DOT# 113 REF# 8327-5.2
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DOT# 114 REF 8327-5.1

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Report No. (to be assigned by NHTSA)

PHASE II, TASK 5
TEST REPORT
LCMB-TO-SIDE IMPACTOR
BOGEY VEHICLE

TESTS 5.1 (0° @ 29.3 MPH) AND 5.2 (30° @ 29.2 MPH)

CONTRACT DOT-HS-8-01933(II)

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July 1980

TEST REPORT

Prepared for:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

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16. Abstract

Two full scale Load Cell Moving Barrier-to-Side Impactor crash tests were conducted under Task 5 of Phase II of contract DOT-HS-8-01933, "Test Device and Test Procedure to Assess Side Structures." This program is sponsored by the National Highway Traffic Safety Administration.

The object of these tests was to obtain force/crush data to evaluate the Task 5 Design Energy-Absorbing Side Impactor Face.

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Form DOT F 1700.7 (8-69)

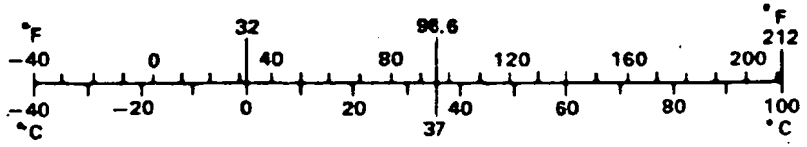
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric ton	t
	VOLUME			
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	degrees Fahrenheit	5 9 (after subtracting 32)	degrees Celsius	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton (1000 kg)	1.1	short tons	
	VOLUME			
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	degrees Celsius	9/5 (then add 32)	degrees Fahrenheit	°F



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1.0 INTRODUCTION

This document presents the results of two Load Cell Moving Barrier-to-Side Impactor crash tests, 8327-5.1 (0°) and 8327-5.2 (30°). These tests were conducted under Phase II, Task 5 of the NHTSA "Test Device and Test Procedure to Assess Side Structures" program (DOT-HS-8-01933). Table 1-1 presents the Crash Test Matrix for Task 5.

TABLE 1-1. TASK 5 CRASH TEST MATRIX

Test Number	Test Date	Test Conditions	LCMB Weight (lb)	Side Impactor Weight (lb)	Closing Speed (mph)*
5.1	4/3/80	0° Head-on Frontal Impact	3389	3404	29.33
5.2	4/23/80	30° Angular Frontal Impact	3384	3416	29.18

*Side Impactor stationary.

1.1 TEST OBJECTIVE

The objective of these tests was to obtain data to analyze and develop the force/crush characteristics for the Task 5 (DSL-1267) Energy-Absorbing Honeycomb face of the NHTSA Side Impactor. The DSL-1267 face was developed from the data gathered throughout the course of Phase I and Phase II crash testing which supplied baseline automobile data and the force/crush characteristics of earlier designs of the Energy-Absorbing Face (EAF). The DSL-1267 EAF also incorporates features developed from the data gathered during the Task 5 Static Component and Subsystem Tests.

The force/crush characteristics of the Task 5 EAF will be compared to the characteristics of the Chevrolet Citation (Phase II, Task 3, Tests 8327-3.1 and 3.2) and to the characteristics of the DSL-1172-10 EAF (Phase I, Task 4, Tests 8321-4.04 and 4.05). These comparisons are presented in Sections 4 and 5 for Test 8327-5.1 (0°) and 8327-5.2 (30°) respectively.

2.0 TEST 8327-5.1 - LOAD CELL MOVING BARRIER-TO-SIDE IMPACTOR AT 0° (HEAD-ON FRONTAL IMPACT)

2.1 TEST DESCRIPTION

The vehicle configuration for this test was as shown in Figure 2-1, with the LCMB striking the stationary Side Impactor bogey. The DSL-1267 Energy-Absorbing Face (Appendix E) was affixed to the Side Impactor bogey. For the Task 5 dynamic crash tests, approximately 600 pounds was removed from the LCMB to reduce its weight to 3400 ±20 pounds. Additionally, the standard LCMB Load Cell Module (Figure 2-2) has a 3/4-inch plywood face instead of the 1-1/2-inch thickness used in previous tests in an effort to reduce the inertia loads caused by the weight of the plywood and to reduce the response time of the load cells. Instrumentation for the test is documented in Appendix C.

2.2 TEST RESULTS

The data from Test 8327-5.1 are presented in Tables 2-1 through 2-9 and Figures 2-3 through 2-24 of this section. The Calcomp plots are presented in Appendix A.

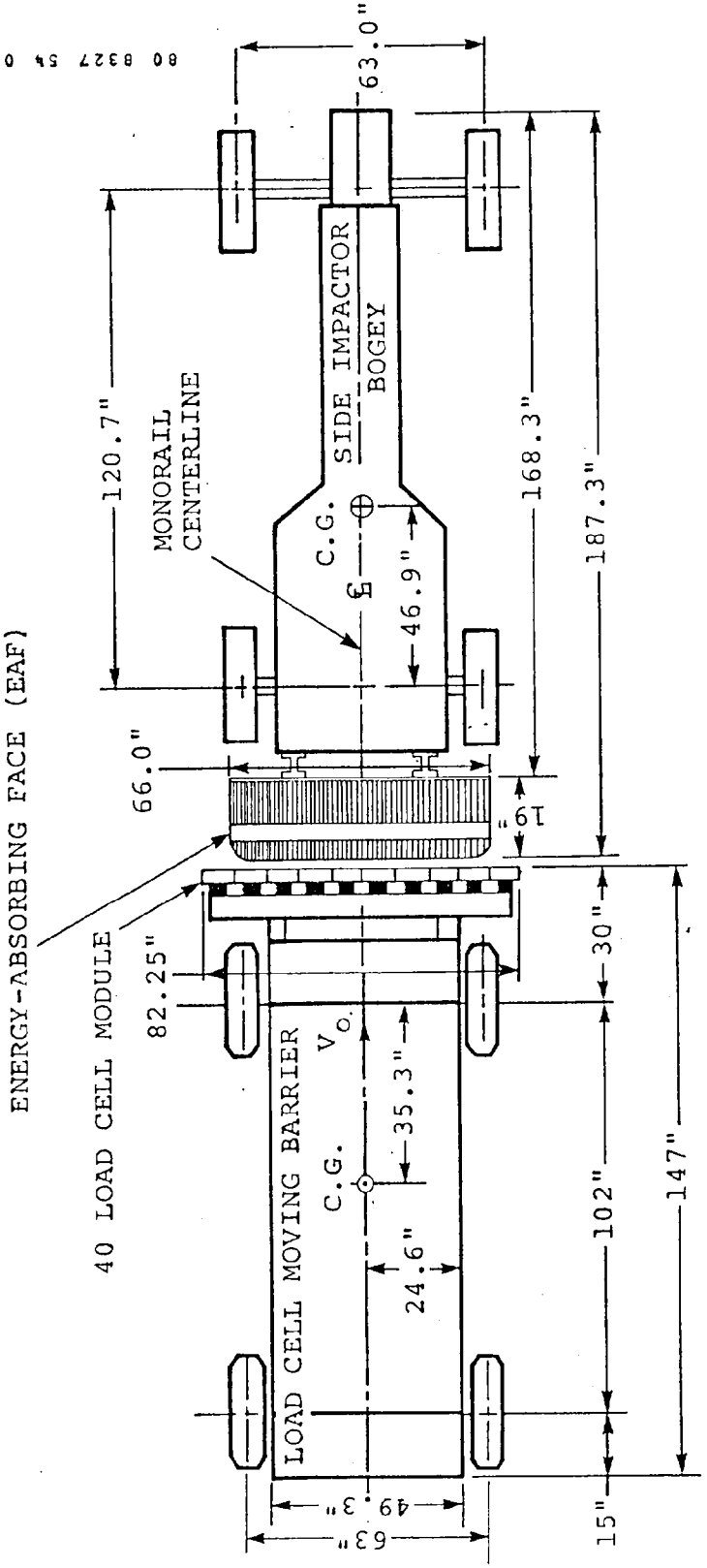


Figure 2-1. 0 Degree LCMB-to-Side Impactor Test Configuration (Test 8327-5.1).

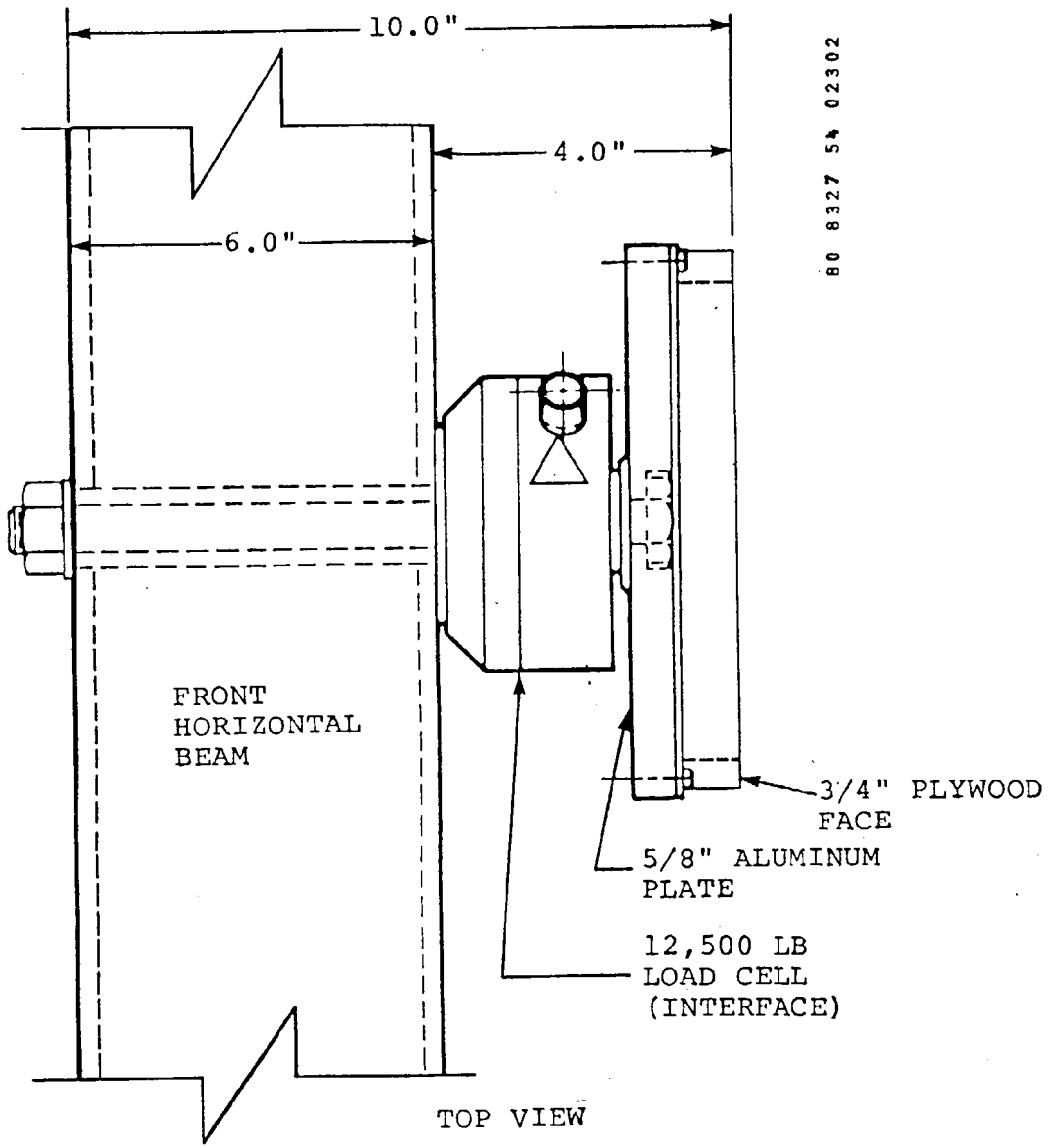


Figure 2-2. Typical Load Cell Instrumentation Module (8327 Task 5 Tests).

TABLE 2-1. CRASH TEST SUMMARY (TEST 8327-5.1)

TEST NO. 8327-5.1 CONTRACT: DOT-HS-8-01933(II)

TEST DATE: April 3, 1980 TIME: 11:33 TEMPERATURE: 63 °F

TEST CONFIGURATION: Head-on, Symmetric

VEHICLE NO. 1: Load Cell Moving Barrier (LCMB)

VEHICLE NO. 2: Side Impactor Bogey Vehicle

VEHICLE DATA	VEHICLE NO. 1	VEHICLE NO. 2
Overall Length/Width (in.)	147/82.3	187.3/66
Test Weight by Wheel (lb)	LF 1112 RF 1105 LR 615 RR 557	LF 1050 RF 1031 LR 666 RR 657
Total Weight (lb)	3389	3404
Wheelbase (in.)	102.9	120.7
Longitudinal C.G. (from Center of Front Axle) (in.)	35.3	46.9
Impact Angle (deg)*	0	0
Center of Gravity-to-Center of Gravity Offset Distance (in.)	0	0
Car Speed (mph)	29.3	0
Maximum Resultant Velocity Change (mph)**	-16.2	+16.1
Maximum Resultant Compartment Acceleration (G @ msec)	-25.5 @ 32***	-26.1 @ 21***
Maximum Mutual Dynamic Crush (Film Data) (in.)	8.7 @ 33 ms	
Maximum Static Crush (in.)		
• Top of Stack Level (32.6 in.)	N/A	3.6
• Center of Stack Level (23.5 in.)	N/A	5.6
• Bumper Level (17.1 in.)	N/A	8.0
Maximum Individual Load Cell (B-6) Force (klb @ msec)	7.5 @ 26	N/A
Maximum Total Load Cell Force (klb @ msec)	76.4 @ 24	N/A
INSTRUMENTATION		
Number of Data Channels	44	6
Number of Cameras	5	

*With respect to tow track centerline.
**Film data
***Average of Locations 1 and 2 - data unreliable(See Section 2.3)
N/A = Not applicable

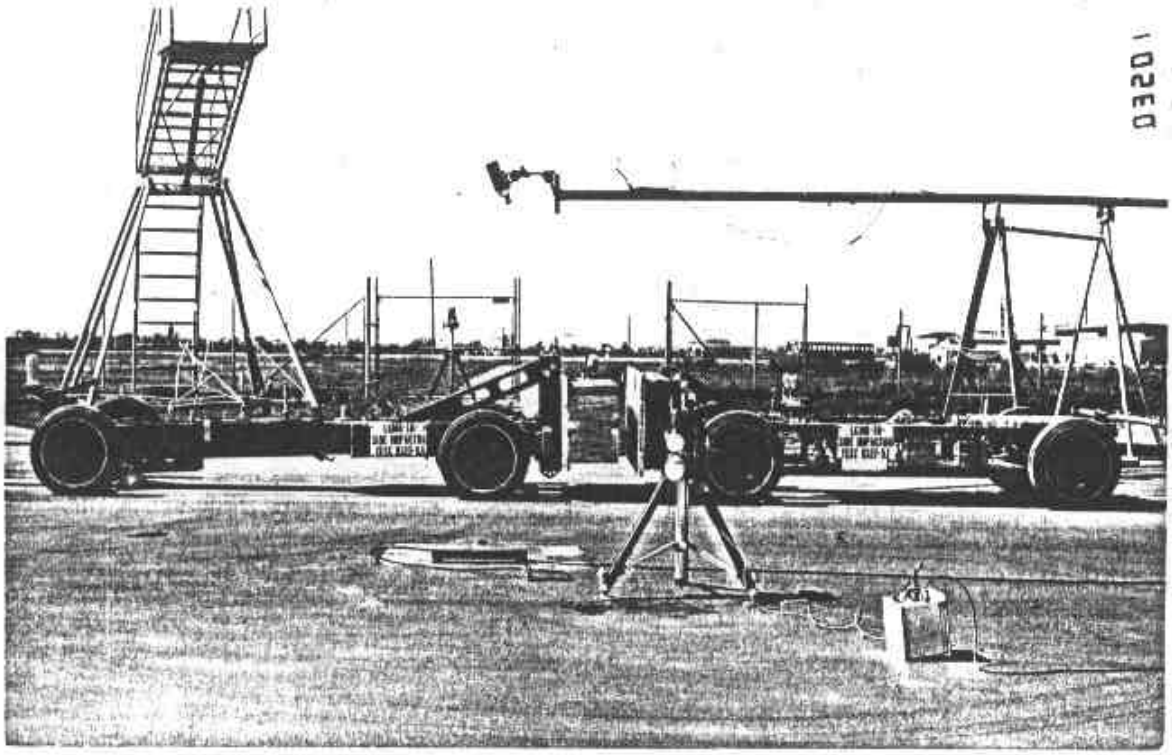


Figure 2-3. Pre-test Vehicle Configurations.

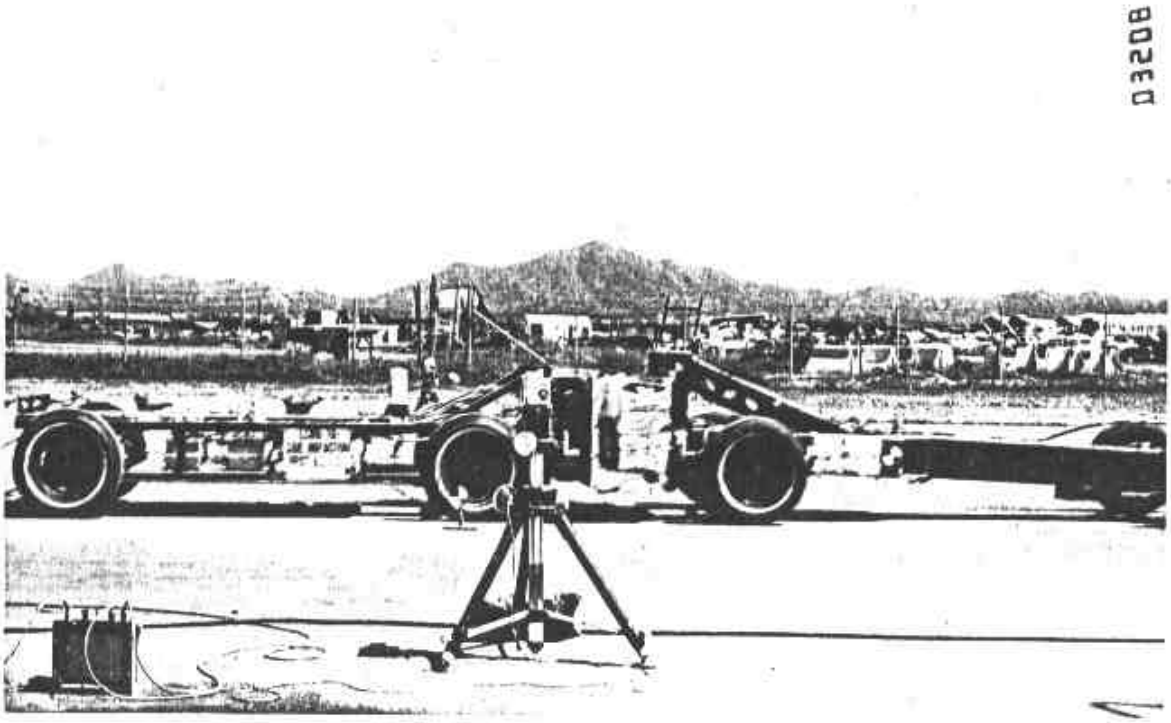


Figure 2-4. View of Vehicles Shortly After Impact.

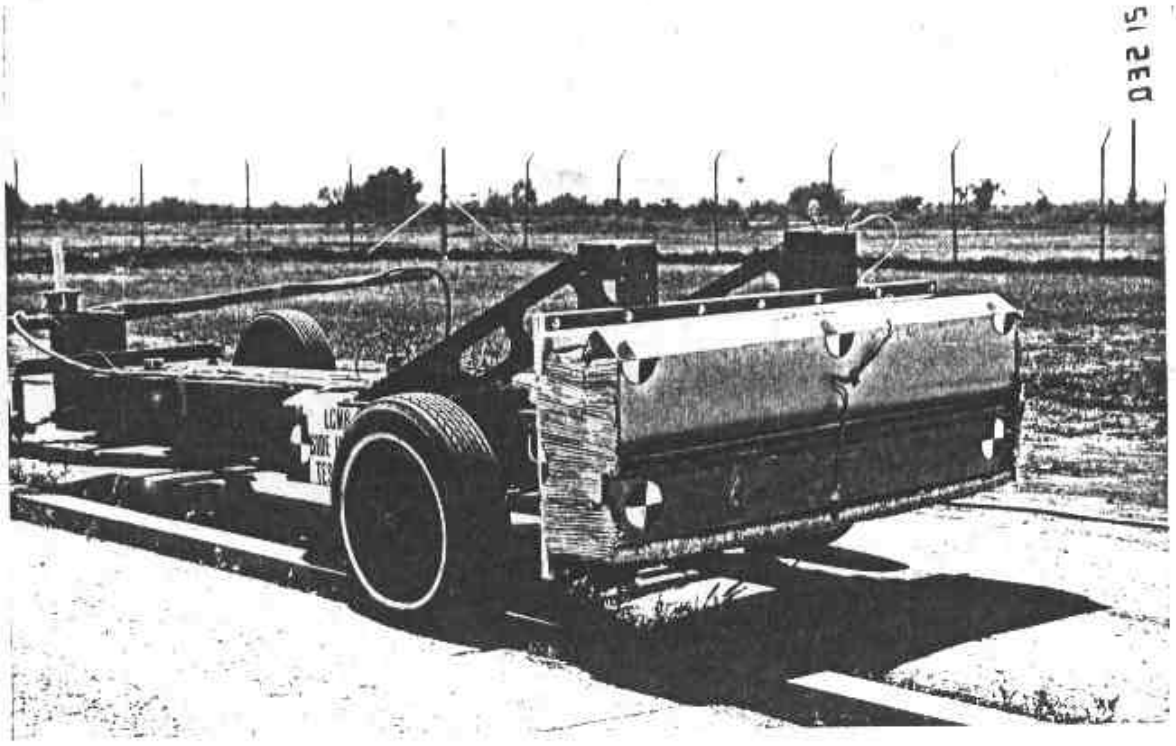


Figure 2-5. Post-test Configuration of Side Impactor.

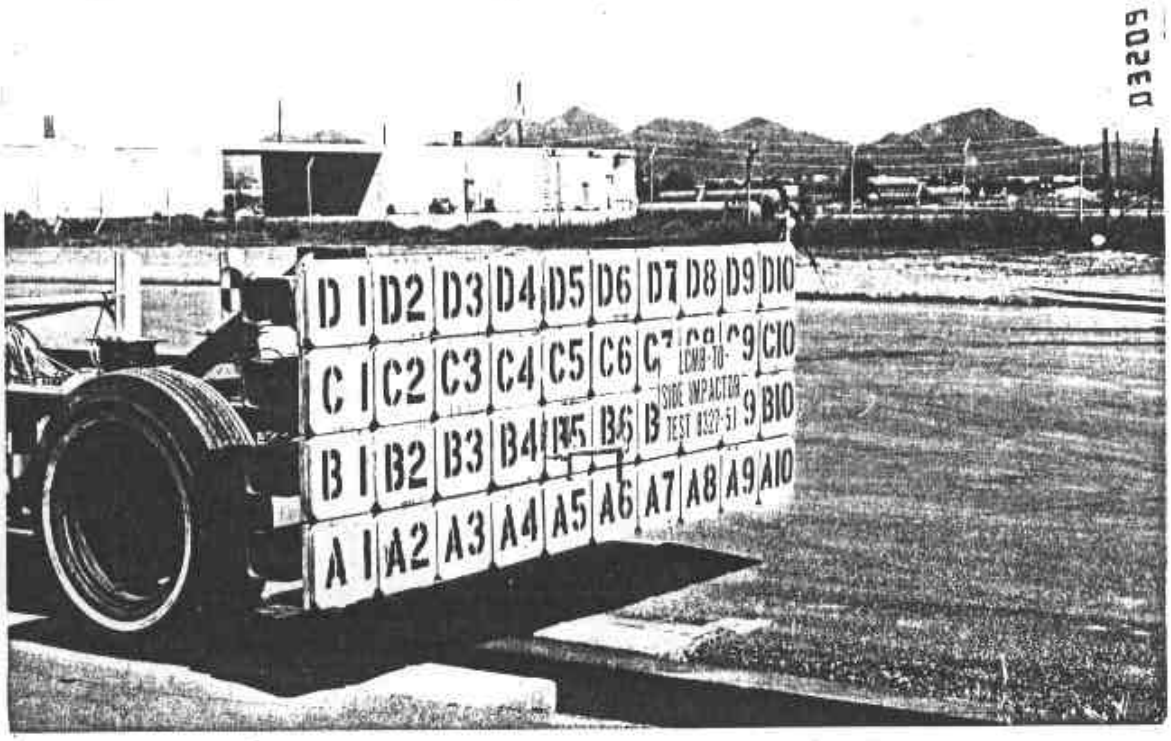


Figure 2-6. Post-test Configuration of LCMB.

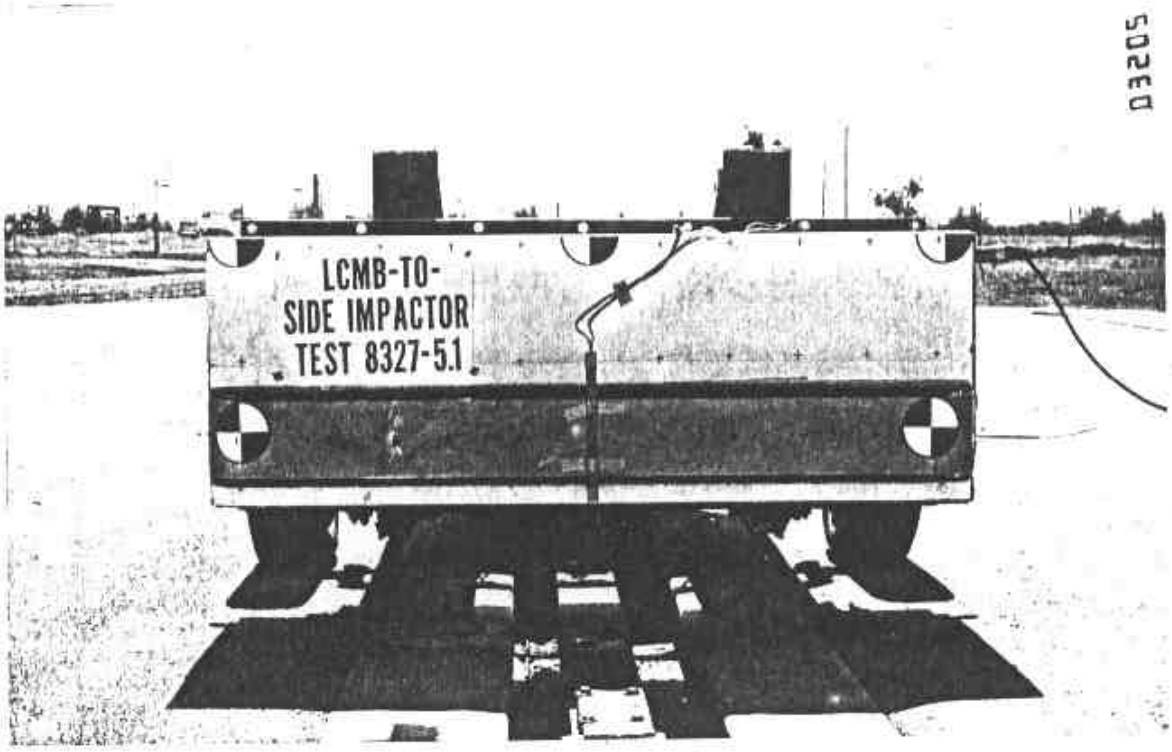


Figure 2-7. Pre-test Frontal View of Side Impactor.

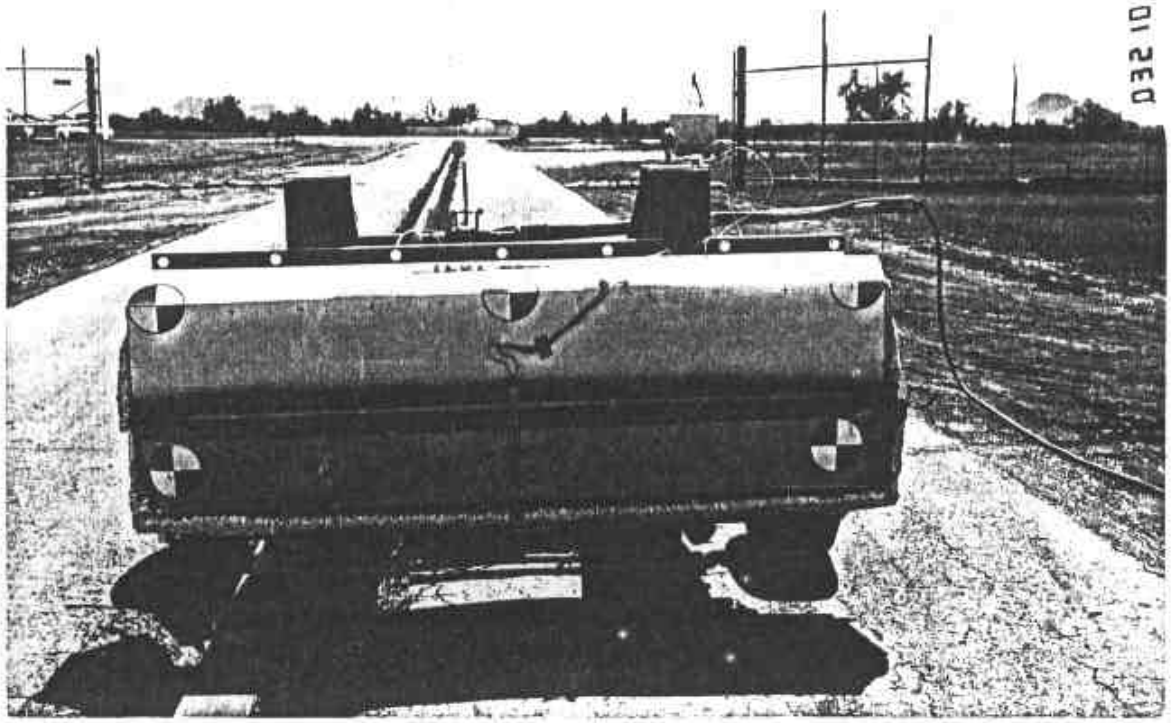


Figure 2-8. Post-test Frontal View of Side Impactor.

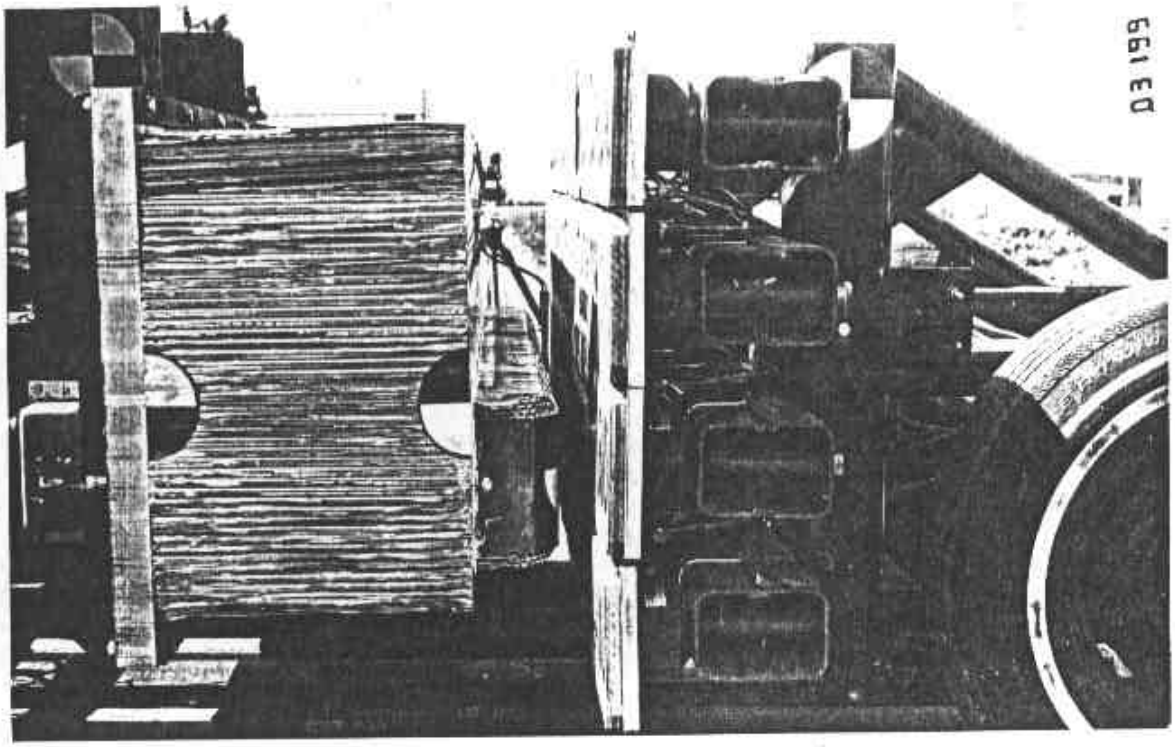


Figure 2-9. Pre-test Side View of Side Impactor Face.

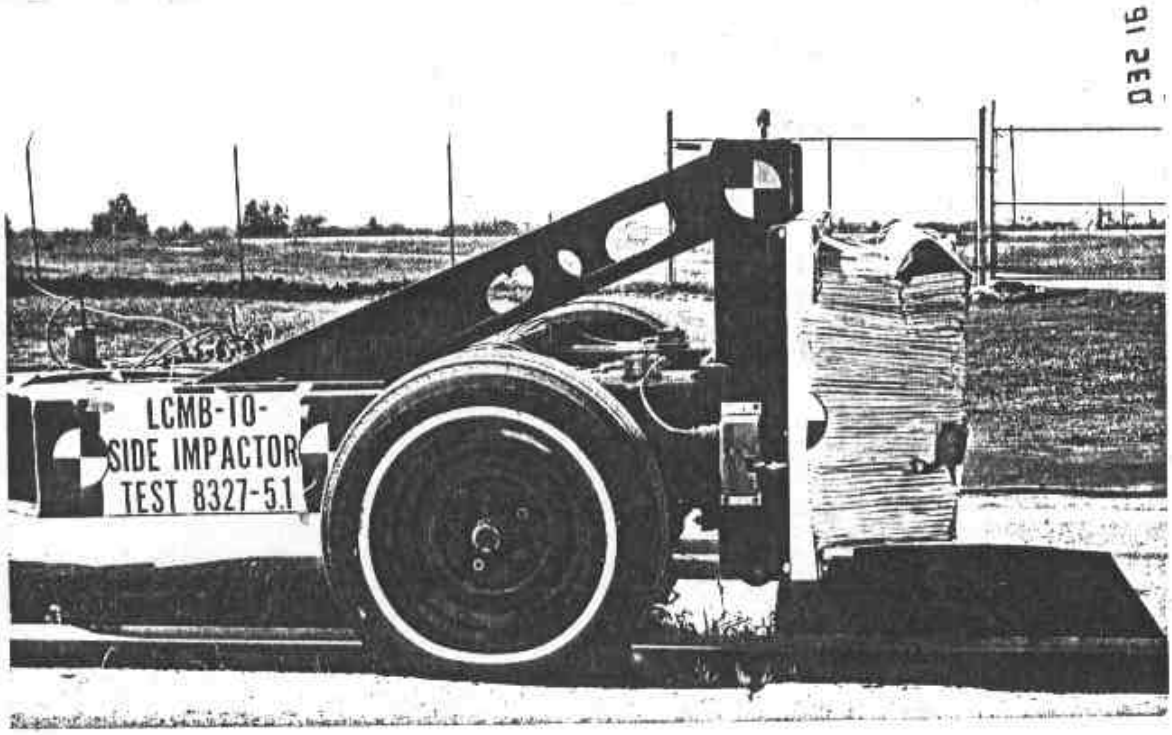


Figure 2-10. Post-test Side View of Side Impactor Face.

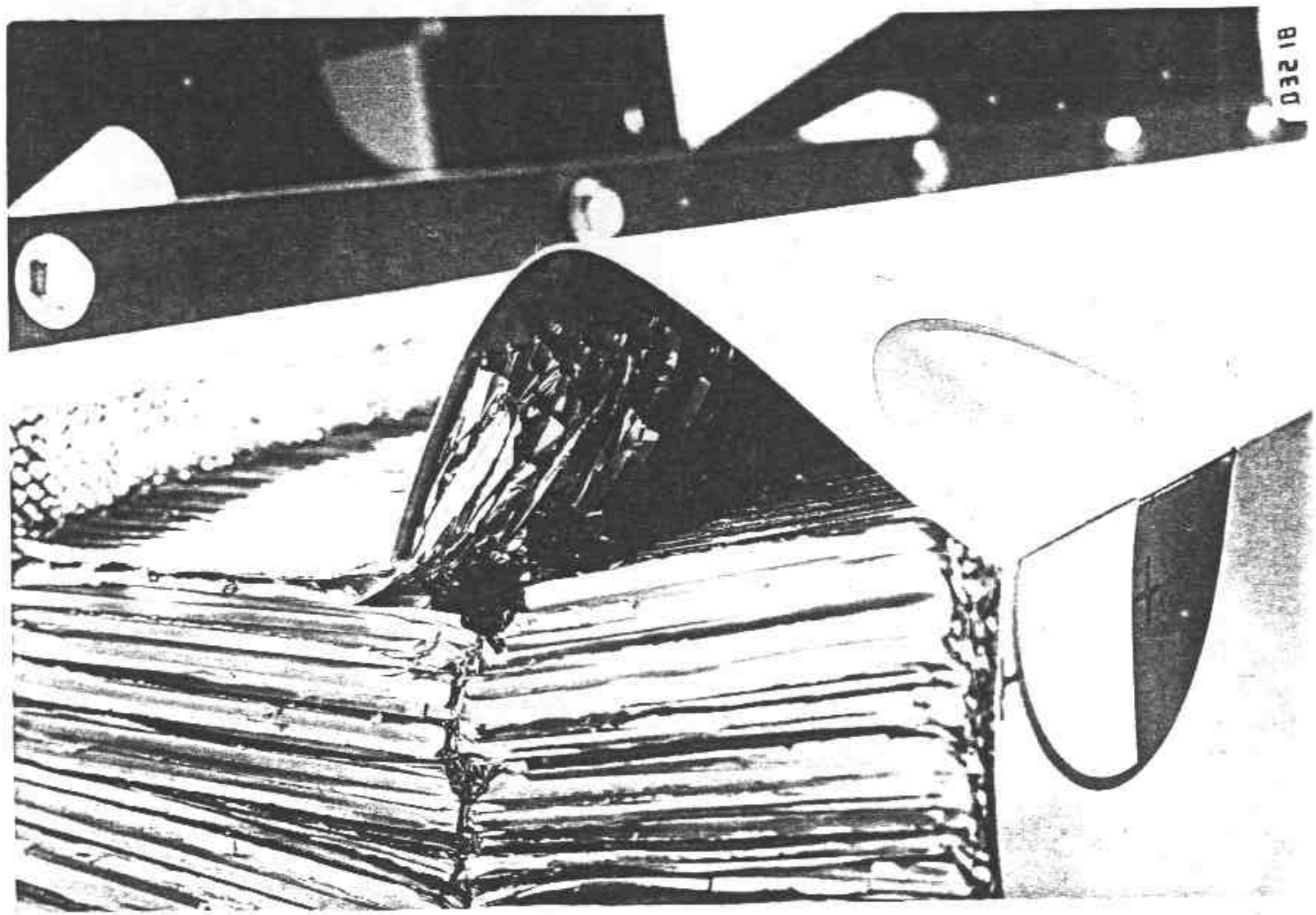


Figure 2-11. Post-test Close-up View of Top of Side Impactor Face.

TABLE 2-2. CHRONOLOGY OF CRASH EVENTS (TEST 8327-5.1)

Vehicle 1: Load Cell Moving Barrier

Vehicle 2: Side Impactor Bogey Vehicle with DSL-1267 EAF

Time (msec)	Crash Event*
0	Impact (visual).
1	Bumper starts to intrude into stack.
5	Top of stack begins to separate from backplate.
8	Maximum separation of stack from backplate; LCMB contacts full Side Impactor face area.
10	Top of stack begins downward motion; top sheet begins to buckle.
11	Stack recontacts backplate; Side Impactor bogey begins rearward motion.
18	Top sheet begins to cut into top of stack.
26	Maximum downward displacement of stack top surface.
33	Maximum dynamic crush (8.7 in.) of face.
50	Vehicles begin to separate.

*From film data

TABLE 2-3. SUMMARY OF LCMB ACCELEROMETER DATA (TEST 8327-5.1) (0 ≤ t ≤ 250 MSEC)

Accelerometer Number*	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)	Max/Min Velocity V (mph)	Max/Min Velocity Time (msec)	Maximum Displacement S (in.)	Maximum Displacement Time (msec)
A1X**	-26.1	30	17.5	57	84.4	250
A2X**	-25.6	23	15.7	45	86.4	250
Average of A1X and A2X**	-25.5	32	16.6	45	85.4	250
A3Y	9.0	7	-0.2	250	3.4	230
A4Y	4.1	9	0.1	13	-12.3	250
Average of A3Y and A4Y	5.0	9	0.8	31	-4.5	250

*For location of accelerometers, see Figure D-1.
**Data unreliable, see Section 2.3.

TABLE 2-4. SUMMARY OF SIDE IMPACTOR ACCELEROMETER DATA (TEST 8327-5.1) (0 ≤ t ≤ 250 MSEC)

Accelerometer Number*	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)	Maximum Velocity V (mph)	Maximum Velocity Time (msec)	Maximum Displacement S (in.)	Maximum Displacement Time (msec)
B1X**	-25.1	21	-12.5	244	-49.5	250
B2X**	-27.0	21	-10.1	71	-40.1	250
Average of B1X and B2X**	-26.0	21	-11.3	250	-44.8	250
B3Y	8.8	12	-0.2	8	7.7	250
B4Y	-8.7	34	-0.7	48	-0.2	82
Average of B3Y and B4Y	7.2	50	-0.2	48	3.8	250

*For accelerometer locations, see Figure D-2.
**Data unreliable, see Section 2.3.

TABLE 2-5. SUMMARY OF MAXIMUM LOAD CELL DATA FOR LCMB (TEST 8327-5.1)

Parameter	Passenger Side of Impactor					Driver Side of Impactor				
Load Cell (No.)	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1
Force (klb)	0.17	0.46	0.62	0.63	0.44	0.44	0.22	0.28	0.46	0.15
Time (msec)	154	22	13	16	16	97	14	12	200	245
Load Cell (No.)	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1
Force (klb)	0.60	3.18	2.99	3.95	2.88	3.11	3.02	3.54	3.34	0.08
Time (msec)	60	24	25	25	24	22	32	21	17	134
Load Cell (No.)	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
Force (klb)	0.17	6.13	5.43	5.70	7.51*	2.85	3.28	7.16	4.66	0.17
Time (msec)	75	25	16	14	26	25	24	13	21	121
Load Cell (No.)	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
Force (klb)	1.04	2.32	2.10	1.26	2.31	1.09	0.85	2.79	2.34	0.18
Time (msec)	114	4	4	4	5	32	4	4	4	230

*Maximum Measured Force

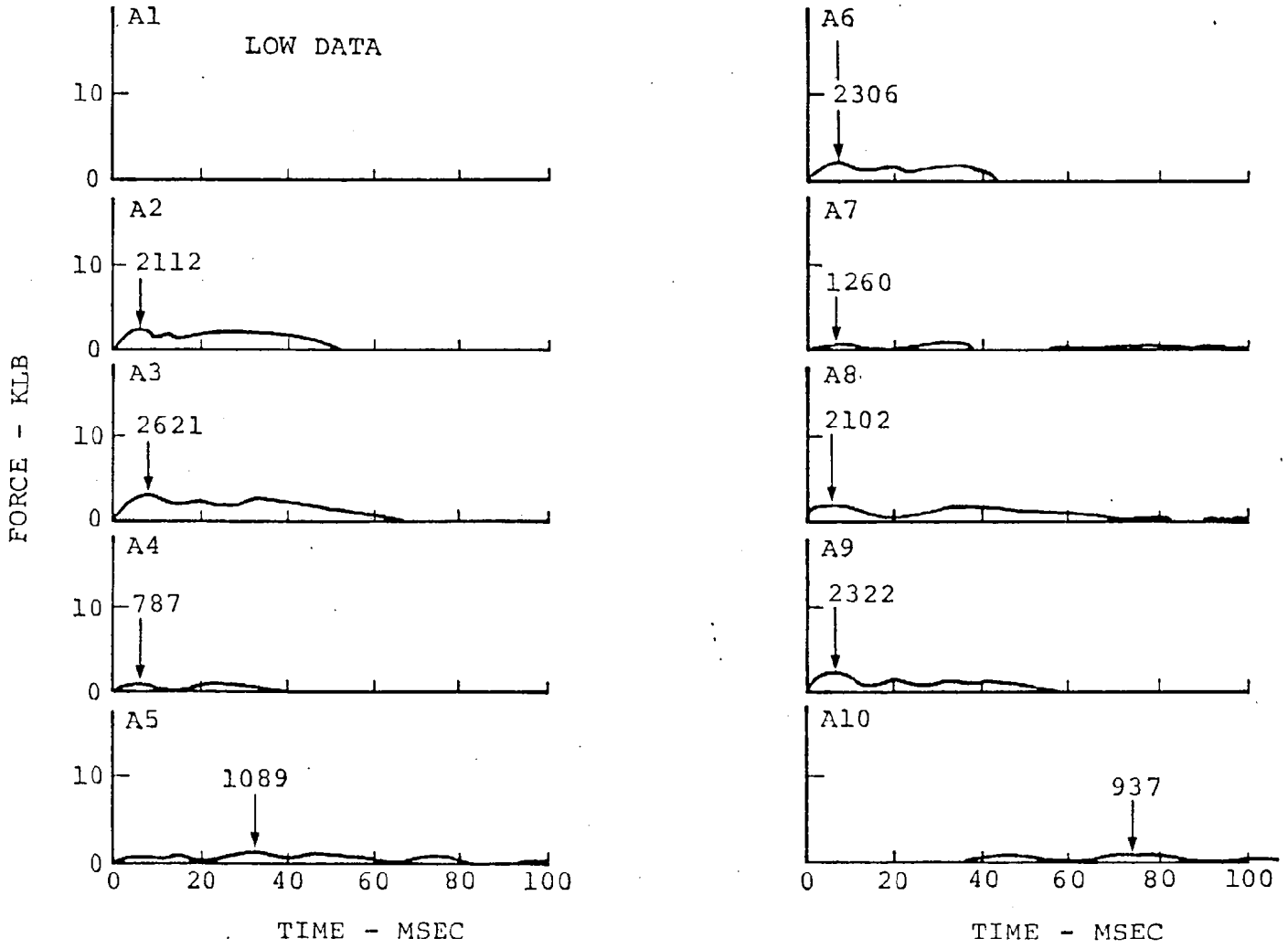


Figure 2-12. LCMB Force Versus Time on Row A (Test 8327-5.1).

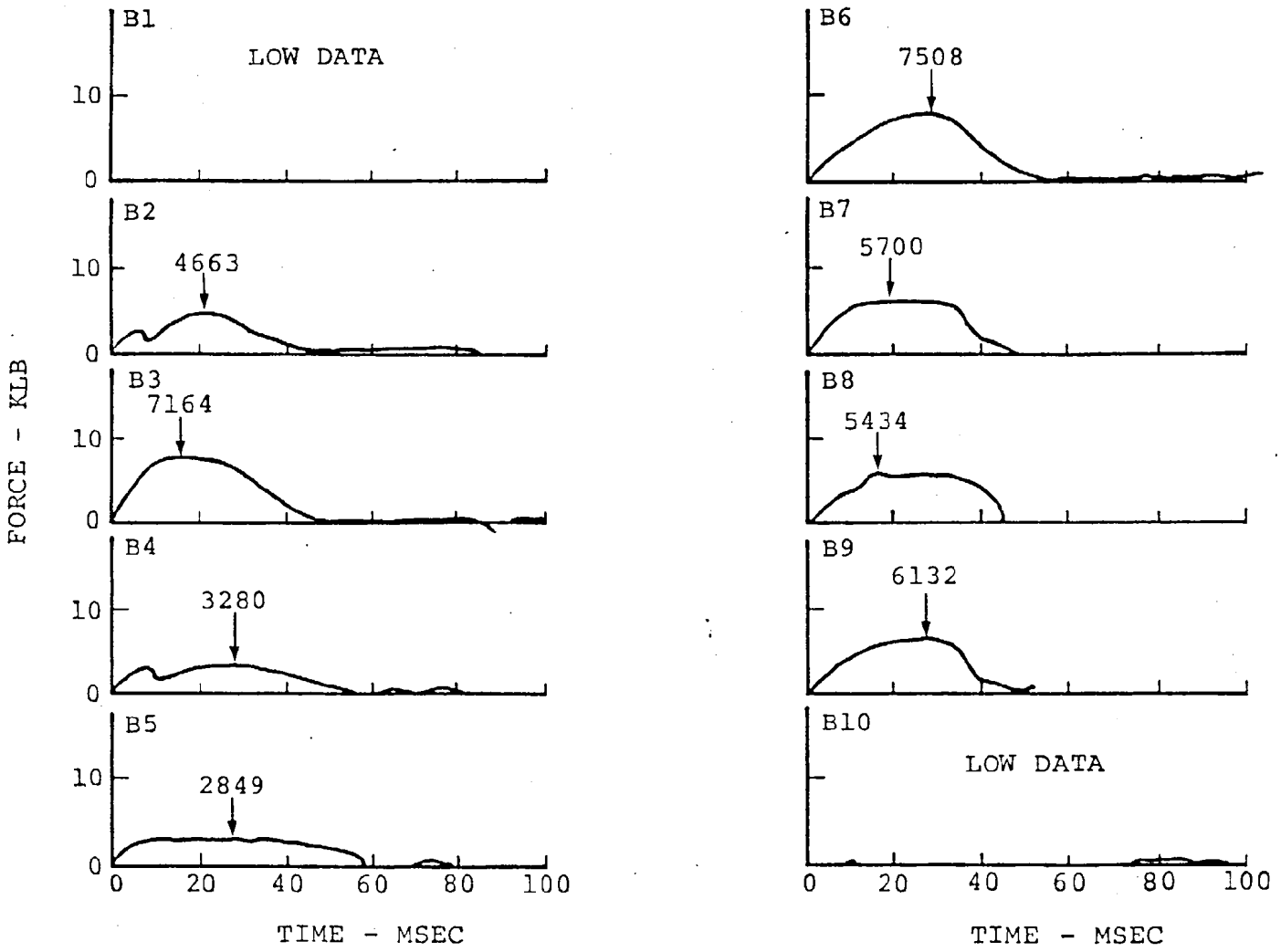


Figure 2-13. LCMB Force Versus Time on Row B (Test 8327-5.1).

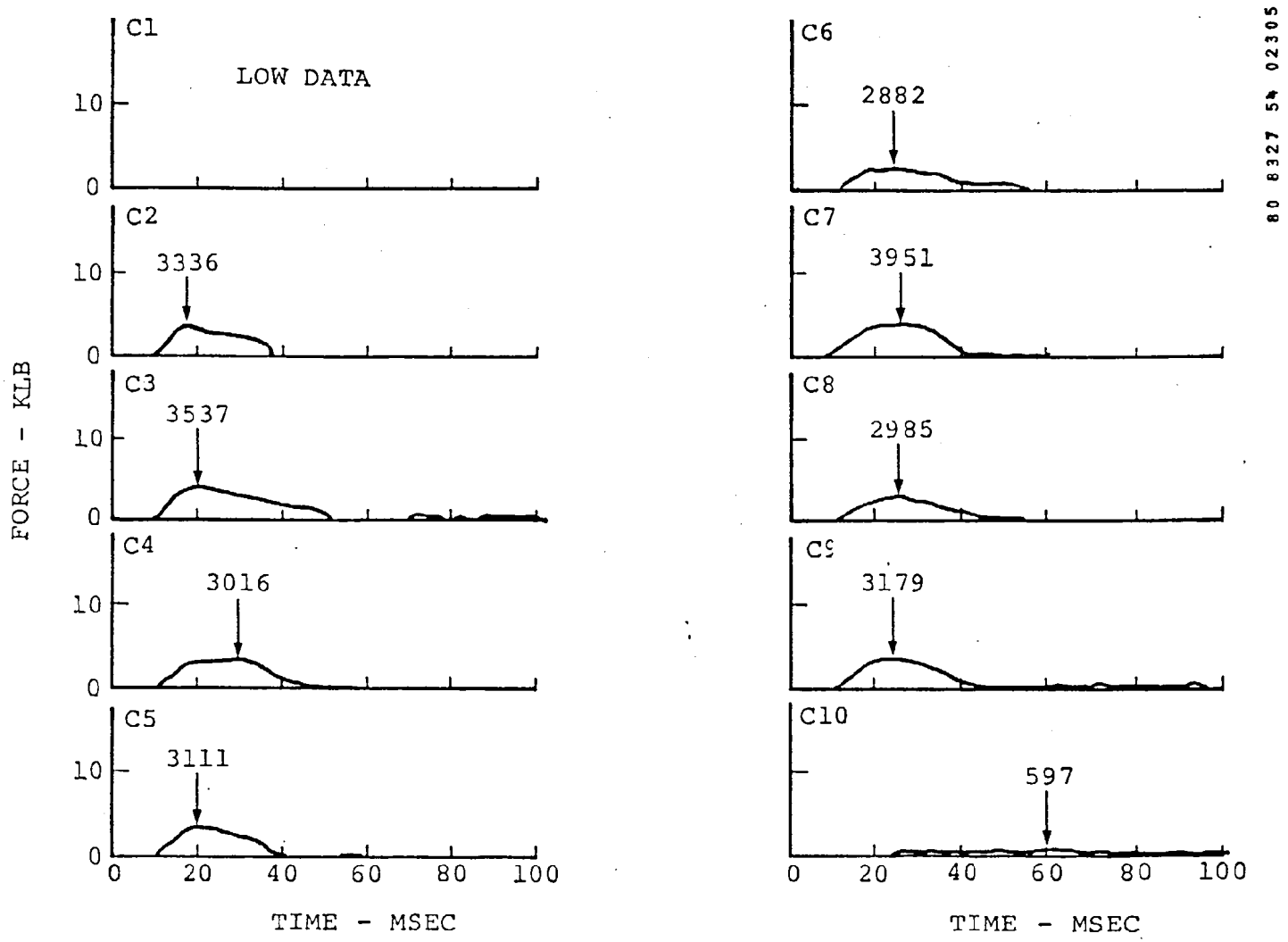


Figure 2-14. LCMB Force Versus Time on Row C (Test 8327-5.1).

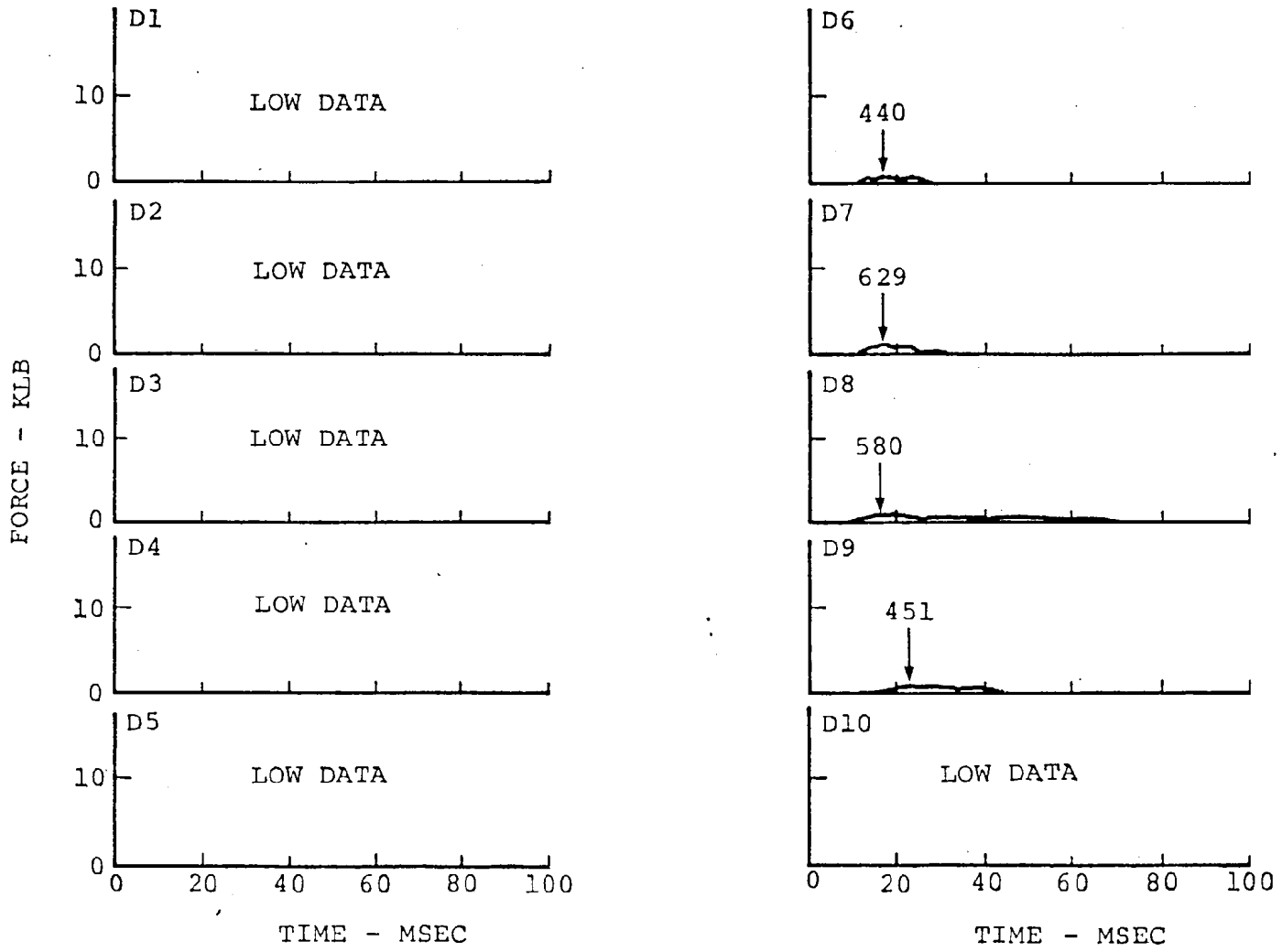


Figure 2-15. LCMB Force Versus Time on Row D (Test 8327-5.1).

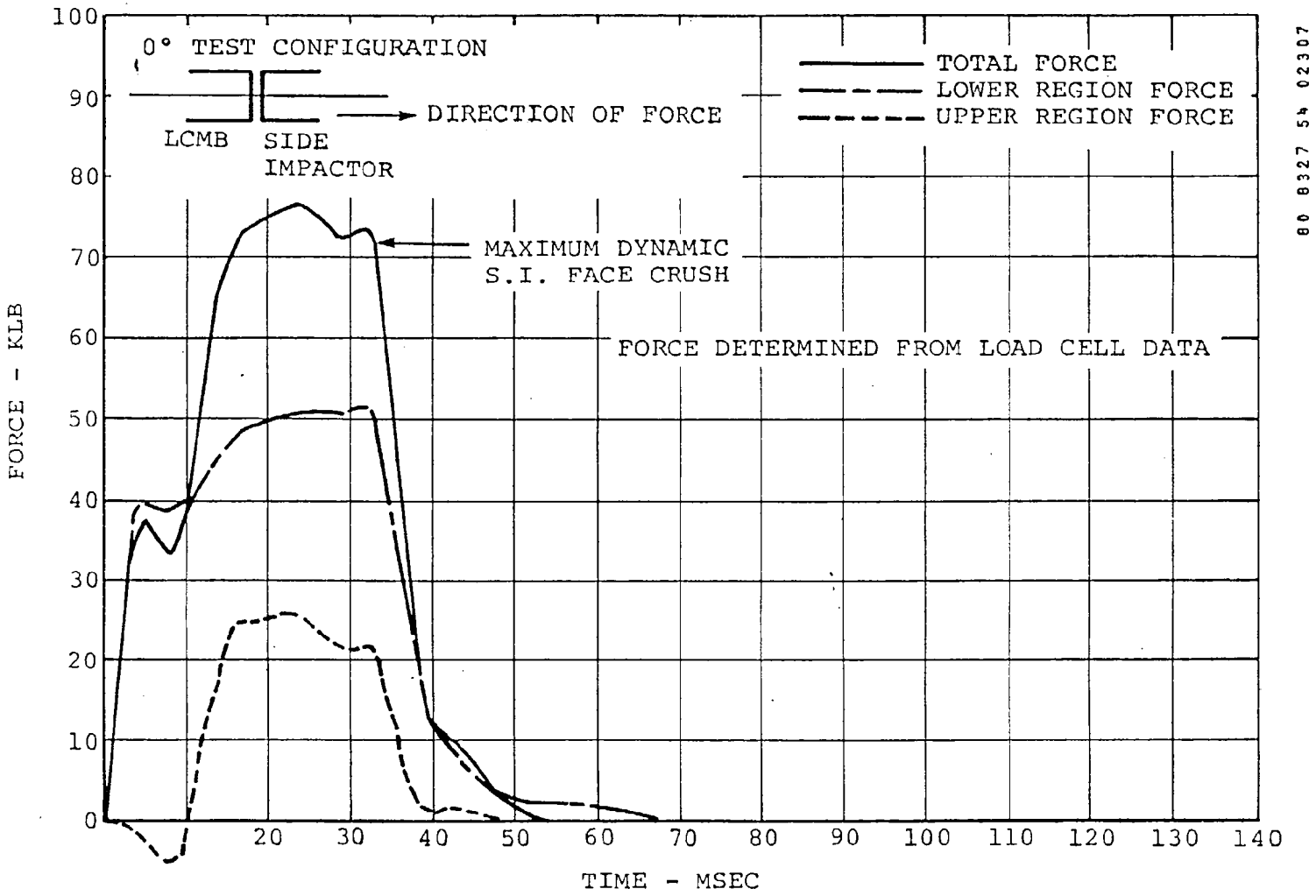


Figure 2-16. Lower Region, Upper Region, and Total Force Versus Time (Test 8327-5.1).

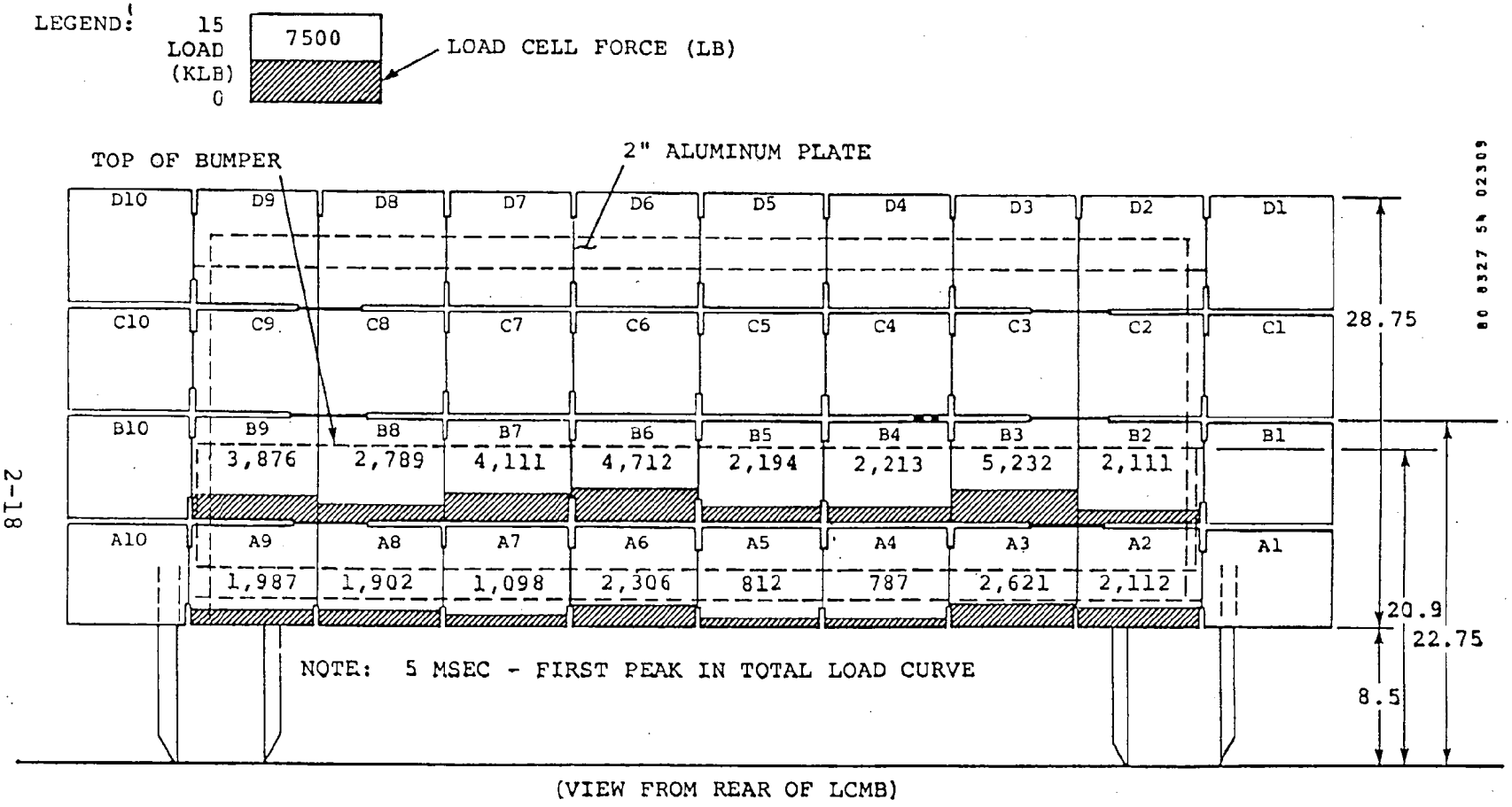


Figure 2-17. LCMB-to-Side Impactor Head-on Frontal Impact Load Distribution at 5 msec (Test 8327-5.1).

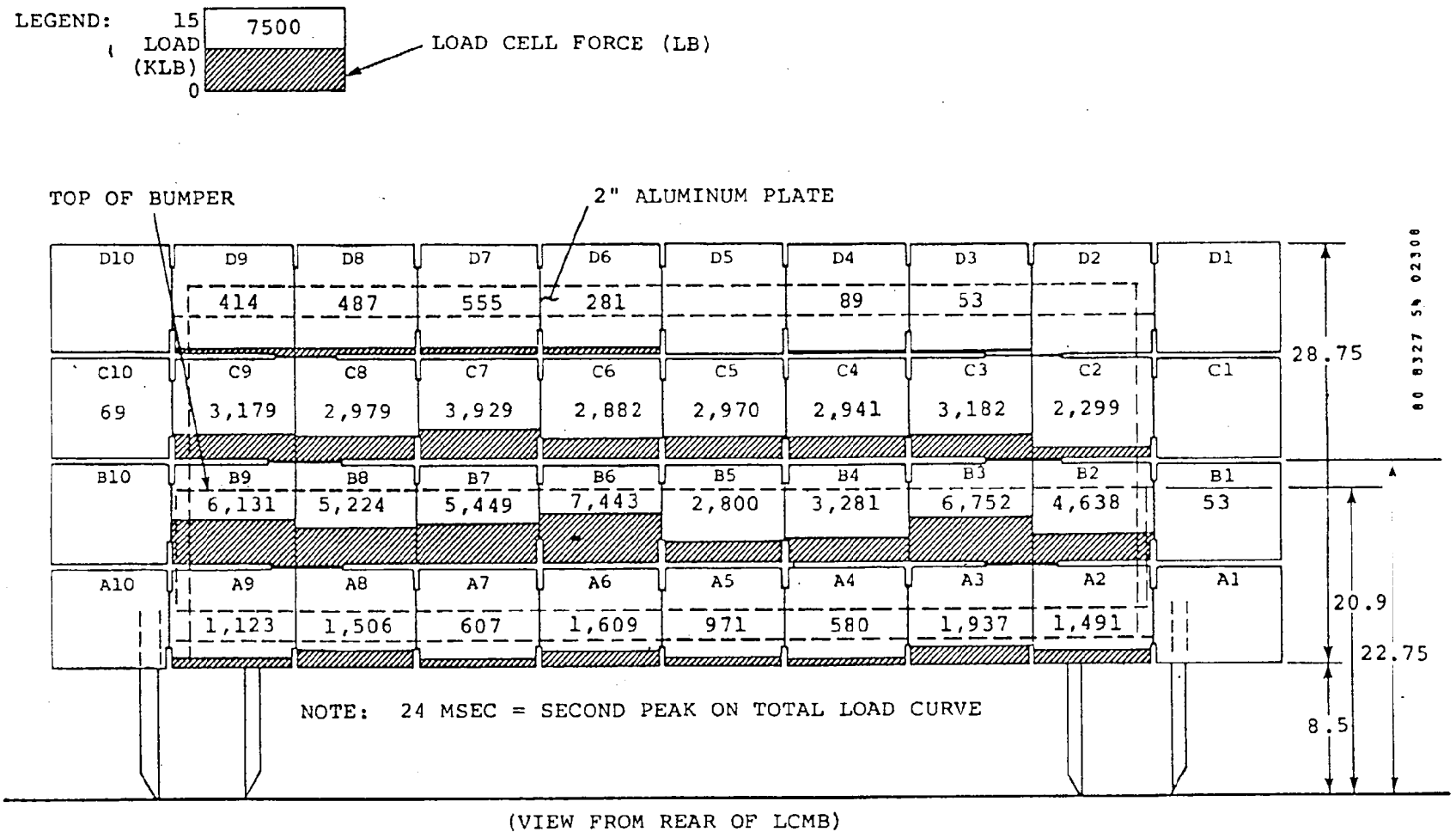


Figure 2-18. LCMB-to-Side Impactor Head-on Frontal Impact Load Distribution at 24 msec (Test 8327-5.1).

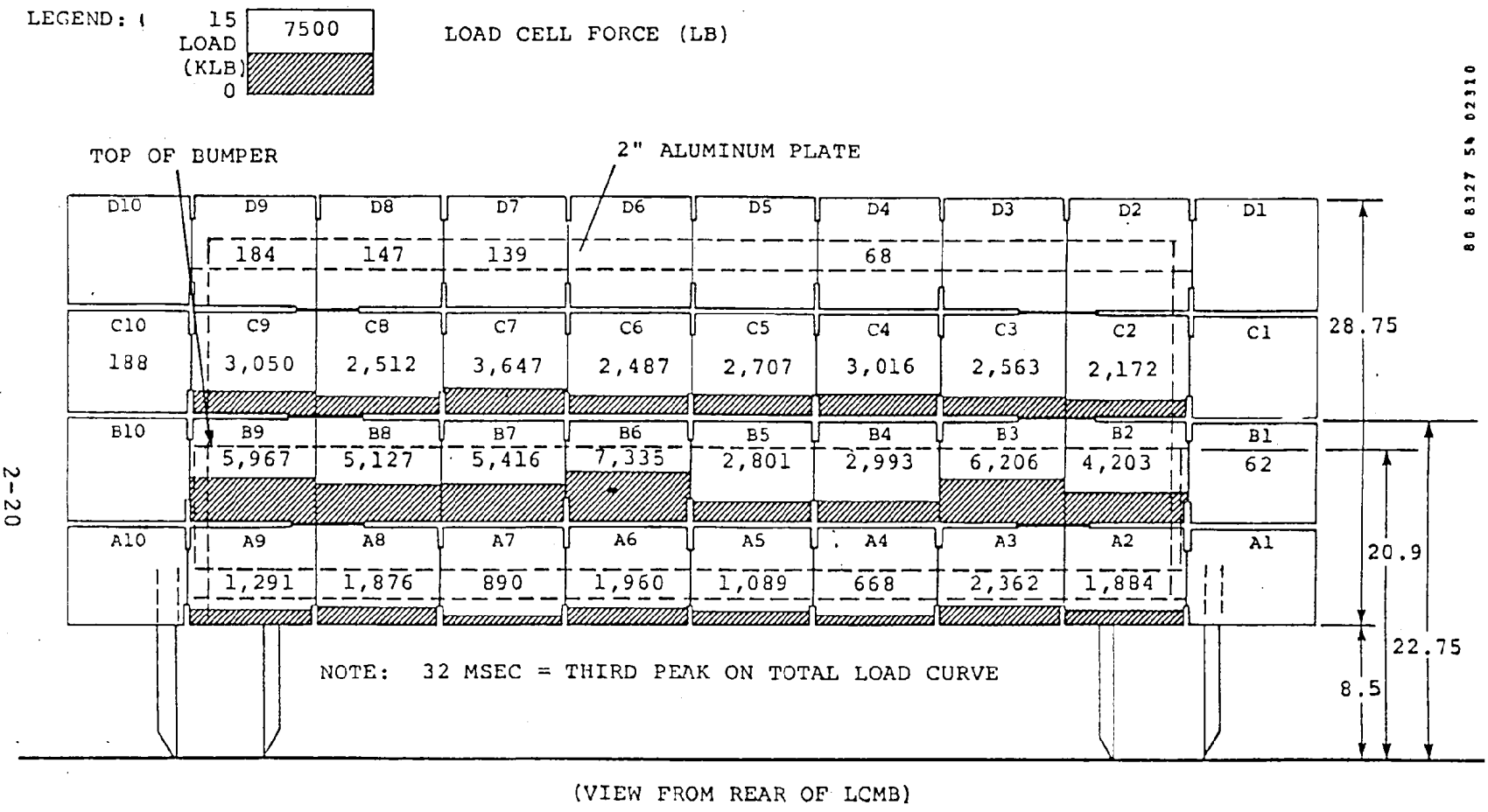


Figure 2-19. LCMB-to-Side Impactor Head-on Frontal Impact Load Distribution at 32 msec (Test 8327-5.1).

