STATE OF NEVADA

DEPARTMENT OF TRANSPORTATION

MATERIALS AND TESTING DIVISION

GEOTECHNICAL SECTION

FOUNDATION REPORT

Rock Slope Study on SR-160

Pahrump Valley Road

Milepost SR-160-Cl-18.2 to 21.42

February, 1994

E. A. No. 71713-1

Clark COUNTY, NEVADA

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Table of Contents

I. INTRODUCTION

A. General

This rock slope study has been performed for the proposed widening of the roadway on the State Route 160, Pahrump Valley Road, Clark County, Nevada.

B. Purpose and Scope

The purpose of this study is to investigate the stability of the rock cuts and the role of geological discontinuities in the rock slope behavior along the proposed alignment. The scope of this investigation included surface reconnaissance, examination of existing regional geology maps, stereoscopic examination of aerial photographs, detailed examination and mapping of the geological discontinuities of the critical regions, evaluation of the potential rock slope stability problems, and report preparation. This report provides recommendations for the maximum safe slope angles.

C. Project Description

The project is located on State Route 160, Pahrump Valley Road, Milepost SR-160-CL-14.30 to 22.00. For this project, the existing 24 foot roadway width will increase to a minimum of 52 feet and a maximum of 66 feet. A roadside ditch 12 foot wide and 2 foot deep will be constructed.

It was requested by N.D.O.T. Roadway Design Division to evaluate the stability of the proposed excavated rock slopes from Milepost 18.20 to 21.42.

D. Site Description

The project is located in section 7, T.22 S., R.58 E., M.D.B. & M. The approximate elevation of the site is 5000 to 5500 feet at the Mountain Spring Summit.

E. Field Investigation

In December, 1993, the Geotechnical Section of the Materials and Testing Division conducted mapping of the critical geological discontinuity features along the proposed roadway alignment. The end product of this investigation was collecting structural geological data related to the discontinuities and strength of rocks which were needed for stability studies of the rock cuts. These data include:

* Mapping location
* Classification of discontinuities by type
* Orientation of discontinuities
* Infilling of the discontinuities
* Surface properties
* Spacing of discontinuities within sets
* Persistence of fractures
* Rock mass parameters

These parameters define the strength properties and the geometry of the blocks forming the rock mass.

The orientations of these sets were plotted on stereonets (see the Appendix).

II. DISCUSSION

A. Site Geology and Seismicity

The primary geologic reference for this area is a geologic map prepared by C.R. Longwell, E.H. Pampeyan, and Ben Bowyer, 1965. According to this geologic map, a Devonian age formation covers the site. It consists of limestone, dolomite, and sandstone. According to this map, the subject site is within 10 miles of several faults. The ages of these faults are unknown. The site is located in an area defined by the NEHRP map as having a horizontal acceleration coefficient in rock of 0.075g to 0.1g.

B. Geological Structural Discontinuities

Rock units are closely jointed and faulted. Spacings of joint sets at different locations vary from a few millimeters to several centimeters. Due to the large number of joints mapped and the small extent of the mapped area, it was assumed that the joints can be located anywhere throughout the slopes. The joints encountered were assumed to have definite patterns. The faults and bedding planes consist of fractures separated by gouge, breccia, calcite, clay, or other mineral filler having physical properties different from the surrounding parent rocks. Most of the joints, faults, and bedding planes are filled with several millimeters of calcite and clay.

Inspection of natural slopes and existing cuts at the site indicates that the rocks near the surface are intensely weathered with open fractures from Milepost 18.2 to 19.43 (station 944 to 1009). From milepost 21.06 to 21.42 (station 1097 to 1116) the degree of alteration decreases.

There is no evidence of slope failures having occurred recently at the site.

C. Rockfall History

Based on the N.D.O.T. District I maintenance record, There has not been any rockfall history or rockfall accident report along the existing rock cut slopes in this area.

D. Rock Slope Analyses

After choosing the most hazardous slopes within the study area, the orientation data of the critical rock joints, bedding planes, faults, and slope faces were plotted on equal-area stereonets utilizing the computer program DISCANAL (Nicholl, 1987). Then the poles were contoured by hand to determine the joint clusters. Once the most prevalent clusters were identified, the orientations of these joint sets were determined and plotted on equal-angle stereonets using DISCANAL. DISCANAL evaluates the angular relationships between the major joint sets and the slope face to determine the planar, wedge, or toppling failure potential. Rock slope stability assessment, including the DISCANAL analysis, requires that the friction angles of the joint surfaces be known. To obtain this information, field and laboratory shear tests should be performed on rock samples. Unfortunately, due to lack of sufficient time and equipment, these tests were not performed. The friction angles were estimated from the available literatures.

Hand calculations were done to check the safety factors on those slopes which are kinematically unstable.

Portions of several slopes are composed of residual soils which can not be evaluated using this program.

The plots of kinematically possible modes of slope failures are presented in the Appendix.

III. CONCLUSIONS AND RECOMMENDATIONS

STATION 944+00 TO 951+00

This is a soil slope which is located on the left side of the roadway. It is recommended that the cut slope be laid back on 2H:1V.

STATION 958+00 TO 961+50

This is a combination of soil-rock slope.

The soil slope is between station 958+00 to 959+00 and it is recommended that the slope not be cut steeper than 2H:1V.

The rock slope is between station 959+00 to 961+50. The slope in this area is closely fractured and its height varies within the Right- of- Way. For the slope steeper than 1H:1V (45 degrees), a potential wedge failure will daylight in the face of the slope.

It is recommended that the slope not be cut steeper than 1H:1V (45 degrees). Since the proposed roadside ditch at the toe of the slope will be only 2 feet deep, it will not be very effective in intercepting the rock falls and rocks will bounce outward from the ditch. Construction of a gabion wall between station 959+50 to 961+50 could alleviate this problem. Gabion walls are able to withstand the impact of falling rock because of their flexibility. The loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

STATION 963+00 TO 966+50

The slope in this area is closely fractured and highly weathered. Rock jointing is very irregular and there is sloughing at the toe of the existing slope. It is recommended that the slope not be cut steeper than 1H:1V (45 degrees). From station 965+80 to 966+50, the rocks are intensely fractured, and it is recommended the slopes not be cut steeper than 1.5H:1V.

Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

STATION 972+35 TO 974+45

This slope is moderately fractured and weathered. Based on the stability analyses of the slope in this area, the cut slope should not be steeper than 2H:1V (26 degrees). Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

STATION 984+50 TO 987+00

The beginning and the end portions of this slope are intensely fractured & the rock fragments are loose. The cut slope should not be steeper than 1.5H:1V (33 degrees). Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

STATION 991+00 TO 993+40

Sections of this slope are intensely fractured. The cut slope should not be steeper than 1.5H:1V (33 degrees).

Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

STATION 995+14 TO 998+63

Portion of this slope is very irregular and intensely fractured. For cut slope steeper than 1H:1V (45 degrees), a potential wedge failure will daylight in the face of the slope. The cut slope should not be steeper than 1H:1V (45 degrees).

Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

STATION 1002+43 TO 1005+63

Sections of the slope are closely fractured and the discontinuities are very irregular. There are traces of the original blasting on the face of the existing slope. For slope angle steeper than 56 degrees, a potential wedge failure will daylight in the face of the slope. The cut slope should not be steeper than 1H:1.5V (56 degrees).

Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

Since the proposed roadside ditch at the toe of the slope will be only 2 feet deep, it will not be very effective in intercepting the rock falls and rocks will bounce outward from the ditch. Construction of a gabion wall in this area could alleviate this problem. Gabion walls are able to withstand the impact of falling rock because of their flexibility.

STATION 1105+47 TO 1109+13

This slope is located on the left side of the roadway. For slope angles steeper than 50 degrees, a potential wedge failure will daylight in the face of the slope. The cut slope should not be steeper than 1H:1V (45 degrees). Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way. Due to location and height of the slope, the roadway surface is mostly in shade and consequently it is icy in cold and wet seasons and creates a traffic hazard. It is advised that the slope be laid back as far as possible to reduce the potential of a traffic hazard.

Since the proposed roadside ditch at the toe of the slope will be only 2 feet deep, it will not be very effective in intercepting the rock falls and rocks will bounce outward from the ditch. Construction of a gabion wall in this area could alleviate this problem. Gabion walls are able to withstand the impact of falling rock because of their flexibility.

STATION 1112+50 TO 1116+15

For the slope angle steeper than 50 degrees, a potential wedge failure will daylight in the face of the slope. The cut slope should not be steeper than 1.5H:1V (33 degrees). Loose rocks and boulders should be scaled from slopes above the cuts to the limit of Right-of-Way.

Special Note:

The above recommendations are for the rock cut areas only. In the soil slope areas, it is recommended the slopes not be cut steeper than 2H:1V.

Scaling of the Rock Slopes:

Scaling the loose rocks and boulders above the cuts to the limit of the Right-of-Way can be performed by conventional scaling techniques or by the use of a water cannon. The cannon is similar to the high-pressure turret common to fire department pumps. It discharges 500 gallons of water per minute at 160 psi through a 1-1/8 inch nozzle. The loose rocks and debris fall down into the roadway or ditch where it is picked up by loaders.

REFERENCES

Nicholl, M.J., "Computer Assisted Analysis of Discontinuous Rock Masses", Master Thesis, University of Nevada, Reno, Nevada, 1987

Golder Associates, "Rock Slope: Design, Excavation, Stabilization", Publication No. FHWA-TS-89-045, U.S. Department of Transportation, Federal Highway Administration, McLean, Virginia, 1989

Longwell, C.R., Pampeyan, E.H., Bowyer, Ben, "Geologic Map of Clark County, Nevada", Nevada Bureau of Mines, Bulletin 62, University of Nevada Reno, Reno, Nevada, 1965

APPENDIX

STATION 959+00 TO 961+50

SLOPE ORIENTATION

DIP AZIMUTH: 349
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	266	32	25	NO
2.	305	80	25	NO
3.	340	85	25	NO
4.	9	73	25	NO
5.	277	11	25	NO
6.	85	74	25	NO
7.	168	68	25	NO

AT SLOPE ANGLES STEEPER THAN 73.00, A POTENTIAL FAILURE PLANE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

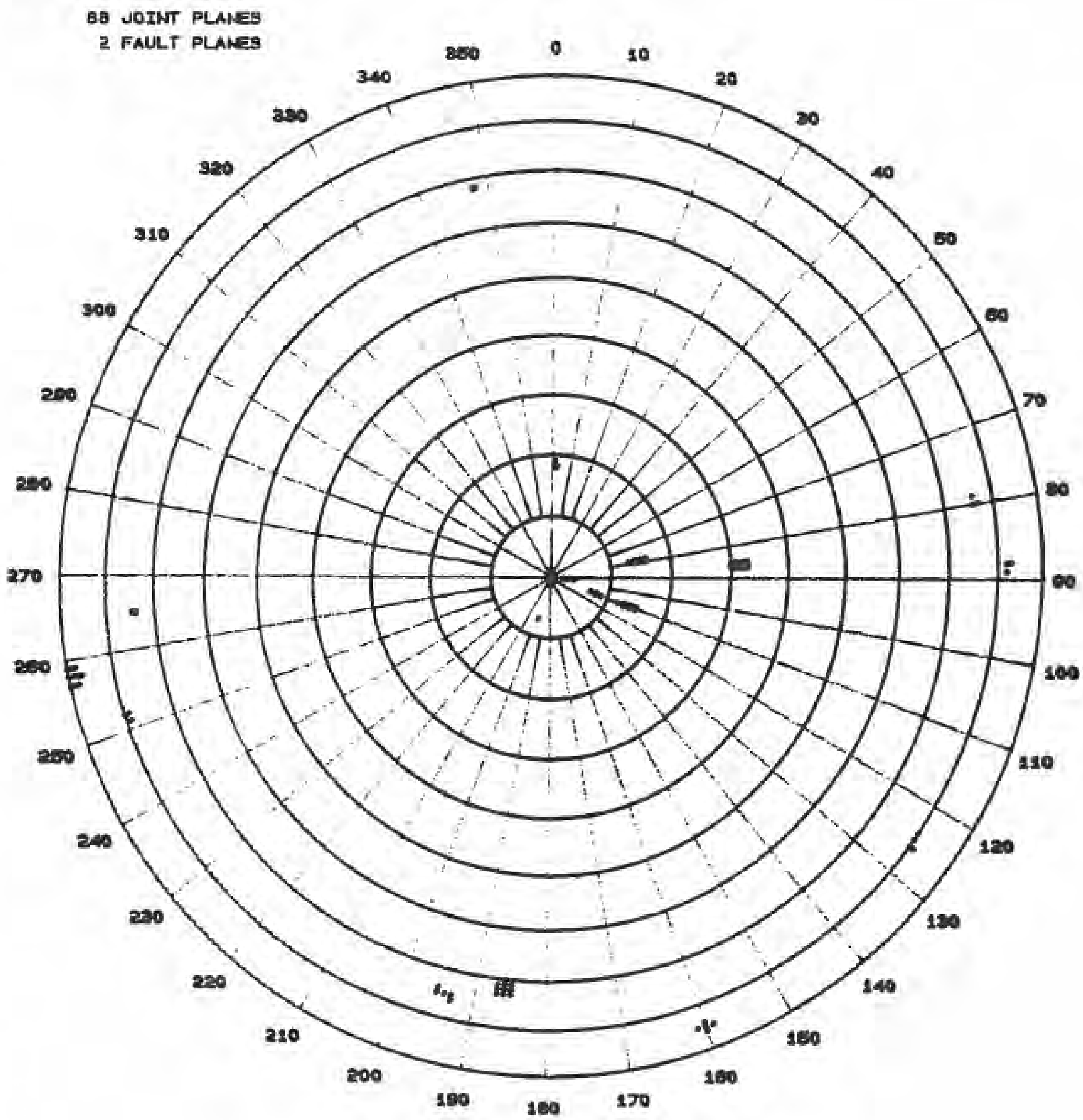
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 7	30.15	244.43	NO	90.00
2 & 1	23.21	219.34	NO	90.00
2 & 5	5.37	215.96	NO	90.00
2 & 7	51.30	227.72	NO	90.00
3 & 1	31.34	253.06	NO	90.00
3 & 2	78.56	275.62	NO	86.69
3 & 5	9.89	250.88	NO	90.00
3 & 7	15.83	251.43	NO	90.00
4 & 1	29.88	289.12	YES	48.87
4 & 2	72.81	0.24	NO	73.12
4 & 3	64.32	59.51	NO	80.89
4 & 5	10.95	282.40	NO	90.00
5 & 1	3.04	351.12	NO	90.00
5 & 7	10.13	253.86	NO	90.00
6 & 1	0.52	355.16	NO	90.00
6 & 2	55.80	19.96	YES	59.77
6 & 3	71.63	54.72	NO	82.23
6 & 4	69.38	44.65	NO	78.01
6 & 5	2.19	355.63	NO	90.00
7 & 4	27.17	89.97	NO	90.00
7 & 6	64.84	137.36	NO	90.00

AT SLOPE ANGLES STEEPER THAN 48.87, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING EXISTS



