Chapter 8 – HAZUS Results

8.1 Methodology

Using SAP-2000 software a nonlinear time history analysis has been performed of 20 near field records to evaluate the peak displacement of Pre-Northridge building. A non-linear Direct Integration method was employed with an input parameter of time step size 0.01 sec, a total number of output time step 3000 to 6000 (30 sec to 60 sec) depend upon the length of the accelerogram. To consider a geometric non-linearity, P-Delta plus large displacement effects are also taken into account. All accelerograms are applied in positive y-direction (U2) and a damping near to 5 % is used in this analysis. Finally, obtained displacements are plotted on a fragility curve to calculate the probability of exceedance of each limit state. On the basis of these probabilites the performance of building has commented.

8.2 Results

The tabulated results are based on the location, displacement, type of directivity, distance from the fault and the five damage levels attained by the model under the seismic records. For a particular maximum displacement which is smaller than the average displacement of the vulnerability curve for the yield (0.029m), is given the designation non- yield (green). For a maximum dislocation which is located between the portion of the yielded (0.029m) area and the slight limit is categorized as (light blue), (0.20 m), designated as a slight damage state. Accordingly, the maximum displacement between the vulnerability curves of slight (0.20m) and moderate faults (0.219), (blue), characterized as moderate damage. The displacement between the moderate (0.219 m) and extensive damage (0.42 m), (yellow), classified as partial collapse (protected life). And the displacements that are between extensive (0.42m) and complete damage (0.49 m), (red), characterized as complete collapse of the building.

8.2.1 IMPERIAL VALLEY CA, USA 1940

Location	Mw	Dir/Ty	C/D	Displacement	Limit State
ELC 180-1	6.6	B	8.0	0.179	YIELDING
ELC 270-1				0.194	YIELDING

Table 8.1 the table Displacement and damage level for recording station in Imperial Valley , USA 1940

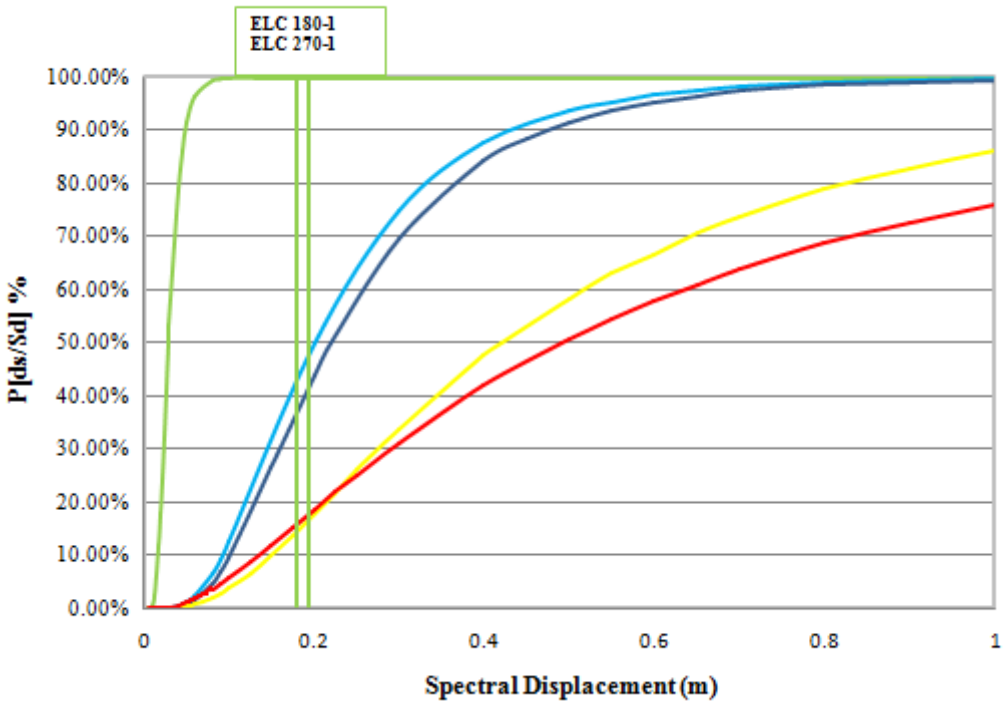


Figure 8.1 Fragility curves showing damage limit state for recording station in Imperial Valley,USA, 1940

Imperial Valley earthquake from 1940, had a magnitude of Mw=6.6. The stations exhibits a backward directivity. The results places our building in the yielding area. This is the result of the big distance of the station from the rift.

8.2.2 IMPERIAL VALLEY CA, USA 1979

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
AEP 045-1	6.4	F	0.4	0.325	MODERATE
AEP 315-1				0.164	YIELDING
AGR 003-1		N	0.6	0.401	MODERATE
AGR 273-1				0.374	MODERATE
BCR 140-1		F	2.0	0.283	MODERATE
BCR 230-1				0.204	YIELDING
CXO 225-1		N	11.0	0.159	YIELDING
CXO 315-1				0.142	YIELDING
E03 140-1		F	11.7	0.157	YIELDING
E03 230-1				0.106	YIELDING
E04 140-1		F	6.0	0.368	MODERATE
E04 230-1				0.212	SLIGHT
E05 140-1		F	2.7	0.118	YIELDING
E05 230-1				0.209	SLIGHT
E06 140-1		F	0.3	0.299	MODERATE
E06 230-1				0.266	MODERATE
E07 140-1		F	1.8	0.358	MODERATE
E07 230-1				0.290	MODERATE
EMO 000-1		F	1.2	0.371	MODERATE
EMO 090-1				0.379	MODERATE
MXC 000-1		N	10.4	0.107	YIELDING
MXC 270-1				0.122	YIELDING
HVP 225-1		F	6.9	0.294	MODERATE
HVP 315-1				0.305	MODERATE

Table 8.2 The table Displacement and damage level for recording station in Imperial Valley , USA 1979

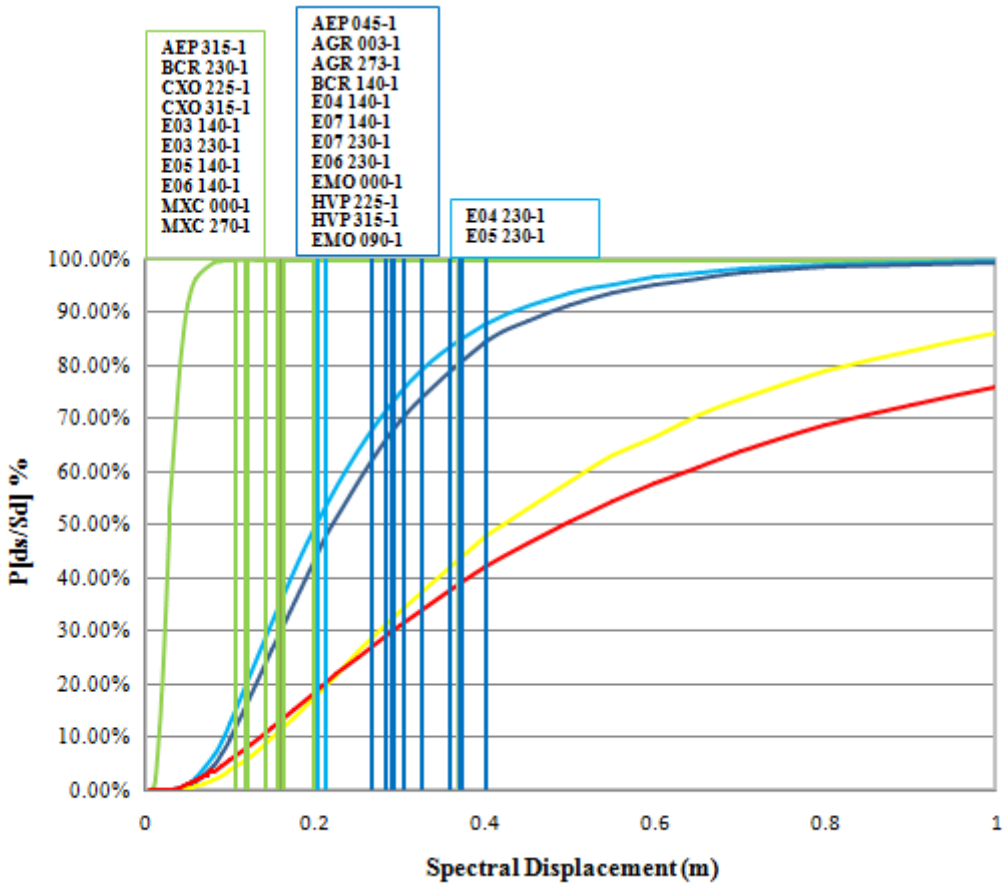


Figure 8.2 Fragility curves showing damage limit state for recording station in Imperial Valley,USA, 1979

The earthquake in the Imperial Valley from 15-10-1979 had a magnitude of 6.4. most of the stations showed forward directivity, but AGR, CXO and MXC showed neutral directivity. Approximately equal number of recordings are plotted yielded area and in the region of the upper limit of the moderate region.. However the displacement that put the building in the moderate damage state, are influenced by the fact that the stations are very near the rift and a forward directivity Below is given the Map 8.1 for a better understanding of the diversity of displacement.

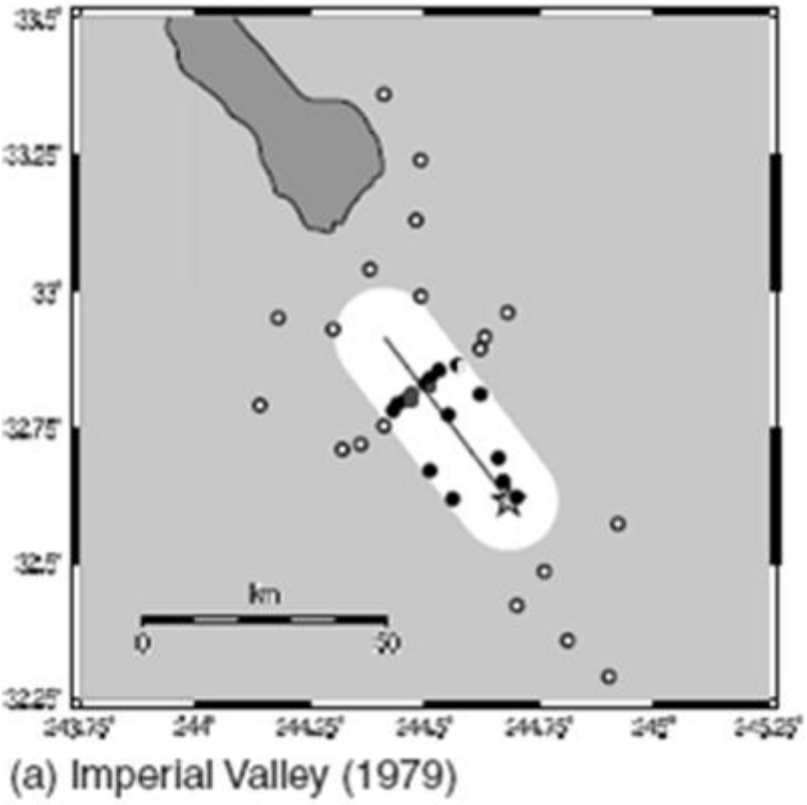


Figure 8.1 Map of stations in relation to the rupture of the earthquake area in IMPERIAL Valley, CA, USA, 1979

8.2.3 IZMIT, TURKEY

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
ARC 000-1	7.4	F	14	0.183	YIELDING
ARC 090-1				0.177	YIELDING
YPT 000-1		F	2.6	0.219	SLIGHT
YPT 090-1				0.245	MODERATE

Table 8.3 Displacement and attained peak damage levels for recording stations in Izmit, Turkey

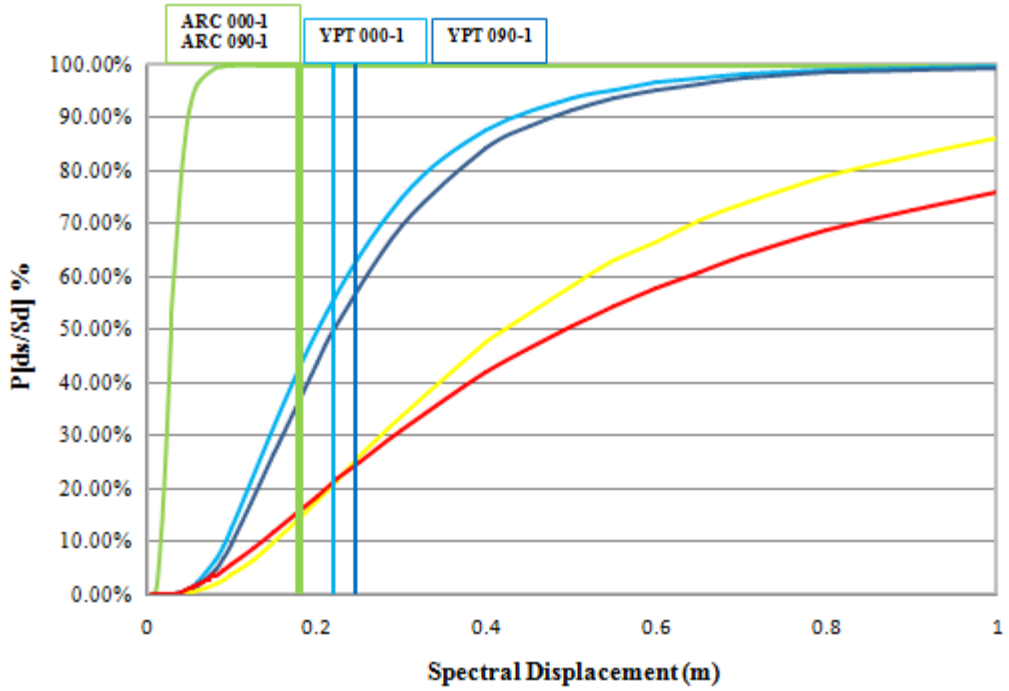


Figure 8.3 Fragility curves showing damage limit state for recording station in Izmit, Turkey

The Izmit earthquake had a magnitude of 7.4 on Richter's scale. It was recorded by 2 stations ARC and YPT. Both of them showed a forward directivity pattern, but ARC was at a far distance from the trace of the fault, 14 km, and as a result the recordings showed displacements belonging to the yielding area, while the YPT was only 2.6 km, recording a displacement belonging to the slight area and of the upper limit of the moderate one. Even if the earthquake magnitude was great and showed a forward directivity , it seem that the distance of the rift played an important role in the building's behavior.

