4 Seismic Assessment of Hospitals in Nepal

The seismic assessment of hospitals was carried out using the developed methodology defined in chapter 3 above. In Kathmandu Valley, only non-structural assessments were made whereas both structural and non-structural assessment was carried out outside the valley.

4.1 Selection of Hospitals

Ten hospitals, five from Kathmandu Valley selected amongst 14 major hospitals and five from outside the valley selected amongst regional and zonal hospitals, were chosen for the non-structural assessment. The list of hospitals is given in Table 4 and Table 5.

Following criteria were considered when selecting the hospitals:

Hospitals within Kathmandu Valley

- Recommendations from the structural assessment study that was conducted in 2001.
    - Those hospitals are chosen where a detailed qualitative structural assessment was performed in 2001 and a non-structural assessment specifically recommended.
- Importance.
    - Importance in terms of emergency management is considered. All selected institutions are general hospitals and are main hospitals of Kathmandu Valley.

Hospitals outside Kathmandu Valley

General criteria such as number of beds and geographical distribution are considered when selecting hospitals outside Kathmandu Valley.

Table 4: List of Hospitals Selected for Non-Structural Assessment within Kathmandu Valley

Code	Name of Hospital	Type	Location				Structure Type	Number of Storeis	Date of Completion	No of Beds	Total Doctor	Total Nurses	Remarks
			District	Municipality	Ward No.	Place							
Government Hospitals													
GH-1	Bir Hospital	General	Kathmandu	Kathmandu	30	Mahaboudha	RC	5	1985	392	180	210	
							BM	4	1968				
							BM	3	_				
GH-2	Birendra Army Hospital	General	Kathmandu	Kathmandu	14	Chauni	RC	3	_	380	80	85	
GH-3	Birendra Police Hospital	General	Kathmandu	Kathmandu	3	Maharajganj	RC	2	1985	150	40	42	
							RC	3	1983				
GH-5	Sukra Raj Tropical and Infectious Disease	Infectious	Kathmandu	Kathmandu	12	Teku	BC	2	1982	103	13	50	
							BC	1	1999				
GH-6	Kanti Hospital	Children		Kathmandu	3	Maharajanj	RC	2	1993	250	75	107	
							RC	2	1993				
GH-7	Maternity Hospital	Maternity	Kathmandu	Kathmandu	2	Thapathali	BC	3	1965	310	60	110	
							BL	2	1959				
							RC	5,4,3	1975				
GH-9	Patan Hospital	General	Lalitpur	Lalitpur	5	Lagankhel	RC	4	1982	200	60	250	
GH-11	Bhaktapur Hospital	General	Bhakutapur	Bhaktapur	17	Dudh Pati	BC	3	1978	50	11	25	
							HC	1	2001				
GH-14	Military Hospital					Mohaboudha							
Teaching Hospitals													
TH-1	Teaching Hospital	General	Kathmandu		3	Maharajanj	RC	2,4	1984	401	200	350	
Private Hospitals													
TH-2	Nepal Medical College	General	Kathmandu		7	Aterkhel	RC	1	1997	394	140	87	
							RC	6	1997				
							BC	1	_				
TH-3	Kathmandu Medical College	General	Kathmandu	Kathmandu	7	Sinamangle	RC	7	2000		62	54	
PH-8	Medicare National Hospital & Research Center	General	Kathmandu	Kathmandu	1	Naxal	RC	4	_	60	70	39	
							RC	1					
							RC	4					
PH-20	B & B Hospital	Orthopedic	Lalitpur	Lalitpur	7	Gwarko	RC	5	1997	100	50	110	
Non-Governmental Hospitals													
NH-1	Model Hospitals	General	Kathmandu	Kathmandu	31	Baghbazar	BM	3	_	50	8	34	
							RC	5	_				

Selected Hospitals

Table 5: List of Hospitals Selected for Structural and Non-Structural Assessment outside Kathmandu Valley

