ATTACHMENT 7-IV

VENEER STABILITY CALCULATIONS

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Leachate Collection System Veneer Stability			Scale NA
	Designed By KMC	Date 4/5/2016	Checked By TAP	Date 4/25/2016	Sheet No: 1 of 4

Objective:	Determine minimum interface shear strength requirements for 12-inch leachate collection layer or sideslope.
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic Technical Paper 40 - National Weather Service

The methods specified in "Designing with Geosynthetics" and "Selection of Method for Seismic Slope Stability Analysis" were utilized to determine the minimum allowable peak strength interface angle within the bottom liner system.

STEP 1: Determine the minimum interface shear strength required using infinite slope analysis of 3:1 slope calculated as follows (Equation (1) "Selection of Method for Seismic Slope Stability Analysis"):

$$\phi = \tan^{-1} \frac{FS * (n_g + \tan\beta) - c / (\gamma_c z_c \cos^2\beta)}{(1 - (\gamma_w * (z_c - d_w) / (\gamma_c z_c)) - n_g \tan\beta}$$

where:

FS = factor of safty against shallow failure (see below)		
n_g = peak horizontal acceleration at the failure surface (%g)	0	
γ_c = field density of cover materials	125	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction	TO BE DETERMINED	
β = angle of slope (3H:1V)	0.32172	radians
z_c = depth of cover soils above membrane	1	feet

d_w = depth to water table assumed parallel to slope = $z_c - h_{avg}$
ρ_d = porosity of drainage layer
f_d = field capacity of drainage material

$$h_{avg} = \frac{P(1 - RC) * L(\cos\beta)}{k_d(\sin\beta) + L(\rho_d - f_d)} \quad \text{for } P(1-RC) < k_c$$

$$h_{avg} = \frac{k_c * L(\cos\beta)}{k_d(\sin\beta) + L(\rho_d - f_d)} \quad \text{for } P(1-RC) > k_c$$

h_{avg} = average head
P = precipitation
β = angle of slope
L = slope length
T_c = thickness of cover soil
RC = runoff coefficient
k_d = permeability of drainage layer (adjust for FS per Richardson Extrapolation)
T_d = thickness of drainage layer
k_c = permeability of cover material

The minimum allowable factors of safety are as follows:

FS > 1.5 for static unsaturated conditions
FS > 1.1 for static saturated conditions

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Leachate Collection System Veneer Stability			Scale NA
	Designed By KMC	Date 4/5/2016	Checked By TAP	Date 4/25/2016	Sheet No: 2 of 4

Objective:	Determine minimum interface shear strength requirements for 12-inch leachate collection layer or sideslope.
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic Technical Paper 40 - National Weather Service

Case 1 - Static Unsaturated Condition

where:

FS = factor of safty against shallow failure	1.5	
n_g = peak horizontal acceleration at the failure surface (%g)	0	
γ_c = field density of cover materials	125	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction		
β = angle of slope	0.32172	radians
z_c = depth of cover soils	1	feet
d_w = depth to water table assumed parallel to slope = z_c - h_{avg}	1	

ϕ = 0.46361 radians = 26.56 degrees

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Leachate Collection System Veneer Stability			Scale NA
	Designed By KMC	Date 4/5/2016	Checked By TAP	Date 4/25/2016	Sheet No: 3 of 4

Objective:	Determine minimum interface shear strength requirements for 12-inch leachate collection layer or sideslope.
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic Technical Paper 40 - National Weather Service

Case 2 - Static Saturated Condition

where:

FS = factor of safty against shallow failure	1.1	
n_g = peak horizontal acceleration at the failure surface (%g)	0	
γ_c = field density of cover materials	125	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction	TO BE DETERMINED	
β = angle of slope	0.32175	radians
z_c = depth of cover soils	1	feet
d_w = depth to water table assumed parallel to slope = z_c - h_{avg}	0.96352	feet
h_{avg} = average head (calculated below)	0.03648	feet
P = precipitation (50-year storm, see attached figure)	2.3	inches/hour
L = slope length	100	feet
T_c = thickness of cover soil	1	feet
RC = runoff coefficient	0	
T_T = transmissivity of geocomposite (not present)	0.00	m^2/sec
T_d = thickness of drainage layer	30.48	cm
k_c = permeability of leachate drainage material	4.20E-05	cm/sec
ρ_d = porosity of drainage layer (from HELP Model)	0.471	vol/vol
f_d = field capacity of drainage material (from HELP Model)	0.342	vol/vol

P * (1 - RC) = 2.3 in/hr = 0.00162 cm/sec therefore > kc

In order to determine depth of flow in gravel, use water balance for one hour storm, where:

Q_{in} (drainage into protective layer) = Q_{out} (protective layer) + Storage (protective layer)

(this is consistent with OEPA guidance which requires soil to be at field capacity)

$$k_c*\cos\beta*L = k_c*\sin\beta*h_{avg} + L*h_{avg}*(\rho_d-f_d)$$

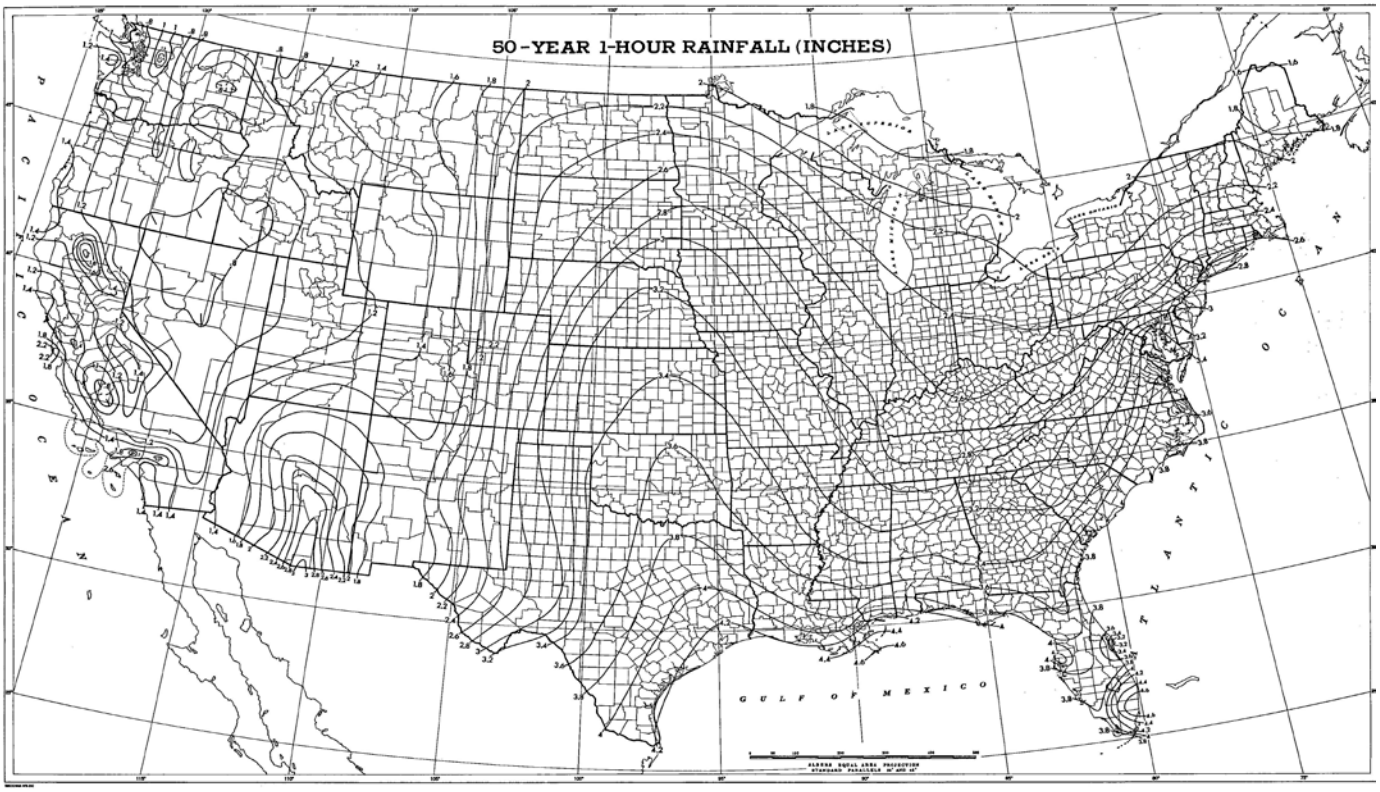
437 cm^3/hr = 0.04781 $*h_{avg}$ cm^3/hr + 393.192 $*h_{avg}$ cm^3/hr

h_{avg} = 1.11181 cm < T_d - OK

ϕ = 0.35743 radians = 20.48 degrees

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Leachate Collection System Veneer Stability			Scale NA
	Designed By KMC	Date 4/5/2016	Checked By TAP	Date 4/25/2016	Sheet No: 4 of 4

Objective:	Determine minimum interface shear strength requirements for 12-inch leachate collection layer or sideslope.
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic Technical Paper 40 - National Weather Service



Reference: Technical Paper 40 - National Weather Service
http://www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Static Final Cover Veneer Stability			Scale NA
	Designed By KMC	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 1 of 5

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps Technical Paper 40 - National Weather Service

The methods specified in "Designing with Geosynthetics" and "Selection of Method for Seismic Slope Stability Analysis" were utilized to determine the minimum allowable peak strength parameters in the final cover system.

STEP 1: Determine the minimum interface shear strength required using infinite slope analysis of 4:1 slope calculated as follows (Equation (1) "Selection of Method for Seismic Slope Stability Analysis"):

$$\phi = \tan^{-1} \frac{FS * (n_g + \tan\beta) - c / (\gamma_c z_c \cos^2\beta)}{(1 - (\gamma_w * (z_c - d_w) / (\gamma_c z_c)) - n_g \tan\beta}$$

where:

FS = factor of safty against shallow failure		
n_g = peak horizontal acceleration at the failure surface (%g)	0.02	
γ_c = field density of cover materials	130	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction		
β = angle of slope (4H:1V)	0.24498	radians
z_c = depth of cover soils above membrane	2.5	feet
d_w = depth to water table assumed parallel to slope = $z_c - h_{avg}$		

$$h_{avg} = \frac{P(1 - RC) * L(\cos\beta)}{k_d(\sin\beta) + L\rho_d} \quad \text{for } P(1-RC) < k_c$$

$$h_{avg} = \frac{k_c * L(\cos\beta)}{k_d(\sin\beta) + L\rho_d} \quad \text{for } P(1-RC) > k_c$$

h_{avg} = average head
P = precipitation
β = angle of slope
L = slope length
T_c = thickness of cover soil
RC = runoff coefficient
k_d = permeability of drainage layer (adjust for FS per Richardson Extrapolation)
T_d = thickness of drainage layer
k_c = permeability of cover material
ρ_d = porosity of drainage layer

The minimum allowable factors of safety are as follows:

FS > 1.5 for static unsaturated conditions
FS > 1.1 for static saturated conditions
FS > 1.0 for seismic unsaturated conditions

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Static Final Cover Veneer Stability			Scale NA
	Designed By KMC	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 2 of 5

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps Technical Paper 40 - National Weather Service

Case 1 - Static Unsaturated Condition

where:

FS = factor of safty against shallow failure	1.5	
n_g = peak horizontal acceleration at the failure surface (%g)	0	
γ_c = field density of cover materials	130	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction		
β = angle of slope	0.24498	radians
z_c = depth of cover soils	2.5	feet
d_w = depth to water table assumed parallel to slope = z_c - h_{avg}	2.5	

ϕ = 0.35877 radians = 20.56 degrees

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Static Final Cover Veneer Stability			Scale NA
	Designed By KMC	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 3 of 5

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps Technical Paper 40 - National Weather Service

Case 2 - Static Saturated Condition

where:

FS = factor of safty against shallow failure	1.1	
n_g = peak horizontal acceleration at the failure surface (%g)	0	
γ_c = field density of cover materials	130	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction		
β = angle of slope	0.24498	radians
z_c = depth of cover soils	2.5	feet
d_w = depth to water table assumed parallel to slope = z_c - h_{avg}	2.46729	feet
h_{avg} = average head (calculated below)	0.03271	feet
P = precipitation (100-year storm, see attached figure)	2.6	inches/hour
L = slope length	150	feet
T_c = thickness of cover soil	2.5	feet
RC = runoff coefficient	0.74	
T_T = transmissivity of geocomposite (Agru DS-200 or better)	0.0001	m^2/sec
T_d = thickness of drainage layer	0.51	cm
k_c = permeability of cover material (from HELP Model Soil Type)	4.2E-05	cm/sec
ρ_d = porosity of drainage layer (from HELP Model)	0.85	vol/vol

Determine long-term transmissivity of geocomposite:

$T_L = T_T/(F_{si} * FS_{cr} * FS_{cc} * FS_B * FS_S)$

F_{si} = Factor of Safety for intrusion	1.5
FS_{cr} = Factor of Safety for creep	1.4
FS_{cc} = Factor of Safety chemical clogging	1.2
FS_B = Factor of Safety biological clogging	1.5

T_L = 2.65E-05 m^2/sec

k_d = long term transmissivity of geocomposite = T_L/T_d 0.52 cm/sec

P * (1 - RC) = 0.676 in/hr = 0.00048 cm/sec therefore > k_c (use k_c)

In order to determine depth of flow in geocomposite, use water balance where:

Q_{in} (drainage into geocomposite) = Q_{out} (geocomposite) + Storage (in geocomposite)

(this is consistent with guidance which requires soil to be at field capacity)

$k_c*\cos\beta*L = k_d*\sin\beta*h_{avg} + L*h_{avg}*\rho_d$

670.646 cm^3/hr + 452.914 $*h_{avg}$ cm^3/hr + 3886.2 $*h_{avg}$ cm^3/hr

h_{avg} = 0.15456 cm < T_d (OK)

ϕ = 0.26998 radians = 15.47 degrees

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Static Final Cover Veneer Stability			Scale NA
	Designed By MA	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 4 of 5

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps Technical Paper 40 - National Weather Service

STEP 2: utilize XSTABL to determine the stability of the surface water drainage channels.

