MULHERN+KULP
RESIDENTIAL STRUCTURAL ENGINEERING

7220 Trade Street, Suite 295, San Diego, CA 92121 ▸ p 619-650-0010 ▸ *mulhernkulp.com*

CALCULATION PACKAGE

April 20, 2023

Lochwood Lozier

Lightstone Addition
5910 E. Mercer Way

Mercer Island, Washington

MULHERN & KULP STRUCTURAL ENGINEERING, INC.

Prepared By:

Riley J. Denis, E.I.T. *Staff Engineer*

Richard J. Zabel, P.E. *Project Manager + Director of Engineering*

Signature, Seal & Date

Lochwood Lozier

Lightstone

Mercer Island, WA

Shear Wall Calculations

Reviewed By: RJZ

April 13, 2023

Parameters:

Single Family Home

Design Wind Speed: 100 MPH

wind Exposure Category: C

Seismic Design Category: D

Code & Design Standard: 2018 IBC Ch. 1609, ASCE 7-16 Ch. 26-30

MULHERN+KULP
RESIDENTIAL STRUCTURAL ENGINEERING

MULHERN+KULP
RESIDENTIAL STRUCTURAL ENGINEERING

PROJECT NAME: LIGHTSTONE
M&K PROJECT #: 268-23003
ENGINEER: RJD
DATE: 13-APR-23

WIND DESIGN SUMMARY PER ASCE 7-16

PARAMETERS:

WIND SPEED	100
EXPOSURE CATEGORY	C
RISK CATEGORY	II
WIND DIRECTIONALITY FACTOR, K_D	0.85
TOPOGRAPHIC FACTOR, K_{ZT}	1.00
GUST FACTOR, G	0.85
GROUND ELEV. ABOVE SEA LEVEL [FT]	0
DESIGN TYPE	ASD

0.60

ROOF GEOMETRY:

TRANS. ROOF PITCH	0.0	:12
LONG. ROOF PITCH	0.0	:12
MEAN ROOF HEIGHT, H	8.00	FT

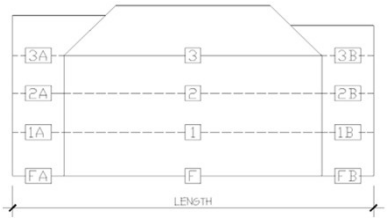
BUILDING GEOMETRY:

LENGTH	30	FT
WIDTH	20	FT
NUMBER OF STORIES	1	

TRANSVERSE DIRECTION (PERPENDICULAR TO MAIN RIDGE LINE)

TRIBUTARY DESIGN AREAS:

DIAPHRAGM LEVEL	FLOOR-TO-FLOOR HEIGHT		SECTION A	SECTION O	SECTION B	
1	8 FT	Roof Surface	0	0	0	sq ft
		Wall surface	0	145	0	sq ft
FND		Roof Surface	0	0	0	sq ft
		Wall surface	0	0	0	sq ft



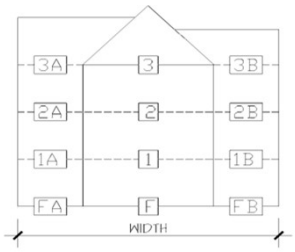
TRIBUTARY DESIGN LOADS: (0.6W)

	SECTION A	SECTION O	SECTION B	
Story Shear	0.00	1.78	0.00	kips
Total Shear	0.00	1.78	0.00	kips
		1.78		kips
Story Shear	0.00	0.00	0.00	kips
Total Shear	0.00	1.78	0.00	kips
		1.78		kips

LONGITUDINAL DIRECTION (PARALLEL TO MAIN RIDGE LINE)

