STRUCTURAL BARN EVALUATION

243 POST ROAD
BOWDOINHAM, MAINE 04008

Prepared for:

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Inspection Date: September 25, 2020
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Project No. 20-0377-ME

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Introduction

Criterium Engineers is pleased to provide a structural evaluation of the building located at 243 Post Road in Bowdoinham, Maine. This building was built as a 3-story chicken barn around 90 years ago, was extended to the back shortly thereafter with a similar construction, and has been in used for storage and as the Town of Bowdoinham's Recycling Barn for 30 years. The building also includes one rental apartment on the third floor. The floor loading capacity, and the structural strength of the roof, has been evaluated by various structural engineers. This evaluation is to provide a second opinion.

Criterium Engineer, Helen C. Watts, P.E. (ME), visited the site on September 25, 2020 to inspect the structural condition of the barn. We met onsite with David Berry, who provided additional engineering reports done in 2008 through 2011. The weather was warm and dry.

Standards and Limitations

Our inspection report is limited to observations made from visual evidence and a review of the available engineering reports.

Our inspection and report has been conducted consistent with that level of care and skill that is ordinarily exercised by members of the profession providing the same services under similar conditions at the time the services are performed.

Our report is an opinion about the condition of this portion of the building. It is based on evidence available during a diligent inspection of all reasonably accessible areas. No surface materials were removed, no destructive testing undertaken, and no furnishings moved.

Description

The barn is 36'x288', and approximately 22' from the concrete slab to the eaves. The building is wood-framed, with corrugated metal roofing and siding, and a concrete slab-on-grade with concrete frost walls. There are two lines of columns and beams at 11'-8" from the south and north sides, and the posts are spaced 12' on center, generally with 2x8 construction for the beams and 6x6 or built-up 6x6s for the posts. The posts have some angle bracing. There is no siding on the south face of the building. The building has been modified to remove flooring in some areas, and the siding on the south side was removed and replaced with clear plastic. There is a ground floor addition made of concrete block on a concrete slab and foundation housing the wood boiler heating the building and the apartment.

The barn roof had a partial collapse the winter of 2011 near the back at the south side, at which point the south roof framing was reinforced.

There have been various structural evaluations to determine the floor loading capacity of the building, which contains the municipal recycling program, and which uses parts of all three floors.

For the purposes of this report, the orientation of the building will be discussed as north, south, east, west, , with the 36′ end facing Post Road being the west end, and the 288′ right side being the south side of the building.

See attached photos for more detail.

Observations and Discussion

During the inspection, we went around the outside of the building, north, west and east, then through the three levels of the building inside. The back of the building is grown up with vegetation.

We noted the following items during our inspection:

1. The life safety issues have been evaluated by the State Fire Marshal's office and are not included in this report.
2. The original barn is at the west end of the barn, then the barn was extended to the east. The barn was built as a chicken barn, and includes a large central ventilator on the roof, and a boiler room added near the middle of the barn at the first floor.
3. The framing is in three bays of 2x8 joists at 24″ on center, with 12′ spans. The joists land on two interior wood beams running front-to-back, originally built with 3 – 2x8s, spanning 12′ from post-to-post. The posts are 6x6 solid or built-up posts. There are 45 degree angle braces from the post to the beams, and in some locations there are angle braces north-to-south as well. The material appears to be hemlock or pine. The floor sheathing is wood boards. The joists are generally in good condition, though in some areas they are stained and have debris left over from the chicken barn use. The beams supporting the joists are generally deflected in the center.
4. The barn is somewhat taller than most chicken barns I've inspected, though the floor-to framing heights are still limited.
5. The roof framing is at 36″ on center, and consists of 2x6 or 2x8 rafter framing with eaves ties for each pair of rafters. This supports nailers supporting the corrugated metal roof. The framing is insulated at the front half of the building with a mix of fiberglass batts and blown cellulose insulation; some areas towards the east end are uninsulated.
6. The original interior wood beams have some deflection at the center of the spans for most of the beam spans. Some beams have been reinforced by sistering a 2x10 on each side of the beam.
7. Some floor areas have been removed, including the second floor framing at the front of the building in the center aisle, the second floor framing near the center of the building in the north aisle, and the second floor framing at the back end of the building. The removed post-and-beam framing has been replaced with wood trusses to replace the removed supports for the third floor.

8. There is an apartment on the third floor covering the center and south bays of the building, with an exterior stair and an interior stair. The third floor framing in this area is covered with drywall.
9. The roof to the barn was rebuilt in 2011 in the area where the collapse occurred, comprising 30′ at the south end of the barn.
10. The south side of the building has had the corrugated metal siding removed and a layer of clear plastic sheeting installed. This was done to allow some daylighting in the building, with some solar gain. The shear capacity of the siding was supplanted by letting in some diagonal bracing from the eaves to the sill plates at the top of the foundation walls.

Review of the Engineering Reports

It is our opinion that the Associated Design Partners (ADP) report dated May 27, 2011 is an inaccurate report; the dimensions of the building and the framing listed were incorrect.

The ADP report dated September 30, 2011 lists the building as having 2 stories and being 35′ wide; we measured 36′ out-to-out. The snow loading calculation assumes very good insulation in the roof and doesn't include the slippery roofing surface, resulting in a higher snow load than should be used in calculations. Note that the ASCE 7 snow loading requirements haven't changed since ASCE 7-05, when the unbalanced snow loading requirements were added, so the current requirements are the same.

The unbalanced loading requirements place the full, unfactored ground snow load on one side of a gable roof; these are the typical snow conditions that have been observed with this building, with no snow on the north side, and blown snow collecting on the south side of the building, and also the conditions under which the partial roof collapse occurred.

The Calderwood Engineering (CE) reports are dated July 3, 2008 and February 20, 2009, and cover roof loading and floor loading. The report uses slightly different factors than those that I feel are correct, and I have different dead load (building material weight numbers in some areas) so I gain some additional strength for the calculated floor and roof systems. However, the values I calculated are for a typical floor and roof system, and there have been modifications to the framing in various locations throughout the building, some of which add an adequate amount of strength, and some of which remain undersized. The need for framing modifications, and the size of the modifications, are similar.

None of the ADP or CE calculations included the use of the 1/8″ steel plates, which add over 5 pounds per square foot (psf) of dead load to the floor system on the third floor, and which help spread the weight of the loaded pallet jack to multiple rafters. The plates provide a durable and smooth surface for the pallet jack.

CE inspected the barn and created a repair plan in 2013. They re-inspected the building in August of 2020, and found that the needed modifications hadn't been done. They also found other conditions of concern. These two reports include drawings for the repairs.

Discussion

Every wood-framed chicken barn in Maine has an ongoing list of maintenance needed. Most of these barns have a relatively low floor-to-framing height, and therefore don't support other uses well. This barn has been used for the last 30 years as a recycling barn. The areas of the barn that were especially lightly framed are typical for chicken barns but inadequate for the current building code requirements. The applicable building codes from the Maine Uniform Building and Energy Code are the 2015 IBC, the 2015 IEBC (the Existing Building Code), and the ASCE 7-10, which provides the loading requirements. The wood framing design is based on the 2012 NDS (National Design Specification), which uses wood graded to modern specifications by organizations such as NELMA (New England Lumber Manufacturer's Association).

For new buildings, the building framing design is based on the code-specified loading and deflection requirements, with modern building materials.

In this case, we have an existing building that has been built without engineering for an agricultural purpose, matching many other chicken barns built in the 1930s. The building was built without concern for deflection of individual members, and framed using light and repetitive framing. The building would have been warmed by the chickens as well as the boiler, minimizing snow loads on the roof.

When the building was repurposed into a new use as a recycling center, the barn was modified in some locations to make openings in the floors. Some of these modifications weren't engineered, and resulted in an inadequate structure.

<u>Roof System</u>

The roof system needs to be able to handle the expected snow loads adequately. These are best characterized by using the latest ASCE 7 requirements, which include the balanced snow loads, where a uniform load is on both sides of the rafter-framed gable roof. However, the barn roof failure in 2011 demonstrated the unbalanced loading condition, which was a new design requirement placed in the ASCE 7-05 and later versions, including the current ASCE 7-10. The unbalanced snow load needs to be applied to both the north and south sides of the roof, even though the prevailing wind usually has the north side clear and the south side snow-covered. A storm can come from any direction.

The rafters on the south side have been strengthened, but all the rafters should be upgraded to be made adequate for the unbalanced condition. This is reasonably correctly calculated by CE. Every engineer uses slightly different methods, but the framing needed for the repair will be similar when the drawings are stamped. CE has provided two repair methods, to allow the owner to select the least expensive option. Note that most contractors are now using engineered wood screws rather than bolts or lag screws; they are fast to install and make a robust connection, with less section loss in the wood part of the connection. There may be some economies available in revising the connection details.

The rafter beams are undersized, on both sides of the building. This is a typical problem with chicken barns. These can be sistered with LVLs (engineered lumber); and the beams should be made adequate for the unbalanced snow load. My rough calculations showed that two LVLs were needed, rather than one, for each beam.

The rafter tails should be fastened to the top plate of the wall with an uplift fastener such as the Simpson H2.5.

The CE design shows adding one 1.75"x11.25" Versalam to the beam supporting the rafters. I calculated the need for two Versalam beams; I assumed that the stronger and deeper material would take all the load from the 2x8s because the lower edge of the engineered lumber is taking the tension below the bottom of the 2x8s. This calculation should be checked.

The work should be inspected at the start of the work to assure that the design has been properly interpreted by the contractor, then at the end of the project.

Floor System

The analysis of existing building floor systems for a new use is per the 2015 IEBC as well as the 2015 IBC. The allowable loading can be determined by inspecting the building, evaluating the materials and their condition, then performing a structural analysis, or it can be determined by load testing.

