39-ST-08

Floor Load Rating
Bowdoinham Recycling Center

In the Town of

Bowdoinham, Maine

Prepared for:

The Town of Bowdoinham

By:

Calderwood Engineering etc

July 3rd, 2008

STATE OF MAINE
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No. 9069
LICENSED PROFESSIONAL ENGINEER

Cover photo: Pedestrian Truss, City of Augusta

Load rating summary – Existing conditions:

On June 6th 2008 I inspected the Bowdoinham Recycling center. The building is a converted (3) story Chicken barn, and has been modified many times throughout its service life. Overall the building appears to be in relatively serviceable condition, and the current occupant has been prudent with upkeep and in fact some floor sheathing was being strengthened during my inspection. This regular maintenance should continue as required.

The following is the results of my analysis: (Loads are allowable live loads in pounds per square foot, dead loads have been deducted from these values already)

Floor Joists (2x8x12' @ 2' Centers) – 27.6
Triple (2x8 Girder supporting (1) span (center bay undecked) – 27.7
Triple (2x8 Girder supporting (2) span (center bay decked) – 11.4
6x6 Builtup post (1st floor center bay undecked) – 51.7
6x6 Builtup post (1st floor center bay decked) – 37.5
6x6 Solid Sawn (1st floor center bay undecked) – 33.7
6x6 Solid Sawn (1st floor center bay decked) – 24.1

Sawn Lumber Nail connected Truss –
- Bottom Chord – 40.1
- Tension Diagonals – 34.2
- Connection of Tens Diag (10 16d nails/2x8 end) - 7.4
- Compression Chord – will not govern
- Compression Diagonals (10 16d nails/2x8 end) – 32.1

12x12 Posts (16ft tall) – 179.0

Recommendations & Modifications:

The floor load ratings given above should be posted on the floors in a visible location.

The floor load rating above the Trussed area may be increased to 32.1 if (2) 1" diameter bolts are installed through the 2x8 tension diagonals all the way through the Bottom chord on one end and (2) 1" diameter bolts are installed through the tension diagonal all the way through the top chord on the other. Exact details should conform to NDS for wood construction recommendations for minimum end. This is recommended and would result in the installation of (4) bolts on each of (2) trusses.

The floor load rating may be increased in the center bay decked over areas from the 11.4 by strengthening the main girder. These girders may be increased from (3) 2x8's to (4) 2x8's by simply nail laminating as required which would result in an allowable load of 16.8 psf. Additional strength may be provided by using either steel angle lagged to the girder corners, or by using a deeper section or an LVL microlam of the same depth

nail laminated, these retrofits seem excessive for the intended use and would not result in a load rating greater than 27.6 psf or 24.1 psf if posts are solid sawn unless the joists & or posts were retrofit also.

One area where a post supporting the 3rd floor bears on a short section of builtup girder between the 1st and 2nd floors is in need of repair. The short section of girder was cut off short, and should be secured tightly in place by laminating the posts with a piece of plywood in both the x & y axis of the posts the short piece of girder should be cut off flush with the side of the posts and should be fastened to the plywood to prevent it from walking out under loads over time. Ref. photo.

Floor Sheathing – Sheathing does not govern the load rating, and it's condition is suspect in some areas, this is to be expected due to the former presence of chickens and certain areas of the flooring will likely need to be strengthened due to poor performance. Those areas where the floor sheathing is not performing adequately should be strengthened by adding plywood, osb or similar 3/8" min thickness in the localized area where performance is suspect. These areas will become apparent during use and should be promptly addressed as they become apparent.

Additional Items noted during inspection:

Although roofing members were outside of the scope of my consideration where purlins are supported over posts they affect the post capacity by transferring snow load to the posts below. This barely has any effect on the post capacity or the floorload rating, however a couple of things should be mentioned that were noticed. The purlins are undersized for the roof snow load. Also the existing roofing material is corrugated metal and should be maintained as corrugated metal or another "slippery surface" should it

come time to replace the roof. If a non-slippery surface roofing is ever installed in the future the snow load on the roof increases by 15% theoretically and will require the roof to be retrofit, and may result in a lower floor load rating for the floors below unless columns are retrofit as well.

There is a short area about 30' long x 4'-6" where the floor joists are supported by a single 2x8 header 30' long +/- this header is supported at 6' increments +/- by 2x6 hangers from the rafters. This area has no capacity for any live load at all, and should be permanently blocked off to prevent accidental storage within that area, or it should be strengthened adequately to handle intended loadings. This is part of the (3rd floor in an area near where the second floor is omitted and the 3rd floor is supported by trusses.

