

LOAD CASES - SHEYENNE AQUEDUCT - Phase 4

Client Name:	U.S. ARMY CORPS OF ENGINEERS	MBI
Project Name:	FARGO – MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT, FEASIBILITY STUDY, PHASE 4	
Work Description:	LOAD CASES - SHEYENNE AQUEDUCT - Phase 4	1/24/2011
		34091004
File Path:	P:\Mpls\34 ND\09\34091004 Fargo Moorhead Metropolitan Feas. Study\WorkFiles_Phase4\070 Structural\Aqueducts\Sheyenne\34091004 PH4 Sheyene Pile Calcs.xlsx\Load Cases	

REF.	1
	2

ID#	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Name	100 yr. flood	100 yr. flood + ice	500 yr. flood	T.O. Levee	Normal flow + ice	Construction
Load Category	Usual	Unusual	Unusual	Extreme	Usual	Unusual
Tributary - Water El. (ft)	914.56	914.56	914.67	916	903.24	NA
Diversions - Head Water El. (ft)	902.12	902.12	903.32	916	NA	NA
Diversions - Tail Water El. (ft)	901.91	901.91	903.06	916	NA	NA
Tributary - T.O. Wall El. (ft)	916					
Tributary - T.O. Deck L.P. El.(ft)	898.7					
Tributary - T.O. Deck H.P. El.(ft)	900.7					
Diversions - T.O. Mat El. (ft)	883.68					
Tributary - Deck Slab thickness @ L.P. (ft)	2					
Tributary - Deck Slab thickness @ H.P. (ft)	4					
Diversions - Mat Slab thickness (ft)	4					
Tributary - Water height (ft)	15.86	15.86	15.97	17.3	4.54	NA
Diversions - Head Water height (ft)	18.44	18.44	19.64	32.32	NA	NA
Ice	NA	2ft Ice	NA	NA	2ft Ice	NA
Ice Load	NA	10 kips/ft	NA	NA	10 kips/ft	NA
Ice Load El. (ft)	NA	914.56	NA	NA	903.24	NA
Uplift @ HW (ft)	22.44	22.44	23.64	36.32	NA	NA
Uplift @ TW (ft)	22.23	22.23	23.38	36.32	NA	NA
Pile Condition	Undrained	Undrained	Undrained	Undrained	Drained	Undrained
Load Category	Usual	Unusual	Unusual	Extreme	Usual	Unusual
Safety Factors	2	1.5	1.5	1.15	2	1.5
Allowable Lateral Capacity (tons)	18	20.5	20.5	24	11.5	20.5
Allowable Pile Capacity (tons) - Axial	61.95	82.60	82.60	107.74	36.525	82.60
Allowable Pile Capacity (tons) - Uplift	38.65	51.53	51.53	67.22	5.9	51.53

Pile Capacity	Ultimate Axial Capacity (kips)	Allowable Lateral Capacity (kips)		
		0.5" (Usual)	0.67" (Unusual)	0.875" (Extreme)
Undrained - Axial	247.8	36	41	48
Undrained - Uplift	154.6			
Drained - Axial	146.1	23	29	36
Drained - Uplift	23.6			

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Hydrolic Profile

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Diversion - Head Water El. (ft)	902.12	902.12	903.32	916	NA	NA
Diversion - Tail Water El. (ft)	901.91	901.91	903.06	916	NA	NA
Tributary - T.O. Wall El. (ft)	916					
Tributary - T.O. Deck L.P. El.(ft)	898.7					
Tributary - T.O. Deck H.P. El.(ft)	900.7					
Diversion - T.O. Mat El. (ft)	883.68					
Tributary - Deck Slab thickness @ L.P. (ft)	2					
Tributary - Deck Slab thickness @ H.P. (ft)	4					
Diversion - Mat Slab thickness (ft)	4					
Tributary - Water height (ft)	15.86	15.86	15.97	17.3	4.54	NA
Diversion - Head Water height (ft)	18.44	18.44	19.64	32.32	NA	NA
Ice	NA	2ft Ice	NA	NA	2ft Ice	NA
Ice Load	NA	10 kips/ft	NA	NA	10 kips/ft	NA
Ice Load El. (ft)	NA	914.56	NA	NA	903.24	NA
Uplift @ HW (ft)	22.44	22.44	23.64	36.32	NA	NA
Uplift @ TW (ft)	22.23	22.23	23.38	36.32	NA	NA

