NATIONAL SOCIETY FOR EARTHQUAKE TECHNOLOGY NEPAL
(NSET-NEPAL)
GPO BOX 13775, Kha 2-731, Mahadevsthan, Baneshwor, Kathmandu Nepal
Telephone: (977-1) 474 192
Fax: (977-1) 490 943
E-mail: nset@mos.com.np

A PRELIMINARY INSPECTION REPORT on

STRUCTURAL SAFETY EVALUATION AND STRENGTHENING MEASURES FOR BUILDINGS OF

UMN HEADQUARTER S COMPLEX

Submitted to:
UNITED MISSION TO NEPAL
Thapathali
Kathmandu
Nepal

February 2000, Kathmandu, Nepal

February 14, 2000

Mr. Farley Maxwell
Director ,Headquarter
United Mission to Nepal
Thapathali Kathmandu
Nepal

RE: Submission of Report on **Structural Safety Evaluation and Strengthening Measures for the Buildings of UMN Headquarters Complex**

Dear Sirs,

Please find herewith a Preliminary Inspection report on **Structural Safety Evaluation and Strengthening Measures for Building of UMN Headquarters Complex, Nepal**, prepared by NSET-Nepal at your request of on 20 August 1999.

For further queries, please feel free to contact us.

Sincerely,

Amod M. Dixit
Secretary General

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1 INTRODUCTION

This report presents the methodology and findings of a Preliminary inspection of the building complexes of the United Missions to Nepal (UMN) headquarters located at Thapathali, Kathmandu, Nepal. The inspection was carried out by the National Society for Earthquake Technology - Nepal (NSET-Nepal) at the request of UMN by later dated 6 August 1999.

2 METHODOLOGY

NSET-Nepal constituted a team of experts, namely, Mr. Mahesh Nakarmi, Civil Engineer, and Mr. Jitendra Bothara, Structural Engineer, to undertake the inspection of the UMN building complex with the aim to assess the seismic vulnerability, and to identify other structural problem.

The visit was conducted on 20 August 1999. Mr. Farley Maxwell, Director UMN, Mr. Murari Binod Pokhrel briefed the team on the problems seen and escorted the team members to the problem areas. Mr. Jitendra K. Bothara and Mr. Mahesh Nakarmi conducted the structural assessment .

The study was based on visual inspection and discussion with UMN staff. No walls or any other structural members had been opened for investigation and no measurements were taken. No structural drawings were available for the study.

The UMN building complex consists of five buildings, namely, Biswas Niketan, Aasha Niketan, Shanti Niketan, Jyoti Niketan and Prem Niketan (Fig 1). All the buildings were inspected.

3 FINDINGS

The following presents the findings of the inspection.

3.1 BISWAS NIKETAN

3.1.1 Building Characteristics

The following provides the building characteristics as revealed by the inspection:

Elements	Characteristics
Terrain:	Flat
Configuration:	
Plan:	Rectangular with an appendage in front (The first floor room of appendage is supported by wall of main building and two brick piers seems added afterwards)
Elevation:	Flat
Wall density:	compact
Openings:	relatively less in number and small
No. of stories :	2
Floor height:	2.7m
Vertical and Lateral load resisting structural system:	Load bearing brick masonry.
Walling material:	Brick masonry (mortar unknown) with plastering on both faces.
Wall thickness:	more than 350 mm in first story and 350mm in second story

Elements	Characteristics
Floor structure:	RC slab.
Roof structure:	RC slab
Defects:	Severe cracking of back wall

3.1.2 Problems Identified:

- The back longitudinal foundation of the building has suffered severe settlement. Its north west corner has settled severely and more than 4 mm wide settlement cracks can be seen in the first story wall. The cracks are traversed to second story walls also but no cracks were observed in floor slab. At least a part of the building is under threat. As it seems from the investigation, main cause behind the unequal settlement is a deep sewer line running along or very close to its foundation (ref Figures 1 and 2). The sewer line is under use. Unequal settlement of foundation remains major problem of the building even for normal loading condition.
- The staircase is cantilever type and could be under problem during seismic shaking leading to loss of vertical circulation.
- The appendage could be in problem during seismic shaking.
- Building is lacking seismic strengthening features.

3.1.3 Discussion

High wall density, small and few openings, small floor to floor height and over all height, availability of rigid diaphragm are features in the favor of seismic safety. Crack pattern of different part of the building reveals that no seismic bands or vertical bars are incorporated in it, which is further conformed by old staffs of UMN. The building is lacking other earthquake resisting features also.

3.1.4 Possible Remedies

- New elements can be incorporated to bridge the building foundation over the sewer line (Fig 3) to mitigate the settlement problem.
- The appendage needs to be either separated or well integrated and brick piers strengthened.
- The building needs to be strengthened against earthquake. Splint and bandage (Fig 4), stitching of walls (Fig 5) at the junctions are recommended for retrofitting.
- The staircase needs new supports and strengthening.

