LOAD CASES - MAPLE 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 Describtion:	**LOAD CASES - MAPLE 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\Maple\[34091004 PH4 Maple 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)	895.99	895.99	896.38	902	881.5	**NA**
Diversion - Head Water El. (ft)	893.89	893.89	895.46	902	**NA**	**NA**
Diversion - Tail Water El. (ft)	892.57	892.57	893.66	902	**NA**	**NA**
Tributary - T.O. Wall El. (ft)	902					
Tributary - T.O. Deck L.P. El.(ft)	881.06					
Tributary - T.O. Deck H.P. El.(ft)	883.06					
Diversion - T.O. Mat El. (ft)	872.06					
Tributary - Deck Slab thickness @ L.P. (ft)	2					
Tributary - Deck Slab thickness @ H.P. (ft)	4					
Diversion - Mat Slab thickness (ft)	4					
Tibutary - Water height (ft)	**14.93**	**14.93**	**15.32**	**20.94**	**0.44**	**NA**
Diversion - Head Water height (ft)	**21.83**	**21.83**	**23.4**	**29.94**	**NA**	**NA**
Ice	**NA**	2ft Ice	**NA**	**NA**	2ft Ice	**NA**
Ice Load	**NA**	10 kips/ft	**NA**	**NA**	10 kips/ft	**NA**
Ice Laod El. (ft)	**NA**	**895.99**	**NA**	**NA**	**881.5**	**NA**
Uplift @ HW (ft)	**25.83**	**25.83**	**27.4**	**33.94**	**NA**	**NA**
Uplift @ TW (ft)	**24.51**	**24.51**	**25.6**	**33.94**	**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
Allwable Lateral Capacity (tons)	**18**	**21**	**21**	**24**	**11.5**	**21**
Allowable Pile Capacity (tons) - Axial	**57.18**	**76.23**	**76.23**	**99.43**	**31.425**	**76.23**
Allowable Pile Capacity (tons) - Uplift	**33.88**	**45.17**	**45.17**	**58.91**	**4.625**	**45.17**

Pile Capacity	**Ultimate Axial Capacity (kips)**	**Allowable Lateral Capacity (kips)**		
		0.5" (Usual)	**0.67" (Unusual)**	**0.875" (Extreme)**
Undrained - Axial	228.7	36	42	48
Undrained - Uplift	135.5			
Drained - Axial	125.7	23	29	33
Drained - Uplift	18.5			

LOAD CASES - SHEYENNE AQUEDUCT - Phase 4

Client Name:	**U.S. ARMY CORPS OF ENGINEERS**	**Design By:**	**MBI**
Project Name:	**FARGO – MOORHEAD METRO FLOOD RISK MANAGEMENT PROJECT, FEASIBILITY STUDY, PHASE 4**	**Review By:**	
		Date:	**1/24/2011**
Work Describtion:	**LOAD CASES - SHEYENNE AQUEDUCT - Phase 4**	**Job #:**	**34091004'**
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REF.	**1**
	2

Hydrolic Profile

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)	**895.99**	**895.99**	**896.38**	**902**	**881.5**	**NA**
Diversion - Head Water El. (ft)	**893.89**	**893.89**	**895.46**	**902**	**NA**	**NA**
Diversion - Tail Water El. (ft)	**892.57**	**892.57**	**893.66**	**902**	**NA**	**NA**
Tributary - T.O. Wall El. (ft)	**902**					
Tributary - T.O. Deck L.P. El.(ft)	**881.06**					
Tributary - T.O. Deck H.P. El.(ft)	**883.06**					
Diversion - T.O. Mat El. (ft)	**872.06**					
Tributary - Deck Slab thickness @ L.P. (ft)	**2**					
Tributary - Deck Slab thickness @ H.P. (ft)	**4**					
Diversion - Mat Slab thickness (ft)	**4**					
Tibutary - Water height (ft)	**14.93**	**14.93**	**15.32**	**20.94**	**0.44**	**NA**
Diversion - Head Water height (ft)	**21.83**	**21.83**	**23.4**	**29.94**	**NA**	**NA**
Ice	**NA**	**2ft Ice**	**NA**	**NA**	**2ft Ice**	**NA**
Ice Load	**NA**	**10 kips/ft**	**NA**	**NA**	**10 kips/ft**	**NA**
Ice Laod El. (ft)	**NA**	**895.99**	**NA**	**NA**	**881.5**	**NA**
Uplift @ HW (ft)	**25.83**	**25.83**	**27.4**	**33.94**	**NA**	**NA**
Uplift @ TW (ft)	**24.51**	**24.51**	**25.6**	**33.94**	**NA**	**NA**

