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Structural and Seismic Evaluation of Existing Buildings of

Stevens HOSPITAL
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for Swedish Health Services

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Table of Contents

General Overview

Swedish Health Services has contracted with Lund & Everton LLC to provide a structural review of the existing buildings at Stevens Hospital. Structural review includes an evaluation and professional opinion of the conditions of the facility to support to weights of people and equipment within the building, weights of snow or rain on the roofs and withstand wind and earthquake forces.

We have reviewed the facility for the following:

- structural conditions or deterioration,
- ability of the structure to support the weights of current occupancies and modern equipment in the various departments,
- ability of the structures to withstand wind forces,
- levels of life-safety expectations in earthquakes, and
- performance of non-structural items (ceilings utility systems, canopies, etc) in earthquakes.

The Stevens Hospital campus, as with all of Puget Sound region, is in an area of high seismic risk. All modern structures are designed to provide for the safety of occupants. The design requirements are dictated by the building codes and are dependent on the size, type and uses of the building. The requirements for seismic design have changed significantly over the past 40 years. Much has been learned about building performance in recent earthquakes and the building codes have evolved to achieve better results. In the last 20 years the codes have added a special category for hospital buildings that requires a higher level of performance of the structure so that the building is immediately available to provide services after the earthquake. Buildings built before 1980 frequently lack the strength and ductility to withstand the earthquake intensity expected in this region without significant damage. Further discussion of seismic expectations is covered in the Investigation section.

Executive Summary

The general conditions of the structures that make up Stevens Hospital are good. We did not observe any areas of significant damage. In the areas where we could see the actual structures there were no indications of deterioration. There are localized areas of water damage and roof concerns that are mentioned in the individual building reports.

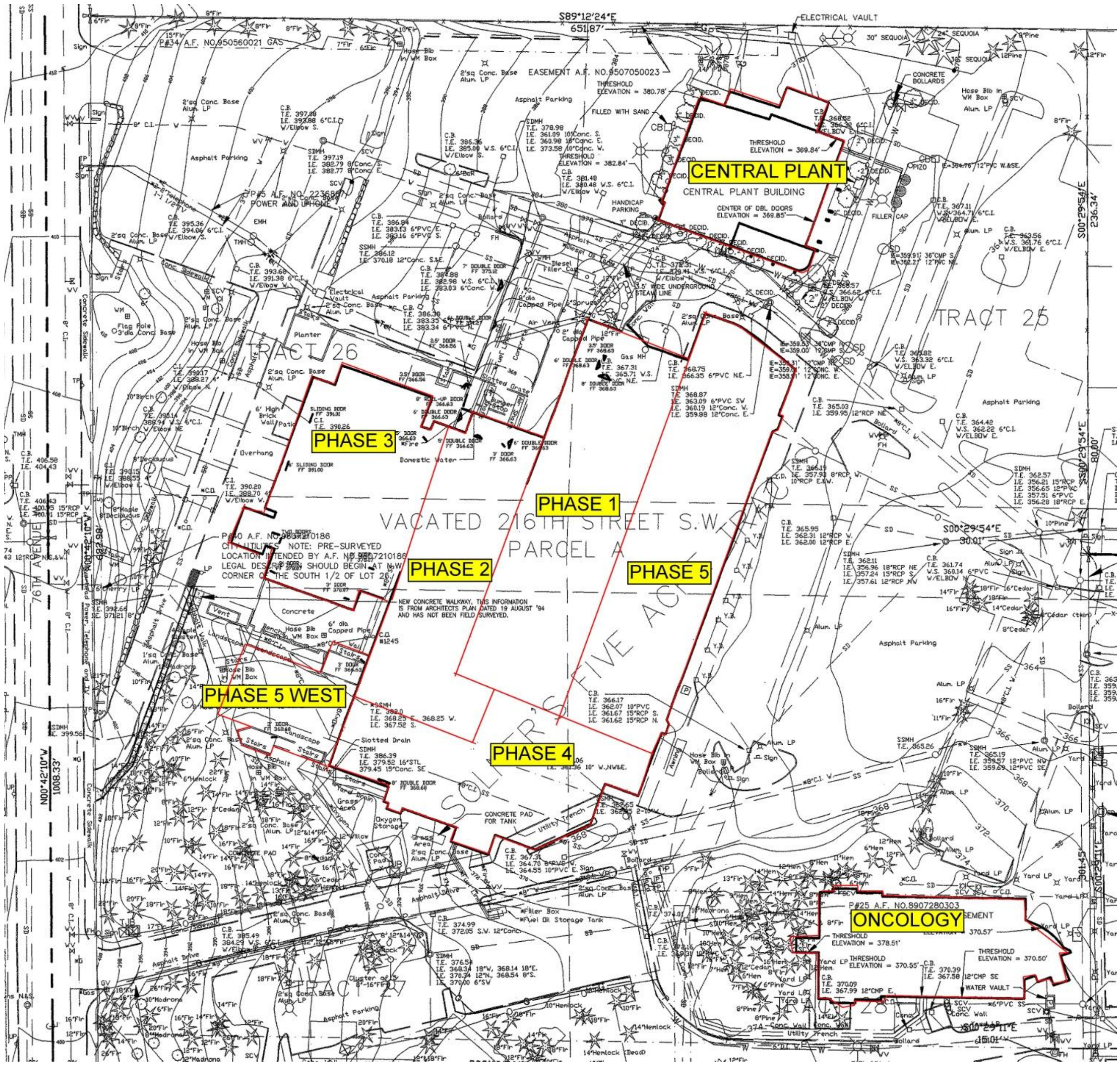
Other than seismic safety, the structures are adequate to serve their intended use. Load capacities of the floors are acceptable for hospital occupancies of patient rooms and offices. Imaging department with heavier loads is located on the slab on ground at Level 1. Future remodels that may include hanging equipment and patient lifts are expected to be feasible with the current structures.