RH-1	WESTERN REGIONAL HOSPITAL	General	Kaski	Pokhara	-	-	-	-	-	230	-	-	-	*
ZH-1	Koshi Zonal Hospital	General	Morang	Biratnagar	-	-	-	-	-	150	-	-	-	*
ZH-2	Mechi Zonal Hospital	General	Jhapa	Bhadrapur	-	-	-	-	-	75	-	-	-	*
ZH-3	Narayani Zonal Hospital	General	Parsa	Birgunj	-	-	-	-	-	76	-	-	-	*
ZH-4	Lumbini Zonal Hospital	General	Rupandehi	Butwal	-	-	-	-	-	75	-	-	-	*
ZH-5	Seti Zonal Hospital	General	Kailali	Dhangadhi	-	-	-	-	-	75	-	-	-	*
ZH-6	Janakpur Zonal Hospital	General	Dhanusha	Janakpurdham	-	-	-	-	-	75	-	-	-	*
ZH-7	Mahakali Zonal Hospital	General	Kanchanpur	Mahendra	-	-	-	-	-	75	-	-	-	*
ZH-8	Bheri Zonal Hospital	General	Banke	Nepalgunj	-	-	-	-	-	-	-	-	-	*
ZH-9	Sagarmatha Zonal Hospital	General	Saptari	Rajbiraj	-	-	-	-	-	75	-	-	-	*
DH-1	Bharatpur Hospital	General	Chitawan	Bharatpur	-	-	-	-	-	140	-	-	-	*

Notes:

Code	Description	Code	Description
GH	**Government Hospital**	**RC**	**Reinforced Concrete Frame**
TH	**Teaching Hospital**	**BM**	**Brick in Mud**
PH	**Private Hospital**	**BC**	**Brick in Cement**
NH	**Nongovernmental Hospital**	**BL**	**Brick in Lime**
ZH	**Zonal Hospital**		
DH	**District Hospital**		

Selected Hospitals

4.2 Hospital Performance Assessment

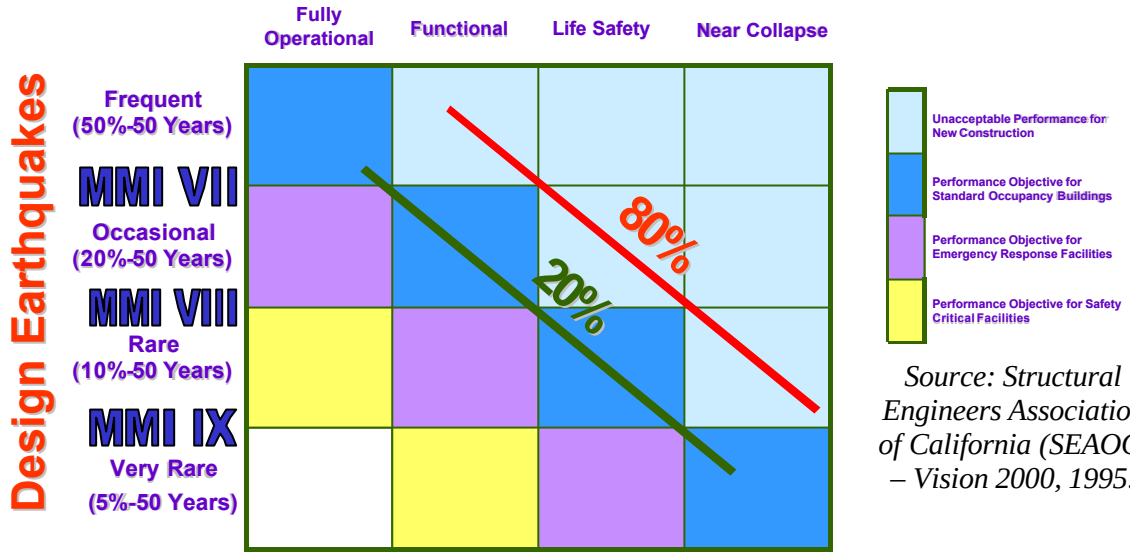
Based upon the structural and non-structural vulnerability assessment of the hospital buildings and different critical systems and facilities, the functional assessment of the hospitals was made for two different earthquake scenarios.