8.2.4 LANDERS, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
JSH 000-1	**7.3**	**B**	**11.6**	**0.143**	YIELDING
JSH 090-1				**0.101**	YIELDING

LUC 000-1		**F**	**1.1**	**0.267**	MODERATE
LUC090-1				**0.342**	MODERATE

Table 8.4 the table Displacement and damage level for recording station in Landers, CA, USA

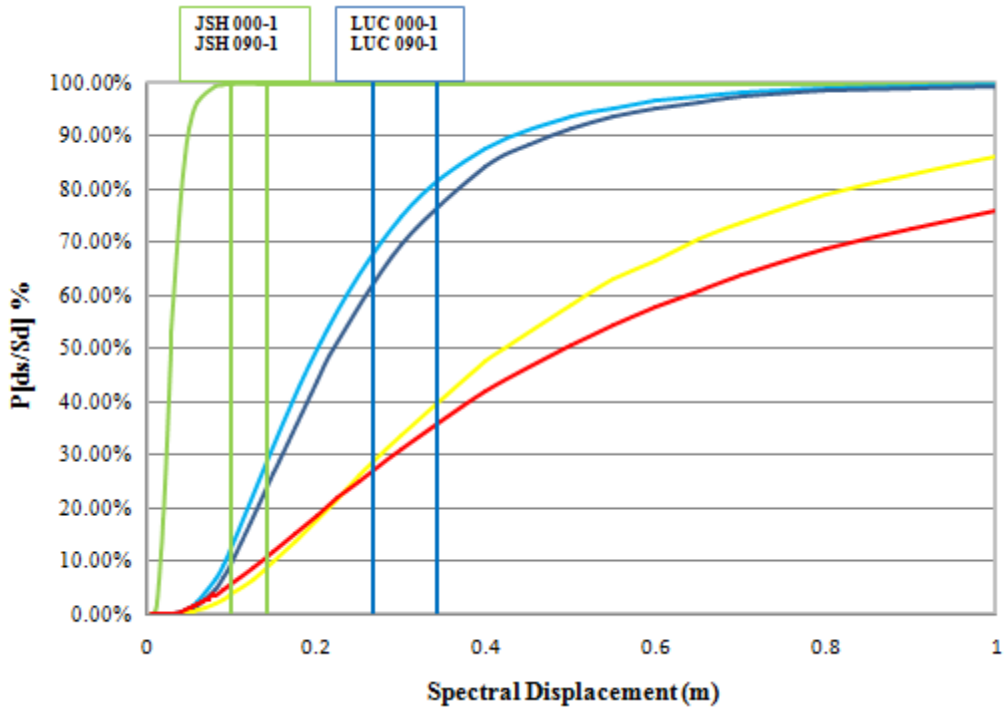
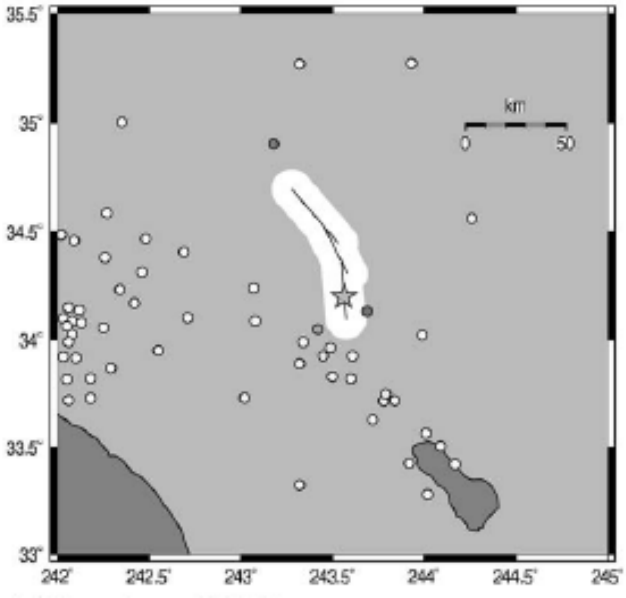


Figure 8.4 Fragility curves showing damage limit state for recording station in Landers, USA

The earthquake from Landers, had a magnitude of 7.3 on Richter's scale. The JSH station received backward directivity and abstained long distance from the trace of the fault (11.6 km) as a consequence the building lies in the yielding area. In contrast, the LUC station showed a pulse nature and also a short distance from the trace of the rift (1,1 km) played significant role in the results, placing the building in the moderate area. The map below shows the rupture and the locations of stations.



Map 8.2 Focus earthquake LANDERS, CA, USA (indicated by the asterisk), positions recording stations.

8.2.5 LOMA PRIETA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
BRN 000-1	6.9	B	11.5	0.164	YIELDING
BRN 090-1				0.148	YIELDING
CAP 000-1		B	15.8	0.112	YIELDING
CAP 090-1				0.125	YIELDING
COR 000-1		N	2.3	0.236	MODERATE
COR 090-1				0.110	YIELDING
GIL 067-1		N	10.5	0.159	YIELDING
GIL 337-1				0.124	YIELDING
G01 000-1		N	10.1	0.161	YIELDING
G01 090-1				0.146	YIELDING
GHB 090-1		F	11.1	0.145	YIELDING
GHB 180-1				0.121	YIELDING
LGP 000-1		F	3.0	0.413	MODERATE
LGP 090-1				0.271	SLIGHT
STG 000-1		F	8.3	0.168	YIELDING
STG 090-1				0.264	MODERATE

Table 8.5 the table Displacement and damage level for recording station in Loma Prieta, USA

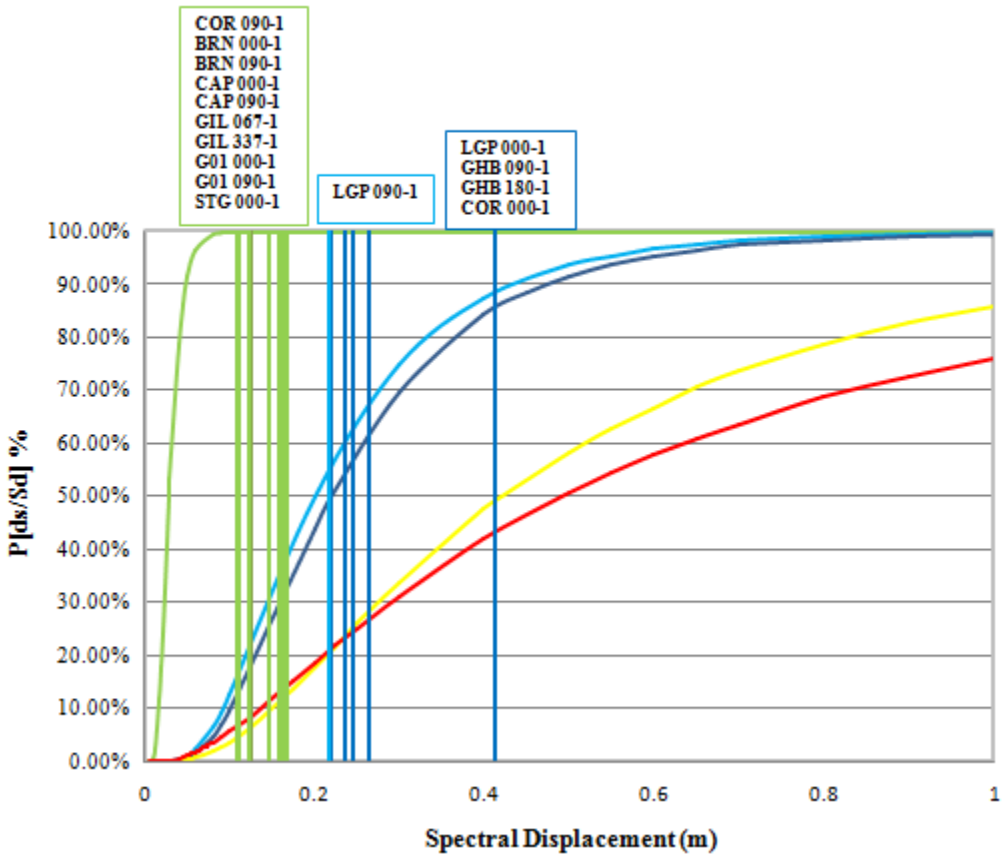


Figure 8.5 Fragility curves showing damage limit state for recording station in Loma Prieta

The Loma Prieta earthquake had a magnitude of 6.9 on Richter's scale. The displacement provided by the recordings places our building between the yield area and moderate. GHB, LGP and STG stations show a forward directivity an small distance from the surface of the rift (like in the case of LGP and STG) . other recordings that have neutral directivity or backward directivity recorded at relatively an big distance of the rift, exception been made by the COR station, which the results place the building in the moderate area, due to the small distance with the rift . GHB exhibits a forward directivity and places the building in the yielding area with small displacements.

8.2.6 MEXICALI VALLEY, MEXICO

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
CPR 045-1	6.4	F	6.5	0.237	MODERATE
CPR 315-1				0.296	MODERATE

Table 8.6 the table Displacement and damage level for recording station in Mexicali Valley, Mexico

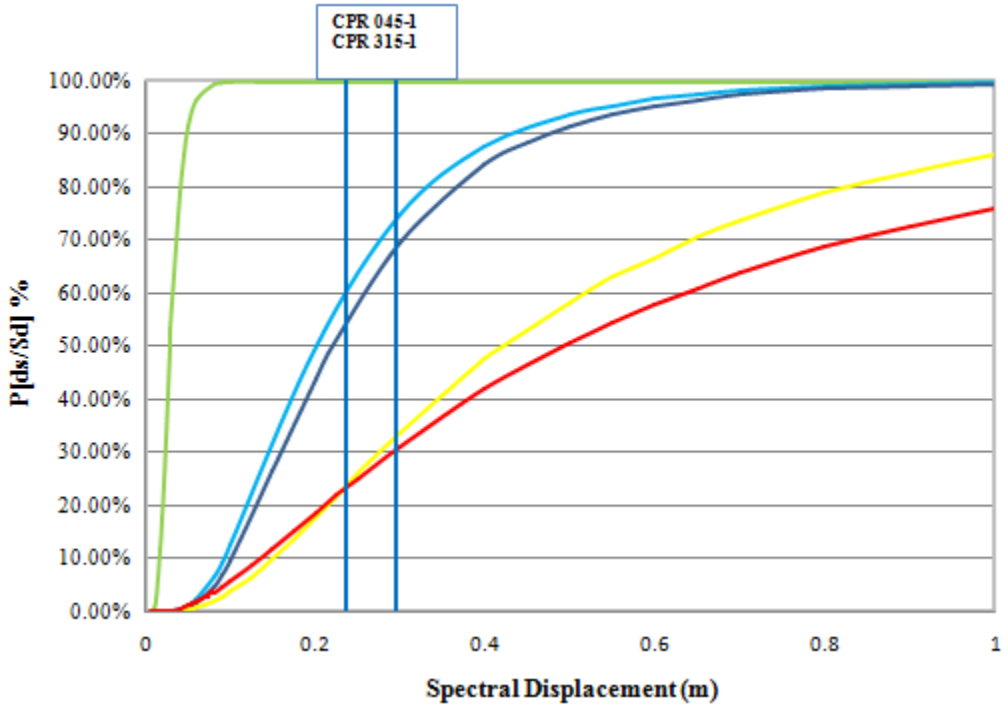


Figure 8.6 Fragility curves showing damage limit state for recording station in Mexically Valley

Mexicali Valley earthquake, had a magnitude of 6.4 on Richter's scale, showing a forward directivity. The recordings maintained the building in the upper limit of moderated area (dark blue). Although the size of the earthquake was large, the element that prevailed such results was a large distance of the station from the trace of the rift (6.5 km)

8.2.7 MORGAN HILL, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
AND 250-1	6.2	F	2.6	0.145	YIELDING
AND 340-1				0.170	YIELDING
CLD 195-1		F	0.1	0.237	MODERATE
CLD 285-1				0.155	YIELDING
HAL 150-1		B	2.0	0.109	YIELDING
HAL 240-1				0.162	YIELDING

Table 8.7the table Displacement and damage level for recording station in Morgan Hill, USA

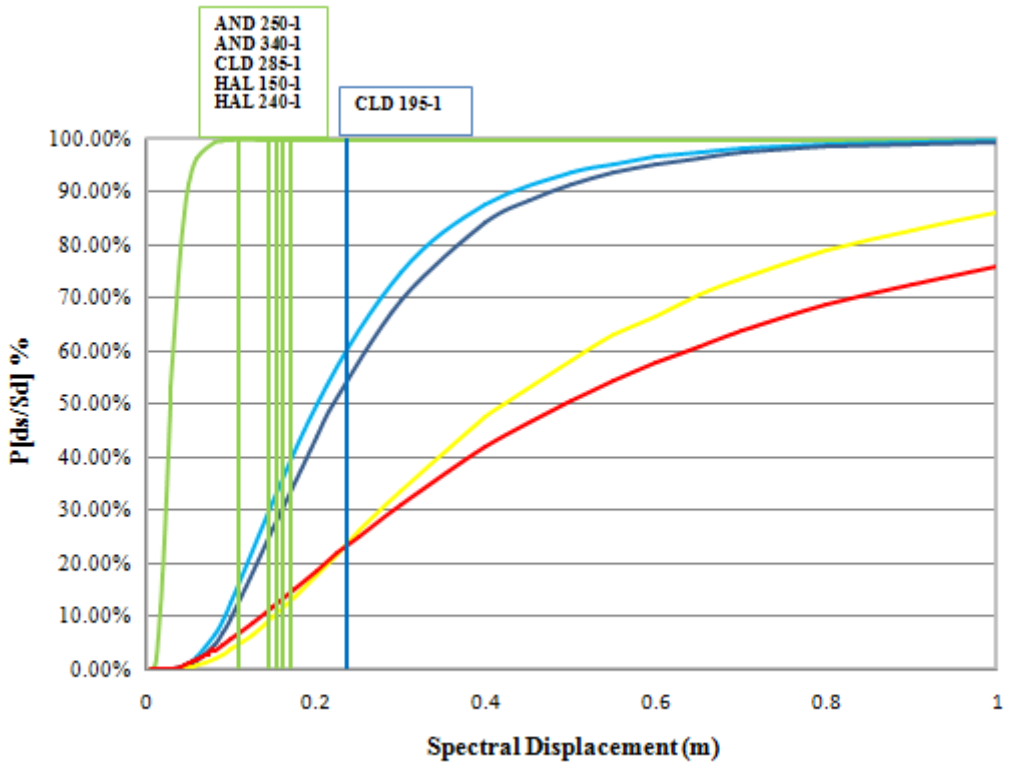


Figure 8.7 Fragility curves showing damage limit state for recording station in Morgan Hill

Morgan Hill earthquake had a magnitude of 6.2 on Richter's scale. The epicenter of the quake was located near Mount Hamilton in the Diablo Range of the California Coast Ranges, although nearby communities, including Morgan Hill, sustained serious damage. Recordings revealed that the building maintained a yielded area, except for CLD 195 which was at a very

small distance from the rift (0.1 km) so that the building was placed in the moderate zone with 0.237m displacement.

