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The Village at Waugh Chapel –
Senior Living Facility III
2614 Chapel Lake Drive
Gambrills, MD 21054

Pro-Con Structural Study of Alternate Floor Systems

Executive Summary

Included in this report is an analysis of the lateral load resisting system for The Village at Waugh Chapel – Senior Living Facility III. As part of the report, the layout of the current shear wall locations was shown within the floor plan of the building and calculations done to determine the adequacy of each member. The layout of the floor plan is the same for each floor so the shear walls fall directly on top of each other providing the equivalent of a wall the full height of the structure. This provides a great deal of added rigidity for the building. Also, the floor trusses span across the shear walls which puts extra load across the wall and helps combat the overturning moment about the wall. The shear wall placement is also of great advantage because they are located at the party walls which separate the apartments from each other. These walls are actually the thickness of two walls placed side by side which increases rigidity and allows each wall to take more load and eliminate the need for intermediate shear walls in the floor plan which cuts down a great deal on construction costs and time. Because of the layout of the floor plan and the material being used in the construction of the building, this method of lateral system is the obvious choice. Each apartment is approximately the same dimensions which spaces the shear walls at equal intervals and prevents building torsion from becoming a problem because the lateral loads are distributed evenly to each wall in each direction. Another advantage that the building layout gives to the construction is the overall architecture of the building has been repeated many times and the way the building will respond to the lateral loads can be anticipated. This gives the engineer a great deal of confidence that the design of the lateral system will work and no additional time will need to be taken to try to predict reactions that have not yet been analyzed.

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Introduction

The Village at Waugh Chapel – Senior Living Facility III is a five story apartment complex in Gambrills, Maryland. It is approximately 105,000 square feet with four residential stories above grade and one garage deck below grade. The basic layout of the building is a rectangle with APA rated gypsum sheathed shear walls supporting the building's lateral loads in both directions. There are a total of 9 shear walls in the left-right direction and 12 shear walls in the front-back direction.

BUILDING STRUCTURAL COMPONENTS

Foundation System

The foundation for Waugh Chapel's Senior Living Facility III is composed of spread footings placed at an approximate 20' x 22' grid. The footings range in size from 4'-0" x 4'-0" to 12'-0" x 12'-0" depending on its location in the building. There are also 2'-0" and 3'-0" continuous footings around the perimeter of the building.

Below Grade Level Systems

In the below grade level, the walls are made from 1'-0" thick poured concrete with some additional walls made from 8" and 12" CMU block. The floor is composed of a 5" thick reinforced concrete slab on grade on an 8 mil vapor retarder on 4" crushed stone on compacted fill. Erected on top of the foundation's footings are concrete columns ranging from 12"x12" to 20" x 24" around the building's perimeter and W10x45 to W10x60 steel columns in the building's interior.

First Floor Framing System

The first floor framing consists of a steel beam and girder system resting on the concrete and steel columns below. The floor is made up of a 4½"

thick reinforced concrete slab on 2", 22 gage, galvanized composite metal deck. The total slab thickness is 4½". The deck is supported by steel beams running side-to-side which rest on girders running front-to-back which transfer the load into the steel and concrete columns and into the footings. Exterior walls for the first floor shall consist of Spruce-Pine-Fir Grade No. 2 studs.

