



BRICK NOGGING: INVESTIGATION AND REPAIR

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ABSTRACT

Nogging is a historical method of masonry construction used as infill between wood framing. This method was used until about the early-1900s in the United States. Figure 1 shows an example of a wall where the nogging is exposed on the exterior. It functions as a veneer, fire-protection, and as an integral portion of the structure. However, nogging was rarely attached mechanically to the wood framing. Typically, only mortar bond and friction held the masonry in place.



Figure 1 – Brick Nogging on a Residence

This paper will illustrate the historical use of brick nogging. A case study will be presented for an 1854 tavern building that developed exterior wall bowing from outward displacement of the brick nogging. Figure 2 shows the north elevation of the tavern where the backup to the exterior wythe is brick nogging. Two wood-framed additions are behind the tavern. The restoration scheme used to restore the masonry walls and to maintain the historical integrity of the building will be presented. The restoration of the wood-framed additions is not included. Upon full restoration, this historical site will become a Vermont state museum.

KEYWORDS: investigation, restoration, brick veneer, nogging



Figure 2 – Kent Tavern, Calais, Vermont

INTRODUCTION

Kent Tavern in Calais, Vermont, was built at the corner of what is now known as Kent Hill Road and Old West Church Road, between 1833 and 1837 by Abdiel Kent as his home. From 1837 to 1846, it was a stagecoach stop on the route between Boston and Montreal until the arrival of the railroad in 1846. Kent subsequently married, and the tavern served as his family home.

The three-story tavern has a brick exterior and a basement constructed with fieldstone. Two wood-sided additions were used as an apartment and a store (Figure 3, west wall is the side entrance).

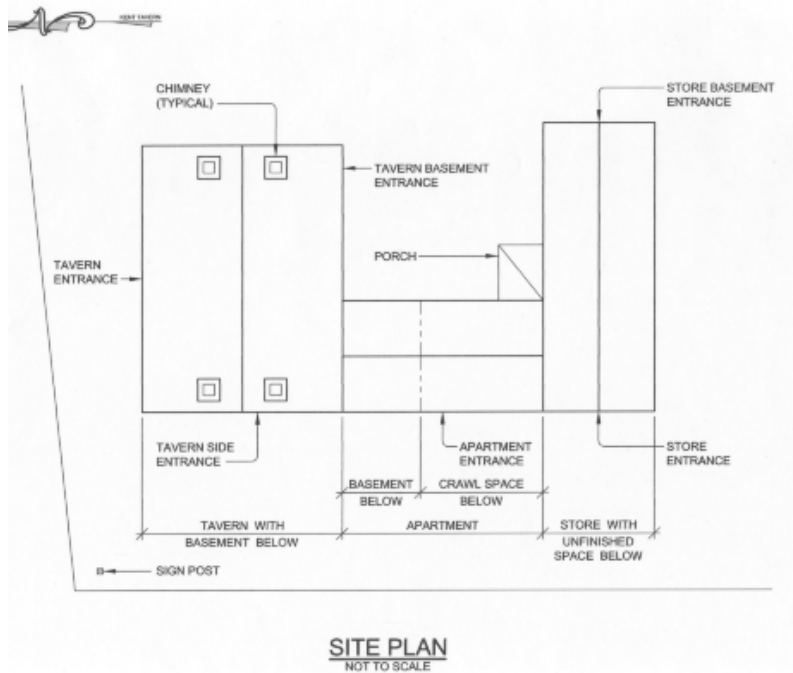


Figure 3 – Site Plan

The Kent family originally settled in Calais in 1798, and this area became known as Kents Corners. One of Abdiel's six brothers, Ira Kent, lived in the white clapboard house across the street from what became the tavern. Ira and Abdiel operated the Ira & Abdiel Kent General Store and Post Office in the two-story, wooden addition from 1837 to 1860.

