UMTRI-83-40

EVALUATION OF BARRIER LIMIT CAPACITY FOR DIFFERENT CLASSES OF VEHICLES AND IMPACT CONDITIONS

Parameter Measurements of:

1982 Chevrolet S-10 Pickup
1982 Chevrolet C-10 Pickup
1982 Ford F-150 Van

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Subcontract L300005(RF4798)

August 1983

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle EVALUATION OF BARRIER LIMIT CAPACITY FOR DIFFERENT CLASSES OF VEHICLES AND IMPACT CONDITIONS Parameter Measurements of: 1982 Chevrolet S-10 Pickup, 1982 Chevrolet C-10 Pickup, 1982 Ford F-150 Van		5. Report Date August 1983
		6. Performing Organization Code
7. Author(s) C.B. Winkler		8. Performing Organization Report No. UMTRI-83-40
9. Performing Organization Name and Address The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, Michigan 48109		10. Work Unit No.
		11. Contract or Grant No. L 300005(RF4798)
12. Sponsoring Agency Name and Address Texas Transportation Institute Texas A&M University College Station, Texas		13. Type of Report and Period Covered Final 4-1-83/7-31-83
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Parameter measurements of three vehicles—1982 Chevrolet S-10 pickup, 1982 Chevrolet C-10 pickup, 1982 Ford F-150 van—were made. Techniques used for making the measurements are described and results are given.

17. Key Words Measurement, parameters, center of gravity, moments of inertia, suspension rates, unsprung mass	18. Distribution Statement UNLIMITED		
19. Security Classif. (of this report) NONE	20. Security Classif. (of this page) NONE	21. No. of Pages 41	22. Price

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The author would like to acknowledge the assistance of the following individuals who provided the shock absorber data presented herein: Mr. Michael Bethell, Monroe Auto Equipment Company, Messrs. Phillip Doolittle and J.W. Wensits, General Motors Corporation, and Dr. A. Sitchen, Ford Motor Company.

1. INTRODUCTION

This document is the second of two reporting on the parameter measurements of six vehicles. The previous report was concerned with (1) a 1978 Honda Civic, (2) a 1979 Dodge B-200 van, and (3) a 1979 Ford F150 pickup. This document reports on measurements of (1) a 1982 S-10 Chevrolet pickup truck, (2) a 1982 C-10 Chevrolet pickup truck, and (3) a 1982 F-150 Ford van. The first set of three vehicles was purchased by UMTRI and later sent to TTI for crash testing. The three vehicles reported on herein were rented by UMTRI, and no further physical testing is planned.

Parameter data to be provided for each of the six vehicles are:

Total Vehicle Inertial Properties:
- Center of gravity position
- Three principal moments of inertia

Unsprung Mass, Front and Rear:
- Weights
- Position on the vehicle

Suspension Properties, Front and Rear:
- Vertical force deflection characteristics including bump stop location
- Shock absorber damping coefficient applicable to large-displacement, low-frequency regime

In the previous report, all parameters for the first three vehicles, except shock absorber data, were presented. This report presents all parameter data for the second three vehicles, plus shock absorber data for all six vehicles.

Section 2 of this document describes the measurement procedure. Resulting data are presented tabularly in Section 3. References appear in Section 4.

2. MEASUREMENT PROCEDURES

2.1 Total Vehicle Inertial Measurements

Center of Gravity Position. Center of gravity position was measured vertically and longitudinally (and assumed to be on the plane of symmetry laterally) for each vehicle. For the two heavier vehicles, measurements were made using the UMTRI pitch plane inertial measurement facility [1]. Shown in Figure 1, this facility is a pendulum-like device. Center of gravity position is measured by applying a known torque to the pendulum with the vehicle in place and measuring the resulting pitch attitude. These data, along with vehicle weight and known properties of the facility, are used to calculate the longitudinal and vertical c.g. position of the test vehicle.

In this case, the vehicle was placed on a light, tilt-table structure supported by a knife-edge bearing and a vertical filar (see Figure 2). Measurements of filar tension at several tilt angles, along with the appropriate geometric data, were used to calculate the c.g. height of the vehicle via static moment balance analysis.

C.g. heights are reported "above the ground," but also relative to a vertical reference fixed in the sprung mass. Given the variabilities associated with tire and suspension deflections, we feel that the second reporting method is more reliable.

Total Vehicle Moment of Inertia. Pitch and roll moments of inertia were measured for each vehicle using a compound pendulum measurement technique. In this procedure, the vehicle is placed on a pendulum-supporting device and oscillated freely in the direction of interest. The period of oscillation is measured and used, along with vehicle weight and c.g. position and the known properties of the device, to calculate the moment of inertia of the vehicle.

In the case of the two heavier vehicles, the pitch plane facility was used to determine pitch moments. The roll moments of inertia of all these vehicles, plus the pitch moment of the S-10, were measured on the pendulum shown in Figure 3.

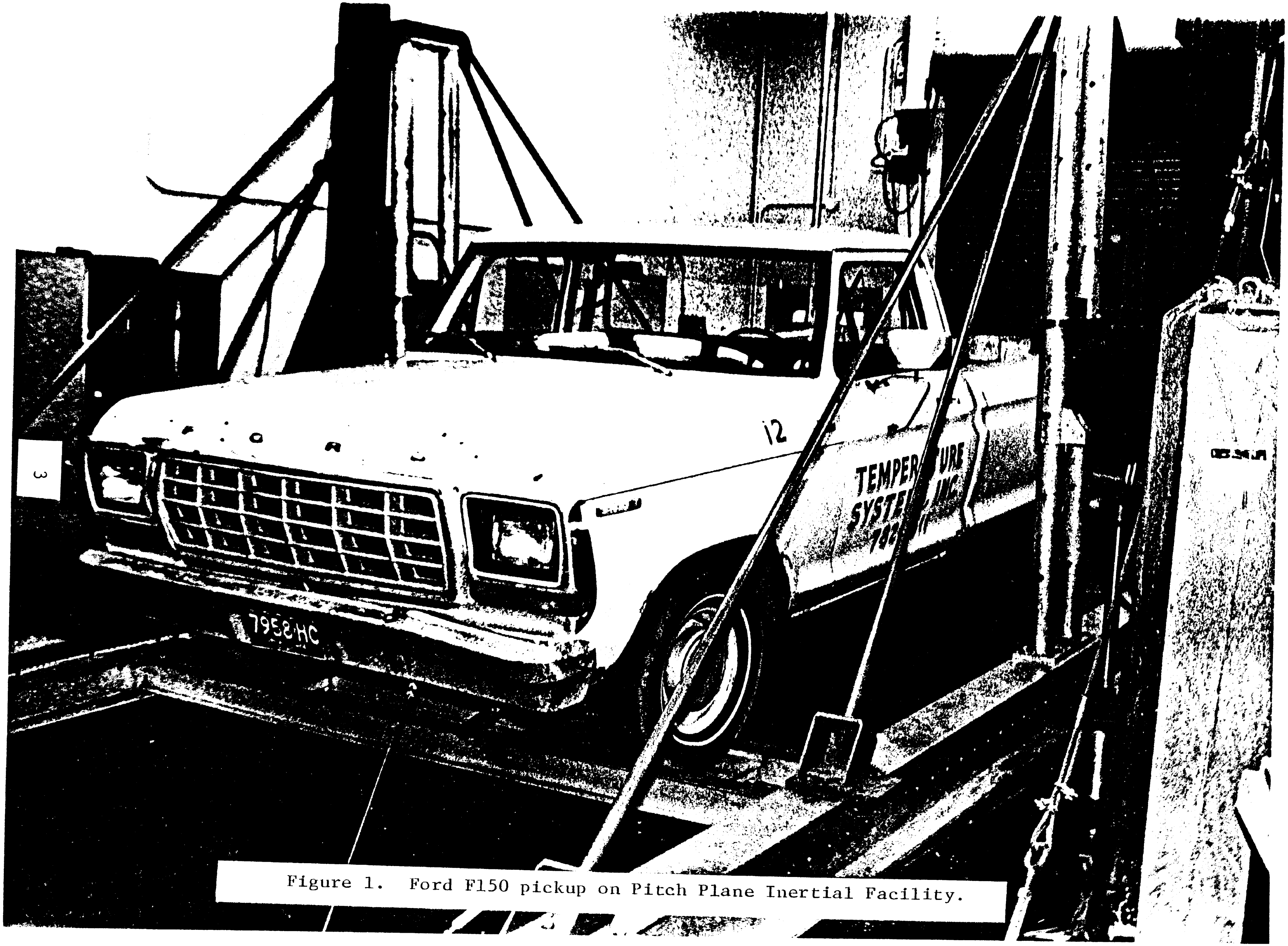


Figure 1. Ford F150 pickup on Pitch Plane Inertial Facility.

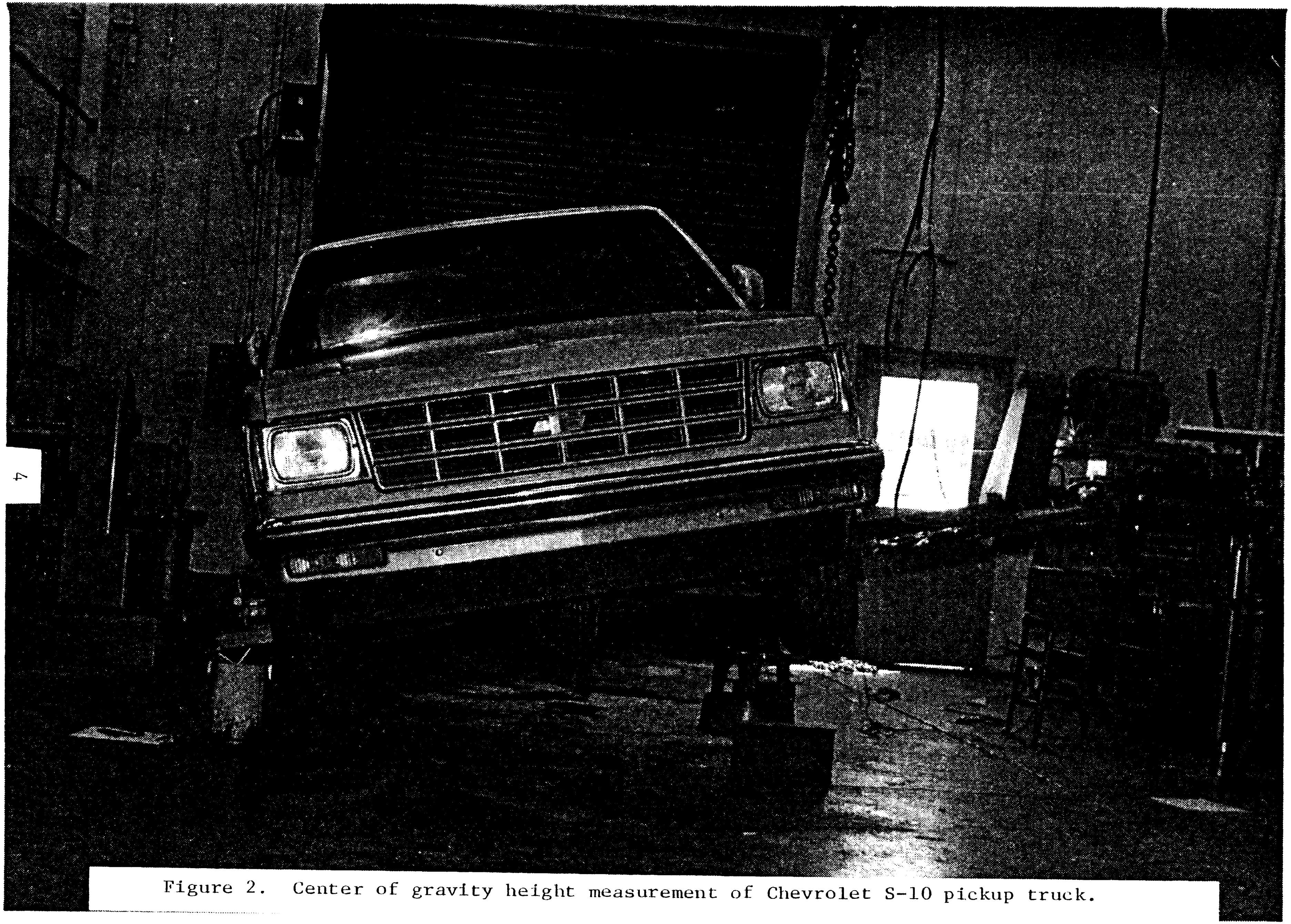


Figure 2. Center of gravity height measurement of Chevrolet S-10 pickup truck.

