LAFAYETTE
ENGINEERING COMPANY
Civil and Environmental Engineering Services

740 High Street # 319 AEC | Easton, Pennsylvania 18042
Tel: (610) 330-5437 | Fax: (610) 330-5437 | www.ce.lafayette.edu

PROPOSED

LAFAYETTE COLLEGE

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Report 6

Hummel Building - Structural Design Report

Site

Former Hummel Lumber Supply at 900 Bushkill Drive

City of Easton, Northampton County, Pennsylvania

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Group Name Analysis Table of Contents

FIGURES AND TABLES

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I Design Loads

I.1 Dead Loads

		Unit weight
1.	Existing Wood Deck	12.5 psf
2.	Beams	VARIED
3.	Joists	VARIED
4.	Columns	VARIED

I.2 Live Loads

		Uniform
1.	Variable Use Office Space*	100 psf
2.	Light Manufacturing	125 psf

*100 psf live load was chosen to conservatively estimate that any portion of the floor may be corridor.

I.3 Roof Loads

		Dead	Live	Snow
1.	Edge Column	66.25 k	32 k	7.36 k
2.	Corner Column	33.12 k	16 k	3.68 k

II Retrofit Design

II.1 Structure Lab Beam Retrofit Design – 40 ft Span

Beam 5 – typical

Tributary width	8 ft
W_u, uniform floor load	1.4 klf
P_u, point loads from columns above	19.6 kips
M_u (excluding self weight of reinforcement)	515.2 kip-ft
$M_u/2$ (1 beam on either side of existing wood)	257.6 kip-ft

From Table 3-2 in AISC Manual 2013 Edition
W16x40 $\Phi_b M_n = 274$ kip-ft

Check selfweight – Corrected M_u 265.6 kip-ft

Alternative Beam Design

Use prefabricated steel joists to reduce tributary with to interior beams and columns on floors 1 and 2.

Beam:

Tributary Width	4 ft
W_u, uniform floor load	0.7 klf
P_u, point loads from columns above	9.8 kips
M_u (excluding self weight of reinforcement)	257.6 kip-ft
$M_u/2$ (1 beam on either side of existing wood)	128.8 kip-ft

From Table 3-2 in AISC Manual 2013 Edition

W12x26	$\Phi_b M_n = 140$ kip-ft
Check selfweight – Corrected M_u	133.8 kip-ft

Joist

Tributary Width	2 ft
W_u, uniform floor load	0.35 klf

From New Millennium Joist Tables
22K5 Joists at 2 ft center to center spacing

II.2 Typical 2 Bay Beam Reinforcement – 28 ft Span

<u>Beam 5 – typical</u>

Tributary width	8 ft
W_u, uniform floor load	1.4 klf
P_u, point loads from columns above	19.6 kips
M_u (excluding self weight of reinforcement)	271.6 kip-ft
$M_u/2$ (1 beam on either side of existing wood)	135.8 kip-ft

From Table 3-2 in AISC Manual 2013 Edition

W12x26	$\Phi_b M_n = 140$ kip-ft
Check selfweight – Corrected M_u	138.4 kip-ft

II.3 Column Reinforcement

<u>Parimeter Columns – A2,A3,A4,A6,A5,A7,D10,D12,D13</u>

Tributary Area	123.68 $ft.^2$
Floor Height	10ft.
P_u	184.87 kips

From Euler buckling analysis

2C6 x 10.5	$\Phi Pn = 223.15$ kips

<u>Perimeter Columns A8,A10,A12,D8</u>

Tributary Area	48.8 ft.^{2}
Floor Height	10ft.
P_u	151.46 kips

From Euler buckling analysis

2C6 x 8.2	ΦPn= 177.47 kips

<u>Perimeter Columns D4 –D7</u>

Tributary Area	48.8 ft.^{2}
Floor Height	10ft.
P_u	174.52 kips

From Euler buckling analysis

2C6 x 8.2	ΦPn= 177.47 kips

<u>Perimeter Columns B1,B14,C1,C14</u>

Tributary Area	102 ft.^{2}
Floor Height	10 ft.
P_u	170.08 kips

From Euler buckling analysis

2C6 x 8.2	ΦPn= 177.47 kips

<u>Corner Columns A1,A14,D14</u>

Tributary Area	24.4 ft.^{2}
Floor Height	10ft.
P_u	82.57 kips

From Euler buckling analysis

2C6 x 8.2	ΦPn= 177.47 kips

<u>Interior Columns – B10,B12,B13</u>

Tributary Area	173 ft.^{2}
Floor Height	10ft.
P_u	67.76 kips

From Euler buckling analysis

2C6 x 8.2	ΦPn= 177.47 kips

II.4 Loading Bay – New Steel Design

Loading

Dead Load	50 psf
Live Load (Light Manufactoring)	125 psf

Typical Beam

Tributary width	8 ft
W_u, uniform floor load	2.08 klf
M_u (including self weight)	204 kip-ft

