DEPARTMENT OF PUBLIC WORKS

Seismic Evaluation of

San Francisco Sherriff's Department County Jail - Building CJ-6

One Moreland Drive
San Bruno, California

Prepared for:
San Francisco Sherriff's Department through
Department of Public Works Project Management
City and County of San Francisco

Prepared by:
Structural Engineering Section
Infrastructure Design and Construction Division
Department of Public Works
City and County of San Francisco

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Executive Summary

The City and County of San Francisco Department of Public Works (DPW), Infrastructure Design and Construction, Structural Engineering Section has performed a seismic evaluation of Building CJ-6 at the San Francisco Sherriff's Department County Jail Facility in San Bruno, California. The seismic evaluation of CJ-6 was based on ASCE/SEI 31-03, *Seismic Evaluation of Existing Buildings*.

This report presents information about the conditions of the existing building, the evaluation procedures, and the building performance when subjected to earthquake forces.

Per ASCE 31, the building was evaluated for the Life Safety and Immediate Occupancy performance levels using Tier 1- Screening Phase Checklists. Deficiency-Only Tier 2 evaluation procedures were performed where required by corresponding statements from Tier 1. The non-structural checklists were omitted from the evaluation since only the structural shell is under consideration. All of the non-structural components would be demolished and upgraded for any future use of the building.

Based on our evaluation of the existing building, we expect minor structural damage to occur due to shaking caused by large magnitude earthquakes, without implementing any retrofit strengthening measures. Though the expected damage may be minor and can be repaired while the building is occupied, due to anticipated usage and security issues, it may be infeasible to repair while the building is occupied. Based on visual observations, review of available drawings, and ASCE 31 evaluation, it is our professional engineering opinion that the building be assigned a Seismic Hazard Rating of 2. Furthermore, a minor seismic upgrade to the areas of highest vulnerability may bring the building to a Seismic Hazard Rating of 1.

Seismic Evaluation Summary

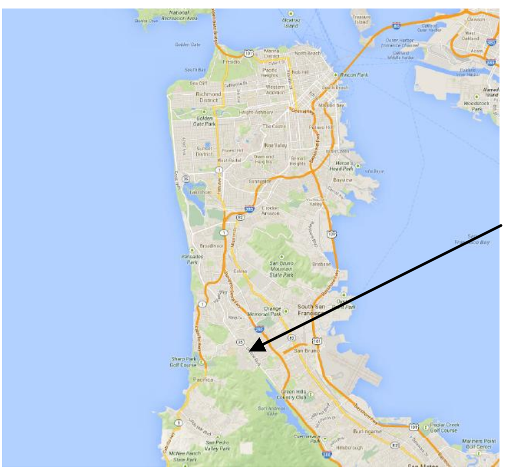
Facility: **San Francisco County Jail CJ-6**
Address: One Moreland Drive, San Bruno, CA 94066
Year Constructed: 1988
Year Retrofitted: N/A
Function: Currently Unoccupied Detention Space and Administrative

Site Assessment
Soils: Silty Sand underlain with Clayey Sand

Landslide: Low	Fault Rupture: Low
Liquefaction: Low	Shaking Intensity: Strong
Settlement: Low	Adjacent Hazards: None

Building Assessment
SHR: 2

Collapse Potential: Low	Economic Impact: Moderate
Safety Hazard: Moderate	Operational Losses: Moderate



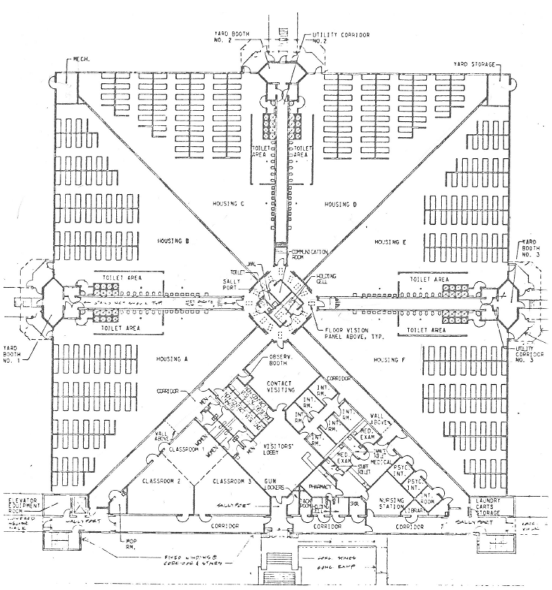
Building Description: Built in 1988, Building CJ-6 at the San Francisco County Jail Facility is located at One Moreland Drive, San Bruno, California. It is a square, single-story, pre-cast concrete shear wall building, measuring approximately 220 feet by 220 feet in plan dimensions. The story height is 25 feet at the peak with a 2-foot parapet at the perimeter. The building is split into eight triangular sections with a cross and X through a center core. Six of the eight triangles are dormitory type jail houses, currently unoccupied. The remaining two triangles serve as the administrative offices and have a second floor mezzanine level with additional office space.