While a new building will be analyzed based on a live load from Table 4.1 in the ASCE 7-10, and a new building built for storage of materials like these would have a live load rating of 125 psf for "Light Storage". In this case, an existing building is generally inspected and given a load rating based on the available structure, or, if additional loading is expected, that load is determined and the framing is upgraded to the required loading. All of the different areas to be used should be placarded for their available live load strength.

We also recommend that the areas used for loads over 30 psf be marked out and a design be made to take those loads down to the ground. The design should include the actual expected loads of the loaded pallet jack.

In any case, storage of loads over 30 psf (or 28 psf if using the CE calculations factors instead of mine) should be prioritized on the ground floor slab, and the upper floors should be used for lighter material storage. Pallets sent to the upper floors should be weighed before leaving the first floor, and can be marked or tagged. Heavier loads on the upper floor will be restricted to specifically enhanced floor framing areas. Loads placed on the upper floors should be weighed so the loads don't exceed the allowable storage load.

The Pallet Jack and Bale Transport in the West End

The calculated load on the third floor at the west end should include 5 psf of added dead load for the 1/8" steel plate. The live load for this area should be planned for the expected weight of the bales handled, and the weight of the pallet jack. Assuming a pallet jack weighing 200#, and a bale of materials handled at not-to-exceed 1000#, and multiplying by a factor of safety of 1.2 (20%), with a pallet being 4'x4', gives a floor live load rating requirement of 90 psf for the west end in the center and north bays. The floor joists, floor sheathing, beams and posts should be upgraded to handle this amount, down to the floor slab, but only in the area where this load occurs.

If we assume that the area of the third floor used for the pallet jack is just used for the one pallet jack, and that the rest of the span in that area is unloaded except for dead load, then only that load is on the framing at one time – so the 4x4 area carries 1440 sf, and the rest of the structure supporting the rest of the floor in that bay is unloaded except for the dead load. This would require restricting the load to the one pallet jack. Note that this is the current loading condition in the third floor near the truck opening. This means that no material would be stored in the same bay as the pallet jack travel. The floor that has been enhanced should be painted, or curbed, so the pallet jack can't travel beyond the enhanced floor area, and placarded for only that use with no storage.

Assuming that the 120 psf load is over 5' (for an added 25% factor of safety, and an amount of leeway in the location of the travelling load), the joists in the travel area should still be sistered, or a joist added in each bay, of 2x8 SPF #2 or HF #2. The beam supporting the joists would need to be 4 – 1.75"x11.25" 2.0E Microllams (or Versalams), 2 on each side of the existing 2x8s beam. These can be sistered to the existing beam. The posts can be checked by calculation later.

Other Floor Loading Issues

The CE design for the trusses uses some 1" diameter A325 bolts. These connections work well for steel-to-steel applications, but a steel-to-wood application should use more, smaller, connectors rather than one, larger, connector, to prevent wood failure at the joint.

The extensive repairs recommended for the large trusses at the east end of the building may be more simply addressed by installing a steel beam in these two locations, supported by the 12x12 columns as needed.

This is a large building. The enhancement of the floor load rating should be targeted at the areas with payback. All other areas should be restricted to light loads, and the loads should be put on a scale to prevent overloading before being sent to the framing above. Additional floor areas can be enhanced per the drawings as funded uses occur.

Other Structural Issues

The area around the composter should have the floor sheathing removed, so nothing can be stored there, or the floor joists can be removed and re-installed with full joists and new floor sheathing.

There are some areas with the original board floor sheathing. These areas should be inspected periodically, if kept in use, as the use for chickens may have deteriorated the strength properties over time. Most of the floors have been surfaced over with plywood, which is in good condition and adequately attached, where observed.

Further non-engineered changes to the framing should be avoided, as this is no longer an agricultural building use.

<u>South Wall</u>

The south wall of the building is sheathed with plastic sheeting stapled to the studs. Some limited diagonal braces have been let into the wall for the full height of the wall. I recommend that the building be fully evaluated and that parts of the wall be sheathed and fastened as needed per the evaluation. The sheathing would need to be fully attached to bring the shear loads from the roof framing down to the foundation. We discussed installing the sheathing on the inside; this would involve some complications to the wind design analysis. A better solution still allowing the solar gain may be to install the sheathing to the outside of the studs and then install a Trombe-wall type collector to the outside of the sheathing.

CE's inspection noted some damage to studs and lack of connection between the building and the foundation in one area. Repairs should be made per the Calderwood report.

Conclusion

The Recycling Barn was framed for use as a chicken barn, with light, wood framing. The current use exceeds the design capacity of the framing, as does the expected snow loading; the wind loading is expected to exceed the capacity of the south wall framing. Some modifications are needed to continue the current use, and to accommodate the expected snow loading without distress. Some repairs are needed as well.

The CE design generally meets the needs of the building, but our recommendation for the building is to only improve the second and third floor load rating for the areas that will be specifically used for high loads. The roof framing should be modified to one of the CE repair methods, or another engineered repair design, for the full area of the roof framing.

We hope that you will call if you have further questions concerning this report.

Respectfully submitted,

Criterium Engineers

STATE OF MAINE
HELEN C. WATTS
No. 5261
LICENSED
PROFESSIONAL ENGINEER

Helen C. Watts, P.E. (ME)
Senior Structural Engineer

Attachments: Photographs
Schematic Floor Plans
Older Engineering Reports
2020 Calderwood Report and Plans
Watts Calculations
Professional Resume

ATTACHMENT A
PHOTOGRAPHS

STRUCTURAL EVALUATION

Description:
North and West Exterior

Photo Number
1

Description:
West End of South Wall
Note Let-in Bracing, Plastic Sheathing

Photo Number
2

STRUCTURAL EVALUATION

Description:
South Exterior, Apartment is at the 3rd Floor

Photo Number
3

Description:
East end of South Wall, East Exterior

Photo Number
4

STRUCTURAL EVALUATION

Description:
West end bays with third floor roof hatch for truck loading

Photo Number
5

Description:
chicken pee debris on location of previous power lines

Photo Number
6

STRUCTURAL EVALUATION

Description:
southwest end 3rd with pallet jack, insulation at roof framing

Photo Number
7

Description:
typical roof framing no insulation

Photo Number
8

STRUCTURAL EVALUATION

Description:
Inadequately supported floor area

Photo Number
9

Description:
truss at north wall opening

Photo Number
10

STRUCTURAL EVALUATION

Description:
roof framing at north side, east end, typical

Photo Number
11

Description:
roof framing with beefed up roof purlin

Photo Number
12

Description:
typical joist and floor sheathing condition

Photo Number
13

Description:
south bay with second floor removed and added trusses taking column loads

Photo Number
14

Location:
Recycling Barn
243 Post Road
Bowdoinham, Maine

Photo Taken by:
Helen C. Watts, P.E. (ME)

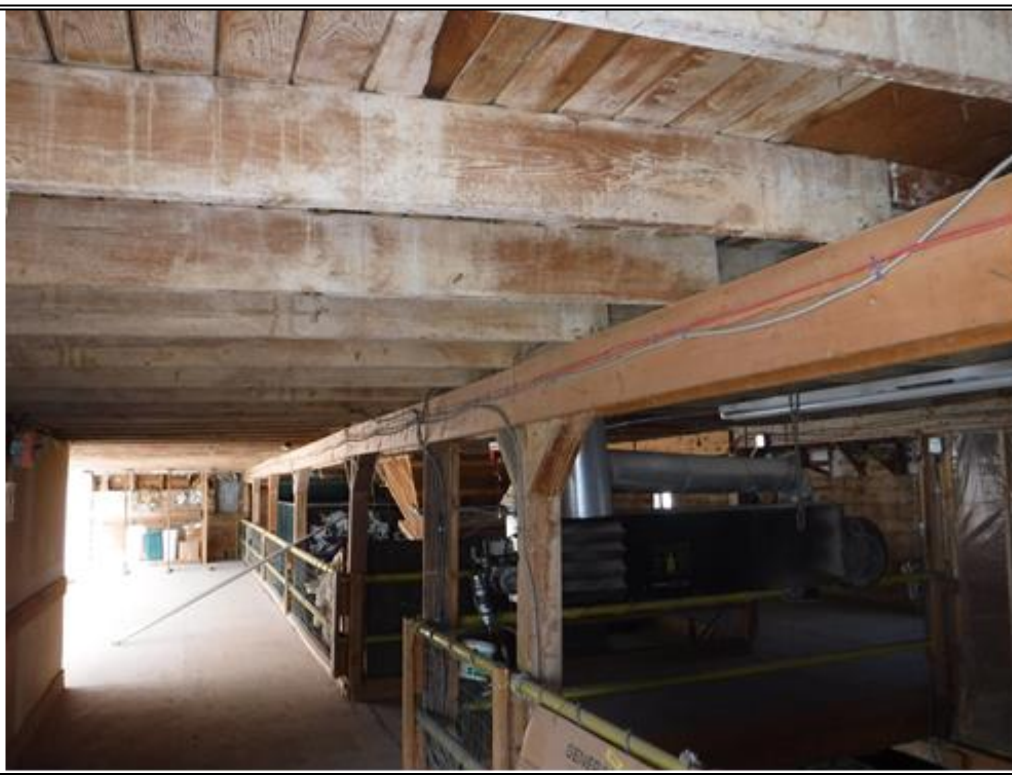
Date:
September 25, 2020

CRITERIUM ENGINEERS

STRUCTURAL EVALUATION

Description:
added beam to support third floor north bay

Photo Number
15



Description:
typical floor framing, with beam supporting joists strengthened

Photo Number
16

Location:	*Photo Taken by:*	*Date:*
Recycling Barn	Helen C. Watts, P.E. (ME)	September 25, 2020
243 Post Road		
Bowdoinham, Maine		