LOAD CASES - SHEYENNE AQUEDUCT - Phase 4

Client Name:	**U.S. ARMY CORPS OF ENGINEERS**	**Design By:**	**MBI**
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		Date:	**1/24/2011**
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Quantity Take Off (Revit)

Volume of Walls (ft3)	Vw (ft3)	45558.53	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		**176451.53**	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)		**902**	ft
Tributary - T.O. Deck L.P. El.(ft)		**881.06**	ft
Tributary - T.O. Deck H.P. El.(ft)		**883.06**	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	4	ft
Tributary - Low Flow Channel width (ft)	wlowflow TC	4	ft
Tributary - Low Flow Channel thickness (ft)	tlowwall TC	1	ft
Tributary - Wall Height (ft)	hwall TC	**22.94**	ft

Diversion Channel

Diversion - T.O. Wall El. (ft)		**879.06**	ft
Diversion - T.O. Mat El. (ft)		**872.06**	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	**29.94**	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	**7**	ft

Mat Foundation

Overall Width (ft)	wmat	**78**	ft
Overall Length (ft)	lmat	**262**	ft
Triburtary - Channel Length (ft)	lslab TC	**258**	ft
Triburtary - 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

LOAD CASES - SHEYENNE AQUEDUCT - Phase 4

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		Date:	**1/24/2011**
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Weight of Structure

Tibutary	Volume (ft3)	Weight (tons)
Walls	29319	2199
Deck	41022	3077
Low Flow Chanel	2064	155
Bridge	8127	860
Sub Total	80532	6290

Diversion	Volume (ft3)	Weight (tons)
Walls	9016	676
Mat	81744	6131
Butress Walls	4940	371
Sub Total	95700	7178
Total	176232	13217

Whole Structure	Volume (ft3)	Weight (tons)
Walls	45339	3400
Deck	41022	3077
Bridge	8127	860
Mat	81744	6131
Total	176232	13217

Take off (Revit)	Volume (ft3)	Weight (tons)
Walls	45559	3417
Deck	41022	3077
Bridge	8127	610
Mat	81744	6131
Total	176452	13234

Ratio **0.998757109**

Forces

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
Tibutary - Water height (ft)	14.93	14.93	15.32	20.94	0.44	NA
Triburtary - Channel Length (ft)	258.00					
Tributary - Clear Width (ft)	50.00					
Tributary - Water force (psf)	931.63	931.63	955.97	1306.66	27.46	NA
Tributary - Water Volume (ft3)	192597.00	192597.00	197628.00	270126.00	454.08	NA
Tributary - Water Weight (tons)	6009.03	6009.03	6165.99	8427.93	14.17	NA
Diversion - Head Water height (ft)	21.83	21.83	23.40	29.94	NA	NA
Mat Foundation - Overall Width (ft)	78.00					
Mat Foundation - Clear Length (ft)	162.00					
Diversion - Water force (psf)	1362.19	1362.19	1460.16	1868.26	NA	NA
Diversion - Water Volume (ft3)	275843.88	275843.88	295682.40	378321.84	NA	NA
Diversion - Water Weight (tons)	8606.33	8606.33	9225.29	11803.64	NA	NA
Total Water Weight on the Structure (tons)	14615.36	14615.36	15391.28	20231.57	14.17	NA
Tributary - Uplift on the Deck (ft)	14.83	14.83	16.40	22.94	NA	NA
Tributary - Uplift force (psf)	925.39	925.39	1023.36	1431.46	NA	NA
Tributary - Uplift force (tons)	-6685.03	-6685.03	-7392.75	-10340.84	NA	NA
Uplift @ HW (ft)	25.83	25.83	27.40	33.94	NA	NA
Uplift @ TW (ft)	24.51	24.51	25.60	33.94	NA	NA
Diversion - Uplift force on the Mat (psf)	1570.61	1570.61	1653.60	2117.86	NA	NA
Diversion - Uplift force on the Mat (tons)	-16048.47	-16048.47	-16896.48	-21640.25	NA	NA
Total Uplif Force on the Structure (tons)	-22733.50	-22733.50	-24289.24	-31981.09	NA	NA
Weight of Structure (tons)	13233.9					