For this step, 2 cases were examined:

Static, unsaturated case, F.S. $\geq$ 1.5

Static case w/ perched water due to 100-year storm and drainage channels full (modeled as surface loading).
F.S > 1.1

XSTABL output follows the calculation sheets and are summarized as follows:

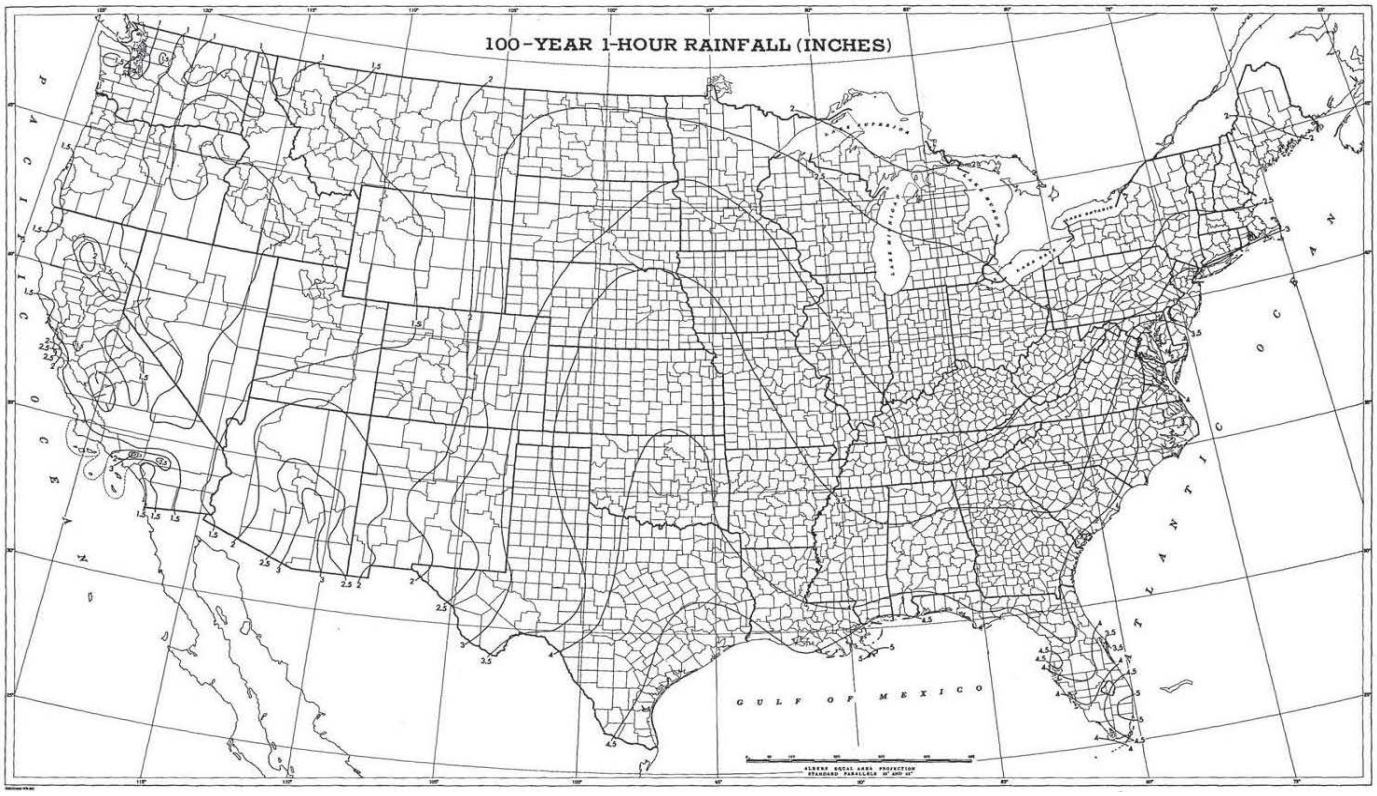
CASE	FILE NAME	MIN SHEAR STRENGTH	F.S
Static, unsaturated case - translational failure	OCFTER1B	17.00	1.51
Static, unsaturated case - circular failure	OCFTER1C	17.00	1.97
Static, saturated case - translational failure	OCFTER2B	17.00	1.38
Static, saturated case - circular failure	OCFTER2C	17.00	1.87

Based on these analyses, the minimum peak interface shear strength friction angle for the final cover system is 17.0 degrees. The XSTABL output files are included with the attachment for reference.

Soil Unit	Description	γ MOIST (pcf)	γ SATURATED (pcf)	γ COHESION (pcf)	Friction, ϕ (degress)
1	Grading Layer Fill/ Intermediate & Final Cover	128	130	180	24
2	Waste	80	85	210	25
3	Proposed Critical Interface – Peak	65	65	0	17
4	Compacted Clay Liner	128	130	180	24

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Static Final Cover Veneer Stability			Scale NA
	Designed By KMC	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 5 of 5

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps Technical Paper 40 - National Weather Service



Reference: Technical Paper 40 - National Weather Service
http://www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Seismic Final Cover Veneer Stability			Scale NA
	Designed By KMC/MA	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 1 of 3

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps

The methods specified in "Designing with Geosynthetics" and "Selection of Method for Seismic Slope Stability Analysis" were utilized to determine the minimum allowable peak strength parameters in the final cover system under seismic loading.

Case 3 - Seismic Unsaturated Condition

where:

FS = factor of safety against shallow failure	1	
n_g = peak horizontal acceleration at the failure surface (%g) (see following pages)	0.02	
γ_c = field density of cover materials	130	pcf
γ_w = density of water	62.4	pcf
c = cohesion/adhesion of failure surface	0	psf
ϕ = internal angle of friction		
β = angle of slope	0.24498	radians
z_c = depth of cover soils	2.5	feet
d_w = depth to water table assumed parallel to slope = z_c - h_{avg}	2.5	

ϕ = 0.26498 radians = 15.18 degrees

The results of these analyses indicate that the minimum shear strength must be no less than:

22.15 degrees (static unsaturated case)

STEP 2: utilize XSTABL to determine the stability of the surface water tack-on terraces.

Seismic, unsaturated case, F.S. $\geq$ 1.0

Static case with perched water due to 100-year storm and terraces full of water (modeled as surface loading).

XSTABL output follows the calculation sheets and are summarized as follows:

CASE	FILE NAME	MIN SHEAR STRENGTH	F.S
Seismic, unsaturated case - translational failure	OCFTER3B	17.00	1.351
Seismic, unsaturated case - circular failure	OCRTER3C	17.00	1.783

Based on these analyses, the minimum peak interface shear strength friction angle for the final cover system is 17.00 degrees. The XSTABL output files are included with the attachment for reference.

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Final Cover Veneer Stability			Scale NA
	Designed By KMC/MA	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 2 of 3

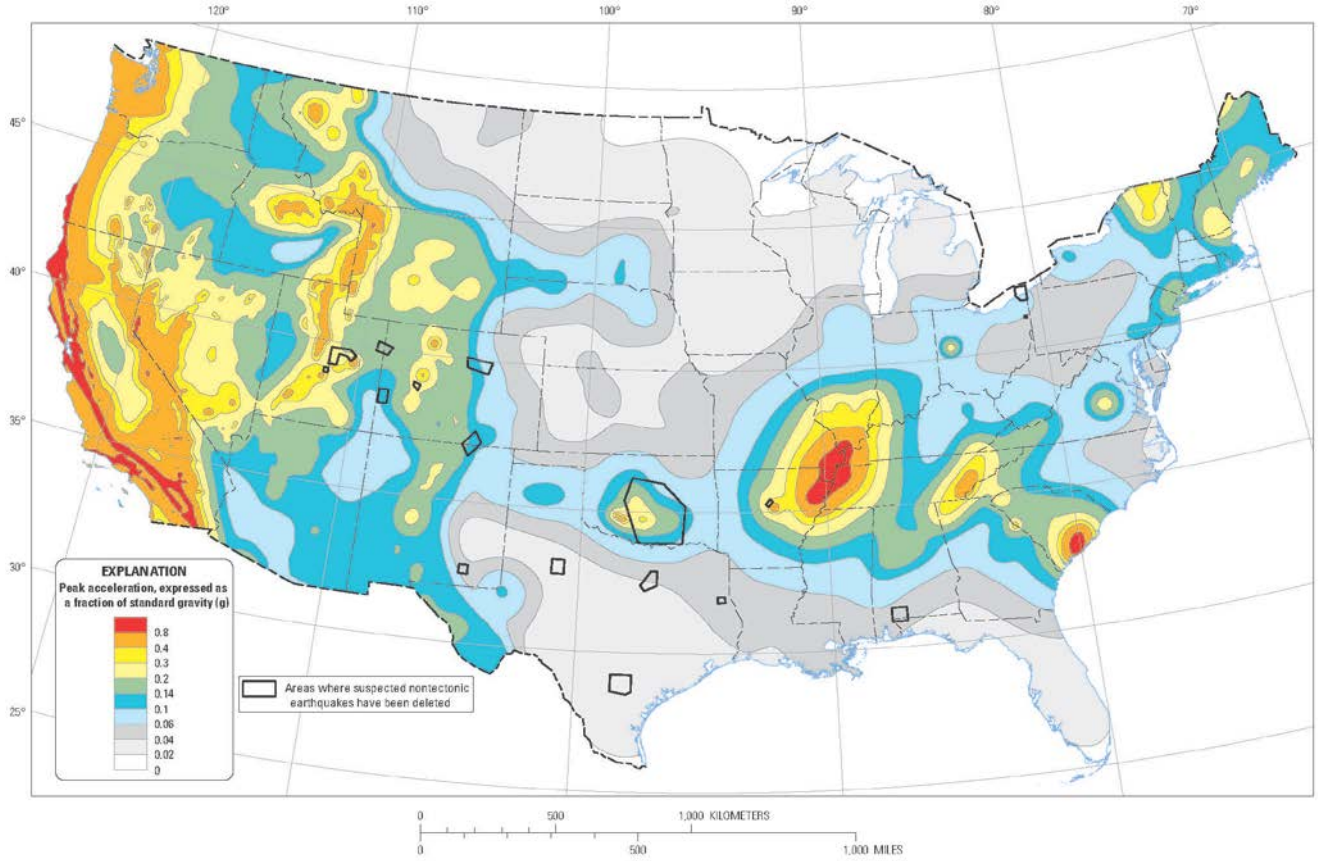
Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps

Determine Seismic Coefficient

From the USGS National Seismic Hazard Map (shown on Sheet 3) the seismic coefficient for the Ottawa County Farms Landfill area is 0.02g.