3.2 AASHA NIKETAN

3.2.1 Building Characteristics

The following provides the building characteristics as revealed by the inspection:

Elements	Characteristics
Terrain:	Flat
Configuration:	
Plan:	Rectangular (L< 3B) with small offsets in front and back.
Elevation:	Flat
Wall density:	compact
Openings:	relatively less in number and small
No. of stories :	2
Floor height:	2.7m
Vertical and Lateral load resisting structural system:	Load bearing brick masonry.
Walling material:	Brick masonry (mortar unknown) on both faces.
Wall thickness:	more than 350 mm in first story and 350mm in second story
Floor structure:	RC slab.
Roof structure:	RC slab
Defects:	Cracking of back walls, separation of orthogonal walls.

3.2.2 Problems Identified:

- The back wall has suffered diagonal cracking, which represents that the back longitudinal wall foundation has suffered severe settlement. Its north west corner has settled and more than 2 mm wide settlement cracks can be seen in the first story wall. The effect has transferred to second story also. The vertical cracks due to separation of walls at junctions have also been observed. The investigation shows that the sewer line, which runs along northern wall of Biswas Niketan, is either running below or along its wall foundation (ref Fig 1 and 2). Unequal settlement of foundation remains major problem of the building even for normal loading condition.
- The building is lacking seismic strengthening.
- The staircase is too clumsy.

3.2.3 Discussion

Simple configuration, high wall density, small and few openings, small floor to floor height and over all height, availability of rigid diaphragm are features in the favor of seismic safety. Crack pattern of different part of the building reveals that no seismic bands or vertical bars are incorporated in it, which is further conformed by old staffs of UMN. The building is lacking other earthquake resisting features also.

3.2.4 Possible Remedies

- New elements can be incorporated to bridge the building foundation over the sewer line (Fig 3) to mitigate the settlement problem.
- The building needs to be strengthened against earthquake. Splint and bandage (Fig 4), stitching of walls (Fig 5) at the junctions are recommended for retrofitting.
- The vertical and horizontal circulation of building also needs re-planning because of possibility of confusion and congestion at the end of staircase.

3.3 JYOTI NIKETAN

3.3.1 Building Characteristics

The following provides the building characteristics as revealed by the inspection:

Elements	Characteristics
Terrain:	Flat
Configuration:	
Plan:	Rectangular (L< 3B) with small offsets in front.
Elevation:	Flat
Wall density:	compact
Openings:	relatively less in number and small
No. of stories :	2
Floor height:	2.7m
Vertical and Lateral load resisting structural system:	Load bearing brick masonry.
Walling material:	Brick masonry (in mud mortar) with pointing on outer face and plaster on inner face.
Wall thickness:	350 mm in first and second story.
Floor structure:	Semi-flexible floor (floor is constructed of brick laid on timber joists with a topping of cement concrete)
Roof structure:	Semi-flexible roof (roof is constructed of brick laid on timber joists with a topping of lime concrete
Defects	No structural cracks are observed in building that indicates that the building has not gone any significant unequal settlement.

3.3.2 Problems Identified:

- The building lacks seismic strengthening.
- Walls shifting in upper story leading to problem of load path.

3.3.3 Discussion

The building has simple configuration, high wall density, small and few openings, small floor to floor and overall height. But the flexible floor and roof, shifting of structural walls, un-strengthened corners, and weak walling materials are basic deficiency. General inspection reveals that no seismic bands or vertical bars are incorporated in it, which is further conformed by old staffs of UMN. The building is lacking other earthquake resisting features too.

3.3.4 Possible Remedies

- Re-plan the space and re-locate the walls to make load path clearly defined and vertical.
- The floor and roof needs to be stiffened to act as a rigid diaphragm.
- The building can be strengthened against earthquakes using splint and bandage (Fig 4). Stitching the orthogonal walls (Fig 5) can strengthen the junction.

3.4 SHANTI NIKETAN

3.4.1 Building Characteristics

The following provides the building characteristics as revealed by the inspection:

Elements	Characteristics
Terrain:	Flat
Configuration:	
Plan:	Rectangular (L< 3B) with small offsets in front.
Elevation:	Flat
Wall density:	compact
Openings:	relatively less in number and small
No. of stories :	1
Floor height:	2.7m
Vertical and Lateral load resisting structural system:	Load bearing brick masonry.
Walling material:	Brick masonry (in mud mortar) with pointing on outer face and plastering on inner face.
Wall thickness:	350 mm or more.
Roof structure:	Semi-flexible roof (roof is constructed of brick laid on timber joists with a topping of lime concrete
Defects	Defect: No structural cracks are observed in building that indicates that the building has not gone any significant unequal settlement

3.4.2 Problems Identified:

- Building lacks seismic strengthening.
- No major problem jeopardizing stability of building during normal load has been observed.

