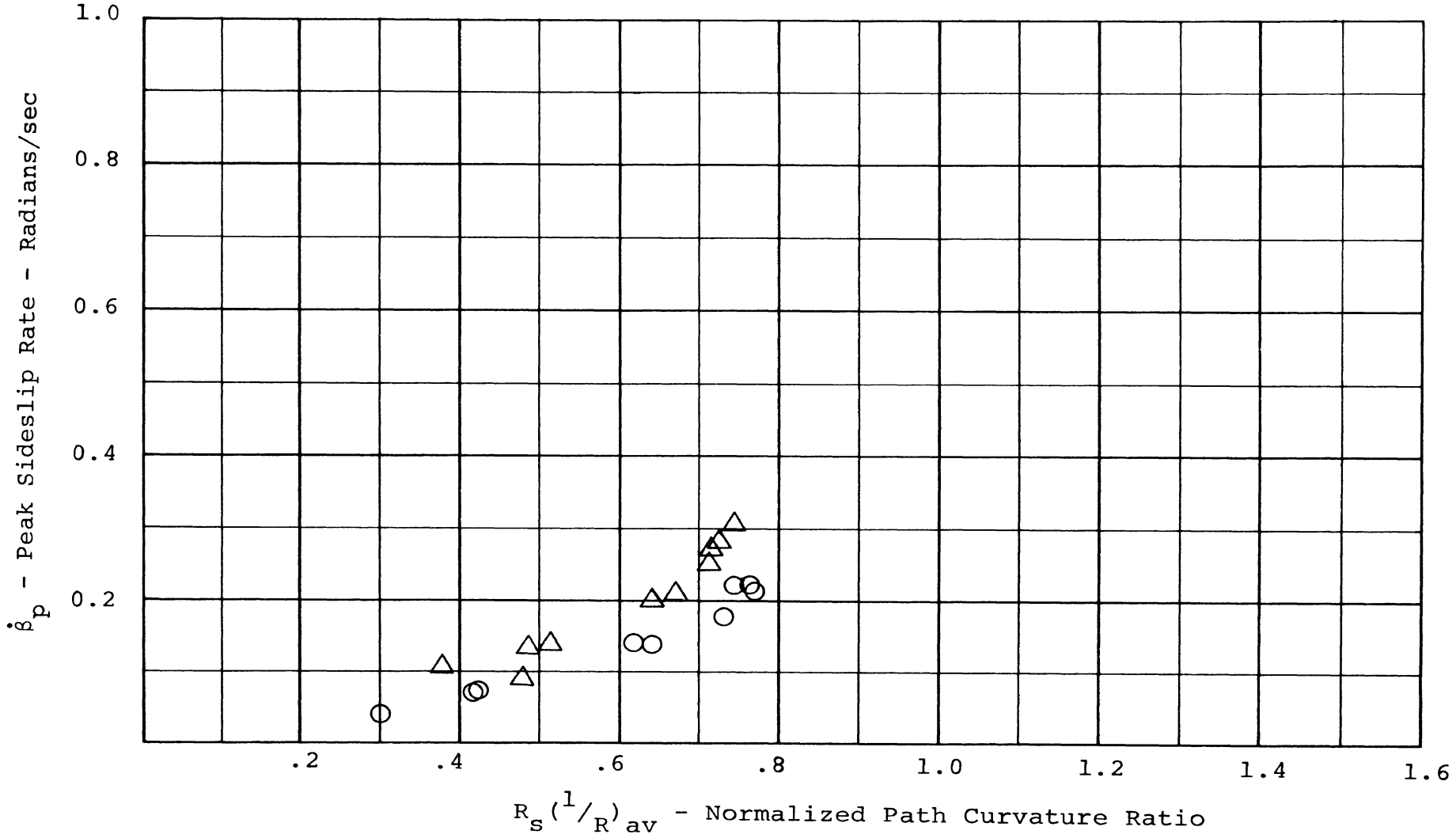
TRAPEZOIDAL STEER - DODGE [CONDITION - OE]



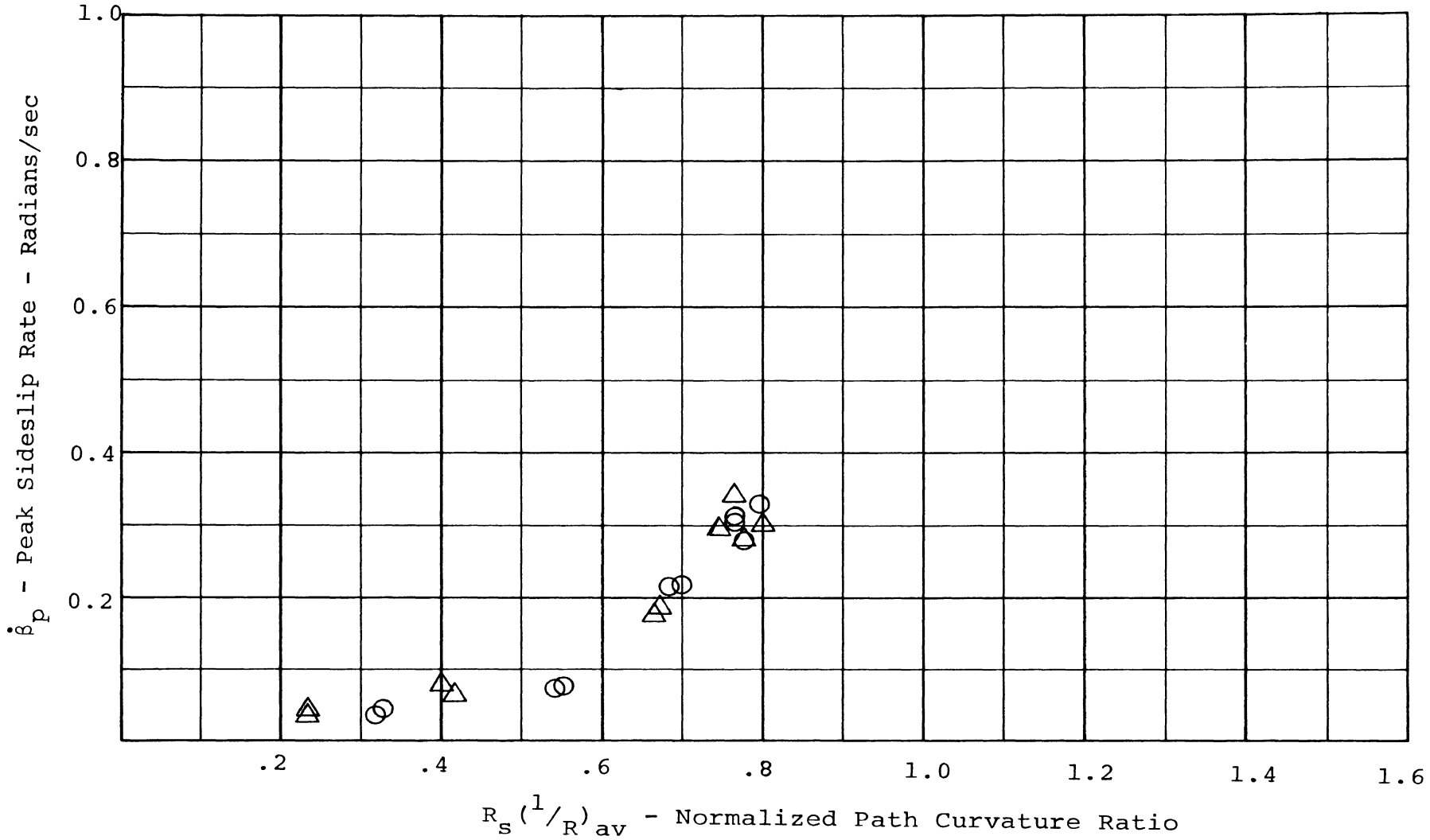
TRAPEZOIDAL STEER - DODGE [CONDITION - A-1]



TRAPEZOIDAL STEER - DODGE [CONDITION - A-2]



TRAPEZOIDAL STEER - DODGE [CONDITION - A-3]



TRAPEZOIDAL STEER - DODGE [CONDITION - A-4]

VHTP #5 - SINUSOIDAL STEER

$\Delta\psi$ - Vehicle Heading Angle Deviation After 3.4 Seconds

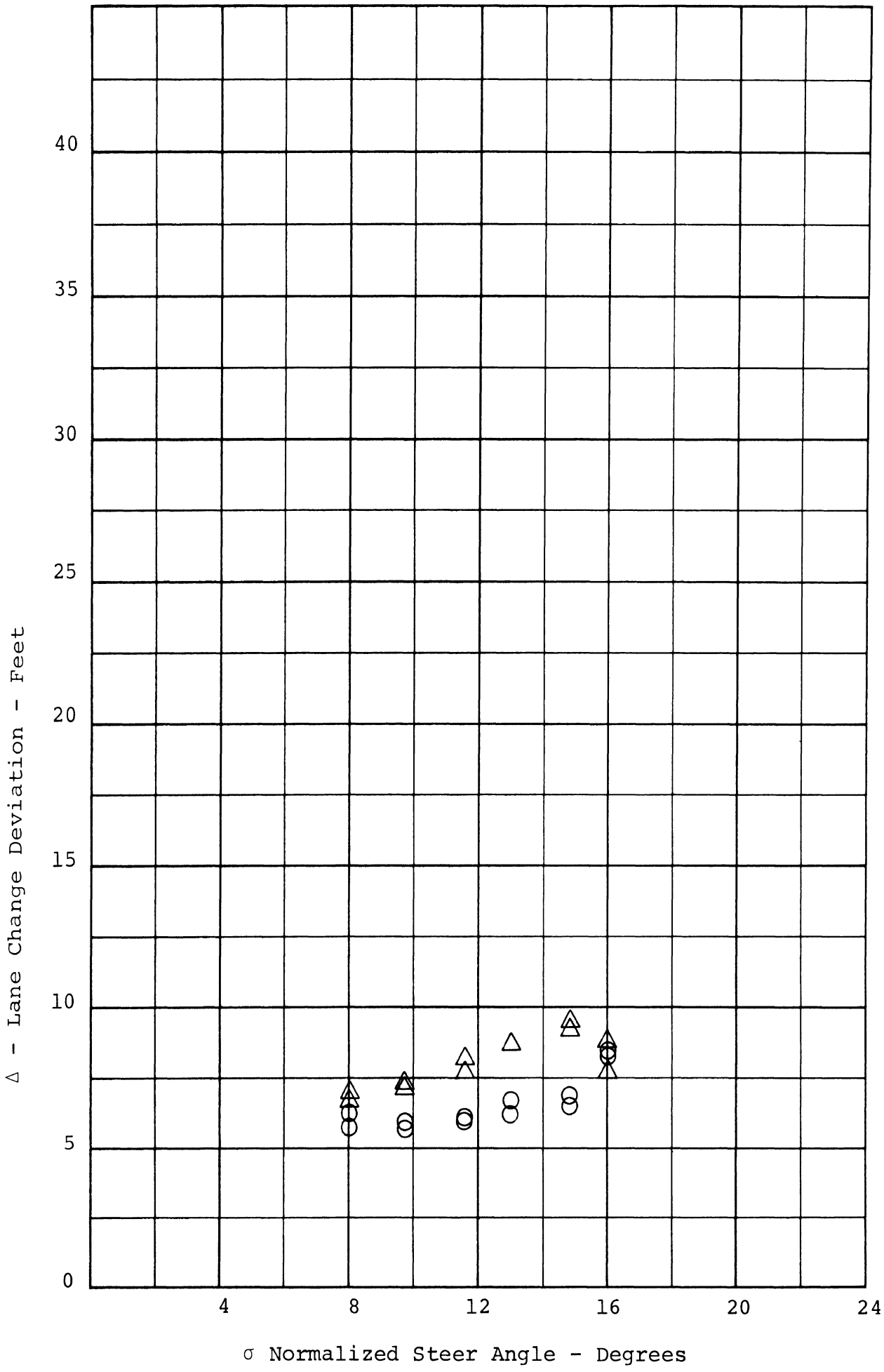
σ - Normalized Steer Angle, or Nominal Front Wheel Steer Angle

Δ - Lane Change Deviation from "Ideal" Lane Change Displacement

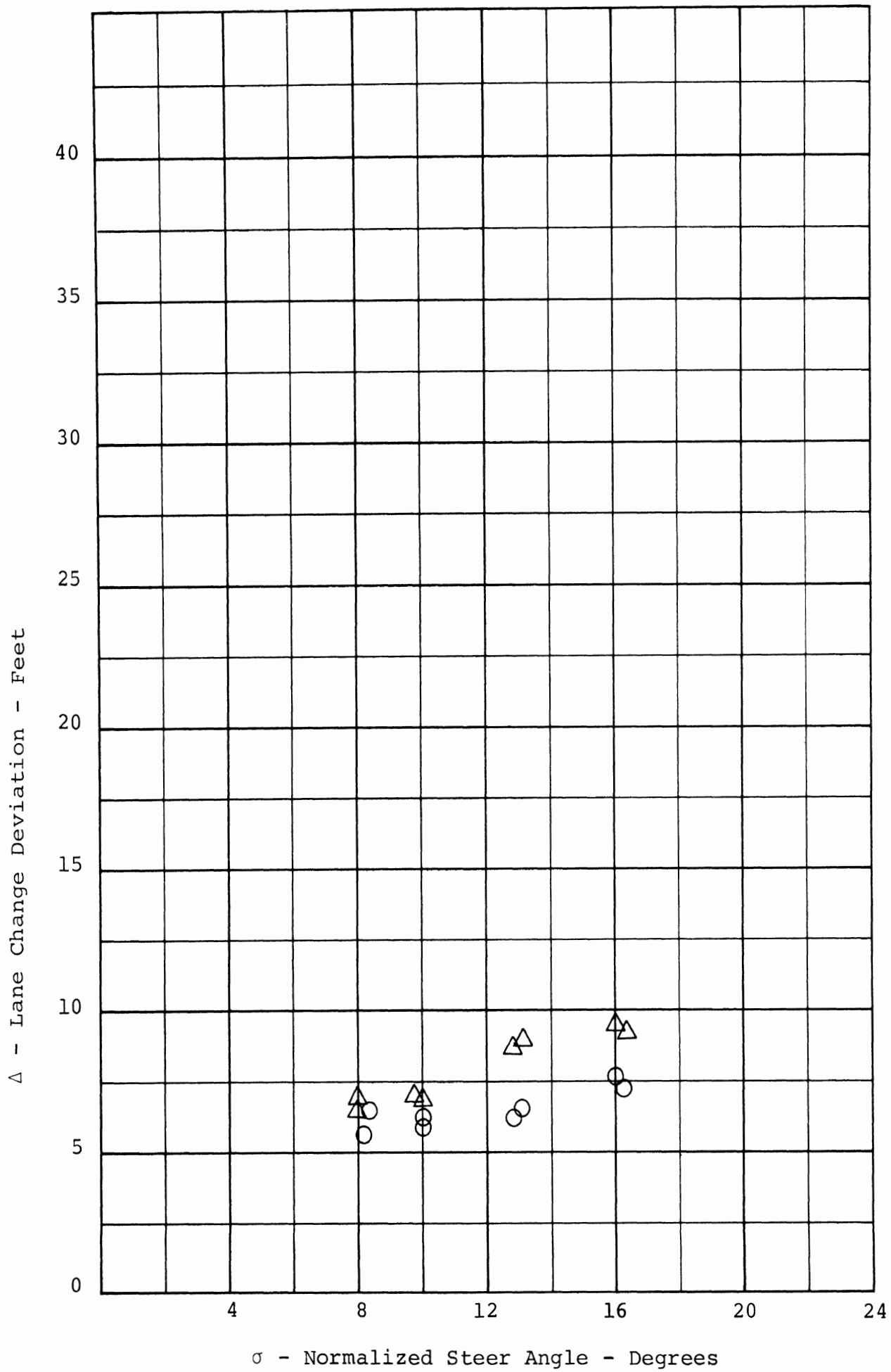
β_p - Peak Sideslip Angle

Δ - Indicates Sine Steer Input is of "Initially Left" polarity

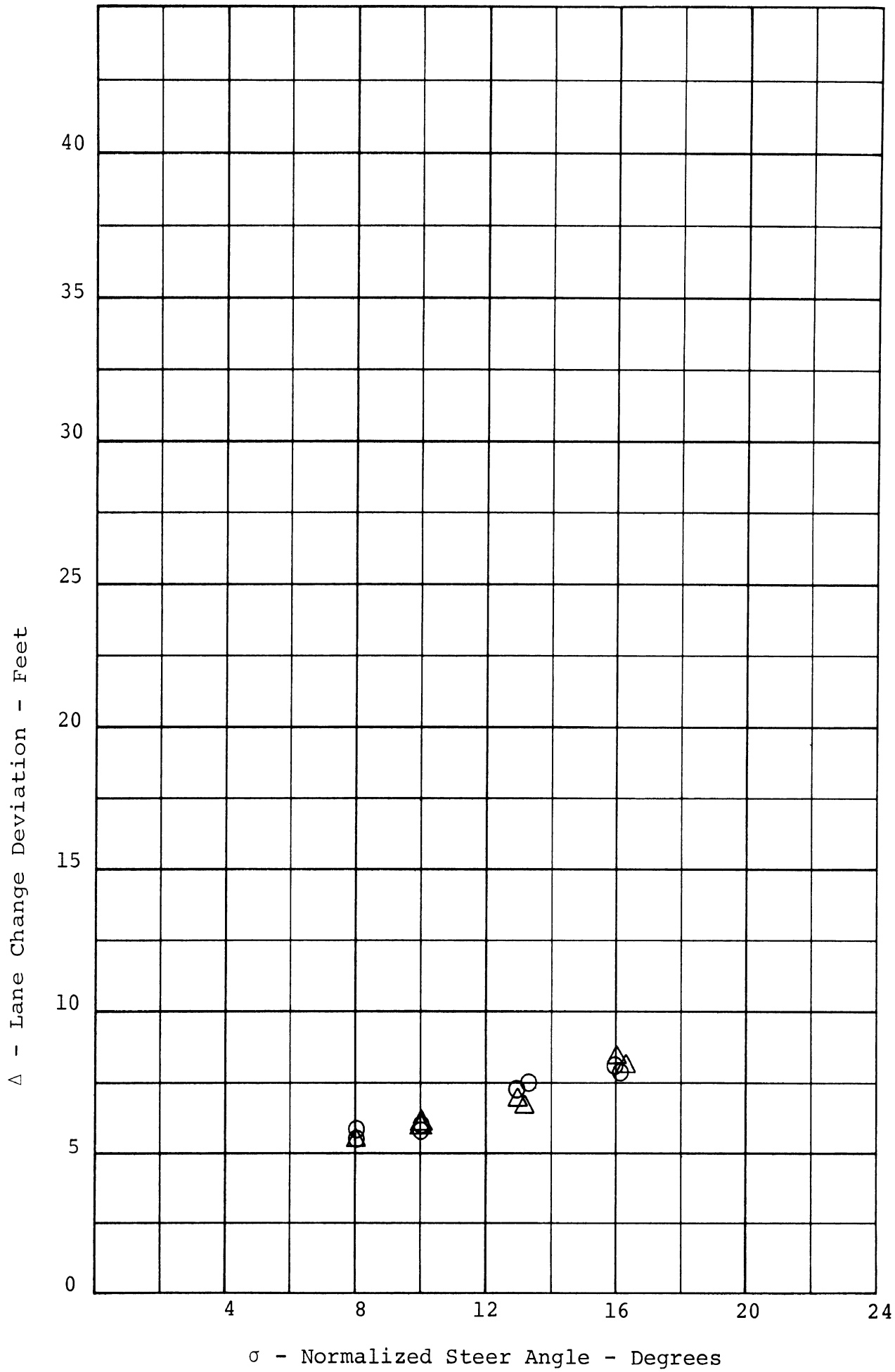
O - Indicates Sine Steer Input is of "Initially Right" polarity



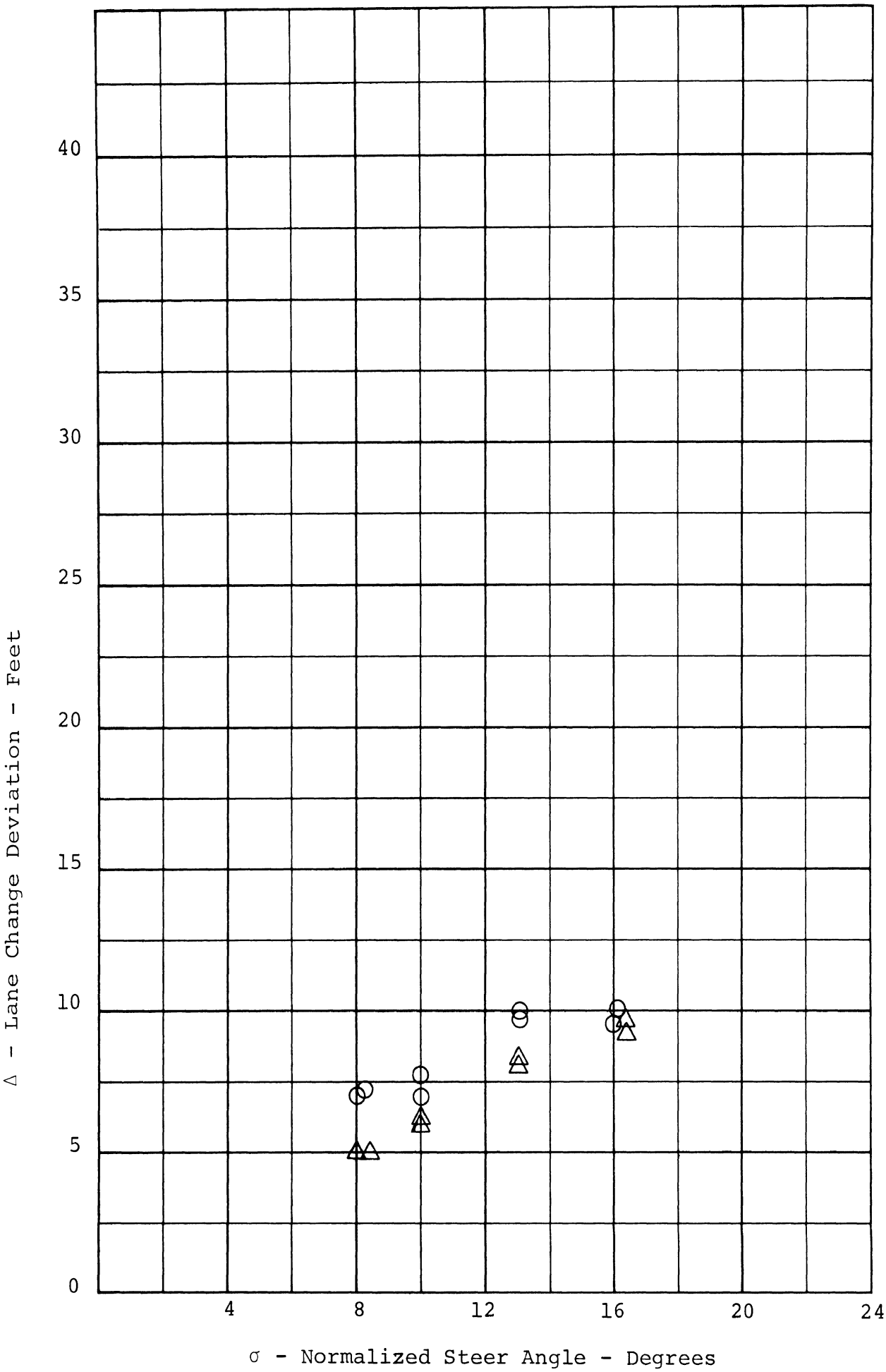
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition OE]



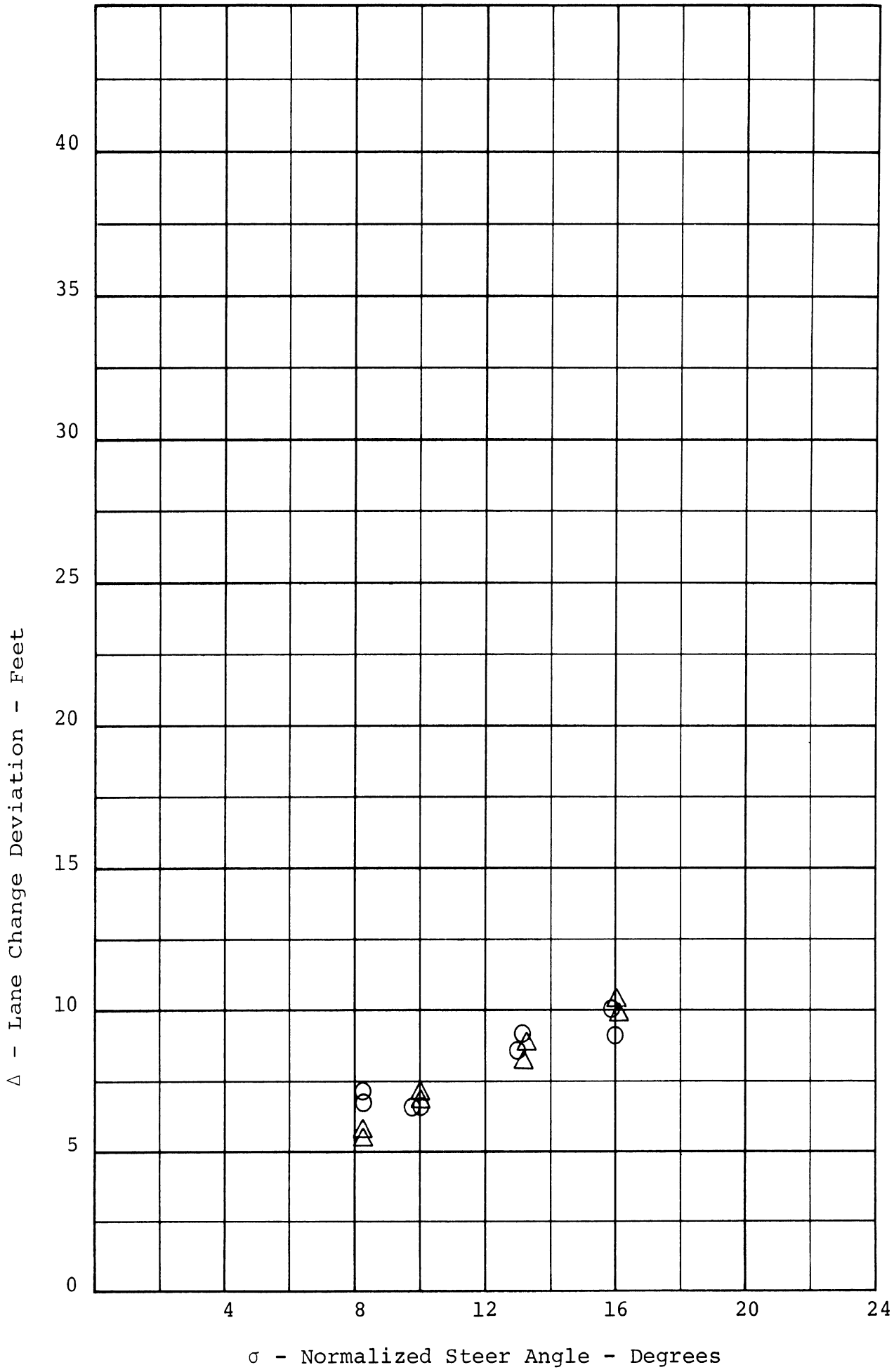
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A1]



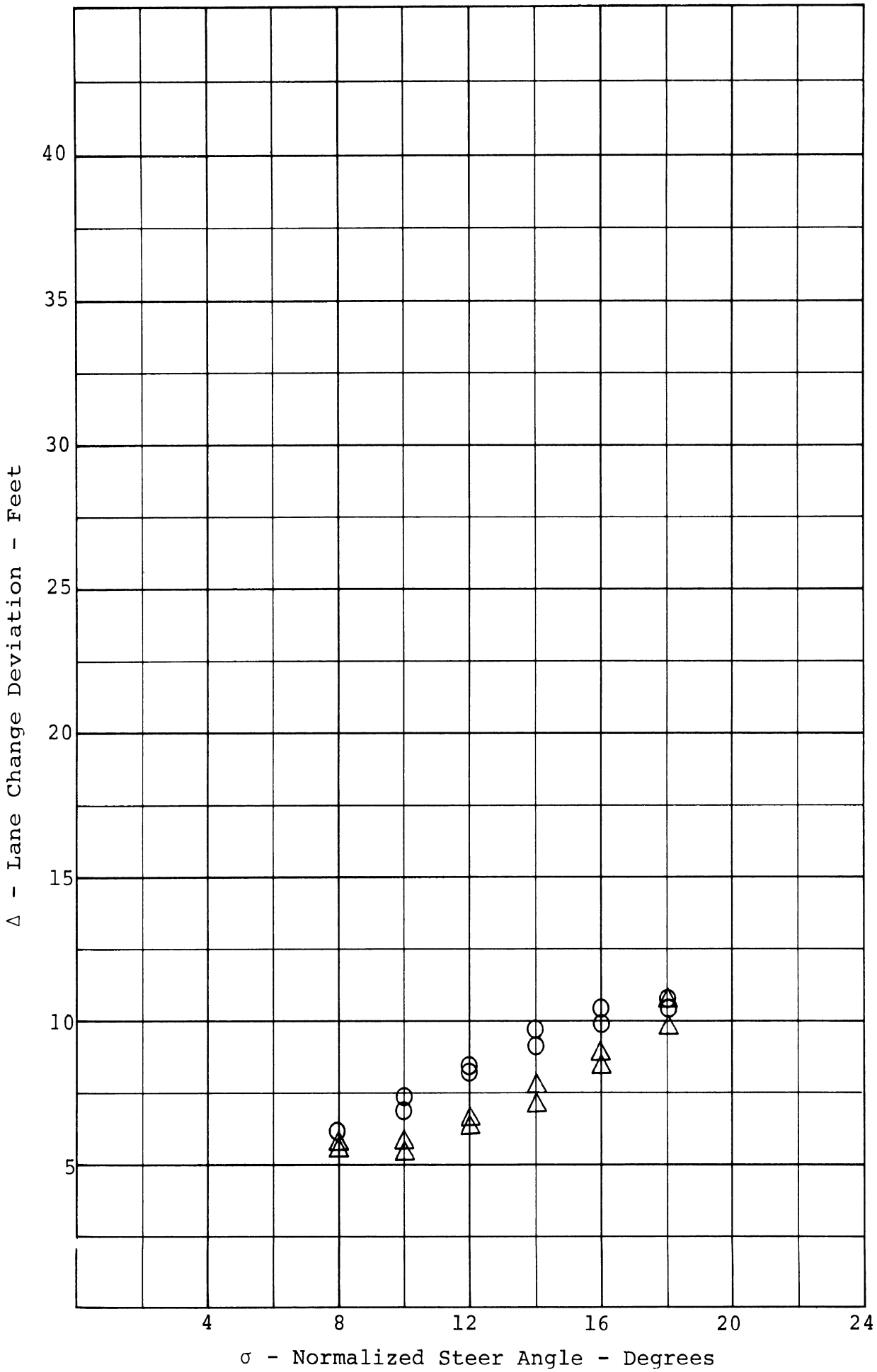
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A2]



