ENGINEERING VENTURES INC

208 Flynn Avenue, Suite 2A, Burlington, VT 05401 · Tel: 802-863-6225 · Fax: 802-863-6306
85 Mechanic Street, Suite 350A, Lebanon, NH 03766 · Tel: 603-442-9333 · Fax: 603-442-9331
18 Division Street, Saratoga Springs, NY 12866 · Tel: 518-224-0004

Design Calculations

For:

Warren Bridge Abutment
Lifting/Handling Review
Warren, VT

For:

S.D. Ireland

Submitted On:

March 13, 2014

For Approval

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Basis of Design

Reference:

- PCI Design Handbook: Precast and Prestressed Concrete; 6th Edition

General Design Parameters:

- Stripping Strength: 3000 psi
- Handling Strength: 3000 psi
- Shipping Strength: 5000 psi
- Abutment Width: 3'-6"
- Abutment Width at Wingwall: 1'-6"
- Abutment AB1L & AB2L Length: b_1 = 22'-5 3/8"
- Abutment AB1R & AB2R Length: b_2 = 24'-2"
- Wingwall Length: b_3 = 8'-8 ¾"
- Abutment Height: a_1 = 5'-2"
- Abutment Height at Wingwall: a_2 = 10'-9 5/8"
- Equivalent Static Load Multipliers (from PCI Table 5.3.3.1)
    - Stripping:
        - Flat, with removable side forms, no false joints or reveals; Smooth mold (form oil only): 1.3
    - Yard Handling and Erection:
        - All products: 1.2
    - Travel:
        - All products: 1.5

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Calculations

AB1R & AB2R:

Note: AB1R and AB2R were analyzed as it was determined that this abutment configuration would control over the configuration of AB1L and AB2L.

Area of abutment: A_1 = (24'-2")(5'-2") = 17980 in^2
Area of wingwall: A_2 = (8'-8 ¾")(10'-9 5/8") = 13578 in^2

Resisting Section for M_y:

Abutment: $S_{b,y1}$* = $bh^2/6$ = (3'-6")$(5'-2")^2/6$ = 26908 in^3
Wingwall: $S_{b,y2}$* = $bh^2/6$ = (1'-6")$(10'-9\ 5/8")^2/6$ = 50408 in^3

Unit weight at abutment: (5'-2")(150 pcf) = 775 psf = .775 ksf
Unit weight at wingwalls: (10'-9 ¼")(150 pcf) = 1615 psf = 1.615 ksf
Total weight: (.775 ksf)(24'-2")(3'-6") + (1.615 ksf)(8'-8 ¾")(1'-6") = 86.7 k

Allowable tensile stresses at stripping and lifting (PCI Eq. 5.3.3.1):
$5\lambda\sqrt{fc'}$ = 5(1.0) $\sqrt{3000\ psi}$ = 0.274 ksi
Allowable tensile stresses at traveling (PCI Eq. 5.3.3.1):
$5\lambda\sqrt{fc'}$ = 5(1.0) $\sqrt{5000\ psi}$ = 0.354 ksi

From PCI Figure 5.3.1.2:
Abutment: a = 3'-6" ; b = 24'-2"; Wingwall: a = 1'-6" ; b = 8'-8 ¾"
w_{y1} = (0.775 ksf)(3'-6") = 2.71 ksf (for abutment)
w_{y2} = (1.615 ksf)(1'-6")(8'-8 ¾")/(2.77') = 7.63 klf (for idealized wingwall at abutment)
w_{y3} = (0.775 ksf)(24'-2"/2)(3'-6")/(2.10') = 15.72 klf (for idealized abutment at wingwall)
w_{y4} = (1.615 ksf)(1'-6") = 2.42 klf (for idealized wingwall)

Using mechanics of materials (see shear and moment diagrams on pages 4-6):
+ M_{y1}* = (0.5)(2.77')(21.1 k) + (0.5)(4.2')(32.1 k – 21.1 k) + (4.2')(21.1 k) = 140.9 k-ft
- M_{y1}* = (0.5)(16.3 k)(6') – (0.5)(22.0 k)(8.1') = -40.2 k-ft
+ M_{y2} = (0.5)(62.8 k)(4.54') = 142.6 k-ft

* Note: In order to maximize effects, the location of the second lift support was varied between the second lift support location on the abutment the lift support located on the wingwall.

