OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50210232 Date 6/21/12 Initials RaT Region (A B C D)

Site _____ Location S Cliff Ave & Big Sioux River

Q_{100} = Qzs 32900 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 32900 (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 = 322 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 = 320.77 ft* $q_2 = Q_2/W_2$ = 102.6 ft^2/s

Bridge Vel, V_2 = 7.2 ft/s Final $y_2 = q_2/V_2$ = 14.3 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.3 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,

Water Surface Elev. = 0-0.7 ft

Low Steel Elev. = 14.9 ft

n (Channel) = 0.040

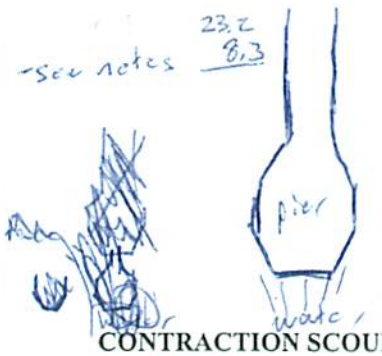
n (LOB) = 0.080

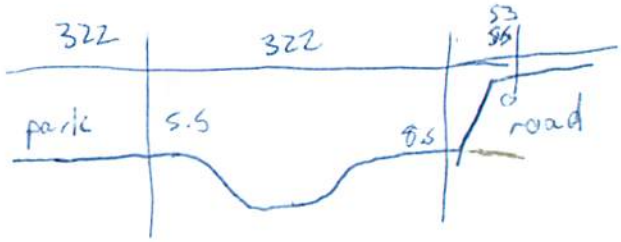
n (ROB) = 0.080

Pier Width = 3.1 ft

Pier Length = 59 ft

Piers for 100 yr = 3 ft





8.5/2 =

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 322 ft

Width of left overbank flow at approach, W_{lob} = 322 ft Average left overbank flow depth, y_{lob} = 5.5 ft

Width of right overbank flow at approach, W_{rob} = 53 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 4.51 From Figure 9 W_2 (effective) = 311.5 ft y_{cs} = 5.2 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 19.67

Froude # at bridge = 0.34

Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Using pier width a on Figure 11, ξ = 10.9 Pier scour y_{ps} = 13.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.5 ft right abutment, y_{aRT} = 4.3 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} = 15.9 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50210232 Date 6/21/12 Initials MJT Region (A B C D)

Site _____ Location S Cliff Avenue & Big Sioux River

Q_{500} = Q500 43500 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 35812 (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 = 322 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 = 322 ft* $q_2 = Q_2/W_2$ = 111.6 ft^2/s

Bridge Vel, V_2 = 7.5 ft/s Final $y_2 = q_2/V_2$ = 14.9 ft 320.77 Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16. 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. = 0-0.7 ft

Low Steel Elev. = 14.9 ft

n (Channel) = 0.040

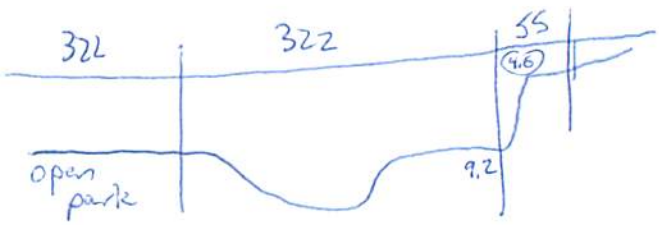
n (LOB) = 0.030

n (ROB) = 0.050

Pier Width = 3.1 ft

Pier Length = 59 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 322 ft

Width of left overbank flow at approach, W_{lob} = 322 ft Average left overbank flow depth, y_{lob} = 6.2 ft

Width of right overbank flow at approach, W_{rob} = 55 ft Average right overbank flow depth, y_{rob} = 55 4.6 ft

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

x = 5.26 From Figure 9 W_2 (effective) = 311.5 ft y_{cs} = 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 19.67 Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.34 Using pier width a on Figure 11, ξ = 10.9 Pier scour y_{ps} = 14 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.2 ft right abutment, y_{aRT} = 4.6 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} = 17.2 and ψ_{RT} = 14.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.3 ft

Route S Cliff Ave Stream Big Sioux River MRM _____ Date 6/21/12 Initials JaT

Bridge Structure No. 50210232 Location S Cliff Ave & Big Sioux River

GPS coordinates: N 43° 30' 41.8" W 96° 42' 42.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 3764.95 sq. mi.

The average bottom of the main channel was 23.2 ft below top of guardrail at a point 240 ft from left abutment.

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

3764.95
6/15

2	5830
5	13900
10	21300
25	32900
50	43500
100	55300
500	88100

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ = Q_{25} 32900			Q_{500} = Q_{50} 43500		
Estimated flow passing through bridge		32900			35812	
Estimated road overflow & overtopping		C			7688	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow	X	X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes ____No X Marginal ~~X~~ Small rocks on left abutment

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

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

Notes: * Due to heavy Traffic, I took channel depth/ low steel etc. from down stream side of bridge (Ie there is a walkway,

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	32900	35812
Flow depth at left abutment (yaLT), in feet	5.5	6.2
Flow depth at right abutment (yaRT), in feet	4.3	4.6
Contraction scour depth (ycs), in feet	5.2	6
Pier scour depth (yps), in feet	13.9	14
Left abutment scour depth (yas), in feet	15.9	17.2
Right abutment scour depth (yas), in feet	13.8	14.3
1Flow angle of attack	5	5

See Comments/Diagram for justification where required