Weaver Consultants Group	PROJECT	Ottawa County Farms Landfill Expansion			Project Number 0120-685-11-03
	SUBJECT	Final Cover Veneer Stability			Scale NA
	Designed By KMC/MA	Date 4/6/2016	Checked By TAP	Date 5/11/2016	Sheet No: 3 of 3

Objective:	Determine minimum interface shear strength requirements for final cover components
References:	"Designing with Geosynthetics", Robert Koerner "Selection of Method for Seismic Slope Stability Analysis", Neven Matasovic USGS National Seismic Hazard Maps

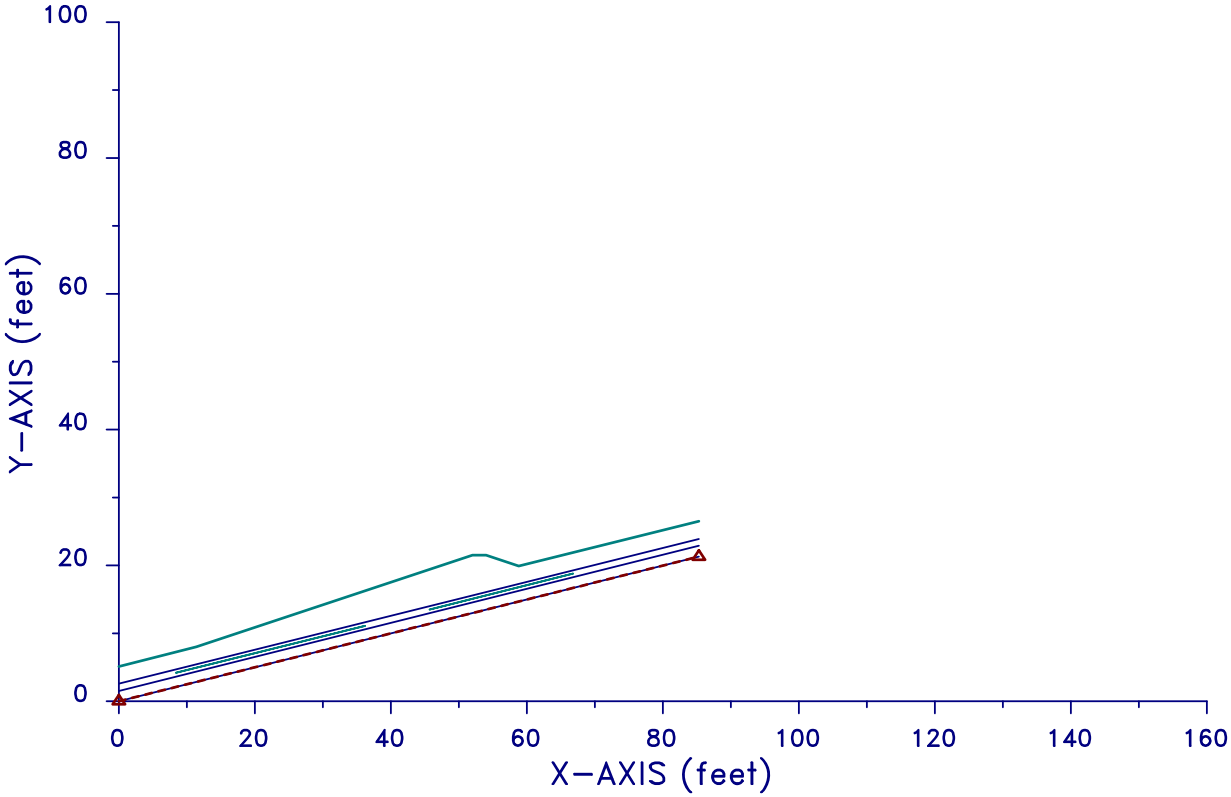


Two-percent probability of exceedance in 50 years map of peak ground acceleration

Reference: USGS National Seismic Hazard Maps
http://earthquake.usgs.gov/hazards/products/conterminous/2014/2014pga2pct.pdf

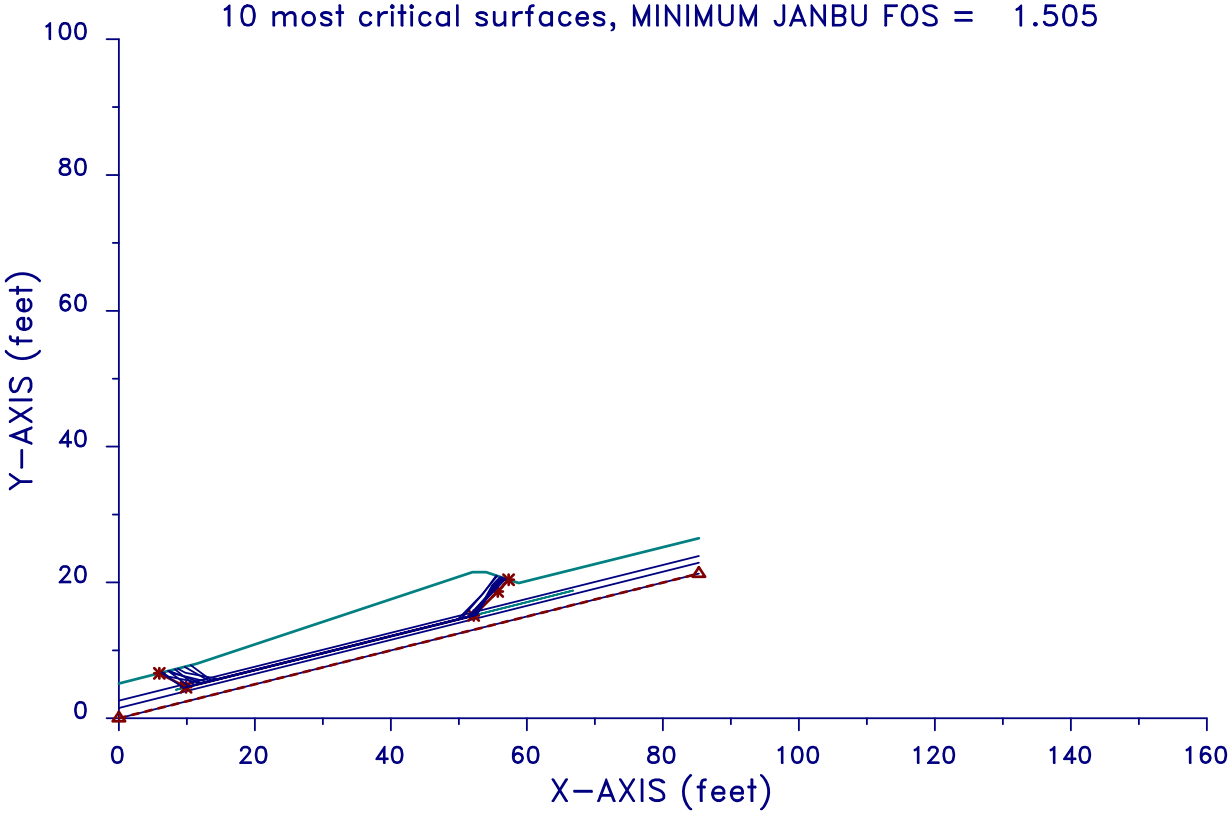
OCFTER1B 5-09-** 13:40

OCF FC Terrace Static Unsat Block



OCFTER1B 5-09-** 13:40

OCF FC Terrace Static Unsat Block
10 most critical surfaces, MINIMUM JANBU FOS = 1.505



XSTABL File: OCFTER1B 5-09-** 13:40

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 96       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.200                 96 Ä 1477 *
*****************************************
```

Problem Description : OCF FC Terrace Static Unsat Block

SEGMENT BOUNDARY COORDINATES
---

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	5.1	11.4	8.0	1
2	11.4	8.0	52.0	21.5	1
3	52.0	21.5	54.0	21.5	1
4	54.0	21.5	58.8	19.9	1
5	58.8	19.9	85.3	26.5	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	2.6	85.3	23.9	3
2	.0	1.5	85.3	22.9	4
3	.0	.0	85.3	21.3	2

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Water Surface Constant (psf)	Water Surface No.
1	128.0	130.0	180.0	24.00	.000	.0	1
2	80.0	85.0	210.0	25.00	.000	.0	1
3	65.0	65.0	.0	17.00	.000	.0	1
4	128.0	130.0	180.0	24.00	.000	.0	1

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	.0	85.3	21.3

A critical failure surface searching method, using a random technique for generating sliding BLOCK surfaces, has been specified.

500 trial surfaces will be generated and analyzed.

2 boxes specified for generation of central block base

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * * * * *

Length of line segments for active and passive portions of sliding block is 5.0 ft

Box no.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Width (ft)

1	8.4	4.2	36.2	11.1	.0
2	45.7	13.5	66.8	18.8	.0

```
*************************************************************
**     Factor of safety calculation for surface #   438    **
**     failed to converge within FIFTY iterations          **
**                                                         **
**    The last calculated value of the FOS was -15.0556    **
**    This will be ignored for final summary of results    **
*************************************************************
```

The trial failure surface in question is
defined by the following 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	24.60	12.39
2	28.14	9.10
3	47.22	13.88
4	47.31	18.88
5	47.83	20.11

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	5.96	6.62
2	9.89	4.57
3	52.19	15.13
4	55.72	18.67
5	57.31	20.40

** Corrected JANBU FOS = 1.505 ** (Fo factor = 1.032)

Failure surface No. 2 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.30	6.70
2	9.51	4.48
3	51.69	15.00
4	55.10	18.66
5	56.88	20.54

** Corrected JANBU FOS = 1.507 ** (Fo factor = 1.034)

Failure surface No. 3 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.26	6.95
2	10.34	4.68
3	49.82	14.54
4	53.31	18.12
5	55.63	20.96

** Corrected JANBU FOS = 1.516 ** (Fo factor = 1.039)

Failure surface No. 4 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.40	6.73
2	7.31	6.13
3	12.22	5.15
4	50.35	14.67
5	53.64	18.44
6	55.48	21.01

** Corrected JANBU FOS = 1.518 ** (Fo factor = 1.040)

Failure surface No. 5 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	9.69	7.57
2	13.39	5.44
3	51.30	14.91
4	54.74	18.54
5	56.51	20.66

** Corrected JANBU FOS = 1.520 ** (Fo factor = 1.038)

Failure surface No. 6 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.25	6.94
2	7.53	6.90
3	12.21	5.15
4	52.52	15.21
5	54.91	19.60
6	56.09	20.80

** Corrected JANBU FOS = 1.529 ** (Fo factor = 1.038)

Failure surface No. 7 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.66	7.30
2	9.81	6.70
3	14.72	5.77
4	51.37	14.92
5	54.71	18.64
6	56.68	20.61

** Corrected JANBU FOS = 1.533 ** (Fo factor = 1.036)

Failure surface No. 8 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.34	6.97
2	8.21	6.55
3	13.06	5.36
4	52.67	15.25
5	55.22	19.55
6	56.36	20.71

** Corrected JANBU FOS = 1.534 ** (Fo factor = 1.037)

Failure surface No. 9 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.23	7.19
2	11.16	4.89
3	52.55	15.22

4	55.13	19.50
5	56.30	20.73

** Corrected JANBU FOS = 1.536 ** (Fo factor = 1.038)

Failure surface No.10 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	10.61	7.80
2	13.67	5.51
3	52.14	15.12
4	55.11	19.14
5	56.28	20.74

** Corrected JANBU FOS = 1.542 ** (Fo factor = 1.039)

```
*******************************************************************
          **
**
          **  Out of the    500 surfaces generated and analyzed by
XSTABL,  **
          **        1 surfaces were found to have MISLEADING FOS values.
**
          **
**