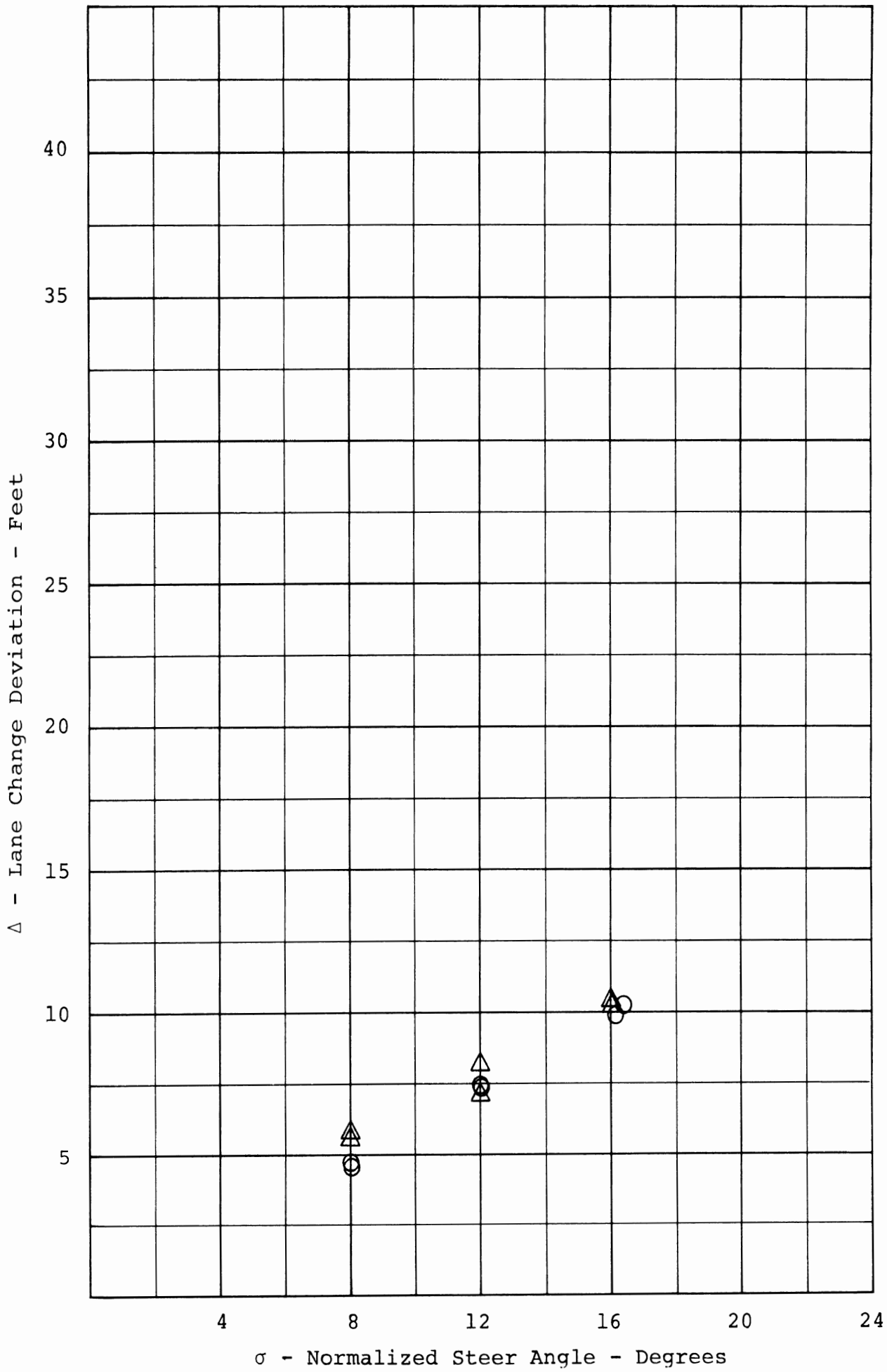
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A3]



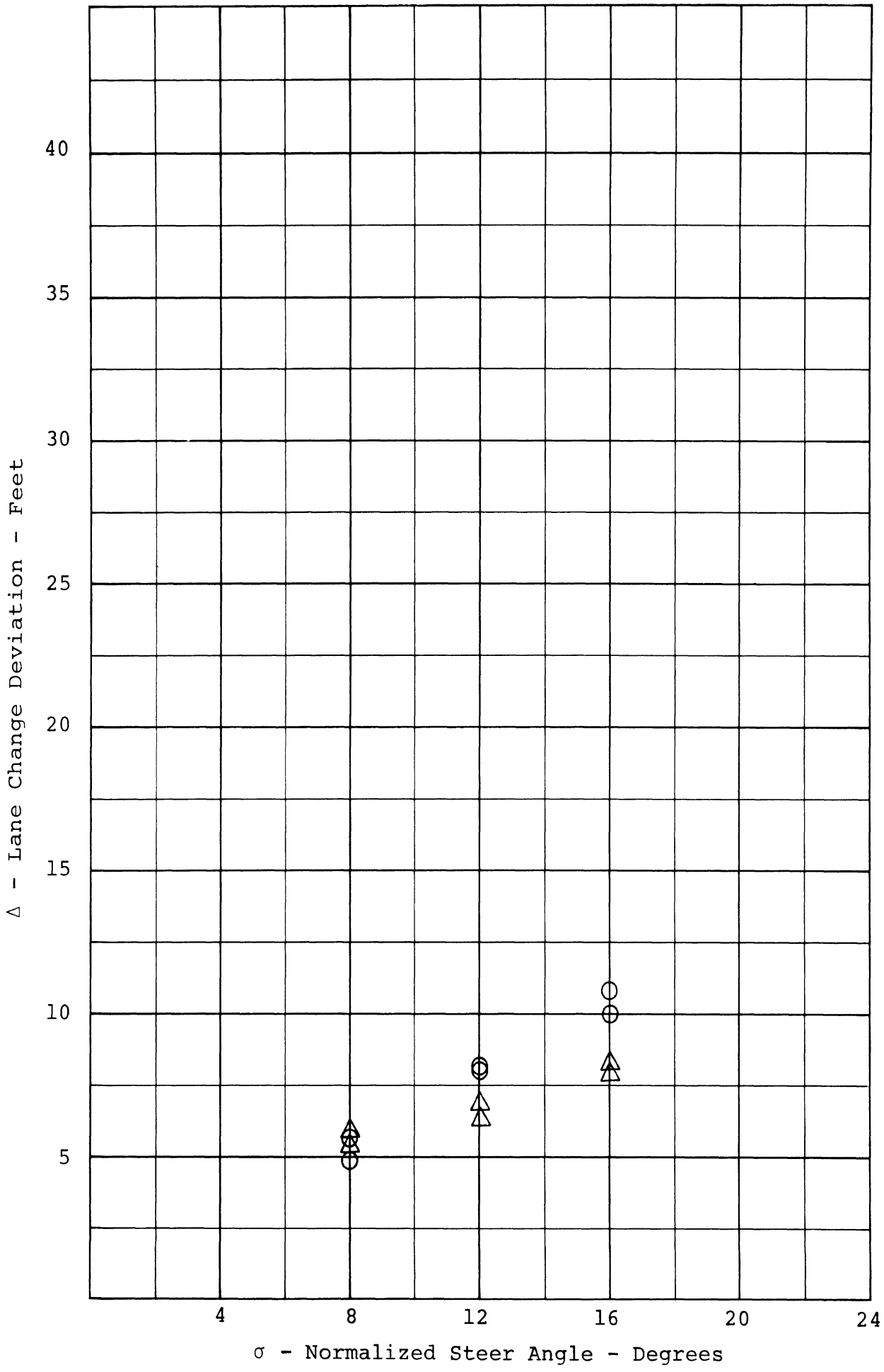
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A4]



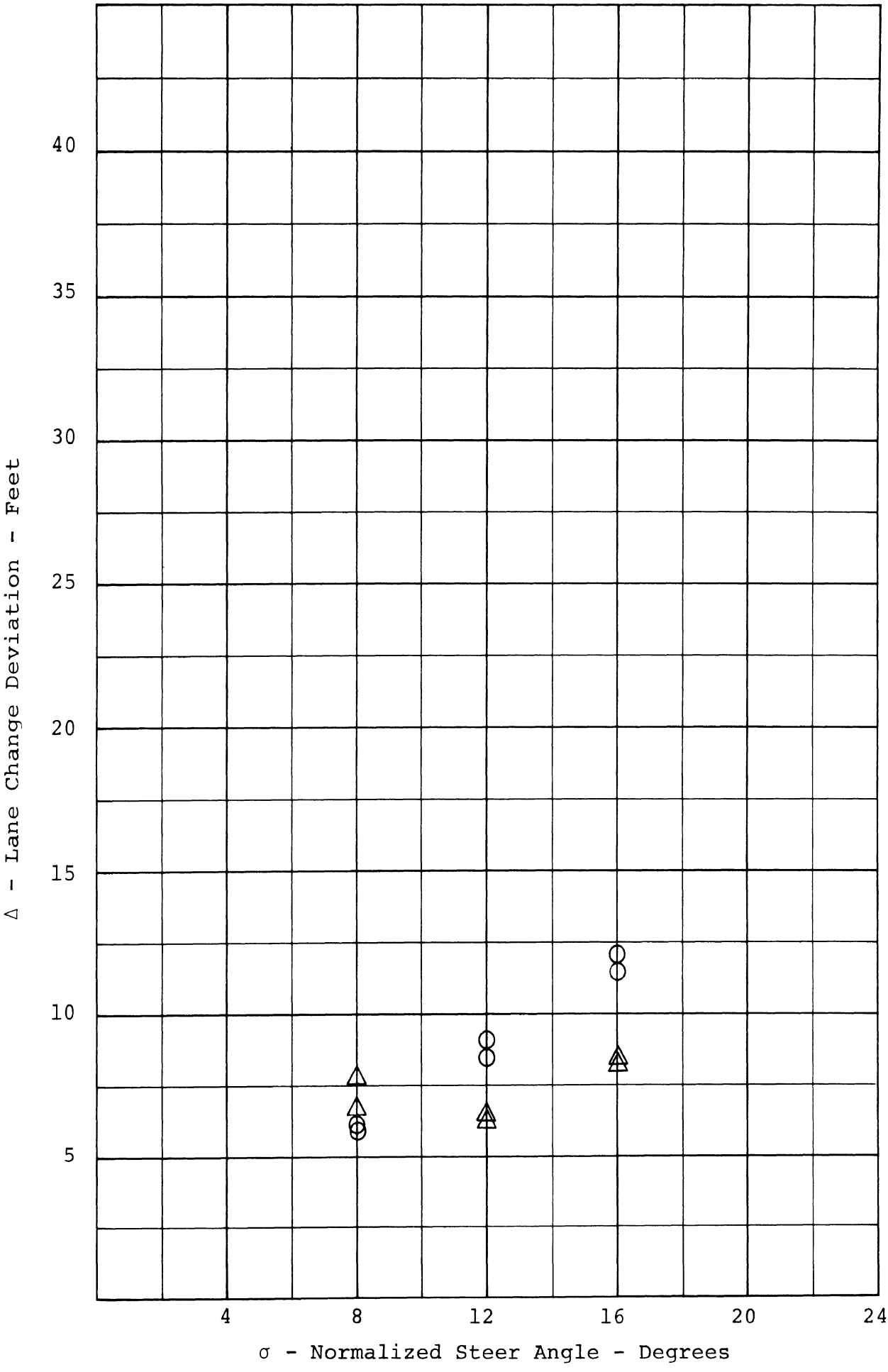
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - OE]



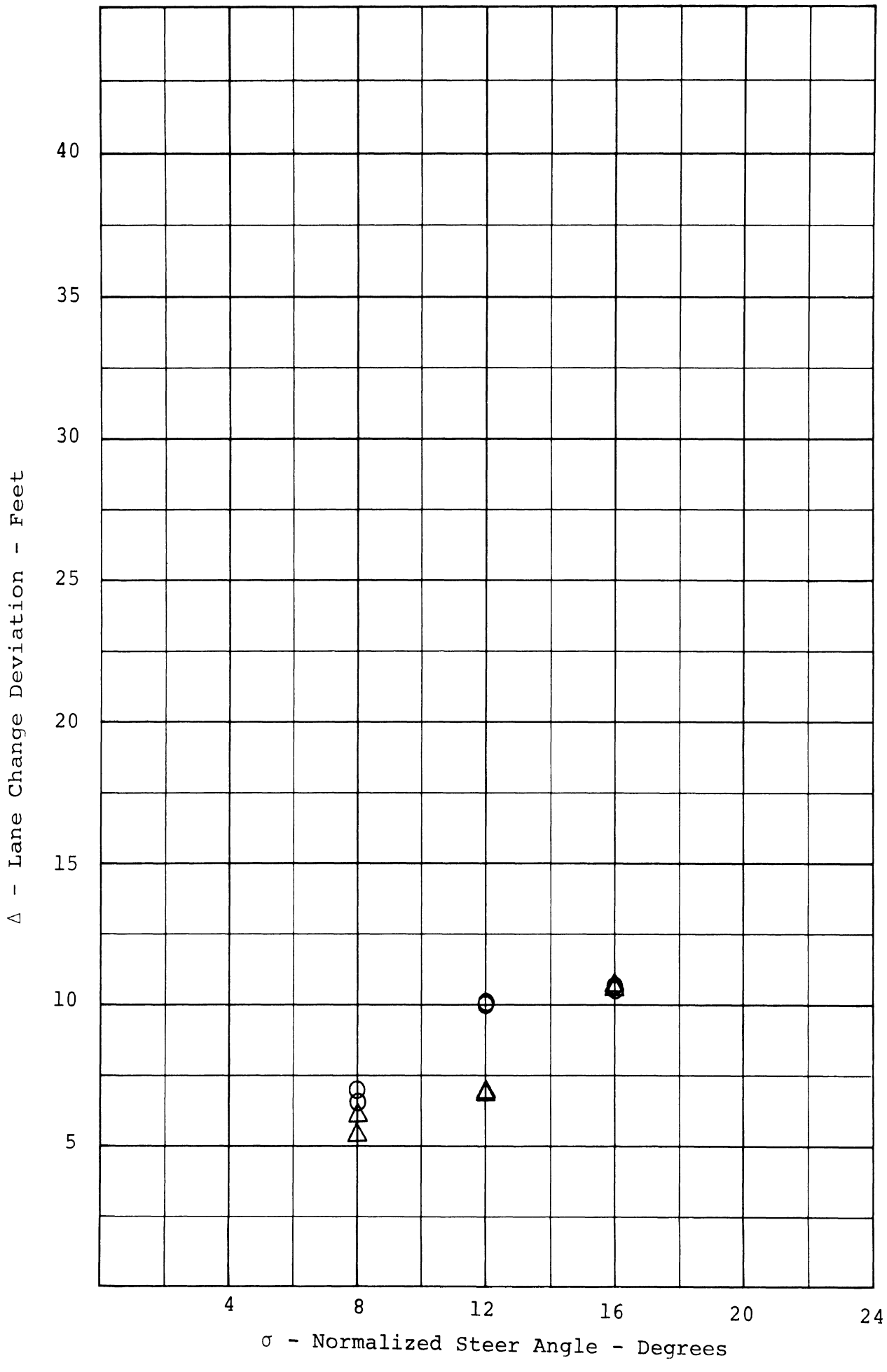
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A1]



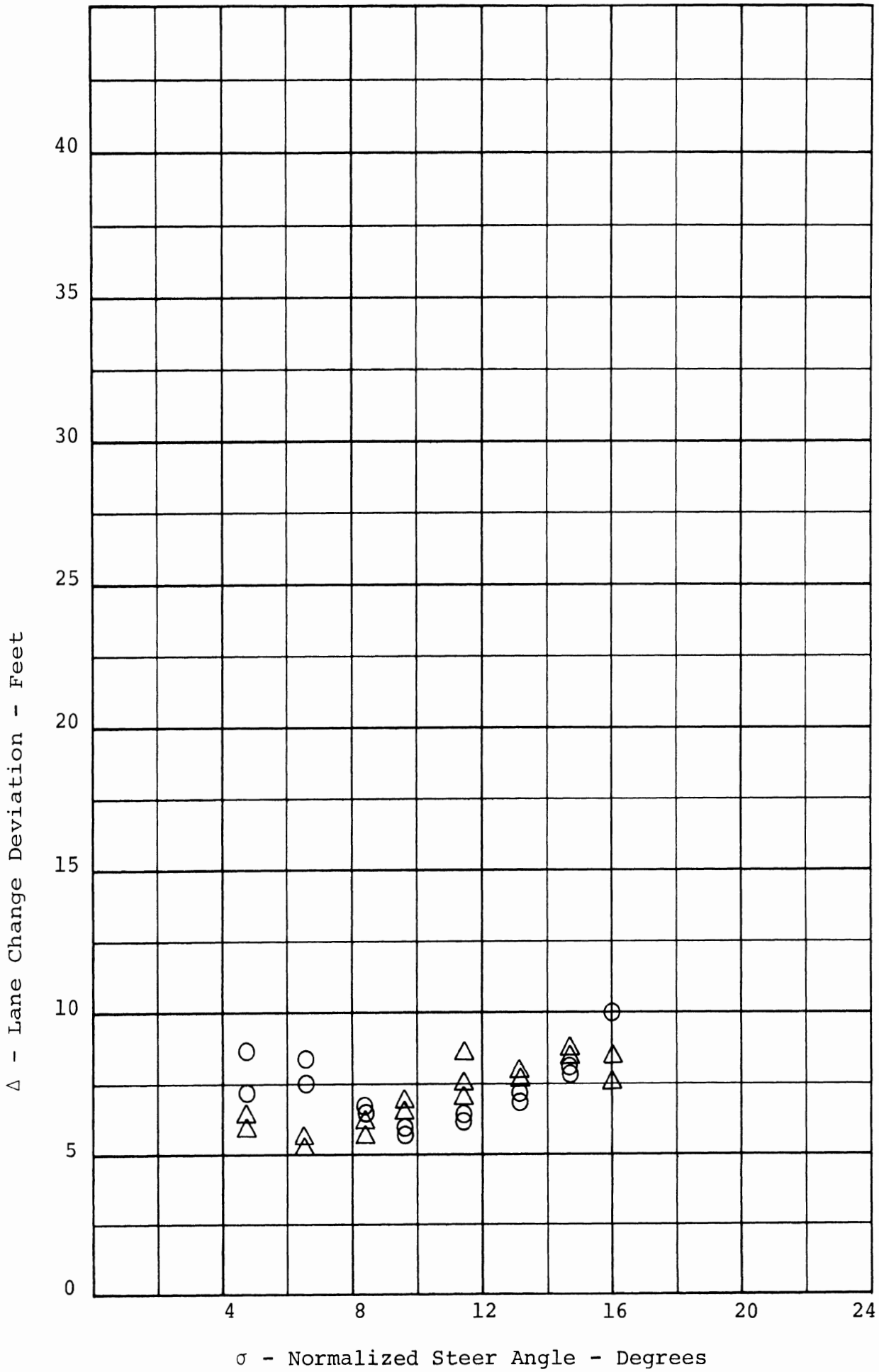
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A2]



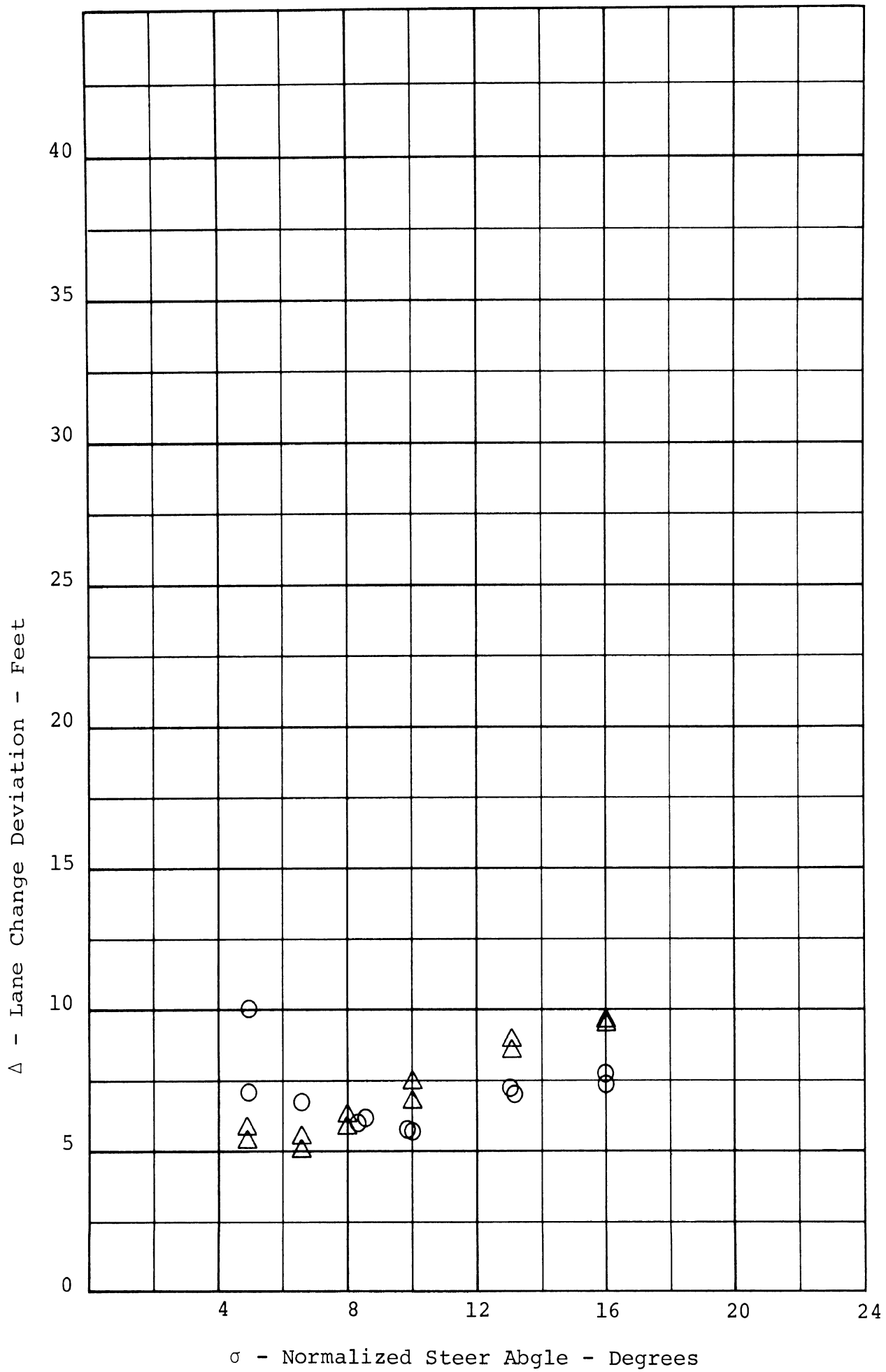
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A3]



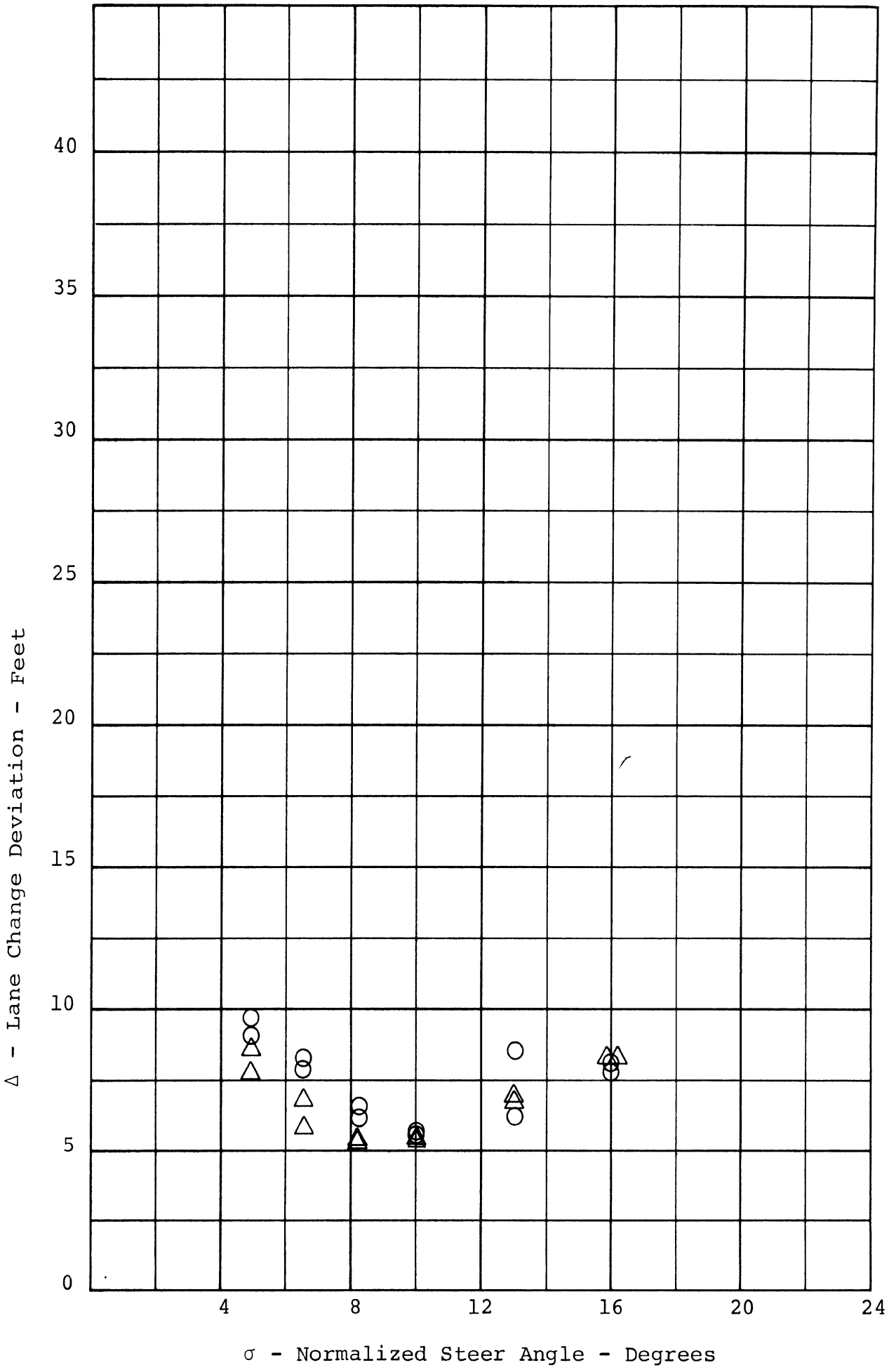
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A4]