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JOB Residence Renovation 09-55-05
SHEET NO. 1 OF 10
CALCULATED BY ETC DATE 6/09
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SCALE

GEN. INFO. ALL LUMBER IN EXISTING BLDG. FLOORING SYSTEM WAS INSPECTED AND THIS REPORT RECOMMENDS THE USE OF SPF #2 AS A REPRESENTATIVE OF THE MINIMUM THAT IS INCORPORATED INTO THE WORK.

GROUND SNOW $P_g = 60$ psf (BOWDOINHAM ME. ASCE 7-05

$P_f = C_E C_T (0.7)(P_g)$ $C_E = 1.0$ $C_T = 1.1$

→ THE RAFTERS ARE ONLY 2x6 & THE INSULATION IS QUESTIONABLE, BUT THE STRUCTURE'S HEATING IS LIMITED ∴ 1.1 IS RECOMMENDED

$P_f = 1.0\ (1.1)(0.7)(60) = 46.2$ psf

PITCH OF ROOF EST. = 5 on 12 $C_S = 0.85$ SLIPPERY
$C_S = 1.0$ NON-SLIPPERY

$P_s = (0.85)(46.2\ psf) = 39.27$ psf

TYPICAL DEAD LOAD -

1x FLOORING - 2 psf
½" PLYWOOD - 1.5 psf
2x8 JOISTS @ 2' CENTERS - 1.4 psf

TOTAL DEAD LOAD = 4.9 psf

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JOB: Fowscowham Recycling Ctr 55-ST-05

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SPF #2 (south)

$F_b = 775$ psi
$F_c = 1000$ psi $E_{MIN} = 400{,}000$ psi
$F_v = 135$ psi
$C_F = 1.15$ for bending $F_t = 350$ psi
$F_{c\perp} = 335$ psi

Size Factor (2x6) = 1.2 (F_b) & (F_c)
1.10 (F_c) (2x6)

For 6x6 posts said same $F_c = 425$ psi $C_F = (1.0)$
$E_{MIN} = 370{,}000$ psi

$l_1 = 96$ in.

$F_c^* = 1000(1.10)$ or $425(1.0) = 425$ psi (6x6)
$= 1100$ psi or 425 psi

$F_{cE} = \frac{0.822\,(400{,}000)}{(96/4.5)^2} = 722.5$

$F_{cE} = \frac{0.822\,(370{,}000)}{(96/5.5)^2} = 998.3$

$c = 0.8$

$c = 0.8$

$C_P = \frac{1 + 722.5/1100}{1.6} - \sqrt{\left(\frac{1 + 722.5/1100}{1.6}\right)^2 - \frac{722.5/1100}{0.8}}$

$= 0.534$

$C_P = \frac{1 + 998.3/425}{1.6} - \sqrt{\left(\frac{1 + 998.3/425}{1.6}\right)^2 - \frac{998.3/425}{0.8}}$

$C_P = 0.89$

$F_c' = (0.534)(1100) = 587.7$ psi

$F_c' = 0.89(425) = 378.25$ psi

Then $P = 587.7\,(5.5)(9.5)$
$= 14546$ LBS / post

TOTAL $P = (5.5)^2\,(378.25) = 11{,}442$ lbs

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ALLOWABLE BENDING MOMENT OF (3) 2X8

ASSUME BRACED AGAINST ROTATION BY JOISTS FROM l_b = 2'-0"

$d/b = 7.25/4.5 = 1.61 \leq 2.0$ ∴ NO LATERAL SUPPORT REQ'D

$F_b' = F_b = 775$ psi $(1.2)(1.15) = 1070$ psi

$S_x = (4.5)(7.25)^2/6 = 39.42$ in^3

$M_{max\ allowable} = (1070)(39.42) = 42,181.41$ lb-in
$= 3,515$ lb-ft

$M_u = w l^2/8$ $l = 12'$

$w_{max} = 195.3$ lbs/LF

$w/12$ SF/ft MAX FLOOR LOAD FOR TRIPLE

16.3 lbs/S.F. (TOTAL (3) 2X8 ONLY)
WHERE CENTER BAY IS DECKED OVER, 32.5 lbs/SF WHERE CENTER BAY IS NOT DECKED OVER

FLR. JOISTS:
$S_x = 39.42/3 = 13.14$ in^3 $M_{u\ all.} = 13.14\ (1070) = 14,060$ lb-in