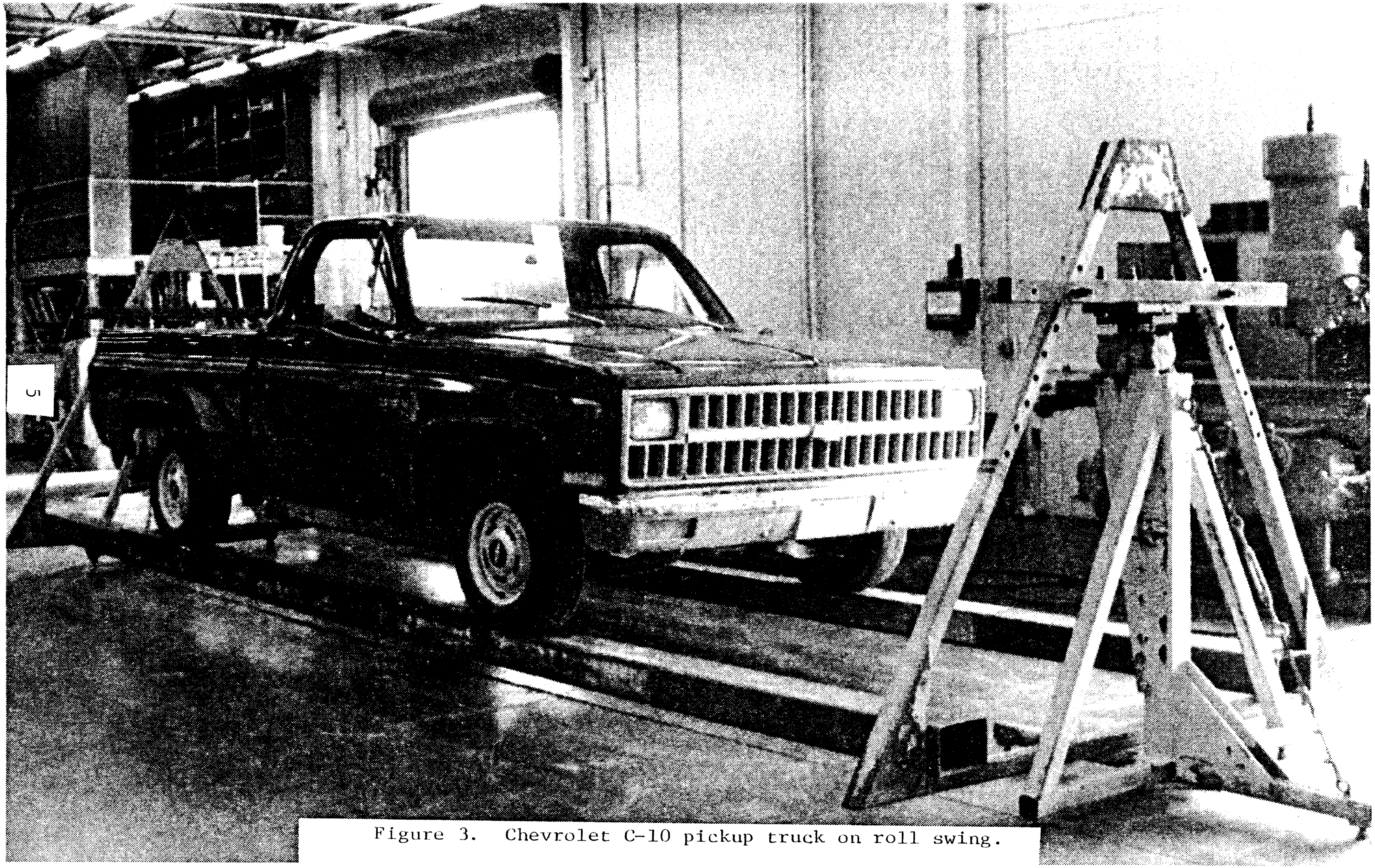


Figure 3. Chevrolet C-10 pickup truck on roll swing.

Yaw moment of inertia of each vehicle was measured using a multi-filar pendulum technique. Figure 4 illustrates the device used in each case. In this case, the vehicle is oscillated freely in yaw and the period of oscillation is measured. Again, using vehicle weight (the vehicle is oriented on the device with its c.g. on the centroid of the filars) and known properties of the device, yaw moment of inertia is calculated.

The results of all of these measurements are quite consistent with expectations, based on UMTRI's previous experience in inertial parameter measurement [1].

2.2 Unsprung Masses

The effective unsprung masses were measured by two different methods. (1) For the solid rear axles, shock absorbers were removed and the connecting bolts between leaf springs and the sprung mass were removed. With the sprung mass supported on jack stands, the unsprung mass was then weighed by suspending it from a strain gauge load cell, as seen in Figure 5. One leaf spring was then removed and the spring and shock absorber were weighed separately. (2) For front independent suspensions, the suspension spring element and the shock absorbers were removed from the vehicle. In this condition, the sprung mass was supported by an overhead crane, and the effective weight of the unsprung mass was measured by determining the tire vertical load using a balance scale (Figure 6). The proper ride height and chassis attitudes were maintained. The effects of Coulomb friction were accounted for by making this measurement once following a rebound stroke and once following a compression stroke and averaging the results. Spring and shock were weighed separately.

Assuming the unsprung mass c.g. to be on the spindle axis, straight-forward tape measurements were taken to locate the unsprung masses.

2.3 Suspension Properties

Suspension Force-Deflection Properties. Suspension vertical rate properties were measured on UMTRI's heavy vehicle suspension measurement

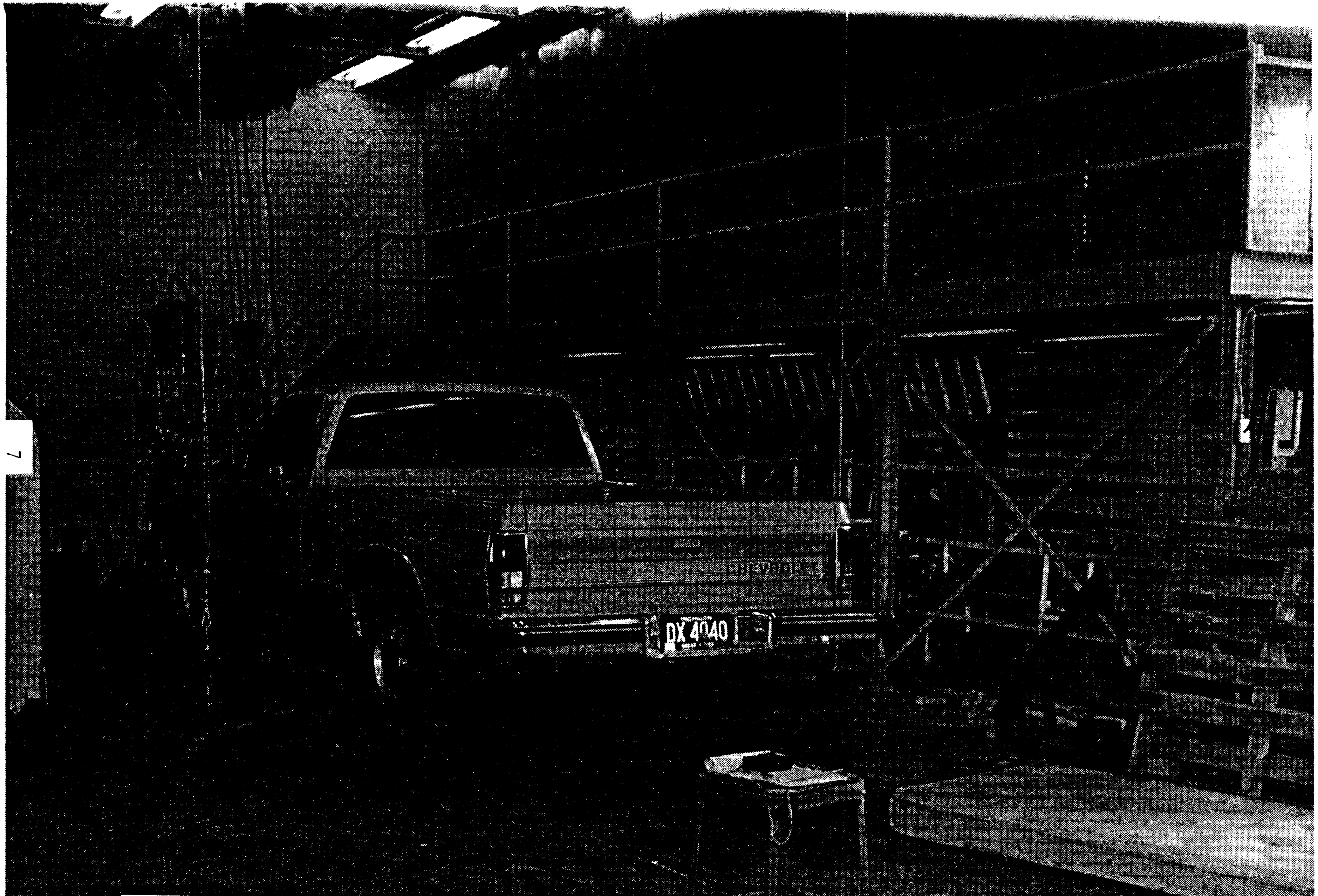


Figure 4. Yaw moment of inertia measurement of Chevrolet S-10 pickup truck.

Figure 5. Rear unsprung mass measurement of Ford F150 van.

Figure 6. Front unsprung mass measurement of Chevrolet C-10 pickup truck.

facility [2]. The facility was modified, however, to provide a vertical load measurement transducer more appropriate to light vehicles. A test setup is shown in Figure 7.

Resulting data are presented graphically in Section 3 and contain information describing vertical wheel rate (in the "normal range," as well as in the range of bump stop contact), ride height, and bump stop "location."

Shock Absorber Properties. For all six test vehicles, shock absorber data were obtained from the vehicle or shock absorber manufacturer.

For the three vehicles sent to TTI for crash testing, original shock absorbers were removed and the appropriate, new, Monroe replacement shock absorbers were installed. Data describing the performance of these shock absorbers were provided by Monroe Auto Equipment Company.

For the other three vehicles, data describing the performance of the original equipment shock absorbers were obtained from the vehicle manufacturers, viz., General Motors Corporation and Ford Motor Company.

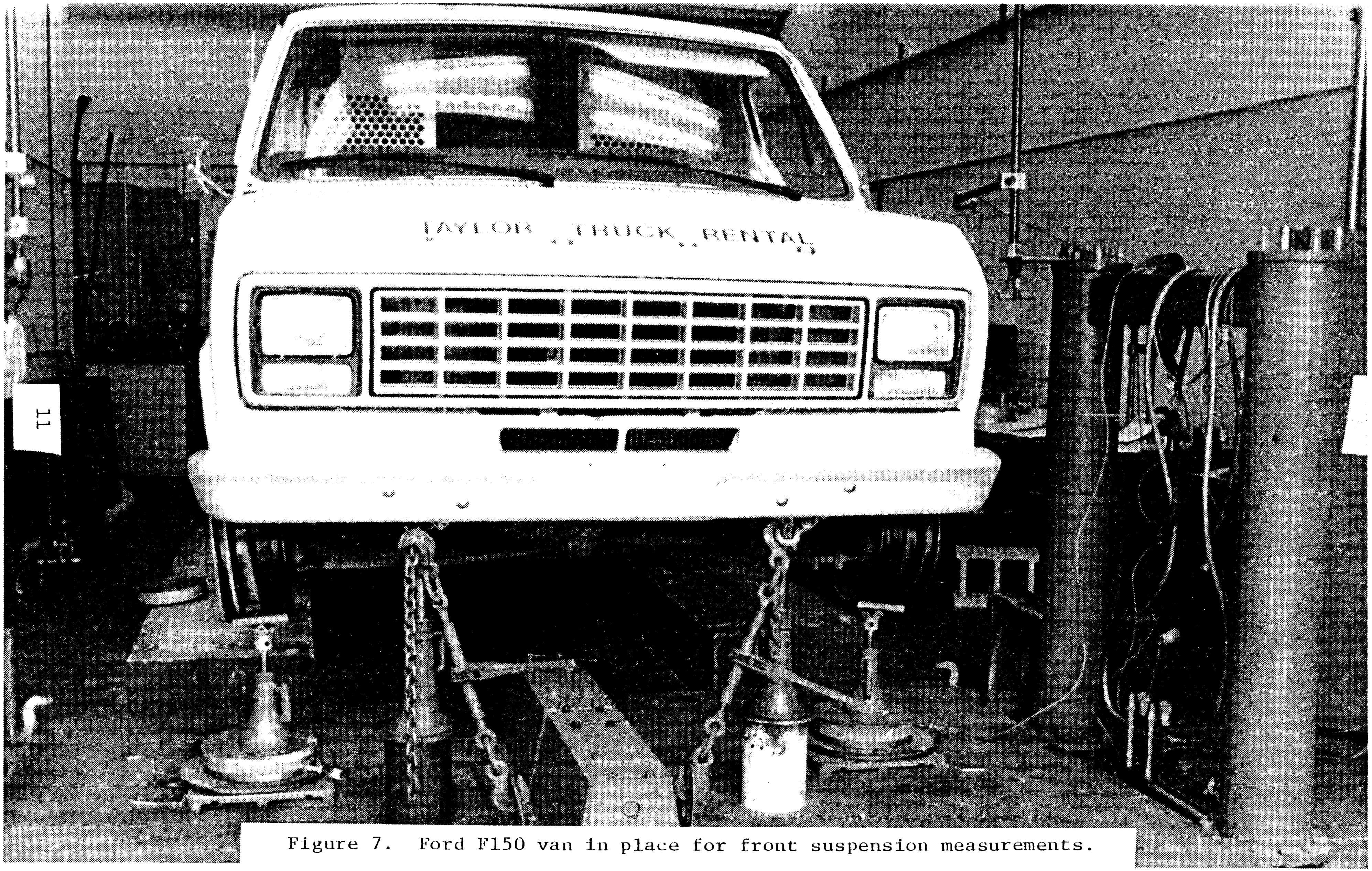


Figure 7. Ford F150 van in place for front suspension measurements.