The Kent family owned the property until 1916. It was purchased by A. Atwater Kent, Abdiel's great nephew, in 1930 to restore it as a museum. It operated for some time as a museum. Subsequently, the property became the possession of a local historical society and then the state of Vermont; it is now a state historical site.

BRICK NOGGING – HISTORICAL PERSPECTIVE

By various dictionaries, brick nogging is the brickwork used to fill in space between vertical uprights in a frame building. It developed in the late-fifteenth and early-sixteenth centuries in England.

For centuries, good quality timber was available in England and was typically used for the common buildings until about 1650. Infill between the timbers took several forms. The earliest form was wattle and daub, a wet mixture of clay, dung, and straw attached to a lattice work of split hazel on willow boughs woven around staves. After drying out, the outside face of this infill was usually lime-washed.

A second method used lath and plaster. This method uses a soft lime plaster reinforced with animal hair on laths (thin timber strips). Again, the outside surfaces were lime-washed after drying out [1].

The third method used brick nogging to infill between the timber framing. Brick nogging appeared in the 1500s after production of quality brick began. The first uses were generally as a replacement for the other two methods of infill. Bricks were laid in horizontal coursing or in a herringbone pattern.

Nogging was used for interior and exterior walls. It served many purposes including an aesthetic finish for the exterior (see Figure 1), a backing for a plaster coating, fireproofing, soundproofing, and insulation. Exterior walls with brick nogging can have exposed brick, plaster coating, or lime wash.

NOGGING CHARACTERISTICS

Characteristics that affect the performance of brick nogging in the wall system include:

1. Brick expansion due to irreversible moisture growth.
2. Shrinkage of the timber framing.
3. Connection of the nogging to the timber frame.

Exterior nogging with exposed timber creates some maintenance concerns. The shrinkage of the wood can open gaps in the mortar joints between the wood and the bricks. Moisture growth of the bricks may compensate for some of that shrinkage, but water penetration was common. The mortar joints constructed against the timber retains the moisture and causes the timber to rot.

Lateral support of the nogging is typically provided by the bond between the mortar and the timber. Generally, lateral support anchors between the brick nogging and the timber are not provided. High lateral forces and deterioration of the mortar/timber connection may lead to a loss of the infill. Figure 4 shows a barn with several triangular-shaped infills missing.



Figure 4 – Missing Nogging in Gable End

WALL CONSTRUCTION AND PROBLEMS - KENT TAVERN

The exterior walls of the tavern are double wythe brick; they have an outer brick wythe bonded to an inner brick wythe with header courses at every tenth course. The inner brick wythe is nogging infilled between timber studs. The openings have stone lintels and sills (Figure 5).



Figure 5 – West Wall



Figure 6 – West Wall

Figure 6 is looking from the south along the west wall. There is a granite base at ground level. The door in Figure 5 can be seen also. Figure 6 shows the wall bowing (arrows) evident at both sides of the door.

The owner requested an investigation to ascertain the cause of several conditions that required suitable intervention before the overall plan to utilize the building could proceed. The visible

defects included masonry cracking on all elevations, significant bowing on the west wall (as seen in Figure 6), and settlement of the west wall near the door (partially visible in Figure 5).

PREVIOUS WORK

When the site was obtained from a local historical society, there were a few records of previous maintenance and repairs to the tavern. These included electrical upgrades, new interior concrete footings and posts, and foundation stabilization in the 1970s, and security controls and dampproofing in 1994.

MASONRY INVESTIGATION

The investigation included several parts:

1. Exterior survey.
2. Partial excavation of the foundation wall.
3. Interior probes of the exterior wall.
4. Mortar sampling.

1. A survey of the gable end of the west wall was conducted to document the horizontal and vertical displacements. It indicated the wall was bowed approximately 46 mm (1.81 in.) between the first floor and the second floor; it was plumb above the second floor. The entire west wall of the tavern had settled approximately 29 mm (1.13 in.) from the northwest corner to the southwest corner. The cracks in the west wall are partially seen in Figures 7 and 8 (arrows). The pattern is indicative of settlement movement.

