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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 68124204 Date 5/29/17 Initials rat Region (A B C D)

Site _____ Location Pine St & Marne Ck in Yankton

Q_{100} = 2560 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2560 (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 = 34 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 37.86 ft* $q_2 = Q_2/W_2$ = 67.6 ft^2/s

Bridge Vel, V_2 = 5.8 ft/s Final $y_2 = q_2/V_2$ = 11.6 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.3 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. = 0.1 ft

Low Steel Elev. = 14.8 ft - ~~Not~~ bridge ~~entrance~~ entrance is an archway assumed highest point for low steel

n (Channel) = 0.025

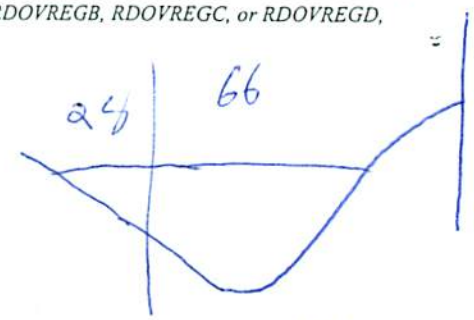
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft



5.3 · 2/3 = 10.6

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~34~~ 66 ft

Width of left overbank flow at approach, W_{lob} = 24 ft Average left overbank flow depth, y_{lob} = 3.5 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

8.9

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

x = 10.08 From Figure 9 W_2 (effective) = 37.9 ft y_{cs} = 11 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 = _____ 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} = 3.5 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} = 12.4 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 22.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 68124204 Date 5/29/12 Initials RAT Region (A B C D)

Site _____ Location Pine St & Marne Ck in Yankton

Q_{500} = 5110 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 41170 (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 = 34 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 37.86 ft* $q_2 = Q_2/W_2$ = 110.7 ft^2/s

Bridge Vel, V_2 = 7.4 ft/s Final $y_2 = q_2/V_2$ = 14.6 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.9 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. = 0.1 ft

Low Steel Elev. = 14.6 ft

n (Channel) = 0.023

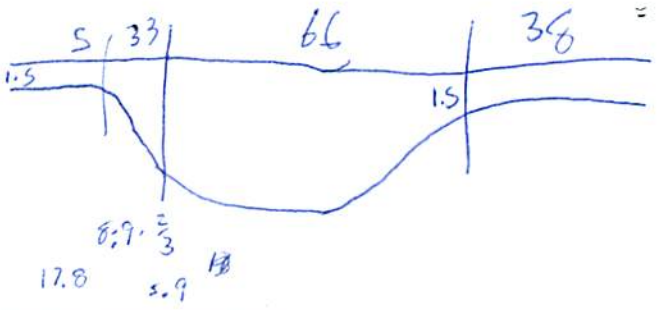
n (LOB) = 0.030

n (ROB) = 0.035

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} = 33 ft Average left overbank flow depth, y_{lob} = 5.8 ft

Width of right overbank flow at approach, W_{rob} = 36 ft Average right overbank flow depth, y_{rob} = 1.5 ft

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

x = 14.52 From Figure 9 W_2 (effective) = 37.9 ft y_{cs} = 14.7 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 = NA 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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.8 ft right abutment, y_{aRT} = 1.5 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} = 16.5 and ψ_{RT} = WW 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 29.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.4 ft

Route Pine St Stream Marne ck MRM _____ Date 5/29/12 Initials RAL

Bridge Structure No. 68124204 Location Pine St & Marne Ck in Yankton

GPS coordinates: N 42° 51' 27.61" taken from: USL abutment X centerline of ⇑ MRM end _____

W 97° 23' 20.0" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 30.46 sq. mi.

The average bottom of the main channel was 19.3 ft below top of guardrail at a point 19 ft from left abutment.

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

8/26

2	92.1
5	328
10	622
25	1200
50	1800
100	2580
500	5130

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2560			Q_{500} = 5110		
Estimated flow passing through bridge		2560			4170	
Estimated road overflow & overtopping		0			940	
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	

5/22

2	91.8
5	327
10	620
25	1200
50	1800
100	2560
500	5110

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____	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). main channel
2). main channel
3). right abut
4). left abut
5). left obs
6). right obs

- Note: bridge entrance is an arch. Used highest point for low steel.

Summary of Results

	Q100	Q500
Bridge flow evaluated	2560	4170
Flow depth at left abutment (yaLT), in feet	3.5	5.6
Flow depth at right abutment (yaRT), in feet	0	1.5
Contraction scour depth (ycs), in feet	11	14.7
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	22.5	29.9
Right abutment scour depth (yas), in feet	0	11.4
1Flow angle of attack	5	5

See Comments/Diagram for justification where required