3. VEHICLE PARAMETERS

All parameters given herein were gathered with the test vehicles in the empty condition. In the case of the S-10 pickup, the fuel tank was full. The C-10 pickup and F150 van were measured with fuel tanks empty.

TOTAL VEHICLE INERTIAL PROPERTIES

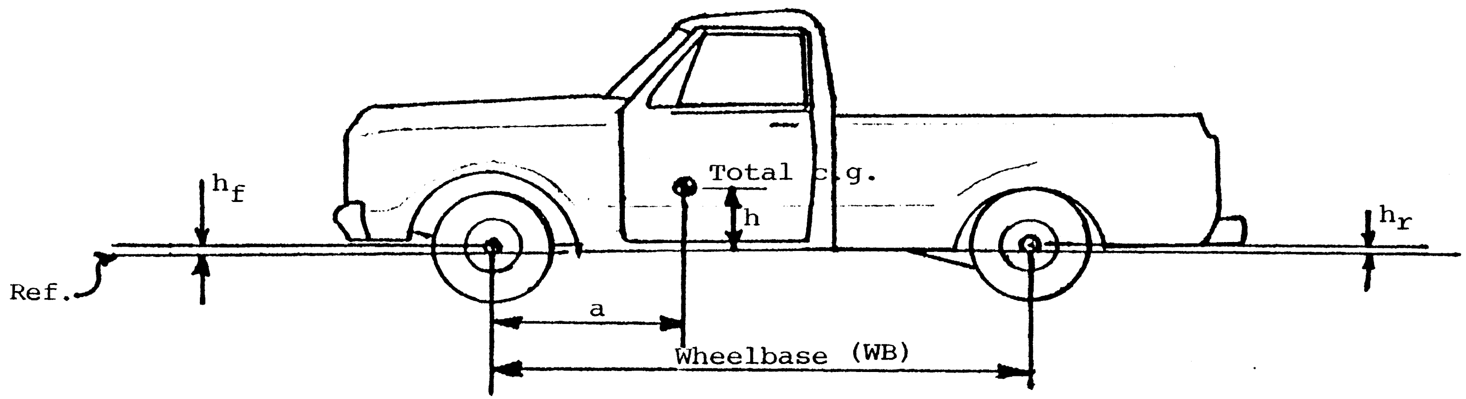
Vehicle	Weight (lb.)	Wheelbase (in.)	C.G. Position (In.)			Principal Moments of Inertia (in-lb-sec^2)		
			Vertical		Longitudinal			
			Above Ground	Above Vehicle Reference*	Aft of Front Axle Center	Roll I_{xx}	Pitch I_{yy}	Yaw I_{zz}
1982 Chev. S-10 Pickup	2717	108	25.0	13.5	44.5	3460	17700	20210
1982 Chev. C-10 Pickup	3540	117.5	24.6	11.32	48.07	7025	27760	29580
1982 Ford F150 Van	4170	138	27.8	14.27	62.29	11320	50180	49250

*Vehicle reference for each vehicle is the lower edge of body pinch mold (beneath door sill) at longitudinal c.g. position.

UNSPRUNG MASSES

Vehicle	Weight
1982 Chevrolet S-10 Pickup	
Effective front unsprung weight without spring or shock, one side	115 lb.
Front spring, one side	10 lb.
Front shock, one side	2 lb.
Rear unsprung weight complete, with springs, without shocks, one side	360 lb.
Rear spring, one side	38 lb.
Rear shock, one side	3 lb.
1982 Chevrolet C-10 Pickup	
Effective front unsprung weight without spring or shock, one side	153 lb.
Front spring, one side	15 lb.
Front shock, one side	2 lb.
Rear unsprung weight complete, with springs, without shocks	524 lb.
Rear spring, one side	53 lb.
Rear shock, one side	3 lb.
1982 Ford F150 Van	
Effective front unsprung weight without spring or shock, one side	132 lb.
Front spring, one side	14 lb.
Front shock, one side	2 lb.
Rear unsprung weight complete, with springs, without shocks	462 lb.
Rear spring, one side	47 lb.
Rear shock, one side	3 lb.

UNSPRUNG MASS LOCATIONS



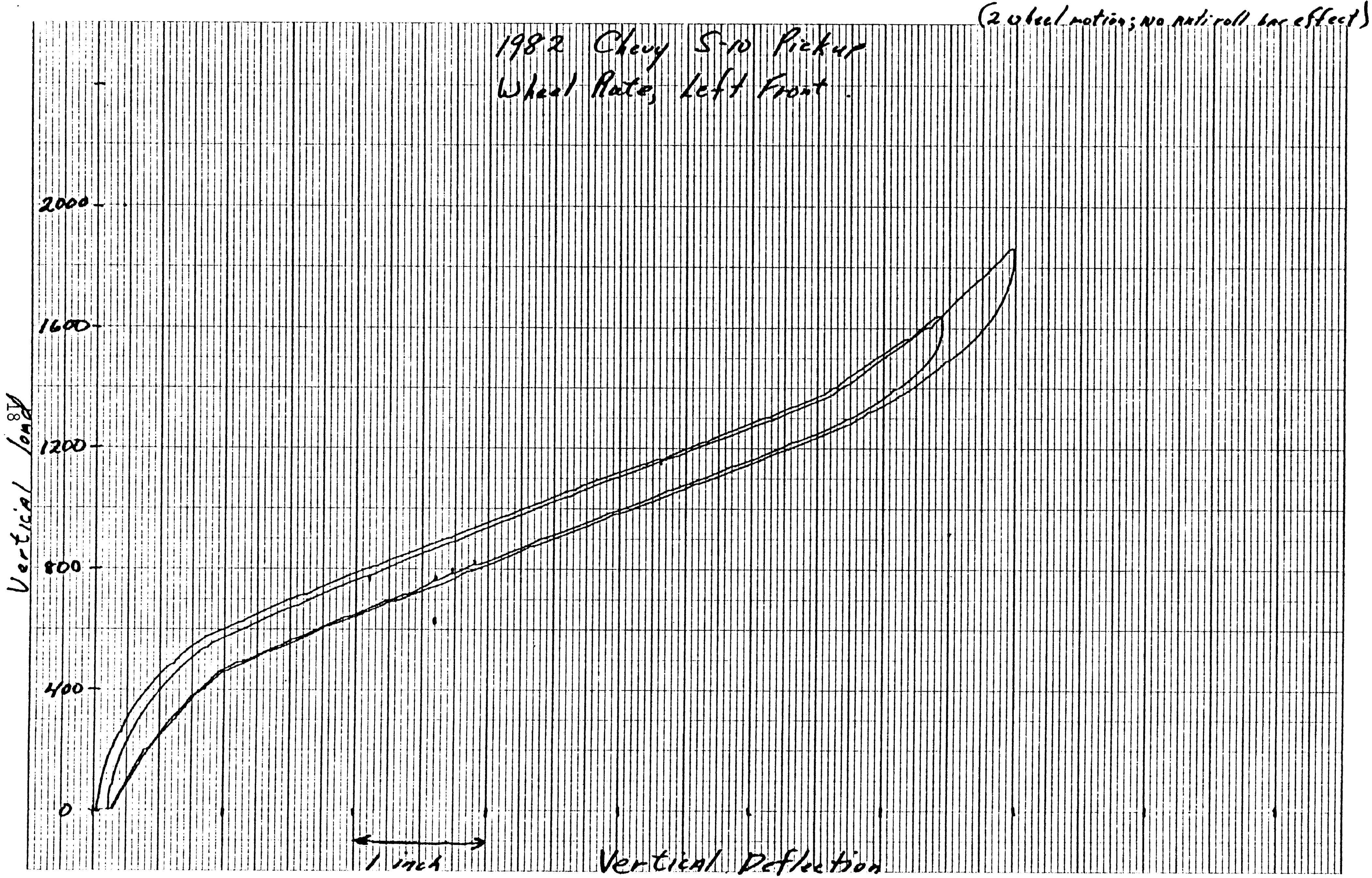
Vehicle	Height Above Vehicle Reference* (In.)			Distance Aft of Front Axle (In.)	
	h	h_f**	h_r**	WB	a
1982 Chevrolet S-10	13.5	0.5	0.5	108.0	44.5
1982 Chevrolet C-10	11.3	1.2	1.5	117.5	48.1
1982 Ford F150	14.3	-1.6	-1.3	138.0	62.3

*Reference is low edge of pinch weld below door sill at longitudinal c.g. position.

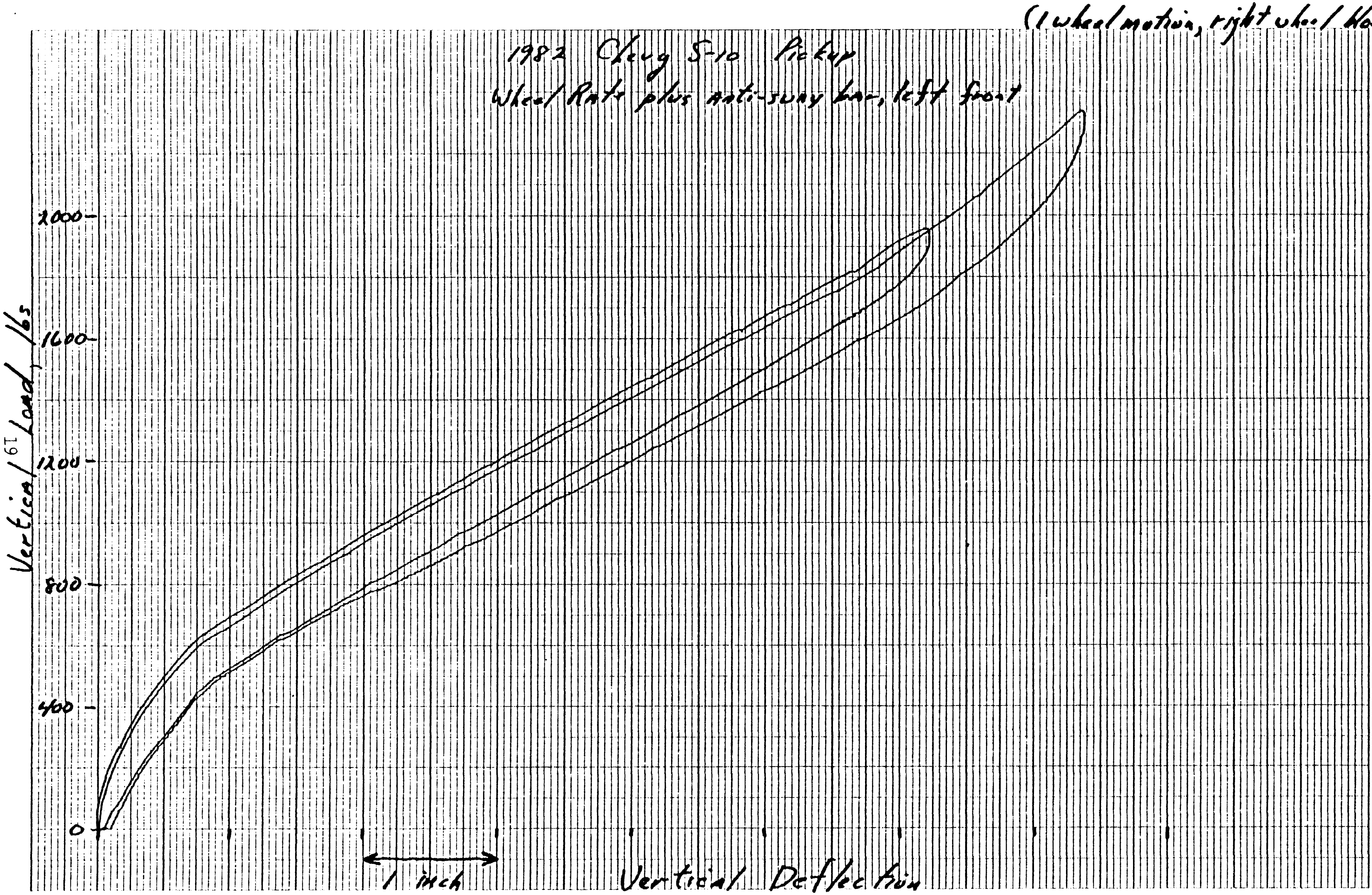
**h_f and h_r vary with loading and tire inflation pressure.

