4. CONCLUSIONS for On-Site Visit Results

1. At pr esent, the pr evailing b uilding t ypes u nder c onstruction a re r einforced c oncrete frame (RC Frame) and masonry, mainly brick masonry. The preference is visibly towards RC Frame with masonry infill.
2. A negligible percentage of the buildings under construction are engineered buildings, the rest are non-engineered buildings. A " non-engineered building" means that there was no engineering input in structural design, supervision during construction including quality control. Although, in some of these non-engineered constructions, owners reported some inputs by engineering technicians, we classify these buildings as non-engineered.
3. In non-engineered RC Frame structures, the main problems are the lack of detailing and quality control, use of insufficient amount of steel and inadequate size of RC sections. The following gives the details:
   a. Improper and or insufficient column ties, stirrups, and hooks
   b. Insufficient anchorage of beam bars
   c. Improper and insufficient column and beam bar splices
   d. Use of poor concreting works in RC elements, notably,
      1) High water-cement ratio
      2) Poor quality materials
      3) Use of high proportion of sand
      4) Poor mixing
      5) Lack of compaction of concrete works
   e. Use of corrugated steel
   f. Inadequate concrete cover over reinforcements
   g. Brick laying without watering the bricks adequatelyh. Almost all of the above-mentioned problems could be observed in most of the non-engineered buildings surveyed.
4. In engineered RC Frame constructions, the majority of the above-mentioned problems have been rectified, however, there still remain some problems of detailing and quality control. In each of the surveyed engineered construction, a few of the above-mentioned problems of detailing and quality control were observed. Quantity of steel used in engineered buildings was mostly adequate.
5. The most important intervention identified for improving the seismic performance of RC Frame building construction is ductile detailing.
6. During the survey, we could not observe any "engineered" masonry building under construction.
7. In the masonry buildings, the main problems were the absence of structural integrity, poor quality of masonry, staged construction of different stories using different construction materials, especially mortars, poor quality of materials, and lack of proper workmanship:
   a. No s tructural c onnection between w all a nd w all (perpendicular w alls), w all a nd floor, and wall and roof.
   b. Brick laying without watering the bricks adequately
   c. Improper bonding between walling units
   d. Use of lean cement mortar, mostly 1: 6 (cement:sand)
   e. Use of different types of masonry (brick and stone) in the same building. Majority

of the masonry buildings surveyed were constructed in stages resulting in the use of different materials in different stories (ground story in mud-mortar, and upper stories in cement mortar)

f. Existence of relatively large openings.

8. The most important intervention identified for improving the seismic performance of Masonry building construction are:
   a. Use of reinforcements such as horizontal bands, corner stitches and vertical steels for providing integrity between structural elements
   b. Provision of reinforcement around openings
   c. Improvement in quality control and workmanship.

5. REPORTS on site observations to Hospital Buildings of Kathmandu Valley

Site-visit Team Members: Hideo Kagawa, JICA and Ramesh Guragain, NSET- Nepal

Purpose of visit

1). To understand the situation of existing structure of different hospitals in Kathmandu Valley

2). To analyze the weakness and good aspects and to find out necessary steps for improvement

#B-1 Bhaktapur Hospital

Observation:

- The main building of Bhaktapur Hospital was found as three story masonry building in cement mortar.
- One new earthquake resistant building constructed jointly by Royal Nepal Army and American Army.

Comments and Conclusion :

There is an one story earthquake resistant building but the main building of the Bhaktapur Hospital is three story masonry building and it is necessary to improve the building capacity for better seismic performance. Thus following are the steps towards improvement.

- Preliminary structural vulnerability assessment of main building in the complex of Bhaktapur Hospital should be performed. Such assessment should be based for different earthquake intensity scenarios.
- Detailed structural analysis for vulnerability assessment and to find out the appropriate method of improvement,based on the findings of the preliminary assessments, should be performed.
- Develop methods for reconstruction or retrofitting and implement it.
- Incorporate the findings into overall development plan of the Hospital.

Earthquake resistant one story building of Bhaktapur Hospital

Main building of Bhaktapur Hospital:Three story masonry building

#B-2 Bir Hospital

Observation:

➢ The Bir Hospital complex made up of three major buildings and a number of minor structures placed within a walled enclosure in core of Kathmandu. The older structure was built in 1968 while the newest was constructed in 1985

➢The older structures were found to be extensively re-modeled by the placement of additional stories and wings at various times. It can be assumed that the older structures and subsequent remodels had been accomplished without the benefit of seismic consideration. It was also observed that the older building is an unreinforced masonry structure with cast-in –place floors and roof.

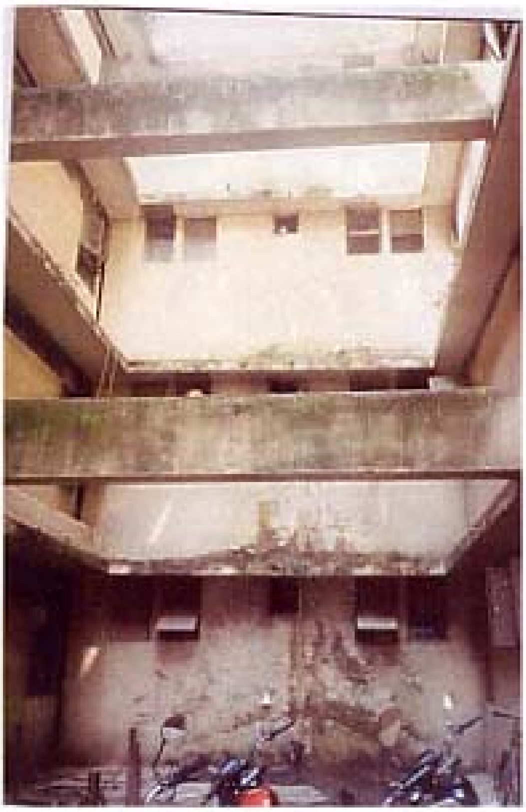
➢It was also noted that, the oldest of these structures, is also the largest and contains the majority of the in-patient beds.