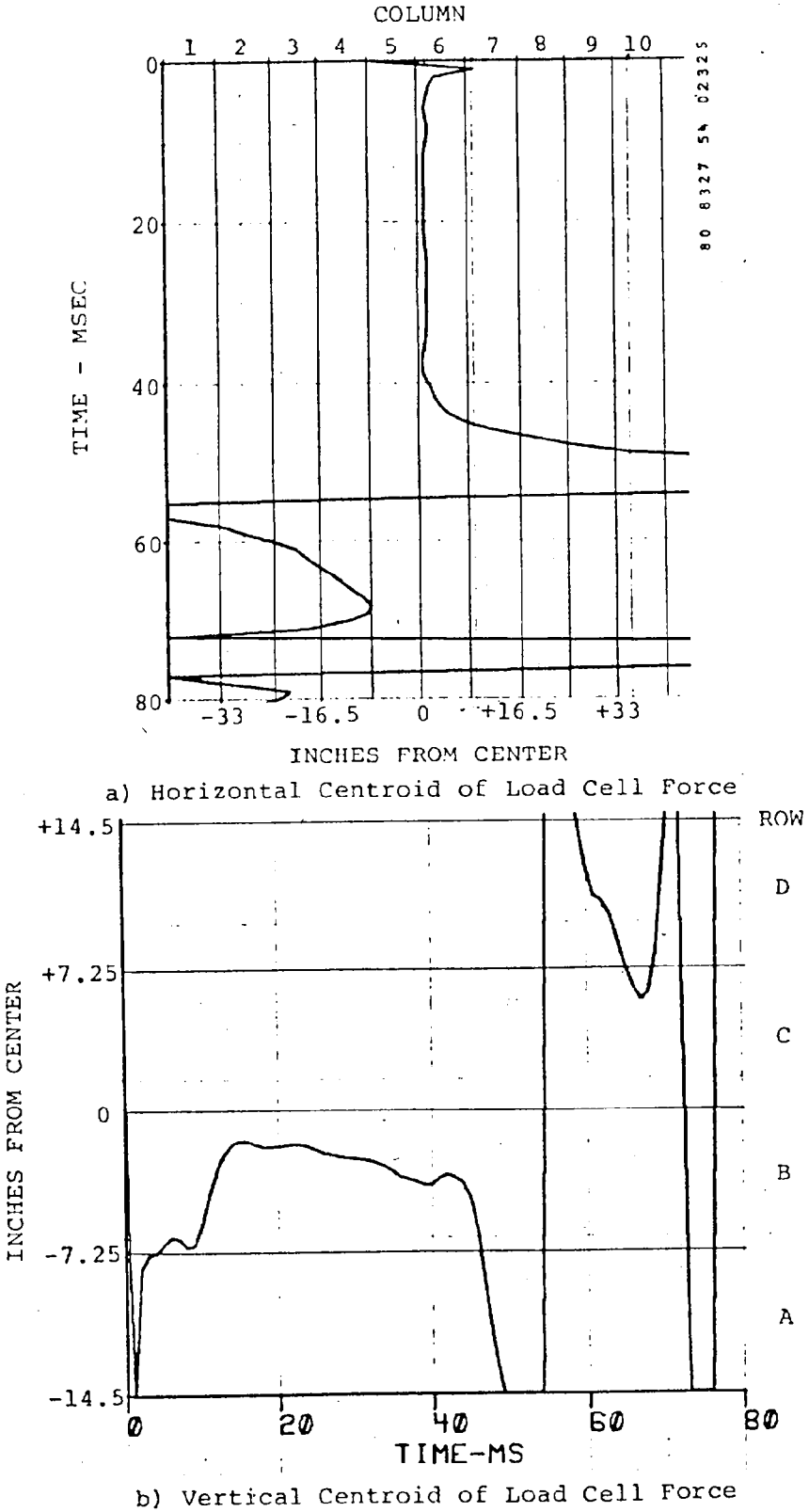


Figure 2-20. Centriod of Load Cell Force for LCMB (Test 8327-5.1).

TABLE 2-6. SUMMARY OF GROUPED LOAD CELL DATA (TEST 8327-5.1)

Parameter	Passenger Side of Impactor	Center of Impactor	Driver Side of Impactor
Load Cells (No.)	D8 - D10 & C8 - C10	D4 - D7 & C4 - C7	D1 - D3 & C1 - C3
Force (klb)	6.69	13.74	6.49
Time (msec)	24	23	18
Load Cells (No.)	B8 - B10 & A8 - A10	B4 - B7 & A4 - A7	B1 - B3 & A1 - A3
Force (klb)	13.80	23.15	14.93
Time (msec)	33	32	26

TABLE 2-7. COMPARISON OF TOTAL LOAD CELL FORCE FROM LOAD CELL AND ACCELEROMETER DATA (TEST 8327-5.1)

Parameter	LCMB Load Cell Data*	LCMB Inertia Acceleration Data†	Side Impactor Acceleration Data**
Force (lb)	76,380	86,768	88,414
Time (msec)	24	32	28

*Sum of 40 load cells.
†Average of LCMB accelerometers 1 and 2 times LCMB weight.
**Average of Side Impactor accelerometers 1 and 2 times Side Impactor weight, in direction of LCMB.

Note: LCMB and SI longitudinal accelerometer data unreliable (see Section 2.3)

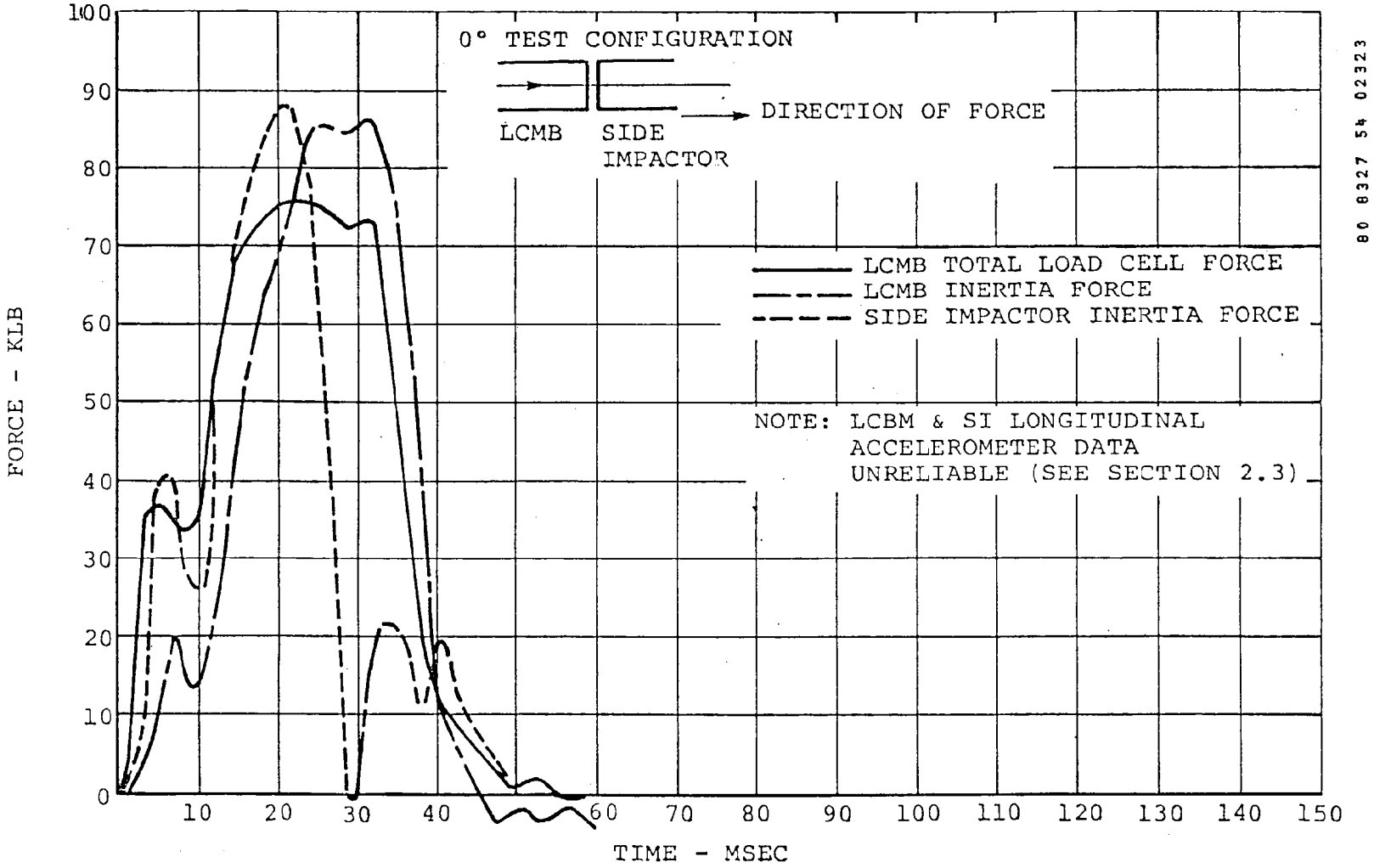
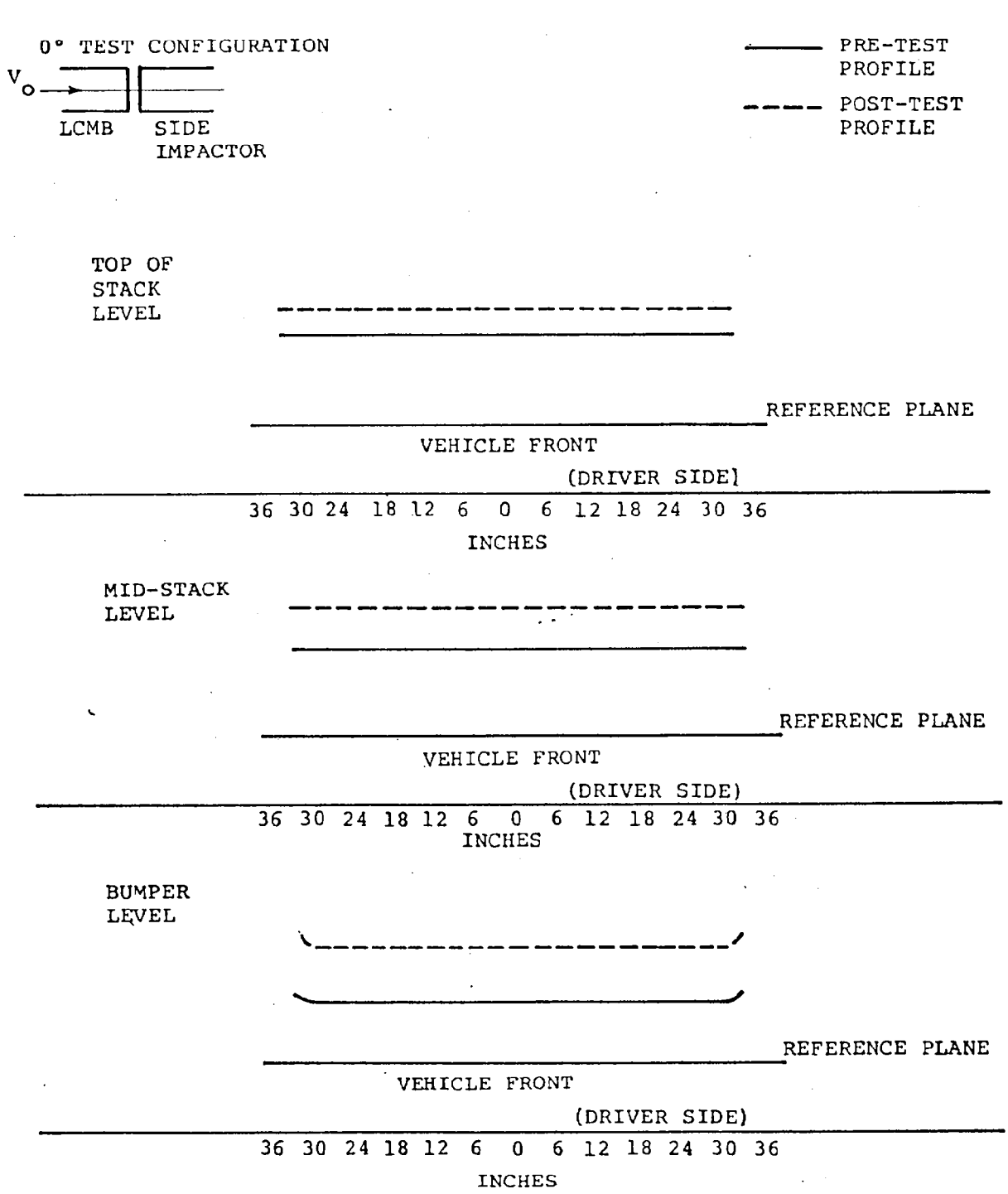


Figure 2-21. Comparison of Total Force From Load Cell and Vehicle Accelerometer Data (Test 8327-5.1).

TABLE 2-8. EXTERIOR STATIC CRUSH FOR SIDE IMPACTOR (TEST 8327-5.1)

Location	Height at ℄ (in.)	Distance Left of Center (in.)*								Distance Right of Center (in.)*						
		33	32	30	24	18	12	6	0	6	12	18	24	30	32	33
Pre-test Measurements (in.)																
Top of Stack Level	32.6	12.9	-	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	-	12.9
Mid-Stack Level	23.5	12.6	-	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	-	12.6
Bumper Level	17.1	-	9.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9.6	-
Post-test Measurements (in.)																
Top of Stack Level	31.1	16.5	-	16.5	16.5	16.5	16.4	16.3	16.2	16.2	16.2	16.2	16.2	16.2	-	16.2
Mid-Stack Level	22.4	17.8	-	18.0	18.0	18.0	18.0	18.1	18.2	18.2	18.1	18.2	18.1	18.0	-	18.2
Bumper Level	17.0	-	17.4	16.5	16.5	16.5	16.5	16.5	16.4	16.4	16.4	16.4	16.4	16.4	17.5	-
Static Crush (in.)																
Top of Stack Level	-1.5	3.6	-	3.6	3.6	3.6	3.5	3.4	3.3	3.3	3.3	3.3	3.3	3.3	-	3.3
Mid-Stack Level	-1.1	5.2	-	5.4	5.4	5.4	5.4	5.5	5.6	5.6	5.5	5.6	5.5	5.4	-	5.6
Bumper Level	-0.1	-	7.9	8.0	8.0	8.0	8.0	8.0	8.0	7.9	7.9	7.9	7.9	7.9	7.9	-

*From Side Impactor driver position.
Reference Plane: 30" forward of back edge of 2" plate.



NOTE: FOR PROFILE POINT LOCATIONS, SEE FIGURE D-3

Figure 2-22. Pre- and Post-test Profiles at Top, Mid, and Bumper Levels of Side Impactor.

TABLE 2-9. SUMMARY OF SIDE IMPACTOR STRING POTENTIOMETER DATA (TEST 8327-5.1)

Displacement Potentiometer Number*	Maximum Dynamic Displacement		Residual Static Displacement (in.)
	D (in.)	Time (msec)	
1	6.4	36	5.7
2	7.7	36	7.0

*For string potentiometer location, see Figures D-2 and D-3.

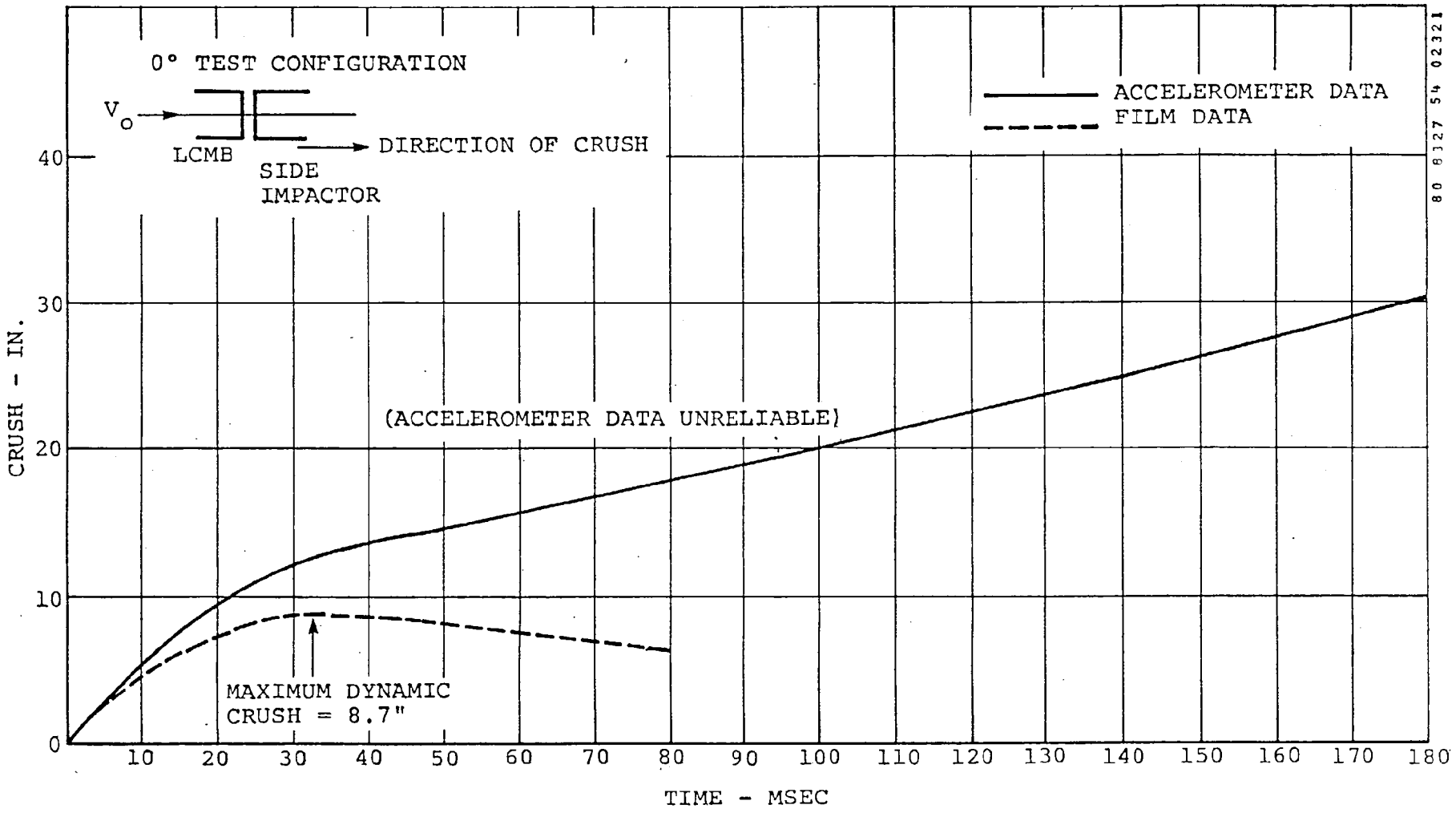


Figure 2-28. Mutual Crush Versus Time (Test 8327-5.1).

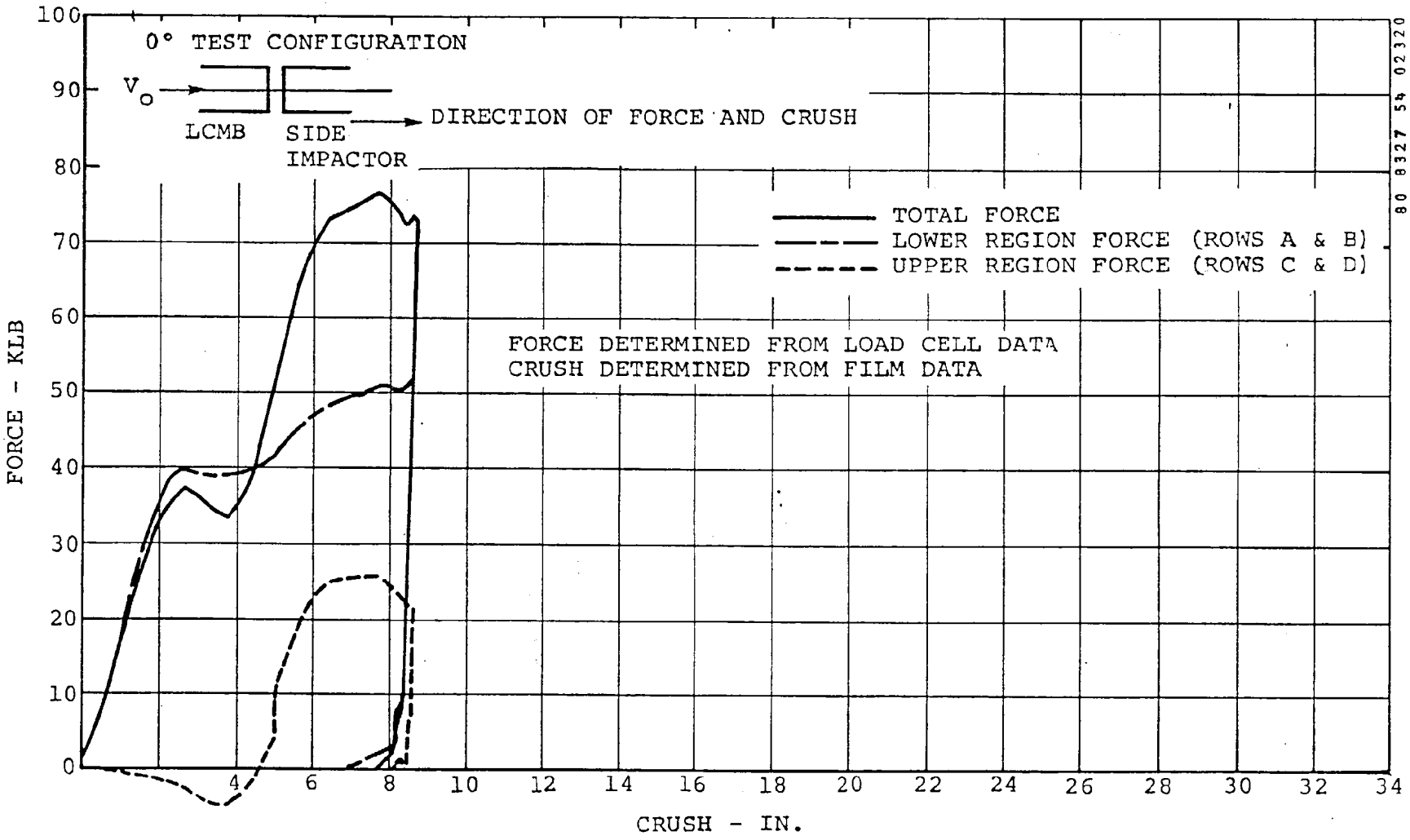


Figure 2-29. Lower Region, Upper Region, and Total Force Versus Crush (Test 8327-5.1).

2.3 SUMMARY AND CONCLUSIONS

The longitudinal acceleration on the LCMB and the Side Impactor are included in this report but these data are considered unreliable due to clipping and attenuation of the higher than expected accelerometer signals during the crash. This anomaly resulted in reduced vehicle velocity changes not consistent with the dynamics of the crash event (15-16 mph). The longitudinal displacement data used for generating plots involving displacement were obtained from high speed film analysis.

Table 2-10 shows the comparison of the initial impact velocity obtained from film analysis and the velocity change for each vehicle derived from film analysis and from integration of load cell data. The impact velocity for the crash was 29.3 mph, verified within 0.1 mph by two primary speed traps and two back-up sources recorded during the test.

TABLE 2-10. COMPARISON OF VELOCITY DATA (MPH)

Vehicle	Data Source: S.I. Driver Side C/U Camera	S.I. Driver Side O/A Camera	S.I. Passenger Side C/U Camera	Load Cell Impulse
Initial Velocity				
• S.I.	0	0	0	NA
• LCMB	29.05	29.02	28.81	NA
ΔVelocity Change				
• S.I.	15.3	15.9	15.7	14.9
• LCMB	16.2	16.1	16.0	15.0

During the initial impact of the bumper with the LCMB, the honeycomb crushed above and below bumper level because of the load transfer to the .032" thick aluminum face sheet. The top surface

of the honeycomb was pulled downward and sheared from the back plate when the 8" horizontal leg of the face sheet buckled.

To verify the load cell data for the crash, the energy (area) under the load cell force/crush plot was divided by the dynamic crush volume of the honeycomb. The average honeycomb crush strength was computed as 46 psi which is reasonably consistent with the impactor face honeycomb. Two samples tested by Hexcel of the honeycomb material used in this impactor face had crush strengths of 45.7 and 45.8 psi.

3.0 TEST 8327-5.2 - LOAD CELL MOVING BARRIER-TO-SIDE IMPACTOR AT 30° (ANGULAR FRONTAL IMPACT)

3.1 TEST DESCRIPTION

The vehicle configuration for this test was as shown in Figure 3-1, with the LCMB striking the stationary Side Impactor Bogey. The DSL-1266 Energy Absorbing Face (Appendix C) was affixed to the Side Impactor Bogey. As in Test 5.1, vehicle target weights for each vehicle were 3400 ± 20 lb, and 3/4 inch plywood load cell impact faces were used on the LCMB. Additional instrumentation was added to both vehicles after Test 5.1. The instrumentation setup is documented in Appendix D.

3.2 TEST DATA

The data from Test 8327-5.2 are presented in Tables 3-1 through 3-8, Figures 3-2 through 3-29, and Appendix B (Calcomp plots).

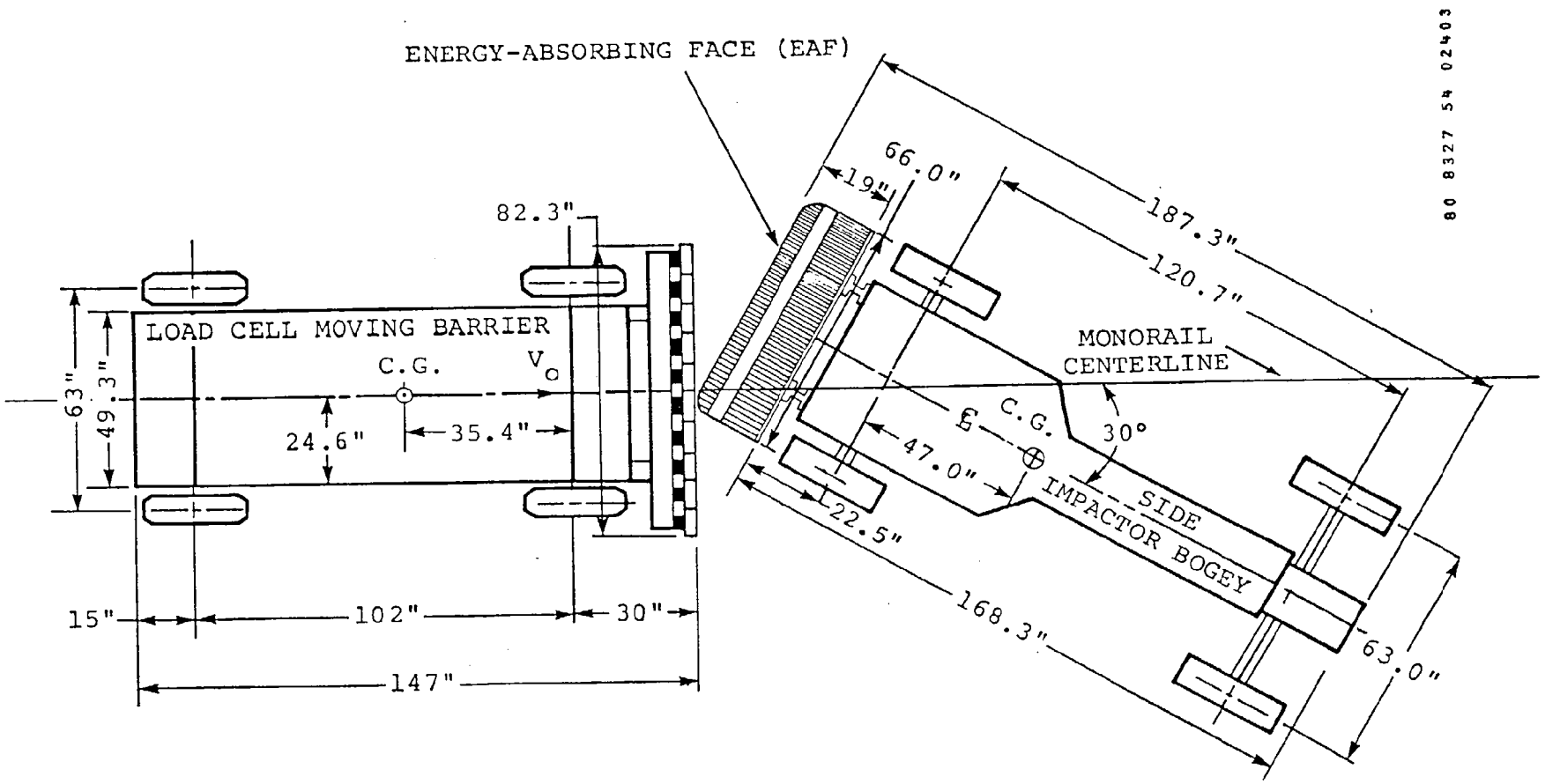


Figure 3-1. 30° LCMB-to-Side Impactor Test Configuration (Test 8327-5.2).

TABLE 3-1. CRASH TEST SUMMARY (TEST 8327-5.2)

TEST NO. 8327-5.2 CONTRACT: DOT-HS-8-01933

TEST DATE: 4-23-80 TIME: 13:25 TEMPERATURE: 62 °F

TEST CONFIGURATION: 30° Angular Frontal Impact

VEHICLE NO. 1: Load Cell Moving Barrier (Bullet)

VEHICLE NO. 2: Side Impactor Bogey Vehicle (Target)

VEHICLE DATA	VEHICLE NO. 1	VEHICLE NO. 2
Overall Length/Width (in.)	147 82.3	187.3 66
Test Weight by Wheel (lb)	LF 1082 RF 1128 LR 592 RR 582	LF 1035 RF 1052 LR 663 RR 666
Total Weight (lb)	3384	3416
Wheelbase (in.)	102.0	120.7
Longitudinal C.G. (from Center of Front Axle) (in.)	35.4	47.0
Impact Angle (deg)*	0°	30°
Bullet Vehicle C.G. to Target Vehicle C.G. Perpendicular Distance at Impact (in.)	17.5	
Car Speed (mph)	29.18	0.0
Maximum Resultant Velocity Change (mph @ msec)**	17.71 @ 69	18.73 @ 87
Maximum Resultant Compartment Acceleration (G @ msec)	29.54 @ 49	35.83 @ 50
Maximum Mutual Dynamic Crush (Corrected Accelerometer Data)	17.0 in. @ 55 msec	
Maximum Static Crush (in.)		
• Top of Stack Level	NA	14.0
• Center of Stack Level	NA	13.9
• Bumper Level	NA	15.2
Maximum Individual Load Cell (B-6) Force (klb @ msec)	8.238 @ 15	NA
Maximum Total Load Cell Force (klb @ msec)	53.029 @ 46	NA
INSTRUMENTATION		
Number of Data Channels	45	14
Number of Cameras	5	

*With respect to tow track centerline.
**Accelerometer Data (Avg Location 1 & 2 on LCMB, Avg 6 & 7 on SI)
NA = Not Applicable

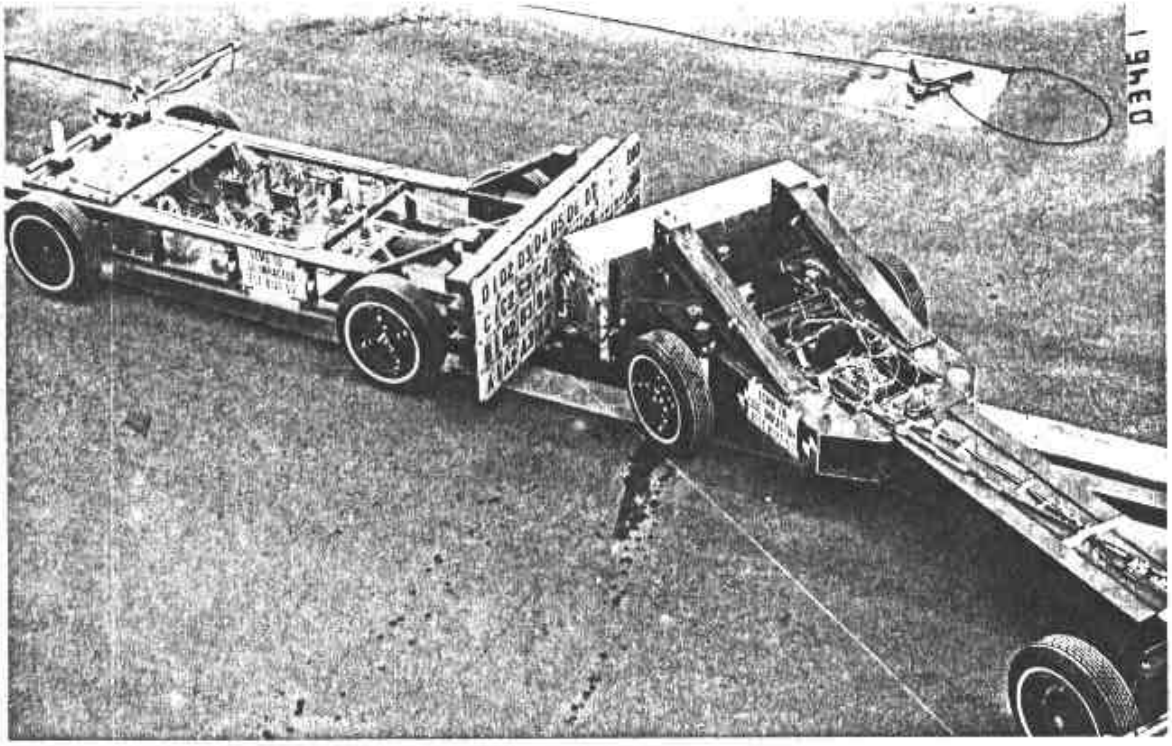


Figure 3-2. Pre-test Configuration of Vehicles (Test 8327-5.2).

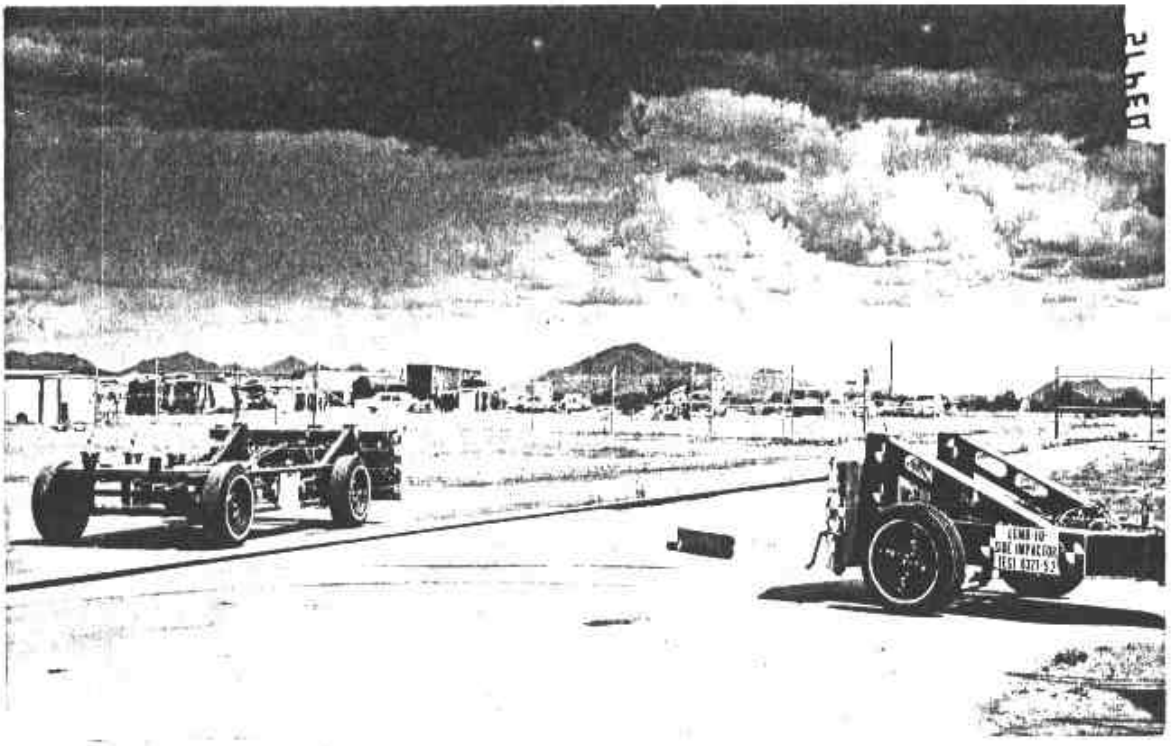


Figure 3-3. Post-test Configuration of Vehicles (Test 8327-5.2).

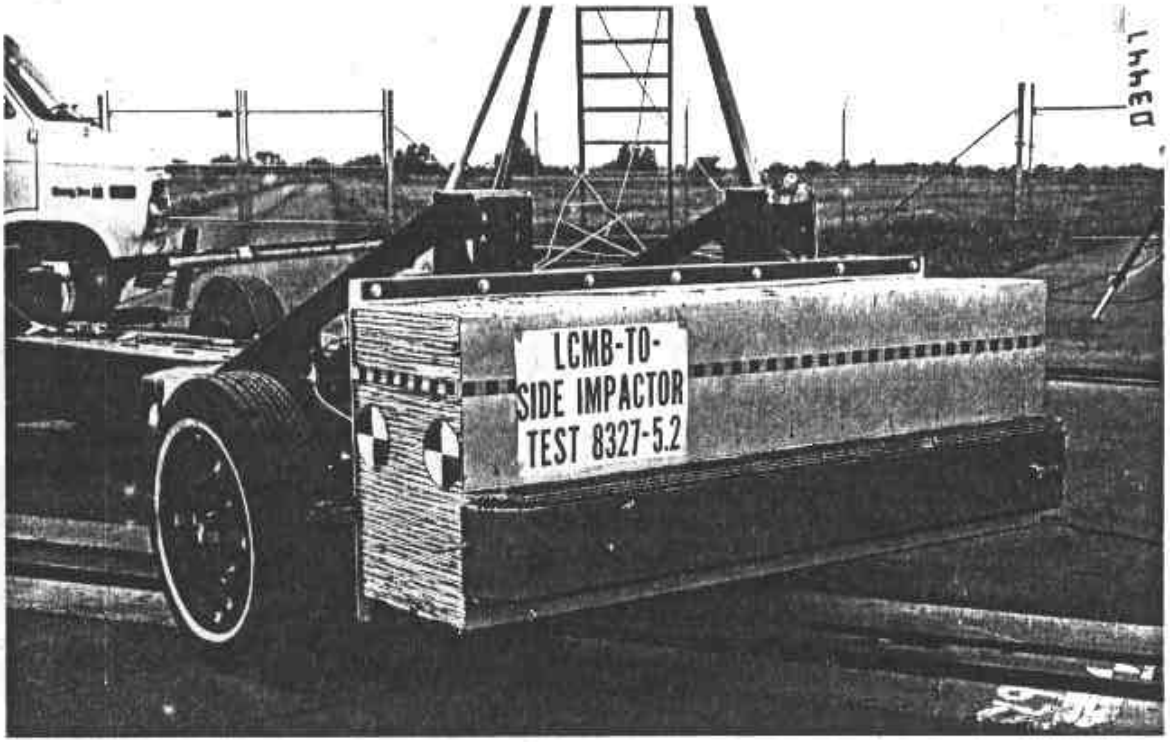


Figure 3-4. Pre-test Frontal View of Side Impactor (Test 8327-5.2).

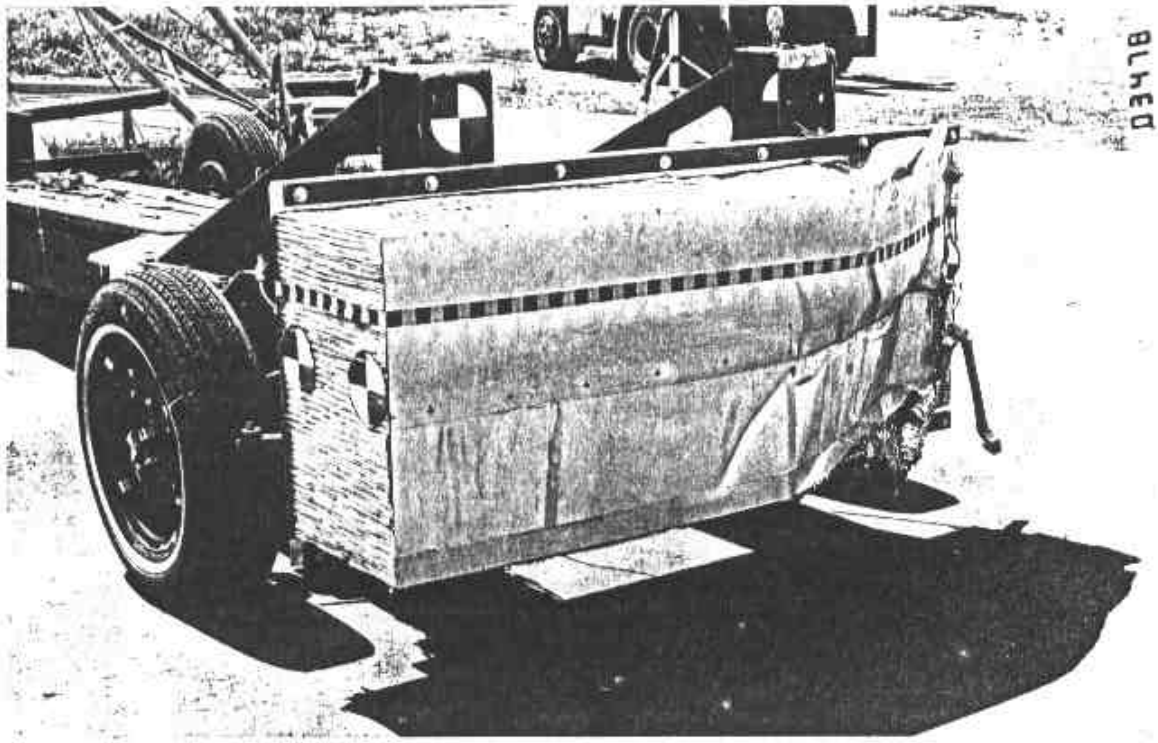


Figure 3-5. Post-test Frontal View of Side Impactor (Test 8327-5.2).

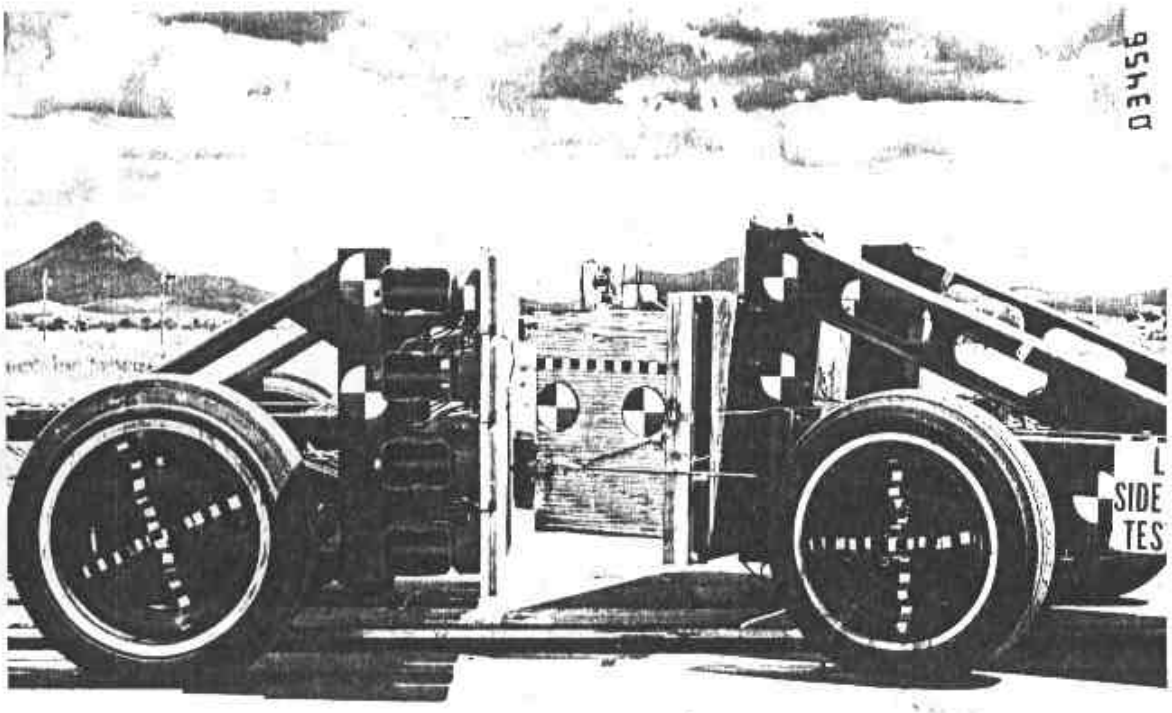


Figure 3-6. Pre-test Side View of Side Impactor, Showing Bumper Matchup with LCMB (Test 8327-5.2).

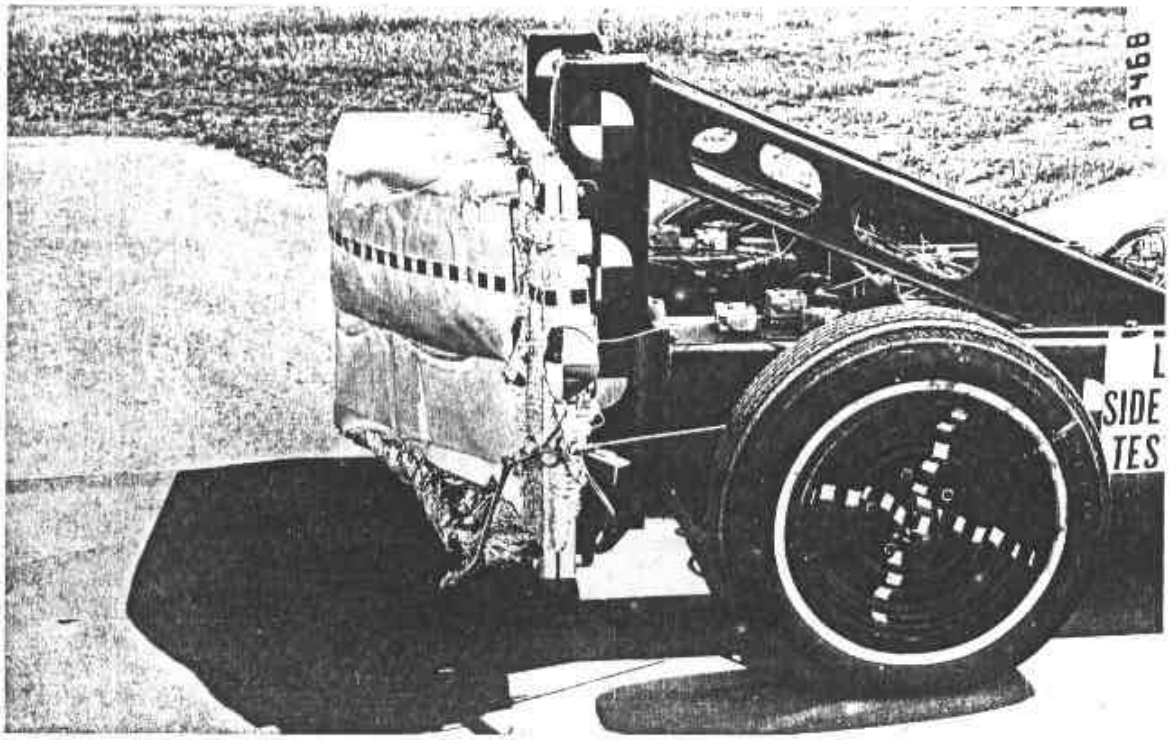


Figure 3-7. Post-test Side View of Side Impactor (Test 8327-5.2).

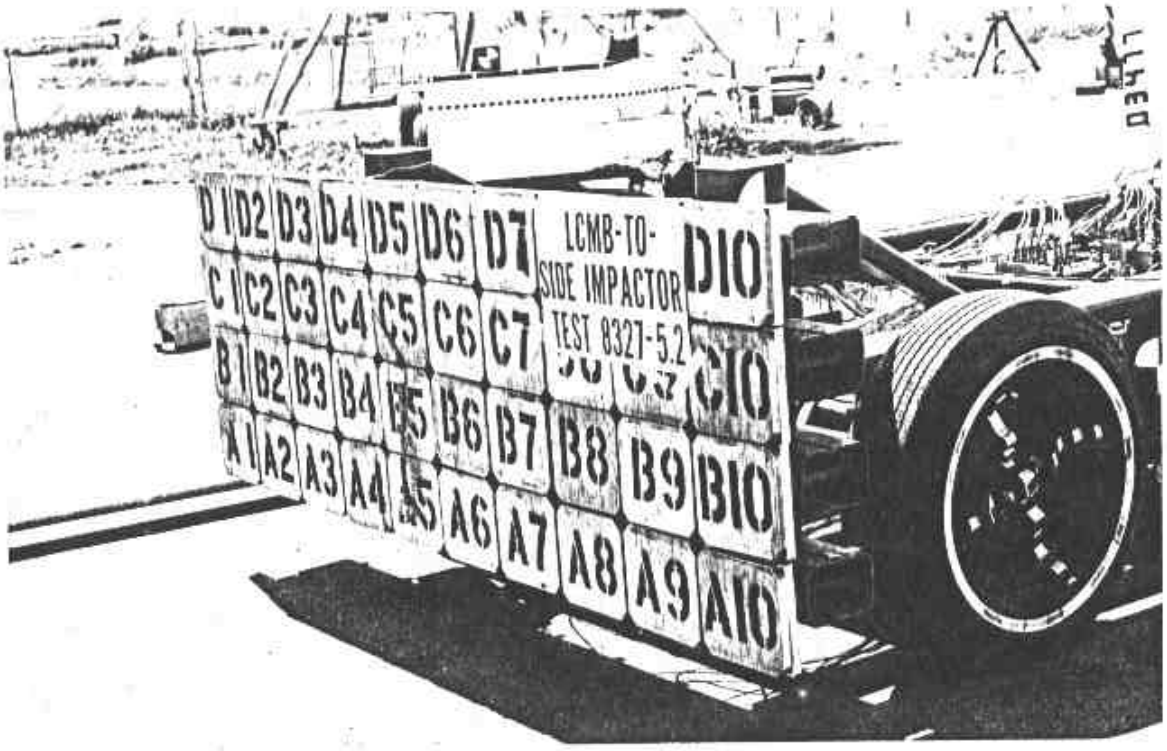


Figure 3-8. Post-test LCMB Configuration (Test 8327-5.2).

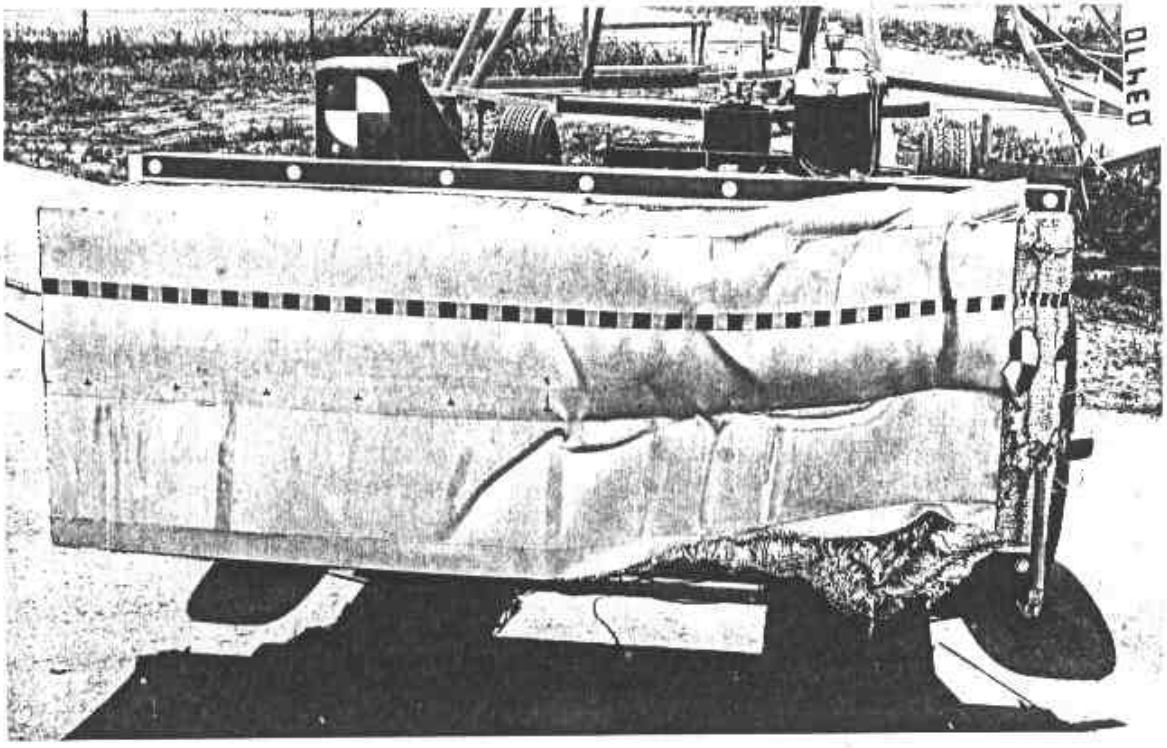


Figure 3-9. Post-test Side Impactor Configuration (Test 8327-5.2).

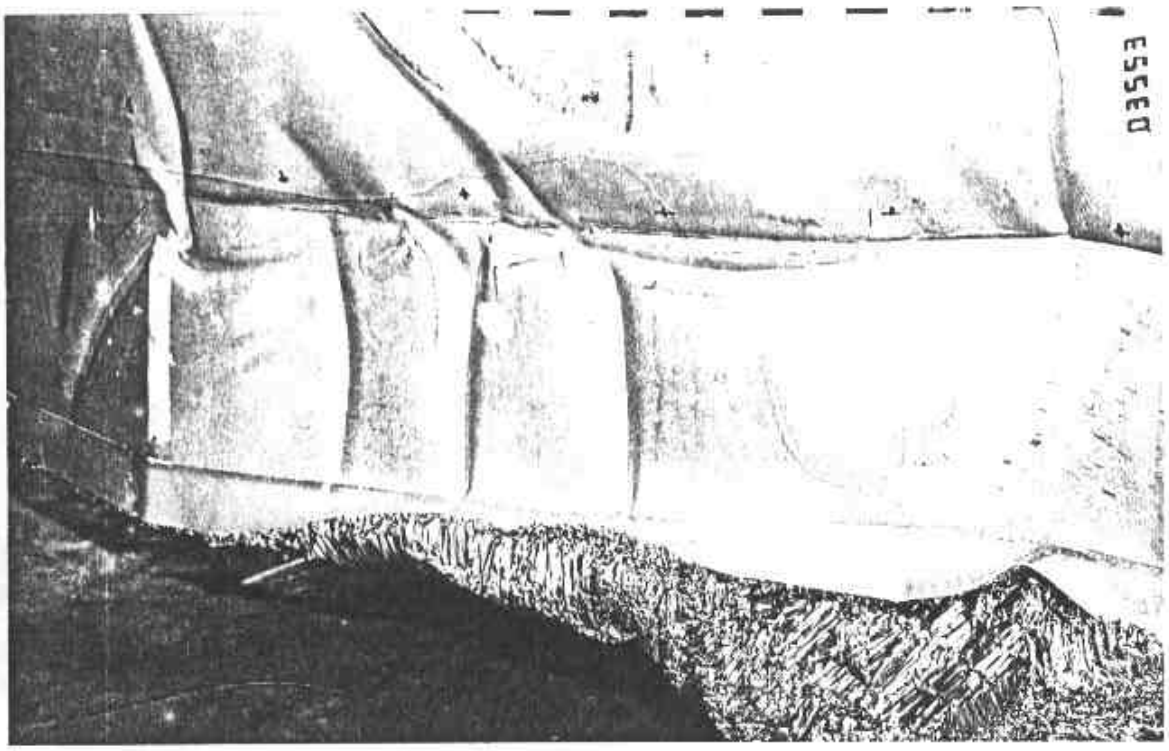


Figure 3-10. Area of Bond Failure on EAF Facesheet (Test 8327-5.2).

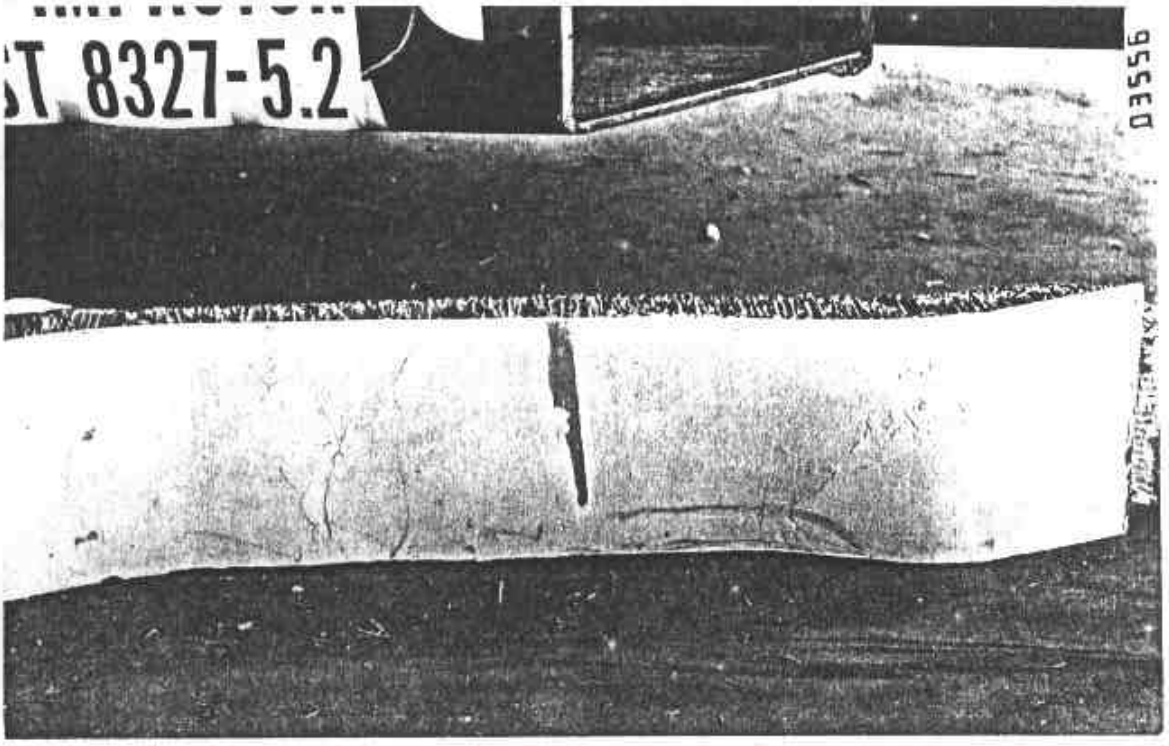


Figure 3-11. Area of Bond Failure on Back of Bumper (Test 8327-5.2).

TABLE 3-2. CHRONOLOGY OF CRASH EVENTS* (TEST 8327-5.2)

Vehicle 1: Load Cell Moving Barrier
Vehicle 2: Side Impactor Bogey with DSL-1266 EAF

Time (msec)	Crash Event
0	Impact (visual).
1	Bumper starts to intrude into stack.
6	LCMB strikes full stack.
15	LCMB strikes momentary impact switch.
22	Side Impactor Bogey begins rearward motion.
43	LCMB strikes 2 inch mounting plate on SI Bogey.
46	EAF bumper begins to separate from facesheet.
48	Stack separates from backsheet.
54	Maximum stack separation from backsheet.
55	Maximum initial bumper separation.
61	Stack re-contacts backsheet.
62	Minimum bumper separation.
71	Vehicles begin to separate.

*Film data - Average of the various views.

TABLE 3-3. SUMMARY OF LCMB ACCELEROMETER DATA (TEST 8327-5.2) ($0 \leq t \leq 250$ MSEC)

Accelerometer Number*	Maximum Acceleration A (G)	Maximum Acceleration Time (msec)	Minimum Velocity V (mph)	Minimum Velocity Time (msec)	Maximum Displacement S (in.)	Maximum Displacement Time (msec)
A1X	-29.5	48	11.5	77	64.4	250
A2X	-30.8	51	11.1	67	65.5	250
A3X	-29.4	51	8.6	250	60.9	250
Average of A1X and A2X	-29.5	50	11.5	70	65.0	250
A3Y	-10.7	53	-4.0	76	-10.4	250
A4Y	4.0	40	-0.8	242	1.4	162
Average of A3Y and A4Y	-4.9	53	-1.7	177	-4.9	250

TABLE 3-4. SUMMARY OF SIDE IMPACTOR BOGEY ACCELEROMETER DATA (TEST 8327-5.2) ($0 \leq t \leq 250$ MSEC)

Accelerometer Number*	Maximum Acceleration* A (G)	Maximum Acceleration* Time (msec)	Maximum Velocity* V (mph)	Maximum Velocity* Time (msec)	Maximum Displacement* S (in.)	Maximum Displacement* Time (msec)
B1X	-27.4	50	-14.7	250	-52.5	250
B2X	-32.9	50	-16.0	65	-57.4	250
B4X	-29.3	51	-14.2	64	-47.0	250
B5X	-29.7	51	-15.5	76	-52.8	250
B8X	-27.1	50	-16.6	240	-57.8	250
B9X	-33.2	50	-17.5	240	-62.6	250
B10X	-37.4	49	-17.4	238	-61.4	250
Average of B1X and B2X	-30.2	50	-15.3	66	-54.9	250
Average of B8X and B9X	-30.1	50	-17.0	240	-60.2	250
Average of B5X and B10X	-32.9	49	-16.0	65	-57.1	250
B6 (30°)	-33.1	50	-18.0	87	-63.7	250
B7 (30°)	-38.6	50	-19.5	82	-68.8	250
Average of B6 and B7 (30°)	-35.8	50	-18.7	87	-66.2	250
B3Y	19.3	49	10.7	55	35.1	250
B4Y	15.8	55	4.3	93	9.7	250
B10Y	28.3	46	11.2	51	31.8	250
Average of B3Y and B4Y	12.6	50	7.2	62	22.4	250

*Note: Negative X values are toward rear of bogey. Positive Y values are toward right of bogey.

TABLE 3-5. SUMMARY OF MAXIMUM LOAD CELL DATA FOR LCMB (TEST 8327-5.2)

Parameter	Right Half of Impactor					Left Half of Impactor				
Load Cell (No.)	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1
Force (klb)	0.29	0.12	0.09	0.41	0.97	1.14	1.37	0.02	0.21	0.17
Time (msec)	46	100	243	47	23	14	47	248	112	76
Load Cell (No.)	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1
Force (klb)	0.10	0.05	0.30	3.12	2.66	4.24	6.94	0.24	0.18	0.74
Time (msec)	240	4	48	43	47	49	48	101	67	113
Load Cell (No.)	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
Force (klb)	0.12	2.00	6.72	7.89	8.24*	6.20	1.51	0.06	0.11	0.07
Time (msec)	3	50	40	24	15	51	46	139	156	141
Load Cell (No.)	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
Force (klb)	0.22	1.92	3.55	3.51	3.34	7.48	1.58	0.05	0.14	0.10
Time (msec)	118	51	33	25	15	52	44	211	247	244

*Maximum measured load cell force.
Note: LCMB struck 2 inch mounting plate on SI Bogey @ 43 ms

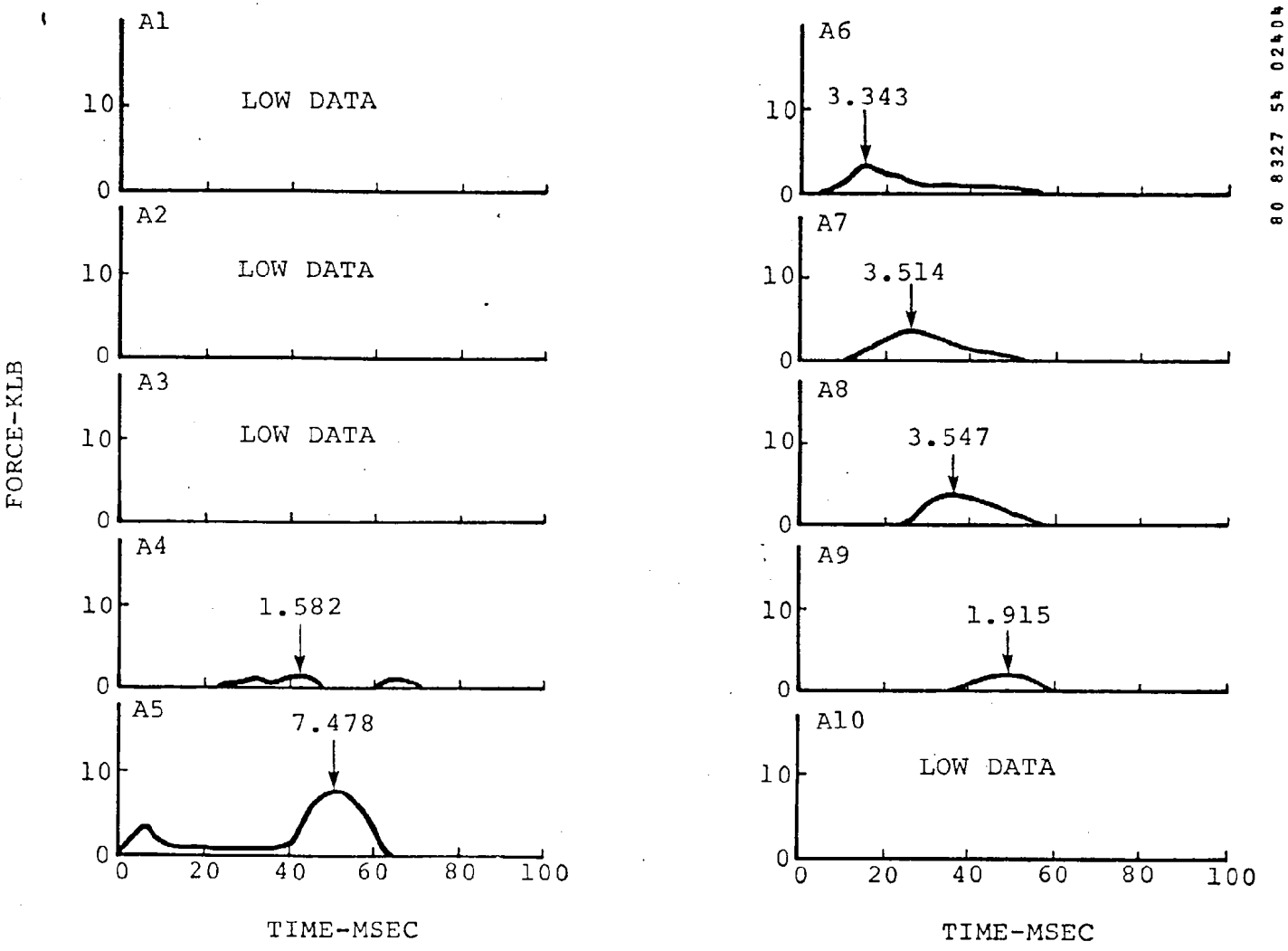


Figure 3-12. LCMB Force Versus Time on Row A (Test 8327-5.2).

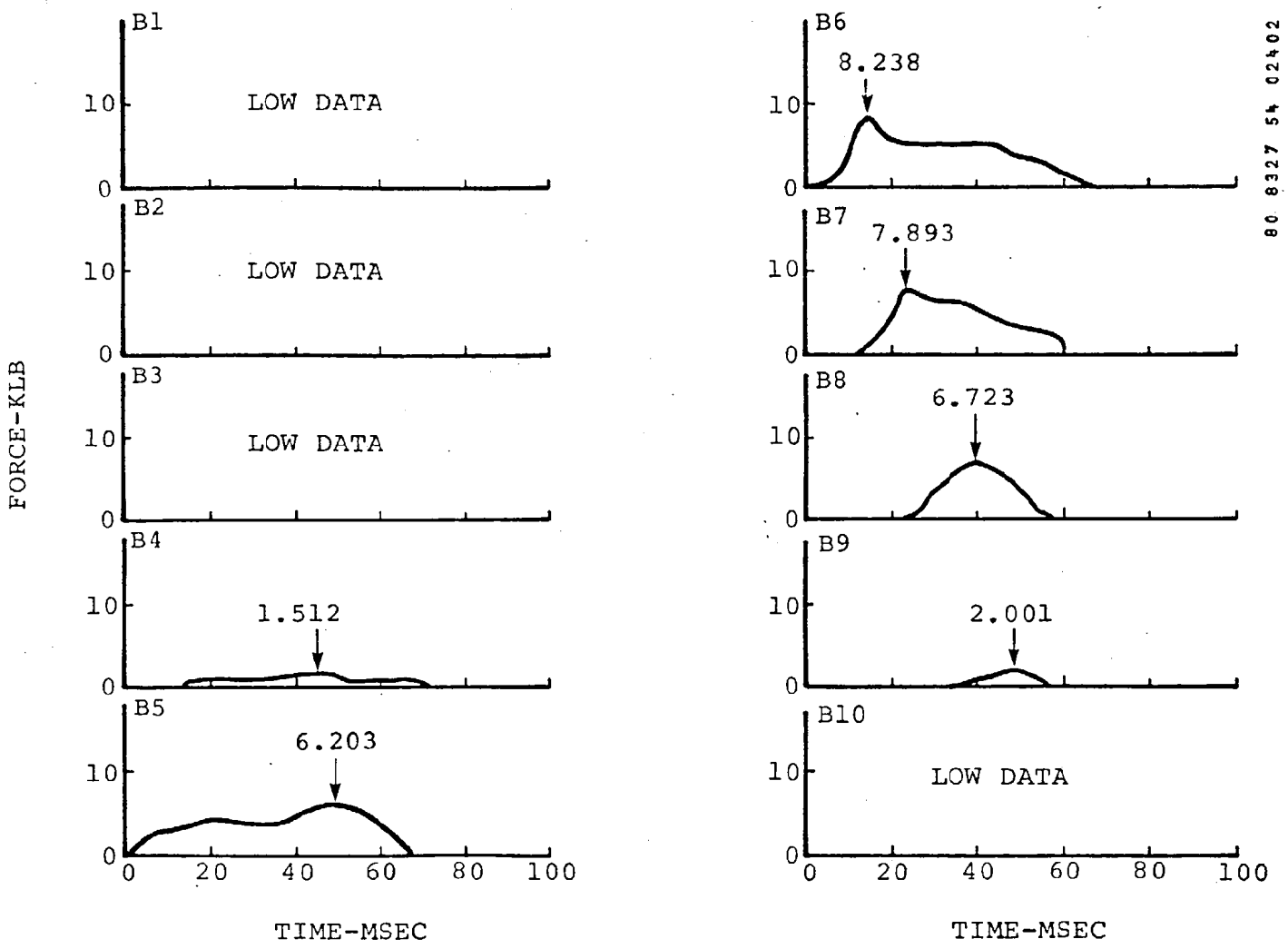


Figure 3-13. LCMB Force Versus Time on Row B (Test 8327-5.2)

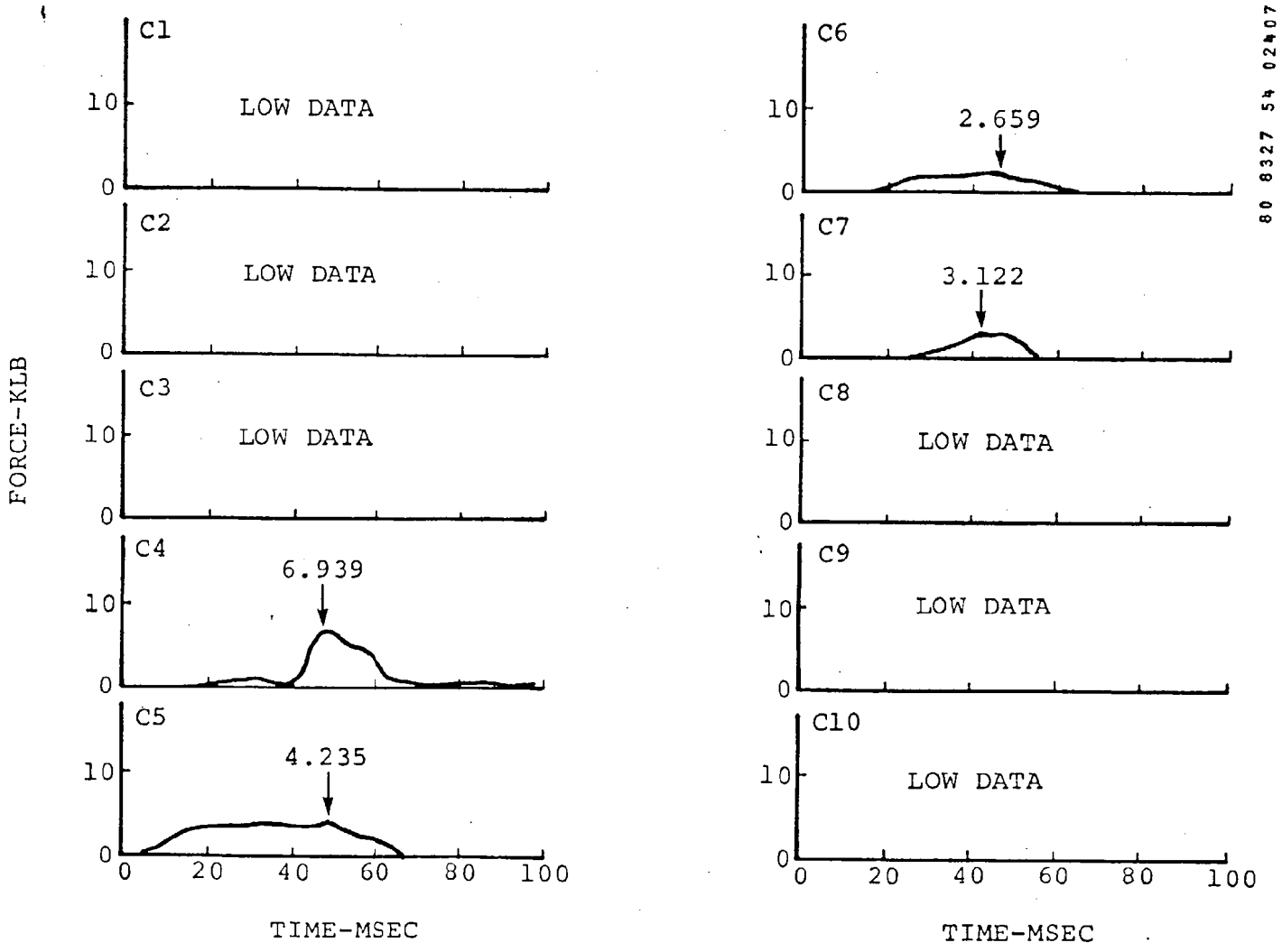


Figure 3-14. LCMB Force Versus Time on Row C (Test 8327-5.2).

