CALCULATIONS FOR:

Waterbury, VT 089-2 (43) Re-Advertised

529.2, Partial Removal of Structure (Bridge 46A)
Demolition of Existing Bridge Deck, Girders, and Substructures

March 30, 2016

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References:

Design of Concrete Structures, 12th ed., 1997, Arthur Nilson
LRFD Steel Design, 2nd ed., 1999, William Segui
Manual of Steel Construction, Load & Resistance Factor Design, 2nd ed., 1998, AISC

Scope of Structure Removal:

Demolish the entire bridge 46A structure in three phases: deck, steel, and substructures.

Deck demolition is to proceed with the sawcutting and removal of the existing deck by excavator. The concrete diaphragms at span ends are to be removed by sawcutting the portion between girders and picking with excavator or crane, and hand chipping the remainder onto the subdecking. Provide temporary cross-bracing between the middle two girders at bearings after removing concrete diaphragms. Subdecking, as previously submitted, provides debris protection and fall protection.

Girder removal is to take place per span, with a crane removing individual girders with diaphragms attached. The final girder in each span will be braced at the ends as needed, to stabilize it until picked.

Substructure demolition is to take place conventionally. One or more piers will be removed by wire saw, and pieces supported and picked by crane as they are cut.

Worker Protection for Demolition:

The deck is to be removed by sawcutting, with removal of slab sections by excavator. Typically, fall protection will be provided by subdecking between girders and on brackets at overhangs. See the previously submitted subdecking design for details. The existing 46A girders are 7’-4”, vs 7’-6” for the 46N/46S girders, so the same subdecking design is used.

If fall protection is not provided by subdecking, workers on the deck will either be protected from falls by the existing bridge rail, or cable safety lines connected to fall protection posts, guardrail posts, or concrete deadmen. Workers using safety cable will use compliant harnesses and shock-absorbing lanyards or self-retracting lifelines. To limit worker exposure to falls, the interior sawcuts are to be made prior to removing overhang sections of deck and the associated sections of bridge rail. The longitudinal sawcut on the outside girder will be made last, with the excavator lifting each piece as it is removed, and the sawcut crew tied off if harnesses are required. After removing the overhangs, the center slab sections are removed.

A control line set back 12’ and safety cable, or wood guardrail system, will be installed at the existing abutment, where proximity to a fall hazard exists.

Public Protection and Environmental Protection for Demolition:

Subdecking between girders and at overhangs is located over all roads and sidewalks to provide protection against falling debris. A plastic liner will be provided over the road/sidewalk and stream and wetland areas during sawcutting, to prevent cutting slurry from spilling onto these areas.

Section 1: Deck Demolition

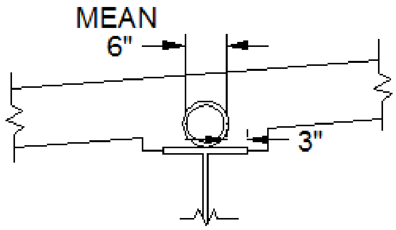
Equipment in use during Deck Demolition Operations:

Equipment to be used for deck demolition operation includes the following:
Concrete saws and related equipment by a subcontractor
Caterpillar 324 / 329E excavator with "slab-crab" type attachment
64,000 lb dumptruck
Various cranes for man-basket and scale pan

Part 1: Checks of Concrete Deck

Removal of Bridge Deck:

Check the location of shear studs or spirals before sawcutting, by chipping out a small area at the leading edge abutment. Shear spirals with 6" mean diameter are anticipated, with sawcuts to be made a minimum 1.5" (3" typ.) from the edge of girder.



Prior to deck removal, remove all pavement and sawcut the lateral and longitudinal lines at the interior girders, followed by longitudinal cuts at overhangs. Once any fall protection measures are in place on the deck, the overhangs in the area of the day's cuts will be removed. This is to be accomplished by first chipping out the coping at the lateral cut location, cutting or removing the bridge rail, and then sawcutting longitudinally along the outside girder, with the overhang section supported by excavator or crane, hooked onto the slab section using the existing guardrail anchor bolts.

Assume an 8' long overhang section. Weight = 4.32 SF *150 pcf *8' = 5,184 lb = 5.2 k
¾" anchor bolt, assumed A307, has:
allowable tensile load = 0.6*0.75*45 ksi*0.44 in2 = 8.9 k/bolt
allowable shear load = 0.6*0.75*24 ksi * 0.44 in2 = 4.7 k/bolt
Need to connect to a minimum of 2 bolts per 8' slab section.
Pick using a minimum of 4 existing anchor bolts, either 2 ea. at 2 post locations, or 4 ea. at a single post.

Check cutoff overhang loading on subdecking vs subdecking design:

Overhang subdecking design is for 210 psf * 2.5' width + 1000 lb / 4' spacing = 775 lb/ft total concrete and screed loading. Ignore that about ½ the load will be resting on the edge of girder flange instead of subdecking

Applied overhang load during demolition = 2' wide beyond girder * 2' high * 150 pcf + 100 lb worker = **700 lb < 775 lb. Okay to let concrete deck+curb at overhangs rest on overhang subdecking**.

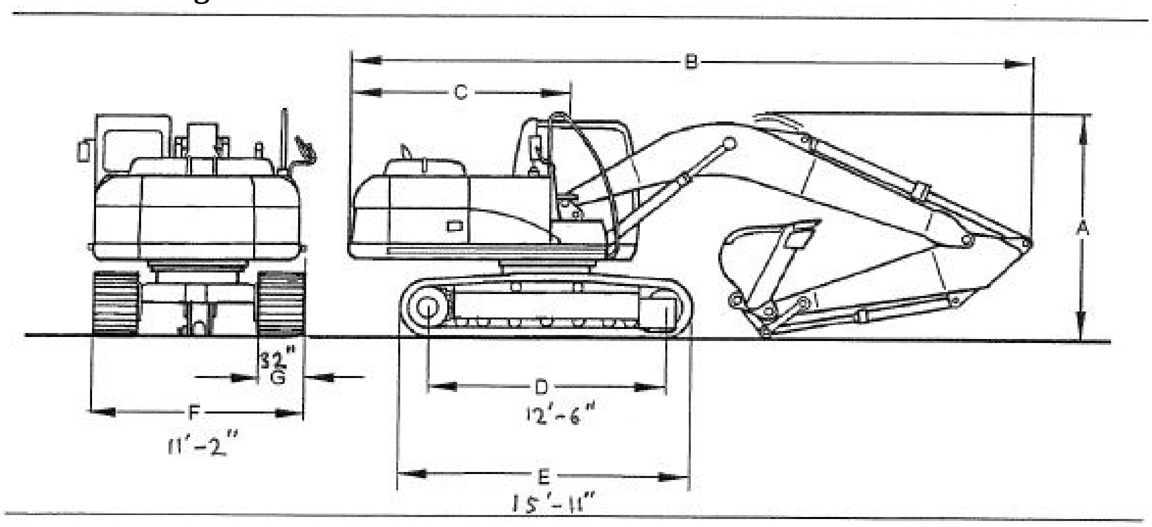
After removal of the overhangs, the interior slab sections will be removed by the excavator with a “slab crab” attachment, and loaded onto a truck for transportation to the disposal site. The interior bay slabs will be lifted out individually. The deck slabs and other concrete and rebar will be disposed of off-site.