➢The plan of the buildings were found during study but the detail structural drawings were not found.

Comments and Conclusion :

As the buildings of Bir Hospital were not sufficiently good for big earthquake during visual observation so Bir Hospital needs to perform following operations for improvement.

- Preliminary structural vulnerability assessment of all buildings. Such assessment should be based for different earthquake intensity scenarios.
- Detailed structural analysis based on the findings of the preliminary assessments.
- Develop methods for reconstruction or retrofitting.
- Incorporate the findings into overall development plan of the Hospital.



Part of New Building: Almost no maintenance, start of deterioration

Four story masonry Building: Needs some improvement

Diagonal cracks from opening

#B-3 Birendra Police Hospital

Observation:

- The Birendra Police Hospital complex made up of four buildings.
- Plan of some buildings were available for study.
- Major buildings are of RC type but some deficiency such as insufficient section of RC elements like 9"x9" column, absence of transverse beam etc. were observed.
- The columns were found to be covered by half brick thick brick wall.
- Some grass on the brick wall indicates some dampness on the wall and poor type of maintenance practice which can lead the building to further deterioration.

Comments and Conclusion :

From the different reasons found during visual observation the Birendra Police Hospital buildings need some improvement for better seismic behavior. So it is concluded that

- Preliminary structural vulnerability assessment of all buildings in the complex of Birendra police Hospital should be performed. Such assessment should be based for different earthquake intensity scenarios.
- Detailed structural analysis for vulnerability assessment and to find out the appropriate method of improvement,based on the findings of the preliminary assessments, should be performed.
- Develop methods for reconstruction or retrofitting.
- Incorporate the findings into overall development plan of the Hospital.

Four story Building of Birendra Police Hospital

Grass on the wall; cause of deterioration

Very thin beam in transverse direction; may cause failure during big earthquake in that direction

#B-4 Teaching Hospital

Observation:

➢ The Teaching Hospital complex made up of some new and some old buildings.

➢The major buildings were found to be constructed under Japanese co-operation and found to be constructed in the period of 1981-1982

➢Drawings of the major buildings were found for study

➢Major buildings were found to be properly maintained in comparison to other hospitals in city.

➢There are also some older buildings in the complex.

Two story frame building of Teaching Hospital

Comments and Conclusion :

- Major buildings of Teaching Hospital were found to be better on visual observation.
- Preliminary structural vulnerability assessment of all buildings is not necessary. Only some buildings need.
- Detailed structural analysis of the buildings which are not designed considering seismic force, based on the findings of the preliminary assessments, should be done.
- Develop methods for reconstruction or retrofitting if necessary.
- Incorporate the findings into overall development plan of the Hospital.

#B-5 Teku Hospital

Observation:

➢ The Teku Hospital complex made up of four buildings.

➢The major structure was built in 1974 and was funded by the Kingdom of Nepal.

➢Some Plan of buildings were available for study.

➢Major buildings were found to be properly maintained in comparison to other hospitals in city.

➢There are also some older buildings in the complex.

Comments and Conclusion :

Although the major structure of Teku Hospital is only two story but sufficient reasons could not be made during visual observation, which can describe the safety of the structure during big earthquake. Following recommendations are applicable for seismic improvement.

- Preliminary structural vulnerability assessment of all buildings. Such assessment should be based for different earthquake intensity scenarios.
- Detailed structural analysis based on the findings of the preliminary assessments.
- Develop methods for reconstruction or retrofitting.
- Incorporate the findings into overall development plan of the Hospital.

The major structure of Teku Hospital: Two story masonry building

6. CASE STUDY due to Draft of NBC 201 & 205:1994

One o f t he most important s uggestions a re "Quantitative E valuation" for t he s trength o f buildings against earthquake motion. Then, the Survey Team tried a **ROUGH CASE STUDY** based on the National Building Codes (Draft), using ordinary properties shown as below.

1) **Cases:**

4 (four) cases are identified using 3 storied with 9 inches pillars.

Table 6-1 Calculation Condition for the Case Study

item	Case-1	Case-2	Case-3	Case-4
room	3	3	9	9
story	3	3	3	3
materials	RC-frame with masonry			
wall	With in fill	Without in fill	With in fill	Without in fill
Seismic force	0.08G as designated in NBC(Plan)			

2) **Plan and Result of the Four Cases:**

a) All four cases showed vulnerability against seismic force of 0.08G designed in the Draft of NBC.

