COFFMAN ENGINEERS

SEISMIC RETROFIT STUDY

Santa Barbara Police Station

Santa Barbara, CA

PREPARED FOR

Santa Barbara Department of Public Works
Santa Barbara, California

Project No. 10303 **September, 2010**

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I – EXECUTIVE SUMMARY

This report has been prepared in accordance with an agreement between Coffman Engineers, Inc. and Santa Barbara Department of Public Works. The report pertains only to the Santa Barbara Police Station located at 215 East Figueroa Street, Santa Barbara, California.

The Santa Barbara Police Station building was designed and constructed around 1959. It is located within one mile of the North Channel Slope Fault and two miles from the Arroyo Parida Fault. The potential ground motion (seismic hazard) for this site is significant and the proximity of known active faults is very close. The site observations and our review of the design drawings and analysis indicate that the existing building has deficiencies that could result in poor seismic performance during a design earthquake event.

Performance Based Rehabilitation methodology following ASCE41-06 was used as a guideline for the evaluation and retrofit of the structure. As a first step in the evaluation of the building, the Demand Capacity Ratios (DCRs) of individual wall elements under linear elastic dynamic loads (MCE & 2/3MCE response spectra) was checked by using an ETABS 3D computer model. The final results show that many wall piers and spandrels are flagged with shear / flexural DCRs greater than 1. Numerous existing concrete elements (piers and spandrels) have DCRs greater than 2. The basement 10” wall piers along Grid 6 (East Elevation) and spandrels along Grid-F (interior 3-story walls) are severely overstressed in shear and flexure at the 2/3MCE seismic hazard level (475 year reoccurrence).

A non-linear static analysis (NSP) was performed to better characterize the behavior of the structure and to achieve selected seismic performance objectives for specific seismic hazards. Nonlinear PERFORM 3D models were created in compliance with ASCE41-06 standards. The nonlinear pushover analytical results, from the existing building computer model, show that the basement wall piers along Grids 1, 2 and 6 (Y-direction, N/S orientation) exhibit shear failure at the *Life Safety* (LS) performance level at 2/3 MCE (475 year) before achieving the target roof displacement. Also, the existing building does not develop enough base shear along Y-direction when the shear failure occurs. The pushover curve in the Y-direction shows significant strength and stiffness degradation before a reasonable base shear is developed. Along X-direction (E/W orientation) Grid F three basement 10’’ spandrels fail in shear (at LS performance) before the target displacement.

Implementation of a cost-effective retrofit scheme was based on extensive and iterative nonlinear pushover analysis. We proposed an innovative multifaceted retrofit scheme that includes shotcrete walls (pneumatically applied concrete) and FRP (Fiber Reinforced Polymers) laminates to strengthen the structure and provide increased ductility. The final nonlinear pushover analytical result shows that the retrofitted building would achieve the LS performance objective and come close to the *Immediate Occupancy* (IO) performance objective at 2/3 MCE event.

In addition to the proposed retrofit scheme, a number of issues need to be addressed to provide satisfactory seismic performance including; 1. Out-of-plane anchorage of third floor walls to roof diaphragm. 2. Strengthening concrete columns for deformation compatibility and ductility. 3. Diaphragm strengthening for load path to new shear walls. 4. Heavy suspended plaster ceiling removal.

Overall, the seismic rehabilitation measures required, when considered alone, are straightforward, reasonable and relatively cost efficient. However, when handicap accessibility, asbestos removal, replacement of antiqued MEP systems and architectural finishes, and temporary relocation of essential police services are considered the cost and complexity of this proposed rehabilitation increases dramatically. Nonstructural work is likely to make up the majority of work required to complete the proposed seismic retrofit.

Alternative Scheme:

One alternate option was investigated during this study. The rear (northerly) two-story portion of the existing police station could be torn down and replaced by a modern structure separated by a seismic separation joint. The remaining (southerly) three-story structure would require a significant seismic retrofit to meet the *Life Safety* performance criteria of ASCE41 for the 2/3MCE (475 year) seismic hazard. Additional shear walls would be required at the Basement Level on the east and west elevation. On the east elevation the existing mechanical room has three openings where at least one will need to be in filled. The north elevation would require strengthening of the spandrel beams. The roof diaphragm will need strengthening along with remediation of the out-of-plane anchorage of roof framing to the existing concrete walls.

II – INTRODUCTION AND SCOPE

As-Built Existing Building Structural Description

The Santa Barbara Police Station building located at 215 East Figueroa Street was designed and constructed around 1959. The building footprint is 89 feet by 144 feet in the largest dimensions. There are three stories at the southern elevation and two stories at the northern elevation. The total floor area of the building is approximately 27,000 square feet. The 1st and 2nd floors are a concrete pan-joist system including a 4½ inch thick slab and 18½ inch deep joists. The high roof over the southern street entry consists of steel and wood frame with a tile roof. From the south street entrance the building has one story partially below grade (Basement Level). The west elevation also has the Basement Level partially below grade. The east elevation starts at the south partially below grade and daylights out completely moving north to the garage openings.

The structure is a concrete structure with interior and exterior perforated shear walls. The thickness of walls at Basement Level is 10 inches, and 8 inches at the first floor and above. On the first floor, there are several discontinuous shear walls (interior) supported by the concrete girders and concrete columns. The columns are founded on conventional spread, concrete footings. The typical rectangular strip footings with various widths were designed for all concrete shear walls. The lateral loads (wind and seismic forces) are distributed horizontally through the wood/steel framed high roof and the concrete pan joist floors (including low roof on the northerly portion of the building) to the perimeter concrete perforated walls. The shear walls were designed before modern detailing and analysis techniques were developed for buildings located in high seismic locations, and not in compliance with the modern building codes.

Site Visit Observations

The existing building is in good condition considering the age of the original structure. There were no apparent signs of significant deterioration or distress. Some minor cracks were observed in the low roof parapet at the large notch in the roof diaphragm directly above the west entrance door (Second Level). On the east elevation there are two additional window openings not shown on the original drawings from 1959. On the west elevation, First Level, one narrow wall opening has been closed (northern end of east elevation, old holding cell area) and another narrow opening has been enlarged to accommodate a new door. There is no evidence of subsidence or differential settlement.

Destructive Testing

Destructive testing was performed under the guidelines of ASCE41. Limited concrete cores and reinforcing steel samples were extracted in conformance with ASCE4. Material sampling locations and quantities were selected to reduce disruption at the functioning police station. Eight concrete shear wall core samples were taken at random locations on the exterior walls. Additionally, two beam cores and two slab cores samples were extracted. Compressive strength of existing concrete shear wall samples ranged from 4,815 psi to 2,196 psi. The coefficient of variation is 26% for the tests. The mean minus one standard deviation is 2,523 psi. The 1959 design documents indicate the concrete strength as 2,500 psi for all elements except for the slab-on-grade. The concrete design values used in this study are appropriate for Basic Safety Objective (BSO) of *Life Safety* Building Performance Level (LS) at BSE-1. The large coefficient of variation found would not be appropriate for the Enhanced Rehabilitation Objectives of *Immediate Occupancy* (IO) at BSE-1. Additional testing samples could be performed to lower the coefficient of variation. However, the cost and disruption is not warranted based on the findings and recommendations of this study.

Rebar samples have virtually identical yield values (51.3 ksi and 51.2 ksi). A value of 50 ksi was used for rebar properties. The rebar samples are consistent with steel reinforcement of the 1950s.

Site Seismic Hazards

The Santa Barbara Police Station is located within one mile of the North Channel Slope Fault and two miles from the Arroyo Parida Fault. The North Channel Slope Fault could generate a 7.4 magnitude earthquake that could result in 0.747g of ground acceleration at the site (MMI = XI). The USGS 475 year seismic hazard (2/3 MCE) has SDS = 1.364g and SD1 = 0.782g and the USGS 2,475 (MCE) year seismic hazard has SDS = 2.047g and SD1 = 1.173g. The design earthquake for new buildings is the 475 year hazard (2/3 MCE) and corresponds to Seismic Design Category F (seismic hazards range from A to F) when you consider a police station is an essential facility (Occupancy Class IV). The potential ground motion (seismic hazard) for this site is significant and the proximity of known active faults is very close. (See Appendix A for the seismic hazard analysis by using EQFAULT Version 2.20).

The only major historical earthquake that caused moderate ground shaking at the SB Police Station site was a 5.5 magnitude earthquake on August 13, 1978 where the epicenter was south of the city in the Santa Barbara Channel (See Appendix A). It appears that the 1978 ground shaking did not cause any significant damage to the SB Police Station. The ground motion from the August 13, 1978 earthquake was likely very small (approximately 0.15g or less) when compared to the potential ground motion due to a rupture of the North Channel Slope Fault or Arroyo Parida Fault (up to 0.747g).

Existing Building Deficiencies

FEMA 454 (see page 7-42, Figure 7-11A) recognizes that concrete buildings with perforated shear walls (window and door openings in a concrete wall) can be unstable when subjected to large ground motion unless properly detailed. Reinforcement detailing and shear wall layout factor greatly into the seismic performance of perforated shear wall buildings. Unfortunately, the SB Police Station (circa 1959) was designed before modern detailing and analysis techniques were developed for buildings located in high seismic locations. Our review of the design drawings and analysis indicate that the existing building has the following deficiencies:

1) Out-of-plane anchorage of third floor (2nd Floor as labeled by original drawings) walls to roof diaphragm. This deficiency could result in partial roof collapse. An adequate connection needs to be added between the steel roof trusses and the exterior concrete wall. Also, the existing straight sheathed roof diaphragm needs to be strengthened by adding new plywood.
2) Discontinuous shear walls on second floor in the east west direction (1st Floor per plans) that do not continue to Basement level. Dynamic behavior of this type of system is undesirable without special detailing considerations which are absent in the original configuration. Adding new continuous walls to the basement level is impractical and would be a major disruption in the current building programming. Strengthening and improving the ductility of the existing concrete columns below the discontinuous shear walls will improve seismic performance and mitigate the potential hazard of column failure.
3) Spacing and minimum reinforcing ratios for vertical and horizontal reinforcement (rebar) in the existing shear walls exceeds current code requirements. Modern code requirements, in high seismic regions, dictate maximum spacing and minimum reinforcement ratios for concrete shear walls to provide a minimum expected ductility (deformation without brittle failure) needed to control damage and provide stability during strong ground motion. The concrete shear wall reinforcing requirements of modern codes improves energy dissipation and reduces crack widths in shear walls when subjected to a design earthquake. Based on the nonlinear analysis most walls have sufficient strength to perform well under strong ground motion. Localized strengthening will be added as needed to improve overall seismic performance and to achieve the seismic performance objective.
4) Existing concrete column detailing does not provide the required ductility (ability to deform without brittle failure) to support gravity beams and discontinuous shear walls. Building sway under earthquake motion requires that the columns have tightly spaced transverse ties (confinement) to preclude buckling of longitudinal (vertical) reinforcing. The existing detailing of the concrete columns could result in brittle shear or buckling

failure. Partial collapse could occur. Wrapping the existing concrete columns with FRP (Fiber Reinforced Polymers) is an effective method to improve ductility and strength.

5) Insufficient lateral resistance along the East Elevation (driveway running north south where mechanical room door, stair well and motorcycle garage are located). Many openings are located in the East Elevation running in the long direction of the building. The nonlinear analysis indicates that a "story mechanism" (failure mode of plastic hinges) can form along the Basement Level in the north south direction. This mechanism then transfers lateral loading to the West Elevation and another "story mechanism" forms along the West Elevation. Additional stiffness and strength is required along the East and West Elevations at the Basement Level.
6) Very high flexural and shear demands develop across window and door openings in the spandrel beams. In the east west direction (short direction) the spandrels (header) beams transfer forces between the solid piers (vertical wall elements) when the building deforms due to strong ground motion. Spandrel beams need additional strength to transfer wall forces.
7) Insufficient rebar lap splices can cause tension failures in perforated shear walls. However, the detailing and anticipated locations of lap splices in shear walls do not appear to be a significant hazard. Some wall damage and strength/stiffness degradation is anticipated from the insufficient lap splices. The nonlinear backbone curves of ASCE41 were developed using shear wall segments that had antiquated reinforcement detailing. Recent testing of shear wall piers and spandrels indicate that the backbone curves of ASCE41 are conservative. Therefore, we believe our nonlinear analysis captures the effects of insufficient lap splices without being overly conservative or un-conservative.
8) Large reentrant corner (notch in roof diaphragm) midway down the West Elevation at side entrance at 2^{nd} Floor. This notch causes a discontinuity in the roof diaphragm. It is expected that the notch will cause significant damage in the roof diaphragm due to stress concentrations. Also, the notch interrupts the flow of inertial forces through the roof diaphragm to the adjacent shear walls. Closing the notch by filling in the roof opening with a reinforced concrete slab will improve seismic performance and reduce earthquake damage.
9) There are many original hard ceilings throughout the police station consisting of cement or gypsum plaster suspended by gravity wires. The ceiling weighs approximately 10 to 14 pounds per square foot. There are no earthquake sway bracing or compression struts as required for new construction. Corrosion of the gravity wires along with inadequate bracing could result in a significant falling hazard during a major earthquake. The heavy ceilings could block egress and cause injury to occupants. Original plaster ceilings should be properly braced or removed.

Note: Other nonstructural seismic hazards may exist. This study specifically excludes nonstructural seismic hazards. A comprehensive investigation of nonstructural hazards is required under ASCE31 and ASCE41 along with structural evaluation. In order to provide a complete seismic hazard study a nonstructural hazard assessment is required. The absence of properly anchored architectural elements, mechanical equipment, furniture, computers and other components can cause significant falling hazards that pose a risk of injury and operational disruption. Falling hazards can block egress and result in hazardous material spills.

Discussion of Retrofit Performance Objective

The anticipated seismic performance of the SB Police Station under the Design Earthquake (BSE-1, 2/3 MCE, 475 year reoccurrence) is poor. In order to meet the *Life Safety* seismic performance requirements of ASCE41 for the Design Earthquake significant strengthening is required. The proposed retrofit scheme exceeds the *Life Safety* performance level approaching the *Immediate Occupancy* requirement.

In our opinion, a retrofit scheme that would achieve the *Immediate Occupancy* seismic performance is almost impossible and impractical. The *Immediate Occupancy* level of seismic performance requires very strict limits on damage. Based on the 1959 concrete reinforcing detailing standards reducing crack widths to 1/8 of an inch (see ASCE41 Table C1-3) is practically impossible without considerable cost and loss of usable space.

New building code requirements for police stations require a *Life Safety* seismic performance level. Additionally, police stations are required to be designed for pseudo earthquake forces 50% higher than a typical private building (I = 1.5) because they are used as essential facilities. The increase in design forces "enhance" the seismic performance of the building by reducing the ductility demands (less deformation results in less damage). The seismic performance for a police station, fire station and hospital could be categorized as "enhanced *Life Safety*". The term *Immediate Occupancy* is not required or even discussed in new building design codes for emergency service buildings. The *Immediate Occupancy* seismic performance objective of ASCE41 appears to be appropriate and rational for an essential police facility. The reality is that ASCE41 is the only national standard to address seismic performance above *Life Safety* but only for existing structures. New construction building codes may adopt the enhanced seismic performance objectives of ASCE41 in the near future. The cost implications of enhanced seismic performance objectives, such as *Immediate Occupancy,* appear to be a roadblock to implementation in new building design and codes.

Current seismic detailing practices improve seismic performance and reduce the extent of earthquake damage. Codes are regularly updated to reflect new research and "lessons learned" from recent earthquake damage worldwide. A circa 1959 building is more likely to experience more earthquake damage than a new building because modern detailing reduces the likelihood of earthquake damage. However, the epicenter distance, local geology, building orientation, building configuration, structural system and quality of construction all effect how new or older buildings perform in a major earthquake. Ironically, sometimes an older building seismically performs better than an adjacent modern structure. Typically modern structures fair much better after major earthquakes due to improvements in design and detailing.

The Santa Barbara Police Station is categorized as a non-ductile perforated concrete shear wall structure. Thousands of buildings of this type and of similar age exist statewide. There is a reasonable concern that buildings of this age and type could be a significant seismic hazard. Currently, state and local governments do not require a mandatory retrofit for this type and age of structure. However, a change in occupancy or a major renovation would likely trigger an ASCE41 seismic retrofit under the 2007 California Building Code.

The proposed seismic retrofit scheme will provide *Life Safety* to occupants while reducing earthquake damage. However, earthquake damage to the retrofitted structure is anticipated due to the age, original design methodologies and existing concrete reinforcing detailing of the original structure. Cracks in the perforated shear walls will likely occur under the anticipated strong ground motion. The retrofitted building could be damaged where repair is not economical or practical. Replacement could be the only option after a major earthquake close to the building site.

III – METHODOLOGY AND RESULTS

Seismic Retrofit & Design Code:

ASCE 41-06: Seismic Rehabilitation of Existing Buildings

Linear Dynamic Procedure (LDP Analysis) – ETABS 3D Models

-See Appendix E for the detail analysis

Seismic Hazard: MCE and 2/3MCE response spectra (See Appendix B)

Modeling Assumptions:

Gravity Loading (see Appendix B for the design load criteria)

Effective lateral stiffness of exiting walls:

- 50% E_cI_g for Flexural rigidity;
- 40% E_cA_w for Shear rigidity
- (fc' = 2.5 ksi; fy = 50 ksi)

MODEL1: Existing Building with Pinned Base (Rigid Base)

Assume all walls and columns are pinned at the base

Building Periods:

T_1 = 0.10 sec along Y-direction (longitudinal direction)

T_2 = 0.08 sec along X-direction (short direction)

Building Base Shear for 2/3MCE:

4325 kips along X-direction

5020 kips along Y-direction

MODEL2: Existing Building with Flexible-Base (Soil- Structure Interaction)

All walls and columns are supported by soil spring derived from ASCE41-06.

Building Periods:

T_1 = 0.17 sec along Y-direction (longitudinal direction)

T_2 = 0.16 sec along X-direction (short direction)

Building base shear for 2/3MCE:

5883 kips along X-direction (Note: Higher base shear than pinned base)

5889 kips along Y-direction

Summary of LDP Analytical Results:

Based on ASCE41, the DCR (Demand Capacity Ratio) with appropriate m-factor were calculated for all existing wall piers and spandrels at different performance and earthquake hazard levels. Two cases of 2/3MCE at LS (*Life Safety*) and MCE at CP (*Collapse Prevention*) were included. The final results show that many wall piers and spandrels are flagged with shear / flexural DCRs (demand capacity ratios) greater than 1. Numerous elements have DCRs greater than 2. The basement 10" wall piers along Grid 6 (East Elevation) and spandrels along Grid-F (interior 3-story walls) are severely overstressed in shear and flexure at the 2/3MCE seismic hazard level (475 year reoccurrence). The LDP model was used to understand the dynamic behavior and act as a benchmark for elevating the results of the Nonlinear Static Procedure of ASCE41.

Nonlinear Static Procedure (NSP Analysis / Push Over Analysis) – PERFORM 3D

-See Appendix F for the detail analysis

Modeling Assumptions:

Gravity Loading:

Based on ETABS model, all gravity loads are applied as line loads to the PERFORM model. The self weight of columns and walls are automatically accounted by program. Use the following load combinations for gravity loads:
$Q_G = 1.1(DL + ¼ LL)$, and $Q_G = 0.9$ DL

Boundary Conditions:

All columns and walls are pinned on the base. All gravity beams and columns are modeled as linear elements, and concrete walls are modeled as inelastic elements.

Material Properties:

Use the stress-strain curves of reinforcing bar and concrete to define the inelastic properties of rebar and concrete fibers in PERFORM model (trilinear / bilinear), see Appendix F. The initial lateral stiffness of concrete wall was defined as follows:
50% $E_c = 0.5 \times 57000 \sqrt{f_c'}$ for concrete flexure;
$G_c = 0.4 \times E_c / [2(1+\nu)]$ and $\nu = 0.2$ for concrete shear
($f_c' = 2.5$ ksi for concrete; $f_y = 50$ ksi and $E_s = 29000$ksi for rebars)

Fiber Element Modeling:

Concrete wall is modeled as an inelastic wall element by using Fiber Model, including

i). Inelastic concrete fiber (4, 3, and 2 fibers are used in an element depending on the different length/ height of wall piers/spandrels);

ii). Inelastic steel fiber (4, 3, and 2 fibers are used in an element depending on the different length/ height of wall piers/spandrels);

iii). Inelastic shear material component (Based on Table 6-19 of ASCE41-06, and shear stress capacity v_n based on the shear reinforcing area of walls)

Mass Assignments:

Nodes on each floor are slaved as a rigid diaphragm, and apply the following masses at mass center (from ETABS, unit: kip-in).

Diaphragm	MassX	MassY	MMI	XM	YM	ZM
ROOF	0.9448	0.9448	195212	538.118	-1471.5	390
2NDFLR	6.5607	6.5607	2893717	555.887	-889.258	270
1STFLR	7.6347	7.6347	2895851	554.393	-886.818	120

Pushover Profiles:

The vertical distribution of lateral pushover forces is proportional to the fundamental mode shape (1^{st} Mode of Free Vibration) in the direction under consideration.

Target Displacement:

Target displacement calculation is based on ASCE 41-06 and coefficients input under “user defined” in PERFORM 3D. Manually input all coefficients C_0, C_1, C_2, C_3 and S_a (computed from hand calculations based on linear and nonlinear models).

Nonlinear Acceptance Criteria:

The limits for wall rotation and wall shear strain under the different performance levels are defined as follows (based on ASCE 41-06):

Performance Level	**Wall Rotation**	**Wall Shear Strain**
Immediate Occupancy (IO)	0.002	0.40%
Life Safety (LS)	0.004	0.60%
Collapse Prevention (CP)	0.006	0.75%

Summary of Pushover Analytical Results:

1). Pushover Analysis for the Existing Building:

Target Displacement drift ratio: δ_t = 0.07% along X-direction
δ_t = 0.17% along Y-direction

The pushover curves of the existing building show that the basement wall piers along Grids 1, 2 and 6 exhibit shear failure at the *Life Safety* performance level at 2/3 MCE (475 year) before achieving the target roof displacement. Also, the existing building does not develop enough base shear along Y-direction when the shear failure occurs. The pushover curve in the Y-direction shows significant strength and stiffness degradation before a reasonable base shear is developed.

Along X-direction Grid F the three basement 10'' spandrels shear fail (LS) before target displacement.

2). Pushover analysis for the retrofitted building:

Proposed Retrofit Scheme: (see schematic retrofit drawings)

- Infill two openings and add 8" shotcrete wall to existing 10"wall along Grid-6 and Grid-1
- Use FRP (fiber reinforced polymers) shear/flexural strengthening of concrete spandrels to increase the shear capacity
- Confine existing concrete columns with FRP to improve ductility and deformation compatibility
- Add out-of-plane anchorage to high roof diaphragm and strengthening wood diaphragm
- Infill notch in concrete diaphragm on low roof (2nd Floor) with reinforced concrete slab

Target Displacement drift ratio: δ_t = 0.06% along X-direction
δ_t = 0.09% along Y-direction

Pushover curves show that the building was able to achieve *Immediate Occupancy* (IO) performance level before target displacement for shear, and achieve *Life Safety* (LS) level for flexure. However, the building would achieve IO performance level if numerous other locations had enhanced flexural strength.

IV - ADDITIONAL RETROFIT CONSIDERATIONS AND ACTIONS

In addition, the following deficiencies of the existing building were examined, and the corresponding retrofit actions are proposed (See Appendix I for Schematic Drawings).

1). Deformation Incompatibility and Ductility of Existing Concrete Columns:

Deficiencies:

- All gravity concrete columns are non-ductile and incompatible with the anticipated inelastic building lateral drift.
- Existing columns at Basement Level supporting discontinuous shear walls on First Level do not have sufficient ductility (transverse tie spacing and detailing) to resist overturning loads from shear walls above.

Retrofit Actions:

- ✓ FRP all gravity concrete columns to improve the ductility.

2) Load Path:

Deficiencies:

- Diaphragm and collector strength to new lateral elements (load path)
- Large reentrant corner (notch in roof diaphragm) midway down the West Elevation at side entrance at 2nd Floor.
- Out-of-plane anchorage of third floor walls to roof diaphragm.
- Foundation capacity at shotcrete walls

Retrofit Actions:

- ✓ Strengthen the diaphragm to provide an adequate load path to new lateral elements
- ✓ Closing the notch by filling in the roof opening with a reinforced concrete slab will improve seismic performance and reduce earthquake damage.
- ✓ Add steel member HSS to strengthen the anchorage
- ✓ Modify foundations for concentrated loading from new braced framed columns

3) Falling Hazards:

Deficiency:

- Heavy suspended gypsum plaster ceilings are located throughout the building. The existing suspension anchorage consists of gravity wires only. Hanger wires cannot resist compression loading and lateral loading from strong ground motion.

Retrofit Actions:

- ✓ Remove all existing suspended heavy gypsum plaster ceilings or retrofit ceilings with new gravity wires, compression struts and sway braces in compliance with current code.

Note: Nonstructural anchorage is specifically excluded from this study. The ceiling falling hazard was included in this study because of the potential severity of the hazard and the cost implications. A complete nonstructural hazard assessment should be conducted as a supplement to this study in conformance with ASCE41.

V – ESTIMATE RETROFIT COST ANALYSIS

A construction estimate was prepared by a professional construction estimator for the two proposed seismic retrofit schemes. The first scheme is for a complete seismic retrofit of the entire existing structure. The second scheme is a partial seismic retrofit of the southern three-story portion of the building where the back two-story structure is demolished and replaced by a new structure.

The estimates include only the work required to complete the seismic retrofit schemes and the associated collateral architectural, mechanical, plumbing and electrical work required. The estimate does not include the new structure proposed in the second scheme where the northern two-story portion of the existing building is demolished. Also, a demolition cost for the northern two-story structure is excluded from the second scheme estimate.

Scheme #1 – Complete Seismic Retrofit (with collateral architectural and MEP work)

Estimated Cost - $3,147,300 (see Appendix H for detailed estimate)

Scheme #2 – Partial Seismic Retrofit (three-story southern portion only with collateral architectural and MEP work)

Estimated Cost - $1,864,700 (see Appendix H for detailed estimate)

Exclusions:

1. ADA upgrades
2. Asbestos abatement other than ceilings as indicated on schematic plans
3. Hazardous waste surveys and remediation (mold, fuel, lead and others)
4. Mechanical, electrical and plumbing (MEP) system upgrades (only local MEP replacement due to associated retrofit actions)
5. Relocation of personnel and/or essential facilities including temporary services or structures

VI – CONCLUSIONS AND RECOMMENDATIONS

The retrofit scenarios performed in this study has resulted in the following recommendations:

- Shotcrete new shear walls and infill openings at the existing Basement Level along Grids 1 and 6
- Add new 8" wall pier at the basement garage door of the north-east corner
- FRP laminate selected wall spandrels
- FRP wrap existing concrete columns to increase ductility and deformation compatibility
- FRP laminate existing floor diaphragm to provide an adequate load path to new shear walls
- Remove or retrofit all existing heavy suspended gypsum plaster ceilings

See Appendix I for proposed retrofit scheme drawings.

The provided schematic retrofit drawings shall be used for pricing purposes only and shall not be used for construction. Complete design and construction drawings are not part of the current scope of work. Future implementation of the proposed retrofit scheme requires additional detailed analysis and design to create a comprehensive and complete set of construction documents.

A complete ASCE41 nonstructural anchorage evaluation should be part of a comprehensive seismic rehabilitation project.

VII-Limitations and Exclusions

This report is based on a limited physical observation of the premises and the limited structural evaluation described above. Construction drawings were also available for the review. The onsite observation was made solely to determine the vertical and lateral load structural integrity of the building based on observed features, which were exposed and accessible. The specific items noted were those that were observable, and there may be additional defects that were not observed. The recommendations are based on the assumptions stated herein. Neither the observation, evaluation, nor the recommendations are intended to cover mechanical, electrical, geotechnical, environmental, pest control, or architectural features.

CEI has prepared this report for the exclusive use by the City of Santa Barbara. Services were performed by CEI in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty, expressed or implied, is made.

VIII - CONTACTS

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XI – REFERENCES

Reference Standards:

ASCE / SEI 31-03: *Seismic Evaluation of Existing Buildings*

ASCE/SEI 41-06: *Seismic Rehabilitation of Existing Buildings*

FEMA 454: *Designing for Earthquakes: A Manual for Architects*

FEMA 356: *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*

X – APPENDICES

APPENDIX A: SEISMIC HAZARD ANALYSIS

SITE SEISMIC HAZARDS

The site is located in the City of Santa Barbara, California. Although this region has not been as seismically active as other areas of the state in recent history, the site may experience strong ground shaking from earthquakes on a number of fault zones. Using the computer program EQFAULT Version 2.20, we have determined the approximate distances to the most significant faults and have listed the Maximum Capable Earthquake (MCE) magnitudes. The MCE corresponds to the maximum earthquake that appears capable of occurring under the presently known tectonic framework.

Earthquake Fault	*Distance (miles)*	*Maximum Credible Earthquake Magnitude*
North Channel Slope	1	7.4
Mission Ridge-Arroyo Parida-Santa Ana	2	7.2
Red Mountain	5	7.0
Santa Ynez (West)	6	7.1
Santa Ynez (East)	6	7.1
Ventura-Pitas Point	12	6.9
Oakridge (Mid-Channel)	12	6.6
Oak Ridge (Offshore)	17	7.1
Big Pine	24	6.9
Los Alamos-W. Baseline	25	6.9
Santa Cruz Island	28	7.0
Santa Rosa Island	30	7.1
Channel Island Thrust	31	7.5
Oak Ridge (Onshore)	31	7.0
San Cayetano	31	7.0
Anacapa-Dume	32	7.5
San Andreas	39	8.0

PROBABILISTIC GROUND MOTION HAZARD ASSESSMENT

The seismic intensity (see **Glossary**) at the site was estimated for earthquakes on the known active fault zones within a 50-mile radius of the site. Using the computer program FRISKSP, Version 4.00, we evaluated the peak ground acceleration and then converted the acceleration to a corresponding modified Mercalli Intensity (see **Glossary** and **Table 1**).

Average Recurrence Interval	*Peak Ground Acceleration*	*Modified Mercalli Intensity*
475 years	0.46g	VIII½

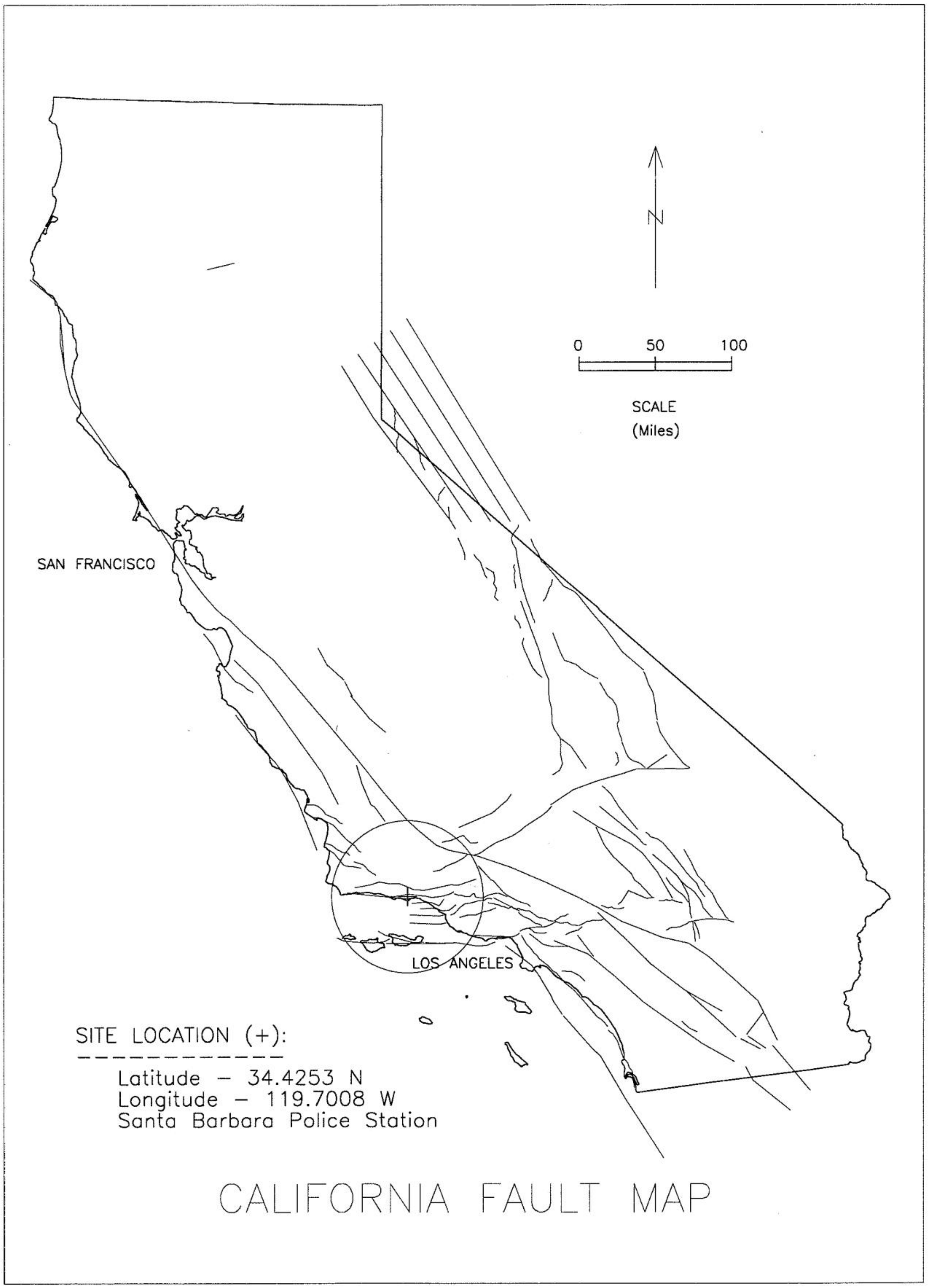
OTHER SEISMIC HAZARDS

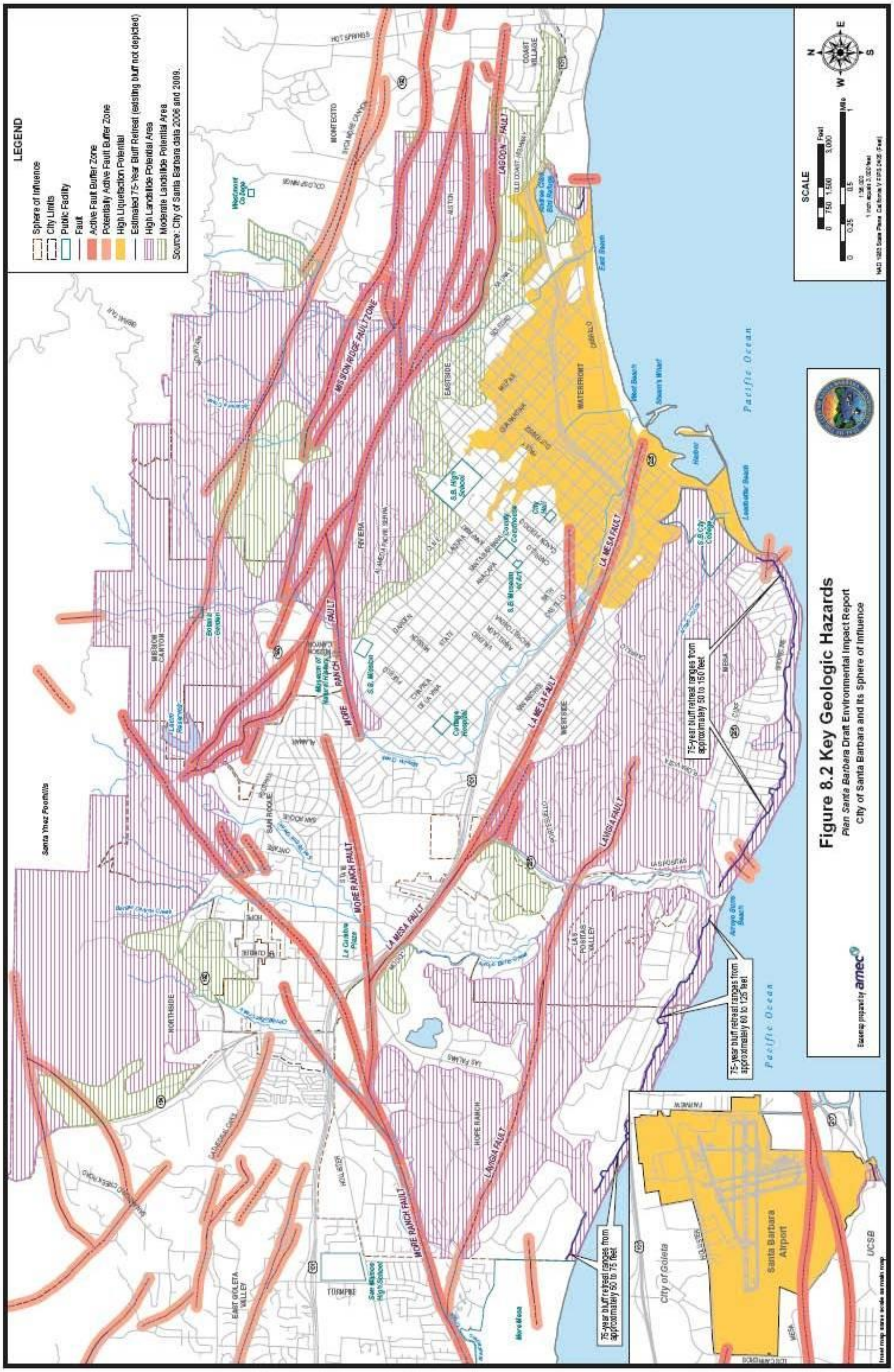
The other earthquake hazards at the site were evaluated based on the following information:

Regional Sources:

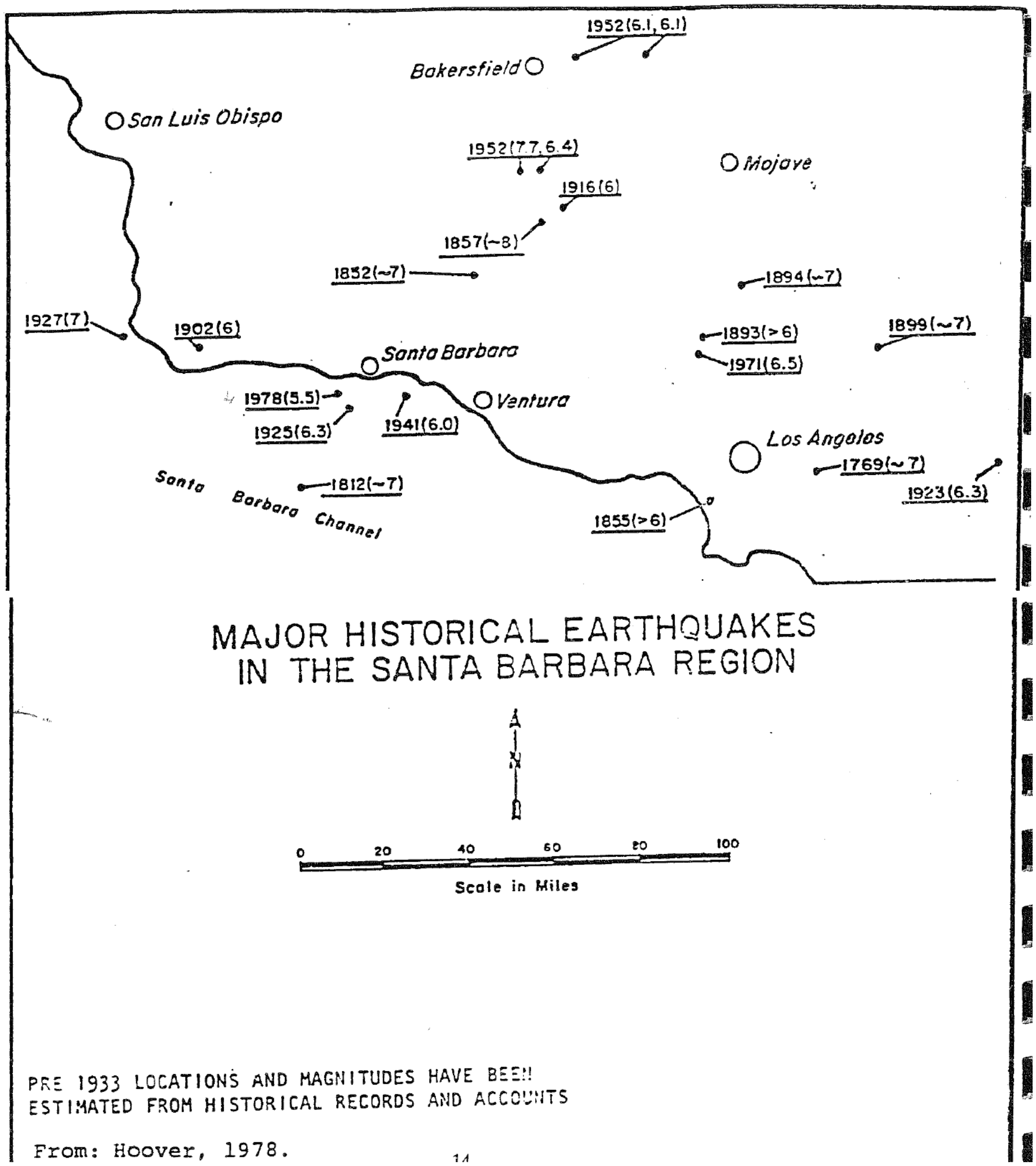
- California Geological Survey: Special Publication 42 (1999); Geologic Data Map No. 6 (1994).
- City of Santa Barbara: Safety Element of the General Plan (1979); Draft Environmental Impact Report (2010) .

Seismic Hazard	*Potential*	*Within State Hazard Zone?*	*Within City Hazard Zone?*
Surface Fault Rupture	Low	No	No
Liquefaction (see **Glossary**)	Low	Not Mapped	No
Earthquake-Induced Landslides	Low	Not Mapped	No


N
0 50 100
SCALE
(Miles)
SAN FRANCISCO
LOS ANGELES
SITE LOCATION (+):
Latitude – 34.4253 N
Longitude – 119.7008 W
Santa Barbara Police Station
CALIFORNIA FAULT MAP


LEGEND
Sphere of Influence
City Limits
Public Facility
Fault
Active Fault Buffer Zone
Potentially Active Fault Buffer Zone
High Liquefaction Potential
Estimated 75-Year Bluff Retreat (existing bluff not depicted)
High Landslide Potential Area
Moderate Landslide Potential Area
Source: City of Santa Barbara data 2006 and 2009.
SCALE
MISSION RIDGE FAULT ZONE
LA MESA FAULT
MORE RANCH FAULT
LAGOON FAULT
Pacific Ocean
75-year bluff retreat ranges from approximately 50 to 150 feet
75-year bluff retreat ranges from approximately 60 to 125 feet
75-year bluff retreat ranges from approximately 50 to 75 feet
Santa Barbara Airport
City of Goleta
UCSB
Figure 8.2 Key Geologic Hazards
Plan Santa Barbara Draft Environmental Impact Report
City of Santa Barbara and its Sphere of Influence

Major Historical Earthquakes in The Santa Barbara Region:



APPENDIX B: DESIGN LOADING CRITERIA

STRUCTURAL DESIGN CRITERIA:

BUILDING CODE USED FOR DESIGN : ASCE 41-06

SEISMIC CRITERIA USED FOR DESIGN: ASCE 41-06

Latitude	34.42525
Longitude	-119.70077
Ss	2.047
S1	0.782
Sds	1.364
Sd1	0.782

Project Site: 215 East Figueroa St. Santa Barbara, CA

Soil Type: SD

LATERAL FORCE RESISTING SYSTEM: **Concrete Shear Walls**

DEAD LOADS:

Main Roof Diaphragm:

	Gravity		Seismic		Mass (slugs/ft^2)
Tile Roofing	20.0	psf	20.0	psf	0.62
Plywood Roofing	3.0	psf	3.0	psf	0.09
Framing	4.0	psf	4.0	psf	0.12
MEP	2.0	psf	2.0	psf	0.06
Fire Sprinklers	1.5	psf	1.5	psf	0.05
Cement Plaster Ceiling	15.0	psf	15.0	psf	0.47
FLOOR DL (ADD PARTITION WEIGHT, SEISMIC ONLY)	45.5	psf	45.5	psf	1.41

2nd Floor Diaphragm:

	Gravity		Seismic		Mass (slugs/ft^2)
Concrete Pan Joist System	110.0	psf	110.0	psf	3.42
Flooring	5.0	psf	5.0	psf	0.16
Fire Sprinklers	1.5	psf	1.5	psf	0.05
MEP	3.0	psf	3.0	psf	0.09
Ceiling	2.0	psf	2.0	psf	0.06
FLOOR DEAD LOAD (ADD PARTITION WEIGHT)	121.5	psf	121.5	psf	3.77

Flat Roof (2nd Level) Diaphragm:

	Gravity		Seismic		Mass (slugs/ft^2)
Concrete Pan Joist System	110.0	psf	110.0	psf	3.42
Roofing (2 Layers)	10.0	psf	10.0	psf	0.31
Fire Sprinklers	1.5	psf	1.5	psf	0.05
MEP	3.0	psf	3.0	psf	0.09
Ceiling	2.0	psf	2.0	psf	0.06
FLOOR DL (ADD PARTITION WEIGHT, SEISMIC ONLY)	126.5	psf	126.5	psf	3.93

1st Floor Diaphragm:

	Gravity		Seismic		Mass ($slugs/ft^2$)
Concrete Pan Joist System	110.0	psf	110.0	psf	3.42
Flooring	5.0	psf	5.0	psf	0.16
Fire Sprinklers	1.5	psf	1.5	psf	0.05
MEP	3.0	psf	3.0	psf	0.09
Ceiling	2.0	psf	2.0	psf	0.06
TOTAL DEAD LOAD (ADD PARTITION WEIGHT)	121.5	psf	121.5	psf	3.77

Partition Loads:

	Gravity		Seismic		Mass ($slugs/ft^2$)
ROOF PARTITION LOAD	0	psf	10.0	psf	0.31
2ND FLOOR PARTITION LOAD	20	psf	20.0	psf	0.62
1ST FLOOR PARTITION LOAD	20	psf	20.0	psf	0.62

LIVE LOADS:

Roof	20	psf	
Floor	50	psf	
Corridor/Stairs	80	psf	
Property Room	150	psf	(high density file cab)

MATERIALS:

Concrete, Slab on Grade	f'_c =	2	ksi	
Concrete, Structural Slabs	f'_c =	2.5	ksi	
Concrete, Column	f'_c =	2.5	ksi	
Reinforcing Steel	f_y =	40	ksi	Typical
		50	ksi	Columns

LOAD COMBINATIONS: (ASCE41-06)

1). $1.1\ (Q_D + Q_L) \pm Q_E$

2). $0.9\ Q_D \pm Q_E$

Note: Q_D = Design Dead Loads;

Q_L = Design Live Loads (unreduced);

Q_E = Design Earthquake Loads.

CRACKED WALL EFFECTIVE STIFFNESS: (Table 6-5 in ASCE41-06)

Flexural Rigidity: $0.5\ E_c\ I_g$

Shear Rigidity: $0.4\ E_c\ A_w$

Axial Rigidity: $E_c\ A_g$

MCE & 2/3MCE RESPONSE SPECTRA (USGS)

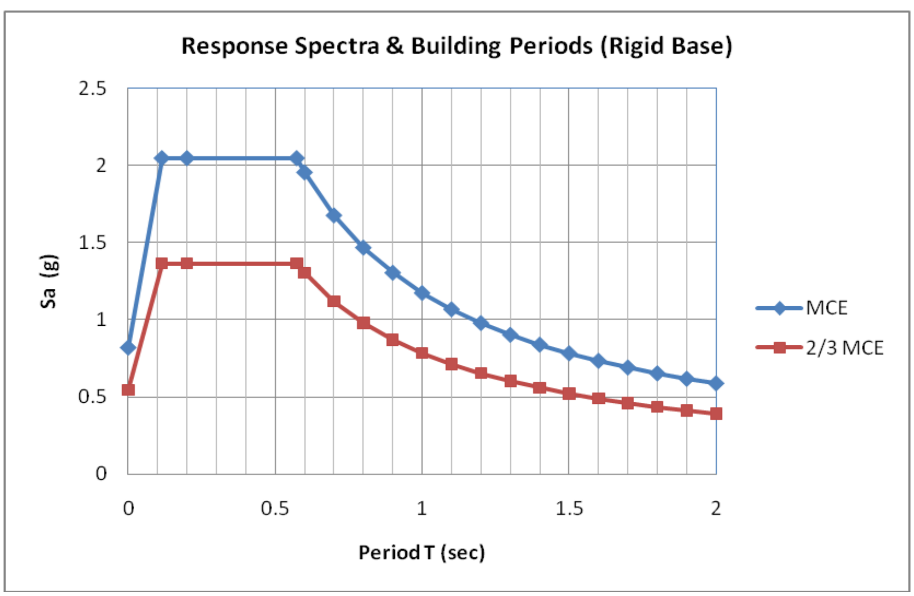
Conterminous 48 States
2006 International Building Code
Latitude 34.42524 6
Longitude = -119.70 774
Site Modified Response Spectrum for Site Class D
SMs = Ss and
Fa SM1 = FVS1
Site Class D - Fa = 1.0 ,Fv = 1.5

Period (sec)	Sa (g)	Sd (inches)
0	0.819	0
0.115	2.047	0.263
0.2	2.047	0.8
0.573	2.047	6.571
0.6	1.955	6.877
0.7	1.676	8.024
0.8	1.467	9.17
0.9	1.304	10.316
1	1.173	11.462
1.1	1.067	12.609
1.2	0.978	13.755
1.3	0.902	14.901
1.4	0.838	16.047
1.5	0.782	17.194
1.6	0.733	18.34
1.7	0.69	19.486
1.8	0.652	20.632
1.9	0.617	21.779
2	0.587	22.925

Conterminous 48 States
2006 International Building Code
Latitude 34.42524 6
Longitude = -119.70 774
Site Modified Response Spectrum for Site Class D

SDs = 2/3 x SMs and SD1 = 2/3 x SM1
Site Class D - Fa = 1.0 ,Fv = 1.5

Period (sec)	Sa (g)	Sd (inches)
0	0.546	0
0.115	1.364	0.175
0.2	1.364	0.533
0.573	1.364	4.38
0.6	1.304	4.585
0.7	1.117	5.349
0.8	0.978	6.113
0.9	0.869	6.877
1	0.782	7.642
1.1	0.711	8.406
1.2	0.652	9.17
1.3	0.602	9.934
1.4	0.559	10.698
1.5	0.521	11.462
1.6	0.489	12.227
1.7	0.46	12.991
1.8	0.435	13.755
1.9	0.412	14.519
2	0.391	15.283



APPENDIX C: MATERIAL TESTING REPORTS

Summary of Material Testing Results *

* See Attached Test Results from ACCU-TEST Structural Laboratories Inc.