Structural Condition: Good

Structural Deficiencies: No Structural Deficiencies

Non-structural Deficiencies: Not evaluated

Expected Building Performance at 10%/50 Year Earthquake: CJ-6 appears to meet the criteria for Life Safety Performance Level outlined in ASCE 31. Although seismic building performance is expected to be good, some incidental structural damage to the building is possible during a severe earthquake, including cracking and spalling of concrete at the perimeter walls at corners of window and door openings, cracked or broken windows. The damage may be such that the building can be occupied during repair, however due to security issues, it may be infeasible to repair while fully occupied.



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1. Introduction

1.1 Purpose

The San Francisco Sherriff's Department is in the process of exploring various options for repurposing current operations including detention, rehabilitation, and court logistics as part of a master plan for an overhaul of the Hall of Justice. The department operates various jail and administrative facilities including several buildings at the San Bruno Complex. Building CJ-6 is not currently in use due to outdated functions to meet current detention needs. In order to assess the feasibility of repurposing the building for use as a modern jail, the Sherriff's Department needs to assess the extent of retrofit, if any, in order to continue using the existing structure. As part of that program, the San Francisco Department of Public Works, Project Management has requested the San Francisco Department of Public Works (DPW) Infrastructure Design and Construction Structural Engineering Section perform a seismic evaluation of Building CJ-6 and to determine the Seismic Hazard Rating (SHR).

This report presents information about the conditions of the existing building, as well as findings related to the expected seismic performance of the building when subjected to earthquake loadings. The results in this report are primarily based on available existing drawings and visual observations.

The main objectives of this evaluation are to determine the relative seismic strength of the building and to identify existing seismic hazards, including structural and geotechnical. A SHR is assigned after the evaluation process.

1.2 Scope of Work

Our scope of work included the following:

- Review available existing architectural and structural drawings.
- Verify construction materials and structural components within the existing building and compare that to the existing drawings.
- Perform seismic evaluation of the building per ASCE 31, Tier 1 Screening Phase Checklists.
- Where required, Deficiency-Only evaluation of the building per ASCE 31, Tier 2 Evaluation Phase.
- Perform calculations where required by the Basic Structural Checklist.
- Prepare a detailed report and summarize all findings associated with the existing conditions and seismic performance of the building.

1.3 Limitations

Findings presented in this report are based on analysis of the existing building as represented by the available existing drawings. No material testing was performed as part of our evaluation. Therefore, calculations regarding existing material strength, reinforcement, and connection properties were primarily performed based on professional engineering judgment.

2. Building Description

Built in 1988, Building CJ-6 at the San Francisco County Jail Facility is located at One Moreland Drive, San Bruno, California. It is a square, single-story, pre-cast concrete shear wall building, measuring approximately 220 feet by 220 feet in plan dimensions. The story height is 25 feet at the peak with a 2-foot parapet at the perimeter. The building is split into eight triangular sections with a cross and X through a center core. Six of the eight triangles are dormitory type jail houses, currently unoccupied. The remaining two triangles serve as the administrative offices and have a second floor mezzanine level with additional office space.

Figure 1 – Entrance on East Side

2.1 Gravity-Load-Carrying System

The gravity-load-carrying system comprises slabs of lightweight concrete fill over metal deck, spanning between steel wide-flange beams and girders. The steel framing is supported on a combination of concrete bearing walls and steel posts. The mezzanine level is supported by a combination of concrete and masonry bearing walls. The foundation system for this building includes shallow reinforced concrete spread footings supporting the columns and continuous reinforced concrete footings supporting the load bearing concrete walls.

2.2 Lateral-Load-Resisting System

The lateral-load-resisting system comprises solid diaphragm roof slabs of lightweight concrete fill over metal deck, spanning between 9 ¼"-thick reinforced concrete shear walls, with small window openings. The shear walls are tilt-up pre-cast sections interconnected with 18" pour strips between panels. The roof slabs serve as horizontal diaphragms to distribute lateral loads to the concrete shear walls and foundation below. Most masonry walls are non-bearing except for a few smaller walls at the mezzanine area that support the floor. For the purposes of seismic evaluation, the resistance of the masonry walls is neglected, though in reality they provide some additional seismic resistance.

