



**Structural Assessment  
for the:**

# **Old Town Hall**

**Salem, MA**

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## Executive Summary

The Old Town Hall was constructed in 1816 as the home of Salem's former "Town Meeting"- style government, with a large meeting hall at the second floor, offices at the first floor, and storage and retail spaces in the basement. Constructed in the formal Federal style, the Old Town Hall is situated on a gentle grade that slopes northward toward Essex Street and is oriented on a north-south axis.

Throughout its 190-year history, it has served the city in a variety of ways, but has recently fallen into a state of disuse, despite the efforts of many that have lovingly restored and maintained the structure, and made occasional improvements to it.

Presently, there is a relatively minor amount of repair and maintenance that is needed to bring the building structure and exterior envelope up to a "state of good repair" Overall, the building has both fared and been treated quite well.

Although the Old Town Hall continues to serve as a venue for a variety of occasional public events, calculated safe live loads, and therefore occupant loads are limited in part by the bending capacity of timber transfer beams in the basement. Bolstering these beams would go a long way toward increasing the load capacity of the building.

## General Structural Description

Structurally, the old town hall is composed of load-bearing multi-wythe brick walls that support a trussed gabled roof and two interior wood-framed floors.

The north wall has a large arched doorway at the center, flanked by two paired arched windows at the first floor, a Palladian window at the center of the second floor flanked by two paired arched windows, and semi-circular fan window at the top gable.

The south wall has a three granite stairways leading to arched doorways alternating with two arched windows at the first floor, a Palladian window at the center of the second floor flanked by two paired arched windows, and then a semi-circular fan window at the top gable.

The east and west walls each have eleven arched windows that are recessed between wall piers at the first floor, and eleven arched windows at the second floor.

The roof structure consists of 10 A-frame-like timber “king post” trusses with braced top chords that span from the east-to-west and support north-south-running board-sheathed roof purlins. The roof is clad in slate, and penetrated by two brick chimneys at its south end and a ventilating cupola at its center.

The second floor structure is constructed of heavy 13x13 timber beams of white pine that run in the east-west direction, from exterior wall to exterior wall and are supported near the center of the building by two rows of modern-era wood-cased steel pipe columns. Framing conditions in the basement suggest that even the present column locations were not original to the building, rather, there may have been a single row down the center of the structure that was split into two rows some time during the first half of the 20<sup>th</sup> century (*please see “first floor structure” below*). These are regularly spaced and centered about the pier lines between windows of the east and west walls.

Running between the beams in the north-south direction are sawn lumber 4x14 white pine joists that are butt-cogged into the beams. These are covered with two layers of rough-sawn boards and then a layer of hardwood strip flooring that is the present floor surface.

The first floor structure was constructed, originally, of 4x14 sawn lumber joists that span in the east-west direction between the exterior wall foundations and the center of the building, where they pass uninterruptedly over a single north-south-running, rough-hewn heavy timber beam. This beam runs for most the

building's length, spanning across the tops of 16-inch square brick piers that are centered about the pier lines on the east and west walls. The joist spans were broken at many locations where former floor openings are headed off by older and sometimes newer timbers. The original joinery consisted of double tenons passing from the ends of the supported joist or header, through the supporting header or trimmer, as was commonly done around the turn of the nineteenth century.

Later, ca. 1933-1934, the floor framing was modified considerably to accommodate the column relocations (*please see "second floor structure" above*) at the first floor and additional floor openings and infills. East-west-running 10x14 sawn heavy timber beams were inserted into the first floor framing at the pier lines to support the lines of doubled wooden columns between the first and the second. Visually, the beams are of an obvious later vintage than the surrounding framing, and are composed of southern yellow pine, a wood that was not available locally until the late nineteenth century. The later floor openings were made with sawn timbers and joists that are of a similar surface appearance, and all of which were connected with mass-produced pressed metal bridle hangers (an earlier version of today's "Simpson" hangers).

More recently, a concrete block masonry wall was constructed against the interior face of the original stone rubble foundation wall running around most or all of the building. This was presumably done to create a cleaner interior surface and perhaps to stop occasional leaks that may have emanated from the original rough-jointed stonework. There have also been other framing modifications using modern dimensional lumber, and 1976 the double row of columns was replaced with steel columns in "turned" wooden enclosures.

