

ANEJO A-6

CÁLCULOS

**ESTABILIZACIÓN DE UN DESMONTE SITUADO EN
ESTRIBO IZQUIERDO DE LA PRESA DE BARRENDIOLA
- LEGAZPI -**

INDICE

1.- Introducción

ANEXO

A-1- Cálculos

1.- INTRODUCCIÓN

En el presente anejo Cálculos se presentan los diferentes cálculos realizados para el dimensionado del sistema de sostenimiento del **"Proyecto de construcción. Estabilización de un desmonte situado en estribo izquierdo de la presa de Barrendiola – LEGAZPI"**.

A-1 – Cálculos

- Estabilidad de ladera
- Diseño de bulones

ESTABILIDAD DE LADERA

– ANÁLISIS DE CUÑAS – CAÍDAS PLANARES

Programa **DIPS v5.1, MARKLAND 3.0 y SWEDGE v5.0**

Método de cálculo: Hoek & Bray (1.974 – 1.981)

CÁLCULOS DE ESTABILIDAD ESTRUCTURAL

DIAGRAMA DE FRACTURACIÓN. RED POLAR EQUIAREAL

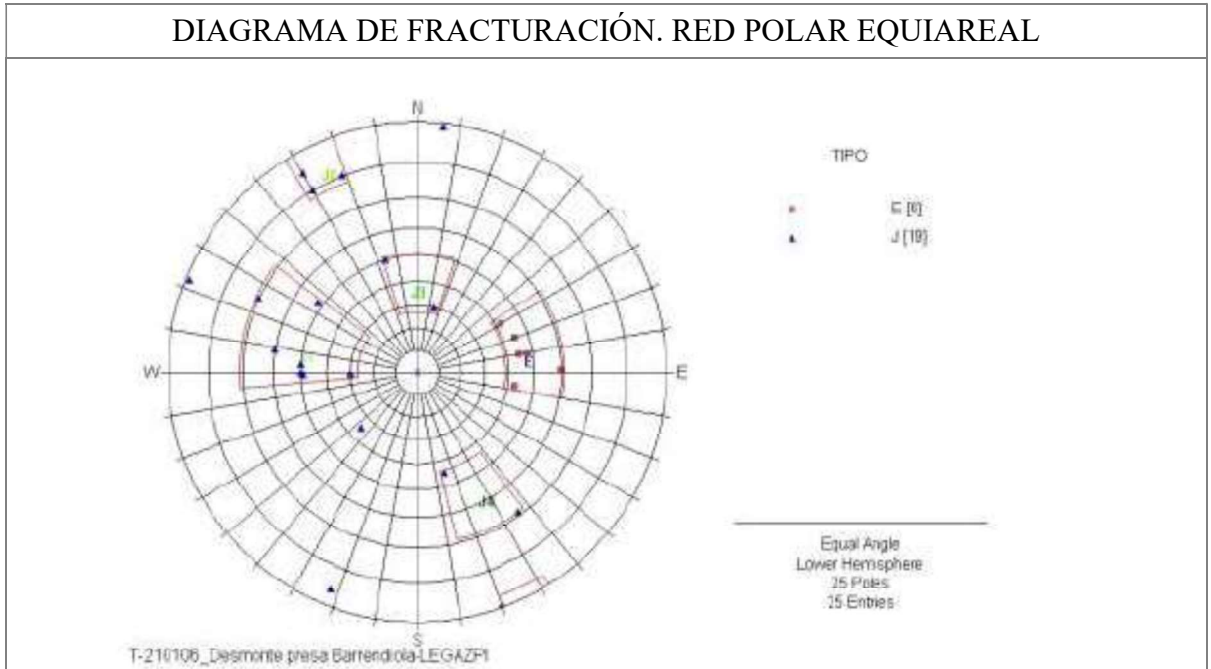
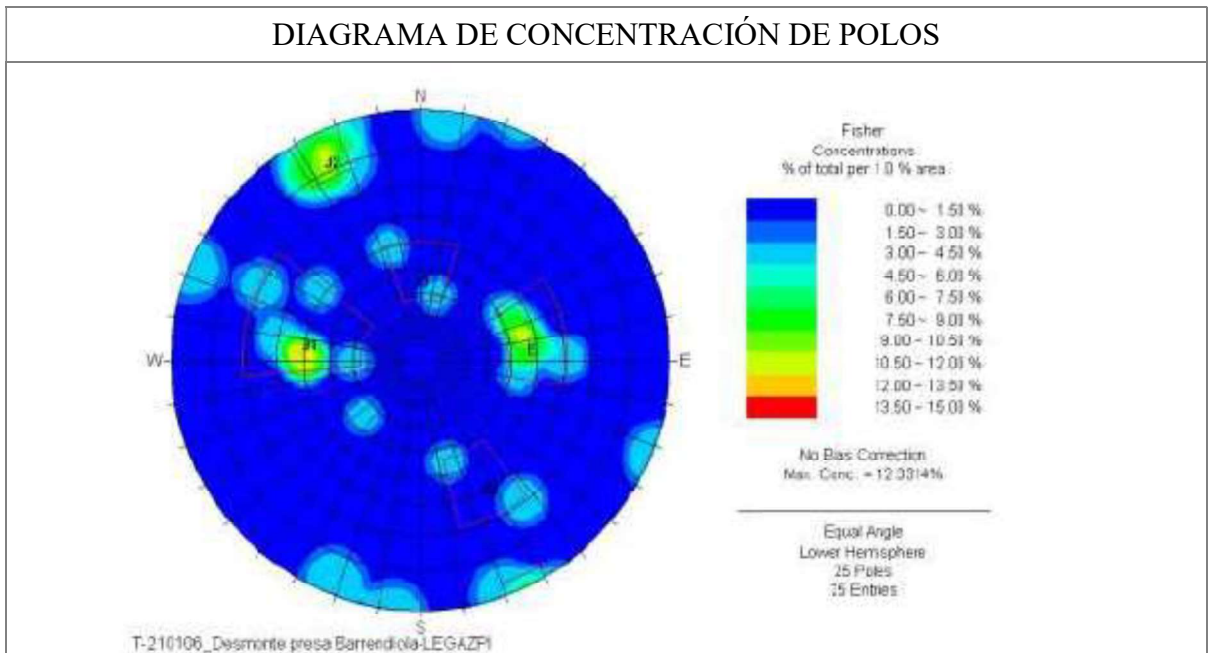
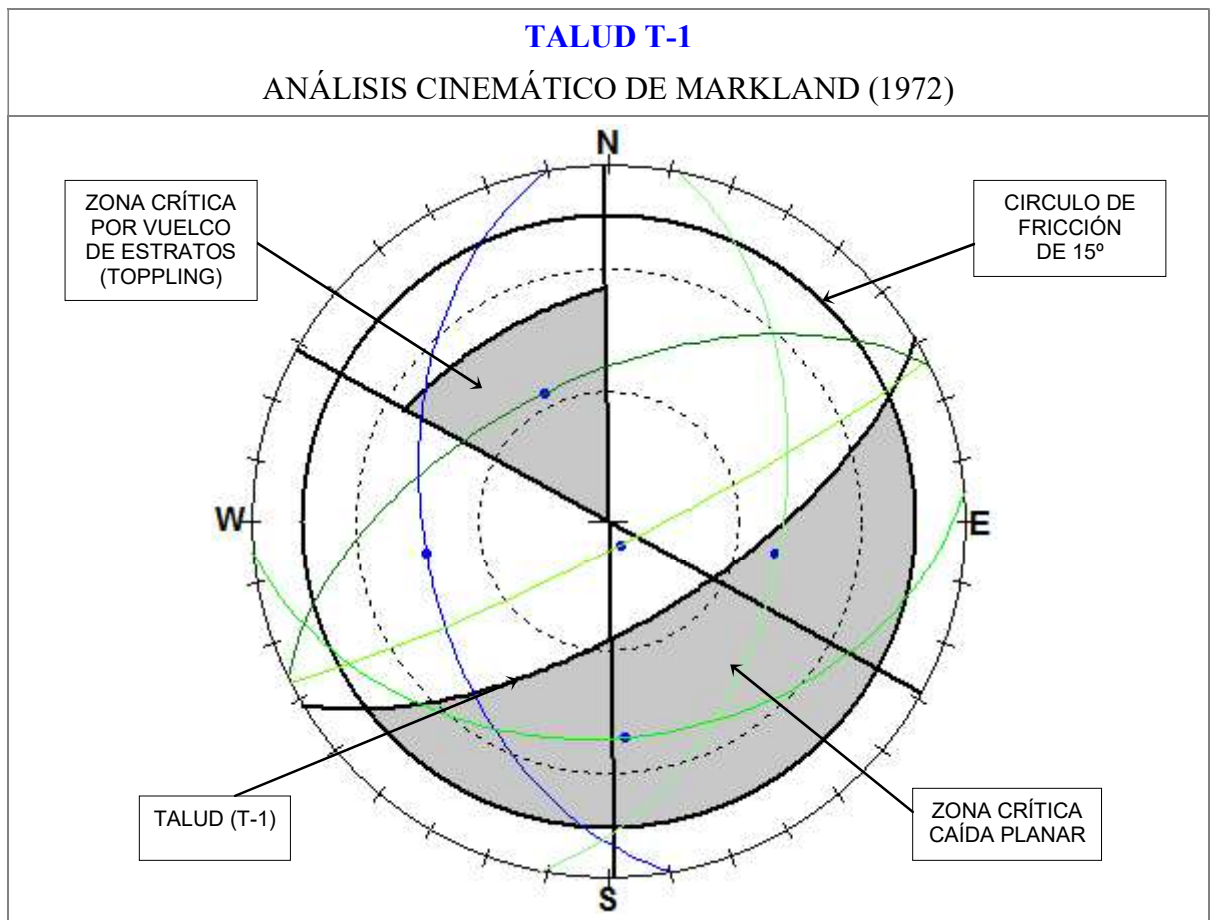
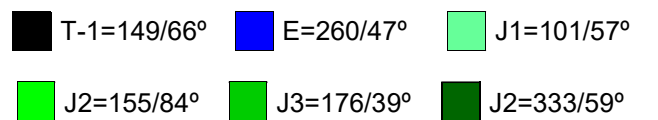


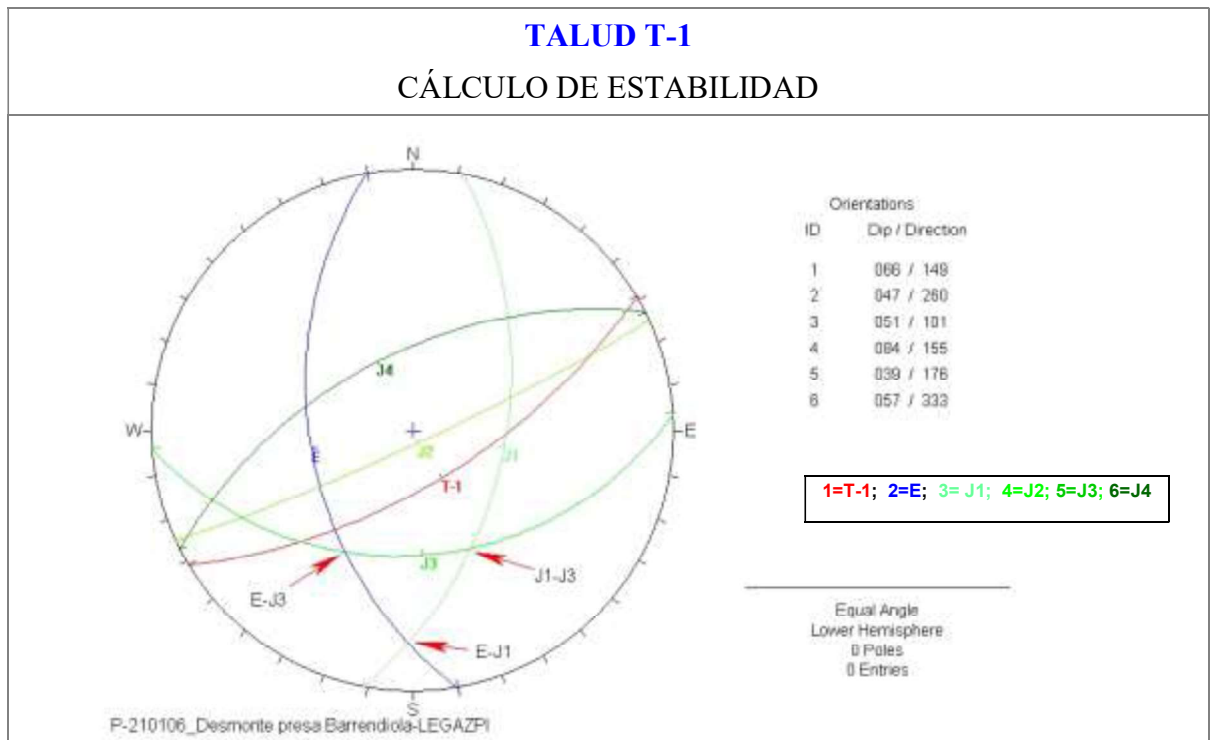
DIAGRAMA DE CONCENTRACIÓN DE POLOS





FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

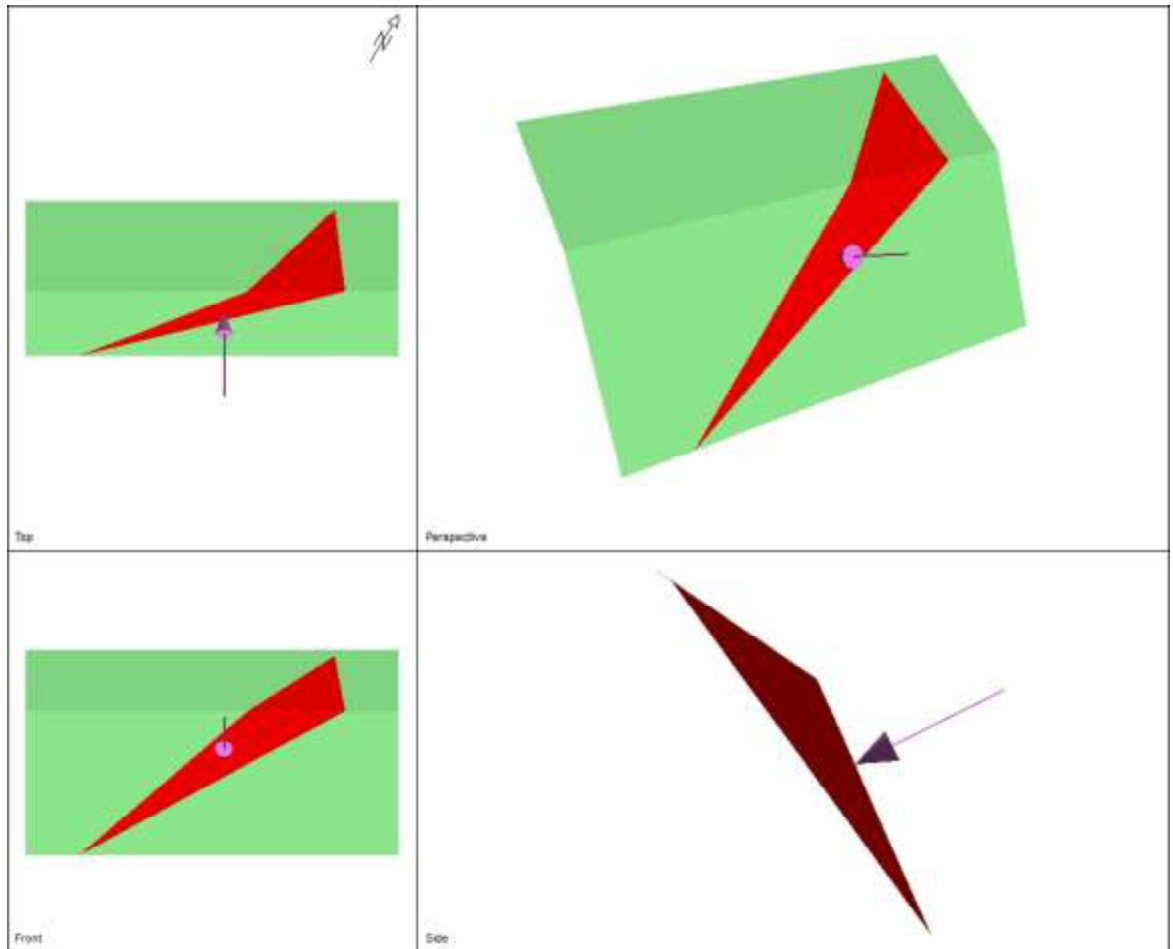
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-1	$E \cap J3$	Bloque a través de J3	0,71	53°	$2,00 \text{ t/m}^2$
T-1	$J1 \cap J3$	Cuña a través de intersección	0,84	36°	$1,46 \text{ t/m}^2$

CONCLUSIONES

- Talud estructural estable en roca sana: 36°

TALUD T-1. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.4996
- Wedge height (on slope) [m]: 11.00
- Bench width (on upper face) [m]: 6.28
- Wedge volume [m³]: 59.923
- Wedge weight [tonnes]: 155.800
- Wedge area (joint1) [m²]: 35.38
- Wedge area (joint2) [m²]: 84.55
- Wedge area (slope) [m²]: 44.80
- Wedge area (upper face) [m²]: 28.17

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	2.24	198.49
Effective Normal stress [t/m^2]	0.06	2.35
Shear Strength [t/m^2]	0.02	1.36
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 76.82
- Resisting force [tonnes]: 115.20

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	27.16

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	17.62	10.07
Joint 2	23.61	7.61

Persistence:

- Joint 1 [m]: 27.16
- Joint 2 [m]: 27.16

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	12.44	47.30
Joint 1 & Crest	136.90	48.76
Joint 2 & Crest	30.66	83.95

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	66.00	149.00
Upper Face	34.00	149.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 11.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	329.00	89.70

Resultant:

- Trend [deg]: 329.00
- Plunge [deg]: 26.50
- Force [tonnes]: 89.70

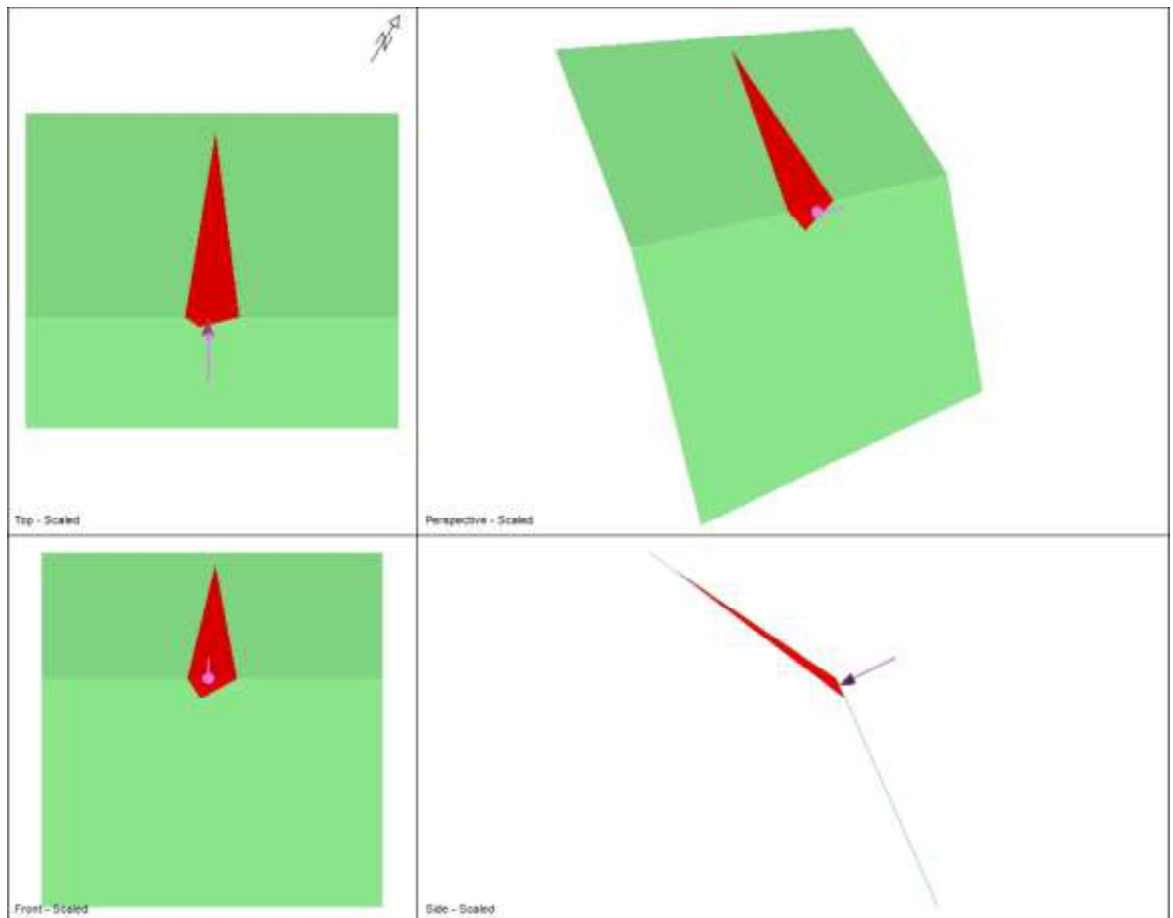
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	8.5071312101	10.8252053155	11.0000000000
234	14.8859120458	14.6579635171	11.0000000000
123	10.9647374778	19.6252368152	15.2341182447