STRUCTURAL EVALUATION

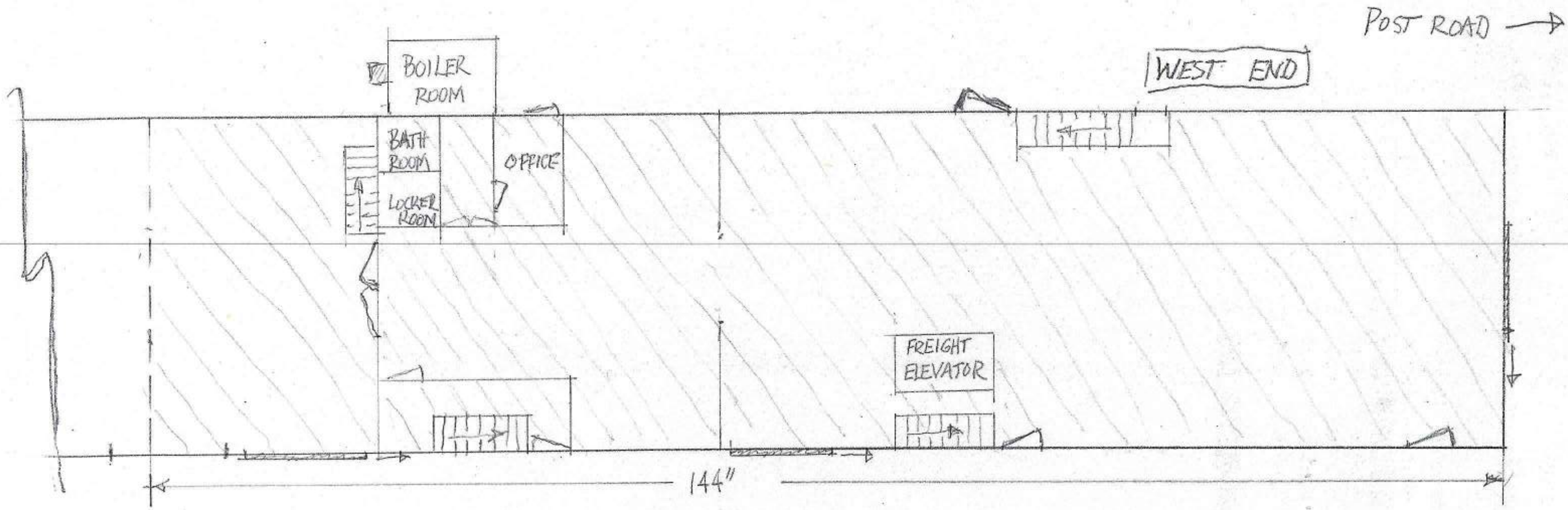
Description:
area of second floor should be checked

Photo Number
17

Description:
original floor sheathing

Photo Number
18

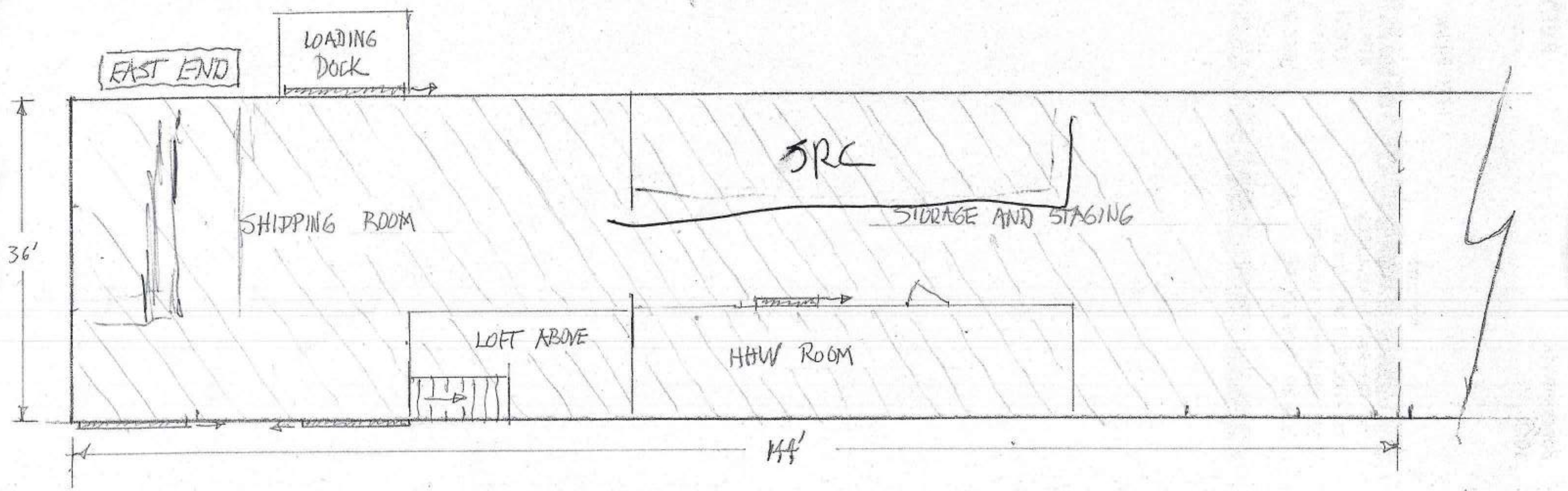
ATTACHMENT B
SCHEMATIC FLOOR PLANS

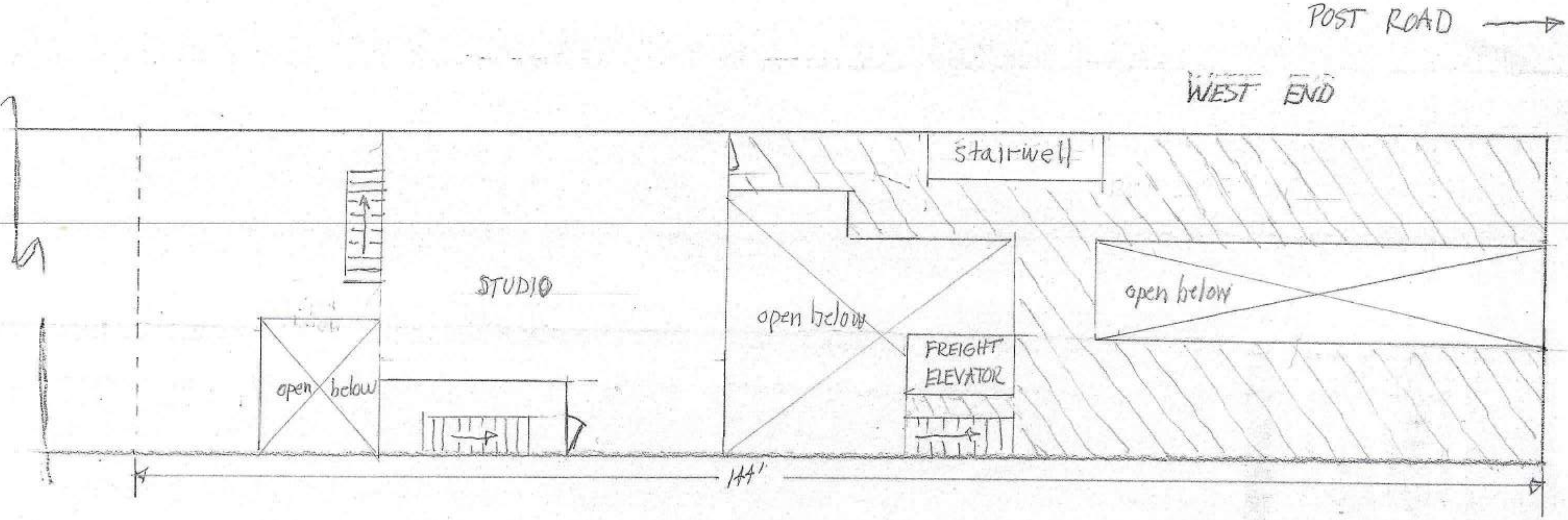


- TOWN LEASEHOLD AREA - 10,368 ft²

GROUND FLOOR
BOWDOINHAM RECYCLING BARN

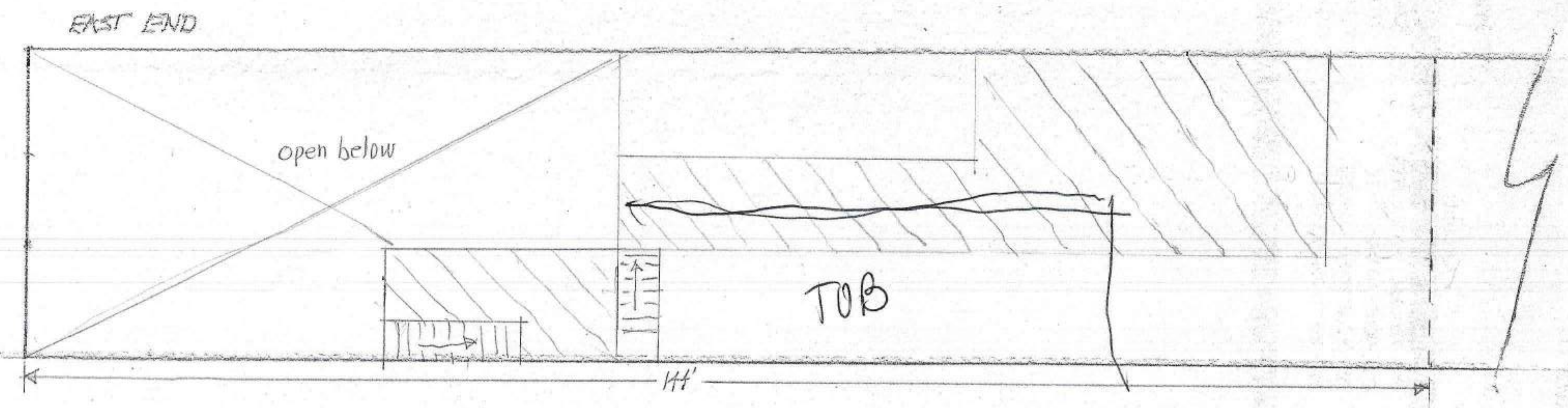
scale - 1" = 16'-0"