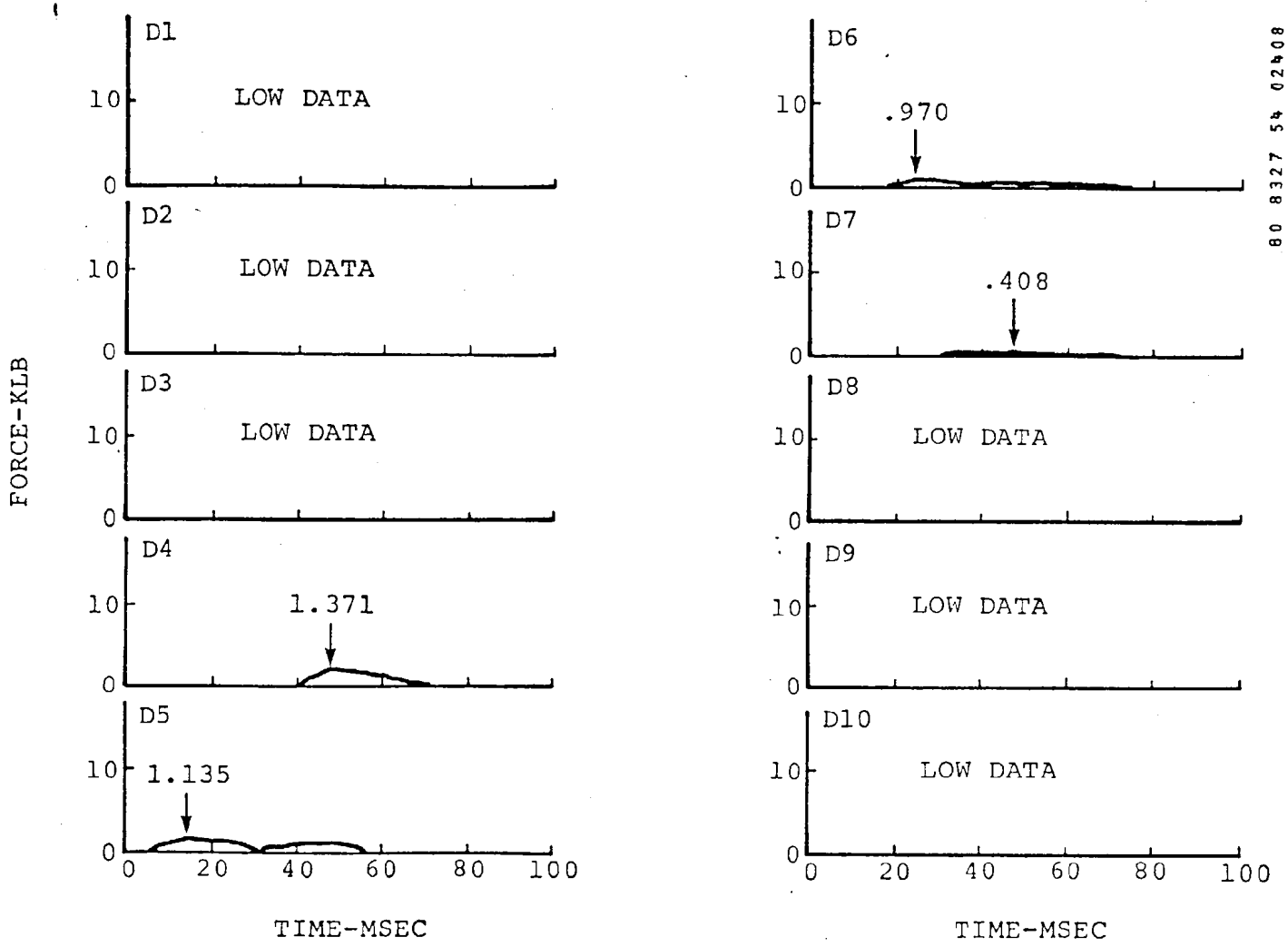


Figure 3-15. LCMB Force Versus Time on Row D (Test 8327-5.2).

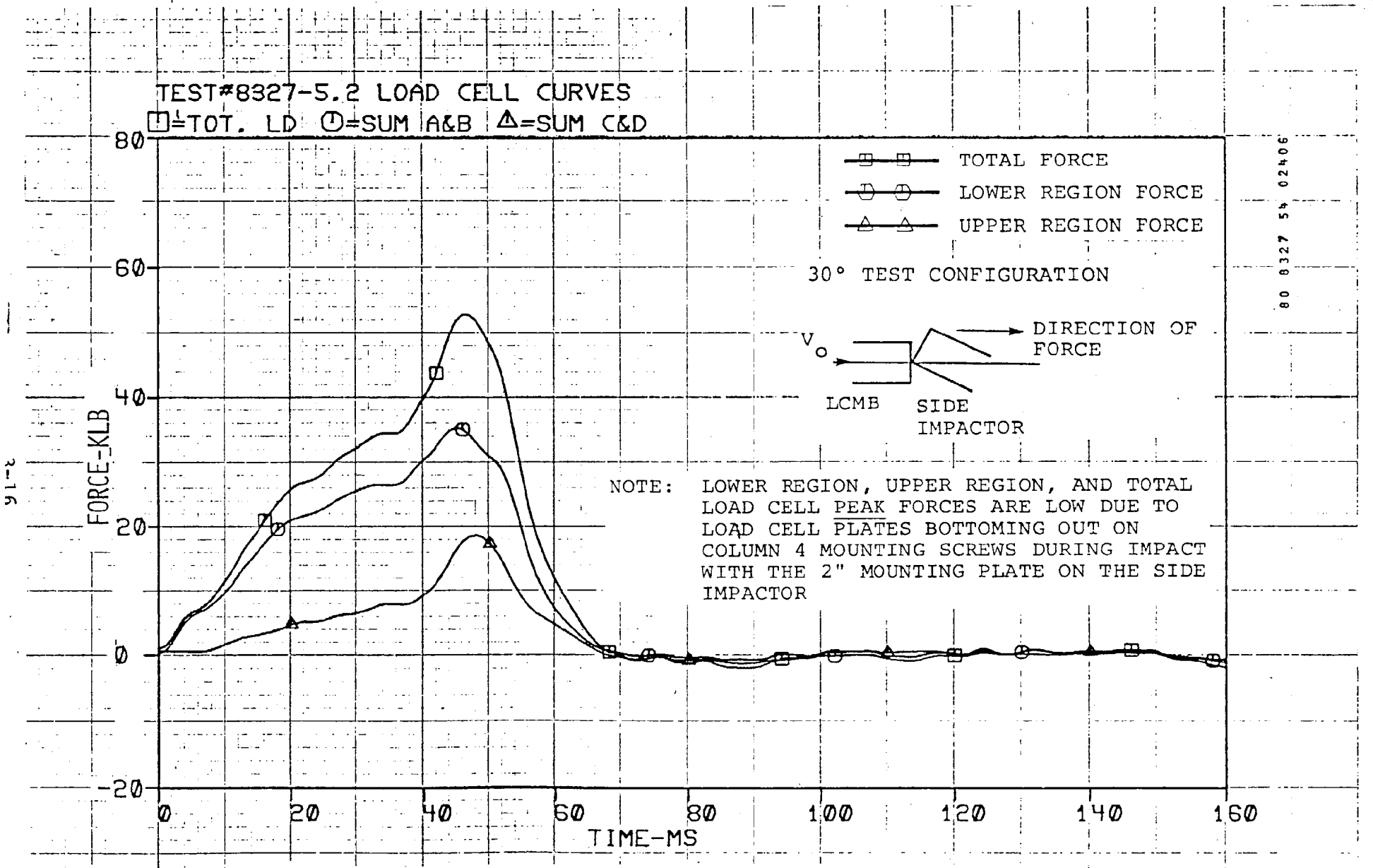


Figure 3-16. Lower Region, Upper Region, and Total Force in Direction of LCMB Versus Time (Test 8327-5.2).

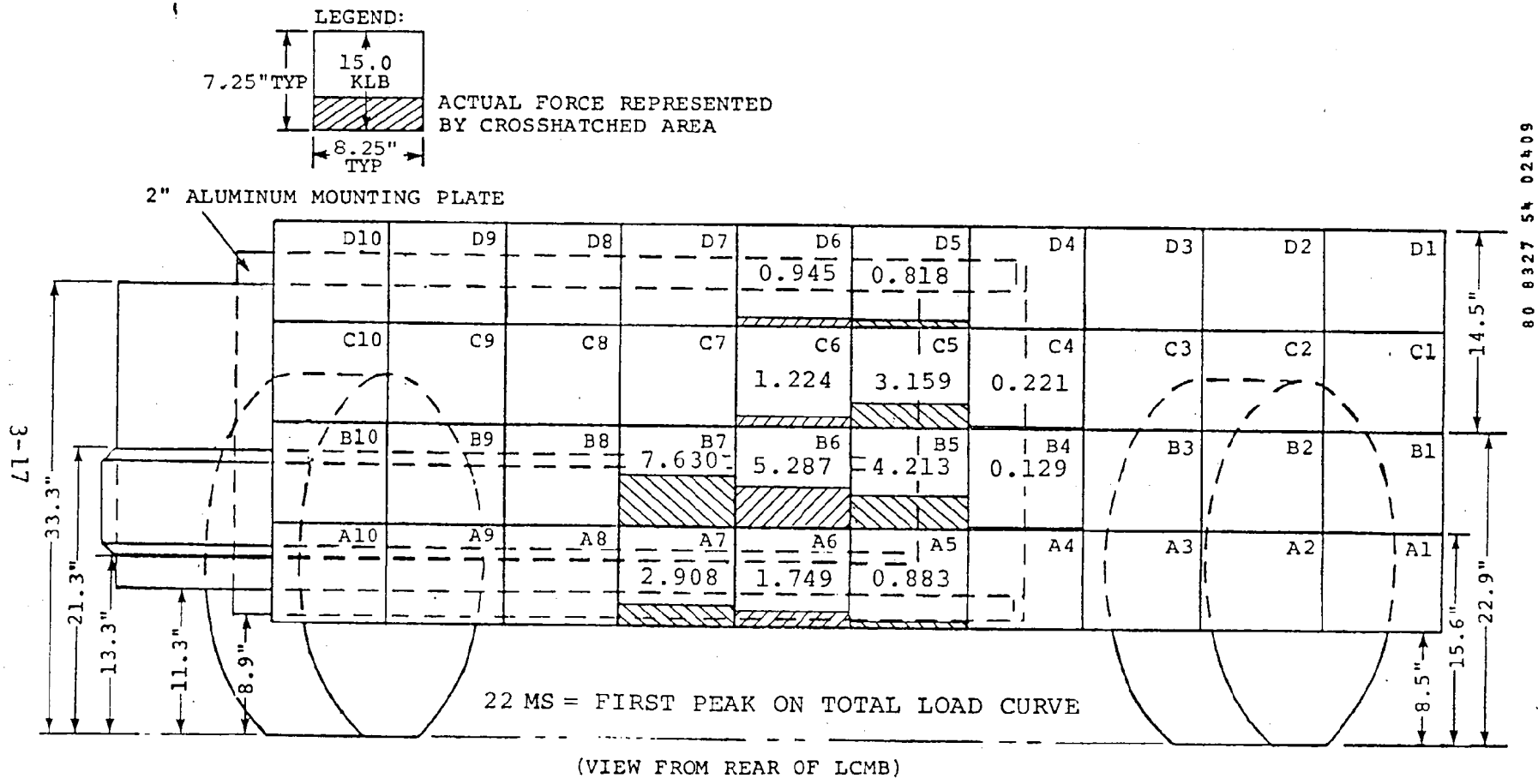


Figure 3-17. LCMB-to-Side Impactor 30° Frontal Impact Load Distribution at 22 msec (Test 8327-5.2).

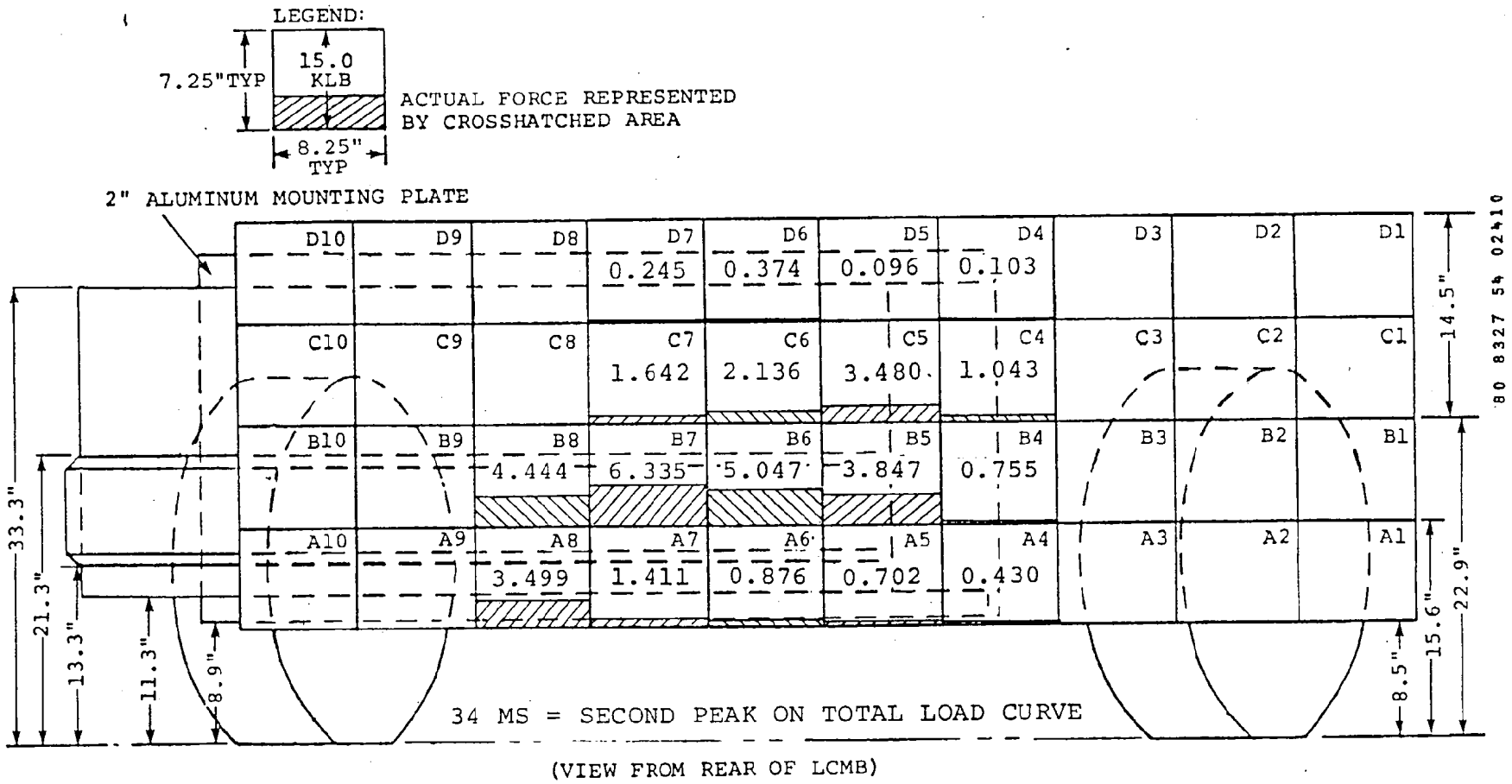


Figure 3-18. LCMB-to-Side Impactor 30° Frontal Impact Load Distribution at 34 msec (Test 8327-5.2).

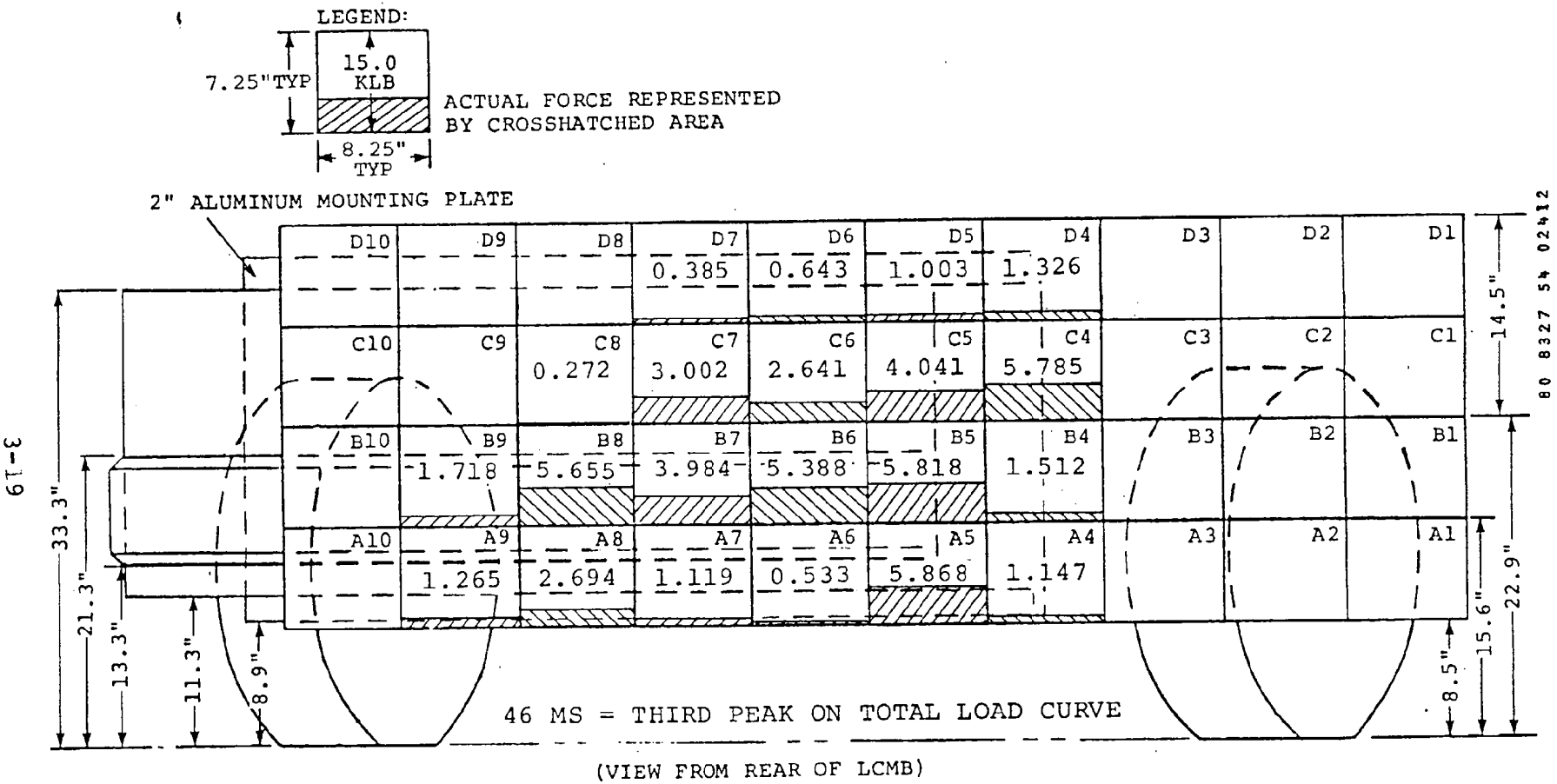
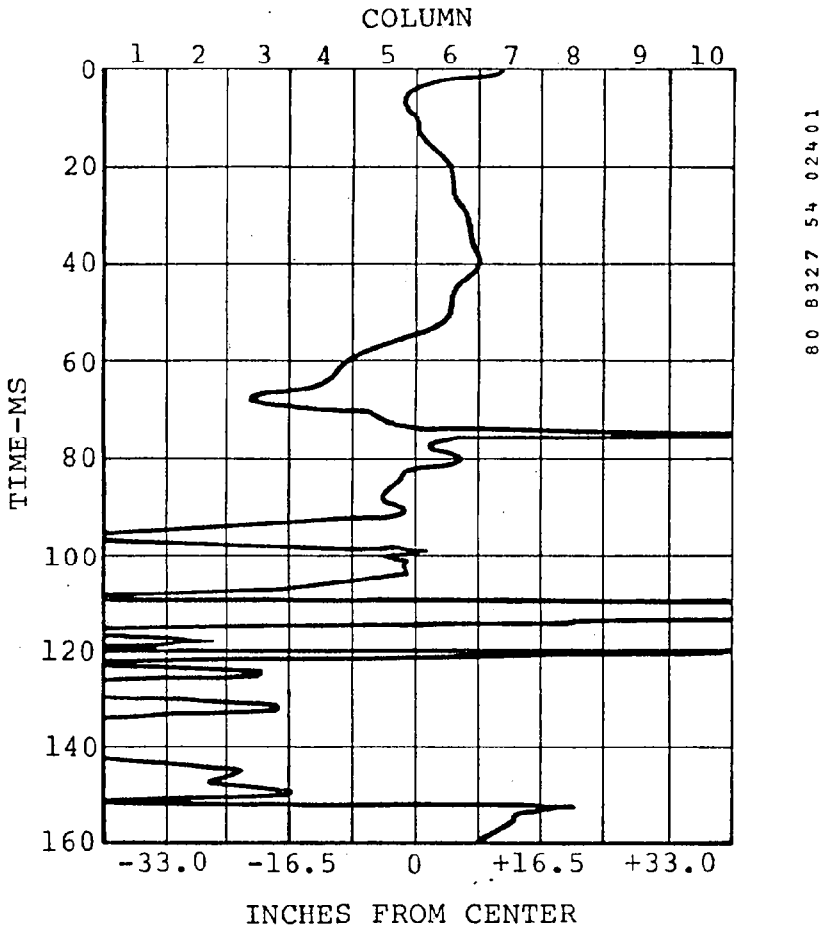
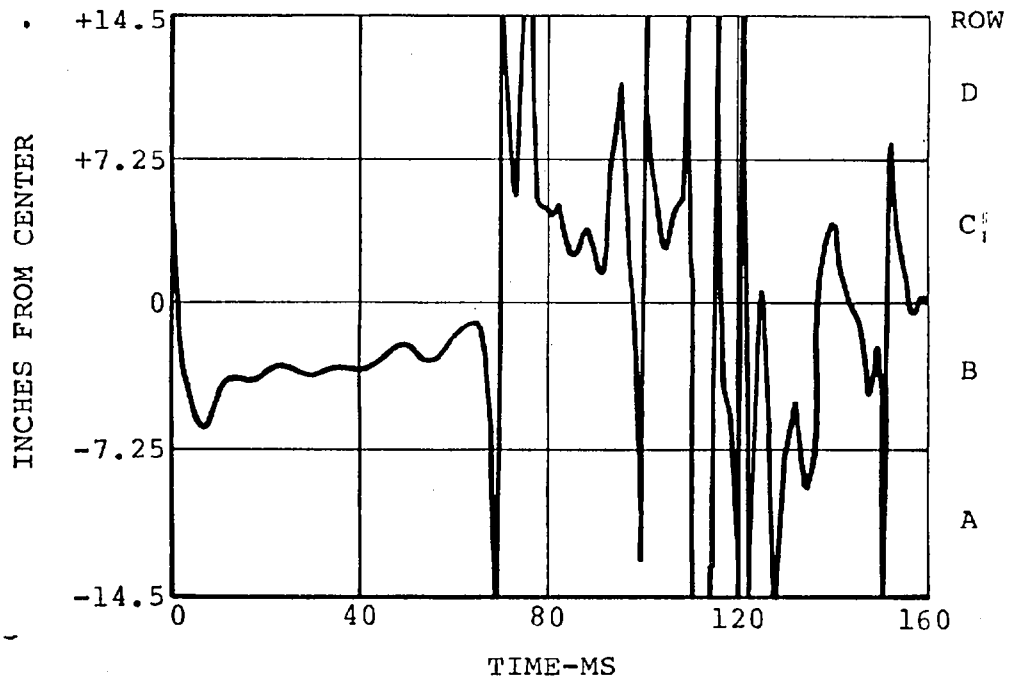


Figure 3-19. LCMB-to-Side Impactor 30° Frontal Impact Load Distribution at 46 msec (Test 8327-5.2).



a) Horizontal Centroid of Load Cell Force



b) Vertical Centroid of Load Cell Force

Figure 3-20. Centroid of Load Cell Force for LCMB (Test 8327-5.2)

TABLE 3-6. SUMMARY OF GROUPED LOAD CELL DATA (TEST 8327-5.2)

Parameter	Passenger Side of Impactor	Center of Impactor	Driver Side of Impactor
Load Cells (No.)	D8 - D10 & C8 - C10	D4 - D7 & C4 - C7	D1 - D3 & C1 - C3
Force (lb)	483	20,195	883
Time (msec)	3	48	112
Load Cells (No.)	B8 - B10 & A8 - A10	B4 - B7 & A4 - A7	B1 - B3 & A1 - A3
Force (lb)	11,507	25,369	315
Time (msec)	43	46	148

TABLE 3-7. COMPARISON OF TOTAL LOAD CELL FORCE AND ACCELEROMETER DATA IN DIRECTION OF THE LCMB (TEST 8327-5.2)

Parameter	LCMB Load Cell Force Data*	LCMB Acceleration Data†	Side Impactor Acceleration Data**
Force (lb)	53,029	99,944	110,790
Time (msec)	46	50	50

*Sum of 40 load cells. Column 4 load cell forces lost during contact with 2 inch mounting plate (see note - Figure 3-21)
†Average of LCMB accelerometers 1 and 2 times LCMB weight.
**[Average of SI accelerometers 1 and 2 (cos 30°) plus average of SI accelerometers 3 and 4 (sin 30°)] times SI weight.

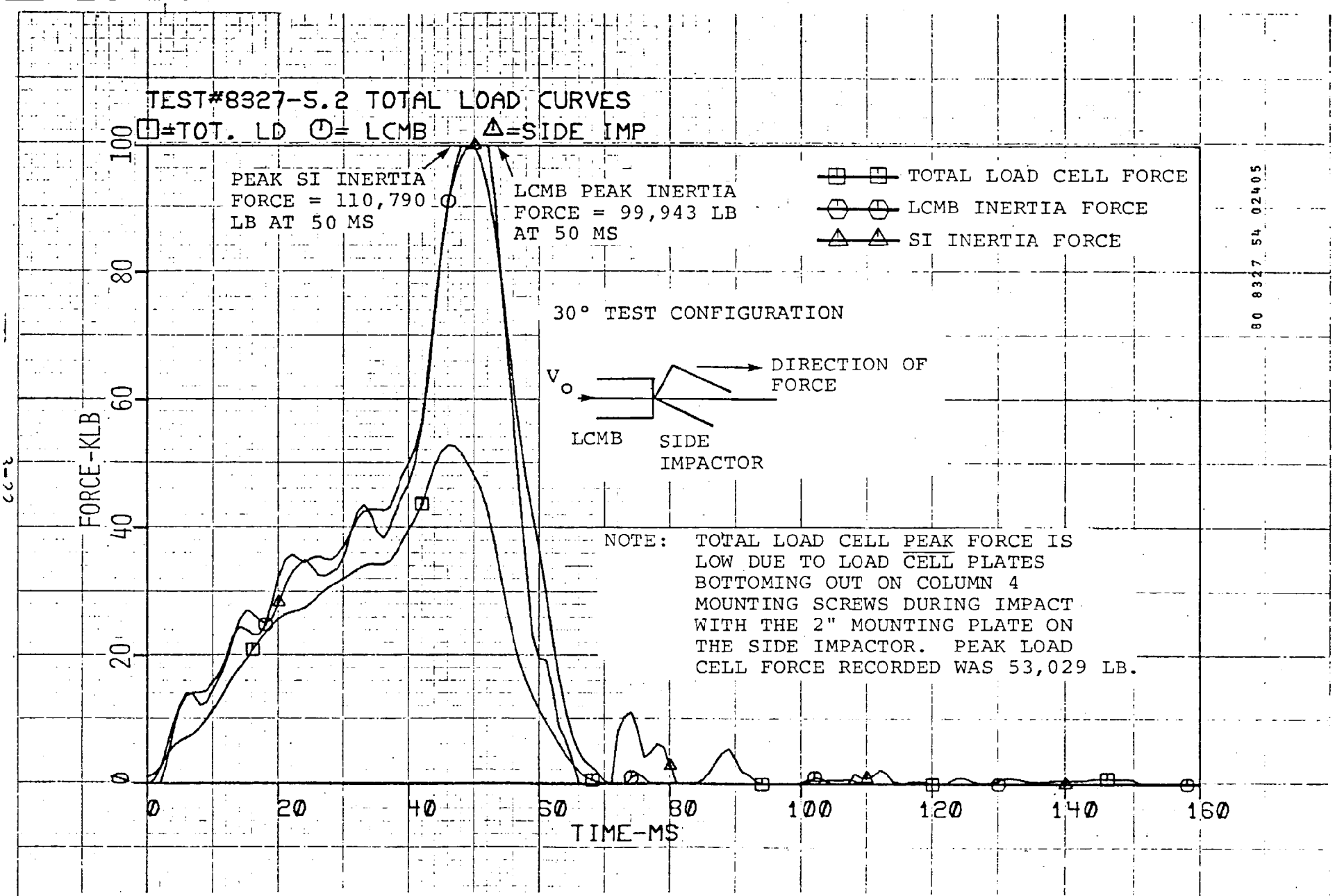
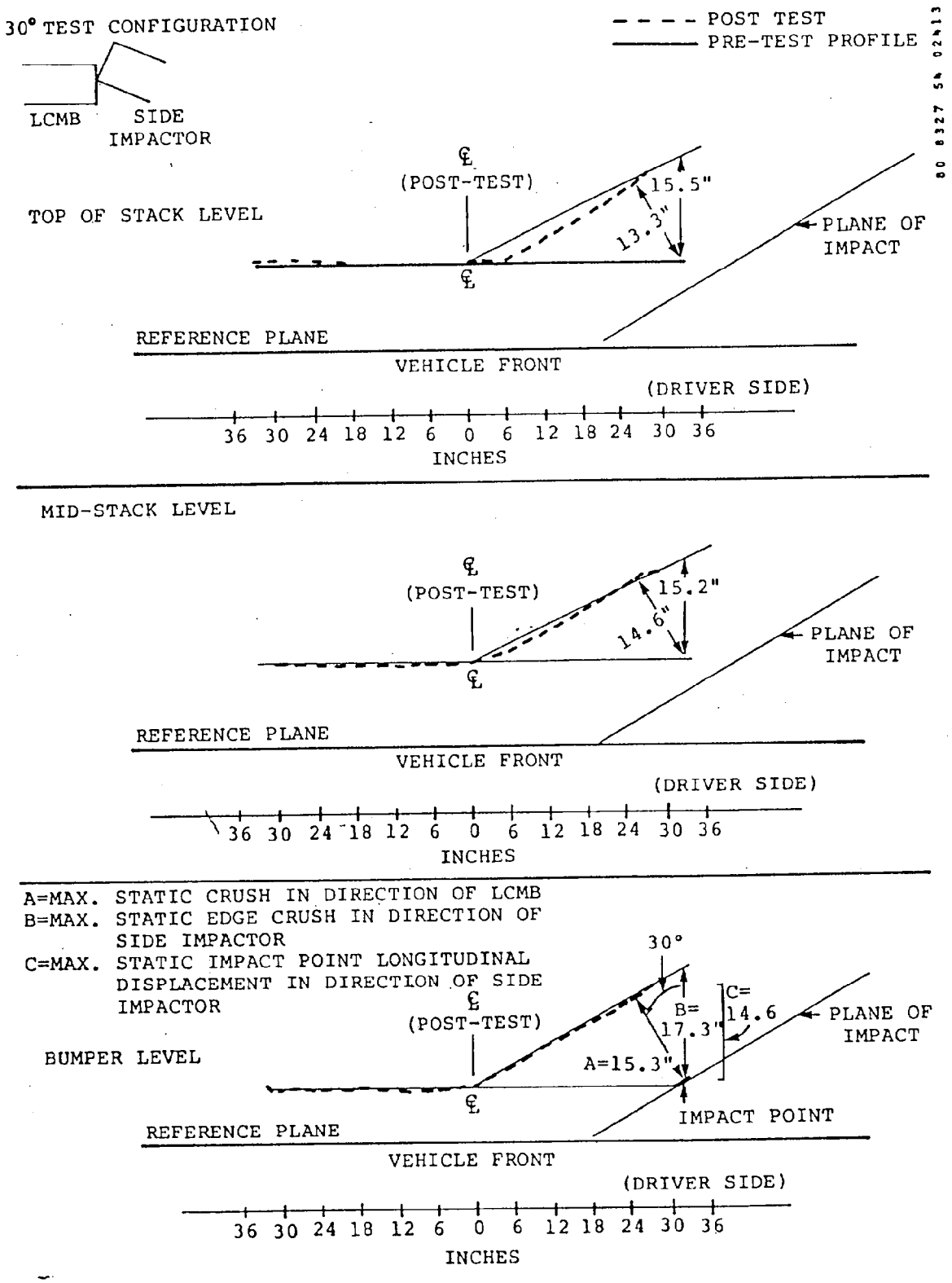


Figure 3-21. Comparison of Total Force in Direction of LCMB From Load Cell and Vehicle Accelerometer Data (Test 8327-5.2).

TABLE 3-8. SIDE IMPACTOR EXTERIOR PROFILES AND STATIC CRUSH (TEST 8327-5.2)

Location	R.P.**	Height at ℄	Distance Left of Center (in.)*								Distance Right of Center (in.)*						
			33	32	30	24	18	12	6	0	6	12	18	24	30	32	33
Pre-test Profile Measurements (Distance from R.P. - in.)																	
Top of Stack Level	30	33.5	12.9	-	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	-	12.9
Mid-stack Level	30	22.4	12.8	-	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	-	12.8
Bumper Level	30	17.5	-	9.3	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9.1	-
Post-test X - Measurements (in.)																	
Top of Stack Level	30	33.4	26.1	-	24.4	21.3	18.5	15.9	13.3	12.8	12.9	12.9	13.0	13.0	13.1	-	13.2
Mid-stack Level	30	22.3	26.0	-	25.5	22.8	19.4	16.9	14.3	12.6	12.5	12.5	12.5	12.5	12.6	-	12.8
Bumper Level	30	17.4	-	23.8	22.8	20.0	17.0	14.2	11.4	8.6	8.1	8.1	8.2	8.3	8.4	8.8	-
Post-test Y - Measurements (in.)																	
Top of Stack Level	-	-	-4.6	-	-3.7	-2.5	-1.6	-.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
Mid-stack Level	-	-	-4.4	-	-4.1	-2.8	-2.5	-1.5	-.5	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
Bumper Level	-	-	-	-4.65	-4.15	-3.25	-2.75	-1.95	-1.15	+.55	+.55	+.55	+.55	+.55	+.55	+.55	-
Crush (in.) - Direct Linear Measurement from Pre- to Post-test Positions																	
Top of Stack Level	-	-0.1	14.0	-	12.1	8.8	5.8	3.0	0.4	-0.1	0.0	0.0	0.1	0.1	0.2	-	0.3
Mid-stack Level	-	-0.1	13.9	-	13.3	10.4	6.8	4.4	1.6	-0.2	-0.3	-0.3	-0.3	-0.3	-0.2	-	0.0
Bumper Level	-	-0.1	-	15.2	14.9	12.0	8.9	6.0	3.1	0.6	-0.8	-0.8	-0.8	-0.7	-0.6	-0.8	-

*As viewed from Side Impactor driver position.
**Reference Plane is 30 inches forward of backside of 2 inch EAF mounting plate.
Note: Bumper fell off vehicle during test and had to be propped up against E/A Face in best approximate position to take post-test measurements.



NOTE: FOR PROFILE POINT LOCATIONS, SEE FIGURE D-3.

Figure 3-22. Pre- and Post-test Profiles at Top, Mid Stack, and Bumper Levels of Side Impactor (Test 8327-5.2).

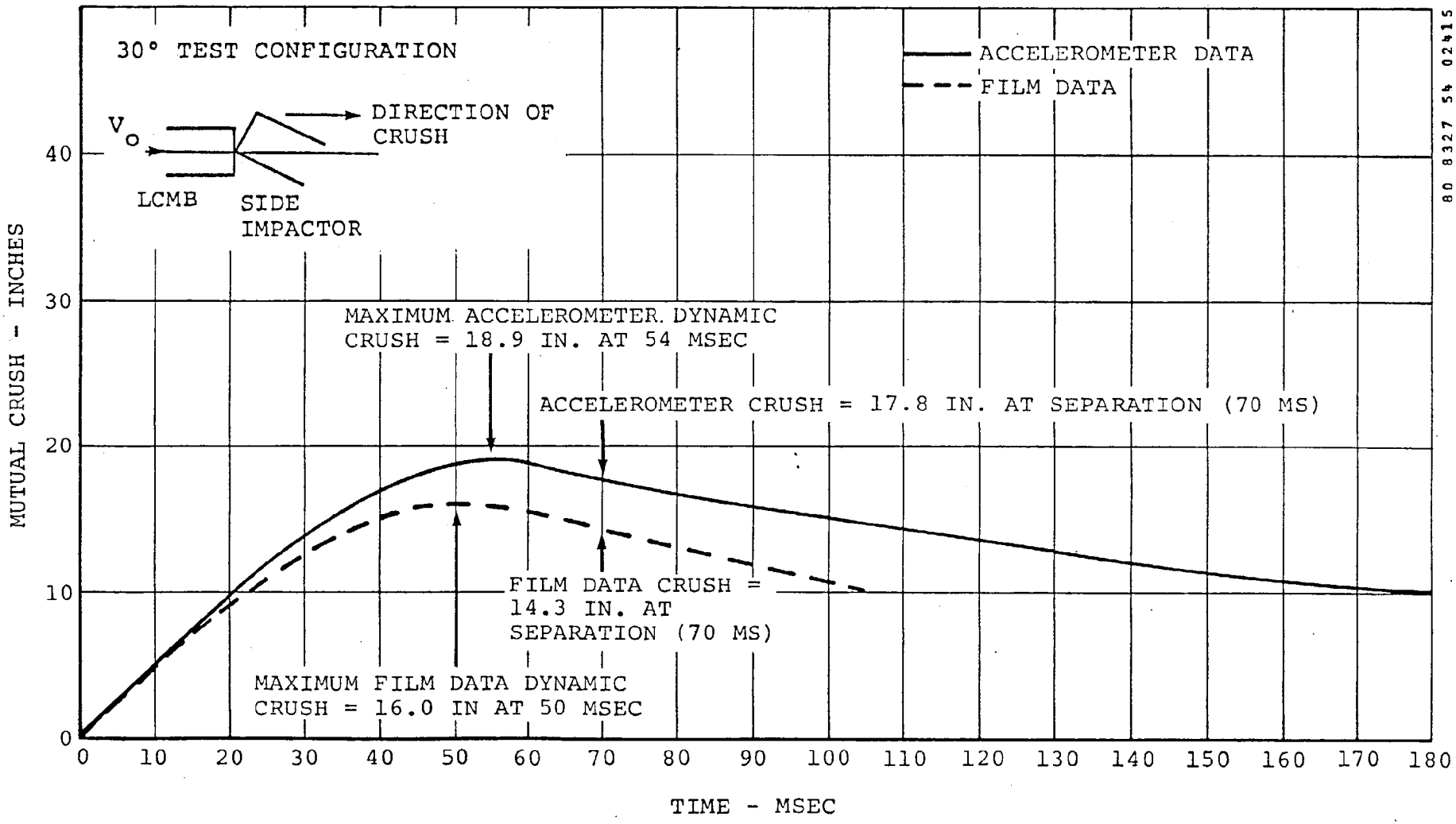


Figure 3-23. Uncorrected Mutual Crush Versus Time in Direction of LCMB (Test 8327-5.2).

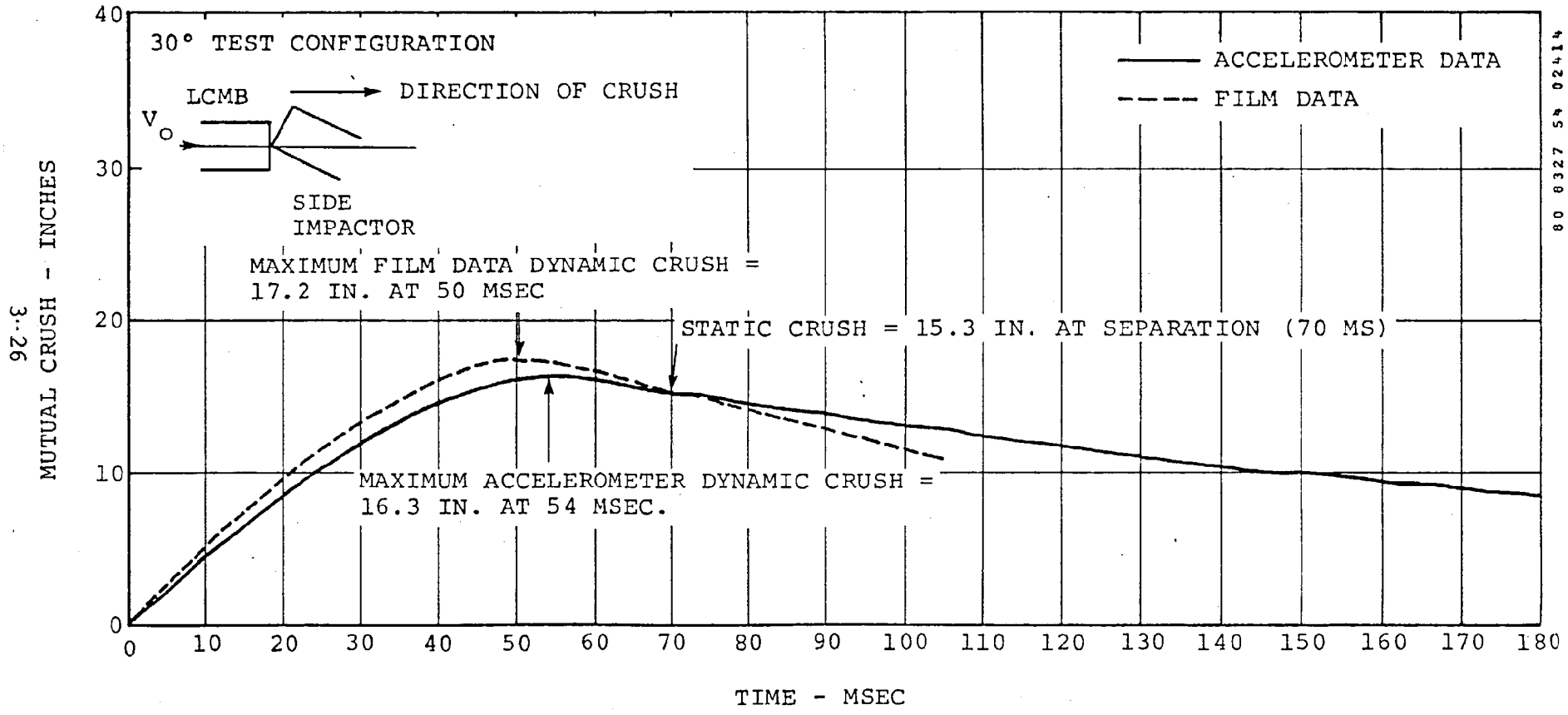


Figure 3-24. Corrected Mutual Crush Versus Time in Direction of LCMB (Test 8327-5.2).

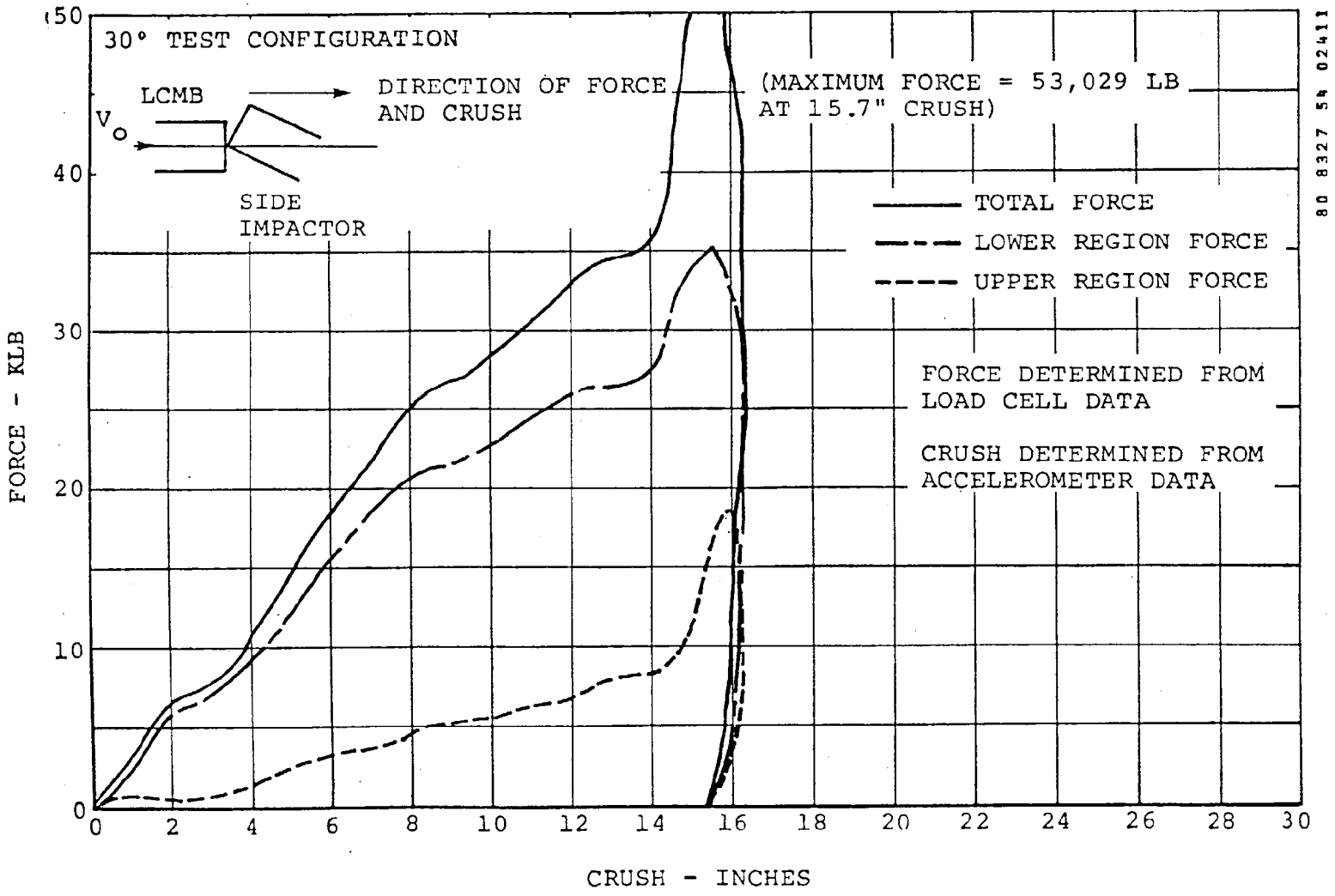


Figure 3-25. Lower Region, Upper Region, and Total Force Versus Crush in Direction of LCMB (Test 8327-5.2).

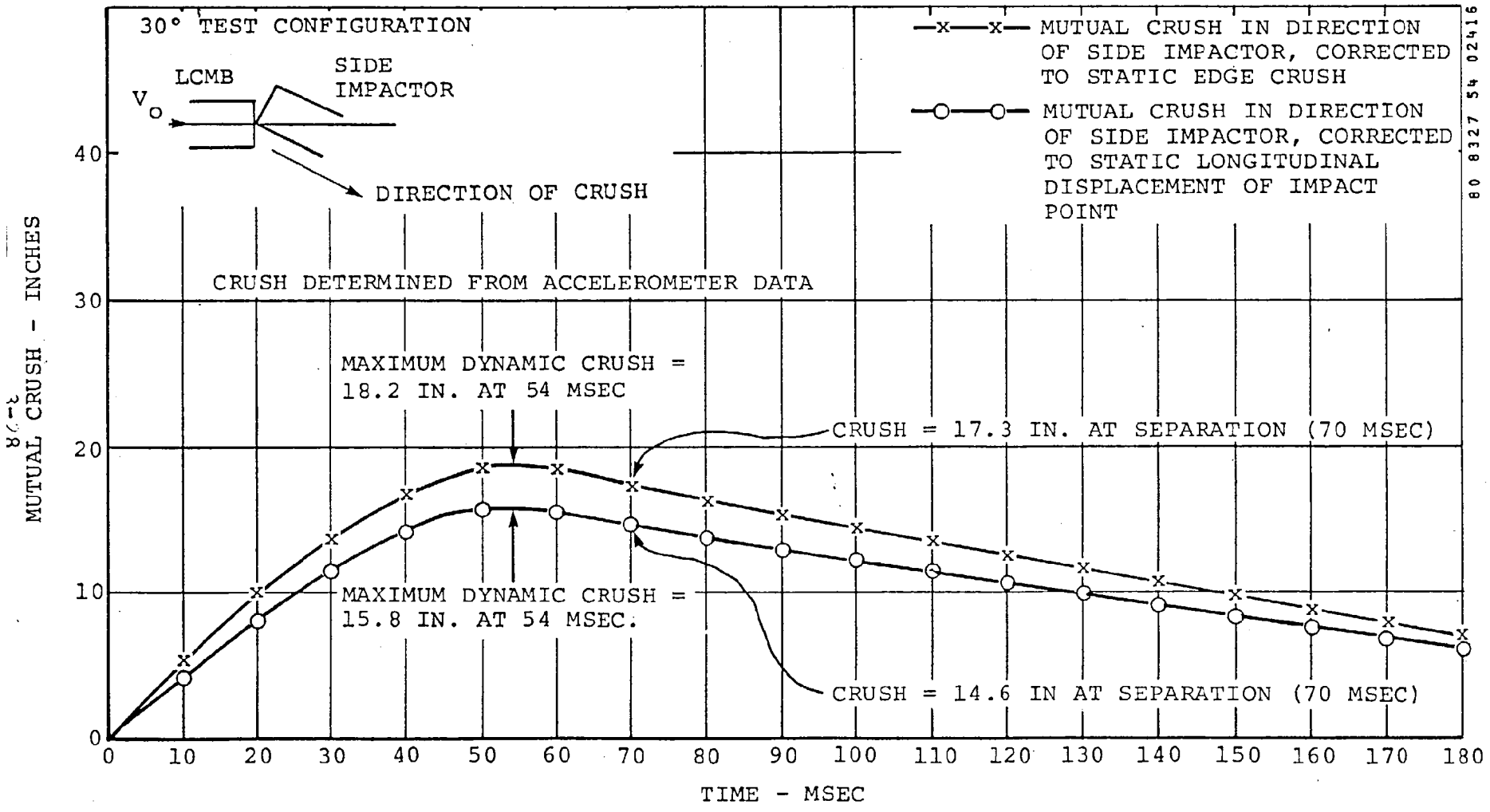


Figure 3-26. Corrected Mutual Crush Versus Time in Direction of Side Impactor (Test 8327-5.2).

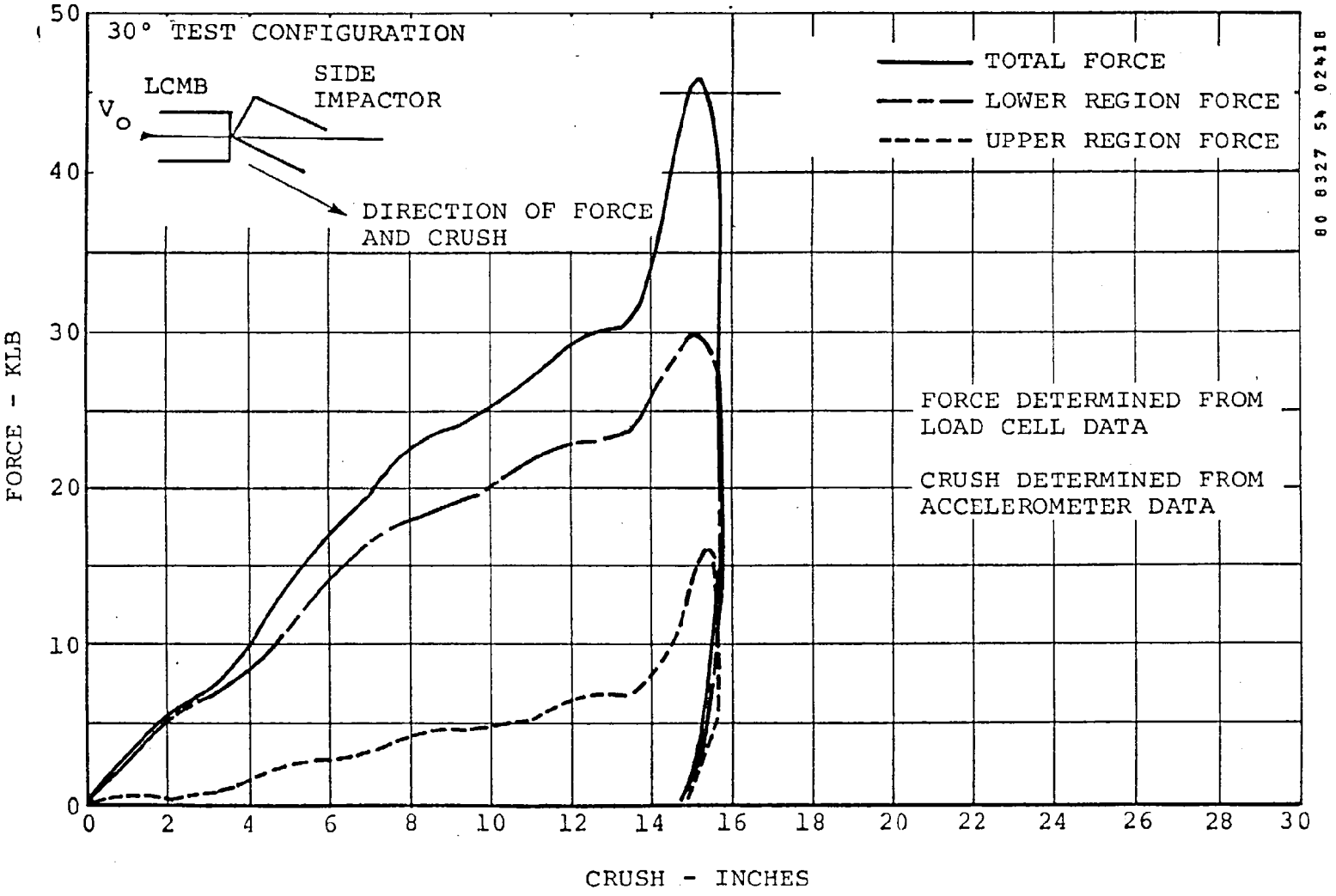


Figure 3-27. Lower Region, Upper Region, and Total Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Side Impactor (Test 8327-5.2).

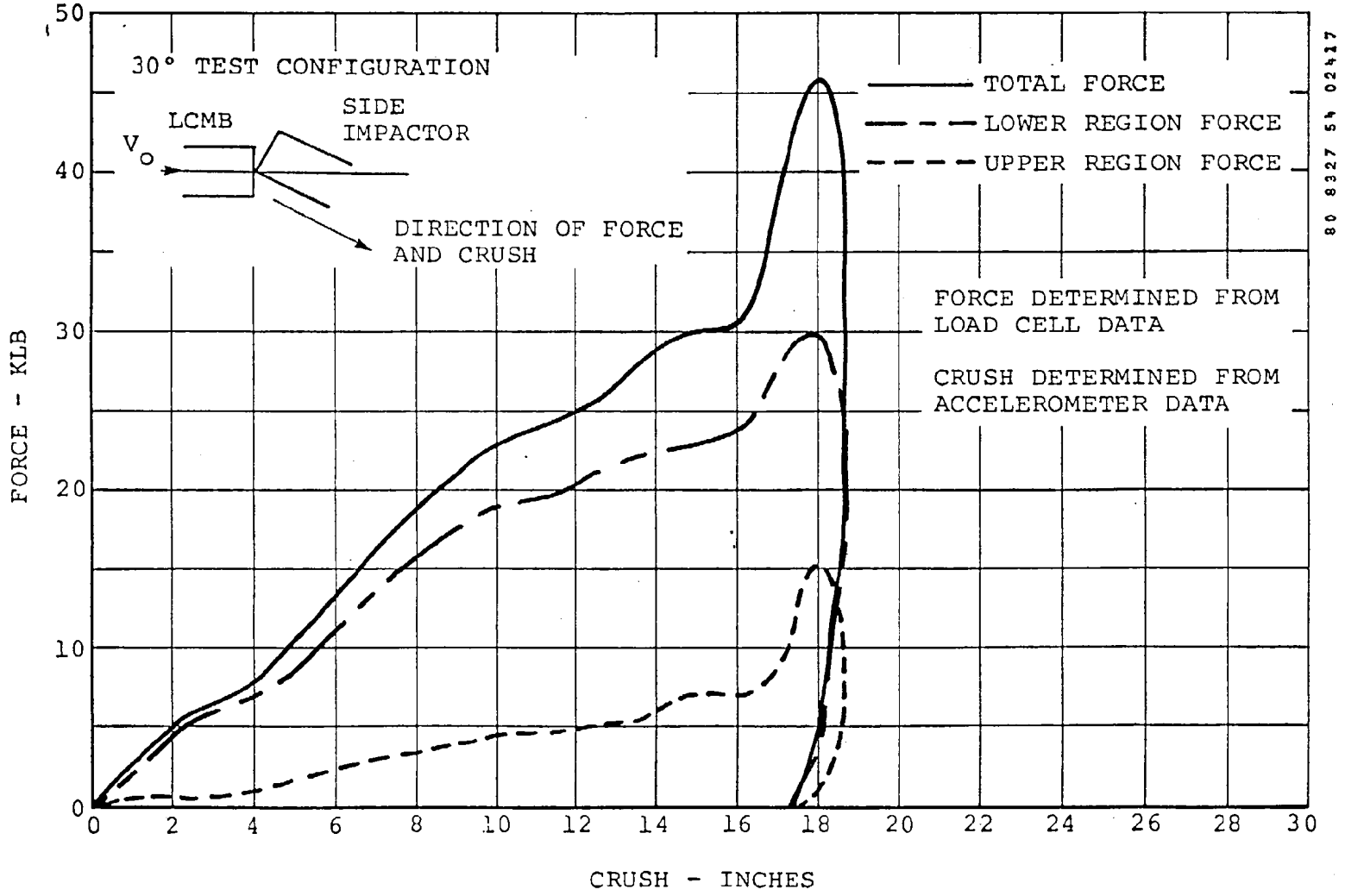


Figure 3-28. Lower Region, Upper Region, and Total Force Versus Crush (Corrected to Static Edge Crush) in Direction of Side Impactor (Test 8327-5.2).

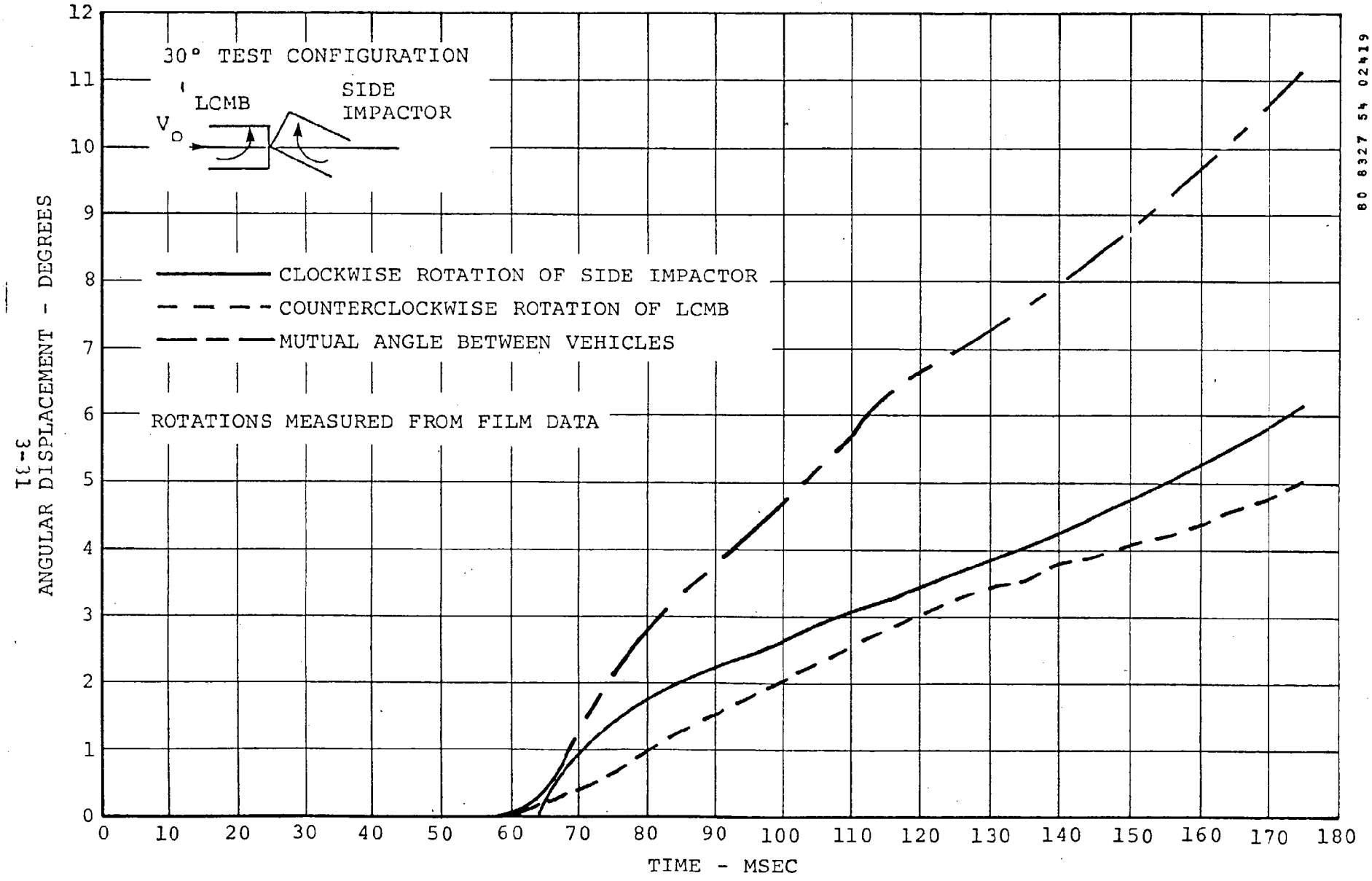


Figure 3-29. Angular Displacement Versus Time for LCMB and Side Impactor (Test 8327-5.2).

3.3 SUMMARY AND CONCLUSIONS

Due to the attenuation of some vehicle accelerometer data in Test 8327-5.1, additional accelerometers were installed on the Side Impactor Bogey in both the longitudinal and in the direction of the LCMB impact for this test. After investigation of the accelerometer data, it appears that no anomalies occurred during this test.

To verify the time when the SI face crushed seven inches in the impact direction of the LCMB, a momentary switch was installed on the SI vehicle. The switch activated at 15 ms after impact. The mutual crush obtained from accelerometer data at this time was 7.4 inches.

During the impact, the LCMB totally crushed the SI face and bottomed out on the two-inch face mounting plate at the impacted corner. The simulated honeycomb bumper bent at the approximate centerline of the face paralleling the same crush mode as the rest of the face. The 231 PSI crush strength honeycomb in the bumper structure crushed one inch along the impacted area. The bumper bond to the front skin of the face failed during bottoming out of the honeycomb, causing complete separation of the bumper later in the crash event. Upon contact of the LCMB into the two-inch aluminum SI face mounting plate, the load cells in column four were impacted near the edge of the load cell impact plate resulting in loss of load cell data when the plate contacted the load cell bolts. The load loss during bottoming out accounts for the difference in the load cell force versus inertia loads of the two vehicles in Figure 3-22.

4.0 COMPARATIVE ANALYSIS OF TEST RESULTS (TEST 8327-5.1)

4.1 INTRODUCTION

The LCMB load cell data/S.I. face crush from this test were analyzed in order to compare the impactor response with that of the 1980 Chevrolet Citation (Test 8327-3.1) and the previous Side Impactor face (Test 8321-4.05). Table 4-1 presents a summary of their respective test conditions.

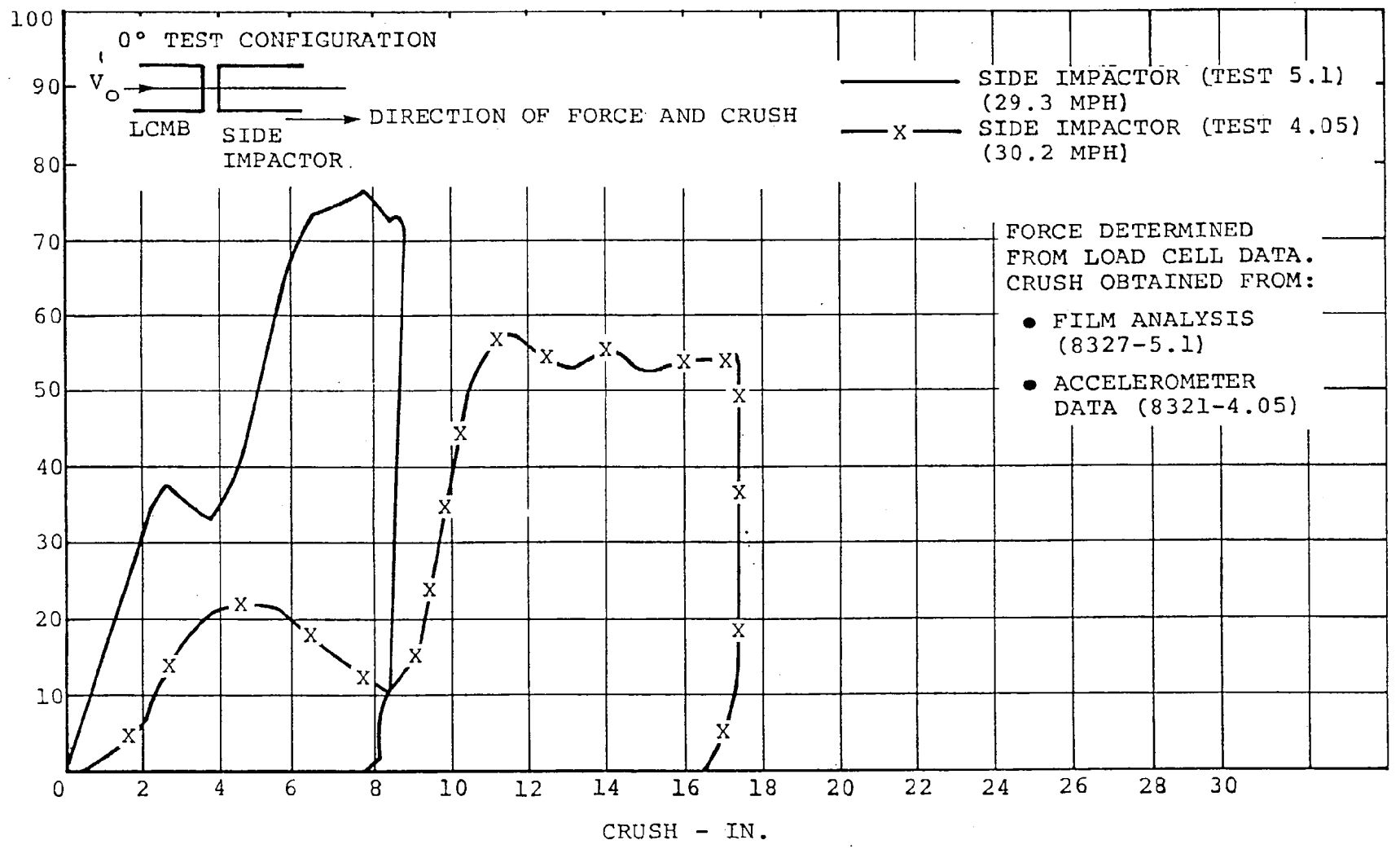
TABLE 4-1. COMPARISON OF TEST CONDITIONS FOR SIDE IMPACTOR AND CHEVROLET CITATION TESTS

Test No.	Bullet Vehicle Weight (lb)	Target Vehicle Weight (lb)	Impact Speed (mph)	Angle (Frontal)
8327-5.1	LCMB (3389)	S.I. (Phase II) (3404)	29.3	0°
8321-4.05	LCMB (3994)	S.I. (Phase I) (3798)	30.2	0°
8327-3.1	LCMB (3991)	Chev. Citation (3179)	40.2	0°

For comparative purposes, the load cell data/car or impact crush were grouped into the total load cell face, lower load cell region (rows A and B), corresponding to the bumper region and upper region (rows C and D) corresponding to the region above the bumper.

4.2 COMPARISON OF TEST 8327-5.1 WITH TEST 8321-4.05

The comparative force/crush plots for Phase II, Test 8327-5.1 and Phase I, Test 8321-4.05 Side Impactor faces are presented in Figures 4-1, 4-2, and 4-3. The Side Impactor face for Test 8321-4.05 was designed in Phase I of this program to simulate the



80 8327 54 02319

Figure 4-1. Comparison of Total Force Versus Crush (Tests 8327-5.1 and 8321-4.05).

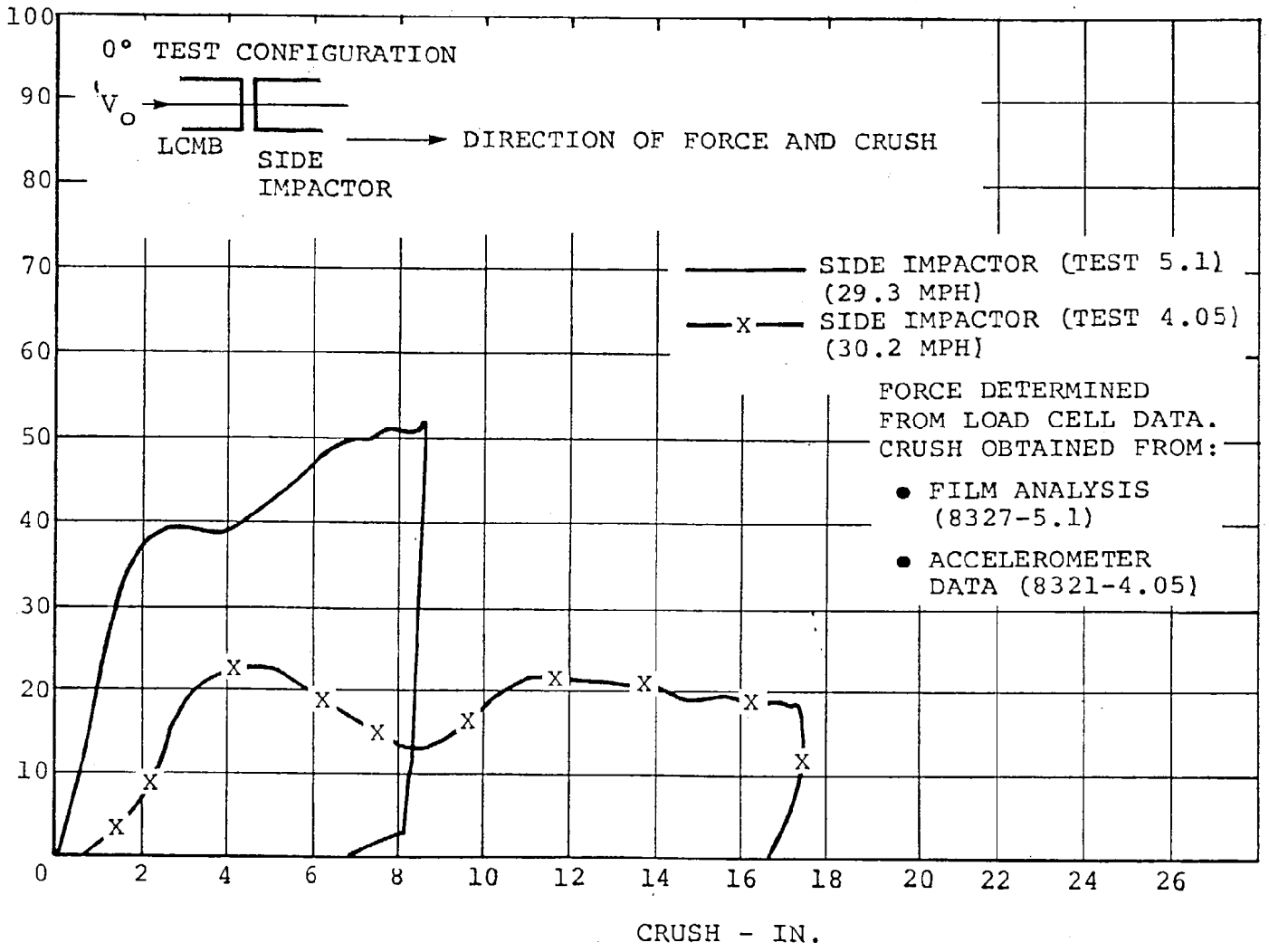


Figure 4-2. Comparison of Lower Region Force Versus Crush (Tests 8327-5.1 and 8321-4.05).