Member	CORE #	f'_c	E	Unit Weight
		psi	ksi	pcf
WALL	1	3885	3,553	142.0
	2	3322	3,285	139.0
	3	2196	2,671	139.0
	4	2961	3,102	137.0
	5	4487	3,818	142.0
	6	4815	3,955	139.0
	7	2779	3,005	134.0
	8	2937	3,089	135.0
	Mean=	**3423**	**3310**	**138.4**
	Variance=	809044	189664	
	Standard Deviation=	899	436	
	Coefficient of Variation=	**26.3%**	**13.2%**	
	Mean - Std. Deviation=	**2523**		

Member	CORE #	f'_c	E	Unit Weight
		psi	ksi	pcf
BEAM	1	3895	3,557	144.0
	2	4129	3,663	137.0
	Mean=	**4012**	**3610**	**140.5**
	Variance=	27378	5544	
	Standard Deviation=	165	74	
	Coefficient of Variation=	**4.1%**	**2.1%**	
	Mean - Std. Deviation=	**3847**		

Member	CORE #	f'_c	E	Unit Weight
		psi	ksi	pcf
SLAB	1	4937	4,005	144.0
	2	6191	4,485	137.0
	Mean=	**5564**	**4245**	**140.5**
	Variance=	786258	115147	
	Standard Deviation=	887	339	
	Coefficient of Variation=	**15.9%**	**8.0%**	
	Mean - Std. Deviation=	**4677**		

Member	Specimen#	Yield Point	Tensile Strenght
		ksi	ksi
Rebar	1	51.3	80.4
	2	51.2	76.4
	Mean=	**51.3**	**78.4**
	Variance=	0.0	8.0
	Standard Deviation=	0.1	2.8
	Coefficient of Variation=	**0.1%**	**3.6%**
	Mean - Std. Deviation=	**51.2**	

APPENDIX D: GEOTECHNICAL REPORT (LETTER):

Pacific
Materials
Laboratory
of Santa Barbara, Inc.

35-A South La Patera Lane
P.O. Box 96
Goleta, CA 93116
Ph: (805) 964-6901

Santa Ynez
Ph: (805) 688-7587

FAX No: (805) 964-6239
E-mail: pml@pml.sbcoxmail.com

July 16, 2010
Lab No: 89030-2
File No: 10-8671-2

City of Santa Barbara
c/o Coffman Engineers, Inc.
Attn: Paul Van Benschoten
16133 Ventura Blvd., Suite 1010
Encino, CA 91436

SUBJECT: Seismic Resistance Retrofitting
Santa Barbara Police Station
215 East Figueroa Street
Santa Barbara, California

REFERENCE: This Laboratory's Report No. 47479-2, Dated October 16 2001

Dear Mr. Van Benschoten:

It is my understanding you are designing structural elements for seismic resistance retrofitting of the building at the subject site. The District Attorney Office building is adjacent to the Police Station located at 215 East Figueroa Street. I have reviewed the reference soil report for the District Attorney Office building at 1112 Santa Barbara Street.

The soil conditions encountered at the District Attorney Office building are of the geologic formation known as the Older Alluvium. The Older Alluvium is a stable formation from a Geotechnical viewpoint, having a Site Class D as defined by Table 1613.5.2 of the California Building Code.

The Allowable Soil Pressure provided for the design of the District Attorney Office building footings was 2,500 psf for a footing depth of 30 inches. A Factor of Safety of 3 was assumed, therefore, the Ultimate Soil Pressure is 7,500 psf. The Soil Subgrade Modulus is estimated to be approximately 200 pci.

It is my opinion these soil values, which are based on the soil conditions encountered at the District Attorney Office building, may be applied to the Santa Barbara Police Station building.

If you have any questions concerning this matter, please do not hesitate to call. Thank you for the opportunity of providing this service.

Respectfully submitted,

PACIFIC MATERIALS LABORATORY, INC.

Ronald J. Pike
Geotechnical Engineer, G. E. 2291

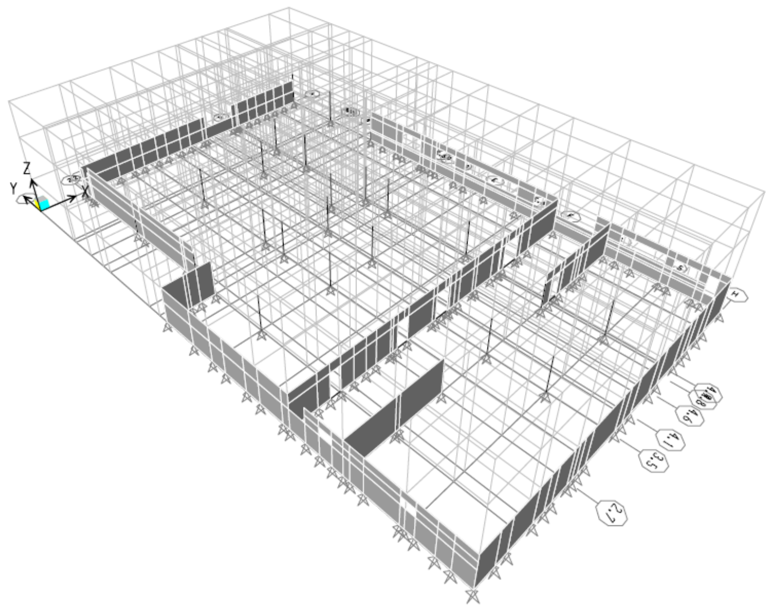
RJP:vlh

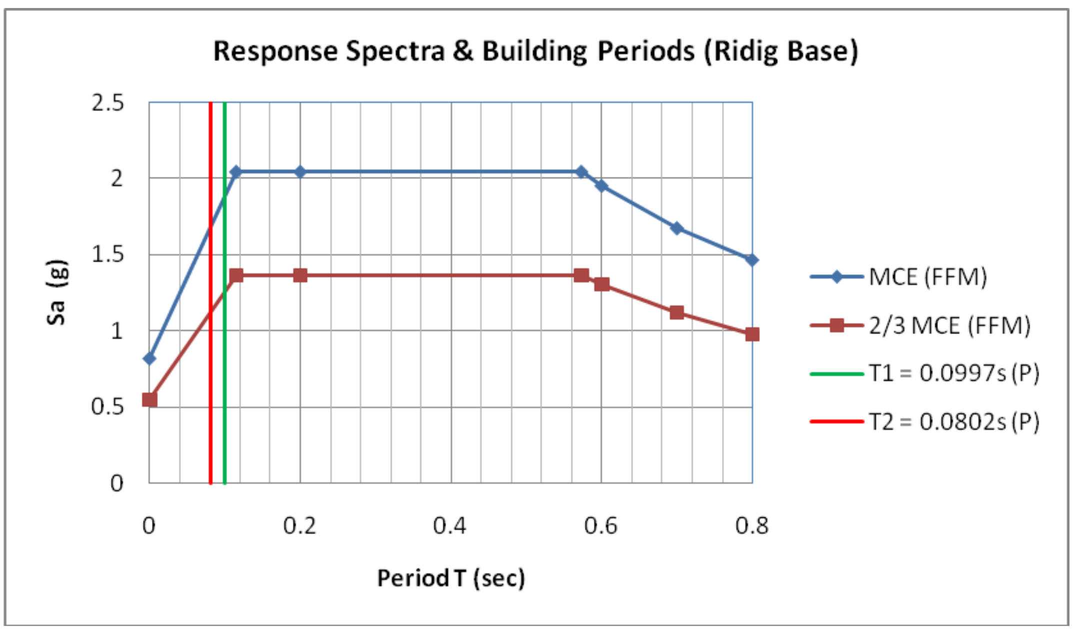
cc: Coffman Engineers, Attn: Paul Van Benschoten, FAX (818) 285-2651

APPENDIX E: LDP ANALYSIS – ETABS MODEL:

MODEL1: Existing Building With Rigid Base (Pinned Base)

Assume all walls and columns are pinned at the base (as shown in the following picture).





As shown in the response spectra above, the first mode periods of existing building $T_1 \approx 0.1$ sec along Y- direction, and $T_2 \approx 0.08$ sec along X-direction, and both fall within the first part of code design response spectrum (less than T_0), which building is very rigid and unconservative design. Therefore we consider the soil – structure interaction effects for the existing building. Also see the following page for the story shear distribution and modal participating mass ratios up to 100% (total 9 modes).

STORY SHEAR OF EXISTING BUILDING w/ PINNED BASE (Unit: kips)

	Static (CODE)		2/3 MCE		MCE	
Story	V_x	V_y	V_x	V_y	V_x	V_y
ROOF	361	361	370	500	555	750
SECOND FL	2095	2095	2754	3212	4132	4821
FIRST FL	2991	2991	4325	5020	6490	7533
Vbase/Wt	51%	51%	74%	86%	111%	129%

ETABS Mass Output Unit: kip-in

Story	Diaphragm	MassX	MassY	MMI	XM	YM
ROOF	ROOF	0.9448	0.9448	195211.82	538.118	-1471.5
SECOND FL	2NDFLR	6.5607	6.5607	2893716.7	555.887	-889.258
FIRST FL	1STFLR	7.6347	7.6347	2895850.6	554.393	-886.818

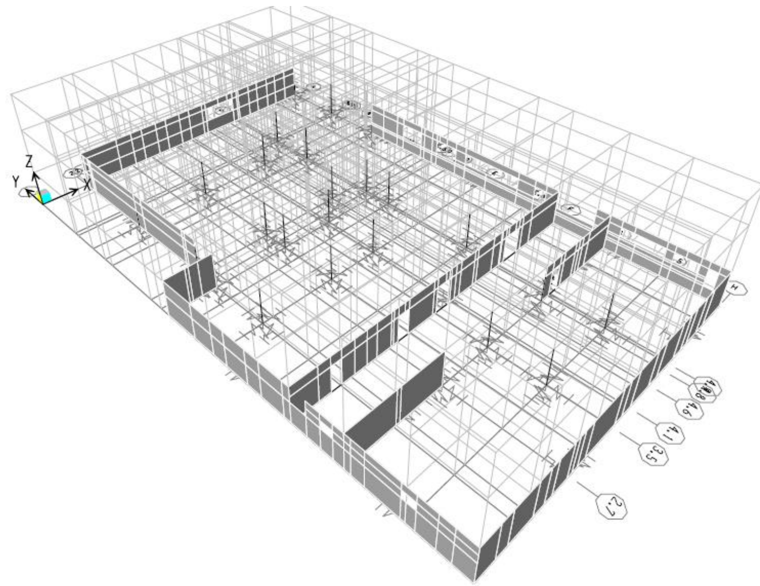
Floor Level	ETABS Model Weight (kips)	Hand Calc Weight (kips)	AutoSeismic Weight (kips)
ROOF	365	342	↓
SECOND FL	2535	2469	
FIRST FL	2950	2987	
Total	5850 kips	5799 kips	5845 kips
Error %	0.88%		

MODAL PARTICIPATING MASS RATIOS w/ PINNED BASE

Mode	Period	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
1	0.0997	0.30	90.36	0	0.30	90.36	0	96.44	0.18	1.69	96.44	0.18	1.69
2	0.0802	85.76	0.45	0	86.06	90.81	0	0.75	88.35	6.54	97.19	88.53	8.23
3	0.0702	4.91	0.55	0	90.97	91.36	0	1.27	10.02	78.39	98.47	98.55	86.62
4	0.0409	0.09	6.67	0	91.06	98.03	0	1.38	0.00	0.43	99.84	98.56	87.04
5	0.0337	0.21	1.68	0	91.26	99.71	0	0.01	0.00	0.01	99.85	98.56	87.05
6	0.0319	6.95	0.00	0	98.21	99.71	0	0.05	1.23	0.00	99.90	99.79	87.05
7	0.0275	0.81	0.25	0	99.02	99.96	0	0.09	0.01	10.84	99.99	99.79	97.89
8	0.0266	0.52	0.01	0	99.53	99.97	0	0.00	0.00	0.16	99.99	99.80	98.05
9	0.0229	0.47	0.03	0	100	100	0	0.01	0.20	1.95	100	100	100

MODEL1: Existing Building With Flexible Base (Soil – Structure Interaction)

Assume all walls and columns are supported by Soil Spring derived from ASCE41-06.

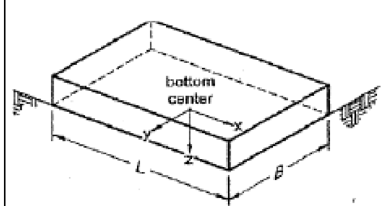


SOIL - STRUCTURE INTERACTION EFFECTS (Section 4.4.2.1 of ASCE41-06)

Summary Table of Soil Stiffness - Shallow Bearing Foundations

SOIL PROPERTIES:

Site Class:	D	
$S_{XS}/2.5 = S_{MS}/2.5 = F_aS_S/2.5 =$	0.8188	
Unit weight of soil γ =	110	pcf
Shear wave velocity v_s =	1000	ft/sec
Gravity Acceleration g =	32.2	ft/sec^2
Initial shear modulus G_0 =	23.72	ksi (Eq.4-4)
Effective shear modulus G/G_0 =	0.10	(Table 4-7)
G =	2.37	ksi
Poisson's ratio ν =	0.3	



LINE SPRING STIFFNESS (See the calc detail in Appendix)

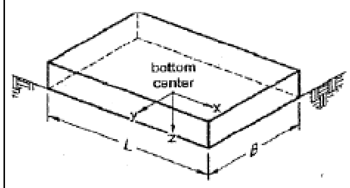
Wall	Dimension			Translational Stiffness (per length)			Rotational Stiffness (per length)		
Footing	Length	Width	Depth	K_x /L	K_y /L	K_z /L	K_{xx}	K_{yy}	K_{zz}
ID	L (ft)	B (in)	d (in)	k/in/in	k/in/in	k/in/in	k-in/rad	k-in/rad	k-in/rad
FTG34X12X29	29.00	34.0	12.0	3.56	5.40	4.03	1176545	21293617	31327774
FTG24X12X55	55.58	24.0	12.0	2.41	4.53	3.16	1325434	76430735	146465104
FTG36X12X13	13.00	36.0	12.0	5.56	7.32	5.43	620324	3679525	4791550
FTG24X12X59	59.67	24.0	12.0	2.33	4.44	3.10	1416744	90027367	174042550
FTG45X12X52	52.33	45.0	12.0	2.86	4.39	3.50	3116362	97019509	135210480
FTG24X12X23	23.67	24.0	12.0	3.66	5.95	4.11	604090	10920069	18628540
FTG45X12X21	21.08	45.0	12.0	4.50	6.05	4.75	1333754	12284881	15426134
FTG34X12X44	44.08	34.0	12.0	2.90	4.70	3.53	1738183	55295200	85805106
FTG39X12X43	43.50	39.0	12.0	3.01	4.68	3.62	2102762	58247271	84611431
FTG45X12X56	56.08	45.0	12.0	2.76	4.30	3.43	3328767	113780658	159829362
FTG36X12X32	32.92	36.0	12.0	3.38	5.16	3.90	1438140	29385695	42783378
FTG42X12X21	21.17	42.0	12.0	4.41	6.04	4.67	1205048	11897652	15354286
FTG51X12X27	27.00	51.0	12.0	4.08	5.53	4.47	2035609	23115748	28418165
FTG60X12X89	89.00	60.0	12.0	2.42	3.72	3.14	8215708	393921993	517595518

SOIL - STRUCTURE INTERACTION EFFECTS (Section 4.4.2.1 of ASCE41-06)

Summary Table of Soil Stiffness - Shallow Bearing Foundations

SOIL PROPERTIES:

Site Class:	D	
$S_{XS}/2.5 = S_{MS}/2.5 = F_a S_S/2.5 =$	0.8188	
Unit weight of soil γ =	110	pcf
Shear wave velocity v_s =	1000	ft/sec
Gravity Acceleration g =	32.2	ft/sec^2
Initial shear modulus G_0 =	23.72	ksi (Eq.4-4)
Effective shear modulus G/G_0 =	0.10	(Table 4-7)
G =	2.37	ksi
Poisson's ratio ν =	0.3	



POINT SPRING STIFFNESS (See the calc detail in Appendix)

Column Footing ID	Dimension: Length L (ft)	Width B (in)	Depth d (in)	Translational Stiffness: K_x k/in	K_y k/in	K_z k/in	Rotational Stiffness: K_{xx} k-in/rad	K_{yy} k-in/rad	K_{zz} k-in/rad	
FTG1	5.75	69.0	14.0	815	815	695	966656	966656	1813523	FTG3
FTG2	7.50	90.0	18.0	987	987	890	2114649	2114649	3995782	
FTG4	7.25	86.0	18.0	961	963	861	1907984	2158319	3606973	
FTG5	8.50	86.0	18.0	1005	1036	922	2149924	2914004	4311566	
FTG6	9.50	114.0	20.0	1167	1167	1101	4012300	4012300	7623901	
FTG7	6.75	81.0	16.0	914	914	805	1535774	1535774	2895117	FTG8/18/23
FTG9	10.00	120.0	22.0	1214	1214	1161	4770913	4770913	9079194	
FTG10	12.00	144.0	26.0	1386	1386	1382	8155402	8155402	15575282	
FTG11	9.00	108.0	20.0	1124	1124	1051	3502457	3502457	6650632	
FTG12	9.00	86.0	20.0	1027	1069	956	2378202	3371172	4890097	FTG15
FTG13	9.00	84.0	20.0	1018	1065	947	2288289	3316575	4759830	
FTG14	6.50	78.0	16.0	891	891	780	1399987	1399987	2634071	FTG21
FTG16	8.00	84.0	18.0	978	1002	889	1973247	2550359	3884232	
FTG17	6.00	72.0	16.0	847	847	730	1153209	1153209	2157735	FTG24
FTG19	7.25	87.0	18.0	965	965	865	1945976	1945976	3670864	FTG20
FTG22	7.00	84.0	18.0	943	943	840	1786638	1786638	3363158	
FTG25	4.75	57.0	14.0	724	724	595	611935	611935	1128439	

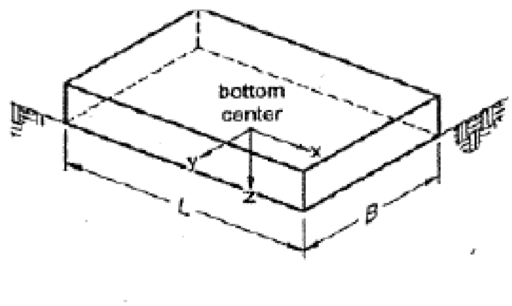
A sample calculation spreadsheet for soil spring stiffness based on ASCE41-06:

SOIL - STRUCTURE INTERACTION EFFECTS (ASCE41-06)

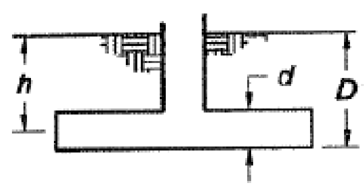
- Shallow Bearing Foundations

Foundation ID: FTG34X12X29

SOIL PROPERTIES:		
Site Class:	D	
$S_{XS}/2.5 = S_{MS}/2.5 = F_aS_S/2.5 =$	0.8188	
Unit weight of soil $\gamma =$	110	pcf
Shear wave velocity $v_s =$	1000	ft/sec
Gravity Acceleration g =	32.2	ft/sec^2
Initial shear modulus $G_0 =$	23.72	ksi (Eq.4-4)
Effective shear modulus $G/G_0 =$	0.10	(Table 4-7)
G =	2.37	ksi
Poisson's ratio $\nu =$	0.3	
FOUNDATION DIMENSIONS:		
Length L =	29.00	ft
Width B =	34.0	in
Thickness d =	12.0	in
Depth D =	2.00	ft
Depth to centroid h =	18.0	in
TRANSLATIONAL STIFFNESS: (Figure 4-4)		
at surface, $K_{x,sur} =$	788	k/in
embedment factor, $\beta_x =$	1.57	
at depth, $K_x =$	1238	k/in
at surface, $K_{y,sur} =$	964	k/in
embedment factor, $\beta_y =$	1.95	
at depth, $K_y =$	1880	k/in
at surface, $K_{z,sur} =$	1114	k/in
embedment factor, $\beta_z =$	1.26	
at depth, $K_z =$	1402	k/in
ROTATIONAL STIFFNESS: (Figure 4-4)		
at surface, $K_{xx,sur} =$	558668	k-in/rad
embedment factor, $\beta_{xx} =$	2.11	
at depth, $K_{xx} =$	1176545	k-in/rad
at surface, $K_{yy,sur} =$	16632975	k-in/rad
embedment factor, $\beta_{yy} =$	1.28	
at depth, $K_{yy} =$	21293617	k-in/rad
at surface, $K_{zz,sur} =$	14792145	k-in/rad
embedment factor, $\beta_{zz} =$	2.12	
at depth, $K_{zz} =$	31327774	k-in/rad



Orient axes such that $L>B$. If L=B, use x-axis equations for both x-axis and y-axis.



d = height of effective sidewall contact (may be less than total foundation height)
h = depth to centroid of effective sidewall contact

For each degree of freedom, calculate

$K_{emb} = \beta K_{sur}$

SOIL - STRUCTURE INTERACTION EFFECTS (Section 4.5.1 of ASCE41-06)

Kinematic Interaction (Simplified Procedure)

Effective Foundation Size:

$a =$ 89.00 ft

$b =$ 144.00 ft

Embedment:

$e =$ 5.00 ft

$b_e = \sqrt{(ab)} =$ 113.21 ft

Ratio of response spectra for base slab averaging: (RRS factor)

$RRS_{bsa} = 1 - 1/14100 \times (b_e/T)^{1.2} \geq$ the value for T = 0.2 sec (Eq. 4-11)

min $RRS_{bsa} =$ 0.8574

RRS factor for embedment e: (Eq. 4-12)

$RRS_e = \cos(2\pi e/Tnv_s) \geq$ the larger of 0.453 or the RRSe value for T = 0.2 sec

Shear wave velocity $v_s =$ 1000 ft/sec

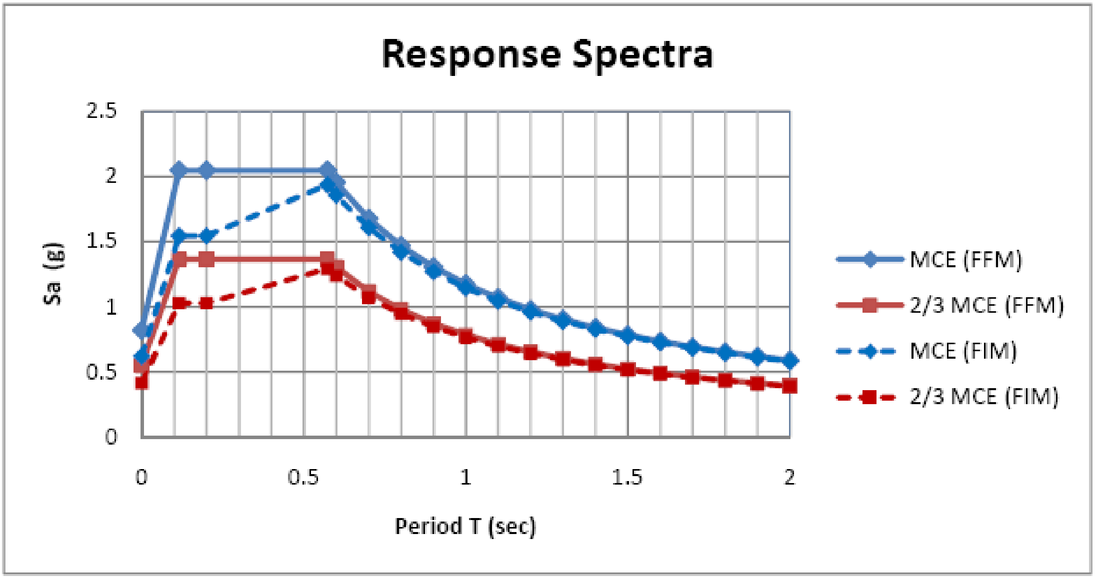
$n = \sqrt{(G/G_0)} =$ 0.3162

RRS_e (T=0.2) = 0.8791

Foundation Input Motion (FIM):

$(S_a)_{FIM} = RRS_{bsa}\, RRS_e\, (S_a)_{FFM}$

$(S_a)_{FFM} =$ Free Field Motion spectrum



STORY SHEAR OF EXISTING BUILDING w/ FLEXIBLE BASE (Unit: kips)

	Static (CODE)		2/3 MCE		MCE	
Story	V_x	V_y	V_x	V_y	V_x	V_y
ROOF	361	361	516	516	774	774
SECOND FL	2095	2095	3429	3455	5146	5186
FIRST FL	2991	2991	5883	5889	8828	8838
Vbase/Wt	51%	51%	101%	101%	151%	151%

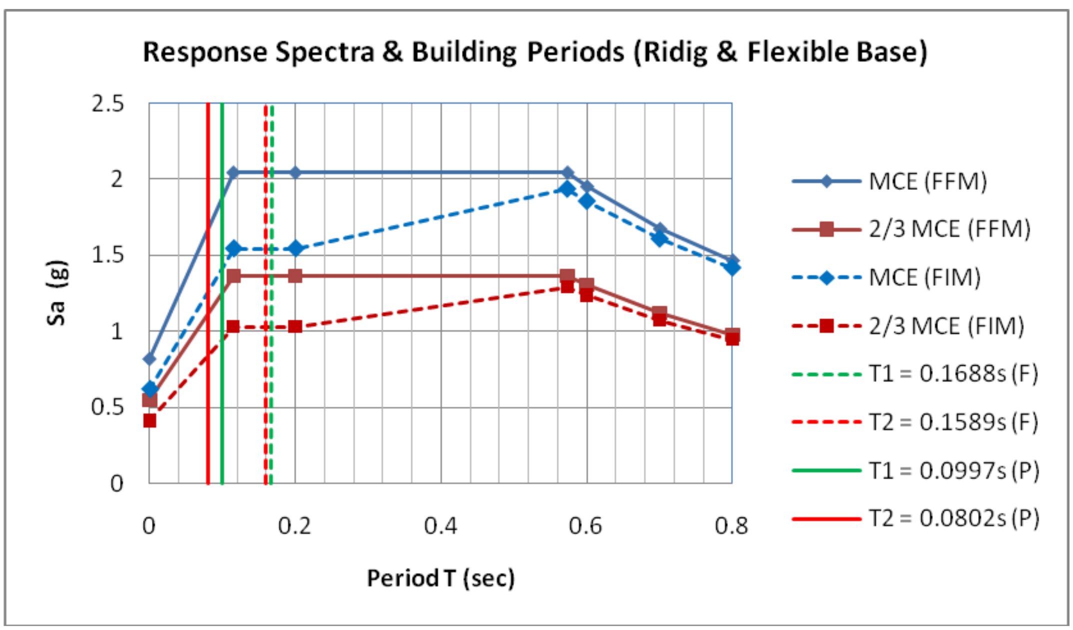
ETABS Mass Output Unit: kip-in

Story	Diaphragm	MassX	MassY	MMI	XM	YM
ROOF	ROOF	0.9448	0.9448	195211.82	538.118	-1471.5
SECOND FL	2NDFLR	6.5607	6.5607	2893716.7	555.887	-889.258
FIRST FL	1STFLR	7.6347	7.6347	2895850.6	554.393	-886.818

Floor Level	ETABS Model Weight (kips)	Hand Calc Weight (kips)	AutoSeismic Weight (kips)
ROOF	365	342	
SECOND FL	2535	2469	
FIRST FL	2950	2987	↓
Total	5850 kips	5799 kips	5845 kips
Error %	0.88%		

MODAL PARTICIPATING MASS RATIOS w/ FLEXIBLE BASE

Mode	Period	UX	UY	UZ	SumUX	SumUY	SumUZ	RX	RY	RZ	SumRX	SumRY	SumRZ
1	0.1688	5.75	87.99	0	5.75	87.99	0	87.43	5.54	0.01	87.43	5.54	0.01
2	0.1589	88.30	5.62	0	94.05	93.61	0	5.54	86.28	0.87	92.97	91.82	0.88
3	0.1372	0.75	0.06	0	94.80	93.68	0	0.12	0.24	96.75	93.09	92.06	97.63
4	0.0530	0.00	4.82	0	94.80	98.50	0	6.20	0.00	0.27	99.29	92.06	97.90
5	0.0472	4.44	0.00	0	99.24	98.51	0	0.00	7.67	0.04	99.29	99.73	97.94
6	0.0396	0.02	0.00	0	99.25	98.51	0	0.26	0.00	1.57	99.55	99.73	99.51
7	0.0365	0.00	0.28	0	99.26	98.78	0	0.16	0.00	0.08	99.72	99.73	99.59
8	0.0277	0.01	0.01	0	99.26	98.79	0	0.00	0.00	0.00	99.72	99.74	99.59
9	0.0240	0.01	0.00	0	99.2678	98.792	0	0.00	0.02	0.02	99.715	99.755	99.605
10	0.022218	0.0333	1.1809	0	99.3011	99.9729	0	0.2386	0	0.09	99.954	99.755	99.694
11	0.019283	0.6975	0.0135	0	99.9986	99.9864	0	0.0166	0.23	0.05	99.971	99.99	99.743
12	0.016583	0.0014	0.0136	0	100	100	0	0.0294	0.01	0.26	100	100	100



For the soil-structure model, the first mode periods of existing building $T_1 \approx 0.17$ sec along Y-direction, and $T_2 \approx 0.16$ sec along X-direction, and both fall within the max design response spectrum (greater than T_0 and less than T_s), which building design is reasonable. Therefore we check the DCRs (Demand Capacity Ratios) of concrete walls by using the soil – structure interaction model.

Wall DCR CHECK (2/3 MCE @ LS)

Note: Tables list the piers and spandrels with the shear or/and flexural DCR ≥ 1.0 only

EXISTING CONCRETE WALL PIER DCR CHECK - EXISTING BUILDING w/ FLEXIBLE BASE

For Shear Check			ϕ = 1.0	Shear m-factor		For Flexural Check
8" wall #4@18" H. ea. Face As =	0.27	in^2/ft	f'c = 2.5 ksi	IO & LS	2	8" wall #4@24" v. ea. Face
10" wall #4@15" H. ea. Face As =	0.32	in^2/ft	fy = 50 ksi	CP	3	10" wall #4@12" v. ea. Face

Select Earthquake Hazard Level: **2/3MCE**
Select Performance Level: **LS**

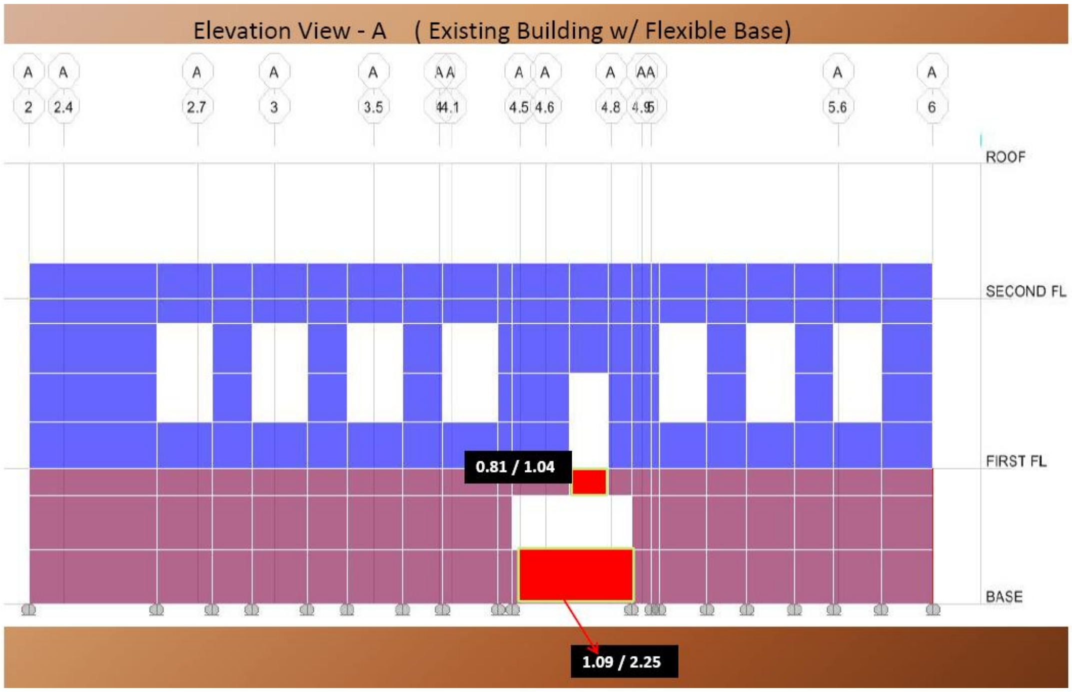
Story	PierLbl	PierLen (inch)	PierThk (inch)	$A_{s\ existing}/ft$ (in^2/ft)	ϕV_n (kips)	V_u (kips)	Shear DCR	DesignLen (inch)	ϕM_n (ft-k)	M_u (ft-k)	P_u (kips)	Flexural m-Factor	Flexural DCR
SECOND FL	P16	36	8	0.27	69	66	0.48	36	82	214	109	1.50	1.73
SECOND FL	P18	52	8	0.27	99	140	0.71	52	158	310	43	1.50	1.31
SECOND FL	P51	50	8	0.27	96	77	0.40	50	151	437	72	2.36	1.23
SECOND FL	P64	51	8	0.27	97	116	0.59	50	151	448	49	2.05	1.44
SECOND FL	PF7	34	8	0.27	65	61	0.47	33	73	225	93	1.50	2.05
SECOND FL	PC6	51	8	0.27	97	94	0.48	51	154	375	61	2.23	1.09
SECOND FL	PC7	42	8	0.27	80	71	0.44	42	97	271	19	2.30	1.22
SECOND FL	PE2	24	8	0.27	46	29	0.32	24	34	116	45	2.49	1.35
FIRST FL	P16	36	10	0.32	84	146	0.87	36	108	287	106	1.94	1.37
FIRST FL	P61	28	10	0.32	65	71	0.54	28	82	177	45	2.16	1.00
FIRST FL	P62	23	10	0.32	54	103	0.96	23	50	153	70	1.93	1.58
FIRST FL	P63	36	10	0.32	84	200	1.19	36	108	279	151	1.77	1.46
FIRST FL	P65	41	10	0.32	96	167	0.87	41	151	369	79	1.50	1.63
FIRST FL	P66	62	10	0.32	145	401	1.39	62	310	826	158	1.99	1.34
FIRST FL	P67	65	10	0.32	152	421	1.39	65	326	866	194	1.94	1.37
FIRST FL	P68	70	10	0.32	163	335	1.03	70	351	734	134	1.50	1.39

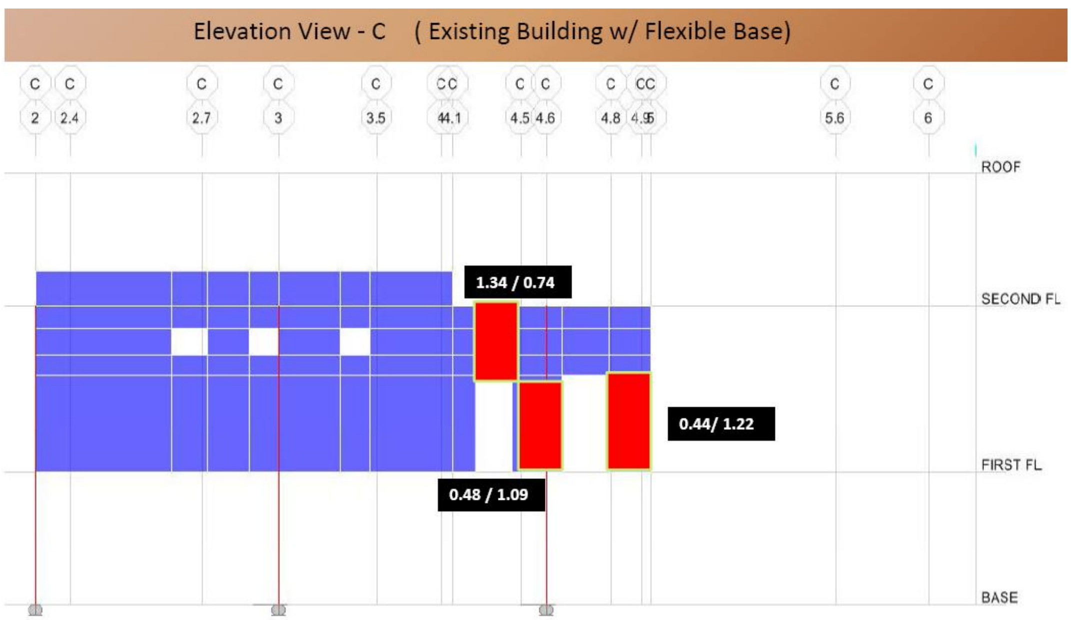
EXISTING CONCRETE WALL SPANDREL DCR CHECK - EXISTING BUILDING w/FLEXIBLE BASE

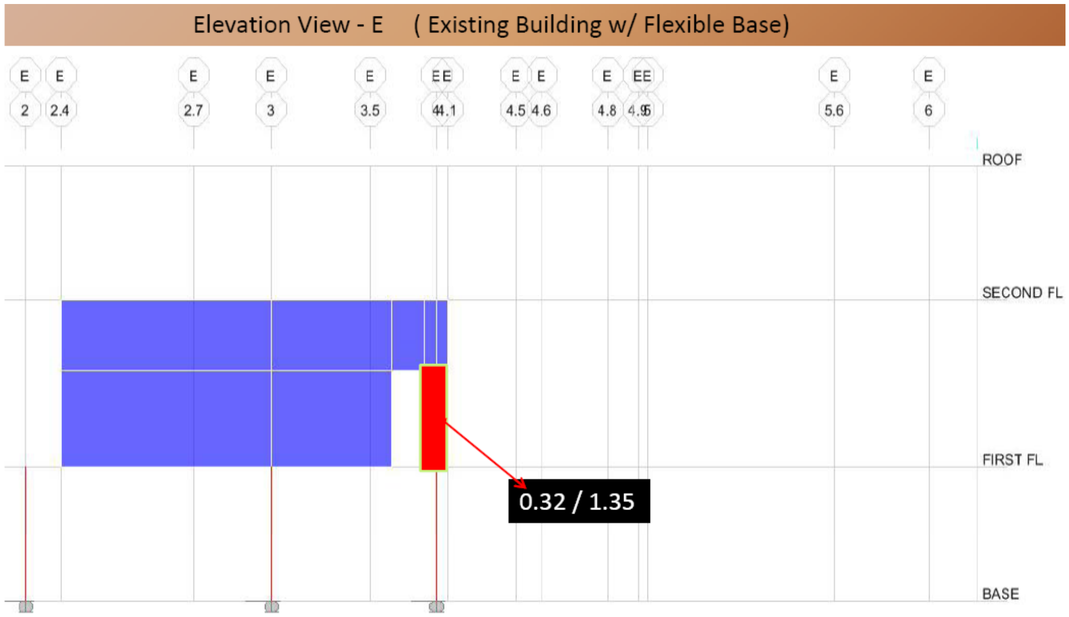
For Shear Check			ϕ = 1.0	For Flexural Check
8" wall #4@24" V. ea. Face As =	0.20	in^2/ft	f'c = 2.5 ksi	8" wall #4@18" H. ea. Face
10" wall #4@12"V.IF. #4@20"V.OF. =	0.32	in^2/ft	fy = 50 ksi	10" wall #4@15" H. ea. Face

Select Earthquake Hazard Level: **2/3MCE**
Select Performance Level: **LS**

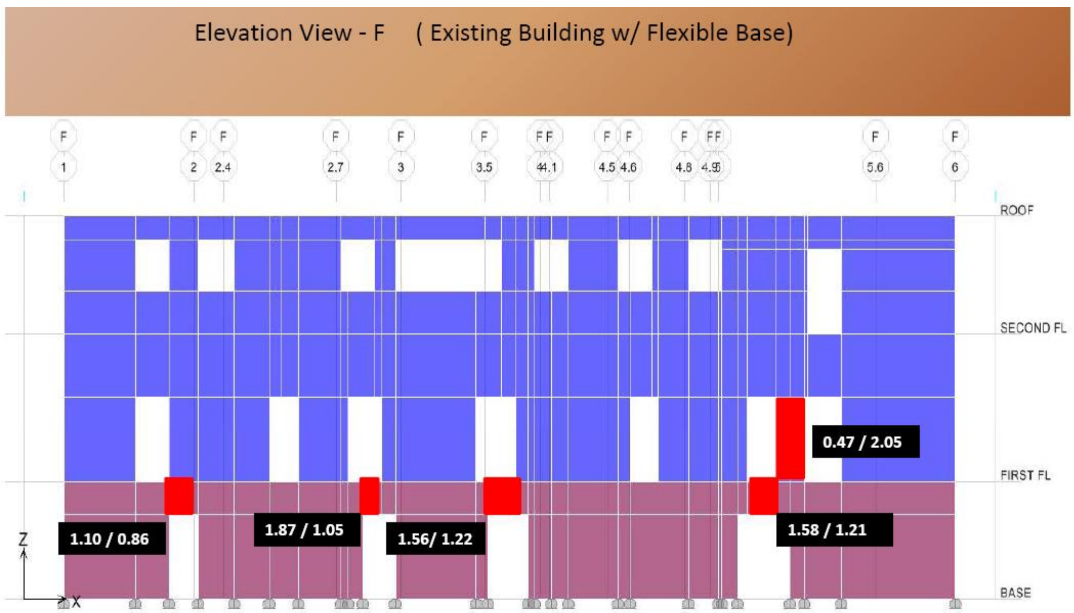
Story	SpandLbl	SpandHt (inch)	SpandThk (inch)	$A_{s\ existing}/ft$ (in^2/ft)	ϕV_n (kips)	V_u (kips)	Shear m-Factor	Shear DCR	DesignHt (inch)	ϕM_n (ft-k)	M_u (ft-k)	Flexural m-Factor	Flexural DCR
SECOND FL	SC4	62	8	0.20	101	162	1.20	1.34	62	231	309	1.80	0.74
FIRST FL	S14	56	8	0.20	108	177	1.20	1.36	56	208	373	1.80	1.00
FIRST FL	S66	82	8	0.20	151	204	1.20	1.13	82	358	1725	1.80	2.68
FIRST FL	SF1	33	10	0.32	77	101	1.20	1.10	33	98	151	1.80	0.86
FIRST FL	*SF2*	33	10	0.32	77	172	1.20	1.87	33	98	185	1.80	1.05
FIRST FL	*SF3*	33	10	0.32	77	144	1.20	1.56	33	98	214	1.80	1.22
FIRST FL	*SF4*	33	10	0.32	77	146	1.20	1.58	33	98	213	1.80	1.21
FIRST FL	SA5	24	10	0.32	56	65	1.44	0.81	24	53	118	2.12	1.04
BASE	S14	70	10	0.32	163	265	1.20	1.35	70	304	452	1.80	0.82
BASE	S15	70	10	0.32	163	353	1.20	1.80	70	304	839	1.80	1.53
BASE	S64	58	10	0.32	135	191	1.20	1.18	58	216	1015	1.80	2.62
BASE	S65	44	10	0.32	103	119	1.46	0.79	44	132	208	2.14	0.74
BASE	S66	58	10	0.32	135	178	1.20	1.10	58	216	1038	1.80	2.68
BASE	S67	44	10	0.32	103	139	1.20	1.13	44	132	484	1.80	2.03
BASE	S68	44	10	0.32	103	154	1.20	1.25	44	132	545	1.80	2.29
BASE	SA5	48	10	0.32	112	146	1.20	1.09	48	178	720	1.80	2.25


Elevation View - A (Existing Building w/ Flexible Base)
ROOF
SECOND FL
FIRST FL
BASE
0.81 / 1.04
1.09 / 2.25

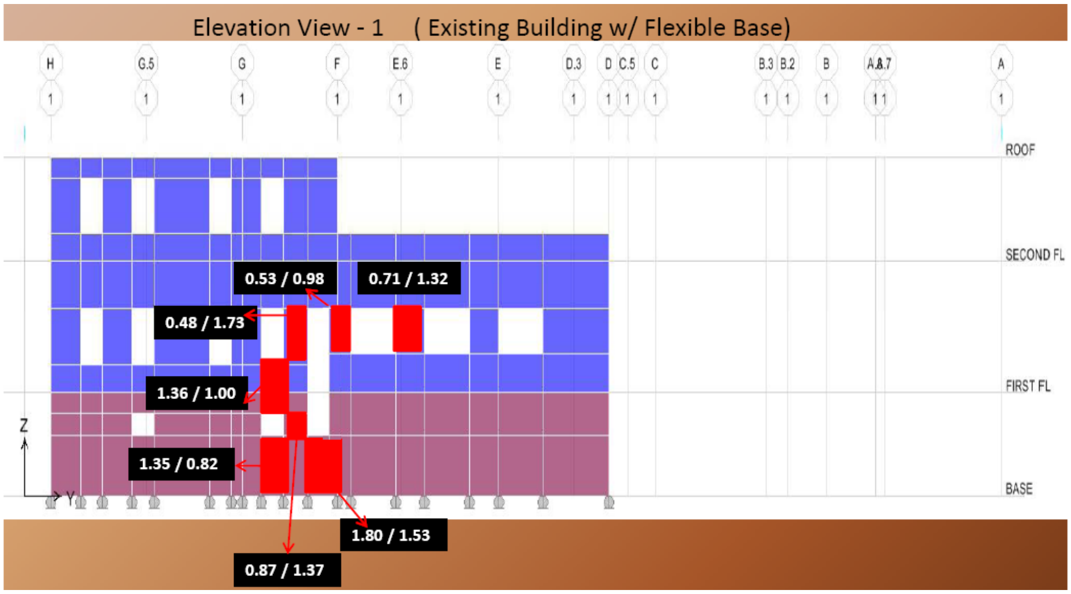

Elevation View - C (Existing Building w/ Flexible Base)
ROOF
SECOND FL
FIRST FL
BASE
1.34 / 0.74
0.44/ 1.22
0.48 / 1.09

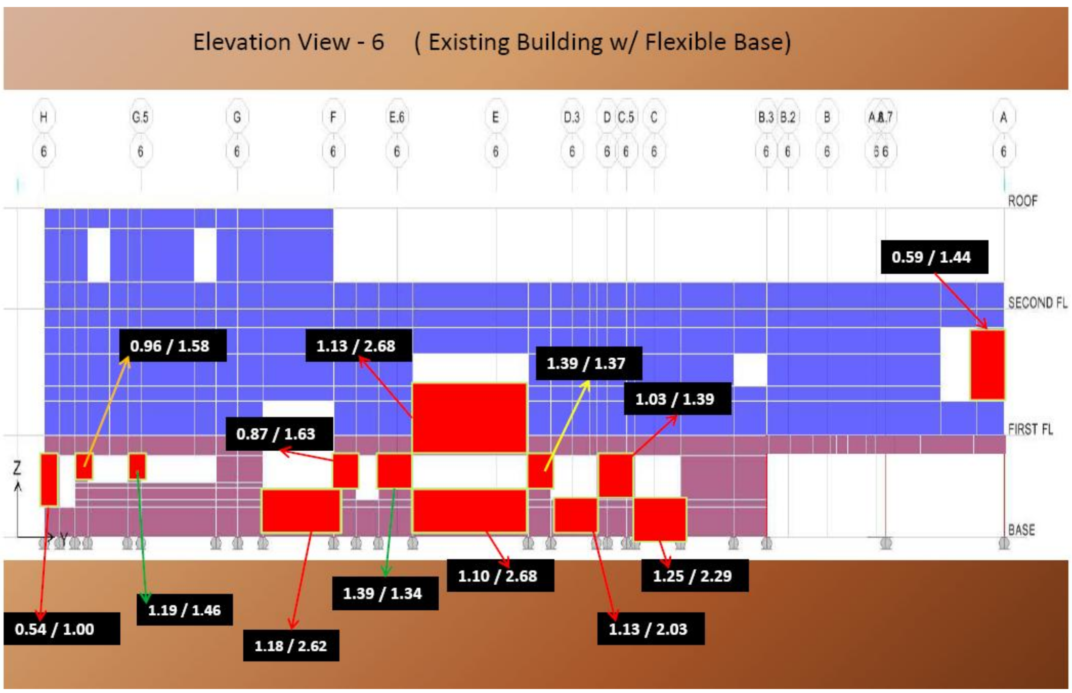


Elevation View - E (Existing Building w/ Flexible Base)
ROOF
SECOND FL
FIRST FL
BASE
0.32 / 1.35



Elevation View - F (Existing Building w/ Flexible Base)
ROOF
SECOND FL
FIRST FL
BASE
0.47 / 2.05
1.10 / 0.86
1.87 / 1.05
1.56/ 1.22
1.58 / 1.21


Elevation View - 1 (Existing Building w/ Flexible Base)
ROOF
SECOND FL
FIRST FL
BASE
0.53 / 0.98
0.71 / 1.32
0.48 / 1.73
1.36 / 1.00
1.35 / 0.82
1.80 / 1.53
0.87 / 1.37


Elevation View - 6 (Existing Building w/ Flexible Base)
ROOF
SECOND FL
FIRST FL
BASE
0.59 / 1.44
0.96 / 1.58
1.13 / 2.68
1.39 / 1.37
1.03 / 1.39
0.87 / 1.63
1.10 / 2.68
1.25 / 2.29
1.39 / 1.34
1.19 / 1.46
0.54 / 1.00
1.18 / 2.62
1.13 / 2.03

Wall DCR CHECK (MCE @ CP)

Note: Tables list the piers and spandrels with the shear or/and flexural DCR ≥ 1.0 only