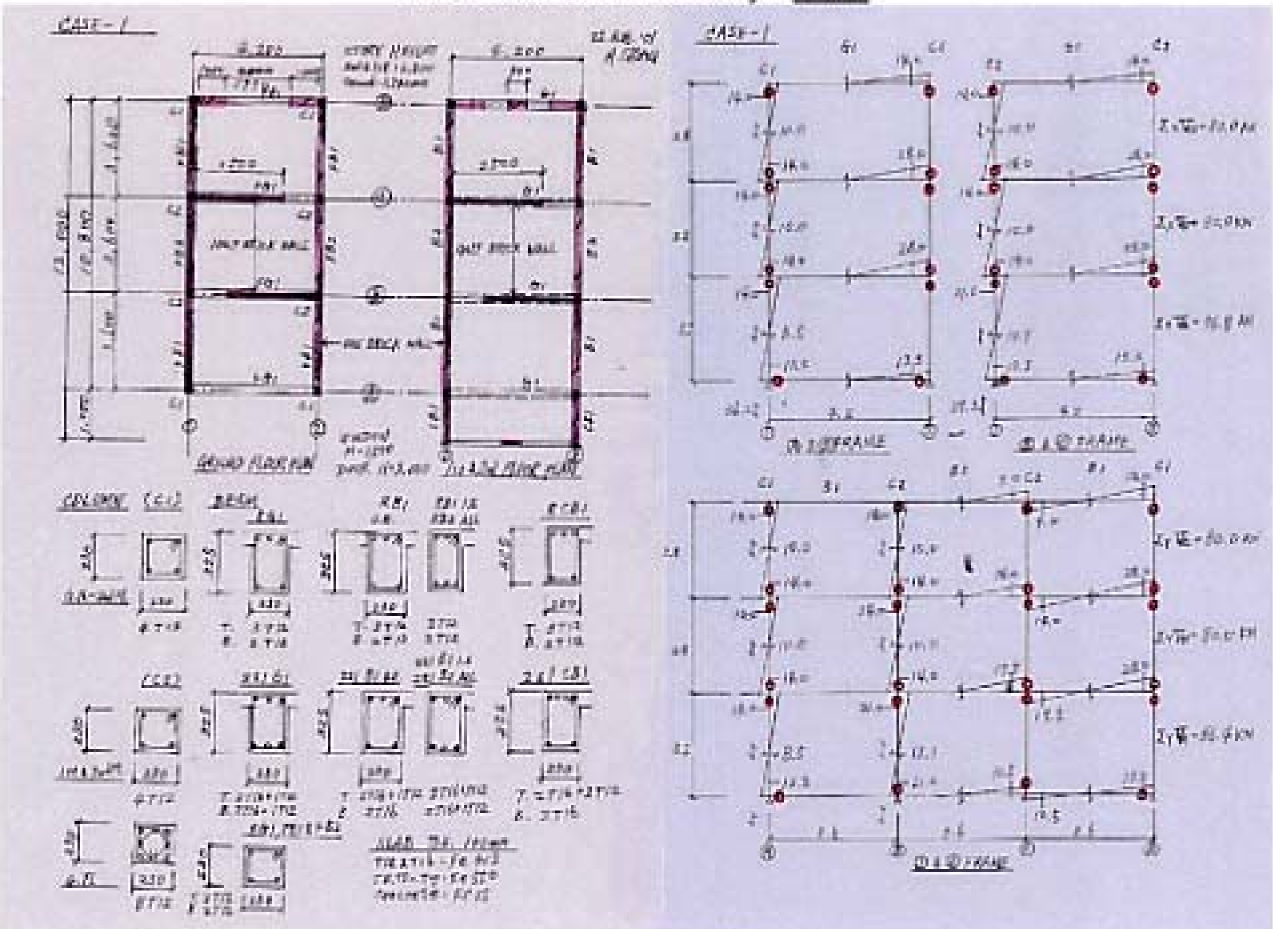
b) Especially, insufficiency of seismic capacity appeared in lower stories on all cases.

c) Case-1 and 3 (With in fill cases), showed more vulnerable than Case- 2 and 4 (Without in fill cases). However, the case study is ROUGH disregarding the seismic capacity of Masonry Walls. More detail calculations should be considered next chance.