8.2.8 NAHANI, CANADA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
SITE1 010-1	6.7	N	9.4	0.342	MODERATE
SITE1 280-1				0.159	YIELDING
SITE2 240-1		N	5.2	0.297	MODERATE
SITE2 330-1				0.201	SLIGHT

Table 8.8 the table Displacement and damage level for recording station in Nahanni, Canada

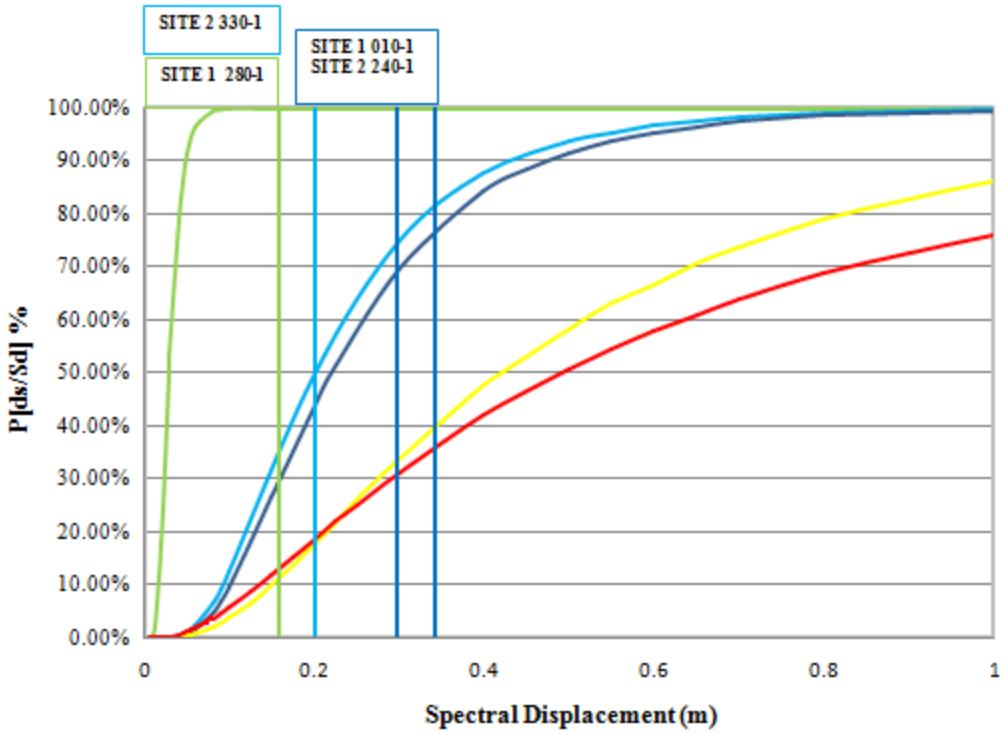


Figure 8.8 Fragility curves showing damage limit state for recording station in Nahani River, Canada

The earthquake in the South Nahani River in Canada, had a seismicity of 6.7 on Richter's scale. Both the stations have maintained the building damageability between the yielded and moderate area with small difference between the displacements. The neutral directivity, the distance from the surface of the epicenter and the intensity of the earthquake affects the results.

8.2.9 PALM SPRINGS, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
CAB 180-1	**6.1**	**F**	**6.0**	**0.149**	**YIELDING**
CAB 270-1				**0.138**	**YIELDING**
DSP 000-1		**N**	**6.4**	**0.165**	**YIELDING**
DSP 090-1				**0.104**	**YIELDING**
NPS 210-1		**F**	**4.0**	**0.277**	**MODERATE**
NPS 300-1				**0.236**	**MODERATE**
PSA 000-1		**F**	**10.8**	**0.128**	**YIELDING**
PSA 090-1				**0.159**	**YIELDING**
WWT 180-1		**F**	**6.5**	**0.168**	**YIELDING**
WWT 270-1				**0.141**	**YIELDING**

Table 8.9 the table Displacement and damage level for recording station in Palm Springs, USA

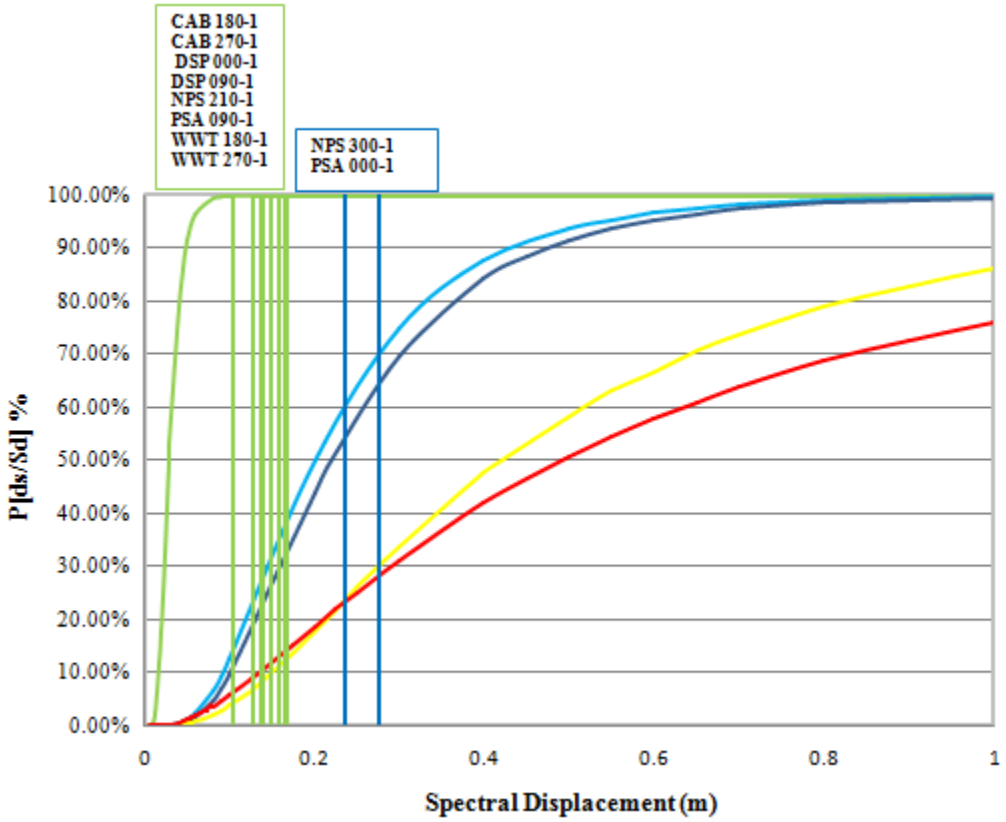


Figure 8.9 Fragility curves showing damage limit state for recording station in Palm Springs

The Palm Spring earthquake had a magnitude of 6.1 on Richter's scale. The stations revealed a forward directivity except the station DSP , which exhibits a neutral directivity. The results revealed that the NPS station at the distance of 4 km from the rift, places, the building in the moderate area. The rest of the stations places the building in the green area, with an average distance from the rift from 6 to 11 km.

8.2.10 SUPERSTITION HILLS, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
ELC 000-1	**6.4**	**F**	**13.6**	**0.209**	**SLIGHT**
ELC 090-1				**0.165**	**YIELDING**
KRN 270-1		**N**	**17.8**	**0.129**	**YIELDING**
KRN 360-1				**0.160**	**YIELDING**

PTS 225-1		**F**	**0.7**	**0.362**	**MODERATE**
PTS 315-1				**0.472**	**P.COLLAPSE**
POE 270-1		**N**	**10.7**	**0.312**	**MODERATE**
POE 270-1				**0.260**	**MODERATE**
SSM 045-1		**N**	**5.7**	**0.122**	**YIELDING**
SSM 135-1				**0.109**	**YIELDING**
WST 090-1		**F**	**13.2**	**0.201**	**SLIGHT**
WST 180-1				**0.311**	**MODERATE**

Table 8.10 the table Displacement and damage level for recording station in Superstition Hills

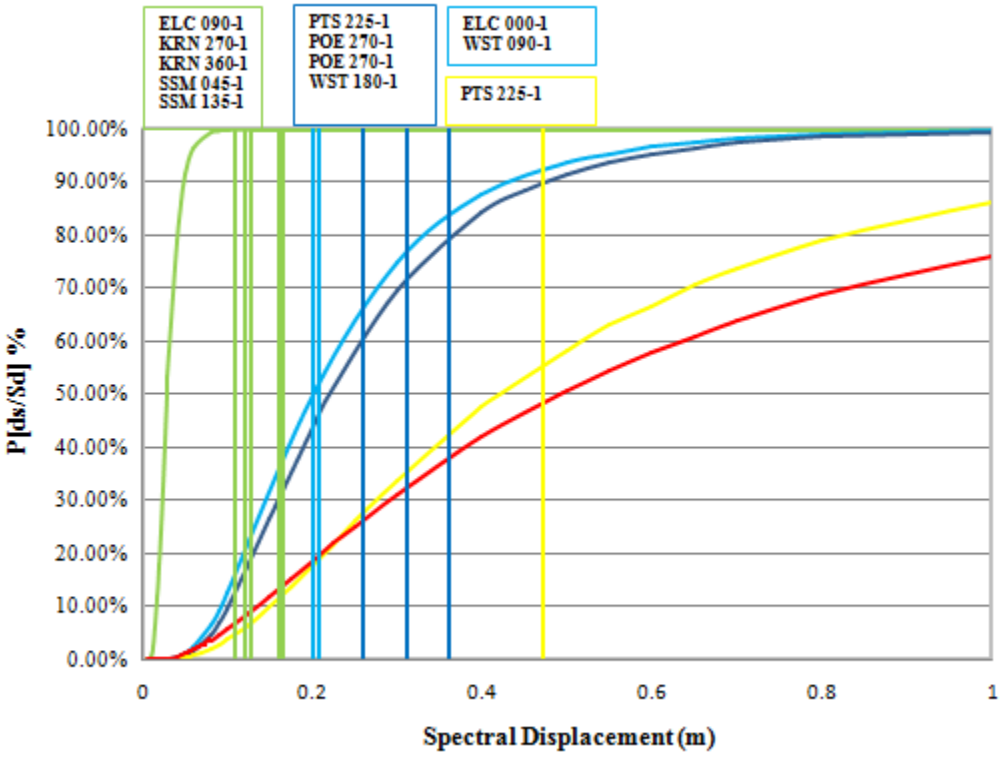


Figure 8.10 Fragility curves showing damage limit state for recording station in Superstition Hills

The Superstition Hills Earthquake has a magnitude of 6.4 on Richters scale. The recording stations heve the meutral or forward directivity. A special case is PTS 315. The recordings put the building in the partial collapsed zone, mainly because of the forward directivity plu the small distance of t he station with the rift. The other results are placing the building in the yielding zone, until moderate one.

8.2.11 TABAS, IRAN

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
TAB 074-1	7.1	N	1.2	0.261	MODERATE
TAB 344-1				0.301	MODERATE

Table 8.11 the table Displacement and damage level for recording station in Tabas, Iran

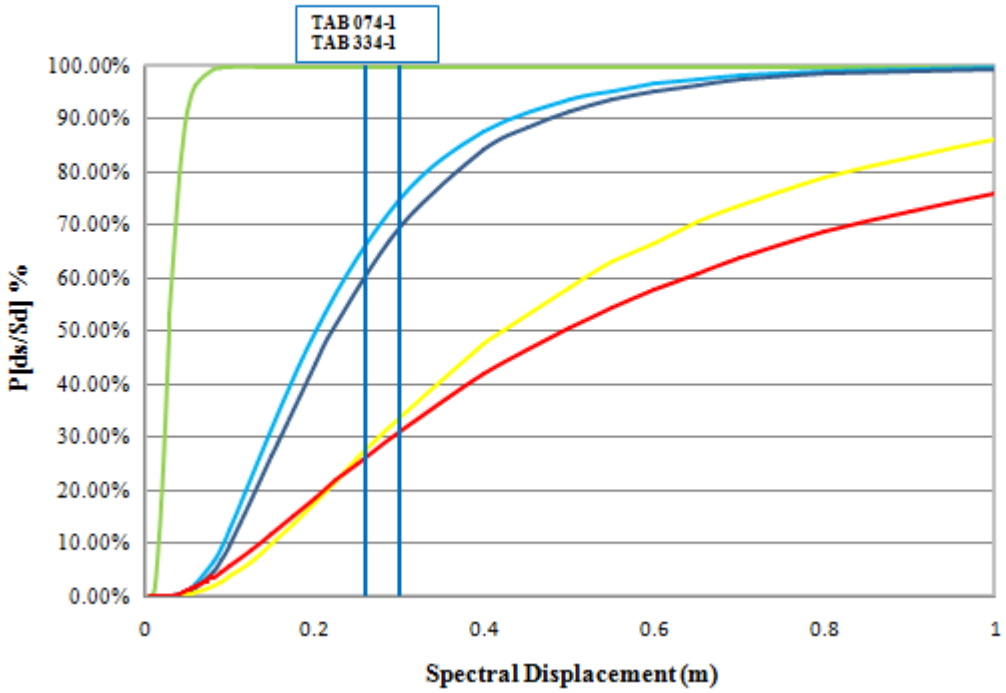


Figure 8.11 Fragility curves showing damage limit state for recording station in Tabas, Iran

The earthquake in Tabas had a magnitude of 7.1. the TAB record gave a top displacement of building places it in the upper limit of the moderate area. A very small distance of the station from the trace of the rift, but the directivity is negligible which was neutral contributed to this result. Also in comparison with other intensified earthquakes here the great intensity of the earthquake does not significantly affect the movement of the building instead of the shortest distance contributed t the displacement.

