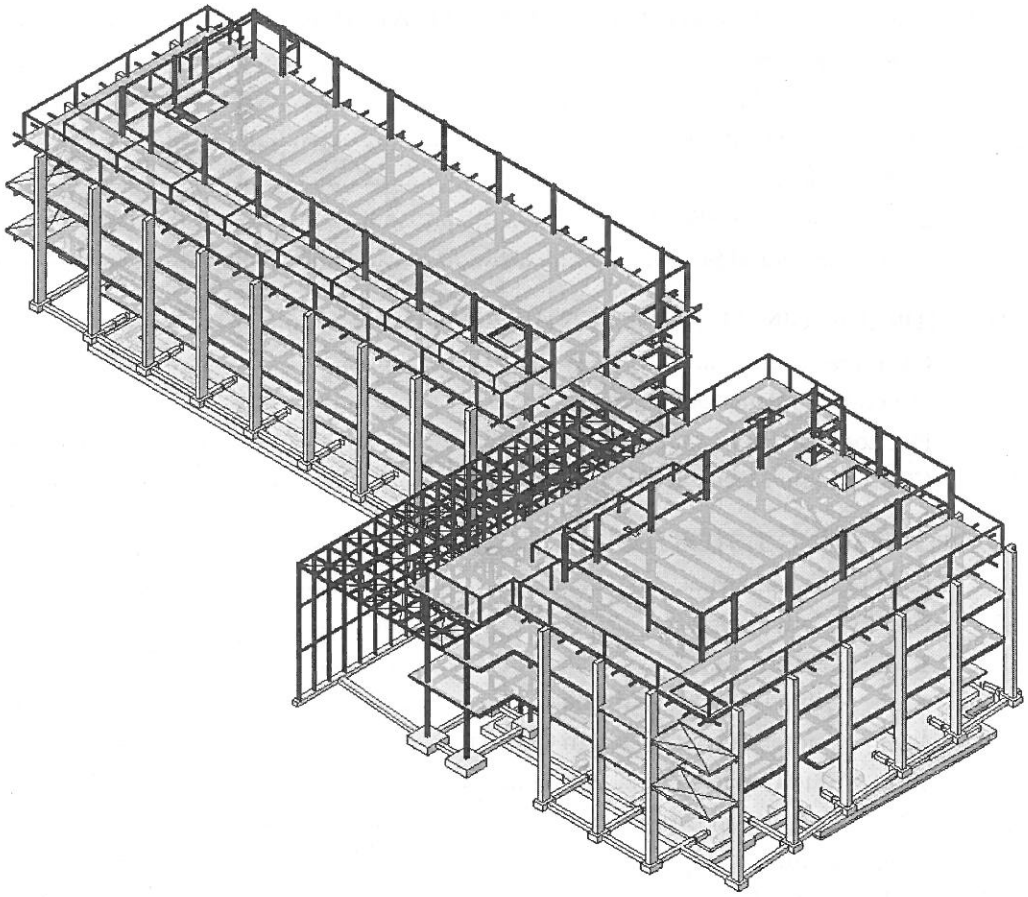
RUTHERFORD & CHEKENE

UC MERCED
SCIENCE AND ENGINEERING 2

STRUCTURAL DESIGN CRITERIA



R&C Job No. 2008092S

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1. INTRODUCTION

The construction project consists of two structures with a shared basement. The two structures make up the 3-story laboratory and office buildings, comprised of wet research laboratory space, robotic and analytical research laboratory space, research support space, and office administrative support space. The overall plan dimensions of the buildings are approximately 326' wide by 131' long for a total of about 100,000ft² of space. The story heights are approximately 18'-0" from Basement to Level L1 and 15'-" for each story above.