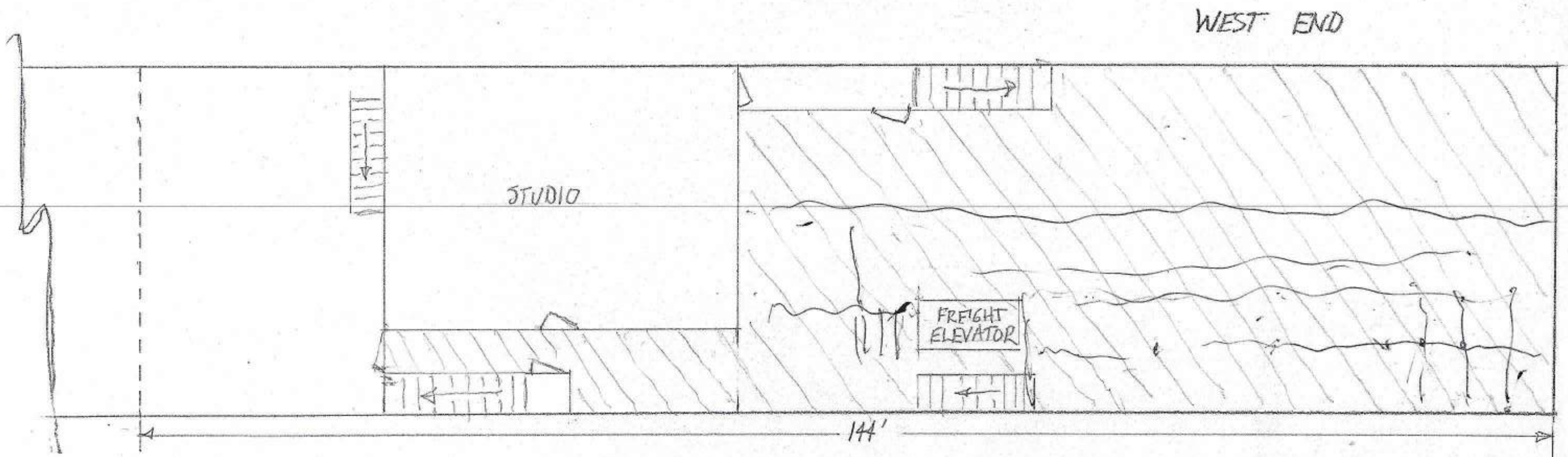




- TOWN LEASEHOLD AREA - 3180 ft^2

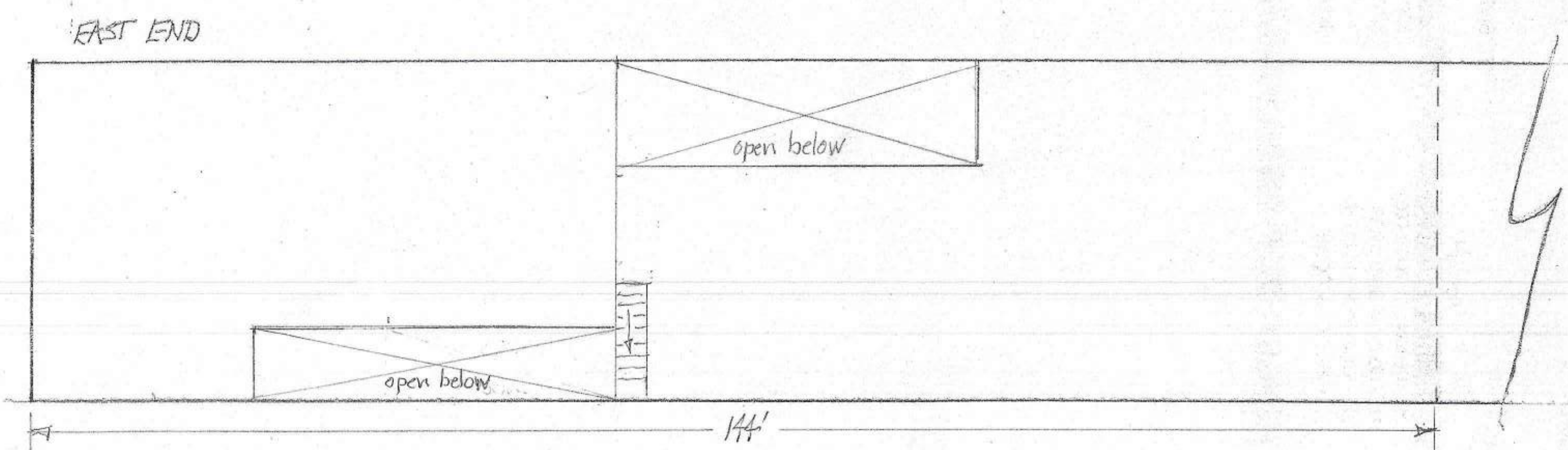
SECOND FLOOR
BOWDOINHAM RECYCLING BARN
scale - 1" = 16'-0"





- TOWN LEASEHOLD AREA – 3240 ft²

THIRD FLOOR
BOWDOINHAM RECYCLING BARN



1/20/10

ATTACHMENT C
OLDER ENGINEERING REPORTS

OMITTED FOR TOWN WEBSITE DISPLAY
DUE TO UPLOAD LIMITATIONS - PLEASE
SEE TOWN FOR THESE REPORTS

ATTACHMENT D
CALCUALTION SHEETS

ROOF

Bowdoinham P_g = 60 psf (Chazards @ ATCouncil.org)

Roofing: Corrugated Metal @ 0.4 psf.
Strapping assume 1x4 HF @ 16' oc = 0.95 plf nailer on rafter
2x8 HF = 2.11 plf rafter
HF, dry, 28 pcf (Engineering toolbox.com), Assume #1
Cellulose Insul. 3 pcf x 8"/12" = 2 pcf

DL roofing = 5.01 psf

wind (Chazards @ AT Council.org) RC II ASCE 7-10, 115 mph

Snow load calcs Medeek
Slippery roof C_s = 0.79 (CALDERWOOD (CEE) USED .85, MORE CONSERVATIVE THAN CODE)
Thermal C_t = 1.1
Exposure C_E = 1.0
Importance I_S = 1.0

p_f = 46.2 psf
p_s = 36.5 psf

Unbalanced snow load
P windward (North) = 0 psf } This condition matches owner's
P lee (SOUTH) = 60 psf } experience, roof collapse was on South side @ East end

Cr (repetitive member) only applies for spacing of 24" or less.

Rafter
For Vitruvius Calcs: OK in Bending by 6% w/ no wind or Roof Live load, not unbalanced, 9' SPAN

Span = 9 + 9'

Rafter Beam Span = 12', A_T = 12' x 14' (10' + 4')
Fails in Bending by 64%, shear by 8%, in Deflection by 28%

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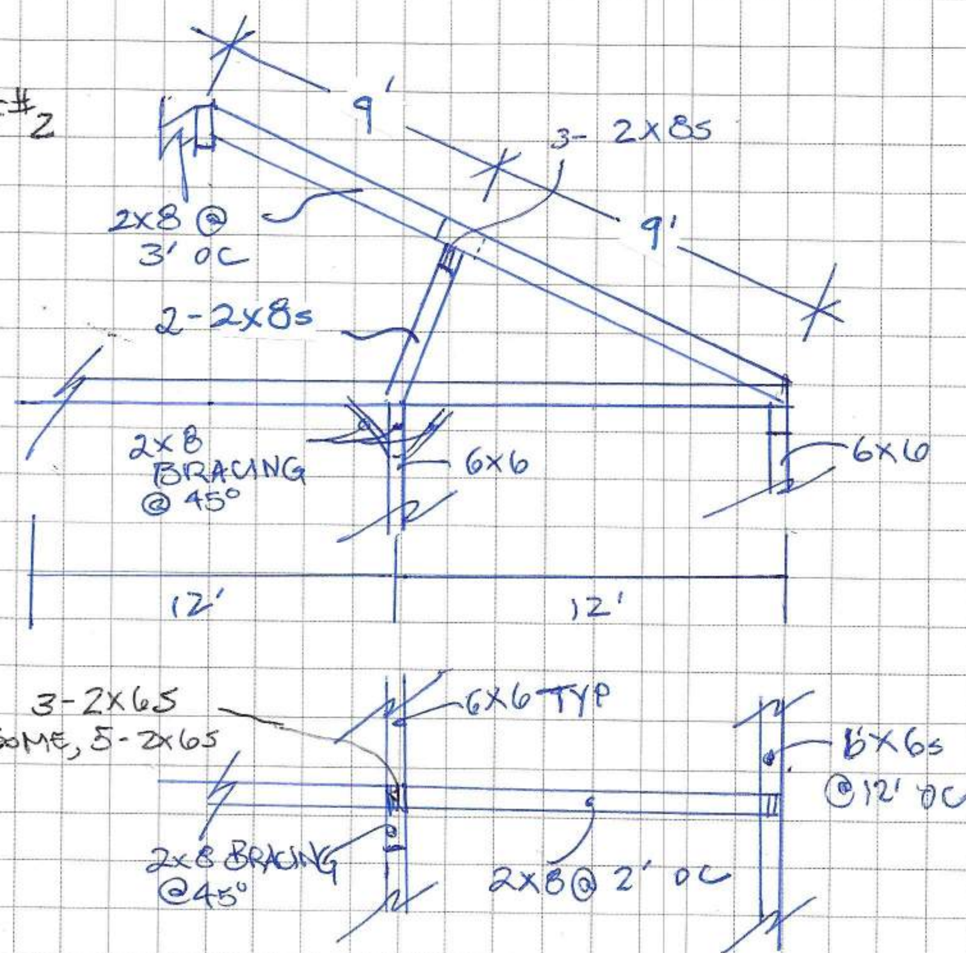
Project Name 243 Post Rd, B'ham
Designed by HCW Date 9/28/20
Checked by ______ Date ______
HWE P/N 20-0388-ME Sheet 1 of 3

