SECTION 4

TEST MATRICES AND TEST RESULTS

4.1 Test Matrices

A comprehensive test program was conducted over the three test periods in order to assess the performance of various installation methods as described in Sec. 3 under a wider spectrum of seismic input accelerations as described in Sec. 2. Due to practical constraints, not all installation methods were tested on every computer system and not all seismic inputs were used in every test. In addition, test objectives for different computer systems required different scale factors to be assigned to the seismic inputs.

The most convenient way of describing the types of tests conducted for each computer system is to construct a test matrix for each case.

4.1.1 June 1991 Test

The complete test matrices for this test series are given in Tables 4-1 and 4-2. The maximum input acceleration levels are summarized in Table 4-3.

4.1.2 August 1991 Test

The complete test matrix for this test series is given in Table 4-4. The maximum input acceleration levels are summarized in Tabel 4-5.

4.1.3 June 1992 Test

The complete test matrices for the test series are given in Tables 4-6 to 4-8. The maximum input acceleration levels are summarized in Table 4-9.

4.2 Test Results

Test results of most practical interest are the maximum absolute acceleration level experienced by the computer system and its maximum lateral displacement. A selected set of these values for each installation method and for each mainframe computer system is given in the appendix.

Figures 4-1 through 4-22 show performance comparisons of the installation methods for a selected series of test runs in terms of maximum absolute accelerations and lateral

displacements. The plots of only the best-case installation methods are shown, which are chosen on the basis of smallest lateral displacements and lowest maximum acceleration levels. In these plots, the maximum value at each accelerometer location is plotted on the y-axis with respect to the accelerometer location on the x-axis.

Table 4-1 Test Matrix For IBM-9370, June 1991

9370	SIMULATION RUNS								
INSTAL. TYPE	EC-1	EC-5	EC-7	Taft 1	Taft 5	Taft 7	BELL CORE	IBM 1	IBM 2
Locked Casters	X	X	X	X	X	X	X	X	X
Free Casters			33%			33%	33%		33%
Bungee Cords F.C.			X			X	X		X
Bungee Cords L.C.			X						
Two Springs			X			X	X	X	
Four Springs			X			X	X	X	
Four Toggle Bars								X	
F VE Dampers			X			X			
D VE Dampers	50%		X			X	50%		50%
2-Hz Wire Ropes			X			X			
4-Hz Wire Ropes			X			X	X		
Fixed Base			X			X	X		X

Table 4-2 Test Matrix For IBM-9371, June 1991

IBM-9371	SIMULATION RUNS			
INSTALATION TYPE	EC-7	Taft-7	BELLCORE	IBM-2
Glides	X	X	X	X
E VE Dampers	X	X	X	X
Fixed to Rear Wall	X	X	X	X
Fixed Base	X	X	X	X

Table 4-3 Maximum Acceleration Levels for June 1991

Maximum Acceleration Values	Slab X-Axis (g's)	Floor Z-Axis (g's)	Floor X-Axis (g's)
El Centro RC-7	0.66	0.24	0.71
Taft RC-7	0.20	0.19	0.62
IBM-1	0.68	0.24	0.71
IBM-2	1.02	0.33	1.02
Bellcore	1.02	0.51	0.72

Table 4-4 Test Matrix For IBM-9221, August 1991

IBM-9221	SIMULATION RUNS				
INSTALLATION TYPE	EC-1	EC-3	EC-7	IBM 1	IBM 2
Locked Casters	X	X	X		X
Locked Casters Rotated 90 Deg.	X	X			
Four Toggle Bars Free Casters 40-Dur. Bushings	X		X		X
Four Toggle Bars Free Casters 80-Dur. Bushings			X		X
Front & Back Fixed		X	X		X
Sides Fixed		X	X		X
Two Console Series Fixed Front & Back	X	X	X		X
Two Console Series Toggle Bars	X	X	X		X
Two Console Series Locked Casters	X	X	X		
VE Dampers, Case-1	X	X	X		
VE Dampers, Case-2	X	X	X		
VE Dampers, Case-3	X	X	X		

Table 4-5 Maximum Acceleration Levels for August 1991

Maximum Acceleration Values	Slab X-Axis (g's)	Slab Z-Axis (g's)	Floor X-Axis (g's)
El Centro RC-1	0.45	0.24	0.53
El Centro RC-3	0.50	0.24	0.57
El Centro RC-7	0.82	0.23	1.15
IBM-2	1.83	0.34	2.04

Table 4-6 Test Matrix for Frame-8, June 1992

FRAME-8	SIMULATION RUNS							
INSTALLATION TYPE	EC-1	EC-3	EC-5	EC-7	EC-1.5	IBM 1	IBM 2	BELL CORE
Toggle Bars 80-Durometer		X		X	X	X	X	X
3/16 Wire Cable, 80-Durometer		X		X	X	X	X	X
3/16 Wire Cable, Teflon Bush.		X		X				
Springs K=570 lb/in Teflon Bush.		X		X	X	X	X	
5/32 Wire Cable Teflon Bush.		X		X	X	X		
Toggle Bars Alum. Bush.		X		X	X	X	X	X
Toggle Bars Loose, Alum. Bush.						X	X	
Normal Lev. X-Axis	X	X	X	X		X		
Normal Lev. Y-Axis		X		X		X	X	

Table 4-7 Test Matrix for Frame-1, June 1992

FRAME-1	SIMULATION RUNS							
INSTALLATION TYPE	EC-1	EC-3	EC-5	EC-7	EC 1.5	IBM 1	IBM 2	BELL CORE
Casters	X	X						
NTT Levelers	X	X	X	X				
Normal lev.	X	X	X	X				
Toggle Bars 80-Durometer		X		X	X	X	X	X
Toggle Bars Alum. Bush.		X		X	X	X	X	X
5/32 Wire Cable Teflon Bush.		X		X	X	X	X	X
NTT Levelers Toggle Bars Alum. Bush.		X	X	X	X	X	X	X
NTT Levelers 3/16 Wire Cable Alum. Bush.		X		X	X	X	X	X
3/16 Wire Cable Teflon Bush.		X		X	X	X	X	X
Springs K=570 lb/in.		X		X	X	X		
Springs K=290 lb/in.		X						
Fixed X-Axis		X		X	X	X	X	X
Fixed Y-Axis		X		X	X	X	X	X
Fixed 1-Bolt X-Axis		X		X	X	X	X	X

Table 4-8 Test Matrix for Endicott Frame, June 1992

ENDICOTT FRAME	SIMULATION RUNS							
INSTALLATION TYPE	EC-1	EC-3	EC-5	EC-7	EC 1.5	IBM 1	IBM 2	BELL CORE
Normal Lev. X-Axis		X		X		X	X	X
Toggle Bars 80-Durometer		X		X		X	X	X
NTT Levelers Toggle Bars 80-Durometer		X		X		X	X	X
Toggle Bars Alum. Bush.		X		X		X	X	X
NTT levelers Toggle Bars Alum. Bush.		X		X		X	X	X
Toggle Bars Loose Alum. Bush.						X	X	

Table 4-9 Maximum Acceleration Levels for June 1992

Maximum Acceleration Values	Slab X-Axis (g's)	Slab Z-Axis (g's)	Floor X-Axis (g's)
El Centro RC-3	0.48	0.16	0.54
El Centro RC-7	0.70	0.16	0.73
IBM-1	0.78	0.30	0.91
IBM-2	0.97	0.31	1.80
Bellcore	0.81	0.35	1.35

