Shear Wall Design

Introduction

The existing lateral system used in UFC's Academic Villages is composed entirely of interior and exterior masonry shear walls. The shear walls are present on every level and resist lateral forces due to wind in both N/S and E/W directions. In the existing structure, the designer found the most critical shear case in the entire structure, (wall 1 on the second floor in this case, please refer back to the shear diagram on page 7 for location of the existing shear walls) and designed all the walls for that one particular case. As a result, each wall was an 8" masonry unit with #5 @ 24" reinforcement. Please refer to Table 10 below for shear wall values at every level.

Lateral Forces (kips)						
	Wall 1		Wall 4		Wall 7	
	Shear Force	Total	Shear Force	Total	Shear Force	Total
4th Floor	7.21	7.21	1.07	1.07	5.18	5.18
3rd Floor	13.52	20.73	1.97	3.04	9.7	14.88
2nd Floor	13.48	34.21	1.98	5.02	9.67	24.55
	Wall 2		Wall 5		Wall 8	
	Shear Force	Total	Shear Force	Total	Shear Force	Total
4th Floor	6.01	6.01	2.1	2.1	1.07	1.07
3rd Floor	11.27	17.28	3.94	6.04	1.97	3.04
2nd Floor	11.23	28.51	3.93	9.97	1.98	5.02
	Wall 3		Wall 6			
	Shear Force	Total	Shear Force	Total		
4th Floor	2.56	2.56	6.04	6.04		
3rd Floor	4.79	7.35	11.32	17.36		
2nd Floor	4.77	12.12	11.28	28.64		

Table 10: Shear Forces

Since the bearing wall that is bearing removed in each unit was not included in the lateral analysis, the lateral forces on each wall due to wind will remain the same for the new design. However, since the clear span is being increased from 12 feet to 24 feet between each wall, each of the shear/bearing walls is taking nearly twice the gravitational loads in the proposed system than in the existing system.

Design Criteria

The following criteria which must be considered for the design of a lateral shear wall system:

1. *The proposed lateral system must meet the current code.* The codes governing the design the shear walls will be the MSJC Code and IBC 2003.
2. *Will the proposed slab system bring up other additional issues that need to be addressed?* Since no changes are being made to actual structure of the building except for additional weight to the bearing/shear walls, there shouldn't be any additional problems.

If the first criterion is not met, the proposed lateral system cannot even be considered and the post-tensioned system will not be a reasonable solution. The existing system will then be accepted as the best solution for the project. The remaining criterion will only be effective once the first criterion is met.

Design Analysis

Since the locations of the shear walls are already known from the existing structure and the height of each wall was also known is also known, the thickness of each wall could be estimated using the a slenderness ration of h/30, where h = the height in inches. Each walls stiffness was then determined from the known properties.

Wall	Direction	L (ft)	W (ft)	H (ft)	A (ft^2)	I (in^4)	k (k/in)
Wall 1	N/S	96	0.833	44.5	79.968	1157811	1107
Wall 2	N/S	78	0.833	44.5	64.974	1157811	1098
Wall 3	N/S	52	0.833	44.5	43.316	1157811	1056
Wall 4	N/S	24	1	44.5	24	1389929	985
Wall 5	E/W	52	0.833	44.5	43.316	1157811	1056
Wall 6	E/W	78	0.833	44.5	64.974	1157811	1098
Wall 7	E/W	96	0.833	44.5	79.968	1157811	1107
Wall 8	E/W	24	1	44.5	24	1389929	985

Table 11: Shear Wall Properties

Once the stiffness in each wall was known, a stiffness analysis was performed to find the building's center of rigidity. Due to symmetry, the center of rigidity was very close to the center of gravity which greatly limits torsional effects

on the building due to uneven wind loading. See Appendix 3 for the complete spreadsheet calculated with excel.

Drift Analysis

Due to the fact that the proposed lateral system uses larger blocks than the existing system and also that the lateral forces on each shear wall is the same for both systems, the drift analysis can be omitted since the existing system satisfied drift requirements.

Conclusion

The shear walls were strengthened to carry the additional loads provided by the proposed one way slab system according to the code. The final design can be found in Table 12 below.

	Direction	# of walls	Thickness (in)	Reinforcement
Shear 1	N/S	1	10	5 @ 24"
Shear 2	N/S	1	10	5 @ 24"
Shear 3	N/S	1	10	5 @ 24"
Shear 4	N/S	6	12	5 @ 24"
Shear 5	E/W	1	10	5 @ 24"
Shear 6	E/W	1	10	5 @ 24"
Shear 7	E/W	1	10	5 @ 24"
Shear 8	E/W	6	12	5 @ 24"

Table 12: Shear Wall Results