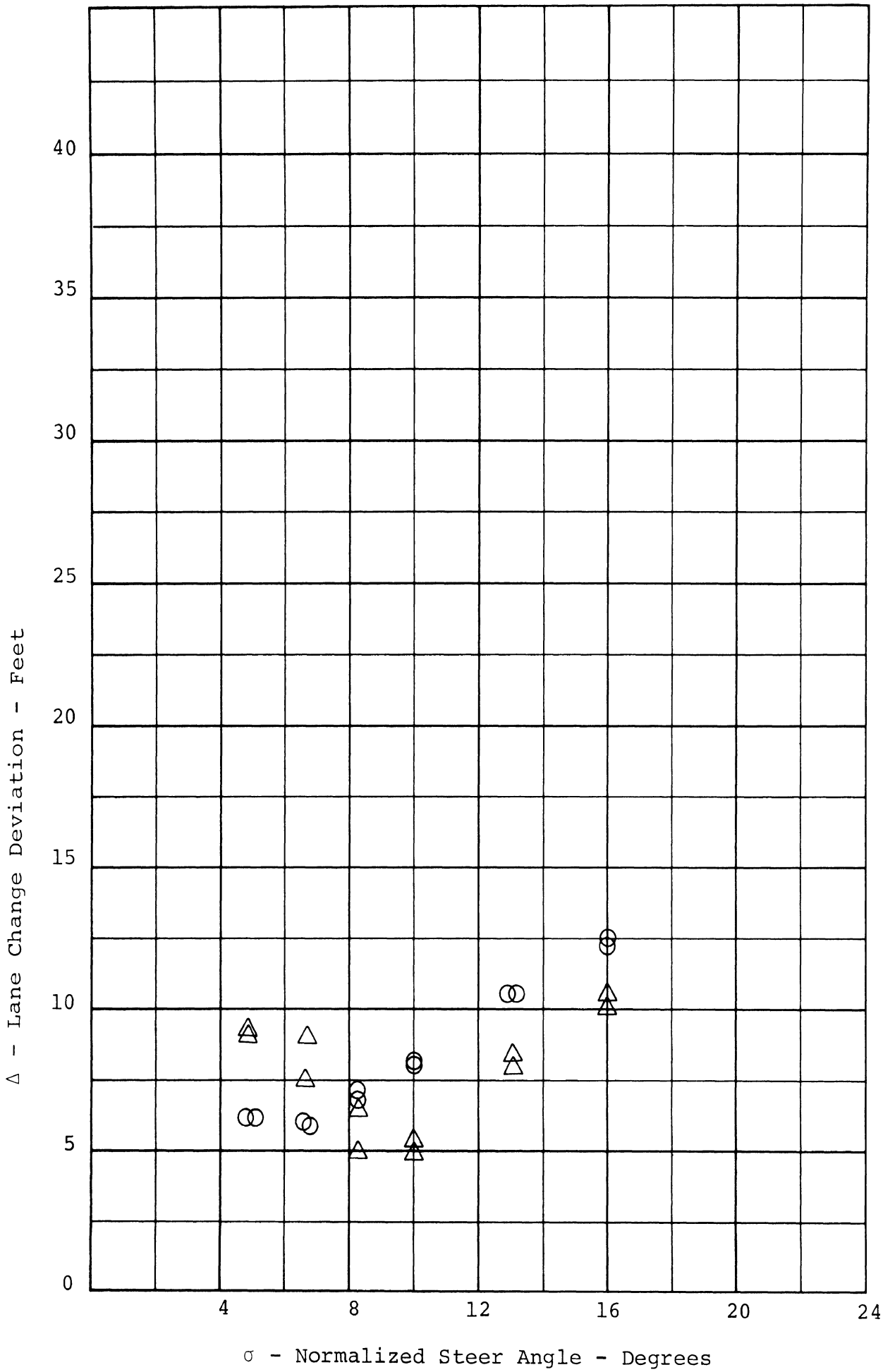
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition OE]



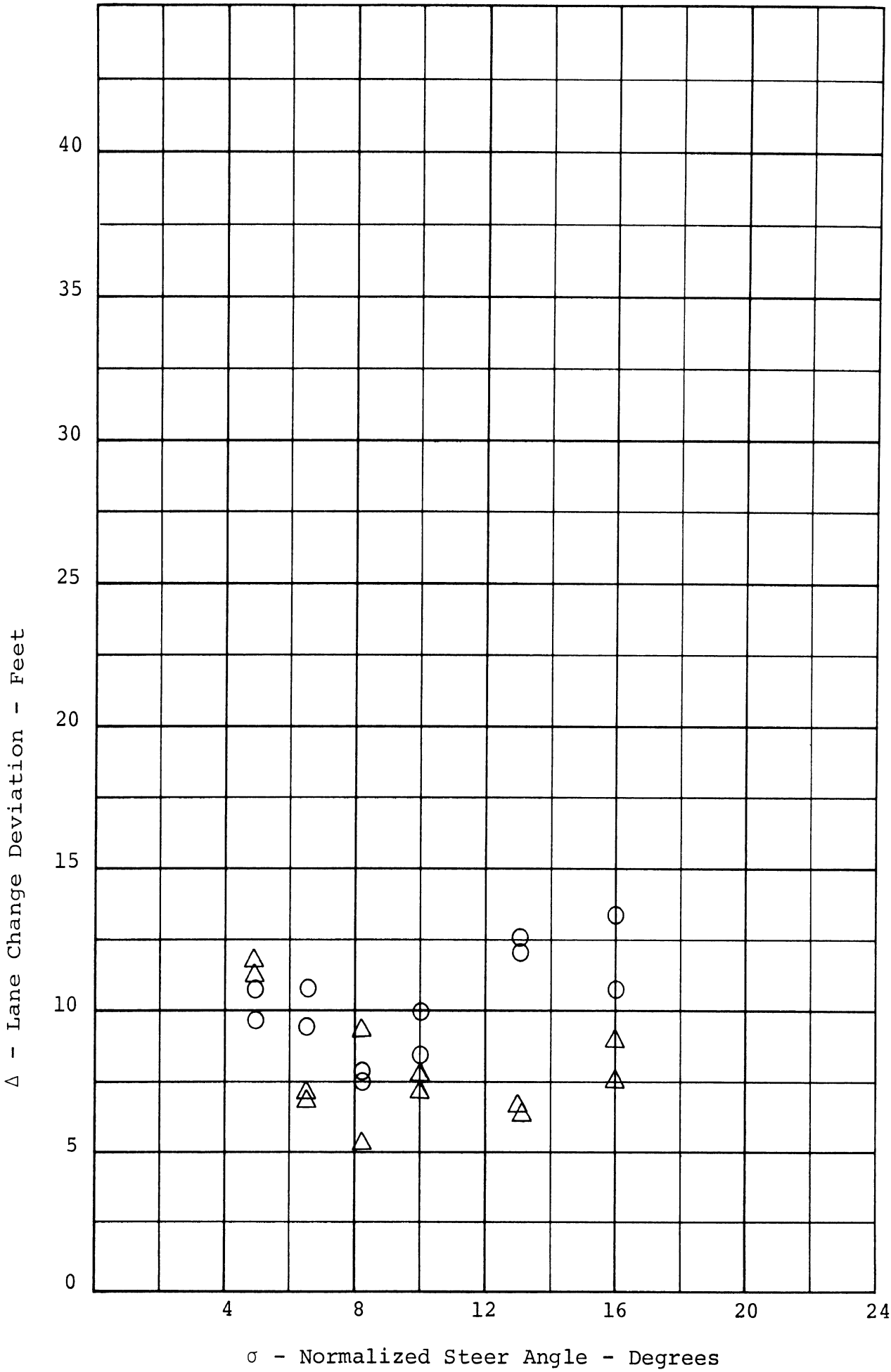
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition - A1]



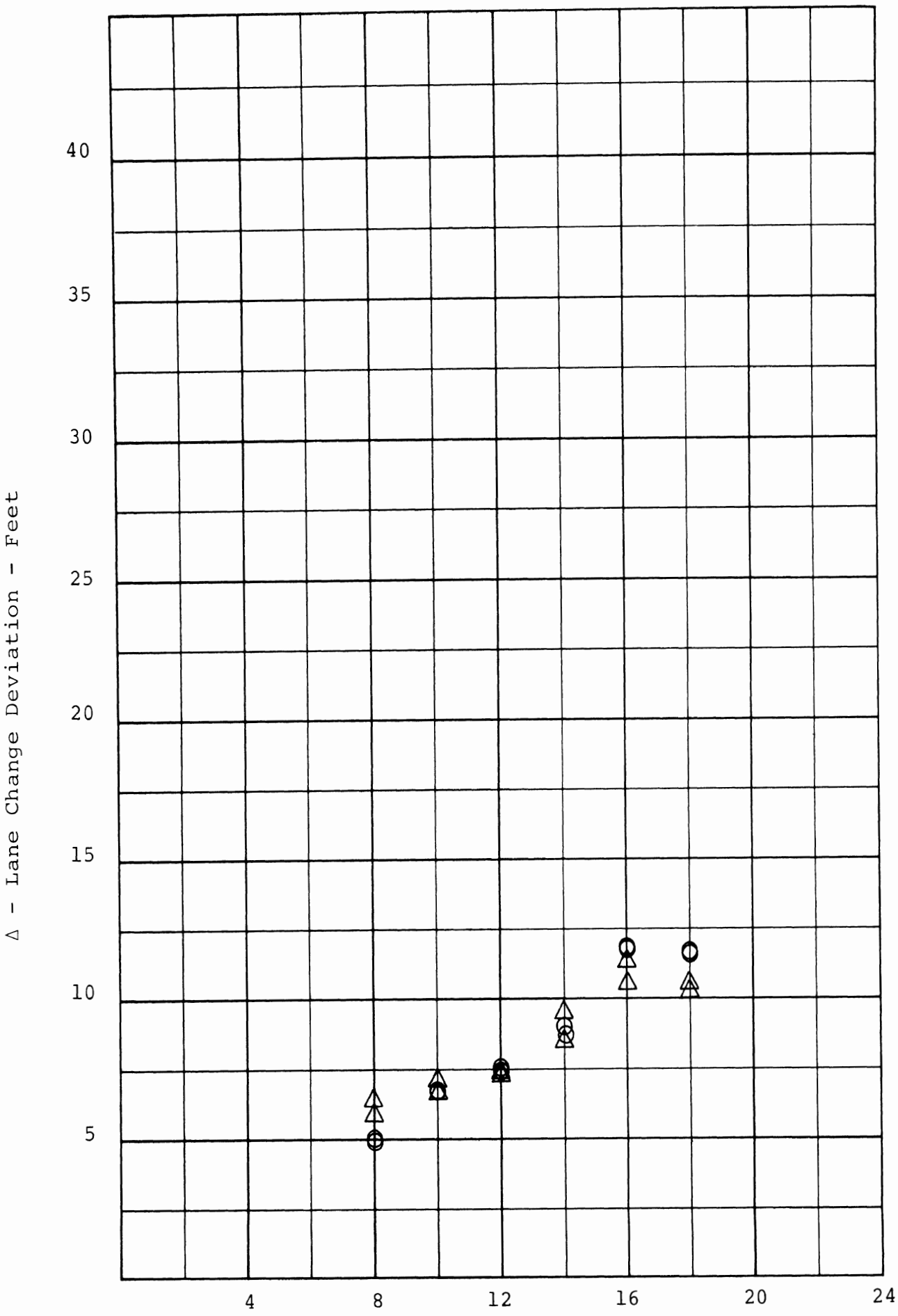
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition - A2]



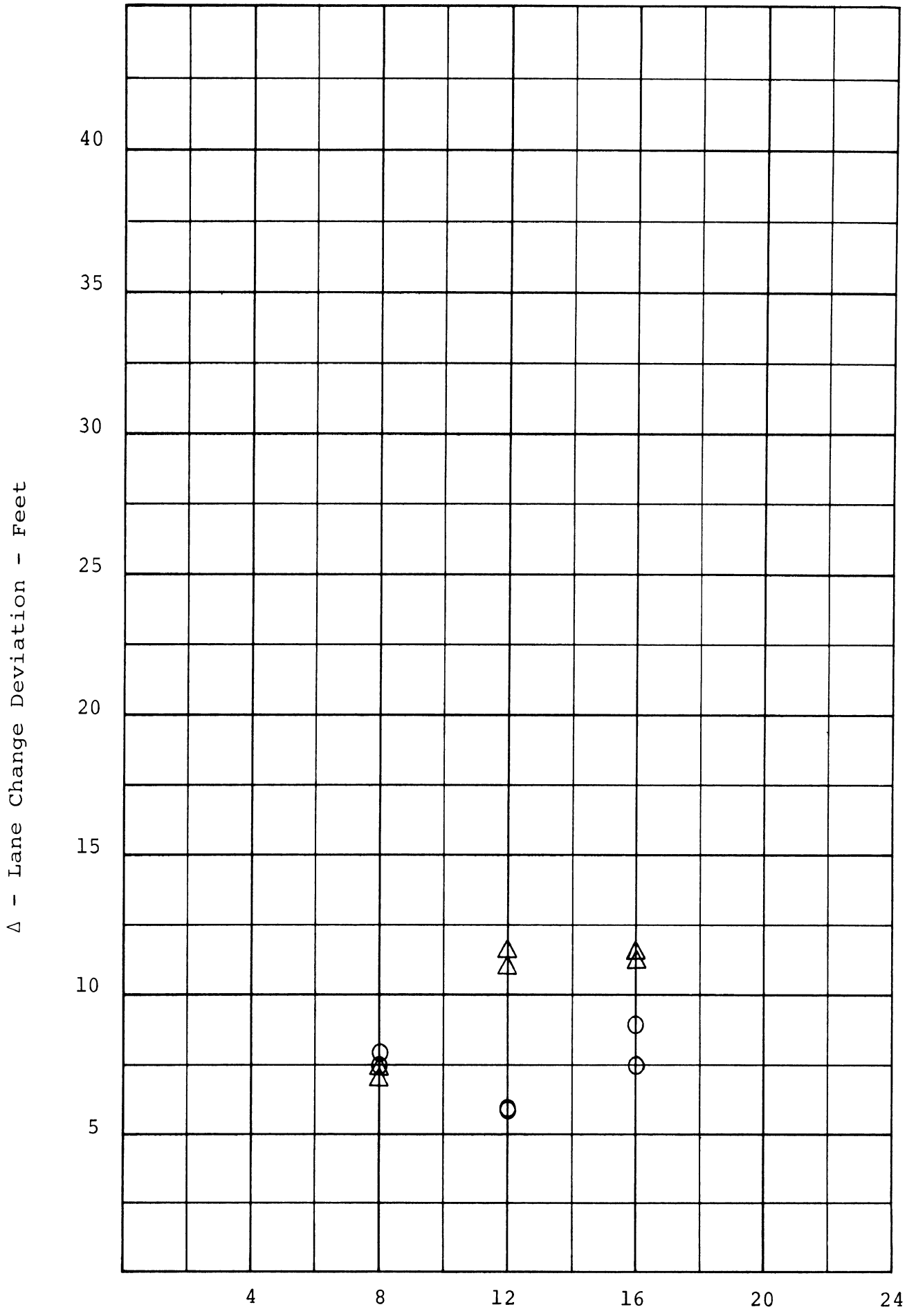
SINUSOIDAL STEER - 60 MPH - AMBASSADOR[condition A3]



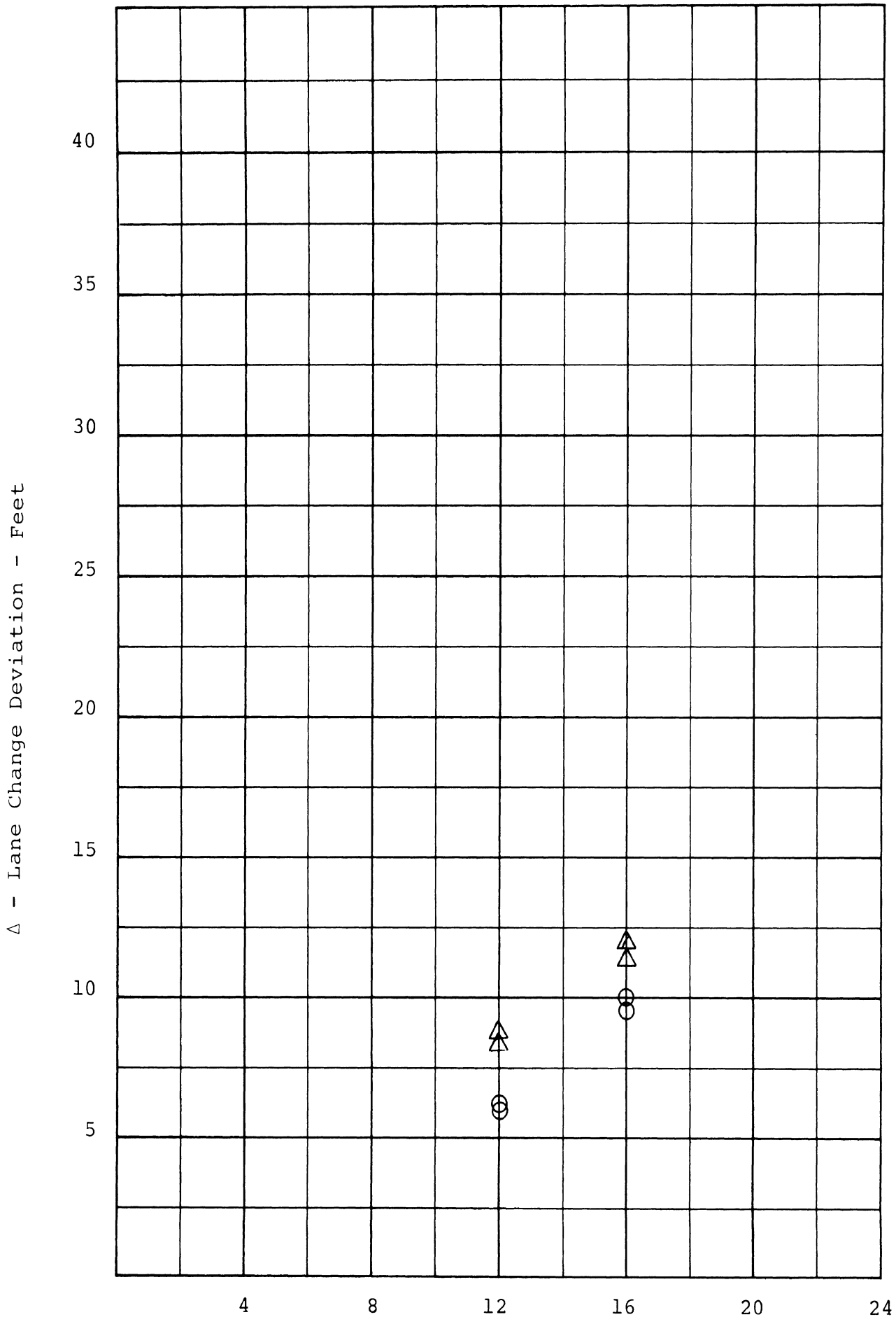
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition A4]



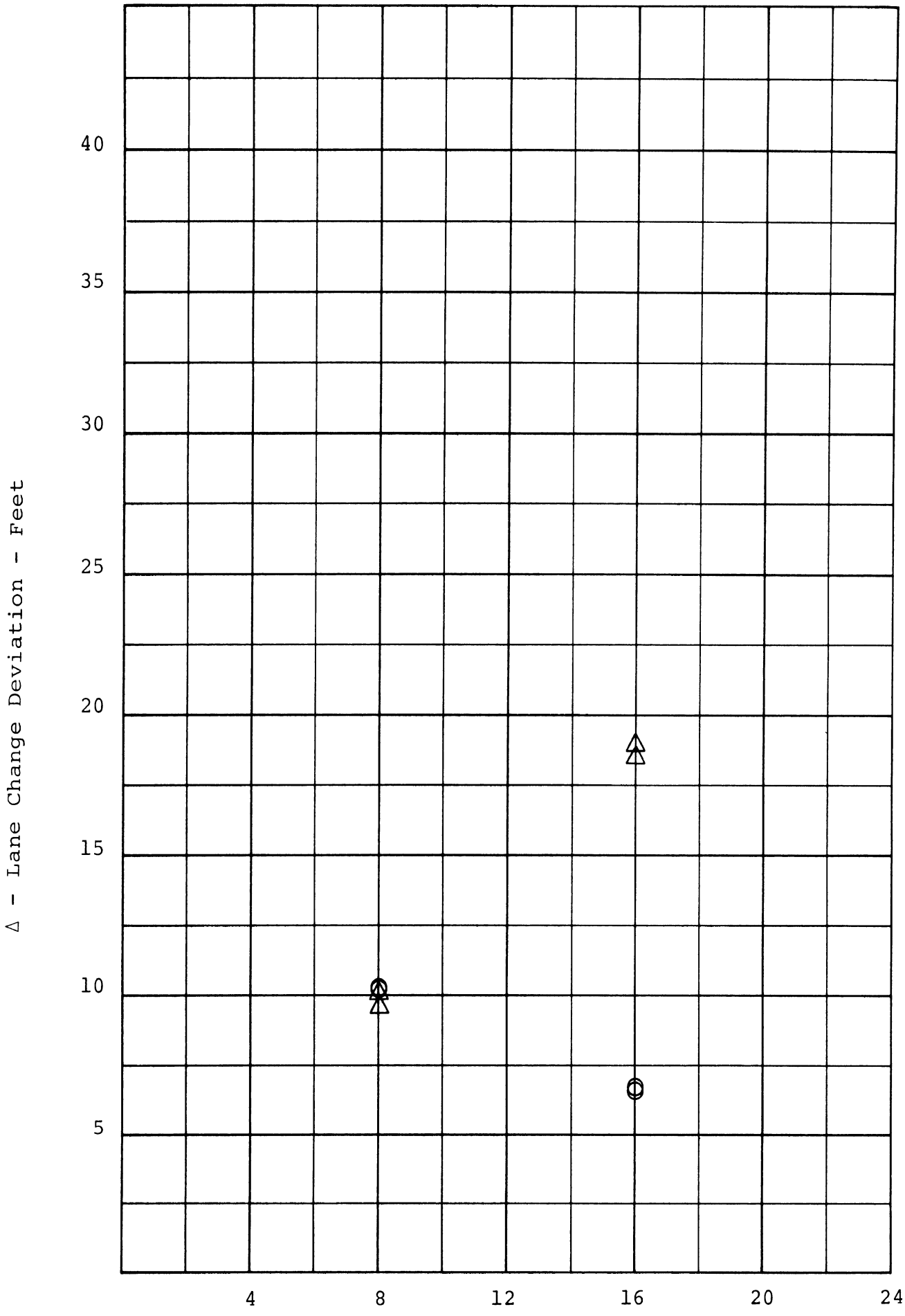
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - O.E.]



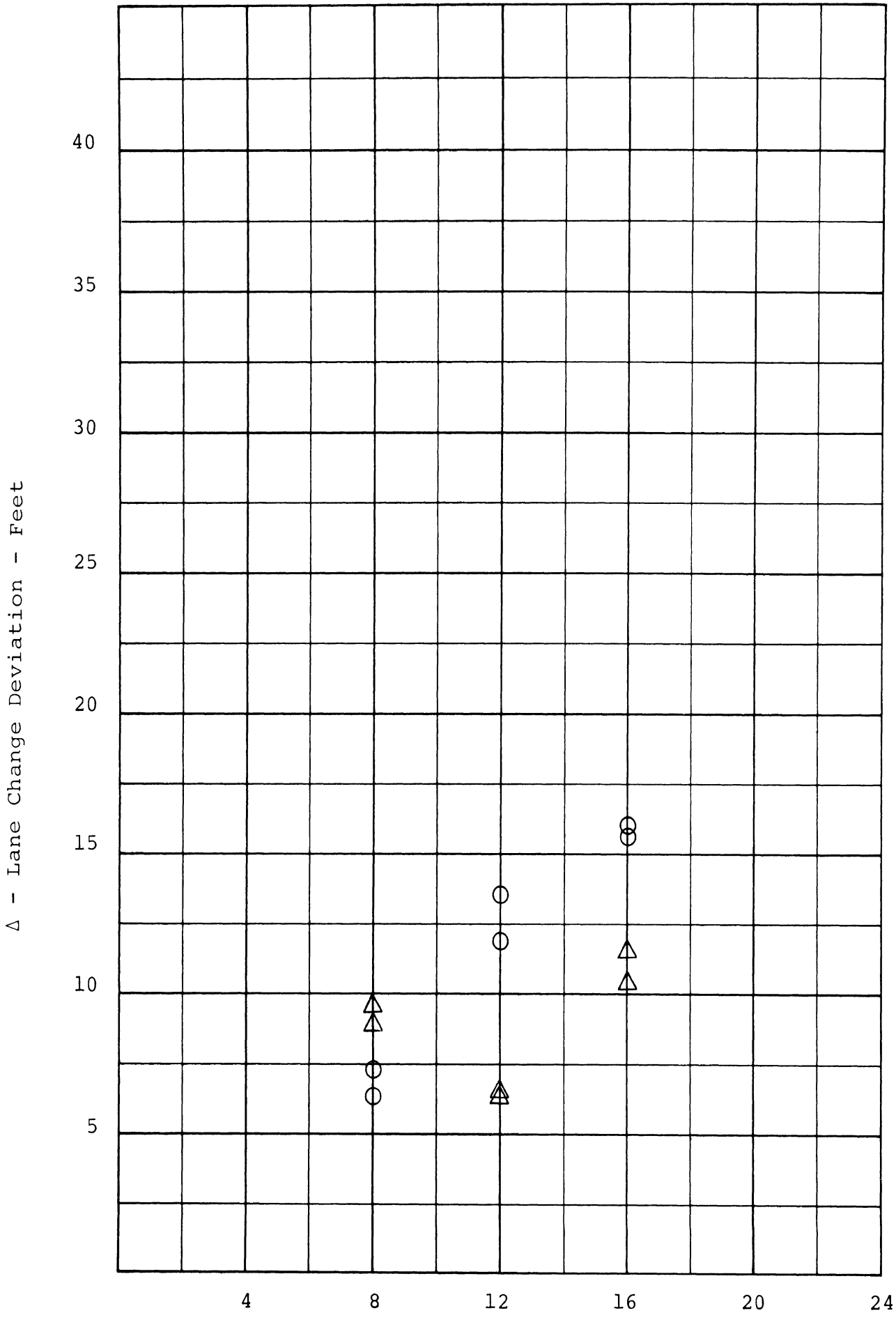
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A1]



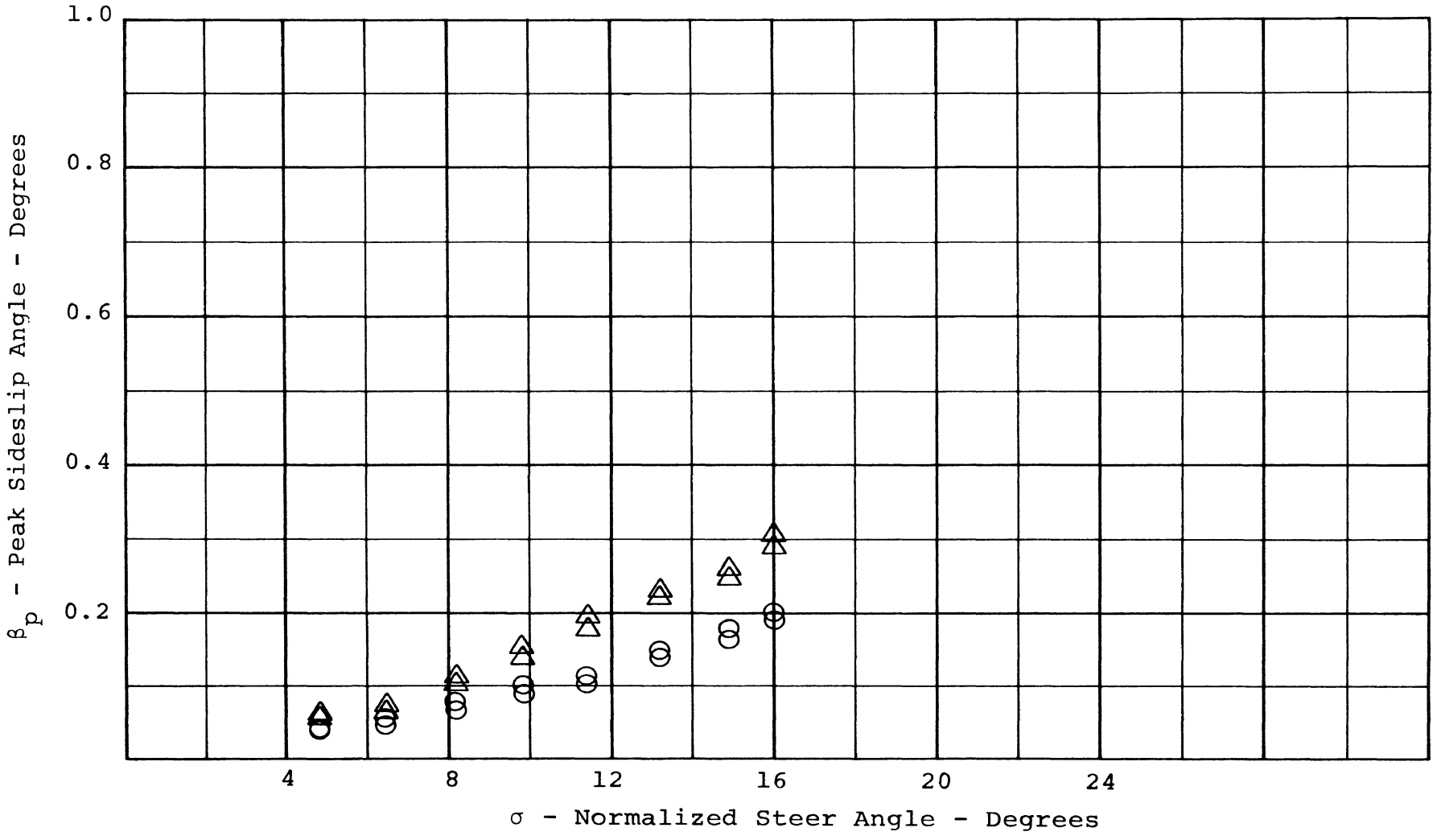
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A2]