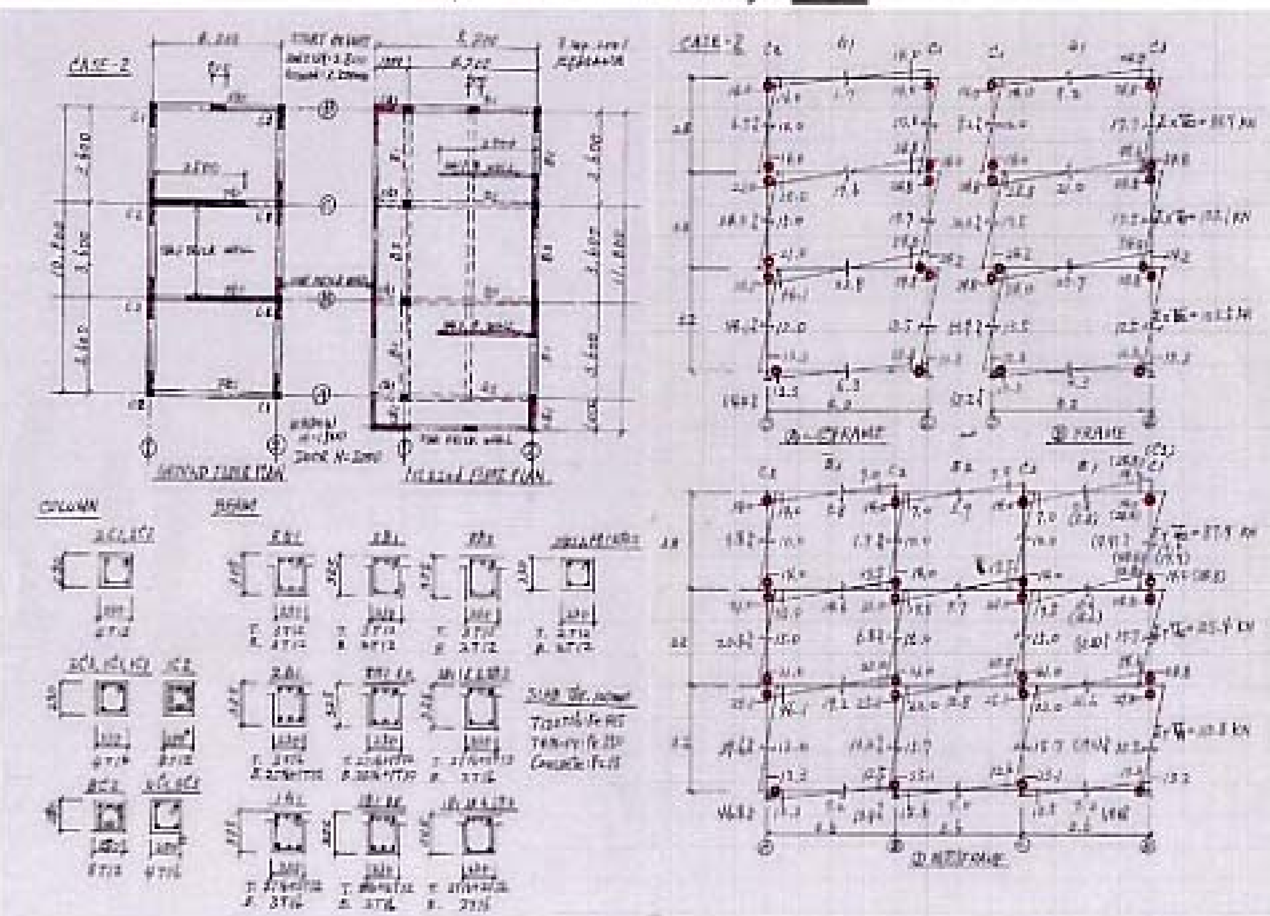
Table 6-2 Input Data and Results for the case study

	Case-1 (IN FILL Wall)	Case-2 (NOT IN FILL W.)	Case-3 (IN FILL WALL)	Case-4 (NOT IN FILL W.)
Floor Area(m2):A	12x4.2=50.4	12x4.2=50.4	13.6x11.8=160.5	13.6x11.8=160.5
Build. Weight (kN)				
Roof	9.5 A=479	9.0 A=454	9.5 A=1,525	9.0 A=1,445
2 nd Fl.	11.0 A=554	10.5 A=529	11.0 A=1,765	10.5 A=1,685
1 st Fl.	10.5 A=529	10.0 A=504	10.5 A=1,685	10.0 A=1,605
Sum of Buil. W. (kN)				
Roof	479	454	1,525	1,445
2 nd Fl.	1,033	983	3,290	3,130
1 st Fl.	1,562	1,487	4,975	4,735
Design Seismic Load	DV(kN)=SBWx0.08			
Roof	38.3	36.3	122.0	115.6
2 nd Fl.	82.6	78.6	263.2	250.4
1 st Fl.	125.0	119.0	398.0	350.0
Ultimate Lateral Shear Capacity	UV(kN)			
2 nd Fl. X-Direction	80.0	87.7	160.0	167.7
Y-Direction	80.0	87.7	158.6	167.7
1 st Fl. X-Direction	80.0	133.1	196.0	258.7
Y-Direction	80.0	125.4	181.9	258.7
G Fl. X-Direction	76.8	103.5	220.0	215.7
Y-Direction	86.4	113.8	187.2	215.7
JUDGMENT	UV / DV>= 1.0			
2 nd Fl. X-Direction	80.0/38.3=2.09	2.42	1.31	1.45
Y-Direction	80.0/38.3=2.09	2.42	1.30	1.45
JUDGMENT	**OK**	**OK**	**OK**	**OK**
1 st Fl. X-Direction	0.97	133.1/78.6=1.69	0.74	1.03
Y-Direction	0.97	125.4/78.6=1.60	0.69	1.03
JUDGMENT	**OK**	**OK**	***NO***	**OK**
G Fl. X-Direction	0.61	0.87	220.5/398.0=0.55	0.62
Y-Direction	0.69	0.96	187.2/398.0=0.47	0.62
JUDGMENT	***NO***	***NO***	***NO***	***NO***

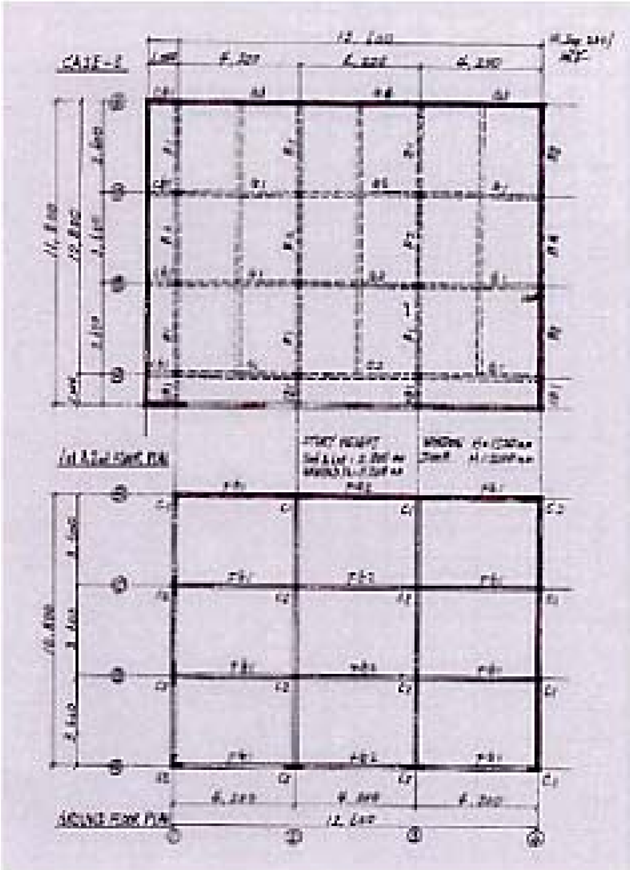
Plan, Member List and Results for Case-1