$M_u = 14060/12 = 1172$ lb-ft

$w_{all} = 1172/18 = 65$ lbs/LF @ 2' SPACING

FLOOR LOAD RATING = 32.5 lbs/SF

FOR JOISTS @ 18" SPACING
RATING GOVERNED BY (3) 2X8 GIRDERS

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LOAD FROM ROOF PURLINS

(18)(1/2)(320)(3) = 1060 lbs / RAFTER

PURLINS ARE HIGHLY UNDERSIZED

REACTION @ POSTS = (1060)(5) = 5300 (SNOW APPLY)

DEAD LOAD SAY 5 psf (12½%)

TOTAL @ POSTS FROM ROOF = 1.125 (5300) =

5964 lbs / POST

REMAINING CAPACITY OF POSTS SUPPORTS

(12)(6) = 72 SF / FLR OR

(12)(12) = 144 SF / FLR (IF COVERED

BUILT UP (3) 2x6 POSTS (14546)(1.25) - 5964

= 12218.5 lbs / (72 + 144) = 56.6 lbs / SF
42.4 lbs / SF (AREA COVERED)

OR SOLID SAWN 1.25 (11442) - 5964

= 8338.5 lbs / (72+144) = 38.6 lbs / SF
29.0 lbs / SF (CTR AREA COVERED)

W/O SNOW (14546 - 675) = 13871 / (72+144) = 64.2 psf
ROOF DEAD LOAD OR 48.2 psf

(11942 - 675) / (72+144) = 49.0 psf
37.4 psf

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DECKING - SPF SOUTH 2"-4" DECKING TIMBERS 1150 psi

SIZE FACTORS = 1.04 FOR 3" NOM DECKING

$F'_b = 1.04\ (1150) = 1196$ psi

$S_x = 12\ (0.75)^2/6 = 1.125$ in^3

$l = 2.5'$ $\quad M_{n\,ALL} = 1.125\ (1196)\ /12 = 112.13$ lb-ft

$w_{ALL} = 112.13/0.5 = 224$ psf

✓ SHEAR $\quad F'_v = 125$ psi

$F_{vH} = \frac{3V}{2A}$ $\quad A = 12\ (0.75) = 9$ in^2

$125\ (2/3)\ (9) = 750$ lbs - DECKING WILL NOT GOVERN

RECOMMEND CONTINUING TO ADD PLYWOOD AS REQ'D

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✓ SINGLE 2×8 BEAM

30 ft LONG – SUPPORTED FROM RAFTERS @ 6' CENTERS (RAFTERS ARE IN CAPABLE OF SUPPORTING MORE THAN THE ROOF LOAD & ARE VISIBLY UNDISTURBED EITHER A MORE SUBSTANTIAL HOPPER BEAM SHOULD BE INSTALLED, SUPPORTED FROM THE FLOOR UP OR THIS AREA SHOULD BE PHYSICALLY ROPED OFF TO PREVENT ANY STORAGE FROM TAKING PLACE W/IN THIS NARROW STRIP)

(2×8) 775 (1.2) = 930 psi

M_u = 13.14 (930) /12 = 1018.4 lb-ft

l = 30' $w l^2/8$ = 1018.4 w = 9.05 lbs/LF

2.25 SF/LF 9.05 / 2.25 = 4.02 lbs/SF (TOTAL

SELF WT ≈ 5 lbs/LF (say OK. FOR SELF WT

BUT ELIMINATE USE OF AREA OR STRENGTHEN)

✓ TRUSSES & 12×12 POSTS

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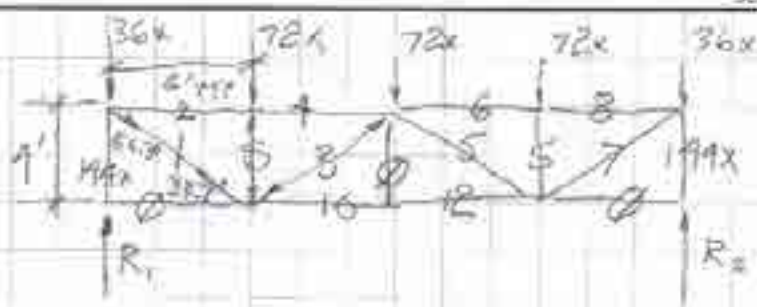

$R_1 = R_2 = 36x(2) + 72x = 144x$

S = 72K X = FLOOR LOAD IN PSF

CENTER STRUT = NO LOAD BY INSP.