## Noted Conditions and *Remedial Recommendations*

### Interior/ Attic Level and Roof Framing-

- A visual inspection of the roof structure found all trusses, purlins and sheathing to be in an outwardly, generally sound condition, with no significant rot, insect damage or distress that would in any way threaten the structure.
- The exposed ceiling joists also appeared to be in good condition. Most of the ceiling plaster and lath system is covered with insulation.
- There is a concave ovular plaster structure sitting on the ceiling structure that many have likened to a tub or tank. This is actually the dome of an oculus that was once located in the center of the main hall's ceiling and was removed to make way for the present ventilation duct.

### Interior/ Second Floor-

- A visual inspection of the second floor interior spaces found nothing that would suggest or indicate any weakness or damage in the building structure. The limited, regularly spaced undulations in the floor surfaces follow the floor framing plan and the stiffness differences between the floor joists and the main carrying beams. These are within normal and reasonable limits.

### Interior/ First Floor-

- The first floor slopes irregularly in several areas. This is due to framing conditions and modifications that are visible from within the basement level (*please see "Interior/ Basement"*).

### Interior/ Basement-

- Where visible from below, the first floor construction appears to be in generally good condition.
- Nearly all of the re-framed openings and modifications structure have been done using metal bridle hangers at flush framed connection, however, some of these are just toe-nailed. *Flush-framed metal hangers should be provided at all toe-nailed connections (item #B-1).*
- Most of the brick piers that support the center bearing line have been damaged to varying degrees by rising damp, which is where moisture is

wicked upward from below the floor slab through brick piers and evaporates on their surfaces. The evaporating moisture often carries salts with it, which crystallizes (cryptofloresces) within the brick and mortar matrices, softening the mortar and often spalling and cracking the bricks.

*The brick piers should be repaired by removal and replacement of all damaged mortar and brick units with more durable materials, and an attempt to create moisture barriers through the bottoms of the piers with metal or synthetic flashing. Otherwise, the brick piers can be replaced (item #B-2).*

*In the event that additional column lines are constructed in the basement (please see "Floor Capacity" section below), the piers can be left to deteriorate as they will no longer be needed as load-carrying elements.*

### Exterior Masonry-

#### General-

- The building has been sand blasted as a method to clean the exterior; this has caused the layer of glazing on the brick to be removed. The loss of glazing will inevitably shorten the expected life of the brickwork. *Short-term solutions such as applying breathable surface-applied water-repellant sealers can help slow this decline, but will require repeated application every 7- to 10-years (item #E-1). The exterior still looks sound overall, and an on-going program of replacing the most damaged individual bricks can also be helpful (item #E-2).*
- Most of the bricks have cracks in them from firing, which may be becoming more severe due to surface-weathering. *The worst of these bricks may need to be replaced in the future (set item #E-2).*

#### North Elevation (facing Essex Street)-

- The north elevation is in relatively good condition and only needs a few repairs.
- The insides of the second floor window arches *need to be repointed* as well as an area below the first floor west window (item #E-3).
- There is a broken window in the arched window in the pediment *that must be replaced (item #E-4).*

- The first floor window frames are soiled at the base of the arched glass and the paint at the sills is peeling.
- Efflorescence can be seen below the center second floor window, the window to the east of the center window and above the two first floor windows to the west of the door. *This appears to be from water passing through the brownstone sills, which are now painted, or through the window surround. The tops of the sills should be sealed or parged to prevent additional infiltration, and the window surrounds should be checked for watertightness. The white deposits should be removed (item #E-5).*

*West Elevation-*

- There is efflorescence below most of the second floor windows, the base of the chimney and north of the north window. *The moisture sources should be eliminated and the deposits removed (item #E-5).*
- Other than a broken brick at the top of the chimney, *which must be replaced (item #E-2)*, the brickwork is in good condition.
- There is a pile of bricks at the base of the north window.
- On the south half of the building there are a few locations of widened joints between the granite stones of the foundation, possibly because of chips and broken stones.
- The granite cornerstone has been re-pointed.
- Between the last two windows at the south end there is some discoloration of the granite including some rust streaks from the railings.
- The railing on the south side of the door is no longer connected to the building *and should be reattached (item #E-6).*
- The windows at the basement level have been boarded over.
- The area above the granite between the fifth and sixth first floor windows has been rebuilt.



