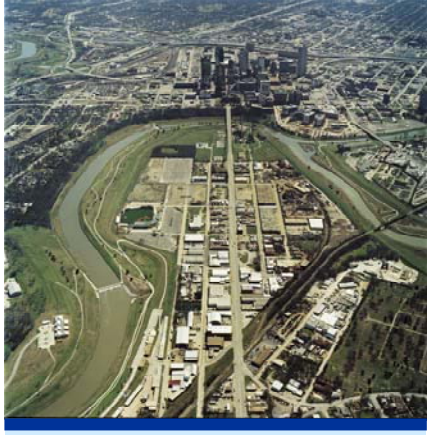
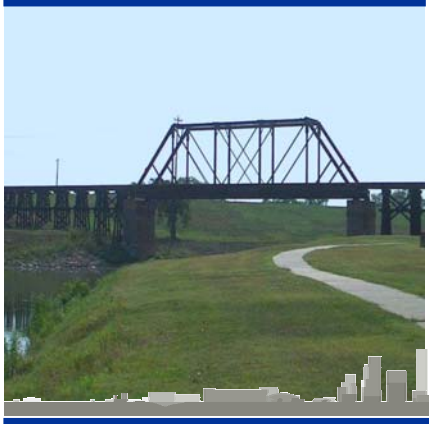
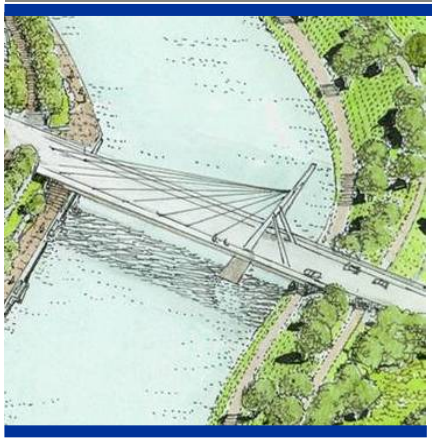




Fort Worth Central City Preliminary Design

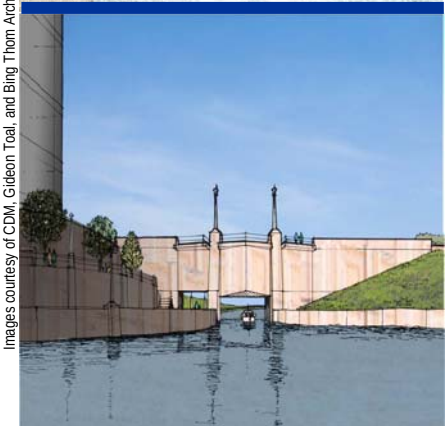
Civil/Structural Preliminary Design



Draft Environmental Impact Statement

Appendix C

May 2005



Volume III – Stability Analysis Isolation Gates

Images courtesy of CDM, Gideon Toal, and Bing Thom Architects

STABILITY ANALYSES FOR GATE STRUCTURES

Contents: Stability Analyses for Gate Structures

Volume III

CDM

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I1 SPF-NoDrain-RCC TRWD.XLS
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Roller Compacted Concrete Foundation:

I1 SPF-NoDrain-RCC TPoint.XLS
(Standard Project Flood Case)
I2 MAX-NoDrain-RCC TPoint.XLS
(Maximum Water Level Case, at top of RCC)
I2 MAX-NoDrain-RCC-Base TPoint.XLS
(Maximum Water Level Case, at base of RCC)

Pile Foundation:

I1 SPF-NoDrain-Pile TPoint.XLS
(Standard Project Flood Case)
I2 MAX-NoDrain-Pile TPoint.XLS
(Maximum Water Level Case)
I3 SEISMIC-NoDrain-Pile TPoint.XLS
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Mass Concrete Foundation:

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(Standard Project Flood Case)
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(Maximum Water Level Case)
I2 MAX-Drain-Mass CFork.XLS
(Maximum Water Level Case, incl. foundation drains)

Roller Compacted Concrete Foundation:

I1 SPF-NoDrain-RCC CFork.XLS
(Standard Project Flood Case)
I2 MAX-NoDrain-RCC CFork.XLS
(Maximum Water Level Case, at top of RCC)
I2 MAX-NoDrain-RCC-Base CFork.XLS
(Maximum Water Level Case, at base of RCC)

Pile Foundation:

I1 SPF-NoDrain-Pile CFork.XLS
(Standard Project Flood Case)
I2 MAX-NoDrain-Pile CFork.XLS
(Maximum Water Level Case)
I3 SEISMIC-NoDrain-Pile CFork.XLS
(Normal Pool Level, with Seismic)

Section 2
TRWD Isolation Gate Structures-
Mass Concrete Foundation

CDM

TRWD Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-Mass TRWD.XLS)

1. Mass concrete foundation on rock.

2. Sliding Factor of Safety = 1.50

3. SPF level at El 540.0 on driving side.

4. Tailwater at El 520.0 on resisting side.

5. Friction angle at rock = 35 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	540	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	474	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	22	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.5	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	25.02	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4125	PSF
UPLIFT AT TOE (UT):	2875	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	22	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	47	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		34.00	510,000	
WALKWAY GATE:	5,000		34.00	170,000	
CONCRETE PIERS:	3,217,500		34.50	111,003,750	
UPPER STRUCTURE:	1,058,400		34.50	36,514,800	
CHANNEL BLOCK FDN:	7,590,000		34.50	261,855,000	
CHANNEL WEDGE FDN:	5,009,400		12.25	61,348,452	
WALKWAY BLOCK FDN:	2,520,000		34.50	86,940,000	
WALKWAY WEDGE FDN:	1,306,800		12.25	16,003,944	
HEEL SLAB:	0		47.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		47.00	0	
FLUID ON CHANNEL SILL:	342,000		41.00	14,022,000	
FLUID ON WALKWAY SILL:	90,000		41.00	3,690,000	
FLUID ON D/S WEDGE:	877,250		7.33	6,433,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-7,837,250		23.50		184,175,375
UPLIFT FORCE (U2):	-1,703,750		31.33		53,384,167
FLUID HORIZ FORCE (H):		7,895,250	22.00		173,695,500
RESISTING FLUID FORCE:		-3,835,250	15.33	58,807,167	
SUBTOTAL AT BASE (V,MR,MO)	12,490,350	4,060,000		657,298,279	411,255,042

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	5,830,558	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	4,060,000	LB	DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.44	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.60	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))	3.80	(RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)			
MAX BEARING PRESS =	6805	PSF	
MIN BEARING PRESS	2358	PSF	
VOLUME OF CONCRETE =	5,112	CY	

TRWD Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-Mass TRWD.XLS)

1. Mass concrete foundation on rock.

2. Sliding Factor of Safety = 1.33

3. Maximum water level at El 544.0 on driving side.

4. Tailwater at El 520.0 on resisting side.

5. Friction angle at rock = 35 degrees.

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	474	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	22	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4375	PSF
UPLIFT AT TOE (UT):	2875	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	22	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	47	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		34.00	510,000	
WALKWAY GATE:	5,000		34.00	170,000	
CONCRETE PIERS:	3,217,500		34.50	111,003,750	
UPPER STRUCTURE:	1,058,400		34.50	36,514,800	
CHANNEL BLOCK FDN:	7,590,000		34.50	261,855,000	
CHANNEL WEDGE FDN:	5,009,400		12.25	61,348,452	
WALKWAY BLOCK FDN:	2,520,000		34.50	86,940,000	
WALKWAY WEDGE FDN:	1,306,800		12.25	16,003,944	
HEEL SLAB:	0		47.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		47.00	0	
FLUID ON CHANNEL SILL:	342,000		41.00	14,022,000	
FLUID ON WALKWAY SILL:	90,000		41.00	3,690,000	
FLUID ON D/S WEDGE:	877,250		7.33	6,433,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	7,837,250		23.50		184,175,375
UPLIFT FORCE (U2):	-2,044,500		31.33		64,061,000
FLUID HORIZ FORCE (H):		8,881,250	23.33		207,229,167
RESISTING FLUID FORCE:		-3,835,250	15.33	58,807,167	
SUBTOTAL AT BASE (V,MR,MO)=	12,149,600	5,046,000		657,298,279	455,465,542

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	6,396,422	LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	COHESION * BASE AREA
NET SLIDING FORCE =	5,046,000	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.27	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)	1.44	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	6.89	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	8376	PSF	
MIN BEARING PRESS =	538	PSF	
VOLUME OF CONCRETE =	5,112	CY	

TRWD Isolation Gate Structure (with Drains)

Unusual Load Condition – Max Water Level

(File I2 MAX-Drain-Mass TRWD.XLS)

1. Mass concrete foundation on rock, with foundation drainage system.

2. Maximum water level at El 544.0 on driving side.

3. Tailwater at El 520.0 on resisting side.

4. Drains 33 percent effective, 10-ft downstream of headwall.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	474	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
STREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	24	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
DRAIN EFFICIENCY (DE):	0.33	
DRAIN DIMENSION FROM HEADWALL (DD):	13	FT

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4375	PSF
UPLIFT AT TOE (UT):	2875	PSF
UPLIFT AT DRAIN (UD):	3590	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	20	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	45	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDL DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		32.00	480,000	
WALKWAY GATE:	5,000		32.00	160,000	
CONCRETE PIERS:	3,217,500		32.50	104,568,750	
UPPER STRUCTURE:	1,058,400		32.50	34,398,000	
CHANNEL BLOCK FDN:	7,590,000		32.50	246,675,000	
CHANNEL WEDGE FDN:	4,692,000		11.00	51,612,000	
WALKWAY BLOCK FDN:	2,520,000		32.50	81,900,000	
WALKWAY WEDGE FDN:	1,224,000		11.00	13,464,000	
HEEL SLAB:	0		45.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		45.00	0	
FLUID ON CHANNEL SILL:	342,000		39.00	13,338,000	
FLUID ON WALKWAY SILL:	90,000		39.00	3,510,000	
FLUID ON D/S WEDGE:	725,000		6.67	4,833,333	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-5,336,000		16.00		85,376,000
UPLIFT FORCE (U2):	-663,211		21.33		14,148,494
UPLIFT FORCE (U3):	-2,706,609		38.50		104,204,434
UPLIFT FORCE (U4):	-296,071		40.67		12,040,207
FLUID HORIZ FORCE (H):		8,881,250	23.33		207,229,167
RESISTING FLUID FORCE:		-3,835,250	15.33	58,807,167	
SUBTOTAL AT BASE (V,MR,MO)=	12,477,010	5,046,000		613,746,250	422,998,302

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	6,568,794	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	5,046,000	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.30	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.45	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	7.21	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	9377	PSF	
MIN BEARING PRESS =	184	PSF	
VOLUME OF CONCRETE =	5,013	CY	

Section 3
TRWD Isolation Gate Structures-
RCC Foundation

CDM

TRWD Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-RCC TRWD.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at top of RCC.

3. Sliding Factor of Safety = 1.50

4. SPF level at El 540.0 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle on RCC = 45 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	540	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	496	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.5	
ACTUAL SOIL FRICTION ANGLE (PHI):	45	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	33.69	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2750	PSF
UPLIFT AT TOE (UT):	1500	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	10	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	35	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		22.00	330,000	
WALKWAY GATE:	5,000		22.00	110,000	
CONCRETE PIERS:	3,217,500		22.50	72,393,750	
UPPER STRUCTURE:	1,058,400		22.50	23,814,000	
CHANNEL BLOCK FDN:	3,795,000		22.50	85,387,500	
CHANNEL WEDGE FDN:	1,173,000		5.50	6,451,500	
WALKWAY BLOCK FDN:	1,530,000		22.50	34,425,000	
WALKWAY WEDGE FDN:	306,000		5.50	1,683,000	
HEEL SLAB:	0		35.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		35.00	0	
FLUID ON CHANNEL SILL:	342,000		29.00	9,918,000	
FLUID ON WALKWAY SILL:	90,000		29.00	2,610,000	
FLUID ON D/S WEDGE:	181,250		3.33	604,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-3,045,000		17.50		53,287,500
UPLIFT FORCE (U2):	-1,268,750		23.33		29,604,167
FLUID HORIZ FORCE (H):		3,509,000	14.67		51,465,333
RESISTING FLUID FORCE:		-1,044,000	8.00	8,352,000	
SUBTOTAL AT BASE (V,MR,MO)=	7,399,400	2,465,000		246,078,917	134,357,000

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	4,932,933 LB	= U*(WEIGHT CONC + GATES + WATER	UPLIFT)
COHESION FORCE (CND*L*B)	0 LB	= COHESION * BASE AREA	
NET SLIDING FORCE =	2,465,000 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES	
SLIDING RATIO =	2.00 >1.0?	(FRICTION + COHESION)/(NET SLIDING)	
OVERTURNING RATIO (MR/MO)=	1.83 >1.0?		
ECCENTRICITY (E=L/2-(MR-MO)/V))	2.40 (RELATIVE TO CL)		
BEARING PRESSURE = V/L(1+-6*E/L)			
MAX BEARING PRESS =	5145 PSF		
MIN BEARING PRESS	2145 PSF		
VOLUME OF CONCRETE =	2,736 CY		

TRWD Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-RCC TRWD.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at top of RCC.

3. Sliding Factor of Safety = 1.33

4. Maximum water level at El 544.0 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle on RCC = 45 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	496	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	45	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	36.94	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	3000	PSF
UPLIFT AT TOE (UT):	1500	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	10	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	35	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		22.00	330,000	
WALKWAY GATE:	5,000		22.00	110,000	
CONCRETE PIERS:	3,217,500		22.50	72,393,750	
UPPER STRUCTURE:	1,058,400		22.50	23,814,000	
CHANNEL BLOCK FDN:	3,795,000		22.50	85,387,500	
CHANNEL WEDGE FDN:	1,173,000		5.50	6,451,500	
WALKWAY BLOCK FDN:	1,530,000		22.50	34,425,000	
WALKWAY WEDGE FDN:	306,000		5.50	1,683,000	
HEEL SLAB:	0		35.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		35.00	0	
FLUID ON CHANNEL SILL:	342,000		29.00	9,918,000	
FLUID ON WALKWAY SILL:	90,000		29.00	2,610,000	
FLUID ON D/S WEDGE:	181,250		3.33	604,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-3,045,000		17.50		53,287,500
UPLIFT FORCE (U2):	-1,522,500		23.33		35,525,000
FLUID HORIZ FORCE (H):		4,176,000	16.00		66,816,000
RESISTING FLUID FORCE:		-1,044,000	8.00	8,352,000	
SUBTOTAL AT BASE (V,MR,MO)	7,145,650	3,132,000		246,078,917	155,628,500

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	5,372,669	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE	3,132,000	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.72	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)	1.58	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	4.84	(RELATIVE TO CL)	
BEARING PRESSURE	V/L(1+-6*E/L)		
MAX BEARING PRESS =	6442	PSF	
MIN BEARING PRESS =	598	PSF	
VOLUME OF CONCRETE =	2,736	CY	

TRWD Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-RCC-Base TRWD.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at base of RCC (approximate).

3. Sliding Factor of Safety = 1.33

4. Maximum water level at El 544.0 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle at rock = 35 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	474	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	2	FT
HEEL THICKNESS (HTH):	22	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	21	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4375	PSF
UPLIFT AT TOE (UT):	2875	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	23	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	50	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		35.00	525,000	
WALKWAY GATE:	5,000		35.00	175,000	
CONCRETE PIERS:	3,217,500		35.50	114,221,250	
UPPER STRUCTURE:	1,058,400		35.50	37,573,200	
CHANNEL BLOCK FDN:	7,590,000		35.50	269,445,000	
CHANNEL WEDGE FDN:	5,157,750		12.88	66,450,070	
WALKWAY BLOCK FDN:	2,520,000		35.50	89,460,000	
WALKWAY WEDGE FDN:	1,345,500		12.88	17,334,801	
HEEL SLAB:	382,800		49.00	18,757,200	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	348,000		49.00	17,052,000	
FLUID ON CHANNEL SILL:	342,000		42.00	14,364,000	
FLUID ON WALKWAY SILL:	90,000		42.00	3,780,000	
FLUID ON D/S WEDGE:	958,812		7.67	7,350,896	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-8,337,500		25.00		208,437,500
UPLIFT FORCE (U2):	-2,175,000		33.33		72,500,000
FLUID HORIZ FORCE (H):		8,881,250	23.33		207,229,167
RESISTING FLUID FORCE:		-3,835,250	15.33	58,807,167	
SUBTOTAL AT BASE (V,MR,MO)	12,518,262	5,046,000		715,295,584	488,166,667

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	6,590,513 LB	U*(WEIGHT CONC + GATES + WATER UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE	5,046,000 LB	DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.31 >1.0?	= (FRICTION + COHESION) / (NET SLIDING)
OVERTURNING RATIO (MR/MO)	1.47 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	6.86 (RELATIVE TO CL)	
BEARING PRESSURE	V/L(1+-6*E/L)	
MAX BEARING PRESS =	7868 PSF	
MIN BEARING PRESS =	765 PSF	
VOLUME OF CONCRETE =	5,252 CY	

Section 4
TRWD Isolation Gate Structures-
Pile Foundation

CDM

TRWD Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-Pile TRWD.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. SPF level at El 540.0 on driving side.

3. Tailwater at El 520.0 on resisting side.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: DDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	540	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	496	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2750	PSF
UPLIFT AT TOE (UT):	1500	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	10	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	35	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		22.00	330,000	
WALKWAY GATE:	5,000		22.00	110,000	
CONCRETE PIERS:	3,217,500		22.50	72,393,750	
UPPER STRUCTURE:	1,058,400		22.50	23,814,000	
CHANNEL BLOCK FDN:	3,795,000		22.50	85,387,500	
CHANNEL WEDGE FDN:	1,173,000		5.50	6,451,500	
WALKWAY BLOCK FDN:	1,530,000		22.50	34,425,000	
WALKWAY WEDGE FDN:	306,000		5.50	1,683,000	
HEEL SLAB:	0		35.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		35.00	0	
FLUID ON CHANNEL SILL:	342,000		29.00	9,918,000	
FLUID ON WALKWAY SILL:	90,000		29.00	2,610,000	
FLUID ON D/S WEDGE:	181,250		3.33	604,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-3,045,000		17.50		53,287,500
UPLIFT FORCE (U2):	-1,268,750		23.33		29,604,167
FLUID HORIZ FORCE (H):		3,509,000	14.67		51,465,333
RESISTING FLUID FORCE:		1,044,000	8.00	8,352,000	
SUBTOTAL AT BASE (V,MR,MO)	7,399,400	2,465,000		246,078,917	134,357,000

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	3,895,576 LB		U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0 LB		COHESION * BASE AREA
NET SLIDING FORCE =	2,465,000 LB		= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.58	>1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.83	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	2.40	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	5145	PSF	
MIN BEARING PRESS =	2145	PSF	
VOLUME OF CONCRETE =	2,736	CY	

TRWD Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-Pile TRWD.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Maximum water level at El 544.0 on driving side.

3. Tailwater at El 520.0 on resisting side.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	496	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	3000	PSF
UPLIFT AT TOE (UT):	1500	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	10	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	35	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	58	FT
(B = CGW + WGW + PN*PT)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		22.00	330,000	
WALKWAY GATE:	5,000		22.00	110,000	
CONCRETE PIERS:	3,217,500		22.50	72,393,750	
UPPER STRUCTURE:	1,058,400		22.50	23,814,000	
CHANNEL BLOCK FDN:	3,795,000		22.50	85,387,500	
CHANNEL WEDGE FDN:	1,173,000		5.50	6,451,500	
WALKWAY BLOCK FDN:	1,530,000		22.50	34,425,000	
WALKWAY WEDGE FDN:	306,000		5.50	1,683,000	
HEEL SLAB:	0		35.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		35.00	0	
FLUID ON CHANNEL SILL:	342,000		29.00	9,918,000	
FLUID ON WALKWAY SILL:	90,000		29.00	2,610,000	
FLUID ON D/S WEDGE:	181,250		3.33	604,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-3,045,000		17.50		53,287,500
UPLIFT FORCE (U2):	-1,522,500		23.33		35,525,000
FLUID HORIZ FORCE (H):		4,176,000	16.00		66,816,000
RESISTING FLUID FORCE:		1,044,000	8.00	8,352,000	
SUBTOTAL AT BASE (V,MR,MO)=	7,145,650	3,132,000		246,078,917	155,628,500

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	3,761,983 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE =	3,132,000 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.20 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.58 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	4.84 (RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+ 6*E/L)		
MAX BEARING PRESS =	6442 PSF	
MIN BEARING PRESS =	598 PSF	
VOLUME OF CONCRETE =	2,736 CY	

TRWD Isolation Gate Structure

Extreme Load Condition – Seismic

(File I3 SEISMIC-NoDrain-Pile TRWD.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Normal pool level at El 525.0 on driving side.

3. Tailwater at El 520.0 on resisting side.

4. Horizontal ground acceleration = 0.05 g.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
NORMAL POOL ELEVATION WITH SEISMIC (EXTREME CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	525	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	496	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.1	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
SEISMIC COEFFICIENT (A):	0.05	g

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	32.48	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	1813	PSF
UPLIFT AT TOE (UT):	1500	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	10	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	35	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	58	FT
(B = CGW + WGW + PN*PT)		

SEISMIC PARAMETERS:

SEISMIC INERTIA DUE TO MASS =	SUM(DL) * A
ASSUMED CENTROID OF MASS =	0.4*(PE-BE)
SESIMIC FLUID FORCE (PER WESTERGAARD) =	0.67*51*A*(PE-BE)^2
FLUID FORCE RESULTANT ABOVE BASE =	0.4*(FE-BE)
	OR 0.4*(TE-BE)

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		22.00	330,000	
WALKWAY GATE:	5,000		22.00	110,000	
CONCRETE PIERS:	3,217,500		22.50	72,393,750	
UPPER STRUCTURE:	1,058,400		22.50	23,814,000	
CHANNEL BLOCK FDN:	3,795,000		22.50	85,387,500	
CHANNEL WEDGE FDN:	1,173,000		5.50	6,451,500	
WALKWAY BLOCK FDN:	1,530,000		22.50	34,425,000	
WALKWAY WEDGE FDN:	306,000		5.50	1,683,000	
HEEL SLAB:	0		35.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		35.00	0	
FLUID ON CHANNEL SILL:	342,000		29.00	9,918,000	
FLUID ON WALKWAY SILL:	90,000		29.00	2,610,000	
FLUID ON D/S WEDGE:	181,250		3.33	604,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-3,045,000		17.50		53,287,500
UPLIFT FORCE (U2):	-317,187		23.33		7,401,042
FLUID HORIZ FORCE (H):		1,524,312	9.67		14,735,021
RESISTING FLUID FORCE:		-1,044,000	8.00	8,352,000	
SEISMIC INERTIA FORCE:		554,995	24		13,541,878
SEISMIC FLUID FORCE U/S:		1,437	11.6		16,667
SEISMIC FLUID FORCE D/S:		984	9.6		9,447
SUBTOTAL AT BASE (V,MR,MO)	8,350,962	1,037,728		246,078,917	88,991,555

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	5,315,824 LB		= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0 LB		= COHESION * BASE AREA
NET SLIDING FORCE =	1,037,728 LB		= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	5.12	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	2.77	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	-1.31	(RELATIVE TO CL)	
BEARING PRESSURE - V/L(1+6*E/L)			
MAX BEARING PRESS =	3189	PSF	
MIN BEARING PRESS =	5038	PSF	
VOLUME OF CONCRETE =	2,736	CY	

Section 5
Trinity Point Isolation Gate Structures-
Mass Concrete Foundation

CDM

Trinity Point Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-Mass TPoint.XLS)

1. Mass concrete foundation on rock.

2. Sliding Factor of Safety = 1.50

3. SPF level at El 545.5 on driving side.

4. Tailwater at El 520.0 on resisting side.

5. Friction angle at rock = 35 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	545.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	465	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT - 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	18	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.5	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	25.02	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	5031	PSF
UPLIFT AT TOE (UT):	3438	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	35	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	60	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	80	FT
(B = CGW + WGW + PN*PT)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		47.00	705,000	
WALKWAY GATE:	10,000		47.00	470,000	
CONCRETE PIERS:	4,680,000		47.50	222,300,000	
UPPER STRUCTURE:	1,411,200		47.50	67,032,000	
CHANNEL BLOCK FDN:	11,130,000		47.50	528,675,000	
CHANNEL WEDGE FDN:	10,437,000		20.43	213,260,250	
WALKWAY BLOCK FDN:	5,850,000		47.50	277,875,000	
WALKWAY WEDGE FDN:	4,473,000		20.43	91,397,250	
HEEL SLAB:	0		60.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		60.00	0	
FLUID ON CHANNEL SILL:	342,000		54.00	18,468,000	
FLUID ON WALKWAY SILL:	180,000		54.00	9,720,000	
FLUID ON D/S WEDGE:	3,062,500		11.67	35,729,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-16,500,000		30.00		495,000,000
UPLIFT FORCE (U2):	-3,825,000		40.00		153,000,000
FLUID HORIZ FORCE (H):		16,200,625	26.83		434,716,771
RESISTING FLUID FORCE:		-7,562,500	18.33	138,645,833	
SUBTOTAL AT BASE (V,MR,MO)=	21,265,700	8,638,125		1,604,277,500	1,082,716,771

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	9,926,936	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	8,638,125	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO	1.15	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.48	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	5.47	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+ 6*E/L)		
MAX BEARING PRESS =	6856	PSF	
MIN BEARING PRESS =	2005	PSF	
VOLUME OF CONCRETE =	9,378	CY	

Trinity Point Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-Mass TPoint.XLS)

1. Mass concrete foundation on rock.

2. Sliding Factor of Safety = 1.33

3. Maximum water level at El 549.5 on driving side.

4. Tailwater at El 520.0 on resisting side.

5. Friction angle at rock = 35 degrees.

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	465	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	18	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	5281	PSF
UPLIFT AT TOE (UT):	3438	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	35	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	60	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	80	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		47.00	705,000	
WALKWAY GATE:	10,000		47.00	470,000	
CONCRETE PIERS:	4,680,000		47.50	222,300,000	
UPPER STRUCTURE:	1,411,200		47.50	67,032,000	
CHANNEL BLOCK FDN:	11,130,000		47.50	528,675,000	
CHANNEL WEDGE FDN:	10,437,000		20.43	213,260,250	
WALKWAY BLOCK FDN:	5,850,000		47.50	277,875,000	
WALKWAY WEDGE FDN:	4,473,000		20.43	91,397,250	
HEEL SLAB:	0		60.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		60.00	0	
FLUID ON CHANNEL SILL:	342,000		54.00	18,468,000	
FLUID ON WALKWAY SILL:	180,000		54.00	9,720,000	
FLUID ON D/S WEDGE:	3,062,500		11.67	35,729,167	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-16,500,000		30.00		495,000,000
UPLIFT FORCE (U2):	-4,425,000		40.00		177,000,000
FLUID HORIZ FORCE (H):		17,850,625	28.17		502,792,604
RESISTING FLUID FORCE:		-7,562,500	18.33	138,645,833	
SUBTOTAL AT BASE (V,MR,MO)=	20,665,700	10,288,125		1,604,277,500	1,174,792,604

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	10,879,909	LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	10,288,125	LB	DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO	1.06	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.37	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)]	9.22	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS -	8274	PSF	
MIN BEARING PRESS	337	PSF	
VOLUME OF CONCRETE =	9,378	CY	

Trinity Point Isolation Gate Structure (with Drains)

Unusual Load Condition – Max Water Level

(File I2 MAX-Drain-Mass TPoint.XLS)

1. Mass concrete foundation on rock, with foundation drainage system.

2. Maximum water level at El 549.5 on driving side.

3. Tailwater at El 520.0 on resisting side.

4. Drains 33 percent effective, 10-ft downstream of headwall.

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	465	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT - 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	20	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
DRAIN EFFICIENCY (DE):	0.33	
DRAIN DIMENSION FROM HEADWALL (DD):	10	FT

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	5281	PSF
UPLIFT AT TOE (UT):	3438	PSF
UPLIFT AT DRAIN (UD):	4460	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	33	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	58	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	80	FT
(B = CGW + WGW + PN*PT)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TBDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		45.00	675,000	
WALKWAY GATE:	10,000		45.00	450,000	
CONCRETE PIERS:	4,680,000		45.50	212,940,000	
UPPER STRUCTURE:	1,411,200		45.50	64,209,600	
CHANNEL BLOCK FDN:	11,130,000		45.50	506,415,000	
CHANNEL WEDGE FDN:	10,117,800		19.04	192,602,718	
WALKWAY BLOCK FDN:	5,850,000		45.50	266,175,000	
WALKWAY WEDGE FDN:	4,336,200		19.04	82,544,022	
HEEL SLAB:	0		58.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		58.00	0	
FLUID ON CHANNEL SILL:	342,000		52.00	17,784,000	
FLUID ON WALKWAY SILL:	180,000		52.00	9,360,000	
FLUID ON D/S WEDGE:	2,722,500		11.00	29,947,500	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-13,200,000		24.00		316,800,000
UPLIFT FORCE (U2):	-1,962,869		32.00		62,811,807
UPLIFT FORCE (U3):	-3,567,862		53.00		189,096,690
UPLIFT FORCE (U4):	-328,569		54.67		17,961,770
FLUID HORIZ FORCE (H):		17,850,625	28.17		502,792,604
RESISTING FLUID FORCE:		-7,562,500	18.33	138,645,833	
SUBTOTAL AT BASE (V,MR,MO)	21,735,400	10,288,125		1,521,748,673	1,089,462,871

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	11,443,076 LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0 LB	COHESION * BASE AREA
NET SLIDING FORCE	10,288,125 LB	. DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO	1.11 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.40 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	9.11 (RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+ 6*E/L)		
MAX BEARING PRESS =	9100 PSF	
MIN BEARING PRESS =	269 PSF	
VOLUME OF CONCRETE =	9,265 CY	

Section 6
Trinity Point Isolation Gate Structures-RCC Foundation

CDM

Trinity Point Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-RCC TPoint.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at top of RCC.

3. Sliding Factor of Safety = 1.50

4. SPF level at El 545.5 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle on RCC = 45 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WGS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	545.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	509	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT - 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	0	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.5	
ACTUAL SOIL FRICTION ANGLE (PHI):	45	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (FFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	33.69	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2281	PSF
UPLIFT AT TOE (UT):	688	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	9	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	34	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	80	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		21.00	315,000	
WALKWAY GATE:	10,000		21.00	210,000	
CONCRETE PIERS:	4,680,000		21.50	100,620,000	
UPPER STRUCTURE:	1,411,200		21.50	30,340,800	
CHANNEL BLOCK FDN:	1,890,000		21.50	40,635,000	
CHANNEL WEDGE FDN:	340,200		6.03	2,051,406	
WALKWAY BLOCK FDN:	1,890,000		21.50	40,635,000	
WALKWAY WEDGE FDN:	145,800		6.03	879,174	
HEEL SLAB:	0		34.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		34.00	0	
FLUID ON CHANNEL SILL:	342,000		28.00	9,576,000	
FLUID ON WALKWAY SILL:	180,000		28.00	5,040,000	
FLUID ON D/S WEDGE:	202,500		3.00	607,500	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-1,870,000		17.00		31,790,000
UPLIFT FORCE (U2):	-2,167,500		22.67		49,130,000
FLUID HORIZ FORCE (H):		3,330,625	12.17		40,522,604
RESISTING FLUID FORCE:		-302,500	3.67	1,109,167	
SUBTOTAL AT BASE (V,MR,MO)	7,069,200	3,028,125		232,019,047	121,442,604

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	4,712,800	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	3,028,125	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.56	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.91	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	1.36	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	3222	PSF	
MIN BEARING PRESS =	1976	PSF	
VOLUME OF CONCRETE =	2,557	CY	

Trinity Point Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-RCC TPoint.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at top of RCC.

3. Sliding Factor of Safety = 1.33

4. Maximum water level at El 549.5 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle on RCC = 45 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	509	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	0	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	45	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	36.94	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2531	PSF
UPLIFT AT TOE (UT):	688	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	9	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	34	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	80	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		21.00	315,000	
WALKWAY GATE:	10,000		21.00	210,000	
CONCRETE PIERS:	4,680,000		21.50	100,620,000	
UPPER STRUCTURE:	1,411,200		21.50	30,340,800	
CHANNEL BLOCK FDN:	1,890,000		21.50	40,635,000	
CHANNEL WEDGE FDN:	340,200		6.03	2,051,406	
WALKWAY BLOCK FDN:	1,890,000		21.50	40,635,000	
WALKWAY WEDGE FDN:	145,800		6.03	879,174	
HEEL SLAB:	0		34.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		34.00	0	
FLUID ON CHANNEL SILL:	342,000		28.00	9,576,000	
FLUID ON WALKWAY SILL:	180,000		28.00	5,040,000	
FLUID ON D/S WEDGE:	202,500		3.00	607,500	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-1,870,000		17.00		31,790,000
UPLIFT FORCE (U2):	-2,507,500		22.67		56,836,667
FLUID HORIZ FORCE (H):		4,100,625	13.50		55,358,438
RESISTING FLUID FORCE:		-302,500	3.67	1,109,167	
SUBTOTAL AT BASE (V,MR,MO)=	6,729,200	3,798,125		232,019,047	143,985,104

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	5,059,549 LB		= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB		= COHESION * BASE AREA
NET SLIDING FORCE =	3,798,125 LB		DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.33	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.61	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	3.92	(RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)			
MAX BEARING PRESS =	4184	PSF	
MIN BEARING PRESS =	764	PSF	
VOLUME OF CONCRETE =	2,557	CY	

Trinity Point Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-RCC-Base TPoint.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at base of RCC (approximate).

3. Sliding Factor of Safety = 1.33

4. Maximum water level at El 549.5 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle at rock = 35 degrees.

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	465	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	2	FT
HEEL THICKNESS (HTH):	44	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	20	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	5281	PSF
UPLIFT AT TOE (UT):	3438	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	33	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	60	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	80	FT
(B = CGW + WGW + PN*PT)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		45.00	675,000	
WALKWAY GATE:	10,000		45.00	450,000	
CONCRETE PIERS:	4,680,000		45.50	212,940,000	
UPPER STRUCTURE:	1,411,200		45.50	64,209,600	
CHANNEL BLOCK FDN:	11,130,000		45.50	506,415,000	
CHANNEL WEDGE FDN:	10,117,800		19.04	192,602,718	
WALKWAY BLOCK FDN:	5,850,000		45.50	266,175,000	
WALKWAY WEDGE FDN:	4,336,200		19.04	82,544,022	
HEEL SLAB:	1,056,000		59.00	62,304,000	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	405,000		59.00	23,895,000	
FLUID ON CHANNEL SILL:	342,000		52.00	17,784,000	
FLUID ON WALKWAY SILL:	180,000		52.00	9,360,000	
FLUID ON D/S WEDGE:	2,722,500		11.00	29,947,500	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	-16,500,000		30.00		495,000,000
UPLIFT FORCE (U2):	-4,425,000		40.00		177,000,000
FLUID HORIZ FORCE (H):		17,850,625	28.17		502,792,604
RESISTING FLUID FORCE:		-7,562,500	18.33	138,645,833	
SUBTOTAL AT BASE (V,MR,MO)=	21,330,700	10,288,125		1,607,947,673	1,174,792,604

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	11,230,013	LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	10,288,125	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.09	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.37	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	9.69	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	8752	PSF	
MIN BEARING PRESS =	136	PSF	
VOLUME OF CONCRETE =	9,526	CY	

Section 7
Trinity Point Isolation Gate Structures-Pile Foundation

CDM

Trinity Point Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-Pile TPoint.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. SPF level at El 545.5 on driving side.

3. Tailwater at El 520.0 on resisting side.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	545.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	509	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT - 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	4	FT
HEEL THICKNESS (HTH):	3	FT
ADDL TOE WIDTH (TW):	2	FT
TOE THICKNESS (TTH):	3	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2281	PSF
UPLIFT AT TOE (UT):	688	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	37	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	80	FT

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		20.00	300,000	
WALKWAY GATE:	10,000		20.00	200,000	
CONCRETE PIERS:	4,680,000		20.50	95,940,000	
UPPER STRUCTURE:	1,411,200		20.50	28,929,600	
CHANNEL BLOCK FDN:	1,890,000		20.50	38,745,000	
CHANNEL WEDGE FDN:	302,400		5.51	1,666,224	
WALKWAY BLOCK FDN:	1,890,000		20.50	38,745,000	
WALKWAY WEDGE FDN:	129,600		5.51	714,096	
HEEL SLAB:	144,000		35.00	5,040,000	
TOE SLAB:	72,000		1.00	72,000	
FLUID ON HEEL:	670,000		35.00	23,450,000	
FLUID ON CHANNEL SILL:	342,000		27.00	9,234,000	
FLUID ON WALKWAY SILL:	180,000		27.00	4,860,000	
FLUID ON D/S WEDGE:	90,000		4.00	360,000	
FLUID ON TOP:	80,000		1.00	80,000	
UPLIFT FORCE (U1):	-2,035,000		18.50		37,647,500
UPLIFT FORCE (U2):	-2,358,750		24.67		58,182,500
FLUID HORIZ FORCE (H):		3,330,625	12.17		40,522,604
RESISTING FLUID FORCE:		302,500	3.67	1,109,167	
SUBTOTAL AT BASE (V,MR,MO)=	7,512,450	3,028,125		249,445,087	136,352,604

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	3,955,093 LB		= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB		COHESION * BASE AREA
NET SLIDING FORCE	3,028,125 LB		= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.31	>1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)	1.83	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))	3.45	(RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)			
MAX BEARING PRESS	3956 PSF		
MIN BEARING PRESS =	1120 PSF		
VOLUME OF CONCRETE	2,597 CY		

Trinity Point Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-Pile TPoint.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Maximum water level at El 549.5 on driving side.

3. Tailwater at El 520.0 on resisting side.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	509	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT - 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	4	FT
HEEL THICKNESS (HTH):	3	FT
ADDL TOE WIDTH (TW):	2	FT
TOE THICKNESS (TTH):	3	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2531	PSF
UPLIFT AT TOE (UT):	688	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	37	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	80	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		20.00	300,000	
WALKWAY GATE:	10,000		20.00	200,000	
CONCRETE PIERS:	4,680,000		20.50	95,940,000	
UPPER STRUCTURE:	1,411,200		20.50	28,929,600	
CHANNEL BLOCK FDN:	1,890,000		20.50	38,745,000	
CHANNEL WEDGE FDN:	302,400		5.51	1,666,224	
WALKWAY BLOCK FDN:	1,890,000		20.50	38,745,000	
WALKWAY WEDGE FDN:	129,600		5.51	714,096	
HEEL SLAB:	144,000		35.00	5,040,000	
TOE SLAB:	72,000		1.00	72,000	
FLUID ON HEEL:	750,000		35.00	26,250,000	
FLUID ON CHANNEL SILL:	342,000		27.00	9,234,000	
FLUID ON WALKWAY SILL:	180,000		27.00	4,860,000	
FLUID ON D/S WEDGE:	90,000		4.00	360,000	
FLUID ON TOE:	80,000		1.00	80,000	
UPLIFT FORCE (U1):	-2,035,000		18.50		37,647,500
UPLIFT FORCE (U2):	2,728,750		24.67		67,309,167
FLUID HORIZ FORCE (H):		4,100,625	13.50		55,358,438
RESISTING FLUID FORCE:		-302,500	3.67	1,109,167	
SUBTOTAL AT BASE (V,MR,MO)	7,222,450	3,798,125		252,245,087	160,315,104

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	3,802,416 LB		= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB		= COHESION * BASE AREA
NET SLIDING FORCE =	3,798,125 LB		= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.00	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.57	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	5.77	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	4724	PSF	
MIN BEARING PRESS =	156	PSF	
VOLUME OF CONCRETE =	2,597	CY	

Trinity Point Isolation Gate Structure

Extreme Load Condition – Seismic

(File I3 SEISMIC-NoDrain-Pile TPoint.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Normal pool level at El 525.0 on driving side.

3. Tailwater at El 520.0 on resisting side.

4. Horizontal ground acceleration = 0.05 g.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BOA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
NORMAL POOL ELEVATION WITH SEISMIC (EXTREME CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	525	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	509	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	4	FT
HEEL THICKNESS (HTH):	3	FT
ADDL TOE WIDTH (TW):	2	FT
TOE THICKNESS (TTH):	3	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.1	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
SEISMIC COEFFICIENT (A):	0.05	g

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	32.48	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	1000	PSF
UPLIFT AT TOE (UT):	688	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	6	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	37	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	80	FT
(B = CGW + WGW + PN*PT)		

SEISMIC PARAMETERS:

SEISMIC INERTIA DUE TO MASS =	SUM(DL) * A
ASSUMED CENTROID OF MASS =	0.4*(PE-BE)
SESTMIC FLUID FORCE (PER WESTERGAARD) =	0.67*51*A*(FE-BE)^2
FLUID FORCE RESULTANT ABOVE BASE =	0.4*(FE-BE)
	OR 0.4*(TE-BE)

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		20.00	300,000	
WALKWAY GATE:	10,000		20.00	200,000	
CONCRETE PIERS:	4,680,000		20.50	95,940,000	
UPPER STRUCTURE:	1,411,200		20.50	28,929,600	
CHANNEL BLOCK FDN:	1,890,000		20.50	38,745,000	
CHANNEL WEDGE FDN:	302,400		5.51	1,666,224	
WALKWAY BLOCK FDN:	1,890,000		20.50	38,745,000	
WALKWAY WEDGE FDN:	129,600		5.51	714,096	
HEEL SLAB:	144,000		35.00	5,040,000	
TOE SLAB:	72,000		1.00	72,000	
FLUID ON HEEL:	260,000		35.00	9,100,000	
FLUID ON CHANNEL SILL:	342,000		27.00	9,234,000	
FLUID ON WALKWAY SILL:	180,000		27.00	4,860,000	
FLUID ON D/S WEDGE:	90,000		4.00	360,000	
FLUID ON TOE:	80,000		1.00	80,000	
UPLIFT FORCE (U1):	-2,035,000		18.50		37,647,500
UPLIFT FORCE (U2):	-462,500		24.67		11,408,333
FLUID HORIZ FORCE (H):		640,000	5.33		3,413,333
RESISTING FLUID FORCE:		-302,500	3.67	1,109,167	
SEISMIC INERTIA FORCE:		516,410	19		9,915,072
SEISMIC FLUID FORCE U/S:		437	6.4		2,799
SEISMIC FLUID FORCE D/S:		207	4.4		910
SUBTOTAL AT BASE (V,MR,MO)=	8,998,700	854,554		235,095,087	62,387,947

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	5,728,143 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE =	854,554 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	6.70 >1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	3.77 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	.69 (RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)	
MAX BEARING PRESS =	2699 PSF	
MIN BEARING PRESS =	3381 PSF	
VOLUME OF CONCRETE =	2,597 CY	

Section 8
Clear Fork Isolation Gate Structures-
Mass Concrete Foundation

CDM

Clear Fork Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-Mass CFork.XLS)

1. Mass concrete foundation on rock.

2. Sliding Factor of Safety = 1.50

3. SPF level at El 552.5 on driving side.

4. Tailwater at El 520.0 on resisting side.

5. Friction angle at rock = 35 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	552.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	487	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	20	FT
HEEL THICKNESS (HTH):	25	FT
ADDL TOE WIDTH (TW):	20	FT
TOE THICKNESS (TTH):	25	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.5	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	25.02	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4094	PSF
UPLIFT AT TOE (UT):	2063	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	71	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		38.00	570,000	
WALKWAY GATE:	5,000		38.00	190,000	
CONCRETE PIERS:	3,217,500		38.50	123,873,750	
UPPER STRUCTURE:	1,058,400		38.50	40,748,400	
CHANNEL BLOCK FDN:	5,347,500		38.50	205,878,750	
CHANNEL WEDGE FDN:	1,159,200		23.11	26,788,284	
WALKWAY BLOCK FDN:	1,935,000		38.50	74,497,500	
WALKWAY WEDGE FDN:	302,400		23.11	6,988,248	
HEEL SLAB:	4,350,000		61.00	265,350,000	
TOE SLAB:	4,350,000		10.00	43,500,000	
FLUID ON HEEL:	2,936,250		61.00	179,111,250	
FLUID ON CHANNEL SILL:	342,000		45.00	15,390,000	
FLUID ON WALKWAY SILL:	90,000		45.00	4,050,000	
FLUID ON D/S WEDGE:	65,250		22.00	1,435,500	
FLUID ON TOE:	580,000		10.00	5,800,000	
UPLIFT FORCE (U1):	-8,493,375		35.50		301,514,812
UPLIFT FORCE (U2):	-4,182,344		47.33		197,964,271
FLUID HORIZ FORCE (H):		7,776,078	21.83		169,777,706
RESISTING FLUID FORCE:		-1,973,812	11.00	21,711,937	
SUBTOTAL AT BASE (V,MR,MO)=	13,077,781	5,802,266		1,015,883,619	669,256,789

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	6,104,774	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	COHESION * BASE AREA
NET SLIDING FORCE =	5,802,266	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.05	>1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.52	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	8.99	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	5590	PSF	
MIN BEARING PRESS =	762	PSF	
VOLUME OF CONCRETE =	5,363	CY	

Clear Fork Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-Mass CFork.XLS)

1. Mass concrete foundation on rock.

2. Sliding Factor of Safety = 1.33

3. Maximum water level at El 556.5 on driving side.

4. Tailwater at El 520.0 on resisting side.

5. Friction angle at rock = 35 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	487	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	20	FT
HEEL THICKNESS (HTH):	25	FT
ADDL TOE WIDTH (TW):	20	FT
TOE THICKNESS (TTH):	25	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4344	PSF
UPLIFT AT TOE (UT):	2063	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	71	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		38.00	570,000	
WALKWAY GATE:	5,000		38.00	190,000	
CONCRETE PIERS:	3,217,500		38.50	123,873,750	
UPPER STRUCTURE:	1,058,400		38.50	40,748,400	
CHANNEL BLOCK FDN:	5,347,500		38.50	205,878,750	
CHANNEL WEDGE FDN:	1,159,200		23.11	26,788,284	
WALKWAY BLOCK FDN:	1,935,000		38.50	74,497,500	
WALKWAY WEDGE FDN:	302,400		23.11	6,988,248	
HEEL SLAB:	4,350,000		61.00	265,350,000	
TOE SLAB:	4,350,000		10.00	43,500,000	
FLUID ON HEEL:	3,226,250		61.00	196,801,250	
FLUID ON CHANNEL SILL:	342,000		45.00	15,390,000	
FLUID ON WALKWAY SILL:	90,000		45.00	4,050,000	
FLUID ON D/S WEDGE:	65,250		22.00	1,435,500	
FLUID ON TOE:	580,000		10.00	5,800,000	
UPLIFT FORCE (U1):	-8,493,375		35.50		301,514,812
UPLIFT FORCE (U2):	-4,697,094		47.33		222,329,104
FLUID HORIZ FORCE (H):		8,754,828	23.17		202,820,185
RESISTING FLUID FORCE:		-1,973,812	11.00	21,711,937	
SUBTOTAL AT BASE (V,MR,MO)=	12,853,031	6,781,016		1,033,573,619	726,664,102

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	6,766,759 LB		U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB		COHESION * BASE AREA
NET SLIDING FORCE =	6,781,016 LB		= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO	1.00 >1.0?		= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.42 >1.0?		
ECCENTRICITY (E=L/2-(MR-MO)/V))=	11.62 (RELATIVE TO CL)		
BEARING PRESSURE =	V/L(1+ 6*E/L)		
MAX BEARING PRESS =	6187 PSF		
MIN BEARING PRESS =	56 PSF		
VOLUME OF CONCRETE =	5,363 CY		

Clear Fork Isolation Gate Structure (with Drains)

Unusual Load Condition – Max Water Level

(File I2 MAX-Drain-Mass CFork.XLS)

1. Mass concrete foundation on rock, with foundation drainage system.

2. Maximum water level at El 556.5 on driving side.

3. Tailwater at El 520.0 on resisting side.

4. Drains 33 percent effective, 10-ft downstream of headwall.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	487	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	16	FT
HEEL THICKNESS (HTH):	25	FT
ADDL TOE WIDTH (TW):	20	FT
TOE THICKNESS (TTH):	25	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
DRAIN EFFICIENCY (DE):	0.33	
DRAIN DIMENSION FROM HEADWALL (DD):	10	FT

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4344	PSF
UPLIFT AT TOE (UT):	2063	PSF
UPLIFT AT DRAIN (UD):	2998	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L HW + PL + WH + TW)	67	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHANGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		38.00	570,000	
WALKWAY GATE:	5,000		38.00	190,000	
CONCRETE PIERS:	3,217,500		38.50	123,873,750	
UPPER STRUCTURE:	1,058,400		38.50	40,748,400	
CHANNEL BLOCK FDN:	5,347,500		38.50	205,878,750	
CHANNEL WEDGE FDN:	1,159,200		23.11	26,788,284	
WALKWAY BLOCK FDN:	1,935,000		38.50	74,497,500	
WALKWAY WEDGE FDN:	302,400		23.11	6,988,248	
HEEL SLAB:	3,480,000		59.00	205,320,000	
TOE SLAB:	4,350,000		10.00	43,500,000	
FLUID ON HEEL:	2,581,000		59.00	152,279,000	
FLUID ON CHANNEL SILL:	342,000		45.00	15,390,000	
FLUID ON WALKWAY SILL:	90,000		45.00	4,050,000	
FLUID ON D/S WEDGE:	65,250		22.00	1,435,500	
FLUID ON TOE:	580,000		10.00	5,800,000	
UPLIFT FORCE (U1):	-4,904,625		20.50		100,544,812
UPLIFT FORCE (U2):	1,112,087		27.33		30,397,033
UPLIFT FORCE (U3):	-4,520,701		54.00		244,117,867
UPLIFT FORCE (U4):	-1,014,837		58.33		59,198,818
FLUID HORIZ FORCE (H):		8,754,828	23.17		202,820,185
RESISTING FLUID FORCE:		-1,973,812	11.00	21,711,937	
SUBTOTAL AT BASE (V,MR,MO) :	12,976,000	6,781,016		929,021,369	637,078,715

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	6,831,499	LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0	LB	COHESION * BASE AREA
NET SLIDING FORCE =	6,781,016	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.01	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.46	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V) =	11.00	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	6629	PSF	
MIN BEARING PRESS =	49	PSF	
VOLUME OF CONCRETE =	5,148	CY	

Section 9
Clear Fork Isolation Gate Structures-RCC Foundation

CDM

Clear Fork Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-RCC CFork.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at top of RCC.

3. Sliding Factor of Safety = 1.50

4. SPF level at El 552.5 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle on RCC = 45 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	552.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	504	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	26	FT
HEEL THICKNESS (HTH):	8	FT
ADDL TOE WIDTH (TW):	12	FT
TOE THICKNESS (TTH):	8	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.5	
ACTUAL SOIL FRICTION ANGLE (PHI):	45	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	33.69	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	3031	PSF
UPLIFT AT TOE (UT):	1000	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	69	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA . DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		30.00	450,000	
WALKWAY GATE:	5,000		30.00	150,000	
CONCRETE PIERS:	3,217,500		30.50	98,133,750	
UPPER STRUCTURE:	1,058,400		30.50	32,281,200	
CHANNEL BLOCK FDN:	2,415,000		30.50	73,657,500	
CHANNEL WEDGE FDN:	455,400		15.28	6,957,684	
WALKWAY BLOCK FDN:	1,170,000		30.50	35,685,000	
WALKWAY WEDGE FDN:	118,800		15.28	1,815,048	
HEEL SLAB:	1,809,600		56.00	101,337,600	
TOE SLAB:	835,200		6.00	5,011,200	
FLUID ON HEEL:	3,817,125		56.00	213,759,000	
FLUID ON CHANNEL SILL:	342,000		37.00	12,654,000	
FLUID ON WALKWAY SILL:	90,000		37.00	3,330,000	
FLUID ON D/S WEDGE:	65,250		14.00	913,500	
FLUID ON TOE:	348,000		6.00	2,088,000	
UPLIFT FORCE (U1):	-4,002,000		34.50		138,069,000
UPLIFT FORCE (U2):	-4,064,531		46.00		186,968,437
FLUID HORIZ FORCE (H):		4,263,453	16.17		68,925,826
RESISTING FLUID FORCE:		-464,000	5.33	2,474,667	
SUBTOTAL AT BASE (V,MR,MO) =	7,695,744	3,799,453		590,698,149	393,963,263

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	5,130,496 LB	= U*(WEIGHT CONC + GATES + WATER	UPLIFT)
COHESION FORCE (CND*L*B) =	0 LB	= COHESION * BASE AREA	
NET SLIDING FORCE =	3,799,453 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES	
SLIDING RATIO =	1.35 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)	
OVERTURNING RATIO (MR/MO) =	1.50 >1.0?		
ECCENTRICITY (E=L/2 (MR-MO)/V)) =	8.94 (RELATIVE TO CL)		
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	3417 PSF		
MIN BEARING PRESS =	429 PSF		
VOLUME OF CONCRETE =	2,736 CY		

Clear Fork Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-RCC CFork.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at top of RCC.

3. Sliding Factor of Safety = 1.33

4. Maximum water level at El 556.5 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle on RCC = 45 degrees.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275-PRSTR.DCS

DESIGNED BY: WGS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	504	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	26	FT
HEEL THICKNESS (HTH):	8	FT
ADDL TOE WIDTH (TW):	12	FT
TOE THICKNESS (TTH):	8	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	45	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	36.94	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	3281	PSF
UPLIFT AT TOE (UT):	1000	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	69	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGN

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		30.00	450,000	
WALKWAY GATE:	5,000		30.00	150,000	
CONCRETE PIERS:	3,217,500		30.50	98,133,750	
UPPER STRUCTURE:	1,058,400		30.50	32,281,200	
CHANNEL BLOCK FDN:	2,415,000		30.50	73,657,500	
CHANNEL WEDGE FDN:	455,400		15.28	6,957,684	
WALKWAY BLOCK FDN:	1,170,000		30.50	35,685,000	
WALKWAY WEDGE FDN:	118,800		15.28	1,815,048	
HEEL SLAB:	1,809,600		56.00	101,337,600	
TOE SLAB:	835,200		6.00	5,011,200	
FLUID ON HEEL:	4,194,125		56.00	234,871,000	
FLUID ON CHANNEL SILL:	342,000		37.00	12,654,000	
FLUID ON WALKWAY SILL:	90,000		37.00	3,330,000	
FLUID ON D/S WEDGE:	65,250		14.00	913,500	
FLUID ON TOE:	348,000		6.00	2,088,000	
UPLIFT FORCE (U1):	-4,002,000		34.50		138,069,000
UPLIFT FORCE (U2):	-4,564,781		46.00		209,979,937
FLUID HORIZ FORCE (H):		4,995,703	17.50		87,424,805
RESISTING FLUID FORCE:		-464,000	5.33	2,474,667	
SUBTOTAL AT BASE (V,MR,MO)=	7,572,494	4,531,703		611,810,149	435,473,742

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	5,693,604	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	COHESION * BASE AREA
NET SLIDING FORCE	4,531,703	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.26	>1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.40	>1.0?	
ECCENTRICITY (E=L/2 - (MR MO)/V))=	11.21	(RELATIVE TO CL)	
BEARING PRESSURE	V/L(1+-6*E/L)		
MAX BEARING PRESS =	3737	PSF	
MIN BEARING PRESS	47	PSF	
VOLUME OF CONCRETE =	2,736	CY	

Clear Fork Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-RCC-Base CFork.XLS)

1. Concrete structure on roller compacted concrete foundation to rock.

2. Stability at base of RCC (approximate).

3. Sliding Factor of Safety = 1.33

4. Maximum water level at El 556.5 on driving side.

5. Tailwater at El 520.0 on resisting side.

6. Friction angle at rock = 35 degrees.

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WGS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	487	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	26	FT
HEEL THICKNESS (HTH):	25	FT
ADDL TOE WIDTH (TW):	11.5	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	4344	PSF
UPLIFT AT TOE (UT):	2063	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	19	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	81.5	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		42.50	637,500	
WALKWAY GATE:	5,000		42.50	212,500	
CONCRETE PIERS:	3,217,500		43.00	138,352,500	
UPPER STRUCTURE:	1,058,400		43.00	45,511,200	
CHANNEL BLOCK FDN:	5,347,500		43.00	229,942,500	
CHANNEL WEDGE FDN:	2,818,650		22.43	63,214,453	
WALKWAY BLOCK FDN:	1,935,000		43.00	83,205,000	
WALKWAY WEDGE FDN:	735,300		22.43	16,490,727	
HEEL SLAB:	5,655,000		68.50	387,367,500	
TOE SLAB:	1,200,600		5.75	6,903,450	
FLUID ON HEEL:	4,194,125		68.50	287,297,562	
FLUID ON CHANNEL SILL:	342,000		49.50	16,929,000	
FLUID ON WALKWAY SILL:	90,000		49.50	4,455,000	
FLUID ON D/S WEDGE:	654,312		17.83	11,668,573	
FLUID ON TOE:	875,437		5.75	5,033,766	
UPLIFT FORCE (U1):	-9,749,437		40.75		397,289,578
UPLIFT FORCE (U2):	5,391,734		54.33		292,950,901
FLUID HORIZ FORCE (H):		8,754,828	23.17		202,820,185
RESISTING FLUID FORCE:		1,973,812	11.00	21,711,937	
SUBTOTAL AT BASE (V,MR,MO)	13,002,653	6,781,016		1,318,933,169	893,060,664

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	6,845,531 LB	=	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0 LB	=	COHESION * BASE AREA
NET SLIDING FORCE =	6,781,016 LB	=	DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	1.01 >1.0?	=	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.48 >1.0?		
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	8.00 (RELATIVE TO CL)		
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	4370 PSF		
MIN BEARING PRESS =	1131 PSF		
VOLUME OF CONCRETE =	5,424 CY		

Section 10
Clear Fork Isolation Gate Structures-
Pile Foundation

CDM

Clear Fork Isolation Gate Structure

Usual Load Condition – SPF

(File I1 SPF-NoDrain-Pile CFork.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. SPF level at El 552.5 on driving side.

3. Tailwater at El 520.0 on resisting side.

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
SPF WATER ELEVATION (USUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	552.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	506	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	17	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	2906	PSF
UPLIFT AT TOE (UT):	875	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	48	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		35.00	525,000	
WALKWAY GATE:	5,000		35.00	175,000	
CONCRETE PIERS:	3,217,500		35.50	114,221,250	
UPPER STRUCTURE:	1,058,400		35.50	37,573,200	
CHANNEL BLOCK FDN:	2,070,000		35.50	73,485,000	
CHANNEL WEDGE FDN:	372,600		20.34	7,578,684	
WALKWAY BLOCK FDN:	1,080,000		35.50	38,340,000	
WALKWAY WEDGE FDN:	97,200		20.34	1,977,048	
HEEL SLAB:	0		48.00	0	
TOE SLAB:	887,400		8.50	7,542,900	
FLUID ON HEEL:	0		48.00	0	
FLUID ON CHANNEL SILL:	342,000		42.00	14,364,000	
FLUID ON WALKWAY SILL:	90,000		42.00	3,780,000	
FLUID ON D/S WEDGE:	65,250		19.00	1,239,750	
FLUID ON TOE:	493,000		8.50	4,190,500	
UPLIFT FORCE (U1):	-2,436,000		24.00		58,464,000
UPLIFT FORCE (U2):	2,827,500		32.00		90,480,000
FLUID HORIZ FORCE (H):		3,919,078	15.50		60,745,711
RESISTING FLUID FORCE:		-355,250	4.67	1,657,833	
SUBTOTAL AT BASE (V,MR,MO)	4,529,850	3,563,828		306,650,165	209,689,711

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	2,384,838	LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	COHESION * BASE AREA
NET SLIDING FORCE =	3,563,828	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	0.67	>1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.46	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	2.60	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	2155	PSF	
MIN BEARING PRESS =	1099	PSF	
VOLUME OF CONCRETE =	2,169	CY	

Clear Fork Isolation Gate Structure

Unusual Load Condition – Max Water Level

(File I2 MAX-NoDrain-Pile CFork.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Maximum water level at El 556.5 on driving side.

3. Tailwater at El 520.0 on resisting side.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	506	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	17	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	3156	PSF
UPLIFT AT TOE (UT):	875	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	6	FT
(WH = CSE-BE-TTH)		
FDN LENGTH (L):	48	FT
(L = HW + PL + WH + TW)		
FDN WIDTH (B):	58	FT
(B = CGW + WGW + PN*PT)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		35.00	525,000	
WALKWAY GATE:	5,000		35.00	175,000	
CONCRETE PIERS:	3,217,500		35.50	114,221,250	
UPPER STRUCTURE:	1,058,400		35.50	37,573,200	
CHANNEL BLOCK FDN:	2,070,000		35.50	73,485,000	
CHANNEL WEDGE FDN:	372,600		20.34	7,578,684	
WALKWAY BLOCK FDN:	1,080,000		35.50	38,340,000	
WALKWAY WEDGE FDN:	97,200		20.34	1,977,048	
HEEL SLAB:	0		48.00	0	
TOE SLAB:	887,400		8.50	7,542,900	
FLUID ON HEEL:	0		48.00	0	
FLUID ON CHANNEL SILL:	342,000		42.00	14,364,000	
FLUID ON WALKWAY SILL:	90,000		42.00	3,780,000	
FLUID ON D/S WEDGE:	65,250		19.00	1,239,750	
FLUID ON TOE:	493,000		8.50	4,190,500	
UPLIFT FORCE (U1):	-2,436,000		24.00		58,464,000
UPLIFT FORCE (U2):	-3,175,500		32.00		101,616,000
FLUID HORIZ FORCE (H):		4,622,328	16.83		77,809,190
RESISTING FLUID FORCE:		-355,250	4.67	1,657,833	
SUBTOTAL AT BASE (V,MR,MO)=	4,181,850	4,267,078		306,650,165	237,889,190

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	2,201,626 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)	
COHESION FORCE (CND*L*B)=	0 LB	COHESION * BASE AREA	
NET SLIDING FORCE =	4,267,078 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES	
SLIDING RATIO =	0.52 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)	
OVERTURNING RATIO (MR/MO)	1.29 >1.0?		
ECCENTRICITY (E=L/2-(MR-MO)/V))=	7.56 (RELATIVE TO CL)		
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	2921 PSF		
MIN BEARING PRESS	83 PSF		
VOLUME OF CONCRETE =	2,169 CY		

Clear Fork Isolation Gate Structure

Extreme Load Condition – Seismic

(File I3 SEISMIC-NoDrain-Pile CFork.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Normal pool level at El 525.0 on driving side.

3. Tailwater at El 520.0 on resisting side.

4. Horizontal ground acceleration = 0.05 g.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
NORMAL POOL ELEVATION WITH SEISMIC (EXTREME CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	525	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	506	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	17	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.1	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
SEISMIC COEFFICIENT (A):	0.05	g

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	32.48	DEGREES
DESIGN COHESION (CND):	0	PSF
UPLIFT AT HEEL (UH):	1188	PSF
UPLIFT AT TOE (UT):	875	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	48	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

SEISMIC PARAMETERS:

SEISMIC INERTIA DUE TO MASS =	SUM(DL) * A
ASSUMED CENTROID OF MASS =	0.4*(PE-BE)
SESIMIC FLUID FORCE (PER WESTERGAARD) =	0.67*51*A*(FE-BE)^2
FLUID FORCE RESULTANT ABOVE BASE =	0.4*(FE-BE)
	OR 0.4*(TE-BE)

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGN

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		35.00	525,000	
WALKWAY GATE:	5,000		35.00	175,000	
CONCRETE PIERS:	3,217,500		35.50	114,221,250	
UPPER STRUCTURE:	1,058,400		35.50	37,573,200	
CHANNEL BLOCK FDN:	2,070,000		35.50	73,485,000	
CHANNEL WEDGE FDN:	372,600		20.34	7,578,684	
WALKWAY BLOCK FDN:	1,080,000		35.50	38,340,000	
WALKWAY WEDGE FDN:	97,200		20.34	1,977,048	
HEEL SLAB:	0		48.00	0	
TOE SLAB:	887,400		8.50	7,542,900	
FLUID ON HEEL:	0		48.00	0	
FLUID ON CHANNEL SILL:	342,000		42.00	14,364,000	
FLUID ON WALKWAY SILL:	90,000		42.00	3,780,000	
FLUID ON D/S WEDGE:	65,250		19.00	1,239,750	
FLUID ON TOE:	493,000		8.50	4,190,500	
UPLIFT FORCE (U1):	-2,436,000		24.00		58,464,000
UPLIFT FORCE (U2):	-435,000		32.00		13,920,000
FLUID HORIZ FORCE (H):		654,312	6.33		4,143,979
RESISTING FLUID FORCE:		-355,250	4.67	1,657,833	
SEISMIC INERTIA FORCE:		395,785	20		8,074,014
SEISMIC FLUID FORCE U/S:		617	7.6		4,687
SEISMIC FLUID FORCE D/S:		335	5.6		1,875
SUBTOTAL AT BASE (V,MR,MO)	6,922,350	695,799		306,650,165	84,608,556

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	4,406,438 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	COHESION * BASE AREA
NET SLIDING FORCE =	695,799 LB	DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	6.33 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	3.62 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	-8.08 (RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)	
MAX BEARING PRESS =	-24 PSF	
MIN BEARING PRESS =	4997 PSF	
VOLUME OF CONCRETE =	2,169 CY	

Section 11
Stability Analyses for Abutment Structures

CDM

TRWD Abutment Structures

Unusual Load Condition – Max Water Level

(Files: MAX-Abut-E TRWD.XLS & MAX-Abut-W TRWD.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Maximum water level at El 544.0 on driving side.

3. Tailwater below base on resisting side.

4. Balanced soil pressures neglected for preliminary design.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WGS DATE: 12/18/2004

CHECKED BY: TDH DATE: 12/20/04

GATE ABUTMENT STRUCTURE STABILITY
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	2	FT
NO. OF BUTTRESS WALLS (NB):	3	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	3	FT
STRUCTURE LENGTH (B):	53	FT
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	0	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID): (PHID = ARCTAN(TAN(PHI)/FS))	21.79	DEGREES
DESIGN COHESION (CND): (CND = CN / FS)	0	PSF
UPLIFT AT HEEL (UH): (UH = (FE-BE) * EFP)	1125	PSF
UPLIFT AT TOE (UT): (UT = (TE-BE) * EFP)	0	PSF
FDN LENGTH (L): (L = HW + DW + TW)	25	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	373,650		24.00	8,967,600	
BUTTRESS WALLS(1):	596,250		12.50	7,453,125	
BUTTRESS WALLS(2):	0		0.00	0	
TOP SLAB:	298,125		12.50	3,726,563	
BOTTOM SLAB:	596,250		12.50	7,453,125	
HEEL SLAB:	0		25.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		25.00	0	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	0		12.50		0
UPLIFT FORCE (U2):	-745,313		16.67		12,421,875
FLUID HORIZ FORCE (H):		536,625	6.00		3,219,750
RESISTING FLUID FORCE:		0	2.00	0	
SUBTOTAL AT BASE (V,MR,MO)	1,118,963	536,625		27,600,413	15,641,625

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	447,341 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0 LB	COHESION * BASE AREA
NET SLIDING FORCE =	536,625 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	0.83 >1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO) =	1.76 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	1.81 (RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)		
MAX BEARING PRESS =	1212 PSF	
MIN BEARING PRESS =	477 PSF	
VOLUME OF CONCRETE =	460 CY	

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE ABUTMENT STRUCTURE STABILITY
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	544	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	2	FT
NO. OF BUTTRESS WALLS (NB):	2	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	3	FT
STRUCTURE LENGTH (B):	26	FT
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	0	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	1125	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT = (TE-BE) * EFP)		

FDN LENGTH (L): 25 FT
(L = HW + DW + TW)

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TBDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	174,900		24.00	4,197,600	
BUTTRESS WALLS(1):	397,500		12.50	4,968,750	
BUTTRESS WALLS(2):	0		0.00	0	
TOP SLAB:	146,250		12.50	1,828,125	
BOTTOM SLAB:	292,500		12.50	3,656,250	
HEEL SLAB:	0		25.00	0	
TOE SLAB:	0		0.00	0	
FLUID ON HEEL:	0		25.00	0	
FLUID ON TOE:	0		0.00	0	
UPLIFT FORCE (U1):	0		12.50		0
UPLIFT FORCE (U2):	-365,625		16.67		6,093,750
FLUID HORIZ FORCE (H):		263,250	6.00		1,579,500
RESISTING FLUID FORCE:		0	-2.00	0	
SUBTOTAL AT BASE (V,MR,MO)=	645,525	263,250		14,650,725	7,673,250

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	258,069 LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE =	263,250 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	0.98 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)=	1.91 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	1.69 (RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)		
MAX BEARING PRESS =	1396 PSF	
MIN BEARING PRESS =	590 PSF	
VOLUME OF CONCRETE =	250 CY	

Trinity Point Abutment Structures

Unusual Load Condition – Max Water Level

(File: MAX-Abut-E & W TPoint.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Maximum water level at El 549.5 on driving side.

3. Tailwater below base on resisting side.

4. Balanced soil pressures neglected for preliminary design.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TDA DATE: 12/20/04

GATE ABUTMENT STRUCTURE STABILITY
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	2	FT
NO. OF BUTTRESS WALLS (NB):	2	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	3	FT
STRUCTURE LENGTH (B):	22	FT
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	6	FT
TOE THICKNESS (TTH):	3	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	1469	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT = (TE-BE) * EFP)		
FDN LENGTH (L):	31	FT
(L = HW + DW + TW)		

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDC DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	143,100		30.00	4,293,000	
BUTTRESS WALLS(1):	397,500		18.50	7,353,750	
BUTTRESS WALLS(2):	44,100		4.00	176,488	
TOP SLAB:	123,750		18.50	2,289,375	
BOTTOM SLAB:	247,500		18.50	4,578,750	
HEEL SLAB:	0		31.00	0	
TOE SLAB:	59,400		3.00	178,200	
FLUID ON HEEL:	0		31.00	0	
FLUID ON TOE:	0		3.00	0	
UPLIFT FORCE (U1):	0		15.50		0
UPLIFT FORCE (U2):	-500,844		20.67		10,350,771
FLUID HORIZ FORCE (H):		379,672	7.83		2,974,096
RESISTING FLUID FORCE:		0	-2.00	0	
SUBTOTAL AT BASE (V,MR,MO)=	514,506	379,672		18,869,563	13,324,867

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	205,690 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE	379,672 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	0.54 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)	1.42 >1.0?	
ECCENTRICITY (E=L/2 (MR-MO)/V))=	4.72 (RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)		
MAX BEARING PRESS =	1444 PSF	
MIN BEARING PRESS =	65 PSF	
VOLUME OF CONCRETE =	251 CY	

Clear Fork Abutment Structures

Unusual Load Condition – Max Water Level

(Files: MAX-Abut-E CFork.XLS & MAX-Abut-W CFork.XLS)

1. Concrete structure on battered steel H-piles to rock.

2. Maximum water level at El 556.5 on driving side.

3. Tailwater below base on resisting side.

4. Balanced soil pressures neglected for preliminary design.

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TDA DATE: 12/20/04

GATE ABUTMENT STRUCTURE STABILITY
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	3	FT
NO. OF BUTTRESS WALLS (NB):	4	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	6	FT
STRUCTURE LENGTH (B):	80	FT
ADDL HEEL WIDTH (HW):	12	FT
HEEL THICKNESS (HTH):	6	FT
ADDL TOE WIDTH (TW):	10	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	1906	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT = (TE-BE) * EFP)		
FDN LENGTH (L):	47	FT
(L = HW + DW + TW)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275=PRSTR.DGS

DESIGNED BY: WGS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	479,400		34.00	16,299,600	
BUTTRESS WALLS(1):	1,057,500		22.50	23,793,750	
BUTTRESS WALLS(2):	193,500		6.67	1,290,645	
TOP SLAB:	450,000		22.50	10,125,000	
BOTTOM SLAB:	1,800,000		22.50	40,500,000	
HEEL SLAB:	864,000		41.00	35,424,000	
TOE SLAB:	720,000		5.00	3,600,000	
FLUID ON HEEL:	1,470,000		41.00	60,270,000	
FLUID ON TOE:	0		5.00	0	
UPLIFT FORCE (U1):	0		23.50		0
UPLIFT FORCE (U2):	3,583,750		31.33		112,290,833
FLUID HORIZ FORCE (H):		2,325,625	10.17		23,643,854
RESISTING FLUID FORCE:		0	-2.00	0	
SUBTOTAL AT BASE (V,MR,MO)	3,450,650	2,325,625		191,302,995	135,934,688

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	1,379,506 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	COHESION * BASE AREA
NET SLIDING FORCE	2,325,625 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	0.59 >1.0?	= (FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO):	1.41 >1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V))=	7.45 (RELATIVE TO CL)	
BEARING PRESSURE	V/L(1+-6*E/L)	
MAX BEARING PRESS =	1791 PSF	
MIN BEARING PRESS	44 PSF	
VOLUME OF CONCRETE =	1,374 CY	

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

GATE ABUTMENT STRUCTURE STABILITY
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	3	FT
NO. OF BUTTRESS WALLS (NB):	2	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	6	FT
STRUCTURE LENGTH (B):	23	FT
ADDL HEEL WIDTH (HW):	12	FT
HEEL THICKNESS (HTH):	6	FT
ADDL TOE WIDTH (TW):	8	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID): (PHID = ARCTAN(TAN(PHI)/FS))	21.79	DEGREES
DESIGN COHESION (CND): (CND = CN / FS)	0	PSF
UPLIFT AT HEEL (UH): (UH = (FE-BE) * EFP)	1906	PSF
UPLIFT AT TOE (UT): (UT = (TE-BE) * EFP)	0	PSF
FDN LENGTH (L): (L = HW + DW + TW)	45	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TBDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LAT'L FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	119,850		32.00	3,835,200	
BUTTRESS WALLS(1):	528,750		20.50	10,839,375	
BUTTRESS WALLS(2):	77,400		5.34	413,006	
TOP SLAB:	129,375		20.50	2,652,188	
BOTTOM SLAB:	517,500		20.50	10,608,750	
HEEL SLAB:	248,400		39.00	9,687,600	
TOE SLAB:	165,600		4.00	662,400	
FLUID ON HEEL:	422,625		39.00	16,482,375	
FLUID ON TOE:	0		4.00	0	
UPLIFT FORCE (U1):	0		22.50		0
UPLIFT FORCE (U2):	-986,484		30.00		29,594,531
FLUID HORIZ FORCE (H):		668,617	10.17		6,797,608
RESISTING FLUID FORCE:		0	2.00	0	
SUBTOTAL AT BASE (V,MR,MO)	1,223,016	668,617		55,180,894	36,392,139

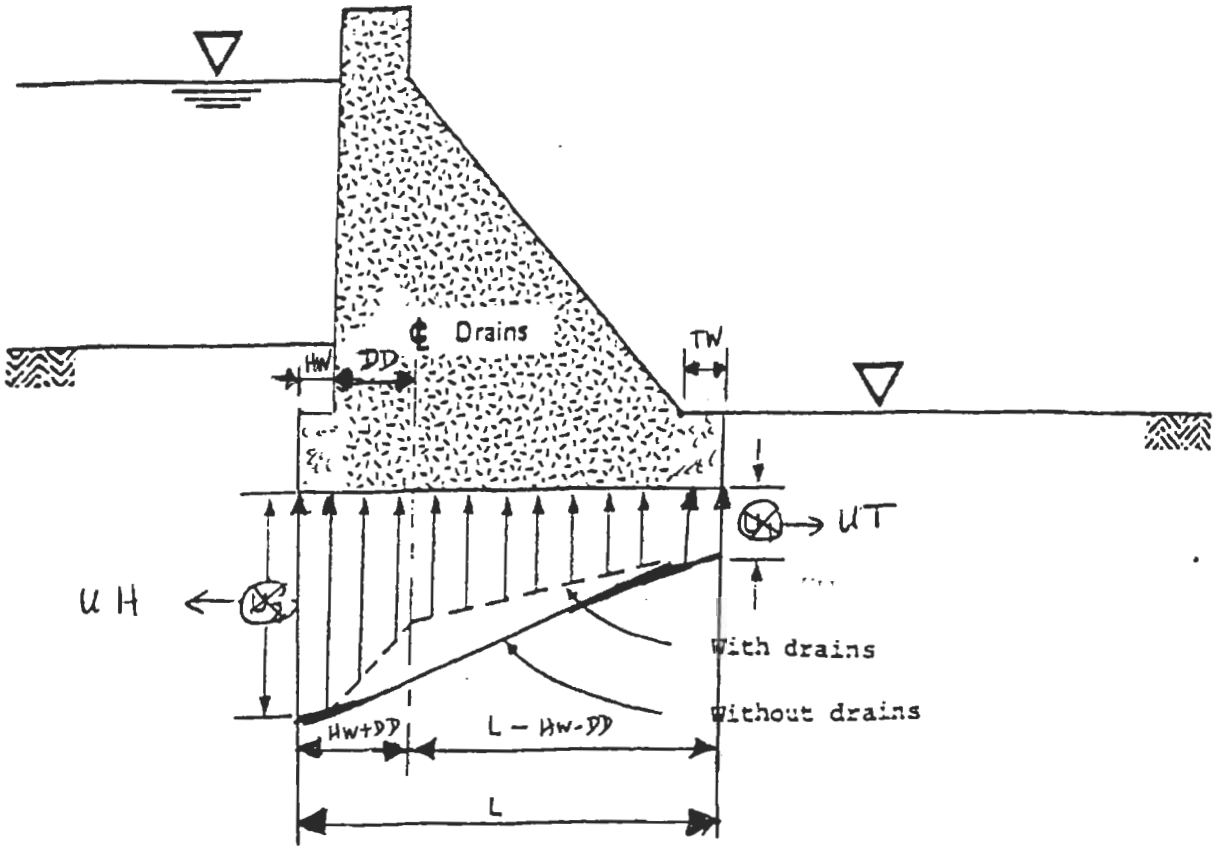
STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID)) =	488,939	LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B) =	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	668,617	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
SLIDING RATIO =	0.73	>1.0?	(FRICTION + COHESION)/(NET SLIDING)
OVERTURNING RATIO (MR/MO)	1.52	>1.0?	
ECCENTRICITY (E=L/2-(MR-MO)/V)) =	7.14	(RELATIVE TO CL)	
BEARING PRESSURE = V/L(1+-6*E/L)			
MAX BEARING PRESS =	2306	PSF	
MIN BEARING PRESS =	57	PSF	
VOLUME OF CONCRETE	441	CY	

Section 12
Cell Formulas for Excel Spreadsheets

CDM

CELL FORMULAS FOR EXCEL SPREADSHEETS



$$UT + R\frac{L-HW-DD}{L}(UH-UT)$$

Pressure Head at Drains = $U_x = U_1 + R\left(\frac{L-x}{L}\right)(U_2 - U_1)$

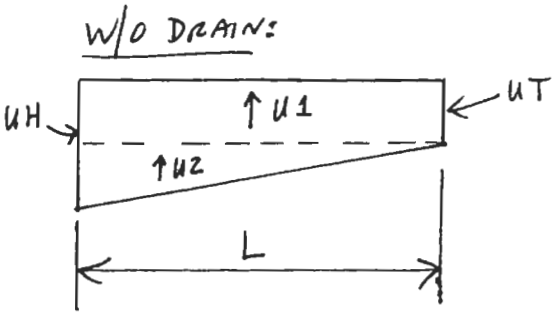
UT (U_1) = Pressure Head at Toe

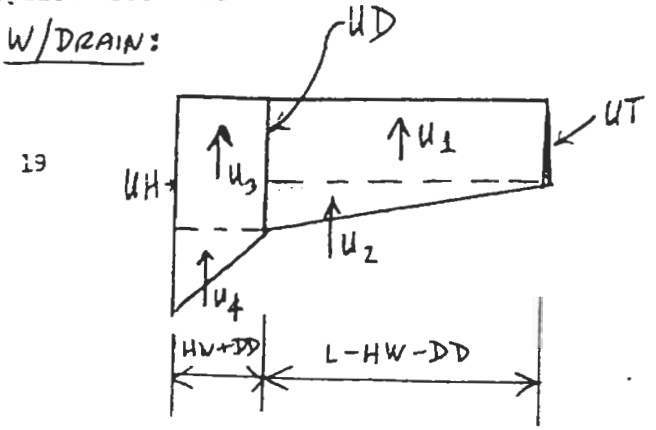
UH (U_2) = Pressure Head at Heel

R = Constant {100 - (25% → 50%)}

SAY $R = \frac{100-33}{100} = 0.67$

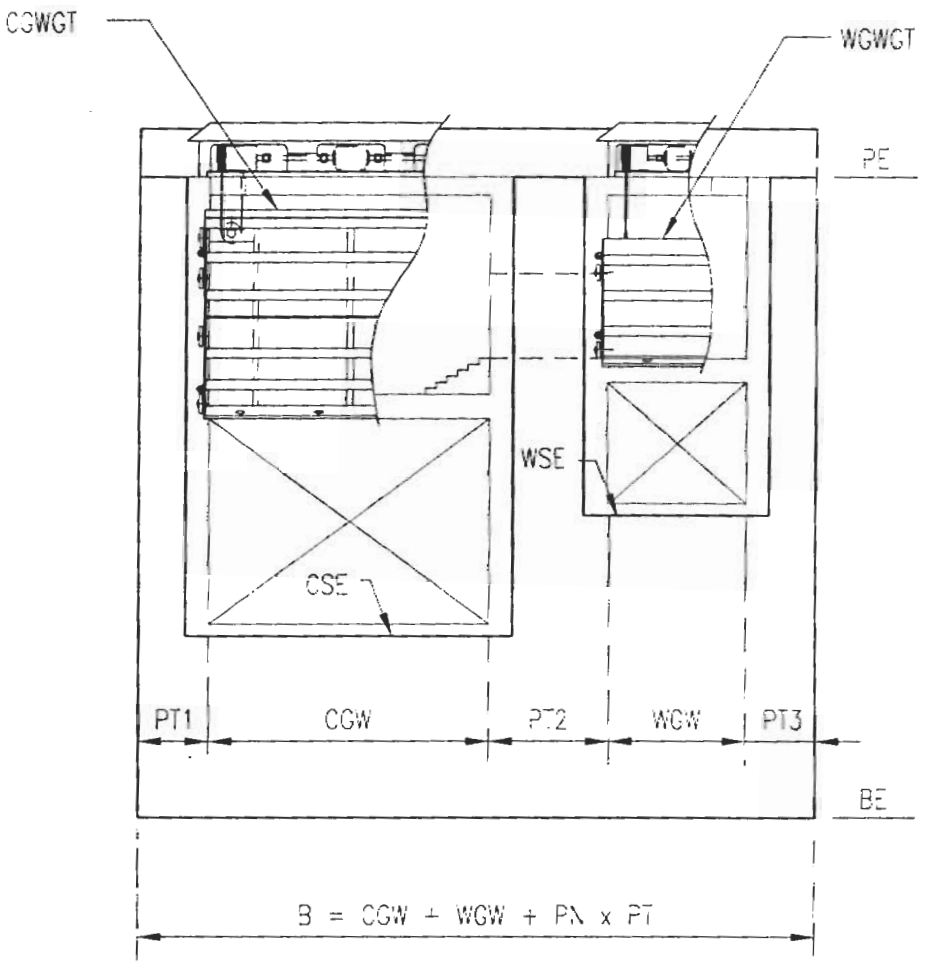
Figure 10. Uplift Pressures





Gate Structure Stability Analysis (No Drains)

Excel Spreadsheet with Cell Formulas Displayed



$$PT = \frac{PT1+PT2+PT3}{3} = \text{AVERAGE PIER THICKNESS}$$

PN = NO. OF PIERS

LONGITUDINAL SECTION

1/16"=1'-0"

SCALE: 1/16 "=1'-0"

1'0 8' 16' 24'

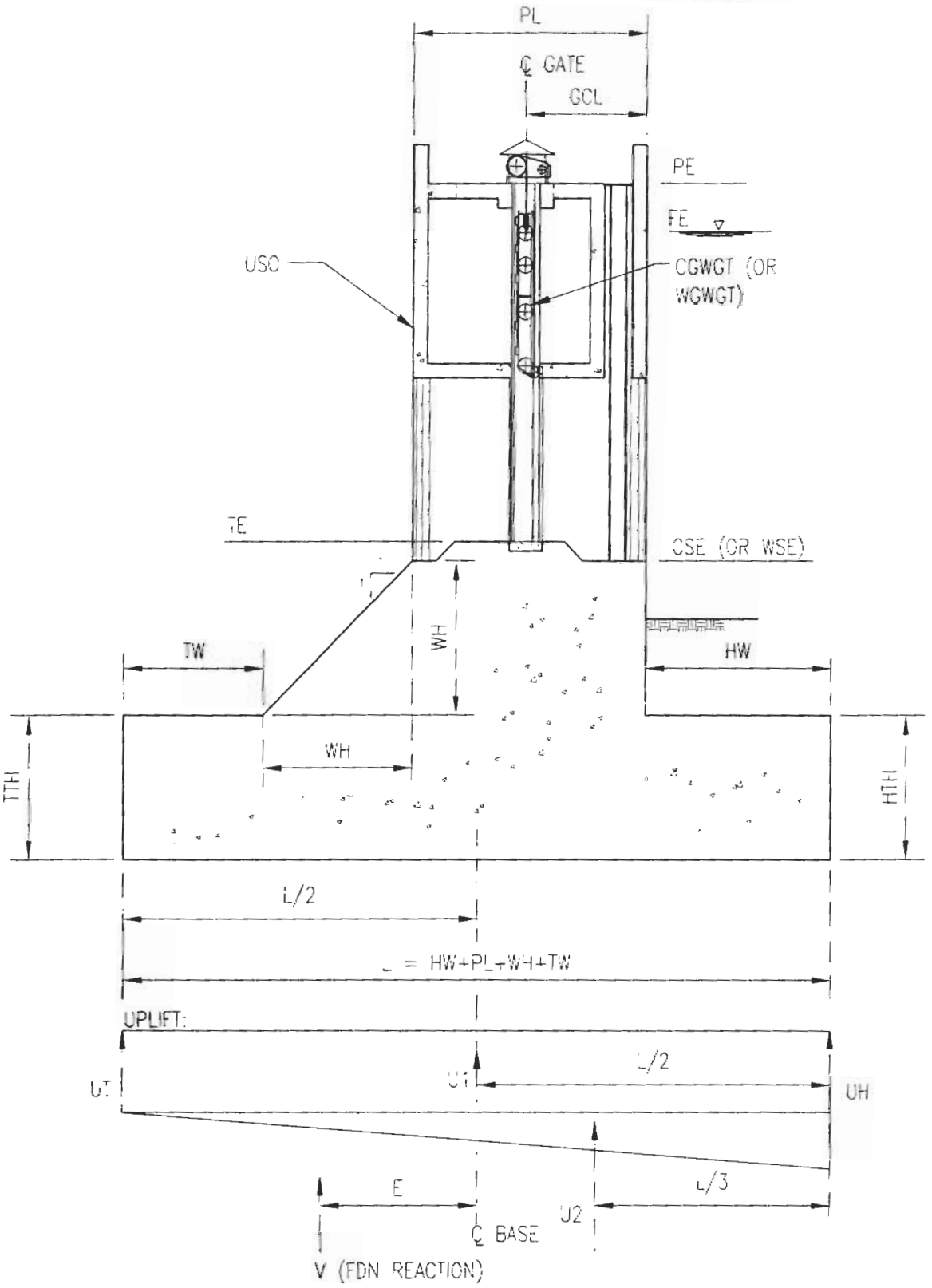
FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

CELL NAMES
GATE STRUCTURE I

DATE 12-21-04 | FIGURE No. B-1

CDM

S:\2521\42275\SIRU\gs_dwgs\ FIG--B1 12/21/04 15:13 reddincp XREFS: 8X11 PRI I



TRANSVERSE SECTION (NO DRAIN)

1/16"=1'-0"

SCALE: 1/16 "=1'-0"

0' 8' 16' 24'

FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

CELL NAMES
GATE STRUCTURE II

CDM

DATE 12-21-04 | FIGURE No. B-2

S:\2521\42275\STRU\gs_dwgs\ FIG-B2 12/21/04 15:15 reddincp XREFS: 8X11 PREI

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: _ ___ ___ ___ ___ DATE: _ ___ _

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITIO

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	487	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.3333333333	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5000	LBS
ADDL HEEL WIDTH (HW):	20	FT
HEEL THICKNESS (HTH):	25	FT
ADDL TOE WIDTH (TW):	20	FT
TOE THICKNESS (TTH):	25	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	=DEGREES(ATAN(TAN(RADIANS(PHI))/FS))		DEGREES
DESIGN COHESION (CND):	=CN/FS		PSF
UPLIFT AT HEEL (UH):	=(FE-BE)*EFP		PSF
UPLIFT AT TOE (UT):	=(TE-BE)*EFP		PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	=CSE-BE-TTH	(WH = CSE-BE-TTH)	FT
FDN LENGTH (L):	=HW+PL+WH+TW	(L = HW + PL + WH + TW)	FT
FDN WIDTH (B):	=CGW+WGW+PN*PT	(B = CGW + WGW + PN*PT)	FT

=A1

=A3

=A5

=A7

DATE: =C5

DATE: =C7

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB
CHANNEL GATE:	=CGWGT	
WALKWAY GATE:	=WGWGT	
CONCRETE PIERS:	=(PE-CSE)*PL*PN*PT*CUW	
UPPER STRUCTURE:	=USO*2*(CGW+WGW)*CUW	
CHANNEL BLOCK FDN:	=(CSE-BE)*PL*(CGW+PN*PT)*CUW	
CHANNEL WEDGE FDN:	=(WH*WH/2+TTH*WH)*(CGW+PN*PT)*CUW	
WALKWAY BLOCK FDN:	=(WSE-BE)*PL*WGW*CUW	
WALKWAY WEDGE FDN:	=(WH*WH/2+TTH*WH)*(WGW)*CUW	
HEEL SLAB:	=HW*B*HTH*CUW	
TOE SLAB:	=TW*B*TTH*CUW	
FLUID ON HEEL:	=HW*B*(FE-BE-HTH)*EFP	
FLUID ON CHANNEL SILL:	=(GCL-1)*(19)*CGW*EFP	
FLUID ON WALKWAY SILL:	=(GCL-1)*(10)*WGW*EFP	
FLUID ON D/S WEDGE:	=WH*WH/2*B*EFP	
FLUID ON TOE:	=TW*B*(TE BE-TTH)*EFP	
UPLIFT FORCE (U1):	=-UT*L*B	
UPLIFT FORCE (U2):	=-0.5*(UH-UT)*L*B	
FLUID HORIZ FORCE (H):		=B*(FE-BE)^2*EFP/2
RESISTING FLUID FORCE:		=-B*((TE-BE)^2*EFP/2)
SUBTOTAL AT BASE (V,MR,MO)=	=SUM(H13:H31)	=SUM(I13:I31)

STABILITY RESULTS:

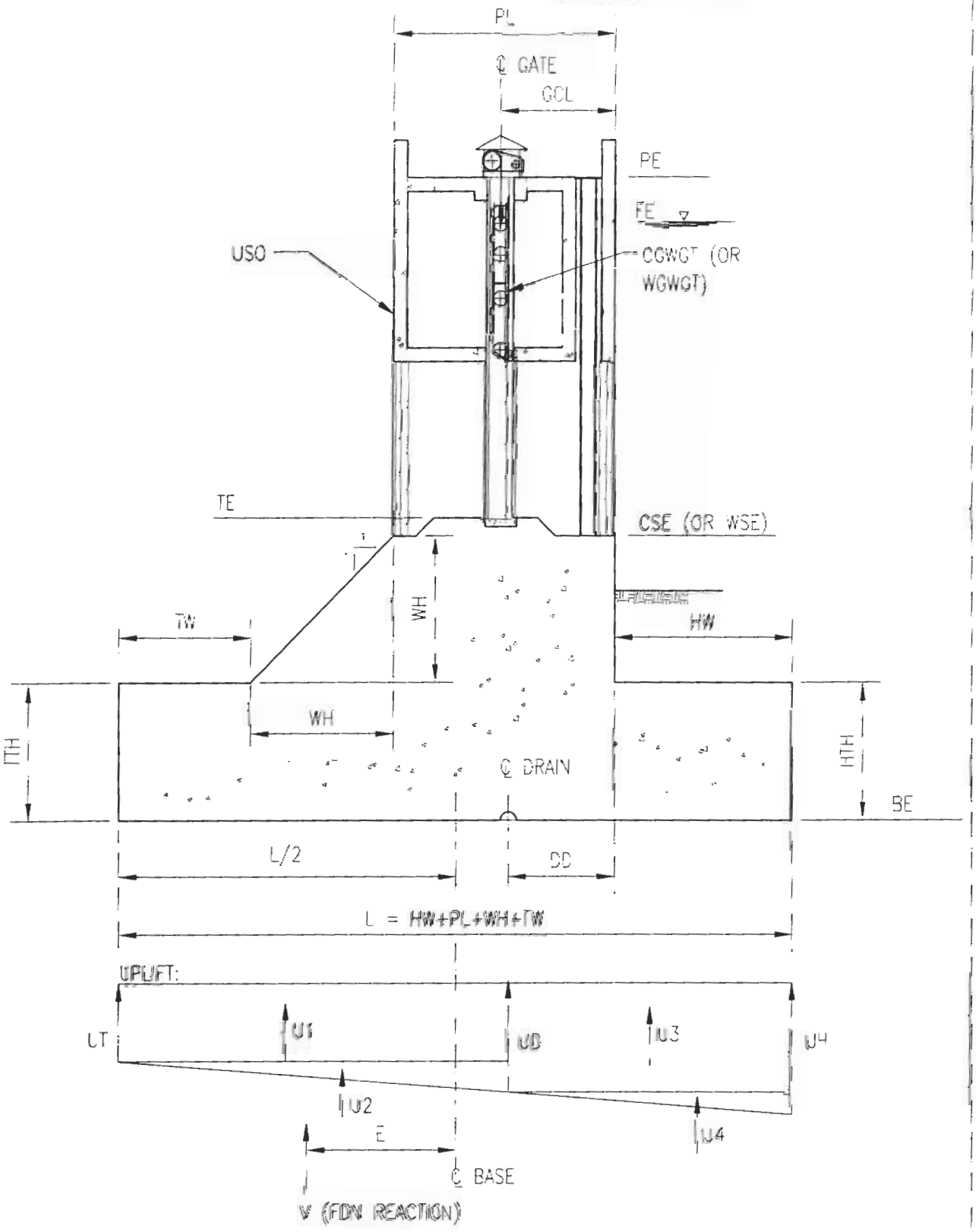
FRICTION FORCE (V*TAN(PHID))=	=V*TAN(RADIANS(PHID))	LB
COHESION FORCE (CND*L*B)=	=CND*L*B	LB
NET SLIDING FORCE =	=I33	LB
SLIDING RATIO =	=(H37+H38)/H39	>1.0?
OVERTURNING RATIO (MR/MO)=	=MR/MO	>1.0?
ECCENTRICITY (E=L/2-(MR-MO)/V))=	=(L/2)-((MR-MO)/V)	(RELATIVE TO CL)
BEARING PRESSURE =	V/L(1+-6*E/L)	
MAX BEARING PRESS =	=V/L*(1+6*H42/L)/B	PSF
MIN BEARING PRESS =	=V/L*(1-6*H42/L)/B	PSF
VOLUME OF CONCRETE =	=(SUM(H15:H22)/150)/27	CY

ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
=L-HW-GCL	=H13*J13	
=L-HW-GCL	=H14*J14	
=L-HW-PL/2	=H15*J15	
=L-HW-PL/2	=H16*J16	
=L-HW-PL/2	=H17*J17	
=IF(H18=0," ",(WH*WH/2*(TW+WH*0.67)+TTH*WH*(TW+WH/2))/(WH*WH/2+TTH*WH))	=H18*J18	
=TW+WH+PL/2	=H19*J19	
=IF(H20=0," ",(WH*WH/2*(TW+WH*0.67)+TTH*WH*(TW+WH/2))/(WH*WH/2+TTH*WH))	=H20*J20	
=L-HW/2	=H21*J21	
=TW/2	=H22*J22	
=L-HW/2	=H23*J23	
=L-HW-(GCL-1)/2	=H24*J24	
=L-HW-(GCL-1)/2	=H25*J25	
=TW+WH/3	=H26*J26	
=TW/2	=H27*J27	
=L/2		=-H28*J28
=2*L/3		=-H29*J29
=(FE-BE)/3		=H*J30
=(TE-BE)/3	=-I31*J31	
	=SUM(K13:K31)	=SUM(L13:L31)

= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION * BASE AREA
= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
= (FRICTION + COHESION)/(NET SLIDING)

Gate Structure Stability Analysis (with Drains)

Excel Spreadsheet with Cell Formulas Displayed



TRANSVERSE SECTION (WITH DRAIN)

1/16"=1'-0"

SCALE: 1/16 "=1'-0"

0' 8' 16' 24'

FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

CELL NAMES
GATE STRUCTURE III

CDM

DATE 12-21-04 | FIGURE No. B-3

S:\2521\42275\STRU\gs_dwgs\ FIG-B3 12/21/04 15:16 reddincp XREFS: 8X11_PREL

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: _____ DATE: ___ ___

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITI

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	487	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.3333333333	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5000	LBS
ADDL HEEL WIDTH (HW):	16	FT
HEEL THICKNESS (HTH):	25	FT
ADDL TOE WIDTH (TW):	20	FT
TOE THICKNESS (TTH):	25	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
DRAIN EFFICIENCY (DE):	0.33	
DRAIN DIMENSION FROM HEADWALL (DD):	10	FT

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	=DEGREES(ATAN(TAN(RADIANS(PHI))/FS))		DEGREES
DESIGN COHESION (CND):	=CN/FS		PSF
UPLIFT AT HEEL (UH):	=(FE-BE)*EFP		PSF
UPLIFT AT TOE (UT):	=(TE-BE)*EFP		PSF
UPLIFT AT DRAIN (UD):	=UT+(1-DE)*((L-HW-DD)/L)*(UH-UT)		PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	=CSE-BE-TTH	(WH = CSE-BE-TTH)	FT
FDN LENGTH (L):	=HW+PL+WH+TW	(L = HW + PL + WH + TW)	FT
FDN WIDTH (B):	=CGW+WGW+PN*PT	(B = CGW + WGW + PN*PT)	FT

=A1

=A3

=A5 DATE: =C5

=A7 DATE: C7

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB
CHANNEL GATE:	=CGWGT	
WALKWAY GATE:	=WGWGT	
CONCRETE PIERS:	=(PE-CSE)*PL*PN*PT*CUW	
UPPER STRUCTURE:	=USO*2*(CGW+WGW)*CUW	
CHANNEL BLOCK FDN:	=(CSE-BE)*PL*(CGW+PN*PT)*CUW	
CHANNEL WEDGE FDN:	=(WH*WH/2+TTH*WH)*(CGW+PN*PT)*CUW	
WALKWAY BLOCK FDN:	=(WSE-BE)*(PL)*WGW*CUW	
WALKWAY WEDGE FDN:	=(WH*WH/2+TTH*WH)*(WGW)*CUW	
HEEL SLAB:	=HW*B*HTH*CUW	
TOE SLAB:	=TW*B*TTH*CUW	
FLUID ON HEEL:	=HW*B*(FE-BE-HTH)*EFP	
FLUID ON CHANNEL SILL:	=(GCL-1)*(19)*CGW*EFP	
FLUID ON WALKWAY SILL:	=(GCL-1)*(10)*WGW*EFP	
FLUID ON D/S WEDGE:	=WH*WH/2*B*EFP	
FLUID ON TOE:	=TW*B*(TE-BE-TTH)*EFP	
UPLIFT FORCE (U1):	-UT*(L-HW-DD)*B	
UPLIFT FORCE (U2):	= 0.5*(UD-UT)*(L-HW-DD)*B	
UPLIFT FORCE (U3):	= UD*(HW+DD)*B	
UPLIFT FORCE (U4):	=-0.5*(UH-UD)*(HW+DD)*B	
FLUID HORIZ FORCE (H):		=B*(FE-BE)^2*EFP/2
RESISTING FLUID FORCE:		= B*((TE-BE)^2*EFP/2)
SUBTOTAL AT BASE (V,MR,MO)	=SUM(H13:H33)	=SUM(I13:I33)

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	=V*TAN(RADIANS(PHID))	LB
COHESION FORCE (CND*L*B)	=CND*L*B	LB
NET SLIDING FORCE	=I35	LB
SLIDING RATIO	=(H39+H40)/H41	>1.0?
OVERTURNING RATIO (MR/MO)	=MR/MO	>1.0?
ECCENTRICITY (E=L/2-(MR-MO)/V))	=(L/2)-((MR-MO)/V)	(RELATIVE TO CL)
BEARING PRESSURE	=V/L(1+ 6*E/L)	
MAX BEARING PRESS	=V/L*(1+6*H44/L)/B	PSF
MIN BEARING PRESS	=V/L*(1-6*H44/L)/B	PSF
VOLUME OF CONCRETE	=(SUM(H15:H22)/150)/27	CY

ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
=L-HW-GCL	=H13*J13	
=L-HW-GCL	=H14*J14	
=L-HW-PL/2	=H15*J15	
=L-HW-PL/2	=H16*J16	
=L-HW-PL/2	=H17*J17	
=IF(H18=0," ",(WH*WH/2*(TW+WH*0.67)+TTH*WH*(TW+WH/2))/(WH*WH/2+TTH*WH))	=H18*J18	
=TW+WH+PL/2	=H19*J19	
=IF(H20=0," ",(WH*WH/2*(TW+WH*0.67)+TTH*WH*(TW+WH/2))/(WH*WH/2+TTH*WH))	=H20*J20	
=L-HW/2	=H21*J21	
=TW/2	=H22*J22	
=L-HW/2	=H23*J23	
=L-HW-(GCL-1)/2	=H24*J24	
=L-HW-(GCL-1)/2	=H25*J25	
=TW+WH/3	=H26*J26	
=TW/2	=H27*J27	
=(L-HW-DD)/2		=H28*J28
=2*(L-HW-DD)/3		=-H29*J29
=L-(HW+DD)/2		=-H30*J30
=2*(HW+DD)/3+(L-HW-DD)		=-H31*J31
=(FE-BE)/3		=H*J32
=(TE-BE)/3	=-H33*J33	
	=SUM(K13:K33)	=SUM(L13:L33)

= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
= COHESION * BASE AREA
= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
= (FRICTION + COHESION)/(NET SLIDING)

Gate Structure Seismic Analysis

Excel Spreadsheet with Cell Formulas Displayed

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: _____ DATE: _____

GATE STRUCTURE STABILITY (W/ UPLIFT)
NORMAL POOL ELEVATION WITH SEISMIC (EXTREME CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	525	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	506	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.3333333333	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	17	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.1	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
SEISMIC COEFFICIENT (A):	0.05	g

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	=DEGREES(ATAN(TAN(RADIANS(PHI))/FS))	DEGREES
DESIGN COHESION (CND):	=CN/FS	PSF
UPLIFT AT HEEL (UH):	=(FE-BE)*EFP	PSF
UPLIFT AT TOE (UT):	=(TE-BE)*EFP	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH):	=CSE-BE-TTH (WH = CSE BE-TTH)	FT
FDN LENGTH (L):	=HW+PL+WH+TW (L = HW + PL + WH + TW)	FT
FDN WIDTH (B):	=CGW+WGW+PN*PT (B = CGW + WGW + PN*PT)	FT

SEISMIC PARAMETERS:

SEISMIC INERTIA DUE TO MASS =	SUM(DL) * A
ASSUMED CENTROID OF MASS =	0.4*(PE-BE)
SEISMIC FLUID FORCE (PER WESTERGAARD)	0.67*51*A*(FE-BE)^2
FLUID FORCE RESULTANT ABOVE BASE	0.4*(FE-BE)
OR	0.4*(TE-BE)

=A1

=A3

=A5

=A7

DATE: =C5

DATE: =C7

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB
CHANNEL GATE:	=CGWGT	
WALKWAY GATE:	=WGWGT	
CONCRETE PIERS:	=(PE-CSE)*PL*PN*PT*CUW	
UPPER STRUCTURE:	=USO*2*(CGW+WGW)*CUW	
CHANNEL BLOCK FDN:	=(CSE-BE)*PL*(CGW+PN*PT)*CUW	
CHANNEL WEDGE FDN:	=(WH*WH/2+TTH*WH)*(CGW+PN*PT)*CUW	
WALKWAY BLOCK FDN:	=(WSE-BE)*(PL)*WGW*CUW	
WALKWAY WEDGE FDN:	=(WH*WH/2+TTH*WH)*(WGW)*CUW	
HEEL SLAB:	=HW*B*HTH*CUW	
TOE SLAB:	=TW*B*TTH*CUW	
FLUID ON HEEL:	=HW*B*(FE-BE-HTH)*EFP	
FLUID ON CHANNEL SILL:	=(GCL-1)*(19)*CGW*EFP	
FLUID ON WALKWAY SILL:	=(GCL-1)*(10)*WGW*EFP	
FLUID ON D/S WEDGE:	=WH*WH/2*B*EFP	
FLUID ON TOE:	=TW*B*(TE-BE-TTH)*EFP	
UPLIFT FORCE (U1):	=-UT*L*B	
UPLIFT FORCE (U2):	=-0.5*(UH-UT)*L*B	
FLUID HORIZ FORCE (H):		=B*(FE-BE)^2*EFP/2
RESISTING FLUID FORCE:		=-B*((TE-BE)^2*EFP/2)
SEISMIC INERTIA FORCE:		=SUM(H13:H20)*A
SEISMIC FLUID FORCE U/S:		=0.67*51*A*(FE-BE)^2
SEISMIC FLUID FORCE D/S:		=0.67*51*A*(TE-BE)^2
SUBTOTAL AT BASE (V,MR,MO)=	=SUM(H13:H34)	=SUM(I13:I34)

STABILITY RESULTS:

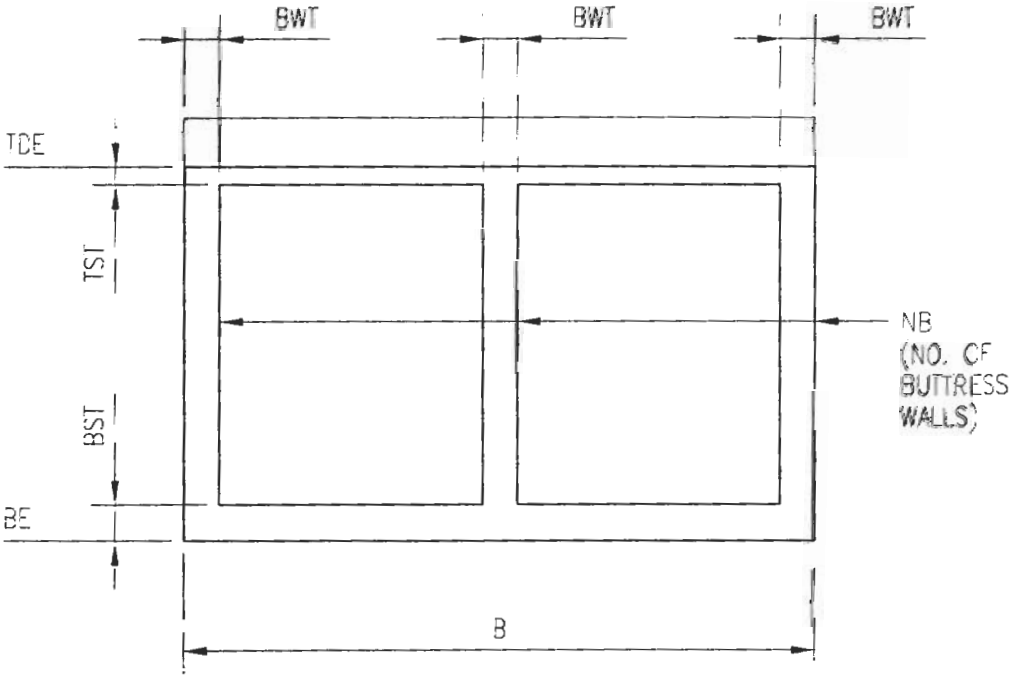
FRICTION FORCE (V*TAN(PHID))=	=V*TAN(RADIANS(PHID))	LB
COHESION FORCE (CND*L*B)=	=CND*L*B	LB
NET SLIDING FORCE =	=I36	LB
SLIDING RATIO =	=(H40+H41)/H42	>1.0?
OVERTURNING RATIO (MR/MO)=	=MR/MO	>1.0?
ECCENTRICITY (E=L/2-(MR-MO)/V))=	=(L/2)-((MR-MO)/V)	(RELATIVE TO CL)
BEARING PRESSURE =	V/L(1+6*E/L)	
MAX BEARING PRESS =	=V/L*(1+6*H45/L)/B	PSF
MIN BEARING PRESS =	=V/L*(1-6*H45/L)/B	PSF
VOLUME OF CONCRETE =	=(SUM(H15:H22)/150)/27	CY

ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
=L-HW-GCL	=H13*J13	
=L-HW-GCL	=H14*J14	
=L-HW-PL/2	=H15*J15	
=L-HW-PL/2	=H16*J16	
=L-HW-PL/2	=H17*J17	
=IF(H18=0,"",(WH*WH/2*(TW+WH*0.67)+TTH*WH*(TW+WH/2))/(WH*WH/2+TTH*WH))	=H18*J18	
=TW+WH+PL/2	=H19*J19	
=IF(H20=0,"",(WH*WH/2*(TW+WH*0.67)+TTH*WH*(TW+WH/2))/(WH*WH/2+TTH*WH))	=H20*J20	
=L-HW/2	=H21*J21	
=TW/2	=H22*J22	
=L-HW/2	=H23*J23	
=L-HW-(GCL-1)/2	=H24*J24	
=L-HW-(GCL-1)/2	=H25*J25	
=TW+WH/3	=H26*J26	
=TW/2	=H27*J27	
=L/2		=-H28*J28
=2*L/3		=-H29*J29
=(FE-BE)/3		=H*J30
(TE-BE)/3	=I31*J31	
=0.4*(PE-BE)		=I32*J32
=0.4*(FE-BE)		=I33*J33
=0.4*(TE-BE)		=I34*J34
	SUM(K13:K34)	=SUM(L13:L34)

= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
= COHESION * BASE AREA
= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
(FRICTION + COHESION)/(NET SLIDING)

Abutment Structure Stability Analysis

Excel Spreadsheet with Cell Formulas Displayed



LONGITUDINAL SECTION

1/16"=1'-0"

SCALE: 1/16 "=1'-0"

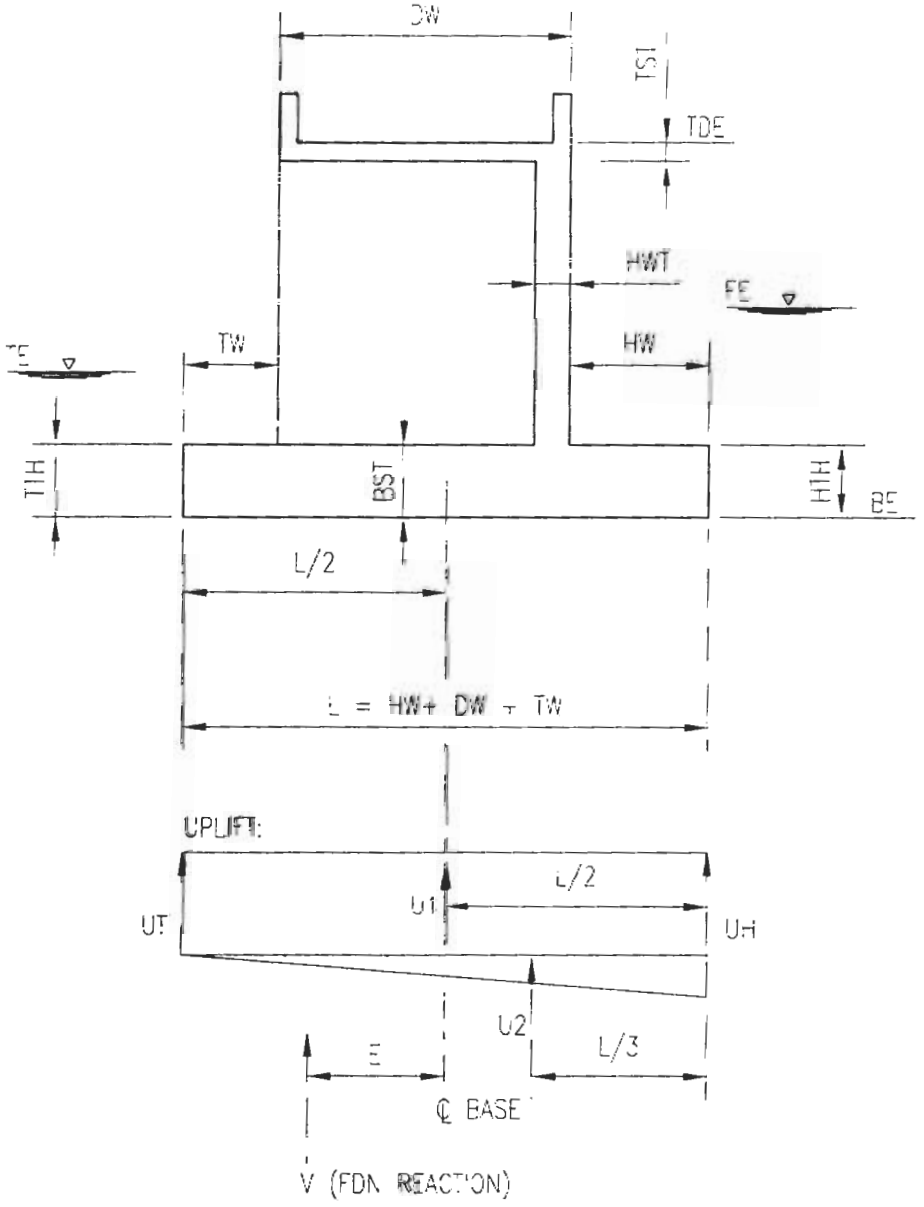
0' 8' 16' 24'

FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

CELL NAMES
ABUTMENT STRUCTURE I

DATE 12-21-04 | FIGURE No. B-4

CDM



TRANSVERSE SECTION

1/16"=1'-0"

SCALE: 1/16 "=1'-0"

0' 8' 16' 24'

FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

CELL NAMES
ABUTMENT STRUCTURE II

CDM

DATE 12-21-04 | FIGURE No. B-5

S:\2521\42275\STRU\gs_dwgs\ HG-B4 12/21/04 14:18 reddincp XREFS: 8X11_PREI

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: _____ DATE: _____

GATE ABUTMENT STRUCTURE STABILITY
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	556.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	3	FT
NO. OF BUTTRESS WALLS (NB):	4	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	6	FT
STRUCTURE LENGTH (B):	80	FT
ADDL HEEL WIDTH (HW):	12	FT
HEEL THICKNESS (HTH):	6	FT
ADDL TOE WIDTH (TW):	10	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	62.5	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	=DEGREES(ATAN(TAN(RADIANS(PHI))/FS))	(PHID = ARCTAN(TAN(PHI)/FS))	DEGREES
DESIGN COHESION (CND):	=CN/FS	(CND = CN / FS)	PSF
UPLIFT AT HEEL (UH):	=(FE-BE)*EFP	(UH = (FE-BE) * EFP)	PSF
UPLIFT AT TOE (UT):	=IF((TE-BE)<0,0,(TE-BE)*EFP)	(UT = (TE-BE) * EFP)	PSF
FDN LENGTH (L):	=HW+DW+TW	(L = HW + DW + TW)	FT

=A1

=A3

=A5

A7

DATE: =C5

DATE: =C7

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	
HEADWALL:	=(TDE-TST-BE-BST)*HWT*(B-BWT*NB)*CUW		
BUTTRESS WALLS(1):	=(TDE-TST-BE-BST)*BWT*NB*DW*CUW		
BUTTRESS WALLS(2):	=0.5*(TDE-TST-2-BE-BST)*BWT*NB*TW*CUW		
TOP SLAB:	=TST*B*DW*CUW		
BOTTOM SLAB:	=BST*B*DW*CUW		
HEEL SLAB:	=HW*HTH*B*CUW		
TOE SLAB:	=TW*TTH*B*CUW		
FLUID ON HEEL:	=HW*B*(FE-BE-HTH)*EFP		
FLUID ON TOE:	=IF(BE>TE,0,TW*B*(TE-BE-TTH)*EFP)		
UPLIFT FORCE (U1):	=-UT*L*B		
UPLIFT FORCE (U2):	=-0.5*(UH-UT)*L*B		
FLUID HORIZ FORCE (H):		=(FE-BE)^2*EFP/2*B	
RESISTING FLUID FORCE:		=IF(TE-BE<0,0,-((TE-BE)^2*EFP/2*B))	
SUBTOTAL AT BASE (V,MR,MO)=	=SUM(H13:H26)	=SUM(I13:I26)	

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))	=V*TAN(RADIANS(PHID))	LB
COHESION FORCE (CND*L*B)	=CND*L*B	LB
NET SLIDING FORCE =	=I28	LB
SLIDING RATIO =	=(H34+H35)/H36	>1.0?
OVERTURNING RATIO (MR/MO)	=MR/MO	>1.0?
ECCENTRICITY (E=L/2-(MR-MO)/V))	=(L/2)-((MR-MO)/V)	(RELATIVE TO CL)
BEARING PRESSURE =	V/L*(1+-6*E/L)	
MAX BEARING PRESS =	=V/L*(1+6*E/L)/B	PSF
MIN BEARING PRESS =	=V/L*(1-6*E/L)/B	PSF
VOLUME OF CONCRETE	=SUM(H14:H20)/150/27	CY

ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
=DW+TW-HWT/2	=H14*J14	
=DW/2+TW	=H15*J15	
=0.667*TW	=H16*J16	
=DW/2+TW	=H17*J17	
=DW+TW+HW/2	=H18*J18	
=TW/2	=H19*J19	
=DW+TW+HW/2	=H20*J20	
=TW/2	=H21*J21	
=L/2	=H22*J22	
=2*L/3		=-H23*J23
=(FE-BE)/3		=-H24*J24
=(TE-BE)/3		=H*J25
	=-I26*J26	
	=SUM(K13:K26)	=SUM(L13:L26)

= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
= COHESION * BASE AREA
= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
= (FRICTION + COHESION)/(NET SLIDING)

Section 13
Design of H-Piles (Manual Calculations)

CDM

CDM

CLIENT TRWD
PROJECT GATE STR
DETAIL PILE CAPACITY

JOB NO. 42275
DATE CHECKED 11-19-04
CHECKED BY MCK

COMPUTED BY EDA
DATE 11-15-04
PAGE NO.

STEEL PILE CAPACITY

ASSUME:

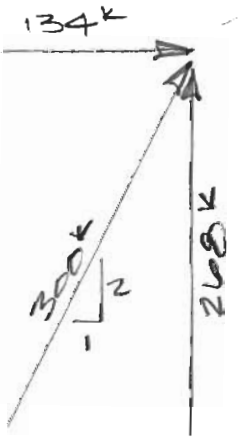
HP 14 x 102

MAX STRESS = 10.0 KSI

AREA = 30 IN²

$\therefore P_{max} = 30 in^2 (10.0 ksi) = 300 K$

FOR A 2:1 BATTER



CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR	DATE CHECKED	11-19-04	DATE	11-15-04
DETAIL	TRWD	CHECKED BY	WDF	PAGE NO.	

Rev. 12-21-04

STEEL PILE LAYOUT

ASSUME:

HP14 x 102 PILES

FIND BATTER ANGLE

FROM MAX LOAD CONDITIONS -TRWD GATE

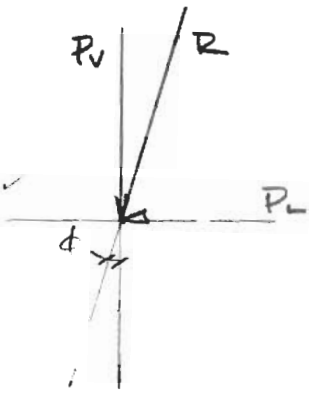
$P_V = 7146^K$ ✓

$P_L = 3132^K$ ✓

$\tan\phi = \frac{3132^K}{7146^K} = 0.438$ ✓

$1/0.438 = 2.3$

USE 1H : 2.5V ✓



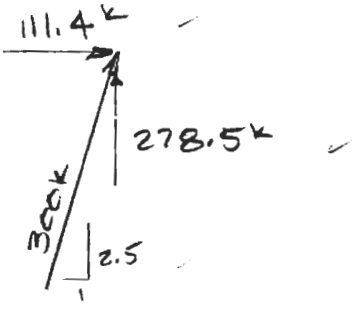
HP14 x 102

CAPACITY

MAX STRESS = 10 KSI

A = 30 IN2

$P_{max} = 300^K$ ✓



CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY BDA
PROJECT GATE STR | DATE CHECKED 11-19-04 | DATE 11-15-04
DETAIL TRWD | CHECKED BY [illegible] | PAGE NO.

Rev. 12-21-04

STEEL PILE LAYOUT

NUMBER OF PILES REQ'D

BATTERED

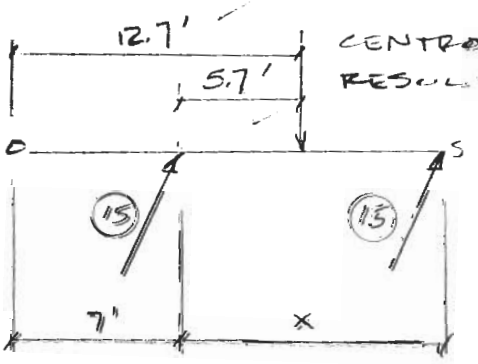
$$\frac{313^{K}}{111.4^{K}/\text{PILE}} = 28.1 \text{ PILES}$$

$$\frac{7146^{K}}{278.5^{K}/\text{PILE}} = 25.7 \text{ PILES}$$

∴ USE (SAY) 30 PILES

PILE LOCATION

MAX LOAD CONDITION $L = 35'-0''$ (TRWD GATE) $e = 4.84'$



◯ => # OF PILES PER ROW

$15(5.7) = 15(x + 7' - 12.70')$

$85.5 = 15x + 105 - 190.5$

$x = 11.4'$

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR	DATE CHECKED	11-19-04	DATE	11-15-04
DETAIL	TRWD	CHECKED BY	MCK	PAGE NO.	

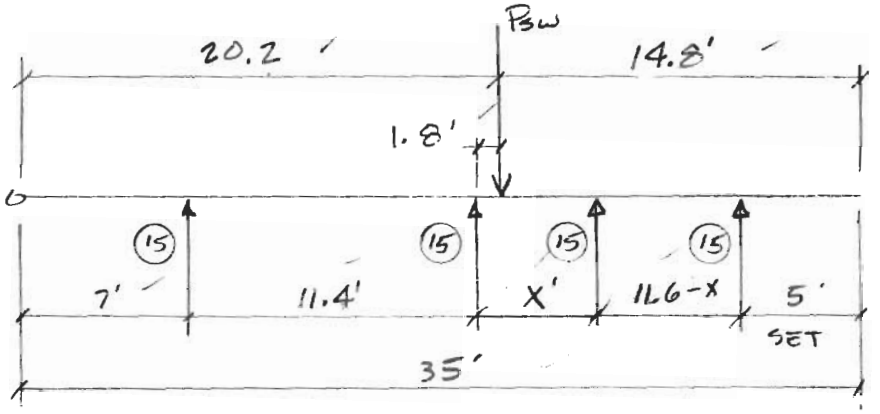
Rev. 12-21-04

STEEL PILE LAYOUT

PILE LOCATION

LOW WATER - MAXIMUM SELF WT.

$P_{SW} = 11,100^{K}$ ✓ $e = 2.73'$



ABOUT P_{SW}

$$15(13.2') + 15(1.8') = 15(x - 1.8') + 15(9.8')$$

$$198 + 27.0 = 15x - 27.0 + 147$$

$$x = 7.0$$ ✓

4 - ROWS OF 15 PILES EACH

$\frac{58'}{15} = 3.87'$ SAY 3'8" SPACING

$4 \times 15 \times 278.5^{K} = 16,710^{K} > 11,100^{K}$ OK

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	496	FT
TAILWATER ELEV (TE):	496	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	496	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
TREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	12	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	10	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	35	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TBM DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		22.00	330,000	
WALKWAY GATE:	5,000		22.00	110,000	
CONCRETE PIERS:	3,217,500		22.50	72,393,750	
UPPER STRUCTURE:	1,058,400		22.50	23,814,000	
CHANNEL BLOCK FDN:	3,795,000		22.50	85,387,500	
CHANNEL WEDGE FDN:	1,173,000		5.50	6,451,500	
WALKWAY BLOCK FDN:	1,530,000		22.50	34,425,000	
WALKWAY WEDGE FDN:	306,000		5.50	1,683,000	
HEEL SLAB:	0		35.00	0	
TOE SLAB:	0		0.00	0	
SUBTOTAL AT BASE (V,MR,MO)=	11,099,900	0		224,594,750	0

STABILITY RESULTS:

ECCENTRICITY (E=L/2-(MR-MO)/V))=	-2.73	(RELATIVE TO CL)
BEARING PRESSURE = V/L(1+ 6*E/L)		
MAX BEARING PRESS =	2905	PSF
MIN BEARING PRESS =	8031	PSF
VOLUME OF CONCRETE =	2,736	CY

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR	DATE CHECKED	11-19-04	DATE	11-15-04
DETAIL	TRINITY POINT	CHECKED BY		PAGE NO.	

Rev. 12-21-04

STEEL PILE LAYOUT

ASSUME:

HP 14 x 102 PILES

FIND BATTER ANGLE

FROM MAX LOAD CONDITIONS – TRINITY PT. GATE

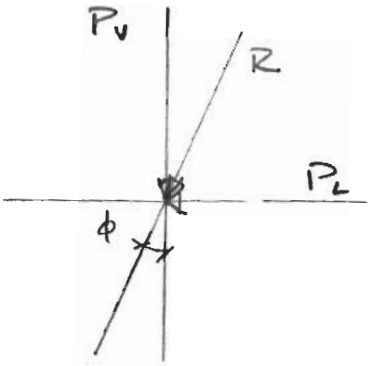
$P_V = 7223\ K$

$P_L = 3798\ K$

$$\tan\phi = \frac{3798^K}{7223^K} = 0.526$$

$1/0.526 = 1.90$

USE 1H : 2V



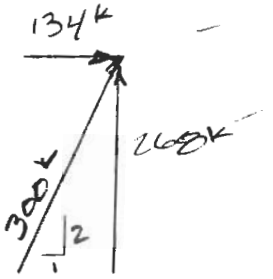
HP 14 x 102

CAPACITY

MAX STRESS = 10 ksi

$A = 30\ in^2$

$P_{max} = 302^K$



CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	TBDA
PROJECT	GATE STR	DATE CHECKED	11-19-04	DATE	11-15-04
DETAIL	TRINITY POINT	CHECKED BY	JLK	PAGE NO.	

Rev. 12-21-04

STEEL PILE LAYOUT

NUMBER OF PILES REQ'D

BATTERED

$$\frac{3798^{K}}{134^{K}/\text{PILE}} = 29 \text{ PILES}$$

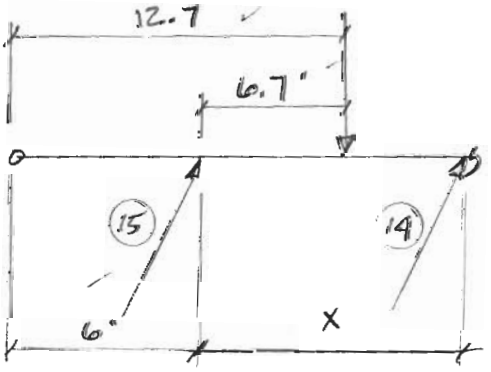
$$\frac{7223^{K}}{268^{K}/\text{PILE}} = 27 \text{ PILES}$$

∴ USE 29 PILES

(USE 30)

PILE LOCATION

MAX LOAD CONDITION L = 37'-0" e = 5.77



○ = # OF PILES

$$15(6.7') = 14(x + 6' - 12.7')$$

$$100.5' = 14x + 84' - 177.8$$

$$x = 13.9'$$

SAY 14.0'

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR.	DATE CHECKED	11-19-04	DATE	11-15-04
DETAIL	TRINITY POINT	CHECKED BY	WW	PAGE NO.	

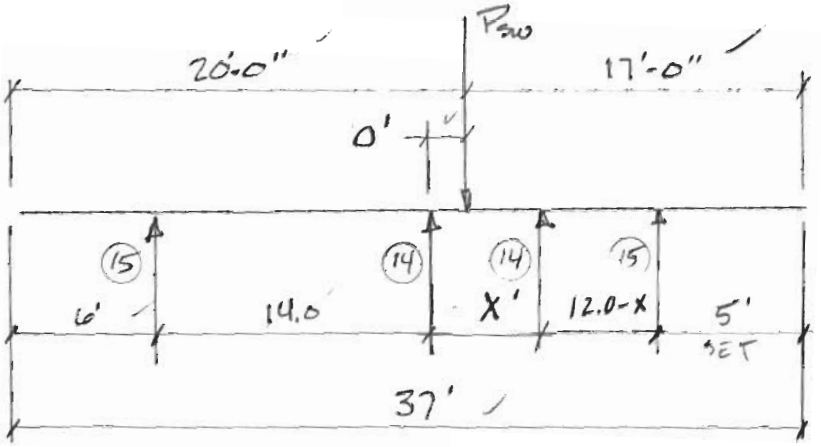
Rev. 12-21-04

STEEL PILE LAYOUT

PILE LOCATION

LOW WATER - MAXIMUM SELF WT.

$P_{SW} = 10,544.2^K$ $e = 1.45'$



ABOUT P_{SW}

$15(14.0') + 14(0') = 14(X - 0') + 15(12')$

$210' = 14x + 180'$

$X = 2.1'$

USE MIN STA = 3.5'

@ $X = 3.5'$

SAY USE 30 PILES:

4 ROWS OF 15 EACH

$\frac{80'}{15} = 5.33'$ SAY 5'-3" OC

$4 \times 15 \times 268^K = 16,080^K > 16,544^K$ OK

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TBD DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	549.5	FT
TAILWATER ELEV (TE):	520	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	509	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	8	FT
NO. OF CONC PIERS (PN):	4	
UPPER STRUCTURE OUTLINE (USO):	98	FT
UPSTREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATES:		
GATE WIDTH - 2 GATES (WGW):	24	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT - 2 GATES (WGWGT):	10,000	LBS
ADDL HEEL WIDTH (HW):	4	FT
HEEL THICKNESS (HTH):	3	FT
ADDL TOE WIDTH (TW):	2	FT
TOE THICKNESS (TTH):	3	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	37	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	80	FT

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDH DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LAT'L FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		20.00	300,000	
WALKWAY GATE:	10,000		20.00	200,000	
CONCRETE PIERS:	4,680,000		20.50	95,940,000	
UPPER STRUCTURE:	1,411,200		20.50	28,929,600	
CHANNEL BLOCK FDN:	1,890,000		20.50	38,745,000	
CHANNEL WEDGE FDN:	302,400		5.51	1,666,224	
WALKWAY BLOCK FDN:	1,890,000		20.50	38,745,000	
WALKWAY WEDGE FDN:	129,600		5.51	714,096	
HEEL SLAB:	144,000		35.00	5,040,000	
TOE SLAB:	72,000		1.00	72,000	
SUBTOTAL AT BASE (V,MR,MO) =	10,544,200	0		210,351,920	0

STABILITY RESULTS:

ECCENTRICITY (E=L/2-(MR-MO)/V)) =	1.45	(RELATIVE TO CL)
BEARING PRESSURE = V/L(1+-6*E/L)		
MAX BEARING PRESS =	2725	PSF
MIN BEARING PRESS =	4400	PSF
VOLUME OF CONCRETE	2,597	CY

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR.	DATE CHECKED	11-15-04	DATE	11-15-04
DETAIL	CLEAR FORK	CHECKED BY	WH	PAGE NO.	

Rev. 12-21-04

STEEL PILE LAYOUT

ASSUME:

HP 14 x 102

FIND BATTER ANGLE

FROM MAX LOAD CONDITIONS - CLEAR FORK GATE

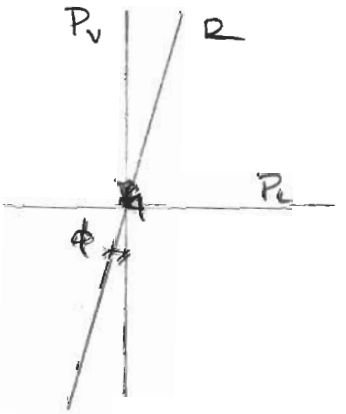
P_V = 4182 K

P_L = 4267 K ✓

$$\tan\phi = \frac{4267\ K}{4182\ K} = 1.02$$ ✓

$1/1.02 = 0.98$

USE 1H:2V



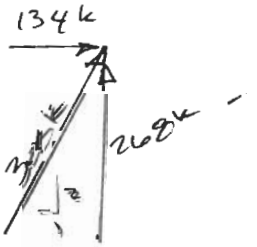
HP 14 x 102

CAPACITY

MAX STRESS = 10 KSI

A = 30 IN^2

P_{max} = 300 K



NO. OF PILES

4182 K / 268 K/PILE = 16 PILES ✓

4267 K / 134 K/PILE = 32 PILES ✓ → USE 32 PILES

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR	DATE CHECKED	11-19-04	DATE	11-16-04
DETAIL	CLEAR FORK	CHECKED BY	[illegible]	PAGE NO.	

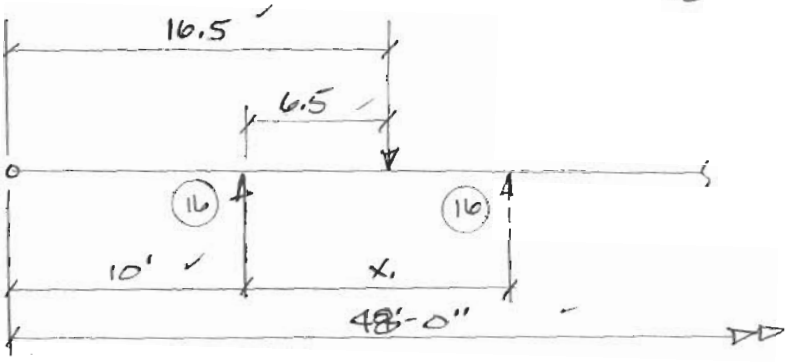
Rev. 12-21-04

STEEL PILE LAYOUT

MAX NO DRAIN PILE CASE

MAX LOAD CONDITION

$L = 48'-0"$ ✓ $e = 7.56'$ ✓



○ => # OF PILES

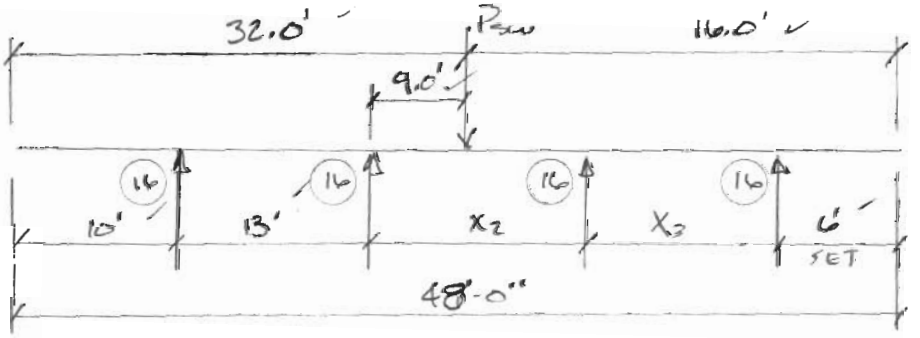
$$16(6.5') = 16(x_1 + 10 - 16.5')$$
$$104 = 16x_1 + 160 - 264$$
$$X_1 = 13.0'$$

PILE LOCATION

LOW WATER - MAXIMUM SELF WT. CASE

$P_{sw} = 8803$ KIPS ✓

$e = 7.97'$



$$16(22.0') + 16(9.0') = 16(x_2 - 9.0') + 16(10.0')$$
$$352 + 144 = 16x_2 - 144 + 160$$
$$X_2 = 30.0'$$ ✓

IF $X_2 = 30'$ THEN THE TOTAL SUM OF LENGTH BETWEEN PILES IS GREATER THAN 48 "OK" ✓

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR	DATE CHECKED	12-21-04	DATE	12-20-04
DETAIL	CLEAR FORK	CHECKED BY	[illegible]	PAGE NO.	

STEEL PILE LAYOUT

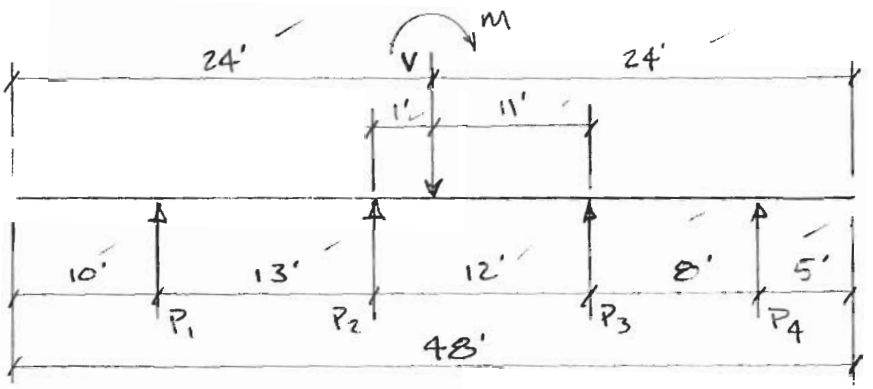
SELF WEIGHT CONDITION

TOTAL WEIGHT = 8803.1 K

ECCENTRICITY = 7.97 F REL TO ℄ OF STRUC.

∴ MOMENT ON PILE GROUP

$M_P = 8803.1^K (7.97^F) = 70,161^{F\text{-}K}$



MOMENT EFFECTS AT PILES

$$P_1 = \frac{70,161^{F\text{-}K}\ (14')}{(14')^2 + (1.0')^2 + (11')^2 + (19')^2} = 1447^K$$

679

$$P_2 = \frac{70,161^{F\text{-}K}\ (1.0')}{(14')^2 + (1')^2 + (11')^2 + (19')^2} = 103^K$$

$$P_3 = \frac{70,161^{F\text{-}K}\ (11')}{(14')^2 + (1')^2 + (11')^2 + (19')^2} = 1137^K$$

$$P_4 = \frac{70,161^{F\text{-}K}\ (19')}{(14')^2 + (1')^2 + (11')^2 + (19')^2} = 1963^K$$

MAXIMUM CASE

$P_4 \Rightarrow 1963^K / 16$ PILES/ROW $= 122.7^K$/PILE

$P_{TOT}/N = 8803^K / 16\ (4) = 137.5^K$/PILE

MAX LOAD ON PILE = $122.7^K + 137.5^K = 260.2^K$/PILE

$260^K < 268^K$ CAPACITY ∴ OK

4 RWS OF 16 PILES EACH = $\frac{58'}{16}$ 3.63' Say 3'6" SPACING

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TDH DATE: 12/20/04

GATE STRUCTURE STABILITY (W/ UPLIFT)
MAXIMUM WATER LEVEL TO TOP OF LEVEE (UNUSUAL CONDITION)

DIMENSIONS & WEIGHTS (INPUT):

GATE STRUCTURE:		
FLOOD ELEV (FE):	506	FT
TAILWATER ELEV (TE):	506	FT
TOP OF PIER ELEV (PE):	557	FT
FDN BASE EL (BE):	506	FT
PIER LENGTH (PL):	25	FT
PIER THICKNESS (PT):	7.33	FT
NO. OF CONC PIERS (PN):	3	
UPPER STRUCTURE OUTLINE (USO):	98	FT
STREAM FACE TO GATE CTR LINE (GCL):	13	FT
CHANNEL GATE:		
GATE WIDTH (CGW):	24	FT
SILL ELEV (CSE):	518	FT
GATE WEIGHT (CGWGT):	15,000	LBS
WALKWAY GATE:		
GATE WIDTH (WGW):	12	FT
SILL ELEV (WSE):	530	FT
GATE WEIGHT (WGWGT):	5,000	LBS
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	17	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	35	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	27.77	DEGREES
DESIGN COHESION (CND):	0	PSF
CONCRETE WEDGE HEIGHT & LGTH (WH): (WH = CSE-BE-TTH)	6	FT
FDN LENGTH (L): (L = HW + PL + WH + TW)	48	FT
FDN WIDTH (B): (B = CGW + WGW + PN*PT)	58	FT

PROJECT: TRWD · FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
CHANNEL GATE:	15,000		35.00	525,000	
WALKWAY GATE:	5,000		35.00	175,000	
CONCRETE PIERS:	3,217,500		35.50	114,221,250	
UPPER STRUCTURE:	1,058,400		35.50	37,573,200	
CHANNEL BLOCK FDN:	2,070,000		35.50	73,485,000	
CHANNEL WEDGE FDN:	372,600		20.34	7,578,684	
WALKWAY BLOCK FDN:	1,080,000		35.50	38,340,000	
WALKWAY WEDGE FDN:	97,200		20.34	1,977,048	
HEEL SLAB:	0		48.00	0	
TOE SLAB:	887,400		8.50	7,542,900	
SUBTOTAL AT BASE (V,MR,MO)=	8,803,100	0		281,418,082	0

STABILITY RESULTS:

ECCENTRICITY (E=L/2-(MR MO)/V))= -7.9' (RELATIVE TO CL)

BEARING PRESSURE = V/L(1+-6*E/L)

MAX BEARING PRESS = 13 PSF

MIN BEARING PRESS = 6311 PSF

VOLUME OF CONCRETE = 2,169 CY

be necessary. If the resultant load does not coincide with the center of gravity of the area of the footing, the computation of the soil pressures becomes a problem involving bending on an unsymmetrical section. Theoretically, eq. 20.7 is not applicable even though the entire base may be in compression. However, unless the footing is greatly unsymmetrical, the errors involved in using eq. 20.7 are tolerable for design. The subject of bending on unsymmetrical sections has received adequate treatment elsewhere.

20.7. Moment on Pile Footings

The reactions exerted by piles beneath a footing subject to moment are calculated in a manner similar to that described in the preceding articles concerning the pressure under soil-supported footings. Pile caps, such as those shown in Fig. 20.5 and Fig. 20.6, are commonly

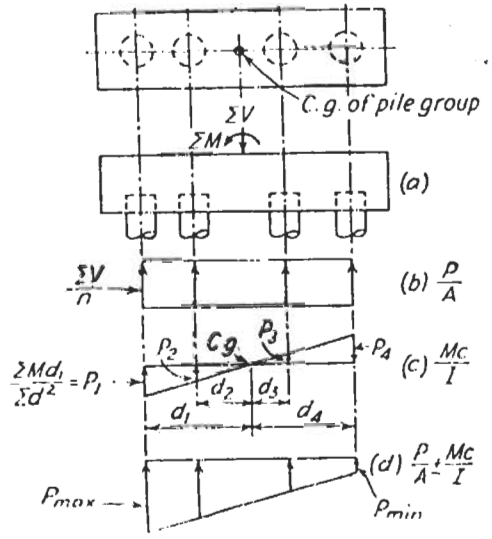


FIG. 20.5. Computation of pile reaction.

assumed to act as rigid structures. A planar distribution of the vertical settlement of the piles follows as a result of this assumption. Finally, if the ratio of reaction to settlement is assumed to be constant, the loads in the piles vary in the same planar fashion. Neither the assumption of the rigid cap nor the supposition that reaction is directly proportional to settlement is strictly valid, but each is generally considered sufficiently accurate for the purposes of design.

The analysis of a moment-resistant group of piles is illustrated in

Fig. 20.5. If there were no moment and ΣV acted through the center of gravity of the four piles, the loads in the piles would be as shown in *b*. On the other hand, if there were no resultant vertical force and only ΣM acted on the group of piles, the loads would be as shown in *c*.

The loads shown in *d* represent the total reaction and are the sums of those in *b* and *c*. The same loads would have been produced by ΣV acting eccentrically at a distance e to the left of the center of gravity.

From statics, it is evident that the resisting moment of the reactions furnished by the piles, Fig. 20.5*c*, must equal the applied moment, ΣM. The following equation expresses this relationship if resisting moments at the junctions of the piles and the cap either do not exist or are disregarded.

$$\Sigma M = P_1 d_1 + P_2 d_2 + P_3 d_3 + P_4 d_4 \qquad 20.8a$$

If the variation in pile reactions shown in *c* is assumed to be linear, then

$$P_1/d_1 = P_2/d_2 = P_3/d_3 = P_4/d_4$$

or

$$P_2 = P_1 d_2/d_1; \qquad P_3 = P_1 d_3/d_1; \qquad P_4 = P_1 d_4/d_1$$

Substituting these values of P_2, P_3, and P_4 in eq. 20.8*a*, we have

$$\Sigma M = P_1 d_1^2/d_1 + P_1 d_2^2/d_1 + P_1 d_3^2/d_1 + P_1 d_4^2/d_1 \qquad 20.8b$$

Solving for P_1,

$$P_1 = \frac{\Sigma M d_1}{d_1^2 + d_2^2 + d_3^2 + d_4^2} = \frac{\Sigma M d_1}{\Sigma d^2} \qquad 20.9$$

Similarly, the part of the load on any other pile due to moment may be computed by means of eq. 20.9 if d_1 is replaced by the distance from the pile to the center of gravity of the group.

The total reaction on any pile, found by adding the load shown in Fig. 20.5*c* to that in *b*, may be expressed in the form of eq. 20.10.

$$P = \frac{\Sigma V}{n} \pm \frac{\Sigma M d}{\Sigma d^2} \qquad 20.10$$

where P = total pile reaction resulting from moment and direct load

ΣV = sum of vertical loads acting on the foundation

ΣM = sum of moments about the center of gravity of the group. ΣM is sometimes expressed as ΣVe.

n = number of piles in the group

Foundation Engineering by Peck, Hanson, and Thornburn

d = distance from the center of gravity of the group to pile in question

Σd^2 = sum of the squares of the distances to each pile from the center of gravity of the group

Inspection of eq. 20.10 reveals that it is no more than a special form of the basic formula for stress on a section or for pressure beneath a soil-supported footing when either is subjected simultaneously to direct load and moment. The number of piles n is sub-

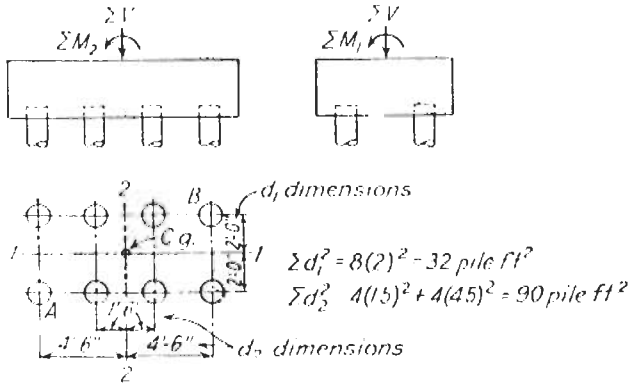


FIG. 20.6. Group of piles subjected to direct load and to moments about both axes.

stituted for the area, and the term Σd^2 replaces the moment of inertia of the area. For this reason Σd^2 is sometimes called the moment of inertia of the group of piles. The analogy between the terms of the two equations is shown in Fig. 20.5.

Most groups of piles contain several rows. Furthermore, moment about both axes is not uncommon. Equation 20.11 applies to these conditions.

$$P = \frac{\Sigma V}{n} \pm \frac{\Sigma M_1 d_1}{\Sigma d_1^2} \pm \frac{\Sigma M_2 d_2}{\Sigma d_2^2} \qquad 20.11$$

The subscript of the moment denotes the centroidal axis about which the moment acts. The subscript of the distance indicates the centroidal axis to which the distance from the pile is measured. These symbols are shown in Fig. 20.6.

If the moments have the directions shown in Fig. 20.6, it is apparent that pile A carries the greatest load whereas pile B carries the least. Both ΣM_1 and ΣM_2 increase the reaction at A and decrease that at

B. Thus, it is possible to select by inspection the proper signs in the application of eq. 20.11 to any pile.

The determination of Σd^2 for large groups of piles may be considerably simplified by the use of eq. 20.12 which applies to a single row of piles with equal spacing.

$$\Sigma d^2 \text{ (one row)} = \frac{s^2}{12} n_1(n_1^2 - 1) \qquad 20.12$$

where s = spacing of piles in the row

n_1 = number of piles in the row

20.8. Piles Subjected to Tension

Ordinarily the piles beneath a footing are expected to act in compression, and only nominal provision is made to anchor them to the footing. This condition exists whenever all the pile reactions computed in accordance with eq. 20.10 and 20.11 are positive. If some of the reactions are negative but the piles are not anchored to the cap, the situation is analogous to that described in Arts. 20.3 and 20.5 which deal with footings having only part of their bases in compression. If the piles corresponding to the negative reactions cannot resist the tensile forces, the compression in the other piles is increased.

On the other hand, piles are often used specifically to resist tensile forces beneath several common types of structures such as towers, gas storage tanks, and tall stacks. Beneath such structures the tensile forces are usually temporary and are almost always caused by the moment due to wind. Under these conditions, if the piles are capable of withstanding tension and are adequately anchored to the cap, the loads in each pile may be computed by means of eq. 20.10 and 20.11.

20.9. Illustrative Design. DP D-4. Bridge Pier

The base of a bridge pier is a common example of a footing subjected to vertical loads together with moment about both axes. The vertical loads are due to the dead weight and live load of the superstructure and to the weight of the pier itself. Moments and shears on the foundation are produced by horizontal forces such as centrifugal force and those due to traction, nosing, wind, current, and ice. For the most unfavorable combination of these loadings, the allowable soil pressure or pile reaction beneath the base is commonly increased from 25 to 50 per cent above the value permitted under dead plus live load.

CDM

CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	BDA
PROJECT	GATE STR	DATE CHECKED	12-21-04	DATE	12-20-04
DETAIL	ABUTMENTS	CHECKED BY	MB	PAGE NO.	

MAXIMUM LOAD
ABUTMENT SUMMARY

		LENGTH	WEIGHT	LAT. FORCE
①	CFORK E	80'	3451K	2326K
②	CFORK W	23'	1223K	669K
③	T. POINT E/W	22'	515K	380K
④	TRWD E	53'	1119K	537K
⑤	TRWD W	26'	646K	264K

GROUPING OF SIM. LATERAL LOADING

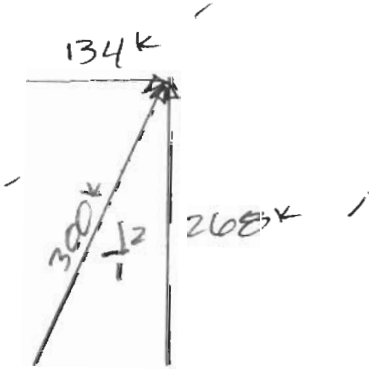
STUDY COMPARISON

①	CFORK E	2326K
② ④	CFORK W + TRWD E	669K (MAX)
③ ⑤	TPOINT E/W + TRWD W	380K (MAX)

ASSUME A 1H:2V BATTER

HP 14 x 102

P_{MAX} = 300K



CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY BDA
PROJECT GATE STR. | DATE CHECKED 12-21-04 | DATE 12-20-04
DETAIL ABUTMENTS | CHECKED BY MOK | PAGE NO.

NUMBER OF PILES REQ'D

(1) CFORK E

LAT $\frac{2326^k}{134^k/\text{PILE}}$ = 18 PILES ✓ 1 ROW

VERT $\frac{3451^k}{268^k/\text{PILE}}$ = 13 PILES ✓ 1 ROW

SELF WT $\frac{5565^k}{268^k/\text{PILE}}$ = 21 PILES TOTAL

PROVIDE 2 ROWS OF ~~21~~ 18 PILES

$\frac{80'}{18} = 4.44'$ SAY 4'-4" SPACING

(2) CFORK W & TRWD E

LAT $\frac{666^k}{134^k/\text{PL}}$ = 5 PILES/ROW

VERT $\frac{1865}{268^k/\text{PL}}$ = 7 ~~5~~ PILES/ROW

SELF WT $\frac{1787^k}{268^k/\text{PL}}$ = 7 PILES TOTAL

PROVIDE 2 ROWS OF ~~X~~ 7 PILES AT TRWD E

CFORK W; VERT = $\frac{1223}{268}$ = 5 PILES ✓ ↳ $\frac{53'}{7} = 7.57'$ SAY 7'-6" SPACING

PROVIDE 2 ROWS OF 5 PILES AT CFORK W

$\frac{23'}{5} = 4.6'$ SAY 4'6" SPACING

CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY BDA
PROJECT GATE STR. | DATE CHECKED 12-21-04 | DATE 12-20-04
DETAIL ABUTMENTS | CHECKED BY MA | PAGE NO.

NUMBER OF PILES REQ'D

③ T. POINT E/W & TRWD W

LAT $\frac{380^k}{134^k/PL}$ = 3 PILES/ROW

VERT $\frac{646^k}{268^k/PL}$ = 2 PILES/ROW

SELF WT $\frac{1016^k}{268^k/PL}$ = 4 PILES TOTAL

SAY PROVIDE 2 ROWS OF 5 PILES (MIN)

④ TRWD E

$\frac{22'}{5} = 4.4'$ Say 4'-4" SPACING AT T-POINT

LAT $\frac{537^k}{134^k/PL}$ = 4 PILES $\frac{26'}{5} = 5.2'$

SAY 5'-0" SPACING AT TRWD W

VERT $\frac{1119^k}{268^k/PL}$ = 5 PILES

SELF WT $\frac{1865^k}{268^k/PL}$ = 7 PILES

PROVIDE 2 ROWS OF 7 PILES

⑤ TRWD W

LAT $\frac{264^k}{134^k/PL}$ = 2 PILES

VERT $\frac{646^k}{268^k/PL}$ = 3 PILES

SELF WT $\frac{1012^k}{268^k/PL}$ = 4 PILES

PROVIDE 2 ROWS OF 5 PILES (MIN)

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BOA DATE: 12/20/04

GATE ABUTMENT STRUCTURE
SELF-WEIGHT

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	526	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	3	FT
NO. OF BUTTRESS WALLS (NB):	4	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	6	FT
STRUCTURE LENGTH (B):	80	FT
ADDL HEEL WIDTH (HW):	12	FT
HEEL THICKNESS (HTH):	6	FT
ADDL TOE WIDTH (TW):	10	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	0	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT = (TE-BE) * EFP)		
FDN LENGTH (L):	47	FT
(L = HW + DW + TW)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TJD DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	479,400		34.00	16,299,600	
BUTTRESS WALLS(1):	1,057,500		22.50	23,793,750	
BUTTRESS WALLS(2):	193,500		6.67	1,290,645	
TOP SLAB:	450,000		22.50	10,125,000	
BOTTOM SLAB:	1,800,000		22.50	40,500,000	
HEEL SLAB:	864,000		41.00	35,424,000	
TOE SLAB:	720,000		5.00	3,600,000	
FLUID ON HEEL:	0		41.00	0	
FLUID ON TOE:	0		5.00	0	
SUBTOTAL AT BASE (V,MR,MO)=	5,564,400	0		131,032,995	0

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	2,224,544 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE =	0 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
		= (FRICTION + COHESION)/(NET SLIDING)
ECCENTRICITY (E-L/2-(MR-MO)/V))=	.05 (RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)	
MAX BEARING PRESS =	1471 PSF	
MIN BEARING PRESS =	1489 PSF	
VOLUME OF CONCRETE =	1,374 CY	

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BJH DATE: 12/20/04

GATE ABUTMENT STRUCTURE
SELF-WEIGHT

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	526	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	3	FT
NO. OF BUTTRESS WALLS (NB):	2	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	6	FT
STRUCTURE LENGTH (B):	23	FT
ADDL HEEL WIDTH (HW):	12	FT
HEEL THICKNESS (HTH):	6	FT
ADDL TOE WIDTH (TW):	8	FT
TOE THICKNESS (TTH):	6	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID): 21.79 DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))

DESIGN COHESION (CND): 0 PSF
(CND = CN / FS)

UPLIFT AT HEEL (UH): 0 PSF
(UH = (FE-BE) * EFP)

UPLIFT AT TOE (UT): 0 PSF
(UT = (TE-BE) * EFP)

FDN LENGTH (L): 45 FT
(L = HW + DW + TW)

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BJCA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	119,850		32.00	3,835,200	
BUTTRESS WALLS(1):	528,750		20.50	10,839,375	
BUTTRESS WALLS(2):	77,400		5.34	413,006	
TOP SLAB:	129,375		20.50	2,652,188	
BOTTOM SLAB:	517,500		20.50	10,608,750	
HEEL SLAB:	248,400		39.00	9,687,600	
TOE SLAB:	165,600		4.00	662,400	
SUBTOTAL AT BASE (V,MR,MO)=	1,786,875	0		38,698,519	0

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	714,360 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	COHESION * BASE AREA
NET SLIDING FORCE =	0 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES (FRICTION + COHESION)/(NET SLIDING)
ECCENTRICITY (E=L/2-(MR-MO)/V))=	.84 (RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)	
MAX BEARING PRESS =	1920 PSF	
MIN BEARING PRESS =	1532 PSF	
VOLUME OF CONCRETE =	441 CY	

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDG DATE: 12/20/04

GATE ABUTMENT STRUCTURE
SELF-WEIGHT

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	526	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	2	FT
NO. OF BUTTRESS WALLS (NB):	2	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	3	FT
STRUCTURE LENGTH (B):	22	FT
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	6	FT
TOE THICKNESS (TTH):	3	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	0	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT (TE BE) * EFP)		

FDN LENGTH (L): 31 FT
(L HW + DW + TW)

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TSOA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	143,100		30.00	4,293,000	
BUTTRESS WALLS(1):	397,500		18.50	7,353,750	
BUTTRESS WALLS(2):	44,100		4.00	176,488	
TOP SLAB:	123,750		18.50	2,289,375	
BOTTOM SLAB:	247,500		18.50	4,578,750	
HEEL SLAB:	0		31.00	0	
TOE SLAB:	59,400		3.00	178,200	
SUBTOTAL AT BASE (V,MR,MO)=	1,015,350	0		18,869,563	0

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	405,918 LB	= U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0 LB	= COHESION * BASE AREA
NET SLIDING FORCE =	0 LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
		= (FRICTION + COHESION)/(NET SLIDING)
ECCENTRICITY (E=L/2-(MR MO)/V))=	-3.08 (RELATIVE TO CL)	
BEARING PRESSURE	V/L(1+-6*E/L)	
MAX BEARING PRESS =	600 PSF	
MIN BEARING PRESS =	2378 PSF	
VOLUME OF CONCRETE =	251 CY	

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DGS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: TBH DATE: 12/20/04

GATE ABUTMENT STRUCTURE
SELF-WEIGHT

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	526	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	2	FT
NO. OF BUTTRESS WALLS (NB):	3	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	3	FT
STRUCTURE LENGTH (B):	53	FT
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	0	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	0	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT = (TE-BE) * EFP)		
FDN LENGTH (L):	25	FT
(L = HW + DW + TW)		

PROJECT: TRWD - FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	373,650		24.00	8,967,600	
BUTTRESS WALLS(1):	596,250		12.50	7,453,125	
BUTTRESS WALLS(2):	0		0.00	0	
TOP SLAB:	298,125		12.50	3,726,563	
BOTTOM SLAB:	596,250		12.50	7,453,125	
HEEL SLAB:	0		25.00	0	
TOE SLAB:	0		0.00	0	
SUBTOTAL AT BASE (V,MR,MO)=	1,864,275	0		27,600,413	0

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	745,303	LB	U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)	0	LB	= COHESION * BASE AREA
NET SLIDING FORCE =	0	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES
			= (FRICTION + COHESION)/(NET SLIDING)
ECCENTRICITY (E=L/2-(MR-MO)/V))=	-2.30	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	629	PSF	
MIN BEARING PRESS =	2185	PSF	
VOLUME OF CONCRETE =	460	CY	

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521-42275-PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BSH DATE: 12/20/04

GATE ABUTMENT STRUCTURE
SELF-WEIGHT

DIMENSIONS & WEIGHTS (INPUT):

GATE ABUTMENT STRUCTURE:		
FLOOD ELEV (FE):	526	FT
TAILWATER ELEV (TE):	520	FT
TOP OF DECK ELEV (TDE):	557	FT
FDN BASE EL (BE):	526	FT
DECK WIDTH (DW):	25	FT
HEADWALL THICKNESS (HWT):	2	FT
BUTTRESS WALL THICKNESS (BWT):	2	FT
NO. OF BUTTRESS WALLS (NB):	2	
TOP SLAB THICKNESS (TST):	1.5	FT
BOTTOM SLAB THICKNESS (BST):	3	FT
STRUCTURE LENGTH (B):	26	FT
ADDL HEEL WIDTH (HW):	0	FT
HEEL THICKNESS (HTH):	0	FT
ADDL TOE WIDTH (TW):	0	FT
TOE THICKNESS (TTH):	0	FT

DESIGN PARAMETERS (INPUT):

FACTOR OF SAFETY (FS):	1.33	
ACTUAL SOIL FRICTION ANGLE (PHI):	28	DEGREES
ACTUAL SOIL COHESION (CN):	0	PSF
FLUID PRESS (EFP):	0	PCF
CONC UNIT WGT (CUW):	150	PCF
CONTAINED SOIL WGT (CSW):	110	PCF

RESULTING DESIGN VALUES & DIMENSIONS:

DESIGN FRICTION ANGLE (PHID):	21.79	DEGREES
(PHID = ARCTAN(TAN(PHI)/FS))		
DESIGN COHESION (CND):	0	PSF
(CND = CN / FS)		
UPLIFT AT HEEL (UH):	0	PSF
(UH = (FE-BE) * EFP)		
UPLIFT AT TOE (UT):	0	PSF
(UT = (TE-BE) * EFP)		

FDN LENGTH (L): 25 FT
(L = HW + DW + TW)

PROJECT: TRWD FLOOD GATE CONTROL STRUCTURE

CHARGE NO.: 2521 42275 PRSTR.DCS

DESIGNED BY: WCS DATE: 12/18/2004

CHECKED BY: BDA DATE: 12/20/04

STABILITY ANALYSIS:

	WEIGHT: LB	LATL FORCE: LB	ARM TO TOE:	RESISTING MOMENT:	OVERTURNING MOMENT:
HEADWALL:	174,900		24.00	4,197,600	
BUTTRESS WALLS(1):	397,500		12.50	4,968,750	
BUTTRESS WALLS(2):	0		0.00	0	
TOP SLAB:	146,250		12.50	1,828,125	
BOTTOM SLAB:	292,500		12.50	3,656,250	
HEEL SLAB:	0		25.00	0	
TOE SLAB:	0		0.00	0	
SUBTOTAL AT BASE (V,MR,MO)-	1,011,150	0		14,650,725	0

STABILITY RESULTS:

FRICTION FORCE (V*TAN(PHID))=	404,239	LB	- U*(WEIGHT CONC + GATES + WATER - UPLIFT)
COHESION FORCE (CND*L*B)=	0	LB	- COHESION * BASE AREA
NET SLIDING FORCE =	0	LB	= DRIVING FORCES MINUS ACTIVE RESISTING FORCES (FRICTION + COHESION)/(NET SLIDING)
ECCENTRICITY (E=L/2-(MR MO)/V))=	-1.99	(RELATIVE TO CL)	
BEARING PRESSURE =	V/L(1+-6*E/L)		
MAX BEARING PRESS =	813	PSF	
MIN BEARING PRESS =	2298	PSF	
VOLUME OF CONCRETE =	250	CY	

Section 14
Training Wall Stability Analysis and Design (CTWall Results and Manual Calculations)

CDM

CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY MCJ
PROJECT FWCC | DATE CHECKED 12-20-2004 | DATE 11-23-04
DETAIL TRAINING WALLS | CHECKED BY BDA | PAGE NO.
Rev. 1/18/05

BASED ON PRELIMINARY ANALYSES, PUT TRAINING WALLS ON PILES
(EXCESSIVE FTG. LG. FOR STD. RTNG. WALL)

- ASSUME CHANNEL FILLED IN TO EL 512.0 (min) ✓ w/
  BASE OF WALL AT EL 508.0 ✓
- ASSUME GRADE BEHIND WALL AT EL 530 ✓ w/
  TOP OF WALL AT EL 533.50 ✓

BASED ON PRELIMINARY CT WALL ANALYSES, USE 6' TOE & 26' TOTAL BASE:

CT WALL RESULTS:

I 1 NL PILE: O.T. RATIO = 1.54, 100% COMPR., NET LATL FORCE = 31.9 K/. ✓
I 1 NS PILE: " = 1.10, " , " " " = 15.5 K/ ✓
I 4 CL PILE. " = 2.15, " , " " " = 37.6 K/, ✓
I 4 C S PILE- " = 5.26, " , " " " = 25.3 K/. ✓
(ADD'L 1-12-05) { I 1 FL PILE: " = 1.67 " = 34.2 K/.
I 1 FS PILE; " = 2.27 " = 18.2 K/.

CHECK BASE OF STEM FOR LOADS FROM I 4 CL PILE:

DETERMINE EQUIV. LATERAL PRESSURE EL 530 TO 508:

EARTH LOAD: $28.052^{\checkmark} = \frac{1}{2}\gamma_e (22')^2$: $\gamma_e = 0.116$ ✓

SURCHARGE LOAD (UNIFORM): $1.377^{\checkmark} = \gamma_s (22')^2$: $\gamma_s = 0.0028$ ✓

WATER LOAD: $8.196^{\checkmark} = \frac{1}{2}\gamma_w (22')^2$: $\gamma_w = 0.034$ ✓

V @ BASE OF STEM $= 0.0028(18)^2 + \frac{1}{2}(0.116+0.034)(18)^2$
$= 0.907 + 24.30^{\checkmark} = 25.2$ K/, ✓

$V_u = 1.3 \times 1.7 \times 25.2 = 55.7$ K/, ✓

TRY 48" AT BASE. $\phi V_c = 0.1075 \times 45" \times 12" = 58.0$ K/, > 55.7 K/, OK ✓

M @ BASE OF STEM $= 0.0028(18)^3/2 + \frac{1}{6}(0.116+0.034)(18)^3 = 8.1^{\checkmark} + 145.8^{\checkmark}$
$= 154$ IK/, ✓

$M_u = 1.3 \times 1.7 \times 154. = 340.^{\checkmark}$ IK/, $K = \frac{340 \times 1000}{(45)^2} = 168$, $a/n = 4.37$ ✓

$A_s = 340/(4.37 \times 45) = 1.73$ in²/ft ✓ > #8 @ 6", USE 4½" @ BASE OF STEM

CDM

CDM

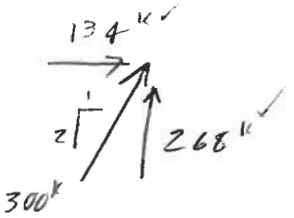
CLIENT	TRWD	JOB NO.	42275	COMPUTED BY	
PROJECT	FWCC	DATE CHECKED	12-20-2004	DATE	11-29-04
DETAIL	TRAINING WALLS	CHECKED BY	BDA	PAGE NO.	

$K = \frac{340 \times 1000}{(51)^2} = 131^{\checkmark}, \quad a_n = 4.39^{\checkmark}$

$A_s = \frac{340}{4.39 \times 51} = 1.52 \text{ in}^2/\text{ft} \Rightarrow \#8@6 = 1.58 \text{ in}^2/\text{ft}^{\checkmark}$

$\therefore$ USE 4 1/6" @ BASE OF WALL$^{\checkmark}$

PILES: USE HP14 X102 @ 2:1 BATTER



$\frac{134^K}{38^K/\text{ft}} = 3.53'^{\checkmark}$

USE 2 ROWS OF PILES @ 7' SPACING (STAGGERED)

DEAD WGT. OF WALL $= \left[\frac{(2'+4.5')}{2} \times 21.5' + 4' \times 26'\right] \times 0.150 = 26.1^{K}/_{L} \checkmark$

LOAD ON 2 ROWS OF PILES @ 7' SPACING

$\frac{26.1 \times 7'}{2} = 91.4^K$ EACH $<< 268.^K \checkmark$

SAY PROVIDE 1 ROW OF VERTICAL PILES @ 7' SPACING?

$\frac{26.1^K/_L \times 7'}{3} = 60.9^K/\text{PILE} \checkmark$

LATERAL LOAD @ BATTERED PILES $= 60.9 \times \frac{134}{268} = 30.5^{K\ \checkmark}$ EACH

$\rightarrow$ USE 2 ROWS BATTERED UPSTREAM TO BALANCE LATERAL FORCE

$X_R = 9.53'$ MEASURED FROM TOE:

SAY PILES @ 7' FROM TOE & 12' FROM TOE

********** Echoprint of Input Data **********

Date: **/11/23 Time: 10.47.26

Flood Wall Stability Analysis Using CTWALL
Filename: I1NLPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
phi for soil-structure interface = 27.00 (deg)
c for soil-structure interface = .100 (ksf)
phi for soil-soil interface = 27.00 (deg)
c for soil-soil interface = .100 (ksf)

Water data:
Driving side elevation = 530.00 ft
Resisting side elevation = 524.30 ft
Unit weight of water = .0625 kcf
Seepage pressures computed by Line of Creep method.

Uniform load data:
Magnitude of load = .10 k/ft

Minimum required factors of safety:
  Sliding FS = 1.50
  Overturning = 100.00% base in compression

Crack options:
  o Crack depth is to be calculated
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************     *** Satisfied ***
* Overturning *     Required base in comp. = 100.00 %
***************     Actual base in comp.   = 100.00 %
                    Overturning ratio      =   1.54

Xr (measured from toe) =   8.67 ft
Resultant ratio        =  .3336
Stem ratio             =  .2308
Base pressure at heel  =    .0025 ksf
Base pressure at toe   =   3.6358 ksf
```

*** Warning *** The maximum available shear along the base of the structure has been exceeded!

```
***********     *** Not Satisfied ***
* Sliding *     Min. Required =   1.50
***********     Actual FS     =   1.07
```

To increase stability try one or a combination of the following:

1. Increase the base width
2. Slope the base of the structure
3. Lower the wall base
4. Add a key

********** Output Results **********

Date: **/11/23 Time: 10.47.26

Flood Wall Stability Analysis Using CTWALL
Filename: I1NLPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -44.1002
Calculated earth pressure coefficients:
Driving side at rest K = .4886
Driving side at rest Kc = 1.1474
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = .00 ft

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
530.00	.0000
508.00	1.2117

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
530.00	.4500
515.76	1.3363
508.00	1.6203

Surcharge pressures:

Elev. (ft)	Press. (ksf)
536.04	.049
508.00	.049

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
524.30	.0000
508.00	1.0187
508.00	1.0187

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.2117
26.00	1.0187

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	1.850		-16.75	-30.99
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	4.612		-3.00	-13.84
Driving side:				
Effective earth loads.....		25.548	9.79	249.99
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		1.370	14.02	19.21
Water loads.....		13.329	7.33	97.73
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-8.303	5.43	-45.12
Foundation:				
Vertical force on base.....	-47.299		-8.67	410.21
Shear on base.....		-31.944	.00	.00
Uplift.....	-28.996		-13.37	387.82
** Statics Check ** SUMS =	.000	.000		.00

Angle of base = .00 degrees
Normal force on base = 47.299 kips
Shear force on base = 31.944 kips
Max. available shear force = 26.700 kips

*** Warning *** The maximum available shear along the base of the structure has been exceeded!

Base pressure at heel = .0025 ksf
Base pressure at toe = 3.6358 ksf

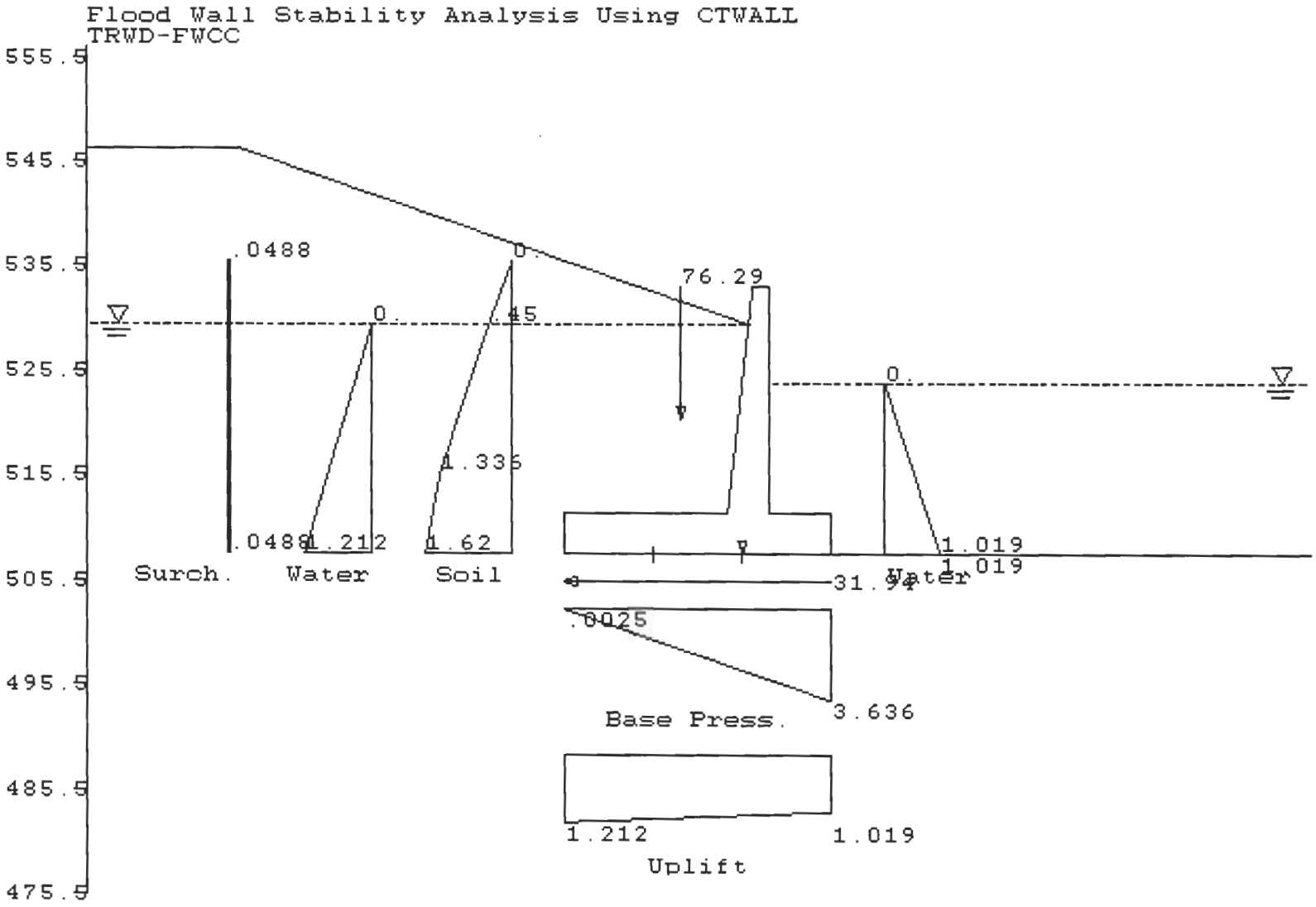
Xr (measured from toe) = 8.67 ft
Resultant ratio = .3336
Stem ratio = .2308
Base in compression = 100.00 %
Overturning ratio = 1.54

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

```
**********************
**  Sliding Results  **
**********************

Solution converged.  Summation of forces = 0.

            Horizontal   Vertical
  Wedge       Loads       Loads
  Number     (kips)      (kips)
  ================================
     1         .000       3.379
     2       -8.303       6.462
     3         .000        .000

  Water pressures on wedges:

              Top      Bottom
    Wedge    press.   press.   x-coord.    press.
    number   (ksf)    (ksf)     (ft)       (ksf)
  ============================================
       1     .0000    1.2117
       2                        .0000     1.2117
       2                      26.0000     1.0187
       3     .0000     .0000

Points of sliding plane:
  Point 1 (left),  x =      .00 ft,   y =   508.00 ft
  Point 2 (right), x =    26.00 ft,   y =   508.00 ft

Depth of cracking =      .00 ft

          Failure   Total    Weight    Submerged   Uplift
  Wedge    angle    length  of wedge    length     force
  number   (deg)     (ft)    (kips)      (ft)      (kips)
  ========================================================
     1   -48.862    51.355     54.711   29.212    17.698
     2      .000    26.000     69.832   26.000    28.996
     3      .000      .000       .000     .000      .000

  Wedge     Net force
  number     (kips)
  ==================
     1      -33.348
     2       33.348
     3         .000
  ==================
     SUM =     .000
```

| Factor of safety = 1.066 |


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
.0488
0.
0.
.45
76.29
0.
1.336
.0488
1.212
1.62
1.019
1.019
Surch.
Water
Soil
31.94
Water
.0025
3.636
Base Press.
1.212
1.019
Uplift

********** Echoprint of Input Data **********

Date: **/11/23 Time: 11.04.55

Flood Wall Stability Analysis Using CTWALL
Filename: I1NSPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
.00	1.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
.00	1.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
phi for soil-structure interface = .00 (deg)
c for soil-structure interface = 1.000 (ksf)
phi for soil-soil interface = .00 (deg)
c for soil-soil interface = 1.000 (ksf)

Water data:
Driving side elevation = 530.00 ft
Resisting side elevation = 524.30 ft
Unit weight of water = .0625 kcf
Seepage pressures computed by Line of Creep method.

Uniform load data:
Magnitude of load = .10 k/ft

Minimum required factors of safety:
  Sliding FS = 1.50
  Overturning = 100.00% base in compression

Crack options:
  o Crack *is* down to bottom of heel
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************     *** Satisfied ***
* Overturning *     Required base in comp. = 100.00 %
***************     Actual base in comp.   = 100.00 %
                    Overturning ratio      =   2.10

Xr (measured from toe) =  11.43 ft
Resultant ratio        =  .4397
Stem ratio             =  .2308
Base pressure at heel  =   1.3075 ksf
Base pressure at toe   =   2.7911 ksf

***********     *** Satisfied ***
* Sliding *     Min. Required =   1.50
***********     Actual FS     =   1.60
```

********** Output Results **********

Date: **/11/23 Time: 11.04.55

Flood Wall Stability Analysis Using CTWALL
Filename: I1NSPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -31.6073
Calculated earth pressure coefficients:
Driving side at rest K = 1.0000
Driving side at rest Kc = 2.4441
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = 14.94 ft
Crack extends to bottom of base of structure.

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
521.11	.9335
508.00	1.1291

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
521.11	.0000
508.00	.3068

Surcharge pressures:

Elev. (ft)	Press. (ksf)
521.11	.100
508.00	.100

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
524.30	.0000
508.00	1.0187
508.00	.6412

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.1291
26.00	.6412

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	1.850		-16.75	-30.99
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	4.612		-3.00	-13.84
Driving side:				
Effective earth loads.....		2.010	4.37	8.78
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		1.311	6.55	8.59
Water loads.....		20.487	10.34	211.84
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-8.303	5.43	-45.11
Foundation:				
Vertical force on base.....	-53.282		-11.43	609.09
Shear on base.....		-15.505	.00	.00
Uplift.....	-23.013		-14.19	326.65
** Statics Check ** SUMS =	.000	.000		.00

Angle of base = .00 degrees
Normal force on base = 53.282 kips
Shear force on base = 15.505 kips
Max. available shear force = 26.000 kips

Base pressure at heel = 1.3075 ksf
Base pressure at toe = 2.7911 ksf

Xr (measured from toe) = 11.43 ft
Resultant ratio = .4397
Stem ratio = .2308
Base in compression = 100.00 %
Overturning ratio = 2.10

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****
** Sliding Results **
****

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	16.270	6.462
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.0000		
2			.0000	1.3750
2			26.0000	.6412
3	.0000	.0000		

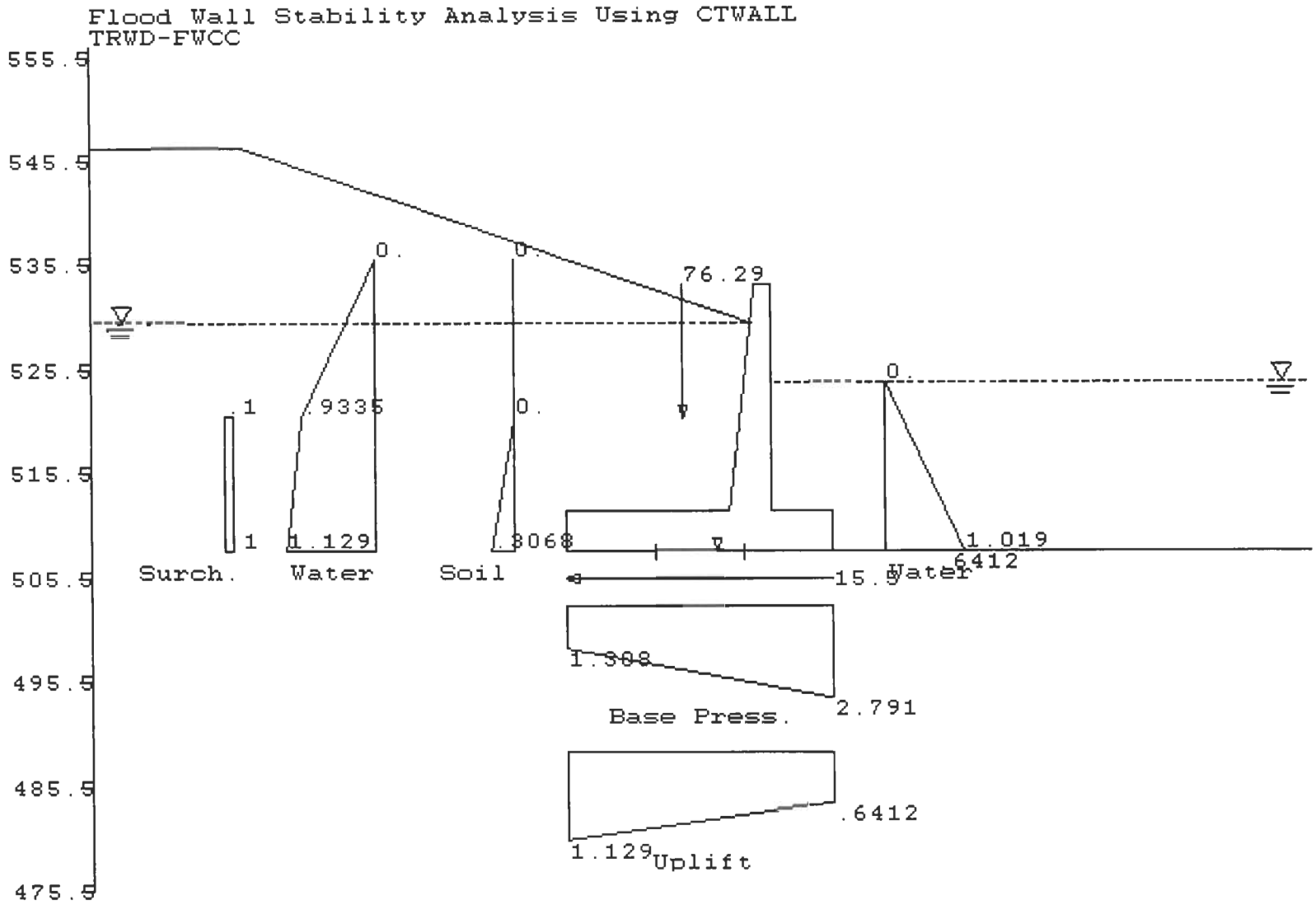
Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	.000	.000	.000	.000	.000
2	.000	26.000	69.832	26.000	26.210
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	.000
2	.001
3	.000
SUM =	.001

Factor of safety = 1.598


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
0.
0.
76.29
0.
.1
.9335
0.
1
1.129
.3068
1.019
.6412
Surch.
Water
Soil
15.9
Water
1.308
2.791
Base Press.
.6412
1.129
Uplift

********** Echoprint of Input Data **********

Date: **/11/23 Time: 10.48.50

Flood Wall Stability Analysis Using CTWALL
Filename: I4CLPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
- phi for soil-structure interface = 27.00 (deg)
- c for soil-structure interface = .100 (ksf)
- phi for soil-soil interface = 27.00 (deg)
- c for soil-soil interface = .100 (ksf)

Water data:
- Driving side elevation = 530.00 ft
- Resisting side elevation = 508.01 ft
- Unit weight of water = .0625 kcf
- Seepage pressures computed by Line of Creep method.

Uniform load data:
- Magnitude of load = .10 k/ft

Minimum required factors of safety:
  Sliding FS = 1.33
  Overturning = 75.00% base in compression

Crack options:
  o Crack depth is to be calculated
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************     *** Satisfied ***
* Overturning *     Required base in comp. =  75.00 %
***************     Actual base in comp.   = 100.00 %
                    Overturning ratio      =   2.15

Xr (measured from toe) =   9.53 ft
Resultant ratio        =  .3667
Stem ratio             =  .2308
Base pressure at heel  =    .4771 ksf
Base pressure at toe   =   4.2912 ksf
```

*** Warning *** The maximum available shear along the base of the structure has been exceeded!

```
***********     *** Not Satisfied ***
* Sliding *     Min. Required =   1.33
***********     Actual FS     =   1.10
```

To increase stability try one or a combination of the following:

1. Increase the base width
2. Slope the base of the structure
3. Lower the wall base
4. Add a key

********** Output Results **********

Date: **/11/23 Time: 10.48.50

Flood Wall Stability Analysis Using CTWALL
Filename: I4CLPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -44.6301
Calculated earth pressure coefficients:
Driving side at rest K = .4912
Driving side at rest Kc = 1.1308
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = .00 ft

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
530.00	.0000
508.00	.7451

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
530.00	.4480
515.18	1.5189
508.00	1.8580

Surcharge pressures:

Elev. (ft)	Press. (ksf)
536.04	.049
508.00	.049

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
508.01	.0000
508.00	.0006
508.00	.0006

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	.7451
26.00	.0006

** Forces and moments **

Part	Force (kips) Vert.	Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	1.850		-16.75	-30.99
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
Driving side:				
Effective earth loads.....		28.052	9.54	267.64
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		1.377	14.02	19.31
Water loads.....		8.196	7.33	60.10
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		.000	-.95	.00
Foundation:				
Vertical force on base.....	-61.988		-9.53	590.99
Shear on base.....		-37.625	.00	.00
Uplift.....	-9.694		-17.33	167.96
** Statics Check ** SUMS =	.000	.000		.00

Angle of base = .00 degrees
Normal force on base = 61.988 kips
Shear force on base = 37.625 kips
Max. available shear force = 34.185 kips

*** Warning *** The maximum available shear along the base of the structure has been exceeded!

Base pressure at heel = .4771 ksf
Base pressure at toe = 4.2912 ksf

Xr (measured from toe) = 9.53 ft
Resultant ratio = .3667
Stem ratio = .2308
Base in compression = 100.00 %
Overturning ratio = 2.15

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****
** Sliding Results **
****

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	3.378
2	.000	1.850
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.7451		
2			.0000	.7451
2			26.0000	.0006
3	.0000	.0000		

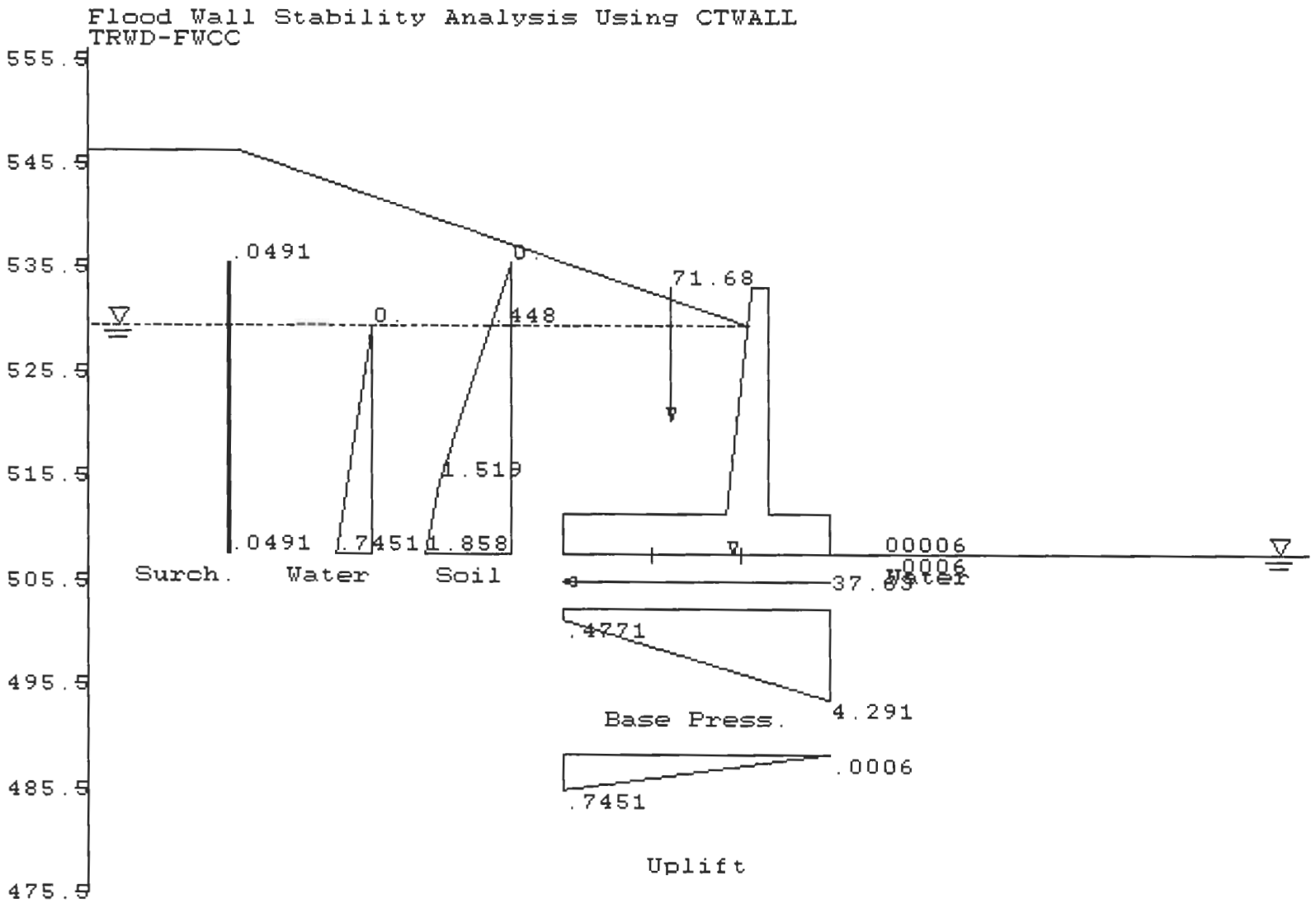
Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = .00 ft

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	-48.867	51.351	54.698	29.209	10.882
2	.000	26.000	69.832	26.000	9.694
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	-30.964
2	30.964
3	.000
SUM =	.000

| Factor of safety = 1.104 |


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
.0491
0.
71.68
0.
.448
1.519
.0491
.7451
1.858
00006
.0006
Surch.
Water
Soil
Water
37.69
.4771
4.291
Base Press.
.0006
.7451
Uplift

********** Echoprint of Input Data **********

Date: **/11/23 Time: 11.03.16

Flood Wall Stability Analysis Using CTWALL
Filename: I4CSPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
.00	1.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
.00	1.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
  phi for soil-structure interface = .00 (deg)
  c for soil-structure interface = 1.000 (ksf)
  phi for soil-soil interface = .00 (deg)
  c for soil-soil interface = 1.000 (ksf)

Water data:
  Driving side elevation = 530.00 ft
  Resisting side elevation = 508.01 ft
  Unit weight of water = .0625 kcf
  Seepage pressures computed by Line of Creep method.

Uniform load data:
  Magnitude of load = .10 k/ft

Minimum required factors of safety:
  Sliding FS = 1.33
  Overturning = 75.00% base in compression

Crack options:
  o Crack *is* down to bottom of heel
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************    *** Satisfied ***
* Overturning *    Required base in comp. =  75.00 %
***************    Actual base in comp.   = 100.00 %
                   Overturning ratio      =   5.26

Xr (measured from toe) =  13.05 ft
Resultant ratio        =  .5020
Stem ratio             =  .2308
Base pressure at heel =    2.9973 ksf
Base pressure at toe  =    2.9277 ksf

***********    *** Not Satisfied ***
* Sliding *    Min. Required =   1.33
***********    Actual FS     =   1.06
```

To increase stability try one or a combination of the following:

1. Increase the base width
2. Slope the base of the structure
3. Lower the wall base
4. Add a key

********** Output Results **********

Date: **/11/23 Time: 11.03.16

Flood Wall Stability Analysis Using CTWALL
Filename: I4CSPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -31.6073
Calculated earth pressure coefficients:
Driving side at rest K = 1.0000
Driving side at rest Kc = 2.4441
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = 14.94 ft
Crack extends to bottom of base of structure.

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
521.11	.9335
508.00	.7879

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
521.11	.0000
508.00	.8795

Surcharge pressures:

Elev. (ft)	Press. (ksf)
521.11	.100
508.00	.100

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
508.01	.0000
508.00	.0006
508.00	-.3770

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	.7879
26.00	-.3770

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	1.850		-16.75	-30.99
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
Driving side:				
Effective earth loads.....		5.763	4.37	25.17
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		1.311	6.55	8.59
Water loads.....		18.251	11.07	202.07
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		.000	-508.00	.00
Foundation:				
Vertical force on base.....	-77.024		-13.05	1005.23
Shear on base.....		-25.325	.00	.00
Uplift.....	5.342		-25.28	-135.06
** Statics Check ** SUMS =	.000	.000		.00

Angle of base = .00 degrees
Normal force on base = 77.024 kips
Shear force on base = 25.325 kips
Max. available shear force = 26.000 kips

Base pressure at heel = 2.9973 ksf
Base pressure at toe = 2.9277 ksf

Xr (measured from toe) = 13.05 ft
Resultant ratio = .5020
Stem ratio = .2308
Base in compression = 100.00 %
Overturning ratio = 5.26

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****
** Sliding Results **
****

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	24.573	1.850
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.0000		
2			.0000	1.3750
2			26.0000	-.3770
3	.0000	.0000		

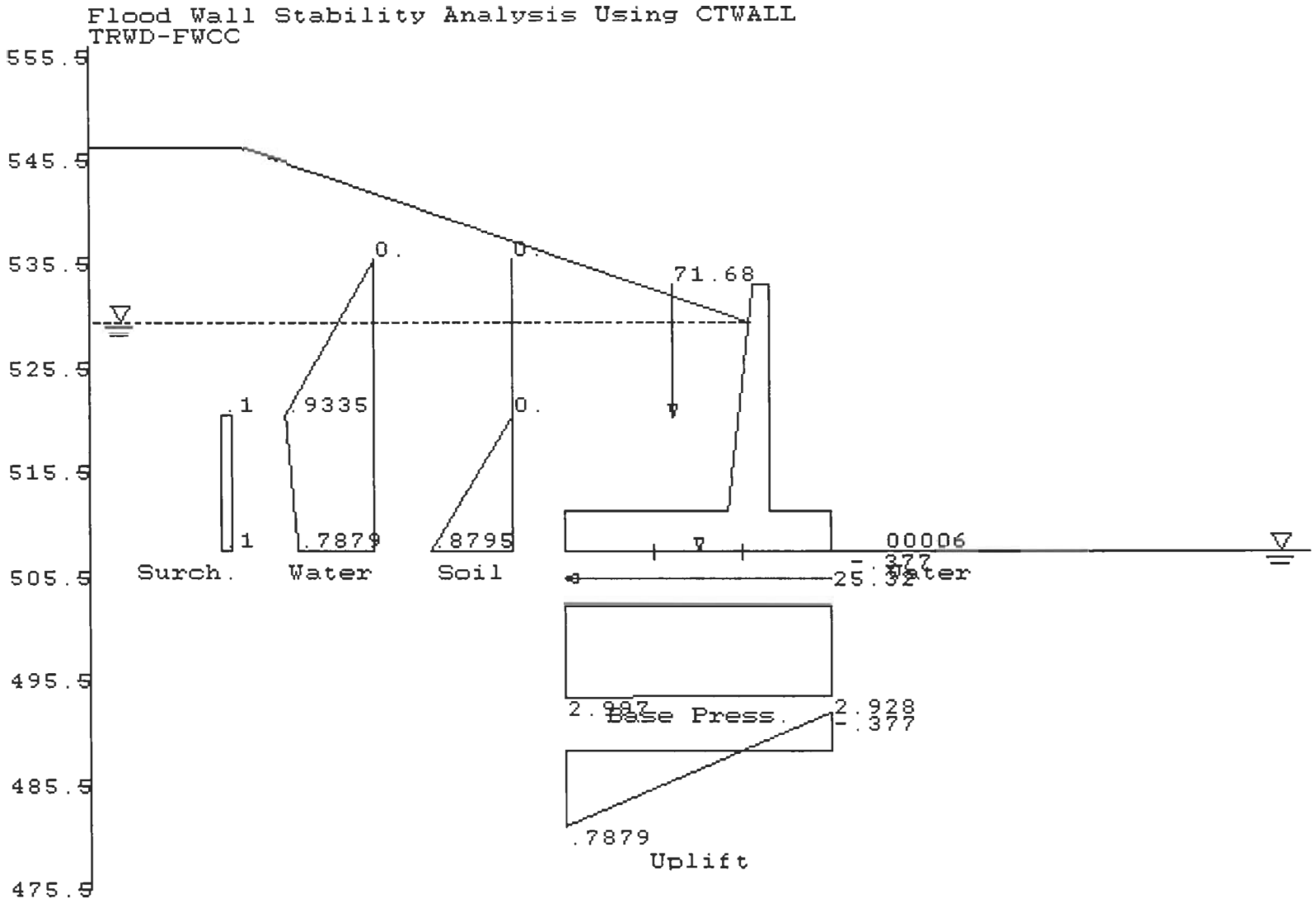
Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	.000	.000	.000	.000	.000
2	.000	26.000	69.832	26.000	12.974
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	.000
2	.000
3	.000
SUM =	.000

Factor of safety = 1.058


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
0.
0.
71.68
.1
.9335
0.
1
.7879
.8795
00006
-.377
Surch.
Water
Soil
25.32
Water
2.928
-.377
Base Press.
.7879
Uplift

********** Echoprint of Input Data **********

Date: **/01/17 Time: 10.59.43

Flood Wall Stability Analysis Using CTWALL
Filename: I1FLPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
phi for soil-structure interface = 27.00 (deg)
c for soil-structure interface = .100 (ksf)
phi for soil-soil interface = 27.00 (deg)
c for soil-soil interface = .100 (ksf)

Water data:
Driving side elevation = 530.00 ft
Resisting side elevation = 519.00 ft
Unit weight of water = .0625 kcf
Seepage pressures computed by Line of Creep method.

Minimum required factors of safety:
  Sliding FS = 1.50
  Overturning = 100.00% base in compression

Crack options:
  o Crack depth is to be calculated
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************    *** Satisfied ***
* Overturning *    Required base in comp. = 100.00 %
***************    Actual base in comp.   = 100.00 %
                   Overturning ratio      =   1.67

Xr (measured from toe) =   8.82 ft
Resultant ratio        =  .3392
Stem ratio             =  .2308
Base pressure at heel =     .0670 ksf
Base pressure at toe  =    3.7592 ksf

*** Warning ***  The maximum available shear along the
base of the structure has been exceeded!

***********    *** Not Satisfied ***
* Sliding *    Min. Required =   1.50
***********    Actual FS     =   1.05

  To increase stability try one or a combination
  of the following:
    1.  Increase the base width
    2.  Slope the base of the structure
    3.  Lower the wall base
    4.  Add a key
```

********** Output Results **********

Date: **/01/17 Time: 10.59.43

Flood Wall Stability Analysis Using CTWALL
Filename: I1FLPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -43.8621
Calculated earth pressure coefficients:
Driving side at rest K = .4874
Driving side at rest Kc = 1.1551
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = .00 ft

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
530.00	.0000
508.00	1.0599

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
530.00	.4509
516.01	1.3707
508.00	1.6903

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
519.00	.0000
508.00	.6875
508.00	.6875

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.0599
26.00	.6875

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	2.625		-3.00	-7.88
Driving side:				
Effective earth loads.....		26.365	9.72	256.31
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		11.659	7.33	85.51
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-3.781	3.67	-13.87
Foundation:				
Vertical force on base.....	-49.741		-8.82	438.64
Shear on base.....		-34.243	.00	.00
Uplift.....	-22.716		-13.92	316.29
** Statics Check ** SUMS =	.000	.000		.00

```
Angle of base          =      .00 degrees
Normal force on base =   49.741 kips
Shear force on base  =   34.243 kips
Max. available shear force =   27.944 kips

*** Warning ***  The maximum available shear along the
base of the structure has been exceeded!

Base pressure at heel =    .0670 ksf
Base pressure at toe  =   3.7592 ksf

Xr (measured from toe) =     8.82 ft
Resultant ratio        =    .3392
Stem ratio             =    .2308
Base in compression    =   100.00 %
Overturning ratio      =     1.67

Volume of concrete =     6.04 cubic yds/ft of wall

NOTE:  The engineer shall verify that the computed
bearing pressures below the wall do not exceed the
allowable foundation bearing pressure, or, perform a
bearing capacity analysis using the program CBEAR.
Also, the engineer shall verify that the base pressures
do not result in excessive differential settlement of
the wall foundation.
```

****
** Sliding Results **
****

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	-3.781	2.625
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	1.0599		
2			.0000	1.0599
2			26.0000	.6875
3	.0000	.0000		

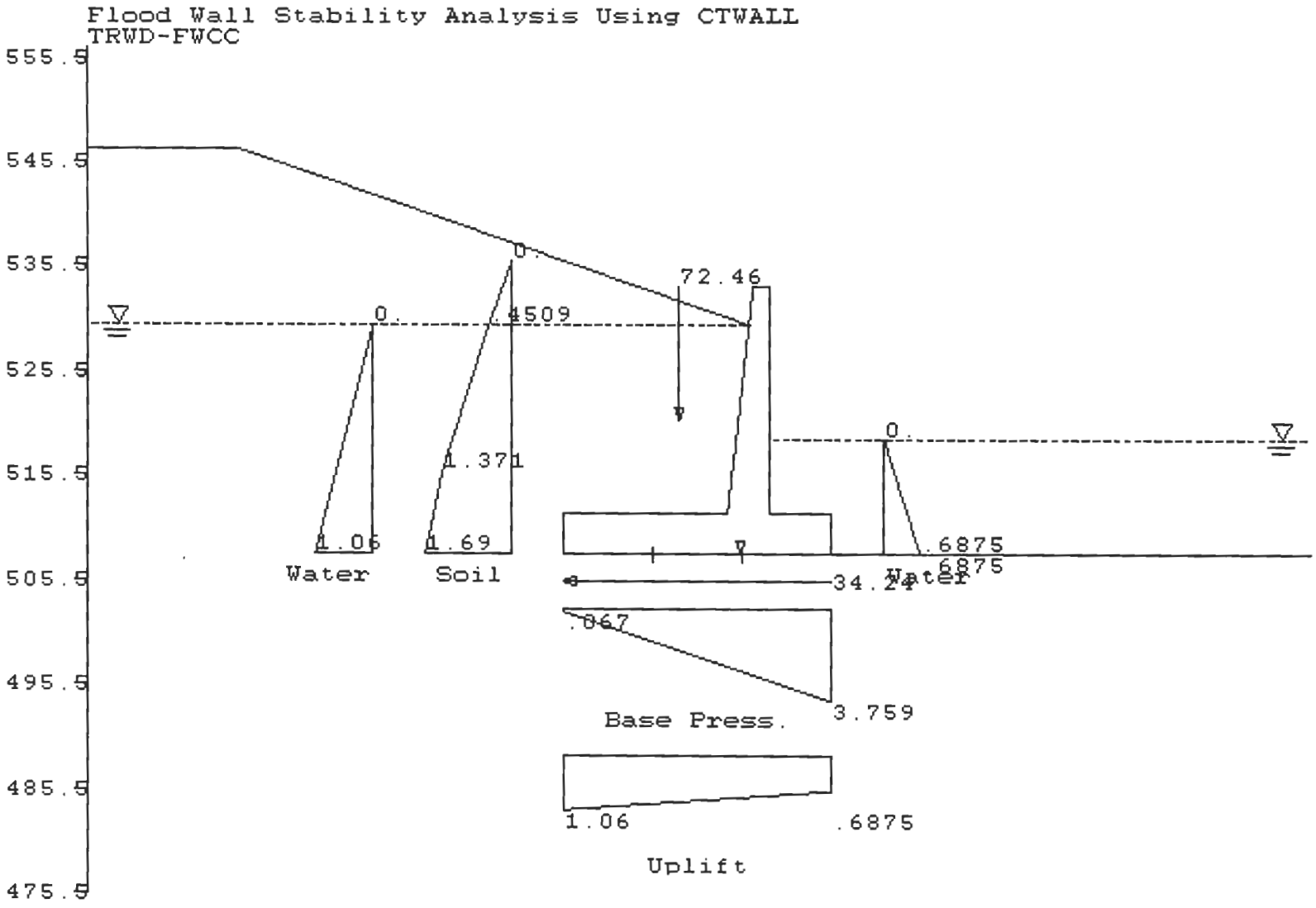
Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = .00 ft

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	-48.938	51.296	54.519	29.178	15.463
2	.000	26.000	69.832	26.000	22.716
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	-30.475
2	30.475
3	.000
SUM =	.000

+-----------------------------+
| Factor of safety = 1.047 |
+-----------------------------+


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
0.
72.46
0.
.4509
0.
1.371
1.06
1.69
.6875
.6875
Water
Soil
Water
34.24
.067
3.759
Base Press.
1.06
.6875
Uplift

****************** Echoprint of Input Data ******************

Date: **/01/17 Time: 10.57.07

Flood Wall Stability Analysis Using CTWALL
Filename: I1FSPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
.00	1.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
.00	1.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
phi for soil-structure interface = .00 (deg)
c for soil-structure interface = 1.000 (ksf)
phi for soil-soil interface = .00 (deg)
c for soil-soil interface = 1.000 (ksf)

Water data:
Driving side elevation = 530.00 ft
Resisting side elevation = 519.00 ft
Unit weight of water = .0625 kcf
Seepage pressures computed by Line of Creep method.

Minimum required factors of safety:
  Sliding FS = 1.50
  Overturning = 100.00% base in compression

Crack options:
  o Crack *is* down to bottom of heel
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************    *** Satisfied ***
* Overturning *    Required base in comp. = 100.00 %
***************    Actual base in comp.   = 100.00 %
                   Overturning ratio      =   2.27

Xr (measured from toe) =  11.12 ft
Resultant ratio        =  .4276
Stem ratio             =  .2308
Base pressure at heel =    1.1996 ksf
Base pressure at toe  =    3.0423 ksf

***********    *** Not Satisfied ***
* Sliding *    Min. Required =   1.50
***********    Actual FS     =   1.25
```

To increase stability try one or a combination of the following:

1. Increase the base width
2. Slope the base of the structure
3. Lower the wall base
4. Add a key

********** Output Results **********

Date: **/01/17 Time: 10.57.07

Flood Wall Stability Analysis Using CTWALL
Filename: I1FSPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -30.8493
Calculated earth pressure coefficients:
Driving side at rest K = 1.0000
Driving side at rest Kc = 2.5701
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
520.90	.9465
508.00	1.0218

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
520.90	.0000
508.00	.3283

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
519.00	.0000
508.00	.6875
508.00	.3099

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.0218
26.00	.3099

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	2.625		-3.00	-7.88
Driving side:				
Effective earth loads.....		2.117	4.30	9.10
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		19.860	10.54	209.41
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-3.781	3.67	-13.87
Foundation:				
Vertical force on base.....	-55.145		-11.12	613.08
Shear on base.....		-18.196	.00	.00
Uplift.....	-17.313		-15.32	265.17
** Statics Check ** SUMS =	.000	.000		.00

Angle of base = .00 degrees
Normal force on base = 55.145 kips
Shear force on base = 18.196 kips
Max. available shear force = 26.000 kips

Base pressure at heel = 1.1996 ksf
Base pressure at toe = 3.0423 ksf

Xr (measured from toe) = 11.12 ft
Resultant ratio = .4276
Stem ratio = .2308
Base in compression = 100.00 %
Overturning ratio = 2.27

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****
** Sliding Results **
****

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	20.791	2.625
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.0000		
2			.0000	1.3750
2			26.0000	.3099
3	.0000	.0000		

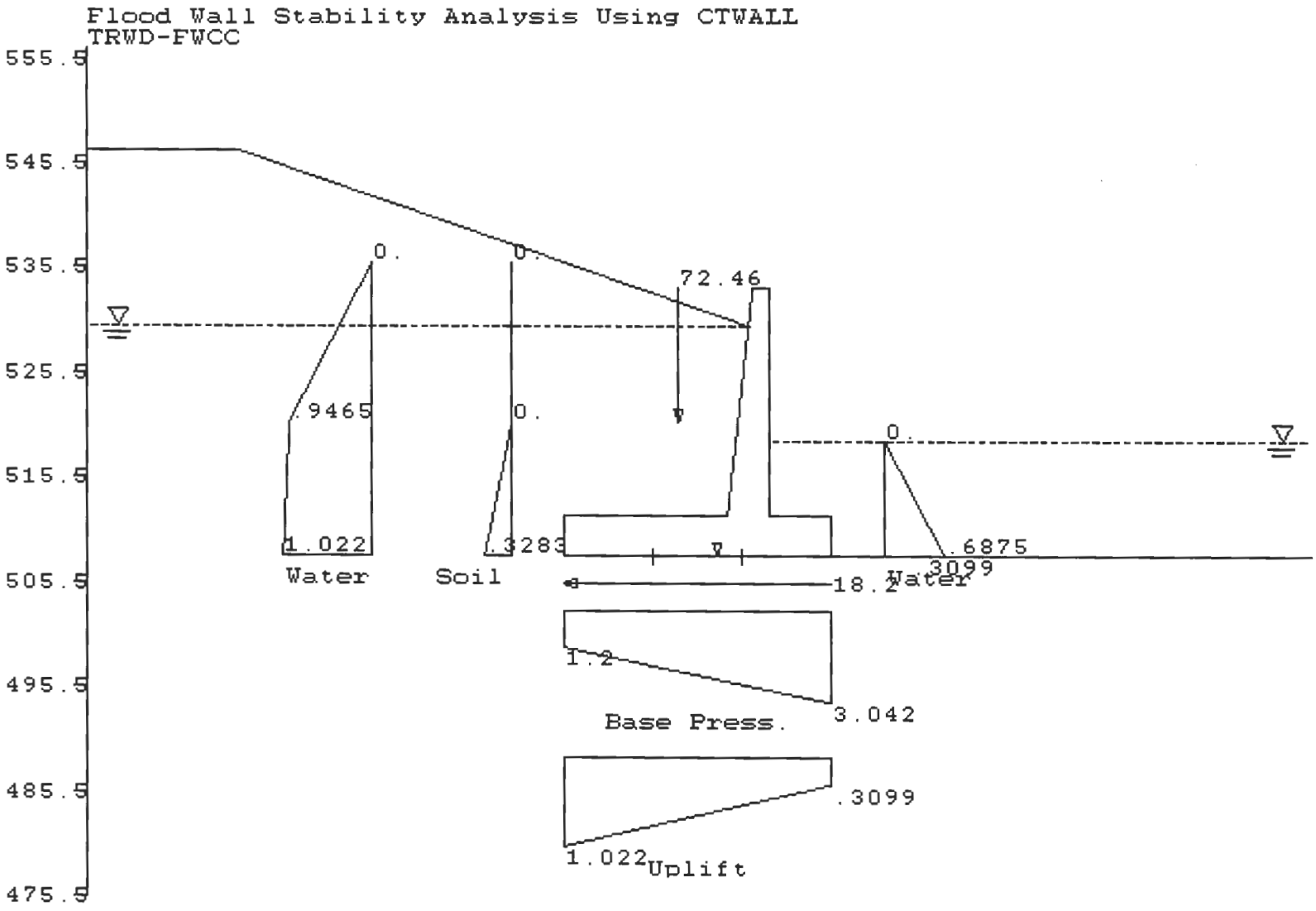
Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	.000	.000	.000	.000	.000
2	.000	26.000	69.832	26.000	21.904
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	.000
2	.000
3	.000
SUM =	.000

Factor of safety = 1.251


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
0.
0.
72.46
.9465
0.
0.
1.022
.3283
.6875
3099
Water
Soil
18.2
Water
1.2
3.042
Base Press.
.3099
1.022
Uplift

CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY WCF
PROJECT FWCC | DATE CHECKED | DATE 1-7-05
DETAIL TRAINING WALLS — SEISMIC | CHECKED BY | PAGE NO.