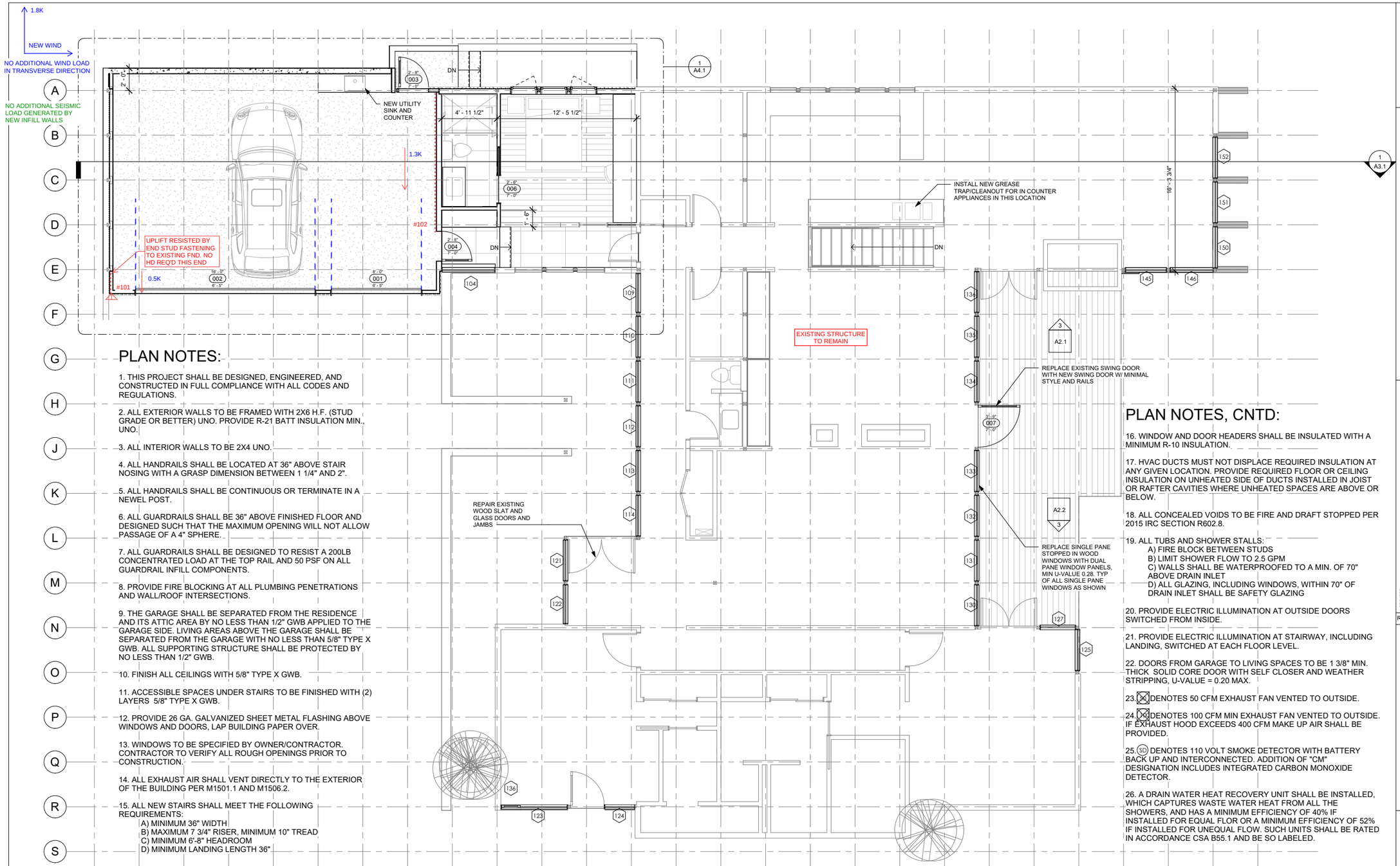
TRIBUTARY DESIGN AREAS:

DIAPHRAGM LEVEL	FLOOR-TO-FLOOR HEIGHT		SECTION A	SECTION O	SECTION B	
1	8 FT	Roof Surface	0	0	0	sq ft
		Wall surface	0	0	0	sq ft
FND		Roof Surface	0	0	0	sq ft
		Wall surface	0	0	0	sq ft



TRIBUTARY DESIGN LOADS: (0.6W)

	SECTION A	SECTION O	SECTION B	
Story Shear	0.00	0.00	0.00	kips
Total Shear	0.00	0.00	0.00	kips
		0.00		kips
Story Shear	0.00	0.00	0.00	kips
Total Shear	0.00	0.00	0.00	kips
		0.00		kips



PLAN NOTES:

1. THIS PROJECT SHALL BE DESIGNED, ENGINEERED, AND CONSTRUCTED IN FULL COMPLIANCE WITH ALL CODES AND REGULATIONS.

2. ALL EXTERIOR WALLS TO BE FRAMED WITH 2X6 H.F. (STUD GRADE OR BETTER) UNO. PROVIDE R-21 BATT INSULATION MIN., UNO.

3. ALL INTERIOR WALLS TO BE 2X4 UNO.

4. ALL HANDRAILS SHALL BE LOCATED AT 36" ABOVE STAIR NOSING WITH A GRASP DIMENSION BETWEEN 1 1/4" AND 2".

5. ALL HANDRAILS SHALL BE CONTINUOUS OR TERMINATE IN A NEWEL POST.

6. ALL GUARDRAILS SHALL BE 36" ABOVE FINISHED FLOOR AND DESIGNED SUCH THAT THE MAXIMUM OPENING WILL NOT ALLOW PASSAGE OF A 4" SPHERE.