Seismic safety is a more complicated evaluation and is covered in more depth in this report. In general the structures provide for basic life safety but the facility as a whole is not up to current standards for a hospital that is expected to provide post-earthquake emergency services. We have evaluated each of the structures for their potential life-safety in an earthquake and have a table of results to give a visual comparison of the structures. This is shown in Summary of Conditions on page 4.

Following the Summary of Conditions is a section of Recommended Upgrade Measures outlining possible improvements that could be made to the Hospital. There are two categories of improvements shown. Category 1 are recommendations to meet a minimum level of life safety as described in this report.

Category 2 recommendations are based on the Hospital's commitment to disaster preparedness as outlined in *"Stevens Hospital Emergency Operations Plan 2010" (EOP).* This plan indicates areas within the Phase 1, Phase 3 - tower and Phase 4 structures used as Emergency Operation Centers. The support of these areas should have additional review. The EOP identifies the Oncology Center as the alternate emergency location. Given the structural deficiencies in this building we recommend a different location for the Alternate, or structural upgrade measures are needed to this building.

Stevens Hospital Campus Map



Summary of Building Conditions

The following table summarizes the relative seismic risk of the primary structures at Stevens Hospital based on criteria in this report. This does not summarize specific areas of concern and non-structural items that are addressed in the individual sections. More detailed descriptions are included in the Investigation sections below.

The highest level of performance, Operational Level, is required for emergency centers that are required for regional trauma centers. The EOP outlines Stevens Hospital's obligations to community post-earthquake preparedness. Ideally an Operational Level would be the appropriate status for all portions of the Hospital. However, given the age of the existing buildings and the seismic design knowledge during the time of design, the buildings don't currently meet this standard. This is common in many community hospitals. It is important for the Hospital to determine the financially most viable improvements that can be performed to come close to this level of performance.

The next highest level, Immediate Occupancy, is for hospitals with more than 50 patients. This would be applicable to all core hospital spaces on the campus. Immediate Occupancy Level means that, whether or not the structure was originally designed as an essential facility, it may be available for post-earthquake services.

The Life-Safety level of building performance is required for other buildings. The Life Safety level of performance means that occupants will be able to exit the building after a major earthquake but that damage in the building is expected. Buildings that fit in this level may not be useable immediately after an earthquake and repairs may not be economically viable. Office buildings and residences are commonly designed to the life-safety level. The lowest level of Collapse Prevention is not thought to be adequate standard for hospital and medical office buildings.