SEISMIC ANALYSIS

USE $K_h = 0.05g$

$\Psi = \tan^{-1}(K_h) = 2.86$

$K_V = \gamma = \theta = 0°$

$\beta = \tan^{-1}\left(\frac{1}{3}\right) = 18.4°$

$$K_{AE} = \frac{\cos^2(24.85° - 2.86)}{(\cos 2.86)^2\left[1 + \sqrt{\frac{\sin(24.85)(\sin(24.85 - 2.86 - 18.4)}{\cos(18.4)(\cos 2.86)}}\right]^2} \quad [3-45]$$

$$= \frac{0.860}{0.998[1.167]^2} = 0.633$$

STATIC:

$$K_A = \frac{\cos^2(24.85)}{\left[1 + \sqrt{\frac{\sin(24.85)\sin(24.85 - 18.4)}{\cos(18.4)}}\right]^2} \quad [3-14]$$

$$= \frac{0.823}{[1.223]^2} = 0.550$$

$\Delta K_{AE} = 0.633 - 0.550 = 0.083$

where

$$K_A = \frac{\sin^2 (\theta + \phi) \cos \delta}{\sin \theta \sin (\theta - \delta) \left[1 + \sqrt{\frac{\sin (\phi + \delta) \sin (\phi - \beta)}{\sin (\theta - \delta) \sin (\theta + \beta)}} \right]^2} \qquad [3\text{-}12]$$

Examples 1 and 2 in Appendix M and the examples in Appendix N demonstrate the use of Equation 3-12.

(2) When wall friction is neglected ($\delta = 0$), Equation 3-12 reduces to:

$$K_A = \frac{\sin^2 (\theta + \phi)}{\sin^2 \theta \left[1 + \sqrt{\frac{\sin \phi \sin (\phi - \beta)}{\sin \theta \sin (\theta + \beta)}} \right]^2} \qquad [3\text{-}13]$$

(3) For the case of is no wall friction ($\delta = 0$) and a vertical wall ($\theta = 90$ degrees),

$$K_A = \frac{\cos^2 \phi}{\left[1 + \sqrt{\frac{\sin \phi \sin (\phi - \beta)}{\cos \beta}} \right]^2} \qquad [3\text{-}14]$$

(4) For the special case of no wall friction, horizontal backfill surface, and a vertical wall, Coulomb's equation for K_A reduces to:

$$K_A = \frac{1 - \sin \phi}{1 + \sin \phi} = \tan^2 \left(45° - \frac{\phi}{2} \right) \qquad [3\text{-}15]$$

which is identical to Rankine's equation for this special case.

(5) As stated in paragraph 3-11c and demonstrated in Figure 3-6 and Appendix E, a developed ϕ angle computed by Equation 3-10 using an SMF of 2/3 can be used in Coulomb's equation to compute an earth pressure coefficient close to that given by the Jaky or Danish Code equations.

For driving (active) wedges (Figure 3-34a),

$$P_{AE} = \frac{1}{2} K_{AE} \gamma (1 - k_v) h^2 \qquad [3\text{-}44]$$

$$K_{AE} = \frac{\cos^2 (\phi - \Psi - \theta)}{\cos \Psi \cos^2 \theta \cos (\Psi + \theta + \delta) \left[1 + \sqrt{\frac{\sin (\phi + \delta) \sin (\phi - \Psi - \beta)}{\cos (\beta - \theta) \cos (\Psi + \theta + \delta)}} \right]^2} \qquad [3\text{-}45]$$

For resisting (passive) wedges (Figure 3-34b),

$$P_{PE} = \frac{1}{2} K_{PE} \gamma (1 - k_v) h^2 \qquad [3\text{-}46]$$

$$K_{PE} = \frac{\cos^2 (\phi - \Psi + \theta)}{\cos \Psi \cos^2 \theta \cos (\Psi - \theta + \delta) \left[1 - \sqrt{\frac{\sin (\phi - \delta) \sin (\phi - \Psi + \beta)}{\cos (\beta - \theta) \cos (\Psi - \theta + \delta)}} \right]^2} \qquad [3\text{-}47]$$

P_{AE} and P_{PE} are the combined static and dynamic forces due to the driving and resisting wedges, respectively. The equations are subject to the same limitations that are applicable to Coulomb's equations. Definitions of terms are as follows:

γ = unit weight of soil

k_v = vertical acceleration in g's

h = height of wall

ϕ = internal friction angle of soil

$\Psi = \tan^{-1} \left(\frac{k_h}{1 - k_v} \right)$ = seismic inertia angle

k_h = horizontal acceleration in g's

θ = inclination of wall with respect to vertical (this definition of θ is different from θ in Coulomb's equations)

δ = wall friction angle

β = inclination of soil surface (upward slopes away from the wall are positive)

CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY
PROJECT FWCC | DATE CHECKED | DATE 1-7-05
DETAIL TRAINING WALLS - SEISMIC | CHECKED BY | PAGE NO.

SEISMIC ANALYSIS:

CASE I3EL PILE.DAT

INERTIA OF CONC WALL PLUS SOIL ABOVE HEEL $= K_h W$

$W = 24.469 + (5.475 + 39.889) = 69.83^{K}$

$I_{cs} = 0.05(69.83) = 3.49^{K}$

$P_{AE} = P_A + P_{ws} + \Delta P_{AE}$

$= \frac{1}{2} K_A \gamma_b h^2 + \frac{1}{2} \gamma_w h^2 + \frac{1}{2} \Delta K_{AE} \gamma h^2$

$= \frac{1}{2}(0.550)\left(\frac{130 - 62.5}{1000}\right)(25.5)^2 + \frac{1}{2}(0.0625)(25.5)^2$

$+ \frac{1}{2}(0.083)(0.130)(25.5)^2$

$= 12.07 + 20.32 + 3.51 = 35.9^{K}$

P_A P_{ws} ΔP_{AE}

DRIVING WEDGE NET FORCE FROM CTWALL (F.S. = 1.10): 32.529^{K}

NET ADDL FORCE $= 35.9 + 3.49 - 32.53 = 6.86^{K}$

$P_A + P_{ws} = 12.07 + 20.32 = 32.39^{K}$ $\Delta P_{AE} = 3.51^{K}$

TOTAL SEISMIC MOMENT:

$M_s = (32.39^{K})\left(\frac{25.5'}{2}\right) + (3.51^{K})(0.67 \times 25.5') + (3.49^{K})\left(\frac{25.5'}{2}\right)$

$= 379.8^{1K}$

$\Delta M = 379.8 - (250.55 + 97.73) = 31.52^{1K}$ (FROM CT-WALL)

$h_e = \frac{31.52^{1K}}{3.51^{K}} = 9.0'$

∴ APPLY 3.51^{K} @ 9.0' ABOVE BASE = EL 517.0'

CONCLUSION: SEISMIC DRIVING FORCE < MAX. STATIC LATERAL FORCE

∴ SEISMIC DOES NOT CONTROL

CTWALL: I3ELPILE.DAT
w/o ADDED SURCHARGE LINE LOAD

Water pressures:

Elevation (ft)	Pressure (ksf)
524.30	.0000
508.00	1.0187
508.00	1.0187

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.2117
26.00	1.0187

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	4.612		-3.00	-13.84
Driving side:				
Effective earth loads.....		25.552	9.81	250.55
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		13.329	7.33	97.73
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-8.303	5.43	-45.12
Foundation:				
Vertical force on base.....	-45.449		-8.75	397.88
Shear on base.....		-30.578	.00	.00
Uplift.....	-28.996		-13.37	387.82
** Statics Check ** SUMS =	.000	.000		.00

****
** Sliding Results **
****

Stationary solution. Static sum of forces.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	-8.303	4.612
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	1.2117		
2			.0000	1.2117
2			26.0000	1.0187
3	.0000	.0000		

Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = .00 ft

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	-47.996	52.048	56.926	29.606	17.937
2	.000	26.000	69.832	26.000	28.996
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	-32.529
2	31.719
3	.000
SUM =	-.811

NOTE: Forces are calculated for the FS specified below.

Factor of safety = 1.100

********** Echoprint of Input Data **********

Date: **/01/07 Time: 11.51.38

Flood Wall Stability Analysis Using CTWALL
Filename: I3ELPILE.DAT

w/ SEISMIC SURCHARGE LINE LOAD

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
27.00	.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
27.00	.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
- phi for soil-structure interface = 27.00 (deg)
- c for soil-structure interface = .100 (ksf)
- phi for soil-soil interface = 27.00 (deg)
- c for soil-scil interface = .100 (ksf)

Water data:
- Driving side elevation = 530.00 ft
- Resisting side elevation = 524.30 ft
- Unit weight of water = .0625 kcf
- Seepage pressures computed by Line of Creep method.

Horizontal line load data:

Elevation (ft)	Force (kips)
517.00	3.51

Minimum required factors of safety:
  Sliding FS = 1.10
  Overturning = .10% base in compression

Crack options:
  o Crack depth is to be calculated
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

Forces for sliding are calculated for the REQUIRED FS.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************    *** Satisfied ***
* Overturning *    Required base in comp. =    .10 %
***************    Actual base in comp.   =  80.66 %
                   Overturning ratio      =   1.35

Xr (measured from toe) =   6.99 ft
Resultant ratio        =  .2689
Stem ratio             =  .2308
Base pressure at x=  20.97 ft from toe =     .0000 ksf
Base pressure at toe                   =    4.0466 ksf
```

*** Warning *** The maximum available shear along the base of the structure has been exceeded!

```
***********    *** Satisfied ***
* Sliding *    Min. Required =   1.10
***********    Actual FS     =   1.10
```

********** Output Results **********

Date: **/01/07 Time: 11.51.38

Flood Wall Stability Analysis Using CTWALL
Filename: I3ELPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 5 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -43.5082
Calculated earth pressure coefficients:
Driving side at rest K = .4856
Driving side at rest Kc = 1.1670
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = .00 ft

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
530.00	.0000
508.00	1.3750

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
530.00	.4521
516.39	1.3464
508.00	1.6773

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
524.30	.0000
508.00	1.0187
508.00	1.0187

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.3750
5.03	1.3750
26.00	1.0187

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		3.510	9.00	31.59
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	4.612		-3.00	-13.84
Driving side:				
Effective earth loads.....		26.290	9.75	256.22
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		15.125	7.33	110.92
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-8.303	5.43	-45.12
Foundation:				
Vertical force on base.....	-42.431		-6.99	296.61
Shear on base.....		-36.622	.00	.00
Uplift.....	-32.014		-13.70	438.63
** Statics Check ** SUMS =	.000	.000		.00

Angle of base = .00 degrees
Normal force on base = 42.431 kips
Shear force on base = 36.622 kips
Max. available shear force = 23.717 kips

*** Warning *** The maximum available shear along the base of the structure has been exceeded!

Base pressure at x= 20.97 ft from toe = .0000 ksf
Base pressure at toe = 4.0466 ksf

Xr (measured from toe) = 6.99 ft
Resultant ratio = .2689
Stem ratio = .2308
Base in compression = 80.66 %
Overturning ratio = 1.35

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****
** Sliding Results **
****

Stationary solution. Static sum of forces.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	-4.793	4.612
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	1.3750		
2			.0000	1.3750
2			5.0264	1.3750
2			26.0000	1.0187
3	.0000	.0000		

Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = .00 ft

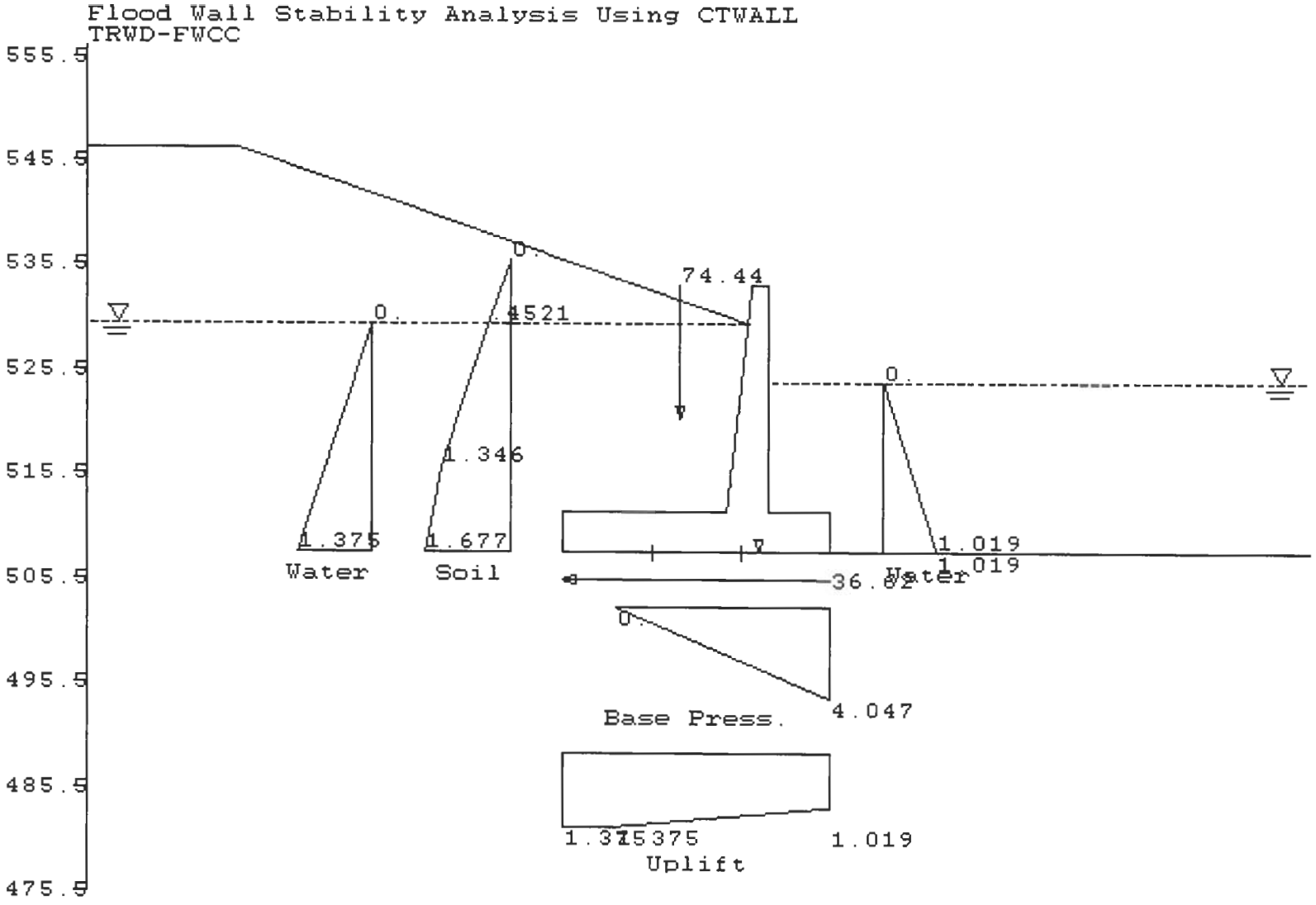
Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	-47.777	52.228	57.497	29.708	20.425
2	.000	26.000	69.832	26.000	32.014
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	-33.635
2	26.353
3	.000
SUM =	-7.282

→ DRIVING FORCE < 37.6 K/l PER STATIC ANALYSES
∴ SEISMIC DOES NOT CONTROL

NOTE: Forces are calculated for the FS specified below.

Factor of safety = 1.100


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
0.
0.
.4521
74.44
0.
1.346
1.375
1.677
1.019
1.019
Water
Soil
Water
36.82
0.
4.047
Base Press.
1.375
1.019
Uplift

CDM

CLIENT TRWD | JOB NO. 42275 | COMPUTED BY [illegible]
PROJECT FWCC | DATE CHECKED | DATE 1-7-05
DETAIL TRAINING WALLS – SEISMIC | CHECKED BY | PAGE NO.

CASE I3ESPILE.DAT

– FULL CRACK TO BASE OF FOOTING
– SO NEGLECT "DYNAMIC EARTH PRESSURE" & JUST INCLUDE LATERAL INERTIA OF WALL + SOIL ABOVE FTG

$W = 24.169 + (5.475 + 39.889) = 69.83^{K}$

$I_{CS} = 0.05(69.83) = 3.49^{K}$

→ APPLY AT $\frac{25.50'}{2} = 12.75'$, SAY 13.0' ABOVE BASE
→ EL 521.0

CONCLUSION: THIS CASE DOES NOT CONTROL DESIGN

CTWALL : I3ESPILE.DAT
w/o ADDED SURCHARGE LINE LOAD

Water pressures:

Elevation (ft)	Pressure (ksf)
524.30	.0000
508.00	1.0187
508.00	.6412

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.1317
26.00	.6412

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	4.612		-3.00	-13.84
Driving side:				
Effective earth loads.....		.909	4.30	3.91
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		20.568	10.33	212.47
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-8.303	5.43	-45.11
Foundation:				
Vertical force on base.....	-51.398		-11.49	590.35
Shear on base.....		-13.175	.00	.00
Uplift.....	-23.047		-14.20	327.24
** Statics Check ** SUMS =	.000	.000		.00

****
** Sliding Results **
****

Stationary solution. Static sum of forces.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	16.270	4.612
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.0000		
2			.0000	1.3750
2			26.0000	.6412
3	.0000	.0000		

Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	.000	.000	.000	.000	.000
2	.000	26.000	69.832	26.000	26.210
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	.000
2	7.367
3	.000
SUM =	7.367

NOTE: Forces are calculated for the FS specified below.

Factor of safety = 1.100

********** Echoprint of Input Data **********

Date: **/01/07 Time: 13.05.06

Flood Wall Stability Analysis Using CTWALL
Filename: I3ESPILE.DAT

w/ SEISMIC SURCHARGE LINE LOAD ADDED

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

Structural geometry data:

Elevation of top of stem (ELTS)	=	533.50 ft
Height of stem (HTS)	=	21.50 ft
Thickness top of stem (TTS)	=	1.50 ft
Thickness bottom of stem (TBS)	=	4.00 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	4.00 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	4.00 ft
Width of toe (TWIDTH)	=	6.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	26.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	508.00
.00	512.00
16.00	512.00
18.50	533.50
20.00	533.50
20.00	512.00
26.00	512.00
26.00	508.00

NOTE: X=0 is located at the left-hand side of the structure. The Y values correspond to the actual elevation used.

Structural property data:
Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
.00	1.000	.100	.130	.00	530.01

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	4.00	50.00
2	.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1081.91	546.68
2	-31.91	546.68
3	18.09	530.01

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
.00	1.000	.100	.130	508.00	.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	26.00	508.00
2	526.00	508.00

Foundation property data:
phi for soil-structure interface = .00 (deg)
c for soil-structure interface = 1.000 (ksf)
phi for soil-soil interface = .00 (deg)
c for soil-soil interface = 1.000 (ksf)

Water data:
Driving side elevation = 530.00 ft
Resisting side elevation = 524.30 ft
Unit weight of water = .0625 kcf
Seepage pressures computed by Line of Creep method.

Horizontal line load data:

Elevation (ft)	Force (kips)
521.00	3.49

Minimum required factors of safety:
  Sliding FS = 1.10
  Overturning = .10% base in compression

Crack options:
  o Crack *is* down to bottom of heel
  o Computed cracks *will* be filled with water

Strength mobilization factor = .6667

50% of full passive *is used* in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

Forces for sliding are calculated for the REQUIRED FS.

***** Summary of Results *****

Flood Wall Stability Analysis Using CTWALL

Project name: TRWD-FWCC

```
***************     *** Satisfied ***
* Overturning *     Required base in comp. =     .10 %
***************     Actual base in comp.   = 100.00 %
                    Overturning ratio      =   1.93

Xr (measured from toe) =  10.60 ft
Resultant ratio        =  .4078
Stem ratio             =  .2308
Base pressure at heel =     .8834 ksf
Base pressure at toe  =    3.0703 ksf

***********     *** Satisfied ***
* Sliding *     Min. Required =   1.10
***********     Actual FS     =   1.10
```

********** Output Results **********

Date: **/01/07 Time: 13.05.06

Flood Wall Stability Analysis Using CTWALL
Filename: I3ESPILE.DAT

Company name:
CDM
Project name:
TRWD-FWCC
Project location:
Fort Worth, TX / Tarrant Regional Water District
Wall location:
Training Walls
Computed by: WCS

****
** Overturning Results **
****

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
Alpha for the SMF = -30.8493
Calculated earth pressure coefficients:
Driving side at rest K = 1.0000
Driving side at rest Kc = 2.5701
Resisting side at rest K = .0000
Resisting side at rest Kc = .0000
Full passive K calculated for resisting side.
50% of full passive will be used.

Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
520.90	.9465
508.00	1.1317

Earth pressures:

Elevation (ft)	Pressure (ksf)
536.04	.0000
520.90	.0000
508.00	.1410

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
524.30	.0000
508.00	1.0187
508.00	.6412

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	1.1317
26.00	.6412

** Forces and moments **

Part	Force (kips) Vert.	Force (kips) Horiz.	Mom. Arm (ft)	Moment (ft-k)
Structure:				
Structure weight.....	24.469		-11.00	-269.05
Structure, driving side:				
Moist soil.....	5.475		-19.96	-109.27
Saturated soil.....	39.889		-17.47	-696.70
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		3.490	13.00	45.37
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	4.612		-3.00	-13.84
Driving side:				
Effective earth loads.....		.909	4.30	3.91
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		20.568	10.33	212.47
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-8.303	5.43	-45.11
Foundation:				
Vertical force on base.....	-51.398		-10.60	544.98
Shear on base.....		-16.665	.00	.00
Uplift.....	-23.047		-14.20	327.24
** Statics Check ** SUMS =	.000	.000		.00

$< 37.6^{k}/_{l}$

∴ DOES NOT CONTROL

Angle of base = .00 degrees
Normal force on base = 51.398 kips
Shear force on base = 16.665 kips
Max. available shear force = 26.000 kips

Base pressure at heel = .8834 ksf
Base pressure at toe = 3.0703 ksf

Xr (measured from toe) = 10.60 ft
Resultant ratio = .4078
Stem ratio = .2308
Base in compression = 100.00 %
Overturning ratio = 1.93

Volume of concrete = 6.04 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

****
** Sliding Results **
****

Stationary solution. Static sum of forces.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	19.760	4.612
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.0000		
2			.0000	1.3750
2			26.0000	.6412
3	.0000	.0000		

Points of sliding plane:
Point 1 (left), x = .00 ft, y = 508.00 ft
Point 2 (right), x = 26.00 ft, y = 508.00 ft

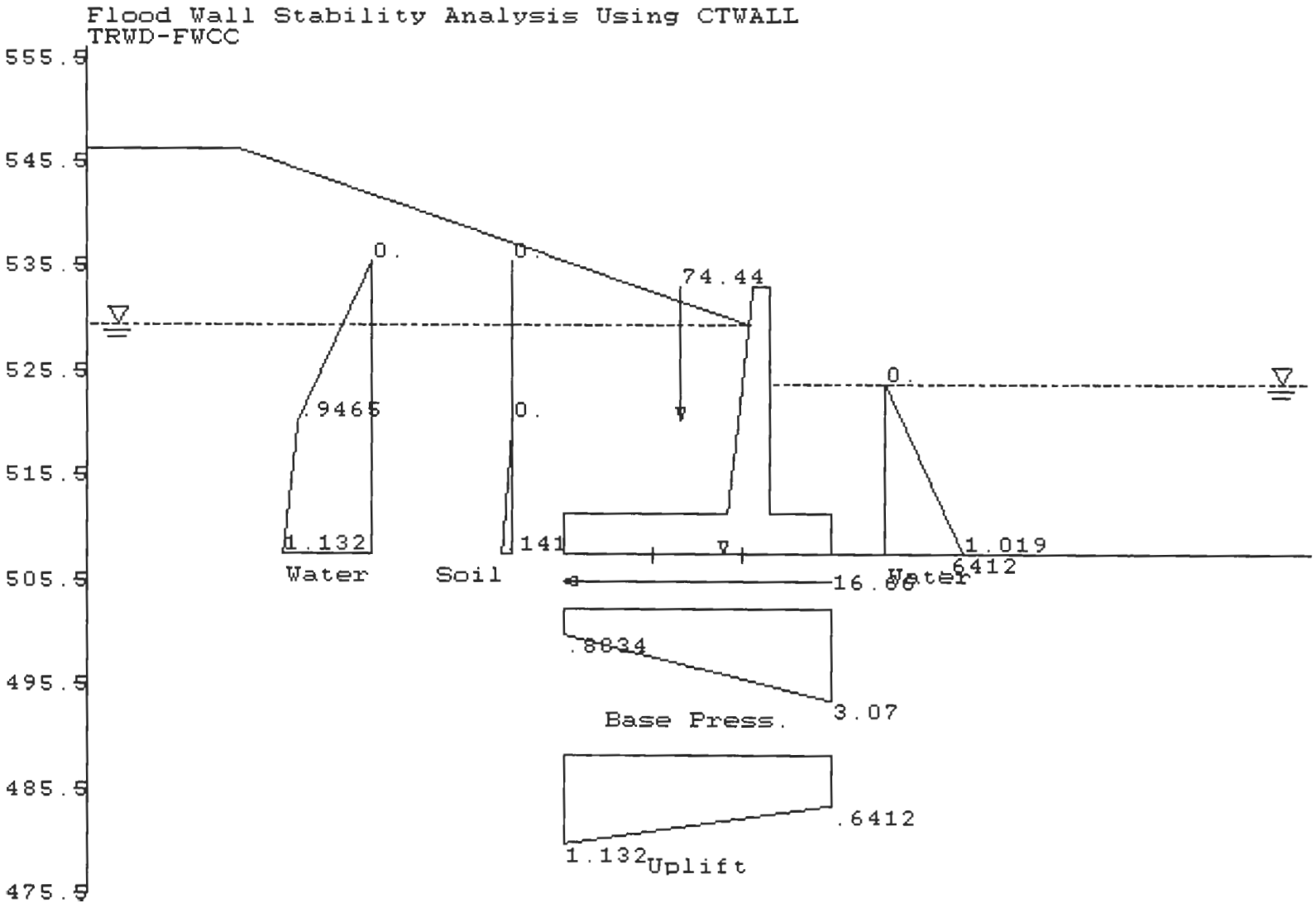
Depth of cracking = 28.04 ft
Crack extends to bottom of base of structure.

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	.000	.000	.000	.000	.000
2	.000	26.000	69.832	26.000	26.210
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	.000
2	3.877
3	.000
SUM =	3.877

NOTE: Forces are calculated for the FS specified below.

Factor of safety = 1.100


Flood Wall Stability Analysis Using CTWALL
TRWD-FWCC
555.5
545.5
535.5
525.5
515.5
505.5
495.5
485.5
475.5
0.
0.
74.44
0.
.9465
0.
1.132
141
1.019
.6412
Water
Soil
Water
16.86
.8834
3.07
Base Press.
.6412
1.132
Uplift