From Table 3-2 in AISC Manual 2013 Edition

W12x26	$\Phi_b M_n = 223$ kip-ft

Increased capacity of this beam due to composite action

Typical Column

Controlling Tributary Area	140.82 $ft.^2$
Floor Height	10 ft.
P_u	36.61 kips

From Table 4-1 in AISC Manual 2013 Edition

W8x31	$\Phi_c P_n = 317$ kip-ft

Bending from an asymmetic tributary area was not analyzed, due to the allowable load being 8 times the applied, this can be assumed as being adequate

Steel Decking with Concrete Slab

Clear Span (2 bays)	7.5 ft.

From VULCRAFT manual

1.5 VLR 22	Slab thickness- 3.5 in.
Shear Studs	¾ in. studs 1ft. C-C

II.5 Foundation Recommendation

Soil conditions and existing foundations are unknown, so calculations could not been done. Due to the largely increased loads due to the green roof, more investigation of the foundation system of the builiding should been done to confirm that it is adequate for the loads. Recomendations for investigate are addition of concrete pilaters or indermidiate foundation system.

II.6 Exisitng Wood Column/Beam Analysis

Analysis of the adequacy of the existing wood column and beam structure was not completed due to lack of information on the type of wood and inexperience with wood design/analysis. Due to the increased loads on the structure, this anlaysis should be completed before final approval of the design. The structural plans do not include all features of the building, such stair wells. These should be included and analyzed before final approval of the design.

II.7 Design Summary

The retrofit design included the reinforcement of beams, that instead of spanning only 12ft. or 16ft. were increased to 28 and 40ft. spans. The loads used for this design were a live load of 100 psf (variable use office space) and a variable dead load. The beams spanning 28ft. included reinforcing the exisitng wood beam with two I-beams (See Figure II.1). For the beams spanning 40ft. in the structural lab, the retrofit also included reinforcing the exisitng wood beam with two I-beams and the addition of 22K5 joists spaced at 2 ft. center to center.

Due to the increased loads from both the green roof and increased tributary areas of the column, reinforcement was required. The loads used for this design were a live load of 100 psf (variable use office space) and a variable dead load. The design included reinforcing the exisitng wood columns with two steel C-Channels. The two sizes of C-Channels used were C6x8.2 and C6x10.5. See Figure II.2 for a detail of this reinforcement and Figure II.3 for detail of the connection of the reinforced beams and columns.

The design of the loading bay included the design of new steel columns and beams and steel decking with a concrete slab. See Figure II.4 for the plan view of the loading bay. The loads used for this design were a live load of 125 psf (light manufacturing) and a dead load of 50 psf. A W8x31 was found to be adequate for the columns and W12x26 was adequate for the beams. The thickness of the deck using the VULCRAFT manual was 3.5 inches and the adequate size and spacing of shear studs are ¾” studs at 1 ft. center to center spacing.