*******************************************************************
```

The following is a summary of the TEN most critical surfaces

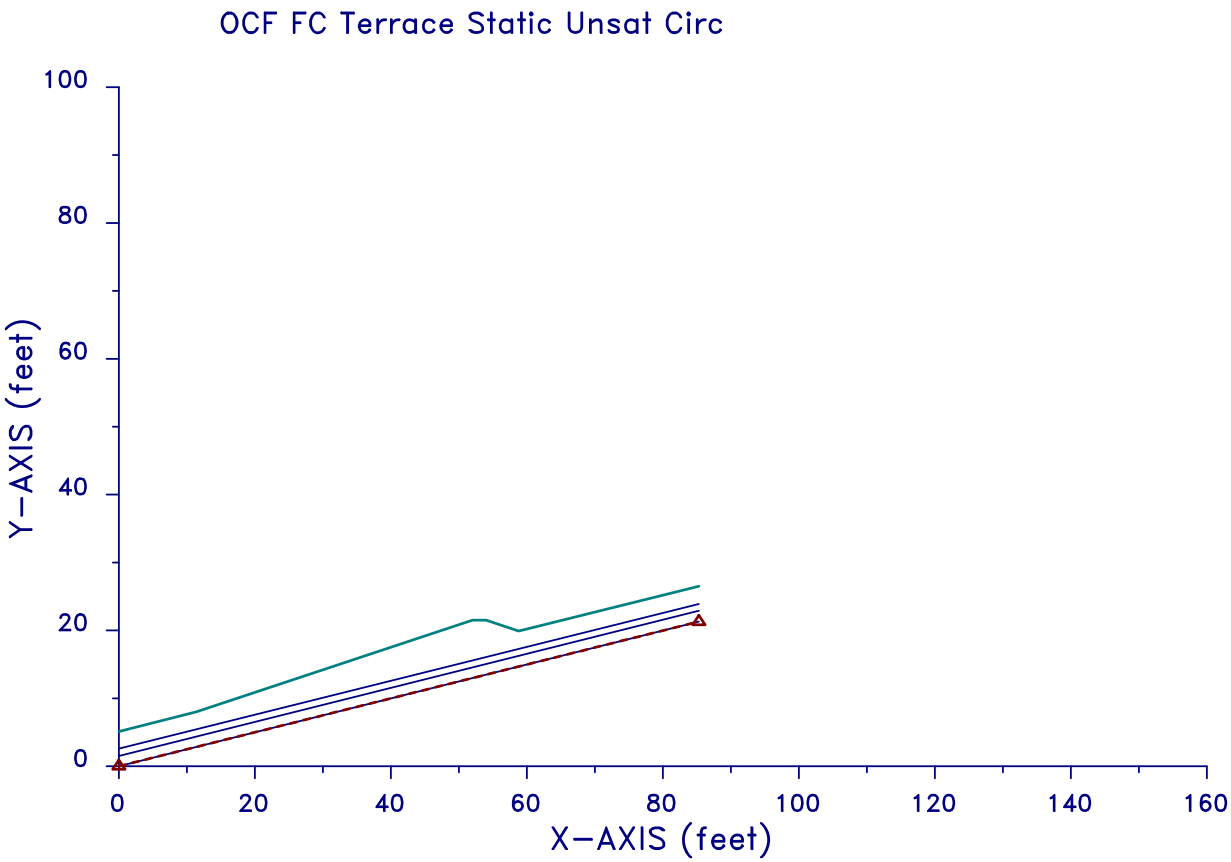
Problem Description : OCF FC Terrace Static Unsat Block

	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Available Strength (lb)
1.	1.505	1.032	5.96	57.31	1.028E+04
2.	1.507	1.034	6.30	56.88	1.021E+04
3.	1.516	1.039	7.26	55.63	1.003E+04

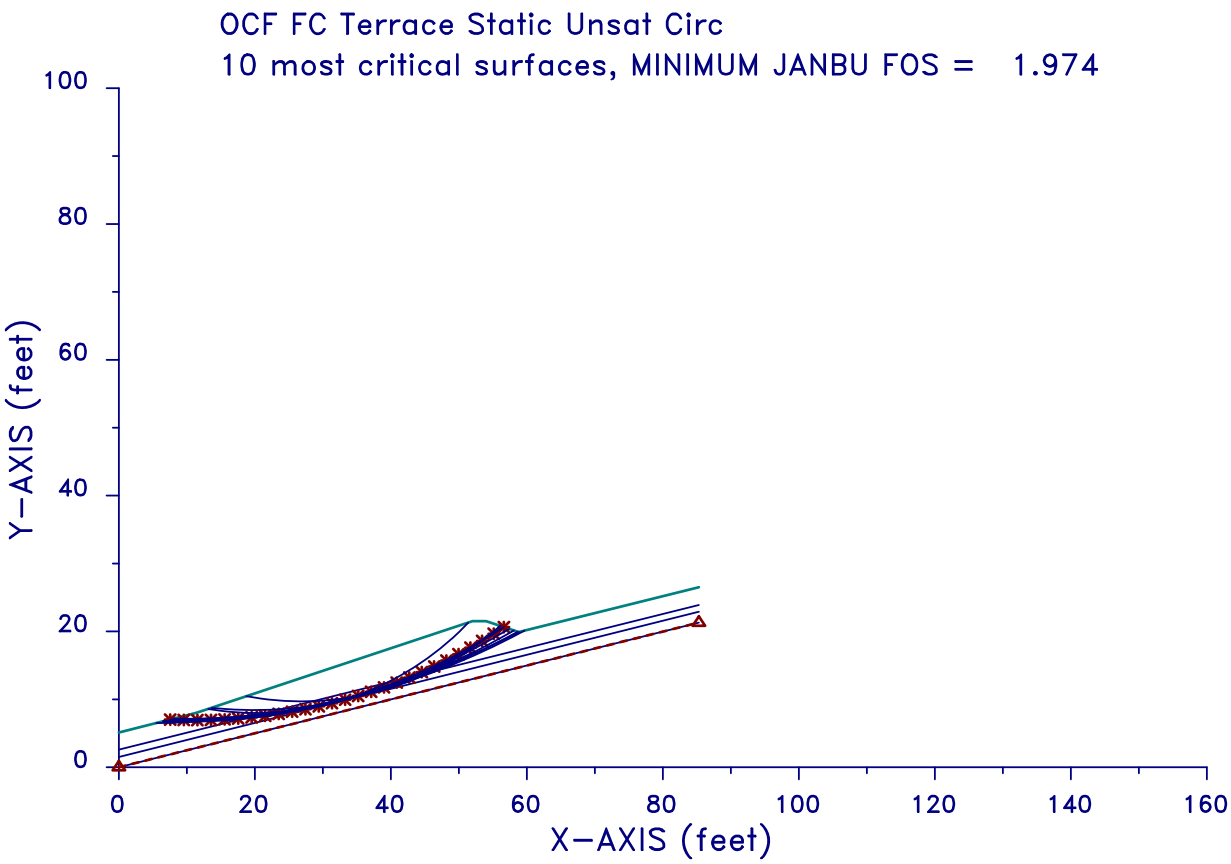
4.	1.518	1.040	6.40	55.48	1.016E+04
5.	1.520	1.038	9.69	56.51	9.823E+03
6.	1.529	1.038	7.25	56.09	9.869E+03
7.	1.533	1.036	8.66	56.68	1.010E+04
8.	1.534	1.037	7.34	56.36	9.977E+03
9.	1.536	1.038	8.23	56.30	9.794E+03
10.	1.542	1.039	10.61	56.28	9.607E+03

* * * END OF FILE * * *

OCFTER1C 5-09-** 13:44



OCFTER1C 5-09-** 13:44



XSTABL File: OCFTER1C 5-09-** 13:44

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 96       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.200                 96 Ä 1477 *
*****************************************
```

Problem Description : OCF FC Terrace Static Unsat Circ

SEGMENT BOUNDARY COORDINATES
---

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	5.1	11.4	8.0	1
2	11.4	8.0	52.0	21.5	1
3	52.0	21.5	54.0	21.5	1
4	54.0	21.5	58.8	19.9	1
5	58.8	19.9	85.3	26.5	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	2.6	85.3	23.9	3
2	.0	1.5	85.3	22.9	4
3	.0	.0	85.3	21.3	2

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Water Surface Constant (psf)	Water Surface No.
1	128.0	130.0	180.0	24.00	.000	.0	1
2	80.0	85.0	210.0	25.00	.000	.0	1
3	65.0	65.0	.0	17.00	.000	.0	1
4	128.0	130.0	180.0	24.00	.000	.0	1

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	.0	85.3	21.3

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1500 trial surfaces will be generated and analyzed.

30 Surfaces initiate from each of 50 points equally spaced along the ground surface between x = 5.0 ft
and x = 30.0 ft

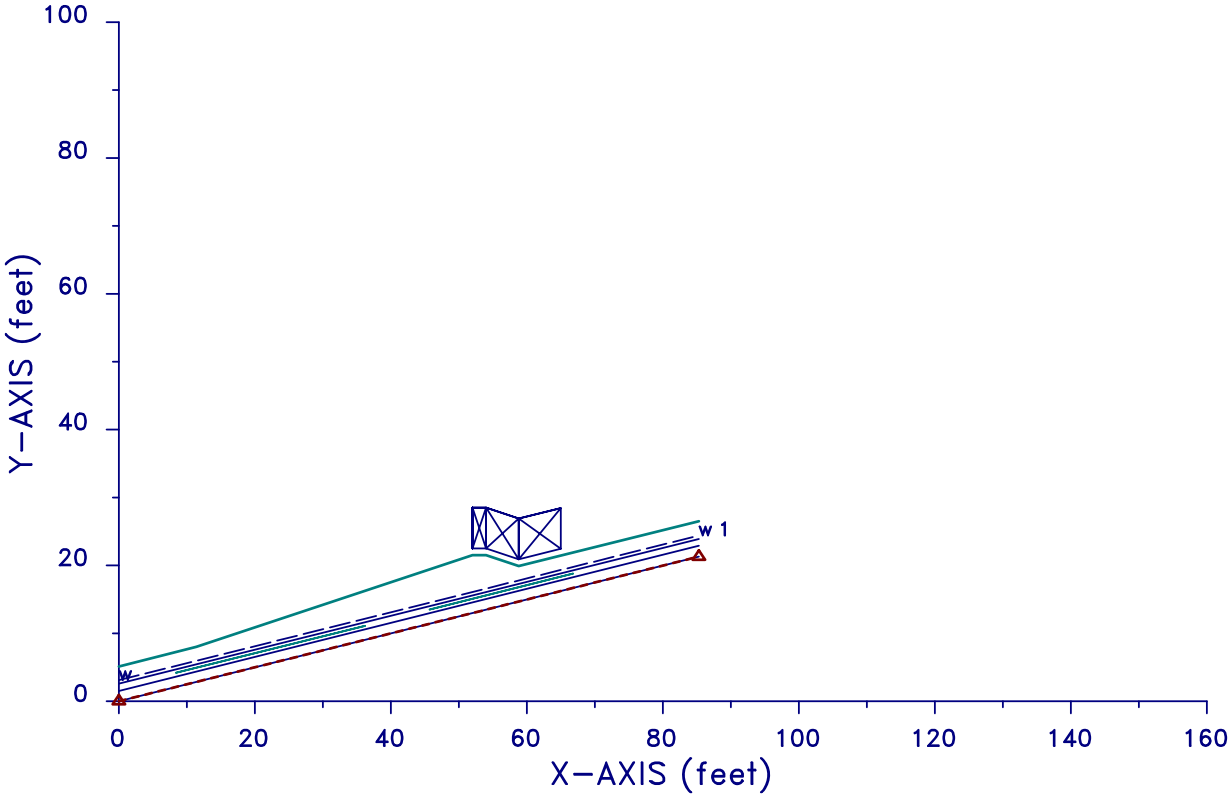
Each surface terminates between x = 40.0 ft
and x = 60.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * *

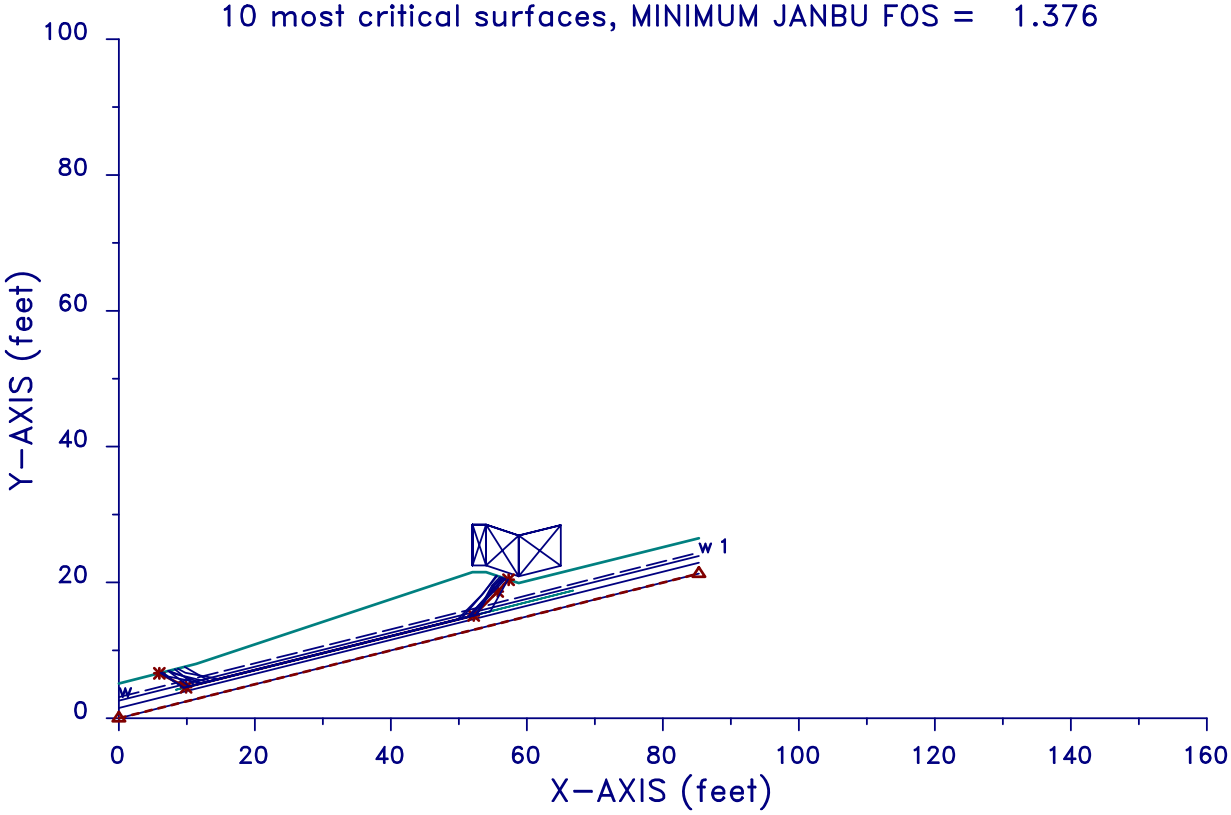
OCFTER2B 5-09-** 13:51

OCF FC Terrace Static Sat Block



OCFTER2B 5-09-** 13:51

OCF FC Terrace Static Sat Block
10 most critical surfaces, MINIMUM JANBU FOS = 1.376



