A VIBRATION METHOD FOR INTEGRITY MONITORING OF FIXED OFFSHORE STEEL PLATFORMS

VOLUME TWO

Olaf Loland B.Sc.

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY OF GLASGOW

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DOCTOR OF PHILOSOPHY

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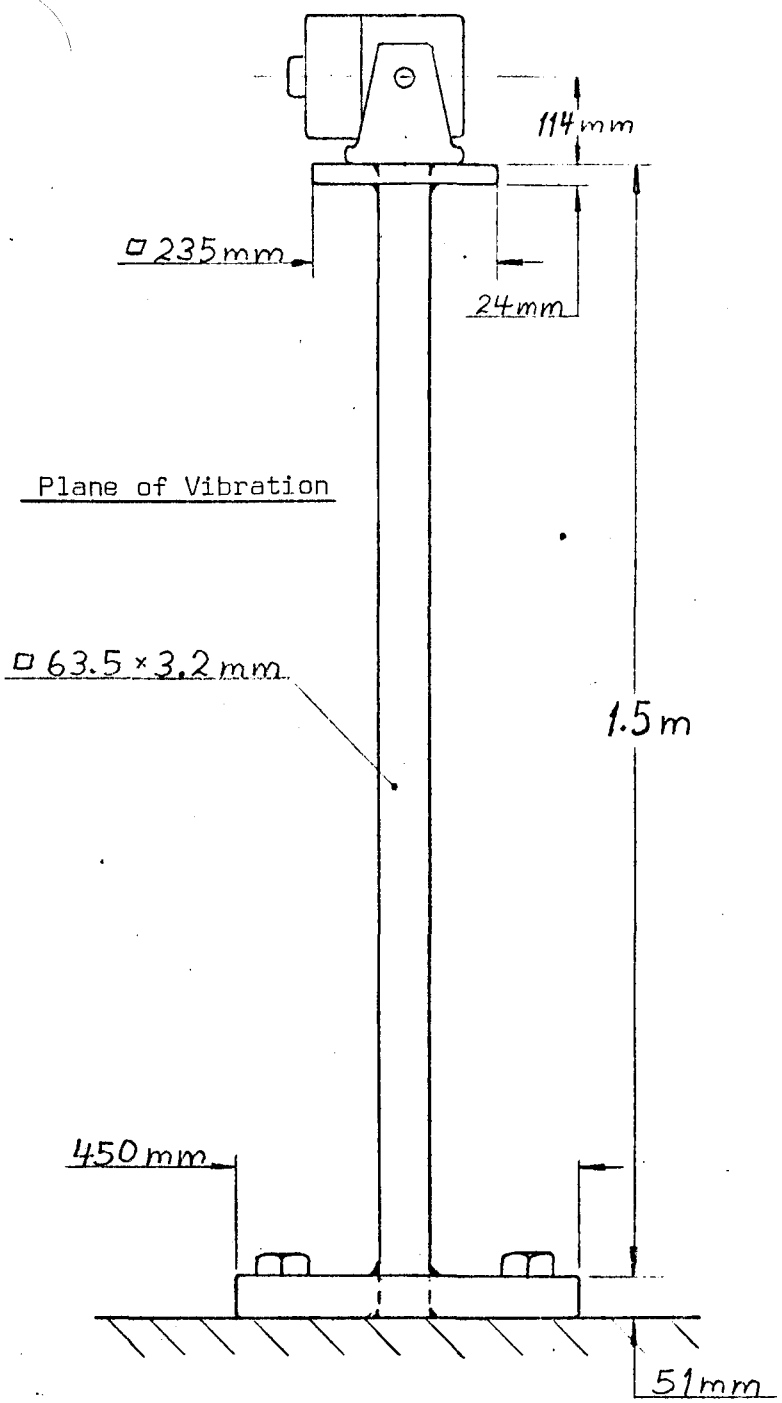
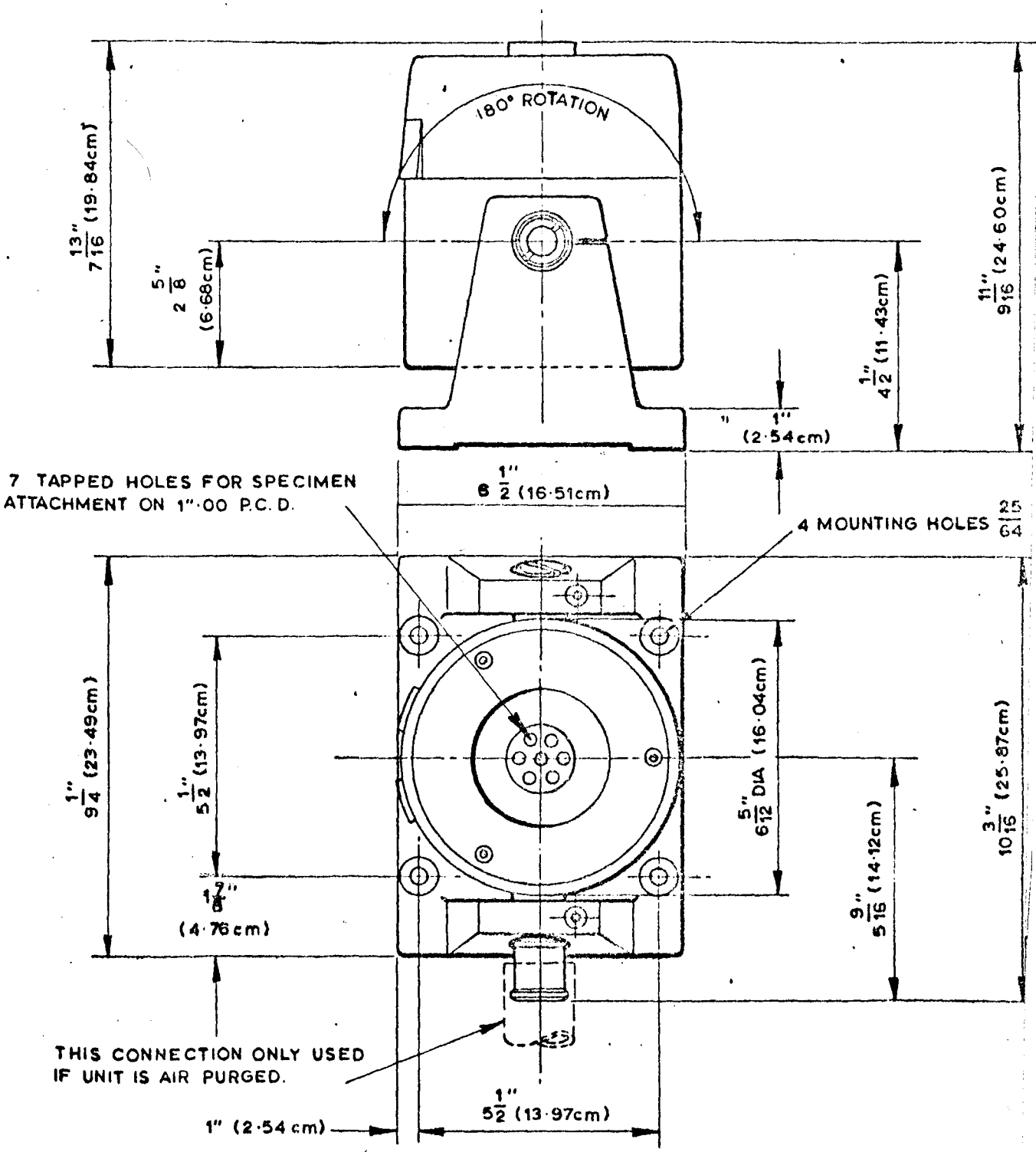
CHAPTER 2

PRELIMINARY COMPUTATIONS AND EXPERIMENTS ON SIMPLE STRUCTURES



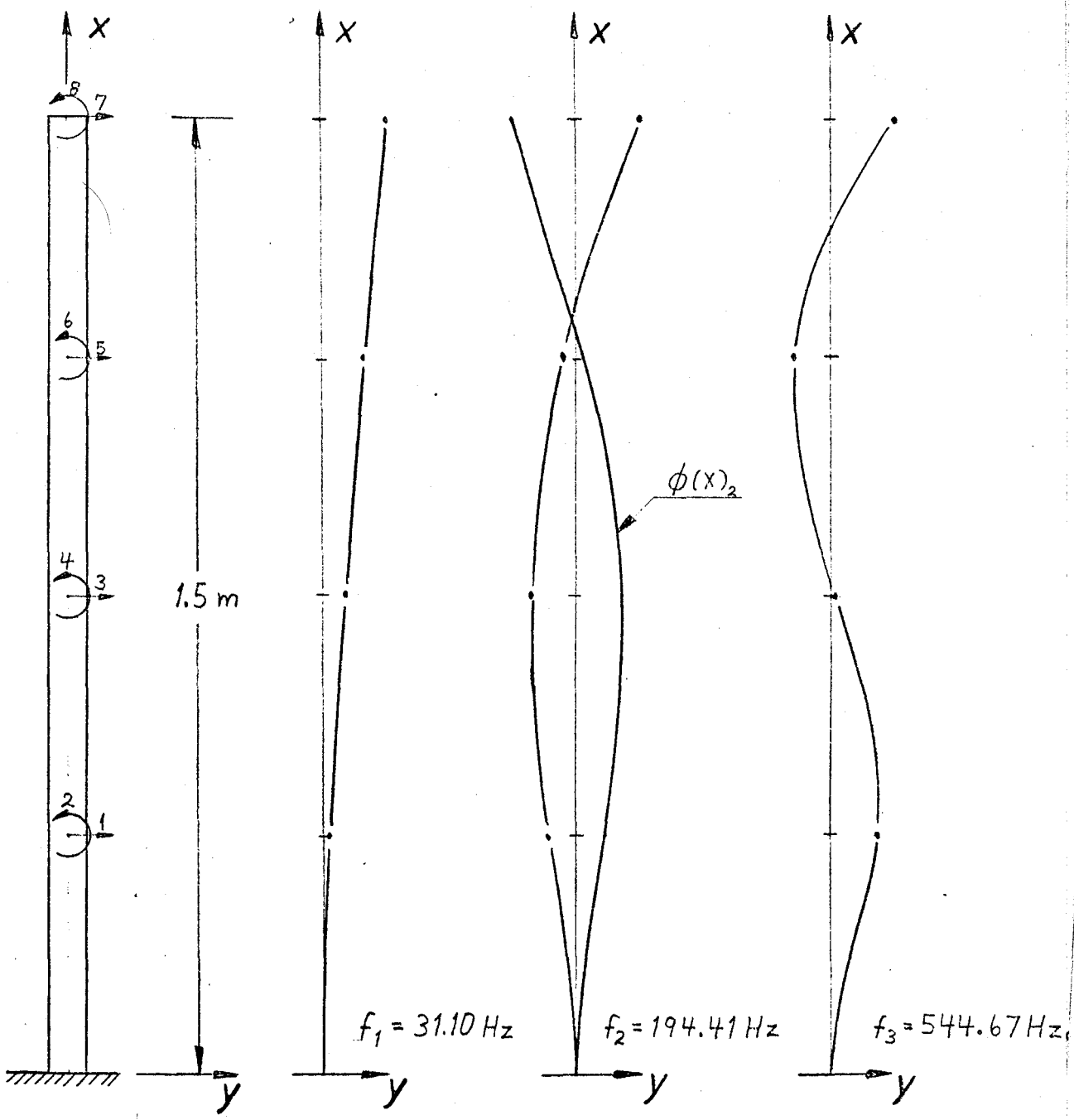
Cantilever beam with shaker assembly attached to free end.

Figure 2.1



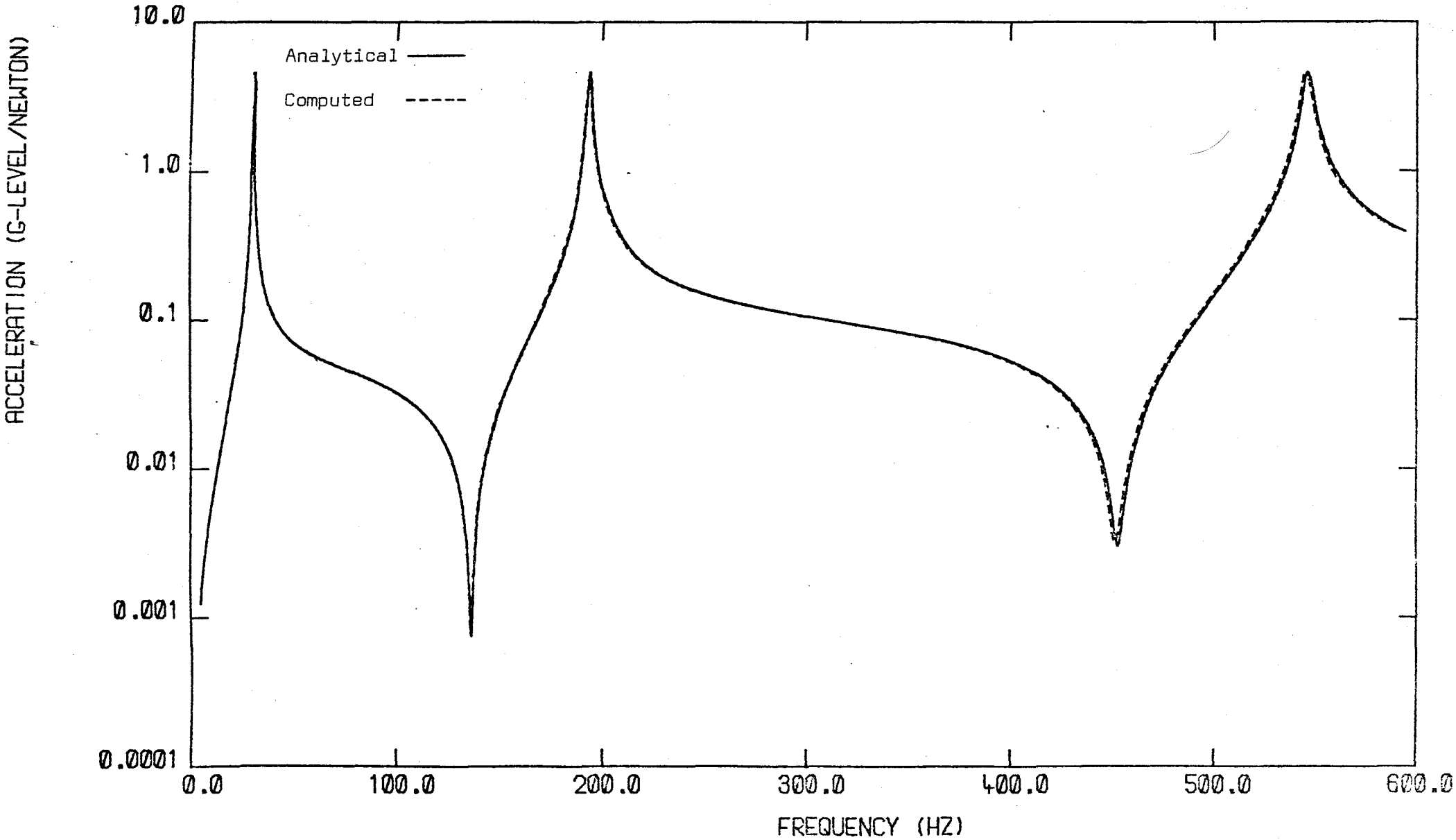
Electro-magnetic shaker assembly

Figure 2.2



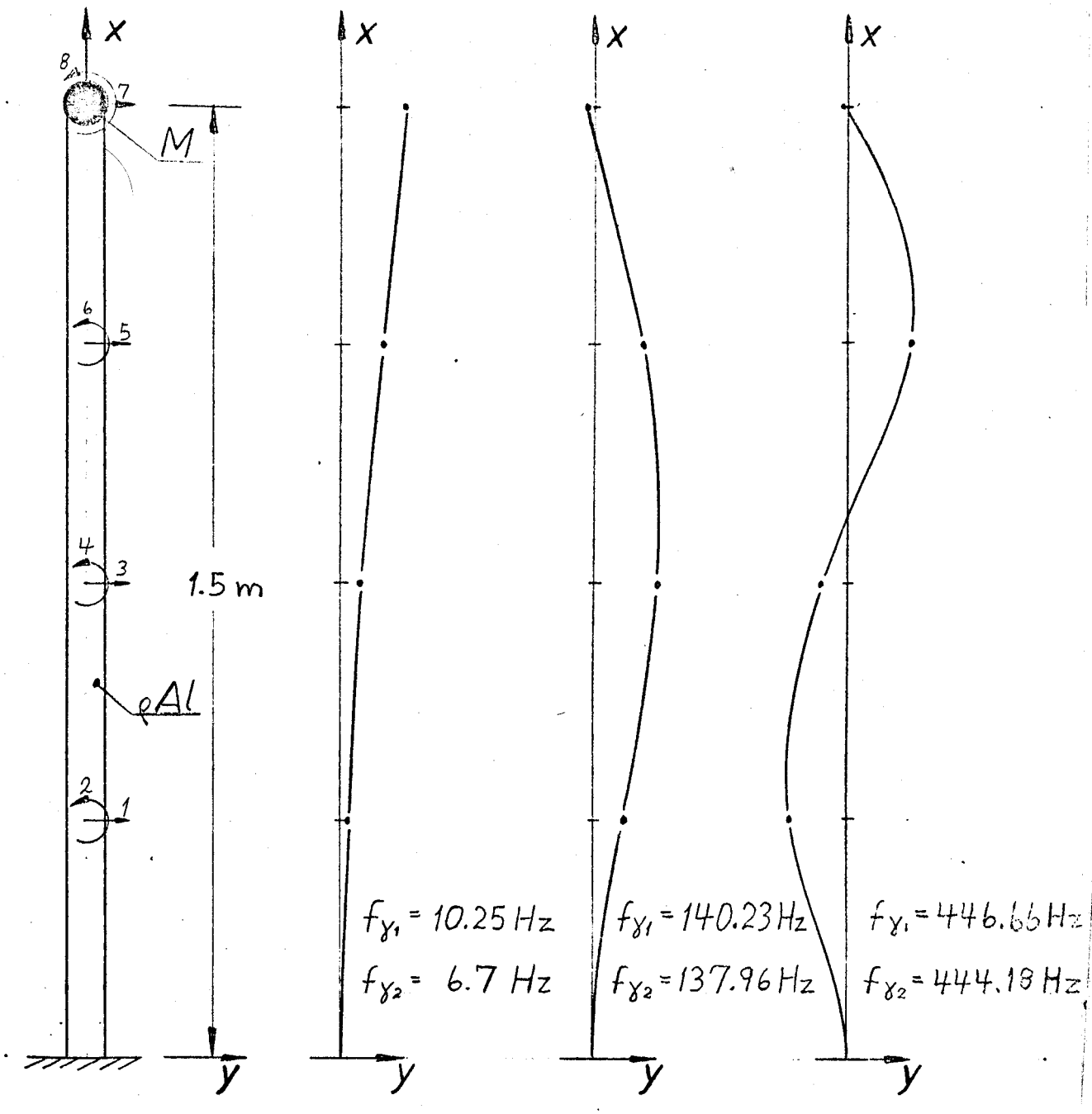
Computed mode shapes for cantilever beam

Figure 2.3



Analytical and computed acceleration receptance $\ddot{\alpha}_{77}$ of cantilever beam (Table 2.1 and Figure 2.3)

Figure 2.4

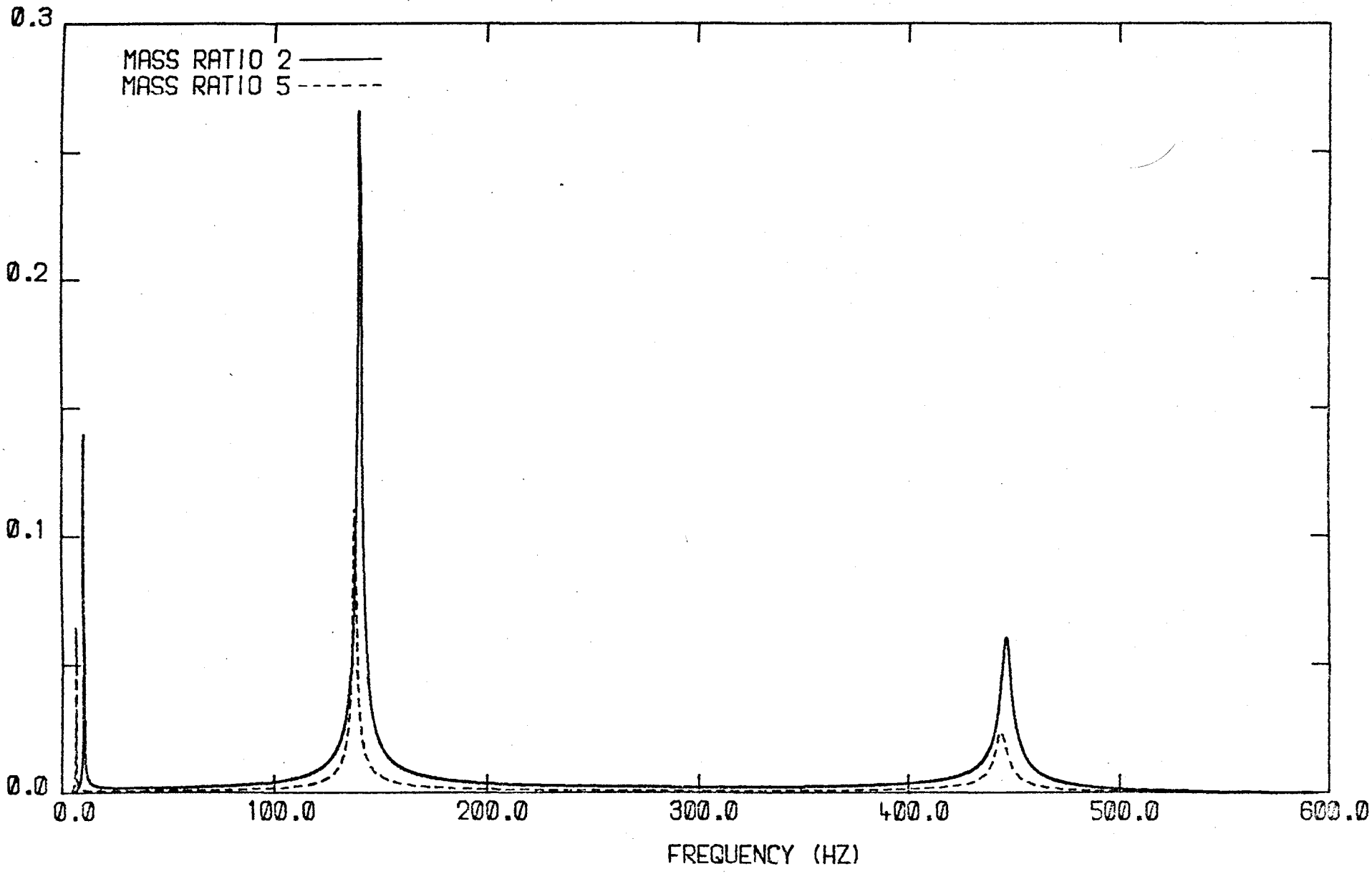


$$\gamma = \frac{M}{\rho A l} = \text{Mass ratio} \qquad \gamma_1 = 2 \;,\; \gamma_2 = 5$$

Computed mode shapes for cantilever beam

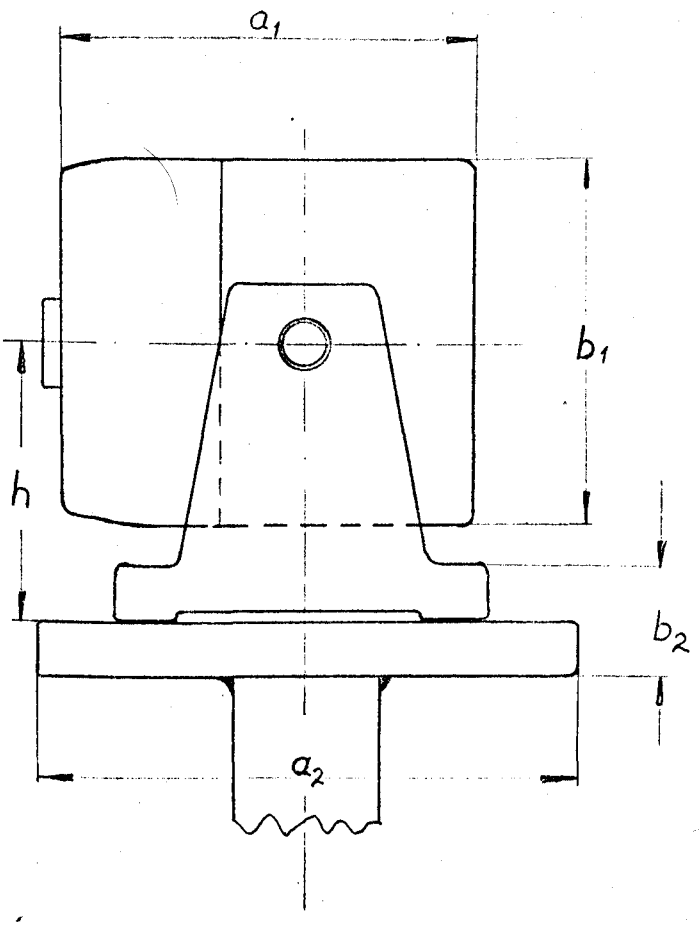
with point mass at free end.

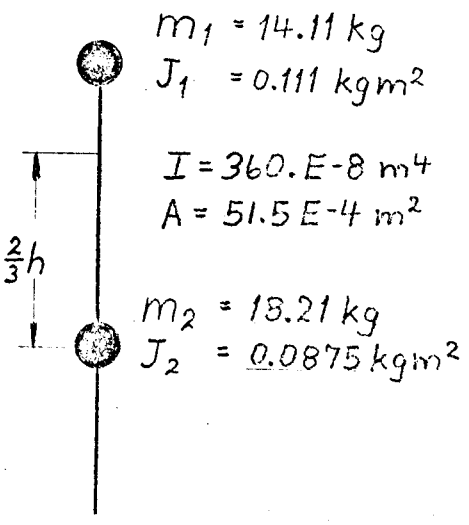
Figure 2.5



Computed acceleration receptance $\ddot{\alpha}_{37}$ for cantilever beam with a point mass attached at free end (Table 2.3 and 2.4)

Figure 2.6



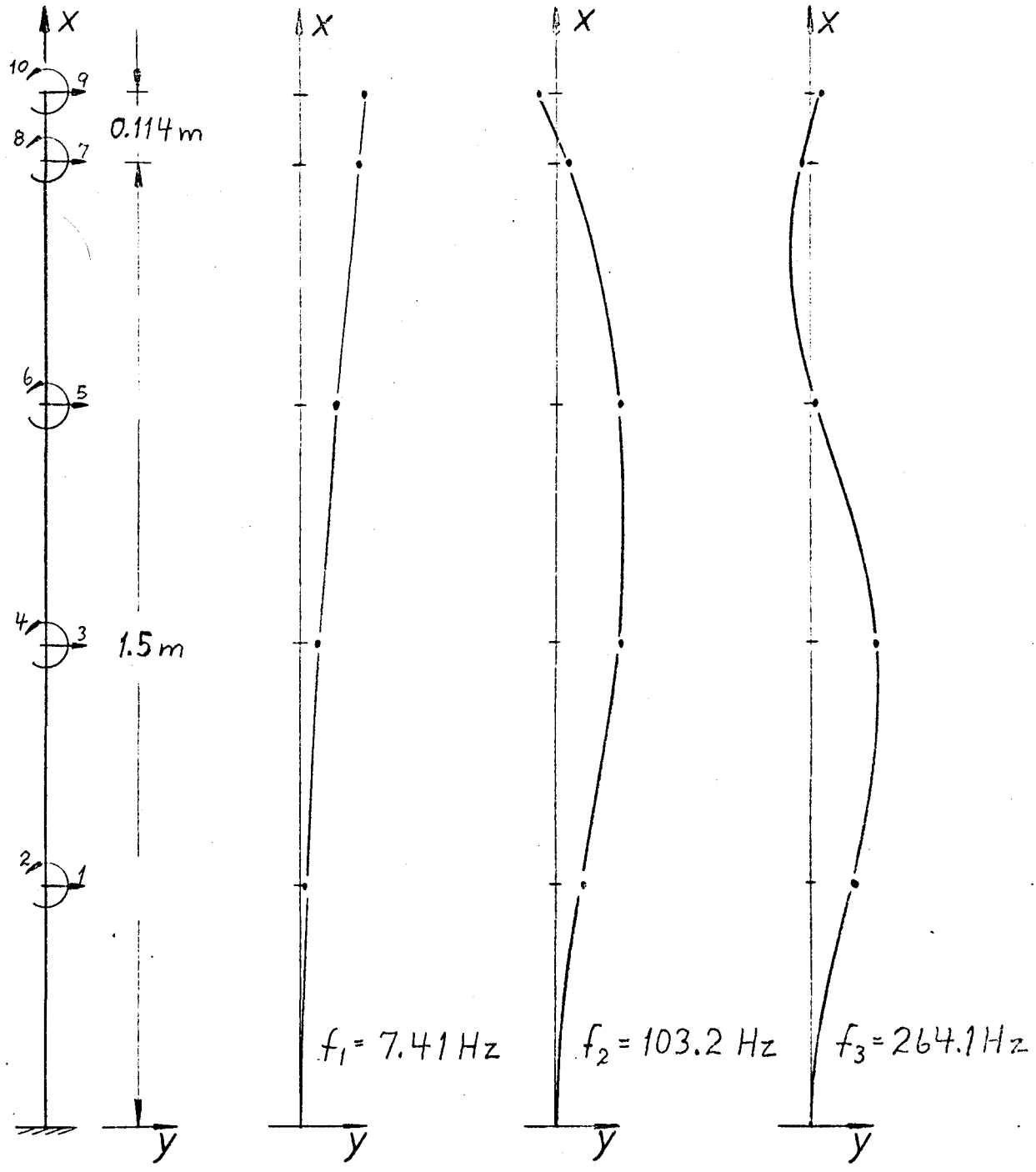


$$J_1 = (a_1^2 + 3b_1^2)m_1/12 \quad \text{.....(2.64)}$$

$$J_2 = (a_2^2 + b_2^2)m_2/12 \quad \text{.....(2.65)}$$

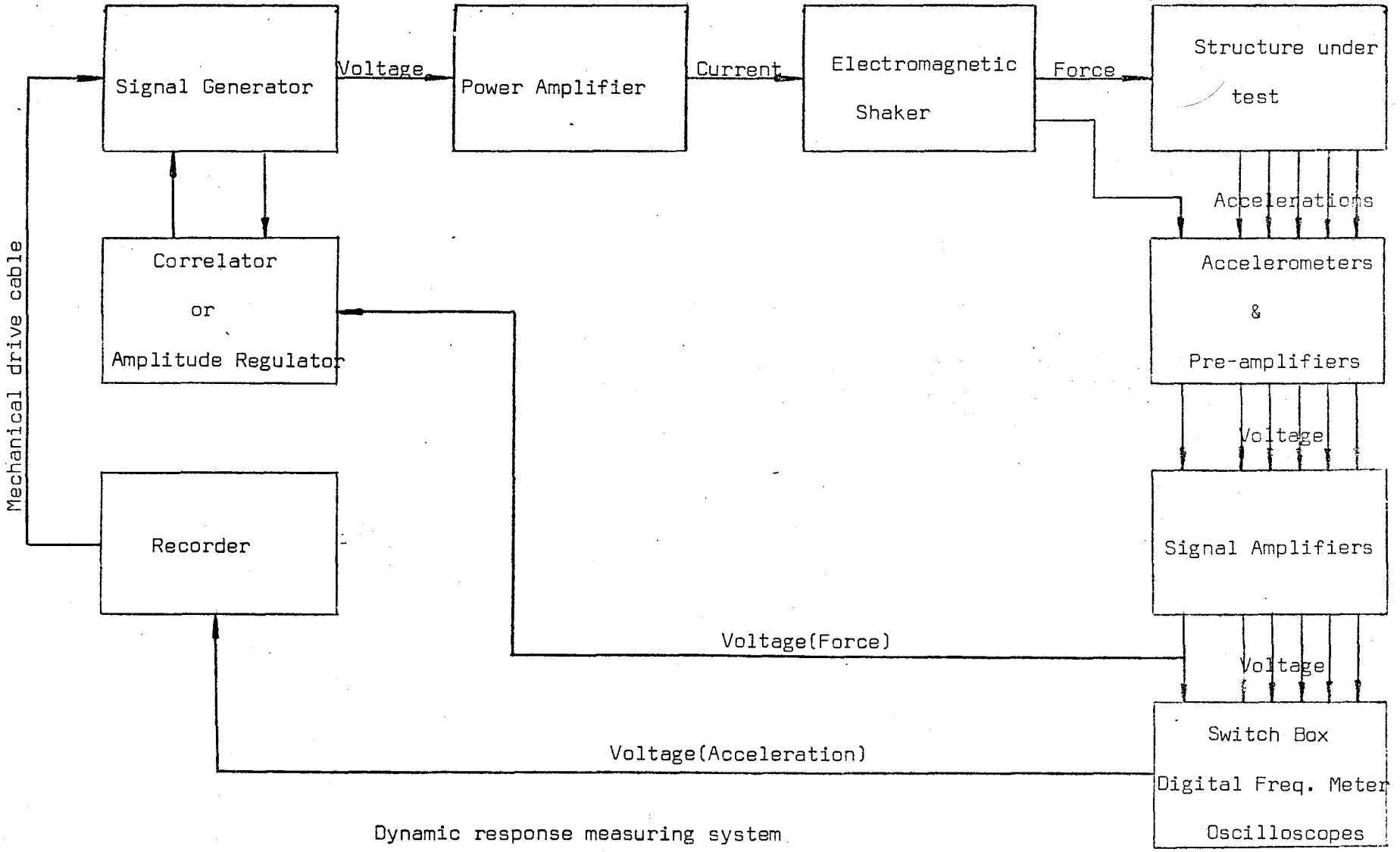
Dynamic model of shaker assembly (Figures 2.1 and 2.2)

Figure 2.7



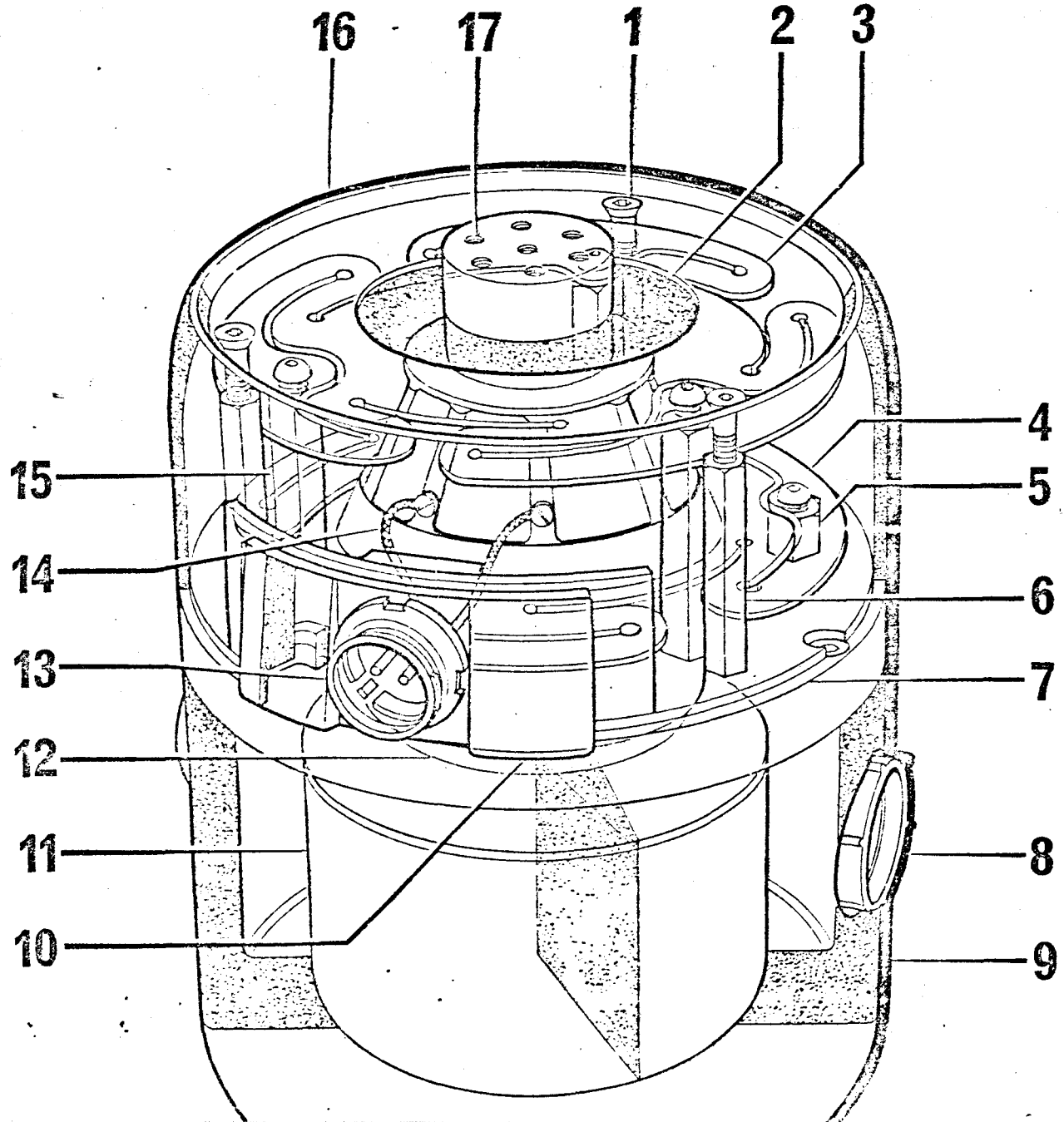
Computed mode shapes for cantilever beam with shaker assembly attached to free end.

Figure 2.8



Dynamic response measuring system

Figure 2.9



1) Top cover retaining screws

2) Dust seal

3) Upper flexure

4) Lower flexure

5) Lower flexure support pillars

6) Top cover retaining pillars

7) Flexure support ring

8) Trunnion attachment and air cooling inlet

9) Magnet housing

10) Cooling air exhaust ports

11) Permanent magnet

12) Moving platform and driving coil assembly

13) Shaker input drive socket

14) Electrical bonding leads

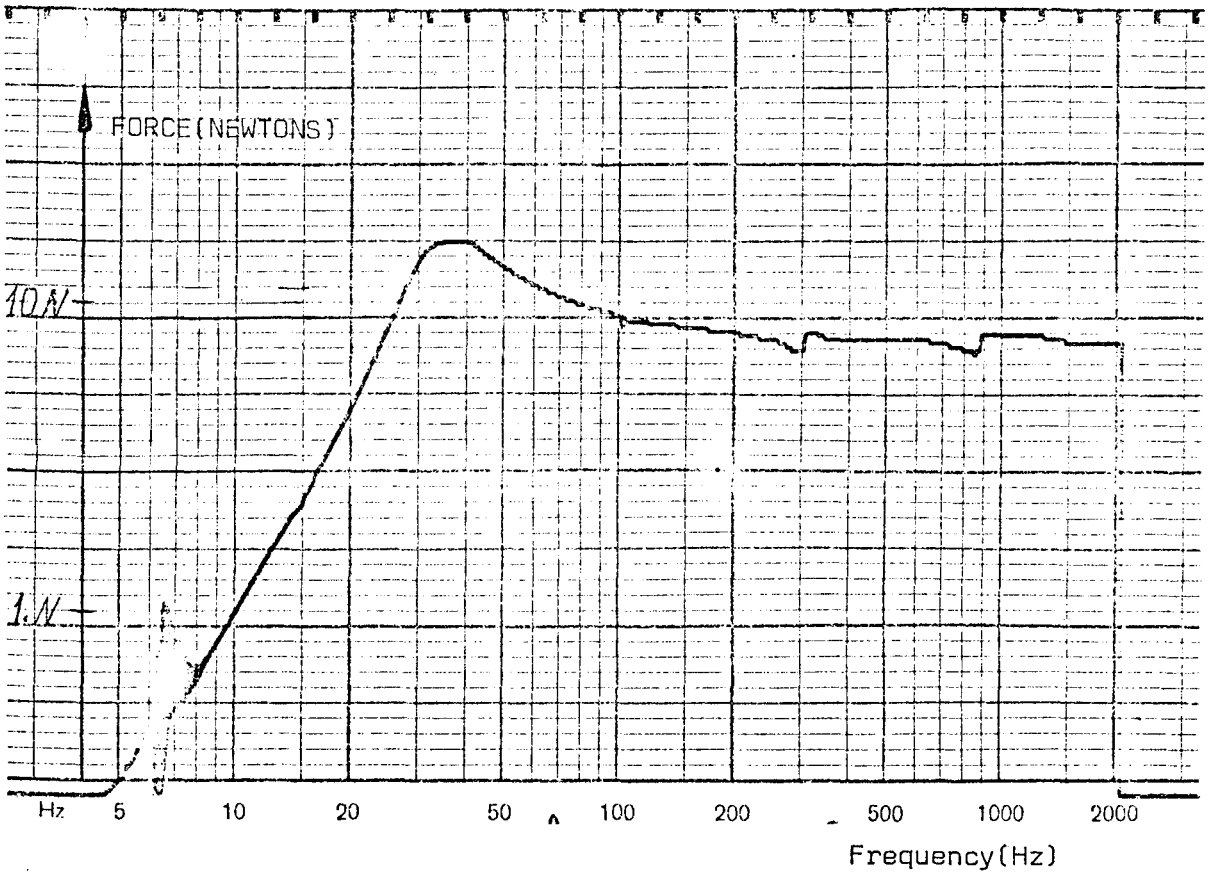
15) Upper flexure support pillars

16) Top cover

17) Moving platform

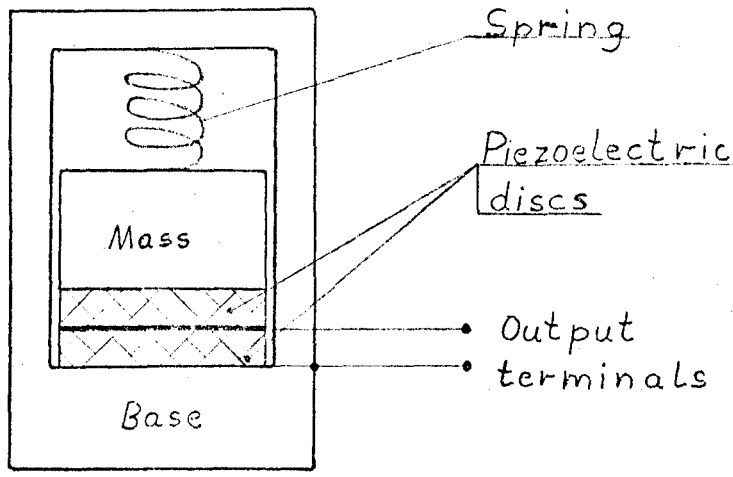
Electro-magnetic shaker

Figure 2.10

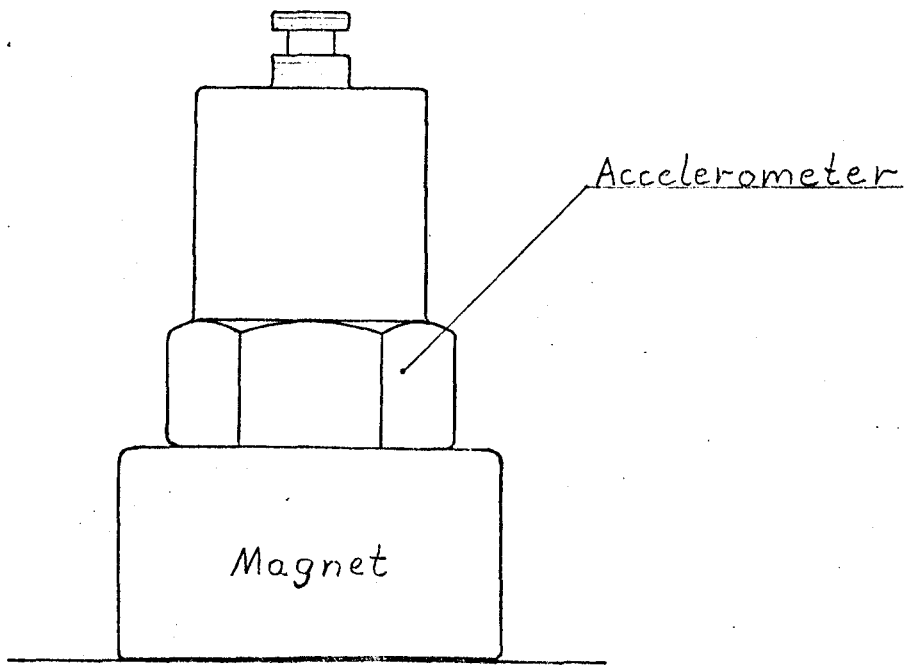


Inertia force generated by electromagnetic shaker at free end of cantilever beam (Fig. 2.1 and Fig. 2.17 joint 5Y).

Figure 2.11

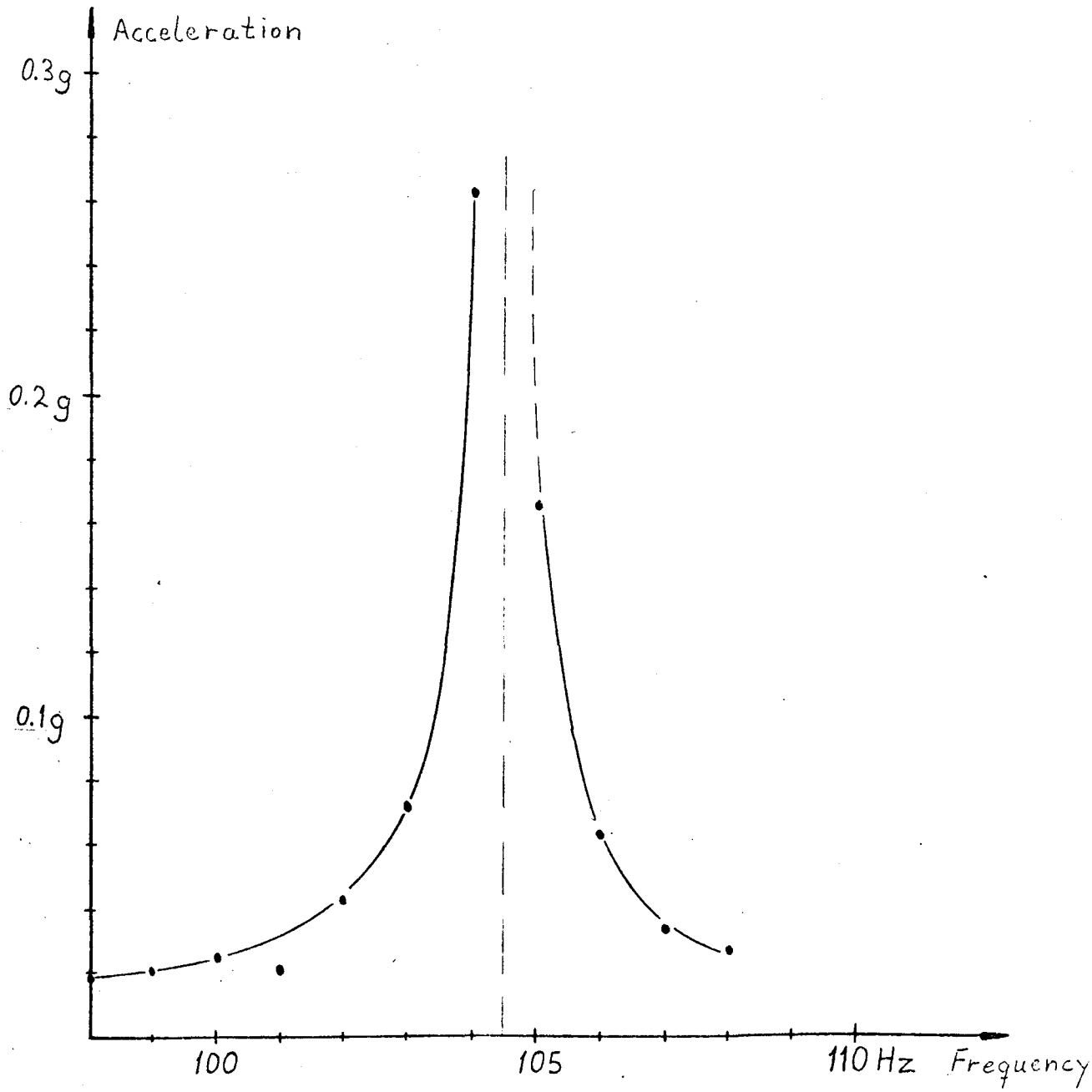


Schematic drawing of piezoelectric accelerometer



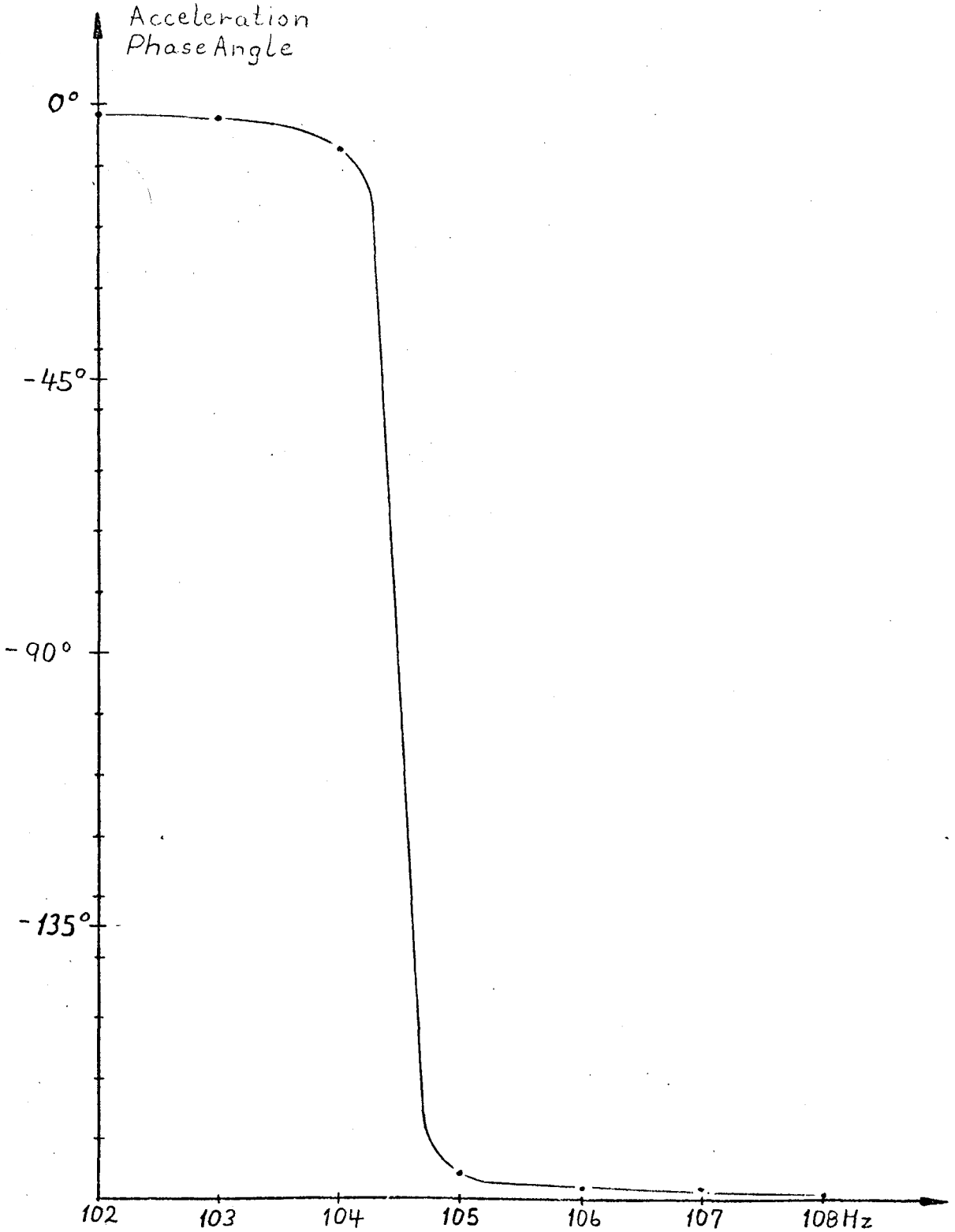
Piezoelectric accelerometer on magnetic base

Figure 2.12



Measured acceleration response of cantilever beam(Fig.2.17) at joint 3Y.
Input force 1 Newton at joint 5Y. Natural frequency 104.48Hz

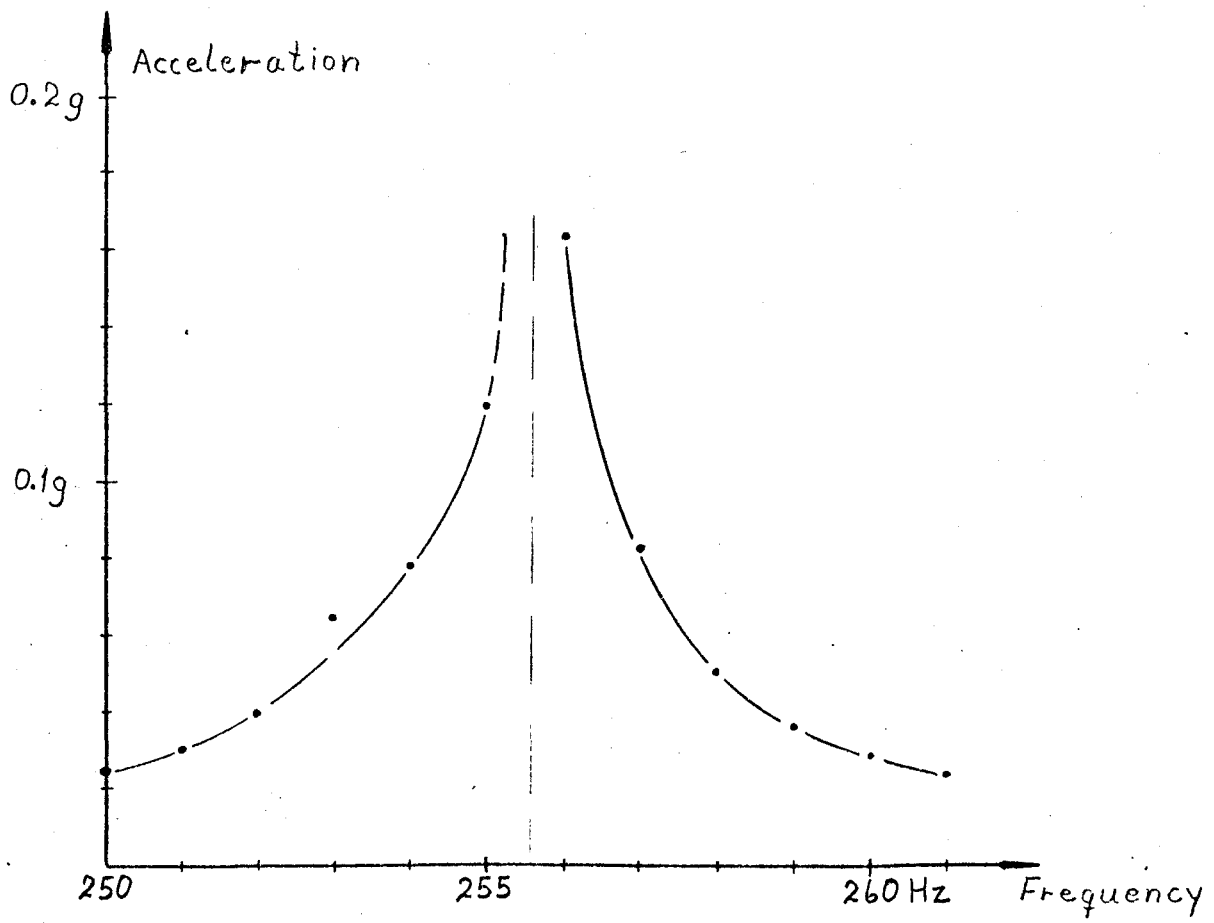
Figure 2.13



Measured phase angle response of cantilever beam(Fig.2.17) at joint 3Y .

Input force 1 Newton at joint 5Y . Natural frequency 104.48 Hz

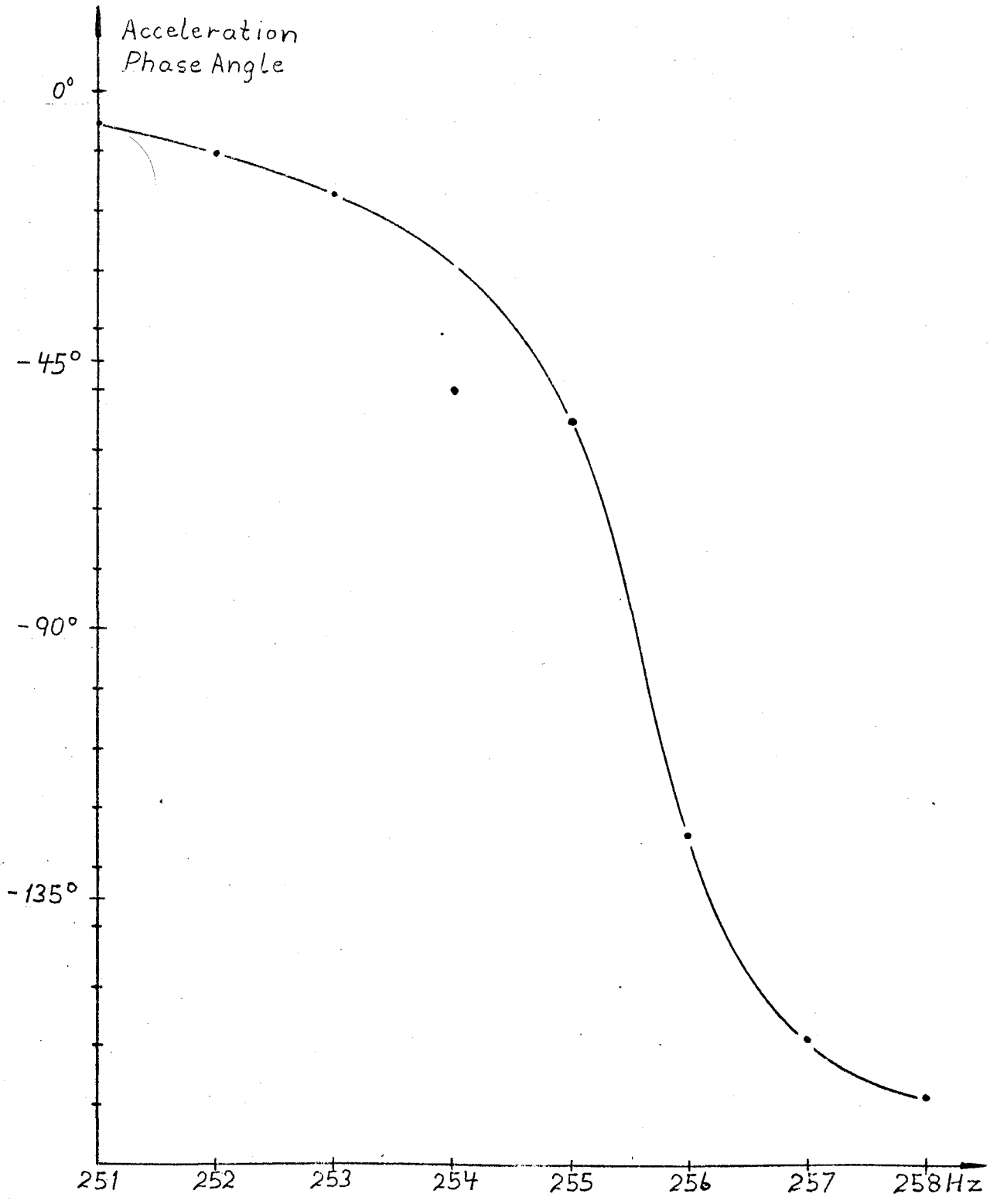
Figure 2.14



Measured acceleration response of cantilever beam(Fig.2.17) at joint 3Y.

Input force 1 Newton at joint 5Y. Natural frequency=255.55Hz

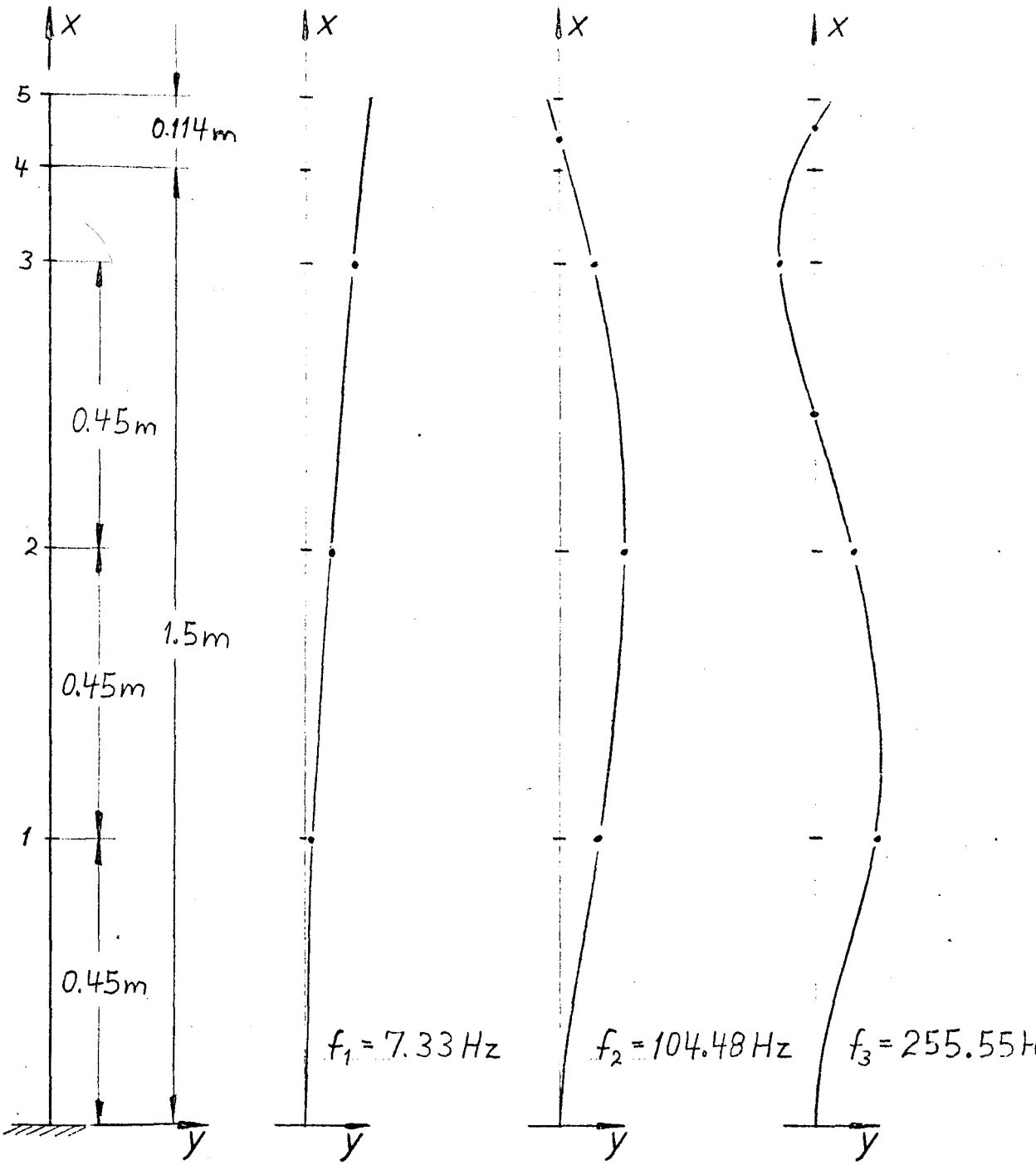
Figure 2.15



Measured phase angle response of cantilever beam(Fig.2.17) at joint 3Y .

Input force 1 Newton at joint 5Y . Natural frequency 255.55 Hz

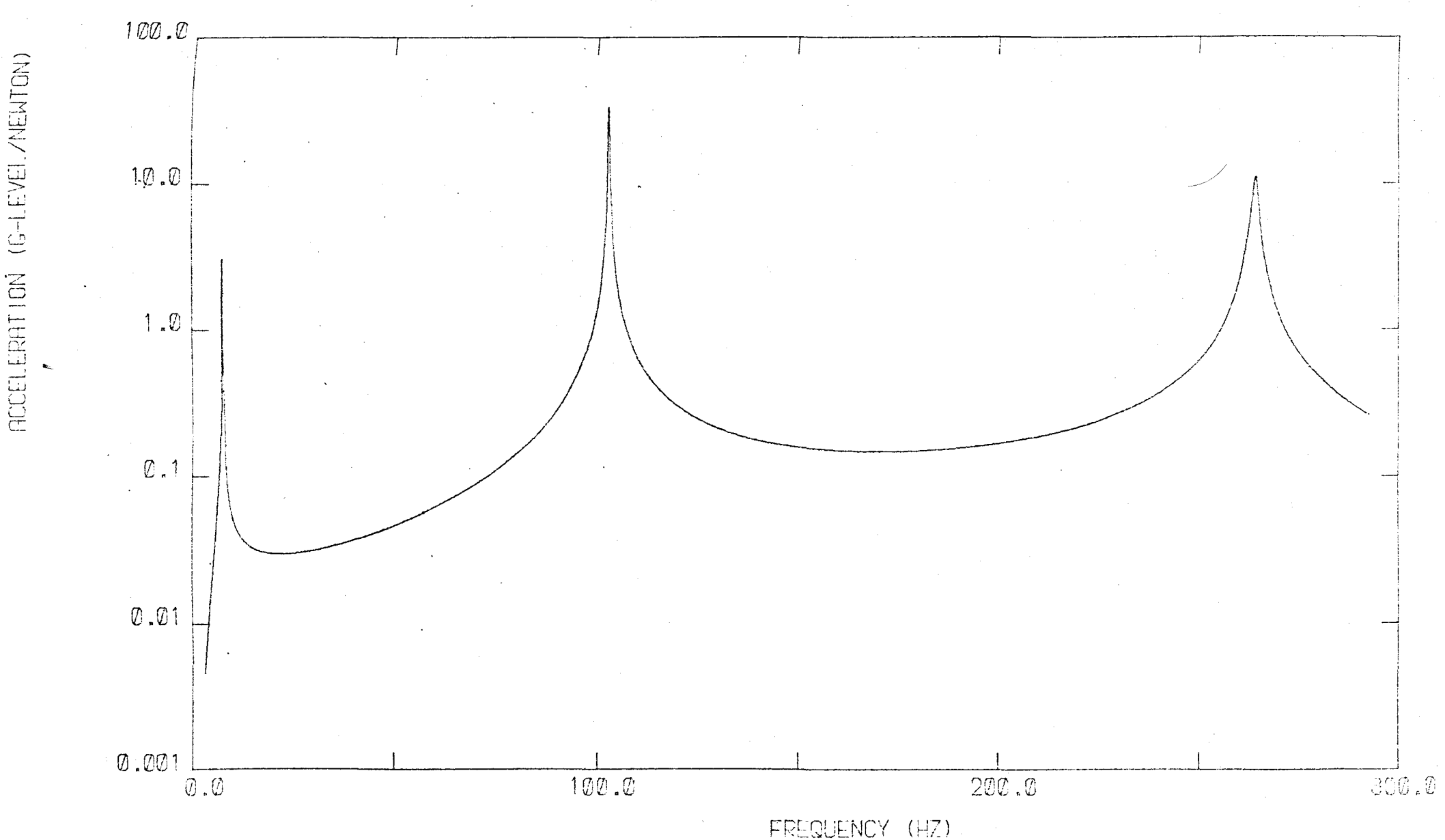
Figure 2.16



Measured mode shapes for cantilever beam

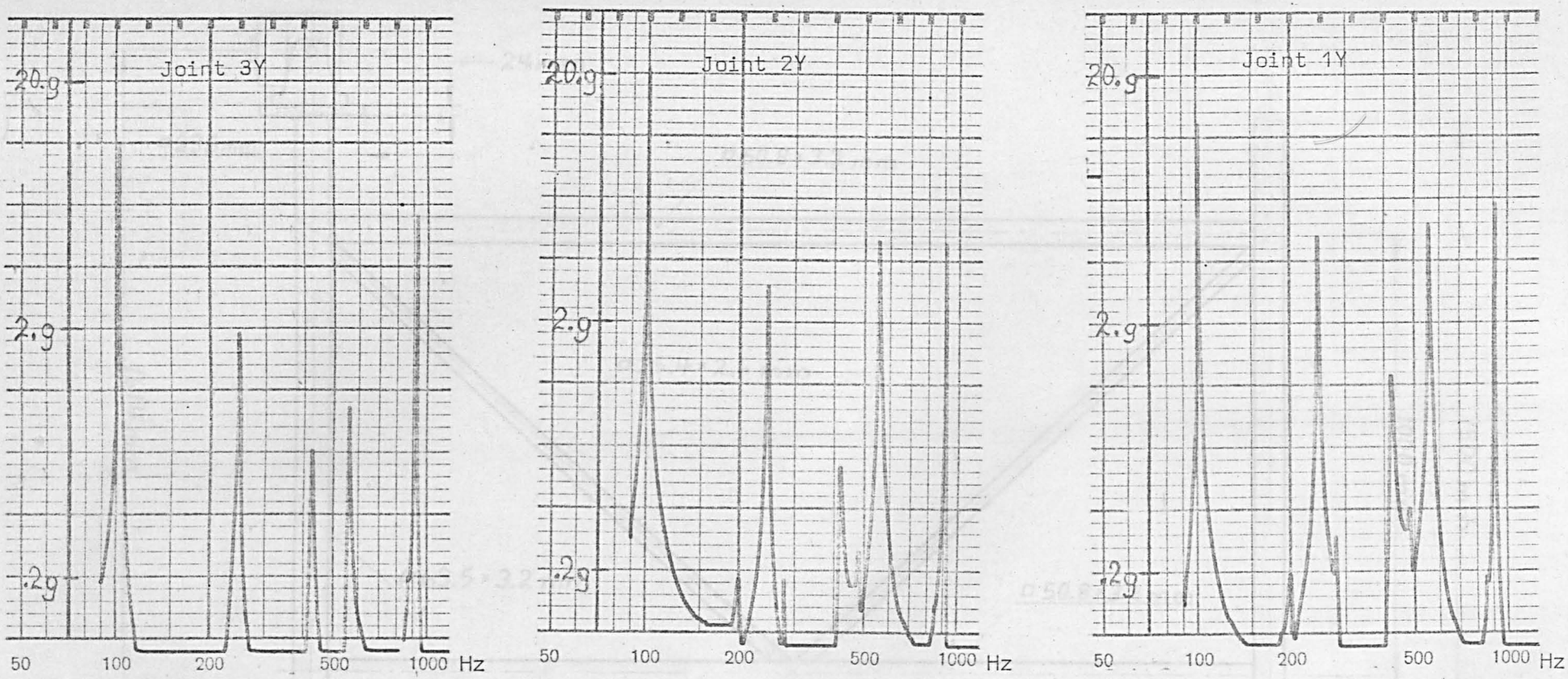
with shaker assembly attached to free end.

Figure 2.17



Computed acceleration receptance $\ddot{\alpha}_{39}$ (Figure 2.8) for cantilever beam with a shaker attached at free end (Table 2.5)

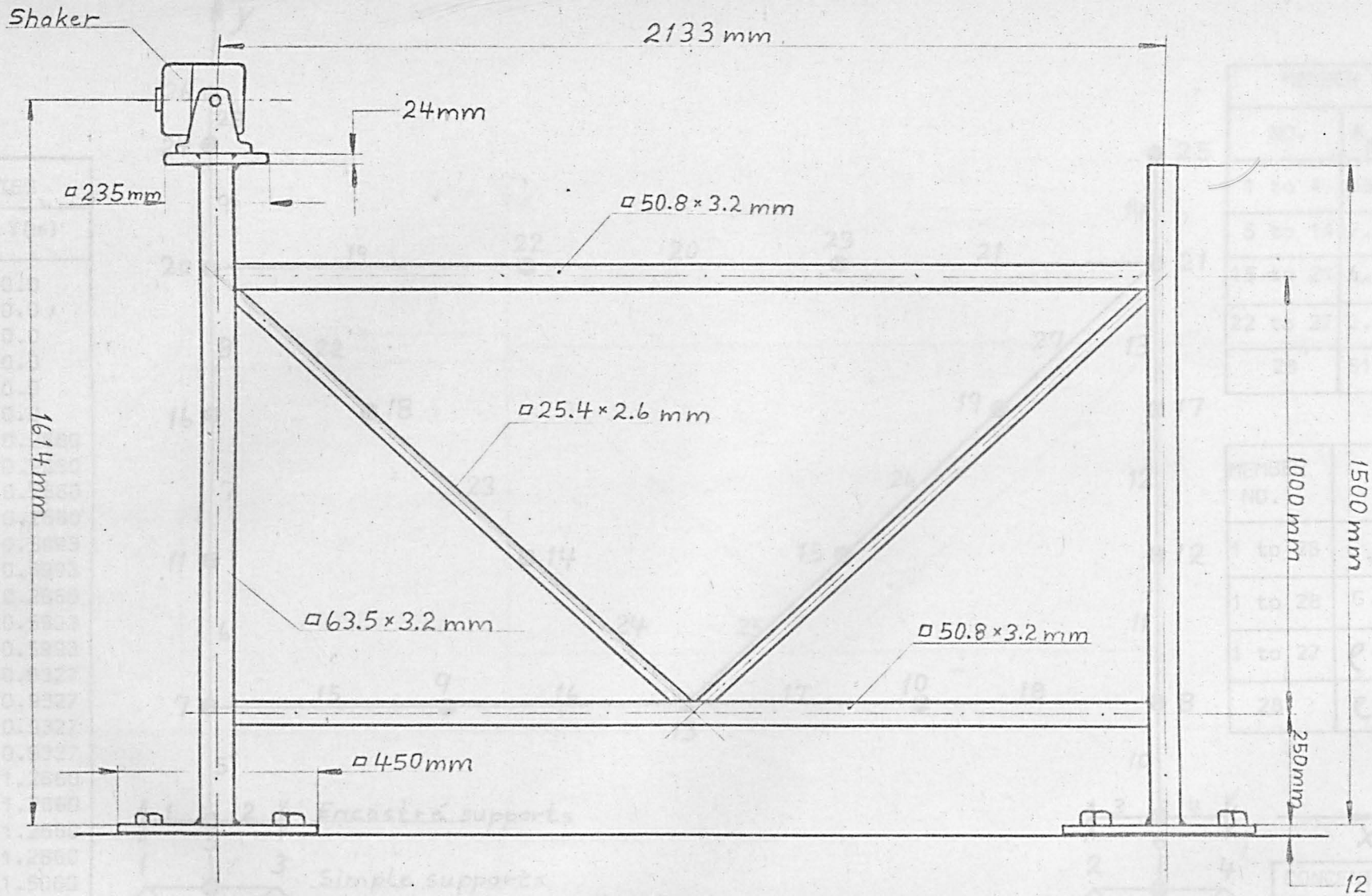
Figure 2.18



Measured acceleration response of cantilever beam (Fig. 2.17) at joints 3Y, 2Y, and 1Y .

