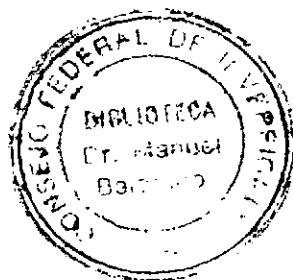


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PROVINCIA DE SANTA FE

DIRECCION PROVINCIAL DE VIALIDAD

**Avenida de Circunvalación
a la ciudad de Santa Fe.
Tramo Ruta Nacional N°11 -
Autopista Rosario / Santa Fe.**

**PROYECTO HIDRAULICO
Y ANTREPROYECTO
DE LA OBRA DE DEFENSA
CONTRA INUNDACIONES**

Informe Parcial N° 2

Ing. Daniel E. WEBER

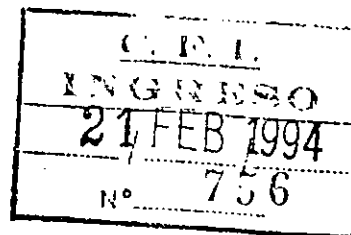
Santa Fe, Febrero 1994.

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Santa Fe, 8 de febrero de 1994.-

Señor Secretario General

Consejo Federal de Inversiones



Ing. Juan José CIACERA

Tengo el agrado de dirigirme a usted a fin de remitirle de acuerdo al Contrato de Obra, Expediente N° 2591 para la realización del proyecto "Avenida de Circunvalación a la Ciudad de Santa Fe, tramo Ruta Nacional N°11 - Autopista Rosario / Santa Fe", el Informe Parcial N°2 de acuerdo al punto 5, Informes, del Anexo I , Plan de Trabajo.

Por tal motivo, solicito a usted se proceda a la Certificación de la presentación para el pago del 25% del monto global del Contrato según el ANEXO V - Plan de Pagos. Adjuntamos las facturas correspondientes.

Sin otro particular lo saludo muy atentamente.

A handwritten signature in dark ink, appearing to read 'Daniel Weber'.

Ing. Daniel WEBER

L.E. 4.751.297

De acuerdo con el contrato el experto entrega un (1) ejemplar directamente a la D.P.V. Santa Fe y tres (3) al CFI. De ellos, dos (2) ejemplares se reservan en el Área para su evaluación.

A handwritten signature in dark ink, appearing to read 'Carlos A. Landó'.

Ing. Carlos A. Landó

EQUIPO DE TRABAJO

EXPERTO: Ing. Daniel Eduardo WEBER.

COLABORADOR: Lic. Jorge Eduardo CAMUSSO

Ing. Juan Cristóbal ACUÑA.

AYUDANTE ADMINISTRATIVO: Leticia N. DEBUCK FANTIN.

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3. PROYECTO DE OBRA DE DEFENSA.

En el Proyecto Estructural de las obras de defensa, se estableció como premisa, garantizar la estabilidad global y local del cuerpo de presa, y su impermeabilidad, en estados de sollicitaciones críticas respecto de los niveles de crecida, efecto del oleaje y parámetros resistentes de los suelos de fundación.

En el Proyecto Estructural se analizan separadamente los dos siguientes casos:

I.- Defensas existentes que deben ser acondicionadas para superar con éxito las exigencias de hipótesis de cargas hidráulicas críticas como las que impusieron las crecientes de 1982, 1983 y 1992.

A estas obras se las acondicionó armónicamente a las prestaciones del nuevo proyecto integral.

En general se mantienen los paramentos de aguas arriba (paramento mojado), y se reacondiciona el paramento de aguas abajo (paramento seco).

El nivel de coronamiento existente sufre un pequeño recrecimiento y se adiciona la presencia de un muro rompeola, que trabaja en condiciones de exigencias excepcionales, que absorbe los efectos dinámicos de la marea eólica y oleaje. Además evita un aumento significativo en el volumen de material de aporte para lograr la protección contra crecidas.

Simultáneamente este muro evita la reubicación de líneas de alta tensión que transitan longitudinalmente el coronamiento de la presa y lo atraviesan en las proximidades de la Estación Transformadora Santa Fe Oeste.

El pequeño recrecimiento del coronamiento y la implantación del muro permiten mantener en el tránsito del coronamiento la distancia eléctrica mínima de seguridad que requieren los conductores en carga.

Se prevé el acondicionamiento de la protección impermeable del paramento mojado y el recubrimiento vegetal en el paramento seco.

II.- Defensas a construir.

En estas obras de retención se consideraron:

- a- Las etapas constructivas que surgen de los niveles de cota de fundación, respecto de los niveles medios del río Salado, que superan anualmente al anterior. Esto hace necesario la construcción de

una banqueta refulada que sirva de apoyo y desplante en seco del recrecimiento de las obras.

- b- La poca capacidad portante de los suelos de fundación, arcillas blandas normalmente consolidadas, permitieron calcular un asentamiento del orden de los 32 cm por la sobrecarga incorporada con la construcción del terraplén hasta su coronamiento.

No es conveniente acelerar el proceso de consolidación con drenes de arena en la fundación, ya que estos pueden intervenir desfavorablemente en el incremento de las presiones neutras por filtración.

Se deben evitar estructuras rígidas que no acompañen los asentamientos diferidos del cuerpo de presa.

Este mismo suelo obliga a la ejecución de taludes más tendidos para lograr la estabilidad global, e incorpora la barrera de filtración en el cuerpo de la presa por intermedio de un núcleo impermeable, en sustitución a la protección superficial impermeable de talud que se utilizó en el punto I.

- c- El volumen de material necesario del perfil de presa, en definitiva, surge del análisis de la estabilidad global, tipo de yacimiento a utilizar, metodología constructiva, asentamientos máximos esperados y barrera de impermeabilización.

En ambas secciones características de presa se ubica el muro rompeolas el cual se calculó con los siguientes condicionantes:

- * velocidad máxima del viento en dirección perpendicular al muro $V = 20 \text{ m/s} = 72 \text{ km/hora}$
- * altura de ola no excedida en más del 1% $h_{1\%} = 1.00 \text{ m}$
- * nivel máximo de aguas calmas (nivel estático de diseño) cota + 16.20 IGM
- * la ola rompe en aguas poco profundas, cuando el tirante de agua con respecto al nivel máximo en calma es del orden de 1.25 m la altura de la ola
- * Se supone el plano de acortamiento (restricción al ascenso de talud de la ola), coincidente con el paramento vertical del muro.
- * Se determina la altura de ascenso de la ola rompiente y la presión ejercida sobre el paramento, en flujo y reflujo.

La sección del muro se adoptó de manera de tener un límite fijo entre el coronamiento horizontal terraplenado y talud descendente del paramento mojado, de manera que armonice hacia el interior un parapeto que obstaculice lo menos posible la visual; y desde el exterior tenga la configuración de un rompeola.

El coeficiente de seguridad al vuelco y deslizamiento de estos muros supera el valor de 1.5 en flujo y reflujo con la reacción de la resistencia pasiva del suelo de fundación, además de la colaboración de la superficie de corte en el plano de fundación, donde se consideró el efecto de subpresión en función del ascenso de ola sobre el paramento.

Una optimización de la sección del muro permitió una economía de obra con respecto al volumen de material cohesivo que sería necesario adicionar para cumplir esa función si se considerara el ascenso total de la ola sobre paramento mojado y nivel de coronamiento 17.50.

Este muro, cumple además como se ha dicho, con la ventaja de mantener las líneas de transmisión de energía que recorren el coronamiento longitudinalmente como se detalla en el documento anexo, foto N° 7 Planimetría y cortes.

3.1. ESTABILIDAD DE TALUDES.

I. VERIFICACION DE ESTABILIDAD.

El terraplén se construirá con suelos cohesivos de yacimientos ubicados próximos al emplazamiento, y que fueran localizados por la D.P.V..

De los datos obtenidos por D.P.V., sobre 31 perforaciones realizadas, es posible clasificar al suelo (CLASIFICACION S.U.C.S.) como CL, suelos aptos por su utilización como terraplén de defensa.

Los suelos CL, serán colocados en capas desagregadas, de un espesor menor a 30 cm, con contenidos de humedad, próxima a la óptima, para su posterior compactación.

Dado que estos suelos tienen como característica la de sufrir grandes cambios volumétricos entre sus estados seco y húmedo, deberán colocarse en obra cuidadosamente y con una correcta compactación para lograr la densidad seca máxima, a los fines de reducir a un mínimo el contenido de humedad que pueda incorporarse. Se evitará así cambios volumétricos de importancia en el cuerpo del

terraplén, que aseguren de esta manera la estabilidad del mismo con respecto a ese fenómeno.

Los datos del ensayo PROCTOR realizado por la D.P.V. arrojan los siguientes datos:

$$D_s \text{ máx.} = 1.694$$

$$H \text{ opt} = 18.3\%$$

$$LL = 29\%$$

$$LP = 17.7\%$$

$$IP = 11.3\% \quad - \text{ suelo de mediana a baja plasticidad.}$$

89% pasa #200
clasificado como A6 en el sistema HRB.

El "suelo de yacimiento" obtenido como valores promedios de los 31 ensayos realizados por D.P.V., tienen las siguientes características:

$$\overline{LL} = 36\%$$

$$\overline{LP} = 19\%$$

$$\overline{IP} = 17\%$$

% pasa #200 = 83
clasificado como A6 en el sistema HRB
e índice de grupo IG = 13.

Con estos datos, se definieron en forma conservadora los siguientes valores, para el cálculo del terraplén a construir con suelos cohesivos:

$$C = 0,4 \text{ kg-cm}^{-2}$$

$$\phi (\psi) = 4^\circ$$

El diseño adoptado del terraplén permite que su construcción sea simple, y asegura la estabilidad con un coeficiente de seguridad acorde al fin de resguardo de vidas humanas y bienes que tiene la defensa. La cota adoptada para el coronamiento del terraplén de defensa es de + 16.75m IGM.

Dicha cota es complementada hasta la cota de coronamiento de proyecto : + 17.50 IGM, con un muro rompeola de H²A°.

Una vez definida la cota de coronamiento, el siguiente paso fue la adopción de los taludes de aguas arriba y aguas abajo; de manera de asegurar una adecuada estabilidad del conjunto terraplén - suelo de fundación.

Una de las tareas más importantes consistió en el análisis de los distintos perfiles geotécnicos y la selección de un modelo matemático para el cálculo de la estabilidad del conjunto.

Dicho análisis se realizó en base a un programa computacional de modelación matemática del método rotacional según la formula de Bishop modificada, programa desarrollado en la Universidad de Perdue (EEUU), verificándose superficies de fallas circulares. (Ver ANEXO I)

Dadas las características propias de este proyecto, se dividió, para un mejor estudio y definición de la misma, se dividió a la obra de Defensa contra inundaciones en tramos:

TRAMO I: desde el comienzo del actual terraplén Irigoyen hasta el cruce con las vías del FCGBM.

En este tramo, el recubrimiento del talud de aguas arriba está en buena condiciones, por lo que se decidió su mantenimiento como tal, debiéndose proceder únicamente a la reparación del tratamiento asfáltico existente, (siendo el talud existente de aproximadamente pendiente 1:3). Se realizará únicamente un alteo del coronamiento a cota + 16.75 IGM y colocación del muro rompeola, y una adecuación del perfil de aguas abajo. Los taludes adoptados son:

1- Aguas arriba = 1:2 desde el coronamiento +16.75 IGM hasta la intersección del paramento existente.

2- Aguas abajo = 1:2.5

TRAMO II: desde el cruce de las vías del FCGBM hasta el inicio del nuevo terraplén.

En este tramo el recubrimiento existente está muy deteriorado, por lo que se decidió su remoción y perfilado, conjuntamente con el alteo del coronamiento del terraplén y colocación de una protección vegetal.

Los taludes adoptados son:

1- Aguas arriba :

* 1:2 descendente desde el coronamiento del terraplén hasta la cota + 15.50 IGM

- * 1:3 descendente desde la cota 15.50 IGM hasta la intersección con el talud existente por encima de la cota + 11.50 IGM; ó hasta esa cota de no haber intersección.
- * 1:6 descendente a partir de la cota 11.50 IGM hasta llegar al nivel de terreno natural, cuando previamente no se produce intersección con el talud existente; ó 1:6 descendente a partir de la intersección del talud 1:3 con el perfil existente, y desde allí hasta el terreno natural.

2- Aguas abajo : 1:2.5

TRAMO III: este tramo responde al terraplén nuevo y estará compuesto por una banqueta de arena refulada libre desde cota + 13.50 IGM, con taludes estimados en un valor de 1:30. Sobre ésta apoyará un terraplén de suelos cohesivos, cuyos taludes serán:

1- Aguas arriba = 1:3

2- Aguas abajo = 1:2

Una vez adoptados los taludes, se verificaron la estabilidad y coeficiente de seguridad de los paramentos de aguas arriba y de aguas abajo, con la condición más desfavorable correspondiente al máximo nivel de agua esperado en el río Salado y considerando saturado a todo el cuerpo del terraplén. Dicha condición es extremadamente conservadora, dado que la poca permanencia del nivel correspondiente a la crecida de proyecto, hace improbable, para el tipo de suelos que conformará el terraplén, que este se llegue a saturar completamente, estableciéndose un flujo estacionario dentro del cuerpo del mismo.

Un par de ejes coordenados, x e y, permite ubicar el centro del círculo péximo, que se corresponde con una superficie circular de deslizamiento, de menor coeficiente de seguridad, indicándose también su radio. (Ver ANEXO I)

Los parámetros de corte utilizados en los cálculos, fueron extraídos del "Estudio de Mecánica de Suelos" realizado por la Gerencia Proyectos Litoral de AyEE en el marco de un convenio con la Provincia de Santa Fe y que fuera entregado como antecedente técnico por el comitente. Ello se realizó de esta manera, dado que los datos de parámetros de corte producidos por la D.P.V. en la campaña solicitada, fueron escasos y no representativos por su poco número.

En dicho informe, en su punto IV.2. tramo Ruta Nacional N° 11 - E.T. Santa Fe (Terraplén Irigoyen), se recomienda para las verificaciones de estabilidad, el empleo de las siguientes parámetros geotécnicos:

*** Cuerpo del Terraplén Irigoyen.**

1) Suelos a Humedad Natural.

Tipo de suelos:

$$N_{(SPT)} = 12$$

$$\phi (\varphi) = 10^{\circ}$$

$$C = 0,25 \text{ kg/cm}^2$$

$$\gamma (\gamma) h = 1,75 \text{ t/m}^3$$

2) Suelos Saturados.

Tipo de suelos:

$$N_{(SPT)} = 8$$

$$\phi (\varphi) = 7^{\circ}$$

$$C = 0,25-0,30 \text{ kg/cm}^2$$

$$\gamma (\gamma) h = 1,95 \text{ t/m}^3$$

*** Suelo de Fundación.**

Se presentan dos perfiles típicos, cuyo límite es la zona donde están las vías del FCGMB.

Fundación I.

| Prof. (m) | S.U.C.S. | N | $\phi (\varphi) (^{\circ})$ | $C (\text{kg/cm}^2)$ | $(\gamma)' (\text{t/m}^3)$ |
|-----------|----------|------|-----------------------------|----------------------|----------------------------|
| 0,00-1,50 | CL/ML | 3 | 5 | 0,100 | 0,85 |
| 1,50-6,50 | CL/ML/MH | 6 | 5 | 0,300 | 0,90 |
| 6,50-7,50 | SM | 5-10 | 15 | 0,100 | 0,95 |
| >7,50 | SM-SP | 15 | 22 | 0 | 1,00 |

Fundación II.

| Prof. (m) | S.U.C.S. | N | $\phi(\psi)(^\circ)$ | $C(\text{kg/cm}^2)$ | $(\gamma)'(\text{t/m}^3)$ |
|-----------|-------------|------|----------------------|---------------------|---------------------------|
| 0,00-6,00 | CL/CL-ML/MH | 3 | 4,5 | 0,100-0,150 | 0,85 |
| 6,00-7,00 | SM | 5-13 | 15 | 0,100 | 0,95 |
| >7,50 | SM-SP | 15 | 22. | 0 | 1,00 |

Estos parámetros corresponden a los ya mencionados tramos I y II de la defensa.

En cuanto al tramo III, aquél que es totalmente nuevo, se aplicó las recomendaciones dadas en el punto IV.3. de dicho informe, que para los cálculos de estabilidad dá los siguientes valores:

| S.U.C.S. | $\phi(\psi)(^\circ)$ | $C(\text{kg/cm}^2)$ | $(\gamma)'(\text{t/m}^3)$ | cota del lecho |
|----------|----------------------|---------------------|---------------------------|----------------|
| CH | 3 | 0,150 | 0,90 | + 9 IGM |
| CL | 3 | 0,100 | 0,90 | + 5 IGM |
| SM | 10 | 0,100 | 0,95 | + 4 IGM |
| SM-SP/SP | 24 | 0 | 1,00 | ? |

En tanto que para el terraplén a construir se tomaron los siguientes parámetros de corte:

1) Para arena refulada libre:

$$C = 0 \quad \phi(\psi) = 30^\circ$$

$$(\gamma)'_h = 1,8 \text{ t/m}^3 \quad \text{y} \quad (\gamma)'_{\text{sat}} = 2 \text{ t/m}^3$$

2) Terraplenes, suelos cohesivos:

$$C = 0,4 \text{ kg/cm}^2 \quad \phi(\psi) = 4^\circ$$

$$(\gamma)'_h = 1,9 \text{ t/m}^3 \quad \text{y} \quad (\gamma)'_{\text{sat}} = 2,0 \text{ t/m}^3$$

Un párrafo aparte merece las características de la zona en donde la Municipalidad de Santa Fe construyó una banqueta con material refulado, detectado en la perforación N° 1 efectuada por la D.P.V. el 28/10/93, como integrada por arcillas arenosas grisáceas oscuras de aprox. 1,30 m de profundidad, y otra capa subyacente de arcillas plásticas negruzcas de aprox. 1,50 m de espesor. Los valores de los

parámetros de suelo adoptados, basados en el ensayo de penetración normal (SPT) realizado son:

capa superficial $\Rightarrow N=1 \rightarrow C=0,5 \text{ t/m}^2$ y

$$\phi (\psi) = 0$$

capa subyacente $\Rightarrow N=6 \rightarrow C=1 \text{ t/m}^2$ y

$$\phi (\psi) = 0$$

$$(\gamma)_{\text{sat}} = 1,8 \text{ t/m}^3 \equiv (\gamma)_{\text{h}}$$

Otro estudio fue realizado a pedido de los proyectistas viales de la D.P.V., para seleccionar los taludes de la multitrocha en los tramos de acceso al puente sobre las vías del FCGBM, dada su gran altura (alrededor de los 13m).

Se procedió a aplicar el modelo con los datos correspondientes a parámetros de corte anteriormente especificados y el agregado de una sobrecarga de tránsito, correspondiente a la carga máxima de tránsito especificada por la D.P.V.. Se realizó un estudio con 3 taludes distintos, para un terraplén construido con arena refulada contenida lateralmente. La siguiente tabla muestra los coeficientes de seguridad que se obtuvieron:

CALCULO COEFICIENTE DE ESTABILIDAD

Perfil Progresiva 1+385,34

| PENDIENTE | COEFICIENTE | OBSERVACIONES |
|-----------|-------------|------------------------|
| 1:3 | 1,22 | CIRCULOS PROFUNDOS |
| | 1,31 | FALLA LOCALIZADA TALUD |
| 1:3,5 | 1,28 | CIRCULOS PROFUNDOS |
| | 1,39 | FALLA LOCALIZADA TALUD |
| 1:4 | 1,43 | CIRCULOS PROFUNDOS |
| | 1,53 | FALLA LOCALIZADA TALUD |

Adaptándose en forma conjunta con el equipo de proyecto vial, el talud 1:4 para la máxima altura y luego, a medida que la misma va disminuyendo, el talud también lo hace progresivamente, hasta alcanzar el valor 1:3, adoptado para la traza en general.

