FULL SCALE EARTHQUAKE RESPONSE

OF A REHABILITATED BUILDING

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SUMMARY

The ambient, harmonic vibrator and earthquake response of a three story concrete shear wall building has recorded and analyzed. The harmonic response was measured prior to and after a major strengthing rehabilitation. This paper summarizes the response data analysis to date.

INTRODUCTION

This building is one of several under study at the UCLA Full Scale Earthquake and Wind Laboratory. The accompaning figures and tables describe a three story building which has experienced various dynamic environments. The building has been studied both before and after rehabilitation which added increased lateral force resistance. One earthquake induced response of the building. The earthquake was the Richter magnitude 5.8, August 13, 1978, Santa Barbara earthquake.

OBSERVATIONS

The accompaning tables and figures speak for themselves. References are cited for those interested in performing further study of the building. The fundamental observations are the following: (1) The earthquake base shear was approximately 2.5 times the design base shear and was approximately 50% of the building weight; (2) The ground floor level experience measurable and significant twisting earthquake motion; (3) Intrastory drifts were approximately 0.3 percent of the story height and no noticable structural damage was experienced; (4) Floor fundamental mode motion was a combination of translation, torsion and inplane slab deformation; (5) Ground level input motion was slightly less than 1940 El Centro intensity translational and twisting input motion.

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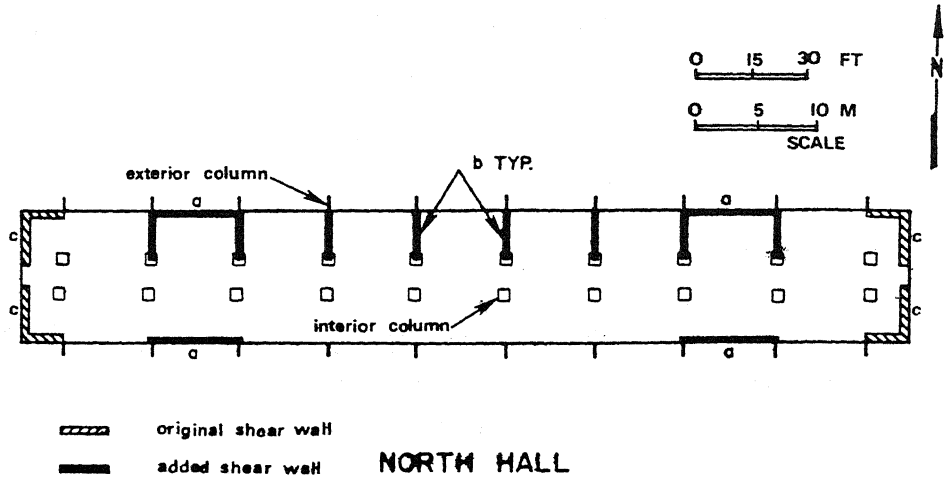
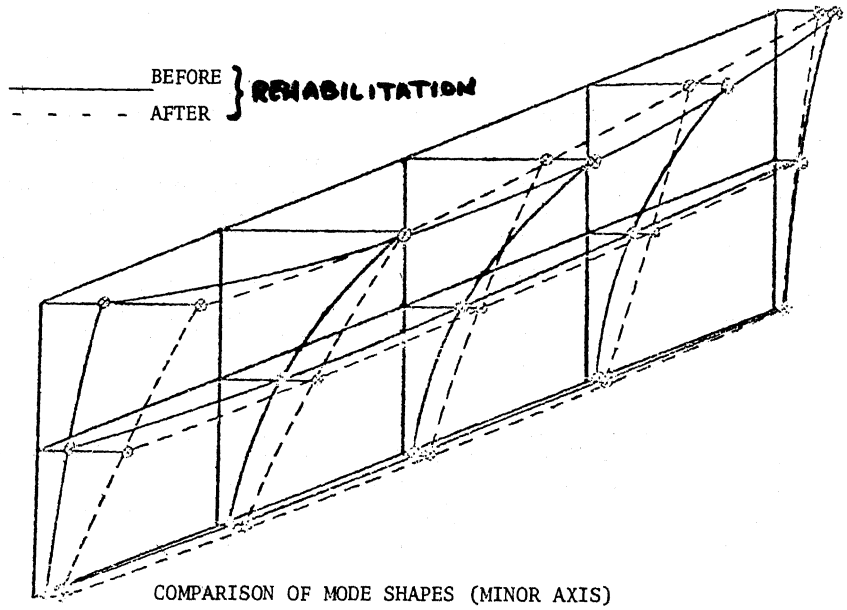