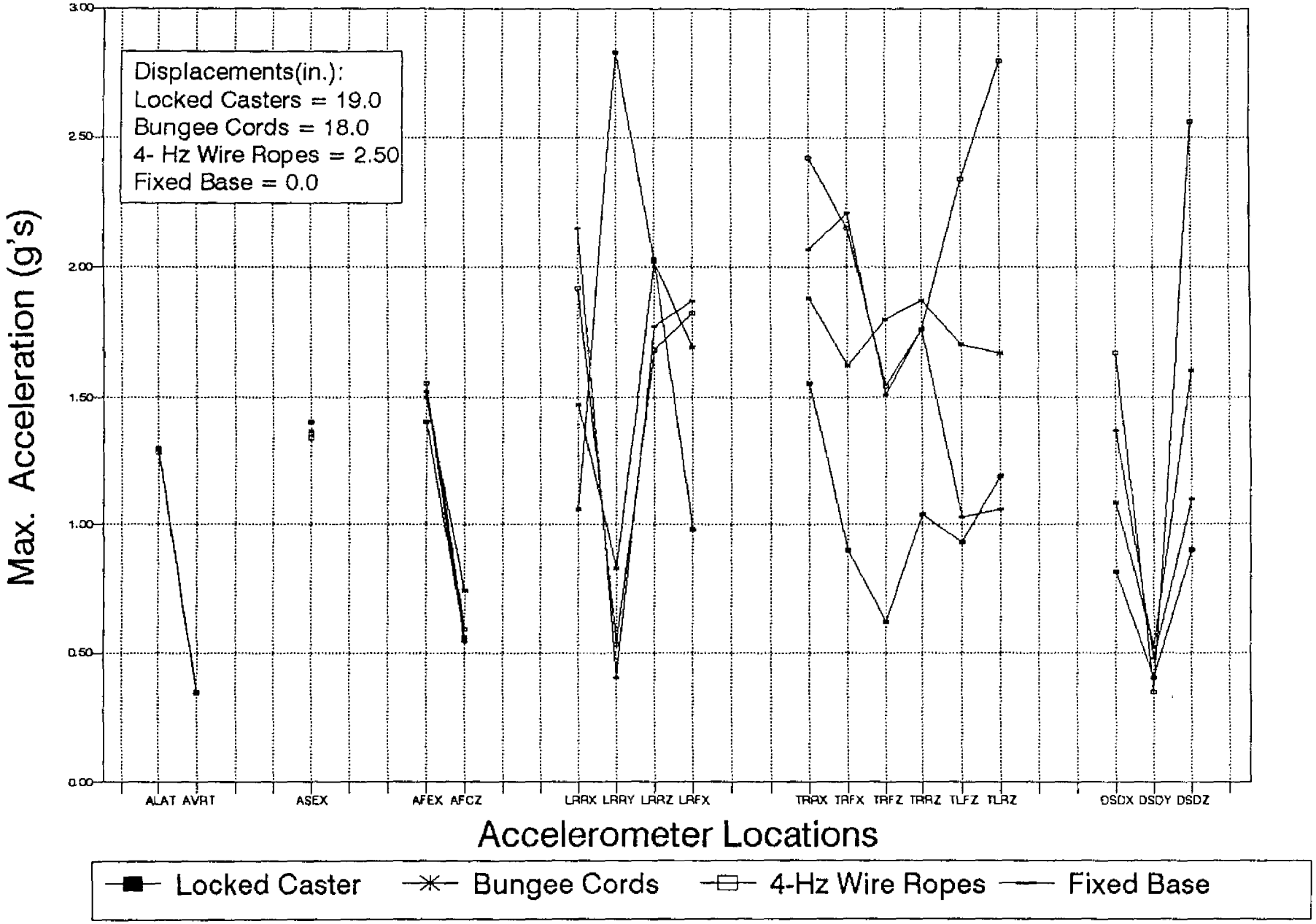

Fig. 4-1 IBM 9370, IBM2 Input

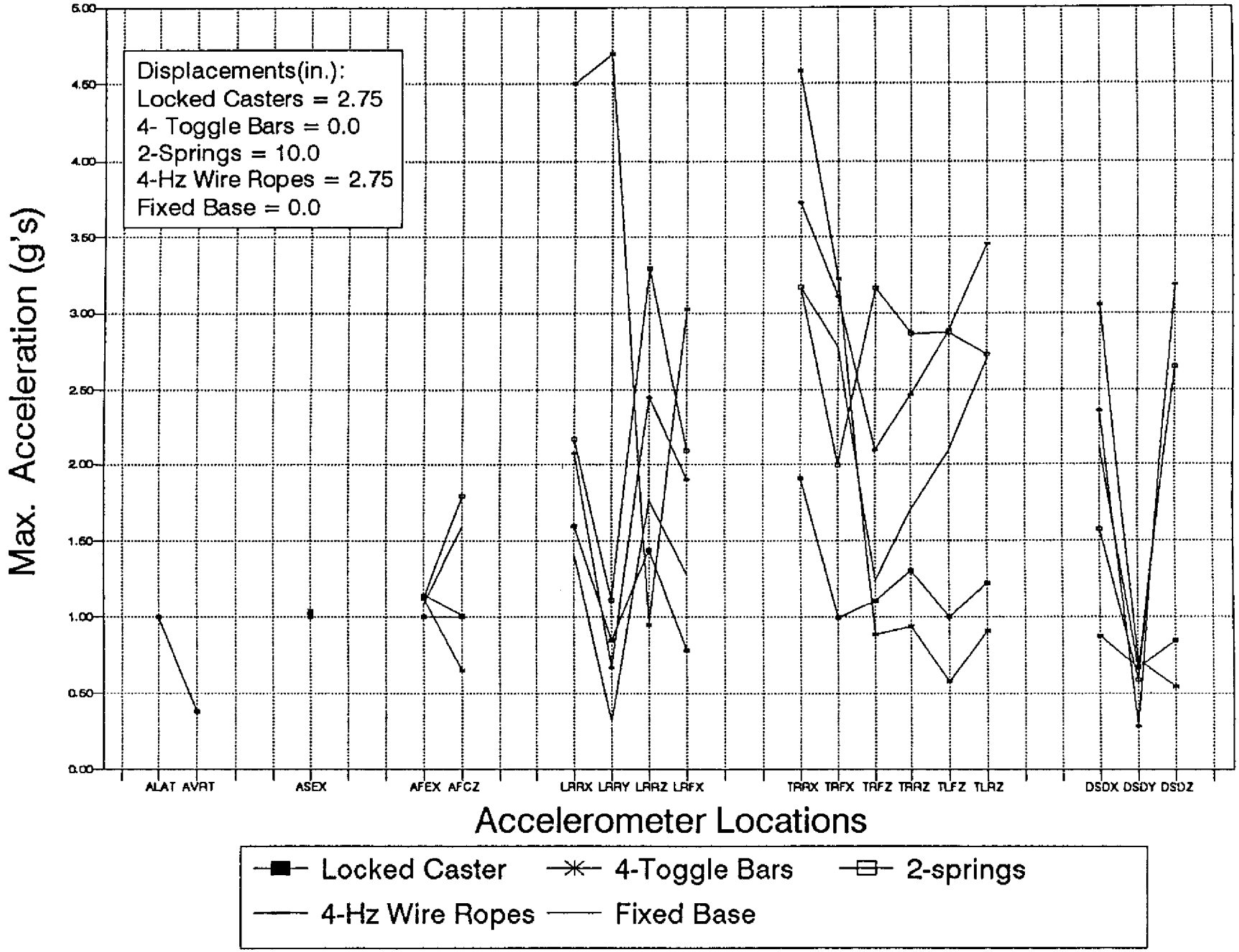

Fig. 4-2 IBM 9370, Bellcore Input

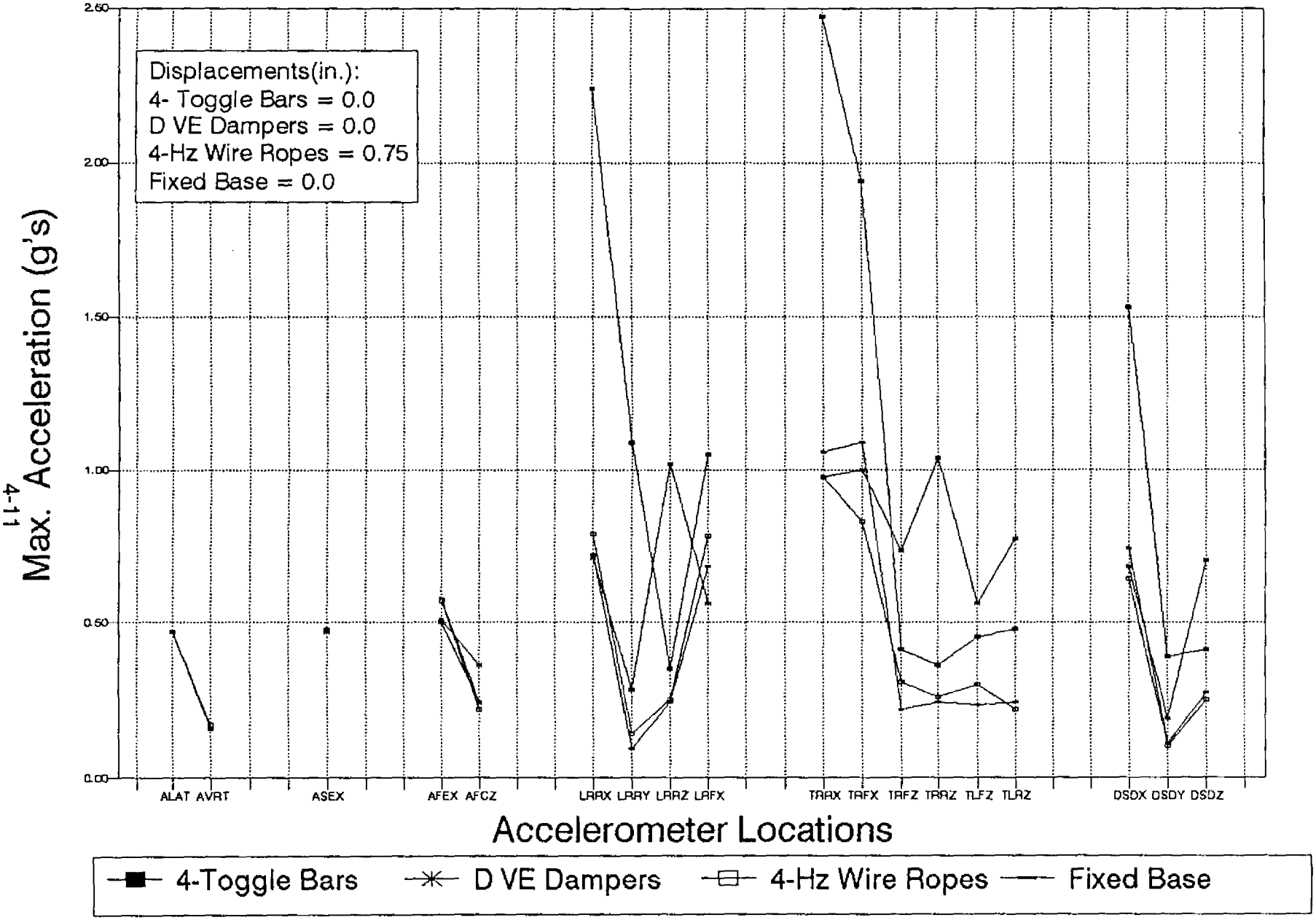

Fig. 4-3 IBM 9370, Taft RC-7 Input