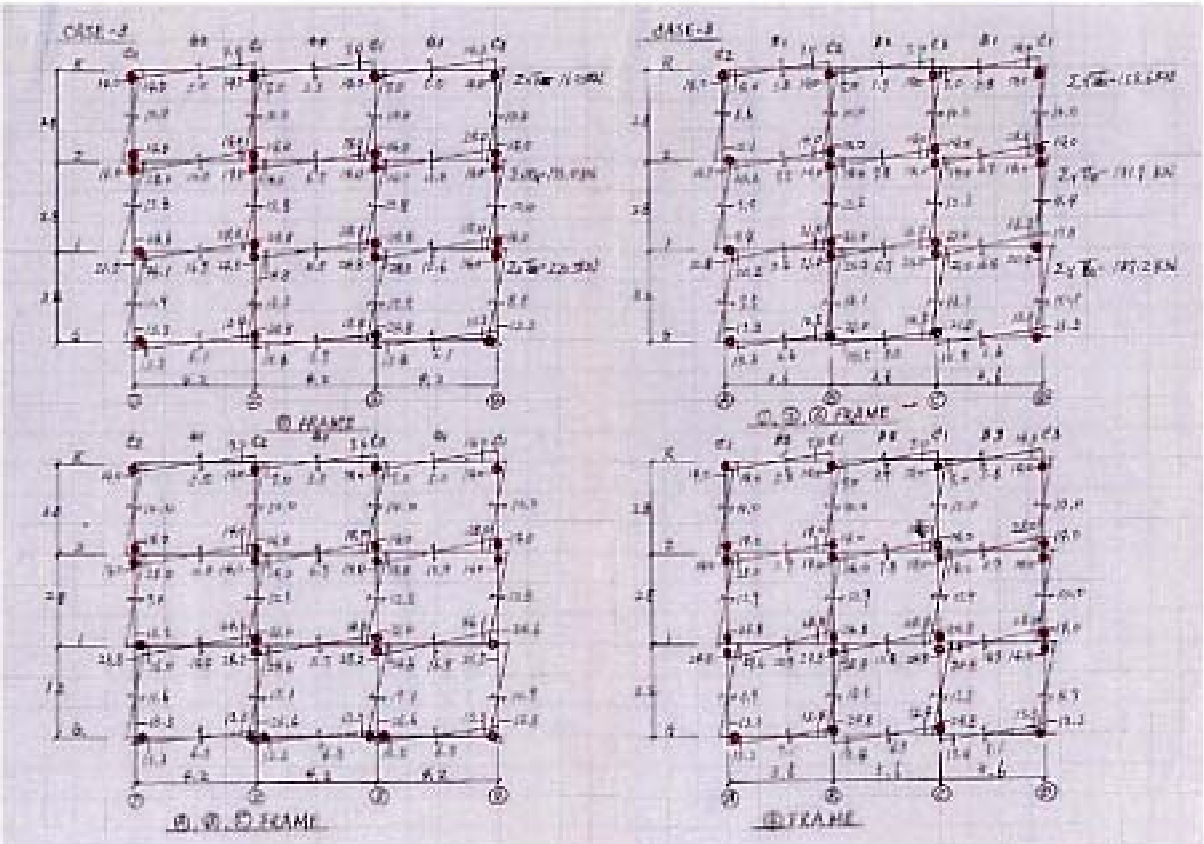


Plan, Member List and Results for Case-2

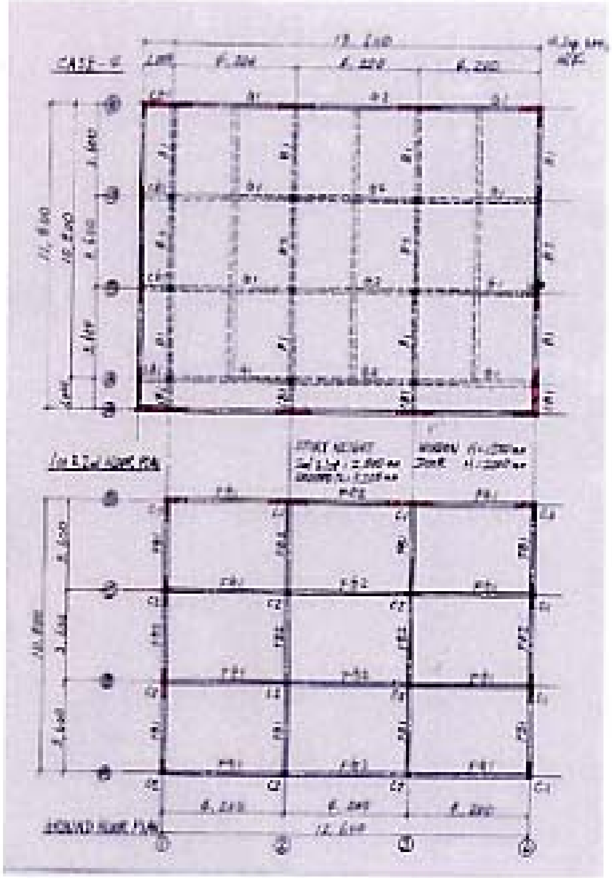


