The Structures Studio, PLC
Structural Engineers

June 20, 2016

Jeudevine Library Expansion
Structural Evaluation of 81 North Main Street - Hardwick VT

Dear Tom,

At your request, I visited the former Senior Citizens Center at 81 North Main Street in Hardwick, Vermont with you on June 7 of this year. The purpose of my site visit was to perform a walk-through structural evaluation of the existing building to determine the nature and condition of the existing structural systems, and the structural feasibility of renovating the building as part of an expansion of the adjacent Jeudevine Memorial Library. This letter documents my observations and recommendations.

The scope of this structural evaluation was limited to a walk-through visual evaluation of the existing structural systems, to the extent that they are readily visible and accessible. It should be noted that in most places the existing framing could not be observed directly due to the presence of architectural finishes, so there may be hidden structural conditions that were not obvious during my visit. Even where framing is hidden, observation of the finishes for signs of movement or distress can offer some insight on the condition and performance of the hidden framing. No load-rating calculations were done for this preliminary evaluation given the limited direct access to determine the size of framing members.

General Layout of the Building
The senior center building is a former single-family residence with three wings extending back from the street:

- The front section is a 19th century, two-story posted cape with a front porch. It measures approximately 20' wide along the sidewalk by 24' deep (not including the porch), and has a full basement. This is the most historically-significant portion of the building.
- The middle section is a single-story gable-roofed addition, approximately 14' wide by 20' deep. Construction date is estimated as late 1800's to early 1900's. It has a shallow crawlspace, and a single-story enclosed porch was added to the south side at a later date.
- The back section is a more contemporary extension of the single-story gable, measuring approximately 14' wide and 16'-6" deep. It has a shallow crawlspace and concrete frost walls.

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The building faces to the southeast, but for purposes of this report the front of the building will be referred to as the east elevation, with uphill to the north and downhill to the south.

Structural Observations - Front Wing

During my site visit I was able to walk through all the interior spaces at the first and second floors of the front wing, though the structural framing in these areas was hidden behind finishes. A limited number of roof rafters were visible through a ceiling hatch, but we did not have a suitable ladder with us to climb into the attic. All of the first floor framing was exposed to view from within the basement.

Exterior Building Lines: Viewed from the exterior, the walls are generally plumb, the ridge line is reasonably straight, and there is no sign of excessive foundation settlement. The roof rafters have enough residual deflection to merit a closer look, but not an alarming level of deflection. On the south side of the building, the eave bows out horizontally by about 2 to 3", which raised concerns about the adequacy of the roof tying system. The outward bow is more modest at the north eave.

Front Porch: The framing of the front porch is entirely hidden by finishes but there are no obvious signs of structural distress at the porch floor or roof framing. Grade is high against the northeast corner of the porch and is causing deterioration of the siding; the supporting post in this area is likely deteriorated as well. One post supporting the roof has been replaced with a 4x4. The condition of the porch footings (if there are any) and the porch posts below the floor framing are all suspect, and I anticipate they would need to be replaced in addition to replacing the 4x4 post with a post to match the others. At some point the solid porch skirting should be removed to allow a more thorough evaluation of the porch floor framing. It is recommend to replace this solid skirting with a lattice-type skirting that will allow free flow of air beneath the porch framing, or to simply leave it exposed for better ventilation.

Basement and Foundation Walls: The existing foundation walls are mortared rubble stone topped with vertical slabs of granite that are visible from the exterior. The timber sills bear directly on the granite slabs. From within the basement, most of the stonework is hidden behind a thick concrete abutment that extends from basement floor to above the bottom of the granite slabs on all four basement walls. This is presumably a prior attempt to stabilize the stone foundation walls and appears to be working adequately, with no sign of cracking or further movement at the walls. One granite slab at the east end of the north wall is leaning into the basement by several inches and needs to be reset. A short length of stone wall remains exposed at the west end of the north wall, and may need some patching at the interior.

The basement floor is a mix of concrete slab and dirt, with signs of regular water infiltration in spite of the addition of an exterior wall drain along the south side of the house. The basement is very damp, and the moisture is causing deterioration of the wood framing.

First Floor Framing:

The existing first floor framing is a cobbled-together collection of original pole joists, replacement joists, sistering joists, and shoring beams added to prop the framing up from below. The floor framing as a whole sags approximately 2" towards the middle of the building, near the stair opening, and this settlement projects upward to the second floor framing. The perimeter sill beams on top of the granite slabs appear to be in good shape with little sign of deterioration, but much of the interior floor framing is in poor condition due to rot from the damp conditions, failed connections, and prior alterations such as for the addition of the mechanical systems. Several of the beams and joists have been posted down to the new concrete abutments where connections to the sill beam have failed. All of the original basement posts have been replaced, typically with cedar poles, and there are several added wood shoring posts. The interior posts typically sit

on stones buried in the dirt or are slightly raised on concrete block; all shows signs of water damage at the base and several are in need in of replacement.