3. Seismic Evaluation Criteria

The seismic evaluation of Building CJ-6 was based on ASCE/SEI 31-03, *Seismic Evaluation of Existing Buildings.*

This document represents the state-of-the-art structural engineering practice for the seismic evaluation of existing buildings. The goal of ASCE 31 is to identify the specific deficiencies in a building's lateral force resisting system that can lead to significant failure and/or collapse.

Buildings are evaluated to either the Life Safety or Immediate Occupancy Performance Level utilizing a three-tiered evaluation process as follows:

- Tier 1 – Screening Phase
- Tier 2 – Evaluation Phase
- Tier 3 – Detailed Evaluation Phase

The ASCE 31 Tier 1 procedure is a preliminary screening tool designed to quickly identify potential seismic deficiencies of the structural lateral-force resisting system and nonstructural building systems. The Tier 1 evaluation procedure utilizes a series of checklists for rapid evaluation of the building while requiring only a minimum level of structural calculations. Our Tier 1 evaluation is based on a review of the original building drawings and the information collected during our site visit.

The Tier 1 checklists address the structural system deficiencies. The evaluating engineer addresses each checklist statement and determines whether it is compliant or non-compliant. Compliant statements identify conditions that are acceptable. Noncompliant statements identify conditions that are in need of rehabilitation. At this point, the Tier 1 deficiencies can be rehabilitated or further evaluation can be performed using the Tier 2 procedures.

The Tier 2 procedures use structural calculations to address non-compliant Tier 1 checklist statements with the intent to demonstrate the Tier 1 potential seismic deficiencies are actually satisfactory and need not be rehabilitated. The Tier 2 evaluation consists of a building analysis that only addresses the deficiencies identified by the rapid Tier 1 evaluation.

If there are still identified potential structural deficiencies at the completion of the Tier 2 evaluation, either the evaluation can be completed and the deficiencies rehabilitated, or a Tier 3 evaluation can be conducted. The Tier 3 evaluation consists of a comprehensive, full building detailed seismic evaluation, typically utilizing non-linear analysis methods.

ASCE 31 Tier 1 analysis and Deficiency-Only Tier 2 evaluations (where required) quick checks are done to evaluate the stiffness and strength of certain building components to determine whether the building complies with certain design criteria. These quick checks are performed where triggered by evaluation statements from the checklists. Based on the building type, level of seismicity, and level of performance, the following are completed (see Appendix A).

A. Basic Structural Checklist for Building Type PC1A: Precast/Tilt-up Concrete Shear Walls with Stiff Diaphragms.
B. Supplemental Structural Checklist for Building Type PC1A: Precast/Tilt-up Concrete Shear walls with Stiff Diaphragms.

3.1 Performance Objective

The structural performance objective of the building should conform to the standards for Life Safety (LS) Performance Level as defined by ASCE 31. To assist the Client in making an informed assessment of the seismic performance, the building is also checked for Immediate Occupancy (IO) Performance Level. Various seismic performance levels are defined in the table below.

Table 1 – Definition of Seismic Performance Level

Seismic Performance Level	Definition
Immediate Occupancy (IO)Performance Level	Building performance that includes damage to both structural and nonstructural components during a design earthquake, such that the damage is not life-threatening, so as to permit immediate occupancy of the building after a design earthquake and the damage is repairable while the building is occupied.
Life Safety (LS) Performance Level	Building performance that includes damage to both structural and nonstructural components during a design earthquake, such that partial or total structural collapse does not occur and damage to nonstructural components is non-life-threatening.
Collapse Prevention (CP) Performance Level	Building performance that includes damage to both structural and nonstructural components during a design earthquake, such that the building is on the verge of partial or total collapse.

3.2 Earthquake Hazard Level

Building CJ-6 is located in a high seismic region. Per ASCE 31, the seismic demand is based on a fraction of the Maximum Considered Earthquake (MCE) spectral response acceleration values which correspond to the Design Earthquake (DE) as noted in the table below.

Table 2 – Description of Earthquake Hazard Level

Earthquake Level[1]			Description[2]	Probability of Occurrence	Return Interval
ASCE 7	ASCE 31	SPUR			
		Routine	Earthquakes that are likely to occur routinely. In general, earthquakes of this size will have magnitudes equal to 5.0 to 5.5, should not cause any noticeable damage, and should only serve as a reminder of the inevitable.	70 percent probability of occurring in 50 years	43 years
Design Earthquake (DE)	BSE-1[3]	Expected	An earthquake that can reasonably be expected to occur once during the useful life of a structure or system. San Francisco's Community Action Plan for Seismic Safety (CAPSS) assumed that a magnitude 7.2 earthquake located on the peninsula segment of the San Andreas Fault would produce this level of shaking in most of the City.	10 percent probability of occurring in 50 years	474 years
Maximum Considered Earthquake (MCE)	BSE-2[4]	Extreme	The extreme earthquake that can reasonably be expected to occur on a nearby fault. The CAPSS defined magnitude 7.9 earthquake located on the peninsula segment of the San Andreas Fault would produce this level of shaking in most of the City.	2 percent probability of occurring in 50 years[5]	2,475 years

1. Earthquake Level nomenclature per ASCE 7-05, ASCE 41-06 and SPUR documents.
2. Description of earthquake level is from SPUR document.
3. Basic Safety Earthquake – 1
4. Basic Safety Earthquake – 2
5. In high seismic regions such as the San Francisco Bay Area, BSE-2 is limited by a deterministic estimate of ground motion based on 150% of the median attenuation of the shaking likely to be experienced.

3.3 Comparative Code and Evaluation Level Base Shear

A quick review of static base shear requirements for the building utilizing the original design code, current code, ASCE 31 IO Performance Level, and LS Performance Level indicates that the seismic demands are significantly higher for current code and IO than for the original Code-required design strength. It should be noted that using the ASCE 31 Evaluation procedure follows the philosophy that existing buildings do not need to conform to the same stringency of new buildings due to continuously evolving codes that would perpetually render existing buildings to be non-compliant. As such, there are reductions on the overall demand/capacity ratios buried into the evaluation procedures to relax the acceptance criteria from that of a new building. The ASCE 31 Tier 1 procedure is quite conservative to serve as a quick screening process, sometimes resulting in a higher calculated base shear than for new buildings as noted in the following table. This higher Tier 1 demand generally triggers the need for a more refined Tier 2 analysis where the effective base shear is lower than that used in Tier 1. In the case of CJ-6, since the system was deemed compliant even at the more conservative Tier 1 base shear level, there was no need to perform the Tier 2 analysis. It appears that the excess shear capacity in the original design was a result of the functional layouts of the walls and the nature of the usage requiring large walls with small openings.

When looking at base shears between new code design per ASCE 7 and existing building evaluation per ASCE 31, the base shear coefficient is not a straight comparison. New code design is based on establishing a design level earthquake that is then adjusted with factors for occupancy category and lateral system type. The lateral load resisting system is designed to have enough strength with reduction factors to exceed that design level force. Existing building evaluation is based on establishing an unreduced design level earthquake, and then evaluating the stress on each lateral resisting component individually. How far above the yield strength each member can resist through ductility is checked against thresholds established for various performance objectives, by using component-specific *m*-factors.

For Code based design of new buildings, the design level earthquake load is reduced by an R-factor of 4 for a reinforced concrete shear wall building, to account for building system ductility. In typical buildings with an Occupancy Category II, this approximately translates to Life Safety performance under a "Design Earthquake". For Essential Facilities such as hospitals and fire stations which have an Occupancy Category IV, the earthquake load is multiplied by a 1.5 factor which approximately translates to Immediate Occupancy performance under a "Design Earthquake". For jails and other buildings with high population density or hazardous materials, classified as Occupancy Category III, the earthquake load is multiplied by a 1.25 factor which approximately translates to seismic performance between Life Safety and Immediate Occupancy under a "Design Earthquake".

In contrast, for evaluation of existing structures using ASCE 31, the component capacity is increased by an effective ductility factor of 4 for shear walls when evaluating the capacity at Life Safety and 2 when evaluating the capacity at Immediate Occupancy. There is no evaluation level that would translate to halfway between Life Safety and Immediate Occupancy although straight-line interpolation between the two categories can be used to evaluate a comparative performance objective. For comparison purposes with new code base shears, the *m*-factors that increase the component capacities have been used to reduce the design earthquake levels.

The 2010 CBC which references the ASCE 7-05 Standard for new buildings and the ASCE 41-06 for retrofit of existing buildings are currently enforced through December 31, 2013. Any designs submitted after January 1, 2014 are subject to the forces prescribed in the 2013 CBC which references ASCE 7-10 Standard and ASCE 41-13, both based on updated ground motion parameters from the US Geological Survey.

Base Shear Comparison

Code	V_{base} [% g]
1982 UBC[1]	0.26
1982 UBC III[1,2]	0.33
2010 CBC	0.36
2010 CBC III[2]	0.45
2013 CBC	0.41
2013 CBC III[2]	0.51
ASCE 31 – LS[3]	0.51
ASCE 31 avg[5]	0.76
ASCE 31 – IO[4]	1.01

1. The 1982 UBC base shear has been multiplied by 1.4 for comparison with CBC ultimate strength design force level.
2. "UBC-III" and "CBC-III" correspond to enhanced design base shear for jail facilities with "Occupancy Category = III".
3. The ASCE 31 base shear has been divided by 4.0 for comparison with CBC ultimate strength levels. The 4.0 value corresponds to the governing shear wall *m* factor.
4. The ASCE 31 base shear has been divided by 2.0 for comparison with CBC ultimate strength levels. The 2.0 value corresponds to the governing shear wall *m* factor.
5. "ASCE 31 avg" corresponds to straight-line average between LS and IO to compare to CBC III level base shear.

3.4 Seismic Hazard Rating

In the late 1980's and early 1990's, approximately 300 City-owned buildings and facilities were seismically evaluated by various consultants for the Department of Public Works. Utilizing the procedures outlined in ATC-14, *Evaluating the Seismic Resistance of Existing Buildings* and FEMA-178, *NEHRP Handbook for Seismic Evaluation of Existing Buildings*, the consultants performed seismic assessments of these buildings by identifying buildings or building components that present unacceptable risks to human safety. The principal objectives of these evaluations were to determine the relative seismic strengths of these buildings, to identify existing seismic hazards, and to develop schematic strengthening options to correct those deficiencies.

In addition, each of these buildings and facilities were assigned a Seismic Hazard Rating (SHR) based on the levels of seismic hazards and potential damage. The ratings range from 1 to 4, and correspond to estimates of minor damage, moderate damage, major damage, and collapse potential, as shown in the table below.

Table 3 – Seismic Hazard Rating

SHR	Description
1	**Minor damage** (good performance). Some structural or nonstructural damage and/or falling hazards may occur, but these would pose minimal life hazards to occupants. The damage can be repaired while the building is occupied and with minimum disruptions to functions. Buildings and structures with this rating represent an acceptable level of earthquake safety, and funds need not be spent to improve their seismic resistance to gain greater life safety.
2	**Moderate damage** (fair performance). Structural and nonstructural damage and/or falling hazards are anticipated which would pose low life hazards to occupants. The damage can be repaired while the building is occupied. Buildings and structures with this rating will be given a low priority for expenditures to improve seismic performance and/or falling hazards to the "good performance" level.
3	**Major damage** (poor performance). Structural and nonstructural damage are anticipated which would pose appreciable life hazards to occupants. The building has to be vacated during repairs, or possibly cannot be repaired due to the extent and/or economic considerations. Buildings and structures with this rating will be given a high priority for expenditures to improve seismic performance and/or falling hazards to the "good performance" level, or would be considered for other abatement programs such as reduction of occupancy.
4	**Partial/total collapse** (very poor performance). Extensive structural and nonstructural damage, potential structural collapse and/or falling hazards are anticipated which would pose high life hazards to occupants. There is a good likelihood that damage repairs would not be feasible. Buildings and structures with this rating will be given the highest priority for expenditures to improve seismic performance and/or falling hazards to the "good performance" level, or would be considered for other abatement programs such as reduction of occupancy or vacation.

The Life Safety Performance Level essentially corresponds to a SHR between 2 and 3.

The Immediate Occupancy Performance Level essentially corresponds to a SHR of 1.

4. Seismic Evaluation

4.1 Document Review

The following documents were reviewed:

- Architectural Drawings titled "300 Bed Convertible Building for the San Francisco Sherriff's Department", prepared by VBN Corporation, Architects, dated May 25, 1988.
- Structural Drawings titled "300 Bed Convertible Building for the San Francisco Sherriff's Department", prepared by Leong, Razzano & Associates, dated March 17, 1988.

4.2 ASCE 31 Tier 1 Analysis

Building CJ-6 is located in an area of high seismicity. Per ASCE 31, this building is considered Type PC1A: Precast/Tilt-up Concrete Shear Walls with Stiff Diaphragms.

