CALCULATIONS FOR:

Waterbury, VT IM 089-2 (43)
Item 531.18 Bearing Device, Elastomeric with Sole Plate

Calculations for Jacking of 46A Pier Bearings

APPROVED: Approval of drawings and/or procedures indicates concurrence with the information presented and does not relieve the Contractor or Fabricator of compliance with all specifications and code requirements		Stantec
APPROVED AS NOTED	✓	
REVISE AND RESUBMIT		
NOT REVIEWED		
Date: 9/20/16		
Signature: TEK		

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September 14, 2016

Prepared by:

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Vermont Agency of Transportation
Accepted
By Douglas Bonneau at 1:37 pm, Sep 20, 2016

STATE OF VERMONT
CHRISTOPH E. SCHROEDER
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PROFESSIONAL ENGINEER

9-14-2016

Design References:

Manual of Steel Construction, LRFD 2nd Ed, AISC, 1998
LRFD Steel Design, Segui, 1999

Plans and Specifications from State:

Waterbury AC IM 089-2 (43) contract drawings and specifications

Design Method:

Allowable Stress Design, as jacks are rated by working loads.

Jacking Operations:

Temporary jacking and support for girders is to be provided to allow for adjustment of pier bearings after the deck is in place..

Jacking will generally proceed on one pier at a time, lifting girders as a group at each bearing line. Do not lift a partial line of girders(allowable offset = ¼" between girders).

Provide solid blocking under girders if bearings need to be removed for any reason.

Composite Girder+Deck Properties:

Girder section A:

C.G. :	A	ybar	A*ybar
Girder	68.50	36.88	2,525.94
Concrete+rebar	84.00	80.25	6,741.00
sum:	152.50		9,266.94

C.G. = Ybar = 60.8 inch from bottom

Mom of Inertia:	I	A	d	I + A*d^2
Girder	54,670.00	68.50	23.89	93,771.05
Concrete+rebar	546.75	84.00	19.48	32,432.73
sum:				126,203.78

M. Inertia = I = 126,204 in^4

Girder section B:

C.G. :	A	ybar	A*ybar
Girder	85.50	37.13	3,174.19
Concrete+rebar	84.00	80.75	6,783.00
sum:	169.50		9,957.19

C.G. = Ybar = 58.7 inch from bottom

Mom of Inertia:	I	A	d	I + A*d^2
Girder	77,660.00	85.50	21.62	117,622.82
Concrete+rebar	546.75	84.00	22.01	41,223.20
sum:				158,846.02

M. Inertia = I = 158,846 in^4

Girder section C:

C.G. :	A	ybar	A*ybar
Girder	110.50	37.75	4,171.38
Concrete+rebar	84.00	82.00	6,888.00
sum:	194.50		11,059.38

C.G. = Ybar = 56.9 inch from bottom

Mom of Inertia:	I	A	d	I + A*d^2
Girder	112,700.00	110.50	19.11	153,056.01
Concrete+rebar	546.75	84.00	25.14	53,634.12
sum:				206,690.12

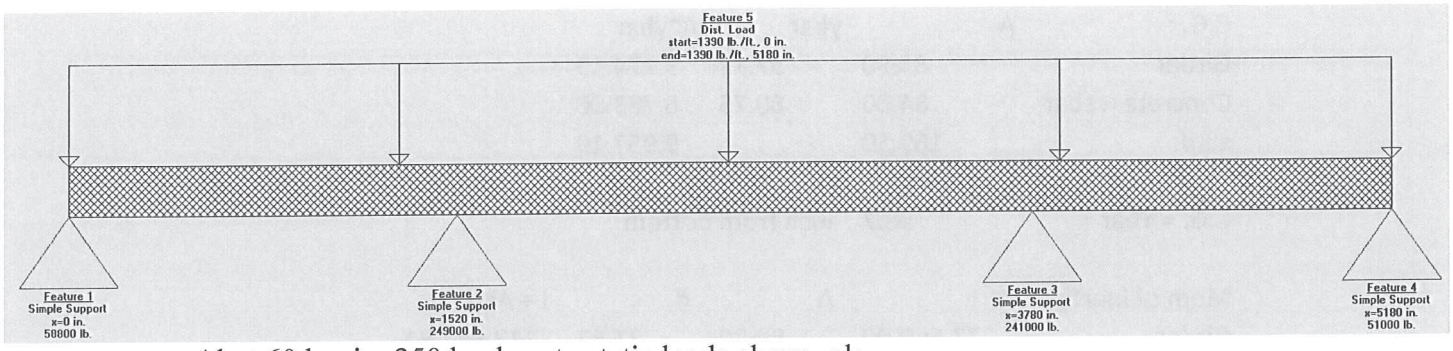
M. Inertia = I = 206,690 in^4

Loading on Jacks:

The bridge is composed of 3 continuous spans. Lift girders a max of 1", with flexure of girder+deck producing additional load beyond bearing DL.