Given the extensive deterioration, alteration, and shoring, the vertical load path for the support of the first floor framing is dubious at best and is beyond a simple fix. The most straight-forward approach would be to replace everything but the sills with new framing that is adequately designed for the spans involved, likely with the addition of a few new posts and footings on a more regular spacing. It may be possible to retain portions of the existing framing, replacing/repairing only the most deteriorated members, and adding a more rational system of shoring beams and posts to support the existing framing in place by reducing span length. This approach, while likely less expensive, would require a lot more engineering evaluation to figure out how to work around the existing framing, and the added shoring would limit the usable space in the basement. Either approach would allow for jacking the framing up to re-level the first and second floors.

Interior Rooms at the First and Second Floors: The wall studs and second floor framing are all hidden by finishes. However, there are numerous signs of waterstaining at walls and ceilings, which is a red flag for possible deterioration of the hidden framing. There is extensive and pronounced cracking of the plaster at the second floor rooms, particularly where the walls meet the sloped ceiling. Some of the cracking may be associated with foundation settlement and/or temporary jacking of the building during the foundation repair work, however most of the cracking appears to be a result of significant movements at the wall studs and roof framing that is inherent to the nature of the framing system used.

Framing Systems Above the First Floor: Wall framing is not visible but would be expected to be 2"x4" studs based on observations of similar buildings. The second floor joists are not visible but likely bear on some of the interior walls for support. Based on experience with other houses of this vintage, the live load rating of the existing floor joists is likely less than the code minimum of 40 psf for residential use. Any change of use would require the floor framing to meet current code requirements for the intended use, meaning that the second floor framing would likely need to be reinforced as almost all of the non-residential occupancies require a live load capacity of more than 40 psf.

The roof framing is a posted cape system, with bottoms of the rafters located about four feet above the second floor, second floor joists serving as the tying elements to prevent outward thrust of the rafters, and attic joists serving as compression struts to stiffen the rafters under balanced loads. The rafters are common rafters, approximately 3" wide by 4" deep and spaced about 24" on center. The few rafters visible from the ceiling hatch showed some signs of water staining but generally appeared to be of good quality wood and showed no obvious signs of structural distress. The rafters butt against each other at the ridge. The attic joists are buried in insulation and could not be seen without a ladder.

While no load-rating calculations have been performed, the roof rafters appear to be undersized and would likely need sistering to meet code snow loads. This type of posted cape roof framing system is particularly prone to large deflections, as the spreading of the rafters causes the wall studs to bend outward between the top plate and second floor joists. This would explain the observed outward bowing of the eaves and the extensive plaster cracking at the second floor rooms. Based on prior experience with these systems, the wall studs are likely overstressed in bending to two or more times allowable stress levels, so the studs would need to be upgraded if the scope of proposed renovations require the building be brought up to code.

Structural Observations - Middle and Back Wings

The middle and back wings are clear-span structures between the north and south walls. At the interior of the first floor space, the floors feel bouncy underfoot. All of the framing above the first floor is hidden from view, but there are no obvious signs of structural distress apparent in the wall and ceiling finishes,

aside from some distortion of the wall between the front and middle wings that is likely the result of localized foundation settlement or settlement that was built in as a result of reframing work below.

The attic space is inaccessible at both the middle and back wings, so the nature of the roof framing is unknown. It is likely a tied rafter system in the middle wing, and the back wing could be tied rafters or roof trusses. Viewed from the exterior, there are no obvious signs of distress at the roof framing, as the roof lines are reasonably straight and rafter sag is minimal.

The exterior walls of both wings are reasonably plumb, with no obvious signs of foundation settlement. The middle wing has a mortared rubble-stone frost wall, most of which has been faced with concrete parging at the exterior. The back wing has a concrete frost wall. Depth of these frost walls is unknown, but there is no sign that foundation heaving has been a problem.

The middle and back wings have shallow crawlspaces, accessible from the basement of the front wing if one is willing to wriggle on one's stomach through narrow openings in the foundation walls. This initial site visit was too short for such a time-consuming excursion, but the general nature of the first floor framing could be determined by looking through the wall openings from the front basement. The back wing is framed with 2x joists running in the east-west direction. The middle wing has one east-west cross beam, with infill joists spanning in the north-south direction. The infill joists are logs (with bark still intact) on the east side of the cross beam and (assumed replacement) 2x joists on the west side of the cross beam. All of the joists in the middle wing were dripping with condensation, meaning that there will likely be deterioration due to rot. If the plans for incorporation of this building into the library addition move forward, a more detailed evaluation of the first floor framing will need to be made from within the crawl space.