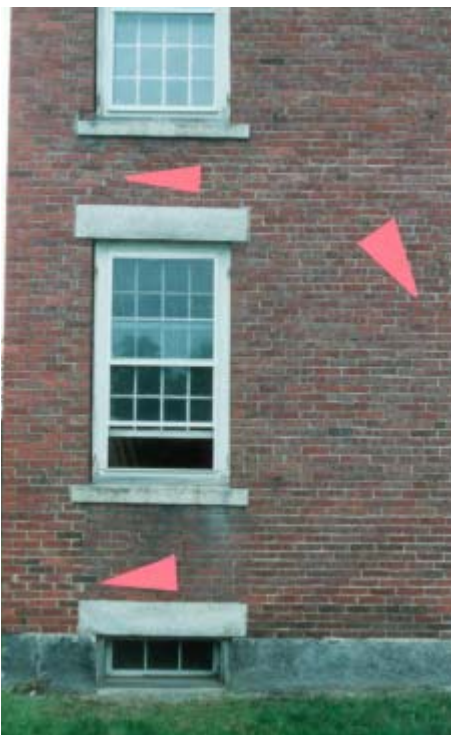


Figure 7 – North end of West Wall

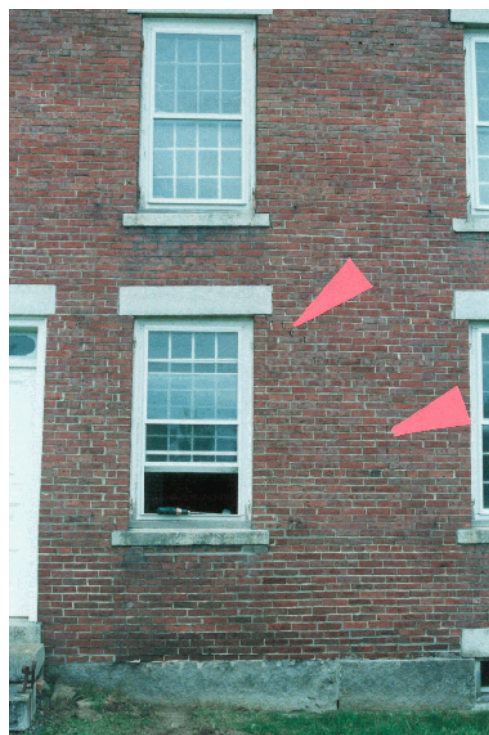


Figure 8 – South of Door on West Wall

In addition, several of the granite base stones were rotated outward below the masonry piers on either side of the doors.

During the survey, visual observations were made of the entire exterior noting masonry cracks, mortar deterioration, and movement of the granite base.

2. Excavations were performed on the east, north, and west walls. Below the granite base of the wall, there is a mortared fieldstone foundation. Just below grade, a concrete pad approximately 0.46 m (18 in.) thick was encountered. Apparently, the pad had been placed during the 1970s work to stabilize the foundation wall; however, it was not effective in preventing movement of the granite base.

There were no clear signs of continuing settlement. However, long-term settlement gauges were to be installed on the building to check for future settlement.

3. Interior removals were facilitated by the partial removal of the plaster finish. Figure 9 shows the interior at a corner; the lath is still on the left and removed on the right. Nine courses of brick nogging are in between horizontal timber blocking. There is mortar parging below the blocking that covers brick headers; the headers are visible on the exterior. The wall is two wythes (one course of nogging and a veneer) except at the timber studs and wood blocking where the wall is only a one-wythe veneer. No mechanical anchorage between the nogging and the timber was observed; no anchors attached the veneer to the timber framing. Surprisingly, no wood rot was observed in the several spots observed.



Figure 9 – Interior Probes

The bricks were 89 mm x 178 mm x 48 mm (3.5 in. x 7 in. x 1.88 in.). The studs were 76 mm x 152 mm (3 in. x 6 in.) spaced approximately 0.56 m (22 in.) on center. The horizontal blocking was 44 mm x 89 mm (1.75 in. thick x 3.5 in wide) spaced every tenth brick course.

