SEISMIC EVALUATION

Of

Beach Cities Health District
Medical Office Building

510 N. Prospect Avenue
Redondo Beach, CA

PRIVILEGED AND CONFIDENTIAL

Prepared for:

Beach Cities Health District
514 North Prospect Avenue
Redondo Beach, CA

Prepared by:

Nabih Youssef Associates
Structural Engineers
550 South Hope Street, Suite 1700
Los Angeles, California 90071
NYA Job # 17171.10

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TABLE OF CONTENTS

0.0 EXECUTIVE SUMMARY

The objective of this report is to present the results of the seismic evaluation of the 3-story medical office building located at 510 North Prospect Avenue on the Beach Cities Health District Campus in Redondo Beach.

The building consists of the original building constructed circa 1976 and the north wing addition constructed circa 1979. The original building and addition are 3-stories tall and are seismically separated by a 2 inches wide joint. The original building and addition were designed to the 1973 edition of the Uniform Building Code (UBC).

The roof and floors of the original building are constructed of pre-stressed spancrete planks with concrete topping slabs that span to pre-cast concrete beams and reinforced CMU walls. The beams are supported by pre-cast concrete columns that are continuous to the foundation. The foundation system consists of shallow spread footings. The reinforced CMU walls resist seismic forces.

The 1979 Addition is constructed of a wood framed plywood roof and metal deck with concrete fill floors supported by wide flange steel beams and reinforced CMU walls. The steel beams are supported by wide flange steel columns that are continuous to the foundation. The foundation consists of shallow spread footings and grade beams. The lateral system consists of CMU shear walls.

The expected seismic performance of the building was determined by a site review, review of available structural drawings, dynamic analyses and a general seismic hazard analysis for the region.

The methodology of ASCE 41-17, Seismic Evaluation and Retrofit of Existing Buildings, was used to evaluate the seismic performance. The results of the analysis indicate that the CMU walls have inadequate shear and/or flexural strength, and the diaphragm-to-CMU wall connections have inadequate strength to transfer expected seismic forces for both the original building and the 1979 Addition.

The plywood roof diaphragm of the 1979 Addition has an extensive cantilever on the south side and there are no chord elements to resist/transfer seismic loads. In addition, approximately 40% of the footings and grade beams of the 1979 Addition have inadequate strength.

The maximum combined displacement response of the original building and Addition exceed the provided separation joint and impact between buildings is likely. Since the roof and floors align vertically the damage due to pounding is likely to be limited/localized and unlikely to compromise structural integrity.

The results indicate that the office building does not meet the Basic Performance Objective for Existing Buildings (BPOE), as defined by ASCE 41-17. The BPOE, or objectives close to it, has been used for characterizing seismic performance in other standards and regulations. The BPOE accepts a lower level of safety and a higher risk of collapse than would that provided by similar standards for new buildings.

The City of Redondo Beach does not currently have a mandatory seismic retrofit ordinance for buildings with reinforced masonry walls with stiff/rigid diaphragm. Thus, mandatory seismic upgrade would only be triggered for change of use or occupancy, or significant structural alteration/addition. Retrofit to mitigate identified deficiencies would be strictly voluntary.

Recommended mitigation measures have been developed to improve the seismic performance. These measures are preliminary and are intended to identify representative scope for planning, coordination, and rough order of magnitude estimate of cost.

The recommended strengthening for the Original building consists of the following:

- Strengthen select existing CMU walls at perimeter and around elevator core with shotcrete from foundation to roof. At perimeter, shotcrete to be applied to exterior face of existing wall. At elevator core, shotcrete to be applied to outside face of existing wall (not in shaft). Since the existing roof and floors are constructed with pre-stressed pre-cast spancrete planks, planks adjacent to the elevator core need to be removed for the construction of the new shotcrete walls (allowing the placement of continuous vertical reinforcement). The removed planks will be replaced with metal deck and concrete fill supported on new steel beams spanning to existing CMU walls and pre-cast concrete beams.
- Strengthen existing footings at new shotcrete walls. Foundation strengthening at elevator core to include micropiles.
- Strengthen roof and floor diaphragms by removing existing concrete topping slab at select locations and replacing with new reinforced concrete slab.

The recommended strengthening for the 1979 Addition consists of the following:

- Strengthen existing interior CMU wall with shotcrete from foundation to underside of 3rd floor.
- Strengthen existing footing at new shotcrete wall.
- Strengthen existing footings and grade beams at select locations.
- Strengthen existing roof and floor diaphragm to CMU wall connection with additional drilled and epoxied dowels.
- Strengthen existing steel beam to beam connections at roof level by welding steel shear tab plate to beam web.

1.0 INTRODUCTION

1.1 General

The objective of this report is to present the results of the seismic evaluation of the 3-story medical office building located at 510 North Prospect Avenue on the Beach Cities Health District Campus in Redondo Beach. Figure 1.1 shows the location of the structure on an aerial view of the site.

The building was visited by *Nabih Youssef Associates* (NYA) staff to observe the general condition of the visible portions of the structural system. A general review of the structural elements was performed during the site visit to develop an understanding of the building's construction.

The expected seismic performance was determined by a site review, review of available structural and architectural drawings, a general seismic hazard analysis for the region, and linear dynamic analyses.

The methodology of ASCE 41-17, Seismic Evaluation and Retrofit of Existing Buildings, was used to evaluate the seismic performance of the building. ASCE 41-17 is a nationally recognized standard for the seismic evaluation and retrofit of buildings.

This evaluation of the structural system represents the opinion of *NYA* based on the available information.

1.2 Scope of Work

The following tasks outline the scope of work for the structural evaluation:

1) Review existing structural and architectural drawings and prior engineering/repair reports made available by the Client.
2) Perform limited walk-through and visually confirm, to the extent possible, that the provided construction documents generally correspond with the actual conditions.
3) Perform Tier 1 evaluation to identify potential seismic deficiencies.
4) Develop a computer model of the building and perform linear dynamic analyses to assess its seismic performance.
5) Develop professional opinion of the adequacy of the building based on prevailing seismic performance standards.
6) Develop conceptual strengthening approach to address identified seismic deficiencies, as necessary.
7) Prepare a written report summarizing the results of the site visit, structural evaluation, and conceptual strengthening including sketches of plans and details.

1.3 Evaluation References

The following documents and available information were examined in the evaluation:

- Structural drawings for Prospect I Medical Building, as prepared by Theodore E. Anvick, dated December 8, 1975.

- Structural drawings for Prospect I Medical Building Addition, as prepared by Reiss and Brown, dated February 20, 1978.
- Seismic Evaluation and Retrofit of Existing Buildings, ASCE/SEI 41-17, 2017.

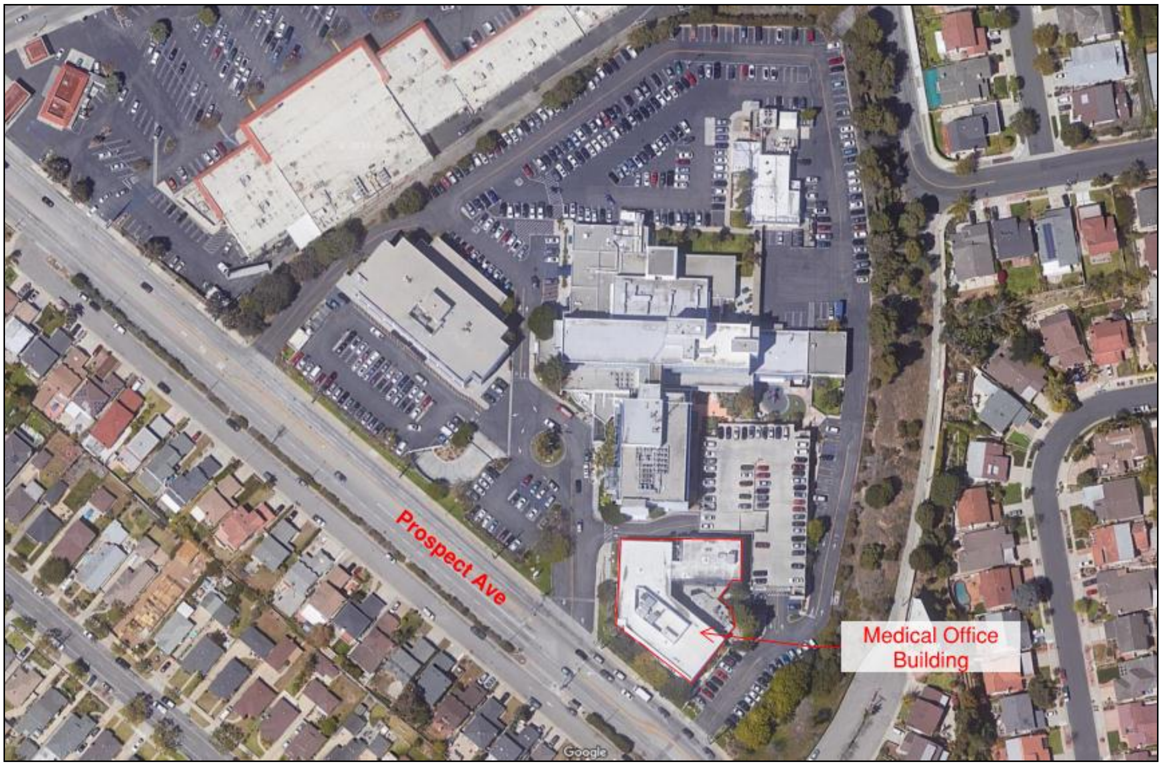


Figure 1.1 – Aerial View

2.0 BUILDING DESCRIPTION

2.1 General

The medical office building consists of the original building constructed circa 1976 and the north wing addition constructed circa 1979. The original building and addition are 3-stories tall and are seismically separated by a 2 inches wide joint. The original building and addition were designed to the 1973 edition of the Uniform Building Code (UBC). Figure 2.1 shows a plot plan of the medical office building.