3.4.3 Discussion

No structural cracks are observed in building that indicates that the building has not gone any significant unequal settlement.

The building has simple configuration, high wall density, small and few openings, small floor to floor height, and small overall height. But the flexible floor and roof, shifting of structural walls, un-strengthened corners, and weak walling material are basic deficiency. General inspection reveals that no seismic bands or vertical bars are incorporated in it, which is further conformed by old staffs of UMN. The building is lacking other earthquake resisting features too.

3.4.4 Possible Remedies

- The roof needs to be stiffened to act as a rigid diaphragm.
- The building can be strengthened against earthquakes using splint and bandage (Fig 4). Stitching the orthogonal walls (Fig 5) can strengthen the junction.

3.5 PREM NIKETAN

3.5.1 Building Characteristics

The following provides the building characteristics as revealed by the inspection:

Elements	Characteristics
Terrain:	Flat

Elements	Characteristics
Configuration:	
Plan:	Square with a small offset in back.
Elevation:	Pagoda type roof.
Openings:	Relatively large and many in number.
No. of stories :	2 (split level)
Floor/ roof height:	Variable
Vertical and Lateral load resisting structural system:	Mixed, the central part of the building is reinforced frame construction with masonry infill where as peripheral part is in load bearing masonry construction.
Walling material:	Brick masonry (in cement mortar).
Wall thickness:	230 mm
Floor structure:	RC slab.
Roof structure:	RC slab (tired pagoda).
Defects:	No structural cracks are observed in building that indicates that the building has not gone any significant unequal settlement.

3.5.2 Problems:

- The walls may suffer out of plane collapse during seismic shaking (as the walls are long without any intermediate stiffening measures).
- Building may be lacking seismic strengthening features (According to Mr. Maxwell, the building is base isolated (but not sure!). During visual inspection no separation gap between peripheral ground and building was observed which is most for effectiveness of the isolation system).
- No major problem jeopardizing stability of building during normal load has been observed.

3.5.3 Discussion

Regular shape of the building plan and availability of rigid diaphragms are features in favor of seismic safety. But split-levels, long slender peripheral walls, hybrid structural system are the features against the seismic safety.

3.5.4 Possible Remedies

The building is complex in nature because of mixed structural system, construction, and split-levels. The building needs in-depth material study, analysis before any intervention. The building can be strengthened against earthquake but needs different options weighted for improvement. Jacketing of columns (Fig 6) and incorporation of stiffeners in peripheral walls and improvement of integrity could be one option.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Based upon the preliminary inspection, the following conclusions are drawn:

- Out of five buildings in UMN headquarter complex four are load bearing masonry buildings and one is RC frame-masonry mixed construction.
- Buildings in UMN headquarter are well maintained though there remains some problem.
- Northern structural wall of Asha Niketan is suffering severe cracking where as and Jyoti Niketan is also suffering cracking due to unequal settlement caused by an underground sewer line running along or close to their foundations. No structural cracks observed in other buildings.
- Non of the four-masonry load bearing buildings are designed and constructed against earthquake.
- Configuration of all these four buildings in general is OK though remains some deficiency.
- Prem Niketan is relatively complex building from structural point of view.
- All the buildings of UMN headquarter can be effectively strengthened against earthquake shaking.

4.2 RECOMMENDATIONS

The following recommendations are suggested.

- An in-depth study of foundations of Biswas and Asha Niketan is recommended before any intervention for their foundation improvement. The foundation can be improved by underpinning.
- Exploration of materials, detailed study of structures, vulnerability assessment is recommended before strengthening work.
- Splint and bandage, stitching of orthogonal walls is recommended for seismic strengthening of four masonry buildings namely Biswas, Asha, Jyoti and Shanti Niketan. Floor and roof stiffening of Jyoti and Shanti Niketan is also recommended to create diaphragm effect.
- Prem Niketan can be strengthened by jacketing columns with reinforced concrete and with incorporation of stiffeners in external peripheral walls (if it is not constructed for earthquake).
- Improvement in non-structural safety in these buildings is recommended which can be done by proper planing, tying-up non-structural elements with main structure.

Figure 1: UMN Headquarters Building Complex

Figure 2: Expected Sources of the Problem in the Foundations of Bishwas Niketan and Aasha Niketan

Figure 3: Proposed under-pinning System to carry the Foundation Load over the Existing Sewer Line at Bishwas Niketan ad Aasha Niketan

Figure 4: Splint and Bandage Strengthening Technique

Figure 5: Stitching of Walls at Junctions with Inclined Bars

Figure 6: Jacketing of Beams and Columns