TALUD T-1. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.0864
- Safety Factor: 1.5004
- Wedge height (on slope) [m]: 0.95
- Bench width (on upper face) [m]: 8.21
- Wedge volume [m³]: 2.193
- Wedge weight [tonnes]: 5.701
- Wedge area (joint1) [m²]: 4.73
- Wedge area (joint2) [m²]: 9.56
- Wedge area (slope) [m²]: 1.25
- Wedge area (upper face) [m²]: 11.93

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	2.04	4.72
Effective Normal stress [t/m^2]	0.43	0.49
Shear Strength [t/m^2]	0.25	0.29
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 2.60
- Resisting force [tonnes]: 3.91

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	10.83

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	1.23	10.00
Joint 2	2.04	9.96

Persistence:

- Joint 1 [m]: 10.83
- Joint 2 [m]: 10.83

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	91.52	13.86
Joint 1 & Crest	57.82	82.19
Joint 2 & Crest	30.66	83.95

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	66.00	149.00
Upper Face	34.00	149.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 11.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	329.00	1.83

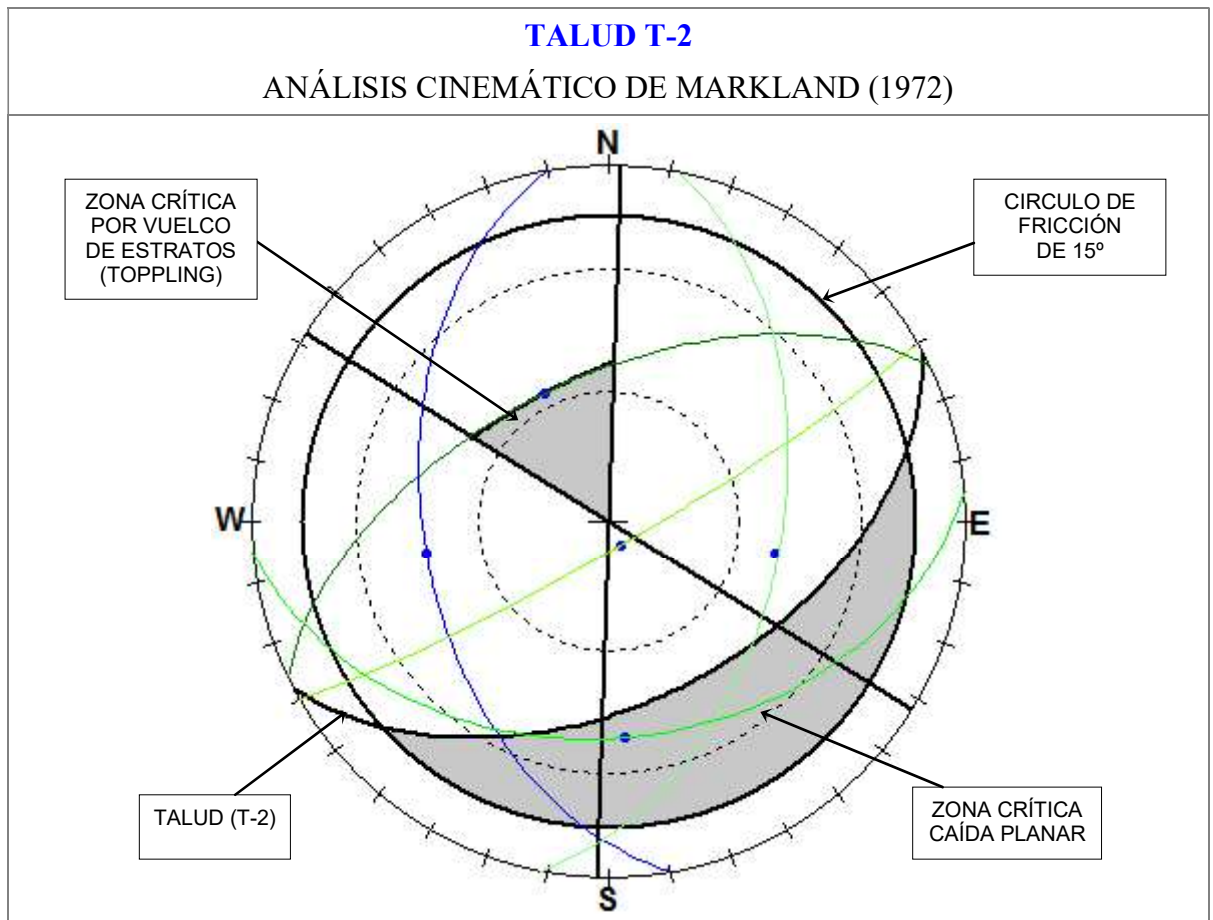
Resultant:

- Trend [deg]: 329.00
- Plunge [deg]: 26.50
- Force [tonnes]: 1.82

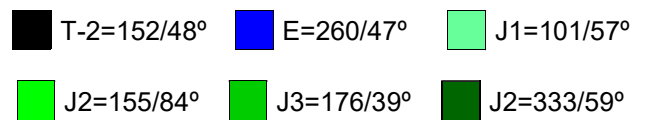
Wedge Vertices:

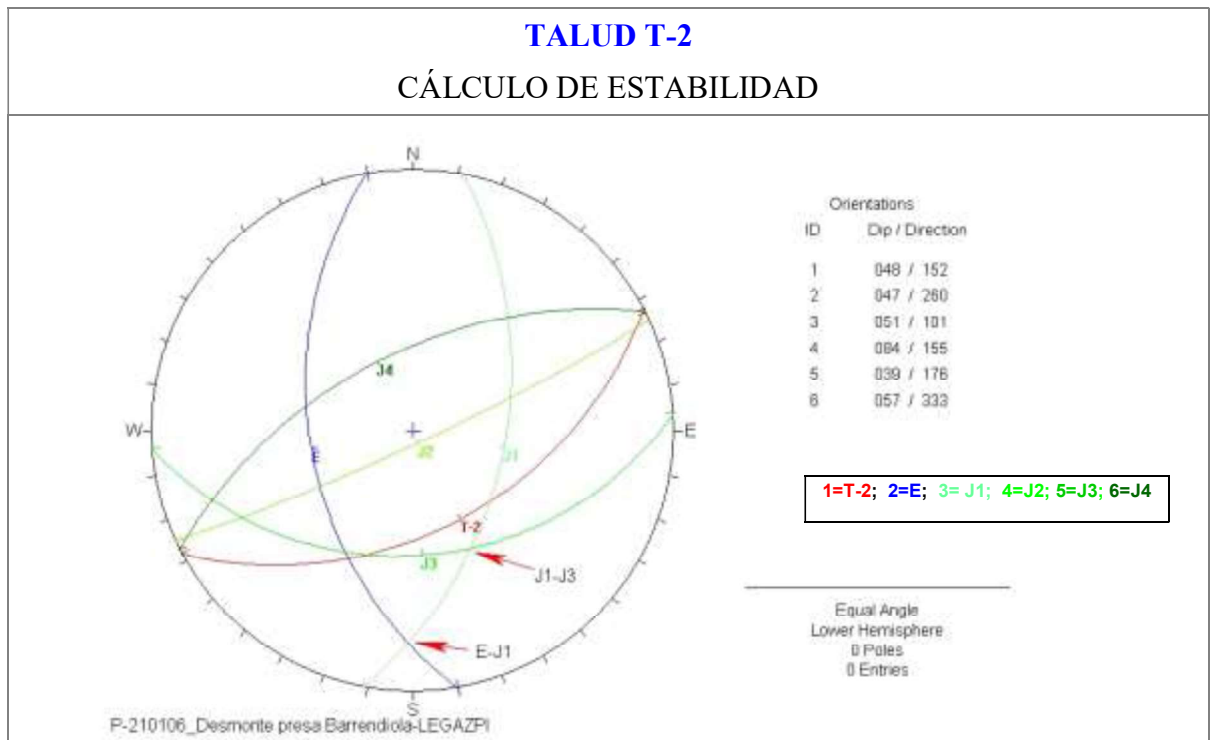
- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-0.7789423349	0.0255471363	0.9502602696
234	1.2859537085	1.2662618512	0.9502602696
123	-3.8446594833	7.7656302086	6.4903408106



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $U = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

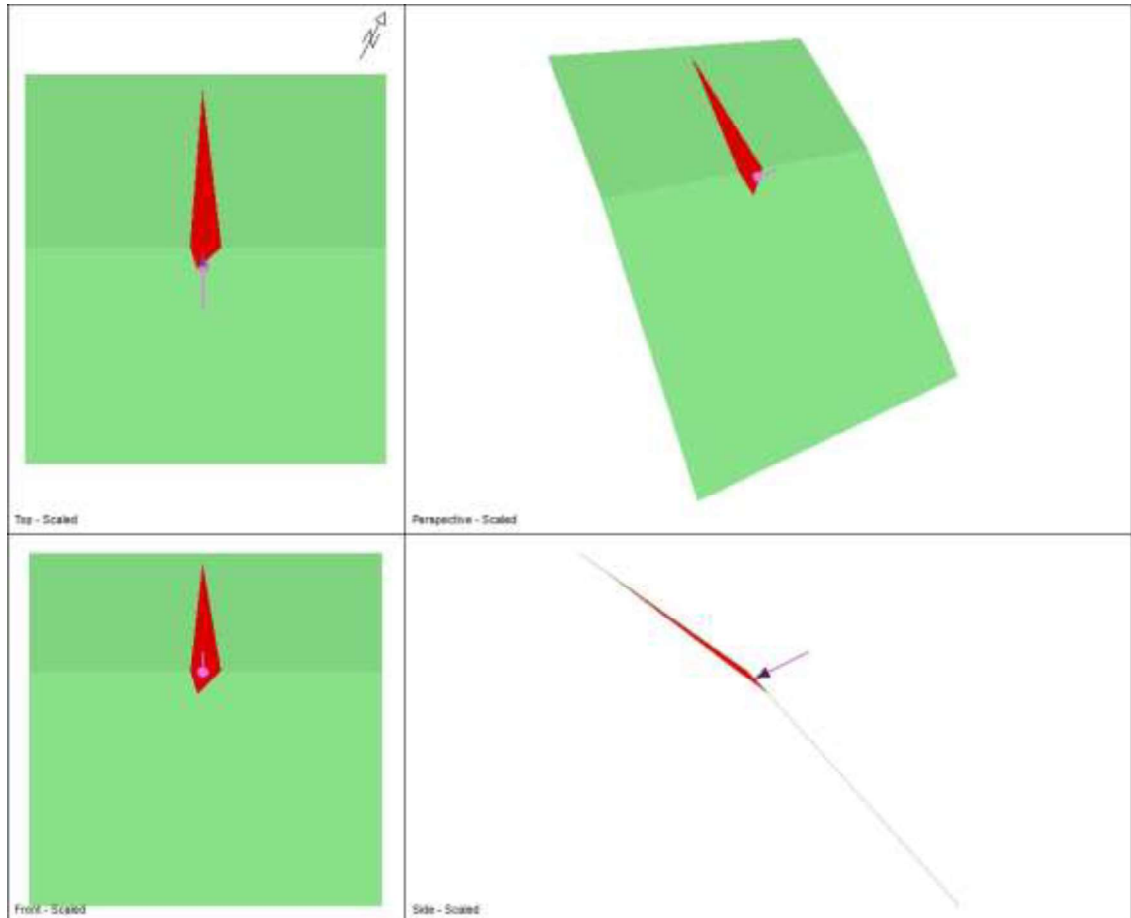
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-2	J1 \cap J3	Cuña a través de intersección	0,84	36°	1,00 t/m ²

CONCLUSIONES

- Talud estructural estable en roca sana: 36°

TALUD T-2. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.0987
- Safety Factor: 1.4998
- Wedge height (on slope) [m]: 1.97
- Bench width (on upper face) [m]: 13.08
- Wedge volume [m³]: 4.166
- Wedge weight [tonnes]: 10.833
- Wedge area (joint1) [m²]: 7.90
- Wedge area (joint2) [m²]: 18.64
- Wedge area (slope) [m²]: 3.48
- Wedge area (upper face) [m²]: 20.91

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	3.68	9.14
Effective Normal stress [t/m^2]	0.47	0.49
Shear Strength [t/m^2]	0.27	0.28
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 4.94
- Resisting force [tonnes]: 7.40

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	18.57

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	2.73	16.00
Joint 2	3.33	16.04

Persistence:

- Joint 1 [m]: 18.57
- Joint 2 [m]: 18.57

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	50.08	9.38
Joint 1 & Crest	76.91	86.24
Joint 2 & Crest	53.01	84.38

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	48.00	152.00
Upper Face	35.00	152.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 20.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	332.00	3.47

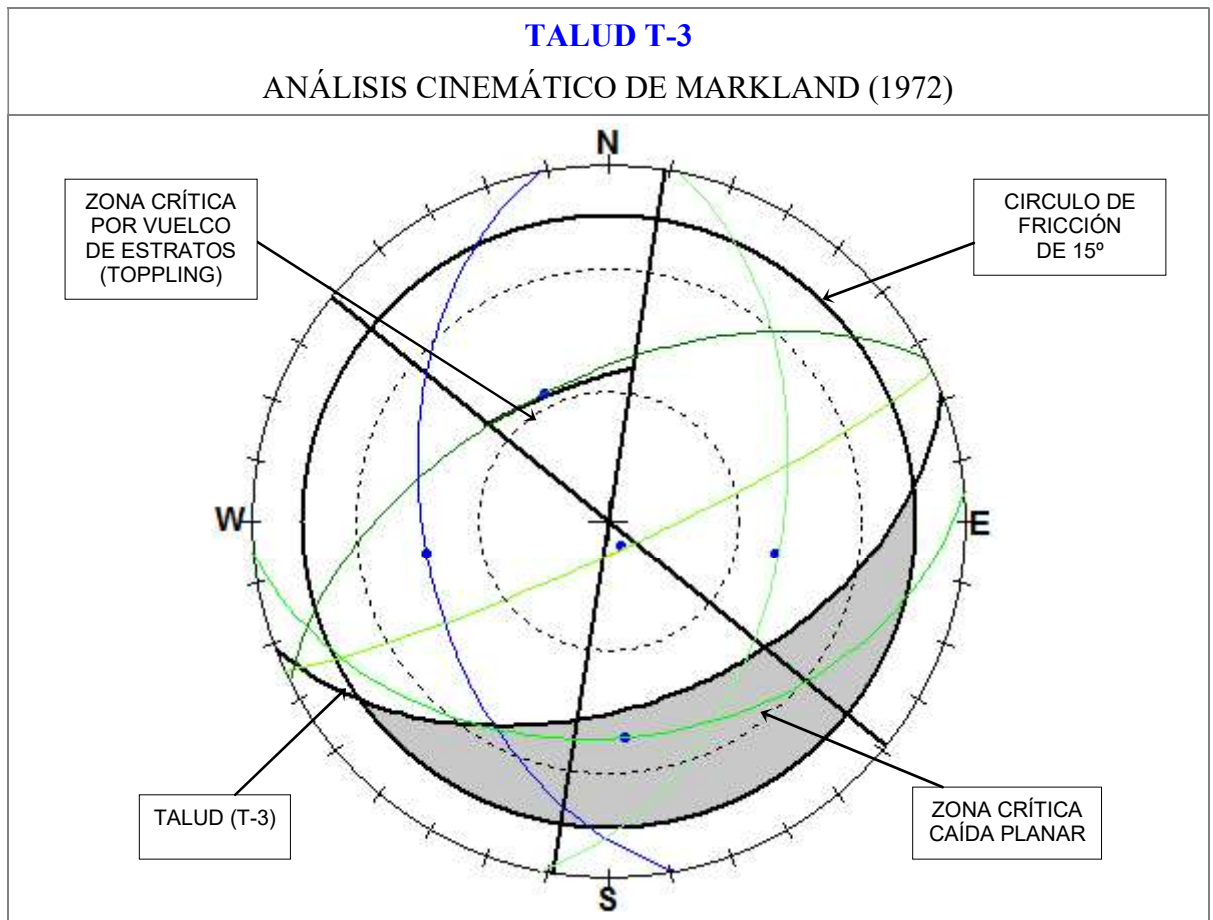
Resultant:

- Trend [deg]: 332.00
- Plunge [deg]: 26.50
- Force [tonnes]: 3.47

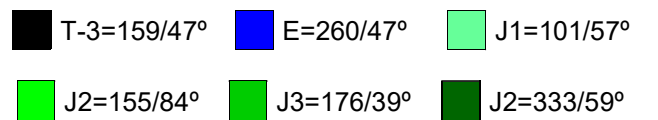
Wedge Vertices:

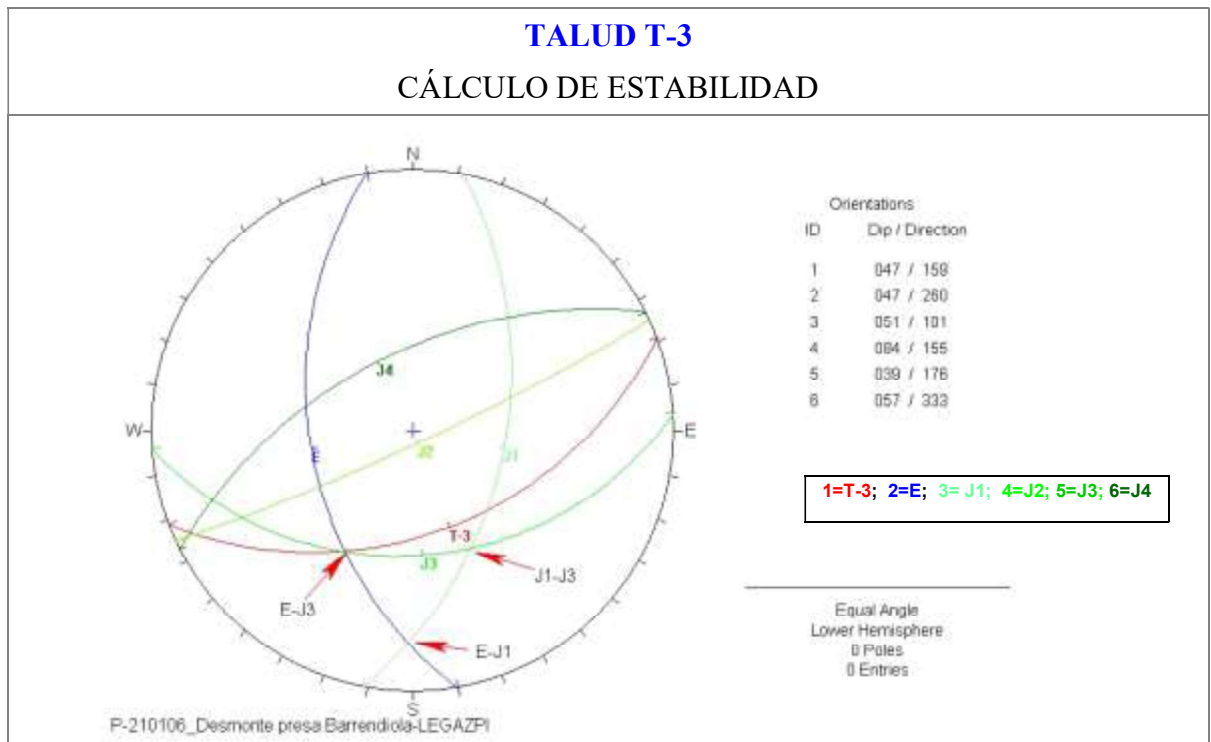
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-1.3801586375	1.2797928332	1.9745971213
234	0.9327820880	2.5096052319	1.9745971213
123	-6.5942782219	13.3194438641	11.1320945968