Earthquake Risk of Existing Buildings

Building	Year Designed				Earthquake Risk Level (see page 6 & 7 for description)			
	1960-1970	1970-1980	1980-1990	1990-2000	Collapse Prevention	Life-safety Level	Immediate Occupancy Level	Operational Level
Phase 1	X					X		
Phase 2	X						X	
Phase 3-Tower	X				X	X (Condition is questionable)		
Phase 4		X					X	
Phase 5		X				X		
Oncology			X		X			
Central Plant				X			?	?
Utility routing from Central Plant to Emergency Services	X	X	X	X		X		

Upgrade Measures

Building owners are not required to bring older buildings up to current seismic standards unless there are substantial changes to the occupancy of the building or major renovations that extend the life of the structure. The Hospital may choose to make upgrades for life safety reasons or may make some upgrades when performing other remodels. The chart below shows the mitigation measures recommended based on this investigation. Descriptions on the reasons for these recommendations are in the individual building reports.

The most critical areas of concern are:

- In the Phase 3 tower building: Replace or modify the main entrance canopy. Seismically brace the bridging corridor between Phase 1 and 3.
- Route utilities from the central plant to the emergency department through underground exterior trenches or review and upgrade the areas of Phase 1 and 2 containing the utilities.
- Seismically brace all water piping in upper floors. This will reduce disruption to hospital services caused by breakage of piping. Reports from recent California earthquakes have shown that water damage alone has shut down and caused evacuation of major hospitals even in a moderate earthquake.

Summary of Upgrade Measures by Building

Building	Category 1 - Life-Safety – minimum recommended upgrades				Category 2 - Operational Level – recommended upgrades (in addition to those for Life-Safety)				
	Review main utility systems bracing and joints	Brace all upper floor piping	Clean roof and/or modify slopes to drains	Structural Items	Perform Tier 2 seismic evaluation	Anticipate added shear walls	Anticipate added localized structural strengthening	Check all equipment anchorage	Brace all utility distribution systems
Phase 1	X	X	X		X	X		X	X
Phase 2	X							X	X
Phase 3-Tower	X	X	X		X	X	X	X	X
Main Canopy	X			Remove or seismic strengthen		Remove and replace			
Bridge from Ph 3 to Ph 1	X		X	Seismic strengthen	X	X	X		X
Phase 4	X				X			X	X
Phase 5	X			X	X		X	X	X
Oncology	X	X	X	X	X	X	X	X	X
Central Plant									X

Investigation Procedures

The Hospital has provided Lund & Everton LLC with electronic versions of all known construction documents for the existing structures. We have reviewed the structural drawings for general concept of the material details, connections and reinforcing of concrete and masonry.

We have visited the site for building condition assessment. On March 22, 2010 we performed a brief walk-through to gain a general knowledge of the building conditions. We observed most mechanical rooms for equipment anchorage and system bracing. We looked at the primary structure where visible within mechanical rooms and ceiling spaces. No structural damage or significant deterioration was observed.

The buildings have been evaluated for seismic safety based on ASCE 31-03 as described below. This process has a three tier analysis for evaluating the buildings. Only a Tier 1 level has been performed at this time on the Stevens Hospital buildings. The purpose of an earthquake assessment is to determine the risk to human life posed by damage or failure of structures in a major earthquake. In general the evaluation does not determine the likelihood of the structure to be repairable after an earthquake but we have provided some comments from our engineering judgments based on the information we have evaluated.

The city of Edmonds is in a seismically active area, as is all of Puget Sound. The calculations performed for the building reviews are based on guidelines that define the maximum considered earthquake as one that has a 2% probability of exceedance in 50 years. For the purpose of the ASCE 31-03 review, the site is classified as Site Class C. Mapped short-period spectral acceleration and 1-second period acceleration taken from National Earthquake Hazard Reduction Program (NEHRP) spectral response acceleration contour map are Ss = 1.25 and S1 = 0.42.

ASCE 31-03 Seismic Evaluation of Existing Buildings:

This document, published by the American Society of Civil Engineers, is a national standard of existing building review developed by the Federal Emergency Management Agency (FEMA).

The basis of the ASCE 31-03 methodology is a multi-tiered evaluation of existing buildings based on available information. The Tier 1 evaluation uses standardized checklists and short engineering calculations to determine generalized acceptance criteria for earthquake performance based on the need for a structure to provide either basic Life-Safety or in the case of hospital occupancies, Immediate Occupancy. Further Tier 2 and 3 evaluations may be performed on buildings to more closely determine the extent of deficiencies that are reported in the Tier 1 evaluation. Only Tier 1 evaluation has been performed on the Stevens Hospital buildings.

Design of upgrades for existing structures for earthquake resistance is regulated by the building codes. The standards for building performance vary depending on the occupancy of the building. Current seismic design practices identify four levels of building performance described in the "NEHRP Guidelines for Seismic Rehabilitation of Buildings", published by FEMA (FEMA 273). These descriptions gave a better understanding of the expected performance:

- Operational Level: Damage in a major earthquake would be very light. All important systems would be operational. Back-up power and utilities would be available. This level is used for upgrade design of essential facilities.
- Immediate Occupancy Level: Light non-structural damage is expected in a moderate to severe earthquake. Structural damage would not occur or it would be easily repairable.
- Life Safety Level: Moderate damage would be expected. Gravity load-bearing system would function but lateral system would need repairs. Utility systems may be damaged. Building may be beyond economical repair. This is the level of performance required by building codes for ordinary structures; that is structures other than those with higher risk occupancy such as hospitals, jails, schools and large assembly areas, and essential facilities.
- Collapse Prevention Level: Damage in a major earthquake would be severe. Large movements are expected with significant non-structural damage. Some exits may be blocked. Building is near collapse. This level is only allowed for existing building renovations and is sometimes used for mandatory seismic rehabilitation ordinances enacted by municipalities to mitigate the most severe life-safety hazards at a relatively low cost.

Soils

The ability for a building to withstand earthquakes is dependent on the condition of the soils that support it as well as the structural system. We have not received geotechnical report for the site but have seen a few boring logs on the Phase 1 construction documents. The soils appear to be loose to dense sands. These may contain ground water and have potential for settlements. Liquefaction potential at this site is possible and is probably addressed in the more recent geotechnical reports.

Non-structural Components and Utilities

Significant damage and injury can occur in earthquakes due to non-structural items. Current building codes require anchorage of items such as tall shelving and mechanical units. At the time that most of these buildings were constructed this anchorage was not a construction standard. It does appear that some of the subsequent remodels provide for seismic anchorage of some of the interior components. The non-structural items were not reviewed as part of the study however it was noticed that there was an overall lack of anchorage of piping. The following list are some of the typical components that often fail in earthquake causing risk to life-safety:

- Hung ceilings, light fixtures, sprinklers need to have lateral bracing. Recent remodels in the hospital have been bracing ceilings and light fixtures.
- Shelving and storage racks need to be anchored to the floor or walls. The hospital is reducing the amount of heavy file storage and does not have significant areas of free-standing shelving.
- Mechanical and electrical units need to be bolted to floor or roof framing. Nearly all equipment viewed appeared to be bolted.
- Piping in multi-story buildings needs to be braced so that failure does not cause water damage. This should be a priority in planning any upgrades and remodels.
- Gas and water lines entering buildings and crossing between buildings need expansion joints to allow building movement. This was not observed during our walk-through.
- Bio hoods and units containing hazardous materials need to be braced to walls or floor. Also not observed.

Conclusion

The recommendations from this study are outlined in Suggestions for Upgrade Measures. More information on each item is contained in the following individual building summaries.

This report does not cover non-structural issues such as asbestos, fire protection, insulation, energy code requirements, roofing material conditions, and roof fall protection.

Non-structural items in a building can cause injury in an earthquake. We observed, where possible, the anchorage of ceiling and the bracing of the mechanical and electrical systems. Our comments on upgrades include non-structural items.

We noticed a number of the mechanical rooms throughout the facility are being used for miscellaneous storage. There is furniture, cabinetry, shelving, decorations and other probably forgotten items in the rooms. These items stored in the mechanical spaces are a hazard to the ability for facilities maintenance personnel to quickly repair utility systems after an earthquake. We recommend removal of these items.

The ratings and descriptions of building conditions in this report are the professional opinions of Lund & Everton LLC. Lund & Everton LLC has assisted Swedish Health Services for over twelve years in facility assessments, earthquake risk evaluations and renovations. After the Nisqually Earthquake of 2001, Lund & Everton provided immediate assessment of all of Swedish's facilities on three campuses for immediate occupancy and damage review. Later, a more thorough review of each building was made to discover damage and design repairs.

We have not performed in-depth evaluation of the original designs nor have we confirmed that the actual construction completely follows the details shown on the documents. If further evaluation of any of the structures is needed for upgrading the structure or costing analysis, then a more complete evaluation of the documents will be required. Field verification and destructive testing may be required to determine actual conditions. Opinions expressed herein may change given additional information and material testing. No detailed analysis has been made on the structures for this report. The opinions expressed here are based on type of structural system, building age as it relates to code requirements and construction standards and building configuration.