Cambio de talud de la multitrocha en función de su altura:

| PROG. MULTITROCHA | PERFIL ESTUDIO | h | TALUD |
|----------------------|-------------------|-------|-------|
| 973 | cp 1000 | 1,20 | 1:3 |
| 1082 | cp 1300 | 3,60 | 1:3,3 |
| 1185 | cp 1400 | 8,70 | 1:3,6 |
| 1285 | cp 1500 | 11,00 | 1:4 |
| 1386 | cp 1600 | 12,80 | 1:4 |
| 1486 | cp 1700 | 10,60 | 1:4 |
| 1588 | cp 1800 | 8,60 | 1:3,5 |
| 1692 | cp 1900 | 2,10 | 1:3,0 |

3.2. PROTECCION DE TERRAPLENES.

I.- INTRODUCCION

Las protecciones de terraplenes tienden a disminuir la acción destructiva sobre los mismos, provocada por efectos erosivos de desmoronamiento por oleaje y carcavamiento en el caso de precipitaciones; y por otro lado completa una visión paisajística del terreno circundante a los sectores de emplazamiento de las obras.

Se asume que una cubierta adecuada que combine ambos requisitos es la diagramación e implante de una masa vegetal, densa, tanto en su parte aérea como subterránea (arraige) para aumentar el grado de agregación y estabilidad de las partículas del terreno sometidas a estos efectos.

II.- OBJETIVOS

Realizar un diagrama de cobertura vegetal con especies adaptadas a la zona con el propósito de :

- * minimizar los efectos erosivos de terraplenes de defensa contra crecidas derivados del oleaje, marea eólica y lluvias locales.
- * brindar una franja de seguridad a través de barreras vegetales en las áreas perimetrales a los reservorios de aguas
- * ofrecer una adecuada visión paisajística a través de la combinación de especies a implantar de provada adaptación al medio
- * recomendar sobre cobertura de espacios verdes en áreas linderas a las obras proyectadas.

En general la cubierta propuesta debe ofrecer una cobertura de crecimiento escalonado en el tiempo, mayor economicidad en su efectivización y fácil mantenimiento operativo.

III.- ANTECEDENTES - METODOLOGIA

La protección de taludes y/o barrancas mediante métodos biológicos en base al desarrollo de estructuras herbáceas y/o arbóreas han sido poco desarrollada en el país, con escasa trascendencia bibliográfica. La

documentación mas frondosa provienen de Vialidad Provincial, Agua y Energía y Ferrocarriles. Recientemente y con motivo de obras de protección contra crecidas en la provincia (terraplén Garello/Santo Tomé y Terraplén French en la ciudad de Santa Fe) se realizaron trabajos de protección con cubierta vegetal, el cuál se adoptó como documentación de base para el proyecto que nos ocupa.

La metodología empleada, toma como premisa ponderar los parámetros básicos que ayuden a definir la cobertura vegetal que más se adapte al medio, y que cumpla con los objetivos previamente fijados.

El análisis previo, abarcó los siguientes aspectos:

- * Características agroclimática regional.
- * Emplazamiento de obras, extensión y perfiles tipos de presa.
- * Niveles de crecidas, movimiento de napa freática, curva de saturación.
- * Tipo de suelo soporte de los terraplenes, talud seco y húmedo.
- * Especies vegetales, características, ciclos y tipos de habitat.
- * Requerimientos del suelo superficial para la cobertura.
- * Método de implante, mantenimiento.

IV.- PARAMETROS ANALIZADOS

La región cuenta con un clima templado de temperaturas medias anuales de 18 grados promedio (mínimas de -4 aisladas, y máximas de 41 grados), con predominio de vientos aislados del noreste.

Las precipitaciones se presentan dominantes en el período estival, las épocas de sequia cuando coinciden con altas temperaturas o vientos secos provocan intensa evapotranspiración. Las bajas invernales acentúan la caducidad foliar y/o muerte de numerosas plantas anuales.

Es necesario ponderar además, los efectos intrazonales derivados del frente de humectación que provoca el tirante de agua en el talud externo de la defensa, que obliga a seleccionar especies que tengan adaptación a las alternancias de humectación y secado en dicha franja.

Esta intrazonalidad se convierte en la diferencia principal a considerar en la cobertura entre el talud externo (mojado) e interno (seco) del terraplén.

En cuanto a las características intrínsecas de la obra a proteger, se observa que el terraplén contra crecidas estará basado en material cohesivo y la obra vial propiamente dicha, en material refulado. Para ambos casos, es imprescindible contar con una capa superficial de horizonte húmifero (ver especificaciones punto VII) que servirá de cama de siembra y de fuente nutricional para la cubierta vegetal.

Sin duda, por la magnitud de los taludes y por el tipo de obra a proteger, la base de cohesivo del terraplén para los fines aquí tratado, se comporta como suelo soporte de alta retención de humedad gravitacional, elemento aprovechable por la masa vegetal de cobertura. Además su elevada estructuración a causa de la presencia de texturas finas, ofrece una favorable resistencia a los efectos erosivos y a su vez mayor anclaje para las raíces de especies arbóreas a implantar.

Respecto de la obra vial, su base de refulado, texturalmente mas grueso y de baja tortuosidad para la retención de agua gravitacional, requiere, para asegurar la cobertura vegetal, una cubierta húmifera de mayor espesor.

Aparte del material constitutivo se debe atender al tramo de la obra a proteger, en este sentido se ha analizado cuatro situaciones tipo con las que cuenta el emprendimiento:

- Terraplén contra crecidas en ambos paramentos
- Multitrocha
- Reservorios
- Emplazamiento del camino colector

Del estudio de los vegetales considerados de buena adaptación, se determinó el siguiente listado de especies, que posteriormente forman parte de los distintos estratos según el modelo requerido.

- a- cobertura basal: Festuca alta, Pasto ovinillo, Ryegrass, Trebol blanco, Grama rhodes, Moha, Agropiro, Trebol blanco.
- b- cobertura de adaptación hidromórfica: Juncos, Durasnillo, Paja de techar.
- c- vegetación arbórea: Sauce, Aliso de río, Ceibo, Ciprés calvo, Lapacho, Jacarandá, Tipa blanca, Ibirá pita, Casuarina, Laurel de jardín, Aguaribay, Pino taeda, Tuya, Ligustro

V.- DESCRIPCION DE LA PROTECCION SELECCIONADA - REQUERIMIENTOS

Se agruparon las especies seleccionadas en tres modelos de cobertura en función de las necesidades de protección y el análisis de parámetros realizado.

Modelo A: Estructura herbácea cerrada cespitosa

Modelo B: Estructura arbórea densa con adaptación hidromórfica

Modelo C: Estructura arbórea de ornamentación

Modelo D: Cerco vivo de alta densidad.

El modelo A se estructura en base a una consociación de gramíneas y leguminosas rastreras estoloníferas o arrochetadas de buena adaptación y rápido poder colonizador. Esta cubierta vegetal actuará como agente amortiguador a la acción erosiva de las precipitaciones, a la vez que acentuará la cohesión de las partículas de suelo mediante sus densas cabelleras radiculares.

Se seleccionaron dos grupos de consociaciones, pensadas para épocas de implantación diferentes, dependiendo su elección de la época del año en la cual comenzarán los trabajos de cobertura.

1- Epoca de siembra: otoño - invierno.

| Especies | | Densidad de siembra gr/10m ² | Requisitos mínimos de calidad | |
|-----------------------------------|---------------------|--|-------------------------------|---------------|
| Nombre vulgar | Nombre científico | | % de pureza | % germinación |
| Festuca alta | Festuca arundinacea | 5 | 97 | 85 |
| Pasto ovinillo | Dactylis glomerata | 5 | 90 | 85 |
| Ryegrass | Lolium perenne | 3 | 95 | 85 |
| Trebol blanco | Trifolium repens | 3 | 98 | 85 |
| Composición inerte (sorgo molido) | | 484 | ---- | ---- |
| Densidad total | | 500 | ---- | ---- |

2- Epoca de siembra: primavera - verano.

| Especies | | Densidad de siembra gr/10m ² | Requisitos mínimos de calidad | |
|-----------------------------------|----------------------|--|-------------------------------|---------------|
| Nombre vulgar | Nombre científico | | % de pureza | % germinación |
| Grama Rhodes | Chloris gayana | 10 | 500.000 | gérmenes |
| Moha | Setaria itálica | 10 | ---- | ---- |
| Agropino | Agropirum eleongatum | 10 | 94 | 90 |
| Trebol blanco | Trifolium repens | 5 | 98 | 85 |
| Composición inerte (sorgo molido) | | 465 | ---- | ---- |
| Densidad total | | 500 | ---- | ---- |

Para ambas épocas de siembra, el Modelo A presenta las siguientes especificaciones a tener en cuenta:

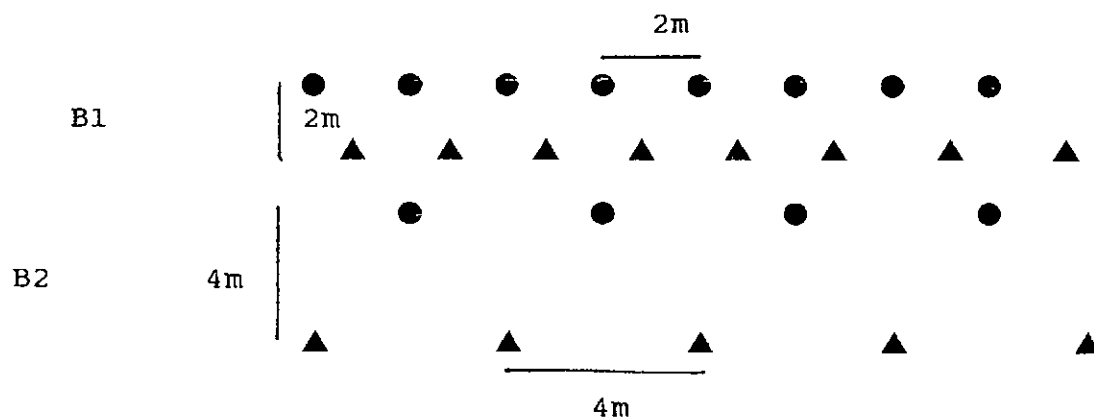
- a- Poseer una cobertura humífera de 15 cm de espesor promedio, suficientemente nivelada y rodada, con un grado de humectación próximo a capacidad de campo.
- b- Realizar siembra manual al voleo desde el coronamiento al pie, con esparcimiento homogéneo. Para lograr un mayor grado de distribución se propone junto a la consociación el agregado de material inerte.
- c- Hacer un paso superficial de rastrillo, posterior a la siembra.
- d- Realizar un riego de implantación.

El Modelo B, lo componen principalmente especies vegetales, adaptados a prolongados tiempos de anegamiento como el Sauce y Aliso de río. Estos árboles desarrollan una densa masa radicular que favorecen la estabilidad estructural en áreas críticas, particularmente en paramentos húmedos, a la vez de disipar la energía del oleaje con su característico follaje.

Los requerimientos de esta cobertura figuran en el siguiente cuadro:

| | Modelo B1 (simple) | Modelo B2 (compuesto) |
|---------------------------|--|--|
| Especie | Sauce llorón Sauce criollo Aliso de río | Sauce llorón Sauce criollo Aliso de río |
| Densidad de implantación | Tresbolillo simple, de dos metros | Tresbolillo de 2 metros combinado con tresbolillo de 3 metros |
| Método de implante | Plantines de raíz desnuda, apoyados con tutores descortezados | Plantines de raíz desnuda, apoyados con tutores descortezados |
| Largo y diámetro de fuste | 1.60 m de largo y 3 cm de diámetro. Tutores de 2.5 m de largo y 5 cm de diámetro | 1.60 m de largo y 3 cm de diámetro. Tutores de 2.5 m de largo y 5 cm de diámetro |
| Epoca de implante | Raíz desnuda: mayo/agosto Con panes de tierra: todo el año | Raíz desnuda: mayo/agosto Con panes de tierra: todo el año |

Diagrama Tipo



- Sauce
- ▲ Aliso de río

El Modelo C, consiste en una estructura arbórea de copas expandidas (nativas y exóticas) destinado fundamentalmente al pie de los paramentos secos, con fines estéticos-paisajísticos, contribuyendo además al mejoramiento del estado de agregación al subsuelo de textura disturbada y aporte de materia orgánica a la capa húmifera superficial.

El modelo se diagrama de dos formas, según especificaciones del siguiente cuadro:

| | Modelo C1 | Modelo C2 |
|----------------------------------|--|---|
| Especie | Lapacho Jacarandá Ibirá Pitá Aguaybai Pino taeda Casuarina Laurel de jardín | Jacarandá Laurel de jardín Pino taeda |
| Diagrama de implantación | Disposición no simétrica en bosque combinando forma de copas, caducidad foliar, época de florecencia y evolución de crecimiento. | Tresbolillo simple a 5 metros entre especie. |
| Método | Plantines de raíz desnuda, apoyados con tutores descortezados | Plantines de raíz desnuda, apoyados con tutores descortezados |
| Largo y diámetro de juste | 1.6 m de largo y 3 cm de diámetro; tutores de 2.5 m de alto por 5 cm de diámetro. | 1.6 m de largo y 3 cm de diámetro; tutores de 2.5 m de alto por 5 cm de diámetro. |
| Epoca | Raíz desnuda: mayo/agosto. Con panes de tierra: todo el año | Raíz desnuda: mayo/agosto. Con panes de tierra: todo el año |

El Modelo D, lo constituye un cerco vivo, de árboles y arbustos adaptados, implantados en alta densidad, combinando un fin estético y de seguridad, aptos para delimitar zonas de acceso restringido. Las especies mas apropiadas abarca a la Tuya, implantadas en hileras de 50 metros, con una densidad de una cada 2 metros, intercaladas con hileras simples de Casuarina, de 20 metros de extensión y una densidad de una planta cada 5 metros. Eventualmente, las hileras de Tuyas, pueden sustituirse por especies de ligustro que presenta una rusticidad y adaptación similar.

VI CUADRO DE LABORES CULTURALES TIPO

| Modelo | Tareas |
|-------------|--|
| A | <ul style="list-style-type: none"> * Control de especies indeseables * Resiembra en los sectores sin cobertura * Riego en los primeros estadios |
| B C D | <ul style="list-style-type: none"> * Combatir hormigas y otros insectos * Desmalezar en los primeros estadios * Reposición por fallas de implante * Riego inicial * Reposición de tutores |

VII.- REQUERIMIENTOS DEL SUELO HUMIFERO

- Aspecto físico:
 - * texturas francas
 - * estructura insitu masiva o bloquiforme
 - * debe constatarse la ausencia de barnices de arcilla; moteados en la matrix edáfica y concreciones de hierro o de hierro-manganeso.
- Aspecto químico:

- * Salinidad por debajo de los 2 mmhos/cm
- * Sodicidad por debajo del 2% del Valor T
- * Materia Orgánica con valores mayores a 1,5%
- * Ph de debilmente acido a debilmente alcalino

- Espesor de cobertura:

- * sobre material cohesivo no inferior a 20 cm
- * sobre paramentos de material refulado no inferior a 30 cmm
- * sobre canteros centrales y banquetas de material refulado no inferior a 15 cm

- Colocación de cobertura:

Sobre material cohesivo, con compactación ligera, dejando una superficie en terrones finos (factor de rugosidad) para la posterior siembra y/o implante de árboles.

| |
|---------|
| Tramo 1 |
|---------|

Longitud : 600 m

Protección: Paramento seco y húmedo del terraplén
Irigoyen existente, desde Ruta 11 hasta la
casa de bomba N° 1

Diagrama de cobertura:

| Talu d | Area específica | Cobertur a | Especificaciones |
|-----------|--|---------------|---|
| Seco | Del coronamient o al pie | Modelo A | Eventual resiembre para mantener la cobertura existente |
| Húmed | Coronamient o hasta media pendiente | Modelo A | Según descripción del modelo. |

Tramo 2

Longitud : 600 m

Protección: Paramento seco y húmedo del terraplén
Irigoyen existente, desde casa de bomba N°
1 hasta el F.C.G.B.M.

Diagrama de cobertura:

| Talu d | Area específica | Cobertur a | Especificaciones |
|-----------|-----------------------------------|---------------|--|
| Seco | Del coronamient o al pie | Modelo A | Eventual resiembre para mantener la cobertura existente |
| Húmed | Coronamient o al pie | Modelo A | La remoción completa del concreto asfáltico existente (muy deteriorado), crea la necesidad de colocar un horizonte humífero previo a la cobertura vegetal. |
| | Pie del talud | Modelo B1 | |

Tramo 3

Longitud : 1600 m

Protección: Paramento seco y húmedo del terraplén Irigoyen existente, desde el F.C.G.B.M. hasta acceso calle Mendoza.

Diagrama de cobertura:

| Talud | Area específica | Cobertura | Especificaciones |
|--------|---------------------|-----------|---|
| Húmedo | Coronamiento al pie | Modelo A | Los restos vegetales que quedan en el subsuelo posterior al nuevo perfilado, posibilitan reducir al 50% (10cm) el espesor de la capa húmifera a colocar, previo a la cobertura vegetal. |
| | Pie de talud | Modelo B1 | |
| Seco | Coronamiento al pie | Modelo A | Eventual resiembra para mantener la cobertura existente. |
| | Medio talud y pie | Modelo C2 | Tresbolillo simple en base a casuarina alterando con aguaribay |

Tramo 4

Longitud : 2000 m

Protección: Paramento seco y húmedo del terraplén
Irigoyen a construir, desde acceso calle
Mendoza, hasta Autopista Santa Fe - Rosario

Diagrama de cobertura:

| Talu d | Area específica | Cobertur a | Especificaciones |
|-----------|----------------------------|---------------|--|
| Seco | Coronamient o al pie | Modelo A | Según modelo |
| | Medio talud y pie | Modelo C1 | Disposición no simétrica en bosque, combinando espe- cies de lapacho, jacaran- dá aguaribay, pino taeda y laurel |
| Húmed | Coronamient o al pie | Modelo A | Según modelo |
| | Pie de talud | Modelo B2 | Tresbolillo combinado en la zona de cambio de pendiente del talud |

Tramo 5

Longitud : 850 m

Protección: Paramento interno y externo multitrocha de acceso Suipacha hasta Autopista, área perimetral NE del lago.

Diagrama de cobertura:

| Area | Area específica | Cobertura | Especificaciones |
|-------------------------------|------------------------------|----------------------|---|
| Multitrocha talud | Interno/ Externo | Modelo A | Según modelo Cobertura húmifera 30 cm de espesor |
| Multitrocha otros | Banquina s/ Cantero central | | Según modelo Cobertura húmifera 15 cm de espesor |
| Area Perimetral NE del Lago 1 | Franja de seguridad del lago | Modelo D | Cerdo de tuya alternando con casuarina |
| | Espacio verde aledaño | Modelo A + Modelo C1 | Arboleda no simétrica en bosque con cobertura cespitosa |

| |
|---------|
| Tramo 6 |
|---------|

Longitud : 3600 m

Protección: Paramento interno y externo, banquetas y canchero central de multitrack, desde Ruta 11 hasta acceso Suipacha.