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

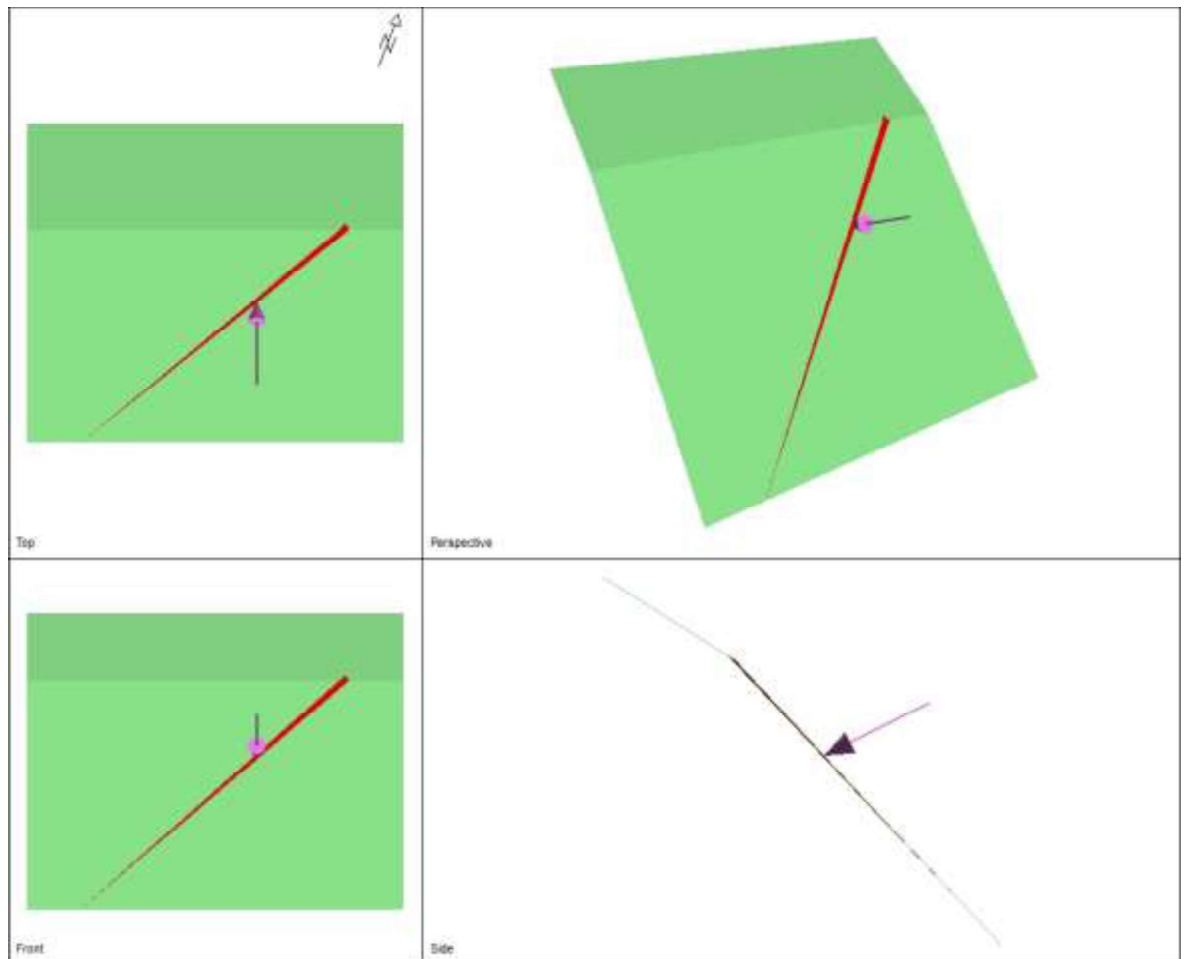
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-3	$E \cap J3$	Bloque a través de J3	0,71	46°	0,10 t/m ²
T-3	$J1 \cap J3$	Cuña a través de intersección	0,84	36°	1,46 t/m ²

CONCLUSIONES

- Talud estructural estable en roca sana: 36°

TALUD T-3. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.5007
- Wedge height (on slope) [m]: 14.00
- Bench width (on upper face) [m]: 0.42
- Wedge volume [m³]: 0.241
- Wedge weight [tonnes]: 0.628
- Wedge area (joint1) [m²]: 1.70
- Wedge area (joint2) [m²]: 6.63
- Wedge area (slope) [m²]: 5.68
- Wedge area (upper face) [m²]: 0.15

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	0.75
Effective Normal stress [t/m^2]	0.00	0.11
Shear Strength [t/m^2]	0.00	0.07
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 0.29
- Resisting force [tonnes]: 0.44

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	25.42

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	24.84	0.59
Joint 2	25.23	0.56

Persistence:

- Joint 1 [m]: 25.42
- Joint 2 [m]: 25.42

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	1.04	61.93
Joint 1 & Crest	129.60	56.25
Joint 2 & Crest	49.36	61.83

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	47.00	159.00
Upper Face	32.00	159.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 14.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	339.00	0.30

Resultant:

- Trend [deg]: 339.00
- Plunge [deg]: 26.50
- Force [tonnes]: 0.30

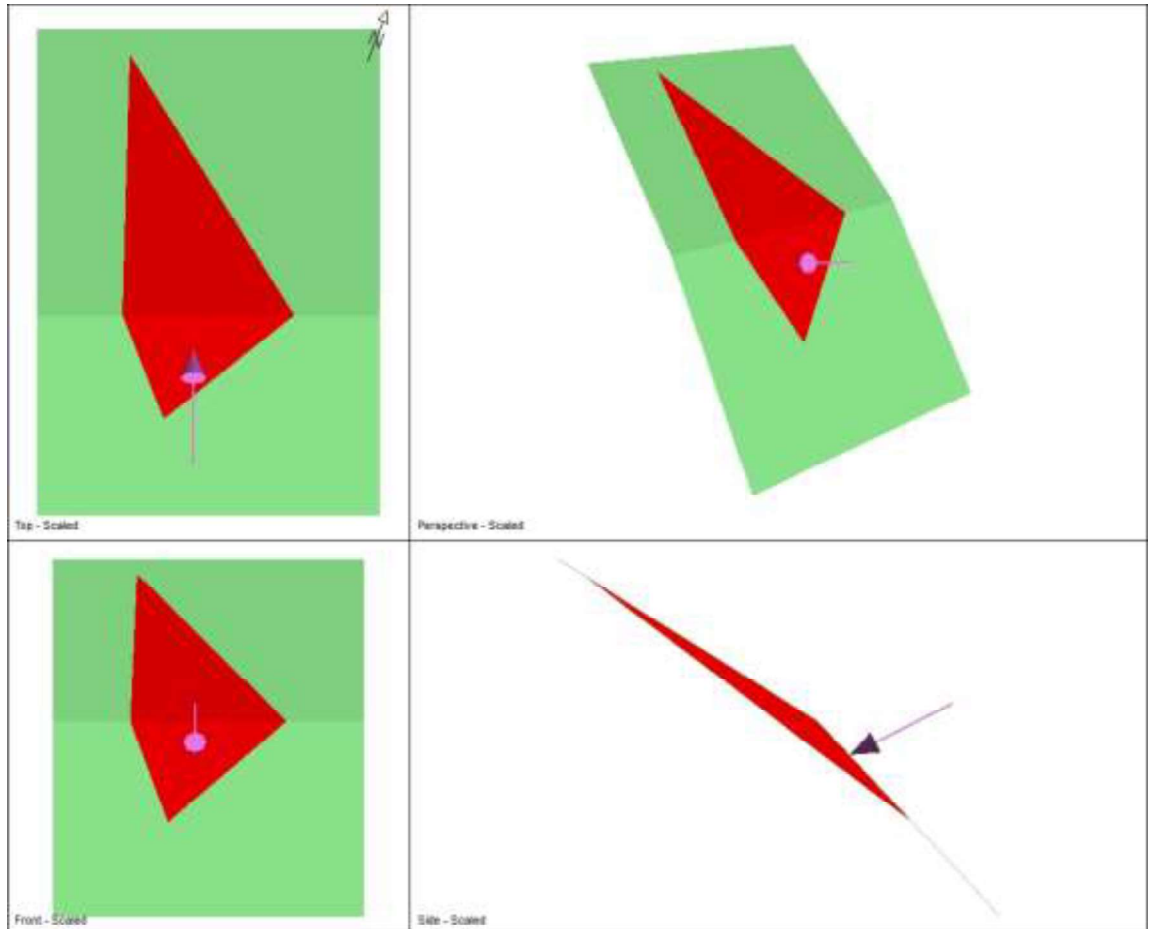
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	10.1067657640	17.8636480114	14.0000000000
234	10.6605802790	18.0762374858	14.0000000000
123	10.2644261076	18.3717844172	14.2611240217

TALUD T-3. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.5169
- Safety Factor: 1.4999
- Wedge height (on slope) [m]: 7.24
- Bench width (on upper face) [m]: 16.96
- Wedge volume [m³]: 95.481
- Wedge weight [tonnes]: 248.249
- Wedge area (joint1) [m²]: 38.85
- Wedge area (joint2) [m²]: 139.16
- Wedge area (slope) [m²]: 55.35
- Wedge area (upper face) [m²]: 111.84

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	73.90	219.05
Effective Normal stress [t/m^2]	1.90	1.57
Shear Strength [t/m^2]	1.10	0.91
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 112.77
- Resisting force [tonnes]: 169.14

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	29.75

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	10.26	20.00
Joint 2	13.04	22.68

Persistence:

- Joint 1 [m]: 29.75
- Joint 2 [m]: 29.75

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	55.87	29.54
Joint 1 & Crest	74.77	88.63
Joint 2 & Crest	49.36	61.83

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	47.00	159.00
Upper Face	32.00	159.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 14.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	339.00	80.90

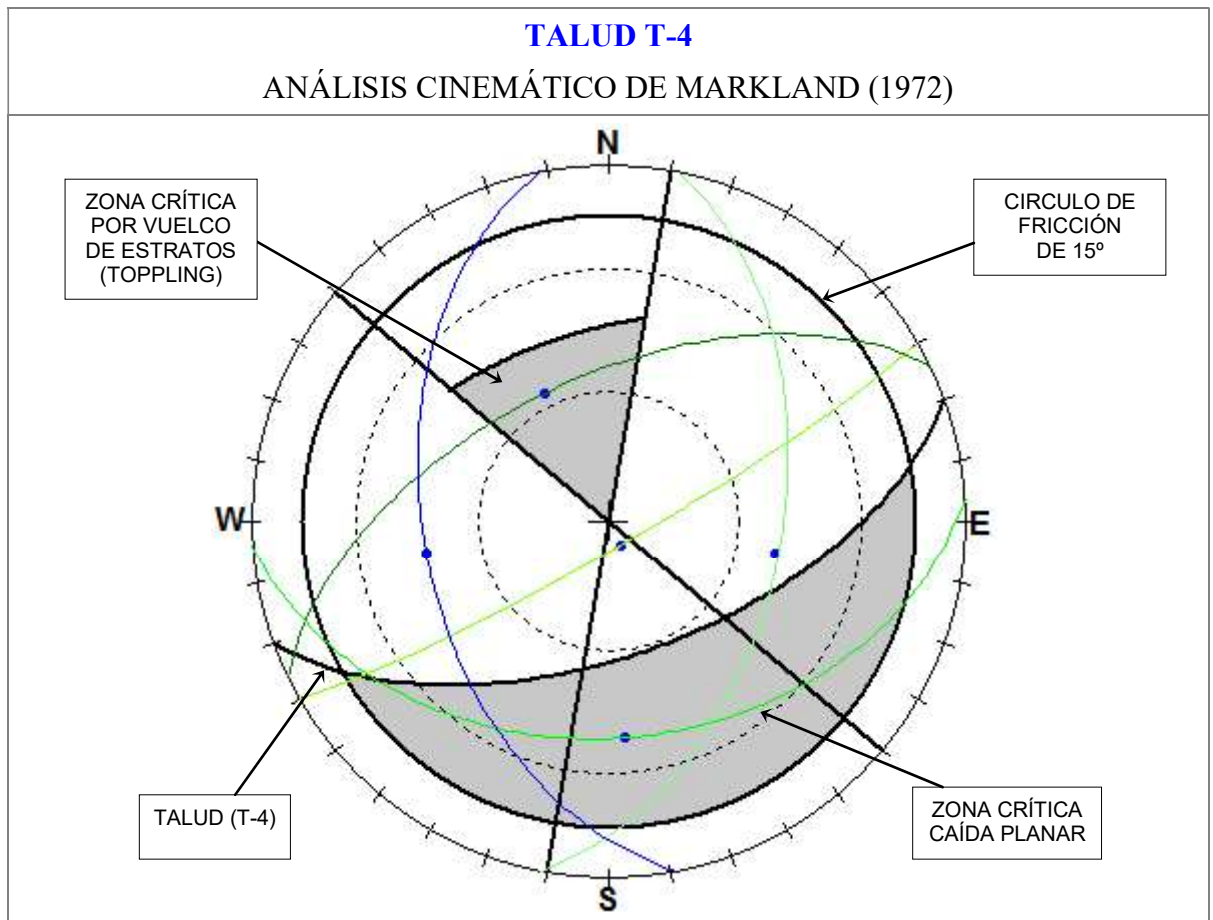
Resultant:

- Trend [deg]: 339.00
- Plunge [deg]: 26.50
- Force [tonnes]: 80.90

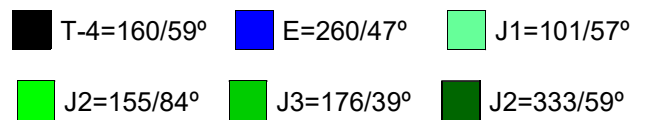
Wedge Vertices:

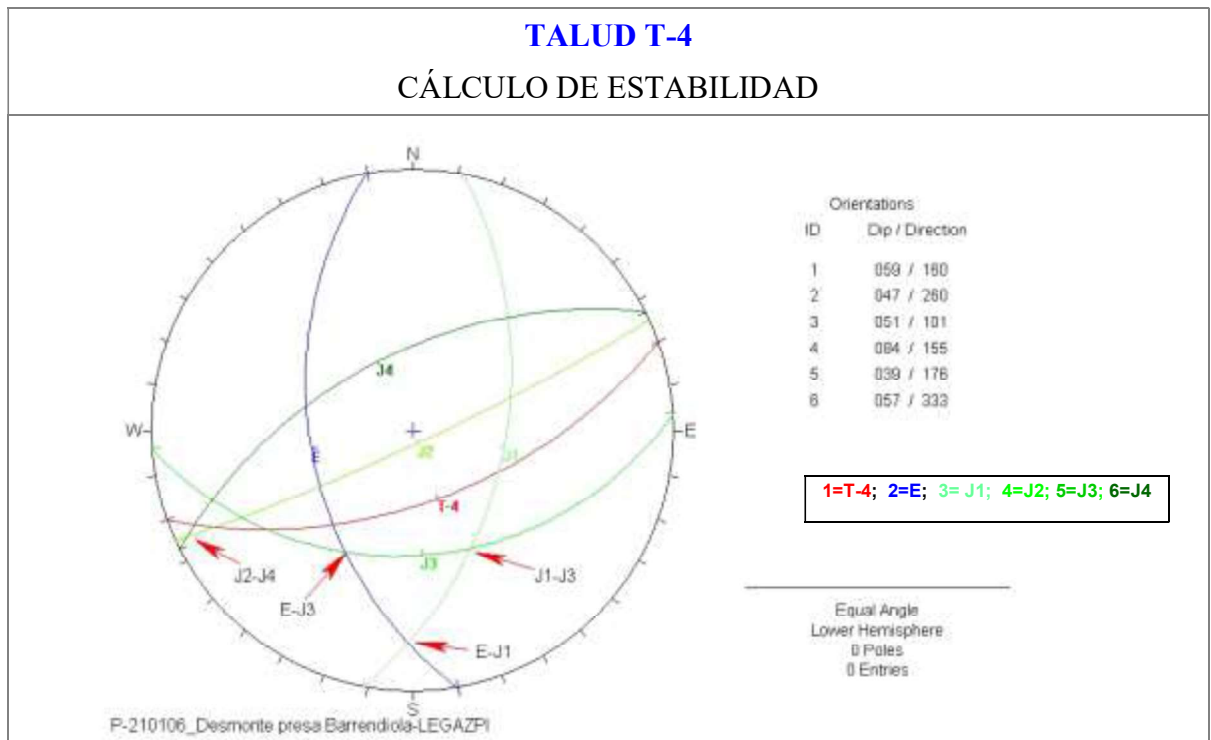
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-4.9331971009	5.3352770527	7.2372126268
234	5.5109204432	9.3443981555	7.2372126268
123	-10.5634141971	21.3364977449	17.8325697142



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

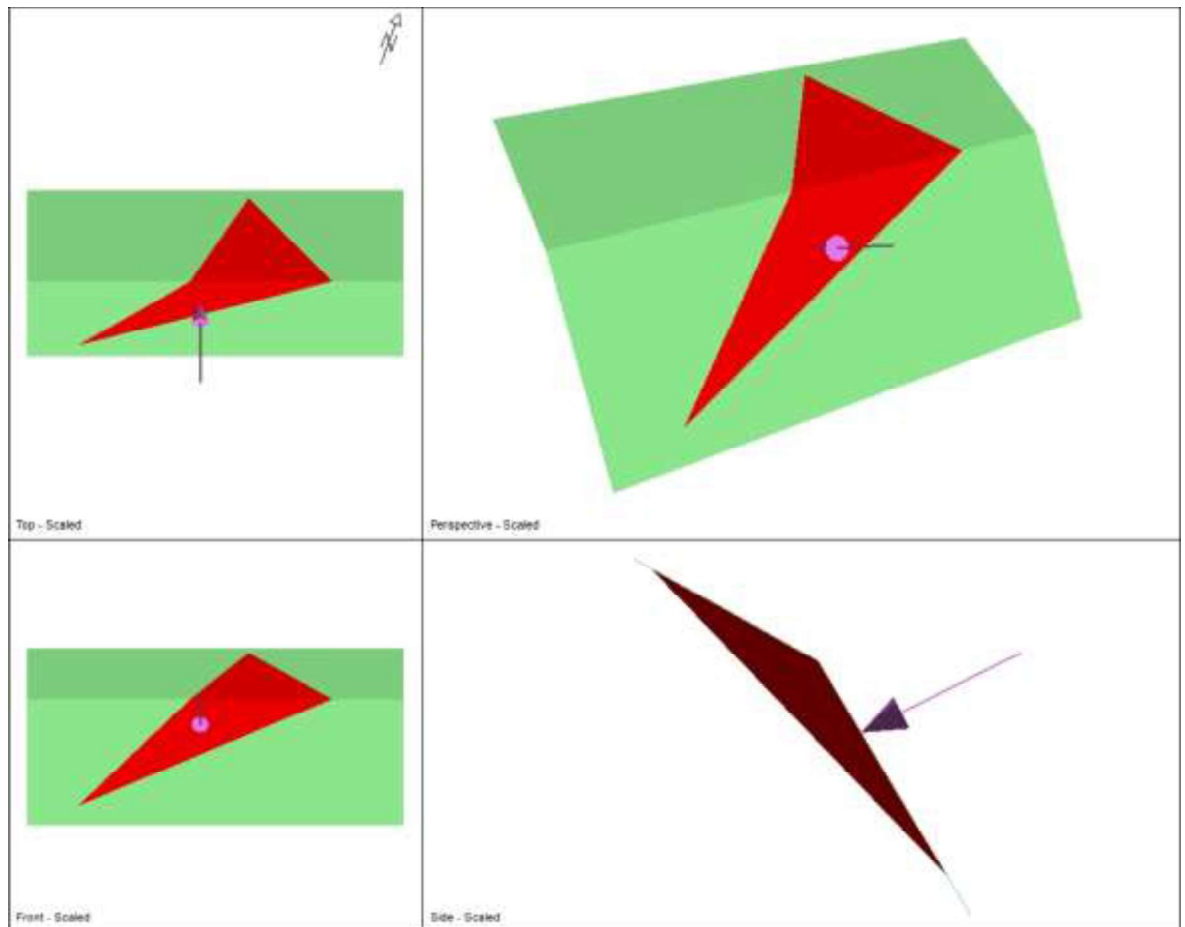
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-4	$E \cap J3$	Bloque a través de J3	0,71	46°	2,33 t/m ²
T-4	$J1 \cap J3$	Cuña a través de intersección	0,84	37°	2,12 t/m ²

CONCLUSIONES

- Talud estructural estable en roca sana: 37°

TALUD T-4. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.8485
- Safety Factor: 1.5000
- Wedge height (on slope) [m]: 12.73
- Bench width (on upper face) [m]: 9.94
- Wedge volume [m³]: 238.360
- Wedge weight [tonnes]: 619.737
- Wedge area (joint1) [m²]: 58.57
- Wedge area (joint2) [m²]: 243.20
- Wedge area (slope) [m²]: 125.84
- Wedge area (upper face) [m²]: 96.32

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	742.07
Effective Normal stress [t/m^2]	0.00	3.05
Shear Strength [t/m^2]	0.00	1.76
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 285.62
- Resisting force [tonnes]: 428.44

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	32.51

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	20.00	13.33
Joint 2	33.79	15.13

Persistence:

- Joint 1 [m]: 32.51
- Joint 2 [m]: 33.79

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	21.87	72.81
Joint 1 & Crest	132.07	58.48
Joint 2 & Crest	26.07	48.71