8.2.12 SAN FERNANDO, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
PCD 164-1	6.7	F	3.0	0.274	MODERATE
PCD 254-1				0.162	YIELDING

Table 8.12the table Displacement and damage level for recording station in San Francisco, USA

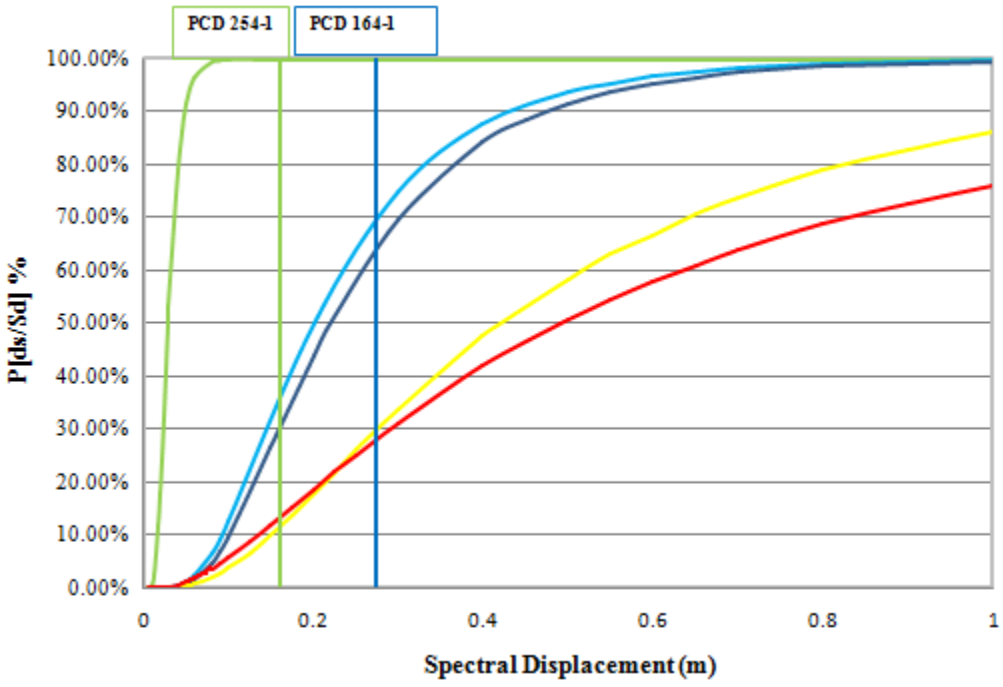


Figure 8.12 Fragility curves showing damage limit state for recording station in San Francisco

The earthquake in San Fernando had a magnitude of 6.7 on Richter's scale. The record PCD 254 gave displacement corresponding to elastic region (green) although the directivity is ahead, the distance from the trace of the fault (3 km) and the seismic intensity high. More interesting is the result of the record PCD-164 that result in moderate damage state.

8.2.13 SIERRA MADRE, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
COG 065-1	5.6	F	9.4	0.070	NON-YIELDING
COG 155-1				0.081	NON-YIELDING
ETN 000-1		F	9.6	0.059	NON-YIELDING
ETN 090-1				0.083	NON-YIELDING
MTW 000-1		F	11.9	0.050	NON-YIELDING
MTW 090-1				0.056	NON-YIELDING
SNM 000-1		F	15.6	0.047	NON-YIELDING
SNM 090-1				0.090	NON-YIELDING

Table 8.13the table Displacement and damage level for recording station in Sierra Madre, USA

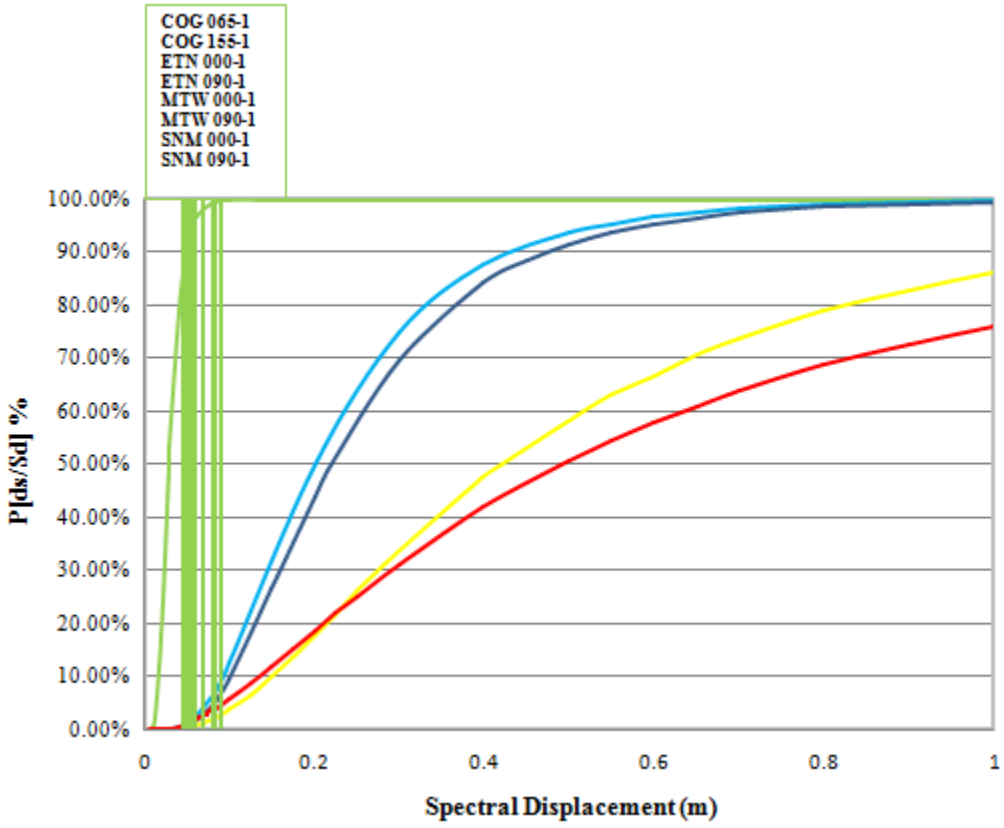


Figure 8.13 Fragility curves showing damage limit state for recording station in Sierra Madre

The earthquake from Sierra Madre, California had a magnitude of 5.6 on the Richter scale. All the seismic excitations maintained the building in the non-yielding recording very small displacements. Although, in other words, that the seismic triggers showed a forward

directivity, the great distance of stations from the surface of the fault in combinations with the small magnitude of the earthquake, justifies the low values od peak displacement of the building.

8.2.14 PARKFIELD, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
CO2 065-1	**6.0**	**F**	**0.1**	**0.239**	**MODERATE**
CO5 085-1		**F**	**5.2**	**0.199**	**YIELDING**
CO5 355-1				**0.207**	**SLIGHT**
CO8 050-1		**F**	**9.2**	**0.198**	**YIELDING**
CO8 320-1				**0.171**	**YIELDING**
TMB 205-1		**F**	**6.5**	**0.102**	**YIELDING**
TMB 295-1				**0.155**	**YIELDING**

Table 8.14 the table Displacement and damage level for recording station in Parkfield, USA

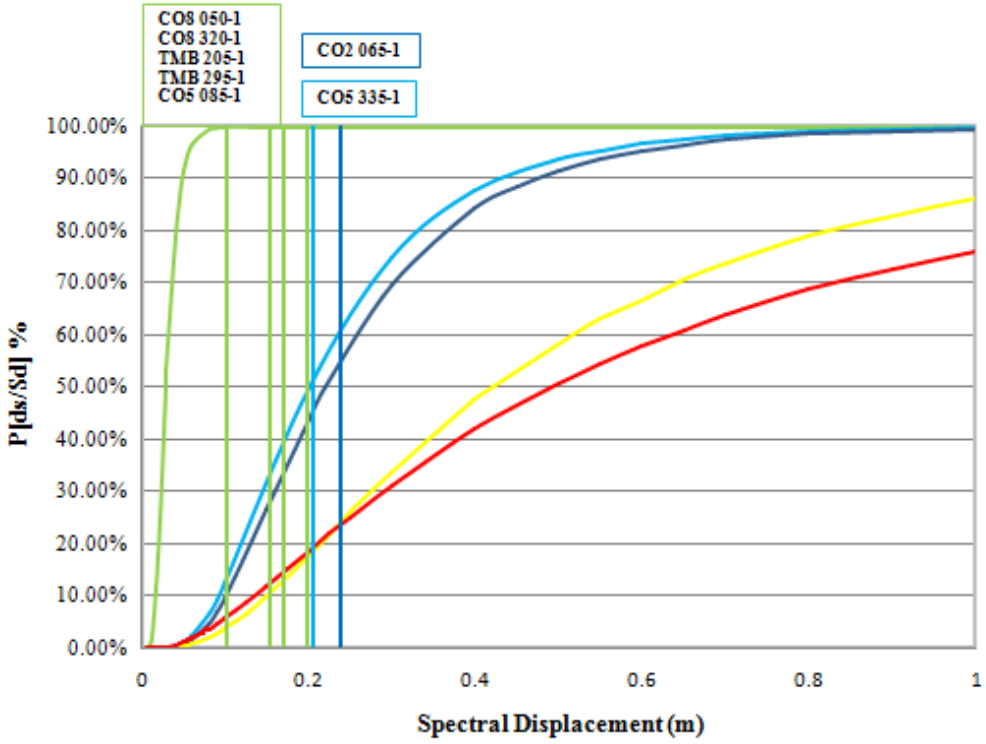


Figure 8.14 Fragility curves showing damage limit state for recording station in Parkfield, USA

The Parkfield earthkuake had a magnitude of 6 on the Richters scale. The stations record a forward directivity for all the station. The results place our building in the yielded area, except

for the CO5 335 (placing the building in the slight area, due to the small distance) and the station CO2 065, due to the very small distance, 0.1 km, brings our building in the moderate area.

8.2.15 CHI CHI, TAIWAN

The Chi-Chi earthquake was recorded by 422 free- strong motion instruments, including about 60 recordings within 20 km of the fault and 10 recordings within 3 km of the fault, making this by far the best recorded large earthquake ever.

The surface ruspture from the September 21, 1999 Taiwan earthquake extends for about 75km alonf the north-south trending Chelungpu with vertical displacements of 1-8 km. At the fault's northern end, near Fengyuan, it curves toward the northeast and splinters into complex branches. This area of faulting, which trends towards the northeast, extends for ana additional 10 km and was not previously considered an active fault.

More than 10 000 aftershocks were recorded in the first 3 weeks following the mainshock, including over 100 felt events and 5 aftershocks of magnitude greater than 6.0

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
CHI 024 090-1	**7.6**	**F**	**7.7**	**0.276**	**MODERATE**
CHI 024 360-1				**0.288**	**MODERATE**
CHI 028 090-1		**N**	**2.3**	**0.178**	**YIELDING**
CHI 028 360-1				**0.192**	**YIELDING**
CHI 101 090-1		**F**	**7.7**	**0.183**	**YIELDING**
CHI 101 360-1				**0.284**	**MODERATE**
TCU 049 090-1		**F**	**2.7**	**0.130**	**YIELDING**
TCU 049 360-1				**0.320**	**MODERATE**
TCU 051 090-1		**F**	**6.9**	**0.110**	**YIELDING**
TCU 051 360-1				**0.317**	**MODERATE**
TCU 052 090-1		**F**	**0.8**	**0.311**	**MODERATE**
TCU 052 360-1				**0.235**	**MODERATE**
TCU 053 090-1		**F**	**4.6**	**0.100**	**YIELDING**
TCU 053 360-1				**0.180**	**YIELDING**
TCU 054 090-1		**F**	**4.7**	**0.267**	**MODERATE**
TCU 054 360-1				**0.277**	**MODERATE**
TCU 055 090-1		**F**	**6.5**	**0.284**	**MODERATE**