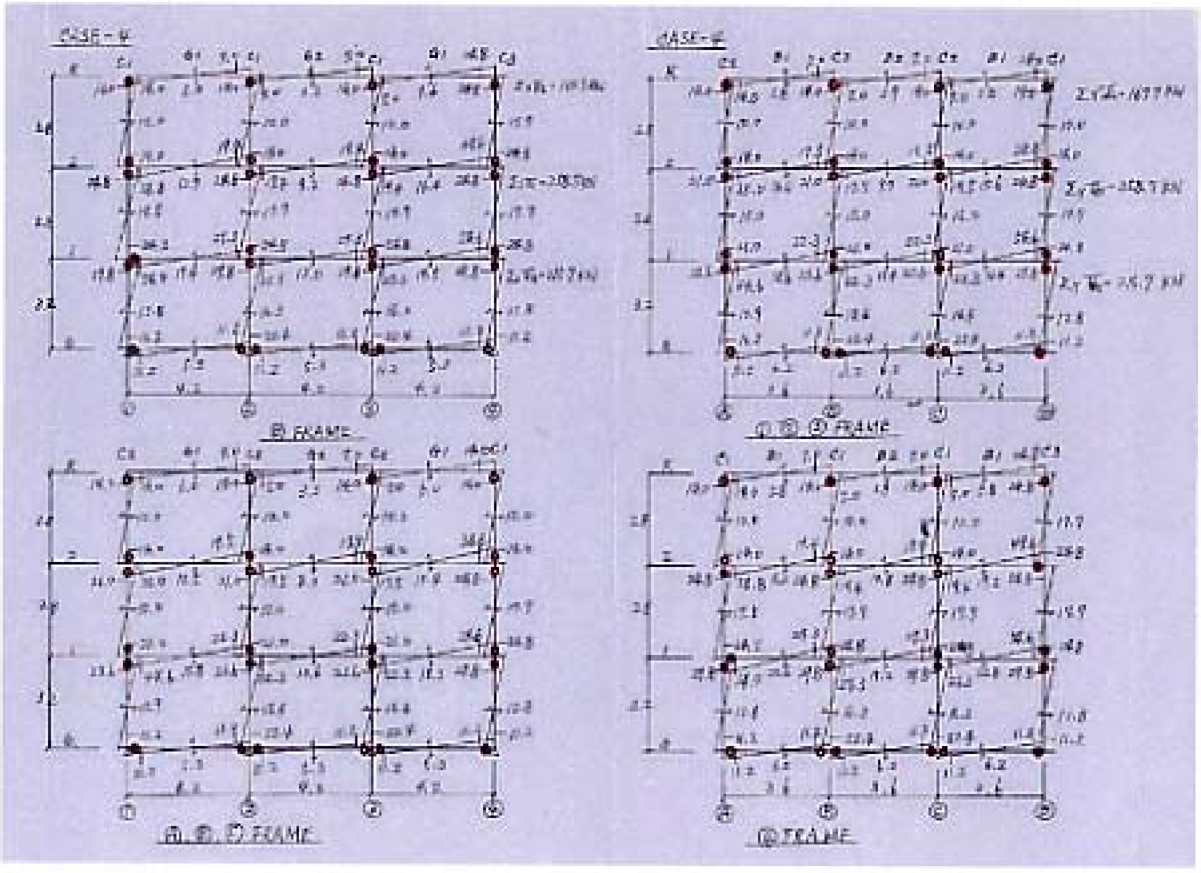
Plan, Member List and Results for ***Case-3***





