OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 26352030 Date 8/13/10 Initials CMW Region (A B C D)

Site _____ Location From Milbank, SD - 4 North + 6.1 East on 145 St.

Q_{100} = 12900 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 12900 (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 = 200 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 156 164 161 ____

Avg. flow depth at bridge, y_2 iteration = 13.2 12.9 13.0 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 151.29 ft* $q_2 = Q_2/W_2$ = 85.3 ft^2/s

Bridge Vel, V_2 = 6.5 ft/s Final $y_2 = q_2/V_2$ = 13.0 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.9 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. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = 0.035

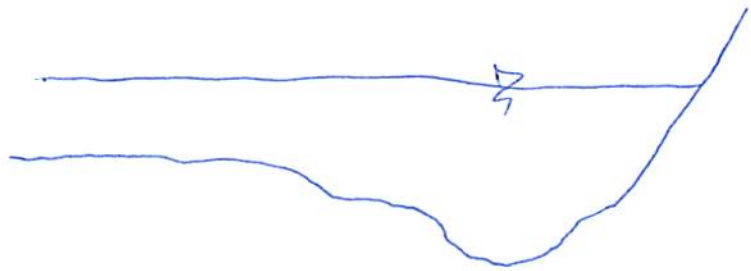
n (LOB) = 0.035

n (ROB) = 0.037

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 200 ft

Width of left overbank flow at approach, W_{lob} = 200 ft Average left overbank flow depth, y_{lob} = 7.4 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 = 12.48 From Figure 9 W_2 (effective) = 145.6 ft y_{cs} = 13.6 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 6.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 7.4 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} = 19.6 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 26352030 Date 8/13/10 Initials CW Region (A B C D)

Site _____ Location From Milbank, SD - 4 North & 6.1 East - on 145 St.

Q_{500} = 19000 by: drainage area V flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 19000 (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 = 200 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 200 164 174 ____

Avg. flow depth at bridge, y_2 iteration = 14.2 15.5 15.2 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 163.51 ft* $q_2 = Q_2/W_2$ = 116.2 ft^2/s

Bridge Vel, V_2 = 7.6 ft/s Final $y_2 = q_2/V_2$ = 15.2 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.4 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. = ____ ft

Low Steel Elev. = ____ ft

n (Channel) = .035

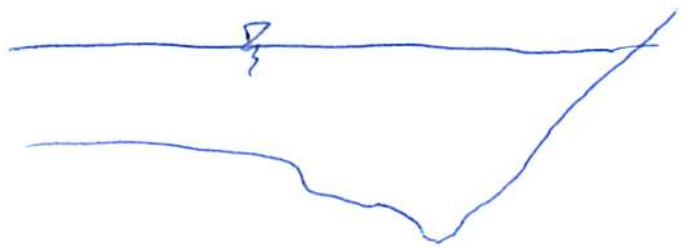
n (LOB) = .035

n (ROB) = .037

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 200 ft

Width of left overbank flow at approach, W_{lob} = 206 ft Average left overbank flow depth, y_{lob} = 10.3 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 = 13.96 From Figure 9 W_2 (effective) = 157.8 ft y_{cs} = 14.4 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.34 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 6.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 10.3 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} = 21.6 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Route 145 St. Stream Whetstone River MRM _____ Date 8/13/10 Initials CW

Bridge Structure No. 26352030 Location 4N & 6.1E Milbank

GPS coordinates: 45 17' 00" taken from: USL abutment _____ centerline of ⇑ MRM end _____
96 30' 38.6" Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 400.94 sq. mi.

The average bottom of the main channel was 22.5 ft below top of guardrail at a point 56 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓drainage area adjustment ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 12900			Q_{500} = ~~19200~~ 19000		
Estimated flow passing through bridge	12900			19000		
Estimated road overflow & overtopping						
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 (DS side only)

Evidence of past Scour? X Yes ____No ____Don't know scour/erosion on right abut.

Debris Potential? X High ____Med ____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	____No	____Don't know	X NA

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

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

Comments, Diagrams & orientation of digital photos

1059 - Structure #

1060 - Approach XS from bridge

1061 - Left over bank (LOB)

1062 - Channel

~~1063~~ - ROB

1064 - bridge from approach

1065 - Right abut. @ bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	12900	19000
Flow depth at left abutment (yaLT), in feet	7.4	10.3
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	13.6	14.4
Pier scour depth (yps), in feet	6.5	6.5
Left abutment scour depth (yas), in feet	19.6	21.6
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	20	20

See Comments/Diagram for justification where required