TCU 055 360-1				**0.290**	**MODERATE**
TCU 065 090-1		**F**	**0.1**	**0.297**	**MODERATE**
TCU 065 360-1				**0.344**	**MODERATE**
TCU 067 090-1		**F**	**0.2**	**0.319**	**MODERATE**
TCU 067 360-1				**0.467**	**P.COLLAPSE**
TCU 068 090-1		**F**	**0.2**	**0.503**	**COLLAPSE**
TCU 068 360-1				**0.586**	**COLLAPSE**
TCU 071 090-1		**F**	**4.1**	**0.218**	**SLIGHT**
TCU 071 360-1				**0.269**	**MODERATE**
TCU 072 090-1		**F**	**6.8**	**0.336**	**MODERATE**
TCU 072 360-1				**0.210**	**SLIGHT**
TCU 074 090-1		**F**	**11.4**	**0.279**	**MODERATE**
TCU 074 360-1				**0.138**	**YIELDING**
TCU 075 090-1		**F**	**0.6**	**0.442**	**P.COLLAPSE**
TCU 075 360-1				**0.337**	**MODERATE**
TCU 076 090-1		**F**	**2.3**	**0.360**	**MODERATE**
TCU 076 360-1				**0.274**	**MODERATE**
TCU 078 090-1		**F**	**5.4**	**0.190**	**YIELDING**
TCU 078 360-1				**0.258**	**MODERATE**
TCU 082 090-1		**F**	**5.0**	**0.181**	**YIELDING**
TCU 082 360-1				**0.299**	**MODERATE**
TCU 087 090-1		**F**	**5.8**	**0.298**	**MODERATE**
TCU 087 360-1				**0.203**	**SLIGHT**
TCU 089 090-1		**F**	**6.2**	**0.362**	**MODERATE**
TCU 089 360-1				**0.333**	**MODERATE**
TCU 101 090-1		**F**	**1.5**	**0.349**	**MODERATE**
TCU 101 360-1				**0.414**	**MODERATE**
TCU 102 090-1		**F**	**0.6**	**0.446**	**P.COLLAPSE**
TCU 102 360-1				**0.383**	**MODERATE**
TCU 103 090-1		**F**	**4.4**	**0.457**	**P.COLLAPSE**
TCU 103 360-1				**0.268**	**MODERATE**
TCU 116 090-1		**F**	**11.5**	**0.296**	**MODERATE**
TCU 116 360-1				**0.350**	**MODERATE**
TCU 120 090-1		**F**	**6.1**	**0.337**	**MODERATE**
TCU 120 360-1				**0.185**	**YIELDING**
TCU 122 090-1		**F**	**8.5**	**0.234**	**MODERATE**
TCU 122 360-1				**0.193**	**YIELDING**
TCU 129 090-1		**F**	**1.5**	**0.386**	**MODERATE**
TCU 129 360-1				**0.290**	**MODERATE**

Table 8.15 the table Displacement and damage level for recording station in Chi Chi, Taiwan

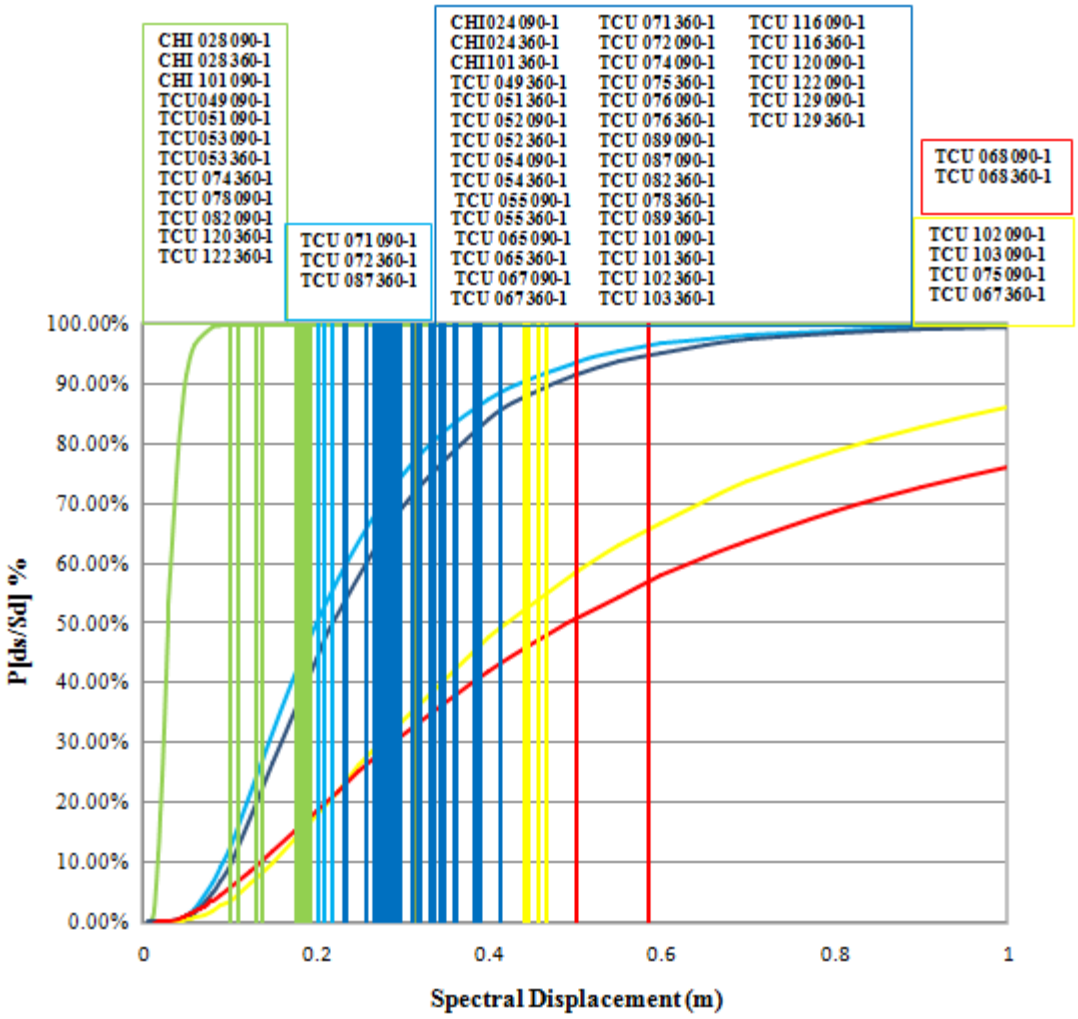
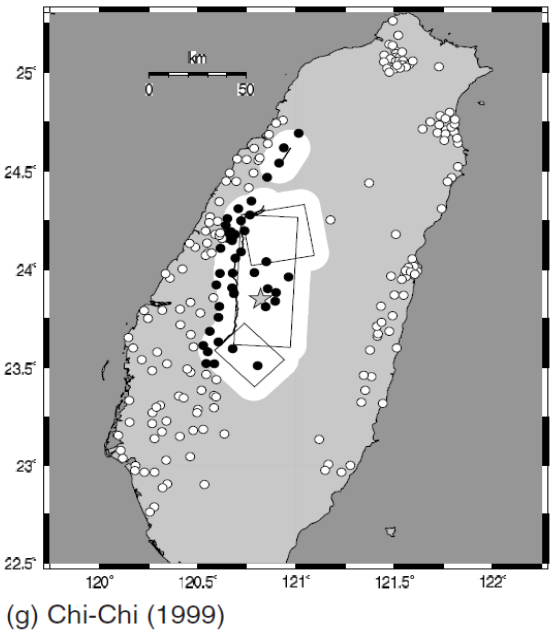
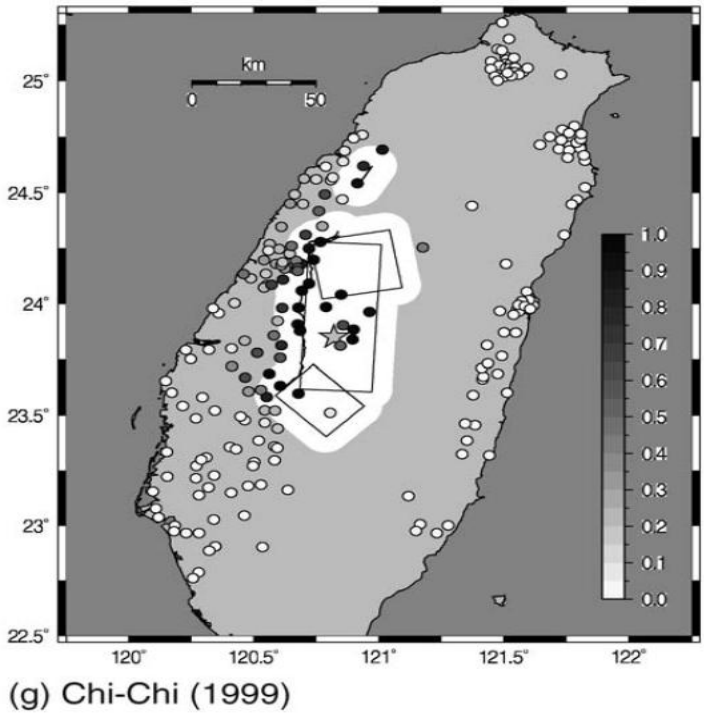


Figure 8.15 Fragility curves showing damage limit state for recording station in Chi-Chi, Taiwan

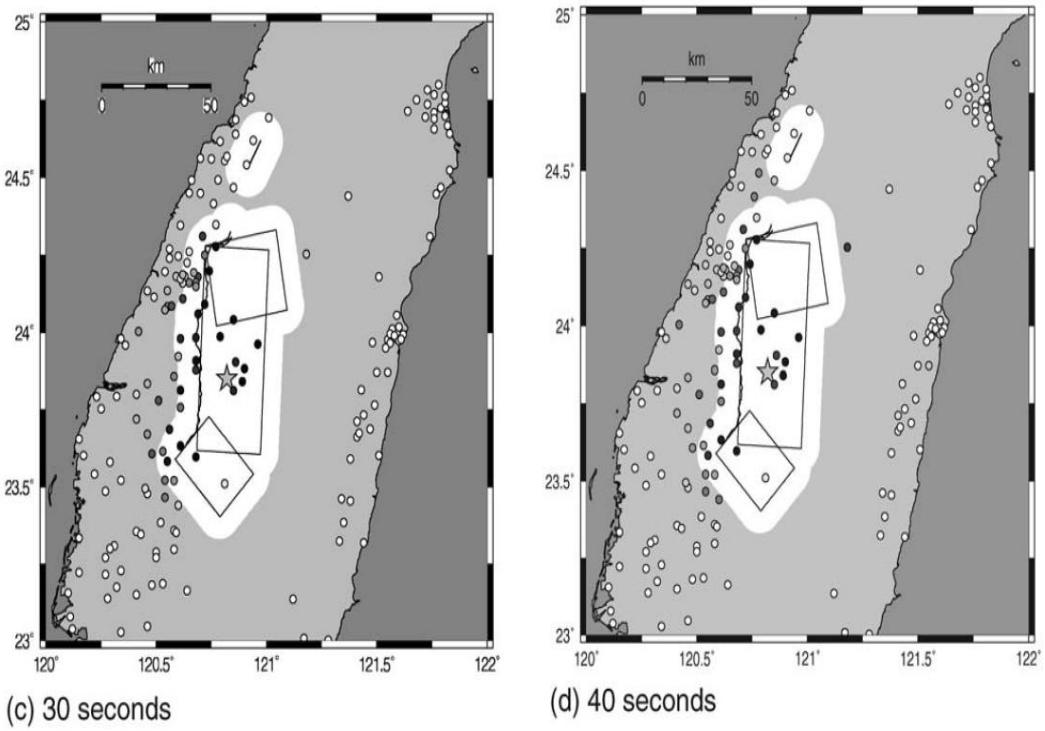
The Chi-Chi Earthquake has a seismic magnitude of 7.6. The stations are showing a forward directivity, except Chi028 (neutral directivity).Mostly of the results maintained the building in the moderate zone, exception being made by the station TCU 068, which places our building in the collapsed area with displacements of 0.508 and 0.586 respectively, the main cause being the combination of the forward directivity, small distance of the stations until the rift, and the magnitude of the earthquake, made the building not capable to resist to its lateral load. Other stations placed the building in the partially collapsed area, again making the correlation between its directivity and the distance of the station from the rift.



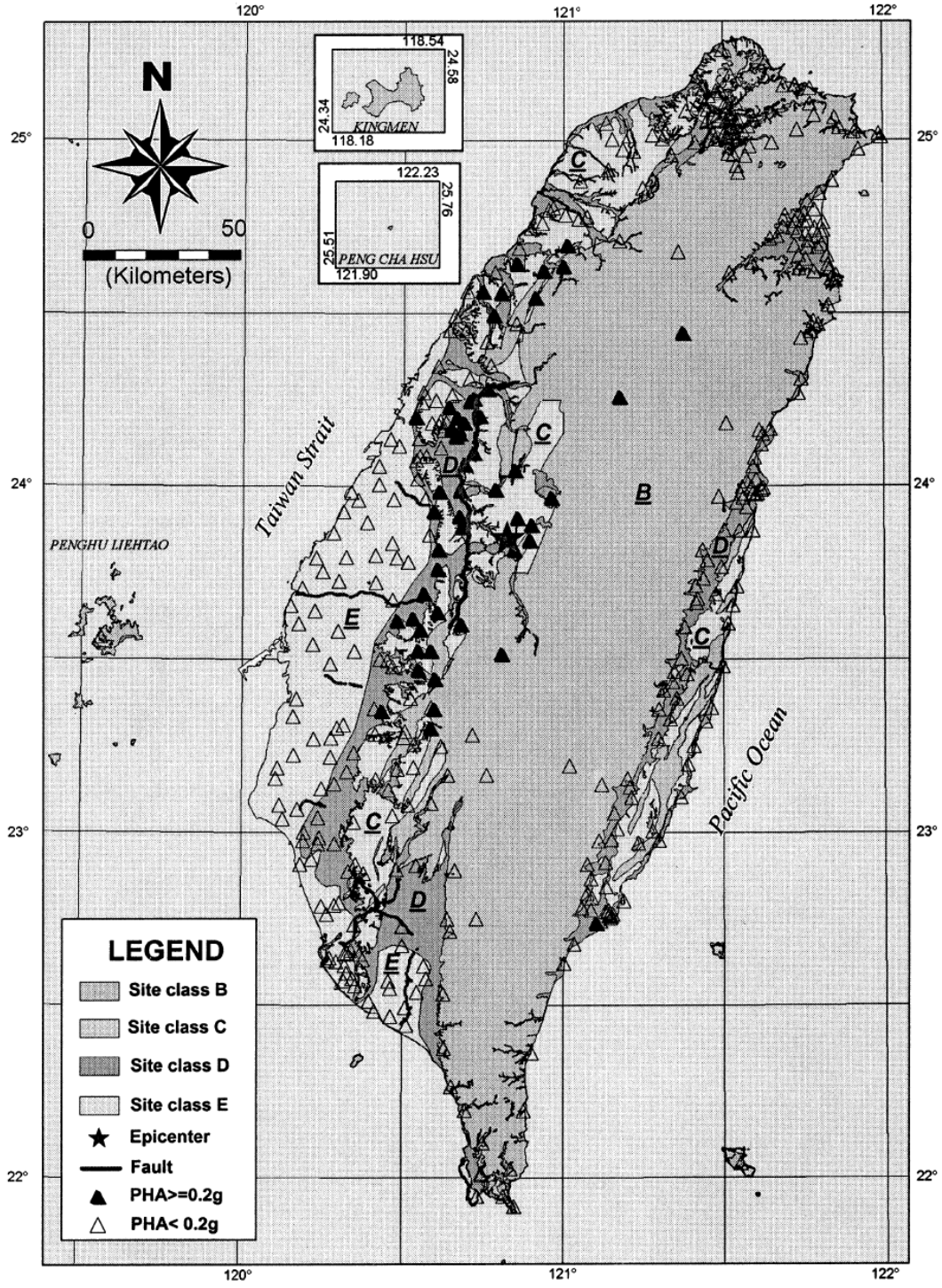
Map 8.3 Map in which the black lines show the view of surface rupture based on the models of failure. Stations within 10 km from the view of the Gulf (white areas in figure) are classified as nearby field, and are marked with black circles. The stations that are further away are shown with white circles. The star indicates the epicentre of the quake.