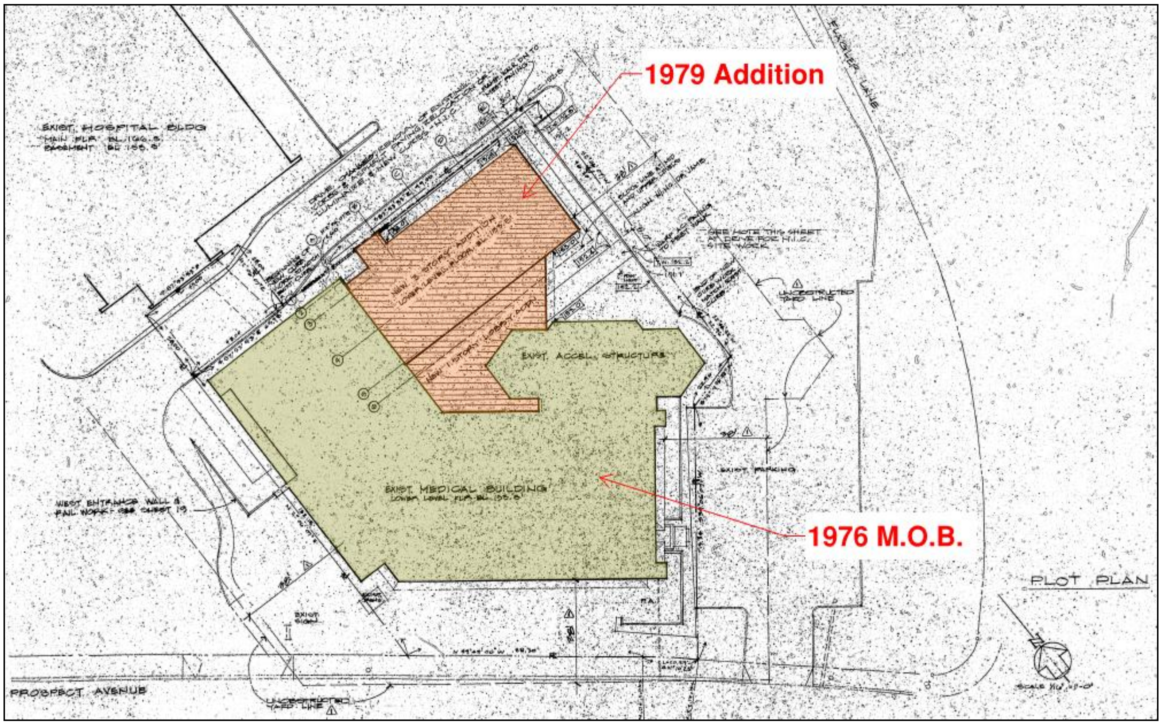


Figure 2.1 – Plot Plan

2.2 Gravity System

The gravity framing system typically consists of the following:

Original Building:

- The roof and floors are typically constructed of 8″ pre-stressed concrete spancrete planks with 3″ thick reinforced concrete topping slab spanning to pre-cast concrete beams supported by pre-cast concrete columns.

  The pre-cast planks bear on the pre-cast beams. Gap between planks are filled by the concrete topping slab that has 90º bent dowels into the pre-cast beams. Figure 2.2 shows the detail of the topping slab to pre-cast beam connection.

  The pre-cast beams bear on the pre-cast column corbels. Figure 2.3 shows a section at a typical column. Steel plates embedded in the pre-cast beams and column corbels are welded together to create a positive connection. Figure 2.4 shows the detail of the pre-cast beam to column corbel connection.

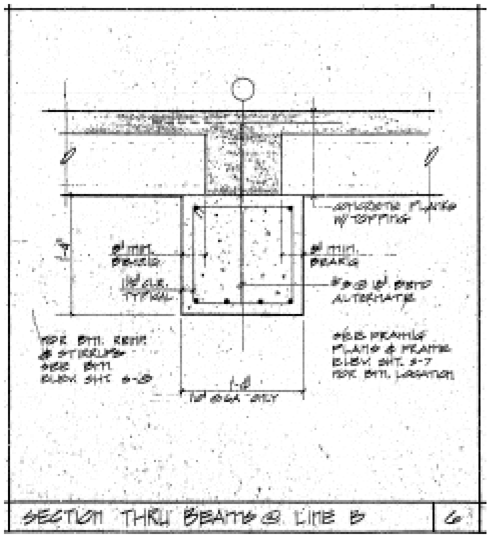


Figure 2.2 – Topping Slab to Pre-Cast Beam Connection

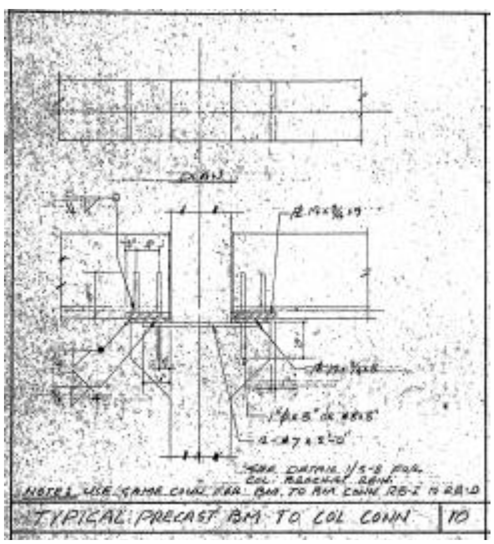


Figure 2.4 – Pre-Cast Beam to Column Corbel Connection

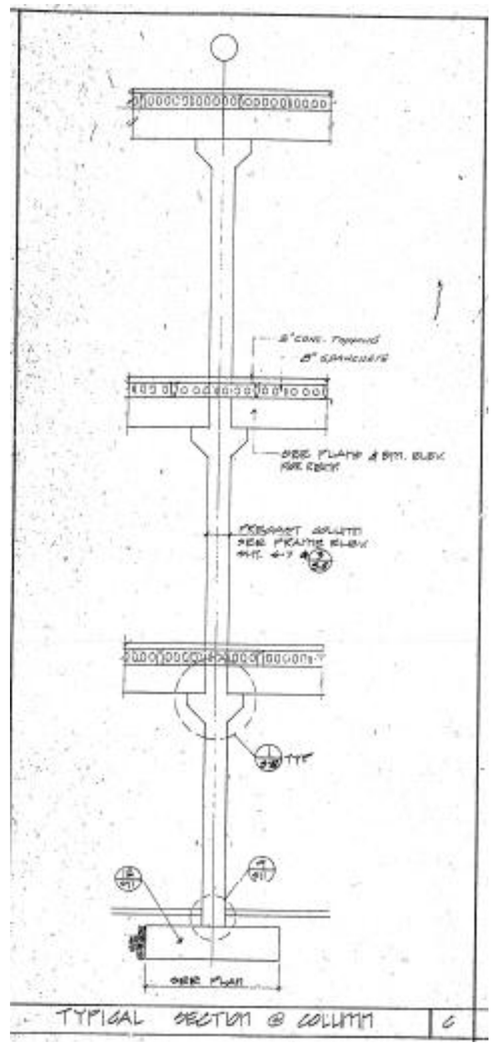


Figure 2.3 – Typical Section at Pre-Cast Column

- The spancrete roof and floors are also supported by reinforced masonry walls.

  The spancrete planks bear on the masonry walls and the concrete topping slabs have hooked dowels into the walls. Figure 2.5 shows the detail of the spancrete plank to masonry wall connection.
- The columns and walls are typically continuous to the foundation.
- The foundation system typically consists of shallow spread footings. A 4″ thick reinforced concrete slab-on-grade forms the first floor level.
- The roof of the X-ray building is constructed of 24″ thick two-way reinforced concrete slab spanning to 24″ thick reinforced concrete walls. A 6″ thick reinforced slab-on-grade forms the floor.

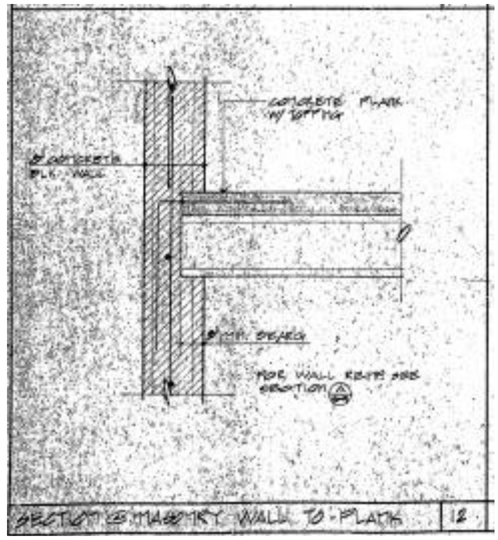


Figure 2.5 – Spancrete Plank to Masonry Wall Connection

<u>1979 Addition:</u>

- The roof is constructed of ½″ structural plywood sheathing supported by 2″x10″ joists spaced at 16″ on center spanning to wide flange steel beams.
- The floors are typically constructed of 3″ metal deck with 3¼″ concrete fill spanning to wide flange steel beams.
- The steel beams are supported by wide flange steel columns that are continuous to the foundation.
- The foundation system typically consists of shallow spread footings. A 4″ thick reinforced concrete slab-on-grade forms the first floor level.

