Robert M. Arnold Public Health Sciences Building
The Fred Hutchinson Cancer Research Center
Seattle, Washington

Technical Report 1

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Executive Summary

The Robert M. Arnold Public Health Sciences Building was constructed on the campus of the Fred Hutchinson Cancer Research Center (FHCRC). The Public Health Sciences Building houses four programs: Epidemiology, Cancer Biology, Biostatistics & Mathematics, and Cancer Prevention. This purpose of this report is to provide and introduction and initial investigation of the structural system used for Arnold building. Included in the report are detailed descriptions of the various elements which make up the structural system of the building. There are also spot check calculations of gravity members and one lateral force resisting member. The assumptions made in these analyses may differ from those made by the hired professionals.

The structure of Robert M. Arnold Building has various different elements. The floor system is compose primarily of two way slabs. These slabs transfer the load to what are typically concrete columns. At the base of the columns the loads are then transferred to spread footings. Lateral loads are resisted by a combined system of shear walls and braced frames.

Code Requirements:

The Robert M. Arnold Building was designed and completed prior to the City of Seattle adopting the International Building Code (IBC). The applicable building code at that time was the 1997 Uniform Building Code (UBC) as amended by the Department of Planning and Development. The design of concrete structures shall also be in accordance with standards set forth by the American Concrete Institution (ACI). The Seattle Building Code is comprised of the 1997 Uniform building code and the amendments made by the City of Seattle.

Load Calculations:

All loads shall meet the minimum design loads specified by The 1997 UBC.

Gravity Loads:

All loads shall conform to standards specified in the 1997 UBC. Live load are taken from Table 16-A, which is a table that was amended by Seattle.

Live Loads

Description	Uniform Load (lb/ft^2)	
	code	Structural Drawings
Floor		
Offices	50	80
Levels 1—4 (Office)	50	75
Laboratories	-	100
Interstitial	-	25
Corridors	100	100
Parking	50	50
Sidewalks & Driveways	250	250
Partition Load	20	20
Roof		
Roof	25	25

Table 1-1

Live Loads

Table 1-1 shows the live loads as obtained from the code and also those obtained from the structural drawings. Certain loads are not specified by the Seattle Building Code and do not fall into a broader category. The loads listed on the structural drawings in some areas differ from the code. For the purpose of analysis the Live loads determined by the design professionals will be used. The structural engineers had more information regarding building occupancy, building equipment, and building use. The office live load takes into account the additional loads of filing systems. In accordance with the Seattle Building Code reduction of live loads are permitted, however, the structural engineers have specified that there will be no live load reduction for the first level through the fourth level.

Dead Loads

As specified by the Seattle Building Code, the dead loads are considered to be, "the weight of all materials and fixed equipment incorporated into the structure." Unlike the live loads, there is no table or reference specified by the code. Where necessary minimum design dead loads from ASCE 7-05(Appendix 2) will be used.

DEAD LOADS

Description		
Materials		
Steel		In superimposed dead load
Concrete	150 lb/ft^3	

Table 1-2

Snow Loads

The Uniform Building Code does not specify a method for determining snow loads. The division concerning snow loads states only that snow loads in excess of 20 lb/ft^2 may use a reduction factor. For this initial investigation the snow load will be taken to be 20 lb/ft^2.

Lateral Loads:

Wind Loads

The wind loads were calculated in accordance to the methods determined by the Seattle building Codes. For the purpose of this report calculations of wind pressures were completed through the use of tables and queries in a Microsoft access database. A report of these calculations maybe be found in appendix 1.

Design Wind Pressures (lb/ft^2)
Numbers correspond to pressure calculations found in appendix 1