Input force 20 Newtons at joint 5Y

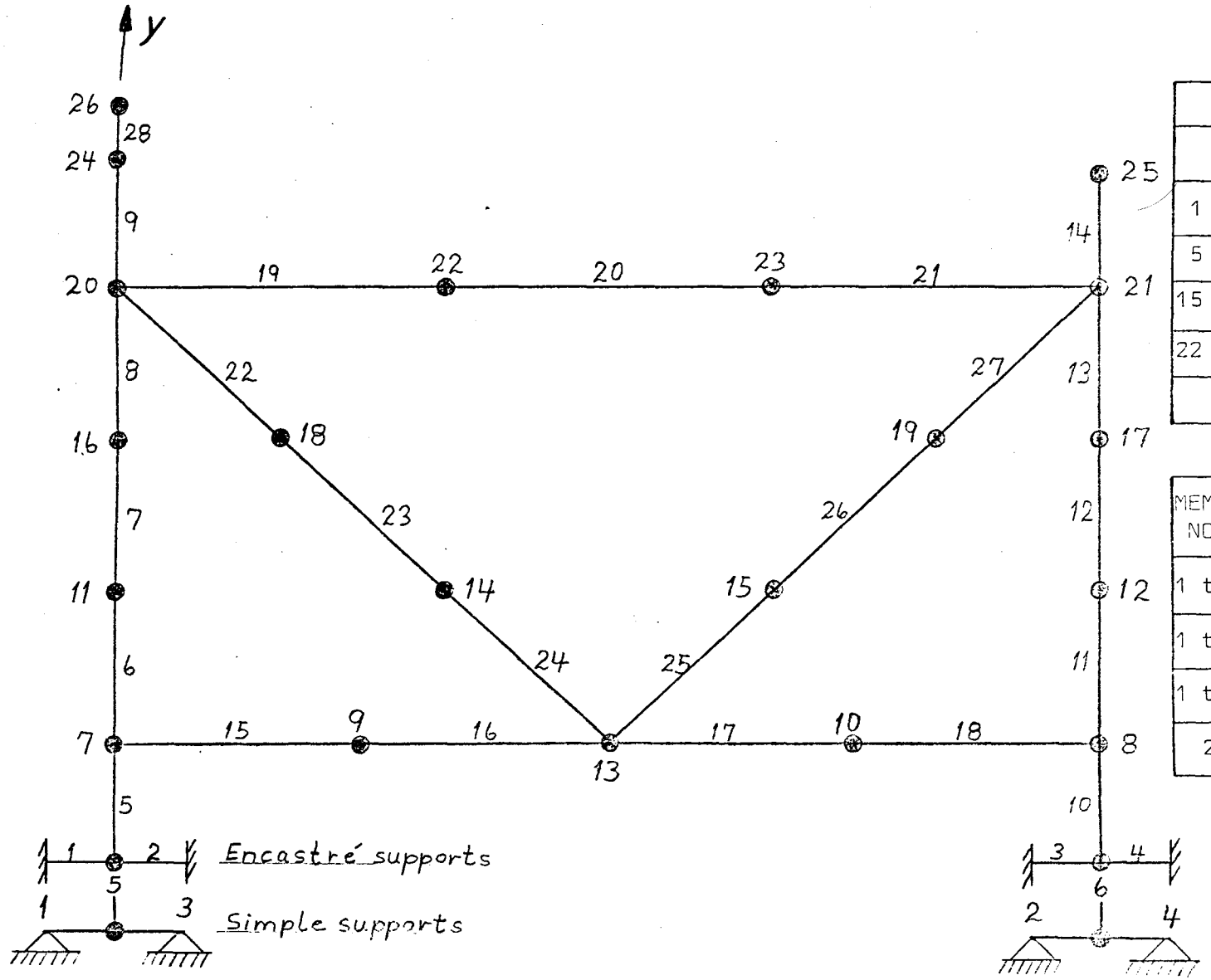
Figure 2.19



Plane frame with shaker assembly

Figure 2.20

JOINT CO-ORDINATES		
NO.	X(m)	Y(m)
1	-0.1524	0.0
2	1.9812	0.0
3	0.1524	0.0
4	2.2860	0.0
5	0.0	0.0
6	2.1336	0.0
7	0.0	0.2660
8	2.1336	0.2660
9	0.5334	0.2660
10	1.6002	0.2660
11	0.0	0.5993
12	2.1336	0.5993
13	1.0668	0.2660
14	0.7112	0.5993
15	1.4224	0.5993
16	0.0	0.9327
17	2.1336	0.9327
18	0.3556	0.9327
19	1.7780	0.9327
20	0.0	1.2660
21	2.1336	1.2660
22	0.7112	1.2660
23	1.4224	1.2660
24	0.0	1.5060
25	2.1336	1.5060
26	0.0	1.6203



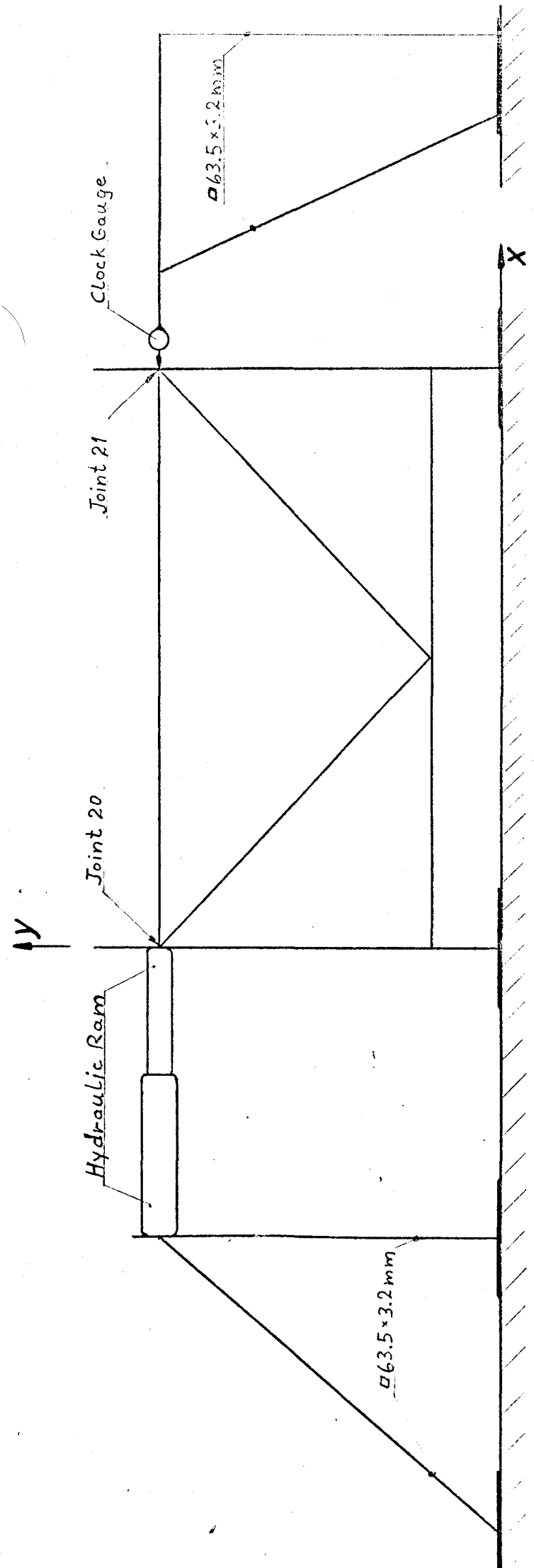
Beam element model of plane frame

Figure 2.21

MEMBER PROPERTIES		
NO.	$A_X(m^2)$	$I_Z(m^4)$
1 to 4	38.7E-4	5.2E-8
5 to 14	7.55E-4	45.E-8
15 to 21	5.91E-4	21.8E-8
22 to 27	2.23E-4	1.83E-8
28	51.5E-4	360.E-8

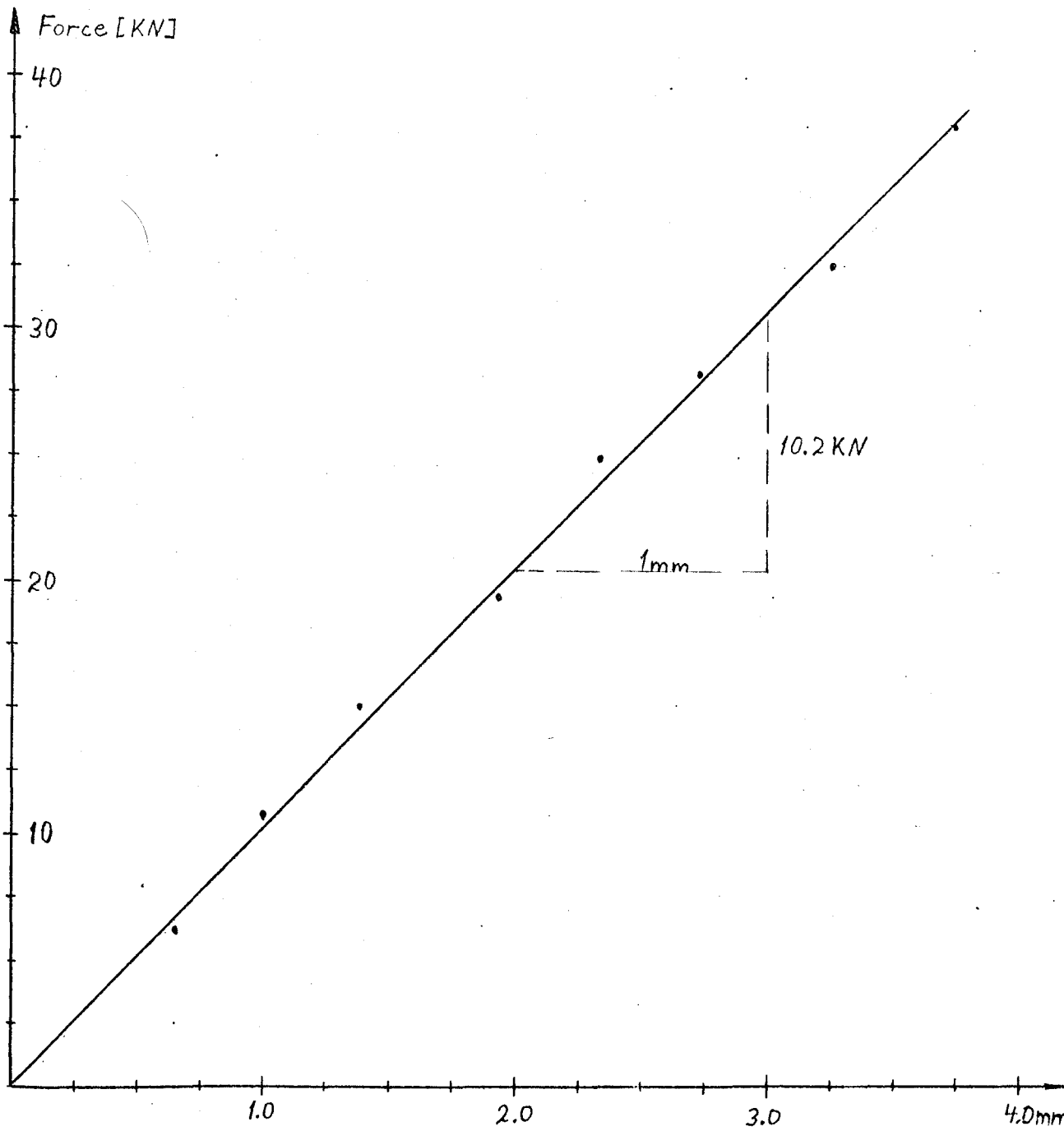
MEMBER NO.	MATERIAL CONSTANTS
1 to 28	E = 2.1E11 (N/m^2)
1 to 28	G = 0.82E11 (N/m^2)
1 to 27	ρ = 7.85E3 (kg/m^3)
28	ρ = 0.0

CONCENTRATED INERTIA		
JOINT NO.	LINEAR (kg)	ANGULAR (kgm^2)
24	18.21	87.5E-3
26	14.11	111.2E-3



Stiffness measurement of plane frame

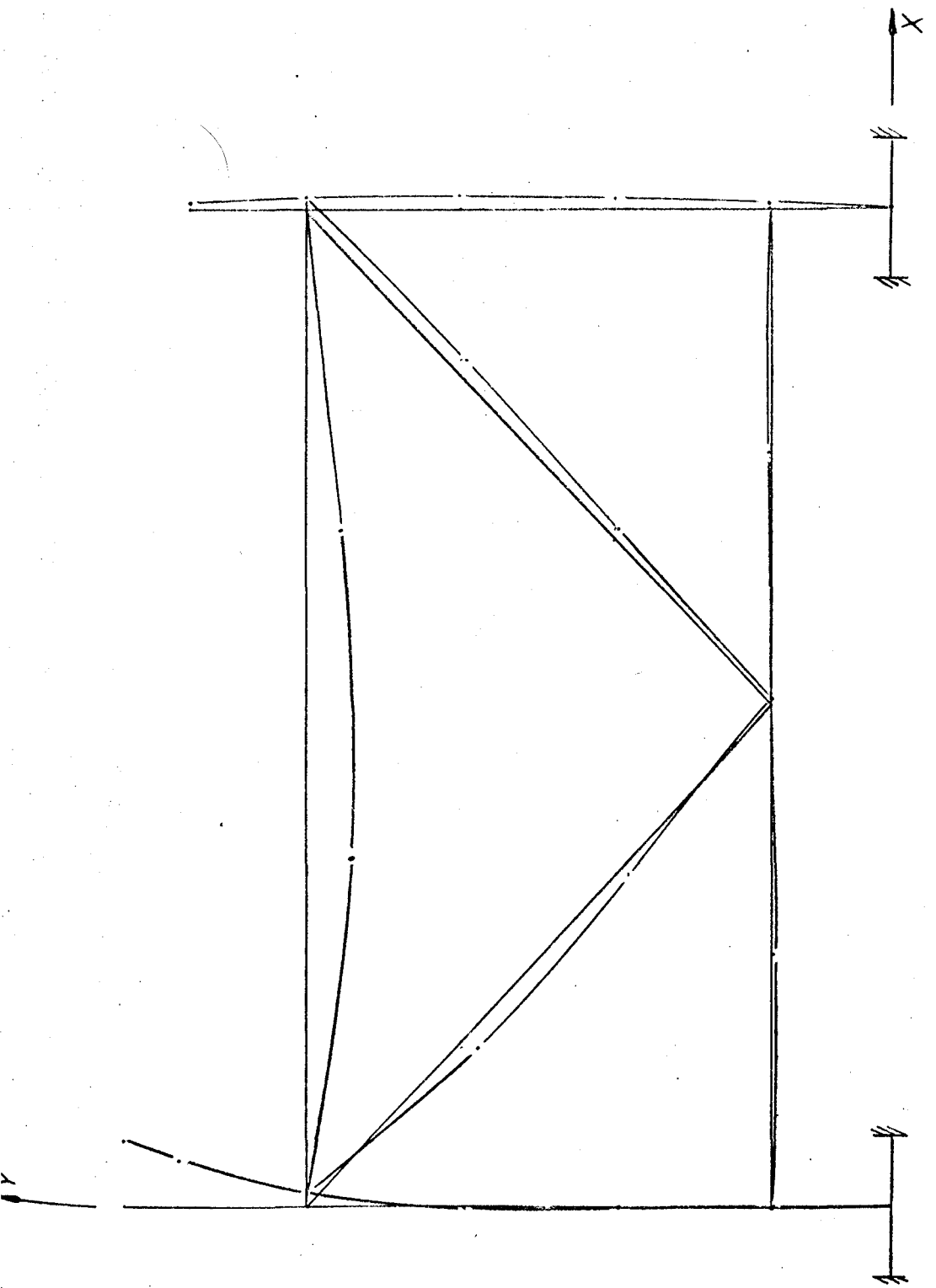
Figure 2.22



Measured stiffness of plane frame (Figure 2.22)

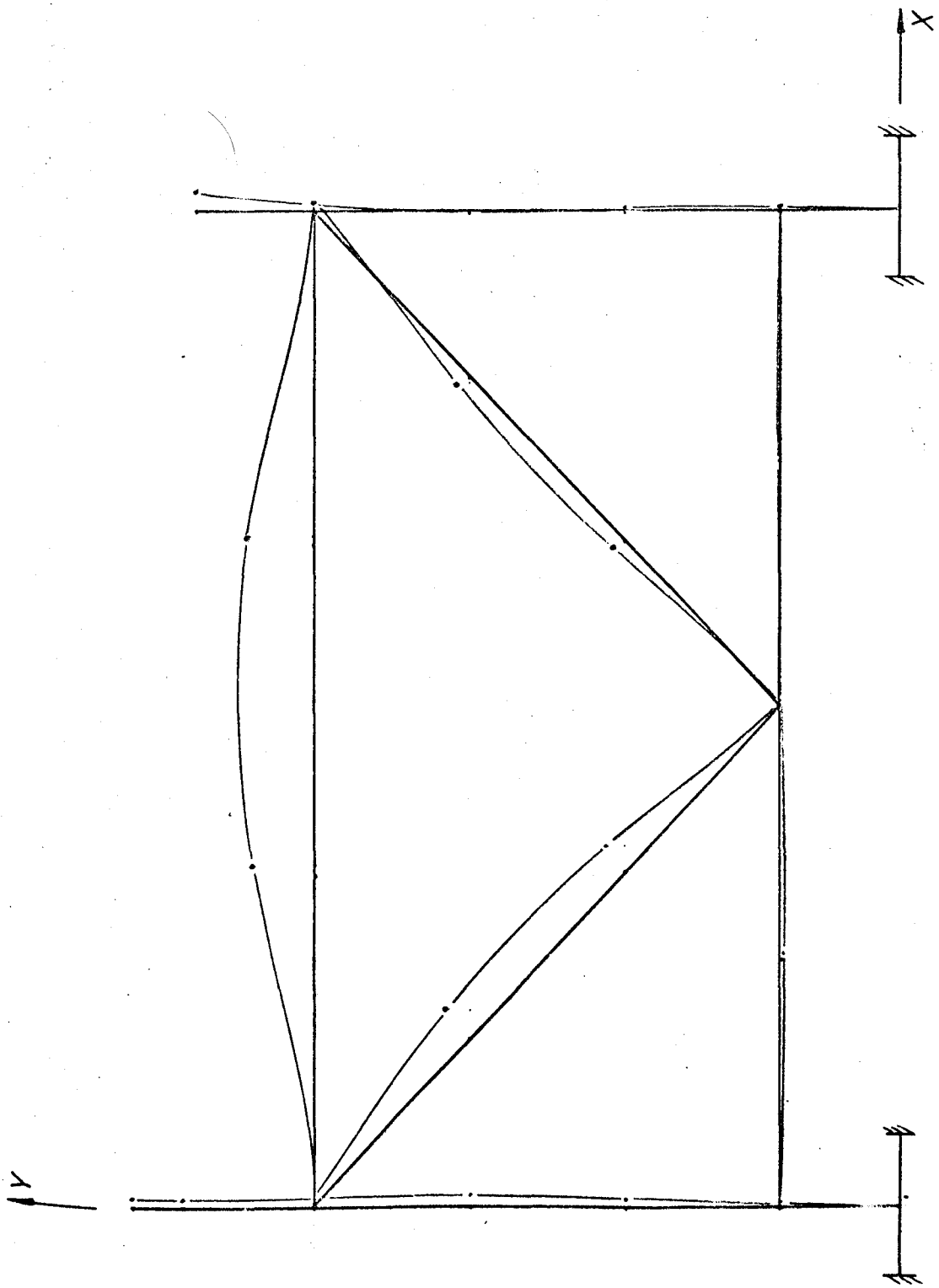
Force applied at joint 20X. Displacement measured at joint 21X .

Figure 2.23



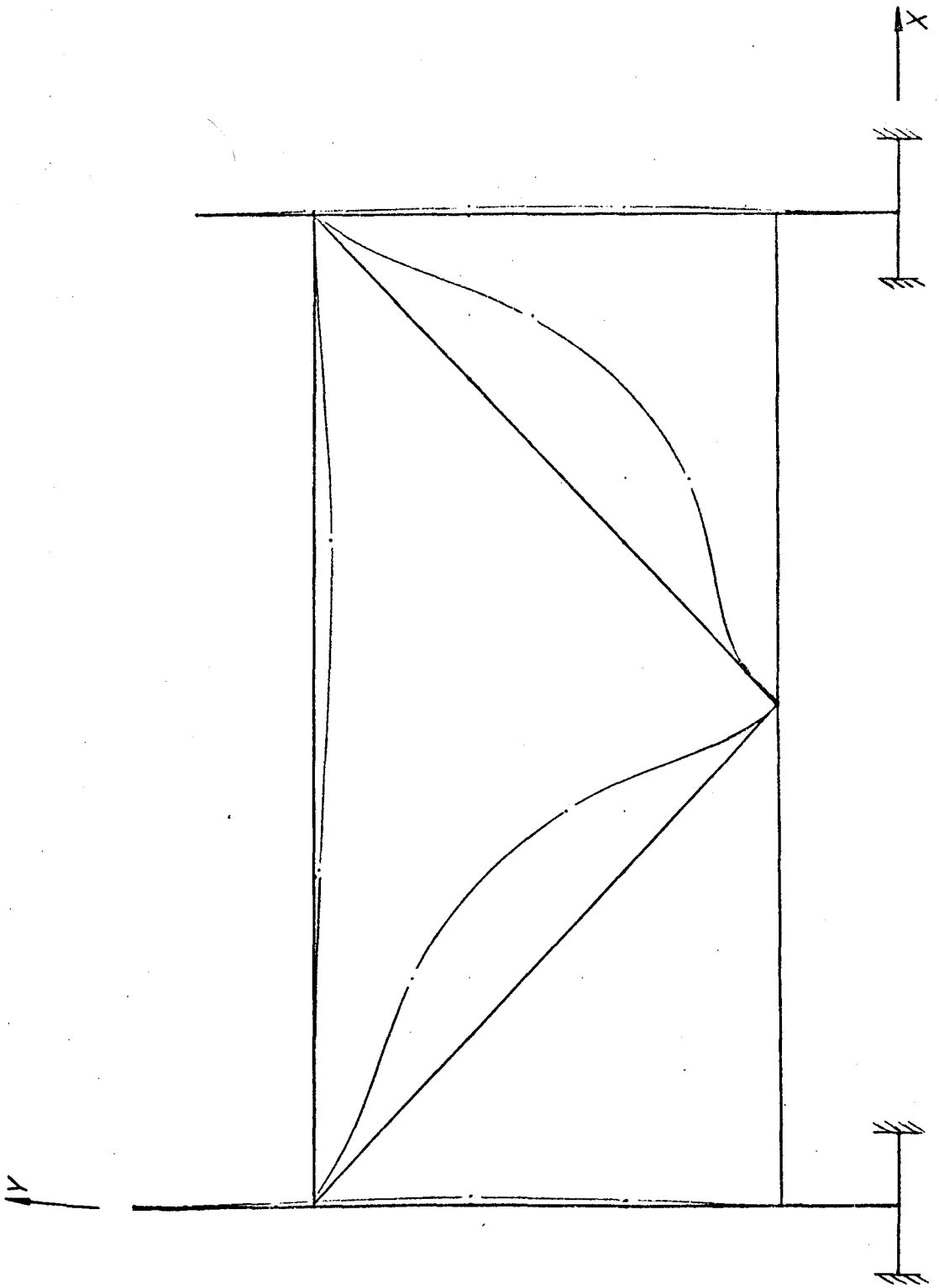
Fundamental mode shape for plane frame at 41.21 Hz (Table 2.9)

Figure 2.24



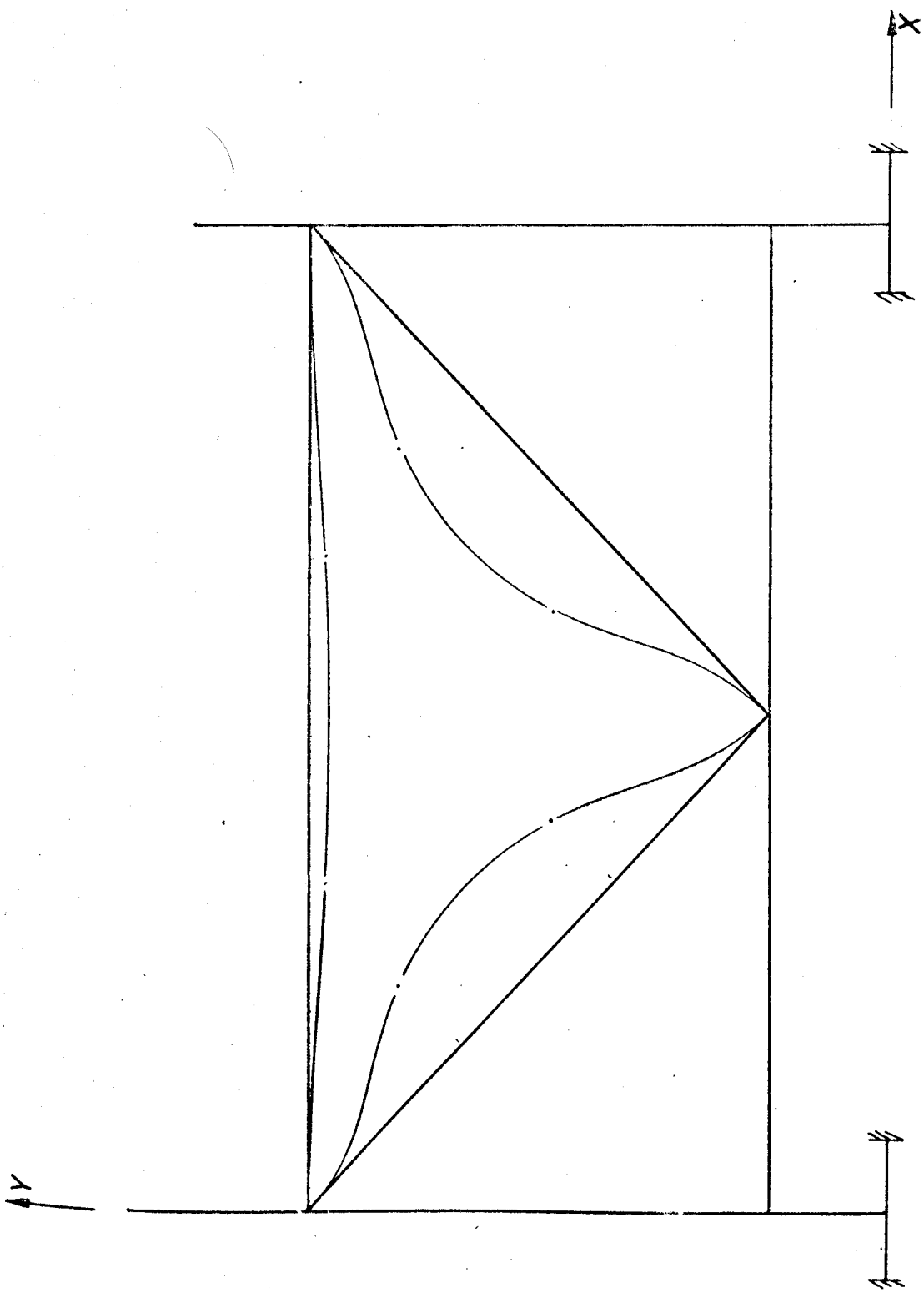
Second mode shape for plane frame at 67.60 Hz (Table 2.10)

Figure 2.25



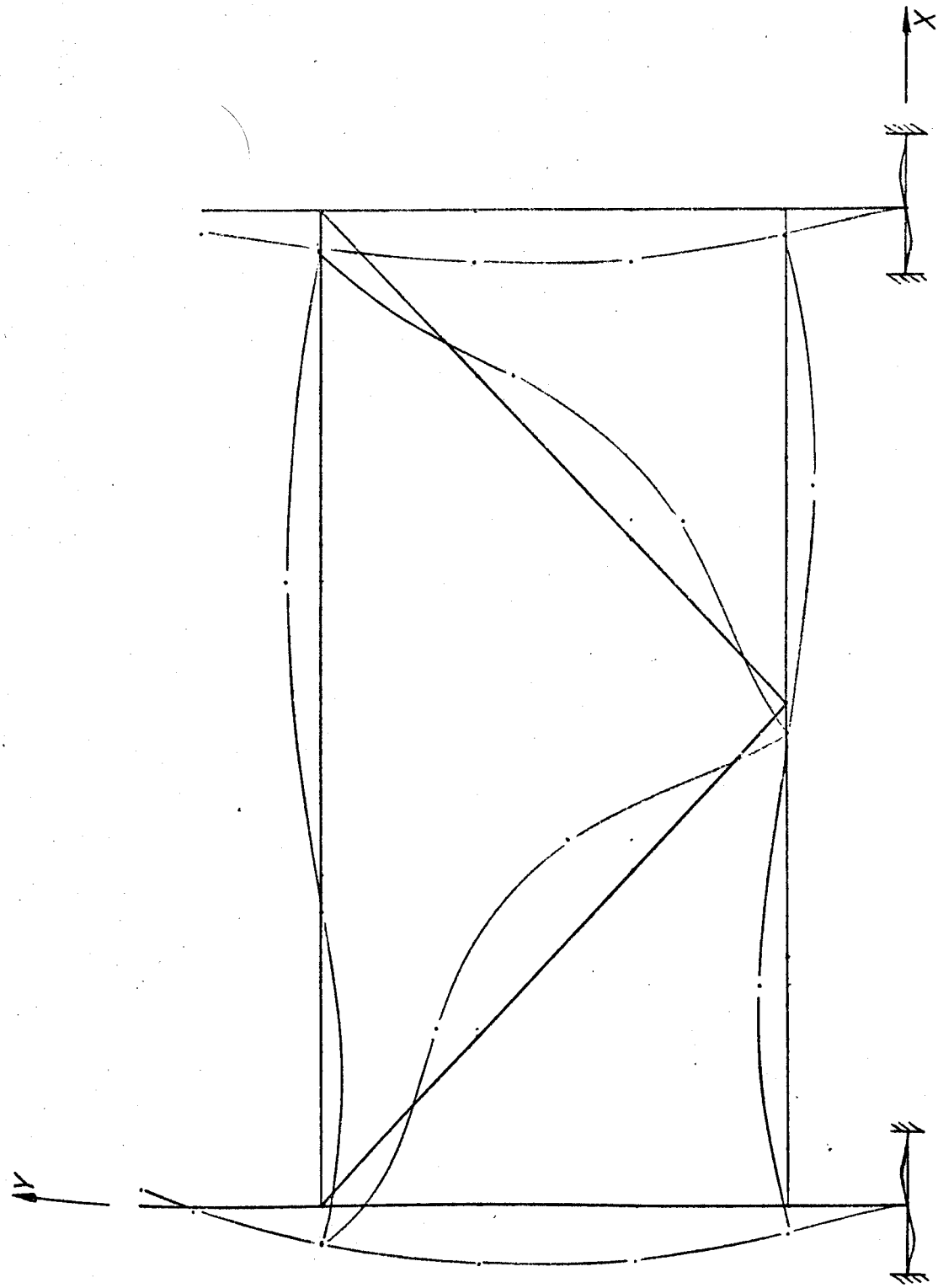
Third mode shape for plane frame at 73.22 Hz (Table 2.11)

Figure 2.26



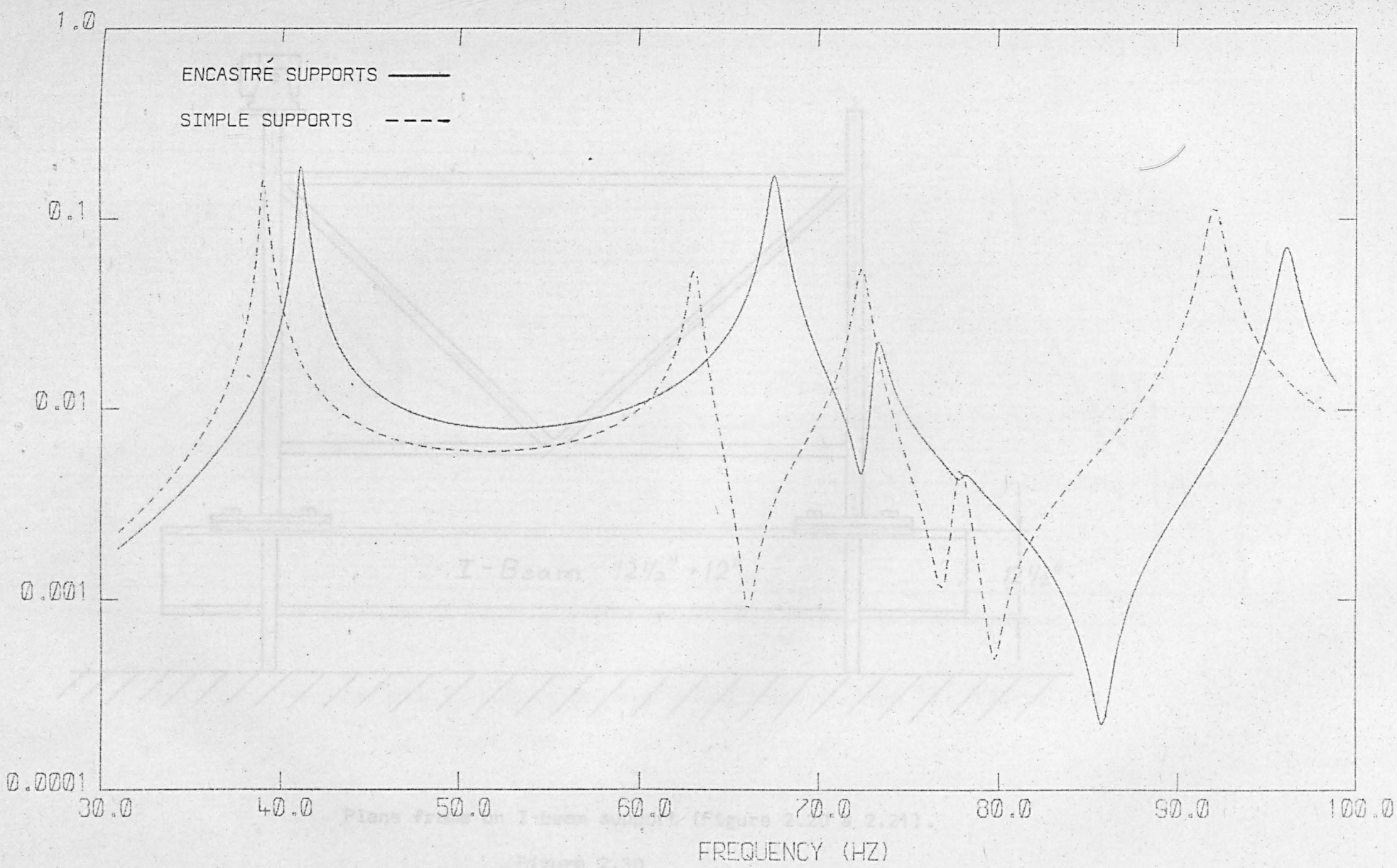
Fourth mode shape for plane frame at 78.08 Hz (Table 2.12)

Figure 2.27



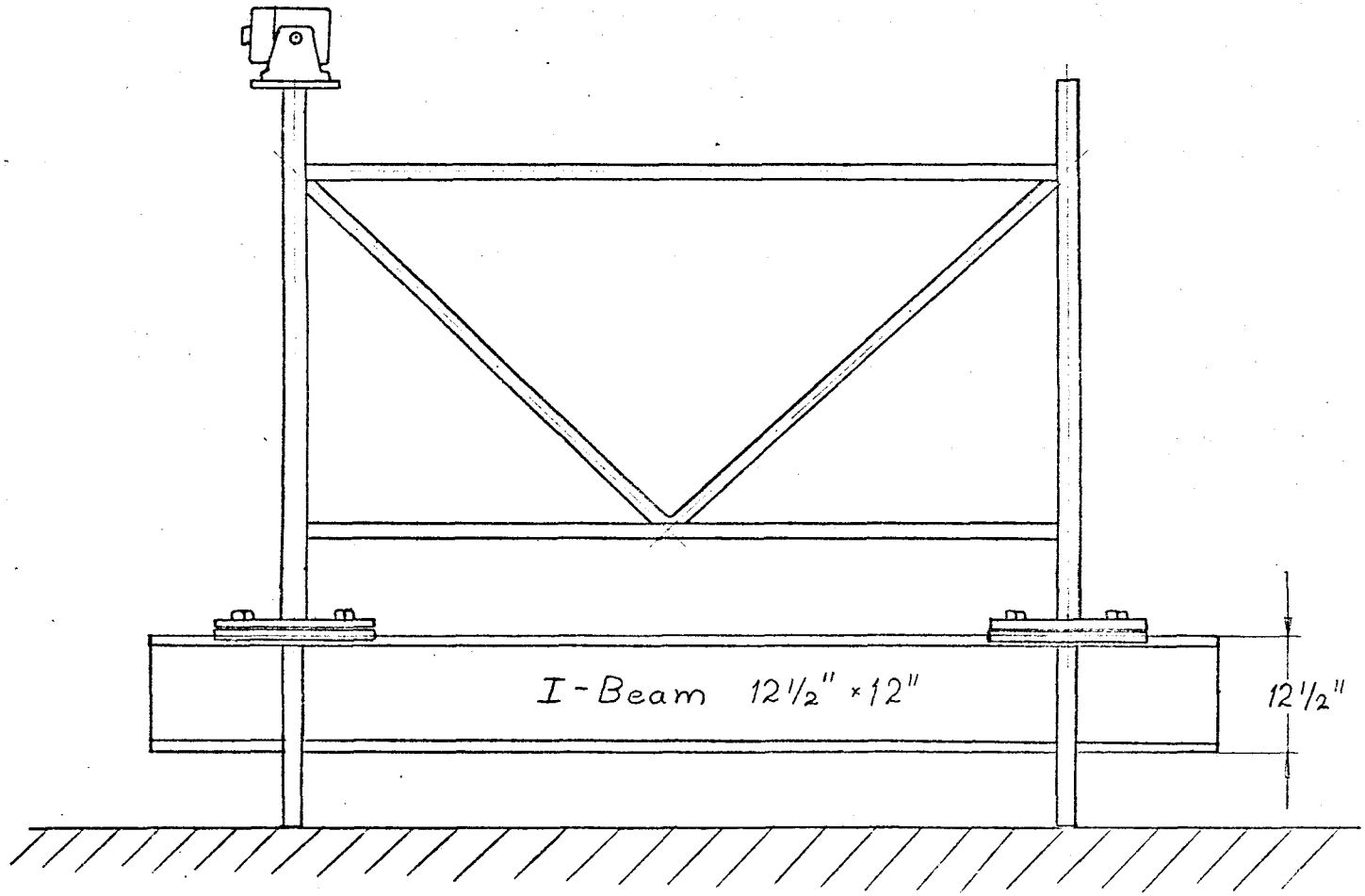
Fifth mode shape for plane frame at 96.12 Hz (Table 2.13)

Figure 2.28



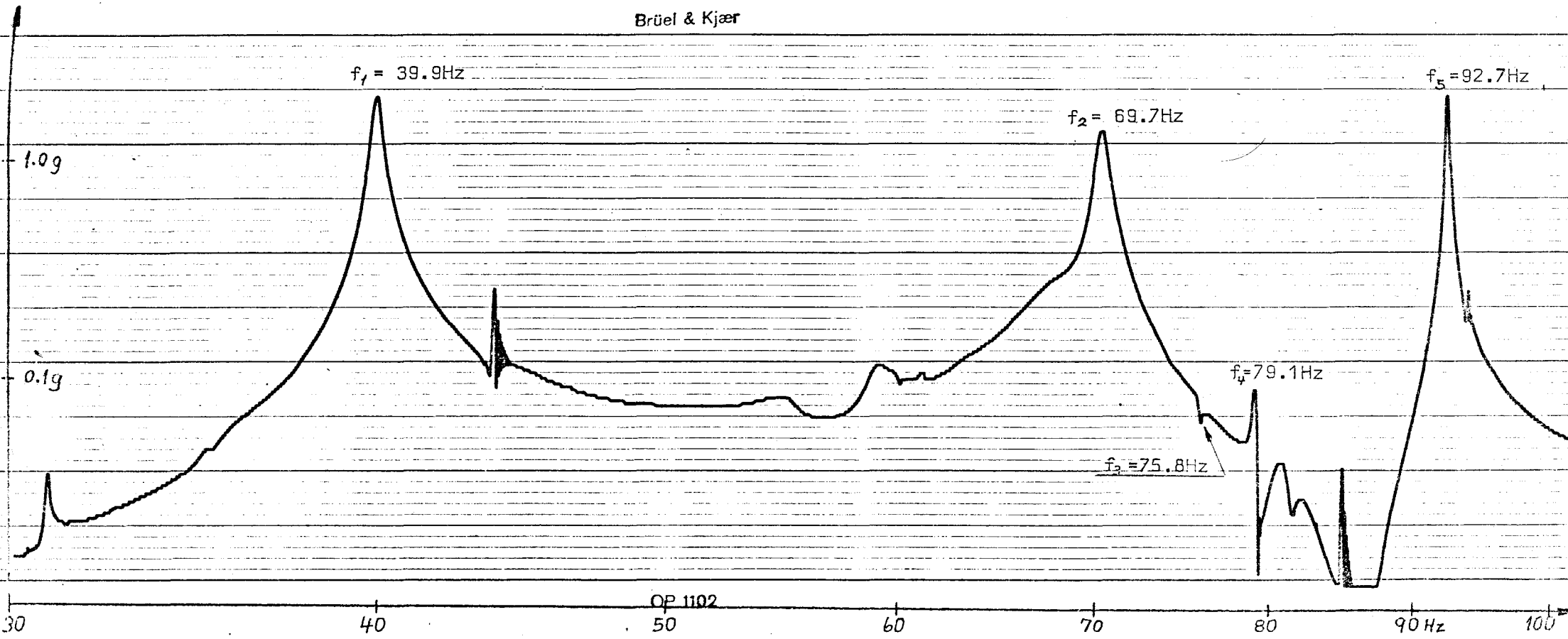
Computed acceleration receptance $\ddot{\alpha}_{23Y,26X}$ (Fig. 2.21) for plane frame (Table 2.9 to 2.13)

Figure 2.29



Plane frame on I-beam support (Figure 2.20 & 2.21).

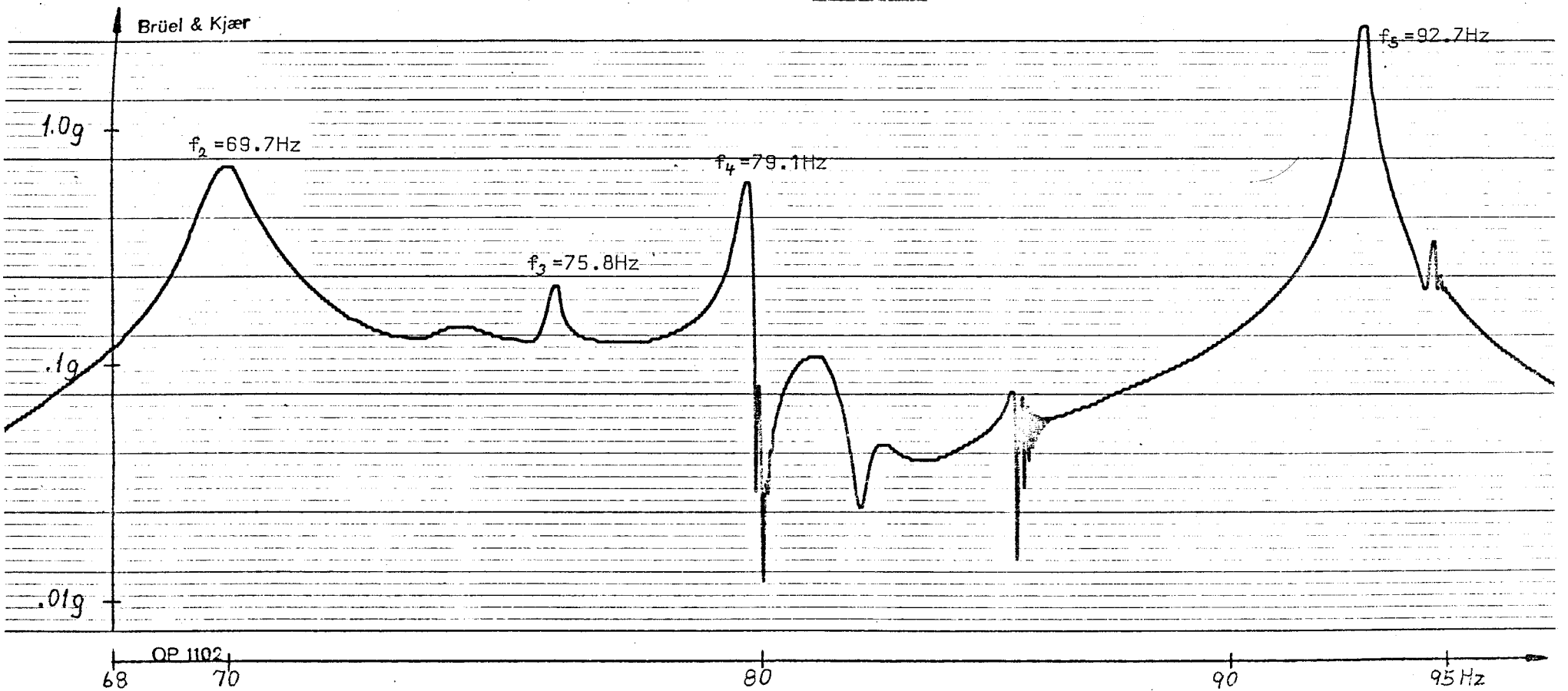
Figure 2.30



Measured acceleration response of plane frame at joint 23Y (Figure 2.21)

Input force 10 Newtons at joint 26X

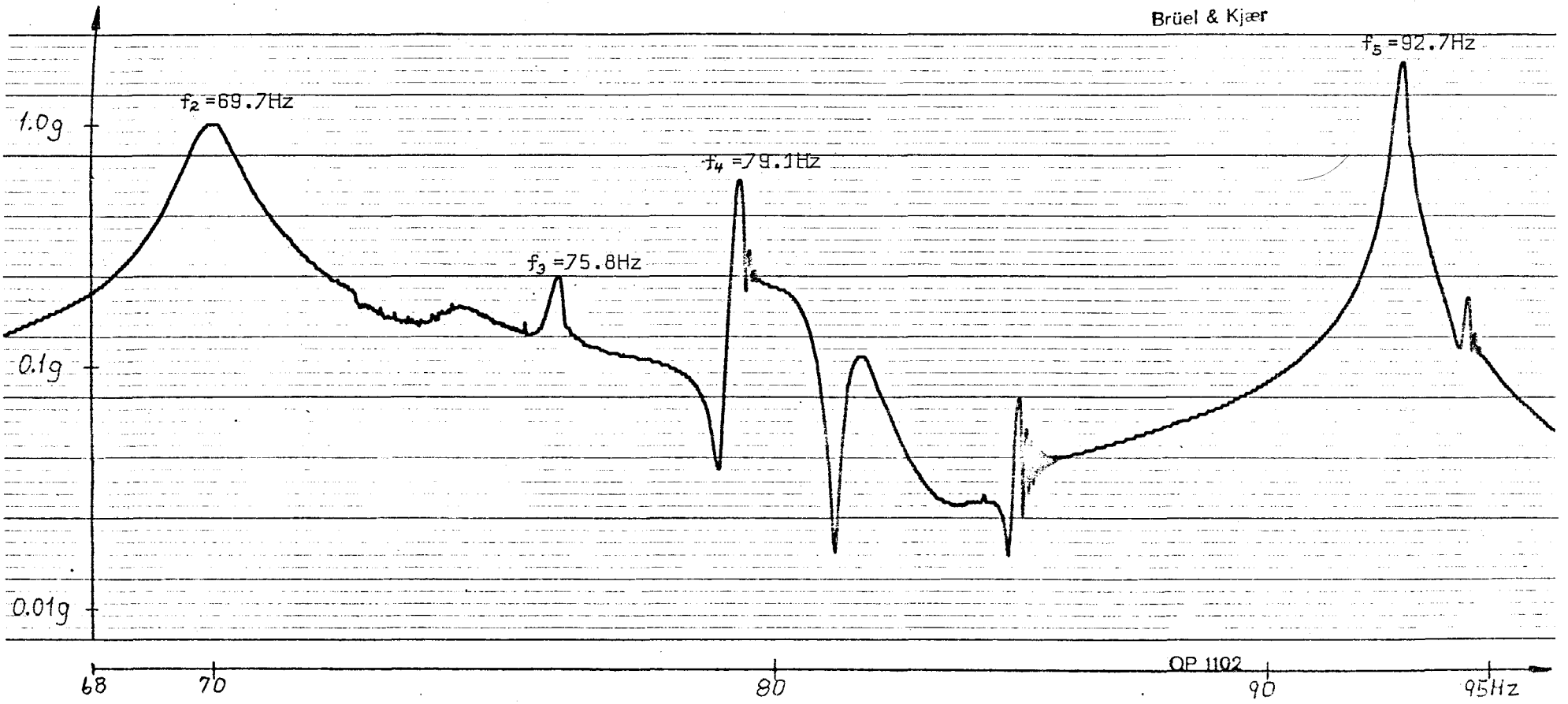
Figure 2.31



Measured acceleration response of plane frame at joint 18 Figure 2.21

Input force 10 Newtons at joint 26X

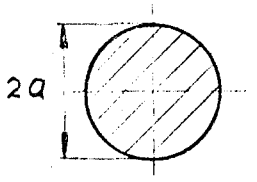
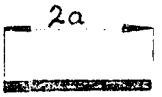
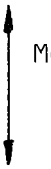
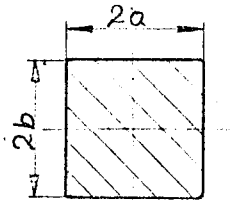
Figure 2.32



Measured acceleration response of plane frame at joint 19 (Figure 2.21)

Input force 10 Newtons at joint 26X

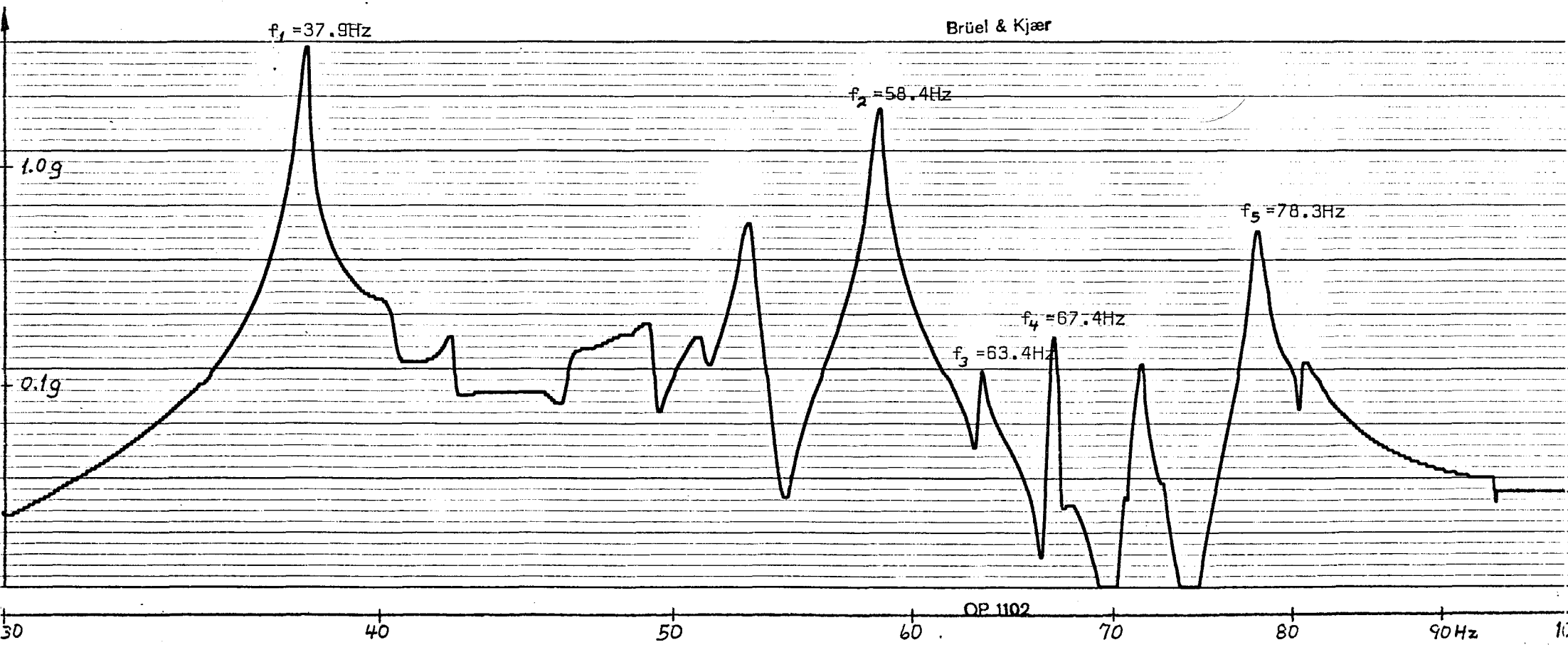
Figure 2.33

Form of Two-Dimensional Body	Added Mass per Unit Length	Added Moment of Inertia per Unit Length
 Rod of circular section	 Mode of motion $m_L = \varrho\pi a^2$	 Mode of motion $J_L = 0$
 Long flat plate	 Mode of motion $m_L = \varrho\pi a^2$	 Mode of motion $J_L = \varrho\pi a^4/8$
 Rod of square or rectangular section	 Mode of motion $m_L = k_1\varrho\pi a^2$	 Mode of motion $J_L = k_2\varrho\pi a^4$

a/b	k_1	k_2
0.2	1.98	9.4
1.0	1.51	.234
2.0	1.36	0.15

Added liquid mass for some two-dimensional geometric shapes.

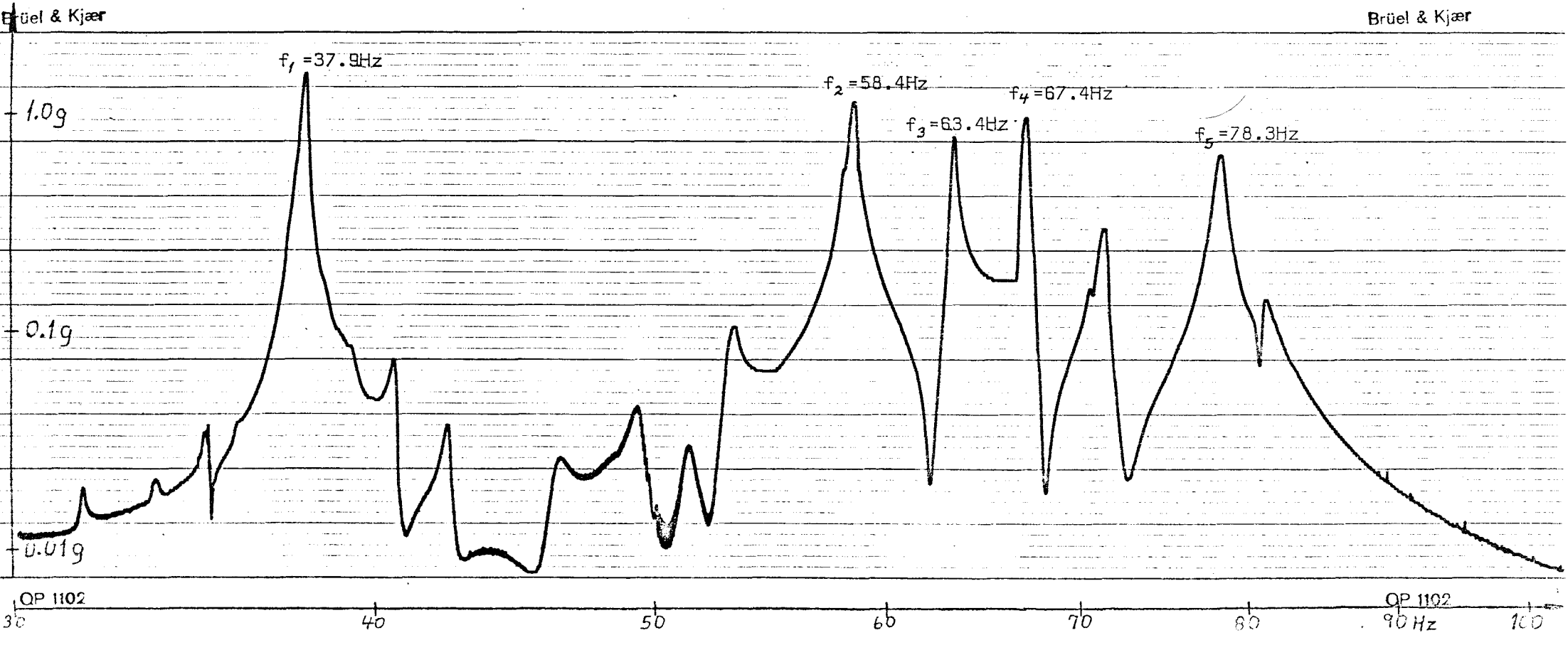
Figure 2.34



Measured acceleration response of plane frame in water at joint 23Y (Figure 2.21)

Input force 10 Newtons at joint 26X

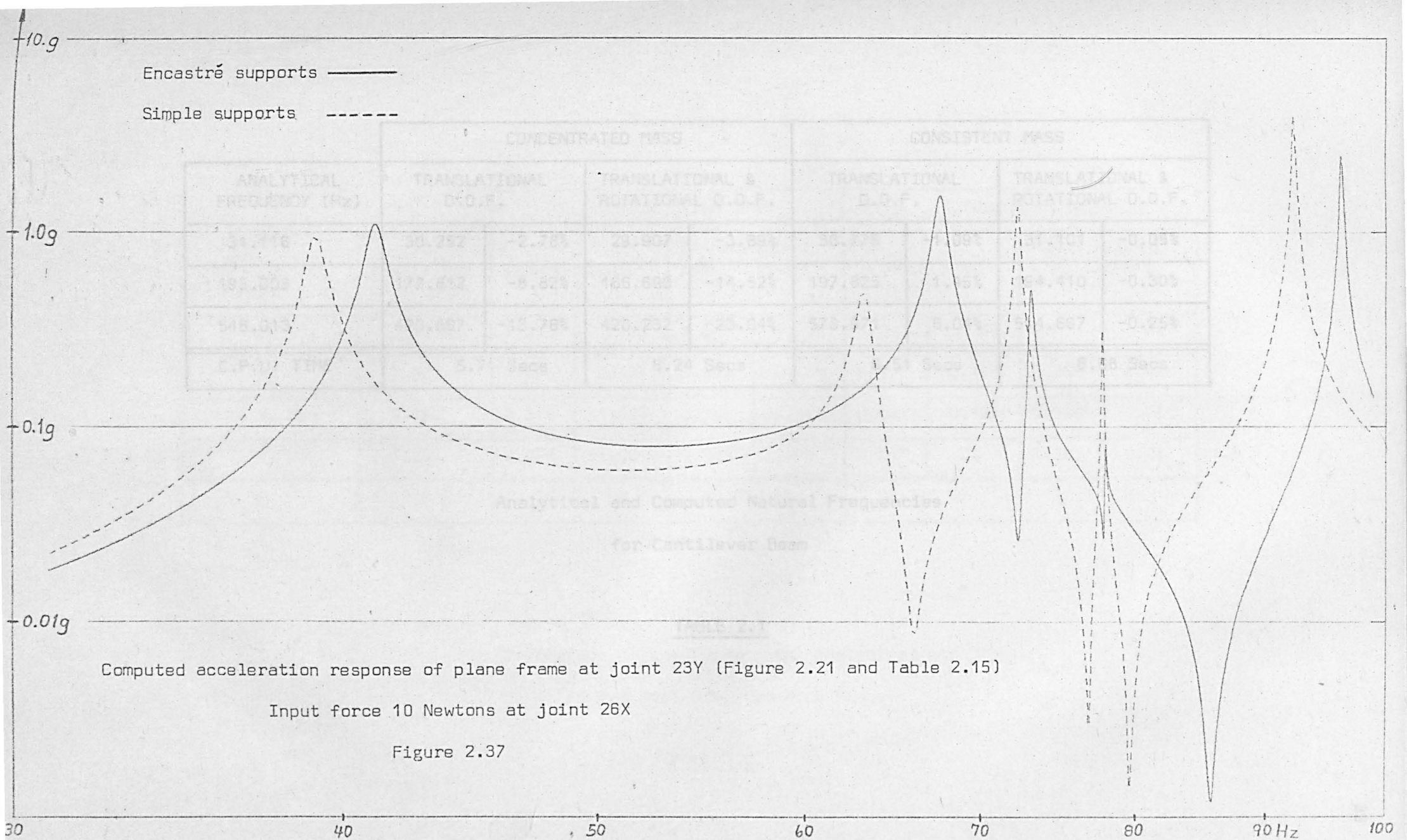
Figure 2.35



Measured acceleration response of plane frame in water at joint 18 (Figure 2.21)

Input force 10 Newtons at joint 26X

Figure 2.36



Computed acceleration response of plane frame at joint 23Y (Figure 2.21 and Table 2.15)

Input force 10 Newtons at joint 26X

Figure 2.37

	CONCENTRATED MASS				CONSISTENT MASS			
ANALYTICAL FREQUENCY (Hz)	TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.		TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.	
31.116	30.252	-2.78%	29.907	-3.89%	30.776	-1.09%	31.101	-0.05%
195.003	177.812	-8.82%	166.690	-14.52%	197.825	1.45%	194.410	-0.30%
546.013	470.867	-13.76%	420.232	-23.04%	578.971	6.04%	544.667	-0.25%
C.P.U. TIME	5.71 Secs		6.24 Secs		6.51 Secs		6.68 Secs	

Analytical and Computed Natural Frequencies

for Cantilever Beam

TABLE 2.1

		CONCENTRATED MASS				CONSISTENT MASS			
COORDINATES (FIGURE 2.3)	ANALYTICAL MODE SHAPE	TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.		TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.	
y_7	1.0	1.0	0%	1.0	0%	1.0	0%	1.0	0%
y_5	0.658	0.655	-0.46%	0.653	-0.76%	0.655	-0.46%	0.658	0.0%
y_3	0.340	0.336	-1.18%	0.335	-1.47%	0.337	-0.88%	0.339	-0.29%
y_1	0.097	0.096	-1.0%	0.095	-2.0%	0.097	0%	0.097	0.0%
f_n	31.116 Hz	30.252 Hz		29.907 Hz		30.776 Hz		31.101 Hz	

Comparison of the Fundamental Analytical and

Fundamental Computed Mode Shapes

TABLE 2.2

	CONCENTRATED MASS				CONSISTENT MASS			
ANALYTICAL FREQUENCY (Hz)	TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.		TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.	
10.246	10.215	-0.3%	10.201	-0.44%	10.236	-0.10%	10.250	0.04%
140.398	139.538	-0.61%	135.294	-3.64%	145.992	3.98%	140.233	-0.12%
446.448	436.306	-2.27%	398.821	-10.67%	504.370	12.97%	446.664	0.05%

Analytical and Computed Natural Frequencies for Cantilever

Beam with Point Mass at Free End.

Mass Ratio $\gamma = \frac{M}{\rho AL} = 2$

TABLE 2.3

	CONCENTRATED MASS				CONSISTENT MASS			
ANALYTICAL FREQUENCY (Hz)	TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.		TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.	
6.699	6.689	-0.15%	6.685	-0.21%	6.695	-0.06%	6.699	0%
138.081	137.665	-0.30%	133.651	-3.21%	143.731	4.09%	137.959	-0.09%
443.966	435.048	-2.01%	397.929	-10.37%	502.250	13.13%	444.183	0.05%

Analytical and Computed Natural Frequencies for Cantilever

Beam with Point Mass at Free End.

Mass Ratio $\gamma = \frac{M}{\rho AL} = 5$

TABLE 2.4

CONCENTRATED MASS						CONSISTENT MASS					
TRANSLATIONAL D.O.F.			TRANSLATIONAL & ROTATIONAL D.O.F.			TRANSLATIONAL D.O.F.			TRANSLATIONAL & ROTATIONAL D.O.F		
5 elements	9 elements	Δ %	5 elements	9 elements	Δ %	5 elements	9 elements	Δ %	5 elements	9 elements	Δ %
7.414	7.424	0.14	7.389	7.403	+0.19	7.422	7.426	0.05	7.408	7.408	0.0
120.103	119.803	-0.25	101.948	102.942	0.98	123.873	120.661	-2.59	103.199	103.178	-0.02
335.788	331.783	-1.19	255.743	262.235	2.54	356.571	337.134	-5.45	264.087	263.743	-0.13

Computed Natural Frequencies of 5 and 9 Beam Element Cantilever

with Shaker Assembly Attached to Free End (Figure 2.1 and 2.8)

TABLE 2.5

MEASURED FREQUENCY AND DYNAMIC MAGNIFICATION		CONCENTRATED MASS				CONSISTENT MASS			
(Hz)	Q	TRANSLATIONAL D.O.F.		TRANSLATIONAL AND ROTATIONAL D.O.F.		TRANSLATIONAL D.O.F.		TRANSLATIONAL AND ROTATIONAL D.O.F.	
7.33	524	7.41	1.1%	7.39	0.8%	7.42	1.2%	7.41	1.1%
104.48	418	120.10	15.0%	101.95	-2.4%	123.87	18.6%	103.20	-1.2%
255.55	182	335.79	31.4%	255.74	0.07%	356.57	39.5%	264.09	3.3%
C.P.U. Time		6.52 secs		6.67 secs		7.32 secs		8.03 secs	

Comparison of Measured and Computed Natural Frequencies

(Table 2.5, 5 beam element model) for Cantilever Beam

with Shaker Assembly Attached to Free End

TABLE 2.6

	CONCENTRATED MASS				CONSISTENT MASS			
MEASURED FREQUENCY (hz)	TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.		TRANSLATIONAL D.O.F.		TRANSLATIONAL & ROTATIONAL D.O.F.	
7.33	7.42	1.2%	7.40	1.0%	7.43	1.4%	7.41	1.1%
104.48	119.80	14.7%	102.94	-1.5%	120.66	15.5%	103.18	-1.2%
255.55	331.78	29.8%	262.24	+2.6%	337.13	31.9%	263.74	3.2%
C.P.U. Time	8.01 Secs		9.15 Secs		9.22 Secs		10.52 Secs	

Comparison of Measured and Computed Natural Frequencies

(Table 2.5, 9 beam element model) for Cantilever Beam

with Shaker Assembly Attached to Free End

TABLE 2.7

Frequency (Hz) / Mode	Encastré Supports	Simple Supports	
1	41.21	39.11	-5.1%
2	67.60	63.19	-6.5%
3	73.21	72.40	-1.1%
4	78.08	77.89	-0.24%
5	96.12	92.10	-4.2%

Computed Natural Frequencies for Plane Frame

with Encastré and Simple Supports

TABLE 2.8

PLANE FRAME MODE-SHAPE IN AIR — WATER

Encastré supports				Simple supports				Encastré supports		
NATURAL FREQUENCY(1)= 41.21 HZ				CHANGE IN FREQUENCY -5.102%				CHANGE IN FREQUENCY -5.082%		
NORMALIZED MODE-SHAPE				MODE-SHAPE RATIO*				MODE-SHAPE RATIO*		
JOINT-ID	XDISP.	YDISP.	ZROT.	COOR-X	COOR-Y	COOR-Z		COOR-X	COOR-Y	COOR-Z
26	1.000	0.028	-0.063	0.987	3.149	0.901		0.898	0.740	0.887
24	0.717	0.028	-0.063	1.021	3.149	0.901		0.902	0.740	0.887
20	0.212	0.028	-0.039	1.301	3.150	0.907		0.906	0.740	0.931
16	-0.046	0.025	-0.004	-0.717	3.377	1.227		1.008	0.740	0.870
11	0.008	0.022	0.008	7.108	3.659	0.660		0.921	0.741	0.960
7	0.072	0.019	-0.003	1.236	4.020	1.774		0.950	0.741	0.954
5	******	0.017	-0.006	********	4.383	1.250		********	0.742	0.950
25	0.121	-0.033	0.007	1.748	2.773	0.650		0.574	0.982	1.499
21	0.190	-0.033	0.007	1.350	2.773	0.654		0.910	0.982	1.497
17	0.232	-0.030	-0.001	1.180	2.966	3.593		1.040	0.983	-0.185
12	0.186	-0.027	-0.006	1.150	3.205	1.149		1.031	0.983	1.137
8	0.087	-0.024	-0.009	1.173	3.507	1.140		0.966	0.984	1.014
-	******	-0.021	-0.006	********	3.824	1.282		********	0.985	0.941
20	0.212	0.028	-0.039	1.301	3.150	0.907		0.906	0.740	0.931
22	0.205	-0.698	-0.010	1.315	0.808	0.951		0.908	1.212	1.706
23	0.196	-0.520	0.019	1.332	0.873	0.746		0.909	1.350	1.267
21	0.190	-0.033	0.007	1.350	2.773	0.654		0.910	0.982	1.497
7	0.072	0.019	-0.003	1.236	4.020	1.774		0.950	0.741	0.954
9	0.082	-0.023	-0.001	1.197	-0.264	2.018		0.950	1.147	0.937
13	0.091	-0.014	0.002	1.167	0.890	0.275		0.949	1.148	1.010
10	0.089	0.039	0.001	1.170	0.172	-0.219		0.957	1.007	1.092
8	0.087	-0.024	-0.009	1.173	3.507	1.140		0.966	0.984	1.014
20	0.212	0.028	-0.039	1.301	3.150	0.907		0.906	0.740	0.931
18	-0.100	-0.277	-0.007	-0.031	0.641	0.896		1.166	1.026	1.147
14	-0.041	-0.184	0.014	-0.742	0.654	0.641		1.418	1.063	1.055
13	0.091	-0.014	0.002	1.167	0.890	0.275		0.949	1.148	1.010
21	0.190	-0.033	0.007	1.350	2.773	0.654		0.910	0.982	1.497
19	0.238	-0.113	0.000	1.205	1.337	-2.123		1.135	1.427	8.087
15	0.166	-0.064	-0.007	1.214	1.341	1.185		1.153	1.584	1.387
13	0.091	-0.014	0.002	1.167	0.890	0.275		0.949	1.148	1.010

* Mode shapes normalised to unit generalised mass.

Table 2.9 Comparison of first normal modes for plane frame in air and water.

PLANE FRAME MODE-SHAPE IN AIR AND WATER

Encastré supports			*	Simple supports			*	Encastré supports		
NATURAL FREQUENCY(2)= 67.60 HZ			*	CHANGE IN FREQUENCY -6.519%			*	CHANGE IN FREQUENCY -20.045%		
NORMALIZED MODE-SHAPE			*	MODE-SHAPE RATIO*			*	MODE-SHAPE RATIO*		
JOINT-ID	XDISP.	YDISP.	ZROT.	*	COOR-X	COOR-Y	COOR-Z	*	COOR-X	COOR-Y	COOR-Z
26	0.128	0.038	-0.001	*	0.375	3.518	-7.017	*	1.632	0.846	5.722
24	0.123	0.038	-0.001	*	0.684	3.518	-7.512	*	1.461	0.846	6.042
20	0.143	0.038	0.007	*	1.185	3.523	1.524	*	1.052	0.849	0.296
16	0.192	0.034	0.000	*	1.232	3.771	-0.488	*	0.877	0.849	0.462
11	0.159	0.031	-0.005	*	1.152	4.078	1.406	*	0.928	0.850	0.698
7	0.073	0.027	-0.007	*	1.044	4.466	1.088	*	1.044	0.851	0.971
5	******	0.024	-0.005	*	********	4.870	1.100	*	********	0.852	1.083
25	0.300	-0.002	-0.017	*	1.028	-1.429	0.862	*	0.863	3.421	0.705
21	0.140	-0.002	-0.017	*	1.218	-1.430	0.861	*	1.043	3.421	0.702
17	0.036	-0.002	-0.001	*	2.110	-1.518	1.602	*	2.114	3.417	0.581
12	0.060	-0.002	0.003	*	1.355	-1.626	0.413	*	1.474	3.411	0.417
8	0.065	-0.001	-0.004	*	1.048	-1.762	1.165	*	1.099	3.404	1.281
6	******	-0.001	-0.005	*	********	-1.921	1.096	*	********	3.408	1.051
20	0.143	0.038	0.007	*	1.185	3.523	1.524	*	1.052	0.849	0.296
22	0.142	0.954	0.033	*	1.196	0.962	0.756	*	1.049	0.712	0.749
23	0.142	1.000	-0.031	*	1.207	0.872	0.912	*	1.046	0.727	0.730
21	0.140	-0.002	-0.017	*	1.218	-1.430	0.861	*	1.043	3.421	0.702
7	0.073	0.027	-0.007	*	1.044	4.466	1.088	*	1.044	0.851	0.971
9	0.075	-0.023	0.001	*	1.029	-2.792	0.409	*	1.056	1.369	0.729
13	0.077	0.019	0.001	*	1.014	3.893	-0.809	*	1.067	0.607	1.511
10	0.071	0.038	-0.000	*	1.030	1.569	38.092	*	1.082	1.107	-8.067
8	0.065	-0.001	-0.004	*	1.048	-1.762	1.165	*	1.099	3.404	1.281
20	0.143	0.038	0.007	*	1.185	3.523	1.524	*	1.052	0.849	0.296
18	0.440	0.371	0.020	*	1.191	1.408	1.111	*	0.653	0.525	0.476
14	0.380	0.325	-0.026	*	1.169	1.388	1.195	*	0.635	0.505	0.540
13	0.077	0.019	0.001	*	1.014	3.893	-0.809	*	1.067	0.607	1.511
21	0.140	-0.002	-0.017	*	1.218	-1.430	0.861	*	1.043	3.421	0.702
19	-0.071	0.208	-0.009	*	-0.424	0.690	0.571	*	-0.576	0.428	0.336
15	-0.050	0.169	0.012	*	-0.649	0.772	0.426	*	-0.864	0.410	0.318
13	0.077	0.019	0.001	*	1.014	3.893	-0.809	*	1.067	0.607	1.511

* Mode shapes normalised to unit generalised mass.

Table 2.10 Comparison of second normal modes for plane frame in air and water.