For Stripping:
f_t = + M_{y1} /$S_{b,1y}$ = (140.9 k/ft)(12"/ft)(1.3)/(26908 in^3) = **.082 ksi < 0.274 ksi → O.K.**
f_t = - M_{y1} /$S_{b,y1}$ = (40.2 k/ft)(12"/ft)(1.3)/(26908 in^3) = **.023 ksi < 0.274 ksi → O.K.**

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$f_t = M_{y2} / S_{b,y2}$ = (24.8 k/ft)(12"/ft)(1.3)/(50408 in^3) = **0.01 ksi < 0.274 ksi → O.K.**

For Yard Handling and Erection:

f_t = + $M_{y1} / S_{b,y1}$ = (140.9 k/ft)(12"/ft)(1.2)/(26908 in^3) = **.075 ksi < 0.274 ksi → O.K.**

f_t = - $M_{y1} / S_{b,y1}$ = (40.2 k/ft)(12"/ft)(1.2)/(26908 in^3) = **.022 ksi < 0.274 ksi → O.K.**

$f_t = M_{y2} / S_{b,y2}$ = (24.8 k/ft)(12"/ft)(1.2)/(50408 in^3) = **0.01 ksi < 0.274 ksi → O.K.**

For Travel: (Strip lumber to dunnage to be aligned with lifting points)

$f_t = M_{y1} / S_{b,y1}$ = (140.9 k/ft)(12"/ft)(1.5)/(26908 in^3) = **.094 ksi < 0.354 ksi → O.K.**

f_t = + $M_{y1} / S_{b,y1}$ = (40.2 k/ft)(12"/ft)(1.5)/(26908 in^3) = **.027 ksi < 0.354 ksi → O.K.**

f_t = - $M_{y2} / S_{b,y2}$ = (24.8 k/ft)(12"/ft)(1.5)/(50408 in^3) = **0.01 ksi < 0.354 ksi → O.K.**

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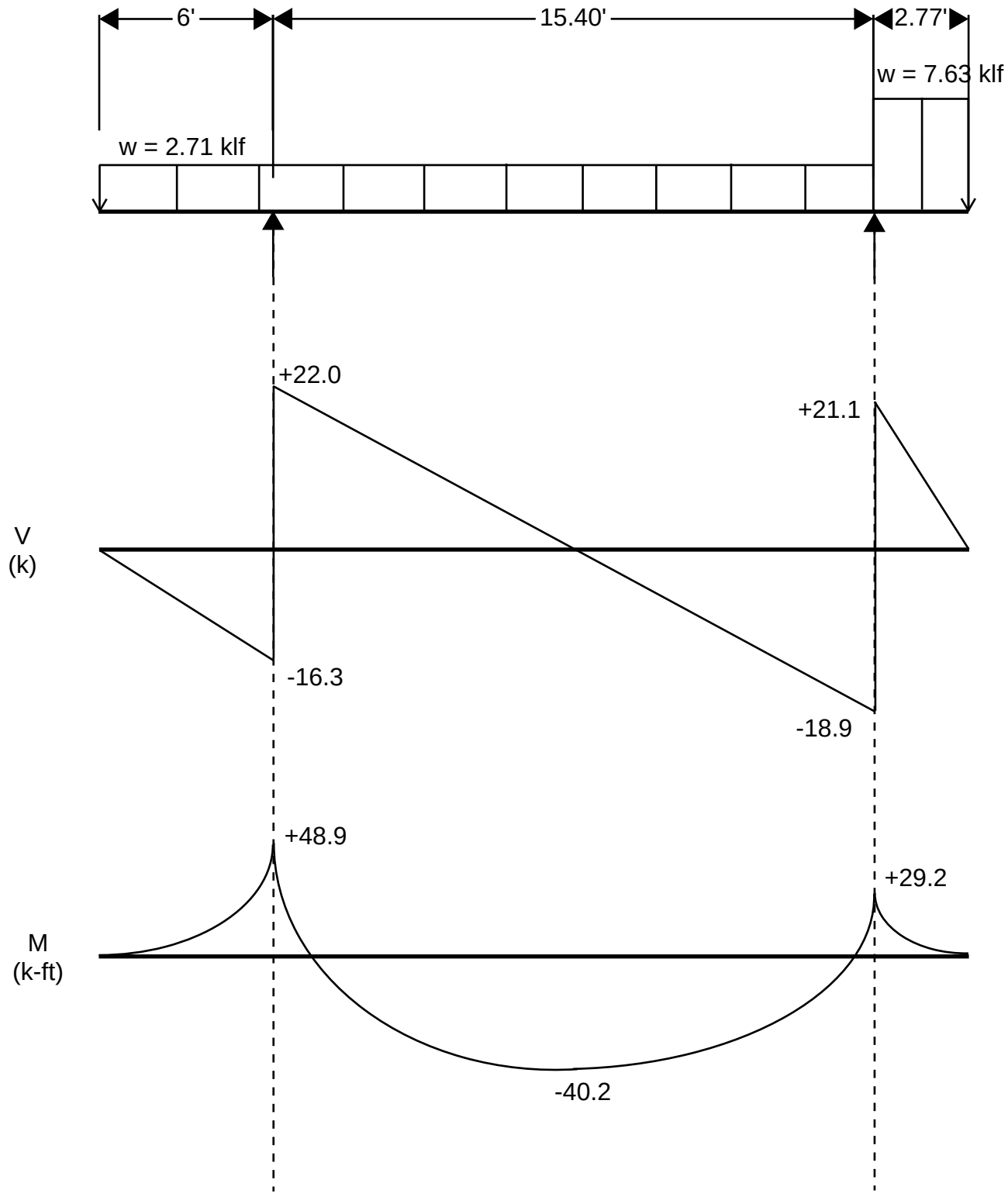
Max Negative M_y:



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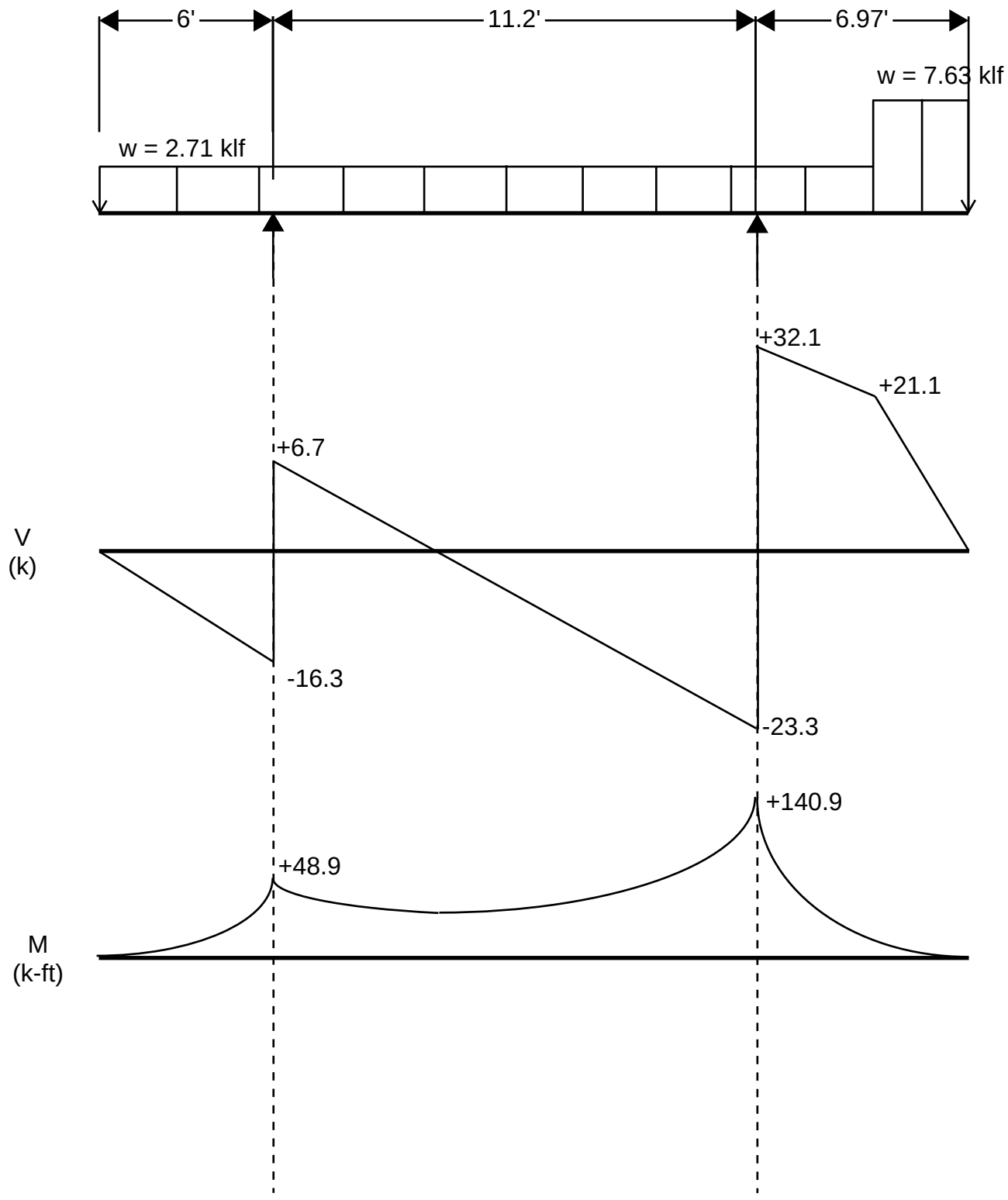
Max Positive M_y:



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Max M_y in Wingwall: