OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. SS0660438 Date 9/2/12 Initials RAJ Region (A B C D)

Site _____ Location 1.8 mi S of HWY 12 on 455 Ave

Q_{100} = 1000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1000 (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 = 41 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 40.14 ft* $q_2 = Q_2/W_2$ = 24.5 ft^2/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

11.4
5.4
6.0

** 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,

left 5.2 -3.2
right 5.6 -3.8

Water Surface Elev. = dry ft

Low Steel Elev. = 9.4 ft

n (Channel) = 0.035

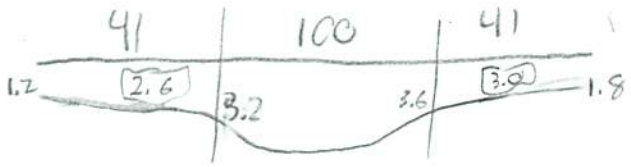
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 41 ft Average left overbank flow depth, y_{lob} = 2.6 ft

Width of right overbank flow at approach, W_{rob} = 41 ft Average right overbank flow depth, y_{rob} = 3.0 ft

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

x = _____ From Figure 9 X W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

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

Estimated bed material D_{50} = 0.7 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = ~~4.39~~ 0.76 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ~~14.21~~ 13.78 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.009 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} = 0 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 = 6 Pier scour y_{ps} = 4.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.6 ft right abutment, y_{aRT} = 3.0 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} = 10.6 and ψ_{RT} = 11.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 55060438 Date 8/2/12 Initials RAJ Region (A B C D)

Site _____ Location 1.6 mi S of Hwy 12 on 455 Ave

Q_{500} = 1600 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1600 (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 = 41 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 40.64 ft* $q_2 = Q_2/W_2$ = 39.2 ft^2/s

Bridge Vel, V_2 = 4.4 ft/s Final $y_2 = q_2/V_2$ = 8.8 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.2 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.

Water Surface Elev. = dry ft

Low Steel Elev. = 9.7 ft

n (Channel) = 0.035

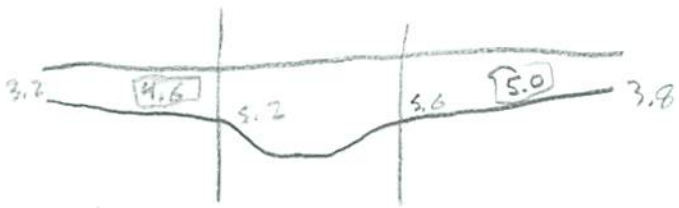
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 41 ft Average left overbank flow depth, y_{lob} = 4.6 ft

Width of right overbank flow at approach, W_{rob} = 41 ft Average right overbank flow depth, y_{rob} = 5.0 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

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

Estimated bed material D_{50} = 0.7 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ~~4.26~~ 0.96 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ~~14.67~~ 14.36 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.015 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} = 0 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 = 0.26 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.6 ft right abutment, y_{aRT} = 5.0 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} = 14.3 and ψ_{RT} = 15

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 26 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 27.3 ft

Route 455 Ave Stream Big Sioux River MRM _____ Date 8/2/12 Initials RAT

Bridge Structure No. 55060438 Location 1.8 mi S of HWY 12 on 455 Ave

GPS coordinates: N 45° 18' 04.11" W 97° 6' 11.01" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 13.14 sq. mi.

The average bottom of the main channel was 13.8 ft below top of guardrail at a point 31 ft from left abutment.

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

7-3
~~8/26~~

2	74.3
5	214
10	352
25	578
50	778
100	1000
500	1600

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1000			Q_{500} = 1600		
Estimated flow passing through bridge		1000			1600	
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? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know substantial pier/contraction - since covered by riprap

Debris Potential? ____High ____Med ____Low

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

Riprap X Yes ____No ____Don't know ____NA rose quartz fillips up

Spur Dike ____Yes X No ____Don't know ____NA channel.

Other _____ ____Yes X No ____Don't know ____NA

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

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

Channel is riprap

Comments, Diagrams & orientation of digital photos

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

Summary of Results

	Q100	Q500
Bridge flow evaluated	1000	1600
Flow depth at left abutment (yaLT), in feet	2.6	4.6
Flow depth at right abutment (yaRT), in feet	3.0	5.0
Contraction scour depth (ycs), in feet	0	0
Pier scour depth (yps), in feet	4.8	4.9
Left abutment scour depth (yas), in feet	19.3	26.0
Right abutment scour depth (yas), in feet	20.9	27.3
1Flow angle of attack	5	5

See Comments/Diagram for justification where required