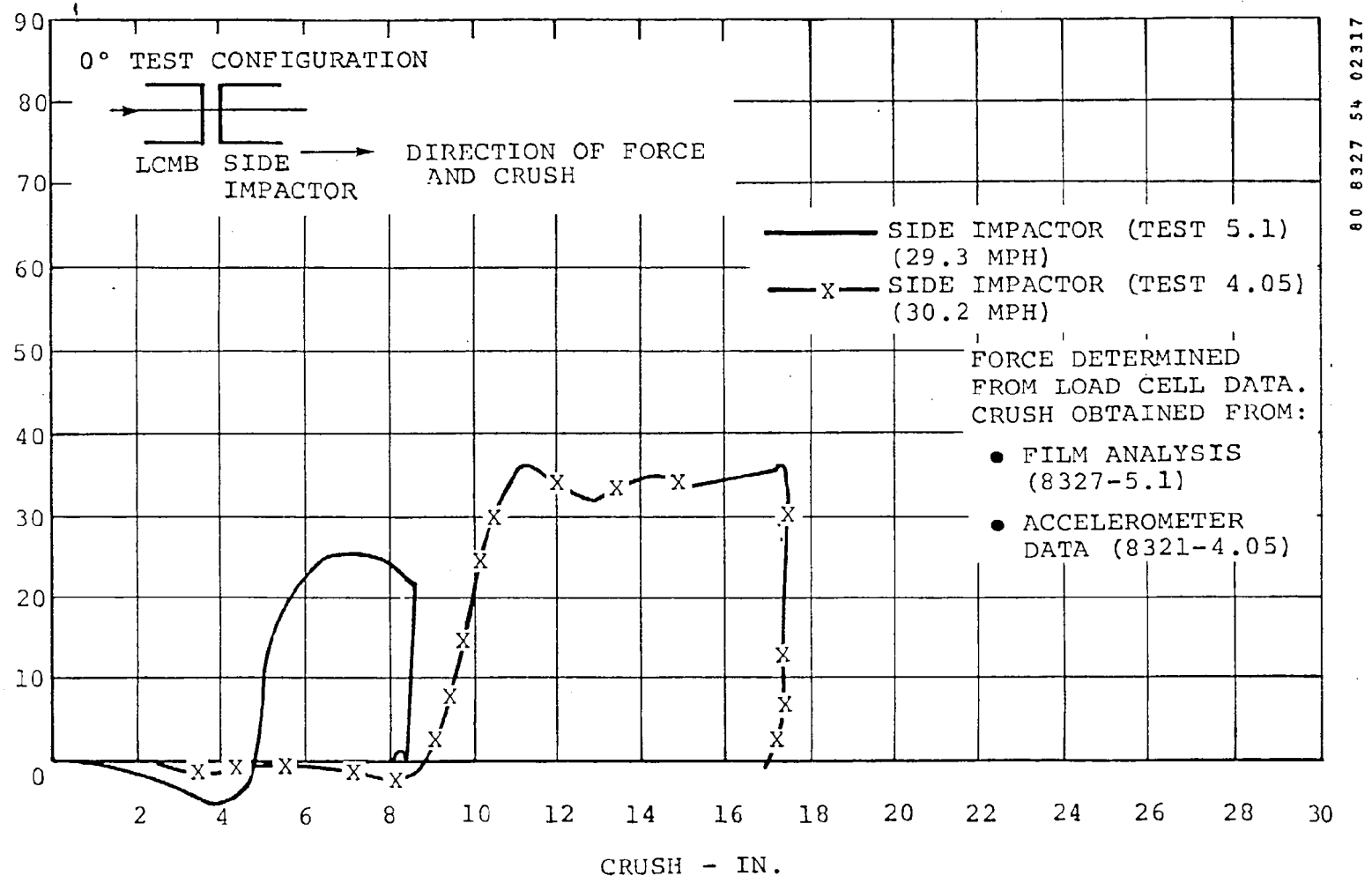


Figure 4-3. Comparison of Upper Region Force Versus Crush (Tests 8327-5.1 and 8321-4.05).

the frontal load/crush structure of a 1979 Oldsmobile Cutlass at 0 degrees. The Side Impactor requirements in Phase II were re-defined to reflect the continuing downsizing of newer designed passenger cars, i.e.; 1980 Chevrolet Citation.

The total force/crush plots of these two tests show higher peak forces occurring earlier for Test 8327-5.1 during the initial bumper crush phase, and secondary force pulse during the later part of the crush. The generally higher loading is reflected in a significant reduction in the total crush distance. As might be expected because of the differences in the total force/crush plot of these two honeycombed faces, the load/crush phase relationships for the lower and upper regions show similar differences. However, the lower region shows higher loading and the upper region shows lower loading for the current Test 8327-5.1 than in Test 8321-4.05.

4.3 COMPARISON OF TEST 8327-5.1 WITH TEST 8327-3.1

The 0 degrees frontal impact load cell force plots for the total, lower, and upper regions for Tests 8327-5.1 and 8327-3.1 are presented in Figures 4-4, 4-5, and 4-6. It should be noted that the impact speed of the Chevrolet Citation was 40 mph in Test 8327-3.1, compared to the nominal 30 mph impact speed for the side impactor test.

The total force and lower region force of these tests show a characteristic steady rise in load when the bumper is contacted, followed by a slight decrease in load, and then increases to a peak load near the final phase of the impactor/vehicle crush. The load peaks for these plots for the Citation (3.1) and Phase II

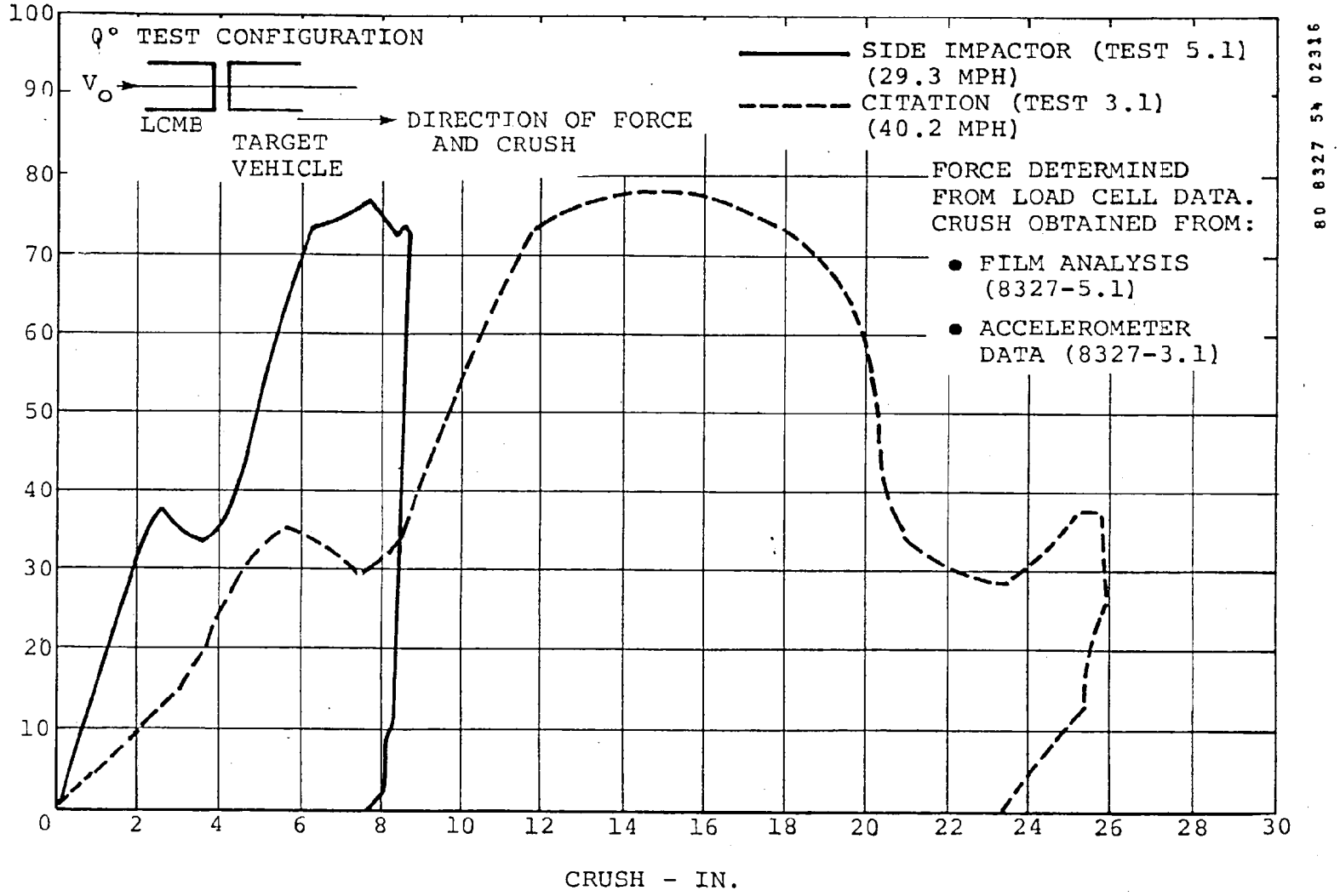


Figure 4-4. Comparison of Total Force Versus Crush (Tests 8327-5.1 and 8327-3.1).

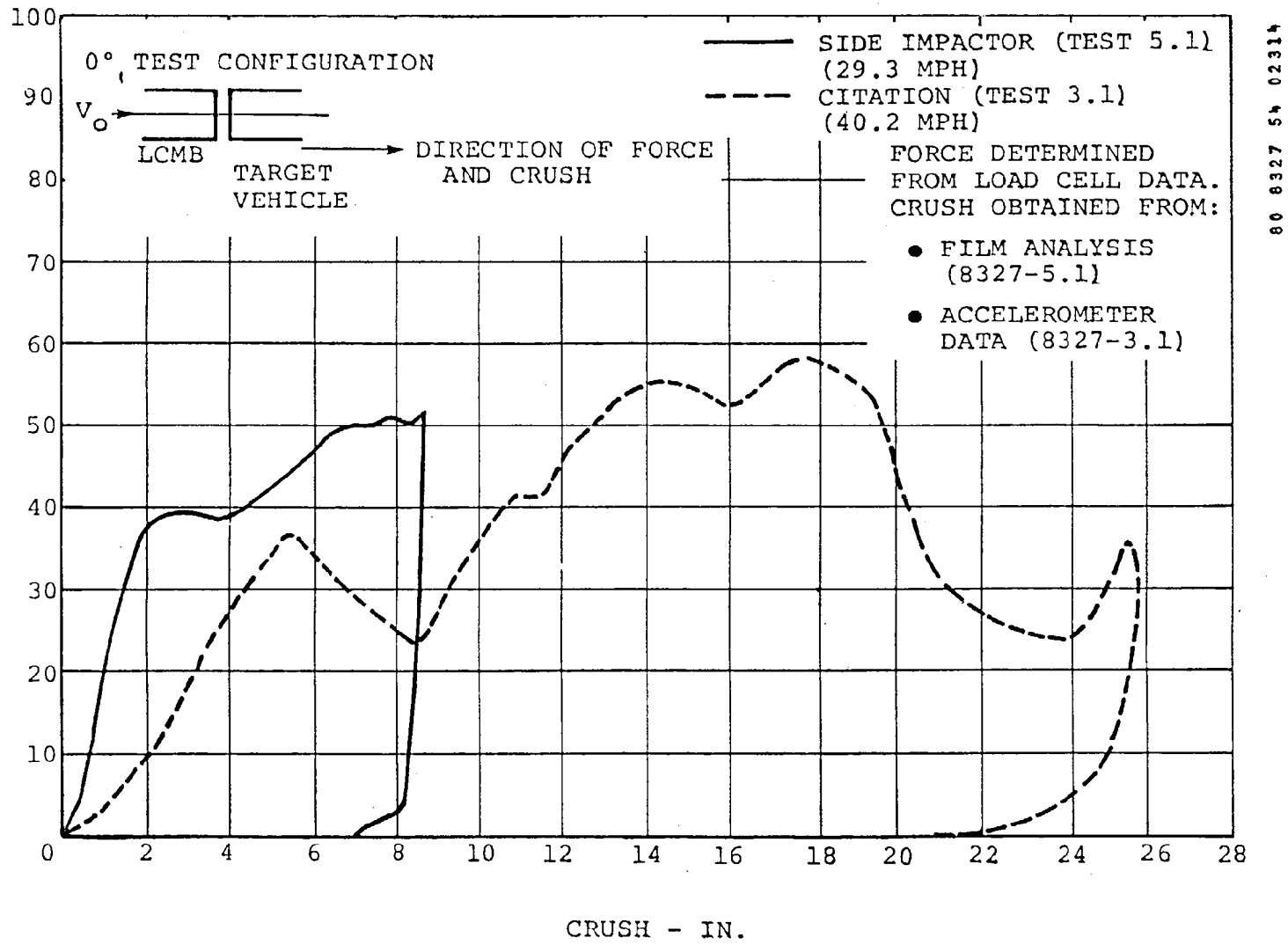


Figure 4-5. Comparison of Lower Region Force Versus Crush (Tests 8327-5.1 and 8327-3.1).

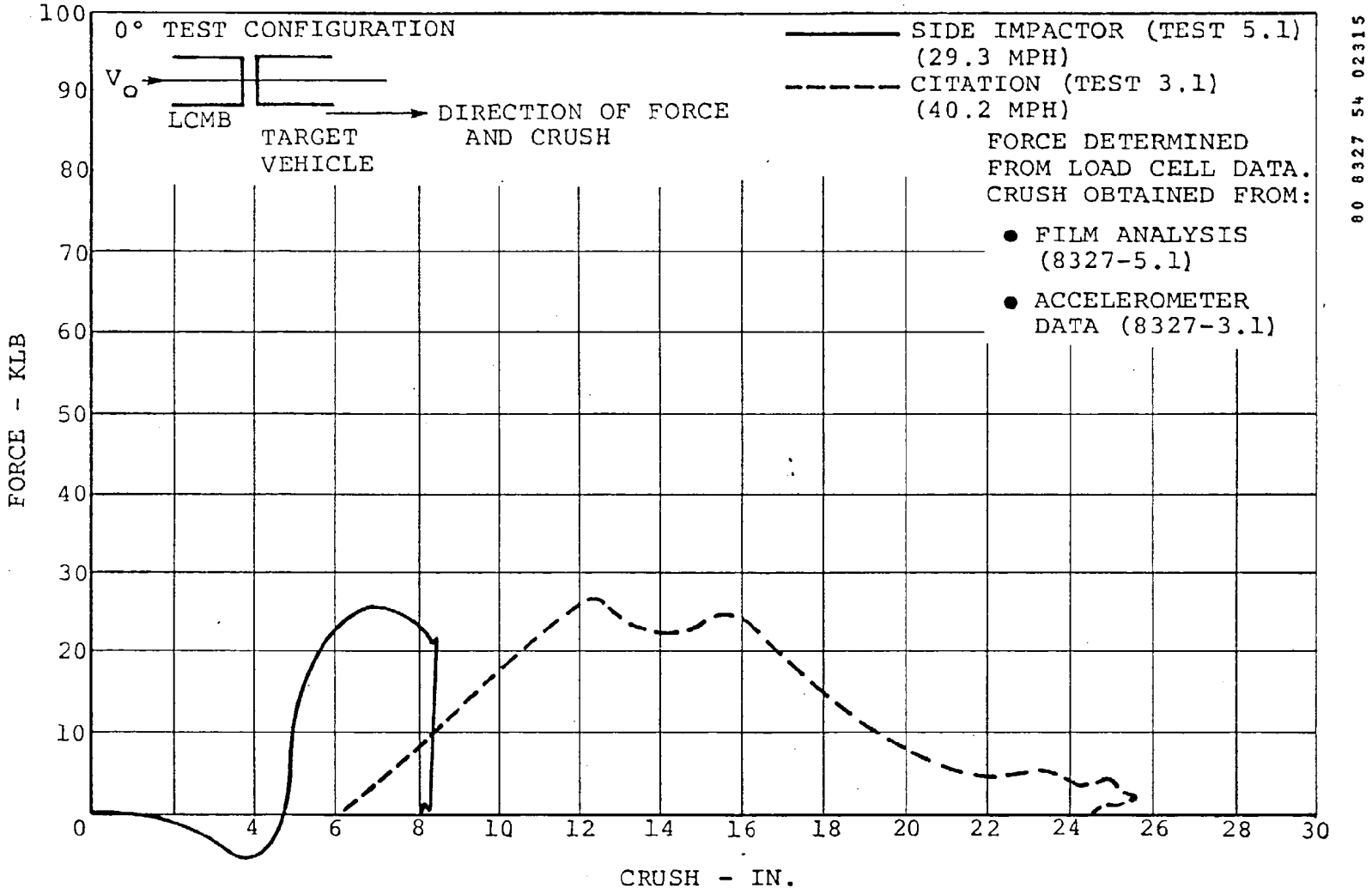


Figure 4-6. Comparison of Upper Region Force Versus Crush (Tests 8327-5.1 and 8327-3.1).

impactor (5.1) show comparable levels, although their peaks occurs at somewhat differenct values of crush distance. Also, the force/crush slopes are slightly steeper for side impactor Test 8327-5.1. Because of the difference in impact speeds for the two tests, a reduction in the total crush would be expected for the 30 mph side impactor test. (However, it is not expected that the force/crush slope for the Citation would be appreciably affected by this difference in the initial impact velocity.)

In comparing the upper region force/crush plots, the peak load for the Test 8327-5.1 impactor and the Citation are the same magnitude. However, the load pulses initiate at noticeably different crush distances, with a substantial difference in the force-crush slopes (the impactor slope was much steeper).

The comparison of Tests 8327-3.1 and 8327-5.1 are quite similar except for the crush distance at which the two characteristics force-crush pulses occur. To provide a better correlation of the impactor face and the Citation, additional force/crush plots (Figure 4-7, 4-8, and 4-9) were generated for comparison by shifting the initiation of the impactor loading curve by four-inches of crush distance. This is physically equivalent to adding four inches of soft material (on) in front of the bumper. It is assumed that the Citation load/crush curve would not be substantially altered except for reduction of the later load-crush area if the impact speed were reduced from 40 to 30 mph. The impactor face for Test 8327-5.1 could be modified to produce this force/crush response by adding four inches of foam or weak honeycomb in front of the existing bumper structure in the lower region.

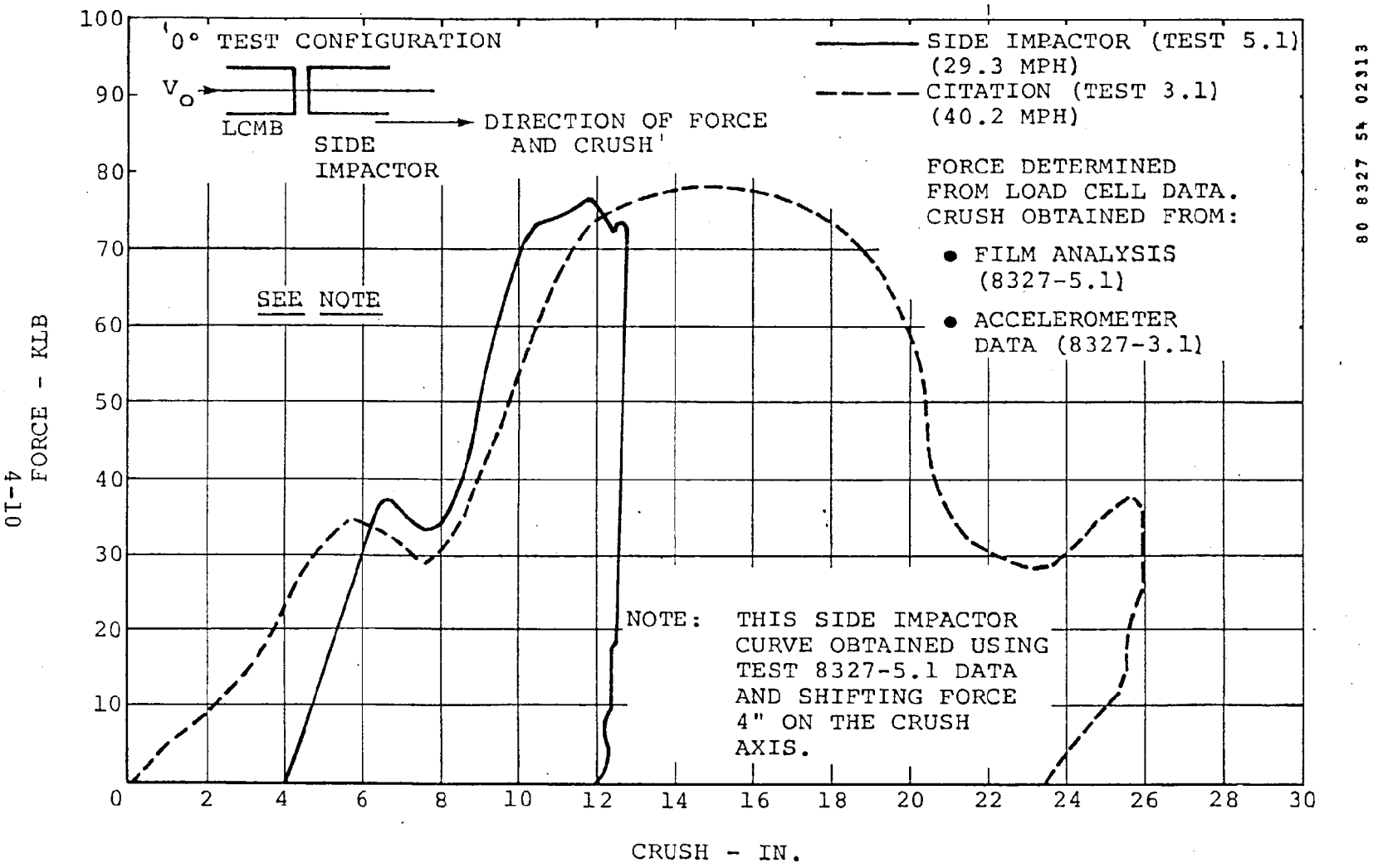


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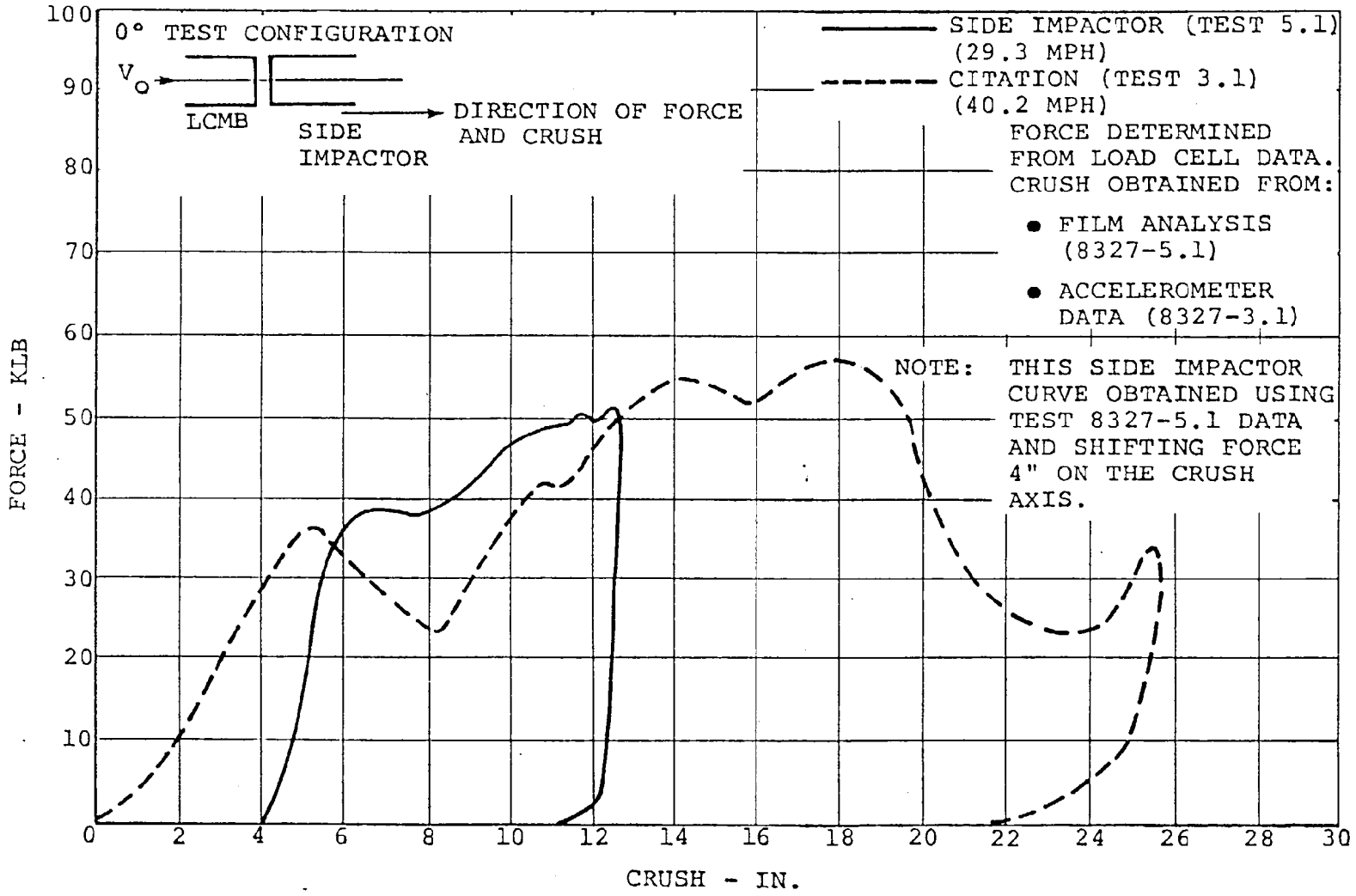
Figure 4-7. Comparison of Total Force Versus Crush (Modified Tests 8327-5.1 and 8327-3.1).



80 8327 54 02312

Figure 4-8. Comparison of Lower Force Region Versus Crush (Modified Tests 8327-5.1 and 8327-3.1).

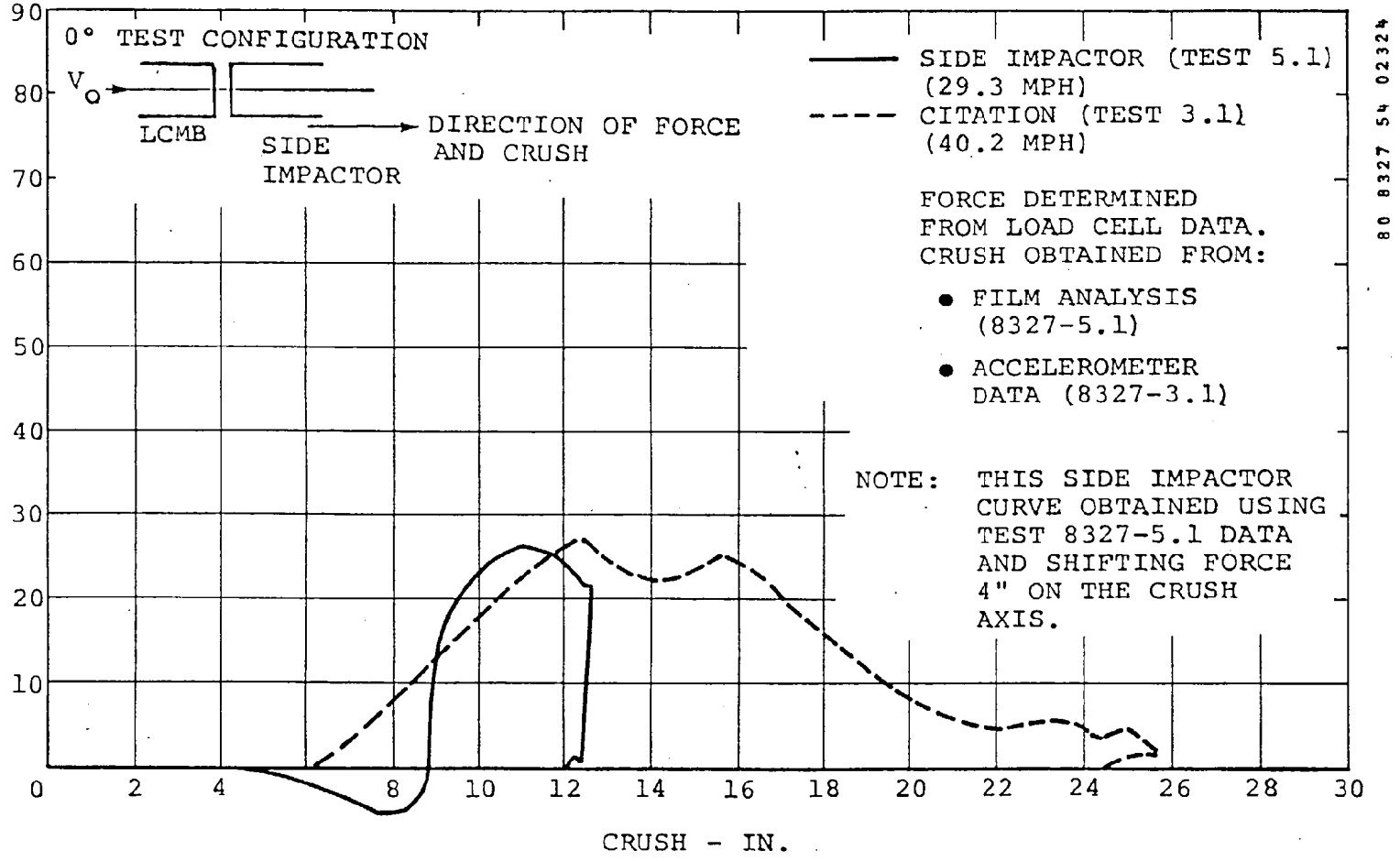


Figure 4-9. Comparison of Upper Force Region Versus Crush (Modified Tests 8327-5.1 and 8327-3.1).

5.0 COMPARITIVE ANALYSIS OF THE TEST RESULTS (TEST 8327-5.2)

5.1 INTRODUCTION

The LCMB load cell data/SI face crush data from this 30° impact angle test were analyzed in order to compare the impact response with that of the 1980 Chevrolet Citation (Test 8327-3.2) and the previous design Side Impactor face (Test 8321-4.04). Table 5-1 presents a summary of their respective test conditions.

TABLE 5-1. COMPARISON OF TEST CONDITIONS FOR SIDE IMPACTOR AND CHEVROLET CITATION TESTS

Test No.	Bullet Vehicle Weight (lb)	Target Vehicle Weight (lb)	Impact Speed (mph)	Angle (Frontal)
8327-5.2	LCMB (3384)	S.I.(Phase II) (3416)	29.2	30°
8321-4.04	LCMB (3994)	S.I. (Phase I) (3798)	30.5	30°
8327-3.2	LCMB (3991)	Chev. Citation (3214)	29.7	30°

For comparative purposes, the load cell data/car or impact crush were grouped into the total load cell face, lower load cell region (rows A and B), corresponding to the bumper region and upper region (rows C and D) corresponding to the region above the bumper. The load cell versus face crush are plotted by three different methods:

(1) Load cell force/crush in the direction of the LCMB impact.

(2) Load cell force/crush in the direction of the SI vehicle corrected to the static edge crush.

(3) Load cell force/crush in the direction of the SI vehicle corrected to the longitudinal displacement of the impact point of the impactor face.

5.2 COMPARISON OF TEST 8327-5.2 WITH TEST 8321-4.04

The comparative force/crush plots for Phase II, Test 8327-5.2 and Phase I, Test 8321-4.04 Side Impactor faces by the above mentioned methods are presented in this section. The Side Impactor face for Test 8321-4.04 was designed in Phase I of this program to simulate the frontal load/crush structure of a 1979 Oldsmobile Cutlass at 30 degrees.

5.2.1 Load/Crush Comparison in the Direction of the LCMB (Tests 8327-5.2 with Test 8321-4.04)

The total, lower, and upper regions load/crush in the direction of the LCMB are presented in Figures 5-1, 5-2, and 5-3. The total and lower load regions are similar to 4 inches of crush, the slope of Test 8327-5.2 is much steeper - from 4 to 13 inches of crush. The slope and load up to 14 inches of crush are compatible in the upper load region.

5.2.2 Load/Crush Comparison Corrected to Static Edge Crush (Test 8327-5.2 with Test 8321-4.04)

The load/crush comparison plot in the direction of the SI vehicle corrected to static edge crush is shown in Figures 5-4, 5-5 and 5-6. The total load region is identical to 5 inches of crush. At this point, the initial slope continues for Test 5.2 with Test 4.04 changing to a more gentle slope - up to 16 inches crush. The lower region is very similar to the total region comparison except that the Test 4.04 slope reduces to zero from 5 to 16 inches of crush. The load/crush plot of the upper region shows a lower slope for Test 5.2 - up to 11.5 inches of crush.

Test 4.04 shows no load for the first 5 inches of crush. Between 11.5 and 16 inches of crush, the load/crush curves are identical.

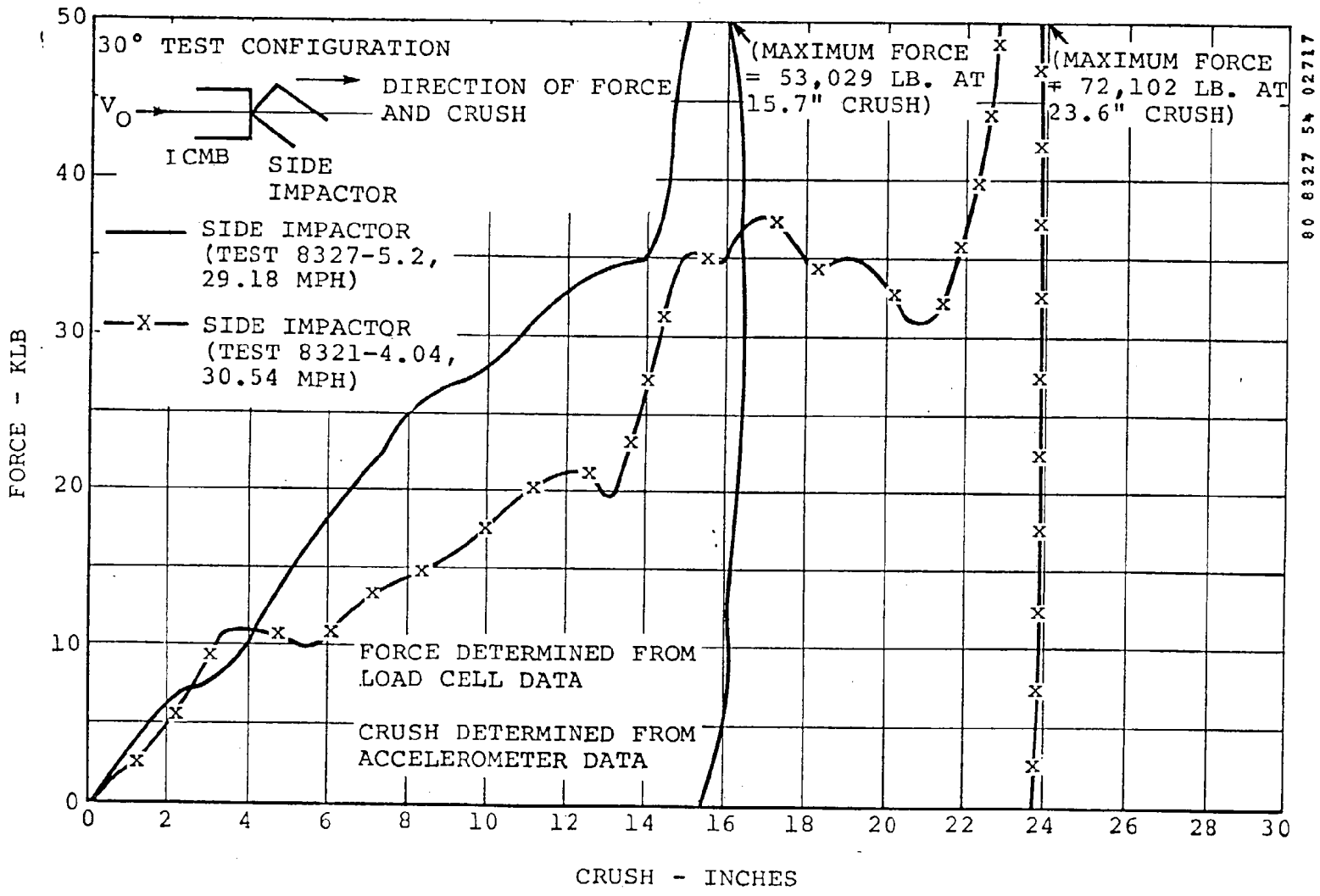


Figure 5-1. Comparison of Total Force Versus Crush in Direction of LCMB (Tests 8327-5.2 and 8321-4.04).

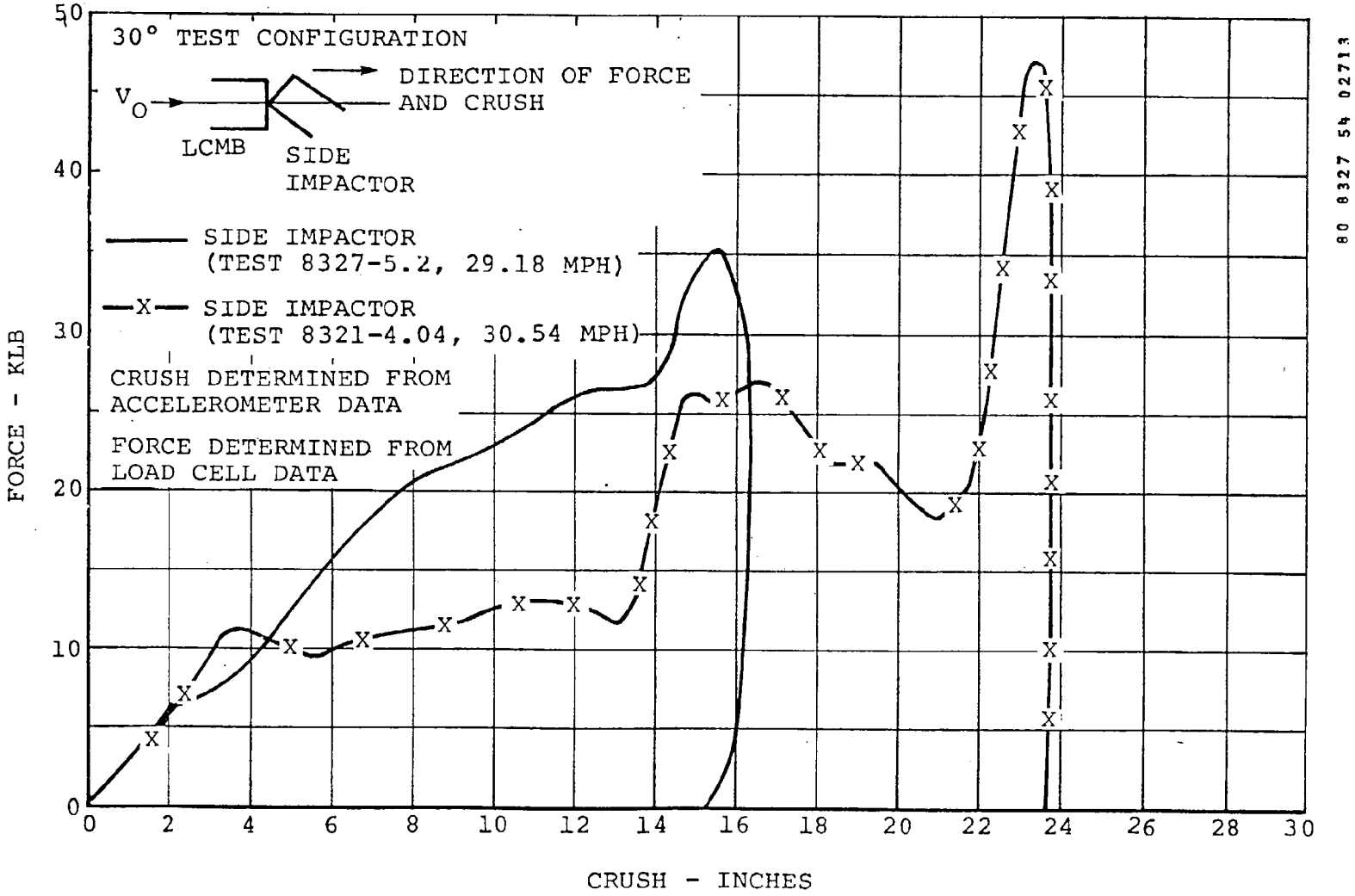


Figure 5-2. Comparison of Lower Region Force Versus Crush in Direction of LCMB (Tests 8327-5.2 and 8321-4.04)

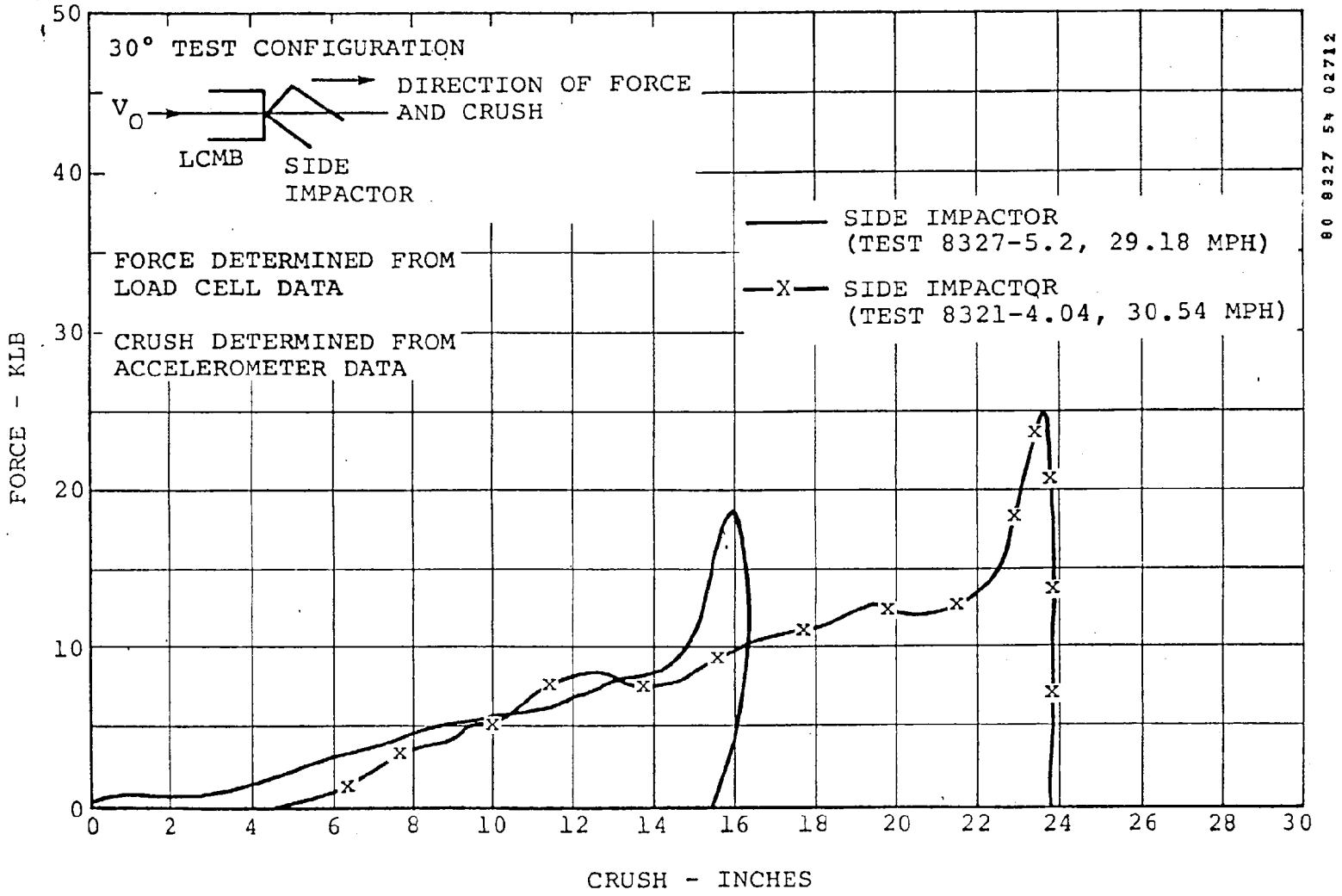


Figure 5-3. Comparison of Upper Region Force Versus Crush in Direction of LCMB (Tests 8327-5.2 and 8321-4.04).

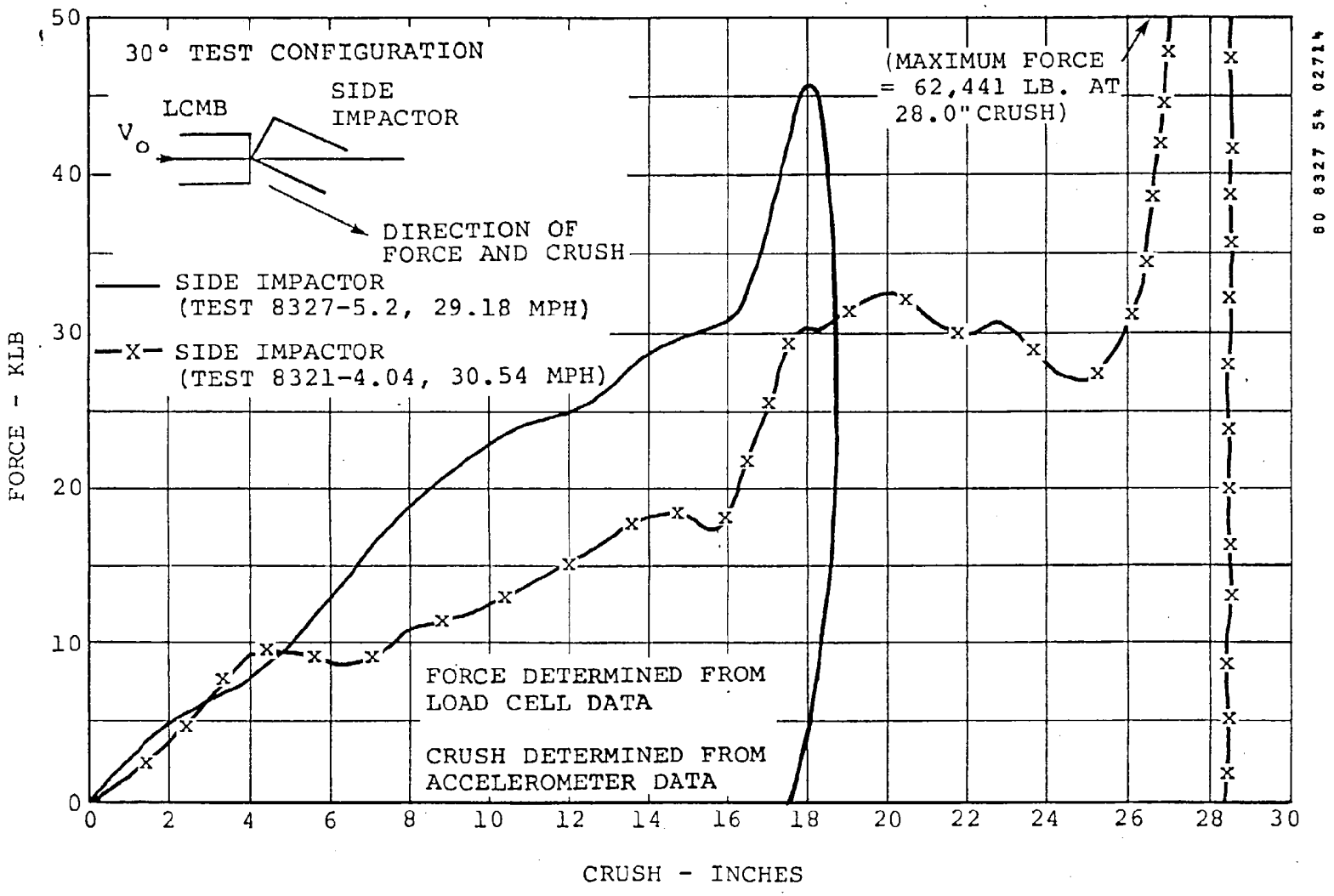


Figure 5-4. Comparison of Total Force Versus Crush (Corrected to Static Edge Crush) in Direction of Target Vehicle (Tests 8327-5.2 and 8321-4.04).

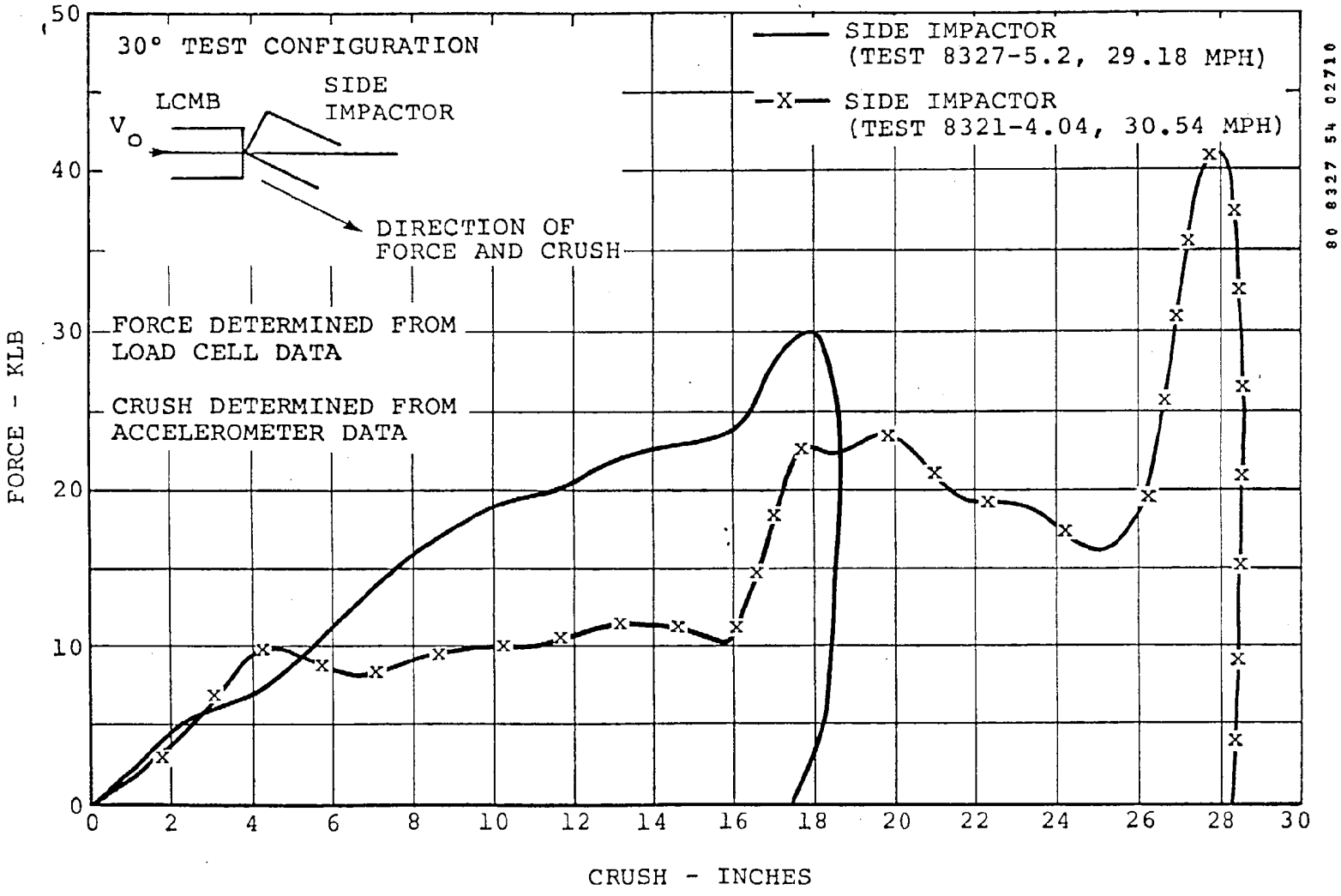


Figure 5-5. Comparison of Lower Region Force Versus Crush (Corrected to Static Edge Crush) in Direction of Target Vehicle (Tests 8327-5.2 and 8321-4.04).

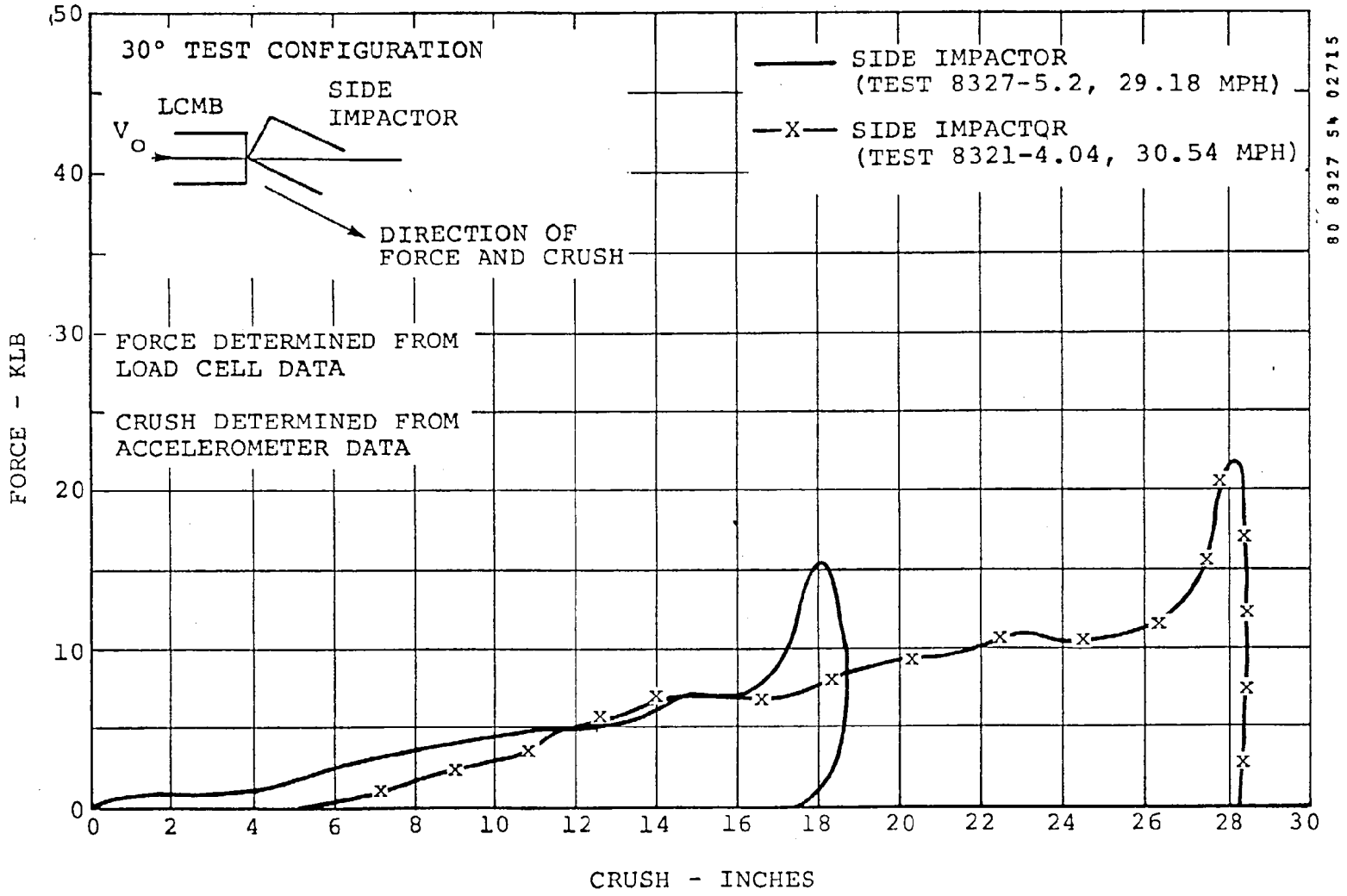


Figure 5-6. Comparison of Upper Region Force Versus Crush (Corrected to Static Edge Crush) in Direction of Target Vehicle (Tests 8327-5.2 and 8321-4.04).

5.2.3 Load/Crush Comparison Corrected to Longitudinal Displacement of the Impact Point (Tests 8327-5.2 with Test 8321-4.04)

The load/crush comparison plots in the direction of the SI vehicle corrected to longitudinal displacement of the impact point is presented in Figures 5-7, 5-8, and 5-9. As might be expected, the total and lower region load/crush comparison are similar. The load/crush slope for Test 5.2 up to 13 inches of crush is constant. Test 4.04 curve is identical for 2 inches of crush, then changes to a lower slope from 4 to 11 inches of crush. The upper region load/crush for both tests are reasonably comparable up to 14 inch crush.

5.3 COMPARISON OF TEST 8327-5.2 WITH TEST 8327-3.2

The comparative force/crush plots for Phase II Test 8327-5.2 Side Impactor Energy Absorbing Face and Phase II Test 8327-3.2 of the Chevrolet Citation by the above mentioned three methods are presented in this section. The Side Impactor requirements in Phase II were redefined to reflect the continuing downsizing of newer designed passenger cars, i.e.; 1980 Chevrolet Citation.

5.3.1 Load/Crush Comparison in the Direction of the LCMB (Tests 8327-5.2 with Test 8327-3.2)

Figures 5-10, 5-11, and 5-12 present the load/crush comparison of Tests 8327-5.2 and 8327-3.2 in the direction of the LCMB. Comparison of the total load cell force are practically identical for the first 12 inches of crush. The lower region force for the two tests are of the same shape with the Test 3.2 load, slightly lower from 4 to 12 inches of crush. The upper region force of Test 3.2 is approximately twice the force of Test 5.2 - from 8 to 12 inches of crush.

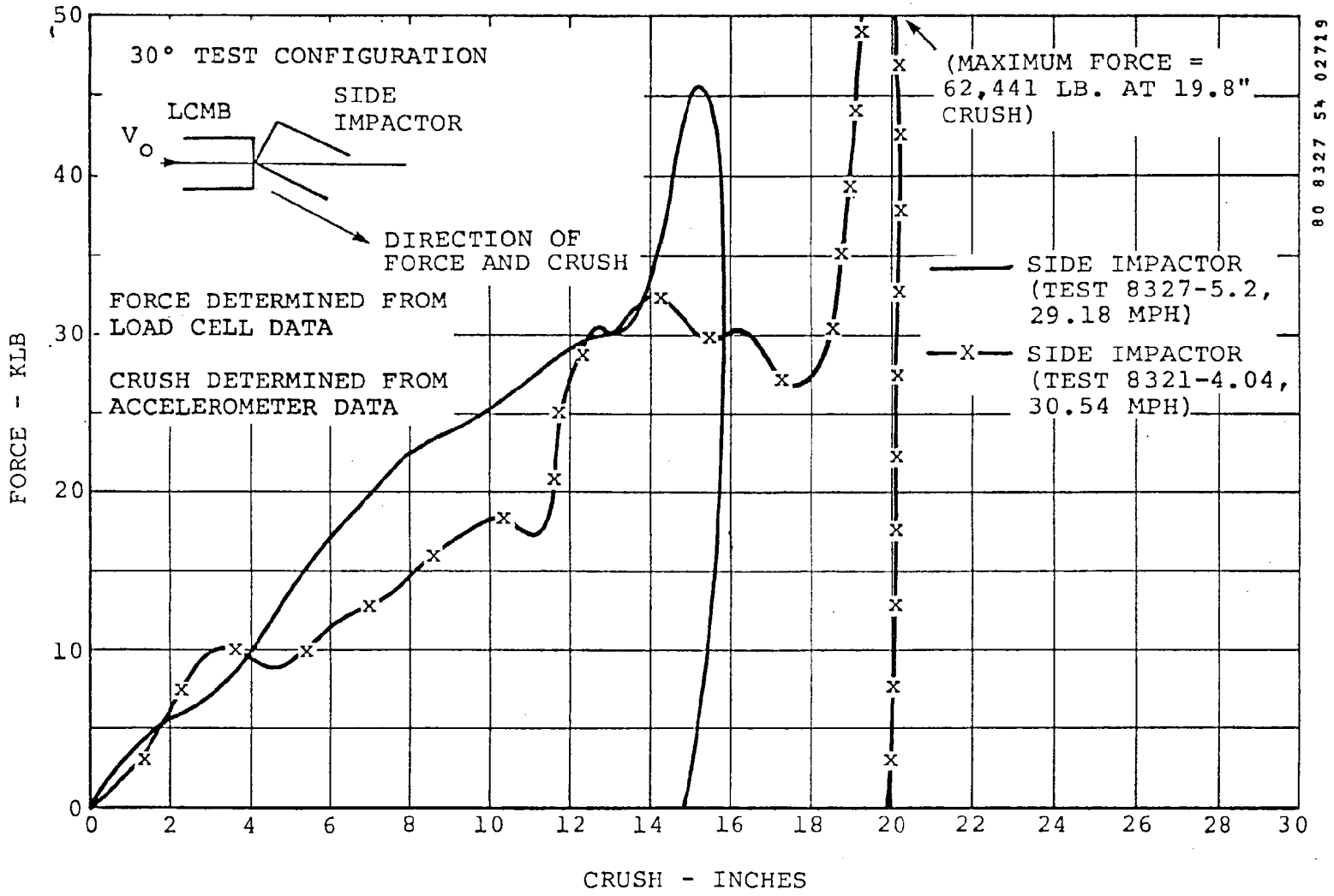


Figure 5-7. Comparison of Total Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Target Vehicle (Tests 8327-5.2 and 8321-4.04).

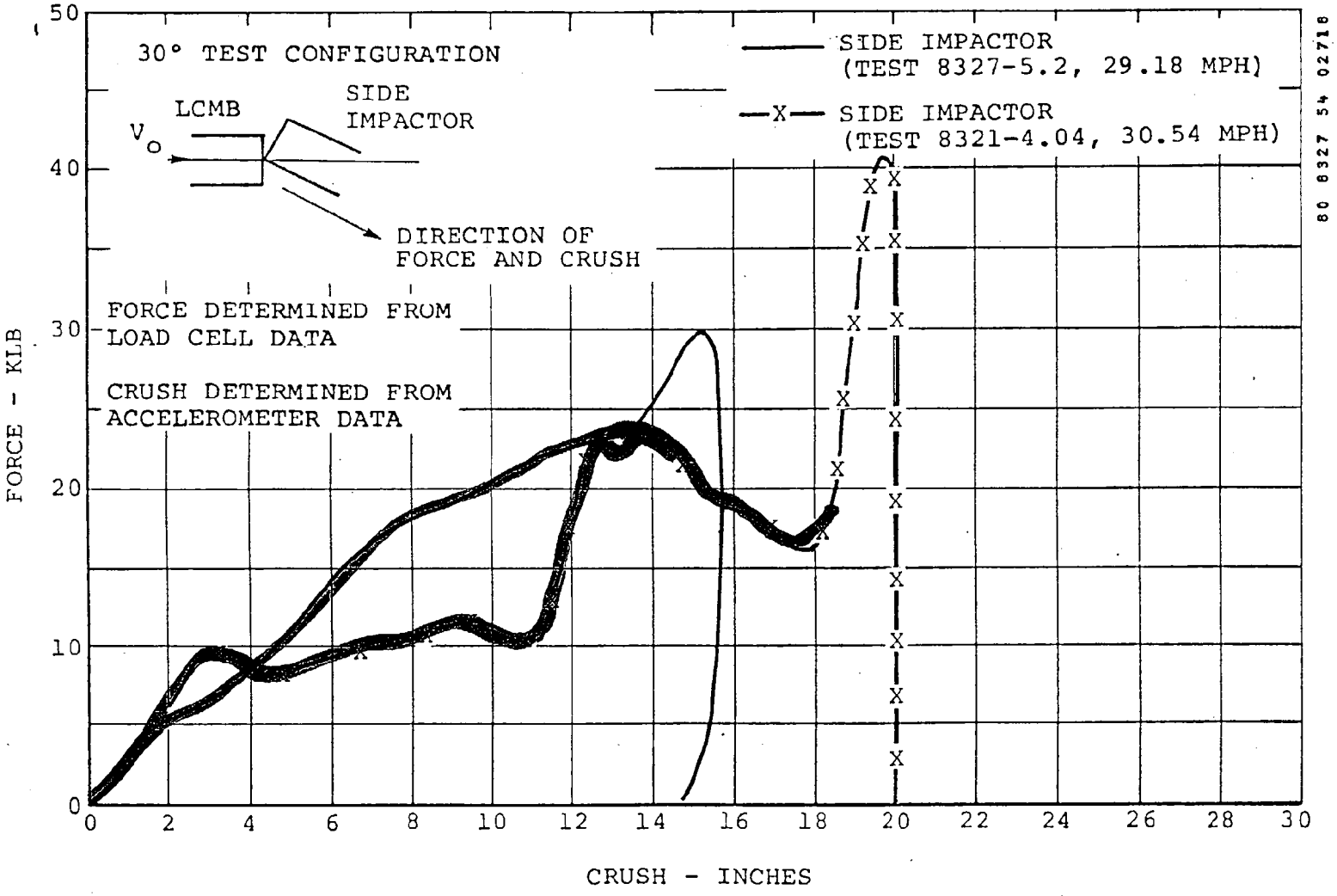


Figure 5-8. Comparison of Lower Region Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Side Impactor (Tests 8327-5.2 and 8321-4.04).

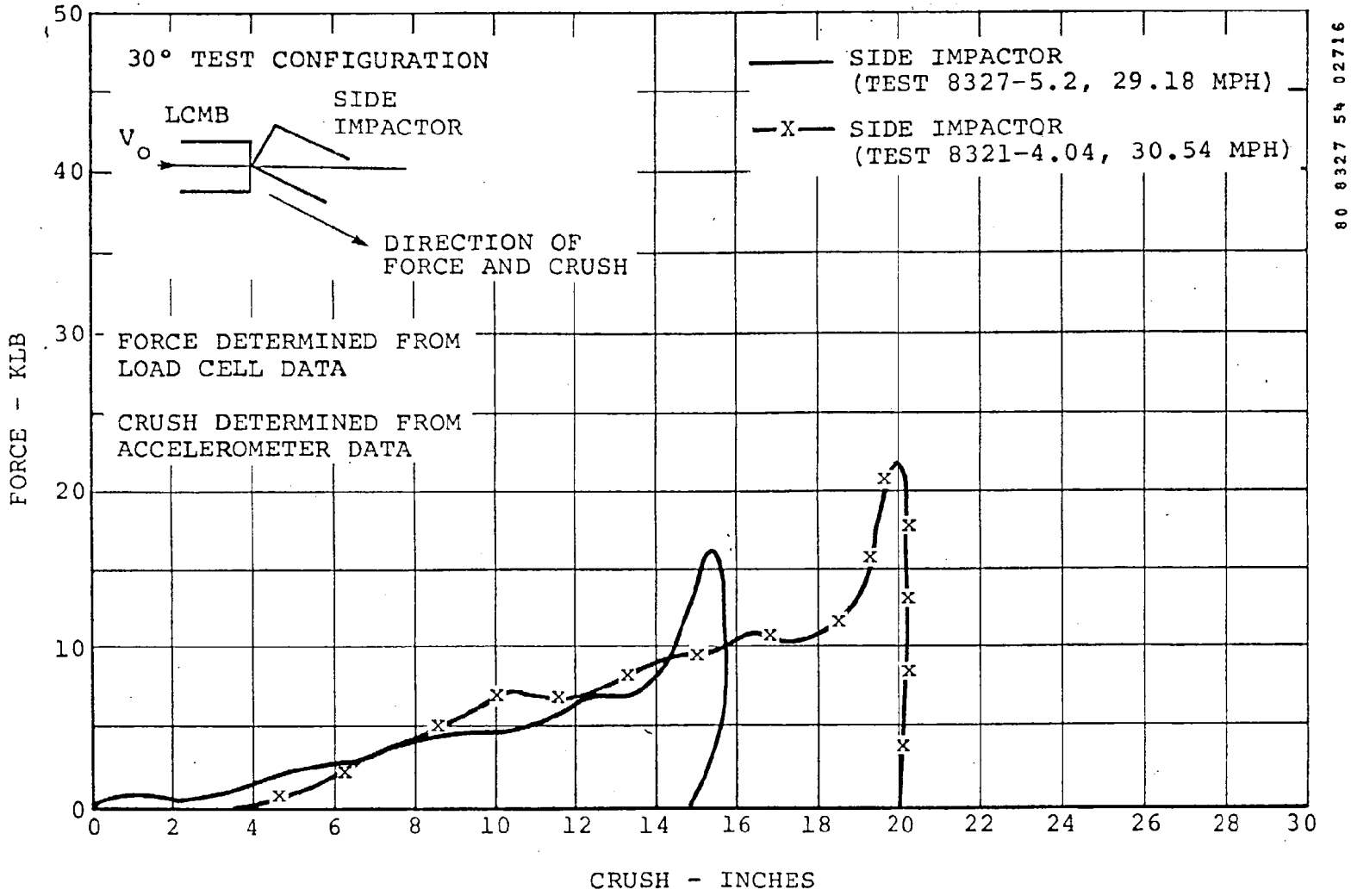


Figure 5-9. Comparison of Upper Region Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Target Vehicle (Tests 8327-5.2 and 8321-4.04).

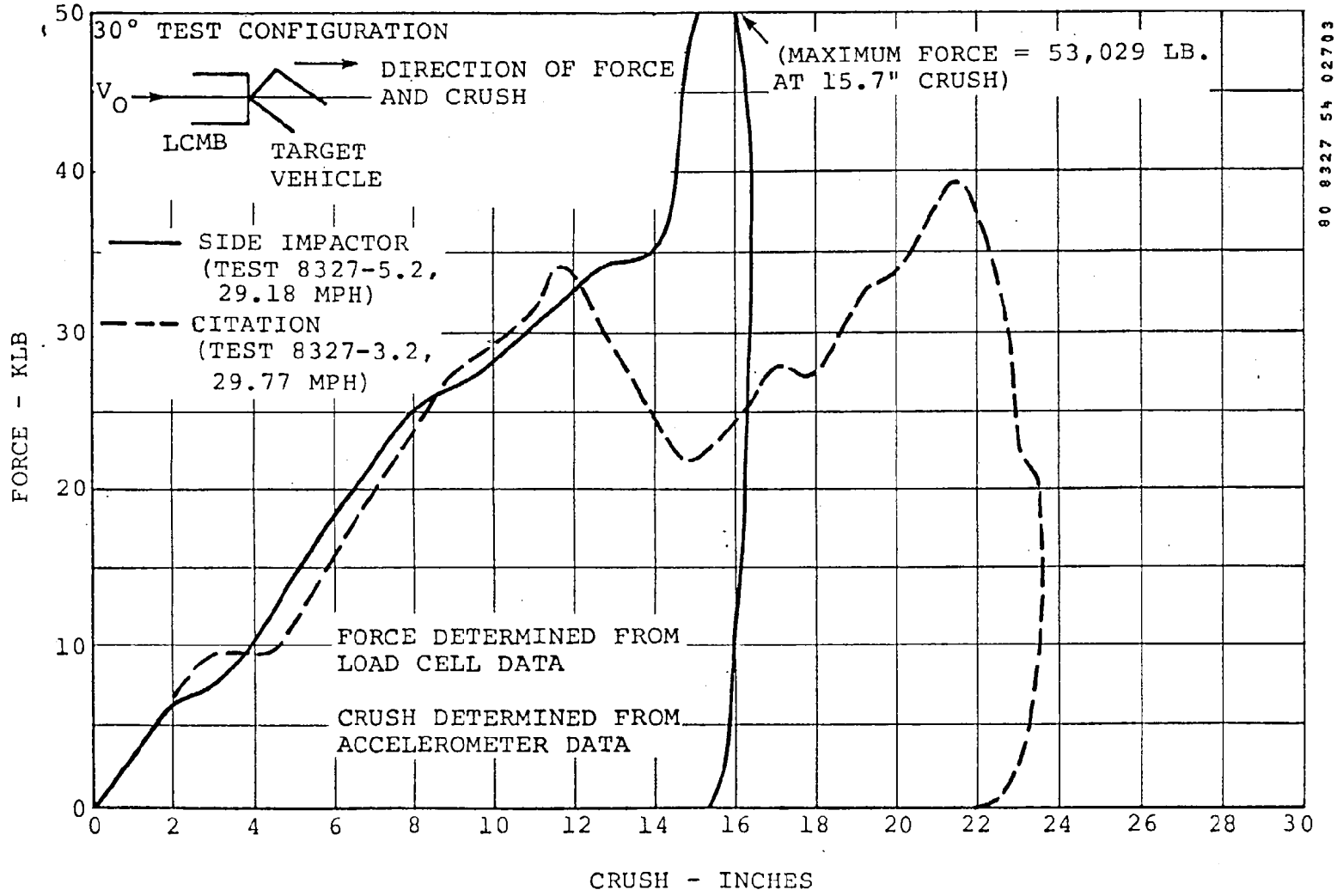


Figure 5-10. Comparison of Total Force Versus Crush in Direction of LCMB (Tests 8327-5.2 and 8327-3.2).