Table 6: Expected Seismic Performance of Assessed Hospitals in Different Earthquake Scenarios

Hospitals	Earthquake Scenario	
	Moderate Earthquake (MMI VI – MMI VII)	**Severe Earthquake (MMI VIII – MMI IX)**
1. Bir Hospital	**Out of Service for Some Time** • Severe damage to the water supply system, electricity system, medical gas system. • Many partition walls will fail. • Most of the medical facilities will not be operational. • Some OPDs may be functional after some hours of maintenance.	**Out of Service** • Critical systems and most hospital departments will be out of service for a long time. • There will be heavy structural and non-structural damage.
2. Teaching Hospital	**Partially Operational** • All critical systems will be functional. • There may be electric power losses and some damage to the medical gas system may occur. • The labs and operation theatres may not be functional.	**Partially Operational after Some Time** • There will be moderate damage to the medical gas supply system. • Many medical facilities might not be operational for some time, some hours or even days.
3. Patan Hospital	**Partially Operational** • Most of the critical systems, OPD, Emergency Department, X-ray and CSSD may be operational after some hours.	**Partially Operational or Out of Service** • Some critical systems and most hospital departments will be out of service for a long time.
4. Bhaktapur Hospital	**Partially Operational** • Some medical facilities like OPD, Emergency Department, and CSSD may be operational after some hours. • The electricity system and water supply system may be out of order for a long time.	**Out of Service** • Critical systems and most hospital departments will be out of service for a long time.

5. Western Regional Hospital	**Partially Operational** • Electricity and water supply systems may be interrupted. • There is a possibility of heavy damage to the lab, maternity ward and some parts of the OPD. • Most of the wards and the OPD will be functional after some hours.	**Out of Service** • All critical systems and most hospital departments will be out of service for a long time. • There will be heavy damage to most facilities.
6. Koshi Zonal Hospital	**Partially Operational** • The water supply system will be functional. The electricity system may be partially operational. • X-ray, CSSD and some wards may be operational after some hours. • The OPD and laboratory block, ICU block and maternity cabin block may be heavily damaged.	**Out of Service** • All critical systems and most hospital departments will be out of service for a long time. • There will be heavy damage to most of the facilities. • Some buildings may have been destructed.
7. Bheri Zonal Hospital	**Partially Operational** • The electricity system may not be functional. • X-ray, CSSD and some wards may be operational after some hours. The OPD and laboratory block, ICU block and maternity cabin block may be heavily damaged.	**Out of Service** • All critical systems and most hospital departments will be out of service for a long time. • There will be heavy damage to most of the facilities. • Some buildings may have been destructed.
8. Seti Zonal Hospital	**Partially Operational** • The water supply system may be interrupted. • The electricity system may work. • X-ray and OPD may be operational after some hours.	**Out of Service** • All critical systems and most hospital departments will be out of service for a long time. • There will be heavy damage to most of the facilities.
9. Bharatpur Hospital	**Partially Operational** • The electricity and water supply systems may be interrupted. • X-ray, CSSD and Lab will be out of function for several hours. • Some parts of the hospital like the general store may be severely damaged.	**Out of Service** • All critical systems and most hospital departments will be out of service for a long time. • There will be heavy damage to most of the facilities.

The comparison of the expected seismic performance of the hospitals with an internationally accepted standard risk assessment matrix shows that about 80% of the hospitals assessed will be partially operational after a moderate earthquake and out of service after a severe earthquake. The remaining 20% of the hospitals will be partially operational even after severe earthquakes.



Source: Structural Engineers Association of California (SEAOC) – Vision 2000, 1995.