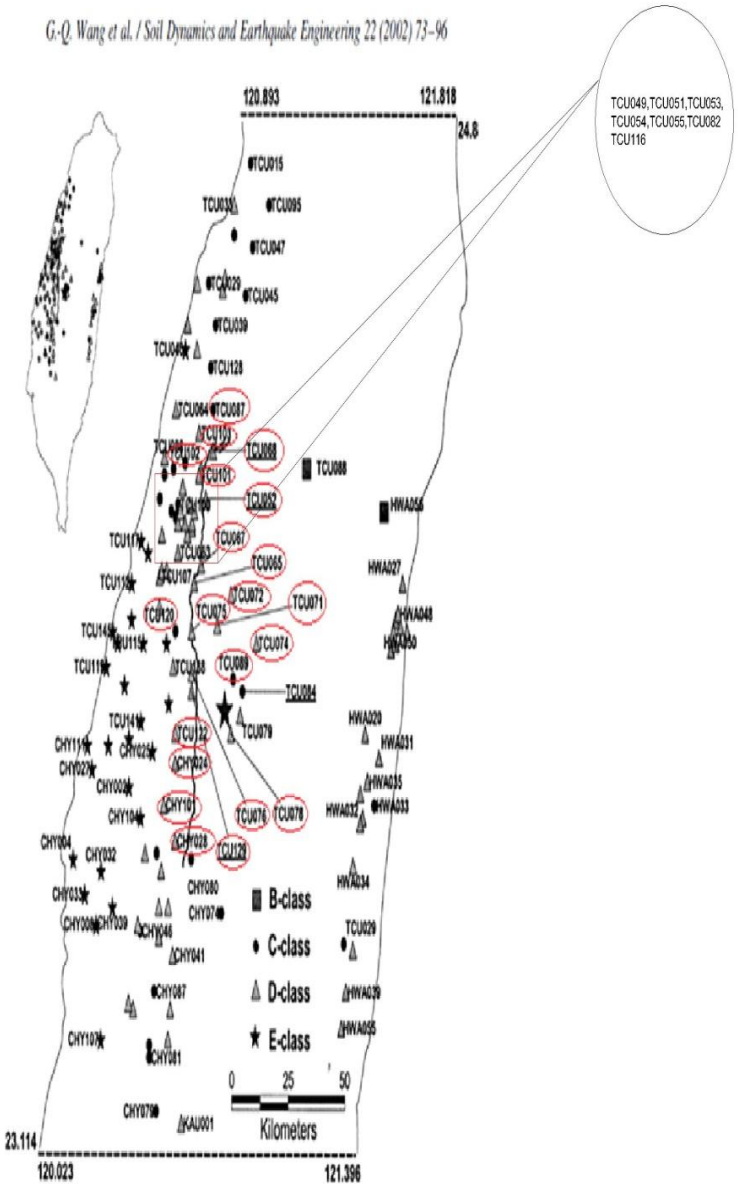
Map 8.4 Map in which the dark spot are likely to be used as stations which are located in a region near the source. All stations use the same color code for the scale. The symbols for the failure and the focus is the same as before



Map 8.5 maps showing snapshots of the potential near the source for the Chi-Chi earthquake, according to the best discreet from the Bayesian approach. The large circle is the theoretical front rupture assuming that the rupture speed is 2 kilometers per second.



Map 8.6 map showing the 441 acceleration recording stations. Because some stations have more than one recorder accelerograph, essentially there are 412 stations. Among the 441 stations, 56 of them which are indicated by a solid black triangle, show the stations to record maximum horizontal ground acceleration greater than 0.2 g.



Map 8.7 map showing the location 130 stations nearby field. The different symbols indicate the different geological characteristics of the soil. 2 stations are in soil category B, 30 in category C, 73 in D and 25 in E soil category respectively.

Map 8.8 The surface rupture zone and the locations of seismic. The star shows the focus of the main earthquake

8.2.16 COYOTE LAKE, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
GA1 230-1	5.6	F	9.0	0.106	YIELDING
GA1 360-1				0.156	YIELDING
GA2 050-1		F	7.2	0.147	YIELDING
GA2 140-1				0.108	YIELDING
GA3 050-1		F	5.1	0.173	YIELDING
GA3 140-1				0.116	YIELDING
GA4 270-1		F	3.5	0.153	YIELDING
GA4 360-1				0.367	MODERATE
GA6 230-1		F	1.2	0.198	YIELDING
GA6 320-1				0.330	MODERATE
SMCC 160-1		B	0.2	0.284	MODERATE
SMCC 250-1				0.253	MODERATE

Table 8.16 the table Displacement and damage level for recording station in Coyote Lake, USA

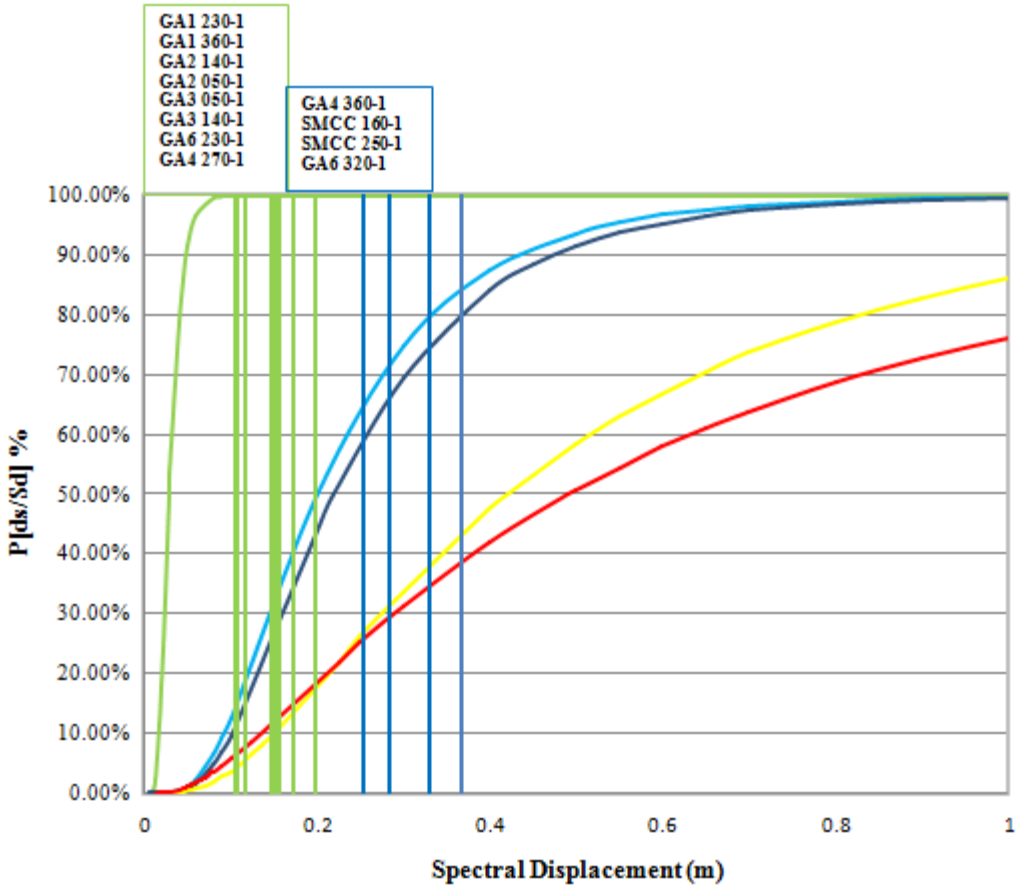


Figure 8.16 Fragility curves showing damage limit state for recording station in Coyote Lake, USA

Coyote Lake earthquake had a magnitude of the 5.6. the stations recorded a forward directivity, exception being made by the SMCC station (backward directivity). The results shows that the moderate placing of the building is mainly because of the directivity and the small distance between the station and the rift. The other station kept the building in the yielding area.

8.2.17 DUZCE, TURKEY

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
BOL 000-1	7.1	F	19.9	0.131	YIELDING
BOL 090-1				0.236	MODERATE
DZC 180-1		N	8.3	0.445	P.COLLAPSE
DZC 270-1				0.435	P.COLLAPSE

Table 8.17 Displacement of building with damage level under seismic recording of Duzce, TR

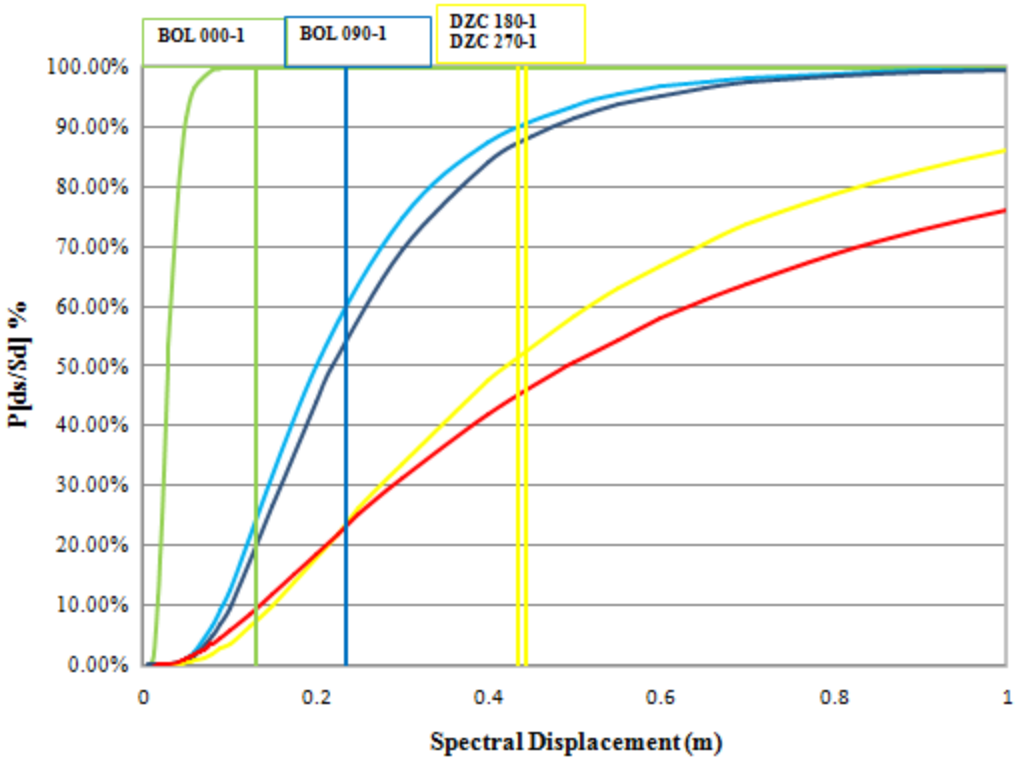


Figure 8.17 Fragility curves showing damage limit state for recording station in Duzce, Turkey

Duzce earthquake had a seismic magnitude of 7.1 on Richter's scale. For this earthquake, two stations were used for recordings. The BOL, at a distance of 19.9 km from the rift, shows a forward directivity; the results showed that the building's displacements were small (the building was , compared to the DZC station, at a distance of 8.3 km, showing a neutral directivity, placing the building in an area of partially collapse. In this case it might, for the DZC station, the magnitude of the earthquake in combination with the directivity effect, had an influence in the building's behavior results.