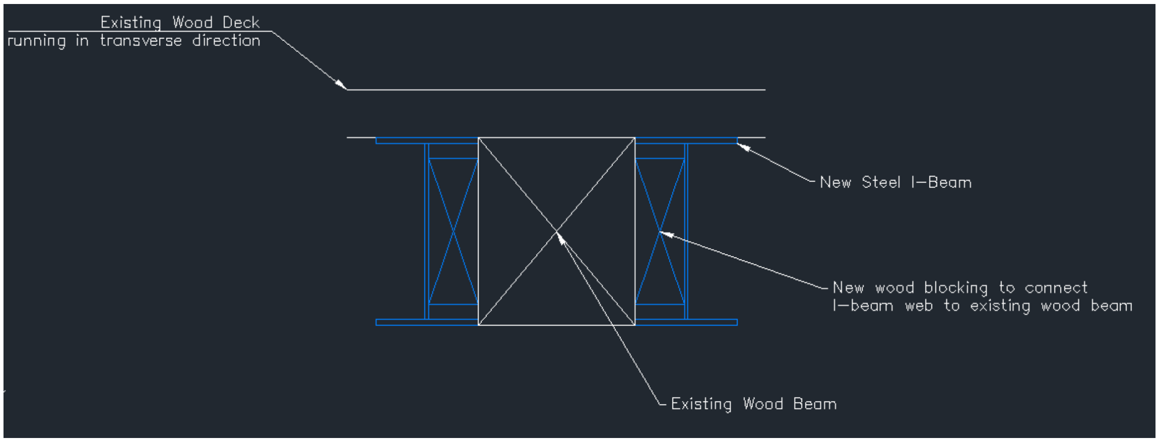

Figure II. 1: Detail of Beam Reinforcement

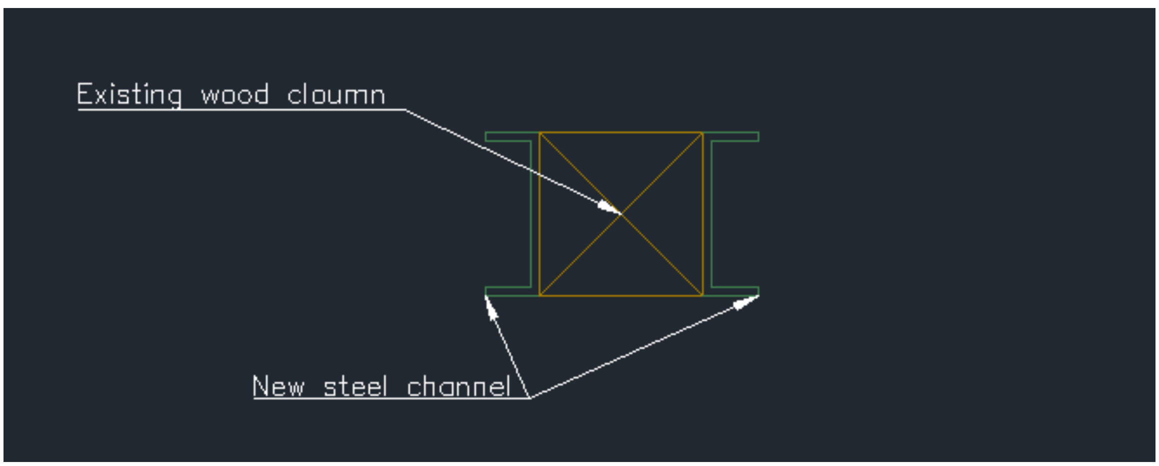

Figure II. 2: Detail of Column Reinforcement

