OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20050273 Date 7/30/12 Initials RaT Region (A B (C) D)

Site ______ Location 5.4 mi E of Estelline + 0.7 mi N on 471 Av

Q_{100} = 1210 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1210 (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 = 89 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

Width (W_2) iteration = 89   50   53   ____

Avg. flow depth at bridge, y_2 iteration = 5.5   7.3   7.1   ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 48.03 ft* $q_2 = Q_2/W_2$ = 25.2 ft²/s

Bridge Vel, V_2 = 3.6 ft/s Final $y_2 = q_2/V_2$ = 7.1 ft Δh = 0.3 ft

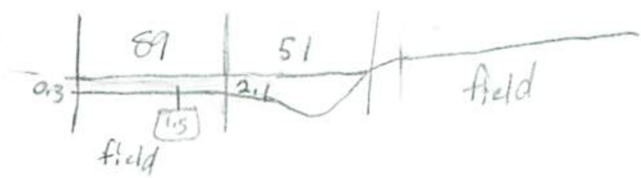
Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.3 ft

** 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.

0.8 / 40

Water Surface Elev. = 0-3.2 ft
Low Steel Elev. = 16.6 ft
n (Channel) = 0.040
n (LOB) = 0.030
n (ROB) = 0.035
Pier Width = 1.7 ft
Pier Length = 1.7 ft
Piers for 100 yr = 2 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} = 89 ft Average left overbank flow depth, y_{lob} = 1.5 ft

Width of right overbank flow at approach, W_{rob} = 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 = 2.43 From Figure 9 W_2 (effective) = 44.6 ft y_{cs} = 3 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 0.24 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.5 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} = 6.3 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20050273 Date 7/30/12 Initials RAT Region (A B (C) D)

Site ______ Location 5.4 mi E & 0.7 mi N of Estelline on 471 Av

Q_{500} = 1870 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1870 (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 = 89 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

Width (W_2) iteration = 89 52 61 59

Avg. flow depth at bridge, y_2 iteration = 6.8 8.9 8.2 8.3

Corrected channel width at bridge Section = W_2 times cos of flow angle = 53.47 ft* $q_2 = Q_2/W_2$ = 35 ft^2/s

Bridge Vel, V_2 = 4.2 ft/s Final $y_2 = q_2/V_2$ = 8.3 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.7 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. = 0-3.2 ft

Low Steel Elev. = 16.6 ft

n (Channel) = 0.040

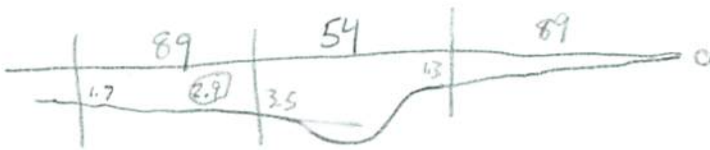
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 54 ft

Width of left overbank flow at approach, W_{lob} = 89 ft Average left overbank flow depth, y_{lob} = 0.9 ft

Width of right overbank flow at approach, W_{rob} = 89 ft Average right overbank flow depth, y_{rob} = 2.9 ft

1.3·2/3 3.5→1.7 3.5/1.7

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

x = ~~4.67~~ 3.99 From Figure 9 W_2 (effective) = 50.1 ft y_{cs} = ~~5.6~~ 4.6 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 $D_{50} >= D_{c50}$, χ = 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 = 0.26 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.9 ft right abutment, y_{aRT} = 2.9 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} = 3.9 and ψ_{RT} = 11.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 3.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.3 ft

44° 35' 0.492"
96° 47' 5.172"

96.78477
44.58347

Route 471 Av Stream Peg Munky Run Ck MRM ________ Date 7/30/12 Initials [illegible]

Bridge Structure No. 20050273 Location 5.4 mi E & 0.7 mi N of Estelline on 471 Av

GPS coordinates: N44° 34' 59.7" W96° 47' 5.0" taken from: USL abutment X centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 8.50 sq. mi.

The average bottom of the main channel was 20.4 ft below top of guardrail at a point 59 ft from left abutment.

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

7/13
8/23

2	105
5	283
10	452
25	719
50	951
100	1210
500	1870

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	1210		Q_{500} =	1870	
Estimated flow passing through bridge		1210			1870	
Estimated road overflow & overtopping		0			0	
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 and left 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). left abutment
7). main channel.
8-9). right abutment.

Summary of Results

	Q100	Q500
Bridge flow evaluated	1210	1870
Flow depth at left abutment (yaLT), in feet	1.5	0.9
Flow depth at right abutment (yaRT), in feet	0	2.9
Contraction scour depth (ycs), in feet	3	~~5.6~~ 4.6
Pier scour depth (yps), in feet	5.7	5.7
Left abutment scour depth (yas), in feet	6.3	3.9
Right abutment scour depth (yas), in feet	0	11.3
1Flow angle of attack	25	25

See Comments/Diagram for justification where required