ROOF + FLOOR

FRAMING SCHEMATIC
NTS

MATERIAL ASSUMED
HF #1
EXCPT NEW 2x12s, HF#2



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Designed by HCW Date 9/28/20

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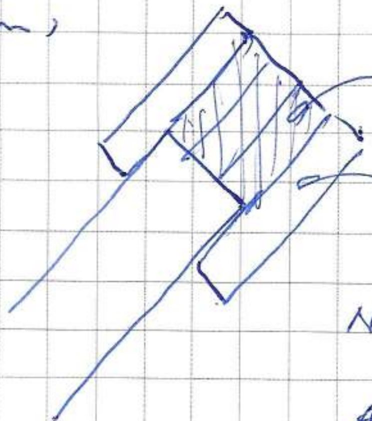
CEP/N 20-0389-ME Sheet 2 of 3

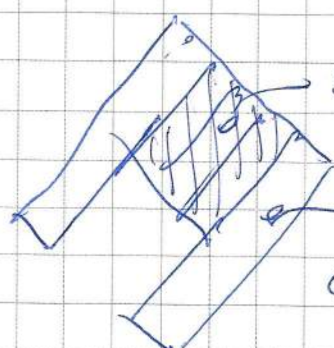
ROOF

Rafter Beam, MODIFIED



NEW 2x12s ALONE FAIL BY 58% Bending, 4% Shear
ADDING 2 MORE 2X12s FAILS IN BENDING BY 16%

TRY ADDING LVLs



OK BY 34% (REGULAR LOAD)

RAFTERS @ 8' WORKS BY 25% (REGULAR LOAD)
RAFTERS @ 9' WORKS BY 6% (" ")
UPPER RAFTERS NEED TO BE SIZED FOR UNBALANCED LOAD.

RAFTER BEAM: ADD 1 LVL EA. SIDE OF BEAM - SIZE FOR ADDITIONAL LOAD OF UNBALANCED SNOW.

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HWE P/N 20 - 0388 - MB Sheet 3 of 3

FLOOR LOADING

FRAMING AT THE
THE OPENING ABOVE THE COMPOSTER ISN'T WELL SUPPORTED.
1) REMOVE THE PLYWOOD SHEATHING, RELOC. THE HANDRAIL
OR 2) REINFORCE W/ AN ENG. DESIGN

FLOOR DL

4/4 DECKING 2.15 PSF × 2 = 4.3 PLF
2X8S @ 24" OC 2.67# PLF
6.97 PLF EXISTING ORIGINAL
ADD 1/2" PLYWOOD 1.42 PSF × 2 = 2.84#
9.81 PLF MOST OF 2nd & 3RD FLOORS

WHERE USED,
ADD 1/8" STEEL PLATE SHEETS
5.1 PSF × 2 = 10.2 PLF
20.01 PLF AREAS USING PALLET JACK

CEE USED 4.9 PSF FOR
DEAD LOAD, = 9.8 PLF. ✓

SPANS: 36' − 1' = 35'
35'/3 = 11'−8"
MAX LOAD W/ DL OF 9.8 PLF = 65 PLF = 32.5 PSF
W/ DL OF 20.01 PLF = 44 PLF = 22.0 PSF

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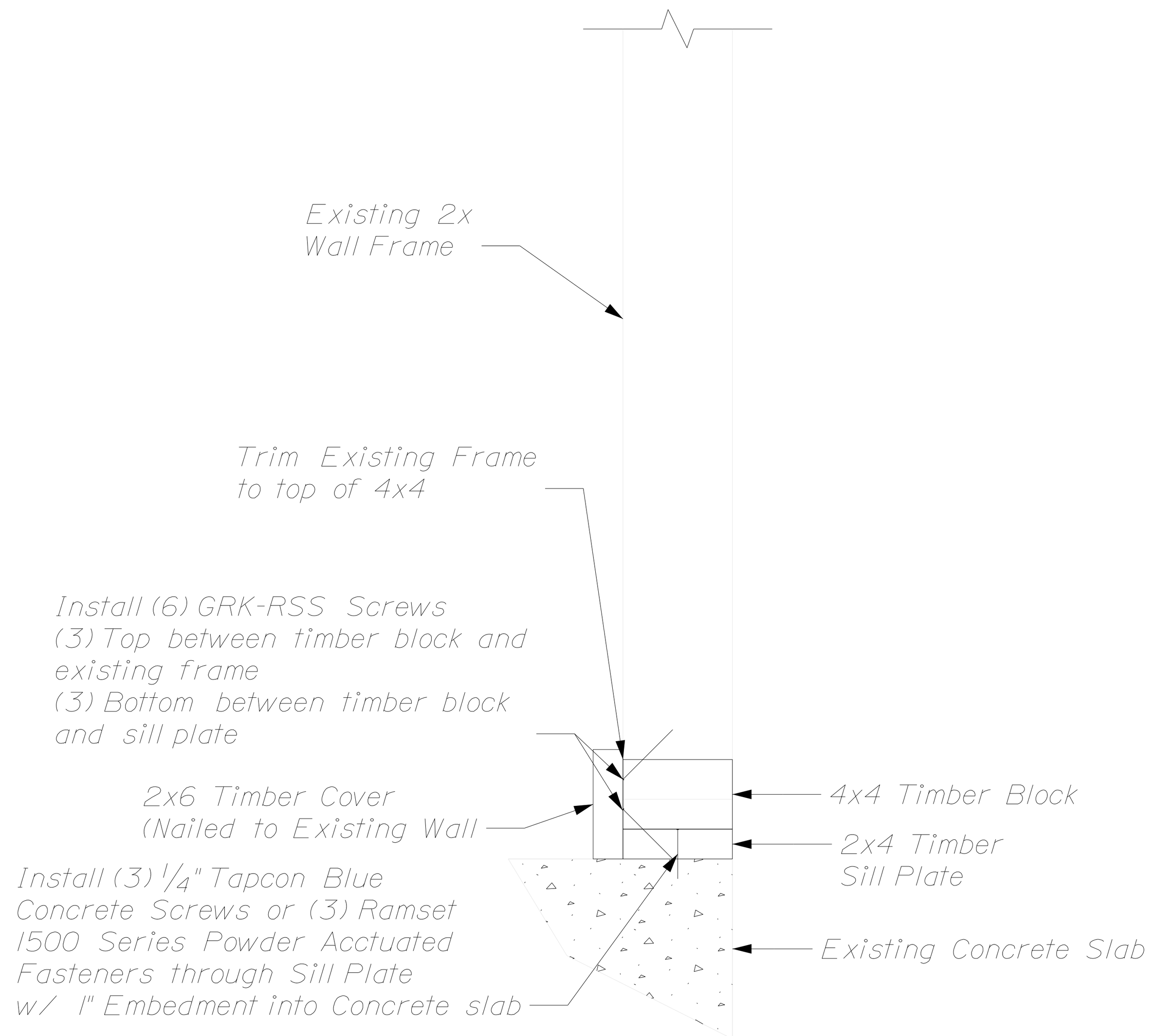
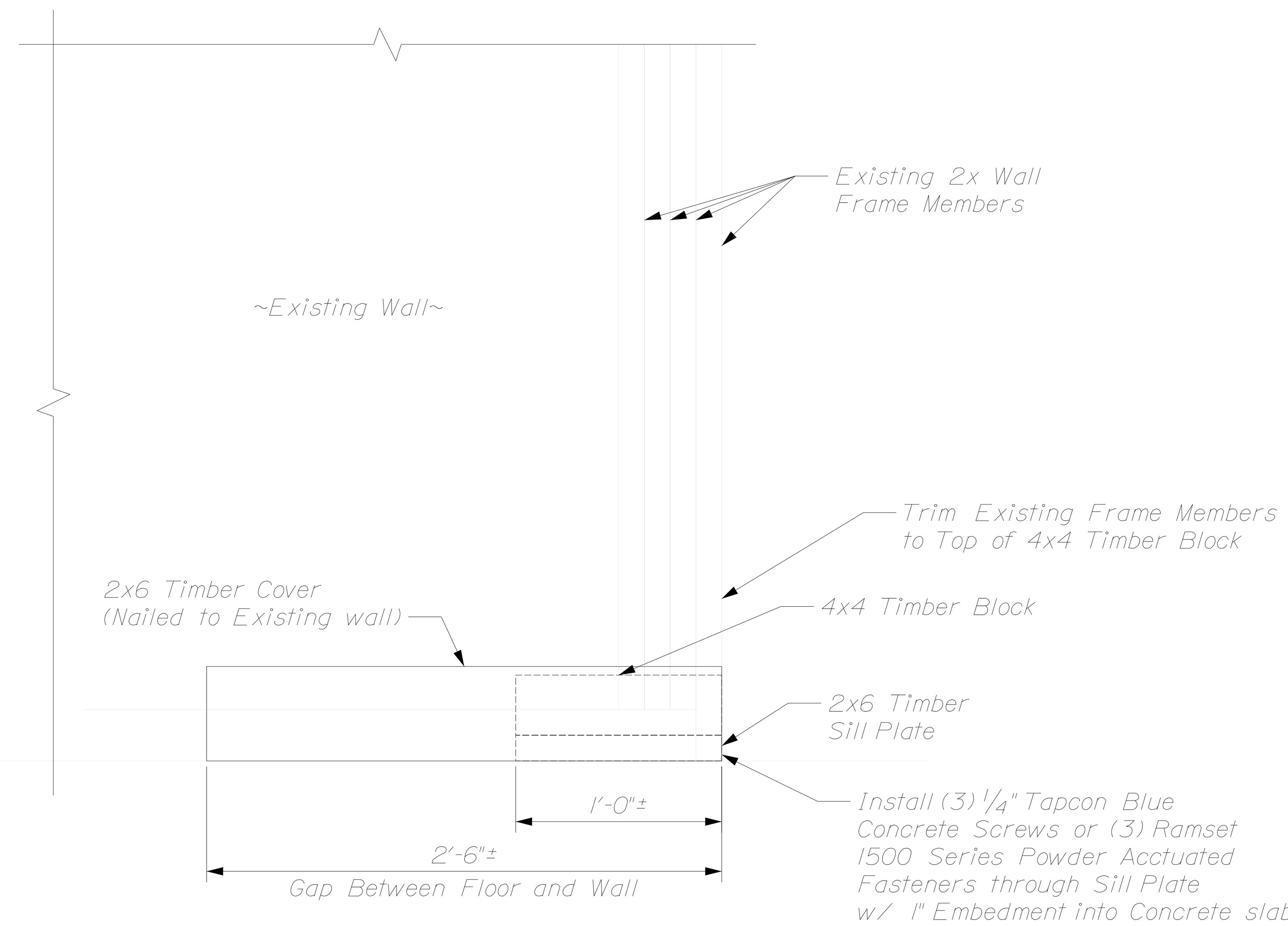