### *South Elevation-*

- There is efflorescence below all of the windows on the first and second floors, above the west second floor window and to the west of the west door. *The moisture sources should be eliminated and the white deposits removed (item #E-5).*
- *Some repointing is needed* at the tops of both chimneys and below the west end of the arched window in the pediment. At the bottom east corners of the center and east stairs the mortar has worn away between the stones and needs to be repointed. A hole in the mortar to the east of the west window needs to be pointed.
- There is a chipped brick to the west of the west doorway and four holes to the east of which was probably the location of a sign, which has been removed. *The chipped bricks should be replaced and the holes filled (item #E-2).* Some other chipped bricks at the corner to the west of the west door have been patched with mortar.
- The area between the stairways seems to have been rebuilt as it does not match the rest of the building.
- The paint is peeling at the first floor windows and doors.
- Rust streaks can be seen on all stair sidewalls.

### *East Elevation-*

- There is efflorescence below all but the three southern windows on the second floor and above the five center first floor windows. It is between the fourth and fifth windows from the south along the edges of the windows as well as at the north corner and to the south of the north window. *The moisture sources should be eliminated and the deposits removed (item #E-5).*
- The infilling below some of the windows, the first two from the south, the fifth from the south and the north window *needs repointing (item #E-3).* The top of the chimney *is also in need of repointing* as well as the returns at the second, third and fourth first floor windows from the south.
- There are broken bricks below the south window and to the south of the fourth window from the south. A brick is broken on the north sidewall of the door. A brick between the sixth and seventh window from the south has a hole in it and another in the same area has a line worn into it. There is

chipped brick below the seventh first floor window from the south and the north corner below the window is worn. A brick below the north first floor window there is a brick that has worn away. The faces of some bricks between the second and third first floor windows have broken off. *The damaged bricks should be replaced (item #E-2).*

- There are rust streaks on the sidewalls of the front stairs and the ones to the door on this elevation.
- The granite to the north of the door is chipped. There are also wide mortar joints between the granite and brick infill below the south first floor window.
- The first floor window frames are dirty at the base of the arched glass and the paint at the sills is peeling.
- There are metal rods in the granite on both sides of the wall below the fourth first floor window from the south.
- Concrete rather than stone is found at the ground level below the second and third windows from the north.
- A windowpane is broken at the sixth second floor window from the south, is now covered with plastic *and should be replaced (item #E-4)*. The top sash of the third second floor window from the south is missing and covered with Plexiglas. The windows at the basement level have been boarded over.
- The area above the granite between the first and second and third and fourth first floor windows from the north has been rebuilt as well as a large area between the second and third fourth floor windows from the north.

## Floor Load Capacity

### Assumptions-

The floor capacity of the Old Town Hall was calculated based upon the following assumptions:

1. Floor Dead Load= 15 to 20 pounds per square foot (psf)- typical value for heavy wood-framed construction.
2. Partition loads to be subtracted out of calculated Floor Live Load.
3. Wood species is Eastern White Pine- based upon wood sample analysis.
4. Wood grade is "Select Structural"- based upon density and visual grading of exposed members.
5. Steel pipe columns assumed to be "standard" series- conservative assumption.