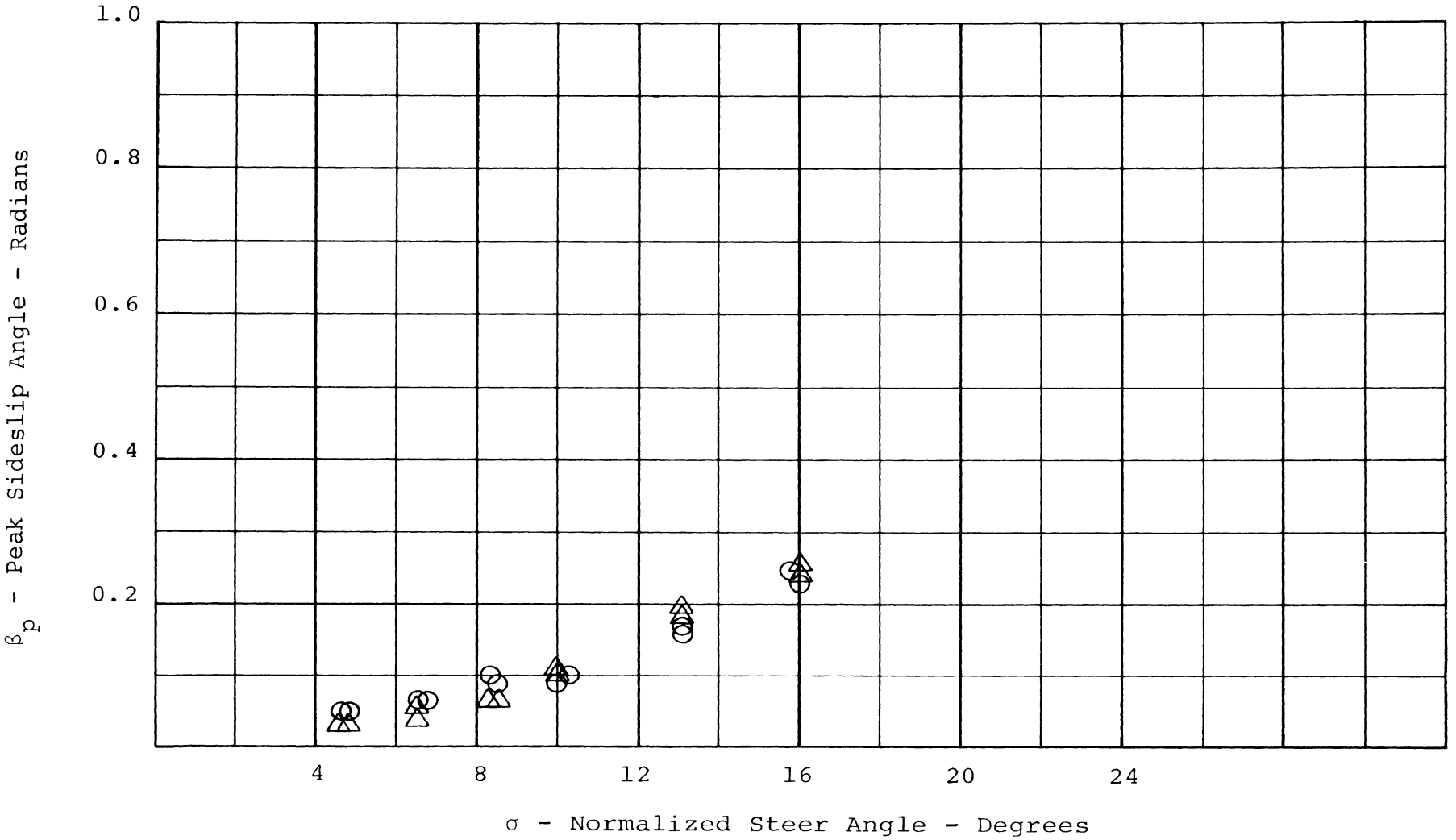
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A3]



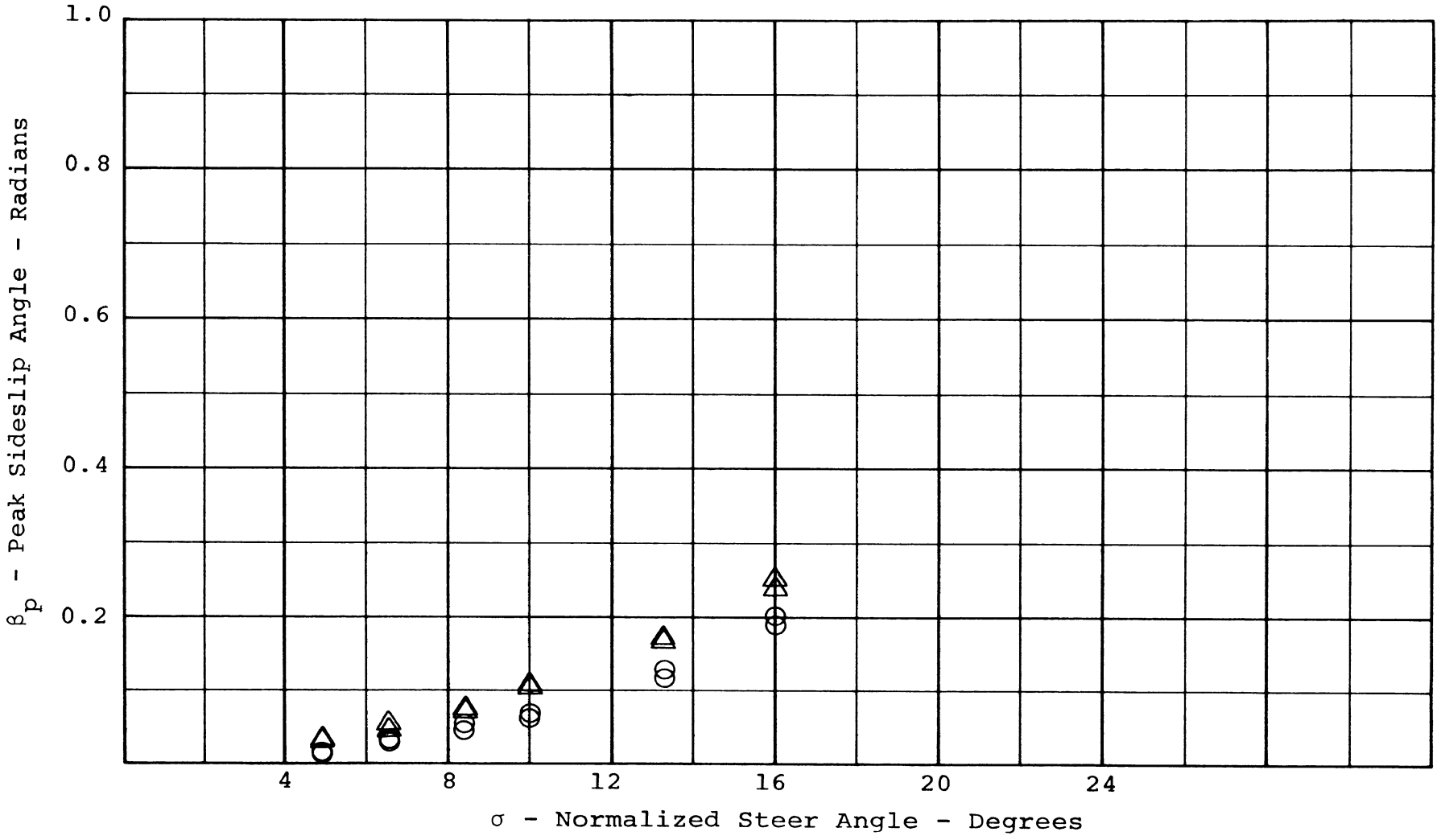
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A4]



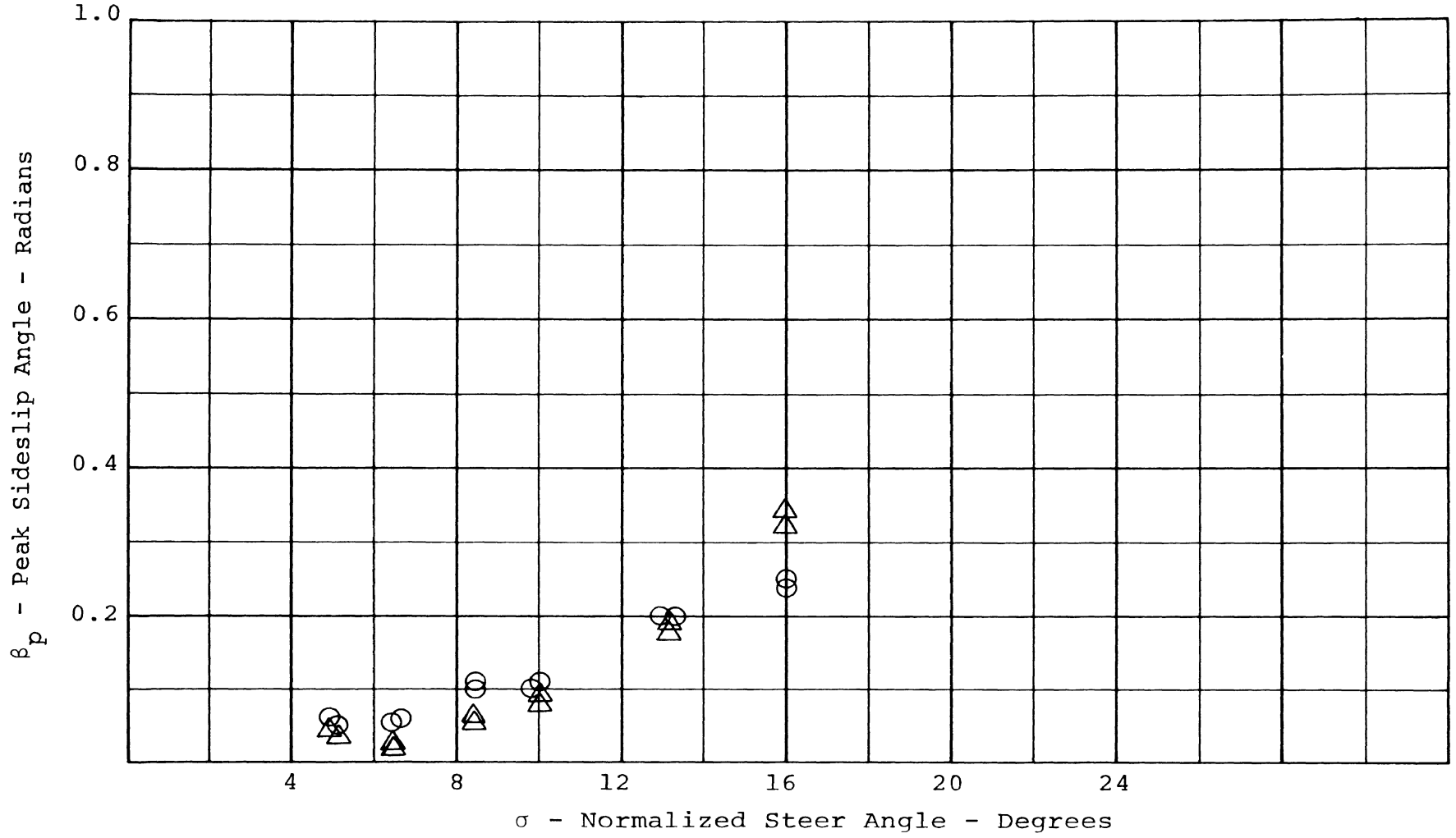
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [CONDITION - OE]



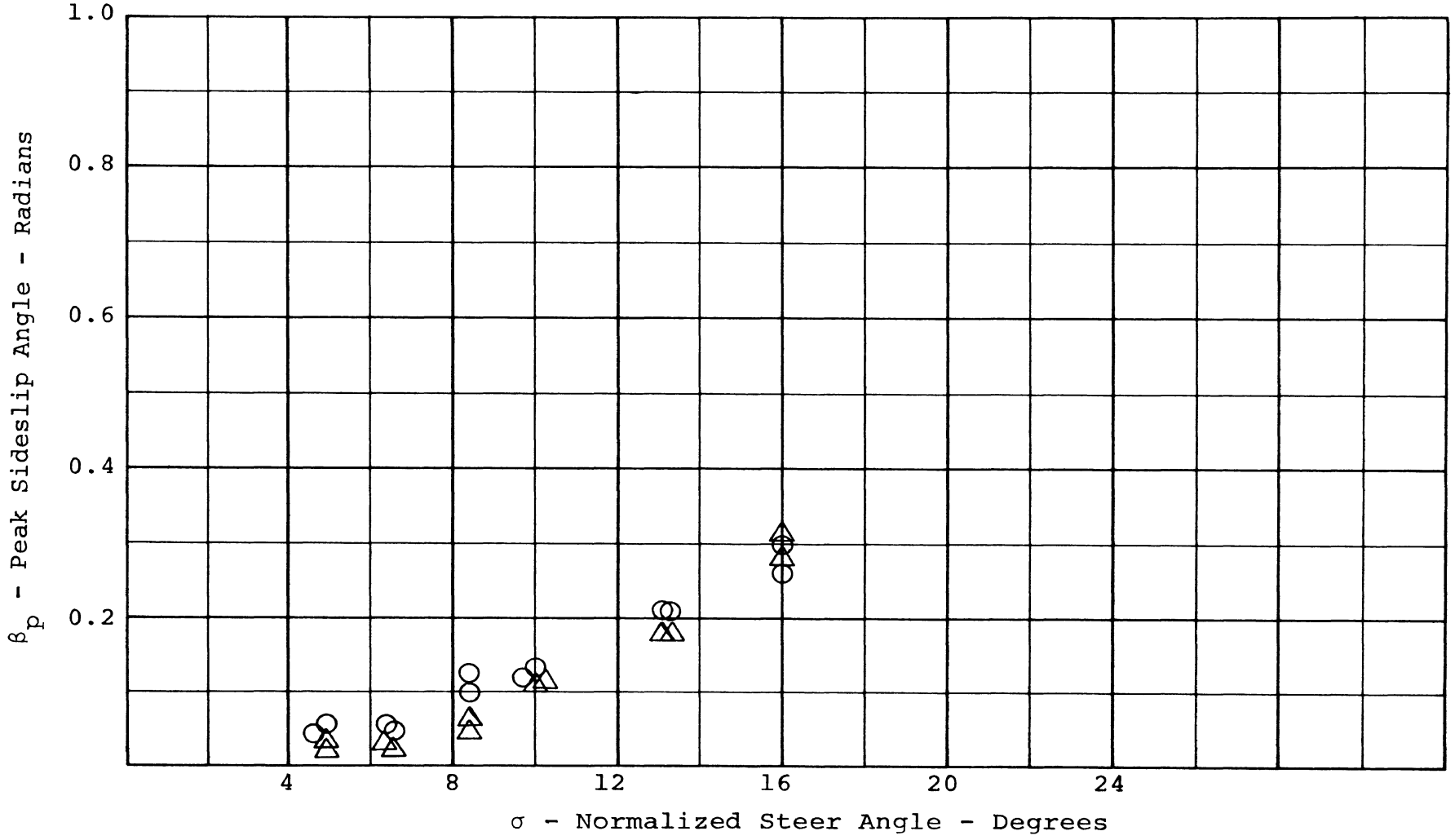
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [CONDITION - A-1]



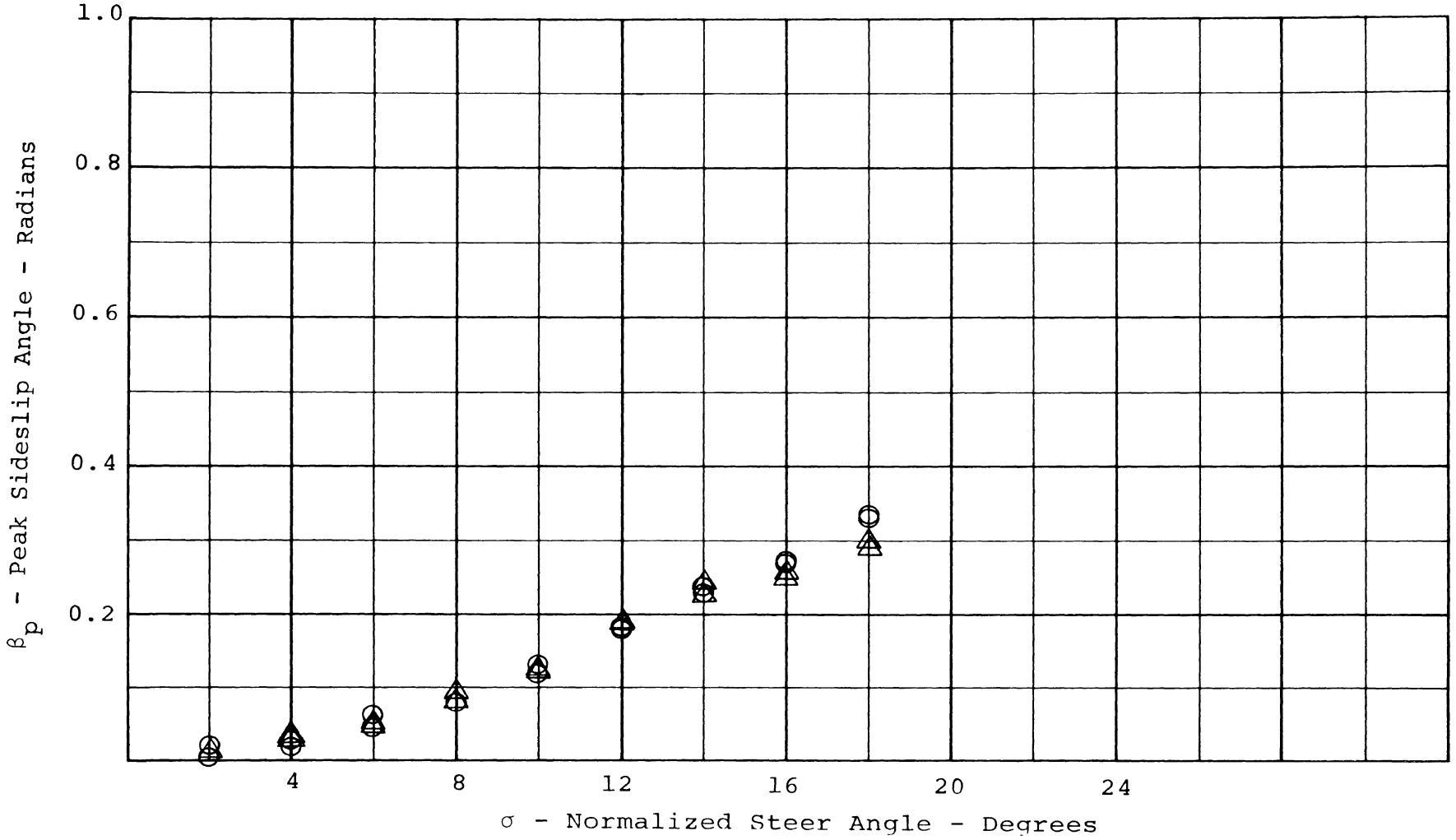
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [CONDITION - A-2]



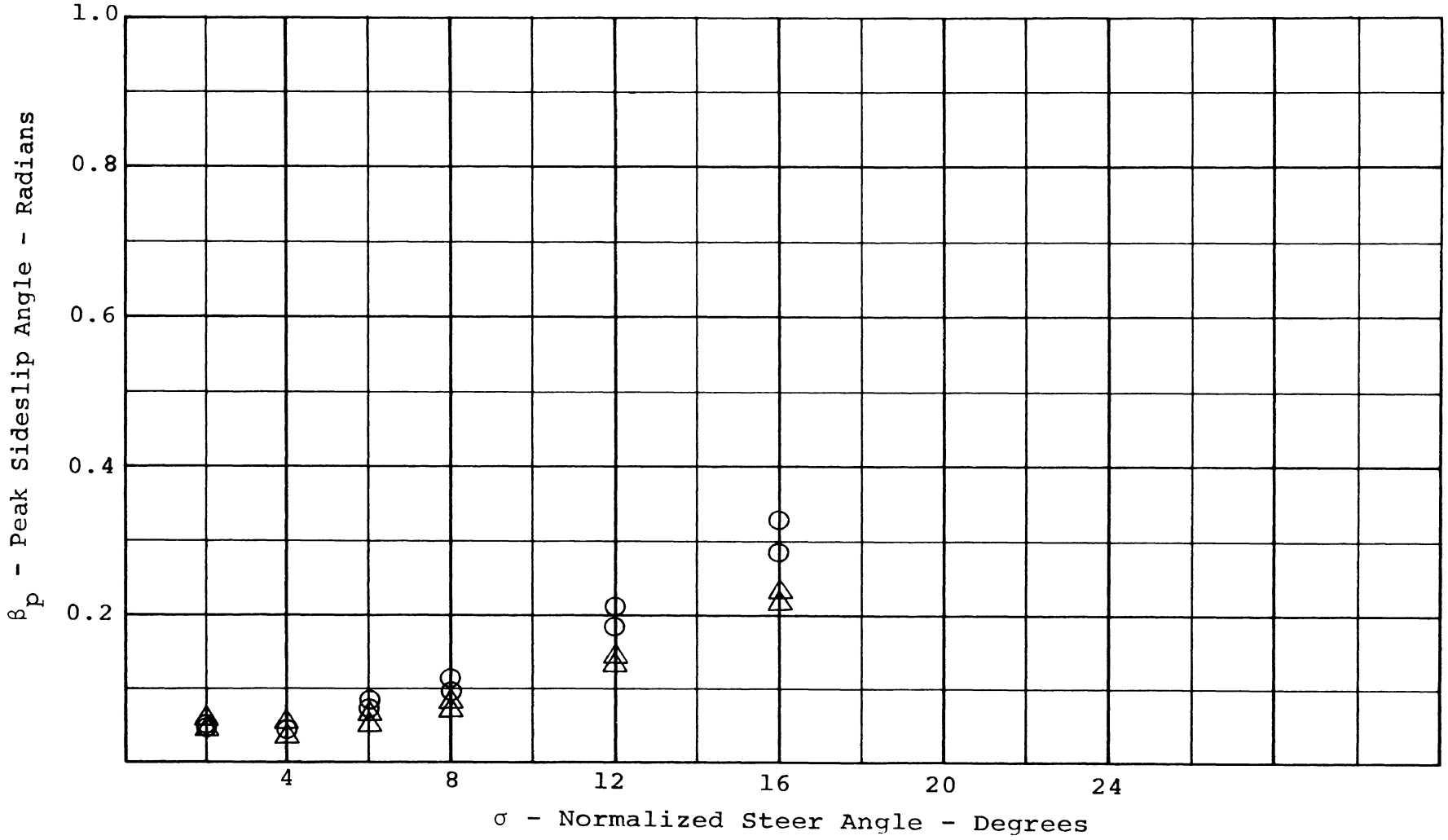
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [CONDITION - A-3]



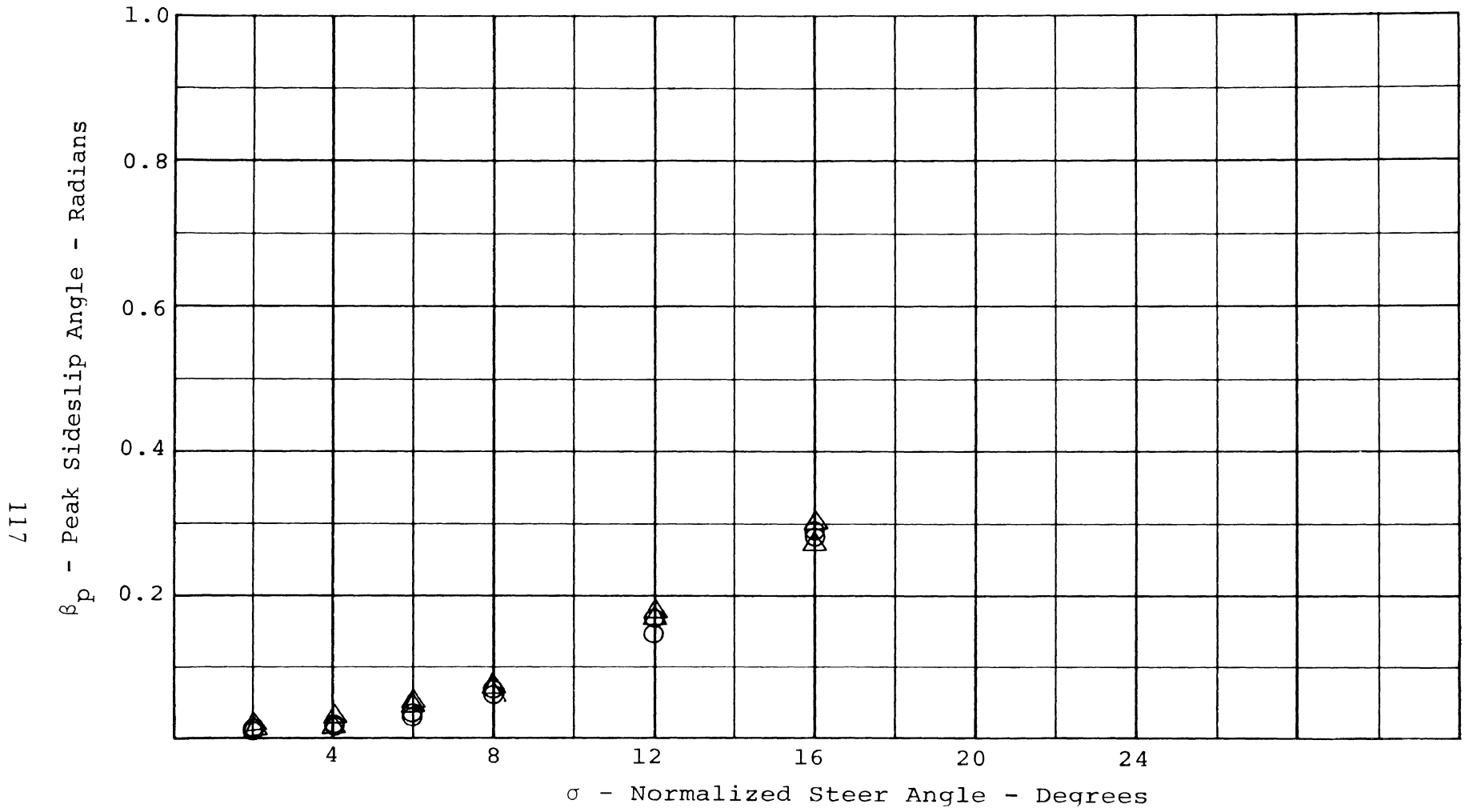
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [CONDITION - A-4]



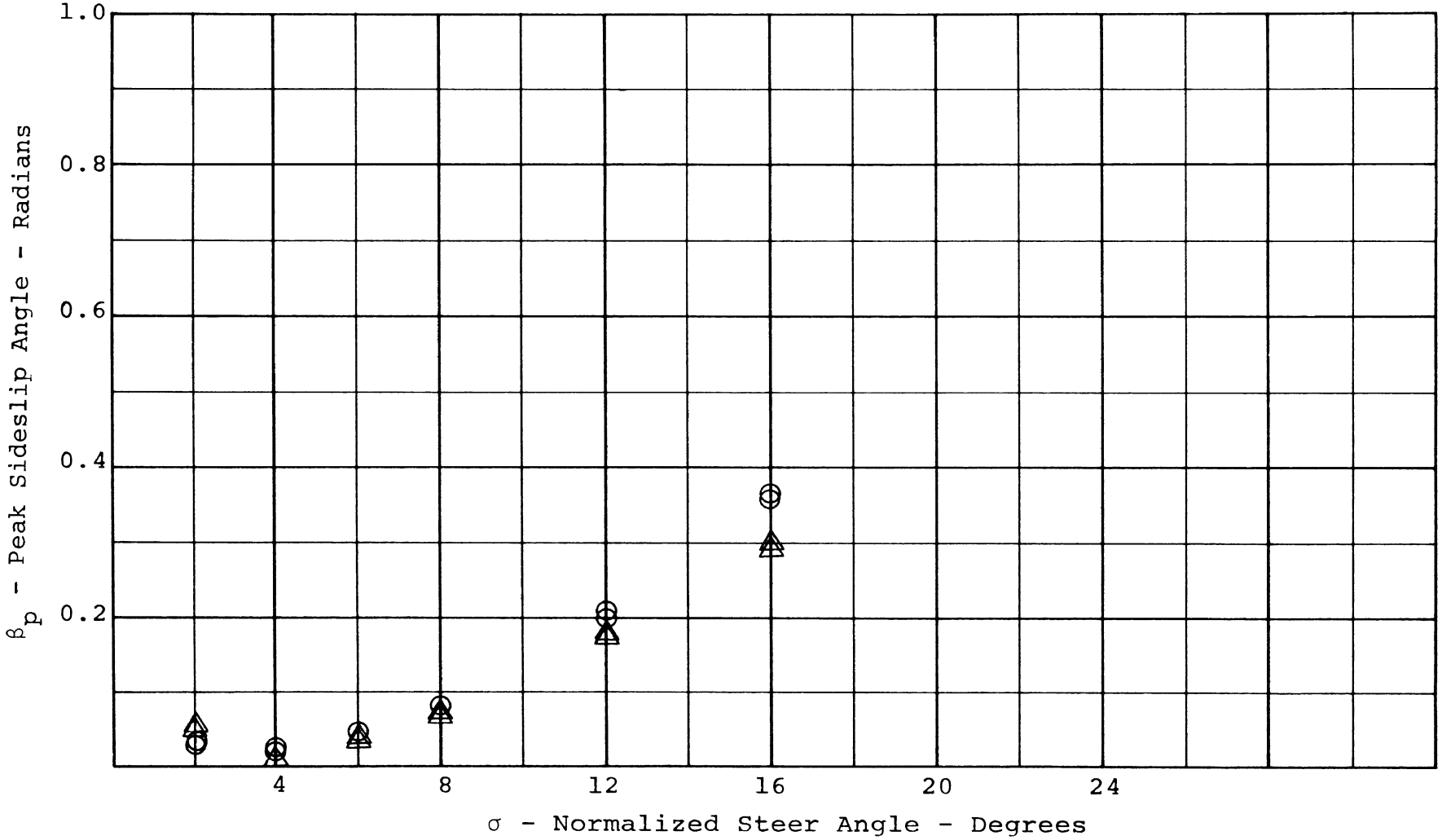
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - OE]