Diagrama de cobertura:

| Area específica | Cobertura | Especificaciones |
|---|---|--|
| Paramento interno y externo. Banquetas y cancheros centrales | Modelo A En áreas de acceso Gral. López se suma el modelo C2 para taludes de mayor altura (en la base y en su parte media) | Cobertura humífera de 30 cm/15 cm de espesor según especificaciones. Modelo A según especificaciones El modelo C2 contará con especies de casuarina y pino taeda |

Tramo 7

Protección: áreas circunscriptas dentro de canales reservorio, entre el F.C.G.B.M. y el predio de Agua y Energía Eléctrica.

Diagrama de cobertura:

| Estrato de cobertura | Modelo | Especificaciones |
|----------------------|------------------------|---|
| Cespitoso | Modelo A | Según modelo |
| Arbóreo | Modelo B2 Modelo C1 | <p>Especies colonizadoras (B2) de resistencia a condiciones hidromórficas y heterogeneidad edáfica.</p> <p>Eventualmente se implantará el modelo C1 (casuarina, tipa y aguaribay) en cotas más elevadas.</p> <p>La cubierta humífera deberá ser como mínimo de 20 cm.</p> <p>Se deberá nivelar el terreno (según pendiente de proyecto) y adecuar la cama de siembra.</p> |

Tramo 8

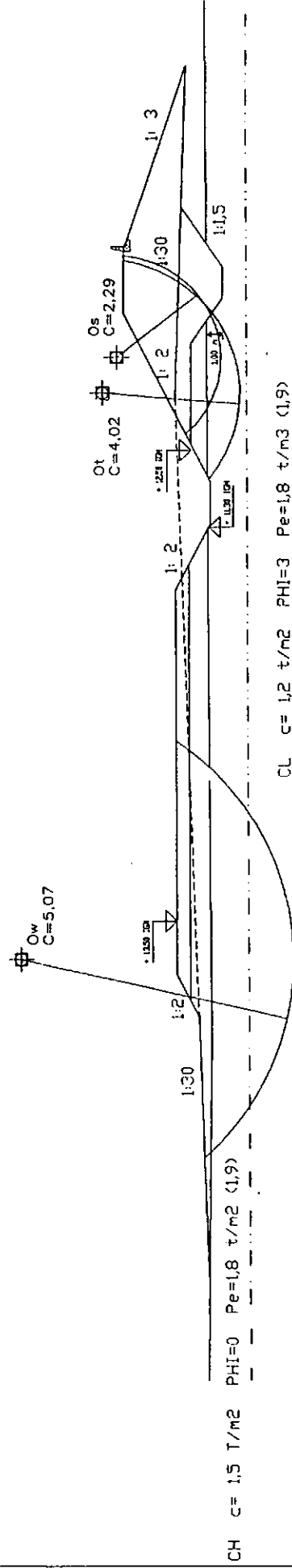
Longitud :

Protección: áreas perimetrales del emplazamiento del camino colector.

Diagrama de cobertura:

| Area | Cobertura | Especificaciones |
|----------------------------------|-----------|---|
| Continúa al alambrado perimetral | Modelo C2 | Tresbolillo simple, con hilera de casuarina y aguaribay. Estas especies combinan porte, tonalidad de copa y rapidez de crecimiento. Implantación en el inicio del cronograma de obras. |

PERFIL DE ESTUDIO CP-3770 ESTABILIDAD DEL TALUD DE AGUAS ABAJO Y DE LA MULTITROCHA



CL $C=1.2$ t/m2 PHI=3 Pe=1.8 t/m3 (1.9)

SM $C=1.7$ t/m2 PHI=10 Pe=1.8 t/m3 (1.9)

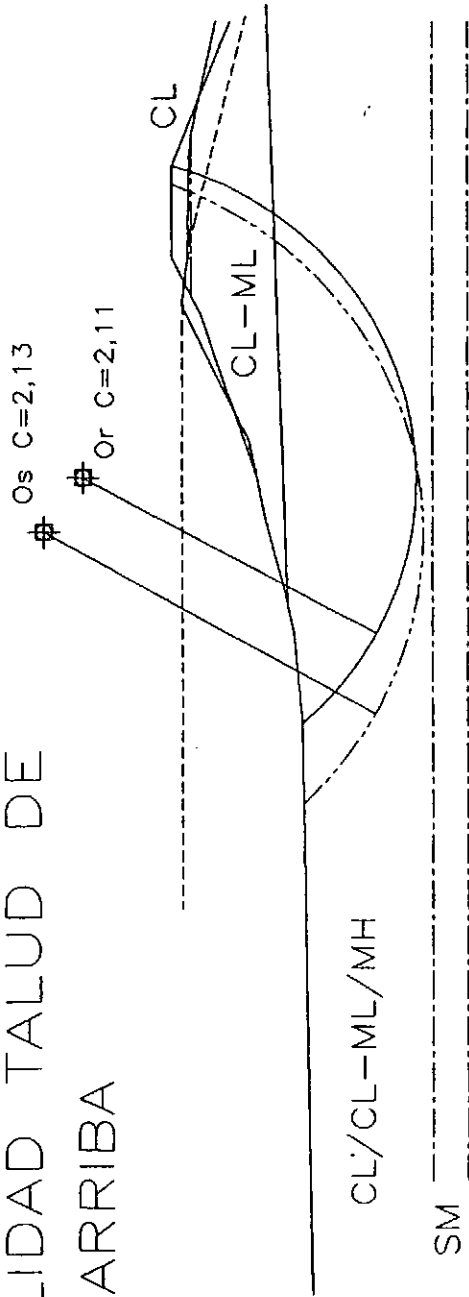
SP $C=0$ PHI=24 Pe=1.9 t/m3 (2.0) SP-SM /

| PROGRESIVAS | 16.10 | 11.65 |
|-------------|-------|-------|
| COTAS | 11.37 | 11.37 |

PERFIL YRIGOYEN 2306

Perfil de estudio cp2600

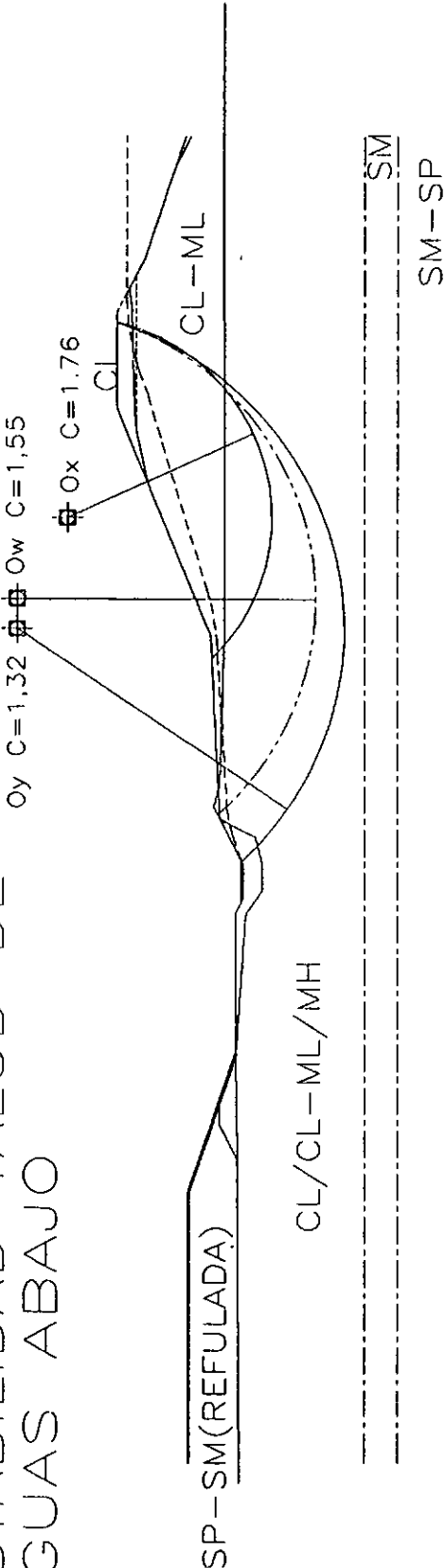
ESTABILIDAD TALUD DE
AGUAS ARRIBA



| COTAS | |
|-------------|-------|
| 100.00 | 10.74 |
| 125.00 | 11.14 |
| 129.00 | 11.49 |
| 131.00 | 11.91 |
| 134.00 | 12.72 |
| 137.50 | 13.40 |
| 143.50 | 16.31 |
| 145.50 | 16.08 |
| 150.00 | 15.98 |
| 151.00 | 15.89 |
| 156.00 | 14.83 |
| PROGRESIVAS | |

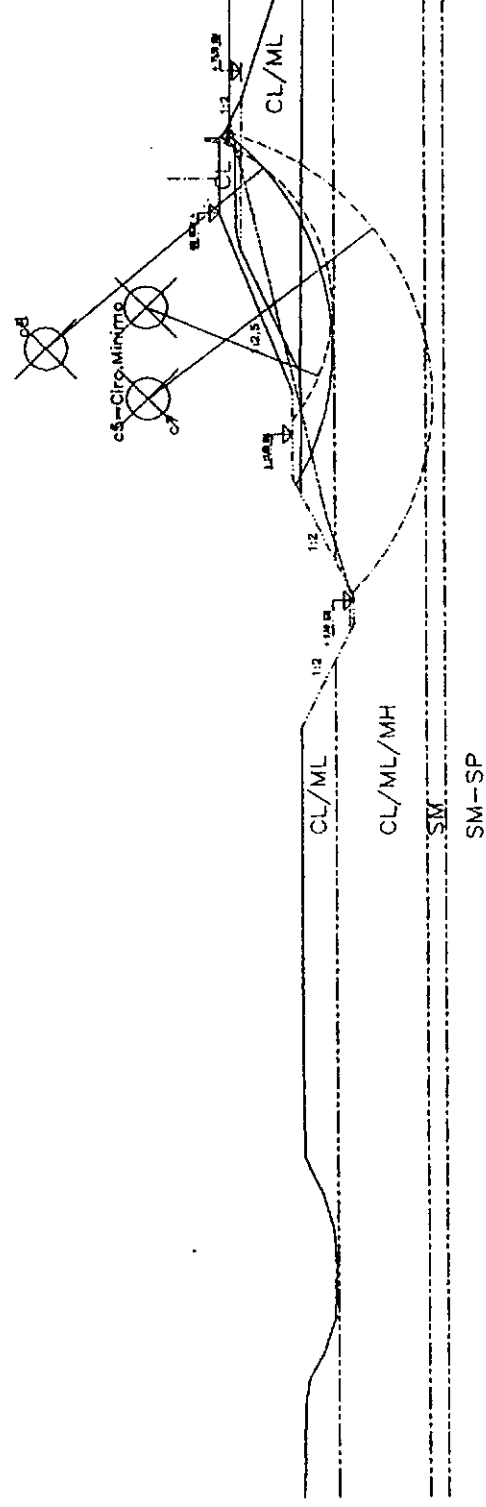
PERFIL YRIGOYEN 2306 Perfil de estudio cp2600

ESTABILIDAD TALUD DE AGUAS ABAJO

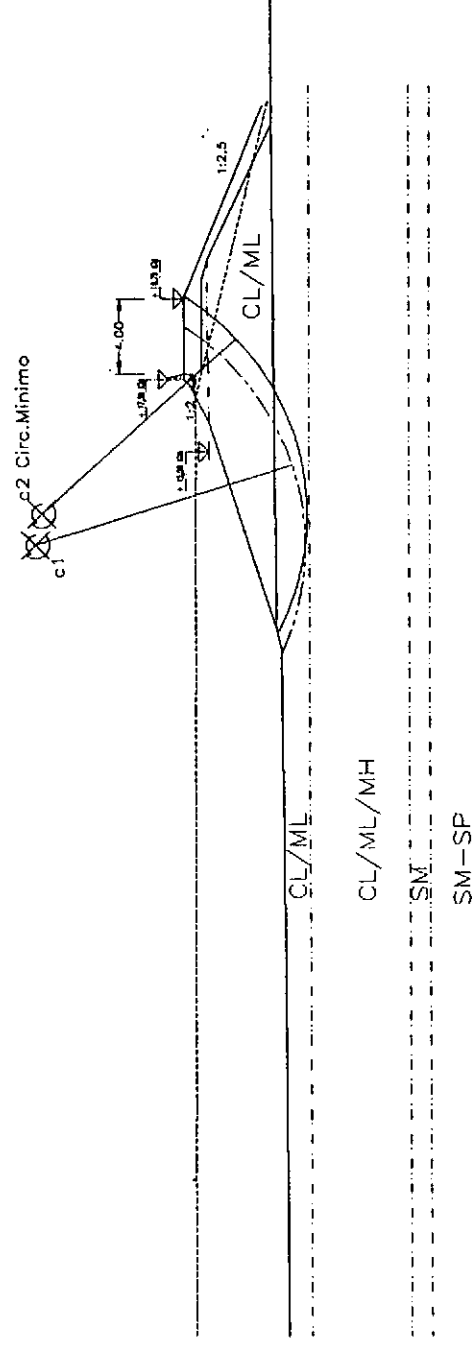


| COTAS | |
|-------------|-------|
| 200.00 | 11.19 |
| 174.20 | 11.34 |
| 172.50 | 10.14 |
| 171.20 | 10.14 |
| 170.00 | 10.46 |
| 169.00 | 12.41 |
| 162.20 | 12.00 |
| 156.00 | 14.83 |
| 151.00 | 15.89 |
| 150.00 | 15.98 |
| 145.50 | 16.08 |
| 143.50 | 16.31 |
| 137.50 | 13.40 |
| PROGRESIVAS | |

PERFIL YRIGOYEN 560 (cp\$300) ESTABILIDAD TALUD A. ABAJO



PERFIL YRIGOYEN 560 (cp\$300) ESTABILIDAD TALUD A. ARRIBA



PCSTABL5

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 07/12/93
Time of Run: 18.40
Run By: jdcg
Input Data Filename: av1613-2.dat
Output Filename: av1613-2.sal

PROBLEM DESCRIPTION Avenida-1:4-T.REF-pr.1600/3/2-CIRC. PROF
.-suelos s/AYE- s=5t/m en l calzada

BOUNDARY COORDINATES

7 Top Boundaries
12 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|-----------------|----------------|----------------|-----------------|-----------------|------------------------|
| 1 | .00 | 12.92 | 215.00 | 12.92 | 4 |
| 2 | 215.00 | 12.92 | 257.00 | 23.40 | 5 |
| 3 | 257.00 | 23.40 | 259.00 | 23.90 | 6 |
| 4 | 259.00 | 23.90 | 284.00 | 23.90 | 6 |
| 5 | 284.00 | 23.90 | 286.00 | 23.40 | 6 |
| 6 | 286.00 | 23.40 | 328.00 | 12.95 | 5 |
| 7 | 328.00 | 12.95 | 400.00 | 12.96 | 4 |
| 8 | 257.00 | 23.40 | 286.00 | 23.40 | 5 |
| 9 | 215.00 | 12.92 | 328.00 | 12.95 | 4 |
| 10 | .00 | 11.50 | 400.00 | 11.50 | 3 |
| 11 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 12 | .00 | 5.50 | 400.00 | 5.50 | 1 |

ISOTROPIC SOIL PARAMETERS

6 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. (psf) | Pressure Constant (psf) | Piez. Surface No. |
|---------------------|----------------------------|--------------------------------|--------------------------------|----------------------------|-------------------------------------|-------------------------------|-------------------------|
| 1 | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| 2 | 1.6 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| 3 | 1.6 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| 4 | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| 5 | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 2.0 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |

Unit Weight of Water = 1.00

Piezometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|--------------|-----------------|-----------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 328.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|-------------|----------------|-----------------|------------------------|---------------------|
| 1 | 271.50 | 279.00 | 5.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 150.00 ft.
and X = 255.00 ft.

Each Surface Terminates Between X = 259.00 ft.
and X = 284.00 ft.

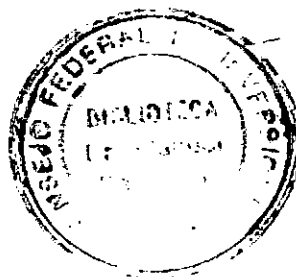
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 29 Coordinate Points



| No. | (ft) | (ft) |
|-----|--------|-------|
| 1 | 196.67 | 12.92 |
| 2 | 198.98 | 11.00 |
| 3 | 201.40 | 9.24 |
| 4 | 203.93 | 7.63 |
| 5 | 206.56 | 6.18 |
| 6 | 209.27 | 4.90 |
| 7 | 212.07 | 3.80 |
| 8 | 214.92 | 2.88 |
| 9 | 217.83 | 2.14 |
| 10 | 220.78 | 1.59 |
| 11 | 223.75 | 1.22 |
| 12 | 226.75 | 1.04 |
| 13 | 229.75 | 1.05 |
| 14 | 232.74 | 1.26 |
| 15 | 235.71 | 1.65 |
| 16 | 238.66 | 2.23 |
| 17 | 241.56 | 2.99 |
| 18 | 244.41 | 3.94 |
| 19 | 247.19 | 5.06 |
| 20 | 249.89 | 6.36 |
| 21 | 252.51 | 7.83 |
| 22 | 255.03 | 9.46 |
| 23 | 257.43 | 11.25 |
| 24 | 259.73 | 13.19 |
| 25 | 261.89 | 15.26 |
| 26 | 263.92 | 17.47 |
| 27 | 265.80 | 19.81 |
| 28 | 267.54 | 22.26 |
| 29 | 268.55 | 23.90 |

Circle Center At X = 228.0 ; Y = 48.4 and Radius, 47.3

*** 1.431 ***

Failure Surface Specified By 28 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 196.67 | 12.92 |
| 2 | 198.84 | 10.86 |
| 3 | 201.16 | 8.95 |
| 4 | 203.61 | 7.22 |
| 5 | 206.18 | 5.67 |
| 6 | 208.85 | 4.30 |
| 7 | 211.61 | 3.13 |
| 8 | 214.45 | 2.15 |
| 9 | 217.35 | 1.39 |
| 10 | 220.30 | .83 |
| 11 | 223.28 | .48 |
| 12 | 226.27 | .35 |
| 13 | 229.27 | .43 |
| 14 | 232.26 | .72 |
| 15 | 235.21 | 1.23 |
| 16 | 238.13 | 1.94 |
| 17 | 240.98 | 2.86 |
| 18 | 243.76 | 3.99 |
| 19 | 246.46 | 5.31 |
| 20 | 249.05 | 6.81 |
| 21 | 251.53 | 8.50 |
| 22 | 253.89 | 10.36 |
| 23 | 256.10 | 12.39 |
| 24 | 258.16 | 14.56 |
| 25 | 260.07 | 16.88 |

28 264.38 23.90

Circle Center At X = 226.6 ; Y = 42.4 and Radius, 42.0

*** 1.441 ***

Failure Surface Specified By 27 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 196.67 | 12.92 |
| 2 | 198.93 | 10.98 |
| 3 | 201.37 | 9.20 |
| 4 | 203.91 | 7.60 |
| 5 | 206.56 | 6.19 |
| 6 | 209.30 | 4.98 |
| 7 | 212.12 | 3.96 |
| 8 | 215.01 | 3.15 |
| 9 | 217.95 | 2.55 |
| 10 | 220.93 | 2.17 |
| 11 | 223.92 | 1.99 |
| 12 | 226.92 | 2.04 |
| 13 | 229.91 | 2.30 |
| 14 | 232.87 | 2.77 |
| 15 | 235.79 | 3.45 |
| 16 | 238.66 | 4.35 |
| 17 | 241.45 | 5.44 |
| 18 | 244.16 | 6.74 |
| 19 | 246.76 | 8.22 |
| 20 | 249.26 | 9.89 |
| 21 | 251.62 | 11.74 |
| 22 | 253.85 | 13.75 |
| 23 | 255.93 | 15.91 |
| 24 | 257.84 | 18.22 |
| 25 | 259.59 | 20.66 |
| 26 | 261.16 | 23.22 |
| 27 | 261.51 | 23.90 |