Sta 959+00 to 961+50
Joints and fault/bedding planes

DISCONTINUITY DATA

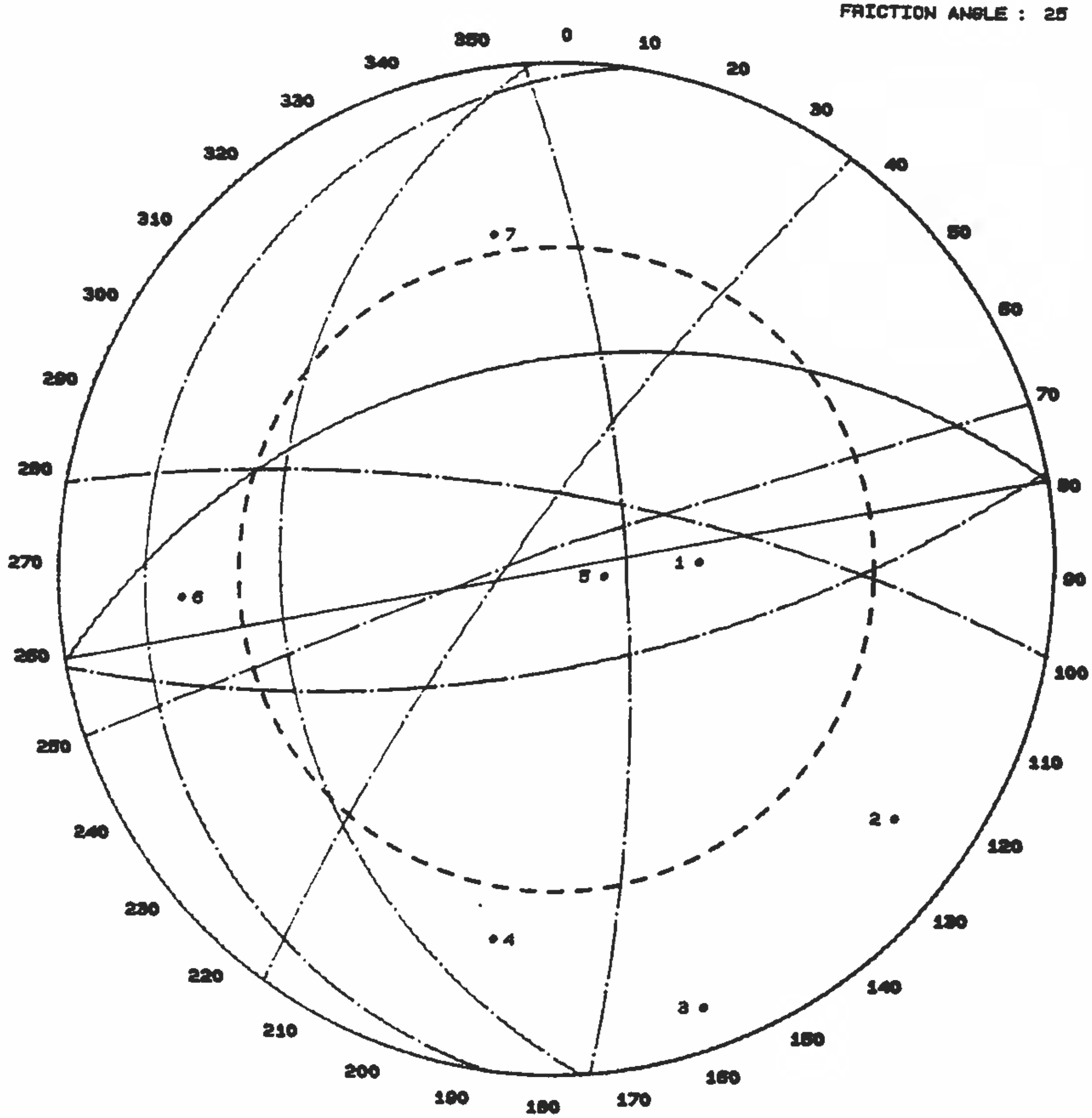
	AZIMUTH	DIP
1.	266.00	32.00
2.	305.00	80.00
3.	340.00	85.00
4.	9.00	73.00
5.	277.00	11.00
6.	85.00	74.00
7.	166.00	68.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 45
DIP AZIMUTH : 349
FRICTION ANGLE : 25



STATION 959+00 TO 961+50
PRINCIPAL JOINTS & FAULTS WITH 45° SLOPE

STATION 963+85 TO 965+80

SLOPE ORIENTATION

DIP AZIMUTH: 198
DIP : 55

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	211	89	25	NO
2.	237	86	25	NO
3.	275	87	25	NO
4.	288	82	25	NO
5.	308	86	25	NO
6.	146	80	25	NO
7.	319	7	25	NO
8.	103	5	25	NO
9.	126	42	25	NO

AT SLOPE ANGLES STEEPER THAN 89.00, A POTENTIAL FAILURE PLANE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

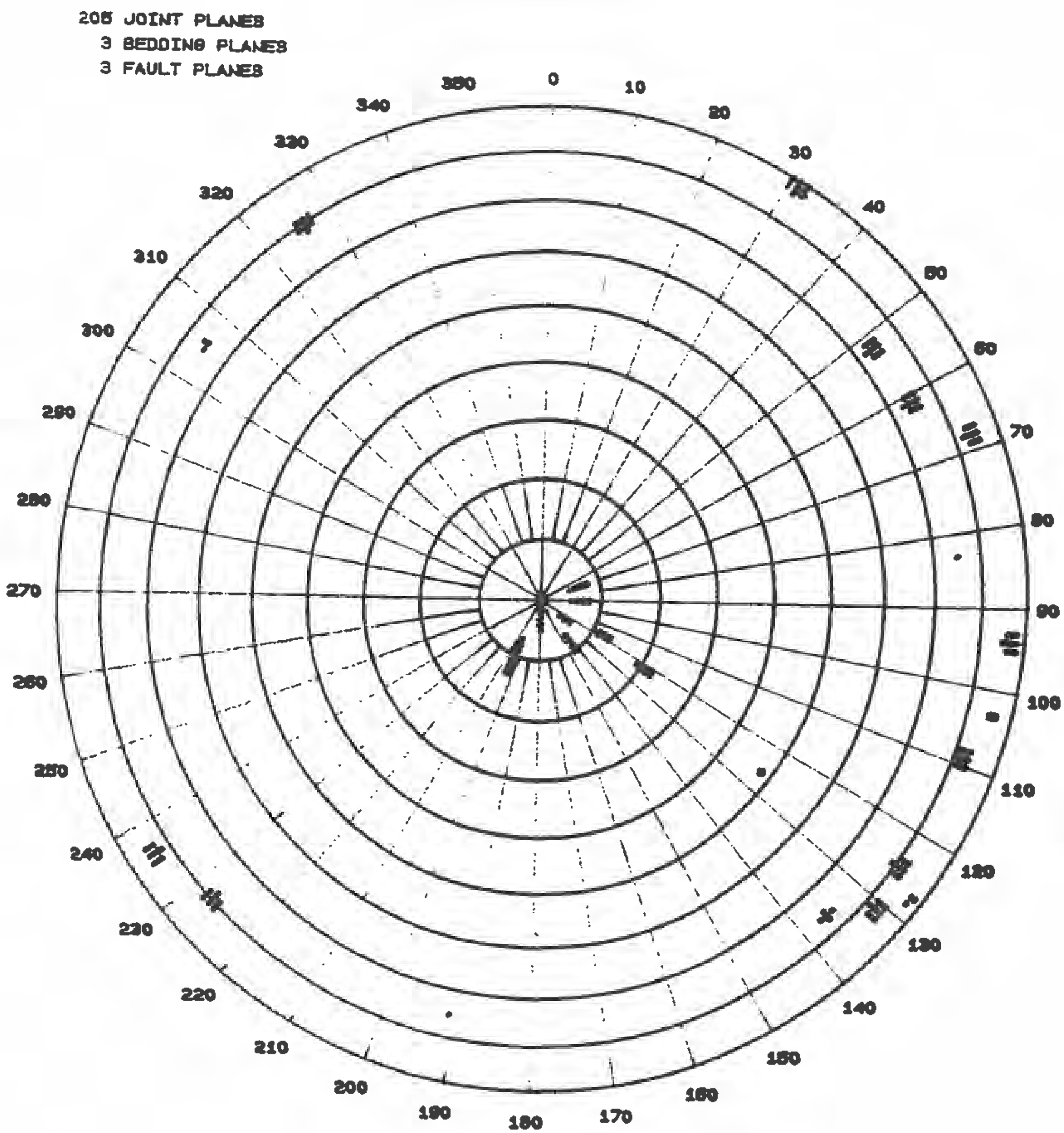
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 6	79.39	126.34	NO	86.63
1 & 8	4.75	121.08	NO	90.00
1 & 9	41.92	121.89	NO	75.03
2 & 1	82.87	292.97	NO	90.00
2 & 6	79.19	168.49	NO	80.57
2 & 8	3.58	147.25	NO	90.00
2 & 9	39.37	150.28	YES	50.65
3 & 1	86.97	281.69	NO	89.67
3 & 2	85.99	233.42	NO	86.73
3 & 6	74.65	196.02	NO	74.67
3 & 8	0.69	185.04	NO	90.00
3 & 9	24.01	186.34	NO	90.00
4 & 1	81.95	293.91	NO	90.00
4 & 2	81.88	297.63	NO	90.00
4 & 3	68.13	357.50	NO	90.00
4 & 6	64.03	214.78	NO	65.00
4 & 9	13.93	200.00	NO	90.00
5 & 1	85.72	287.49	NO	89.96
5 & 2	85.09	272.51	NO	88.69
5 & 3	85.94	317.31	NO	90.00
5 & 4	77.06	235.73	NO	79.70
5 & 6	51.72	223.09	YES	54.45
6 & 8	3.45	56.60	NO	90.00
6 & 9	19.86	59.65	NO	90.00
7 & 1	6.65	300.89	NO	90.00
7 & 2	6.94	326.52	NO	90.00
7 & 3	4.89	4.74	NO	90.00
7 & 4	3.67	17.48	NO	90.00
7 & 5	1.35	37.90	NO	90.00
7 & 6	0.83	235.86	NO	90.00
8 & 4	0.43	17.93	NO	90.00
8 & 5	2.10	37.85	NO	90.00
8 & 7	1.80	34.12	NO	90.00
9 & 5	1.69	37.88	NO	90.00
9 & 7	1.39	37.55	NO	90.00
9 & 8	2.14	38.38	NO	90.00

AT SLOPE ANGLES STEEPER THAN 50.65, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW



Sta 963+85 to 965+80
Joints and fault/bedding planes

STATION 972+35 TO 974+45

SLOPE ORIENTATION

DIP AZIMUTH: 212
DIP : 45

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	180	89	25	NO
2.	253	71	25	NO
3.	120	38	25	NO
4.	103	68	25	NO
5.	297	90	25	NO
6.	296	90	25	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 3	34.26	90.68	NO	90.00
1 & 4	67.65	92.43	NO	90.00
2 & 1	70.44	267.19	NO	78.54
2 & 3	25.46	172.43	YES	31.71
2 & 4	34.66	176.77	YES	40.25
3 & 4	17.97	185.47	NO	90.00
4 & 5	30.91	26.99	NO	90.00
4 & 6	29.10	25.99	NO	90.00
5 & 1	88.87	207.02	NO	88.88
5 & 2	63.63	207.00	NO	63.72
5 & 3	2.34	207.00	NO	90.00
5 & 6	90.00	219.59	NO	90.00
6 & 1	88.88	206.01	NO	88.89
6 & 2	63.21	206.00	NO	63.34
6 & 3	3.11	206.01	NO	90.00

AT SLOPE ANGLES STEEPER THAN 31.71, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW

DISCONTINUITY DATA

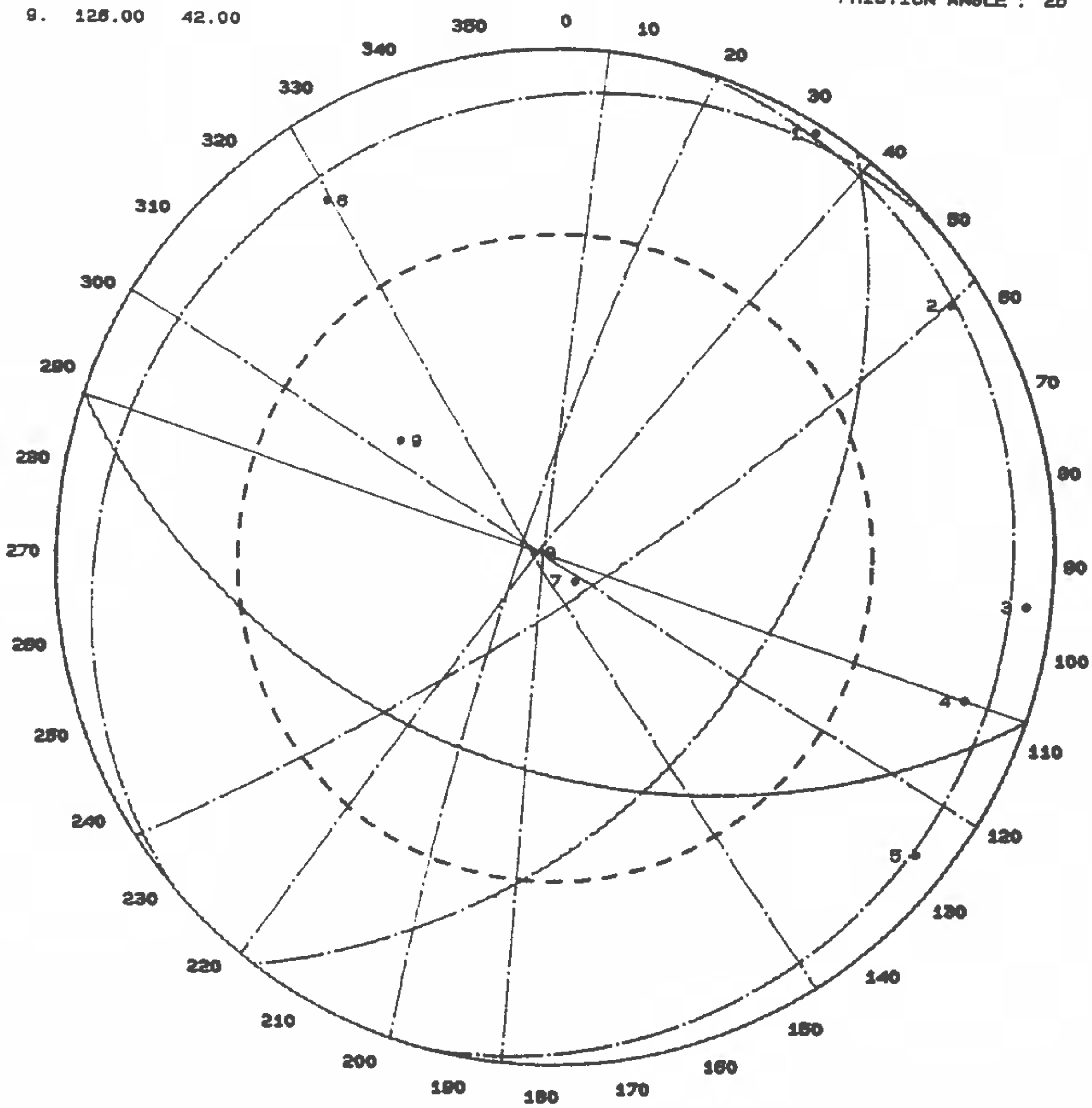
	AZIMUTH	DIP
1.	211.00	89.00
2.	237.00	86.00
3.	275.00	87.00
4.	288.00	82.00
5.	308.00	86.00
6.	146.00	80.00
7.	319.00	7.00
8.	103.00	5.00
9.	126.00	42.00