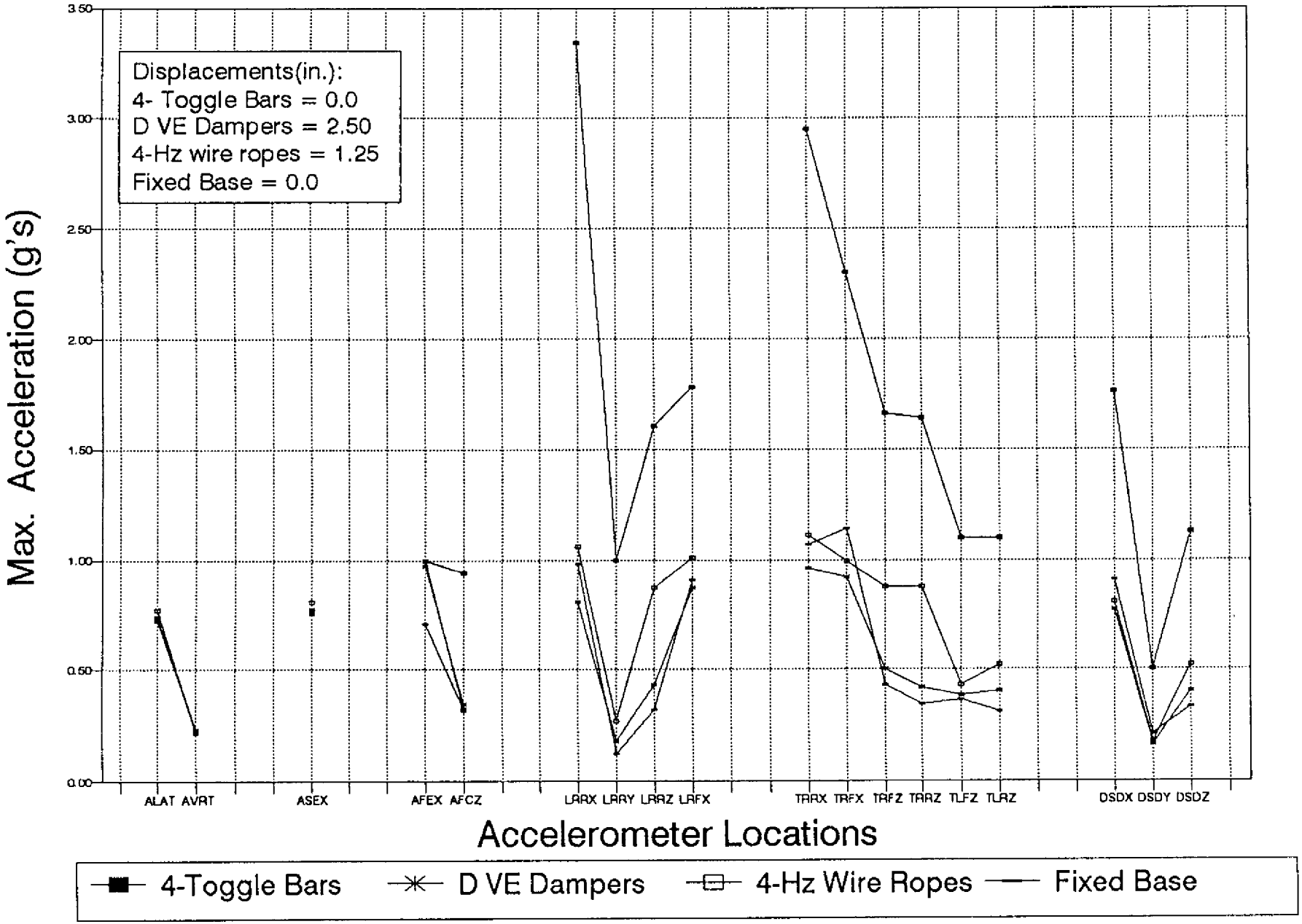

Fig. 4-4 IBM 9370, El Centro RC-7 Input

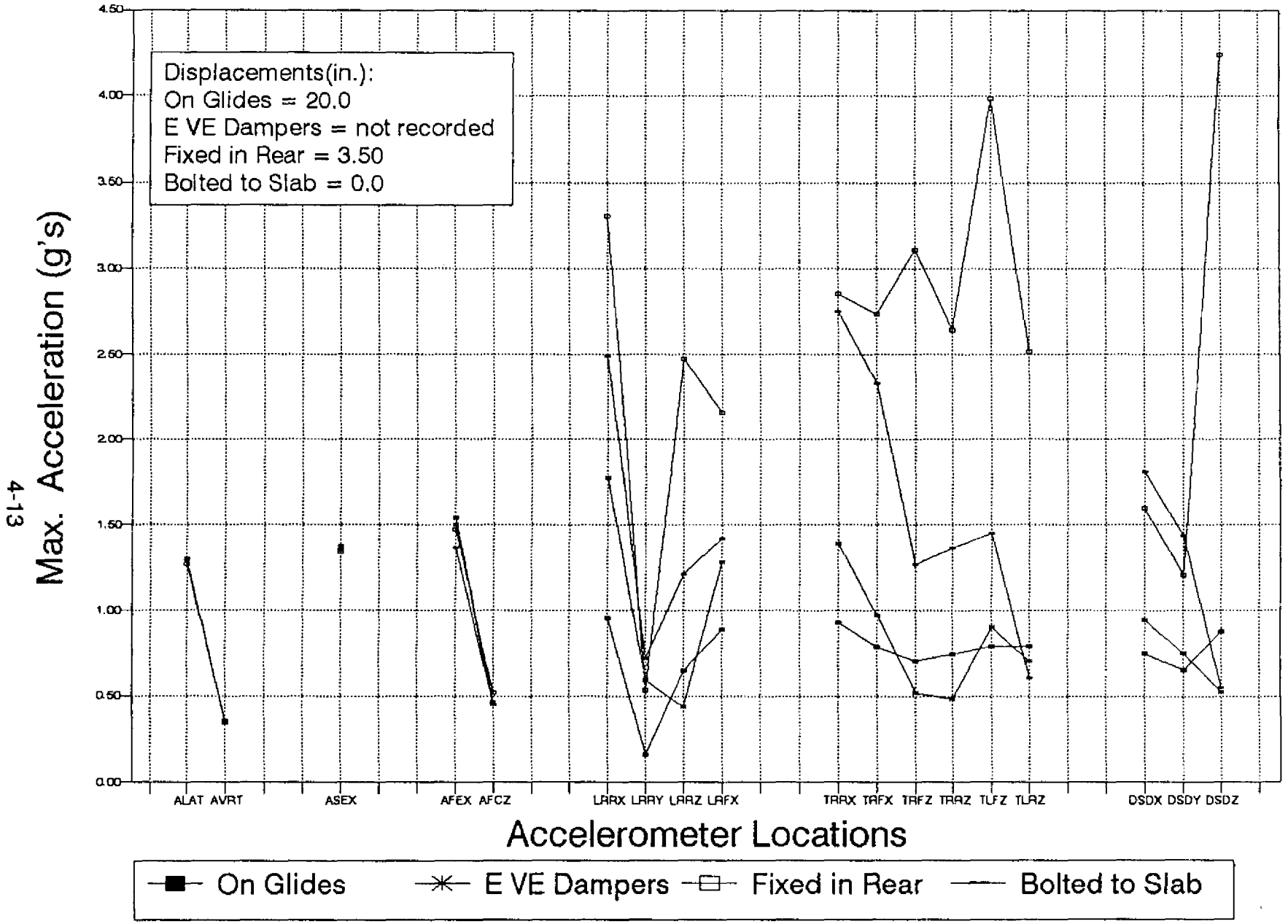

Fig. 4-5 IBM 9371 IBM2 Input

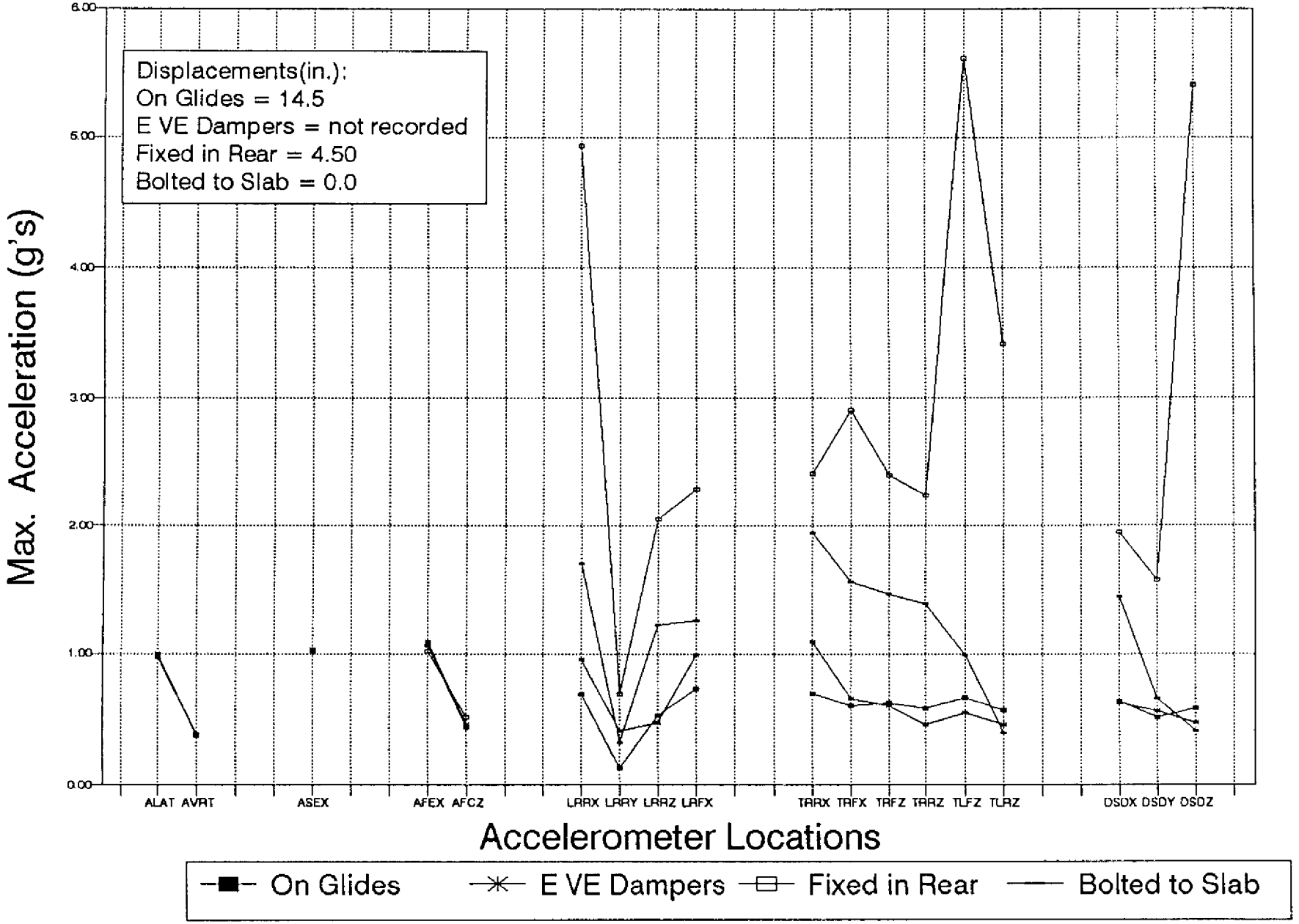

Fig. 4-6 IBM 9371, Bellcore Input

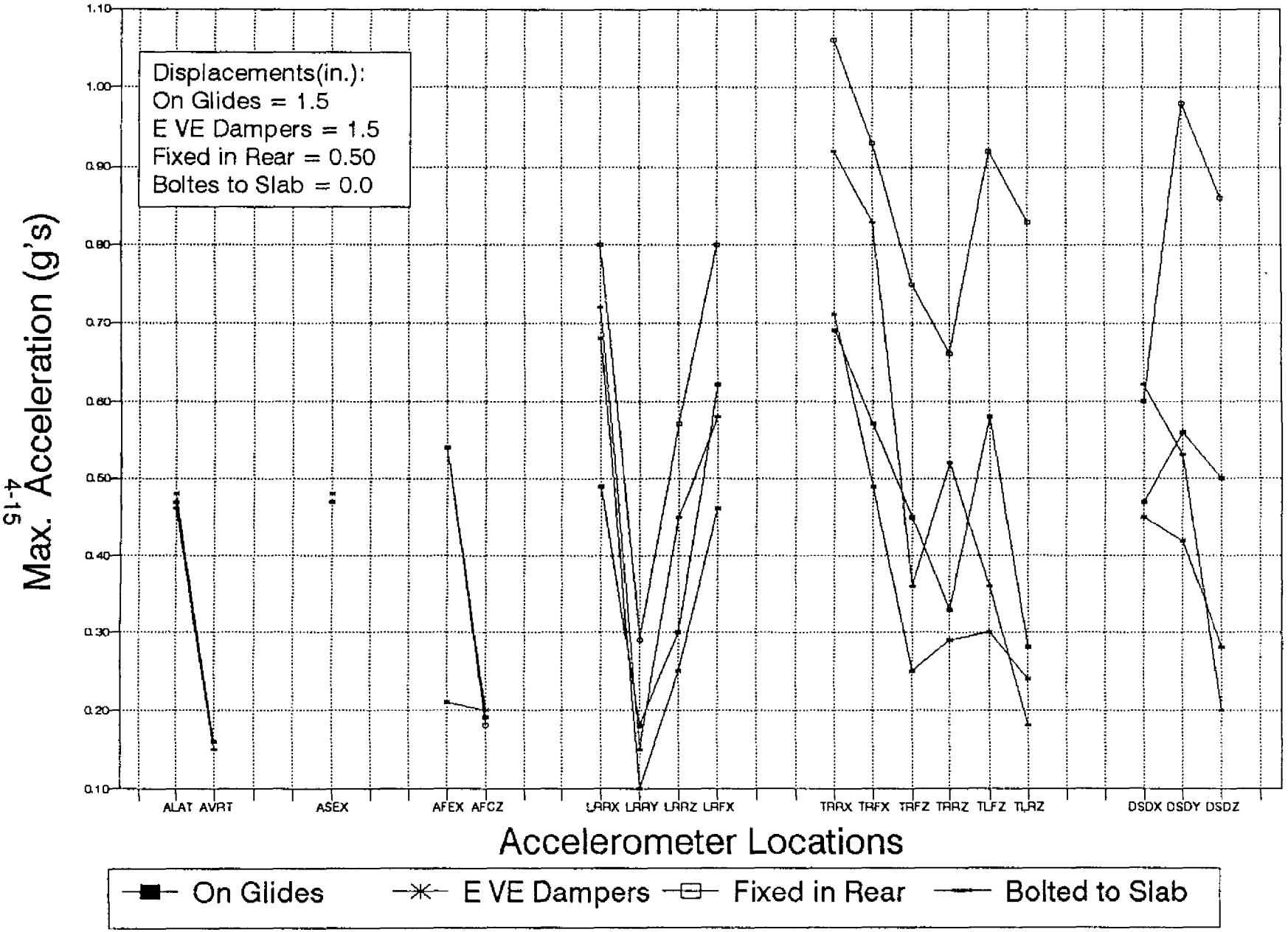

