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 7

Hummel Building Green Roof - Structural Design Report

Site
Former Hummel Lumber Supply at 900 Bushkill Drive

City of Easton, Northampton County, Pennsylvania

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Green Roof Structural Analysis Table of Contents

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I.1 Introduction

The existing hip roof on the Hummel Lumber building is not adequate for our project's needs. It has therefore been decided that the current roof structure will be removed and a new roof will be put in its place.

The new roof will be flat so as to be able to accommodate a pedestrian congregation area with sections dedicated to a green roof and photovolataics. Benches and educational signage will also be placed on the roof. A staircase from the connector building will provide access to the roof from the parking garage and outdoor area. A staircase in the southwest corner will offer an entrance to the roof from the building itself.

I.2 Load Calculations

Because the new roof acts as a congregational area, several different loads had to be considered. ASCE-7 Live Loads was used as a reference as well as several other sources. The area where pedestrians can walk will be covered with pavers while the green roof area includes saturated soil loads, plant loads, and photovoltaic loads. The usual structural loads, live loads, and snow loads were also taken into account. Values for each of the considered loads can be seen in Attachment I.1

The loading calculations were done using the ASD method. Typical edge and column loads were calculated and given to the team designing the rest of the structural members of the building below the roof. These calculations are detailed in Attachment I.1.

I.3 Member Sizing

Member sizing was performed using the calculated live loads and the AISC Steel Manual. A W36 X 150 I-beam was chosen based on lightness rather than depth. Depth was not an issue since the new roof can be placed on the building with a variable top elevation. 18-gage steel decking was picked based on its ability to handle the appropriate span.

Please see Attachment I.2 for more information.

I.4 Final Design

The final design included tying in the proposed green roof design with the connecting pieces designed by other project teams. This included the staircase connections, green roof soil layers, and loading from the roof to the existing building.

Please see roof elevation calculations in Attachment I.3.

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Attachment I.1 Load Calculations

Design Loads

Dead Load

Pavers	23 psf
Green Roof Load (8" System with Drainage Plates)	57 psf
Photovoltaic Load	5 psf
Solar panel point load = 5 psf x 3.33 ft x 4.5 feet = 75 lbs	
Concrete Decking (4" thickness)	50 psf
Rigid Insulation	10 psf
Steel Decking	2.70 psf

Live Load

Roofs used for roof gardens	100 psf

Snow Load

Ground snow load	23 psf

$p_g = 30$ psf
Exposure factor, $C_e = 0.9$
Thermal factor, $C_t = 1.2$
Importance factor, $I_s = 1.0$
Flat roof snow load, $p_f = 0.7\ C_e\ C_t\ I_s\ p_g = 23$ psf

Column Load

Column Position	Dead Load	Live Load	Snow Load	Sum
Edge	36.7 k	32 k	7.36 k	76.1 k
Corner	18.4 k	16 k	3.68 k	38.1 k

Edge Column (16 ft trib. Width):
Dead per column (unfactored):
114.7 psf *16 ft = 1835 lb/ft
1835 lb/ft * 40 ft span = 73.4 k
73.4 k * 0.5 (column on each end) = 36.7 k

Live per column (unfactored):
100 psf * 16 ft = 1600 lb/ft
1600 lb/ft * 40 ft span = 64 k
64 k * 0.5 (column on each end) = 32 k

Snow per column (unfactored):

23 psf *16 ft = 368 lb/ft
368 lb/ft * 40 ft span = 14.72 k
14.72 k * 0.5 (column on each end) = 7.36 k

Corner Column (8 ft. trib. Width):
Dead per column (unfactored):
114.7 psf * 8 ft = 917.6 lb/ft
1656 lb/ft * 40 ft span = 36.7 k
36.7 k * 0.5 (column on each end) = 18.4 k

Live per column (unfactored):
100 psf * 8 ft = 800 lb/ft
800 lb/ft * 40 ft span = 32 k
64 k * 0.5 (column on each end) = 16 k

Snow per column (unfactored):
23 psf *8 ft = 184 lb/ft
184 lb/ft * 40 ft span = 7.36 k
7.36 k * 0.5 (column on each end) = 3.68 k

Attachment I.2 Member Sizing

ASD Load Combinations
1. 1.4*D*
2. 1.2*D* + 1.6*L* + 0.5(*Lr* or *S* or *R*)
3. 1.2*D* + 1.6(*Lr* or *S* or *R*) + (*L* or 0.5*W*)
4. 1.2*D* + 1.0*W* + *L* + 0.5(*Lr* or *S* or *R*)
5. 1.2*D* + 1.0*E* + *L* + 0.2*S*
6. 0.9*D* + 1.0*W*
7. 0.9*D* + 1.0*E*

Largest Load: 1.2*D* + 1.6*L* + 0.5(*Lr* or *S* or *R*)
512 + 427 + 36.8 = Moment: 975.8 k-ft

16 ft trib. Width * 40 ft. Length = 640 sf trib. Area

Beam Options:
W18 X 234
W24 X 192
W27 X 178
W30 X 173
W33 X 152
W36 X 150

This beam is still adequate for the loads.

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Attachment I.3 Elevation Determination

Existing gutterline elevation from drawings (assume the same as the base of existing roof) 242.75 ft.

As designed, the roof thickness is 4.5 ft.

The short side of the proposed roof is 47.15 ft.

A 1.5 percent slope downwards towards the south side makes the north side an elevation of:
242.75 ft + 4.5 ft. + (0.015 * 47.15 ft.) = **247.96 ft.**

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