4.3 Recommendations for Improving Seismic Performance

Based upon the Structural and Non-structural assessment of the hospitals, the following priority-wise recommendations are made to improve the seismic performance of different hospitals. The seismic vulnerability of different systems, technical and economical feasibility of implementing mitigation options, structural vulnerability and importance of the different critical systems and departments in order to operate the hospital after an earthquake are taken as basis for the prioritization.

Phase I: To expect the Hospitals Fully Operational after a Moderate Earthquake

Activities: Fixing of all equipment and contents, Strengthening of critical systems, Training to hospital personnel and Providence of some redundancy in critical system.

Estimated Cost: **US$150,000.00 to phase I recommendations in assessed 9 hospitals**

Phase II and III: Additional Recommendations for Improving Performance of the Hospital to a Desirable Level after a Severe Earthquake

Activities: Seismic retrofitting of hospital buildings, further strengthening of critical systems and providence of extra redundancy in the systems.

Estimated Cost: US$1,200,000.00 to implement structural and non-structural mitigation options in 5 hospitals outside Kathmandu valley and implementation of non-structural mitigation options in 4 hospitals within valley.

Bir Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	500,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	60,000.00	
3. A yearly one-day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	40,000.00	The cost covers one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	1,000,000.00	
5. Bracing of partition walls.	Second	3,000,000.00	
Total cost for Improvement		**4,600,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
6. Installation of flexible couplings in the water supply system and in the electricity system.	Third	2,000,000.00	
7. Provision of redundancy in the system (extra generator, spare pumps).	Third	2,000,000.00	
Total additional cost		**4,000,000.00**	

Note: *The second phase of the non-structural mitigation measures should only take place after the seismic retrofitting recommended in the previous structural vulnerability assessment has been carried out. This cost is not included in the total additional cost above but is detailed in the structural assessment report from 2002.*

Teaching Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	500,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. A yearly one-day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	40,000.00	This cost is for one training programme and is meant to pay for local resource persons and awareness materials.
3. Plastic lamination of glass windows in selected important places.	Second	100,000.00	
Total cost for Improvement		**640,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
4. Plastic lamination of remaining windows.	Second	1,000,000.00	
5. Installation of another generator to supply power to CSSD and X-ray.	Third	2,000,000.00	
6. Installation of another deep boring.	Third	3,000,000.00	
Total additional cost		**6,000,000.00**	

Note: *The second phase of the non-structural mitigation measures should only take place after the seismic retrofitting recommended in the previous structural vulnerability assessment has been carried out. This cost is not included in the total additional cost above but is detailed in the structural assessment report from 2002.*

Patan Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	300,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for generator.	First	30,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	40,000.00	The cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	200,000.00	
Total cost for Improvement		**5,70,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
5. Bracing of partition walls.	Second	200,000.00	The work is expected to be carried out by the maintenance section using local materials. The cost is to pay for those materials.
6. Installation of flexible couplings in the water supply system and the medical gas system.	Second	500,000.00	
7. Improvement of the solar heater system.	Third	50,000.00	
8. Provision of redundancy in the system (extra generator, spare pumps).	Third	20,00,000.00	
Total additional cost		**2,550,000.00**	

Note: *The second phase of the non-structural mitigation measures should only take place after the seismic retrofitting recommended in the previous structural vulnerability assessment has been carried out. This cost is not included in the total additional cost above but is detailed in the structural assessment report from 2002.*

Bhaktapur Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	80,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	30,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	40,000.00	The cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	250,000.00	
5. Repair of the deep boring system.	Second	200,000.00	
Total cost for Improvement (Phase I)		**600,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
6. Installation of flexible couplings in the water supply system and the electricity system.	Third	500,000.00	
7. Provision of redundancy in the system (extra generator, spare pumps).	Third	1,200,000.00	
Total additional cost (Phase II)		**1,700,000.00**	

Note: *The second phase of the non-structural mitigation measures should only take place after the seismic retrofitting recommended in the previous structural vulnerability assessment has been carried out. This cost is not included in the total additional cost above but is detailed in the structural assessment report from 2002.*

