OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20200071 Date 9/1/15 Initials RaJ Region (A B C D)

Site _____ Location 1 mi W & 5.9 N of Gary on 486 Ave

Q_{100} = 1550 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1550 (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 = 109 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 108 59 77 74

Avg. flow depth at bridge, y_2 iteration = 5.4 7.3 6.4 6.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 72.88 ft* $q_2 = Q_2/W_2$ = 21.3 ft^2/s

Bridge Vel, V_2 = 3.3 ft/s Final $y_2 = q_2/V_2$ = 6.5 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.7 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. = 20.2 ft

Low Steel Elev. = 16.4 ft

n (Channel) = 0.035

n (LOB) = 0.030

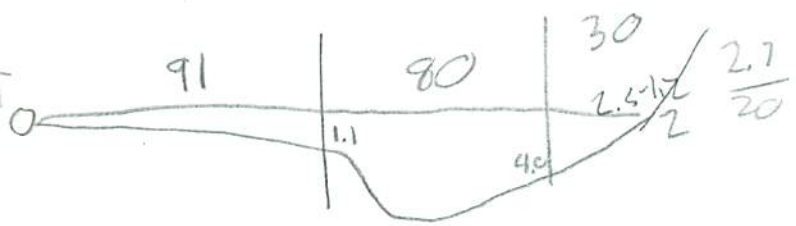
n (ROB) = 0.035

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 100 yr = 4 ft

19
20.2
- 3.8
16.4



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 180 ft

Width of left overbank flow at approach, W_{lob} = 91 ft Average left overbank flow depth, y_{lob} = 6.7 ft

Width of right overbank flow at approach, W_{rob} = 30 ft Average right overbank flow depth, y_{rob} = 2 ft

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

x = 2.07 From Figure 9 W_2 (effective) = 66.1 ft y_{cs} = 2.6 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = 1

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

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.7 ft right abutment, y_{aRT} = 2 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} = 3.1 and ψ_{RT} = 8.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 3.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 8.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20200071 Date 8/11/12 Initials RaJ Region (A B C D)

Site _____ Location 1 mi W + 5.9 mi N of Gary on 486 Ave

Q_{500} = 2420 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2420 (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 = 196 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 108 75 61 80

Avg. flow depth at bridge, y_2 iteration = 6.7 6.1 7.4 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 79.78 ft* $q_2 = Q_2/W_2$ = 30.7 ft^2/s

Bridge Vel, V_2 = 3.9 ft/s Final $y_2 = q_2/V_2$ = 7.8 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.1 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. = 0-1.6 ft

Low Steel Elev. = 16.4 ft

n (Channel) = 0.035

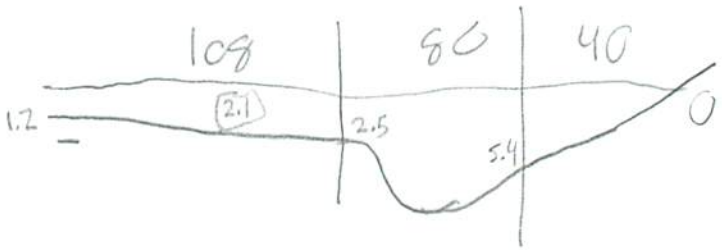
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 80 ft

Width of left overbank flow at approach, W_{lob} = 108 ft Average left overbank flow depth, y_{lob} = 2.1 ft

Width of right overbank flow at approach, W_{rob} = 40 ft Average right overbank flow depth, y_{rob} = 2.7 ft

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

x = 3.12 From Figure 9 W_2 (effective) = 72 ft y_{cs} = 3.7 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.25 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.1 ft right abutment, y_{aRT} = 2.7 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} = 8.6 and ψ_{RT} = 11

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11 ft

44° 52' 31.2418"
96° 28' 47.352"

96.47982
44.87618

Route 486 Ave Stream _____ MRM _____ Date 8/4/12 Initials DAT

Bridge Structure No. 20200071 Location 1 mi W of 5.9 Not Gary on 486 Ave

GPS coordinates: N 44° 52' 34.21" W 96° 28' 47.61" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 13.50 sq. mi.

The average bottom of the main channel was 20.2 ft below top of guardrail at a point 68 ft from left abutment.

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

713
8/23

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1550			Q_{500} = 2420		
Estimated flow passing through bridge	1550			2420		
Estimated road overflow & overtopping	0			0		
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	

2	134
5	362
10	578
25	921
50	1220
100	1550
500	2420

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know minor 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

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). left CB
2). main channel
3). right CB
4). pier
5-6). left abutment
7-8). right abutment
9). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	1550	2420
Flow depth at left abutment (yaLT), in feet	0.7	2.1
Flow depth at right abutment (yaRT), in feet	2	2.7
Contraction scour depth (ycs), in feet	2.6	3.7
Pier scour depth (yps), in feet	5.6	5.7
Left abutment scour depth (yas), in feet	3.1	8.6
Right abutment scour depth (yas), in feet	8.2	11
1Flow angle of attack	10	10

See Comments/Diagram for justification where required