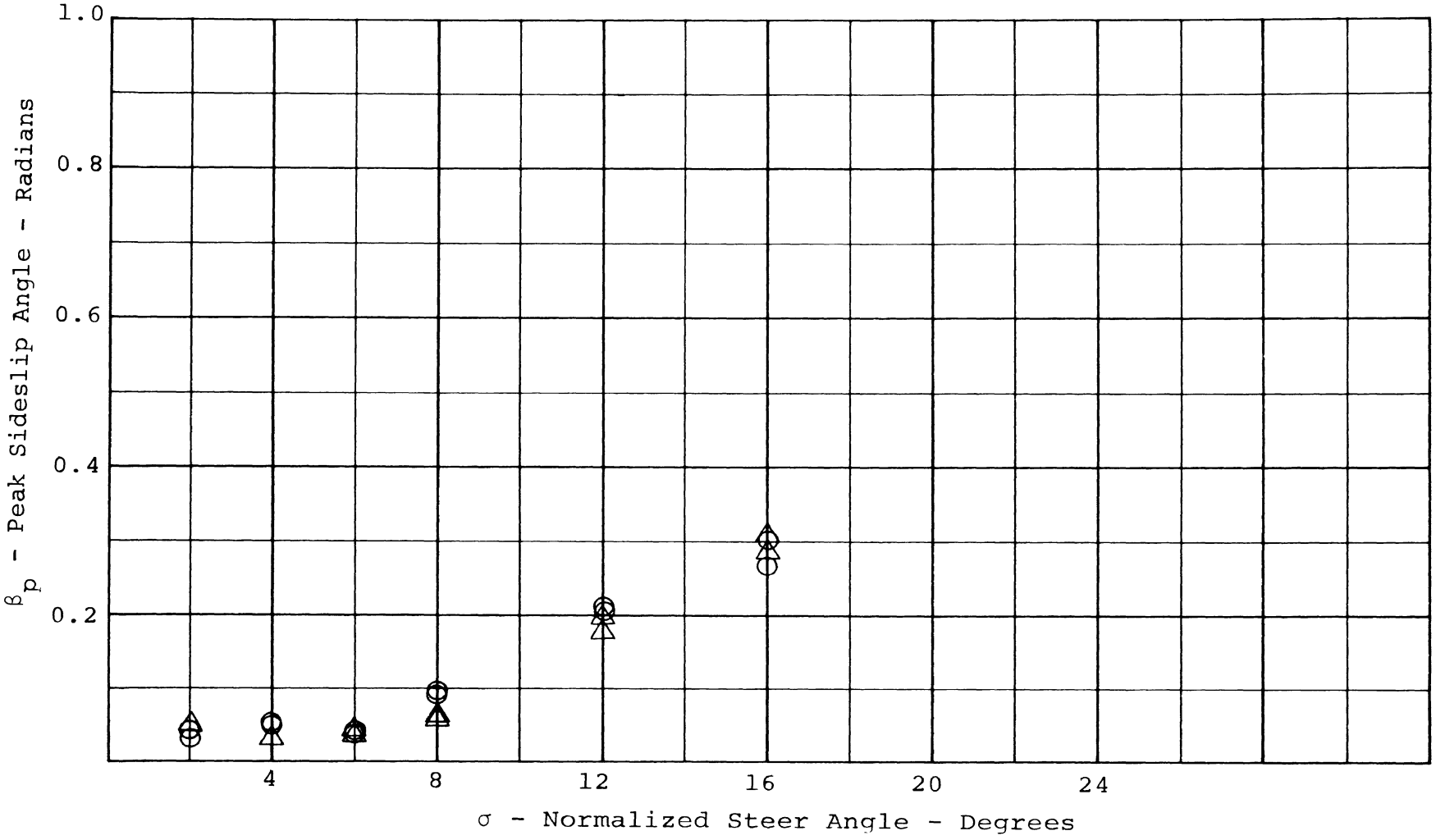
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A1]



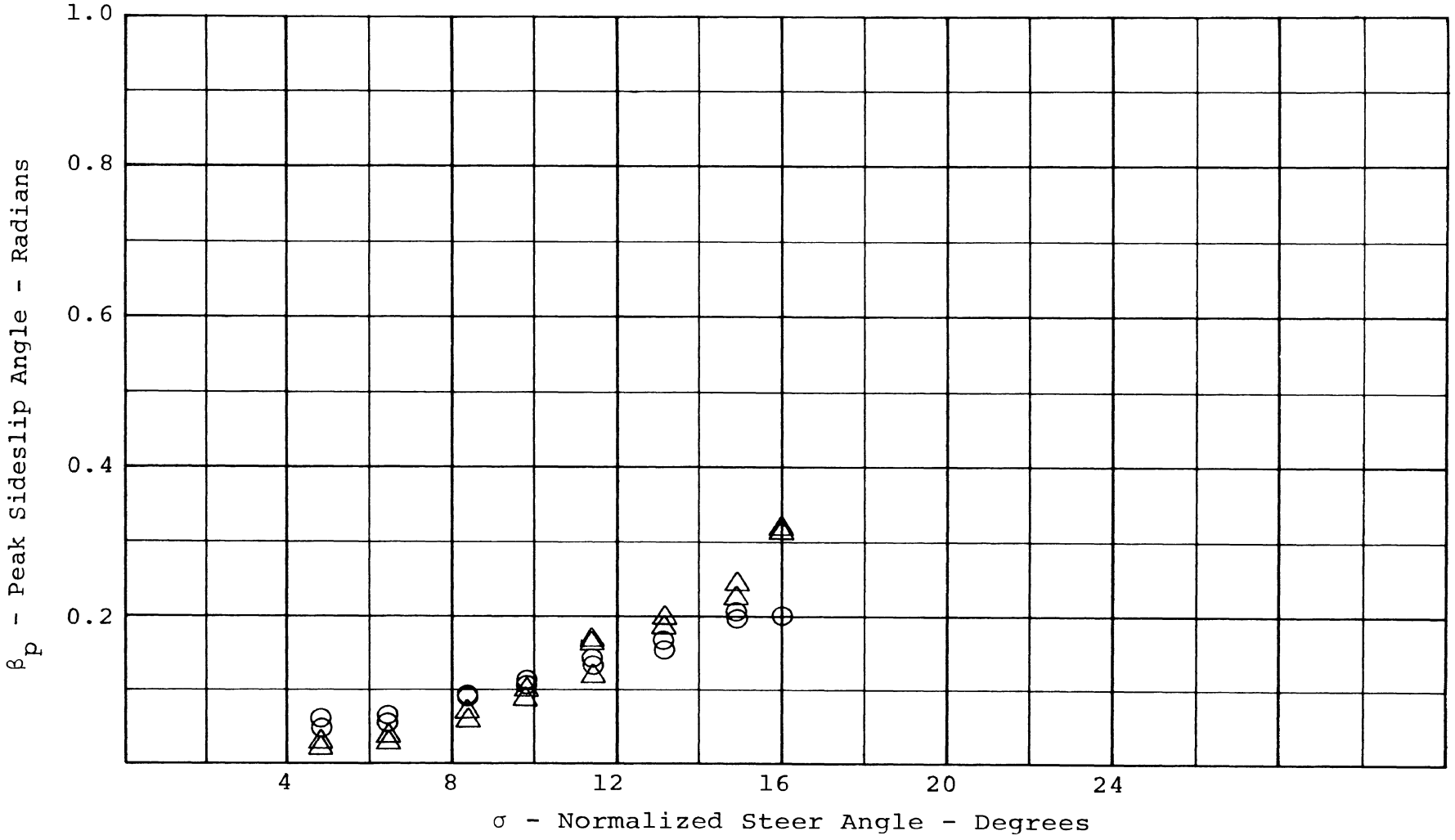
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A2]



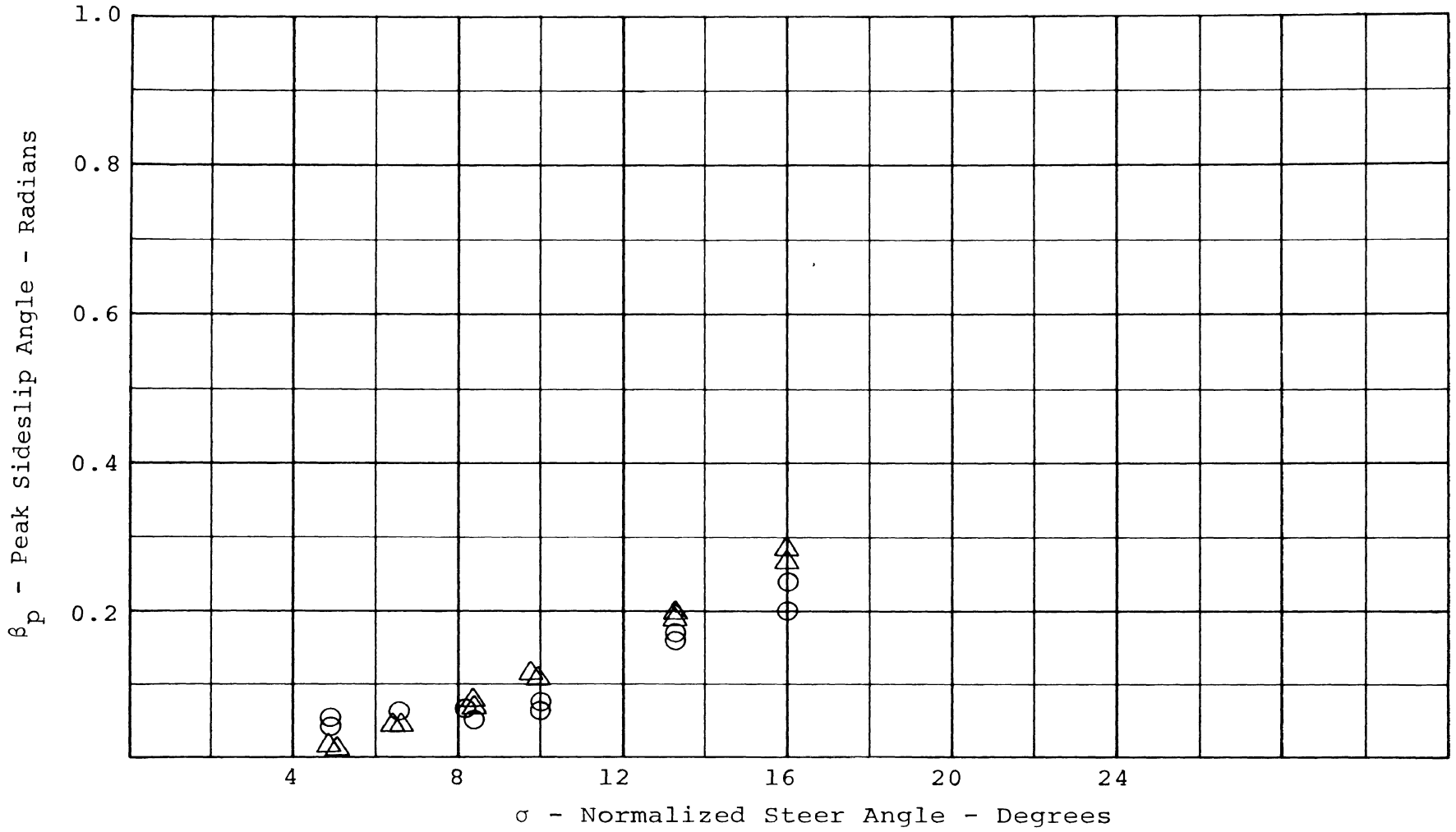
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A3]



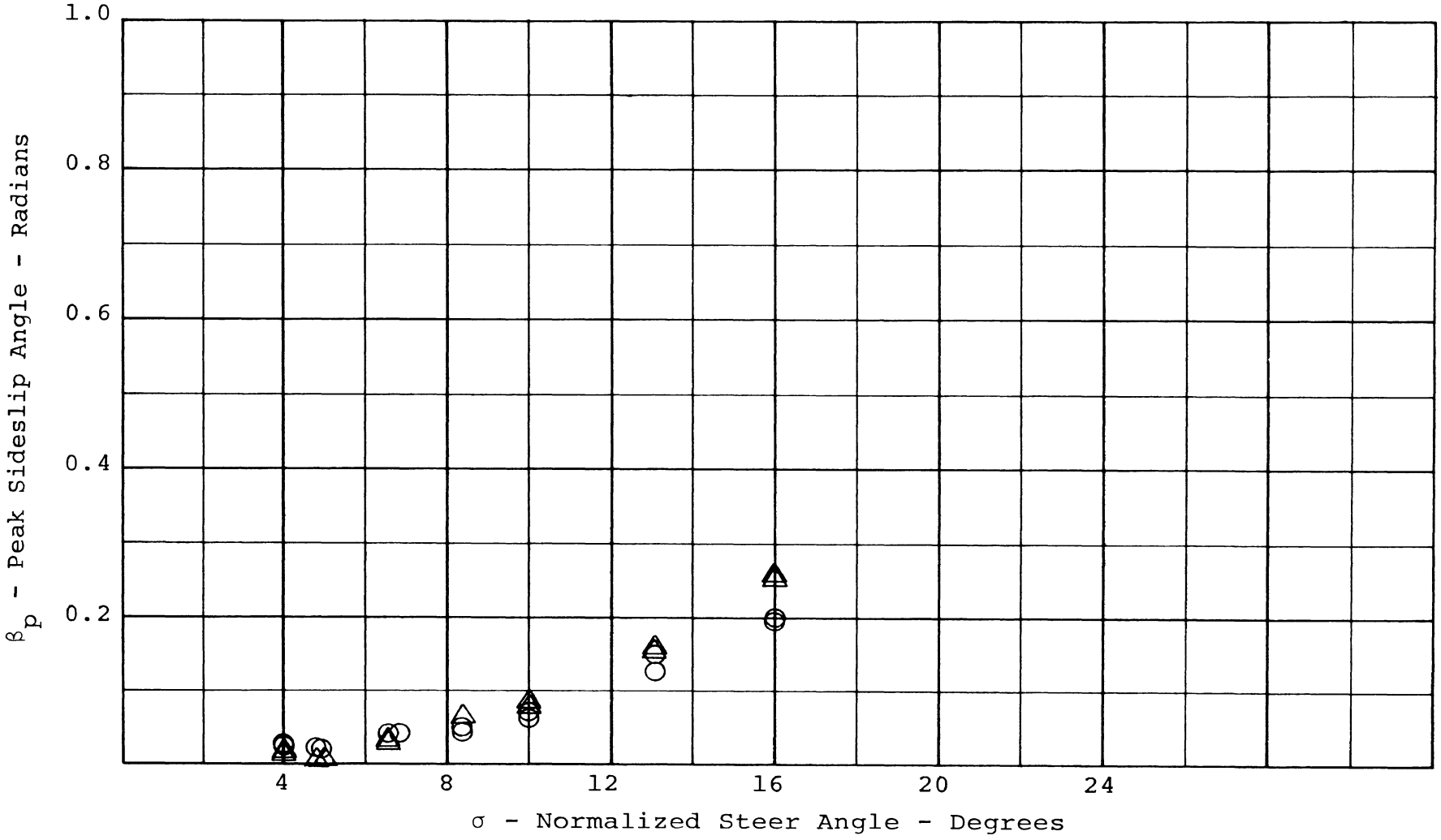
SINUSOIDAL STEER - 45 MPH - DODGE [CONDITION - A4]



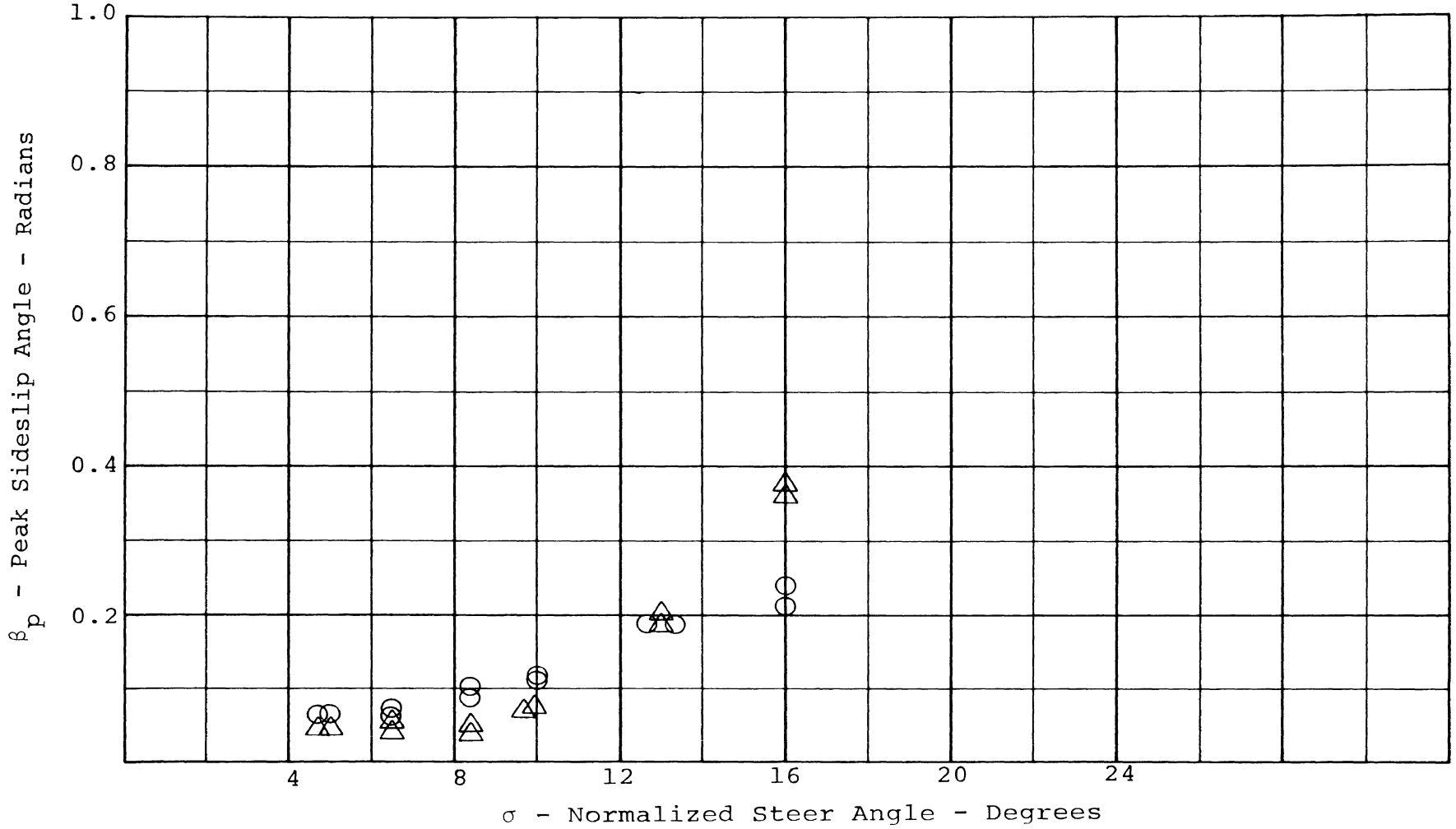
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [CONDITION - OE]



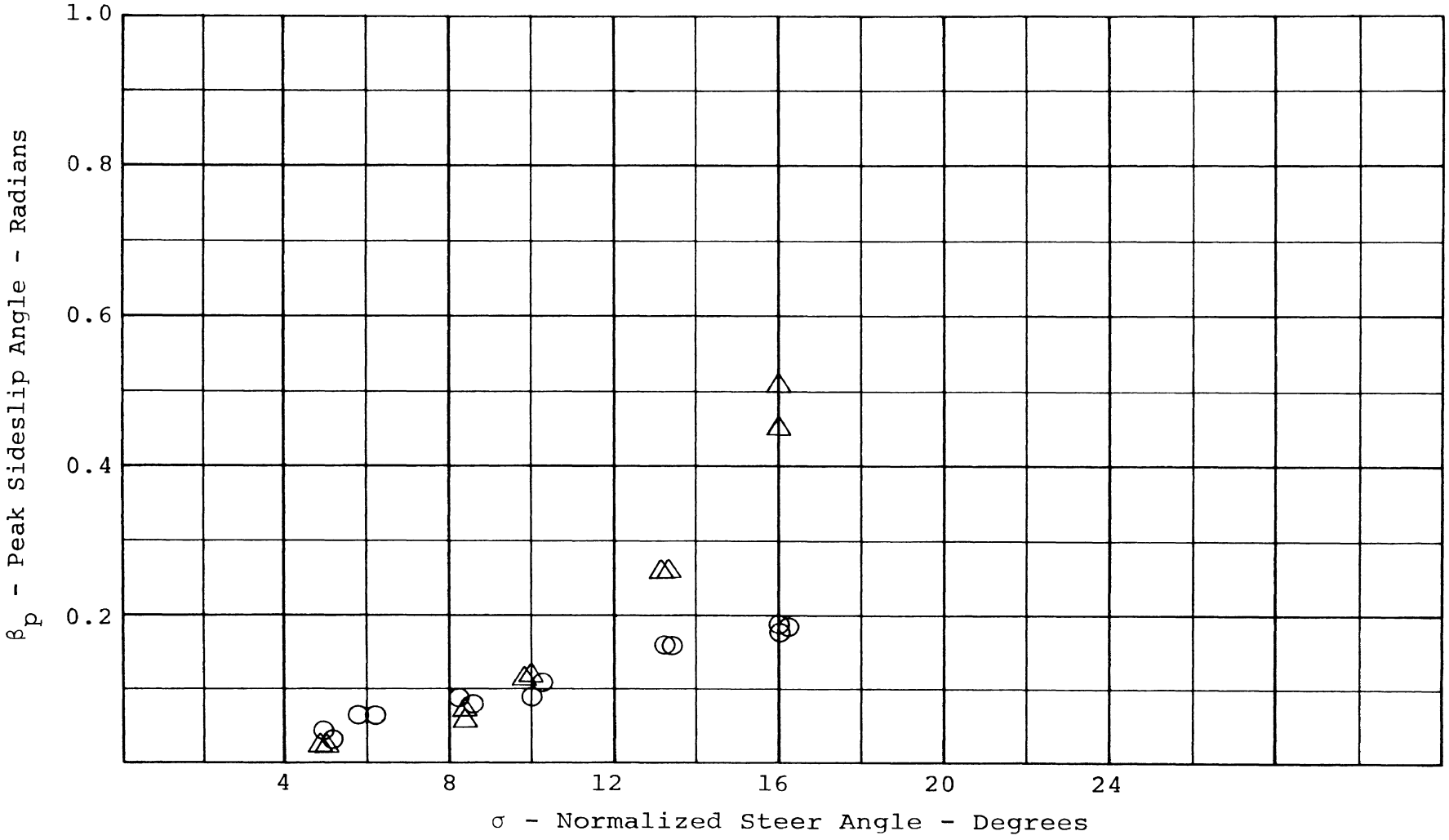
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [CONDITION - A-1]



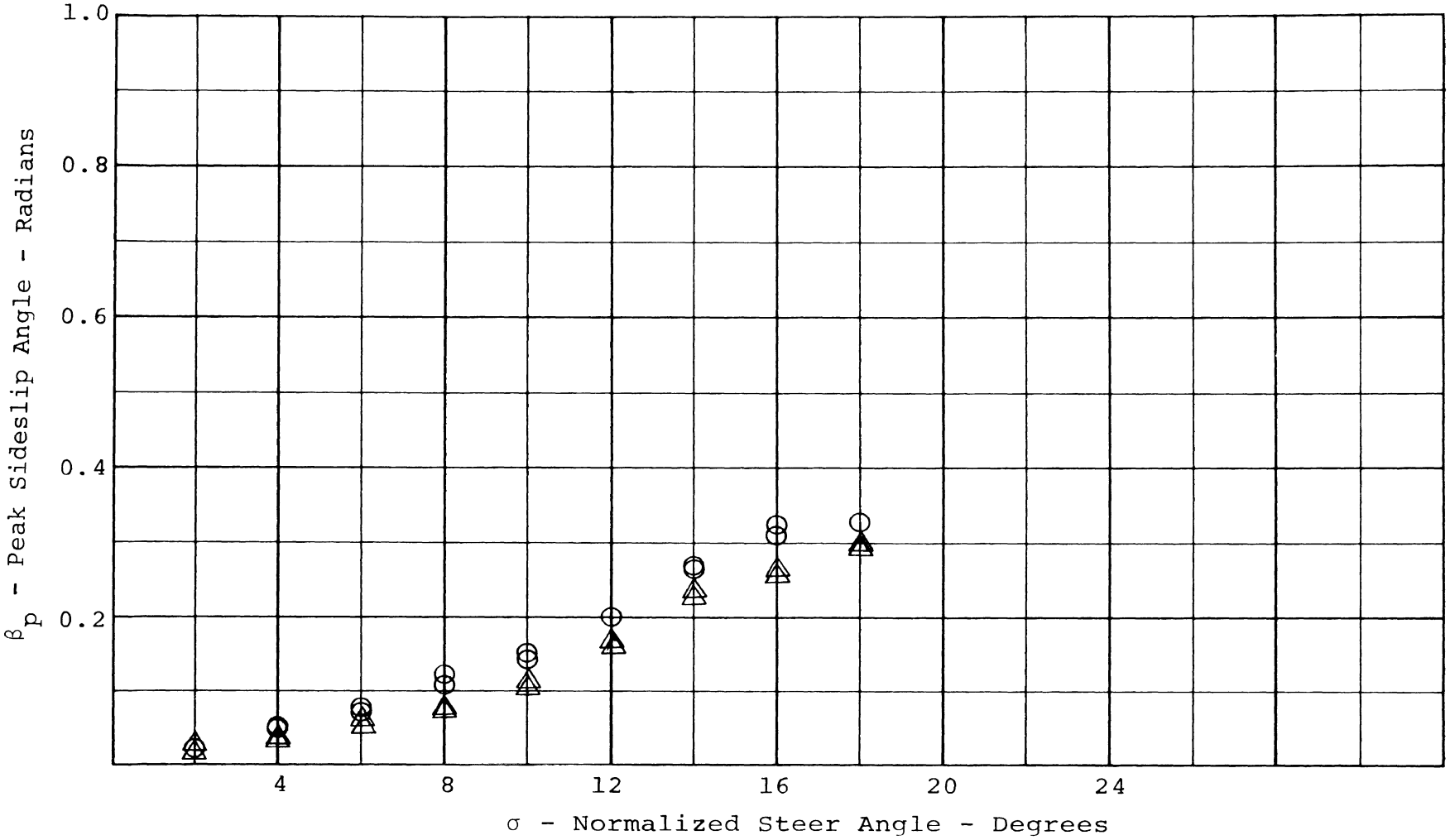
SINSUOIDAL STEER - 60 MPH - AMBASSADOR [CONDITION - A-2]



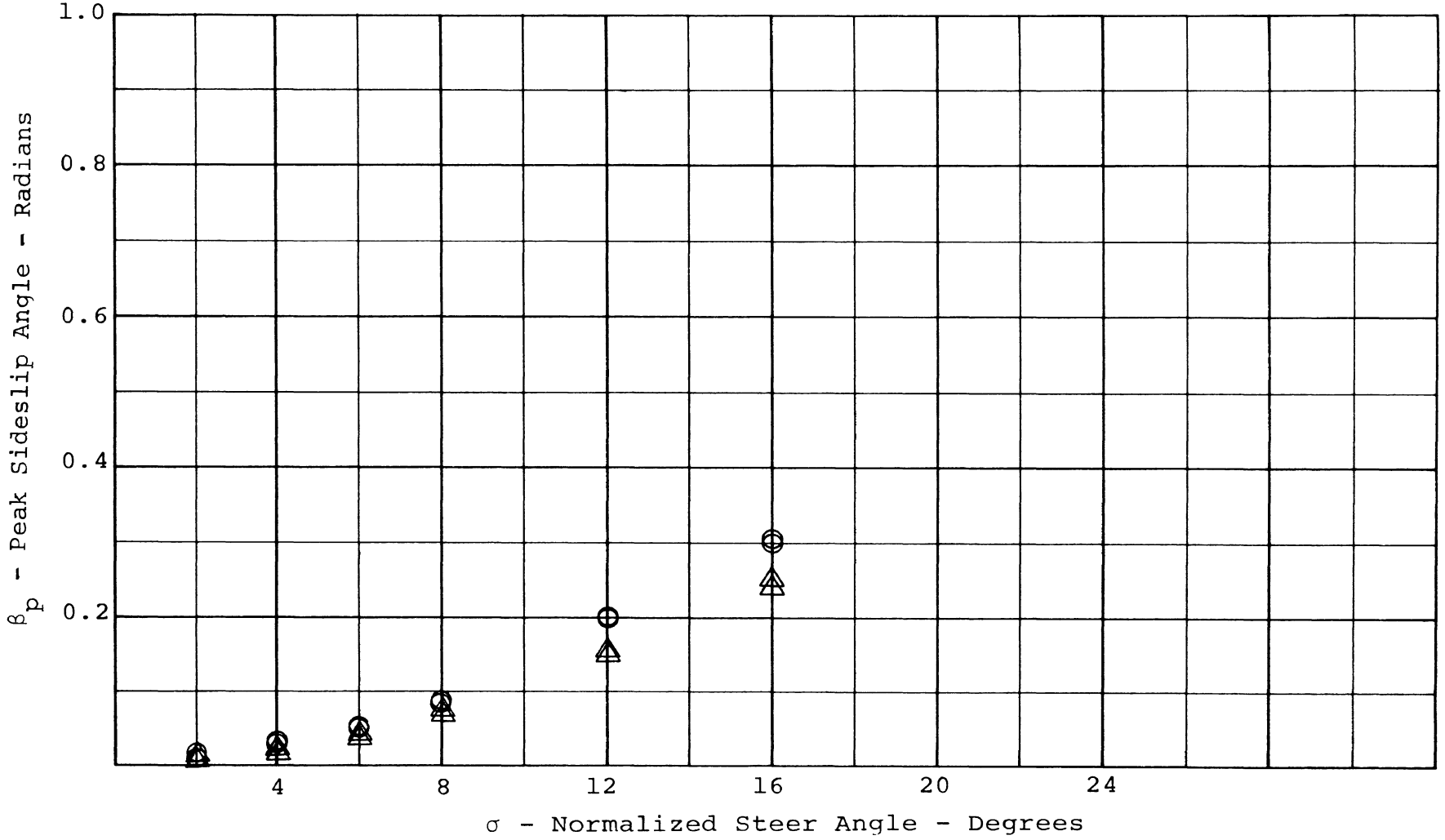
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [CONDITION - A-3]



