ok TCT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51120044 Date 8/18/10 Initials CW Region (A B C D)

Site _____ Location 5.5 E, 1.5 S from I-29 Exit 121

Q_{100} = 23900 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 23900 (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

Bridge Width = 247 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 247 216 215 ____

Avg. flow depth at bridge, y_2 iteration = 13.9 15 ~~14.9~~ 14.9

Corrected channel width at bridge Section = W_2 times cos of flow angle = 215 ft* $q_2 = Q_2/W_2$ = 111.2 ft^2/s

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

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.0 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,

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

Water Surface Elev. = ____ ft

Low Steel Elev. = 16.5 ft

n (Channel) = 0.033

n (LOB) = 0.035

n (ROB) = 0.037

Pier Width = 2.0 ft

Pier Length = 2.6 ft

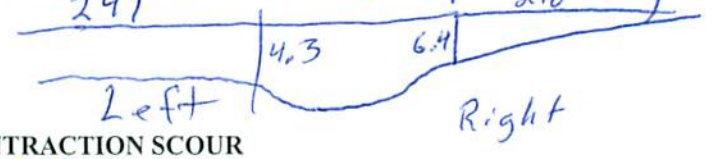
Piers for 100 yr = 3 ft

Water flowing deep & sorta fast

~~→ estimate pier width & length~~

→ Average channel bottom

(Flow keeps taking tape DS)



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 250 ft

Width of left overbank flow at approach, W_{lob} = 247 ft Average left overbank flow depth, y_{lob} = ~~4.3~~ 4.3 ft

Width of right overbank flow at approach, W_{rob} = 210 ft Average right overbank flow depth, y_{rob} = 3.2 ft

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

x = ~~6.11~~ ok From Figure 9 W_2 (effective) = 209 ft y_{cs} = ~~7.3~~ 6.9 ~~6.9~~ ft

~~7.3~~

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 = 0.34 Using pier width a on Figure 11, ξ = 4 Pier scour y_{ps} = 6.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.3 ft right abutment, y_{aRT} = 3.2 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, ~~0.55~~ 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 13.8 and ψ_{RT} = 11.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.9 ft

6.4
1.9
4.3

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51120044 Date 8/18/10 Initials CW Region (A B C D)

Site _____ Location 5.5 E, 1.5 S from I-29 Exit 121

Q_{500} = 36000 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 33826 (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 = 247 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 247 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 17.0 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 247 ft* $q_2 = Q_2/W_2$ = 136.9 ft^2/s

Bridge Vel, V_2 = 8.3 ft/s Final $y_2 = q_2/V_2$ = 16.5 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.9 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,

$Y_2 > LS \rightarrow$ Road overflow

Water Surface Elev. = _____ ft

Low Steel Elev. = 16.5 ft

n (Channel) = 0.033

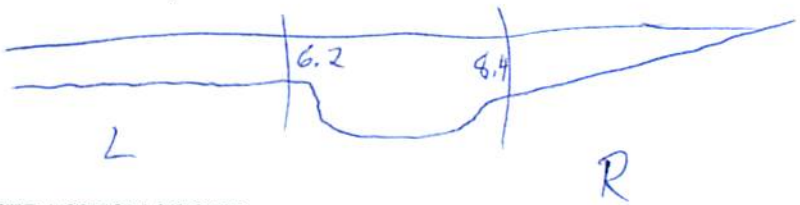
n (LOB) = 0.035

n (ROB) = 0.037

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 250 ft

Width of left overbank flow at approach, W_{lob} = 247 ft Average left overbank flow depth, y_{lob} = 6.2 ft

Width of right overbank flow at approach, W_{rob} = 230 ft Average right overbank flow depth, y_{rob} = 4.2 ft

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

x = 4.98 From Figure 9 W_2 (effective) = 241 ft y_{cs} = 5.7 ft 5.7

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

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 = 0.36 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.2 ft right abutment, y_{aRT} = 4.2 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, ~~0.55 for spill-through~~ 0.55

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 17.2 and ψ_{RT} = 13.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.6 ft

Route 478th Ave Stream Big Sioux River MRM _____ Date 8/16/10 Initials CW

Bridge Structure No. 51120044 Location 5.5 E, 1.5 S from I-29 Exit 121

GPS coordinates: N 44°07'56.0" W 096°38'54.6" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 2542.97 sq. mi.

The average bottom of the main channel was 21.8 ft below top of guardrail at a point 49 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 23900			Q_{500} = 36000		
Estimated flow passing through bridge		23900			33826	
Estimated road overflow & overtopping					2174	
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 A lot ~~was~~ washed away

Evidence of past Scour? ____Yes X No ____Don't know

Debris Potential? X High ____Med ____Low

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

Riprap	X Yes	____No	____Don't know	____NA
Spur Dike	____Yes	____No	____Don't know	X NA
Other _____	____Yes	____No	____Don't know	X 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

1166 - Bridge #
67 - US Face of bridge from approach XS
68 - Left Abut. US
69 - R. Abut. US
70 - US from bridge
71 - RB US
72 - LB US

Summary of Results

	Q100	Q500
Bridge flow evaluated	23900	33826
Flow depth at left abutment (yaLT), in feet	4.3	6.2
Flow depth at right abutment (yaRT), in feet	3.2	4.2
Contraction scour depth (ycs), in feet	6.9	~~5.1~~ 5.7
Pier scour depth (yps), in feet	6.8	6.8
Left abutment scour depth (yas), in feet	13.8	17.2
Right abutment scour depth (yas), in feet	11.9	13.6
1Flow angle of attack	0	0

See Comments/Diagram for justification where required