XSTABL File: OCFTER2B 5-09-** 13:51

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 96       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.200                 96 Ä 1477 *
*****************************************
```

Problem Description : OCF FC Terrace Static Sat Block

SEGMENT BOUNDARY COORDINATES
---

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	5.1	11.4	8.0	1
2	11.4	8.0	52.0	21.5	1
3	52.0	21.5	54.0	21.5	1
4	54.0	21.5	58.8	19.9	1
5	58.8	19.9	85.3	26.5	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	2.6	85.3	23.9	3
2	.0	1.5	85.3	22.9	4
3	.0	.0	85.3	21.3	2

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Water Constant (psf)	Surface No.
1	128.0	130.0	180.0	24.00	.000	.0	1
2	80.0	85.0	210.0	25.00	.000	.0	1
3	65.0	65.0	.0	17.00	.000	.0	1
4	128.0	130.0	180.0	24.00	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 2 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	3.10
2	85.30	24.40

BOUNDARY LOADS
---

1 load(s) specified

Load No.	x-left (ft)	x-right (ft)	Intensity (psf)	Direction (deg)
1	52.0	65.0	31.2	.0

NOTE - Intensity is specified as a uniformly distributed

force acting on a HORIZONTALLY projected surface.

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	.0	85.3	21.3

A critical failure surface searching method, using a random technique for generating sliding BLOCK surfaces, has been specified.

500 trial surfaces will be generated and analyzed.

2 boxes specified for generation of central block base

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * * * * *

Length of line segments for active and passive portions of sliding block is 5.0 ft

Box no.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Width (ft)
1	8.4	4.2	36.2	11.1	.0
2	45.7	13.5	66.8	18.8	.0

```
************************************************************
**     Factor of safety calculation for surface #   438    **
**     failed to converge within FIFTY iterations          **
**                                                         **
**    The last calculated value of the FOS was -12.3683    **
**    This will be ignored for final summary of results    **
************************************************************
```

The trial failure surface in question is defined by the following 5 coordinate points

Point	x-surf	y-surf

No.	(ft)	(ft)
1	24.60	12.39
2	28.14	9.10
3	47.22	13.88
4	47.31	18.88
5	47.83	20.11

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	5.96	6.62
2	9.89	4.57
3	52.19	15.13
4	55.72	18.67
5	57.31	20.40

** Corrected JANBU FOS = 1.376 ** (Fo factor = 1.032)

Failure surface No. 2 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.30	6.70
2	9.51	4.48
3	51.69	15.00
4	55.10	18.66
5	56.88	20.54

** Corrected JANBU FOS = 1.380 ** (Fo factor = 1.034)

Failure surface No. 3 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	9.69	7.57
2	13.39	5.44

3	51.30	14.91
4	54.74	18.54
5	56.51	20.66

** Corrected JANBU FOS = 1.397 ** (Fo factor = 1.038)

Failure surface No. 4 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.26	6.95
2	10.34	4.68
3	49.82	14.54
4	53.31	18.12
5	55.63	20.96

** Corrected JANBU FOS = 1.397 ** (Fo factor = 1.039)

Failure surface No. 5 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.25	6.94
2	7.53	6.90
3	12.21	5.15
4	52.52	15.21
5	54.91	19.60
6	56.09	20.80

** Corrected JANBU FOS = 1.398 ** (Fo factor = 1.038)

Failure surface No. 6 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.40	6.73
2	7.31	6.13
3	12.22	5.15
4	50.35	14.67
5	53.64	18.44
6	55.48	21.01

** Corrected JANBU FOS = 1.398 ** (Fo factor = 1.040)

Failure surface No. 7 specified by 6 coordinate points

Point	x-surf	y-surf

No.	(ft)	(ft)
1	7.34	6.97
2	8.21	6.55
3	13.06	5.36
4	52.67	15.25
5	55.22	19.55
6	56.36	20.71

** Corrected JANBU FOS = 1.403 ** (Fo factor = 1.037)

Failure surface No. 8 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.23	7.19
2	11.16	4.89
3	52.55	15.22
4	55.13	19.50
5	56.30	20.73

** Corrected JANBU FOS = 1.406 ** (Fo factor = 1.038)

Failure surface No. 9 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.14	6.66
2	9.59	4.50
3	54.66	15.75
4	57.07	20.13
5	57.23	20.42

** Corrected JANBU FOS = 1.409 ** (Fo factor = 1.033)

Failure surface No.10 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.66	7.30
2	9.81	6.70
3	14.72	5.77
4	51.37	14.92
5	54.71	18.64
6	56.68	20.61

** Corrected JANBU FOS = 1.412 ** (Fo factor = 1.036)

```
*******************************************************************
          **
**
          **  Out of the    500 surfaces generated and analyzed by
XSTABL,  **
          **        1 surfaces were found to have MISLEADING FOS values.
**
          **
**

*******************************************************************
```

The following is a summary of the TEN most critical surfaces

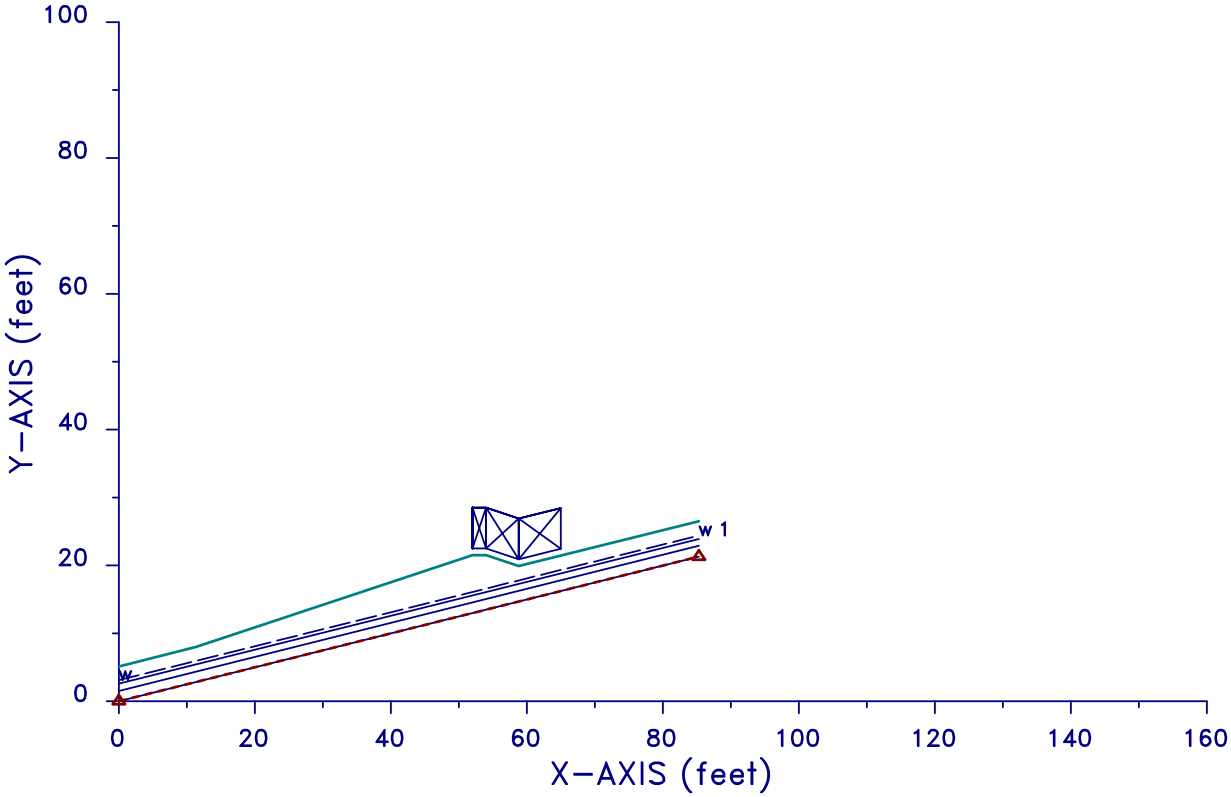
Problem Description : OCF FC Terrace Static Sat Block

	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Available Strength (lb)
1.	1.376	1.032	5.96	57.31	9.547E+03
2.	1.380	1.034	6.30	56.88	9.480E+03
3.	1.397	1.038	9.69	56.51	9.157E+03
4.	1.397	1.039	7.26	55.63	9.322E+03
5.	1.398	1.038	7.25	56.09	9.149E+03
6.	1.398	1.040	6.40	55.48	9.460E+03
7.	1.403	1.037	7.34	56.36	9.267E+03
8.	1.406	1.038	8.23	56.30	9.078E+03
9.	1.409	1.033	6.14	57.23	9.202E+03
10.	1.412	1.036	8.66	56.68	9.444E+03

* * * END OF FILE * * *

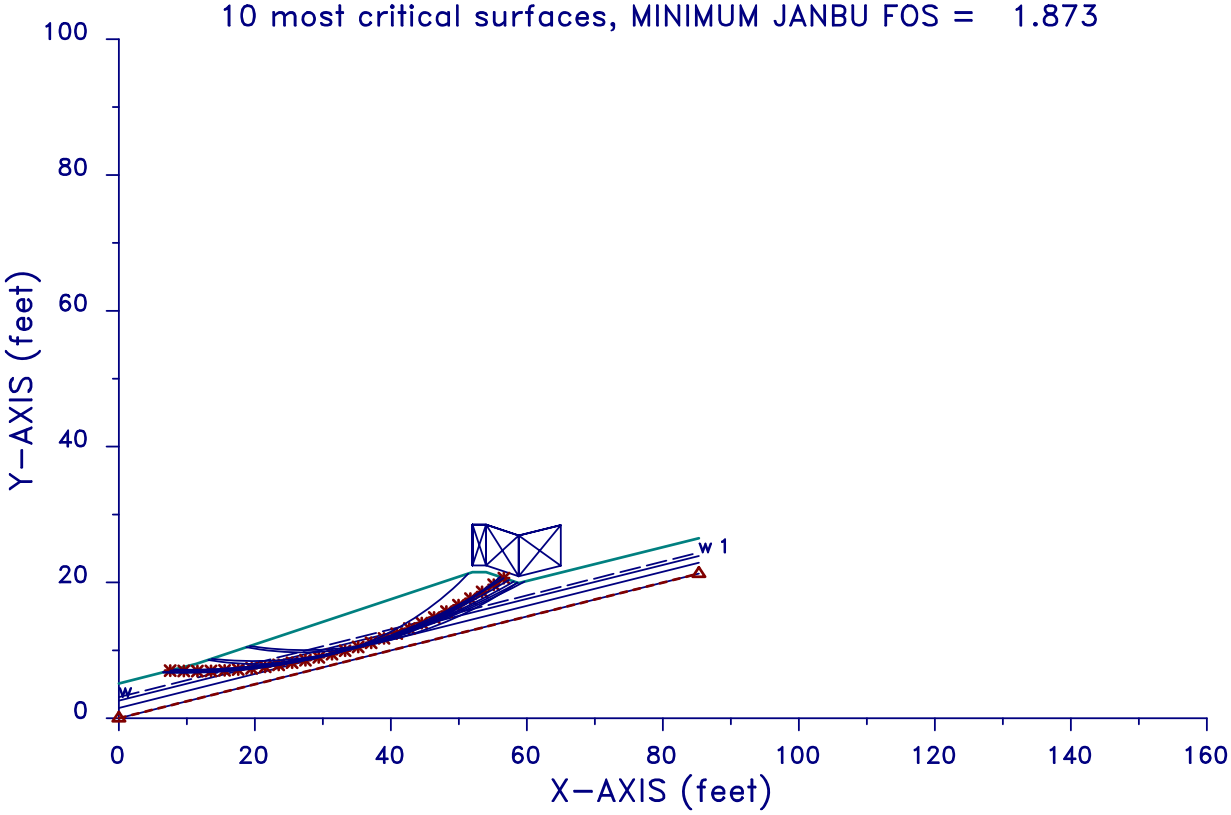
OCFTER2C 5-09-** 13:52

OCF FC Terrace Static Sat Circ



OCFTER2C 5-09-** 13:52

OCF FC Terrace Static Sat Circ
10 most critical surfaces, MINIMUM JANBU FOS = 1.873



XSTABL File: OCFTER2C 5-09-** 13:52

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 96       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.200                 96 Ä 1477 *
*****************************************
```

Problem Description : OCF FC Terrace Static Sat Circ

SEGMENT BOUNDARY COORDINATES
---

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	5.1	11.4	8.0	1
2	11.4	8.0	52.0	21.5	1
3	52.0	21.5	54.0	21.5	1
4	54.0	21.5	58.8	19.9	1
5	58.8	19.9	85.3	26.5	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	2.6	85.3	23.9	3
2	.0	1.5	85.3	22.9	4
3	.0	.0	85.3	21.3	2

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Water Constant (psf)	Surface No.
1	128.0	130.0	180.0	24.00	.000	.0	1
2	80.0	85.0	210.0	25.00	.000	.0	1
3	65.0	65.0	.0	17.00	.000	.0	1
4	128.0	130.0	180.0	24.00	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 2 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	3.10
2	85.30	24.40

BOUNDARY LOADS
---

1 load(s) specified

Load No.	x-left (ft)	x-right (ft)	Intensity (psf)	Direction (deg)
1	52.0	65.0	31.2	.0

NOTE - Intensity is specified as a uniformly distributed

force acting on a HORIZONTALLY projected surface.