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	59.00	160.00
Upper Face	29.00	160.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 15.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	340.00	293.25

Resultant:

- Trend [deg]: 340.00
- Plunge [deg]: 26.50
- Force [tonnes]: 293.25

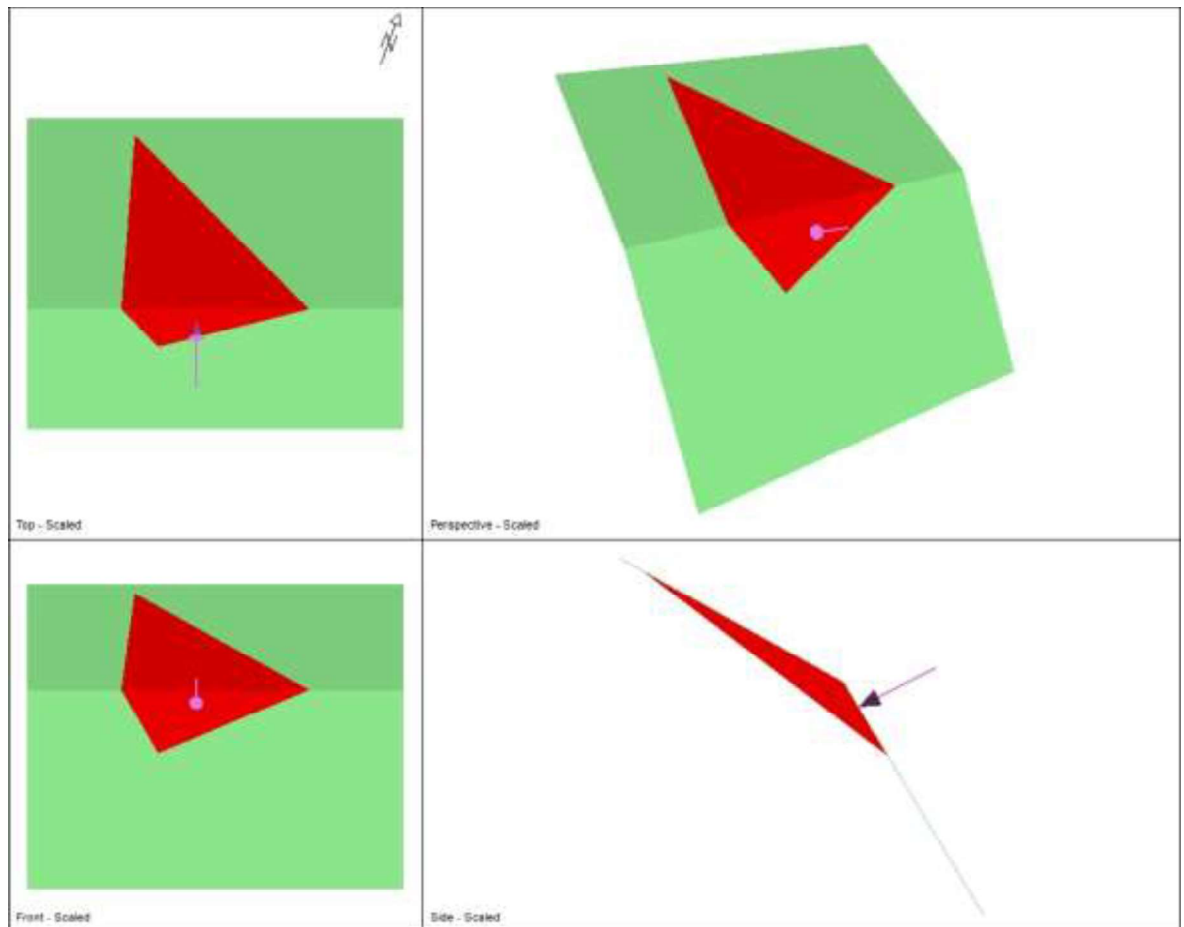
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	9.9759677858	11.7688362316	12.7269226638
234	25.9041253006	17.5662114536	12.7269226638
123	13.1259797193	23.4935365250	18.2368914463

TALUD T-4. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.3179
- Safety Factor: 1.4999
- Wedge height (on slope) [m]: 4.77
- Bench width (on upper face) [m]: 13.09
- Wedge volume [m³]: 98.177
- Wedge weight [tonnes]: 255.260
- Wedge area (joint1) [m²]: 31.24
- Wedge area (joint2) [m²]: 119.97
- Wedge area (slope) [m²]: 39.36
- Wedge area (upper face) [m²]: 105.90

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	74.42	226.72
Effective Normal stress [t/m^2]	2.38	1.89
Shear Strength [t/m^2]	1.38	1.09
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 115.92
- Resisting force [tonnes]: 173.86

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	20.06

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	6.22	15.00
Joint 2	12.66	19.92

Persistence:

- Joint 1 [m]: 20.06
- Joint 2 [m]: 20.06

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	90.51	45.15
Joint 1 & Crest	63.42	86.14
Joint 2 & Crest	26.07	48.71

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	59.00	160.00
Upper Face	29.00	160.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 15.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	340.00	83.50

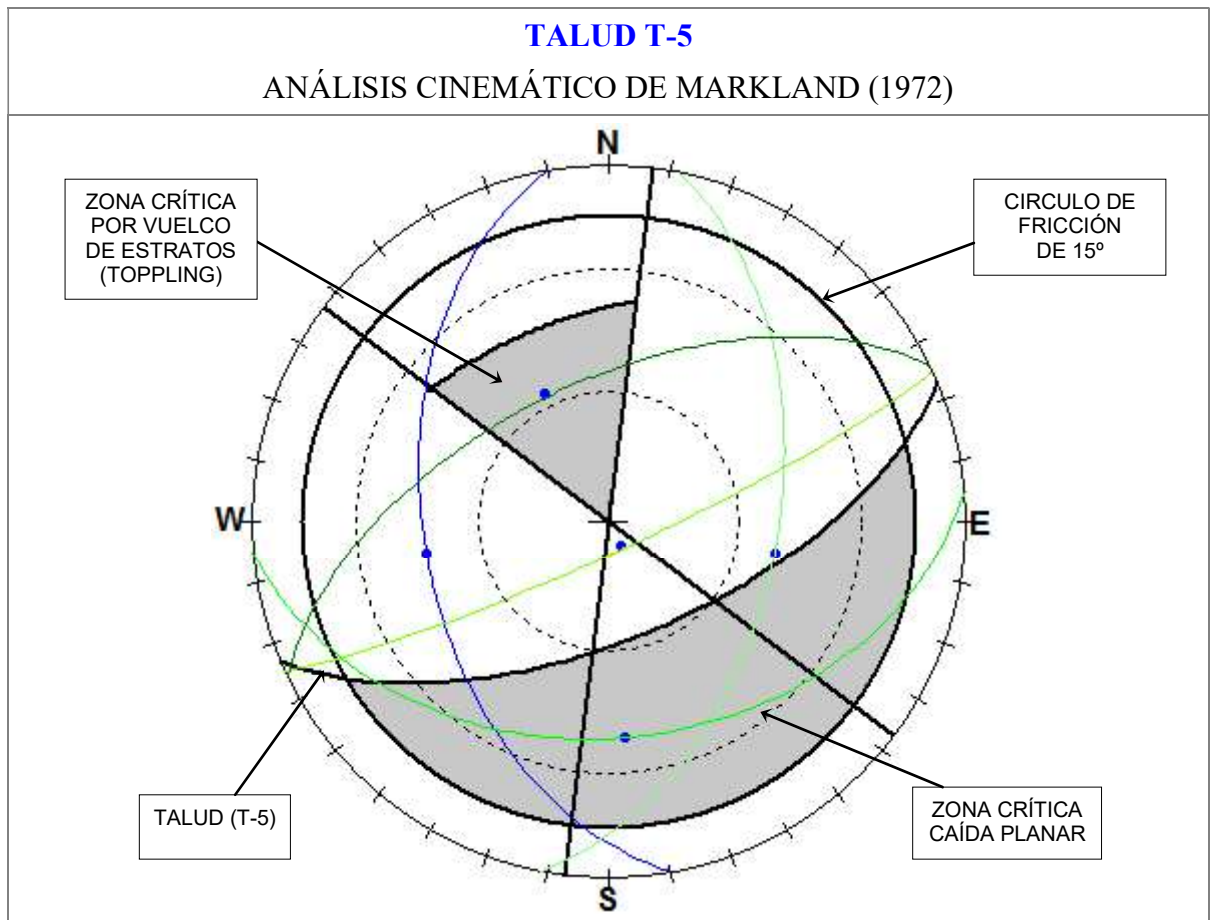
Resultant:

- Trend [deg]: 340.00
- Plunge [deg]: 26.50
- Force [tonnes]: 83.50

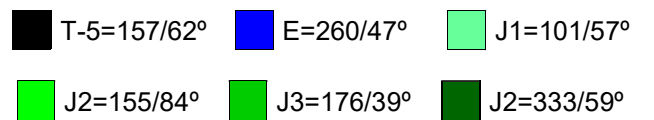
Wedge Vertices:

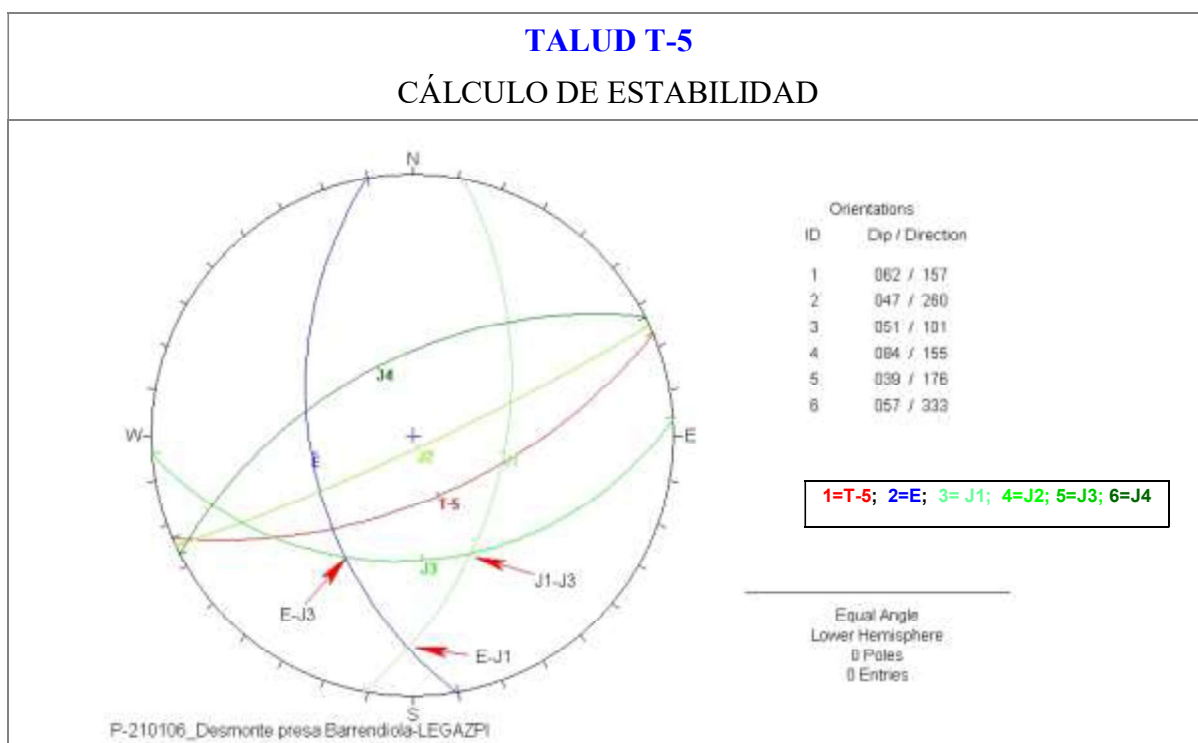
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-3.5948709497	1.7401968025	4.7677752223
234	9.7042348748	6.5806754649	4.7677752223
123	-7.1222586866	14.3858844848	12.0234019212



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

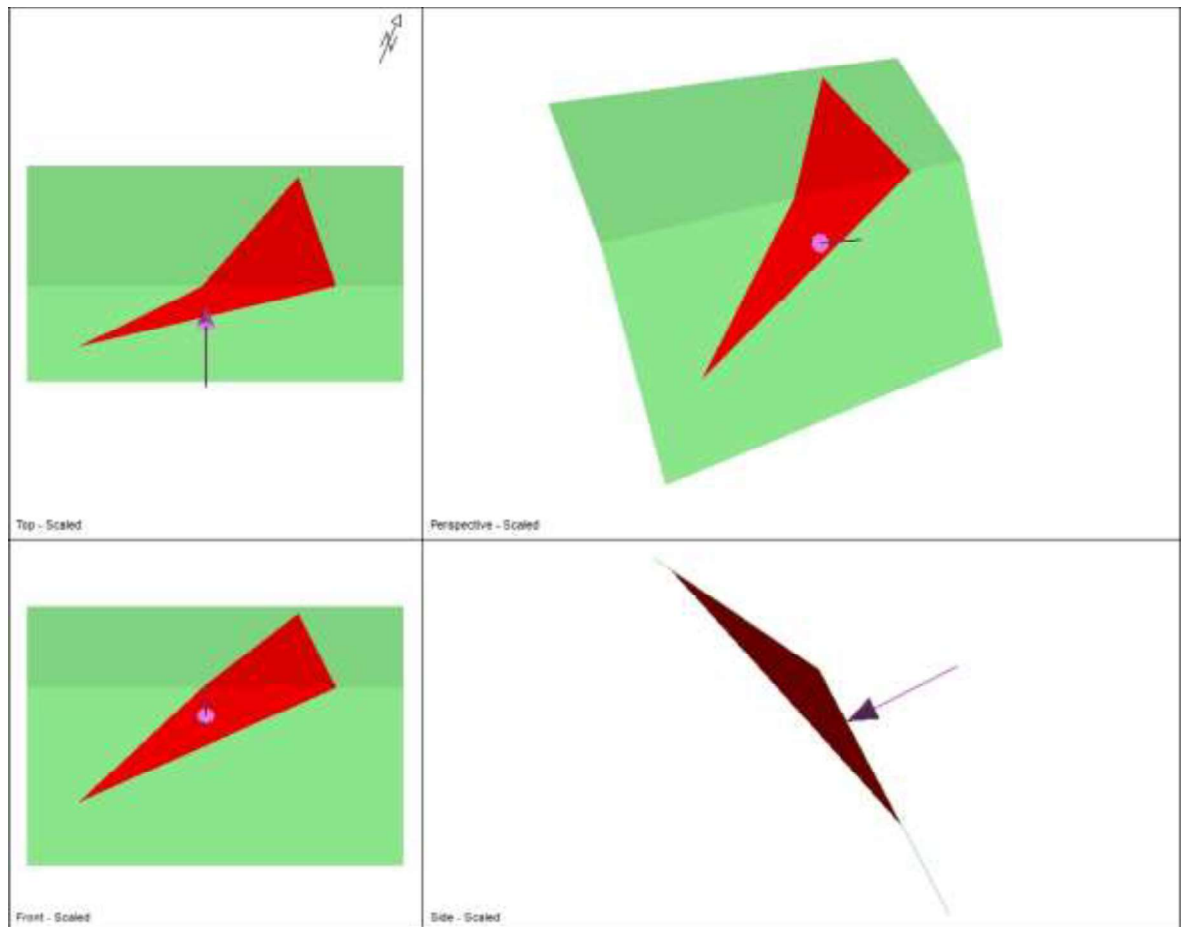
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-5	$E \cap J3$	Bloque a través de J3	0,71	47°	2,22 t/m ²
T-5	$J1 \cap J3$	Cuña a través de intersección	0,84	36°	1,97 t/m ²

CONCLUSIONES

- Talud estructural estable en roca sana: 36°

TALUD T-5. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.6390
- Safety Factor: 1.5002
- Wedge height (on slope) [m]: 9.59
- Bench width (on upper face) [m]: 9.17
- Wedge volume [m³]: 105.285
- Wedge weight [tonnes]: 273.740
- Wedge area (joint1) [m²]: 39.55
- Wedge area (joint2) [m²]: 137.57
- Wedge area (slope) [m²]: 60.83
- Wedge area (upper face) [m²]: 61.97

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	331.53
Effective Normal stress [t/m^2]	0.00	2.41
Shear Strength [t/m^2]	0.00	1.39
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 127.59
- Resisting force [tonnes]: 191.41

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	28.11

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	15.00	13.67
Joint 2	24.14	11.51

Persistence:

- Joint 1 [m]: 28.11
- Joint 2 [m]: 28.11

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	19.64	52.00
Joint 1 & Crest	133.63	54.00
Joint 2 & Crest	26.73	74.00

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	62.00	157.00
Upper Face	34.00	157.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 15.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	337.00	135.10

Resultant:

- Trend [deg]: 337.00
- Plunge [deg]: 26.50
- Force [tonnes]: 135.10

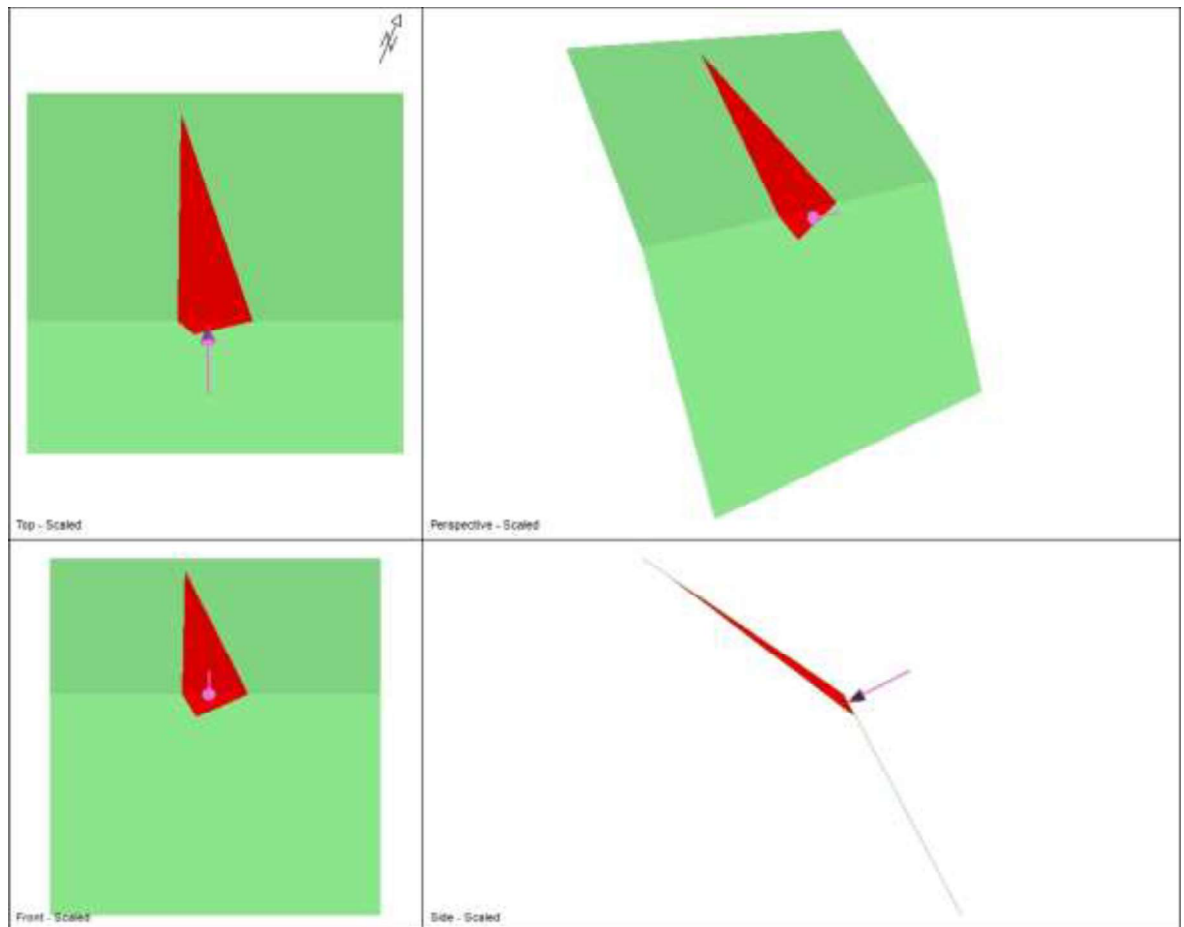
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	7.5363457345	8.7359756610	9.5857301349
234	17.8517713324	13.1146140458	9.5857301349
123	11.3507398558	20.3161232221	15.7704198097

TALUD T-5. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.1045
- Safety Factor: 1.4996
- Wedge height (on slope) [m]: 1.57
- Bench width (on upper face) [m]: 12.43
- Wedge volume [m³]: 9.364
- Wedge weight [tonnes]: 24.346
- Wedge area (joint1) [m²]: 9.70
- Wedge area (joint2) [m²]: 30.51
- Wedge area (slope) [m²]: 3.99
- Wedge area (upper face) [m²]: 33.70

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	7.54	21.20
Effective Normal stress [t/m^2]	0.78	0.70
Shear Strength [t/m^2]	0.45	0.40
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 11.07
- Resisting force [tonnes]: 16.60

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	16.61

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	2.02	15.00
Joint 2	3.95	15.60

Persistence:

- Joint 1 [m]: 16.61
- Joint 2 [m]: 16.61

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	91.89	16.74
Joint 1 & Crest	61.38	89.26
Joint 2 & Crest	26.73	74.00

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	62.00	157.00
Upper Face	34.00	157.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 15.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	337.00	7.88

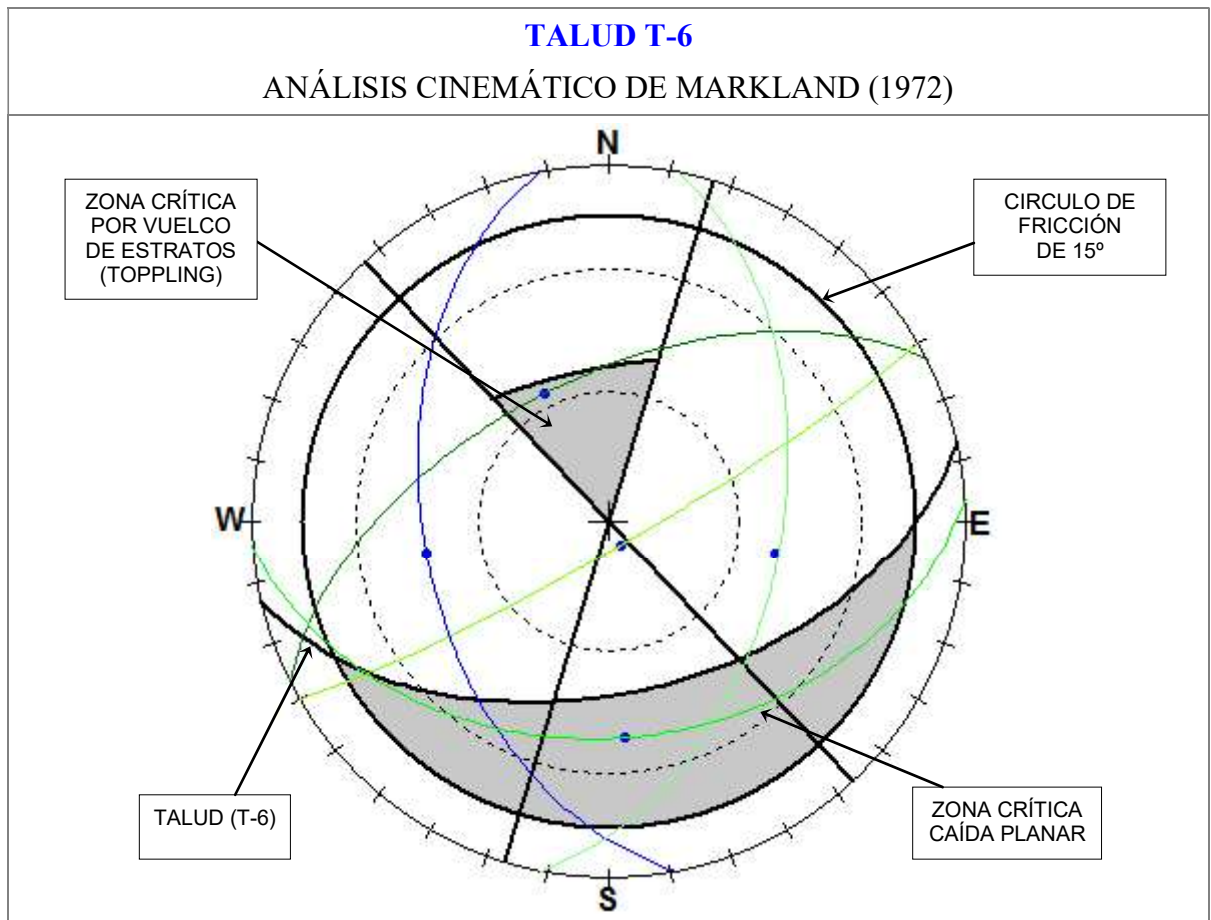
Resultant:

- Trend [deg]: 337.00
- Plunge [deg]: 26.50
- Force [tonnes]: 7.88

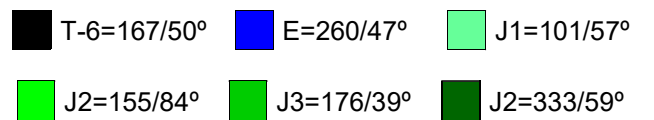
Wedge Vertices:

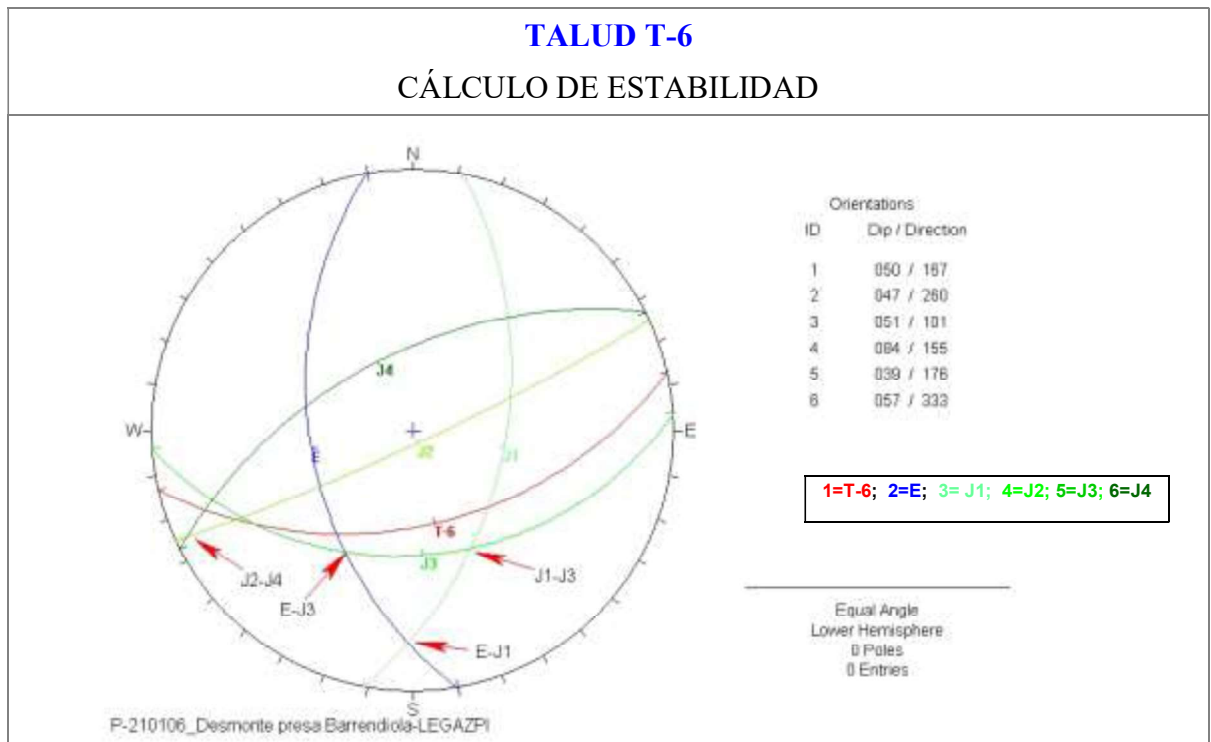
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-1.2176080266	0.3886266475	1.5675668398
234	2.9193232418	2.1446497873	1.5675668398
123	-5.8968607725	11.9107661810	9.9547531564



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

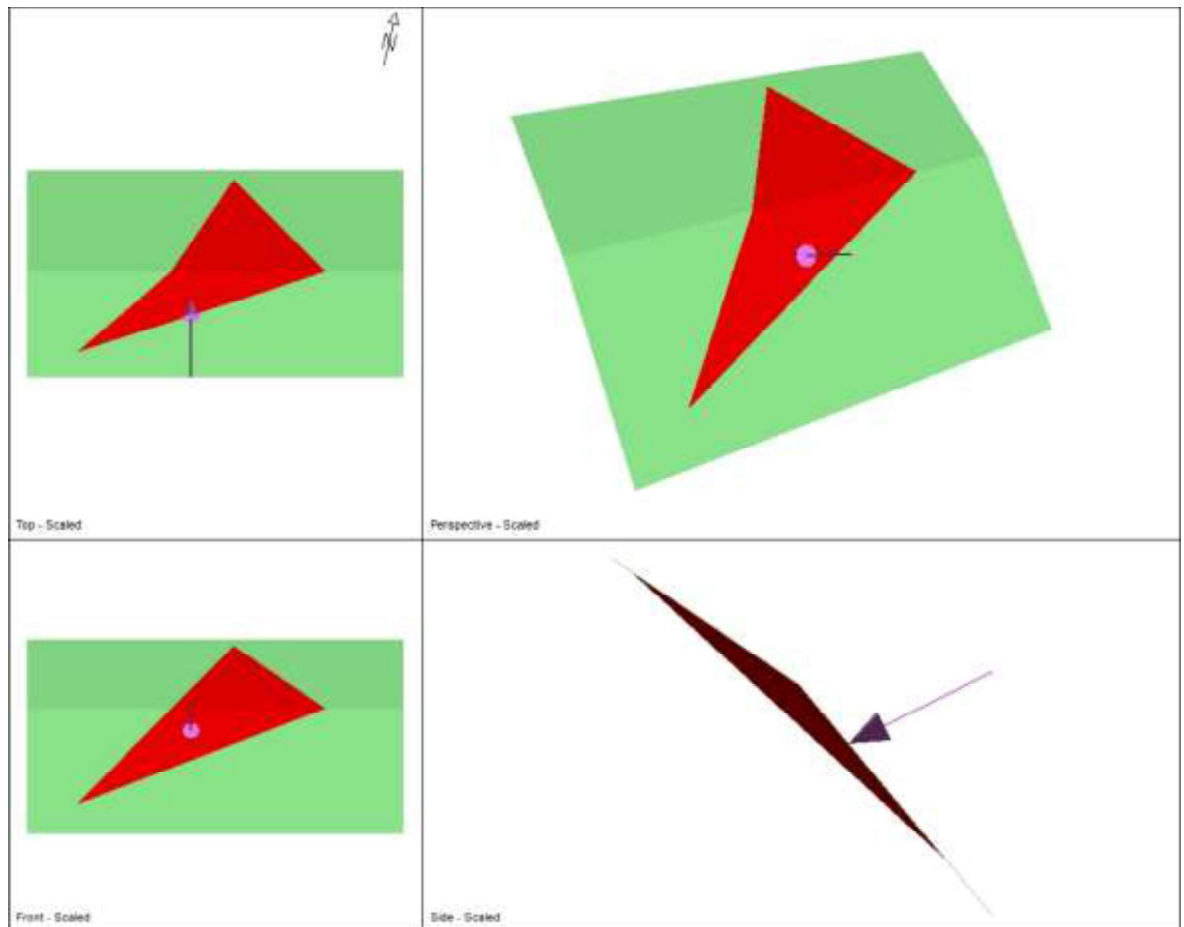
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-6	$E \cap J3$	Bloque a través de J3	0,71	42°	1,90 t/m ²
T-6	$J1 \cap J3$	Cuña a través de intersección	0,84	37°	1,61 t/m ²

CONCLUSIONES

- Talud estructural estable en roca sana: 37°

TALUD T-6. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.7664
- Safety Factor: 1.5000
- Wedge height (on slope) [m]: 15.33
- Bench width (on upper face) [m]: 14.84
- Wedge volume [m³]: 408.228
- Wedge weight [tonnes]: 1061.393
- Wedge area (joint1) [m²]: 67.60
- Wedge area (joint2) [m²]: 501.47
- Wedge area (slope) [m²]: 248.19
- Wedge area (upper face) [m²]: 222.05

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	1250.18
Effective Normal stress [t/m^2]	0.00	2.49
Shear Strength [t/m^2]	0.00	1.44
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 481.21
- Resisting force [tonnes]: 721.79

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	45.17

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	25.00	20.57
Joint 2	44.54	23.15

Persistence:

- Joint 1 [m]: 45.17
- Joint 2 [m]: 45.17

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	26.47	68.85
Joint 1 & Crest	126.83	60.51
Joint 2 & Crest	26.69	50.65

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	50.00	167.00
Upper Face	34.00	167.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 20.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	347.00	471.00

Resultant:

- Trend [deg]: 347.00
- Plunge [deg]: 26.50
- Force [tonnes]: 471.00

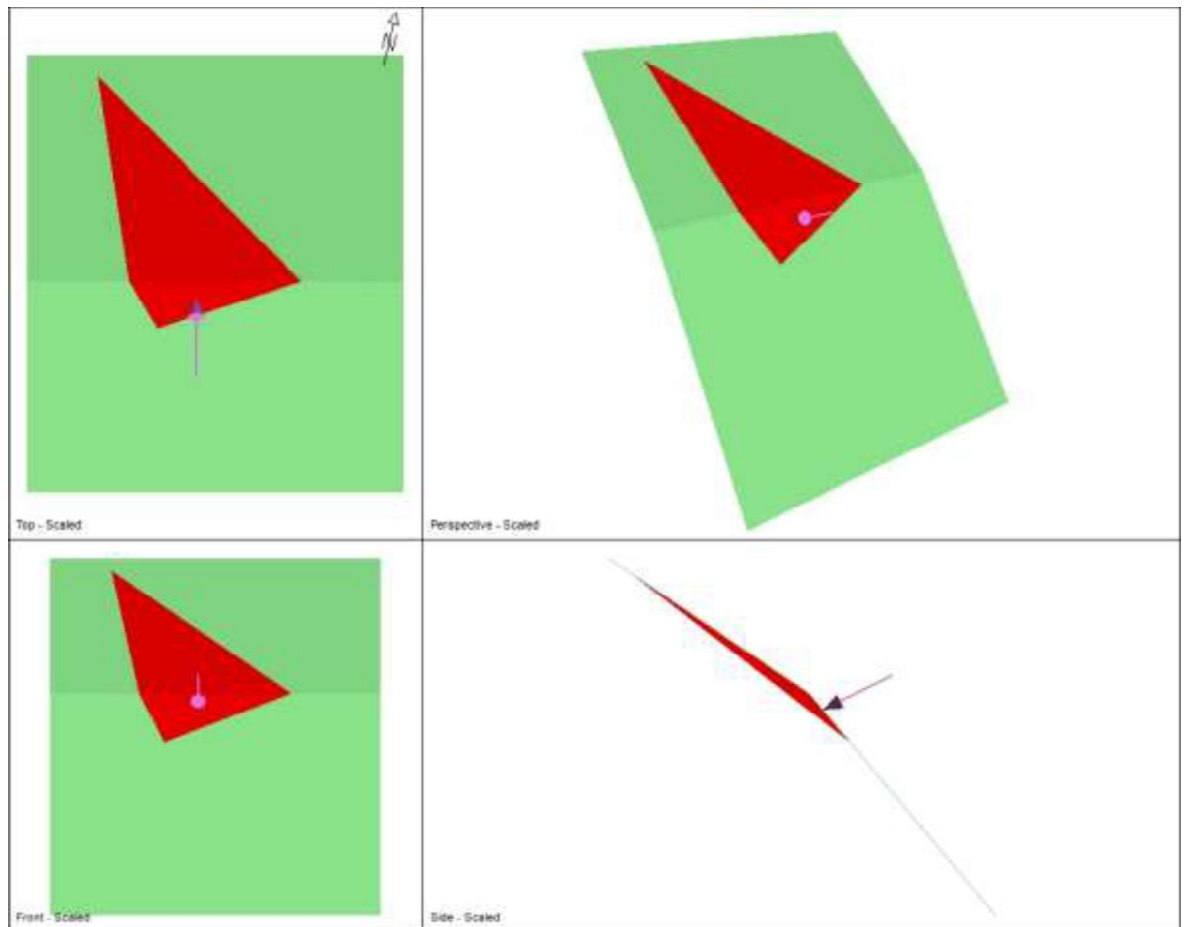
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	11.7099806213	15.9036091794	15.3281299877
234	35.8810077282	21.4839304852	15.3281299877
123	18.2377048915	32.6427584959	25.3389881326

TALUD T-6. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.2213
- Safety Factor: 1.5005
- Wedge height (on slope) [m]: 4.43
- Bench width (on upper face) [m]: 16.45
- Wedge volume [m³]: 72.465
- Wedge weight [tonnes]: 188.409
- Wedge area (joint1) [m²]: 22.25
- Wedge area (joint2) [m²]: 160.48
- Wedge area (slope) [m²]: 39.75
- Wedge area (upper face) [m²]: 136.51

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	46.57	175.54
Effective Normal stress [t/m^2]	2.09	1.09
Shear Strength [t/m^2]	1.21	0.63
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 85.46
- Resisting force [tonnes]: 128.24

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	25.89

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	6.21	20.00
Joint 2	12.86	25.66

Persistence:

- Joint 1 [m]: 25.89
- Joint 2 [m]: 25.89

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	84.75	32.14
Joint 1 & Crest	68.55	97.21
Joint 2 & Crest	26.69	50.65

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	50.00	167.00
Upper Face	34.00	167.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 20.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	347.00	64.00

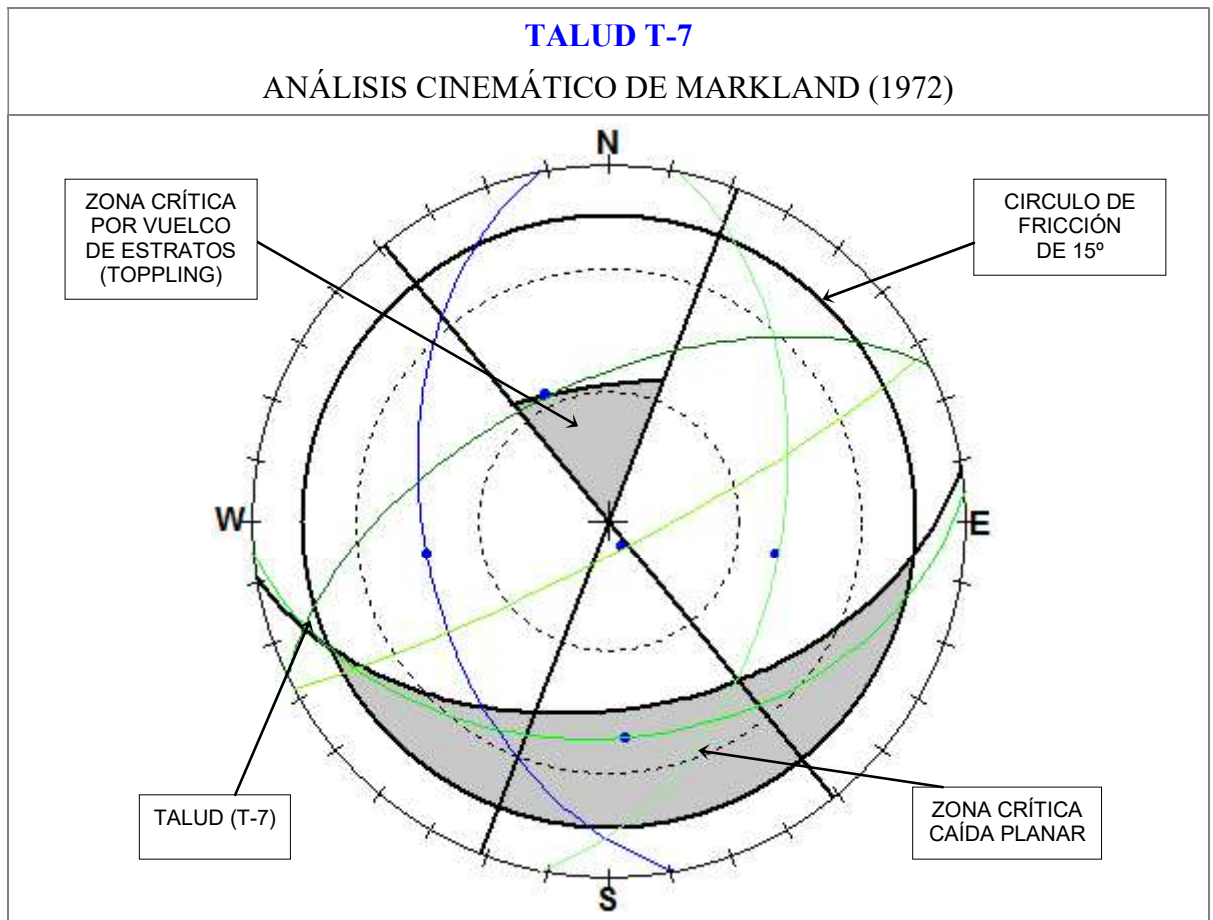
Resultant:

- Trend [deg]: 347.00
- Plunge [deg]: 26.50
- Force [tonnes]: 64.00

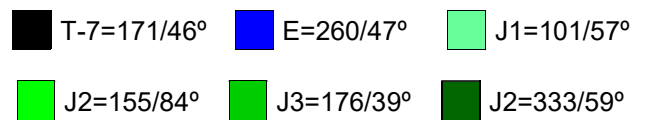
Wedge Vertices:

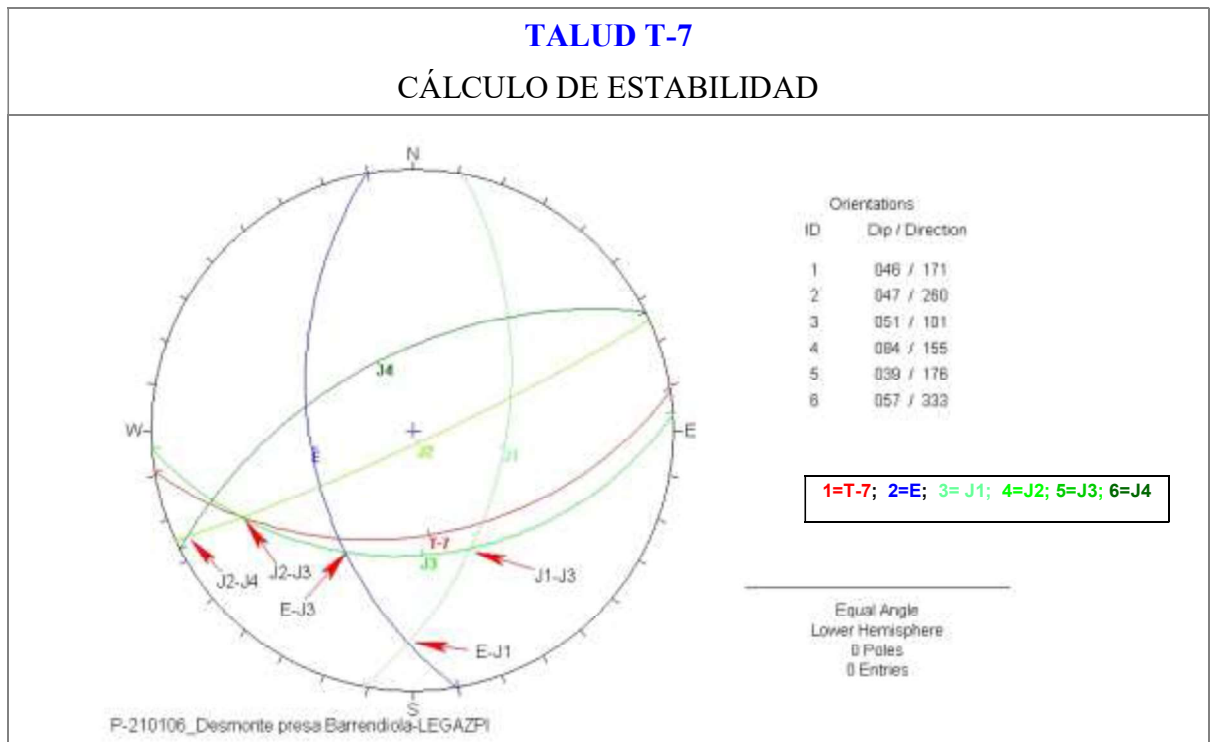
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-3.0469539888	3.1079959756	4.4258793764
234	10.3603643912	6.2033193178	4.4258793764
123	-9.1942484136	18.5709901063	15.5212200096



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

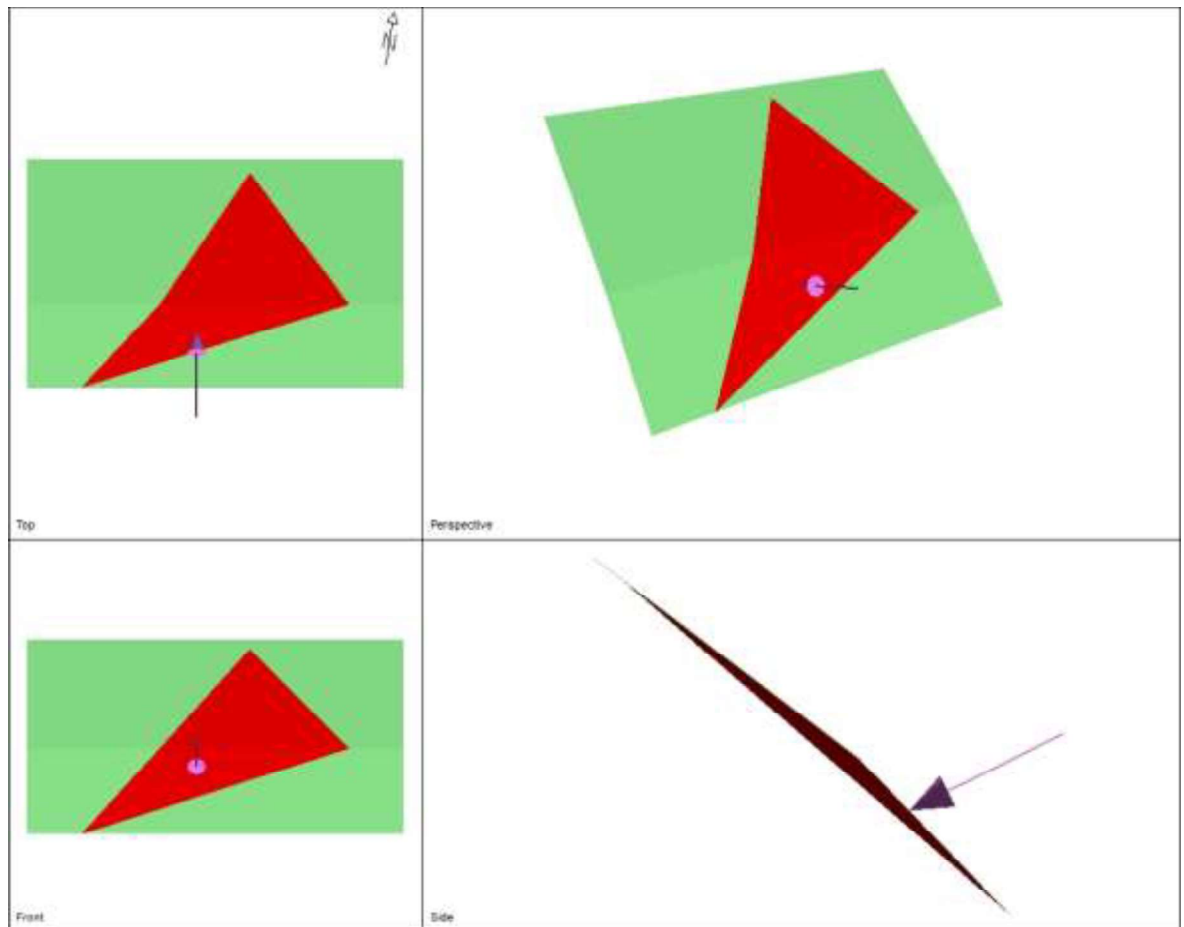
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-7	$E \cap J3$	Bloque a través de J3	0,71	40°	2,39 t/m^2
T-7	$J1 \cap J3$	Cuña a través de intersección	0,84	38°	0,95 t/m^2
T-7	$J2 \cap J3$	Bloque a través de J3	0,71	45°	0,10 t/m^2

CONCLUSIONES

- Talud estructural estable en roca sana: 38°

TALUD T-7. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.5001
- Wedge height (on slope) [m]: 21.00
- Bench width (on upper face) [m]: 32.34
- Wedge volume [m³]: 1433.816
- Wedge weight [tonnes]: 3727.923
- Wedge area (joint1) [m²]: 126.45
- Wedge area (joint2) [m²]: 1685.85
- Wedge area (slope) [m²]: 679.02
- Wedge area (upper face) [m²]: 941.88

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	4370.53
Effective Normal stress [t/m^2]	0.00	2.59
Shear Strength [t/m^2]	0.00	1.50
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 1682.08
- Resisting force [tonnes]: 2523.33

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	80.88

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	34.96	46.16
Joint 2	71.94	47.25

Persistence:

- Joint 1 [m]: 80.88
- Joint 2 [m]: 80.88

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	32.68	59.72
Joint 1 & Crest	123.38	61.31
Joint 2 & Crest	23.94	58.98

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	46.00	171.00
Upper Face	37.00	171.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 21.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	351.00	1623.00

Resultant:

- Trend [deg]: 351.00
- Plunge [deg]: 26.50
- Force [tonnes]: 1623.00

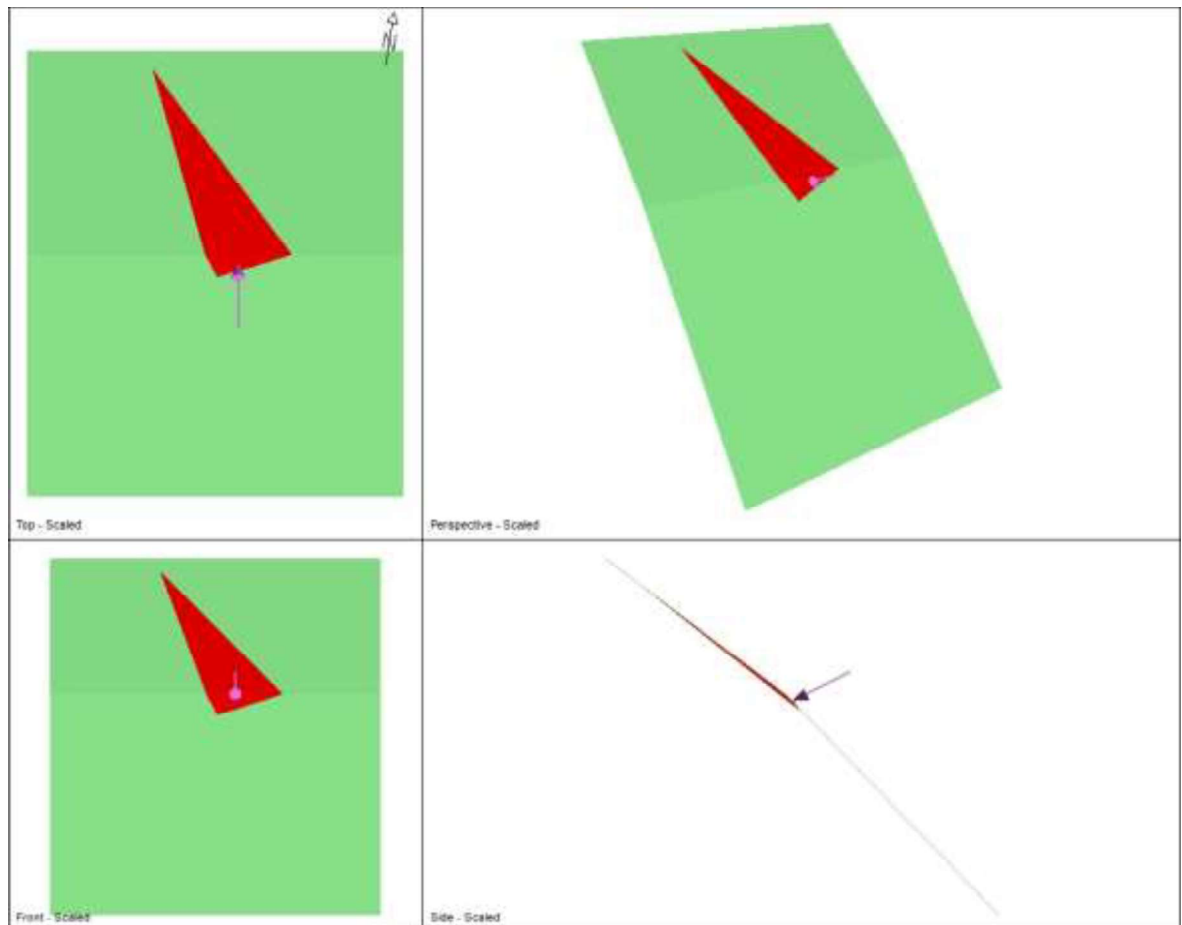
Wedge Vertices:

- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	15.8226376878	23.0383099586	21.0000000000
234	61.7687292343	30.3154559533	21.0000000000
123	32.6552435060	58.4479918792	45.3703375830

TALUD T-7. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.0952
- Safety Factor: 1.4999
- Wedge height (on slope) [m]: 2.00
- Bench width (on upper face) [m]: 15.57
- Wedge volume [m³]: 10.295
- Wedge weight [tonnes]: 26.767
- Wedge area (joint1) [m²]: 5.81
- Wedge area (joint2) [m²]: 77.32
- Wedge area (slope) [m²]: 10.12
- Wedge area (upper face) [m²]: 71.01

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	5.90	25.67
Effective Normal stress [t/m^2]	1.02	0.33
Shear Strength [t/m^2]	0.59	0.19
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 12.15
- Resisting force [tonnes]: 18.22

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	22.91

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	2.96	20.00
Joint 2	6.85	22.75

Persistence:

- Joint 1 [m]: 22.91
- Joint 2 [m]: 22.91

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	86.21	18.18
Joint 1 & Crest	69.84	102.84
Joint 2 & Crest	23.94	58.98

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	46.00	171.00
Upper Face	37.00	171.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 21.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	351.00	9.36

Resultant:

- Trend [deg]: 351.00
- Plunge [deg]: 26.50
- Force [tonnes]: 9.36

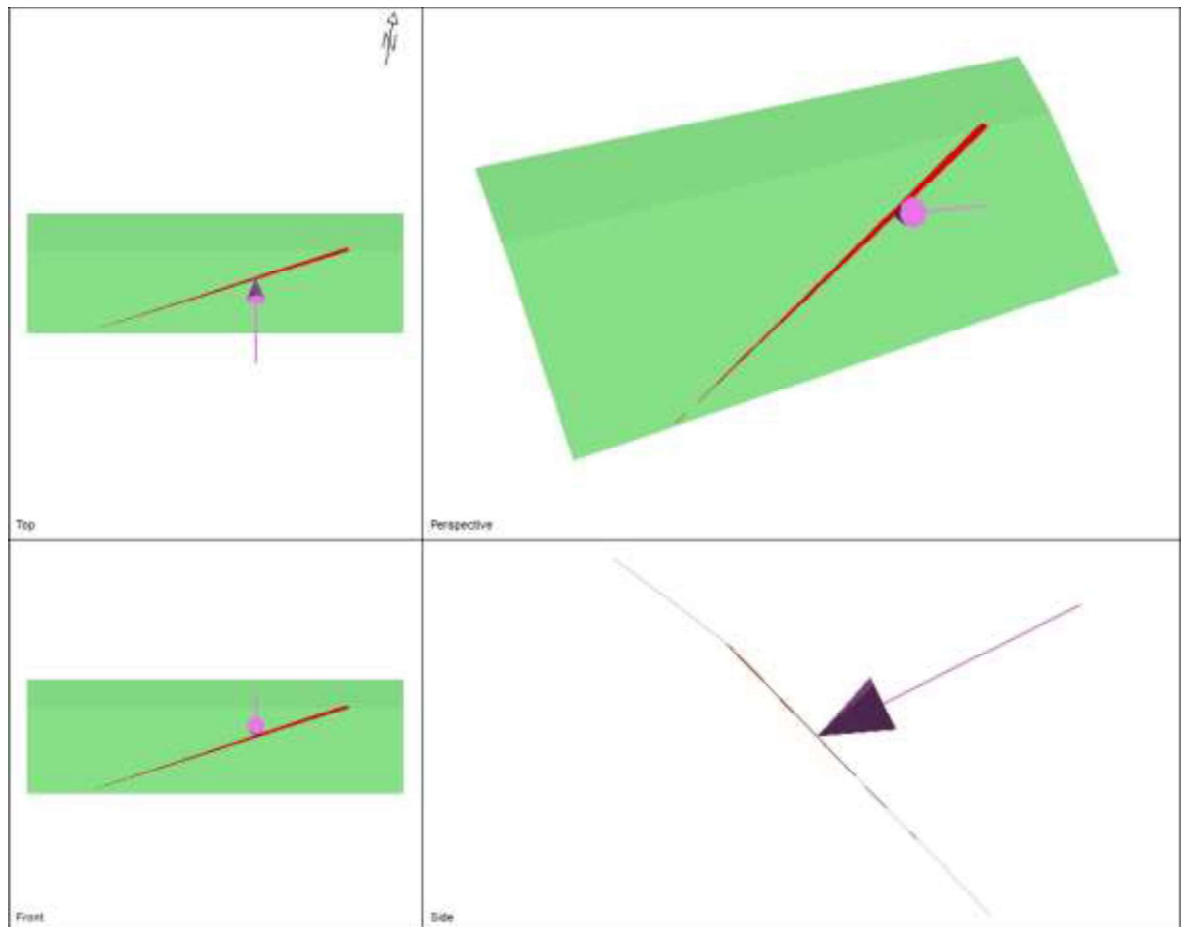
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-1.3101609715	1.7480136838	2.0000719857
234	5.8829478539	2.8872901993	2.0000719857
123	-8.1363750437	16.4342460244	13.7353768849

TALUD T-7. INTERSECCIÓN J2-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J2-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.5004
- Wedge height (on slope) [m]: 21.00
- Bench width (on upper face) [m]: 0.77
- Wedge volume [m³]: 2.221
- Wedge weight [tonnes]: 5.775
- Wedge area (joint1) [m²]: 8.01
- Wedge area (joint2) [m²]: 40.03
- Wedge area (slope) [m²]: 44.31
- Wedge area (upper face) [m²]: 1.46

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	6.77
Effective Normal stress [t/m^2]	0.00	0.17
Shear Strength [t/m^2]	0.00	0.10
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 2.61
- Resisting force [tonnes]: 3.91

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
17.49	243.10	71.81

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	69.18	2.64
Joint 2	71.94	1.12

Persistence:

- Joint 1 [m]: 71.81
- Joint 2 [m]: 71.94

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	1.02	99.65
Joint 1 & Crest	155.04	21.37
Joint 2 & Crest	23.94	58.98

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	84.00	155.00
Joint Set 2	39.00	176.00
Slope	46.00	171.00
Upper Face	37.00	171.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 21.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	351.00	2.52

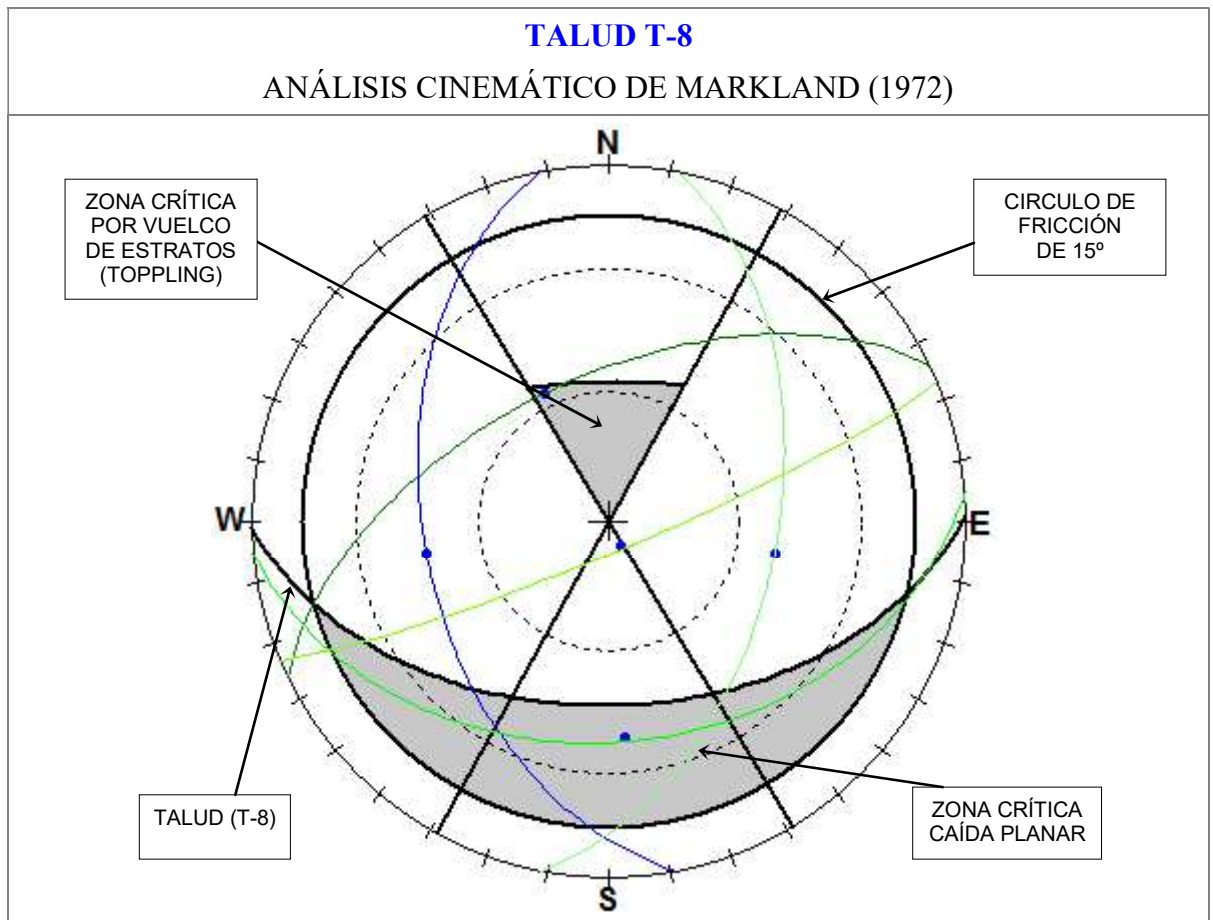
Resultant:

- Trend [deg]: 351.00
- Plunge [deg]: 26.50
- Force [tonnes]: 2.52

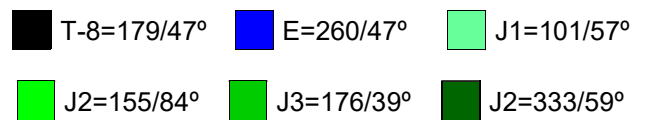
Wedge Vertices:

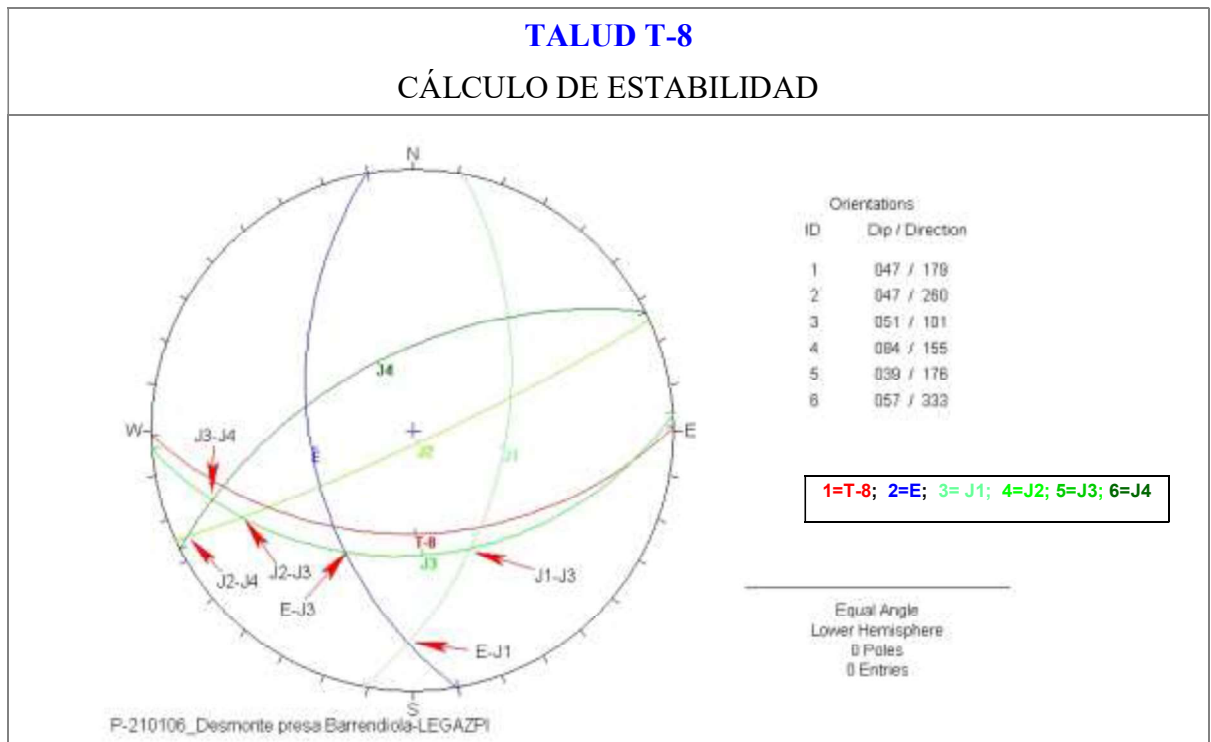
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	58.7707771161	29.8406269850	21.0000000000
234	61.7687292343	30.3154559533	21.0000000000
123	61.0775176811	30.9833778241	21.5785998643



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

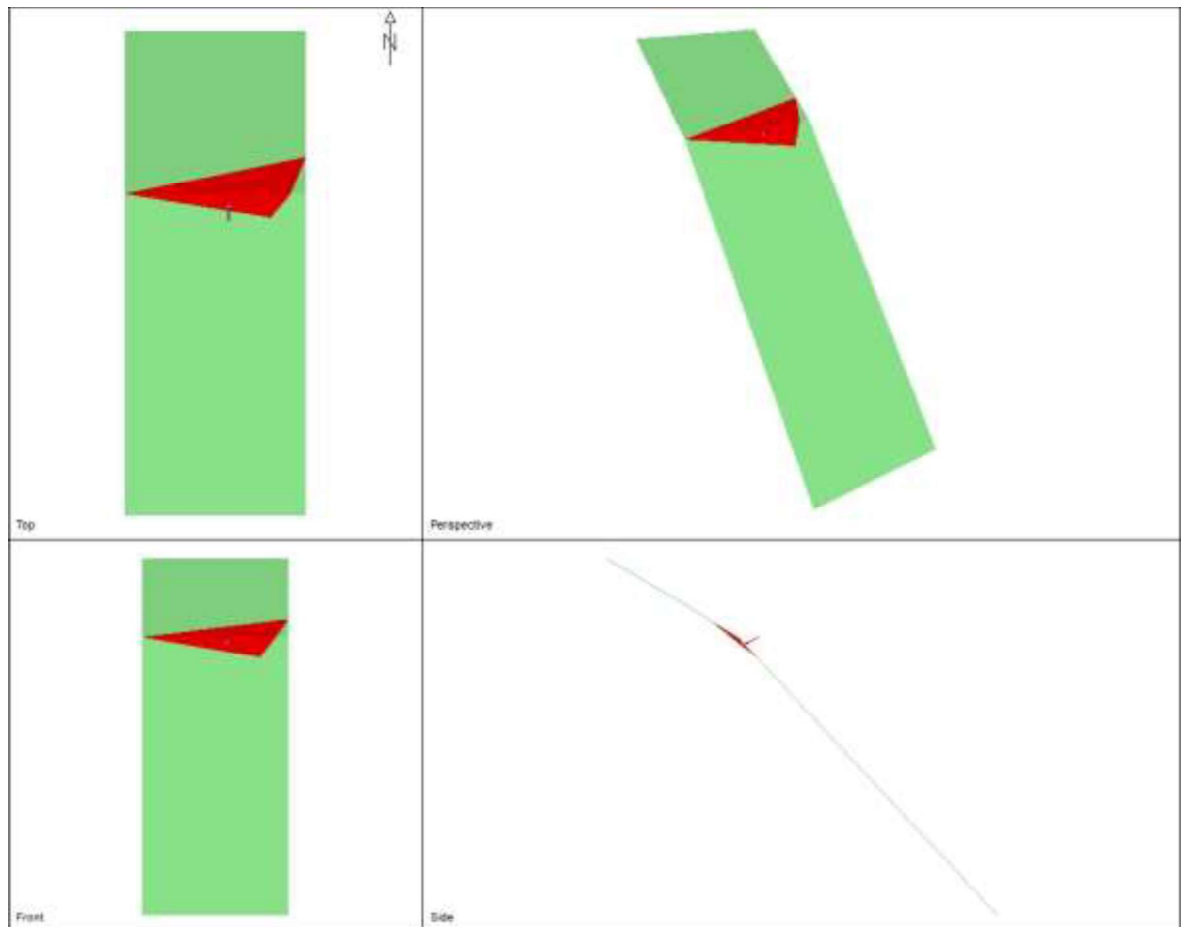
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-8	$E \cap J3$	Cuña a través de intersección	0,76	38°	0,30 t/m ²
T-8	$J1 \cap J3$	Bloque a través de J3	0,71	39°	0,21 t/m ²
T-8	$J2 \cap J3$	Cuña a través de intersección	3,86	35°	-
T-8	$J3 \cap J4$	Cuña a través de intersección	3,94	34°	-

CONCLUSIONES

- Talud estructural estable en roca sana: 38°

TALUD T-8. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.5001
- Wedge height (on slope) [m]: 1.39
- Bench width (on upper face) [m]: 2.04
- Wedge volume [m³]: 1.903
- Wedge weight [tonnes]: 4.947
- Wedge area (joint1) [m²]: 0.86
- Wedge area (joint2) [m²]: 18.91
- Wedge area (slope) [m²]: 8.70
- Wedge area (upper face) [m²]: 10.90

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	1.40	4.70
Effective Normal stress [t/m^2]	1.63	0.25
Shear Strength [t/m^2]	0.44	0.14
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 2.06
- Resisting force [tonnes]: 3.09

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	4.66

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	2.20	2.52
Joint 2	8.28	10.28

Persistence:

- Joint 1 [m]: 4.66
- Joint 2 [m]: 10.28

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	106.96	57.30
Joint 1 & Crest	59.78	109.32
Joint 2 & Crest	13.26	13.38

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	47.00	179.00
Upper Face	31.00	179.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 19.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	359.00	1.83

Resultant:

- Trend [deg]: 359.00
- Plunge [deg]: 26.50
- Force [tonnes]: 1.83

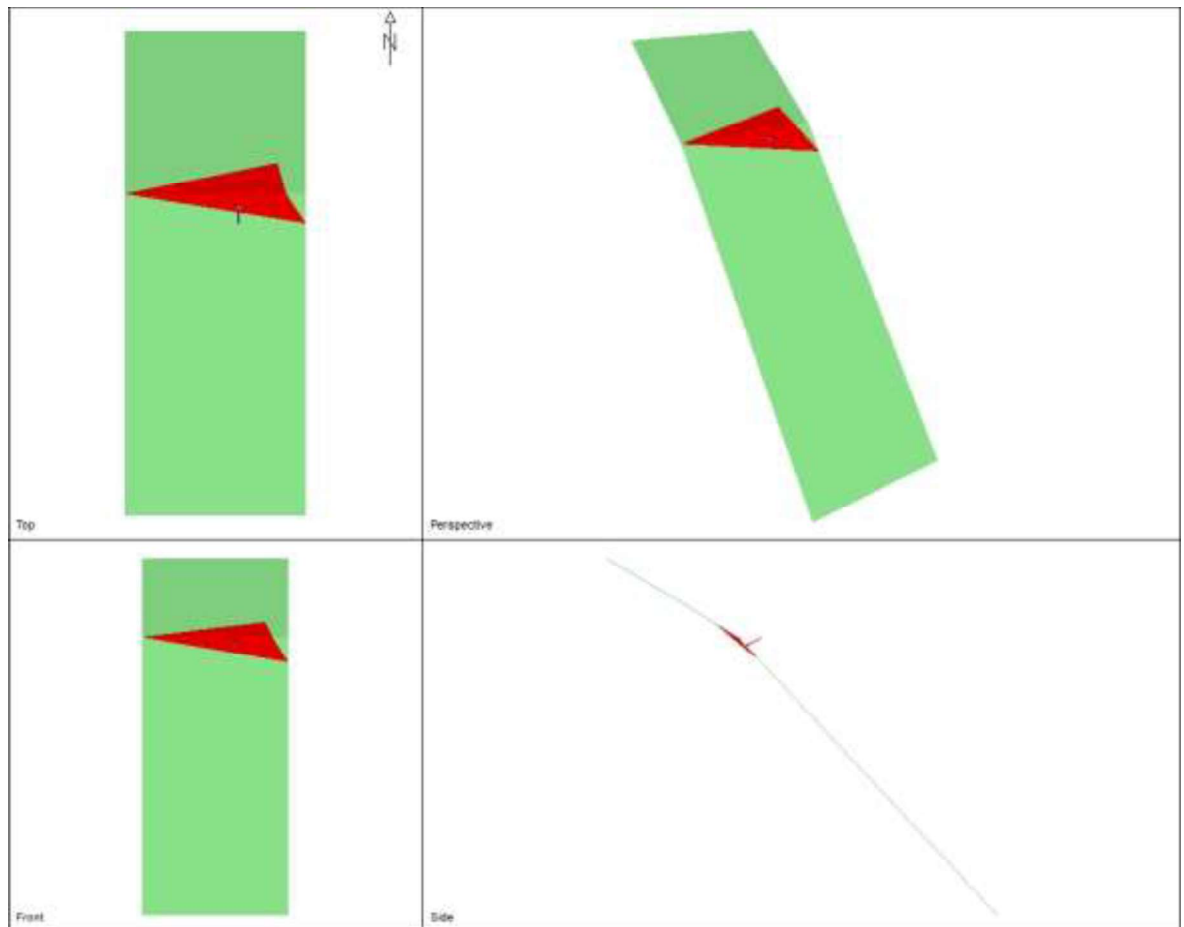
Wedge Vertices:

- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	1.0835636445	1.3144678109	1.3891001199
234	-8.0811197814	1.1544976667	1.3891001199
123	1.8817653125	3.3680778917	2.6144752974

TALUD T-8. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.4996
- Wedge height (on slope) [m]: 1.72
- Bench width (on upper face) [m]: 1.72
- Wedge volume [m³]: 1.935
- Wedge weight [tonnes]: 5.030
- Wedge area (joint1) [m²]: 0.86
- Wedge area (joint2) [m²]: 19.77
- Wedge area (slope) [m²]: 10.50
- Wedge area (upper face) [m²]: 8.94

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	5.89
Effective Normal stress [t/m^2]	0.00	0.30
Shear Strength [t/m^2]	0.00	0.17
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 2.27
- Resisting force [tonnes]: 3.40

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	4.60

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	2.59	2.06
Joint 2	10.27	8.66

Persistence:

- Joint 1 [m]: 4.60
- Joint 2 [m]: 10.27

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	52.01	90.34
Joint 1 & Crest	114.73	76.28
Joint 2 & Crest	13.26	13.38

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	47.00	179.00
Upper Face	31.00	179.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 19.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	359.00	2.18

Resultant:

- Trend [deg]: 359.00
- Plunge [deg]: 26.50
- Force [tonnes]: 2.18

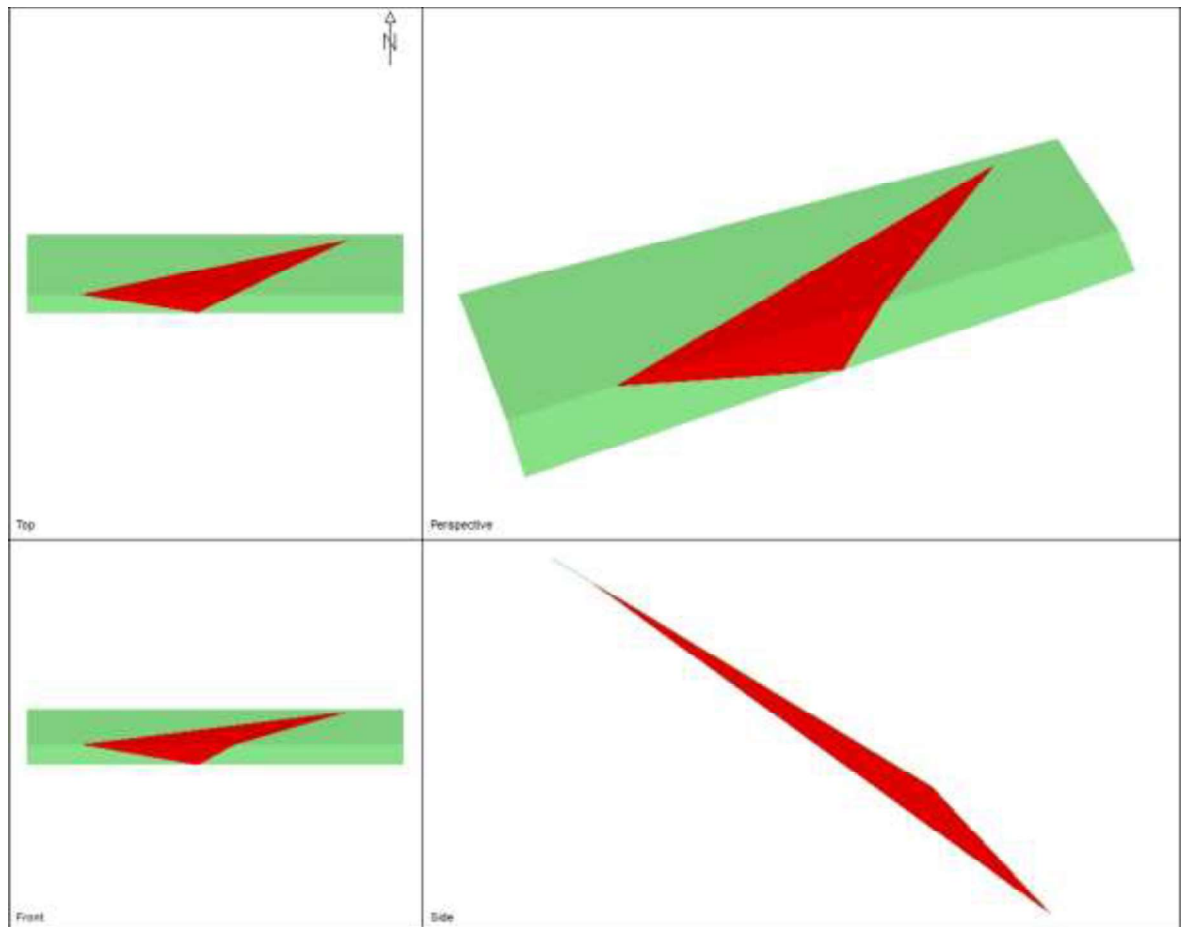
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-1.1131111533	1.5880096475	1.7235048291
234	-10.0265263589	1.4324254063	1.7235048291
123	-1.6325131763	3.2974295105	2.7559181608

TALUD T-8. INTERSECCIÓN J2-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J2-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 3.8636
- Wedge height (on slope) [m]: 19.00
- Bench width (on upper face) [m]: 51.60
- Wedge volume [m³]: 10425.801
- Wedge weight [tonnes]: 27107.081
- Wedge area (joint1) [m²]: 532.79
- Wedge area (joint2) [m²]: 6543.57
- Wedge area (slope) [m²]: 1885.12
- Wedge area (upper face) [m²]: 4367.84

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	20081.89	34431.39
Effective Normal stress [t/m^2]	37.69	5.26
Shear Strength [t/m^2]	21.76	3.04
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 8146.04
- Resisting force [tonnes]: 31473.25

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
17.49	243.10	166.39

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	43.50	123.53
Joint 2	113.26	260.06

Persistence:

- Joint 1 [m]: 166.39
- Joint 2 [m]: 260.06

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	130.06	15.78
Joint 1 & Crest	36.68	150.84
Joint 2 & Crest	13.26	13.38

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	84.00	155.00
Joint Set 2	39.00	176.00
Slope	47.00	179.00
Upper Face	31.00	179.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 19.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: NO
- Tension crack: NO