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Quantity Take Off (Revit)

Volume of Walls (ft3)	Vw (ft3)	51100	ft3
Volume Tributary Deck Slab (ft3)	Vs (ft3)	41022	ft3
Volume of Bridge Deck (ft3)	Vs (ft3)	8127	ft3
Volume Diversion Mat Slab (ft3)	Vs (ft3)	81744	ft3
Total		181993	ft3

Material Properties

Concrete	γ Concrete (pcf)	150
Steel	γ Steel (pcf)	495
Soil Dry	γs Dry (pcf)	120
Soil Saturated	γs Sat. (pcf)	130
Water	γ Water (pcf)	62.4

Geometry

Tributary Channel

Tributary - T.O. Wall El. (ft)		916	ft
Tributary - T.O. Deck L.P. El. (ft)		898.7	ft
Tributary - T.O. Deck H.P. El. (ft)		900.7	ft
Tributary - Clear Width (ft)	w TC	50	ft
Tributary - Wall Thickness (ft)	twall TC	3	ft
Tributary - Deck Slope Width (ft)	lslab slope TC	17.5	ft
Tributary - Deck Slab thickness @ L.P. (ft)	tslab TC	2	ft
Tributary - Deck Slab thickness @ H.P. (ft)	tslab TC	4	ft
Tributary - Low Flow Channel height (ft)	hlowflow TC	10	ft
Tributary - Low Flow Channel width (ft)	wlowflow TC	10	ft
Tributary - Low Flow Channel thickness (ft)	tlowwall TC	1	ft
Tributary - Wall Height (ft)	hwall TC	19.3	ft

Diversion Channel

Diversion - T.O. Wall El. (ft)		896.7	ft
Diversion - T.O. Mat El. (ft)		883.68	ft
Diversion - Clear Opening Width	wopen DC	30	ft
Diversion - # of Openings	#open DC	6	
Diversion - Wall Thickness (ft)	twall DC	3	ft
Diversion - Mat Slab thickness (ft)	tslab DC	4	ft
Diversion - Butress height (ft)	hbutress	32.32	ft
Diversion - Butress Top width (ft)	wbutress Top	2	ft
Diversion - Butress Top width (ft)	wbutress Bot	9	ft
Diversion - Wall Height (ft)	hwall DC	13.02	ft

Mat Foundation

Overall Width (ft)	wmat	78	ft
Overall Length (ft)	lmat	262	ft
Tributary - Channel Length (ft)	lslab TC	258	ft
Tributary - Channel Width (ft)	wslab TC	56	ft

Access Bridge

Overall Width (ft)	wbridge	15	ft
Overall Length (ft)	lbridge	258	ft
Minimum Deck Thickness	tbridge	1.5	ft
Maximum Deck Thickness	tbridge	3	ft

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Weight of Structure

	<u>Volume (ft3)</u>	<u>Weight (tons)</u>		<u>Volume (ft3)</u>	<u>Weight (tons)</u>
<i>Tributary</i>			<i>Diversion</i>		
Walls	23684	1776	Walls	16770	1258
Deck	41022	3077	Mat	81744	6131
Low Flow Chanel	5160	387	Butress Walls	5333	400
Bridge	8127	860	Sub Total	103847	7788
Sub Total	77993	6100	Total	181840	13638
<i>Whole Structure</i>			<i>Take off (Revit)</i>		
Walls	50947	3821	Walls	51100	3833
Deck	41022	3077	Deck	41022	3077
Bridge	8127	860	Bridge	8127	610
Mat	81744	6131	Mat	81744	6131
Total	181840	13638	Total	181993	13649