Investigation Reports and Building Performance Summaries

1960 – 1970 Buildings

The buildings built between 1960 and 1970 were designed to the early versions of Uniform Building Code seismic provisions. In the 1952 code the seismic design criteria was increased due to the performance of buildings in the 1949 Olympia Earthquake. Again in 1961 major increase were made to the seismic design requirements. However the most significant changes to the building codes, and the requirement for special provisions for essential facilities, occurred in 1974 after the 1971 San Fernando Earthquake. The structures built in this decade were all constructed before that time and although they had intended lateral systems they do not have the level of seismic detailing required of current buildings.

Phase 1

Drawing Summary:
Year Designed: 1961 Ralf Decker Architect
Remodels: Phases 2, 4 and 5 abut the original building. Openings have been cut in the concrete shear wall on Level 1. No other structural modifications are known to have occurred. Plaster hard ceilings have been replaced in many areas. The replacement has been gypsum board attached directly to the floor joist for fire-rating. Most areas have a lower hung ceiling with a congested ceiling cavity.

Floor elevations: Level 1: 362.0’ per original datum. Listed as 380.22’ in Phase 2, and 368.70’ in Phase 3 and 4.
Story heights: 11.5’,11.0’, 11.0’, 11.0’

Materials: Level 2 & 3 floors have 2-1/2” slabs supported on 12” deep open-web joist at 2’-0” on center. Joist span 19-2” and 25-2” to 12” steel wide-flange beams. Beams span 14’-0” to columns and walls. Roof is 2-1/2” slab on 12” joist at 2’-0” and 2’-6” oc. Steel columns and spread footings provide vertical support.

Design floor loads = 40 psf live load for wards, 60 psf corridors and Level 1. 100 psf for stairs and entry.
Stresses used: concrete f’c=3,000 psi, rebar fs=20,000 psi, structural steel A36 fs= 22,000 psi with high-strength bolts.
Exterior enclosure is non-structural brick, metal panel and single-pane windows.

Lateral System: The lateral system is concrete shear walls around stairs and elevator cores. On Level 1 the entire west wall is concrete due to original grade on this side of the building.

Lateral Design Code comparison:
Original design code: 1958 Earthquake Design “Zone 2” V=ZKCW= 0.1W
IBC 2006: R = 4 , I=1.5, V= 0.22W (Allowable Stress Design)

Building Performance:
Basic Structure:
No deterioration is noticed in the structure other than minor rust at the penthouse roof. The Level 2 & 3 structure will continue to support basic lightly loaded hospital occupancies such as patient rooms. Level 1, as slab on ground, can support heavier floor loadings. The roof slopes are too shallow to properly drain and ponding is occurring. This affects the roofing material and if drains fail it could cause structural damage.

Seismic:
The shear walls are basically adequate for a life-safety level of performance. The building would not be able to be immediately occupied after a major earthquake. Expect that heavy non-structural damage will occur at a moderate level earthquake. Major damage is likely at a design earthquake. The weakest components in the structure are the short concrete walls at the stairwells that provide seismic resistance in the north/south direction. The building can be strengthened by adding concrete walls or steel cross-bracing on the east and west exterior of the structure at all levels. We have two primary concerns with non-structural items in this structure. One is the safety of utilities that pass through the building to serve the emergency department. Steam, chilled water, med gas and regular power are served from the Central Plant through a tunnel to the Phase 1 structure and then the rest of the facility. These services may be heavily damaged if the Phase 1 structure is damaged and thus not be available to other departments. Secondly it appears that piping in the penthouse and upper floors in not seismically braced. Broken pipes can cause water damage throughout the building, even on lower floors, and the entire building may not be able to be occupied.

Phase 1 – Photos

View of exterior walls at south end of Level 2 and 3 showing brick, metal panels and windows.

View of roof of Phase 1 from the roof of the tower building.

Crack in concrete wall in stair wall appears to be recent. Cause of crack is probably the 2001 earthquake. The crack occurred at this location because the concrete is quite thin behind the fire extinguisher cabinet. This is not a structural concern.

Phase 2

Drawing Summary:
Year Designed: 1968 Decker Kolb & Stansfield Architects
Remodels: Phases 3 & 4 remodeled this structure. Openings have been cut in the concrete shear wall on Level 1. No other structural modifications are known to have occurred.