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Flotation						
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**
Downward force on the Structure (tons)	**5115.72**	**5115.72**	**4335.91**	**1484.35**	**13248.03**	**13233.86**
Uplift Ratio	**1.23**	**1.23**	**1.18**	**1.05**	**NA**	**NA**
Uplift Ratio (No water in the Tributary)	**0.96**	**0.96**	**0.92**	**0.78**	**NA**	**NA**
Condition	**Usual**	**Unusual**	**Unusual**	**Extreme**	**Usual**	**Unusual**
Safety Factors - Flotation	**1.30**	**1.20**	**1.20**	**1.10**	**1.30**	**1.20**
Check	**NG!!!**	**OK**	**NG!!!**	**NG!!!**	**OK**	**OK**

Pile Computation						
ID#	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 6**
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**
Allwable Lateral Capacity (tons)	**18**	**21**	**21**	**24**	**11.5**	**21**
Allowable Pile Capacity (tons) - Axial	**57.18**	**76.23**	**76.23**	**99.43**	**31.43**	**76.23**
# of Piles Required	**89.47**	**67.11**	**56.88**	**14.93**	**421.58**	**173.60**
Uniform Spacing	**15.11**	**17.45**	**18.96**	**37.00**	**6.96**	**10.85**
# of Columns (along length)	35.00	35.00	35.00	35.00	35.00	35.00
Pile Spacing (along length)	**7.53**	**7.53**	**7.53**	**7.53**	**7.53**	**7.53**
# of Rows (along width)	**2.56**	**1.92**	**1.63**	**0.43**	**12.05**	**4.96**
# of Rows (along widht) provided	13.00	13.00	13.00	13.00	13.00	13.00
Actual Pile Spacing (along width)	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**	**6.00**
Total number of pile provided	**455**	**455**	**455**	**455**	**455**	**455**
Pile Load	**11.24**	**11.24**	**9.53**	**3.26**	**29.12**	**29.09**
Utilization Ratio	**0.20**	**0.15**	**0.13**	**0.03**	**0.93**	**0.38**
Check	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**
ID#	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 6**
Final # of Piles	**455**					
Pile Load	**11.24**	**11.24**	**9.53**	**3.26**	**29.12**	**29.09**
Utilization Ratio	**0.20**	**0.15**	**0.13**	**0.03**	**0.93**	**0.38**
Check	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**

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

A_{tip} = 198.5 in², A_{steel} = 21.4 in², perimeter = 56.4 in, width (b) = 14.6 in, I = 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"	
Maple River Aqueduct Crossing Foundations	725+92	898	~~866.5~~ 872.06	~~862.46~~ 868.06	893	Undrained Analysis 827.5'	Total	228.7	36	42	48	<0.5"
							Uplift Resistance	135.5				
						Drained Analysis	Total	125.7	23	29	33	
							Uplift Resistance	18.5				

See following link for details
P:\Mpls\34 ND\09\34091004 Fargo Moorhead Metropolitan Feas. Study\WorkFiles_Phase4\060 Geotech\Deep Foundations