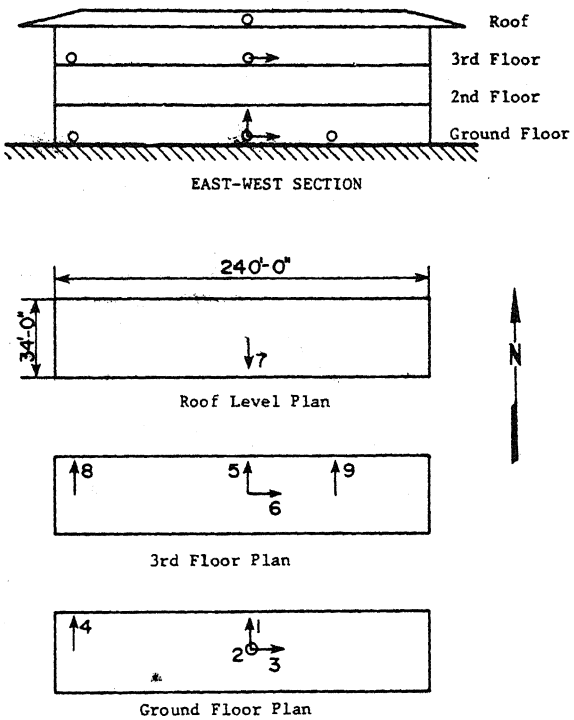
Floor plan of North Hall, UCSB.

Figure 1*



COMPARISON OF MODE SHAPES (MINOR AXIS)