PLANE FRAME MODE-SHAPE IN AIR AND WATER

Encastré supports				Simple supports				Encastré supports		
NATURAL FREQUENCY(3)= 73.22 HZ				CHANGE IN FREQUENCY -1.111%				CHANGE IN FREQUENCY -16.850%		
NORMALIZED MODE-SHAPE				MODE-SHAPE RATIO*				MODE-SHAPE RATIO*		
JOINT-ID	XDISP.	YDISP.	ZROT.	COOR-X	COOR-Y	COOR-Z		COOR-X	COOR-Y	COOR-Z
26	-0.056	0.008	0.011	-1.771	-1.254	-1.372		1.590	0.711	1.133
24	-0.005	0.008	0.011	-6.034	-1.254	-1.371		6.465	0.711	1.134
20	0.086	0.008	0.007	-1.048	-1.254	-1.165		0.847	0.714	1.136
16	0.143	0.008	0.001	-1.077	-1.340	-0.952		0.965	0.718	1.195
11	0.126	0.007	-0.004	-1.048	-1.440	-1.152		0.961	0.722	1.036
7	0.062	0.007	-0.006	-1.008	-1.559	-1.028		0.916	0.728	0.961
5	******	0.006	-0.004	********	-1.700	-1.077		********	0.729	0.896
25	0.001	-0.013	0.009	18.504	-3.223	-1.200		-1.647	0.787	0.879
21	0.087	-0.013	0.009	-1.065	-3.223	-1.199		0.861	0.787	0.879
17	0.155	-0.012	0.001	-1.102	-3.417	-0.939		0.884	0.789	1.057
12	0.133	-0.011	-0.004	-1.065	-3.648	-1.190		0.901	0.790	0.870
8	0.063	-0.010	-0.006	-1.011	-3.928	-1.035		0.905	0.792	0.914
5	******	-0.009	-0.004	********	-4.284	-1.077		********	0.794	0.902
20	0.086	0.008	0.007	-1.048	-1.254	-1.165		0.847	0.714	1.136
22	0.087	-0.093	-0.009	-1.054	-2.062	-1.545		0.853	0.683	0.916
23	0.087	-0.225	0.002	-1.060	-1.610	-2.260		0.857	0.867	0.705
21	0.087	-0.013	0.009	-1.065	-3.223	-1.199		0.861	0.787	0.879
7	0.062	0.007	-0.006	-1.008	-1.559	-1.028		0.916	0.728	0.961
9	0.064	0.022	0.003	-0.998	-0.650	-0.806		0.909	0.516	0.862
13	0.066	-0.002	-0.009	-0.988	-7.570	-0.973		0.902	0.451	0.771
10	0.064	-0.024	0.003	-0.999	-1.833	-0.839		0.904	0.577	0.823
8	0.063	-0.010	-0.006	-1.011	-3.928	-1.035		0.905	0.792	0.914
20	0.086	0.008	0.007	-1.048	-1.254	-1.165		0.847	0.714	1.136
18	0.917	0.899	0.064	-0.898	-0.883	-0.862		0.859	0.858	0.842
14	0.912	0.897	-0.065	-0.888	-0.868	-0.883		0.850	0.848	0.855
13	0.066	-0.002	-0.009	-0.988	-7.570	-0.973		0.902	0.451	0.771
21	0.087	-0.013	0.009	-1.065	-3.223	-1.199		0.861	0.787	0.879
19	1.000	-0.990	0.070	-1.000	-1.020	-0.975		0.790	0.783	0.776
15	0.988	-0.982	-0.071	-0.988	-1.005	-0.997		0.787	0.779	0.781
13	0.066	-0.002	-0.009	-0.988	-7.570	-0.973		0.902	0.451	0.771

* Mode shapes normalised to unit generalised mass.

Table 2.11 Comparison of third normal modes for plane frame in air and water.

PLANE FRAME MODE-SHAPE IN AIR								AND WATER		
Encastré supports				Simple supports				Encastré supports		
NATURAL FREQUENCY(4)= 78.08 HZ				CHANGE IN FREQUENCY -0.241%				CHANGE IN FREQUENCY -16.703%		
NORMALIZED MODE-SHAPE				MODE-SHAPE RATIO*				MODE-SHAPE RATIO*		
JOINT-ID	XDISP.	YDISP.	ZROT.	COOR-X	COOR-Y	COOR-Z		COOR-X	COOR-Y	COOR-Z
26	-0.002	0.006	-0.000	5.026	4.084	-0.328		-3.322	1.262	-15.039
24	-0.002	0.006	-0.000	4.940	4.084	0.583		-3.524	1.262	-13.708
20	-0.002	0.006	-0.000	4.824	4.084	4.781		-3.556	1.267	-2.886
16	-0.004	0.005	-0.000	4.734	4.372	4.209		-3.103	1.267	-0.876
11	-0.004	0.005	0.000	4.714	4.726	4.426		-2.800	1.267	-3.364
7	-0.001	0.004	0.000	5.531	5.171	3.957		-3.230	1.266	-1.964
5	******	0.004	0.000	********	5.639	7.889		********	1.269	-4.671
25	-0.005	0.005	0.000	5.134	3.736	4.659		-3.919	0.878	-3.229
21	-0.002	0.005	0.000	6.047	3.736	4.653		-5.250	0.878	-3.209
17	0.001	0.005	0.000	-1.839	3.999	0.648		4.595	0.881	-1.053
12	-0.000	0.004	-0.000	60.806	4.321	4.395		-56.755	0.885	-2.140
8	-0.001	0.004	-0.000	6.548	4.727	-13.573		-4.114	0.890	16.912
6	******	0.003	0.000	********	5.155	5.629		********	0.892	-2.731
20	-0.002	0.006	-0.000	4.824	4.084	4.781		-3.556	1.267	-2.886
22	-0.002	-0.254	-0.010	5.147	1.213	1.267		-4.006	0.547	0.578
23	-0.002	-0.256	0.010	5.543	1.238	1.233		-4.556	0.530	0.600
21	-0.002	0.005	0.000	6.047	3.736	4.653		-5.250	0.878	-3.209
7	-0.001	0.004	0.000	5.531	5.171	3.957		-3.230	1.266	-1.964
9	-0.001	0.015	0.001	5.703	2.680	0.898		-3.380	0.470	0.802
13	-0.001	0.020	-0.000	5.882	1.848	6.379		-3.535	0.909	-6.619
10	-0.001	0.013	-0.001	6.169	1.994	1.101		-3.785	1.379	1.062
8	-0.001	0.004	-0.000	6.548	4.727	-13.573		-4.114	0.890	16.912
26	-0.002	0.006	-0.000	4.824	4.084	4.781		-3.556	1.267	-2.886
18	0.918	0.992	0.075	0.972	0.999	0.987		0.827	0.819	0.809
14	0.921	1.000	-0.074	0.977	1.003	0.980		0.820	0.813	0.818
13	-0.001	0.020	-0.000	5.882	1.848	6.379		-3.535	0.909	-6.619
21	-0.002	0.005	0.000	6.047	3.736	4.653		-5.250	0.878	-3.209
19	-0.917	0.987	-0.075	0.963	0.970	0.962		0.875	0.885	0.878
15	-0.920	0.995	0.074	0.966	0.975	0.958		0.874	0.883	0.879
13	-0.001	0.020	-0.000	5.882	1.848	6.379		-3.535	0.909	-6.619

* Mode shapes normalised to unit generalised mass.

Table 2.12 Comparison of fourth normal modes for plane frame in air and water.

PLANE FRAME MODE-SHAPE IN AIR							AND WATER			
Encastré supports				Simple supports			Encastré supports			
NATURAL FREQUENCY(5)= 96.12 HZ				CHANGE IN FREQUENCY -4.181%			CHANGE IN FREQUENCY -20.620%			
NORMALIZED MODE-SHAPE				MODE-SHAPE RATIO*			MODE-SHAPE RATIO*			
JOINT-ID	XDISP.	YDISP.	ZROT.	COOR-X	COOR-Y	COOR-Z	COOR-X	COOR-Y	COOR-Z	
26	0.252	-0.034	-0.069	1.227	4.701	1.017	1.208	0.381	0.837	
24	-0.058	-0.034	-0.068	0.109	4.701	1.017	-0.759	0.382	0.840	
20	-0.578	-0.033	-0.039	0.904	4.708	0.917	0.700	0.384	0.876	
16	-0.937	-0.030	-0.013	0.882	5.094	0.683	0.765	0.379	0.878	
11	-0.875	-0.026	0.022	0.846	5.582	0.952	0.768	0.372	0.801	
7	-0.428	-0.023	0.043	0.821	6.219	0.821	0.748	0.363	0.766	
5	******	-0.020	0.028	********	6.781	0.885	********	0.364	0.739	
25	-0.377	0.042	-0.022	0.917	2.235	0.912	0.638	0.639	0.834	
21	-0.588	0.042	-0.023	0.915	2.235	0.910	0.705	0.639	0.832	
17	-0.835	0.037	-0.011	0.883	2.409	0.643	0.746	0.638	0.856	
12	-0.807	0.033	0.016	0.845	2.627	0.974	0.754	0.636	0.760	
8	-0.422	0.029	0.041	0.821	2.910	0.823	0.745	0.634	0.756	
6	******	0.026	0.029	********	3.173	0.883	********	0.635	0.740	
20	-0.578	-0.033	-0.039	0.904	4.708	0.917	0.700	0.384	0.876	
22	-0.585	0.014	0.028	0.907	10.369	1.329	0.703	0.188	0.832	
23	-0.589	0.569	-0.001	0.911	1.326	10.141	0.706	0.826	0.784	
21	-0.588	0.042	-0.023	0.915	2.235	0.910	0.708	0.639	0.832	
7	-0.428	-0.023	0.043	0.821	6.219	0.821	0.748	0.363	0.766	
9	-0.436	0.451	-0.001	0.815	0.603	-2.016	0.745	0.812	0.496	
13	-0.443	0.002	-0.036	0.809	-24.648	0.806	0.741	2.198	0.825	
10	-0.433	-0.431	-0.000	0.814	0.781	-10.614	0.743	0.795	-0.587	
8	-0.422	0.029	0.041	0.821	2.910	0.823	0.745	0.634	0.756	
20	-0.578	-0.033	-0.039	0.904	4.708	0.917	0.700	0.384	0.876	
18	0.100	0.656	0.085	4.243	1.275	1.240	2.370	0.993	0.902	
14	0.457	1.000	-0.049	1.666	1.176	1.421	1.120	0.923	0.991	
13	-0.443	0.002	-0.036	0.809	-24.648	0.806	0.741	2.198	0.825	
21	-0.588	0.042	-0.023	0.915	2.235	0.910	0.708	0.639	0.832	
19	-0.005	-0.545	0.068	-32.290	1.135	1.110	-21.395	0.916	0.850	
15	0.295	-0.826	-0.038	1.478	1.099	1.171	1.089	0.855	0.921	
13	-0.443	0.002	-0.036	0.809	-24.648	0.806	0.741	2.198	0.825	

* Mode shapes normalised to unit generalised mass.

Table 2.13 Comparison of fifth normal modes for plane frame in air and water.

MODE	MEASURED FREQUENCY (Hz)	COMPUTED FREQUENCY (Hz)	Δ %	*Q
1	37.9	39.1	3.2%	81
—	52.7	—	—	93
2	58.4	54.1	-7.4%	151
3	63.4	60.9	-3.9%	242
4	67.4	65.0	-3.6%	158
—	72.9	—	—	85
5	78.3	76.3	-2.6%	128

*Q = Measured dynamic magnification

Comparison of Measured and Computed Natural Frequencies for Plane Frame in Water

TABLE 2.14

MODE	MEASURED FREQUENCY (Hz)	ENCASTRÉ SUPPORTS		SIMPLE SUPPORTS		*Q
1	39.9	41.2	3.3%	39.1	-2.0%	59
2	69.7	67.6	-3.0%	63.2	-9.3%	92
3	75.8	73.2	-3.4%	72.4	-4.5%	250
4	79.1	78.1	-1.3%	77.9	-1.5%	706
5	92.7	96.1	3.7%	92.1	-0.7%	346

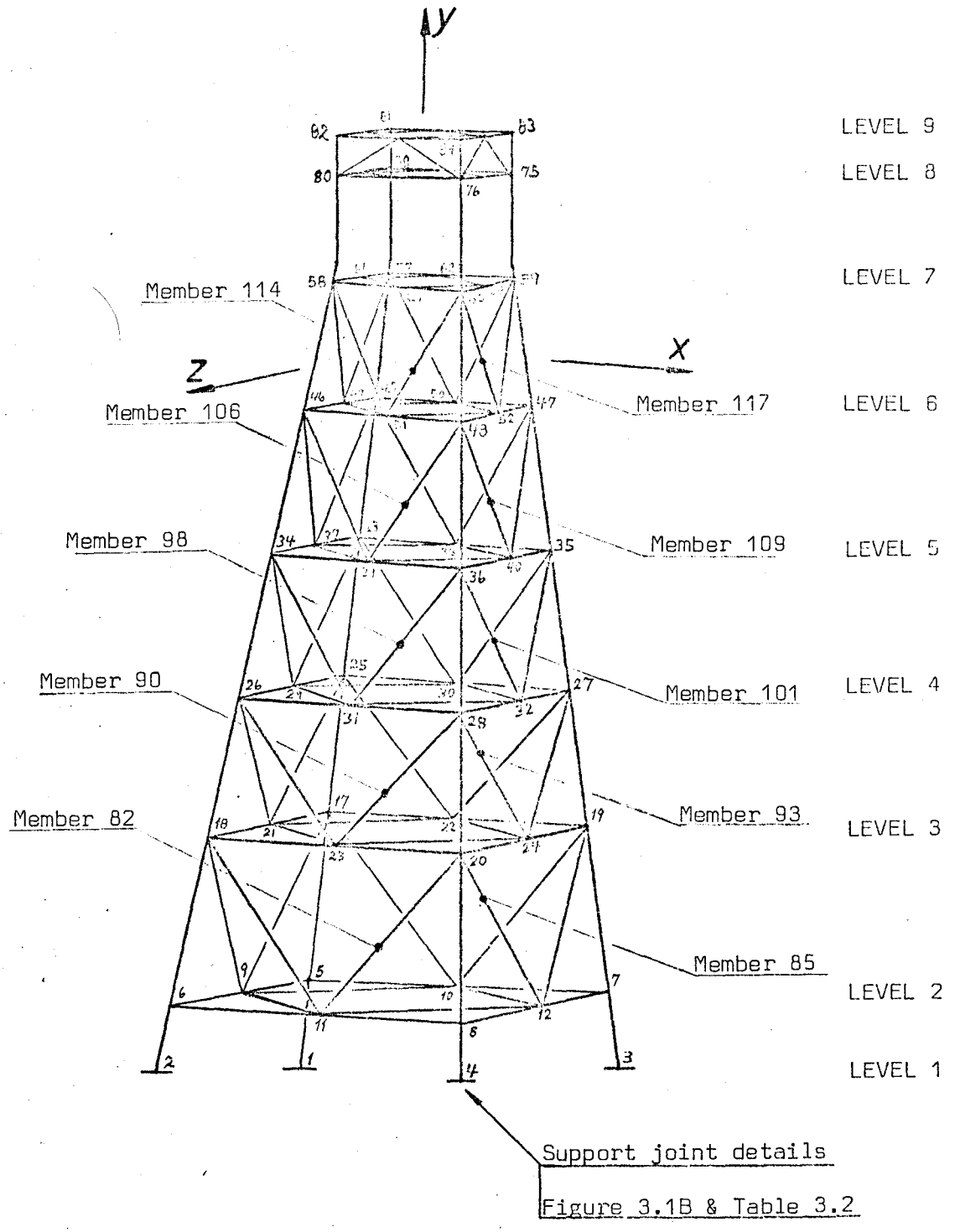
*Q = Measured dynamic magnifications

Comparison of Measured and Computed Natural Frequencies for Plane Frame

TABLE 2.15

CHAPTER 3

SELECTION OF FULL SCALE PLATFORM AND COMPUTED RESULTS



Beam element model of full scale platform

Figure 3.1 A

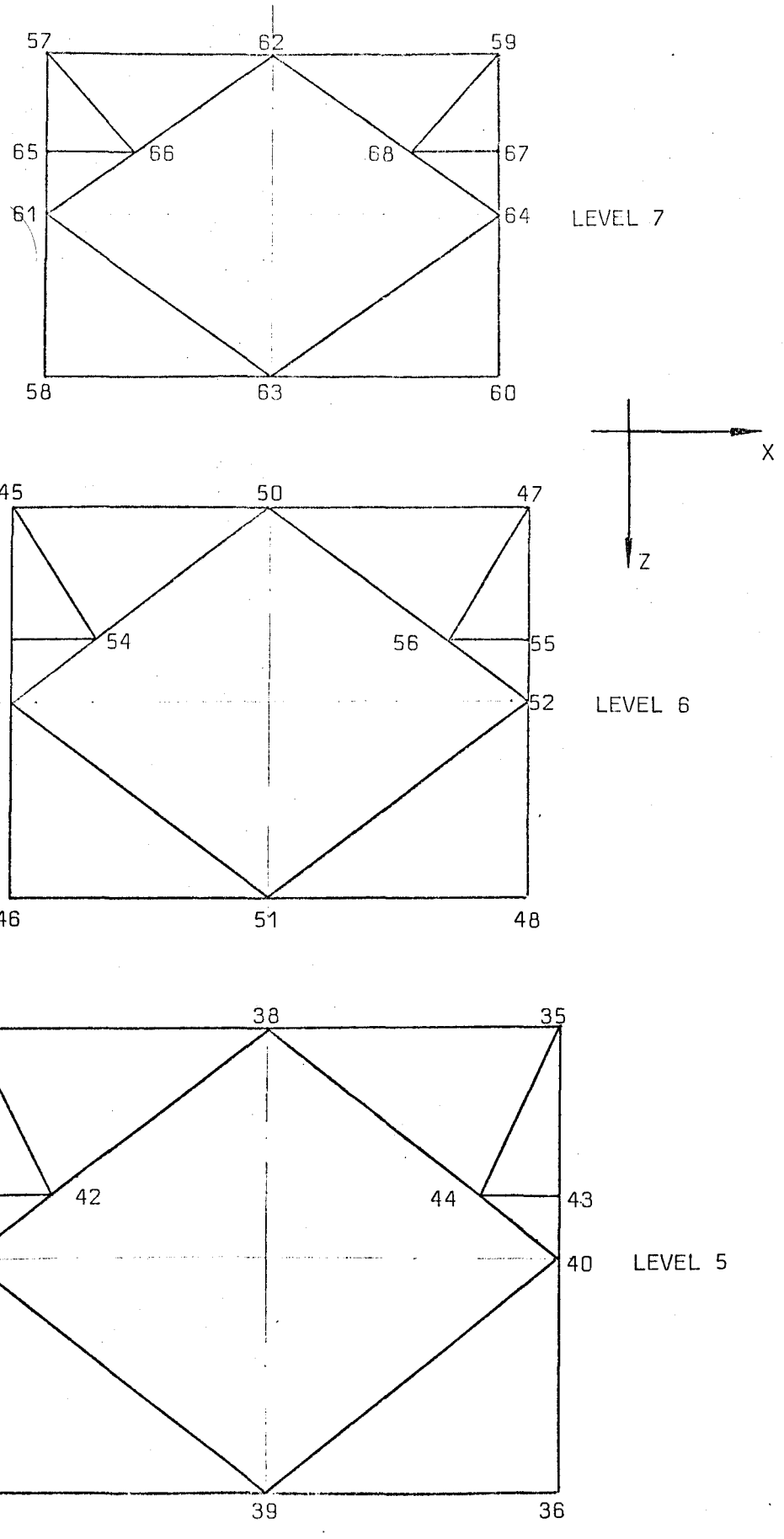
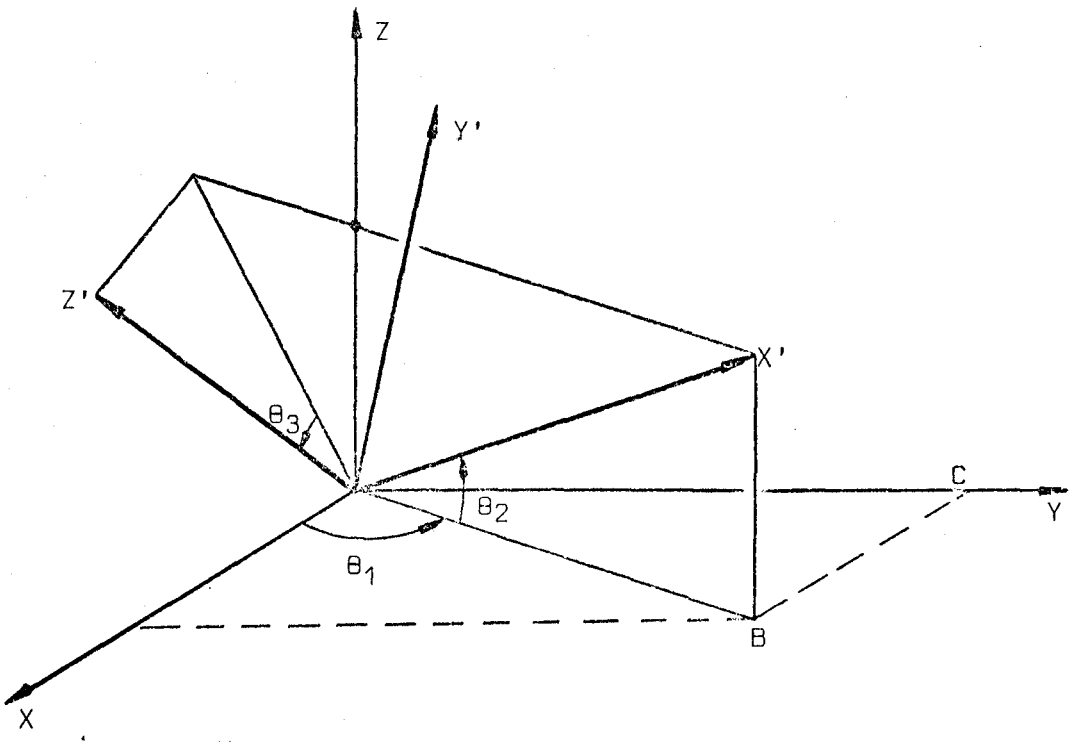


Figure 3.1A contd



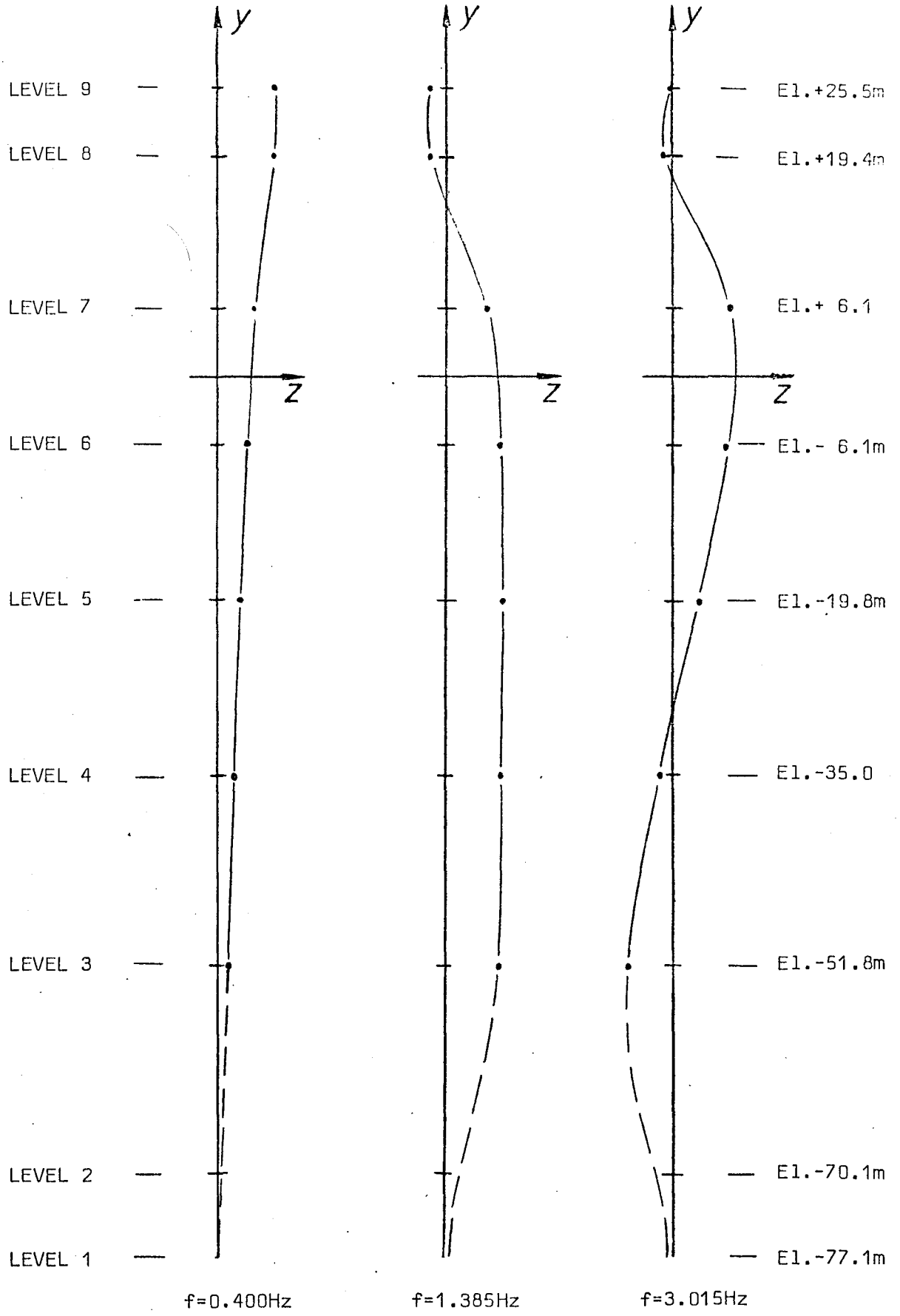
X , Y , Z Global co-ordinate directions

X', Y', Z' Support joint co-ordinate directions

θ_1, θ_2, θ_3 Support joint angles with respect to global co-ordinate directions

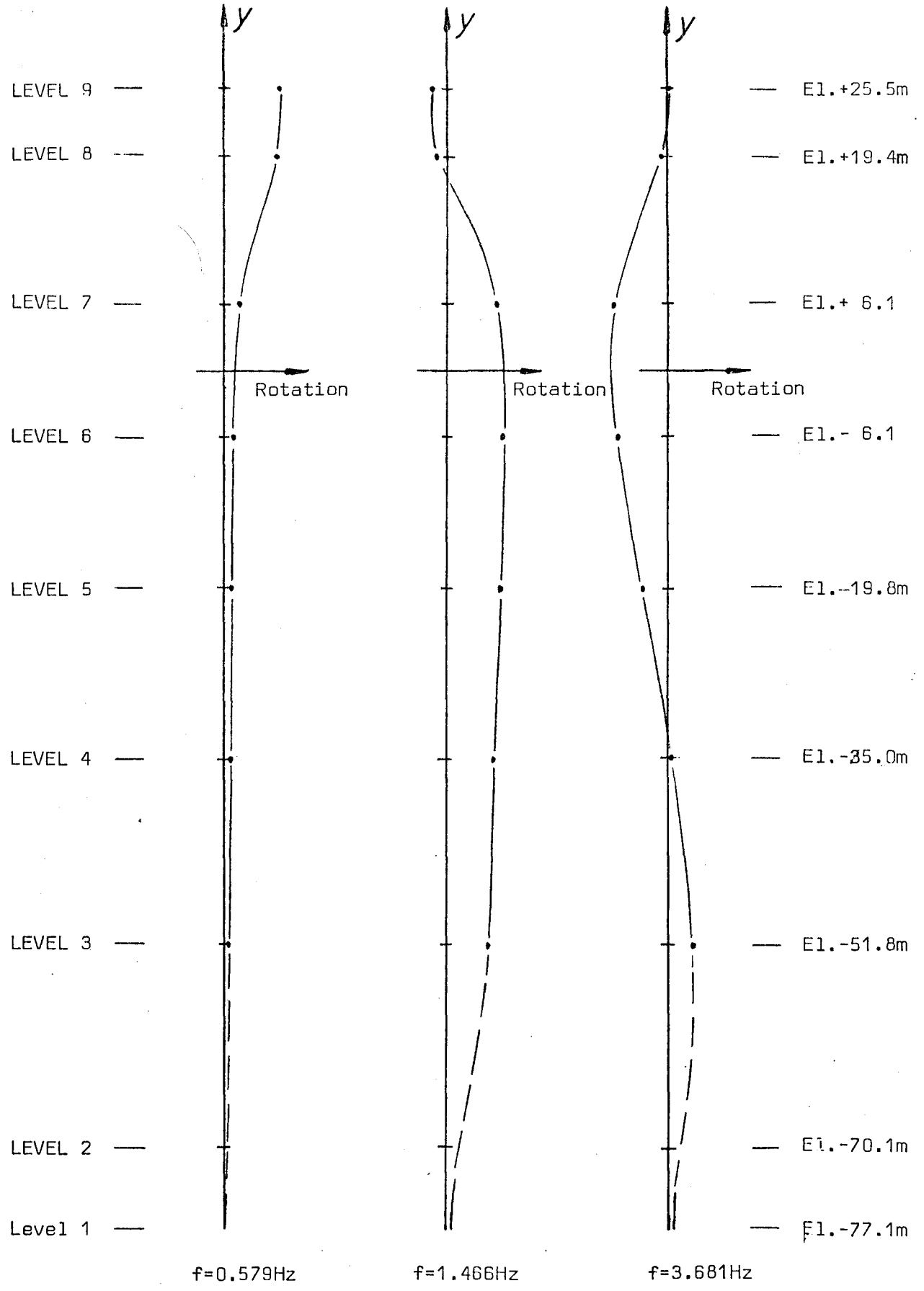
Orientation of support joint (Table 3.2)

Figure 3.1 B



Mean computed sway mode shapes for full scale platform(Tables 3.8,3.12 & 3.15)

Figure 3.2



Mean computed torsion mode shapes for full scale platform(Tables 310,3.13 &3.16)

Figure 3.3

Joint No.	X(m)	Z(m)	Y(m)	Condition
1	-20.915	-17.867	-77.100	Support
2	-20.915	17.867	-77.100	Support
3	20.915	-17.867	-77.100	Support
4	20.915	17.867	-77.100	Support
5	-20.041	-16.993	-70.104	
6	-20.041	16.993	-70.104	
7	20.041	-16.993	-70.104	
8	20.041	16.993	-70.104	
9	-20.041	0.0	-70.104	
10	0.0	-16.993	-70.104	
11	0.0	16.993	-70.104	
12	20.041	0.0	-70.104	
13	-19.388	-16.340	-64.846	
14	-19.388	16.340	-64.846	
15	19.388	-16.340	-64.846	
16	19.388	16.340	-64.846	
17	-17.755	-14.707	-51.816	
18	-17.755	14.707	-51.816	
19	17.755	-14.707	-51.816	
20	17.755	14.707	-51.816	

Joint co-ordinates of full scale platform

Table 3.1

Joint No.	X(m)	Z(m)	Y(m)	Condition
21	-17.755	0.0	-51.816	
22	0.0	-14.707	-51.816	
23	0.0	14.707	-51.816	
24	17.755	0.0	-51.816	
25	-15.661	-12.613	-35.052	
26	-15.661	12.613	-35.052	
27	15.661	-12.613	-35.052	
28	15.661	12.613	-35.052	
29	-15.661	0.0	-35.052	
30	0.0	-12.613	-35.052	
31	0.0	12.613	-35.052	
32	15.661	0.0	-35.052	
33	-13.753	-10.705	-19.812	
34	-13.753	10.705	-19.812	
35	13.753	-10.705	-19.812	
36	13.753	10.705	-19.812	
37	-13.753	0.0	-19.812	
38	0.0	-10.705	-19.812	
39	0.0	10.705	-19.812	
40	13.753	0.0	-19.812	

Table 3.1 contd.

Joint No.	X(m)	Z(m)	Y(m)	Condition
41	-13.753	-2.896	-19.812	
42	-10.028	-2.896	-19.812	
43	13.753	-2.896	-19.812	
44	10.028	-2.896	-19.812	
45	-12.040	-8.992	-6.096	
46	-12.040	8.992	-6.096	
47	12.040	-8.992	-6.096	
48	12.040	8.992	-6.096	
49	-12.040	0.0	-6.096	
50	0.0	-8.992	-6.096	
51	0.0	8.992	-6.096	
52	12.040	0.0	-6.096	
53	-12.040	-2.896	-6.096	
54	-8.138	-2.896	-6.096	
55	12.040	-2.896	-6.096	
56	8.138	-2.896	-6.096	
57	-10.516	-7.468	6.096	
58	-10.516	7.468	6.096	
59	10.516	-7.468	6.096	

Table 3.1 contd.

Joint No.	X(m)	Z(m)	Y(m)	Condition
60	10.516	7.468	6.096	
61	-10.516	0.0	6.096	
62	0.0	-7.468	6.096	
63	0.0	7.468	6.096	
64	10.516	0.0	6.096	
65	-10.516	-2.896	6.096	
66	-6.440	-2.896	6.096	
67	10.516	-2.896	6.096	
68	6.440	-2.896	6.096	
69	-9.144	-6.096	17.069	
70	-9.144	6.096	17.069	
71	9.144	-6.096	17.069	
72	9.144	6.096	17.069	
73	0.0	-6.096	19.431	
74	0.0	6.096	19.431	
75	9.144	-6.096	19.431	
76	9.144	6.096	19.431	
77	-9.144	0.0	19.431	
78	9.144	0.0	19.431	
79	-9.144	-6.096	19.431	

Table 3.1 contd.

Joint No.	X(m)	Z(m)	Y(m)	Condition
80	-9.144	6.096	19.431	
81	-9.144	-6.096	25.527	
82	-9.144	6.096	25.527	
83	9.144	-6.096	25.527	
84	9.144	6.096	25.527	
85	-9.144	0.0	25.527	
86	9.144	0.0	27.527	
87	0.0	-6.096	25.527	
88	0.0	6.096	25.527	

Table 3.1 contd

	JOINT ROTATIONS			ELASTIC SUPPORT CONSTANTS					
	DEGREES			NEWTON/METER			NEWTON x METER / RADIAN		
JOINT NO.	θ_1	θ_2	θ_3	KFX	KFY	KFZ	KMX	KMY	KMZ
1	79.98	45.0	0.0	2.98E8	1.01E8	1.01E8	0.0	1.25E9	1.25E9
2	79.98	-45.0	0.0	2.98E8	1.01E8	1.01E8	0.0	1.25E9	1.25E9
3	79.98	135.0	0.0	2.98E8	1.01E8	1.01E8	0.0	1.25E9	1.25E9
4	79.98	-135.0	0.0	2.98E8	1.01E8	1.01E8	0.0	1.25E9	1.25E9

Support joint details (Figure 3.1 B)

Table 3.2

Member No.	Start	End	Length (m)
1	5	10	20.041
2	10	7	20.041
3	7	12	16.993
4	12	8	16.993
5	11	8	20.041
6	6	11	20.041
7	5	9	16.993
8	9	6	16.993
9	10	9	26.275
10	10	12	26.275
11	9	11	26.275
12	12	11	26.275
13	17	22	17.755
14	22	19	17.755
15	19	24	14.707
16	24	20	14.707
17	18	23	17.755
18	23	20	17.755
19	17	21	14.707

Member incidences of full scale platform

Table 3.3

Member No.	Start	End	Length (m)
20	21	18	14.707
21	22	24	23.055
22	22	21	23.055
23	21	23	23.055
24	24	23	23.055
25	25	30	15.661
26	30	27	15.661
27	27	32	12.613
28	32	28	12.613
29	26	31	15.661
30	31	28	15.661
31	25	29	12.613
32	29	26	12.613
33	30	32	20.108
34	30	29	20.108
35	29	31	20.108
36	32	31	20.108
37	33	38	13.753
38	38	35	13.753
39	35	43	7.809
40	43	40	2.896

Table (3.3) Contd.

Member No.	Start	End	Length (m)
41	40	36	10.705
42	34	39	13.753
43	39	36	13.753
44	33	41	7.809
45	41	37	2.896
46	37	34	10.705
47	38	42	12.710
48	42	37	4.718
49	38	44	12.710
50	44	40	4.718
51	37	39	17.428
52	40	39	17.428
53	45	50	12.040
54	50	47	12.040
55	47	55	6.096
56	55	52	2.896
57	52	48	8.992
58	46	50	12.040
59	50	48	12.040
60	45	55	6.096
61	55	49	2.896
62	49	46	8.992
63	50	54	10.168

Table (3.3) Contd.

Member No.	Start	End	Length (m)
64	54	49	4.859
65	50	56	10.168
66	56	52	4.859
67	49	51	15.027
68	52	51	15.027
69	57	62	10.516
70	62	59	10.516
71	59	67	4.572
72	67	64	2.896
73	64	60	7.468
74	58	63	10.516
75	63	60	10.516
76	57	65	4.572
77	65	61	2.896
78	61	58	7.468
79	10	17	25.591
80	10	19	25.591
81	11	18	25.591
82	11	20	25.591
83	9	18	23.579
84	9	17	23.579
85	12	20	23.579
86	12	19	23.579

Table (3.3) Contd.

Member No.	Start	End	Length (m)
87	22	25	23.036
88	22	27	23.036
89	23	26	23.036
90	23	28	23.036
91	21	26	21.083
92	21	25	21.083
93	24	28	21.083
94	24	27	21.083
95	30	33	20.616
96	30	35	20.616
97	31	34	20.616
98	31	36	20.616
99	29	34	18.721
100	29	33	18.721
101	32	36	18.721
102	32	35	18.721
103	38	45	18.331
104	38	47	18.331
105	39	46	18.331
106	39	48	18.331
107	37	46	16.490
108	37	45	16.490
109	40	48	16.490

Table (3.3) Contd.

Member No.	Start	End	Length (m)
110	40	47	16.490
111	50	57	16.172
112	50	59	16.172
113	51	58	16.172
114	51	60	16.172
115	49	58	14.378
116	49	57	14.378
117	52	60	14.378
118	52	59	14.378
119	1	5	7.104
120	3	7	7.104
121	2	6	7.104
122	4	8	7.104
123	17	25	17.024
124	25	33	15.477
125	33	45	13.928
126	45	57	12.381
127	19	27	17.024
128	27	35	15.477
129	35	47	13.928
130	47	59	12.381
131	18	26	17.024
132	26	34	15.477

Table (3.3) Contd.

Member No.	Start	End	Length (m)
133	34	46	13.928
134	46	58	12.381
135	20	28	17.024
136	28	36	15.477
137	36	48	13.928
138	48	60	12.381
139	19	15	13.233
140	17	13	13.233
141	20	16	13.233
142	18	14	13.233
143	62	66	7.898
144	66	61	4.999
145	61	63	12.897
146	62	68	7.898
147	68	64	4.999
148	64	63	12.897
149	57	69	11.143
150	71	59	11.143
151	58	70	11.143
152	72	60	11.143
153	6	14	5.338
154	8	16	5.338
155	7	15	5.338

Table (3.3) Contd.

Member No.	Start	End	Length (m)
156	5	13	5.338
157	35	44	8.652
158	43	44	3.725
159	42	41	3.725
160	33	42	8.652
161	45	54	7.238
162	54	53	3.901
163	47	56	7.238
164	55	56	3.901
165	57	66	6.125
166	66	65	4.075
167	59	68	6.125
168	67	68	4.075
169	83	86	6.096
170	86	84	6.096
171	87	83	9.144
172	81	87	9.144
173	85	82	6.096
174	81	85	6.096
175	88	84	9.144
176	82	88	9.144
177	87	86	10.990
178	87	85	10.990

Table (3.3) Contd.

Member No.	Start	End	Length (m)
179	86	88	10.990
180	85	88	10.990
181	75	78	6.096
182	78	76	6.096
183	73	75	9.144
184	79	75	18.288
185	77	80	6.096
186	79	77	6.096
187	74	76	9.144
188	80	74	9.144
189	73	78	10.990
190	73	77	10.990
191	78	74	10.990
192	77	74	10.990
193	75	86	8.621
194	76	86	8.621
195	75	87	10.990
196	79	87	10.990
197	80	85	8.621
198	79	85	8.621
199	76	88	10.990
200	80	88	10.990
201	75	83	6.096

Table (3.3) Contd.

Member No.	Start	End	Length (m)
202	76	83	6.096
203	80	82	6.096
204	79	81	6.096
205	75	71	2.362
206	76	72	2.362
207	79	69	2.362
208	80	70	2.362

Table 3.3 contd

MEMBER NO.	Ax(m^2)	Ix(m^4)	Iy(m^4)	Iz(m^4)
1 to 8	3.213E-2	3.340E-3	1.67E-3	1.67E-3
9 to 12	1.568E-2	6.094E-4	3.047E-4	3.047E-4
13 to 20	2.381E-2	2.122E-3	1.061E-3	1.061E-3
21 to 24	1.368E-2	4.024E-4	2.015E-4	2.015E-4
25 to 32	2.181E-2	1.625E-3	8.125E-4	8.125E-4
33 to 36	1.368E-2	4.029E-4	2.015E-4	2.015E-4
37 to 46	2.181E-2	1.625E-3	8.125E-4	8.125E-4
47 to 52	1.368E-2	4.029E-4	2.015E-4	2.015E-4
53 to 62	1.974E-2	1.213E-3	6.064E-4	6.064E-4
63 to 68	1.368E-2	4.029E-4	2.015E-4	2.015E-4
69 to 78	1.774E-2	8.766E-4	4.383E-4	4.383E-4
79 to 86	3.213E-2	3.340E-3	1.670E-3	1.670E-3
87 to 94	2.381E-2	2.122E-3	1.061E-3	1.061E-3
95 to 110	2.181E-2	1.625E-3	8.125E-4	8.125E-4
111 to 118	1.974E-2	1.213E-3	6.064E-4	6.064E-4
119 to 122	1.674E-1	4.318E-2	2.159E-2	2.159E-2
123 to 142	1.507E-1	4.014E-2	2.007E-2	2.007E-2
143 to 148	1.368E-2	4.029E-4	2.015E-4	2.015E-4
149 to 152	1.428E-1	3.738E-2	1.869E-2	1.869E-2
153 to 156	1.648E-1	4.475E-2	2.188E-2	2.188E-2
157 to 168	1.368E-2	4.029E-4	2.015E-4	2.015E-4
169 to 172	1.428E-1	3.738E-2	1.869E-2	1.869E-2
173 to 188	2.858E-3	8.325E-6	2.104E-3	1.399E-4
189 to 196	8.645E-3	4.162E-7	1.045E-4	3.663E-5
197 to 204	2.619E-2	1.261E-3	6.306E-4	6.306E-4
205 to 208	1.428E-1	3.738E-2	1.869E-2	1.869E-2

Member properties

Table 3.4

JOINT NO.	DYNAMIC DEGREES OF FREEDOM		JOINT INERTIAS (kg)
17	X	Z	154.3E3
18	X	Z	154.3E3
19	X	Z	154.3E3
20	X	Z	154.3E3
25	X	Z	76.2E3
26	X	Z	76.2E3
27	X	Z	76.2E3
28	X	Z	76.2E3
33	X	Z	72.2E3
34	X	Z	72.2E3
35	X	Z	72.2E3
36	X	Z	72.2E3
45	X	Z	69.4E3
46	X	Z	69.4E3
47	X	Z	69.4E3
48	X	Z	69.4E3
57	X	Z	35.3E3
58	X	Z	35.3E3
59	X	Z	35.3E3
60	X	Z	35.3E3
75	X	Z	263.9E3
76	X	Z	263.9E3
79	X	Z	263.9E3
80	X	Z	263.9E3
81	X	Z	239.9E3
82	X	Z	239.9E3
83	X	Z	239.9E3
84	X	Z	239.9E3

Joint inertias of full scale platform

Table 3.5

	DAMAGED / UNDAMAGED	MEMBER NO. 117		MEMBER NO. 109		MEMBER NO. 101		MEMBER NO. 93		MEMBER NO. 85	
MODE	FREQ(Hz)	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION
SWAY Z,1	0.400	0.368	8.0%	0.393	1.8%	0.391	2.3%	0.393	1.8%	0.389	2.8%
SWAY X,1	0.426	0.426	N.R.	0.426	N.R.	0.426	N.R.	0.426	N.R.	0.426	N.R.
TORSION 1	0.579	0.543	6.2%	0.573	1.0%	0.570	1.6%	0.571	1.4%	0.563	2.8%
SWAY X,2	1.373	1.372	N.R.	1.373	N.R.	1.373	N.R.	1.373	N.R.	1.372	N.R.
SWAY Z,2	1.385	1.320	4.7%	1.383	N.R.	1.335	3.6%	1.240	10.5%	0.944	31.8%
TORSION 2	1.466	1.460	N.R.	1.462	N.R.	1.447	1.3%	1.442	1.6%	1.437	2.0%
SWAY Z,3	3.015	2.996	N.R.	2.410	20.1%	2.243	25.6%	2.420	19.7%	2.784	7.7%
SWAY X,3	3.110	3.109	N.R.	3.110	N.R.	3.110	N.R.	3.110	N.R.	3.110	N.R.
TORSION 3	3.681	3.675	N.R.	3.601	2.2%	3.601	2.2%	3.601	2.2%	3.631	1.4%

N.R. <1% Reduction

Computed natural frequencies of full scale platform

Table 3.6

	DAMAGED / UNDAMAGED	MEMBER NO. 114		MEMBER NO. 106		MEMBER NO. 98		MEMBER NO. 90		MEMBER NO. 82	
MODE	FREQ(Hz)	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION	FREQ(Hz)	REDUCTION
SWAY Z,1	0.400	0.400	N.R.	0.400	N.R.	0.400	N.R.	0.400	N.R.	0.400	N.R.
SWAY X,1	0.426	0.390	8.5%	0.417	2.1%	0.413	3.1%	0.415	2.6%	0.410	3.8%
TORSION 1	0.579	0.544	6.0%	0.562	2.9%	0.559	3.5%	0.563	2.8%	0.559	3.5%
SWAY X,2	1.373	1.325	3.5%	1.372	N.R.	1.347	1.9%	1.280	6.8%	1.027	25.2%
SWAY Z,2	1.385	1.385	N.R.	1.385	N.R.	1.385	N.R.	1.385	N.R.	1.385	N.R.
TORSION 2	1.466	1.460	N.R.	1.465	N.R.	1.452	1.0%	1.441	1.7%	1.434	2.2%
SWAY Z,3	3.015	3.015	N.R.	3.015	N.R.	3.015	N.R.	3.015	N.R.	3.015	N.R.
SWAY X,3	3.110	3.103	N.R.	2.608	16.1%	2.396	23%	2.524	18.8%	2.909	6.5%
TORSION 3	3.681	3.659	N.R.	3.604	2.1%	3.602	2.2%	3.602	2.2%	3.659	N.R.

N.R. <1% Reduction

Computed natural frequencies of full scale platform

Table 3.7

LEVEL	JOINT ID	83	81	82	84	MEAN DISPL.
9	DX	0.003	0.004	0.005	0.004	
	DZ	1.000	0.999	0.999	1.000	1.000
LEVEL	JOINT ID	75	79	80	76	
8	DX	0.004	0.003	0.003	0.005	
	DZ	0.980	0.979	0.979	0.980	0.980
LEVEL	JOINT ID	59	57	58	60	
7	DX	0.003	0.003	0.003	0.003	
	DZ	0.616	0.610	0.610	0.616	0.613
LEVEL	JOINT ID	47	45	46	48	
6	DX	0.003	0.003	0.004	0.004	
	DZ	0.503	0.501	0.501	0.503	0.502
LEVEL	JOINT ID	35	33	34	36	
5	DX	0.004	0.004	0.004	0.004	
	DZ	0.406	0.405	0.405	0.406	0.406
LEVEL	JOINT ID	27	25	26	28	
4	DX	0.004	0.004	0.005	0.005	
	DZ	0.301	0.299	0.299	0.301	0.300
LEVEL	JOINT ID	19	17	18	20	
3	DX	0.005	0.005	0.005	0.005	
	DZ	0.199	0.197	0.197	0.199	0.198

NORMALISED MODE SHAPE FOR SWAY Z,1 ; f = 0.400 Hz.

TABLE 3.8

LEVEL	JOINT ID	83	81	82	84	MEAN DISPL.
9	DX	0.999	0.999	1.000	1.000	1.000
	DZ	0.000	0.001	0.001	0.000	
LEVEL	JOINT ID	75	79	80	76	
8	DX	0.979	0.979	0.980	0.980	0.980
	DZ	0.001	0.000	0.002	0.001	
LEVEL	JOINT ID	59	57	58	60	
7	DX	0.561	0.561	0.561	0.561	0.561
	DZ	0.000	0.001	0.000	0.000	
LEVEL	JOINT ID	47	45	46	48	
6	DX	0.463	0.463	0.463	0.463	0.463
	DZ	0.000	0.000	0.000	0.000	
LEVEL	JOINT ID	35	33	34	36	
5	DX	0.382	0.382	0.382	0.382	0.382
	DZ	0.000	0.000	0.000	0.000	
LEVEL	JOINT ID	27	25	26	28	
4	DX	0.290	0.290	0.280	0.290	0.290
	DZ	0.000	0.000	0.000	0.000	
LEVEL	JOINT ID	19	17	18	20	
3	DX	0.200	0.200	0.200	0.200	0.200
	DZ	0.000	0.000	0.000	0.000	

NORMALISED MODE SHAPE FOR SWAY X,1 ; f = 0.427 Hz

TABLE 3.9

LEVEL	JOINT ID	83	81	82	84	ROTATION	MEAN ROTATION
9	DX	-0.668	-0.668	0.667	0.667	1.00	1.000
	DZ	-0.980	1.000	1.000	-0.980	0.988	
LEVEL	JOINT ID	75	79	80	76		
8	DX	-0.639	-0.639	0.638	0.638	0.957	0.963
	DZ	-0.958	0.960	0.960	-0.958	0.958	
LEVEL	JOINT ID	59	57	58	60		
7	DX	-0.194	-0.194	0.192	0.192	0.236	0.251
	DZ	-0.302	0.304	0.304	-0.302	0.263	
LEVEL	JOINT ID	47	45	46	48		
6	DX	-0.161	-0.161	0.160	0.160	0.163	0.171
	DZ	-0.231	0.233	0.233	-0.231	0.176	
LEVEL	JOINT ID	35	33	34	36		
5	DX	-0.155	-0.155	0.153	0.153	0.131	0.136
	DZ	-0.209	0.211	0.211	-0.209	0.139	
LEVEL	JOINT ID	27	25	26	28		
4	DX	-0.137	-0.137	0.136	0.136	0.099	0.103
	DZ	-0.179	0.180	0.180	-0.179	0.105	
LEVEL	JOINT ID	19	17	18	20		
3	DX	-0.123	-0.123	0.122	0.122	0.076	0.078
	DZ	-0.154	0.154	0.154	-0.154	0.079	

NORMALISED MODE SHAPE FOR TORSION 1 ; f = 0.579 Hz.

TABLE 3.10

LEVEL	JOINT ID	83	81	82	84	MEAN DISPL.
9	DX	-0.260	-0.261	-0.260	-0.260	-0.260
	DZ	-0.006	-0.007	-0.006	-0.007	
LEVEL	JOINT ID	75	79	80	76	
8	DX	-0.239	-0.238	-0.239	-0.239	-0.239
	DZ	-0.009	-0.005	-0.008	-0.005	
LEVEL	JOINT ID	59	57	58	60	
7	DX	0.777	0.777	0.777	0.777	0.777
	DZ	0.019	0.018	0.019	0.019	
LEVEL	JOINT ID	47	45	46	48	
6	DX	0.942	0.942	0.942	0.942	0.942
	DZ	0.024	0.023	0.024	0.024	
LEVEL	JOINT ID	35	33	34	36	
5	DX	1.000	1.000	1.000	1.000	1.000
	DZ	0.026	0.025	0.025	0.026	
LEVEL	JOINT ID	27	25	26	28	
4	DX	0.997	0.997	0.997	0.997	0.997
	DZ	0.026	0.025	0.025	0.026	
LEVEL	JOINT ID	19	17	18	20	
3	DX	0.934	0.933	0.933	0.933	0.933
	DZ	0.024	0.024	0.023	0.024	

NORMALISED MODE SHAPE FOR SWAY X,2 ; f = 1.373 Hz.

TABLE 3.11

LEVEL	JOINT ID	83	81	82	84	MEAN DISPL.
9	DX	-0.005	0.000	-0.010	-0.008	
	DZ	-0.259	-0.255	-0.255	-0.259	-0.259
LEVEL	JOINT ID	75	79	80	76	
8	DX	-0.007	-0.004	-0.007	-0.002	
	DZ	-0.258	-0.254	-0.254	-0.258	-0.256
LEVEL	JOINT ID	59	57	58	60	
7	DX	0.006	0.008	0.002	0.008	
	DZ	0.730	0.728	0.728	0.730	0.730
LEVEL	JOINT ID	47	45	46	48	
6	DX	0.007	0.007	0.008	0.010	
	DZ	0.928	0.926	0.926	0.928	0.928
LEVEL	JOINT ID	35	33	34	36	
5	DX	0.008	0.007	0.009	0.010	
	DZ	1.000	0.998	0.998	1.000	1.000
LEVEL	JOINT ID	27	25	26	28	
4	DX	0.007	0.005	0.008	0.006	
	DZ	0.998	0.994	0.994	0.998	0.997
LEVEL	JOINT ID	19	17	18	20	
3	DX	0.004	0.005	0.006	0.004	
	DZ	0.926	0.924	0.924	0.926	0.926

NORMALISED MODE SHAPE FOR SWAY Z,2 ; f = 1.385 Hz.

TABLE 3.12

LEVEL	JOINT ID	83	81	82	84	ROTATION	MEAN ROTATION
9	DX	0.124	0.124	-0.123	-0.123	-0.283	-0.281
	DZ	0.168	-0.197	-0.197	0.168	-0.279	
LEVEL	JOINT ID	75	79	80	76		
8	DX	0.095	0.095	-0.095	-0.095	-0.218	-0.220
	DZ	0.144	-0.148	-0.148	0.144	-0.222	
LEVEL	JOINT ID	59	57	58	60		
7	DX	-0.487	-0.487	0.486	0.486	0.907	0.905
	DZ	-0.678	0.685	0.685	-0.678	0.903	
LEVEL	JOINT ID	47	45	46	48		
6	DX	-0.645	-0.645	0.643	0.643	1.000	1.000
	DZ	-0.858	0.869	0.869	-0.858	1.000	
LEVEL	JOINT ID	35	33	34	36		
5	DX	-0.741	-0.741	0.739	0.739	0.964	0.970
	DZ	-0.958	0.967	0.967	-0.958	0.975	
LEVEL	JOINT ID	27	25	26	28		
4	DX	-0.798	-0.798	0.796	0.796	0.881	0.885
	DZ	-0.996	1.000	1.000	-0.996	0.889	
LEVEL	JOINT ID	19	17	18	20		
3	DX	-0.809	-0.809	0.806	0.806	0.765	0.768
	DZ	-0.980	0.986	0.986	-0.980	0.771	

NORMALISED MODE SHAPE FOR TORSION 2 ; f = 1.466 Hz.

TABLE 3.13

LEVEL	JOINT ID	83	81	82	84	MEAN DISPL.
9	DX	-0.013	-0.013	-0.014	-0.014	-0.014
	DZ	0.000	0.000	0.001	0.001	
LEVEL	JOINT ID	75	79	80	76	
8	DX	-0.112	-0.113	-0.114	-0.113	-0.113
	DZ	0.002	-0.003	0.002	-0.002	
LEVEL	JOINT ID	59	57	58	60	
7	DX	1.000	1.000	1.000	1.000	1.000
	DZ	0.002	0.001	0.002	0.001	
LEVEL	JOINT ID	47	45	46	48	
6	DX	0.894	0.894	0.894	0.894	0.894
	DZ	0.002	0.001	0.001	0.001	
LEVEL	JOINT ID	35	33	34	36	
5	DX	0.437	0.437	0.437	0.437	0.437
	DZ	0.001	0.001	0.001	0.001	
LEVEL	JOINT ID	27	25	26	28	
4	DX	-0.191	-0.191	-0.192	-0.192	-0.192
	DZ	-0.001	0.000	0.000	0.000	
LEVEL	JOINT ID	19	17	18	20	
3	DX	-0.768	-0.769	-0.769	-0.768	-0.769
	DZ	0.00	-0.001	0.000	-0.001	

NORMALISED MODE SHAPE FOR SWAY X,3 ; f = 3.110 Hz

TABLE 3.14

LEVEL	JOINT ID	83	81	82	84	MEAN DISPL.
9	DX	0.001	0.002	0.001	0.001	
	DZ	-0.002	-0.004	-0.004	-0.002	-0.003
LEVEL	JOINT ID	75	79	80	76	
8	DX	0.005	0.002	0.003	0.001	
	DZ	-0.151	-0.153	-0.153	-0.151	-0.152
LEVEL	JOINT ID	59	57	58	60	
7	DX	0.008	0.003	0.009	0.002	
	DZ	0.998	1.000	1.000	0.998	1.000
LEVEL	JOINT ID	47	45	46	48	
6	DX	0.007	0.005	0.006	0.009	
	DZ	0.916	0.918	0.918	0.916	0.918
LEVEL	JOINT ID	35	33	34	36	
5	DX	0.005	0.004	0.005	0.003	
	DZ	0.442	0.444	0.444	0.442	0.443
LEVEL	JOINT ID	27	25	26	28	
4	DX	0.002	0.004	0.003	0.005	
	DZ	-0.202	-0.200	-0.200	-0.200	-0.201
LEVEL	JOINT ID	19	17	18	20	
3	DX	0.001	0.002	0.005	0.004	
	DZ	-0.777	-0.782	-0.782	-0.777	-0.780

NORMALISED MODE SHAPE FOR SWAY Z,3 ; f = 3.015 Hz

TABLE 3.15

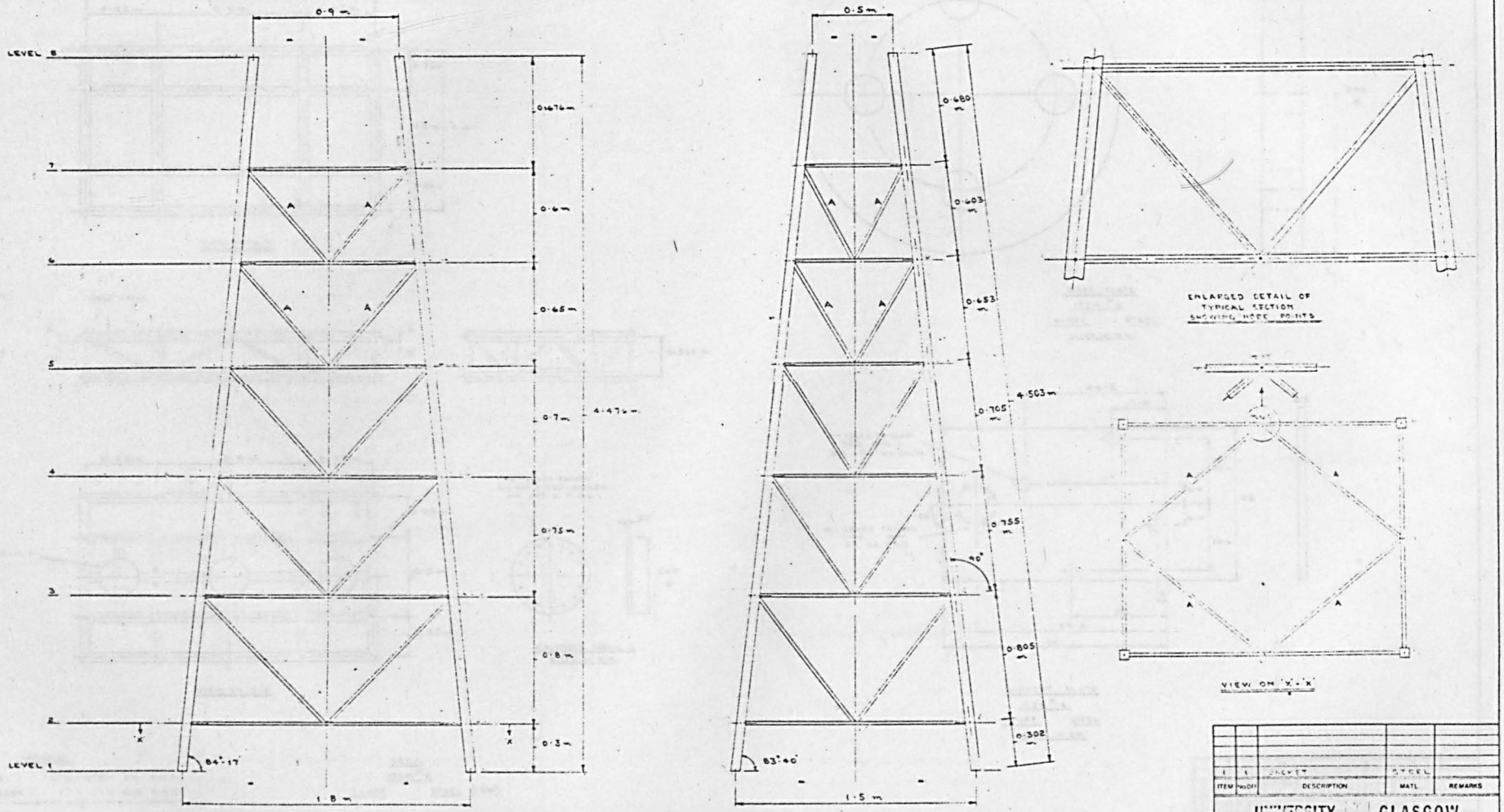
LEVEL	JOINT ID	83	81	82	84	ROTATION	MEAN ROTATION
9	DX	0.067	0.067	-0.066	-0.066	-0.120	0.008
	DZ	-0.116	0.111	0.111	-0.116	0.136	
LEVEL	JOINT ID	75	79	80	76		
8	DX	0.125	0.125	-0.125	-0.125	-0.225	-0.047
	DZ	-0.108	0.110	0.110	-0.108	0.131	
LEVEL	JOINT ID	59	57	58	60		
7	DX	0.674	0.674	-0.678	-0.678	-0.994	-1.000
	DZ	0.960	-0.955	-0.955	0.960	-1.000	
LEVEL	JOINT ID	47	45	46	48		
6	DX	0.740	0.740	-0.740	-0.740	-0.904	-0.910
	DZ	1.000	-0.998	-0.998	1.000	-0.911	
LEVEL	JOINT ID	35	33	34	36		
5	DX	0.457	0.457	-0.458	-0.458	-0.469	-0.472
	DZ	0.594	-0.589	-0.589	0.594	-0.472	
LEVEL	JOINT ID	27	25	26	28		
4	DX	-0.092	-0.092	0.092	0.092	0.080	0.078
	DZ	-0.112	0.104	0.104	-0.112	0.076	
LEVEL	JOINT ID	19	17	18	20		
3	DX	-0.616	-0.616	0.617	0.617	0.460	0.459
	DZ	-0.739	0.735	0.735	-0.739	0.456	

NORMALISED MODE SHAPE FOR TORSION 3 ; f = 3.681 Hz

TABLE 3.16

CHAPTER 4

MODEL PLATFORM DESIGN AND COMPUTED RESULTS



ITEM	No OFF	DESCRIPTION	MATL	REMARKS
1	1	JACKET	STEEL	

UNIVERSITY GLASGOW
ENGINEERING LABORATORIES

TITLE OF DRAWING:- DETAILS OF OIL RIG
TITLE OF PROJECT:- MODEL OF OFFSHORE OIL RIG
DEPARTMENT:- MECHANICS & MECHANISMS

PROJECT No.	COST No.	WHEN QUOTING BRWG. PLEASE QUOTE LETTER OF ISSUE
		SCALE 1 : 10 + 1 : 5
DRAWN BY	A.F.	
TRACED BY		3040276
CHECKED BY		
APPROVED BY		
DATE OF ISSUE		No OF SHEETS 2 SHEET No. 2

NOTE: THIS DRAWING IS A PRIVATE AND CONFIDENTIAL COMMUNICATION AND THE PROPERTY OF THE UNIVERSITY OF GLASGOW IT MUST NOT BE COPIED OR LOANED WITHOUT THE WRITTEN CONSENT OF THE UNIVERSITY AND MUST BE RETURNED IMMEDIATELY ON COMPLETION OF TENDER OR CONTRACT

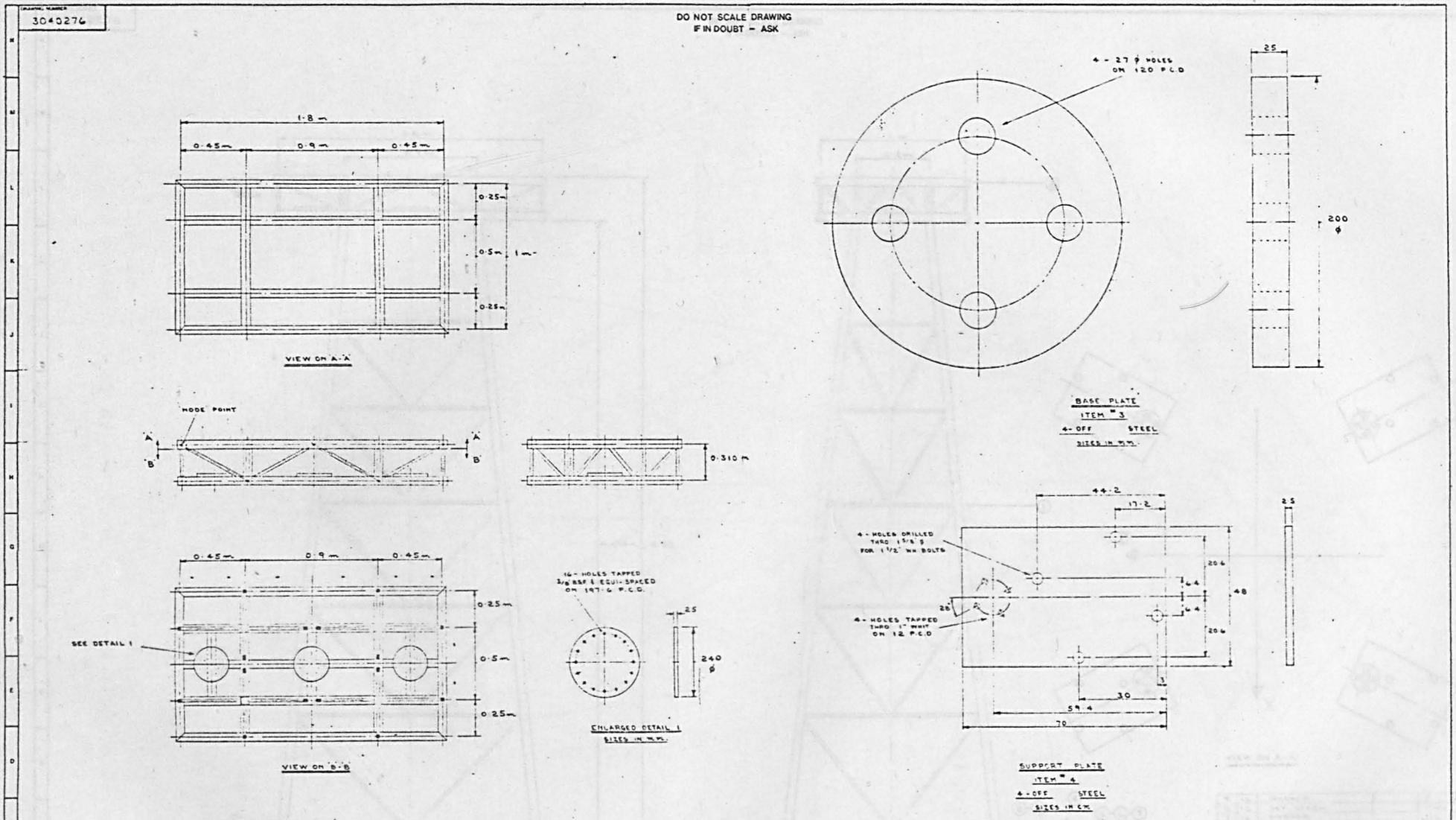
A ORDER LETTER OF ISSUE

MODEL PLATFORM JACKET

DIMENSIONS MUST NOT BE TAKEN OFF THIS DRAWING BUT FINISHED SIZES TO BE SPECIFIED BY NOTES TO FINISHED DIMENSIONS GIVEN IN ALL CASES

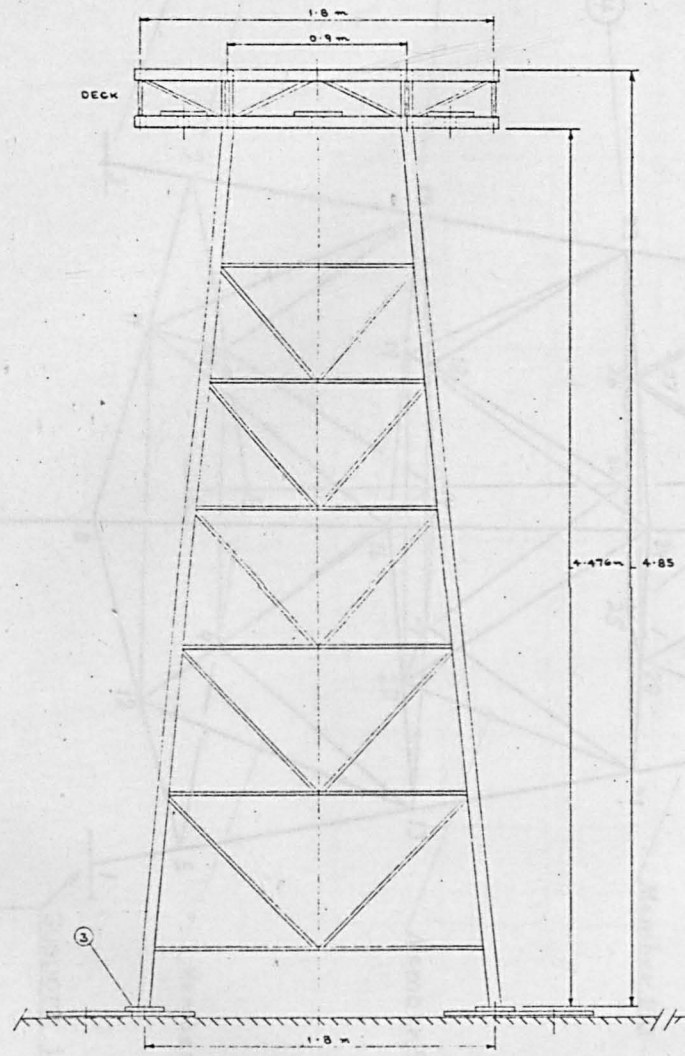
ALL DIMENSIONS TO BE IN DECIMALS TO BE

Figure 4.1

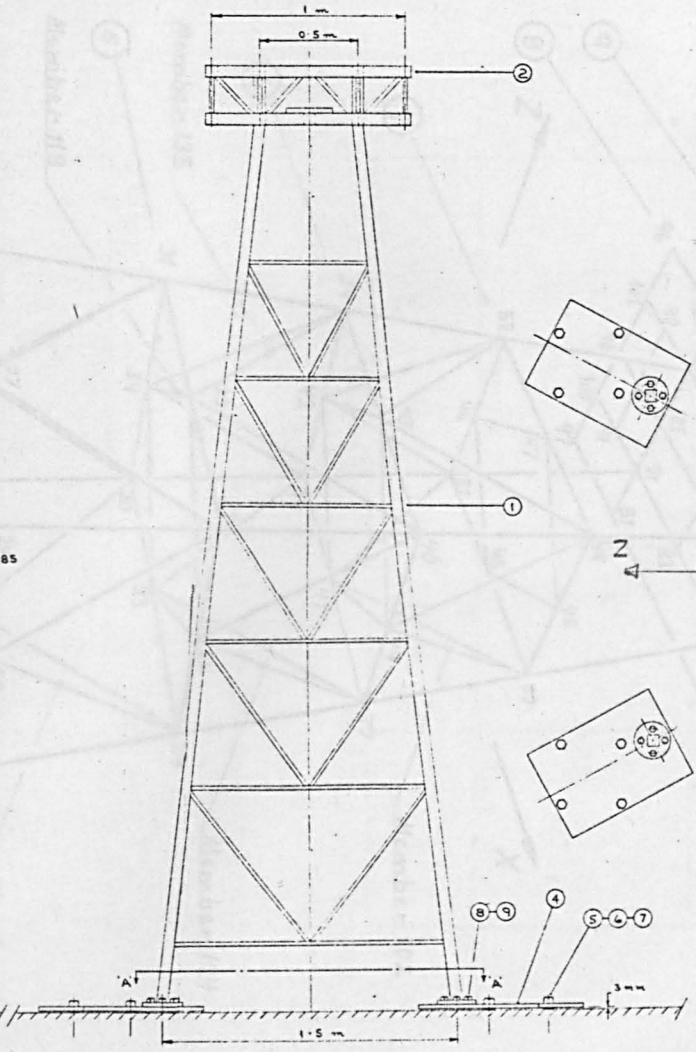


MODEL PLATFORM DECKS AND BASE SUPPORT PLATES

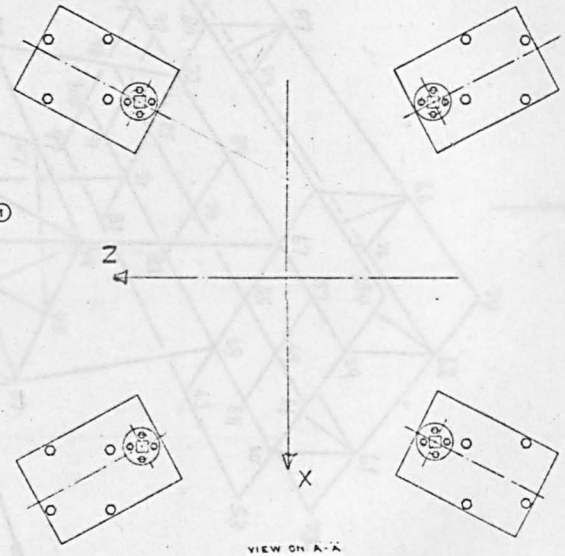
Figure 4.2



FRONT ELEVATION



SIDE ELEVATION



VIEW ON A-A

MODEL PLATFORM ASSEMBLY

Figure 4.3

ITEM	No.OFF	DESCRIPTION	MATL.	REMARKS
9	16	WASHER		1"
8	16	SET SCREW		1" NM
7	16	WASHER		1"/8
6	16	SET SCREW		1"/8 NM
5	16	DISTANCE PIECE	STEEL	3mm TH
4	4	SUPPORT PLATE	STEEL	SHEET 3
3	4	BASE PLATE	STEEL	SHEET 3
2	1	DECK	STEEL	SHEET 3
1	1	JACKET	STEEL	SHEET 2

UNIVERSITY GLASGOW
ENGINEERING LABORATORIES

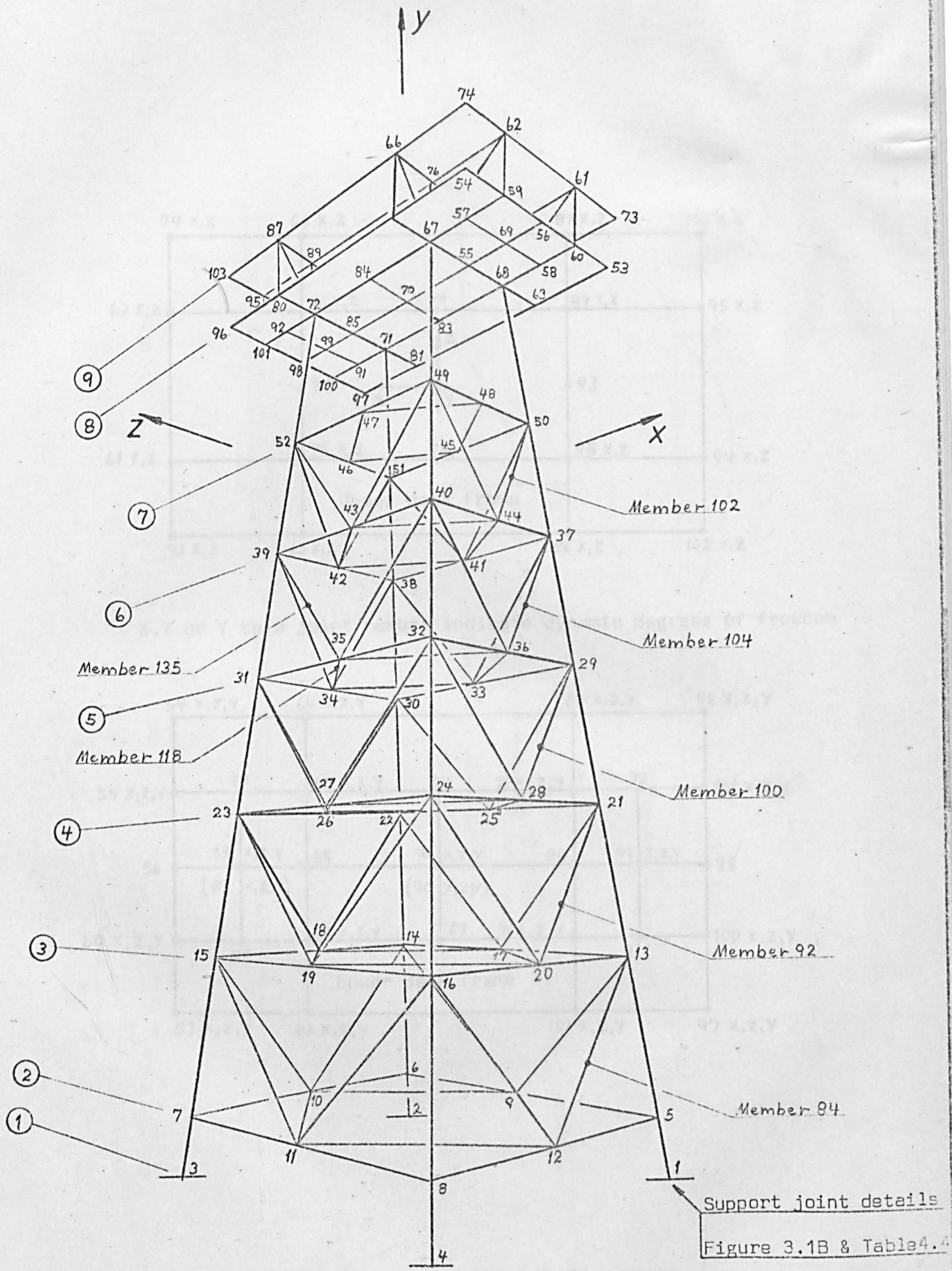
TITLE OF DRAWING:- ASSEMBLY OF OIL RIG.
TITLE OF PROJECT:- MODEL OF OFFSHORE OIL RIG.
DEPARTMENT:- MECHANICS & MECHANISMS.