Fig. 4-7 IBM 9371, Taft RC-7 Input

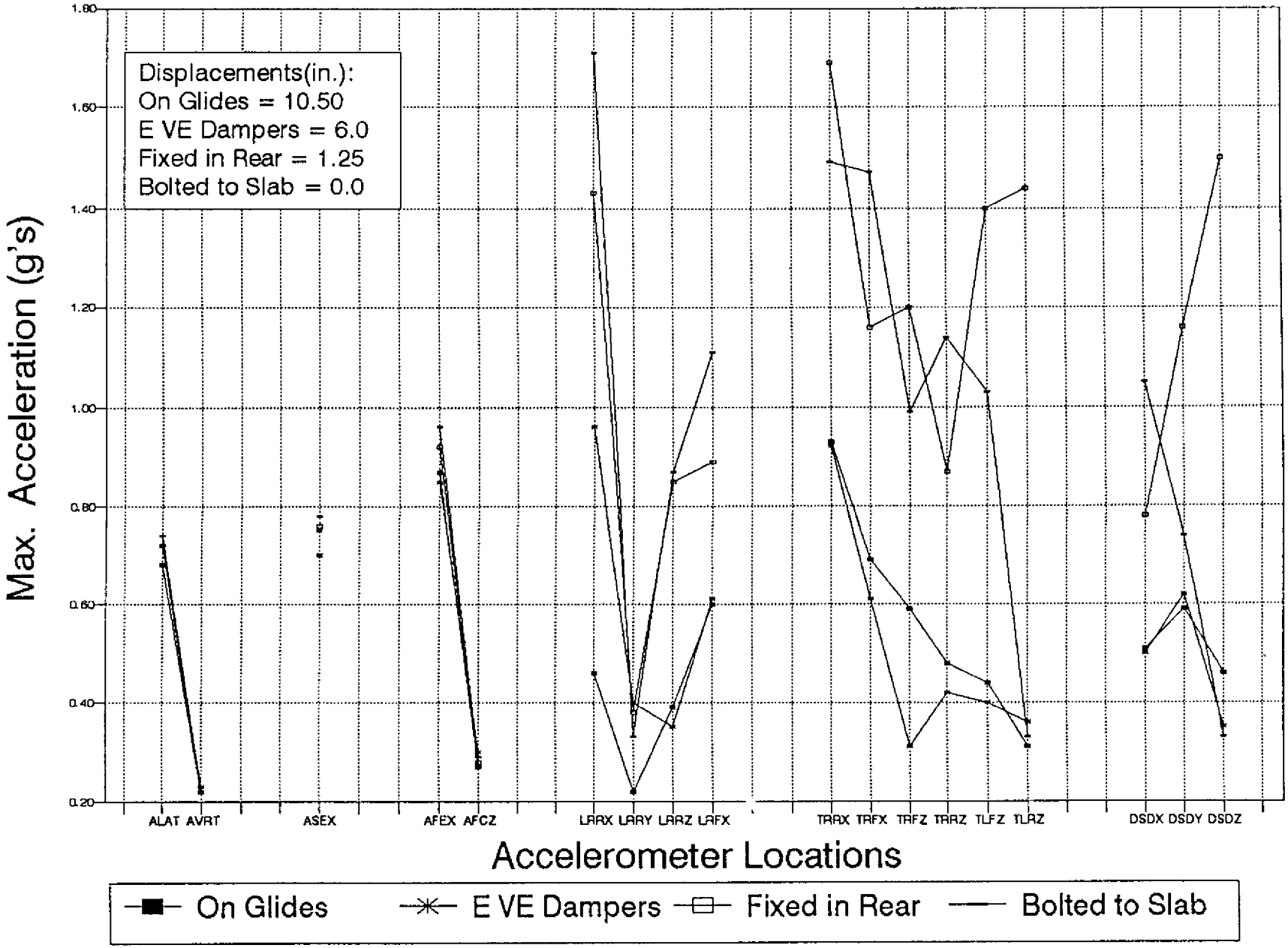

Fig. 4-8 IBM 9371, El Centro RC-7 Input

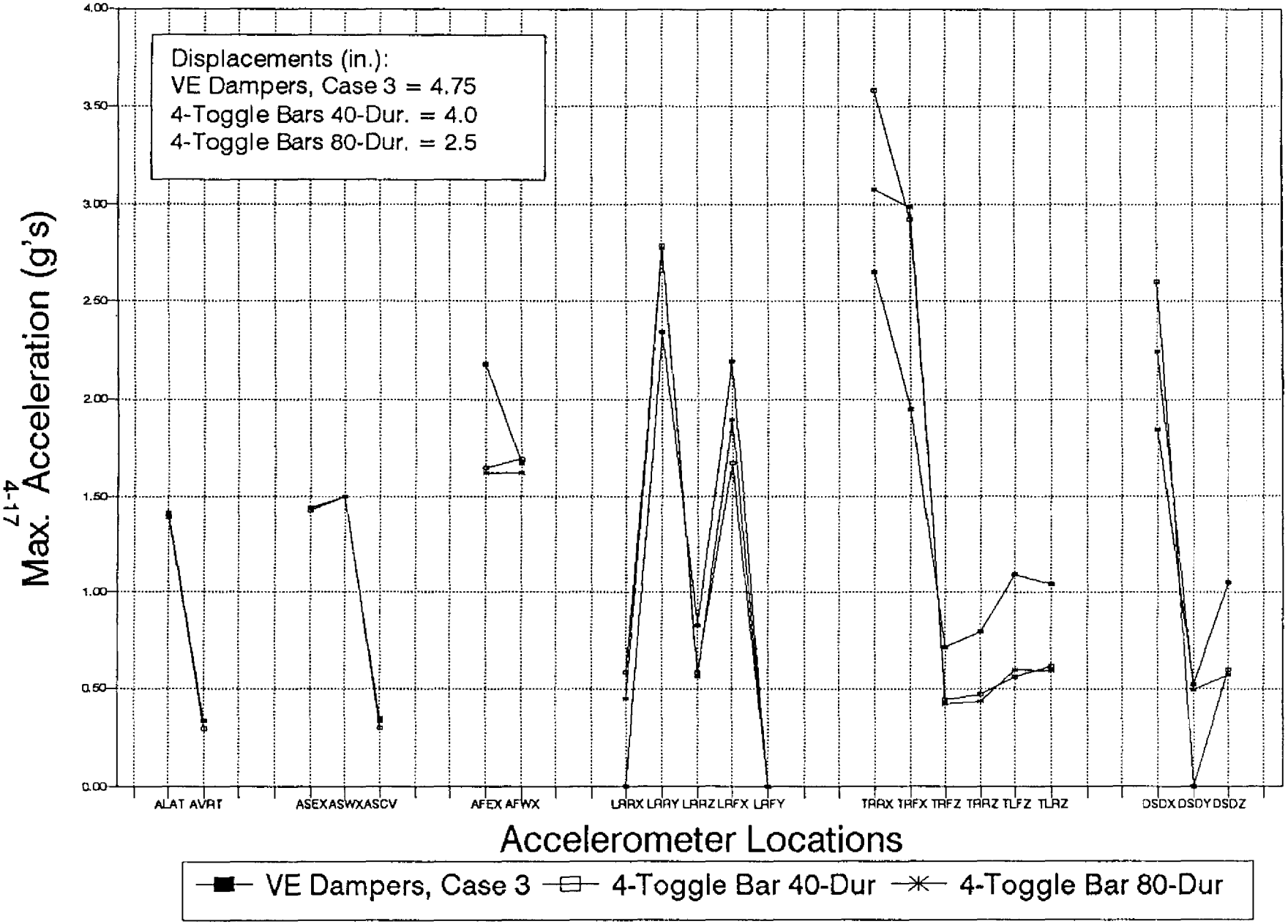

Fig. 4-9 IBM 9221, IBM2 Input

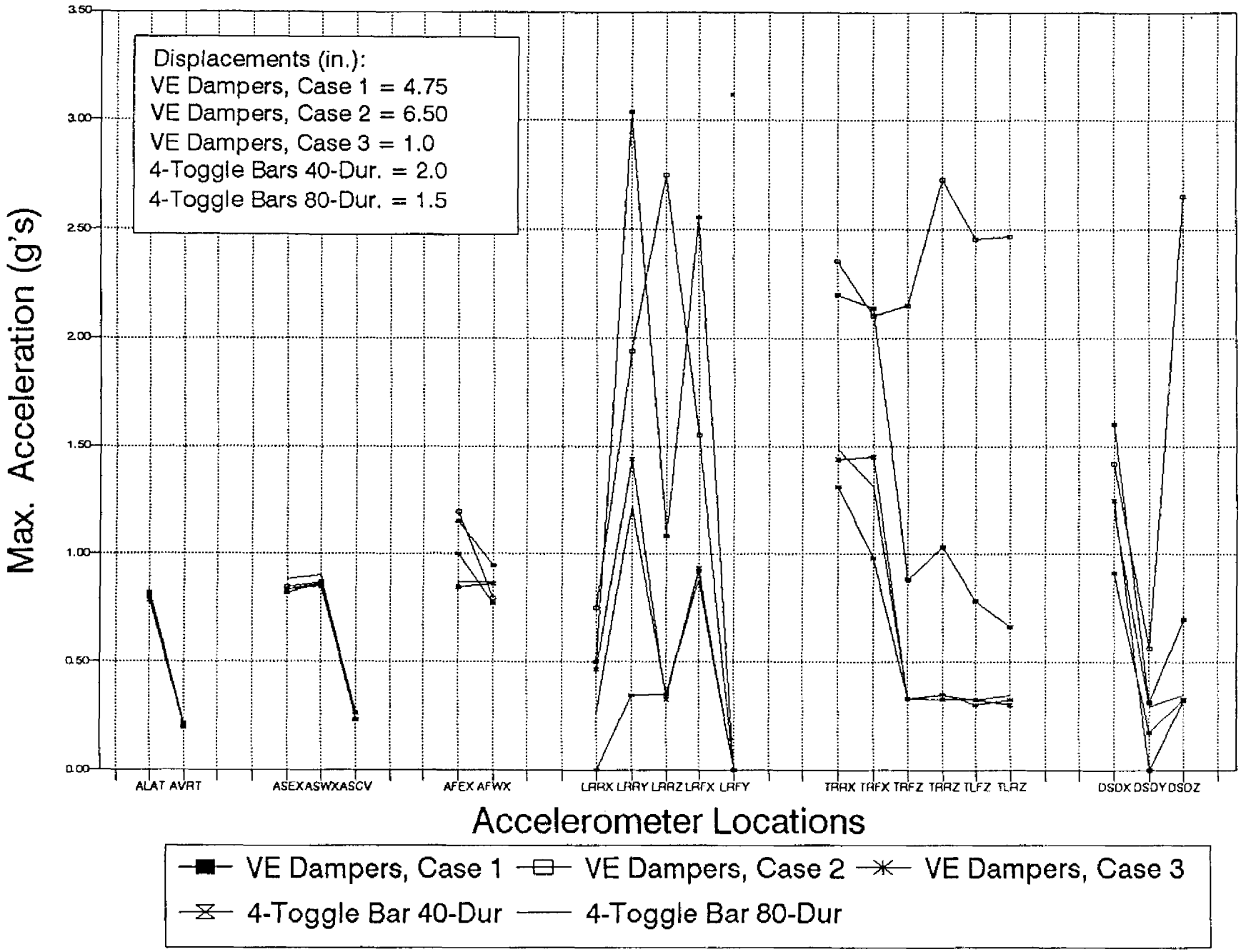

