OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 15190111 Date 9/2/12 Initials RaT Region (A B (C) D)

Site _____ Location 5 mi N of Watertown on 455 Ave

Q_{100} = 870 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 870 (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

Bridge Width = 51 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 47.92 ft* $q_2 = Q_2/W_2$ = 18.2 ft^2/s

Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 6 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.2 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,

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

Water Surface Elev. = 0.8 ft

Low Steel Elev. = 7.0 ft

n (Channel) = 0.060

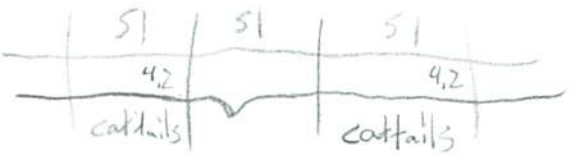
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 1.25 ft

Pier Length = 1.25 ft

Piers for 100 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 51 ft

Width of left overbank flow at approach, W_{lob} = 51 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 51 ft Average right overbank flow depth, y_{rob} = 4.2 ft

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

x = 1002 From Figure 9 W_2 (effective) = 46.7 ft y_{cs} = 11 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 5.6 Pier scour y_{ps} = 4.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.2 ft right abutment, y_{aRT} = 4.2 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} = 13.6 and ψ_{RT} = 13.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 15110111 Date 8/2/12 Initials RAT Region (A B C D)

Site _____ Location 5 mi N of Watertown on 455 Ave

Q_{500} = 1380 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1178 (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

Bridge Width = 51 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 47.92 ft* $q_2 = Q_2/W_2$ = 24.6 ft²/s

Bridge Vel, V_2 = 3.5 ft/s Final $y_2 = q_2/V_2$ = 7 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.2 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,

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

Water Surface Elev. = 0.8 ft

Low Steel Elev. = 7.0 ft

n (Channel) = 0.060

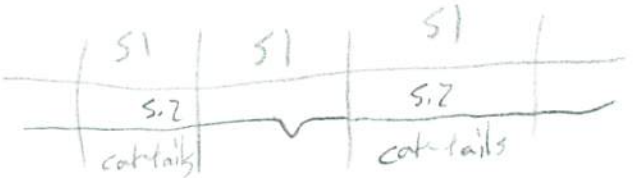
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 1.25 ft

Pier Length = 1.25 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 51 ft

Width of left overbank flow at approach, W_{lob} = 51 ft Average left overbank flow depth, y_{lob} = 5.2 ft

Width of right overbank flow at approach, W_{rob} = 51 ft Average right overbank flow depth, y_{rob} = 5.2 ft

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

x = 12.87 From Figure 9 W_2 (effective) = 46.7 ft y_{cs} = 13.8 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 5.6 Pier scour y_{ps} = 4.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.2 ft right abutment, y_{aRT} = 5.2 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} = 15.4 and ψ_{RT} = 15.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.4 ft

44° 59' 28.524
97° 6' 21.96

97.1061
44.99134

Route 455 Ave Stream ______ MRM ______ Date 8/2/12 Initials RaT

Bridge Structure No. 15190111 Location 5 mi N of Watertown on 455 Ave

GPS coordinates: N 44° 59' 29.4" W 97° 6' 21.7" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 8.36 sq. mi.

The average bottom of the main channel was 10.9 ft below top of guardrail at a point 40 ft from left abutment.

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

7/3
8/23

2	67
5	191
10	311
25	507
50	679
100	870
500	1380

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	870		Q_{500} =	1380	
Estimated flow passing through bridge		870			1178	
Estimated road overflow & overtopping		0			202	
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	

Riprap at abutments? ____Yes ____No X Marginal

Evidence of past Scour? X Yes ____No ____Don't know some pier/contraction/abutment

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
5-6). right abutment
7-8). left abutment
9). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	870	1178
Flow depth at left abutment (yaLT), in feet	4.2	5.2
Flow depth at right abutment (yaRT), in feet	4.2	5.2
Contraction scour depth (ycs), in feet	11	13.8
Pier scour depth (yps), in feet	4.5	4.5
Left abutment scour depth (yas), in feet	13.6	~~15.4~~ 15.4
Right abutment scour depth (yas), in feet	13.6	15.4
1Flow angle of attack	20	~~20~~ 20

See Comments/Diagram for justification where required