EXISTING CONCRETE WALL PIER DCR CHECK - EXISTING BUILDING w/ FLEXIBLE BASE

For Shear Check			ϕ = 1.0	Shear m-factor		For Flexural Check
8" wall #4@18" H. ea. Face As =	0.27	in²/ft	f'c = 2.5 ksi	IO & LS	2	8" wall #4@24" v. ea. Face
10" wall #4@15" H. ea. Face As =	0.32	in²/ft	fy = 50 ksi	CP	3	10" wall #4@12" v. ea. Face

Select Earthquake Hazard Level: **MCE**

Select Performance Level: **CP**

Story	PierLbl	PierLen (inch)	PierThk (inch)	$A_{s\ existing}$/ft (in^2/ft)	ϕV_n (kips)	V_u (kips)	Shear DCR	DesignLen (inch)	ϕM_n (ft-k)	M_u (ft-k)	P_u (kips)	Flexural m-Factor	Flexural DCR
SECOND FL	P15	54	8	0.27	103	142	0.46	54	163	413	98	2.00	1.26
SECOND FL	P16	36	8	0.27	69	93	0.45	36	82	305	143	2.00	1.85
SECOND FL	P17	35	8	0.27	67	104	0.52	35	80	253	87	2.38	1.33
SECOND FL	P18	52	8	0.27	99	205	0.69	52	158	452	51	2.00	1.43
SECOND FL	P19	52	8	0.27	99	176	0.59	54	163	384	44	2.00	1.18
SECOND FL	P51	50	8	0.27	96	99	0.35	50	151	543	105	1.75	2.05
SECOND FL	P64	51	8	0.27	97	173	0.59	50	151	664	72	2.00	2.20
SECOND FL	PF7	34	8	0.27	65	85	0.43	33	73	311	123	2.10	2.02
SECOND FL	PC6	51	8	0.27	97	136	0.47	51	154	537	66	2.00	1.74
SECOND FL	PC7	42	8	0.27	80	103	0.43	42	97	389	24	2.00	2.01
SECOND FL	PE2	24	8	0.27	46	36	0.26	24	34	140	49	1.75	2.32
FIRST FL	P16	36	10	0.32	84	212	0.84	36	108	413	149	2.17	1.76
FIRST FL	P61	28	10	0.32	65	105	0.53	28	82	263	54	2.00	1.60
FIRST FL	P62	23	10	0.32	54	152	0.94	23	50	228	87	2.24	2.04
FIRST FL	P63	36	10	0.32	84	300	1.19	36	108	414	185	1.97	1.95
FIRST FL	P65	41	10	0.32	96	248	0.86	41	151	548	101	2.00	1.81
FIRST FL	P66	62	10	0.32	145	594	1.37	62	310	1220	193	2.38	1.65
FIRST FL	P67	65	10	0.32	152	629	1.38	65	326	1289	230	2.29	1.73
FIRST FL	P68	70	10	0.32	163	486	0.99	70	351	1065	158	2.00	1.52
FIRST FL	PG3	34	10	0.32	79	59	0.25	34	101	236	103	1.75	1.33

EXISTING CONCRETE WALL SPANDREL DCR CHECK - EXISTING BUILDING w/FLEXIBLE BASE

For Shear Check			ϕ = 1.0	For Flexural Check
8" wall #4@24" V. ea. Face As =	0.20	in²/ft	f'c = 2.5 ksi	8" wall #4@18" H. ea. Face
10" wall #4@12"V.IF. #4@20"V.OF. =	0.32	in²/ft	fy = 50 ksi	10" wall #4@15" H. ea. Face

Select Earthquake Hazard Level: **MCE**

Select Performance Level: **CP**

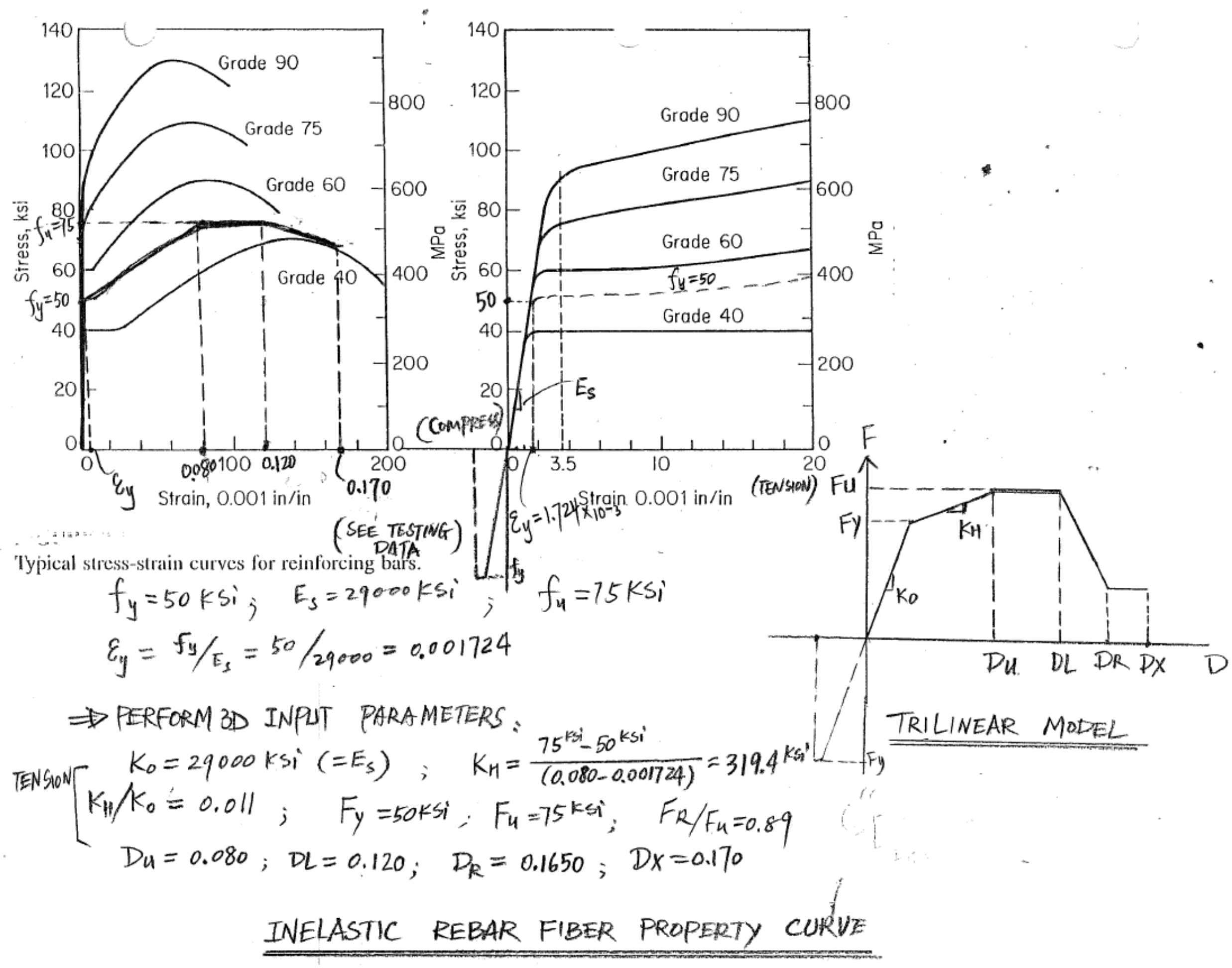
Story	SpandLbl	SpandHt (inch)	SpandThk (inch)	$A_{s\ existing}$/ft (in^2/ft)	ϕV_n (kips)	V_u (kips)	Shear m-Factor	Shear DCR	DesignHt (inch)	ϕM_n (ft-k)	M_u (ft-k)	Flexural m-Factor	Flexural DCR
SECOND FL	S65	206	8	0.20	336	541	1.50	1.07	206	1757	1335	2.50	0.30
SECOND FL	S66	86	8	0.20	140	178	1.91	0.66	86	374	1534	3.18	1.29
SECOND FL	S67	206	8	0.20	336	589	1.50	1.17	206	1757	1163	2.50	0.26
SECOND FL	SF8	63	8	0.20	103	176	1.50	1.14	54	163	375	2.50	0.92
SECOND FL	SF9	63	8	0.20	103	192	1.50	1.25	54	163	291	2.50	0.71
SECOND FL	SD4	20	8	0.20	33	57	1.50	1.16	20	43	93	2.50	0.86
SECOND FL	SC4	62	8	0.20	101	226	1.50	1.49	62	231	441	2.50	0.76
SECOND FL	SC5	62	8	0.20	101	195	1.50	1.28	62	231	393	2.50	0.68
SECOND FL	SA5	98	8	0.20	160	247	1.50	1.03	90	392	468	2.50	0.48
SECOND FL	S60	54	8	0.20	88	151	1.50	1.14	54	163	420	2.50	1.03
FIRST FL	S12	56	8	0.20	91	172	1.50	1.25	54	163	314	2.50	0.77
FIRST FL	S13	32	8	0.20	52	79	1.50	1.01	24	53	134	2.50	1.00
FIRST FL	S14	56	8	0.20	108	254	1.50	1.57	56	208	536	2.50	1.03
FIRST FL	S17	44	8	0.20	72	118	1.50	1.09	44	132	418	2.50	1.26
FIRST FL	S21	64	10	0.32	149	231	1.50	1.03	64	278	169	2.50	0.24
FIRST FL	S66	82	8	0.20	151	301	1.50	1.33	82	358	2577	2.50	2.88
FIRST FL	SF1	33	10	0.32	77	142	1.50	1.23	33	98	212	2.50	0.87
FIRST FL	SF2	33	10	0.32	77	250	1.50	2.16	33	98	267	2.50	1.09
FIRST FL	SF3	33	10	0.32	77	214	1.50	1.85	33	98	317	2.50	1.30
FIRST FL	SF4	33	10	0.32	77	207	1.50	1.79	33	98	303	2.50	1.24
FIRST FL	SA5	24	10	0.32	56	94	1.50	1.12	24	53	172	2.50	1.29
FIRST FL	S60	64	8	0.20	105	208	1.50	1.33	64	239	660	2.50	1.10
BASE	S12	70	10	0.32	163	265	1.50	1.08	65	242	439	2.50	0.72
BASE	S14	70	10	0.32	163	382	1.50	1.56	70	304	653	2.50	0.86
BASE	S15	70	10	0.32	163	502	1.50	2.05	70	304	1196	2.50	1.57
BASE	S61	36	10	0.32	84	132	1.50	1.05	36	132	200	2.50	0.61
BASE	S64	58	10	0.32	135	276	1.50	1.36	58	216	1470	2.50	2.73
BASE	S65	44	10	0.32	103	175	1.50	1.13	44	132	312	2.50	0.94
BASE	S66	58	10	0.32	135	254	1.50	1.25	58	216	1515	2.50	2.81
BASE	S67	44	10	0.32	103	201	1.50	1.30	44	132	704	2.50	2.13
BASE	S68	44	10	0.32	103	223	1.50	1.45	44	132	792	2.50	2.40
BASE	SA5	48	10	0.32	112	215	1.50	1.28	48	178	1065	2.50	2.40

APPENDIX F: NSP ANALYSIS – PERFORM 3D MODEL:

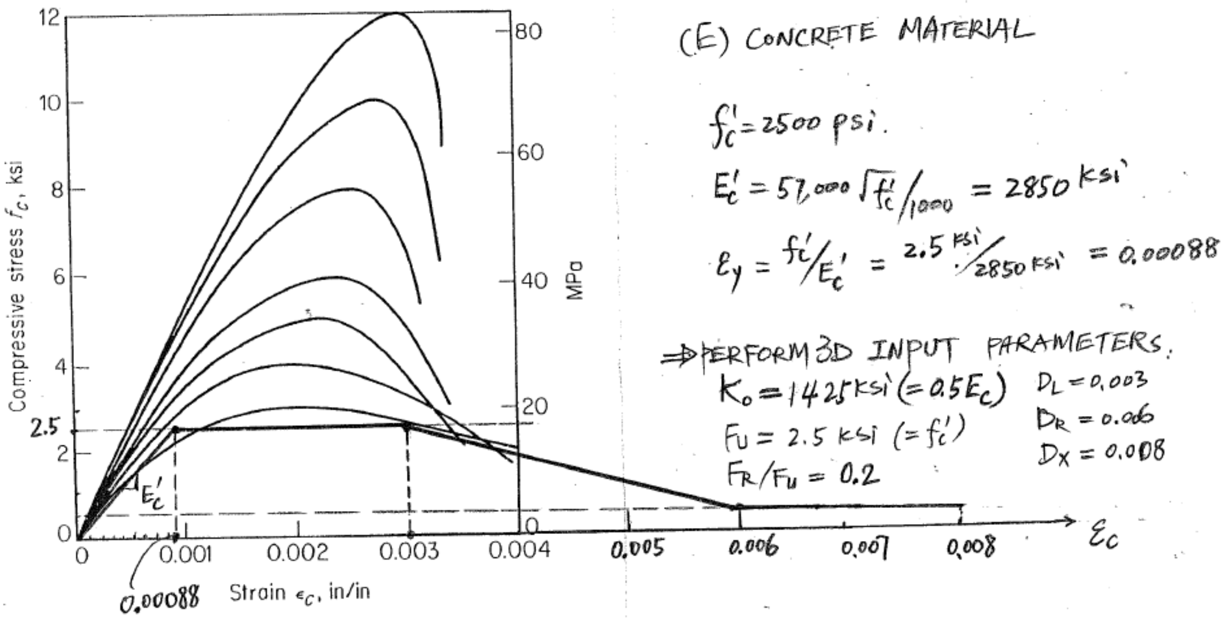
In the Nonlinear Static Procedure (NSP), the model directly incorporates the non-linear load-deformation characteristics of individual elements of the building. Finite elements in the PERFORM model have the capacity of modeling nonlinear stress-strain behavior. The structure is analyzed subject to monotonically increasing lateral loads (Push-Over) representing the inertia forces in an earthquake until a target displacement is exceeded. The target displacement is intended to represent the maximum displacement likely to be experienced during the design earthquake.

NONLINEAR STRESS-STRAIN BACKBONE CURVES

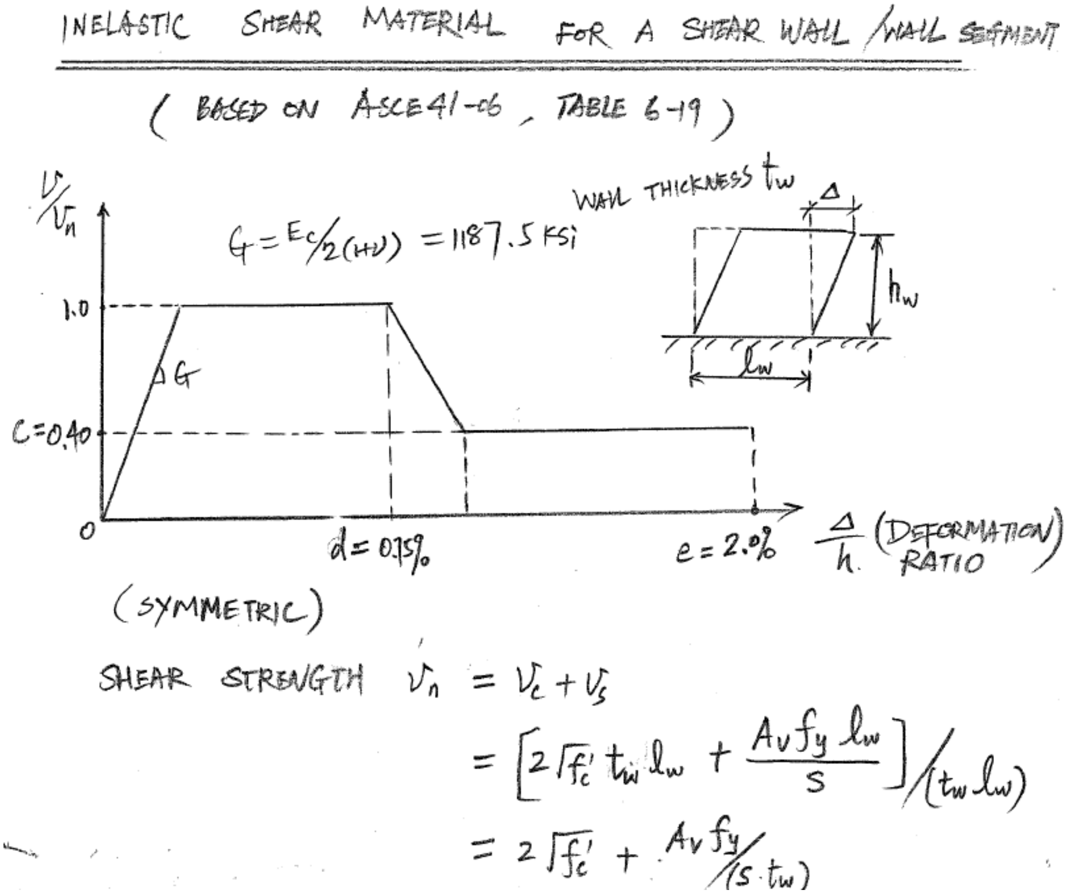
1). Inelastic Reinforcing Bar:



2). Inelastic Concrete Compression Property:



3). Inelastic Concrete Shear Property:



PERFORM Model Input Parameters:

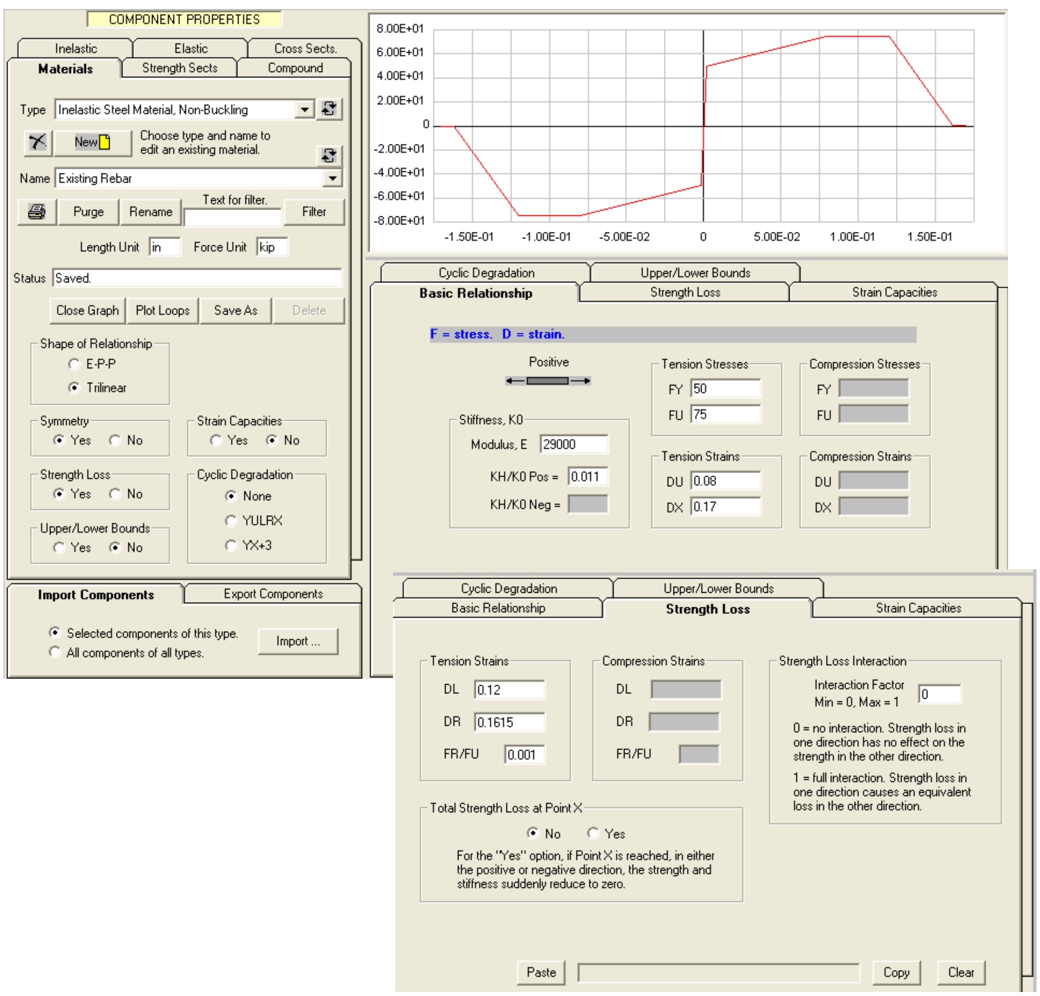
$K_0 = G_c = 0.4\ E_c/2(1+\nu) = 475$ ksi ; $F_u = v_n$ (Varies, see the following table);

$D_L = 0.75\%$; $D_R = 0.85\%$; $F_R/F_u = 0.40$; $D_X = 2\%$

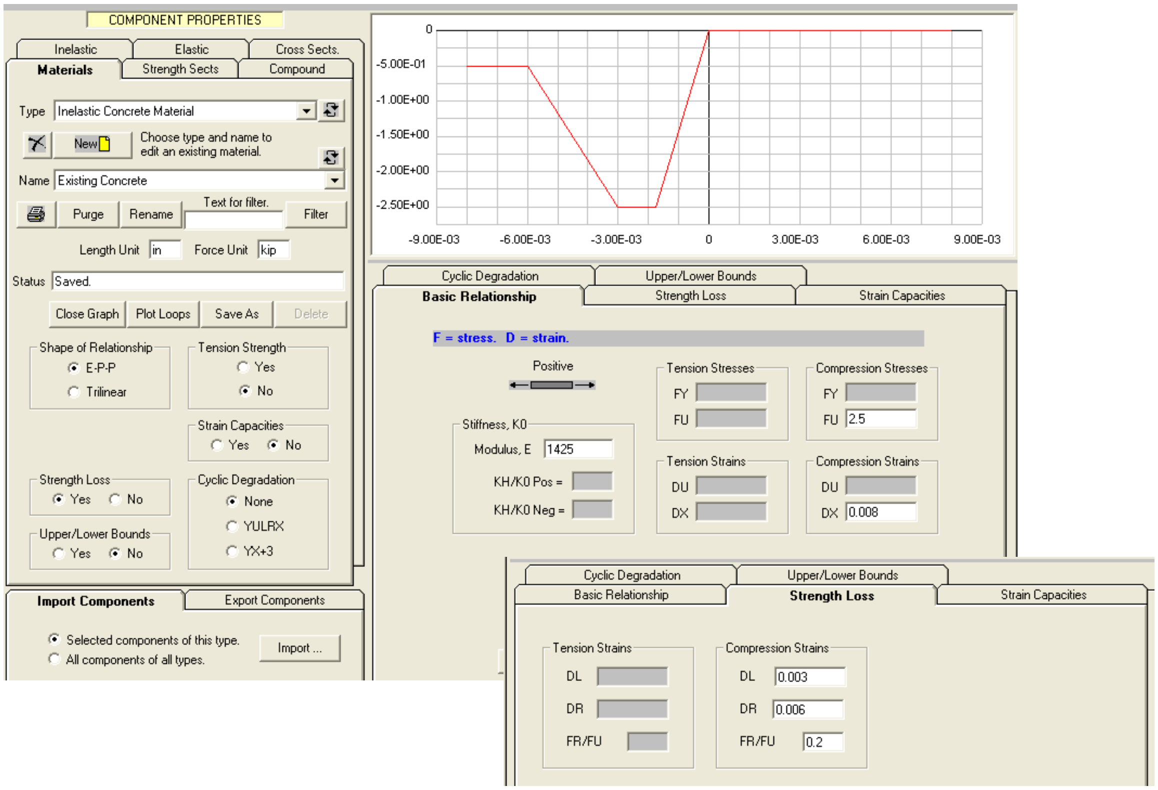
Shear Stress Capacity v_n						
	(E) f_y =	50	(ksi)			
	(E) f_c' =	2500	(psi)			
	$v_c = 2\sqrt{(fc')}$ =	0.1000	(ksi)			
	$6\sqrt{(fc')}$ =	**0.3000**	**(ksi)**			
Existing Wall t_w (in)	Reinforcing (*)-Layer	As (in2)	s (in)	v_s (ksi)	v_n (ksi)	$v_n / \sqrt{(f_c')}$
8	(2) #4@18" (H)	0.4	18	0.1389	0.2389	4.8
8	(2) #4@24" (V)	0.4	24	0.1042	0.2042	4.1
10	(2) #4@15" (H)	0.4	15	0.1333	0.2333	4.7
10	(2) #4@14" (V)	0.4	14	0.1429	0.2429	4.9
10	#4@12" (V.I.F), #4@20" (V.O.F)	0.32	12	0.1333	0.2333	4.7

PERFORM INPUT PROPERTIES

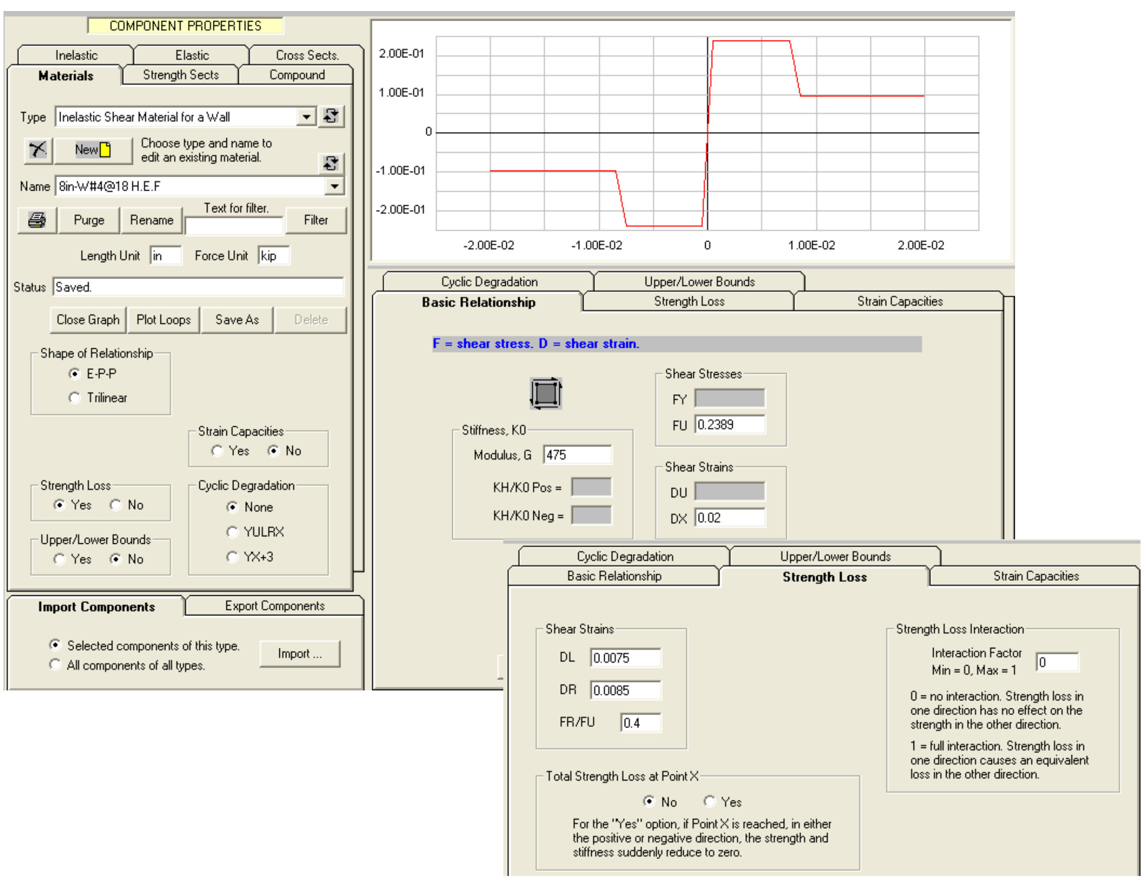
1). Existing Rebar:



2). Existing Concrete Compression Material Property:



3). Existing Concrete Shear Property:



TARGET DISPLACEMENT CALCULATION (EXISTING STRUCTURE)

TARGET DISPLACEMENT CALCULATION (Based on ASCE 41-06)

(EXISTING BUILDING)

C_m =	0.8				(TABLE 3-1)
C_0 =	1.2				(TABLE 3-2)
S_{XS} =	S_{MS} =	$F_a S_S$ =	2.047 g		(Eq. 1-4)
S_{X1} =	S_{M1} =	$F_v S_1$ =	1.173 g		(Eq. 1-5)
$B_1 = 4/[5.6\text{-}\ln(100\beta)]$ =			1.0024 ;	β = 5.0%	(Eq. 1-3)
T_S =	S_{X1}/S_{XS} =	0.573 sec			(Eq. 1-13)
T_0 =	$0.2\ T_S$ =	0.1146 sec			(Eq. 1-12)
H =	390 in	(Total Building height)			
Total WT =	5751 k				
a =	60	(For Site Class D)			
g =	386.4				

Along X-Direction: 2nd Mode & Period T_2 = 0.09232 sec

Based on Pushover Curve along X-Direction

Initial : V_i = 2005 k — Yielding : V_y = 6928 k

d_i = 1.069E-04 — d_y = 4.020E-04

$K_i = V_i/(d_i\ xH)$= 4.8092E+04 — $K_e = V_y/(d_y\ xH)$= 4.4189E+04

$T_e = T_i\ \sqrt{(K_i/K_e)}$= 0.09631 sec (Eq. 3-13)

S_a = 1.8469 (Eq.1-8~10)

$R = S_a C_m/(V_y/W)$= 1.2265

$C_1 = 1+(R-1)/(aT_e^2)$ = 1.4069

$C_2 = 1+[(R-1)/T_e]^2/800$ = 1.0069

Target Displacement: $\delta_{t,X} = C_0\ C_1 C_2\ S_a\ T_e^2 g\ /(4\pi^2)$ = 0.2850 in (Eq. 3-14)

Drift Ratio : $\Delta_{t,X}$ = **0.073%**

Along Y-Direction: 1st Mode & Period T_1 = 0.10840 sec

Based on Pushover Curve along Y-Direction

Initial : V_i = 1499 k — Yielding : V_y = 4605 k

d_i = 1.262E-04 — d_y = 4.106E-04

$K_i = V_i/(d_i\ xH)$= 3.0456E+04 — $K_e = V_y/(d_y\ xH)$= 2.8757E+04

$T_e = T_i\ \sqrt{(K_i/K_e)}$= 0.11156 sec (Eq. 3-13)

S_a = 2.0096 (Eq.1-8~10)

$R = S_a C_m/(V_y/W)$= 2.0078

$C_1 = 1+(R-1)/(aT_e^2)$ = 2.3497

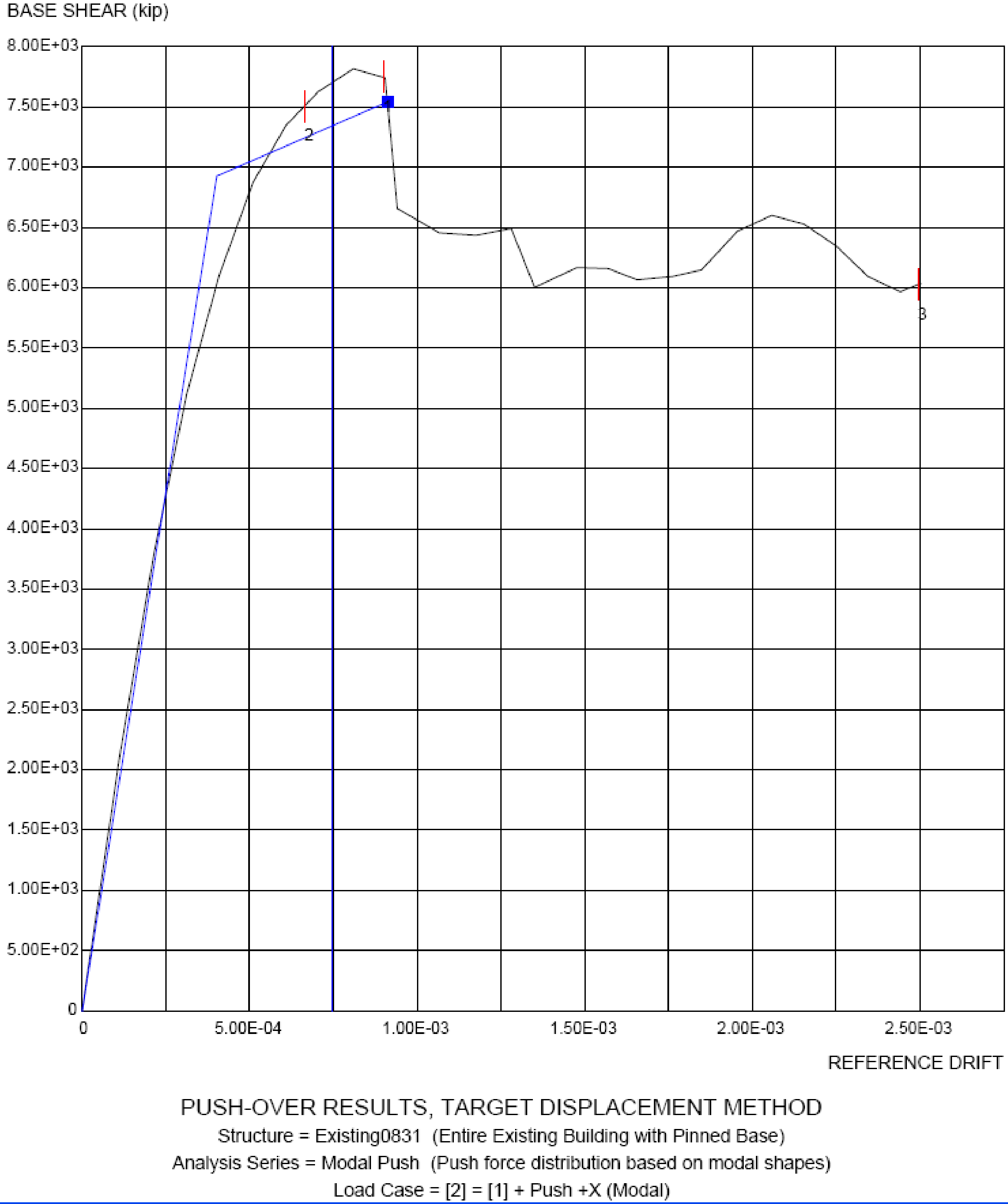
$C_2 = 1+[(R-1)/T_e]^2/800$ = 1.1020

Target Displacement: $\delta_{t,X} = C_0\ C_1 C_2\ S_a\ T_e^2 g\ /(4\pi^2)$ = 0.7606 in (Eq. 3-14)

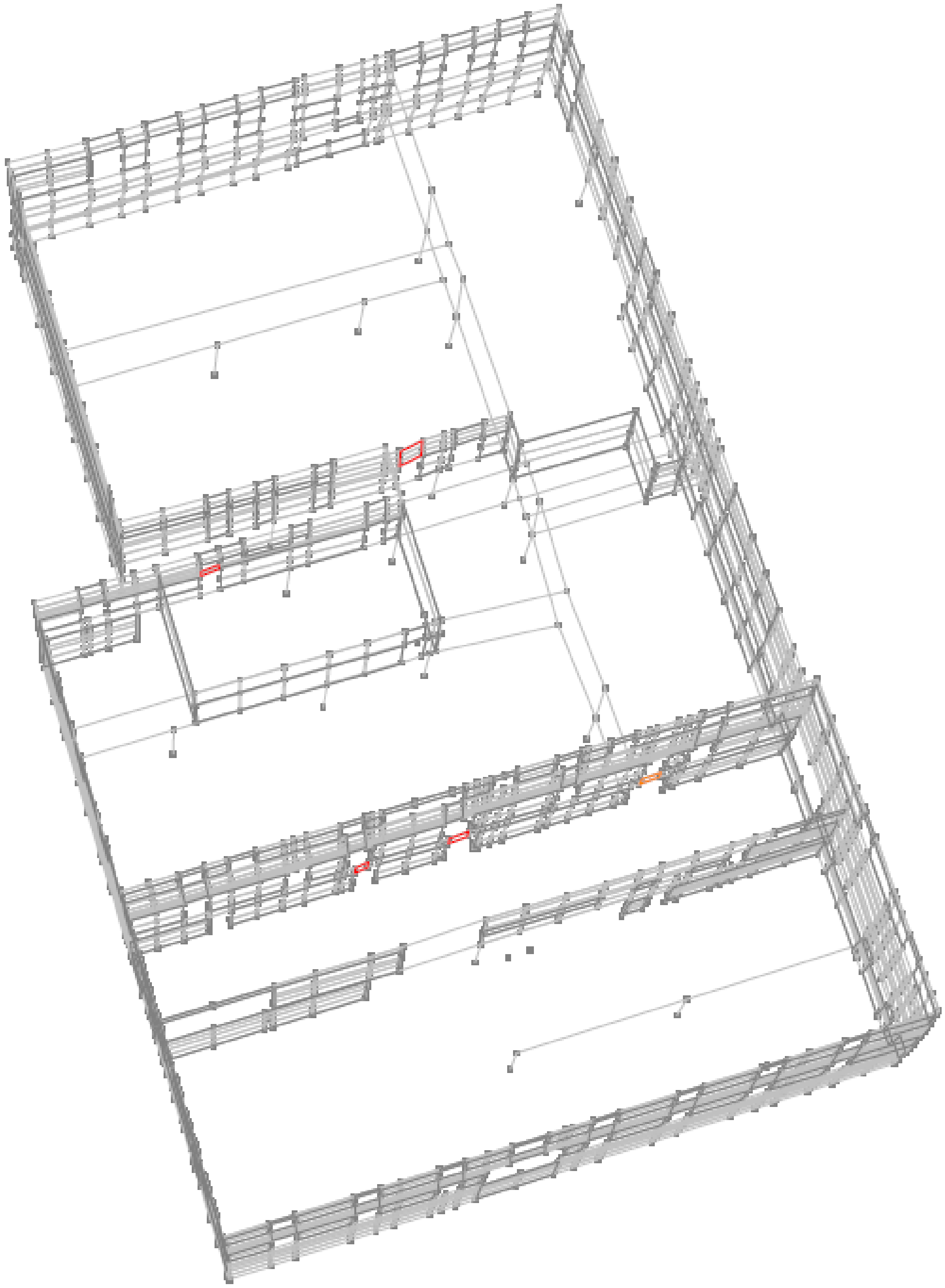
Drift Ratio : $\Delta_{t,X}$ = **0.195%**

PUSHOVER CURVES (EXISTING STRUCTURE)

1). Pushover Along X-Direction



Note: In the pushover curve above, the red mark 1 indicates the wall rotation (bending) limit at LS performance; and the red mark 2 indicates the wall shear strain limit (shear) at LS performance. The curve shows that the existing wall shear fails before the target displacement and wall bending failure. See the following figure for the shear failure locations.



DEFLECTED SHAPE SHOWING ELEMENT USAGE RATIOS

Structure = Existing0831 (Entire Existing Building with Pinned Base)

Analysis Series = Modal Push (Push force distribution based on modal shapes)

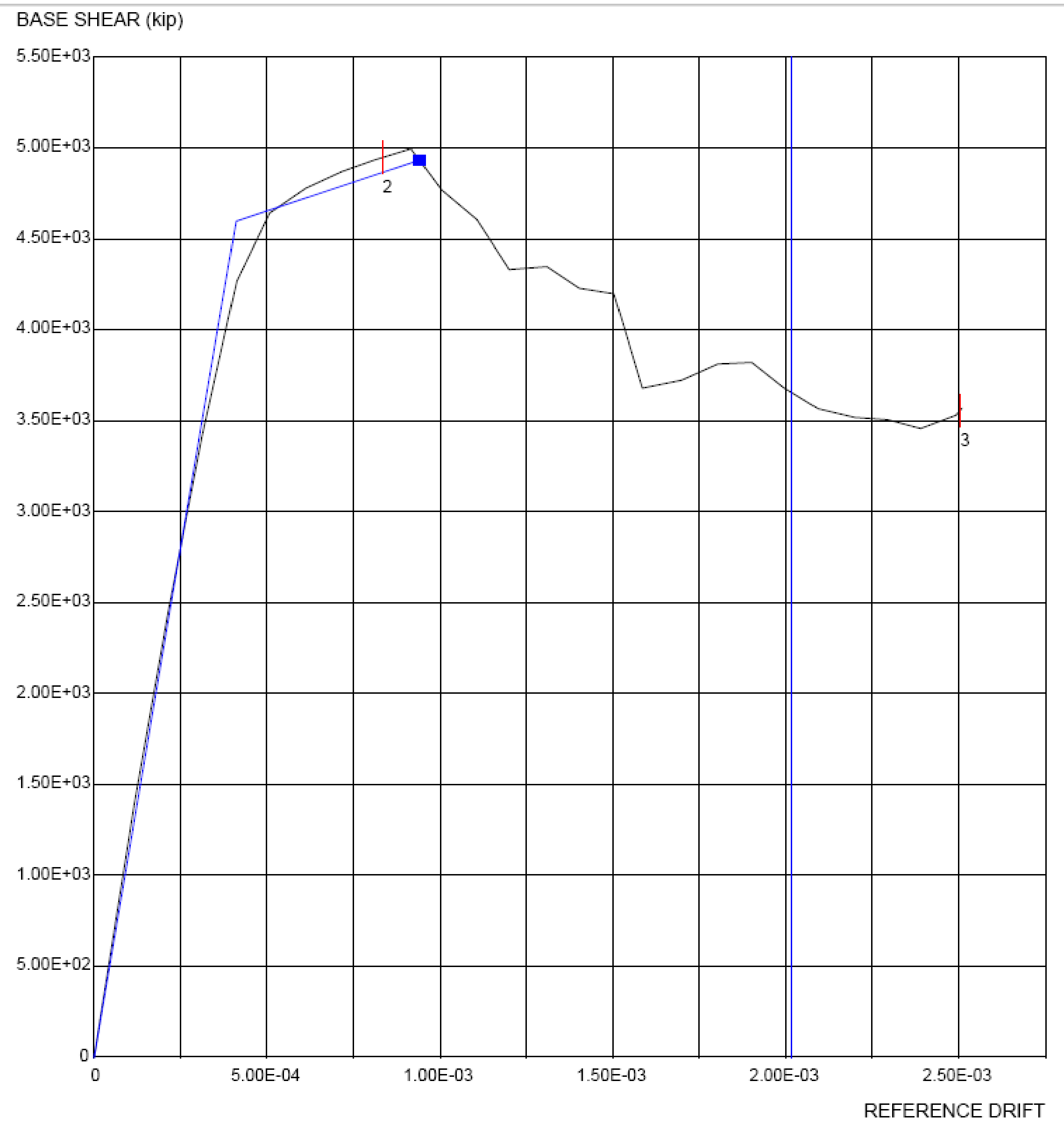
Load Case = [2] = [1] + Push +X (Modal)

Reference Drift = 9.044e-4

Limit state group = Wall Shear Strain

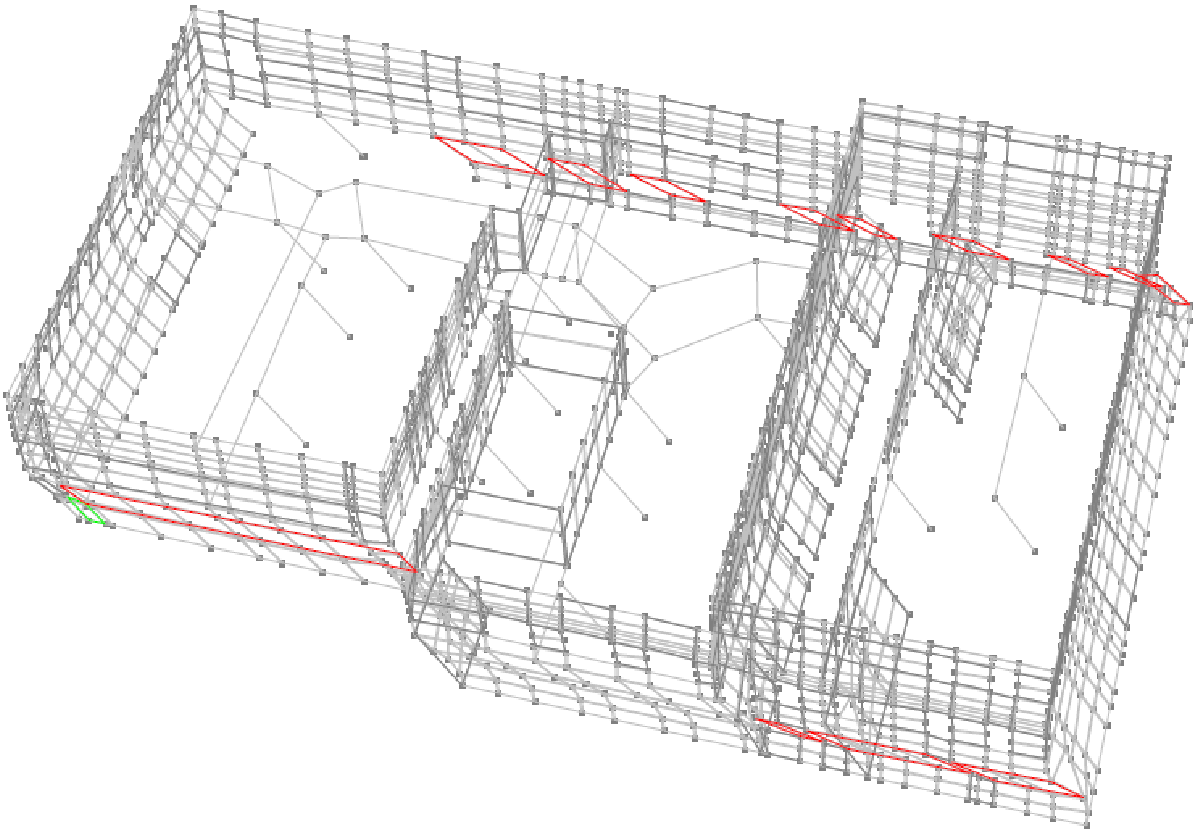
Minimum usage ratio for each color : 0.0 0.7 0.8 0.9 1

2). Pushover Along Y-Direction



PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Existing0831 (Entire Existing Building with Pinned Base)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [3] = [1] + Push +Y (Modal)

Note: In the pushover curve above, the red mark 2 indicates the wall shear strain limit (shear) at LS performance. The curve shows that the existing wall shear fails before the target displacement, and the stiffness degradation of the existing structure occurs away before the target displacement since the wall piers along Grids 1, 2 and 6 lost the shear stiffness. See the following figure for the shear failure locations.



DEFLECTED SHAPE SHOWING ELEMENT USAGE RATIOS
Structure = Existing0831 (Entire Existing Building with Pinned Base)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [3] = [1] + Push +Y (Modal)
Reference Drift = 0.001699
Limit state group = Wall Shear Strain
Minimum usage ratio for each color : 0.0 0.7 0.8 0.9 1

TARGET DISPLACEMENT CALCULATION (RETROFITTED STRUCTURE)

Based on the pushover analysis of the existing structure, the retrofit scheme was proposed to use the shotcrete and fiber reinforced polymers (FRP) to strengthen the existing wall piers and spandrels where were shown as shear/bending failure of the existing structure. See the proposed retrofit schematic drawings for detail. The pushover analyses were performed for two load combinations $Q_G \pm Q_E = 1.1(DL + ¼ LL) \pm Q_E$ and $Q_G \pm Q_E = 0.9 DL \pm Q_E$; and four directions Positive/Negative X-direction and Positive/Negative Y-direction.

Shear capacity of shotcrete wall and new concrete wall:

Retofitted Wall t_w (in)	Reinforcing (*)-Layer	As (in2)	s (in)	v_s (ksi)	v_n (ksi)	v_n / √ (f_c')
(E)10” wall + (N) 8” shotcete wall	(2) #4@15" (H) + (N)#6@12"	0.76	12	0.1759	0.2759	5.5
(N) 8” Wall	(N) #6@12" (H)	0.44	12	0.2750	0.4015	6.3
(N) 8” Wall	(N) f_y = 60 (ksi) (N) f_c' = 4000 (psi)					

Shear capacity of FRP wall by using Tyfo SEH51A:

Shear capacity of one layer Tyfo SEH51A = 1.74 kips per ft of wall, where efficiency factor k =0.75 for one-side bonding to a wall. Therefore, the shear capacity for 8” spandrel with vertical reinforcing of #4@24” each face can be increased to $6\sqrt{(f_c')}$ = $6\sqrt{(2500)}/1000$ = 0.3 ksi by applying 3 layers Tyfo SEH51A on each side of wall.