Western Regional Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	300,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	50,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	50,000.00	This cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	500,000.00	
Total cost for Improvement (Phase I)		**900,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
5. Installation of deep boring system for water with a 50,000 liters overhead tank and treatment plant.	Second	5,000,000.00	
6. Installation of a new 50 KVA Generator.	Second	600,000.00	
7. Retrofitting of OPD block 1.	Third	1,000,000.00	
8. Retrofitting of OPD block 2.	Third	1,500,000.00	
9. Retrofitting of X-Ray block.	Third	1,000,000.00	
10. Retrofitting of inpatient block 1.	Third	1,500,000.00	
11. Retrofitting of inpatient block 2.	Third	1,500,000.00	
12. Retrofitting of administration and maternity block	Second	2,700,000.00	Maternity and laboratory buildings were found relatively weaker and should be given highest priority.
13. Retrofitting of Laboratory Block	Second	1,200,000.00	
14. Bracing of partition walls of the new building.	Third	900,000.00	
Total cost for Improvement (Phase II)		**16,900,000.00**	

Phase III: Additional Recommendations for Improving the Non-Structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
15. Installation of flexible couplings in the water supply system and the electricity system.	Fourth	500,000.00	
16. Provision of redundancy in the system (extra generator, spare pumps).	Fourth	2,000,000.00	
Total additional cost (Phase III)		**2,500,000.00**	

Koshi Zonal Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	150,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	50,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	50,000.00	The cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	500,000.00	
Total cost for Improvement (Phase I)		**750,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
5. Repair and maintenance of existing small boring (75mm diameter).	Second	300,000.00	
6. Installation of a new 100 KVA generator.	Second	1,000,000.00	
7. Retrofitting of OPD + laboratory block.	Third	2,000,000.00	
8. Retrofitting of ICU + emergency + training center block.	Third	2,000,000.00	
9. Retrofitting of inpatient + OT + labor block.	Third	3,500,000.00	
10. Retrofitting of new OT + CSSD block.	Third	750,000.00	
11. Retrofitting of maternity cabin block.	Third	2,000,000.00	
12. Retrofitting of administration block.	Third	1,000,000.00	
13. Bracing of infill walls in pediatric block, oral health + X-ray block and the medical blocks.	Third	1,500,000.00	
Total cost for Improvement (Phase II)		**14,050,000.00**	

Phase III: Additional Recommendations for Improving the Non-Structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
14. Installation of flexible couplings in the water supply system and the electricity system.	Fourth	500,000.00	
15. Provision of redundancy in the system (extra generator, spare pumps).	Fourth	2,000,000.00	
Total additional cost (Phase III)		**2,500,000.00**	

Bheri Zonal Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	200,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	50,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	50,000.00	The cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Installation of a new 100 KVA generator.	Second	1,000,000.00	
5. Plastic lamination of glass windows in important departments.	Second	300,000.00	
Total cost for Improvement (Phase I)		**1,600,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
6. Retrofitting of main block.	Third	11,500,000.00	
7. Retrofitting of operation theater block.	Third	400,000.00	
8. Retrofitting of emergency block.	Third	800,000.00	
9. Retrofitting of ramp.	Third	800,000.00	
10. Retrofitting of trauma ward block.	Third	600,0000.00	
11. Retrofitting of one masonry column overhead tank.	Third	400,000.00	
Total cost for Improvement (Phase II)		**14,500,000.00**	

Phase III: Additional Recommendations for Improving the Non-Structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
12. Installation of flexible couplings in the water supply system and the electricity system.	Fourth	500,000.00	
13. Provision of redundancy in the system (extra generator, spare pumps).	Fourth	2,000,000.00	
Total additional cost (Phase III)		**2,500,000.00**	