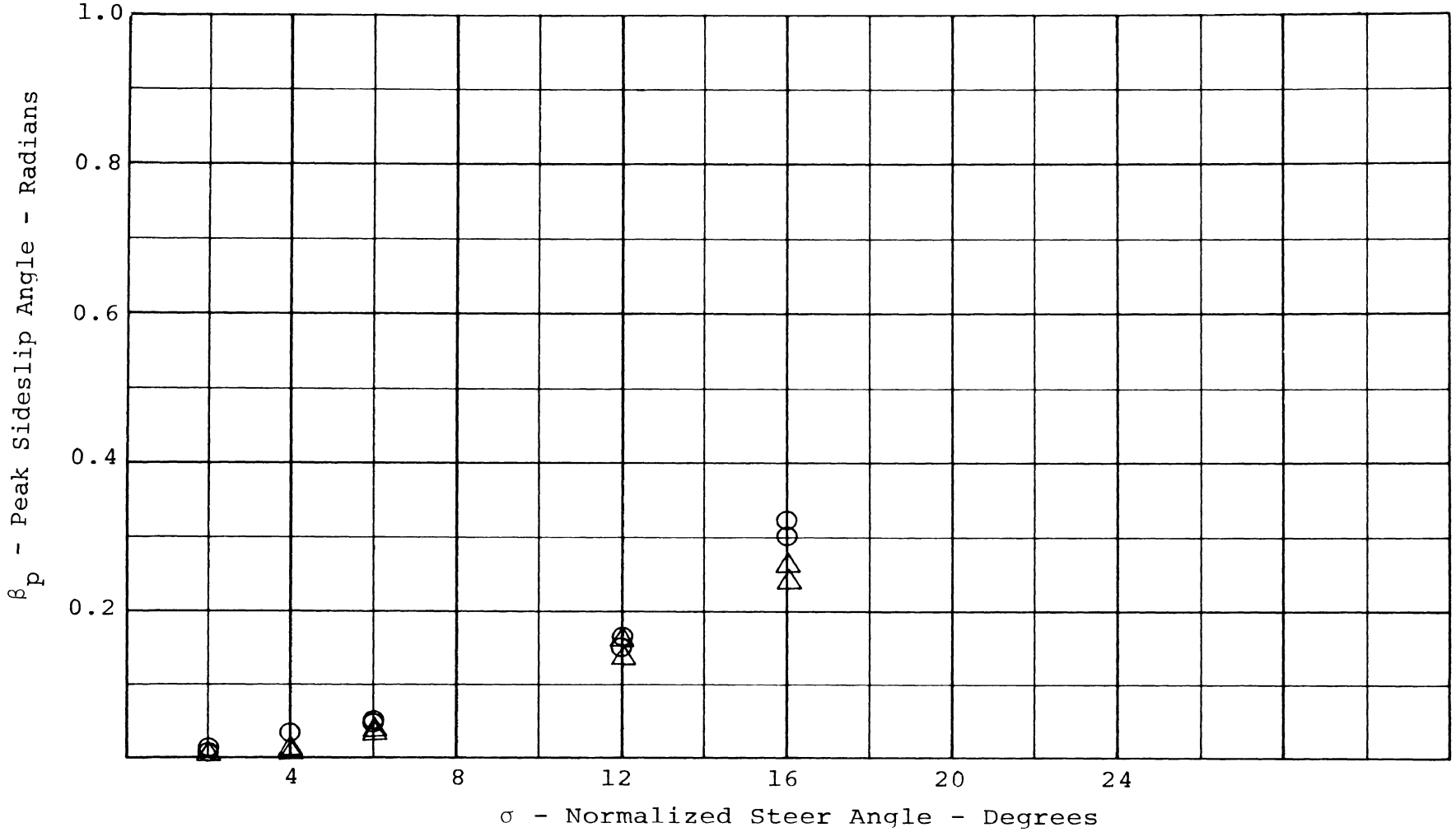
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [CONDITION - A-4]



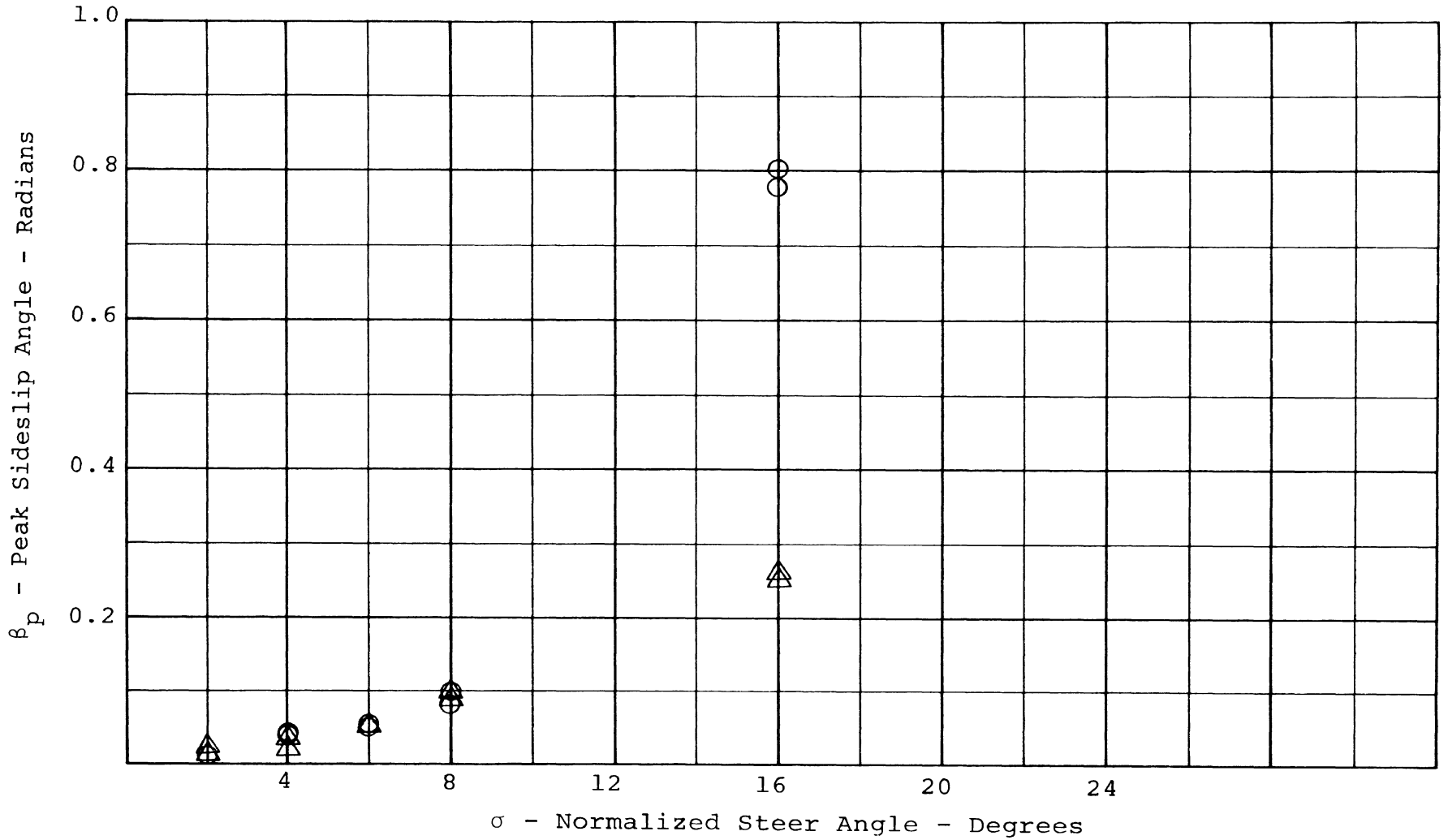
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - OE]



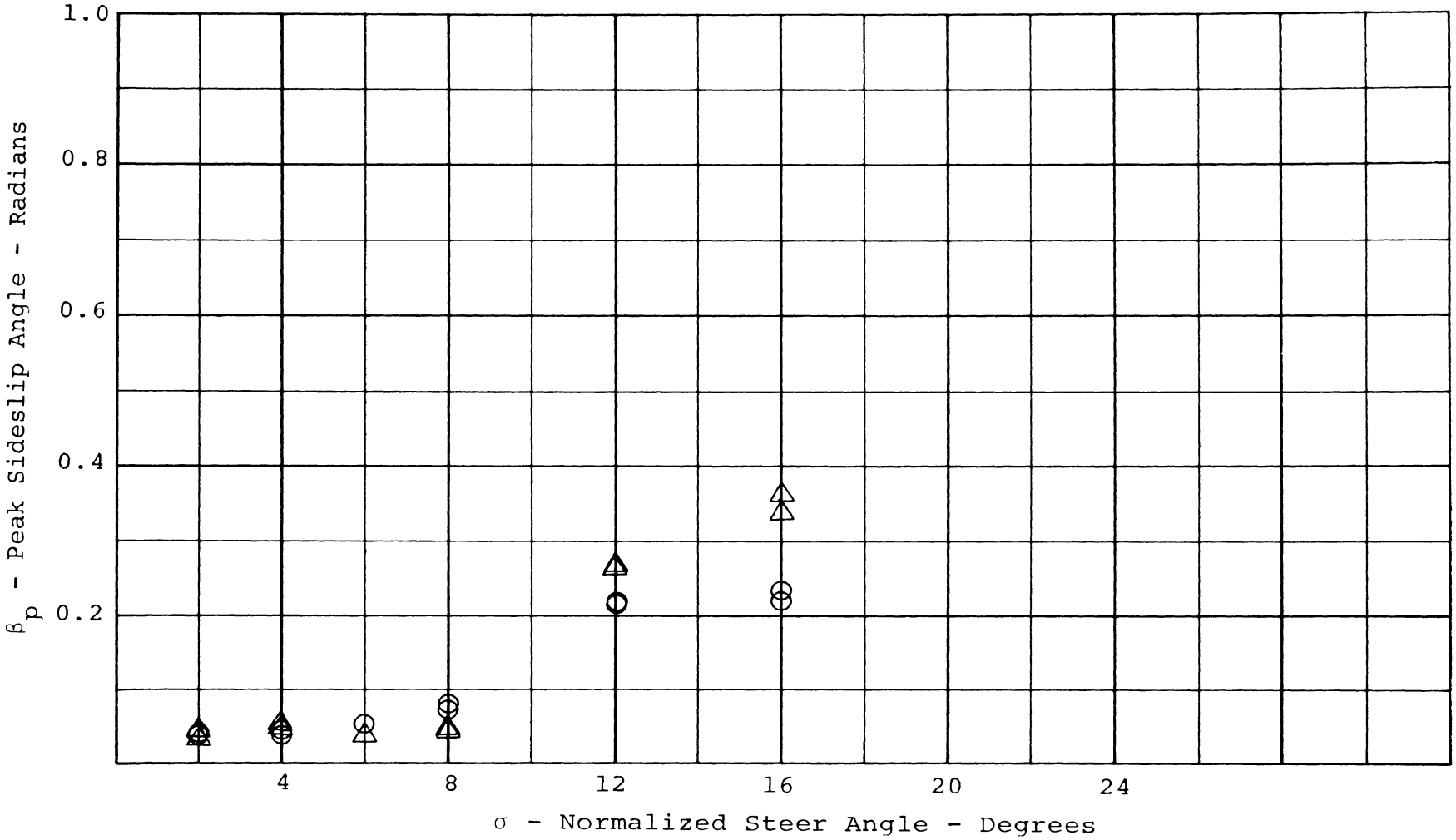
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A1]



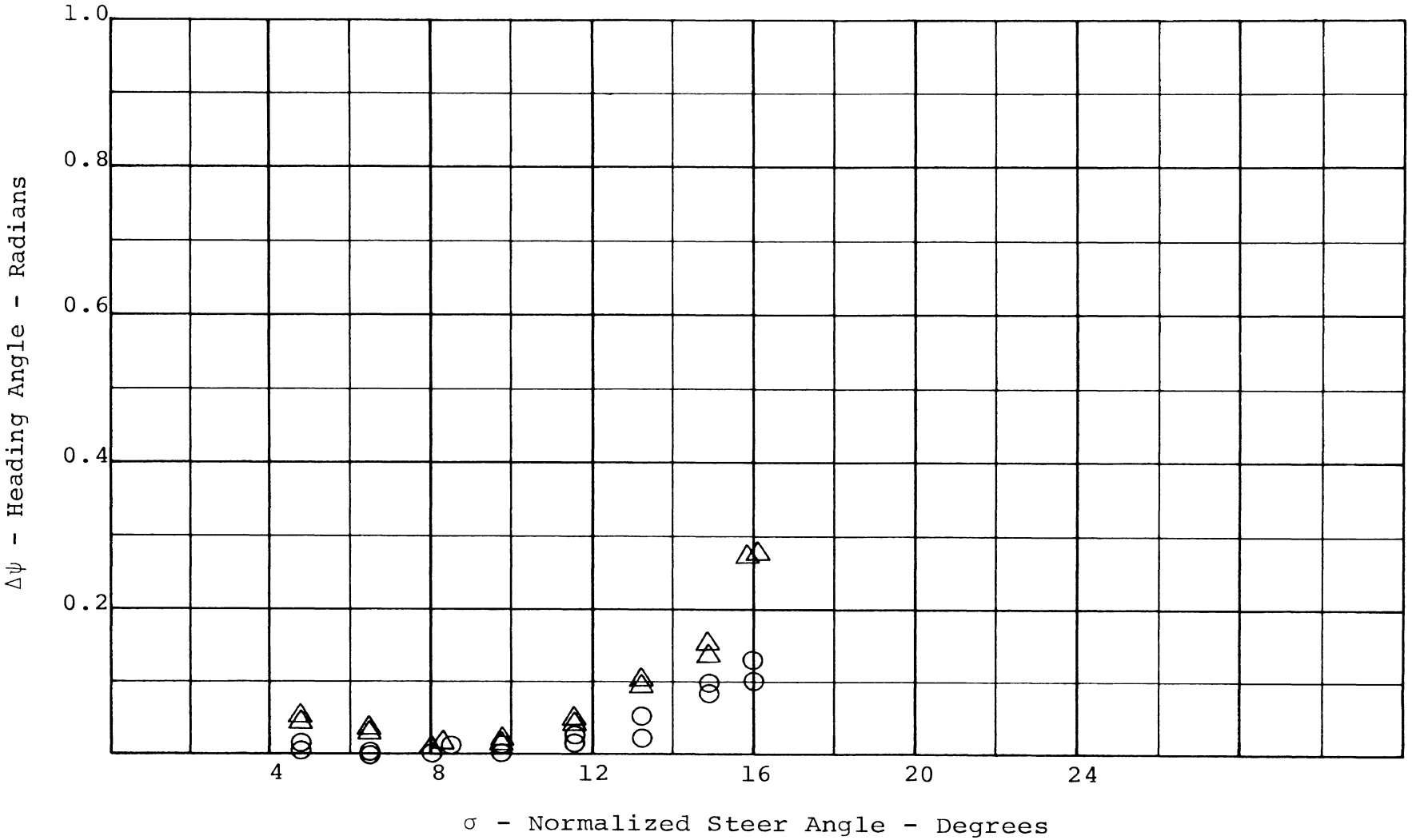
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A2]



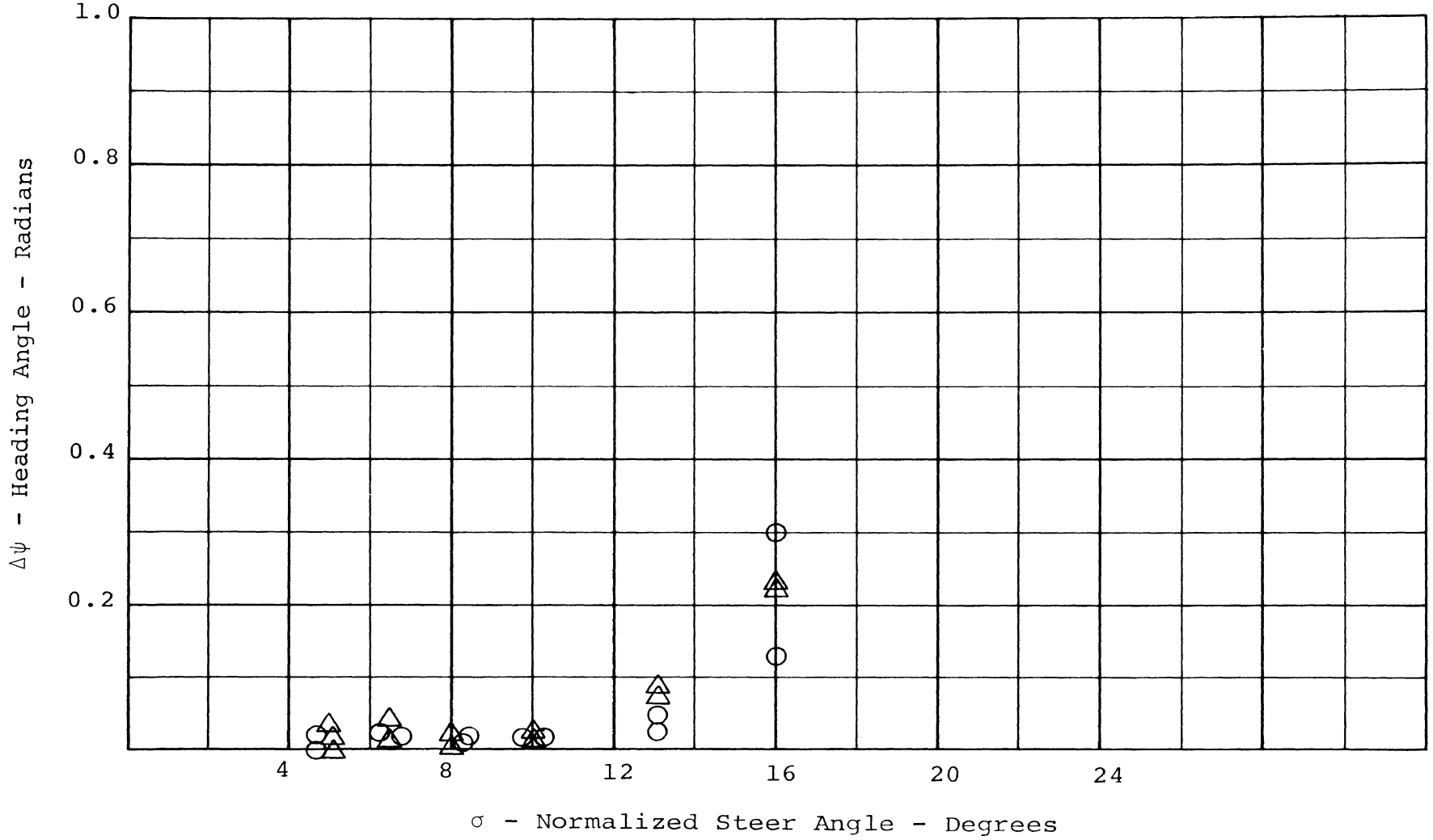
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A3]



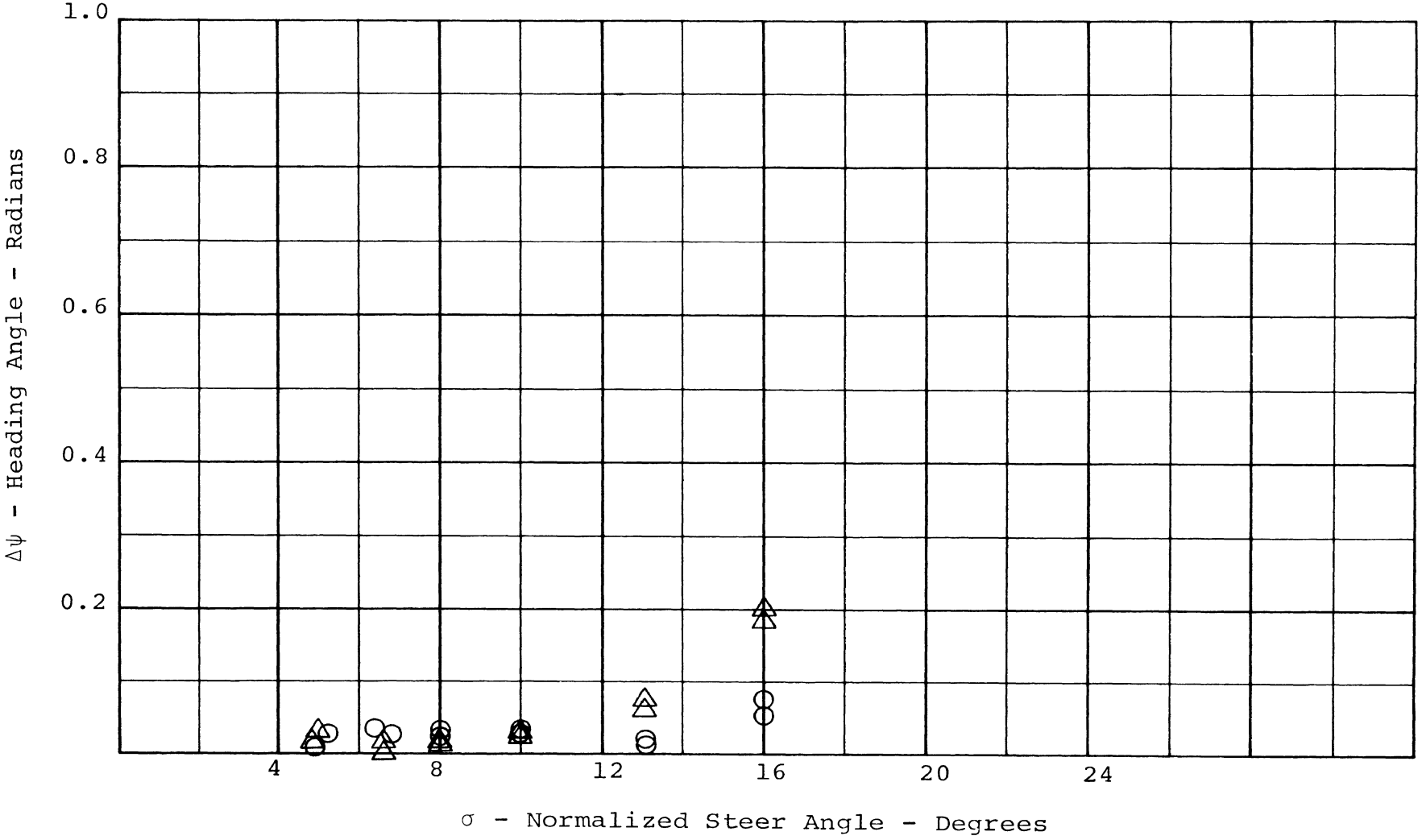
SINUSOIDAL STEER - 60 MPH - DODGE [CONDITION - A4]



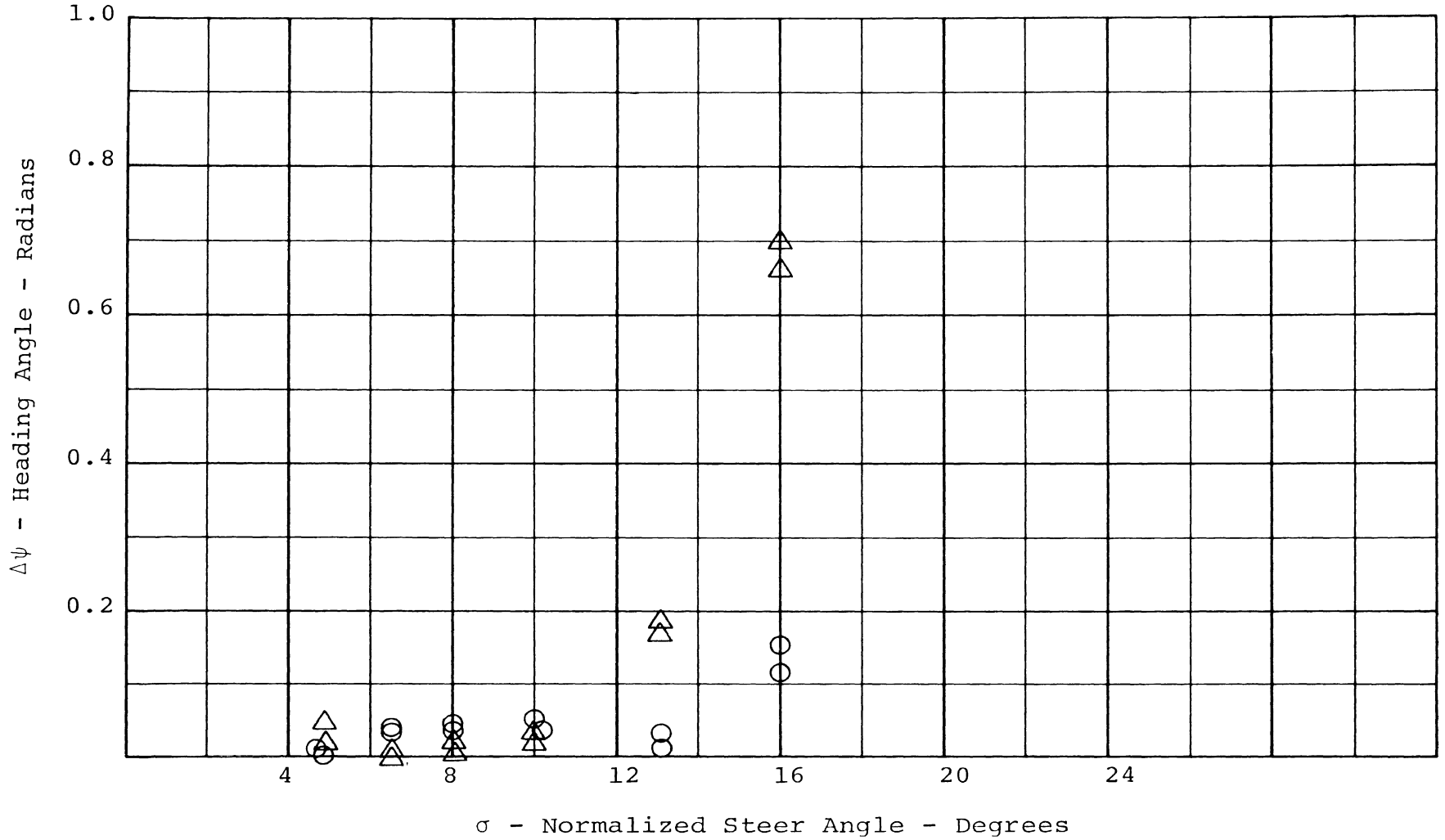
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition OE]