The following member types were considered:

1. First and second floor joists- loaded at each respective level, spanning approximately 8 ½-feet between timber beams. Actual size: 3 7/8" wide x 13 ½" deep, Eastern White Pine #1. Checked for bending and shear stresses of 775 pounds per square inch (psi) and 135 psi allowable, respectively.
2. Second floor timber beams- supporting joist end loads, spanning approximately 13-feet from wall to double row of interior pipe columns. Adjusted size: 9 ¾" wide (reduced from 13" to account for joist cogs, wane) x 13" deep, Eastern White Pine No. 1. Checked for bending and shear stresses of 875 psi and 125 psi allowable, respectively.
3. First floor timber beams- supporting first floor joists and second floor columns, spanning approximately 17-feet between foundation walls and the center pier line in the basement. Actual size: 9 ¾" wide (reduced from 13" to account for joist cogs, wane) x 13" deep, Southern Yellow Pine No. 1. Checked for bending and shear stresses of 1350 psi and 165 psi allowable, respectively.
4. First floor columns- supporting first floor framing with a 13-foot maximum unbraced length, size: 3 ½" nominal diameter (4" outside diameter). Checked for axial load with 46,000 psi assumed yield stress.

5. Basement piers- supporting first and second floor framing. Checked for bearing stress based upon masonry crushing strength of 750 psi.

#### Calculated Floor Load Capacities-

Were it not for the first floor conditions, the second floor would have a live load capacity of 90 psf, limited by the floor beams in bending. Because the second floor is supported by the first floor through "transfer beams" that support the steel pipe columns, its live load capacity is limited by them.

Not considering the contribution of second floor live loads on the timber transfer beams, the first floor has a maximum live load capacity of at least 90 psf, limited by the header beams that frame across former openings and support joists on either side. In bays that are not "headed-off" or have two headers per joist span, the live load capacity is greater than 100 psf.

The timber transfer beams that support the second floor columns see between 50 and 75 percent of their bending and shear loads coming from the second floor. Where there are no header beams framing into their sides, these beams see about as much load from the second floor as a common joist, while carrying all of the loads of the second floor columns that land on them. In such cases, they have the ability to support 80 psf on the second floor, assuming no live load on the first. Although with an 80 psf live load on the first floor, they have no excess capacity to support loads on the second floor, if the first floor load is limited to 50 psf, such as in an office use, the live load capacity of the second floor becomes 65 psf.

If the cases where transfer beams support header beams on one or both sides, the contribution of the first versus second floor loading becomes about even. Assuming headers frame into both sides of a given transfer beam, the total live combines load capacity becomes about 65 psf. This can either mean 65 psf at the second floor and no live load at the first, 65 psf at the first and none at the second, or 32.5 psf at both levels at the same time.

To understand floor loading, consider a 10-foot square area with evenly distributed persons each weighing 200-pounds. Approximately 5-people could occupy the 100 square foot area per 10 psf of capacity.

#### Required Floor Load Capacity, Limitations-

The code requires that public meeting spaces have live load capacities of 100 psf if moveable seating is used, 60 psf with fixed seating. First floor retail spaces must have a live load capacity 100 psf while office spaces must have 50 psf capacity, but with an additional 20 psf allowance for partitions. With the present

situation, the floors of the old town hall do not meet any of these criteria unless one floor is kept empty while the other is in use.

In a fixed seating situation, all occupants are uniformly distributed over the floor area. Typical limits on seating would have the seats spaced at 18" within rows spaced 32" apart, resulting in 4 square feet per occupant. Adding 40 pounds per seat with a 200-pound person, this would result in 60 psf, which is the same as what the code requires. Assuming fixed seating over 75% of the useable floor area the floor could support up to 325 people. This would limit the available live load at the first floor to 20 psf, which in our opinion is too low to allow unrestricted public occupancy (see below), and we therefore recommend that access be restricted at the first floor during large second floor events.

In the case of non-fixed seating, the difficulty is predicting where and how closely occupants will stand. In a moderately condensed crowd, each person occupies approximately 3 square feet, generating 67 psf on the floor. In the event of an emergency, evacuation, or even a one-time monumental event, the crowd could condense to 2 square feet per person, creating the 100 psf prescribed by code. With no live load on the first floor, there is still a limit of 80 psf on the second floor, which is less than the 100 psf prescribed by code, however, the code also allows live loads on members that support more than one floor to be reduced by 20%, resulting in a net effective live load of 80 psf, which equals the capacity of the supporting beams. Again, this requires that the first floor be unoccupied, or at most minimally occupied in a controlled manner.