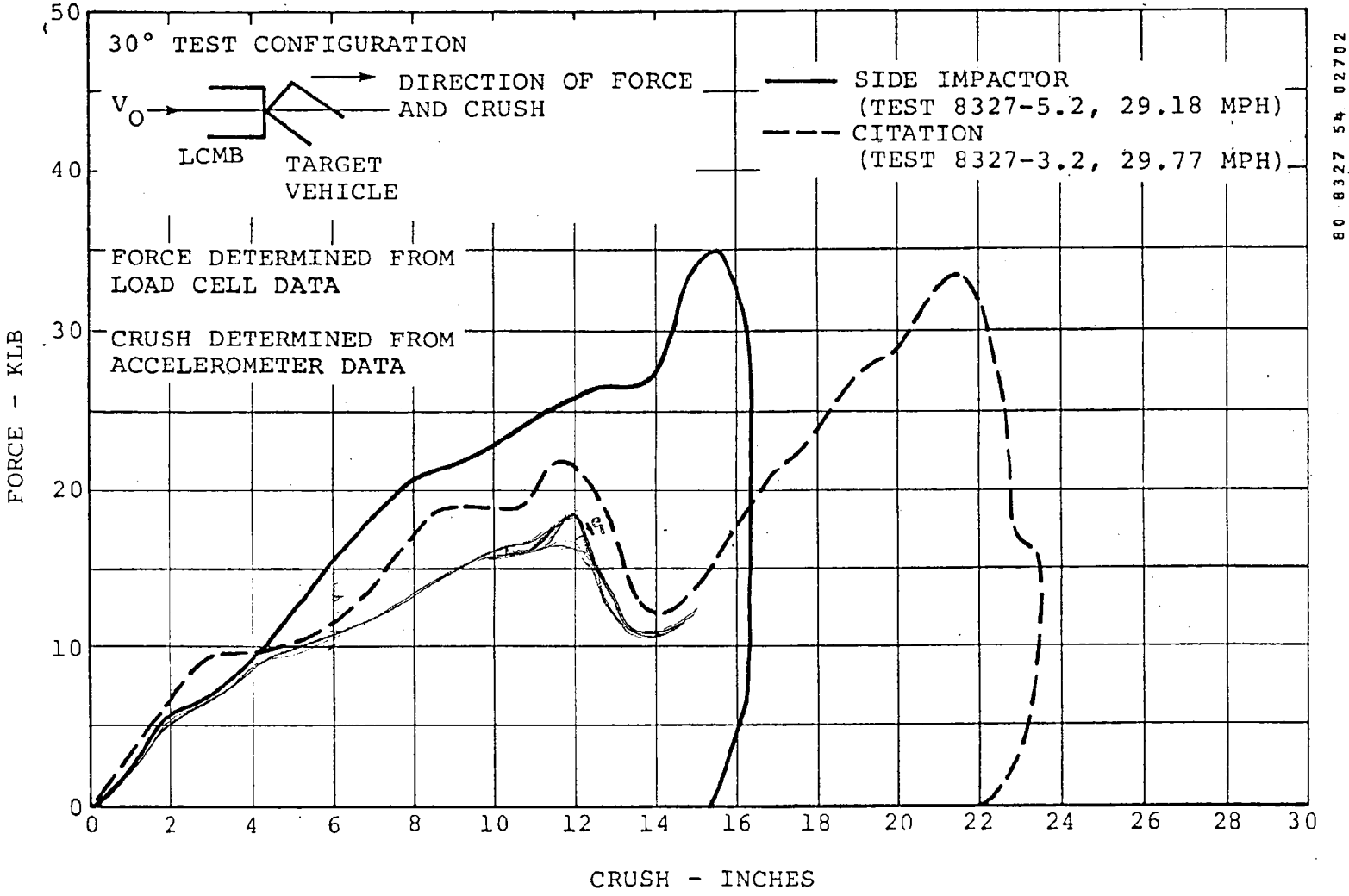


Figure 5-11. Comparison of Lower Region Force Versus Crush in Direction of LCMB (Tests 8327-5.2 and 8327-3.2).

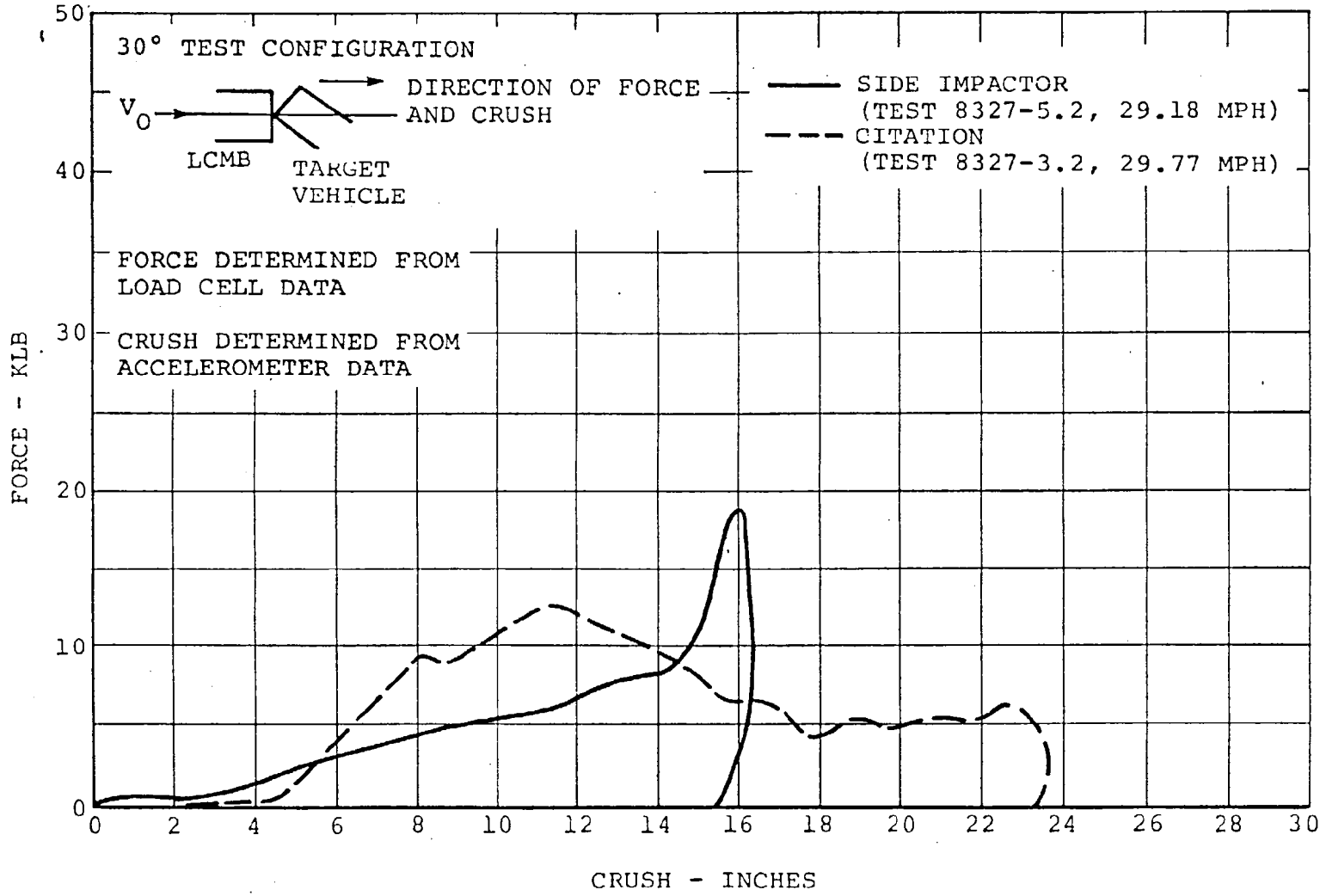


Figure 5-12. Comparison of Upper Region Force Versus Crush in Direction of LCMB (Tests 8327-5.2 and 8327-3.2).

5.3.2 Load/Crush Comparison Corrected to Static Edge Crush (Test 8327-5.2 with Test 8327-3.2)

The load/crush comparison plots in the direction of the SI corrected to static edge crush for the total, lower, and upper force regions are presented in Figure 5-13, 5-14, and 5-15. The total and lower regions of the corrected load/crush are very similar through approximately 14 inches of crush. From 6.5 inches to 16 inches of crush, the upper region force of Test 3.2 is nearly twice the force of Test 5.2.

5.3.3 Load/Crush Comparison Corrected to Longitudinal Displacement of the Impact Point (Test 8327-5.2 with Test 8327-3.2)

The load/crush comparison for Tests 8327-5.2 and 8327-3.2 corrected to longitudinal displacement of the impact point are presented in Figures 5-16, 5-17, and 5-18. The total and lower region of the two tests follow the same path from 0 to 10 inches of crush. The upper region forces are quite different from 5 to 13 inches of crush. The energy absorbed in Test 3.2 is approximately twice that absorbed in Test 5.2 during the crush distance.

5.4 RECOMMENDATIONS

The Side Impactor face used in Test 8327-5.2 (30° angled impact) compares favorably with the 30° angled impact of the 1980 Chevrolet Citation (Test 8327-3.2) in the total and lower crush regions up to 10 - 14 inches depending on the method of load/crush comparison analysis as described in Section 5.3. The upper region shows the greatest disparity between these two tests. However, efforts to obtain better correlation in the upper crush region would complicate the side impactor face construction by requiring different crush strength honeycomb in the upper and lower crush regions.

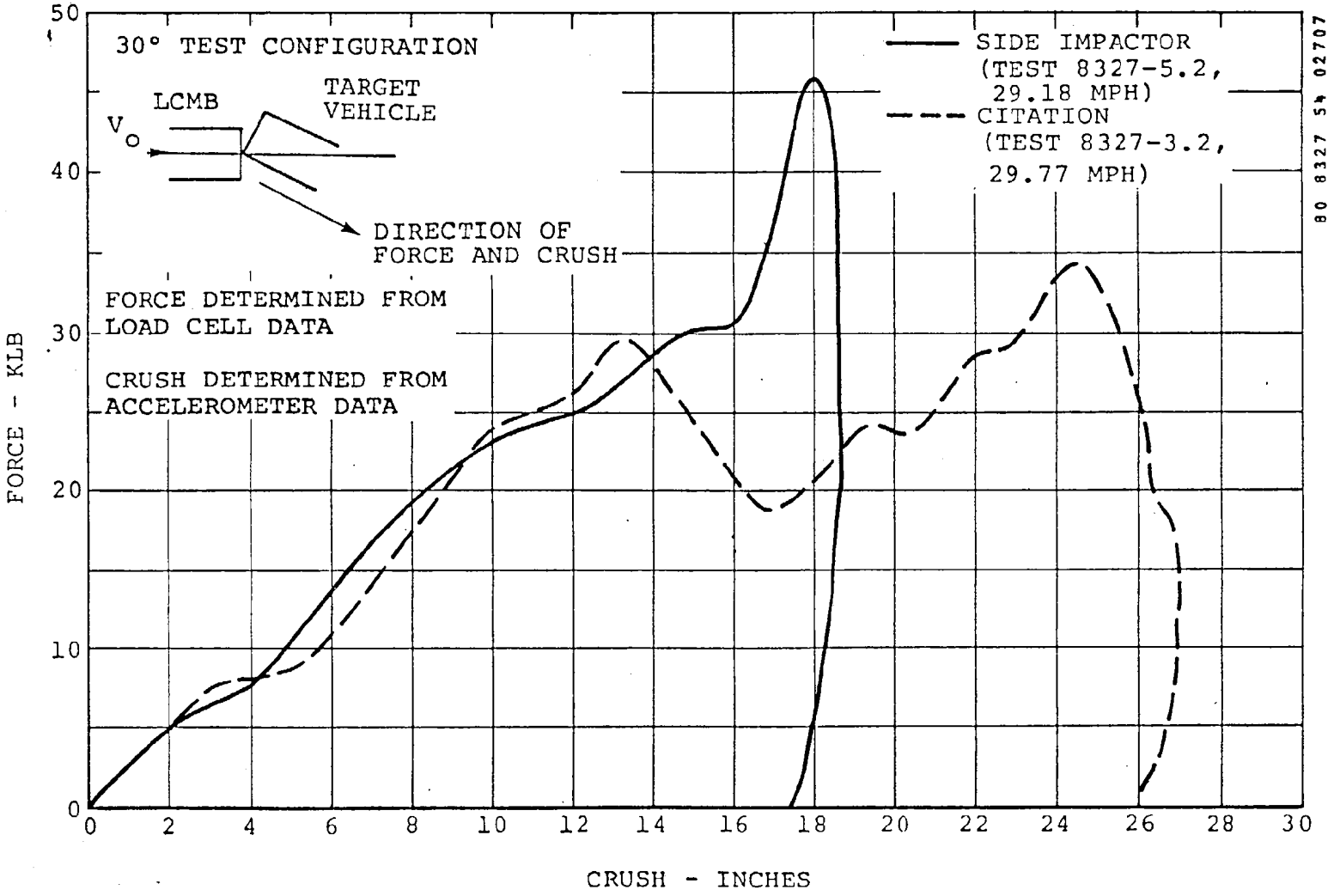


Figure 5-13. Comparison of Total Force Versus Crush (Corrected to Static Edge Crush) in Direction of Target Vehicle (Tests 8327-5.2 and 8327-3.2).

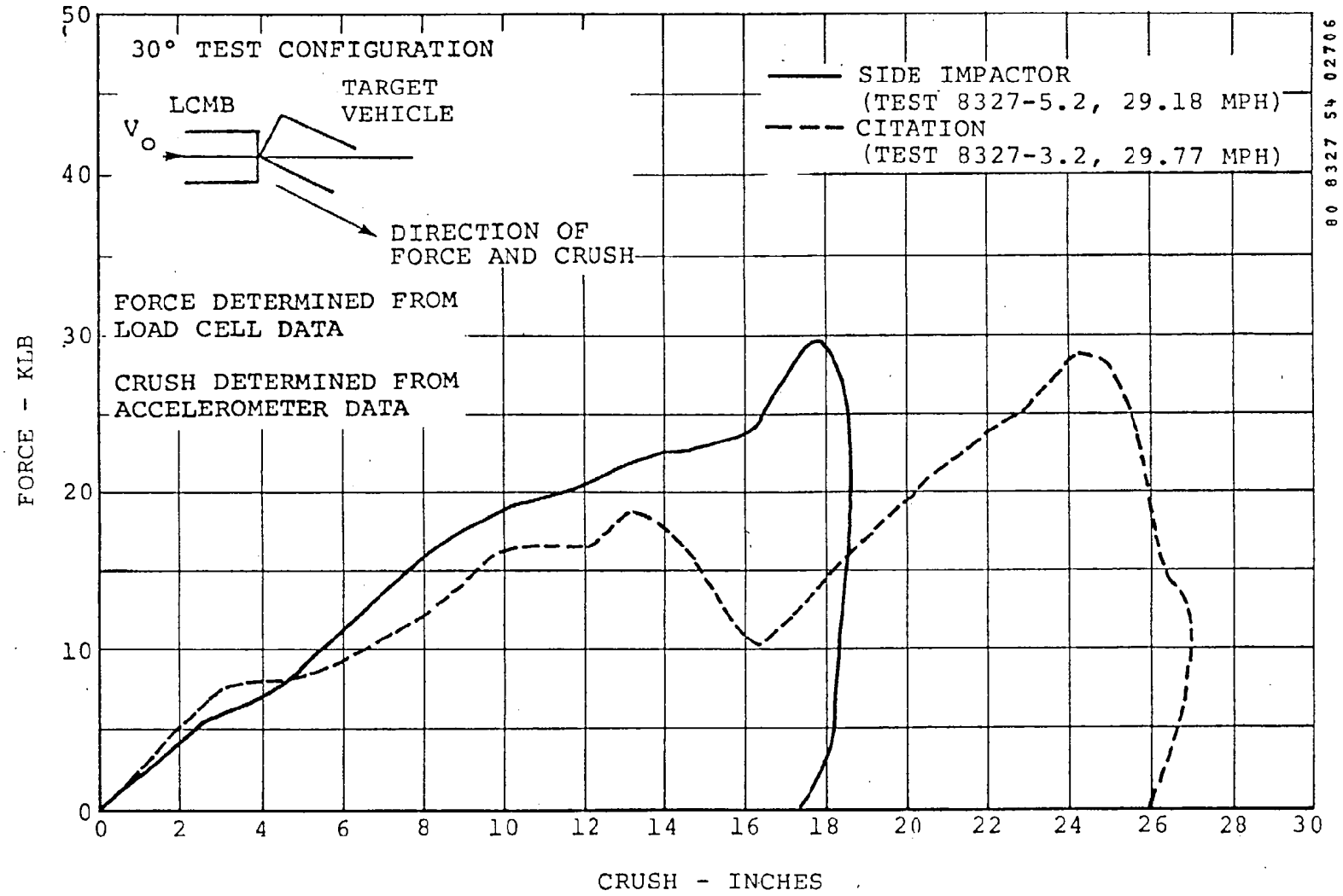


Figure 5-14. Comparison of Lower Region Force Versus Crush (Corrected to Static Edge Crush) in Direction of Target Vehicle (Tests 8327-5.2 and 8327-3.2).

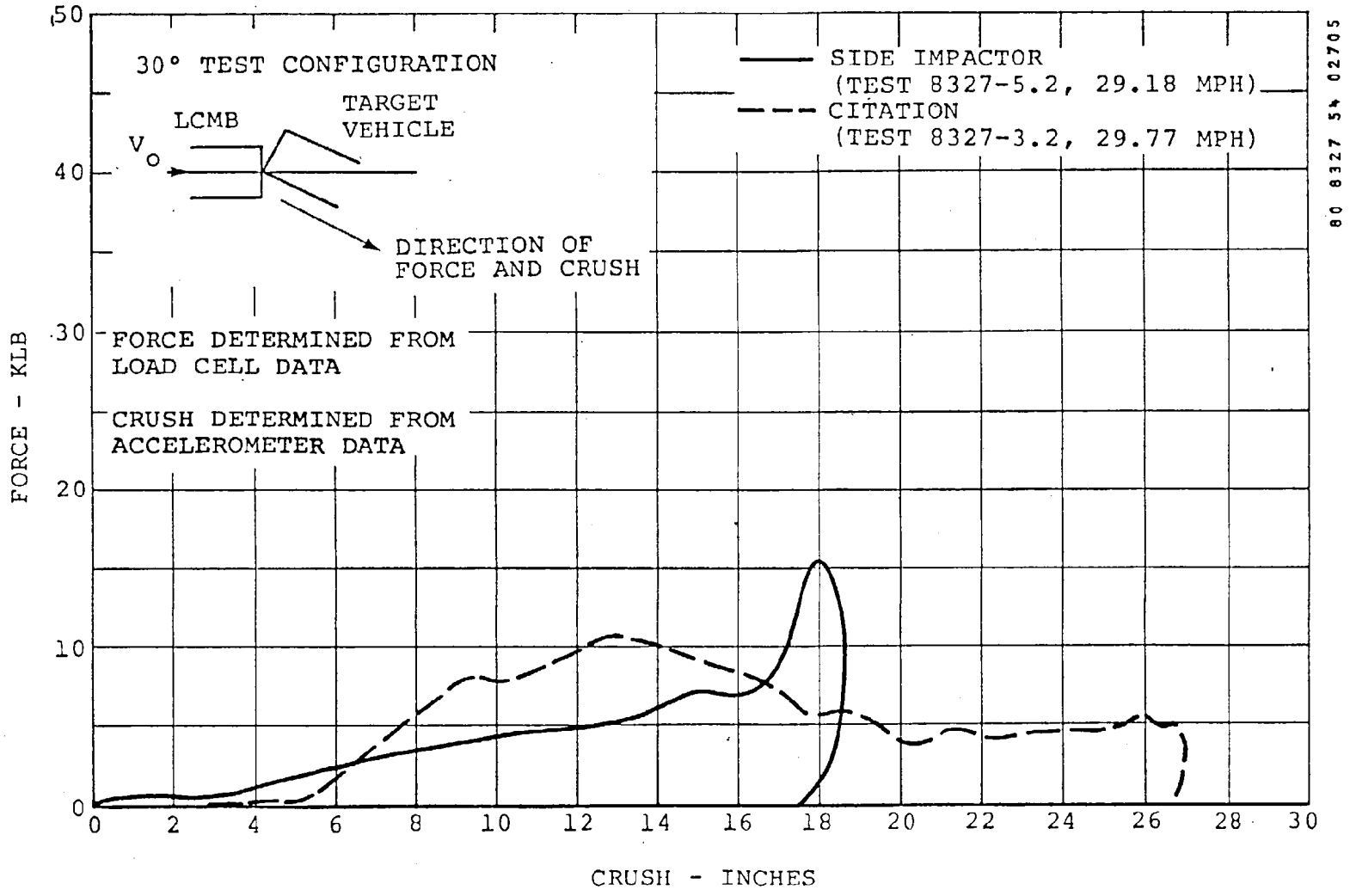


Figure 5-15. Comparison of Upper Region Force Versus Crush (Corrected to Static Edge Crush) in Direction of Target Vehicle (Tests 8327-5.2 and 8327-3.2).

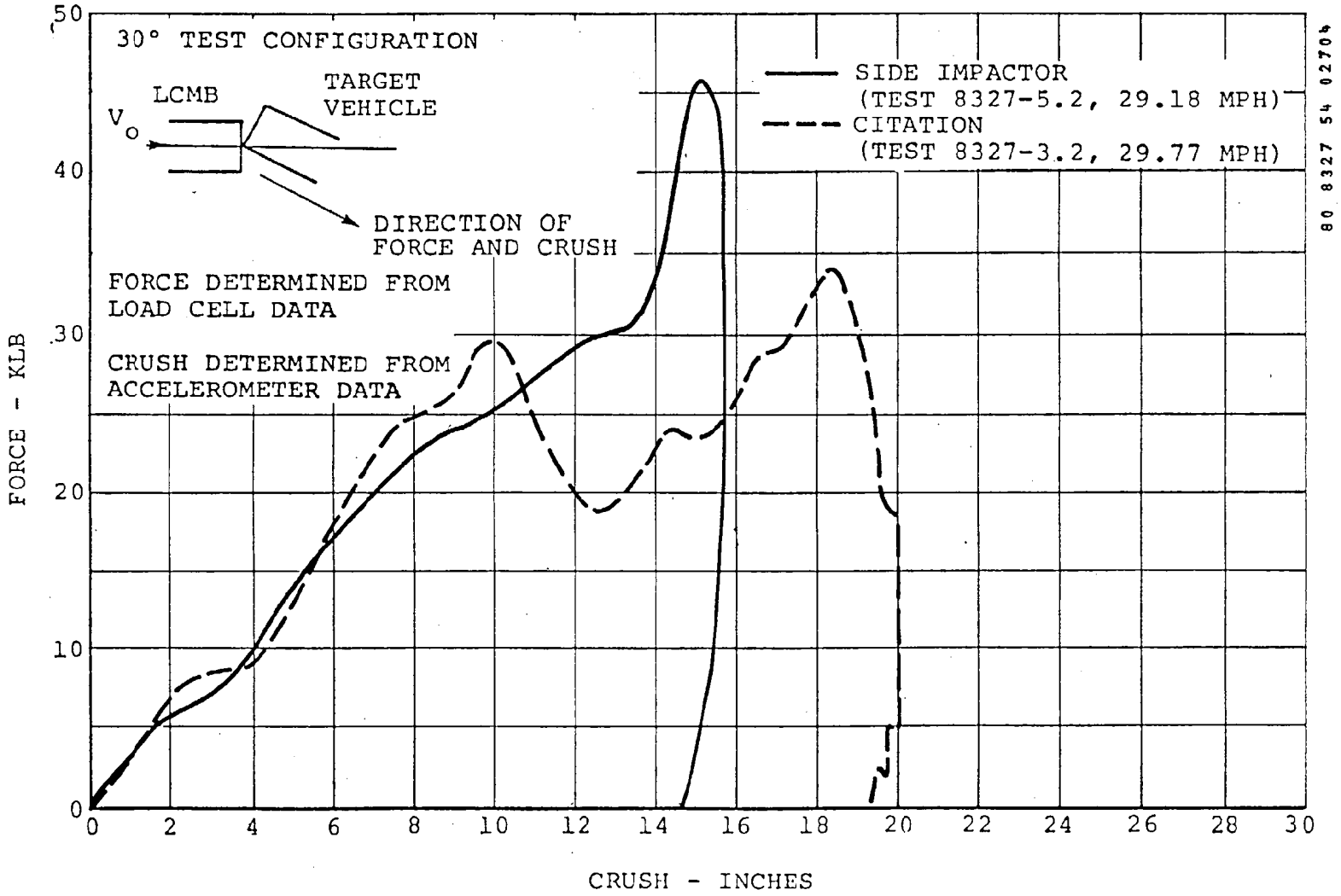


Figure 5-16. Comparison of Total Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Target Vehicle (Tests 8327-5.2 and 8327-3.2).

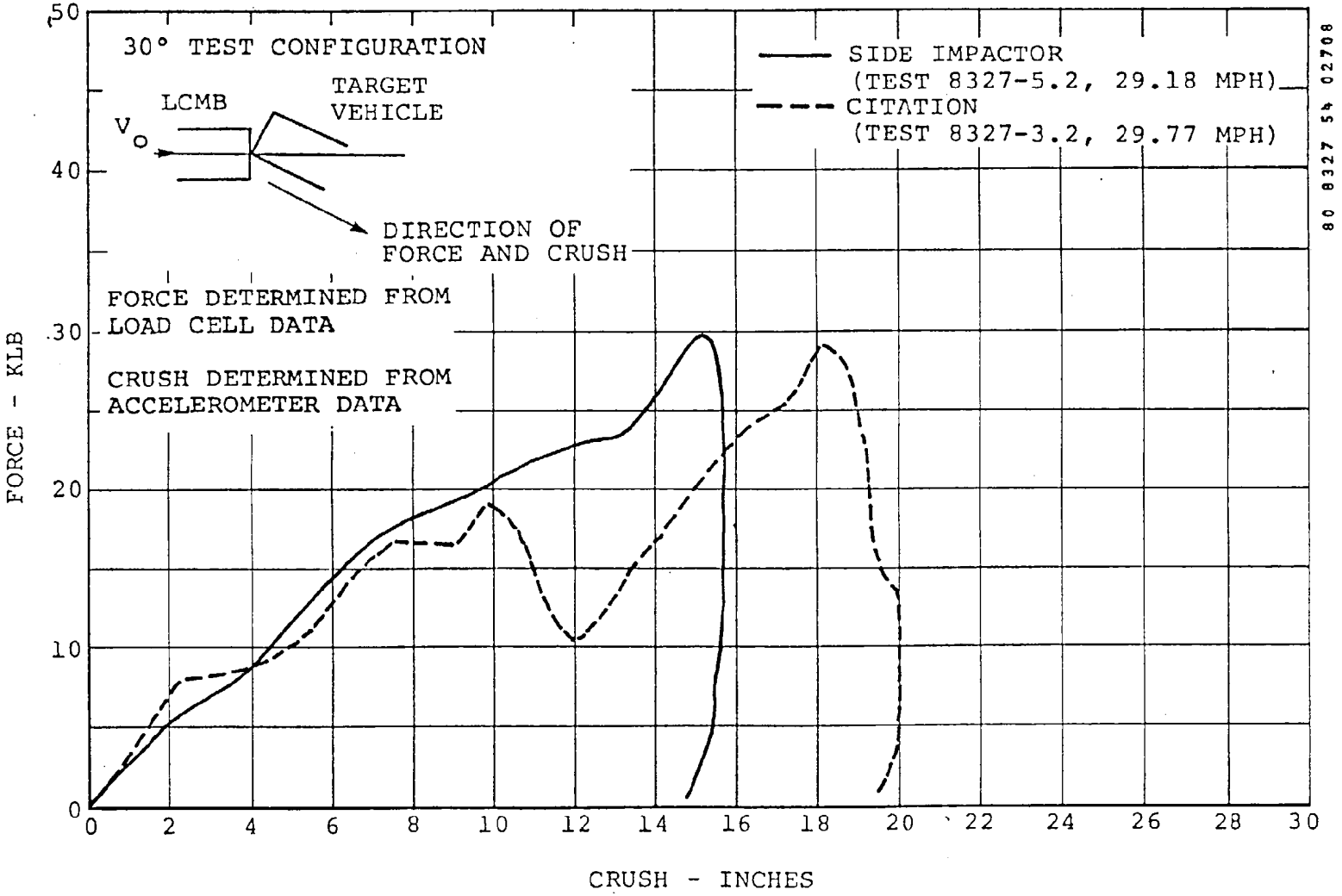


Figure 5-17. Comparison of Lower Region Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Target Vehicle (Tests 8327-5.2 and 8327-3.2).

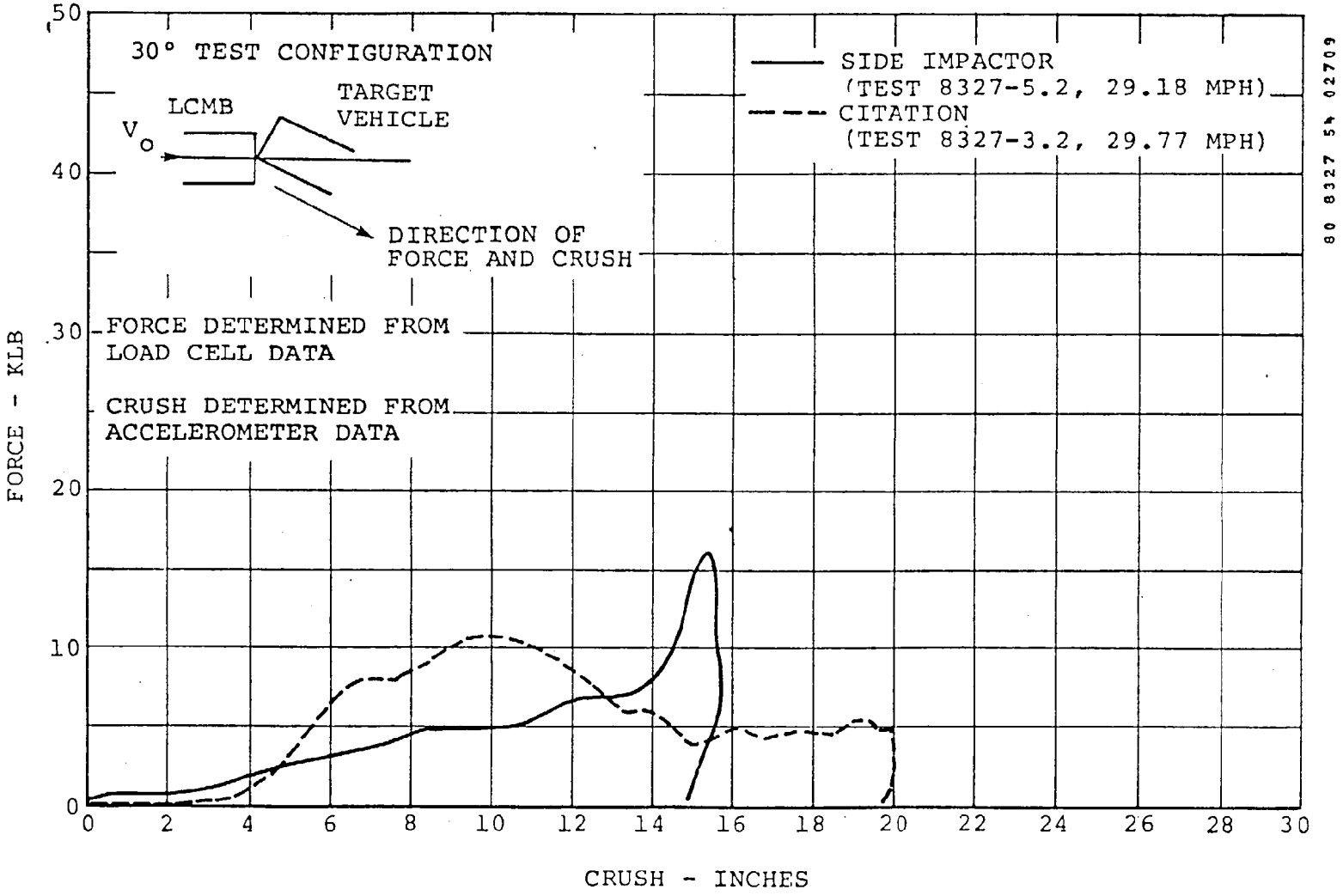


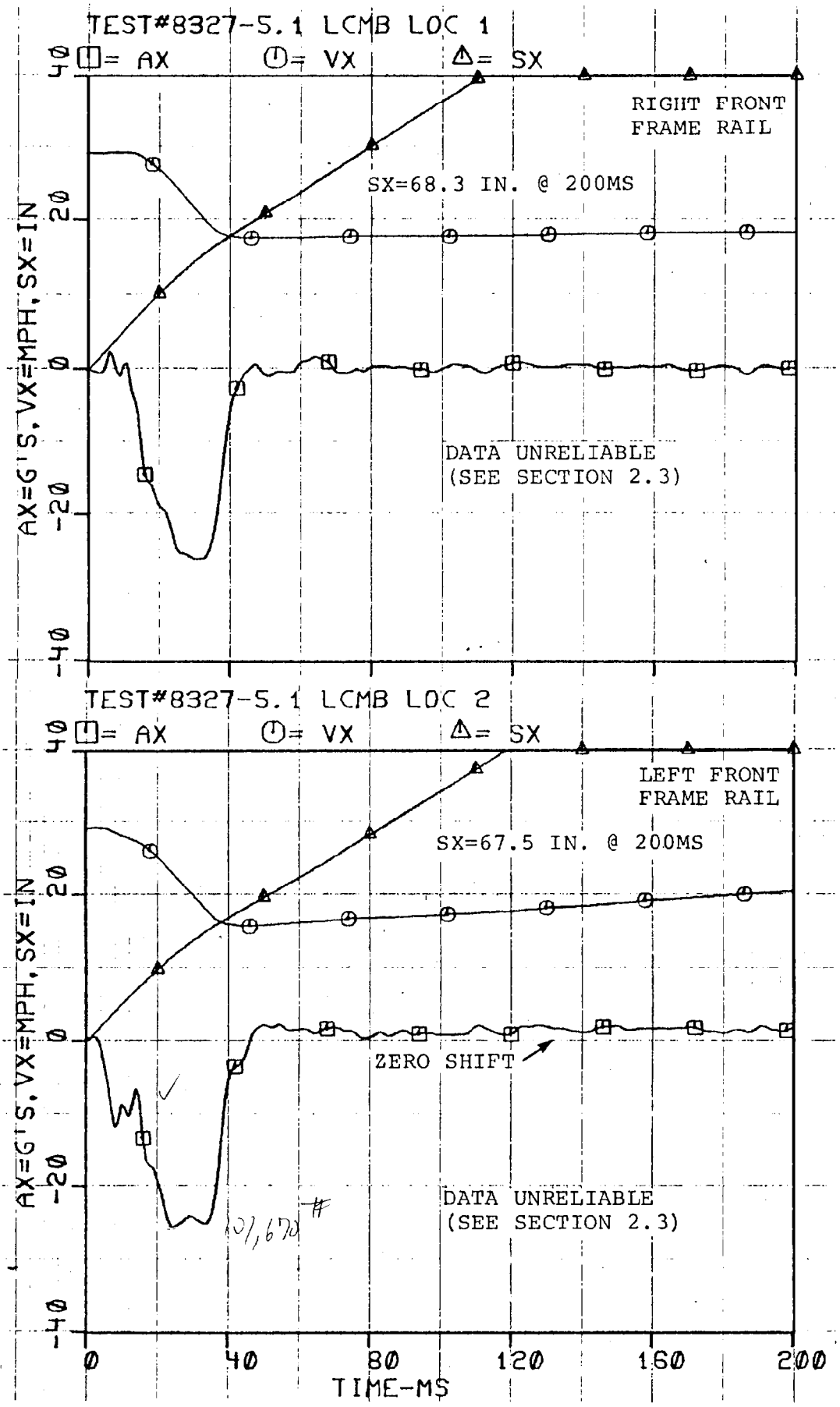
Figure 5-18. Comparison of Upper Region Force Versus Crush (Corrected to Longitudinal Displacement of Impact Point) in Direction of Target Vehicle (Tests 8327-5.2 and 8327-3.2).

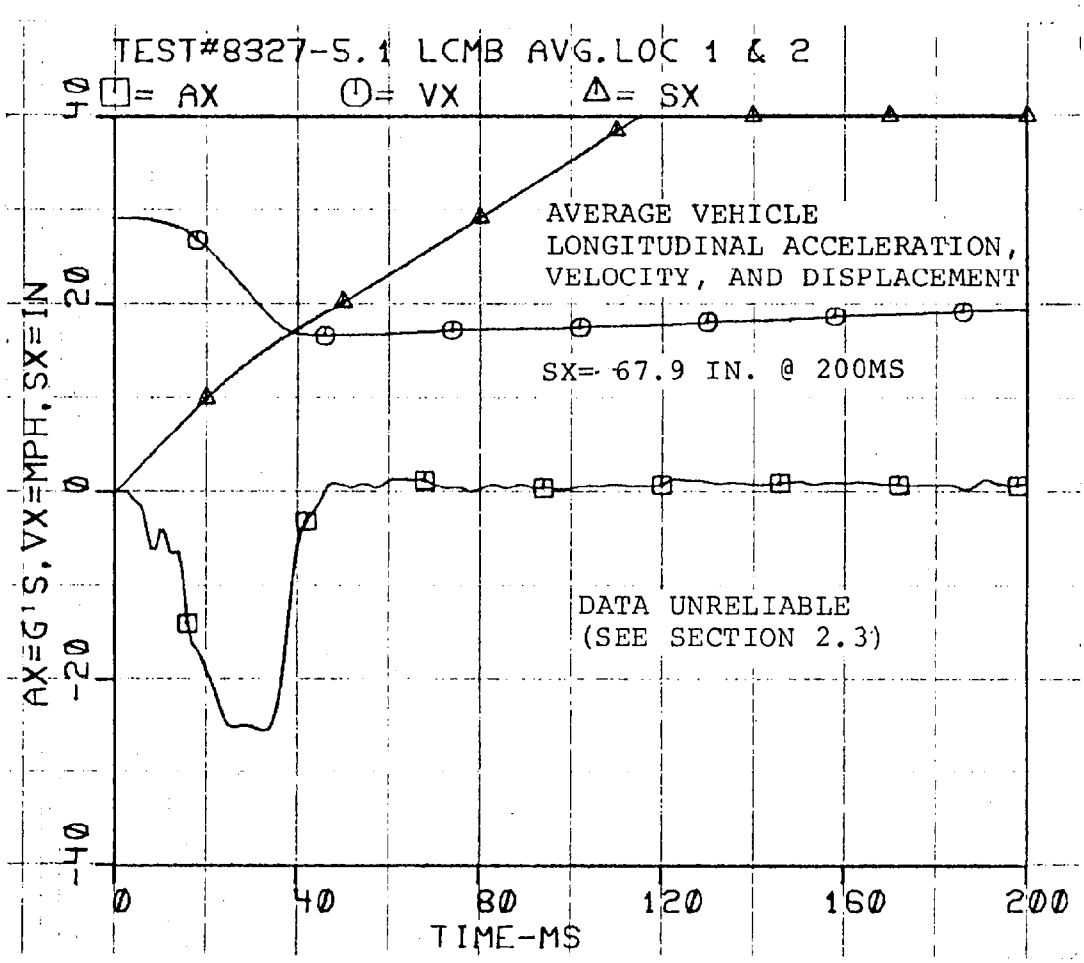
APPENDIX A

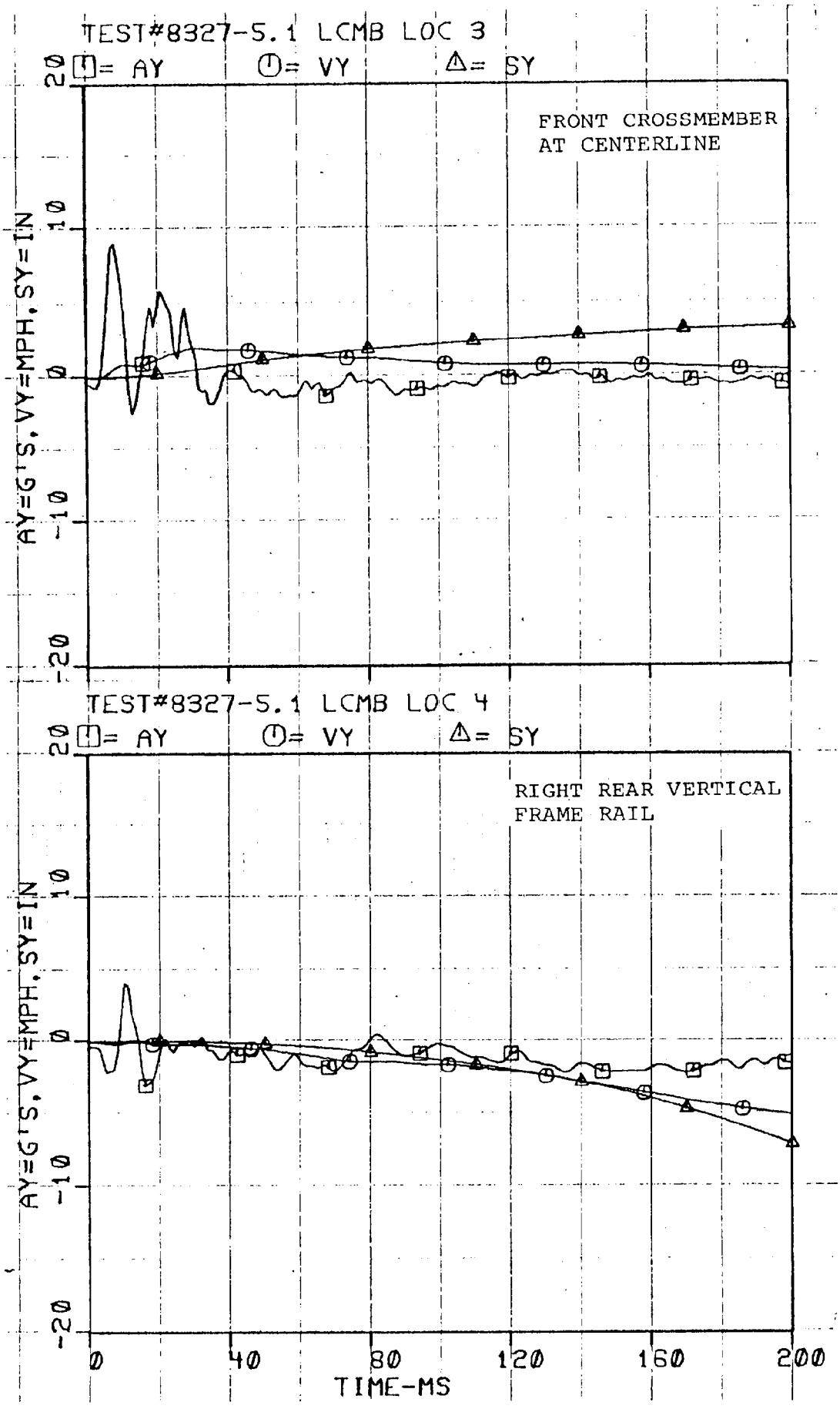
CALCOMP PLOTS FOR

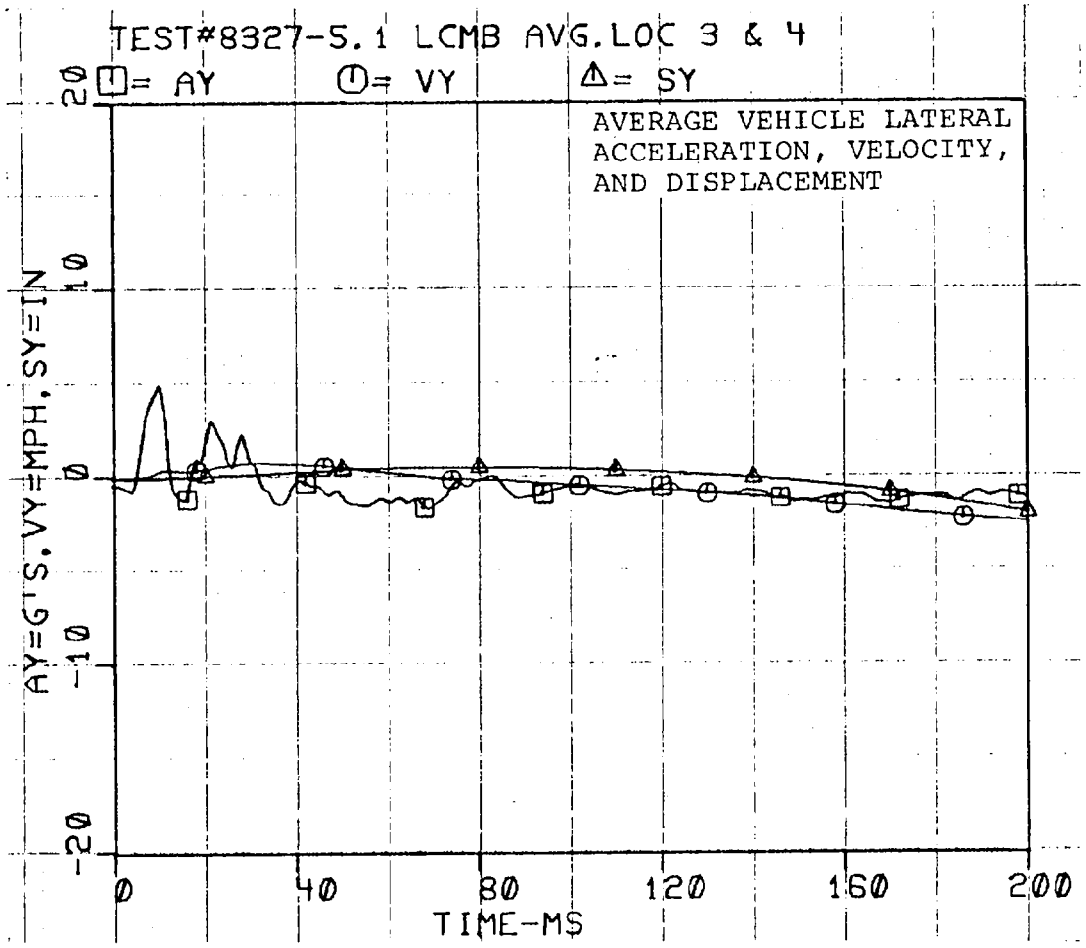
TEST 8327-5.1

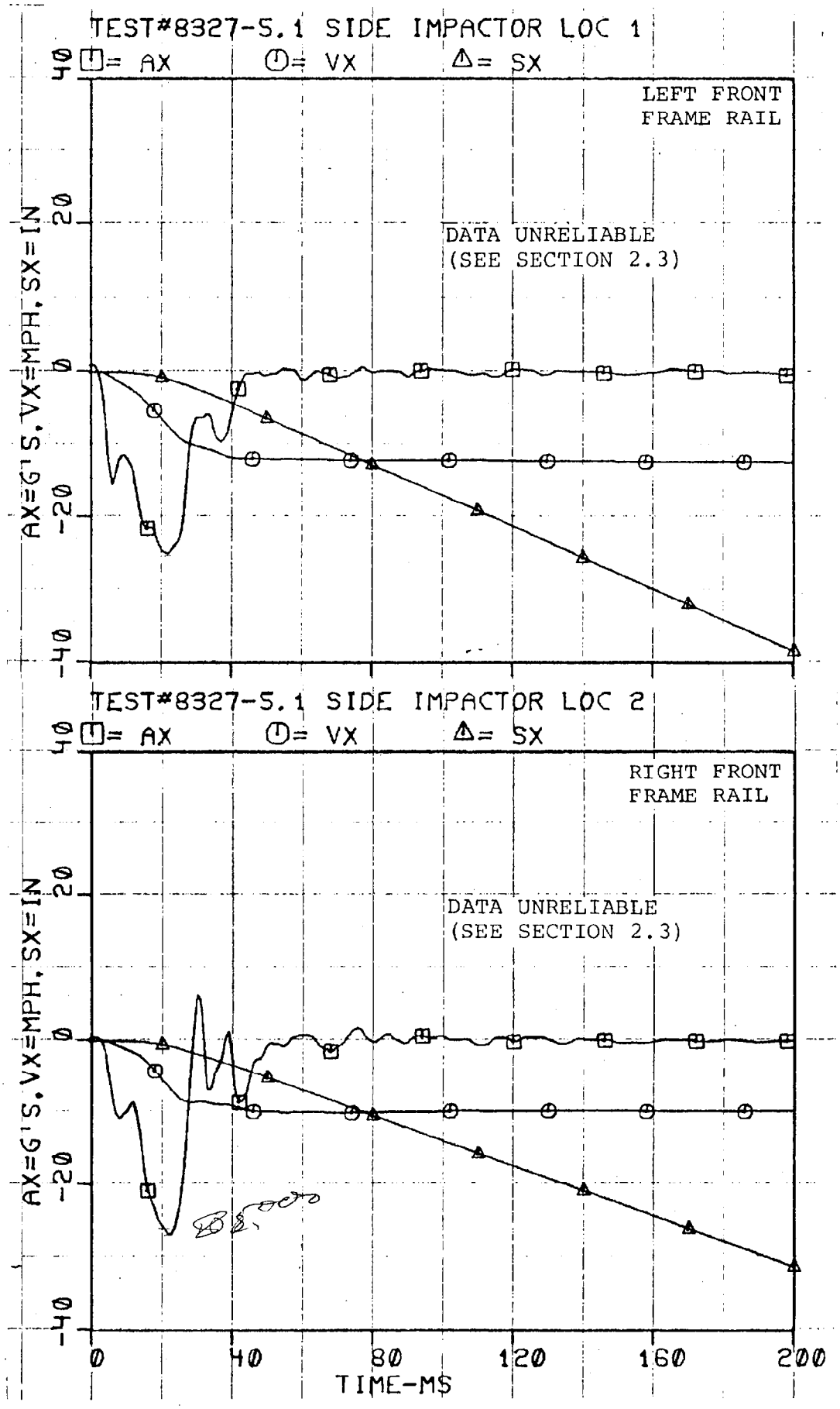
(STRUCTURAL DATA FILTER 315/100 HZ)

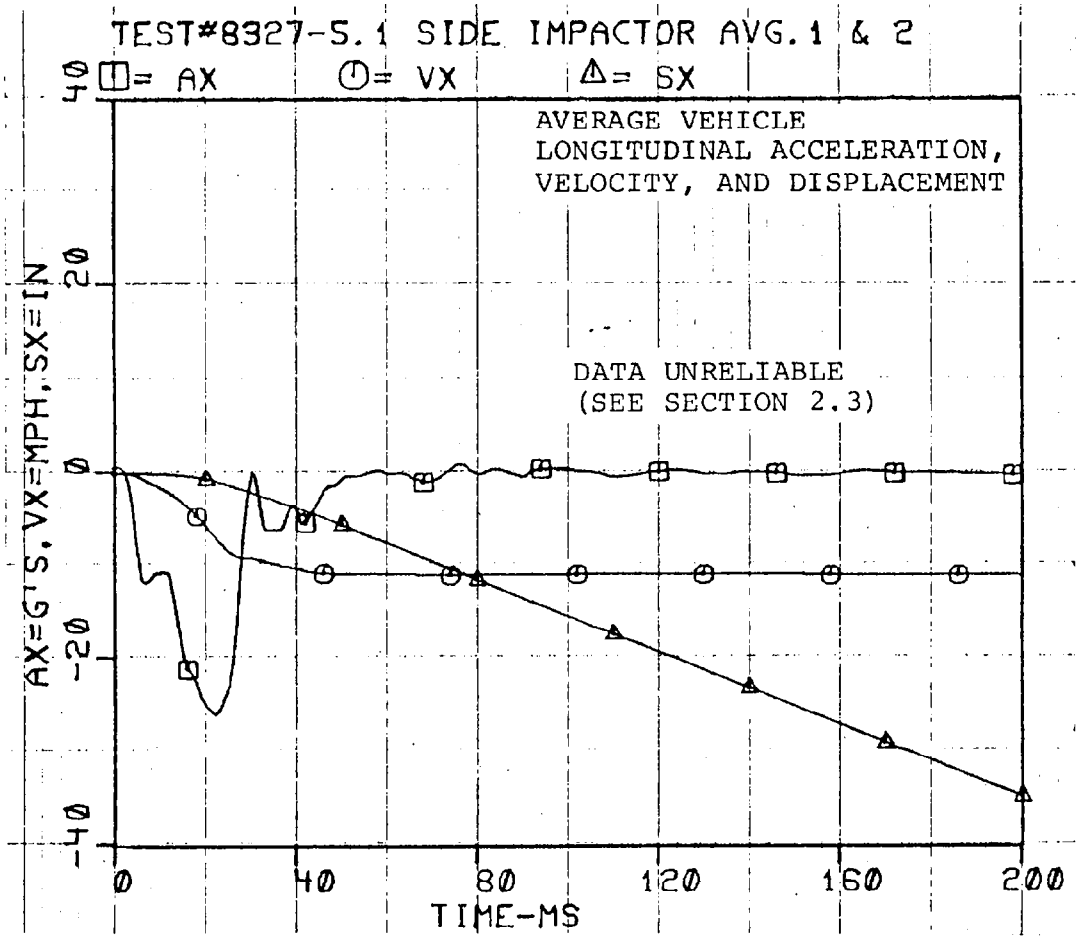

TEST#8327-5.1 LCMB LOC 1
□= AX
○= VX
△= SX
RIGHT FRONT FRAME RAIL
SX=68.3 IN. @ 200MS
DATA UNRELIABLE (SEE SECTION 2.3)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
TEST#8327-5.1 LCMB LOC 2
□= AX
○= VX
△= SX
LEFT FRONT FRAME RAIL
SX=67.5 IN. @ 200MS
ZERO SHIFT
DATA UNRELIABLE (SEE SECTION 2.3)
0
40
80
120
160
200
TIME-MS

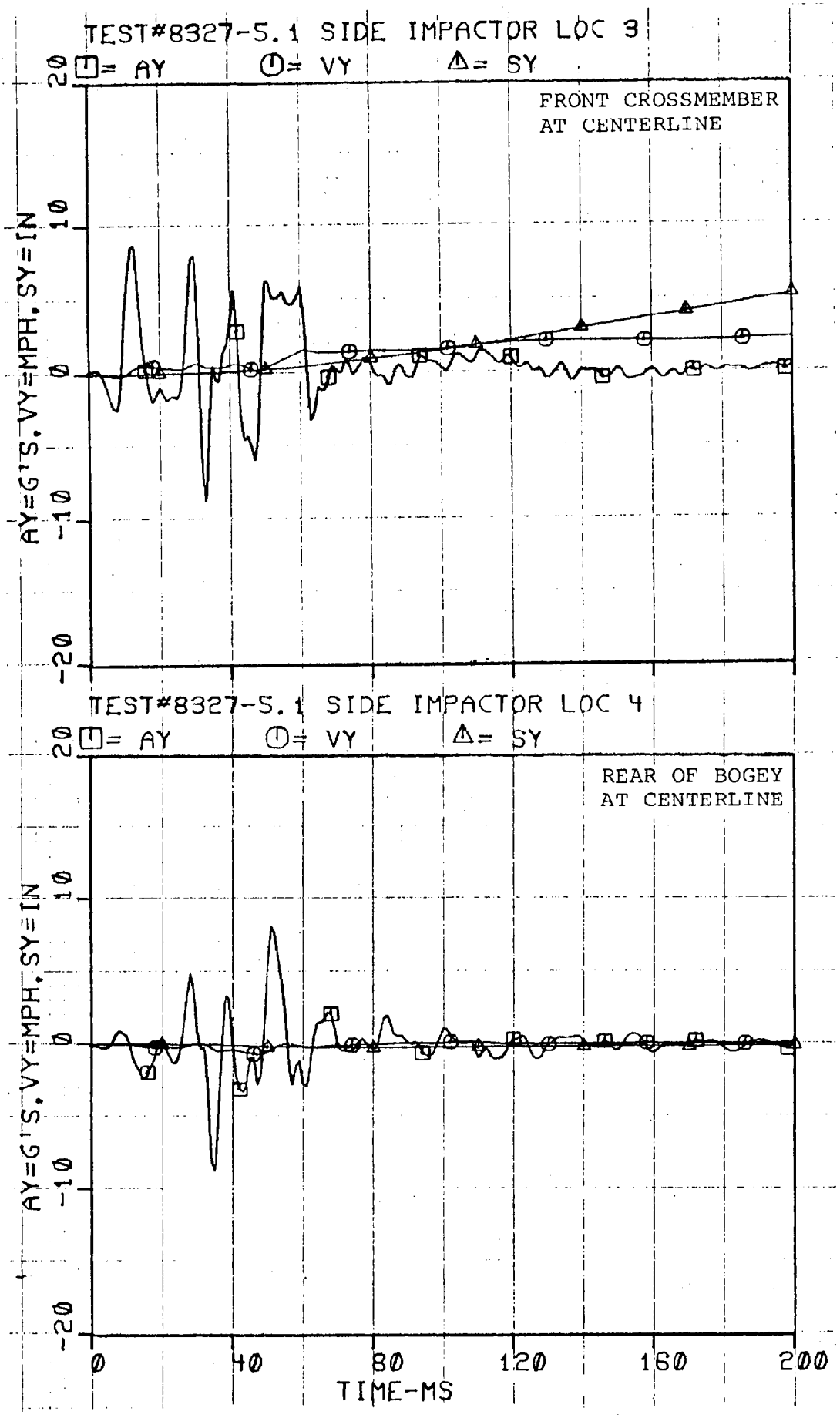

TEST#8327-5.1 LCMB AVG.LOC 1 & 2
□= AX
○= VX
△= SX
AVERAGE VEHICLE
LONGITUDINAL ACCELERATION,
VELOCITY, AND DISPLACEMENT
SX= 67.9 IN. @ 200MS
DATA UNRELIABLE
(SEE SECTION 2.3)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
0
40
80
120
160
200
TIME-MS

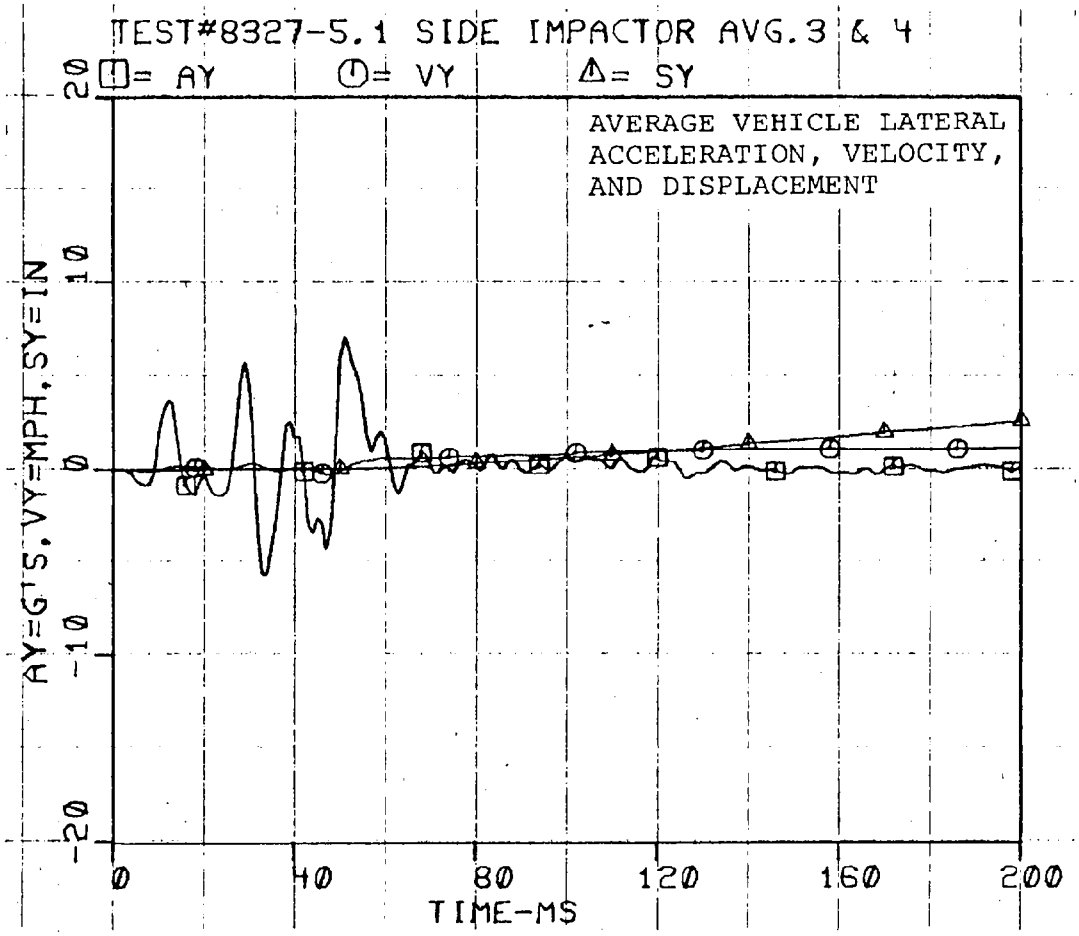

TEST#8327-5.1 LCMB LOC 3
□= AY
○= VY
△= SY
FRONT CROSSMEMBER
AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
TEST#8327-5.1 LCMB LOC 4
□= AY
○= VY
△= SY
RIGHT REAR VERTICAL
FRAME RAIL
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-MS

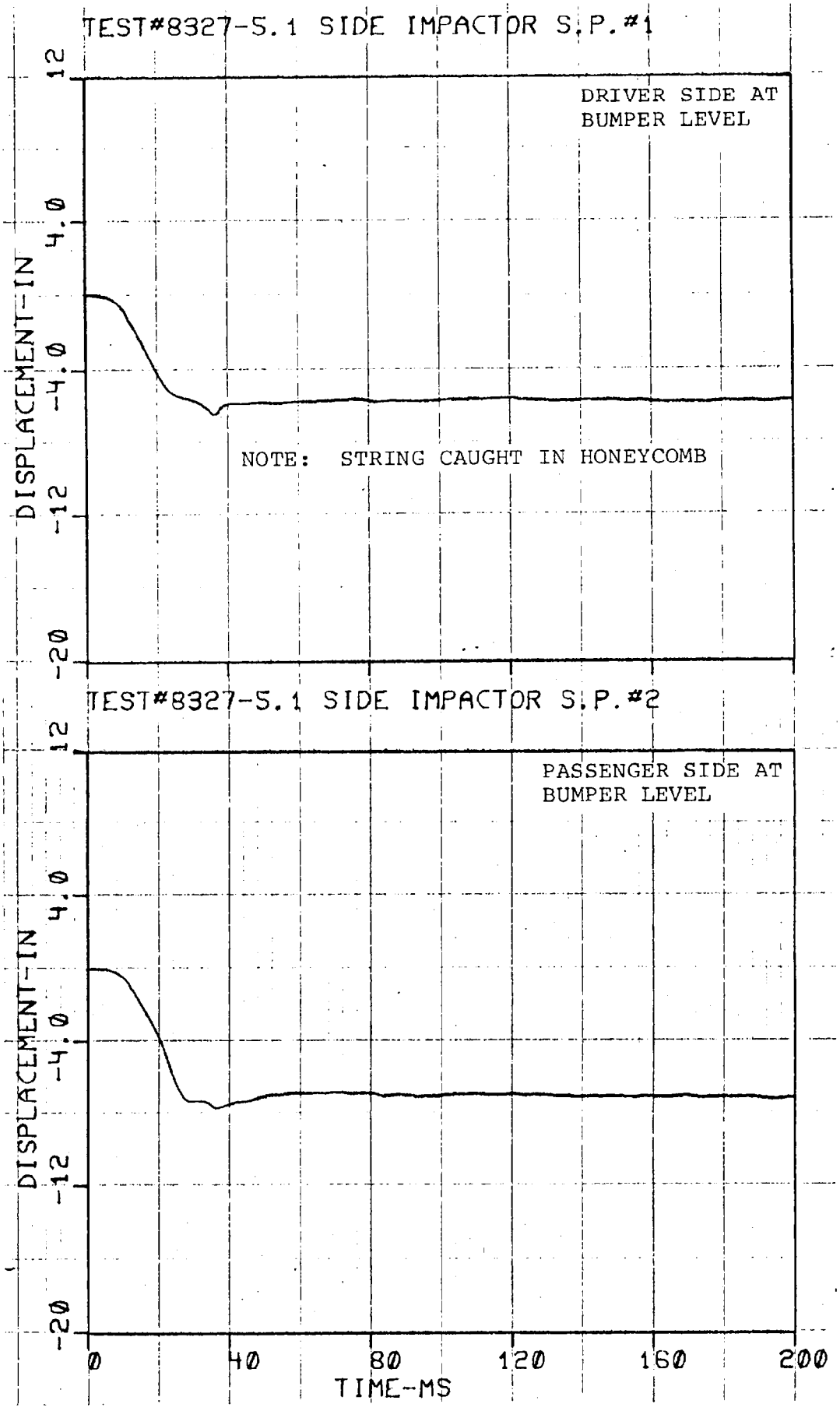

TEST#8327-5.1 LCMB AVG.LOC 3 & 4
□= AY
○= VY
△= SY
AVERAGE VEHICLE LATERAL ACCELERATION, VELOCITY, AND DISPLACEMENT
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-MS

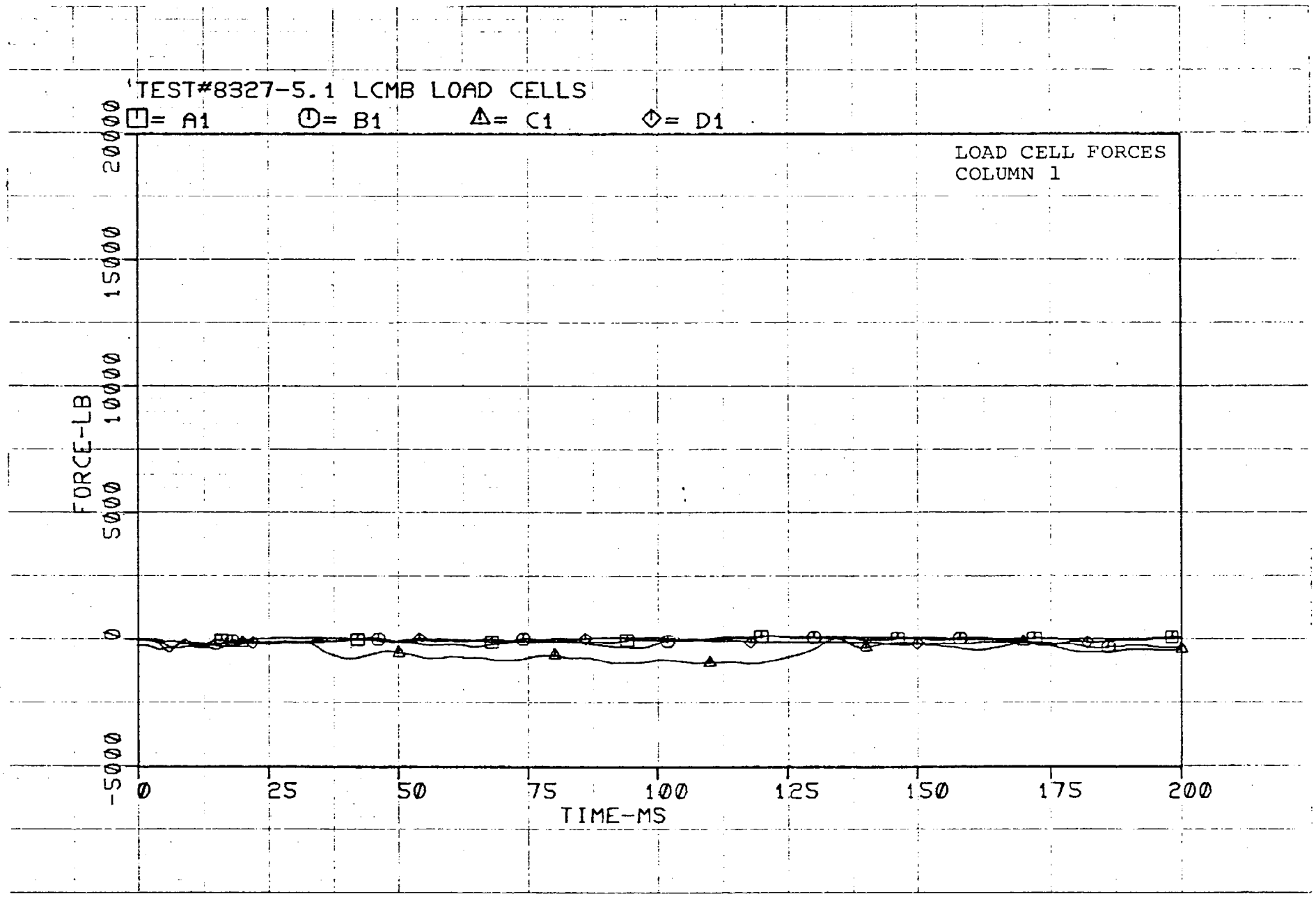

TEST#8327-5.1 SIDE IMPACTOR LOC 1
□= AX
○= VX
△= SX
LEFT FRONT
FRAME RAIL
DATA UNRELIABLE
(SEE SECTION 2.3)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
TEST#8327-5.1 SIDE IMPACTOR LOC 2
□= AX
○= VX
△= SX
RIGHT FRONT
FRAME RAIL
DATA UNRELIABLE
(SEE SECTION 2.3)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
0
40
80
120
160
200
TIME-MS

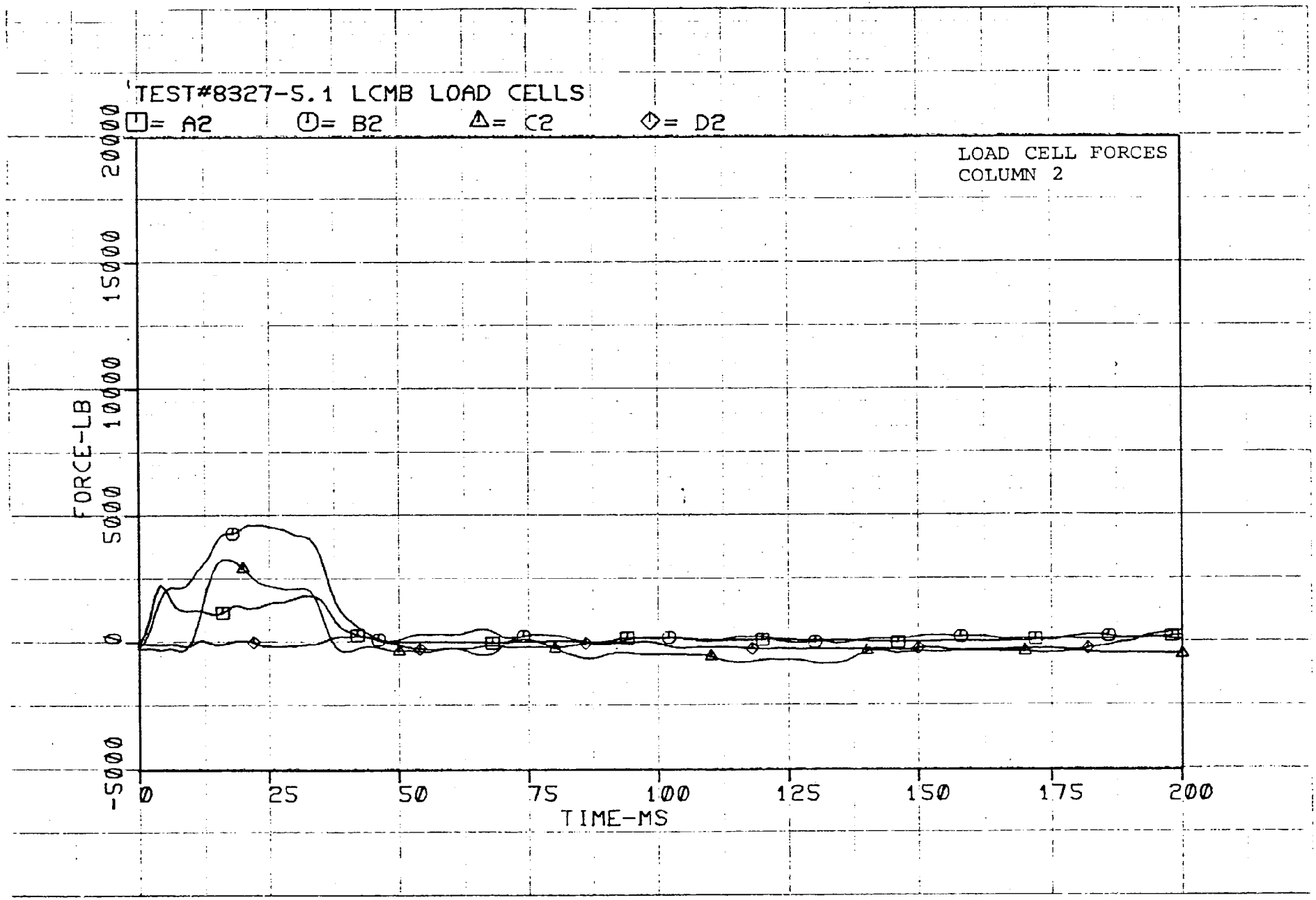

TEST#8327-5.1 SIDE IMPACTOR AVG.1 & 2
□= AX
⊙= VX
△= SX
AVERAGE VEHICLE
LONGITUDINAL ACCELERATION,
VELOCITY, AND DISPLACEMENT
DATA UNRELIABLE
(SEE SECTION 2.3)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
0
40
80
120
160
200
TIME-MS