Plan, Member List and Results for Case-4

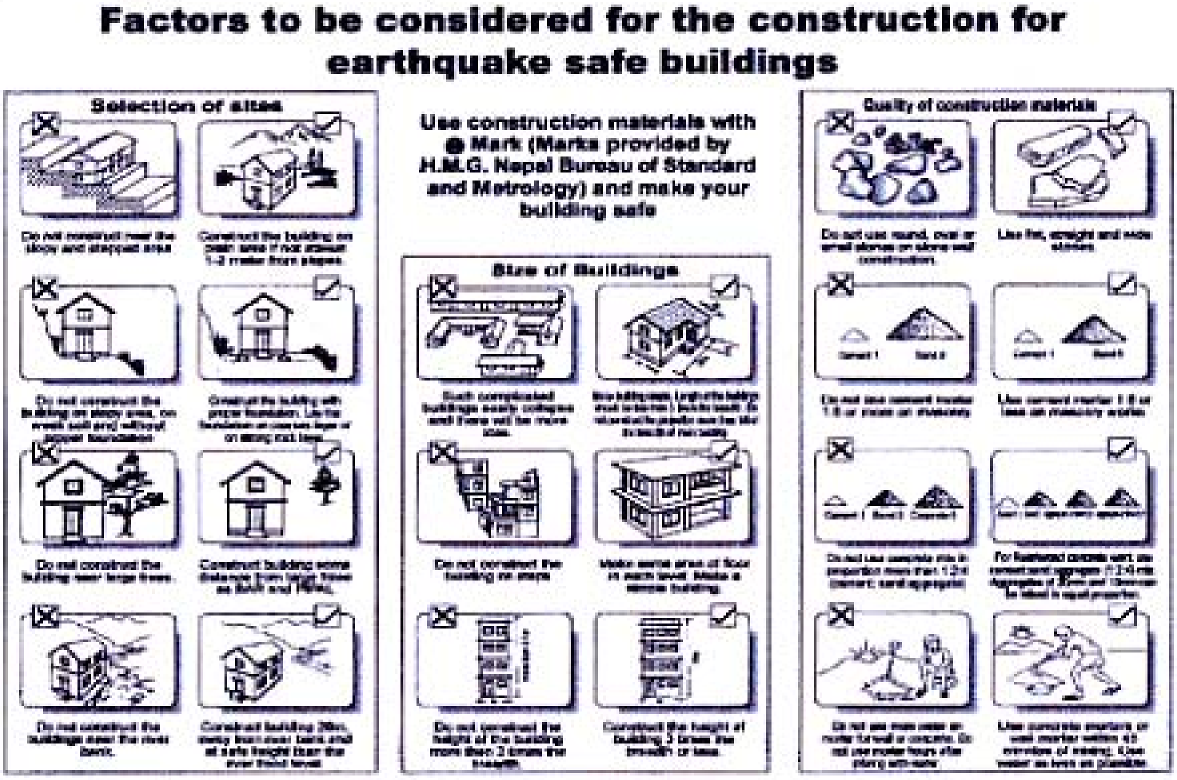




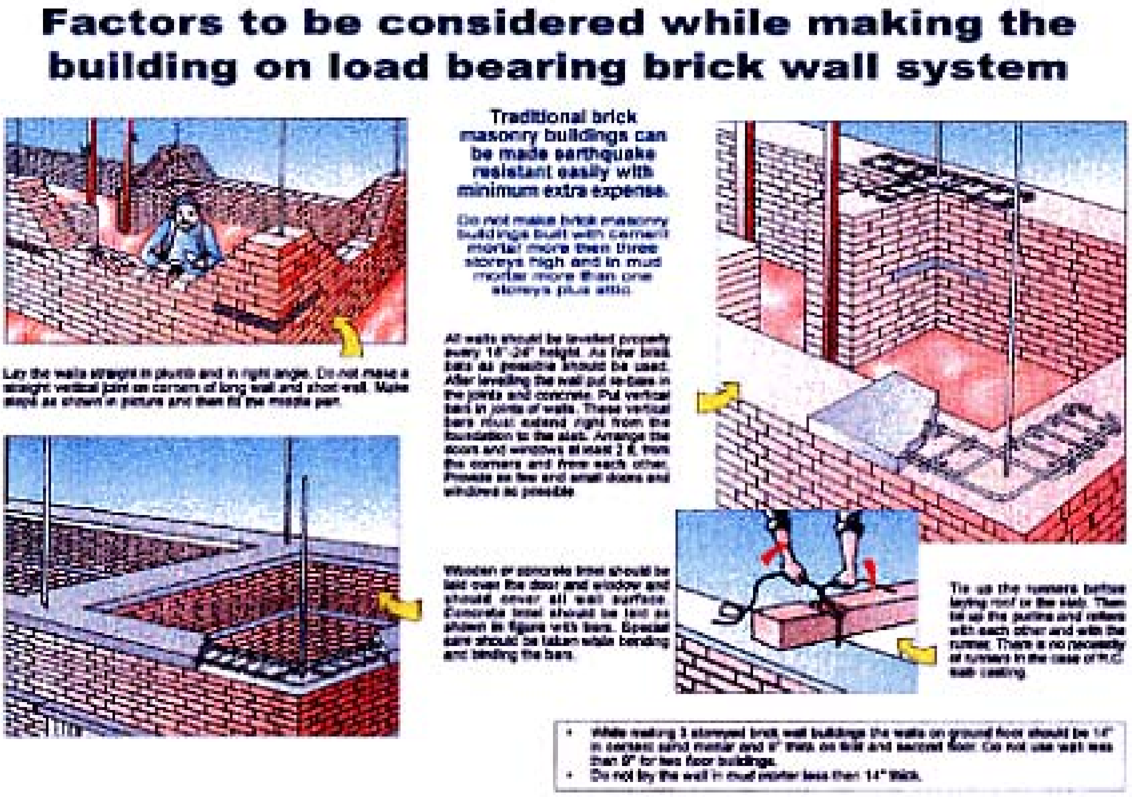
7. DISSEMINATION MATERIALS

The following four dissemination materials were made based on both existing materials by NSET-Nepal and the observation results this time.

1) General suggestion for construction plan.