Concrete left on girders at shear connectors will be chipped into a scale pan or similar device to catch the debris, as needed to pick the girder by crane.

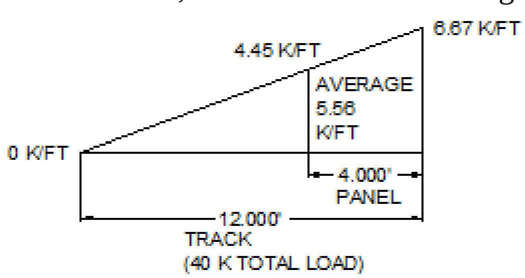
Structural Checks for Deck Removal:

Of concern during demolition is the capacity of the cut deck panels, to withstand the loads imposed during removal operations. The loads consist of deck panel self-weight, and either the CAT 324 excavator track or truck tires on any given panel.

Excavator Loading on Slab:



The excavator load is 55k gross weight + 1k to swap the slab crab for bucket + 5k for a panel being hoisted = 61 k * 1.3 impact = 79 k. This load is taken as distributed equally between the tracks in a triangular distribution. Load per track = 79k/2 = 40 k. If excavator is in full contact with deck, the load can be taken as triangular in the worst case, and take the max loading on an assumed 4’ wide panel section.



The track is 2.67’ wide, so the max bearing pressure over the 4’ panel is 6.67 k/ft / 2.67’ = **2.50 ksf, as long as the excavator is kept stable with the tracks in full contact with the deck.**

Use dumptruck instead of tractor-trailer:

10-wheeler dumptruck is a 64,000 lb. GVWR International, or similar. To use a dumptruck instead of a tractor-trailer, it must be in-line with the excavator bucket.

Dumptruck has 64 k max weight, distributed on 6 axles. Dual axles have a weight of 16 k, and front axle is taken as negligible, since it's near the end of the span when span is most heavily loaded.

Use 420 backhoe-loader to chip concrete left on girders after panel removal:

The backhoe Max. operating weight is 21.6 k, much less than the other equipment in use. **The 420 is okay for use instead of excavator or truck**.

Use the 420 for removal of concrete from the tops of girders as work progresses. **Chipping operations are not to damage the top flange of girder**. Hand-chip to clean up remaining concrete.

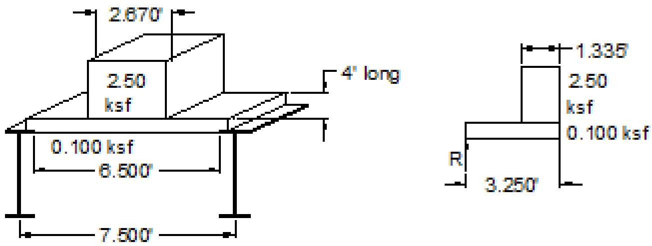
Slab Deadload:

The slab is 7.5", carry 8" thick, so has loading of 150 pcf * 8/12' = 0.100 ksf

Check of Slab in Bending:

Use larger 7'-6" girder spacing from bridges 46N/46S. Actual spacing is 7'-4". The slabs are cut into rectangles, with sawcuts 3" from the edge of the existing girders, and transversely every 8' +/-. The slabs span 6.5' max between girder flanges. Check the capacity of half the assumed panel width, or a 4' wide panel.

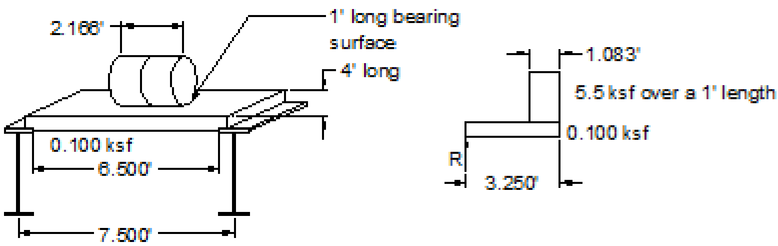
Bending from excavator track load, using the maximum bearing pressure:



Mmax = (2.50 ksf * 4') * 1.335' * 2.582' excavator + (0.100 ksf * 4') *3.25'*1.625' deck

Mmax = 36.6 k-ft

Bending from truck wheel load:



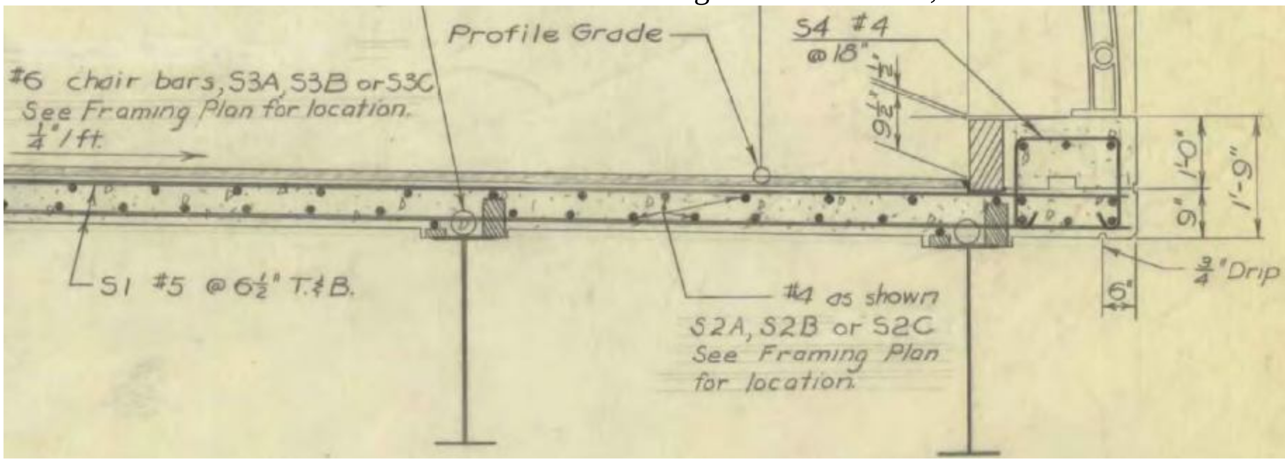
Mmax = (5.5 ksf * 1') * 1.083' * 2.709' truckwheel + (0.100 ksf * 4') *3.25'*1.625' deck