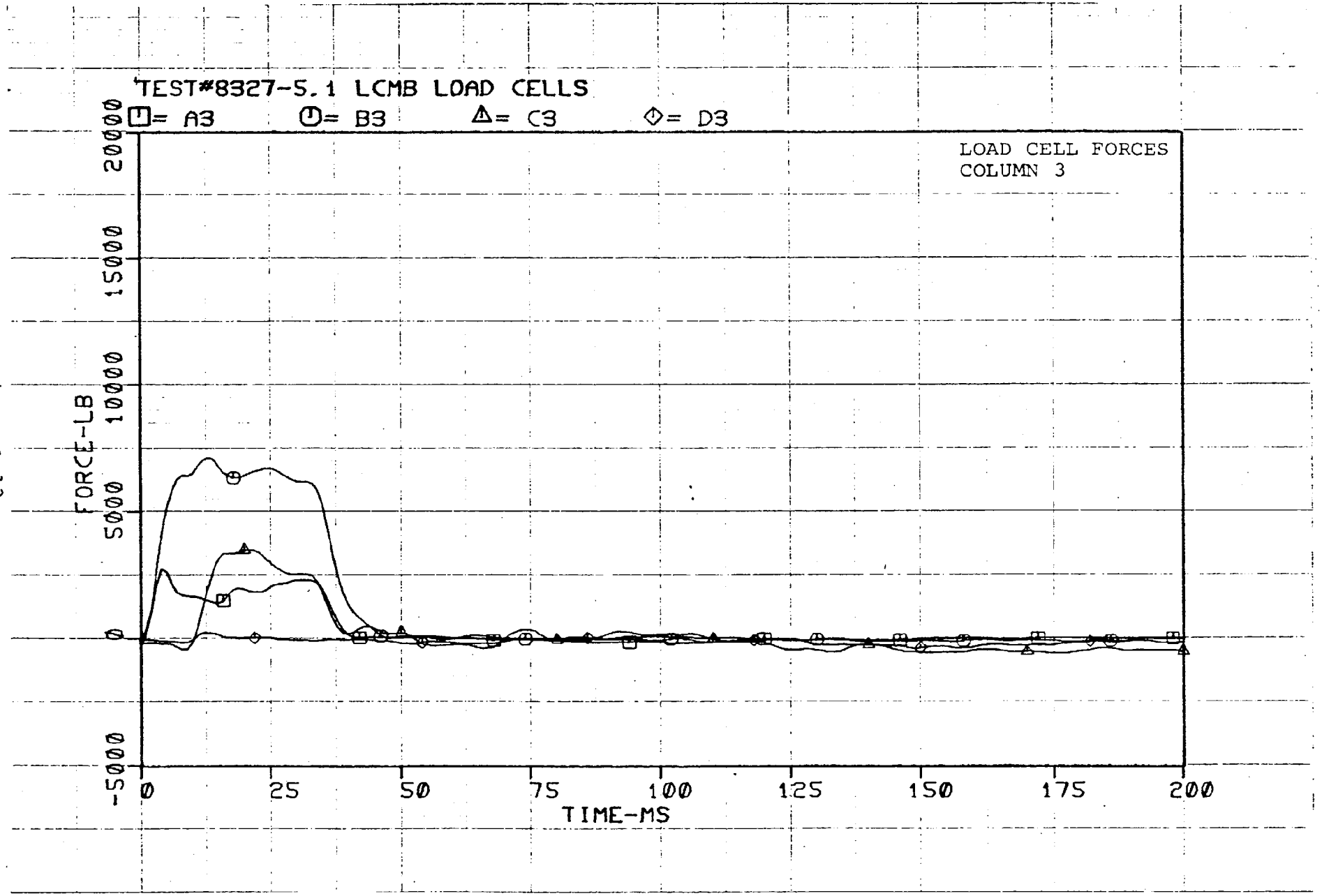

TEST#8327-5.1 SIDE IMPACTOR LOC 3
□= AY
○= VY
△= SY
FRONT CROSSMEMBER
AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
TEST#8327-5.1 SIDE IMPACTOR LOC 4
□= AY
○= VY
△= SY
REAR OF BOGEY
AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-MS

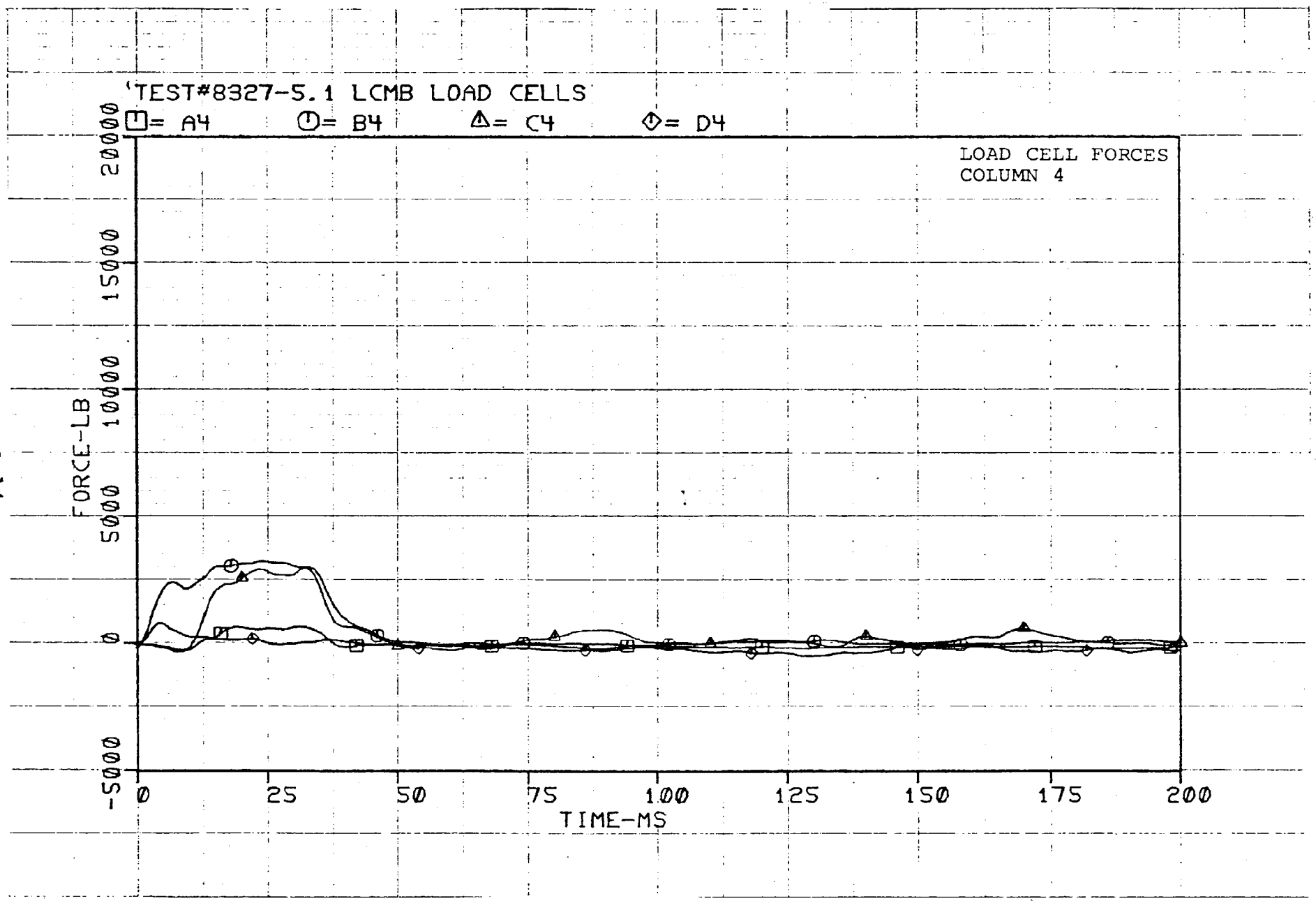

TEST#8327-5.1 SIDE IMPACTOR AVG.3 & 4
□= AY
○= VY
△= SY
AVERAGE VEHICLE LATERAL ACCELERATION, VELOCITY, AND DISPLACEMENT
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-MS

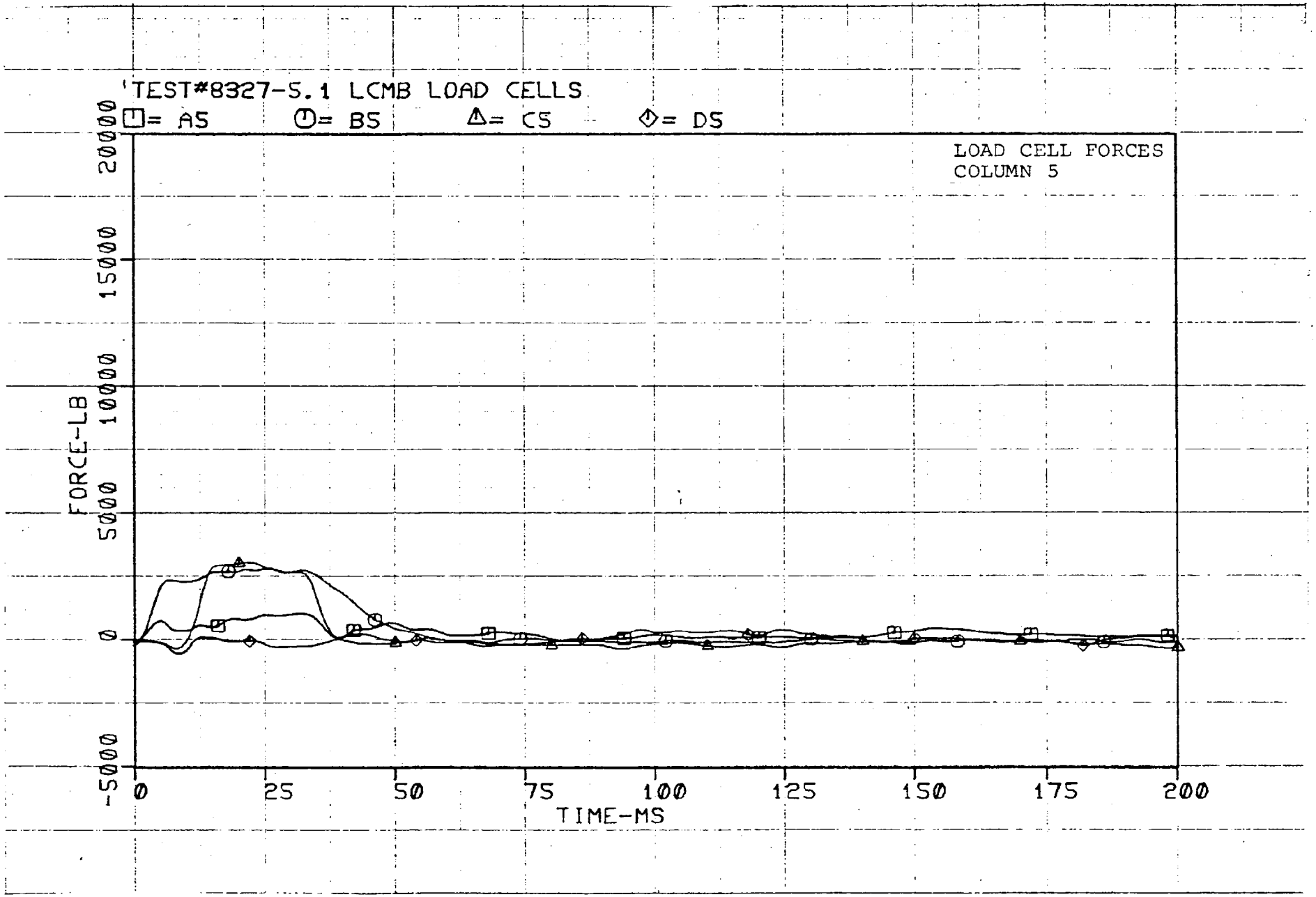

TEST#8327-5.1 SIDE IMPACTOR S.P.#1
DRIVER SIDE AT BUMPER LEVEL
NOTE: STRING CAUGHT IN HONEYCOMB
DISPLACEMENT-IN
12
4.0
-4.0
-12
-20
TEST#8327-5.1 SIDE IMPACTOR S.P.#2
PASSENGER SIDE AT BUMPER LEVEL
DISPLACEMENT-IN
12
4.0
-4.0
-12
-20
0
40
80
120
160
200
TIME-MS

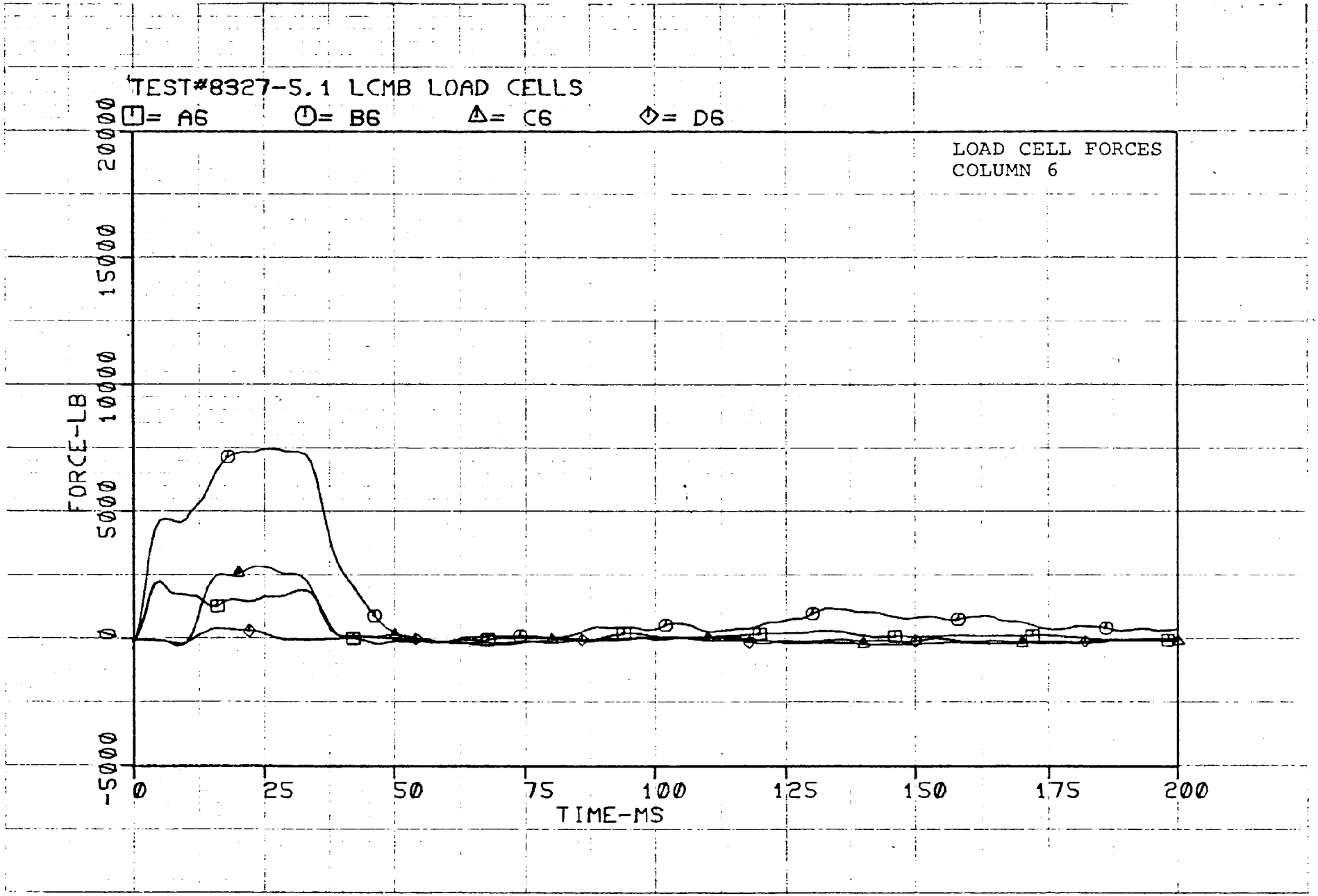

TEST#8327-5.1 LCMB LOAD CELLS
= A1
= B1
= C1
= D1
LOAD CELL FORCES
COLUMN 1
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

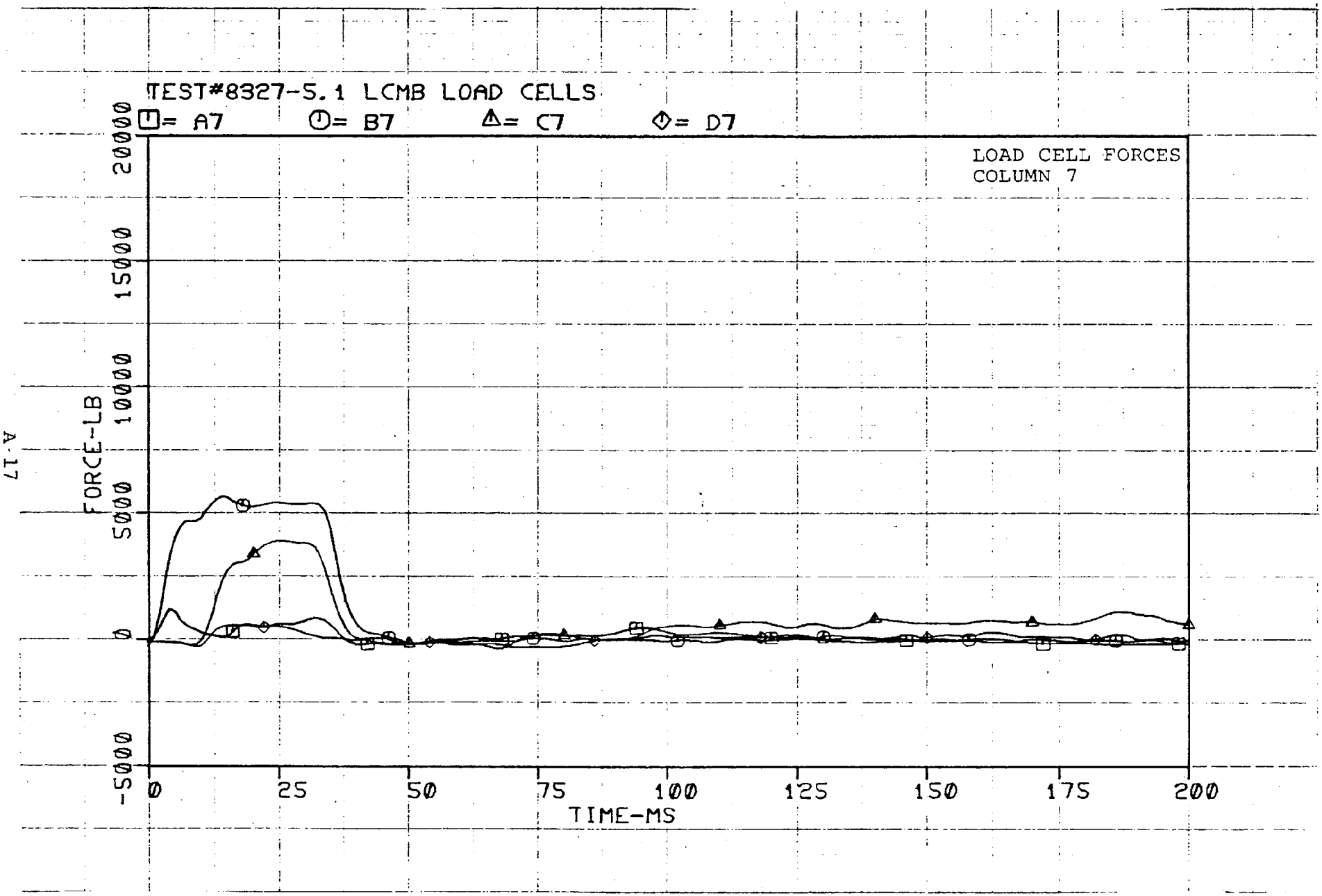

TEST#8327-5.1 LCMB LOAD CELLS
= A2
= B2
= C2
= D2
LOAD CELL FORCES
COLUMN 2
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

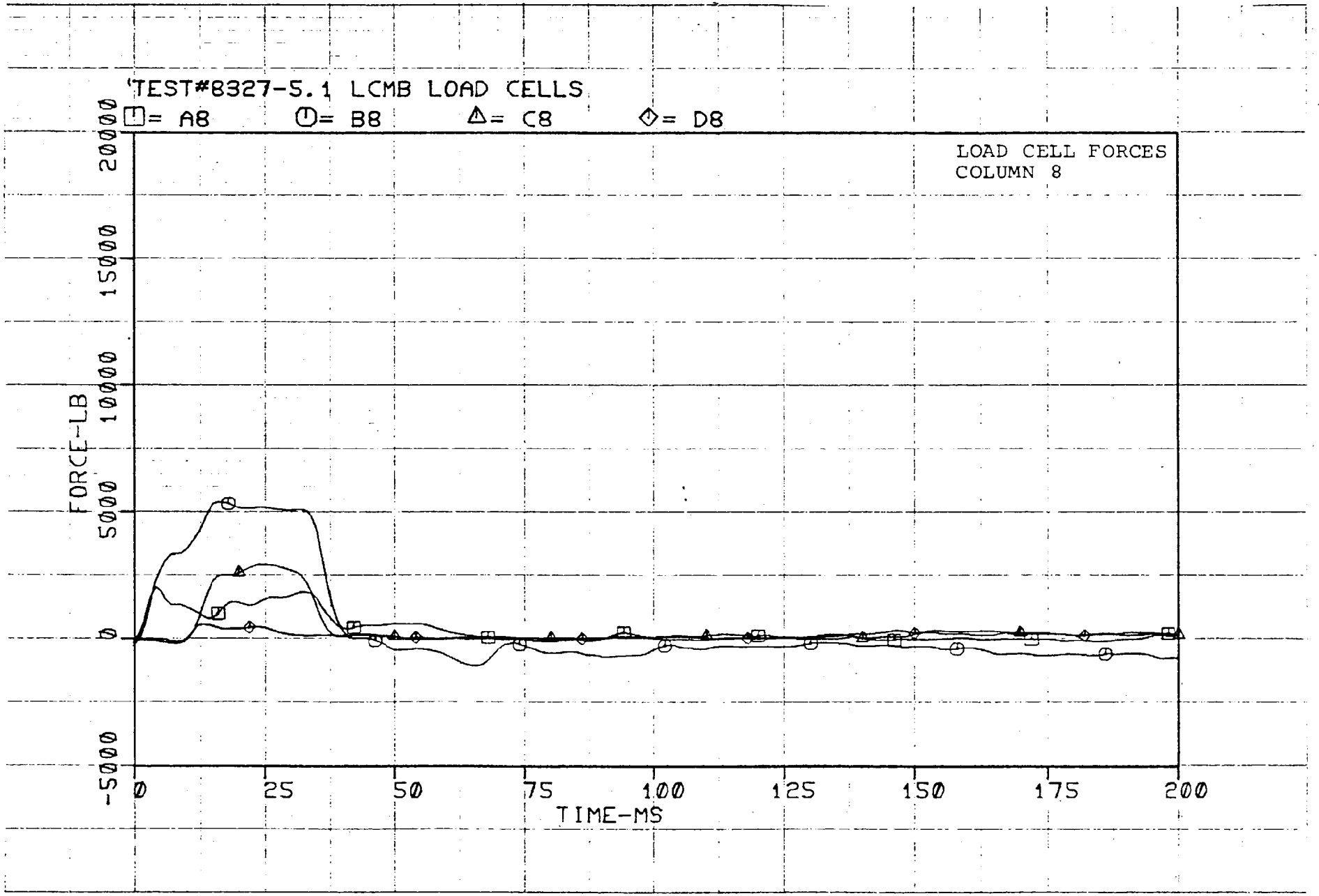

TEST#8327-5.1 LCMB LOAD CELLS
= A3
= B3
= C3
= D3
LOAD CELL FORCES
COLUMN 3
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

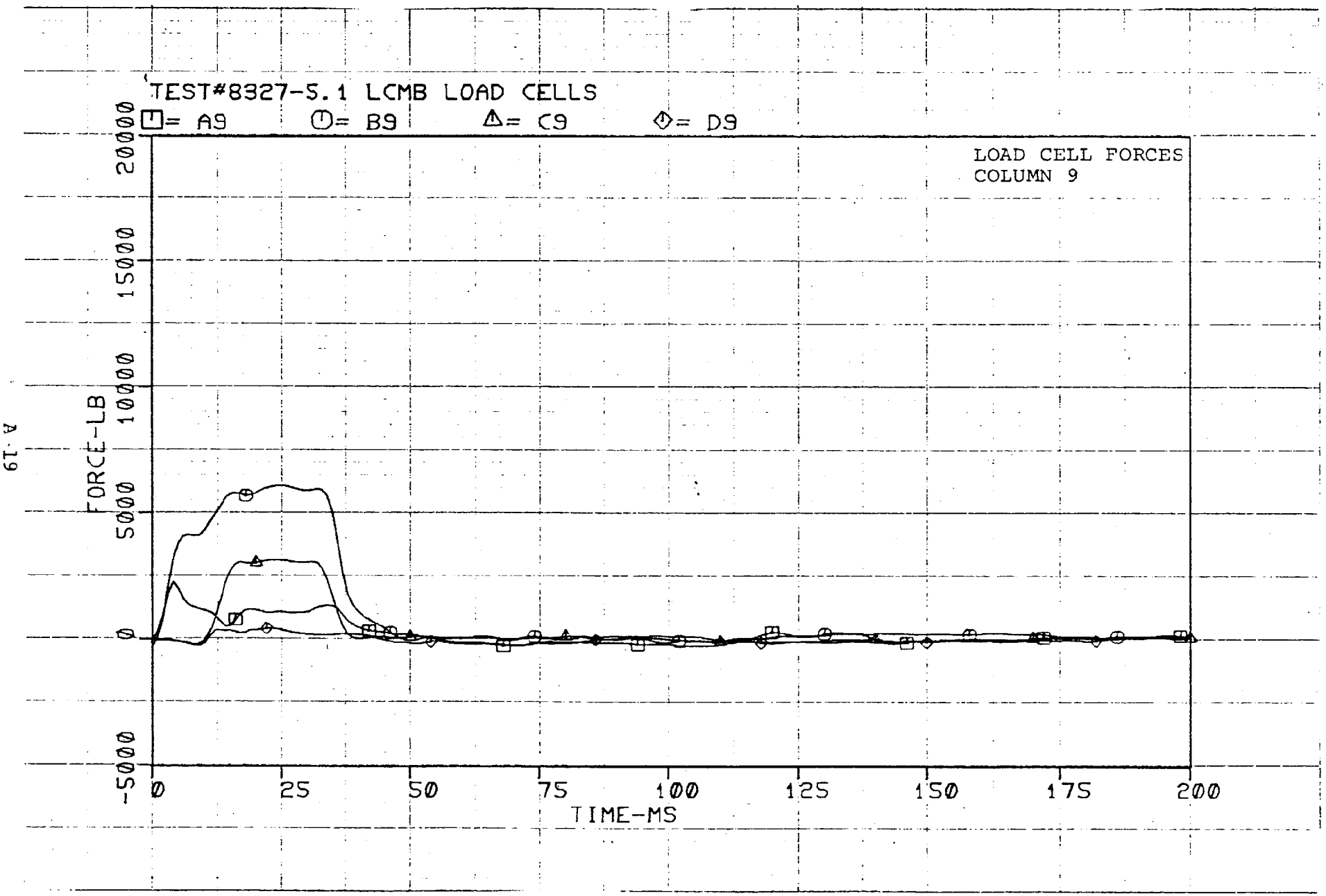

TEST#8327-5.1 LCMB LOAD CELLS
□= A4
○= B4
△= C4
◇= D4
LOAD CELL FORCES
COLUMN 4
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

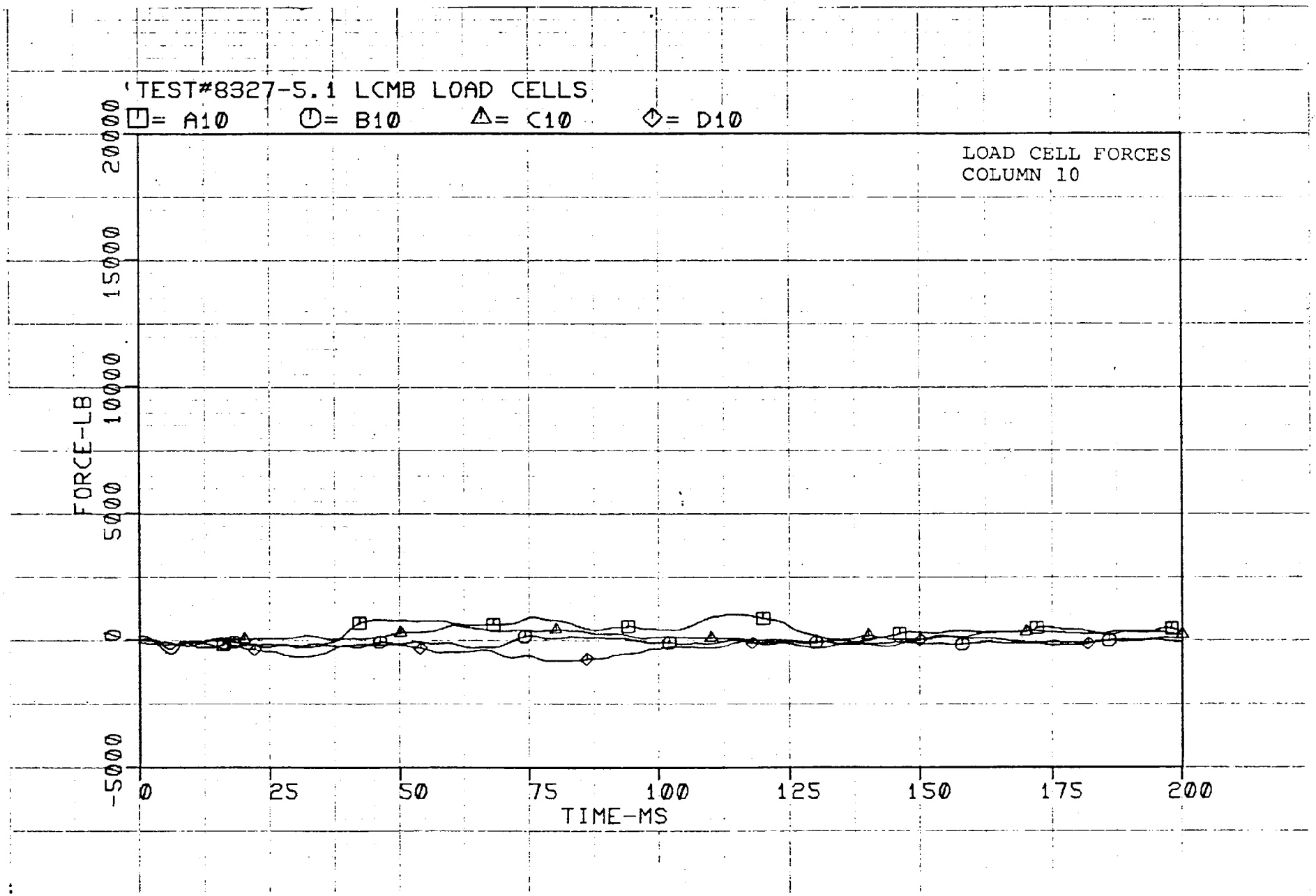

TEST#8327-5.1 LCMB LOAD CELLS
□= A5
○= B5
△= C5
◇= D5
LOAD CELL FORCES
COLUMN 5
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

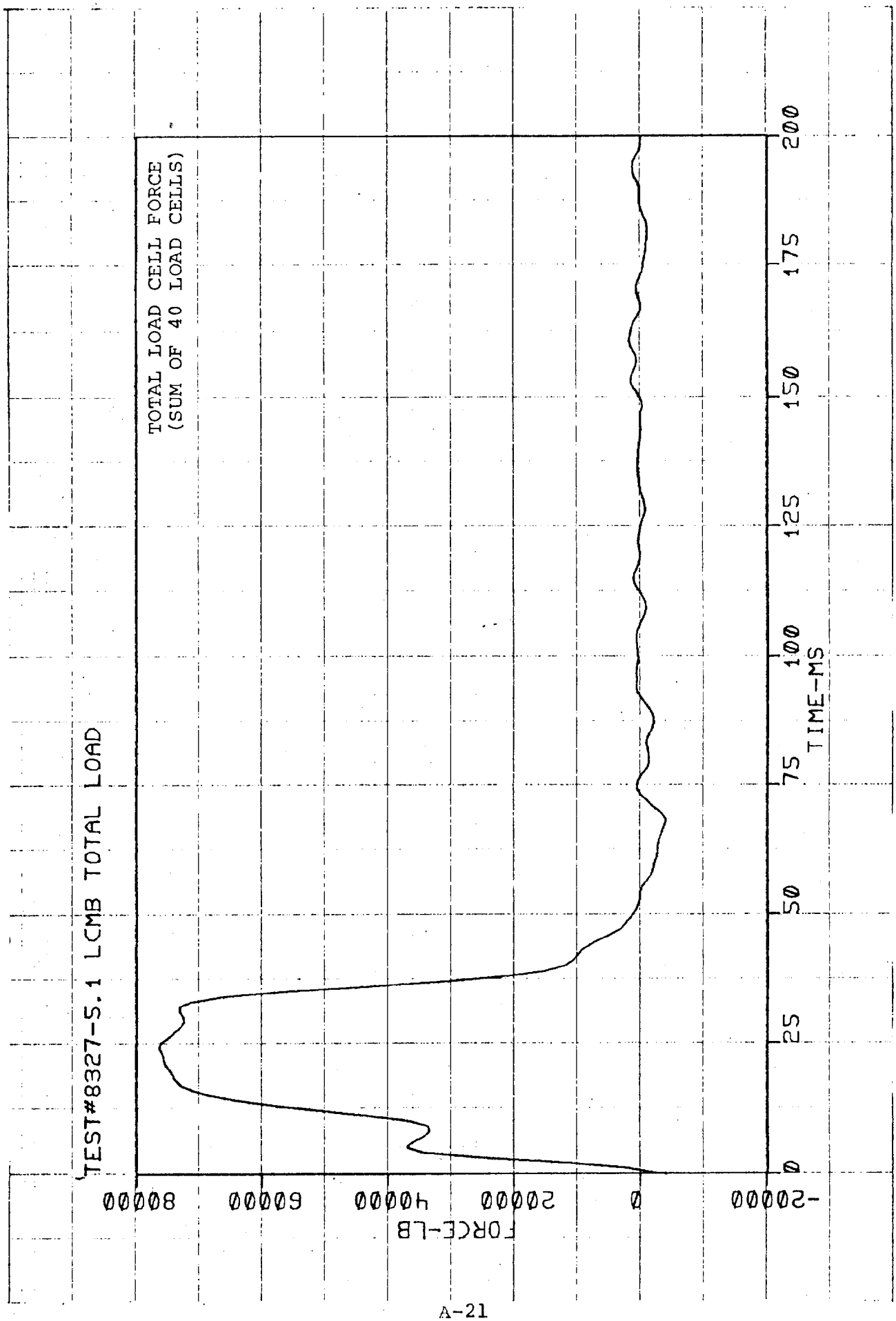

TEST#8327-5.1 LCMB LOAD CELLS
□= A6
○= B6
△= C6
◇= D6
LOAD CELL FORCES
COLUMN 6
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

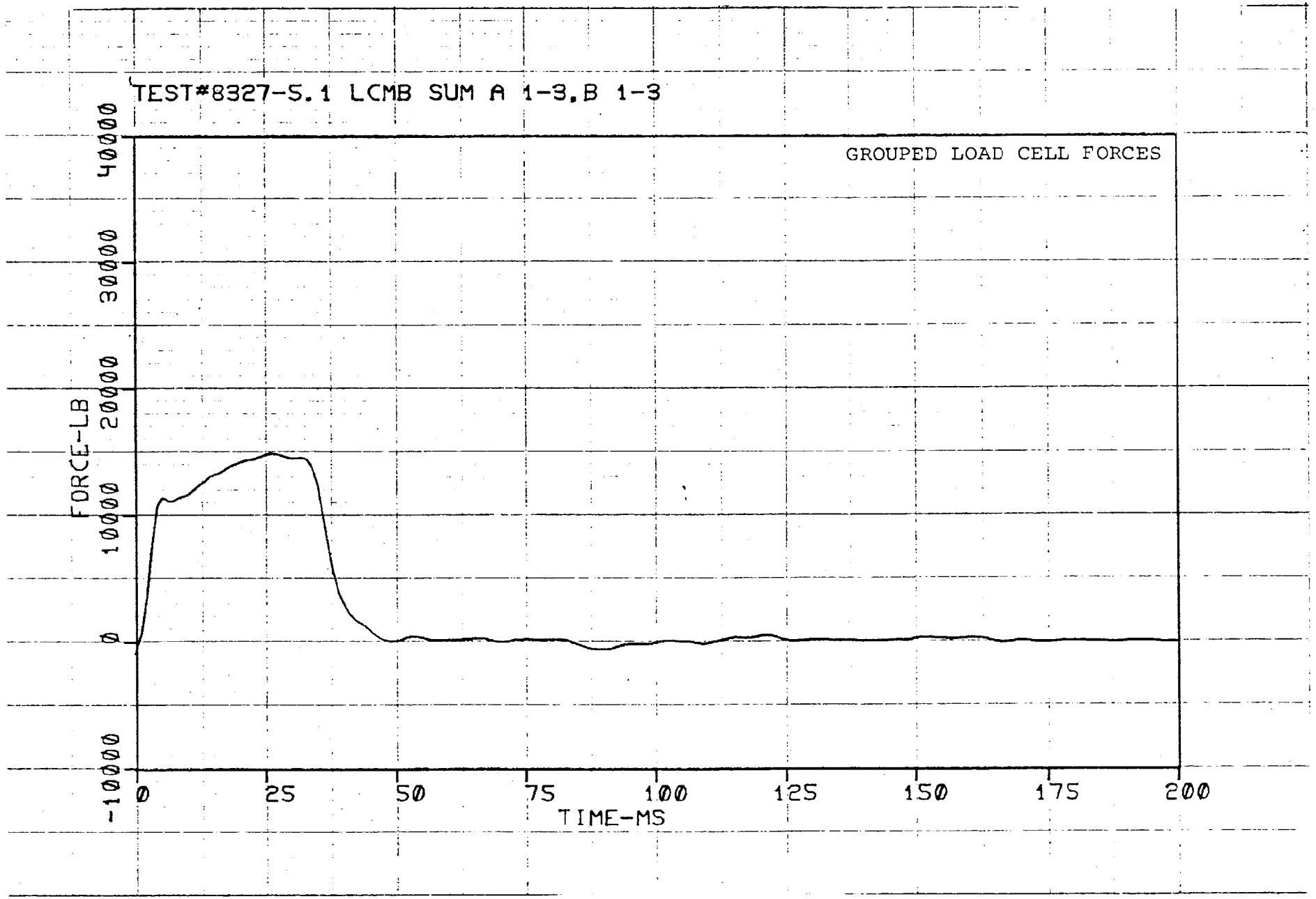

TEST#8327-5.1 LCMB LOAD CELLS
□= A7 ○= B7 △= C7 ◇= D7
LOAD CELL FORCES
COLUMN 7
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

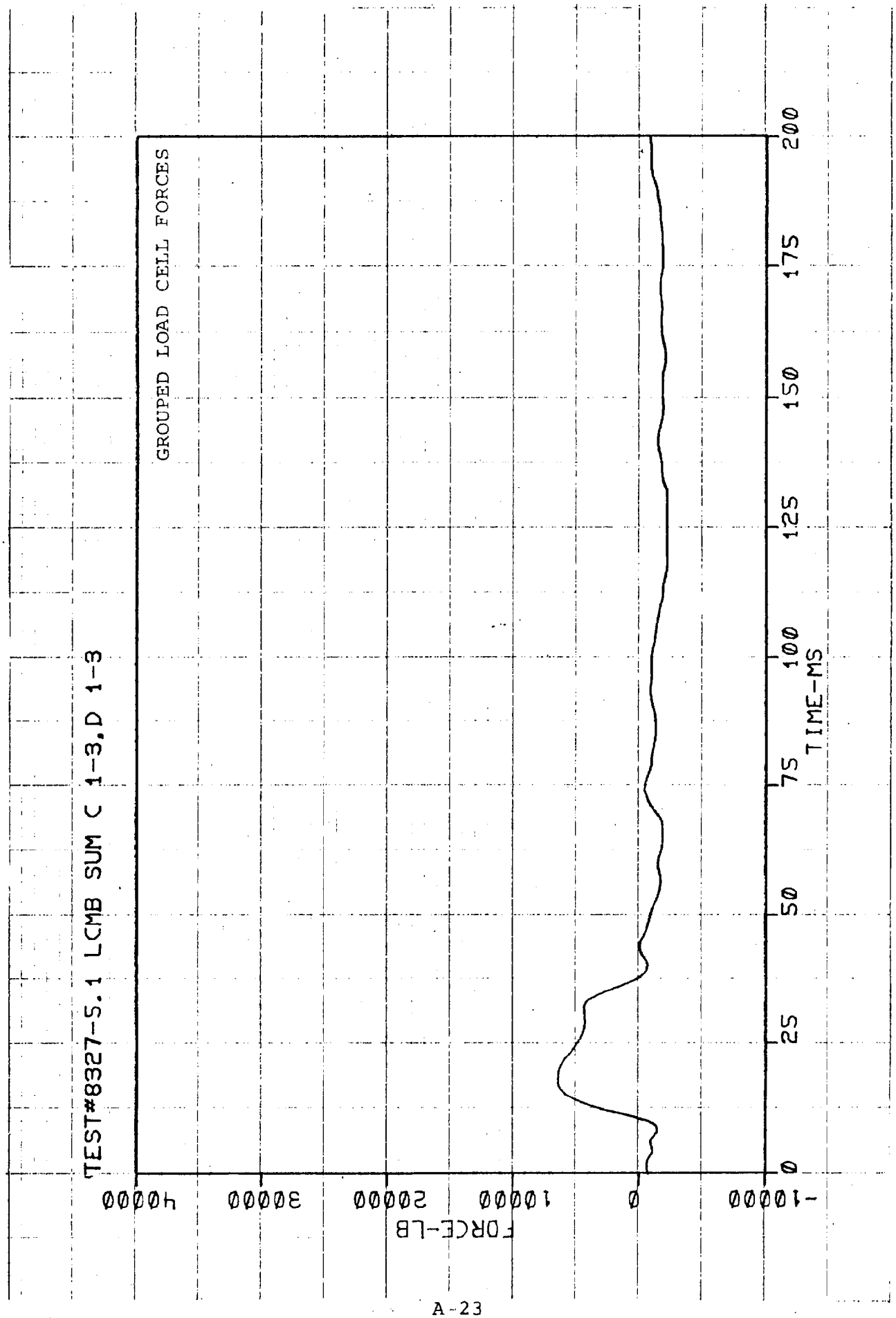

TEST#8327-5.1 LCMB LOAD CELLS
□= A8
○= B8
△= C8
◇= D8
LOAD CELL FORCES
COLUMN 8
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

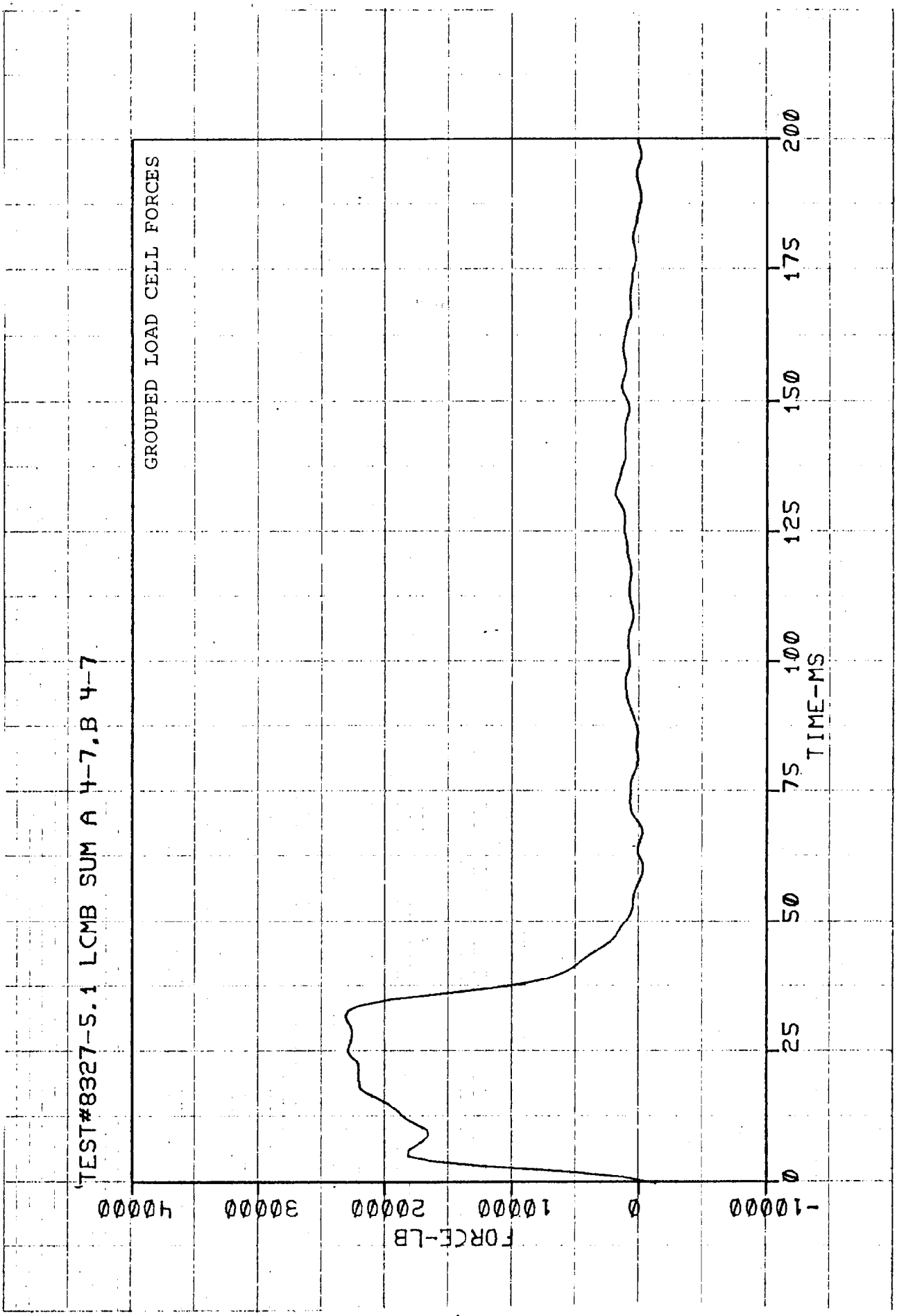

TEST#8327-5.1 LCMB LOAD CELLS
□= A9
○= B9
△= C9
◇= D9
LOAD CELL FORCES
COLUMN 9
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

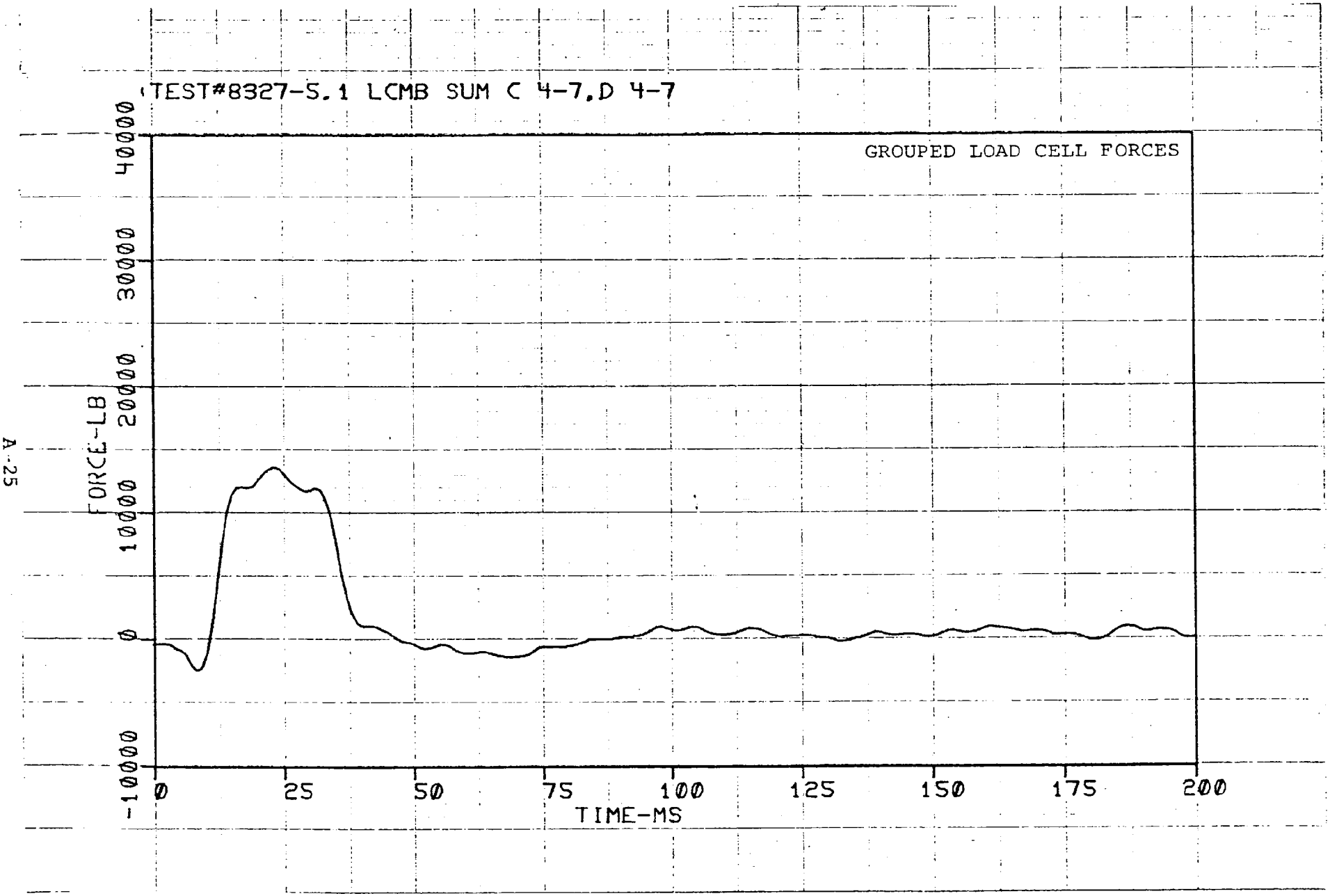

'TEST#8327-5.1 LCMB LOAD CELLS
□= A10
○= B10
△= C10
◇= D10
LOAD CELL FORCES
COLUMN 10
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

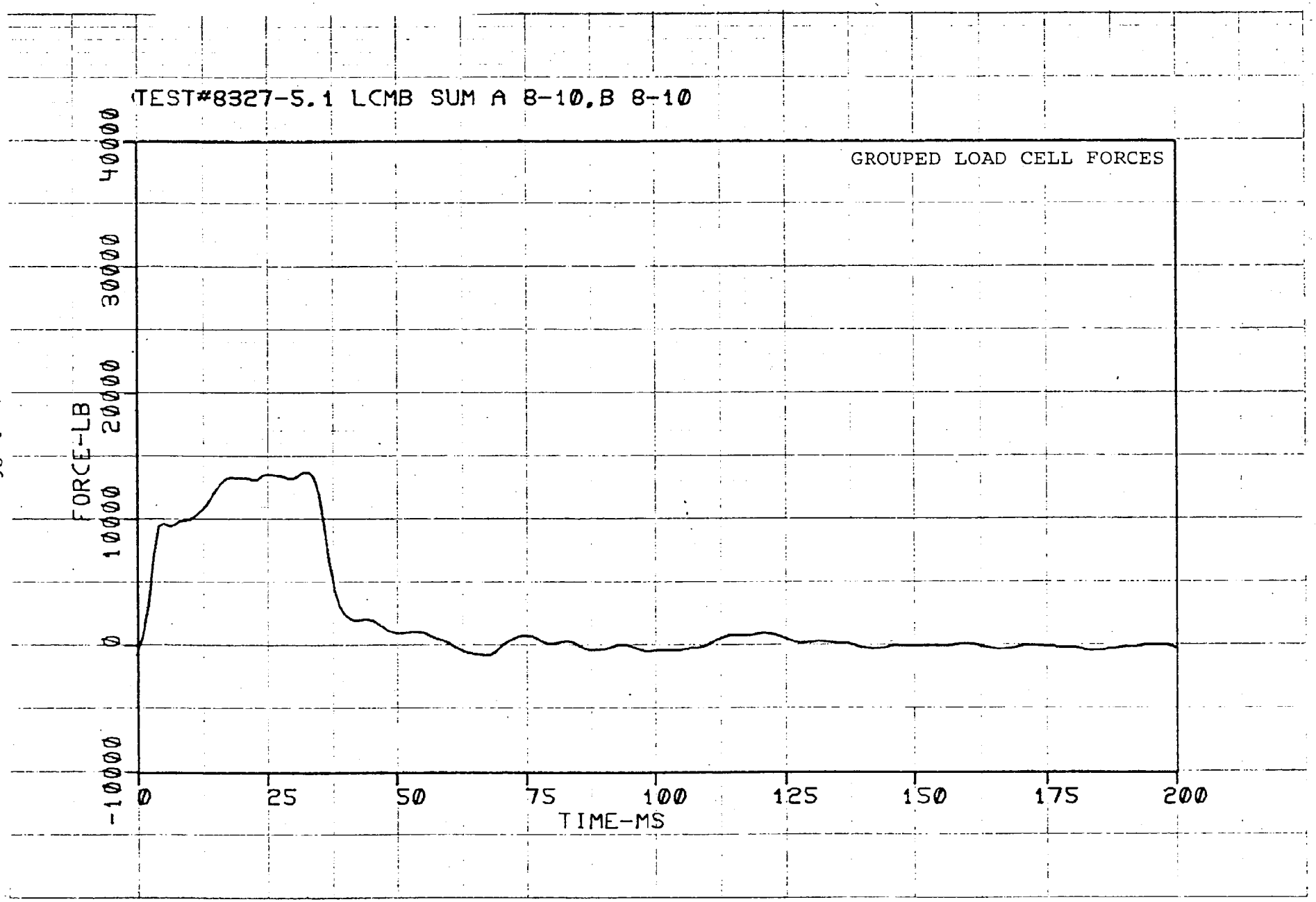

TEST#8327-5.1 LCMB TOTAL LOAD
TOTAL LOAD CELL FORCE
(SUM OF 40 LOAD CELLS)
FORCE-LB
80000
60000
40000
20000
0
-20000
TIME-MS
0
25
50
75
100
125
150
175
200

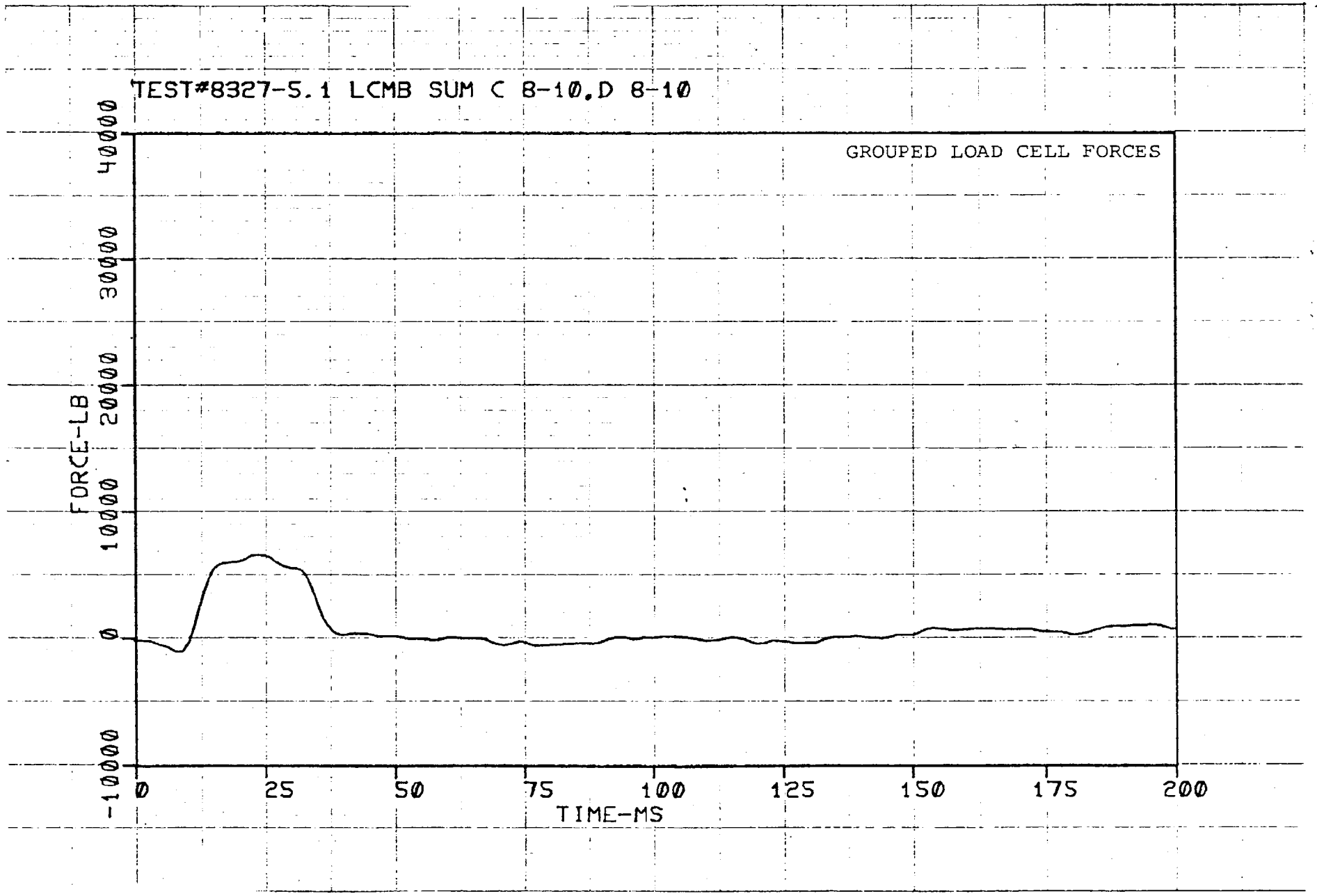

TEST*8327-5.1 LCMB SUM A 1-3,B 1-3
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


GROUPED LOAD CELL FORCES
TEST#8327-5.1 LCMB SUM C 1-3,D 1-3
FORCE-LB
40000
30000
20000
10000
0
-10000
TIME-MS
0
25
50
75
100
125
150
175
200


GROUPED LOAD CELL FORCES
TEST#8327-5.1 LCMB SUM A 4-7,B 4-7
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


TEST#8327-S.1 LCMB SUM C 4-7,D 4-7
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


TEST#8327-5.1 LCMB SUM A 8-10,B 8-10
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS

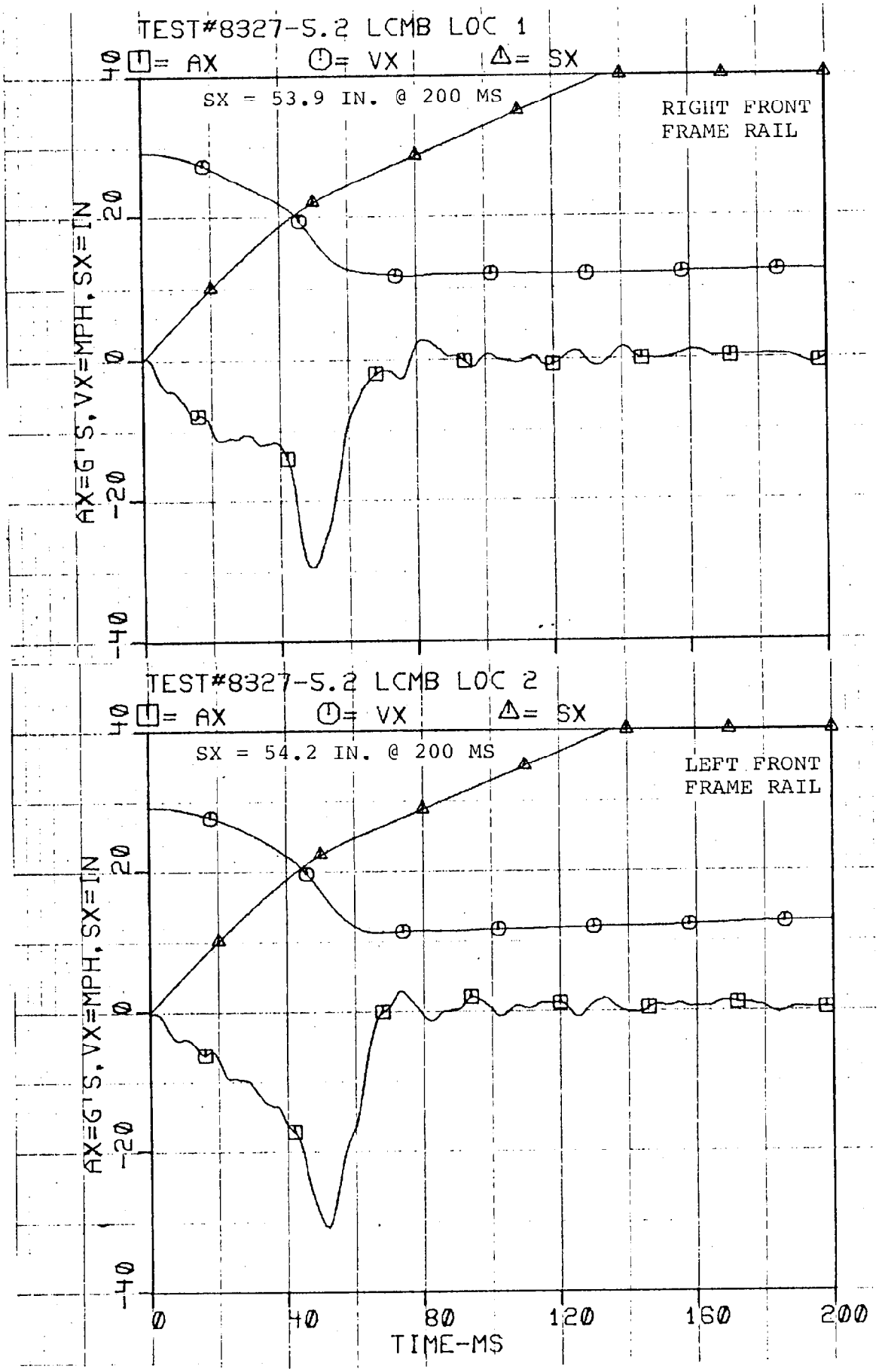

TEST#8327-5.1 LCMB SUM C 8-10,D 8-10
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS

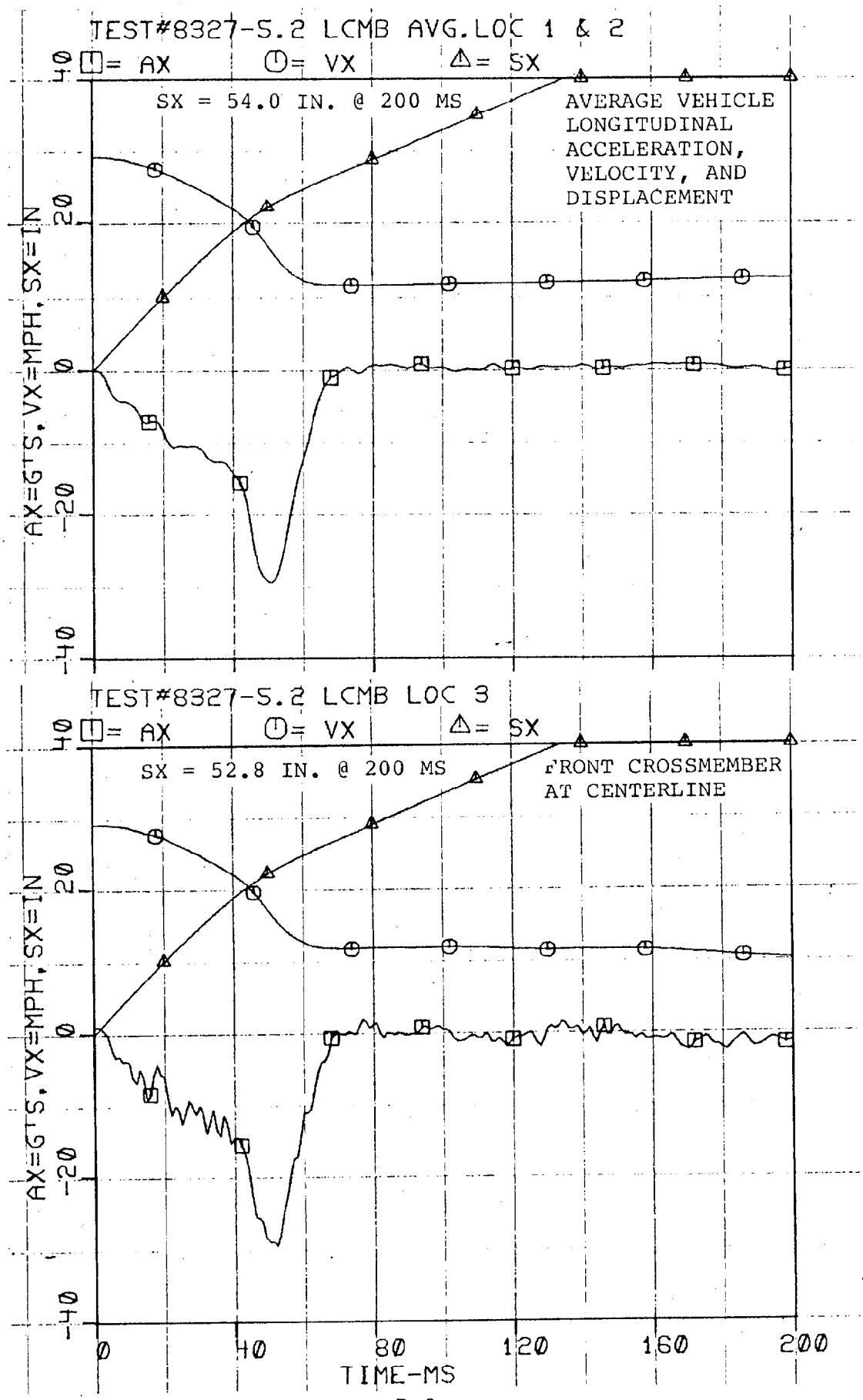
APPENDIX B

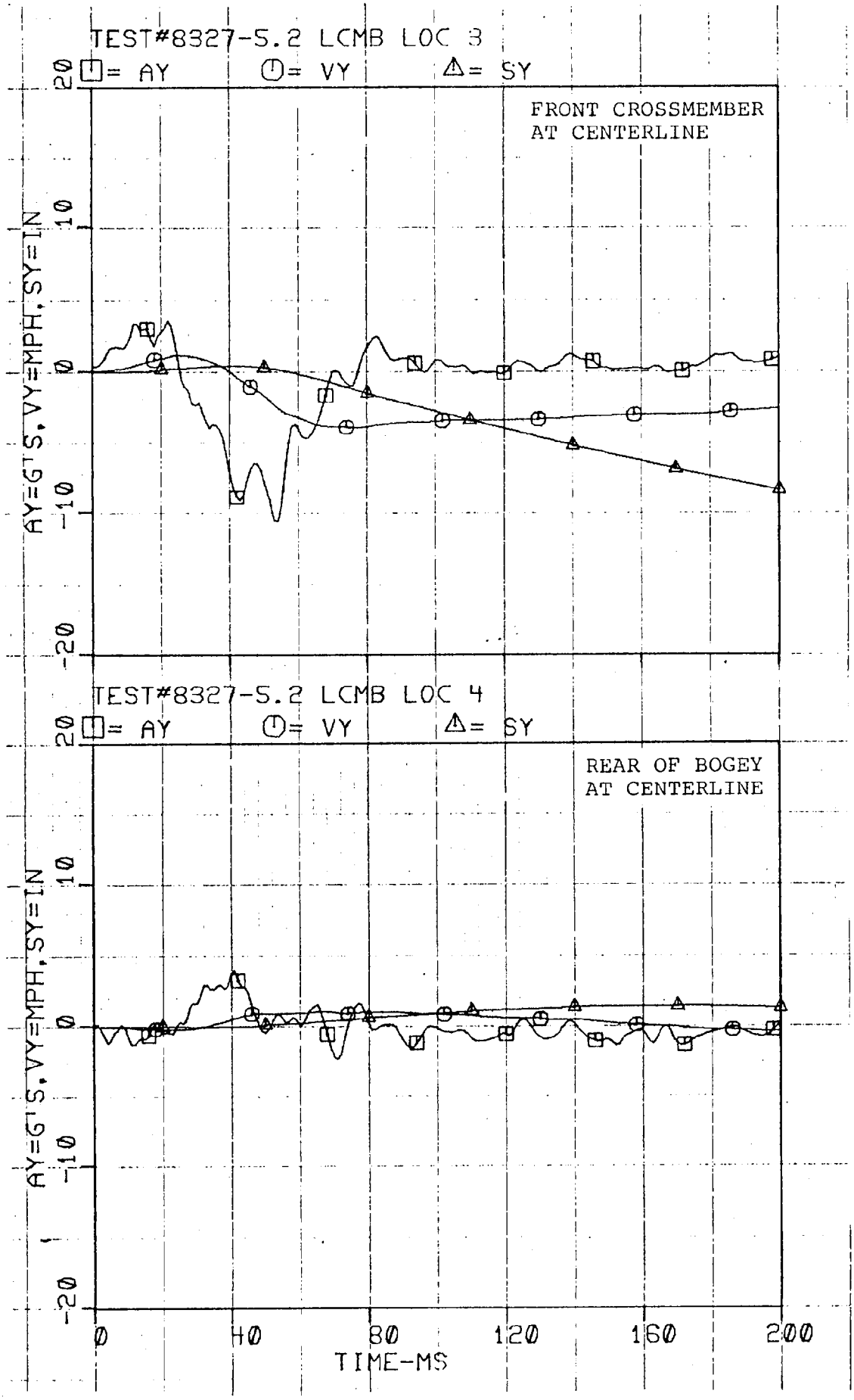
CALCOMP PLOTS FOR

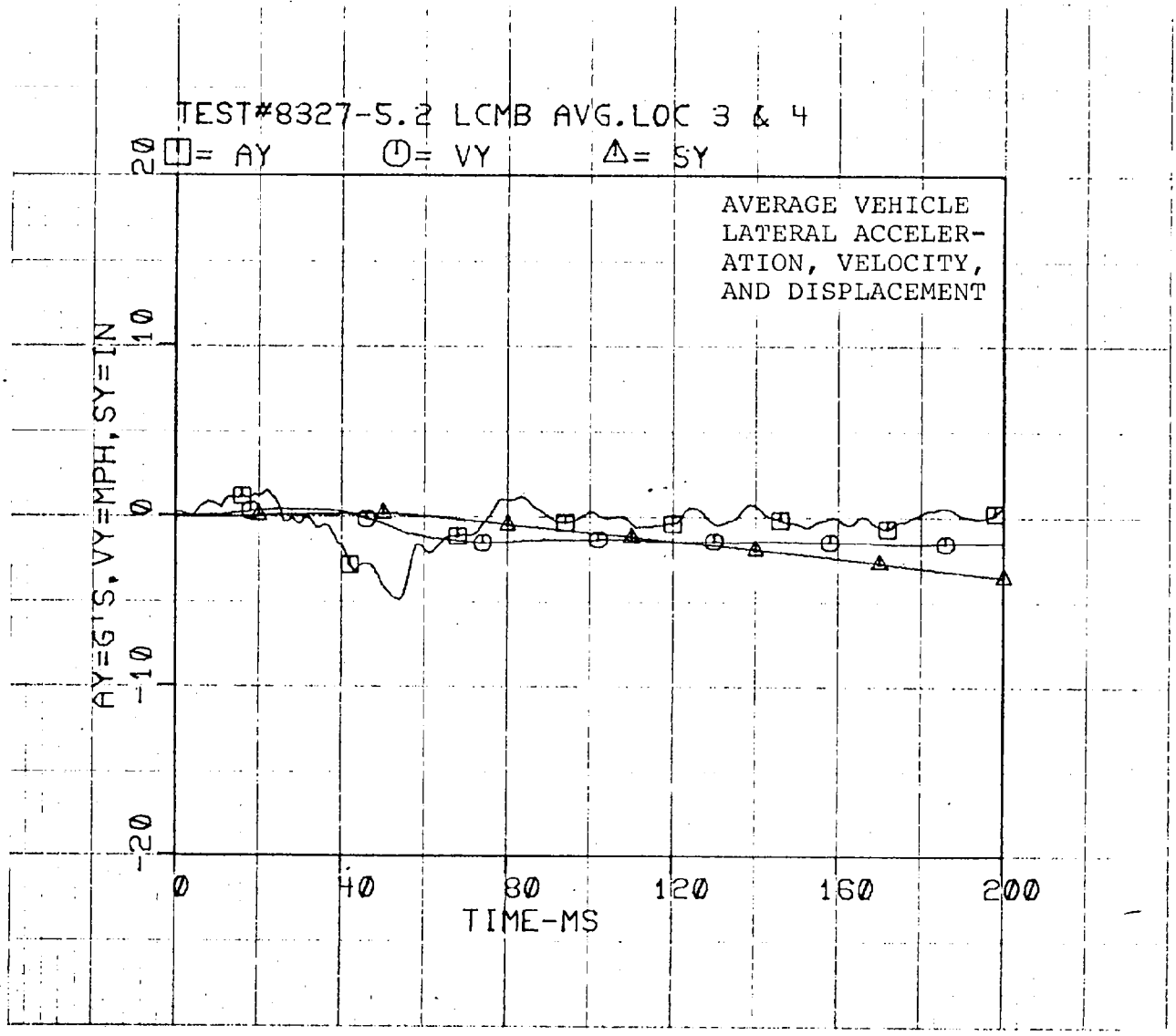
TEST 8327-5.2

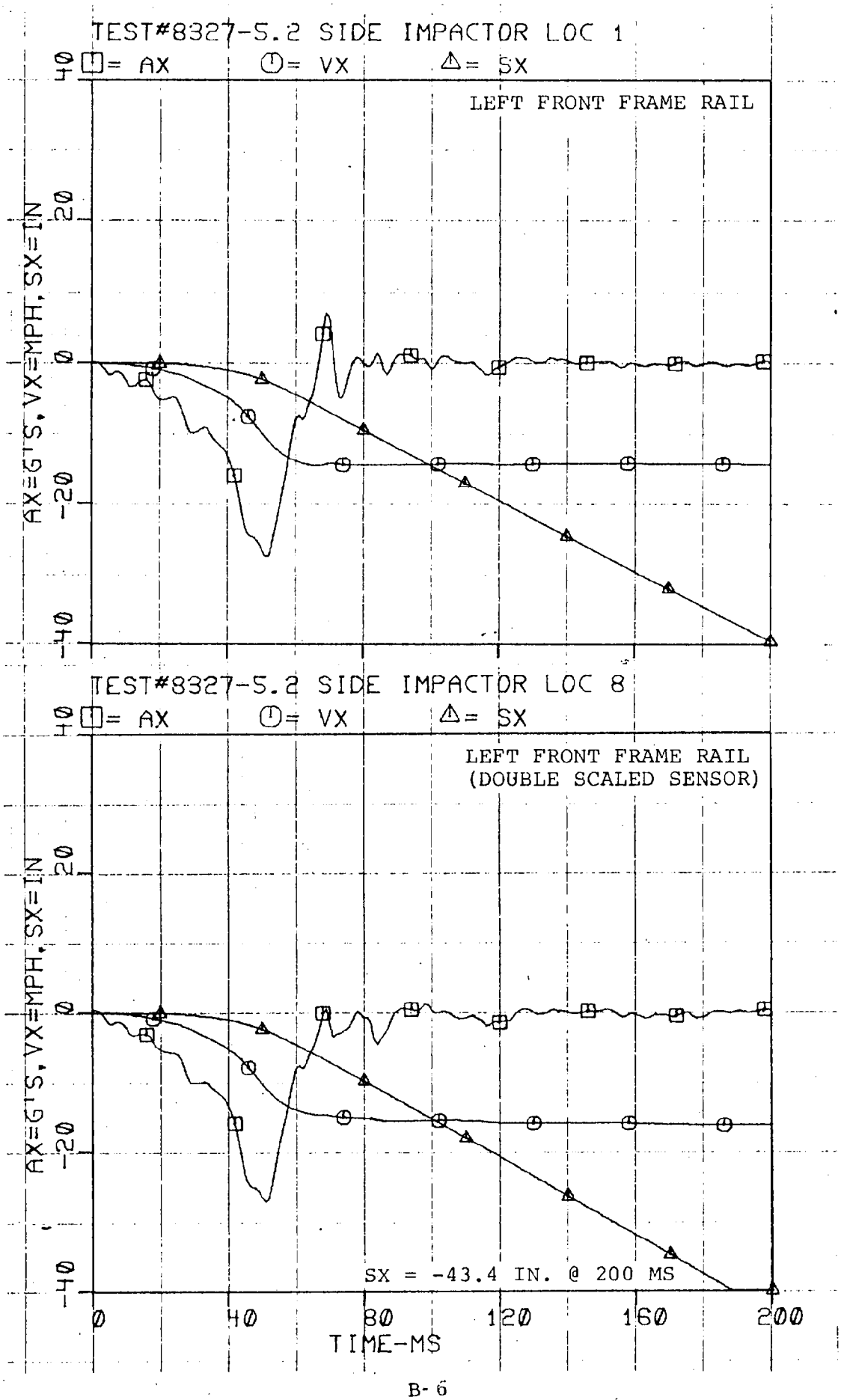
(STRUCTURAL DATA FILTER: 315/100)