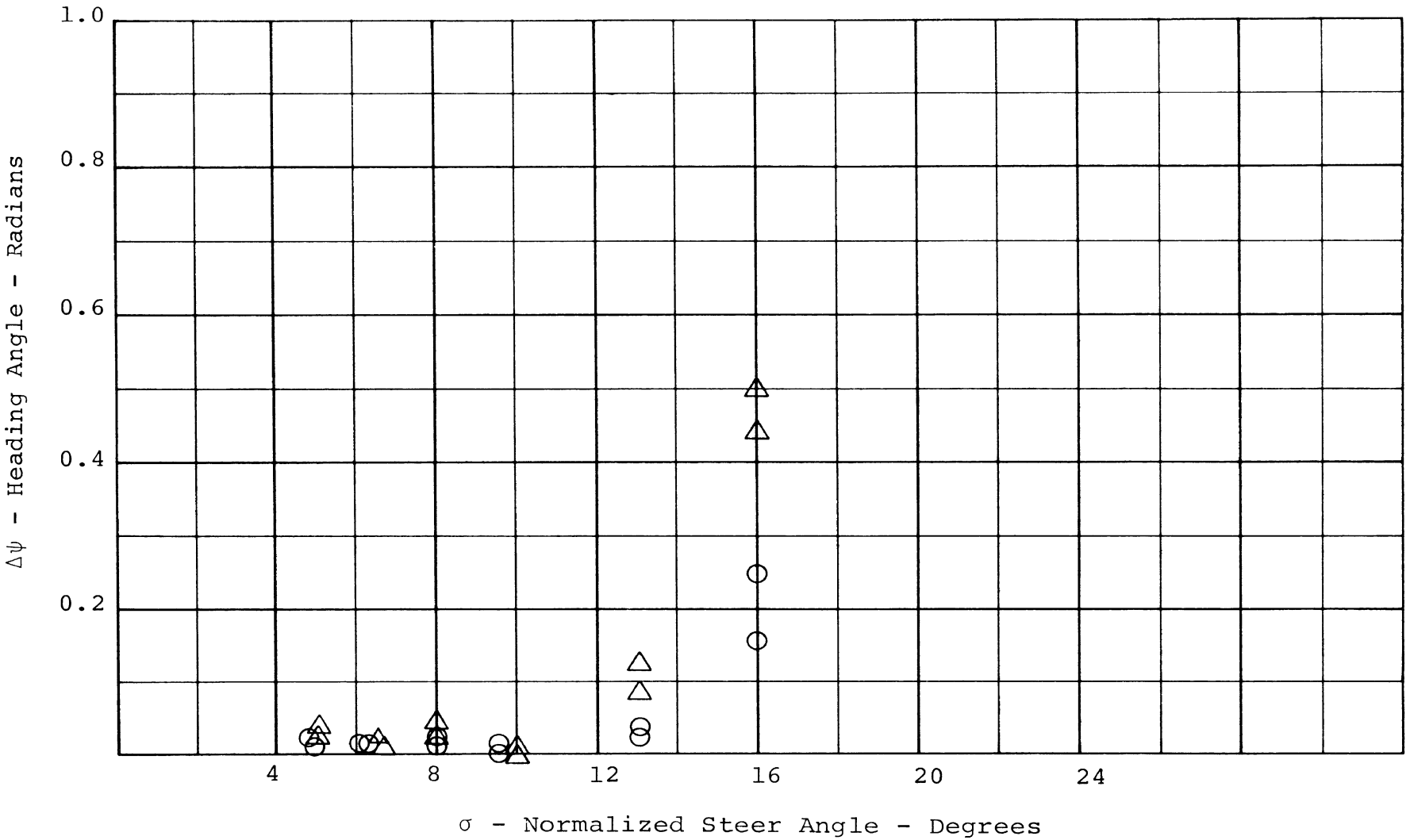
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A1]



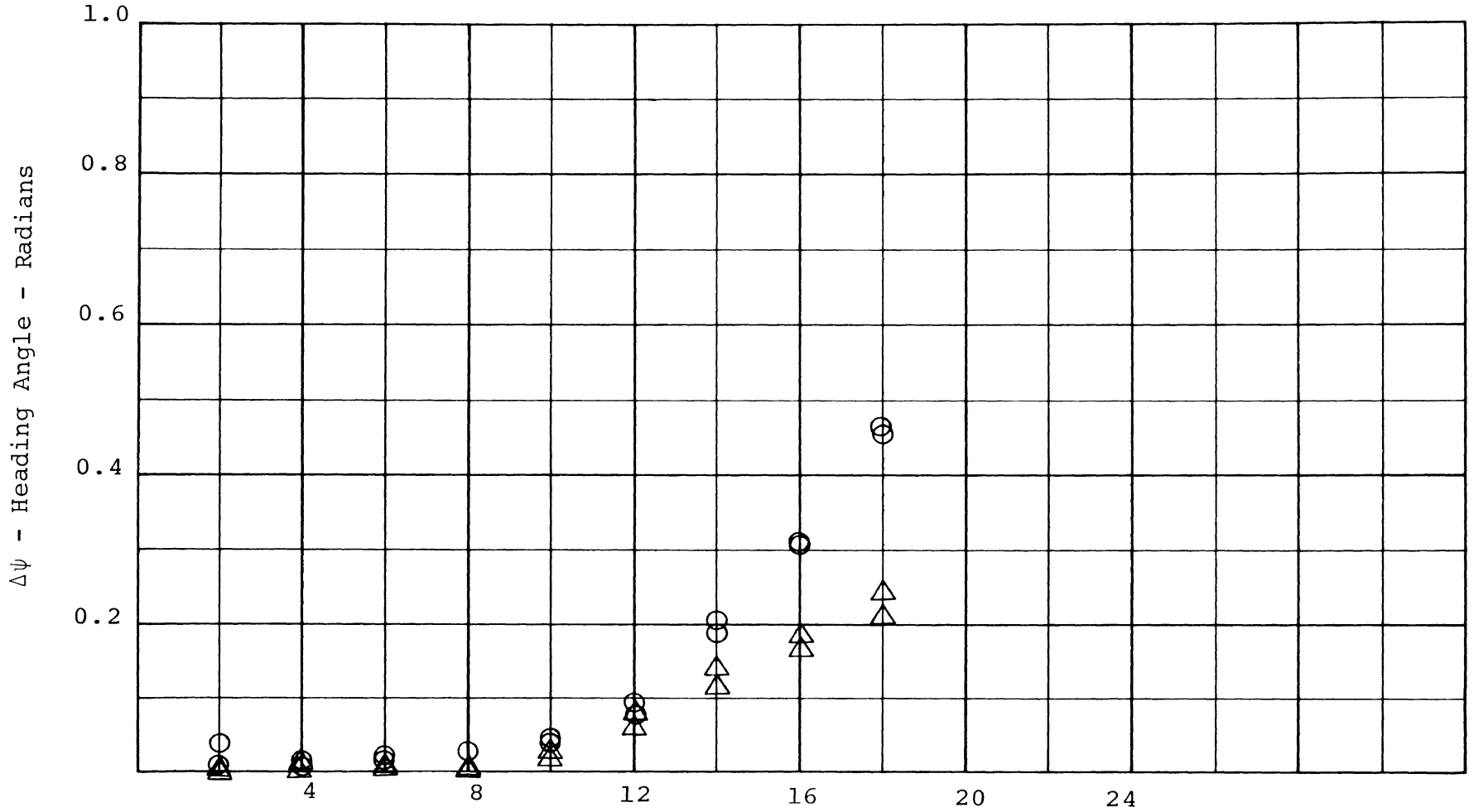
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A2]



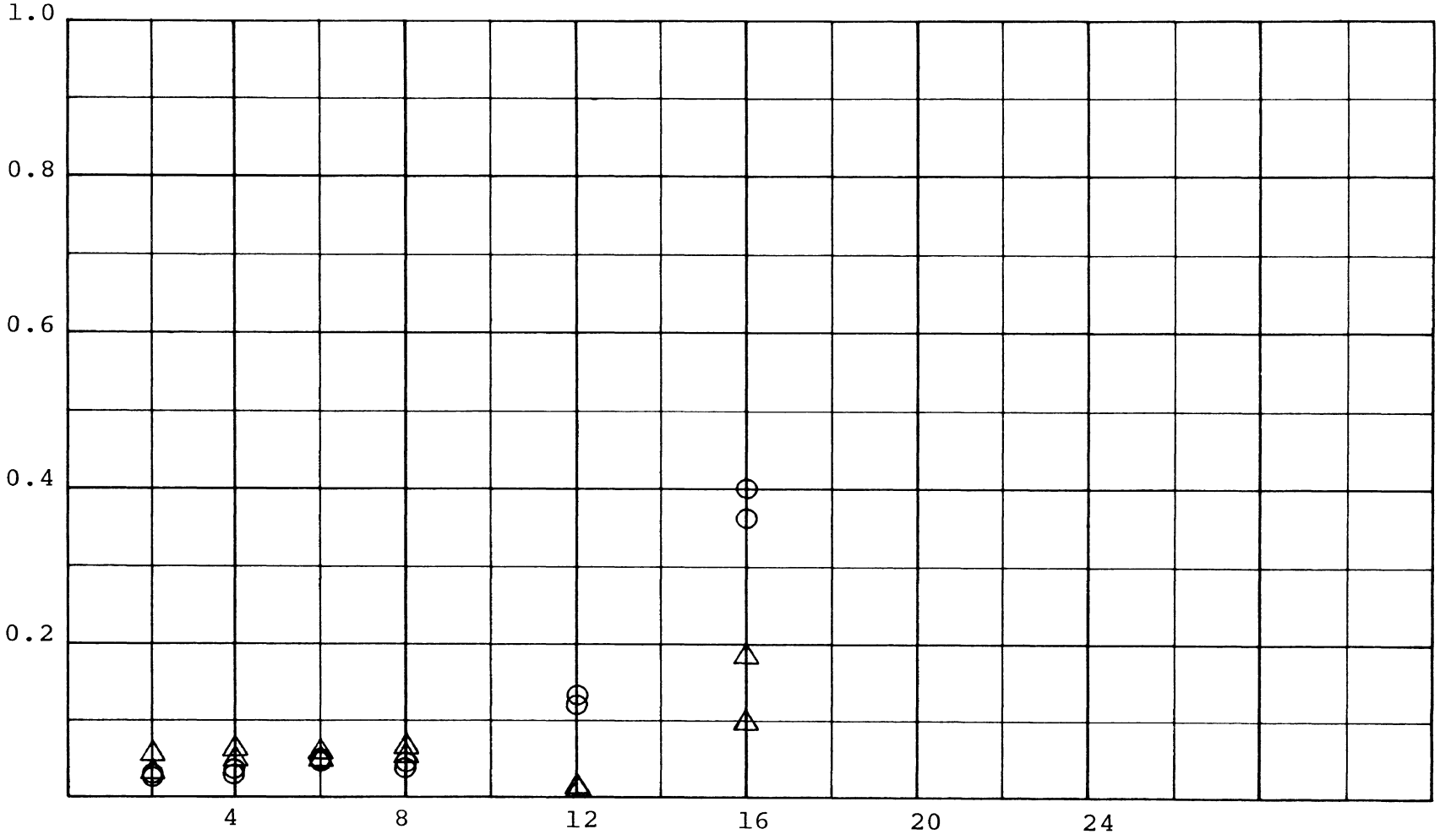
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A3]



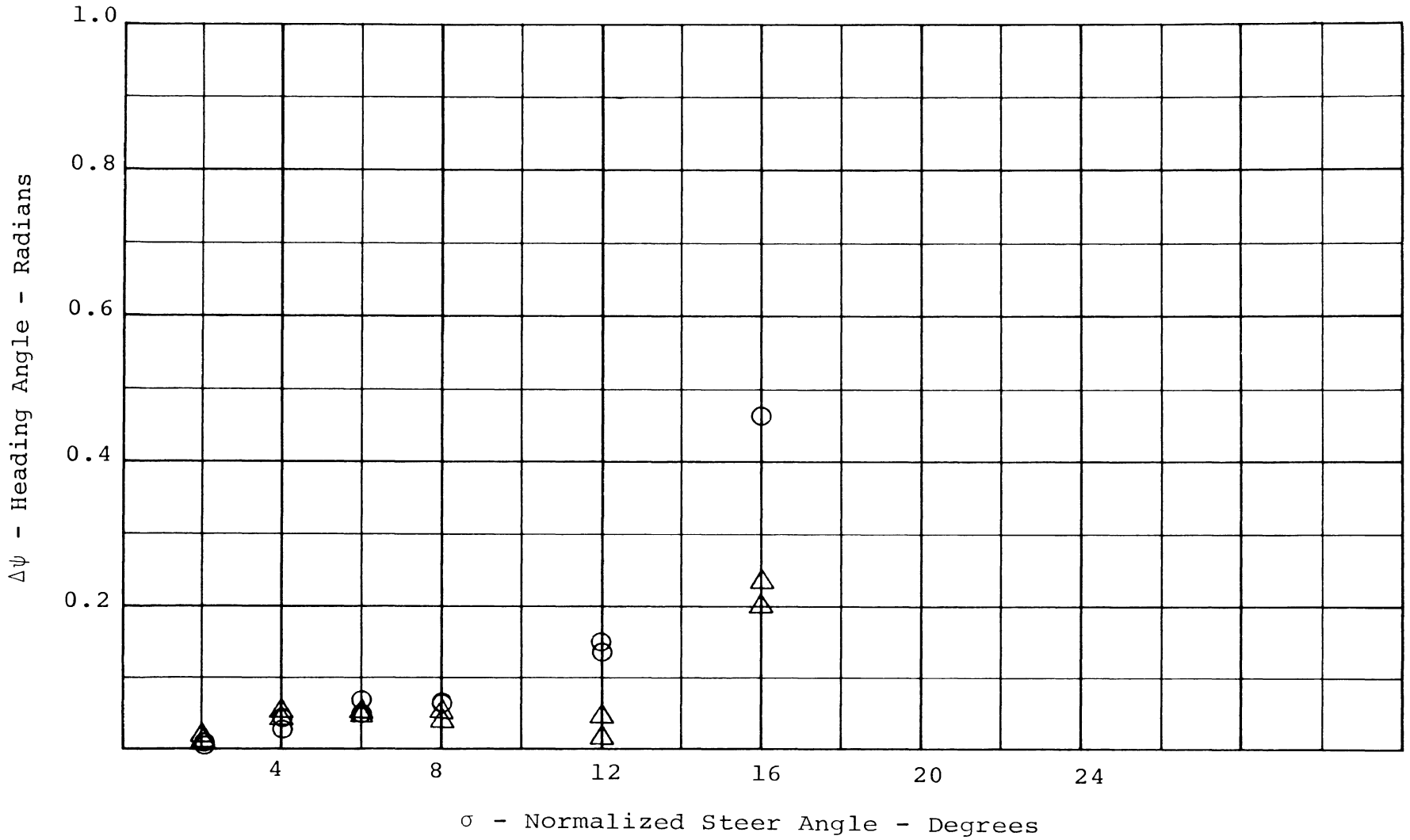
SINUSOIDAL STEER - 45 MPH - AMBASSADOR [condition A4]



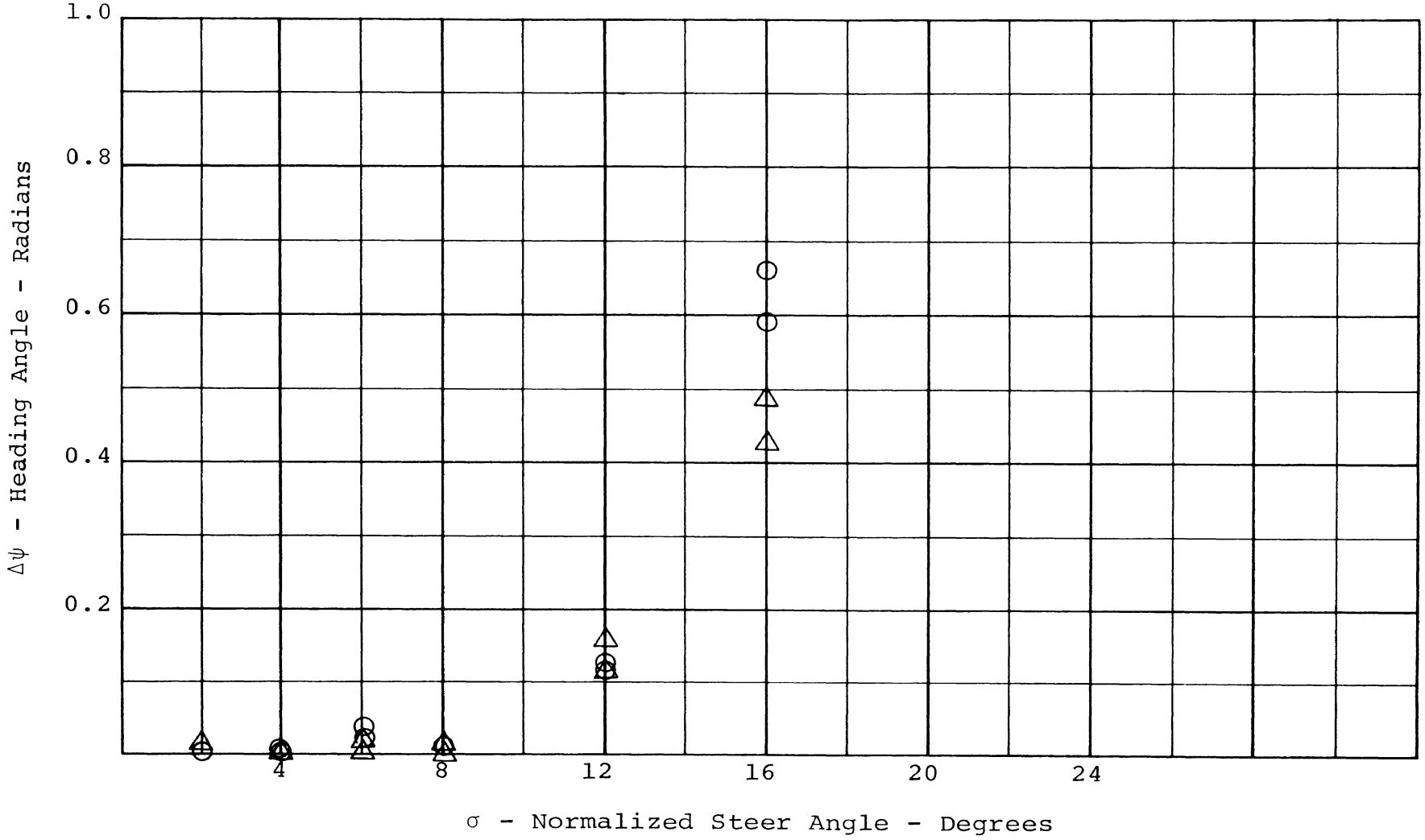
SIMUSOIDAL STEER - 45 MPH - DODGE [condition OE]



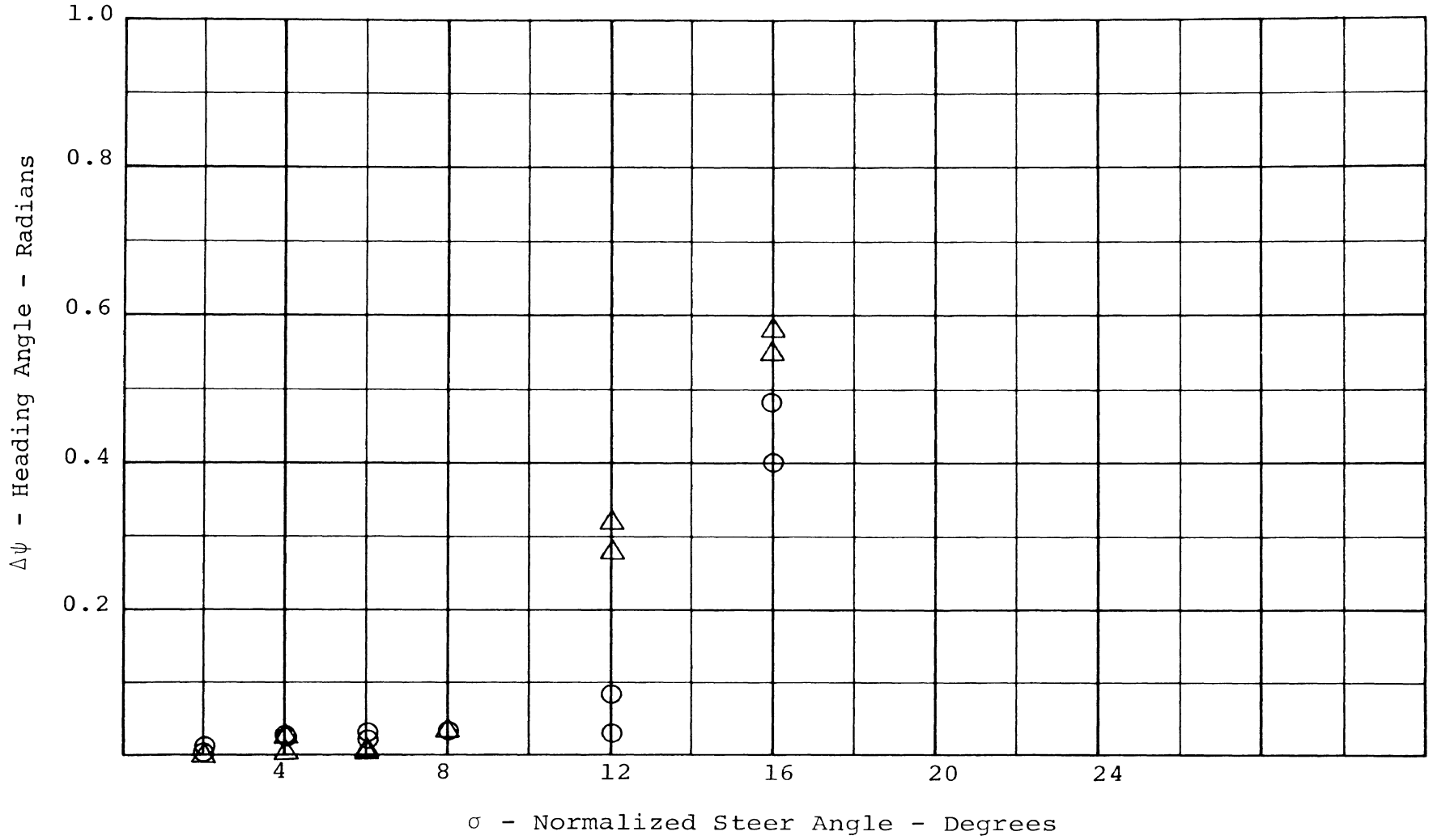
SINUSOIDAL STEER - 45 MPH - DODGE [condition A1]



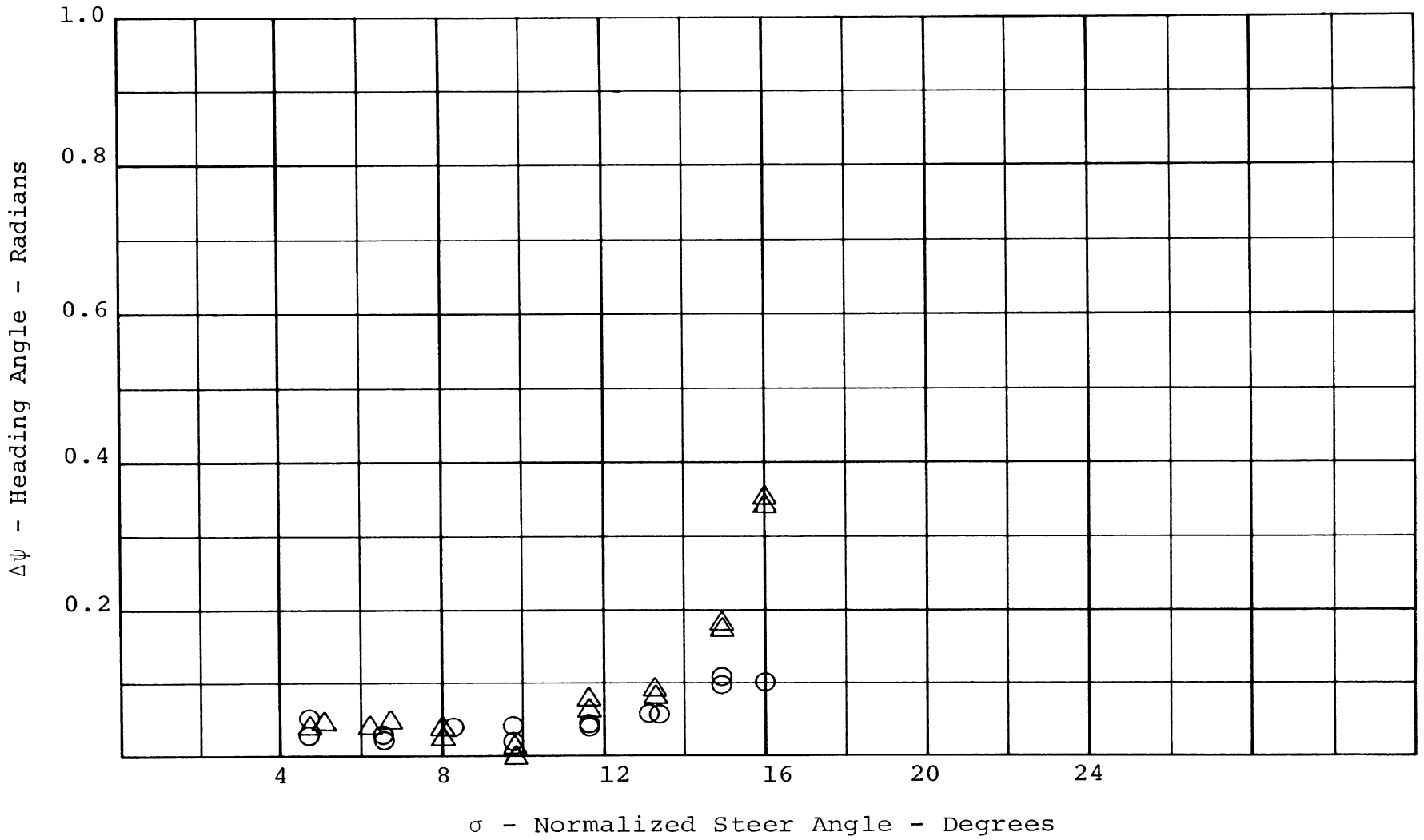
SINUSOIDAL STEER - 45 MPH - DODGE [condition A2]



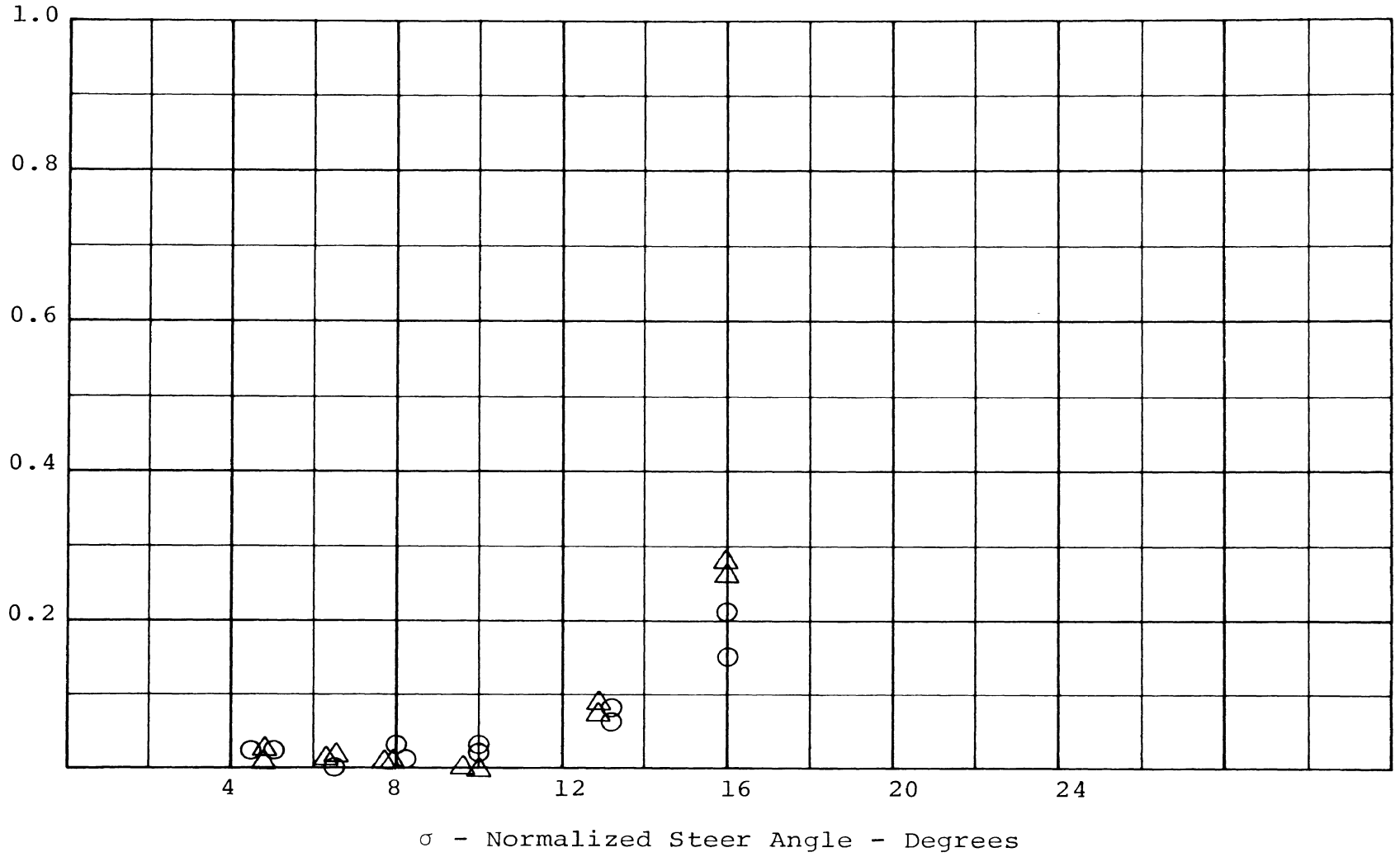
SINUSOIDAL STEER - 45 MPH - DODGE [condition A3]