2.3 Lateral System

The seismic system of the building typically consists of the following:

<u>Original Building:</u>

- The concrete topping slab roof and floors act as structural diaphragms to distribute seismic inertial forces to distributed reinforced masonry walls/piers.

<u>1979 Addition:</u>

- The plywood roof and metal deck with concrete fill floors act as structural diaphragms to distribute seismic inertial forces to distributed reinforced masonry walls/piers.

3.0 FIELD OBSERVATIONS

3.1 General

A site visit was made by Nabih Youssef Associates staff to observe the condition and characteristics of the building. The majority of the structural framing was covered and was not visually observable. Observation was limited to the visible areas of the structure.

3.2 Structural Observations

- In general, the building appeared to be in good condition; there were no signs of significant structural cracking, spalling or deterioration of the structural framing.
- No permanent offset of the building that would indicate structural distress was observed.
- The configuration of the building was in general conformance with the original structural drawings. No significant structural alterations were observed.

4.0 BUILDING PERFORMANCE IN EARTHQUAKES

A detailed evaluation of the office building was performed, including three-dimensional linear dynamic analyses. The criteria used to evaluate the performance of the building, the analysis procedures and results are discussed in the following sections.

4.1 Evaluation Criteria

The office building was evaluated using the methodology of ASCE 41-17, *Seismic Evaluation and Retrofit of Existing Buildings*, a national standard that provides guidelines for relating engineering limit states to expected damage/performance. The Basic Performance Objective for Existing Buildings (BPOE), as defined by ASCE 41-17, was the performance criteria used in the assessment. The BPOE, or objectives close to it, has been used for characterizing seismic performance in other standards and regulations. The BPOE accepts a lower level of safety and a higher risk of collapse than would that provided by similar standards for new buildings. Building meeting the BPOE are expected to experience little damage from relatively frequent, moderate earthquakes but significantly more damage and potential economic loss from the more severe and infrequent earthquakes that could affect them.

The BPOE incorporates a two (2) tier procedure to evaluate seismic performance. Table 4.1 summarizes the criteria.

Table 4.1 – Basic Performance Objective for Existing Buildings

Earthquake Hazard Level	**Structural Performance Level**
BSE-1E (20/50 – 225 yr)	Life Safety
BSE-2E (5/50 – 975 yr)	Collapse Prevention

The design response spectral accelerations for the BSE-1E and BSE-2E seismic hazard levels for the site, assuming soil type D, is provided in Table 4.2.

Table 4.2 –Design Response Spectral Acceleration for BSE-1E & BSE-2E

Spectral Acceleration	BSE-1E	BSE-2E
S_{XS}	0.817g	1.407g
S_{X1}	0.454g	0.880g

4.2 Analysis Approach

A Tier 1 evaluation was initially performed to screen for potential deficiencies. Results identified inadequate seismic separation, insufficient shear strength of the reinforced masonry walls/piers, inadequate connection of metal deck and concrete fill floors to masonry wall in 1979 addition as potential deficiencies. A Tier 3 evaluation using the linear dynamic procedure (LDP) of ASCE 41-17 was performed.

A three-dimensional computer model of the original building and additon was developed using ETABS 2017, developed by Computers & Structures, Inc. The models included all elements that significantly contribute to the lateral force resistance including the concrete topping slab roof and floors of the original building, and the plywood roof and metal deck with concrete fill floors of the addition, and reinforced masonry walls/piers. The concrete slab roof and floors were assumed to behave as semi-rigid diaphragms. The pre-cast concrete beams and columns, and the wide flange steel beam and columns were included in the models to provide vertical support to the concrete slabs. Figure 4.1 and 4.2 show plots of the ETABS model for the original building and 1979 Addition, respectively.

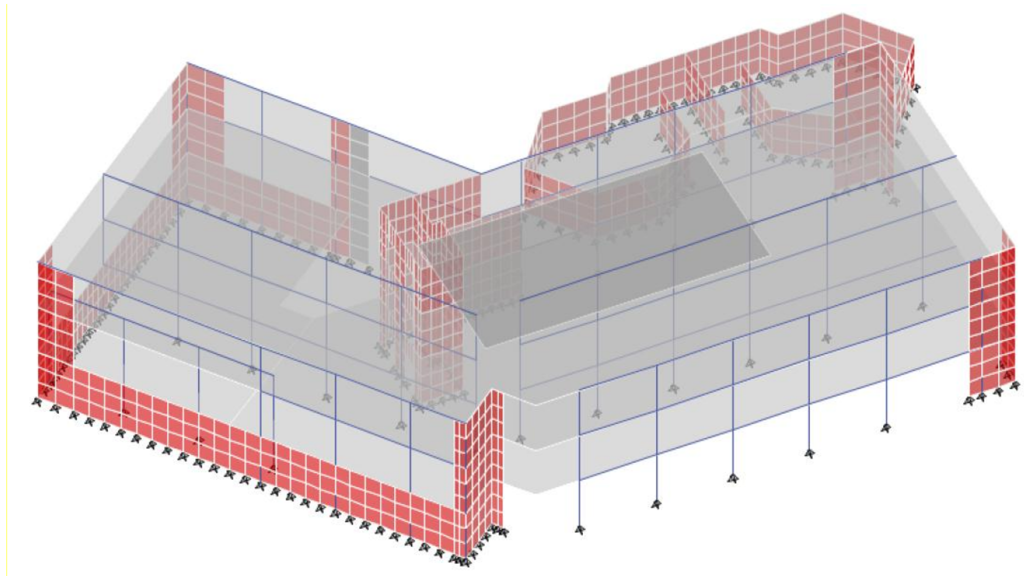


Figure 4.1 – Plot of ETABS model of Original Building

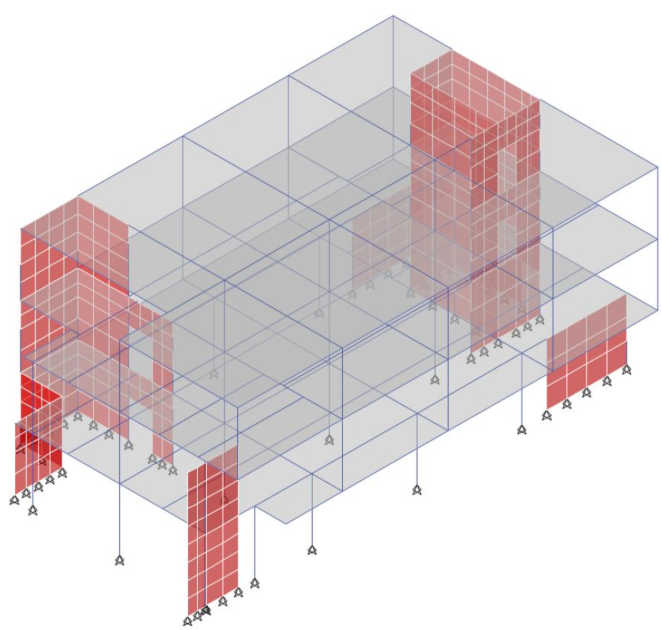


Figure 4.2 – Plot of ETABS model of 1979 Addition

The material properties for concrete and masonry were provided on the original structural drawings and used in the model.

LDP consists of performing modal spectral analysis using linearly elastic response spectra that are not modified to account for anticipated nonlinear response. The procedure produces displacements that approximate maximum displacements expected during the design earthquake, but internal forces exceed those that the building can sustain because of anticipated inelastic response of components and elements. These forces are evaluated using acceptance criteria that include modification factors.

4.3 Discussion of Results

Modal and dynamic analyses were performed to determine the dynamic characteristics of the buildings and to establish likely earthquake demand on individual structural components and global response. The demands on individual components were evaluated using ASCE 41-17 acceptance criteria for Life Safety and Collapse Prevention performance.

4.3.1 Original Building

The results of the modal analysis indicate that the lateral force resisting elements of the building are ill distributed resulting in an irregular (torsional) response. Figures 4.3 through 4.5 show plots of the fundamental mode shapes for the building. Table 4.3 summarizes the fundamental periods.