8.2.18 ERZICAN, TURKEY

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
ERZ 000-1	6.6	F	2.0	0.356	MODERATE
ERZ 090-1				0.321	MODERATE

Table 8.18 Displacement of building with damage level under seismic recording of Erzican,Turkey

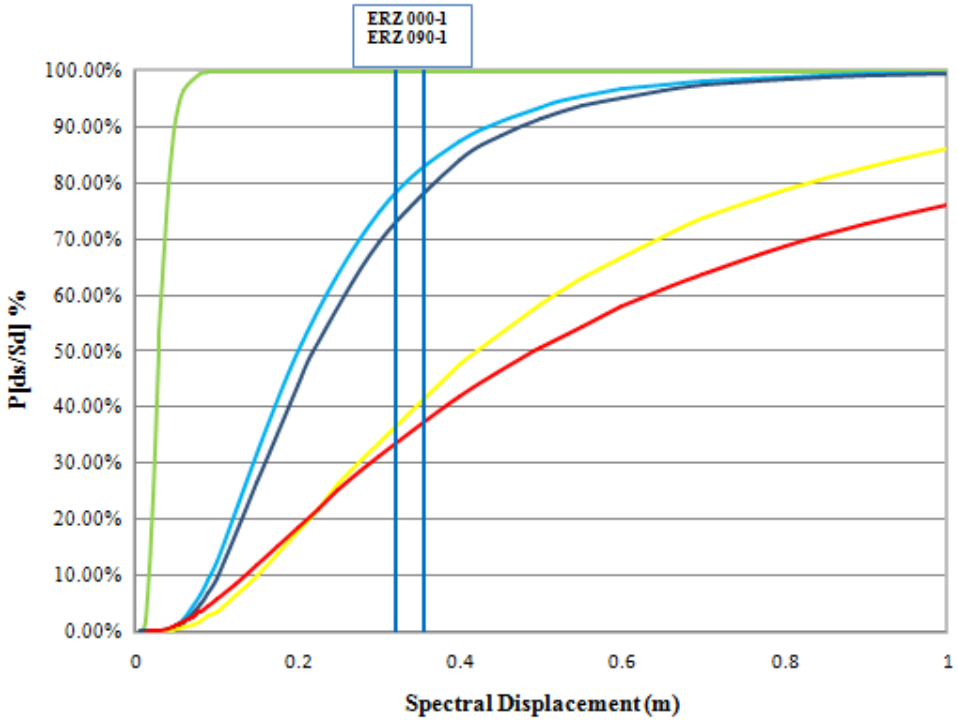


Figure 8.18 Fragility curves showing damage limit state for recording station in Erzican, Turkey

The earthquake in the area of Erzican, in Turkey had a magnitude of 6.6 on Richters scale, and it's station in the Erz Mountains recorded forwarded directivity pattern with a distance from the fault of 2 km. these factors, together with a large size of seismic magnitude justify these displacements, and they put our building into the moderate area

8.2.19 GAZLI, URSS

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
KAR 000-1	**6.7**	**N**	**3.0**	**0.302**	**MODERATE**
KAR 090-1				**0.297**	**MODERATE**

Table 8.19 Displacement of building with damage level under seismic recording of Gazli, URSS

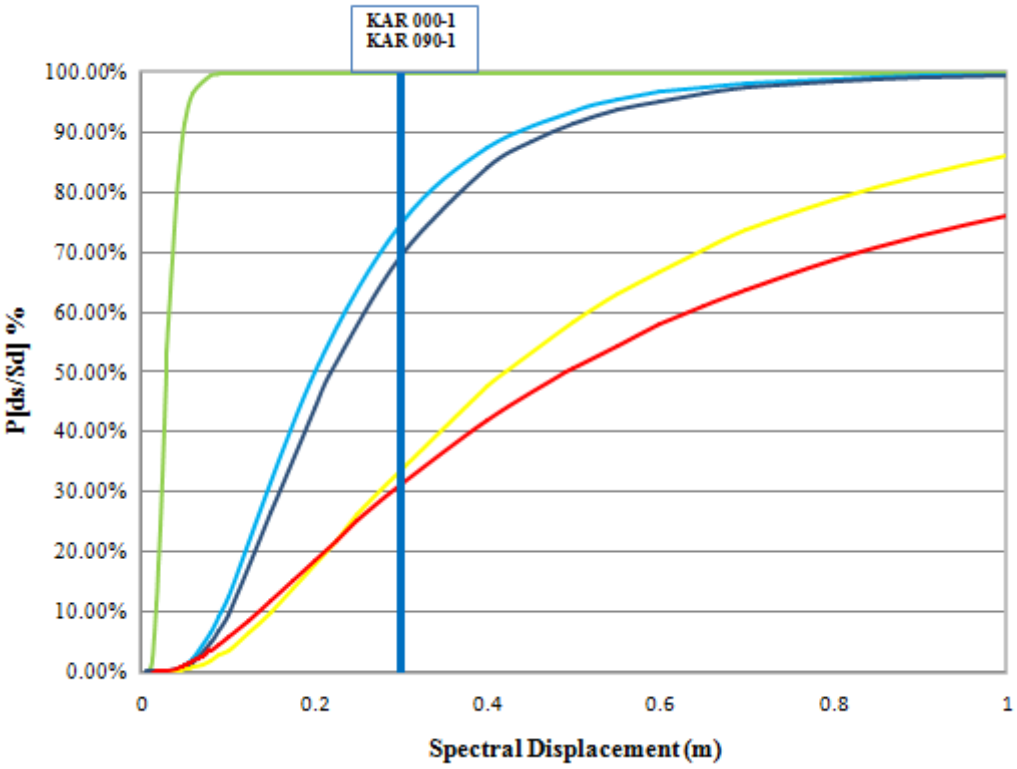


Figure 8.19 Fragility curves showing damage limit state for recording station in Gazli, URSS

The earthquake in Gazli had a magnitude of 6.7 on Richter's scale. The displacements are somehow large close to each other and they place our building in the moderate area. Due to the short distance of the station KAR (3km) and the neutral directivity recorded by it plus the large magnitude

8.2.20 HANSHIN(KOBE), JAPAN

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
KPI 000-1	6.8	F	0.7	0.450	P.COLLAPSE
KPI 090-1				0.112	YIELDING
KBU 000-1		F	3.2	0.384	MODERATE
KBU 090-1				0.143	YIELDING
NIS 000-1		N	10.5	0.302	MODERATE
NIS 090-1				0.275	MODERATE
TAZ 000-1		F	0.4	0.405	MODERATE
TAZ 090-1				0.145	YIELDING
TAK 000-1		F	1.1	0.160	YIELDING
TAK 090-1				0.315	MODERATE

Table 8.20 the table Displacement and damage level for recording station in Kobe, Japan

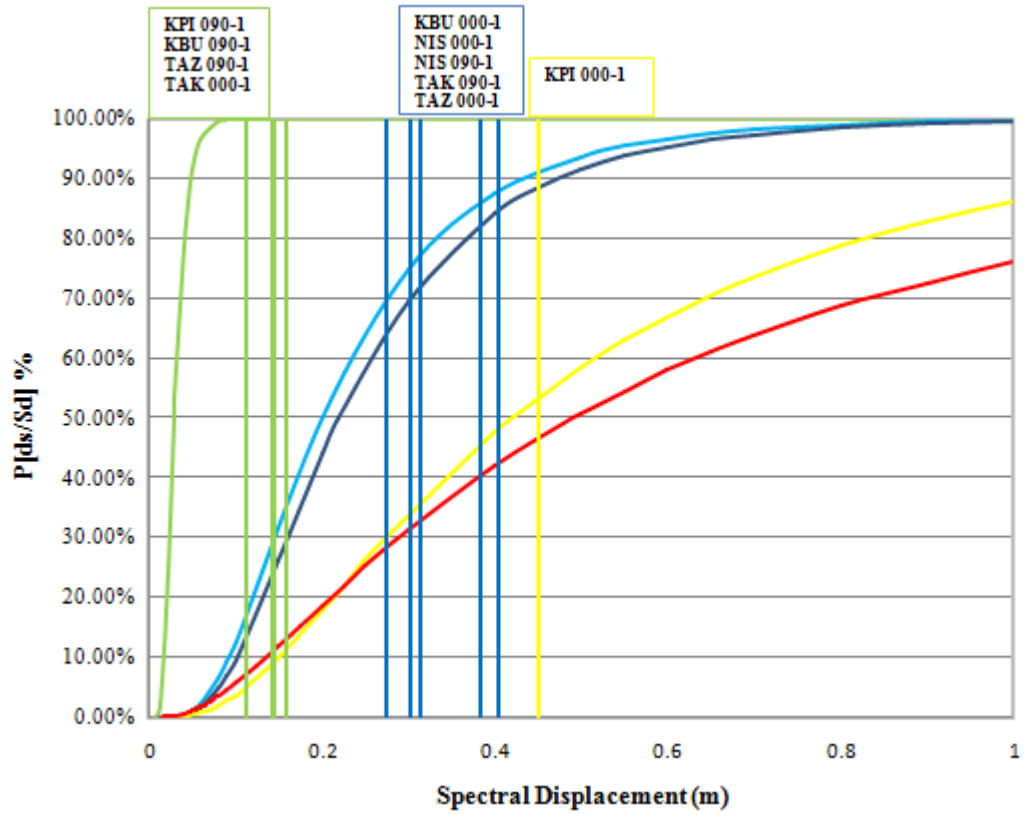


Figure 8.20 Fragility curves showing damage limit state for recording station in Kobe, Japan

The earthquake in the area of Hanshin (Kobe) of Japan had a magnitude of 6.8 on the Richters scale. An equal number of yielding and moderate results had revealed. An exception has the staton KPI 000, where the distance of the station toward the rift is very small (0.7 km), so the results place the building into the Partially collapse region**.**

8.2.21 NORTHRIDGE, CA, USA

Location	Mw	Dir/Ty	C/D	Displacement (m)	Limit State
SFY 090-1	**6.7**	**N**	**8.0**	**0.178**	**YIELDING**
SFY 360-1				**0.137**	**YIELDING**
CPC 106-1		**N**	**13.7**	**0.185**	**YIELDING**
CPC 196-1				**0.167**	**YIELDING**
CCY 000-1		**F**	**12.9**	**0.387**	**MODERATE**
CCY090-1				**0.143**	**YIELDING**
JFA 022-1		**F**	**5.2**	**0.231**	**MODERATE**
JFA 292-1				**0.472**	**P.COLLAPSE**
LF6 009-1		**B**	**17.3**	**0.216**	**SLIGHT**
LF6 279-1				**0.194**	**YIELDING**
LF5 035-1		**B**	**19.2**	**0.185**	**YIELDING**
LF5 135-1				**0.207**	**SLIGHT**
ULA 090-1		**B**	**19.9**	**0.107**	**YIELDING**
ULA 360-1				**0.170**	**YIELDING**
LWS 000-1		**B**	**19.0**	**0.102**	**YIELDING**
LWS 090-1				**0.209**	**SLIGHT**
LDW 064-1		**F**	**5.6**	**0.367**	**MODERATE**
LDW 334-1				**0.406**	**MODERATE**
NWH 090-1		**F**	**6.5**	**0.154**	**YIELDING**
NWH 360-1				**0.375**	**MODERATE**
NWS 046-1		**F**	**5.3**	**0.348**	**MODERATE**
NWS 316-1				**0.326**	**MODERATE**
NHW 180-1		**N**	**11.8**	**0.265**	**MODERATE**
NHW 270-1				**0.211**	**SLIGHT**

NRG 090-1 NRG 180 -1		**F**	**11.5**	**0.142** **0.217**	**YIELDING** **SLIGHT**
PCD 175-1 PCD 265-1		**F**	**7.2**	**0.253** **0.147**	**MODERATE** **YIELDING**
PKC 090-1 PKC 360-1		**N**	**7.4**	**0.112** **0.146**	**YIELDING** **YIELDING**
RRS 228-1 RRS 318-1		**F**	**6.0**	**0.134** **0.373**	**YIELDING** **MODERATE**
VSP 270-1 VSP 360-1		**F**	**8.0**	**0.412** **0.389**	**MODERATE** **MODERATE**
SMI 000-1 SMI-090-1		**N**	**12.4**	**0.191** **0.201**	**YIELDING** **SLIGHT**
SVG 000-1 SVG 090-1		**N**	**9.3**	**0.135** **0.267**	**YIELDING** **MODERATE**
SCG 052-1 SCG 142-1		**F**	**5.1**	**0.341** **0.363**	**MODERATE** **MODERATE**
SCH 011-1 SCH 281-1		**F**	**5.0**	**0.351** **0.481**	**MODERATE** **P.COLLAPSE**
SYH 090-1 SYH 360-1		**F**	**5.5**	**0.352** **0.357**	**MODERATE** **MODERATE**
TAR 090-1 TAR 360-1		**B**	**14.8**	**0.129** **0.281**	**YIELDING** **MODERATE**

Table 8.21 the table Displacement and damage level for recording station in Northridge, USA