Ratio 0.999159089

Forces

<u>ID#</u>	<u>Case 1</u>	<u>Case 2</u>	<u>Case 3</u>	<u>Case 4</u>	<u>Case 5</u>	<u>Case 6</u>
<i>Name</i>	100 yr. flood	100 yr. flood + ice	500 yr. flood	T.O. Levee	Normal flow + ice	Construction
<i>Load Category</i>	Usual	Unusual	Unusual	Extreme	Usual	Unusual
<i>Tributary - Water height (ft)</i>	15.86	15.86	15.97	17.30	4.54	NA
<i>Tributary - Channel Length (ft)</i>	258.00					
<i>Tributary - Clear Width (ft)</i>	50.00					
<i>Tributary - Water force (psf)</i>	989.66	989.66	996.53	1079.52	283.30	NA
<i>Tributary - Water Volume (ft3)</i>	204594.00	204594.00	206013.00	223170.00	11713.20	NA
<i>Tributary - Water Weight (tons)</i>	6383.33	6383.33	6427.61	6962.90	365.45	NA
<i>Diversion - Head Water height (ft)</i>	18.44	18.44	19.64	32.32	NA	NA
<i>Mat Foundation - Overall Width (ft)</i>	78.00					
<i>Mat Foundation - Clear Length (ft)</i>	162.00					
<i>Diversion - Water force (psf)</i>	1150.66	1150.66	1225.54	2016.77	NA	NA
<i>Diversion - Water Volume (ft3)</i>	233007.84	233007.84	248171.04	408395.52	NA	NA
<i>Diversion - Water Weight (tons)</i>	7269.84	7269.84	7742.94	12741.94	NA	NA
Total Water Weight on the Structure (tons)	13653.18	13653.18	14170.54	19704.84	365.45	NA
<i>Tributary - Uplift on the Deck (ft)</i>	5.42	5.42	6.62	19.30	NA	NA
<i>Tributary - Uplift force (psf)</i>	338.21	338.21	413.09	1204.32	NA	NA
<i>Tributary - Uplift force (tons)</i>	-2443.21	-2443.21	-2984.15	-8700.01	NA	NA
<i>Uplift @ HW (ft)</i>	22.44	22.44	23.64	36.32	NA	NA
<i>Uplift @ TW (ft)</i>	22.23	22.23	23.38	36.32	NA	NA
<i>Diversion - Uplift force on the Mat (psf)</i>	1393.70	1393.70	1467.02	2266.37	NA	NA
<i>Diversion - Uplift force on the Mat (tons)</i>	-14240.87	-14240.87	-14990.05	-23157.75	NA	NA
Total Uplif Force on the Structure (tons)	-16684.08	-16684.08	-17974.20	-31857.76	NA	NA
Weight of Structure (tons)	13649.5					

Fargo-Moorhead Food Control Structures
Preliminary Pile Foundation Analyses
HP 14X73

$A_{tip} = 198.5 \text{ in}^2$, $A_{stem} = 21.4 \text{ in}^2$, perimeter = 56.4 in, width (b) = 14.6 in, l = 729 in⁴

Structure	Diversion Channel Station Location	Approximate Ground (Bank) Surface Elevation (ft)	Invert Elevation (ft)	Estimated Foundation Elevation (ft)	Estimated Ground Water Elevation (ft)	Design Condition/Tip Elevations	Ultimate Axial Capacity (kips)	Allowable Lateral Capacity (kips) (fixed head - single pile)			Estimated Settlement at allowable load	
								0.5"	0.67"	0.875"		
Sheyenne River Aqueduct Crossing Foundations	1493+98	916	881.8 883.68	877.83 879.68	908	Undrained Analysis 842.8'	Total	247.8	36	41	48	<0.5"
							Uplift Resistance	154.6				
						Drained Analysis 842.8'	Total	146.1	23	29	36	
							Uplift Resistance	23.6				

See following link for details

<P:\Mpls\34 ND\09\34091004 Fargo Moorhead Metropolitan Feas. Study\WorkFiles\ Phase4\060 Geotech\Deep Foundations>