SUSPENSION PROPERTIES

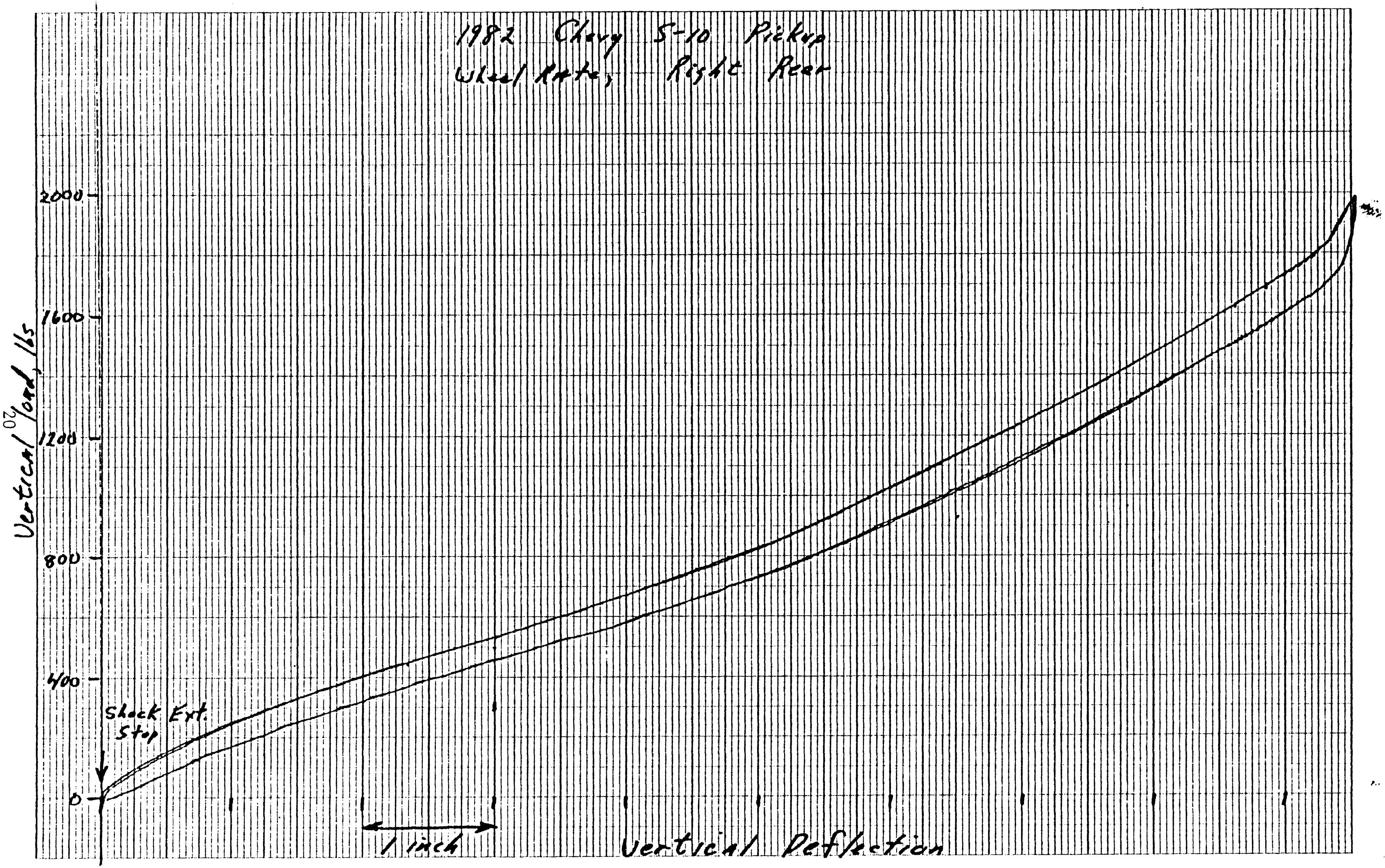

(2 wheel motion; no anti-roll bar effe
1982 Chevy S-10 Pickup
Wheel Rate, Right front
2000
1600
1200
800
400
0
Vertical load
1 inch
Vertical Deflection

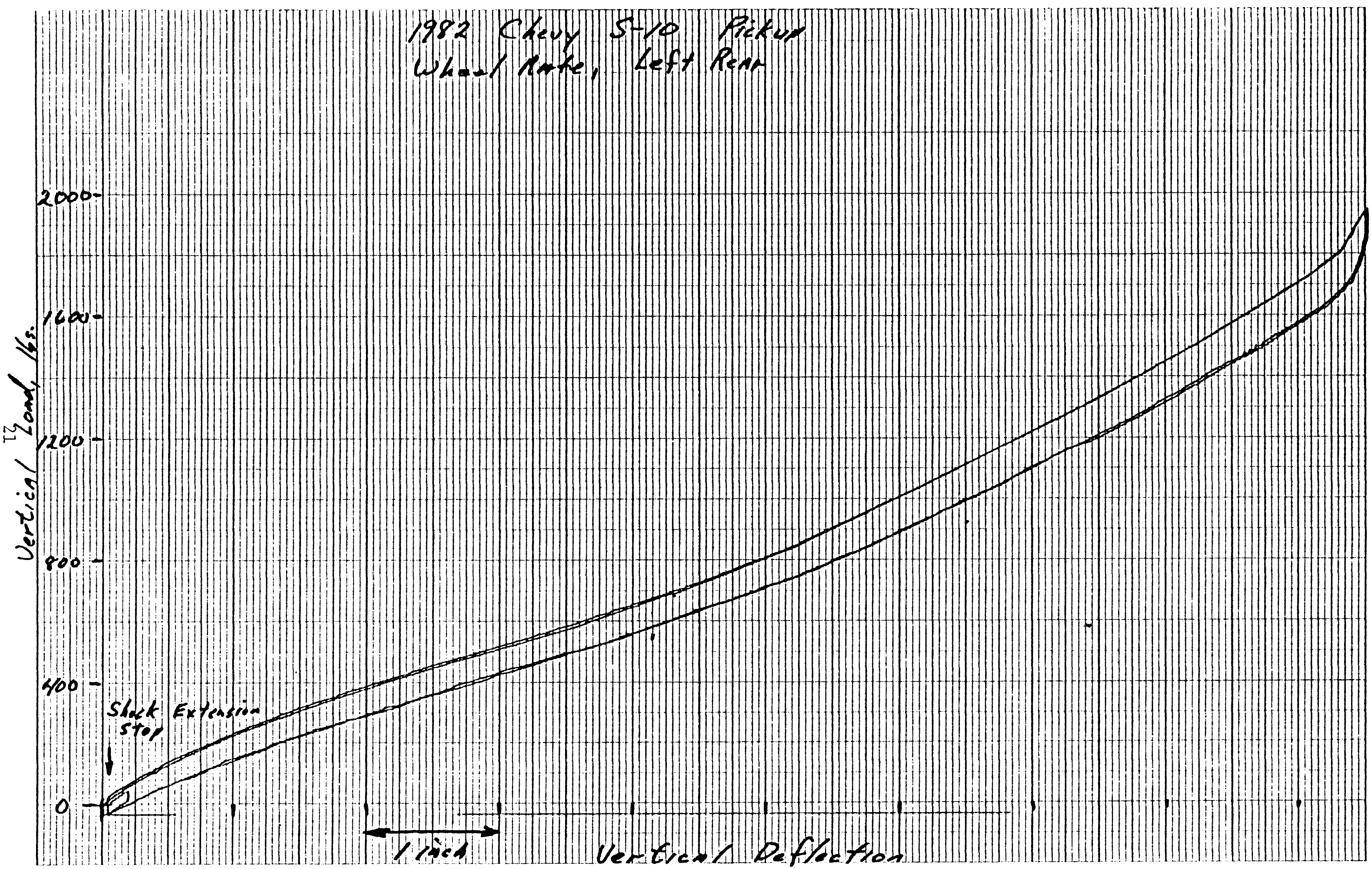

(2 wheel motion; no anti-roll bar effect)
1982 Chevy S-10 Pickup
Wheel Rate, Left Front
2000
1600
1200
800
400
0
Vertical load
1 inch
Vertical Deflection

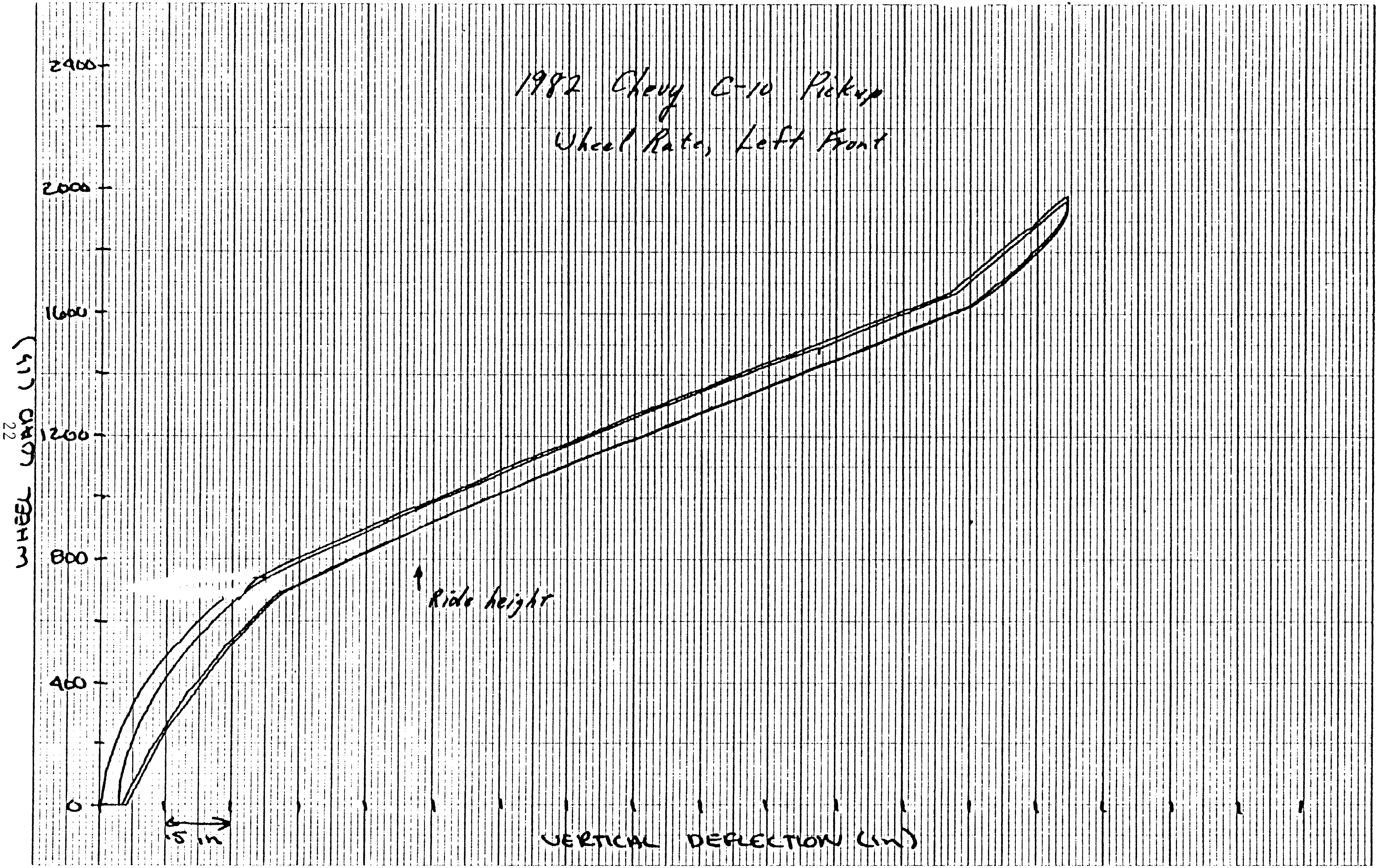
RF BLOCKED



(1 wheel motion, right wheel blocked
1982 Chevy S-10 Pickup
Wheel Rate plus anti-sway bar, left front
2000
1600
1200
800
400
0
Vertical Load, lbs
1 inch
Vertical Deflection