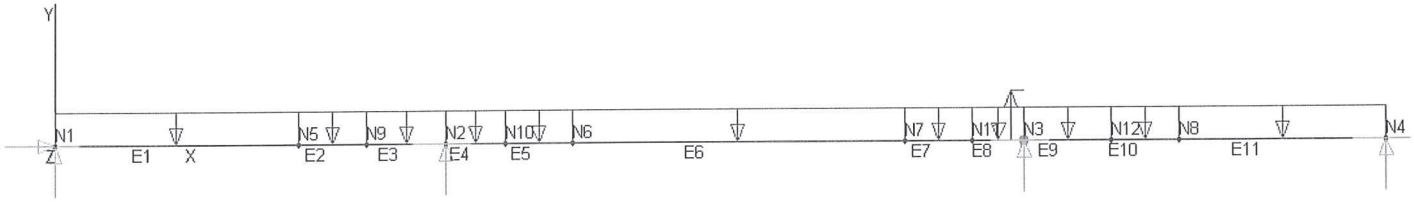
Static loading on bearings:
Abut 1: 52.7 k
Pier 1: 246.5 k
Pier 2: 238.5 k
Abut 2: 45.5 k

Check with simple tributary area loading: average load near piers = 0.118 k/in
Abut 1 = 0.109 k/in * 762" = 83 k
Pier 1 = 0.118 k/in * 1890" = 223 k
Pier 2 = 0.118 k/in * 1830" = 216 k
Abut 2 = 0.109 k/in * 702" = 77 k
Close, considering this is not a continuous model.
Check with Beamboy:



Abut 60 k, pier 250 k, close to static loads above, ok.

During jacking, loads are:



With 1" of jacking at Pier 1:
Abut 1: 49.3 k
Pier 1: 253.8 k = jack load
Pier 2: 232.2 k
Abut 2: 48.0 k

With 1" of jacking at Pier 2:
Abut 1: 55.0 k
Pier 1: 240.1 k
Pier 2: 246.6 k = jack load
Abut 2: 41.5 k

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Check loads for ¼" jacking, to try relieving stress with one jack only.
With ¼" of jacking at Pier 1:
Pier 1: 248.4 k
With ¼" of jacking at Pier 2:
Pier 2: 240.6 k
Loads are similar to above, so just use 1" jacking height for analysis.

Jack sizing:

Jacks are rated in tons of working load, at a 2:1 factor of safety.
Min jack rating = 254 k / (2 k/1 ton) = 127 ton,
150-ton minimum jack size required, per girder supported.

Jacking is for zeroing out bearing deflections due to deck weight. Bearings will still be in place, so no temporary support is needed. Can provide steel blocking on opposite side of bearing from jack if needed.

Check bearing at girder: load = 254 k
assume N = **3" bearing width from jack piston**

Web yielding, interior support: $R_{allow} = 0.66*R_n = 0.66*1.0*(5.0*k+N)*F_y*t_w$, k = 1.75" flange + 5/16" weld = 2.0"
= 0.66*1.0*(5.0*2.0"+3")*50 ksi * 0.5625"
= **241 k approx = 254 k, web yield okay, note jack selected has larger contact area, ok.**

Web crippling at interior:
$R_{allow} = 0.66*\Phi*R_n = 0.66*0.75*135*t_w^2*(1+3*(N/d)*(t_w/t_f)^{1.5})*\sqrt{(Fy*t_f/t_w)}$
R_{allow} = **224 k < 254 k, but bearing stiffener at C.L. bearing is only 19" away vs. 72" web depth, so this is acceptable; also note jack selected has larger contact area, ok.**
For argument, check assuming web depth = 72*2/3 = 48":
R_{allow} = 268 k, web crippling is okay.