The approximate overall dimensions and the elevations of all the levels are provided in the table below:

Overall building dimensions, levels and elevations:

Level	Approx. Overall Dimensions	Overall Area	Elevation	Absolute Elevation
Roof (West)	200ft by 75ft	15,000 sq ft	45'-0"	300'-0"
Roof (East)	100ft by 100ft	10,000 sq ft	45'-0"	300'-0"
Level 3 (West)	200ft by 75ft	15,000 sq ft	30'-0"	285'-0"
Level 3 (East)	100ft by 100ft	10,000 sq ft	30'-0"	285'-0"
Level 2 (West)	200ft by 75ft	15,000 sq ft	15'-0"	270'-0"
Level 2 (East)	100ft by 100ft	10,000 sq ft	15'-0"	270'-0"
Level 1 (West)	200ft by 75ft	15,000 sq ft	0'-0"	255'-0"
Level 1 (East)	100ft by 100ft	10,000 sq ft	0'-0"	255'-0"
Basement (West)	250ft by 60ft	15,000 sq ft	-18'-0"	237'-0"
Basement (East)	100ft by 100ft	10,000 sq ft	-18'-0"	237'-0"

2. GOVERNING CODES, STANDARDS AND SPECIFICATIONS

2.1. *Governing Code*

California Building Code (CBC), 2007 edition, including California Amendments.

2.2. *Reference Standards*

American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI)
Minimum Design Loads for Buildings and Other Structures, 7-05

American Institute of Steel Construction (AISC)
Specification for Structural Steel Buildings, 360-05
Seismic Provisions for Structural Steel Buildings, 341-05

American Concrete Institute (ACI)
Building Code Requirements for Structural Concrete, 318-05

American Welding Society (AWS)
Structural Welding Code, D1.1-06

2.3. *Material Specifications*

2.3.1. Concrete

f'c = 4000 psi (Light Weight Concrete) fill over metal deck
f'c = 4000 psi (Normal Weight Concrete) fill over metal deck, grade beams, footings
f'c = 4000 psi (Normal Weight Concrete) shotcrete, cast-in-place walls
f'c = 4000 psi (Normal Weight Concrete) slabs on grade. columns, suspended slabs

2.3.2. Reinforcing Steel

ASTM A615, Grade 60, typical
ASTM A706, Grade 60 for all welded bars
ASTM A185 for welded wire fabric

2.3.3. Structural Steel

ASTM A992, Grade 50 for all wide flange shapes
ASTM A36 for all channels and angles
ASTM A572, Grade 50 or ASTM A36 for all plates, as noted
ASTM A500, Grade B for all square or rectangular tubes
ASTM A500, Grade C for all round tubes
ASTM A53, Grade B for all pipes
ASTM F1554, Grade 36, for gravity columns anchor bolts
ASTM F1554, Grade 105, for frame columns anchor bolts
ASTM A325 or A490 for high strength bolts, as noted.
E70XX for welding electrodes
ASTM A446 for metal deck
AISC Steel Tips Publication "Seismic Design of Buckling-Restrained Braced Frames" dated July 2004

3. STRUCTURAL ENGINEERING DESIGN APPROACH

3.1. *Overview*

The structural engineering analysis, design and documentation for the UC Merced Science and Engineering 2 is to be performed using a Building Information Modeling (BIM) central database for coordination of the design drawings and structural models. The building structural gravity and lateral analysis is performed using both RAM and ETABS analysis and design software packages, respectively. The foundation system consisting of spread footings and basement retaining walls is designed using MathCAD and Excel spreadsheets.

3.2. *Structural Systems Description*

The gravity system consists of concrete fill over metal deck supported by wide flange composite beams and columns from Level 1 to Roof.

The lateral system consists of Buckling Restrained Braced Frames (BRBF) with moment-resisting beam-column connections and Steel Special Moment Resisting Frames (SMRF). The lateral system in the basement area consists of special reinforced concrete shear walls (SRCSW).

The foundation system consists of isolated spread footings supporting both gravity system columns as well as lateral system columns and strip footings supporting bearing and retaining walls. Lateral system spread footings in net tension will have soil anchors to resist uplift.