Seti Zonal Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	150,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	30,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	40,000.00	This cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	100,000.00	
Total cost for Improvement		**3,20,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
5. Installation of deep boring system.	Second	2,000,000.00	
6. Retrofitting of the old building.	Third	3,600,000.00	
7. Retrofitting of OPD block.	Third	300,000.00	
8. Retrofitting of the mother children centre.	Third	600,000.00	
9. Bracing of partitions and infill wall of the new building.	Third	800,000.00	
10. Retrofitting of the encephalitis block.	Third	200,000.00	
Total cost for Improvement (Phase II)		**7,500,000.00**	

Phase III: Additional Recommendations for Improving the Non-Structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
11. Installation of flexible couplings in the water supply system and the electricity system.	Fourth	500,000.00	
12. Provision of redundancy in the system (extra generator, spare pumps).	Fourth	2,000,000.00	
Total additional cost		**2,500,000.00**	

Bharatpur Hospital

Phase I: Recommended Improvements of the Non-structural Performance Expected to Render the Hospital Fully Operational after a Moderate Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
1. Fixing of all equipment and contents.	First	150,000.00	Work is expected to be done by the maintenance section. The cost is to pay for locally available materials.
2. Provision of extra fuel for the generator.	First	30,000.00	
3. A yearly one day training or workshop on non-structural safety for all maintenance, medical and administrative staff.	First	40,000.00	The cost is for one training programme and is meant to pay for local resource persons and awareness materials.
4. Plastic lamination of glass windows in important departments.	Second	100,000.00	
5. Installation of a new 50 KVA generator.	Second	400,000.00	
Total cost for Improvement		**6,70,000.00**	

Phase II: Additional Recommendations for Improving the Non-structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

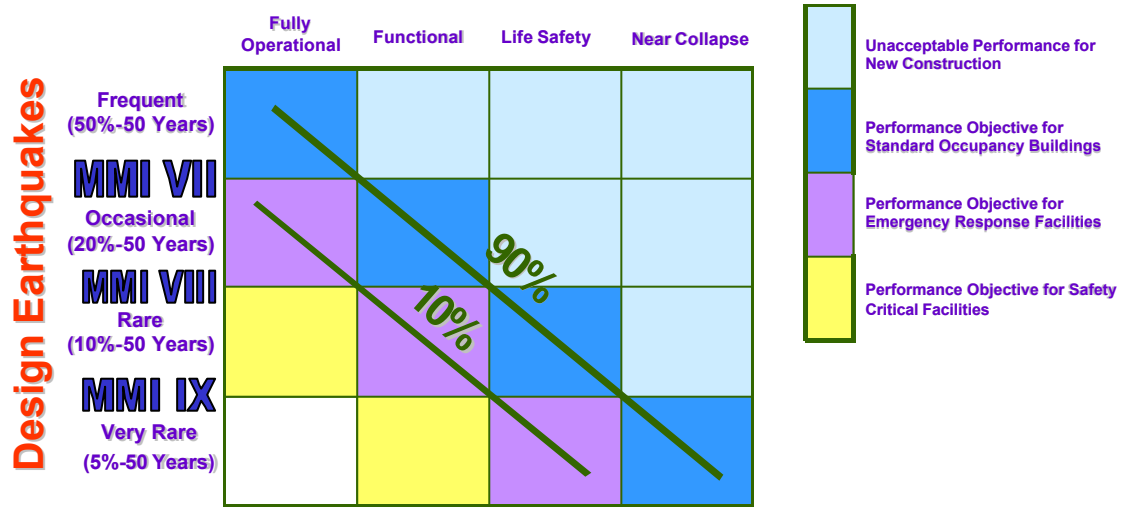
Recommendations	Priority	Estimated Cost (NRs.)	Remarks
6. Construction of a new overhead water tank of 100,000.00 litre capacity.	Second	600,000.00	
7. Retrofitting of the main building.	Third	1,000,000.00	
8. Retrofitting of the inpatient block.	Third	1,400,000.00	
9. Retrofitting of the maternity and the medical ward block.	Third	1,100,000.00	
10. Retrofitting of the paediatric ward block.	Third	700,000.00	
11. Retrofitting of the orthopaedic ward block.	Third	600,000.00	
12. Reconstruction of the store block.	Second	200,000.00	Retrofitting is not feasible.
13. Bracing of the partition walls of the OPD block.	Third	600,000.00	
14. Retrofitting of the administration block.	Third	400,000.00	
Total cost for Improvement (Phase II)		**6,600,000.00**	