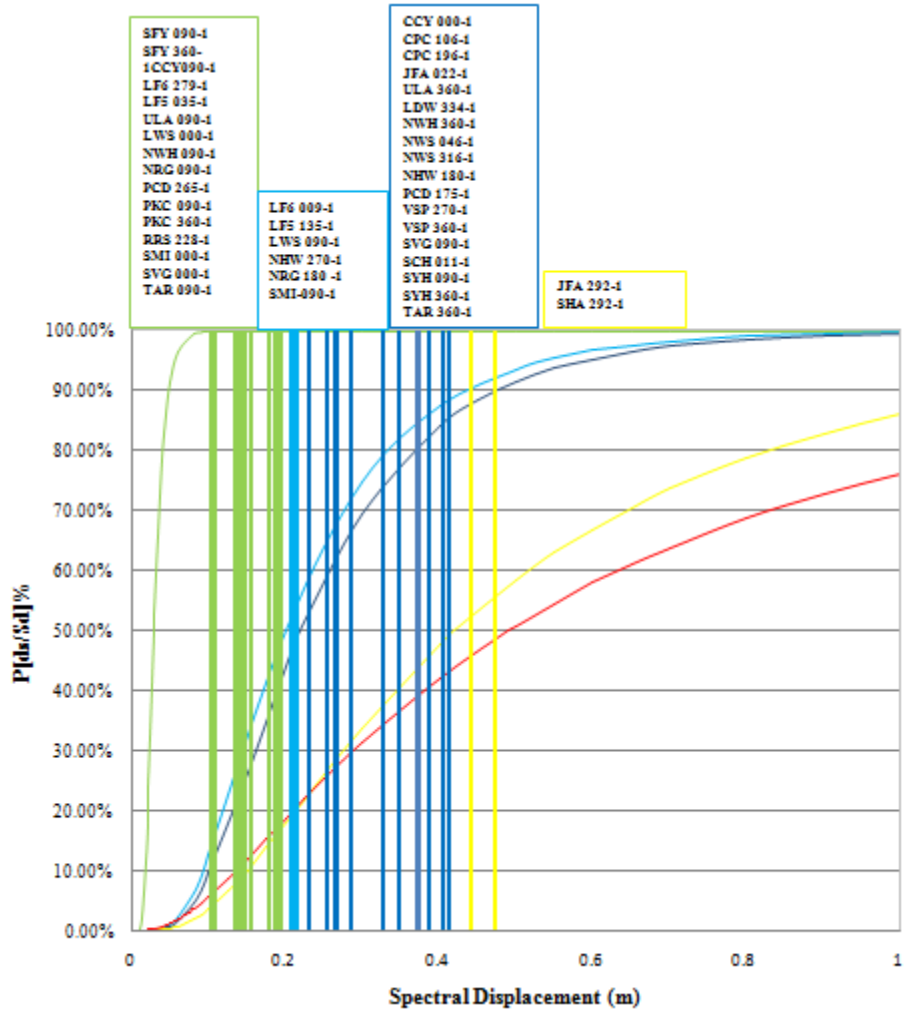
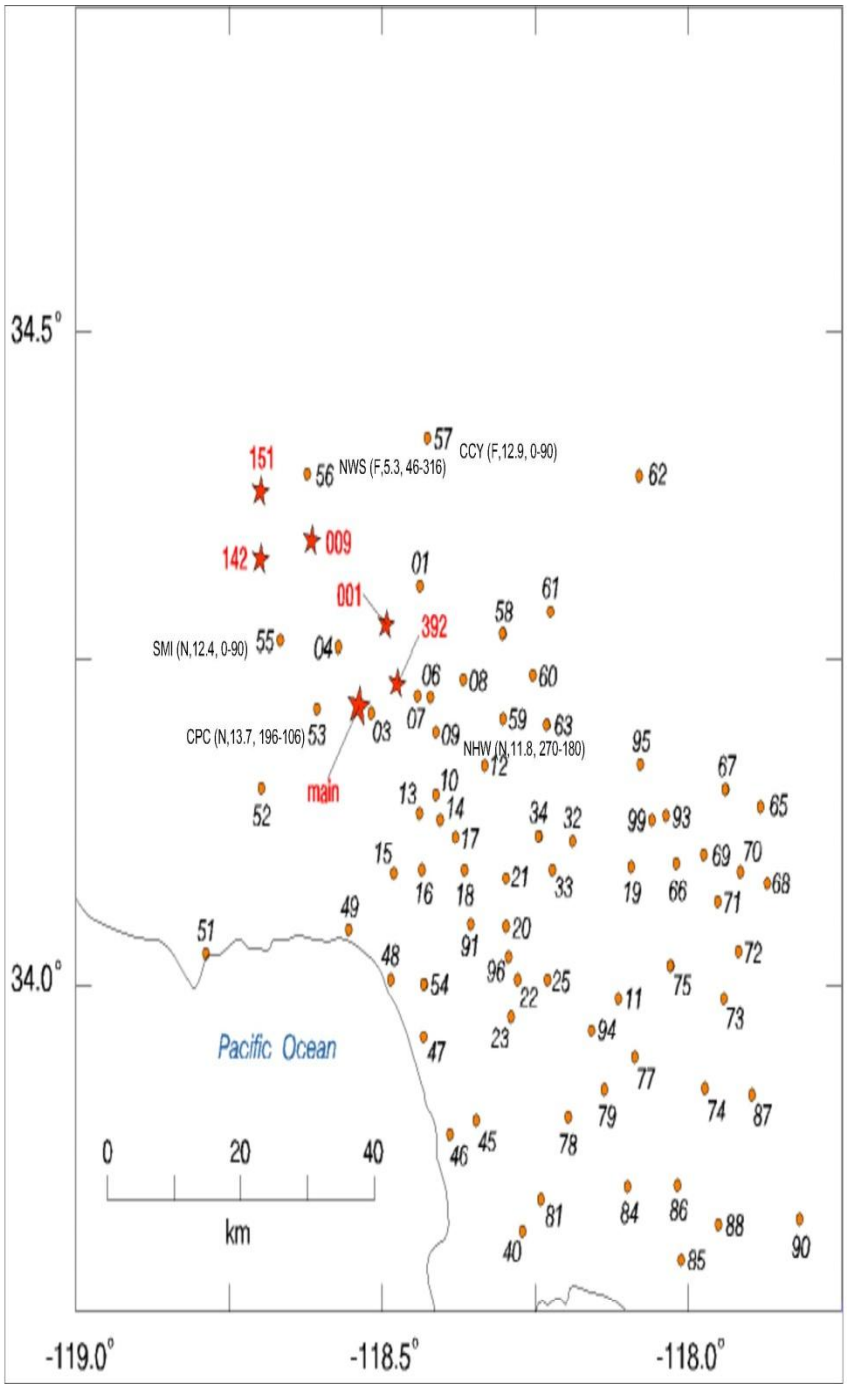
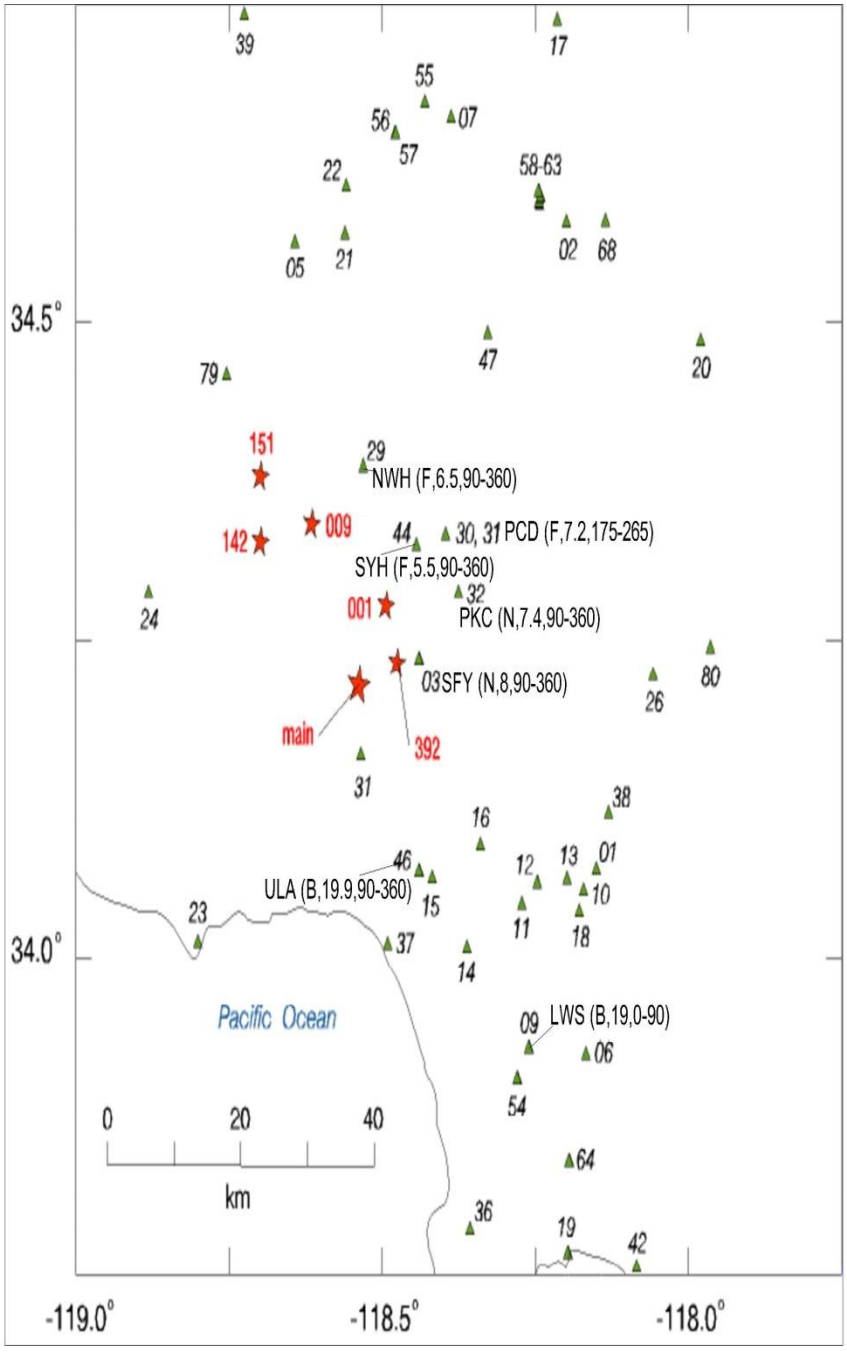


Figure 8.21 Fragility curves showing damage limit state for recording station in Northridge, USA

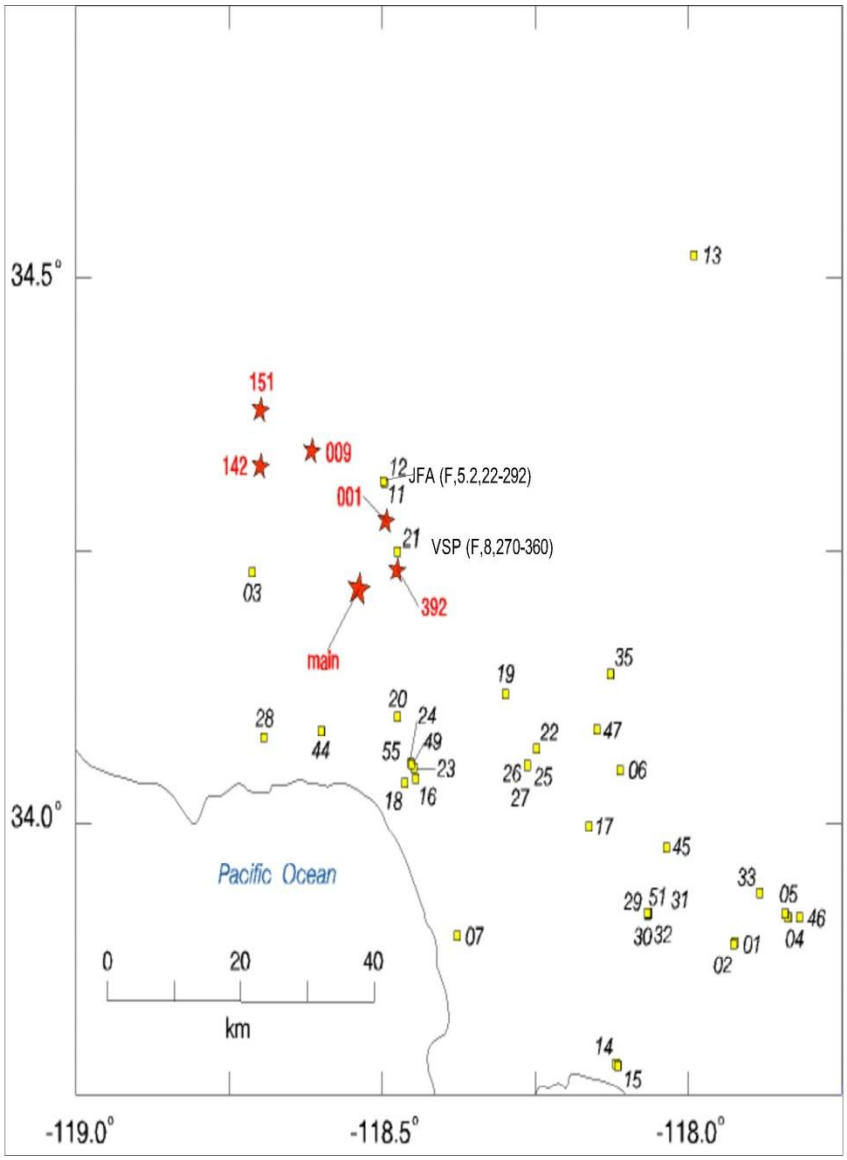
The earthquake of Northridge California from 17-01-1994 had magnitude of 6.7 the stations which have maintained the building in the moderated area were mainly in position s which showed reverse and neutral directivity This is justified by the fact that all these stations were long distances from the surface of the rift, which is why we have experienced small movements. The recordings with the largest displacements were SCH and JFA since they were in positions ahead directivities and abstained small distances from the surface of the rift.



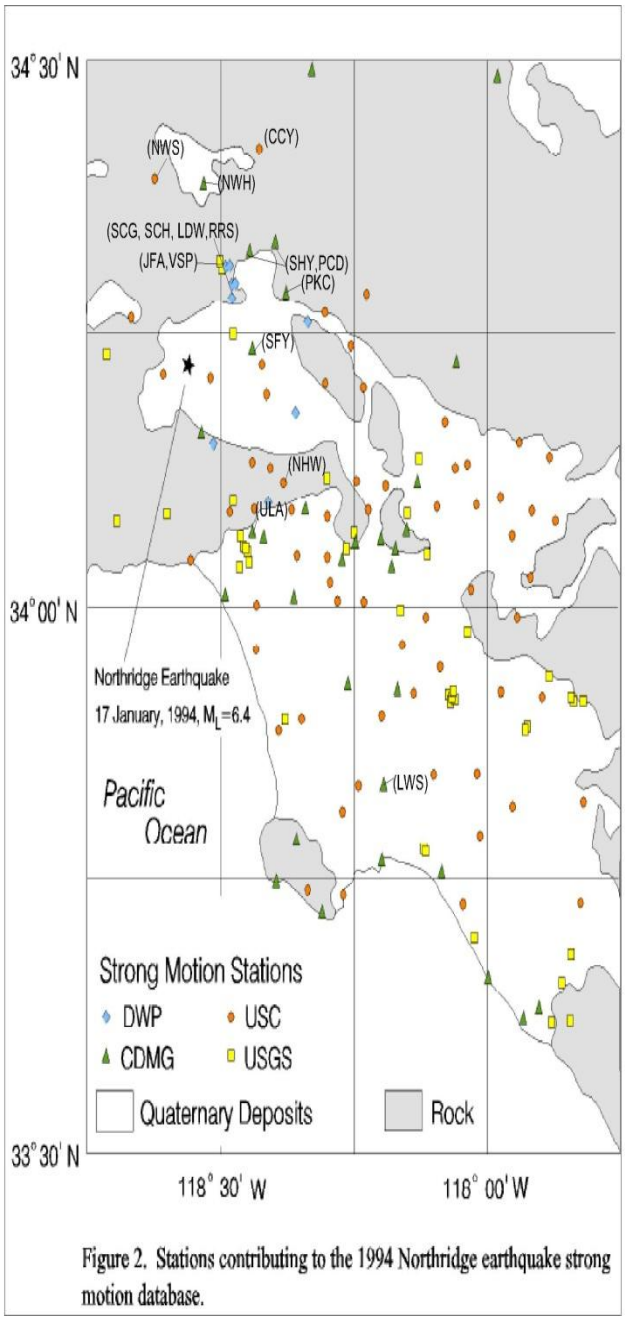
Map 8.9 Stations DWP sensed the Northridge earthquake



Map 8.10 Stations DWP sensed the Northridge earthquake



Map 8.11 Stations USC sensed the earthquake Northridge



Map 8.12 CDMG Stations sensed the Northridge earthquake