Circle Center At X = 224.8 ; Y = 43.7 and Radius, 41.7

*** 1.447 ***

Failure Surface Specified By 25 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.33 | 12.92 |
| 2 | 210.53 | 10.88 |
| 3 | 212.89 | 9.03 |
| 4 | 215.40 | 7.37 |
| 5 | 218.03 | 5.93 |
| 6 | 220.77 | 4.72 |
| 7 | 223.60 | 3.73 |
| 8 | 226.51 | 2.98 |
| 9 | 229.46 | 2.47 |
| 10 | 232.45 | 2.21 |
| 11 | 235.45 | 2.19 |
| 12 | 238.44 | 2.42 |
| 13 | 241.41 | 2.90 |

| | | |
|----|--------|-------|
| 13 | 247.16 | 4.38 |
| 15 | 249.91 | 5.77 |
| 17 | 252.56 | 7.18 |
| 18 | 255.08 | 8.81 |
| 19 | 257.46 | 10.63 |
| 20 | 259.68 | 12.65 |
| 21 | 261.73 | 14.85 |
| 22 | 263.59 | 17.20 |
| 23 | 265.24 | 19.70 |
| 24 | 266.69 | 22.33 |
| 25 | 267.39 | 23.90 |

Circle Center At X = 234.1 ; Y = 38.5 and Radius, 36.3

*** 1.472 ***

Failure Surface Specified By 25 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.33 | 12.92 |
| 2 | 210.46 | 10.81 |
| 3 | 212.77 | 8.89 |
| 4 | 215.23 | 7.17 |
| 5 | 217.83 | 5.67 |
| 6 | 220.55 | 4.40 |
| 7 | 223.36 | 3.37 |
| 8 | 226.26 | 2.58 |
| 9 | 229.21 | 2.04 |
| 10 | 232.19 | 1.76 |
| 11 | 235.19 | 1.73 |
| 12 | 238.19 | 1.96 |
| 13 | 241.15 | 2.45 |
| 14 | 244.05 | 3.19 |
| 15 | 246.89 | 4.18 |
| 16 | 249.63 | 5.40 |
| 17 | 252.25 | 6.86 |
| 18 | 254.74 | 8.53 |
| 19 | 257.07 | 10.41 |
| 20 | 259.24 | 12.49 |
| 21 | 261.22 | 14.74 |
| 22 | 263.00 | 17.15 |
| 23 | 264.57 | 19.71 |
| 24 | 265.91 | 22.39 |
| 25 | 266.51 | 23.90 |

Circle Center At X = 234.0 ; Y = 36.7 and Radius, 35.0

*** 1.479 ***

Failure Surface Specified By 27 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 196.67 | 12.92 |
| 2 | 198.79 | 10.80 |
| 3 | 201.07 | 8.85 |
| 4 | 203.50 | 7.09 |
| 5 | 206.07 | 5.53 |
| 6 | 208.74 | 4.19 |

| | | |
|----|--------|-------|
| 8 | 214.38 | 2.14 |
| 9 | 217.30 | 1.46 |
| 10 | 220.27 | 1.01 |
| 11 | 223.26 | .81 |
| 12 | 226.26 | .84 |
| 13 | 229.25 | 1.10 |
| 14 | 232.21 | 1.61 |
| 15 | 235.11 | 2.35 |
| 16 | 237.95 | 3.31 |
| 17 | 240.71 | 4.50 |
| 18 | 243.36 | 5.91 |
| 19 | 245.89 | 7.52 |
| 20 | 248.28 | 9.33 |
| 21 | 250.53 | 11.32 |
| 22 | 252.61 | 13.48 |
| 23 | 254.51 | 15.80 |
| 24 | 256.22 | 18.27 |
| 25 | 257.72 | 20.86 |
| 26 | 259.02 | 23.57 |
| 27 | 259.15 | 23.90 |

Circle Center At X = 224.4 ; Y = 36.5 and Radius, 37.7

*** 1.483 ***

Failure Surface Specified By 26 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.33 | 12.92 |
| 2 | 210.46 | 10.80 |
| 3 | 212.75 | 8.87 |
| 4 | 215.20 | 7.13 |
| 5 | 217.78 | 5.60 |
| 6 | 220.48 | 4.29 |
| 7 | 223.28 | 3.21 |
| 8 | 226.15 | 2.37 |
| 9 | 229.09 | 1.77 |
| 10 | 232.07 | 1.41 |
| 11 | 235.07 | 1.31 |
| 12 | 238.07 | 1.45 |
| 13 | 241.04 | 1.84 |
| 14 | 243.97 | 2.48 |
| 15 | 246.84 | 3.36 |
| 16 | 249.63 | 4.47 |
| 17 | 252.31 | 5.81 |
| 18 | 254.87 | 7.37 |
| 19 | 257.30 | 9.14 |
| 20 | 259.56 | 11.10 |
| 21 | 261.66 | 13.25 |
| 22 | 263.57 | 15.56 |
| 23 | 265.29 | 18.02 |
| 24 | 266.79 | 20.62 |
| 25 | 268.07 | 23.33 |
| 26 | 268.28 | 23.90 |

Circle Center At X = 234.9 ; Y = 37.4 and Radius, 36.1

*** 1.494 ***

Failure Surface Specified By 37 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 185.00 | 12.92 |
| 2 | 187.49 | 11.25 |
| 3 | 190.06 | 9.69 |
| 4 | 192.69 | 8.26 |
| 5 | 195.39 | 6.95 |
| 6 | 198.15 | 5.77 |
| 7 | 200.96 | 4.72 |
| 8 | 203.81 | 3.80 |
| 9 | 206.71 | 3.02 |
| 10 | 209.64 | 2.37 |
| 11 | 212.60 | 1.87 |
| 12 | 215.58 | 1.50 |
| 13 | 218.57 | 1.27 |
| 14 | 221.57 | 1.18 |
| 15 | 224.56 | 1.24 |
| 16 | 227.56 | 1.43 |
| 17 | 230.54 | 1.76 |
| 18 | 233.50 | 2.24 |
| 19 | 236.44 | 2.85 |
| 20 | 239.34 | 3.60 |
| 21 | 242.21 | 4.48 |
| 22 | 245.03 | 5.50 |
| 23 | 247.80 | 6.65 |
| 24 | 250.52 | 7.93 |
| 25 | 253.17 | 9.33 |
| 26 | 255.75 | 10.86 |
| 27 | 258.26 | 12.50 |
| 28 | 260.69 | 14.26 |
| 29 | 263.03 | 16.14 |
| 30 | 265.29 | 18.12 |
| 31 | 267.44 | 20.20 |
| 32 | 269.50 | 22.38 |
| 33 | 270.80 | 23.90 |

Circle Center At X = 221.9 ; Y = 65.1 and Radius, 64.0

*** 1.509 ***

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 196.67 | 12.92 |
| 2 | 199.32 | 11.53 |
| 3 | 202.04 | 10.23 |
| 4 | 204.81 | 9.10 |
| 5 | 207.62 | 8.06 |
| 6 | 210.48 | 7.15 |
| 7 | 213.38 | 6.37 |
| 8 | 216.31 | 5.71 |
| 9 | 219.26 | 5.18 |
| 10 | 222.23 | 4.78 |
| 11 | 225.22 | 4.51 |
| 12 | 228.22 | 4.38 |
| 13 | 231.22 | 4.37 |
| 14 | 234.21 | 4.49 |
| 15 | 237.20 | 4.75 |
| 16 | 240.18 | 5.13 |
| 17 | 243.13 | 5.64 |
| 18 | 246.07 | 6.29 |
| 19 | 248.96 | 7.06 |
| 20 | 251.83 | 7.95 |
| 21 | 254.65 | 8.97 |
| 22 | 257.42 | 10.11 |

| | | |
|----|--------|-------|
| 25 | 265.41 | 14.25 |
| 26 | 267.94 | 15.86 |
| 27 | 270.40 | 17.57 |
| 28 | 272.79 | 19.39 |
| 29 | 275.07 | 21.32 |
| 30 | 277.31 | 23.34 |
| 31 | 277.87 | 23.90 |

Circle Center At X = 229.9 ; Y = 73.1 and Radius, 68.7

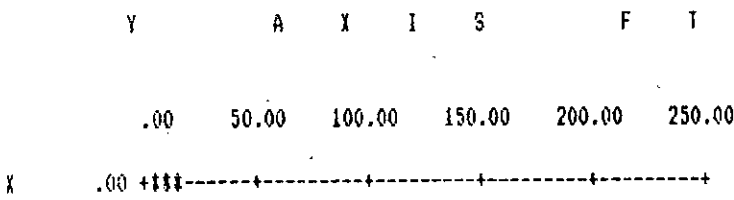
1.512

Failure Surface Specified By 31 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 185.00 | 12.92 |
| 2 | 187.29 | 10.98 |
| 3 | 189.70 | 9.19 |
| 4 | 192.20 | 7.54 |
| 5 | 194.81 | 6.05 |
| 6 | 197.49 | 4.72 |
| 7 | 200.26 | 3.55 |
| 8 | 203.08 | 2.55 |
| 9 | 205.97 | 1.72 |
| 10 | 208.90 | 1.06 |
| 11 | 211.86 | .59 |
| 12 | 214.84 | .29 |
| 13 | 217.84 | .18 |
| 14 | 220.84 | .24 |
| 15 | 223.83 | .48 |
| 16 | 226.80 | .91 |
| 17 | 229.74 | 1.51 |
| 18 | 232.64 | 2.29 |
| 19 | 235.48 | 3.24 |
| 20 | 238.26 | 4.36 |
| 21 | 240.97 | 5.65 |
| 22 | 243.60 | 7.09 |
| 23 | 246.14 | 8.70 |
| 24 | 248.57 | 10.45 |
| 25 | 250.90 | 12.35 |
| 26 | 253.10 | 14.38 |
| 27 | 255.19 | 16.54 |
| 28 | 257.13 | 18.82 |
| 29 | 258.94 | 21.22 |
| 30 | 260.59 | 23.72 |
| 31 | 260.70 | 23.90 |

Circle Center At X = 218.3 ; Y = 50.0 and Radius, 49.8

1.570



| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.51 | 10.35 |
| 3 | 195.79 | 8.05 |
| 4 | 199.24 | 6.04 |
| 5 | 202.86 | 4.33 |
| 6 | 206.61 | 2.93 |
| 7 | 210.46 | 1.86 |
| 8 | 214.39 | 1.11 |
| 9 | 218.37 | .70 |
| 10 | 222.37 | .63 |
| 11 | 226.36 | .90 |
| 12 | 230.31 | 1.51 |
| 13 | 234.20 | 2.45 |
| 14 | 237.99 | 3.72 |
| 15 | 241.66 | 5.31 |
| 16 | 245.19 | 7.20 |
| 17 | 248.54 | 9.38 |
| 18 | 251.69 | 11.84 |
| 19 | 254.63 | 14.56 |
| 20 | 257.32 | 17.52 |
| 21 | 259.75 | 20.70 |
| 22 | 261.80 | 23.90 |

Circle Center At X = 221.2 ; Y = 47.7 and Radius, 47.1

*** 1.503 ***

Failure Surface Specified By 23 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.44 | 10.26 |
| 3 | 195.65 | 7.88 |
| 4 | 199.65 | 5.78 |
| 5 | 202.63 | 3.99 |
| 6 | 206.35 | 2.52 |
| 7 | 210.19 | 1.38 |
| 8 | 214.10 | .56 |
| 9 | 218.08 | .13 |
| 10 | 222.08 | .02 |
| 11 | 226.07 | .26 |
| 12 | 230.03 | .86 |
| 13 | 233.91 | 1.79 |
| 14 | 237.71 | 3.06 |
| 15 | 241.37 | 4.66 |
| 16 | 244.89 | 6.57 |
| 17 | 248.22 | 8.78 |
| 18 | 251.35 | 11.28 |
| 19 | 254.25 | 14.03 |
| 20 | 256.89 | 17.03 |
| 21 | 259.27 | 20.25 |
| 22 | 261.35 | 23.67 |
| 23 | 261.46 | 23.90 |

Circle Center At X = 221.3 ; Y = 45.8 and Radius, 45.7

*** 1.512 ***

| | | |
|----|--------|-------|
| 1 | 189.44 | 12.92 |
| 2 | 192.54 | 10.39 |
| 3 | 195.83 | 8.11 |
| 4 | 199.28 | 6.10 |
| 5 | 202.89 | 4.37 |
| 6 | 206.63 | 2.93 |
| 7 | 210.46 | 1.80 |
| 8 | 214.38 | .98 |
| 9 | 218.35 | .48 |
| 10 | 222.34 | .29 |
| 11 | 226.34 | .42 |
| 12 | 230.31 | .87 |
| 13 | 234.24 | 1.64 |
| 14 | 238.09 | 2.71 |
| 15 | 241.85 | 4.10 |
| 16 | 245.48 | 5.77 |
| 17 | 248.96 | 7.73 |
| 18 | 252.28 | 9.97 |
| 19 | 255.41 | 12.46 |
| 20 | 258.33 | 15.19 |
| 21 | 261.02 | 18.15 |
| 22 | 263.47 | 21.31 |
| 23 | 265.16 | 23.90 |

Circle Center At X = 222.7 ; Y = 50.3 and Radius, 50.1

*** 1.476 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.81 | 10.75 |
| 3 | 196.31 | 8.82 |
| 4 | 199.93 | 7.11 |
| 5 | 203.65 | 5.65 |
| 6 | 207.46 | 4.44 |
| 7 | 211.35 | 3.48 |
| 8 | 215.28 | 2.79 |
| 9 | 219.26 | 2.35 |
| 10 | 223.26 | 2.18 |
| 11 | 227.26 | 2.27 |
| 12 | 231.24 | 2.62 |
| 13 | 235.19 | 3.24 |
| 14 | 239.10 | 4.11 |
| 15 | 242.93 | 5.25 |
| 16 | 246.69 | 6.63 |
| 17 | 250.34 | 8.26 |
| 18 | 253.88 | 10.12 |
| 19 | 257.28 | 12.22 |
| 20 | 260.55 | 14.53 |
| 21 | 263.65 | 17.06 |
| 22 | 266.58 | 19.79 |
| 23 | 269.32 | 22.70 |
| 24 | 270.31 | 23.90 |

Circle Center At X = 223.9 ; Y = 62.7 and Radius, 60.5

*** 1.486 ***

| | | |
|----|--------|-------|
| 3 | 195.84 | 8.12 |
| 4 | 199.29 | 6.11 |
| 5 | 202.90 | 4.37 |
| 6 | 206.62 | 2.92 |
| 7 | 210.45 | 1.76 |
| 8 | 214.36 | .90 |
| 9 | 218.32 | .34 |
| 10 | 222.31 | .10 |
| 11 | 226.31 | .17 |
| 12 | 230.29 | .54 |
| 13 | 234.24 | 1.23 |
| 14 | 238.11 | 2.22 |
| 15 | 241.90 | 3.50 |
| 16 | 245.57 | 5.08 |
| 17 | 249.12 | 6.94 |
| 18 | 252.51 | 9.06 |
| 19 | 255.72 | 11.45 |
| 20 | 258.74 | 14.07 |
| 21 | 261.54 | 16.93 |
| 22 | 264.11 | 19.99 |
| 23 | 266.44 | 23.24 |
| 24 | 266.84 | 23.90 |

Circle Center At X = 223.5 ; Y = 51.6 and Radius, 51.5

*** 1.471 ***

Failure Surface Specified By 23 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 205.55 | 10.70 |
| 3 | 209.03 | 8.73 |
| 4 | 212.64 | 7.00 |
| 5 | 216.36 | 5.54 |
| 6 | 220.18 | 4.34 |
| 7 | 224.07 | 3.42 |
| 8 | 228.02 | 2.77 |
| 9 | 232.00 | 2.41 |
| 10 | 236.00 | 2.33 |
| 11 | 239.99 | 2.53 |
| 12 | 243.96 | 3.02 |
| 13 | 247.89 | 3.79 |
| 14 | 251.75 | 4.83 |
| 15 | 255.53 | 6.15 |
| 16 | 259.20 | 7.73 |
| 17 | 262.76 | 9.57 |
| 18 | 266.17 | 11.65 |
| 19 | 269.43 | 13.98 |
| 20 | 272.51 | 16.52 |
| 21 | 275.41 | 19.28 |
| 22 | 278.10 | 22.24 |
| 23 | 279.41 | 23.90 |

Circle Center At X = 238.1 ; Y = 58.7 and Radius, 56.3

*** 1.474 ***

Failure Surface Specified By 23 Coordinate Points

| | | |
|----|--------|-------|
| 3 | 208.26 | 7.69 |
| 4 | 211.59 | 5.63 |
| 5 | 215.32 | 3.95 |
| 6 | 219.13 | 2.73 |
| 7 | 223.05 | 1.94 |
| 8 | 227.03 | 1.59 |
| 9 | 231.03 | 1.71 |
| 10 | 234.99 | 2.28 |
| 11 | 238.86 | 3.30 |
| 12 | 242.59 | 4.75 |
| 13 | 246.12 | 6.62 |
| 14 | 249.42 | 8.88 |
| 15 | 252.45 | 11.50 |
| 16 | 255.15 | 14.45 |
| 17 | 257.50 | 17.68 |
| 18 | 259.46 | 21.17 |
| 19 | 260.62 | 23.90 |

Circle Center At X = 228.0 ; Y = 36.6 and Radius, 35.0

*** 1.451 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.63 | 10.50 |
| 3 | 195.99 | 8.32 |
| 4 | 199.49 | 6.39 |
| 5 | 203.12 | 4.71 |
| 6 | 206.86 | 3.30 |
| 7 | 210.69 | 2.15 |
| 8 | 214.60 | 1.29 |
| 9 | 218.56 | .71 |
| 10 | 222.55 | .41 |
| 11 | 226.55 | .40 |
| 12 | 230.54 | .67 |
| 13 | 234.50 | 1.23 |
| 14 | 238.41 | 2.07 |
| 15 | 242.25 | 3.20 |
| 16 | 246.00 | 4.59 |
| 17 | 249.64 | 6.25 |
| 18 | 253.15 | 8.16 |
| 19 | 256.51 | 10.32 |
| 20 | 259.72 | 12.72 |
| 21 | 262.74 | 15.34 |
| 22 | 265.57 | 18.17 |
| 23 | 268.18 | 21.19 |
| 24 | 270.21 | 23.90 |

Circle Center At X = 224.7 ; Y = 56.2 and Radius, 55.8

*** 1.466 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
|--------------|----------------|----------------|

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 205.28 | 10.34 |
| 3 | 208.60 | 8.11 |
| 4 | 212.14 | 6.25 |
| 5 | 215.87 | 4.80 |
| 6 | 219.73 | 3.76 |
| 7 | 223.68 | 3.16 |
| 8 | 227.68 | 2.99 |
| 9 | 231.67 | 3.26 |
| 10 | 235.61 | 3.97 |
| 11 | 239.44 | 5.11 |
| 12 | 243.13 | 6.66 |
| 13 | 246.63 | 8.60 |
| 14 | 249.88 | 10.92 |
| 15 | 252.87 | 13.59 |
| 16 | 255.54 | 16.56 |
| 17 | 257.88 | 19.81 |
| 18 | 259.84 | 23.30 |
| 19 | 260.10 | 23.90 |

Circle Center At X = 227.2 ; Y = 39.4 and Radius, 36.4

*** 1.446 ***

Failure Surface Specified By 19 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 205.20 | 10.25 |
| 3 | 208.47 | 7.94 |
| 4 | 211.77 | 6.01 |
| 5 | 215.67 | 4.47 |
| 6 | 219.52 | 3.40 |
| 7 | 223.47 | 2.75 |
| 8 | 227.46 | 2.54 |
| 9 | 231.45 | 2.80 |
| 10 | 235.39 | 3.50 |
| 11 | 239.22 | 4.64 |
| 12 | 242.90 | 6.21 |
| 13 | 246.38 | 8.18 |
| 14 | 249.62 | 10.53 |
| 15 | 252.56 | 13.24 |
| 16 | 255.19 | 16.26 |
| 17 | 257.45 | 19.56 |
| 18 | 259.33 | 23.09 |
| 19 | 259.65 | 23.90 |

Circle Center At X = 227.2 ; Y = 37.9 and Radius, 35.3

*** 1.449 ***

1
Failure Surface Specified By 19 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
|--------------|----------------|----------------|

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 1.00

Piezometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|--------------|-----------------|-----------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 328.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|-------------|----------------|-----------------|------------------------|---------------------|
| 1 | 271.50 | 279.00 | 5.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between $X = 100.00$ ft.
and $X = 215.00$ ft.

