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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50183230 Date 6/21/12 Initials RaT Region (A B C D)

Site _____ Location Big Sioux R & 41st St

Q_{100} = 53100 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 53100 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

$310^2 - 48^2 = d^2$

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 306 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 = 287.55 ft* $q_2 = Q_2/W_2$ = 184.7 ft^2/s

Bridge Vel, V_2 = 9.6 ft/s Final $y_2 = q_2/V_2$ = 19.2 ft Δh = 1.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 21.1 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. = 0-2.5 ft

Low Steel Elev. = 19.5 ft

n (Channel) = 0.030

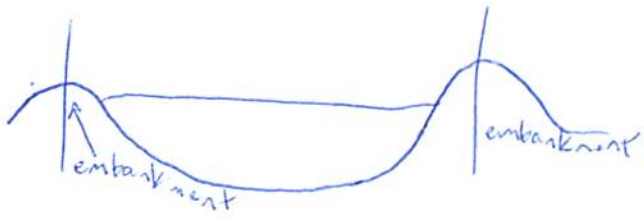
n (LOB) = 0.016 ~~0.013~~ asphalt

n (ROB) = 0.013

Pier Width = 3 ft

Pier Length = 120 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 306 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 = 1.83 From Figure 9 W_2 (effective) = 281.6 ft y_{cs} = 2.4 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

- Note: piers have wing walls

L/a ratio = 40

Froude # at bridge = 0.39

Correction factor for flow angle of attack (from Table 1), K2 = 2.8

Using pier width a on Figure 11, ξ = ~~10.7~~ 10.7 Pier scour y_{ps} = 26 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. 50183230 Date 6/21/12 Initials RLT Region (A B C D)

Site _____ Location Big Sioux R & 41st St

Q_{500} = 84800 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 55026 (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 = 306 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 = 287.55 ft* $q_2 = Q_2/W_2$ = 191.4 ft^2/s

Bridge Vel, V_2 = 9.8 ft/s Final $y_2 = q_2/V_2$ = 19.5 ft Δh = 2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 21.5 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. = 0-2.5 ft

Low Steel Elev. = 19.5 ft

n (Channel) = 0.030

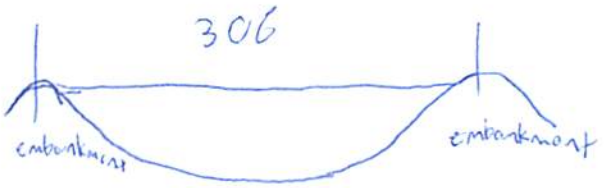
n (LOB) = 0.013 .016

n (ROB) = 0.013

Pier Width = 3 ft

Pier Length = 120 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 306 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 = 1.67 From Figure 9 W_2 (effective) = 281.6 ft y_{cs} = 2.4 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 = 40 Correction factor for flow angle of attack (from Table 1), K2 = 2.8

Froude # at bridge = 0.39 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 26.1 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

96° 45' 59.868"
43° 30' 54.072

96.76663
43.51502

Route 415t St Stream Big Sioux River MRM _____ Date 6/21/12 Initials RaC

Bridge Structure No. 50183230 Location Big Sioux R. & 41st St

GPS coordinates: N 43° 30' 53.7" W 96° 45' 54.6" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 3748.61 sq. mi.

The average bottom of the main channel was 29.0 ft below top of guardrail at a point 11E ft from left abutment.

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

3748.61
6/18

2	5520
5	13300
10	20300
25	31600
50	41700
100	53100
500	84800

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 53100			Q_{500} = 84800		
Estimated flow passing through bridge	53100			55026		
Estimated road overflow & overtopping	0			29774		
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 minor pier/ contraction

Debris Potential? ____High ____Med X Low

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

Riprap	X Yes	____No	____Don't know	____NA	rose quartz.
Spur Dike	____Yes	X No	____Don't know	____NA	> see picture 8. Cinder block pattern. essentially no exposed dirt. pier has wing walls.
Other _____	X Yes	____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

embankments are built @ road ~~high~~ height in line with abutments.

Comments, Diagrams & orientation of digital photos

1). left cB
2). main channel
3). right cB
4). pier
5-7). left abutment
8). design
9). left abutment
10). pier wing walls
11). pier scour.
12-14). right abutment
15). main channel.

Summary of Results

	Q100	Q500
Bridge flow evaluated	53100	55026
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	2.4	~~2.4~~ 2.4
Pier scour depth (yps), in feet	26	26.1
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	20	20

Note: piers have wing walls

See Comments/Diagram for justification where required