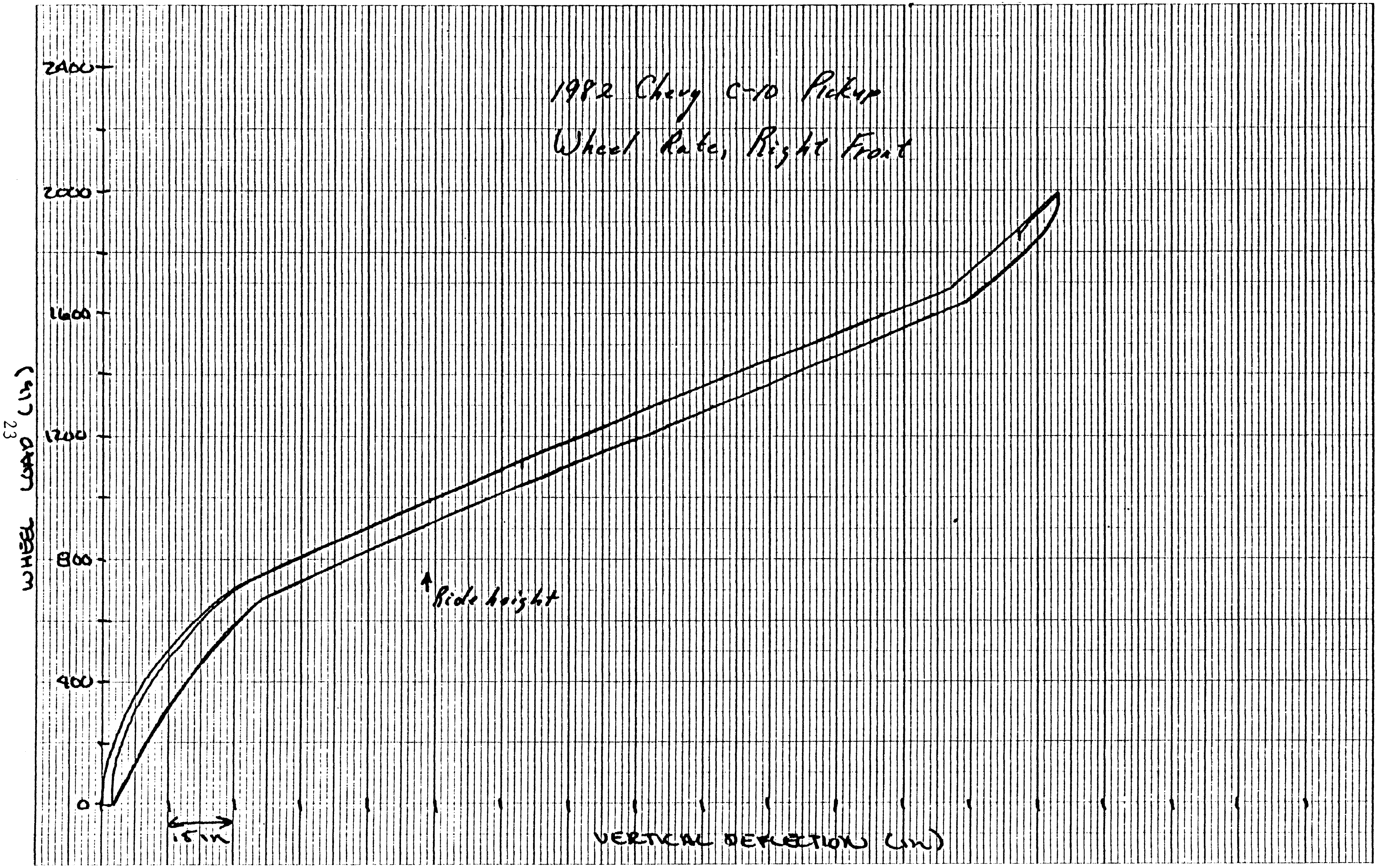

1982 Chevy S-10 Pickup
Wheel Rate, Right Rear
2000
1600
1200
800
400
0
Vertical load, lbs
Shock Ext. Stop
1 inch
Vertical Deflection

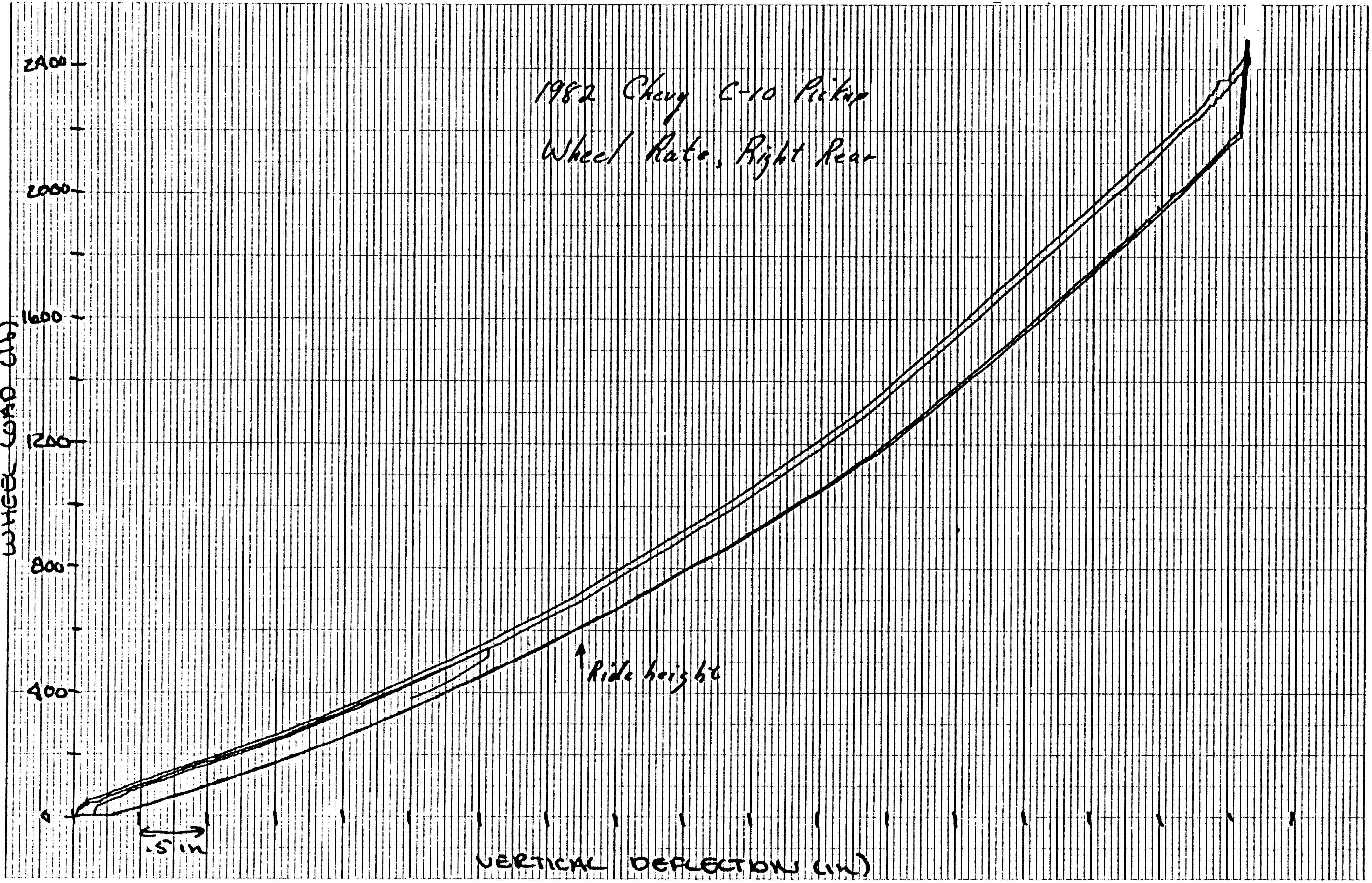

1982 Chevy S-10 Pickup
Wheel Rate, Left Rear
2000
1600
1200
800
400
0
Vertical Load, lbs.
Shock Extension Stop
1 inch
Vertical Deflection

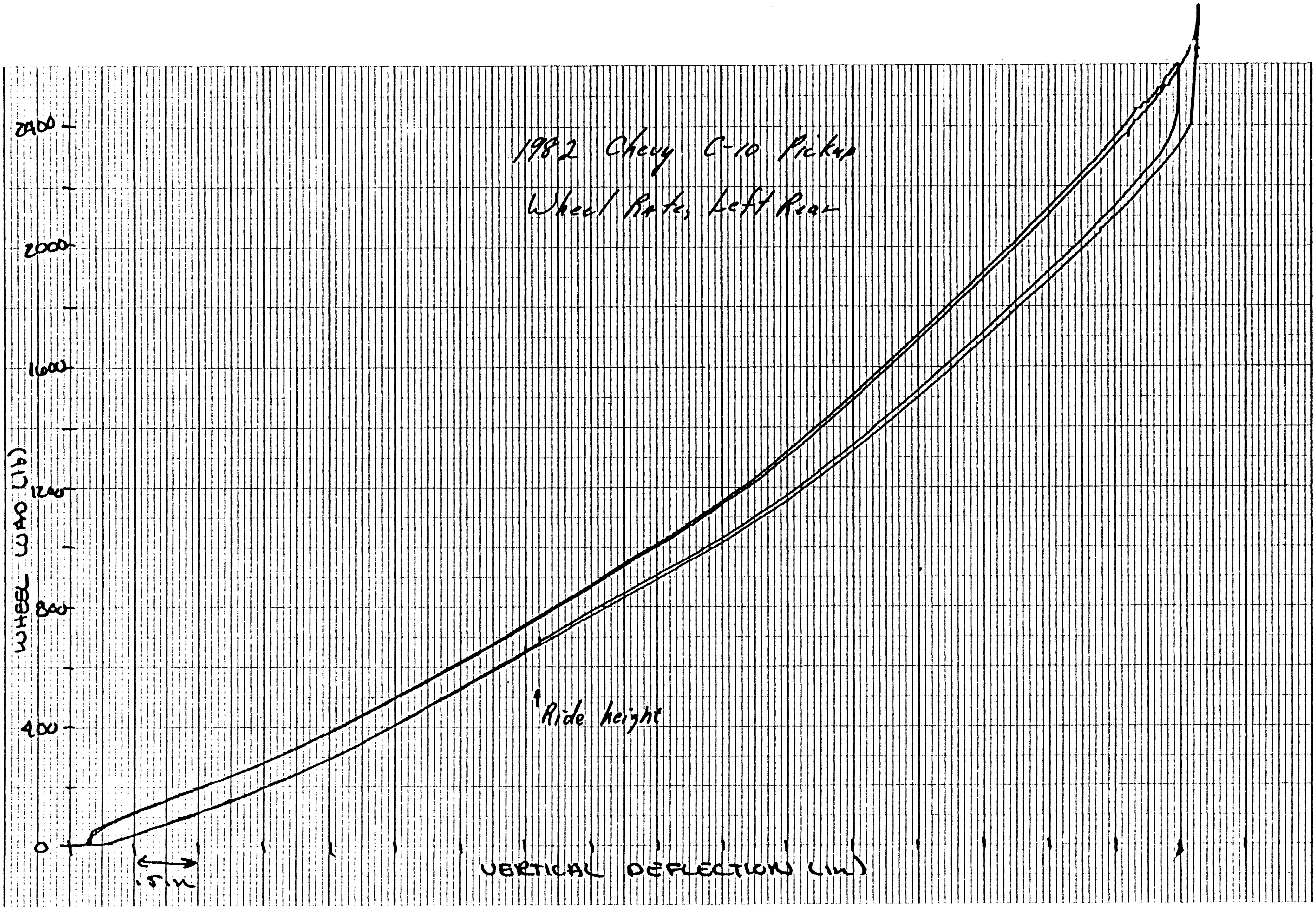

1982 Chevy C-10 Pickup
Wheel Rate, Left Front
2400
2000
1600
1200
800
400
0
WHEEL LOAD (lb)
Ride height
.5 in
VERTICAL DEFLECTION (in)

