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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34242222 Date 6/9/17 Initials RaT Region (A B C D)

Site _____ Location 0.9 mi N of Yankton/Bon Homme Co Line

Q_{100} = Q25 1850 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1850 (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 = 48 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 48 ft* $q_2 = Q_2/W_2$ = 38.5 ft^2/s

Bridge Vel, V_2 = 4.4 ft/s Final $y_2 = q_2/V_2$ = 8.8 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.2 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 3 ft

Low Steel Elev. = 8.9 ft

n (Channel) = 0.033

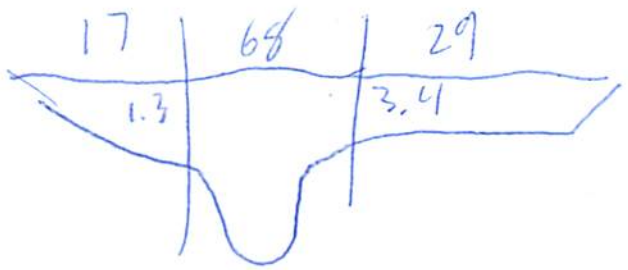
n (LOB) = 0.030

n (ROB) = 0.050

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR 2.2/3

PGRM: Contract

Width of main channel at approach section W_1 = ~~48~~ 68 ft

Width of left overbank flow at approach, W_{lob} = 17 ft Average left overbank flow depth, y_{lob} = 1.3 ft

Width of right overbank flow at approach, W_{rob} = 29 ft Average right overbank flow depth, y_{rob} = 3.4 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer) 5.8

x = ~~4.53~~ 5.13 From Figure 9 W_2 (effective) = 48 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, y_{cs} = _____ ft

PGRM: Pier

PIER SCOUR CALCULATIONS

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

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.3 ft right abutment, y_{aRT} = 3.4 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} = 5.3 and ψ_{RT} = 12.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34242222 Date 6/9/12 Initials RJT Region (A B C D)

Site _____ Location 0.9 mi N of Yankton/Bon Homme Co Line

Q_{500} = 2930 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1909 (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 = 48 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 6 °

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 = 48 ft* $q_2 = Q_2/W_2$ = 39.8 ft^2/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 8.9 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.3 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. = 6-0.3 ft

Low Steel Elev. = 8.9 ft

n (Channel) = 0.033

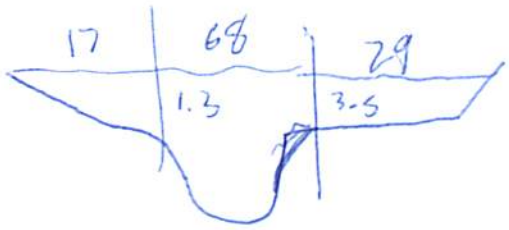
n (LOB) = 0.030

n (ROB) = 0.050

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 66 ft

Width of left overbank flow at approach, W_{lob} = 17 ft Average left overbank flow depth, y_{lob} = 1.3 ft

Width of right overbank flow at approach, W_{rob} = 29 ft Average right overbank flow depth, y_{rob} = 3.5 ft

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

x = ~~4.74~~ 5.22 From Figure 9 W_2 (effective) = 48 ft y_{cs} = ~~5.4~~ 5.9 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, y_{cs} = _____ ft

PGRM: Pier

PIER SCOUR CALCULATIONS

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

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.3 ft right abutment, y_{aRT} = 3.5 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} = 5.5 and ψ_{RT} = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 5.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.5 ft

97° 38' 27.6"
43° 10' 50.3"

-97.6341
43.18066

Route 428 Ave Stream _____ MRM _____ Date 6/9/12 Initials RaT

Bridge Structure No. 34242222 Location 0.9 mi N of Yankton/Bon Homme Co Line

GPS coordinates: N43° 18' 50.41" W97° 38' 2.91" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 69.54 sq. mi.

The average bottom of the main channel was 13.0 ft below top of guardrail at a point 27 ft from left abutment.

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

5/24
~~8/24~~

2	122
5	471
10	927
25	1850
50	2830
100	4100
500	8370

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ = Q_{25} 1850			Q_{500} = Q_{50} 2830		
Estimated flow passing through bridge	1850			1909		
Estimated road overflow & overtopping	0			921		
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 X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know 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). main channel
2). right OB
3). left OB
4-5). right abutment
6-7). left abutment
8). drainage pipe

9). main channel

Summary of Results

	Q100 Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	1850	1909
Flow depth at left abutment (yaLT), in feet	1.3	1.3
Flow depth at right abutment (yaRT), in feet	3.4	~~3.5~~ 3.5
Contraction scour depth (ycs), in feet	~~5.7~~ 5.8	~~5.4~~ 5.9
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	8.1	8.1
Right abutment scour depth (yas), in feet	18.2	18.5
1Flow angle of attack	0	0

See Comments/Diagram for justification where required