At wall studs, the mortar bond was typically broken by wood and mortar shrinkage. In the areas of bowing, the nogging was displaced outward and there was a gap of up to 19 mm (0.75 in.) between the timber framing and the exterior wythe. The collar joint had gaps from the displacement as well.

Interior observations of the foundation were made from the basement. The walls were in generally good condition from the repair work of the 1970s.

4. Mortar samples were taken from the exterior. Overall, the original lime-based mortar was in excellent condition with little erosion or deterioration except at cracks. Using acid digestion techniques, the original sand was identified and a replication mortar mix was developed.

CONCLUSIONS

The masonry conditions at the tavern required significant repairs. The bowing and deflection of the west wall related to the brick nogging were the most critical. The remaining interventions of mortar repointing and crack repair were fairly straightforward.

The integrity of the brick nogging was compromised by the movement. The exterior wythe was separating from the nogging, and the nogging was bowing outward as well. The bowing and the rotation were significant enough to be considered a safety concern.

To repair the wall bowing and settlement, the exterior wythe of the masonry had to be removed below the second floor; the masonry above could remain as long as restoration anchors were installed. By analyzing the wood framing, it was determined that the exterior wythe could be removed independently of the brick nogging.

MASONRY RESTORATION

The first step of the restoration was to stabilize the brick nogging in the area of the bulge; it needed to be reattached to the timber framing. Figure 10 shows the nogging from the interior with the lath and plaster removed and a galvanized diamond mesh fastened to the framing ready to receive parging. Figure 11 shows the interior after the parging was installed over the mesh and nogging. The parging adhered to the nogging and the mesh was fastened to the timber with staples to effectively develop an attachment of the nogging to the timber as well as provide a moisture barrier for the wall.

A few panels of nogging were removed and rebuilt to plumb the exterior wall between the first and second floors. With the interior stabilized, the exterior restoration began. The upper wall was shored and the bowed exterior wythe was marked and subsequently removed. Figure 12 shows the wall shoring in place and the lower exterior veneer removed. An advantage of the timber frame and brick nogging, is that the horizontal wood beam used for shoring could be bolted to the timber frame to form a ledger for supporting the upper brick veneer.



Figure 10 – Brick Nogging with Mesh Attached to Studs



Figure 11 – Brick Nogging with Parging Installed



**Figure 12 – West Wall with Shoring in Place
Veneer Removed Below the Shoring.**

Figure 13 shows the exterior veneer laid out so it could be reconstructed exactly. The header bricks were broken (arrow) leaving the other half in the nogging.

During the rebuild of the veneer, the granite bases were reset and anchored to prevent further movement. The exposed wood was preservative treated (there was no rot after 148 years!). The exterior of the brick nogging was repointed. Masonry veneer ties were attached to both the timber studs and horizontal blocking, and the brick veneer was reinstalled level as an anchored veneer. The masonry ties were stainless steel and were lagged bolted into the timber framing. Figure 14 shows the mortar tooling to match the original.



Figure 13 – West Wall Exterior Veneer

The remainder of the wall and the rest of the building were repointed at deteriorated mortar. Vertical and step cracks were stitched using joint reinforcement composed of 6mm spiral reinforcement. Mortar joints were cut out and the joint reinforcement placed in the repointing mortar. The reinforcement extends 0.4 m (16 in.) either side of a crack. The reinforcement is spaced approximately 0.4 m (16 in.) vertically along a crack.

A replication mortar that simulated the original mortar was used by matching the original sand aggregates. The mortar was an ASTM C270, Type O mixed by proportions (1:2:9 portland cement, lime, sand by volume). Figure 15 shows the west wall after the project was completed. After several months, the replication mortar darkened and blended into the original.



Figure 14 – Rebuild Tooling



Figure 15 – West Wall after Restoration

ACKNOWLEDGEMENTS

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