Mmax = 18.2 k-ft

The excavator produces the greater bending moment, take

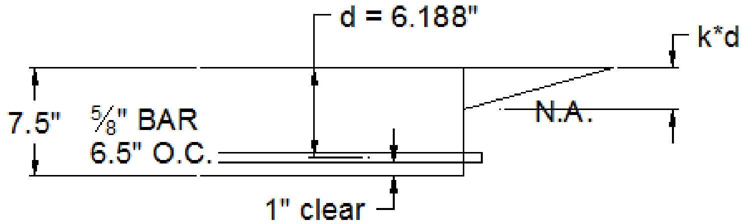
Mmax = 36.6 k-ft = 439 k-in for a 4' panel section.

Use the cracked deck section to find allowable bending. For the width b, use 48”.



(from existing bridge 46A plans)

At high-moment regions of slab, bot. mat is #5 bar @ 5” o.c. Ignore top mat.



The following procedure for bending and shear is from Design of Concrete Structures, section 3.3:

Set f_c*A_c and f_s*A_s to have equal moments about N.A.:

$\frac{b*(kd)^2}{2} - n*A_s*(d-kd) = 0$; solve for kd:

$n = 8.0$, $b = 48”$, $d = 6.188”$, $A_s = 0.31$ in^2 per #5 bar * 7.38 bars (at 6.5” centers in 48”)

$A_s = 2.288$ in^2

Solving equation graphically, kd = 1.824”

find f_s and f_c, by taking moments about the other member.

for f_s:

$\Sigma M_c = A_s * f_s * j*d$; limit ΣM_c to the applied moment.

$j = 1 - k/3$;

$k = \sqrt{(pn)^2 + 2*pn} - pn$

$pn = {}^{As}/_{b*d} * 8.0 = 2.288$ in^2 / (48”*6.188”) * 8.0 = 0.0616

$k = \sqrt{(0.0616^2 + 2*0.0616)} - 0.0616$

$k = 0.295$

$j = 1 - 0.295/3 =$ **$0.902 = j$**

$\Sigma M_c = M_{max}$ of 439 k-in = 2.288 in^2 * f_s * 0.902 * 6.188”; solve for f_s

f_s = 34.4 ksi, vs 33 ksi min. yield, and 55 ksi ultimate, assumed for reinforcing prior to 1950s. 34.4/33 = 104% of yield, 34.4/55 = 63% of ultimate (60% is adequate; ok). Since bending (with impact) is slightly past the yield point,

excavator tracks are to be located over or adjacent to girder lines when possible during slab removal to reduce bending stress. Bending stress is allowable vs. ultimate tensile strength, and yielding of the rebar is allowable for demolition.

ASTM Spec, Steel Type	Years	Grade 33 (Structural)	
		Min. Yield (ksi)	Min. Tensile (ksi)
A15, Billet	1911-1966	33	55

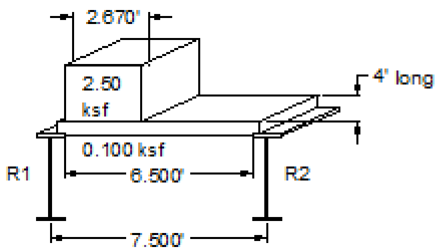
See shear calculations for check of bending during this loading condition. If excavator track is located at center span, it may result in reinforcement yielding, producing an evident deflection of slab.

for f_c:
$\Sigma M_s = M_{max}$ of 439 k-in = f_c / 2 * b*k*d^2*j = f_c / 2 * 48" * 0.295 * 6.188^2 in^2 * 0.902; solve for f_c

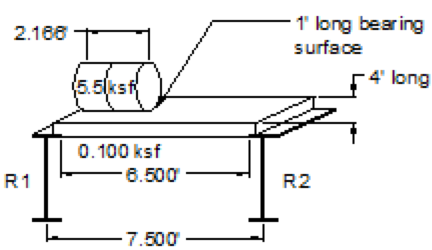
f_c = 1.8 ksi, vs 3 ksi concrete, 60% of ultimate, ok; concrete stress is proportionally less than steel stress.
Steel FoS is slightly critical: under-reinforced, which is preferable.

Check Concrete Deck Shear at Girder:

The max shear will occur if the excavator or wheel load is right next to the beam.



Excavator shear load, sum moments about R2:
R1 * 6.5' = (2.50 ksf*4') * 2.67' * 5.165' + (0.100 ksf * 4') * 6.5' * 3.25'
R1 = max shear = 22.5 k excavator



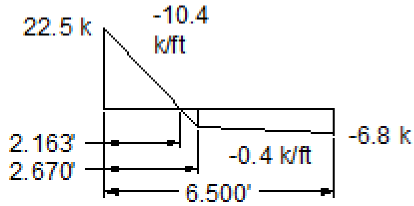
Truck shear load, sum moments about R2:
R1 * 6.5' = (5.5 ksf * 1') * 2.166' * 5.417 + (0.100 ksf * 4') * 6.5'* 3.25'
R1 = max shear = 11.2 k wheel

The excavator produces the greatest shear, so
Vmax = 22.5 k.