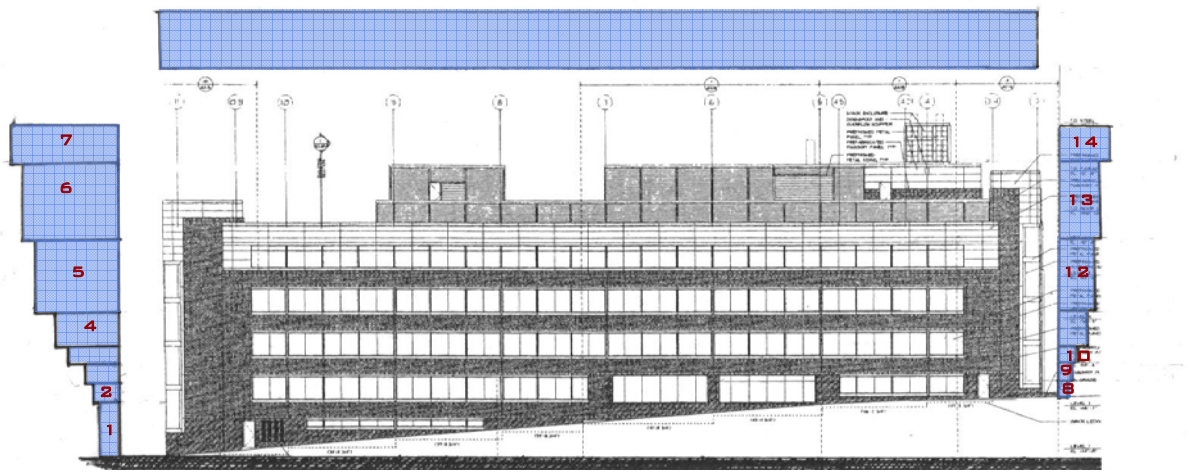
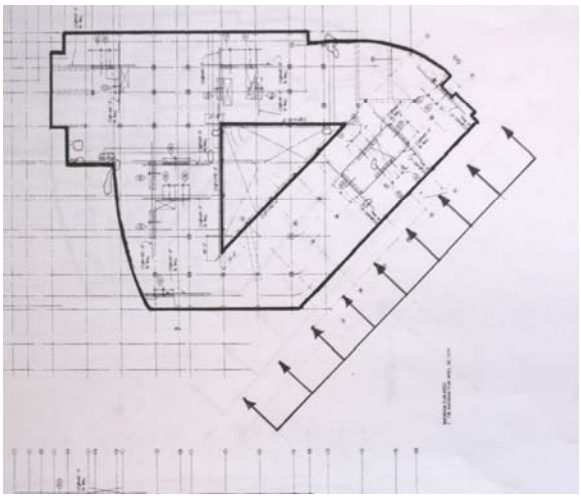
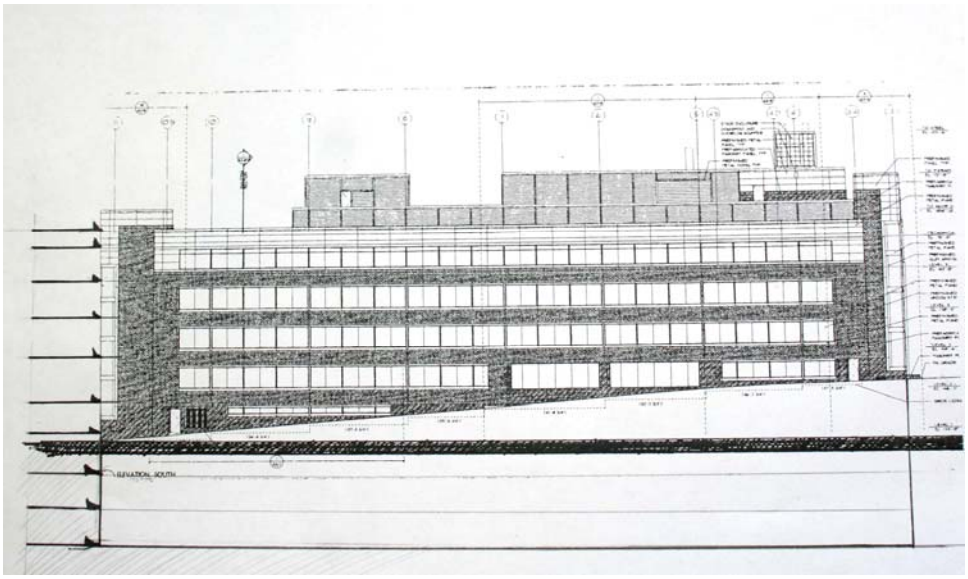


Figure 1-1



Seismic Loads

The seismic loads were calculated using one of the methods determined by the Seattle Building Code. The Static Force Procedure was used in calculating the base shear of Arnold building. Assumptions regarding soil conditions were taken from the drawings since the soils report is currently being retrieved. The weight of the building was approximated using data from Level D. The self weight of the structure of level D was calculated using the cubic weight of concrete and the size of each member. Appendix three is a summary of the weight of the concrete members. This weight was then divided by the square footage of the floor to provide the approximation, in lbs/ft^2, which was used in calculating the weight of the structure. The building base shear was calculated to be 5900 kips and the base shear listed on the drawings is listed as 5980 kips. The difference is probably due to the approximation made in calculating building self weight.



Structural System:

The Robert M. Arnold Public Health Sciences Building is an interesting collage of structural systems. Different portions of this building employ different methods of supporting the necessary loads. The building itself consists of five stories above grade plus a mechanical "penthouse" on the roof, while also extending 3 stories below grade. The triangular transfer of load around the atrium provides an element of structural complexity unseen in rectilinear buildings. Arnold Building houses the Public Health Science Department of the Fred Hutchinson Cancer Research Center. FHCRC specified that the building a standard of structural integrity higher than that of the code.

