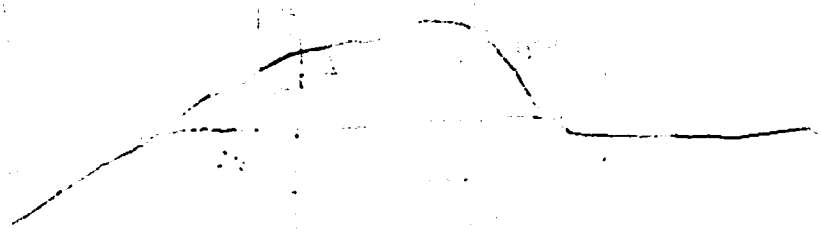


ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07008480 Date 7/19/12 Initials ~~7/19/12~~ LaT Region (A B C D)

Site _____ Location 148 St, 6.6 mi W of Mansfield

Q_{100} = Q50 5770 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5770 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 140 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 135.23 ft* $q_2 = Q_2/W_2$ = 42.7 ft^2/s

Bridge Vel, V_2 = 3.2 ft/s Final $y_2 = q_2/V_2$ = 13.2 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.4 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

Water Surface Elev. = 0-1.1 ft

Low Steel Elev. = 14.2 ft

n (Channel) = 0.035

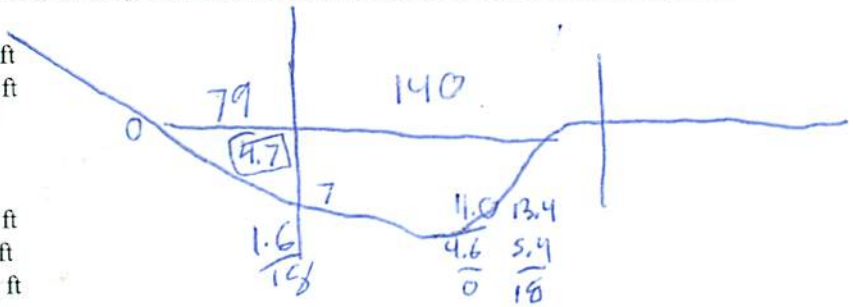
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 79 ft Average left overbank flow depth, y_{lob} = 4.7 ft

Width of right overbank flow at approach, W_{rob} = ~~146~~ 0 ft Average right overbank flow depth, y_{rob} = 0 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

x = 2.54 From Figure 9 W_2 (effective) = 131.2 ft y_{cs} = 3.1 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = _____ ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ ft/s

If $V_1<V_c$ and D_{50} >= 0.2 ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, y_{cs} = _____ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.16 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.7 ft right abutment, y_{aRT} = 0 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 14.5 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07008480 Date 7/19/12 Initials RJT Region (A B C D)

Site _____ Location 148 St, 6.6 mi W of Mansfield

Q_{500} = Q500 4560 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6621 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 140 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ _____

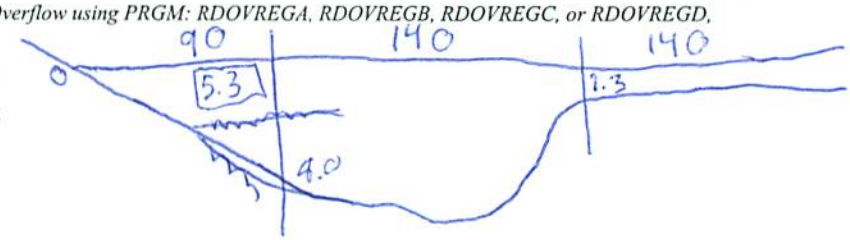
Corrected channel width at bridge Section = W_2 times cos of flow angle = 135.23 ft* $q_2 = Q_2/W_2$ = 49 ft^2/s

Bridge Vel, V_2 = 3.4 ft/s Final $y_2 = q_2/V_2$ = 14.2 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.4 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,



Water Surface Elev. = 0-1.1 ft

Low Steel Elev. = 14.2 ft

n (Channel) = 0.035

n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 90 ft Average left overbank flow depth, y_{lob} = 5.3 ft

Width of right overbank flow at approach, W_{rob} = 140 ft Average right overbank flow depth, y_{rob} = 1.3 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

x = 3.47 From Figure 9 W_2 (effective) = 131.2 ft y_{cs} = 4.1 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = _____ ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ ft/s

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, y_{cs} = _____ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.16 Using pier width a on Figure 11, ξ = 1.8 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.3 ft right abutment, y_{aRT} = 1.3 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 15.6 and ψ_{RT} = 5.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.5 ft

98° 42' 8.2"
45° 14' 37.176"

98.70226
45.24366

Route 148 St Stream Snake Ck MRM _____ Date 7/19/12 Initials RJT

Bridge Structure No. 07008480 Location 148 St, 6.6 mi W of Mansfield

GPS coordinates: N 45° 14' 37.31" W 98° 42' 8.41" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 319.36 sq. mi.

The average bottom of the main channel was 19.6 ft below top of guardrail at a point 104 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio X regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ Q_{SC} = 5770			~~Q_{500}~~ Q_{10C} = 8560		
Estimated flow passing through bridge	5770			6621		
Estimated road overflow & overtopping	0			1939		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow		X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

7/2

2	169
5	802
10	1710
25	3650
50	5770
100	8560
500	18100

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know minor pier/contraction heavy abutment on left. unable to tell on right

Debris Potential? ____High ____Med X Low

Does scour countermeasure(s) appear to have been designed?

Riprap	____Yes	X No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other _____	____Yes	X No	____Don't know	____NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay X	Sand____	Gravel____	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

1). left OB
2). main channel
3). right OB
4). pier
5). pier scour
6-7). ~~left~~ right abutment
8-9). ~~left~~ right abutment

10-11). left abutment scour
12). main channel

Summary of Results

	~~Q100~~ Q_{SC}	~~Q500~~ Q_{10C}
Bridge flow evaluated	5770	6621
Flow depth at left abutment (yaLT), in feet	4.7	5.3
Flow depth at right abutment (yaRT), in feet	0	1.3
Contraction scour depth (ycs), in feet	3.1	4.1
Pier scour depth (yps), in feet	6	6.1
Left abutment scour depth (yas), in feet	14.5	15.6
Right abutment scour depth (yas), in feet	0	5.5
1Flow angle of attack	15	15

See Comments/Diagram for justification where required