LEGEND

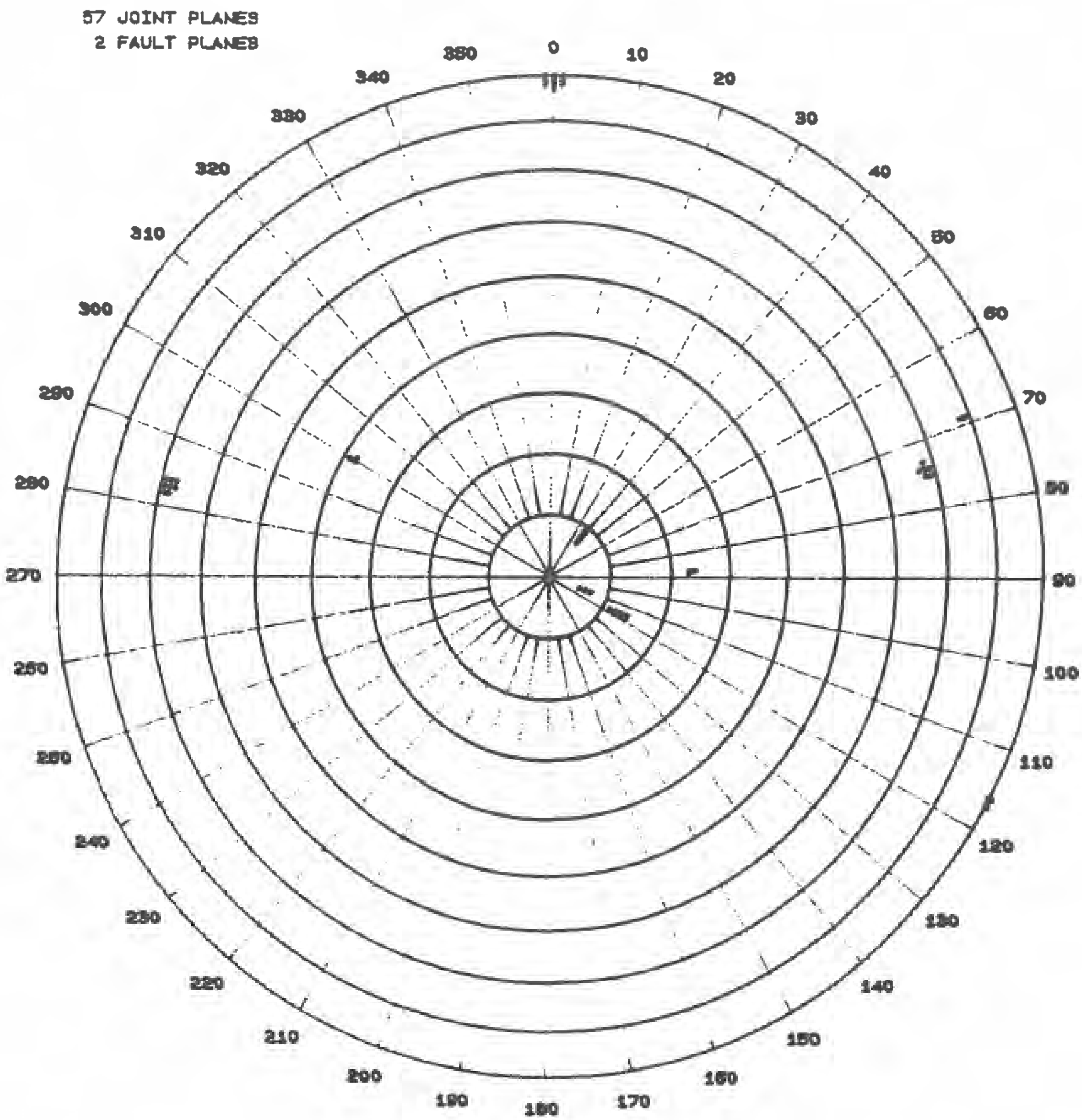
SLOPE FACE ————
FRICTION CIRCLE – – – –
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 45
DIP AZIMUTH : 198
FRICTION ANGLE : 25



STATION 963+85 TO 965+80
PRINCIPAL JOINTS & FAULTS WITH 45° SLOPE



Sta 972+35 to 974+45
Joint and fault/bedding planes

DISCONTINUITY DATA

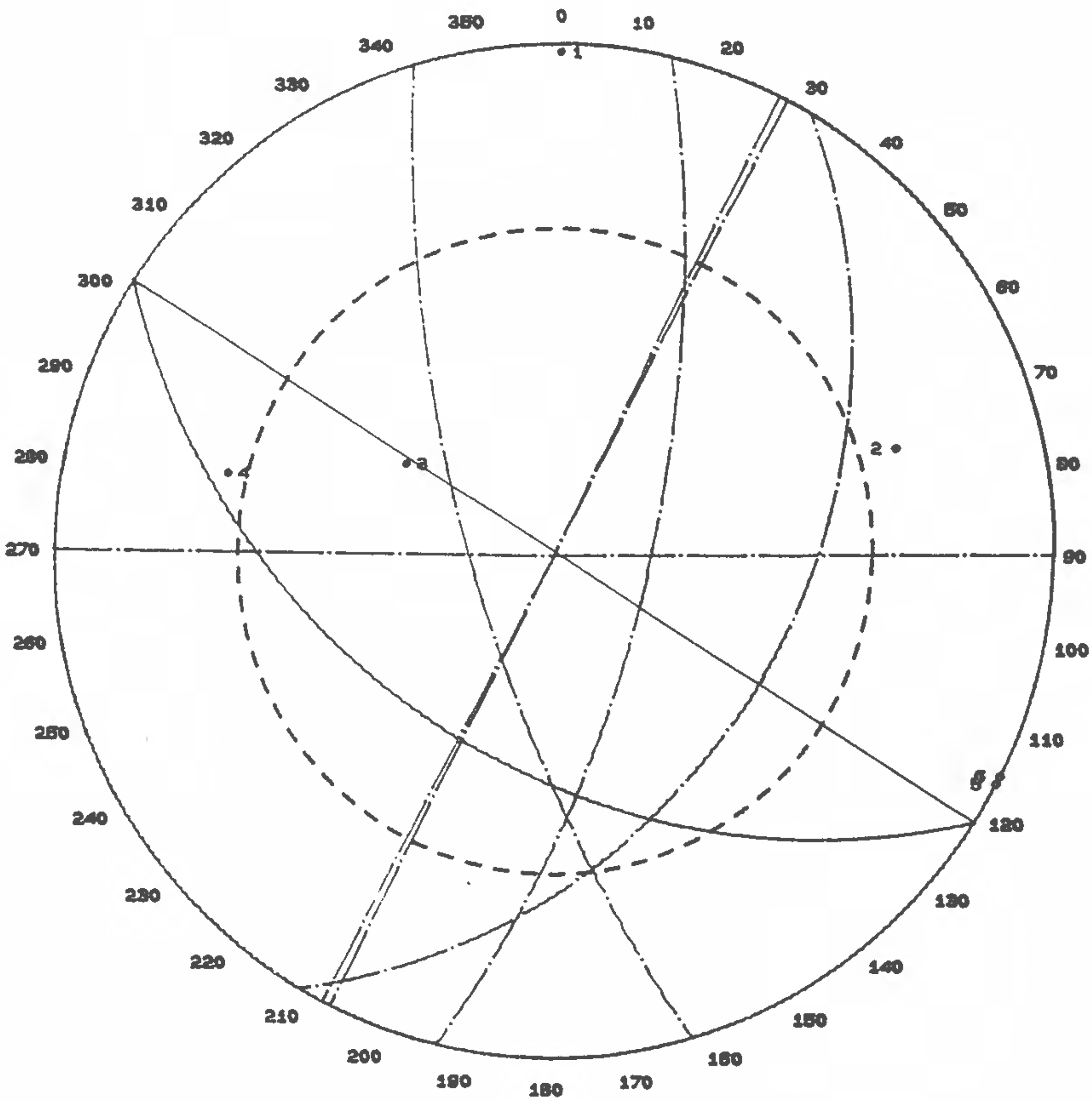
	AZIMUTH	DIP
1.	180.00	89.00
2.	253.00	71.00
3.	120.00	38.00
4.	103.00	68.00
5.	297.00	90.00
6.	296.00	90.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 45
DIP AZIMUTH : 212
FRICTION ANGLE : 25



STATION 972+35 TO 974+45
PRINCIPAL JOINTS & FAULTS WITH 45° SLOPE

STATION 984+50 TO 987+00

SLOPE ORIENTATION

DIP AZIMUTH: 201
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	55	66	30	NO
2.	266	57	30	NO
3.	120	64	30	NO
4.	264	66	30	NO
5.	354	87	30	NO
6.	192	75	30	NO
7.	207	89	30	NO
8.	242	86	30	NO
9.	97	89	30	NO
10.	143	82	30	NO

AT SLOPE ANGLES STEEPER THAN 75.00, A POTENTIAL FAILURE PLANE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 2	25.99	337.54	NO	90.00
1 & 4	29.35	339.51	NO	90.00
1 & 5	64.22	77.76	NO	90.00
1 & 8	13.32	331.06	NO	90.00
2 & 3	27.19	195.49	NO	90.00
2 & 4	9.65	349.66	NO	90.00
2 & 6	56.73	257.90	NO	70.29
2 & 7	53.22	295.67	NO	90.00
2 & 8	34.75	329.22	NO	90.00
2 & 9	15.97	186.72	NO	90.00
2 &10	48.75	223.78	YES	51.04
3 & 1	60.99	91.59	NO	90.00
3 & 5	57.25	79.32	NO	90.00
3 & 9	39.63	186.18	YES	40.59
4 & 3	33.51	191.16	YES	33.91
4 & 6	65.02	246.89	NO	72.03
4 & 7	62.53	295.08	NO	90.00
4 & 8	44.49	328.07	NO	90.00
4 & 9	25.94	186.52	NO	90.00
4 &10	58.20	219.90	YES	59.60
5 & 2	56.97	268.63	NO	76.10
5 & 4	65.85	270.72	NO	81.16
5 & 6	44.16	266.92	NO	67.21
5 & 7	82.91	288.93	NO	89.74
5 & 8	83.72	292.49	NO	90.00
6 & 1	45.64	117.90	NO	83.29
6 & 3	63.29	134.18	NO	78.80
6 & 9	74.83	183.31	NO	75.52
6 &10	74.78	201.89	NO	74.79
7 & 1	45.53	118.01	NO	83.16
7 & 3	63.99	119.05	NO	86.09
7 & 6	45.86	118.03	NO	83.23
7 & 9	88.25	151.99	NO	88.86
7 &10	81.53	123.73	NO	88.12
8 & 3	58.08	158.44	NO	65.36
8 & 6	73.33	165.50	NO	76.30
8 & 7	84.37	286.80	NO	89.59
8 & 9	81.58	180.23	NO	82.13
8 &10	80.43	176.51	NO	81.28
9 & 1	57.12	8.54	NO	90.00
9 & 5	86.54	23.79	NO	90.00
10 & 1	65.18	70.69	NO	90.00
10 & 3	47.14	61.71	NO	90.00
10 & 5	70.00	75.71	NO	90.00
10 & 9	79.83	181.42	NO	80.41

AT SLOPE ANGLES STEEPER THAN 33.91, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW

STATION 984+50 TO 987+00

SLOPE ORIENTATION

DIP AZIMUTH: 192
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	55	66	30	NO
2.	266	57	30	NO
3.	120	64	30	NO
4.	264	66	30	NO
5.	354	87	30	NO
6.	192	75	30	NO
7.	207	89	30	NO
8.	242	86	30	NO
9.	97	89	30	NO
10.	143	82	30	NO

AT SLOPE ANGLES STEEPER THAN 75.00, A POTENTIAL FAILURE PLANE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

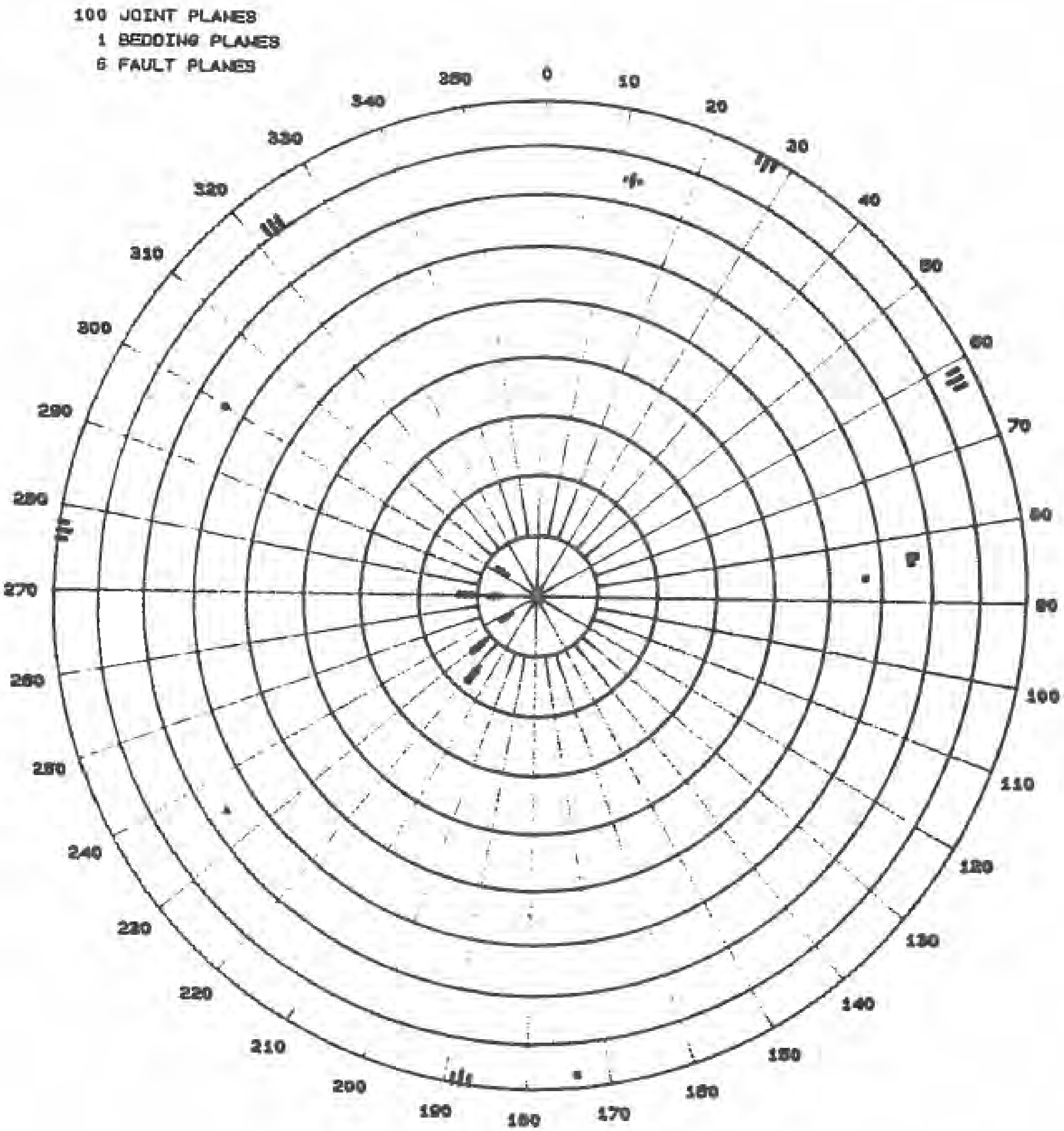
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 2	25.99	337.54	NO	90.00
1 & 4	29.35	339.51	NO	90.00
1 & 5	64.22	77.76	NO	90.00
1 & 8	13.32	331.06	NO	90.00
2 & 3	27.19	195.49	NO	90.00
2 & 4	9.65	349.66	NO	90.00
2 & 6	56.73	257.90	NO	75.00
2 & 7	53.22	295.67	NO	90.00
2 & 8	34.75	329.22	NO	90.00
2 & 9	15.97	186.72	NO	90.00
2 &10	48.75	223.78	YES	53.30
3 & 1	60.99	91.59	NO	90.00
3 & 5	57.25	79.32	NO	90.00
3 & 9	39.63	186.18	YES	39.78
4 & 3	33.51	191.16	YES	33.52
4 & 6	65.02	246.89	NO	75.00
4 & 7	62.53	295.08	NO	90.00
4 & 8	44.49	328.07	NO	90.00
4 & 9	25.94	186.52	NO	90.00
4 &10	58.20	219.90	NO	61.28
5 & 2	56.97	268.63	NO	81.45
5 & 4	65.85	270.72	NO	84.99
5 & 6	44.16	266.92	NO	75.00
5 & 7	82.91	288.93	NO	90.00
5 & 8	83.72	292.49	NO	90.00
6 & 1	45.64	117.90	NO	75.00
6 & 3	63.29	134.18	NO	75.00
6 & 9	74.83	183.31	NO	75.00
6 &10	74.78	201.89	NO	75.00
7 & 1	45.53	118.01	NO	74.85
7 & 3	63.99	119.05	NO	81.86
7 & 6	45.86	118.03	NO	75.00
7 & 9	88.25	151.99	NO	88.66
7 &10	81.53	123.73	NO	86.84
8 & 3	58.08	158.44	NO	62.57
8 & 6	73.33	165.50	NO	75.00
8 & 7	84.37	286.80	NO	90.00
8 & 9	81.58	180.23	NO	81.76
8 &10	80.43	176.51	NO	80.77
9 & 1	57.12	8.54	NO	90.00
9 & 5	86.54	23.79	NO	90.00
10 & 1	65.18	70.69	NO	90.00
10 & 3	47.14	61.71	NO	90.00
10 & 5	70.00	75.71	NO	90.00
10 & 9	79.83	181.42	NO	80.00

AT SLOPE ANGLES STEEPER THAN 33.52, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING EXISTS



Sta 984+50 to 987+00
Joint and fault/bedding planes

DISCONTINUITY DATA

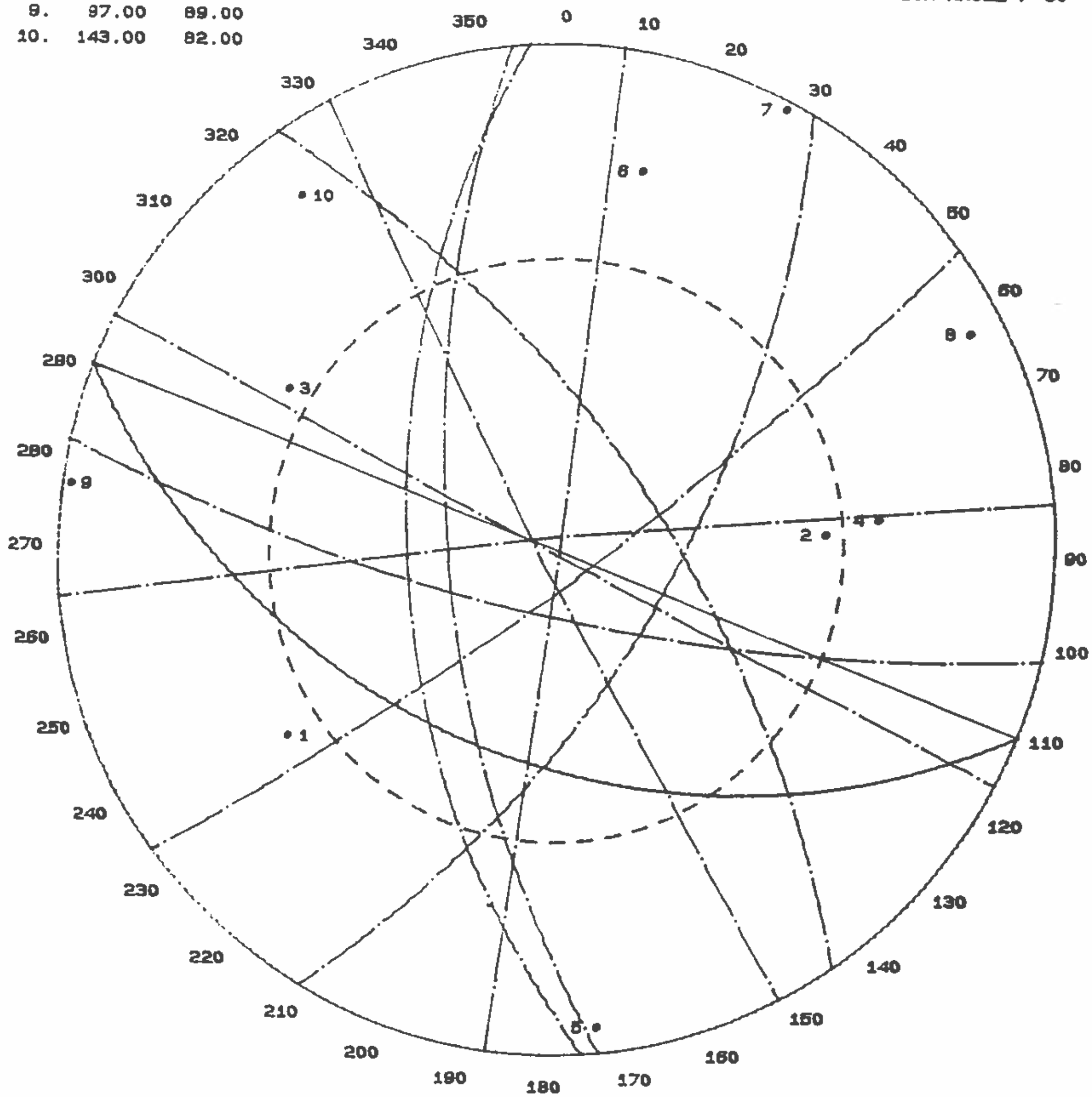
	AZIMUTH	DIP
1.	55.00	66.00
2.	256.00	67.00
3.	120.00	64.00
4.	254.00	66.00
5.	354.00	87.00
6.	192.00	75.00
7.	207.00	89.00
8.	242.00	86.00
9.	97.00	89.00
10.	143.00	82.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 45
DIP AZIMUTH : 201
FRICTION ANGLE : 30



STATION 984+50 TO 987+00
PRINCIPAL JOINTS & FAULTS WITH 45° SLOPE

STATION 991+00 TO 993+40

SLOPE ORIENTATION

DIP AZIMUTH: 9
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	188	89	30	NO
2.	247	69	30	NO
3.	267	70	30	NO
4.	95	70	30	NO
5.	279	76	30	NO
6.	156	87	30	NO
7.	243	87	30	NO
8.	262	81	30	NO
9.	160	67	30	NO
10.	132	81	30	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 4	69.90	100.73	NO	90.00
1 & 6	85.82	111.81	NO	90.00
1 & 9	48.92	99.14	NO	90.00
1 &10	79.78	103.56	NO	90.00
2 & 1	66.36	275.72	NO	90.00
2 & 4	32.90	171.38	NO	90.00
2 & 6	68.77	238.25	NO	90.00
2 & 7	11.87	332.37	NO	90.00
2 & 9	60.83	200.47	NO	90.00
2 &10	62.43	204.34	NO	90.00
3 & 1	69.80	275.28	NO	90.00
3 & 2	68.99	248.43	NO	90.00
3 & 4	10.84	181.01	NO	90.00
3 & 6	67.54	238.72	NO	90.00
3 & 7	52.08	329.15	YES	59.12
3 & 8	22.86	348.17	NO	90.00
3 & 9	56.42	210.25	NO	90.00
3 &10	55.33	208.76	NO	90.00
4 & 5	6.49	7.37	NO	90.00
5 & 1	75.94	274.01	NO	90.00
5 & 2	67.71	226.47	NO	90.00
5 & 3	57.82	212.35	NO	90.00
5 & 6	71.45	237.02	NO	90.00
5 & 7	70.40	324.54	NO	75.75
5 & 8	69.68	326.68	NO	74.69
5 & 9	56.11	210.80	NO	90.00
5 &10	54.27	209.29	NO	90.00
6 & 4	68.66	73.71	NO	80.53
6 &10	74.53	76.91	NO	84.06
7 & 1	86.87	259.37	NO	90.00
7 & 4	52.31	156.89	NO	90.00
7 & 6	85.86	199.51	NO	90.00
7 & 9	66.99	160.09	NO	90.00
7 &10	78.86	168.43	NO	90.00
8 & 1	80.86	271.77	NO	90.00
8 & 2	47.82	182.07	NO	90.00
8 & 4	23.41	175.93	NO	90.00
8 & 6	79.39	229.75	NO	90.00
8 & 7	71.30	324.09	NO	90.00
8 & 9	63.72	190.72	NO	76.52
8 &10	69.45	197.01	NO	90.00
9 & 4	64.78	134.36	NO	90.00
9 & 6	10.61	245.44	NO	90.00
9 &10	57.92	207.36	NO	90.00
10 & 4	66.96	63.86	NO	90.00
				76.25

AT SLOPE ANGLES STEEPER THAN 59.12, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING EXISTS

STATION 991+00 TO 993+40

SLOPE ORIENTATION

DIP AZIMUTH: 186
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	188	89	30	NO
2.	247	69	30	NO
3.	267	70	30	NO
4.	95	70	30	NO
5.	279	76	30	NO
6.	156	87	30	NO
7.	243	87	30	NO
8.	262	81	30	NO
9.	160	67	30	NO
10.	132	81	30	NO

AT SLOPE ANGLES STEEPER THAN 89.00, A POTENTIAL FAILURE PLANE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

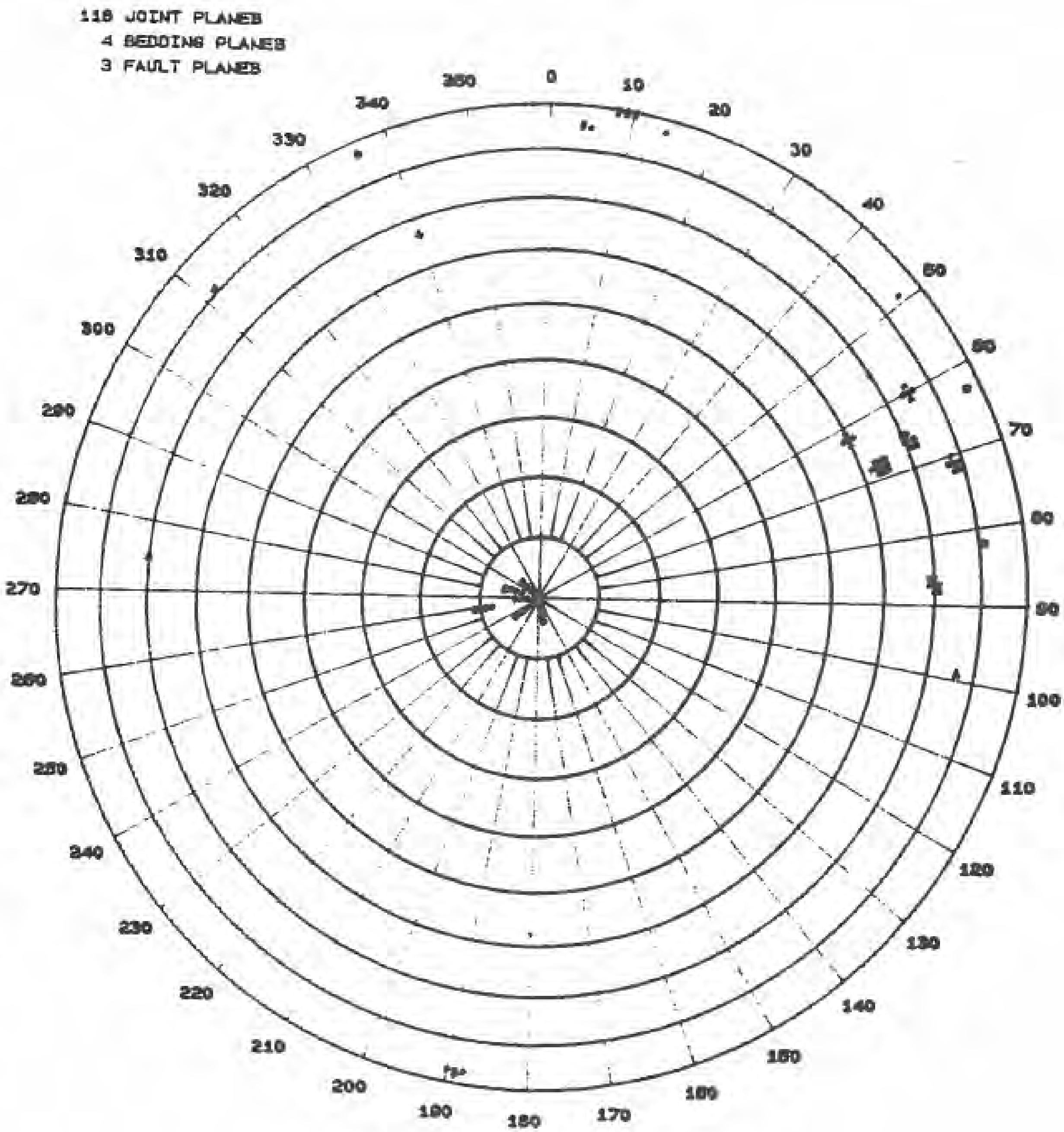
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 4	69.90	100.73	NO	88.27
1 & 6	85.82	111.81	NO	88.86
1 & 9	48.92	99.14	NO	87.26
1 &10	79.78	103.56	NO	88.64
2 & 1	66.36	275.72	NO	89.88
2 & 4	32.90	171.38	YES	33.77
2 & 6	68.77	238.25	NO	76.62
2 & 7	11.87	332.37	NO	90.00
2 & 9	60.83	200.47	NO	61.62
2 &10	62.43	204.34	NO	63.64
3 & 1	69.80	275.28	NO	89.74
3 & 2	68.99	248.43	NO	79.92
3 & 4	10.84	181.01	NO	90.00
3 & 6	67.54	238.72	NO	75.94
3 & 7	52.08	329.15	NO	90.00
3 & 8	22.86	348.17	NO	90.00
3 & 9	56.42	210.25	YES	58.82
3 &10	55.33	208.76	YES	57.48
4 & 5	6.49	7.37	NO	90.00
5 & 1	75.94	274.01	NO	89.50
5 & 2	67.71	226.47	NO	72.68
5 & 3	57.82	212.35	NO	60.59
5 & 6	71.45	237.02	NO	78.08
5 & 7	70.40	324.54	NO	90.00
5 & 8	69.68	326.68	NO	90.00
5 & 9	56.11	210.80	YES	58.63
5 &10	54.27	209.29	YES	56.54
6 & 4	68.66	73.71	NO	90.00
6 &10	74.53	76.91	NO	90.00
7 & 1	86.87	259.37	NO	89.10
7 & 4	52.31	156.89	YES	55.98
7 & 6	85.86	199.51	NO	85.98
7 & 9	66.99	160.09	NO	69.10
7 &10	78.86	168.43	NO	79.37
8 & 1	80.86	271.77	NO	89.32
8 & 2	47.82	182.07	YES	47.89
8 & 4	23.41	175.93	NO	90.00
8 & 6	79.39	229.75	NO	82.30
8 & 7	71.30	324.09	NO	90.00
8 & 9	63.72	190.72	NO	63.80
8 &10	69.45	197.01	NO	69.80
9 & 4	64.78	134.36	NO	73.71
9 & 6	10.61	245.44	NO	90.00
9 &10	57.92	207.36	YES	59.73
10 & 4	66.96	63.86	NO	90.00