Fig. 4-10 IBM 9221, El Centro RC-7 Input

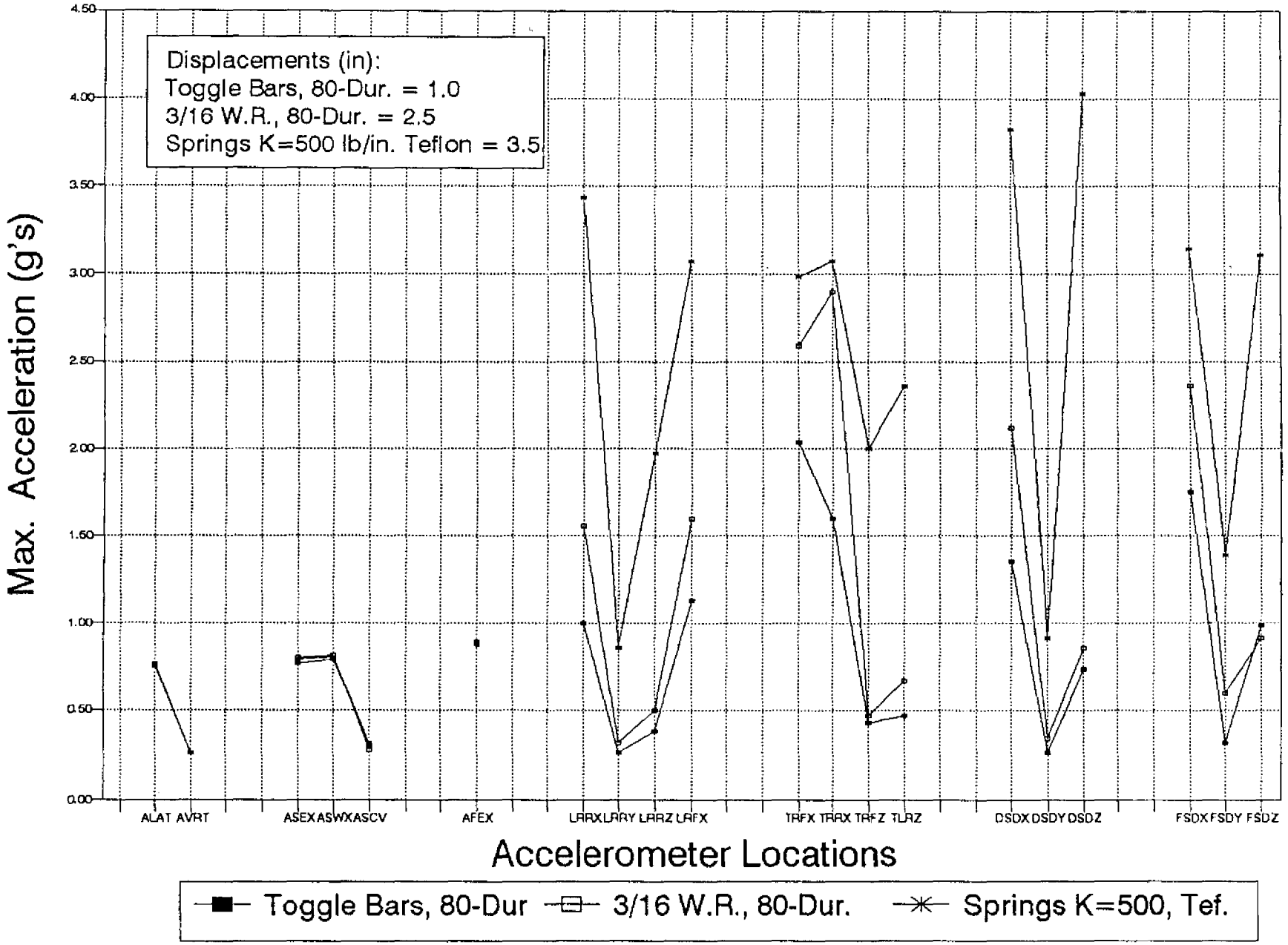

Fig. 4-11 Frame-8, IBM1 Input

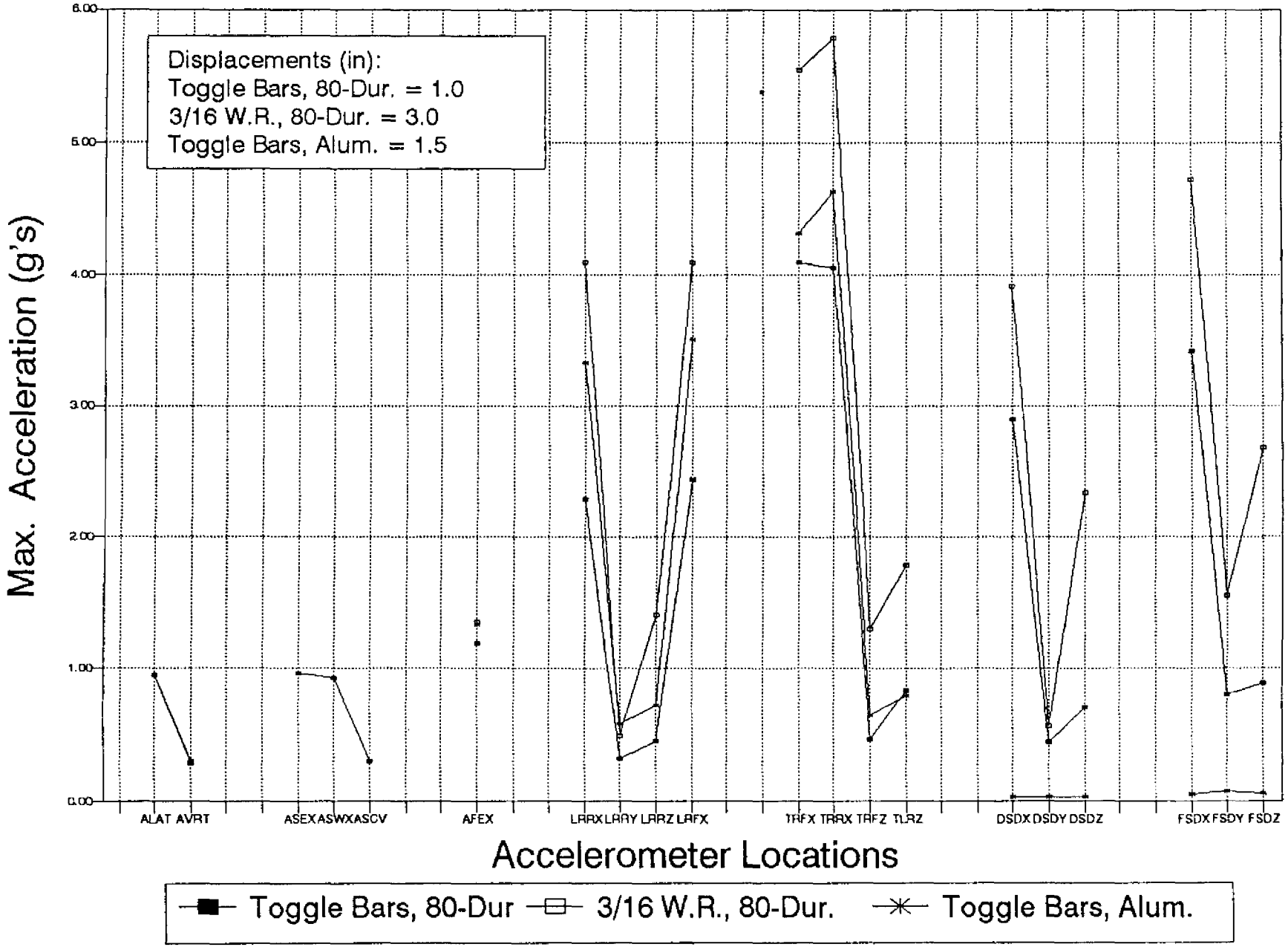

Fig. 4-12 Frame-8, IBM2 Input

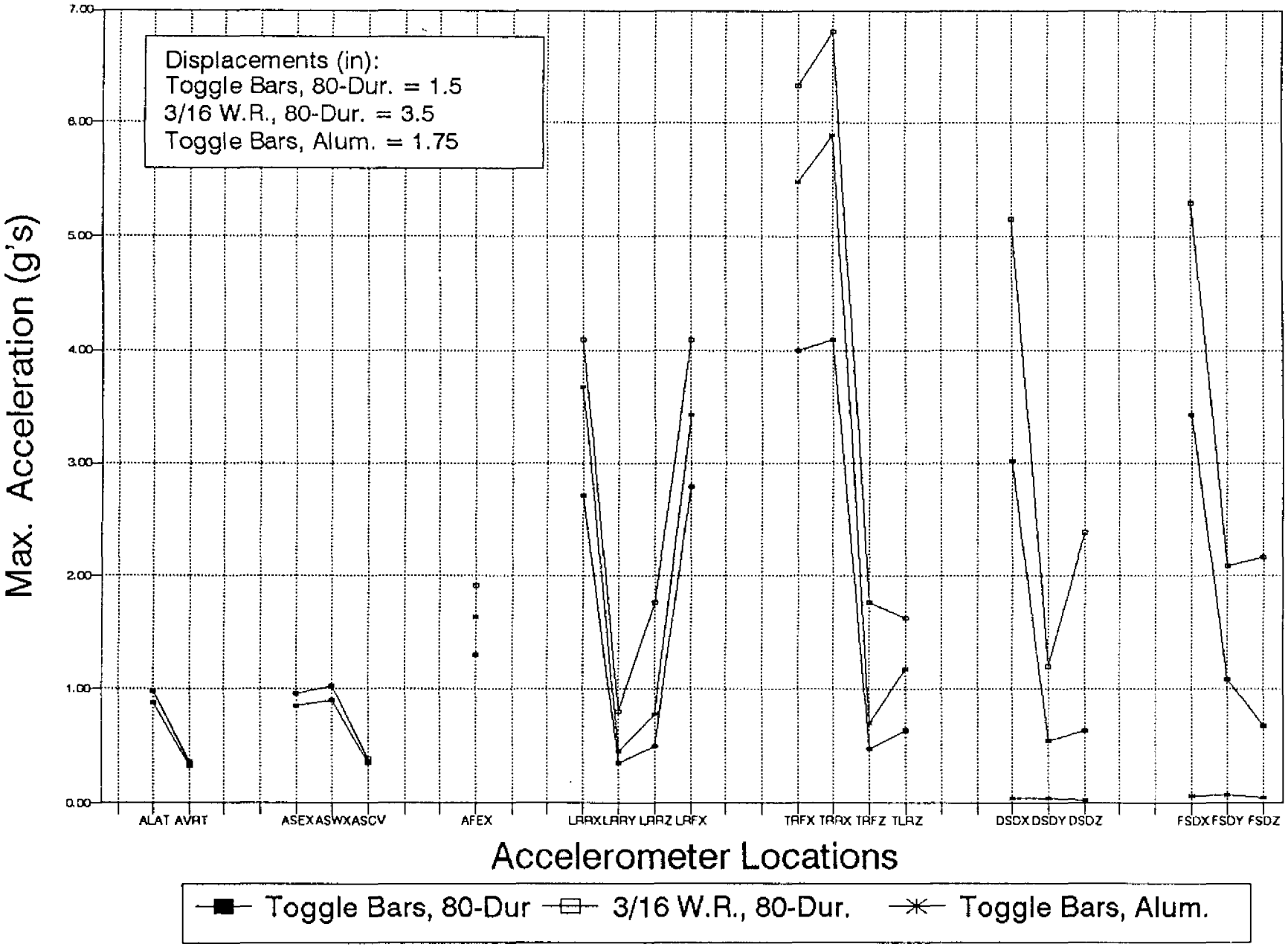

Fig. 4-13 Frame-8, Bellcore Input