$v_{max} = V_{max}$ / (b*d) = 22.5 k / (48”*6.188”) (not v_{max} = VQ / Ib normally used)
v_{max} = 0.076 ksi = 76 psi

find v_{cr} based on proportion of moment and shear during the maximum shear condition:
At Vmax for the excavator track above, find Mmax:

Excavator + concrete load = 2.50 ksf * 4’ + 0.100 ksf * 4’ = 10.4 k/ft
Concrete load = 0.100 ksf * 4’ = 0.4 k/ft



Mmax at 2.16’ from R1.
Mmax = 10.4 k/ft * 2.16’ * 2.16’/2 = 24.26 k-ft = 291 k-in (448/291 = 1.5, ok.)

Per Design of Concrete Structures, section 3.3:

$v_{cr} = 1.9*\sqrt{f'_c} + 2500*\rho*V*d/M < 3.5\sqrt{f'_c}$ where

include bottom and top mat of rebar, total 3 ea #5 bar at 10” o.c.;

A_s = 0.31 in^2 * 2 layers * 7.3 ea. bars (@ 6.5” over 48” wide slab) = 4.526 in^2

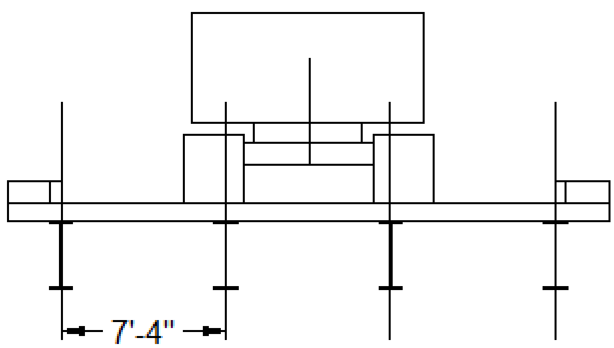
ρ = 4.526 in^2 / (6.188”*48”) = 0.0152

f'_c = 3000 psi

$3.5\sqrt{f'_c}$ = 192 psi

$v_{cr} = 1.9*\sqrt{3000}$ + 2500 * 0.0152 * 22,500 lb * 6.188” / 291,000 lb-in
v_{cr} = 122 psi < 192 psi, so use **v_{cr} = 122 psi**.

v_{max} = 76 psi, **FoS = 122/76 = 1.6, concrete shear is ok**. Note tracks should be located so they are at least partially over a girder when possible, which will reduce shear stress. **Typically, excavator is to straddle the middle 2 girders**.



Check bearing capacity of slab on edge of girder flange:

The maximum bearing load on the slab edge is equal to the max shear force figured above = **22.5 k** for a 4’ long slab section.

The allowable bearing pressure on the concrete slab is conventionally limited to 1000 psi. For a 4’ long contact area, the required width is 22.5 k / (48” * L) = 1.00 ksi The minimum L = 0.5” * 1.5 factor of safety = 0.75” bearing width required. **Say the minimum bearing width is 1.5” for sawcutting panels, 3” typ based on shear spiral layout. Prior to cutting, investigate the locations of the shear studs, to lay out and cut as close to the centerline of girder as possible.**

Part 2: Checks of Steel Superstructure

See the attached girder stability calculations. Below, integrate these calculations into the demolition sequence.

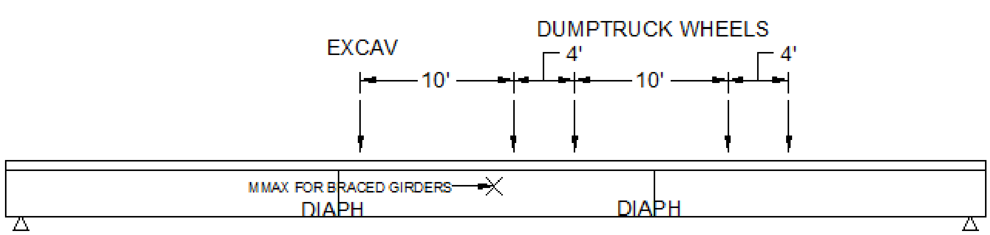
Due to limited width on bridge, equipment is to be located in a train along the bridge, with the excavator loading a dumptruck with slab sections. The truck is to pull up behind the excavator. Typically locate both excavator and dumptruck over middle girders for demolition operations.

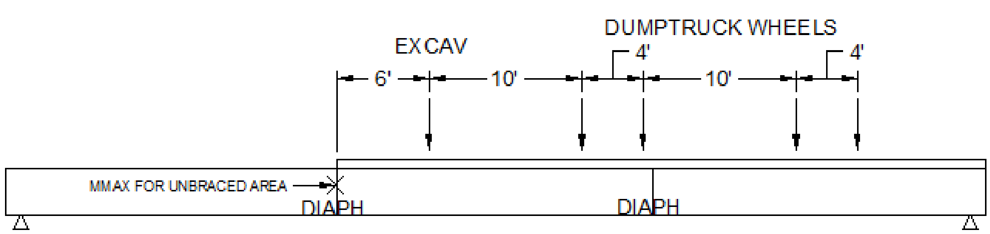
Limit equipment to 5 mph speeds on the bridge once sawcuts have begun.

Check girder capacity:
Attached calculations check the three different spans (62, 72’ and 92’) for overall strength, including the bottom cover plates. Stability checks are also made as deck removal proceeds along each span.

Start deck removal from Pier 3, with separate removal operations toward each abutment. See the attached dimensions taken from the existing bridge plans.

Bending is checked in the steel calculations under full deck load, and with deck removal to the first diaphragm. As noted in the calculations, Mmax is calculated for the unbraced girders as the point where the deck is removed, as the actual Mmax is always in the braced portion of the span.





At girder ends, Lb is taken as the distance from end of girder to first diaphragm. Cb = 1.0 for unbraced end. Results indicate that no lateral bracing is needed at girder ends. To prevent unwanted sidesway, provide temporary X-bracing between the two middle girders at each bearing location. This cross-bracing may be installed beforethe deck is sawcut, or after removing the concrete diaphragm located over the bearing line.

X-bracing diaphragms must resist 2% of the compressive load from bending. Figure bracing for the heaviest girder. Check W36x300 for bending with deck removed to first diaphragm, for max bending near end of girder (p. 51):
Mu = 1333 k-ft; compressive component = 1333 / 2 = 667 k-ft = 8,000 k-in.
Take moment arm as 18" – 1.33" (y_p for WT18x150) = 16.67"
Compressive load to resist = 0.02 * 8000 k-in / 16.67" = **9.6 k X-bracing load**

Provide substantial timber X-bracing to span between girders with wire ropes in tension between girder flanges.