NON-FRAME BEAMS	
– Required strength vs. design strength	RAM
– Deflection checks	RAM and by hand
– Vibration checks Laboratory Areas Office Areas	Excel Spreadsheet
NON-FRAME COLUMNS	
– Required strength vs. design strength	RAM
– Column Deformation Compatibility Checks	Excel Spreadsheet
– Base plate	RAM BASEPLATE/MathCAD
LATERAL FORCE RESISTING SYSTEM (LFRS)	
– Required strength vs. design strength at design base shear	RAM
– Required strength vs. design strength at amplified seismic load	RAM
– Irregularity checks	Excel spreadsheet
– Interstory drift ratio checks	RAM/Excel spreadsheet
– BRB size selection (based on lower bound yield strength)	RAM
– BRBF column and beam capacity design	Excel spreadsheet
– Unbalanced force check due to V-type and inverted V-type bracing	Excel spreadsheet
– Frame column base plates at amplified seismic loads	RAM BASEPLATE/MathCAD
– Frame column anchor rods and horizontal rebar at amplified seismic loads	By hand or Excel spreadsheet
FOUNDATION DESIGN	By hand or Excel spreadsheet
DIAPHRAGM DESIGN	
– Loading	By hand or MCAD
– Required strength	RAM
– Design strength	By hand or MCAD
STEEL COLLECTOR DESIGN	
– Loading	By hand or Excel spreadsheet
– Required strength	By hand or Excel spreadsheet
– Design strength	By hand or Excel spreadsheet

3.3. *Flat Load Tables*

The building flat load tables are summarized in the following tables.

1. LABORATORY SPACE		
ITEM	**DESCRIPTION**	**LOAD (PSF)**
DEAD LOAD:		
Concrete Fill (Wet Wt of conc @ 150pcf)	4.5" NWC	69
Steel Deck	18 ga W2	3
Allowance for Additional Fill	10% of Fill	7
Ceiling, Mech, Misc.	Includes Fireproofing	14
Partitions		10
Cabinetry and Lab Equipment		20
SUPERIMPOSED DEAD LOAD TOTAL		**51**
DEAD LOAD TOTAL (Applied to Analysis Models)		**123**
Framing Self-Weight	RAM Determines	0
Cabinetry and Lab Equipment	Reduced as not over entire area	-10
SEISMIC DEAD LOAD TOTAL (for Verification)		**113**
LIVE LOAD (Applied to Analysis Models):		
Construction Live Load	reducible	**20**
Typical Live Load	reducible	**100**

[a] Live load for areas are reducible in accordance with CBC.

2. NON-LABORATORY (OFFICE) SPACE		
ITEM	**DESCRIPTION**	**LOAD (PSF)**
DEAD LOAD:		
Concrete Fill (Wet Wt of conc @ 150pcf)	4.5" NWC	69
Steel Deck	18 ga W2	3
Allowance for Additional Fill	10% of Fill	7
Ceiling, Mech, Misc.	Includes Fireproofing	14
Partitions		20
SUPERIMPOSED DEAD LOAD TOTAL		**41**
DEAD LOAD TOTAL (Applied to Analysis Models)		**113**
Framing Self-Weight	Estimate	0
Partitions (Seismic)	(Negative to reduce from 20 psf)	-10
SEISMIC DEAD LOAD TOTAL (for Verification)		**103**
LIVE LOAD (Applied to Analysis Models):		
Construction Live Load	reducible	**20**
Typical Live Load	reducible	**100**
Corridor and Stairs Live Load	reducible	**100**

[a] Live load for areas are reducible in accordance with CBC.

3. EXTERIOR DECK OVER BASEMENT SPACE		
ITEM	**DESCRIPTION**	**LOAD (PSF)**
DEAD LOAD:		
Concrete Fill (Conc @ 150pcf)	9" NWC	133
Steel Deck	18 ga W2	3
Allowance for Additional Fill	10% of Fill	13
Ceiling, Mech, WP, Rigid Ins., Misc.	Includes Fireproofing	15
Partitions		0
6" Topping Slab		75
SUPERIMPOSED DEAD LOAD TOTAL		**103**
DEAD LOAD TOTAL (Applied to Analysis Models)		**239**
Framing Self-Weight	RAM Determines	0
SEISMIC DEAD LOAD TOTAL (at dynamic base)		**0**
LIVE LOAD (Applied to Analysis Models):		
Construction Live Load	reducible	**20**
Typical Live Load	unreducible	**150**

[a] Live load for areas are reducible in accordance with CBC.