PROJECT No.	COST No.	WHEN QUOTING DRWG. PLEASE QUOTE LETTER OF ISSUE
		SCALE: 1 : 10
DRAWN BY	A.M.	3040276
TRACED BY		
CHECKED BY		
APPROVED BY		
DATE DRAWN	OCT 1974	No. OF SHEETS 3 SHEET No. 1

A ORIGINAL LETTER OF ISSUE

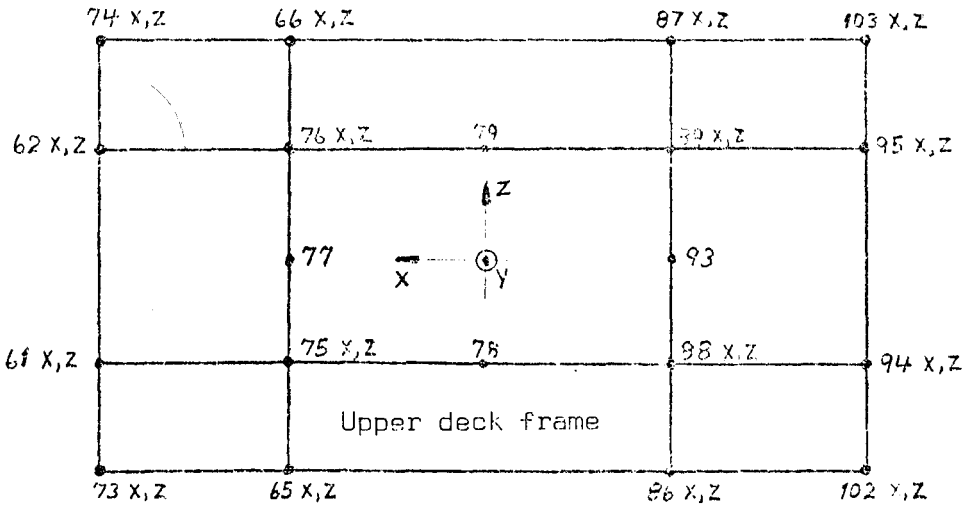
DIMENSIONS MUST NOT BE TAKEN OFF THIS DRAWING BUT FIGURED DIMENSIONS ONLY TO BE WORKED TO FINISHED DIMENSION GIVEN IN ALL CASES. MACHINE SYMBOLS MARKED THUS:- √ MACHINE, √ SMOOTH MACHINE, √ ROUGH MACHINE, √ GROUND FINISH

ALL UNTOLERANCED DIMENSIONS IN DECIMALS TO BE WITHIN THE FOLLOWING LIMITS:- HOLES AND INTERNAL SURFACES ± .010" SHAFTS AND EXTERNAL SURFACES ± .010" CENTRES OF HOLES AND CENTRES TO FACES ± .005" FRACTIONAL DIMENSIONS ± 1/64"

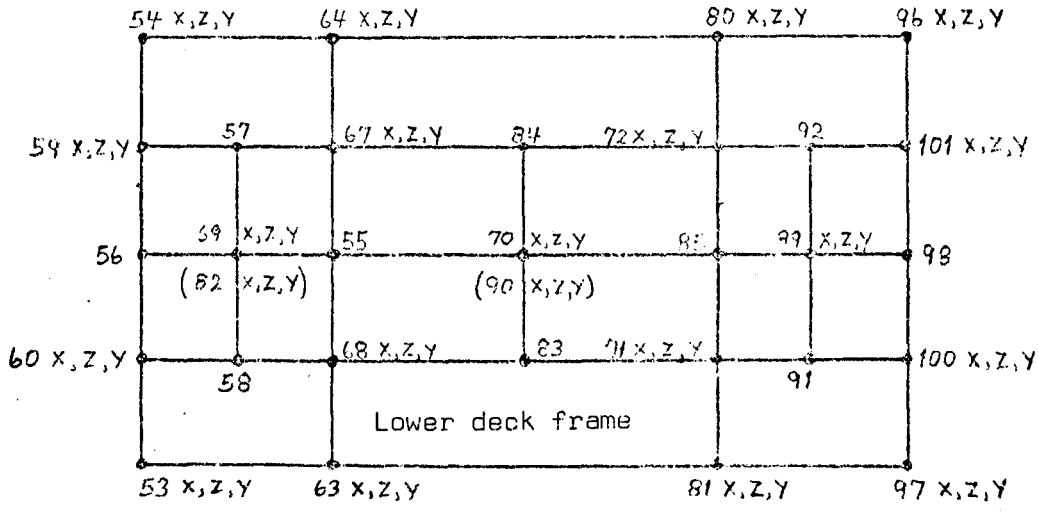


Beam element model of platform structure (Figure 5.1)

Figure 4.4

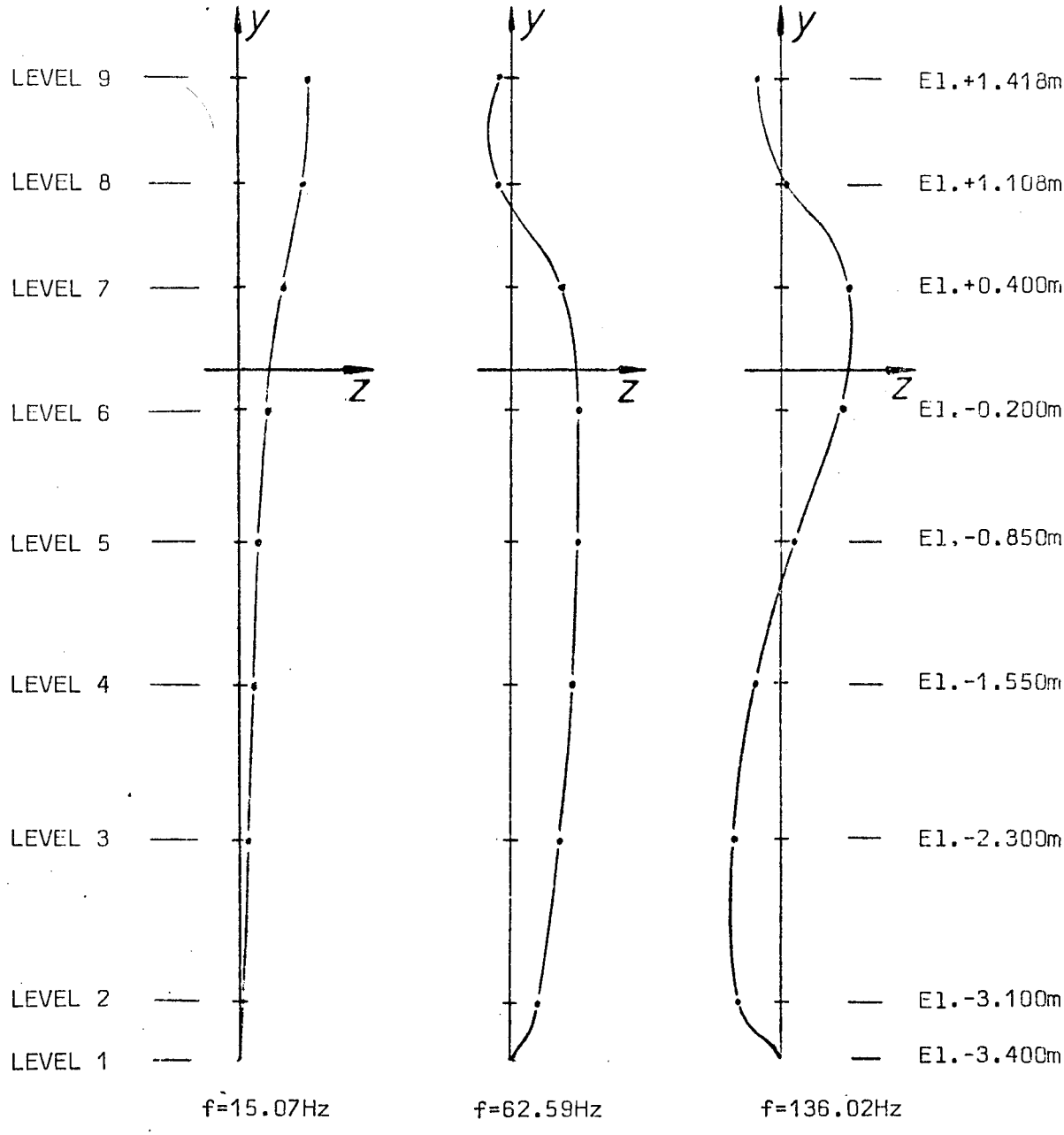


X,Z or Y to a joint number indicate dynamic degrees of freedom



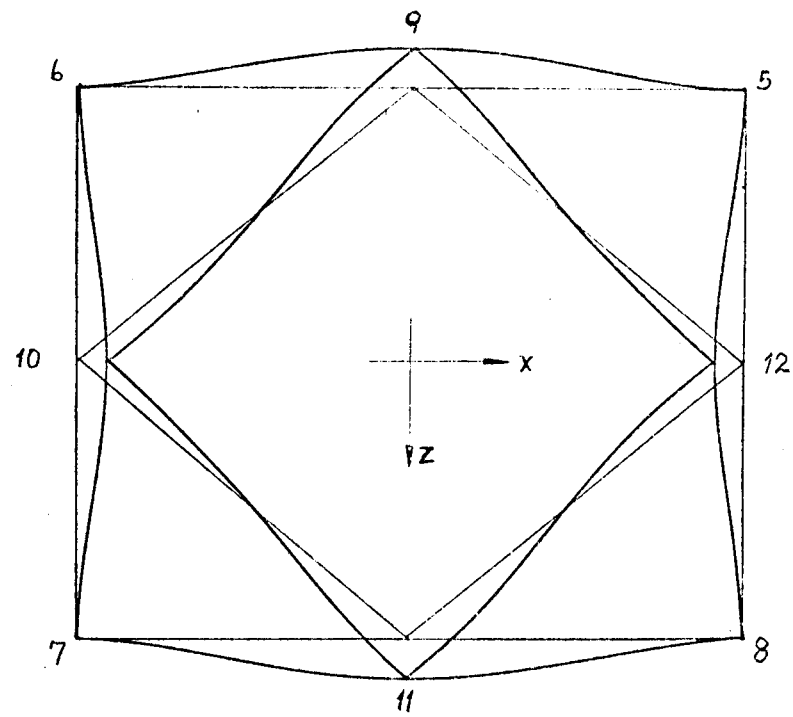
Dynamic degrees of freedom for model platform decks

Figure 4.5



Mean computed sway mode shapes for model platform (Tables 4.10,4.13 & 4.16)

Figure 4.6



Ovalising mode shape of level 2 for model platform, f=39.60 Hz (Table 4.19).

Figure 4.7

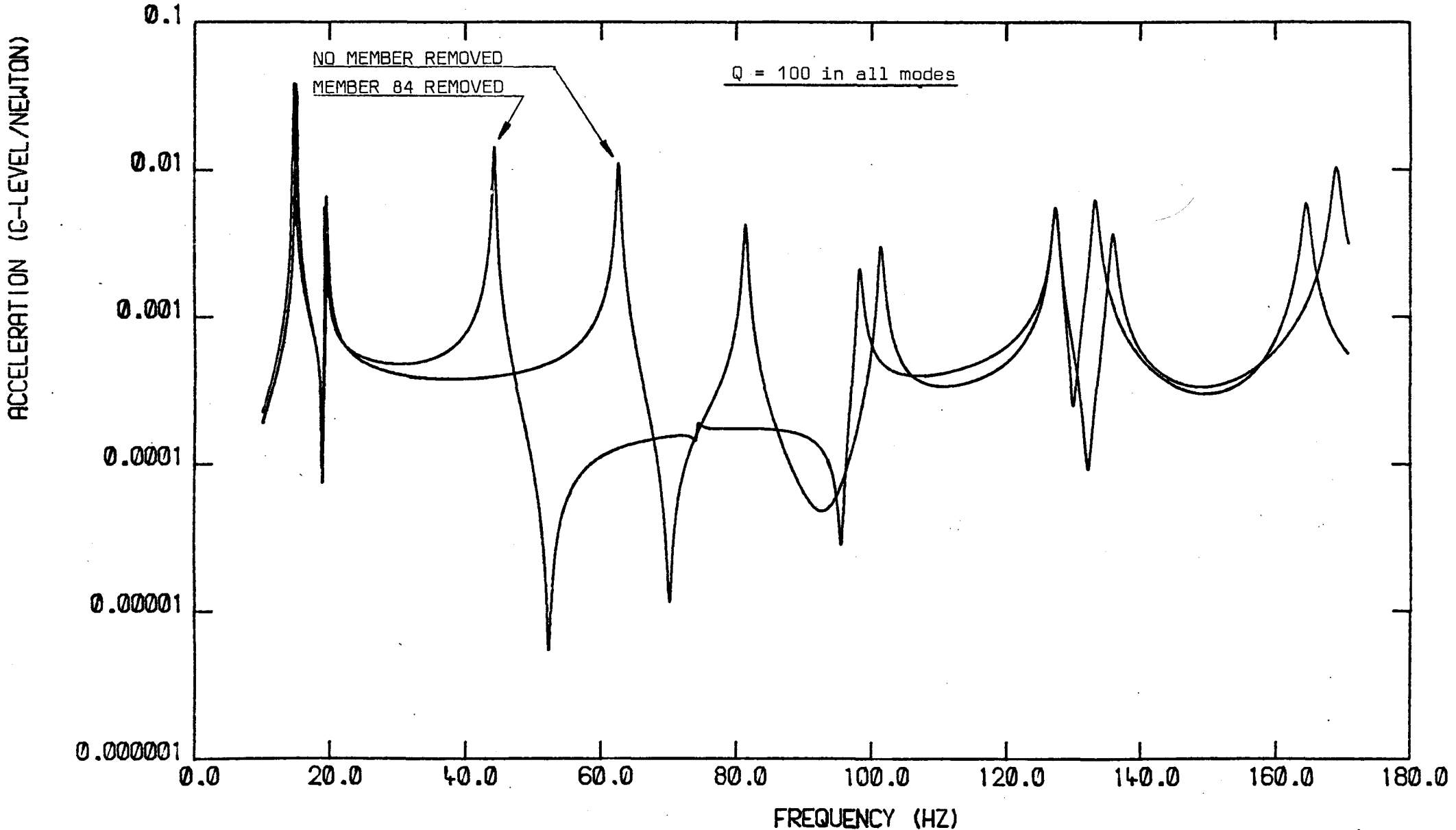


Figure 4.8 Computed acceleration receptance $\ddot{z}_{49Z,82Z}$ (Figures 4.4 & 4.5) for model platform (Tables 4.6 to 4.9)

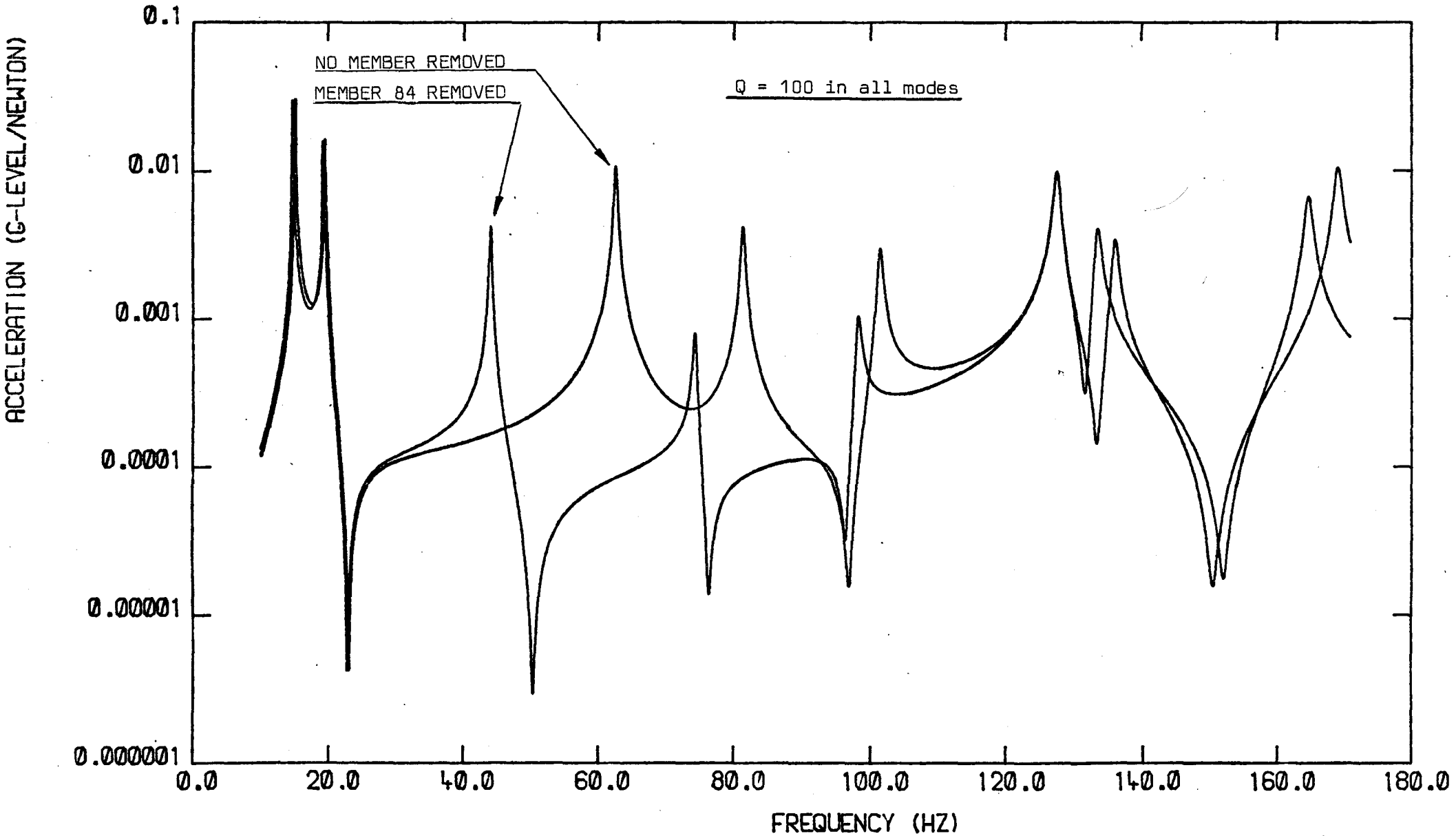


Figure 4.9 Computed acceleration receptance $\ddot{x}_{52Z,82Z}$ (Figure 4.4 & 4.5) for model platform (Tables 4.6 to 4.9)

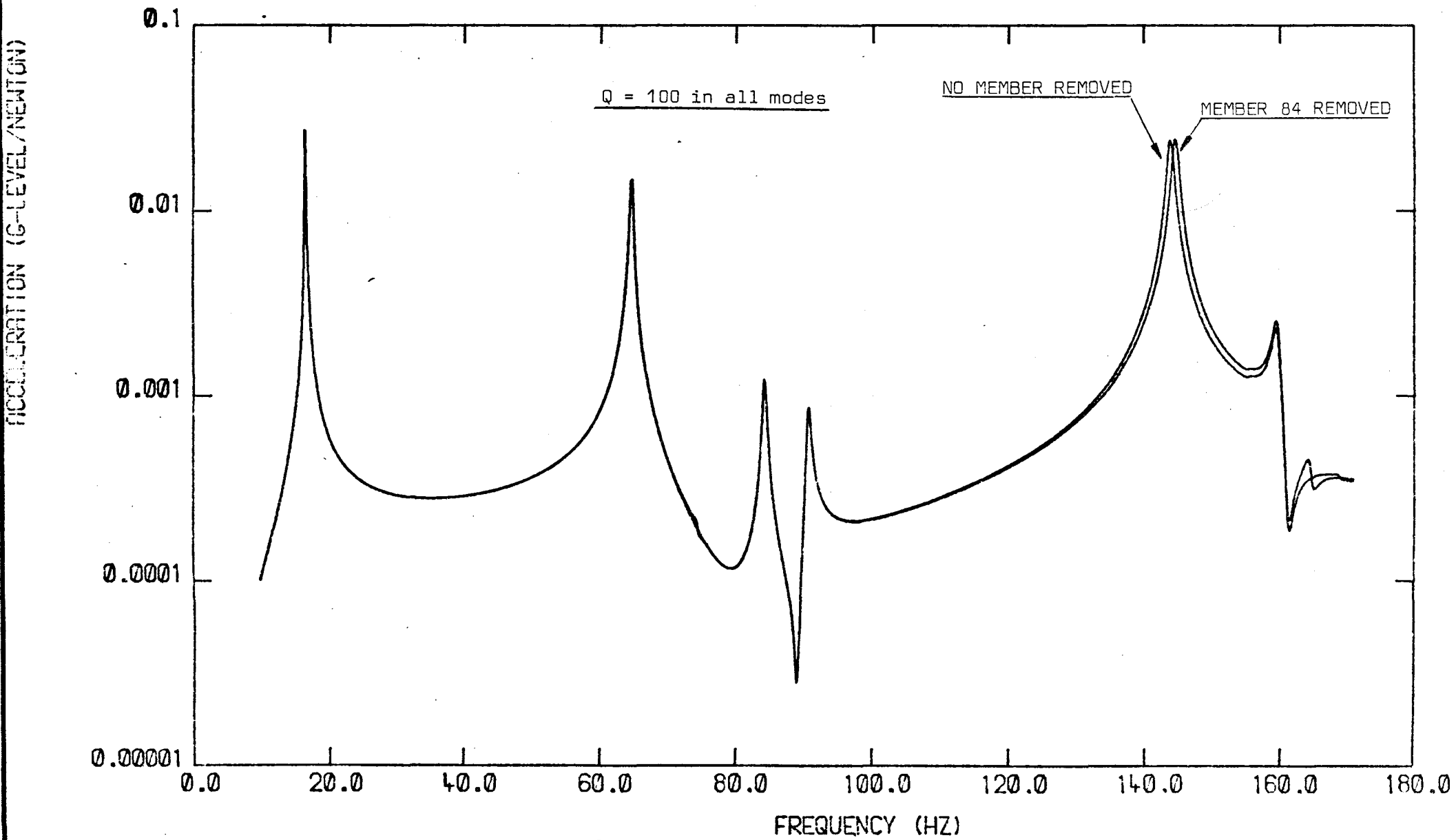


Figure 4.10 Computed acceleration receptance $\ddot{\chi}_{49X,82X}$ (Figure 4.4 & 4.5) for model platform (Tables 4.6 to 4.9)

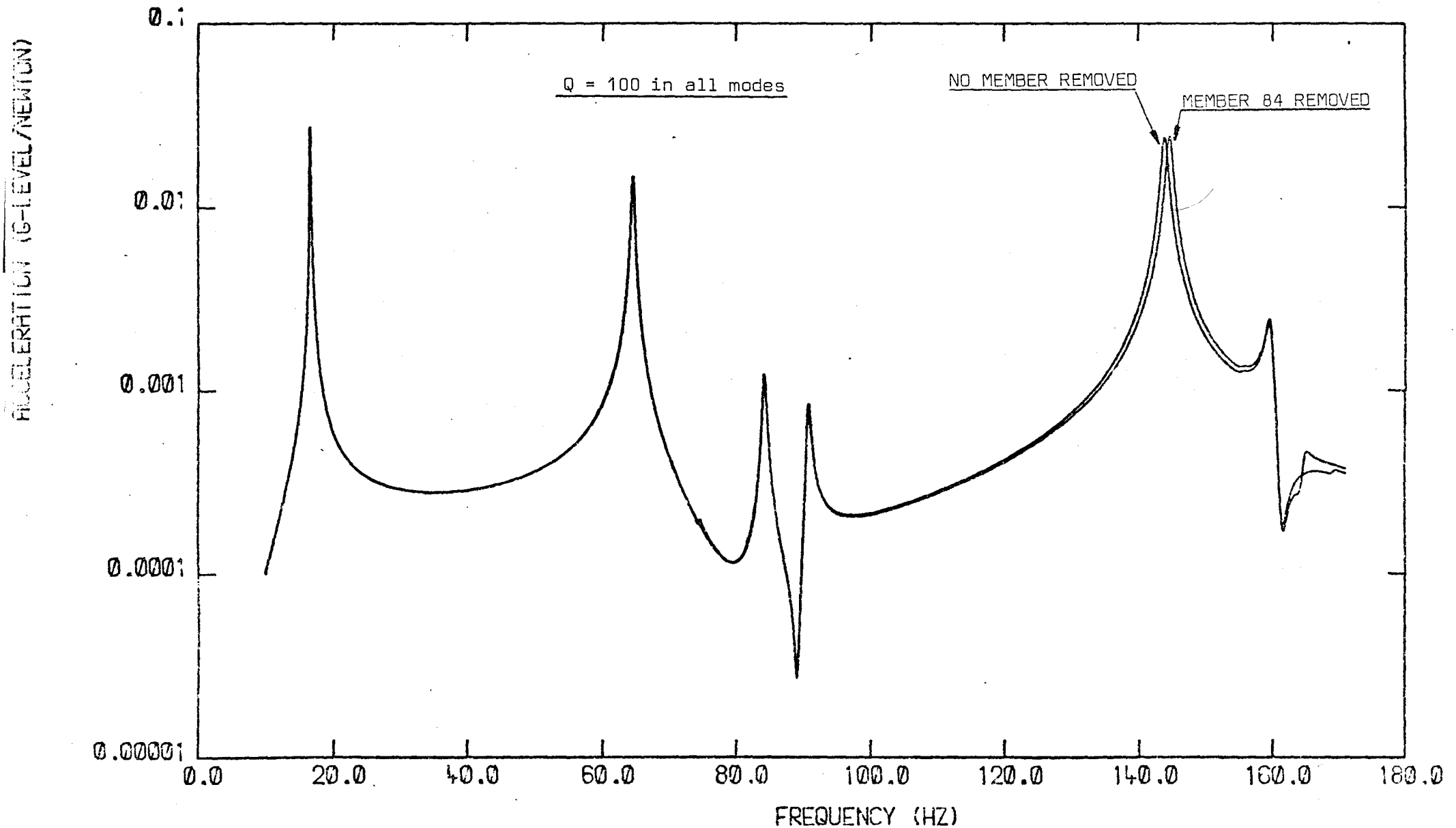
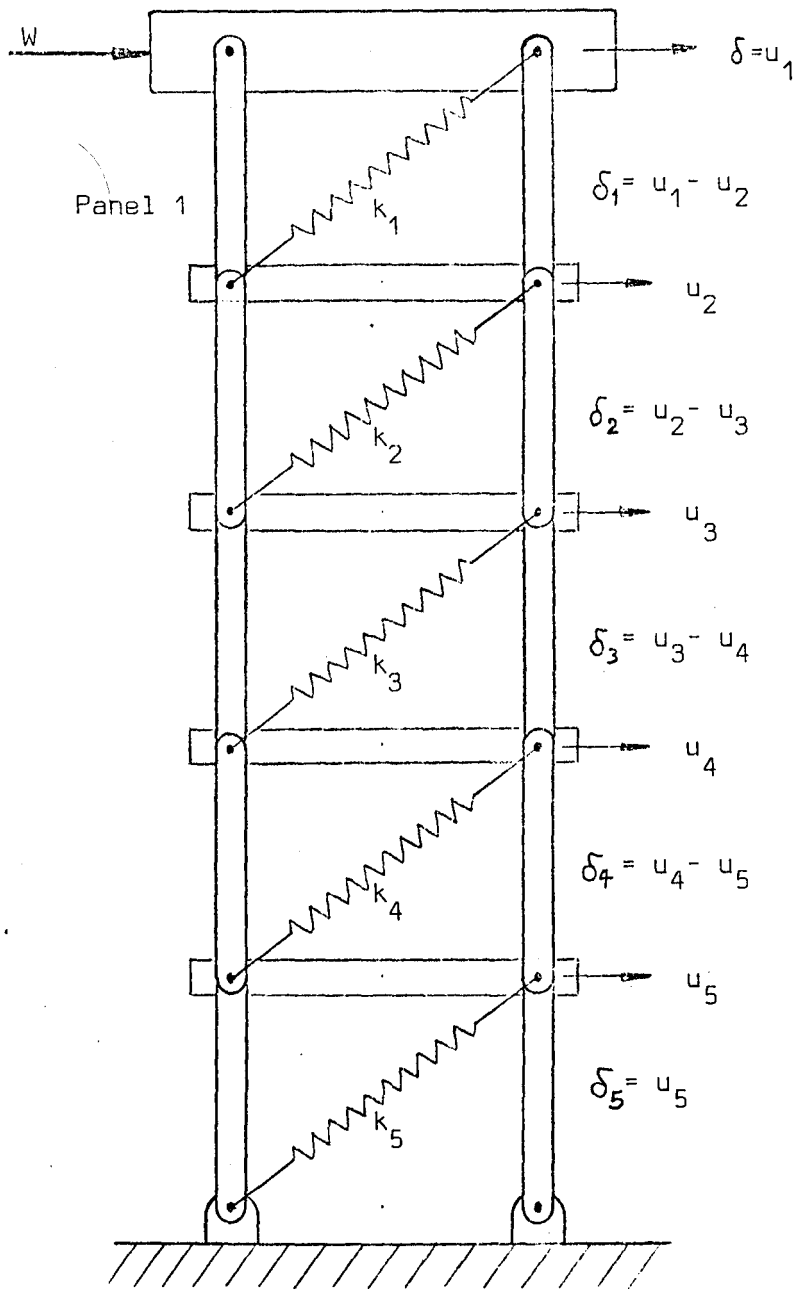
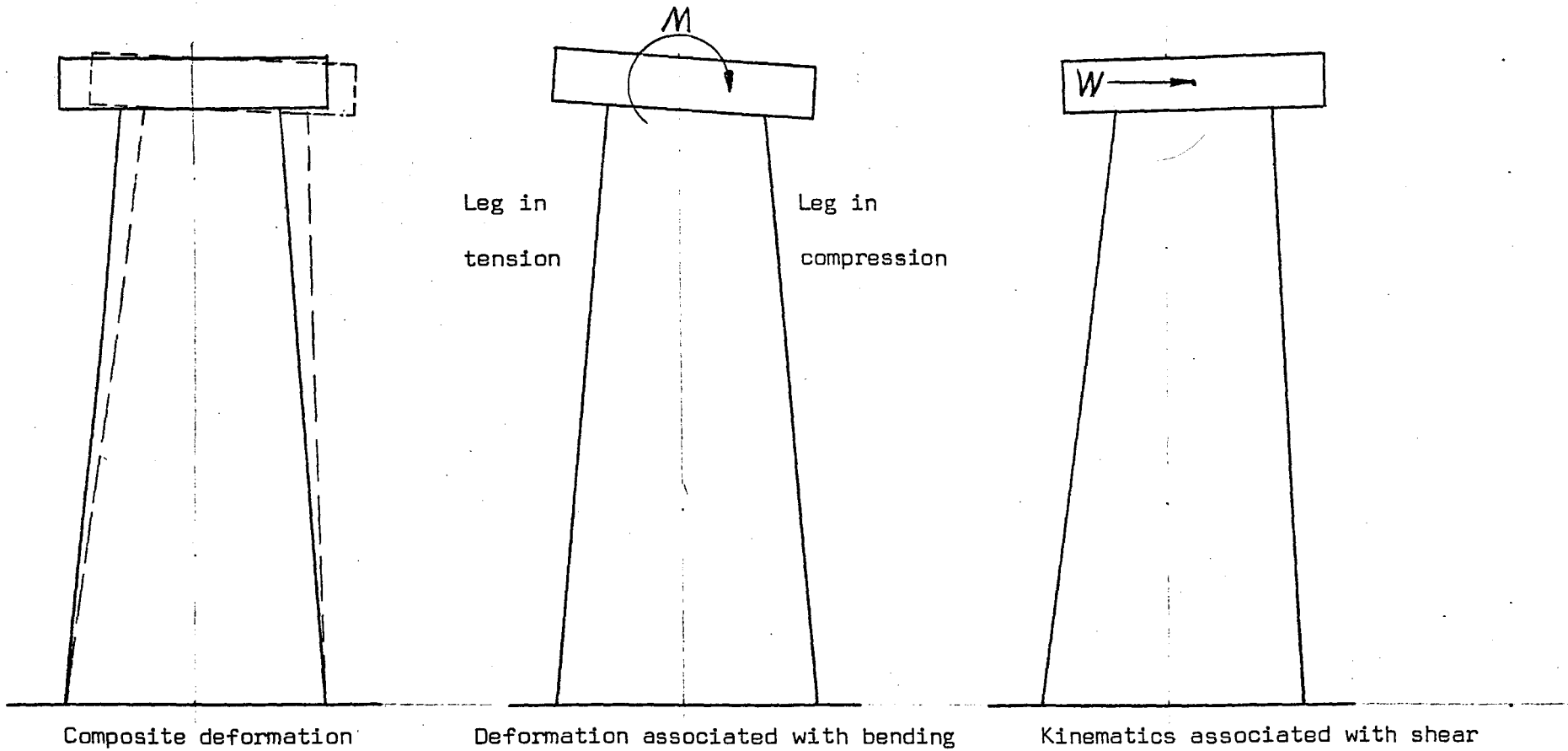


Figure 4.11 Computed acceleration receptance $a_{50X,82X}$ (Figure 4.4 & 4.5) for model platform (Tables 4.6 to 4.9)



Simple shear model of platform

Figure 4.12



Displacement pattern of structure under bending and shear loading

Figure 4.13

Joint No.	X (m)	Z (m)	Y (m)	Condition
1	0.900	-0.750	-3.400	Support
2	-0.900	-0.750	-3.400	Support
3	-0.900	0.750	-3.400	Support
4	0.900	0.750	-3.400	Support
5	0.870	-0.717	-3.100	
6	-0.870	-0.717	-3.100	
7	-0.870	0.717	-3.100	
8	0.870	0.717	-3.100	
9	0.0	-0.717	-3.100	
10	-0.87	0.0	-3.100	
11	0.0	0.717	-3.100	
12	0.87	0.0	-3.100	
13	0.790	-0.628	-2.300	
14	-0.790	0.628	-2.300	
15	-0.790	0.628	-2.300	
16	0.790	0.628	-2.300	
17	0.0	-0.628	-2.300	
18	-0.790	0.0	-2.300	
20	0.79	0.0	-2.300	

Joint co-ordinates of model platform

Table 4.1

Joint No.	X (m)	Z (m)	Y (m)	Condition
21	0.715	-0.544	-1.55	
22	-0.715	-0.544	-1.55	
23	-0.715	0.544	-1.55	
24	0.715	0.544	-1.55	
25	0.0	-0.544	-1.55	
26	-0.715	0.0	-1.55	
27	0.0	0.544	-1.55	
28	0.715	0.0	-1.55	
29	0.645	-0.467	-0.850	
30	-0.645	-0.467	-0.850	
31	-0.645	0.467	-0.850	
32	0.645	0.467	-0.850	
33	0.0	-0.467	-0.850	
34	-0.645	0.0	-0.850	
35	0.0	0.467	-0.850	
36	0.645	0.0	-0.850	
37	0.580	-0.394	-0.200	
38	-0.580	-0.394	-0.200	
39	-0.580	-0.394	-0.200	
40	0.580	0.394	-0.200	

Table 4.1 contd

Joint No.	X (m)	Z (m)	Y (m)	Condition
41	0.0	-0.394	-0.200	
42	-0.580	0.0	-0.200	
43	0.0	0.394	-0.200	
44	0.580	0.0	-0.200	
45	0.0	-0.328	0.40	
46	-0.520	0.0	0.40	
47	0.0	0.328	0.40	
48	0.520	0.0	0.40	
49	0.520	0.328	0.40	
50	0.520	-0.328	0.40	
51	-0.520	-0.328	0.40	
52	-0.520	0.328	0.40	
53	0.900	-0.500	1.108	
54	0.900	0.500	1.108	
55	0.450	0.0	1.108	
56	0.900	0.0	1.108	
57	0.675	0.250	1.108	
58	0.675	-0.250	1.108	
59	0.900	0.250	1.108	
60	0.900	-0.250	1.108	
61	0.900	-0.250	1.418	

Table 4.1 contd

Joint No.	X (m)	Z (m)	Y (m)	Condition
62	0.900	0.250	1.418	
63	0.45	-0.500	1.108	
64	0.45	0.500	1.108	
65	0.45	-0.500	1.418	
66	0.45	0.500	1.418	
67	0.45	0.250	1.108	
68	0.45	-0.250	1.108	
69	0.675	0.0	1.108	
70	0.0	0.0	1.108	
71	-0.450	-0.250	1.108	
72	-0.450	0.250	1.108	
73	0.900	-0.500	1.418	
74	0.900	0.500	1.418	
75	0.450	-0.250	1.418	
76	0.450	0.250	1.418	
77	0.450	0.0	1.418	
78	0.0	-0.250	1.418	
79	0.0	0.250	1.418	
80	-0.450	0.500	1.108	
81	-0.450	-0.500	1.108	
82	0.675	0.0	1.279	

Table 4.1 comtd

Joint No.	X (m)	Z (m)	Y (m)	Condition
83	0.0	-0.250	1.108	
84	0.0	0.250	1.108	
85	-0.450	0.0	1.108	
86	-0.450	-0.500	1.418	
87	-0.450	0.500	1.418	
88	-0.450	-0.250	1.418	
89	-0.450	0.250	1.418	
90	0.0	0.0	1.279	
91	-0.675	-0.250	1.108	
92	-0.675	0.250	1.108	
93	-0.450	0.0	1.418	
94	-0.900	-0.250	1.418	
95	-0.900	0.250	1.418	
96	-0.900	0.500	1.108	
97	-0.900	-0.500	1.108	
98	-0.900	0.0	1.108	
99	-0.675	0.0	1.108	
100	-0.900	-0.250	1.108	
101	-0.900	0.250	1.108	
102	-0.900	-0.500	1.418	
103	-0.900	0.500	1.418	

Table 4.1 contd

Member No.	Start	End	Length (m)
1	1	5	0.303
2	5	13	0.808
3	13	21	0.758
4	21	29	0.707
5	29	37	0.657
6	37	50	0.606
7	50	68	0.715
8	2	6	0.303
9	6	14	0.808
10	14	22	0.758
11	22	30	0.707
12	30	38	0.657
13	38	51	0.606
14	51	71	0.715
15	3	7	0.303
16	7	15	0.808
17	15	23	0.758
18	23	31	0.707
19	31	39	0.657
20	39	52	0.606

Member incidences of model platform

Table 4.2

Member No.	Start	End	Length (m)
21	52	72	0.715
22	4	8	0.303
23	8	16	0.808
24	16	24	0.758
25	24	32	0.707
26	32	40	0.657
27	40	49	0.606
28	49	67	0.715
29	5	9	0.870
30	6	9	0.870
31	6	10	0.717
32	7	10	0.717
33	7	11	0.870
34	8	11	0.870
35	8	12	0.717
36	5	12	0.717
37	13	17	0.790
38	14	17	0.790
39	14	18	0.628
40	15	18	0.628

Table 4.2 contd

Member No.	Start	End	Length (m)
41	15	19	0.790
42	16	19	0.790
43	16	20	0.628
44	13	20	0.628
45	21	25	0.715
46	22	25	0.715
47	22	26	0.544
48	23	26	0.544
49	23	27	0.715
50	24	27	0.715
51	24	28	0.544
52	21	28	0.544
53	29	33	0.645
54	30	33	0.645
55	31	35	0.645
56	32	35	0.645
57	37	41	0.580
58	38	41	0.580
59	39	43	0.580
60	40	43	0.580

Table 4.2 contd

Member No.	Start	End	Length (m)
61	30	34	0.467
62	31	34	0.467
63	29	36	0.467
64	32	36	0.467
65	38	42	0.394
66	39	42	0.394
67	37	44	0.394
68	40	44	0.394
69	50	45	0.520
70	51	45	0.520
71	51	46	0.328
72	52	46	0.328
73	52	47	0.520
74	49	47	0.520
75	49	48	0.328
76	50	48	0.328
77	9	13	1.127
78	9	14	1.127
79	10	14	1.020
80	10	15	1.020

Table 4.2 contd

Member No.	Start	End	Length (m)
81	11	15	1.127
82	11	16	1.127
83	12	16	1.020
84	12	13	1.020
85	17	21	1.039
86	17	22	1.039
87	18	22	0.929
88	18	23	0.929
89	19	23	1.039
90	19	24	1.039
91	20	24	0.929
92	20	21	0.929
93	25	29	0.954
94	25	30	0.954
95	26	30	0.844
96	26	31	0.844
97	27	31	0.954
98	27	32	0.954
99	28	32	0.844
100	28	29	0.844

Table 4.2 contd

Member No.	Start	End	Length (m)
101	44	49	0.686
102	44	50	0.686
103	36	40	0.762
104	36	37	0.762
105	42	52	0.686
106	42	51	0.686
107	34	38	0.762
108	34	39	0.762
109	45	46	0.614
110	46	47	0.614
111	47	48	0.614
112	45	48	0.614
113	41	42	0.701
114	42	43	0.701
115	43	44	0.701
116	41	44	0.701
117	33	34	0.796
118	34	35	0.796
119	35	36	0.796
120	33	36	0.796

Table 4.2 contd

Member No.	Start	End	Length (m)
121	9	10	1.127
122	9	12	1.127
123	10	11	1.127
124	11	12	1.127
125	17	18	1.009
126	17	20	1.009
127	18	19	1.009
128	19	20	1.009
129	25	26	0.898
130	25	28	0.898
131	26	27	0.898
132	27	28	0.898
133	33	37	0.874
134	33	38	0.874
135	35	39	0.874
136	35	40	0.874
137	41	50	0.796
138	41	51	0.796
139	43	52	0.796
140	43	49	0.796

Table 4.2 contd

Member No.	Start	End	Length (m)
141	102	86	0.450
142	88	94	0.450
143	89	95	0.450
144	103	87	0.450
145	53	60	0.250
146	56	60	0.250
147	56	59	0.250
148	54	59	0.250
149	53	63	0.450
150	58	60	0.225
151	68	58	0.225
152	56	69	0.225
153	55	69	0.225
154	58	69	0.250
155	57	69	0.250
156	57	59	0.225
157	67	57	0.225
158	54	64	0.450
159	68	63	0.250
160	68	55	0.250

Table 4.2 contd

Member No.	Start	End	Length (m)
161	67	55	0.250
162	67	64	0.250
163	63	81	0.900
164	68	83	0.450
165	71	83	0.450
166	55	70	0.450
167	70	70	0.450
168	67	84	0.450
169	72	84	0.450
170	64	80	0.900
171	83	70	0.250
172	84	70	0.250
173	71	81	0.250
174	71	85	0.250
175	72	85	0.250
176	72	80	0.250
177	97	81	0.450
178	71	91	0.225
179	91	100	0.225
180	85	99	0.225

Table 4.2 contd

Member No.	Start	End	Length (m)
181	98	99	0.225
182	72	92	0.225
183	92	101	0.225
184	96	80	0.450
185	91	99	0.250
186	92	99	0.250
187	97	100	0.250
188	98	100	0.250
189	98	101	0.250
190	96	101	0.250
191	73	61	0.250
192	61	62	0.500
193	~~64~~ 74	62	0.250
194	73	65	0.450
195	75	61	0.450
196	76	62	0.450
197	74	66	0.450
198	75	65	0.250
199	75	77	0.250
200	76	66	0.250

Table 4.2 contd

Member No.	Start	End	Length (m)
201	65	86	0.900
202	75	78	0.450
203	89	79	0.450
204	66	87	0.900
205	68	75	0.310
206	71	88	0.310
207	72	89	0.310
208	67	76	0.310
209	76	77	0.250
210	88	78	0.450
211	76	79	0.450
212	89	93	0.250
213	88	86	0.250
214	88	93	0.250
215	89	87	0.250
216	102	94	0.250
217	94	95	0.500
218	103	95	0.250
219	70	90	0.171
220	69	82	0.171

Table 4.2 contd

Member No.	Start	End	Length (m)
221	81	86	0.310
222	100	94	0.310
223	100	95	0.310
224	80	87	0.310
225	68	61	0.546
226	67	62	0.546
227	68	65	0.398
228	67	66	0.398
229	68	77	0.398
230	67	77	0.398
231	68	78	0.546
232	71	78	0.546
233	67	79	0.546
234	72	79	0.546
235	71	86	0.398
236	71	93	0.398
237	72	93	0.398
238	72	87	0.398
239	71	94	0.546
240	72	95	0.546

Table 4.2 contd

Member No.	Start	End	Length (m)
241	60	61	0.310
242	59	62	0.310
243	63	65	0.310
244	64	66	0.310

Table 4.2 contd

	Member Properties				Material Constants		
Member No.	Ax(m^2)	Ix(m^4)	Iy (m^4)	Iz(m^4)	E(N/m^2)	G(N/m^2)	ρ(KG/m^3)
1 to 28	9.23E-4	84.3E-8	53.3E-8	53.3E-8	2.1E11	0.8E11	7.85E3
29 to 100	2.61E-4	3.50E-8	2.00E-8	2.00E-8	2.1E11	0.8E11	7.85E3
101 to 140	1.31E-4	1.00E-8	0.62E-8	0.62E-8	2.1E11	0.8E11	7.85E3
141 to 218	9.23E-4	84.3E-8	53.3E-8	53.3E-8	2.1E11	0.8E11	0.0***
219 & 220	52.0E-4	720.E-8	360.E-8	360.E-8	2.1E11	0.8E11	0.0***
221 to 244	2.61E-4	3.50E-8	2.00E-8	2.00E-8	2.1E11	0.8E11	0.0***

*** Mass of deck members calculated manually and included in the computer model as concentrated inertias.

Member properties and material constants

Table 4.3

	JOINT ROTATIONS			ELASTIC SUPPORT CONSTANTS					
	DEGREES			NEWTON/METER			NEWTON × METER / RADIAN		
JOINT NO.	θ_1	θ_2	θ_3	KFX *	KFY	KFZ *	KMX *	KMY *	KMZ
1	0.0	-62.26	0.0	—	117.6E6	—	—	—	905.6E3
2	0.0	-117.74	0.0	—	117.6E6	—	—	—	905.6E3
3	0.0	117.74	0.0	—	117.6E6	—	—	—	905.6E3
4	0.0	62.26	0.0	—	117.6E6	—	—	—	905.6E8

*Elastic support constants assumed infinite

Support joint details (Figure 3.1 B)

Table 4.4

JOINT NO.	DYNAMIC DEGREES OF FREEDOM FORCE	JOINT INERTIAS (KG) X	Y	Z
1 to 4	None	—	—	—
5 to 8	X Y Z	Consistent	Consistent	Consistent
9 to 12	X Z	"	"	"
13 to 16	X Y Z	"	"	"
17 to 20	X Z	"	"	"
21 to 24	X Y Z	"	"	"
25 to 28	X Z	"	"	"
29 to 32	X Y Z	"	"	"
33 to 36	X Z	"	"	"
37 to 40	X Y Z	"	"	"
41 to 48	X Z	"	"	"
49 to 52	X Y Z	"	"	"
53 to 54	X Y Z	2.85	5.38	2.85
55 to 58	None	—	—	—
59 to 60	X Y Z	4.67	9.90	4.67
61 to 62	X Z	5.22	—	5.22
63 to 64	X Y Z	6.11	12.65	6.11
65 to 66	X Z	6.52	—	6.52
67 to 68	X Y Z	10.69	20.40	10.69

Joint inertias of model platform

Table 4.5

JOINT NO.	DYNAMIC DEGREES OF FREEDOM FORCE	JOINT INERTIAS (KG) X	Y	Z
69	X Y Z	24.52	24.52	24.52
70	X Y Z	27.26	27.26	27.26
71 to 72	X Y Z	10.69	20.40	10.69
73 to 74	X Z	2.53	—	2.53
75 to 76	X Z	9.70	—	9.70
77 to 79	None	—	—	—
80 to 81	X Y Z	6.11	12.65	6.11
82	X Y Z	14.02	14.02	14.02
83 to 85	None	—	—	—
86 to 87	X Z	6.52	—	6.52
88 to 89	X Z	9.70	—	9.70
90	X Y Z	14.02	14.02	14.02
91 to 93	None	—	—	—
94 to 95	X Z	5.22	—	5.22
96 to 97	X Y Z	2.85	5.38	2.85
98	None	—	—	—
99	X Y Z	15.89	15.89	15.89
100 to 101	X Y Z	4.67	9.90	4.67
102 to 103	X Z	2.53	—	2.53

Joint inertias of model platform

Table 4.5 contd

	DAMAGED / UNDAMAGED	MEMBER NO. 102		MEMBER NO. 104		MEMBER NO. 100		MEMBER NO. 92		MEMBER NO. 84	
MODE	FREQ(Hz.)	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE
Sway Z,1	15.07	13.62	-9.6%	14.69	-2.5%	14.65	-2.8%	14.74	-2.2%	14.67	-2.7%
Sway X,1	16.46	16.47	N.C.	16.47	N.C.	16.47	N.C.	16.47	N.C.	16.47	N.C.
Torsion 1	19.45	18.68	-3.4%	19.27	N.C.	19.27	N.C.	19.29	N.C.	19.20	-1.3%
Sway Z,2	62.59	60.44	-3.4%	62.40	N.C.	58.88	-5.9%	53.12	-15.1%	44.09	-29.6%
Sway X,2	64.48	64.58	N.C.	64.61	N.C.	64.77	N.C.	64.69	N.C.	64.58	N.C.
Torsion 2	81.44	81.24	N.C.	79.53	-2.3%	76.31	-6.3%	75.19	- 7.7%	74.38	-8.7%
Sway Z,3	136.0	135.0	N.C.	103.2	-24.1%	108.0	-20.6%	131.2	- 3.5%	133.4	-1.9%
Sway X,3	143.9	144.2	N.C.	144.0	N.C.	143.9	N.C.	144.4	N.C.	144.6	N.C.
Torsion 3	169.1	165.3	-2.2%	155.4	-8.1%	158.0	-6.6%	159.2	- 5.9%	164.6	-2.7%

N.C.<1% Change

Computed natural frequencies of model platform

Table 4.6

MODE	DAMAGED / UNDAMAGED	MEMBER NO. 102		MEMBER NO. 104		MEMBER NO. 100		MEMBER NO. 92		MEMBER NO. 84	
	FREQ(Hz.)	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE	FREQ(Hz.)	CHANGE
Ovalising 1	39.60	39.60	N.C.	39.60	N.C.	39.60	N.C.	39.66	N.C.	40.08	1.2%
Ovalising 2	46.39	46.36	N.C.	46.40	N.C.	46.45	N.C.	46.88	+1%	46.36	N.C.
Ovalising 3	57.99	57.99	N.C.	58.01	N.C.	58.56	N.C.	57.95	N.C.	57.99	N.C.
Ovalising 4	79.15	79.20	N.C.	79.91	N.C.	79.04	N.C.	79.14	N.C.	79.15	N.C.
Ovalising 5	101.8	102.5	N.C.	101.7	N.C.	101.7	N.C.	101.8	N.C.	101.8	N.C.
Ovalising 6	155.5	155.4	N.C.	155.5	N.C.	155.5	N.C.	155.5	N.C.	155.5	N.C.
Vertical	84.18	84.20	N.C.	84.20	N.C.	84.23	N.C.	84.24	N.C.	84.23	N.C.
Deck Pitch	90.60	90.60	N.C.	90.60	N.C.	90.62	N.C.	90.64	N.C.	90.64	N.C.
Deck roll	101.3	95.54	-5.7%	101.2	N.C.	101.3	N.C.	100.7	N.C.	98.20	-3.1%
Deck Twist	127.4	122.8	-3.6%	129.5	+1.6%	129.4	+1.6%	122.9	-3.5%	127.5	N.C.
Deck Bending	159.7	159.7	N.C.	159.7	N.C.	159.7	N.C.	159.7	N.C.	159.7	N.C.

N.C.<1% Change

Computed natural frequencies of model platform

Table 4.7

	DAMAGED / UNDAMAGED	MEMBER NO. 135		MEMBER NO. 118	
MODE	FREQ. (Hz.)	FREQ. (Hz.)	CHANGE	FREQ. (Hz.)	CHANGE
Sway Z,1	15.07	15.05	N.C.	15.07	N.C.
Sway X,1	16.46	15.95	- 3.1%	16.47	N.C.
Torsion 1	19.45	18.75	- 3.6%	19.45	N.C.
Sway Z,2	62.59	62.74	N.C.	62.69	N.C.
Sway X,2	64.48	64.79	N.C.	64.60	N.C.
Torsion 2	81.44	81.03	N.C.	81.54	N.C.
Sway Z,3	136.0	136.2	N.C.	135.9	N.C.
Sway X,3	143.9	113.8	-20.9%	143.9	N.C.
Torsion 3	169.1	162.1	- 4.1%	168.8	N.C.

N.C.<1% Change

Computed natural frequencies of model platform

Table 4.8

	DAMAGED / UNDAMAGED	MEMBER NO. 135		MEMBER NO. 118	
MODE	FREQ. (Hz.)	FREQ. (Hz.)	CHANGE	FREQ. (Hz.)	CHANGE
Ovalising 1	39.60	39.60	N.C.	39.59	N.C.
Ovalising 2	46.39	46.41	N.C.	46.38	N.C.
Ovalising 3	57.99	58.05	N.C.	57.99	N.C.
Ovalising 4	79.15	80.62	+1.9%	80.28	+1.4%
Ovalising 5	101.8	101.9	N.C.	102.0	N.C.
Ovalising 6	155.5	155.5	N.C.	155.5	N.C.
Vertical	84.18	83.77	N.C.	84.19	N.C.
Deck Pitch	90.60	90.31	N.C.	90.60	N.C.
Deck Roll	101.3	101.4	N.C.	101.3	N.C.
Deck Twist	127.4	129.3	+1.5%	127.4	N.C.
Deck bending	159.7	159.1	N.C.	159.7	N.C.

N.C. < 1% Change

Computed natural frequencies of model platform

Table 4.9

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	0.038	0.039	-0.039	-0.039	
9	DZ	0.927	0.787	0.788	0.927	1.000
		-	-	-	-	
LEVEL	JOINT ID	68	71	72	67	
	DX	0.038	0.038	-0.038	-0.039	
8	DZ	0.905	0.768	0.768	0.905	0.976
	DY	0.011	0.012	-0.012	-0.011	
LEVEL	JOINT ID	50	51	52	49	
	DX	0.015	0.015	-0.015	-0.015	
7	DZ	0.569	0.515	0.515	0.569	0.632
	DY	0.041	0.038	-0.038	-0.041	
LEVEL	JOINT ID	37	38	39	40	
	DX	0.011	0.011	-0.011	-0.011	
6	DZ	0.421	0.387	0.387	0.421	0.471
	DY	0.049	0.046	-0.046	-0.049	
LEVEL	JOINT ID	29	30	31	32	
	DX	0.008	0.008	-0.008	-0.008	
5	DZ	0.303	0.279	0.279	0.303	0.339
	DY	0.053	0.050	-0.050	-0.053	
LEVEL	JOINT ID	21	22	23	24	
	DX	0.006	0.006	-0.006	-0.006	
4	DZ	0.203	0.185	0.185	0.203	0.226
	DY	0.051	0.049	-0.049	-0.051	
LEVEL	JOINT ID	13	14	15	16	
	DX	0.005	0.005	-0.005	-0.005	
3	DZ	0.114	0.102	0.102	0.114	0.126
	DY	0.046	0.045	-0.045	-0.046	
LEVEL	JOINT ID	5	6	7	8	
	DX	0.001	0.004	-0.004	-0.001	
2	DZ	0.034	0.028	0.028	0.034	0.036
	DY	0.038	0.036	-0.036	-0.038	

Normalised mode shape for sway Z,1 ; f= 15.07Hz

Maximum displacement at joints 73Z & 74Z

Table 4.10

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	0.999	0.999	0.999	0.999	1.000
9	DZ	0.0	0.0	0.0	0.0	
		-	-	-	-	
LEVEL	JOINT ID	68	71	72	67	
	DX	0.978	0.978	0.978	0.978	0.979
8	DZ	0.0	0.0	0.0	0.0	
	DY	-0.015	0.015	0.015	-0.015	
LEVEL	JOINT ID	50	51	52	49	
	DX	0.562	0.562	0.562	0.562	0.563
7	DZ	0.0	0.0	0.0	0.0	
	DY	-0.053	0.053	0.053	-0.053	
LEVEL	JOINT ID	37	38	39	40	
	DX	0.425	0.425	0.425	0.425	0.425
6	DZ	0.0	0.0	0.0	0.0	
	DY	-0.060	0.060	0.060	-0.060	
LEVEL	JOINT ID	29	30	31	32	
	DX	0.313	0.313	0.313	0.313	0.313
5	DZ	0.0	0.0	0.0	0.0	
	DY	-0.062	0.062	0.062	-0.062	
LEVEL	JOINT ID	21	22	23	24	
	DX	0.214	0.214	0.214	0.214	0.214
4	DZ	0.0	0.0	0.0	0.0	
	DY	-0.059	0.059	0.059	-0.059	
LEVEL	JOINT ID	13	14	15	16	
	DX	0.123	0.123	0.123	0.123	0.123
3	DZ	0.0	0.0	0.0	0.0	
	DY	-0.053	0.053	0.053	-0.053	
LEVEL	JOINT ID	5	6	7	8	
	DX	0.037	0.037	0.037	0.037	0.037
2	DZ	-0.002	0.002	-0.002	0.002	
	DY	-0.042	0.042	0.042	-0.042	

Normalised mode shape for sway X,1 ; f=16.46Hz

Maximum displacement at deck joints 73X,74X,102X,103X

Table 4.11

LEVEL	JOINT ID	75	88	89	76	Rotation	Mean Rotation
	DX	-0.247	-0.247	0.247	0.247	1.000	1.000
9	DZ	-0.322	0.554	0.544	-0.322	0.985	
	DY						
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.243	-0.243	0.243	0.243	0.984	0.986
8	DZ	-0.320	0.546	0.546	-0.320	0.974	
	DY	0.003	0.001	-0.001	-0.003		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.098	-0.098	0.098	0.098	0.302	0.324
7	DZ	-0.100	0.251	0.251	-0.100	0.342	
	DY	-0.004	0.015	-0.015	0.004		
LEVEL	JOINT ID	37	38	39	40		
	DX	-0.070	-0.070	0.070	0.070	0.180	0.188
6	DZ	-0.053	0.168	0.168	-0.053	0.193	
	DY	-0.003	0.016	-0.016	0.003		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.051	-0.051	0.051	0.051	0.109	0.117
5	DZ	-0.037	0.120	0.120	-0.037	0.123	
	DY	-0.001	0.015	-0.015	0.001		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.041	-0.041	0.041	0.041	0.076	0.080
4	DZ	-0.030	0.086	0.086	-0.030	0.082	
	DY	0.0	0.014	-0.014	0.0		
LEVEL	JOINT ID	13	14	15	16		
	DX	-0.030	-0.030	0.030	0.030	0.048	0.050
3	DZ	-0.024	0.056	0.056	-0.024	0.051	
	DY	0.001	0.012	-0.012	-0.001		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.016	-0.016	0.016	0.016	0.022	0.022
2	DZ	-0.014	0.024	0.024	-0.014	0.022	
	DY	0.001	0.010	-0.010	-0.001		

Normalised mode shape for torsion 1 ; f= 19.45 Hz

Maximum displacement at deck joints 102Z & 103Z

Table 4.12

LEVEL	JOINT ID	75	88	89	76	Mean displ
9	DX	0.008	0.008	-0.008	-0.008	
	DZ	-0.169	-0.191	-0.192	-0.169	-0.185
	DY	-	-	-	-	
LEVEL	JOINT ID	68	71	72	67	
8	DX	0.007	0.008	-0.008	-0.007	
	DZ	-0.213	-0.236	-0.236	-0.213	-0.231
	DY	0.053	0.053	-0.052	-0.053	
LEVEL	JOINT ID	50	51	52	49	
7	DX	0.005	0.005	-0.005	-0.005	
	DZ	0.725	0.708	0.709	0.725	+0.737
	DY	-0.036	-0.036	0.036	0.036	
LEVEL	JOINT ID	37	38	39	40	
6	DX	0.005	0.005	-0.004	-0.004	
	DZ	0.969	0.955	0.955	0.969	+0.989
	DY	-0.041	-0.042	0.042	0.041	
LEVEL	JOINT ID	29	30	31	32	
5	DX	0.004	0.004	-0.004	-0.004	
	DZ	0.979	0.967	0.967	0.979	+1.000
	DY	-0.022	-0.022	0.022	0.022	
LEVEL	JOINT ID	21	22	23	24	
4	DX	0.004	0.004	-0.003	-0.003	
	DZ	0.899	0.889	0.889	0.899	+0.919
	DY	-0.001	-0.001	0.001	0.001	
LEVEL	JOINT ID	13	14	15	16	
3	DX	0.003	0.003	-0.002	-0.003	
	DZ	0.717	0.710	0.710	0.717	+0.733
	DY	0.017	0.017	-0.016	-0.017	
LEVEL	JOINT ID	5	6	7	8	
2	DX	-0.017	0.020	-0.020	0.017	
	DZ	0.403	0.399	0.399	0.403	+0.412
	DY	0.022	0.022	-0.022	-0.022	

Normalised mode shape for sway Z,2 ;f= 62.59Hz

Maximum displacement at joints 33Z & 35Z

Table 4.13

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	-0.161	-0.162	-0.162	-0.161	-0.161
9	DZ	0.00	0.0	0.0	0.0	
	DY	-	-	-	-	
LEVEL	JOINT ID	68	71	72	67	
	DX	-0.225	-0.224	-0.224	-0.225	-0.224
8	DZ	0.0	0.0	0.0	0.0	
	DY	-0.132	0.111	0.111	-0.132	
LEVEL	JOINT ID	50	51	52	49	
	DX	0.853	0.853	0.853	0.853	0.853
7	DZ	0.0	0.0	0.0	0.0	
	DY	-0.026	0.008	0.008	-0.026	
LEVEL	JOINT ID	37	38	39	40	
	DX	1.000	1.000	1.000	1.000	1.000
6	DZ	0.0	0.0	0.0	0.0	
	DY	-0.020	0.003	0.003	-0.020	
LEVEL	JOINT ID	29	30	31	32	
	DX	0.945	0.945	0.945	0.945	0.945
5	DZ	0.0	0.0	0.0	0.0	
	DY	-0.033	0.018	0.018	0.033	
LEVEL	JOINT ID	21	22	23	24	
	DX	0.819	0.819	0.819	0.819	0.819
4	DZ	0.0	0.0	0.0	0.0	
	DY	-0.046	0.033	0.033	-0.046	
LEVEL	JOINT ID	13	14	15	16	
	DX	0.606	0.606	0.606	0.606	0.606
3	DZ	0.0	0.0	0.0	0.0	
	DY	-0.054	0.044	0.044	-0.054	
LEVEL	JOINT ID	5	6	7	8	
	DX	0.286	0.286	0.286	0.286	0.286
2	DZ	-0.012	0.012	-0.012	0.012	
	DY	-0.052	0.045	0.045	-0.052	

Normalised mode shape for sway X,2 ; f=64.48 Hz

Maximum displacement at joints 37X & 40X

Table 4.14

LEVEL	JOINT ID	75	88	89	76	Rotation	Mean Rotation
	DX	0.057	0.057	-0.057	-0.057	-0.132	
9	DZ	0.054	-0.068	-0.069	0.054	-0.079	-0.106
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.042	0.042	-0.042	-0.042	-0.098	
8	DZ	0.049	-0.065	-0.065	0.049	-0.074	-0.086
	DY	-0.013	0.012	-0.011	0.012		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.517	-0.517	0.517	0.517	0.916	
7	DZ	-0.798	0.794	0.794	-0.798	0.889	0.911
	DY	0.014	-0.016	0.017	0.017		
LEVEL	JOINT ID	37	38	39	40		
	DX	-0.666	-0.666	0.666	0.666	0.982	
6	DZ	-0.997	1.000	1.000	-0.997	1.000	1.000
	DY	0.012	-0.014	0.014	0.014		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.687	-0.687	0.687	0.687	0.855	
5	DZ	-0.976	0.985	0.985	-0.976	0.883	0.877
	DY	0.0	-0.002	0.003	0.0		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.660	-0.660	0.659	0.659	0.766	
4	DZ	-0.903	0.915	0.915	-0.903	0.738	0.759
	DY	-0.007	0.005	-0.005	0.007		
LEVEL	JOINT ID	13	14	15	16		
	DX	-0.545	-0.545	0.545	0.545	0.504	
3	DZ	-0.731	0.743	0.743	-0.731	0.542	0.528
	DY	-0.011	0.010	-0.009	0.011		
LEVEL	JOINT ID	5	5	7	8		
	DX	-0.283	-0.282	0.282	0.282	0.228	
2	DZ	-0.410	0.418	0.418	-0.410	0.276	0.279
	DY	-0.010	0.009	-0.009	0.010		

Normalised mode shape for torsion 2 ; f= 81.44 Hz

Maximum displacement at joints 38Z & 39Z

Table 4.15

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	-0.031	-0.042	0.042	0.031	
9	DZ	-0.153	-0.321	-0.328	-0.154	-0.381
	DY	-	-	-	-	
LEVEL	JOINT ID	68	71	72	67	
	DX	0.003	0.015	-0.014	-0.003	
8	DZ	0.011	0.050	0.050	0.012	0.041
	DY	-0.061	-0.214	0.210	0.061	
LEVEL	JOINT ID	50	51	52	49	
	DX	-0.011	-0.007	-0.003	0.0	
7	DZ	0.780	0.725	0.725	0.780	1.000
	DY	-0.082	-0.177	0.174	0.082	
LEVEL	JOINT ID	37	38	39	40	
	DX	-0.005	-0.005	-0.003	-0.003	
6	DZ	0.714	0.677	0.677	0.714	0.924
	DY	-0.027	-0.097	0.094	0.027	
LEVEL	JOINT ID	29	30	31	32	
	DX	-0.010	-0.010	0.009	0.009	
5	DZ	0.156	0.147	0.147	0.156	0.201
	DY	0.058	0.008	-0.012	-0.058	
LEVEL	JOINT ID	21	22	23	24	
	DX	-0.008	-0.009	0.014	0.013	
4	DZ	-0.286	-0.265	-0.265	-0.286	-0.369
	DY	0.100	0.062	-0.065	-0.099	
LEVEL	JOINT ID	13	14	15	16	
	DX	-0.005	-0.007	0.015	0.013	
3	DZ	-0.597	-0.559	-0.560	-0.597	-0.768
	DY	0.110	0.080	-0.083	-0.109	
LEVEL	JOINT ID	5	6	7	8	
	DX	0.025	-0.023	0.029	-0.019	
2	DZ	-0.511	-0.475	-0.476	-0.511	-0.655
	DY	0.090	0.067	-0.070	-0.090	

Normalised mode shape for sway Z,3 ; f= 136.02 Hz

Maximum displacement at joint 96Y

Table 4.16

LEVEL	JOINT ID	75	88	89	76	Mean displ.
9	DX	-0.157	-0.150	-0.149	-0.156	-0.160
	DZ	0.001	-0.003	0.0	-0.002	
LEVEL	JOINT ID	68	71	72	67	
8	DX	-0.009	-0.013	-0.012	-0.009	-0.011
	DZ	-0.002	0.002	-0.002	0.002	
	DY	-0.012	-0.028	-0.024	-0.011	
LEVEL	JOINT ID	50	51	52	49	
7	DX	0.958	0.955	0.954	0.958	1.000
	DZ	0.004	0.003	0.003	0.004	
	DY	0.020	-0.057	-0.053	0.021	
LEVEL	JOINT ID	37	38	39	40	
6	DX	0.773	0.774	0.774	0.772	0.809
	DZ	0.004	0.003	0.003	0.004	
	DY	-0.042	0.008	0.010	-0.042	
LEVEL	JOINT ID	29	30	31	32	
5	DX	0.089	0.089	0.089	0.089	0.093
	DZ	0.002	0.0	0.001	0.0	
	DY	-0.127	0.097	0.098	-0.128	
LEVEL	JOINT ID	21	22	23	24	
4	DX	-0.434	-0.433	-0.433	-0.433	-0.453
	DZ	0.0	-0.002	0.0	-0.003	
	DY	-0.162	0.136	0.136	-0.163	
LEVEL	JOINT ID	13	14	15	16	
3	DX	-0.752	-0.752	-0.752	-0.752	-0.786
	DZ	-0.002	-0.003	-0.002	-0.004	
	DY	-0.155	0.135	0.135	-0.156	
LEVEL	JOINT ID	5	6	7	8	
2	DX	-0.550	-0.550	-0.550	-0.550	-0.575
	DZ	0.022	-0.027	0.023	-0.028	
	DY	-0.115	0.101	0.100	-0.116	

Normalised mode shape for sway X,3 ; f=143.89 Hz

Maximum displacement at joint 48X

Table 4.17

LEVEL	JOINT ID	75	88	89	76	Rotation	Mean rotation
	DX	0.082	0.087	-0.088	-0.082	-0.177	-0.079
9	DZ	-0.019	0.021	0.019	-0.019	0.023	
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.056	0.058	-0.058	-0.056	-0.119	-0.011
8	DZ	-0.083	0.086	0.086	-0.083	0.098	
	DY	0.009	-0.021	0.020	-0.009		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.590	-0.590	0.591	0.591	0.941	1.000
7	DZ	-0.990	0.999	0.999	-0.990	1.000	
	DY	0.020	-0.030	0.029	-0.020		
LEVEL	JOINT ID	37	38	39	40		
	DX	-0.474	-0.474	0.474	0.474	0.629	0.701
6	DZ	-0.804	0.817	0.817	-0.804	0.731	
	DY	-0.002	-0.005	0.004	0.002		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.014	0.014	-0.014	-0.014	-0.016	0.026
5	DZ	-0.079	0.084	0.084	-0.079	0.066	
	DY	-0.035	0.031	-0.032	0.035		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.327	0.327	-0.327	-0.327	-0.314	-0.310
4	DZ	0.391	-0.394	-0.394	0.391	-0.287	
	DY	-0.045	0.043	-0.043	0.045		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.481	0.481	-0.481	-0.481	-0.400	-0.430
3	DZ	0.650	-0.660	-0.660	0.650	-0.434	
	DY	-0.045	0.044	-0.045	0.045		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.285	0.285	-0.285	-0.286	-0.208	-0.257
2	DZ	0.479	-0.488	-0.488	0.479	-0.291	
	DY	-0.040	0.039	-0.040	0.039		

Normalised mode shape for torsion 3 ; f= 169.10 Hz

Maximum displacement at joint 46Z

Table 4.18

LEVEL	JOINT ID	45	47	46	48
7	DX	0.0	0.00	0.011	-0.011
	DZ	-0.018	0.018	0.0	0.00
LEVEL	JOINT ID	41	43	42	44
6	DX	0.0	0.0	0.029	-0.029
	DZ	-0.042	0.042	0.0	0.0
LEVEL	JOINT ID	33	35	34	36
5	DX	0.0	0.0	0.064	-0.064
	DZ	-0.089	0.089	0.0	0.0
LEVEL	JOINT ID	25	27	26	28
4	DX	0.0	0.0	0.145	-0.145
	DZ	-0.191	0.191	0.0	0.0
LEVEL	JOINT ID	17	19	18	20
3	DX	0.0	0.0	0.321	-0.321
	DZ	-0.405	0.405	0.0	0.0
LEVEL	JOINT ID	9	11	10	12
2	DX	0.0	0.0	0.822	-0.822
	DZ	-1.000	1.000	0.0	0.0

Normalised mode shape for ovalising 1 ; f=39.60 Hz

Maximimum displacement at level 2

Table 4.19

LEVEL	JOINT ID	45	47	46	48
7	DX	0.0	0.0	0.021	-0.021
	DZ	-0.033	0.033	0.0	0.0
LEVEL	JOINT ID	41	43	42	44
6	DX	0.0	0.0	0.055	-0.055
	DZ	-0.081	0.081	0.0	0.0
LEVEL	JOINT ID	33	35	34	36
5	DX	0.0	0.0	0.126	-0.126
	DZ	-0.175	0.175	0.0	0.0
LEVEL	JOINT ID	25	27	26	28
4	DX	0.0	0.0	0.311	-0.311
	DZ	-0.410	0.410	0.0	0.0
LEVEL	JOINT ID	17	19	18	20
3	DX	0.0	0.0	0.792	-0.792
	DZ	-1.000	1.000	0.0	0.0
LEVEL	JOINT ID	9	11	10	12
2	DX	0.0	0.0	-0.351	0.351
	DZ	0.428	-0.428	0.0	0.0

