C Building Foundation Review

When the demolition for the C2 remodeling project began, it exposed many unexpected code violations and safety concerns to the foundation of C Building, unrelated to the C2 remodel. Following is a list of these issues:

- The framing in the common area crawl space under the subfloor was non-existent in many places. The subfloor over those areas was several inches thick. Apparently it was thick enough to carry the weight of what was on top of it sufficiently enough to mask the lack of support.

- The columns supporting the steel beams that carry the load of the building were made of wood. This was completely illegal and not code compliant for fire resistance reasons. The exposed parts of the wooden columns needed to be wrapped in steel in order to meet code and safety concerns.

- Many of the wooden beams supporting the upper units were poorly cobbled together, and all joists and beams were insufficient to carry the load above and meet code. Every joist and beam needed to be sistered and reinforced in order to meet code and safety concerns, and one beam needed to be replaced with a steel beam.

- The footings for the columns and subfloor support beams were either non-existent or were wholly inadequate. The foundation of the Building was not properly supported.

  - The support columns were resting on top of concrete poured over the original 1750 wooden beams. The resulting concrete supporting the load was only a few inches thick on top of wooden beams. Wooden beams that could rot.
  - The “footings were poured on top of poor and unsuitable sub-grade flooring and not the required 4’ below grade for frost protection.
  - The column footings and the cement that had been dumped decades before had to be completely jackhammered out in order to take bore samples and complete the foundation remediation. Jackhammering was extensive because the slab thickness varied from 1” to 7”.

- The exterior cinder block wall was simply stacked and not reinforced with rebar and filled with concrete. There was no footing under the wall.
- The main wood beams holding up the building under the subfloor were resting on stacked wooden blocks or stacked cinder blocks.
- Much of the work in this area had to be done by hand because of the limited head room in the construction area and because the other units were occupied.

- The Trust discovered that the main sewer line for A and C Buildings had several issues which required its replacement.

  - The sewer line was cracked in several places releasing raw sewage into the common area.
  - The sewer line was not sloped properly and actually ran uphill at one point. This resulted in raw sewage back up into the C1 and C2 bathrooms in past years.
  - The clean out for the sewer line was not accessible on the outside of the building, a code requirement.
  - The sewer line connected to a very old cast iron line that shattered when touched.

- The Trust discovered the tidal flow came in under the building all the way to the chimney stack (approximately 20'). This finding exposed several other issues.

  - The tidal flow was removing finer foundation particles and leaving behind larger rocks and other materials which created an unstable foundation for the building, resulting in noticeable settling of the building.
  - The tidal flow limited the type of foundation pilings the Trust could utilize because of the salt water and movement of water.
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  - The materials left behind after the smaller, finer particles were removed created an unstable environment in which the foundation pilings could not be installed without stabilizing the rubble first. Engineered grout was injected into the ground in order to stabilize the building, the chimney column and the foundation around the main columns for the drilling installation of the mini piles.
  - The tidal flow created many voids that the engineered grout needed to fill. The original estimate was only 3 palettes of grout would be needed, but the voids were so many that it took 26 palettes of grout to sta-

bilize the foundation around the main columns, the chimney column and building.

- Several options for foundational stabilization/construction were considered. Al Dennis and Tom Jacobs worked closely with Ed Moll, a structural engineer with Structures North. Structures North is one of only a couple of firms in the Northeast that specialize in foundations of buildings close to water elements, particularly sea water elements. They also consulted with Matthew Grosschedl, the GZA engineer who conducted our drainage study and David Smith, the GZA engineer who conducted our sea wall study.

  - After extensive research, discussion, test borings and considerations relevant to location, building restrictions, etc, helical mini piles were determined to be the only way to address the foundation.
  - Driven piles could not be used because of the lack of head room for the construction equipment and the unstable rubble foundation. Driven piles could not be driven in perfectly vertical, a necessary element of pile foundations, because of the nature of the foundation found under C Building. Driven piles do not cut through rock, so they would have been deflected by the rocks causing the piles to shift to an angle less than vertical. Additionally, the shifting rubble would have destabilized the building further.
  - Helical mini piles screw down through the rocks and engineered grout without destabilizing the rock based foundation. The installation of mini piles does produce vibrations that would destabilize the foundation and building. The equipment for the helical drilling barely fit into the unit but it was ultimately successful.
  - Al and Tom received proposals from two companies; they vetted the proposals and recommended Helical Drilling. The Trust's attorneys reviewed and prepared a contract for the Board's approval.
  - Al Dennis, Ed Moll and Paul Yingling, the engineer at Helical Drilling, eventually designated 44 mini piles would be needed, but were able to reduce the number of mini-piles to 30. This was partially due to the higher load capacity of the mini-piles

- Stoneworks, Inc. was hired to bend rebar supports, build concrete forms and pour the concrete for the pile caps, grade beams and foundational footings for the two main columns and the lally columns supporting C Building. Stoneworks is one of the only companies in the Northeast that

does this extremely specialized work, and it was the only company recommended by Structures North and Helical Drilling for the concrete work.

- Approximately 236,000 pounds of concrete was needed for the foundational grade beams, pile caps and footings.
- Additional grout was needed to shore up the chimney column that extends through the roof of the building. The cinder block foundation was hollow inside except for loose construction material (gravel, rocks), and the grout needed to be put into the hollow to ensure the chimney stack would remain stable.

- FEMA regulations require installation of two new sump pumps below the subfloor. One will be under C2 and one will be under the common storage area. Both will be operated manually if needed.

Bottom line, the Trust was extremely lucky that the experts and contractors needed to complete the C Building foundation remediation and construction were available, and we could schedule them to get this done as quickly as we did. Had the Trust not undertaken all the steps we did, the C Building could have been condemned by the Building Department until the foundation was remedied. That would have meant that all C Building residents would have been displaced until the foundational issues were corrected.