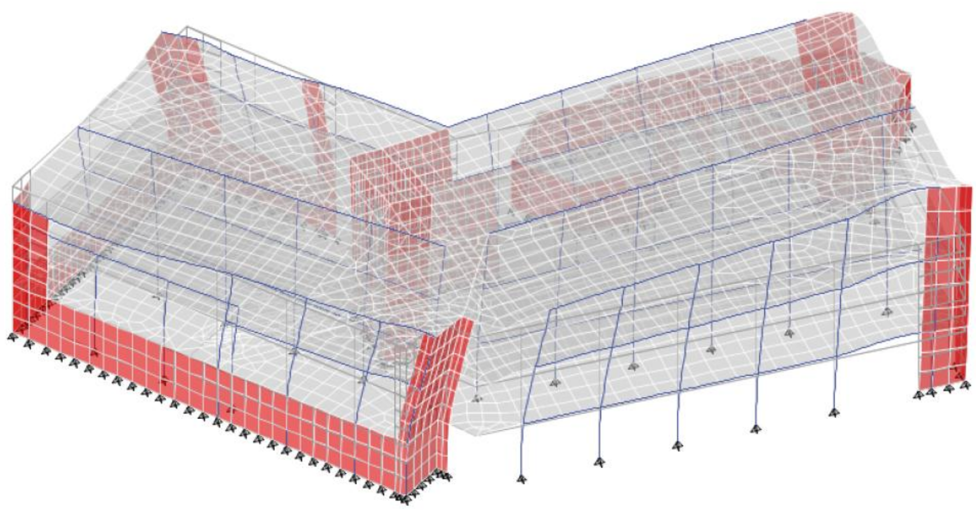


Figure 4.3 – Torsional Mode

Table 4.3 Fundamental Periods - Original

Fundamental Mode	Period (sec.)
Torsion	0.44
E-W Translation	0.35
N-S Translation	0.26

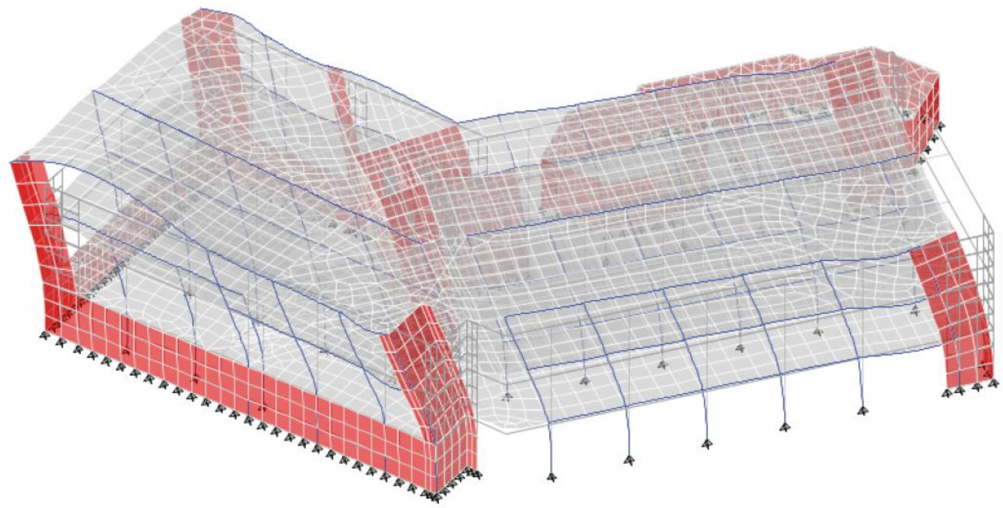


Figure 4.4 – E-W Translational Mode

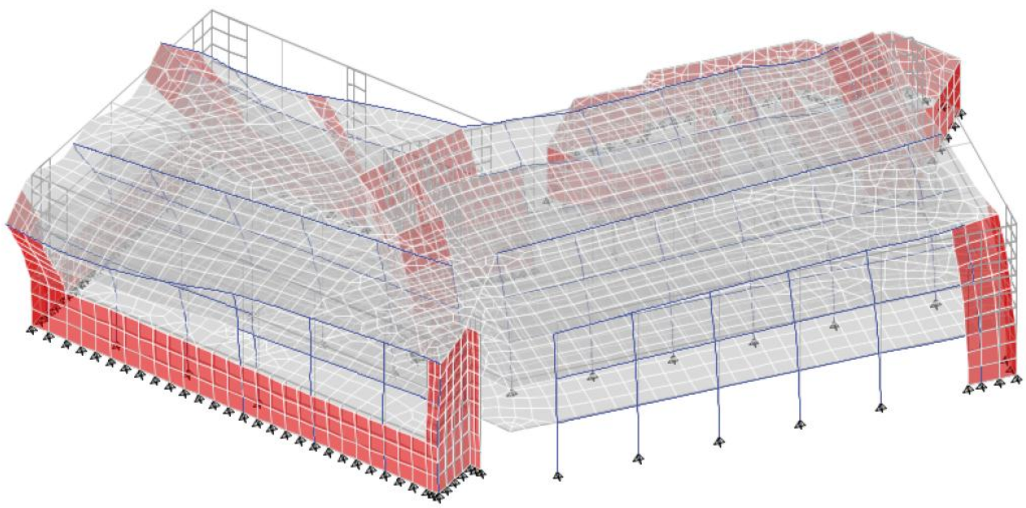


Figure 4.5 – N-S Translational Mode

The results of the analysis indicate that approximately 30% of the CMU walls have inadequate shear and/or flexural strength. In addition, approximately 85% of the slab-to-CMU wall connections have inadequate strength to transfer expected seismic forces with average demand-to-capacity ratio (DCR) of 3.0.

4.3.2 1979 Addition

The modal analysis results indicate that the lateral force resisting elements are not uniformly distributed resulting in an irregular (coupled) response. Figures 4.6 through 4.8 show plots of the fundamental mode shapes. Table 4.4 summarizes the fundamental periods.

The results of the analysis indicate that approximately 10% of the CMU walls have adequate shear and/or flexural strength. The plywood roof diaphragm has an extensive cantilever on the south side and there are no chord elements to resist/transfer seismic loads. The results also indicate that approximately 80% of the slab-to-CMU wall connections have inadequate strength to transfer expected seismic forces with average demand-to-capacity ratio (DCR) of 1.7.

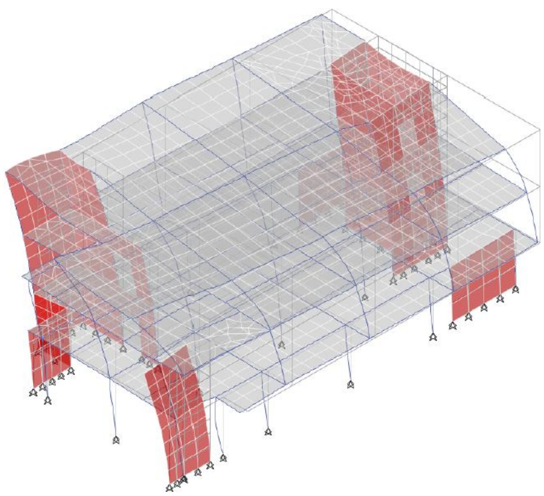


Figure 4.6 – E-W Translational Mode

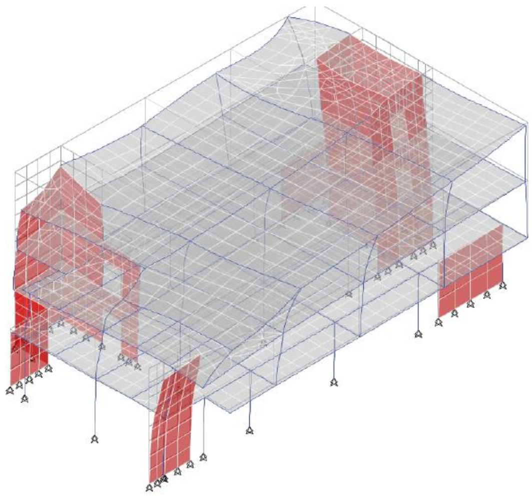


Figure 4.7 – Torsional Mode

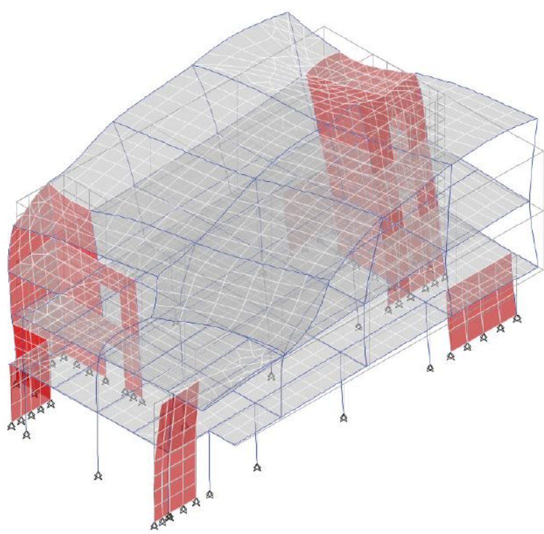


Figure 4.8 – N-S Translational Mode

Table 4.4 Fundamental Periods - Addition

Fundamental Mode	Period (sec.)
E-W Translation	0.18
Torsion	0.17
N-S Translation	0.11

The results indicate that approximately 40% of the footings exceed the allowable soil bearing pressure and 40% of the grade beams have inadequate shear and flexural strength.

In addition, the results indicate that the maximum combined displacement response of the original building and Addition exceed the provided separation joint and impact between buildings is likely. Since the roof and floors align vertically the damage due to pounding is likely to be limited/localized and unlikely to compromise structural integrity.

5.0 CODE ASSESSMENT

The City of Redondo Beach does not currently have a mandatory seismic retrofit ordinance for buildings with reinforced masonry walls with stiff/rigid diaphragm. Thus, mandatory seismic upgrade would only be triggered for change of use or occupancy, or significant structural alteration/addition.

Retrofit to mitigate identified deficiencies would be strictly voluntary.

6.0 RECOMMENDATIONS

Recommended mitigation measures have been developed to improve the seismic performance of the original building and 1979 Addition. The proposed strengthening is preliminary and is intended to identify representative scope for planning, coordination, and rough order of magnitude estimate of cost.