4. ROOF (NON-MECHANICAL)		
ITEM	**DESCRIPTION**	**LOAD (PSF)**
DEAD LOAD:		
Concrete Fill (Wet Wt of conc @ 150pcf)	3.5" NWC	56
Steel Deck	18 ga W2	3
Allowance for Additional Fill	10% of Fill	6
Ceiling, Mech, Misc.	Includes Fireproofing	14
Partitions		0
Mech Equip (Misc)		20
SUPERIMPOSED DEAD LOAD TOTAL		**40**
DEAD LOAD TOTAL (Applied to Analysis Models)		**99**
Framing Self-Weight		0
Partitions		5
Mechanical	Negative as mech. Not over entire area	-10
SEISMIC DEAD LOAD TOTAL (for Verification)		**94**
LIVE LOAD (Applied to Analysis Models):		
Construction Live Load	reducible	**20**
Typical Live Load	reducible	**20**

[a] Live load for roof areas are reducible in accordance with CBC.

5. ROOF (UNDER MECHANICAL EQUIP) GRAVITY		
ITEM	**DESCRIPTION**	**LOAD (PSF)**
DEAD LOAD:		
Concrete Fill (Wet Wt of conc @ 150pcf)	3.5" NWC	56
Steel Deck	18 ga W2	3
Allowance for Additional Fill	10% of Fill	6
Ceiling, Mech, Misc.	Includes Fireproofing	14
Partitions		0
Mech Equip (See detailed calc)	includes concrete slab & curbs	175
SUPERIMPOSED DEAD LOAD TOTAL		**195**
DEAD LOAD TOTAL (Applied to Analysis Models)		**254**
Framing Self-Weight	RAM Determines	0
Partitions		5
Mechanical	Negative as Mech. Not over entire area	-110
SEISMIC DEAD LOAD TOTAL (SEE SEISMIC)		**149**
LIVE LOAD (Applied to Analysis Models):		
Construction Live Load	reducible	20
Typical Live Load	reducible	20

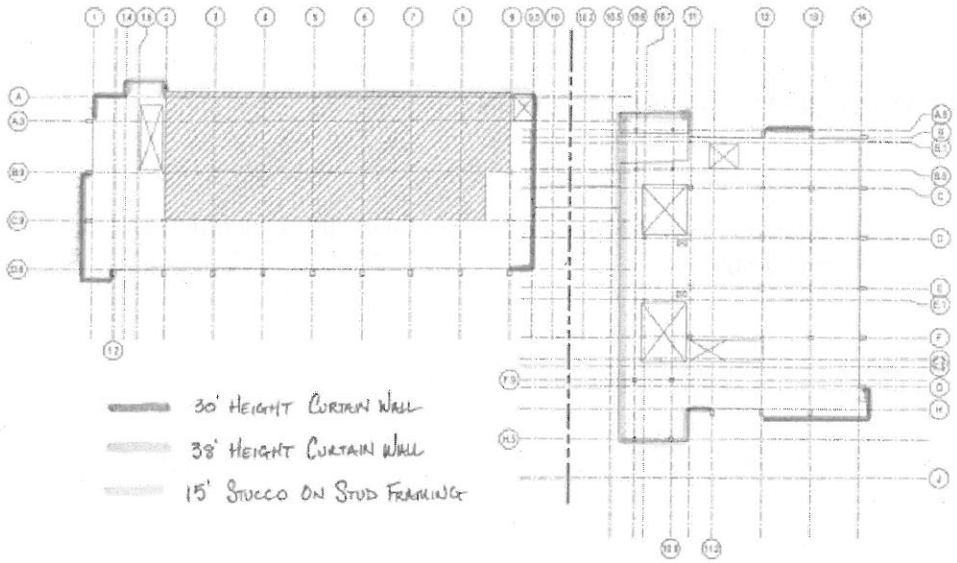
[a] Live load for roof areas are reducible in accordance with CBC.