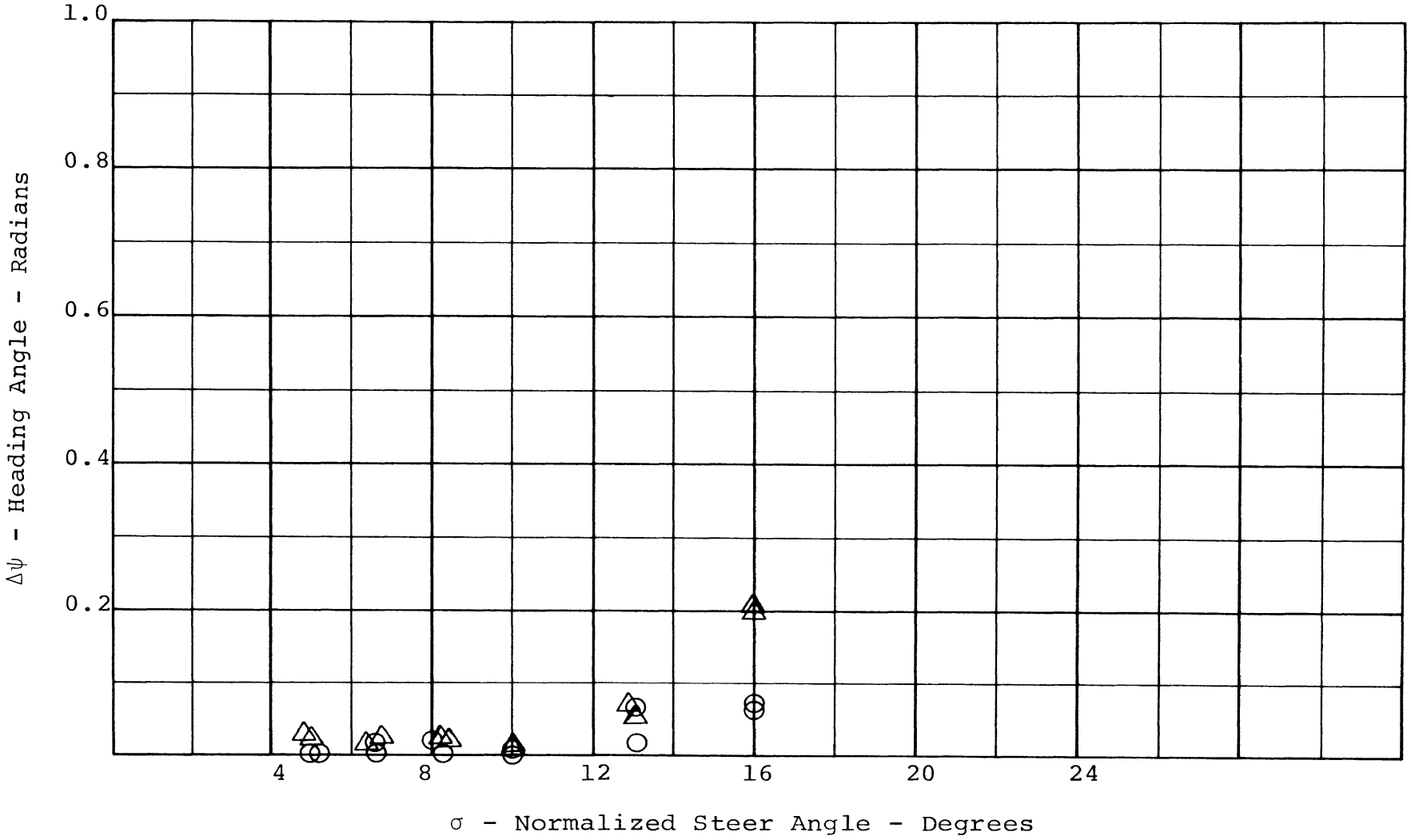
SINUSOIDAL STEER - 45 MPH - DODGE [condition A4]



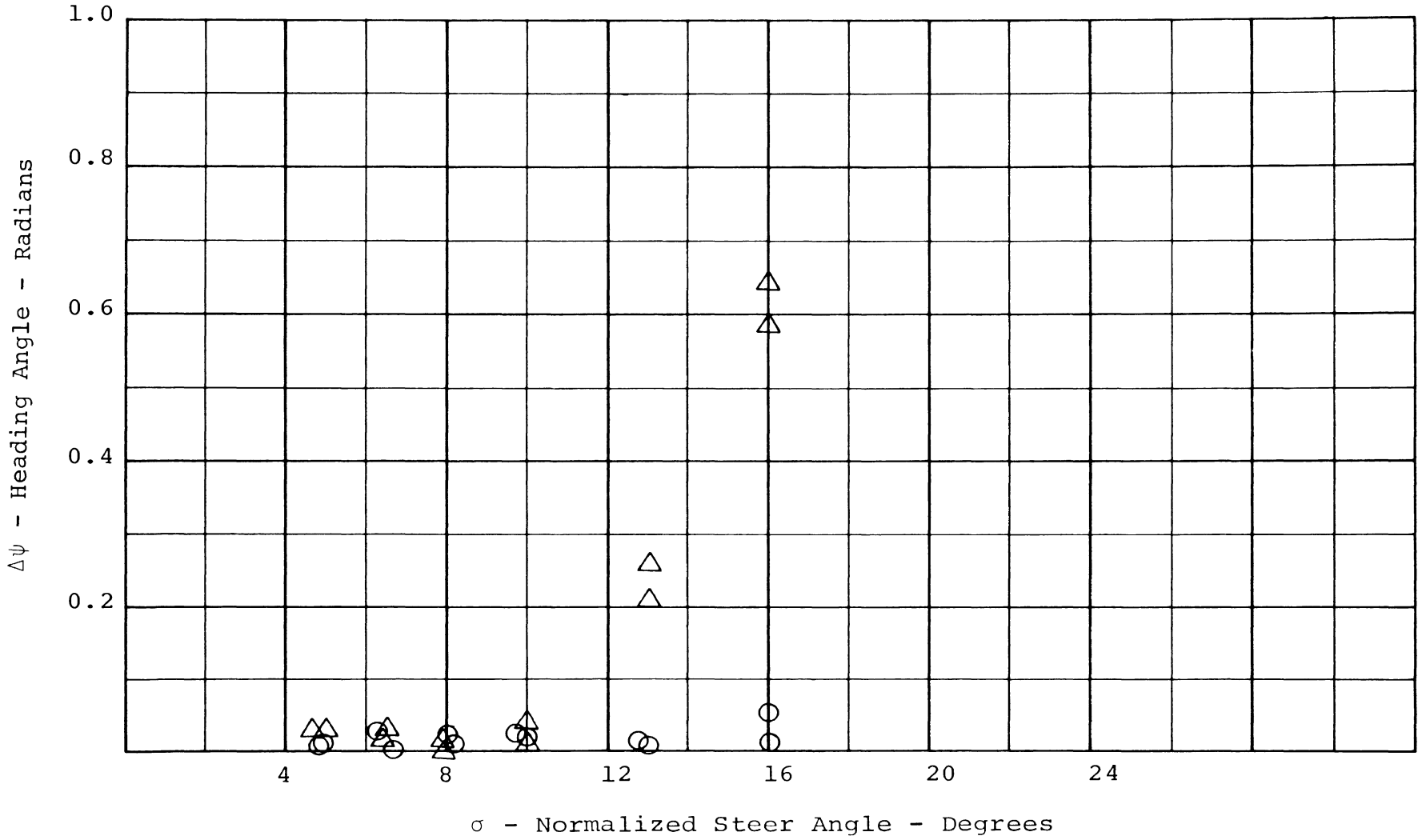
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition OE]



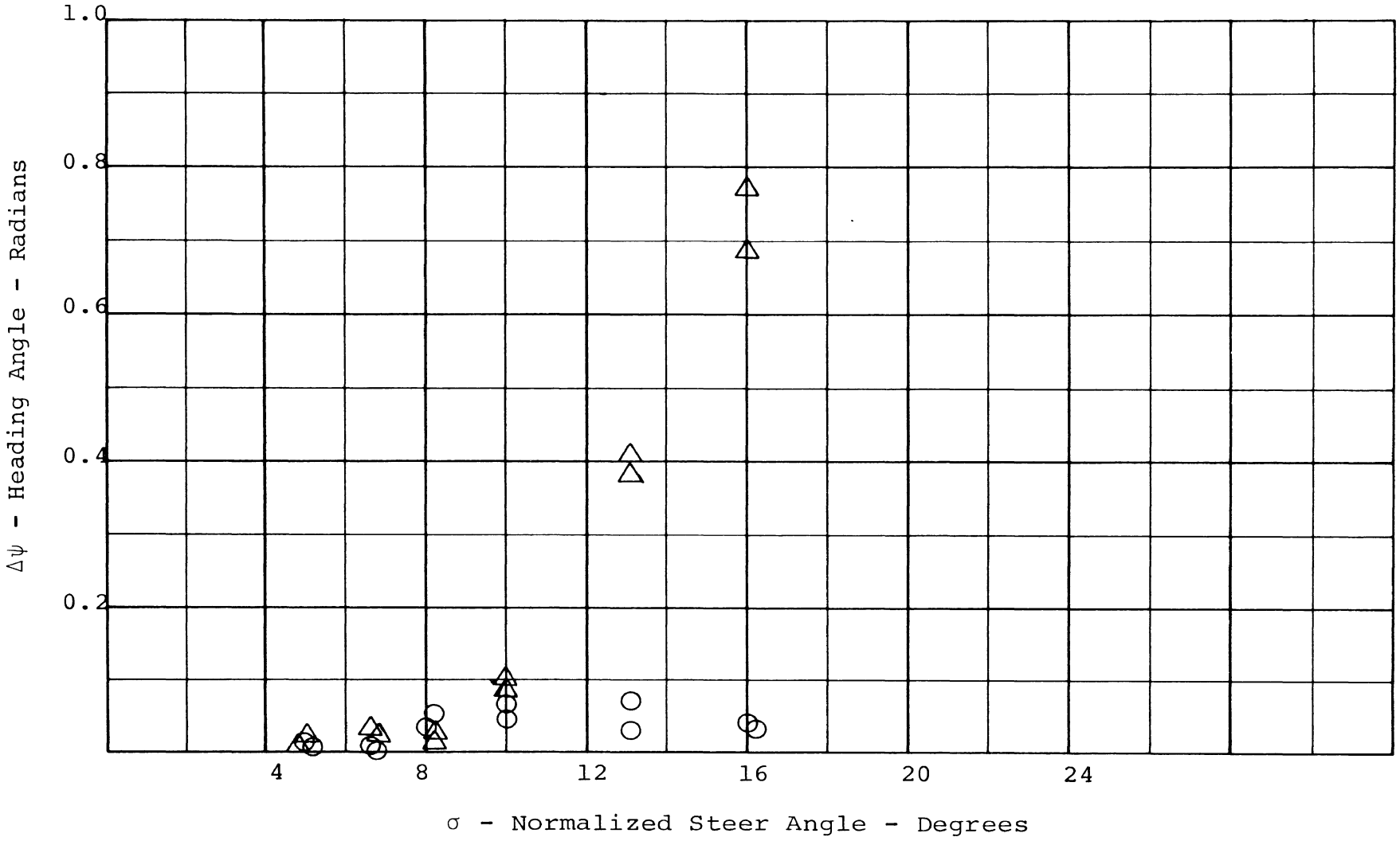
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition A1]



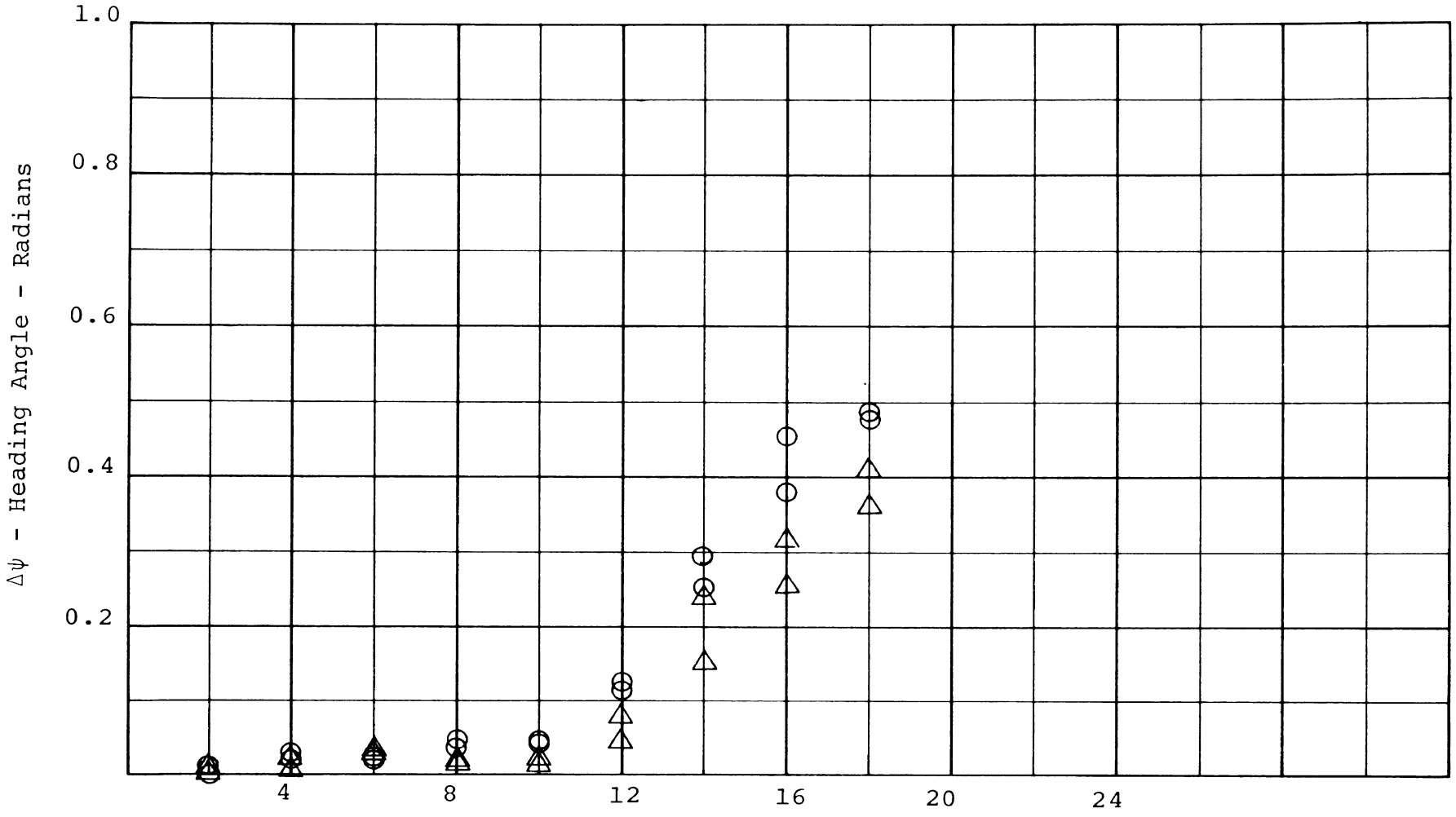
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition A2]



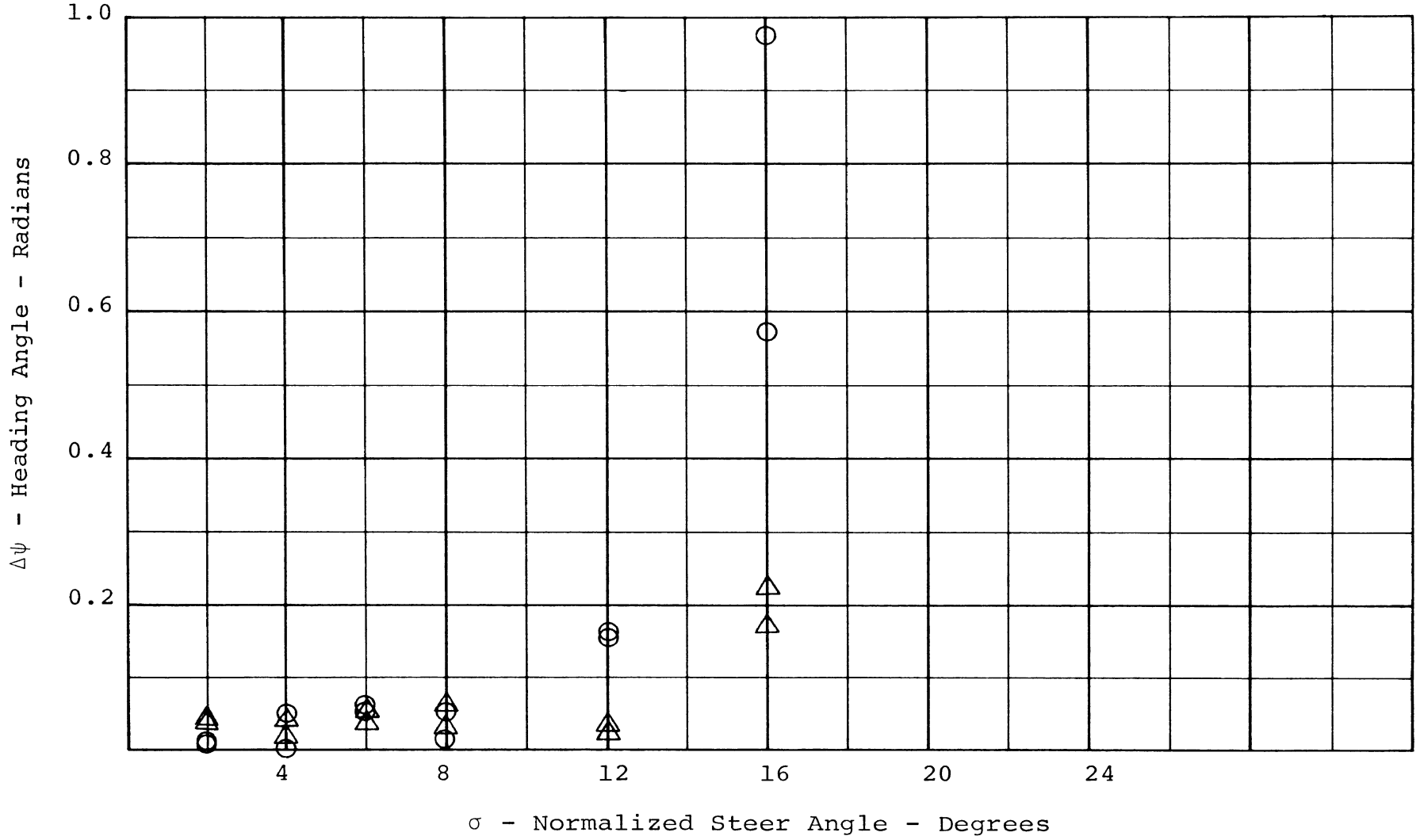
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition A3]



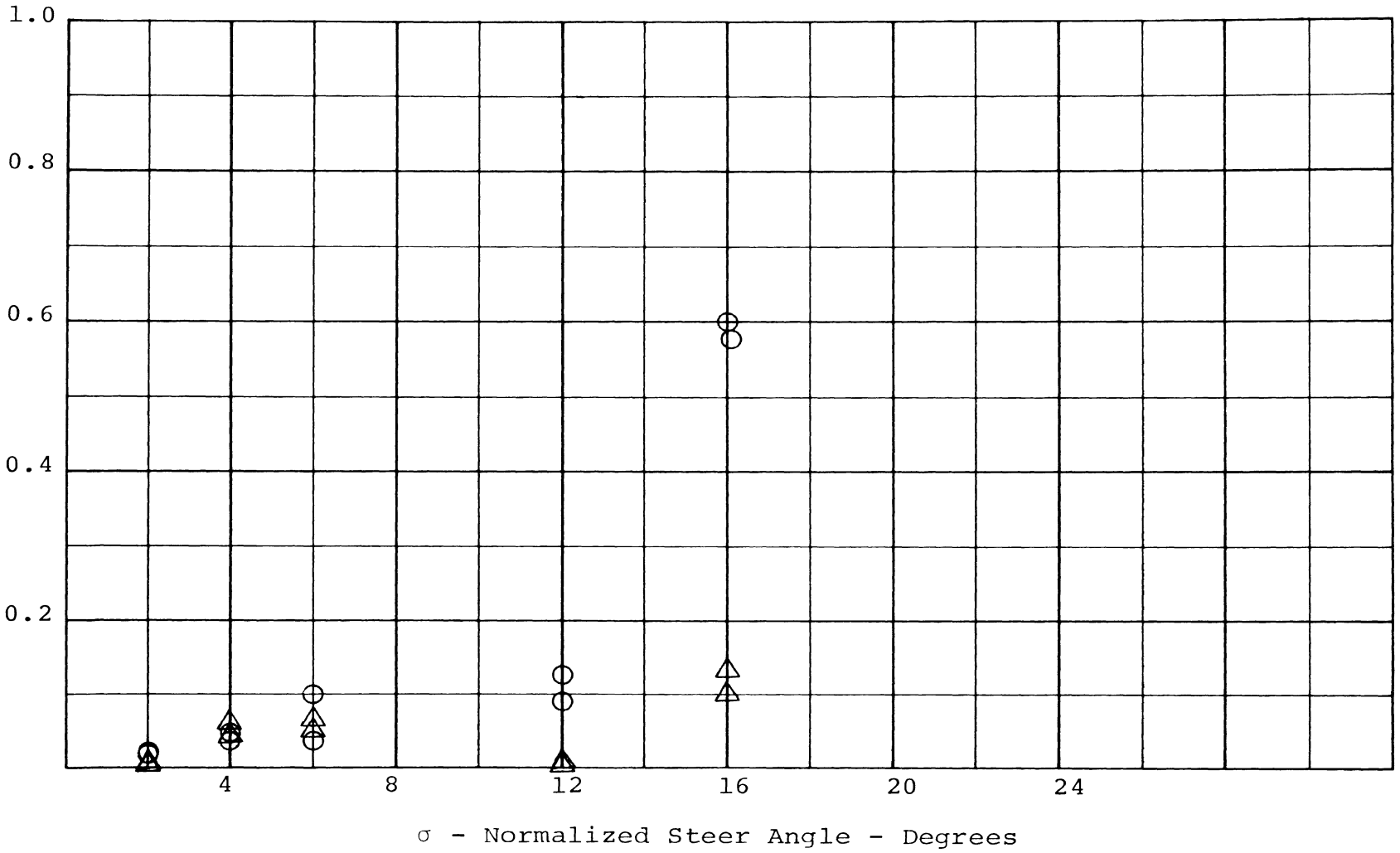
SINUSOIDAL STEER - 60 MPH - AMBASSADOR [condition A4]



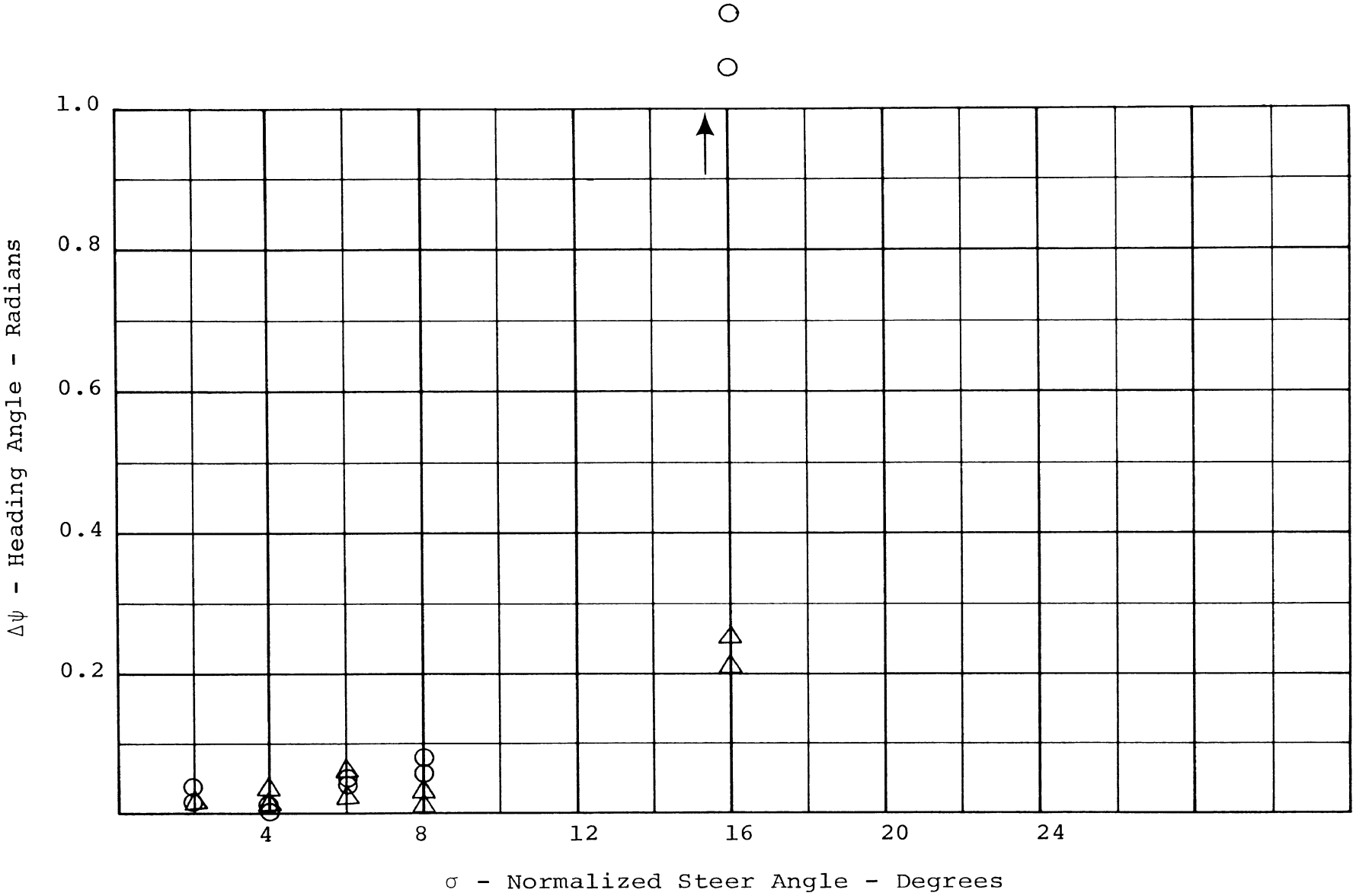
SINUSOIDAL STEER - 60 MPH - DODGE [condition OE]



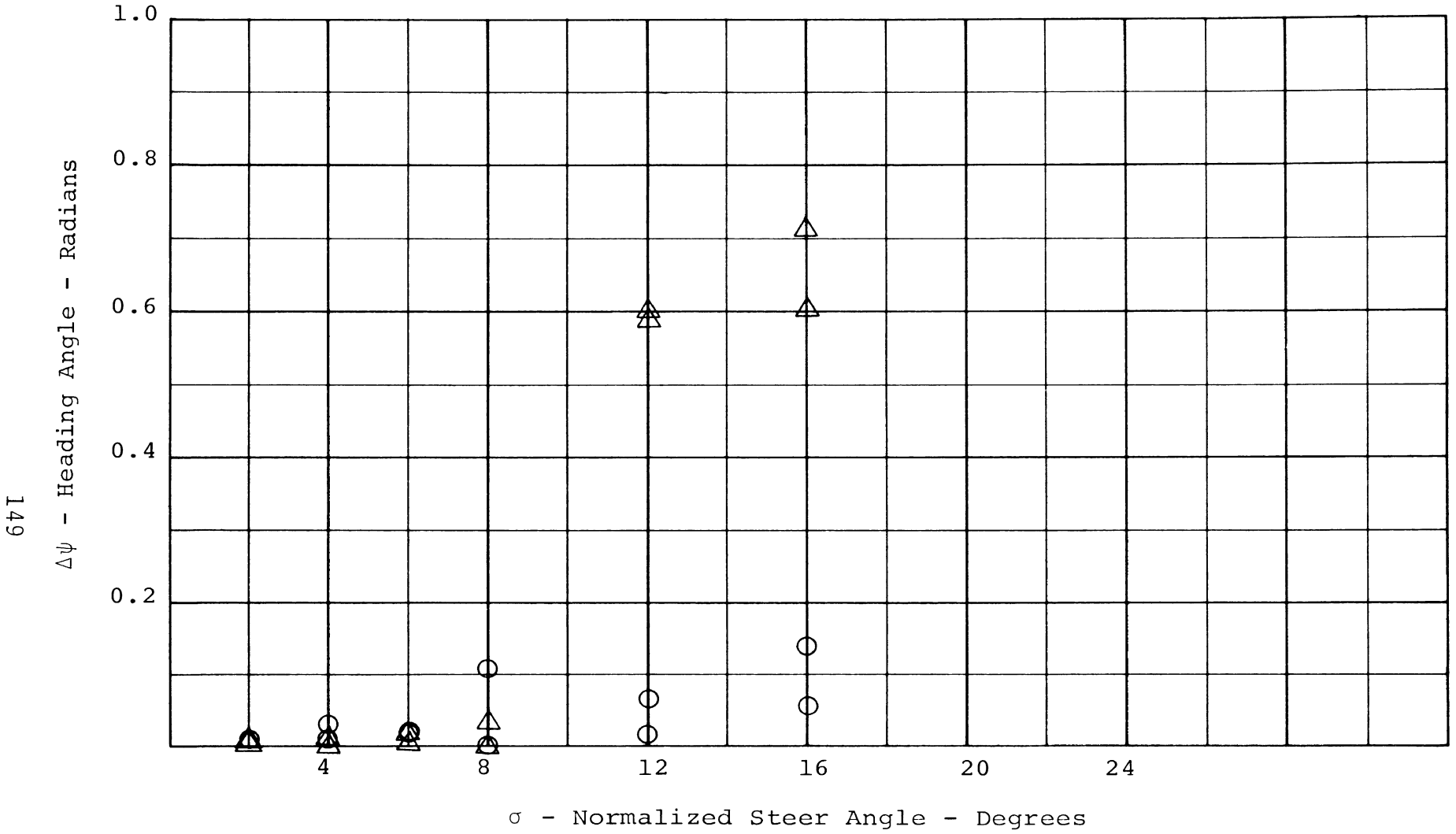
SINUSOIDAL STEER - 60 MPH - DODGE [condition A1]



SINUSOIDAL STEER - 60 MPH - DODGE [condition A2]



SINUSOIDAL STEER - 60 MPH - DODGE [condition A3]



SINUSOIDAL STEER - 60 MPH - DODGE [condition A4]