TARGET DISPLACEMENT CALCULATION (Based on ASCE 41-06)

(RETROFITTED BUILDING)

C_m =	0.8				(TABLE 3-1)
C_0 =	1.2				(TABLE 3-2)
S_{XS} =	S_{MS} =	$F_a S_S$ =	2.047 g		(Eq. 1-4)
S_{X1} =	S_{M1} =	$F_v S_1$ =	1.173 g		(Eq. 1-5)
B_1 =	4/[5.6-ln(100β)] =		1.0024	β = 5%	(Eq. 1-3)
T_S =	S_{X1}/S_{XS} =	0.573 sec			(Eq. 1-13)
T_0 =	0.2 T_S =	0.1146 sec			(Eq. 1-12)
H =	390 in	(Total Building height)			
Total WT =	5751 k				
a =	60	(For Site Class D)			
g =	386.4				

Load Case: $Q_G \pm Q_E = 1.1(DL + ¼\ LL) \pm Q_E$

Along Positive X-Direction:	2nd Mode & Period T_2 =0.08763 sec				
Based on Pushover Curve along X-Direction					
Initial : V_i =	2002 k		Yielding : V_y =	7312 k	
d_i =	1.026E-04		d_y =	4.042E-04	
K_i =	$V_i/(d_i\ xH)$=	5.0032E+04	K_e =	$V_y/(d_y\ xH)$=	4.6385E+04
T_e =	$T_i\sqrt{(K_i/K_e)}$=	0.09101 sec			(Eq. 3-13)
S_a =	1.7903				(Eq.1-8~10)
	$R = S_aC_m/(V_y/W)$=	1.1265			
	$C_1 = 1+(R-1)/(aT_e^2)$ =	1.2545			
	$C_2 = 1+[(R-1)/T_e]^2/800$ =	1.0024			
Target Displacement:			$\delta_{t,X} = C_0\ C_1C_2\ S_a\ T_e^2g\ /(4\pi^2)$ =	0.2190 in	(Eq. 3-14)
Drift Ratio :	$\Delta_{t,X}$ =	**0.056%**			
Along Positive Y-Direction:	1st Mode & Period T_1 =0.10090 sec				
Based on Pushover Curve along Y-Direction					
Initial : V_i =	1512 k		Yielding : V_y =	7185 k	
d_i =	1.155E-04		d_y =	6.308E-04	
K_i =	$V_i/(d_i\ xH)$=	3.3566E+04	K_e =	$V_y/(d_y\ xH)$=	2.9206E+04
T_e =	$T_i\sqrt{(K_i/K_e)}$=	0.10817 sec			(Eq. 3-13)
S_a =	1.9735				(Eq.1-8~10)
	$R = S_aC_m/(V_y/W)$=	1.2637			
	$C_1 = 1+(R-1)/(aT_e^2)$ =	1.3756			
	$C_2 = 1+[(R-1)/T_e]^2/800$ =	1.0074			
Target Displacement:			$\delta_{t,Y} = C_0\ C_1C_2\ S_a\ T_e^2g\ /(4\pi^2)$ =	0.3758 in	(Eq. 3-14)
Drift Ratio :	$\Delta_{t,Y}$ =	**0.096%**			

Load Case: $Q_G \pm Q_E = 1.1(DL + ¼ LL) \pm Q_E$

Along Negative X-Direction:	2nd Mode & Period T_2 =0.08763 sec				
Based on Pushover Curve along X-Direction					
Initial : V_i =	2002 k		Yielding : V_y =	7361 k	
d_i =	1.026E-04		d_y =	3.999E-04	
K_i =	$V_i/(d_i\, xH)$=	5.0032E+04	K_e =	$V_y/(d_y\, xH)$=	4.7198E+04
T_e =	$T_i \sqrt{(K_i/K_e)}$=	0.09022 sec			(Eq. 3-13)
S_a =	1.7819				(Eq.1-8~10)
	$R = S_aC_m/(V_y/W)$=	1.1137			
	$C_1 = 1+(R-1)/(aT_e^2)$ =	1.2328			
	$C_2 = 1+[(R-1)/T_e]^2/800$ =	1.0020			
Target Displacement:			$\delta_{t,X} = C_0\, C_1C_2\, S_a\, T_e^2 g/(4\pi^2)$ =	0.2104 in	(Eq. 3-14)
Drift Ratio :	$\Delta_{t,X}$ =	**0.054%**			

Along Negative Y-Direction:	1st Mode & Period T_1 =0.10090 sec				
Based on Pushover Curve along Y-Direction					
Initial : V_i =	1512 k		Yielding : V_y =	6773 k	
d_i =	1.155E-04		d_y =	5.988E-04	
K_i =	$V_i/(d_i\, xH)$=	3.3566E+04	K_e =	$V_y/(d_y\, xH)$=	2.9002E+04
T_e =	$T_i \sqrt{(K_i/K_e)}$=	0.10855 sec			(Eq. 3-13)
S_a =	1.9775				(Eq.1-8~10)
	$R = S_aC_m/(V_y/W)$=	1.3433			
	$C_1 = 1+(R-1)/(aT_e^2)$ =	1.4856			
	$C_2 = 1+[(R-1)/T_e]^2/800$ =	1.0125			
Target Displacement:			$\delta_{t,Y} = C_0\, C_1C_2\, S_a\, T_e^2 g/(4\pi^2)$ =	0.4116 in	(Eq. 3-14)
Drift Ratio :	$\Delta_{t,Y}$ =	**0.106%**			

Load Case: $Q_G \pm Q_E = 0.9\ DL \pm Q_E$

Along Positive X-Direction: 2nd Mode & Period T_2 = 0.08763 sec

Based on Pushover Curve along X-Direction

Initial : V_i =	2012 k	Yielding : V_y =	7096 k
d_i =	1.048E-04	d_y =	4.063E-04
K_i =	$V_i/(d_i\, xH)$= 4.9227E+04	K_e =	$V_y/(d_y\, xH)$= 4.4782E+04

T_e = $T_i \sqrt{(K_i/K_e)}$= 0.09188 sec (Eq. 3-13)

S_a = 1.7995 (Eq.1-8~10)

$R = S_aC_m/(V_y/W)$= 1.1668

$C_1 = 1+(R-1)/(aT_e^2)$ = 1.3292

$C_2 = 1+[(R-1)/T_e]^2/800$ = 1.0041

Target Displacement: $\delta_{t,X} = C_0\, C_1C_2\, S_a\, T_e^2 g/(4\pi^2)$ = 0.2381 in (Eq. 3-14)

Drift Ratio : $\Delta_{t,X}$ = **0.061%**

Along Positive Y-Direction: 1st Mode & Period T_1 = 0.10090 sec

Based on Pushover Curve along Y-Direction

Initial : V_i =	1502 k	Yielding : V_y =	7204 k
d_i =	1.176E-04	d_y =	6.544E-04
K_i =	$V_i/(d_i\, xH)$= 3.2749E+04	K_e =	$V_y/(d_y\, xH)$= 2.8227E+04

T_e = $T_i \sqrt{(K_i/K_e)}$= 0.10868 sec (Eq. 3-13)

S_a = 1.9789 (Eq.1-8~10)

$R = S_aC_m/(V_y/W)$= 1.2638

$C_1 = 1+(R-1)/(aT_e^2)$ = 1.3723

$C_2 = 1+[(R-1)/T_e]^2/800$ = 1.0074

Target Displacement: $\delta_{t,Y} = C_0\, C_1C_2\, S_a\, T_e^2 g/(4\pi^2)$ = 0.3795 in (Eq. 3-14)

Drift Ratio : $\Delta_{t,Y}$ = **0.097%**

Load Case: $Q_G \pm Q_E = 0.9$ DL$\pm Q_E$

Along Negative X-Direction: 2nd Mode & Period T_2 =0.08763 sec

Based on Pushover Curve along X-Direction

Initial : V_i = 2002 k Yielding : V_y = 7185 k

d_i = 1.048E-04 d_y = 3.999E-04

K_i = $V_i/(d_i\,xH)$= 4.8982E+04 K_e = $V_y/(d_y\,xH)$= 4.6069E+04

T_e = $T_i\sqrt{(K_i/K_e)}$= 0.09036 sec (Eq. 3-13)

S_a = 1.7833 (Eq.1-8~10)

$R = S_aC_m/(V_y/W)$= 1.1419

$C_1 = 1+(R-1)/(aT_e^2)$ = 1.2897

$C_2 = 1+[(R-1)/T_e]^2/800$ = 1.0031

Target Displacement: $\delta_{t,X} = C_0\,C_1C_2\,S_a\,T_e^2g\,/(4\pi^2)$ = 0.2212 in (Eq. 3-14)

Drift Ratio : $\Delta_{t,X}$ = **0.057%**

Along Negative Y-Direction: 1st Mode & Period T_1 =0.10090 sec

Based on Pushover Curve along Y-Direction

Initial : V_i = 1502 k Yielding : V_y = 6576 k

d_i = 1.198E-04 d_y = 5.988E-04

K_i = $V_i/(d_i\,xH)$= 3.2148E+04 K_e = $V_y/(d_y\,xH)$= 2.8159E+04

T_e = $T_i\sqrt{(K_i/K_e)}$= 0.10781 sec (Eq. 3-13)

S_a = 1.9696 (Eq.1-8~10)

$R = S_aC_m/(V_y/W)$= 1.3780

$C_1 = 1+(R-1)/(aT_e^2)$ = 1.5420

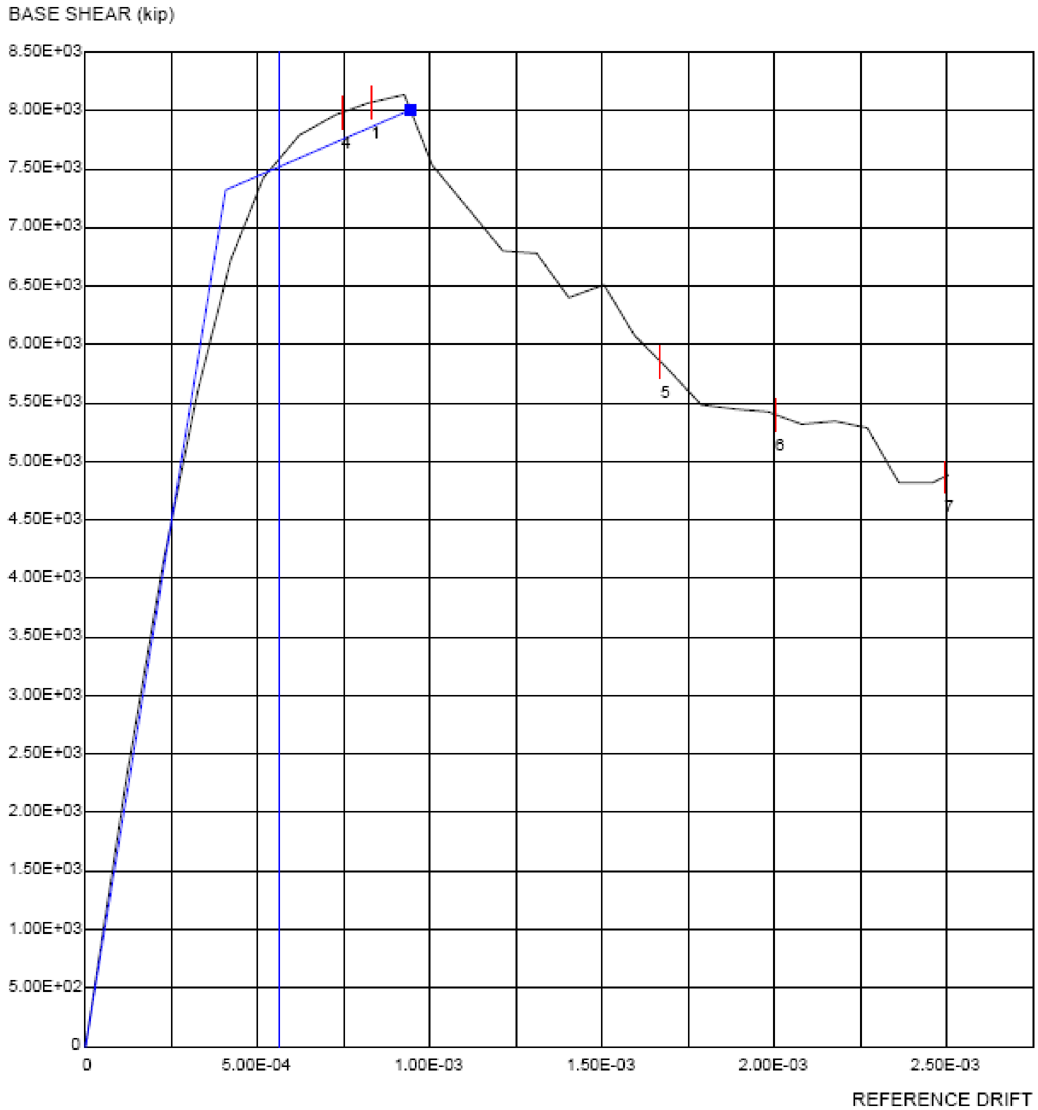
$C_2 = 1+[(R-1)/T_e]^2/800$ = 1.0154

Target Displacement: $\delta_{t,Y} = C_0\,C_1C_2\,S_a\,T_e^2g\,/(4\pi^2)$ = 0.4210 in (Eq. 3-14)

Drift Ratio : $\Delta_{t,Y}$ = **0.108%**

PUSHOVER CURVES (RETROFITTED STRUCTURE)

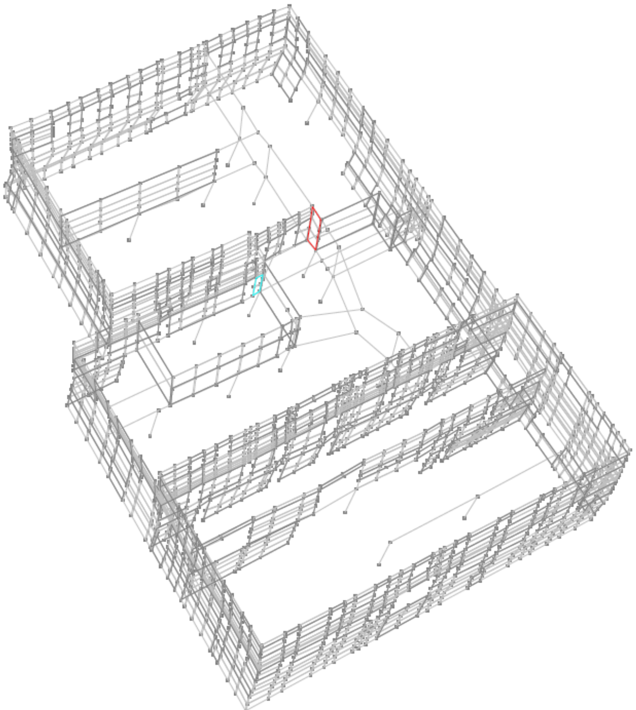
1). Pushover Along Positive X-Direction with **Load Case: $Q_G \pm Q_E = 1.1(DL + ¼ LL) \pm Q_E$**



PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [2] = [1] + Push +X (Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.7903g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.6552 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.2545 (user value). Te (sec) = 0.09118, Sa = 1.79g, Cm = 0, Ratio R = 0.
C2 = 1.0024 (user value). C3 = 1 (user value).
Target Drift = 5.637e-4

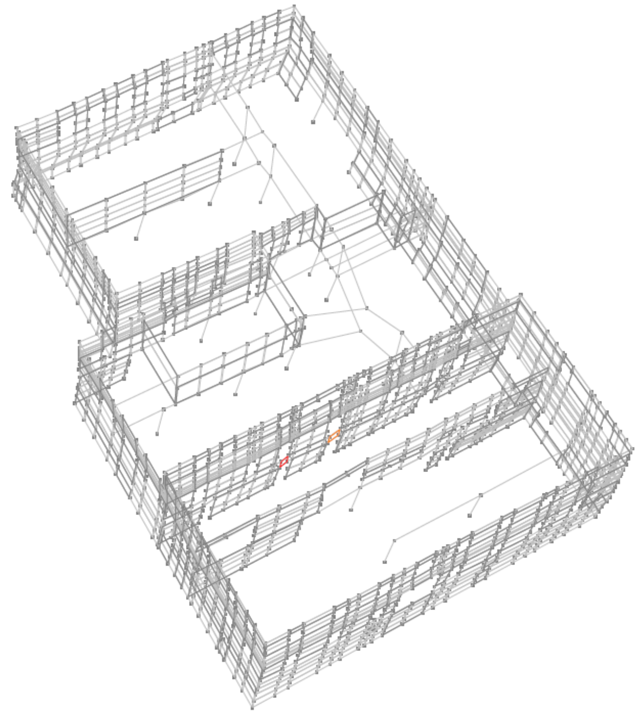
NOTE: Red mark 1 indicates the wall rotation limit at IO performance level; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All limits occur after the target displacement (0.056%). See the following pictures for the locations of the first wall rotation / shear strain reaching the IO performance level after the target displacement.

Wall Rotation at IO Performance:



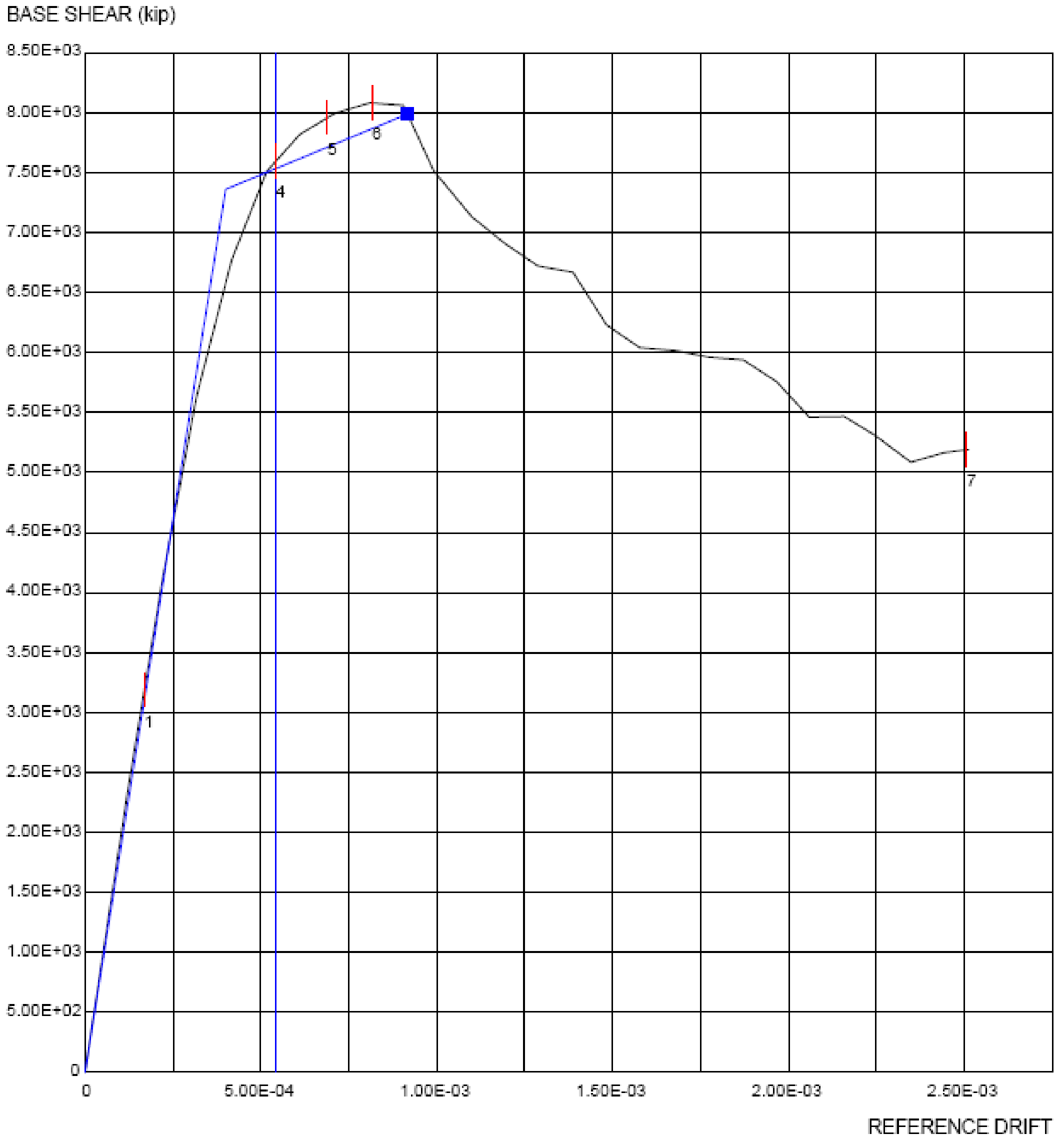
DEFLECTED SHAPE SHOWING ELEMENT USAGE RATIOS
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [2] = [1] + Push +X (Modal)
Reference Drift = 9.254e-4
Limit state group = Wall Rotation -IO
Minimum usage ratio for each color : 0.0 0.7 0.8 0.9 1

Wall Shear Strain at IO Performance:



DEFLECTED SHAPE SHOWING ELEMENT USAGE RATIOS
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [2] = [1] + Push +X (Modal)
Reference Drift = 8.208e-4
Limit state group = Wall Shear Strain -IO
Minimum usage ratio for each color : 0.0 0.7 0.8 0.9 1

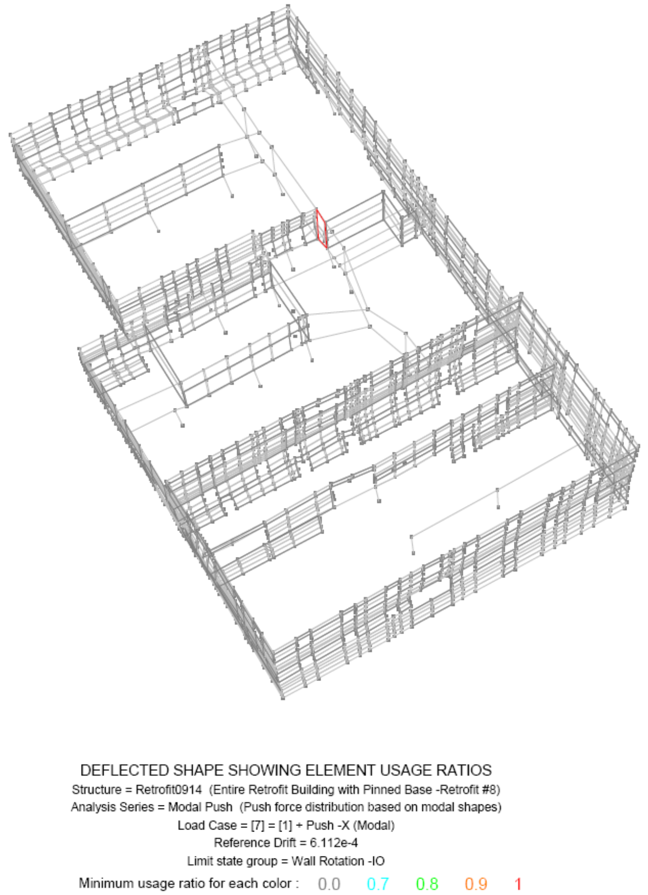
2). Pushover Along Negative X-Direction with **Load Case: $Q_G \pm Q_E = 1.1(DL + ¼\ LL) \pm Q_E$**



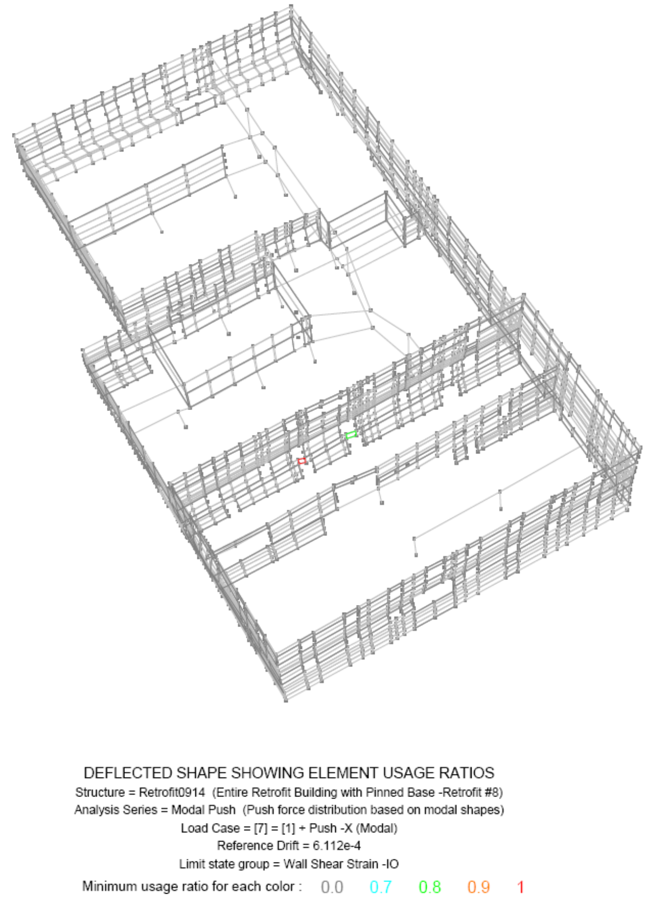
PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [7] = [1] + Push -X (Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.7819g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.65829 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.2328 (user value). Te (sec) = 0.09026, Sa = 1.782g, Cm = 0, Ratio R = 0.
C2 = 1.002 (user value). C3 = 1 (user value).
Target Drift = 5.401e-4

NOTE: Red mark 1 indicates the wall rotation limit at IO performance level, and it occurs before the target displacement (0.054%), see the following page for the location; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All shear limits occur at / after the target displacement (0.054%).

Wall Rotation at IO Performance:

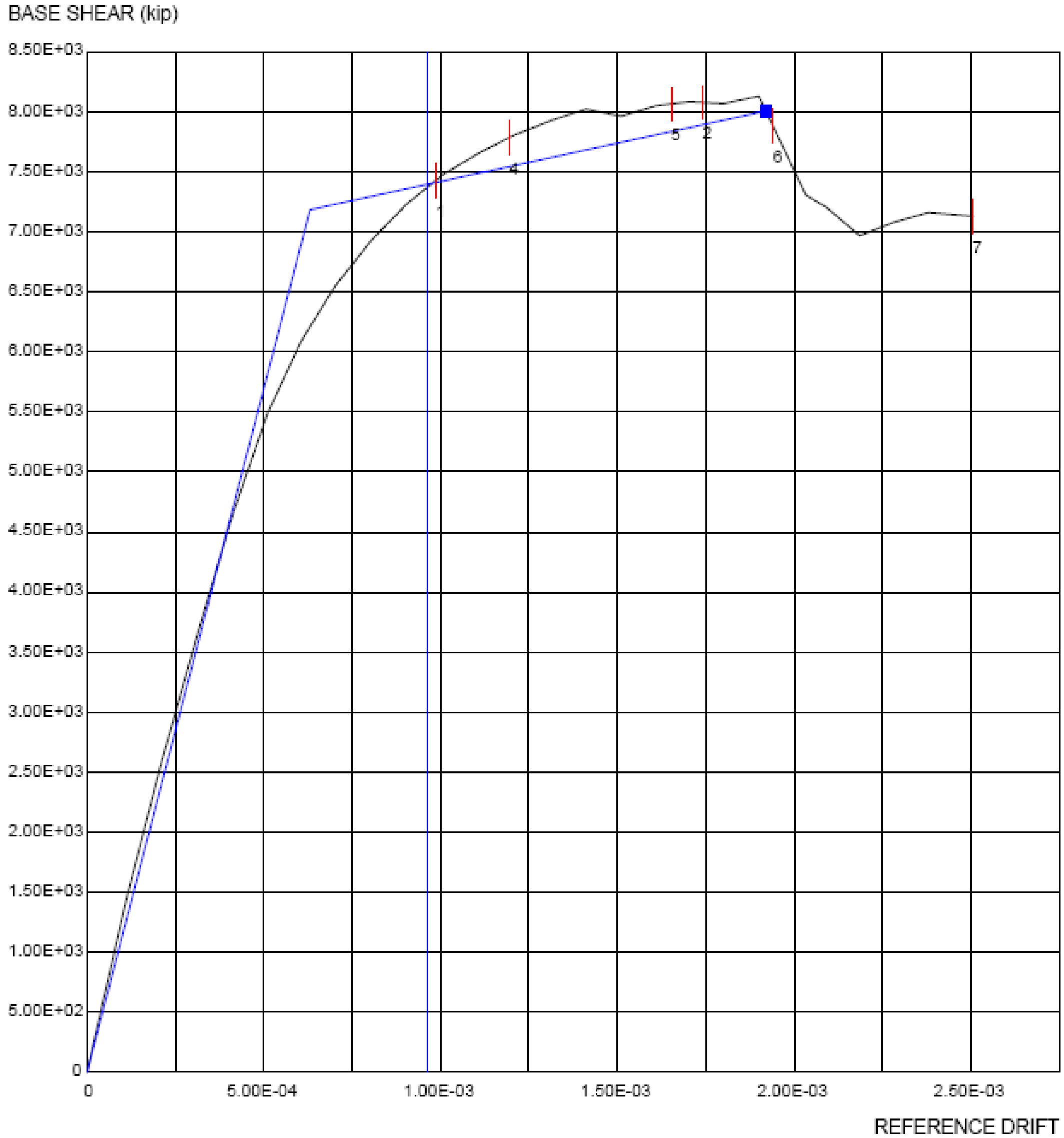


Wall Shear Strain at IO Performance:



NOTE: Red-marked Pier indicates the wall rotation exceeds the limit at IO performance level, and it should be saw-cut three sides of pier to turn into a non-bearing wall (see the schematic drawings – Appendix H). The right-side picture shows, the first spandrel location (Grid-F) which shear strain reaches the shear strain limit at IO performance.

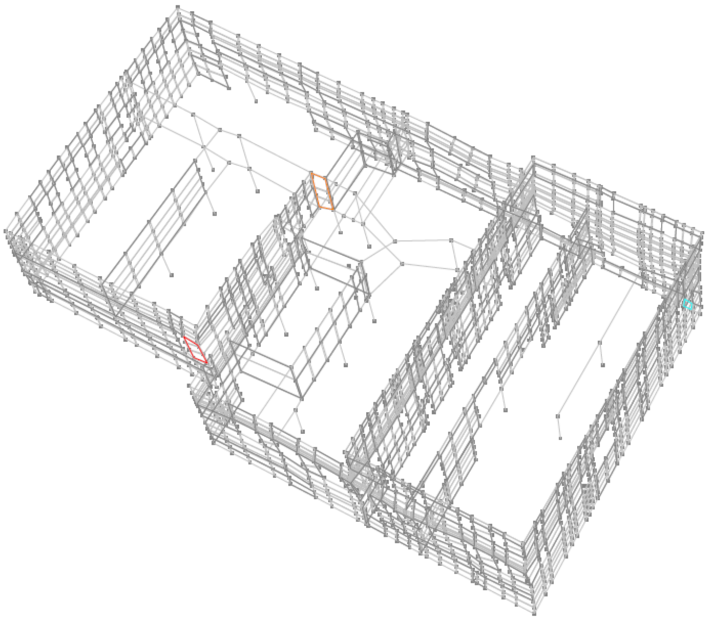
3). Pushover Along Positive Y-Direction with **Load Case:** $Q_G \pm Q_E = 1.1(DL + 1/4\ LL) \pm Q_E$



PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [3] = [1] + Push +Y (Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.9735g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.59438 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.3756 (user value). Te (sec) = 0.1082, Sa = 1.974g, Cm = 0, Ratio R = 0.
C2 = 1.0074 (user value). C3 = 1 (user value).
Target Drift = 9.647e-4

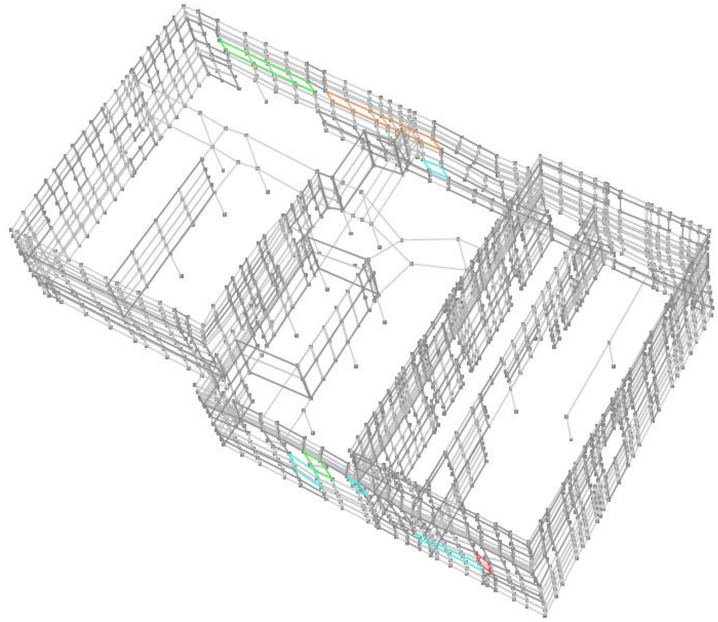
NOTE: Red marks 1 and 2 indicate the wall rotation limit at IO and LS performance levels; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All limits occur after the target displacement (0.096%). See the following pictures for the locations of the first wall rotation / shear strain reaching the IO performance level after the target displacement.

Wall Rotation at IO Performance:



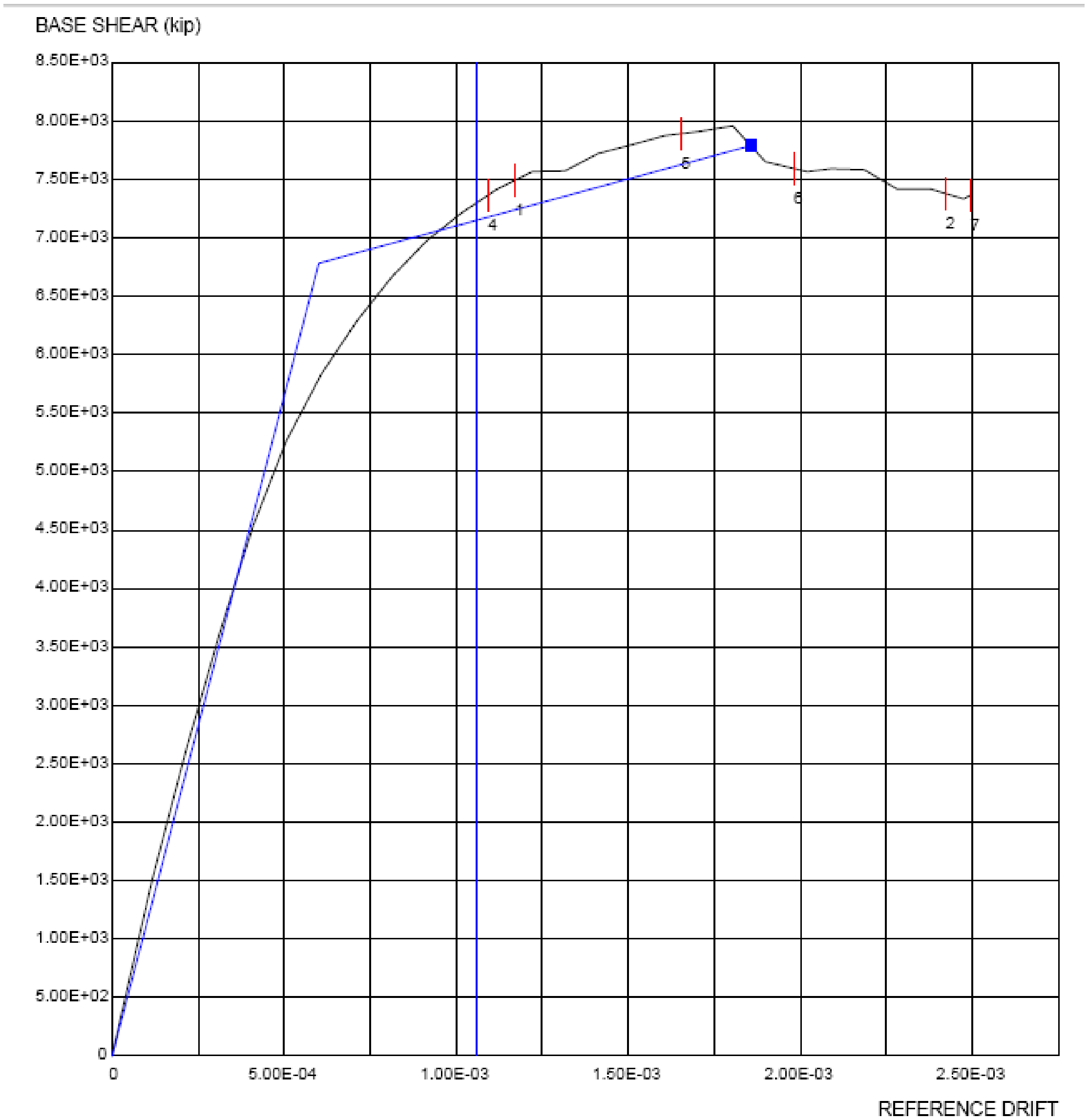
DEFLECTED SHAPE SHOWING ELEMENT USAGE RATIOS
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [3] = [1] + Push +Y (Modal)
Reference Drift = 0.001007
Limit state group = Wall Rotation -IO
Minimum usage ratio for each color : 0.0 0.7 0.8 0.9 1

Wall Shear Strain at IO Performance:



DEFLECTED SHAPE SHOWING ELEMENT USAGE RATIOS
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [3] = [1] + Push +Y (Modal)
Reference Drift = 0.001209
Limit state group = Wall Shear Strain -IO
Minimum usage ratio for each color : 0.0 0.7 0.8 0.9 1

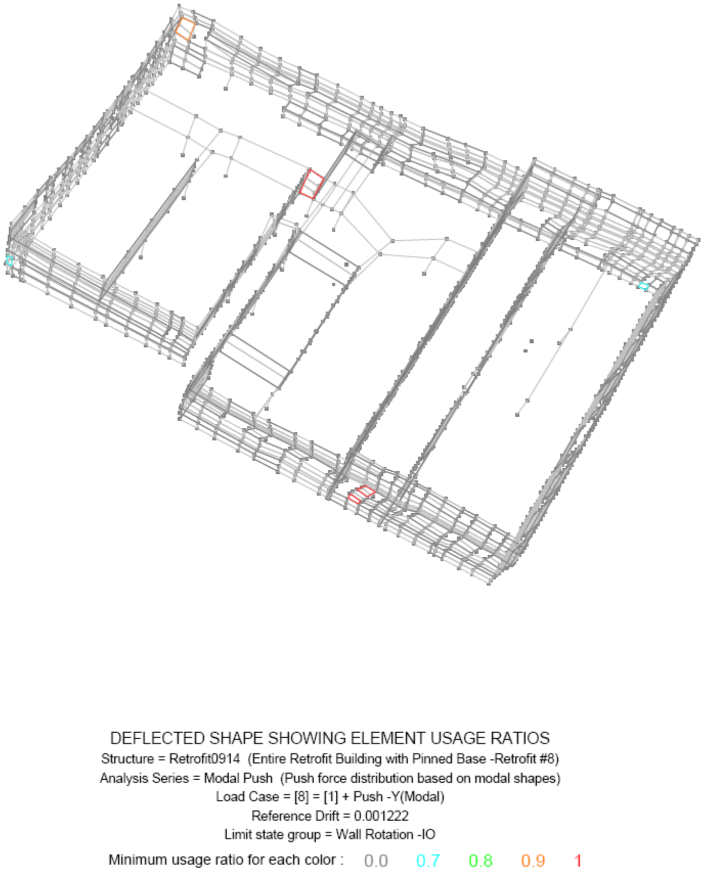
4). Pushover Along Negative Y-Direction with **Load Case: $Q_G \pm Q_E$ = 1.1(DL + ¼ LL) ± Q_E**



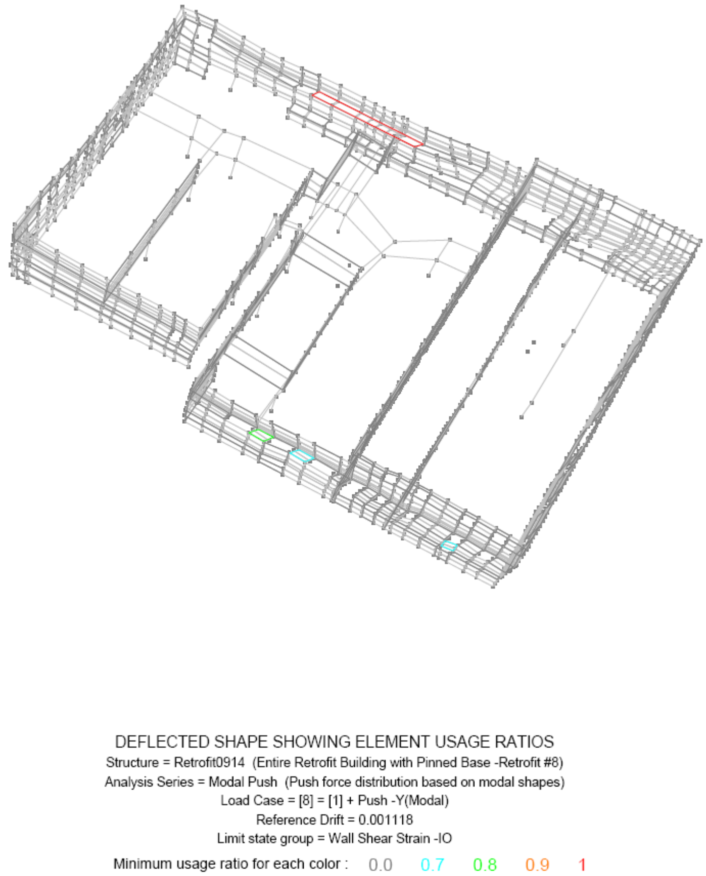
PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [8] = [1] + Push -Y(Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.9775g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.59317 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.4856 (user value). Te (sec) = 0.1087, Sa = 1.978g, Cm = 0, Ratio R = 0.
C2 = 1.0125 (user value). C3 = 1 (user value).
Target Drift = 0.001059

NOTE: Red marks 1 and 2 indicate the wall rotation limit at IO and LS performance levels; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All limits occur after the target displacement (0.106%). See the following pictures for the locations of the first wall rotation / shear strain reaching the IO performance level after the target displacement.

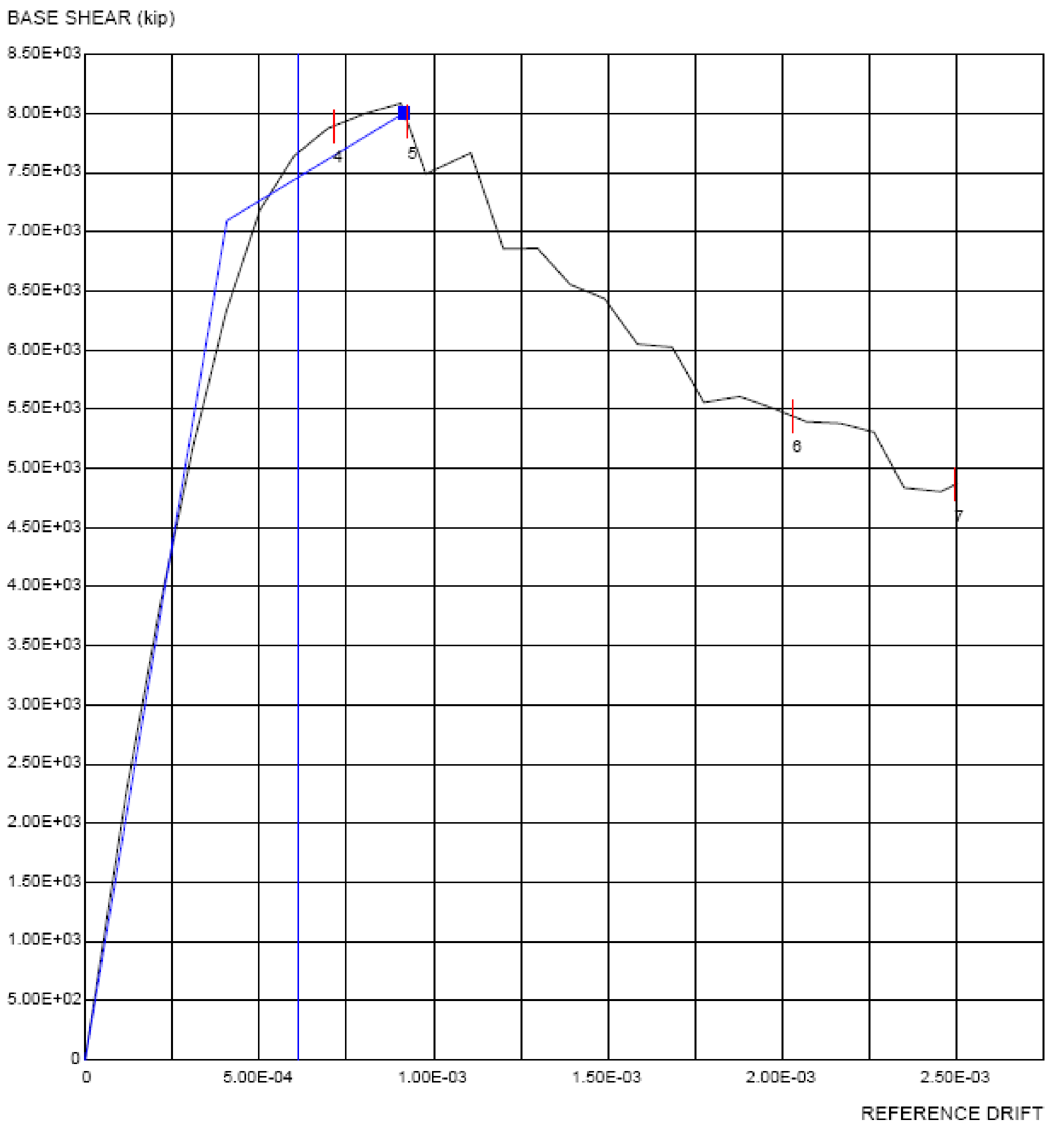
Wall Rotation at IO Performance:



Wall Shear Strain at IO Performance:



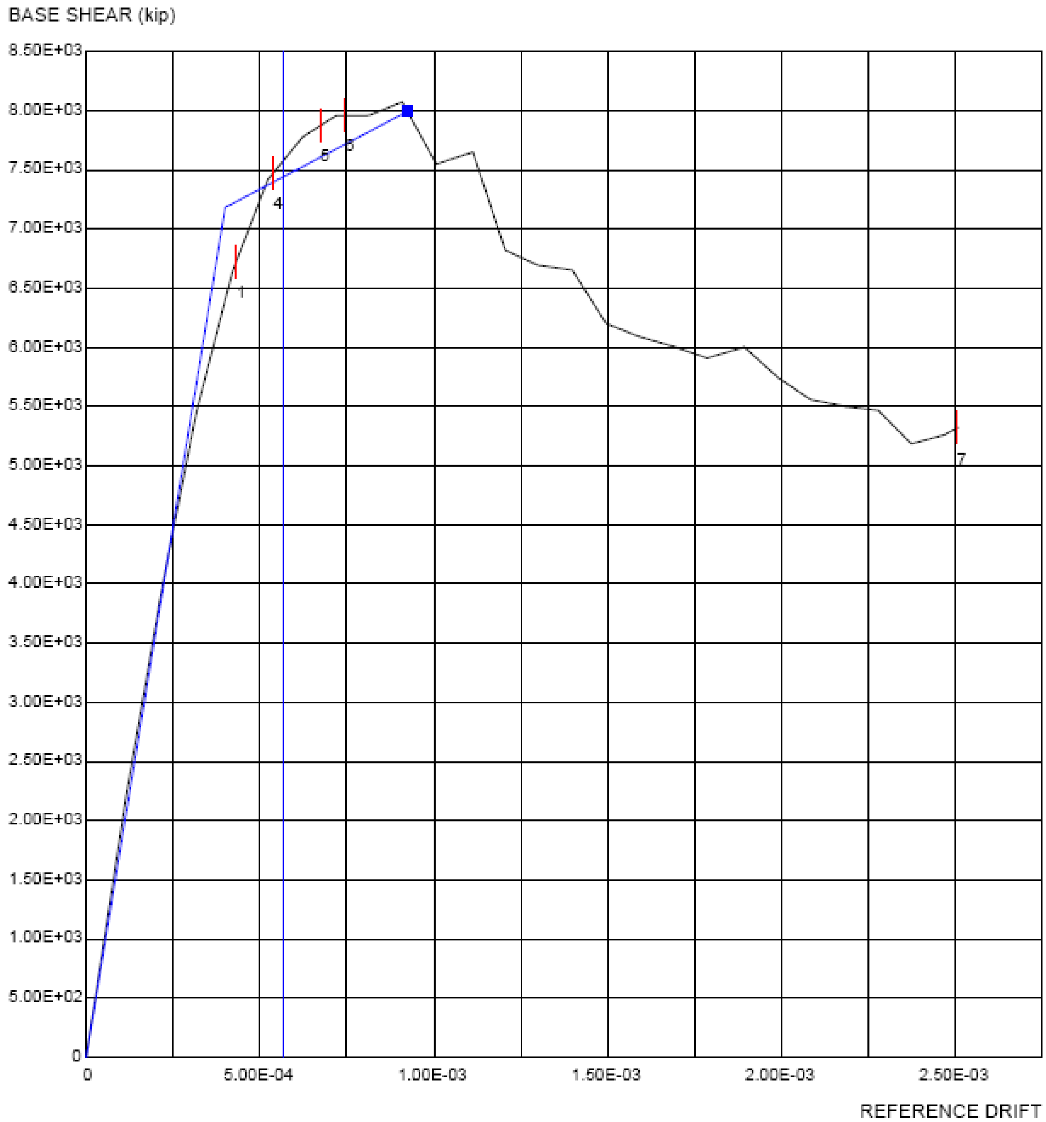
5). Pushover Along Positive X-Direction with **Load Case: $Q_G \pm Q_E$ = 0.9 DL$\pm$ Q_E**



PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [5] = [4] + Push +X (Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.7995g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.65185 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.3292 (user value). Te (sec) = 0.09187, Sa = 1.799g, Cm = 0, Ratio R = 0.
C2 = 1.0041 (user value). C3 = 1 (user value).
Target Drift = 6.105e-4

NOTE: Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All limits occur after the target displacement (0.061%).