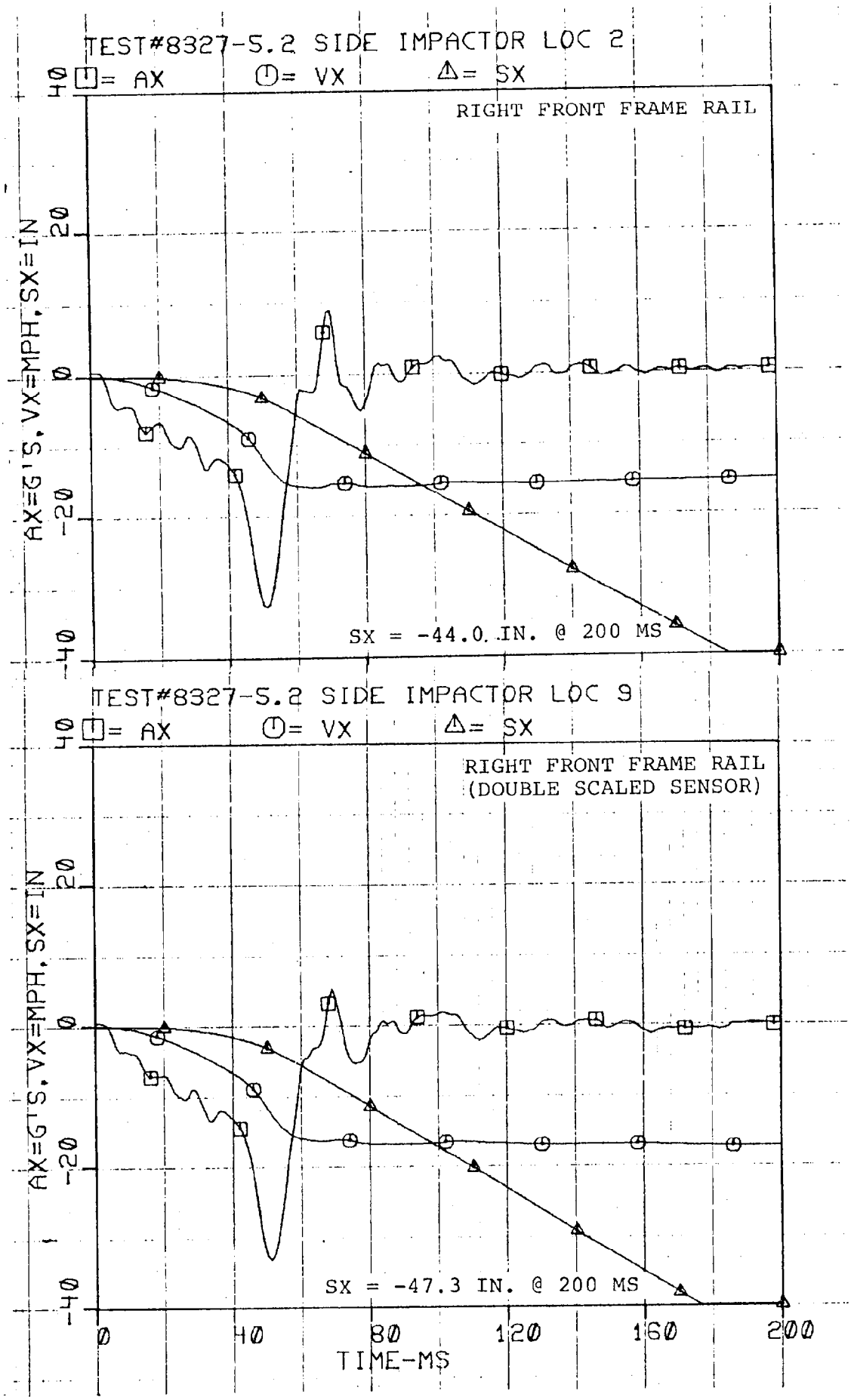

TEST#8327-5.2 LCMB LOC 1
□= AX
○= VX
△= SX
SX = 53.9 IN. @ 200 MS
RIGHT FRONT
FRAME RAIL
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
TEST#8327-5.2 LCMB LOC 2
□= AX
○= VX
△= SX
SX = 54.2 IN. @ 200 MS
LEFT FRONT
FRAME RAIL
AX=G'S, VX=MPH, SX=IN
0
40
80
120
160
200
TIME-MS

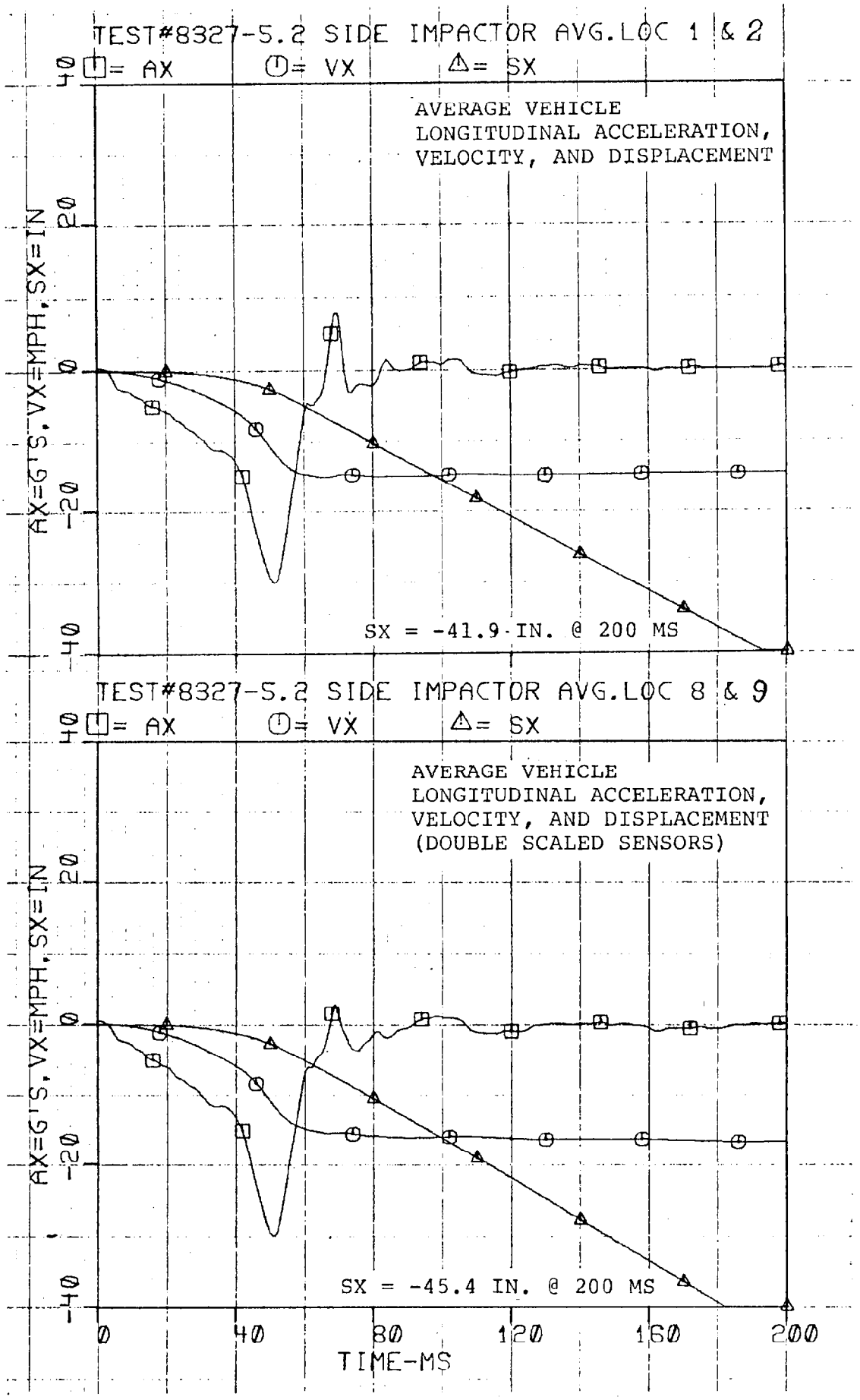

TEST#8327-5.2 LCMB AVG.LOC 1 & 2
□= AX
○= VX
△= SX
SX = 54.0 IN. @ 200 MS
AVERAGE VEHICLE LONGITUDINAL ACCELERATION, VELOCITY, AND DISPLACEMENT
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
TEST#8327-5.2 LCMB LOC 3
□= AX
○= VX
△= SX
SX = 52.8 IN. @ 200 MS
FRONT CROSSMEMBER AT CENTERLINE
AX=G'S, VX=MPH, SX=IN
0
40
80
120
160
200
TIME-MS

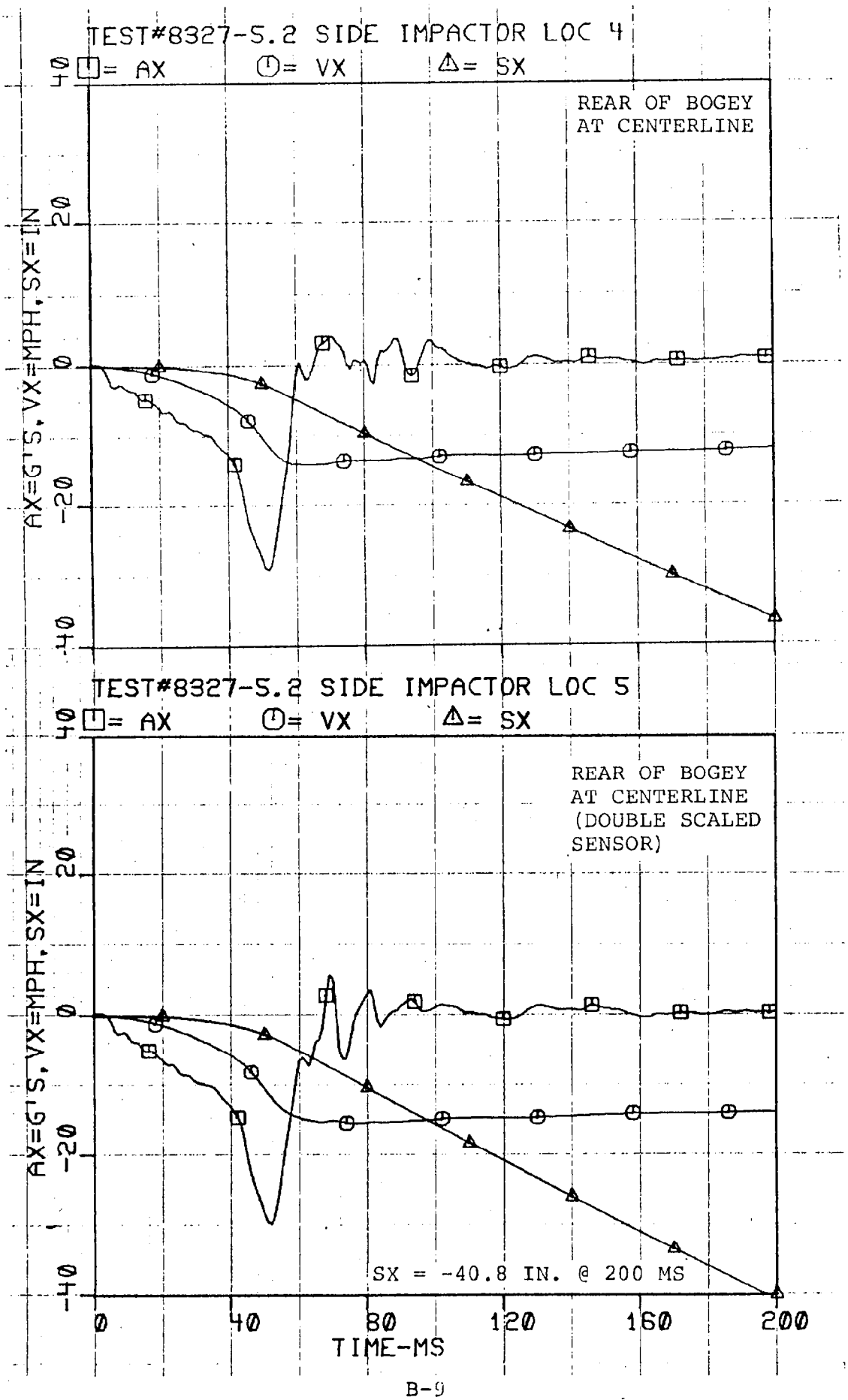

TEST#8327-5.2 LCMB LOC 3
□= AY
○= VY
△= SY
FRONT CROSSMEMBER
AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
TEST#8327-5.2 LCMB LOC 4
□= AY
○= VY
△= SY
REAR OF BOGEY
AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-MS

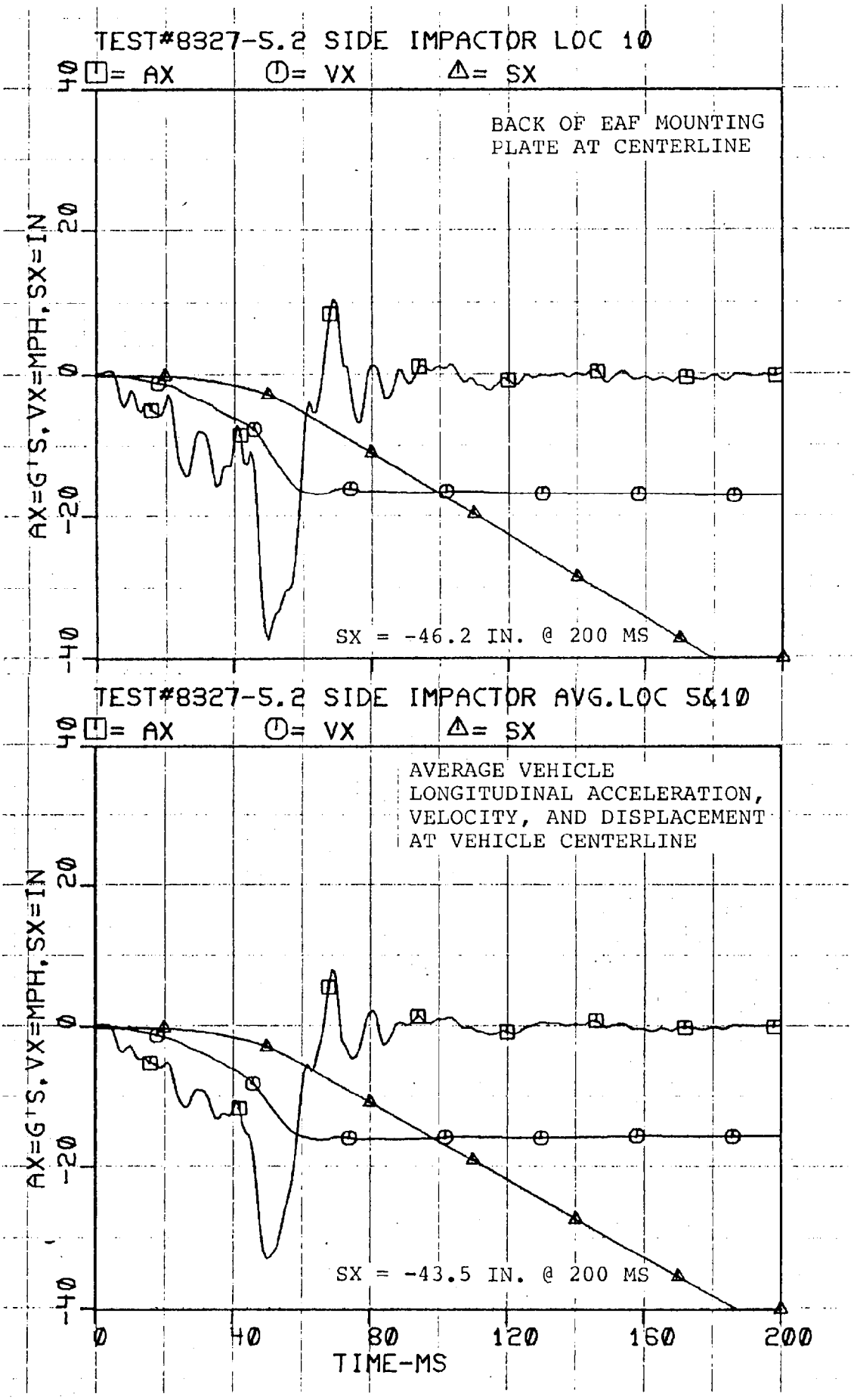

TEST#8327-5.2 LCMB AVG.LOC 3 & 4
□= AY
○= VY
△= SY
AVERAGE VEHICLE LATERAL ACCELER-ATION, VELOCITY, AND DISPLACEMENT
AY=G'S, VY=MPH, SY=IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-MS

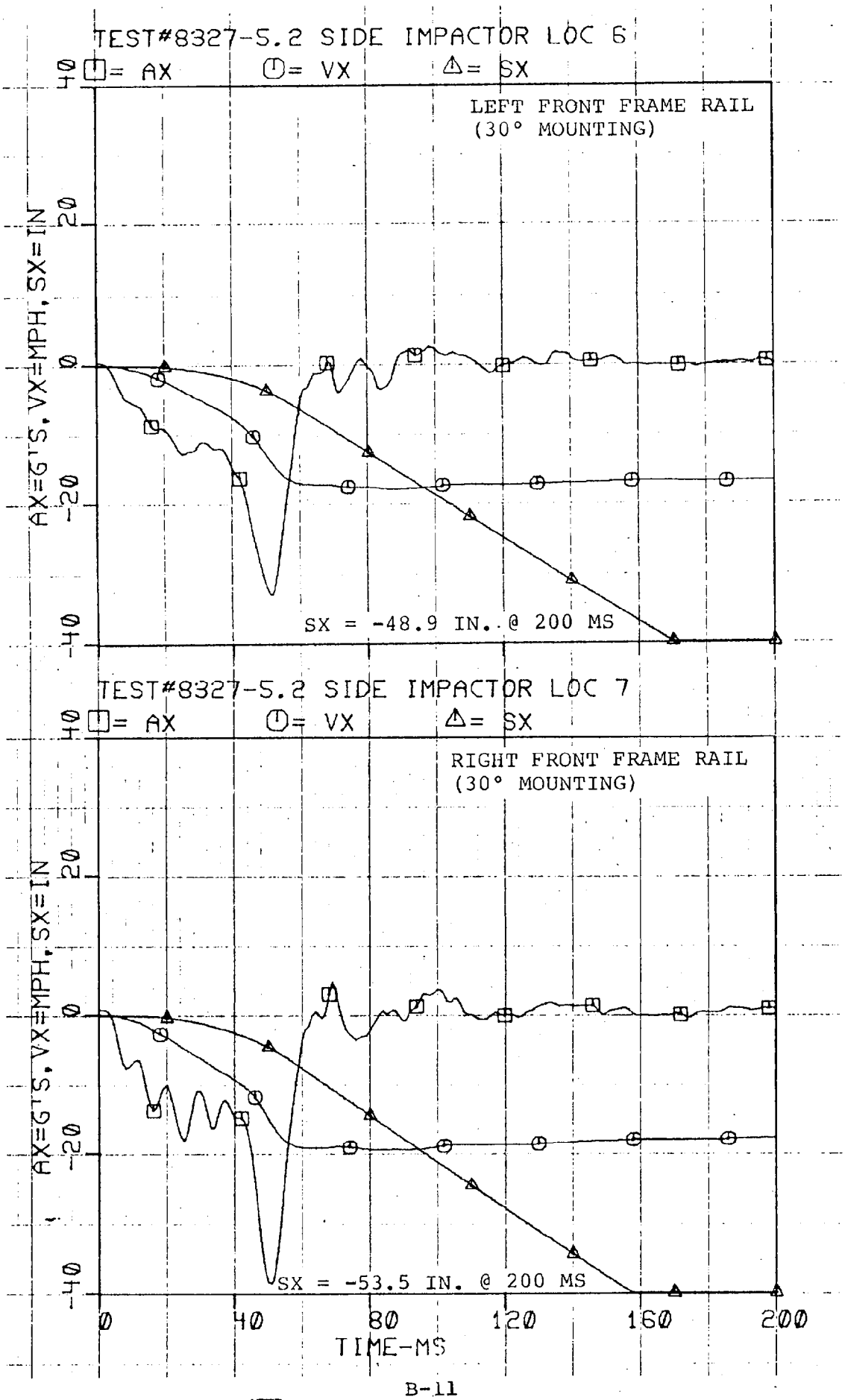

TEST#8327-5.2 SIDE IMPACTOR LOC 1
□= AX
○= VX
△= SX
LEFT FRONT FRAME RAIL
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
TEST#8327-5.2 SIDE IMPACTOR LOC 8
□= AX
○= VX
△= SX
LEFT FRONT FRAME RAIL
(DOUBLE SCALED SENSOR)
AX=G'S, VX=MPH, SX=IN
SX = -43.4 IN. @ 200 MS
0
40
80
120
160
200
TIME-MS

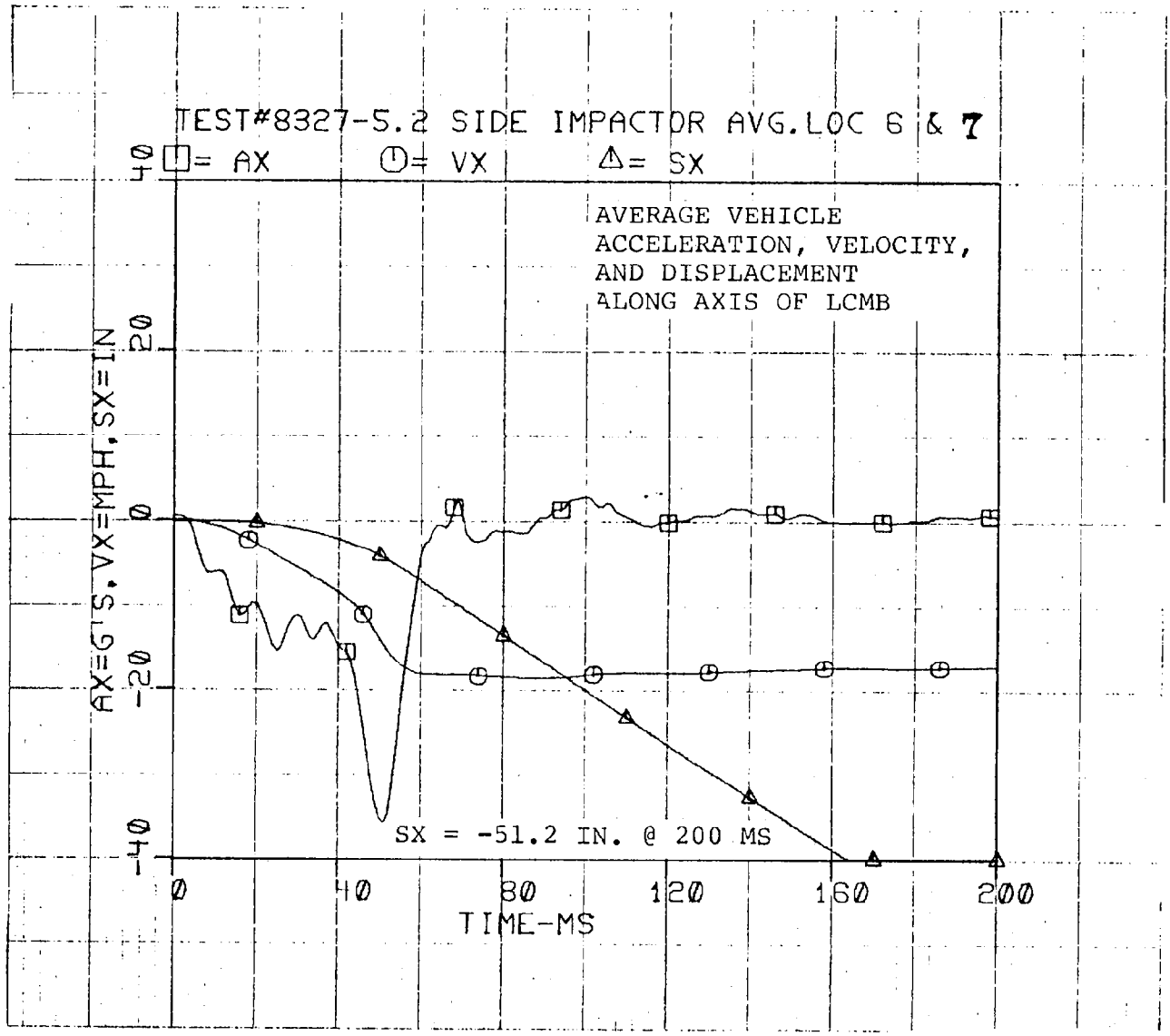

TEST#8327-5.2 SIDE IMPACTOR LOC 2
□= AX
○= VX
△= SX
RIGHT FRONT FRAME RAIL
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
SX = -44.0 IN. @ 200 MS
TEST#8327-5.2 SIDE IMPACTOR LOC 9
□= AX
○= VX
△= SX
RIGHT FRONT FRAME RAIL
(DOUBLE SCALED SENSOR)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
SX = -47.3 IN. @ 200 MS
0
40
80
120
160
200
TIME-MS

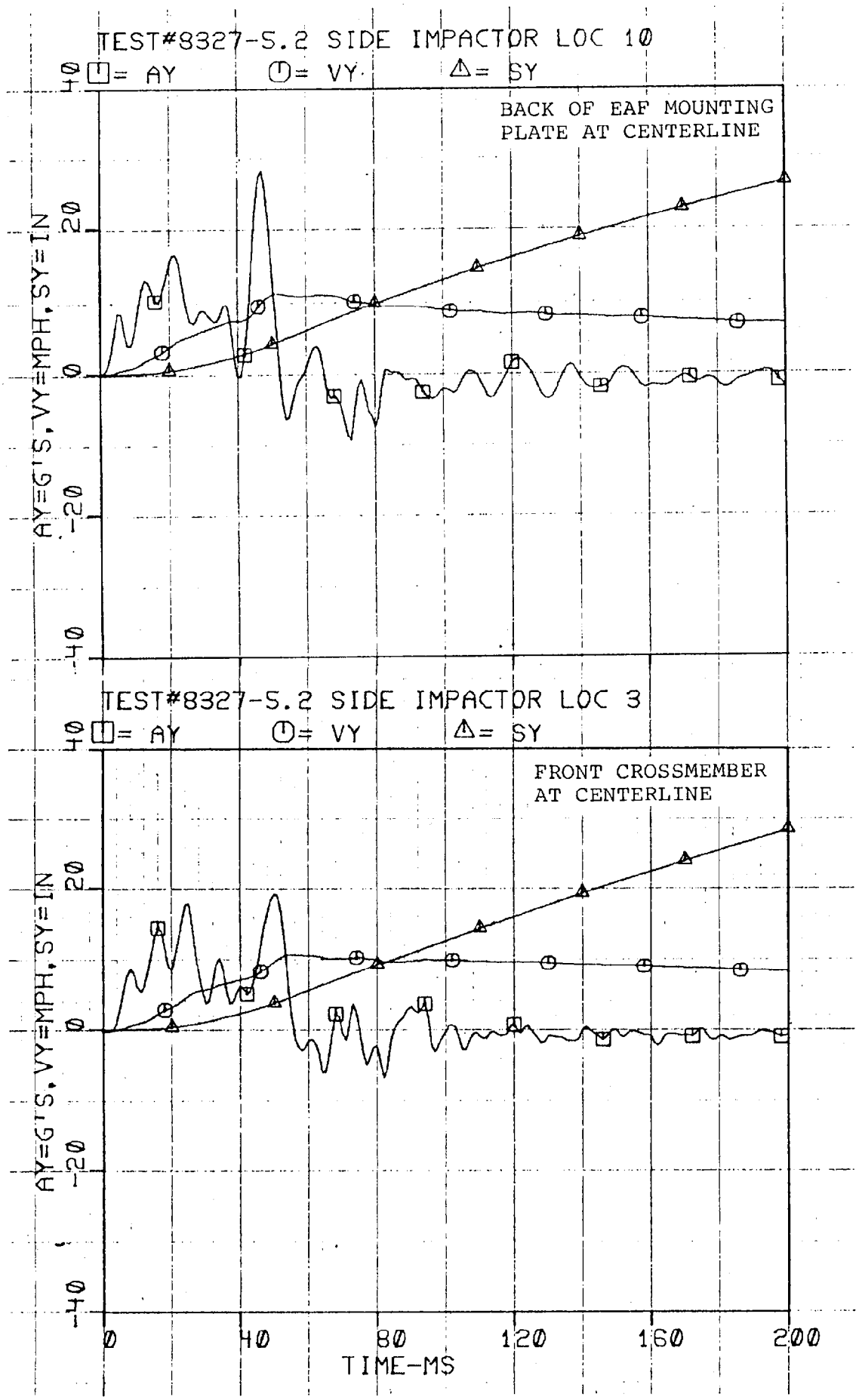

TEST#8327-5.2 SIDE IMPACTOR AVG.LOC 1 & 2
□= AX
○= VX
△= SX
AVERAGE VEHICLE
LONGITUDINAL ACCELERATION,
VELOCITY, AND DISPLACEMENT
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
SX = -41.9 IN. @ 200 MS
TEST#8327-5.2 SIDE IMPACTOR AVG.LOC 8 & 9
□= AX
○= VX
△= SX
AVERAGE VEHICLE
LONGITUDINAL ACCELERATION,
VELOCITY, AND DISPLACEMENT
(DOUBLE SCALED SENSORS)
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
SX = -45.4 IN. @ 200 MS
0
40
80
120
160
200
TIME-MS

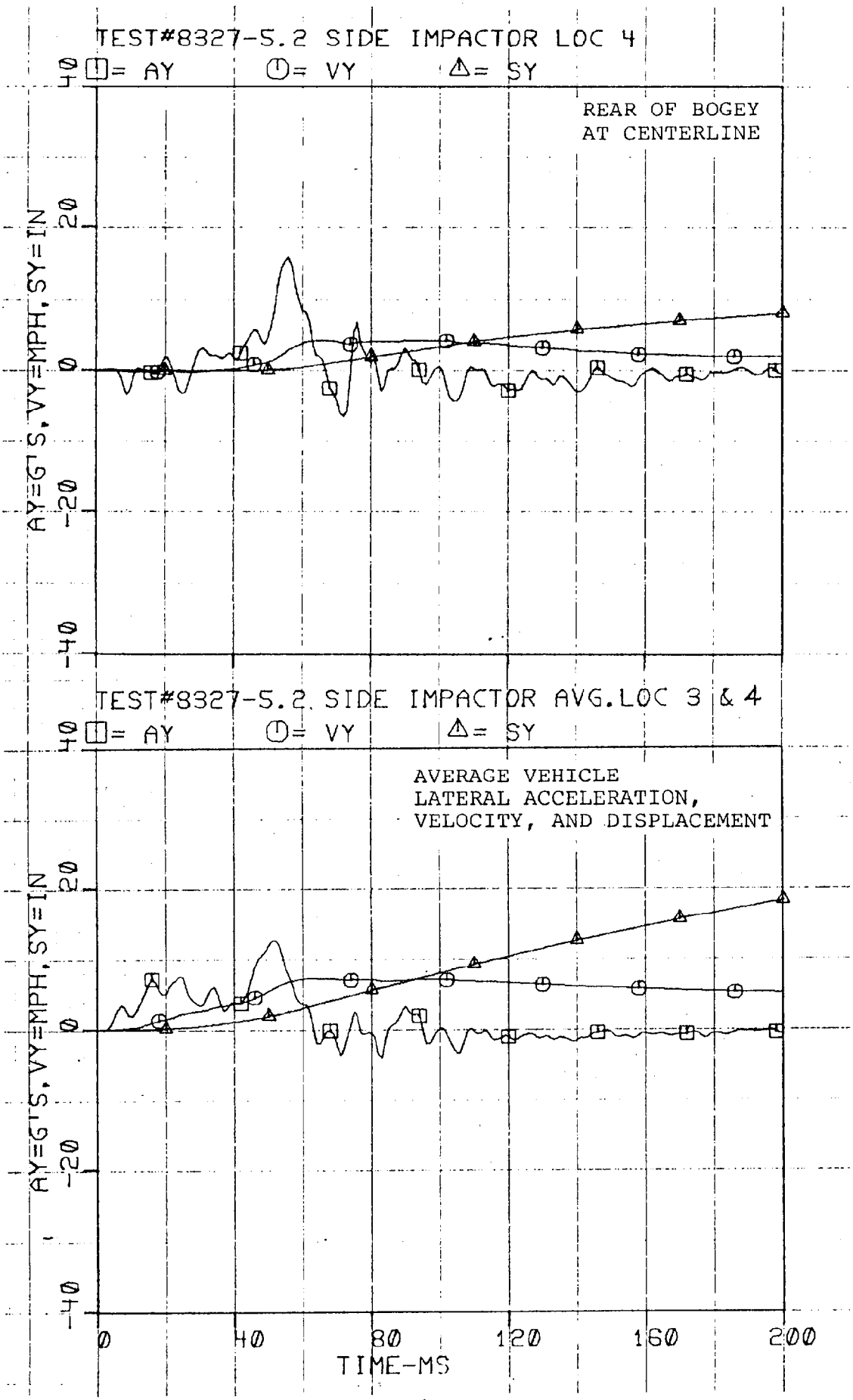

TEST#8327-5.2 SIDE IMPACTOR LOC 4
□= AX
⏲= VX
⚠= SX
REAR OF BOGEY AT CENTERLINE
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
TEST#8327-5.2 SIDE IMPACTOR LOC 5
□= AX
⏲= VX
⚠= SX
REAR OF BOGEY AT CENTERLINE (DOUBLE SCALED SENSOR)
AX=G'S, VX=MPH, SX=IN
SX = -40.8 IN. @ 200 MS
0
40
80
120
160
200
TIME-MS

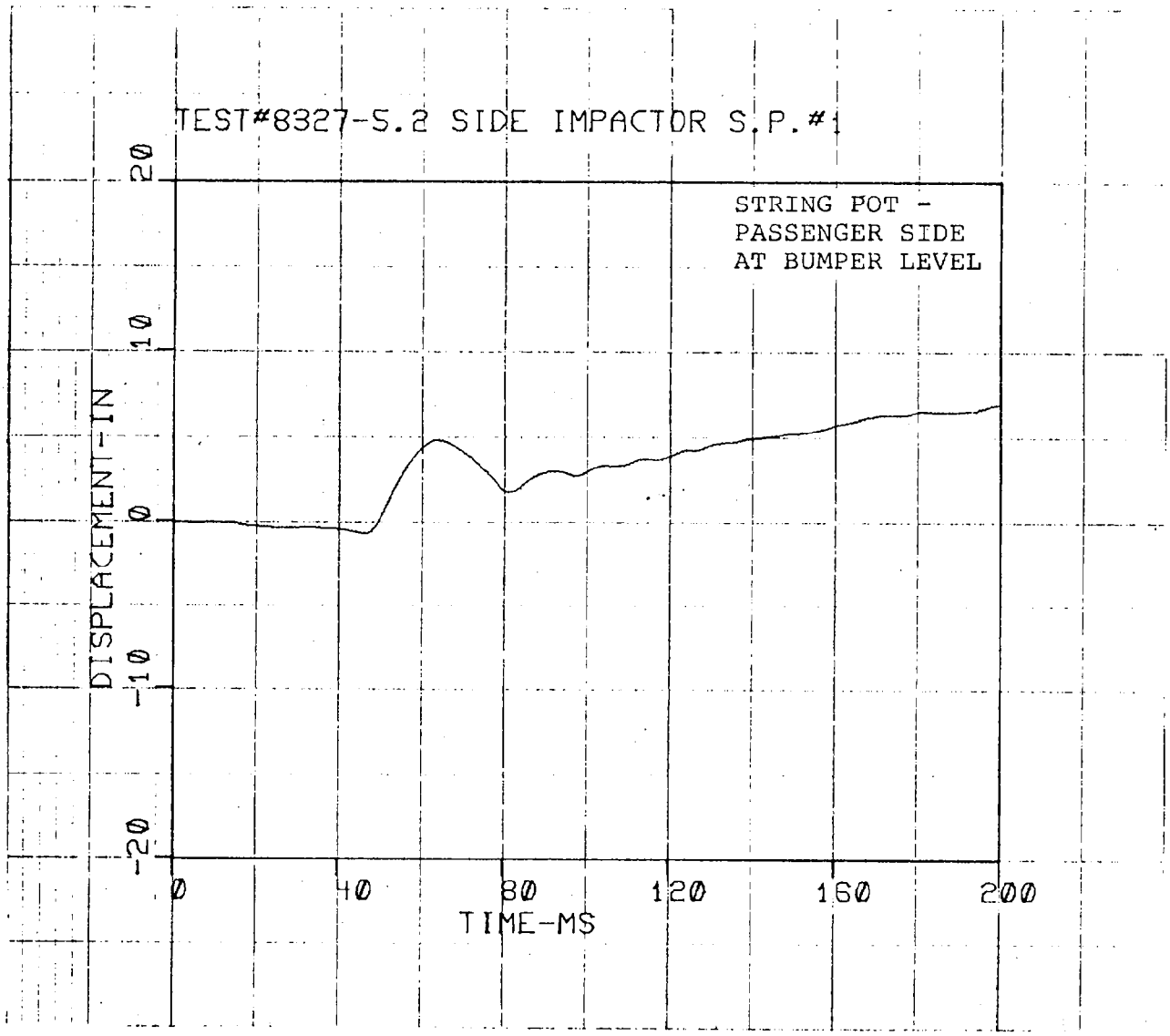

TEST#8327-5.2 SIDE IMPACTOR LOC 10
□= AX
○= VX
△= SX
BACK OF EAF MOUNTING PLATE AT CENTERLINE
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
SX = -46.2 IN. @ 200 MS
TEST#8327-5.2 SIDE IMPACTOR AVG.LOC 5&10
□= AX
○= VX
△= SX
AVERAGE VEHICLE LONGITUDINAL ACCELERATION, VELOCITY, AND DISPLACEMENT AT VEHICLE CENTERLINE
AX=G'S, VX=MPH, SX=IN
SX = -43.5 IN. @ 200 MS
0
40
80
120
160
200
TIME-MS

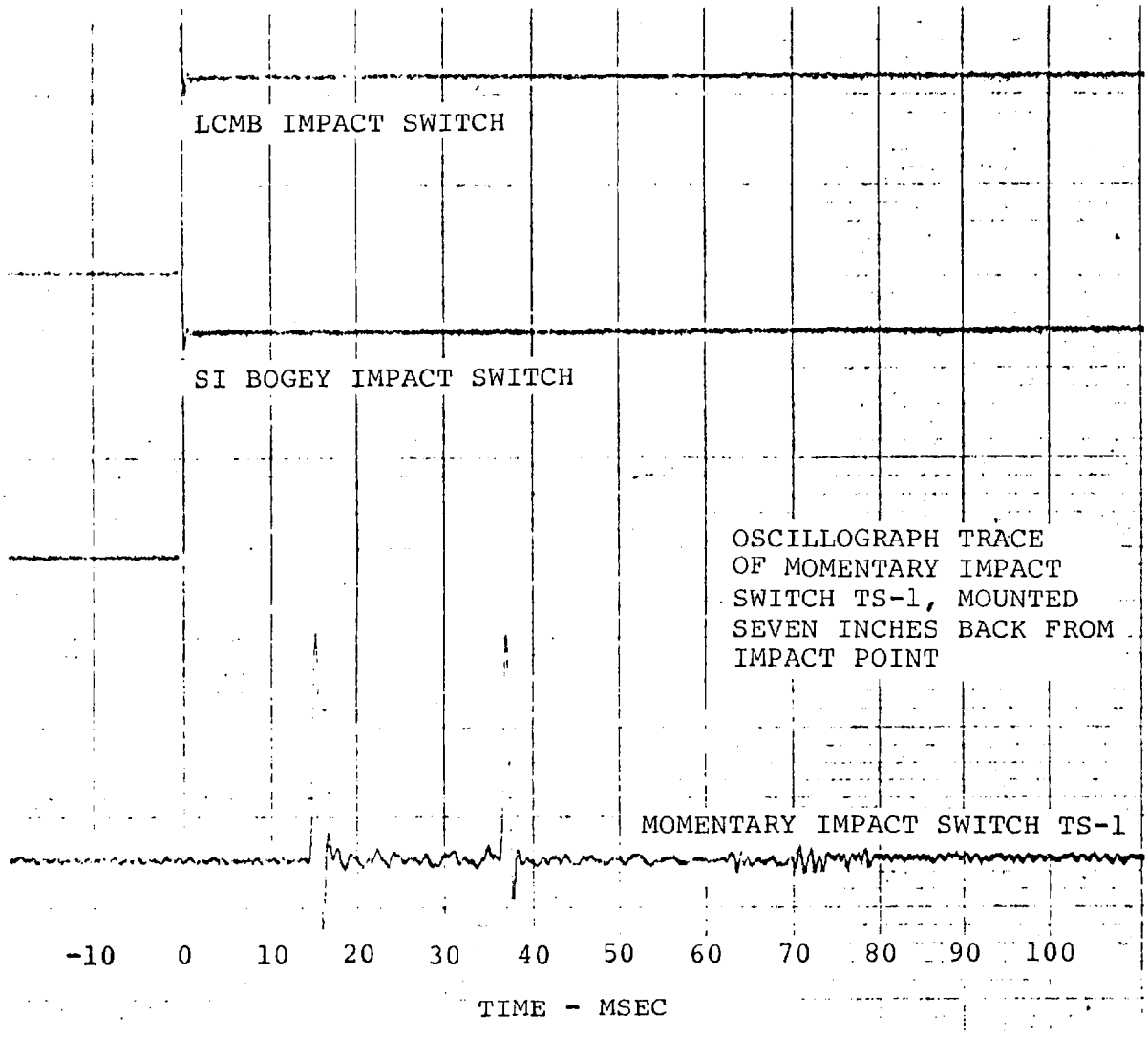

TEST#8327-5.2 SIDE IMPACTOR LOC 6
□= AX
○= VX
△= SX
LEFT FRONT FRAME RAIL
(30° MOUNTING)
SX = -48.9 IN. @ 200 MS
TEST#8327-5.2 SIDE IMPACTOR LOC 7
□= AX
○= VX
△= SX
RIGHT FRONT FRAME RAIL
(30° MOUNTING)
SX = -53.5 IN. @ 200 MS
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
0
40
80
120
160
200
TIME-MS

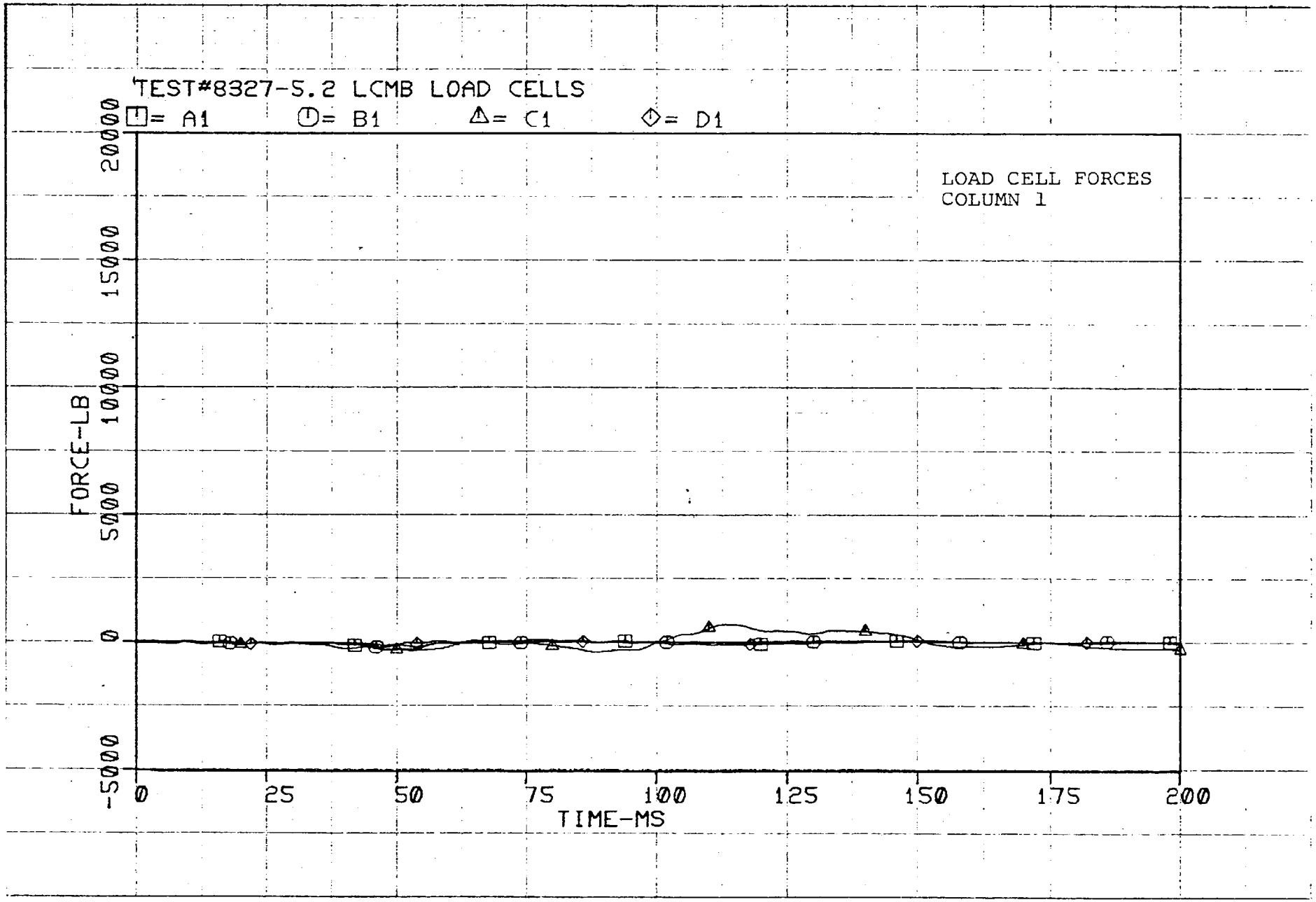

TEST#8327-5.2 SIDE IMPACTOR AVG.LOC 6 & 7
□= AX
○= VX
△= SX
AVERAGE VEHICLE
ACCELERATION, VELOCITY,
AND DISPLACEMENT
ALONG AXIS OF LCMB
AX=G'S, VX=MPH, SX=IN
40
20
0
-20
-40
SX = -51.2 IN. @ 200 MS
0
40
80
120
160
200
TIME-MS

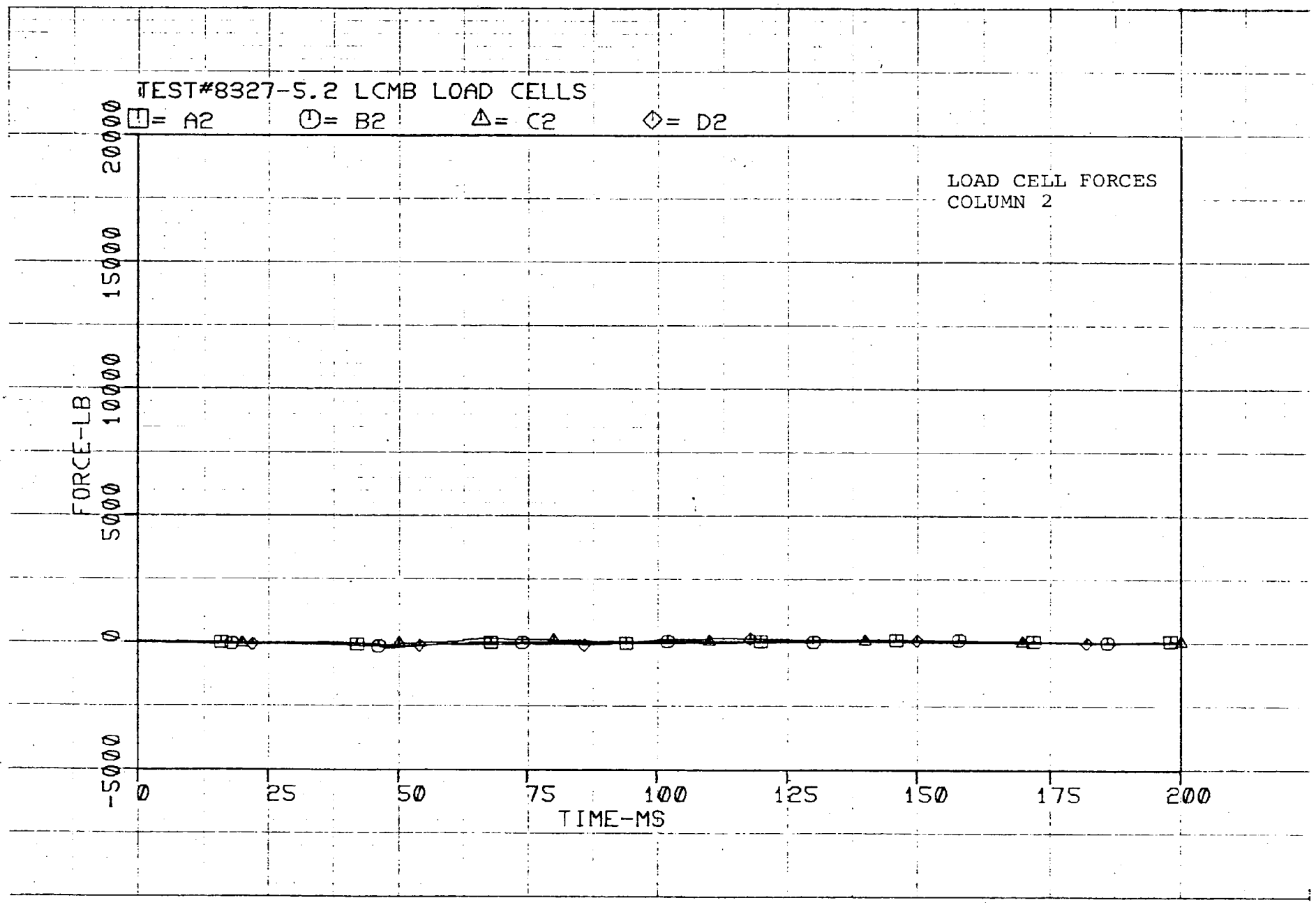

TEST#8327-5.2 SIDE IMPACTOR LOC 10
□= AY
○= VY
△= SY
BACK OF EAF MOUNTING PLATE AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
40
20
0
-20
-40
TEST#8327-5.2 SIDE IMPACTOR LOC 3
□= AY
○= VY
△= SY
FRONT CROSSMEMBER AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
40
20
0
-20
-40
0
40
80
120
160
200
TIME-MS

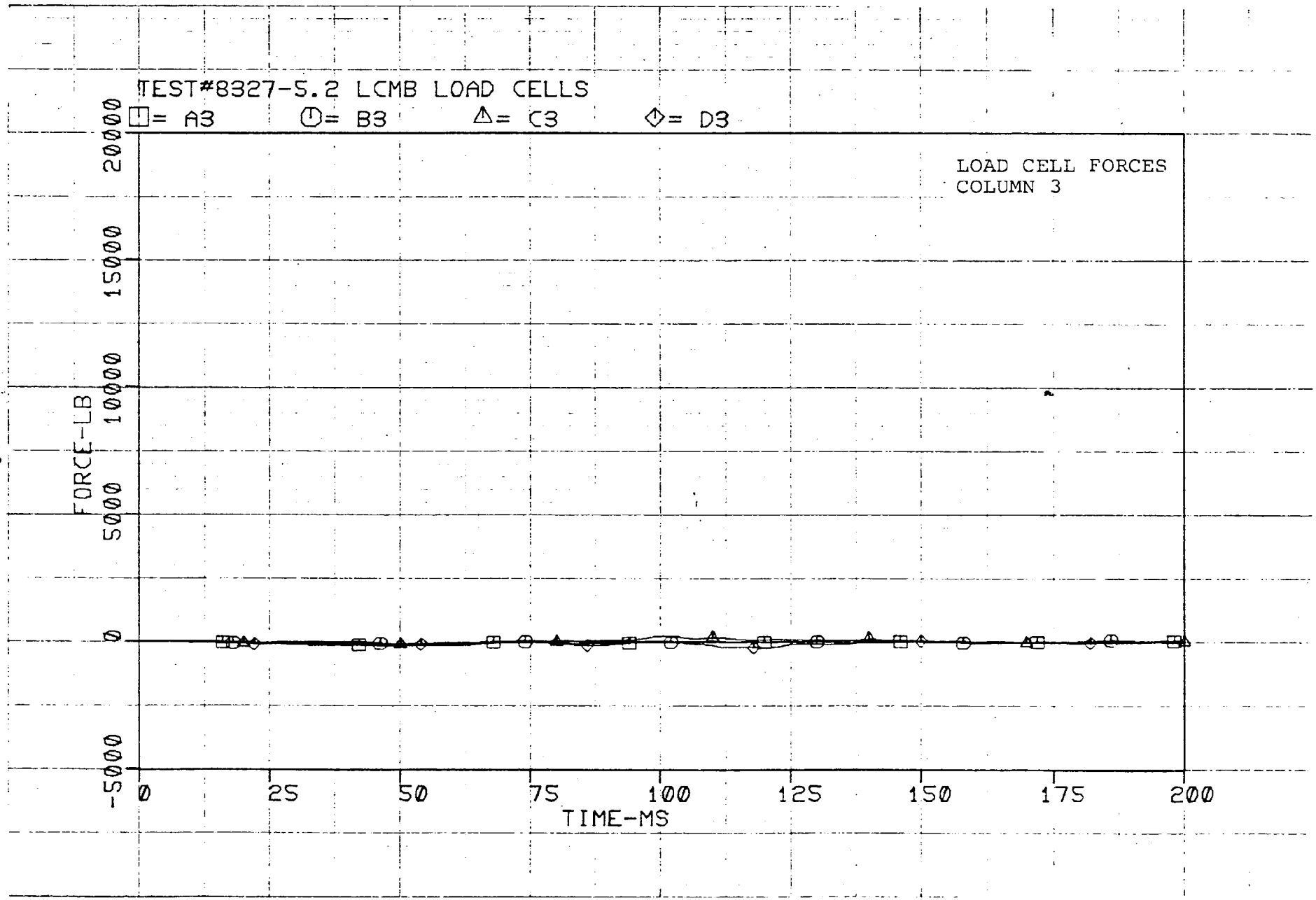

TEST#8327-5.2 SIDE IMPACTOR LOC 4
□= AY
○= VY
△= SY
REAR OF BOGEY
AT CENTERLINE
AY=G'S, VY=MPH, SY=IN
40
20
0
-20
-40
TEST#8327-5.2 SIDE IMPACTOR AVG.LOC 3 & 4
□= AY
○= VY
△= SY
AVERAGE VEHICLE
LATERAL ACCELERATION,
VELOCITY, AND DISPLACEMENT
AY=G'S, VY=MPH, SY=IN
40
20
0
-20
-40
0
40
80
120
160
200
TIME-MS

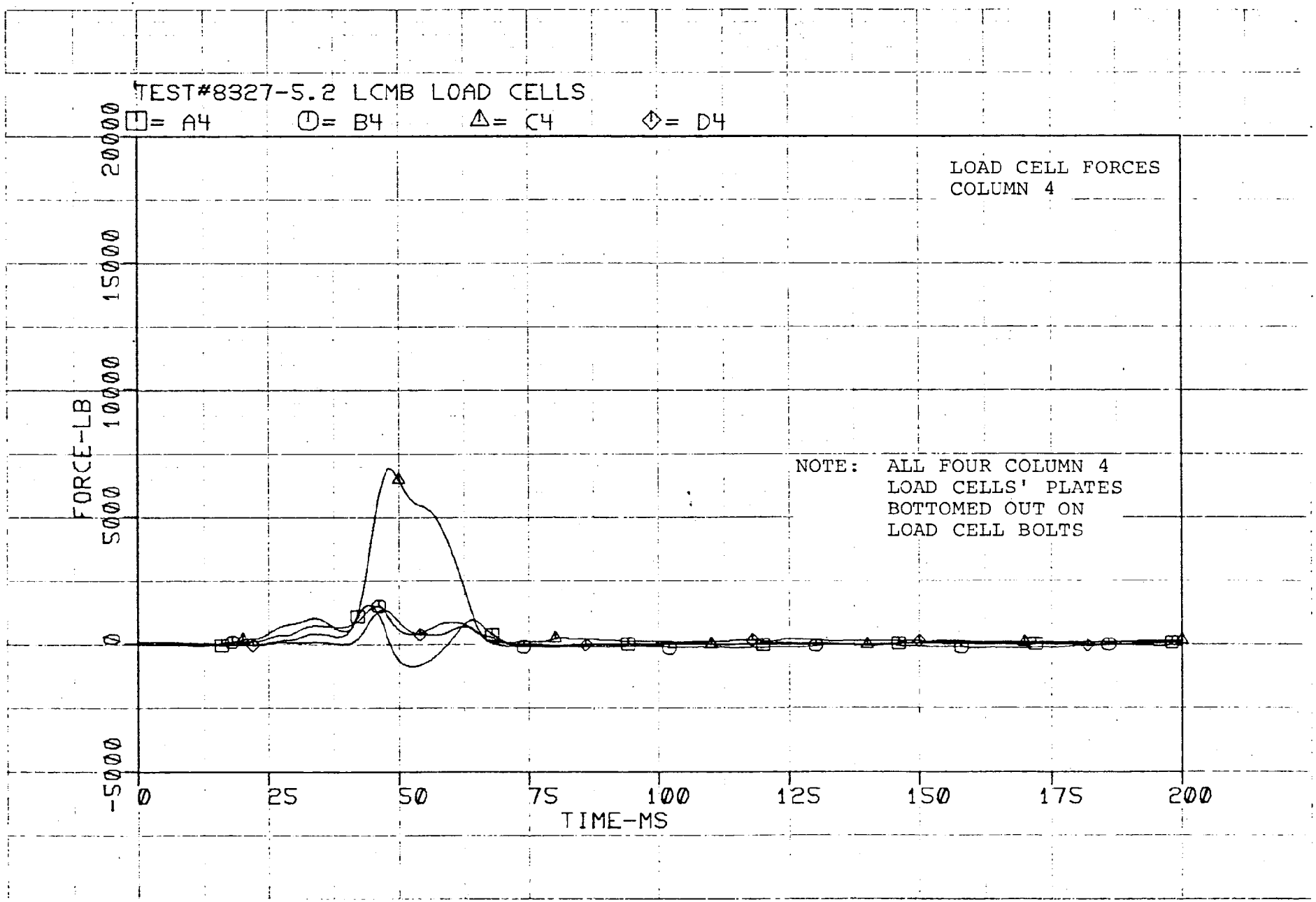

TEST#8327-S.2 SIDE IMPACTOR S.P.#1
STRING POT -
PASSENGER SIDE
AT BUMPER LEVEL
DISPLACEMENT-IN
20
10
0
-10
-20
0
40
80
120
160
200
TIME-M$

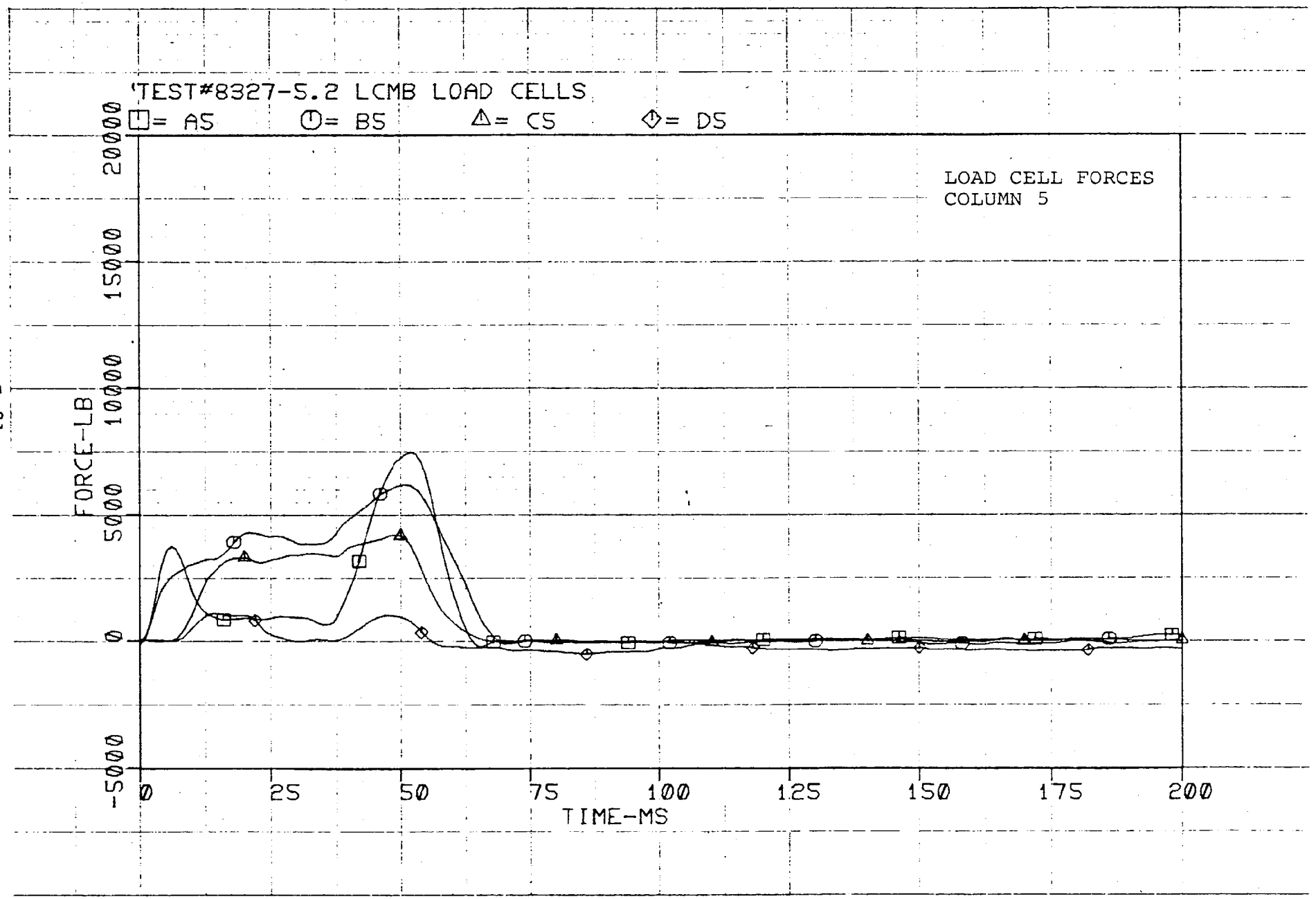

LCMB IMPACT SWITCH
SI BOGEY IMPACT SWITCH
OSCILLOGRAPH TRACE OF MOMENTARY IMPACT SWITCH TS-1, MOUNTED SEVEN INCHES BACK FROM IMPACT POINT
MOMENTARY IMPACT SWITCH TS-1
-10 0 10 20 30 40 50 60 70 80 90 100
TIME - MSEC

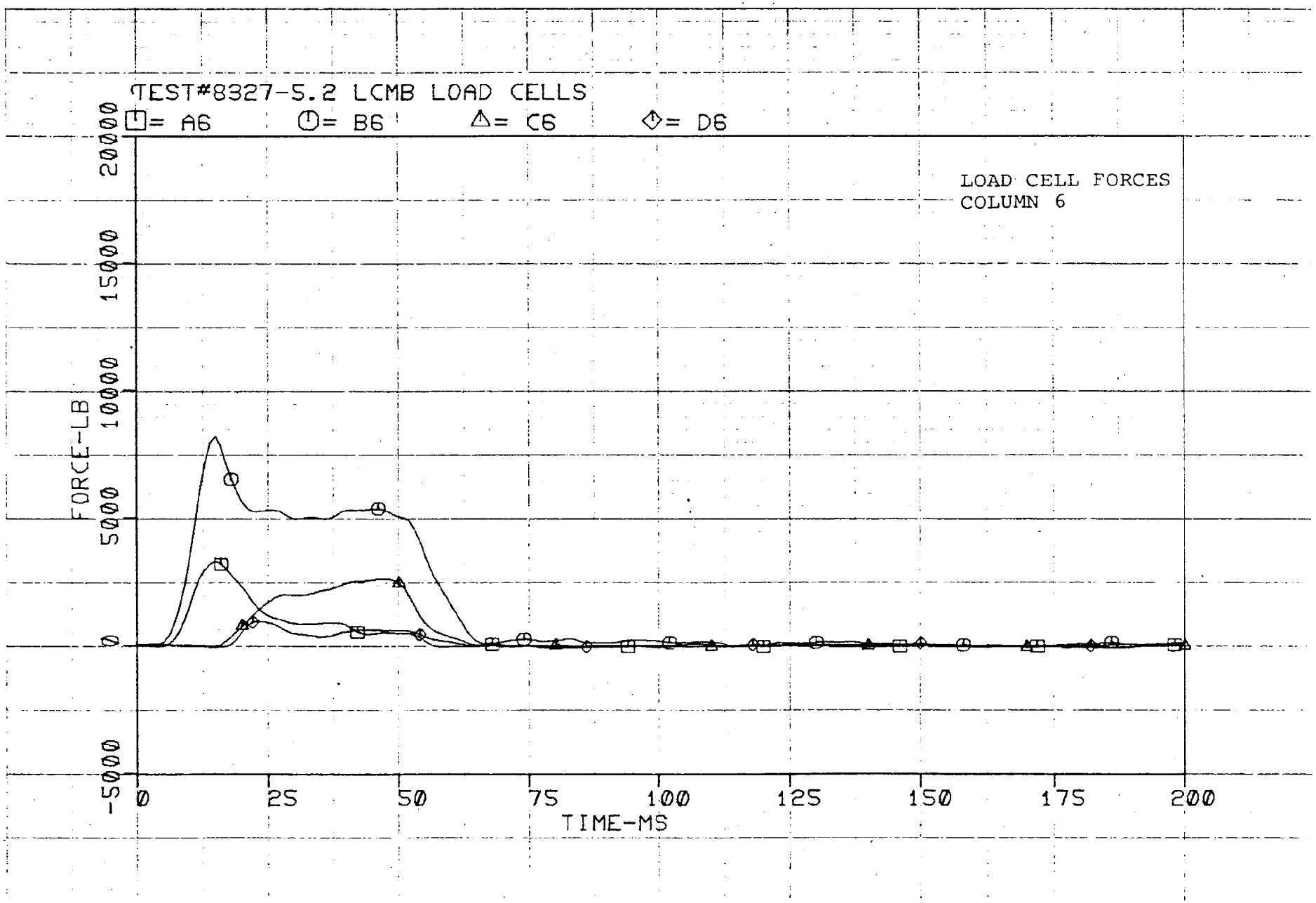

TEST#8327-5.2 LCMB LOAD CELLS
= A1
= B1
= C1
= D1
LOAD CELL FORCES
COLUMN 1
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

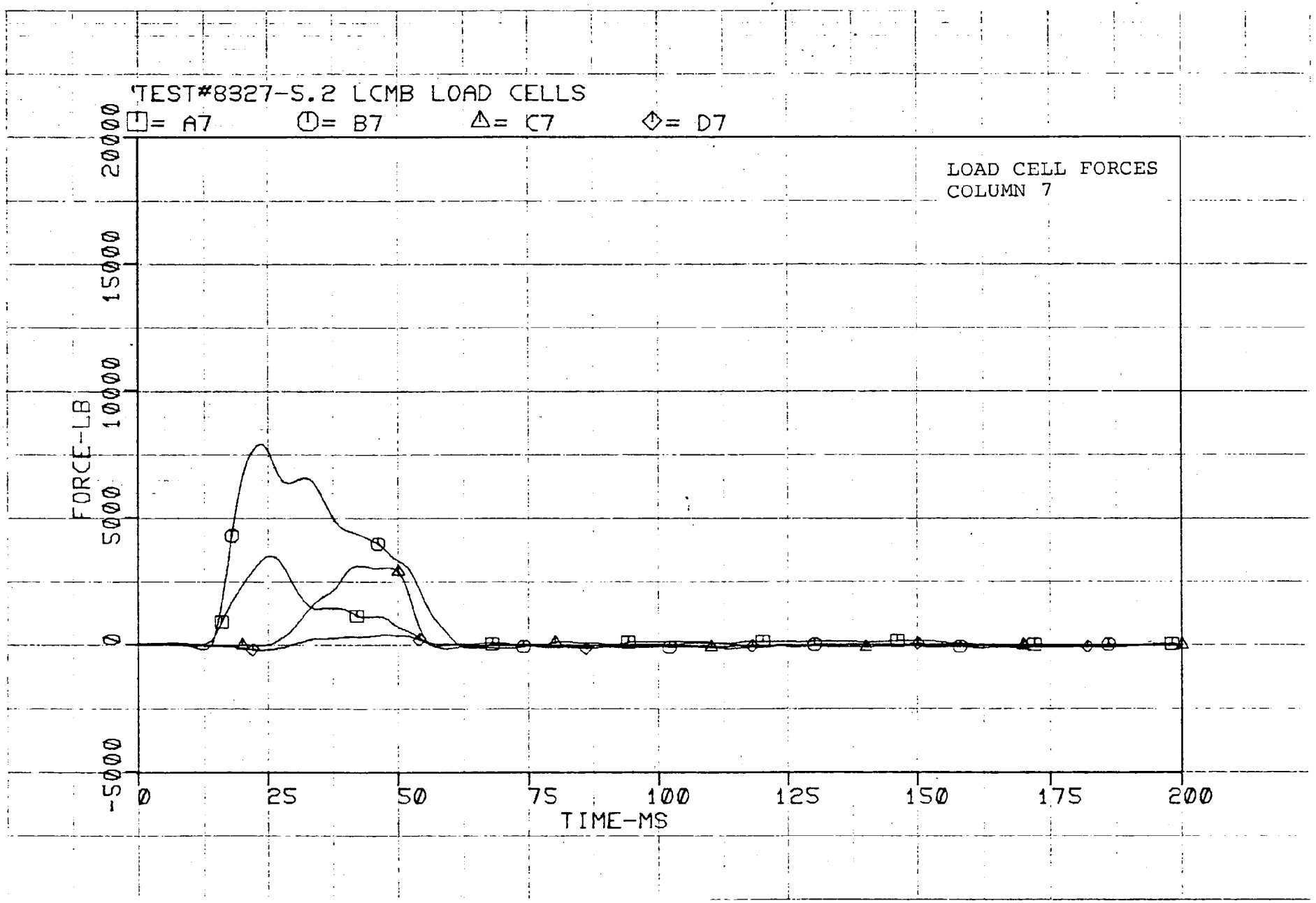

TEST#8327-5.2 LCMB LOAD CELLS
□= A2
○= B2
△= C2
◇= D2
LOAD CELL FORCES
COLUMN 2
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