Each Surface Terminates Between $X = 259.00$ ft.
and $X = 284.00$ ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is $Y = .00$ ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

1 Safety Factors Are Calculated By The Modified Bishop Method 1

Failure Surface Specified By 19 Coordinate Points

PCSTABL5

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 07/12/93
Time of Run: 18.30
Run By: JDCP
Input Data Filename: av1613-1.dat
Output Filename: av1613-1.sal

PROBLEM DESCRIPTION Avenida-1:4-T,REF-pr,1600/3/1-CJRD, PROF
.-suelos s/AYE- s=5t/m en l calzada

BOUNDARY COORDINATES

7 Top Boundaries
12 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|-----------------|----------------|----------------|-----------------|-----------------|------------------------|
| 1 | .00 | 12.92 | 215.00 | 12.92 | 4 |
| 2 | 215.00 | 12.92 | 257.00 | 23.40 | 5 |
| 3 | 257.00 | 23.40 | 259.00 | 23.90 | 6 |
| 4 | 259.00 | 23.90 | 284.00 | 23.90 | 6 |
| 5 | 284.00 | 23.90 | 286.00 | 23.40 | 6 |
| 6 | 286.00 | 23.40 | 328.00 | 12.95 | 5 |
| 7 | 328.00 | 12.95 | 400.00 | 12.96 | 4 |
| 8 | 257.00 | 23.40 | 286.00 | 23.40 | 5 |
| 9 | 215.00 | 12.92 | 328.00 | 12.95 | 4 |
| 10 | .00 | 11.50 | 400.00 | 11.50 | 3 |
| 11 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 12 | .00 | 5.50 | 400.00 | 5.50 | 1 |

ISOTROPIC SOIL PARAMETERS

6 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. (psf) | Pressure Constant (psf) | Piez. Surface No. |
|---------------------|----------------------------|--------------------------------|--------------------------------|----------------------------|-------------------------------------|-------------------------------|-------------------------|
| 1 | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| 2 | 1.6 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| 3 | 1.6 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| 4 | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| 5 | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 2.0 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Burdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

```
Run Date: 07/12/93
Time of Run: 17.00
Run By: jidcp
Input Data Filename: av1611-1.dat
Output Filename: av1611-1.sal
```

PROBLEM DESCRIPTION Avenida-T.REF-pr.1610/1-CIRC.PROF.-suelos s/AYE- con sobre
carga 5t/m en 1 calzada.

BOUNDARY COORDINATES

Top Boundaries
2 Total Boundaries

| Boundary G. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below End |
|----------------|----------------|----------------|-----------------|-----------------|------------------------|
| | .00 | 12.92 | 215.00 | 12.92 | 4 |
| | 215.00 | 12.92 | 246.00 | 23.40 | 5 |
| | 246.00 | 23.40 | 248.00 | 23.90 | 6 |
| | 248.00 | 23.90 | 273.00 | 23.90 | 6 |
| | 273.00 | 23.90 | 275.00 | 23.40 | 6 |
| | 275.00 | 23.40 | 306.00 | 12.95 | 5 |
| | 306.00 | 12.95 | 400.00 | 12.96 | 4 |
| | 246.00 | 23.40 | 275.00 | 23.40 | 5 |
| | 215.00 | 12.92 | 306.00 | 12.95 | 4 |
| 0 | .00 | 11.50 | 400.00 | 11.50 | 3 |
| 1 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 2 | .00 | 5.50 | 400.00 | 5.50 | 1 |

ISOTROPIC SOIL PARAMETERS

Type(s) of Soil

| oil type o. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|-------------------|----------------------------|--------------------------------|--------------------------------|----------------------------|----------------------------|-------------------------------|-------------------------|
| | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| | 1.6 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| | 1.6 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| | 2.0 | 2.0 | 3.0 | 30.0 | .00 | .0 | 1 |

PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 1.00

Isometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|--------------|-----------------|-----------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 306.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|-------------|----------------|-----------------|------------------------|---------------------|
| 1 | 249.50 | 257.00 | 5.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 100.00 ft.
and X = 215.00 ft.

Each Surface Terminates Between X = 248.00 ft.
and X = 273.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 25 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 204.67 | 11.17 |
| 3 | 207.24 | 9.63 |
| 4 | 209.91 | 8.26 |

| | |
|--------|-------|
| 218.40 | 5.34 |
| 221.35 | 4.78 |
| 224.33 | 4.43 |
| 227.33 | 4.29 |
| 230.32 | 4.36 |
| 233.31 | 4.65 |
| 236.27 | 5.15 |
| 239.18 | 5.85 |
| 242.04 | 6.77 |
| 244.83 | 7.88 |
| 247.53 | 9.19 |
| 250.13 | 10.69 |
| 252.61 | 12.37 |
| 254.97 | 14.22 |
| 257.19 | 16.23 |
| 259.27 | 18.40 |
| 261.18 | 20.71 |
| 262.93 | 23.15 |
| 263.39 | 23.90 |

Circle Center At X = 227.8 ; Y = 46.5 and Radius, 42.2

*** 1.243 ***

Failure Surface Specified By 30 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 189.44 | 12.92 |
| 2 | 191.69 | 10.93 |
| 3 | 194.05 | 9.08 |
| 4 | 196.53 | 7.39 |
| 5 | 199.12 | 5.87 |
| 6 | 201.79 | 4.51 |
| 7 | 204.55 | 3.34 |
| 8 | 207.38 | 2.34 |
| 9 | 210.27 | 1.53 |
| 10 | 213.20 | .91 |
| 11 | 216.17 | .47 |
| 12 | 219.16 | .24 |
| 13 | 222.16 | .19 |
| 14 | 225.16 | .34 |
| 15 | 228.14 | .69 |
| 16 | 231.09 | 1.22 |
| 17 | 234.00 | 1.95 |
| 18 | 236.86 | 2.86 |
| 19 | 239.65 | 3.96 |
| 20 | 242.37 | 5.23 |
| 21 | 245.00 | 6.68 |
| 22 | 247.52 | 8.29 |
| 23 | 249.94 | 10.07 |
| 24 | 252.24 | 12.00 |
| 25 | 254.41 | 14.07 |
| 26 | 256.44 | 16.28 |
| 27 | 258.32 | 18.61 |
| 28 | 260.05 | 21.07 |
| 29 | 261.62 | 23.62 |
| 30 | 261.76 | 23.90 |

Circle Center At X = 221.3 ; Y = 46.5 and Radius, 46.3

*** 1.243 ***

5/

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 07/12/93
Time of Run: 17.13
Run By: jdcg
Input Data Filename: av1611-2.dat
Output Filename: av1611-2.sal

PROBLEM DESCRIPTION Avenida-1-REF-pr.1600/L/2-CIRC-PROF.-sue
low e/AVE-con sobrecarga 3t/m en 7m

BOUNDARY COORDINATES

7 Top Boundaries
12 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|--------------|-------------|-------------|--------------|--------------|---------------------|
| 1 | .00 | 12.92 | 215.00 | 12.42 | 4 |
| 2 | 215.00 | 12.92 | 246.00 | 23.40 | 3 |
| 3 | 246.00 | 23.40 | 248.00 | 23.90 | 6 |
| 4 | 248.00 | 23.90 | 273.00 | 23.90 | 6 |
| 5 | 273.00 | 23.90 | 275.00 | 23.40 | 4 |
| 6 | 275.00 | 23.40 | 306.00 | 12.95 | 3 |
| 7 | 306.00 | 12.95 | 400.00 | 12.95 | 4 |
| 8 | 246.00 | 23.40 | 275.00 | 23.40 | 3 |
| 9 | 215.00 | 12.92 | 306.00 | 12.95 | 4 |
| 10 | .00 | 11.50 | 400.00 | 11.50 | 3 |
| 11 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 12 | .00 | 3.50 | 400.00 | 3.50 | 1 |

ISOTROPIC SOIL PARAMETERS

6 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---------------|----------------------|--------------------------|--------------------------|----------------------|----------------------|-------------------------|-------------------|
| 1 | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| 2 | 1.4 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| 3 | 1.4 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| 4 | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| 5 | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 2.0 | 2.0 | 3.0 | 30.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 1.00

Piezometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|--------------|-----------------|-----------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 306.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|-------------|----------------|-----------------|------------------------|---------------------|
| 1 | 249.50 | 257.00 | 9.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 100.00 ft.
and X = 240.00 ft.

Each Surface Terminates Between X = 248.00 ft.
and X = 273.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* 1 Safety Factors Are Calculated By The Modified Bishop Method *

Failure Surface Specified By 21 Coordinate Points

| No. | (ft) | (ft) |
|-----|--------|-------|
| 1 | 193.33 | 12.92 |
| 2 | 196.18 | 10.11 |
| 3 | 199.30 | 7.61 |
| 4 | 202.66 | 5.43 |
| 5 | 206.22 | 3.61 |
| 6 | 209.93 | 2.16 |
| 7 | 213.80 | 1.10 |
| 8 | 217.75 | .44 |
| 9 | 221.74 | .18 |
| 10 | 225.74 | .34 |
| 11 | 229.70 | .89 |
| 12 | 233.58 | 1.85 |
| 13 | 237.35 | 3.20 |
| 14 | 240.96 | 4.93 |
| 15 | 244.37 | 7.01 |
| 16 | 247.55 | 9.43 |
| 17 | 250.47 | 12.17 |
| 18 | 253.10 | 15.18 |
| 19 | 255.41 | 18.45 |
| 20 | 257.37 | 21.94 |
| 21 | 258.22 | 23.90 |

Circle Center At X = 222.3 ; Y = 39.4 and Radius, 39.2

*** 1.222 ***

Failure Surface Specified By 21 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 193.33 | 12.92 |
| 2 | 196.17 | 10.10 |
| 3 | 199.27 | 7.58 |
| 4 | 202.63 | 5.39 |
| 5 | 206.18 | 3.56 |
| 6 | 209.91 | 2.11 |
| 7 | 213.76 | 1.03 |
| 8 | 217.71 | .38 |
| 9 | 221.70 | .13 |
| 10 | 225.70 | .29 |
| 11 | 229.66 | .86 |
| 12 | 233.64 | 1.83 |
| 13 | 237.30 | 3.20 |
| 14 | 240.99 | 4.94 |
| 15 | 244.39 | 7.03 |
| 16 | 247.46 | 9.47 |
| 17 | 250.36 | 12.23 |
| 18 | 252.96 | 15.27 |
| 19 | 255.24 | 18.58 |
| 20 | 257.16 | 22.09 |
| 21 | 257.93 | 23.90 |

Circle Center At X = 222.2 ; Y = 39.0 and Radius, 38.7

*** 1.224 ***

Failure Surface Specified By 22 Coordinate Points

| Point | X-Surf | Y-Surf |
|-------|--------|--------|
|-------|--------|--------|

| | | |
|----|--------|-------|
| 1 | 193.33 | 12.92 |
| 2 | 196.26 | 10.19 |
| 3 | 199.43 | 7.73 |
| 4 | 202.82 | 5.63 |
| 5 | 206.40 | 3.84 |
| 6 | 210.12 | 2.39 |
| 7 | 213.98 | 1.31 |
| 8 | 217.91 | .59 |
| 9 | 221.90 | .26 |
| 10 | 225.90 | .30 |
| 11 | 229.87 | .73 |
| 12 | 233.79 | 1.53 |
| 13 | 237.62 | 2.70 |
| 14 | 241.31 | 4.23 |
| 15 | 244.85 | 6.10 |
| 16 | 248.19 | 8.30 |
| 17 | 251.31 | 10.81 |
| 18 | 254.17 | 13.60 |
| 19 | 256.76 | 16.65 |
| 20 | 259.04 | 19.93 |
| 21 | 261.00 | 23.42 |
| 22 | 261.21 | 23.90 |

Circle Center At X = 223.4 ; Y = 42.3 and Radius, 42.0

*** 1.224 ***

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.89 | 12.92 |
| 2 | 211.79 | 10.17 |
| 3 | 215.04 | 7.83 |
| 4 | 218.56 | 5.94 |
| 5 | 222.31 | 4.55 |
| 6 | 226.22 | 3.67 |
| 7 | 230.20 | 3.32 |
| 8 | 234.20 | 3.51 |
| 9 | 238.13 | 4.23 |
| 10 | 241.93 | 5.48 |
| 11 | 245.53 | 7.22 |
| 12 | 248.87 | 9.42 |
| 13 | 251.88 | 12.06 |
| 14 | 254.51 | 15.07 |
| 15 | 256.71 | 18.41 |
| 16 | 258.45 | 22.02 |
| 17 | 259.06 | 23.90 |

Circle Center At X = 230.8 ; Y = 33.1 and Radius, 29.0

*** 1.237 ***

Failure Surface Specified By 13 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.89 | 12.92 |
| 2 | 212.13 | 10.58 |

9

| | | |
|----|--------|-------|
| 3 | 215.67 | 6.70 |
| 4 | 217.42 | 7.32 |
| 5 | 223.32 | 6.43 |
| 6 | 227.31 | 6.12 |
| 7 | 231.30 | 6.33 |
| 8 | 235.23 | 7.08 |
| 9 | 239.03 | 8.35 |
| 10 | 242.61 | 10.12 |
| 11 | 245.93 | 12.36 |
| 12 | 248.91 | 15.03 |
| 13 | 251.30 | 18.07 |
| 14 | 253.66 | 21.44 |
| 15 | 254.81 | 23.90 |

Circle Center At X = 227.8 ; Y = 35.7 and Radius, 29.6

*** 1.241 ***

Failure Surface Specified By 20 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 193.33 | 12.92 |
| 2 | 196.26 | 10.19 |
| 3 | 199.47 | 7.80 |
| 4 | 202.91 | 5.77 |
| 5 | 206.56 | 4.13 |
| 6 | 210.37 | 2.90 |
| 7 | 214.28 | 2.08 |
| 8 | 218.26 | 1.70 |
| 9 | 222.26 | 1.75 |
| 10 | 226.23 | 2.24 |
| 11 | 230.13 | 3.16 |
| 12 | 233.90 | 4.50 |
| 13 | 237.50 | 6.24 |
| 14 | 240.89 | 8.36 |
| 15 | 244.03 | 10.84 |
| 16 | 246.88 | 13.64 |
| 17 | 249.41 | 16.74 |
| 18 | 251.59 | 20.10 |
| 19 | 253.38 | 23.67 |
| 20 | 253.47 | 23.90 |

Circle Center At X = 219.8 ; Y = 38.4 and Radius, 36.7

*** 1.254 ***

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.89 | 12.92 |
| 2 | 211.97 | 10.37 |
| 3 | 215.34 | 8.22 |
| 4 | 218.90 | 6.48 |
| 5 | 222.73 | 5.19 |
| 6 | 226.69 | 4.36 |
| 7 | 230.63 | 4.01 |
| 8 | 234.63 | 4.19 |
| 9 | 238.68 | 4.76 |
| 10 | 242.43 | 5.84 |

10/

| | | |
|----|--------|-------|
| 11 | 246.13 | 7.59 |
| 12 | 249.61 | 9.34 |
| 13 | 252.83 | 11.72 |
| 14 | 255.74 | 14.46 |
| 15 | 258.30 | 17.53 |
| 16 | 260.47 | 20.89 |
| 17 | 261.94 | 23.90 |

Circle Center At X = 231.5 ; Y = 37.2 and Radius, 33.2

*** 1.254 ***

Failure Surface Specified By 16 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 208.89 | 12.92 |
| 2 | 211.72 | 10.09 |
| 3 | 214.95 | 7.74 |
| 4 | 218.32 | 5.92 |
| 5 | 222.32 | 4.68 |
| 6 | 226.27 | 4.04 |
| 7 | 230.27 | 4.02 |
| 8 | 234.22 | 4.63 |
| 9 | 238.03 | 5.85 |
| 10 | 241.61 | 7.64 |
| 11 | 244.86 | 9.97 |
| 12 | 247.71 | 12.77 |
| 13 | 250.09 | 15.99 |
| 14 | 251.94 | 19.53 |
| 15 | 253.22 | 23.32 |
| 16 | 253.32 | 23.90 |

Circle Center At X = 228.4 ; Y = 29.6 and Radius, 25.6

*** 1.255 ***

Failure Surface Specified By 22 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 193.33 | 12.92 |
| 2 | 196.59 | 10.60 |
| 3 | 200.02 | 8.54 |
| 4 | 203.60 | 6.76 |
| 5 | 207.31 | 5.25 |
| 6 | 211.12 | 4.04 |
| 7 | 215.02 | 3.13 |
| 8 | 218.97 | 2.53 |
| 9 | 222.96 | 2.23 |
| 10 | 226.96 | 2.25 |
| 11 | 230.95 | 2.58 |
| 12 | 234.90 | 3.21 |
| 13 | 238.78 | 4.15 |
| 14 | 242.59 | 5.39 |
| 15 | 246.28 | 6.92 |
| 16 | 249.83 | 8.74 |
| 17 | 253.26 | 10.82 |
| 18 | 256.50 | 13.17 |
| 19 | 259.55 | 15.75 |
| 20 | 262.39 | 18.57 |