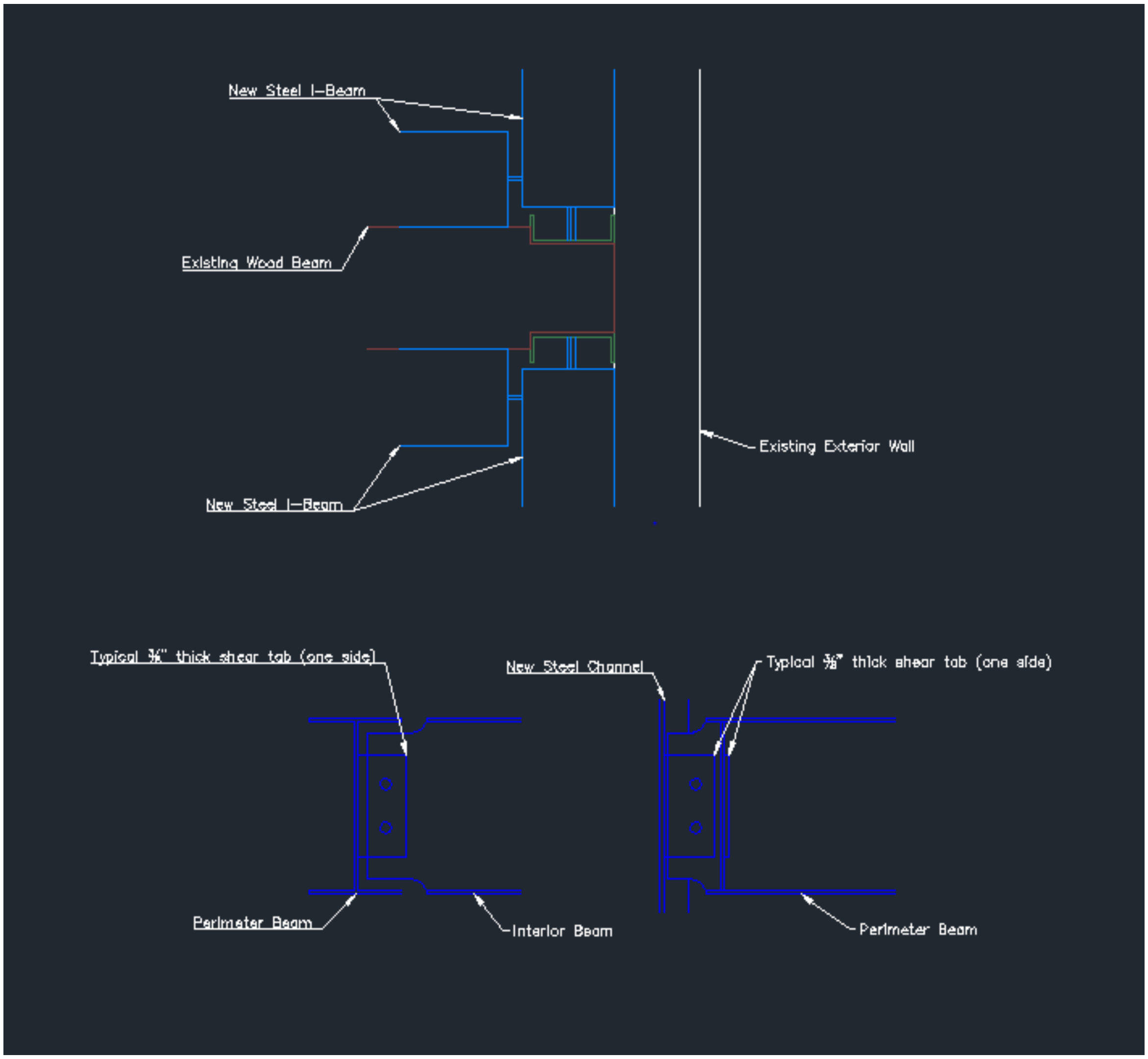

Figure II. 3: Detail of Reinforced Beam to Column Connection

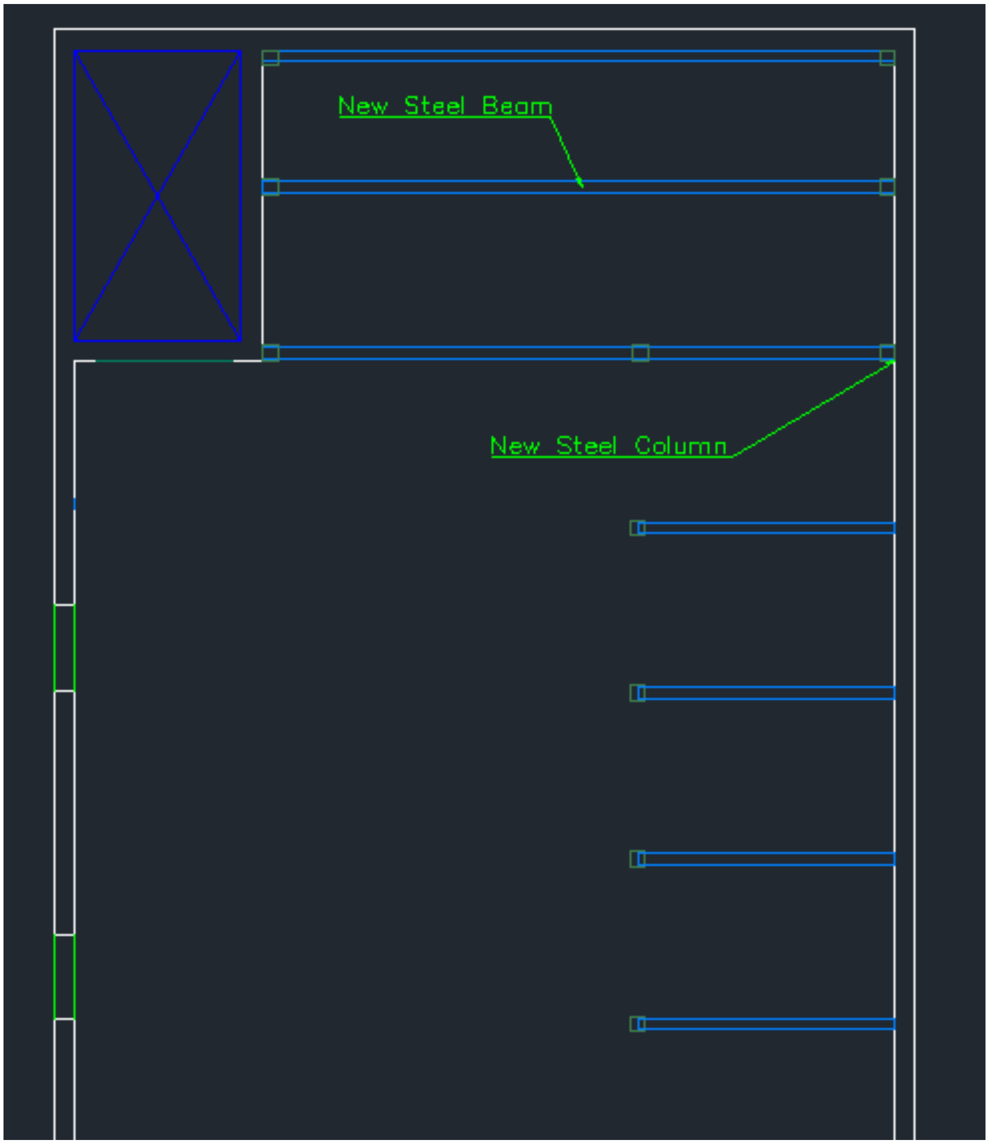

Figure II. 4: Plan View of Loading Bay