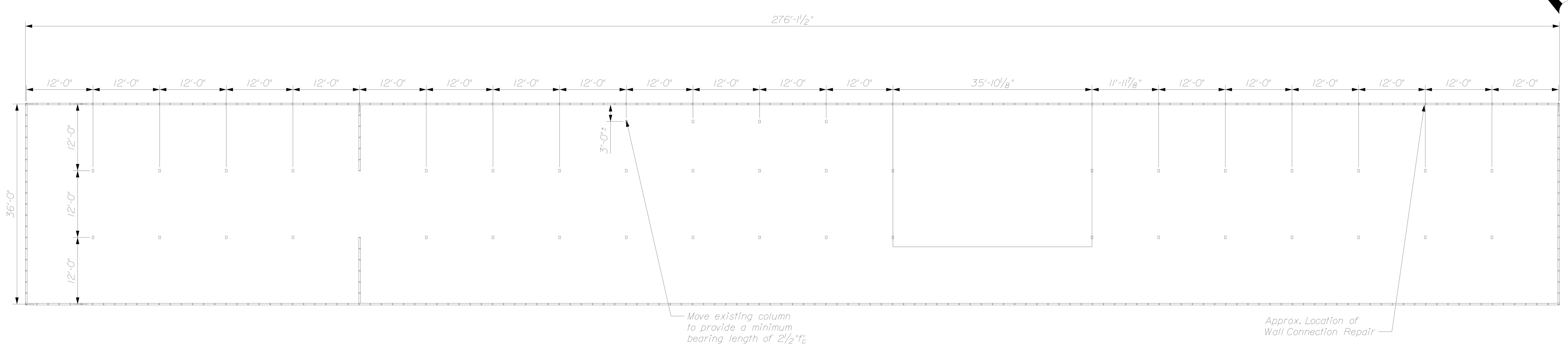
Wall Connection Repair Section
Scale: 1 1/2" = 1'-0"



Wall Connection Repair Elevation
Scale: 1 1/2" = 1'-0"

General Notes

1. Concrete Screws to be Tapcon Blue with 1/4"ϕ and 1" Embedment into Concrete, or approved alternative.
2. Powder Acctuated Nails to be Ramset 1500 Series with 1" Embedment into Concrete, or approved alternative.
3. Timber Screws to be GRK-RSS with a diameter of 1/4" and 1 1/2" Embedment into timber, or an approved alternative.
4. Timber cover to be measured in the field to cover the existing gap.



GENERAL BUILDING PLAN
Scale: 1" = 10'

Date:8/24/2020
Username: common
Division: Bridge
Filename: ...\001_RecyclingCenter.dgn

CALDERWOOD ENGINEERING, ETC.
STRUCTURAL ENGINEERING • DETAILING SERVICES
222 RIVER RD, RICHMOND, ME 04357 PH/FX (207)737-2007/(207)737-2008

PREPARED FOR: TOWN OF BOWDOINHAM
PROJECT NUMBER: 011-TOWNOFBOWDOINHAM-20

STATE OF MAINE
ERIC CALDERWOOD
No 9099
LICENSED
PROFESSIONAL ENGINEER

SIGNATURE
P.E. NUMBER 9099
DATE AUG 2020

NAME	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED	TDC	AUG 2020
CHECKED-REVIEWED	ETC	AUG 2020
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

BOWDOINHAM RECYCLING CENTER
RECYCLING CENTER BUILDING MODIFICATIONS

SHEET NUMBER
1
OF 1

CALDERWOOD ENGINEERING
222 RIVER ROAD
RICHMOND, ME 04357
PH (207) 737-2007 FAX (207) 737-2008

PROJECT SUMMARY

Project Name: 243 Post Road, Bowdoinham, ME

Governing Codes:
Building Code: 2018 International Building Code
ASCE: ASCE 7-16
Steel: AISC 360-16
Concrete: ACI 318-14
Masonry: TMS 402/602-16

Module Location: 2x8 Roof Rafter
Module Level: Roof
Module Type: Roof Rafter
Material Type: Solid Sawn Hem-Fir No. 1
Member Dimensions: 1.5 in. X 7.25 in. X 10 ft @ 36 in. Spacing
Section Adequacy: -14.2%
Controlling Factor: Bending-Tension

Module Location: Roof Purlins
Module Level: Roof
Module Type: Roof Beam
Material Type: Solid Sawn Hem-Fir No. 2
Member Dimensions: 1.5 in. X 11.25 in. X 12 ft
Section Adequacy: -57.7%
Controlling Factor: Bending Stress Y

Module Location: roof purlins w/ added 2x12s
Module Level: Roof
Module Type: Roof Beam
Material Type: Structural Composite Lumber Weyerhaeuser 2.0E Microlam LVL
Member Dimensions: 1.75 in. X 11.25 in. X 12 ft
Section Adequacy: 33.8%
Controlling Factor: Bending Stress Y

Module Location: 2x8 Roof Rafter @9 ft span
Module Level: Roof
Module Type: Roof Rafter
Material Type: Solid Sawn Hem-Fir No. 1
Member Dimensions: 1.5 in. X 7.25 in. X 9 ft @ 36 in. Spacing
Section Adequacy: 5.6%
Controlling Factor: Bending-Tension

Module Location: 2x8 Floor Joist max w plywood over 44 decking
Module Level: Main Floor
Module Type: Floor Joist
Material Type: Solid Sawn Hem-Fir No. 1
Member Dimensions: 1.5 in. X 7.25 in. X 11.67 ft
Section Adequacy: -0.2%
Controlling Factor: Bending Stress Y

Module Location: 2x8 Floor Joist max w plywood + steel plate over 44 decking
Module Level: Main Floor
Module Type: Floor Joist
Material Type: Solid Sawn Hem-Fir No. 1
Member Dimensions: 1.5 in. X 7.25 in. X 11.67 ft
Section Adequacy: 0.5%
Controlling Factor: Bending Stress Y

Module Location: 2x8 Floor Joist w plywood + steel plate and 5 ft of loading
Module Level: Main Floor
Module Type: Floor Joist
Material Type: Solid Sawn Hem-Fir No. 1
Member Dimensions: 1.5 in. X 7.25 in. X 11.67 ft @ 24 in. Spacing
Section Adequacy: 13.9%
Controlling Factor: Bending Stress Y

Module Location: Beam supporting travel lane of pallet jack
Module Level: Main Floor
Module Type: Roof Beam
Material Type: Structural Composite Lumber Weyerhaeuser 2.0E Microlam LVL
Member Dimensions: 1.5 in. X 11.25 in. X 12 ft @ 12 in. Spacing
Section Adequacy: 15.9%
Controlling Factor: Bending Stress Y

FAIL

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Roof	LOADING:	ASD
LOCATION:	2x8 Roof Rafter	CODE:	2018 International Building Code
TYPE:	ROOF RAFTER	NDS:	2018 NDS
MATERIAL:	SOLID SAWN		

Hem-Fir	No. 1	(1) 1.5 X 7.25	36(in) O.C.	DRY	

2x8 Roof Rafter DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 10 Member Slope: 5/12 Actual Length (ft): 10.83 Roof Pitch: 5/12 O.C. Spacing(in): 36

Area	Ix	Iy	BSW	Lams	G	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
10.88	47.63	2.04	2.15	1	0.43	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) $x10^3$	Emin (psi) $x10^3$
Base Values	975	625	150	1350	405	1500	550
Adjusted Values	1170	750	150	1417	405	1500	550
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1
C_i	1	1	1	1	1	1	1
C_F	1.2	1.2	1	1.05	1	1	1