21 265.00 21.60
22 266.68 23.90

Circle Center At X = 224.8 ; Y = 53.6 and Radius, 51.4

*** 1.256 ***

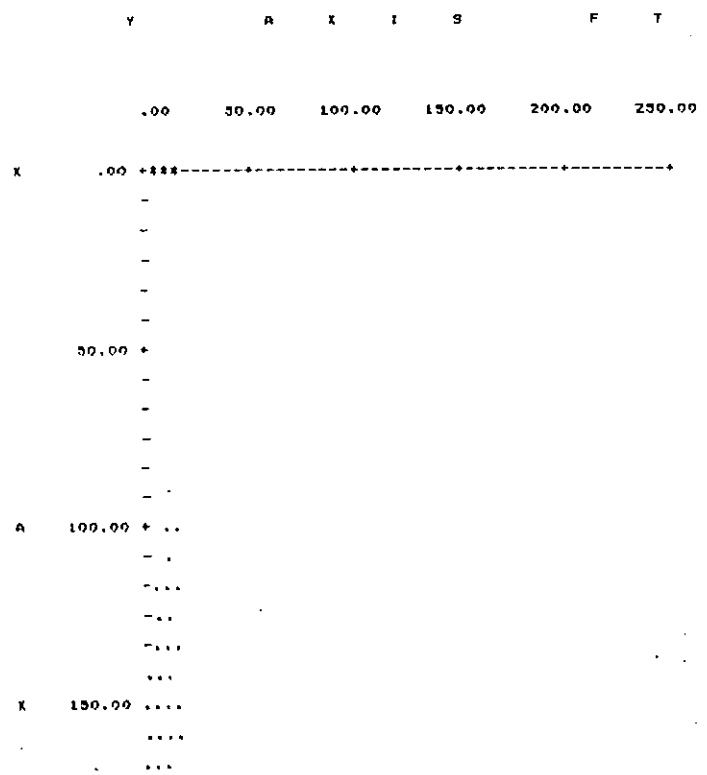
Failure Surface Specified By 20 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 193.33 | 12.92 |
| 2 | 196.70 | 10.76 |
| 3 | 200.24 | 8.90 |
| 4 | 203.93 | 7.36 |
| 5 | 207.74 | 6.13 |
| 6 | 211.64 | 5.24 |
| 7 | 215.60 | 4.68 |
| 8 | 219.60 | 4.47 |
| 9 | 223.59 | 4.60 |
| 10 | 227.37 | 5.07 |
| 11 | 231.48 | 5.89 |
| 12 | 235.31 | 7.03 |
| 13 | 239.03 | 8.51 |
| 14 | 242.61 | 10.29 |
| 15 | 246.03 | 12.38 |
| 16 | 249.28 | 14.75 |
| 17 | 252.23 | 17.39 |
| 18 | 255.02 | 20.28 |
| 19 | 257.33 | 23.39 |
| 20 | 257.87 | 23.90 |

Circle Center At X = 220.1 ; Y = 51.0 and Radius, 46.8

*** 1.267 ***

1



By
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 07/12/93
Time of Run: 17.30
Run By: jdcg
Input Data Filename: avi611-3.dat
Output Filename: avi611-3.sal

PROBLEM DESCRIPTION Avenida-T.REF-pr.1600/1/3-CIRC.PROF.-sus
los s/AVE-con sobrecarga 5t/m en 7m

BOUNDARY COORDINATES

7 Top Boundaries
12 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|--------------|-------------|-------------|--------------|--------------|---------------------|
| 1 | .00 | 12.92 | 215.00 | 12.92 | 4 |
| 2 | 215.00 | 12.92 | 246.00 | 23.40 | 5 |
| 3 | 246.00 | 23.40 | 248.00 | 23.90 | 6 |
| 4 | 248.00 | 23.90 | 273.00 | 23.90 | 6 |
| 5 | 273.00 | 23.90 | 275.00 | 23.40 | 6 |
| 6 | 275.00 | 23.40 | 306.00 | 12.95 | 5 |
| 7 | 306.00 | 12.95 | 400.00 | 12.96 | 4 |
| 8 | 246.00 | 23.40 | 275.00 | 23.40 | 5 |
| 9 | 215.00 | 12.92 | 306.00 | 12.95 | 4 |
| 10 | .00 | 11.50 | 400.00 | 11.50 | 3 |
| 11 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 12 | .00 | 5.50 | 400.00 | 5.50 | 1 |

ISOTROPIC SOIL PARAMETERS

6 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---------------|----------------------|--------------------------|--------------------------|----------------------|----------------------|-------------------------|-------------------|
| 1 | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| 2 | 1.6 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| 3 | 1.6 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| 4 | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| 5 | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 2.0 | 2.0 | 3.0 | 30.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 1.00

13/

Piezometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|--------------|-----------------|-----------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 306.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|-------------|----------------|-----------------|------------------------|---------------------|
| 1 | 247.50 | 257.00 | 5.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between $X = 215.00$ ft.
and $X = 240.00$ ft.

Each Surface Terminates Between $X = 248.00$ ft.
and $X = 273.00$ ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is $Y = .00$ ft.

1.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

1 Safety Factors Are Calculated By The Modified Bishop Method 1 1

Failure Surface Specified By 37 Coordinate Points

14/

Point X-Surf Y-Surf
No. (ft) (ft)

| | | |
|----|--------|-------|
| 1 | 215.00 | 12.92 |
| 2 | 215.71 | 12.21 |
| 3 | 216.44 | 11.53 |
| 4 | 217.20 | 10.88 |
| 5 | 217.98 | 10.26 |
| 6 | 218.79 | 9.67 |
| 7 | 219.61 | 9.10 |
| 8 | 220.46 | 8.57 |
| 9 | 221.33 | 8.07 |
| 10 | 222.21 | 7.61 |
| 11 | 223.12 | 7.18 |
| 12 | 224.03 | 6.78 |
| 13 | 224.96 | 6.42 |
| 14 | 225.91 | 6.09 |
| 15 | 226.87 | 5.80 |
| 16 | 227.83 | 5.54 |
| 17 | 228.81 | 5.32 |
| 18 | 229.79 | 5.14 |
| 19 | 230.78 | 5.00 |
| 20 | 231.78 | 4.89 |
| 21 | 232.77 | 4.82 |
| 22 | 233.77 | 4.79 |
| 23 | 234.77 | 4.79 |
| 24 | 235.77 | 4.84 |
| 25 | 236.77 | 4.92 |
| 26 | 237.76 | 5.03 |
| 27 | 238.75 | 5.19 |
| 28 | 239.73 | 5.38 |
| 29 | 240.70 | 5.61 |
| 30 | 241.67 | 5.88 |
| 31 | 242.62 | 6.18 |
| 32 | 243.56 | 6.52 |
| 33 | 244.49 | 6.89 |
| 34 | 245.40 | 7.30 |
| 35 | 246.30 | 7.74 |
| 36 | 247.18 | 8.21 |
| 37 | 248.04 | 8.72 |
| 38 | 248.88 | 9.26 |
| 39 | 249.71 | 9.83 |
| 40 | 250.50 | 10.43 |
| 41 | 251.28 | 11.06 |
| 42 | 252.03 | 11.72 |
| 43 | 252.76 | 12.41 |
| 44 | 253.46 | 13.12 |
| 45 | 254.13 | 13.87 |
| 46 | 254.77 | 14.63 |
| 47 | 255.39 | 15.42 |
| 48 | 255.97 | 16.23 |
| 49 | 256.53 | 17.06 |
| 50 | 257.05 | 17.92 |
| 51 | 257.54 | 18.79 |
| 52 | 257.99 | 19.68 |
| 53 | 258.41 | 20.59 |
| 54 | 258.80 | 21.51 |
| 55 | 259.16 | 22.44 |
| 56 | 259.47 | 23.39 |
| 57 | 259.62 | 23.90 |

Circle Center At X = 234.1 ; Y = 31.3 and Radius, 26.5

1.310

Failure Surface Specified By 53 Coordinate Points

Point X-Surf Y-Surf

15/

| No. | (ft) | (ft) |
|-----|--------|-------|
| 1 | 217.78 | 13.86 |
| 2 | 218.51 | 13.18 |
| 3 | 219.27 | 12.53 |
| 4 | 220.05 | 11.91 |
| 5 | 220.86 | 11.32 |
| 6 | 221.69 | 10.76 |
| 7 | 222.54 | 10.24 |
| 8 | 223.42 | 9.75 |
| 9 | 224.31 | 9.29 |
| 10 | 225.21 | 8.87 |
| 11 | 226.14 | 8.49 |
| 12 | 227.08 | 8.14 |
| 13 | 228.03 | 7.83 |
| 14 | 228.99 | 7.56 |
| 15 | 229.96 | 7.33 |
| 16 | 230.94 | 7.13 |
| 17 | 231.93 | 6.97 |
| 18 | 232.92 | 6.86 |
| 19 | 233.92 | 6.78 |
| 20 | 234.92 | 6.74 |
| 21 | 235.92 | 6.74 |
| 22 | 236.92 | 6.78 |
| 23 | 237.92 | 6.86 |
| 24 | 238.91 | 6.97 |
| 25 | 239.90 | 7.13 |
| 26 | 240.88 | 7.33 |
| 27 | 241.85 | 7.56 |
| 28 | 242.81 | 7.83 |
| 29 | 243.76 | 8.14 |
| 30 | 244.70 | 8.49 |
| 31 | 245.62 | 8.87 |
| 32 | 246.53 | 9.29 |
| 33 | 247.42 | 9.75 |
| 34 | 248.29 | 10.24 |
| 35 | 249.14 | 10.76 |
| 36 | 249.97 | 11.32 |
| 37 | 250.78 | 11.91 |
| 38 | 251.57 | 12.53 |
| 39 | 252.33 | 13.18 |
| 40 | 253.06 | 13.86 |
| 41 | 253.76 | 14.57 |
| 42 | 254.44 | 15.31 |
| 43 | 255.09 | 16.07 |
| 44 | 255.71 | 16.85 |
| 45 | 256.29 | 17.66 |
| 46 | 256.85 | 18.50 |
| 47 | 257.37 | 19.33 |
| 48 | 257.85 | 20.23 |
| 49 | 258.30 | 21.12 |
| 50 | 258.72 | 22.03 |
| 51 | 259.10 | 22.93 |
| 52 | 259.44 | 23.89 |
| 53 | 259.44 | 23.90 |

Circle Center At X = 235.4 ; Y = 32.1 and Radius, 25.4

1.317

Failure Surface Specified By 45 Coordinate Points

| Point | X-Surf | Y-Surf |
|-------|--------|--------|
| No. | (ft) | (ft) |
| 1 | 215.00 | 12.92 |
| 2 | 215.77 | 12.29 |

16/

| | | |
|----|--------|-------|
| 3 | 216.58 | 11.69 |
| 4 | 217.40 | 11.13 |
| 5 | 218.26 | 10.61 |
| 6 | 219.14 | 10.13 |
| 7 | 220.03 | 9.69 |
| 8 | 220.93 | 9.29 |
| 9 | 221.89 | 8.93 |
| 10 | 222.84 | 8.62 |
| 11 | 223.80 | 8.35 |
| 12 | 224.77 | 8.13 |
| 13 | 225.76 | 7.95 |
| 14 | 226.75 | 7.82 |
| 15 | 227.74 | 7.73 |
| 16 | 228.74 | 7.69 |
| 17 | 229.74 | 7.70 |
| 18 | 230.74 | 7.75 |
| 19 | 231.74 | 7.83 |
| 20 | 232.73 | 7.99 |
| 21 | 233.71 | 8.18 |
| 22 | 234.68 | 8.41 |
| 23 | 235.64 | 8.69 |
| 24 | 236.59 | 9.01 |
| 25 | 237.52 | 9.38 |
| 26 | 238.43 | 9.79 |
| 27 | 239.33 | 10.24 |
| 28 | 240.20 | 10.73 |
| 29 | 241.05 | 11.26 |
| 30 | 241.87 | 11.82 |
| 31 | 242.66 | 12.43 |
| 32 | 243.43 | 13.07 |
| 33 | 244.17 | 13.75 |
| 34 | 244.87 | 14.46 |
| 35 | 245.54 | 15.20 |
| 36 | 246.18 | 15.97 |
| 37 | 246.78 | 16.77 |
| 38 | 247.34 | 17.60 |
| 39 | 247.86 | 18.45 |
| 40 | 248.35 | 19.33 |
| 41 | 248.79 | 20.22 |
| 42 | 249.19 | 21.14 |
| 43 | 249.55 | 22.07 |
| 44 | 249.87 | 23.02 |
| 45 | 250.11 | 23.90 |

Circle Center At X = 229.1 ; Y = 29.4 and Radius, 21.7

*** 1.392 ***

Failure Surface Specified By 43 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 217.78 | 13.86 |
| 2 | 218.62 | 13.32 |
| 3 | 219.48 | 12.81 |
| 4 | 220.36 | 12.34 |
| 5 | 221.26 | 11.91 |
| 6 | 222.18 | 11.51 |
| 7 | 223.12 | 11.16 |
| 8 | 224.07 | 10.85 |
| 9 | 225.03 | 10.58 |
| 10 | 226.00 | 10.34 |
| 11 | 226.99 | 10.15 |
| 12 | 227.98 | 10.01 |
| 13 | 228.97 | 9.90 |
| 14 | 229.97 | 9.84 |
| 15 | 230.97 | 9.82 |

| | | |
|----|--------|-------|
| 16 | 231.97 | 9.84 |
| 17 | 232.97 | 9.91 |
| 18 | 233.96 | 10.02 |
| 19 | 234.95 | 10.17 |
| 20 | 235.93 | 10.36 |
| 21 | 236.90 | 10.59 |
| 22 | 237.86 | 10.87 |
| 23 | 238.81 | 11.18 |
| 24 | 239.75 | 11.54 |
| 25 | 240.66 | 11.93 |
| 26 | 241.57 | 12.37 |
| 27 | 242.45 | 12.84 |
| 28 | 243.31 | 13.35 |
| 29 | 244.15 | 13.90 |
| 30 | 244.96 | 14.48 |
| 31 | 245.75 | 15.09 |
| 32 | 246.51 | 15.74 |
| 33 | 247.24 | 16.42 |
| 34 | 247.95 | 17.13 |
| 35 | 248.62 | 17.87 |
| 36 | 249.26 | 18.64 |
| 37 | 249.87 | 19.43 |
| 38 | 250.44 | 20.25 |
| 39 | 250.97 | 21.10 |
| 40 | 251.48 | 21.96 |
| 41 | 251.94 | 22.85 |
| 42 | 252.36 | 23.76 |
| 43 | 252.42 | 23.90 |

Circle Center At X = 230.9 ; Y = 33.2 and Radius, 23.4

*** 1.409 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 215.00 | 12.92 |
| 2 | 215.92 | 12.53 |
| 3 | 216.85 | 12.16 |
| 4 | 217.79 | 11.81 |
| 5 | 218.73 | 11.47 |
| 6 | 219.67 | 11.19 |
| 7 | 220.63 | 10.92 |
| 8 | 221.62 | 10.67 |
| 9 | 222.59 | 10.45 |
| 10 | 223.57 | 10.25 |
| 11 | 224.56 | 10.08 |
| 12 | 225.55 | 9.93 |
| 13 | 226.54 | 9.81 |
| 14 | 227.54 | 9.72 |
| 15 | 228.53 | 9.65 |
| 16 | 229.53 | 9.60 |
| 17 | 230.53 | 9.59 |
| 18 | 231.53 | 9.59 |
| 19 | 232.53 | 9.63 |
| 20 | 233.53 | 9.69 |
| 21 | 234.53 | 9.77 |
| 22 | 235.52 | 9.89 |
| 23 | 236.51 | 10.02 |
| 24 | 237.50 | 10.19 |
| 25 | 238.48 | 10.38 |
| 26 | 239.46 | 10.59 |
| 27 | 240.43 | 10.83 |
| 28 | 241.39 | 11.09 |
| 29 | 242.35 | 11.38 |

18/

| | | |
|----|--------|-------|
| 30 | 243.30 | 11.89 |
| 31 | 244.24 | 12.03 |
| 32 | 245.17 | 12.39 |
| 33 | 246.10 | 12.78 |
| 34 | 247.01 | 13.19 |
| 35 | 247.91 | 13.62 |
| 36 | 248.80 | 14.08 |
| 37 | 249.68 | 14.56 |
| 38 | 250.54 | 15.06 |
| 39 | 251.39 | 15.59 |
| 40 | 252.23 | 16.13 |
| 41 | 253.05 | 16.70 |
| 42 | 253.86 | 17.29 |
| 43 | 254.65 | 17.90 |
| 44 | 255.43 | 18.53 |
| 45 | 256.19 | 19.18 |
| 46 | 256.94 | 19.84 |
| 47 | 257.66 | 20.53 |
| 48 | 258.37 | 21.24 |
| 49 | 259.06 | 21.96 |
| 50 | 259.73 | 22.71 |
| 51 | 260.38 | 23.47 |
| 52 | 260.73 | 23.90 |

Circle Center At X = 230.7 ; Y = 48.2 and Radius, 38.7

188 1.468 188

Failure Surface Specified By 64 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 213.00 | 12.92 |
| 2 | 213.74 | 12.25 |
| 3 | 216.51 | 11.61 |
| 4 | 217.29 | 10.99 |
| 5 | 218.10 | 10.39 |
| 6 | 218.92 | 9.82 |
| 7 | 219.73 | 9.27 |
| 8 | 220.61 | 8.73 |
| 9 | 221.48 | 8.26 |
| 10 | 222.36 | 7.79 |
| 11 | 223.26 | 7.33 |
| 12 | 224.17 | 6.94 |
| 13 | 225.09 | 6.53 |
| 14 | 226.03 | 6.20 |
| 15 | 226.97 | 5.87 |
| 16 | 227.93 | 5.57 |
| 17 | 228.89 | 5.30 |
| 18 | 229.86 | 5.06 |
| 19 | 230.84 | 4.83 |
| 20 | 231.82 | 4.65 |
| 21 | 232.81 | 4.53 |
| 22 | 233.80 | 4.41 |
| 23 | 234.80 | 4.32 |
| 24 | 235.80 | 4.26 |
| 25 | 236.80 | 4.24 |
| 26 | 237.80 | 4.24 |
| 27 | 238.80 | 4.27 |
| 28 | 239.80 | 4.34 |
| 29 | 240.79 | 4.43 |
| 30 | 241.78 | 4.56 |
| 31 | 242.77 | 4.72 |
| 32 | 243.75 | 4.90 |
| 33 | 244.73 | 5.12 |
| 34 | 245.70 | 5.37 |
| 35 | 246.66 | 5.64 |

| | | |
|----|--------|-------|
| 36 | 247.61 | 5.95 |
| 37 | 248.55 | 6.28 |
| 38 | 249.49 | 6.64 |
| 39 | 250.41 | 7.04 |
| 40 | 251.31 | 7.45 |
| 41 | 252.21 | 7.90 |
| 42 | 253.09 | 8.38 |
| 43 | 253.96 | 8.88 |
| 44 | 254.81 | 9.40 |
| 45 | 255.64 | 9.96 |
| 46 | 256.45 | 10.53 |
| 47 | 257.25 | 11.14 |
| 48 | 258.03 | 11.76 |
| 49 | 258.79 | 12.42 |
| 50 | 259.53 | 13.09 |
| 51 | 260.25 | 13.78 |
| 52 | 260.94 | 14.50 |
| 53 | 261.62 | 15.24 |
| 54 | 262.27 | 16.00 |
| 55 | 262.90 | 16.78 |
| 56 | 263.50 | 17.57 |
| 57 | 264.08 | 18.39 |
| 58 | 264.63 | 19.22 |
| 59 | 265.16 | 20.07 |
| 60 | 265.66 | 20.94 |
| 61 | 266.14 | 21.82 |
| 62 | 266.59 | 22.71 |
| 63 | 267.01 | 23.62 |
| 64 | 267.43 | 23.90 |

