CONTRACT NO. 64B81

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
*754	101M&TS	BOONE	95	49
STA. _____	TO STA._____			
FED. ROAD DIST. NO. _	ILLINOIS	FED. AID PROJECT		

*(IL76)

SHAFT ANALYSIS

BROM'S OVERTURNING & TORSION SHAFT ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT — Modified on 9/1/2005

40 foot mast arm

TOTAL MOMENT APPLIED AT TOP OF SHAFT ========== KIP-FT (POSITIVE BEING CLOCKWISE)
TOTAL SHEAR APPLIED AT TOP OF SHAFT ========== KIPS (POSITIVE TO THE RIGHT)
TOTAL TORQUE APPLIED AT TOP OF SHAFT ========== FT-KIPS
DIAMETER OF FOUNDATION SHAFT ========== FT. (WHICH IS A 36 IN. DIAMETER)
DEPTH BELOW SURFACE TO WATERTABLE ========== FT. (MUST BE PLACED BETWEEN SOIL LAYERS)
DEPTH OF FROST/DISTURBED SOIL BELOW SURFACE == FT. (MUST BE PLACED BETWEEN SOIL LAYERS) (FOR TORQUE ANALYSIS)
DEPTH OF NEGLECTED SOIL PRESSURE (1.5xDIA.) ========== FT. (PLACE BETWEEN LAYERS) (FOR COHESIVE LAYERS/MOMENT ANALYSIS)
CRITICAL SURFACE CROSS SLOPE IN A 15' RADIUS ========== DEG. (WHICH IS A -3.01: 1' SLOPE)
FACTOR OF SAFETY FOR OVERTURNING ========== F.S. (REDUCES SOIL SHEAR STRENGTH BY 69.0%)
FACTOR OF SAFETY FOR TWISTING ========== F.S. (REDUCES SKIN FRICTION RESISTING TORQUE BY 11.3%)

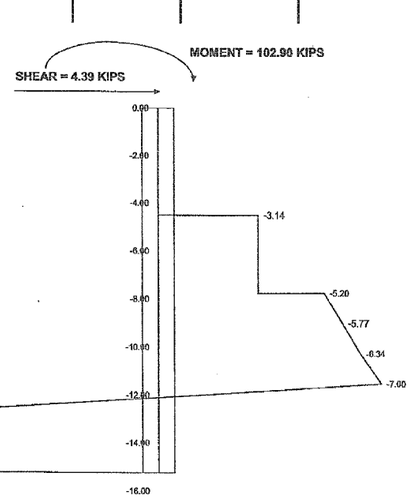
	LAYER THICK (FT.)	COHES. INTER. (KSF)	S.P.T. BLOWS (N)	FRICTON ANGLE (DEG)	UNIT WEIGHT (PCF)	BOUYANT UNIT WT. (PCF)	SOIL PRESSURE (K/FT) AT TOP / AT BOT. OF EACH LAYER		SUM SHEAR (KIPS) AT TOP / AT BOT. OF EACH LAYER		SUM MOMENT (KIP-FT) AT TOP / AT BOT. OF EACH LAYER		SUM TORQUE (FT-K.) AT TOP / AT BOT. OF EACH LAYER	
1	3.00			0.0	115.7	115.7	0.000	0.000	4.390	4.390	102.906	116.070	70.100	70.100
2	1.50			0.0	121.5	59.1	0.000	0.000	4.390	4.390	116.070	122.655	70.100	61.827
3				0.0	115.7	53.3	-3.144	-3.144	4.390	2.032	122.655	125.063	61.827	59.242
4				0.0	115.7	53.3	-3.144	-3.144	2.032	-1.897	125.063	125.148	59.242	54.933
5				0.0	115.7	53.3	-3.144	-3.144	-1.897	-5.827	125.148	120.329	54.933	50.524
6				28.1	115.7	53.3	-5.201	-5.770	-5.827	-12.684	120.329	108.824	50.624	39.459
7				28.1	115.7	53.3	-5.770	-6.339	-12.684	-20.245	108.824	88.338	39.459	27.461
8				31.6	124.2	61.8	-6.339	-6.998	-20.245	-28.580	88.338	57.909	27.461	14.555
9				31.6	124.2	61.8	-6.998	7.658	-28.580	-20.671	57.909	26.294	14.555	0.707
10				32.9	126.9	64.5	7.658	8.346	-20.671	-10.669	26.294	6.617	0.707	-14.068
11				32.9	126.9	64.5	8.346	9.023	-10.669	0.000	6.617	-0.021		
12				32.9	126.9	64.5								
13				33.5	128.0	65.6								
14				33.5	128.0	65.6								
15				33.8	128.5	66.1								
16				33.8	128.5	66.1								
17				33.2	127.5	65.1								
18				33.2	127.5	65.1								