7. ALL GUARDRAILS SHALL BE DESIGNED TO RESIST A 200LB CONCENTRATED LOAD AT THE TOP RAIL AND 50 PSF ON ALL GUARDRAIL INFILL COMPONENTS.

8. PROVIDE FIRE BLOCKING AT ALL PLUMBING PENETRATIONS AND WALL/ROOF INTERSECTIONS.

9. THE GARAGE SHALL BE SEPARATED FROM THE RESIDENCE AND ITS ATTIC AREA BY NO LESS THAN 1/2" GWB APPLIED TO THE GARAGE SIDE. LIVING AREAS ABOVE THE GARAGE SHALL BE SEPARATED FROM THE GARAGE WITH NO LESS THAN 5/8" TYPE X GWB. ALL SUPPORTING STRUCTURE SHALL BE PROTECTED BY NO LESS THAN 1/2" GWB.

10. FINISH ALL CEILINGS WITH 5/8" TYPE X GWB.

11. ACCESSIBLE SPACES UNDER STAIRS TO BE FINISHED WITH (2) LAYERS 5/8" TYPE X GWB.

12. PROVIDE 26 GA. GALVANIZED SHEET METAL FLASHING ABOVE WINDOWS AND DOORS, LAP BUILDING PAPER OVER.

13. WINDOWS TO BE SPECIFIED BY OWNER/CONTRACTOR. CONTRACTOR TO VERIFY ALL ROUGH OPENINGS PRIOR TO CONSTRUCTION.

14. ALL EXHAUST AIR SHALL VENT DIRECTLY TO THE EXTERIOR OF THE BUILDING PER M1501.1 AND M1506.2.

15. ALL NEW STAIRS SHALL MEET THE FOLLOWING REQUIREMENTS:
- A) MINIMUM 36" WIDTH
- B) MAXIMUM 7 3/4" RISER, MINIMUM 10" TREAD
- C) MINIMUM 6'-8" HEADROOM
- D) MINIMUM LANDING LENGTH 36"

PLAN NOTES, CNTD:

16. WINDOW AND DOOR HEADERS SHALL BE INSULATED WITH A MINIMUM R-10 INSULATION.

17. HVAC DUCTS MUST NOT DISPLACE REQUIRED INSULATION AT ANY GIVEN LOCATION. PROVIDE REQUIRED FLOOR OR CEILING INSULATION ON UNHEATED SIDE OF DUCTS INSTALLED IN JOIST OR RAFTER CAVITIES WHERE UNHEATED SPACES ARE ABOVE OR BELOW.

18. ALL CONCEALED VOIDS TO BE FIRE AND DRAFT STOPPED PER 2015 IRC SECTION R602.8.

19. ALL TUBS AND SHOWER STALLS:
- A) FIRE BLOCK BETWEEN STUDS
- B) LIMIT SHOWER FLOW TO 2.5 GPM
- C) WALLS SHALL BE WATERPROOFED TO A MIN. OF 70" ABOVE DRAIN INLET
- D) ALL GLAZING, INCLUDING WINDOWS, WITHIN 70" OF DRAIN INLET SHALL BE SAFETY GLAZING

20. PROVIDE ELECTRIC ILLUMINATION AT OUTSIDE DOORS SWITCHED FROM INSIDE.

21. PROVIDE ELECTRIC ILLUMINATION AT STAIRWAY, INCLUDING LANDING, SWITCHED AT EACH FLOOR LEVEL.

22. DOORS FROM GARAGE TO LIVING SPACES TO BE 1 3/8" MIN. THICK SOLID CORE DOOR WITH SELF CLOSER AND WEATHER STRIPPING, U-VALUE = 0.20 MAX.

23. (X) DENOTES 50 CFM EXHAUST FAN VENTED TO OUTSIDE.

24. (X) DENOTES 100 CFM MIN EXHAUST FAN VENTED TO OUTSIDE. IF EXHAUST HOOD EXCEEDS 400 CFM MAKE UP AIR SHALL BE PROVIDED.

25. (SD) DENOTES 110 VOLT SMOKE DETECTOR WITH BATTERY BACK UP AND INTERCONNECTED. ADDITION OF "CM" DESIGNATION INCLUDES INTEGRATED CARBON MONOXIDE DETECTOR.