AT SLOPE ANGLES STEEPER THAN 33.77, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW



Sta 991+00 to 993+40
Joint and fault/bedding planes

DISCONTINUITY DATA

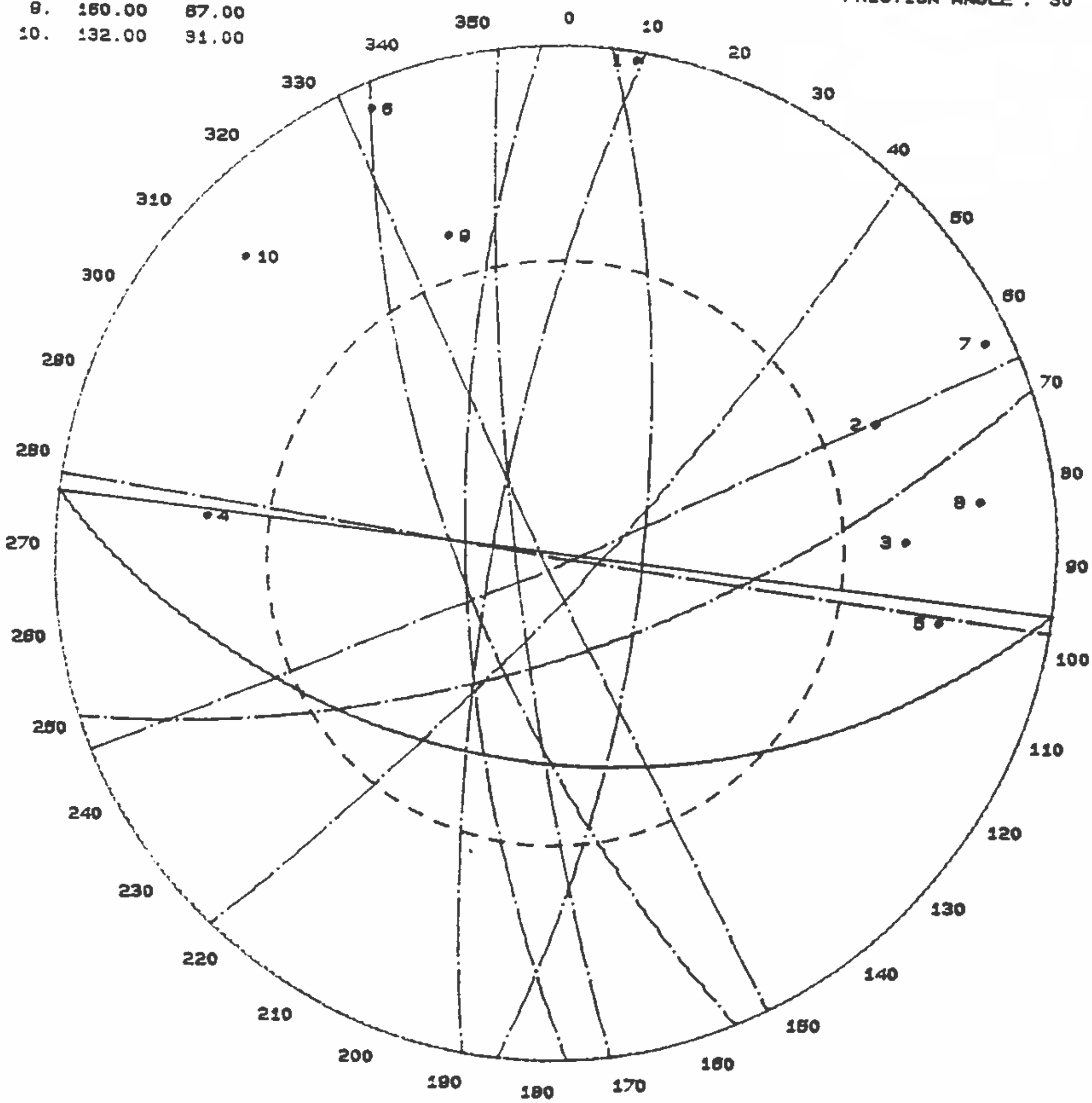
	AZIMUTH	DIP
1.	188.00	89.00
2.	247.00	69.00
3.	257.00	70.00
4.	85.00	70.00
5.	278.00	76.00
6.	156.00	87.00
7.	243.00	87.00
8.	262.00	81.00
9.	160.00	57.00
10.	132.00	31.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 45
DIP AZIMUTH : 186
FRICTION ANGLE : 30



STATION 991+00 TO 993+40
PRINCIPAL JOINTS & FAULTS WITH 45° SLOPE

STATION 995+14 TO 998+63

SLOPE ORIENTATION

DIP AZIMUTH: 185
DIP : 57

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	230	90	30	NO
2.	235	61	30	NO
3.	275	90	30	NO
4.	292	85	30	NO
5.	67	71	30	NO
6.	223	67	30	NO
7.	258	62	30	NO
8.	75	87	30	NO
9.	120	80	30	NO
10.	262	83	30	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

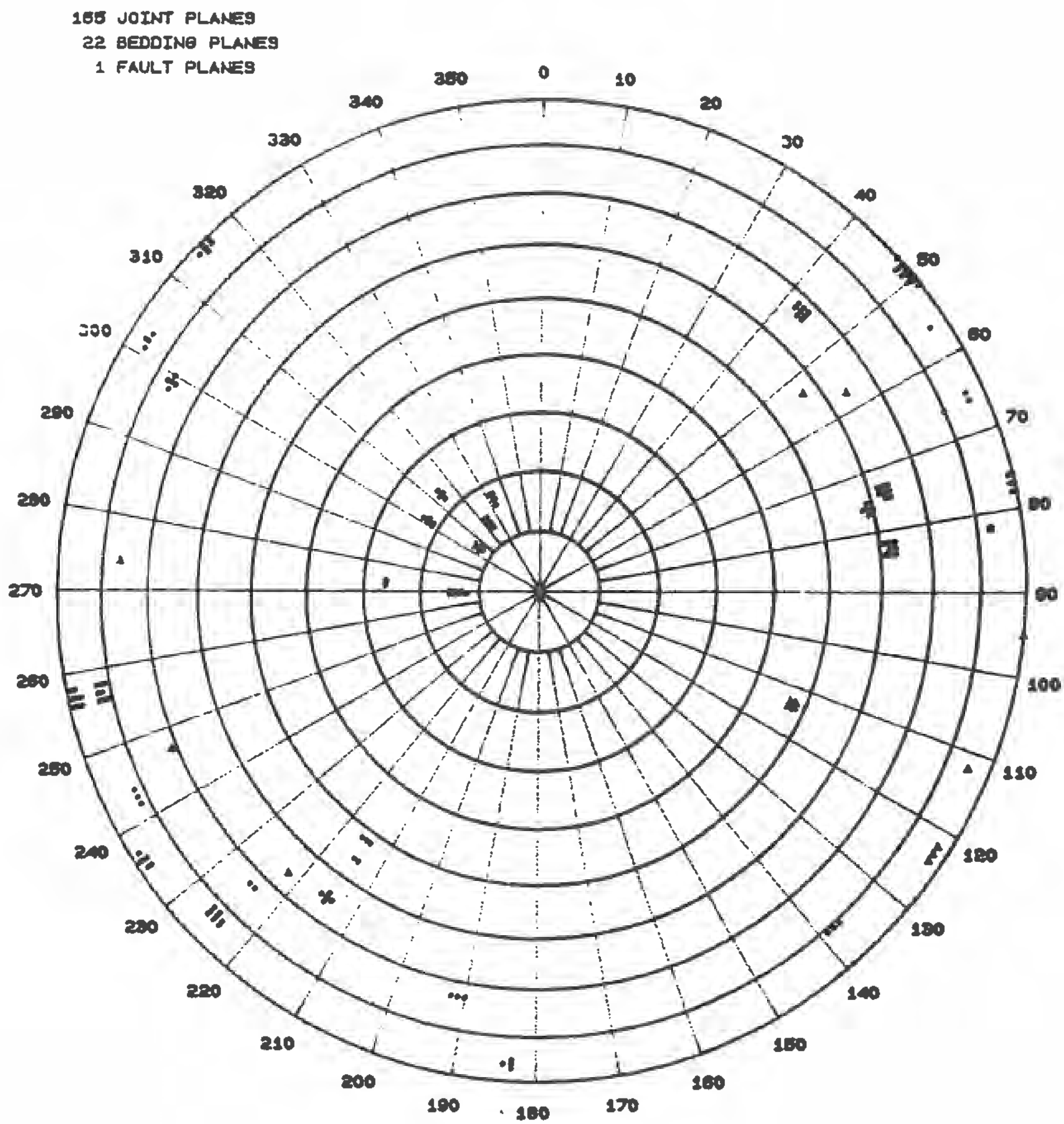
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 5	40.33	139.99	YES	50.21
1 & 6	16.01	139.99	NO	90.00
1 & 8	82.93	140.00	NO	84.99
1 & 9	79.37	140.00	NO	82.44
2 & 1	8.93	320.01	NO	90.00
2 & 5	13.09	152.40	NO	90.00
2 & 6	51.60	280.61	NO	90.00
2 & 8	29.52	163.29	NO	90.00
2 & 9	54.40	195.75	YES	54.88
3 & 1	90.00	304.21	NO	90.00
3 & 2	49.22	185.01	YES	49.23
3 & 6	61.69	185.00	NO	61.69
3 & 7	28.80	185.01	NO	90.00
3 & 9	67.35	185.01	NO	67.35
3 &10	61.37	185.00	NO	61.37
4 & 1	84.34	320.00	NO	90.00
4 & 2	58.59	210.25	NO	61.09
4 & 3	73.34	5.00	NO	90.00
4 & 6	66.72	213.74	NO	69.34
4 & 7	50.45	208.09	YES	52.78
4 & 9	27.86	204.66	NO	90.00
4 &10	82.68	244.94	NO	86.32
5 & 3	53.74	5.00	NO	90.00
5 & 4	59.84	13.34	NO	90.00
5 & 7	12.34	341.33	NO	90.00
5 &10	29.15	348.08	NO	90.00
6 & 5	28.40	146.26	NO	90.00
6 & 8	48.44	161.61	YES	50.87
6 & 9	63.07	189.69	NO	63.15
7 & 1	41.44	320.01	NO	90.00
7 & 2	60.88	240.66	NO	72.56
7 & 6	61.98	260.08	NO	82.20
7 & 9	44.82	199.91	YES	45.81
8 & 3	81.28	5.00	NO	90.00
8 & 4	77.52	358.71	NO	90.00
8 & 5	25.44	346.43	NO	90.00
8 & 7	5.12	345.27	NO	90.00
8 &10	34.86	347.10	NO	90.00
9 & 5	70.88	60.58	NO	90.00
9 & 8	78.48	150.09	NO	80.51
10 & 1	76.95	320.00	NO	90.00
10 & 2	45.35	179.14	YES	45.51
10 & 6	61.76	185.22	NO	61.76
10 & 7	9.67	173.19	NO	90.00
10 & 9	65.28	187.48	NO	65.31

AT SLOPE ANGLES STEEPER THAN 45.51, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW



Sta 995+14 to 998+63
Joints and fault/bedding planes

DISCONTINUITY DATA

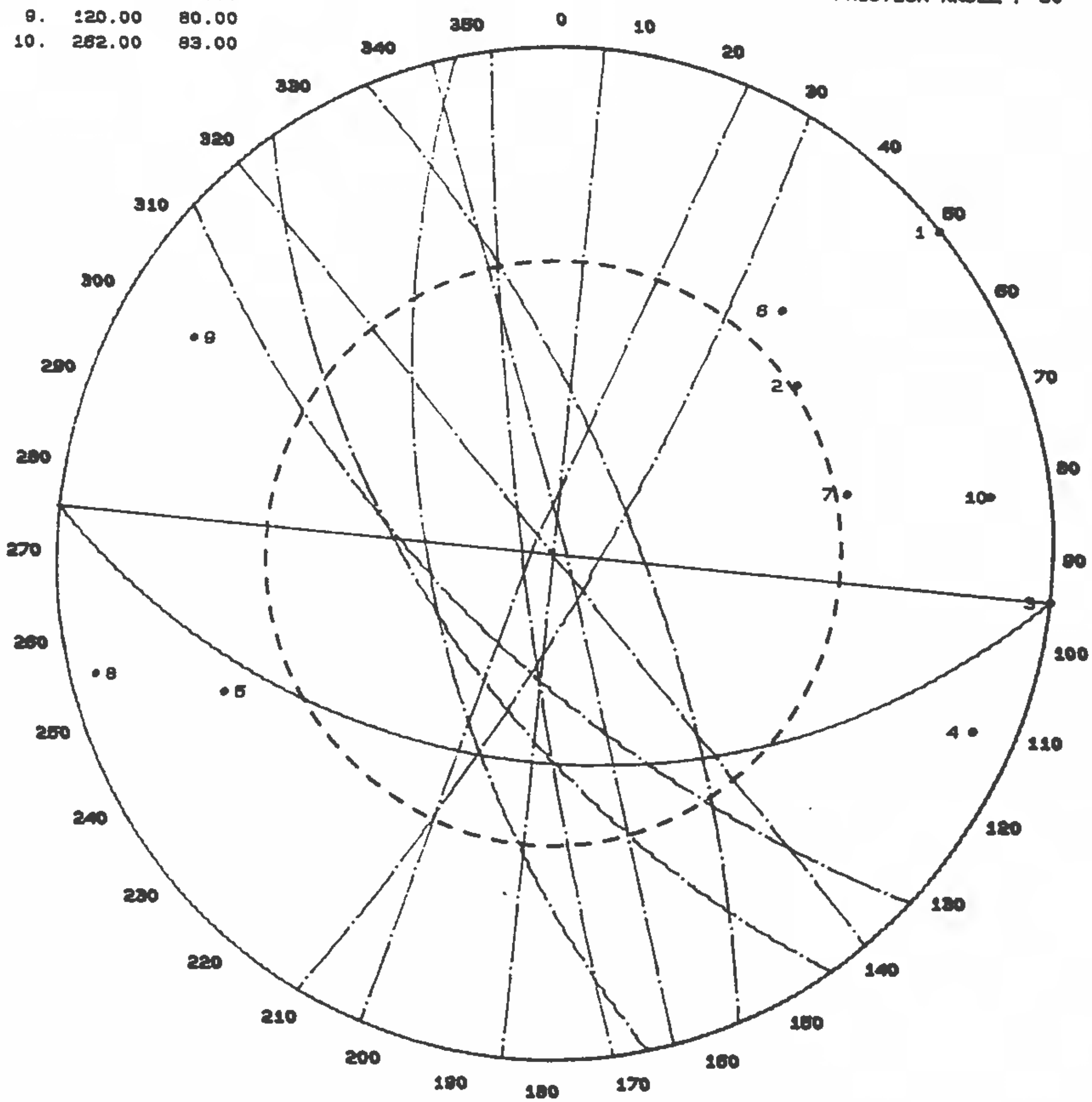
	AZIMUTH	DIP
1.	230.00	90.00
2.	235.00	61.00
3.	275.00	90.00
4.	232.00	35.00
5.	67.00	71.00
6.	223.00	67.00
7.	258.00	62.00
8.	75.00	87.00
9.	120.00	80.00
10.	262.00	83.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 45
DIP AZIMUTH : 185
FRICTION ANGLE : 30



station 995+14 to 998+63
PRINCIPAL JOINTS & FAULTS WITH 45° SLOPE

SLOPE ORIENTATION

DIP AZIMUTH: 23
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	139	39	25	NO
2.	138	40	25	NO
3.	56	68	25	NO
4.	177	37	25	NO
5.	134	35	25	NO
6.	102	70	25	NO
7.	284	80	25	NO
8.	229	89	25	NO
9.	288	87	25	NO
10.	243	89	25	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 2	19.95	202.36	NO	90.00
1 & 3	38.41	127.31	NO	90.00
1 & 5	21.14	77.53	NO	90.00
1 & 6	31.83	178.93	NO	90.00
2 & 3	39.43	126.59	NO	90.00
2 & 5	15.39	67.15	NO	90.00
2 & 6	32.50	178.58	NO	90.00
3 & 7	54.08	359.92	YES	56.33
3 & 9	60.91	12.59	NO	61.32
3 &10	16.13	332.72	NO	90.00
4 & 1	36.28	163.96	NO	90.00
4 & 2	36.50	166.12	NO	90.00
4 & 3	28.57	133.28	NO	90.00
4 & 5	33.92	150.17	NO	90.00
4 & 6	36.99	176.08	NO	90.00
5 & 3	34.92	129.61	NO	90.00
5 & 6	25.00	182.23	NO	90.00
6 & 3	67.20	71.99	NO	74.58
6 & 7	3.69	13.34	NO	90.00
6 & 9	14.10	17.24	NO	90.00
7 & 1	22.52	198.20	NO	90.00
7 & 2	22.62	198.22	NO	90.00
7 & 4	34.54	200.98	NO	90.00
7 & 5	17.52	197.20	NO	90.00
7 & 8	78.48	314.09	NO	85.81
7 &10	76.00	328.99	NO	81.67
8 & 1	38.99	139.80	NO	90.00
8 & 2	39.98	139.83	NO	90.00
8 & 3	16.13	139.28	NO	90.00
8 & 4	30.90	139.59	NO	90.00
8 & 5	34.86	139.69	NO	90.00
8 & 6	64.86	141.13	NO	90.00
9 & 1	21.91	199.21	NO	90.00
9 & 2	22.00	199.22	NO	90.00
9 & 4	34.73	200.09	NO	90.00
9 & 5	16.54	198.90	NO	90.00
9 & 7	29.34	199.69	NO	90.00
9 & 8	86.93	299.99	NO	89.63
9 &10	86.60	315.88	NO	88.68
10 & 1	38.06	153.78	NO	90.00
10 & 2	38.91	153.80	NO	90.00
10 & 4	34.68	153.69	NO	90.00
10 & 5	33.40	153.65	NO	90.00
10 & 6	59.02	154.66	NO	90.00
10 & 8	88.99	236.01	NO	90.00

AT SLOPE ANGLES STEEPER THAN 56.33, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW

STATION 1002+43 TO 1005+63

SLOPE ORIENTATION

DIP AZIMUTH: 23
DIP : 50

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	139	39	30	NO
2.	138	40	30	NO
3.	56	68	30	NO
4.	177	37	30	NO
5.	134	35	30	NO
6.	102	70	30	NO
7.	284	80	30	NO
8.	229	89	30	NO
9.	288	87	30	NO
10.	243	89	30	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

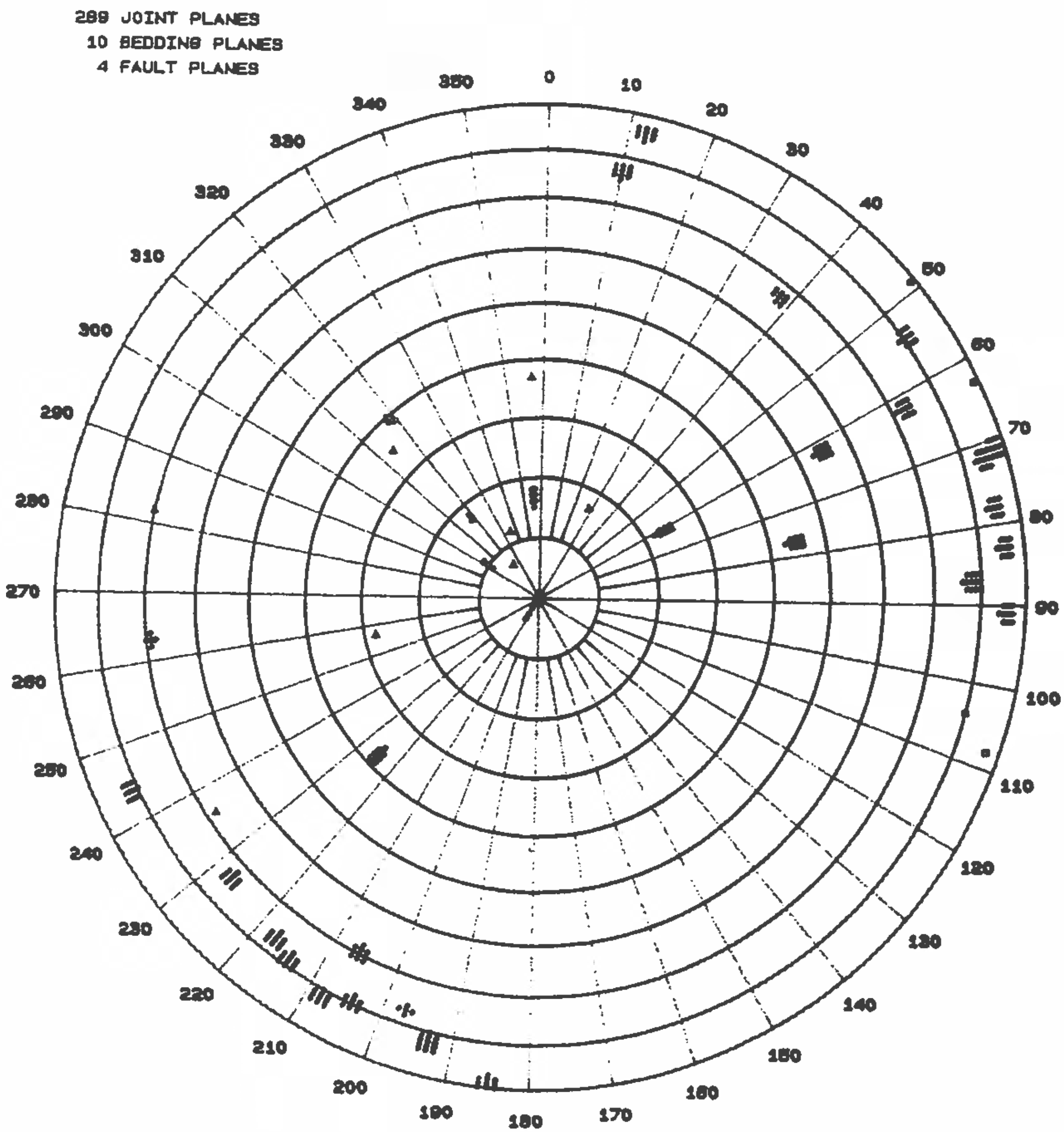
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 2	19.95	202.36	NO	90.00
1 & 3	38.41	127.31	NO	90.00
1 & 5	21.14	77.53	NO	90.00
1 & 6	31.83	178.93	NO	90.00
2 & 3	39.43	126.59	NO	90.00
2 & 5	15.39	67.15	NO	90.00
2 & 6	32.50	178.58	NO	90.00
3 & 7	54.08	359.92	NO	90.00
3 & 9	60.91	12.59	NO	56.33
3 &10	16.13	332.72	NO	61.32
4 & 1	36.28	163.96	NO	90.00
4 & 2	36.50	166.12	NO	90.00
4 & 3	28.57	133.28	NO	90.00
4 & 5	33.92	150.17	NO	90.00
4 & 6	36.99	176.08	NO	90.00
5 & 3	34.92	129.61	NO	90.00
5 & 6	25.00	182.23	NO	90.00
6 & 3	67.20	71.99	NO	90.00
6 & 7	3.69	13.34	NO	74.58
6 & 9	14.10	17.24	NO	90.00
7 & 1	22.52	198.20	NO	90.00
7 & 2	22.62	198.22	NO	90.00
7 & 4	34.54	200.98	NO	90.00
7 & 5	17.52	197.20	NO	90.00
7 & 8	78.48	314.09	NO	90.00
7 &10	76.00	328.99	NO	85.81
8 & 1	38.99	139.80	NO	81.67
8 & 2	39.98	139.83	NO	90.00
8 & 3	16.13	139.28	NO	90.00
8 & 4	30.90	139.59	NO	90.00
8 & 5	34.86	139.69	NO	90.00
8 & 6	64.86	141.13	NO	90.00
9 & 1	21.91	199.21	NO	90.00
9 & 2	22.00	199.22	NO	90.00
9 & 4	34.73	200.09	NO	90.00
9 & 5	16.54	198.90	NO	90.00
9 & 7	29.34	199.69	NO	90.00
9 & 8	86.93	299.99	NO	90.00
9 &10	86.60	315.88	NO	89.63
10 & 1	38.06	153.78	NO	88.68
10 & 2	38.91	153.80	NO	90.00
10 & 4	34.68	153.69	NO	90.00
10 & 5	33.40	153.65	NO	90.00
10 & 6	59.02	154.66	NO	90.00
10 & 8	88.99	236.01	NO	90.00

AT SLOPE ANGLES STEEPER THAN 56.33, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW



Sta 1002+43 to 1005+63
Joints and fault/bedding planes

DISCONTINUITY DATA

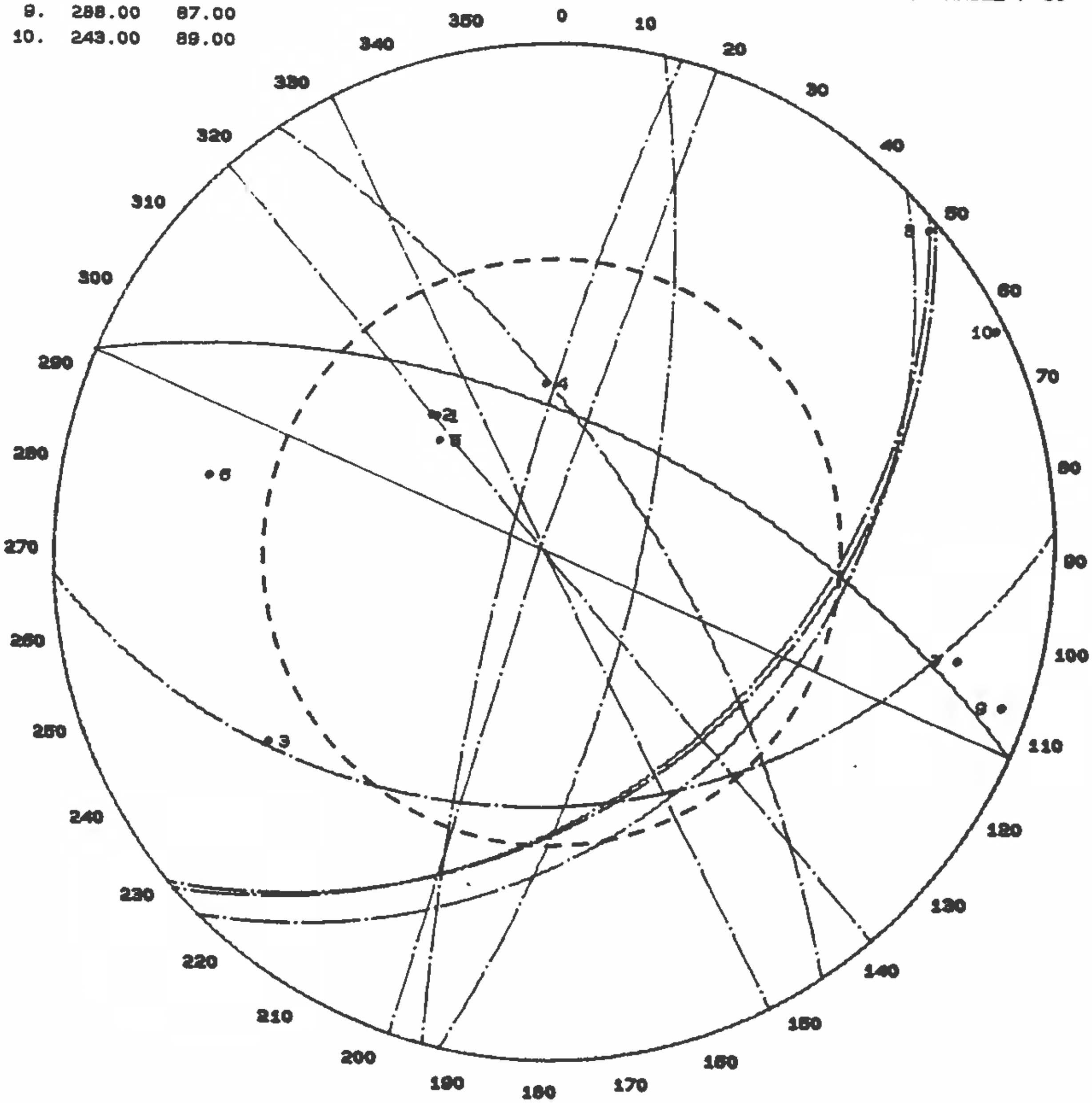
	AZIMUTH	DIP
1.	139.00	39.00
2.	138.00	40.00
3.	56.00	68.00
4.	177.00	37.00
5.	134.00	35.00
6.	102.00	70.00
7.	284.00	80.00
8.	228.00	89.00
9.	288.00	87.00
10.	243.00	89.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 60
DIP AZIMUTH : 23
FRICTION ANGLE : 30