LAYER OF ZERO TORQUE ========== 10
DISTANCE THRU LAYER ========== 0.06 FT.
SUM OF LAYERS ABOVE ========== 12.75 FT.
LENGTH TO RESIST "TORQUE" WITH F.S. ====== **12.81** FT.

LAYER OF ZERO MOMENT ========== 12
DISTANCE THRU LAYER ========== 0.00 FT.
SUM OF LAYERS ABOVE ========== 15.23 FT.
LENGTH TO RESIST "MOMENT" WITH F.S. ====== **15.23** FT.
CONTROLS

USE 36.0 IN. DIAMETER, 15.23 FT. DEEP SHAFT

SHAFT ROTATION DEPTH ========== 11.588 FT.
MAXIMUM MOMENT ========== 125.72 K-FT.
MIN. REQ'D SECT. MODULUS ========== 76.19 IN^3



SHAFT SOIL PRESSURE DIAGRAM

4/19/2006 — *BROMS SHAFT FOUNDATION ANALYSIS* — Broms Overturning Torsion Shaft.xls

BROM'S OVERTURNING & TORSION SHAFT ANALYSIS

I.D.O.T. BBS CENTRAL GEOTECHNICAL UNIT — Modified on 9/1/2005

42 foot mast arm

TOTAL MOMENT APPLIED AT TOP OF SHAFT ========== KIP-FT (POSITIVE BEING CLOCKWISE)
TOTAL SHEAR APPLIED AT TOP OF SHAFT ========== KIPS (POSITIVE TO THE RIGHT)
TOTAL TORQUE APPLIED AT TOP OF SHAFT ========== FT-KIPS
DIAMETER OF FOUNDATION SHAFT ========== FT. (WHICH IS A 36 IN. DIAMETER)
DEPTH BELOW SURFACE TO WATERTABLE ========== FT. (MUST BE PLACED BETWEEN SOIL LAYERS)
DEPTH OF FROST/DISTURBED SOIL BELOW SURFACE == FT. (MUST BE PLACED BETWEEN SOIL LAYERS) (FOR TORQUE ANALYSIS)
DEPTH OF NEGLECTED SOIL PRESSURE (1.5xDIA.) ========== FT. (PLACE BETWEEN LAYERS) (FOR COHESIVE LAYERS/MOMENT ANALYSIS)
CRITICAL SURFACE CROSS SLOPE IN A 15' RADIUS ========== DEG. (WHICH IS A -3.01: 1' SLOPE)
FACTOR OF SAFETY FOR OVERTURNING ========== F.S. (REDUCES SOIL SHEAR STRENGTH BY 69.0%)
FACTOR OF SAFETY FOR TWISTING ========== F.S. (REDUCES SKIN FRICTION RESISTING TORQUE BY 11.3%)

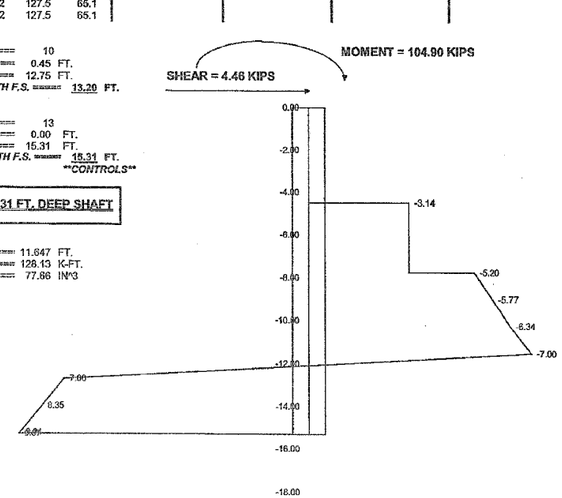
	LAYER THICK (FT.)	COHES. INTER. (KSF)	S.P.T. BLOWS (N)	FRICTON ANGLE (DEG)	UNIT WEIGHT (PCF)	BOUYANT UNIT WT. (PCF)	SOIL PRESSURE (K/FT) AT TOP / AT BOT. OF EACH LAYER		SUM SHEAR (KIPS) AT TOP / AT BOT. OF EACH LAYER		SUM MOMENT (KIP-FT) AT TOP / AT BOT. OF EACH LAYER		SUM TORQUE (FT-K.) AT TOP / AT BOT. OF EACH LAYER	
1	3.00			0.0	115.7	115.7	0.000	0.000	4.460	4.460	104.900	118.280	74.700	74.700
2	1.50			0.0	121.5	59.1	0.000	0.000	4.460	4.460	118.280	124.970	74.700	66.427
3				0.0	115.7	53.3	-3.144	-3.144	4.460	2.102	124.970	127.431	66.427	63.842
4				0.0	115.7	53.3	-3.144	-3.144	2.102	-1.827	127.431	127.603	63.842	59.533
5				0.0	115.7	53.3	-3.144	-3.144	-1.827	-5.757	127.603	122.862	59.533	55.224
6				28.1	115.7	53.3	-5.201	-5.770	-5.757	-12.614	122.862	111.454	55.224	44.059
7				28.1	115.7	53.3	-5.770	-6.339	-12.614	-20.175	111.454	91.056	44.059	32.061
8				31.6	124.2	61.8	-6.339	-6.998	-20.175	-28.510	91.056	60.714	32.061	19.155
9				31.6	124.2	61.8	-6.998	7.658	-28.510	-21.442	60.714	28.225	19.155	5.307
10				32.9	126.9	64.5	7.658	8.346	-21.442	-11.439	28.225	7.585	5.307	-9.468
11				32.9	126.9	64.5	8.346	9.035	-11.439	-0.575	7.585	-0.013		
12				33.5	128.0	65.6	9.035	9.071	-0.575	0.000	-0.013	-0.032		
13				33.5	128.0	65.6								
14				33.5	128.0	65.6								
15				33.8	128.5	66.1								
16				33.8	128.5	66.1								
17				33.2	127.5	65.1								
18				33.2	127.5	65.1								

LAYER OF ZERO TORQUE ========== 10
DISTANCE THRU LAYER ========== 0.45 FT.
SUM OF LAYERS ABOVE ========== 12.75 FT.
LENGTH TO RESIST "TORQUE" WITH F.S. ====== **13.20** FT.

LAYER OF ZERO MOMENT ========== 13
DISTANCE THRU LAYER ========== 0.00 FT.
SUM OF LAYERS ABOVE ========== 15.31 FT.
LENGTH TO RESIST "MOMENT" WITH F.S. ====== **15.31** FT.
CONTROLS

USE 36.0 IN. DIAMETER, 15.31 FT. DEEP SHAFT

SHAFT ROTATION DEPTH ========== 11.647 FT.
MAXIMUM MOMENT ========== 128.13 K-FT.
MIN. REQ'D SECT. MODULUS ========== 77.66 IN^3



SHAFT SOIL PRESSURE DIAGRAM

4/19/2006 — *BROMS SHAFT FOUNDATION ANALYSIS* — Broms Overturning Torsion Shaft.xls

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