MEMBER #1 * COS 56.3 = 144x - 3.6x = 108x

#1 = 194.6x ✓ (TENS)
#2 = 194.6x ✓ COS 33.7 = 161.9x ✓ (COMP)
#3 * COS 56.3 + 72x = 194.6x (COS 56.3) = 64.8x (COMP.)
#4 = 161.9x (BY INSP.) ✓

#10 = 64.8x (COS 33.7) + 194.6x (COS 33.6) = 216x (TENS.)

✓ #12 BY SUMMING MOMENTS ABOUT JT 9-6

$[36x(12) + 72x(6) - 144x(12)] / 4 = -216x$ (VERIFIES INSPECTION)

TOP & BTM CHORD (3)(2x10's) = 7.25(1.5)(3) = 41.625 in²

WEB MEMBERS (2)(2x8's) = 7.25(1.5)(2) = 21.75 in²

VERTICALS = (1)(6x6) EACH

✓ TENSION CHORD $C_D C_M C_t = 1.0$

SPF #2 $F_t = 350$ psi $C_t = 1.0$

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ETM CHORD CAPACITY = 350 * 91.625 = 14,569 lbs =

216 x x = 67 lbs/SF

(SPLICES IN ETM CHORD LIKELY LIMIT THE ALLOWABLE TENSION TO 2/3 RD'S OF THAT VALUE)

∴ (67)(2/3) = 45 lbs/SF

✓ TOP CHORD F_c = 1000 psi

(TOP CHORD WILL NOT GOVERN $F_c >> F_t$ & ALL PLIES CAN BE EFFECTIVE IN COMPRESSION

✓ WEB MEMBERS #1 & #7 LIKELY TO GOVERN TRUSS CAPACITY (TENSION)

CAP = (350)(21.75) = 7612.5 lbs = 194.6x

x = 39.12 psf

✓ CONNECTION OF 2x8's (10) (16d) NAILS IN SINGLE SHEAR

Z = 120 lbs/NAIL = 1200 lbs CAPACITY OR

TOTAL = 2400 lbs CAP = x = 12.33 lbs/SF

FOR INTERIOR WEB MEMBERS

(64.8x) = 2400 ∴ x = 2400/64.8 = 37.04 lbs/SF

INSTALL [7600 - 2400] / (2 * 120) = 21 MORE NAILS W/IN AREA OF CONCERN TOP & BTM OR INSTALL

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PLYWOOD GUSSETS W/ APPROPRIATE # OF CONNECTIONS. ALTERNATELY THE CONNECTIONS MAY BE SUPPLEMENTED W/ BOLTS (THROUGH BOLT FULL THICKNESS

FOR 7/8" BOLTS $Z_{\parallel} = 2880$ lbs

$Z_{M\perp} = 1455$ lbs (INT.

$Z_{M(33.7°)} = -(\sin 33.7)(2880 - 1955) + 2880 = 2090$ lbs/bolt

FOR 7/8" BOLTS USE (3) ✓ 1" BOLTS

$Z_{M\perp} = 1580$ lbs $Z_{M\parallel} = 3550$ lbs

$Z_{M(33.7°)} = -(\sin 33.7)(3530 - 1580) + 3530 = 2447.3$ lbs

USE (2) BOLTS $(2447.3)(2) + 2400 = 7295$ lbs

X = 37.5 ∴ THE LIMIT FOR THE OTHER WEB DIAGONALS ∴ USE (2) 1" ϕ BOLTS IN EACH OF THE END VERTICAL WEB MEMBERS (LEA. END OF)

SAY $F_c = 1000$ psi (12×12 BUILT UP POSTS)
$E_{min}' = 370000$ psi
$F_c^* = 425$ psi $l_e/d = 16(12)/12 = 16$

$F_{cE} = 0.822(370000)/16^2 = 1,188$ psi

$$C_p = \frac{1+(1188.0/1000)}{2(0.8)} - \sqrt{\left[\frac{1+(1188.0/1000)}{2(0.8)}\right]^2 - \frac{1188.0/1000}{0.8}} = 0.75$$

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$F'_c = (425)(0.74) = 314$ psi

EACH CAISSON $(12 + 6)(12) = 216$ SF

CAPACITY $= 314\ (11.25)^2 = 39,740$ lbs

$= 184$ psf (WHICH NOT GOVERNS)