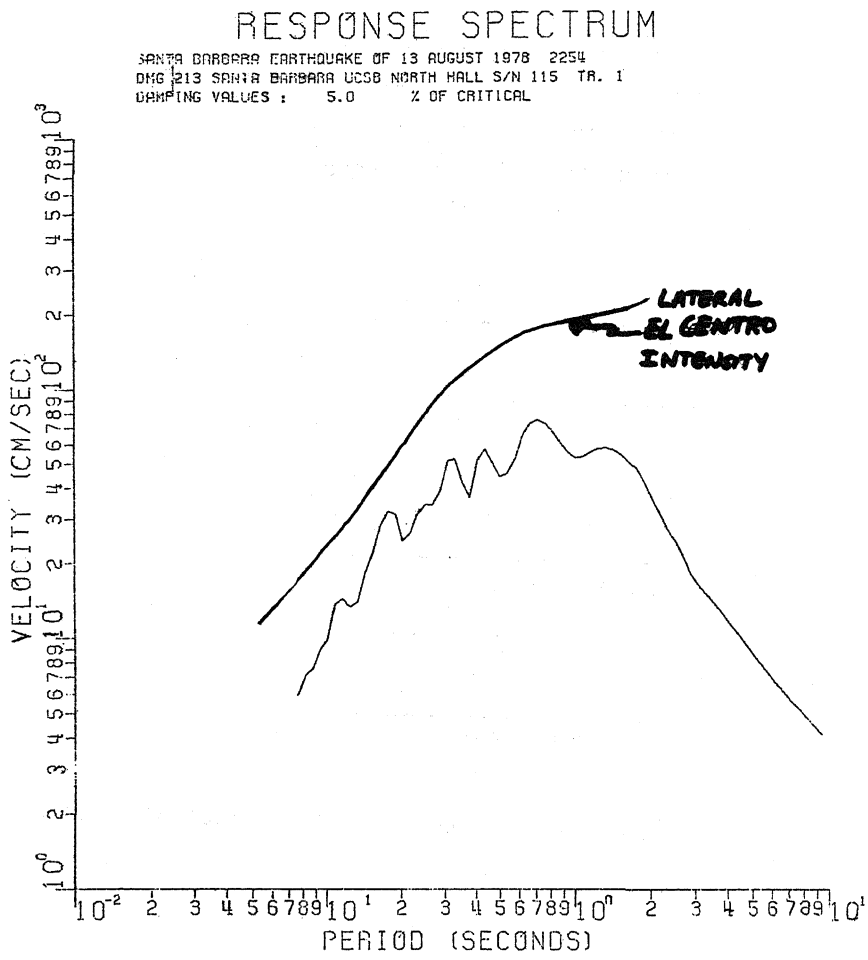
Figure 2



Location of accelerometers within North Hall, UCSB.

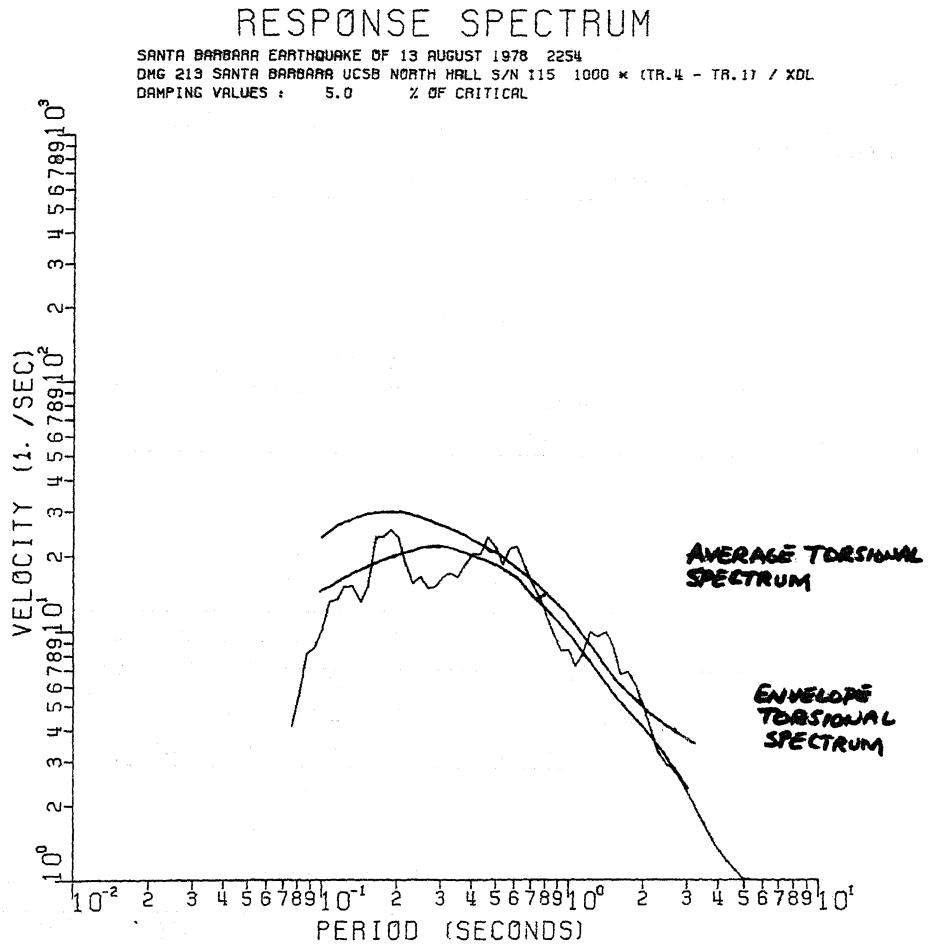
LOCATION OF ACCELEROMETERS WITHIN NORTH HALL, UCSB

Figure 3



RESPONSE SPECTRUM

Figure 4



RESPONSE SPECTRUM

Figure 5

Table 1: Harmonic Vibration Tests:
Maximum Measured Acceleration

	North-South	East-West	Torsion
Pre-Rehabilitation Harmonic Vibration	3%g	3%g	3%g
Post-Rehabilitation Harmonic Vibration	1%g	0.6%g	1%g