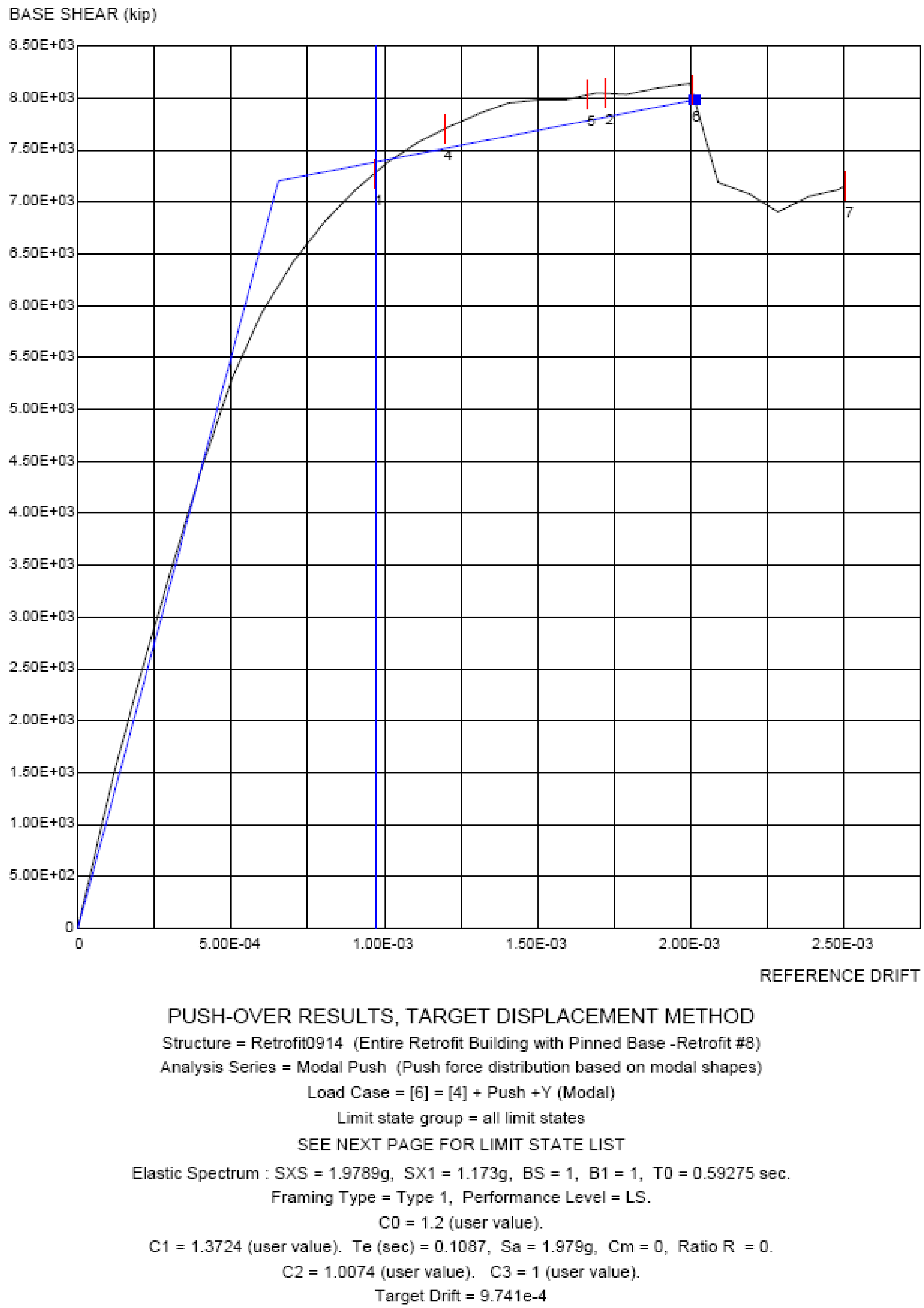
6). Pushover Along Negative X-Direction with **Load Case: $Q_G \pm Q_E$ = 0.9 DL$\pm$ Q_E**



PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [9] = [4] + Push -X (Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.7833g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.65777 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.2897 (user value). Te (sec) = 0.09035, Sa = 1.783g, Cm = 0, Ratio R = 0.
C2 = 1.0031 (user value). C3 = 1 (user value).
Target Drift = 5.672e-4

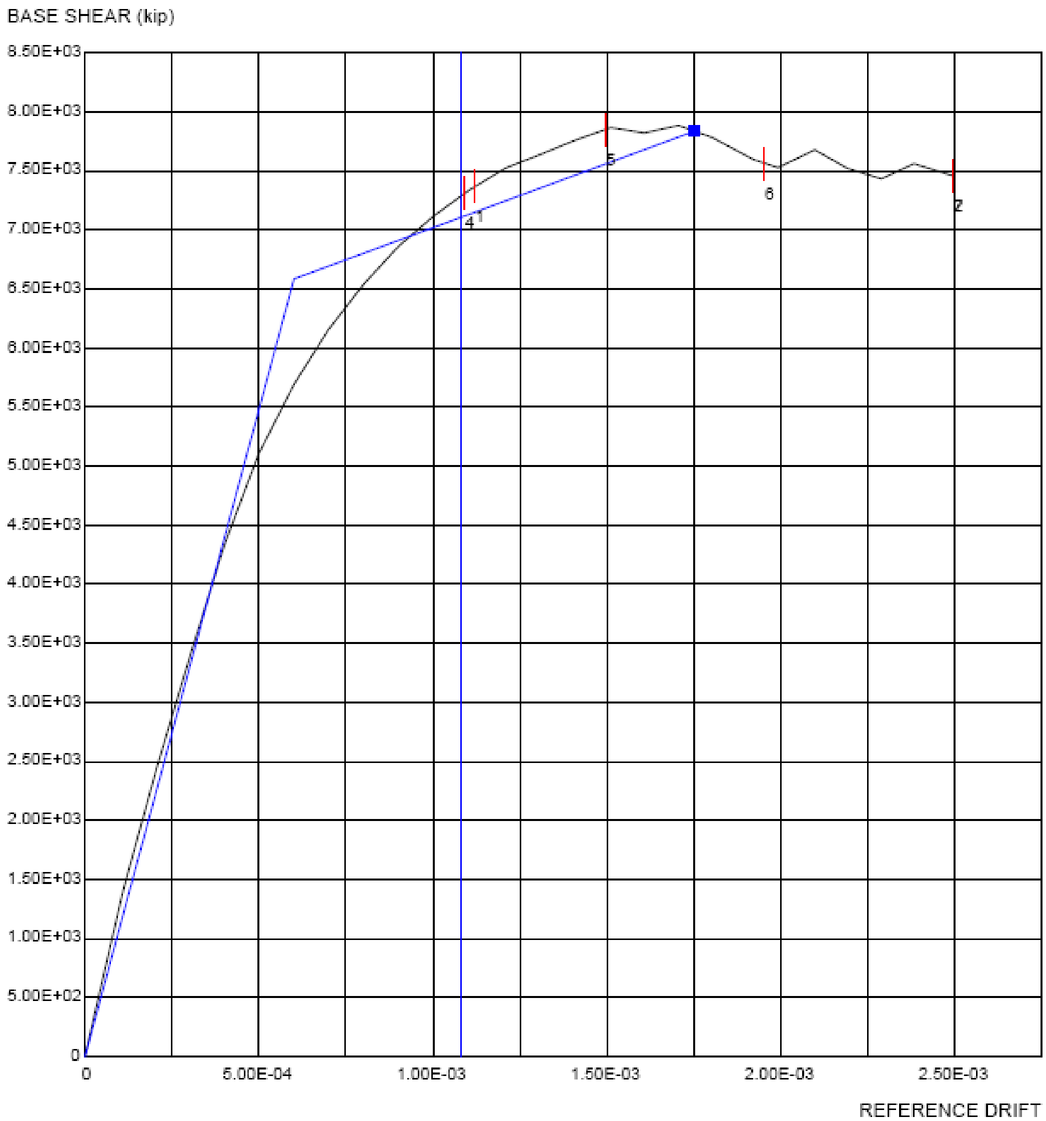
NOTE: Red mark 1 indicates the wall rotation limit at IO performance level; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. Red marks 1 & 4 occur before the target displacement (0.057%), which means the structure is not able to reach the IO performance level before the target displacement (0.057%).

7*). Pushover Along Positive Y-Direction with* **Load Case: $Q_G \pm Q_E$ = 0.9 DL± Q_E**



NOTE: Red marks 1 and 2 indicate the wall rotation limit at IO and LS performance levels; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All IO wall rotation limit (Red mark 1) occur before the target displacement (0.097%).

7*). Pushover Along Negative Y-Direction with* **Load Case: $Q_G \pm Q_E$ = 0.9 DL± Q_E**



PUSH-OVER RESULTS, TARGET DISPLACEMENT METHOD
Structure = Retrofit0914 (Entire Retrofit Building with Pinned Base -Retrofit #8)
Analysis Series = Modal Push (Push force distribution based on modal shapes)
Load Case = [10] = [4] + Push -Y(Modal)
Limit state group = all limit states
SEE NEXT PAGE FOR LIMIT STATE LIST
Elastic Spectrum : SXS = 1.9696g, SX1 = 1.173g, BS = 1, B1 = 1, T0 = 0.59555 sec.
Framing Type = Type 1, Performance Level = LS.
C0 = 1.2 (user value).
C1 = 1.542 (user value). Te (sec) = 0.108, Sa = 1.97g, Cm = 0, Ratio R = 0.
C2 = 1.0154 (user value). C3 = 1 (user value).
Target Drift = 0.001083

NOTE: Red mark 1 indicates the wall rotation limit at IO and LS performance levels; Red marks 4, 5 and 6 indicate the wall shear strain limit at IO, LS and CP performance levels. All limits occur after the target displacement (0.108%).

APPENDIX G: MISC CALCULATIONS:

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ASCE 41-06 DIAPHRAGM FORCES

$S_s = 2.047$

$S_{xs} = 2.047$

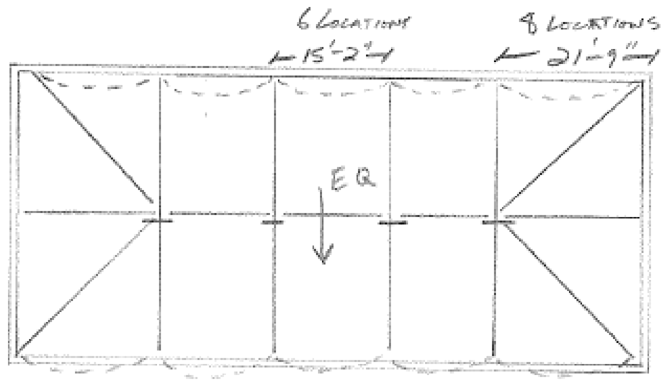
WALL ANCHORAGE FORCES

$\chi = .9$ @ CP 1.2 @ LS 1.8 @ IO

$$F_p = \begin{Bmatrix} .9 \\ 1.2 \\ 1.8 \end{Bmatrix} (2.047)\, W_p = \begin{Bmatrix} 1.84 \\ 2.46 \\ 3.68 \end{Bmatrix} W_p$$

PROVIDE HSS LEDGER @ PERIMETER TO ALLOW WALLS TO SPAN BETWEEN CROSS TIES

MAX SPAN IS 21'-9"



ROOF HEIGHT @ PERIMETER 10'

WALL WEIGHT = 100psf

ASSUME WALLS ARE SOLID

$$F_p = \begin{Bmatrix} 1.84 \\ 2.46 \\ 3.68 \end{Bmatrix} 100psf \left(\frac{10}{2}\right) = \begin{Bmatrix} 920 \\ 1230 \\ 1840 \end{Bmatrix} \#/FT$$

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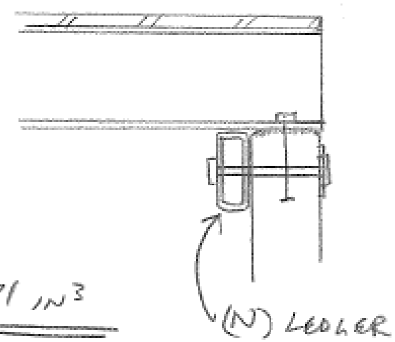
Ledger Design

— Design HSS for 1840 #/ft @ IO

Span 21.75' Pin-Pin

$M = 1840(21.75)^2/8 = \underline{108.8^{k'}}$



$m_{IO} = 1.25$ for STL chord Table 5-5

$Z_{min} = 108.8^{k'} \times 12 / 1.25 \times 46\text{ksi} = \underline{22.71 \text{ in}^3}$

HSS 10×6×3/8 Req'd $Z_y = 23.7\text{in}^3 > 22.71$

— Design HSS for 1230 #/ft @ LS

$M = 72.7^{k'}$

$m_{LS} = 6$

$Z_{min} = \underline{3.16 \text{ in}^3}$

HSS 4×4×1/4 Req'd $Z_y = 4.69\text{in}^3 > 3.16 \text{ in}^3$

→ HSS 4×4×1/4 is sufficient for CP by inspection

Bolt Design

Determine breakout capacity of thru bolt w/ PL.
Then determine required spacing for CP, LS, IO

— For simplicity do not use Appendix D

Perimeter $= 4(8+3+8) = 76''$

Area of shear failure $\simeq 76'' \times 8'' = 608\text{in}^2$

$T_a = 2\sqrt{2500}\,(608\text{in}^2) = 60.8^k$

Bolt $T_a = \frac{3/4^2 \pi}{4}\ 58\text{ksi} = \underline{25.6^k}$

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IT IS EVIDENT THAT FOR A 3/4" A36 THRD ROD
W/ 3"x3" PL THE ROD STRENGTH WILL GOVERN
AND IS MUCH GREATER THAN MAX FORCE W/ J=1.0

$$T_{MAX} = 4' \times 1.840^k / 1.0 = 7.36^k$$

USE 3/4" BOLT THRU WALL W/ 3×3×3/8 PL
@ 4'-0" O.C.

CROSS TIE DESIGN

$$\text{CROSS TIE FORCE} = \begin{Bmatrix} 920 \\ 1230 \\ 1840 \end{Bmatrix} 21.75' = \begin{Bmatrix} 20^k \\ 26.8^k \\ 40^k \end{Bmatrix}$$

TRIB WIDTH MAX 21'-9"

FORCE / m-FACTORS

$$\begin{Bmatrix} 20 \\ 26.8 \\ 40 \end{Bmatrix}^k / \begin{Bmatrix} 8 \\ 6 \\ 1.25 \end{Bmatrix} = \begin{Bmatrix} 2.5^k \\ 4.5^k \\ 32^k \end{Bmatrix}$$

ADD'L STRENGTH EXISTS IN (E) CONNECTIONS (2.5k, 4.5k)

SIGNIFICANT STRENGTHENING REQUIRED BY INSPECTION (32k)

EXISTING FRAMING PER 1/S-4 APPEARS ADEQUATE TO TRANSFER CROSSTIE FORCES FOR CP AND LS. SIGNIFICANT PLS AND STRENGTHENING WOULD BE REQUIRED FOR AN IO OBJECTIVE

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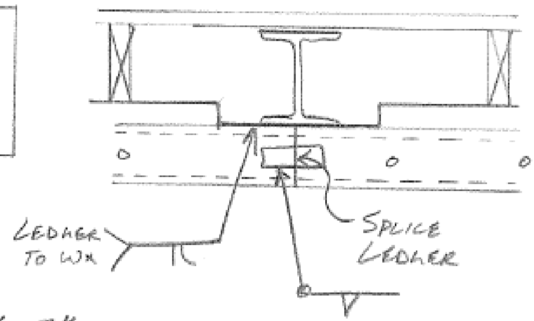
CONNECTION OF LEDGER TO CROSS TIE

- AT CP AND LS
PROVIDE 3" MIN FLARE GROOVE WELD TO Wx FLANGE



CONNECTION IS FORCE-CONT.
SO J = 2.0

$FORCE_{MAX} = 26.8^k/2.0/2SIDES = 6.7^k$

$R_n = 1.392(4^{16THS})3" = 16.7^k > 6.7^k$ OK

- AT IO PROVIDE BRACKET AND STRENGTHENING TO TRANSFER FORCES

CONNECTION IS FORCE-CONT.
SO J = 1.0

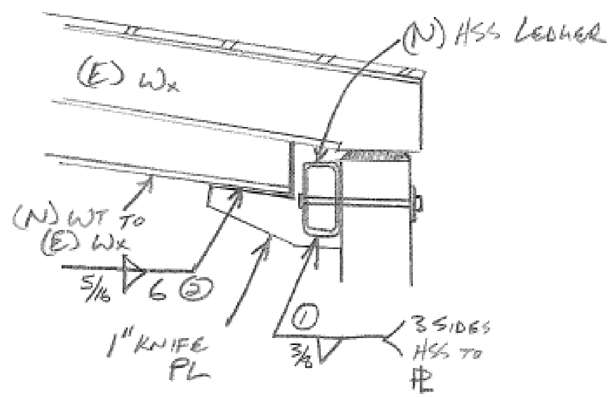
$FORCE = 40^k/1.0 = 40^k$

$R_{n①} = 1.392(6+10+6)6^{16THS} \times 2 = 367^k$

$367^k > 40^k$ OK

$R_{n②} = 1.392(5^{16THS})6" \times 2 = 83^k$

$83^k > 40^k$ OK



PROVIDE KNIFE PL TO BEAM STRENGTHENING ELEMENT AT IO

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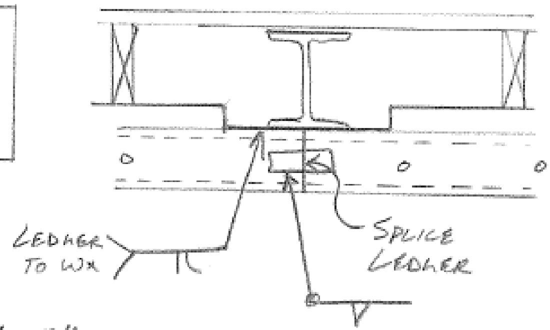
CONNECTION OF LEDGER TO CROSS TIE

– AT CP AND LS
PROVIDE 3" MIN FLARE GROOVE WELD TO Wx FLANGE



CONNECTION IS FORCE-CONT.
SO J = 2.0

$FORCE_{MAX} = 26.8^k / 2.0 / 2SIDES = \underline{6.7^k}$

$R_n = 1.392 (4^{16THS}) 3'' = \underline{16.7^k} > 6.7^k$ OK

– AT IO PROVIDE BRACKET AND STRENGTHENING TO TRANSFER FORCES

CONNECTION IS FORCE-CONT.
SO J = 1.0

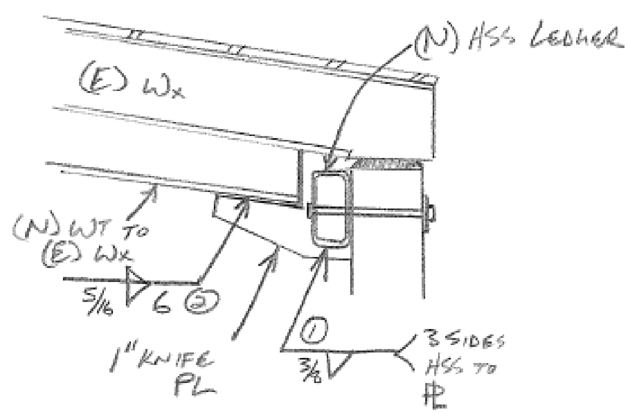
$FORCE = 40^k / 1.0 = \underline{40^k}$

$R_{n①} = 1.392 (6+10+6) 6^{16THS} \times 2 = \underline{367^k}$

$367^k > 40^k$ OK

$R_{n②} = 1.392 (5^{16THS}) 6'' \times 2 = \underline{83^k}$

$83^k > 40^k$ OK



PROVIDE KNIFE PL TO BEAM STRENGTHENING ELEMENT AT IO

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DIAPHRAGM DESIGN

EVALUATE USING 2/3MCE AND MCE ACCELERATIONS FROM ETABS

① CHECK IO @ 2/3MCE AND LS @ MCE

② CHECK LS @ 2/3MCE AND CP @ MCE

ROOF WEIGHT – * ASSUME CEILING DOES NOT CONTRIBUTE TO DIAPHRAGM MASS

$WEIGHT = 45.5psf - 15psf = 30.5psf$

$MASS = 30.5psf / 32.2 FT/S^2 = .9472$

$AREA = 89' \times 43.5' = 3872 SF$

$TOTAL\ MASS = 3872 SF (.9472) = 3668 SLUGS$

① Y-DIR GOVERNS

$a_{y_{MCE}} = 911.4/12 = 75.95 FT/S^2$

$a_{y_{2/3MCE}} = 607.3/12 = 50.61 FT/S^2$ FROM ETABS @ ROOF

$F_{EA\ SIDE} = \begin{matrix} @LS \\ @IO \end{matrix} \begin{Bmatrix} 75.95 \\ 50.61 \end{Bmatrix} 3668 SLUGS / 2 SIDES = \begin{Bmatrix} 139.3^k \\ 92.82^k \end{Bmatrix}$

$V = \begin{Bmatrix} 139.3 \\ 92.82 \end{Bmatrix} / 43.5' = \begin{Bmatrix} 3202 plf \\ 2134 plf \end{Bmatrix}$

CONVERT TO REQUIRED ASD STRENGTH VALUES

$m_{IO} = 1.5 \quad m_{LS} = 2.5 \quad LRFD/ASD \cong 2.0$ PER ASCE 41-06

$V_{ASD\ REQ'D} = \begin{Bmatrix} 3202 \\ 2134 \end{Bmatrix} / 2.0 / \begin{Bmatrix} 2.5 \\ 1.5 \end{Bmatrix} = \begin{Bmatrix} 641 plf \\ 712 plf \end{Bmatrix}$

USE 19/32 PLY W/ 10d @ 2, 3, 12 W/ 2x FRAMING $V_a = 730 plf > 712 plf$

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(2) Y-DIR GOVERNS

$a_{y\,MCE} = 75.95\ FT/S^2$ FROM ETABS @ ROOF

$a_{y\,2/3MCE} = 50.61\ FT/S^2$

$F_{EA\,SIDE}$ @ CP / @ LS $\begin{Bmatrix} 75.95 \\ 50.61 \end{Bmatrix}$ 3668 SLUGS / 2 SIDES $= \begin{Bmatrix} 139.3^k \\ 92.82^k \end{Bmatrix}$

$V = \begin{Bmatrix} 3202\ plf \\ 2134\ plf \end{Bmatrix}$

CONVERT TO REQUIRED ASD STRENGTH VALUES

$m_{LS} = 2.5 \quad m_{CP} = 3.0 \quad LRFD/ASD \cong 2.0$

$V_{ASD\,REQ'D} = \begin{Bmatrix} 3202 \\ 2134 \end{Bmatrix} / 2.0 / \begin{Bmatrix} 3.0 \\ 2.5 \end{Bmatrix} = \begin{Bmatrix} 534\ plf \\ 427\ plf \end{Bmatrix}$

USE 19/32 PLY w/ 10d @ 2½, 4, 12
w/ 2x FRAMING $V_a = 640 > 534$ OK

Unit: in/sec^2

Story	Diaphragm	Load	UX	UY	UZ	RX	RY	RZ
ROOF	ROOF	MCE1X03Y	682.2651	529.6275	24.3232	0.43653	0.35	0.64061
→ ROOF	ROOF	MCE03X1Y	274.7229	911.3735	36.155	1.23162	0.133	0.29967
ROOF	ROOF	23MCE1X03Y	454.6215	352.9125	16.2096	0.29089	0.23323	0.42686
→ ROOF	ROOF	23MCE03X1Y	183.0592	607.2857	24.0935	0.82073	0.08863	0.19968
SECOND FL	2NDFLR	MCE1X03Y	1105.4	492.3605	33.4344	1.12513	2.57436	0.62995
SECOND FL	2NDFLR	MCE03X1Y	445.0248	882.1838	38.3724	2.98639	1.00637	0.29572
SECOND FL	2NDFLR	23MCE1X03Y	736.5732	328.08	22.2802	0.74975	1.71548	0.41976
SECOND FL	2NDFLR	23MCE03X1Y	296.5383	587.8353	25.571	1.99005	0.67061	0.19705
FIRST FL	1STFLR	MCE1X03Y	1040.946	454.0175	92.8935	3.31057	7.94325	0.5847
FIRST FL	1STFLR	MCE03X1Y	422.8363	832.9077	215.3212	9.30738	4.02648	0.27907
FIRST FL	1STFLR	23MCE1X03Y	693.6252	302.5305	61.8997	2.20602	5.29311	0.38961
FIRST FL	1STFLR	23MCE03X1Y	281.7532	555.0006	143.4812	6.20217	2.68309	0.18595

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ANALYZE DISCONTINUOUS SHEARWALL SUPPORT COLUMNS

MAX COMPRESSION OCCURS @ COLUMN 13 = 244.89^k
W/ NO TENSION PER ETABS $M = 114^{k''}$

MAX TENSION OCCURS @ COLUMN 15 = 114.85^k
W/ 157.64^k COMPRESSION PER ETABS $M = 69^{k''}$

— COLUMN 13 IN ETABS MODEL IS SHOWN AS COLUMN 15 ON THE ORIGINAL DRAWINGS.
IT IS 14"x14" W/ (4)#9 BARS AND #3 TIES @ 14" O.C.
AT 2/3 MCE CHECK IO AND LS $m_{IO} = 1.25$ $m_{LS} = 1.6$

ADJUST FORCES FOR m AND ϕ.

$$P_u = 244.89 / \begin{Bmatrix} 1.25 \\ 1.6 \end{Bmatrix} \times .85 = \begin{Bmatrix} 166.5 \\ 130 \end{Bmatrix}$$

$$M_u = 114^{k''}/12 / \begin{Bmatrix} 1.25 \\ 1.6 \end{Bmatrix} \times .9 = \begin{Bmatrix} 6.84 \\ 5.35 \end{Bmatrix}$$

SEE INTERACTION DIAGRAM

COLUMN 13 IS OK FOR LOADS DUE TO DISCONTINUOUS SWALLS

— COLUMN 15 IN ETABS IS SHOWN AS COLUMN 14 ON THE ORIGINAL DRAWINGS
IT IS 14"x14" W/ (4)#7 AND #3 TIES @ 14" O.C.
AT 2/3 MCE CHECK IO AND LS

ADJUST FORCES FOR m AND ϕ

$$P_u = 157^k / \begin{Bmatrix} 1.25 \\ 1.6 \end{Bmatrix} \times .85 = \begin{Bmatrix} 107^k \\ 84^k \end{Bmatrix}$$

$$M_u = 69^{k''}/12 / \begin{Bmatrix} 1.25 \\ 1.6 \end{Bmatrix} \times .9 = \begin{Bmatrix} 4.2 \\ 3.3 \end{Bmatrix}$$

SEE INTERACTION DIAGRAM

COFFMAN ENGINEERS

PROJECT SBPD JOB NO.

MADE BY JW DATE PAGE OF

ADJUST TENSION FORCES FOR m AND ϕ

ASSUME $m = 1.25$ AND $\phi = .9$

$T = 114.9^k \times .9 / 1.25 = \underline{83^k}$

SEE INTERACTION DIAGRAM

COLUMN 15 IS OK FOR LOADS DUE TO DISCONTINUOUS SWALLS

CHECK TENSION LAP SPLICE

$\#7 @ 2'-0'' \quad \left(\frac{50\text{ksi}}{20\sqrt{2500}}\right) .875'' = 43.7'' > 24''$

APPROXIMATE STRENGTH OF #9 w/ 24" LAP IS

$50\text{ksi}\,(.60)(24/43.7) = \underline{16.5^K}$

ASSUME FORCE CONTROLLED (TENSION LAP FAILURE)

$J = 2.0 @ LS \qquad J = 1.0 @ IO$

(1) @ LS

$T_a = 4 \times 16.5^k \times 2.0 = \underline{132^k} > 114.9^k$ OK

(2) @ IO

$T_a = 4 \times 16.5^k \times 1.0 = \underline{66^k} < 114.9^k$ N.G.

TENSION LAP SPLICES FAIL AT IO LEVELS BUT ARE OK AT LS LEVELS

COFFMAN ENGINEERS

PROJECT SBPD JOB NO. ______

MADE BY JW DATE ______ PAGE ____ OF ____

CHECK FOOTINGS UNDER COLUMNS

CHECK COL 13 w/ $P = 245^k$

FOOTING IS 9'-0" × 7'-2" × 1'-8" w/ (10)#7 × (11)#6

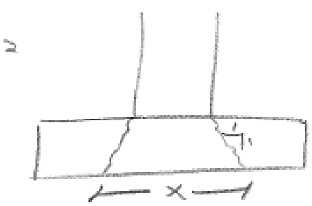
– BEARING PRESSURE AT ULTIMATE IS 7^{ksf}

$$q_a = 7000\,psf \times 9' \times 7.16' = \underline{451^k} > 245^k \ \underline{OK}$$

– COLUMN PUNCHING SHEAR

$$A = 20" \times (14" + 2 \times 20") \times 4 = 4320\,in^2$$

$$V_n = 2\sqrt{2500}\,(4320) = \underline{432^k} > 245^k$$

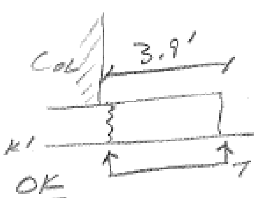


– FOOTING IN BENDING

$$a = \frac{10(.6)50}{.85(2.5)108"} = 1.31"$$

$$M_n = 10(.6)50\left(16" - \frac{1.31}{2}\right) = 383^{k'}$$

$$M = (7ksf \times 7.16')(3.9)^2/2 = \underline{381^{k'}} < 383^{k'} \ \underline{OK}$$

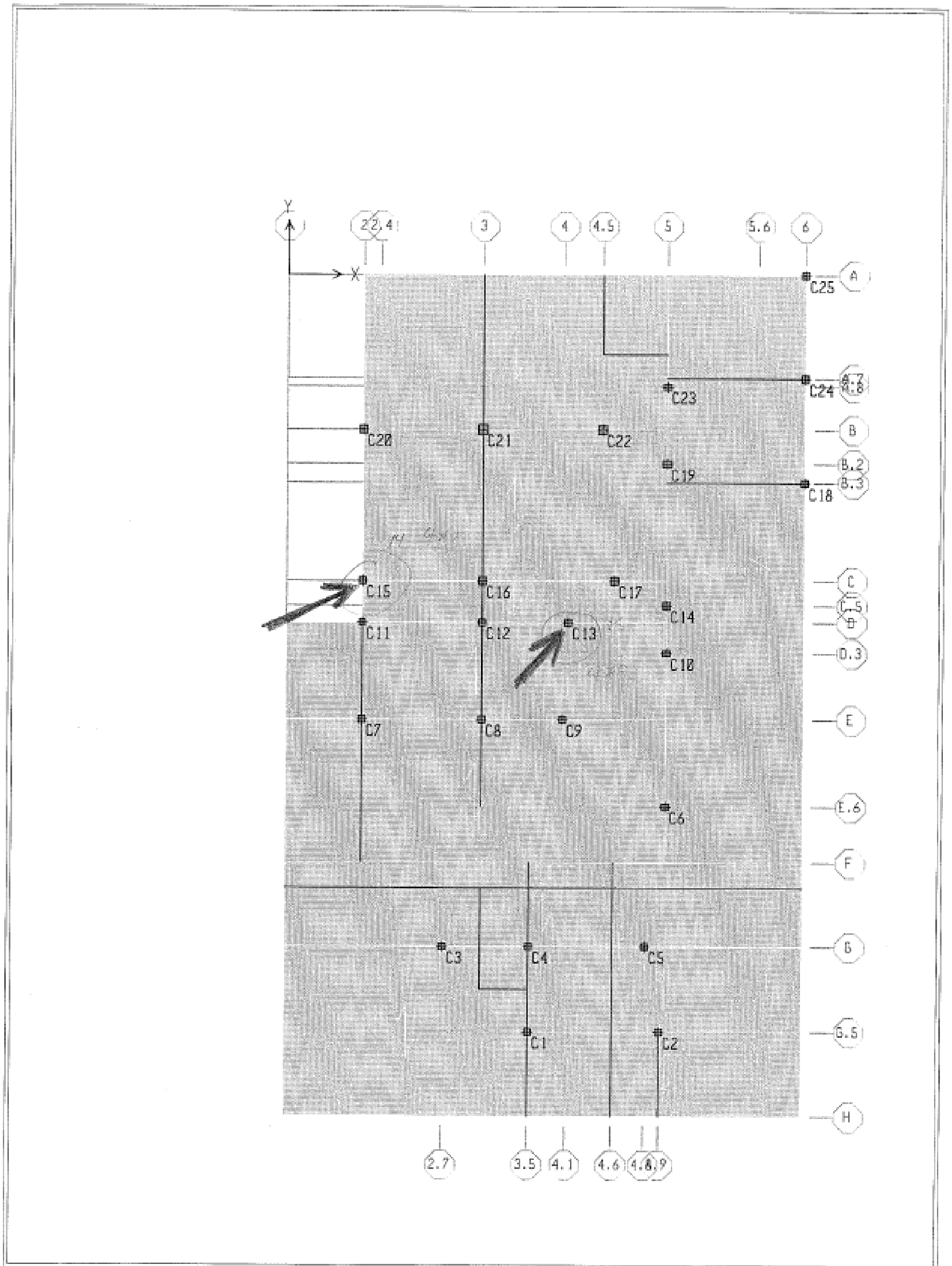


FOOTING UNDER COLUMN 13 IS ACCEPTABLE FOR LOADS

ETABS Column Forces for Columns Under Discontinuous Shearwalls (k-in)

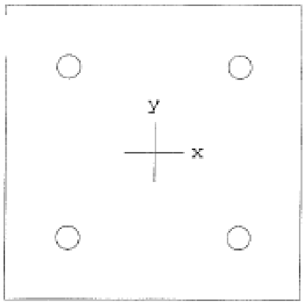
C	P	V2	V3	T	M2	M3
11	-84.16	-1.6	-2.03	-5.604	-10.969	-7.672
11	21.99	1.71	2.38	5.642	11.763	7.686
12	-141.5	-8.62	-10.52	0	-90.206	-73.984
12	-45.92	8.7	10.61	0	89.455	73.31
→ 13	-244.9	-13.32	-10.42	0	-88.555	-113.824
13	24.56	13.46	10.47	0	88.174	112.676
15	-157.6	-13.29	-14.63	-28.577	-68.667	-34.985
→ 15	114.85	15.5	16.01	29.797	64.575	35.461
16	-156.4	-11.22	-19.81	0	-168.949	-95.541
16	-82.87	11.24	19.88	0	168.384	95.401
17	-180.6	-11.85	-20.06	0	-170.215	-100.832
17	-66.18	11.86	20.03	0	170.473	100.692

ETABS



ETABS v9.7.0 - File: 10303-SB-Police-Station-Full-Building with soil spring 07-22-2010 - July 26,2010 15:24
Plan View - FIRST FL - Elevation 120 - Kip-in Units

PCACOL V2.30



14.0 x 14.0 inch

f'c = 2.5 ksi

fy = 50.0 ksi

Confinement: Tied

clr cover = 2.38 in

spacing = 6.99 in

4-#9 at 2.04%

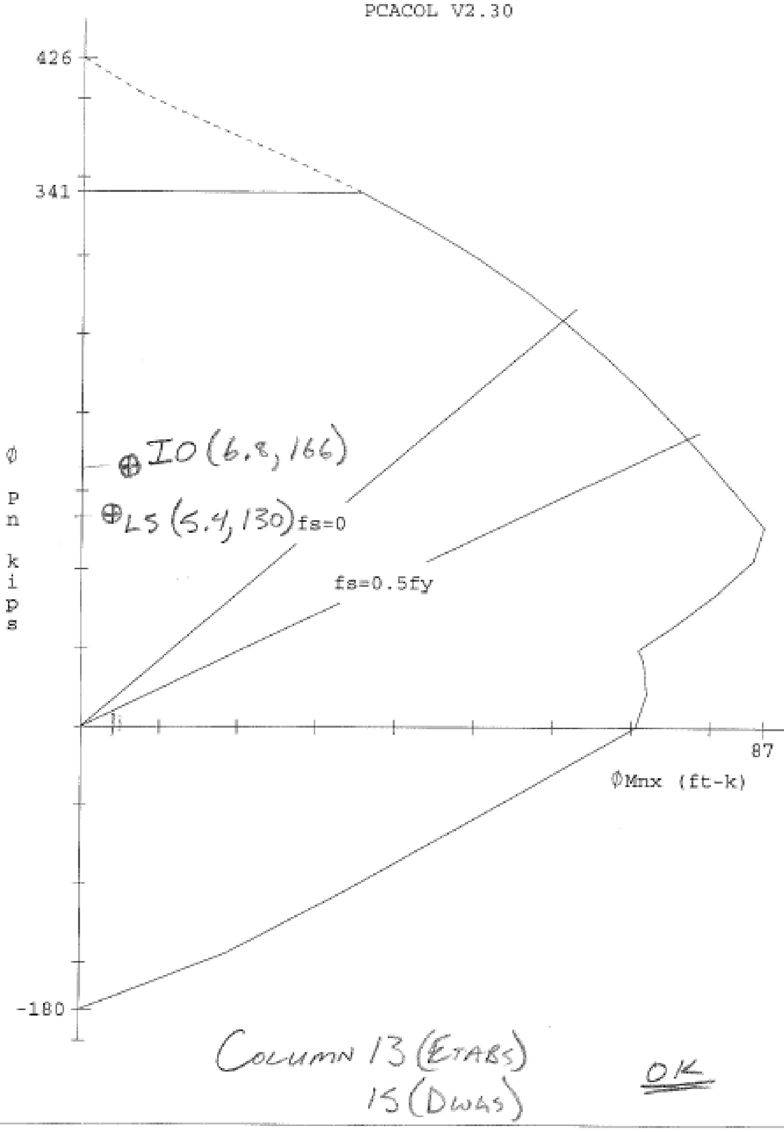
As = 4 in^2

Ix = 3201 in^4

Iy = 3201 in^4

Xo = 0.00 in

Yo = 0.00 in



Licensed To: CEI, Los Angeles, CA

File name: UNTITLED.COL

Project:

Column Id:

Engineer:

Date: 07/28/10 Time: 16:11:48

ode: ACI 318-89

Units: in-lb

X-axis slenderness is not considered.

Material Properties:

Ec = 3031 ksi eu = 0.003 in/in

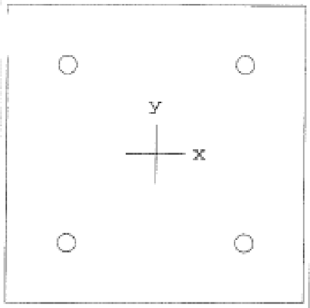
fc = 2.13 ksi Es = 29000 ksi

Beta1 = 0.85

Stress Profile: Block

phi(c) = 0.70, phi(b) = 0.90

PCACOL V2.30



14.0 x 14.0 inch

f'c = 2.5 ksi

fy = 50.0 ksi

Confinement: Tied

clr cover = 2.38 in

spacing = 7.50 in

4-#7 at 1.22%

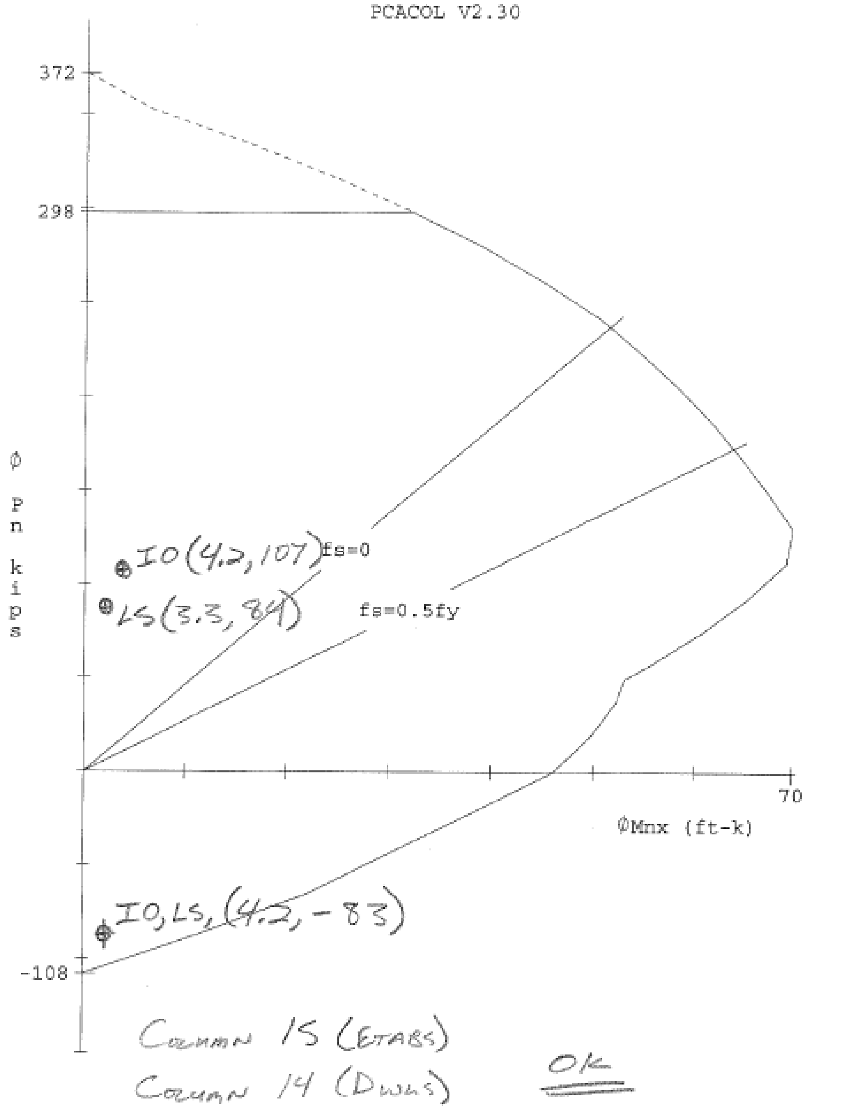
As = 2 in^2

Ix = 3201 in^4

Iy = 3201 in^4

Xo = 0.00 in

Yo = 0.00 in



File name: UNTITLED.COL

Project:

Column Id:

Engineer:

Date: 07/28/10 Time: 16:11:48

ode: ACI 318-89

Units: in-lb

X-axis slenderness is not considered.

Material Properties:

Ec = 3031 ksi eu = 0.003 in/in

fc = 2.13 ksi Es = 29000 ksi

Beta1 = 0.85

Stress Profile: Block

phi(c) = 0.70, phi(b) = 0.90

APPENDIX H: ESTIMATED RETROFIT COST ANALYSIS:

OPINION OF PROBABLE
COST OF CONSTRUCTION
FOR
SEISMIC RETROFIT
FOR
MAIN POLICE DEPARTMENT BUILDING
215 EAST FIGUEROA STREET
CITY OF SANTA BARBARA
SANTA BARBARA, CA

FULL BUILDING RETROFIT

OPINION OF PROBABLE COST OF CONSTRUCTION
OCTOBER 14, 2010

ENGINEERS:

Coffman Engineers
16133 Ventura Blvd #1010
Encino, CA 91436
Tel: (818)285-2650
Fax: (818)285-2651

COST CONSULTANTS

Iskander Associates, Inc
600 N. Tustin Avenue #130
Santa Ana, CA 92705
Tel: (714) 544-4214
Fax: (714) 544-1206

SEISMIC RETROFIT		STATUS:	PRELIMINARY
MAIN POLICE DEPT BUILDING		DATE:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		DATE REV.	14-Oct-10
FULL BUILDING RETROFIT		IAI PROJ #:	10-1950
A/E: COFFMAN ENGINEERING		GFA:	

BASIS OF THE ESTIMATE:

GENERAL:

This probable preliminary cost of construction estimate for the seismic retrofit for the Main police department building in the city of Santa Barbara is based on preliminary structural plans prepared by the design team of Coffman Engineers.

The estimate is also based on measurement of approximate quantities from the plans provided and priced in accordance with the outline specifications discussed with the design team. Where measurement was not possible reasonable allowances have been included in the estimates.

ARRANGEMENT:

It is assumed that the work will be done in phases. Therefore, allowances included for phasing in this estimate.
The estimate is arranged as follows:
1. Estimate for the proposed seismic retrofit work as designed by the engineers.
2. Estimate for reworking areas impacted by the proposed seismic retrofit.

DOCUMENTS USED FOR THE ESTIMATE:

The following drawings were received from Coffman Engineers and used in developing this probable cost of construction:
Progress Structural Set dated August 24, 2010: S0.1, S0.2, S1.1, S2.1, S2.2, S2.3, S2.4 S2.5, S3.1, S3.2 and S3.3
As built set of drawings dated April 4, 1959: Architectural drawings 1 through 7, and 10, Structural Drawings - S-1 through S-8.

ASSUMPTIONS:

The following assumptions were used in developing the cost estimate:

1. Labor wages are based on prevailing wages for normal working hours.
2. Material prices include all related freight, sales taxes and waste.
3. The estimate is based on receiving a minimum of 5 responsive bids with three sub contractor bid in each trade.
4. The building will remain occupied through out the construction period.
5. The work will be done in phases.
6. The phased work will be released to the contractor in timely manner
7. The contractor will be provided with phasing schedule.
8. The contractor will be provided with adequate staging space and parking for his workers.
9. All noise generating work will be done during off hours and weekends.
10. Pathway etc, on site damaged during construction will be repaired and made good
11. Patching and repairing of Impacted architectural and MEP disciplines are included as allowances
12. Hazardous material will be abated prior to demo work at impacted areas and included in the budget by the Engineer.
13. Allowances included for seismic restraints of equipment, pipes, ducts, conduits etc.,
14. Each phase will be totally cleaned after finish of work.

SEISMIC RETROFIT		STATUS:	PRELIMINARY
MAIN POLICE DEPT BUILDING		DATE:	5-Oct-10
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FULL BUILDING RETROFIT		IAI PROJ #:	10-1950
A/E: COFFMAN ENGINEERING		GFA:	

EXCLUSION:

The following items are not included in the hard construction costs for each building.

- o. Hazardous material abatement by others.
- o. Professional fees.
- o. Agencies fee, if any.
- o. Construction contingencies.
- o. Escalation beyond the 4th Quarter of 2010.
- o. Demolition work other than what is in the estimate
- o. Off site work
- o. Owner's costs.
- o. Public agencies costs.
- o. Relocation of personnel to swing space
- o. All Risk Insurance
- o. Preparation of the swing spaces
- o. ADA work.
- o. Architectural work beyond what is called for on the drawings.
- o. FF&E
- o. Seismic work beyond what is shown on the plans.
- o. Electrical work , other than allowance for impacted areas by seismic retrofit work.
- o. Mechanical systems other than allowance for impacted areas by seismic retrofit work.

LIMITATIONS

Since we have no control over the cost of labor, material and equipment, or the contractor's method of carrying out the work and determining the price, or over competitive bidding or market conditions, this opinion of probable construction cost provided, is made on the basis of experience and qualifications. This opinion represents our best judgment as professional construction consultants with the Construction Industry. However, we cannot and do not guarantee that proposals, bids or the construction cost will not vary from opinions of probable cost in this estimate.