Bending Adjustment Factors C_{fu} = 1 C_r = 1

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	10	0	10	4.166667	1.00	0.70	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (49.3%)**	87.5	172.5	0	D+S	1.15
Bending Stress Y (psi)	**FAIL (-14.2%)**	1568.2	1345.5	5.42	D+S	1.15
Deflection (in)	**PASS (39.3%)**	0.438 (=L/297)	0.722 (=L/180)	5.42	S	
Compressive Stress (psi)	**PASS (97.9%)**	24.3	1133.3	0	D+S	1.15
Tensile Stress (psi)	**PASS (97.2%)**	24.3	862.5	10.83	D+S	1.15
Bearing Stress (psi)	**PASS (72.5%)**	111.5	405.0	0	D+S	1.15
Bending-Compression (Unit)	**FAIL (-14.2%)**	1.17	1.00	4.9	D+S	1.15
Bending-Tension (Unit)	**FAIL (-14.2%)**	1.17	1.00	5.1	D+S	1.15

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	94	0	0	593	0	0	0	0	0	0	0
B	94	0	0	593	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	15.17	15.17	0	10	Dead	Y
Uniform (lbf/ft)	109.5	109.5	0	10	Snow	Y
Self Weight (lbf/ft)	2.15	2.15	0	10	Dead	Y

NOTES

FAIL

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Roof	LOADING:	ASD
LOCATION:	Roof Purlins	CODE:	2018 International Building Code
TYPE:	ROOF BEAM	NDS:	2018 NDS
MATERIAL:	SOLID SAWN		

Hem-Fir	No. 2	(2) 1.5 X 11.25	DRY		

Roof Purlins DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 12 Member Slope: 0/12 Actual Length (ft): 12 Roof Pitch: 5/12

Area	Ix	Iy	BSW	Lams	G	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
33.75	355.96	6.33	6.66	2	0.43	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) x10^3	Emin (psi) x10^3
Base Values	850	525	150	1300	405	1300	470
Adjusted Values	850	525	150	1300	405	1300	470
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1
C_i	1	1	1	1	1	1	1
C_F	1	1	1	1	1	1	1

Bending Adjustment Factors C_{fu} = 1 C_r = 1

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	12	0	12	0	1.00	0.54	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**FAIL (-4.4%)**	156.9	150.0	12	D+L	1
Bending Stress Y (psi)	**FAIL (-57.7%)**	2008.7	850.0	6	D+L	1
Deflection (in)	**PASS (35.6%)**	0.515 (=L/280)	0.800 (=L/180)	6	L	
Bearing Stress (psi)	**PASS (17.0%)**	336.3	405.0	0	D+L	1

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	465	3066	0	0	0	0	0	0	0	0	0
B	465	3066	0	0	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	70.84	70.84	0	12	Dead	Y
Uniform (lbf/ft)	511	511	0	12	Live	Y
Self Weight (lbf/ft)	6.66	6.66	0	12	Dead	Y

PASS

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Roof	LOADING:	ASD
LOCATION:	roof purlins w/ added 2x12s	CODE:	2018 International Building Code
TYPE:	ROOF BEAM	NDS:	2018 NDS
MATERIAL:	STRUCTURAL COMPOSITE LUMBER		

Weyerhaeuser	2.0E Microlam LVL	(2) 1.75 X 11.25	DRY		

roof purlins w/ added 2x12s DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 12 Member Slope: 0/12 Actual Length (ft): 12 Roof Pitch: 5/12

Area	Ix	Iy	BSW	Lams	Cfn	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
39.38	415.28	10.05	11.48	2	7.35	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) $x10^3$	Emin (psi) $x10^3$
Base Values	2600	1895	285	2510	750	2000	1016.535
Adjusted Values	2600	1895	285	2510	750	2000	1017
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1

Bending Adjustment Factors C_V = 1.01 C_r = 1 Volume factor Is applied on a load combination basis And Is Not reflected in the adjusted values

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	12	0	12	0	1.00	0.52	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (52.4%)**	135.6	285.0	12	D+L	1
Bending Stress Y (psi)	**PASS (33.8%)**	1735.9	2622.9	6	D+L	1
Deflection (in)	**PASS (64.1%)**	0.287 (=L/502)	0.800 (=L/180)	6	L	
Bearing Stress (psi)	**PASS (61.3%)**	290.6	750.0	0	D+L	1

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	494	3066	0	0	0	0	0	0	0	0	0
B	494	3066	0	0	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	70.84	70.84	0	12	Dead	Y
Uniform (lbf/ft)	511	511	0	12	Live	Y
Self Weight (lbf/ft)	11.48	11.48	0	12	Dead	Y

NOTES

PASS

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Roof	LOADING:	ASD
LOCATION:	2x8 Roof Rafter @9 ft span	CODE:	2018 International Building Code
TYPE:	ROOF RAFTER	NDS:	2018 NDS
MATERIAL:	SOLID SAWN		

Hem-Fir	No. 1	(1) 1.5 X 7.25	36(in) O.C.	DRY	

2x8 Roof Rafter @9 ft span DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 9 Member Slope: 5/12 Actual Length (ft): 9.75 Roof Pitch: 5/12 O.C. Spacing(in): 36

Area	Ix	Iy	BSW	Lams	G	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
10.88	47.63	2.04	2.15	1	0.43	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) $x10^3$	Emin (psi) $x10^3$
Base Values	975	625	150	1350	405	1500	550
Adjusted Values	1170	750	150	1417	405	1500	550
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1
C_i	1	1	1	1	1	1	1
C_F	1.2	1.2	1	1.05	1	1	1

Bending Adjustment Factors $C_{fu} = 1$ $C_r = 1$

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	9	0	10	3.75	1.00	0.70	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (54.4%)**	78.7	172.5	9	D+S	1.15
Bending Stress Y (psi)	**PASS (5.6%)**	1270.3	1345.5	4.88	D+S	1.15
Deflection (in)	**PASS (55.7%)**	0.288 (=L/407)	0.650 (=L/180)	4.88	S	
Compressive Stress (psi)	**PASS (98.2%)**	21.9	1242.1	0	D+S	1.15
Tensile Stress (psi)	**PASS (97.5%)**	21.9	862.5	9.75	D+S	1.15
Bearing Stress (psi)	**PASS (75.2%)**	100.3	405.0	0	D+S	1.15
Bending-Compression (Unit)	**PASS (5.6%)**	0.94	1.00	4.41	D+S	1.15
Bending-Tension (Unit)	**PASS (5.6%)**	0.94	1.00	4.59	D+S	1.15

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	84	0	0	534	0	0	0	0	0	0	0
B	84	0	0	534	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	15.17	15.17	0	9	Dead	Y
Uniform (lbf/ft)	109.5	109.5	0	9	Snow	Y
Self Weight (lbf/ft)	2.15	2.15	0	9	Dead	Y

NOTES

FAIL

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Main Floor	LOADING:	ASD
LOCATION:	2x8 Floor Joist max w plywood over 44 decking	CODE:	2018 International Building Code
TYPE:	FLOOR JOIST	NDS:	2018 NDS
MATERIAL:	SOLID SAWN		

Hem-Fir	No. 1	(1) 1.5 X 7.25	0(in) O.C.	DRY	

2x8 Floor Joist max w plywood over 44 decking DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 11.67 Member Slope: 0/12 Actual Length (ft): 11.67 O.C. Spacing(in): 24

Area	Ix	Iy	BSW	Lams	G	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
10.88	47.63	2.04	2.15	1	0.43	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) $x10^3$	Emin (psi) $x10^3$
Base Values	975	625	150	1350	405	1500	550
Adjusted Values	1346	750	150	1417	405	1500	550
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1
C_i	1	1	1	1	1	1	1
C_F	1.2	1.2	1	1.05	1	1	1

Bending Adjustment Factors C_{fu} = 1 C_r = 1.15

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	11.67	0	10	0	1.00	0.70	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (53.5%)**	69.8	150.0	0	D+L	1
Bending Stress Y (psi)	**FAIL (-0.2%)**	1348.5	1345.5	5.83	D+L	1
Deflection (in)	**PASS (2.4%)**	0.380 (=L/369)	0.389 (=L/360)	5.83	L	
Bearing Stress (psi)	**PASS (76.2%)**	96.4	405.0	0	D+L	1

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	127	379	0	0	0	0	0	0	0	0	0
B	127	379	0	0	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	19.6	19.6	0	11.67	Dead	Y
Uniform (lbf/ft)	65	65	0	11.67	Live	Y
Self Weight (lbf/ft)	2.15	2.15	0	11.67	Dead	Y

PASS

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Main Floor	LOADING:	ASD
LOCATION:	2x8 Floor Joist max w plywood + steel plate over 44 decking	CODE:	2018 International Building Code
TYPE:	FLOOR JOIST	NDS:	2018 NDS
MATERIAL:	SOLID SAWN		

Hem-Fir	No. 1	(1) 1.5 X 7.25	0(in) O.C.	DRY	

2x8 Floor Joist max w plywood + steel plate over 44 decking DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 11.67 Member Slope: 0/12 Actual Length (ft): 11.67 O.C. Spacing(in): 24

Area	Ix	Iy	BSW	Lams	G	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
10.88	47.63	2.04	2.15	1	0.43	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) x10^3	Emin (psi) x10^3
Base Values	975	625	150	1350	405	1500	550
Adjusted Values	1346	750	150	1417	405	1500	550
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1
C_i	1	1	1	1	1	1	1
C_F	1.2	1.2	1	1.05	1	1	1