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	.0	85.3	21.3

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1500 trial surfaces will be generated and analyzed.

30 Surfaces initiate from each of 50 points equally spaced along the ground surface between x = 5.0 ft
and x = 30.0 ft

Each surface terminates between x = 40.0 ft
and x = 60.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * * * * *

2.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined are displayed below - the most critical first

Failure surface No. 1 specified by 27 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.55	7.02
2	9.55	6.95
3	11.55	6.94
4	13.55	6.97
5	15.55	7.05
6	17.54	7.17
7	19.54	7.35
8	21.52	7.58
9	23.50	7.85
10	25.48	8.17
11	27.44	8.54
12	29.40	8.96
13	31.34	9.43
14	33.28	9.94
15	35.20	10.50
16	37.10	11.11
17	38.99	11.76
18	40.87	12.46
19	42.72	13.21
20	44.56	14.00
21	46.38	14.83
22	48.17	15.71
23	49.95	16.64
24	51.70	17.60
25	53.43	18.61
26	55.13	19.66
27	56.62	20.63

** Corrected JANBU FOS = 1.873 ** (Fo factor = 1.035)

Failure surface No. 2 specified by 28 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.53	6.76

2	8.53	6.73
3	10.53	6.74
4	12.53	6.80
5	14.53	6.89
6	16.52	7.03
7	18.51	7.22
8	20.50	7.45
9	22.48	7.72
10	24.46	8.03
11	26.43	8.38
12	28.39	8.78
13	30.34	9.22
14	32.28	9.70
15	34.21	10.23
16	36.13	10.79
17	38.03	11.40
18	39.93	12.05
19	41.80	12.73
20	43.67	13.46
21	45.51	14.23
22	47.34	15.04
23	49.15	15.89
24	50.94	16.77
25	52.72	17.70
26	54.47	18.66
27	56.20	19.66
28	57.37	20.38

** Corrected JANBU FOS = 1.890 ** (Fo factor = 1.033)

Failure surface No. 3 specified by 28 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.53	6.76
2	8.53	6.71
3	10.53	6.71
4	12.53	6.75
5	14.53	6.84
6	16.52	6.97
7	18.51	7.15
8	20.50	7.38
9	22.48	7.65
10	24.46	7.97
11	26.42	8.34
12	28.38	8.75
13	30.33	9.21
14	32.26	9.71
15	34.19	10.26
16	36.10	10.85
17	37.99	11.49
18	39.87	12.17

19	41.74	12.89
20	43.58	13.66
21	45.41	14.47
22	47.22	15.33
23	49.01	16.22
24	50.78	17.16
25	52.52	18.13
26	54.24	19.15
27	55.94	20.21
28	56.59	20.64

** Corrected JANBU FOS = 1.894 ** (Fo factor = 1.035)

Failure surface No. 4 specified by 24 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	13.67	8.76
2	15.67	8.58
3	17.66	8.47
4	19.66	8.42
5	21.66	8.45
6	23.66	8.54
7	25.65	8.69
8	27.64	8.92
9	29.62	9.21
10	31.59	9.57
11	33.54	10.00
12	35.48	10.49
13	37.40	11.05
14	39.30	11.67
15	41.18	12.35
16	43.03	13.10
17	44.86	13.91
18	46.66	14.78
19	48.43	15.72
20	50.17	16.71
21	51.87	17.76
22	53.54	18.86
23	55.17	20.03
24	56.15	20.78

** Corrected JANBU FOS = 1.906 ** (Fo factor = 1.042)

Failure surface No. 5 specified by 28 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.06	7.15
2	10.06	7.13

3	12.06	7.15
4	14.06	7.21
5	16.06	7.32
6	18.05	7.46
7	20.04	7.65
8	22.03	7.88
9	24.01	8.15
10	25.99	8.47
11	27.95	8.82
12	29.92	9.22
13	31.87	9.65
14	33.81	10.13
15	35.74	10.65
16	37.66	11.21
17	39.57	11.81
18	41.46	12.45
19	43.34	13.13
20	45.21	13.85
21	47.06	14.61
22	48.89	15.41
23	50.71	16.24
24	52.51	17.12
25	54.29	18.03
26	56.05	18.98
27	57.79	19.96
28	58.09	20.14

** Corrected JANBU FOS = 1.918 ** (Fo factor = 1.031)

Failure surface No. 6 specified by 29 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.53	6.76
2	8.53	6.77
3	10.53	6.82
4	12.53	6.91
5	14.52	7.03
6	16.52	7.19
7	18.51	7.39
8	20.49	7.62
9	22.48	7.89
10	24.45	8.20
11	26.42	8.54
12	28.39	8.92
13	30.34	9.34
14	32.29	9.79
15	34.23	10.27
16	36.16	10.80
17	38.08	11.36
18	39.99	11.95
19	41.89	12.58

20	43.78	13.24
21	45.65	13.94
22	47.51	14.67
23	49.36	15.44
24	51.19	16.24
25	53.01	17.08
26	54.81	17.94
27	56.60	18.84
28	58.37	19.78
29	58.67	19.94

** Corrected JANBU FOS = 1.941 ** (Fo factor = 1.029)

Failure surface No. 7 specified by 29 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.55	7.02
2	9.55	7.03
3	11.55	7.08
4	13.55	7.17
5	15.54	7.29
6	17.54	7.45
7	19.53	7.65
8	21.52	7.88
9	23.50	8.15
10	25.47	8.45
11	27.44	8.79
12	29.41	9.17
13	31.37	9.58
14	33.31	10.03
15	35.25	10.52
16	37.19	11.04
17	39.11	11.59
18	41.02	12.18
19	42.92	12.81
20	44.81	13.47
21	46.68	14.17
22	48.54	14.89
23	50.39	15.66
24	52.23	16.46
25	54.04	17.29
26	55.85	18.15
27	57.64	19.05
28	59.41	19.98
29	59.65	20.11

** Corrected JANBU FOS = 1.954 ** (Fo factor = 1.029)

Failure surface No. 8 specified by 22 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	18.78	10.45
2	20.75	10.13
3	22.73	9.89
4	24.73	9.75
5	26.73	9.69
6	28.73	9.73
7	30.72	9.86
8	32.71	10.08
9	34.69	10.39
10	36.65	10.79
11	38.59	11.28
12	40.50	11.86
13	42.39	12.52
14	44.24	13.27
15	46.06	14.11
16	47.84	15.03
17	49.57	16.02
18	51.26	17.10
19	52.89	18.25
20	54.48	19.47
21	56.00	20.77
22	56.05	20.82

** Corrected JANBU FOS = 1.981 ** (Fo factor = 1.049)

Failure surface No. 9 specified by 22 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	13.16	8.59
2	15.14	8.29
3	17.13	8.10
4	19.13	7.99
5	21.13	7.98
6	23.13	8.06
7	25.12	8.24
8	27.10	8.50
9	29.07	8.86
10	31.02	9.32
11	32.94	9.86
12	34.84	10.49
13	36.71	11.21
14	38.53	12.02
15	40.33	12.91
16	42.07	13.89
17	43.77	14.94
18	45.42	16.08
19	47.01	17.28
20	48.55	18.57

21	50.02	19.92
22	51.38	21.29

** Corrected JANBU FOS = 2.004 ** (Fo factor = 1.052)

Failure surface No.10 specified by 22 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	19.29	10.62
2	21.27	10.36
3	23.26	10.18
4	25.26	10.07
5	27.26	10.03
6	29.26	10.07
7	31.25	10.18
8	33.25	10.36
9	35.23	10.62
10	37.20	10.95
11	39.16	11.35
12	41.10	11.82
13	43.03	12.37
14	44.93	12.99
15	46.81	13.67
16	48.66	14.43
17	50.48	15.25
18	52.28	16.14
19	54.03	17.09
20	55.76	18.11
21	57.44	19.19
22	58.57	19.98

** Corrected JANBU FOS = 2.010 ** (Fo factor = 1.042)

```
*******************************************************************
          **
**
          **  Out of the   1500 surfaces generated and analyzed by
XSTABL,  **
          **        2 surfaces were found to have MISLEADING FOS values.
**
          **
**

*******************************************************************
```

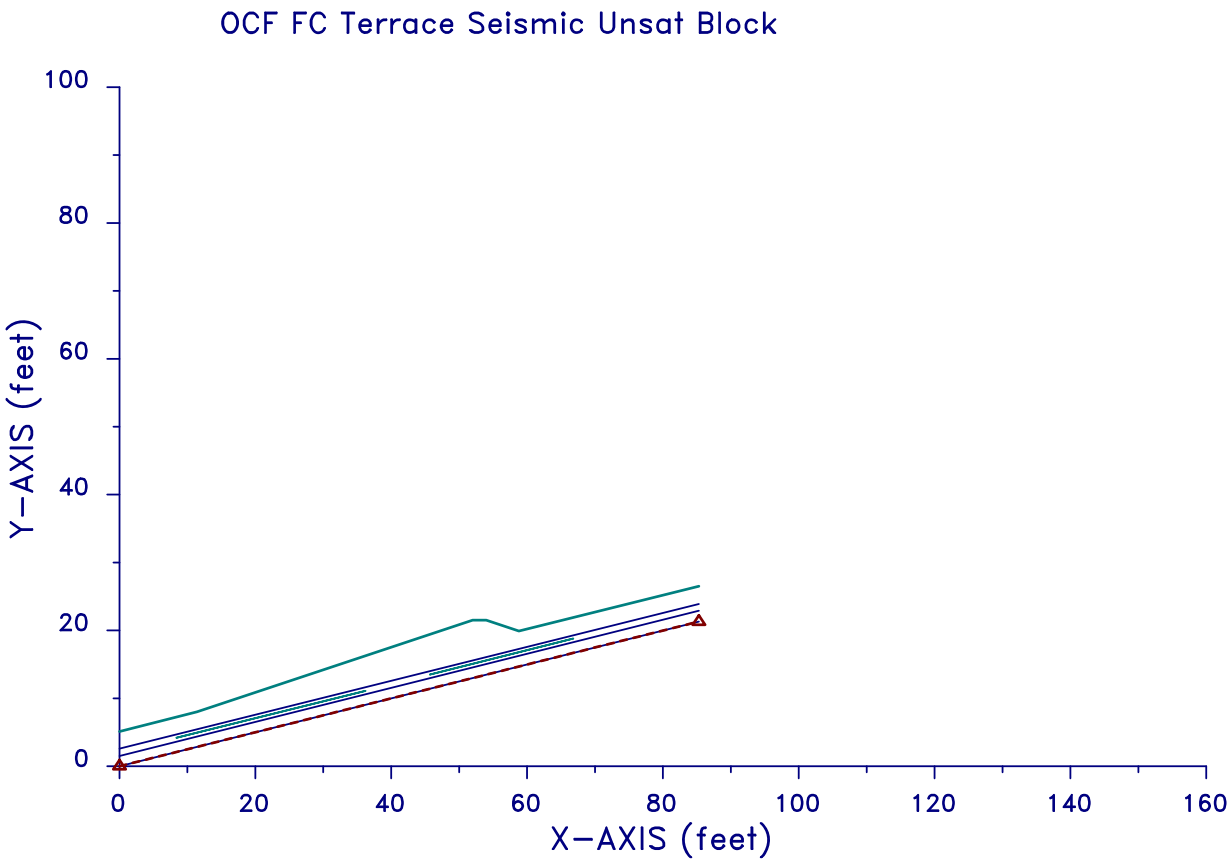
The following is a summary of the TEN most critical surfaces