6. BRIDGE (LEVELS 2 - 3)		
ITEM	**DESCRIPTION**	**LOAD (PSF)**
DEAD LOAD:		
Concrete Fill (Wet Wt of conc @ 150pcf)	4.5" NWC	69
Steel Deck	18 ga W2	3
Allowance for Additional Fill	10% of Fill	7
Ceiling, Mech, Misc.	Includes Fireproofing	14
Partitions		0
SUPERIMPOSED DEAD LOAD TOTAL		**21**
DEAD LOAD TOTAL (Applied to Analysis Models)		**93**
Framing Self-Weight	RAM Determines	0
Ceiling, Mech, Misc.	Negative as mech. Not over entire area	-4
SEISMIC DEAD LOAD TOTAL (for Verification)		**89**
LIVE LOAD (Applied to Analysis Models):		
Construction Live Load	reducible	20
Typical Live Load	reducible	100

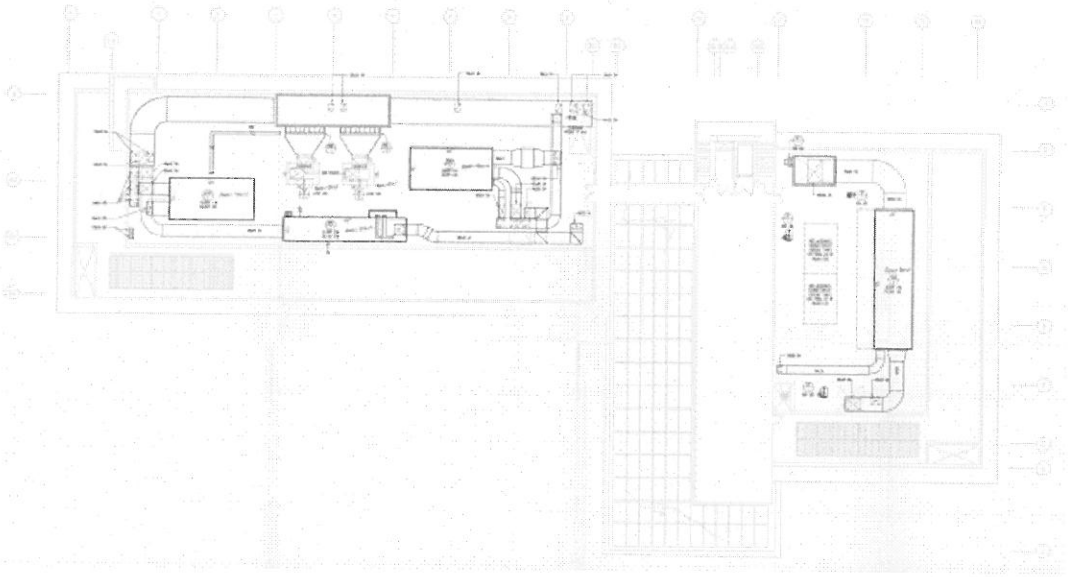
[a] Live load for roof areas are reducible in accordance with CBC.

3.4. *Cladding and Mechanical Loads*

The cladding of the building consists of stucco veneer, precast panels, and curtain walls. The cladding load is considered to be 15psf for stucco veneer, 15psf for precast panels, and 15psf for curtain walls. These loads are applied as line loads on the beams supporting the cladding. The perimeter cladding load due to the stucco veneer is present at all floor levels along Grid A of the west building. All of the curtain wall loads are supported at Level 2 and do not impart gravity loads at the levels above. The Roof Level has a perimeter "eyebrow" that has been considered 15psf. Below is a diagram for the perimeter cladding loads at Level 2.



The mechanical equipment is located at the roof and the weight of the mechanical equipment in the load tables includes the weight of the curbs and the slab. The equipment weights from the mechanical engineer are shown in the figure below and the detailed calc is also included.