K&E 10 X 10 TO 1/2 INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 1320

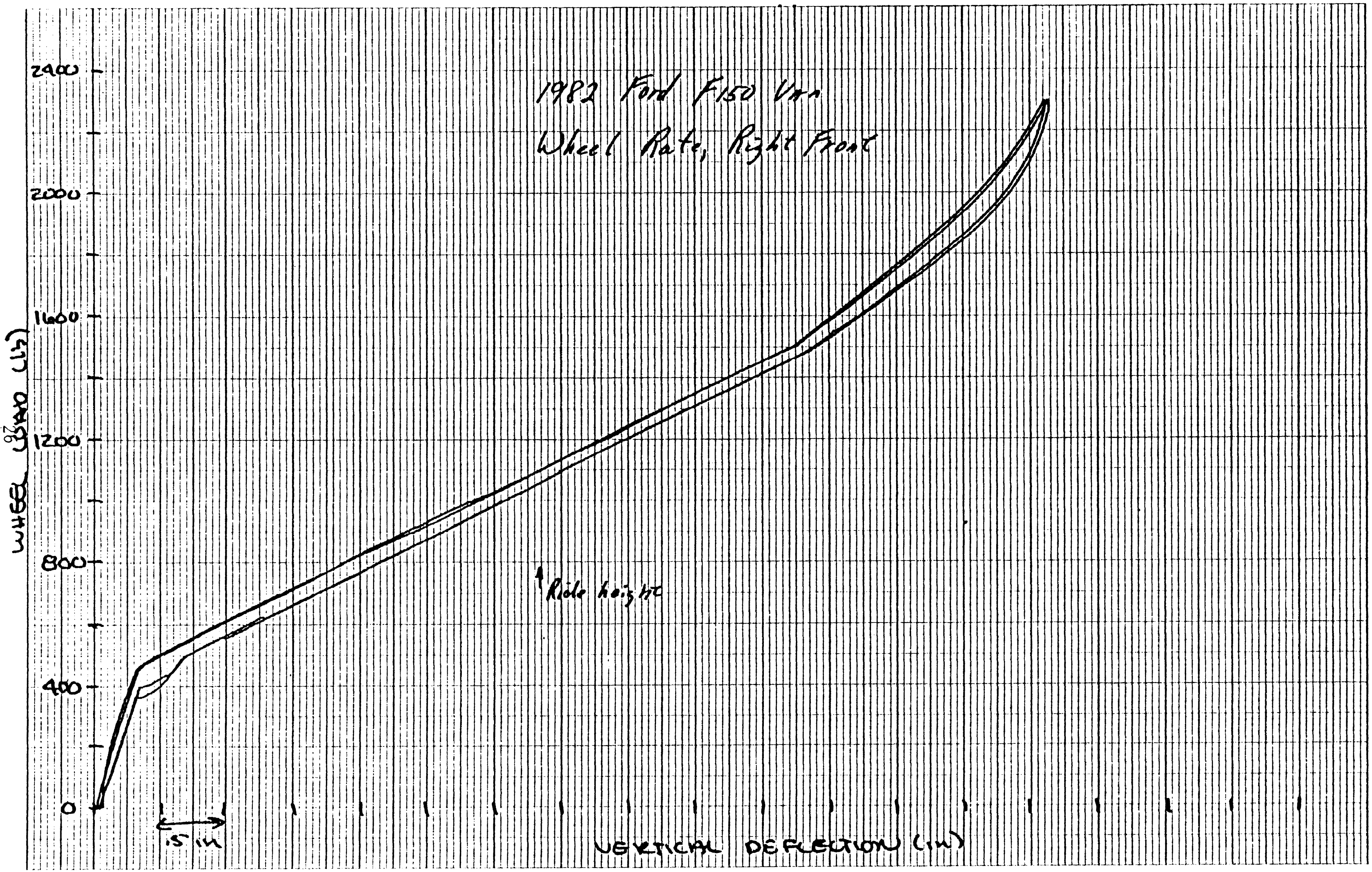


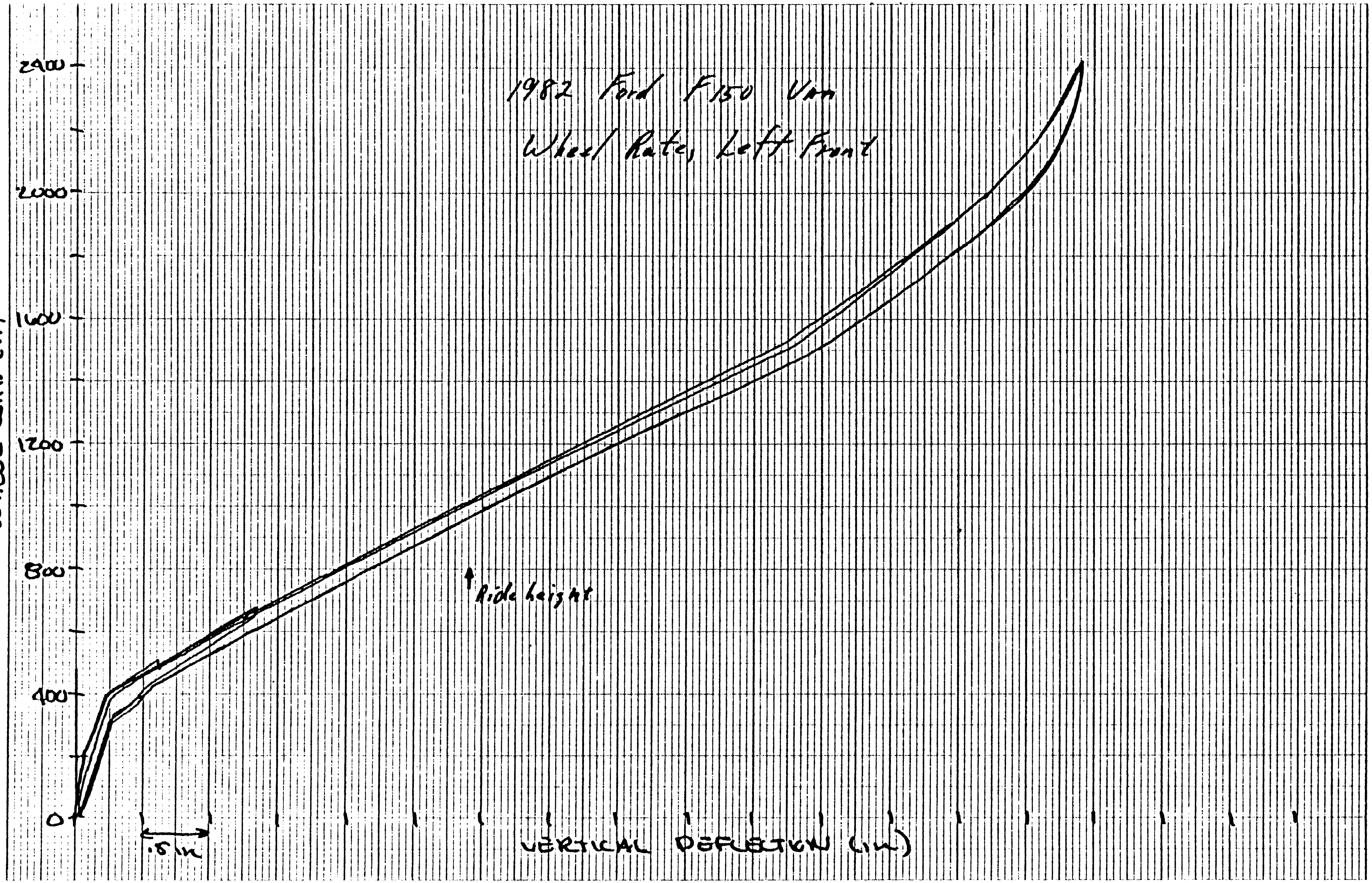

1982 Chevy C-10 Pickup
Wheel Rate, Right Rear
2400
2000
1600
1200
800
400
0
WHEEL LOAD (lb)
.5 in
Ride height
VERTICAL DEFLECTION (in)

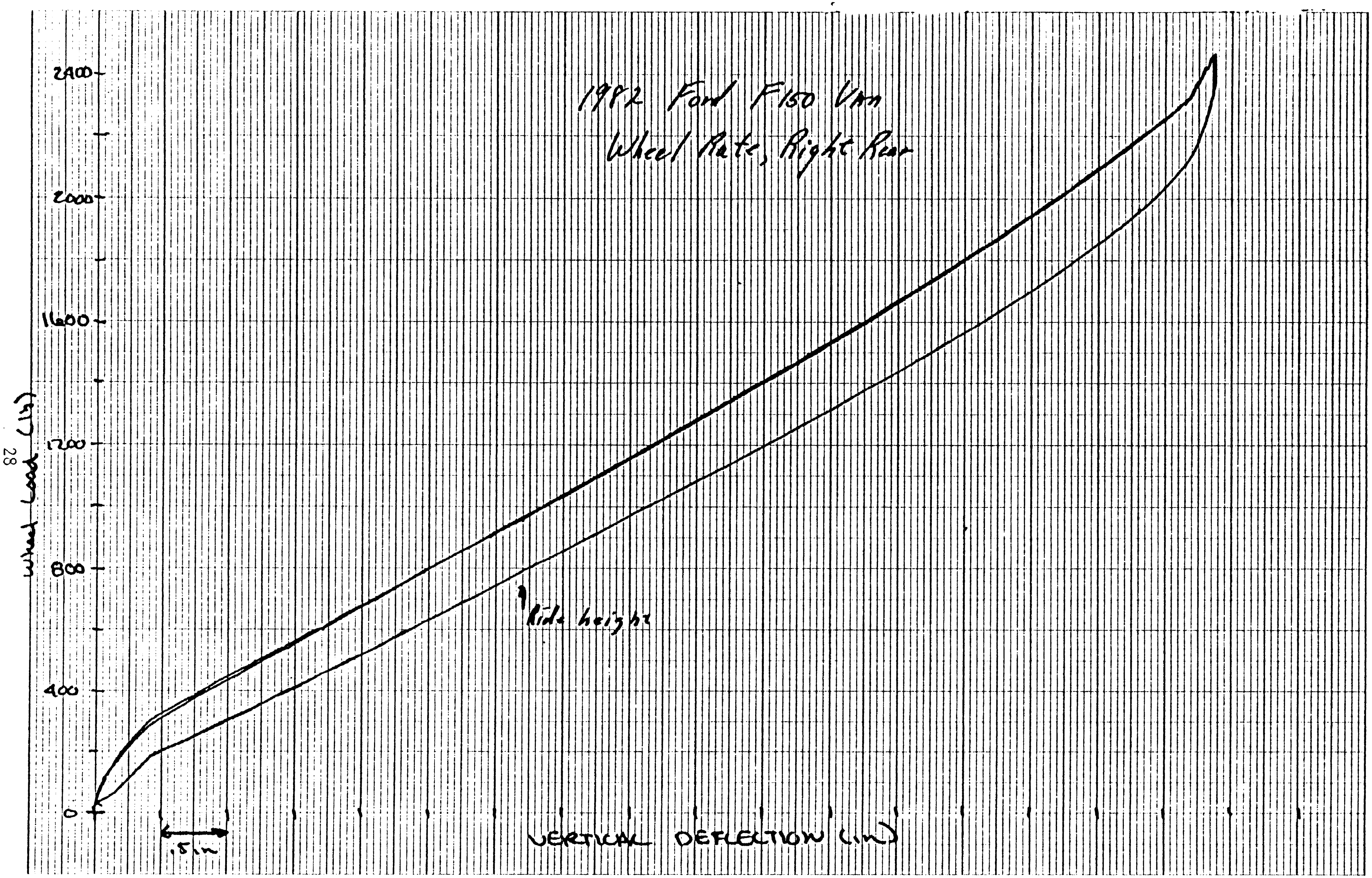


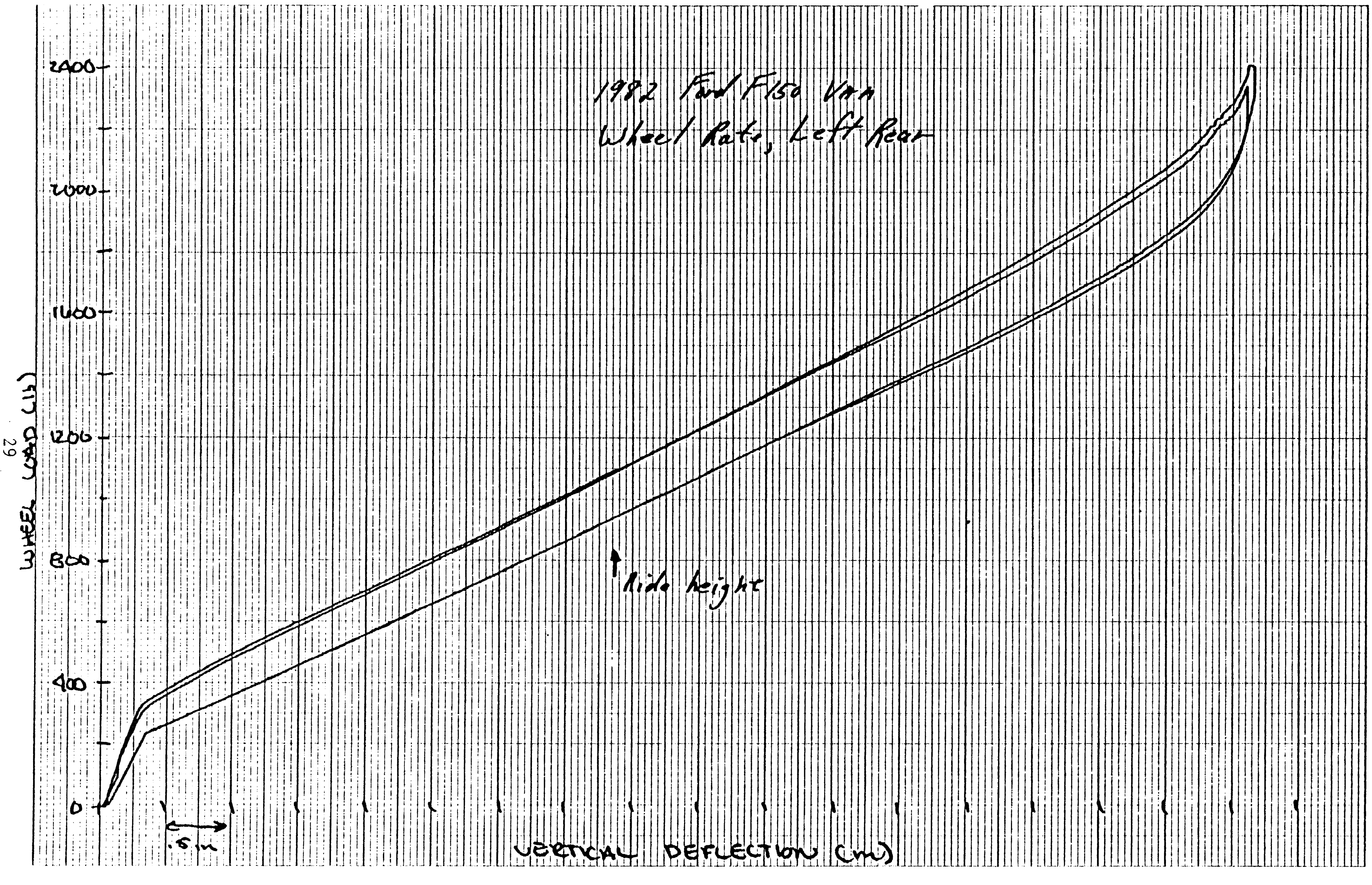
1982 Chevy C-10 Pickup
Wheel Rate, Left Rear
2400
2000
1600
1200
800
400
0
WHEEL LOAD (lb)
Ride height
.5 in
VERTICAL DEFLECTION (in)