Table 2: Harmonic Vibration Tests:
Percent Critical Damping Ratio

	North-South	East-West	Torsion
Pre-Rehabilitation Harmonic Vibration	6.8 - 7.5	9.4 - 11.8	10.3 - 11.4
Post-Rehabilitation Harmonic Vibration	6.1 - 6.3	9.3 - 11.9	------

Table 3: Harmonic Vibration Tests:
Outside Building Response

	West Side		East Side		South Side		
	5 Ft.	25 Ft.	5 Ft.	25 Ft.	5 Ft.	25 Ft.	45 Ft.
Minor	15.5*	4.6	1.5	0+	10.1	9.3	---+
Major	---+	---+	---+	---+	19.1	11.3	10.4
Torsion	44.7	14.5	2.5	0+	10.4	10.3	---+

Table 4: Building Natural Frequencies (Hz)

	North-South	East-West	Torsion
Pre-Rehabilitation Harmonic Vibration	3.5 - 3.7	3.9 - 4.1	4.8 - 4.9
Post-Rehabilitation Harmonic Vibration	4.9	6.1	5.7 - 6.1
Post-Earthquake Ambient Vibration	4.0	4.9	6.5

Note: *: All numbers shown are percent of reference accelerometer at 3rd level.
+: Means do data was taken.

Table 5: Building Earthquake Motion

	Peak Accel. (Time)	Peak Velocity (Time)	Peak Displacement (Time)
Rotational Motion			
CH. 4	351.11 (4.50)	-35.45 (4.36)	5.91 (4.12)
CH. 1	395.69 (4.50)	-35.53 (4.34)	6.19 (4.10)
CH. 4 - CH. 1	99.13 (5.88)	3.67 (4.24)	-0.45 (13.98)
CH. 8	-534.49 (4.72)	-48.26 (4.40)	6.56 (4.06)
CH. 5	679.63 (4.88)	-46.44 (4.40)	7.36 (4.06)
CH. 8 - CH. 5	-363.68 (4.16)	11.19 (4.12)	-0.83 (4.04)
Intra-Story Motion			
CH. 8	-534.49 (4.72)	-48.26 (4.40)	6.56 (4.06)
CH. 4	351.11 (4.50)	-35.45 (4.36)	5.91 (4.12)
CH. 8 - CH. 4	-376.16 (4.72)	-17.48 (4.78)	-1.12 (4.88)
CH. 5	679.63 (4.88)	-46.44 (4.40)	7.36 (4.06)
CH. 1	395.69 (4.50)	-35.53 (4.34)	6.19 (4.10)
CH. 5 - CH. 1	-643.52 (4.04)	-24.26 (4.80)	-1.33 (4.88)
CH. 7	-975.90 (4.06)	-54.34 (3.98)	+8.21 (4.06)
CH. 1	395.69 (4.50)	-35.53 (4.34)	6.19 (4.10)
CH. 7 - CH. 1	-945.13 (4.06)	39.95 (4.00)	2.13 (4.06)
CH. 7	-975.90 (4.06)	+54.34 (3.98)	+8.21 (4.06)
CH. 5	679.63 (4.88)	-46.44 (4.40)	7.36 (4.06)
CH. 7 - CH. 5	-448.88 (4.08)	18.59 (4.00)	0.86 (4.74)

Note: Acceleration Units (cm/sec^2)
Velocity Units (cm/sec)
Displacement Units (cm)
Time Units (seconds after start of record)

Table 6: Base Shear Magnitudes

Direction	Method	V/W
North-South	UBC 1976	0.28
	ATC-3	0.15
East-West	UBC 1976	0.28
	ATC-3	0.15
Santa Barbara Earthquake		0.60

REFERENCES

1. Hart, G.C., DiJulio, R.M. and Lew, M., "Torsional Response of High Rise Buildings", Journal of the Structural Division, ASCE, Vol. 101, No. ST2, February, 1975.

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4. Porter, L.D., Ragsdale, J.T. and McJunkin, R.D., "Processed Data from the Santa Barbara Earthquake of 13 August, 1978", California Division of Mines and Geology Preliminary Report 23. 1979.