ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50242060 Date 6/25/12 Initials RAL Region (A B C D)

Site _____ Location 4.2 mi E of Baltic on 250 St

Q_{100} = 1540 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1540 (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 = 56 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 = 52.62 ft* $q_2 = Q_2/W_2$ = 29.3 ft^2/s

Bridge Vel, V_2 = 3.8 ft/s Final $y_2 = q_2/V_2$ = 7.6 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.9 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. = 0.40 ft

Low Steel Elev. = 9.0 ft

n (Channel) = 0.040

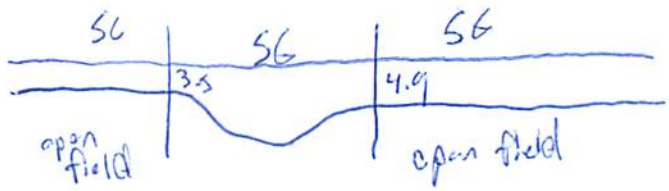
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 56 ft

Width of left overbank flow at approach, W_{lob} = 56 ft Average left overbank flow depth, y_{lob} = 3.5 ft

Width of right overbank flow at approach, W_{rob} = 56 ft Average right overbank flow depth, y_{rob} = 4.9 ft

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

x = 0.33 From Figure 9 W_2 (effective) = 49.3 ft y_{cs} = 9.2 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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

see notes

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.5 ft right abutment, y_{aRT} = 4.9 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} = 12.4 and ψ_{RT} = 14.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 5024060 Date 6/25/12 Initials KaT Region (A B C D)

Site _____ Location 4.2 mi E of Battle on 250 St

Q_{500} = 2310 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2140 (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 = 56 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 = 52.62 ft* $q_2 = Q_2/W_2$ = 40.7 ft^2/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 9 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.4 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. = 0-4.0 ft

Low Steel Elev. = 9.0 ft

n (Channel) = 0.040

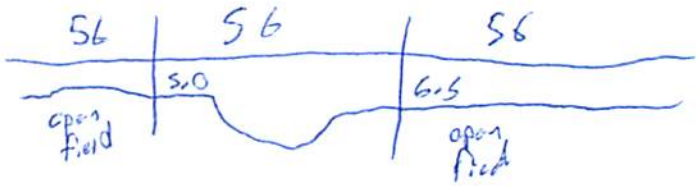
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 56 ft

Width of left overbank flow at approach, W_{lob} = 56 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 56 ft Average right overbank flow depth, y_{rob} = 6.5 ft

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

x = 12.13 From Figure 9 W_2 (effective) = 49.3 ft y_{cs} = 13.2 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 = 0.26 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 ft right abutment, y_{aRT} = 6.5 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} = 15.0 and ψ_{RT} = 17.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.7 ft

96° 38' 49.092"
43° 45' 40.788

96.64697
43.76133

Route 250 St Stream _____ MRM _____ Date 6/25/12 Initials RAT

Bridge Structure No. 50242060 Location 4.2 mi E of Battle on 250 St

GPS coordinates: N 43° 45' 41.0", W 96° 38' 49.2" taken from: USL abutment X centerline of ⫯ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 4.53 sq. mi.

The average bottom of the main channel was 12.6 ft below top of guardrail at a point 15 ft from left abutment.

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

6/14 8/25

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1540			Q_{500} = 2310		
Estimated flow passing through bridge	1540			2140		
Estimated road overflow & overtopping	0			170		
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	

2	167
5	414
10	633
25	965
50	1240
100	1540
500	2310

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know

Debris Potential? ____High ____Med X Low

left abutment under concrete - left side mostly ~~Lots~~ major contraction - water elevation changes from 1ft-4ft within a few yards.

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

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

rose quartz on abutments

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

Note: possibly large amounts of cobble sized riprap ~~bed~~ in bridge channel but water too deep to wade.
8-9). left abutment
10). main channel.

Summary of Results

	Q100	Q500
Bridge flow evaluated	1540	2140
Flow depth at left abutment (yaLT), in feet	3.5	5.0
Flow depth at right abutment (yaRT), in feet	4.9	6.5
Contraction scour depth (ycs), in feet	9.2	13.2
Pier scour depth (yps), in feet	5.6	5.6
Left abutment scour depth (yas), in feet	12.4	15.0
Right abutment scour depth (yas), in feet	14.8	17.7
1Flow angle of attack	20	20

See Comments/Diagram for justification where required