Check blocking strength under bearing:

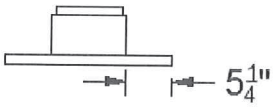
Jacking load at bearings = 254 k.
Wood allowable compression perpendicular to grain: SPF = 425 psi = 0.425 ksi
254 k / 0.425 ksi = 600 in^2 bearing area
25"x25" or equivalent area for wood blocking under girder during bearing removal. N.G. – not feasible size. Use steel blocking opposite the bearing if needed.

Check concrete bearing:

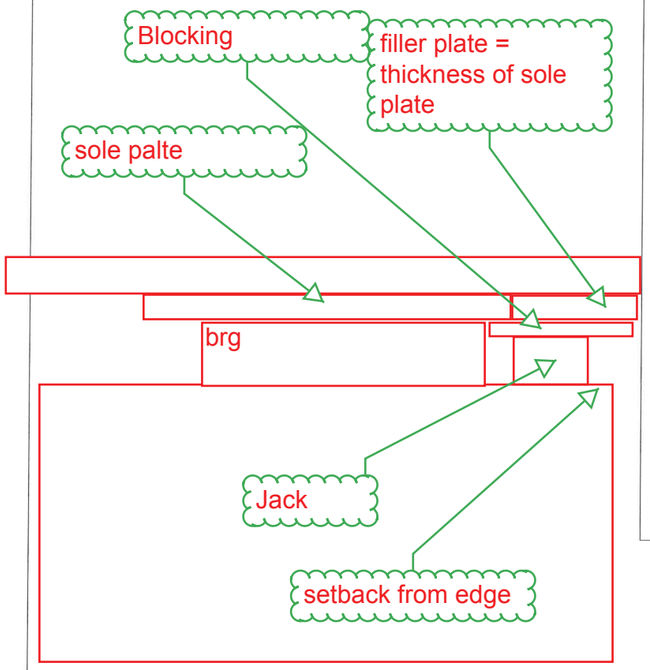
Allowable concrete bearing stress = 1 ksi.
For jack load = 254 k, need 254 k / 1 ksi = 254 in^2 bearing area on concrete.
16"x16" or equivalent area bearing on concrete.

From Design of Concrete Structures, p. 551:
Allowable pressure = 1/2*0.85*4 ksi = 1.7 ksi allowable
Required bearing area = 254 k / 1.7 ksi = 150 in^2, or 8"x19" bearing plate

Plate allowable bending stress = 24 ksi.

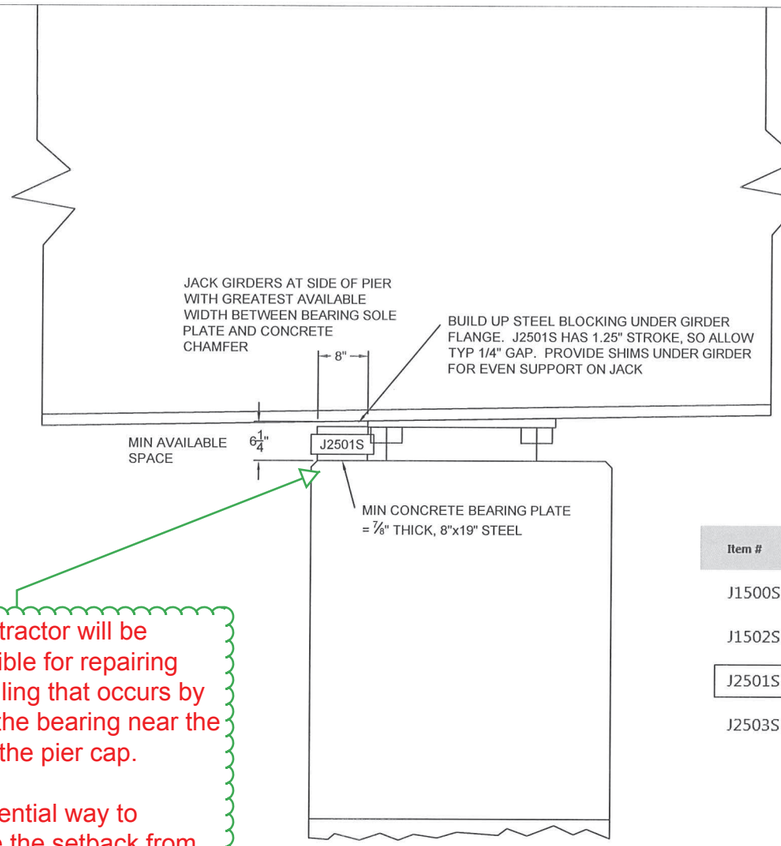


Mmax = 1.7 ksi * 5.25^2 in^2 / 2 = 23.4 k-in
σallow = 24 ksi,
Sreq = 23.4 k-in / 24 ksi = 0.975 in^3
Req. thickness: S = 1/6*b*h^2, h = sqrt(6*S/b) = sqrt(6*0.975 in^3 / 8") = 0.86",
7/8" base plate required, dimensions 8"x19".