Foundation

The foundation of the Public Health Sciences Building consists mainly of spread footings and wall footings. Where the foundation is required to resist lateral loads carried down by shear walls, Arnold Building uses deeper drilled piers. The average footing is about 12 feet square, however, they could be various sizes ranging from eight feet square to 28 feet by 24 feet. The depth ranges from 30 inches to 48 inches deep, but is typically around 40 inches deep.

Framing

The framing of Arnold building is mainly composed of concrete structure, however, there are some portions of the building where steel has been used. Steel framing was used for the stairs and skylight in the atrium. A special stipulation was made that the structure of the atrium be design such that it would not cause any tor-

sional load on the rest of the building. The columns on the fifth story are made of tube steel with the typical size being TS 12x12x$^{5}/_{8}$. Steel was also employed in the design of the roof structure that houses the building's mechanical equipment. The typical steel column in this area is a TS 4x4x$^{1}/_{4}$. The irregularity of the steel roof structure lend itself to atypical beam and girder sizes. They range from W 10x12 to w 30x132. There also are a few steel columns in the main structure.

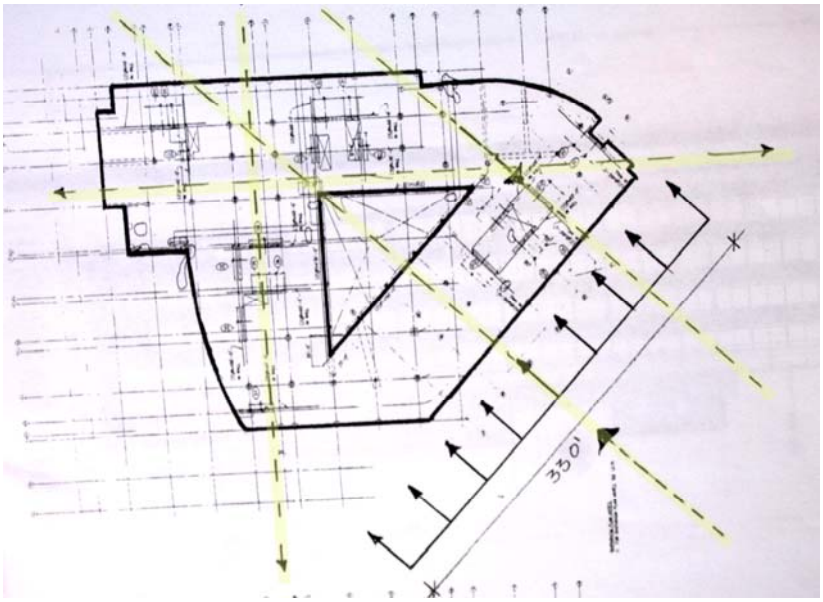
Almost all of the remaining portions of the structure are made of concrete. The columns are continuous cast in place reinforced concrete columns. The typical columns are 24 inches square and are on an average grid of 30 feet by 30 feet. The columns do not taper towards the top, however, the amount of reinforcement can vary. The shape of some columns varies. On certain floors columns may had a diameter of 24 inches instead of a width of 24 inches. Supporting Campus Drive, the turnaround, and the entrance plaza, under which the building extends, is an area of the building which uses cast in place reinforced concrete. The average beam size is 24 inches wide by 30 inches deep.

Structural Slabs

The floor system of Arnold Building is mainly composed of post-tensioned concrete floor slabs. The slab in the basement is not post-tensioned but instead is made of fiber reinforced concrete. The portion of the building that is under the entrance plaza uses reinforced concrete slabs. The roof slab is composed of reinforced concrete. With the noted exceptions the typical floor system is a flat post-tensioned concrete slab with column capitals.

Lateral Force Resisting System

For the purposes of this report it has been assumed that the lateral for is resisted solely by the shear wall and braced frames that are present in the structure. Located on the mechanical level is a lateral system of braced frames which transfer the load directly to the shear walls Further assumptions have been made in the analysis of lateral loads. The shear walls in planes parallel to the applied lateral are assumed to fully resist the load. The shear walls in planes that are not parallel are assumed to have an effective depth equivalent to that of a column and are consequently assumed to resist no portion of the lateral load. In further analysis of the lateral system these shear walls will be factored into the resistance of the resulting building torsion caused by the distance between the centroid of the applied load and that of the resisting force.



Structural Analysis;

In order to verify the assumptions made for this analysis spot checks of various structural elements of the building done. These May be found in appendix four.