Floor elevations: Level 1: 378.22’
Story heights: 13.0’

Materials: Roof level is post-tensioned concrete pan-joist spanning 41’ and cantilevering 17’. Existing Phase 1 west wall is underpinned to lower floor slab of Phase 2 but no column or wall load is added to this line. Buildings are separated by 2”. Level 1 is 4” slab on ground. Building is supported on spread footings.
Design floor loads = 100 psf live load floor and part of the roof.

Stresses used: concrete f’c=3,000 psi, rebar fs=20,000 psi.
Exterior is mostly concrete due to grade against building.

Lateral System: Lateral system is concrete shear walls around stairs and on west side retaining soil.

Lateral Design Code comparison:
Original design code: 1967 Earthquake Design “Zone 3” V=ZKCW= 0.13W
IBC 2006: R = 4 , I=1.5, V= 0.22W (Allowable Stress Design)

Building Performance:
Basic Structure:
No deterioration is noticed in the structure. The Level 2 roof appears to have been designed as a future floor and is adequate for the minor pieces of mechanical equipment supported on it.

Seismic:
The shear walls are adequate for an immediate occupancy level of performance since the building is one story. Torsional irregularity and re-entrant corner exists but as a one-story structure it is not expected to create excessive displacements.
Non-structural systems are expected to perform adequately.

No Photos Included

Phase 3

Drawing Summary:
Year Designed: 1968 Decker Kolb & Stansfield Architects, Skilling Helle Christiansen, Robertson structural.
Remodels: Interior remodels only in this structure.
Floor elevations: Level 1: 366.7'
Story heights: Sub Basement 15.0', Surgery/Basement 12.0', Level 1 11.5', Level 2 13.0', Level 3 14.0', Level 4 13.0', Level 5 to 9 12.0', Penthouse 12.0'

Materials: Floor and roof framing is concrete pan joist supported on concrete beams and columns. All foundations are spread footings. The grade slopes steeply from Level 3 on the west side to Level 1 on the east.

Stresses used: concrete f'c=4,000 psi, rebar fs=20,000 psi.

Design floor loads = 80 psf and 100 psf live load.

Lateral System: Lateral system is concrete shear walls around stairs, elevators and exteriors. Some ductile detailing is used on wall ends. Coupling beams (headers over windows) are not adequately reinforced and will experience cracking in a seismic event. Many of the shear walls do not continue to the foundation creating potential overload on the columns.

Exterior System: Brick exterior veneer does not appear to have elastomeric material at the ledger angles to allow movement between the wall panels. Brick damage and falling bricks are a potential hazard in an earthquake.

Lateral Design Code comparison:
Original design code: 1967 Earthquake Design "Zone 3" V=ZKCW= 0.08W
IBC 2006: R = 4, I=1.5, V= 0.22W (Allowable Stress Design)

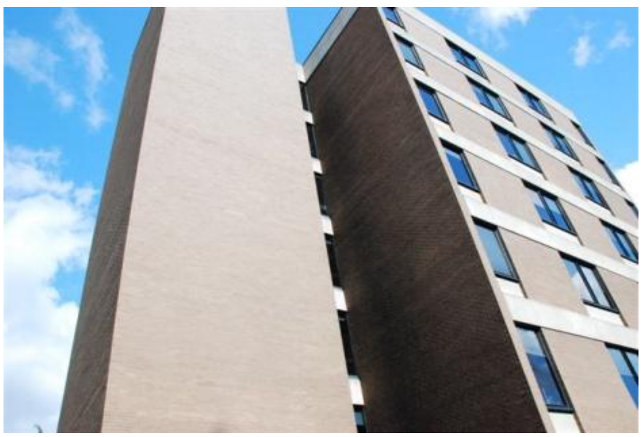
Building Performance:
Basic Structure:
No deterioration is noticed in the structure. Floor design loads will allow for flexibility in the use of the building.

Seismic:
The shear walls are adequate for a life-safety level of performance. The detailing of concrete on the original drawings and the general configuration of the shear walls is a concern for the reliability of the structure in an earthquake. There are many areas where the concrete walls do not continue to the foundations. They stop and are supported by floor framing and columns. These columns and framing may become overloaded from the seismic forces in the walls above and failure may occur. The building is not adequate for an Immediate Occupancy level of service.
The large canopy over the main entrance is a concern for earthquake safety. It has weak columns and does not have adequate strength or ductility to resist a design level earthquake. This heavy roof is likely to collapse in an earthquake and block the primary exit of the building. We recommend seismic strengthening or removal and replacement of the canopy.
The pedestrian bridge from the Phase 3 structure, connecting to Phase 1 at Levels 2 and 3, crosses the roof of Phase 2. This bridge does not have adequate strength to withstand a design level earthquake. It is likely that the bridge will collapse. Strengthening the bridge is recommended.
Non-structural systems are expected to perform adequately but pipe damage on upper floors and penthouses is expected in a major earthquake. The water from damaged pipes could shut down the facility.

Phase 3 – Photos

Phase 3 Tower from east side

West side at entrance



Brick exterior is in good condition but has no visible ledge angles and slip joints.

Roof drainage is poor.

Entrance Canopy has poor seismic resistance

Phase 3 – Photos, cont.

Looking down on Entrance Canopy

Bridge at Levels 2 and 3 connecting Phase 1 and 3

1970 – 1980 Buildings

The conditions of these structures vary but they predate the major seismic engineering developments. The buildings are of good quality construction but lack the detailing and ductility that will allow them to take the energy of a major earthquake without some structural damage.

Phase 4

Drawing Summary:
Year Designed: 1977 Warren LaFon Architect & Decker/Barnes Architects Joint Venture Paul Panagakis Structural
Remodels: Phase 5 remodeled portions of this structure. Openings have been cut in the concrete shear wall on Level 1. No other structural modifications are known to have occurred. This is the emergency department in the facility and is the most critical to remain operational after an earthquake.

Floor elevations: Level 1: 368.76'
Story heights: 13.75'

Materials: Roof is 3-1/2" concrete on 3" metal deck supported by wide-flange steel beams at 8'-10" oc. Beams are supported by concrete walls and columns. Building is separated from existing structures by 3" at the roof level. Level 1 is 4" slab on ground. Building is supported on spread footings.
Design floor loads = 100 psf live load floor.

Stresses used: concrete f'c=3,000 psi, rebar fy=60,000 psi.
Exterior is mostly concrete due to grade against building.

Lateral System: Lateral system is concrete shear walls at exterior.

Lateral Design Code comparison:
Original design code: 1973 Earthquake Design "Zone 3" V=ZKCW= 0.13W
IBC 2006: R = 4 , I=1.5, V= 0.22 W (Allowable Stress Design)

Building Performance:
Basic Structure:
No deterioration is noticed in the structure. The roof appears adequate for the minor pieces of mechanical equipment supported on it.

Seismic:
The shear walls are adequate for an immediate occupancy level of performance since the building is one story. Torsional irregularity exists but as a one-story structure it is not expected to create excessive displacements. The ambulance canopy is well tied into the roof structure and is expected to perform adequately even though the two free-standing columns do not have seismic ductility.
Non-structural systems are expected to perform adequately in a minor earthquake but may not be adequately braced for a major earthquake.

Ambulance canopy on southeast corner


Roof of Phase 4

Phase 5

Drawing Summary:
Year Designed: 1982 Decker Hobbs Fukui Associates Architects; Duane McMahan Structural

Floor elevations: Level 1: 368.80’
Story heights: 13.2’

Materials: The Phase 5 structure on the east side is as follows: Roof level is 2-1/2” concrete over 3” metal deck supported on steel wide-flange and concrete beams. Roof framing is supported on steel columns and concrete shear walls.
Design floor loads = 100 psf live load floor.
The Phase 5 structure on the west side is concrete pan-joist roof supporting soil on the surface. Framing is supported on concrete shear walls.

Stresses used: concrete f’c= 3,000 and 4,000 psi, rebar fy=60,000 psi. Steel A36

Lateral System: Lateral system is concrete shear walls.

Lateral Design Code comparison:
Original design code: 1979 Earthquake Design “Zone 3” V=ZIKCSW= 0.21W
IBC 2006: R = 4 , I=1.5, V= 0.22W (Allowable Stress Design)

Building Performance:
Basic Structure:
The exterior wall on the east side has cracks in the concrete headers above the windows. These headers span 42’between concrete columns. The direction of the cracks are indications of excessive shear stresses and indicate that the reinforcing in the header may not be enough for the given span. If this area is overloaded by roof load (snow, water ponding, or added mechanical equipment) there may be concrete deflection that could damage the windows below or cause structural failure. This condition should have more in-depth review.

Seismic:
The shear walls appear adequate for a life-safety occupancy level of performance since the building is one story. Non-structural systems are expected to perform adequately.