Add 1/2 transverse load (2 members in X-brace):
wind loads = 0.4 k/ft * 21' max between diaphragms = 8.4 k / 2 = 4.2 k

Total brace load = 9.6 + 4.2 = 13.8 k; say 14 k.
If X-brace member is at 30 degrees (max) from horizontal, load on brace =
14 k / cos30 = 16.2 k compressive load.

For timber (oak, SPF, or similar) allowable compressive stress parallel to grain = 1100 psi * 1.6 for a short duration load = 1,760 psi = 1.7 ksi.
Required timber area = 16.2 k / 1.7 ksi = **9.5 in^2 required**
Use a 3x4 rough-sawn timber, 3x6 finished timber,
or equivalent for X-braces (12 in^2 area).

Install threaded rods through holes drilled in girder webs. Secure with double nut at ends. This work may be done before removing deck and concrete end diaphragms.

Threaded rods are to resist 14 k load.
3/4" threaded rod has tensile SWL = 18 k, ok.

Girder bearing:
The girder has bearing stiffeners. Bearing is not a concern.

Girder Shear:
Compare loading to shear produced by HS-20 loading. Check W36x150, which has the proportionally smallest shear capacity. From HS-20 load tables, for 67' span, shear per lane load = 62.1 k.
Divide lane load among 2 girders: LL Vmax = 31 k per girder, no impact.

Vmax from live load during jacking = 56 k excavator * 0.5 DF = 28 k per girder
Dumptruck, with rear wheels at the bearing, Vmax = 68.41 k
68.41 k * 0.6 DF = 41 k per girder, controls over excavator.
DL on girder:
Steel = 0.2 k/ft * 1.05 = 0.21 k/ft

Deck = wext = 1 k/ft
Total shear = 41 k + 1.21 k/ft*67'/2 = 81.6 k shear force
Allowable shear load on girder:

h/tw = 32.125"/0.65" = 49.4; 418/√36 ksi = 69.7 > 49.4, no web instability.
Vallow = 0.6 * Φ * Vn = 0.6*0.9*0.6*36 ksi*(0.65"*32.125") = 243 k
Allowable shear stress is >> applied shear; shear is ok.

Section 2: Steel Demolition

Girder stability during picks

Pick girders using a minimum of a beam clamp at midspan.

W36x150 with cover plate, 64' long
Weight = 0.18 k/ft * 64' = 12 k + 1280 lb diapragms = 13,280 lb.
Use 15-ton beam clamp (flange width = 12", ok).

W36x170 with cover plate, 74' long
Weight = 0.224 k/ft * 74' = 17 k + 1920 lb diapragms = 18,920 lb.
Use 15-ton beam clamp (flange width = 12", ok).

W36x300 with cover plate, 94' long
Weight = 0.362 k/ft * 94' = 34 k + 2560 lb diapragms = 36,560 lb.
Use 25-ton beam clamp (flange width = 16.6", ok).

Girder stability, from NHDOT standard specifications:

(a) One Crane (Overhang using a single line pickup at the girder centerline with or without a spreader) – For the unsupported overhang length, *d*, the maximum *d/b* ratio should not exceed 35 nor should the overhang length exceed 50 ft.

(b) Two Cranes (Distance between beam clamps at the girder ends on a two-point pick-up) – For the unsupported length, *a*, between beam clamps on a two-point pickup, the *a/b* ratio should not exceed 85 nor should the distance between pickup points exceed 100 feet.

For W36x150 and 170 girders, dmax = 74'/2 = 37', bf = 12" = 1'.
d/b = 37 approx. = 35, stability ok.

For W36x300 girders, dmax = 94'/2 = 47', bf = 16.6" = 1.38'.
d/b = 47'/1.38' = 34 = 35, stability ok.

Brace final girder in each span.

Design for heaviest girder:
W36x300 total weight = 38,600 lb / 94' = 0.41 k/ft * 94^2 ft2 / 8
= 453 k-ft bending moment

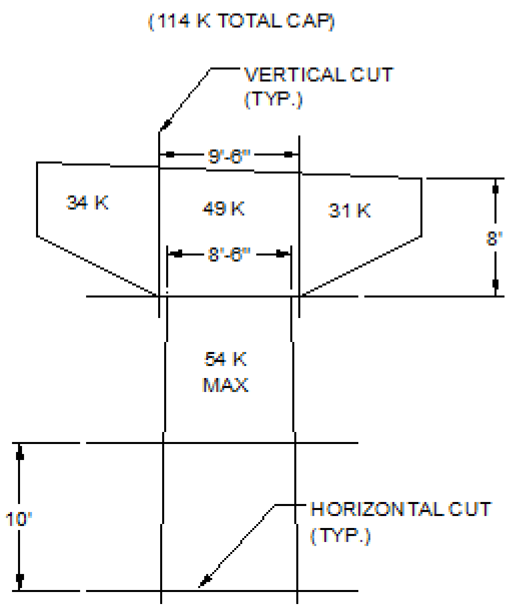
Compressive component = 453 / 2 = 227 k-ft = 2,720 k-in.
Take moment arm as 18" – 1.33" (y_p for WT18x150) = 16.67"
Compressive load to resist = 0.02 * 2,720 k-in / 16.67"
= **3.3 k temp brace load**

If last girder removed is an exterior girder, use an angle brace welded or bolted to the girder at the bearing locations. L7x4x7/16 has column strength of 37 k at 12', ok by inspection. Use min. (1) ¾" bolt and 1 existing anchor bolt for connections.

If last girder removed is an interior girder, use min 3/8" cables with plate hooks connected to bearing anchor bolts to either side of girder at the bearing locations.

Section 3: Substructure Demolition

Wire saw piers near Stowe St. and Thatcher Brook, and pick elevated pieces by crane.
Pre-drill core holes horizontally through pier sections for lifting straps.
Hold concrete sections in place with crane while sawing.