SEISMIC RETROFIT			Status:	Conceptual
MAIN POLICE DEPT BUILDING			Date:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA			Date Revised	14-Oct-10
FULL BUILDING RETROFIT			Project #	10-1950
A/E: COFFMAN ENGINEERING			GFA - SF	

Item Description	**Quantity**	**Unit**	**Rate**		**Total**	
Gross Floor area:						
Basement floor			sf			12,072
First Floor						12,040
Second Floor			sf			3,887
Total Gross Floor area			sf			27,999
PREPAREATORY WORK			$	3.21		90,000
ASBESTOS ABATEMENT WORK			$	4.52		126,500
SELECTIVE DEMOLITION			$	1.64		46,000
STRUCTURAL			$	15.35		429,800
SEISMIC RESTRAINTS			$	1.50		42,000
ARCHITECTURAL			$	11.13		311,700
ROOF			$	2.99		83,800
IMPACTED MEP			$	12.16		340,500
MISCELLANEOUS COSTS			$	10.00		280,000
TOTAL DIRECT COST			$	62.51	$	1,750,300
General Conditions		20.00%	$	12.50	$	350,100
Contractor's Overhead & Profit or Fee		15.00%	$	11.25	$	315,100
Insurance and Bond		3.00%	$	2.59	$	72,500
TOTAL INCLUDING MARK-UPS					$	2,488,000
Phasing allowance		10.00%			$	248,800
DESIGN CONTINGENCY		15.00%			$	410,500
PROBABLE CONSTRUCTION COST OCTOBER 2010			$	112.41	**$**	**3,147,300**

SEISMIC RETROFIT
MAIN POLICE DEPT BUILDING
215 EAST FIGUEROA STREET, SANTA BARBARA, CA
FULL BUILDING RETROFIT
A/E: COFFMAN ENGINEERING

Status: Conceptual
Date: 5-Oct-10
Date Revised 14-Oct-10
Project # 10-1950
GFA - SF

	Item Description	Quantity	Unit	Rate	Total
01	**PREPERATORY WORK:**				
	Barricades	1.00	ls	$ 45,000.00	$ 45,000
	Noise control allowance	1.00	ls	$ 20,000.00	$ 20,000
	Dust Control Allowance	1.00	ls	$ 10,000.00	$ 10,000
	Trash bins	1.00	ls	$5,000.00	$ 5,000
	Protect existing work during construction	1.00	ls	$10,000.00	$ 10,000
	TOTAL PREPARATORY WORK:				**$ 90,000**
02	**ASBESTOS ABATEMENT:**				
	Ceilings with Acoustic spray assumed to be contaminated with asbestos. The following work is limited to the ceiling areas.				
	Preparatory work to abate space allow				
	Equipment and set up and removal	1.00	ls	$ 40,000.00	$ 40,000
	Containment construction set up and removal	1.00	ls	$ 25,000.00	$ 25,000
	Scrape ceilings	8,200	sf	$ 2.00	$ 16,400
	Remove Ballast from fl fixtures allow	200	ea	$ 50.00	$ 10,000
	Disposal of Contaminated material allow	8,200	sf	$ 2.00	$ 16,400
	Monitoring/sampling	1	ls	$ 5,000.00	$ 5,000
	Decontaminate area	1	ls	$ 7,500.00	$ 7,500
	Cover furniture and equipment during decontamination work.	8,200	sf	$ 0.75	$ 6,200
	TOTAL ASBESTOS ABATEMENT WORK				**$ 126,500**
03	**SELECTIVE DEMOLITION:**				
	Ceilings:				
	Remove Gypsum plaster ceilings	11,460.00	sf	$ 1.50	$ 17,200
	Remove suspended gypsum plaster clg	300.00	sf	$ 2.00	$ 600
	Windows and doors				$ -
	Remove windows	2.00	ea	$ 150.00	$ 300
	Remove overhead door	2.00	ea	$ 500.00	$ 1,000
	Remove doors as required and store	1.00	ls	$ 2,500.00	$ 2,500
	Roof				
	Remove existing roof tiles.	4,110.00	sf	$ 2.00	$ 8,200
	Remove from site	1.00	ls	$ 1,200.00	$ 1,200
	Miscellaneous:				
	Allowance for removing cabinets, lockers, etc., to seismic work	1.00	ls	$ 10,000.00	$ 10,000
	Allowance for removing misc specialties	1.00	ls	$ 5,000.00	$ 5,000
	SUBTOTAL SELECTIVE DEMO				**$ 46,000**

SEISMIC RETROFIT		Status:		Conceptual
MAIN POLICE DEPT BUILDING		Date:		5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		Date Revised		14-Oct-10
FULL BUILDING RETROFIT		Project #		10-1950
A/E: COFFMAN ENGINEERING		GFA - SF		

Item Description		Quantity	Unit	Rate	Total
04	**STRUCTURALSEISMIC RETROFIT WORK:**				
1	Foundation work (details 11, 12, 16/S1.1)				
	Saw cut slab on grade	146.00	lf	$ 20.00	$ 2,900
	Breakup and remove slab on grade	550.00	sf	$ 4.00	$ 2,200
	Excavate for foundations and tie beams	41.00	cy	$ 50.00	$ 2,100
	Backfill and compact	14.00	cy	$ 50.00	$ 700
	Haul surplus	10.50	cy	$ 20.00	$ 200
	Drill and epoxy dowel into existing concrete footing.	144.00	ea	$ 30.00	$ 4,300
	Roughen surfaces of existing concrete	130.00	sf	$ 5.00	$ 700
	Concrete in enlarging existing footing	46.50	cy	$ 400.00	$ 18,600
	Concrete Tie beam	18.50	cy	$ 400.00	$ 7,400
	Forming sides of footing	137.00	sf	$ 15.00	$ 2,100
	Forming sides of tie beam	100.00	sf	$ 20.00	$ 2,000
	Reinforcing bars in foundation	1,325.00	lb	$ 1.25	$ 1,700
	Reinforcing bars in tie beam	2,775.00	lb	$ 1.25	$ 3,500
2	Slab on Grade:				
	Drill/ epoxy dowel into existing slab	118.00	ea	$ 35.00	$ 4,100
	Reinforced concrete slab in patching existing slab on grade	1,440.00	sf	$ 15.00	$ 21,600
	Reinforcing rebar and connector to wall	2880.00	lb	$ 1.25	$ 3,600
	Finish concrete slab to receive architectural finishes.	1,440.00	sf	$ 2.50	$ 3,600
3	Shotcrete Shear Wall (Detail 11/S1.1)				
	Roughen surfaces of existing concrete	380.00	sf	$ 5.00	$ 1,900
	Drill and epoxy into existing concrete wall	420.00	ea	$ 30.00	$ 12,600
	Drill and epoxy dowel into soffit of concrete beam	92.00	ea	$ 40.00	$ 3,700
	Drill and epoxy dowel into existing concrete ftg.	60.00	ea	$ 30.00	$ 1,800
	Shotcrete over existing conc wall	16.10	cy	$ 400.00	$ 6,400
	Rebound	1.00	ls	$ 1,000.00	$ 1,000
	Finish surface of shotcrete	650.00	sf	$ 2.50	$ 1,600
	Reinforcing bars in shotcrete wall	2,590.00	lb	$ 1.25	$ 3,200
	Block window opening with shotcrete	27.00	sf	$ 60.00	$ 1,600
4	Concrete Shear wall (Detail 12/S1.1)				
	Roughen soffits of beam	10.00	sf	$ 5.00	$ 100
	Reinforced concrete wall	3.15	cy	$ 300.00	$ 900
	Forming both sides	250.00	sf	$ 20.00	$ 5,000
	Reinforcing steel bars	500.00	lb	$ 1.25	$ 600
	Finish concrete wall	250.00	sf	$ 2.50	$ 600
	Drill/dowel/epoxy soffit of beam	16.00	ea	$ 35.00	$ 600

SEISMIC RETROFIT
MAIN POLICE DEPT BUILDING
215 EAST FIGUEROA STREET, SANTA BARBARA, CA
FULL BUILDING RETROFIT
A/E: COFFMAN ENGINEERING

Status: Conceptual
Date: 5-Oct-10
Date Revised 14-Oct-10
Project # 10-1950
GFA - SF

	Item Description	Quantity	Unit		Rate		Total
5	Fiber Wrap:						
	Saw cut CMU partition walls for Fiber wrap	590.00	lf	$	20.00	$	11,800
	Breakup and remove CMU wall	590.00	sf	$	5.00	$	3,000
	3 layers to Columns	1,195.00	sf	$	45.00	$	53,800
	3 Layers to Walls	320.00	sf	$	45.00	$	14,400
	6 Layers to walls	310.00	sf	$	75.00	$	23,300
	3 Layers to concrete floor slab	890.00	sf	$	45.00	$	40,100
6	Fill Opening in 2nd Floor:						
	Drill/epoxy/dowel in existing slab	80.00	ea	$	40.00	$	3,200
	Reinforced concrete in slab fill 6" thick	40.00	cy	$	400.00	$	16,000
	Form soffit of slab	192.00	sf	$	25.00	$	4,800
	Reinforcing steel bars in slab	500.00	lb	$	1.25	$	600
	Finish concrete	192.00	sf	$	2.50	$	500
7	Roof Seismic Work:						
	Drill through concrete wall for 3/4" Dia bolt	72.00	ea	$	50.00	$	3,600
	3/4" Bolt with nut	72.00	ea	$	10.50	$	800
	HSS member	11000.00	lb	$	5.00	$	55,000
	WT welded to bottom of existing steel beam	46.00	lf	$	125.00	$	5,800
	Miscellaneous steel plates	20.00	ea	$	500.00	$	10,000
	Miscellaneous steel in strengthening work	1.00	ls	$	10,000.00	$	10,000
	New plywood sheathing 19/32"	4,110.00	sf	$	5.00	$	20,600
	Allowance for sistering existing members	4,110.00	sf	$	5.00	$	20,600
	Allowance for removing and replacing dry rot of existing sheathing (10%)	450.00	sf	$	15.00	$	6,800
8	Seismic Joint:						
	Saw cut wall to remove 4" strip of concrete	52.00	lf	$	25.00	$	1,300
	Remove concrete strip 4" wide	4.00	mh	$	150.00	$	600
	6" x 10.5" x 3/16 Steel plate	1.00	ea	$	300.00	$	300
	5/8" bolt and nut	2.00	ea	$	15.00	$	-
	SUBTOTAL STRUCTURAL					**$**	**429,800**
05	**SEISMIC RESTRAINTS:**						
	Impact area seismic restraints	27,999.00	sf	$	1.50	$	42,000
	SUBTOTAL SEISMIC RESTRAINTS					**$**	**42,000**

SEISMIC RETROFIT		Status:	Conceptual
MAIN POLICE DEPT BUILDING		Date:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		Date Revised	14-Oct-10
FULL BUILDING RETROFIT		Project #	10-1950
A/E: COFFMAN ENGINEERING		GFA - SF	

Item Description	Quantity	Unit	Rate	Total
06 **ARCHITECTURAL IMPACT REPAIR**				
New Gypsum plaster ceiling	11,460.00	sf	$ 10.00	$ 114,600
Ditto suspended	300.00	sf	$ 15.00	$ 4,500
Rebuild CMU Walls partitions	590.00	sf	$ 30.00	$ 17,700
Floor finishes allowance	1.00	ls	$ 40,000.00	$ 40,000
Wall finishes allowance	1.00	ls	$ 25,000.00	$ 25,000
Column surfaces finishes allowance	1,195.00	sf	$ 20.00	$ 23,900
Allowance for reinstalling removed doors	1.00	ls	$ 5,000.00	$ 5,000
Allowance for rebuilding cabinets, replacing lockers etc.,	1.00	ls	$ 15,000.00	$ 15,000
Allowance for replacing specialties items	1.00	ls	$ 10,000.00	$ 10,000
Allowance for painting	27,999.00	sf	$ 2.00	$ 56,000
SUBTOTAL ARCHITECTURAL				**$ 311,700**
07 **ROOF**				
New clay roof tile	4,110.00	sf	$ 15.00	$ 61,700
Waterproofing membrane	4,110.00	sf	$ 3.50	$ 14,400
Sheet metal work	265.00	lf	$ 10.00	$ 2,700
Modify roof drains	1.00	ls	$ 5,000.00	$ 5,000
SUBTOTAL ROOF				**$ 83,800**
08 **IMPACTED MEP**				
Plumbing Work allowances due to Seismic work				
Remove and replace plumbing fixtures where impacted by seismic work including modification of all piping to the fixtures allow	1.00	ls	$ 50,000.00	$ 50,000
				$ -
HVAC Allowances due to Seismic work impact:				$ -
Protect louvers in mechanical rooms	1.00	ls	$ 500.00	$ 500
Route / move / and reinstall mechanical equipment impacted by seismic work	1.00	sf	$ 80,000.00	$ 80,000
Allow for rerouting ducts, pipes, registers etc., in ceilings	1.00	sf	$ 20,000.00	$ 20,000
				$ -
Electrical Allowances due to Seismic Impact:				$ -
Remove and replace lighting fixtures in	1.00	sf	$ 125,000.00	$ 125,000
Modify all branch circuitry for lighting fixtures	1.00	sf	$ 50,000.00	$ 50,000
Reroute electrical conduits	1.00	sf	$ 15,000.00	$ 15,000
SUBTOTAL IMPACTED MEP				**$ 340,500**

SEISMIC RETROFIT		Status:	Conceptual
MAIN POLICE DEPT BUILDING		Date:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		Date Revised	14-Oct-10
FULL BUILDING RETROFIT		Project #	10-1950
A/E: COFFMAN ENGINEERING		GFA - SF	

Item Description		Quantity	Unit	Rate		Total	
09	**MISCELLANEOUS COSTS**						
	Miscellaneous cuts and patch	27,999.00	sf	$	1.50	$	42,000
	Scaffolding and barricades	27,999.00	sf	$	2.00	$	56,000
	Patch interior pathway of construction	27,999.00	sf	$	2.50	$	70,000
	Regular cleaning and final clean up	27,999.00	sf	$	2.50	$	70,000
	Miscellaneous items	27,999.00	sf	$	1.50	$	42,000
	SUBTOTAL MISCELLANEOUS COSTS					**$**	**280,000**

OPINION OF PROBABLE COST OF CONSTRUCTION FOR SEISMIC RETROFIT FOR MAIN POLICE DEPARTMENT BUILDING 215 EAST FIGUEROA STREET CITY OF SANTA BARBARA SANTA BARBARA, CA

PARTIAL BUILDING RETROFIT

FROM GRID LINES 1-6 & F-H

OPINION OF PROBABLE COST OF CONSTRUCTION
OCTOBER 14, 2010

ENGINEERS:
Coffman Engineers
16133 Ventura Blvd #1010
Encino, CA 91436
Tel: (818)285-2650
Fax: (818)285-2651

COST CONSULTANTS
Iskander Associates, Inc
600 N. Tustin Avenue #130
Santa Ana, CA 92705
Tel: (714) 544-4214
Fax: (714) 544-1206

SEISMIC RETROFIT		STATUS:	PRELIMINARY
MAIN POLICE DEPT BUILDING		DATE:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		DATE REV.	14-Oct-10
PARTIAL BUILDING RETROFIT		IAI PROJ #:	10-1950
A/E: COFFMAN ENGINEERING		GFA:	

BASIS OF THE ESTIMATE:

GENERAL:

This probable preliminary cost of construction estimate for the seismic retrofit for the Main police department building in the city of Santa Barbara is based on preliminary structural plans prepared by the design team of Coffman Engineers.

The estimate is also based on measurement of approximate quantities from the plans provided and priced in accordance with the outline specifications discussed with the design team. Where measurement was not possible reasonable allowances have been included in the estimates. The estimate covers the south portion of the building from grid lines 1-6 and F-H.

ARRANGEMENT:

It is assumed that the work will be done in phases. Therefore, allowances included for phasing in this estimate.
The estimate is arranged as follows:
1. Estimate for the proposed seismic retrofit work as designed by the engineers.
2. Estimate for reworking areas impacted by the proposed seismic retrofit.

DOCUMENTS USED FOR THE ESTIMATE:

The following drawings were received from Coffman Engineers and used in developing this probable cost of construction:
Progress Structural Set dated August 24, 2010: S0.1, S0.2, S1.1, S2.1, S2.2, S2.3, S2.4 S2.5, S3.1, S3.2 and S3.3
As built set of drawings dated April 4, 1959: Architectural drawings 1 through 7, and 10, Structural Drawings - S-1 through S-8.

ASSUMPTIONS:

The following assumptions were used in developing the cost estimate:
1 Labor wages are based on prevailing wages for normal working hours.
2 Material prices include all related freight, sales taxes and waste.
3 The estimate is based on receiving a minimum of 5 responsive bids with three sub contractor bid in each trade.
4 The building will remain occupied through out the construction period.
5 The work will be done in phases.
6 The phased work will be released to the contractor in timely manner
7 The contractor will be provided with phasing schedule.
8 The contractor will be provided with adequate staging space and parking for his workers.
9 All noise generating work will be done during off hours and weekends.
10 Pathway etc, on site damaged during construction will be repaired and made good
11 Patching and repairing of Impacted architectural and MEP disciplines are included as allowances
12 Hazardous material will be abated prior to demo work at impacted areas and included in the budget by the Engineer.
13 Allowances included for seismic restraints of equipment, pipes, ducts, conduits etc.,
14 Each phase will be totally cleaned after finish of work.

EXCLUSION:

The following items are not included in the hard construction costs for each building.

- o. Hazardous material abatement by others.
- o. Professional fees.
- o. Agencies fee, if any.
- o. Construction contingencies.
- o. Escalation beyond the 4th Quarter of 2010.
- o. Demolition work other than what is in the estimate
- o. Off site work
- o. Owner's costs.
- o. Public agencies costs.
- o. Relocation of personnel to swing space
- o. All Risk Insurance
- o. Preparation of the swing spaces
- o. ADA work.
- o. Architectural work beyond what is called for on the drawings.
- o. FF&E
- o. Seismic work beyond what is shown on the plans.
- o. Electrical work , other than allowance for impacted areas by seismic retrofit work.
- o. Mechanical systems other than allowance for impacted areas by seismic retrofit work.

LIMITATIONS

Since we have no control over the cost of labor, material and equipment, or the contractor's method of carrying out the work and determining the price, or over competitive bidding or market conditions, this opinion of probable construction cost provided, is made on the basis of experience and qualifications. This opinion represents our best judgment as professional construction consultants with the Construction Industry. However, we cannot and do not guarantee that proposals, bids or the construction cost will not vary from opinions of probable cost in this estimate.

SEISMIC RETROFIT
MAIN POLICE DEPT BUILDING
215 EAST FIGUEROA STREET, SANTA BARBARA, CA
PARTIAL BUILDING RETROFIT
A/E: COFFMAN ENGINEERING

Status: Conceptual
Date: 5-Oct-10
Date Revised 14-Oct-10
Project # 10-1950
GFA - SF

Item Description	Quantity	Unit		Rate		Total
Gross Floor area:						
Basement floor			sf			3,842
First Floor						3,842
Second Floor			sf			3,842
Total Gross Floor area			sf			11,526
PREPAREATORY WORK			$	7.85		90,500
ASBESTOS ABATEMENT WORK			$	5.40		62,200
SELECTIVE DEMOLITION			$	2.47		28,500
STRUCTURAL			$	21.37		246,300
SEISMIC RESTRAINTS			$	1.50		17,300
ARCHITECTURAL			$	15.02		173,100
ROOF			$	7.27		83,800
IMPACTED MEP			$	19.10		220,100
MISCELLANEOUS COSTS			$	10.00		115,300
TOTAL DIRECT COST			$	89.98	$	1,037,100
General Conditions		20.00%	$	17.99	$	207,400
Contractor's Overhead & Profit or Fee		15.00%	$	16.20	$	186,700
Insurance and Bond		3.00%	$	3.72	$	42,900
TOTAL INCLUDING MARK-UPS					$	1,474,100
Phasing allowance		10.00%			$	147,400
DESIGN CONTINGENCY		15.00%			$	243,200
PROBABLE CONSTRUCTION COST OCTOBER 2010			$	161.78	**$**	**1,864,700**

SEISMIC RETROFIT		Status:	Conceptual
MAIN POLICE DEPT BUILDING		Date:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		Date Revised	14-Oct-10
PARTIAL BUILDING RETROFIT		Project #	10-1950
A/E: COFFMAN ENGINEERING		GFA - SF	

	Item Description	Quantity	Unit	Rate	Total
01	**PREPERATORY WORK:**				
	Barricades	1.00	ls	$ 20,000.00	$ 20,000
	Noise control allowance	1.00	ls	$ 10,000.00	$ 10,000
	Dust Control Allowance	1.00	ls	$ 50,000.00	$ 50,000
	Trash bins	1.00	ls	$3,000.00	$ 3,000
	Protect existing work during construction	1.00	ls	$7,500.00	$ 7,500
	TOTAL PREPARATORY WORK:				**$ 90,500**
02	**ASBESTOS ABATEMENT:**				
	Ceilings with Acoustic spray assumed to be contaminated with asbestos. The following work is limited to the ceiling areas.				
	Preparatory work to abate space allow				
	Equipment and set up and removal	1.00	ls	$ 20,000.00	$ 20,000
	Containment construction set up and removal	1.00	ls	$ 12,000.00	$ 12,000
	Scrape ceilings	3,300	sf	$ 2.00	$ 6,600
	Remove Ballast from fl fixtures allow	150	ea	$ 50.00	$ 7,500
	Disposal of Contaminated material allow	3,300	sf	$ 2.00	$ 6,600
	Monitoring/sampling	1	ls	$ 3,000.00	$ 3,000
	Decontaminate area	1	ls	$ 4,000.00	$ 4,000
	Cover furniture and equipment during decontamination work.	3,300	sf	$ 0.75	$ 2,500
	TOTAL ASBESTOS ABATEMENT WORK				**$ 62,200**
03	**SELECTIVE DEMOLITION:**				
	Ceilings:				
	Remove Gypsum plaster ceilings	7,522.00	sf	$ 1.50	$ 11,300
	Remove suspended gypsum plaster clg	-	sf	$ 2.00	$ -
	Windows and doors				$ -
	Remove windows	2.00	ea	$ 150.00	$ 300
	Remove overhead door	-	ea	$ 500.00	$ -
	Remove doors as required and store	-	ea	$ 2,500.00	$ -
	Roof				
	Remove existing roof tiles.	4,110.00	sf	$ 2.00	$ 8,200
	Remove from site	1.00	ls	$ 1,200.00	$ 1,200
	Miscellaneous:				
	Allowance for removing cabinets, lockers, etc., to seismic work	1.00	ls	$ 5,000.00	$ 5,000
	Allowance for removing misc specialties	1.00	ls	$ 2,500.00	$ 2,500
	SUBTOTAL SELECTIVE DEMO				**$ 28,500**

SEISMIC RETROFIT	Status:	Conceptual
MAIN POLICE DEPT BUILDING	Date:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA	Date Revised	14-Oct-10
PARTIAL BUILDING RETROFIT	Project #	10-1950
A/E: COFFMAN ENGINEERING	GFA - SF	

	Item Description	Quantity	Unit		Rate		Total
04	**STRUCTURALSEISMIC RETROFIT WORK:**						
1	Foundation work (details 11, 12, 16/S1.1)						
	Saw cut slab on grade	72.00	lf	$	20.00	$	1,400
	Breakup and remove slab on grade	224.00	sf	$	4.00	$	900
	Excavate for foundations and tie beams	34.00	cy	$	50.00	$	1,700
	Backfill and compact	25.00	cy	$	50.00	$	1,300
	Haul surplus	9.00	cy	$	20.00	$	200
	Drill and epoxy dowel into existing concrete footing.	58.00	ea	$	30.00	$	1,700
	Roughen surfaces of existing concrete	112.00	sf	$	5.00	$	600
	Concrete in enlarging existing footing	9.00	cy	$	400.00	$	3,600
	Concrete Tie beam	-	cy	$	400.00	$	-
	Forming sides of footing	114.00	sf	$	15.00	$	1,700
	Forming sides of tie beam	-	sf	$	20.00	$	-
	Reinforcing bars in foundation	1,140.00	lb	$	1.25	$	1,400
	Reinforcing bars in tie beam	-	lb	$	1.25	$	-
2	Slab on Grade:						
	Drill/ epoxy dowel into existing slab	56.00	ea	$	35.00	$	2,000
	Reinforced concrete slab in patching existing slab on grade	224.00	sf	$	20.00	$	4,500
	Reinforcing rebar and connector to wall	560.00	lb	$	1.25	$	700
	Finish concrete slab to receive architectural finishes.	224.00	sf	$	2.50	$	600
3	Shotcrete Shear Wall (Detail 11/S1.1)						
	Roughen surfaces of existing concrete	616.00	sf	$	5.00	$	3,100
	Drill and epoxy into existing concrete wall	616.00	ea	$	30.00	$	18,500
	Drill and epoxy dowel into soffit of concrete beam	88.00	ea	$	40.00	$	3,500
	Drill and epoxy dowel into existing concrete ftg.	60.00	ea	$	30.00	$	1,800
	Shotcrete over existing conc wall	16.00	cy	$	400.00	$	6,400
	Rebound	1.00	ls	$	1,000.00	$	1,000
	Finish surface of shotcrete	616.00	sf	$	2.50	$	1,500
	Reinforcing bars in shotcrete wall	2,464.00	lb	$	1.25	$	3,100
	Block window opening with shotcrete	54.00	sf	$	60.00	$	3,200
4	Fiber Wrap:						
	Saw cut CMU partition walls for Fiber wrap	154.00	lf	$	20.00	$	3,100
	Breakup and remove CMU wall	154.00	sf	$	5.00	$	800
	3 layers to Columns	206.00	sf	$	45.00	$	9,300
	3 Layers to Walls	168.00	sf	$	45.00	$	7,600
	3 Layers to concrete floor slab	620.00	sf	$	45.00	$	27,900

SEISMIC RETROFIT		Status:	Conceptual
MAIN POLICE DEPT BUILDING		Date:	5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA		Date Revised	14-Oct-10
PARTIAL BUILDING RETROFIT		Project #	10-1950
A/E: COFFMAN ENGINEERING		GFA - SF	

	Item Description	Quantity	Unit		Rate		Total
5	Roof Seismic Work:						
	Drill through concrete wall for 3/4" Dia bolt	72.00	ea	$	50.00	$	3,600
	3/4" Bolt with nut	72.00	ea	$	10.50	$	800
	HSS member	11000.00	lb	$	5.00	$	55,000
	WT welded to bottom of existing steel beam	46.00	lf	$	125.00	$	5,800
	Miscellaneous steel plates	20.00	ea	$	500.00	$	10,000
	Miscellaneous steel in strengthening work	1.00	ls	$	10,000.00	$	10,000
	New plywood sheathing 19/32"	4,110.00	sf	$	5.00	$	20,600
	Allowance for sistering existing members	4,110.00	sf	$	5.00	$	20,600
	Allowance for removing and replacing dry rot of existing sheathing (10%)	450.00	sf	$	15.00	$	6,800
	SUBTOTAL STRUCTURAL					**$**	**246,300**
05	**SEISMIC RESTRAINTS:**						
	Impact area seismic restraints	11,526.00	sf	$	1.50	$	17,300
	SUBTOTAL SEISMIC RESTRAINTS					**$**	**17,300**
06	**ARCHITECTURAL IMPACT REPAIR**						
	New Gypsum plaster ceiling	7,522.00	sf	$	10.00	$	75,200
	Ditto suspended	-	sf	$	15.00	$	-
	Rebuild CMU Walls partitions	154.00	sf	$	30.00	$	4,600
	Floor finishes allowance	11,526.00	sf	$	2.50	$	28,800
	Wall finishes allowance	11,526.00	sf	$	1.50	$	17,300
	Column surfaces finishes allowance	206.00	sf	$	20.00	$	4,100
	Allowance for reinstalling removed doors	1.00	ls	$	5,000.00	$	5,000
	Allowance for rebuilding cabinets, replacing lockers etc.,	1.00	ls	$	10,000.00	$	10,000
	Allowance for replacing specialties items	1.00	ls	$	5,000.00	$	5,000
	Allowance for painting	11,526.00	sf	$	2.00	$	23,100
	SUBTOTAL ARCHITECTURAL					**$**	**173,100**
07	**ROOF**						
	New clay roof tile	4,110.00	sf	$	15.00	$	61,700
	Waterproofing membrane	4,110.00	sf	$	3.50	$	14,400
	Sheet metal work	265.00	lf	$	10.00	$	2,700
	Modify roof drains	1.00	ls	$	5,000.00	$	5,000
	SUBTOTAL ROOF					**$**	**83,800**

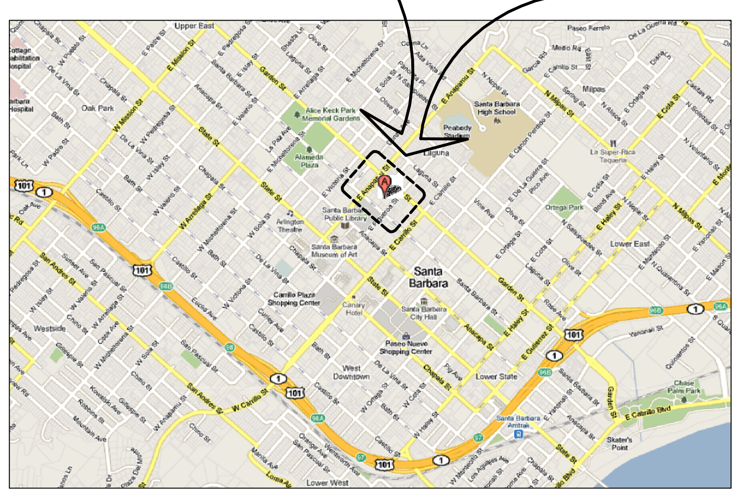
SEISMIC RETROFIT	Status: Conceptual
MAIN POLICE DEPT BUILDING	Date: 5-Oct-10
215 EAST FIGUEROA STREET, SANTA BARBARA, CA	Date Revised 14-Oct-10
PARTIAL BUILDING RETROFIT	Project # 10-1950
A/E: COFFMAN ENGINEERING	GFA - SF

Item Description	Quantity	Unit	Rate	Total
08 **IMPACTED MEP**				
Plumbing Work allowances due to Seismic work				
Rework roof drains allow	1.00	ls	$ 10,000.00	$ 10,000
				$ -
HVAC Allowances due to Seismic work impact:				$ -
Protect louvers in mechanical rooms	1.00	ls	$ 500.00	$ 500
Route / move / and reinstall mechanical equipment impacted by seismic work	1.00	sf	$ 80,000.00	$ 80,000
Allow for rerouting ducts, pipes, registers etc., in ceilings	1.00	sf	$ 15,000.00	$ 15,000
				$ -
Electrical Allowances due to Seismic Impact:				$ -
Remove and replace lighting fixtures in removed ceilings	7,522.00	sf	$ 12.50	$ 94,000
Modify all branch circuitry for lighting fixtures	7,522.00	sf	$ 2.00	$ 15,000
Reroute electrical conduits	7,522.00	sf	$ 0.75	$ 5,600
SUBTOTAL IMPACTED MEP				**$ 220,100**
09 **MISCELLANEOUS COSTS**				
Miscellaneous cuts and patch	11,526.00	sf	$ 1.50	$ 17,300
Scaffolding and barricades	11,526.00	sf	$ 2.00	$ 23,100
Patch interior pathway of construction	11,526.00	sf	$ 2.50	$ 28,800
Regular cleaning and final clean up	11,526.00	sf	$ 2.50	$ 28,800
Miscellaneous items	11,526.00	sf	$ 1.50	$ 17,300
SUBTOTAL MISCELLANEOUS COSTS				**$ 115,300**

APPENDIX I: PROPOSED RETROFIT SCHEMATIC DRAWINGS:

SANTA BARBARA POLICE STATION
SEISMIC RETROFIT STUDY
215 EAST FIGUEROA ST.
SANTA BARBARA, CA 93102

SITE



SHEET INDEX:

S0.1	GENERAL NOTES
S0.2	GENERAL NOTES
S1.1	DETAILS
S2.1	EXISTING BASEMENT RETROFIT PLAN
S2.2	EXISTING FIRST FLOOR RETROFIT PLAN
S2.3	EXISTING SECOND FLOOR PLAN
S2.4	EXISTING ROOF RETROFIT PLAN
S2.5	WALL ELEVATIONS
S3.1	BASEMENT REFLECTED CEILING DEMOLITION PLAN
S3.2	FIRST FLOOR REFLECTED CEILING DEMOLITION PLAN
S3.3	SECOND FLOOR REFLECTED CEILING DEMOLITION PLAN

ABBREVIATIONS

AB	ANCHOR BOLT
ADDL	ADDITIONAL
ALT	ALTERNATE
APA	AMERICAN PLYWOOD ASSOCIATION
ARCH	ARCHITECTURAL
AWPA	AMERICAN WOOD PRESERVERS ASSOCIATION
B	BOTTOM
BLKG	BLOCKING
BM	BEAM
BN	BOUNDARY NAIL
BOF	BOTTOM OF FOOTING
BRG	BEARING
BTN	BETWEEN
BOT	BOTTOM
CBC	CALIFORNIA BUILDING CODE
CIP	CAST-IN-PLACE
CJ	CEILING JOIST
CL	CENTER LINE
CLR	CLEAR
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
DBL	DOUBLE
DF	DOUGLAS FIR/LARCH
DL	DEAD LOAD
DP	DEEP
DIA	DIAMETER
DIM	DIMENSION
DO	DITTO (REPEAT)
DWG	DRAWING
DWL	DOWEL
E	EXISTING
EA	EACH
EF	EACH FACE
EL	ELEVATION
ELEC	ELECTRICAL
ELEV	ELEVATOR
EMBED	EMBEDMENT
EN	EDGE NAIL
EQ	EQUAL OR EQUIVALENT
ES	EACH SIDE
EW	EACH WAY
EXT	EXTERIOR
FA	FRAMING/SHEAR CONNECTOR
FDN	FOUNDATION
FF	FINISHED FLOOR
FJ	FLOOR JOIST
FOC	FACE OF CONCRETE
FOM	FACE OF MASONRY
FOS	FACE OF STUD
FRM	FRAMING
FRT	FIRE-RETARDANT TREATED
FS	FAR SIDE
FTG	FOOTING
GA	GAUGE
GALV	GALVANIZED
GLB	GLUED LAMINATED BEAM
GR	GRADE
H	HORIZONTAL
HDR	HEADER
HGR	HANGER
HT	HEIGHT
HORIZ	HORIZONTAL
HSH	HORIZONTALLY SLOTTED HOLES
ID	INSIDE DIAMETER
IF	INSIDE FACE
I JST	I-JOIST
INT	INTERIOR
IOR	INSPECTOR OF RECORD
JST	JOIST
JT	JOINT
LDGR	LEDGER
LL	LIVE LOAD
LTWT	LIGHT WEIGHT
MATL	MATERIAL
MAX	MAXIMUM
MB	MACHINE BOLT
MECH	MECHANICAL
MFR	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MTL	METAL
NIC	NOT IN CONTRACT
NO	NUMBER
NS	NEAR SIDE
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE
OH	OPPOSITE HAND
OPNG	OPENING
OPP	OPPOSITE
ORIG	ORIGINAL
OSB	ORIENTED STRAND BOARD
PL	PLATE
PLCS	PLACES
PLYWD	PLYWOOD
PT	PRESERVATIVE TREATED
PW	PLATE WASHER
R	RADIUS
REF	REFERENCE
REINF	REINFORCEMENT
REQD	REQUIRED
RF	ROOF
RT	RAFTER CROSSTIE
RR	ROOF RAFTERS
RW	RETAINING WALL
SCHED	SCHEDULE
SECT	SECTION
SEOR	STRUCTURAL ENGINEER OF RECORD
SEP	SEPARATION
SIM	SIMILAR
SN	SHEAR NAIL
SP	SEE PLAN
SPEC	SPECIFICATION
SQ	SQUARE
STD	STANDARD
STGR	STAGGER
STIFF	STIFFENERS
STR	STRUCTURAL
STR I	STRUCTURAL I
T	TOP
T&B	TOP & BOTTOM
T&G	TONGUE & GROOVE
THK	THICKNESS/THICK
THR	THREADED
TN	TOENAIL
TOP	TOP OF PARAPET
TOS	TOP OF SLAB
TOW	TOP OF WALL
TYP	TYPICAL
UBC	UNIFORM BUILDING CODE
UNO	UNLESS NOTED OTHERWISE
V	VERTICAL
VERT	VERTICAL
VSH	VERTICAL SLOTTED HOLES
WD	WOOD
WP	WATERPROOF OR WORK POINT
WPJ	WEAKENED PLANE JOINT
WT	WEIGHT
WWF	WELDED WIRE FABRIC
W/	WITH
W/O	WITH OUT
WO	WHERE OCCURS
XS	EXTRA STRONG (STEEL PIPE)
XXS	DOUBLE EXTRA STRONG (STEEL PIPE)

GENERAL:

THE STRUCTURAL CONTRACT DRAWINGS AND SPECIFICATIONS REPRESENT THE FINISHED STRUCTURE. THEY DO NOT INDICATE THE METHOD OF CONSTRUCTION. THE STRUCTURE IS DESIGNED TO BE A STABLE UNIT AS A COMPLETED WHOLE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DESIGN, ERECT AND INSPECT TEMPORARY SHORES, BRACES, ETC. TO SUPPORT THE STRUCTURE AGAINST ALL ANTICIPATED LOADS INCLUDING GRAVITY, WIND AND LATERAL EARTH PRESSURE UNTIL ITS COMPLETION. OBSERVATION VISITS TO THE SITE BY THE STRUCTURAL ENGINEER SHALL NOT INCLUDE INSPECTION OF THESE METHODS OF CONSTRUCTION. CONSTRUCTION MATERIAL SHALL BE PLACED ON FRAMED FLOORS AND ROOFS SUCH THAT THE DESIGN LIVE LOADS ARE NOT EXCEEDED.

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, ELEVATIONS AND SITE CONDITIONS PRIOR TO STARTING CONSTRUCTION. RESOLVE ANY DISCREPANCY WITH COFFMAN ENGINEERS.

WORKMANSHIP AND MATERIALS SHALL COMPLY WITH 2007 CBC AND ALL OTHER APPLICABLE REGULATIONS.

NOTES AND DETAILS ON THE DRAWINGS TAKE PRECEDENCE OVER THE GENERAL STRUCTURAL NOTES AND TYPICAL DETAILS. "TYPICAL" DETAILS ARE NOT FLAGGED ON THE DRAWINGS, BUT APPLY UNLESS NOTED OTHERWISE.

APPROVED FABRICATORS SHALL BE LICENSED BY CITY OF SANTA BARBARA DEPARTMENT OF BUILDING & SAFETY.

THESE DRAWINGS REPRESENT WORK TO BE PERFORMED IN THE AREA OF SCOPE ONLY. THE ENGINEER TAKES NO RESPONSIBILITY FOR ANY OTHER PORTIONS OF THIS STRUCTURE.

ALL EXISTING ANALYSIS PER ASCE 41-06. ALL NEW DESIGN PER CBC 2007.

ALL EXISTING CONDITIONS ASSUMED IN DETAILS MUST BE CONFIRMED IN THE FIELD PRIOR TO FABRICATION OR CONSTRUCTION. ANY DISCREPANCIES MUST BE BROUGHT TO THE ATTENTION OF COFFMAN ENGINEERS BEFORE CONSTRUCTION OR FABRICATION.

ALL BOLTS INTO MASONRY ARE ASSUMED TO BE INSTALLED INTO FULLY GROUTED CELLS. IF CELLS ARE FOUND TO BE HOLLOW, DO NOT INSTALL BOLTS AND INFORM COFFMAN ENGINEERS FOR INSTRUCTIONS ON HOW TO PROCEED.

COORDINATION:

ALL DRAWINGS ARE CONSIDERED TO BE PART OF THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING THE DRAWINGS AND SPECIFICATIONS AMONG THE SUBCONTRACTORS PRIOR TO START OF CONSTRUCTION. ANY DISCREPANCIES THAT ARE FOUND SHALL BE BROUGHT TO THE ATTENTION OF COFFMAN ENGINEERS PRIOR TO START OF CONSTRUCTION. ANY WORK PERFORMED IN CONFLICT WITH THE CONTRACT DOCUMENTS OR ANY CODE REQUIREMENTS SHALL BE CORRECTED BY THE CONTRACTOR AT HIS OWN EXPENSE AND AT NO EXPENSE TO THE OWNER OR ENGINEER.

COORDINATION SHALL INCLUDE, BUT NOT BE LIMITED TO, VERIFYING THE LOCATION AND WEIGHT OF ALL MECHANICAL AND ELECTRICAL EQUIPMENT AS WELL AS THE SIZE AND LOCATION OF ALL MECHANICAL OPENINGS IN ROOFS, FLOORS AND WALLS. UNLESS OTHERWISE NOTED ON THE DRAWINGS, DO NOT PENETRATE ANY STRUCTURAL ELEMENTS SUCH AS BEAMS, COLUMNS, WALLS, SLABS, ETC. WITHOUT PRIOR WRITTEN APPROVAL OF THE STRUCTURAL ENGINEER.

COORDINATION SHALL INCLUDE, BUT NOT BE LIMITED TO, DETERMINING THE LOCATION OF ALL EXISTING UTILITY LINES THAT MAY INTERFERE WITH THE INSTALLATION OF THE NEW STRUCTURAL ELEMENTS. THE CONTRACTOR SHALL INFORM THE OWNER IF INTERFERENCE IS ENCOUNTERED. THE OWNER WILL DETERMINE IF THE LINES ARE TO BE REMOVED OR RELOCATED.

INSPECTIONS:

THE OWNER SHALL EMPLOY AN INSPECTOR TO PROVIDE INSPECTION PER ________ BUILDING CODE. ALL SPECIAL INSPECTORS SHALL BE APPROVED BY CITY OF SANTA BARBARA DEPARTMENT OF BUILDING & SAFETY.

CODE:

2007 CBC AND ASCE 41-06.

DESIGN LIVE LOADS:
- ROOF LIVE LOAD ---------------------- 20 PSF
- PARTITION LOAD ---------------------- 20 PSF (10 PSF SEISMIC)

WIND:
- BASIC WIND SPEED ---------------------- 85 MPH
- EXPOSURE ---------------------- "C"
- K_z ---------------------- 1.0
- K_{zt} ---------------------- 1.0

SEISMIC:
- SITE CLASS ---------------------- "F"
- IMPORTANCE FACTOR ---------------------- 1.5
- OCCUPANCY CATEGORY ---------------------- IV
- S_s ---------------------- 2.047
- S_1 ---------------------- 0.782
- F_a ---------------------- 1.0
- F_v ---------------------- 1.5
- S_{DS} ---------------------- 1.364
- S_{D1} ---------------------- 0.782

SNOW LOADS DO NOT APPLY TO THIS SITE.
FLOOD LOADS DO NOT APPLY TO THIS SITE.

FOUNDATION:

ALLOWABLE SOIL BEARING PRESSURE:
- 1500 PSF
- 24" MIN. DEPTH
- ULTIMATE SOIL PRESSURE = 7000 PSF

CONCRETE:

CONCRETE CONSTRUCTION SHALL CONFORM WITH THE LATEST EDITION OF ACI 301, "SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS" AND ACI 318, "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE". SUBMIT MIX DESIGNS FOR EACH CLASS OF CONCRETE. ALL LIGHTWEIGHT CONCRETE TO BE SAND LIGHTWEIGHT CONCRETE.

CONCRETE CONTAINING SUPERPLASTICIZING ADMIXTURE SHALL HAVE A SLUMP NOT EXCEEDING 3", TO BE FIELD VERIFIED, PRIOR TO ADDING ADMIXTURE, AND NOT EXCEEDING 8" AT PLACEMENT. ADDITION OF WATER TO A MIX WITH INSUFFICIENT SLUMP WILL NOT BE PERMITTED.

MECHANICALLY VIBRATE ALL CONCRETE WHEN PLACED, EXCEPT THAT SLABS ON GRADE NEED BE VIBRATED ONLY AROUND UNDER-FLOOR DUCTS, ETC. CAST CLOSURE POUR AROUND COLUMNS AFTER DEAD LOAD IS APPLIED.

SHOT PINS AT CURBS ANS SLAB EDGES ARE NOT ALLOWED. THE USE OF EXPANSION ANCHORS AT CURBS IS NOT ALLOWED UNLESS SPECIALLY DETAILED OR APPROVED BY SEOR.

MINIMUM CONCRETE MIX DESIGN REQUIREMENTS SHALL BE AS FOLLOWS:

ITEM	28 DAY STRENGTH F'c (PSI)	MAX. SIZE AGGREGATE	AIR ENTR.	MAX. SLUMP	DENSITY
FOOTINGS/SLAB ON GRADE	3,000	1"	2%	4"	150 PCF
SHOTCRETE	4,000	1"	2%	4"	150 PCF

NOTE- A HIGHER GRADE OF CONCRETE MAY BE SUBSTITUTED FOR THOSE SHOWN ABOVE BUT WILL BE SUBJECT TO THE CODE REQUIREMENTS OF THE HIGHER GRADE.

CONTINUOUS INSPECTION IS REQUIRED FOR ALL CONCRETE IN EXCESS OF 3000 PSI.

BEFORE CONCRETE IS POURED, CHECK WITH ALL TRADES TO INSURE PROPER PLACEMENT OF ALL OPENINGS, SLEEVES, CURBS, CONDUITS, BOLTS, INSERTS, ETC. RELATING TO WORK.

ALL SLEEVES NOT SPECIFICALLY SHOWN ON DRAWINGS SHALL BE LOCATED BY THE TRADES INVOLVED & SHALL BE APPROVED BY STRUCTURAL ENGINEER.

DRYPACK CONCRETE SHALL BE ONE PART PORTLAND CEMENT & ONE PART SAND WITH SUFFICIENT WATER TO ALLOW A SMALL AMOUNT OF PASTE TO COME TO THE SURFACE.

CONCRETE GROUT SHALL BE NON-SHRINKING WITH SUFFICIENT WATER TO ALLOW POURING. MINIMUM ULTIMATE COMPRESSIVE STRENGTH F'C AT 28 DAYS SHALL BE 2000 PSI.

MIX THAT PRODUCES LOWEST SLUMP COMPATIBLE WITH PROPER PLACEMENT SHALL BE USED (4" MAX. SLUMP UNLESS OTHERWISE APPROVED BY STRUCTURAL ENGINEER).

REINFORCING STEEL:

DEFORMED BARS:

ASTM A615 GRADE 40 FOR #3 AND GRADE 60 FOR #4 AND LARGER. REINFORCING TO BE WELDED SHALL BE ASTM A706, GRADE 60, LOW ALLOY.

CLEAR CONCRETE COVERAGE (APPLIES UNLESS NOTED OTHERWISE):
- CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH ---------- 3"
- FORMED CONCRETE EXPOSED TO EARTH OR WEATHER ---------- 2"
- FORMED CONCRETE NOT EXPOSED TO EARTH OR WEATHER ---------- 1 1/2"
- FROM TOP SURFACE OF SLAB ON GRADE ---------- 1 1/2"

WELDING:

UNLESS NOTED OTHERWISE, WELDING OF REINFORCING STEEL IS PROHIBITED. WHERE WELDING IS NOTED, WELD IN ACCORDANCE WITH AWS D1.1 USING E90 SERIES ELECTRODES. SUBMIT MILL TEST REPORTS ON THE REINFORCING TO BE WELDED AND THE PROPOSED WELDING PROCEDURE.

LAP SPLICES IN CONCRETE:

SEE TYPICAL DETAIL FOR LAP SPLICES IN CONCRETE BEAMS, WALLS, SLABS AND FOOTINGS. (UNLESS NOTED OTHERWISE, LAP SPLICES IN CONCRETE BEAMS, WALLS, SLABS AND FOOTINGS SHALL BE CLASS "B" TENSION LAP SPLICES AND LAP SPLICES IN CONCRETE COLUMNS SHALL BE STANDARD COMPRESSION LAP SPLICES PER LATEST EDITION OF ACI 318. STAGGER ALTERNATE SPLICES A MINIMUM OF ONE LAP LENGTH.) LAPS IN WELDED WIRE FABRIC SHALL BE MADE SO THAT THE OVERLAP MEASURED BETWEEN OUTERMOST CROSS WIRES OF EACH FABRIC SHEET IS NOT LESS THAN THE SPACING OF CROSS WIRES PLUS 2 INCHES. ALL SPLICE LOCATIONS SUBJECT TO APPROVAL.

PROVIDE BENT CORNER BARS TO MATCH AND LAP WITH HORIZONTAL BARS AT CORNERS AND INTERSECTIONS OF FOOTINGS AND WALLS. SPACING SHOWN FOR REINFORCING BARS ARE MAXIMUM ON CENTERS. ALL BARS PER CRSI SPECIFICATIONS AND HANDBOOK. DOWEL ALL VERTICAL REINFORCING TO THE FOUNDATION. CONCRETE COLUMN DOWEL EMBEDMENT SHALL BE A STANDARD COMPRESSION DOWEL EMBEDMENT LENGTH ACCORDING TO THE LATEST EDITION OF ACI 318. SECURELY TIE ALL BARS IN POSITION PRIOR TO PLACING CONCRETE. SUPPORT SLAB REINFORCEMENT WITH CONCRETE BLOCKS OR SUPPORT CHAIRS. REINFORCING SHALL NOT BE SUPPORTED BY STAKES DRIVEN INTO THE GROUND.

STRUCTURAL STEEL:

- ROLLED SHAPES OTHER THAN WIDE-FLANGE SHAPES, ALL PLATES, BARS AND RODS -------- ASTM A36, Fy = 36 KSI
- HSS STEEL -------- ASTM A500 GR. B, Fy = 46 KSI
- BOLTS -------- ASTM A307
- ANCHOR BOLTS -------- ASTM A36 ROD STOCK OR F1554, Fy=36
- EXPANSION BOLTS -------- CONCRETE HILTI TZ "ESR# 1917"; MASONRY HILTI KB-3 "ESR# 1385"

FABRICATION AND ERECTION:

LATEST AISC AND AWS CODES APPLY. FABRICATE AND ERECT IN ACCORDANCE WITH LATEST EDITION OF AISC "SPECIFICATION FOR DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS". SPLICING OF STRUCTURAL MEMBERS IS NOT PERMITTED UNLESS NOTED ON THE DRAWINGS. ALL BEAMS SHALL BE ERECTED WITH THE NATURAL CAMBER UPWARDS.

ALL FABRICATORS SHALL BE LICENSED BY CITY OF LOS ANGELES.

WELDING:

ALL WELDING BY CERTIFIED WELDERS HAVING CURRENT EXPERIENCE IN TYPE OF WELD SHOWN ON DRAWINGS OR NOTES. CERTIFICATES SHALL BE THOSE ISSUED BY LADBS. ALL WELDING SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF AWS "CODE FOR ARC AND GAS WELDING IN BUILDING CONSTRUCTION". USE E70 SERIES LOW HYDROGEN ELECTRODES. SHOP WELDS AND FIELD WELDS SHALL BE SHOWN ON SHOP DRAWINGS. ALL COMPLETE PENETRATION WELDS SHALL BE TESTED AND CERTIFIED BY AN INDEPENDENT TESTING AGENCY. ALL DEFORMED BAR ANCHORS, HEADED STUDS AND THREADED STUDS SHALL BE END WELDED PER MANUFACTURER'S RECOMMENDATIONS.

BOLTS:

ALL BOLTS, ANCHOR BOLTS, EXPANSION BOLTS, ETC., SHALL BE INSTALLED WITH STEEL WASHERS. TYPE N BOLTS PER LATEST EDITION OF AISC "SPECIFICATION. INSPECTOR OF RECORD TO VERIFY RE-TIGHTENING OF ALL BOLTS PRIOR TO CLOSING IN. HILTI BOLTS AND ANCHORS MAY BE SUBSTITUTED WITH AN APPROVED LARR RATED PRODUCT.

EPOXY ANCHOR RODS (ALL-THREAD AND REBAR):

1. EPOXY ANCHORS NOTED IN DRAWINGS ARE HILTI RE500 ANCHORS SYSTEM, OR APPROVED EQUAL.

3. MINIMUM EMBEDMENT DEPTHS AS FOLLOWS UNLESS NOTED OTHERWISE.

ALL-THREAD ROD ANCHOR SIZE (DIA.)	EPOXY ANCHOR		ALLOWABLE/TESTING LOADS	
	MINIMUM EMBEDMENT*	MIN. EDGE DIST	T ALLOWABLE LOAD(LBS) **	TESTING LOAD (LBS)
3/8" DIA	3-1/2"	5-1/4"	1,388	2,776
1/2" DIA	4-1/4"	6-3/8"	2,224	4,448
5/8" DIA	5"	7-1/2"	3,900	7,800
3/4" DIA	6-3/4"	10-1/8"	4,888	9,776
7/8" DIA	7-3/4"	11-5/8"	4,888	9,776
1" DIA	9"	13-1/2"	10,036	20,072

* MIN CONCRETE THICKNESS = 1.5 MIN EMBEDMENT
** MIN CONCRETE STRENGTH = 3000 PSI (HARDROCK), ALL-THREAD ROD SHALL BE ASTM A-193 GRADE B7 ALLOWABLE TENSION LOAD = 80% OF ICC REPORT

REBAR ANCHOR SIZE	EPOXY ANCHOR		ALLOWABLE/TESTING LOADS	
	MINIMUM EMBEDMENT*	MIN. EDGE DIST	T ALLOWABLE LOAD(LBS) **	TESTING LOAD (LBS)
#4	4-1/4"	6-3/8"	3,480	6,960
#5	5"	7-1/2"	5,064	10,128
#6	6-3/4"	10-1/8"	7,888	15,776
#7	7-3/4"	11-5/8"	9,552	19,104

* MIN CONCRETE THICKNESS = 1.5 MIN EMBEDMENT
** MIN CONCRETE STRENGTH = 3000 PSI (HARDROCK), REBAR SHALL BE ASTM A615, GRADE 60 ALLOWABLE TENSION LOAD = 80% OF ICC REPORT

3. EPOXY ANCHORS SHALL BE TESTED PER SECTION 1923A.3.5. THE TENSION TEST SHALL BE TWICE THE ALLOWABLE LOAD FOR THE SPECIFIC LOCATION.
4. THE TEST PROCEDURE FOR EXPANSION ANCHORS IN THE EXPANSION ANCHOR TABLE SHALL ALSO BE USED FOR EPOXY ANCHORS. TORQUE TESTING IS NOT PERMITTED. WHERE EPOXY DOWELS ARE USED AS SHEAR DOWELS ACROSS COLD JOINTS IN SLAB ON GRADE AND THE SLAB IS NOT A PART OF THE STRUCTURAL SYSTEM, TESTING OF THOSE DOWELS IS NOT REQUIRED.
5. ANCHORS SHALL EXHIBIT NO DISCERNIBLE MOVEMENT DURING THE TEST.

WOOD:

GENERAL:

DO NOT NOTCH OR DRILL JOISTS, BEAMS OR LOAD BEARING STUDS WITHOUT PRIOR APPROVAL OF THE STRUCTURAL ENGINEER THROUGH THE ARCHITECT. DOUBLE UP STUDS AT JAMBS AND UNDER BEAMS IN BEARING WALLS. PROVIDE 2X SOLID BLOCKING AT MID-HEIGHT OF LOAD BEARING STUD WALLS. ALL NAILS SHALL BE COMMON NAILS. ALL NAILING NOT NOTED SHALL BE IN ACCORDANCE WITH TABLE 2304.9.1 OF THE LATEST EDITION OF THE CALIFORNIA BUILDING CODE. ALL FRAMING ANCHORS AND CONNECTORS SHALL BE AS MANUFACTURED BY SIMPSON COMPANY OR OTHER APPROVED EQUAL WITH ICBO CERTIFICATION. ALL NAIL HOLES IN FRAMING ANCHORS AND CONNECTORS SHALL BE FILLED WITH NAILS PER MANUFACTURERS PUBLISHED NAIL SIZES. ALL BOLTS SHALL BE ASTM A307 BOLTS INSTALLED WITH STEEL WASHERS.

FRAMING LUMBER:

BASE VALUES FOR DIMENSION LUMBER

MEMBER	Fb (PSI)	Fv (PSI)	E (PSI)	Fc//(PSI)	SPECIES & GRADE
JOISTS	875	95	1,600,000	1300	DOUG FIR #2
BEAMS					
4X MEMBERS	1000	95	1,700,000	1450	DOUG FIR #1
6X MEMBERS	1350	85	1,600,000	925	DOUG FIR #1
POSTS					
4X MEMBERS	1000	95	1,700,000	1450	DOUG FIR #1
6X MEMBERS	1200	85	1,600,000	1000	DOUG FIR #1
STUDS	900	95	1,600,000	1350	DOUG FIR #2
LEDGERS AND TOP PLATES	1000	95	1,700,000	1450	DOUG FIR #1
TREATED SILL PLATES	DOUG FIR #2 MIN. EACH PIECE SHALL BEAR A STAMP OF APPROVED INDEPENDENT AGENCY OPERATING UNDER AITC.				

FRAMING LUMBER SHALL COMPLY WITH THE LATEST EDITION OF THE GRADING RULES OF THE WESTERN WOOD PRODUCTS ASSOCIATION OR THE WEST COAST LUMBER INSPECTIONS BUREAU. ALL SAWN LUMBER SHALL BE STAMPED WITH THE GRADE MARK OF AN APPROVED GRADING AGENCY. MOISTURE CONTENT SHALL NOT EXCEED 19%.

MACHINE NAILING:

USE OF MACHINE NAILING IS SUBJECT TO A SATISFACTORY JOBSITE DEMONSTRATION FOR EACH PROJECT AND THE APPROVAL OF THE PROJECT ARCHITECT OR STRUCTURAL ENGINEER AND THE ENFORCEMENT AGENCY. THE APPROVAL IS SUBJECT TO CONTINUED SATISFACTORY PERFORMANCE. MACHINE NAILING IS NOT ALLOWED FOR 5/16" INCH PLYWOOD. IF THE NAIL HEADS PENETRATE THE OUTER PLY MORE THAN WOULD BE NORMAL FOR A HAND HELD HAMMER, OR IF MINIMUM ALLOWABLE EDGE DISTANCES ARE NOT MAINTAINED, THE PERFORMANCE WILL BE DEEMED UNSATISFACTORY AND MACHINE NAILING SHALL BE DISCONTINUED.

UNLESS SPECIFICALLY SHOWN ON THESE PLANS NO STRUCTURAL MEMBER SHALL BE CUT. NEITHER DRILLED NOR NOTCHED WITHOUT PRIOR WRITTEN AUTHORIZATION FROM THE STRUCTURAL ENGINEER AND THE CITY OF LOS ANGELES DEPARTMENT OF BUILDING & SAFETY.

STRUCTURAL SHEATHING:

STRUCTURAL SHEATHING PROPERTIES AND ATTACHMENT (MINIMUM, U.N.O.)

ITEM	THICKNESS	SPAN/INDEX RATIO	EDGE NAILING	INTERMEDIATE NAILING
ROOF	23/32"	32/16	SEE SCHEDULE	SEE SCHEDULE

ALL STRUCTURAL SHEATHING IS TO BE DOUGLAS FIR CONFORMING TO PS-1-83, GROUP 1 OR 2 OR APA PERFORMANCE RATED PANELS. STRUCTURAL-1 SHEATHING INCLUDES ALL-VENEER PLYWOOD, COMPOSITE PANELS CONTAINING A COMBINATION OF VENEER AND WOOD BASED MATERIALS, AND MAT-FORMED PANELS. SUCH PLYWOOD IS TO BE "EXTERIOR" TYPE, GRADED-MARKED BY THE AMERICAN PLYWOOD ASSOCIATION, GRADE STRUCTURAL-1 UNLESS NOTED OTHERWISE. SHEATHING PANEL INDEX TO BE MIN. 32/16 FOR ROOF SHEATHING AND 24/0 FOR EXTERIOR SHEATHING.

THE MINIMUM PLYWOOD WIDTH FOR ROOF SHEATHING SHALL BE 24" WIDE AND 12" WIDE FOR ALL SHEAR WALL SHEATHING. INSTALL PLYWOOD SHEATHING TO ALL EXTERIOR SOLID WALLS, SHEARWALLS & NON-SHEARWALLS, TOP SIDES AND BOTTOM OF WALL OPENINGS.

SILL PLATES ON MASONRY OR CONCRETE TO BE 3x PRESSURE TREATED LUMBER. WALL STUDS AND BLOCKING AT ADJOINING PANEL EDGES TO BE 3x OR LARGER. PLYWOOD JOINT AND SILL PLATE NAILING TO BE STAGGERED IN ALL CASES.

ALL NAILS TO BE COMMON WIRE NAILS AS INDICATED IN THE NAILING SCHEDULE (TABLE 2304.9.1 "FASTENING SCHEDULE" OF THE 2007 CBC) AND PER PLAN. DO NOT USE BOX TYPE NAILS. ALL FIELD NAILING TO BE 12" OC, UNO. NAIL PLYWOOD AS SPECIFIED ON THE PLANS AND/OR ON THE GENERAL NOTES, WITH PERIMETER NAILS NOT CLOSER THAN 1/2" FROM THE EDGES. DO NOT OVERDRIVE THE NAILS THROUGH THE FACE GRAIN OF THE PLYWOOD. OVER DRIVEN NAILS MAY RESULT IN REJECTION AND REPLACEMENT OF PLYWOOD BY THE INSPECTOR OR ENGINEER. EXCEPT FOR PLYWOOD, NAILS SHALL NOT BE DRIVEN CLOSER THAN 1/2 THEIR LENGTH NOR CLOSER TO THE EDGE OR END OF LUMBER THAN 1/4 THEIR LENGTH. THE PENETRATION OF NAILS OR SPIKES INTO PIECES RECEIVING THE POINT SHALL NOT BE LESS THAN 1/2 THE NAIL LENGTH, EXCEPT THAT A 16d MAY BE USED TO CONNECT PIECES OF 2" NOMINAL THICKNESS. USE 16d COMMONS THROUGH SILL.

ALL FRAMING CONNECTORS TO BE SIMPSON STRONG TIE COMPANY OR AS REQUIRED BY THE STRUCTURAL PLANS. SUBSTITUTIONS FOR EQUIVALENT PRODUCTS MAY BE USED. CONTRACTOR IS RESPONSIBLE FOR PROVIDING PROOF OF EQUIVALENCY, TO INCLUDE BUT NOT LIMITED TO THE ICC REPORT. PROVIDE THE TYPE OF NAILS SPECIFIED BY THE MANUFACTURER AND FULLY DRIVE NAILS INTO ALL HOLES OF THE CONNECTOR UNLESS NOTED OTHERWISE ON THE PLANS. ALL CONNECTORS SHALL BE GALVANIZED OR HAVE ANOTHER FACTORY APPLIED FINISH. ALL STEEL FRAMING HANGERS TO BE TORSIONAL RESTRAINT. SOLID BLOCKING REQUIRED BETWEEN JOISTS WHERE TORSIONAL RESTRAINT HANGERS DO NOT OCCUR.

SANTA BARBARA DEPARTMENT OF BUILDING AND SAFETY: GENERAL NOTES FOR STRUCTURAL OBSERVATION:

1. STRUCTURAL OBSERVATION IS REQUIRED FOR THE STRUCTURAL SYSTEM IN ACCORDANCE WITH 2007 CBC CHAPTER 17. STRUCTURAL OBSERVATION IS THE VISUAL OBSERVATION OF THE ELEMENTS AND CONNECTIONS OF THE STRUCTURAL SYSTEMS AT SIGNIFICANT CONSTRUCTION STAGES AND THE COMPLETED STRUCTURE FOR GENERAL CONFORMANCE TO THE APPROVED PLANS AND SPECIFICATIONS. STRUCTURAL OBSERVATION DOES NOT WAIVE THE RESPONSIBILITY FOR THE INSPECTIONS REQUIRED OF THE BUILDING INSPECTOR OR THE DEPUTY INSPECTOR.
2. THE OWNER SHALL EMPLOY A CIVIL OR STRUCTURAL ENGINEER OR ARCHITECT TO PERFORM THE STRUCTURAL OBSERVATION. THE ENGINEER OR ARCHITECT SHALL BE REGISTERED OR LICENSED IN THE STATE OF CALIFORNIA. THE DEPARTMENT OF BUILDING AND SAFETY RECOMMENDS THE USE OF THE ENGINEER OR ARCHITECT RESPONSIBLE FOR THE STRUCTURAL DESIGN WHEN THEY ARE INDEPENDENT OF THE CONTRACTOR.
3. THE STRUCTURAL OBSERVER SHALL PROVIDE EVIDENCE OF EMPLOYMENT BY THE OWNER. A LETTER FROM THE OWNER OR A COPY OF THE AGREEMENT FOR SERVICES SHALL BE SENT TO THE BUILDING INSPECTOR BEFORE THE FIRST SITE VISIT. THE STRUCTURAL OBSERVER SHALL ALSO INFORM THE OWNER OF THE REQUIREMENTS FOR A PRECONSTRUCTION MEETING AND SHALL PRESIDE OVER THIS MEETING.
4. THE OWNER OR OWNER'S REPRESENTATIVE SHALL COORDINATE AND CALL FOR A MEETING BETWEEN THE ENGINEER OR ARCHITECT RESPONSIBLE FOR THE STRUCTURAL DESIGN, STRUCTURAL OBSERVER, CONTRACTOR, AFFECTED SUBCONTRACTORS AND DEPUTY INSPECTORS. THE PURPOSE OF THE MEETING SHALL BE IDENTIFY THE MAJOR STRUCTURAL ELEMENTS AND CONNECTIONS THAT AFFECT THE VERTICAL AND LATERAL LOAD SYSTEMS OF THE STRUCTURE AND TO REVIEW SCHEDULING OF THE REQUIRED OBSERVATIONS. A RECORD OF THE MEETING SHALL BE INCLUDED IN THE FIRST OBSERVATION REPORT SUBMITTED TO THE BUILDING INSPECTOR.
5. THE STRUCTURAL OBSERVER SHALL PERFORM SITE VISITS AT THOSE STEPS IN THE PROGRESS OF THE WORK THAT ALLOW FOR CORRECTION OF DEFICIENCIES WITHOUT SUBSTANTIAL EFFORT OR UNCOVERING OF THE WORK INVOLVED. AT A MINIMUM, THE FOLLOWING SIGNIFICANT CONSTRUCTION STAGES REQUIRE A SITE VISIT AND AN OBSERVATION REPORT FROM THE STRUCTURAL OBSERVER.
6. THE STRUCTURAL OBSERVER SHALL PREPARE A REPORT ON THE DEPARTMENT FOR EACH SIGNIFICANT STAGE OF CONSTRUCTION OBSERVED. THE ORIGINAL OF THE OBSERVATION REPORT SHALL BE SENT TO THE BUILDING INSPECTOR'S OFFICE AND SHALL BE SIGNED AND SEALED (WET STAMP) BY THE RESPONSIBLE STRUCTURAL OBSERVER. ONE COPY OF THE OBSERVATION REPORT SHALL BE ATTACHED TO THE APPROVED PLANS. THE COPY ATTACHED TO THE PLANS NEED NOT BE SEALED BUT SHALL BE SIGNED BY THE RESPONSIBLE STRUCTURAL OBSERVER OR THEIR DESIGNEE. COPIES OF THE REPORT SHALL ALSO BE GIVEN TO THE OWNER, CONTRACTOR, AND DEPUTY INSPECTOR.
7. A FINAL OBSERVATION REPORT MUST BE SUBMITTED WHICH SHOWS THAT ALL OBSERVED DEFICIENCIES WERE RESOLVED AND THE STRUCTURAL SYSTEM GENERALLY CONFORMS WITH THE APPROVED PLANS AND SPECIFICATIONS. THE DEPARTMENT OF BUILDING AND SAFETY WILL NOT ACCEPT THE STRUCTURAL WORK WITHOUT THIS FINAL OBSERVATION REPORT AND THE CORRECTION OF SPECIFIC DEFICIENCIES NOTED DURING NORMAL BUILDING AND DEPUTY INSPECTION.
8. WHEN THE OWNER ELECTS TO CHANGE THE STRUCTURAL OBSERVER OF RECORD, THE OWNER SHALL:
   A. NOTIFY THE BUILDING INSPECTOR IN WRITING BEFORE THE NEXT INSPECTION.
   B. CALL AN ADDITIONAL PRECONSTRUCTION MEETING, AND.
   C. FURNISH THE REPLACEMENT STRUCTURAL OBSERVER WITH A COPY OF ALL PREVIOUS OBSERVATION REPORT.

   THE REPLACEMENT STRUCTURAL OBSERVER SHALL APPROVE THE CORRECTION OF THE ORIGINAL OBSERVED DEFICIENCIES UNLESS OTHERWISE APPROVED BY PLAN CHECK SUPERVISION. THE POLICY OF THE DEPARTMENT SHALL BE TO CORRECT ANY PROPERLY NOTED DEFICIENCIES WITHOUT CONSIDERATION OF THEIR SOURCE
9. THE ENGINEER OR ARCHITECT OF RECORD SHALL DEVELOP ALL CHANGES RELATING TO THE STRUCTURAL SYSTEMS. THE BUILDING DEPARTMENT SHALL REVIEW AND APPROVE ALL CHANGES TO THE APPROVED PLANS AND SPECIFICATIONS.

SHEET INDEX:

REVISIONS			
NO.	DATE	DESCRIPTION	BY

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LASTING creativity | results | relationships

OWNER
CITY OF SANTA BARBARA
SANTA BARBARA, CA

PROJECT
SB POLICE STATION SEISMIC RETROFIT STUDY
215 EAST FIGUEROA ST.
SANTA BARBARA, CA 93102

DRAWING TITLE
GENERAL NOTES

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

DESIGNED BY:	CHECKED BY:	DRAWING NO.
PVB	PVB	S0.1
DRAWN BY: MBH	REVIEWED BY: PVB	

FIBER REINFORCED POLYMER (FRP) STRENGTHENING

1. PROPOSED FRP COMPOSITE SYSTEM SHALL HAVE A CURRENT ICC EVALUATION REPORT AND BE INSTALLED ACCORDING TO THE CONTRACT DOCUMENTS, MANUFACTURER'S AND ICC RECOMMENDATIONS AND PROCEDURES.

2. CONTRACTOR SHALL HAVE A MINIMUM OF TEN (10) STRENGTHENING PROJECT REFERENCES USING FRP COMPOSITE SYSTEMS FOR SIMILAR PROJECTS AND APPLICATIONS IN THE LAST TWO YEARS. THIS LIST SHALL BE INCLUDED IN THE SHOP DRAWING SUBMITTAL.

3. THE ONSITE SUPERVISOR, FOREMAN AND SATURATION/MIXING TECHNICIAN SHALL HAVE A MINIMUM OF THREE (3) YEARS EXPERIENCE ON AT LEAST FIFTEEN (15) DIFFERENT PROJECTS. THESE THREE INDIVIDUALS SHALL PROVIDE WRITTEN VERIFICATION FROM THE MATERIAL MANUFACTURER AS BEING FULLY TRAINED AND CERTIFIED TO INSTALL THE FRP.

4. COMPOSITE SYSTEM APPLICATOR SHALL SUBMIT WITNESS PANELS PREPARED AT THE JOBSITE FOR MATERIALS TESTING (ASTM D3039). THE TESTING SHALL BE DONE BY AN INDEPENDENT TESTING LABORATORY TO VERIFY ALL SUBMITTED DESIGN PROPERTIES. TESTING SHALL BE PAID FOR BY THE OWNER. FIELD TEST RESULTS THAT ARE LOWER THAN THE DESIGN PROPERTIES SUBMITTED SHALL REQUIRE THE CONTRACTOR TO PAY FOR REMEDIAL MEASURES TO BE APPROVED BY THE ENGINEER-OF-RECORD.

5. CONTRACTOR SHALL SUBMIT CALCULATIONS VERIFYING COMPLIANCE WITH THE DESIGN CRITERIA STATED ON THE CONTRACT DRAWINGS. CALCULATIONS SHALL BE BASED ON THE VERIFIED MATERIAL PROPERTIES AND CORRESPONDING LAYER THICKNESS AND SHALL BE STAMPED AND SIGNED BY A REGISTERED CIVIL OR STRUCTURAL ENGINEER.

6. SEE FULL SPECIFICATIONS ON SHEET S0.1.

SECTION 03930

FIBER REINFORCED POLYMER STRENGTHENING SYSTEM

PART 1–GENERAL

1.01 THIS SPECIFICATION IS INTENDED FOR USE IN DEFINING THE REQUIREMENTS OF REINFORCED CONCRETE AND MASONRY STRENGTHENING USING EXTERNALLY BONDED FIBER REINFORCED POLYMER (FRP) SYSTEMS.

1.02 THE CONTRACTOR OR SUB-CONTRACTOR SHALL FURNISH ALL SUBMITTALS, MATERIALS, TOOLS, EQUIPMENT, TRANSPORTATION, NECESSARY STORAGE, LABOR, AND SUPERVISION REQUIRED FOR THE APPLICATION OF THE COMPOSITE SYSTEM.

1.03 REFERENCES
- A. GENERAL
  1. THE PUBLICATIONS LISTED BELOW FORM A PART OF THIS SPECIFICATION TO THE EXTENT REFERENCED.
  2. WHERE A DATE IS GIVEN FOR REFERENCE STANDARDS, THE EDITION OF THAT DATE SHALL BE USED. WHERE NO DATE IS GIVEN FOR REFERENCE STANDARDS, THE LATEST EDITION AVAILABLE ON THE DATE OF NOTICE INVITING BIDS SHALL BE USED.
- B. AMERICAN STANDARD FOR TESTING AND MATERIALS (ASTM)
  1. ASTM D3039 (1995A), STANDARD TEST METHOD FOR TENSILE PROPERTIES OF POLYMER MATRIX COMPOSITE MATERIALS.
- C. INTERNATIONAL CODE COUNCIL (ICC)
  1. ICCAC125 (2006), ACCEPTANCE CRITERIA FOR CONCRETE AND REINFORCED AND UNREINFORCED MASONRY STRENGTHENING USING EXTERNALLY BONDED FIBER-REINFORCED POLYMER (FRP) COMPOSITE SYSTEMS.
  2. ICCAC178 (2001), ACCEPTANCE CRITERIA FOR INSPECTION AND VERIFICATION OF CONCRETE AND REINFORCED AND UNREINFORCED MASONRY STRENGTHENING USING FIBER REINFORCED POLYMER COMPOSITE SYSTEMS.
- D. AMERICAN CONCRETE INSTITUTE (ACI)
  1. ACI 440.2R-02, GUIDE FOR THE DESIGN AND CONSTRUCTION OF EXTERNALLY BONDED FRP SYSTEMS FOR STRENGTHENING CONCRETE STRUCTURES.

1.04 MATERIAL QUALIFICATIONS

MATERIALS FOR THE FRP SYSTEM HAVE BEEN PRE-QUALIFIED AND SHALL BE SUPPLIED BY FYFE CO. LLC (NANCY RIDGE TECHNOLOGY CENTER, 6310 NANCY RIDGE DRIVE, SUITE 103, SAN DIEGO, CA 92121. TEL: 858-642-0694, FAX: 858-642-0947, EMAIL: INFO@FYFECO.COM <MAILTO:INFO@FYFECO.COM>) OR AN APPROVED ALTERNATE. ALTERNATE SYSTEMS MUST PROVIDE ALL ITEMS LISTED IN SECTION 1.06.B OF THIS SPECIFICATION AND SUBMIT TWO-WEEKS PRIOR TO THE PROJECT BID DATE. (LARR 25260)

1.05 CONTRACTOR QUALIFICATIONS

- A. THE WORK SPECIFIED UNDER THIS SPECIFICATION SHALL BE PERFORMED BY AN APPLICATOR WITH PROVEN PAST EXPERIENCE APPLYING THE APPROVED COMPOSITE SYSTEM FOR A MINIMUM OF 20 PROJECTS WITH OVER 200 ELEMENTS STRENGTHENED. THE APPLICATOR MUST SUPPLY THE NAMES OF AT LEAST THREE INDIVIDUALS WHO HAVE BEEN CERTIFIED AND TRAINED BY THE FRP SYSTEM MANUFACTURER AND WHO WILL BE ON SITE DURING ALL PHASES OF THE PROJECT. THE ENGINEER OF RECORD SHALL HAVE THE RIGHT TO APPROVE OR REJECT THE PERSONNEL QUALIFICATIONS AS SUBMITTED. THE ENGINEER MAY SUSPEND THE WORK IF THE CONTRACTOR SUBSTITUTES UNAUTHORIZED PERSONNEL FOR AUTHORIZED PERSONNEL DURING CONSTRUCTION.
- B. THE COMPOSITE SYSTEM APPLICATOR SHALL SUBMIT A WRITTEN DESCRIPTION OF THE PROPOSED EPOXY, INCLUDING VOC LEVELS, AND A COMPLETE WRITTEN DESCRIPTION OF THE APPLICATION PROCEDURES FOR REVIEW BY THE ENGINEER-OF-RECORD. THE APPLICATOR COMPANY MUST BE CERTIFIED BY THE MANUFACTURER/SUPPLIER IN WRITING AND PROVIDE A QUALITY CONTROL PROCEDURE IN ACCORDANCE WITH SECTION 3.04 OF THIS SPECIFICATION.

1.06 SUBMITTALS

- A. DESIGN AND WORKING DRAWINGS:
  1. STAMPED AND SIGNED STRUCTURAL CALCULATIONS AND DRAWINGS BY A LICENSED CIVIL OR STRUCTURAL ENGINEER.
  2. WORKING DRAWINGS DETAILING THE TYPE, LOCATIONS, DIMENSIONS, NUMBERS OF LAYERS, AND ORIENTATION OF ALL FRP MATERIALS AND COATINGS TO BE INSTALLED.
  3. A LIST OF TWO DIFFERENT QUALIFIED TESTING LABORATORIES THAT CAN PERFORM THE REQUIRED ASTM D 3039 TESTS AS PER SECTION 3.04 OF THIS SPECIFICATION.
- B. PRODUCT INFORMATION:
  1. AN APPROVED ICC EVALUATION REPORT FOR THE PROPOSED COMPOSITE SYSTEM. EVALUATION REPORT MUST COVER THE TYPE OF STRENGTHENING BEING PROPOSED.
  2. AN APPROVED RESEARCH REPORT WITH THE CITY OF LOS ANGELES.
  3. PROVIDE A CLASS 1 (A) FLAME AND SMOKE, FIRE RESISTANCE RATING AS PER ASTM E84 FOR THE PROPOSED ASSEMBLY (IF INTERIOR APPLICATION).
  4. PROPERTIES OF THE COMPOSITE MATERIALS AS DETERMINED BY INDEPENDENT LABORATORY TESTING IN ACCORDANCE WITH ASTM D 3039 (TENSILE MODULUS, STRESS AND STRAIN).
  5. LARGE-SCALE STRUCTURAL TESTING ON SIMILAR SECTIONS.
  6. INSTALLATION PROCEDURES, MAINTENANCE INSTRUCTIONS, AND GENERAL RECOMMENDATIONS REGARDING EACH MATERIAL TO BE USED.
  7. MANUFACTURER'S MATERIAL SAFETY DATA SHEETS (MSDS) FOR ALL MATERIALS TO BE USED.
  8. MANUFACTURER'S PRODUCT DATA SHEET INDICATING PHYSICAL, MECHANICAL AND CHEMICAL CHARACTERISTICS OF ALL MATERIALS USED IN THE FRP SYSTEM.
  9. WRITTEN VERIFICATION FROM THE MANUFACTURER THAT THE APPLICATOR HAS RECEIVED THE REQUIRED CERTIFICATIONS AND TRAINING.
  10. CERTIFICATION BY THE MANUFACTURER THAT PRODUCTS SUPPLIED COMPLY WITH LOCAL REGULATIONS CONTROLLING USE OF VOLATILE ORGANIC COMPOUNDS (VOC'S).

1.07 PERFORMANCE

- A. DESIGN THE COMPOSITE SYSTEM TO ACHIEVE THE STRUCTURAL PERFORMANCE SHOWN ON THE STRUCTURAL DRAWINGS. DESIGN CALCULATIONS FOR THE COMPOSITE SYSTEM SHALL BE SUBMITTED FOR APPROVAL BY THE ENGINEER OF RECORD, AND SHALL BE STAMPED BY A REGISTERED CIVIL ENGINEER.
- B. CALCULATIONS SHALL CONFORM TO REQUIREMENTS SET FORTH IN ICC ES ACCEPTANCE CRITERIA (AC125) AND BE BASED ON THE DESIGN MODULUS AND ASSOCIATED AREA OF THE COMPOSITE TO BE INSTALLED. FRP DESIGN VALUES MUST BE LOWER THAN THE CALCULATED MEAN DETERMINED FROM THE TEST RESULTS RECEIVED FROM THE ASTM D3039 FIELD TEST SPECIMENS (SEE SECTION 3.07 OF THIS SPECIFICATION).

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. DELIVER EPOXY MATERIALS IN FACTORY-SEALED CONTAINERS WITH THE MANUFACTURER'S LABELS INTACT AND LEGIBLE WITH VERIFICATION OF DATE OF MANUFACTURE AND SHELF LIFE.
- B. STORE MATERIALS IN A PROTECTED AREA AT A TEMPERATURE BETWEEN 40° AND 100° F.
- C. PRODUCTS SHALL BE STORED ACCORDING THE MANUFACTURER'S REQUIREMENTS AND SHALL AVOID CONTACT WITH MOISTURE.

PART 2–PRODUCTS

2.01 COMPOSITE STRENGTHENING SYSTEM

APPROVED TYFO® FIBRWRAP® SYSTEM TO BE SUPPLIED BY FYFE COMPANY, NANCY RIDGE TECHNOLOGY CENTER, 6310 NANCY RIDGE DRIVE, SUITE 103, SAN DIEGO, CA 92121. TEL: 858-642-0694, FAX: 858-642-0947. PRODUCTS INCLUDE:

- A. COMPOSITE FABRIC: SCH FIBER – PRIMARY CARBON FIBER, UNIDIRECTIONAL.
  SEH FIBER – PRIMARY GLASS FIBER, UNIDIRECTIONAL.
- B. EPOXY SATURANT/PRIMER: TYFO® S EPOXY IS USED AS A PRIMER AND IS ALSO COMBINED WITH THE FIBER TO FORM THE TYFO® FIBRWRAP® SYSTEM.
- C. PRIMER/FILLER: TYFO® WS OR TC THICKENED EPOXY FOR PROTECTIVE SEAL COAT, FILLING VOIDS AND PRIMER WHERE NEEDED.
- D. FINISHES: TYFO® RR OR TYFO® FC/F, TYFO® A PAINT TO BE COLOR MATCHED BY ARCHITECT. ALTERNATE FINISHES MUST BE APPROVED BY THE ARCHITECT.
- E. FIELD THICKENED EPOXY MATRIX, WHICH IS COMPATIBLE WITH COMPOSITE SYSTEM'S RESIN MATRIX, MAY BE USED TO PATCH "BUGHOLES" UP TO 1.5" IN DEPTH AND TO FILL VOIDS.

2.02 OTHER MATERIALS

PROVIDE OTHER MATERIALS AS NEEDED FOR THE PROPER INSTALLATION OF THE COMPLETE COMPOSITE SYSTEM, AS SELECTED BY THE CONTRACTOR IN CONFORMANCE WITH THESE SPECIFICATIONS.

PART 3–EXECUTION OF WORK

3.01 SURFACE PREPARATION:

WALLS:
- A. CONCRETE SURFACES SHALL BE PREPARED FOR BONDING BY MEANS OF ABRASIVE BLASTING OR GRINDING TO ACHIEVE A 1/16" MINIMUM AMPLITUDE. ALL CONTACT SURFACES SHALL THEN BE CLEANED BY HAND OR COMPRESSED AIR. ONE PRIME COAT OF THE MANUFACTURER'S EPOXY SHALL BE APPLIED AND ALLOWED TO CURE FOR A MINIMUM OF ONE HOUR. PRIOR TO THE APPLICATION OF THE SATURATED COMPOSITE FABRIC, FILL ANY UNEVEN SURFACES WITH THE MANUFACTURER'S THICKENED EPOXY. PROVIDE ANCHORAGE AS DETAILED ON APPROVED CONSTRUCTION DRAWINGS.

3.02 PROCEDURES FOR APPLICATION

- A. PREPARATION WORK FOR PROJECT: VISIT SITE TO INSURE THAT ALL PATCH WORK IS COMPLETE AND CURED. REVIEW PROJECT SPECIFICATIONS IN DETAIL.
- B. VERIFY AMBIENT AND CONCRETE TEMPERATURES. NO WORK SHALL PROCEED IF THE TEMPERATURE OF THE CONCRETE SURFACE BEING REPAIRED IS LESS THAN 40° F OR GREATER THAN 100° F. THE TEMPERATURE OF THE EPOXY COMPONENTS SHALL BE BETWEEN 40° AND 100° F AT THE TIME OF MIXING OR AS SPECIFIED ON THE COMPONENT LABELS. WHEN AIR TEMPERATURE IS OUTSIDE THE PRESCRIBED RANGE, OTHER MEASURES MUST BE EMPLOYED TO ENSURE COMPONENTS' TEMPERATURE IS MAINTAINED WITHIN THIS RANGE.
- C. PREPARE THE EPOXY MATRIX BY COMBINING COMPONENTS AT A RATIO SPECIFIED BY THE SYSTEM MANUFACTURER, WITH AN ALLOWABLE TOLERANCE OF ± 10%. THE COMPONENTS OF EPOXY RESIN SHALL BE MIXED WITH A MECHANICAL MIXER UNTIL UNIFORMLY MIXED, TYPICALLY 5 MINUTES AT 400–600 RPM. COMPONENTS THAT HAVE EXCEEDED THEIR SHELF LIFE (AS DESIGNATED ON THE MATERIAL LABEL) SHALL NOT BE USED.
- D. BOTH EPOXY RESIN AND FABRIC SHALL BE MEASURED ACCURATELY, COMBINED, AND DEPOSITED UNIFORMLY AT THE RATES SHOWN ON THE APPROVED WORKING DRAWINGS AND PER MANUFACTURER'S RECOMMENDATIONS. THE COMPOSITE SYSTEM SHALL BE COMPRISED OF FIBERS COMPLETELY SATURATED WITH EPOXY RESIN PER PROPER RATIO.
- E. QUALITY CONTROL PROCEDURES: RECORD BATCH NUMBERS FOR FABRIC AND EPOXY USED EACH DAY, AND NOTE LOCATIONS OF INSTALLATION. MEASURE SQUARE FOOTAGE OF FABRIC AND VOLUME OF EPOXY USED EACH DAY. COMPLETE REPORT AND SUBMIT TO SPECIAL INSPECTOR AND SYSTEM MANUFACTURER. SEE SECTION 3.04 OF THIS SPECIFICATION.
- F. FABRIC SAMPLING PROCEDURE: ON A SMOOTH, FLAT, LEVEL SURFACE COVERED WITH POLYETHYLENE SHEETING, OR 16 MIL PLASTIC FILM, PRIME WITH EPOXY SATURANT, THEN PREPARE SAMPLE BY PLACING TWO LAYERS OF SATURATED FABRIC ORIENTED IN THE SAME DIRECTION AND ALLOW TO CURE. APPLY ADDITIONAL TOPPING OF EPOXY AS REQUIRED TO ENSURE COMPLETE SATURATION. SAMPLES SHALL BE STORED IN A SAMPLE BOX AND NOT MOVED FOR A MINIMUM 48 HOURS AFTER CASTING. THE PREPARED, IDENTIFIED SAMPLES SHALL BE GIVEN TO A PREAPPROVED TESTING LABORATORY FROM THE SUBMITTED LIST. (SEE SECTION 3.04 FOR TESTING PROCEDURES AND REQUIREMENTS).
- G. INSTALLATION PROCEDURES:
  1. PREPARE SURFACE AS REQUIRED, INCLUDING CORNER PREPARATION.
  2. REMOVE DUST AND DEBRIS BY HAND OR WITH COMPRESSED AIR AS PER SPECIFICATION.
  3. CLEAN UP AND PROTECT AREA ADJACENT TO ELEMENT.
  4. USING A ROLLER OR TROWEL, APPLY ONE PRIME COAT OF EPOXY RESIN TO THE CONCRETE SURFACE (2 MIL. MIN.). ALLOW PRIMER TO BECOME TACKY TO THE TOUCH.
  5. FILL ANY UNEVEN SURFACES OR RECESSES WITH THICKENED EPOXY.
  6. SATURATE FABRIC WITH EPOXY MATRIX AS PER MANUFACTURERS SPECIFICATIONS.
  7. APPLY SATURATED FABRIC TO CONCRETE SURFACE BY HAND LAY-UP, USING METHODS THAT PRODUCE A UNIFORM, CONSTANT TENSILE FORCE THAT IS DISTRIBUTED ACROSS THE ENTIRE WIDTH OF FABRIC. UNDER CERTAIN APPLICATION CONDITIONS, THE SYSTEM MAY BE PLACED ENTIRELY BY HAND METHODS ASSURING A UNIFORM, EVEN FINAL APPEARANCE. GAPS BETWEEN COMPOSITE BANDS MAY NOT EXCEED ½" WIDTH IN THE FABRIC'S TRANSVERSE JOINT UNLESS OTHERWISE NOTED ON PROJECT DRAWINGS. A LAP LENGTH OF AT LEAST 6" IS REQUIRED AT ALL NECESSARY OVERLAPS IN THE PRIMARY FIBER DIRECTION OF THE FABRIC.
  8. APPLY SUBSEQUENT LAYERS, CONTINUOUSLY OR SPLICED, UNTIL DESIGNED NUMBER OF LAYERS IS ACHIEVED, PER PROJECT DRAWINGS.
  9. USING A ROLLER OR HAND PRESSURE, INSURE PROPER ORIENTATION OF FIBERS, RELEASE OR ROLL OUT ENTRAPPED AIR, AND ENSURE THAT EACH INDIVIDUAL LAYER IS FIRMLY BEDDED AND ADHERED TO THE PRECEDING LAYER OR SUBSTRATE.
  10. DETAIL ALL FABRIC EDGES, INCLUDING TERMINATION POINTS AND EDGES, WITH EPOXY.
  11. FINISH: ALL EDGES AND SEAMS MUST BE FEATHERED. USE SYSTEM AS DIRECTED BY MANUFACTURER. PAINT AS SPECIFIED BETWEEN 24 AND 72 HOURS AFTER FINAL APPLICATION OF EPOXY. IF AFTER 72 HOURS THE EPOXY IS CURED, THE SURFACE MUST BE ROUGHENED BY HAND SANDING OR BRUSH BLASTING.
  12. SYSTEM MAY INCORPORATE STRUCTURAL FASTENERS BUT LIMITATIONS AND DETAILING MUST BE VERIFIED WITH COMPOSITE SYSTEM MANUFACTURER.

3.03 PROCEDURE MODIFICATIONS

INSTALLATION PROCEDURES MAY BE MODIFIED TO ACHIEVE MAXIMUM RESULTS, SUBJECT TO APPROVAL OF THE CITY/COUNTY AND THE ENGINEER-OF-RECORD. PROCEDURE MODIFICATIONS SHALL BE DISCUSSED WITH THE CITY/COUNTY AND ENGINEER-OF-RECORD PRIOR TO IMPLEMENTING THE MODIFICATIONS.

3.04 FIELD QUALITY CONTROL

- A. INSTALLERS:
  RECORD BATCH NUMBERS FOR FABRIC AND EPOXY USED EACH DAY, AND NOTE LOCATIONS OF INSTALLATION. MEASURE SQUARE FOOTAGE OF FABRIC AND VOLUME OF EPOXY USED EACH DAY. COMPLETE REPORT AND SUBMIT TO CITY/COUNTY, ENGINEER-OF-RECORD AND SYSTEM MANUFACTURER.
- B. INSPECTION:
  CERTIFIED SPECIAL INSPECTOR, APPROVED BY THE CITY/COUNTY, SHALL PERIODICALLY OBSERVE ALL ASPECTS OF PREPARATION, MIXING, AND APPLICATION OF MATERIALS, INCLUDING THE FOLLOWING:
  1. MATERIAL CONTAINER LABELS
  2. SURFACE PREPARATION
  3. MIXING OF EPOXY
  4. APPLICATION OF EPOXY TO THE FIBER
  5. APPLICATION OF COMPOSITE SYSTEM
  6. CURING OF COMPOSITE MATERIAL
  7. PREPARATION AND LABELING OF TEST SAMPLES

  THE CONTRACTOR SHALL MONITOR THE MIXING OF ALL EPOXY COMPONENTS FOR PROPER RATIO AND ADHERENCE TO MANUFACTURER'S RECOMMENDATIONS.
- C. LABORATORY TESTING:
  RECORD LOT NUMBER OF FABRIC AND RESIN USED, AND LOCATION OF INSTALLATION. A "SAMPLE BATCH" SHALL CONSIST OF TWO 12" X 12" SAMPLES OF CURED COMPOSITE. A MINIMUM OF TWO SAMPLE BATCHES SHALL BE MADE DAILY. THE TWO SAMPLE BATCHES WILL BE TAKEN AT APPROPRIATE TIMES DURING THE DAY SO AS TO ENSURE THE MAXIMUM MATERIAL DEVIANCE IN THE COMPONENTS OF THE COMPOSITE. TESTING LABORATORY SHALL PRE-CONDITION SAMPLES AT 140° F FOR 48 HOURS BEFORE TESTING. SAMPLES SHALL BE TESTED, AT RANDOM, AT OWNER'S DISCRETION AND COST.

  TESTED SAMPLES SHALL BE TESTED PER ASTM D3039. THE 12" X 12" PANEL SHALL HAVE 5 COUPONS, ¾" X 9", REMOVED AND TESTED FOR THEIR MATERIAL PROPERTIES IN THE LONGITUDINAL (PRIMARY FIBER) DIRECTION. TESTS SHALL CONFORM TO ASTM PROCEDURES AND MANUFACTURER'S PUBLISHED TESTING METHODS. ONLY PRE-QUALIFIED TESTING LABORATORIES SHALL BE USED.

  TESTING RESULTS SHALL BE MADE AVAILABLE WITHIN 3 WEEKS OF SAMPLE SUBMISSION. THE TESTING SHALL PROVIDE AVERAGE VALUES OF THE FOLLOWING:
  1. ULTIMATE TENSILE STRENGTH
  2. TENSILE MODULUS
  3. PERCENT ELONGATION

  15% OF ALL SAMPLE BATCHES ARE SUGGESTED TO BE TESTED. IF ONE 12" X 12" SAMPLE FAILS (ON AVERAGE), SPECIMENS FROM THE SAME SAMPLE WILL BE TESTED. IF THESE SPECIMENS ALSO FAIL (ON AVERAGE), THE OTHER 12" X 12" FROM THE SAME SAMPLE BATCH WILL BE TESTED. IN THE EXTREME CASE THAT THIS SAMPLE ALSO FAILS, THE REMAINING SAMPLE BATCH FOR THAT DAY WILL BE TESTED AND APPROPRIATE REMEDIAL MEASURES, PER SECTION 3.07.E, WILL BE TAKEN TO ENSURE INTEGRITY OF THE SYSTEM FROM THE FAILED SAMPLE BATCH. IN ADDITION, 25% OF THE REMAINING SAMPLE BATCHES WILL THEN BE TESTED BY THE SAME CRITERIA.
- D. REPAIRS:
  ALL DEFECTS, INCLUDING BUBBLES, DELAMINATIONS, AND FABRIC TEARS, SPANNING MORE THAN 5% OF THE SURFACE AREA, OR AS SPECIFIED BY THE OWNER OR ENGINEER, SHALL BE REPAIRED. TWO TYPES OF REPAIRS SHALL BE PERFORMED:
  1. SMALL DEFECTS (ON THE ORDER OF 3" DIAMETER) SHALL BE INJECTED OR BACK FILLED WITH EPOXY.
  2. LARGE DEFECTS SHALL BE REPAIRED AS REQUIRED BY THE CONSULTING ENGINEER'S SPECIFICATIONS AND MANUFACTURER'S SPECIFICATIONS.

  SMALL ENTRAPPED AIR POCKETS AND VOIDS NATURALLY OCCUR IN MIXED RESIN SYSTEMS AND DO NOT REQUIRE REPAIR OR TREATMENT. DEFECT REPAIR SHALL BE PROVIDED BY THE MANUFACTURER AND BE SUBMITTED TO THE STRUCTURAL ENGINEER OF RECORD FOR APPROVAL.
- E. REMEDIAL MEASURES:
  IN THE EVENT THAT MATERIAL TESTING, PER SECTION 3.07.C, DETERMINES A SAMPLE BATCH TO POSSESS INSUFFICIENT MATERIAL PROPERTIES, REMEDIAL MEASURES SHALL BE TAKEN. IF THE TESTED COMPOSITE SYSTEM HAS MATERIAL PROPERTIES DETERMINED TO BE BELOW THE MINIMUM SPECIFIED VALUES, ADDITIONAL LAYERS SHALL BE INSTALLED UNTIL THE FINAL COMPOSITE THICKNESS IS INCREASED BY THE SAME PERCENTAGE AS THE DEFICIENCY OF THE MATERIAL'S ELASTIC MODULUS. ANY REQUIRED ADDITIONAL MATERIAL AND LABOR FOR REMEDIAL REPAIRS WOULD NOT BE PAID FOR AS AN EXTRA TO THE CONTRACTED WORK.

REVISIONS			
NO.	DATE	DESCRIPTION	BY

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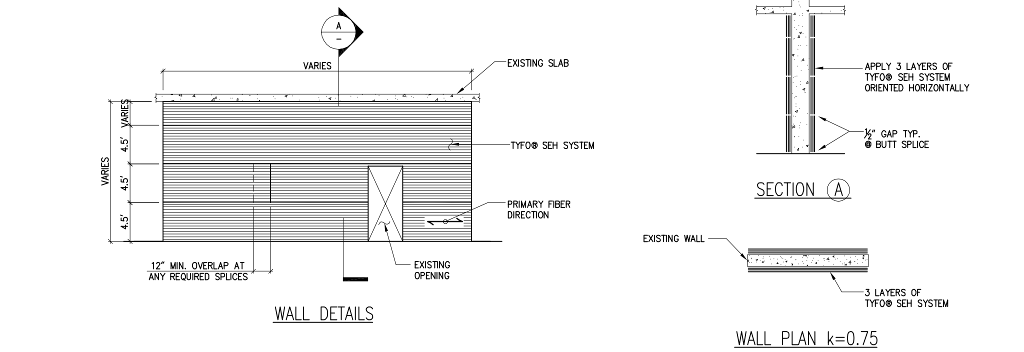
OWNER
CITY OF SANTA BARBARA
SANTA BARBARA, CA

PROJECT
SB POLICE STATION SEISMIC RETROFIT STUDY
215 EAST FIGUEROA ST.
SANTA BARBARA, CA 93102

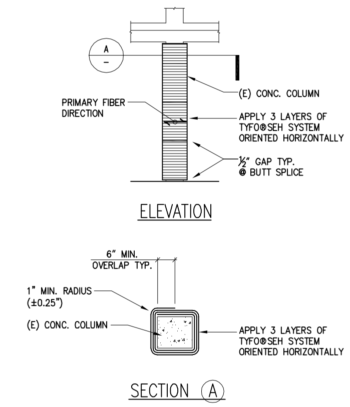
DRAWING TITLE
GENERAL NOTES

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

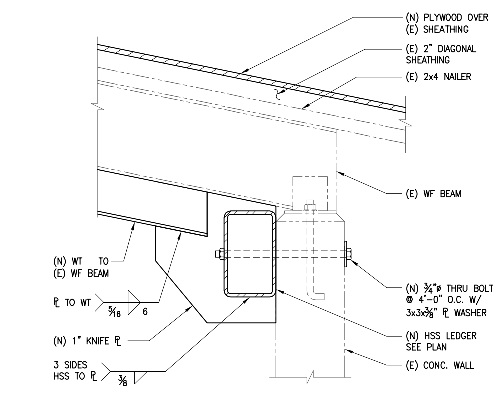
DESIGNED BY:	CHECKED BY:	DRAWING NO.
PVB	PVB	S0.2
DRAWN BY: MBH	REVIEWED BY: PVB	



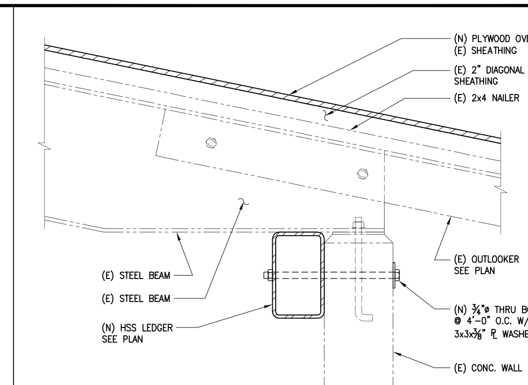
1 TYP. SHEARWALL FRP RETROFIT DETAIL



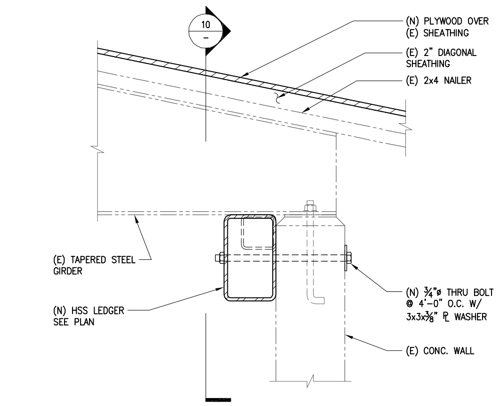
3 TYP. GRAVITY COLUMN FRP RETROFIT DETAIL



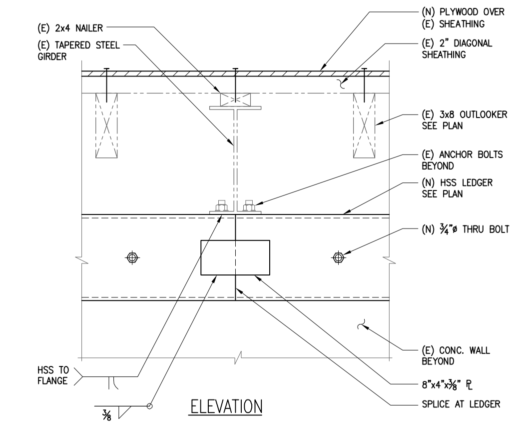
4 SECTION



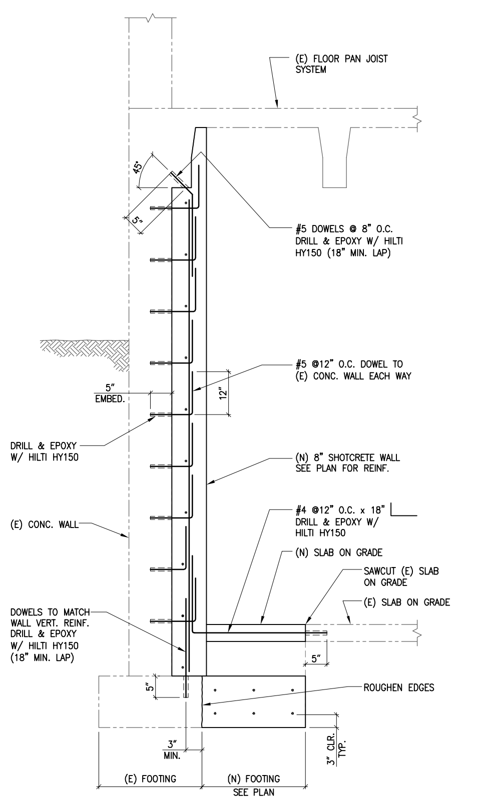
5 SECTION



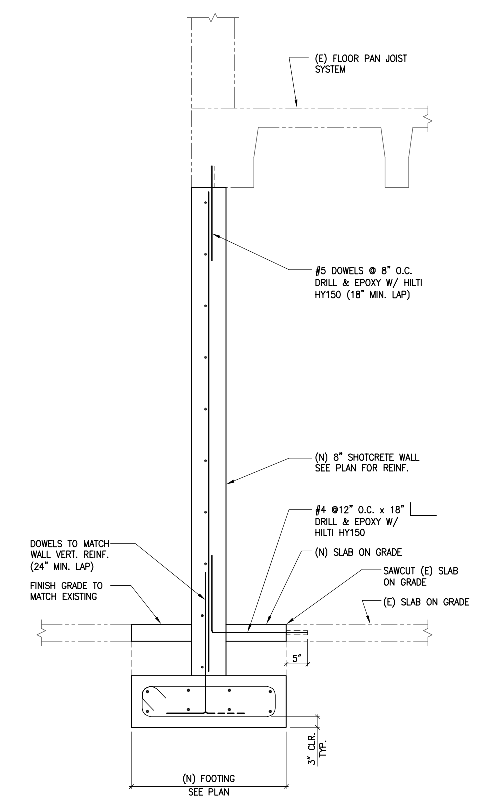
9 SECTION



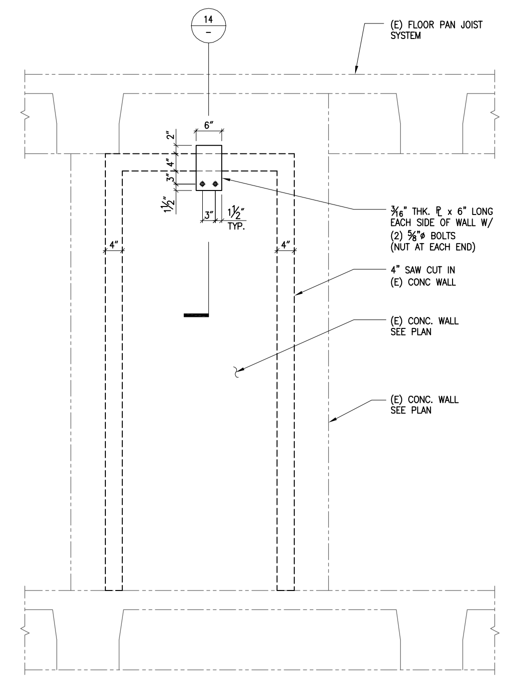
10 DETAIL



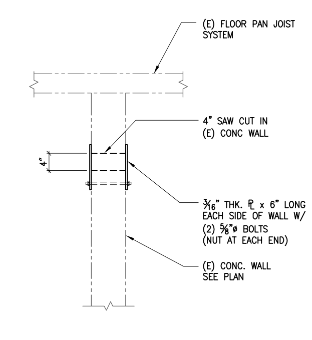
11 (N) SHOTCRETE WALL TO EXISTING DETAIL



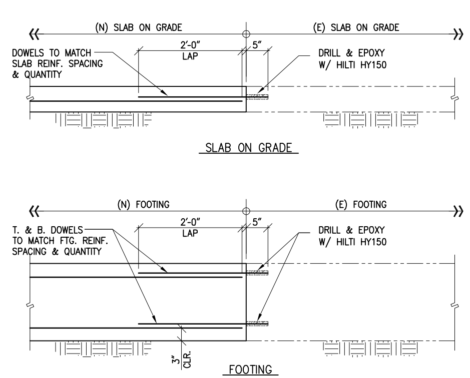
12 (N) SHOTCRETE WALL TO EXISTING DETAIL



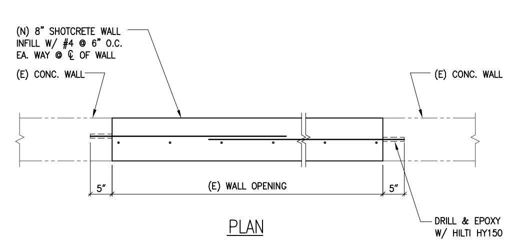
13 SAWCUT IN (E) CONC. WALL



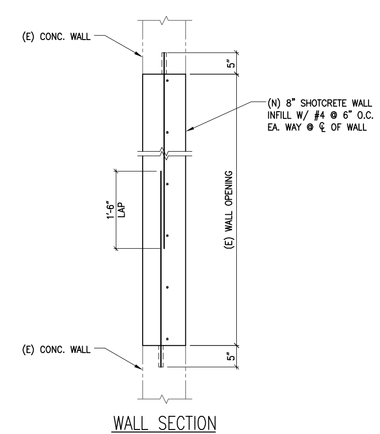
14 SAWCUT IN (E) CONC. WALL



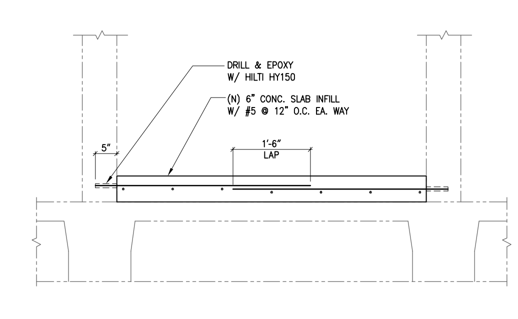
16 EXISTING TO NEW SLAB ON GRADE OR FOOTING



17 (N) SHOTCRETE WALL INFILL TO EXISTING CONC. WALL



18 (N) SHOTCRETE WALL INFILL TO EXISTING CONC. WALL



19 (N) CONC. SLAB INFILL TO EXISTING SLAB

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NO.	DATE	DESCRIPTION	BY

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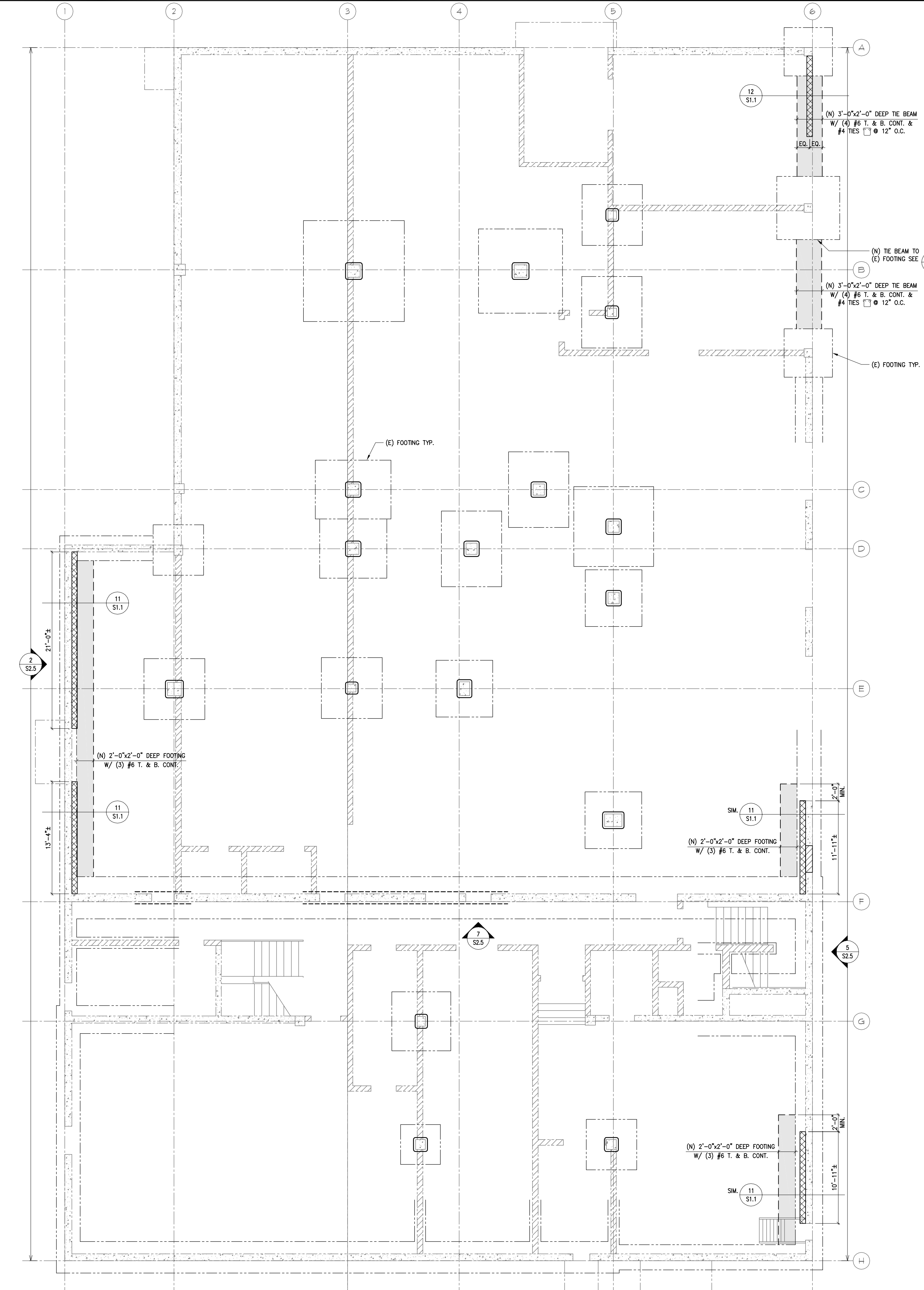
OWNER
CITY OF SANTA BARBARA
SANTA BARBARA, CA

PROJECT
SB POLICE STATION SEISMIC RETROFIT STUDY
215 EAST FIGUEROA ST.
SANTA BARBARA, CA 93102

DRAWING TITLE
DETAILS

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

DESIGNED BY: PVB	CHECKED BY: PVB	DRAWING NO.
DRAWN BY: MBH	REVIEWED BY: PVB	S1.1



LEGENDS:

1. INDICATES (N) 8" FULL HEIGHT SHOTCRETE WALL (Fc'=4 KSI) W/ #6 @ 12" O.C. EA. WAY @ ℄ OF WALL (ONE LAYER) TYP.
2. INDICATES (N) 8" SHOTCRETE WALL INFILL ON (E) WALL OPENING SEE DETAILS 17 & 18/S1.1.
3. INDICATES EXISTING CONC. WALL.
4. INDICATES EXISTING NON-BEARING CMU WALL.
5. 3 LAYERS OF FIBER REINFORCED POLYMER "TYFO FIBRWRAP SEH-51A" AROUND (E) CONC. COLUMN PER DETAIL 3/S1.1.
6. 3 LAYERS OF FIBER REINFORCED POLYMER "TYFO FIBRWRAP SEH-51A" ON EACH SIDE OF (E) CONC. WALL. SEE WALL ELEVATION & DETAIL 1/S1.1.

NOTES:

1. VERIFY ALL DIMENSIONS WITH ARCHITECTURAL DRAWINGS.

EXISTING BASEMENT RETROFIT PLAN

SCALE: 3/16"=1'-0"

REVISIONS			
NO.	DATE	DESCRIPTION	BY

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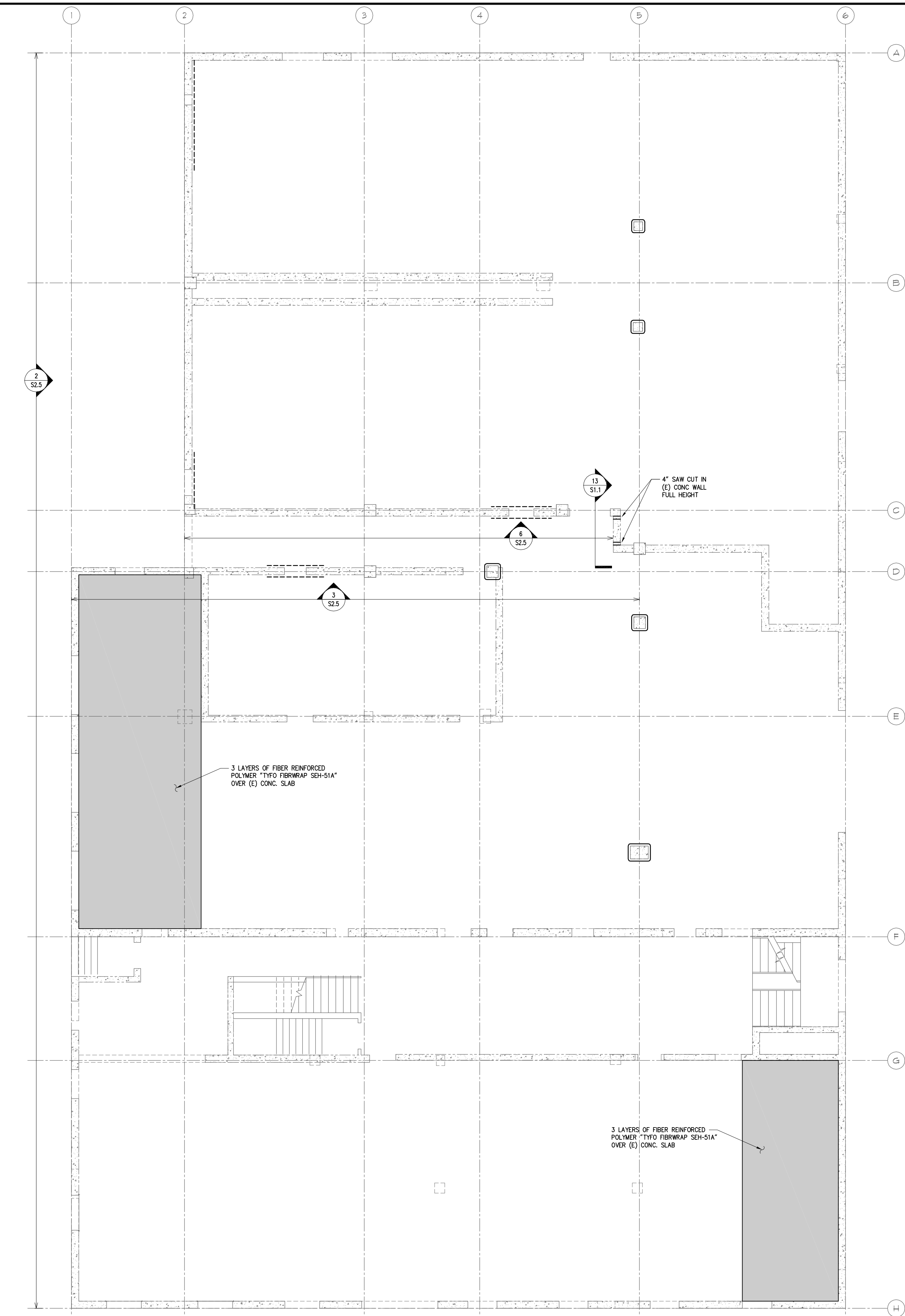
OWNER
CITY OF SANTA BARBARA
SANTA BARBARA, CA

PROJECT
SB POLICE STATION SEISMIC RETROFIT STUDY
215 EAST FIGUEROA ST.
SANTA BARBARA, CA 93102

DRAWING TITLE
EXISTING BASEMENT RETROFIT PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

DESIGNED BY:	CHECKED BY:	DRAWING NO.
PVB	PVB	S2.1
DRAWN BY: MBH	REVIEWED BY: PVB	



LEGENDS:

1. INDICATES EXISTING CONC. WALL.
2. INDICATES EXISTING CONC. WALL BELOW.
3. 3 LAYERS OF FIBER REINFORCED POLYMER "TYFO FIBRWRAP SEH-51A" AROUND (E) CONC. COLUMN PER DETAIL 3/S1.1.
4. 3 LAYERS OF FIBER REINFORCED POLYMER "TYFO FIBRWRAP SEH-51A" ON EACH SIDE OF (E) CONC. WALL. SEE WALL ELEVATION & DETAIL 1/S1.1.
5. 6 LAYERS OF FIBER REINFORCED POLYMER "TYFO FIBRWRAP SEH-51A" ON INSIDE FACE OF (E) CONC. WALL. SEE WALL ELEVATION & DETAIL 1/S1.1 SIM.

NOTES:

1. VERIFY ALL DIMENSIONS WITH ARCHITECTURAL DRAWINGS.

EXISTING FIRST FLOOR RETROFIT PLAN

SCALE: 3/16"=1'-0"

REVISIONS			
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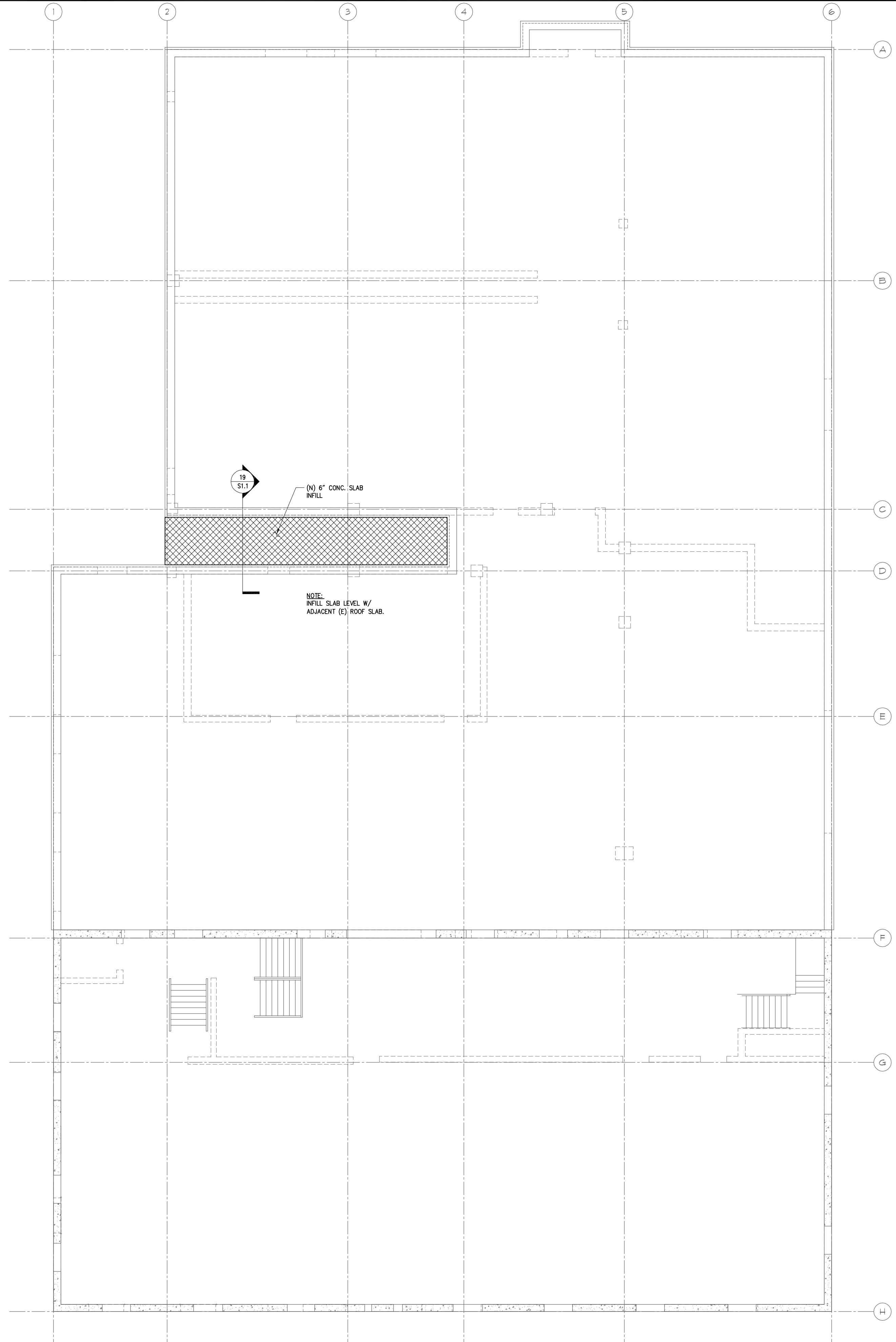
215 EAST FIGUEROA ST.
SANTA BARBARA, CA 93102

DRAWING TITLE
EXISTING FIRST FLOOR
RETROFIT PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	
DESIGNED BY: PVB	CHECKED BY: PVB		DRAWING NO. S2.2
DRAWN BY: MBH	REVIEWED BY: PVB		



EXISTING SECOND FLOOR PLAN

SCALE: 3/16"=1'-0"

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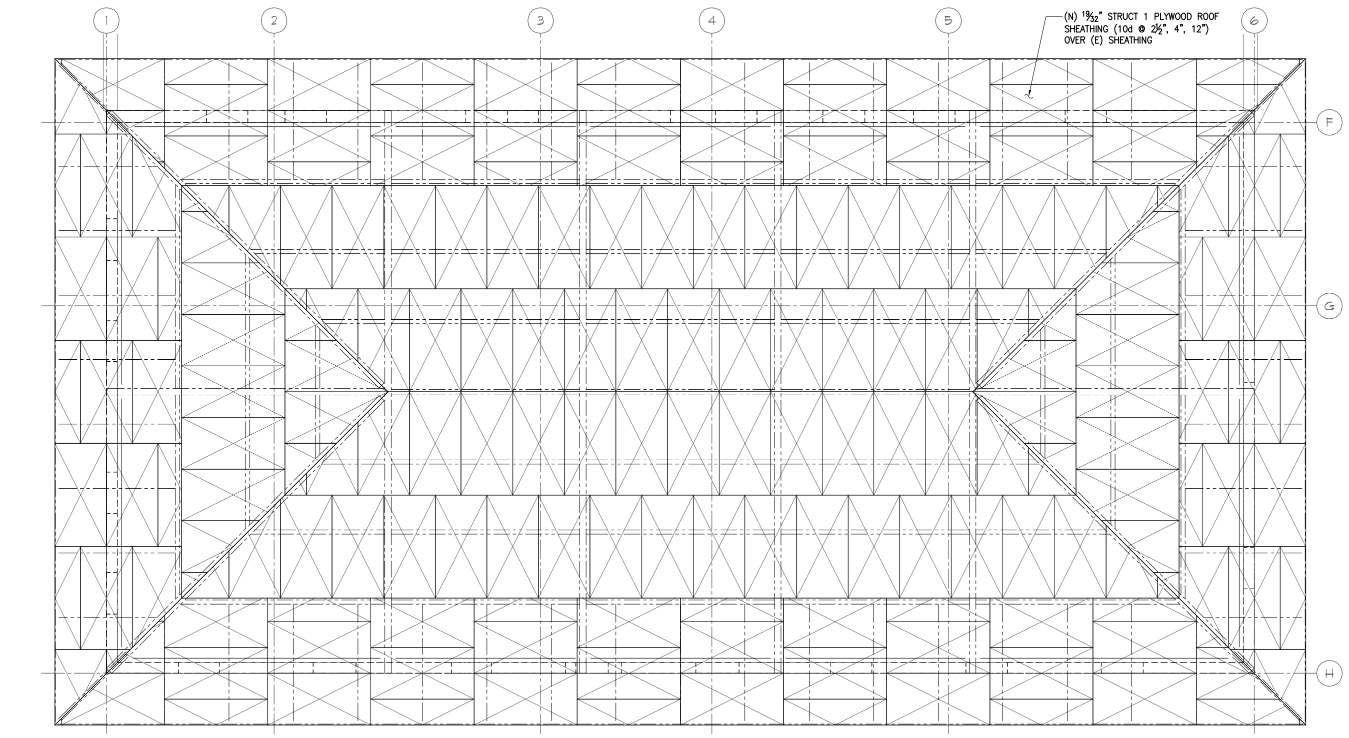
DRAWING TITLE
EXISTING SECOND FLOOR PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	
DESIGNED BY: PVB	CHECKED BY: PVB		DRAWING NO.
DRAWN BY: MBH	REVIEWED BY: PVB		S2.3



NOTES:

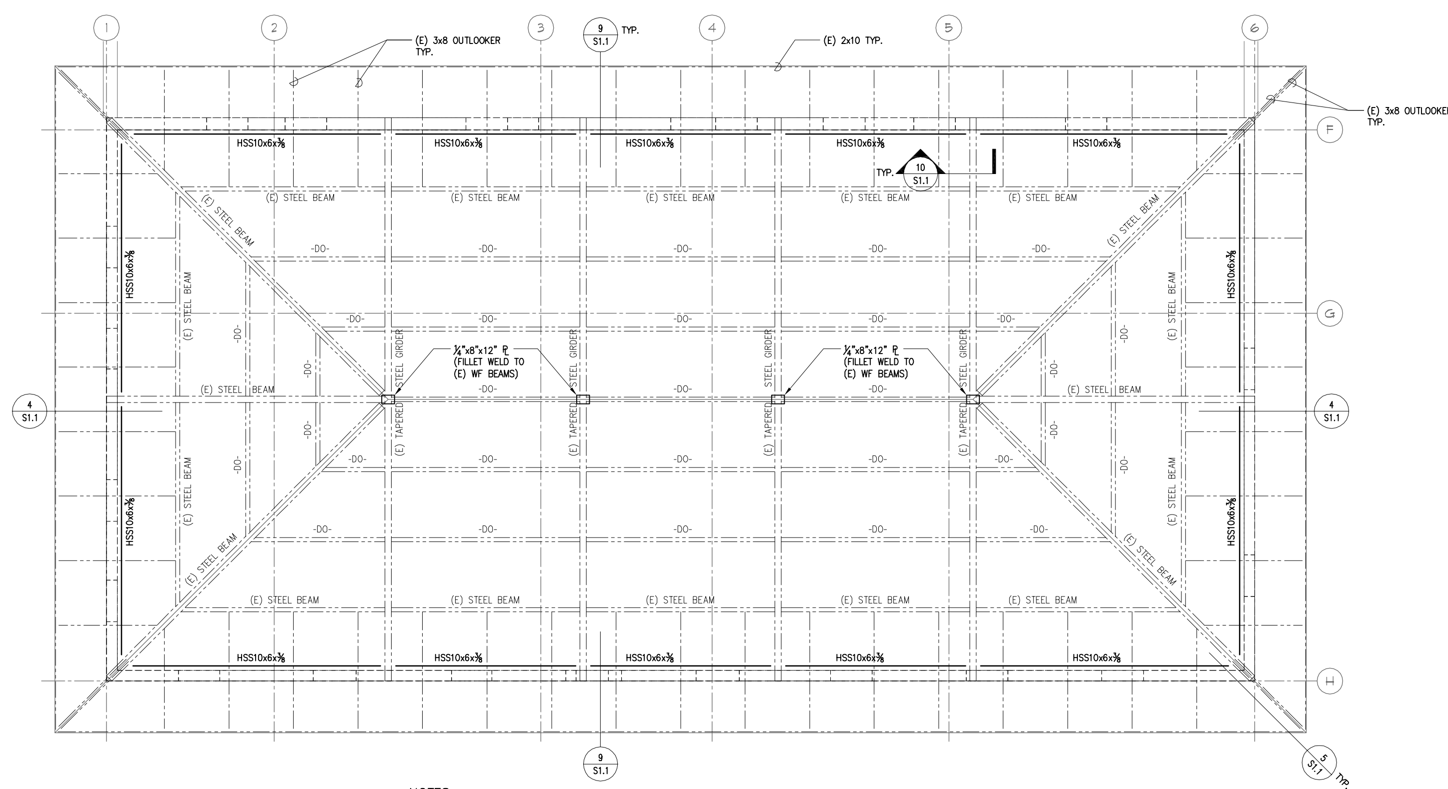
1. ADD 2x MEMBERS SISTERED TO (E) 2x MEMBERS WHERE ROOF NAILING IS LESS THAN 4" O.C.
2. SISTER 2x MEMBER W/ 16d @ 16" O.C. STAGGERED.

(N) ROOF SHEATHING LAYOUT PLAN

SCALE: 3/16"=1'-0"

LEGENDS:

1. INDICATES EXISTING CONC. WALL BELOW.
2. INDICATES EXISTING FRAMING BELOW.
3. INDICATES TYPE OF (N) PLYWOOD SHEATHING ORIENTED & STAGGERED AS SHOWN.



NOTES:

1. VERIFY ALL DIMENSIONS WITH ARCHITECTURAL DRAWINGS.

EXISTING ROOF RETROFIT PLAN

SCALE: 3/16"=1'-0"

LEGENDS:

1. INDICATES EXISTING CONC. WALL BELOW.
2. INDICATES EXISTING FRAMING BELOW.

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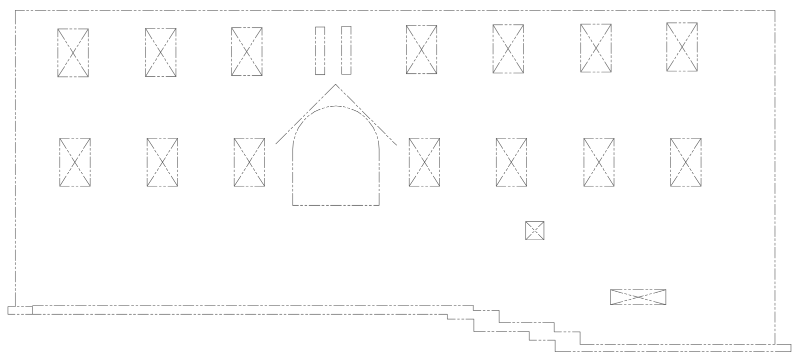
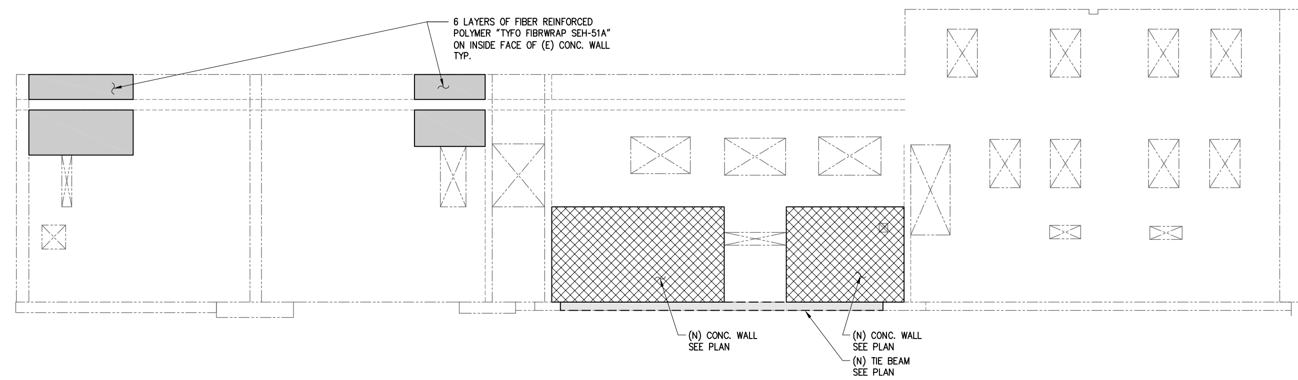
DRAWING TITLE
EXISTING ROOF RETROFIT PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

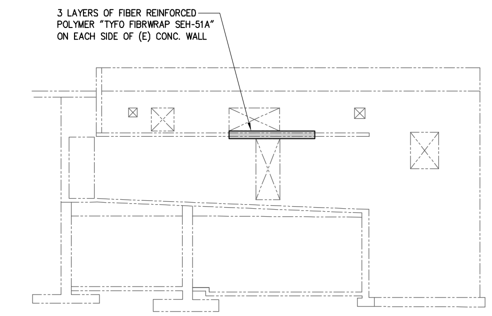
DESIGNED BY:	CHECKED BY:	DRAWING NO.
PVB	PVB	S2.4
DRAWN BY: MBH	REVIEWED BY: PVB	



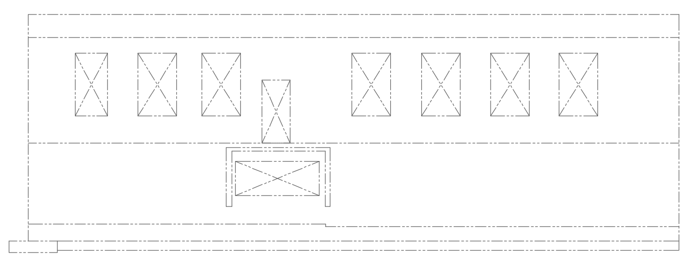
1 **SOUTH WALL ELEVATION**
(GRID H)



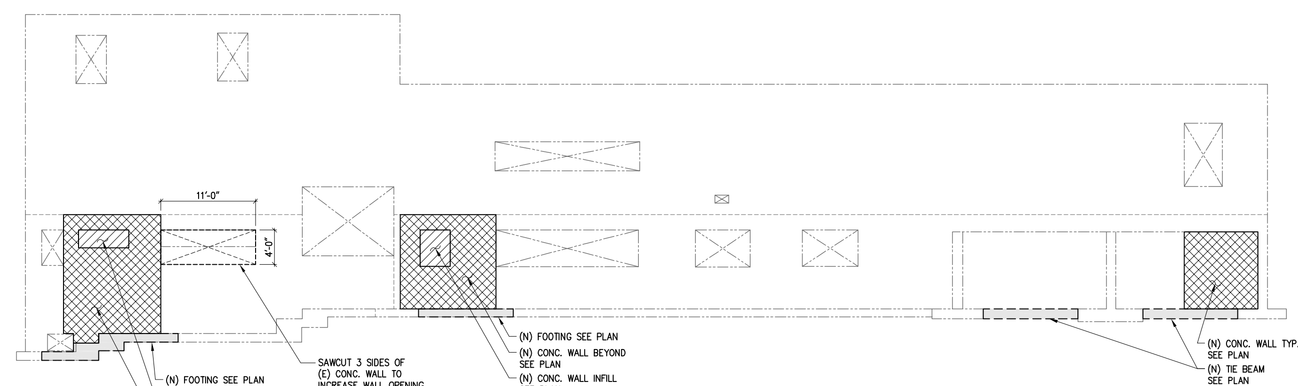
2 **WEST WALL ELEVATION**
(GRID 1 & 2)



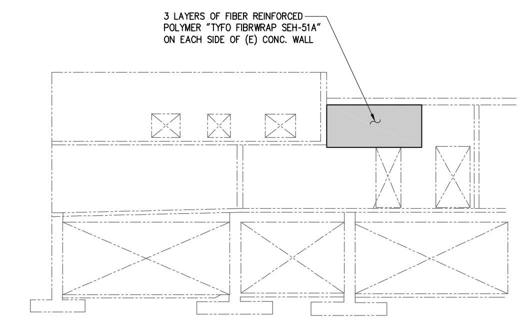
3 **WEST WALL ELEVATION**
(GRID D)



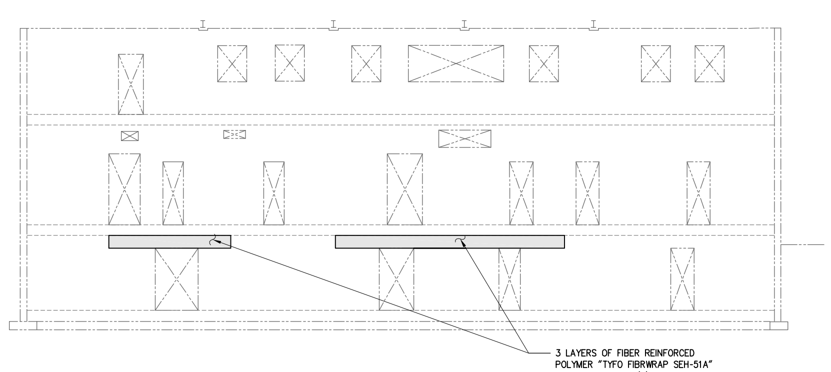
4 **NORTH WALL ELEVATION**
(GRID A)



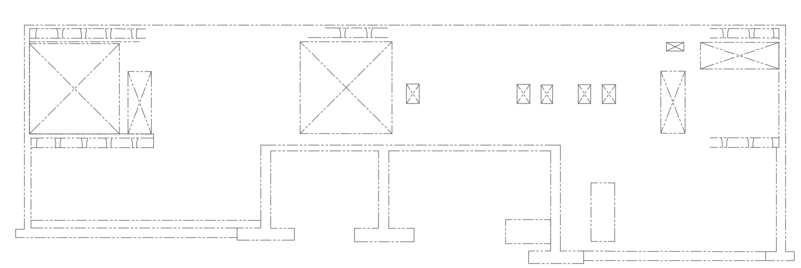
5 **EAST WALL ELEVATION**
(GRID 6)



6 **EAST WALL ELEVATION**
(GRID C)



7 **WALL ELEVATION**
(GRID F)



8 **WALL ELEVATION**
(GRID G)

LEGENDS:

1. INDICATES (N) 8" FULL HEIGHT SHOTCRETE WALL TYP.
2. INDICATES (N) 8" SHOTCRETE WALL INFILL ON (E) WALL OPENING TYP.
3. INDICATES EXISTING STRUCTURE.
4. INDICATES EXISTING STRUCTURE BEYOND.
5. 3 LAYERS OF FIBER REINFORCED POLYMER "TYFO FIBRWRAP SEH-51A" ON (E) CONC. WALL. SEE DETAIL 1/S1.1.

NOTES:
1. VERIFY ALL DIMENSIONS WITH ARCHITECTURAL DRAWINGS.

WALL ELEVATIONS
SCALE: 1/8"=1'-0"

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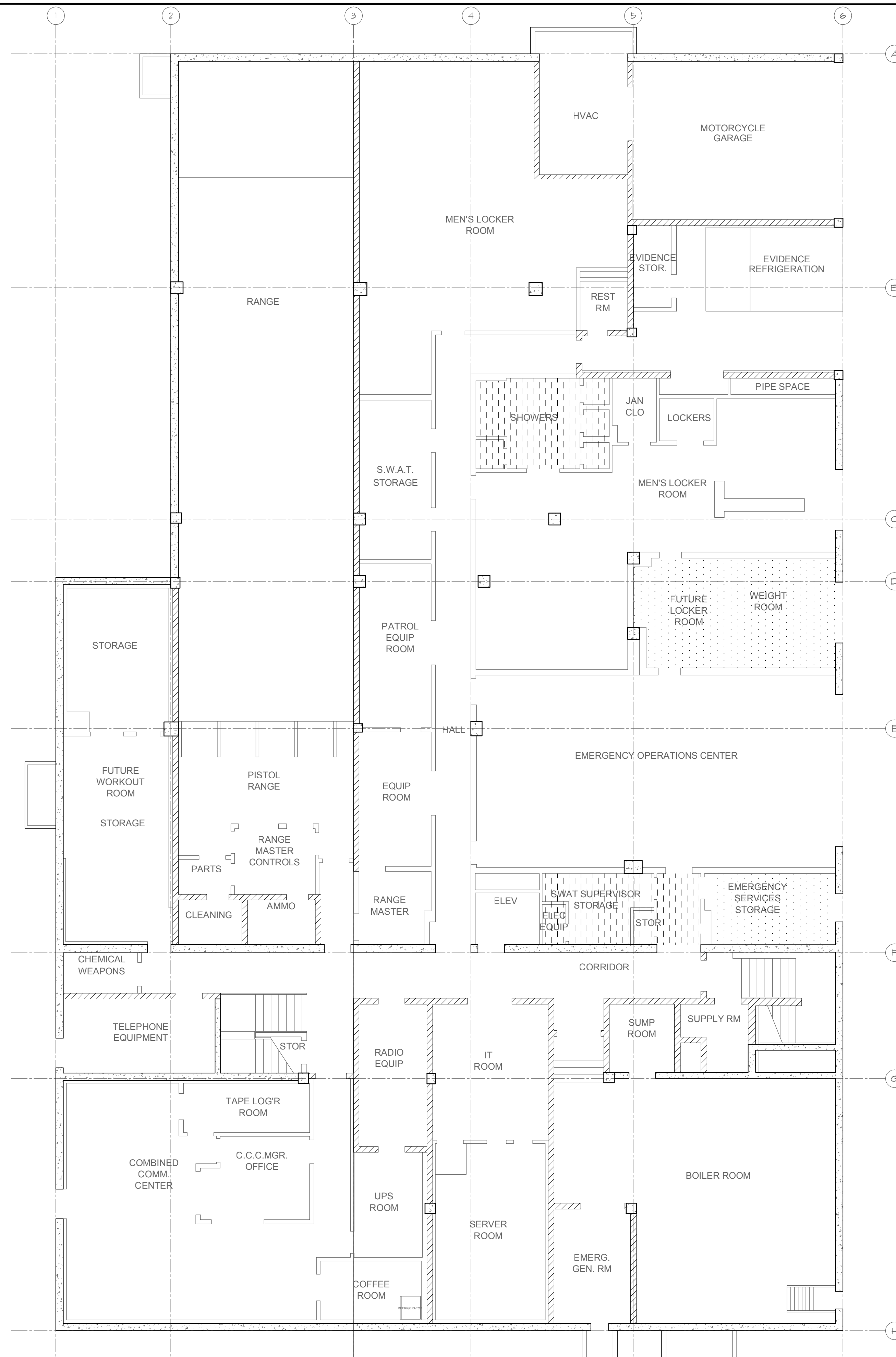
DRAWING TITLE
WALL ELEVATIONS

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	
DESIGNED BY: PVB		CHECKED BY: PVB	DRAWING NO. S2.5
DRAWN BY: MBH		REVIEWED BY: PVB	



BASEMENT REFLECTED CEILING DEMOLITION PLAN

SCALE: 3/16"=1'-0"

LEGENDS:

1. INDICATES (E) SUSPENDED GYPSUM PLASTER (SMOOTH) TO BE REMOVED. SEE WARNINGS & NOTES.
2. INDICATES (E) SUSPENDED GYPSUM PLASTER W/ ACOUSTIC SPRAY TO BE REMOVED. SEE WARNINGS & NOTES.

WARNINGS & NOTES:

1. CEILINGS & FINISHES MAY CONTAIN ASBESTOS.
2. TEST CEILINGS FOR ASBESTOS PRIOR TO REMOVAL.
3. ASBESTOS REMOVAL SHALL BE PERFORMED IN ACCORDANCE WITH LOCAL STATE & FEDERAL LAWS.

REVISIONS

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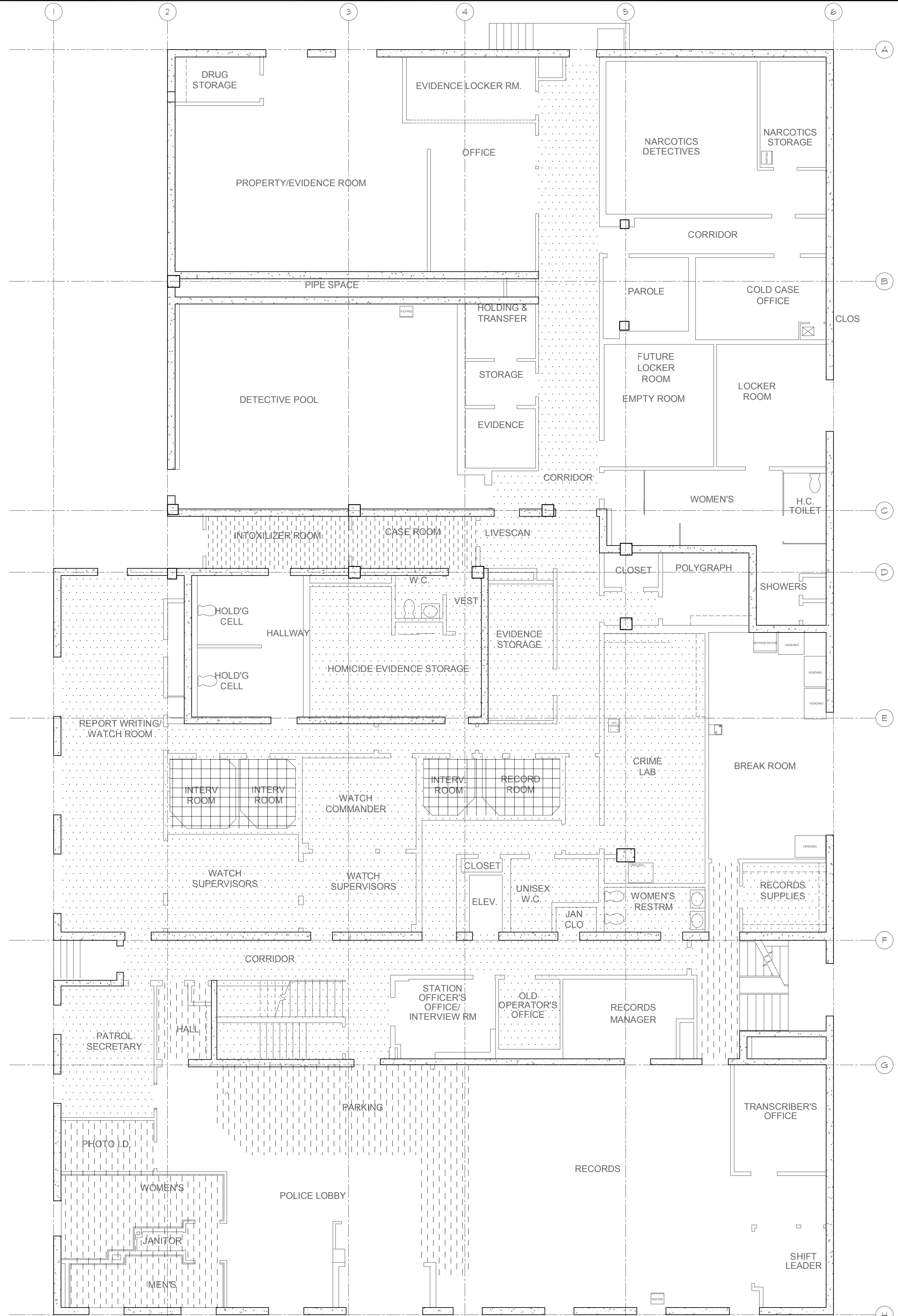
DRAWING TITLE
BASEMENT REFLECTED CEILING DEMOLITION PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

DESIGNED BY:	CHECKED BY:	DRAWING NO.
PVB	PVB	S3.1
DRAWN BY: MBH	REVIEWED BY: PVB	



LEGENDS:

1. INDICATES (E) SUSPENDED GYPSUM PLASTER (SMOOTH) TO BE REMOVED. SEE WARNINGS & NOTES.
2. INDICATES (E) SUSPENDED GYPSUM PLASTER W/ ACOUSTIC SPRAY TO BE REMOVED. SEE WARNINGS & NOTES.
3. INDICATES (E) SUSPENDED GYPSUM PLASTER W/ ACOUSTIC TILE TO BE REMOVED. SEE WARNINGS & NOTES.

WARNINGS & NOTES:

1. CEILINGS & FINISHES MAY CONTAIN ASBESTOS.
2. TEST CEILINGS FOR ASBESTOS PRIOR TO REMOVAL.
3. ASBESTOS REMOVAL SHALL BE PERFORMED IN ACCORDANCE WITH LOCAL STATE & FEDERAL LAWS.

FIRST FLOOR REFLECTED CEILING DEMOLITION PLAN

SCALE: 3/16"=1'-0"

REVISIONS			
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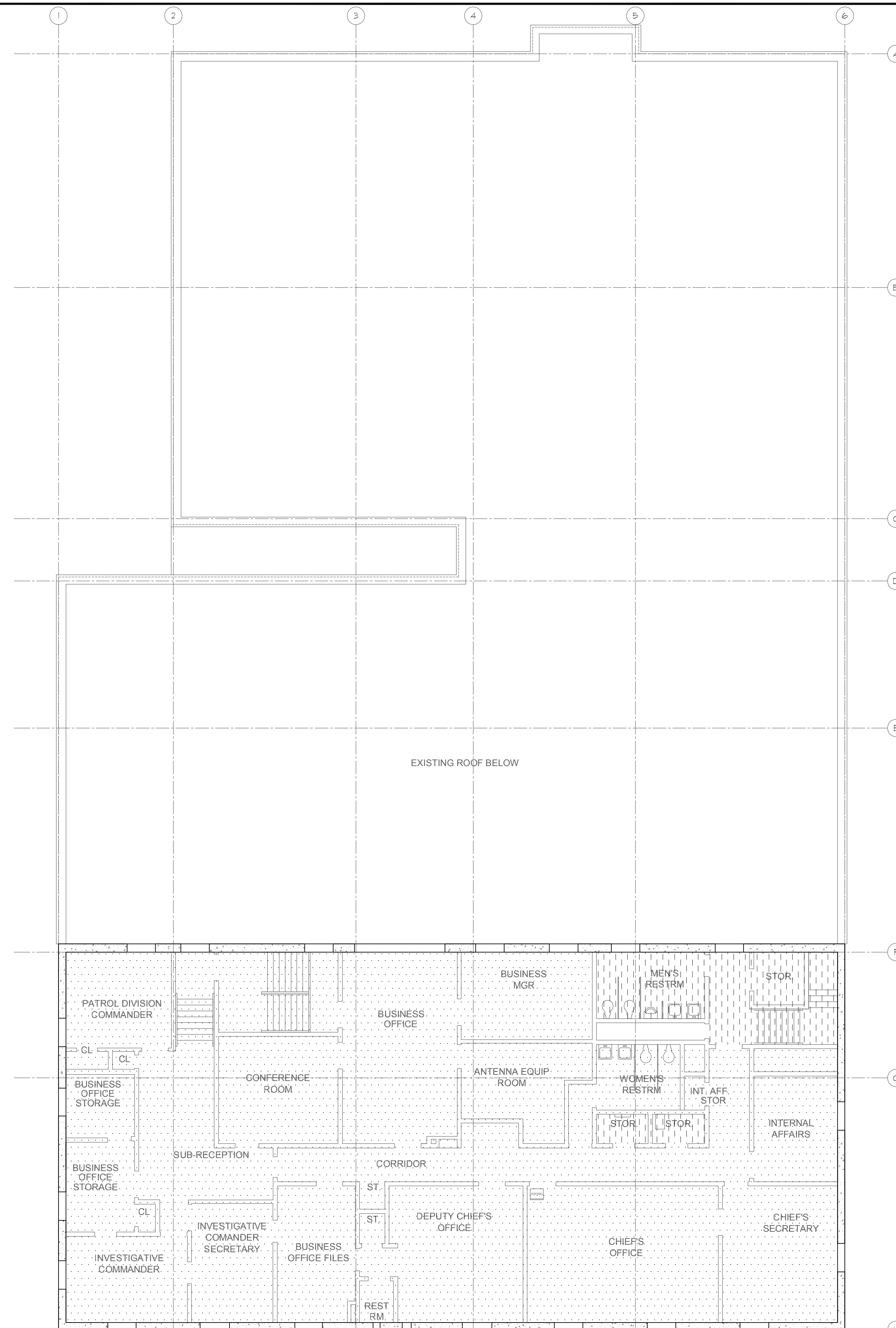
DRAWING TITLE
FIRST FLOOR REFLECTED CEILING DEMOLITION PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	
DESIGNED BY: PVB	CHECKED BY: PVB		DRAWING NO. S3.2
DRAWN BY: MBH	REVIEWED BY: PVB		



SECOND FLOOR REFLECTED CEILING DEMOLITION PLAN

SCALE: 3/16"=1'-0"

LEGENDS:

1. INDICATES (E) SUSPENDED GYPSUM PLASTER (SMOOTH) TO BE REMOVED. SEE WARNINGS & NOTES.
2. INDICATES (E) SUSPENDED GYPSUM PLASTER W/ ACOUSTIC SPRAY TO BE REMOVED. SEE WARNINGS & NOTES.

WARNINGS & NOTES:

1. CEILINGS & FINISHES MAY CONTAIN ASBESTOS.
2. TEST CEILINGS FOR ASBESTOS PRIOR TO REMOVAL.
3. ASBESTOS REMOVAL SHALL BE PERFORMED IN ACCORDANCE WITH LOCAL STATE & FEDERAL LAWS.

REVISIONS			
NO.	DATE	DESCRIPTION	BY

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SANTA BARBARA, CA 93102

DRAWING TITLE
SECOND FLOOR REFLECTED CEILING DEMOLITION PLAN

PROJECT NO.	SCALE:	DATE:	REVISION NO.
10303	AS SHOWN	10/18/10	

DESIGNED BY:	CHECKED BY:	DRAWING NO.
PVB	PVB	S3.3
DRAWN BY: MBH	REVIEWED BY: PVB	