6.1 Recommended Strengthening – Original Building

The recommended strengthening consists of the following:

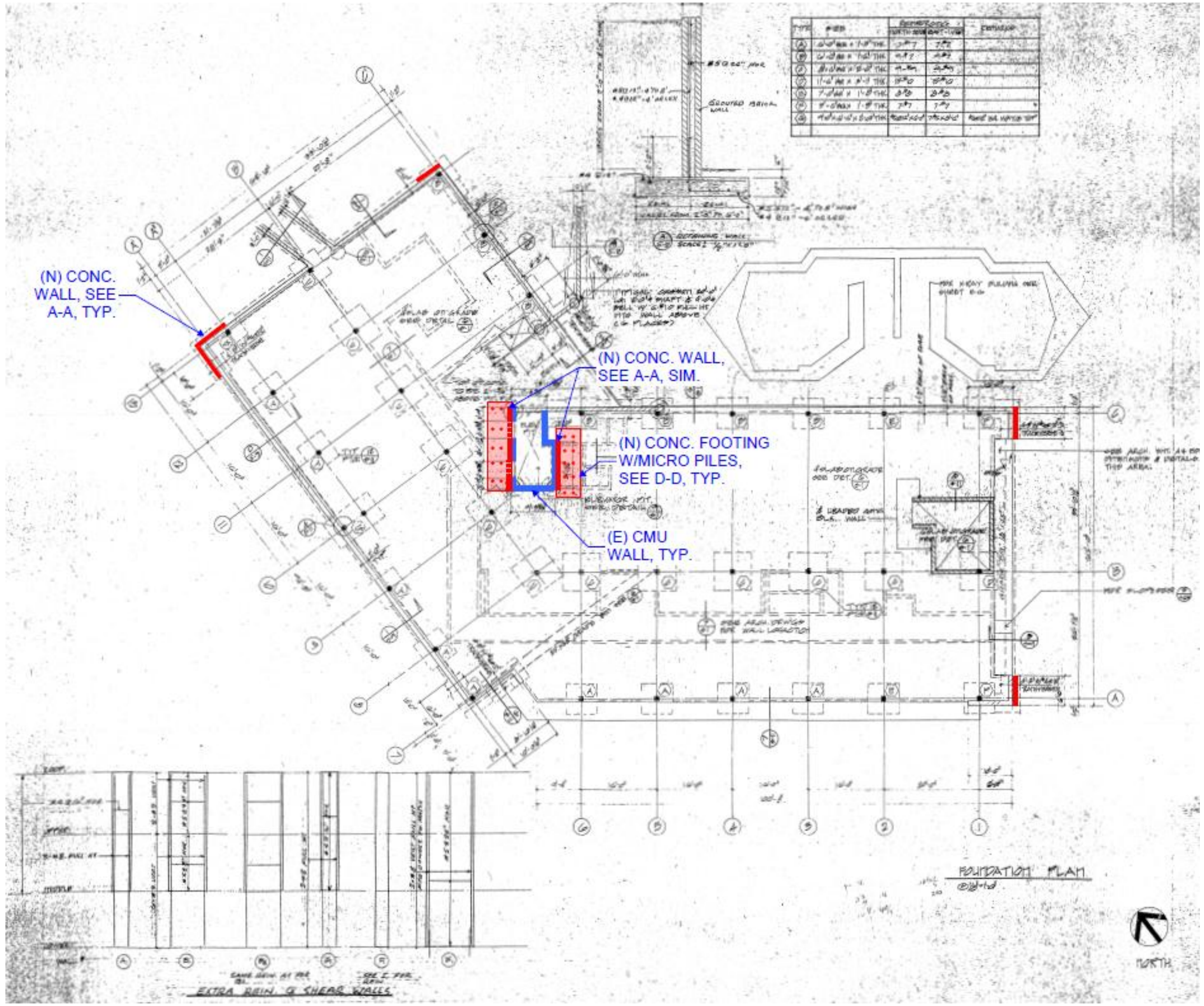
- Strengthen select existing CMU walls at perimeter and around elevator core with shotcrete from foundation to roof. At perimeter, shotcrete to be applied to exterior face of existing wall. At elevator core, shotcrete to be applied to outside face of existing wall (not in shaft). Since the existing roof and floors are constructed with pre-stressed pre-cast spancrete planks, planks adjacent to the elevator core need to be removed for the construction of the new shotcrete walls (allowing the placement of continuous vertical reinforcement). The removed planks will be replaced with metal deck and concrete fill supported on new steel beams spanning to existing CMU walls and pre-cast concrete beams.
- Strengthen existing footings at new shotcrete walls. Foundation strengthening at elevator core to include micropiles.
- Strengthen roof and floor diaphragms by removing existing concrete topping slab at select locations and replacing with new reinforced concrete slab.

6.2 Recommended Strengthening – 1979 Addition

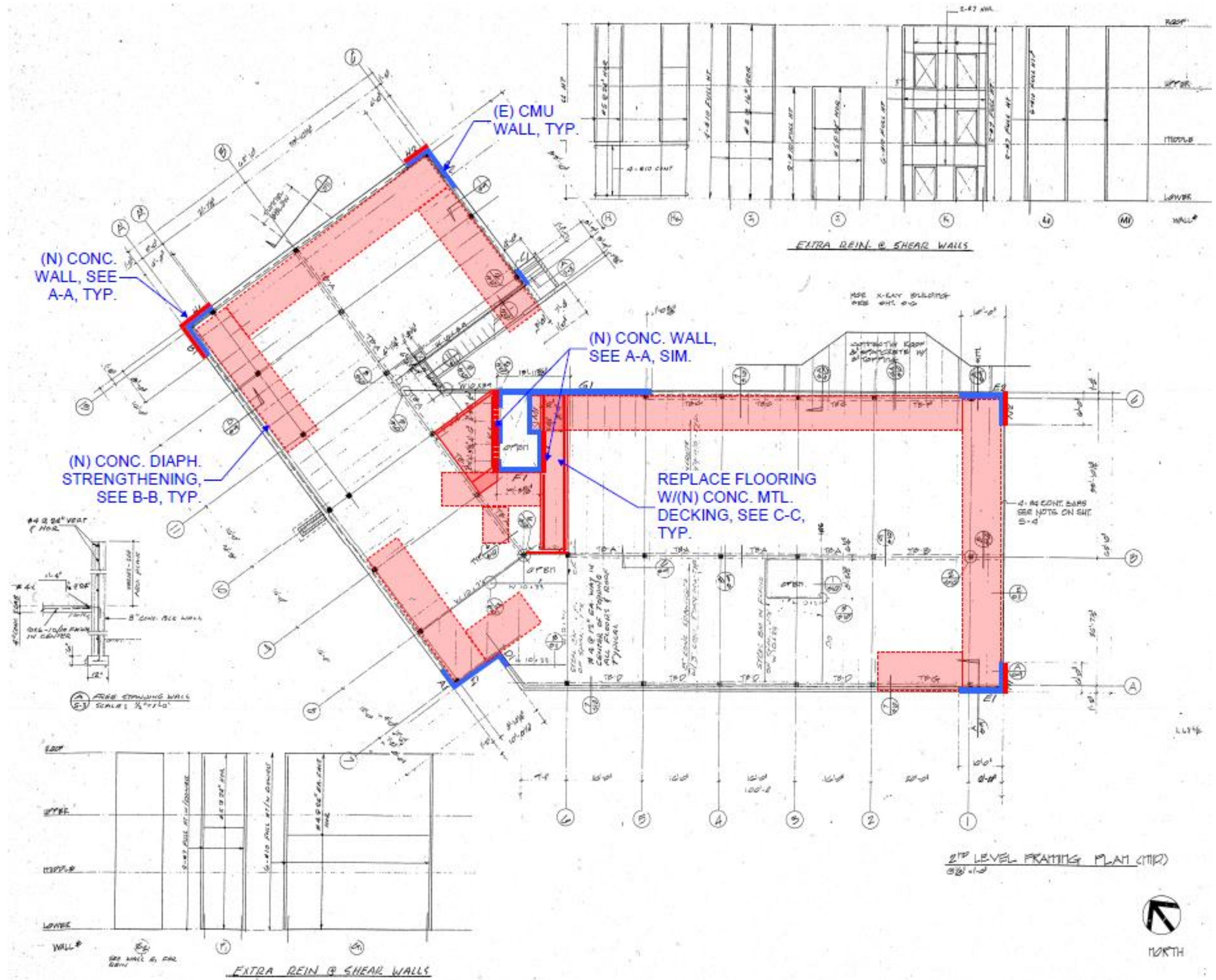
The recommended strengthening consists of the following:

- Strengthen existing interior CMU wall with shotcrete from foundation to underside of 3rd floor.
- Strengthen existing footing at new shotcrete wall.
- Strengthen existing footings and grade beams at select locations.
- Strengthen existing roof and floor diaphragm to CMU wall connection with additional drilled and epoxied dowels.
- Strengthen existing steel beam to beam connections at roof level by welding steel shear tab plate to beam web.