26. A DRAIN WATER HEAT RECOVERY UNIT SHALL BE INSTALLED, WHICH CAPTURES WASTE WATER HEAT FROM ALL THE SHOWERS, AND HAS A MINIMUM EFFICIENCY OF 40% IF INSTALLED FOR EQUAL FLOR OR A MINIMUM EFFICIENCY OF 52% IF INSTALLED FOR UNEQUAL FLOW. SUCH UNITS SHALL BE RATED IN ACCORDANCE CSA B55.1 AND BE SO LABELED.

1 FLOOR PLAN - MAIN LEVEL
1/4" = 1'-0"

LOCHWOOD | LOZIER
ARCHITECTURAL DESIGNS
8708 152ND AVE NE | REDMOND, WA 98052
(425) 576-9200 | www.lochwoodlozier.com

DRAWN BY: MM
CHECKED BY: TL
DATE: 12/04/18
SCALE: 1/4" = 1'-0"

PROJECT
LIGHTSTONE
5910 E MERCER WAY
MERCER ISLAND, WA 98040
22079LIG

REV	DATE	ISSUE/REVISION
	03/17/23	SCHEMATIC DESIGN

NOT FOR CONSTRUCTION

SHEET TITLE
FLOOR PLAN - MAIN LEVEL

REVISION NO.
SUPERSEDES ALL PREVIOUS REVISIONS

SHEET NO.
A1.2

3/17/2023 10:54:42 AM

MULHERN+KULP
RESIDENTIAL STRUCTURAL ENGINEERING

PROJECT NAME: LOCHWOOD LOZIER
LIGHTSTONE
M&K PROJECT #: 268-23003
ENGINEER: RJD
DATE: 13-APR-23

SHEARWALL DESIGN SUMMARY

SHEARWALL 101: 1ST - SIDE INTERIOR GARAGE @ EXTERIOR

SHEARWALL PROPERTIES:

WALL HEIGHT, H	7.0	FT.	MAX WALL OPENING HT, H_c	0.0	FT.		
WALL LENGTH, L	2.0	FT.	QUALIFYING WALL LENGTH, L	2.0	FT.	SHEARWALL ASSEMBLY	P1

CAPACITY EVALUATION:

TOTAL SHEAR LOAD ON WALL		ALLOWABLE SHEARWALL CAPACITY
500 LBS	<	546 LBS

SHEARWALL ASSEMBLY SPECIFICATION

P1 - 1-SIDE 7/16" OSB
FASTENED W/ 8D NAILS AT 6"O.C. PANEL EDGES & 12"O.C. PANEL FIELD - EDGES BLOCKED
ADEQUATE

OVERTURNING EVALUATION:

RESISTIVE DL	100	PLF	OVERTURNING MOMENT	3.5	K-FT	HOLD DOWN DESIGN LOAD	1300	LBS
DL AT ENDS OF WALL	400	LBS	RESISTIVE MOMENT	0.9	K-FT	HOLDOWN CAPACITY	4935	LBS

HOLD-DOWN SPECIFICATION

SIMPSON STHD14RJ HOLDOWN

SHEARWALL 102: 1ST - SIDE INTERIOR GARGE

SHEARWALL PROPERTIES:

WALL HEIGHT, H	8.5	FT.	MAX WALL OPENING HT, Hc	0.0	FT.		
WALL LENGTH, L	12.3	FT.	QUALIFYING WALL LENGTH, L	12.3	FT.	SHEARWALL ASSEMBLY	P1

CAPACITY EVALUATION:

TOTAL SHEAR LOAD ON WALL		ALLOWABLE SHEARWALL CAPACITY
1300 LBS	<	4143 LBS

SHEARWALL ASSEMBLY SPECIFICATION

P1 - 1-SIDE 7/16" OSB
FASTENED W/ 8D NAILS AT 6"O.C. PANEL EDGES & 12"O.C. PANEL FIELD - EDGES BLOCKED
ADEQUATE

OVERTURNING EVALUATION:

RESISTIVE DL	100	PLF	OVERTURNING MOMENT	11.1	K-FT	HOLD DOWN DESIGN LOAD	0	LBS
DL AT ENDS OF WALL	400	LBS	RESISTIVE MOMENT	11.3	K-FT	HOLDOWN CAPACITY	0	LBS