Problem Description : OCF FC Terrace Static Sat Circ

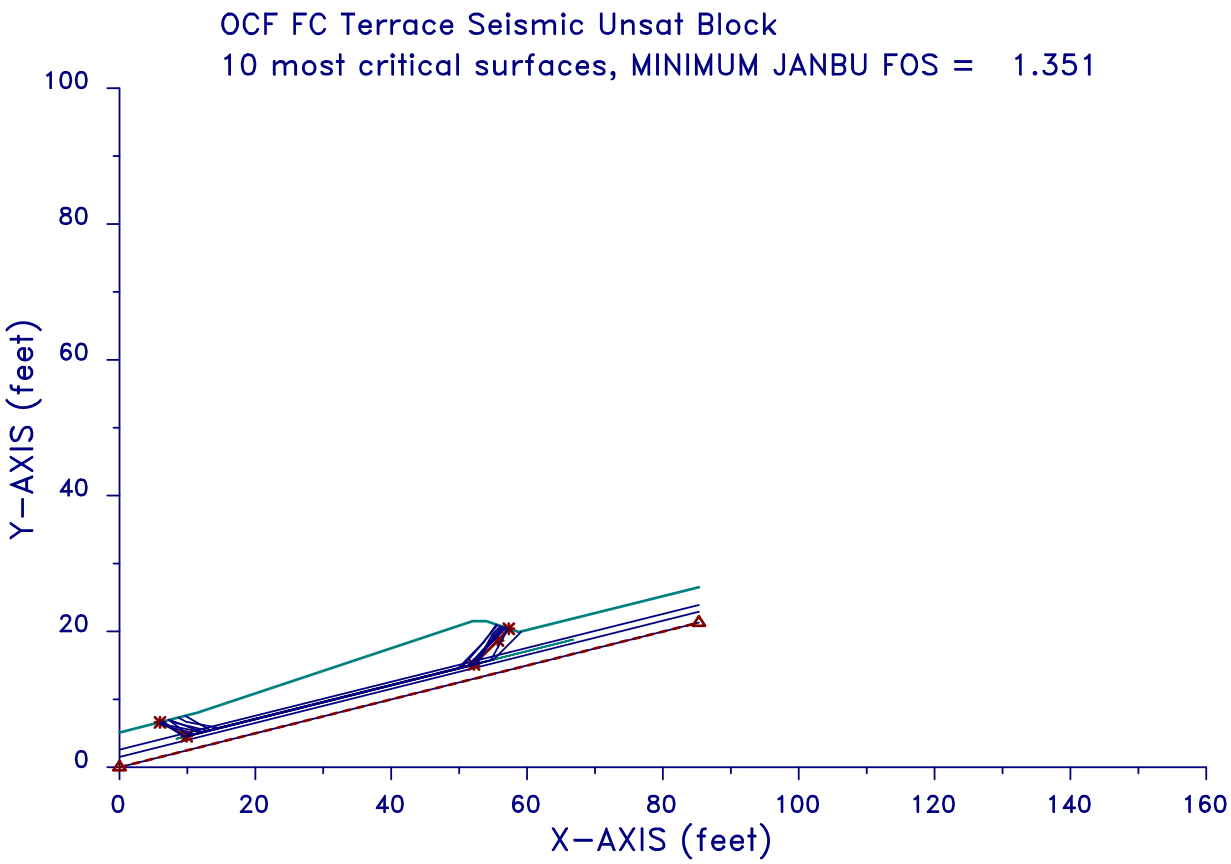
	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Available Strength (lb)
1.	1.873	1.035	7.55	56.62	1.214E+04
2.	1.890	1.033	6.53	57.37	1.252E+04
3.	1.894	1.035	6.53	56.59	1.237E+04
4.	1.906	1.042	13.67	56.15	1.107E+04
5.	1.918	1.031	8.06	58.09	1.249E+04
6.	1.941	1.029	6.53	58.67	1.288E+04
7.	1.954	1.029	7.55	59.65	1.283E+04
8.	1.981	1.049	18.78	56.05	1.020E+04
9.	2.004	1.052	13.16	51.38	9.591E+03
10.	2.010	1.042	19.29	58.57	1.042E+04

* * * END OF FILE * * *

OCFTER3B 5-09-** 13:57



OCFTER3B 5-09-** 13:57



XSTABL File: OCFTER3B 5-09-** 13:57

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 96       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.200                 96 Ä 1477 *
*****************************************
```

Problem Description : OCF FC Terrace Seismic Unsat Block

SEGMENT BOUNDARY COORDINATES
---

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	5.1	11.4	8.0	1
2	11.4	8.0	52.0	21.5	1
3	52.0	21.5	54.0	21.5	1
4	54.0	21.5	58.8	19.9	1
5	58.8	19.9	85.3	26.5	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	2.6	85.3	23.9	3
2	.0	1.5	85.3	22.9	4
3	.0	.0	85.3	21.3	2

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Water Surface Constant (psf)	No.
1	128.0	130.0	180.0	24.00	.000	.0	0
2	80.0	85.0	210.0	25.00	.000	.0	0
3	65.0	65.0	.0	17.00	.000	.0	0
4	128.0	130.0	180.0	24.00	.000	.0	0

A horizontal earthquake loading coefficient
of .031 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	.0	85.3	21.3

A critical failure surface searching method, using a random technique for generating sliding BLOCK surfaces, has been specified.

500 trial surfaces will be generated and analyzed.

2 boxes specified for generation of central block base

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * * * * *

Length of line segments for active and passive portions of sliding block is 5.0 ft

Box no.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Width (ft)
1	8.4	4.2	36.2	11.1	.0
2	45.7	13.5	66.8	18.8	.0

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined are displayed below - the most critical first

Failure surface No. 1 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	5.96	6.62
2	9.89	4.57
3	52.19	15.13
4	55.72	18.67
5	57.31	20.40

** Corrected JANBU FOS = 1.351 ** (Fo factor = 1.032)

Failure surface No. 2 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.30	6.70
2	9.51	4.48
3	51.69	15.00
4	55.10	18.66
5	56.88	20.54

** Corrected JANBU FOS = 1.357 ** (Fo factor = 1.034)

Failure surface No. 3 specified by 6 coordinate points

Point	x-surf	y-surf

No.	(ft)	(ft)
1	6.40	6.73
2	7.31	6.13
3	12.22	5.15
4	50.35	14.67
5	53.64	18.44
6	55.48	21.01

** Corrected JANBU FOS = 1.368 ** (Fo factor = 1.040)

Failure surface No. 4 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	9.69	7.57
2	13.39	5.44
3	51.30	14.91
4	54.74	18.54
5	56.51	20.66

** Corrected JANBU FOS = 1.368 ** (Fo factor = 1.038)

Failure surface No. 5 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.26	6.95
2	10.34	4.68
3	49.82	14.54
4	53.31	18.12
5	55.63	20.96

** Corrected JANBU FOS = 1.370 ** (Fo factor = 1.039)

Failure surface No. 6 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.25	6.94
2	7.53	6.90
3	12.21	5.15
4	52.52	15.21
5	54.91	19.60
6	56.09	20.80

** Corrected JANBU FOS = 1.373 ** (Fo factor = 1.038)

Failure surface No. 7 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.34	6.97
2	8.21	6.55
3	13.06	5.36
4	52.67	15.25
5	55.22	19.55
6	56.36	20.71

** Corrected JANBU FOS = 1.376 ** (Fo factor = 1.037)

Failure surface No. 8 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.66	7.30
2	9.81	6.70
3	14.72	5.77
4	51.37	14.92
5	54.71	18.64
6	56.68	20.61

** Corrected JANBU FOS = 1.379 ** (Fo factor = 1.036)

Failure surface No. 9 specified by 6 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	5.83	6.58
2	6.27	6.26
3	11.07	4.86
4	55.09	15.86
5	58.61	19.40
6	59.15	19.99

** Corrected JANBU FOS = 1.379 ** (Fo factor = 1.025)

Failure surface No.10 specified by 5 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.14	6.66
2	9.59	4.50
3	54.66	15.75

4	57.07	20.13
5	57.23	20.42

** Corrected JANBU FOS = 1.383 ** (Fo factor = 1.033)

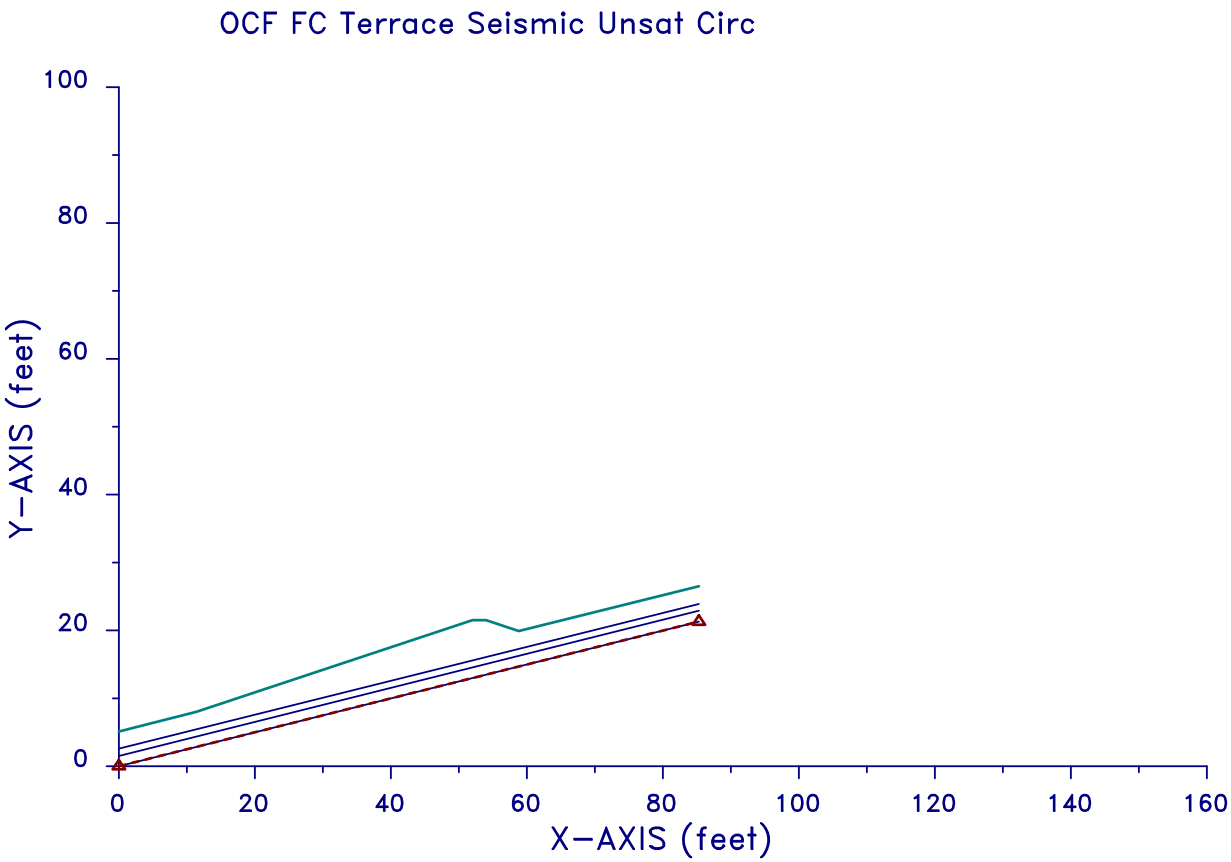
The following is a summary of the TEN most critical surfaces

Problem Description : OCF FC Terrace Seismic Unsat Block

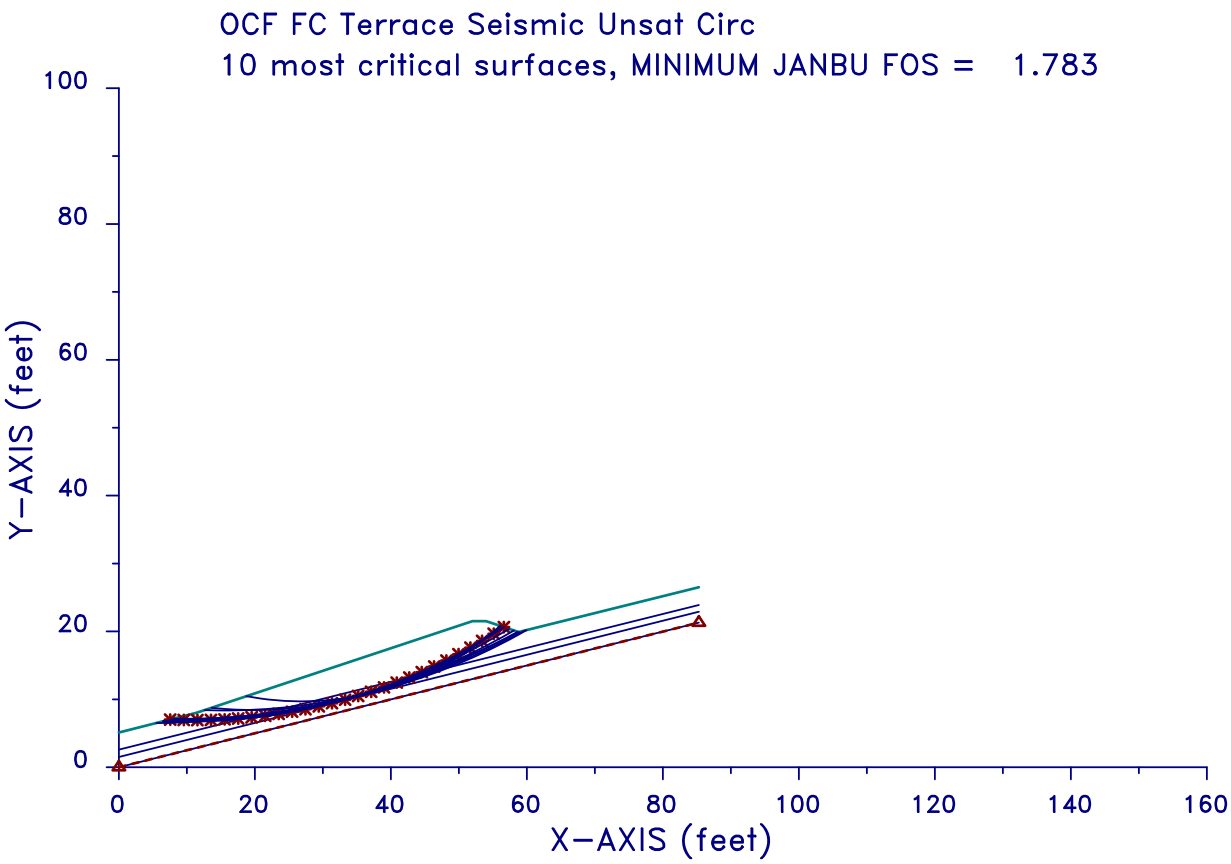
	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Available Strength (lb)
1.	1.351	1.032	5.96	57.31	1.022E+04
2.	1.357	1.034	6.30	56.88	1.015E+04
3.	1.368	1.040	6.40	55.48	1.008E+04
4.	1.368	1.038	9.69	56.51	9.761E+03
5.	1.370	1.039	7.26	55.63	9.967E+03
6.	1.373	1.038	7.25	56.09	9.795E+03
7.	1.376	1.037	7.34	56.36	9.902E+03
8.	1.379	1.036	8.66	56.68	1.003E+04
9.	1.379	1.025	5.83	59.15	1.033E+04
10.	1.383	1.033	6.14	57.23	9.922E+03

* * * END OF FILE * * *

OCFTER3C 5-09-** 14:00



OCFTER3C 5-09-** 14:00



XSTABL File: OCFTER3C 5-09-** 14:00