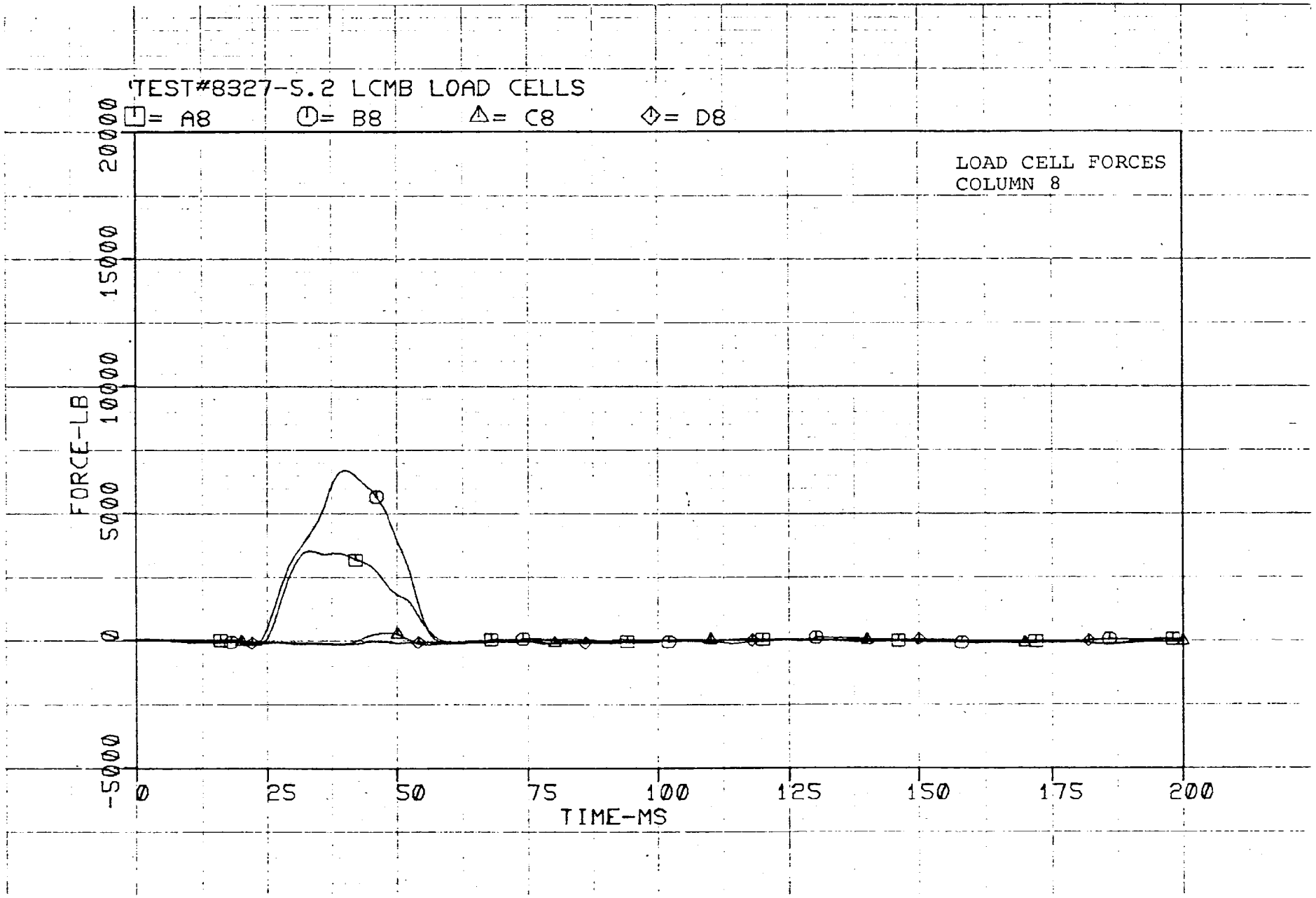

TEST#8327-5.2 LCMB LOAD CELLS
□= A3
○= B3
△= C3
◇= D3
LOAD CELL FORCES
COLUMN 3
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

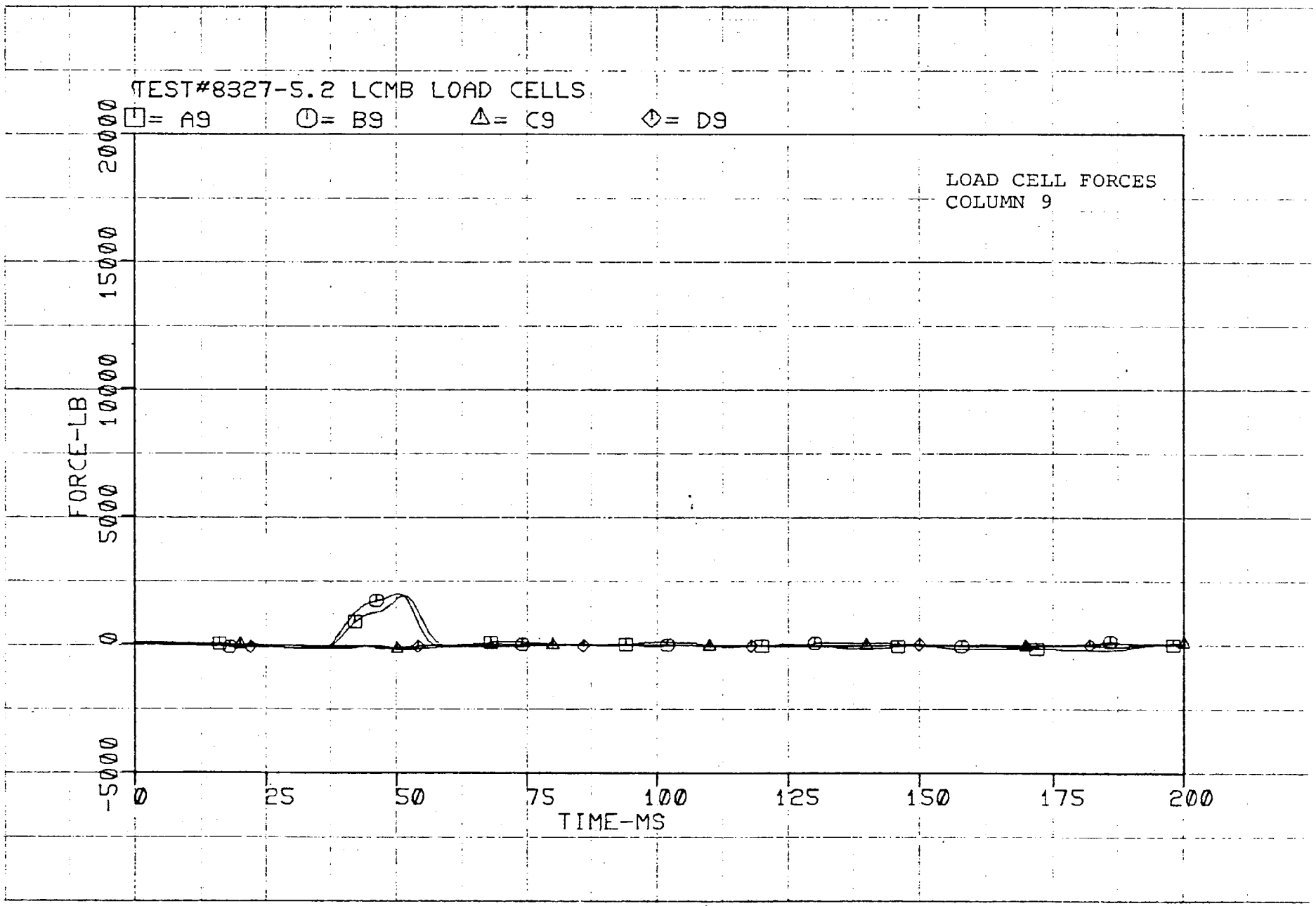

TEST#8327-5.2 LCMB LOAD CELLS
= A4
= B4
= C4
= D4
LOAD CELL FORCES
COLUMN 4
NOTE: ALL FOUR COLUMN 4
LOAD CELLS' PLATES
BOTTOMED OUT ON
LOAD CELL BOLTS
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

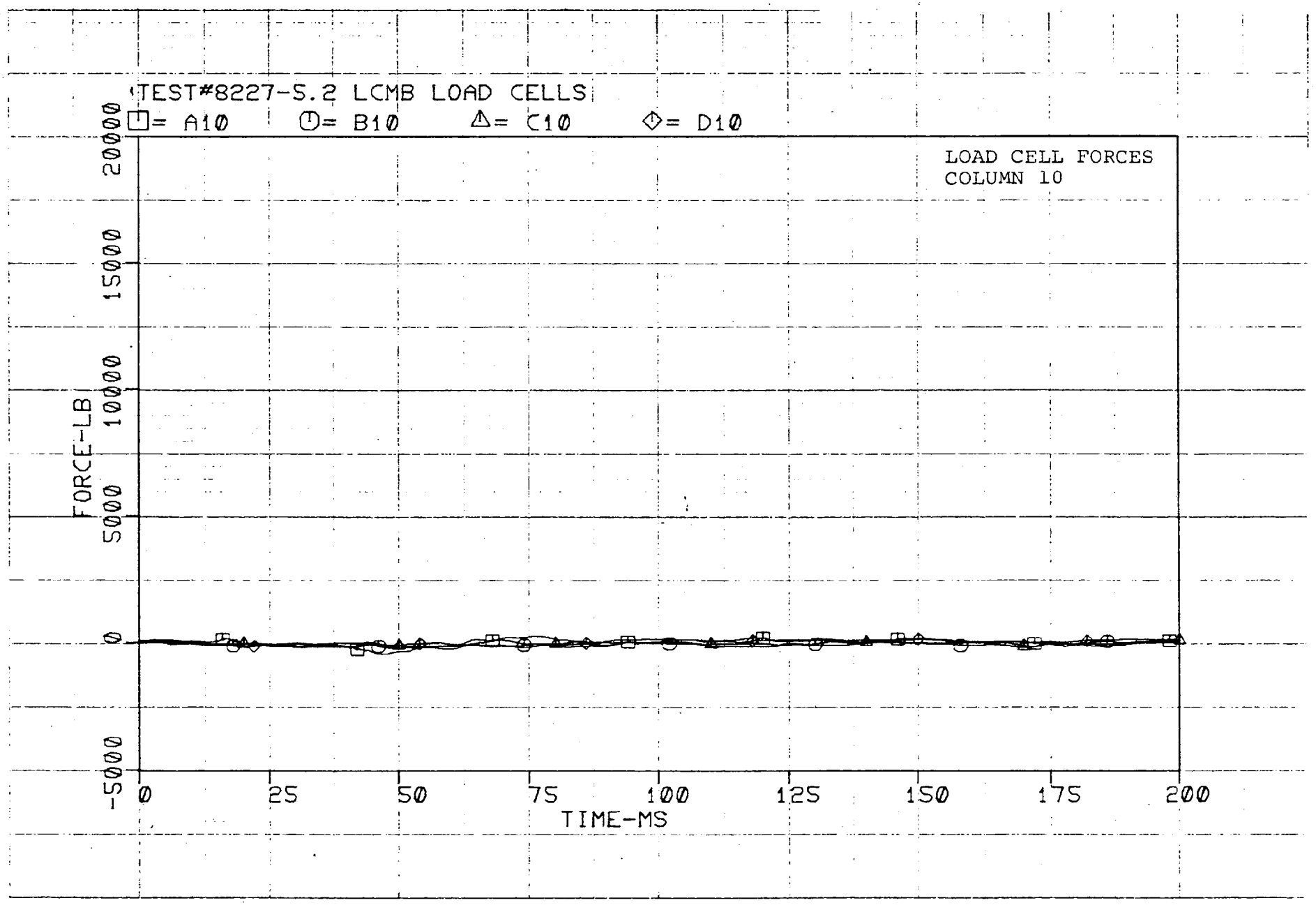

TEST#8327-5.2 LCMB LOAD CELLS
= A5
= B5
= C5
= D5
LOAD CELL FORCES
COLUMN 5
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

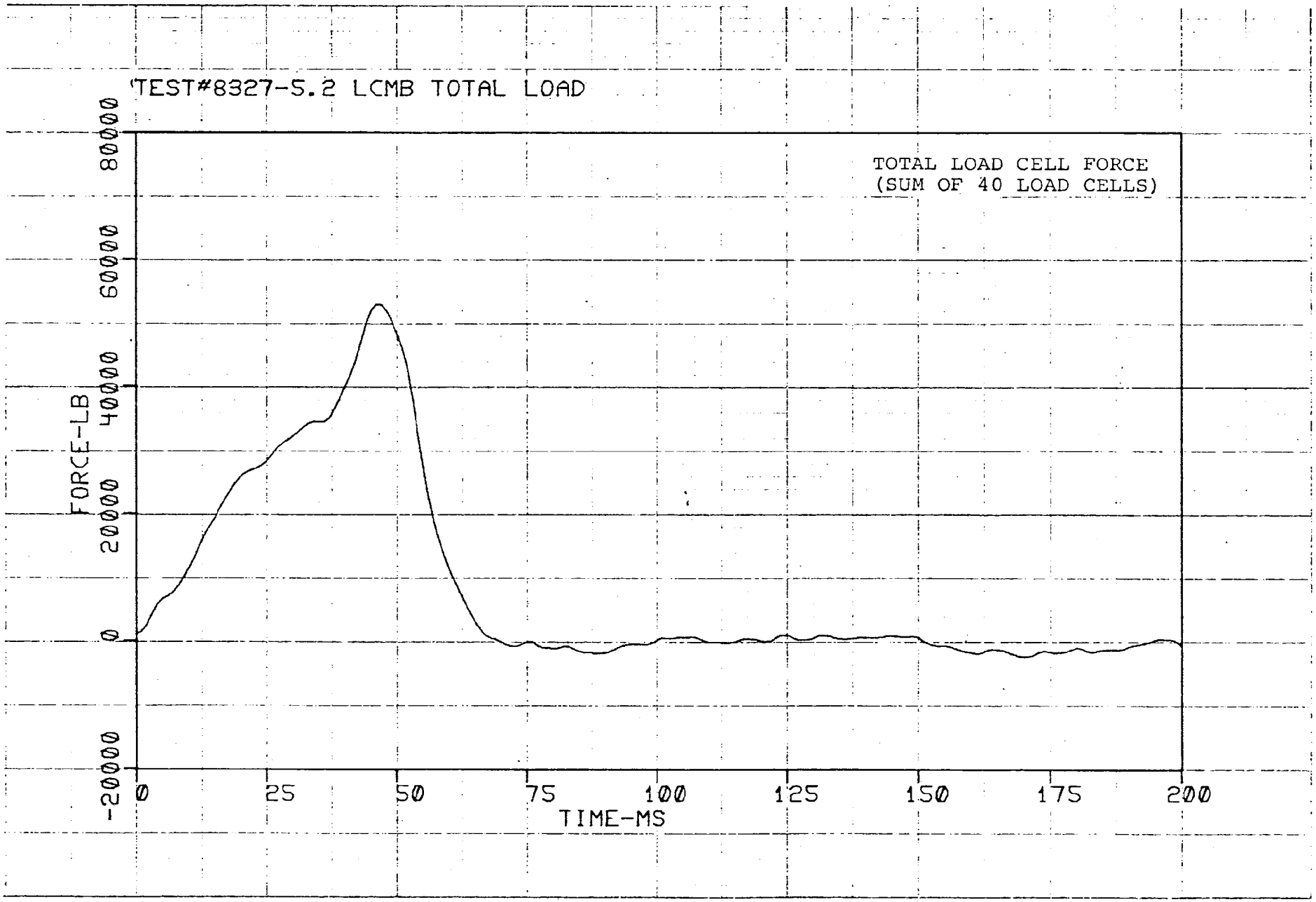

TEST#8327-5.2 LCMB LOAD CELLS
□= A6
○= B6
△= C6
◇= D6
LOAD CELL FORCES
COLUMN 6
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

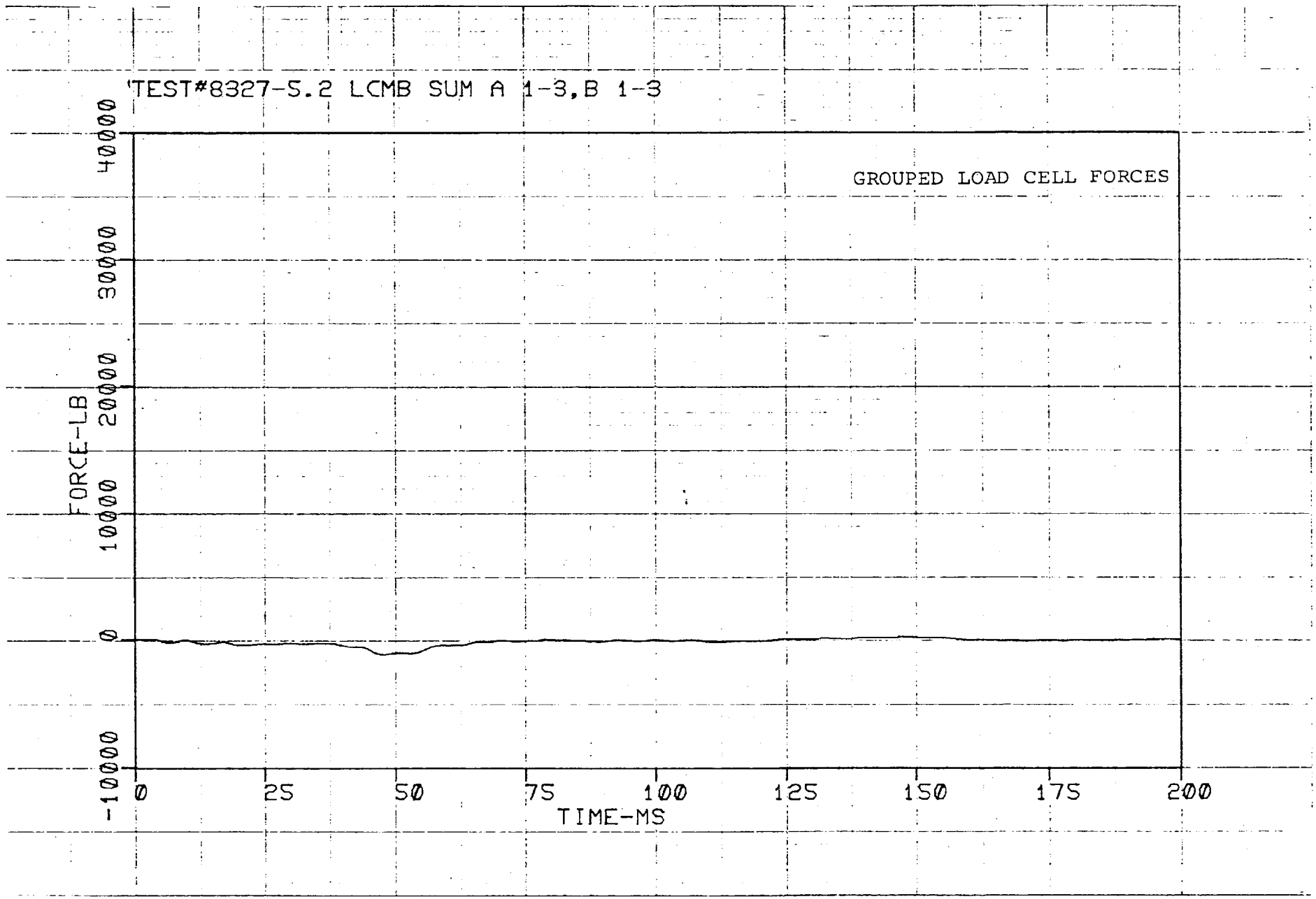

TEST#8327-S.2 LCMB LOAD CELLS
□= A7
○= B7
△= C7
◇= D7
LOAD CELL FORCES
COLUMN 7
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

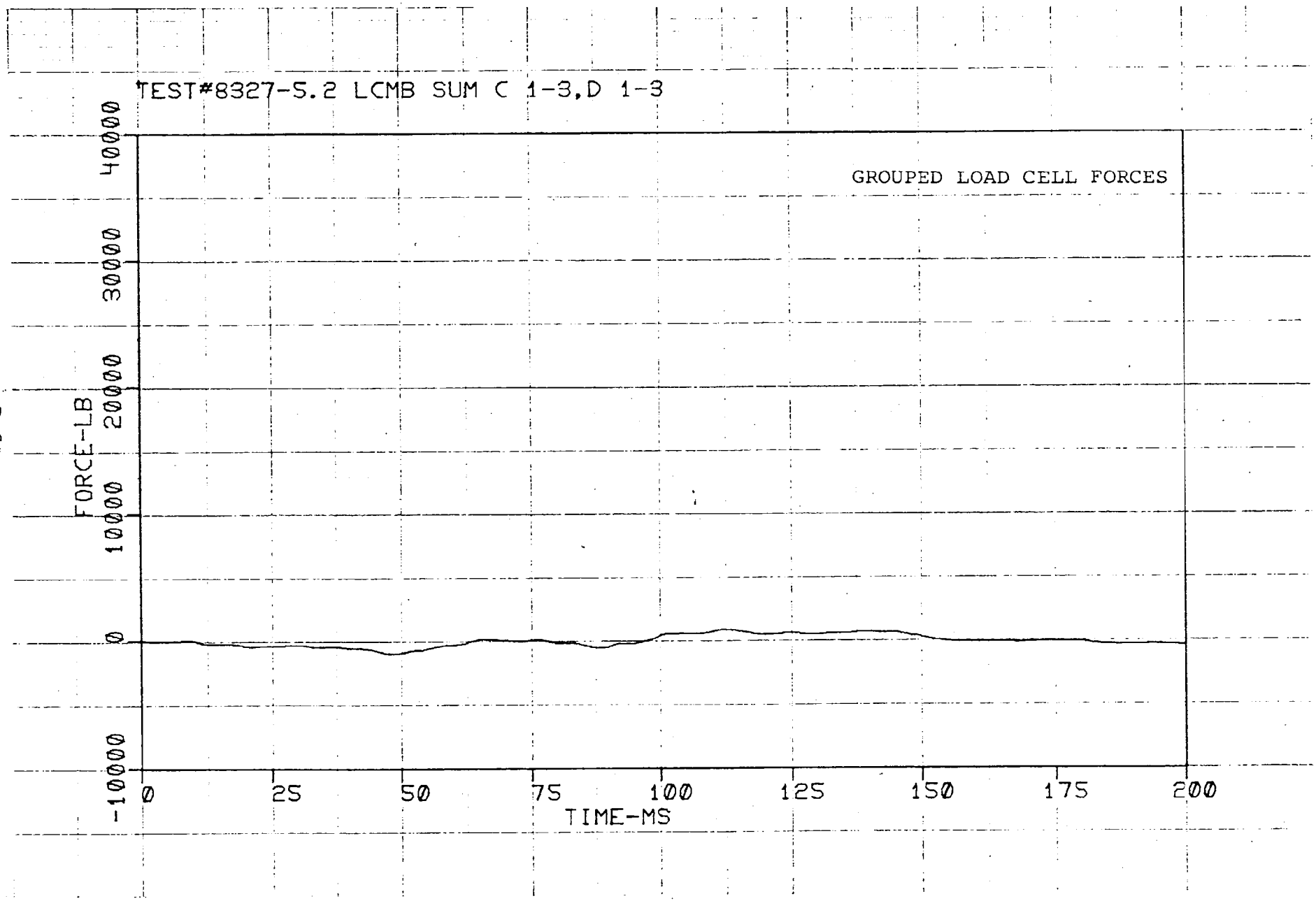

TEST#8327-5.2 LCMB LOAD CELLS
□= A8
○= B8
△= C8
◇= D8
LOAD CELL FORCES
COLUMN 8
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

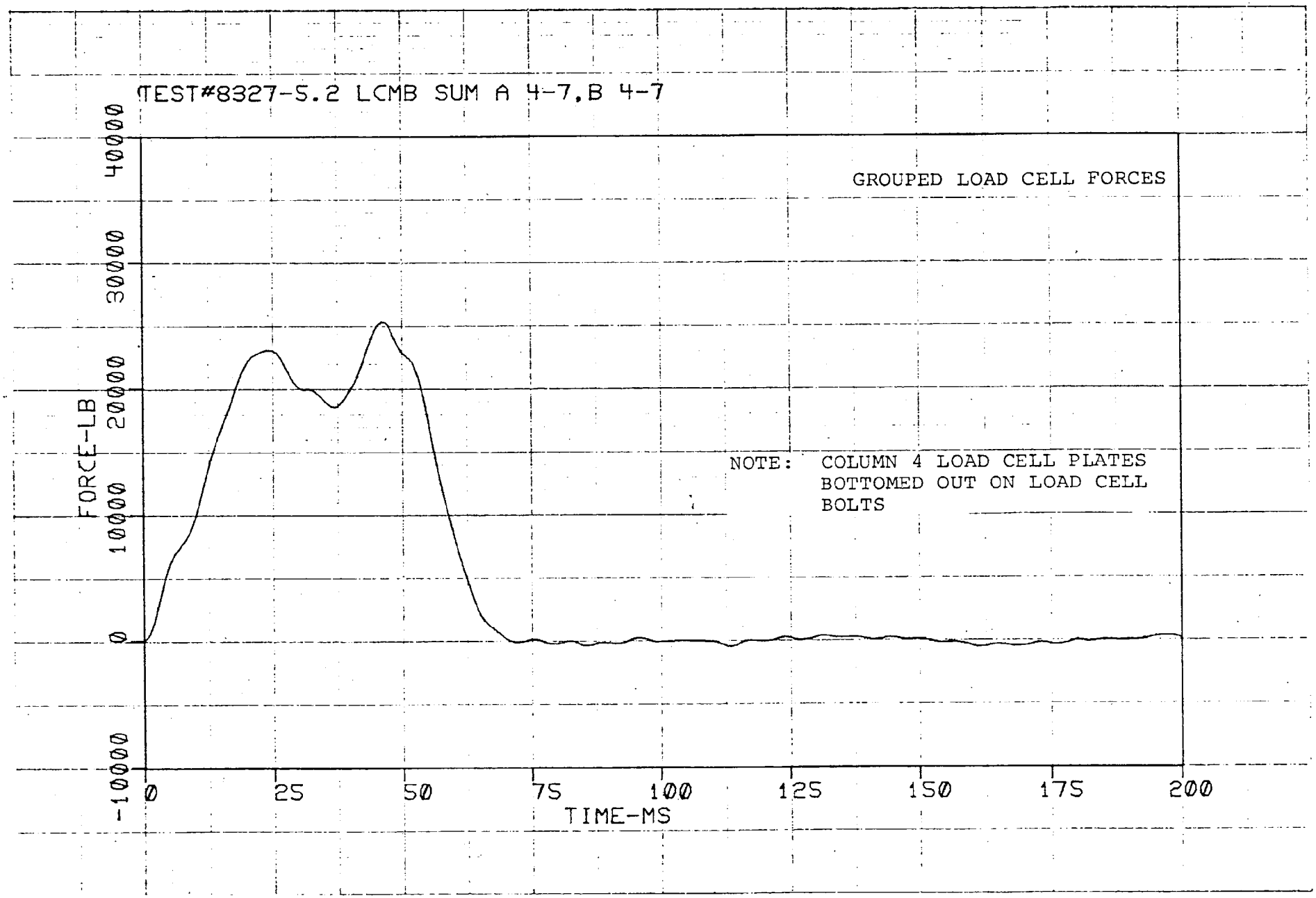

TEST#8327-5.2 LCMB LOAD CELLS
□= A9
○= B9
△= C9
◇= D9
LOAD CELL FORCES
COLUMN 9
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

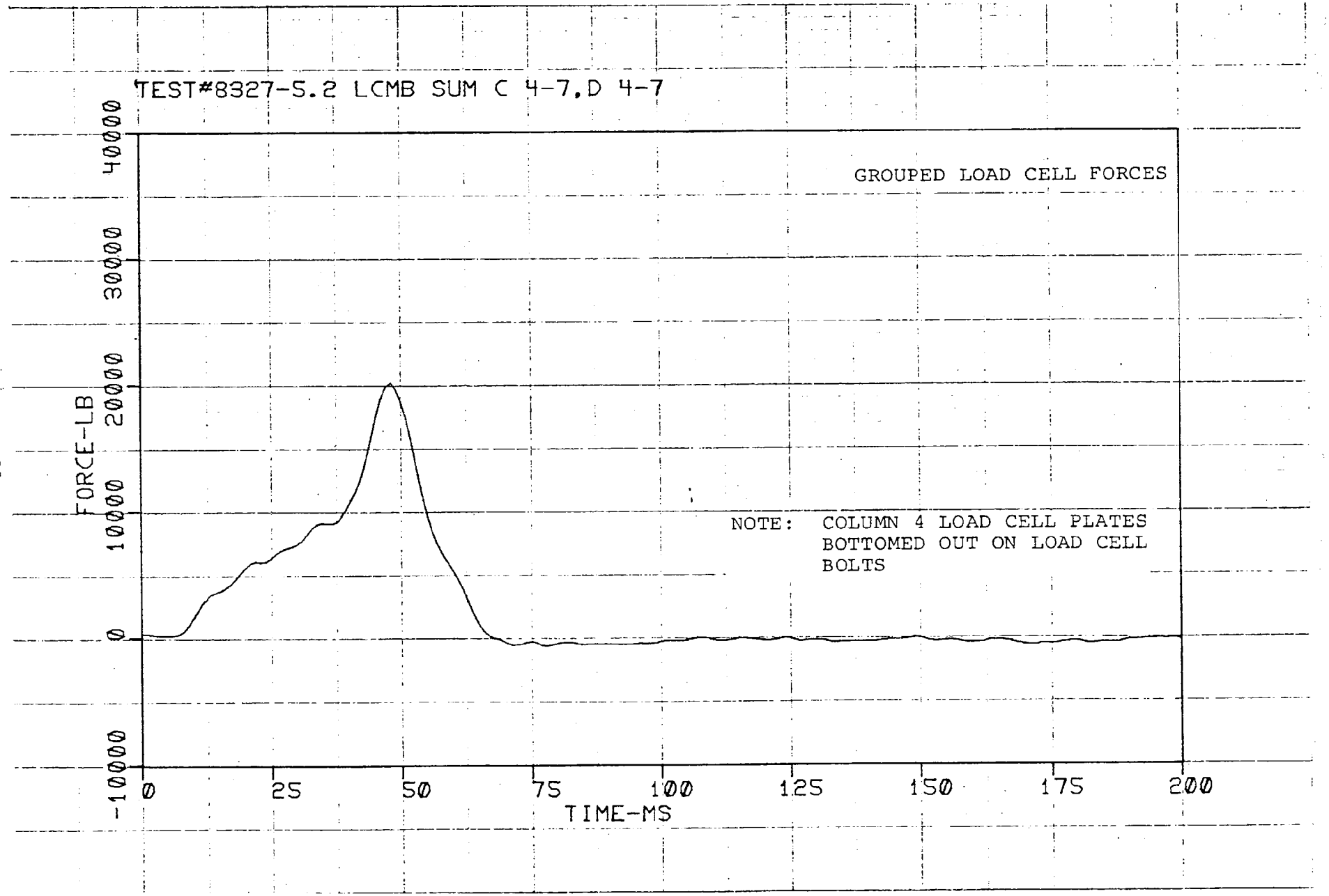

TEST#8227-S.2 LCMB LOAD CELLS
□= A10
○= B10
△= C10
◇= D10
LOAD CELL FORCES
COLUMN 10
FORCE-LB
20000
15000
10000
5000
0
-5000
0
25
50
75
100
125
150
175
200
TIME-MS

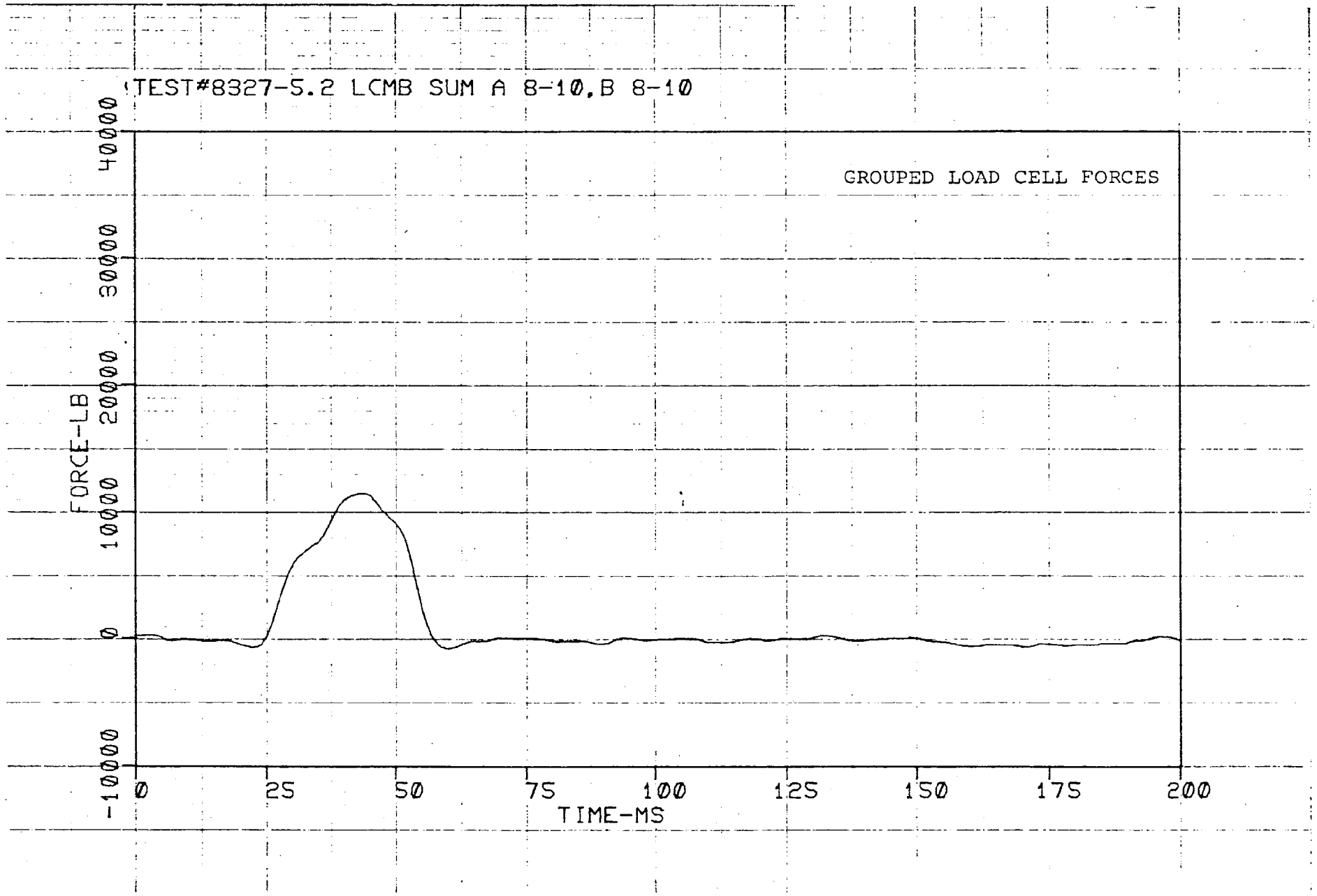

TEST#8327-5.2 LCMB TOTAL LOAD
TOTAL LOAD CELL FORCE
(SUM OF 40 LOAD CELLS)
FORCE-LB
80000
60000
40000
20000
0
-20000
0
25
50
75
100
125
150
175
200
TIME-MS

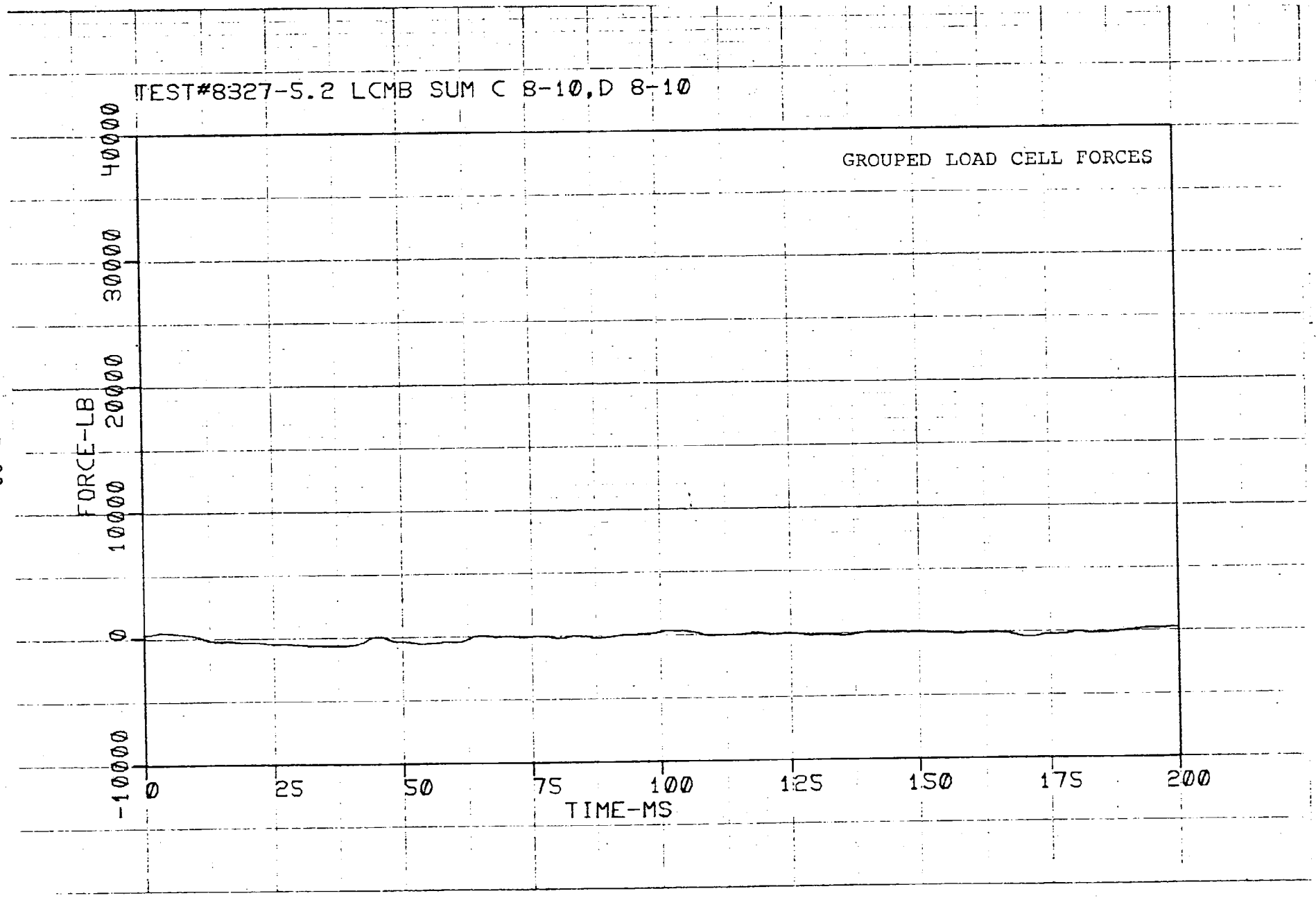

TEST#8327-5.2 LCMB SUM A 1-3,B 1-3
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


TEST#8327-5.2 LCMB SUM C 1-3,D 1-3
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS

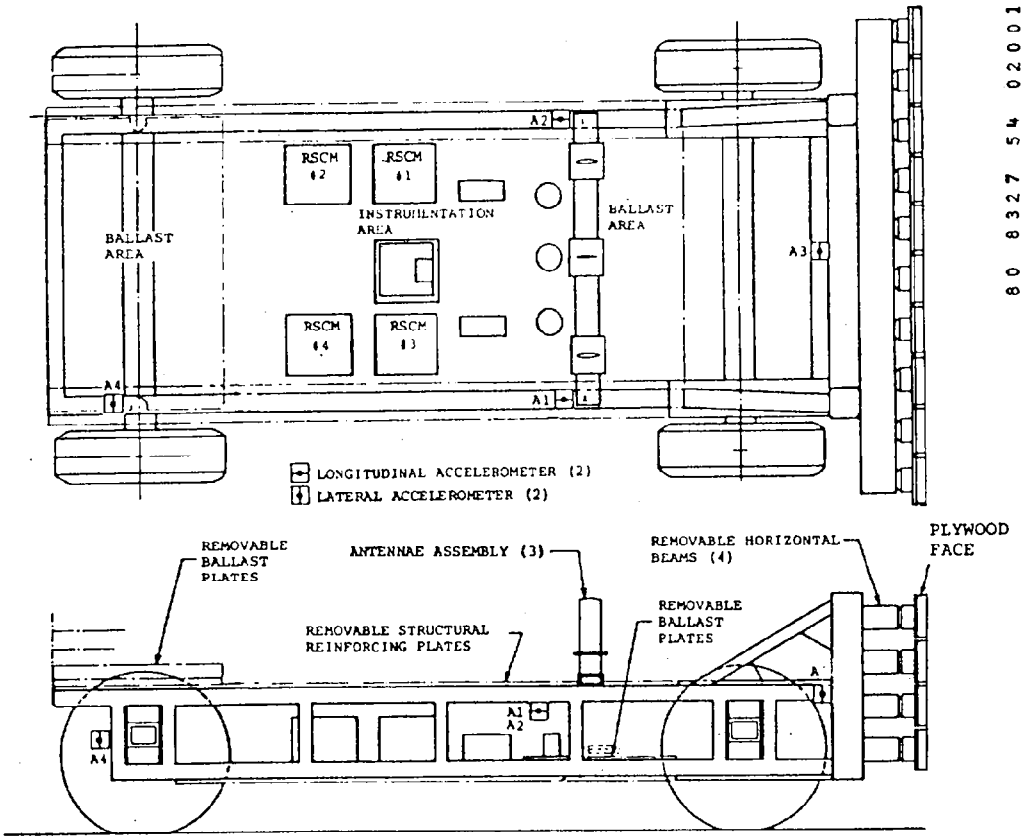

TEST#8327-5.2 LCMB SUM A 4-7,B 4-7
GROUPED LOAD CELL FORCES
NOTE: COLUMN 4 LOAD CELL PLATES BOTTOMED OUT ON LOAD CELL BOLTS
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


TEST#8327-5.2 LCMB SUM C 4-7,D 4-7
GROUPED LOAD CELL FORCES
NOTE: COLUMN 4 LOAD CELL PLATES BOTTOMED OUT ON LOAD CELL BOLTS
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


TEST#8327-5.2 LCMB SUM A 8-10,B 8-10
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS


TEST#8327-5.2 LCMB SUM C 8-10,D 8-10
GROUPED LOAD CELL FORCES
FORCE-LB
40000
30000
20000
10000
0
-10000
0
25
50
75
100
125
150
175
200
TIME-MS

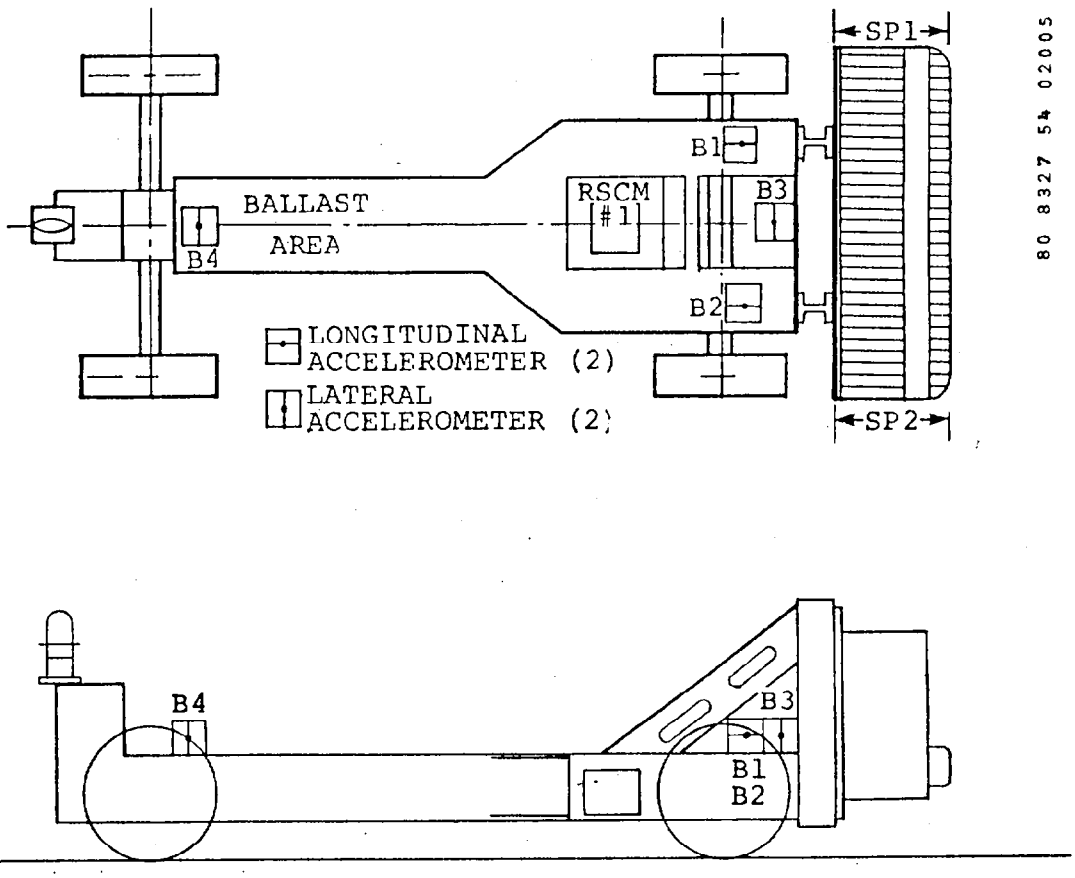
APPENDIX C
INSTRUMENTATION FOR
TEST 8327-5.1



VEHICLE INSTRUMENTATION LOCATIONS AND PHYSICAL COORDINATES					MAXIMUM EXPECTED READINGS (G)		
No.	Description of Location	X*	Y*	Z*	LONG	LAT	VERT
A1	LCMB accelerometer frame rail right side	84	23	20	25		
A2	LCMB accelerometer frame rail left side	84	-23	20	25		
A3	LCMB accelerometer front crossmember	130	-1	23.5		25	
A4	LCMB accelerometer right rear frame rail	9	22	16		25	
40	Load cells				15.0 Klb		

*Reference Points:
X Direction - Rear end of LCMB
Y Direction - Centerline of LCMB - left centerline (-), right centerline (+)
Z Direction - Ground level.

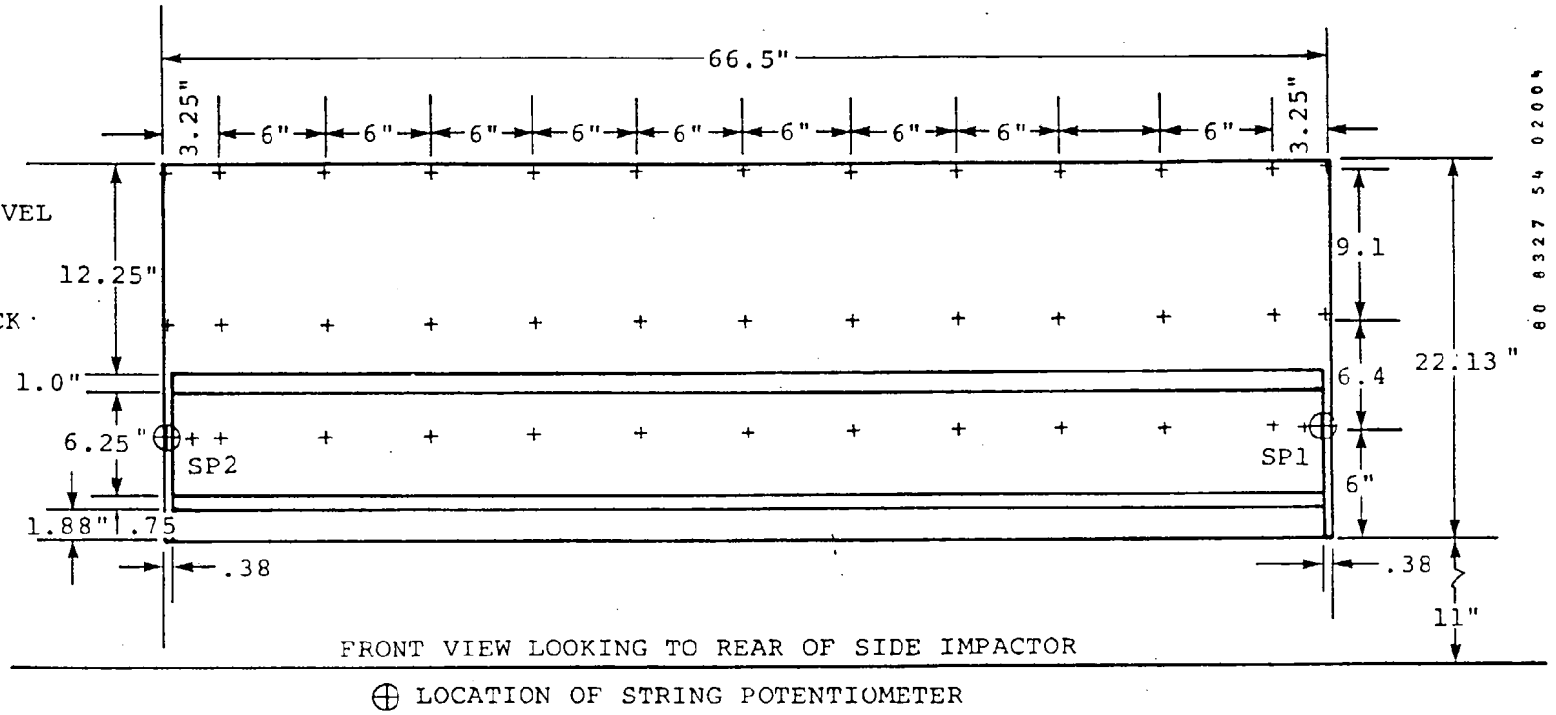
Figure C-1. LCMB Instrumentation (Test 8327-5.1).



VEHICLE ACCELEROMETER LOCATIONS AND PHYSICAL COORDINATES					MAXIMUM EXPECTED READINGS (G)		
No.	Description of Location	X*	Y*	Z*	LONG	LAT	VERT
B1	Left side of bogey	153	-17.25	23	25		
B2	Right side of bogey	153	16.75	23	25		
B3	Front crossmember of bogey	159	-1	19		25	
B4	Rear section of bogey	31	0	19		25	
SP1	Driver side of E/A face	162	-25	18	24"		
SP2	Passenger side of E/A face	162	25	18	±15"		

*Reference Points:
X Direction - Centerline of rear bumper
Y Direction - Centerline of vehicle - left centerline (-), right centerline (+)
Z Direction - Ground level.

Figure C-2. Side Impactor Bogey Vehicle Instrumentation (Test 8327-5.1).



NOTE: PROFILE MEASUREMENTS TAKEN USING POINTS DESIGNATED "+"

Figure C-3. Front View of Side Impactor Face (Looking Aft) Showing String Potentiometer Locations and Static Profiling Points (Test 8327-5.1).

TABLE C-1. INSTRUMENTATION SUMMARY (TEST 8327-5.1)

LCMB		Side Impactor Bogey Vehicle	
Required Number of Channels	Channel Function	Required Number of Channels	Channel Function
40	Load Cells	4	Accelerometers
4	Accelerometers	2	String Potentiometers
44	TOTAL	6	TOTAL
4 RSCM's Required (56 Channels Available)		1 RSCM Required (14 Channels Available)	

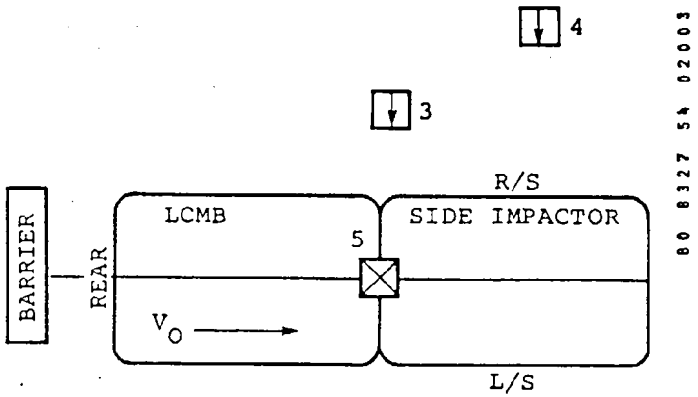
Test No: 8327-5.1 Test Date: 4/3/80

Test Type: LCMB-to-Side Impactor at 0°

Vehicle 1: LCMB

Vehicle 2: Side Impactor Bogey Vehicle

Comments: Side Impactor Bogey is stationary. Test conducted at midrange impact site.



80 8327 54 02003

CAMERA	YES
STILLS	X
SLIDES	X
MOVIE	X
POLAROID	
VIDEO	

CAMERA SYMBOLS

- PIT
- GROUND
- BARRIER
- OVERHEAD
- ON-BOARD
- PANNING

FRAME RATE

1. 1000 fr/sec
2. 200 fr/sec
3. Other 24 fr/sec
4. 400 fr/sec
5. 500 fr/sec

TIMING LIGHT SPEED

1. 100 Hz (10 msec/light)
2. 200 Hz (5 msec/light)
3. Other _____

Loc. No.	Location	Field of View	Lens Size	Nominal Frm Rate	Actual Timing Speed	Ser No	Impact Dist-X*	C.L. Dist-Y	CAM Hght-Z
1	Left Side	Overall Test Device and Side Impactor	13	1	105Hz		+5'6"	33'5"	
2	Left Side	Closeup of Impact	25	1	104Hz		0	20'0"	
3	Right Side	Closeup of Impact	25	1	100Hz		0	19'7"	
4	Right Side	Overall Test Device and Side Impactor	25	1	100Hz		+15'6"	61'0"	
5	Overhead at Centerline	Honeycomb Crush of Both Vehicles	8	1	101				14'7"
6	Left Side	Panning Test and Results	-	3					

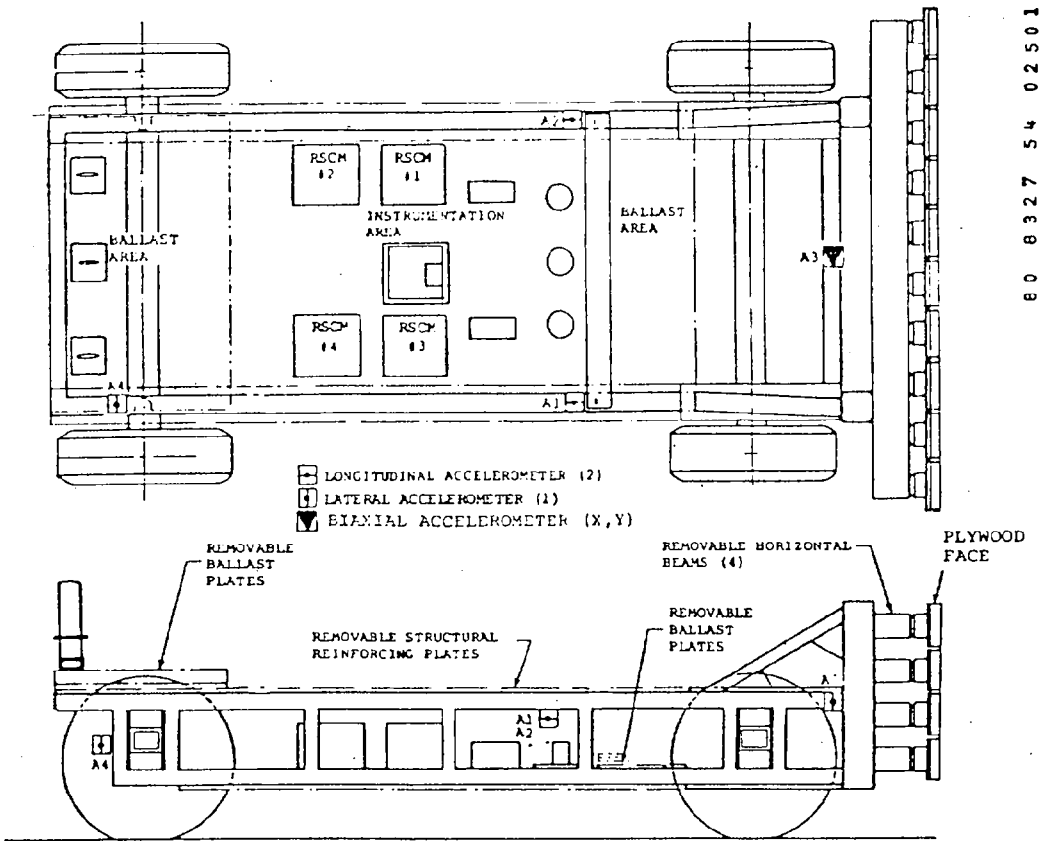
DSI FORM NO. TSO 125 *Positive values downrange

Figure C-4. Camera Locations (Test 8327-5.1).

APPENDIX D

INSTRUMENTATION FOR

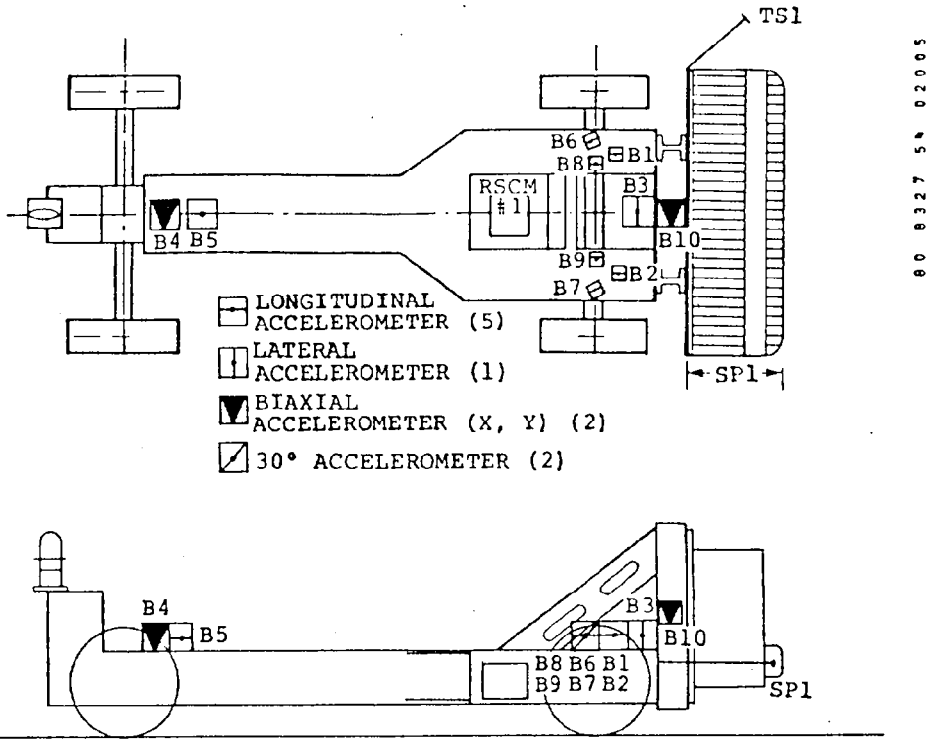
TEST 8327-5.2



No.	VEHICLE INSTRUMENTATION LOCATIONS AND PHYSICAL COORDINATES Description of Location	X*	Y*	Z*	MAXIMUM EXPECTED READINGS (G) LONG	LAT	VERT	SENSOR SCALE (G)
A1	LCMB Accelerometer Frame Rail Right Side	84	23	20	60			75
A2	LCMB Accelerometer Frame Rail Left Side	84	-23	20	60			75
A3	LCMB Accelerometer	130	-1	23.5	60	60		75
A4	LCMB Accelerometer Right Rear Frame Rail	9	22	16		60		75
40	Load Cells				15.0 Klb			

*Reference Points:
X Direction - Rear End of LCMB
Y Direction - Centerline of LCMB - Left ℄ (-), Right ℄ (+)
Z Direction - Ground Level

Figure D-1. LCMB Instrumentation (Test 8327-5.2).



VEHICLE INSTRUMENTATION LOCATIONS AND PHYSICAL COORDINATES					MAXIMUM EXPECTED READINGS (G)			SENSOR SCALE (G)
No.	Description of Location	X*	Y*	Z*	LONG	LAT	VERT	
B1	Left Side of Bogey	153	-17.25	23	25			37.5
B2	Right Side of Bogey	153	16.75	23	25			37.5
B3	Front Crossmember of Bogey	159	-1	19		25		37.5
B4	Rear Section of Bogey	31	0	19	25	25		37.5
B5	Rear Section of Bogey	36.5	0	19	60			75
B6	Left Side of Bogey (30°)	146.5	-21.5	23	60			75
B7	Right Side of Bogey (30°)	146.5	+21.5	23	60			75
B8	Left Side of Bogey	148.5	-17	23	60			75
B9	Right Side of Bogey	148.5	+17	23	60			75
B10	Back of 2" Mounting Plate	166.5	-1	26	60	60		75
TS1 Driver Side (Momentary Impact Switch - Mounted at 30°-7" back from impact point)								
SP1 Passenger Side					±10 in.			

*Reference Points:
X Direction - Centerline of Rear Bumper
Y Direction - Vehicle Centerline - Left ℄ (-), Right ℄ (+)
Z Direction - Ground Level

Figure D-2. SI Bogey Instrumentation (Test 8327-5.2).

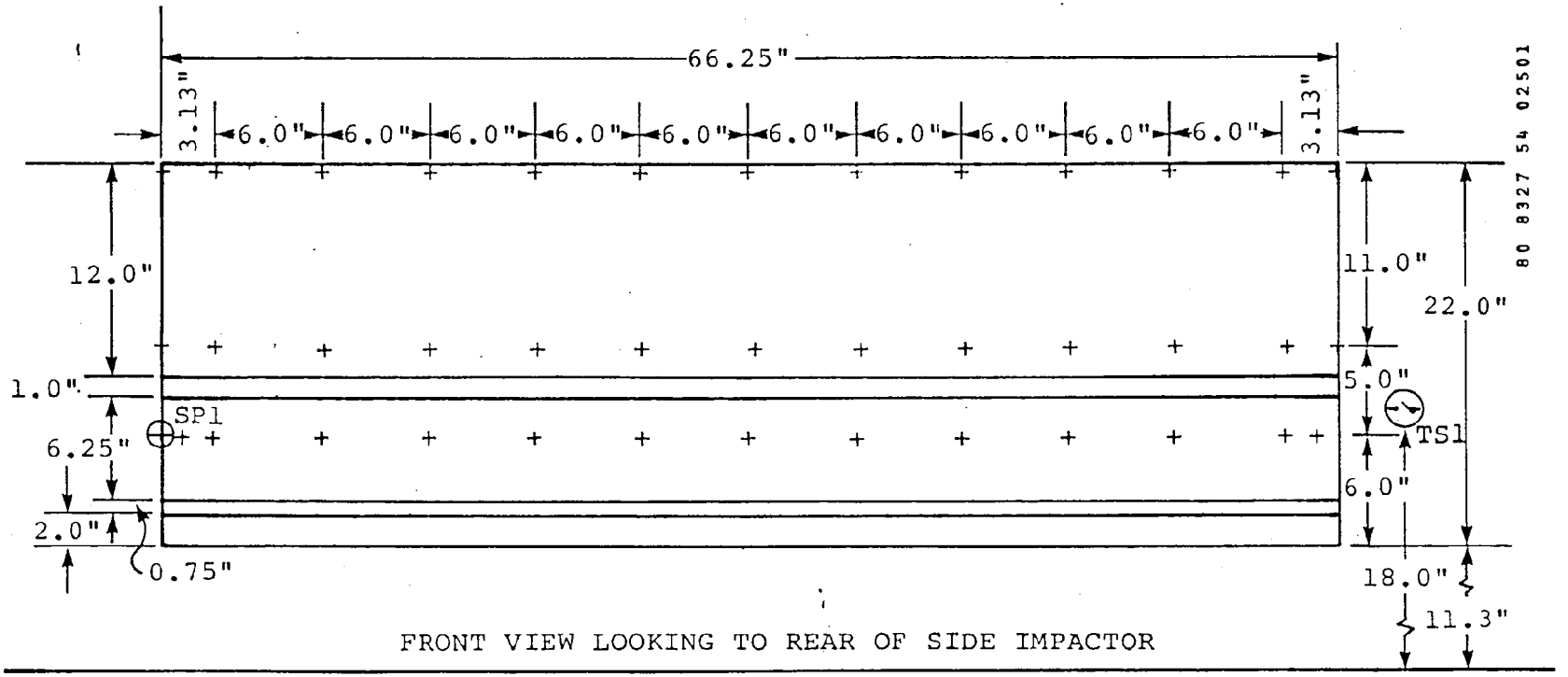


Figure D-3. Front View of Side Impactor Face Showing String Potentiometer Location, Momentary Impact Switch Location, and Profile Points (Test 8327-5.2).

TABLE D-1. INSTRUMENTATION SUMMARY (TEST 8327-5.2)

LCMB		Side Impactor Bogey Vehicle	
Required Number of Channels	Channel Function	Required Number of Channels	Channel Function
40	Load Cells	12	Accelerometers
5	Accelerometers	1	String Potentiometer
		1	Momentary Impact Switch
45	TOTAL	14	TOTAL
4 RSCM's Required (56 Channels Available)		1 RSCM Required (14 Channels Available)	

CAMERA LOCATIONS

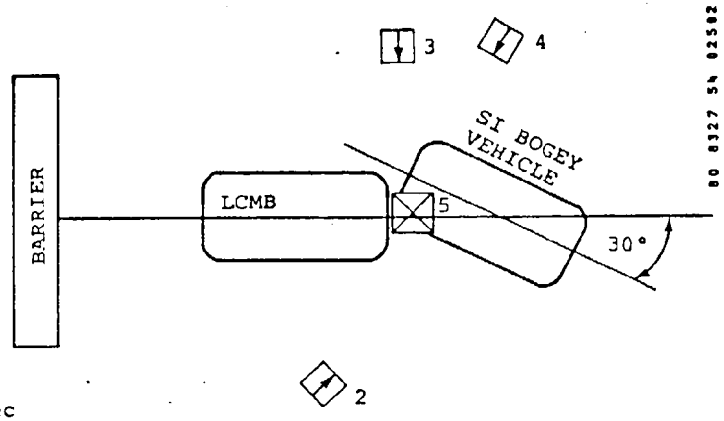
Test No: 8327-5.2 **Test Date:** 4/23/80

Test Type: LCMB-to-SI Bogey at 30°

Vehicle 1: Load Cell Moving Barrier

Vehicle 2: Side Impactor Bogey Vehicle

Comments: SI Bogey is stationary. Test will be conducted at the midrange impact site.



CAMERA	YES
STILLS	X
SLIDES	X
MOVIE	X
POLAROID	
VIDEO	

CAMERA SYMBOLS

- PIT
- GROUND
- BARRIER
- OVERHEAD
- ON-BOARD
- PANNING

FRAME RATE

1. 1000 fr/sec
2. 200 fr/sec
3. Other 24 fr/sec
4. 400 fr/sec
5. 500 fr/sec

TIMING LIGHT SPEED

1. 100 Hz (10 msec/light)
2. 200 Hz (5 msec/light)
3. Other _____

Loc. No.	Location	Field of View	Lens Size (mm)	Nom Frm Rate	Actl Tmng Spd	Ser No	Impact Dist-X*	C.L. Dist-Y	CAM Hght-Z
1	Left Side	Overall - LCMB and SI Bogey	15	1	100hz		+16 1/4"	31'6"	55"
2	Left Side	Parallel to front of SI stack	25	1	105hz		-10' 3 1/2"	20'2"	38"
3	Right Side	Close-up of SI stack	25	1	101hz		+12"	21'6"	47"
4	Right Side	Parallel to front of SI stack	25	1	101hz		15'0"	25'9"	39"
5	Overhead - SI stack	SI stack and slightly downrange	13	1	105hz				15'3 1/2"
6	To be determined	Panning - test and results		3					

*Positive values downrange.

Figure D-4. Camera Locations.

APPENDIX E
ENERGY-ABSORBING
FACE SPECIFICATIONS
FOR TESTS 5.1 AND 5.2

Figure E-1 shows the Side Impactor face mounted on the Brown Bogey and Figure E-2 defines the face components for Test 8327-5.1 and 5.2.

Figure E-1. Three-quarter Front View of Task 5 Side Impactor Face.

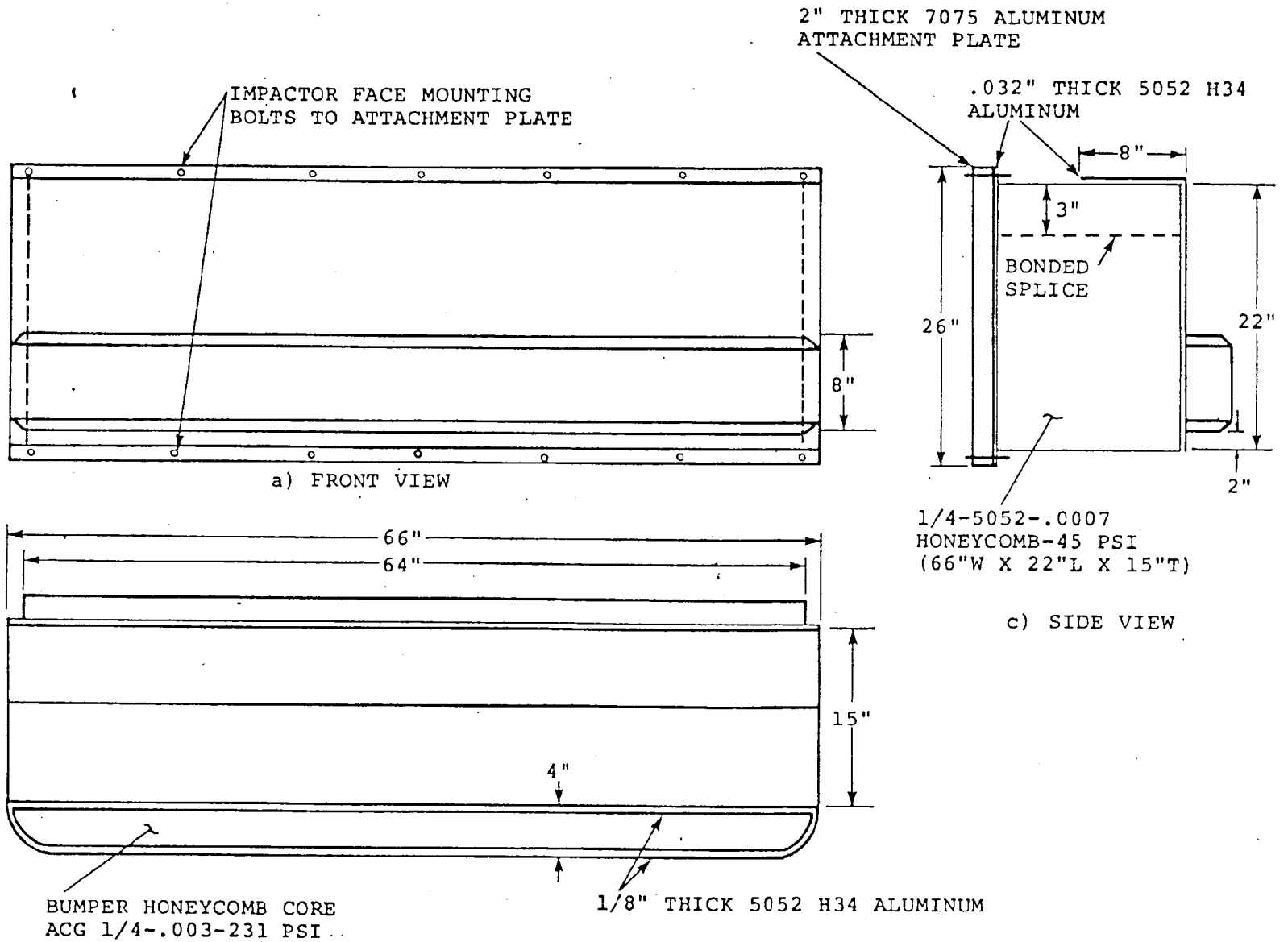


Figure E-2. Task 5 Side Impactor Face.