Normalised mode shape for ovalising 2 ; f=46.39 Hz

Maximum displacement at level 3

Table 4.20

LEVEL	JOINT ID	45	47	46	48
7	DX	0.0	0.0	0.033	-0.033
	DZ	-0.052	0.052	0.0	0.0
LEVEL	JOINT ID	41	43	42	44
6	DX	0.00	0.0	0.091	-0.091
	DZ	-0.134	0.134	0.0	0.0
LEVEL	JOINT ID	33	35	34	36
5	DX	0.0	0.0	0.221	-0.221
	DZ	-0.306	0.306	0.0	0.0
LEVEL	JOINT ID	25	27	26	28
4	DX	0.0	0.0	0.757	-0.757
	DZ	-1.000	1.000	0.0	0.0
LEVEL	JOINT ID	17	19	18	20
3	DX	0.0	0.0	-0.321	0.321
	DZ	0.406	-0.406	0.0	0.0
LEVEL	JOINT ID	9	11	10	12
2	DX	0.0	0.0	-0.016	0.016
	DZ	0.019	-0.019	0.0	0.0

Normalised mode shape for ovalising 3 ; f=57.99 Hz

Maximum displacement at level 4

Table 4.21

LEVEL	JOINT ID	45	47	46	48
7	DX	0.0	0.0	-0.063	0.063
	DZ	0.100	-0.100	0.0	0.0
LEVEL	JOINT ID	41	43	42	44
6	DX	0.0	0.0	-0.211	0.211
	DZ	0.313	-0.313	0.0	0.0
LEVEL	JOINT ID	33	35	34	36
5	DX	0.0	0.0	-0.718	0.718
	DZ	1.000	-1.000	0.0	0.0
LEVEL	JOINT ID	25	27	26	28
4	DX	0.0	0.0	0.186	-0.186
	DZ	-0.247	0.247	0.0	0.0
LEVEL	JOINT ID	17	19	18	20
3	DX	0.0	0.0	0.024	-0.024
	DZ	-0.030	0.030	0.0	0.0
LEVEL	JOINT ID	9	11	10	12
2	DX	0.0	0.0	0.004	-0.004
	DZ	-0.005	0.005	0.0	0.0

Normalised mode shape for ovalising 4 ; f=79.15 Hz

Maximum displacement at level 5

Table 4.22

LEVEL	JOINT ID	45	47	46	48
7	DX	0.0	0.0	0.118	-0.118
	DZ	-0.189	0.189	0.0	0.0
LEVEL	JOINT ID	41	43	42	44
6	DX	0.0	0.0	0.671	-0.671
	DZ	-1.000	1.000	0.0	0.0
LEVEL	JOINT ID	33	35	34	36
5	DX	0.0	0.0	-0.206	0.206
	DZ	0.288	-0.288	0.0	0.0
LEVEL	JOINT ID	25	27	26	28
4	DX	0.0	0.0	-0.018	0.018
	DZ	0.024	-0.024	0.0	0.0
LEVEL	JOINT ID	17	19	18	20
3	DX	0.0	0.0	-0.004	0.004
	DZ	0.005	-0.005	0.0	0.0
LEVEL	JOINT ID	9	11	10	12
2	DX	0.0	0.0	-0.001	0.001
	DZ	0.001	-0.001	0.0	0.0

Normalised mode shape for ovalising 5 ; f=101.75 Hz

Maximum displacement at level 6

Table 4.23

LEVEL	JOINT ID	45	47	46	48
7	DX	0.002	0.002	0.620	-0.616
	DZ	-1.000	1.000	0.0	0.0
LEVEL	JOINT ID	41	43	42	44
6	DX	0.002	0.002	-0.077	0.081
	DZ	0.120	-0.120	0.0	0.0
LEVEL	JOINT ID	33	35	34	36
5	DX	0.001	0.001	-0.014	0.015
	DZ	0.021	-0.021	0.0	0.0
LEVEL	JOINT ID	25	27	26	28
4	DX	-0.001	-0.001	-0.004	0.003
	DZ	0.005	-0.005	0.0	0.0
LEVEL	JOINT ID	17	19	18	20
3	DX	-0.002	-0.002	-0.003	-0.001
	DZ	0.001	-0.001	0.0	0.0
LEVEL	JOINT ID	9	11	10	12
2	DX	-0.002	-0.002	-0.002	-0.002
	DZ	0.0	0.0	0.0	0.0

Normalised mode shape for ovalising 6 ; f= 155.47 Hz

Maximum displacement at level 7

Table 4.24

LEVEL	JOINT ID	75	88	83	76	Mean displ.
	DX	-0.120	-0.111	-0.111	-0.120	-0.380
9	DZ	0.001	0.0	0.001	-0.001	
	DY	-	-	-	-	-
LEVEL	JOINT ID	53	97	96	54	
	DX	0.077	0.075	0.075	0.077	
	DZ	0.0	0.0	0.0	0.0	
	DY	1.000	-0.177	-0.177	1.000	
8	JOINT ID	68	71	72	67	
	DX	0.077	0.070	0.070	0.077	0.242
	DZ	-0.002	0.0	0.0	0.002	
	DY	0.508	0.100	0.100	0.508	1.000
LEVEL	JOINT ID	50	51	52	49	
	DX	-0.081	-0.083	-0.083	-0.081	-0.270
7	DZ	0.0	0.0	0.0	0.0	
	DY	0.427	0.121	0.121	0.427	0.901
LEVEL	JOINT ID	37	38	39	40	
	DX	0.002	0.001	0.001	0.002	0.005
6	DZ	-0.001	0.0	0.001	0.001	
	DY	0.381	0.113	0.113	0.381	0.813
LEVEL	JOINT ID	29	30	31	32	
	DX	0.100	0.099	0.099	0.100	0.327
5	DZ	0.0	0.0	0.0	0.0	
	DY	0.333	0.101	0.101	0.333	0.714
LEVEL	JOINT ID	21	22	23	24	
	DX	0.173	0.172	0.173	0.174	0.569
4	DZ	-0.001	0.0	0.001	0.001	
	DY	0.280	0.086	0.086	0.280	0.602
LEVEL	JOINT ID	13	14	15	16	
	DX	0.198	0.197	0.197	0.198	0.650
3	DZ	-0.001	0.0	0.0	0.0	
	DY	0.221	0.069	0.069	0.221	0.477
LEVEL	JOINT ID	5	6	7	8	
	DX	0.138	0.138	0.139	0.139	0.457
2	DZ	-0.006	0.006	-0.006	0.006	
	DY	0.157	0.049	0.049	0.157	0.339

Normalised mode shape for vertical mode ; f=84.18 Hz

Maximum displacement at joints 53Y & 54Y

Table 4.25

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	0.104	0.112	0.113	0.105	0.358
9	DZ	-0.001	-0.001	-0.003	0.0	
	DY	-	-	-	-	-
LEVEL	JOINT ID	53	97	96	54	
	DX	-0.076	-0.078	-0.078	-0.076	
	DZ	0.0	0.001	0.001	0.001	
	DY	-0.183	0.989	1.000	-0.179	
8	JOINT ID	68	71	72	67	
	DX	-0.072	-0.078	-0.078	-0.072	-0.247
	DZ	0.001	-0.001	0.003	0.0	
	DY	0.102	0.503	0.505	0.103	1.000
LEVEL	JOINT ID	50	51	52	49	
	DX	0.125	0.124	0.124	0.125	0.411
7	DZ	0.0	-0.001	0.0	0.0	
	DY	0.126	0.422	0.423	0.127	0.905
LEVEL	JOINT ID	37	38	39	40	
	DX	0.045	0.044	0.043	0.044	0.145
6	DZ	-0.001	-0.002	0.0	0.0	
	DY	0.117	0.379	0.380	0.118	0.819
LEVEL	JOINT ID	29	30	31	32	
	DX	-0.064	-0.065	-0.065	-0.064	-0.211
5	DZ	0.0	-0.001	0.0	0.0	
	DY	0.103	0.334	0.335	0.103	0.721
LEVEL	JOINT ID	21	22	23	24	
	DX	-0.148	-0.149	-0.150	-0.148	-0.491
4	DZ	0.0	-0.001	0.001	0.001	
	DY	0.086	0.283	0.283	0.087	0.609
LEVEL	JOINT ID	13	14	15	16	
	DX	-0.184	-0.185	-0.185	-0.184	-0.608
3	DZ	0.0	0.0	0.001	0.001	
	DY	0.069	0.224	0.225	0.069	0.484
LEVEL	JOINT ID	5	6	7	8	
	DX	-0.134	-0.134	-0.135	-0.134	-0.443
2	DZ	0.006	0.006	0.006	-0.005	
	DY	0.048	0.160	0.160	0.048	0.343

Normalised mode shape for deck pitch mode ; f=90.60 Hz

Maximum displacement at joint 96Y

Table 4.26

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	0.019	0.005	-0.006	-0.020	
9	DZ	-0.245	-0.206	-0.209	-0.245	-0.559
	DY	-	-	-	-	-
LEVEL	JOINT ID	53	97	96	54	
	DX	0.0	0.001	-0.001	0.0	
	DZ	0.219	0.205	0.205	0.219	
	DY	-0.998	-0.803	0.803	1.000	
8	JOINT ID	68	71	72	67	
	DX	-0.004	0.004	-0.004	0.005	
	DZ	0.200	0.191	0.191	0.200	0.483
	DY	-0.318	-0.294	0.289	0.317	-0.004
LEVEL	JOINT ID	50	51	52	49	
	DX	-0.001	0.003	-0.005	-0.001	
7	DZ	-0.406	-0.403	-0.403	-0.406	-1.000
	DY	-0.198	-0.183	0.179	0.197	-0.003
LEVEL	JOINT ID	37	38	39	40	
	DX	0.001	0.001	-0.002	-0.002	
6	DZ	-0.311	-0.310	-0.310	-0.311	-0.768
	DY	-0.174	-0.164	0.160	0.173	-0.003
LEVEL	JOINT ID	29	30	31	32	
	DX	0.002	0.003	-0.003	-0.002	
5	DZ	-0.034	-0.035	-0.035	-0.034	-0.085
	DY	-0.169	-0.162	0.159	0.168	-0.002
LEVEL	JOINT ID	21	22	23	24	
	DX	0.002	0.003	-0.002	-0.001	
4	DZ	0.206	0.201	0.201	0.206	0.503
	DY	-0.155	-0.150	0.147	0.154	-0.002
LEVEL	JOINT ID	13	14	15	16	
	DX	0.002	0.003	-0.001	0.0	
3	DZ	0.357	0.351	0.351	0.357	0.875
	DY	-0.132	-0.129	0.126	0.132	-0.002
LEVEL	JOINT ID	5	6	7	8	
	DX	-0.014	0.016	-0.015	0.016	
2	DZ	0.316	0.311	0.311	0.316	0.775
	DY	-0.102	-0.099	0.098	0.102	-0.001

Normalised mode shape for deck roll mode ; f=101.35 Hz

Maximum displacement at joint 54Y

Table 4.27

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	-0.118	-0.097	0.097	0.118	
9	DZ	0.187	-0.181	-0.182	0.187	0.019
	DY	-	-	-	-	-
LEVEL	JOINT ID	53	97	96	54	
	DX	-0.009	-0.012	0.012	0.010	-
	DZ	-0.074	0.090	0.090	-0.074	-
	DY	1.000	-0.768	0.770	-1.000	-
8	JOINT ID	68	71	72	67	
	DX	0.005	0.0	0.001	-0.005	
	DZ	-0.053	0.058	0.059	-0.053	0.019
	DY	0.156	-0.168	0.166	-0.156	-0.003
LEVEL	JOINT ID	50	51	52	49	
	DX	-0.016	-0.018	0.016	0.014	
7	DZ	-0.106	-0.190	-0.190	-0.106	-1.000
	DY	0.102	-0.099	0.097	-0.102	-0.003
LEVEL	JOINT ID	17	38	39	40	
	DX	-0.008	-0.007	0.006	0.006	
6	DZ	-0.100	-0.160	-0.160	-0.100	-0.878
	DY	0.066	-0.080	0.078	-0.067	-0.005
LEVEL	JOINT ID	29	30	31	32	
	DX	-0.018	-0.018	0.018	0.018	
5	DZ	-0.017	-0.036	-0.036	-0.017	-0.179
	DY	0.031	-0.071	0.069	-0.031	-0.003
LEVEL	JOINT ID	21	22	23	24	
	DX	-0.017	-0.017	0.018	0.018	
4	DZ	0.040	0.072	0.072	0.040	0.378
	DY	0.012	-0.064	0.062	-0.012	-0.003
LEVEL	JOINT ID	13	14	15	16	
	DX	-0.014	-0.013	0.015	0.015	
3	DZ	0.083	0.143	0.143	0.083	0.764
	DY	0.003	-0.054	0.053	-0.003	-0.002
LEVEL	JOINT ID	5	6	7	8	
	DX	-0.005	0.005	-0.003	0.006	
2	DZ	0.067	0.129	0.129	0.067	0.662
	DY	0.002	-0.043	0.042	-0.002	-0.002

Normalised mode shape for deck twist mode ; f=127.44 Hz

Maximum displacement at joints 53Y & 54Y

Table 4.28

LEVEL	JOINT ID	75	88	89	76	Mean displ.
	DX	-0.008	-0.061	-0.060	-0.007	-0.034
9	DZ	-0.001	-0.002	0.001	0.001	
	DY	-	-	-	-	-
LEVEL	JOINT ID			90		
8+	DY			1.000		1.000
LEVEL	JOINT ID	53	97	96	54	
	DX	-0.002	0.006	0.006	-0.002	
	DZ	0.0	0.001	-0.006	-0.000	
	DY	-0.293	-0.578	-0.571	-0.296	
8	JOINT ID	68	71	72	67	
	DX	-0.011	0.015	0.015	-0.011	0.002
	DZ	0.001	0.002	-0.002	-0.001	
	DY	-0.014	-0.065	-0.062	-0.014	-0.039
LEVEL	JOINT ID	50	51	52	49	
	DX	0.060	0.075	0.074	0.059	0.067
7	DZ	0.004	0.003	-0.003	-0.090	
	DY	-0.016	-0.060	-0.058	-0.015	-0.037
LEVEL	JOINT ID	37	38	39	40	
	DX	0.065	0.061	0.060	0.064	0.063
6	DZ	0.001	0.0	0.001	0.003	
	DY	-0.020	-0.048	-0.047	-0.019	-0.034
LEVEL	JOINT ID	29	30	31	32	
	DX	0.009	0.011	0.011	0.010	0.010
5	DZ	0.001	0.001	0.0	0.0	
	DY	-0.027	-0.036	-0.035	-0.027	-0.031
LEVEL	JOINT ID	21	22	23	24	
	DX	-0.030	-0.030	-0.029	-0.029	-0.030
4	DZ	-0.001	0.0	0.0	-0.001	
	DY	-0.028	-0.026	-0.025	-0.029	-0.027
LEVEL	JOINT ID	13	14	15	16	
	DX	-0.056	-0.056	-0.055	-0.055	-0.056
3	DZ	-0.001	0.0	0.0	-0.002	
	DY	-0.025	-0.019	-0.018	-0.026	-0.022
LEVEL	JOINT ID	5	6	7	8	
	DX	-0.040	-0.040	-0.039	-0.039	-0.040
2	DZ	0.001	-0.002	0.002	-0.003	
	DY	-0.018	-0.013	-0.013	-0.019	-0.016

Normalised mode shape for deck bending mode ; f=159.73 Hz

Maximum displacement at joint 90Y

Table 4.29

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.059	0.059	-0.058	-0.058		
9	DZ	0.892	0.687	0.687	0.892	0.949	- 5%
	DY	-	-	-	-	-	-
LEVEL	JOINT ID	68	71	72	67		
	DX	0.058	0.058	-0.057	-0.057		
8	DZ	0.879	0.673	0.673	0.879	0.932	-4.5%
	DY	0.005	0.008	-0.008	-0.005		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.036	0.037	-0.036	-0.036		
7	DZ	0.585	0.467	0.467	0.585	0.632	0%
	DY	0.030	0.030	-0.030	-0.031		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.035	0.035	-0.035	-0.035		
6	DZ	0.463	0.361	0.361	0.463	0.495	5.1%
	DY	0.036	0.037	-0.037	-0.037		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.036	0.036	-0.036	-0.036		
5	DZ	0.370	0.271	0.271	0.370	0.385	14%
	DY	0.037	0.040	-0.040	-0.037		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.036	0.036	-0.036	-0.036		
4	DZ	0.299	0.191	0.191	0.299	0.294	30%
	DY	0.033	0.041	-0.040	-0.033		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.029	0.029	-0.029	-0.029		
3	DZ	0.238	0.113	0.113	0.238	0.211	67%
	DY	0.025	0.039	-0.039	-0.025		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.009	0.013	-0.013	-0.009		
2	DZ	0.047	0.036	0.036	0.047	0.050	39%
	DY	0.030	0.033	-0.033	-0.030		

Normalised mode shape for sway Z,1 ; f= 14.67 Hz

Maximum displacement at joint 73Z & 74Z

MEMBER 84 REMOVED

Table 4.30

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.018	-0.019	0.019	0.018		
9	DZ	-0.198	-0.107	-0.107	-0.198	-0.419	126%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.020	-0.020	0.020	0.020		
8	DZ	-0.155	-0.089	-0.089	-0.155	-0.336	45%
	DY	-0.026	-0.010	0.010	0.025		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.103	0.103	-0.104	-0.104		
7	DZ	0.412	0.124	0.124	0.412	0.737	0%
	DY	-0.069	-0.040	0.039	0.068		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.148	0.148	-0.149	-0.149		
6	DZ	0.638	0.225	0.225	0.638	1.187	20%
	DY	-0.081	-0.046	0.046	0.081		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.184	0.184	-0.185	-0.185		
5	DZ	0.779	0.289	0.289	0.779	1.469	46.9%
	DY	-0.087	-0.044	0.044	0.086		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.197	0.197	-0.198	-0.198		
4	DZ	0.907	0.316	0.315	0.907	1.681	83%
	DY	-0.096	-0.034	0.034	0.095		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.162	0.162	-0.164	-0.163		
3	DZ	0.996	0.279	0.279	0.994	1.752	139%
	DY	-0.112	-0.017	0.017	0.111		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.054	0.069	-0.071	-0.055		
2	DZ	0.226	0.151	0.151	0.228	0.520	26%
	DY	-0.032	-0.002	0.002	0.032		

Normalised mode shape for sway Z,2 ; f=44.09 Hz

Maximum displacement at joint 20Z

MEMBER 84 REMOVED

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.031	-0.044	0.043	0.031		
9	DZ	-0.179	-0.324	-0.330	-0.179	-0.358	-6%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.002	0.010	-0.009	0.003		
8	DZ	0.025	0.056	0.057	0.025	0.058	41%
	DY	-0.084	-0.226	0.222	0.084		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.071	0.075	-0.082	-0.079		
7	DZ	0.865	0.548	0.548	0.865	1.000	0%
	DY	-0.095	-0.181	0.178	0.094		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.078	0.078	-0.084	-0.084		
6	DZ	0.824	0.520	0.520	0.824	0.951	2.9%
	DY	-0.034	-0.107	0.104	0.033		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.034	0.034	-0.035	-0.035		
5	DZ	0.260	0.105	0.105	0.260	0.258	28%
	DY	0.058	-0.011	0.007	-0.058		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.008	0.007	-0.004	-0.005		
4	DZ	-0.228	-0.220	-0.220	-0.228	-0.317	-13%
	DY	0.113	0.039	-0.042	-0.112		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.0	-0.001	0.007	0.006		
3	DZ	-0.620	-0.439	-0.439	-0.623	-0.751	-2.2%
	DY	0.139	0.053	-0.056	-0.139		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.030	0.0	0.005	-0.026		
2	DZ	-0.285	-0.348	-0.348	-0.286	-0.448	-32%
	DY	0.085	0.042	-0.044	-0.085		

Normalised mode shape for sway Z,3 ; f=133,40 Hz

Maximum displacement at joint 96Y

MEMBER 84 REMOVED

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.054	0.054	-0.053	-0.053		
9	DZ	0.901	0.715	0.715	0.901	0.957	-4.3%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.053	0.053	-0.052	-0.052		
8	DZ	0.887	0.699	0.699	0.887	0.939	-3.8%
	DY	0.005	0.010	-0.010	-0.005		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.033	0.033	-0.032	-0.032		
7	DZ	0.586	0.481	0.481	0.586	0.632	0%
	DY	0.031	0.033	-0.033	-0.032		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.031	0.031	-0.031	-0.031		
6	DZ	0.460	0.369	0.369	0.460	0.491	4.2%
	DY	0.038	0.040	-0.040	-0.038		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.030	0.031	-0.030	-0.030		
5	DZ	0.367	0.273	0.273	0.367	0.379	12%
	DY	0.038	0.044	-0.044	-0.038		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.024	0.024	-0.024	-0.024		
4	DZ	0.290	0.184	0.184	0.290	0.281	24%
	DY	0.033	0.045	-0.045	-0.033		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.011	0.011	-0.011	-0.011		
3	DZ	0.102	0.097	0.097	0.102	0.118	-6.3%
	DY	0.041	0.043	-0.043	-0.041		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.002	0.005	-0.005	-0.002		
2	DZ	0.028	0.026	0.026	0.027	0.032	-11%
	DY	0.033	0.036	-0.036	-0.033		

Normalised mode shape for sway Z,1 ; f= 14.74Hz

Maximum displacement at joint 73Z & 74Z

MEMBER 92 REMOVED

Table 4.33

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.006	-0.008	0.008	0.007		
9	DZ	-0.181	-0.117	-0.118	-0.181	-0.282	52%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.010	-0.010	-0.010	0.011		
8	DZ	-0.147	-0.117	-0.117	-0.147	-0.249	7.8%
	DY	-0.016	0.008	-0.008	0.015		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.109	0.109	-0.111	-0.111		
7	DZ	0.543	0.237	0.237	0.543	0.737	0%
	DY	-0.071	-0.034	0.034	0.070		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.149	0.149	-0.152	-0.151		
6	DZ	0.785	0.361	0.361	0.785	1.083	9.5%
	DY	-0.083	-0.038	0.038	0.082		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.170	0.170	-0.172	-0.172		
5	DZ	0.918	0.400	0.400	0.918	1.245	25%
	DY	-0.087	-0.028	0.028	0.086		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.142	0.142	-0.145	-0.145		
4	DZ	0.993	0.366	0.366	0.992	1.284	40%
	DY	-0.096	-0.007	0.007	0.095		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.066	0.066	-0.068	-0.068		
3	DZ	0.291	0.250	0.250	0.291	0.511	-30%
	DY	-0.016	0.011	-0.011	0.016		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.015	0.028	-0.029	-0.016		
2	DZ	0.154	0.128	0.128	0.153	0.266	-35%
	DY	-0.008	0.015	-0.016	0.008		

Normalised mode shape for sway Z,2 ; f=53.12 Hz

Maximum displacement at joint 28Z

MEMBER 92 REMOVED

Table 4.34

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.093	-0.083	0.084	0.093		
9	DZ	0.051	-0.276	-0.280	0.051	-0.501	31%
	DY	-	-				
LEVEL	JOINT ID	68	71	72	67		
	DX	0.007	0.008	-0.008	-0.006		
8	DZ	-0.028	0.066	0.066	-0.028	0.084	105%
	DY	0.066	-0.219	0.216	-0.066		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.030	-0.029	0.023	0.023		
7	DZ	0.239	0.214	0.214	0.239	1.000	0%
	DY	0.019	-0.151	0.149	-0.019		
LEVEL	JOINT ID	37	38	39	40		
	DX	-0.022	-0.022	0.017	0.017		
6	DZ	0.238	0.234	0.234	0.238	1.042	13%
	DY	0.013	-0.101	0.098	-0.013		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.031	-0.030	0.030	0.030		
5	DZ	0.105	0.093	0.093	0.105	0.437	117%
	DY	0.017	-0.044	0.042	-0.018		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.051	-0.052	0.054	0.054		
4	DZ	-0.019	-0.045	-0.045	-0.022	-0.245	-60%
	DY	0.013	-0.006	0.003	-0.013		
LEVEL	JOINT ID	13	14	15	16		
	DX	-0.085	-0.085	0.089	0.089		
3	DZ	-0.533	-0.195	-0.195	-0.533	-1.607	109%
	DY	0.054	0.016	-0.018	-0.054		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.034	-0.062	0.065	0.037		
2	DZ	-0.412	-0.179	-0.179	-0.412	-1.305	99%
	DY	0.045	0.016	-0.018	-0.044		

Normalised mode shape for sway Z,3 ; f=131.23Hz

Maximum displacement at joint 96Y

MEMBER 92 REMOVED

Figure 4,35

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.058	0.058	-0.056	-0.056		
9	DZ	0.896	0.701	0.701	0.896	0.946	-5.4%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.056	0.056	-0.054	-0.055		
8	DZ	0.885	0.686	0.686	0.885	0.931	-4.6%
	DY	0.003	0.010	-0.010	-0.003		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.038	0.038	-0.037	-0.037		
7	DZ	0.593	0.474	0.474	0.593	0.632	0%
	DY	0.028	0.032	-0.032	-0.028		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.036	0.036	-0.035	-0.035		
6	DZ	0.478	0.365	0.365	0.478	0.499	5.9%
	DY	0.033	0.040	-0.040	-0.033		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.028	0.028	-0.027	-0.027		
5	DZ	0.385	0.265	0.265	0.385	0.385	14%
	DY	0.032	0.045	-0.045	-0.032		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.014	0.014	-0.014	-0.014		
4	DZ	0.183	0.170	0.170	0.183	0.209	-7.5%
	DY	0.043	0.046	-0.046	-0.043		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.008	0.008	-0.007	-0.007		
3	DZ	0.102	0.091	0.091	0.102	0.114	-9.5%
	DY	0.039	0.042	-0.042	-0.039		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.002	0.004	-0.004	-0.002		
2	DZ	0.033	0.024	0.024	0.033	0.034	-5.6%
	DY	0.032	0.034	-0.034	-0.032		

Normalised mode shape for sway Z,1 ; f=14.65 Hz

Maximum displacement at joints 73Z & 74Z

MEMBER 100 REMOVED

Figure 4.36

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.003	0.002	0.004	0.002		
9	DZ	-0.119	-0.086	-0.087	-0.119	-0.225	22%
	DY	-	-				
LEVEL	JOINT ID	68	71	72	67		
	DX	0.0	0.0	0.006	0.006		
8	DZ	-0.101	-0.094	-0.094	-0.101	-0.213	-7.8%
	DY	-0.004	0.012	-0.015	0.006		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.056	0.056	-0.076	-0.076		
7	DZ	0.429	0.245	0.245	0.429	0.737	0%
	DY	-0.049	-0.023	0.023	0.049		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.072	0.072	-0.096	-0.096		
6	DZ	0.610	0.345	0.345	0.610	1.044	5.6%
	DY	-0.058	-0.024	0.024	0.058		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.061	0.060	-0.086	-0.084		
5	DZ	0.660	0.346	0.344	0.658	1.098	9.8%
	DY	-0.058	-0.012	0.012	0.058		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.029	0.026	-0.051	-0.048		
4	DZ	0.328	0.293	0.291	0.327	0.667	-27%
	DY	-0.015	0.001	-0.002	0.015		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.013	0.015	-0.029	-0.031		
3	DZ	0.260	0.225	0.226	0.261	0.531	-28%
	DY	-0.005	0.008	-0.009	0.006		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.002	0.011	-0.018	-0.005		
2	DZ	0.155	0.125	0.125	0.155	0.306	-26%
	DY	-0.002	0.010	-0.011	0.003		

Normalised mode shape for sway Z,2 ; f=58.88 Hz

Maximum displacement at joint 25Z

MEMBER 100 REMOVED

Table 4.37

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.063	-0.049	0.049	0.063		
9	DZ	0.205	0.028	0.029	0.205	0.292	-23%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.003	-0.009	0.009	0.003		
8	DZ	-0.045	0.015	0.015	-0.045	-0.038	-7.3%
	DY	0.169	-0.007	0.007	-0.170		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.022	-0.024	0.025	0.024		
7	DZ	-0.385	-0.415	-0.415	-0.385	-1.000	0%
	DY	0.165	0.022	-0.022	-0.166		
LEVEL	JOINT ID	37	38	39	40		
	DX	-0.002	-0.002	0.004	0.009		
6	DZ	-0.516	-0.460	-0.460	-0.516	-1.220	32%
	DY	0.159	-0.003	-0.003	-0.160		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.088	0.089	-0.088	-0.088		
5	DZ	-0.381	-0.230	-0.230	-0.378	-0.762	279%
	DY	0.149	-0.045	0.045	-0.149		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.234	0.234	-0.234	-0.234		
4	DZ	0.955	0.054	0.054	0.955	1.261	244%
	DY	0.006	-0.075	0.075	-0.008		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.253	0.253	-0.254	-0.253		
3	DZ	0.990	0.215	0.215	0.991	1.507	96%
	DY	0.0	-0.072	0.072	-0.001		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.130	0.169	-0.170	-0.130		
2	DZ	0.614	0.205	0.205	0.614	1.024	56%
	DY	0.005	-0.056	0.056	-0.007		

Normalised mode shape for sway Z,3 ; f=107.96Hz

Maximum displacement at joint 20Z

MEMBER 100 REMOVED

Table 4.38

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ%
	DX	0.057	0.057	-0.055	-0.055		
9	DZ	0.897	0.706	0.706	0.897	0.938	-6.2%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.056	0.055	-0.054	-0.054		
8	DZ	0.886	0.690	0.690	0.886	0.922	-5.5%
	DY	0.003	0.010	0.010	-0.010	-0.003	
LEVEL	JOINT ID	50	51	52	49		
	DX	0.038	0.038	-0.037	-0.037		
7	DZ	0.605	0.476	0.476	0.604	0.632	0%
	DY	0.027	0.032	-0.032	-0.027		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.031	0.031	-0.030	-0.030		
6	DZ	0.481	0.361	0.361	0.481	0.492	4.5%
	DY	0.032	0.041	-0.041	-0.032		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.014	0.014	-0.013	-0.013		
5	DZ	0.275	0.253	0.253	0.276	0.309	-8.9%
	DY	0.045	0.047	-0.046	-0.045		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.009	0.009	-0.008	-0.008		
4	DZ	0.183	0.165	0.165	0.182	0.203	-10%
	DY	0.045	0.046	-0.046	-0.045		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.006	0.006	-0.006	-0.006		
3	DZ	0.104	0.090	0.090	0.104	0.113	-10%
	DY	0.041	0.041	-0.041	-0.041		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.001	0.004	-0.004	-0.001		
2	DZ	0.032	0.024	0.024	0.032	0.033	-8.3%
	DY	0.033	0.034	-0.034	-0.033		

Normalised mode shape for sway Z,1 ; f=14.69Hz

Maximum displacement at joints 73Z & 74Z

MEMBER 104 REMOVED

Table 4.39

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ%
	DX	0.007	0.006	-0.006	-0.007		
9	DZ	-0.176	-0.172	-0.174	-0.176	-0.187	1%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.004	0.005	-0.005	-0.003		
8	DZ	-0.192	-0.206	-0.206	-0.192	-0.214	-7.3%
	DY	0.031	0.042	-0.043	-0.031		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.039	0.039	-0.041	-0.042		
7	DZ	0.750	0.622	0.622	0.750	0.737	0%
	DY	-0.056	-0.037	0.037	0.055		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.038	0.038	-0.041	-0.041		
6	DZ	1.000	0.835	0.835	1.000	0.986	-0.3%
	DY	-0.065	-0.041	0.041	0.064		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.014	0.014	-0.017	-0.017		
5	DZ	0.838	0.827	0.827	0.838	0.894	-11%
	DY	-0.028	-0.019	0.019	0.028		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.008	0.007	-0.010	-0.010		
4	DZ	0.769	0.757	0.757	0.768	0.819	-11%
	DY	-0.008	-0.001	0.001	0.008		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.005	0.005	-0.007	-0.007		
3	DZ	0.619	0.605	0.605	0.619	0.657	-10%
	DY	0.009	0.014	-0.014	-0.009		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.814	0.018	-0.019	0.013		
2	DZ	0.350	0.340	0.340	0.350	0.371	-10%
	DY	0.015	0.019	-0.019	-0.015		

Normalise mode shape for sway Z,2 ;f=62.40 Hz

Maximum displacement at joints 37Z & 40Z

MEMBER 104 REMOVED

Table 4.40

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ%
	DX	0.042	0.032	-0.034	-0.043		
9	DZ	-0.163	-0.006	-0.007	-0.163	-0.132	-65%
	DY	-	-	-	-		-
LEVEL	JOINT ID	68	71	72	67		
	DX	0.0	0.004	-0.003	-0.0		
8	DZ	-0.012	-0.051	-0.051	-0.012	-0.049	Node shift
	DY	-0.095	0.048	-0.048	0.098		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.132	0.133	-0.133	-0.133		
7	DZ	0.847	0.432	0.433	0.847	1.000	0%
	DY	-0.151	-0.005	0.005	0.157		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.073	0.075	-0.073	-0.075		
6	DZ	0.926	0.415	0.416	0.925	1.048	13%
	DY	-0.155	0.015	-0.015	0.156		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.114	-0.116	0.116	0.118		
5	DZ	-0.435	0.095	0.095	-0.435	-0.266	Node Shift
	DY	-0.003	0.062	-0.061	0.007		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.167	-0.167	0.171	0.171		
4	DZ	-0.617	-0.073	-0.073	-0.619	-0.540	48%
	DY	0.013	0.067	-0.066	-0.010		
LEVEL	JOINT ID	13	14	15	16		
	DX	-0.160	-0.160	0.164	0.164		
3	DZ	-0.612	-0.165	-0.165	-0.611	-0.607	-21%
	DY	0.013	0.058	-0.057	-0.010		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.079	-0.105	0.108	0.082		
2	DZ	-0.395	-0.151	-0.151	-0.395	-0.427	-35%
	DY	0.008	0.044	-0.043	-0.006		

Normalised mode shape for sway Z,3 ; f= 103.23Hz

Maximum displacement at joint 43Z

MEMBER 104 REMOVED

Table 4.41

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.098	0.098	-0.097	-0.095		
9	DZ	0.819	0.497	0.497	0.819	0.936	-6.4%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.094	0.094	-0.092	-0.092		
8	DZ	0.830	0.492	0.492	0.830	0.940	-3.7%
	DY	-0.015	0.002	-0.002	0.014		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.051	0.051	-0.050	-0.050		
7	DZ	0.549	0.340	0.340	0.549	0.632	0%
	DY	0.006	0.022	-0.022	-0.007		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.023	0.023	-0.023	-0.023		
6	DZ	0.289	0.243	0.243	0.289	0.378	-20%
	DY	0.029	0.031	-0.031	-0.029		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.013	0.013	-0.013	-0.013		
5	DZ	0.200	0.171	0.171	0.198	0.263	-22%
	DY	0.032	0.034	-0.034	-0.032		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.010	0.010	-0.009	-0.009		
4	DZ	0.136	0.112	0.112	0.136	0.176	-22%
	DY	0.032	0.033	-0.033	-0.032		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.007	0.007	-0.007	-0.007		
3	DZ	0.077	0.059	0.059	0.077	0.097	-23%
	DY	0.029	0.030	-0.030	-0.029		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.002	0.004	-0.004	-0.002		
2	DZ	0.025	0.015	0.015	0.025	0.028	-22%
	DY	0.024	0.024	-0.024	-0.024		

Normalised mode shape for sway Z,1 ; f=13.62Hz

Maximum displacement at joints 53Z & 54Z

MEMBER 102 REMOVED

Table 4.42

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.007	0.009	-0.010	-0.008		
9	DZ	-0.065	-0.156	-0.157	-0.065	-0.146	-21%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.016	0.016	-0.016	-0.016		
8	DZ	-0.192	-0.227	-0.227	-0.192	-0.276	19%
	DY	0.115	-0.070	0.069	-0.113		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.017	-0.017	0.019	0.019		
7	DZ	0.490	0.628	0.628	0.492	0.737	0%
	DY	0.047	-0.013	0.013	-0.045		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.023	0.023	-0.020	-0.020		
6	DZ	1.000	0.866	0.866	1.000	1.229	24%
	DY	0.003	-0.024	0.025	-0.002		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.031	0.031	-0.029	-0.029		
5	DZ	0.981	0.863	0.863	0.982	1.215	22%
	DY	0.014	-0.007	0.008	-0.014		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.030	0.030	-0.028	-0.028		
4	DZ	0.860	0.773	0.773	0.860	1.076	17%
	DY	0.029	0.012	-0.012	-0.029		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.024	0.024	-0.022	-0.023		
3	DZ	0.662	0.601	0.601	0.662	0.832	14%
	DY	0.040	0.027	-0.026	-0.040		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.002	0.030	-0.029	0.003		
2	DZ	0.356	0.328	0.328	0.356	0.450	9.2%
	DY	0.040	0.029	-0.029	-0.039		

Normalised mode shape for sway Z,2 ; f=60.44 Hz

Maximum displacement at joint 37Z & 40Z

MEMBER 102 REMOVED

Table 4.43

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ%
	DX	-0.068	-0.069	0.070	0.069		
9	DZ	-0.064	-0.309	-0.316	-0.064	-0.280	-27%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.002	0.008	-0.008	-0.001		
8	DZ	-0.019	0.043	0.044	-0.019	0.018	-56%
	DY	0.007	-0.210	0.206	-0.008		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.024	0.025	-0.037	-0.035		
7	DZ	0.794	0.548	0.548	0.795	1.000	0%
	DY	-0.053	-0.167	0.165	0.052		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.007	0.007	-0.016	-0.016		
6	DZ	0.552	0.496	0.496	0.552	0.781	-15%
	DY	0.0	-0.095	0.092	0.001		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.014	-0.014	0.013	0.013		
5	DZ	0.100	0.103	0.103	0.100	0.151	-25%
	DY	0.059	-0.009	0.006	-0.057		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.015	-0.016	0.022	0.021		
4	DZ	-0.235	-0.192	-0.192	-0.235	-0.318	-14%
	DY	0.085	0.034	-0.038	-0.083		
LEVEL	JOINT ID	13	14	15	16		
	DX	-0.013	-0.014	0.024	0.023		
3	DZ	-0.467	-0.401	-0.401	-0.467	-0.647	-16%
	DY	0.089	0.050	-0.053	-0.087		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.016	-0.021	0.027	-0.009		
2	DZ	-0.396	-0.339	-0.339	-0.396	-0.368	-44%
	DY	0.073	0.042	-0.045	-0.072		

Normalised mode shape for sway Z,3 ; f= 135.04 Hz

Maximum displacement at joint 96Y

MEMBER 102 REMOVED

Table 4.44

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.802	0.802	0.933	0.933	0.922	-7.6%
9	DZ	0.003	0.248	0.248	0.003		
	DY	-	-	-	-		
LEVEL	JOINT ID	69	71	72	67		
	DX	0.788	0.788	0.920	0.920	0.908	-7.3%
8	DZ	0.005	0.240	0.240	0.004		
	DY	-0.009	0.012	0.002	-0.005		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.484	0.484	0.575	0.575	0.563	0%
7	DZ	0.007	0.152	0.152	0.007		
	DY	-0.037	0.049	0.024	-0.036		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.369	0.368	0.471	0.470	0.446	4.9%
6	DZ	0.006	0.113	0.113	0.006		
	DY	-0.044	0.058	0.025	-0.040		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.255	0.255	0.263	0.263	0.275	-12%
5	DZ	0.019	0.067	0.066	0.019		
	DY	-0.049	0.064	0.037	-0.052		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.171	0.171	0.180	0.180	0.187	-13%
4	DZ	0.015	0.042	0.042	0.015		
	DY	-0.046	0.061	0.036	-0.051		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.096	0.096	0.106	0.106	0.107	-13%
3	DZ	0.008	0.023	0.023	0.008		
	DY	-0.041	0.054	0.033	-0.046		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.027	0.027	0.034	0.034	0.032	-14%
2	DZ	0.001	0.008	0.006	0.004		
	DY	-0.032	0.043	0.026	-0.037		

Normalised mode shape for sway X,1 ; f=15.95 Hz

Maximum displacement at joints 74X & 103X

MEMBER 135 REMOVED

Table 4.45

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.155	-0.155	-0.164	-0.164	-0.165	2.5%
9	DZ	0.0	-0.002	-0.002	0.0		
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.208	-0.208	-0.213	-0.214	-0.217	-3.1%
8	DZ	0.003	-0.006	-0.006	0.003		
	DY	-0.117	0.100	0.092	-0.110		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.809	0.809	0.845	0.845	0.853	0%
7	DZ	-0.021	0.028	0.028	-0.022		
	DY	-0.017	0.001	-0.006	-0.009		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.942	0.942	1.000	1.000	1.002	0.2%
6	DZ	-0.019	0.028	0.028	-0.019		
	DY	-0.013	-0.002	-0.013	-0.001		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.872	0.872	0.858	0.858	0.892	-5.6%
5	DZ	0.0	0.009	0.009	0.0		
	DY	-0.029	0.016	0.010	-0.022		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.755	0.755	0.746	0.746	0.794	-5.5%
4	DZ	0.005	0.004	0.004	0.005		
	DY	-0.041	0.030	0.025	-0.035		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.559	0.559	0.555	0.555	0.575	-5.1%
3	DZ	0.006	0.002	0.002	0.005		
	DY	-0.049	0.041	0.036	-0.045		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.265	0.265	0.264	0.264	0.273	-4.5%
2	DZ	-0.007	0.011	-0.011	0.015		
	DY	-0.047	0.041	0.038	-0.043		

Normalised mode shape for sway X,2 ; f=64.49 Hz

Maximum displacement at joints 39X & 40X

MEMBER 135 REMOVED

Table 4.46

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.009	-0.002	-0.163	-0.174	-0.111	- 31%
9	DZ	-0.095	0.134	0.136	-0.096		
	DY	-	-	-	-		
LEVEL	JOINT ID	69	71	72	67		
	DX	-0.022	-0.021	-0.050	-0.048	-0.048	336%
8	DZ	0.030	-0.051	-0.052	0.031		
	DY	-0.103	0.122	-0.161	0.101		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.543	0.543	0.937	0.938	1.000	0%
7	DZ	-0.258	0.354	0.353	-0.258		
	DY	-0.021	0.026	-0.181	0.138		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.418	0.417	0.995	0.992	0.953	18%
6	DZ	-0.192	0.270	0.270	-0.192		
	DY	-0.047	0.053	-0.178	0.137		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.040	-0.040	-0.431	-0.432	-0.319	Node shift
5	DZ	0.094	-0.079	-0.078	0.094		
	DY	-0.102	0.113	-0.044	0.004		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.230	-0.230	-0.627	-0.630	-0.580	28%
4	DZ	0.181	-0.217	-0.216	0.180		
	DY	-0.099	0.112	-0.024	-0.014		
LEVEL	JOINT ID	13	14	15	16		
	DX	-0.291	-0.291	-0.624	-0.624	-0.618	-21%
3	DZ	0.184	-0.254	-0.254	0.183		
	DY	-0.078	0.091	-0.020	-0.014		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.201	-0.204	-0.357	-0.360	-0.379	-34%
2	DZ	0.134	-0.197	-0.172	0.109		
	DY	-0.055	0.066	-0.022	-0.004		

Normalised mode shape for sway X,3 ; f= 113.83 Hz

Maximum displacement atjoint 43X

MEMBER 135 REMOVED

Table 4.47

	CHANGE / UNCHANGED	DECK MASS INCREASED BY 5%		DECK MASS INCREASED BY 100%	
MODE	FREQ. (Hz.)	FREQ. (Hz.)	CHANGE	FREQ. (Hz.)	CHANGE
Sway Z,1	15.07	14.83	-1.6%	11.32	-24.9%
Sway X,1	16.46	16.14	-1.9%	12.28	-25.4%
Torsion 1	19.45	18.90	-2.8%	15.72	-19.2%
Sway Z,2	62.59	62.46	N.C.	61.43	- 1.9%
Sway X,2	64.48	64.29	N.C.	62.46	- 3.1%
Torsion 2	81.44	81.42	N.C.	81.24	N.C.
Sway Z,3	136.0	136.0	N.C.	131.4	- 3.4%
Sway X,3	143.9	143.7	N.C.	142.5	- 1.0%
Torsion 3	169.1	169.1	N.C.	137.9	-18.5%

N.C. $<$1% Change

Natural frequencies of model platform for changes in deck mass

Table 4.48

	CHANGE / UNCHANGED	DECK MASS INCREASED BY 5%		DECK MASS INCREASED BY 100%	
MODE	FREQ. (Hz.)	FREQ. (Hz.)	CHANGE	FREQ. (Hz.)	CHANGE
Ovalising 1	39.60	39.60	N.C.	39.60	N.C.
Ovalising 2	46.39	46.39	N.C.	46.39	N.C.
Ovalising 3	57.99	57.99	N.C.	57.99	N.C.
Ovalising 4	79.15	79.15	N.C.	79.15	N.C.
Ovalising 5	101.8	101.8	N.C.	101.8	N.C.
Ovalising 6	155.5	155.5	N.C.	155.5	N.C.
Vertical	84.18	84.14	N.C.	69.02	-18%
Deck Pitch	90.66	86.96	-4.0%	76.92	-15.1%
Deck Roll	101.3	101.1	N.C.	85.15	-15.9%
Deck Twist	127.4	127.3	N.C.	108.5	-14.8%
Deck Bending	159.7	158.4	N.C.	158.9	N.C.

N.C. <1% Change

Natural frequencies of model platform for changes in deck mass

Table 4.49

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.017	0.017	-0.017	-0.017		
9	DZ	0.965	0.903	0.903	0.965	1.000	0%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.017	0.017	-0.017	-0.017		
8	DZ	0.943	0.882	0.882	0.943	0.977	0.1%
	DY	0.012	0.012	-0.012	-0.012		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.007	0.007	-0.007	-0.007		
7	DZ	0.602	0.578	0.578	0.602	0.632	0%
	DY	0.044	0.042	-0.042	-0.044		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.005	0.005	-0.005	-0.005		
6	DZ	0.447	0.432	0.432	0.447	0.471	0%
	DY	0.053	0.051	-0.051	-0.053		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.003	0.003	-0.003	-0.003		
5	DZ	0.322	0.311	0.311	0.322	0.339	0%
	DY	0.056	0.055	-0.055	-0.056		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.003	0.003	-0.003	-0.003		
4	DZ	0.215	0.207	0.207	0.215	0.226	0%
	DY	0.055	0.054	-0.054	-0.055		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.002	0.002	-0.002	-0.002		
3	DZ	0.120	0.114	0.114	0.120	0.125	-0.8%
	DY	0.050	0.049	-0.049	-0.050		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.0	0.003	-0.003	0.0		
2	DZ	0.035	0.033	0.033	0.035	0.036	0%
	DY	0.041	0.040	-0.040	-0.041		

Normalised mode shape for sway Z,1 ; f=14.83 Hz

Maximum displacement at joints 73Z & 74Z

DECK MASS INCREASED BY 12.8 kg (5%)

Table 4.50

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ%
	DX	0.999	0.999	0.999	0.999	1.003	0.3%
9	DZ	0.0	0.0	0.0	0.0		
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.979	0.979	0.979	0.979	0.982	0.3%
8	DZ	0.0	0.0	0.0	0.0		
	DY	-0.015	0.015	0.015	-0.015		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.561	0.561	0.561	0.561	0.563	0%
7	DZ	0.0	0.0	0.8	0.0		
	DY	-0.053	0.053	0.052	-0.053		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.424	0.424	0.424	0.424	0.426	0.2%
6	DZ	0.0	0.0	0.0	0.0		
	DY	-0.060	0.060	0.060	-0.060		
LEVEL	JOINT ID	27	30	31	32		
	DX	0.312	0.312	0.312	0.312	0.313	0%
5	DZ	0.0	0.0	0.0	0.0		
	DY	-0.062	0.062	0.062	-0.062		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.214	0.214	0.214	0.214	0.215	0.5%
4	DZ	0.0	0.0	0.0	0.0		
	DY	-0.059	0.059	0.059	-0.059		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.122	0.122	0.122	0.122	0.122	-0.8%
3	DZ	0.0	0.0	0.0	0.0		
	DY	-0.053	0.053	0.053	-0.053		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.037	0.037	0.037	0.037	0.037	0%
2	DZ	-0.002	0.002	-0.002	0.002		
	DY	-0.042	0.042	0.042	-0.042		

Normalised mode shape for sway X,1 ; f=16.14 Hz

Maximum displacement at joints 73X,74X,102X & 103X

DECK MASS INCREASED BY 12.8 kg (5%)

Table 4.51

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.019	0.019	-0.020	-0.019		
9	DZ	0.963	0.892	0.893	0.963	1.015	1.5%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.019	0.019	-0.019	-0.019		
8	DZ	0.940	0.871	0.871	0.940	0.991	1.5%
	DY	0.012	0.013	-0.013	-0.012		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.007	0.008	-0.008	-0.008		
7	DZ	0.591	0.564	0.564	0.591	0.632	0%
	DY	0.044	0.043	-0.043	-0.044		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.005	0.005	-0.005	-0.005		
6	DZ	0.435	0.419	0.419	0.435	0.467	-0.8%
	DY	0.053	0.052	-0.052	-0.053		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.004	0.004	-0.004	-0.004		
5	DZ	0.312	0.300	0.300	0.312	0.335	-1.2%
	DY	0.056	0.055	-0.055	-0.056		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.003	0.003	-0.003	-0.003		
4	DZ	0.206	0.198	0.198	0.206	0.221	-2.2%
	DY	0.055	0.054	-0.054	-0.055		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.002	0.002	-0.002	-0.002		
3	DZ	0.114	0.108	0.108	0.114	0.121	-4%
	DY	0.049	0.049	-0.049	-0.049		
LEVEL	JOINT ID	5	6	9	8		
	DX	0.0	0.003	-0.003	0.0		
2	DZ	0.032	0.029	0.029	0.032	0.033	-8.3%
	DY	0.040	0.039	-0.039	-0.040		

Normalised mode shape for sway Z,1 ; f=11.32 HZ

Maximum displacement at joints 73Z & 74Z

DECK MASS INCREASED BY 256 kg (100%)

Table 4.52

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	1.000	1.000	1.000	1.000	1.022	2.2%
9	DZ	0.0	0.0	0.0	0.0		
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.978	0.978	0.978	0.978	0.999	2%
8	DZ	0.0	0.0	0.0	0.0		
	DY	-0.014	0.014	0.014	-0.014		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.551	0.551	0.551	0.551	0.563	0%
7	DZ	0.0	0.0	0.0	0.0		
	DY	-0.053	0.053	0.053	-0.053		
LEVEL	JOINT ID	37	38	39	40		
	DY	0.412	0.412	0.412	0.412	0.421	-0.9%
6	DZ	0.0	0.0	0.0	0.0		
	DY	-0.060	0.060	0.060	-0.060		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.302	0.302	0.302	0.302	0.309	-1.3%
5	DZ	0.0	0.0	0.0	0.0		
	DY	-0.062	0.062	0.062	-0.062		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.205	0.205	0.205	0.205	0.209	-2.3%
4	DZ	0.0	0.0	0.0	0.0		
	DY	-0.059	0.059	0.059	-0.059		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.117	0.117	0.117	0.117	0.120	-2.4%
3	DZ	0.0	0.0	0.0	0.0		
	DY	-0.052	0.052	0.052	-0.052		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.034	0.034	0.034	0.034	0.935	-5.4%
2	DZ	-0.801	0.001	-0.001	0.001		
	DY	-0.042	0.042	0.042	-0.042		

Normalised mode shape for sway X,1 ; f=12.28 Hz

Maximum displacement at joints 73Z to 76Z,88Z,89Z,102Z & 103Z

DECK MASS INCREASED BY 256 kg (100%)

Table 4.53

LEVEL	JOINT ID	75	88	89	76	Rotation	Mean rotation	Δ
9	DX	-0.263	-0.263	0.263	0.263	1.000	1.013	1.3%
	DZ	-0.412	0.526	0.527	-0.412	0.991		
	DY	-	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67			
8	DX	-0.259	-0.259	0.259	0.259	0.985	0.998	1.2%
	DZ	-0.407	0.519	0.519	-0.407	0.978		
	DY	0.002	0.0	0.0	-0.002			
LEVEL	JOINT ID	50	51	52	49			
7	DX	-0.103	-0.103	0.103	0.103	0.299	0.324	0%
	DZ	-0.148	0.222	0.222	-0.148	0.338		
	DY	-0.007	0.013	-0.013	0.007			
LEVEL	JOINT ID	37	38	39	40			
6	DX	-0.073	-0.073	0.073	0.073	0.176	0.185	-1.6%
	DZ	-0.088	0.143	0.143	-0.088	0.189		
	DY	-0.007	0.014	-0.014	0.007			
LEVEL	JOINT ID	29	30	31	32			
5	DX	-0.053	-0.053	0.053	0.053	0.108	0.116	13%
	DZ	-0.062	0.102	0.102	-0.062	0.121		
	DY	-0.005	0.012	-0.012	0.005			
LEVEL	JOINT ID	21	22	23	24			
4	DX	-0.042	-0.042	0.042	0.042	0.073	0.078	-2.5%
	DZ	-0.047	0.073	0.073	-0.047	0.080		
	DY	-0.004	0.011	-0.011	0.004			
LEVEL	JOINT ID	13	14	15	16			
3	DX	-0.031	-0.031	0.031	0.031	0.047	0.050	0%
	DZ	-0.034	0.049	0.049	-0.034	0.050		
	DY	-0.003	0.009	-0.009	0.003			
LEVEL	JOINT ID	5	6	7	8			
2	DX	-0.017	-0.017	0.017	0.017	0.023	0.023	4.5%
	DZ	-0.018	0.022	0.022	-0.018	0.022		
	DY	-0.002	0.007	-0.007	0.002			

Normalised mode shape for torsion 1 ; f=15.72 Hz

Maximum displacement at joints 102Z & 103Z

DECK MASS INCREASED BY 256 kg (100%)

Table 4.54

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	0.003	0.002	-0.002	-0.003		
9	DZ	-0.073	-0.081	-0.082	-0.073	-0.074	-60%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	0.002	0.003	-0.003	-0.003		
8	DZ	-0.135	-0.143	-0.143	-0.135	-0.133	-42%
	DY	0.067	0.066	-0.066	-0.068		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.003	0.002	-0.001	-0.002		
7	DZ	0.772	0.764	0.764	0.772	0.737	0%
	DY	-0.021	-0.022	0.022	0.021		
LEVEL	JOINT ID	37	38	39	40		
	DX	0.003	0.003	-0.001	-0.001		
6	DZ	0.989	0.983	0.983	0.989	0.946	-4.3%
	DY	-0.027	-0.028	0.028	0.027		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.002	0.002	-0.001	-0.001		
5	DZ	0.976	0.971	0.971	0.976	0.934	-6.6%
	DY	-0.009	-0.009	0.009	0.009		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.002	0.002	-0.001	-0.001		
4	DZ	0.880	0.876	0.876	0.880	0.843	-8.3%
	DY	0.011	0.011	-0.010	-0.011		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.002	0.001	-0.001	-0.001		
3	DZ	0.691	0.688	0.688	0.691	0.662	-9.7%
	DY	0.026	0.026	-0.026	-0.026		
LEVEL	JOINT ID	5	6	7	8		
	DX	-0.017	0.018	-0.018	0.017		
2	DZ	0.381	0.379	0.379	0.381	0.365	-11%
	DY	0.030	0.029	-0.029	-0.030		

Normalised mode shape for sway Z,2 ; f=61.43 Hz

Maximum displacement at joints 33Z & 35Z

DECK MASS INCREASED BY 256 kg (100%)

Table 4.55

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.045	-0.046	-0.046	-0.046	-0.044	-73%
9	DZ	0.0	0.0	0.0	0.0		
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.155	-0.154	-0.154	-0.155	-0.147	-34%
8	DZ	0.0	0.0	0.0	0.0		
	DX	-0.217	0.137	0.137	-0.217		
LEVEL	JOINT ID	50	51	52	49		
	DX	0.894	0.895	0.895	0.894	0.853	0%
7	DZ	0.0	0.0	0.0	0.0		
	DY	-0.100	0.029	0.029	-0.100		
LEVEL	JOINT ID	37	38	39	40		
	DX	1.000	1.000	1.000	1.000	0.954	-4.6%
6	DZ	-0.001	-0.001	-0.001	-0.001		
	DY	-0.086	0.022	0.022	-0.086		
LEVEL	JOINT ID	29	30	31	32		
	DX	0.912	0.912	0.912	0.912	0.870	-7.9%
5	DZ	-0.001	-0.001	-0.001	-0.001		
	DY	-0.090	0.034	0.034	-0.090		
LEVEL	JOINT ID	21	22	23	24		
	DX	0.764	0.764	0.764	0.764	0.729	-11%
4	DZ	-0.001	-0.001	-0.001	-0.001		
	DY	-0.093	0.046	0.046	-0.093		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.545	0.546	0.546	0.545	0.521	-14%
3	DZ	0.0	-0.001	0.0	-0.001		
	DY	-0.091	0.054	0.054	-0.091		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.244	0.244	0.244	0.244	0.233	-19%
2	DZ	-0.011	0.010	-0.011	0.010		
	DY	-0.078	0.052	0.052	-0.078		

Normalised mode shape for sway X,2 ; f=62.46 Hz

Maximum displacement at joints 37X to 40X

DECK MASS INCREASED BY 256 kg (100%)

Table 4.56

LEVEL	JOINT ID	75	88	89	76	Rotation	Mean rotation	Δ %
	DX	0.045	0.044	-0.044	-0.045	-0.103		
9	DZ	0.036	-0.041	-0.042	0.036	-0.050	-0.093	-12%
	DY	-	-	-	-			
LEVEL	JOINT ID	68	71	72	67			
	DX	0.028	0.028	-0.028	-0.028	-0.065		
8	DZ	0.034	-0.037	-0.037	0.034	-0.046	-0.067	-22%
	DY	-0.016	0.011	-0.012	0.016			
LEVEL	JOINT ID	50	51	52	49			
	DX	-0.520	-0.520	0.520	0.520	0.920		
7	DZ	-0.805	0.800	0.800	-0.805	0.895	0.911	0%
	DY	0.012	-0.016	0.015	-0.012			
LEVEL	JOINT ID	37	38	39	40			
	DX	-0.666	-0.666	0.666	0.666	0.980		
6	DZ	-1.000	1.000	1.000	-1.000	1.000	0.994	-0.6%
	DY	0.010	-0.014	0.013	-0.010			
LEVEL	JOINT ID	29	30	31	32			
	DX	-0.685	-0.685	0.686	0.686	0.851		
5	DZ	-0.977	0.982	0.982	-0.977	0.881	0.869	-0.9%
	DY	-0.001	-0.002	0.001	0.001			
LEVEL	JOINT ID	21	22	23	24			
	DX	-0.657	-0.657	0.658	0.658	0.701		
4	DZ	-0.903	0.911	0.911	-0.903	0.736	0.721	-3%
	DY	-0.008	0.005	-0.006	0.008			
LEVEL	JOINT ID	13	14	15	16			
	DX	-0.543	-0.543	0.543	0.543	0.501		
3	DZ	-0.730	0.739	0.739	-0.730	0.539	0.522	-1.1%
	DY	-0.012	0.010	-0.010	0.012			
LEVEL	JOINT ID	5	6	7	8			
	DX	-0.281	-0.281	0.282	0.282	0.228		
2	DZ	-0.408	0.415	0.415	-0.408	0.274	0.252	-9.7%
	DY	-0.010	0.009	-0.009	0.011			

Normalised mode shape for torsion 2 ; f=81.24 Hz

Maximum displacement at joints 37Z to 40Z

DECK MASS INCREASED BY 256 kg (100%)

Table 4.57

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ %
	DX	-0.003	-0.014	0.014	0.004		
9	DZ	-0.139	-0.166	-0.172	-0.139	-0.162	-57%
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
	DX	-0.007	0.002	-0.003	0.007		
8	DZ	0.037	0.027	0.028	0.037	0.034	-17%
	DY	-0.052	-0.079	0.077	0.052		
LEVEL	JOINT ID	50	51	52	49		
	DX	-0.004	-0.002	-0.003	-0.001		
7	DZ	0.958	0.943	0.943	0.958	1.000	0%
	DY	-0.076	-0.094	0.092	0.076		
LEVEL	JOINT ID	37	38	39	40		
	DX	-0.002	-0.002	-0.001	-0.002		
6	DZ	0.851	0.844	0.844	0.851	0.892	-3.5%
	DY	-0.009	-0.023	0.021	0.009		
LEVEL	JOINT ID	29	30	31	32		
	DX	-0.002	-0.003	0.003	0.002		
5	DZ	0.175	0.176	0.176	0.175	0.185	-8.0%
	DY	0.091	0.081	-0.083	-0.091		
LEVEL	JOINT ID	21	22	23	24		
	DX	-0.001	-0.003	0.005	0.004		
4	DZ	-0.359	-0.351	-0.351	-0.359	-0.373	-1.9%
	DY	0.138	0.130	-0.131	-0.137		
LEVEL	JOINT ID	13	14	15	16		
	DX	0.0	-0.002	0.006	0.004		
3	DZ	-0.730	-0.720	-0.720	-0.730	-0.763	0.7%
	DY	0.145	0.139	-0.140	-0.144		
LEVEL	JOINT ID	5	6	7	8		
	DX	0.031	-0.030	0.033	-0.028		
2	DZ	-0.627	-0.618	-0.618	-0.627	-0.655	0%
	DY	0.118	0.113	-0.114	-0.118		

Normalised mode shape for sway Z,3 ; f=131.37Hz

Maximum displacement at joint 47Z

DECK MASS INCREASED BY 256 kg (100%)

Table 4.58

LEVEL	JOINT ID	75	88	89	76	Mean displ.	Δ%
9	DX	-0.124	-0.117	-0.118	-0.124	-0.126	-21%
	DZ	0.001	-0.001	0.002	-0.002		
	DY	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67		
8	DX	0.031	0.027	0.027	0.030	0.030	Node shift
	DZ	-0.002	0.002	-0.002	0.002		
	DY	-0.019	-0.002	0.0	-0.019		
LEVEL	JOINT ID	50	51	52	49		
7	DX	0.963	0.960	0.960	0.963	1.000	0%
	DZ	0.002	0.002	0.002	0.002		
	DY	0.012	-0.032	-0.031	0.013		
LEVEL	JOINT ID	37	38	39	40		
6	DX	0.762	0.763	0.763	0.762	0.793	-2.0%
	DZ	0.002	0.002	0.002	0.002		
	DY	-0.048	0.030	0.031	-0.048		
LEVEL	JOINT ID	29	30	31	32		
5	DX	0.079	0.079	0.079	0.079	0.082	-12%
	DZ	0.001	0.0	0.001	0.0		
	DY	-0.131	0.114	0.115	-0.131		
LEVEL	JOINT ID	21	22	23	24		
4	DX	-0.440	-0.440	-0.440	-0.440	-0.458	1.1%
	DZ	0.0	-0.002	0.001	-0.002		
	DY	-0.164	0.150	0.150	-0.164		
LEVEL	JOINT ID	13	14	15	16		
3	DX	-0.754	-0.754	-0.753	-0.754	-0.784	-0.3%
	DZ	-0.001	-0.002	-0.001	-0.003		
	DY	-0.156	0.145	0.145	-0.157		
LEVEL	JOINT ID	5	6	7	8		
2	DX	-0.551	-0.551	-0.551	-0.551	-0.573	-0.3%
	DZ	0.024	-0.026	0.024	-0.027		
	DY	-0.115	0.108	0.107	-0.116		

Normalised mode shape for sway X,3 ; f=142.48 Hz

Maximum displacement at joint 48X

DECK MASS INCREASED BY 256 kg (100%)

Table 4.59

(Table 4.18

LEVEL	JOINT ID	75	88	89	76	Rotation	Mean rotation	Δ%
	DX	0.525	0.517	-0.518	-0.524	-1.000		
9	DZ	-0.375	0.374	0.374	-0.375	0.399	-5.181	Large change
	DY	-	-	-	-	-		
LEVEL	JOINT ID	68	71	72	67			
	DX	0.479	0.479	-0.479	-0.480	-0.919		
8	DZ	-0.589	0.616	0.616	-0.584	0.642	-2.388	Large change
	DY	0.194	-0.209	0.209	-0.193			
LEVEL	JOINT ID	50	51	52	49			
	DX	-0.015	-0.014	0.011	0.011	0.019		
7	DZ	-0.088	0.123	0.123	-0.088	0.097	1.000	0%
	DY	0.059	-0.070	0.070	-0.059			
LEVEL	JOINT ID	37	38	39	40			
	DX	-0.023	-0.023	0.020	0.020	0.026		
6	DZ	0.006	0.022	0.022	0.006	0.007	0.284	-59.5%
	DY	0.034	-0.041	0.040	-0.034			
LEVEL	JOINT ID	29	30	31	32			
	DX	0.016	0.016	-0.016	-0.016	-0.016		Node
5	DZ	0.035	-0.032	-0.032	0.035	-0.025	-0.353	shift
	DY	0.024	-0.026	0.025	-0.024			
LEVEL	JOINT ID	21	22	23	24			
	DX	0.034	0.034	-0.033	-0.033	-0.030		
4	DZ	0.040	-0.054	-0.054	0.040	-0.032	-0.534	72.4%
	DY	0.018	-0.017	0.016	-0.018			
LEVEL	JOINT ID	13	14	15	16			
	DX	0.040	0.040	-0.037	-0.037	-0.029		
3	DZ	0.033	-0.058	-0.058	0.033	-0.028	-0.491	14.3%
	DY	0.014	-0.012	0.012	-0.014			
LEVEL	JOINT ID	5	6	7	8			
	DX	0.027	0.026	-0.024	-0.025	-0.017		
2	DZ	0.014	-0.034	-0.034	0.014	-0.013	-0.259	0.8%
	DY	0.011	-0.009	0.009	-0.011			

Normalised mode shape ; f= 137.78Hz

Maximum displacement at joint 73X

DECK MASS INCREASED BY 256 kg (100%)

Table 4.60

	CHANGED / UNCHANGED	RIGID SUPPORTS		VERT. SUPPORT STIFFNESS REDUCED BY 10%	
MODE	FREQ. (Hz.)	FREQ. (Hz.)	CHANGE	FREQ. (Hz.)	CHANGE
Sway Z,1	15.07	17.38	15.3%	14.86	-1.4%
Sway X,1	16.46	18.48	12.3%	16.27	-1.2%
Torsion 1	19.45	19.67	1.1%	19.44	N.C.
Sway Z,2	62.59	69.25	10.6%	62.41	N.C.
Sway X,2	64.48	68.24	5.8%	64.22	N.C.
Torsion 2	81.44	82.86	1.7%	81.43	N.C.
Sway Z,3	136.0	142.1	4.5%	136.0	N.C.
Sway X,3	143.9	146.6	1.9%	143.8	N.C.
Torsion 3	169.1	170.8	1%	169.1	N.C.

N.C. < 1% Change

Natural frequencies of model platform with support changes

Table 4.61

	CHANGED / UNCHANGED	RIGID SUPPORTS		VERT. SUPPORT STIFFNESS REDUCED BY 10%	
MODE	FREQ. (Hz.)	FREQ. (Hz.)	CHANGE	FREQ. (Hz.)	CHANGE
Ovalising 1	39.60	39.60	N.C.	39.60	N.C.
Ovalising 2	46.39	46.39	N.C.	46.39	N.C.
Ovalising 3	57.99	57.99	N.C.	57.99	N.C.
Ovalising 4	79.15	79.15	N.C.	79.15	N.C.
Ovalising 5	101.8	101.8	N.C.	101.8	N.C.
Ovalising 6	155.5	155.5	N.C.	155.5	N.C.
Vertical	84.18	103.3	22.7%	83.40	N.C.
Deck Pitch	90.66	89.52	-1.3%	89.80	N.C.
Deck Roll	101.3	106.1	4.7%	101.1	N.C.
Deck	127.4	128.4	N.C.	127.4	N.C.
Deck Bending	159.7	159.9	N.C.	159.7	N.C.

N.C. $<$ 1% Change

Natural frequencies of model platform with support changes

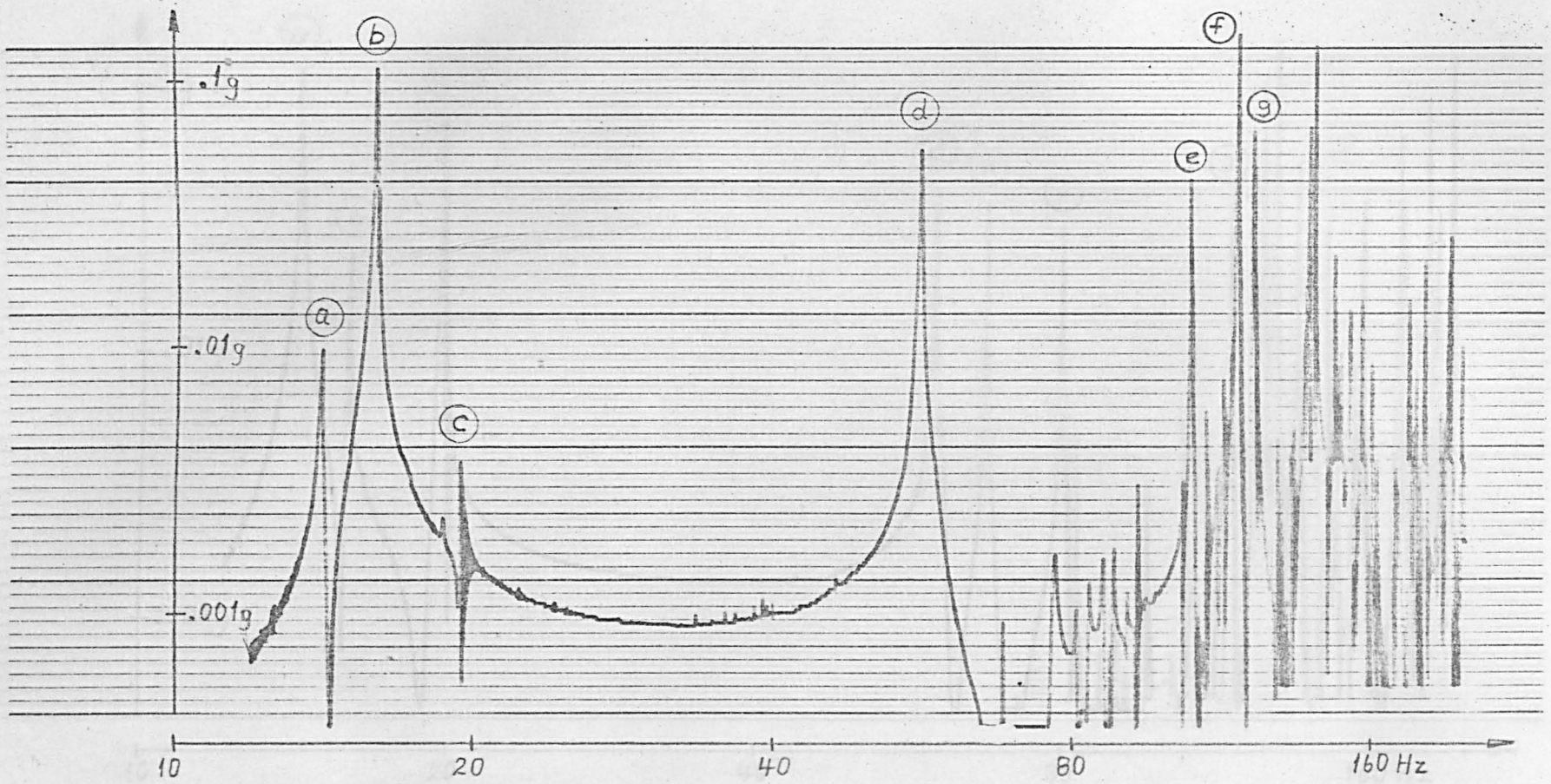
Table 4.62

CHAPTER 5

EXPERIMENTS ON MODEL PLATFORM

Model Platform

Figure 5.1

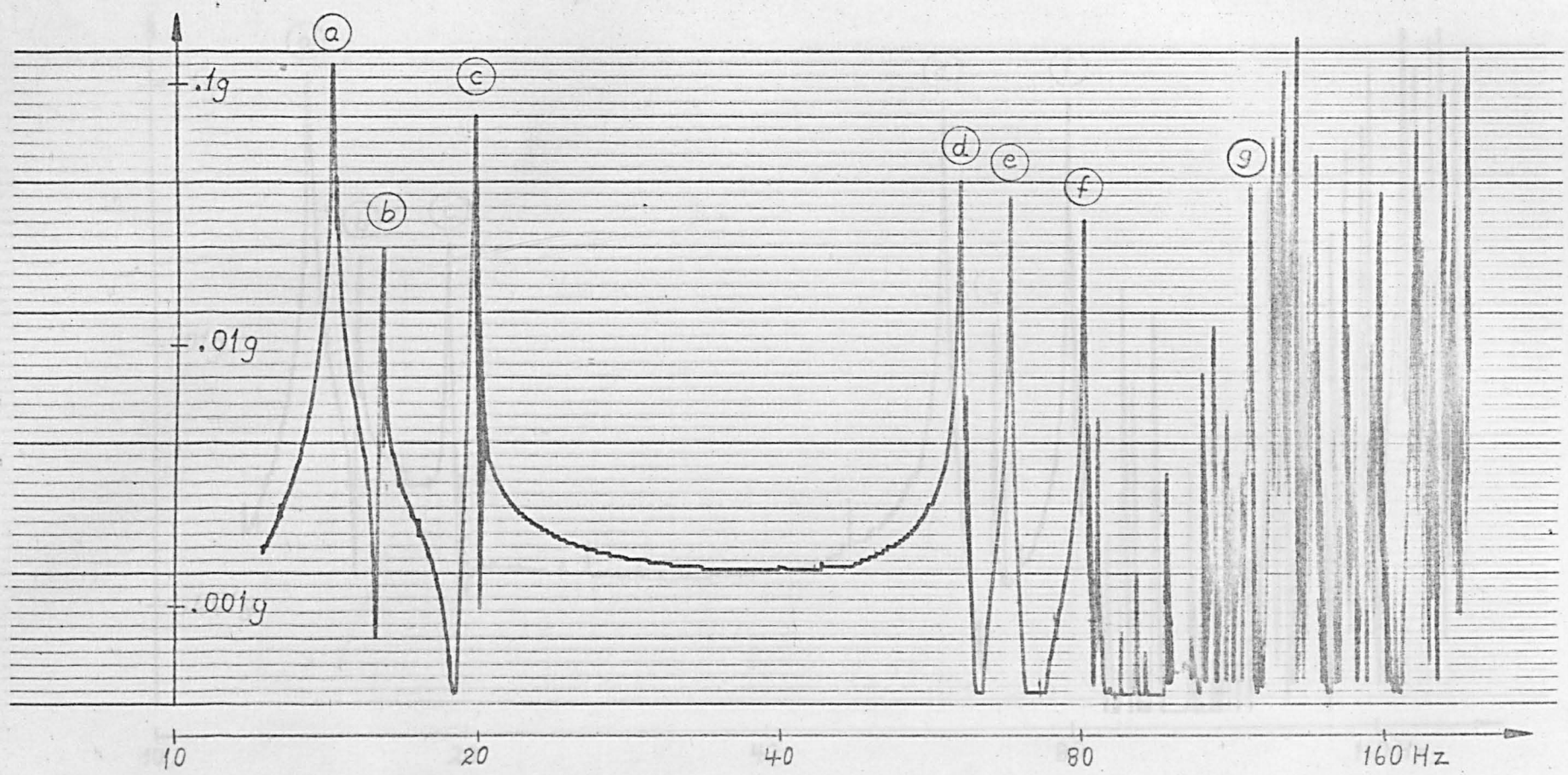


ⓐ 14.2Hz Sway Z,1 ; ⓑ 16.Hz Sway X,1 ; ⓒ 19.5Hz Torsion 1 ; ⓓ 56.4Hz Sway X,2 ; ⓔ 105.4Hz Deck Pitch

ⓕ 118.4Hz Sway X,3 ; ⓖ 122.4Hz

Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

Figure 5.2

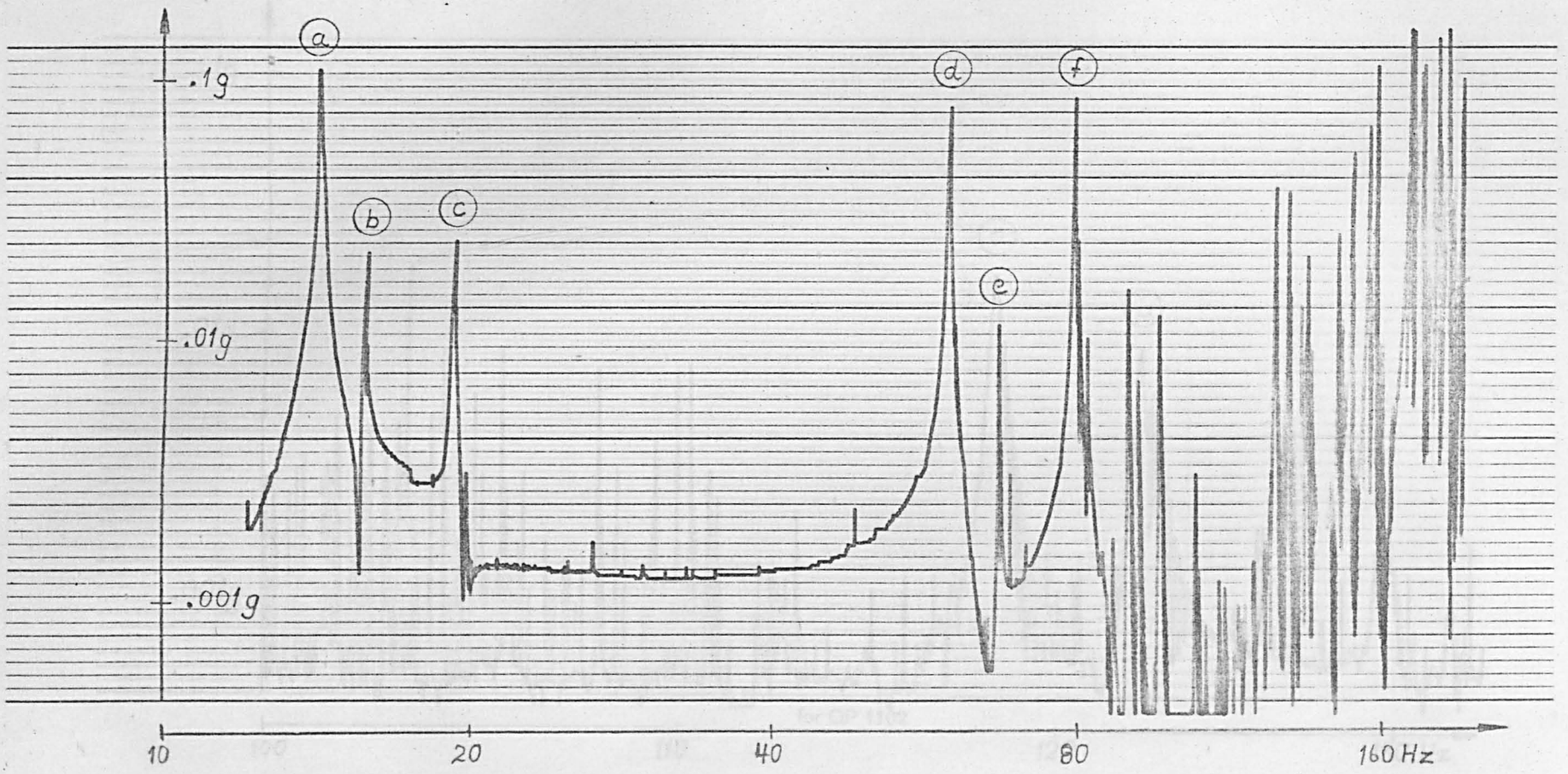


ⓐ 14.2Hz Sway Z,1 ; ⓑ 16.Hz Sway X,1 ; ⓒ 19.5 Torsion 1 ; ⓓ 60.3Hz Sway Z,2 ; ⓔ 67.8Hz Torsion 2

ⓕ 80.3Hz Deck Roll ; ⓖ 119.4 Sway Z,3

Acceleration frequency response at joint 49Z. Input force 2.6 Newtons at joint 82Z.