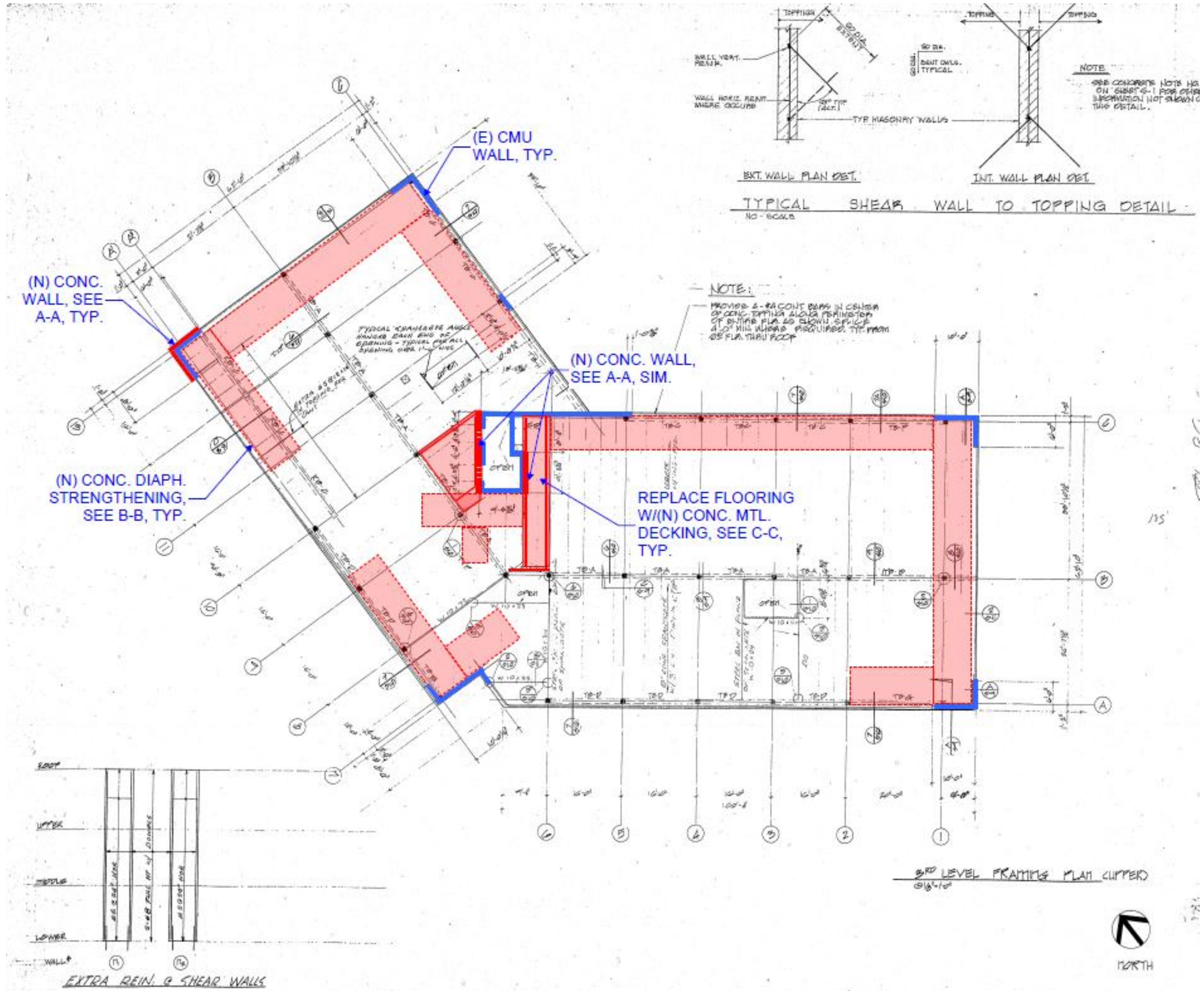
APPENDIX A – SEISMIC STRENGTHENING SKETCHES FOR ORIGINAL BUILDING



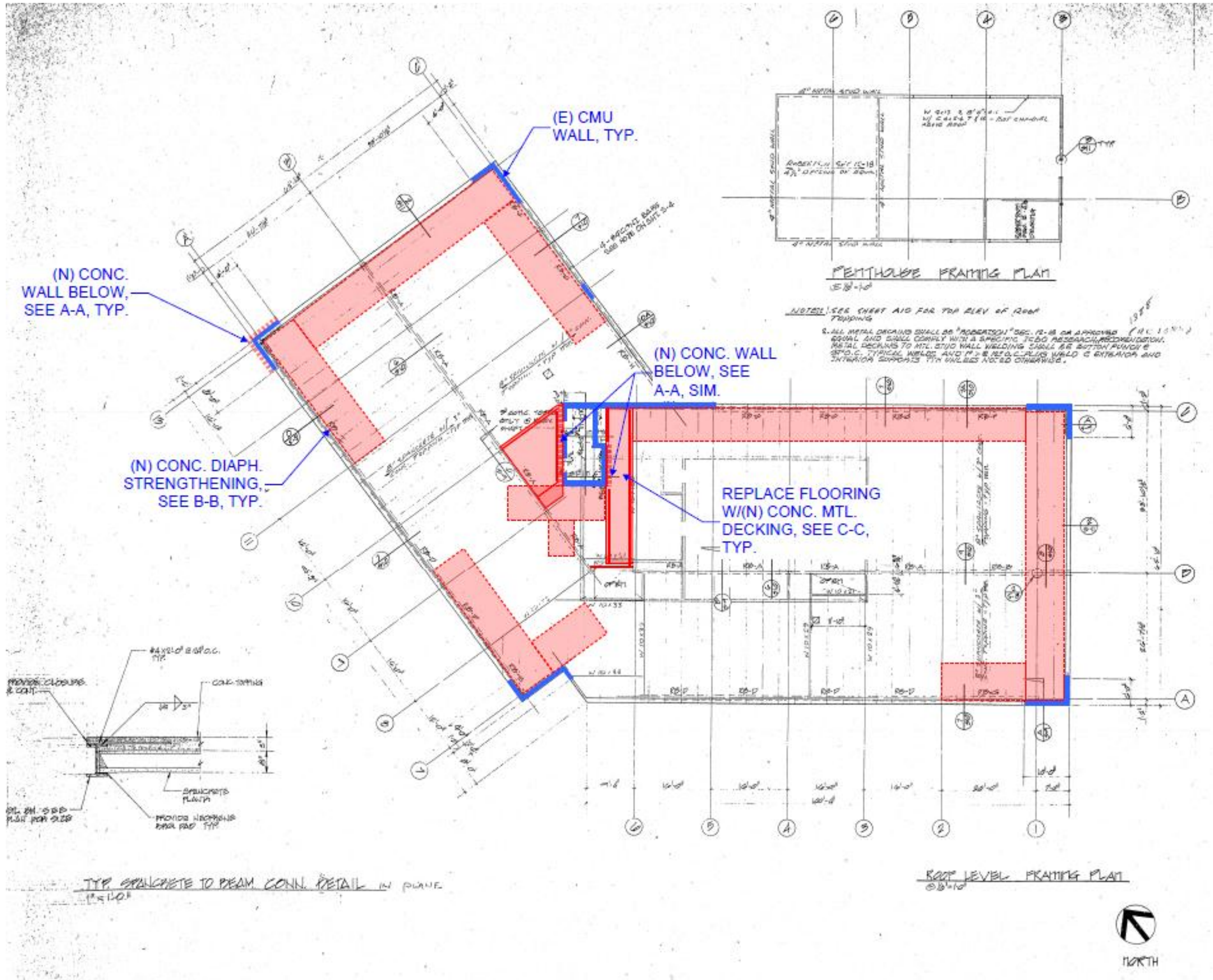
Foundation Plan



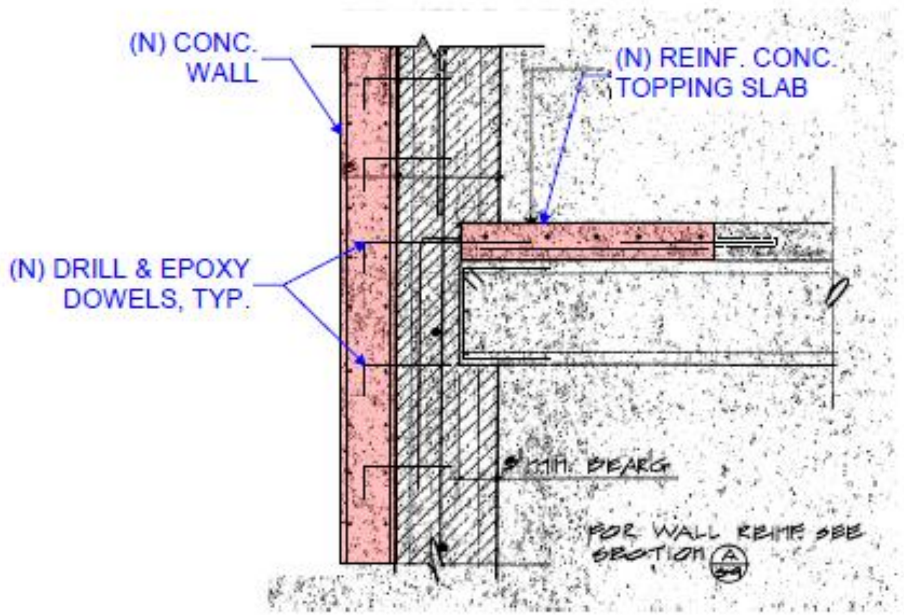
2nd Level Framing Plan



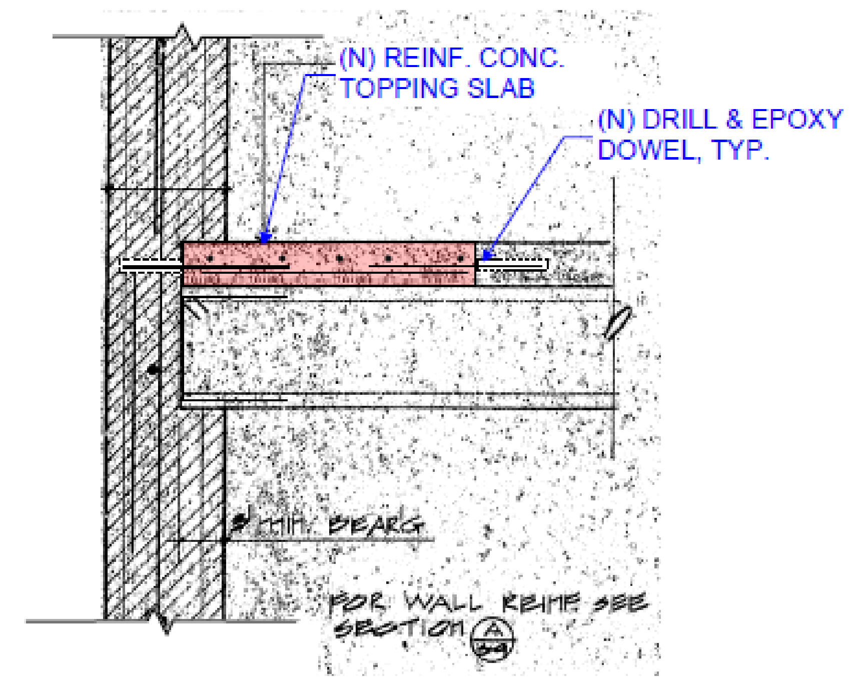
3rd Level Framing Plan



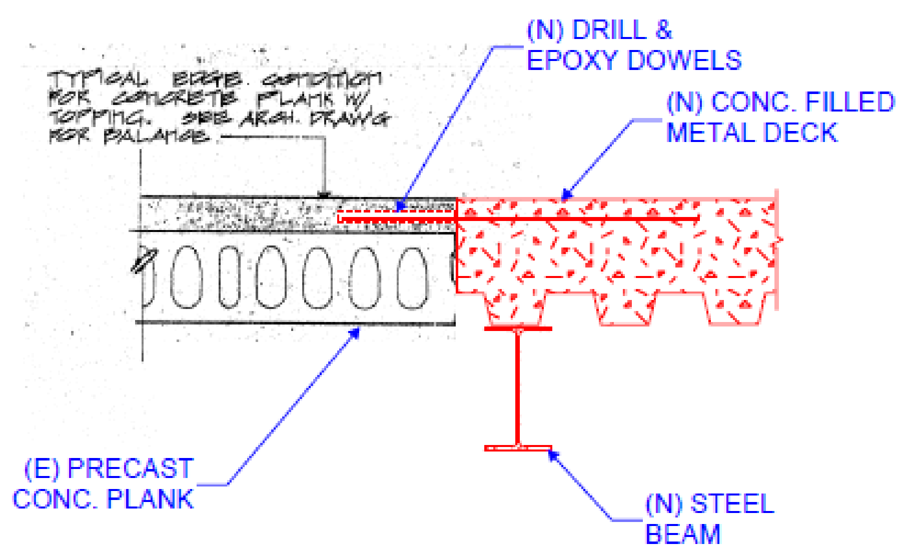
Roof Level Framing Plan



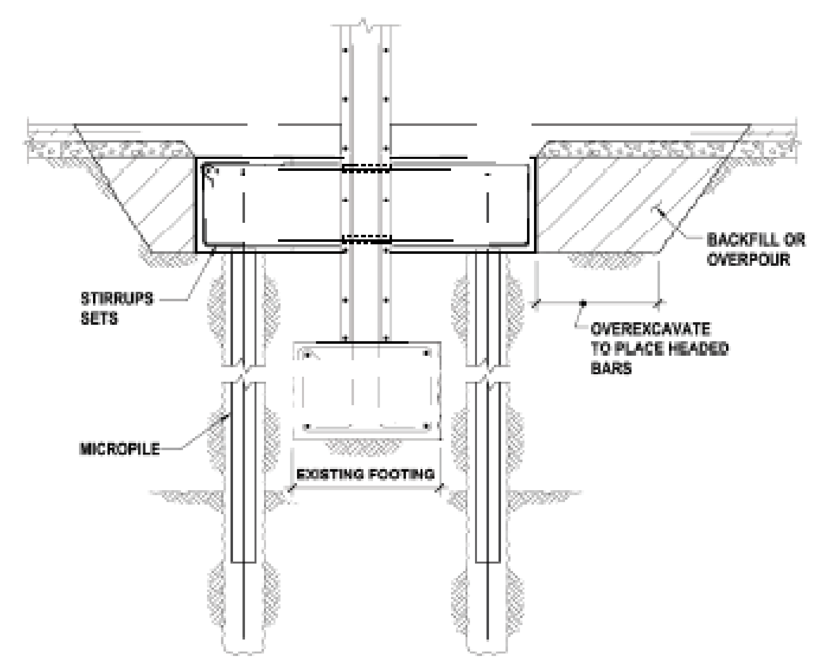