46 1320

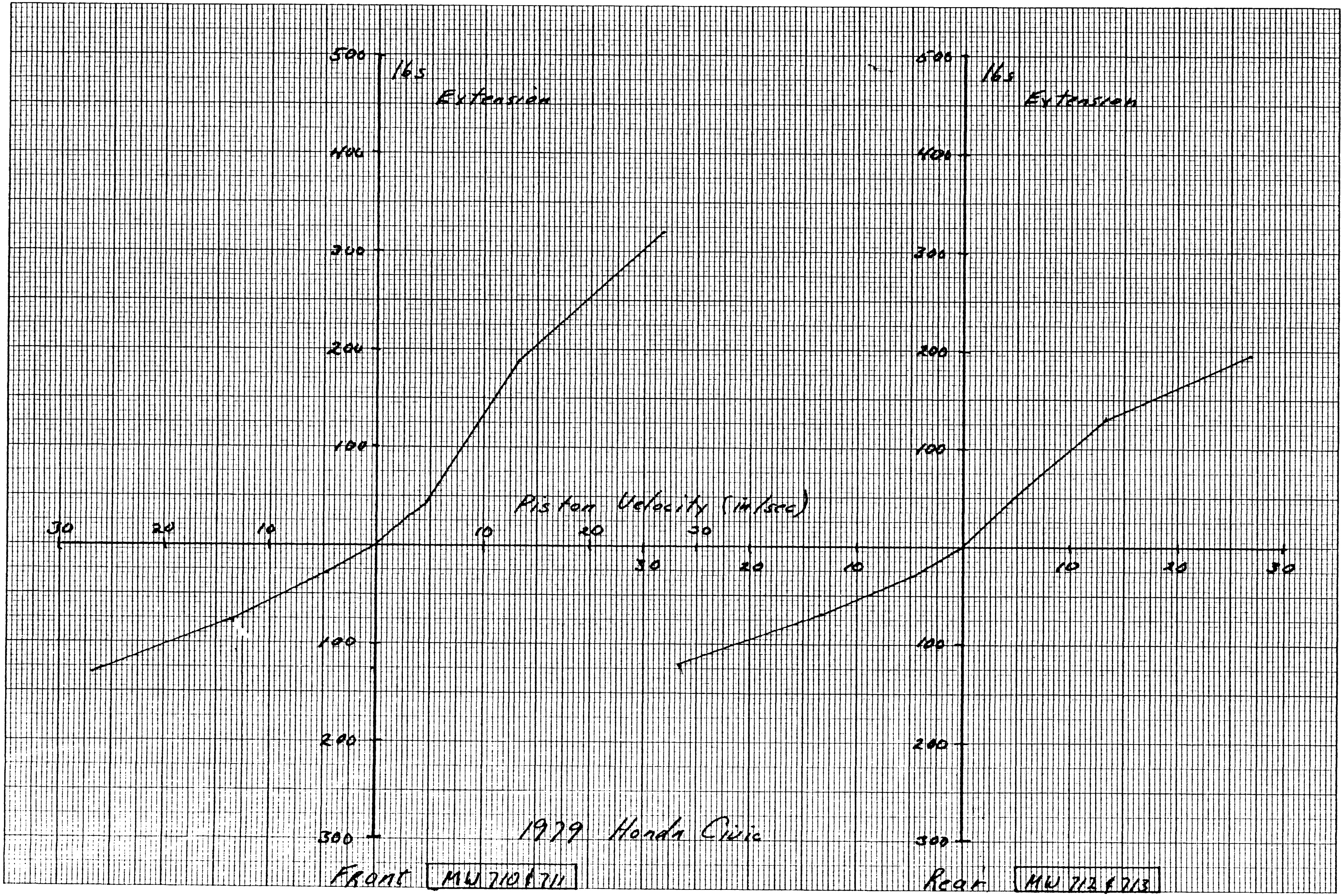

1982 Ford F150 Van
Wheel Rate, Right Front
Ride height
.5 in
VERTICAL DEFLECTION (IN)
WHEEL LOAD (LB)
2400
2000
1600
1200
800
400
0

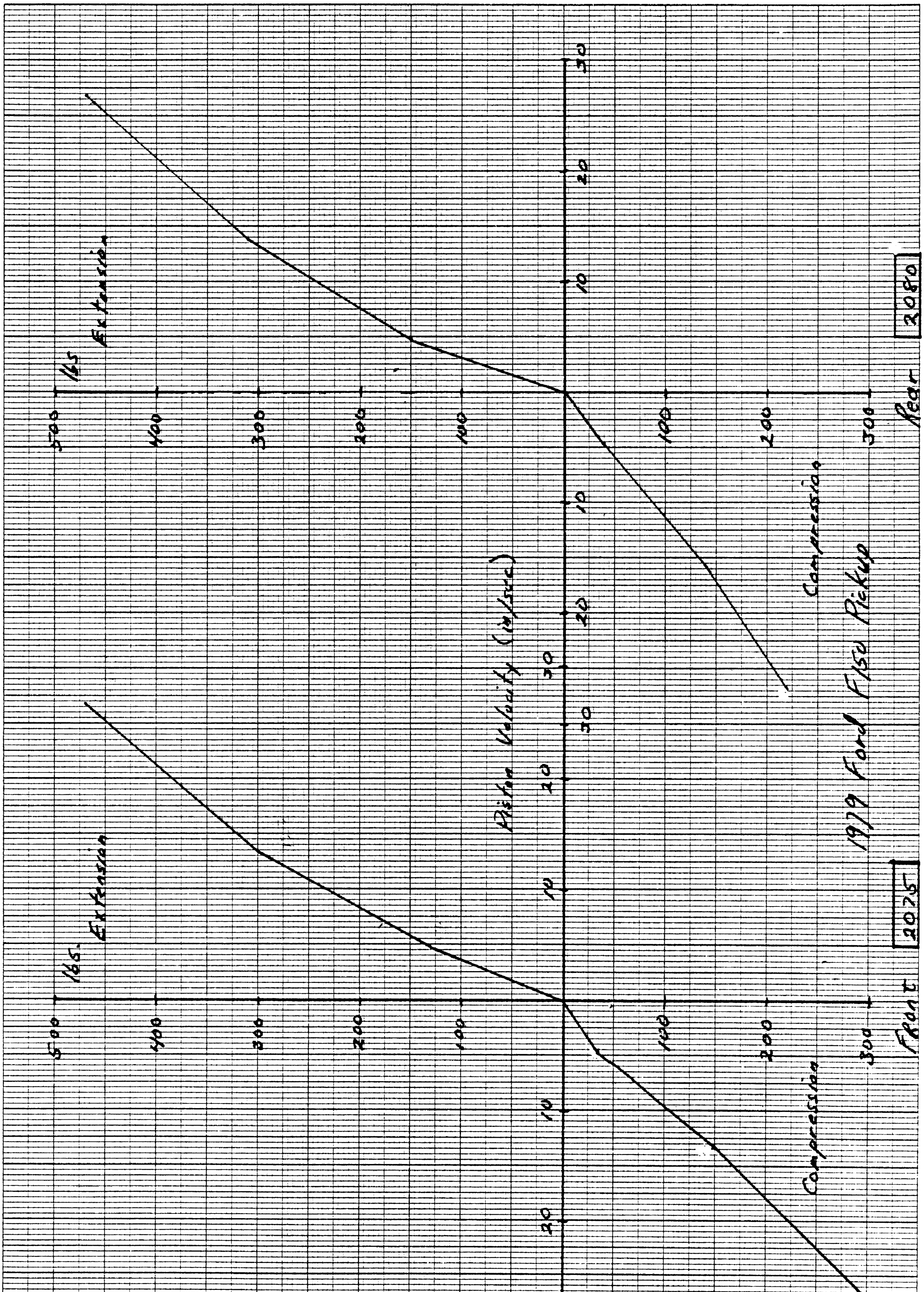

1982 Ford F150 Van
Wheel Rates, Left Front
2400
2000
1600
1200
800
400
0
WHEEL LOAD (lb)
Ride height
.5 in
VERTICAL DEFLECTION (in)

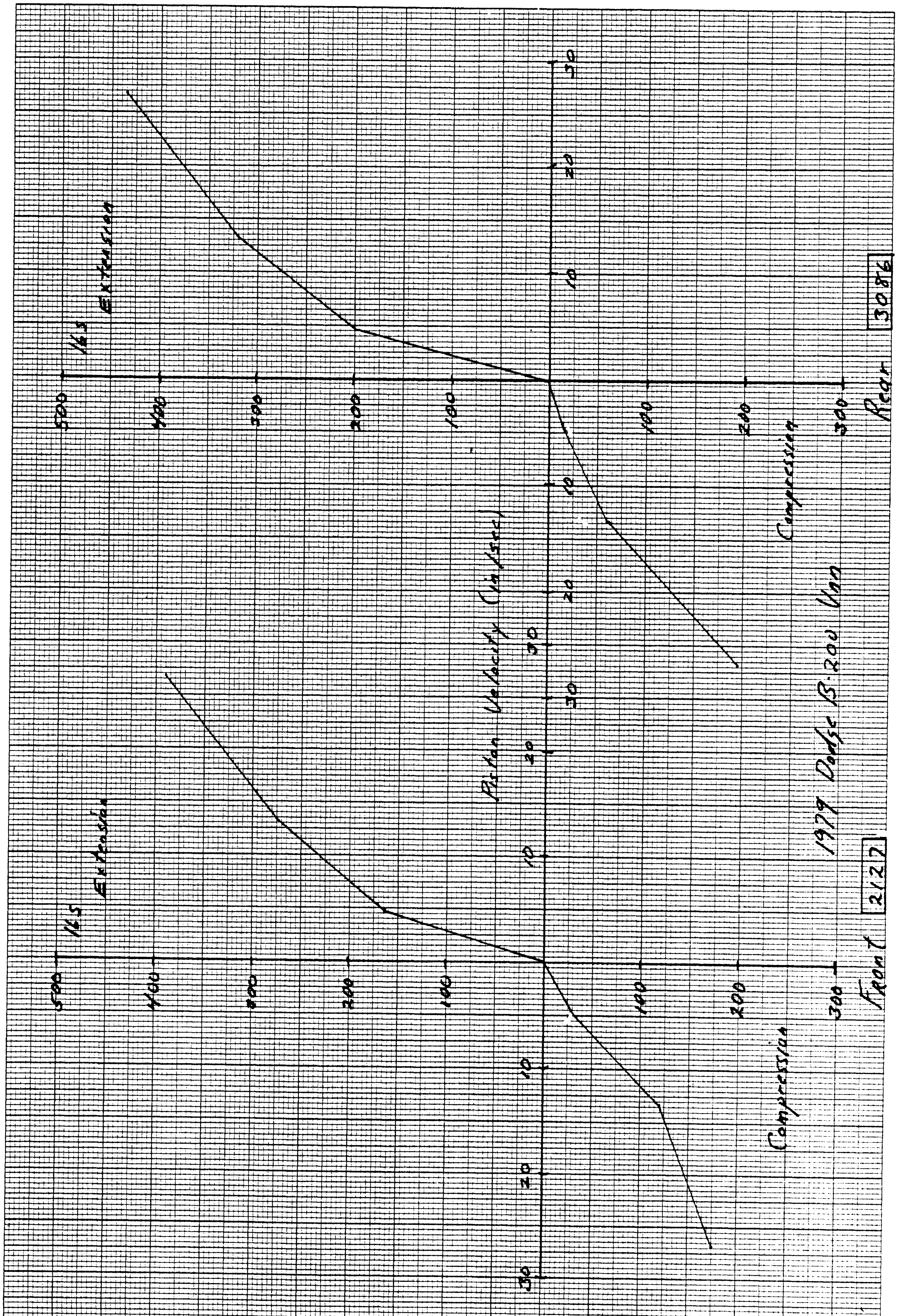

1982 Ford F150 Van
Wheel Rate, Right Rear
2400
2000
1600
1200
800
400
0
Wheel Load (lb)
Ride height
.5 in
VERTICAL DEFLECTION (in)