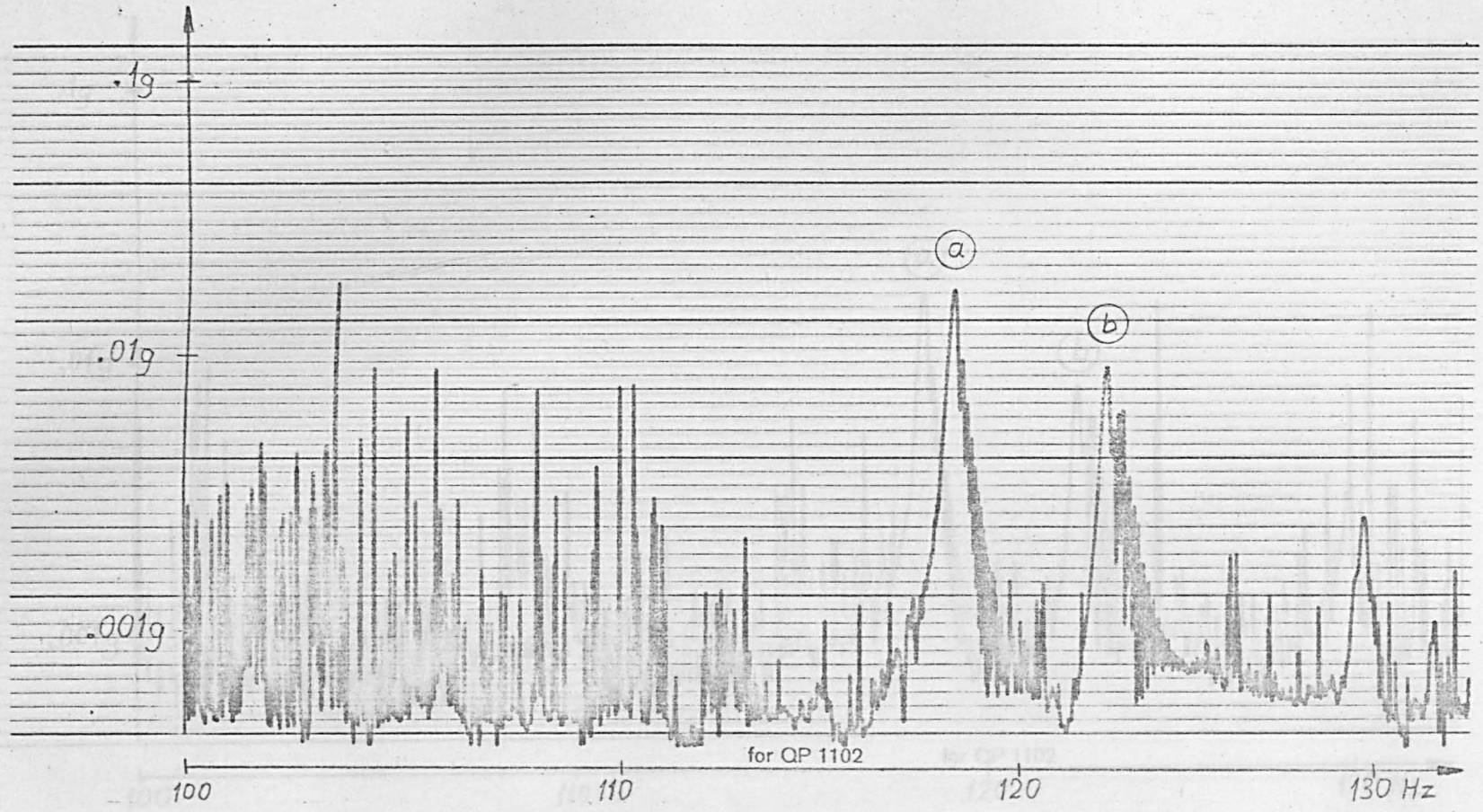
Figure 5.3



(a) 14.2Hz Sway Z,1 ; (b) 16.Hz Sway X,1 ; (c) 19.5Hz Torsion 1 ; (d) 60.3Hz Sway Z,2 ; (e) 67.8Hz Torsion 2 ; (f) 80.3 Deck Roll

Acceleration frequency response at joint 49Z . Input force 4.3 Newtons at joint 90Z .

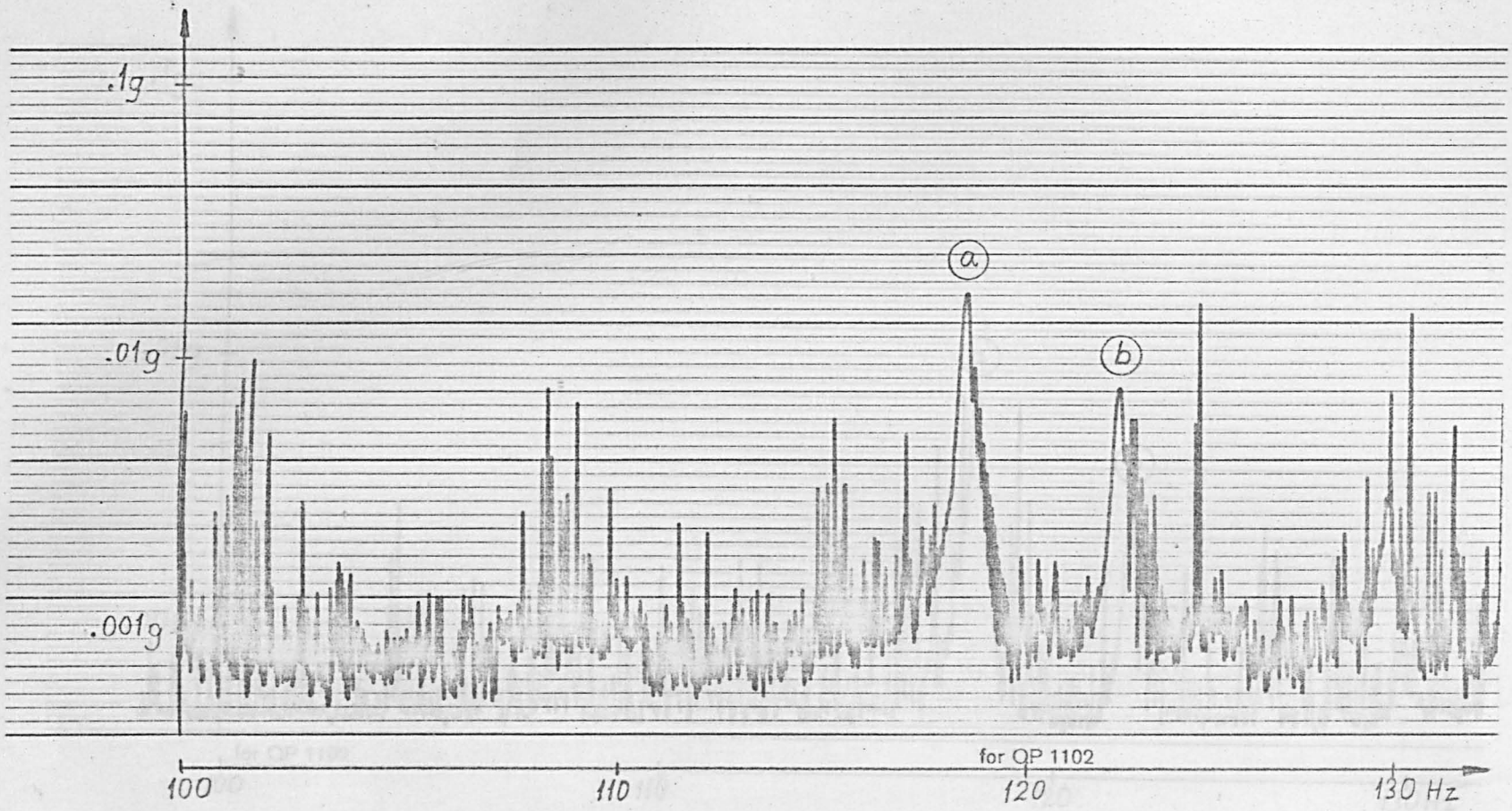
Figure 5.4



(a) 118.4Hz Sway X,3 ; (b) 122.4Hz

Acceleration frequency response at joint 49X (Level 7). Input force 4.3Newtons at joint 90X .

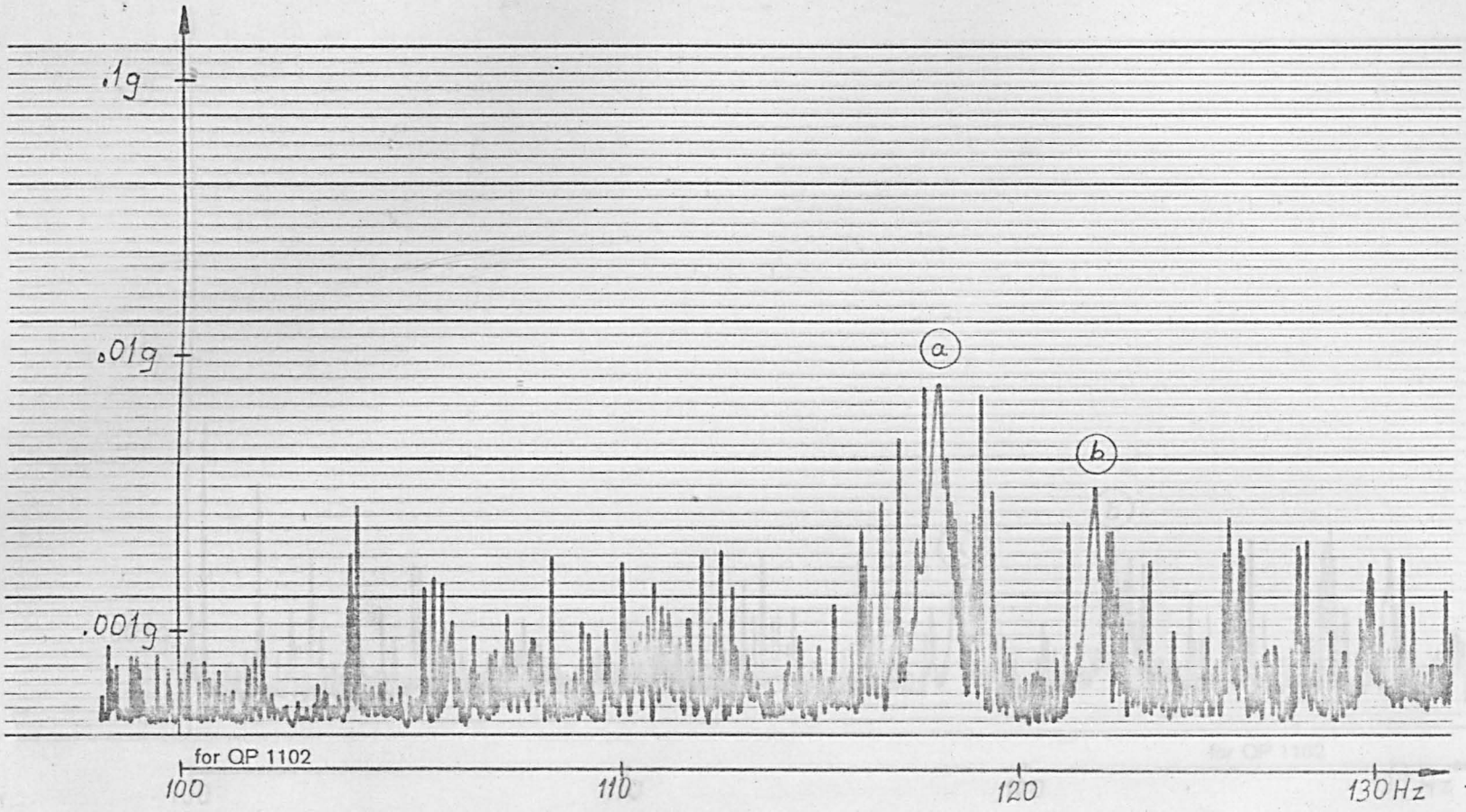
Figure 5.5



ⓐ 118.4Hz Sway X,3 ; ⓑ 122.4Hz

Acceleration frequency response at joint 40X (Level 6). Input force 4.3 Newtons at joint 90X .

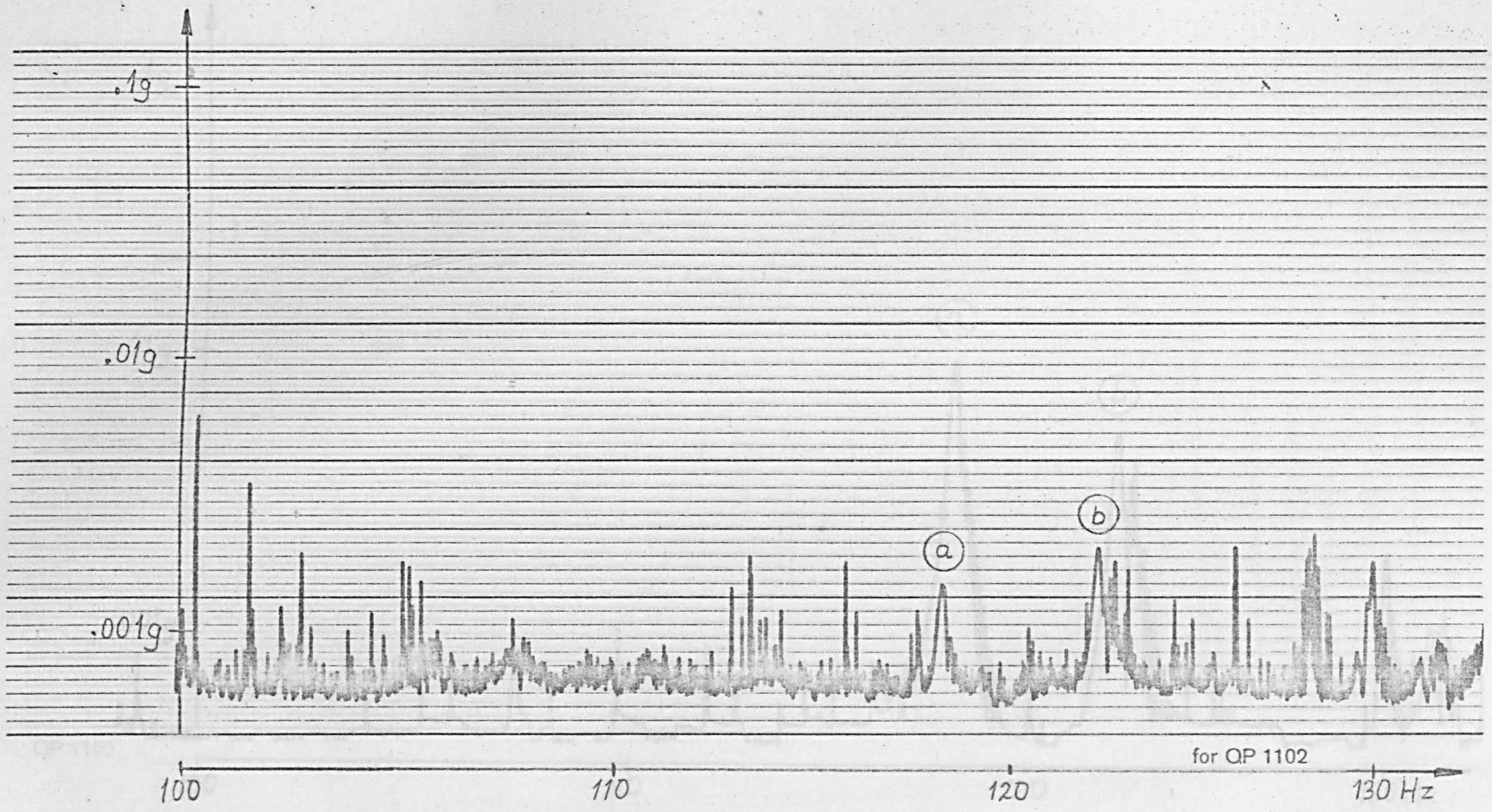
Figure 5.6



ⓐ 118.4Hz Sway X,3 ; ⓑ 122.4Hz

Acceleration frequency response at joint 32X (Level 5). Input force 4.3 Newtons at joint 90X .

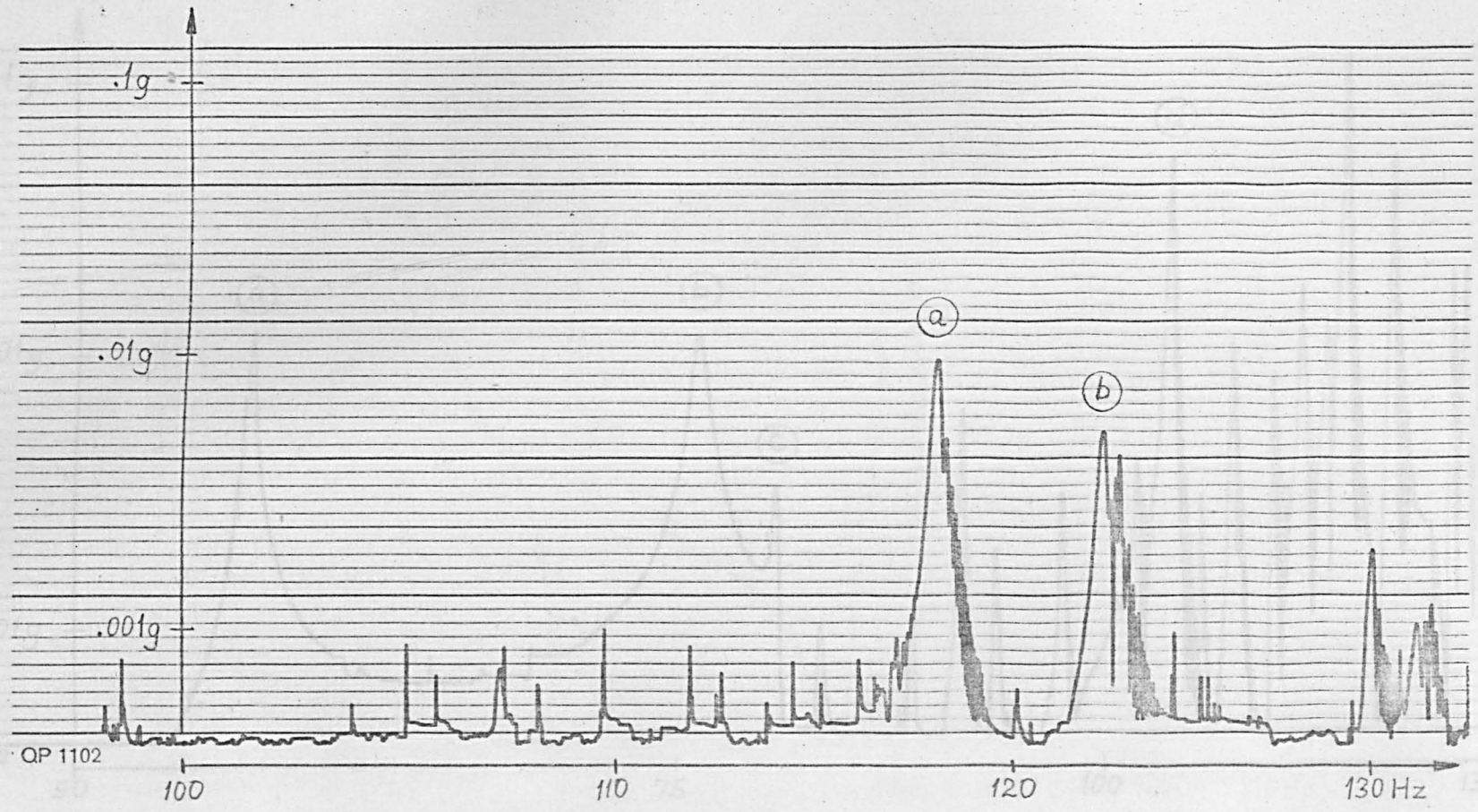
Figure 5.7



ⓐ 118.4Hz Sway X,3 ; ⓑ 122.4Hz

Acceleration frequency response at joint 24X (Level 4). Input force 4.3 Newtons at joint 90X .

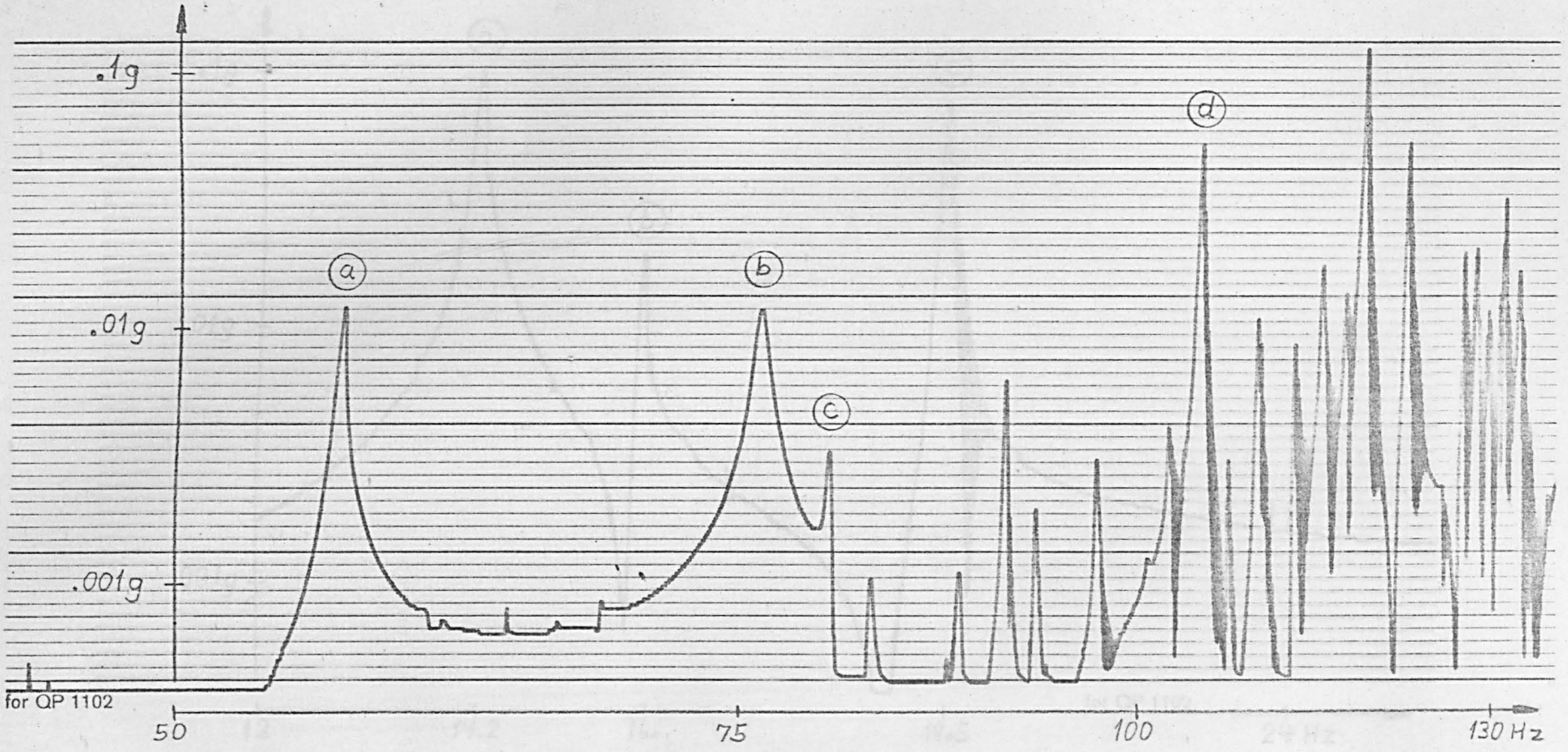
Figure 5.8



ⓐ 118.4Hz Sway X,3 ; ⓑ 122.4Hz

Acceleration frequency response at joint 16X (Level 3). Input force 4.3 Newtons at joint 90X .

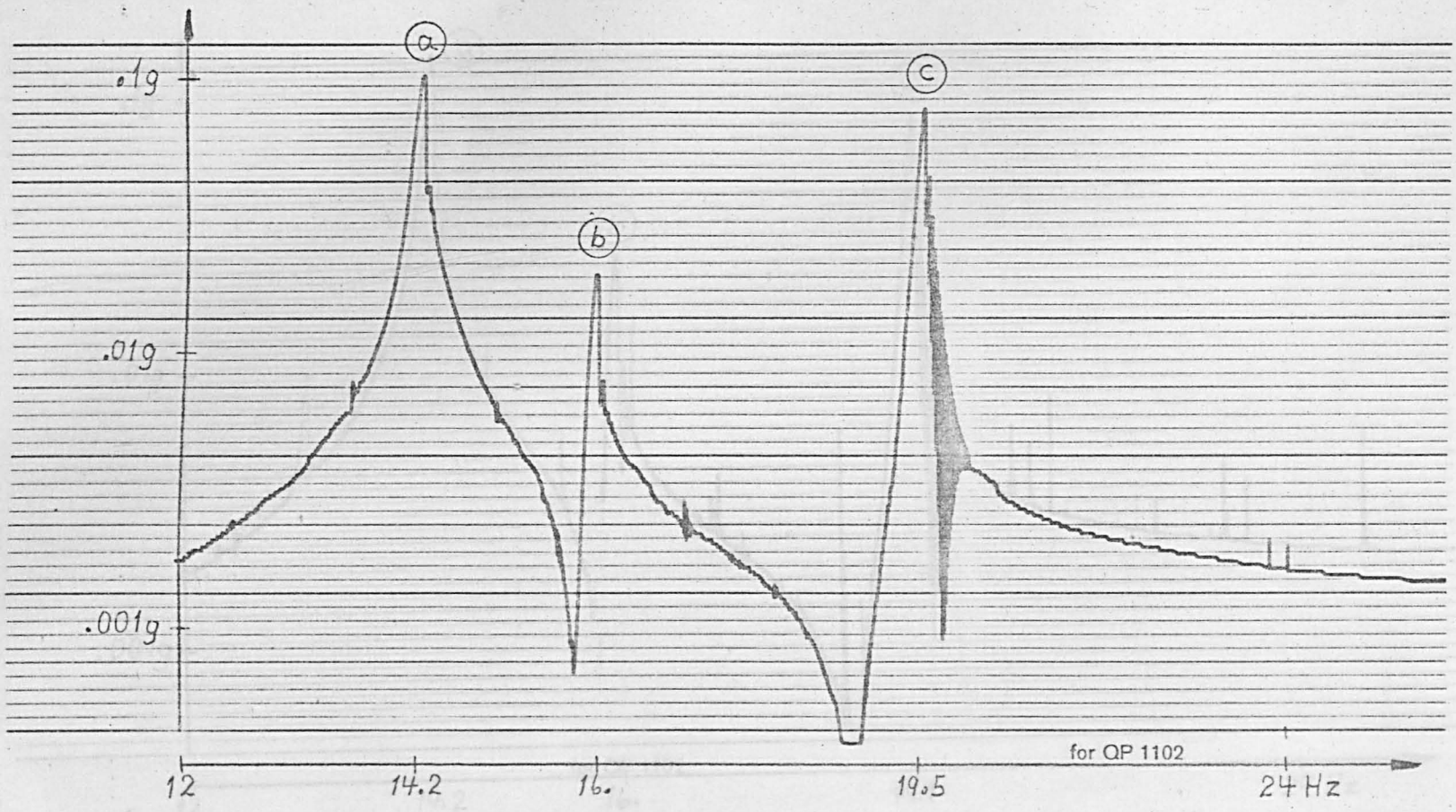
Figure 5.9



(a) 56.4Hz Sway X,2 ; (b) 75.7Hz Vertical ; (c) 80.3Hz Deck Roll ; (d) 105.4Hz Deck Pitch

Acceleration frequency response at joint 53Y . Input force 2.6Newtons at joint 82X .

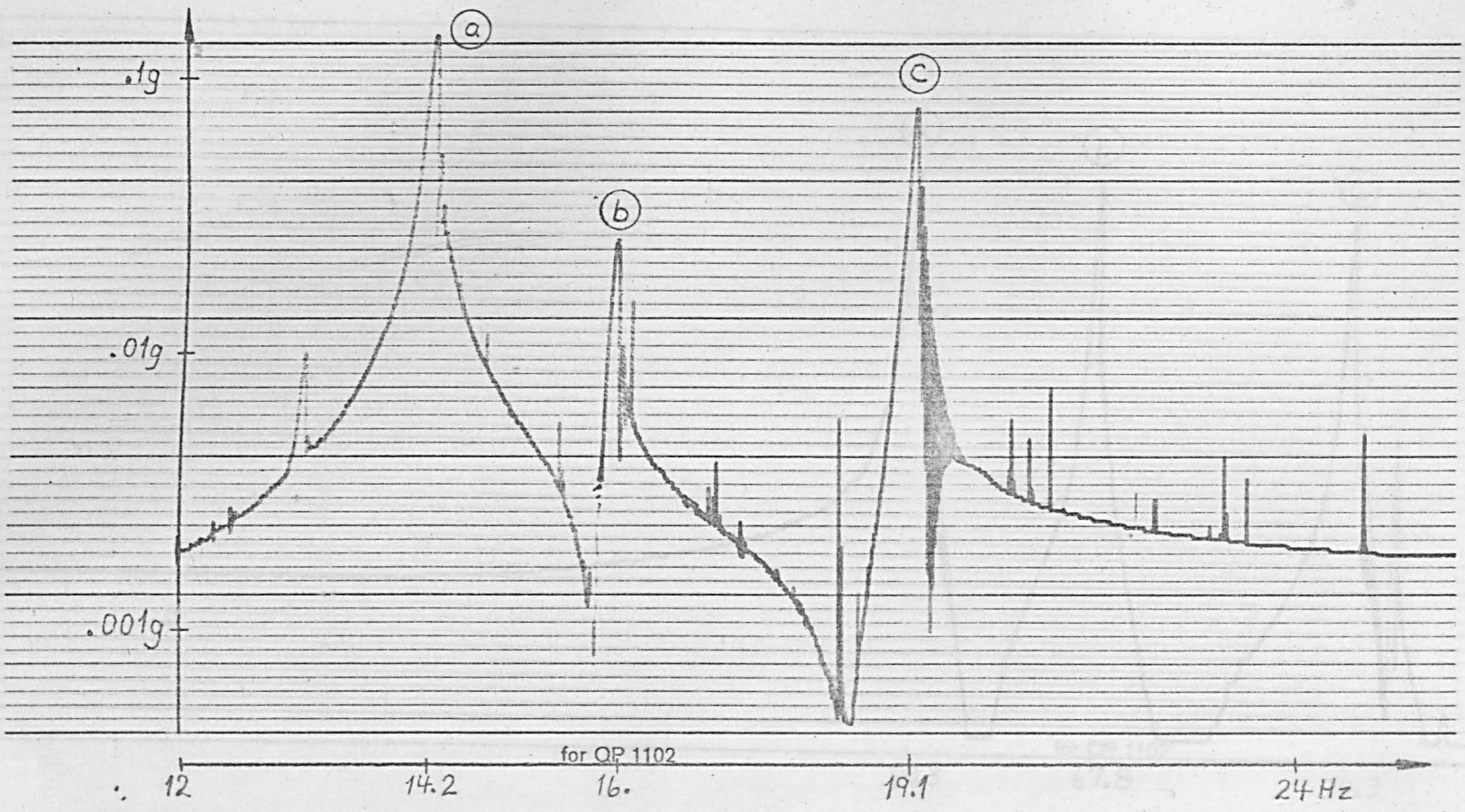
Figure 5.10



ⓐ 14.2 Hz Sway Z,1 ; ⓑ 16.Hz Sway X,1 ; ⓒ 19.5Hz Torsion 1

Acceleration frequency response at joint 49Z . Input force 2.6 Newtons at joint 82Z .

Figure 5.11

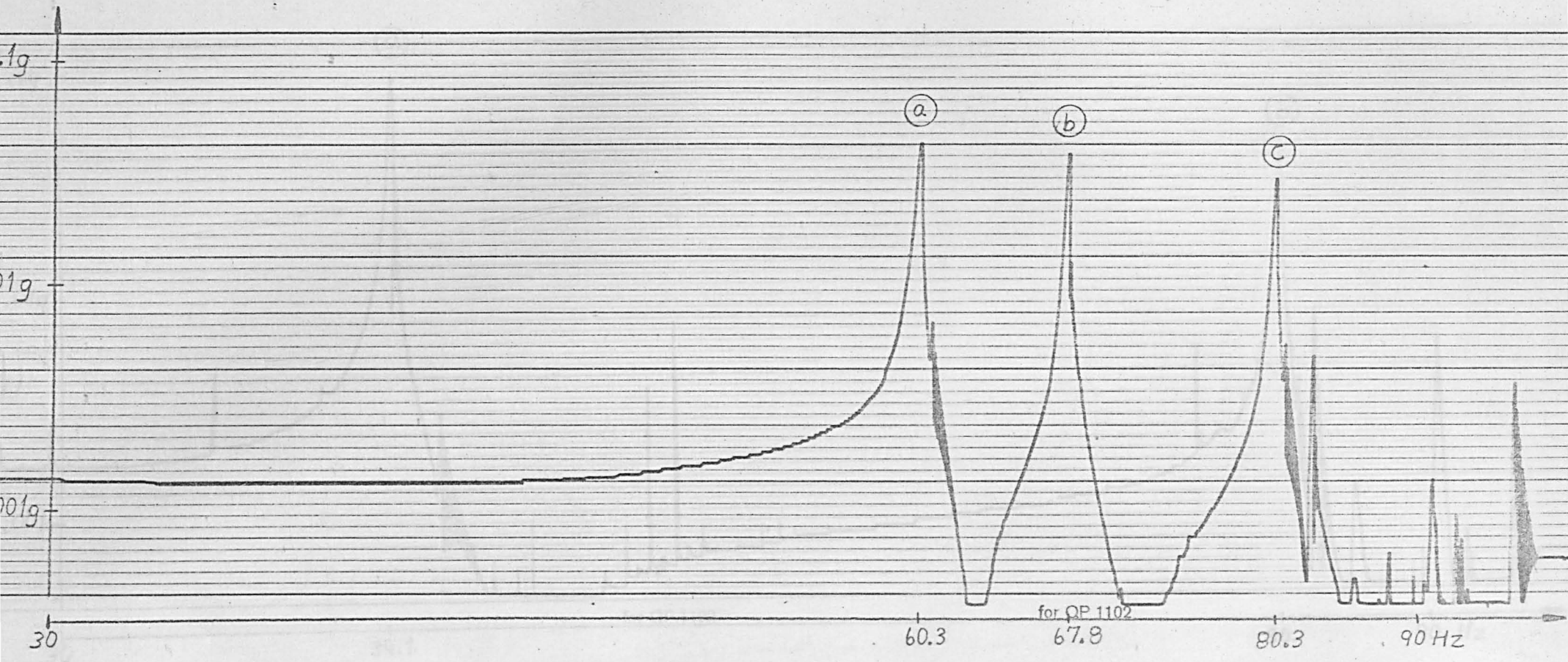


ⓐ 14.2Hz Sway Z,1 ; ⓑ 16.Hz Sway X,1 ; ⓒ 19.1Hz Torsion

Acceleration frequency response at joint 49Z . Input force 2.6 Newtons at joint 82Z .

MEMBER 84 REMOVED

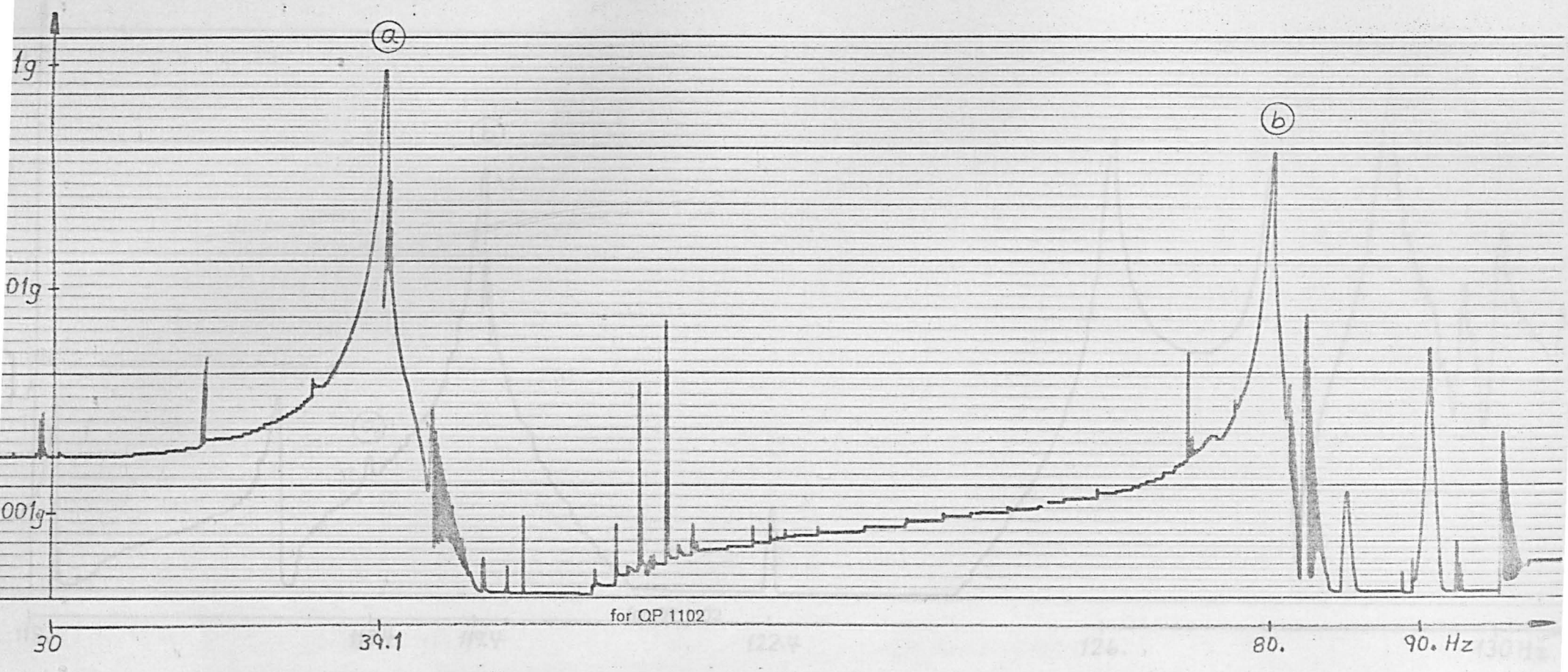
Figure 5.12



ⓐ 60.3Hz Sway Z,2 ; ⓑ 67.8Hz Torsion 2 ; ⓒ 80.3Hz Deck Roll

Acceleration frequency response at joint 49Z. Input force 2.6 Newtons at joint 82Z .

Figure 5.13

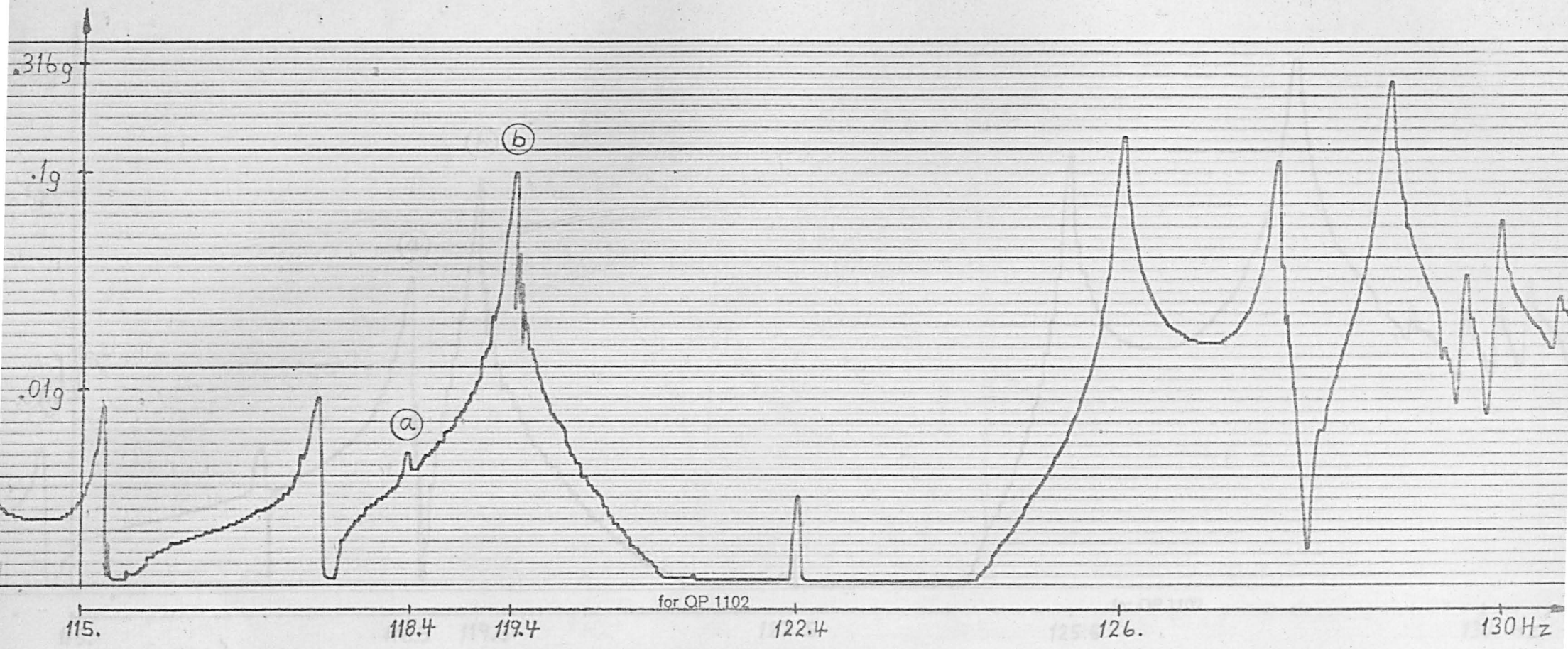


ⓐ 39.1Hz Sway Z,2 ; ⓑ 80.Hz Deck Roll

Acceleration frequency response at joint 49Z. Input force 2.6 Newtons at joint 82Z .

MEMBER 84 REMOVED

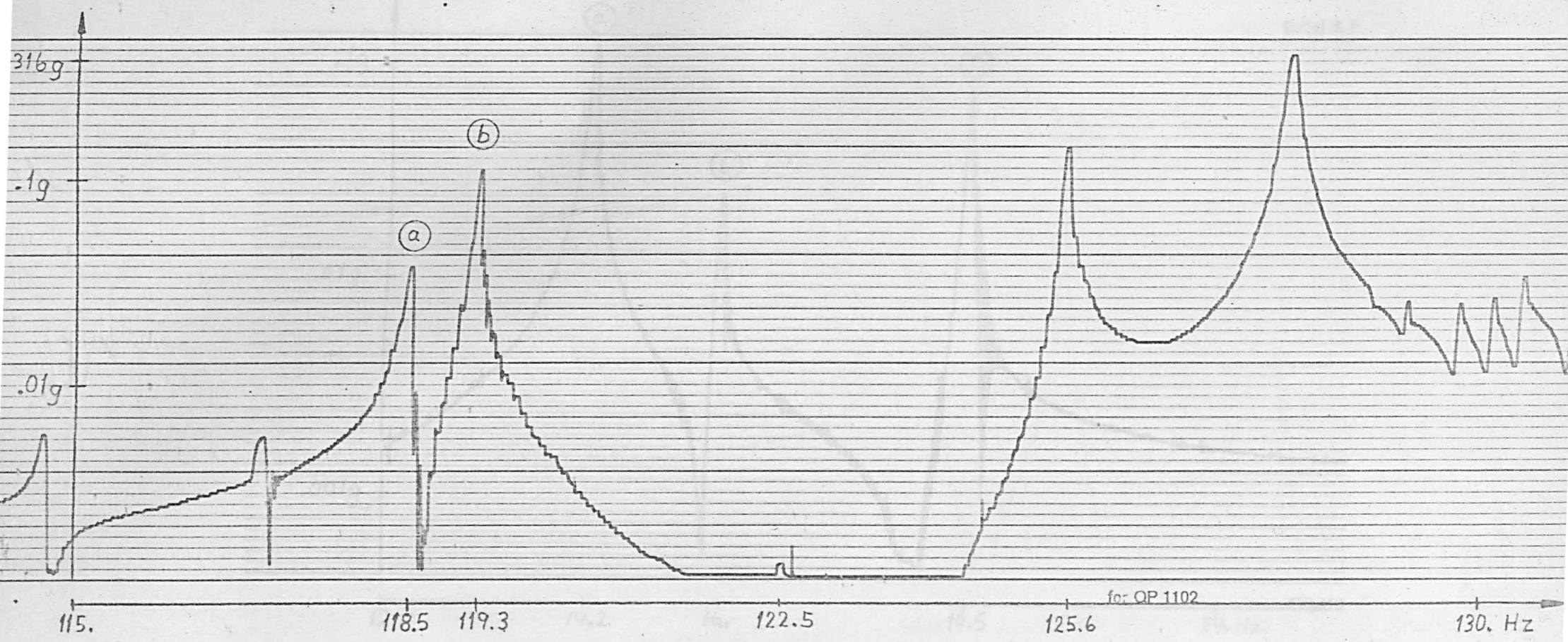
Figure 5.14



ⓐ 118.4Hz Sway X,3 ; ⓑ 119.4Hz Sway Z,3

Acceleration frequency response at joint 49Z. Input force 47. Newtons at joint 82Z .

Figure 5.15

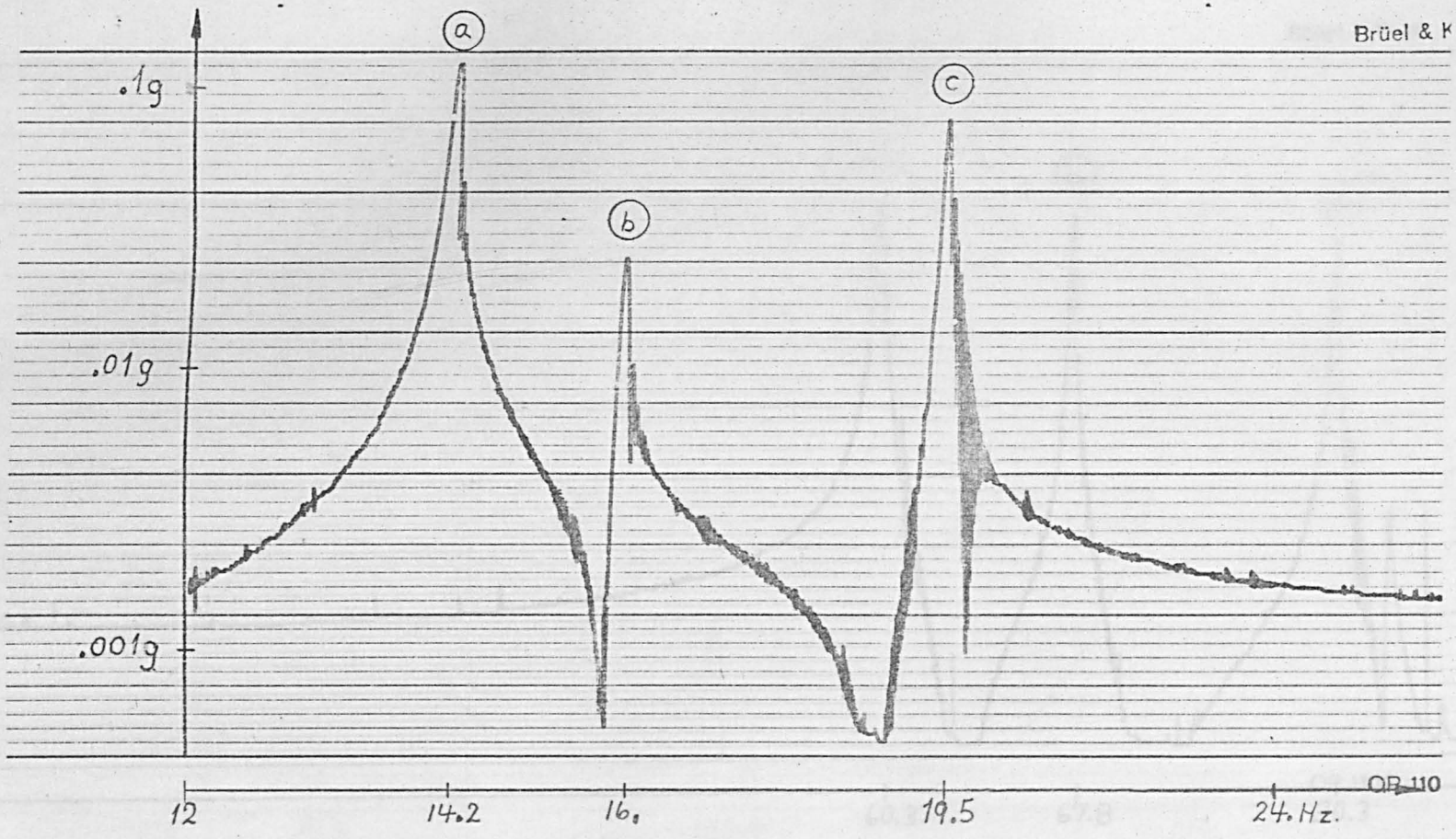


ⓐ 118.5Hz Sway X,3 ; ⓑ 119.3Hz Sway Z,3

Acceleration frequency response at joint 49Z. Input force 47.Newtons at joint 82Z.

MEMBER 84 REMOVED

Figure 5.16

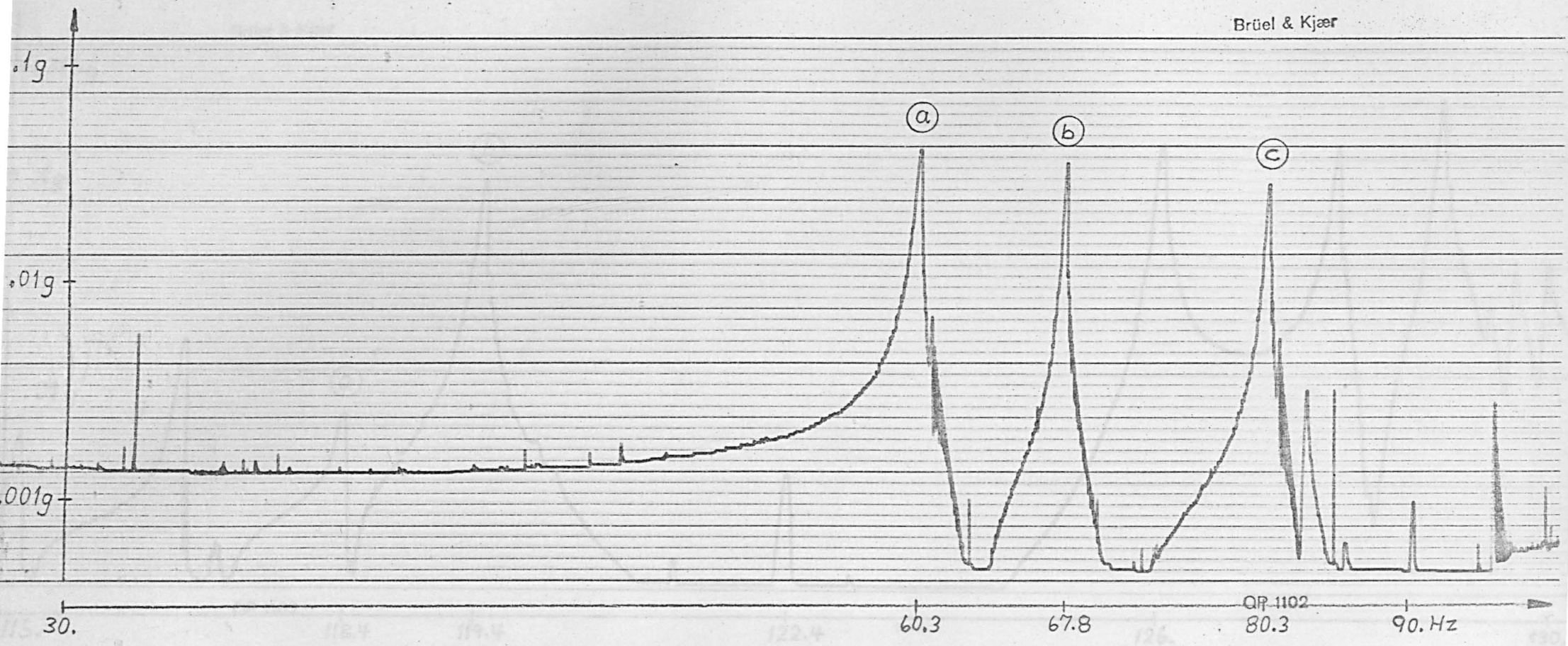


(a) 14.2Hz Sway Z,1 ; (b) 16.Hz Sway X,1 ; (c) 19.5 Torsion 1

Acceleration frequency response at joint 49Z . Input force 2.6 Newtons at joint 82Z .

MEMBER 84 REMOVED AND REPLACED

Figure 5.17

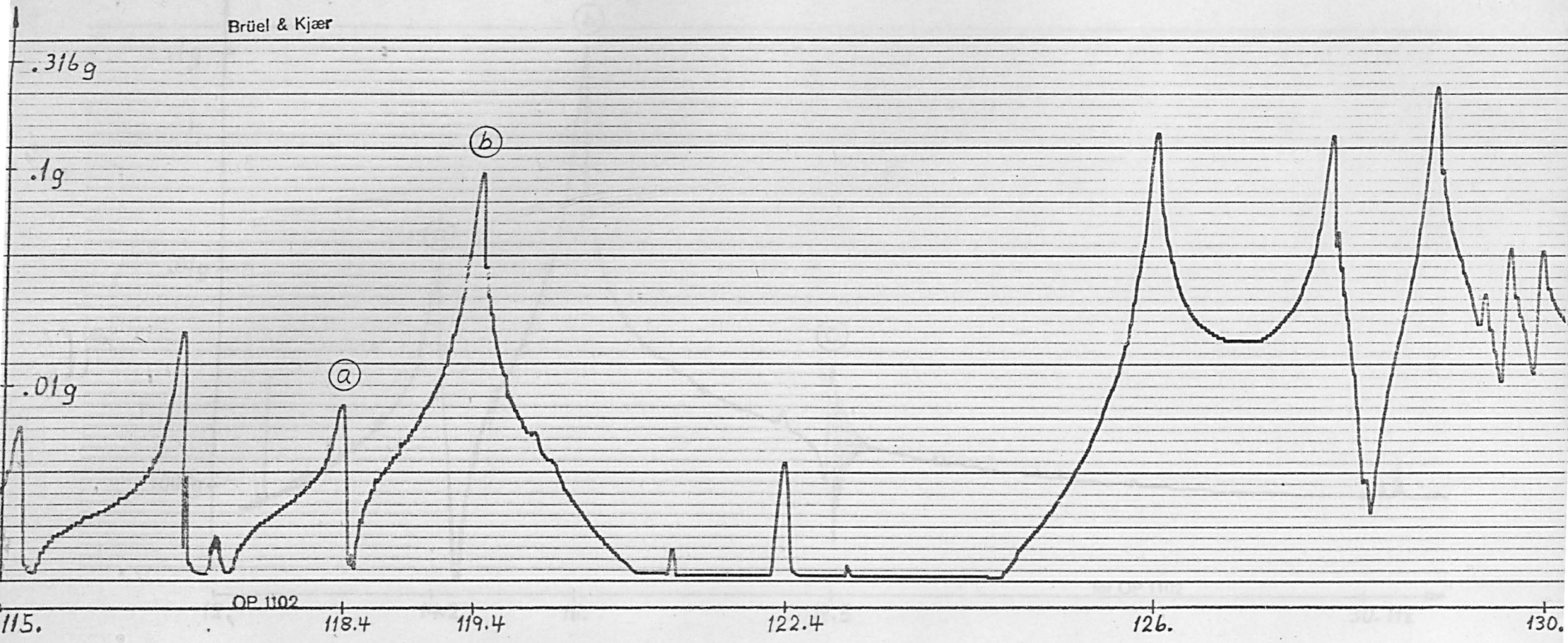


ⓐ 60.3Hz Sway Z,2 ; ⓑ 67.8Hz Torsion 2 ; ⓒ 80.3Hz Deck Roll

Acceleration frequency response at joint 49Z . Input force 2.6Newtons at joint 82Z .

MEMBER 84 REMOVED AND REPLACED

Figure 5.18

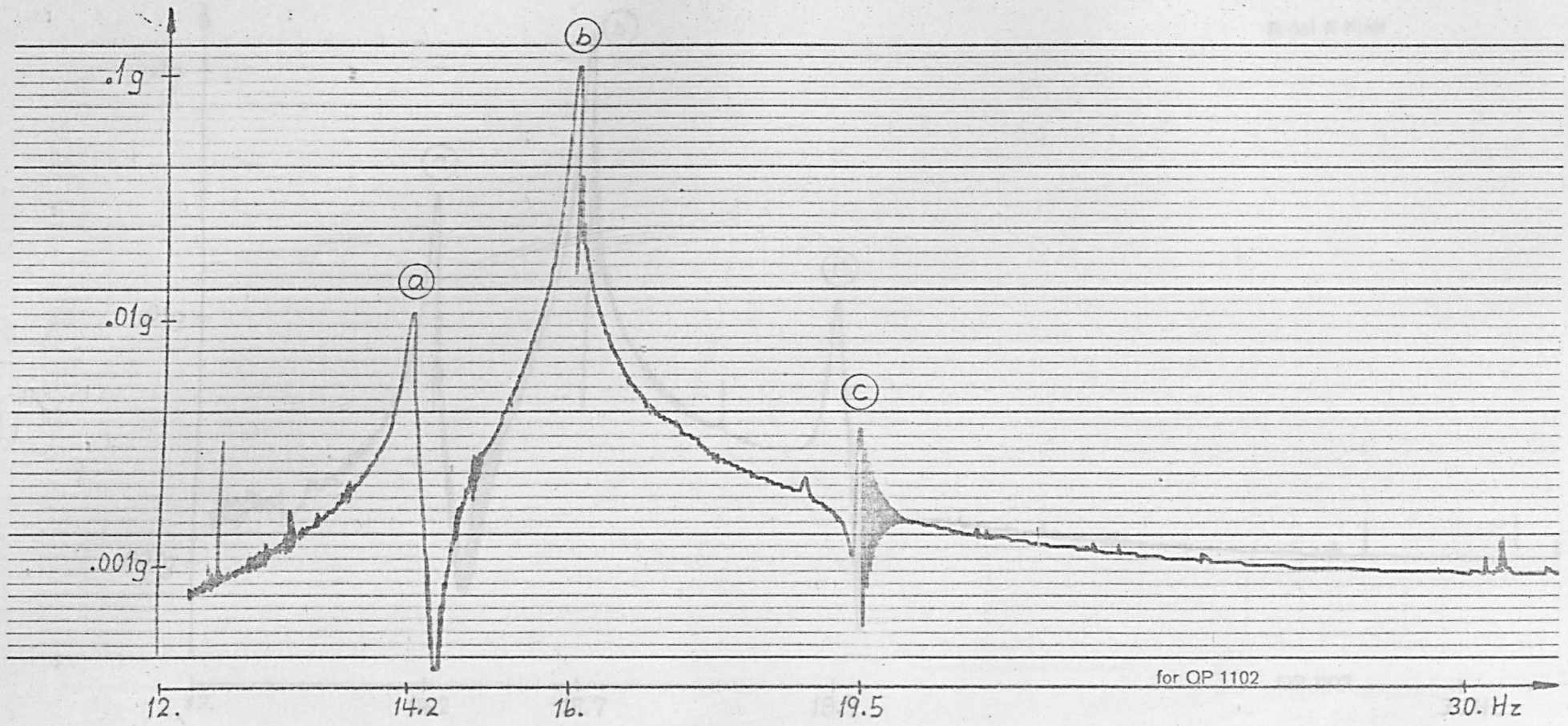


ⓐ 118.4Hz Sway X,3 ; ⓑ 119.4Hz Sway Z,3

Acceleration frequency response at joint 49Z. Input force 47. Newtons at joint 82Z.

MEMBER 84 REMOVED AND REPLACED

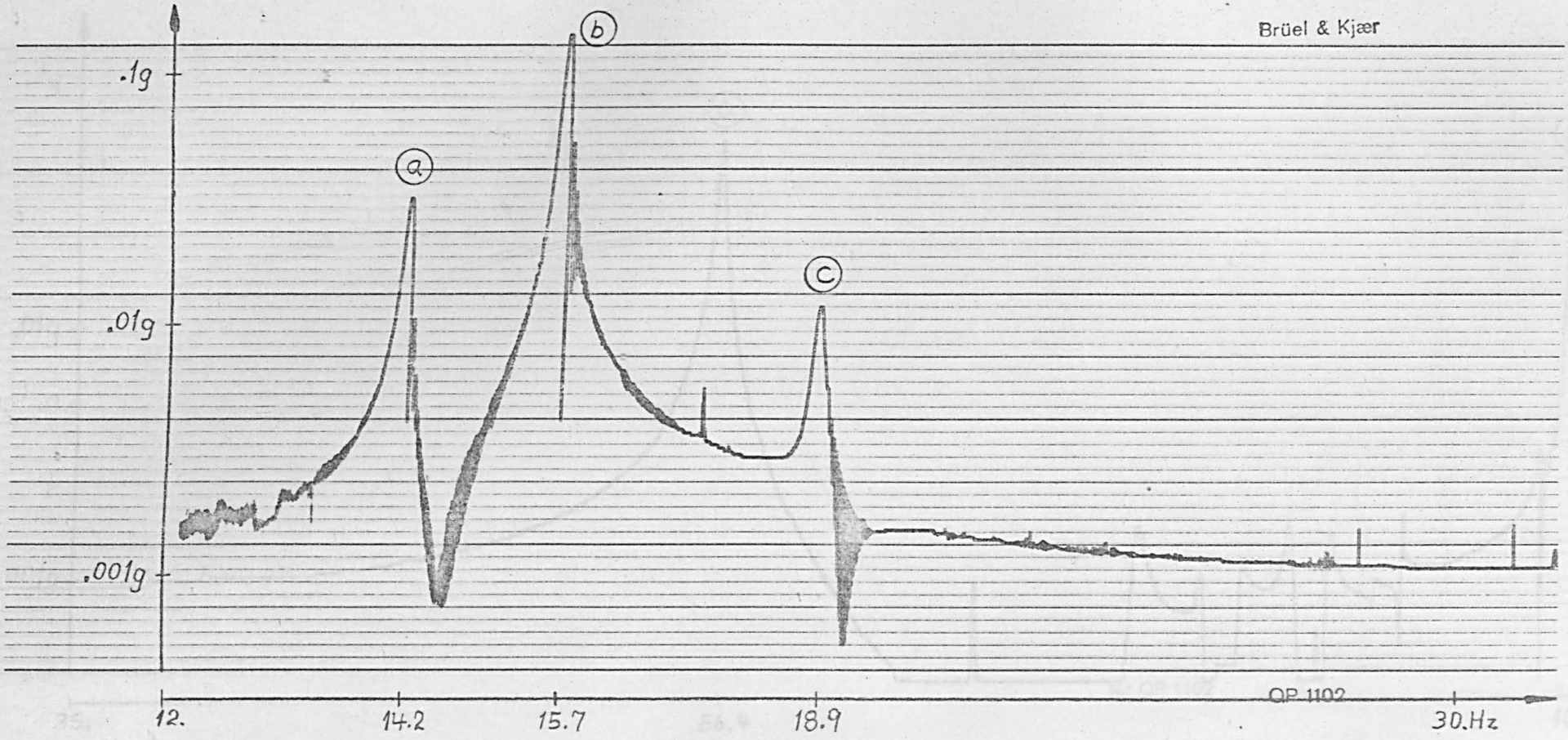
Figure 5.19



ⓐ 14.2Hz Sway Z,1 ; ⓑ 16.Hz Sway X,1 ; ⓒ 19.5Hz Torsion 1

Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

Figure 5.20

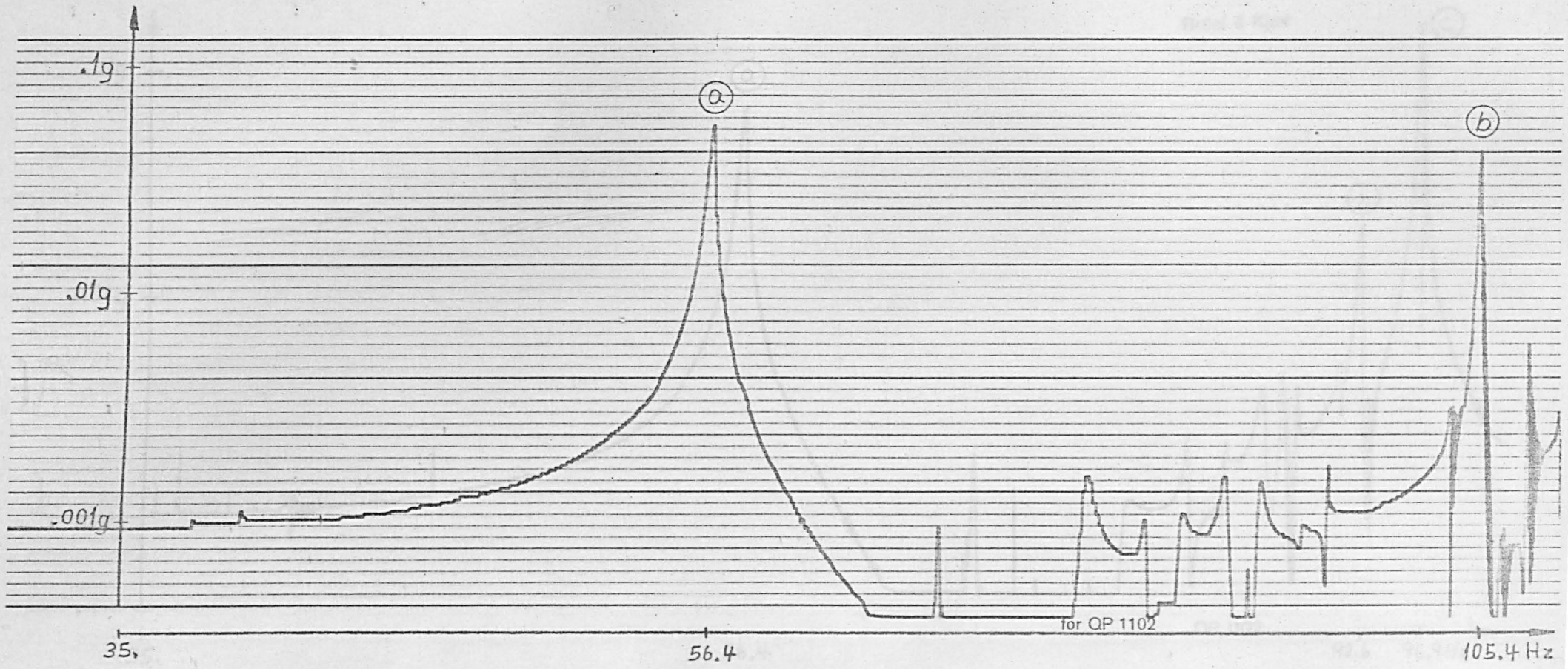


(a) 14.2Hz Sway Z,1 ; (b) 15.7Hz SWay X,1 ; (c) 18.9Hz Torsion 1

Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

MEMBER 135 REMOVED

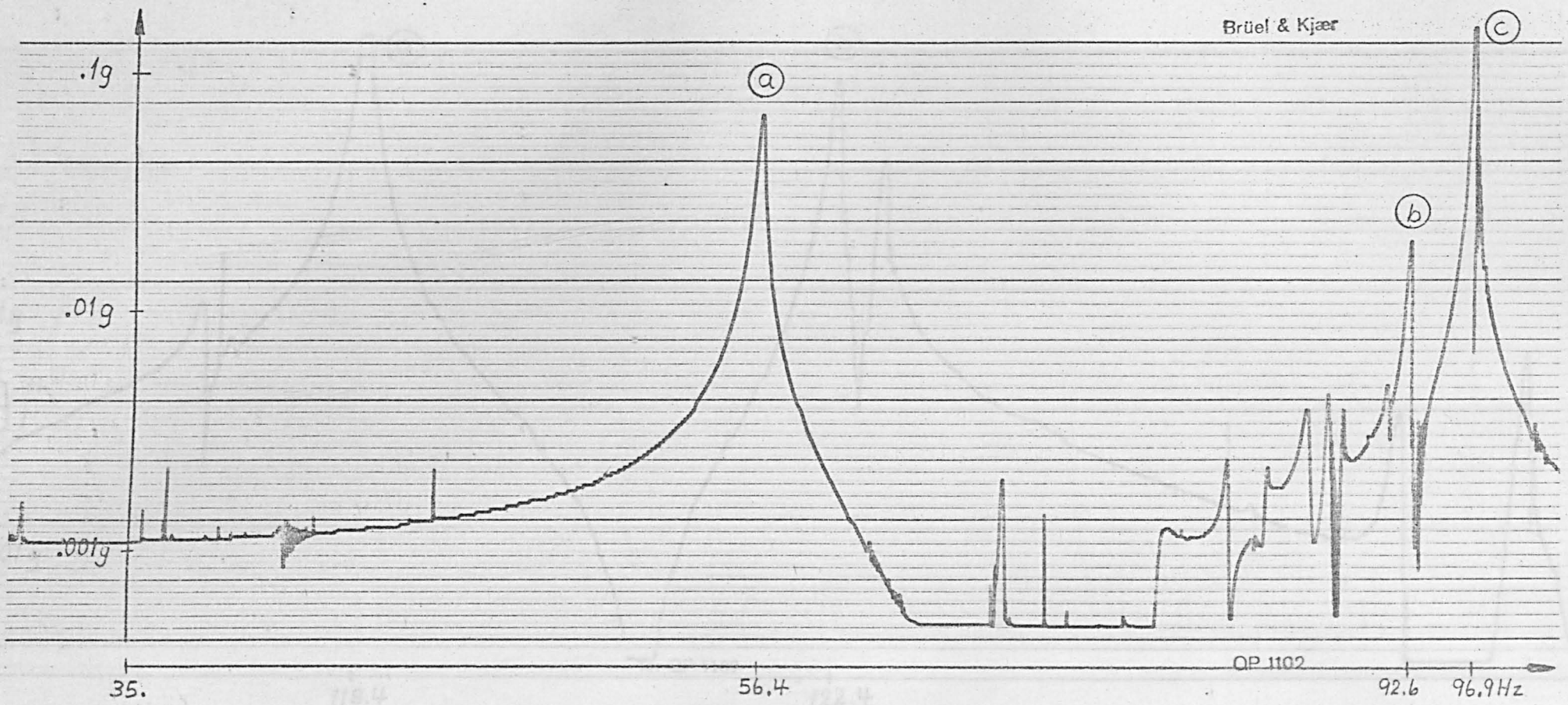
Figure 5.21



ⓐ 56.4Hz Sway X,2 ; ⓑ 105.4Hz Deck Pitch

Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

Figure 5.22

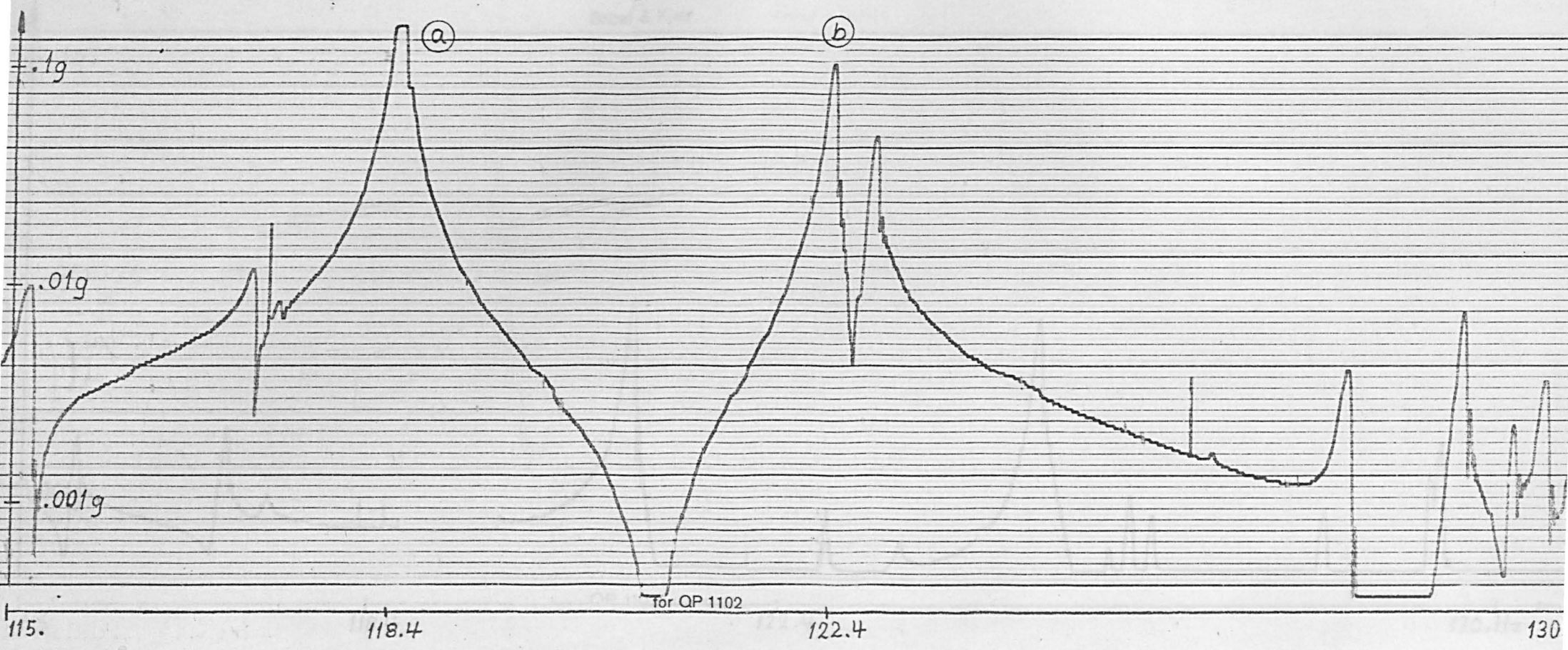


ⓐ 56.4Hz Sway X,2 ; ⓑ 92.6Hz Deck Pitch ; ⓒ 96.9Hz Sway X,3

Acceleration frequency response at joint 49X. Input force 2.6Newtons at joint 82X.