Circle Center At X = 237.1 ; Y = 36.0 and Radius, 32.6

1.471

Failure Surface Specified By 65 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 215.00 | 12.92 |
| 2 | 215.61 | 12.33 |
| 3 | 216.63 | 11.76 |
| 4 | 217.46 | 11.21 |
| 5 | 218.32 | 10.68 |
| 6 | 219.18 | 10.18 |
| 7 | 220.06 | 9.70 |
| 8 | 220.95 | 9.25 |
| 9 | 221.85 | 8.82 |
| 10 | 222.76 | 8.41 |
| 11 | 223.69 | 8.02 |
| 12 | 224.62 | 7.67 |
| 13 | 225.56 | 7.33 |
| 14 | 226.51 | 7.03 |
| 15 | 227.47 | 6.74 |
| 16 | 228.44 | 6.49 |
| 17 | 229.41 | 6.25 |
| 18 | 230.39 | 6.05 |
| 19 | 231.38 | 5.87 |
| 20 | 232.36 | 5.72 |
| 21 | 233.36 | 5.59 |
| 22 | 234.35 | 5.49 |
| 23 | 235.35 | 5.42 |
| 24 | 236.35 | 5.37 |
| 25 | 237.35 | 5.33 |
| 26 | 238.35 | 5.36 |
| 27 | 239.35 | 5.39 |
| 28 | 240.34 | 5.45 |

| | | |
|----|--------|-------|
| 29 | 241.34 | 5.54 |
| 30 | 242.33 | 5.66 |
| 31 | 243.32 | 5.80 |
| 32 | 244.31 | 5.96 |
| 33 | 245.29 | 6.13 |
| 34 | 246.27 | 6.37 |
| 35 | 247.24 | 6.62 |
| 36 | 248.20 | 6.89 |
| 37 | 249.16 | 7.18 |
| 38 | 250.10 | 7.50 |
| 39 | 251.04 | 7.85 |
| 40 | 251.97 | 8.22 |
| 41 | 252.89 | 8.62 |
| 42 | 253.79 | 9.04 |
| 43 | 254.69 | 9.48 |
| 44 | 255.57 | 9.95 |
| 45 | 256.45 | 10.44 |
| 46 | 257.30 | 10.96 |
| 47 | 258.15 | 11.50 |
| 48 | 258.97 | 12.05 |
| 49 | 259.79 | 12.64 |
| 50 | 260.59 | 13.24 |
| 51 | 261.37 | 13.86 |
| 52 | 262.13 | 14.51 |
| 53 | 262.88 | 15.17 |
| 54 | 263.61 | 15.86 |
| 55 | 264.32 | 16.56 |
| 56 | 265.01 | 17.28 |
| 57 | 265.68 | 18.02 |
| 58 | 266.33 | 18.78 |
| 59 | 266.96 | 19.56 |
| 60 | 267.58 | 20.35 |
| 61 | 268.16 | 21.16 |
| 62 | 268.73 | 21.98 |
| 63 | 269.28 | 22.82 |
| 64 | 269.80 | 23.67 |
| 65 | 269.93 | 23.90 |

Circle Center At X = 237.6 ; Y = 42.8 and Radius, 37.5

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Failure Surface Specified By 59 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 217.78 | 13.86 |
| 2 | 218.49 | 13.16 |
| 3 | 219.23 | 12.48 |
| 4 | 219.99 | 11.83 |
| 5 | 220.77 | 11.21 |
| 6 | 221.57 | 10.61 |
| 7 | 222.39 | 10.04 |
| 8 | 223.23 | 9.50 |
| 9 | 224.09 | 8.99 |
| 10 | 224.97 | 8.51 |
| 11 | 225.86 | 8.06 |
| 12 | 226.77 | 7.64 |
| 13 | 227.69 | 7.26 |
| 14 | 228.63 | 6.90 |
| 15 | 229.58 | 6.58 |
| 16 | 230.53 | 6.29 |
| 17 | 231.50 | 6.04 |
| 18 | 232.48 | 5.81 |
| 19 | 233.46 | 5.63 |
| 20 | 234.45 | 5.47 |
| 21 | 235.44 | 5.35 |

| | | |
|----|--------|-------|
| 22 | 236.44 | 5.27 |
| 23 | 237.43 | 5.22 |
| 24 | 238.43 | 5.20 |
| 25 | 239.43 | 5.22 |
| 26 | 240.43 | 5.28 |
| 27 | 241.43 | 5.36 |
| 28 | 242.42 | 5.49 |
| 29 | 243.41 | 5.64 |
| 30 | 244.39 | 5.84 |
| 31 | 245.36 | 6.06 |
| 32 | 246.33 | 6.32 |
| 33 | 247.29 | 6.61 |
| 34 | 248.23 | 6.94 |
| 35 | 249.17 | 7.30 |
| 36 | 250.09 | 7.69 |
| 37 | 250.99 | 8.11 |
| 38 | 251.89 | 8.56 |
| 39 | 252.76 | 9.04 |
| 40 | 253.62 | 9.56 |
| 41 | 254.46 | 10.10 |
| 42 | 255.28 | 10.67 |
| 43 | 256.08 | 11.27 |
| 44 | 256.86 | 11.90 |
| 45 | 257.61 | 12.55 |
| 46 | 258.35 | 13.23 |
| 47 | 259.06 | 13.94 |
| 48 | 259.74 | 14.67 |
| 49 | 260.40 | 15.42 |
| 50 | 261.03 | 16.19 |
| 51 | 261.64 | 16.99 |
| 52 | 262.22 | 17.81 |
| 53 | 262.76 | 18.64 |
| 54 | 263.28 | 19.50 |
| 55 | 263.77 | 20.37 |
| 56 | 264.23 | 21.26 |
| 57 | 264.66 | 22.16 |
| 58 | 265.06 | 23.08 |
| 59 | 265.38 | 23.90 |

Circle Center At X = 238.3 ; Y = 34.0 and Radius, 28.8

111 1.498 111

1

Failure Surface Specified By 38 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 223.33 | 15.74 |
| 2 | 224.15 | 15.16 |
| 3 | 225.00 | 14.63 |
| 4 | 225.87 | 14.13 |
| 5 | 226.76 | 13.68 |
| 6 | 227.67 | 13.28 |
| 7 | 228.61 | 12.92 |
| 8 | 229.55 | 12.60 |
| 9 | 230.52 | 12.33 |
| 10 | 231.49 | 12.11 |
| 11 | 232.48 | 11.93 |
| 12 | 233.47 | 11.81 |
| 13 | 234.47 | 11.73 |
| 14 | 235.46 | 11.70 |
| 15 | 236.46 | 11.72 |
| 16 | 237.46 | 11.78 |
| 17 | 238.46 | 11.90 |
| 18 | 239.44 | 12.06 |
| 19 | 240.42 | 12.27 |

| | | |
|----|--------|-------|
| 20 | 241.39 | 12.53 |
| 21 | 242.34 | 12.84 |
| 22 | 243.27 | 13.19 |
| 23 | 244.19 | 13.58 |
| 24 | 245.09 | 14.02 |
| 25 | 245.97 | 14.51 |
| 26 | 246.82 | 15.03 |
| 27 | 247.64 | 15.60 |
| 28 | 248.44 | 16.20 |
| 29 | 249.20 | 16.84 |
| 30 | 249.94 | 17.52 |
| 31 | 250.64 | 18.24 |
| 32 | 251.30 | 18.99 |
| 33 | 251.93 | 19.76 |
| 34 | 252.52 | 20.57 |
| 35 | 253.07 | 21.41 |
| 36 | 253.57 | 22.27 |
| 37 | 254.04 | 23.16 |
| 38 | 254.39 | 23.90 |

Circle Center At X = 235.6 ; Y = 32.3 and Radius, 20.6

*** 1.499 ***

Failure Surface Specified By 39 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 217.78 | 13.86 |
| 2 | 218.63 | 13.34 |
| 3 | 219.50 | 12.84 |
| 4 | 220.38 | 12.36 |
| 5 | 221.27 | 11.91 |
| 6 | 222.17 | 11.48 |
| 7 | 223.09 | 11.07 |
| 8 | 224.01 | 10.69 |
| 9 | 224.95 | 10.34 |
| 10 | 225.89 | 10.01 |
| 11 | 226.84 | 9.71 |
| 12 | 227.80 | 9.43 |
| 13 | 228.77 | 9.18 |
| 14 | 229.75 | 8.95 |
| 15 | 230.73 | 8.75 |
| 16 | 231.71 | 8.58 |
| 17 | 232.70 | 8.44 |
| 18 | 233.69 | 8.32 |
| 19 | 234.69 | 8.22 |
| 20 | 235.69 | 8.16 |
| 21 | 236.69 | 8.12 |
| 22 | 237.69 | 8.11 |
| 23 | 238.69 | 8.12 |
| 24 | 239.68 | 8.17 |
| 25 | 240.68 | 8.24 |
| 26 | 241.68 | 8.33 |
| 27 | 242.67 | 8.45 |
| 28 | 243.66 | 8.60 |
| 29 | 244.64 | 8.78 |
| 30 | 245.62 | 8.98 |
| 31 | 246.60 | 9.21 |
| 32 | 247.56 | 9.47 |
| 33 | 248.52 | 9.75 |
| 34 | 249.47 | 10.05 |
| 35 | 250.42 | 10.39 |
| 36 | 251.35 | 10.74 |
| 37 | 252.28 | 11.13 |
| 38 | 253.19 | 11.53 |
| 39 | 254.09 | 11.97 |

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 07/12/93
Time of Run: 18.0
Run By: jdcg
Input Data File(s): avi612-1.dat
Output File(s): avi612-1.sai

PROBLEM DESCRIPTION Avenida-1r3,5-T.REF-pr.1600/2/1-CIRC.PRO
F.-sueldos a/AVE-a-St/n en l calzada

BOUNDARY COORDINATES

7 Top Boundaries
12 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil Type Below Bnd |
|--------------|-------------|-------------|--------------|--------------|---------------------|
| 1 | .00 | 12.92 | 215.00 | 12.92 | 4 |
| 2 | 215.00 | 12.92 | 252.00 | 23.40 | 5 |
| 3 | 252.00 | 23.40 | 253.00 | 23.90 | 6 |
| 4 | 253.00 | 23.90 | 278.00 | 23.90 | 6 |
| 5 | 278.00 | 23.90 | 280.00 | 23.40 | 6 |
| 6 | 280.00 | 23.40 | 317.00 | 12.93 | 5 |
| 7 | 317.00 | 12.93 | 400.00 | 12.96 | 4 |
| 8 | 252.00 | 23.40 | 280.00 | 23.40 | 5 |
| 9 | 215.00 | 12.92 | 317.00 | 12.93 | 4 |
| 10 | .00 | 11.30 | 400.00 | 11.30 | 3 |
| 11 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 12 | .00 | 5.50 | 400.00 | 5.50 | 1 |

ISOTROPIC SOIL PARAMETERS

6 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Piez. Surface No. |
|---------------|----------------------|--------------------------|--------------------------|----------------------|----------------------|-------------------------|-------------------|
| 1 | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| 2 | 1.6 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| 3 | 1.6 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| 4 | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| 5 | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 2.0 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |

1. PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 1.00

25

Piezometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|--------------|-----------------|-----------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 317.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|-------------|----------------|-----------------|------------------------|---------------------|
| 1 | 255.00 | 262.00 | 5.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed
Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 100.00 ft.
and X = 215.00 ft.

Each Surface Terminates Between X = 253.00 ft.
and X = 278.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

4.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

8 Safety Factors Are Calculated By The Modified Bishop Method

Failure Surface Specified By 19 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 205.06 | 10.10 |
| 3 | 208.19 | 7.61 |
| 4 | 211.99 | 5.50 |
| 5 | 218.21 | 3.79 |
| 6 | 218.99 | 2.81 |
| 7 | 222.90 | 1.66 |
| 8 | 226.88 | 1.26 |
| 9 | 230.88 | 1.31 |
| 10 | 234.85 | 1.82 |
| 11 | 238.73 | 2.78 |
| 12 | 242.48 | 4.17 |
| 13 | 246.05 | 5.98 |
| 14 | 249.39 | 8.19 |
| 15 | 252.45 | 10.76 |
| 16 | 255.21 | 13.66 |
| 17 | 257.61 | 16.86 |
| 18 | 259.64 | 20.30 |
| 19 | 261.23 | 23.90 |

Circle Center At X = 228.4 ; Y = 36.4 and Radius, 35.1

*** 1.290 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.54 | 10.39 |
| 3 | 195.82 | 8.10 |
| 4 | 199.28 | 6.08 |
| 5 | 202.88 | 4.34 |
| 6 | 206.61 | 2.89 |
| 7 | 210.44 | 1.74 |
| 8 | 214.35 | .89 |
| 9 | 218.31 | .36 |
| 10 | 222.30 | .13 |
| 11 | 226.30 | .22 |
| 12 | 230.28 | .63 |
| 13 | 234.22 | 1.35 |
| 14 | 238.08 | 2.38 |
| 15 | 241.86 | 3.70 |
| 16 | 245.51 | 5.32 |
| 17 | 249.03 | 7.23 |
| 18 | 252.39 | 9.40 |
| 19 | 255.57 | 11.83 |
| 20 | 258.54 | 14.51 |
| 21 | 261.30 | 17.41 |
| 22 | 263.81 | 20.51 |
| 23 | 266.08 | 23.81 |
| 24 | 266.13 | 23.90 |

Circle Center At X = 223.1 ; Y = 50.9 and Radius, 50.8

*** 1.325 ***

Failure Surface Specified By 23 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.55 | 10.40 |
| 3 | 195.89 | 8.13 |
| 4 | 199.31 | 6.14 |
| 5 | 202.93 | 4.44 |
| 6 | 206.68 | 3.03 |
| 7 | 210.32 | 1.93 |
| 8 | 214.45 | 1.13 |
| 9 | 218.42 | .68 |
| 10 | 222.42 | .54 |
| 11 | 226.41 | .72 |
| 12 | 230.38 | 1.22 |
| 13 | 234.30 | 2.04 |
| 14 | 238.13 | 3.17 |
| 15 | 241.86 | 4.61 |
| 16 | 245.47 | 6.35 |
| 17 | 248.92 | 8.37 |
| 18 | 252.19 | 10.67 |
| 19 | 255.27 | 13.22 |
| 20 | 258.14 | 16.01 |
| 21 | 260.77 | 19.03 |
| 22 | 263.14 | 22.24 |
| 23 | 264.17 | 23.90 |

Circle Center At X = 222.2 ; Y = 50.0 and Radius, 49.5

1.327

Failure Surface Specified By 22 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.81 | 10.75 |
| 3 | 196.32 | 8.84 |
| 4 | 199.96 | 7.18 |
| 5 | 203.71 | 5.79 |
| 6 | 207.55 | 4.68 |
| 7 | 211.47 | 3.85 |
| 8 | 215.43 | 3.31 |
| 9 | 219.42 | 3.08 |
| 10 | 223.42 | 3.08 |
| 11 | 227.41 | 3.40 |
| 12 | 231.36 | 4.02 |
| 13 | 235.26 | 4.91 |
| 14 | 239.08 | 6.09 |
| 15 | 242.81 | 7.54 |
| 16 | 246.42 | 9.25 |
| 17 | 249.90 | 11.23 |
| 18 | 253.23 | 13.45 |
| 19 | 256.39 | 15.90 |
| 20 | 259.36 | 18.58 |
| 21 | 262.13 | 21.47 |
| 22 | 264.14 | 23.90 |



Circle Center At X = 221.0 ; Y = 58.2 and Radius, 55.2

1.357

Failure Surface Specified By 22 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 189.44 | 12.92 |
| 2 | 192.44 | 10.26 |
| 3 | 195.65 | 7.89 |
| 4 | 199.08 | 5.82 |
| 5 | 202.67 | 4.06 |
| 6 | 206.41 | 2.64 |
| 7 | 210.26 | 1.57 |
| 8 | 214.20 | .85 |
| 9 | 218.18 | .49 |
| 10 | 222.18 | .49 |
| 11 | 226.17 | .86 |
| 12 | 230.10 | 1.50 |
| 13 | 233.95 | 2.66 |
| 14 | 237.69 | 4.09 |
| 15 | 241.28 | 5.84 |
| 16 | 244.70 | 7.92 |
| 17 | 247.92 | 10.30 |
| 18 | 250.90 | 12.96 |
| 19 | 253.64 | 15.88 |
| 20 | 256.10 | 19.03 |
| 21 | 258.26 | 22.40 |
| 22 | 259.04 | 23.90 |

Circle Center At X = 229.2 ; Y = 44.5 and Radius, 44.0

1.363

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 205.54 | 10.68 |
| 3 | 209.07 | 8.81 |
| 4 | 212.78 | 7.31 |
| 5 | 216.63 | 6.22 |
| 6 | 220.57 | 5.54 |
| 7 | 224.56 | 5.28 |
| 8 | 228.56 | 5.44 |
| 9 | 232.82 | 6.03 |
| 10 | 236.39 | 7.03 |
| 11 | 240.14 | 8.43 |
| 12 | 243.71 | 10.22 |
| 13 | 247.08 | 12.38 |
| 14 | 250.20 | 14.88 |
| 15 | 253.04 | 17.69 |
| 16 | 255.57 | 20.80 |
| 17 | 257.59 | 23.90 |

Circle Center At X = 229.0 ; Y = 43.1 and Radius, 37.8

1.377

Failure Surface Specified By 10 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
|--------------|----------------|----------------|

| | | |
|----|--------|-------|
| 1 | 202.22 | 12.92 |
| 2 | 203.09 | 10.13 |
| 3 | 208.30 | 7.74 |
| 4 | 211.78 | 5.78 |
| 5 | 215.49 | 4.28 |
| 6 | 219.36 | 3.27 |
| 7 | 223.33 | 2.77 |
| 8 | 227.33 | 2.79 |
| 9 | 231.29 | 3.32 |
| 10 | 235.16 | 4.35 |
| 11 | 238.86 | 5.88 |
| 12 | 242.33 | 7.87 |
| 13 | 245.51 | 10.29 |
| 14 | 248.36 | 13.10 |
| 15 | 250.82 | 16.25 |
| 16 | 252.86 | 19.69 |
| 17 | 254.43 | 23.37 |
| 18 | 254.98 | 23.90 |

Circle Center At X = 225.2 ; Y = 33.7 and Radius, 31.0

*** 1.381 ***

Failure Surface Specified By 18 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 202.22 | 12.92 |
| 2 | 203.09 | 10.09 |
| 3 | 208.23 | 7.66 |
| 4 | 211.69 | 5.66 |
| 5 | 215.39 | 4.14 |
| 6 | 219.26 | 3.11 |
| 7 | 223.22 | 2.60 |
| 8 | 227.22 | 2.61 |
| 9 | 231.19 | 3.15 |
| 10 | 235.05 | 4.20 |
| 11 | 238.74 | 5.75 |
| 12 | 242.19 | 7.77 |
| 13 | 245.35 | 10.22 |
| 14 | 248.16 | 13.06 |
| 15 | 250.58 | 16.25 |
| 16 | 252.55 | 19.73 |
| 17 | 254.05 | 23.44 |
| 18 | 254.17 | 23.90 |

Circle Center At X = 225.1 ; Y = 33.0 and Radius, 30.5

*** 1.388 ***

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 215.00 | 12.92 |
| 2 | 217.97 | 10.24 |
| 3 | 221.25 | 7.96 |
| 4 | 224.80 | 6.11 |
| 5 | 228.56 | 4.74 |
| 6 | 232.46 | 3.86 |

| | | |
|----|--------|-------|
| 7 | 236.45 | 3.49 |
| 8 | 240.44 | 3.63 |
| 9 | 244.39 | 4.28 |
| 10 | 248.22 | 5.43 |
| 11 | 251.87 | 7.06 |
| 12 | 255.29 | 9.15 |
| 13 | 258.40 | 11.65 |
| 14 | 261.18 | 14.54 |
| 15 | 263.56 | 17.75 |
| 16 | 265.50 | 21.25 |
| 17 | 266.97 | 23.90 |