Bending Adjustment Factors C_{fu} = 1 C_r = 1.15

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	11.67	0	10	0	1.00	0.70	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (53.8%)**	69.3	150.0	0	D+L	1
Bending Stress Y (psi)	**PASS (0.5%)**	1339.2	1345.5	5.83	D+L	1
Deflection (in)	**PASS (13.8%)**	0.503 (=L/278)	0.584 (=L/240)	5.83	D+L	
Bearing Stress (psi)	**PASS (76.4%)**	95.7	405.0	0	D+L	1

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	246	257	0	0	0	0	0	0	0	0	0
B	246	257	0	0	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	19.6	19.6	0	11.67	Dead	Y
Uniform (lbf/ft)	44	44	0	11.67	Live	Y
Uniform (lbf/ft)	20.4	20.4	0	11.67	Dead	Y
Self Weight (lbf/ft)	2.15	2.15	0	11.67	Dead	Y

PASS

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		

LEVEL:	Main Floor	LOADING:	ASD
LOCATION:	2x8 Floor Joist w plywood + steel plate and 5 ft of loading	CODE:	2018 International Building Code
TYPE:	FLOOR JOIST	NDS:	2018 NDS
MATERIAL:	SOLID SAWN		

Hem-Fir	No. 1	(2) 1.5 X 7.25	24(in) O.C.	DRY	

2x8 Floor Joist w plywood + steel plate and 5 ft of loading DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 11.67 Member Slope: 0/12 Actual Length (ft): 11.67 O.C. Spacing(in): 24

Area	Ix	Iy	BSW	Lams	G	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
21.75	95.27	4.08	4.29	2	0.43	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) x10^3	Emin (psi) x10^3
Base Values	975	625	150	1350	405	1500	550
Adjusted Values	1346	750	150	1417	405	1500	550
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1
C_i	1	1	1	1	1	1	1
C_F	1.2	1.2	1	1.05	1	1	1

Bending Adjustment Factors C_{fu} = 1 C_r = 1.15

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	11.67	0	10	0	1.00	0.73	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (44.8%)**	82.9	150.0	0	D+L	1
Bending Stress Y (psi)	**PASS (13.9%)**	1159.0	1345.5	4.2	D+L	1
Deflection (in)	**PASS (29.5%)**	0.274 (=L/510)	0.389 (=L/360)	5.25	L	
Bearing Stress (psi)	**PASS (71.7%)**	114.4	405.0	0	D+L	1

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	258	943	0	0	0	0	0	0	0	0	0
B	258	257	0	0	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	19.6	19.6	0	11.67	Dead	Y
Uniform (lbf/ft)	20.4	20.4	0	11.67	Dead	Y
Uniform (lbf/ft)	240	240	0	5	Live	Y
Self Weight (lbf/ft)	4.29	4.29	0	11.67	Dead	Y

PASS

DATE:	10/2/2020	COMPANY:	Helen Watts Engineering PLLC
VITRUVIUS BUILD:	Base	DESIGNED BY:	Helen Watts
CUSTOMER:		REVIEWED BY:	Helen Watts
PROJECT LOCATION:	,		
LEVEL:	Main Floor	LOADING:	ASD
LOCATION:	Beam supporting travel lane of pallet jack	CODE:	2018 International Building Code
TYPE:	ROOF BEAM	NDS:	2018 NDS
MATERIAL:	STRUCTURAL COMPOSITE LUMBER		

Weyerhaeuser	2.0E Microlam LVL	(4) 1.5 X 11.25	DRY		

Beam supporting travel lane of pallet jack DIAGRAM

BEAM PROPERTIES

Start (ft): 0 End (ft): 12 Member Slope: 0/12 Actual Length (ft): 12 Roof Pitch: 0/12

Area	Ix	Iy	BSW	Lams	Cfn	Kcr
(in^2)	(in^4)	(in^4)	(lbf/ft)			Creep Factor
67.5	711.91	12.66	19.69	4	7.35	1

STRENGTH PROPERTIES

	Fb (psi)	Ft (psi)	Fv (psi)	Fc (psi)	Fc⊥(psi)	E (psi) x10^3	Emin (psi) x10^3
Base Values	2600	1895	285	2510	750	2000	1016.535
Adjusted Values	2600	1895	285	2510	750	2000	1017
C_M	1	1	1	1	1	1	1
C_T	1	1	1	1	1	1	1

Bending Adjustment Factors C_V = 1.01 C_r = 1 Volume factor Is applied on a load combination basis And Is Not reflected in the adjusted values

BEAM DATA

		Unbraced Length (ft)		Beam End				
Span	Length (ft)	Top	Bottom	Elev. Diff (ft)	CL(Top)	CL(Bottom)	CL(Left)	CL(Right)
1	12	0	12	0	1.00	0.40	1.00	1.00

PASS-FAIL

	PASS/FAIL	MAGNITUDE	STRENGTH	LOCATION (ft)	LOAD COMBO	DURATION FACTOR CD
Shear Stress Y (psi)	**PASS (53.2%)**	133.3	285.0	12	D+L	1
Bending Stress Y (psi)	**PASS (15.9%)**	2205.0	2622.9	6	D+L	1
Deflection (in)	**PASS (49.3%)**	0.406 (=L/355)	0.800 (=L/180)	6	D+L	
Bearing Stress (psi)	**PASS (61.9%)**	285.7	750.0	0	D+L	1

REACTIONS

V-(lbf) M-(lbf-ft)

Y axis	DEAD	LIVE	LIVE ROOF	SNOW	WIND +	WIND -	SEISMIC +	SEISMIC -	ICE	RAIN	EARTH
A	2998	3002	0	0	0	0	0	0	0	0	0
B	2998	3002	0	0	0	0	0	0	0	0	0

Reaction Location

A B

LOAD LIST

Type	Left Magnitude	Right Magnitude	Load Start (ft)	Load End (ft)	Load Type	Direction
Uniform (lbf/ft)	480	480	0	12	Dead	Y
Uniform (lbf/ft)	1201	1201	3.5	8.5	Live	Y
Self Weight (lbf/ft)	19.69	19.69	0	12	Dead	Y

NOTES

ATTACHMENT E
PROFESSIONAL RESUME

CRITERIUM ENGINEERS

BUILDING INSPECTION ENGINEERS
PROUDLY SERVING NORTH AMERICA SINCE 1957

Helen C. Watts, P.E.

Senior Engineer

Helen Watts practices structural engineering with PE licensure in four states, with over 40 years of experience in construction, facilities engineering, inspection, and structural design for repairs, new construction, and building modifications.

Her experience includes hundreds of residential and commercial building inspections, remediation and remodeling designs, forensic investigations, and design for new construction on commercial, industrial, condominium and residential properties, as well as construction management and inspection.

For over 12 years, she worked as a Principal at Helen Watts Engineering PLLC performing inspections and design for wood, timber, masonry, concrete, and steel structures.

Helen has taught a variety of courses to engineers and the trades, including developing a curriculum and teaching the first course of structural engineering for timber framers at KVCC, and teaching structural engineering for the PE preparation course for mechanical engineers.

EDUCATION AND PROFESSIONAL AFFILIATION

University of New Hampshire, Durham, NH – 1980, BS Civil Engineering
University of Maine, Orono, ME – 1983, 5^{th} Year Certificate, Pulp and Paper Manufacturing
Licensed Professional Engineer: Maine, New Hampshire, Massachusetts, Hawaii
Certifications: NCEES, SECB, MaineDOT LPA
Memberships: Structural Engineers Association of Maine
Timber Guild Engineering Council
ASCE Fellow, Lead for 2 Areas for Maine Infrastructure Grade 2008 -
Society of Women Engineers
Pejepscot Terrace, Brunswick, ME – Chair of the Board
Author: The Graphic Handbook of the Pretty Good House (2013)
Volume 2, The Pretty Good House (2016)

WHY I DO WHAT I DO

I want to help every building be the best it can be, and every building owner get the most out of their building dollar. Buildings should be healthy, comfortable, robust and sustainable. My work impacts the productivity of the building occupants, the carbon footprint during construction and maintenance, and the bottom line of the owners. I love finding the little problems that can be big possibilities instead of bad surprises.

WHY CRITERIUM ENGINEERS

Criterium Engineers serves a wide variety of clients across the country, and I like the challenge of assisting Criterium Franchises. I also like the care taken in producing high-quality reports.

PROJECT HIGHLIGHTS

- Inspection and report on the Gedney House, Salem, MA, owned by Historic New England and built in 1665 – Structural adequacy, durability, and ideas for the use of the building as a museum of timber and wood construction methods.
- Hathorn Block, Bowdoinham, ME – Structural evaluation and repair planning, new masonry openings, plus structural design to bring 5 stories of 1849 timber framing up to modern building code floor loadings and to provide an elevated concrete deck.
- New private residence and cottage, Biddeford, Maine – Evaluation of existing retaining wall, and design and permitting of new retaining wall under new Maine Sand Dune regulations, structural design of two new buildings, weekly construction inspection through completion of structural framing.
- Horizontal boring machine, Portsmouth Naval Shipyard, Kittery, ME – Design of foundation and installation of the foundation and the horizontal boring machine in the Controlled Industrial Access area of the shipyard
- Portland House, Portland, ME – Inspection, development of repair plans and specifications, project contracting assistance and construction inspection, repairs to 3-level parking garage. Also, repairs to the masonry exterior, and planning of work for the handrail attachment to the balcony decks.
- Danforth Heights, Portland, ME – Investigation, report, repair planning, specifications and drawings, contracting assistance, construction inspection, repairs to masonry façade to stop water intrusion. Also, inspections of 43 units of low-income townhouses with reports for maintenance planning.

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