The porch that was added to the south side of the middle wing is in poor condition. None of the structural framing was visible aside from some wall studs at an altered area at the west wall of the porch, but the framing is visibly drooping by several inches and the ceiling finishes show extensive signs of water damage and rot. The porch is not historical in nature, so it is recommended to remove it entirely rather than trying to fix it.

Recommendations for Proposed Renovations

Part of the charge for this initial evaluation was to determine whether the existing senior center building can reasonably be renovated to be incorporated into the proposed expansion of the library building next door. Alterations of this scale, combined with the change-of-use, would require the existing senior center building to be brought up to code including the structural systems. A code upgrade is a significant challenge for this building, since none of the floor framing is expected to meet current live load requirements for even the lightest commercial occupancies (classrooms at 40 psf and offices at 50 psf).

If the building is incorporated into the library addition and brought up to code, the nature of the expected structural work would be as follows:

Front Wing:

- The major foundation repair work has already been done. Reset tilted granite panel, patch small remaining area of exposed stone masonry, and seal exterior joints between the granite panels.
- Fix exterior drainage to reduce water infiltration into the basement, damp-proof the foundation walls, and cast a new basement slab that adequately slopes-to-drain to a sump pump.
- Replace all framing at the first floor of the front wing with new framing designed to support the desired occupancy, or repair the existing framing and add supplemental shoring in the basement to reduce span lengths. Jack the floor to level as part of this work. A complete reframing would allow

for occupancies with up to a 100 psf live load; for repairing and shoring, a 50 psf live load would be a more reasonable upper bound.

- Add new posts in the basement to suit the reframing/resupport of the first floor framing, supported on new cast-in-place concrete footings.
- Reinforce second floor framing to meet code live load requirements. A reasonable upper-bound for this would be a 50 psf live load, limiting use of the upper floor to office and meeting rooms.
- Reinforce eaves wall studs with at least 2x6's to deal with the thrusting force from the roof rafters.
- Load rating calculations remain to be done, but it is expected that the roof rafters would need to be reinforced by sistering to meet code snow loads. The extent of reinforcement work could be reduced by replacing the existing asphalt shingle roof with a standing seam metal roof that better sheds the snow load.
- Remove porch skirting to evaluate condition of floor joists, repair as needed. Fix grading to keep it below the floor framing. New footings and new posts below the floor framing will likely be needed. Provide permanent natural ventilation to the underside of the porch framing to limit further deterioration.

Middle and Back Wings

- Correct the drainage problems that are causing condensation within the crawlspace.
- Conduct further site investigation within the crawlspace to determine the nature, condition, and load-rating capacity of the existing first floor framing. At least some level of repair work is anticipated on account of the existing moisture problem. Given the amount of bounce in the existing framing, it likely has a live load capacity of less than 40 psf meaning that it would likely need to be upgraded to meet code requirements. The best way to increase the live load capacity would be to provide additional lines of support in the crawlspace to cut the spans in half.
- Remove the existing side porch.
- Open probes to determine the nature and condition of the roof framing, and check it for code snow loads. Given the relatively short span and minimal rafter deflection, there is a reasonable chance the framing is OK as is for the code snow loads.

Summary

In summary, it is possible to upgrade the existing structural systems to meet code and the demands of the proposed renovation to library use, but it may not be economically feasible or reasonable to do so given the extent of required repair work and amount of structural upgrading needed to bring the building up to code.

At the front wing, the structural work would require a complete stripping of nearly all interior finishes aside from some floor and roof sheathing, extensive strengthening of all floor and roof framing and exterior studs at the eaves walls, plus jacking the floors back to level. At this point almost none of the originally structural framing would remain in its original form. At the middle and back wings, the floor will need to be pulled up for upgrading the floor framing, and depending on the outcome of the attic probes, the roof framing may or may not need upgrades as well. While less structural work is needed at the back wings, these wings are of less historical significance making it questionable whether it is worth all the effort needed to upgrade the space given that it is likely not a desirable layout for library use.

While the existing framing systems are well below current code and construction standards, they are similar to other residential buildings of the era that have performed adequately enough for decades. I do not consider this to be a structurally-hazardous building, aside from a few dubious framing conditions in the basement that could easily be shored. However, it should be expected that there will be more structural movement and more need for periodic structural repairs than would be the case with a new building built to

current standards. The most reasonable reuse of this building would be to return it to use as a single-family residence, as such use is exempt from the state building code and there would be no code requirement to make all the structural upgrades that would be required for conversion to library use.

I hope this provides you with the structural guidance needed to plan for the library expansion. Please do not hesitate to contact me if you have any questions.

Sincerely,

THE STRUCTURES STUDIO, PLC

Katherine E. Hill

Katherine E. Hill, PE
Principal