The contractor will be responsible for repairing any spalling that occurs by placing the bearing near the edge of the pier cap.

One potential way to increase the setback from the edge is to use a filler plate equal to the sole plate thickness as part of the steel blocking under the flange.



PER PLANS, SHEET 125, NOTE 6, JACK GIRDERS TO RELIEVE STRESS IN BEARINGS AFTER PLACING CONCRETE DECK AND CURB.

SHEET JACKING NOTES:

USE (5) 150-TON HYDRAULIC PANCAKE JACKS (DUDGEON J2501S OR SIMILAR) CONNECTED TO A COMMON HYDRAULIC SYSTEM, TO RAISE ALL GIRDERS EVENLY. JACK AT ONE PIER AT A TIME. MAX DIFFERENCE IN JACKING HEIGHT BETWEEN GIRDERS = ¼"

EXPECTED LOADS ARE APPROX. 254 K AT PIER 1, 247 K AT PIER 2.

JACK GIRDERS ONLY AS MUCH AS IS NEEDED TO RELIEVE STRESS IN ELASTOMER AT BEARINGS. EXPECTED TO RAISE ½", MAX 1".

DO NOT PROVIDE BLOCKING UNDER GIRDERUNLESS REQUIRED TO SUPPORT OPERATIONS. IF NEEDED, USE STEEL BLOCKING WITH MIN. 254 SQ INCH OF CONCRETE CONTACT AREA.

Item #	Capacity	Stroke	Area	Pressure	Height	O.D.	Rod Dia.	Oil Ca	Weight
J1500S	150	0.5625	30.68	9,778	4.56	7.5 X 8.5	3	17.2	52
J1502S	150	2	30.68	9,778	6.3	8.06	6.25	61.4	92
J2501S	250	1.25	51.85	9,778	3.13	10	8.13	64.8	70
J2503S	250	3	50.22	9,956	11.875	9.87	5.5	150.6	22

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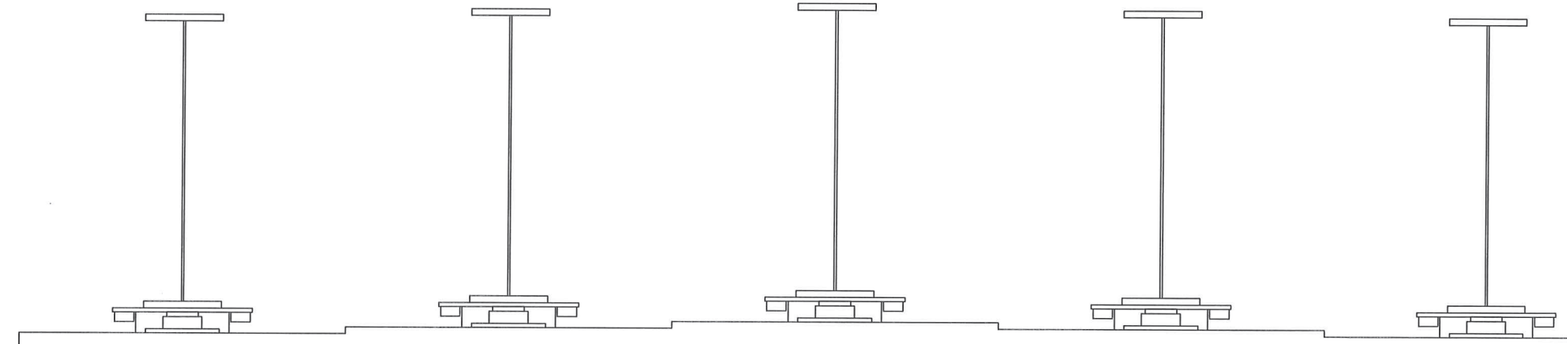

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REV.

SHEET 1 OF 1

TITLE: BRIDGE 46A JACKING PLAN

PROJECT: WATERBURY IM 089-2 (43)

SCALE: NONE

DATE: SEP 14, 2016

BECK & BELLUCCI, INC.
FRANKLIN, NEW HAMPSHIRE