For Tier 1 analysis, quick checks are done to evaluate the stiffness and strength of certain building components to determine whether the building complies with certain design criteria. These quick checks are performed where triggered by evaluation statements from the checklists. Based on the building type, level of seismicity, and level of performance, the following checklists are completed (see Appendix A):

A. Basic Structural Checklist for Building Type PC1A: Precast/Tilt-up Concrete Shear Walls with Stiff Diaphragms.
B. Supplemental Structural Checklist for Building Type PC1A: Precast/Tilt-up Concrete Shear walls with Stiff Diaphragms.

A static pseudo lateral force procedure was used to analyze the structure. Ductility *m*-factors were also used in checking the acceptability of each component. The properties of structural material and material strength information were determined from existing drawings. An m-factor of 4.0 was used in this analysis for reinforced concrete shear walls at Life Safety Performance Level, and 2.0 at Immediate Occupancy Performance Level.

The Tier 1 analysis indicates that when evaluated for the Life Safety Performance Objective, Building CJ-6 has no structural deficiencies. When evaluated for the Immediate Occupancy Performance objective, the following two structural deficiencies are noted:

A. Precast wall panels do not have sufficient connection to the foundation to develop their strength.
B. Thickness of bearing walls is less than 1/25 of the unsupported height or width.

4.3 ASCE 31 Tier 2 Analysis

Each of the non-compliant items from Tier 1 is further evaluated in a Tier 2 using Deficiency-Only evaluation.

The following nonstructural deficiency remains for Immediate Occupancy Performance only:

A. P recast wall panels do not have sufficient connection to the foundation to develop their strength.

4.4 Expected Seismic Performance

The expected seismic performance of Building CJ-6 for the Design Earthquake is good and does not appear to be a collapse hazard during a major earthquake. Although the building meets the Life Safety Performance Level per ASCE 31, some structural damage to the building is expected to occur during a severe earthquake. The perimeter and interior concrete walls may exhibit some minor cracking, especially at the corners of window and door openings as well as where panels interface the closure joints. Depending on the severity of the earthquake, there may be some minor slippage between the precast walls and the footings, due to inadequate shear connection between the panels, slab-on-grade, and strip footing below. This deficiency may be remedied with a relatively minor enhancement of the existing connection along all of the wall bases.

We anticipate the building to retain much of its lateral-load-resisting capacity after a severe earthquake in its current state. The degree of expected damage is such that any required repairs could be performed while the building is occupied; however, security concerns may preclude occupancy during such repairs.

Figure 2 – Typical Interior and Exterior Tilt-up Concrete Walls

5. Conclusions

Based on our evaluation of the existing building, CJ-6 appears to have been built in substantial conformance to the design drawings. Designed and built in 1988, the building appears to be in fairly good condition. There are no major cracks in the concrete shear walls and no signs of settlement can be observed. Per the facilities representative, some minor repair to surface cracks and stucco was done after the 1989 Loma Prieta earthquake. There were no post earthquake damage reports available to review.

Building CJ-6 appears to meet the criteria for Life Safety Performance as outlined in ASCE 31. Although seismic building performance is expected to be good, some structural and non-structural damage to the building is expected during a severe earthquake, including minor cracking of concrete at the perimeter walls at corners of window and door openings and cracked or broken larger windows. The damage may be such that the building can be occupied during repair; however, security concerns and 24-hour occupancy may require vacating portions or all of the building during repairs. The owner is encouraged to consider retrofitting any known seismic deficiencies during tenant improvements and prior to re-occupying the building.

Based upon visual observations, review of available drawings, and ASCE 31 checklists, it is our professional engineering opinion that Building CJ-6 is assigned a Seismic Hazard Rating of 2 in its current state.

6. Appendices

6.1 References and Available Documents

1. American Society of Civil Engineers, *ASCE 31-03: Seismic Evaluation of Existing Buildings*, 2003.
2. American Society of Civil Engineers, *ASCE 41-06: Seismic Rehabilitation of Existing Buildings*, 2006.
3. American Society of Civil Engineers, *ASCE 7: Minimum Design Loads for Buildings and Other Structures*, 2005.
4. International Code Council (ICC), *California Building Code (CBC)*, 2010.
5. The City and County of San Francisco, *San Francisco Building Code (SFBC)*, 2010.

6.2 List of Appendices

Appendix A – ASCE 31 Check Lists
Appendix B – Calculations