Pier cap:
138 HSL 80-ton crane picks 34 k at R=40'
RTC 80100 100-ton crane picks 34 k at R=50'

Column:
138 HSL 80-ton crane picks 54 k at R=28'
RTC 80100 100-ton crane picks 54 k at R=30'

Check moment on pier column after cutting first side of hammerhead:
34 k * 9' = 306 k-ft = 3,672 k-in
S of column at minimum section approx = 1/6*48" * 60^2 in2 = 28,800 in3
Stress = 3672 k-in / 28,800 in3 = 0.128 ksi = 128 psi tension
Allowable tensile stress for plain concrete is approx. 5*sqrt(3000 psi) = 273 psi
Ok even if unreinforced. Concrete column is okay by inspection.

Appendix:
Girder strength and stability calculations, 6 pp
Beam clamp literature

Waterbury bridge 46A demolition
W36x150 with cover plate, 62' span

Carry no composite action with deck, as slabs will be cut.

Section properties:

	A	ybar	A*ybar	
girder	44.2	18.8	830.96	
bot cover	8.75	0.4375	3.828125	
sums:	52.95		834.788125	

Ybar = 15.76559254

	Iox	A	dx	Ix+A*dx^2
girder	9040	44.2	3.03440746	9446.977
bot cover	0.558268229	8.75	15.32809254	2056.374
sums:				11503.35

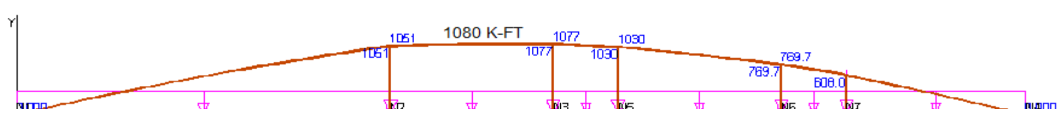
Ix =	11503.4	in^4	(vs 9040 w/o cover)
ext fib dist =	21.0	in	
Sx =	548.8	in^3	(vs 504 w/o cover)
wt =	0.18	k/ft	

Girder loading:
56 k Excavator with tracks over girders.
Carry DF = 0.5
Excavator load on girder = point load
Pexcav = 28.0 k

Dumptruck has wheel load DF = 0.5 vs axle load
axle loads are 16 k on duallies, negligible on single tires
Pwheel = 8 k

Deck is 8" thick, 7.33' wide
Pdeck = 0.73 k/ft

Load locations on girder for Mmax:



Mmax =	1080	k-ft
	12960	k-in
σmax =	23.6	ksi
Steel grade =	36.0	ksi yield
σall (0.66) =	23.8	ksi
overstress:	-1%	

allowable for temporary work, girders to be demolished
lateral bracing is provided by cut slab sections during max load
Loading is found to be low vs. service loads for bearing, shear, etc. checks

Waterbury bridge 46A demolition
W36x170 with cover plate, 72' span

Carry no composite action with deck, as slabs will be cut.

Section properties:

	A	ybar	A*ybar	
girder	50	19.21	960.5	
bot cover	15.75	0.5625	8.859375	
sums:	65.75		969.359375	
Ybar =	14.74310837			
	Iox	A	dx	Ix+A*dx^2
girder	10500	50	4.466891635	11497.66
bot cover	2.135742188	15.75	14.18060837	3169.298
sums:				14666.95
Ix =	14667.0	in^4	(vs 10500 w/o cover)	
ext fib dist =	22.6	in		
Sx =	650.4	in^3	(vs 580 w/o cover)	
wt =	0.224	k/ft		

Girder loading:
56 k Excavator with tracks over girders.
Carry DF = 0.5
Excavator load on girder = point load

Pexcav =	28.0	k

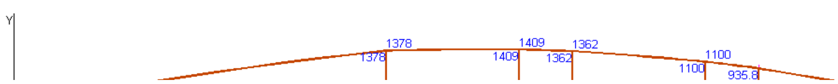
Dumptruck has wheel load DF = 0.5 vs axle load
axle loads are 16 k on duallies, negligible on single tires

Pwheel =	8	k

Deck is 8" thick, 7.33' wide

Pdeck =	0.73	k/ft

Load locations on girder for Mmax:



Mmax =	1409	k-ft
	16908	k-in
σmax =	26.0	ksi
Steel grade =	36.0	ksi yield
σall (0.66) =	23.8	ksi
overstress:	9%	

9% overstress is allowable for temporary work, girders to be demolished
lateral bracing is provided by cut slab sections during max load
Loading is found to be low vs. service loads for bearing, shear, etc. checks

Waterbury bridge 46A demolition
W36x300 with cover plate, 92' span

Carry no composite action with deck, as slabs will be cut.

Section properties:

	A	ybar	A*ybar
girder	88.3	19.37	1710.371
bot cover	18	0.5	9
sums:	106.3		1719.371

Ybar = 16.17470367

	Iox	A	dx	Ix+A*dx^2
girder	20300	88.3	3.195296331	21201.54
bot cover	1.5	18	15.67470367	4424.034
sums:				25625.57

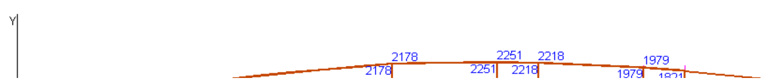
Ix =	25625.6	in^4	(vs 20300 w/o cover)
ext fib dist =	21.6	in	
Sx =	1188.3	in^3	(vs 1110 w/o cover)
wt =	0.362	k/ft	

Girder loading:
56 k Excavator with tracks over girders.
Carry DF = 0.5
Excavator load on girder = point load
Pexcav = 28.0 k

Dumptruck has wheel load DF = 0.5 vs axle load
axle loads are 16 k on duallies, negligible on single tires
Pwheel = 8 k

Deck is 8" thick, 7.33' wide
Pdeck = 0.73 k/ft

Load locations on girder for Mmax:

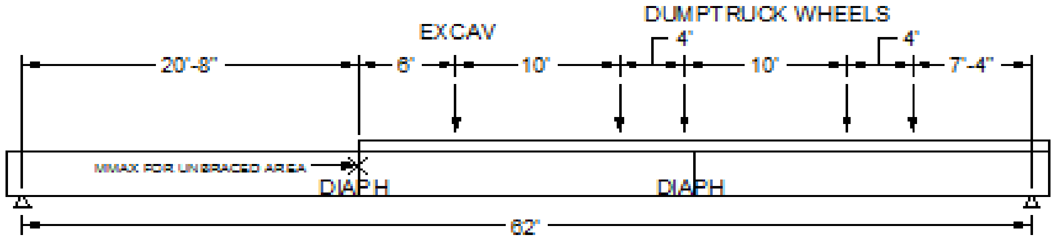


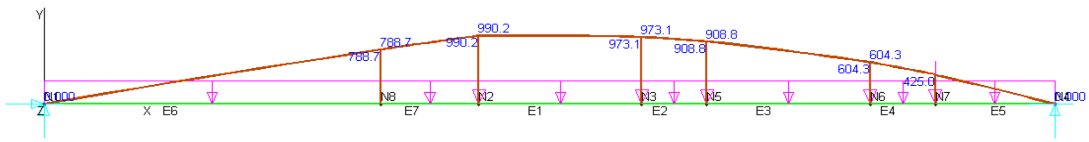
Mmax =	2251	k-ft
	27012	k-in
σmax =	22.7	ksi
Steel grade =	36.0	ksi yield
σall (0.66) =	21.8	ksi
overstress:	4%	

4% allowable for temporary work, girders to be demolished
lateral bracing is provided by cut slab sections during max load
Loading is found to be low vs. service loads for bearing, shear, etc. checks

Waterbury bridge 46A demolition
W36x150 with cover plate, 64' span

Ignore cover plate for checking stability
Find max loading on deck with deck removed to first diaphragm.





Mu = 789 k-ft

Determine if unbraced end of girder is stabile.

Flange and web are compact.

Lb = 248.0 in
Lp = 129.0 in
Lr = 391.8 in

Lp < Lb < Lr, so inelastic LTB. Find Mn:
Cb = 1.0 for unbraced end
E = 29000 ksi
Iy = 270 in^4
G = 11200 ksi
J = 10.1 in^4
Cw = 82200 in^6

Mn = 24954.8 k-in
Mp = 19173 k-in
Mp governs.
Mallow = 12654.18 k-in
1054.515 k-ft

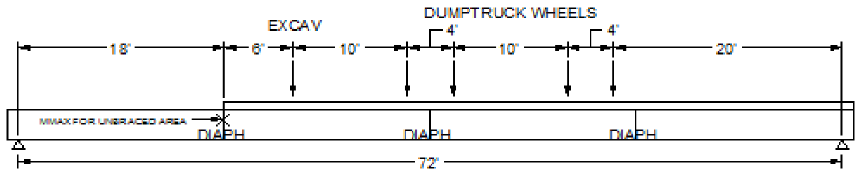
Take Mu as max moment in unbraced region.
Mu = 789 k-ft
Mu < Mallow; Imposed moment is ok.

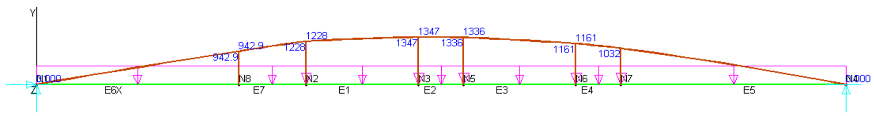
Check with beam design chart:
W36x150, Lb = 21', Mn = 1250 k-ft, Mallow = 825 k-ft > 789 k-ft, ok.
Girder is okay without diaphragm at bearing location.

For demolition to midspan, Mallow = 1054 k-ft (Mp governs).
Mmax with full deck load (see prev. calc) = 1080 k-ft, 3% overstress, ok.
Note under full load, deck slabs will provide lateral support between diapragms.

Waterbury bridge 46A demolition
W36x170 with cover plate, 72' span

Ignore cover plate for checking stability
Find max loading on deck with deck removed to first diaphragm.





Mu = 943 k-ft

Determine if unbraced end of girder is stabile.

Flange and web are compact.

Lb =	216.0	in
Lp =	132.1	in
Lr =	415.1	in

Lp < Lb < Lr, so inelastic LTB. Find Mn:

Cb =	1.0	for unbraced end	
E =	29000	ksi	
Iy =	320	in^4	3880=x*10^6
G =	11200	ksi	x=3880/10^6
J =	15.1	in^4	
Cw =	98500	in^6	

Mn =	38964.4	k-in
Mp =	22044	k-in
Mp governs.		
Mallow =	14549.04	k-in
	1212.42	k-ft

Take Mu as max moment in unbraced region.
Mu = 943 k-ft
Mu < Mallow; Imposed moment is ok.

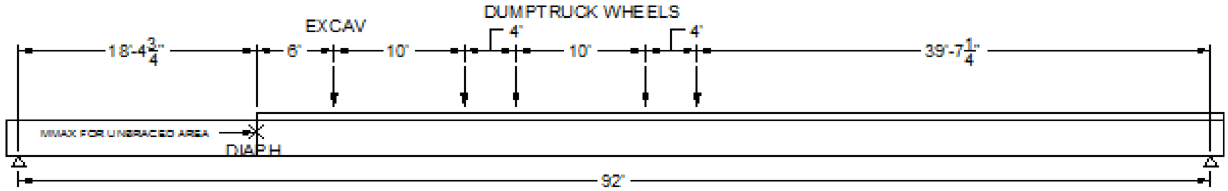
Check with beam design chart:
W36x170, Lb = 18', Mn = 1560 k-ft, Mallow = 1029 k-ft > 943 k-ft, ok.
Girder is okay without diaphragm at bearing location.

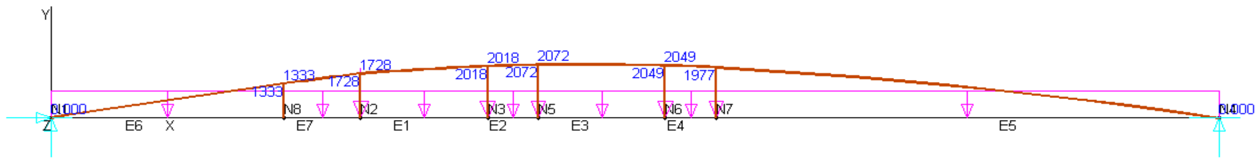
For demolition to midspan, Mallow = 1212 k-ft (Mp governs).
Mmax with full deck load (see prev. calc) = 1409 k-ft, 16% over, NG, must check.
Note under full load, deck slabs will provide lateral support between diapragms.

Check for deck removal to 6' from midspan, Mmax = 1056 k-ft at cut panel section.
1056/1029 = 1.014, 3% overstressed, ok.