Remaining Floors System

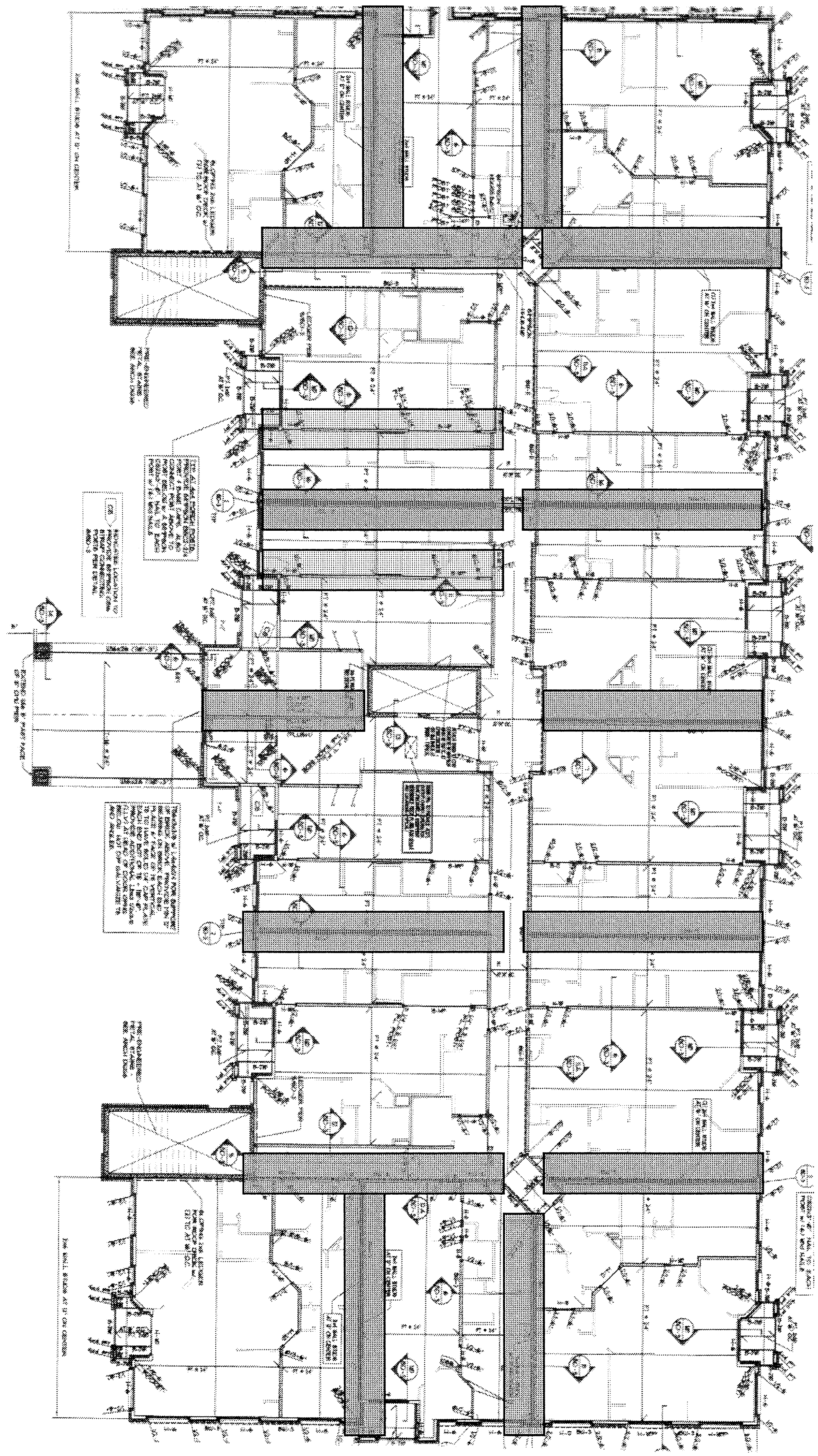
From the second floor to the fourth floor, the floor system is composed of 18" deep, pre-engineered floor trusses sheathed with ¾" APA rated tongue and groove floor deck sheathing attached with 10d nails at 6" o.c. at the sheet edges and 12" o.c. in the field. All load bearing interior stud walls will be made up of 2x4 or 2x6 studs spaced at 16" o.c. (typ.) made from Spruce-Pine-Fir stud grade material. Also, the elevator core and stairwells will be framed by 8" CMU block reinforced with #5 vertical bars in grouted cells. At all locations where posts are required, blocking of the same size and quantity shall be placed in the floor under each post to match the size of the post above.

Roof Framing System

Pre-engineered wood roof trusses spaced at 24" o.c. make up the roof system for Waugh Chapel's Senior Living Facility III. The majority of the trusses span front-to-back over the building with some trusses framing side-to-side over areas such as the stairwells and front entrance. Girder trusses are placed where required along with the valley set roof truss overframing @ 24" o.c. and 2x6 @ 24" o.c. overframing. The trusses will be covered with ½" APA rated sheathing attached with 8d nails at 6" o.c. at sheet edges and 12" o.c. in the field.

Shear Wall Layout

As can be seen in the diagram below, the overall building shape is close to being a rectangle except where the outer wings of the building extend outward at the ends. The shear walls are primarily created by the party walls which are the double stud walls that separate the apartment units from each other. The walls line up with each other to help transfer the loads in a uniform manner. In the diagram below, the dark green boxes denote the party wall shear walls and the light green boxes denote regular shear walls.



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Calculations

Provided below are calculations for a shear wall in the front-back direction and for the left-right direction.

FRONT-BACK

4th floor	h=9.08 ft	h tot=41.03 ft	P*h=2200*41.03=90266 ft #
3rd floor	h=10.65 ft	h tot=31.95 ft	P*h=2600*31.95=83070 ft #
2nd floor	h=10.65 ft	h tot=21.30 ft	P*h=2500*21.30=53250 ft #
1st floor	h= 10.65 ft	h tot=10.65 ft	P*h=2500*10.65=26625 ft #

Length of wall = 40.5 ft

P total = 2200+2600+2500+2500 = 9800 #
M total = 90266+83070+53250+26625 = 253,211 ft #

P/h = 9800/41.5 = 236.1 plf < 239.2

Use 7/16" thick APA rated sheathing with 8d nails at 6" o.c. around the edges and 12" o.c. in the field.