Section A-A (N) Shotcrete Wall



Section B-B (N) Concrete Topping Slab

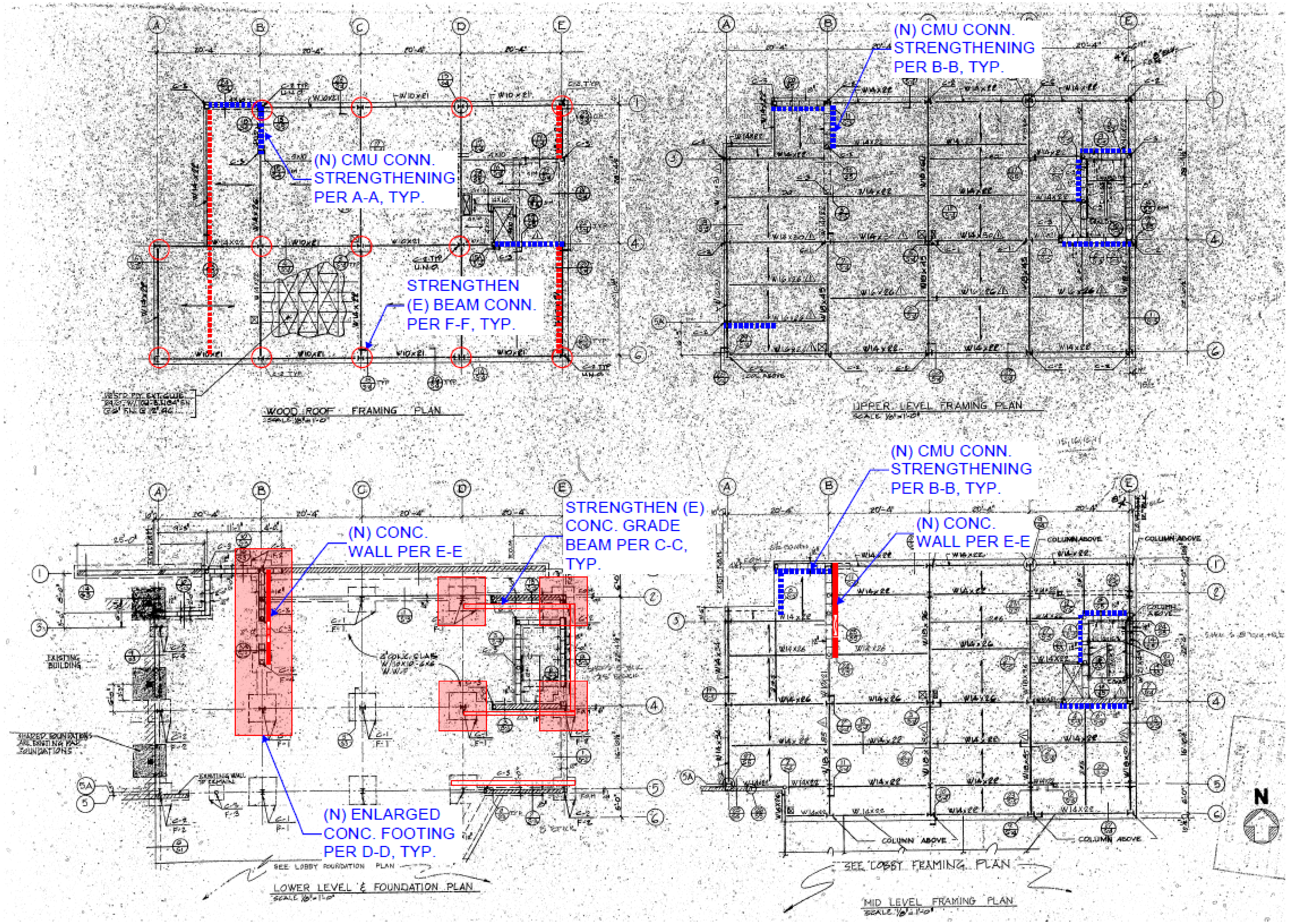


Section C-C (N) Metal Deck with Concrete Fill

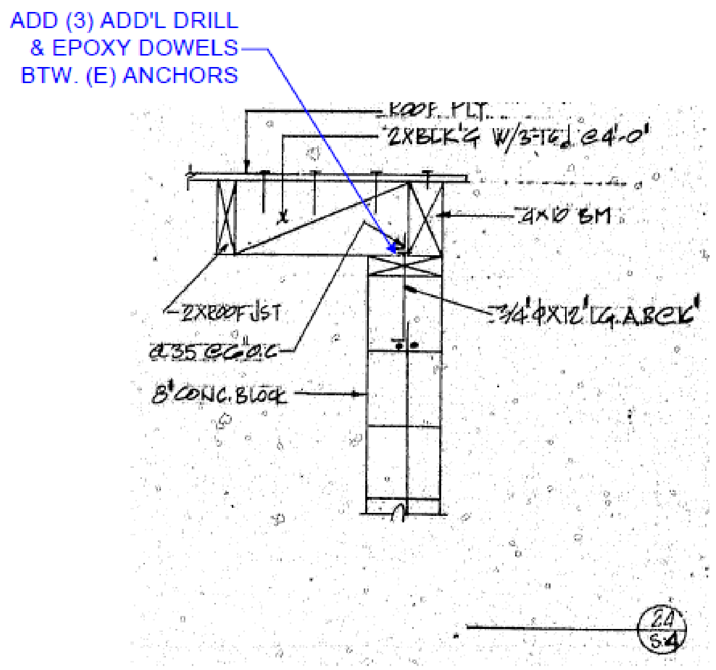


Section D-D (N) Micropile Foundation

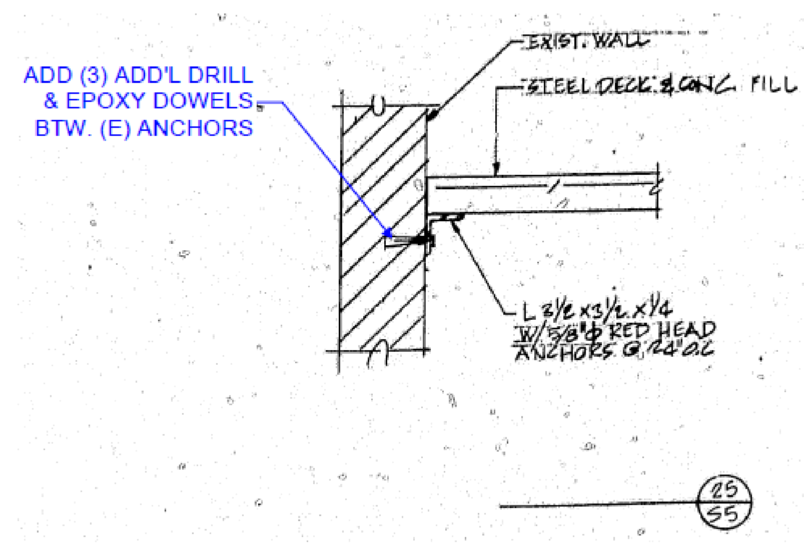
APPENDIX B – SEISMIC STRENGTHENING SKETCHES FOR 1979 ADDITION



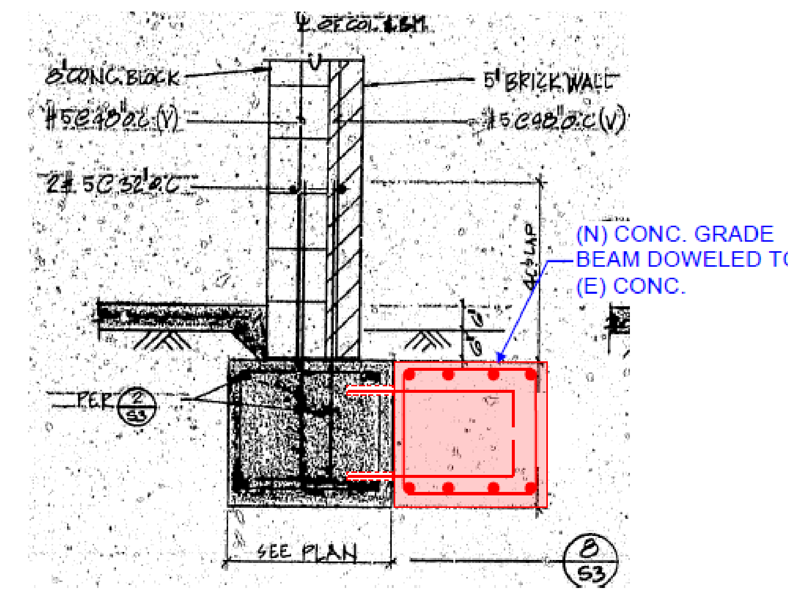
Framing Plans