MEMBER 135 REMOVED

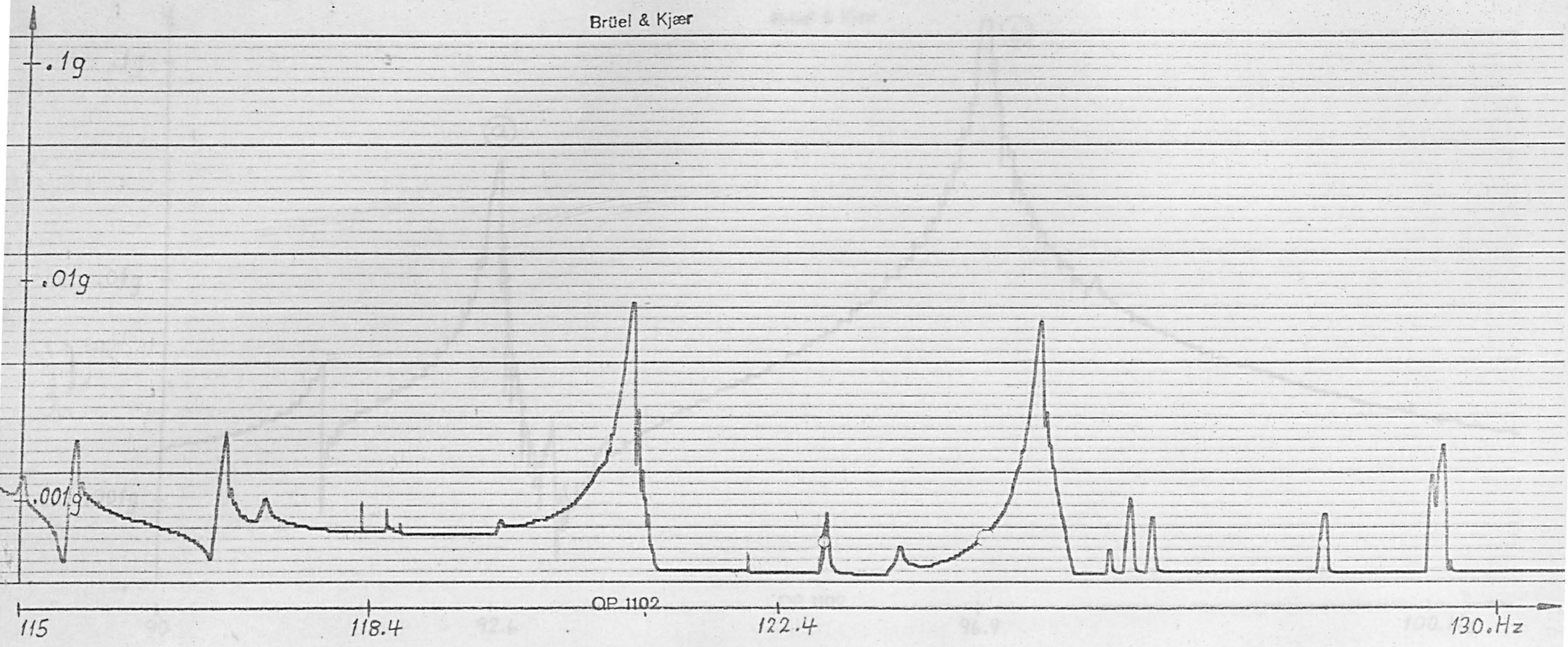
Figure 5.23



ⓐ 118.4Hz Sway X,3 ; ⓑ 122.4Hz

Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

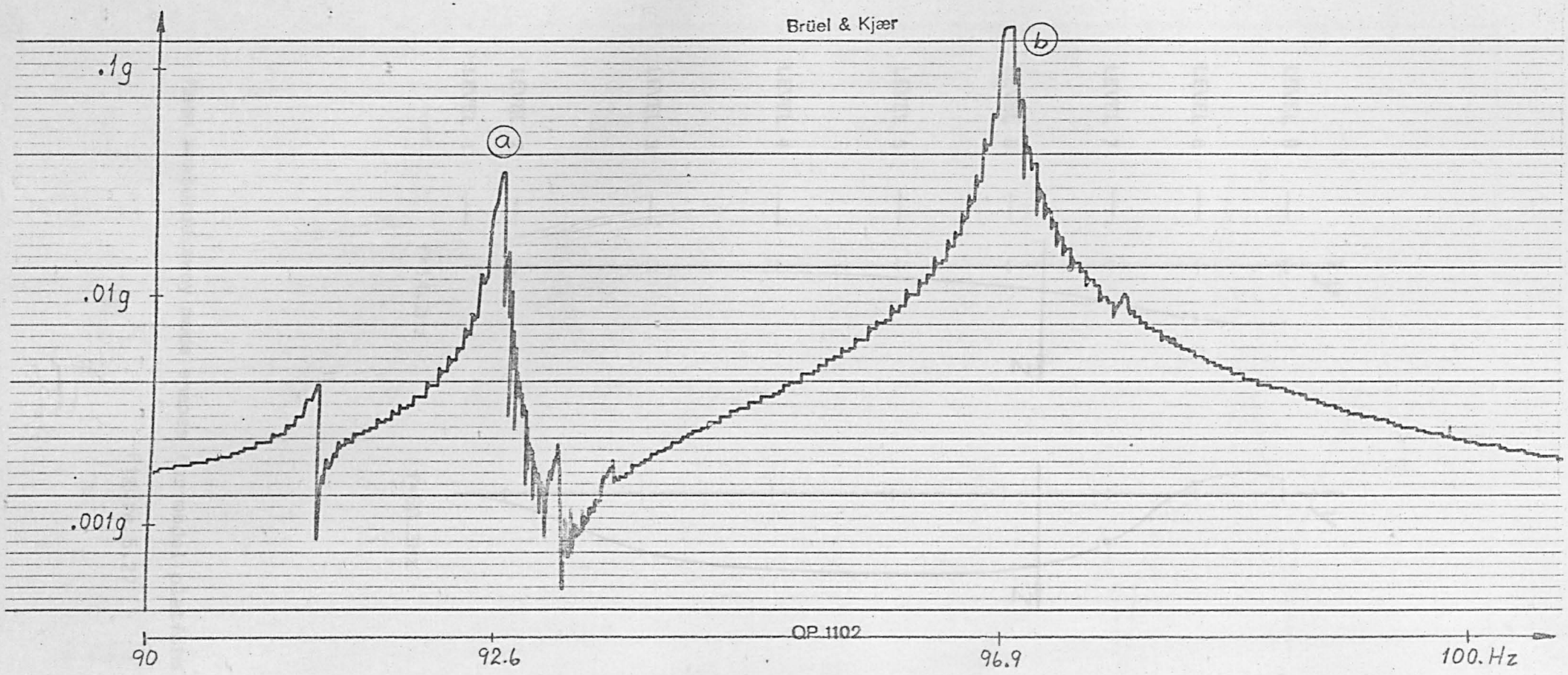
Figure 5.24



Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

MEMBER 135 REMOVED

Figure 5.25

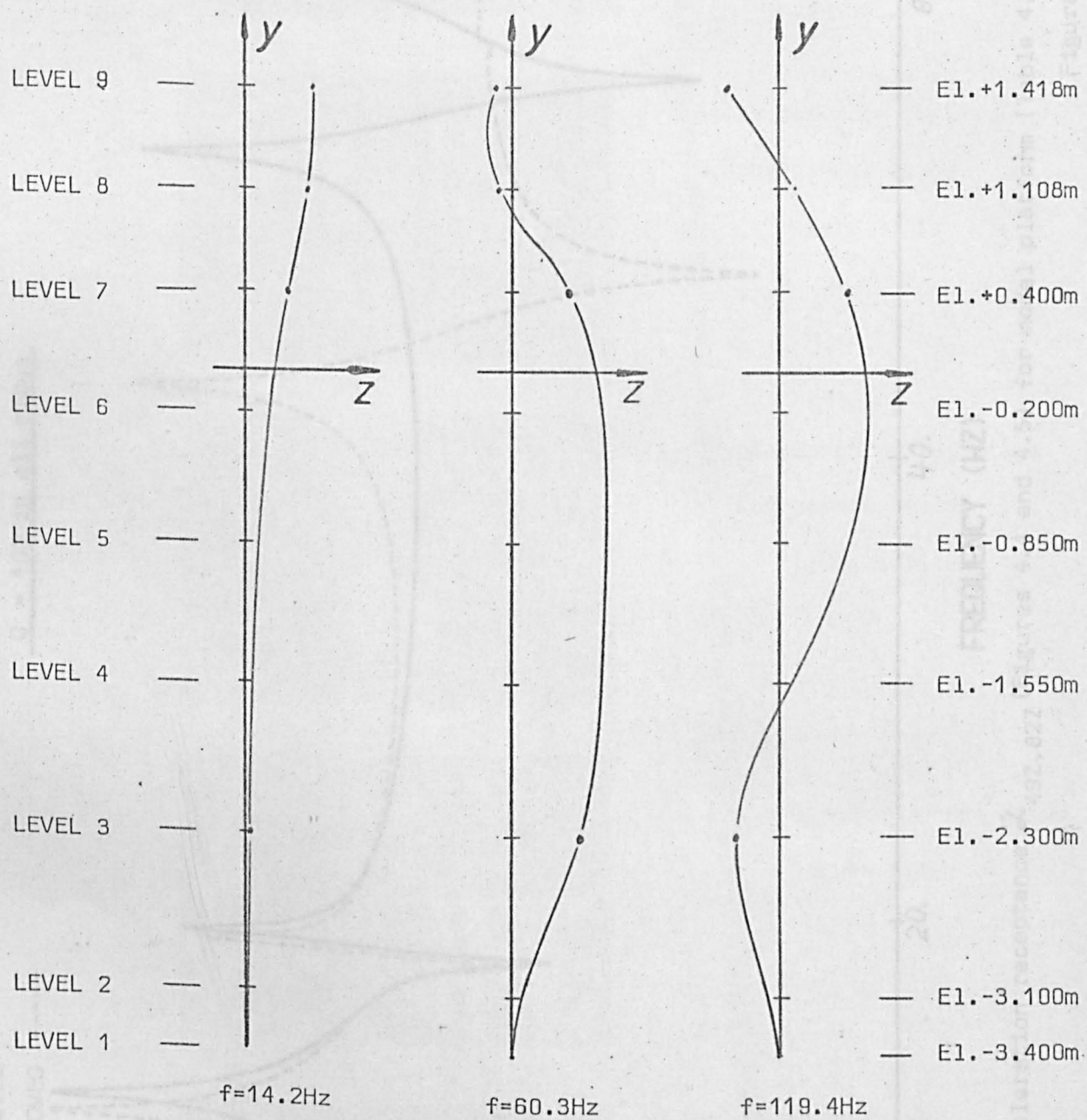


(a) 92.6Hz Deck Pitch ; (b) 96.9Hz Sway X,3

Acceleration frequency response at joint 49X. Input force 2.6 Newtons at joint 82X.

MEMBER 135 REMOVED

Figure 5.26



Mean measured sway mode shapes for model platform (Tables 5.1,5.4 and 5.8)

Figure 5.27

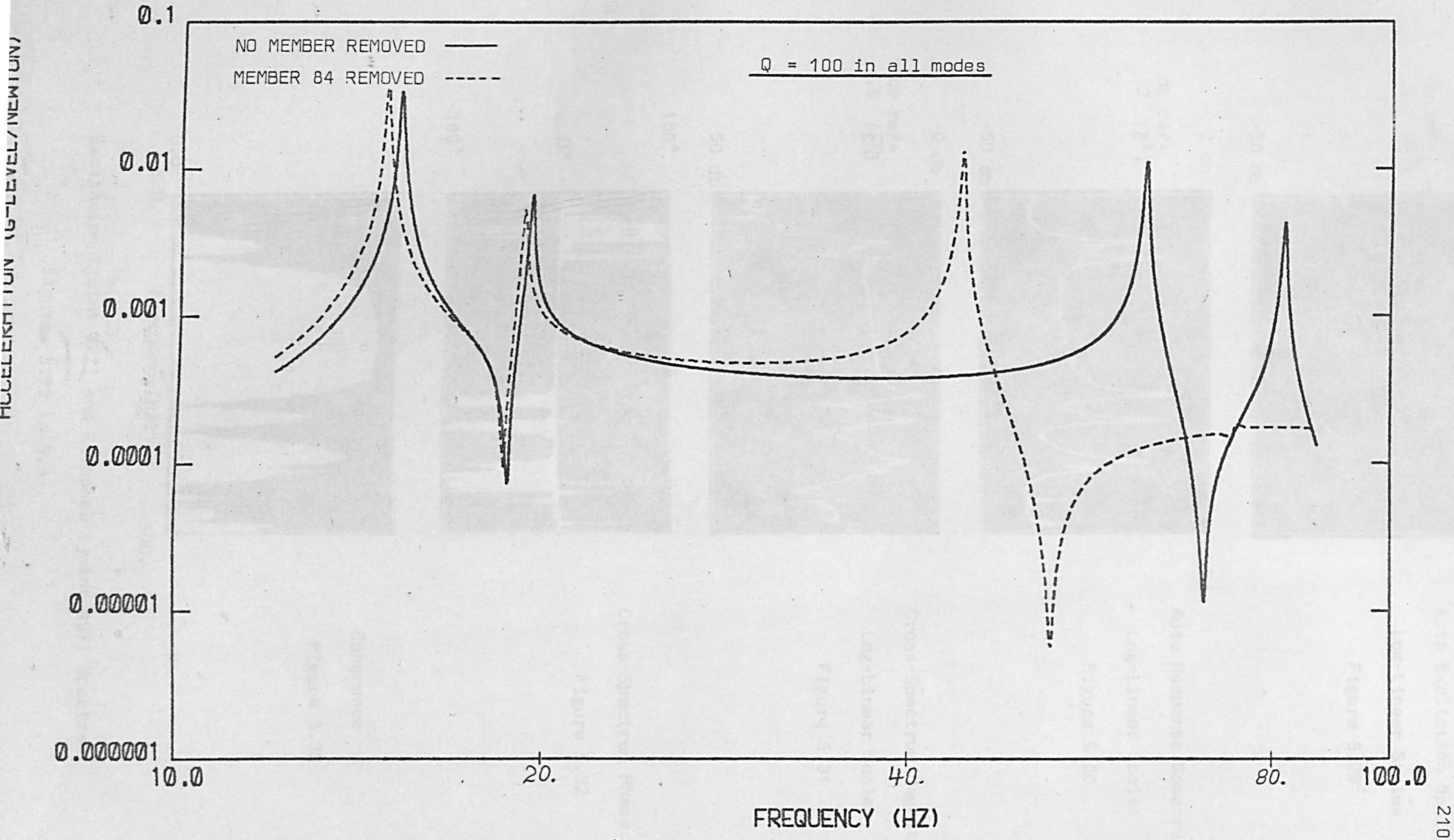
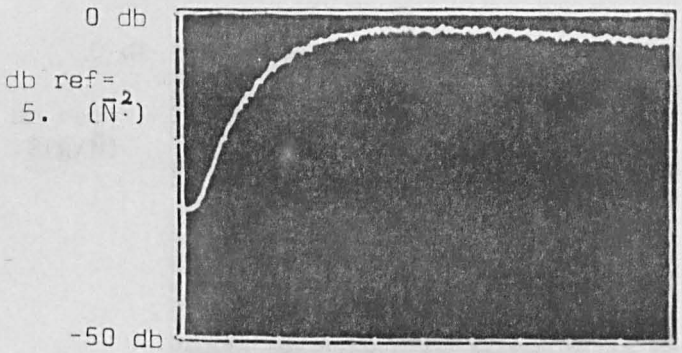


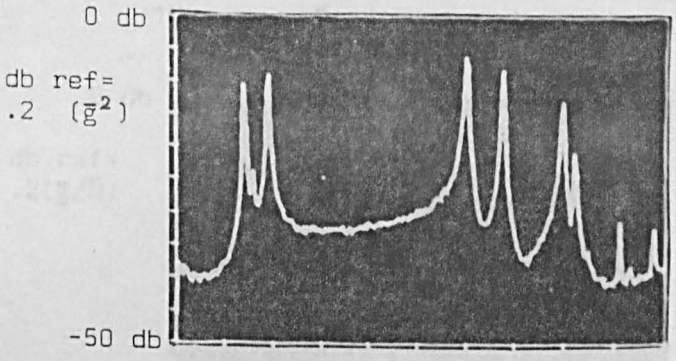
Figure 5.28 Computed acceleration receptance $\ddot{\chi}_{49Z,82Z}$ (Figures 4.4 and 4.5) for model platform (Table 4.6 & Figures 5.11 to 5.14)



Auto Excitation Spectrum

Log-Linear Scales

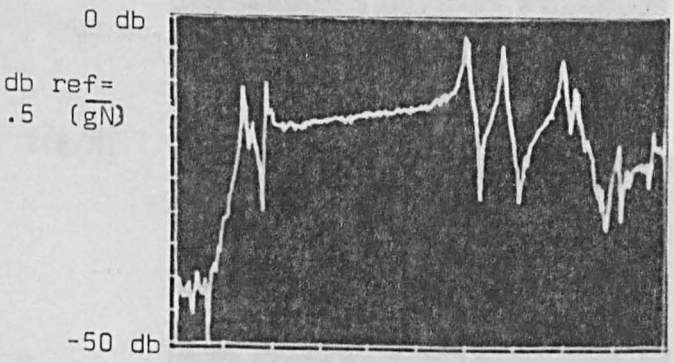
Figure 5.29



Auto Response Spectrum

Log-Linear Scales

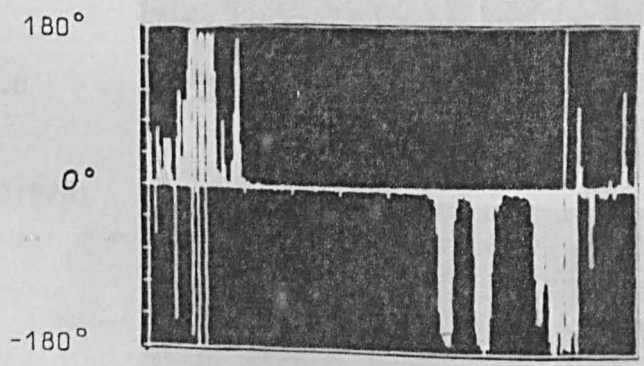
Figure 5.30



Cross-Spectrum Magnitude

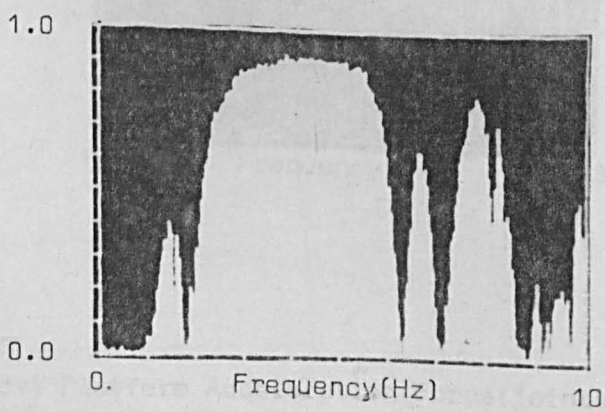
Log-Linear Scales

Figure 5.31



Cross-Spectrum Phase Angle

Figure 5.32

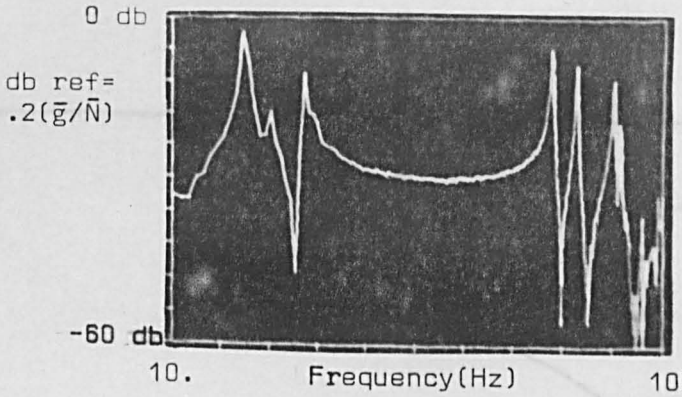


Coherence

Figure 5.33

Excitation (joint 82Z) and Response (joint 49Z) Spectra

Figures 5.29 to 5.33

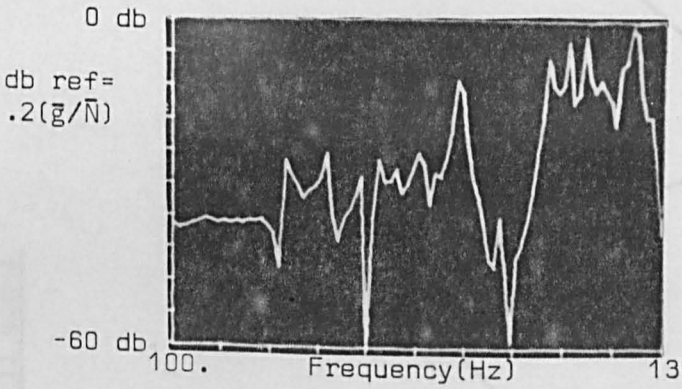


Frequency Response Function

10Hz to 100Hz

Logarithmic Scales

Figure 5.34

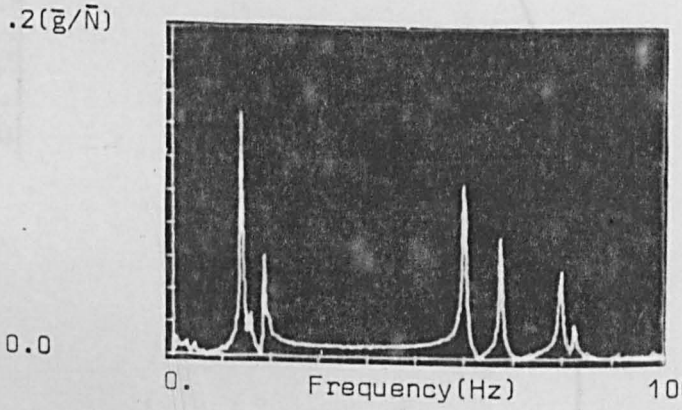


Frequency Response Function

100Hz to 135Hz

Logarithmic Scales

Figure 5.34

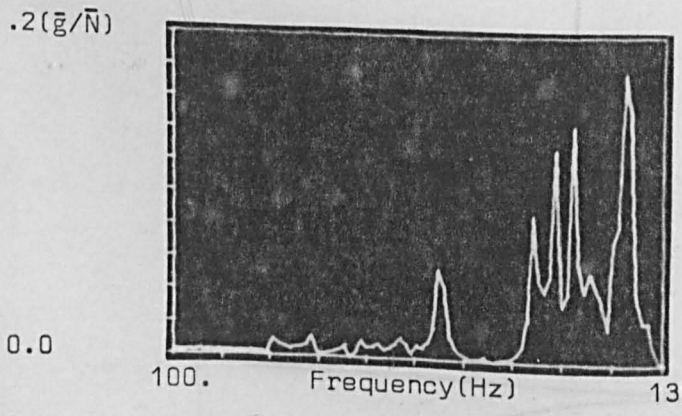


Frequency Response Function

0Hz to 100Hz

Linear Scales

Figure 5.35



Frequency Response Function

100Hz to 135Hz

Linear Scales

Figure 5.35

Model Platform Acceleration/Force(joints 49Z/82Z)

Frequency Response Function

Figures 5.34 & 5.35

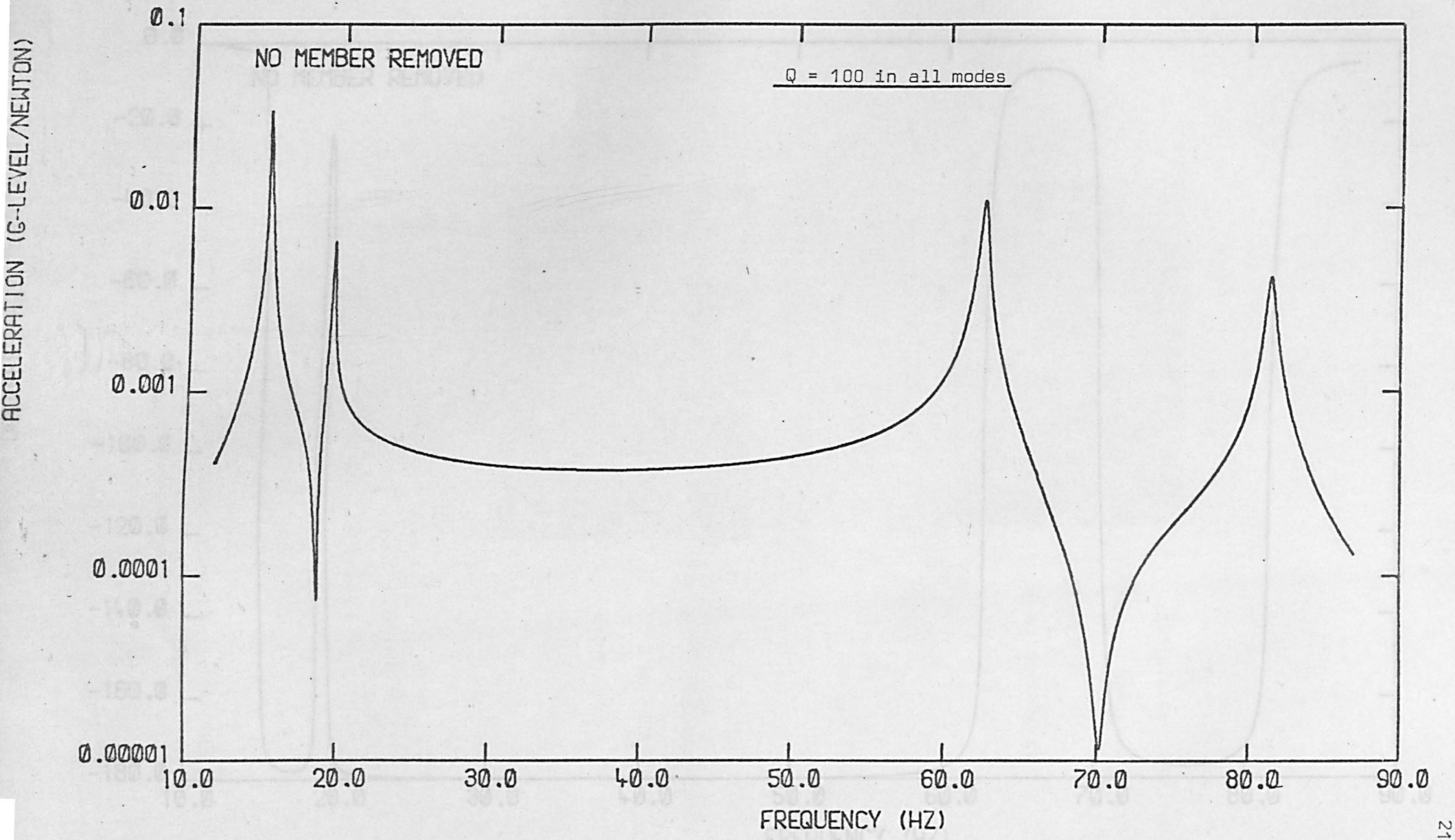


Figure 5.36 Computed acceleration receptance $\ddot{z}_{49Z,82Z}$ (Figures 4.4 & 4.5) for model platform (Table 4.6)

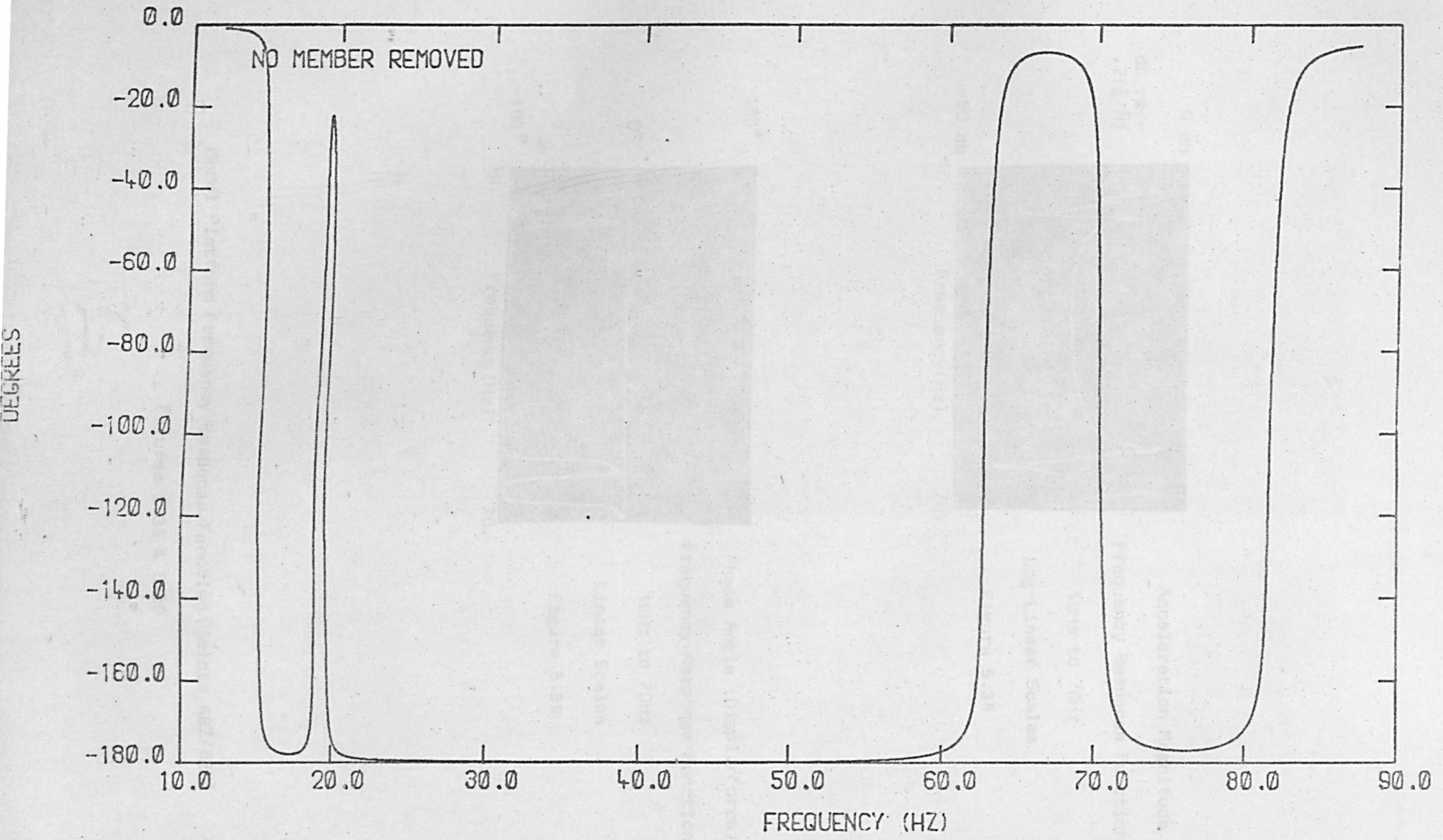
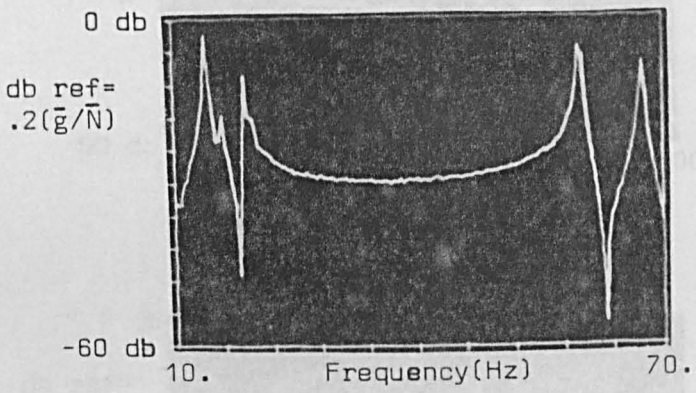


Figure 5.37 Computed phase angle (Displacement/Force) $\theta_{49Z,82Z}$ for model platform (Figure 5.36)



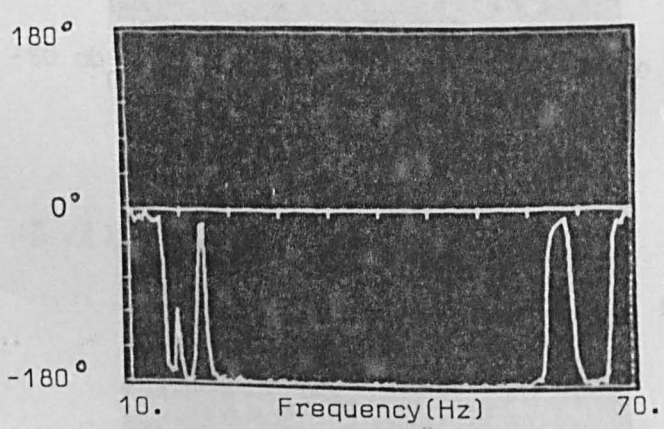
Acceleration Magnitude

Frequency Response Function

10Hz to 70Hz

Log-Linear Scales

Figure 5.38



Phase Angle (Displ./Force)

Frequency Response Function

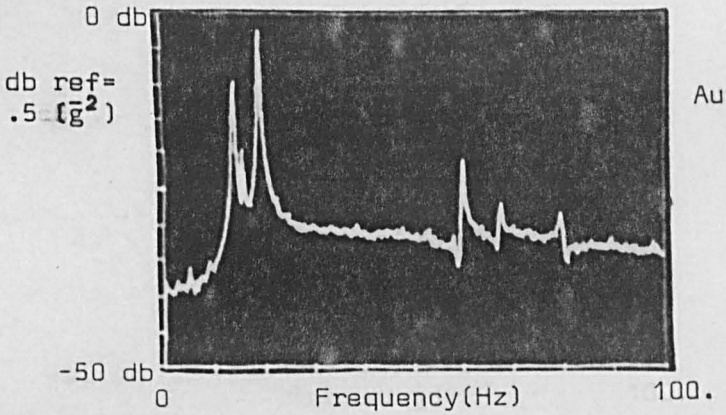
10Hz to 70Hz

Linear Scales

Figure 5.39

Model Platform Frequency Response Function (joints 49Z/82Z)

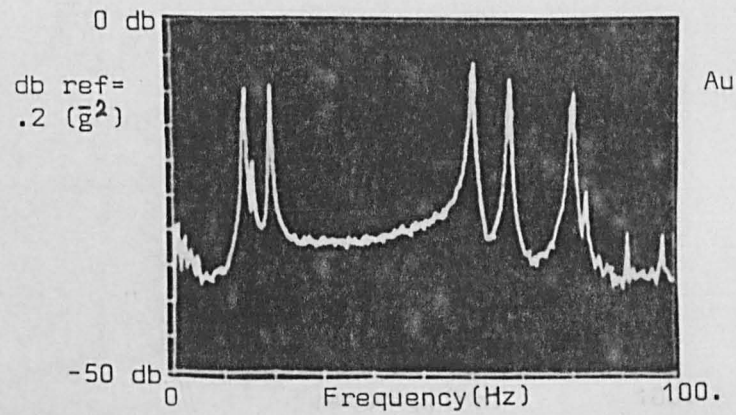
Figures 5.38 & 5.39



Auto Response Spectrum(joint 76Z)

Log-Linear Scales

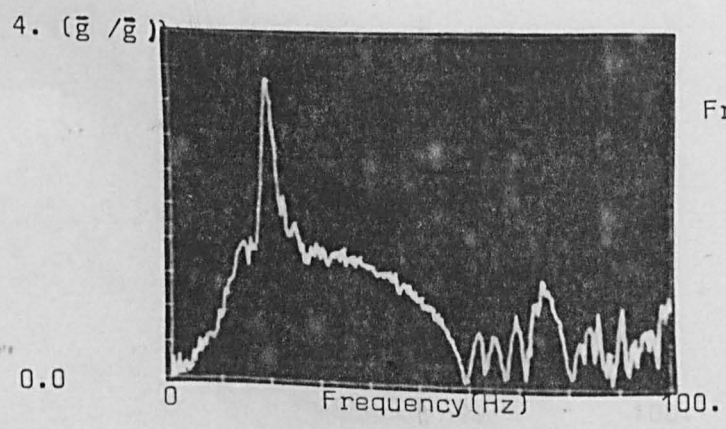
Figure 5.40



Auto Response Spectrum(joint 49Z)

Log-Linear Scales

Figure 5.41



Frequency Response Function

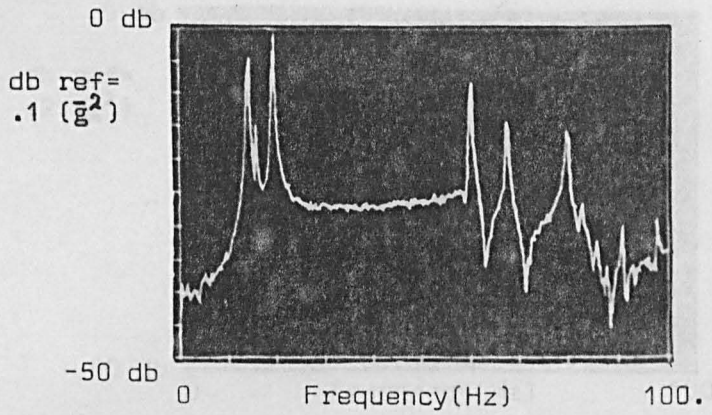
Between Joints 76Z/49Z

Linear Scales

Figure 5.42

Auto Response Spectra and Frequency Response Function

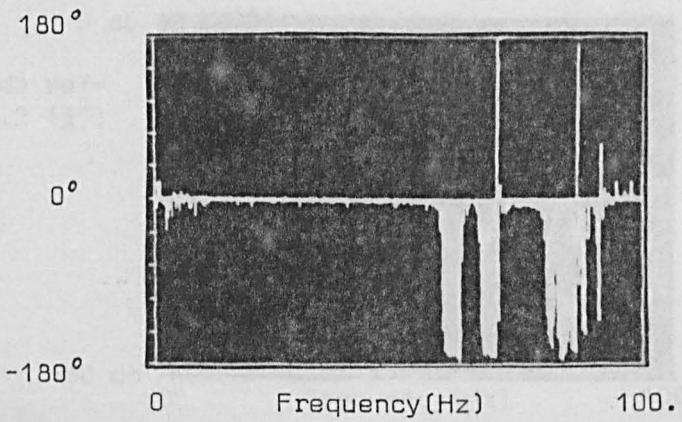
Figures 5.40 to 5.42



Cross Spectrum Magnitude

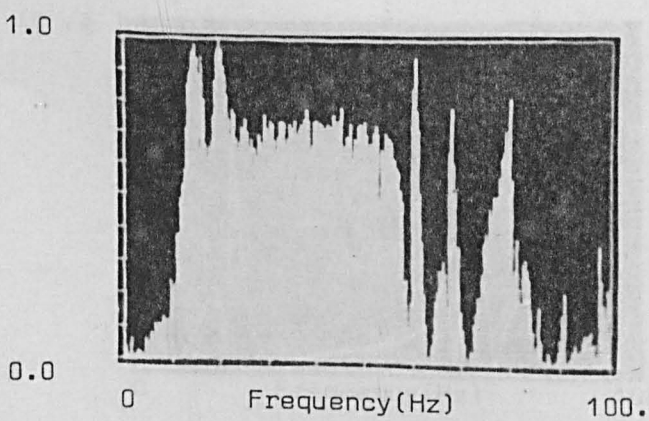
Log-Linear Scales

Figure 5.43



Cross Spectrum Phase Angle

Figure 5.44

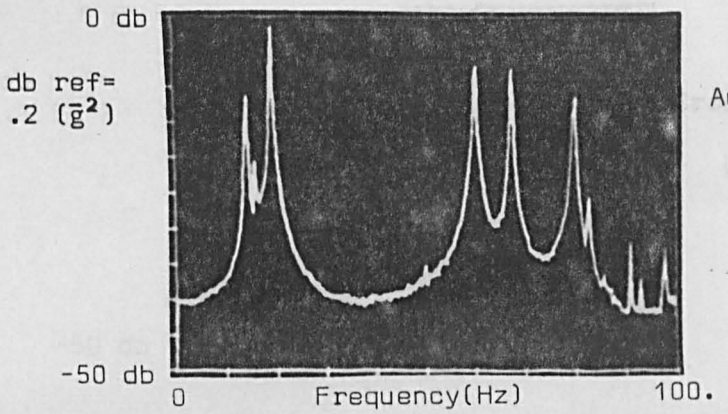


Coherence

Figure 5.45

Cross Spectra and Coherence Between Joints 76Z/49Z

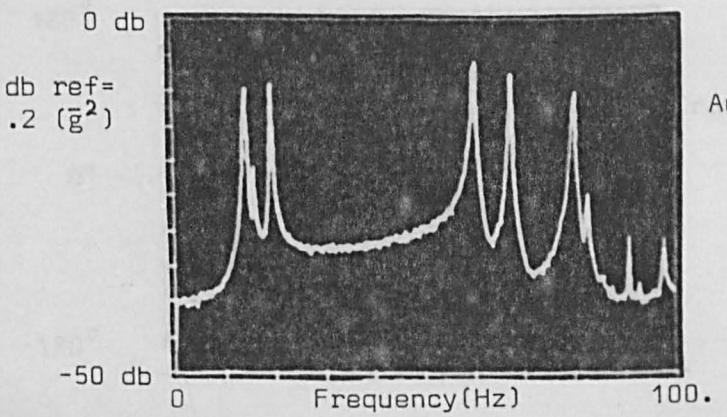
Figures 5.43 to 5.45



Auto Response Spectrum(joint 52Z)

Log-Linear Scales

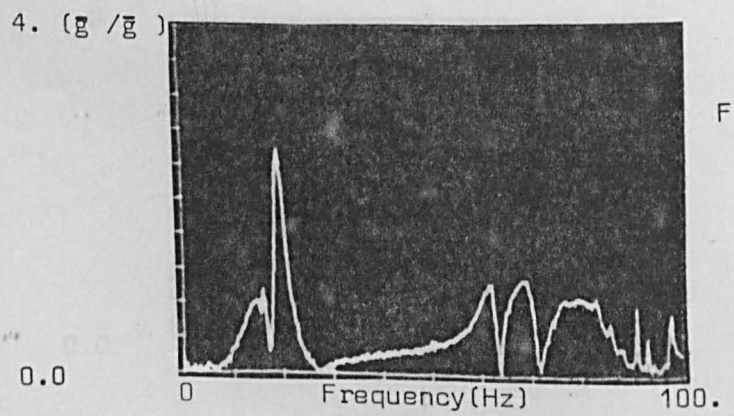
Figure 5.46



Auto Response Spectrum(joint 49Z

Log-Linear Scales

Figure 5.47



Frequency Response Function

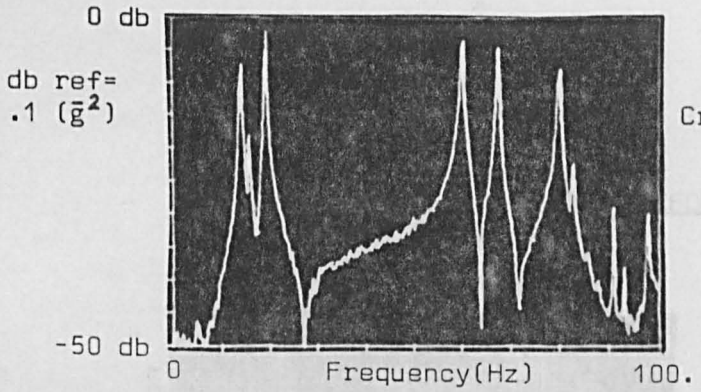
Between Joints 52Z/49Z

Linear Scales

Figure 5.48

Auto Response Spectra and Frequency Response Function

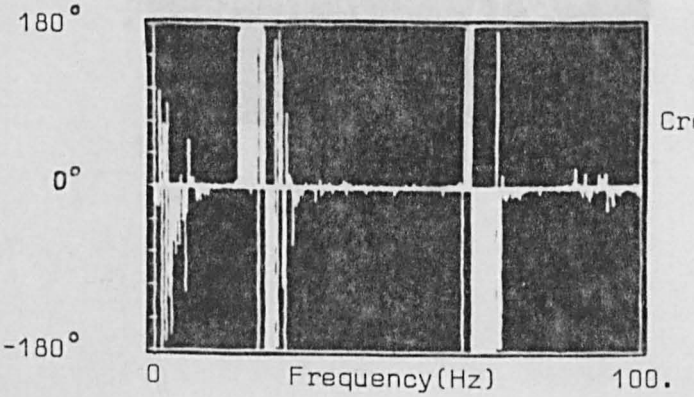
Figures 5.46 to 5.48



Cross Spectrum Magnitude

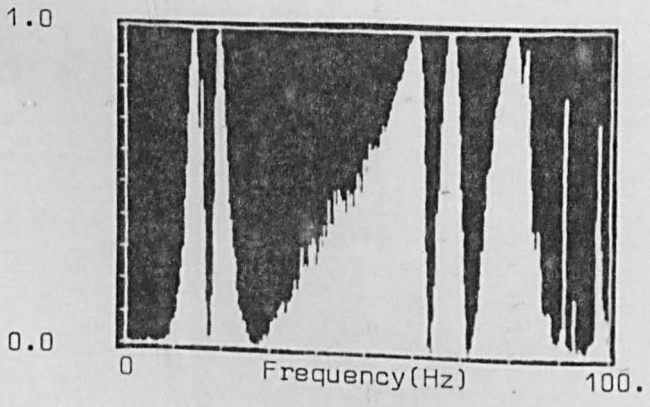
Log-Linear Scales

Figure 5.49



Cross Spectrum Phase Angle

Figure 5.50

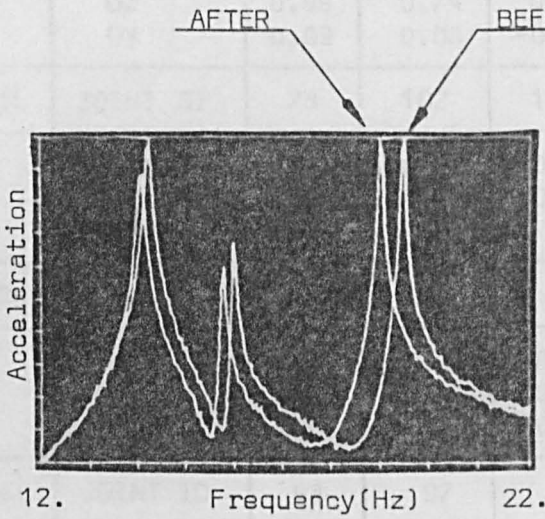


Coherence

Figure 5.51

Cross Spectra and Coherence Between Joints 52Z/49Z

Figures 5.49 to 5.51



Normalised

Auto Response Spectra

At

Joint 49Z

Log-Linear Scales

Fundamental Mode Group Before and After

a 4% Deck Mass Increase

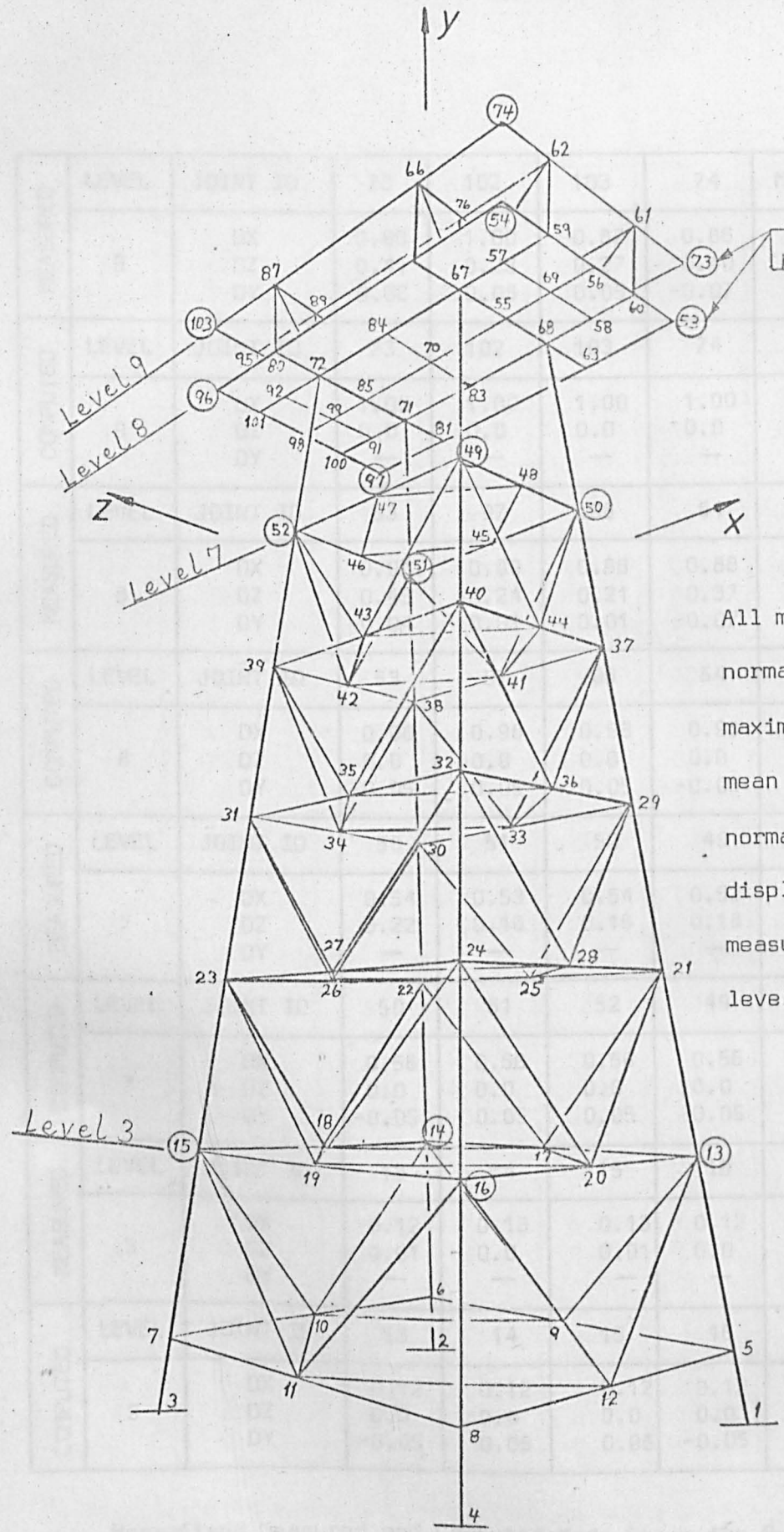
Figure 5.52

	LEVEL	JOINT ID	73	102	103	74	MEAN DISPL.
MEASURED	9	DX DZ DY	-0.25 0.99 0.09	-0.28 0.74 0.03	-0.43 0.71 -0.04	-0.46 1.00 -0.06	1.00
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX DZ DY	0.08 1.00 —	0.08 0.72 —	-0.08 0.72 —	-0.08 1.00 —	0.97
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	-0.27 0.98 0.04	-0.26 0.69 0.04	-0.43 0.68 -0.09	-0.44 0.96 -0.03	0.96
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	0.08 0.98 0.03	0.08 0.70 0.03	-0.08 0.70 -0.03	-0.08 0.98 -0.03	0.95
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	-0.15 0.55 —	-0.21 0.52 —	-0.22 0.51 —	-0.25 0.54 —	0.62
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	0.02 0.57 0.04	0.02 0.52 0.04	-0.02 0.52 -0.04	-0.02 0.57 -0.04	0.62
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	-0.03 0.04 —	-0.04 0.03 —	-0.03 0.02 —	-0.06 0.05 —	0.04
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	0.01 0.11 0.05	0.01 0.10 0.05	-0.01 0.10 -0.05	-0.01 0.11 -0.05	0.12

Normalised Measured and Computed Mode Shape for Sway Z,1

f_m = 14.2 Hz, f_c = 15.07 Hz.

TABLE 5.1A



All mean mode shapes normalised to unity at maximum displacement, and mean computed mode shape normalised to equal displacement with mean measured mode shape at level 7 .

Mode shape table layout

TABLE 5.1B

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISPL.
	9	DX	0.96	1.00	0.87	0.86	1.00
		DZ	0.41	0.23	0.27	0.40	
		DY	-0.06	0.03	0.05	-0.07	
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX	1.00	1.00	1.00	1.00	1.04
		DZ	0.0	0.0	0.0	0.0	
		DY	—	—	—	—	
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX	0.97	0.99	0.86	0.88	1.00
		DZ	0.43	0.24	0.21	0.37	
		DY	-0.04	0.01	0.01	-0.07	
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX	0.98	0.98	0.98	0.98	1.02
		DZ	0.0	0.0	0.0	0.0	
		DY	-0.05	0.05	0.05	-0.05	
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX	0.54	0.53	0.54	0.52	0.58
		DZ	0.22	0.16	0.16	0.18	
		DY	—	—	—	—	
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX	0.56	0.56	0.56	0.56	0.58
		DZ	0.0	0.0	0.0	0.0	
		DY	-0.05	0.05	0.05	-0.05	
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX	0.12	0.13	0.13	0.12	0.14
		DZ	0.01	0.0	0.01	0.0	
		DY	—	—	—	—	
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX	0.12	0.12	0.12	0.12	0.12
		DZ	0.0	0.0	0.0	0.0	
		DY	-0.05	0.05	0.05	-0.05	

Normalised Measured and Computed Mode Shape for Sway X,1

f_m = 16. Hz, f_c = 16.46 Hz.

TABLE 5.2

MEASURED	LEVEL	JOINT ID	73	102	103	74	ROTATION	MEAN ROTATION
	9	DX DZ DY	-0.45 -0.81 0.03	-0.42 1.00 -0.07	0.48 0.95 -0.01	0.48 -0.81 -0.02	0.92 1.00	0.99
COMPUTED	LEVEL	JOINT ID	73	102	103	74		
	9	DX DZ DY	-0.5 -0.77	-0.5 1.00	0.5 1.00	0.5 -0.77	1.00 0.98	0.71
MEASURED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	-0.48 -0.78 -0.01	-0.43 0.95 -0.03	0.47 0.95 -0.05	0.53 -0.80 -0.01	0.96 0.97	1.0
COMPUTED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	-0.49 -0.76 0.01	-0.49 0.99 0.0	0.49 0.99 -0.0	0.49 -0.76 -0.01	0.98 0.97	0.70
MEASURED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	-0.13 -0.14	-0.13 0.33	0.16 0.33	0.14 -0.14	0.22 0.23	0.23
COMPUTED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	-0.1 -0.1 -0.0	-0.1 0.25 0.02	0.1 0.25 -0.02	0.1 -0.1 0.0	0.30 0.34	0.23
MEASURED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	-0.05 -0.05	-0.05 0.07	0.05 0.07	0.05 -0.05	0.04 0.04	0.04
COMPUTED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	-0.03 -0.02 0.0	-0.03 0.06 0.01	0.03 0.06 -0.01	0103 -0.02 -0.0	0.05 0.05	0.04

Normalised Measured and Computed Mode Shape for Torsion 1;

f_m = 19.5 Hz, f_c = 19.45 Hz.

TABLE 5.3

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISP.
	9	DX DZ DY	0.0 -0.20 0.05	0.0 -0.27 0.02	-0.03 -0.26 -0.01	0.0 -0.27 0.04	-0.24
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX DZ DY	0.02 -0.23 --	0.02 -0.29 --	-0.02 -0.29 --	-0.02 -0.23 --	-0.22
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	0.01 -0.20 0.04	0.0 -0.24 0.01	-0.02 -0.24 0.02	-0.01 -0.10 0.07	-0.20
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	0.02 -0.29 0.14	0.02 -0.35 0.14	-0.02 -0.35 -0.14	-0.02 -0.29 -0.14	-0.27
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	0.03 0.80 --	0.02 0.78 --	0.03 0.77 --	0.06 0.83 --	0.82
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	0.0 1.00 -0.05	0.0 0.98 -0.05	0.0 0.98 0.05	0.0 1.00 0.05	0.82
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	0.10 0.98 --	0.11 0.95 --	0.07 0.95 --	0.03 1.00 --	1.00
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	0.0 0.99 0.02	0.0 0.98 0.02	0.0 0.98 -0.02	0.0 0.99 -0.02	0.82

Normalised Measured and Computed Mode Shape for Sway Z,2

f_m = 60.3 Hz, f_c = 62.59 Hz

TABLE 5.4

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISP.
	9	DX DZ DY	-0.25 0.0 -0.20	-0.26 0.02 0.05	-0.25 0.02 0.10	-0.25 0.0 -0.16	-0.26
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX DZ DY	-0.19 0.0 --	-0.19 0.0 --	-0.19 0.0 --	-0.19 0.0 --	-0.19
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	-0.29 0.04 -0.20	-0.29 0.03 0.04	-0.29 0.04 0.11	-0.27 0.03 -0.18	-0.29
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	-0.27 0.0 -0.29	-0.27 0.0 0.27	-0.27 0.0 0.27	-0.27 0.0 -0.29	-0.27
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	0.97 -0.04 --	0.98 -0.06 --	0.97 -0.07 --	0.95 -0.07 --	0.99
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	1.0 0.0 -0.03	1.0 0.0 0.01	1.0 0.0 0.01	1.0 0.0 -0.03	0.99
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	0.97 -0.05 --	1.00 -0.06 --	0.87 -0.06 --	0.98 -0.03 --	1.00
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	0.71 0.0 -0.06	0.71 0.0 0.04	0.71 0.0 0.04	0.71 0.0 -0.06	0.70

Normalised Measured and Computed Mode Shape for Sway X,2

f_m = 5.64 Hz, f_c = 64.48 Hz

TABLE 5.5

MEASURED	LEVEL	JOINT ID	73	102	103	74	ROTATION	MEAN ROTATION
	9	DX DZ DY	0.16 0.27 -0.17	0.19 -0.30 0.07	-0.16 -0.28 0.04	-0.15 0.30 -0.18	-0.41 -0.40	-0.42
COMPUTED	LEVEL	JOINT ID	73	102	103	74		
	9	DX DZ DY	0.15 0.21	0.14 -0.22	-0.14 -0.22	-0.14 0.21	-0.14 -0.12	-0.13
MEASURED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	0.10 0.21 -0.15	0.11 -0.24 0.05	-0.18 -0.22 0.05	-0.15 0.21 -0.19	-0.34 -0.31	-0.33
COMPUTED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	0.11 0.17 -0.06	0.11 -0.19 0.04	-0.11 -0.19 -0.04	-0.11 0.17 0.06	-0.11 -0.10	-0.11
MEASURED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	-0.49 -0.84	-0.45 0.87	0.61 0.75	0.55 -0.79	1.00 -0.95	1.0
COMPUTED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	-0.65 -1.0 0.02	-0.65 0.99 -0.02	0.65 0.99 0.02	0.65 -1.0 -0.02	1.00 0.97	1.0
MEASURED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	-0.79 -0.92	-0.78 0.96	0.73 1.00	0.74 -0.92	0.76 0.75	0.77
COMPUTED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	-0.68 -0.92 -0.01	-0.68 0.93 0.01	0.68 0.93 -0.01	0.68 -0.92 0.01	0.55 0.59	0.58

Normalised Measured and Computed Mode Shape for Torsion 2;

f_m = 67.8 Hz, f_c = 81.44 Hz.

TABLE 5.6

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISP.
	9	DX	-0.27	-0.26	-0.27	-0.33	-0.31
		DZ	0.01	0.04	-0.04	0.05	
		DY	0.80	-0.86	-1.0	0.82	
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX	-0.17	-0.16	-0.16	-0.17	-0.17
		DZ	0.0	0.0	0.0	0.0	
		DY	--	--	--	--	
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX	0.08	0.01	0.07	0.05	0.06
		DZ	-0.01	-0.05	-0.07	-0.02	
		DY	0.80	-0.87	-1.00	0.83	
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX	-0.01	-0.01	-0.01	-0.01	-0.01
		DZ	0.0	0.0	0.0	0.0	
		DY	0.49	-0.42	-0.41	0.49	
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX	0.88	0.90	0.94	0.92	1.00
		DZ	-0.03	0.07	0.09	-0.07	
		DY	--	--	--	--	
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX	1.00	1.00	1.00	1.00	1.00
		DZ	0.0	0.0	0.0	0.0	
		DY	0.02	-0.06	-0.06	0.02	
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX	-0.50	-0.47	-0.48	-0.51	-0.54
		DZ	0.03	-0.03	-0.03	0.04	
		DY	--	--	--	--	
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX	-0.78	-0.78	-0.78	-0.78	-0.78
		DZ	0.0	0.0	0.0	0.0	
		DY	-0.16	0.14	0.14	-0.16	

Normalised Measured and Computed Mode Shape for Sway X,3

f_m = 118.4 Hz, f_c = 143.89 Hz

TABLE 5.7

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISP.
	9	DX DZ DY	-0.02 -0.52 -0.83	-0.05 -0.57 -0.94	0.02 -0.52 0.91	0.04 -0.52 0.85	-0.80
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX DZ DY	-0.06 -0.26 --	-0.06 -0.31 --	0.06 -0.31 --	0.06 -0.26 --	-0.38
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	-0.03 0.11 -0.91	-0.03 0.15 -1.00	0.03 0.16 1.00	0.04 0.15 0.93	0.22
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	0.01 0.01 -0.25	0.01 0.05 -0.99	-0.01 0.05 1.00	-0.01 0.01 0.24	0.04
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	-0.08 0.61 --	-0.02 0.71 --	-0.03 0.68 --	0.04 0.65 --	1.00
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	-0.01 0.78 -0.08	-0.01 0.73 -0.18	0.0 0.73 0.17	0.0 0.78 0.08	1.00
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	0.07 -0.45 --	-0.02 -0.45 --	0.0 -0.43 --	-0.02 -0.46 --	-0.68
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	-0.01 -0.60 0.11	-0.01 -0.56 0.08	0.02 -0.56 -0.08	0.01 -0.60 -0.11	-0.77

Normalised Measured and Computed Mode Shape for Sway Z,3

f_m = 119.4 Hz, f_c = 136.02 Hz

TABLE 5.8

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISPL.	Δ % (TABLE 5.4)
	9	DX DZ DY	-0.03 -0.15 -0.06	-0.04 0.01 -0.03	-0.04 0.02 0.03	0.04 -0.14 0.06	-0.38	58.3%
COMPUTED	LEVEL	JOINT ID	73	102	103	74		
	9	DX DZ DY	-0.04 -0.24	-0.04 -0.07	0.04 -0.07	0.04 -0.24	-0.47	
MEASURED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	-0.04 -0.10 -0.08	-0.04 0.03 -0.03	0.04 0.03 0.03	0.03 -0.11 0.06	-0.22	10%
COMPUTED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	-0.04 -0.20 -0.07	-0.04 -0.05 -0.02	0.04 -0.05 0.02	0.04 -0.20 0.07	-0.38	
MEASURED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	0.08 0.24	0.07 0.04	-0.07 0.04	-0.05 0.24	0.82	0%
COMPUTED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	0.10 0.41 -0.07	0.10 0.12 -0.04	-0.20 0.12 0.04	-0.10 0.41 0.07	0.82	
MEASURED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	0.20 0.99	0.14 0.14	-0.13 0.14	-0.24 1.00	3.32	232%
COMPUTED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	0.16 1.00 -0.11	0.16 0.28 -0.02	-0.16 0.28 0.02	-0.16 1.00 0.11	1.94	

Normalised Measured and Computed Mode Shape for Sway Z,2

f_m = 39.1 Hz, f_c = 44.09 Hz.

MEMBER 84 REMOVED

TABLE 5.9

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISPL.	Δ % (TABLE 5.7)
	9	DX DZ DY	-0.06 0.02 0.10	-0.09 -0.05 -0.33	-0.29 -0.13 -0.10	-0.31 0.08 0.73	-0.28	-9.7%
COMPUTED	LEVEL	JOINT ID	73	102	103	74		
	9	DX DZ DY	0.05 -0.05	0.06 0.03	-0.24 0.03	-0.24 -0.05	-0.12	
MEASURED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	0.09 0.12 0.10	0.08 0.16 -0.34	-0.02 -0.17 -0.88	-0.12 0.07 0.074	0.01	-83%
COMPUTED	LEVEL	JOINT ID	53	97	96	54		
	8	DX DZ DY	0.0 0.08 -0.46	0.0 -0.11 0.45	-0.08 -0.11 -0.72	-0.08 0.08 0.69	-0.05	
MEASURED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DX DY	0.45 -0.53	0.54 0.53	0.87 0.38	0.85 -0.38	1.00	0%
COMPUTED	LEVEL	JOINT ID	50	51	52	49		
	7	DX DZ DY	0.58 -0.28 -0.02	0.58 0.38 0.03	1.00 0.38 -0.19	1.00 -0.28 0.15	1.00	
MEASURED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	-0.23 0.22	-0.21 -0.22	-0.56 -0.25	-0.56 0.23	-0.58	7.4%
COMPUTED	LEVEL	JOINT ID	13	14	15	16		
	3	DX DZ DY	-0.31 0.20 -0.08	-0.31 -0.27 0.10	-0.67 -0.27 -0.02	-0.67 0.20 -0.01	-0.62	

Normalised Measured and Computed Mode Shape X,3

f_m = 96.9 Hz, f_c = 113.83 Hz.

MEMBER 135 REMOVED

TABLE 5.10

MODE	MEASURED FREQ (Hz)	COMPUTED FREQ (Hz)	Δ%
Sway Z,1	14.2	15.07	6.1
Sway X,1	16.0	16.46	2.9
Torsion 1	19.5	19.45	-0.3
Sway Z,2	60.3	62.59	3.8
Sway X,2	56.4	64.48	14.3
Torsion 2	67.8	81.44	20.1
Sway Z,3	119.4	136.0	13.9
Sway X,3	118.4	143.9	21.5
Torsion 3	Not Identified	169.1	--

Comparison of Measured and Computed Sway and Torsion Natural Frequencies

TABLE 5.11

MODE	MEASURED FREQ. (Hz)	COMPUTED FREQ. (Hz)	Δ %
Ovalising 1	40.5	39.60	-2.2
Ovalising 2	48.5	46.39	-4.4
Ovalising 3	60.9	57.99	-4.8
Ovalising 4	81.	79.15	-2.3
Ovalising 5	102.2	101.8	-0.4
Ovalising 6	154.6	155.5	0.6
Vertical	75.7	84.18	11.2
Deck Pitch	105.4	90.60	-14.
Deck Roll	80.3	101.3	26.2
Deck Twist	130.0	127.4	-2.0
Deck Bending	Not Identified	159.7	--

Comparison of Measured and Computed Natural Frequencies

TABLE 5.12

	MEMBER NO. 84		MEMBER NO. 135	
MODE	MEASURED	COMPUTED	MEASURED	COMPUTED
Sway Z,1	N.C.	-2.7%	N.C.	N.C.
Sway X,1	N.C.	N.C.	-1.9%	-3.1%
Torsion 1	-2.0%	-1.3%	-3.1%	-3.6%
Sway Z,2	-35.1%	-29.6%	N.C.	N.C.
Sway X,2	N.C.	N.C.	N.C.	N.C.
Torsion 2	-4%	-8.7%	N.C.	N.C.
Sway Z,3	N.C.	-1.9%	N.C.	N.C.
Sway X,3	N.C.	N.C.	-18.1%	-20.9%
Torsion 3	Not Identified	-2.7%	Not Identified	-4.1%

N.C. < 1% change

Percent Changes in Measured and Computed Sway and Torsion Frequencies with Members 84 and 135 Removed in Turn

TABLE 5.13

	MEMBER NO. 84		MEMBER NO. 135	
MODE	MEASURED	COMPUTED	MEASURED	COMPUTED
Ovalising 1	N.M.	+1.2%	N.C.	N.C.
Ovalising 2	N.M.	N.C.	N.C.	N.C.
Ovalising 3	N.M.	N.C.	N.C.	N.C.
Ovalising 4	N.M.	N.C.	1.4%	1.9%
Ovalising 5	N.M.	N.C.	N.C.	N.C.
Ovalising 6	N.M.	N.C.	N.C.	N.C.
Vertical	N.M.	N.C.	N.M.	N.C.
Deck Pitch	N.C.	N.C.	-12.1%	N.C.
Deck Roll	N.C.	-3.1%	N.C.	N.C.
Deck Twist	N.M.	N.C.	N.M.	+1.5%
Deck Bending	Not Identified	N.C.	Not Identified	N.C.

N.C. < 1% change

Not Measured (N.M.)