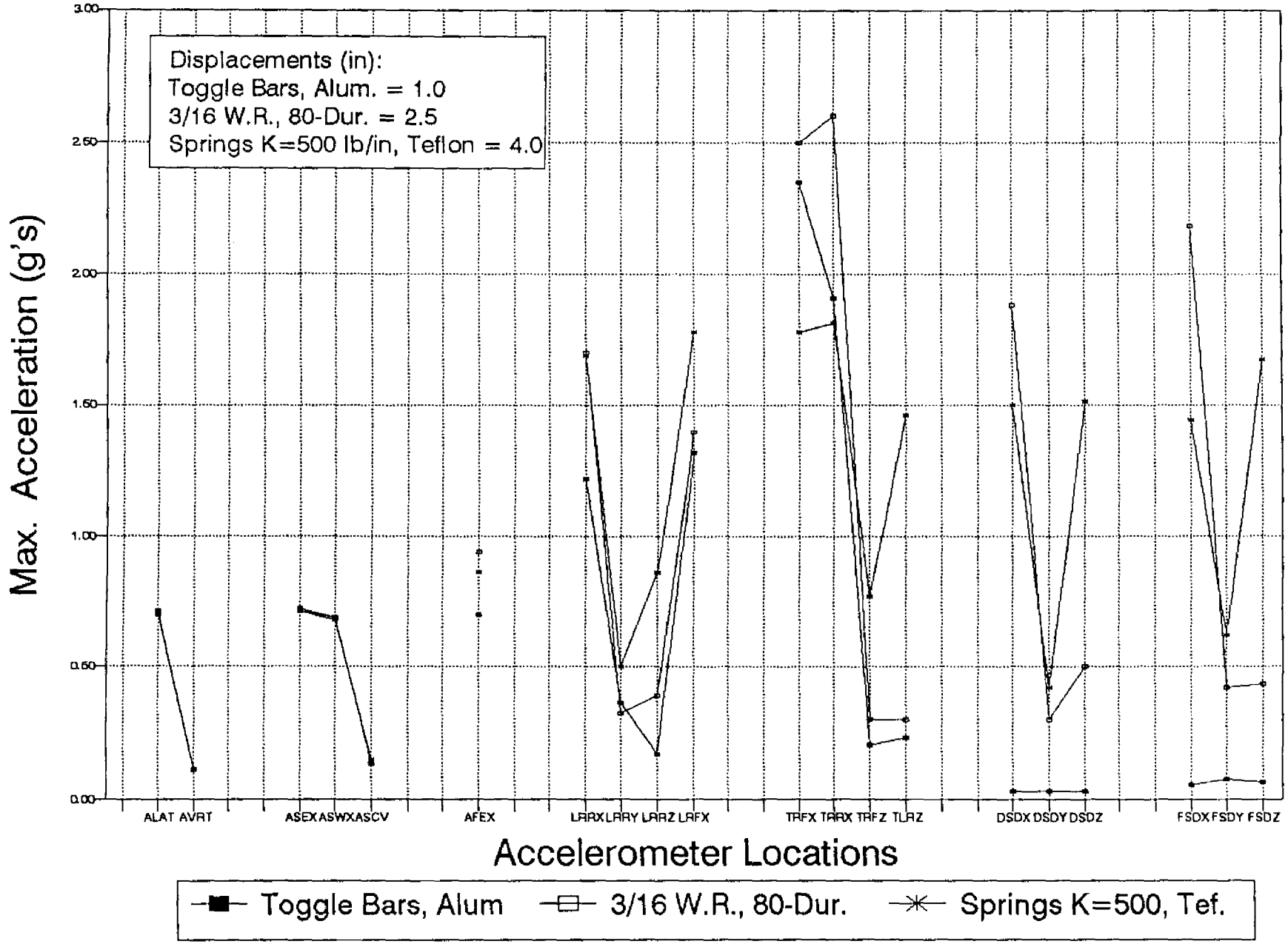

Fig. 4-14 Frame-8, El Centro RC-7 Input

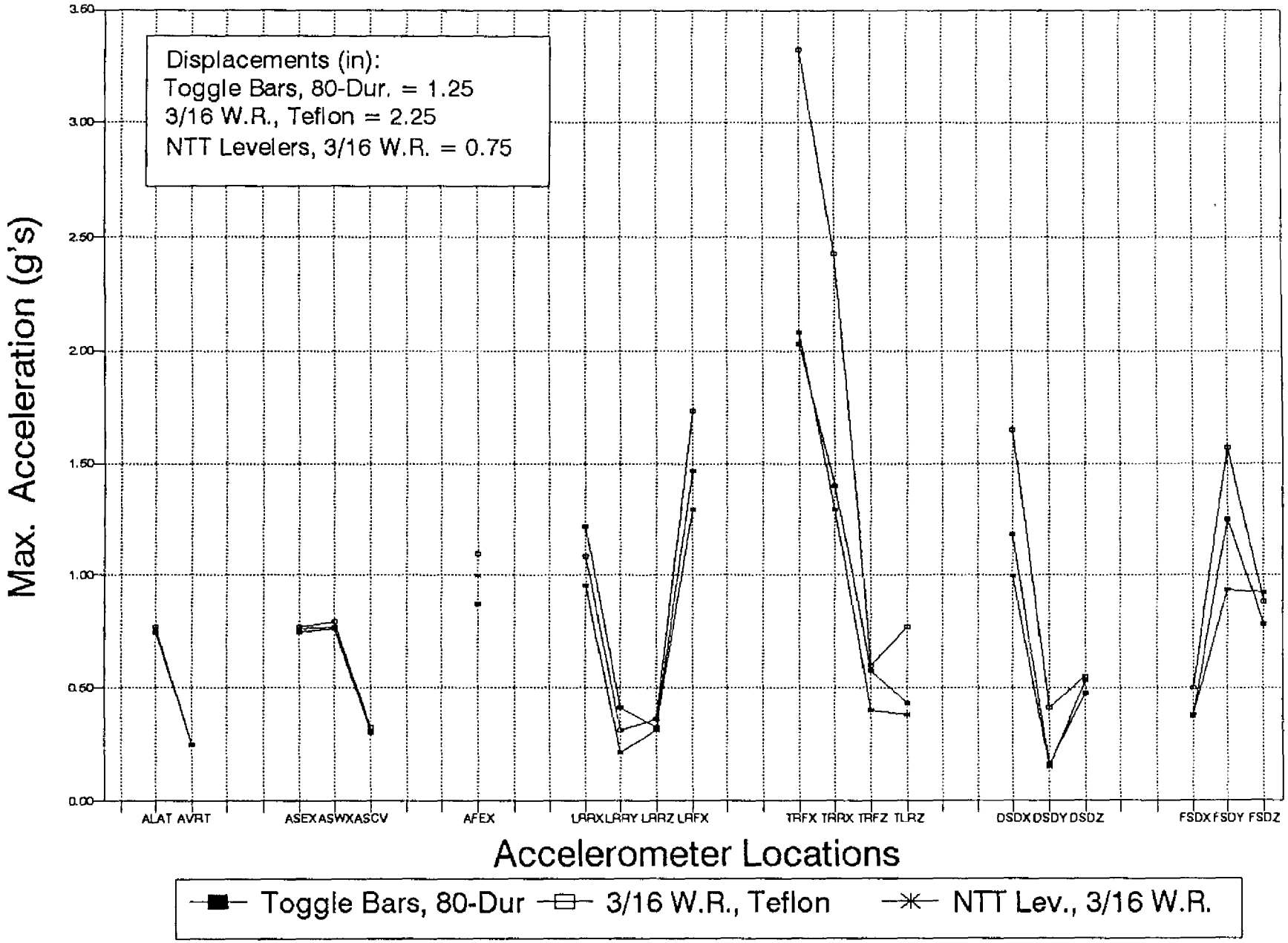

Fig. 4-15 Frame-1, IBM1 Input

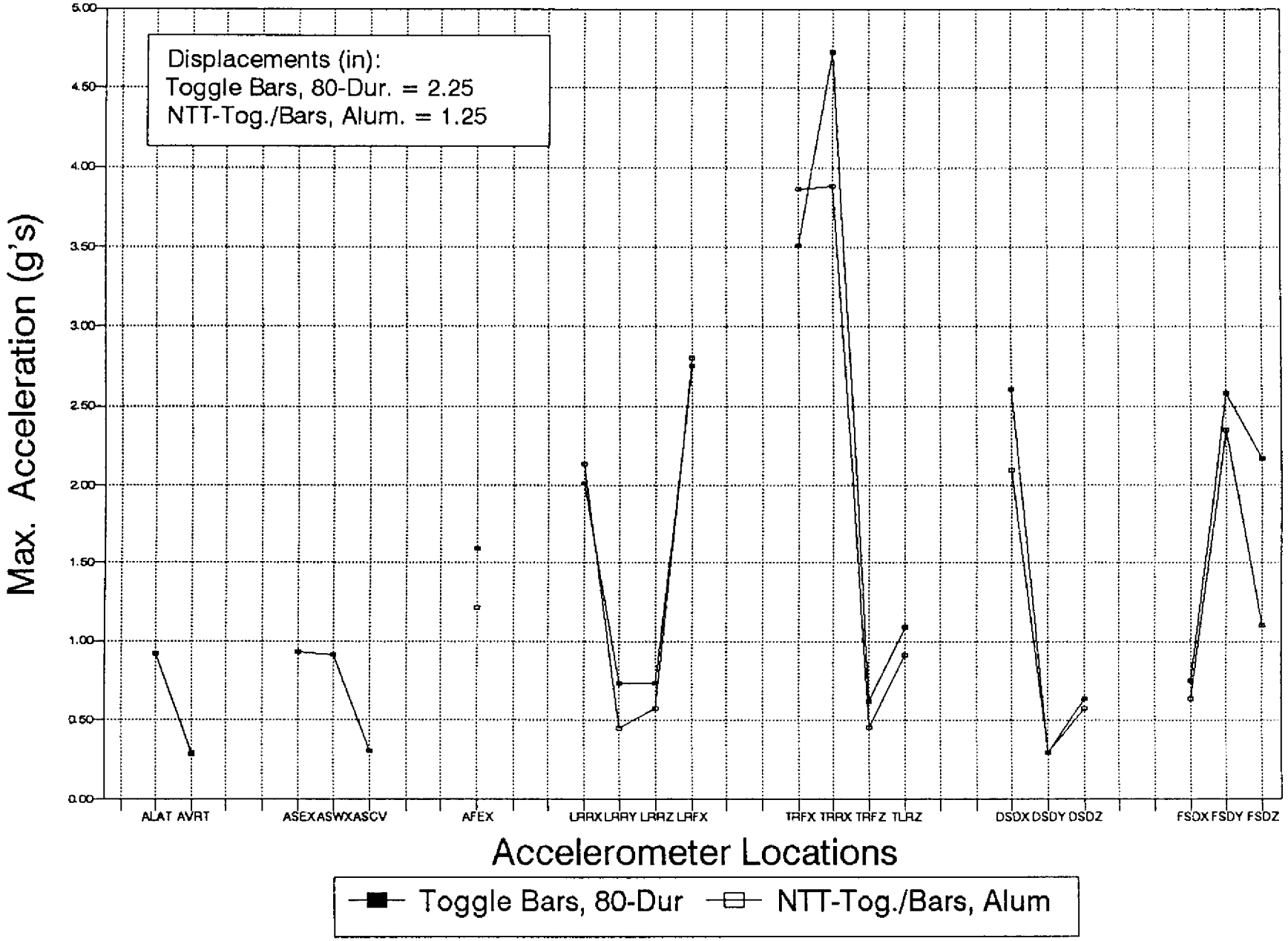

Fig. 4-16 Frame-1, IBM2 Input