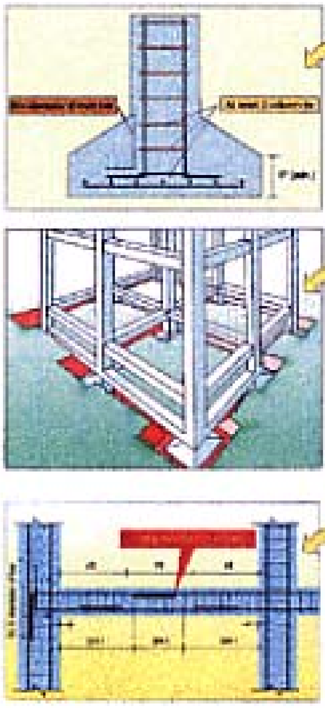


2) Suggestion for construction of Bricks



3) Suggestion for construction of RC

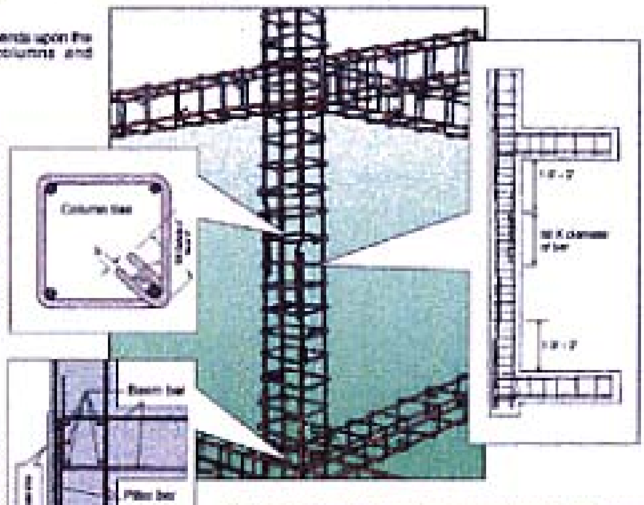
Factors to be considered for the construction of earthquake resistant buildings on pillar system (RC frame)



The size of column depends upon the distance between columns and number of storeys.

Tie beams should be laid below the ground level at the base of the columns similar to tie beams laid over ground level. The width of columns should be 3" greater than the beam width and all beam bars should be inside the column bars, columns should be in rows and at equal distance from each other as far as possible.

The lower bars of the beam should be spliced at a distance of 3' from the column and the splice should not be within 1/4 of the central part of the beam length. Splicing of upper bars must be within 1/3 of the middle part of the beam length. Lapping of the bars should be 60 times the diameter of the bar. Ties must be provided at 4" c/c throughout the spliced length.



Column bar splices should only be placed after leaving distances of 1.5'-2' from the top & bottom of the beams. Lapping of the bars should be 60 times the diameter of the bar. It is better not to lap all have at the same place of the column. Ties should be placed at 4" c/c on the whole lapping area of the column. Do not use bars less than 12mm dia. fro vertical column reinforcement. Ties must be placed 4"c/c for the first 2' of the column beam joint and 5"-6" c/c for the rest. Column and beam ties should be bent as shown in the figure. Ties must be provided at the column joints also. The edge of beam bars should be bent and placed inside columns ([illegible]). Beam bars should be placed inside the column.

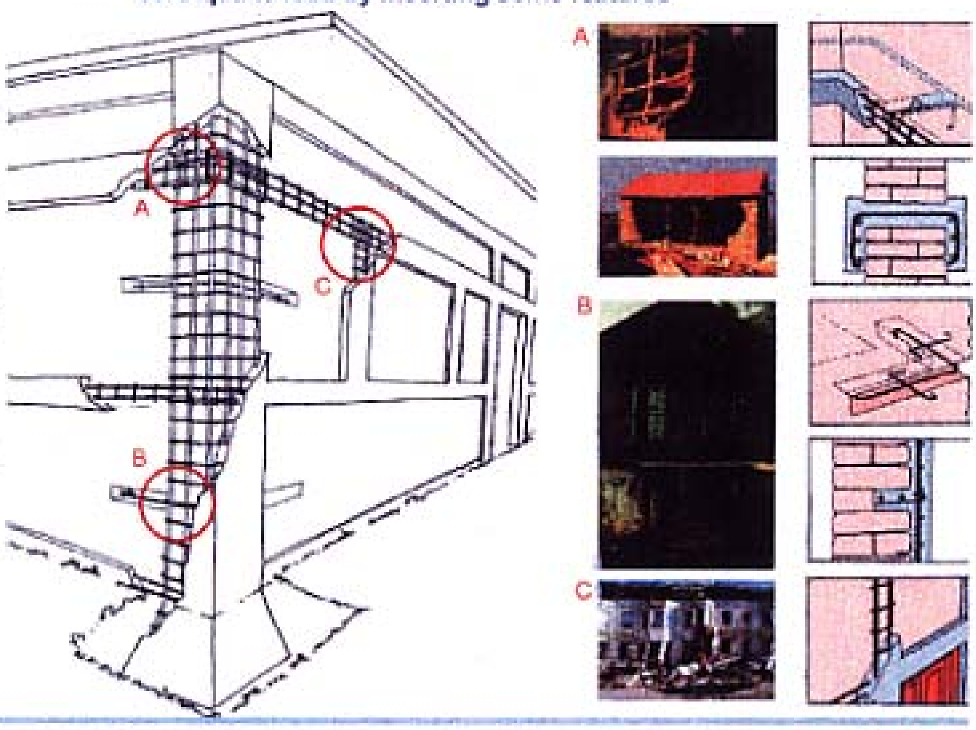
4) Suggestion for retrofit

Low rise masonry buildings if they are good for vertical loads can be retroffitted for earthquake load by inserting some features

A. Very long unsupported walls can fail to out of plane during seismic event. Horizontal bands outside and inside with some micro-concrete can protect from such failure.

B. There is virtually no connection between two perpendicular walls due to our construction practice of toothing and very weak to seismic force. Stitch can be inserted as shown in figure to strengthen the wall corners and prevent from wall separation.

C. Vertical reinforcement from foundation to roof at corners and T-joints and reinforcement around opeings protect the building as they prevent to starting of cracks from these weak points.



These vertical elements (Splint), Horizontal belts (Bandeges), and Stitch improve the overall intergrity of the building to at as a single unit and can save from sudden collapse during earthquake.

END