MECHANICAL EQUIPMENT & CONCRETE PAD LOAD CALC

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Mech Unit	Location	Operating Wt (lbs)	Factor for Unknowns	Effective Wt (kips)	Length (ft)	Width (ft)	Area (sq ft)	Perimeter (ft)	Effective Equip Wt (psf)	Concrete Slab thickness (inch)	Perimeter Curb Width (inch)	Perimeter Curb Depth (inch)	Perimeter Curb Wt (kip)	Effective Area w/o perimeter curb (sq ft)	Concrete Slab Wt w/o perimeter curb (kip)	Total Slab Wt incl perimeter curb (psf)	Total Wt (psf)
AHU1		34000	1.15	39.10	30	15	450	90	86.9	12	12	18	20.3	364.0	54.6	166.3	253.2
AHU2		34000	1.15	39.10	30	16	480	92	81.5	12	12	18	20.7	392.0	58.8	165.6	247.1
AHU3		28100	1.15	32.32	44	8	352	104	91.8	12	12	18	23.4	252.0	37.8	173.9	265.7
AHU4		52500	1.15	60.38	50	14	700	128	86.3	12	12	18	28.8	576.0	86.4	164.6	250.8
EF1		2500	1.15	2.88	11	8	88	38	32.7	12	12	18	8.6	54.0	8.1	189.2	221.9
EF2		2500	1.15	2.88	11	8	88	38	32.7	12	12	18	8.6	54.0	8.1	189.2	221.9
EF3		500	1.15	0.58	3	3	9	12	63.9	12	12	18	2.7	1.0	0.2	316.7	380.6
EF4		300	1.15	0.35	3	3	9	12	38.3	12	12	18	2.7	1.0	0.2	316.7	355.0
EF5		300	1.15	0.35	3	3	9	12	38.3	12	12	18	2.7	1.0	0.2	316.7	355.0
EF6		500	1.15	0.58	3	3	9	12	63.9	12	12	18	2.7	1.0	0.2	316.7	380.6
CT1		29000	1.15	33.35	18	12	216	60	154.4	12	12	18	13.5	160.0	24.0	173.6	328.0
CT2		29000	1.15	33.35	18	12	216	60	154.4	12	12	18	13.5	160.0	24.0	173.6	328.0

4. GRAVITY FRAMING SYSTEM DESIGN

4.1. *Load Combinations*

The following load combinations are per 2007 CBC Section 1605 are used for the gravity framing design.

- 1.4DL
- 1.2DL+1.6LL

4.2. *Gravity Beam Design*

4.2.1. General

Gravity beams will be designed using RAM software, v14.03.

5. LATERAL FORCE RESISTING SYSTEM DESIGN & ANALYSIS

5.1. *Seismic Design Parameters*

5.1.1. Mapped Site Parameters

The seismic parameters for the site based on the code seismic parameters for equivalent static analysis are listed in the following table.

Global Building Seismic Design Parameter per ASCE7-05	Value
Seismic Occupancy Category (All buildings)	III
Short Period MCE at 0.2s, S_S	0.508g
1.0s Period MCE, S_1	0.223g
Soil Profile Type, Site Class	D
Short Period Site Coefficient at 0.2s, F_a	1.394
Long Period Site Coefficient at 1.0s, F_v	1.955
Adjusted Short Period MCE, S_{MS}	0.708g
Adjusted 1.0s Period MCE, S_{M1}	0.436g
Design Spectral Response Acceleration Parameter at Short Period, S_{DS}	0.472g
Design Spectral Response Acceleration Parameter at 1.0s Period, S_{D1}	0.290g
Seismic Design Category	D
Importance Factor	1.25
Vertical Seismic Load Component $E_v = 0.2S_{DS}D$	0.266D
C_S (BRBF & SMRF)	0.074g

5.1.2. Design Response Spectrum

The period and acceleration of the Design Spectral Response Curve is tabulated below. per ASCE 7 Section 11.4.5.

Period (seconds)	Spectral Response Acceleration (g)
0.000	0.189
0.010	0.212
0.030	0.258
0.050	0.304
0.070	0.350
0.090	0.396
0.110	0.442
0.123	0.472
0.300	0.472
0.616	0.472
0.700	0.415
0.800	0.363
0.900	0.323
1.000	0.291
1.500	0.194
2.000	0.145