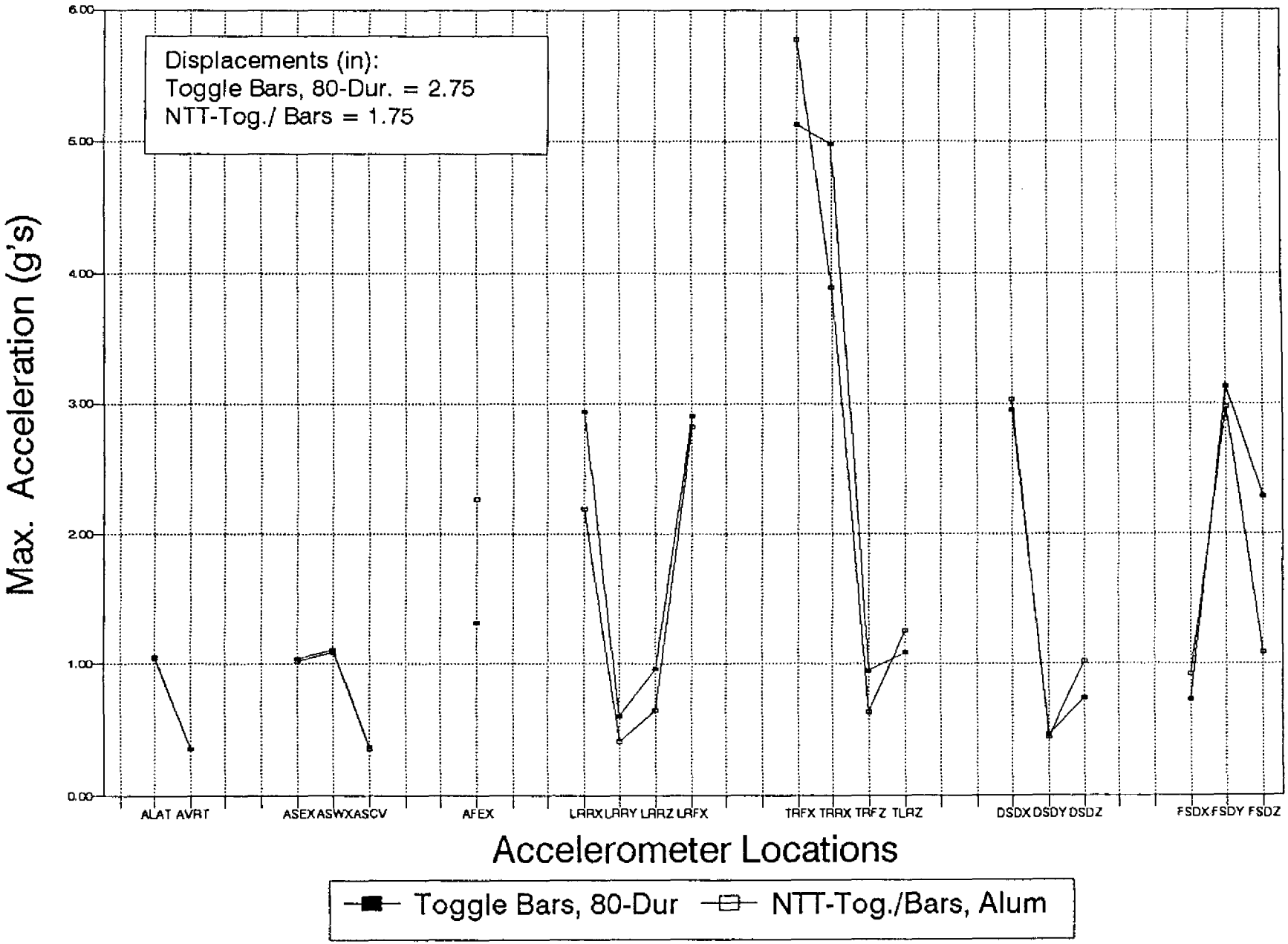

Fig. 4-17 Frame-1, Bellcore Input

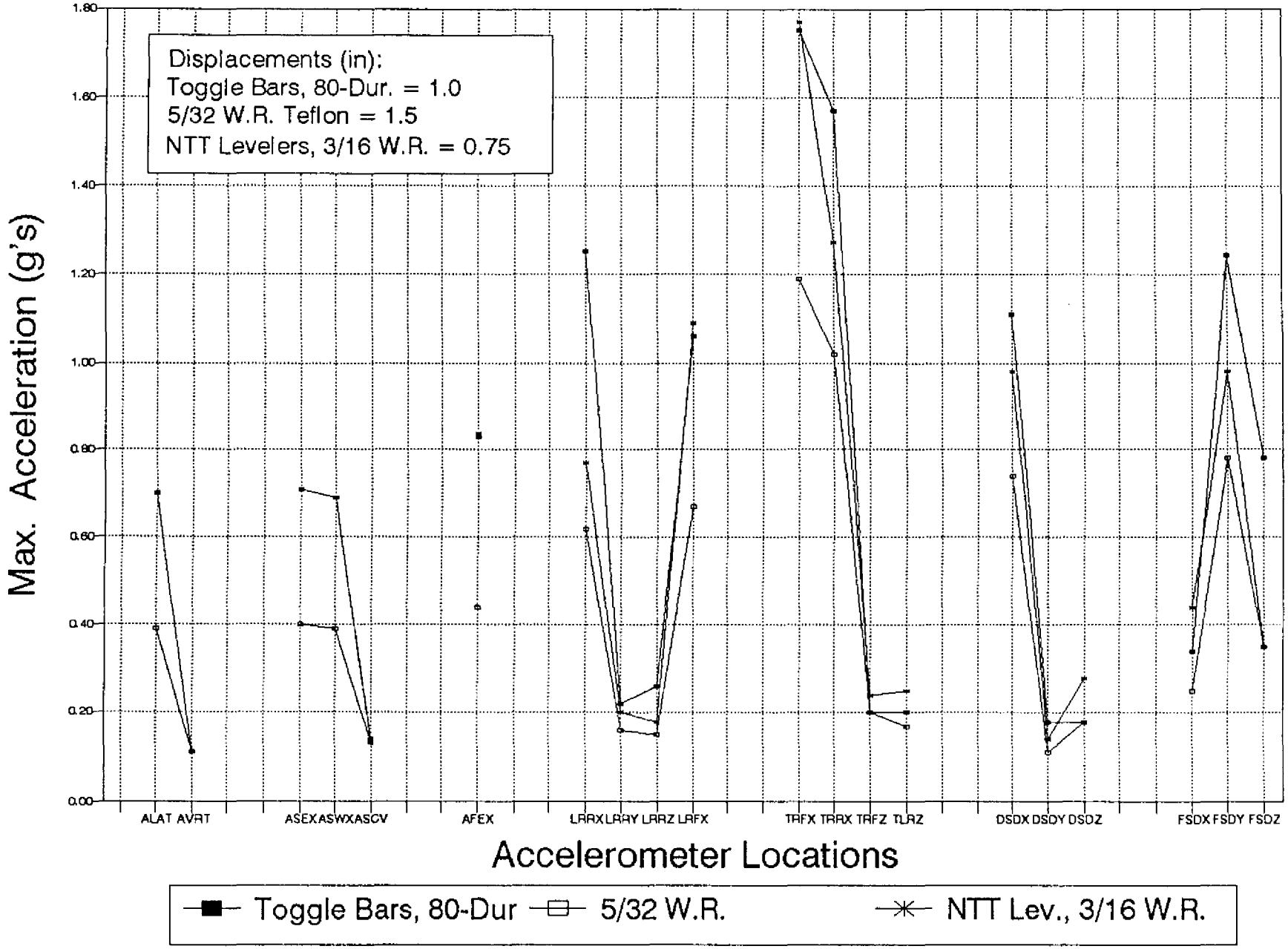

Fig. 4-18 Frame-1, El Centro RC-7 Input

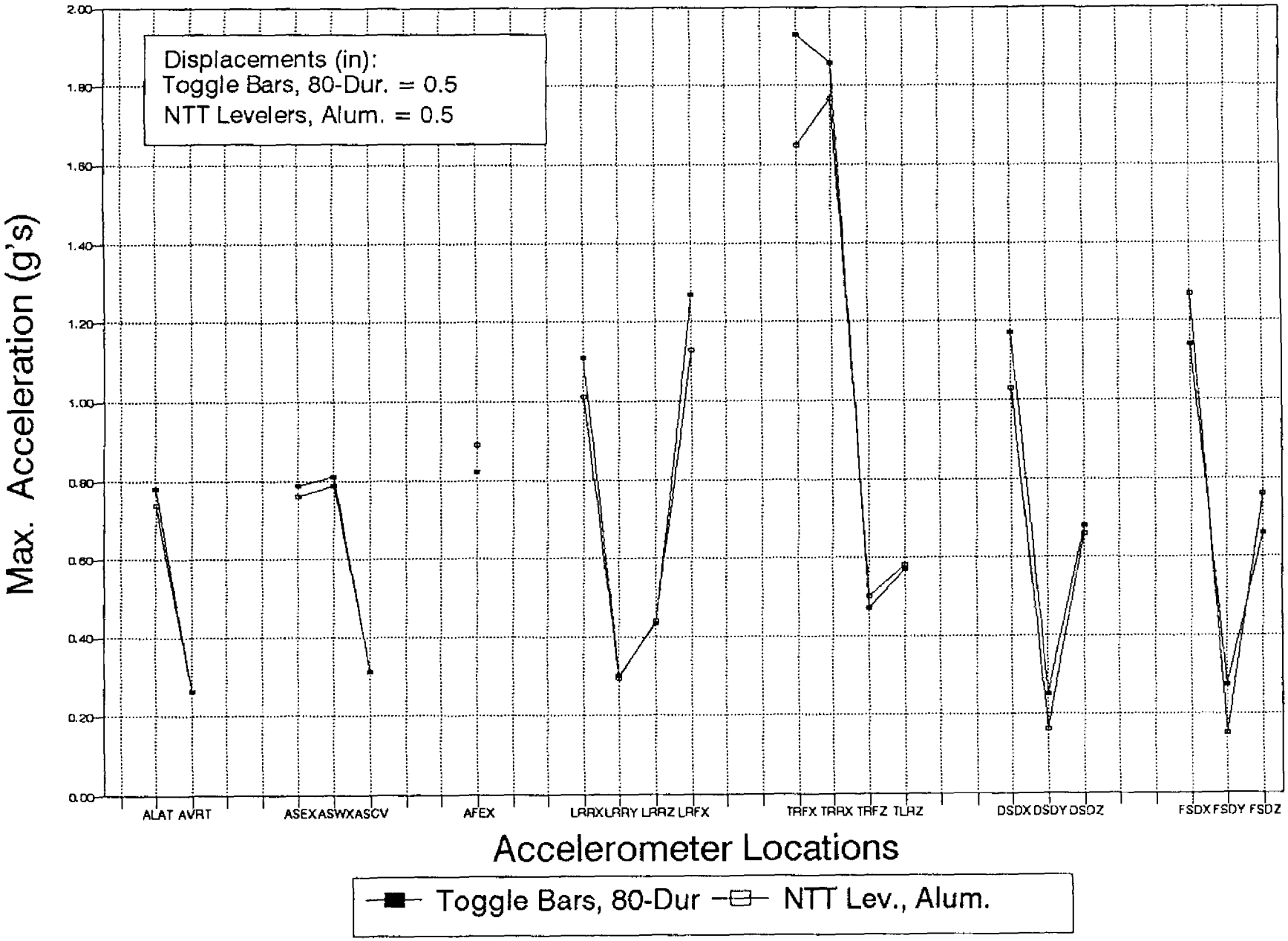

Fig. 4-19 Endicott Frame, IBM1 Input