HOLD-DOWN SPECIFICATION

NO HOLDOWN REQUIRED

Lightstone Addition
Lochwood Lozier
RJD
268-23003
04-18-23

Cantilevered Retaining Wall

Project File: FND.ec6

DESCRIPTION: Garage Retaining Wall

Code Reference

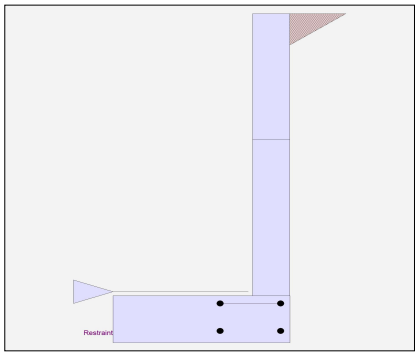
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	250.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0 psf
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Uniform		
Multiplier Used	=	7.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	49.000
Total Seismic Force	=	343.000

Lightstone Addition
Lochwood Lozier
RJD
268-23003
04-18-23

Cantilevered Retaining Wall

Project File: FND.ec6

DESCRIPTION: Garage Retaining Wall

Design Summary

F.O.S. OF 1.1 ADEQUATE w/ SEISMIC APPLIED

Wall Stability Ratios

Overturning	=	1.29	Ratio < 1.5!
Slab Resists All Sliding !			
Global Stability	=	1.21	
Total Bearing Load	=	1,456 lbs	
...resultant ecc.	=	9.90 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	945 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,323 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	9.3 psi	OK
Footing Shear @ Heel	=	5.3 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,097.6 lbs

Vertical component of active lateral soil pressure IS considered in the calculation of soil bearing pressures.

Load Factors

Building Code	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

		2nd	Bottom		
		Stem OK	Stem OK		
Design Height Above Ftg	ft =	3.33	0.00		
Wall Material Above "Ht"	=	Concrete	Concrete		
Design Method	=	SD	SD	SD	SD
Thickness	=	8.00	8.00		
Rebar Size	=	# 5	# 5		
Rebar Spacing	=	16.00	16.00		
Rebar Placed at	=	Edge	Edge		
Design Data					
fb/FB + fa/Fa	=	**0.056**	**0.468**		
Total Force @ Section					
Service Level	lbs =				
Strength Level	lbs =	330.4	1,302.0		
Moment....Actual					
Service Level	ft-# =				
Strength Level	ft-# =	352.3	2,898.0		
Moment.....Allowable	ft-# =	6,186.6	6,186.6		
Shear.....Actual					
Service Level	psi =				
Strength Level	psi =	4.5	17.5		
Shear.....Allowable	psi =	75.0	75.0		
Anet (Masonry)	in2 =				
Wall Weight	psf =	100.0	100.0		
Rebar Depth 'd'	in =	6.19	6.19		

Masonry Data

f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	
Masonry Design Method	=	ASD

Concrete Data

f'c	psi =	2,500.0	2,500.0
Fy	psi =	60,000.0	60,000.0

Lightstone Addition
Lochwood Lozier
RJD
268-23003
04-18-23

Cantilevered Retaining Wall

Project File: FND.ec6

DESCRIPTION: Garage Retaining Wall

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0133 in2/ft		
(4/3) * As :	0.0178 in2/ft	Min Stem T&S Reinf Area 0.513 in2	
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2325 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1097 in2/ft		
(4/3) * As :	0.1463 in2/ft	Min Stem T&S Reinf Area 0.639 in2	
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.2325 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	2.50 ft
Heel Width	=	0.67
Total Footing Width	=	3.17
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe		Heel	
Factored Pressure	=	1,323		0	psf
Mu' : Upward	=	2,625		0	ft-#
Mu' : Downward	=	563		2	ft-#
Mu: Design	=	2,062	OK	2	ft-# OK
phiMn	=	2,500		OK - Flush	
Actual 1-Way Shear	=	9.31		5.34	psi
Allow 1-Way Shear	=	40.00		75.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = Flush heel condition. No reinforcing required.
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = ph*5*lambda*sqrt(fc)*Sm

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area 0.82 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Lightstone Addition
Lochwood Lozier
RJD
268-23003
04-18-23

Cantilevered Retaining Wall

Project File: FND.ec6

DESCRIPTION: Garage Retaining Wall

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		857.5	2.33	2,000.8	Soil Over HL (ab. water tbl)	2.2	3.17	7.0
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		3.17	7.0
Hydrostatic Force					Water Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=		
Seismic Earth Load	=	240.1	3.50	840.4	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	600.0	2.83	1,700.0
					Earth @ Stem Transitions	=			
Total	=	1,097.6	**O.T.M.** =	2,841.2	Footing Weight	=	475.5	1.59	753.7
					Key Weight	=			
					Vert. Component	=	378.5	3.17	1,199.9
					Total =		1,456.2 lbs	**R.M.=**	3,660.5

Resisting/Overturning Ratio = **1.29**
Vertical Loads used for Soil Pressure = 1,456.2 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.050	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.