East Entry


Roof of Phase 5


Cracks in concrete beam

1980 – 1990 Buildings

The conditions of structures built during this decade vary but they all predate the major seismic engineering developments. The buildings are of good quality construction but lack the detailing and ductility that will allow them to take the energy of a major earthquake without some structural damage.

Oncology Building

Drawing Summary:
Year Designed: 1989 Decker /Fukui Architects; Anne Symonds Structural
No Remodels other than equipment installation.

Floor elevations: Level 1: 370.5', Level 2: 386.5'
Story heights: 16.5', 13.5'

Materials: Two radiology treatment rooms on the west end are thick concrete walls. The upper floor framing is concrete pan joist. Above the Upper floor are steel pipe columns supporting wood framed roof with plywood sheathing and engineered wood joists.

Stresses used: concrete f'c=4,000 psi, rebar fy=60,000 psi, Steel A36,

Lateral System: Lateral system is plywood shear walls on the upper floor supported on the concrete structure. The lower floor lateral is taken entirely by the thick concrete walls around the treatment rooms on the west end of the building. The building has excessive torsional eccentric and in our opinion performed poorly in the minor shaking of the 2001 Nisqually Earthquake.

Lateral Design Code comparison:
Original design code: 1985 Earthquake Design "Zone 3" V=ZIKCSW= 0.14W
IBC 2006: R = 5, I=1.0, V= 0.15W (Allowable Stress Design) (Does not include effects of torsional issues and redundancy).

Building Performance:
Basic Structure:
No deterioration of structure is visible. The north end of the roof is heavily covered with moss. This will keep the roof from draining properly and cause excessive water ponding that may overload the roof and lead to water intrusion and potential structural damage. Maintenance is suggested to not only kill the moss but clean out the organic matter that impedes drainage.
The west stair landing on the Upper Floor is being used for storage. The path of travel for exiting and area of refuge is greatly reduced. This is not a structural concern but could be a code violation and substantial risk to life safety. All exit ways should be cleared of obstructions.

Seismic:
The east side lobby has significant wall board crack. The cracks in the wallboard themselves are not structural, It is not known if there is structural damage behind the cracks. The configurations of these cracks are very indicative of earthquake movement in a structure that is not adequately braced for an earthquake. In this building the problem is torsion due to the thick walls on one end of the building and the complete lack of any seismic resistance on the east end of the building. The problem was compounded by the lack of separation joints in the wallboard in the two story spaces of the lobby.
The torsional irregularity, the lack of ductility in gravity columns and the dissimilar materials between floors gives this building a very poor expectation for performance in an earthquake. The addition of shear wall on the east side of the building would improve the seismic performance.
We noticed that the mechanical equipment sitting on grade outside of the Oncology building was not bolted to the supporting slab. The penthouse units were observed but we could not determine if they were anchored. Piping in the building was not braced. Seismic anchoring and bracing would improve the buildings life safety. This would be advisable to maintain services in the building if structural improvements are to be made.

Oncology – Photos

Cracks in non-structural wall board

Moss on roof may cause excessive loads, this north section is shaded

South side of roof is in good condition

Piping in mechanical spaces is not braced

Equipment may not be anchored

<u>Oncology – Photos, cont.</u>

Air handling equipment is not anchored

Some equipment is not anchored

Water heaters are not anchored

1990 – 2000 Buildings

Structures built during these dates are usually in good condition and are capable of withstanding major seismic events with minor damage. These structures are all designed to relatively current seismic standards.

Central Plant

Drawings were not provided. Opinions expressed here are based on the year of construction and brief visual observations.
Year Designed: 1995
No structural modifications are known to have occurred.

Materials: Roof level is open-web joist supporting metal deck. CMU exterior walls support the roof.

Lateral System: Lateral system is the CMU exterior walls.

Lateral Design Code comparison:
Original design code: assumed 1992, Base Shear force unknown.

Building Performance:
Basic Structure:
The structure and systems appear to be in excellent condition.

Seismic:
The structure and systems appear to be in excellent condition.
Non-structural systems are expected to perform well. All equipment is anchored at the floor. Distribution systems are braced however some bracing of piping hanging from the roof appears to be braced to the bottom flanges of open-web steel joist that do not have any lateral support. Excessive movement of the piping may occur and cause breakage and loss of services.

Central Plant

Some piping hanging from the roof is not adequately braced.