#### Short-Term Recommendations-

*In consideration of the above, the second floor or first floor may continue to be used in the same manner in which it has traditionally been used for events as long as the events occupy either the first floor or the second floor, but not both at the same time. The total limit of occupants should be no more than 450, on either floor, one floor at a time.*

*In special cases where it is important to use both floors concurrently, the number of occupants should be limited, seat spacing should be arranged, and attractions or activities should be spaced so that an average of no more than 15-people occupy any given 10-foot square area at any time on either level. This would have people spaced approximately 2.5 to 3-feet apart on all sides, which is about the maximum socially comfortable human density that takes in the typical Salem event. This translates out to a limitation of less than 225 people each over the first and second floor (450 total) and controlled in such a way as limits total density as described above.*

*Please note that the occupant limitations that we have described are based upon floor load capacity only, and not on the capacity of the emergency egresses, which should be evaluated separately.*

Long-Term Recommendations-

In addition to the repairs and improvements that we recommend as remedial recommendations (previously in this report), we recommend the following long-term improvements to provide for adequate structural support for building's end users.

*With Continued Assembly Use-*

*If the Old Town Hall is to continue being used as an assembly space, we recommend adding two lines of columns and footings in the basement, directly below the lines of columns at the first floor. This would eliminate relieve the first floor transfer beams and would increase the allowable live load capacity of both the first and second floors to 90 psf, concurrently. This means that the use possibilities of the building would be almost limitless, other than for fire code and egress issues that are not part of this report. The only loading excluded uses would be storage, manufacturing and library stacks.*

*With Less Load-Intensive Use-*

*If the Old Town Hall is were to become offices and/or residences, which require have live load capacities of 50 psf and 40 psf, respectively, the floor construction as-is would have sufficient capacity to support these loads at each floor concurrently, however, there would be no available capacity for the weight of interior partitions. Adding basement columns and footings below the transfer beams would also be needed under this scenario.*

## Prioritized Budgetary Cost Estimate

### Conditions-Driven/ Remedial Work Items-

<i>Item #</i>	<i>Item Description</i>	<i>Urgency (see below)</i>	<i>Budgetary Estimate</i>
<b>B-1</b>	Install hangers on toe-nailed flush framed beam and joist connections.	<b>2</b>	\$5,000 to \$10,000
<b>B-2</b>	Repair or replace rising damp-damaged brick piers.	<b>2</b>	\$15,000 to \$25,000
<b>E-1</b>	Seal exterior brickwork.	<b>4</b>	\$90,000 to \$125,000
<b>E-2</b>	Replace cracked, damaged or missing bricks.	<b>3 to 4</b>	\$15,000 to \$20,000
<b>E-3</b>	Cut and repoint eroded mortar joints in brickwork.	<b>3</b>	\$25,000 to \$35,000
<b>E-4</b>	Perform specific window repairs- Allowance.	<b>2</b>	\$1,500 to \$2,500
<b>E-5</b>	Investigate efflorescence blooming, seal brick or eliminate water sources, remove white deposits.	<b>4</b>	\$15,000 to \$20,000
<b>E-6</b>	Reattach detached railing.	<b>1</b>	\$1,000 to \$1,500
	<b>Total Remedial Work</b>		\$167,500 to \$239,000

#### Degrees of Urgency:

1= Immediate threat to public safety and/or stability of the structure.

2=Possible or eventual threat to public safety and/or stability of the structure (level 1) if not corrected soon.

3=Will worsen to level 2 or cause other problems if not corrected.

4=Will eventually worsen and increase in severity if not corrected.

5=Would be a good improvement to make, eventually.

Load Capacity-Driven Improvements-

<b>Item #</b>	<b>Item Description</b>	<b>Budgetary Estimate</b>
<b>LB-1</b>	Install new steel columns on footings in basement, below columns at first floor.	\$40,000 to \$50,000
<b>(B-2)</b>	Subtract: Repair or replace rising damp-damaged brick piers.	(\$25,000) to (\$0,000)
	<b>Total Load Capacity-Driven Improvements (w/ credit for not doing pier repairs in low-end estimate)</b>	<b>\$15,000 to \$50,000</b>