Percent Changes in Measured and Computed Natural Frequencies with Members 84 and 135 Removed in Turn

TABLE 5.14

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISPL.
	9	DX DZ DY	-0.23 0.01 0.77	-0.21 0.01 -0.66	-0.23 0.05 -0.72	-0.22 0.04 0.63	-0.24
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX DZ DY	-0.17 0.0	-0.16 0.0	-0.16 0.0	-0.17 0.0	-0.17
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	0.08 -0.07 0.74	0.06 -0.05 -0.63	0.07 -0.06 -0.71	0.05 -0.05 0.59	0.07
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	-0.01 0.0 0.49	-0.01 0.0 -0.42	-0.01 0.0 -0.41	-0.01 0.0 0.49	-0.01
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	0.91 0.20	0.97 0.27	0.84 0.23	1.00 0.23	1.00
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	1.00 0.0 0.02	1.00 0.0 -0.06	1.00 0.0 -0.06	1.00 0.0 0.02	1.00
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	-0.62 -0.17	-0.57 -0.26	-0.63 -0.19	-0.57 -0.31	-0.64
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	-0.78 0.0 -0.16	-0.78 0.0 0.14	-0.78 0.0 0.14	-0.78 0.0 -0.16	-0.78

Normalised Measured and Computed Mode Shape.

f_m = 122.4 Hz, second third sway mode in X-direction; f_c = 143.9 Hz, sway X,3 (Table 5.7)

TABLE 5.15

MEASURED	LEVEL	JOINT ID	73	102	103	74	MEAN DISPL.
	9	DX DZ DY	-0.04 -0.49 -0.69	-0.05 -0.50 -0.92	0.06 -0.49 -0.90	0.06 -0.46 0.71	-0.71
COMPUTED	LEVEL	JOINT ID	73	102	103	74	
	9	DX DZ DY	-0.06 -0.26	-0.06 -0.31	0.06 -0.31	0.06 -0.26	-0.38
MEASURED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	-0.01 0.09 -0.78	0.02 0.16 -1.0	0.03 0.18 0.97	0.04 0.14 0.81	0.21
COMPUTED	LEVEL	JOINT ID	53	97	96	54	
	8	DX DZ DY	0.01 0.01 -0.25	0.01 0.05 -0.99	-0.01 0.05 1.00	-0.01 0.01 0.24	0.04
MEASURED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	-0.02 0.66	-0.01 0.73	0.04 0.65	0.02 0.70	1.00
COMPUTED	LEVEL	JOINT ID	50	51	52	49	
	7	DX DZ DY	-0.01 0.78 -0.08	-0.01 0.73 -0.18	0.0 0.73 0.17	0.0 0.78 0.08	1.00
MEASURED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	-0.02 -0.46	0.08 -0.38	-0.05 -0.40	0.04 -0.43	-0.61
COMPUTED	LEVEL	JOINT ID	13	14	15	16	
	3	DX DZ DY	-0.01 -0.60 0.11	-0.01 -0.56 0.08	0.02 -0.56 -0.08	0.01 -0.60 -0.11	-0.77

Normalised Measured and Computed Mode Shape.

f_m = 126. Hz, second third sway mode in Z-direction; f_c = 136.02 Hz, sway Z,3 (Table 5.8)

TABLE 5.16

MEASURED	LEVEL	JOINT ID	73	102	103	74
	9	DX DZ DY	-0.15 0.05 0.43	-0.18 -0.23 -0.95	0.12 -0.17 0.57	0.12 0.04 -0.51
COMPUTED	LEVEL	JOINT ID	73	102	103	74
	9	DX DZ DY	-0.16 0.2	-0.16 -0.07	0.16 -0.07	0.16 0.2
MEASURED	LEVEL	JOINT ID	53	97	96	54
	8	DX DZ DY	0.0 -0.09 0.44	0.0 0.07 -1.00	0.03 0.11 0.55	0.03 -0.06 -0.61
COMPUTED	LEVEL	JOINT ID	53	97	96	54
	8	DX DZ DY	-0.01 -0.07 1.00	-0.01 0.09 -0.77	0.01 0.09 0.77	0.01 -0.07 -1.00
MEASURED	LEVEL	JOINT ID	50	51	52	49
	7	DX DZ DY	0.01 0.07	0.02 -0.04	-0.03 -0.05	-0.04 0.08
COMPUTED	LEVEL	JOINT ID	50	51	52	49
	7	DX DZ DY	-0.02 -0.11 0.10	-0.02 -0.19 -0.1	0.02 -0.19 0.1	0.01 -0.11 -0.10
MEASURED	LEVEL	JOINT ID	13	14	15	16
	3	DX DZ DY	-0.10 -0.18	0.04 -0.05	0.06 0.03	-0.02 -0.11
COMPUTED	LEVEL	JOINT ID	13	14	15	16
	3	DX DZ DY	-0.01 0.08 0.0	-0.01 0.14 -0.05	0.02 0.14 0.05	0.02 0.08 0.0

Normalised Measured and Computed Mode Shape

for Deck Twist, f_m = 130.Hz, f_c = 127.44 Hz.

TABLE 5.17

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\bar{g}\bar{N}$xE6)	Phase (Deg)	Coherence
10.	91410.	33.55	4.39	401.8	176.3	.052
10.4	104000.	37.44	4.06	422.9	-178.6	.045
10.8	113600.	39.36	4.05	460.2	167.6	.047
11.2	145200.	51.09	6.18	898.2	173.2	.108
11.6	158600.	63.83	6.86	1088.	170.1	.116
12.	162300.	84.36	9.87	1603.	-177.9	.187
12.4	201800.	126.2	12.16	2454.	172.3	.236
12.8	223600.	189.4	15.38	3440.	168.7	.279
13.2	217300.	385.	23.33	5072.	168.5	.307
13.6	273500.	1168.	38.19	10440.	172.5	.341
14.	281100.	17510.	146.5	41180.	127.9	.344
14.4	276000.	3976.	76.05	20990.	17.55	.401
14.8	308300.	791.9	30.55	9423.	11.54	.363
15.2	323100.	385.3	15.48	5005.	12.34	.201
15.6	397800.	741.6	16.	6365.	75.07	.137
16.	443500.	841.1	26.1	11580.	23.01	.359
16.4	436200.	286.7	13.71	5984.	3.97	.286
16.8	481700.	255.7	10.3	4961.	2.46	.199
17.2	533100.	274.8	5.83	3110.	3.64	.066
17.6	575800.	389.7	4.1	2361.	27.97	.024
18.	639300.	705.5	.91	587.6	81.98	.000
18.4	679800.	1869.	10.76	7320.	164.5	.042
18.8	813000.	14910.	60.74	49380.	166.	.201
19.2	674500.	25030.	26.27	17720.	48.24	.018
19.6	754400.	2701.	25.17	18990.	8.58	.176
20.	806200.	1115.	20.96	16900.	8.26	.317
20.4	848400.	549.1	14.04	11910.	2.69	.304
20.8	865500.	385.6	13.19	11420.	4.89	.390
21.2	907200.	298.4	12.37	11220.	-1.14	.465
21.6	920300.	248.7	11.95	11000.	-1.62	.528
22.	1076000.	221.4	10.86	11700.	-.05	.574
22.4	943100.	163.3	10.1	9527.	-1.93	.588
22.8	1045000.	158.4	9.73	10160.	3.96	.623
23.2	1176000.	152.	9.18	10790.	2.05	.651
23.6	1326000.	151.1	8.98	11920.	1.26	.708
24.	1380000.	140.6	8.65	11940.	1.43	.734
24.4	1315000.	128.2	8.44	11100.	.13	.730
24.8	1259000.	110.3	7.91	9964.	.46	.713
25.2	1415000.	120.	7.97	11290.	-.65	.749
25.6	1391000.	110.6	7.79	10840.	.98	.763
26.	1386000.	103.7	7.58	10510.	-.42	.768
26.4	1521000.	117.7	7.85	11940.	-2.09	.796
26.8	1416000.	100.5	7.51	10630.	.15	.794
27.2	1737000.	117.1	7.37	12800.	-.29	.805
27.6	1697000.	108.	7.15	12150.	1.86	.804
28.	1826000.	118.9	7.4	13510.	2.73	.840
28.4	1785000.	110.2	7.24	12940.	-.12	.85
28.8	1921000.	119.2	7.16	13760.	-.37	.826
29.2	1881000.	108.6	7.00	13180.	1.40	.849
29.6	1900000.	109.5	7.08	13460.	.79	.870

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\overline{gN}$xE6)	Phase (Deg)	Coherence
30.	1902000.	103.2	6.79	12920.	-.14	.849
30.4	1955000.	106.3	6.85	13390.	-.05	.862
30.8	2022000.	112.	6.85	13860.	.53	.848
31.2	1957000.	107.5	6.92	13540.	-.40	.871
31.6	2182000.	113.3	6.72	14670.	.07	.870
32.	2120000.	110.	6.73	14280.	1.21	.874
32.4	2218000.	112.2	6.61	14680.	-.18	.865
32.8	2274000.	112.1	6.56	14930.	-.18	.873
33.2	2250000.	112.2	6.66	14990.	.49	.889
33.6	2251000.	111.9	6.64	14970.	-.74	.888
34.	2238000.	111.3	6.63	14840.	-.40	.884
34.4	2273000.	116.2	6.72	15280.	-.34	.883
34.8	2274000.	106.7	6.48	14740.	-1.99	.894
35.2	2080000.	101.	6.49	13500.	-.89	.867
35.6	2321000.	106.5	6.36	14760.	.29	.881
36.	2421000.	116.8	6.56	15890.	-.23	.891
36.4	2097000.	99.75	6.47	13570.	.15	.880
36.8	2428000.	108.7	6.24	15160.	-.60	.869
37.2	2377000.	110.9	6.44	15330.	-.51	.891
37.6	2587000.	115.2	6.35	16430.	.98	.905
38.	2489000.	121.5	6.65	16560.	-.32	.906
38.4	2570000.	117.2	6.4	16440.	-.55	.897
38.8	2627000.	125.1	6.56	17250.	.00	.905
39.2	2675000.	131.1	6.73	18010.	-1.66	.924
39.6	2454000.	119.7	6.63	16280.	-.33	.902
40.	2759000.	138.9	6.77	18680.	.08	.910
40.4	2798000.	130.2	6.50	18210.	-1.33	.91
40.8	2560000.	124.9	6.64	17000.	1.18	.903
41.2	2566000.	126.4	6.64	17060.	1.65	.896
41.6	2753000.	130.9	6.56	18060.	-.63	.904
42.	2867000.	140.5	6.69	19210.	.24	.915
42.4	2514000.	132.	6.91	17370.	.05	.909
42.8	2659000.	141.3	6.96	18510.	-.51	.911
43.2	2886000.	142.9	6.72	19420.	-.03	.914
43.6	2675000.	135.7	6.76	18100.	-1.10	.901
44.	2728000.	142.9	6.92	18900.	.25	.915
44.4	2653000.	142.2	6.99	18570.	.09	.913
44.8	2634000.	144.6	7.03	18530.	-.41	.901
45.2	2647000.	146.1	7.07	18720.	-.48	.906
45.6	2884000.	154.3	6.97	20110.	-1.94	.908
46.	3005000.	165.2	7.08	21290.	.22	.912
46.4	2769000.	158.1	7.20	19940.	.33	.907
46.8	2808000.	159.5	7.17	20150.	-.41	.906
47.2	2862000.	169.6	7.32	20950.	.27	.904
47.6	2802000.	172.7	7.45	20890.	.13	.901
48.	2717000.	161.2	7.33	19920.	.35	.905
48.4	2527000.	163.9	7.62	19260.	.69	.895
48.8	2860000.	188.9	7.74	22140.	-.71	.907
49.2	2665000.	184.5	7.82	20850.	1.20	.884
49.6	2739000.	187.5	7.88	21610.	-1.01	.908

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18 contd

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\bar{g}\bar{N}$xE6)	Phase (Deg)	Coherence
50.	2752000.	216.9	7.83	21570.	-2.06	.779
50.4	2725000.	197.6	8.08	22040.	.68	.901
50.8	2882000.	219.3	8.29	23890.	-.19	.903
51.2	2702000.	206.2	8.24	22270.	-.63	.89
51.6	2799000.	228.6	8.61	24110.	-.31	.908
52.	2486000.	216.	8.75	21760.	-.79	.881
52.4	2547000.	225.5	8.83	22490.	-2.39	.880
52.8	2723000.	243.7	8.89	24210.	-1.00	.882
53.2	2664000.	257.4	9.26	24670.	-1.14	.887
53.6	2902000.	313.2	9.81	28480.	-.02	.891
54.	3107000.	340.1	9.89	30730.	-1.18	.893
54.4	2845000.	336.9	10.27	29240.	-1.88	.891
54.8	2560000.	321.5	10.36	26520.	-.97	.854
55.2	2865000.	400.2	11.04	31650.	-1.54	.873
55.6	2933000.	465.6	11.83	34720.	-2.11	.882
56.	2581000.	420.4	11.69	30190.	-1.67	.839
56.4	2641000.	485.7	12.34	32600.	-2.84	.828
56.8	2680000.	543.1	12.84	34430.	-.99	.814
57.2	2633000.	667.8	14.38	37890.	-1.85	.816
57.6	2560000.	754.5	15.2	38930.	.47	.784
58.	2646000.	1001.	17.13	45350.	-2.10	.775
58.4	2516000.	1336.	19.99	50320.	-4.78	.752
58.8	2812000.	2199.	24.38	68580.	-6.80	.76
59.2	2876000.	3643.	29.98	86250.	-6.28	.709
59.6	2604000.	8335.	46.02	119800.	-14.9	.661
60.	2631000.	47360.	105.2	277000.	-44.53	.615
60.4	2511000.	37330.	88.19	221500.	-130.5	.523
60.8	2985000.	5978.	32.48	96970.	-155.	.526
61.2	2649000.	2154.	18.96	50240.	-161.8	.442
61.6	2573000.	871.4	10.36	26670.	-166.	.317
62.	2687000.	493.5	6.81	18310.	-168.5	.252
62.4	2657000.	290.8	3.85	10230.	-169.9	.135
62.8	2780000.	204.3	1.85	5170.	-153.	.047
63.2	2817000.	155.1	.33	940.	-92.27	.002
63.6	2829000.	140.8	1.72	4889.	-29.51	.059
64.	2736000.	141.8	3.03	8309.	-16.28	.177
64.4	2520000.	147.8	3.65	9210.	-4.30	.227
64.8	2286000.	160.6	4.90	11210.	-5.09	.342
65.2	2402000.	186.	5.55	13330.	-5.98	.397
65.6	2574000.	270.5	7.37	18970.	-1.92	.516
66.	2730000.	385.7	8.99	24560.	-6.04	.572
66.4	2374000.	573.	11.81	28050.	-8.41	.578
66.8	2616000.	1269.	17.55	45920.	-6.05	.634
67.2	2622000.	3748.	30.07	78870.	-15.2	.632
67.6	2604000.	29690.	73.33	190900.	-67.14	.471
68.	2645000.	7026.	39.33	104000.	-153.4	.582
68.4	2513000.	1387.	17.16	43130.	-166.4	.533
68.8	2353000.	505.9	9.76	22970.	-166.1	.443
69.2	2477000.	279.1	6.62	16410.	-171.7	.389
69.6	2495000.	159.8	4.21	10500.	-177.7	.276

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18 contd

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\overline{gN}$xE6)	Phase (Deg)	Coherenc
70.	2489000.	100.9	2.48	6195.	-169.9	.152
70.4	2531000.	73.38	1.29	3284.	-172.	.058
70.8	2532000.	57.68	1.09	2775.	-135.4	.052
71.2	2618000.	49.76	.33	865.7	-86.83	.005
71.6	2414000.	42.48	.67	1624.	-64.09	.025
72.	2299000.	41.37	.86	1993.	-13.86	.041
72.4	2471000.	43.19	1.69	4197.	-19.43	.164
72.8	2157000.	36.2	1.43	3094.	-12.51	.122
73.2	2540000.	41.	1.93	4904.	-10.76	.230
73.6	2170000.	51.01	2.93	6369.	-1.74	.366
74.	2462000.	52.92	2.90	7158.	-.28	.393
74.4	2371000.	57.26	3.40	8074.	1.9	.479
74.8	2486000.	62.94	3.62	9015.	-1.79	.519
75.2	2340000.	76.81	4.46	10450.	-2.44	.607
75.6	2438000.	80.14	4.58	11180.	-3.56	.64
76.	2356000.	95.24	5.17	12190.	-1.58	.662
76.4	2215000.	112.9	5.91	13100.	-2.62	.685
76.8	2368000.	138.9	6.47	15330.	-.54	.714
77.2	2369000.	167.9	7.39	17520.	-4.63	.771
77.6	2073000.	183.3	8.09	16780.	-5.11	.740
78.	2363000.	294.7	9.86	23300.	-3.28	.779
78.4	2513000.	454.	12.05	30300.	-5.86	.804
78.8	2040000.	636.9	15.68	32000.	-7.84	.787
79.2	2174000.	1331.	21.75	47300.	-13.39	.772
79.6	2158000.	4279.	38.73	83610.	-31.47	.756
80.	2221000.	9485.	52.7	117100.	-93.99	.650
80.4	2344000.	2289.	26.17	61370.	-143.5	.701
80.8	2497000.	539.9	10.99	27440.	-145.4	.558
81.2	2293000.	309.3	8.24	18910.	-139.5	.504
81.6	2357000.	143.2	4.11	9692.	-106.5	.277
82.	2197000.	261.6	7.12	15640.	-62.23	.425
82.4	2025000.	1551.	20.15	40810.	-98.27	.529
82.8	2269000.	769.2	15.59	35380.	-161.8	.716
83.2	2170000.	213.9	7.90	17160.	-175.3	.634
83.6	2257000.	115.3	5.46	12340.	-175.1	.584
84.	2266000.	71.97	3.69	8382.	-179.	.430
84.4	2022000.	45.32	2.47	5005.	-167.4	.273
84.8	2066000.	51.08	3.32	6873.	-150.4	.447
85.2	2058000.	37.69	2.69	5543.	-174.8	.395
85.6	2029000.	30.67	2.06	4190.	-169.4	.281
86.	2092000.	26.91	1.80	3773.	174.9	.252
86.4	2002000.	20.92	.82	1644.	-170.8	.064
86.8	2104000.	20.03	.46	988.3	-174.1	.023
87.2	2219000.	20.6	.65	1443.	-156.2	.045
87.6	2186000.	20.99	.28	622.7	-78.17	.008
88.	2105000.	20.6	.60	1281.	-150.9	.037
88.4	2010000.	15.58	.18	362.7	-174.1	.004
88.8	1860000.	16.64	.16	312.1	92.14	.003
89.2	2071000.	17.41	.30	625.1	26.74	.010
89.6	2077000.	16.75	.56	1166.	-3.60	.039

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18 contd

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\overline{gN}$xE6)	Phase (Deg)	Coherence
90.	2044000.	18.3	.98	2019.	3.82	.108
90.4	2000000.	19.04	1.27	2541.	-.86	.169
90.8	1937000.	24.99	1.76	3421.	-4.62	.241
91.2	1899000.	142.8	2.99	5696.	-82.49	.119
91.6	2094000.	21.73	.20	430.4	-34.85	.004
92.	2019000.	19.44	.51	1031.	.01	.027
92.4	1958000.	17.38	.75	1487.	2.13	.064
92.8	1914000.	24.14	1.24	2384.	.75	.122
93.2	1901000.	29.76	.76	1462.	-5.61	.037
93.6	1861000.	22.56	1.02	1901.	3.81	.086
94.	1985000.	17.49	1.22	2430.	-6.84	.169
94.4	1906000.	18.44	1.37	2620.	-5.93	.195
94.8	1749000.	19.38	1.47	2582.	-1.03	.196
95.2	2042000.	23.13	1.38	2821.	10.86	.168
95.6	1817000.	21.71	1.63	2969.	1.94	.223
96.	1676000.	20.44	1.47	2476.	-8.26	.178
96.4	1846000.	22.7	1.35	2498.	.86	.148
96.8	1954000.	22.64	1.50	2942.	4.99	.195
97.2	1749000.	23.21	.78	1365.	1.36	.045
97.6	1707000.	68.04	1.57	2696.	108.1	.062
98.	1887000.	112.4	4.66	8805.	25.71	.365
98.4	1720000.	36.27	3.11	5363.	8.73	.460
98.8	1776000.	29.93	2.79	4961.	-1.73	.462
99.2	1985000.	28.53	2.64	5248.	4.86	.486
99.6	1792000.	27.2	2.42	4340.	-1.72	.386
100.	1719000.	29.64	2.66	4575.	4.16	.410
100.4	1855000.	29.28	2.44	4535.	3.62	.378
100.8	1747000.	27.11	2.51	4399.	3.27	.408
101.2	1734000.	30.37	2.68	4657.	-4.87	.411
101.6	1686000.	30.55	2.80	4734.	1.23	.434
102.	1826000.	32.07	3.02	5516.	.69	.519
102.4	1728000.	32.61	2.90	5021.	2.39	.447
102.8	1807000.	30.07	2.75	4986.	-3.53	.457
103.2	1617000.	29.87	2.83	4580.	.32	.433
103.6	1614000.	28.11	2.77	4475.	1.84	.441
104.	1826000.	34.65	2.87	5243.	3.14	.434
104.4	1829000.	31.75	2.76	5064.	.50	.441
104.8	1663000.	34.	2.92	4869.	-1.5	.419
105.2	1714000.	35.52	2.87	4922.	.52	.397
105.6	1683000.	36.68	3.00	5059.	.66	.414
106.	1549000.	32.49	2.65	4107.	2.01	.334
106.4	1709000.	35.21	2.25	3847.	7.48	.245
106.8	1555000.	64.82	1.08	1687.	109.6	.028
107.2	1507000.	418.7	10.4	15680.	52.33	.389
107.6	1549000.	142.2	7.93	12290.	2.90	.685
108.	1703000.	110.2	6.36	10840.	-10.81	.626
108.4	1557000.	68.13	4.80	7477.	-3.47	.526
108.8	1595000.	80.22	5.53	8825.	-1.89	.608
109.2	1492000.	94.15	6.06	9053.	-2.47	.582
109.6	1633000.	156.2	7.27	11870.	-9.54	.552

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18 contd

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\overline{gN}$xE6)	Phase (Deg)	Coherence
110.	1522000.	634.5	12.03	18320.	-43.93	.347
110.4	1608000.	148.	3.29	5302.	-111.7	.118
110.8	1558000.	54.13	1.93	3017.	-.24	.107
111.2	1571000.	51.53	3.08	4845.	.32	.289
111.6	1673000.	60.94	3.76	6299.	3.16	.388
112.	1548000.	81.06	4.97	7703.	-1.48	.472
112.4	1446000.	571.3	7.38	10680.	-62.29	.138
112.8	1570000.	56.24	.18	289.4	-172.2	.000
113.2	1461000.	122.8	3.21	4691.	123.9	.122
113.6	1395000.	366.9	10.67	14900.	35.23	.433
114.	1468000.	128.6	6.83	10030.	7.84	.533
114.4	1420000.	122.4	6.82	9704.	6.81	.540
114.8	1436000.	221.	8.73	12550.	-19.49	.495
115.2	1534000.	119.5	5.36	8236.	-3.39	.369
115.6	1504000.	141.2	6.28	9461.	.01	.421
116.	1457000.	211.8	8.67	12640.	-.19	.517
116.4	1317000.	458.3	12.37	16300.	-4.38	.439
116.8	1467000.	789.8	9.79	14370.	-71.77	.178
117.2	1283000.	195.9	4.17	5361.	-11.45	.114
117.6	1331000.	286.7	8.05	10710.	-2.56	.300
118.	1336000.	364.3	7.54	10080.	-17.62	.208
118.4	1302000.	657.7	10.8	14070.	-.77	.231
118.8	1460000.	1833.	19.21	28050.	-10.87	.293
119.2	1357000.	14840.	56.18	76280.	-33.29	.288
119.6	1414000.	13080.	45.89	64920.	-137.9	.227
120.	1334000.	1574.	14.25	19020.	-162.4	.172
120.4	1388000.	588.2	7.36	10230.	-165.3	.128
120.8	1430000.	311.6	4.66	6667.	-163.8	.099
121.2	1394000.	209.1	2.66	3716.	-167.	.047
121.6	1367000.	169.9	1.28	1758.	-130.6	.013
122.	1370000.	166.5	1.10	1512.	-47.75	.010
122.4	1378000.	208.9	3.11	4286.	-134.7	.063
122.8	1154000.	142.8	.96	1112.	172.2	.007
123.2	1275000.	146.9	.23	303.6	-84.01	.000
123.6	1212000.	156.9	1.36	1650.	-3.77	.014
124.	1433000.	186.9	1.72	2474.	-10.56	.022
124.4	1215000.	236.8	2.72	3308.	14.35	.038
124.8	1191000.	329.3	4.77	5689.	-9.98	.082
125.2	1265000.	643.4	9.69	12270.	-4.40	.184
125.6	1191000.	2267.	26.03	31030.	-7.48	.356
126.	1169000.	42500.	90.79	106100.	-92.94	.226
126.4	1251000.	5035.	51.62	64590.	-170.8	.662
126.8	1178000.	3573.	44.66	52620.	-176.7	.657
127.2	1147000.	5906.	53.04	60880.	174.4	.546
127.6	1125000.	63860.	131.2	147600.	120.2	.303
128.	1134000.	7452.	35.99	40840.	29.85	.197
128.4	1185000.	7514.	42.88	50830.	156.4	.29
128.8	1197000.	85930.	145.	173600.	72.32	.292
129.2	1141000.	7578.	60.63	69210.	21.77	.553
129.6	1155000.	4040.	44.5	51440.	30.48	.566

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18 contd

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\bar{g}\bar{N}$xE6)	Phase (Deg)	Coherence
130.	1066000.	5179.	55.95	59640.	20.56	.644
130.4	1098000.	3233.	46.54	51130.	2.66	.735
130.8	1104000.	2644.	37.9	41850.	-1.58	.599
131.2	1094000.	3033.	21.85	23900.	12.7	.172
131.6	1054000.	10520.	74.18	78200.	20.02	.551
132.	1035000.	13440.	83.99	86940.	-4.72	.542
132.4	1029000.	70720.	177.3	182500.	-22.42	.457
132.8	1078000.	101800.	153.5	165600.	-119.8	.249
133.2	1195000.	10140.	43.23	51680.	-147.5	.220
133.6	984500.	3967.	25.5	25100.	-108.1	.161
134.	977600.	2721.	25.86	25280.	-157.5	.240
134.4	1003000.	1073.	9.48	9518.	-179.6	.084
134.8	1003000.	684.2	2.24	2251.	-56.62	.007
135.2	947600.	642.4	6.96	6600.	-111.3	.071
135.6	1037000.	380.8	1.75	1818.	-57.36	.008
136.	945600.	364.5	5.84	5529.	2.01	.088
136.4	887900.	450.5	11.8	10480.	-5.79	.274
136.8	953600.	1109.	23.6	22510.	-6.24	.478
137.2	970400.	10090.	48.65	47210.	-82.71	.227
137.6	960500.	474.1	7.04	6768.	-149.4	.100
138.	910800.	311.7	4.98	4542.	-39.56	.072
138.4	918700.	577.5	14.43	13250.	-15.66	.331
138.8	932800.	1593.	25.16	23470.	-13.66	.370
139.2	923000.	30640.	92.77	85620.	-85.86	.259
139.6	908600.	2877.	41.04	37290.	-169.9	.531
140.	901200.	619.	15.95	14380.	-168.8	.370

RMS values between frequency limits 10Hz to 140Hz	
Joint 82Z	Joint 49Z
Force 24.4 (Newtons)	Acceleration 0.912 (g)
	Velocity 29.5 (mm/sec)
	Displacement 0.258 (mm)

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Table 5.18 contd

Freq. (Hz)	Acceln ($\ddot{g}^2$xE6) Joint 49Z	Acceln ($\ddot{g}^2$xE6) Joint 76Z	F.R.F. ($\ddot{g}/\ddot{g}$) (76Z/49Z)	X-Spec. ($\ddot{g}^2$xE6)	Phase (Deg.)	Coherence
10.	50.6	116.3	.691	35.0	-2.31	.207
10.4	57.7	150.2	.7608	43.9	7.35	.222
10.8	60.9	167.5	1.017	62.	-2.45	.376
11.2	78.3	198.2	.9796	76.7	3.71	.379
11.6	97.0	246.4	1.115	108.2	.01	.490
12.	121.5	291.1	1.131	137.4	.31	.534
12.4	187.3	452.	1.181	221.3	-.97	.578
12.8	269.7	653.4	1.315	354.9	.11	.714
13.2	477.4	1197.	1.461	697.7	1.07	.851
13.6	1209.	3037.	1.496	1809.	-.02	.891
14.	7744.	19370.	1.545	11960.	1.37	.954
14.4	21860.	56050.	1.586	34700.	.71	.982
14.8	1993.	5147.	1.554	3099.	1.62	.936
15.2	726.1	1867.	1.514	1099.	.42	.891
15.6	397.9	1084.	1.324	527.1	-2.18	.643
16.	1964.	5480.	1.623	3188.	1.62	.944
16.4	464.9	1330.	1.519	706.6	.20	.807
16.8	292.8	1000.	1.505	440.6	-1.04	.662
17.2	239.7	978.8	1.587	380.5	4.63	.617
17.6	217.6	1251.	1.935	421.2	-1.92	.651
18.	236.8	1838.	2.279	539.8	2.37	.669
18.4	318.7	3292.	2.79	889.4	-.41	.753
18.8	724.4	8683.	3.227	2337.	1.08	.868
19.2	4051.	51390.	3.498	14170.	.86	.964
19.6	24300.	295200.	3.476	84520.	1.03	.995
20.	1767.	19130.	3.238	5723.	1.43	.968
20.4	661.7	6119.	2.908	1924.	2.18	.914
20.8	404.4	3473.	2.758	1115.	-.28	.885
21.2	326.3	2278.	2.397	782.5	.24	.823
21.6	263.6	1597.	2.134	562.7	.51	.751
22.	216.8	1167.	1.932	419.1	1.17	.693
22.4	201.	1184.	2.146	431.4	-.90	.781
22.8	173.9	948.9	2.04	354.9	-1.16	.763
23.2	163.5	740.5	1.758	287.7	-.00	.683
23.6	154.2	674.9	1.685	259.9	1.03	.649
24.	164.2	694.7	1.682	276.3	1.37	.669
24.4	153.8	682.6	1.791	275.6	2.08	.723
24.8	139.5	685.1	1.831	255.5	3.09	.683
25.2	135.4	552.9	1.748	236.7	-.52	.748
25.6	133.	528.4	1.674	222.8	.32	.705
26.	152.4	529.8	1.51	230.2	0.	.656
26.4	139.3	511.8	1.584	220.7	2.49	.683
26.8	140.7	448.3	1.387	195.1	.22	.603
27.2	159.8	520.	1.46	233.5	-3.19	.655
27.6	144.6	437.1	1.377	199.3	-.65	.628
28.	141.8	492.5	1.556	220.7	.63	.697
28.4	130.8	438.5	1.501	196.4	.31	.672
28.8	132.	446.2	1.465	193.5	.01	.635
29.2	132.1	441.1	1.597	211.	.57	.763
29.6	146.3	477.4	1.534	224.5	-.27	.721

Response Spectra at Joints 49Z & 76Z

Table 5.19

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 76Z	F.R.F. ($\bar{g}/\bar{g}$) (76Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
30.	155.7	472.1	1.44	224.3	1.23	.684
30.4	138.5	451.8	1.556	215.6	-.05	.742
30.8	140.2	437.7	1.51	211.8	-.86	.731
31.2	140.5	408.7	1.408	197.8	1.06	.681
31.6	146.9	422.4	1.366	200.8	.52	.649
32.	147.5	439.9	1.435	211.8	1.10	.691
32.4	134.	405.3	1.496	200.6	-2.14	.740
32.8	144.2	418.3	1.467	211.7	3.05	.743
33.2	143.1	435.9	1.498	214.4	-1.15	.736
33.6	138.	468.7	1.504	207.6	-2.30	.666
34.	146.	425.9	1.415	206.6	.24	.686
34.4	138.8	437.9	1.52	211.1	.47	.733
34.8	121.1	397.3	1.538	186.3	2.29	.721
35.2	149.2	398.6	1.368	204.2	-2.14	.701
35.6	146.5	393.5	1.416	207.6	-1.58	.747
36.	140.1	415.6	1.442	202.1	.86	.701
36.4	151.8	416.3	1.402	212.9	1.83	.717
36.8	138.7	406.9	1.467	203.6	2.42	.734
37.2	138.	375.8	1.364	188.3	2.52	.683
37.6	134.7	359.4	1.415	190.5	.47	.750
38.	152.6	409.	1.447	221.	1.08	.782
38.4	148.5	382.1	1.387	206.1	-1.18	.748
38.8	165.3	475.8	1.369	226.3	.68	.651
39.2	144.	409.9	1.376	198.3	-1.94	.665
39.6	153.	370.4	1.341	205.2	2.2	.743
40.	157.9	389.	1.356	214.3	1.19	.747
40.4	150.5	378.4	1.357	204.4	-1.56	.733
40.8	150.4	348.	1.309	197.	-.85	.741
41.2	157.3	356.3	1.292	203.4	.27	.737
41.6	162.7	355.4	1.253	203.9	.23	.719
42.	150.5	333.1	1.265	190.5	-1.11	.723
42.4	169.4	371.4	1.271	215.4	.36	.737
42.8	171.4	371.3	1.248	213.9	-.42	.718
43.2	173.9	388.9	1.275	221.8	.55	.727
43.6	171.7	353.6	1.256	215.8	-1.59	.767
44.	170.	374.4	1.283	218.2	1.36	.748
44.4	202.1	400.2	1.197	242.	1.41	.723
44.8	193.5	366.9	1.191	230.6	.77	.748
45.2	193.8	391.8	1.265	245.3	.58	.792
45.6	214.6	390.3	1.094	235.	1.38	.659
46.	228.	384.7	1.06	241.8	-1.72	.666
46.4	205.1	363.7	1.112	228.2	2.56	.698
46.8	206.2	396.5	1.155	238.3	2.33	.694
47.2	196.5	347.5	1.143	224.7	1.52	.739
47.6	190.2	345.7	1.067	203.1	-1.34	.627
48.	227.6	427.5	1.14	259.6	.69	.692
48.4	222.5	363.4	1.038	231.	1.02	.659
48.8	261.8	371.6	1.018	266.6	-.81	.730
49.2	229.3	349.2	1.061	243.4	-.33	.739
49.6	251.5	335.	.9702	244.	4.72	.706

Response Spectra at Joints 49Z & 76Z

Table 5.19 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 76Z	F.R.F. ($\bar{g}/\bar{g}$) (76Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
50.	255.4	333.1	.9871	252.1	.67	.747
50.4	228.7	324.8	1.	228.7	2.64	.704
50.8	274.3	352.7	.8984	246.4	.19	.627
51.2	263.	321.9	.9098	239.3	.48	.676
51.6	282.6	321.	.8775	247.9	2.94	.677
52.	282.	321.2	.8988	253.4	-1.76	.709
52.4	299.2	324.2	.8931	267.2	.09	.736
52.8	359.2	379.8	.8655	310.9	.64	.708
53.2	331.7	400.4	.7755	257.3	3.98	.498
53.6	335.6	326.9	.8012	268.8	-1.24	.658
54.	317.4	269.1	.7349	233.3	2.49	.637
54.4	394.3	327.3	.7674	302.6	1.41	.709
54.8	355.8	260.5	.6901	245.5	2.31	.650
55.2	423.7	272.6	.6685	283.3	2.31	.694
55.6	482.8	280.1	.6302	304.3	2.09	.684
56.	522.2	259.2	.5604	292.7	2.40	.632
56.4	551.1	256.4	.5401	297.6	8.80	.626
56.8	618.4	249.9	.4931	304.9	2.15	.601
57.2	797.7	259.3	.4374	348.9	2.41	.588
57.6	888.9	236.	.3764	334.6	4.31	.533
58.	1149.	224.1	.3117	358.3	4.17	.498
58.4	1377.	324.	.2451	337.5	8.38	.255
58.8	2130.	200.3	.1569	334.2	7.59	.261
59.2	3887.	139.1	.063	244.9	32.27	.110
59.6	8380.	194.2	.0662	555.1	139.6	.189
60.	36510.	1183.	.1662	6071.	164.	.852
60.4	51670.	3999.	.2714	14020.	168.5	.952
60.8	6105.	1127.	.38	2320.	169.8	.782
61.2	2426.	832.7	.4983	1209.	170.7	.723
61.6	962.9	609.7	.5776	556.2	169.8	.526
62.	513.7	526.3	.6231	320.1	168.1	.378
62.4	334.1	513.4	.5837	195.	171.2	.221
62.8	243.9	461.	.4818	117.5	160.5	.122
63.2	165.1	384.9	.1651	27.2	176.4	.011
63.6	160.8	418.	.2243	36.0	65.41	.019
64.	173.6	453.5	.3801	66.	23.33	.055
64.4	169.2	342.8	.431	72.9	5.40	.091
64.8	219.7	363.	.5691	125.	14.39	.196
65.2	256.8	366.8	.5688	146.1	6.00	.226
65.6	347.8	320.6	.5182	180.2	.53	.291
66.	430.5	305.	.4513	194.3	.40	.287
66.4	757.	304.3	.3585	271.4	3.82	.319
66.8	1383.	292.1	.2453	339.4	11.17	.284
67.2	3783.	232.9	.1041	393.9	43.42	.176
67.6	29880.	681.7	.122	3649.	148.4	.653
68.	10630.	953.7	.2663	2833.	166.3	.791
68.4	1903.	548.4	.4209	801.3	169.2	.615
68.8	751.4	476.9	.5847	439.3	166.	.538
69.2	349.3	422.4	.6533	228.2	168.6	.353
69.6	225.3	410.4	.8196	184.7	171.	.368

Response Spectra at Joints 49Z & 76Z

Table 5.19 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 76Z	F.R.F. ($\bar{g}/\bar{g}$) (76Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
70.	155.1	421.4	.6699	103.9	169.8	.165
70.4	121.1	455.1	.6484	78.5	171.1	.111
70.8	100.4	382.2	.4878	48.9	-179.9	.062
71.2	97.9	370.2	.2693	26.3	130.7	.019
71.6	100.7	381.8	.1077	10.8	-17.56	.003
72.	74.3	350.3	.4414	32.8	11.88	.041
72.4	73.7	368.	.393	28.9	1.96	.030
72.8	86.2	388.3	.7522	64.8	12.98	.125
73.2	68.9	390.6	.9475	65.3	8.75	.158
73.6	91.1	400.5	.9608	87.5	6.05	.209
74.	97.8	333.3	.8499	83.1	2.98	.212
74.4	97.2	317.8	.9647	93.8	.78	.284
74.8	93.5	369.7	1.219	114.	5.36	.376
75.2	99.2	347.3	1.188	117.9	4.34	.403
75.6	111.1	333.5	1.069	118.8	6.84	.381
76.	133.6	334.7	1.094	146.3	5.21	.478
76.4	124.2	297.8	1.047	130.1	4.32	.457
76.8	162.3	328.4	1.024	166.2	3.76	.518
77.2	213.6	331.	.8832	188.6	4.75	.503
77.6	261.8	337.5	.8174	214.	3.15	.518
78.	331.2	368.7	.7987	264.5	6.52	.573
78.4	430.7	367.3	.735	316.6	6.9	.633
78.8	665.9	350.5	.5856	389.9	5.49	.651
79.2	1237.	431.	.5002	619.	10.17	.718
79.6	2686.	490.4	.3568	958.6	9.22	.697
80.	11670.	693.2	.2211	2580.	18.77	.823
80.4	18770.	401.2	.1102	2068.	41.76	.568
80.8	2923.	171.3	.1252	366.1	124.5	.267
81.2	1080.	155.8	.2061	222.7	145.4	.294
81.6	536.3	224.3	.4038	216.5	155.3	.389
82.	268.9	235.2	.4582	123.2	161.5	.24
82.4	170.6	236.9	.5211	88.9	136.7	.195
82.8	370.6	259.1	.4678	173.3	77.07	.312
83.2	680.1	205.5	.3141	213.6	149.7	.326
83.6	167.9	226.6	.6359	106.8	172.3	.299
84.	129.6	226.9	.6833	88.6	176.	.266
84.4	93.7	260.	.7021	65.8	170.	.177
84.8	61.9	236.6	.6313	39.1	165.9	.104
85.2	70.2	249.8	.319	22.4	153.3	.028
85.6	85.1	260.4	.4225	35.9	124.9	.058
86.	69.2	281.1	.8556	59.2	162.7	.180
86.4	48.3	245.6	.6408	31.	165.5	.080
86.8	53.8	257.6	.2636	14.2	166.3	.014
87.2	65.3	243.3	.2391	15.6	-173.1	.015
87.6	60.0	251.3	.155	9.3	91.33	.005
88.	59.7	244.4	.4083	24.4	45.2	.040
88.4	34.4	248.6	.4023	13.8	141.3	.022
88.8	46.6	237.6	.0643	3.	146.8	.000
89.2	38.3	245.	.2389	9.1	5.37	.008
89.6	42.6	277.9	.3254	13.8	41.71	.016

Response Spectra at Joints 49Z & 76Z

Table 5.19 contd

Freq. (Hz)	Acceln ($\ddot{g}^2$xE6) Joint 49Z	Acceln ($\ddot{g}^2$xE6) Joint 76Z	F.R.F. ($\ddot{g}/\ddot{g}$) (76Z/49Z)	X-Spec. ($\ddot{g}^2$xE6)	Phase (Deg.)	Coherence
90.	40.9	309.	.5548	22.7	.19	.040
90.4	32.9	240.4	.7647	25.1	3.72	.080
90.8	48.8	249.8	.9039	44.2	14.3	.159
91.2	178.3	248.8	.565	100.7	46.74	.228
91.6	40.5	221.6	.2231	9.0	131.4	.009
92.	48.2	213.4	.1578	7.6	-60.2	.005
92.4	56.6	234.1	.3067	17.3	20.31	.022
92.8	43.7	253.9	.5011	21.9	-11.76	.043
93.2	46.2	214.2	.5565	25.7	6.00	.066
93.6	49.7	224.6	.2718	13.5	-7.09	.016
94.	51.3	240.8	.4479	23.0	4.23	.042
94.4	47.4	208.3	.4594	21.8	4.90	.048
94.8	44.5	230.5	.6175	27.5	-.06	.073
95.2	42.8	192.9	.6399	27.4	-18.87	.090
95.6	48.1	208.3	.6514	31.3	-2.66	.098
96.	57.1	195.6	.4546	25.9	1.64	.060
96.4	49.1	205.9	.6715	33.0	.82	.107
96.8	36.9	210.9	.5942	21.9	-7.60	.061
97.2	47.2	195.1	.5373	25.3	-1.39	.069
97.6	81.4	214.1	.2712	22.0	-3.66	.027
98.	166.2	270.9	.7754	128.9	-17.76	.368
98.4	59.7	202.4	.9414	56.2	-3.61	.261
98.8	55.0	242.3	.9125	50.1	-2.66	.189
99.2	50.3	199.6	.7597	38.2	2.58	.145
99.6	41.5	182.1	1.008	41.8	1.51	.231
100.	51.9	211.3	.8398	43.6	-8.87	.173
100.4	55.7	188.	.8657	48.2	-4.46	.222
100.8	54.6	194.1	.9738	53.2	-3.12	.267
101.2	45.7	185.8	.8589	39.2	-8.06	.181
101.6	46.6	200.8	.9872	46.0	-.55	.226
102.	53.3	163.8	.9018	48.1	-2.32	.265
102.4	56.2	164.9	.7783	43.7	-2.06	.206
102.8	50.7	174.3	.7466	37.8	8.46	.162
103.2	48.4	153.7	.885	42.8	-.20	.246
103.6	58.8	160.	.8297	48.7	-1.42	.253
104.	51.4	144.5	.735	37.8	2.15	.192
104.4	45.7	147.2	.8016	36.6	-3.32	.199
104.8	59.5	129.7	.5753	34.2	1.07	.151
105.2	57.8	135.	.5283	30.5	-9.61	.119
105.6	60.4	140.	.6229	37.6	6.50	.167
106.	49.7	103.2	.6122	30.4	12.77	.180
106.4	51.	114.	.4217	21.5	3.31	.079
106.8	87.1	106.6	.5197	45.2	-2.22	.220
107.2	473.5	415.4	.7837	371.1	-9.88	.700
107.6	213.5	204.7	.5908	126.1	2.26	.364
108.	152.6	837.2	.8324	127.	139.3	.126
108.4	119.7	653.3	.8715	104.4	17.95	.139
108.8	114.5	269.6	.6885	78.8	8.32	.201
109.2	130.7	212.2	.485	63.4	2.59	.144
109.6	183.7	179.9	.145	26.6	76.67	.021

Response Spectra at Joints 49Z & 76Z

Table 5.19 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 76Z	F.R.F. ($\bar{g}/\bar{g}$) (76Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
110.	717.4	875.9	.9149	656.4	166.1	.685
110.4	290.5	868.2	1.339	389.1	167.3	.600
110.8	78.1	312.4	.3598	28.1	128.3	.032
111.2	67.	199.5	.3358	22.5	33.12	.037
111.6	96.4	146.1	.3773	36.3	18.54	.093
112.	109.7	145.1	.2124	23.3	-1.71	.034
112.4	655.7	1473.	1.325	869.1	170.2	.781
112.8	72.1	348.8	.5275	38.0	174.6	.057
113.2	134.7	243.9	.3986	53.7	-152.1	.087
113.6	466.7	175.7	.2892	135.	-52.72	.222
114.	167.3	171.7	.4401	73.6	.82	.188
114.4	178.8	138.8	.3839	68.6	-9.62	.189
114.8	223.7	163.9	.1792	40.1	62.84	.043
115.2	134.9	181.6	.177	23.8	57.03	.023
115.6	172.9	117.2	.2625	45.4	.80	.101
116.	195.1	121.1	.1954	38.1	10.54	.061
116.4	458.1	93.9	.0720	33.	13.18	.025
116.8	1073.	156.3	.1942	208.5	161.7	.259
117.2	241.8	129.9	.1823	44.1	176.4	.061
117.6	313.	125.3	.1878	58.7	-179.5	.088
118.	553.4	172.8	.3065	169.6	172.7	.300
118.4	644.8	283.6	.461	297.3	171.8	.483
118.8	1511.	590.7	.5482	828.8	179.1	.769
119.2	9921.	4067.	.6304	6254.	178.6	.969
119.6	22920.	11290.	.7005	16050.	178.6	.996
120.	2038.	1280.	.7483	1525.	176.7	.891
120.4	733.9	539.3	.7193	527.9	177.5	.704
120.8	414.2	343.4	.6666	276.1	-179.	.536
121.2	284.4	226.4	.5481	155.8	175.4	.377
121.6	211.3	170.4	.4405	93.0	176.5	.240
122.	212.1	137.5	.2826	59.9	177.2	.123
122.4	303.2	127.2	.2277	69.0	155.4	.123
122.8	198.7	109.1	.1893	37.6	-175.1	.065
123.2	183.1	132.4	.179	32.7	178.7	.044
123.6	222.9	131.5	.2084	46.4	-164.3	.073
124.	244.4	103.4	.1923	47.0	177.3	.087
124.4	315.	141.1	.2116	66.6	-175.6	.1
124.8	439.8	205.4	.2834	124.6	-174.8	.172
125.2	804.6	353.4	.4163	335.	-177.4	.394
125.6	2607.	1176.	.5653	1474.	-176.8	.708
126.	54570.	18500.	.5786	31570.	-177.7	.987
126.4	7251.	1327.	.3417	2478.	-178.9	.637
126.8	4300.	375.1	.0306	131.9	-102.3	.010
127.2	7787.	626.6	.1922	1496.	-6.88	.459
127.6	58570.	6267.	.3157	18490.	-.57	.931
128.	17180.	2137.	.3166	5441.	-.26	.806
128.4	7336.	2322.	.492	3610.	1.30	.764
128.8	128200.	48510.	.6114	78410.	.68	.988
129.2	9554.	3074.	.5165	4934.	.44	.828
129.6	4918.	907.3	.3091	1520.	2.42	.518

Response Spectra at Joints 49Z & 76Z

Table 5.19 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 76Z	F.R.F. ($\bar{g}/\bar{g}$) (76Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
130.	6954.	1762.	.3952	2748.	10.62	.616
130.4	3794.	605.8	.0707	268.4	30.75	.031
130.8	2663.	1188.	.2377	633.1	161.3	.126
131.2	3542.	5479.	.2277	806.7	152.8	.033
131.6	16970.	48680.	1.373	23300.	6.71	.657
132.	14720.	3660.	.0316	465.8	108.7	.004
132.4	53960.	10230.	.3787	20440.	-178.1	.756
132.8	135300.	73980.	.5534	74880.	-173.6	.560

RMS values between frequency limits 10Hz to 132.8Hz			
Joint 49Z		Joint 76Z	
Acceleration	0.947 (g)	Acceleration	0.913 (g)
Velocity	30.1 (mm/sec)	Velocity	61.8 (mm/sec)
Displacement	0.269 (mm)	Displacement	0.560 (mm)

Response Spectra at Joints 49Z & 76Z

Table 5.19 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
10.	41.1	41.4	.2704	11.1	5.95	.072
10.4	46.5	45.1	.3049	14.1	8.57	.095
10.8	55.4	52.8	.3797	21.0	-.10	.151
11.2	63.9	62.0	.4158	26.5	8.75	.178
11.6	87.8	77.7	.4519	39.7	.72	.230
12.	108.8	93.1	.5079	55.2	-.56	.301
12.4	159.	128.4	.602	95.7	1.97	.448
12.8	245.1	190.6	.6583	161.3	1.07	.557
13.2	458.8	316.8	.7047	323.3	1.41	.719
13.6	1215.	810.9	.7632	927.8	1.58	.873
14.	8008.	5182.	.7951	6367.	.59	.977
14.4	22110.	14770.	.8135	17990.	.23	.990
14.8	2137.	1569.	.814	1739.	-.14	.902
15.2	615.8	568.7	.7893	486.1	-1.99	.674
15.6	322.4	359.2	.687	221.5	-2.38	.423
16.	1626.	1737.	.9424	1532.	-1.11	.831
16.4	406.5	584.2	.7775	316.1	2.10	.420
16.8	227.9	509.2	.5448	124.1	-4.60	.132
17.2	186.	587.3	.2679	49.8	-6.92	.022
17.6	170.9	736.1	.3094	52.9	-169.7	.022
18.	189.4	1103.	.9392	177.9	-175.3	.151
18.4	285.1	1727.	1.64	467.7	-176.8	.444
18.8	597.3	4552.	2.44	1457.	-178.3	.781
19.2	3502.	23850.	2.575	9022.	-178.3	.974
19.6	24770.	142900.	2.414	59810.	-178.7	1.01
20.	1604.	7320.	2.065	3314.	-178.8	.935
20.4	599.7	2157.	1.698	1018.	-178.	.801
20.8	388.8	1061.	1.367	531.9	-179.	.685
21.2	286.5	628.5	1.123	322.1	-176.2	.576
21.6	219.2	382.4	.8785	192.5	178.6	.442
22.	182.6	282.7	.7824	142.8	-179.7	.395
22.4	176.8	202.7	.5923	104.7	-179.4	.306
22.8	155.	166.6	.5466	84.7	-173.8	.278
23.2	152.1	127.7	.3809	57.9	179.2	.172
23.6	142.7	105.6	.3065	43.7	177.	.126
24.	137.9	87.6	.266	36.7	179.2	.111
24.4	129.1	76.3	.1752	22.6	177.8	.051
24.8	132.5	66.8	.2003	26.5	176.	.079
25.2	116.4	58.3	.1187	13.8	-163.1	.028
25.6	116.4	51.1	.1264	14.7	174.4	.036
26.	115.8	49.2	.0752	8.7	-174.2	.013
26.4	123.7	46.2	.0465	5.7	-139.4	.005
26.8	115.5	40.8	.0268	3.1	109.6	.002
27.2	101.9	38.3	.0055	.5	179.2	.000
27.6	115.7	35.1	.0304	3.5	-81.36	.003
28.	118.4	33.9	.0247	2.9	-14.36	.002
28.4	117.6	29.8	.0608	7.1	-9.10	.014
28.8	114.7	28.9	.0536	6.1	63.	.011
29.2	107.9	27.2	.0963	10.3	6.05	.036
29.6	115.1	25.0	.0575	6.6	20.09	.015

Response Spectra at Joints 49Z & 52Z

Table 5.20

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
30.	116.8	24.3	.0876	10.2	14.26	.036
30.4	121.2	23.5	.1255	15.2	5.16	.081
30.8	109.4	22.8	.126	13.7	7.99	.075
31.2	116.8	22.4	.1314	15.3	.32	.089
31.6	126.3	22.3	.1244	15.7	-4.85	.087
32.	111.2	22.1	.1529	17.0	-.01	.117
32.4	114.7	22.1	.1598	18.3	-2.98	.132
32.8	120.2	20.9	.1584	19.0	-2.16	.143
33.2	114.	21.8	.1391	15.8	2.95	.100
33.6	116.8	20.2	.1375	16.0	14.06	.108
34.	117.6	21.7	.1637	19.2	.17	.145
34.4	123.8	20.8	.1543	19.1	-8.13	.141
34.8	111.4	19.0	.166	18.5	7.41	.160
35.2	120.6	20.1	.1751	21.1	5.67	.183
35.6	120.5	20.1	.1898	22.8	-3.46	.215
36.	116.3	18.4	.1711	19.9	2.75	.184
36.4	116.	18.4	.1869	21.7	-5.86	.219
36.8	126.8	19.2	.2203	27.9	.38	.319
37.2	127.1	20.1	.1999	25.4	5.82	.252
37.6	124.6	17.0	.1911	23.8	-1.87	.266
38.	117.7	18.7	.2005	23.6	.41	.252
38.4	138.6	20.2	.2188	30.3	1.49	.328
38.8	128.2	19.7	.2108	27.0	-3.60	.289
39.2	137.7	22.2	.238	32.7	.82	.350
39.6	130.	22.4	.2395	31.1	-7.64	.331
40.	137.4	21.4	.2007	27.5	-5.24	.258
40.4	136.2	20.7	.2161	29.4	.39	.306
40.8	127.7	20.8	.2418	30.8	-4.68	.357
41.2	137.7	20.7	.2192	30.2	2.45	.319
41.6	142.4	22.2	.2478	35.3	-1.11	.393
42.	145.3	22.3	.2329	33.8	-3.10	.352
42.4	154.9	23.4	.2668	41.3	-.41	.471
42.8	142.1	20.6	.24	34.1	1.01	.396
43.2	153.5	21.8	.2366	36.3	-2.02	.394
43.6	161.2	24.2	.2737	44.1	-3.68	.498
44.	162.1	23.2	.2556	41.4	5.34	.454
44.4	174.7	25.0	.2697	47.1	-1.60	.508
44.8	170.6	25.2	.2674	45.6	1.92	.483
45.2	151.2	24.6	.2744	41.5	-3.10	.462
45.6	167.9	24.1	.261	43.8	-.53	.474
46.	152.8	26.2	.2725	41.6	1.43	.432
46.4	193.3	31.4	.287	55.5	-.09	.507
46.8	157.2	26.6	.2751	43.2	-.83	.446
47.2	174.5	29.6	.2901	50.6	-2.82	.495
47.6	175.8	28.6	.2707	47.5	1.84	.449
48.	176.6	31.4	.3009	53.1	.97	.508
48.4	208.8	34.2	.302	63.0	.53	.556
48.8	204.4	39.0	.3239	66.2	.95	.548
49.2	178.9	33.4	.3041	54.4	2.28	.495
49.6	227.4	38.9	.3207	72.9	-1.02	.600

Response Spectra at Joints 49Z & 52Z

Table 5.20 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
50.	235.2	57.0	.382	89.8	1.96	.601
50.4	208.8	34.4	.3026	63.2	2.08	.554
50.8	213.7	43.7	.3651	78.0	-.98	.651
51.2	231.8	43.7	.3454	80.1	-.53	.632
51.6	221.8	46.1	.3629	80.5	-1.20	.633
52.	278.6	51.6	.346	96.4	.49	.646
52.4	236.8	49.3	.3477	82.3	-3.88	.580
52.8	275.4	58.3	.368	101.3	.38	.638
53.2	304.8	68.1	.3898	118.8	.62	.680
53.6	308.5	71.5	.4058	125.2	-1.20	.71
54.	308.1	69.6	.3938	121.3	-5.43	.686
54.4	346.9	80.9	.4059	140.8	-.63	.706
54.8	364.4	92.8	.4307	156.9	-2.45	.727
55.2	413.3	106.	.4403	182.	-1.65	.755
55.6	387.6	113.9	.4794	185.8	-1.06	.782
56.	490.	140.4	.4793	234.9	-2.90	.801
56.4	567.	168.2	.492	279.	-1.09	.816
56.8	641.1	209.6	.5262	337.4	-1.71	.846
57.2	710.8	236.3	.5321	378.2	-1.47	.851
57.6	891.6	326.7	.5659	504.6	-2.11	.873
58.	1134.	462.9	.6091	690.7	-1.91	.908
58.4	1402.	641.2	.6472	907.6	-.90	.916
58.8	2224.	1081.	.6796	1511.	-1.42	.949
59.2	3370.	1833.	.7247	2443.	-.69	.965
59.6	7750.	4742.	.7762	6016.	-1.06	.984
60.	40030.	27880.	.8331	33350.	-1.31	.996
60.4	49380.	38760.	.8846	43690.	-1.44	.997
60.8	6212.	5766.	.9514	5911.	-2.55	.975
61.2	2356.	2346.	.968	2281.	-3.52	.941
61.6	982.9	1208.	1.035	1018.	-3.51	.873
62.	531.5	754.5	1.042	553.9	-2.90	.765
62.4	299.6	504.3	.998	299.	-2.09	.591
62.8	213.3	374.1	.7529	160.6	-2.92	.323
63.2	163.6	289.1	.5628	92.1	-5.72	.179
63.6	149.3	254.1	.1854	27.7	-7.50	.020
64.	132.5	234.3	.0148	1.9	176.3	.000
64.4	167.3	260.3	.3986	66.7	-173.6	.102
64.8	185.8	241.5	.529	98.3	-179.4	.215
65.2	243.4	302.3	.7396	180.	-179.4	.440
65.6	270.4	312.4	.7703	208.2	-179.	.513
66.	432.2	448.2	.8635	373.2	179.5	.719
66.4	664.6	681.7	.9283	617.	179.9	.840
66.8	1365.	1312.	.946	1291.	179.6	.930
67.2	3821.	3895.	1.003	3834.	179.5	.987
67.6	33370.	35340.	1.035	34560.	179.5	1.013
68.	9191.	10410.	1.066	9805.	179.5	1.004
68.4	1543.	1910.	1.091	1684.	179.9	.962
68.8	616.	826.	1.093	673.4	179.	.891
69.2	314.2	473.7	1.099	345.4	178.9	.801
69.6	195.8	325.9	1.067	209.	179.5	.684

Response Spectra at Joints 49Z & 52Z

Table 5.20 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
70.	124.8	228.1	.9724	121.3	178.4	.517
70.4	92.3	177.6	.8669	80.0	179.	.390
70.8	68.1	149.8	.7067	48.1	179.1	.227
71.2	58.7	112.6	.4653	27.3	-173.9	.112
71.6	55.6	100.5	.1747	9.7	175.3	.016
72.	47.3	96.1	.0819	3.8	173.5	.003
72.4	50.3	88.3	.1903	9.5	-14.9	.020
72.8	53.6	89.9	.3217	17.2	9.34	.061
73.2	54.9	85.0	.3857	21.2	12.01	.096
73.6	59.2	76.9	.4201	24.9	7.46	.135
74.	52.3	77.8	.5542	29.0	2.61	.206
74.4	69.4	84.6	.6331	43.9	9.24	.328
74.8	68.3	77.6	.6084	41.6	.12	.325
75.2	77.1	85.5	.7118	54.9	7.69	.457
75.6	94.0	88.7	.7311	68.7	6.42	.566
76.	96.1	108.5	.8116	78.0	10.6	.583
76.4	115.1	131.1	.8516	98.0	3.38	.636
76.8	142.8	146.6	.8667	123.7	1.96	.731
77.2	171.9	163.4	.8583	147.5	2.29	.774
77.6	216.2	197.	.857	185.3	.91	.805
78.	306.2	262.1	.8573	262.6	.28	.859
78.4	409.8	342.1	.8652	354.6	-1.36	.896
78.8	570.2	452.2	.8558	488.	1.16	.923
79.2	1060.	859.3	.882	935.	-.29	.959
79.6	2363.	1906.	.8906	2104.	.45	.982
80.	10540.	8240.	.8816	9301.	.11	.995
80.4	18020.	14050.	.8824	15900.	.52	.998
80.8	2843.	2205.	.8748	2488.	.30	.986
81.2	992.7	772.2	.8645	858.3	-.13	.960
81.6	454.9	348.1	.8391	381.7	.53	.92
82.	220.6	184.2	.8395	185.2	-.15	.843
82.4	146.6	119.6	.805	118.	.84	.794
82.8	366.7	287.	.8395	307.8	-.17	.900
83.2	637.4	524.6	.8843	563.7	.09	.950
83.6	149.5	125.5	.8156	121.9	1.11	.792
84.	97.2	82.1	.7378	71.7	2.40	.644
84.4	67.1	50.3	.6238	41.9	-.47	.519
84.8	45.4	36.8	.5601	25.4	-2.23	.387
85.2	40.4	32.1	.5064	20.5	1.10	.322
85.6	43.2	33.6	.5125	22.1	-4.30	.337
86.	44.2	41.2	.6047	26.7	1.84	.392
86.4	33.9	30.1	.4938	16.7	-.43	.274
86.8	30.4	27.2	.3525	10.7	-6.85	.138
87.2	25.0	27.2	.3044	7.6	-20.75	.085
87.6	23.4	18.3	.3151	7.3	-1.36	.127
88.	31.1	21.3	.3091	9.6	-5.79	.139
88.4	23.8	18.4	.3131	7.4	3.79	.126
88.8	21.4	18.1	.2269	4.8	9.03	.060
89.2	22.9	14.5	.1654	3.7	-16.19	.042
89.6	22.9	14.0	.1568	3.6	8.50	.040

Response Spectra at Joints 49Z & 52Z

Table 5.20 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
90.	22.1	13.5	.1346	2.9	13.94	.029
90.4	25.4	13.7	.1699	4.3	7.25	.053
90.8	27.4	14.9	.2164	5.9	.98	.085
91.2	157.	122.7	.7885	123.8	.15	.795
91.6	23.3	18.0	.1651	3.8	3.77	.035
92.	25.3	14.6	.1145	2.9	-14.71	.022
92.4	22.3	14.7	.1373	3.0	2.42	.028
92.8	23.3	13.6	.1043	2.4	-9.36	.018
93.2	35.1	36.0	.4286	15.0	-15.23	.179
93.6	19.6	14.2	.1085	2.1	25.09	.016
94.	21.8	13.7	.0716	1.5	7.37	.008
94.4	20.6	13.9	.1382	2.8	6.42	.028
94.8	21.8	14.1	.1089	2.3	19.38	.018
95.2	23.6	13.8	.0732	1.7	-.06	.009
95.6	24.5	14.3	.0756	1.8	5.58	.009
96.	27.4	13.1	.1123	3.0	7.25	.026
96.4	25.5	14.1	.1512	3.8	-1.95	.041
96.8	25.6	13.8	.1398	3.5	2.65	.036
97.2	28.9	16.4	.1728	5.	.86	.052
97.6	63.6	49.1	.5726	36.4	-1.58	.424
98.	147.3	100.6	.6992	103.	1.97	.715
98.4	47.2	25.7	.426	20.1	2.37	.332
98.8	36.9	19.6	.3115	11.5	3.79	.182
99.2	33.5	20.1	.2986	10.0	-4.18	.148
99.6	29.7	17.1	.2603	7.7	7.72	.117
100.	35.9	20.6	.288	10.3	-.92	.144
100.4	34.9	20.4	.2684	9.3	-7.45	.123
100.8	36.4	18.9	.2538	9.2	-2.11	.124
101.2	33.3	21.5	.2959	9.8	-10.27	.135
101.6	34.4	17.8	.2568	8.8	5.42	.127
102.	33.7	20.0	.299	10.0	.27	.150
102.4	39.8	20.8	.2959	11.8	-.24	.167
102.8	34.9	21.2	.3207	11.1	9.64	.168
103.2	32.7	20.6	.2892	9.4	9.12	.132
103.6	39.5	22.8	.3367	13.3	8.21	.196
104.	38.3	23.9	.3467	13.2	11.46	.192
104.4	38.0	21.1	.3268	12.4	-1.68	.192
104.8	37.8	26.8	.4088	15.4	-2.40	.235
105.2	38.6	31.9	.3804	14.6	7.09	.175
105.6	37.7	34.0	.3494	13.1	-4.84	.135
106.	37.4	38.4	.3844	14.4	-5.47	.144
106.4	42.3	51.0	.2091	8.8	-16.54	.036
106.8	65.8	83.9	.4708	31.0	-166.3	.174
107.2	476.2	346.2	.6993	333.	-156.1	.672
107.6	170.7	53.2	.294	50.2	-166.5	.277
108.	112.2	74.2	.2997	33.6	144.	.135
108.4	85.4	73.9	.3712	31.7	22.68	.159
108.8	88.4	53.3	.4458	39.4	8.63	.329
109.2	103.6	61.0	.5052	52.3	1.03	.433
109.6	166.8	102.1	.4369	72.9	14.53	.311

Response Spectra at Joints 49Z & 52Z

Table 5.20 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
110.	666.8	409.4	.7396	493.1	2.30	.890
110.4	247.8	146.6	.6677	165.4	2.40	.753
110.8	64.5	45.4	.4928	31.7	4.77	.344
111.2	58.9	49.7	.4745	27.9	3.02	.266
111.6	63.3	63.9	.5801	36.7	-.81	.333
112.	94.6	107.5	.7494	70.9	-.89	.494
112.4	612.6	898.5	1.149	704.1	-.53	.900
112.8	59.4	62.2	.1595	9.4	17.88	.024
113.2	110.4	155.4	.595	65.7	-163.6	.251
113.6	438.7	300.	.6664	292.4	-166.5	.649
114.	133.5	54.7	.0367	4.9	-18.17	.003
114.4	133.8	56.9	.2251	30.1	7.54	.119
114.8	210.2	63.0	.1848	38.8	33.75	.113
115.2	121.7	81.5	.3308	40.2	14.6	.163
115.6	127.6	87.3	.4359	55.6	7.33	.277
116.	187.5	97.5	.3539	66.4	4.15	.241
116.4	425.7	135.9	.0904	38.4	28.61	.025
116.8	953.7	524.9	.4649	443.4	152.8	.392
117.2	194.8	337.6	.652	127.	7.49	.245
117.6	264.8	388.3	.944	250.	3.99	.607
118.	450.1	681.3	1.087	489.4	1.24	.780
118.4	579.1	712.3	1.007	583.4	1.38	.825
118.8	1455.	1691.	1.036	1509.	1.53	.925
119.2	8884.	9949.	1.05	9334.	1.14	.985
119.6	23030.	24720.	1.032	23780.	.80	.993
120.	1764.	1806.	.9694	1710.	.47	.918
120.4	619.1	603.3	.8525	527.7	-1.17	.745
120.8	325.5	323.2	.7237	235.5	-.17	.527
121.2	221.5	220.1	.5227	115.7	1.64	.274
121.6	167.4	190.3	.3745	62.7	-.07	.123
122.	154.	212.8	.3147	48.4	.79	.071
122.4	252.	275.5	.451	113.7	10.27	.186
122.8	155.8	206.3	.0497	7.7	17.76	.001
123.2	165.6	259.1	.0844	13.9	-28.91	.004
123.6	191.1	338.	.0702	13.4	12.13	.002
124.	218.4	435.8	.1006	21.9	-8.45	.005
124.4	284.9	627.	.2124	60.5	17.61	.020
124.8	394.8	958.4	.4493	177.4	2.61	.083
125.2	757.7	1666.	.7614	577.	9.76	.263
125.6	2307.	4617.	1.073	2476.	3.43	.575
126.	56030.	63880.	1.043	58490.	5.13	.955
126.4	6592.	3968.	.4726	3115.	4.03	.371
126.8	4009.	2559.	.3423	1372.	170.5	.183
127.2	6534.	6893.	.885	5782.	177.9	.742
127.6	53720.	90200.	1.292	69460.	178.3	.995
128.	15760.	33000.	1.409	22200.	177.9	.948
128.4	5871.	5110.	.739	4339.	176.1	.627
128.8	111300.	51640.	.6805	75780.	179.5	.998
129.2	9210.	5899.	.7673	7066.	177.2	.919
129.6	4675.	3725.	.8416	3934.	-177.6	.888

Response Spectra at Joints 49Z & 52Z

Table 5.20 contd

Freq. (Hz)	Acceln ($\bar{g}^2$xE6) Joint 49Z	Acceln ($\bar{g}^2$xE6) Joint 52Z	F.R.F. ($\bar{g}/\bar{g}$) (52Z/49Z)	X-Spec. ($\bar{g}^2$xE6)	Phase (Deg.)	Coherence
130.	7017.	5402.	.8497	5962.	179.6	.937
130.4	4047.	2498.	.7258	2937.	-177.2	.853
130.8	2738.	1419.	.573	1569.	-170.6	.633
131.2	2645.	1640.	.2837	750.6	-160.4	.129
131.6	15330.	1904.	.2669	4093.	173.4	.573
132.	12630.	2076.	.2984	3770.	-173.9	.542
132.4	47200.	3763.	.1552	7328.	-158.8	.302
132.8	129300.	45340.	.1337	17300.	-115.6	.051

RMS values between frequency limits 10Hz to 132.8Hz			
Joint 49Z		Joint 52Z	
Acceleration	0.918 (g)	Acceleration	0.885 (g)
Velocity	29.8 (mm/sec)	Velocity	41.0 (mm/sec)
Displacement	0.268 (mm)	Displacement	0.346 (mm)

Response Spectra at Joints 49Z & 52Z

Table 5.20 contd

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\bar{g}\bar{N}$xE6)	Phase (Deg)	Coherenc
13.75	80190.	233.9	48.54	3892.	177.9	.807
13.8	84460.	293.6	53.03	4479.	176.7	.808
13.85	82920.	354.4	58.66	4864.	177.	.804
13.9	85790.	476.8	67.2	5765.	173.2	.812
13.95	93740.	693.9	77.33	7301.	173.1	.817
14.	100400.	1057.	93.54	9392.	174.5	.830
14.05	93180.	1636.	120.6	11240.	168.1	.838
14.1	92690.	2959.	163.	15110.	164.5	.832
14.15	101400.	6031.	221.7	22490.	157.8	.824
14.2	106400.	18620.	382.7	40740.	135.3	.836
14.25	83120.	24420.	478.8	39800.	90.88	.78
14.3	78310.	10220.	323.1	25300.	47.3	.799
14.35	78240.	4029.	202.2	15820.	27.58	.793
14.4	79270.	2156.	148.5	11770.	20.69	.810
14.45	82680.	1317.	113.8	9413.	13.59	.813
15.5	116600.	32.92	14.3	1669.	6.02	.725
15.55	107500.	24.55	12.04	1295.	5.59	.635
15.6	126300.	24.53	11.03	1394.	10.	.627
15.65	109200.	18.62	9.18	1002.	18.09	.493
15.7	129700.	17.7	7.46	960.5	21.46	.401
15.75	115000.	16.16	5.83	671.8	24.31	.242
15.8	121000.	17.45	3.52	426.6	79.58	.036
15.85	118400.	30.47	7.70	913.	140.2	.230
15.9	126400.	82.71	17.87	2260.	145.3	.488
15.95	138500.	330.	39.43	5463.	137.6	.657
16.	127000.	1816.	98.56	12520.	96.65	.679
16.05	135900.	1070.	80.15	10890.	33.17	.813
16.1	116900.	346.1	49.66	5809.	13.56	.833
16.15	146900.	230.2	37.23	5470.	8.66	.884
16.2	139500.	155.7	31.61	4412.	6.73	.894
18.75	205200.	16.27	1.57	324.2	127.3	.031
18.8	199900.	18.55	1.22	242.3	169.7	.016
18.85	197900.	22.26	1.94	384.4	-173.9	.033
18.9	203800.	27.87	3.75	765.5	179.4	.103
18.95	214800.	35.06	5.18	1114.	-177.9	.164
19.	204900.	44.08	6.38	1308.	171.7	.189
19.05	213100.	57.23	8.13	1734.	169.8	.246
19.1	230100.	81.34	10.41	2396.	174.4	.306
19.15	205600.	117.4	14.31	2944.	174.3	.358
19.2	222700.	176.3	18.42	4104.	176.2	.428
19.25	222400.	277.9	24.43	5436.	176.3	.477
19.3	232200.	540.1	36.01	8364.	-177.3	.557
19.35	217700.	902.1	46.51	10120.	174.4	.522
19.4	244200.	2509.	77.6	18950.	173.6	.585
19.45	318200.	18890.	209.1	66560.	160.	.736
19.5	136000.	26760.	261.4	32970.	92.61	.723
19.55	154600.	4328.	116.6	18040.	15.6	.495
19.6	190900.	1610.	70.35	13430.	9.73	.584
19.65	172700.	859.3	55.08	9519.	5.98	.609

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Fundamental mode group before a 4% deck mass increase.

Table 5.21

Freq. (Hz)	Force ($\bar{N}^2$xE6)	Acceln ($\bar{g}^2$xE6)	F.R.F. ($\bar{g}$xE3/$\bar{N}$)	X-Spec. ($\bar{g}\bar{N}$xE6)	Phase (Deg)	Coherence
13.75	92240.	491.9	66.43	6127.	175.2	.827
13.8	95330.	710.7	78.88	7520.	174.	.834
13.85	88340.	908.7	91.45	8079.	169.4	.812
13.9	98320.	1699.	120.4	11840.	166.7	.839
13.95	110400.	3300.	159.5	17620.	161.5	.851
14.	104200.	7588.	249.4	26000.	152.5	.854
14.05	95240.	17650.	388.1	36960.	129.7	.812
14.1	88410.	18570.	408.7	36130.	74.76	.794
14.15	76270.	6945.	269.1	20520.	37.74	.794
14.2	94000.	3227.	167.1	15700.	23.39	.813
14.25	91290.	1770.	126.4	11540.	17.88	.823
14.3	89220.	1061.	98.99	8831.	15.82	.823
14.35	95760.	733.8	79.66	7629.	13.33	.827
14.4	89700.	503.	67.9	6091.	9.37	.821
14.45	105500.	436.8	59.25	6254.	9.81	.849
15.5	133700.	15.3	5.11	684.5	34.24	.228
15.55	125800.	15.2	2.37	298.7	66.52	.046
15.6	125000.	23.33	5.46	683.8	127.2	.160
15.65	141100.	47.56	10.47	1478.	144.8	.325
15.7	119500.	163.7	27.86	3331.	146.5	.566
15.75	136100.	939.2	69.05	9400.	124.4	.690
15.8	121900.	1562.	96.3	11730.	55.38	.723
15.85	120300.	469.1	56.1	6749.	18.81	.806
15.9	144500.	264.8	40.01	5783.	11.82	.873
15.95	129100.	146.8	31.33	4047.	7.16	.863
16.	148100.	118.7	26.68	3952.	7.10	.887
16.05	146800.	91.83	23.59	3465.	5.07	.890
16.1	127900.	69.76	21.92	2804.	3.90	.880
16.15	150500.	64.25	19.5	2935.	5.37	.890
16.2	152500.	59.35	18.68	2849.	3.06	.896
18.75	200400.	380.8	30.94	6202.	-176.5	.503
18.8	228300.	632.7	38.87	8879.	173.4	.545
18.85	224200.	1061.	50.91	11420.	179.5	.547
18.9	254200.	2276.	73.01	18560.	174.6	.595
18.95	262200.	6929.	131.	34350.	172.6	.649
19.	340800.	53460.	331.3	112900.	153.1	.699
19.05	110400.	29970.	287.3	31740.	50.15	.304
19.1	147600.	5700.	139.6	20610.	11.3	.504
19.15	187000.	2401.	86.94	16250.	3.70	.588
19.2	190300.	1422.	69.27	13180.	5.07	.641
19.25	205400.	960.9	56.77	11660.	7.15	.688
19.3	196100.	662.7	48.43	9499.	5.49	.694
19.35	211700.	458.2	38.36	8123.	2.35	.679
19.4	206200.	391.7	36.73	7576.	3.55	.710
19.45	225800.	327.	32.79	7406.	4.32	.742
19.5	215000.	275.2	31.06	6679.	2.79	.753
19.55	209200.	233.1	29.13	6096.	4.18	.761
19.6	216600.	208.2	27.41	5938.	3.13	.781
19.65	212600.	165.9	24.43	5196.	1.78	.765

Excitation (joint 82Z) and Response (joint 49Z) Spectra.

Fundamental mode group after a 4% deck mass increase

Table 5.22