STATION 1002+43 TO 1005+63,
PRINCIPAL JOINTS & FAULTS WITH 60° SLOPE

STATION 1105+47 TO 1109+13

SLOPE ORIENTATION

DIP AZIMUTH: 208
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	287	41	25	NO
2.	81	44	25	NO
3.	108	48	25	NO
4.	148	40	25	NO
5.	281	42	25	NO
6.	112	42	25	NO
7.	281	59	25	NO
8.	269	43	25	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 3	0.48	197.57	NO	90.00
1 & 4	16.64	217.13	NO	90.00
1 & 5	39.94	302.55	NO	90.00
1 & 6	2.20	199.55	NO	90.00
1 & 7	10.64	4.51	NO	90.00
1 & 8	40.94	290.50	NO	81.44
2 & 1	11.62	3.30	NO	90.00
2 & 5	9.19	0.64	NO	90.00
2 & 7	11.96	3.68	NO	90.00
2 & 8	3.78	354.93	NO	90.00
3 & 2	43.96	78.28	NO	90.00
4 & 2	36.67	120.54	NO	86.58
4 & 3	39.99	148.93	YES	58.50
4 & 6	39.39	136.19	NO	69.19
5 & 3	3.47	194.87	NO	90.00
5 & 4	19.10	213.63	NO	90.00
5 & 6	4.93	196.51	NO	90.00
5 & 8	41.94	284.47	NO	75.40
6 & 2	41.69	103.68	NO	90.00
6 & 3	17.48	181.53	NO	90.00
7 & 3	4.64	193.81	NO	90.00
7 & 4	23.76	206.35	NO	90.00
7 & 5	0.00	191.01	NO	90.00
7 & 6	6.38	194.86	NO	90.00
7 & 8	22.55	205.46	NO	90.00
8 & 3	9.49	189.34	NO	90.00
8 & 4	23.49	206.80	NO	90.00
8 & 6	10.35	190.30	NO	90.00

AT SLOPE ANGLES STEEPER THAN 58.50, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW

SLOPE ORIENTATION

DIP AZIMUTH: 41
DIP : 60

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	287	41	25	NO
2.	81	44	25	NO
3.	108	48	25	NO
4.	148	40	25	NO
5.	281	42	25	NO
6.	112	42	25	NO
7.	281	59	25	NO
8.	269	43	25	NO

THE GIVEN SLOPE IS STABLE WITH RESPECT TO PLANAR FAILURE

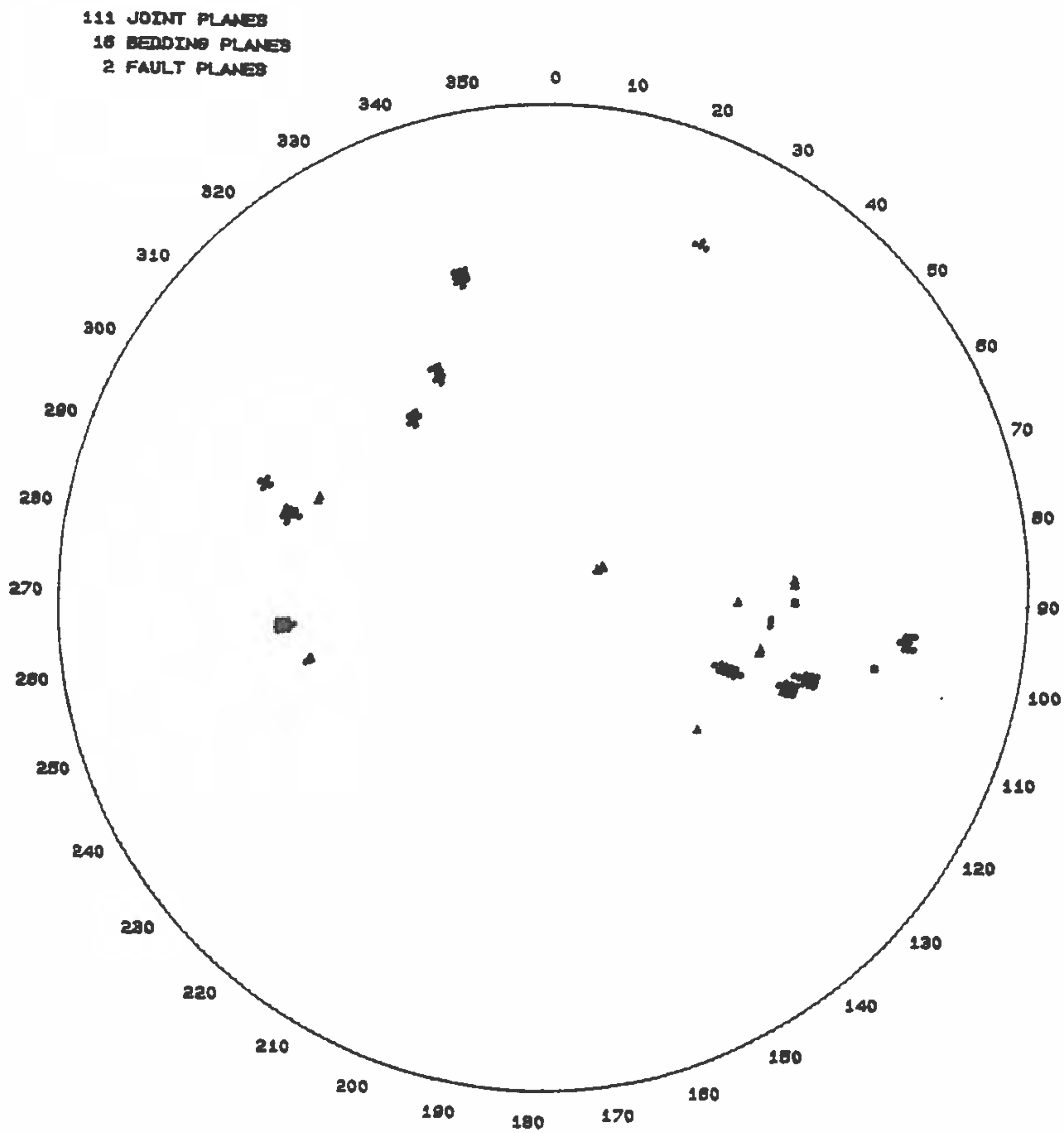
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 3	0.48	197.57	NO	90.00
1 & 4	16.64	217.13	NO	90.00
1 & 5	39.94	302.55	NO	90.00
1 & 6	2.20	199.55	NO	90.00
1 & 7	10.64	4.51	NO	90.00
1 & 8	40.94	290.50	NO	90.00
2 & 1	11.62	3.30	NO	90.00
2 & 5	9.19	0.64	NO	90.00
2 & 7	11.96	3.68	NO	90.00
2 & 8	3.78	354.93	NO	90.00
3 & 2	43.96	78.28	YES	50.48
4 & 2	36.67	120.54	NO	76.31
4 & 3	39.99	148.93	NO	90.00
4 & 6	39.39	136.19	NO	90.00
5 & 3	3.47	194.87	NO	90.00
5 & 4	19.10	213.63	NO	90.00
5 & 6	4.93	196.51	NO	90.00
5 & 8	41.94	284.47	NO	90.00
6 & 2	41.69	103.68	NO	62.75
6 & 3	17.48	181.53	NO	90.00
7 & 3	4.64	193.81	NO	90.00
7 & 4	23.76	206.35	NO	90.00
7 & 5	0.00	191.01	NO	90.00
7 & 6	6.38	194.86	NO	90.00
7 & 8	22.55	205.46	NO	90.00
8 & 3	9.49	189.34	NO	90.00
8 & 4	23.49	206.80	NO	90.00
8 & 6	10.35	190.30	NO	90.00

AT SLOPE ANGLES STEEPER THAN 50.48, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW



SR 160 @ MT. SPRINGS SUMMIT
STA 1105 IN CLARK CO.

DISCONTINUITY DATA

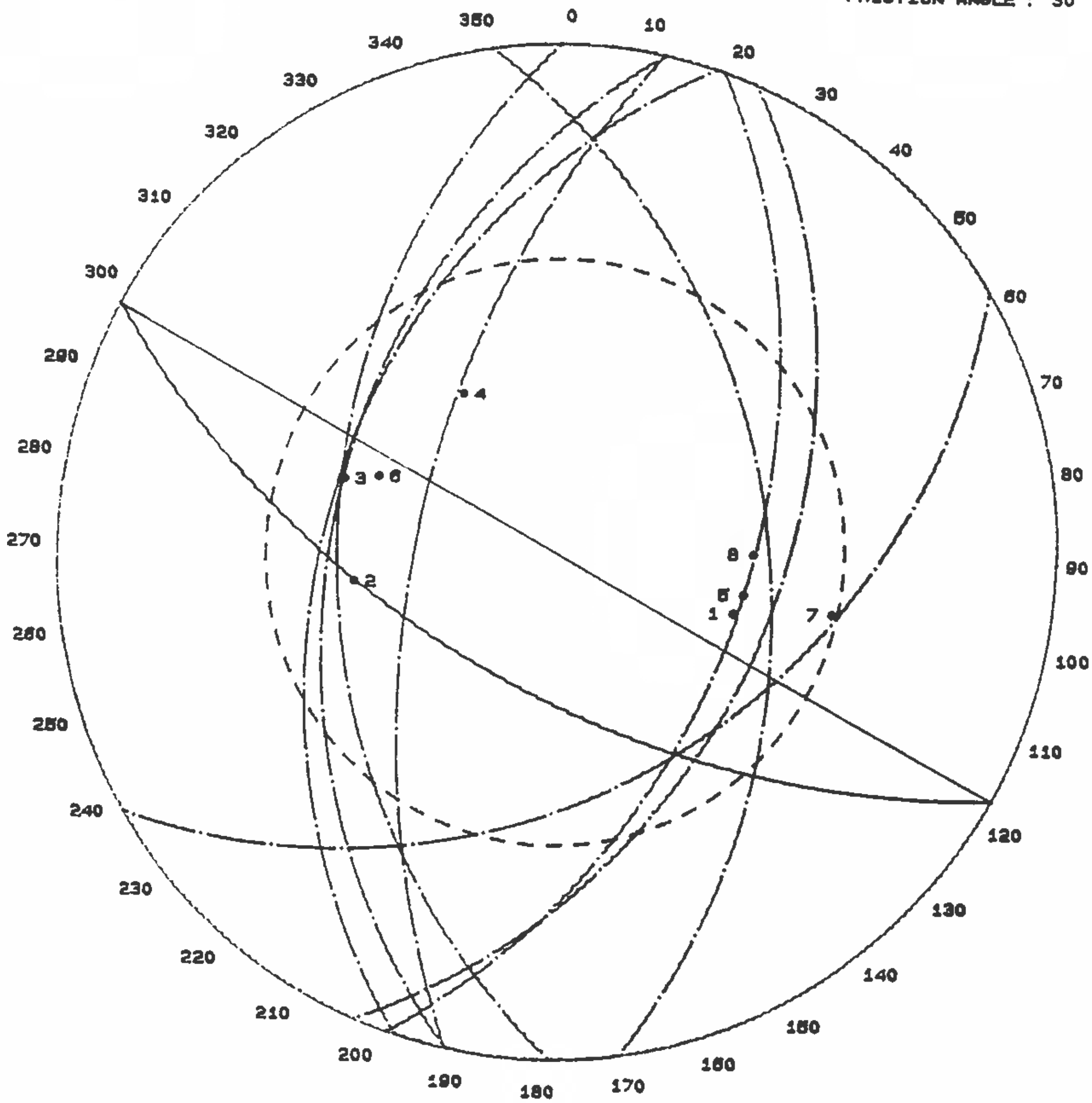
	AZIMUTH	DIP
1.	287.00	41.00
2.	81.00	44.00
3.	108.00	48.00
4.	148.00	40.00
5.	281.00	42.00
6.	112.00	42.00
7.	281.00	59.00
8.	259.00	43.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — —
DISCONTINUITY —·—·