Waterbury bridge 46A demolition
W36x300 with cover plate, 92' span

Ignore cover plate for checking stability





Mu = 1333 k-ft

Determine if unbraced end of girder is stabile.

Flange and web are compact.

Lb =	220.8	in
Lp =	200.0	in
Lr =	729.9	in

Lp < Lb < Lr, so inelastic LTB. Find Mn:

Cb =	1.0	for unbraced end
E =	29000	ksi
Iy =	1300	in^4
G =	11200	ksi
J =	64.2	in^4
Cw =	398000	in^6

Mn =	152711.6	k-in	very large vs. Mp!
Mp =	41580	k-in	verify Mallow below
Mp governs.			
Mallow =	27442.8	k-in	
	2286.9	k-ft	

Take Mu as max moment in unbraced region.
Mu = 1333 k-ft
Mu < Mallow; Imposed moment is ok.

Check with beam design chart:
W36x300, Lb = 18', Mn = 3300 k-ft, Mallow = 2178 k-ft, similar, ok.
Girder is okay without diaphragm at bearing location.

For demolition to midspan, Mallow = 2286 k-ft (Mp governs).
Mmax with full deck load (see prev. calc) = 2251 k-ft, ok.
Note under full load, deck slabs will provide lateral support between diapragms.

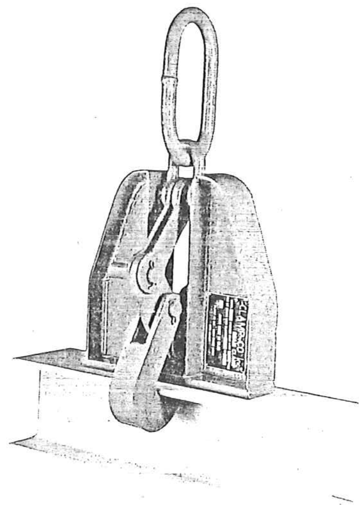
BEAM CLAMPS

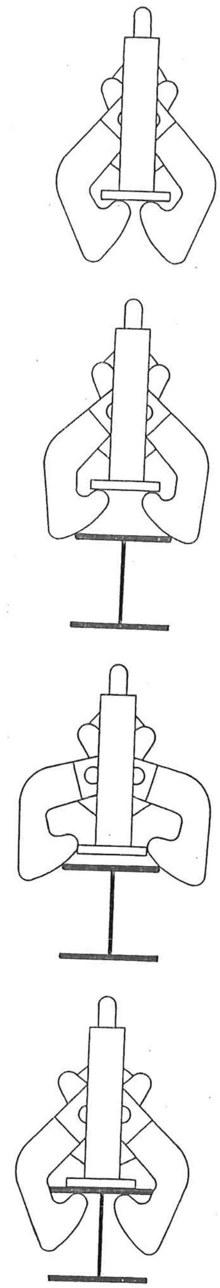
Beam clamps provide an efficient method for handling wide flange beam sections and plate girders. When lifting, they grip the beam at three points. When properly balanced and safely guided, the beam can be handled even if the clamp is slightly off center lengthwise.

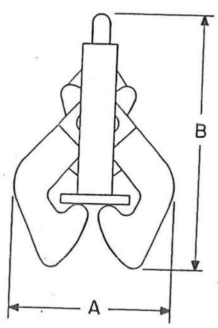
Good safety procedures providing control of the lifted beam must be used. Beams should be gripped as near the center as possible. Snubbing lines at each end must be used to control excessive twisting or swinging, and to guide the beam to its proper place. Each lifting situation may have specific safety demands which should be used as required.

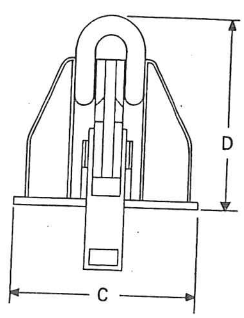
Beam clamps eliminate the need for slings, chokers, and spreader bars. The weight of the beam clamp automatically opens its tongs, which slide under the flanges of the beam. When the clamp is lifting, its center plate and gripping tongs work against each other—the heavier the beam, the greater the clamping pressure.

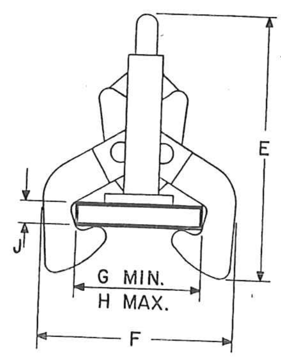
Model "NS" clamps have a recessed base to accept studs welded to a beam surface.



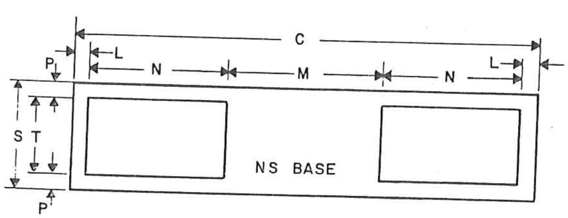








Model No.	Working Load Limit Tons	FlangeGrip Width Range Min. Max.	FlangeGrip Depth	Wt. Lbs.	Dimensions A	B	C	D	E	F	G	H	J
F-5	5	4 to10	1	51	9 1/2	26	12	20	25 1/2	16 3/4	4	10	1
F-15	15	7 to17	2	125	15 1/2	34	17	27	34 1/2	25	7	17	2
NS-15	15	7 to17	2	120	15 1/2	34	17	27	34 1/2	25	7	17	2
F-25	25	16 to 24	3	244	23	48	22 1/4	36	53	37 1/4	16	24	3
NS-25	25	16 to 24	3	234	23	48	22 1/4	36	53	37 1/4	16	24	3
F-35	35	16 to 36	4	495	30	64	27 1/2	48	58	53	16	36	4
NS-35	35	16 to 36	4	484	30	64	27 1/2	48	58	53	16	36	4



Model Number	NS Base Dimensions, Inches S	C	N	T	M	L	P
NS-15	4	16 1/2	4 1/2	2 1/2	6 1/2	1/2	3/4
NS-25	5 1/2	22 1/4	6 1/2	4	7 3/4	3/4	3/4
NS-35	6	27 1/2	8 1/2	4 1/2	9	3/4	3/4

WARNING: Decreasing the load by bumping or substantial imbalance can, under certain circumstances, loosen the grip. Do not use on flange widths less than those specified on the name plate. Do not exceed working load limit.