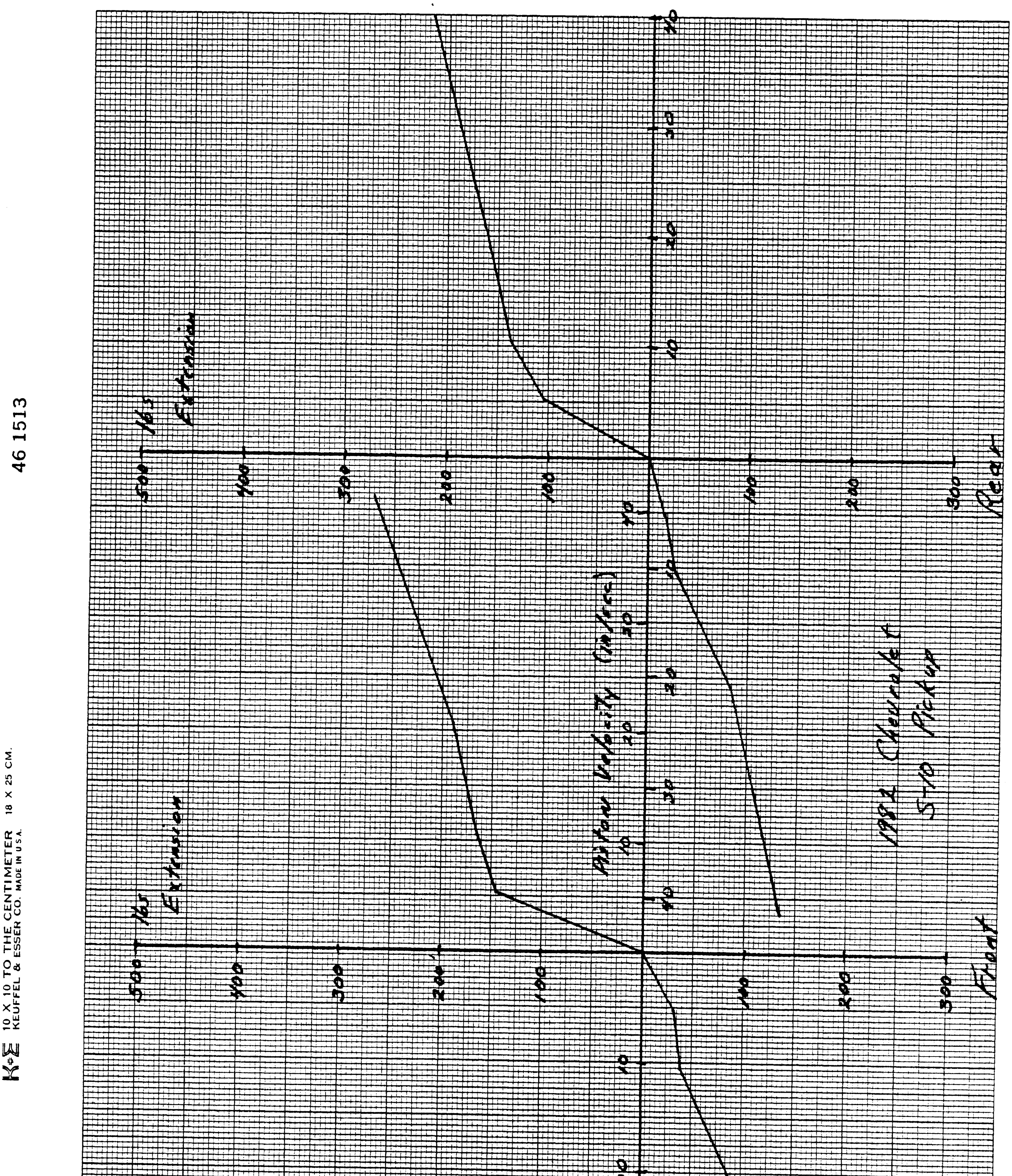

1982 Ford F150 Van
Wheel Rate, Left Rear
2400
2000
1600
1200
800
400
0
WHEEL LOAD (lb)
.5 in
Ride height
VERTICAL DEFLECTION (in)

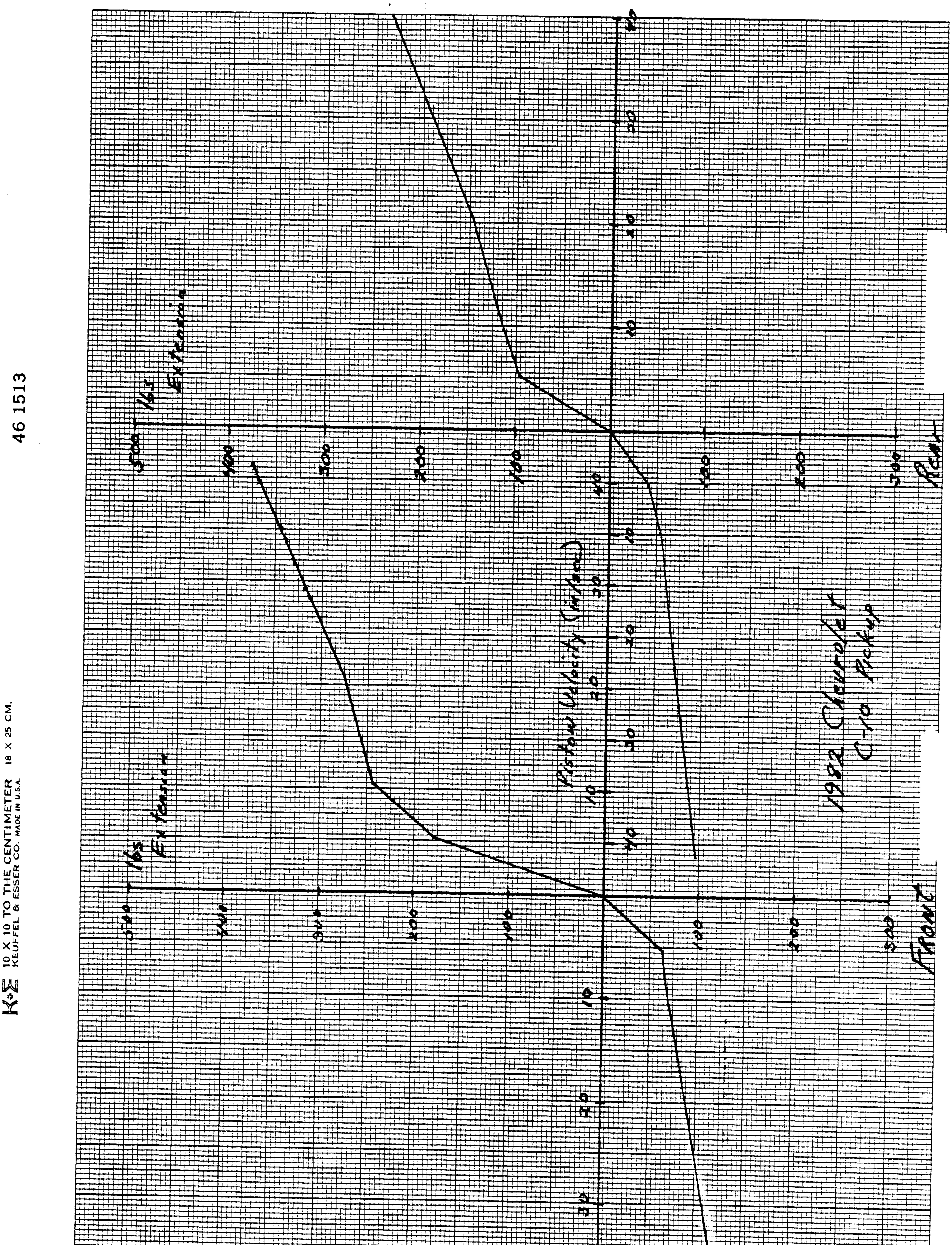
SHOCK ABSORBER PROPERTIES

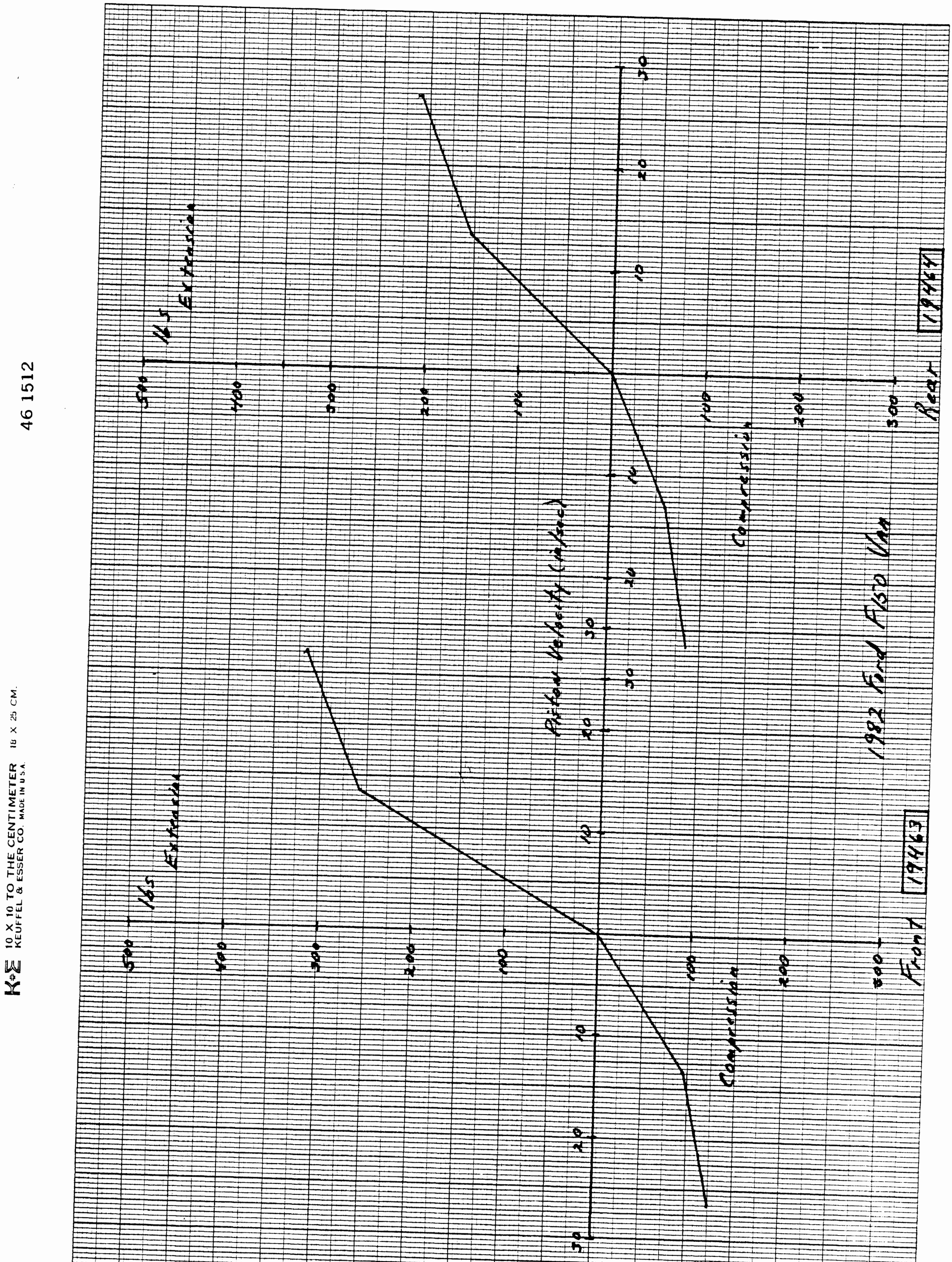

lbs
Extension
500
400
300
200
100
100
200
300
30
20
10
10
20
30
Piston Velocity (in/sec)
lbs
Extension
500
400
300
200
100
100
200
300
30
20
10
10
20
30
1979 Honda Civic
Front
MW 710 & 711
Rear
MW 712 & 713


1979 Ford F150 Pickup
Piston Velocity (in/sec)
lbs.
Extension
Compression
Front
2075
Rear
2080
500
400
300
200
100
10
20
30


lbs
Extension
Compression
500
400
300
200
100
10
20
30
Piston Velocity (in/sec)
1979 Dodge B-200 Van
Front 2127
Rear 3086


K+E 10 X 10 TO THE CENTIMETER 18 X 25 CM.
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1513
1982 Chevrolet
S-10 Pickup
Piston Velocity (in/sec)
Extension
lbs
Front
Rear
500
400
300
200
100
10
20
30
40


K+E 10 X 10 TO THE CENTIMETER 18 X 25 CM.
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1513
lbs
Extension
lbs
Extension
Piston Velocity (in/sec)
1982 Chevrolet
C-10 Pickup
Front
Rear
500
400
300
200
100
10
20
30
40



K+E 10 X 10 TO THE CENTIMETER 18 X 25 CM.
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1512
lbs
Extension
Compression
Piston Velocity (in/sec)
1982 Ford F150 Van
Front
19463
Rear
19464

4. REFERENCES

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