```
*****************************************
*              X S T A B L              *
*                                       *
*        Slope Stability Analysis       *
*               using the               *
*            Method of Slices           *
*                                       *
*         Copyright (C) 1992 Ä 96       *
*   Interactive Software Designs, Inc.  *
*        Moscow, ID 83843, U.S.A.       *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.200                 96 Ä 1477 *
*****************************************
```

Problem Description : OCF FC Terrace Seismic Unsat Circ

SEGMENT BOUNDARY COORDINATES
---

5 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	5.1	11.4	8.0	1
2	11.4	8.0	52.0	21.5	1
3	52.0	21.5	54.0	21.5	1
4	54.0	21.5	58.8	19.9	1
5	58.8	19.9	85.3	26.5	1

3 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	2.6	85.3	23.9	3
2	.0	1.5	85.3	22.9	4
3	.0	.0	85.3	21.3	2

ISOTROPIC Soil Parameters

---

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Water Surface Constant (psf)	No.
1	128.0	130.0	180.0	24.00	.000	.0	0
2	80.0	85.0	210.0	25.00	.000	.0	0
3	65.0	65.0	.0	17.00	.000	.0	0
4	128.0	130.0	180.0	24.00	.000	.0	0

A horizontal earthquake loading coefficient
of .031 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

BOUNDARIES THAT LIMIT SURFACE GENERATION HAVE BEEN SPECIFIED

LOWER limiting boundary of 1 segments:

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)
1	.0	.0	85.3	21.3

A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.

1500 trial surfaces will be generated and analyzed.

30 Surfaces initiate from each of 50 points equally spaced
along the ground surface between x = 5.0 ft
and x = 30.0 ft

Each surface terminates between x = 40.0 ft
and x = 60.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * * * * *

2.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined are displayed below - the most critical first

Failure surface No. 1 specified by 27 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.55	7.02
2	9.55	6.95
3	11.55	6.94
4	13.55	6.97
5	15.55	7.05
6	17.54	7.17
7	19.54	7.35
8	21.52	7.58
9	23.50	7.85
10	25.48	8.17
11	27.44	8.54
12	29.40	8.96
13	31.34	9.43
14	33.28	9.94

15	35.20	10.50
16	37.10	11.11
17	38.99	11.76
18	40.87	12.46
19	42.72	13.21
20	44.56	14.00
21	46.38	14.83
22	48.17	15.71
23	49.95	16.64
24	51.70	17.60
25	53.43	18.61
26	55.13	19.66
27	56.62	20.63

** Corrected JANBU FOS = 1.783 ** (Fo factor = 1.035)

Failure surface No. 2 specified by 28 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.53	6.76
2	8.53	6.73
3	10.53	6.74
4	12.53	6.80
5	14.53	6.89
6	16.52	7.03
7	18.51	7.22
8	20.50	7.45
9	22.48	7.72
10	24.46	8.03
11	26.43	8.38
12	28.39	8.78
13	30.34	9.22
14	32.28	9.70
15	34.21	10.23
16	36.13	10.79
17	38.03	11.40
18	39.93	12.05
19	41.80	12.73
20	43.67	13.46
21	45.51	14.23
22	47.34	15.04
23	49.15	15.89
24	50.94	16.77
25	52.72	17.70
26	54.47	18.66
27	56.20	19.66
28	57.37	20.38

** Corrected JANBU FOS = 1.795 ** (Fo factor = 1.033)

Failure surface No. 3 specified by 28 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.53	6.76
2	8.53	6.71
3	10.53	6.71
4	12.53	6.75
5	14.53	6.84
6	16.52	6.97
7	18.51	7.15
8	20.50	7.38
9	22.48	7.65
10	24.46	7.97
11	26.42	8.34
12	28.38	8.75
13	30.33	9.21
14	32.26	9.71
15	34.19	10.26
16	36.10	10.85
17	37.99	11.49
18	39.87	12.17
19	41.74	12.89
20	43.58	13.66
21	45.41	14.47
22	47.22	15.33
23	49.01	16.22
24	50.78	17.16
25	52.52	18.13
26	54.24	19.15
27	55.94	20.21
28	56.59	20.64

** Corrected JANBU FOS = 1.800 ** (Fo factor = 1.035)

Failure surface No. 4 specified by 24 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	13.67	8.76
2	15.67	8.58
3	17.66	8.47
4	19.66	8.42
5	21.66	8.45
6	23.66	8.54
7	25.65	8.69
8	27.64	8.92
9	29.62	9.21
10	31.59	9.57
11	33.54	10.00
12	35.48	10.49

13	37.40	11.05
14	39.30	11.67
15	41.18	12.35
16	43.03	13.10
17	44.86	13.91
18	46.66	14.78
19	48.43	15.72
20	50.17	16.71
21	51.87	17.76
22	53.54	18.86
23	55.17	20.03
24	56.15	20.78

** Corrected JANBU FOS = 1.811 ** (Fo factor = 1.042)

Failure surface No. 5 specified by 28 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	8.06	7.15
2	10.06	7.13
3	12.06	7.15
4	14.06	7.21
5	16.06	7.32
6	18.05	7.46
7	20.04	7.65
8	22.03	7.88
9	24.01	8.15
10	25.99	8.47
11	27.95	8.82
12	29.92	9.22
13	31.87	9.65
14	33.81	10.13
15	35.74	10.65
16	37.66	11.21
17	39.57	11.81
18	41.46	12.45
19	43.34	13.13
20	45.21	13.85
21	47.06	14.61
22	48.89	15.41
23	50.71	16.24
24	52.51	17.12
25	54.29	18.03
26	56.05	18.98
27	57.79	19.96
28	58.09	20.14

** Corrected JANBU FOS = 1.816 ** (Fo factor = 1.031)

Failure surface No. 6 specified by 29 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	6.53	6.76
2	8.53	6.77
3	10.53	6.82
4	12.53	6.91
5	14.52	7.03
6	16.52	7.19
7	18.51	7.39
8	20.49	7.62
9	22.48	7.89
10	24.45	8.20
11	26.42	8.54
12	28.39	8.92
13	30.34	9.34
14	32.29	9.79
15	34.23	10.27
16	36.16	10.80
17	38.08	11.36
18	39.99	11.95
19	41.89	12.58
20	43.78	13.24
21	45.65	13.94
22	47.51	14.67
23	49.36	15.44
24	51.19	16.24
25	53.01	17.08
26	54.81	17.94
27	56.60	18.84
28	58.37	19.78
29	58.67	19.94

** Corrected JANBU FOS = 1.833 ** (Fo factor = 1.029)

Failure surface No. 7 specified by 29 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	7.55	7.02
2	9.55	7.03
3	11.55	7.08
4	13.55	7.17
5	15.54	7.29
6	17.54	7.45
7	19.53	7.65
8	21.52	7.88
9	23.50	8.15
10	25.47	8.45
11	27.44	8.79
12	29.41	9.17

13	31.37	9.58
14	33.31	10.03
15	35.25	10.52
16	37.19	11.04
17	39.11	11.59
18	41.02	12.18
19	42.92	12.81
20	44.81	13.47
21	46.68	14.17
22	48.54	14.89
23	50.39	15.66
24	52.23	16.46
25	54.04	17.29
26	55.85	18.15
27	57.64	19.05
28	59.41	19.98
29	59.65	20.11

** Corrected JANBU FOS = 1.846 ** (Fo factor = 1.029)

Failure surface No. 8 specified by 22 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	18.78	10.45
2	20.75	10.13
3	22.73	9.89
4	24.73	9.75
5	26.73	9.69
6	28.73	9.73
7	30.72	9.86
8	32.71	10.08
9	34.69	10.39
10	36.65	10.79
11	38.59	11.28
12	40.50	11.86
13	42.39	12.52
14	44.24	13.27
15	46.06	14.11
16	47.84	15.03
17	49.57	16.02
18	51.26	17.10
19	52.89	18.25
20	54.48	19.47
21	56.00	20.77
22	56.05	20.82

** Corrected JANBU FOS = 1.878 ** (Fo factor = 1.049)

Failure surface No. 9 specified by 29 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	5.51	6.50
2	7.51	6.54
3	9.51	6.62
4	11.51	6.73
5	13.50	6.87
6	15.49	7.04
7	17.48	7.25
8	19.47	7.49
9	21.45	7.77
10	23.42	8.08
11	25.39	8.42
12	27.36	8.80
13	29.32	9.21
14	31.27	9.65
15	33.21	10.12
16	35.14	10.63
17	37.07	11.17
18	38.99	11.74
19	40.89	12.35
20	42.79	12.99
21	44.67	13.65
22	46.55	14.35
23	48.41	15.09
24	50.26	15.85
25	52.09	16.64
26	53.91	17.47
27	55.72	18.33
28	57.51	19.21
29	58.90	19.92

** Corrected JANBU FOS = 1.893 ** (Fo factor = 1.027)

Failure surface No.10 specified by 26 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	12.65	8.42
2	14.65	8.37
3	16.65	8.37
4	18.65	8.42
5	20.65	8.51
6	22.65	8.65
7	24.64	8.83
8	26.62	9.05
9	28.61	9.32
10	30.58	9.64
11	32.55	10.00
12	34.51	10.40
13	36.46	10.84

14	38.40	11.33
15	40.32	11.87
16	42.24	12.44
17	44.14	13.06
18	46.03	13.72
19	47.90	14.43
20	49.76	15.17
21	51.60	15.96
22	53.42	16.79
23	55.22	17.65
24	57.00	18.56
25	58.76	19.51
26	59.95	20.19

** Corrected JANBU FOS = 1.894 ** (Fo factor = 1.031)

```
*******************************************************************
          **
**
          **  Out of the   1500 surfaces generated and analyzed by
XSTABL,   **
          **        1 surfaces were found to have MISLEADING FOS values.
**
          **
**

*******************************************************************
```

The following is a summary of the TEN most critical surfaces

Problem Description : OCF FC Terrace Seismic Unsat Circ

	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Available Strength (lb)
1.	1.783	1.035	7.55	56.62	1.256E+04
2.	1.795	1.033	6.53	57.37	1.295E+04
3.	1.800	1.035	6.53	56.59	1.278E+04
4.	1.811	1.042	13.67	56.15	1.142E+04

5.	1.816	1.031	8.06	58.09	1.289E+04
6.	1.833	1.029	6.53	58.67	1.329E+04
7.	1.846	1.029	7.55	59.65	1.323E+04
8.	1.878	1.049	18.78	56.05	1.048E+04
9.	1.893	1.027	5.51	58.90	1.373E+04
10.	1.894	1.031	12.65	59.95	1.242E+04

* * * END OF FILE * * *