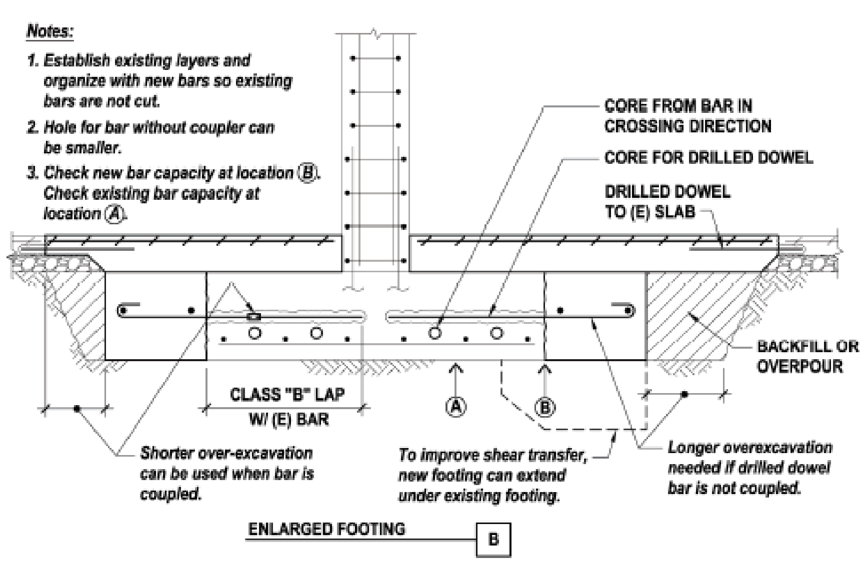
Section A-A Roof Diaphragm to Wall Connection Strengthening



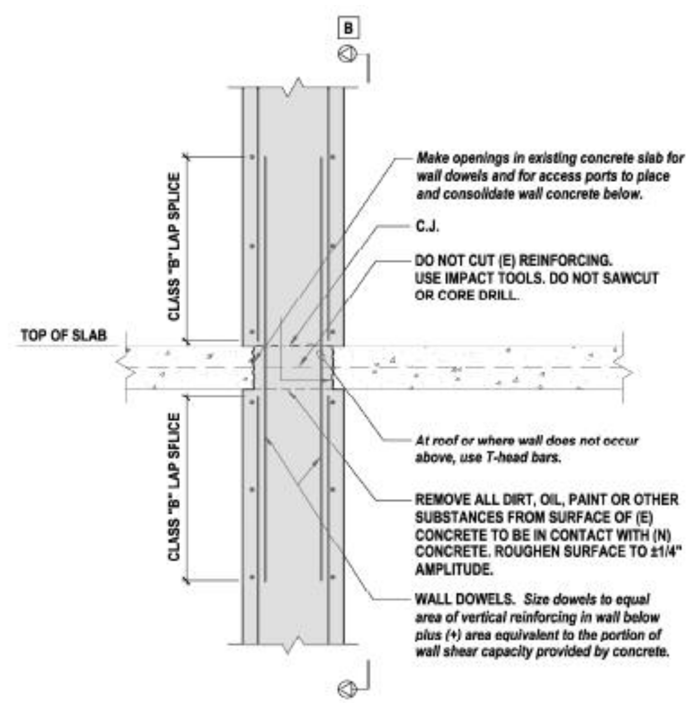
Section B-B Floor Diaphragm to Wall Connection Strengthening



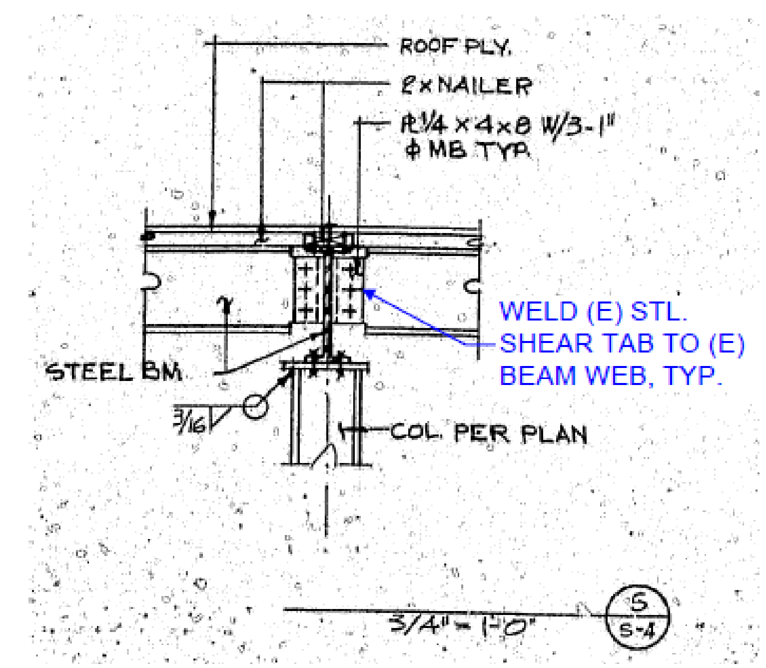
Section C-C Footing Strengthening



Section D-D Footing Strengthening



Section E-E (N) Shotcrete Wall at Floor Slab



Section F-F Beam-to-Beam Connection Strengthening