DATA

DIP OF SLOPE : 60
DIP AZIMUTH : 208
FRICTION ANGLE : 30



STATION 1105+47 TO 1109+13
PRINCIPAL JOINTS & FAULTS WITH SLOPE 60

DISCONTINUITY DATA

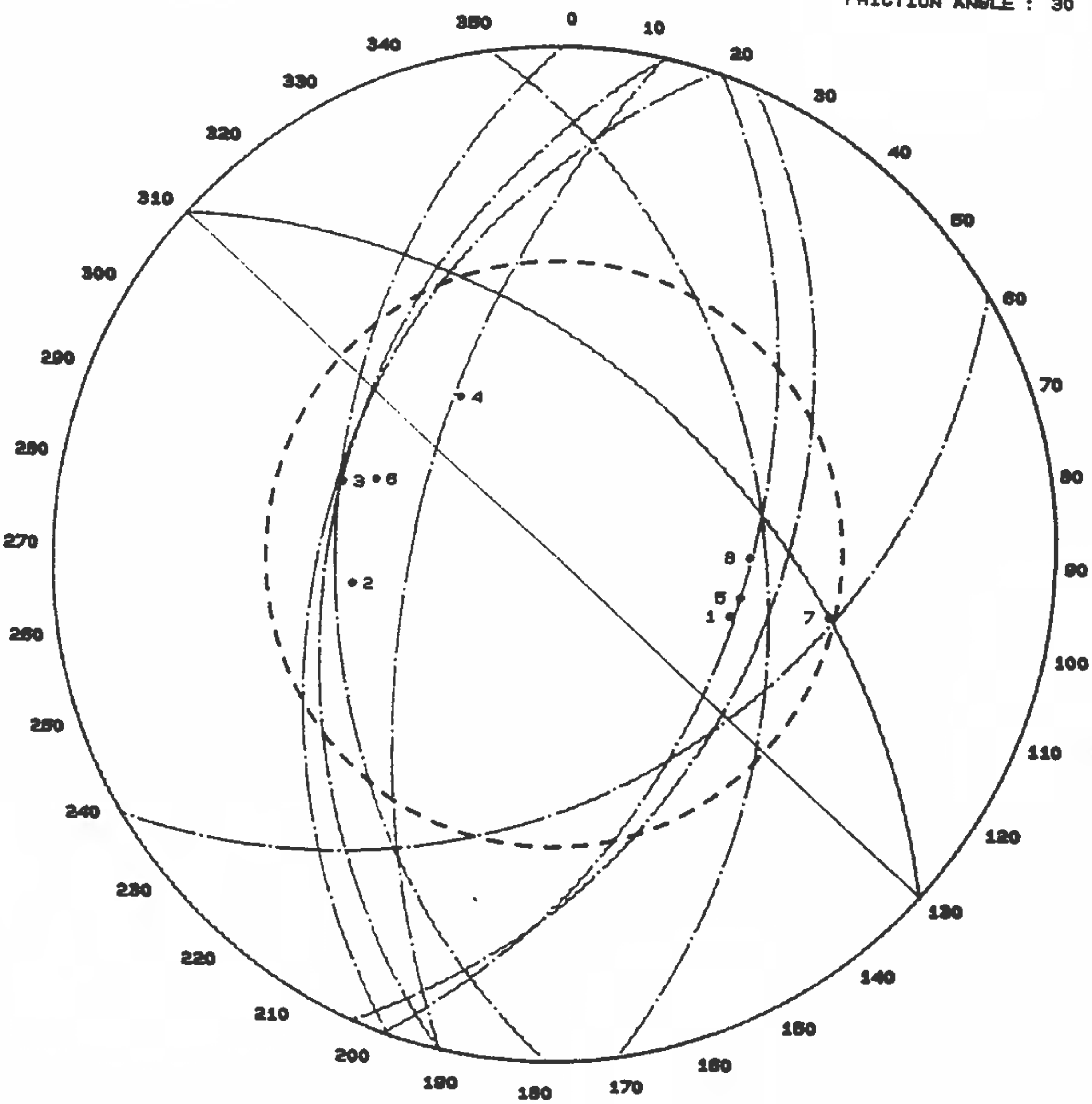
	AZIMUTH	DIP
1.	287.00	41.00
2.	81.00	44.00
3.	108.00	48.00
4.	148.00	40.00
5.	281.00	42.00
6.	112.00	42.00
7.	281.00	59.00
8.	269.00	43.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 50
DIP AZIMUTH : 41
FRICTION ANGLE : 30



STATION 1105+47 TO 1109+13.
PRINCIPAL JOINTS & FAULTS WITH 50° SLOPE

STATION 1112+50 TO 1116+15

SLOPE ORIENTATION

DIP AZIMUTH: 195
DIP : 54

KINEMATIC ANALYSIS OF PLANAR FAILURE ALONG DISCONTINUITES

#	DIP AZIMUTH	DIP	FRICTION ANGLE	POTENTIAL FOR PLANAR FAILURE
1.	291	38	30	NO
2.	21	42	30	NO
3.	39	42	30	NO
4.	47	87	30	NO
5.	127	32	30	NO
6.	153	82	30	NO
7.	180	86	30	NO
8.	283	31	30	NO
9.	59	48	30	NO
10.	110	54	30	NO

AT SLOPE ANGLES STEEPER THAN 86.00, A POTENTIAL FAILURE PLANE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

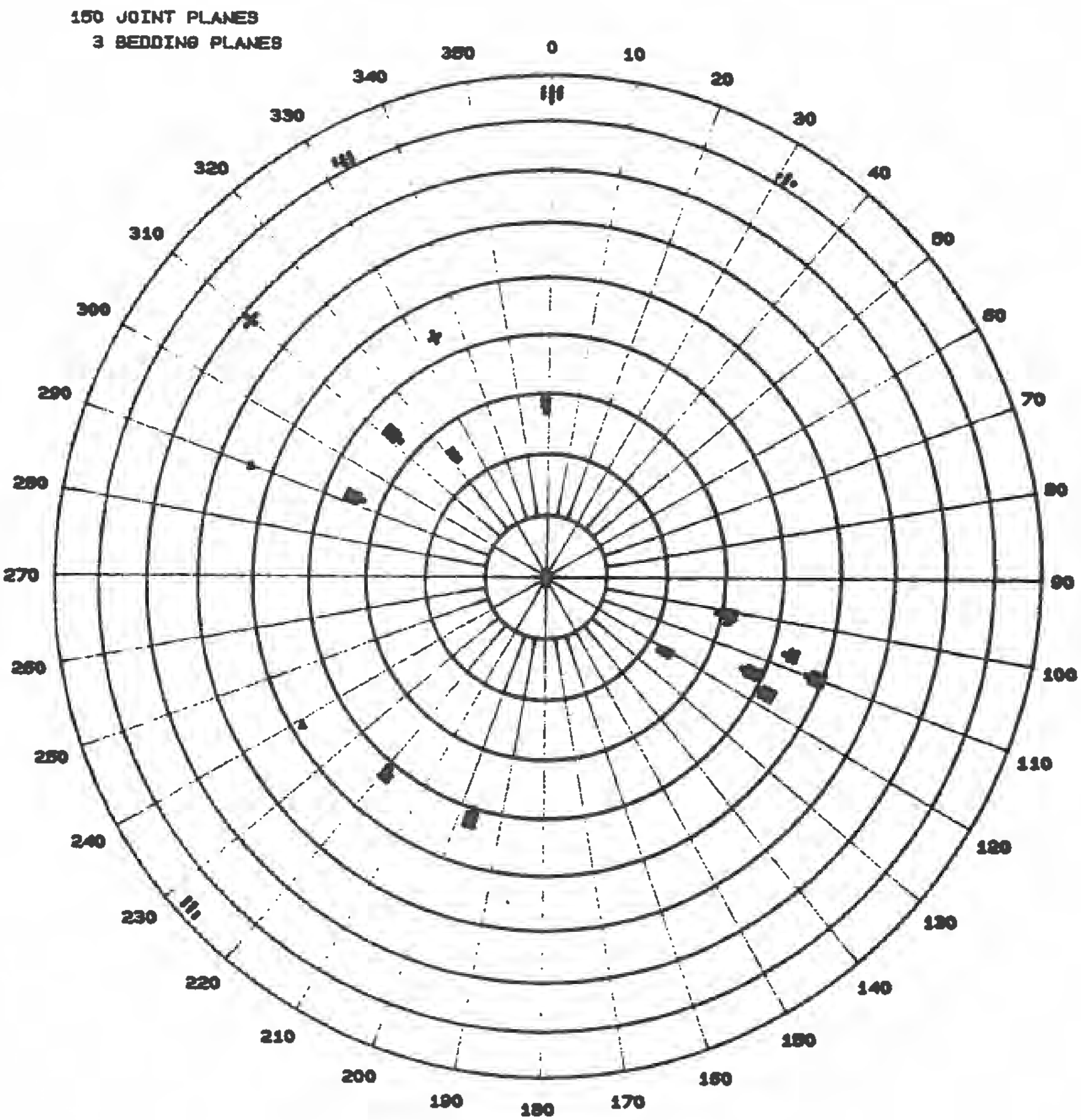
KINEMATIC ANALYSIS OF DISCONTINUITY INTERSECTIONS

PLANES INVOLVED	PLUNGE	TREND	DAYLIGHTS IN DESIGN SLOPE	DAYLIGHTS IF THE SLOPE IS CUT STEEPER THAN
1 & 5	5.51	208.11	NO	90.00
1 & 6	25.74	239.12	NO	90.00
1 & 7	35.54	267.14	NO	66.76
1 & 8	17.74	225.18	NO	90.00
2 & 1	30.54	331.95	NO	90.00
2 & 8	24.98	322.17	NO	90.00
3 & 1	26.15	342.06	NO	90.00
3 & 2	41.64	29.99	NO	90.00
3 & 8	20.75	333.90	NO	90.00
4 & 1	34.58	319.08	NO	90.00
4 & 2	22.39	318.24	NO	90.00
4 & 3	7.48	317.40	NO	90.00
4 & 8	26.07	318.47	NO	90.00
5 & 2	23.74	81.75	NO	90.00
5 & 3	27.54	93.59	NO	90.00
5 & 4	31.73	135.14	YES	50.93
5 & 9	31.48	115.53	NO	73.38
5 &10	17.44	186.80	NO	90.00
6 & 2	31.57	67.95	NO	90.00
6 & 3	37.86	69.27	NO	90.00
6 & 4	80.37	118.99	NO	87.65
6 & 5	16.54	65.39	NO	90.00
6 & 9	47.28	71.75	NO	90.00
6 &10	47.22	71.73	NO	90.00
7 & 2	16.94	91.22	NO	90.00
7 & 3	28.36	92.16	NO	90.00
7 & 4	81.26	117.06	NO	88.16
7 & 5	27.12	92.05	NO	90.00
7 & 6	79.46	112.08	NO	88.69
7 & 9	42.41	93.66	NO	90.00
7 &10	53.09	95.34	NO	90.00
8 & 5	7.25	205.24	NO	90.00
8 & 6	23.54	239.49	NO	90.00
8 & 7	30.09	267.68	NO	62.81
8 &10	2.92	197.88	NO	90.00
9 & 1	21.83	350.15	NO	90.00
9 & 2	41.98	23.11	NO	90.00
9 & 3	40.11	18.34	NO	90.00
9 & 4	13.75	136.26	NO	90.00
9 & 8	16.17	344.14	NO	90.00
10 & 1	0.49	20.36	NO	90.00
10 & 2	37.21	53.49	NO	90.00
10 & 3	40.38	58.16	NO	90.00
10 & 4	51.67	133.19	NO	69.52
10 & 9	47.27	71.87	NO	90.00

AT SLOPE ANGLES STEEPER THAN 50.93, A POTENTIAL WEDGE FAILURE WILL DAYLIGHT IN THE FACE OF A SLOPE WITH THE GIVEN ORIENTATION

ANALYSIS OF POTENTIAL TOPPLING FAILURE

BASIC CRITERIA INDICATES THAT POTENTIAL FOR TOPPLING IS LOW



Sta 1112+50 to 1116+15
Joint and fault/bedding planes

DISCONTINUITY DATA

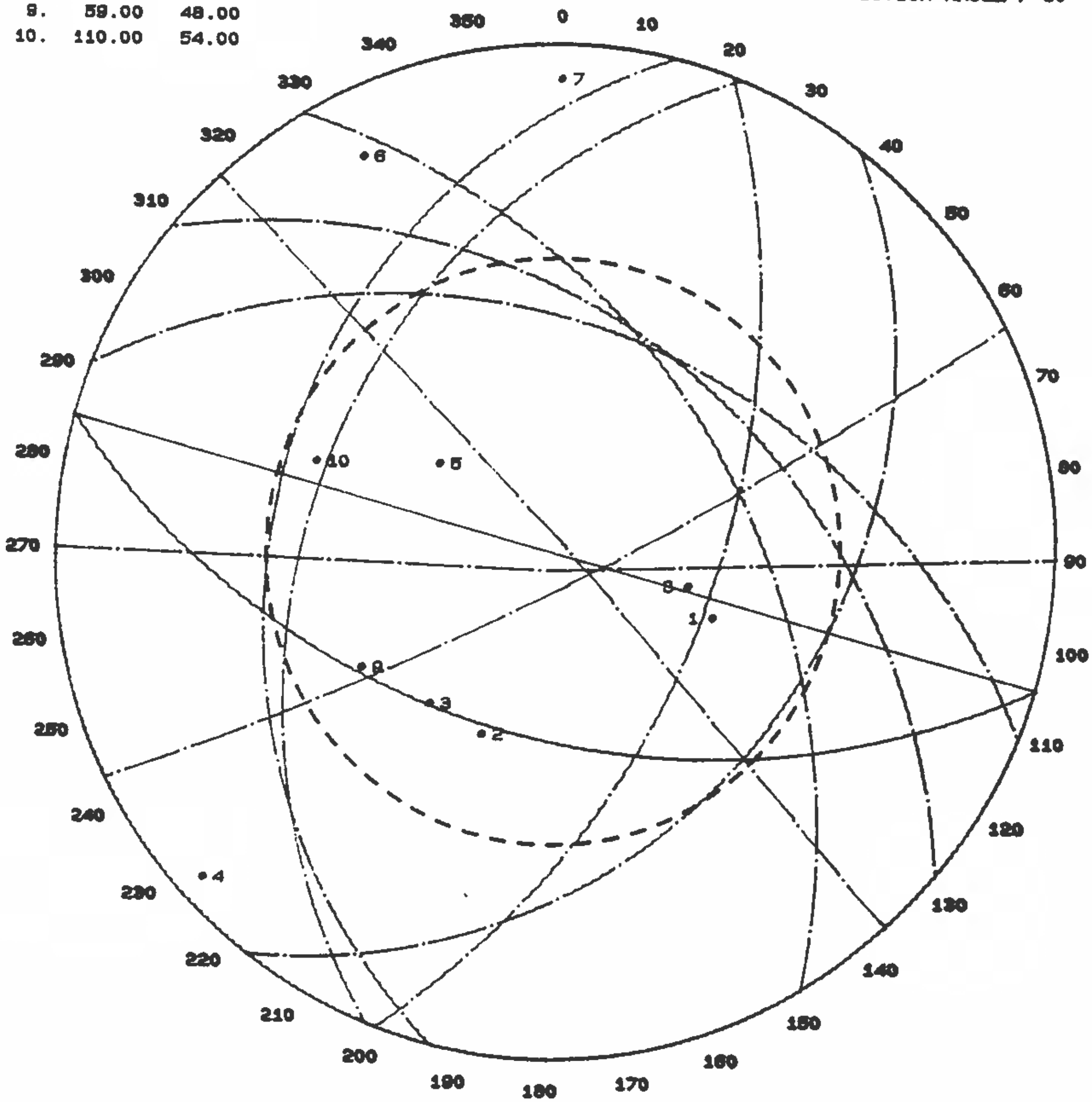
	AZIMUTH	DIP
1.	291.00	38.00
2.	21.00	42.00
3.	39.00	42.00
4.	47.00	87.00
5.	127.00	32.00
6.	153.00	82.00
7.	180.00	86.00
8.	283.00	31.00
9.	59.00	48.00
10.	110.00	54.00

LEGEND

SLOPE FACE ————
FRICTION CIRCLE — — — —
DISCONTINUITY ——·——

DATA

DIP OF SLOPE : 50
DIP AZIMUTH : 195
FRICTION ANGLE : 30



STATION 1112+50 TO 1116+15,
PRINCIPAL JOINTS & FAULTS WITH 50° SLOPE