OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 68121204 Date 5/29/12 Initials Rat Region (A B C D)

Site _____ Location Cedar St & Marne Ck in Yankton

Q_{100} = 2570 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2570 (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 = 105 ft. Flow angle at bridge = 60 ° Abut. Skew = 45 ° Effective Skew = 15 °

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 = 101.42 ft* $q_2 = Q_2/W_2$ = 25.3 ft^2/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, $y_1 = \Delta h + y_2$ = 7.4 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. = 0-0.5 ft

Low Steel Elev. = 7.9 ft

n (Channel) = 0.020 - concrete

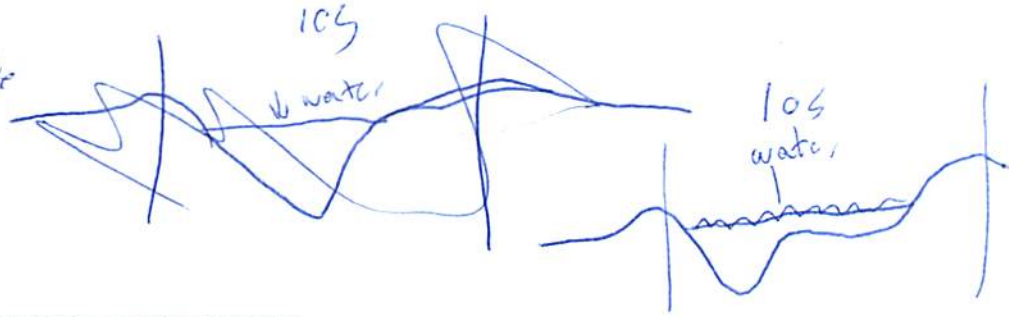
n (LOB) = 0.030

n (ROB) = 0.045

Pier Width = 0.8 ft

Pier Length = 19 ft

Piers for 100 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 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 = 0.32 From Figure 9 W_2 (effective) = 100.6 ft y_{cs} = 0.5 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 = 98.75

Froude # at bridge = 0.24

Correction factor for flow angle of attack (from Table 1), K2 = 2.5

Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 7.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

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

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 6812204 Date 5/29/12 Initials LaT Region (A B C D)

Site _____ Location Cedar St & Marne Ck in Yankton

Q_{500} = 5130 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3177 (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 = 105 ft. Flow angle at bridge = 60° Abut. Skew = 45 Effective Skew = 15 °

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 = 101.42 ft* $q_2 = Q_2/W_2$ = 31.3 ft^2/s

Bridge Vel, V_2 = 4 ft/s Final $y_2 = q_2/V_2$ = 7.9 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.2 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. = 0-0.5 ft

Low Steel Elev. = 7.9 ft

n (Channel) = 0.020

n (LOB) = 0.030

n (ROB) = 0.045

Pier Width = 0.8 ft

Pier Length = 79 ft

Piers for 500 yr = 1 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 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 = 0.36 From Figure 9 W_2 (effective) = 100.6 ft y_{cs} = 0.6 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 98.75 Correction factor for flow angle of attack (from Table 1), K2 = 2.5

Froude # at bridge = 0.25 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 7.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

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

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

Route Cedar Ck Stream Marne Clk MRM _____ Date 5/29/12 Initials RAT

Bridge Structure No. 68121204 Location Cedar St + Marne Ck in Yankton

GPS coordinates: N 42° 52' 30.2" taken from: USL abutment X centerline of ↑ MRM end _____

W 97° 23' 13.3" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 30 mi² sq. mi.

The average bottom of the main channel was 14.9 ft below top of guardrail at a point 32 ft from left abutment.

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

8/26

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2570			Q_{500} = 5130		
Estimated flow passing through bridge		2570		3177		
Estimated road overflow & overtopping		0		1953		
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	

8/26	
2	91.8
5	327
10	620
25	1200
50	1600
100	2570
500	5110

Riprap at abutments? ____Yes X No X Marginal

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

Debris Potential? ____High ____Med X Low

5/22

2	92
5	328
10	622
25	1200
50	1800
100	2570
500	5130

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 _____	X Yes	____No	____Don't know	____NA concrete walkway

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

Material	Silt/Clay____	Sand X	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

1-4) main channel
5). left abutment
6) right abutment
7-9). left abutment damage
10. pier scour
11). right OB
12). left OB

note: dike has been constructed along right abutment at road level and left overbank is along the road.

Summary of Results

	Q100	Q500
Bridge flow evaluated	2570	5130
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	0.5	0.6
Pier scour depth (yps), in feet	7.8	7.9
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	15	15

See Comments/Diagram for justification where required