LEFT-RIGHT

4th floor	h=9.08 ft	h tot=41.03 ft	P*h=16000*41.03=656480 ft #
3rd floor	h=10.65 ft	h tot=31.95 ft	P*h=25000*31.95=798750 ft #
2nd floor	h=10.65 ft	h tot=21.30 ft	P*h=17000*21.30=362100 ft #
1st floor	h= 10.65 ft	h tot=10.65 ft	P*h=8000*10.65=85200 ft #

Length of wall = 17.5+32.5+34+20.5+87.5 = 192 ft

P total = 16000+25000+17000+8000 = 66000 #
M total = 656480+798750+362100+85200 = 1902530 ft #

P/h = 66000/192 = 343.75 plf < 349.6

Use 7/16" thick APA rated sheathing with 8d nails at 4" o.c. around the edges and 12" o.c. in the field.

Complete results for calculations performed for the shear walls are listed below. All walls are sheathed with 7/16" APA rated sheathing.

Wall	Nailing	Anchors
SW-1	8d nails @ 6" o.c.	No
SW-2	8d nails @ 6" o.c.	No
SW-3	8d nails @ 6" o.c.	Yes
SW-4	8d nails @ 6" o.c.	No
SW-5	8d nails @ 6" o.c.	No
SW-6	8d nails @ 6" o.c.	Yes
SW-7	8d nails @ 4" o.c.	Yes
SW-8	8d nails @ 6" o.c.	No
SW-9	8d nails @ 6" o.c.	Yes
SW-10	8d nails @ 4" o.c.	Yes
SW-11	8d nails @ 3" o.c.	Yes
SW-12	8d nails @ 3" o.c.	Yes
SW-13	8d nails @ 4" o.c.	Yes

Foundation anchors are to be HILITI pins placed at 4" o.c. for all necessary shear walls, except for SW-13 which only requires pins at 8" o.c.

Below are some diagrams of the typical shear walls transfer details at different shear wall conditions.

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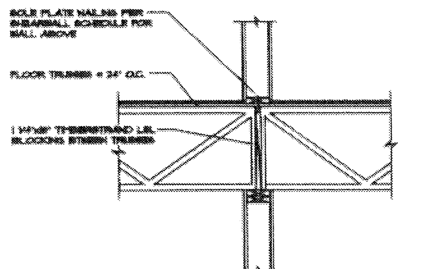
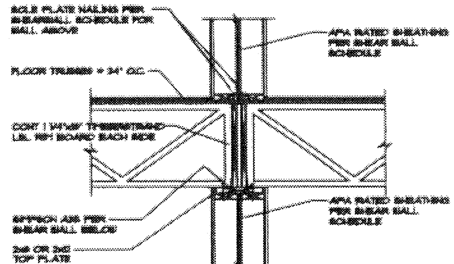
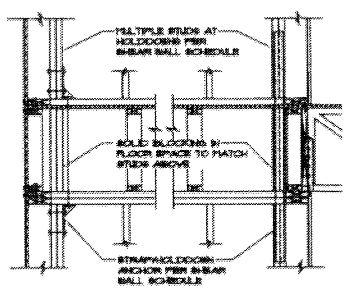


SHEAR TRANSFER DETAIL
@ FLOOR - SINGLE WALL (6 / SD-3)
SCALE: 3/4" = 1'-0"



SHEAR TRANSFER DETAIL
@ FLOOR - DOUBLE WALL (7 / SD-3)
SCALE: 3/4" = 1'-0"



TYPICAL SHEAR WALL
HOLDDOWN DETAIL
SCALE: 3/4" = 1'-0"

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Conclusion

With the layout of the building being very close to rectangular and the spacing of the shear walls being spaced at equal intervals across the layout of the building, the loads on each shear wall should be very close to equal, which they are. Also, the symmetry of the building does not allow for any overall building torsion problems to become an issue. The building has a very basic shape and can probably be easily predicted as to its response to lateral loads. There do not seem to be any areas which would create high pressure areas or wind tunnel situations. This makes the lateral design of this building very accurate because of the information already known about the responsiveness of this building type and its shape. The additional weight placed on the shear walls from the floor trusses which span across them only helps with the issue of overturning. Also, the floor plan layout is the same for each floor which means the shear walls will fall on top of each other which means there will be a large amount of linear load across those areas of the floor. With making the party walls into shear walls, it gives an even greater resisting moment for the lateral loads. The wall is twice as thick as using a regular wall which will add to the rigidity of the member and help it resist more load reducing the amount of shear walls needed. It also helps create a greater distance between apartments limiting noise transmission better and gives more space for the routing of utility lines where necessary. This method of lateral load distribution is the obvious choice for this building because of the material used in the construction and the walls just need to be sheathed properly in order to make them lateral load resisting elements.