Circle Center At X = 237.4 ; Y = 34.7 and Radius, 31.2

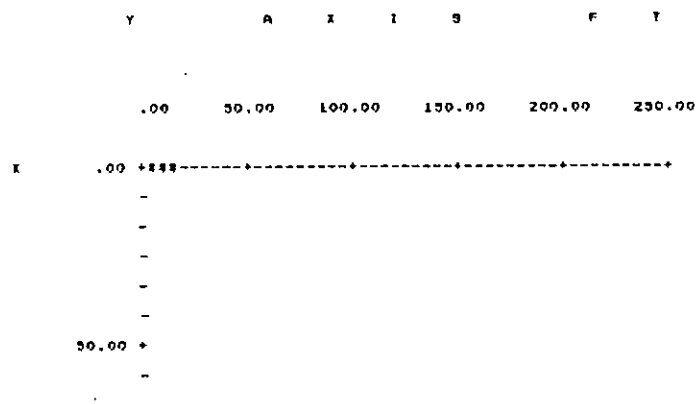
*** 1.421 ***

Failure Surface Specified By 23 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 202.22 | 12.92 |
| 2 | 203.28 | 10.34 |
| 3 | 208.54 | 8.02 |
| 4 | 211.99 | 5.99 |
| 5 | 213.59 | 4.26 |
| 6 | 219.33 | 2.84 |
| 7 | 223.18 | 1.75 |
| 8 | 227.10 | .98 |
| 9 | 231.08 | .55 |
| 10 | 235.08 | .46 |
| 11 | 239.07 | .71 |
| 12 | 243.03 | 1.29 |
| 13 | 246.92 | 2.21 |
| 14 | 250.72 | 3.45 |
| 15 | 254.41 | 5.02 |
| 16 | 257.94 | 6.88 |
| 17 | 261.31 | 9.05 |
| 18 | 264.48 | 11.49 |
| 19 | 267.43 | 14.19 |
| 20 | 270.14 | 17.13 |
| 21 | 272.60 | 20.29 |
| 22 | 274.77 | 23.64 |
| 23 | 274.91 | 23.90 |

Circle Center At X = 234.2 ; Y = 47.6 and Radius, 47.1

*** 1.422 ***



by
Purdue University

1

---Slope Stability Analysis---
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date: 07/12/93
Time of Run: 18.10
Run By: jdcp
Input Data Filename: av1612-2.dat
Output Filename: av1612-2.sal

PROBLEM DESCRIPTION Avenida-1:3,5-1.REF-pr.1600/2/2-CIRC.PRO
F.-suelos s/AYE-s=5t/m en l calzada

BOUNDARY COORDINATES

7 Top Boundaries
12 Total Boundaries

| Boundary No. | X-Left (ft) | Y-Left (ft) | X-Right (ft) | Y-Right (ft) | Soil type Below End |
|--------------|-------------|-------------|--------------|--------------|---------------------|
| 1 | .00 | 12.92 | 215.00 | 12.92 | 4 |
| 2 | 215.00 | 12.92 | 252.00 | 23.40 | 5 |
| 3 | 252.00 | 23.40 | 253.00 | 23.90 | 6 |
| 4 | 253.00 | 23.90 | 278.00 | 23.90 | 6 |
| 5 | 278.00 | 23.90 | 280.00 | 23.40 | 6 |
| 6 | 280.00 | 23.40 | 317.00 | 12.95 | 5 |
| 7 | 317.00 | 12.95 | 400.00 | 12.96 | 1 |
| 8 | 252.00 | 23.40 | 280.00 | 23.40 | 5 |
| 9 | 215.00 | 12.92 | 317.00 | 12.95 | 4 |
| 10 | .00 | 11.50 | 400.00 | 11.50 | 3 |
| 11 | .00 | 6.50 | 400.00 | 6.50 | 2 |
| 12 | .00 | 5.50 | 400.00 | 5.50 | 1 |

ISOTROPIC SOIL PARAMETERS

6 Type(s) of Soil

| Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Pore Pressure Param. | Pressure Constant (psf) | Flow Surface No. |
|---------------|----------------------|--------------------------|--------------------------|----------------------|----------------------|-------------------------|------------------|
| 1 | 1.8 | 2.0 | .0 | 22.0 | .20 | .0 | 1 |
| 2 | 1.6 | 1.8 | 1.0 | 15.0 | .15 | .0 | 1 |
| 3 | 1.6 | 1.9 | 3.0 | 5.0 | .10 | .0 | 1 |
| 4 | 1.4 | 1.8 | 1.0 | 5.0 | .10 | .0 | 1 |
| 5 | 1.8 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |
| 6 | 2.0 | 2.0 | .0 | 30.0 | .00 | .0 | 1 |

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 1.00

Piezometric Surface No. 1 Specified by 4 Coordinate Points

| Point No. | X-Water (ft) | Y-Water (ft) |
|-----------|--------------|--------------|
| 1 | .00 | 12.92 |
| 2 | 215.00 | 12.92 |
| 3 | 317.00 | 12.95 |
| 4 | 400.00 | 12.96 |

BOUNDARY LOAD(S)

1 Load(s) Specified

| Load No. | X-Left (ft) | X-Right (ft) | Intensity (lb/sqft) | Deflection (deg) |
|----------|-------------|--------------|---------------------|------------------|
| 1 | 255.00 | 262.00 | 5.0 | .0 |

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 150.00 ft. and X = 250.00 ft.

Each Surface Terminates Between X = 253.00 ft. and X = 278.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 10 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 250.00 | 22.83 |

| | | |
|----|--------|-------|
| 1 | 250.00 | 22.83 |
| 2 | 252.21 | 20.80 |
| 3 | 254.80 | 19.29 |
| 4 | 257.65 | 18.35 |
| 5 | 260.63 | 18.04 |
| 6 | 263.61 | 18.36 |
| 7 | 266.46 | 19.30 |
| 8 | 269.05 | 20.83 |
| 9 | 271.25 | 22.86 |
| 10 | 271.98 | 23.90 |

33

Factor Of Safety For The Preceding Specified Surface =-62.177

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 12 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 250.00 | 22.83 |
| 2 | 252.24 | 20.84 |
| 3 | 254.77 | 19.23 |
| 4 | 257.53 | 18.05 |
| 5 | 260.44 | 17.32 |
| 6 | 263.43 | 17.06 |
| 7 | 266.42 | 17.29 |
| 8 | 269.34 | 17.99 |
| 9 | 272.11 | 19.15 |
| 10 | 274.65 | 20.73 |
| 11 | 276.91 | 22.70 |
| 12 | 277.91 | 23.90 |

Factor Of Safety For The Preceding Specified Surface =-27.849

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 205.56 | 12.92 |
| 2 | 207.75 | 10.88 |
| 3 | 210.12 | 9.04 |
| 4 | 212.65 | 7.42 |
| 5 | 215.30 | 6.02 |
| 6 | 218.07 | 4.86 |
| 7 | 220.93 | 3.96 |
| 8 | 223.86 | 3.30 |
| 9 | 226.83 | 2.91 |
| 10 | 229.83 | 2.78 |
| 11 | 232.83 | 2.92 |
| 12 | 235.80 | 3.31 |

| | | |
|----|--------|-------|
| 12 | 235.80 | 3.31 |
| 13 | 238.73 | 3.97 |
| 14 | 241.58 | 4.88 |
| 15 | 244.35 | 6.05 |
| 16 | 247.00 | 7.45 |
| 17 | 249.52 | 9.07 |
| 18 | 251.89 | 10.92 |
| 19 | 254.09 | 12.96 |
| 20 | 256.09 | 15.19 |
| 21 | 257.90 | 17.59 |
| 22 | 259.48 | 20.14 |
| 23 | 260.83 | 22.81 |
| 24 | 261.27 | 23.90 |

34

Circle Center At X = 229.8 ; Y = 36.8 , and Radius, 34.1

*** 1.284 ***

Failure Surface Specified By 25 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 205.56 | 12.92 |
| 2 | 207.68 | 10.80 |
| 3 | 209.98 | 8.88 |
| 4 | 212.45 | 7.17 |
| 5 | 215.05 | 5.68 |
| 6 | 217.78 | 4.43 |
| 7 | 220.61 | 3.43 |
| 8 | 223.51 | 2.68 |
| 9 | 226.47 | 2.19 |
| 10 | 229.47 | 1.97 |
| 11 | 232.46 | 2.01 |
| 12 | 235.45 | 2.32 |
| 13 | 238.39 | 2.89 |
| 14 | 241.28 | 3.72 |
| 15 | 244.08 | 4.80 |
| 16 | 246.77 | 6.12 |
| 17 | 249.33 | 7.68 |
| 18 | 251.75 | 9.46 |
| 19 | 254.00 | 11.44 |
| 20 | 256.06 | 13.62 |
| 21 | 257.93 | 15.97 |
| 22 | 259.57 | 18.48 |
| 23 | 260.99 | 21.12 |
| 24 | 262.17 | 23.88 |
| 25 | 262.18 | 23.90 |

Circle Center At X = 230.5 ; Y = 35.8 and Radius, 33.9

*** 1.290 ***

Failure Surface Specified By 24 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 205.56 | 12.92 |
| 2 | 207.69 | 10.81 |
| 3 | 210.00 | 8.90 |
| 4 | 212.48 | 7.21 |
| 5 | 215.11 | 5.76 |
| 6 | 217.85 | 4.55 |
| 7 | 220.70 | 3.60 |

25

| | | |
|----|--------|-------|
| 7 | 220.70 | 3.60 |
| 8 | 223.62 | 2.91 |
| 9 | 226.59 | 2.50 |
| 10 | 229.59 | 2.35 |
| 11 | 232.58 | 2.48 |
| 12 | 235.56 | 2.89 |
| 13 | 238.48 | 3.56 |
| 14 | 241.33 | 4.50 |
| 15 | 244.08 | 5.70 |
| 16 | 246.71 | 7.14 |
| 17 | 249.20 | 8.82 |
| 18 | 251.52 | 10.72 |
| 19 | 253.66 | 12.82 |
| 20 | 255.60 | 15.11 |
| 21 | 257.32 | 17.57 |
| 22 | 258.81 | 20.17 |
| 23 | 260.05 | 22.90 |
| 24 | 260.40 | 23.90 |

35

Circle Center At X = 229.7 ; Y = 35.1 and Radius, 32.8

*** 1.296 ***

Failure Surface Specified By 27 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 194.44 | 12.92 |
| 2 | 196.62 | 10.86 |
| 3 | 198.95 | 8.96 |
| 4 | 201.42 | 7.26 |
| 5 | 204.00 | 5.74 |
| 6 | 206.70 | 4.42 |
| 7 | 209.49 | 3.32 |
| 8 | 212.35 | 2.43 |
| 9 | 215.28 | 1.76 |
| 10 | 218.25 | 1.31 |
| 11 | 221.24 | 1.10 |
| 12 | 224.24 | 1.11 |
| 13 | 227.23 | 1.35 |
| 14 | 230.19 | 1.81 |
| 15 | 233.11 | 2.50 |
| 16 | 235.97 | 3.41 |
| 17 | 238.75 | 4.54 |
| 18 | 241.44 | 5.87 |
| 19 | 244.02 | 7.41 |
| 20 | 246.47 | 9.14 |
| 21 | 248.78 | 11.04 |
| 22 | 250.95 | 13.12 |
| 23 | 252.94 | 15.36 |
| 24 | 254.77 | 17.74 |
| 25 | 256.40 | 20.26 |
| 26 | 257.84 | 22.89 |
| 27 | 258.29 | 23.90 |

Circle Center At X = 222.6 ; Y = 40.4 and Radius, 39.4

*** 1.336 ***

Failure Surface Specified By 28 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
|-----------|-------------|-------------|

36

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 205.56 | 12.92 |
| 2 | 207.80 | 10.93 |
| 3 | 210.17 | 9.10 |
| 4 | 212.67 | 7.44 |
| 5 | 215.28 | 5.96 |
| 6 | 217.99 | 4.67 |
| 7 | 220.79 | 3.57 |
| 8 | 223.65 | 2.67 |
| 9 | 226.57 | 1.98 |
| 10 | 229.53 | 1.50 |
| 11 | 232.51 | 1.22 |
| 12 | 235.51 | 1.16 |
| 13 | 238.51 | 1.30 |
| 14 | 241.49 | 1.66 |
| 15 | 244.43 | 2.23 |
| 16 | 247.33 | 3.00 |
| 17 | 250.17 | 3.98 |
| 18 | 252.93 | 5.15 |
| 19 | 255.60 | 6.52 |
| 20 | 258.17 | 8.06 |
| 21 | 260.62 | 9.79 |
| 22 | 262.95 | 11.69 |
| 23 | 265.14 | 13.74 |
| 24 | 267.17 | 15.95 |
| 25 | 269.05 | 18.29 |
| 26 | 270.75 | 20.76 |
| 27 | 272.28 | 23.34 |
| 28 | 272.56 | 23.90 |

Circle Center At X = 234.9 ; Y = 43.7 and Radius. 42.5

*** 1.396 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|--------------|----------------|----------------|
| 1 | 183.33 | 12.92 |
| 2 | 185.82 | 11.25 |
| 3 | 188.39 | 9.70 |
| 4 | 191.04 | 8.28 |
| 5 | 193.75 | 7.00 |
| 6 | 196.52 | 5.85 |
| 7 | 199.35 | 4.84 |
| 8 | 202.22 | 3.97 |
| 9 | 205.13 | 3.25 |
| 10 | 208.07 | 2.68 |
| 11 | 211.04 | 2.25 |
| 12 | 214.03 | 1.97 |
| 13 | 217.03 | 1.84 |
| 14 | 220.03 | 1.86 |
| 15 | 223.02 | 2.03 |
| 16 | 226.01 | 2.34 |
| 17 | 228.97 | 2.81 |
| 18 | 231.91 | 3.42 |
| 19 | 234.81 | 4.18 |
| 20 | 237.67 | 5.09 |
| 21 | 240.48 | 6.13 |
| 22 | 243.24 | 7.31 |
| 23 | 245.93 | 8.63 |
| 24 | 248.56 | 10.08 |
| 25 | 251.11 | 11.66 |
| 26 | 253.58 | 13.37 |
| 27 | 255.96 | 15.20 |
| 28 | 258.24 | 17.14 |
| 29 | 260.43 | 19.19 |
| 30 | 262.51 | 21.34 |

| | | |
|----|--------|-------|
| 28 | 258.24 | 17.14 |
| 29 | 260.43 | 19.19 |
| 30 | 262.51 | 21.36 |
| 31 | 264.48 | 23.62 |
| 32 | 264.70 | 23.90 |

37

Circle Center At X = 218.1 ; Y = 62.0 and Radius, 60.2

*** 1.397 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 194.44 | 12.92 |
| 2 | 196.89 | 11.18 |
| 3 | 199.42 | 9.57 |
| 4 | 202.02 | 8.08 |
| 5 | 204.70 | 6.73 |
| 6 | 207.45 | 5.52 |
| 7 | 210.25 | 4.45 |
| 8 | 213.10 | 3.53 |
| 9 | 216.00 | 2.75 |
| 10 | 218.93 | 2.11 |
| 11 | 221.90 | 1.63 |
| 12 | 224.88 | 1.30 |
| 13 | 227.87 | 1.12 |
| 14 | 230.87 | 1.10 |
| 15 | 233.87 | 1.22 |
| 16 | 236.86 | 1.50 |
| 17 | 239.83 | 1.93 |
| 18 | 242.77 | 2.51 |
| 19 | 245.68 | 3.24 |
| 20 | 248.55 | 4.12 |
| 21 | 251.37 | 5.14 |
| 22 | 254.13 | 6.30 |
| 23 | 256.84 | 7.60 |
| 24 | 259.47 | 9.04 |
| 25 | 262.03 | 10.61 |
| 26 | 264.50 | 12.31 |
| 27 | 266.88 | 14.13 |
| 28 | 269.17 | 16.07 |
| 29 | 271.36 | 18.13 |
| 30 | 273.44 | 20.29 |
| 31 | 275.40 | 22.58 |
| 32 | 276.46 | 23.90 |

Circle Center At X = 229.9 ; Y = 60.1 and Radius, 59.0

*** 1.398 ***

Failure Surface Specified By 32 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 194.44 | 12.92 |
| 2 | 196.91 | 11.21 |
| 3 | 199.45 | 9.62 |
| 4 | 202.08 | 8.16 |
| 5 | 204.77 | 6.84 |
| 6 | 207.52 | 5.65 |
| 7 | 210.34 | 4.61 |
| 8 | 213.20 | 3.70 |
| 9 | 216.10 | 2.94 |

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| | | |
|----|--------|-------|
| 7 | 210.34 | 3.70 |
| 8 | 213.20 | 3.70 |
| 9 | 216.10 | 2.94 |
| 10 | 219.04 | 2.33 |
| 11 | 222.00 | 1.87 |
| 12 | 224.98 | 1.55 |
| 13 | 227.98 | 1.39 |
| 14 | 230.98 | 1.37 |
| 15 | 233.97 | 1.51 |
| 16 | 236.96 | 1.79 |
| 17 | 239.93 | 2.23 |
| 18 | 242.87 | 2.81 |
| 19 | 245.78 | 3.54 |
| 20 | 248.65 | 4.42 |
| 21 | 251.47 | 5.44 |
| 22 | 254.24 | 6.60 |
| 23 | 256.94 | 7.89 |
| 24 | 259.58 | 9.33 |
| 25 | 262.14 | 10.89 |
| 26 | 264.62 | 12.58 |
| 27 | 267.01 | 14.39 |
| 28 | 269.31 | 16.31 |
| 29 | 271.51 | 18.36 |
| 30 | 273.60 | 20.50 |
| 31 | 275.59 | 22.76 |
| 32 | 276.50 | 23.90 |

Circle Center At X = 229.8 ; Y = 61.1 and Radius, 59.7

*** 1.398 ***

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Failure Surface Specified By 20 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 216.67 | 13.39 |
| 2 | 218.81 | 11.29 |
| 3 | 221.18 | 9.46 |
| 4 | 223.76 | 7.91 |
| 5 | 226.49 | 6.69 |
| 6 | 229.36 | 5.79 |
| 7 | 232.30 | 5.24 |
| 8 | 235.30 | 5.04 |
| 9 | 238.29 | 5.19 |
| 10 | 241.25 | 5.70 |
| 11 | 244.13 | 6.55 |
| 12 | 246.88 | 7.73 |
| 13 | 249.48 | 9.23 |
| 14 | 251.89 | 11.03 |
| 15 | 254.06 | 13.09 |
| 16 | 255.98 | 15.40 |
| 17 | 257.61 | 17.92 |
| 18 | 258.93 | 20.61 |
| 19 | 259.92 | 23.44 |
| 20 | 260.03 | 23.90 |

Circle Center At X = 235.5 ; Y = 30.4 and Radius, 25.4

*** 1.428 ***

Failure Surface Specified By 22 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
|-----------|-------------|-------------|

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1 | 216.67 | 13.39 |
| 2 | 218.80 | 11.28 |
| 3 | 221.14 | 9.41 |
| 4 | 223.66 | 7.78 |
| 5 | 226.34 | 6.42 |
| 6 | 229.14 | 5.35 |
| 7 | 232.04 | 4.57 |
| 8 | 235.00 | 4.09 |
| 9 | 237.99 | 3.93 |
| 10 | 240.99 | 4.07 |
| 11 | 243.96 | 4.52 |
| 12 | 246.86 | 5.27 |
| 13 | 249.67 | 6.32 |
| 14 | 252.36 | 7.66 |
| 15 | 254.89 | 9.26 |
| 16 | 257.25 | 11.12 |
| 17 | 259.40 | 13.21 |
| 18 | 261.32 | 15.51 |
| 19 | 263.00 | 18.00 |
| 20 | 264.41 | 20.65 |
| 21 | 265.54 | 23.43 |
| 22 | 265.68 | 23.90 |

Circle Center At X = 238.1 ; Y = 33.0 and Radius, 29.0

*** 1.451 ***