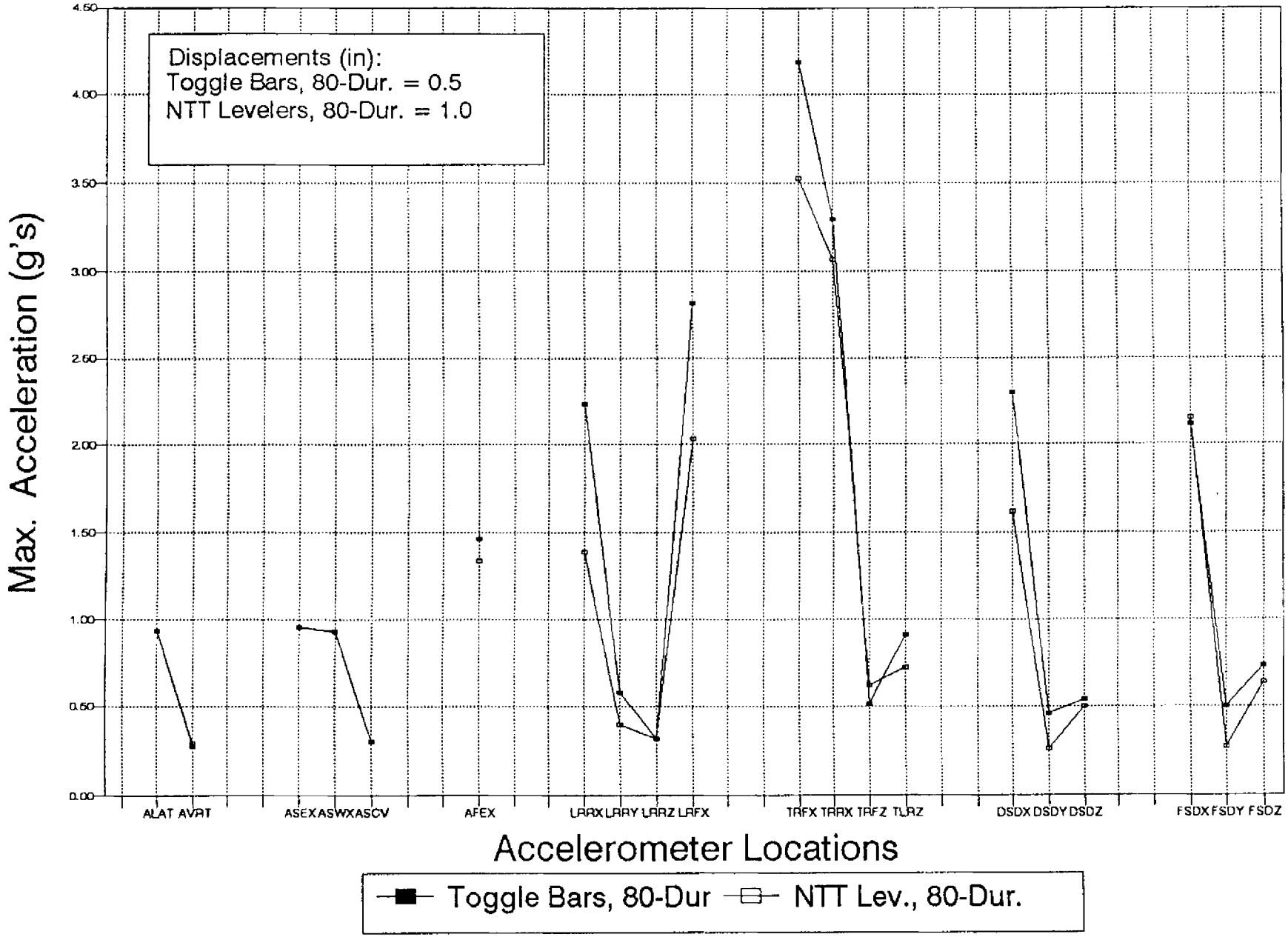

Fig. 4-20 Endicott Frame, IBM2 Input

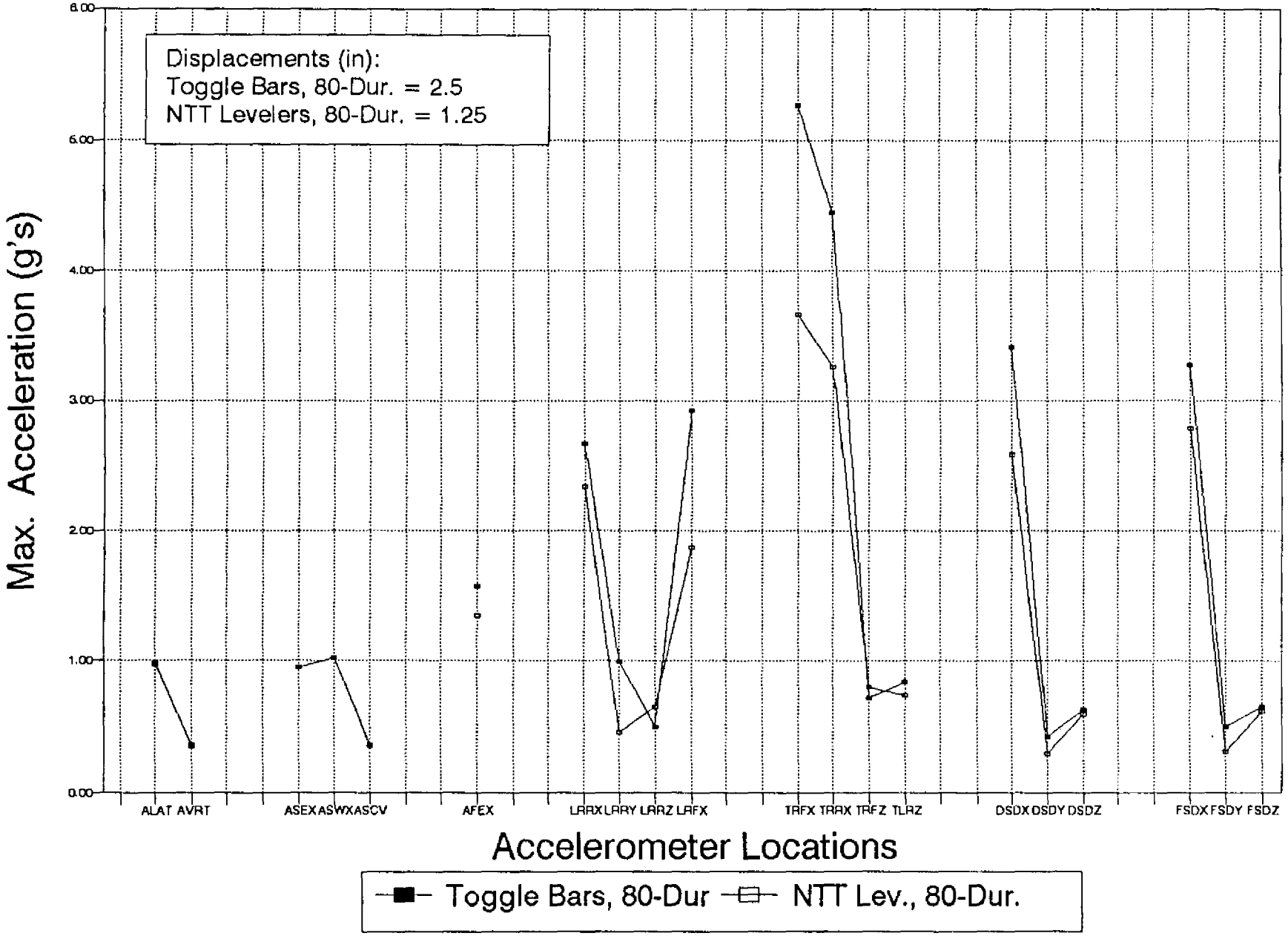

Fig. 4-21 Endicott Frame, Bellcore Input

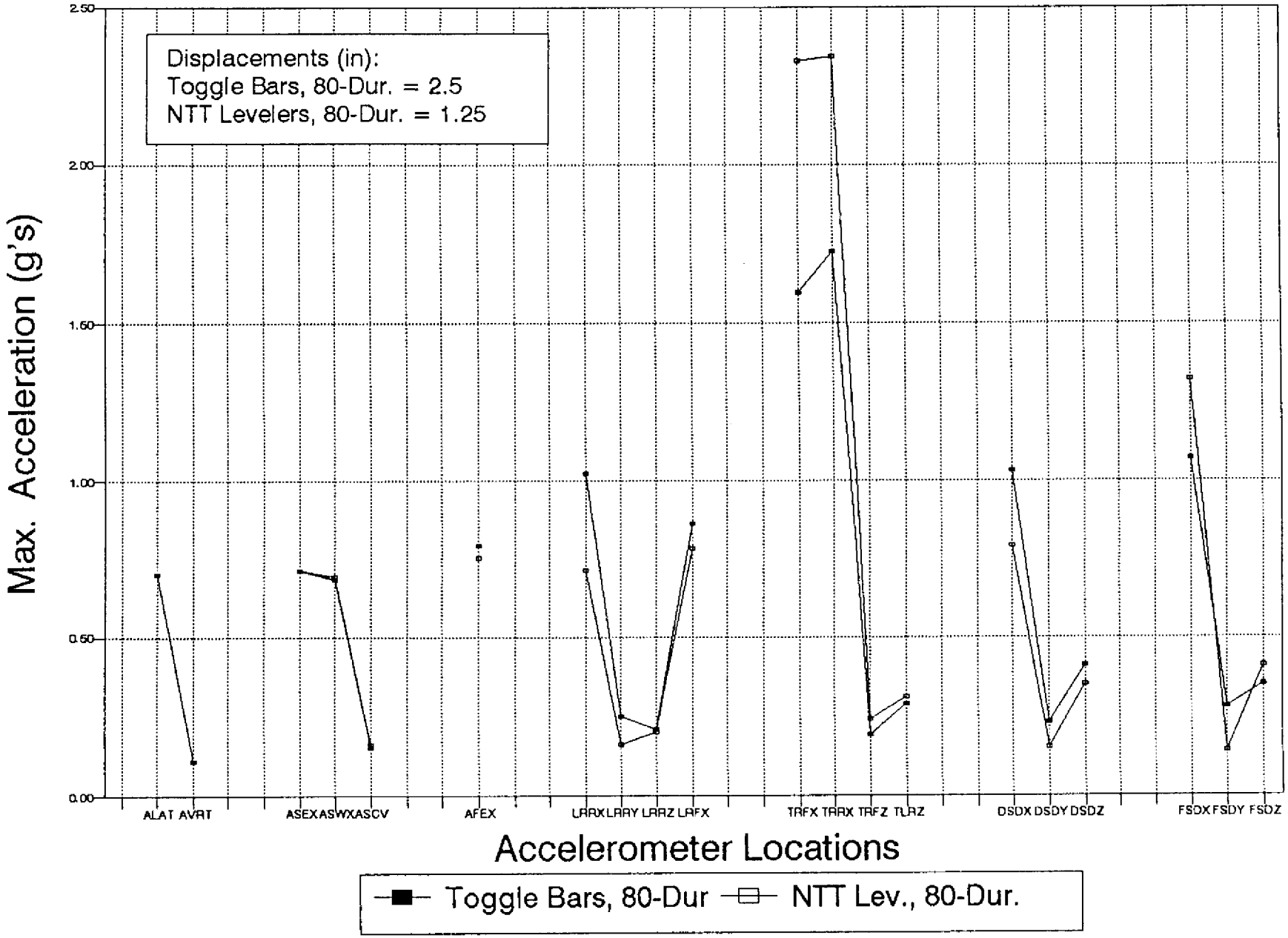

Fig. 4-22 Endicott Frame, El Centro RC-7 Input