Phase III: Additional Recommendations for Improving the Non-Structural Performance of the Hospital to a Desirable Level after a Severe Earthquake

Recommendations	Priority	Estimated Cost (NRs.)	Remarks
15. Installation of flexible couplings in the water supply system and the electricity system.	Fourth	500,000.00	
16. Provision of redundancy in the system (extra generator, spare pumps).	Fourth	2,000,000.00	
Total additional cost (Phase III)		**2,500,000.00**	

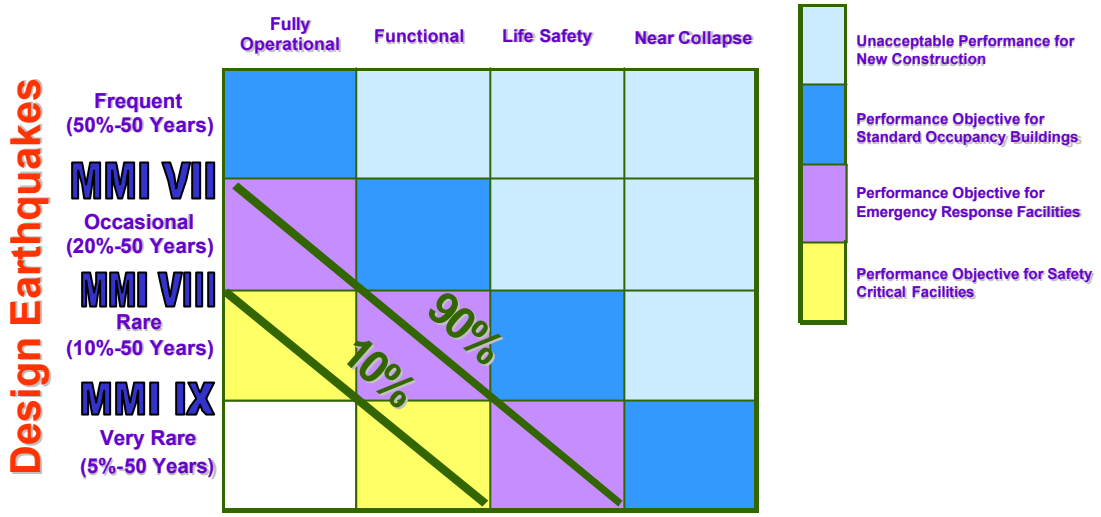
4.4 Expected Performance of Hospitals after Implementation of Recommendations

The expected performance of hospitals after implementation of Phase I recommendations is compared with the standard risk assessment matrix. The study shows that about 90% of the hospitals assessed would be functional after a moderate earthquake and out of service after a severe earthquake whereas 10% would be fully operational after a moderate earthquake and functional after a severe one.



Total cost required to implement Phase I = NRs. 10,700,000.00 (US$ 150,000.00)

The expected performance of hospitals after implementation of Phase II recommendations is compared with the standard risk assessment matrix. The study shows that about 90% of the hospitals assessed would be fully operational after a moderate earthquake and functional after a severe earthquake whereas 10% would be fully operational even after a severe earthquake.



The cost required to implement Phase II & III = NRs. 86,300,000.00 (US$ 1,200,000.00)

[Note: *The cost includes the construction cost for structural retrofitting of the five hospitals assessed outside Kathmandu Valley and the cost for non-structural vulnerability reduction for all 9 assessed hospitals. It does not include the cost for retrofitting of hospitals within Kathmandu Valley. To achieve this expected performance, retrofitting of hospitals within Kathmandu Valley should be carried out as detailed by the study A Structural Vulnerability Assessment of Hospitals in Kathmandu Valley, 2002.]*