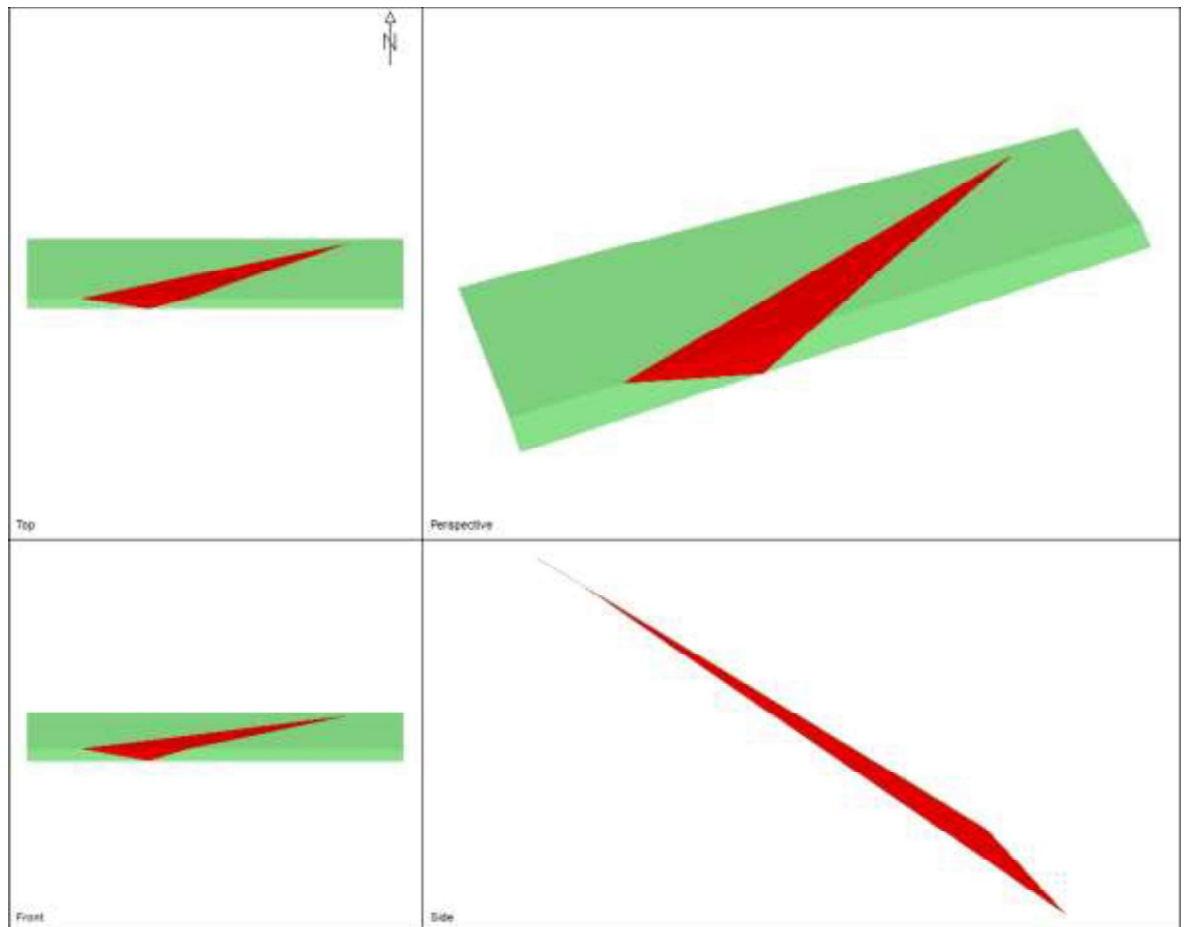
Wedge Vertices:

- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	34.5705062894	18.3239159843	19.0000000000
234	-110.5329080624	15.7911264655	19.0000000000
123	141.5294809127	71.7950163472	50.0021637023

TALUD T-8. INTERSECCIÓN J3-J4

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J3-J4)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 3.9398
- Wedge height (on slope) [m]: 19.00
- Bench width (on upper face) [m]: 89.00
- Wedge volume [m³]: 21650.618
- Wedge weight [tonnes]: 56291.608
- Wedge area (joint1) [m²]: 11287.34
- Wedge area (joint2) [m²]: 1011.18
- Wedge area (slope) [m²]: 2269.47
- Wedge area (upper face) [m²]: 9070.42

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	45844.64	33527.18
Effective Normal stress [t/m^2]	4.06	33.16
Shear Strength [t/m^2]	2.34	19.14
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 11631.53
- Resisting force [tonnes]: 45825.34

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
11.92	250.88	350.76

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	113.26	448.60
Joint 2	69.51	281.55

Persistence:

- Joint 1 [m]: 448.60
- Joint 2 [m]: 350.76

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	144.79	8.26
Joint 1 & Crest	13.26	13.38
Joint 2 & Crest	21.95	158.36

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	39.00	176.00
Joint Set 2	57.00	333.00
Slope	47.00	179.00
Upper Face	31.00	179.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

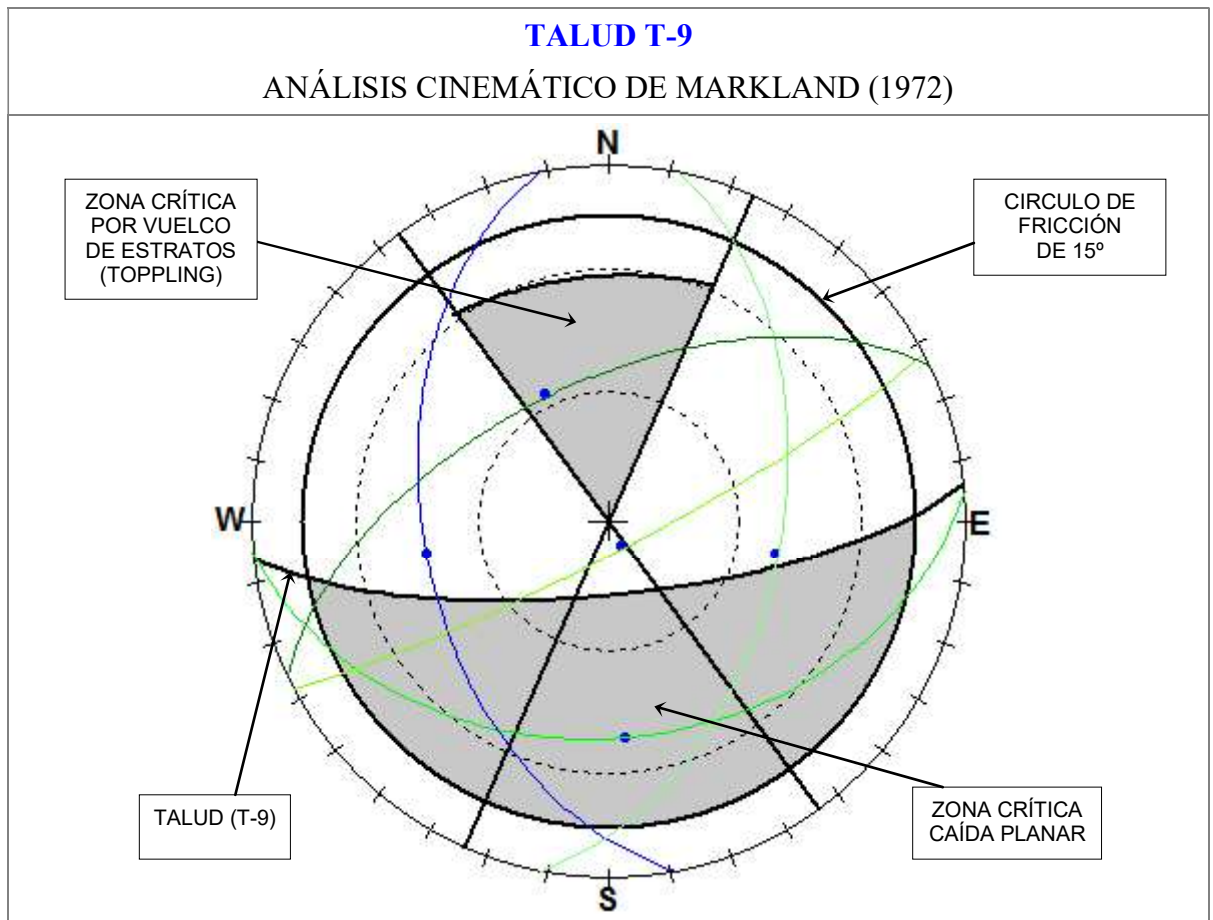
Slope Data:

- Slope height [m]: 19.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: NO
- Tension crack: NO

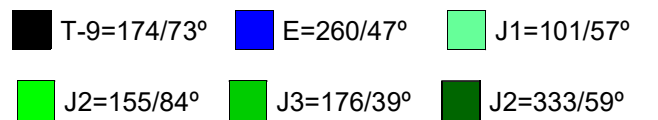
Wedge Vertices:

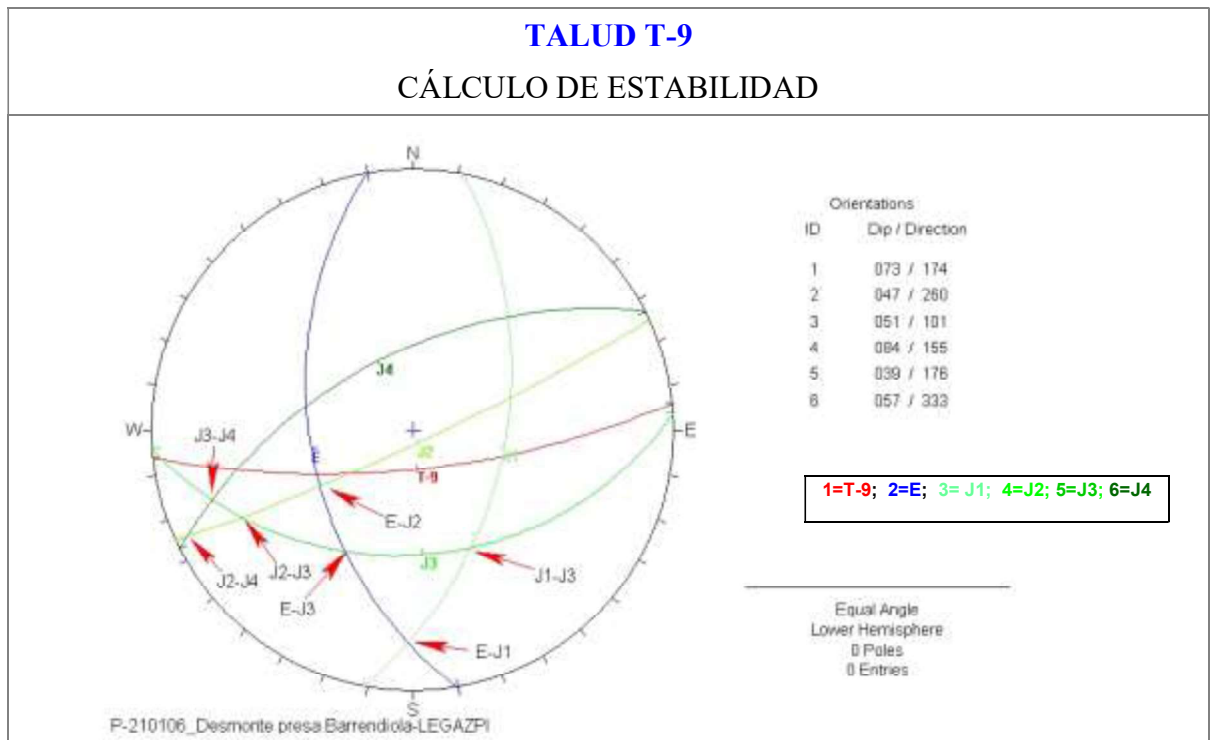
- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-110.5329080624	15.7911264655	19.0000000000
234	64.1546066926	18.8403083777	19.0000000000
123	324.2622566920	112.3950689539	72.4772003450



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS
COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

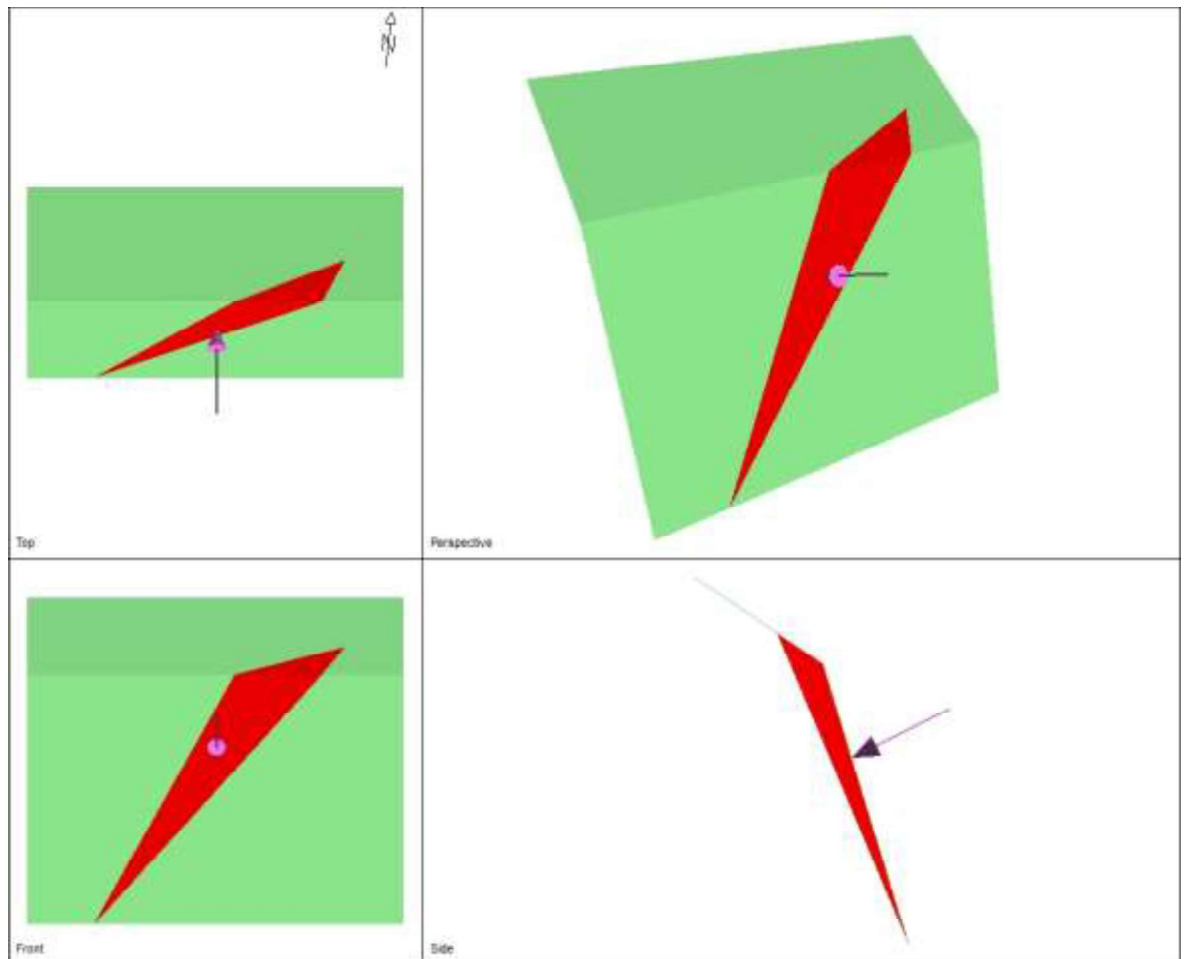
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-9	$E \cap J2$	Cuña a través de intersección	0,42	67°	$1,11 \text{ t/m}^2$
T-9	$E \cap J3$	Bloque a través de J3	0,71	39°	$1,10 \text{ t/m}^2$
T-9	$J1 \cap J3$	Cuña a través de intersección	0,84	38°	$1,20 \text{ t/m}^2$
T-9	$J2 \cap J3$	Bloque a través de J3	0,71	41°	$0,80 \text{ t/m}^2$
T-9	$J3 \cap J4$	Bloque a través de J3	0,71	42°	$0,65 \text{ t/m}^2$

CONCLUSIONES

- Talud estructural estable en roca sana: 38°

TALUD T-9. INTERSECCIÓN E-J2

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J2)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.4998
- Wedge height (on slope) [m]: 8.00
- Bench width (on upper face) [m]: 1.31
- Wedge volume [m³]: 3.866
- Wedge weight [tonnes]: 10.052
- Wedge area (joint1) [m²]: 5.70
- Wedge area (joint2) [m²]: 12.85
- Wedge area (slope) [m²]: 11.66
- Wedge area (upper face) [m²]: 2.20

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	13.02	14.04
Effective Normal stress [t/m^2]	2.28	1.09
Shear Strength [t/m^2]	0.61	0.63
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 7.73
- Resisting force [tonnes]: 11.59

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
45.03	238.96	12.56

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	11.11	1.74
Joint 2	9.51	3.86

Persistence:

- Joint 1 [m]: 12.56
- Joint 2 [m]: 12.56

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	12.75	40.89
Joint 1 & Crest	48.86	114.93
Joint 2 & Crest	118.39	24.18

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	84.00	155.00
Slope	73.00	174.00
Upper Face	34.00	174.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 8.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	354.00	12.91

Resultant:

- Trend [deg]: 354.00
- Plunge [deg]: 26.50
- Force [tonnes]: 12.91

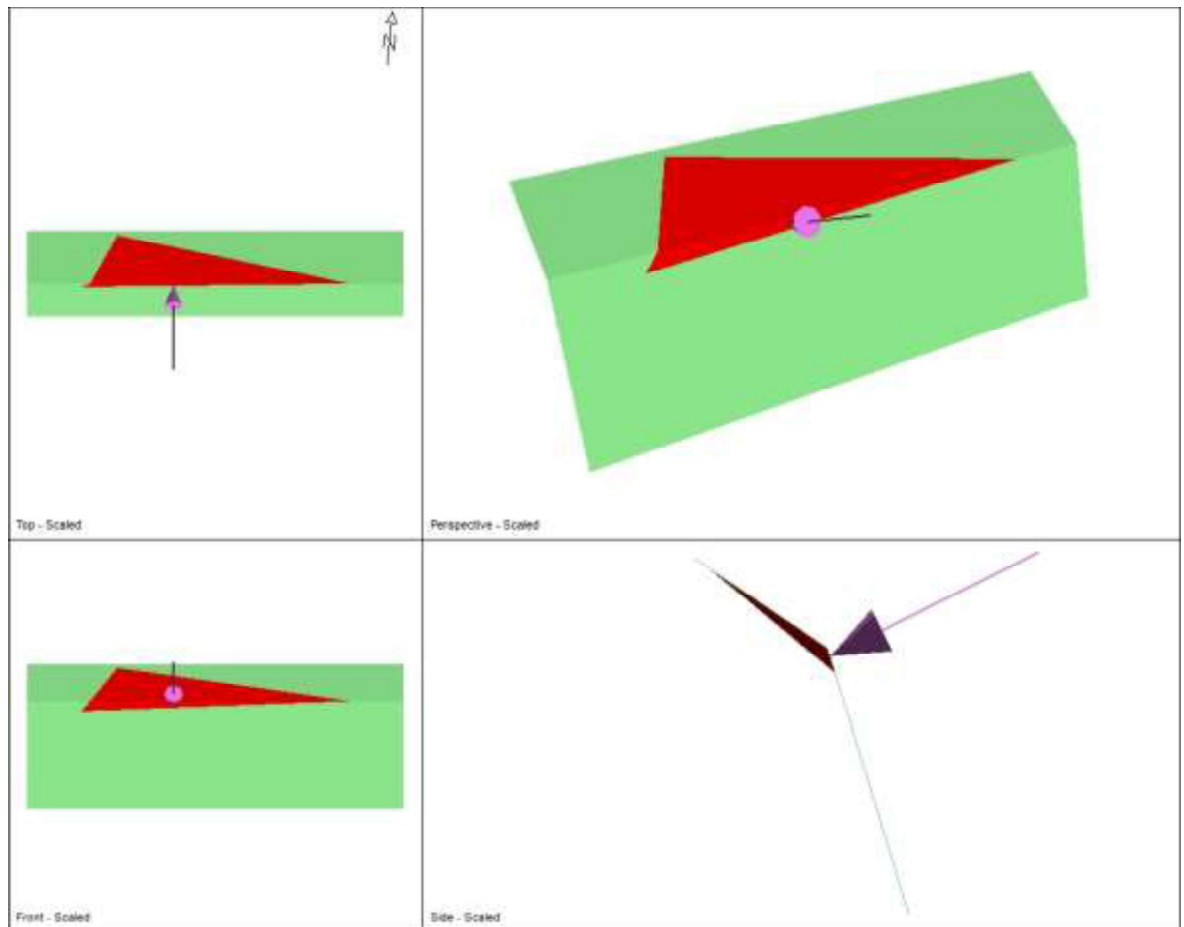
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	7.0116167078	3.1962684642	8.0000000000
234	4.2401600209	2.9049766286	8.0000000000
123	7.6054391673	4.5767715948	8.8841924674

TALUD T-9. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.0938
- Safety Factor: 1.5004
- Wedge height (on slope) [m]: 0.75
- Bench width (on upper face) [m]: 3.62
- Wedge volume [m³]: 6.938
- Wedge weight [tonnes]: 18.039
- Wedge area (joint1) [m²]: 1.48
- Wedge area (joint2) [m²]: 49.11
- Wedge area (slope) [m²]: 7.57
- Wedge area (upper face) [m²]: 42.15

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	21.11
Effective Normal stress [t/m^2]	0.00	0.43
Shear Strength [t/m^2]	0.00	0.25
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 8.12
- Resisting force [tonnes]: 12.19

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	5.69

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	1.04	4.82
Joint 2	20.00	17.81

Persistence:

- Joint 1 [m]: 5.69
- Joint 2 [m]: 20.00

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	46.61	100.73
Joint 1 & Crest	131.14	65.07
Joint 2 & Crest	2.25	14.19

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	73.00	174.00
Upper Face	34.00	174.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 8.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	354.00	7.80

Resultant:

- Trend [deg]: 354.00
- Plunge [deg]: 26.50
- Force [tonnes]: 7.80

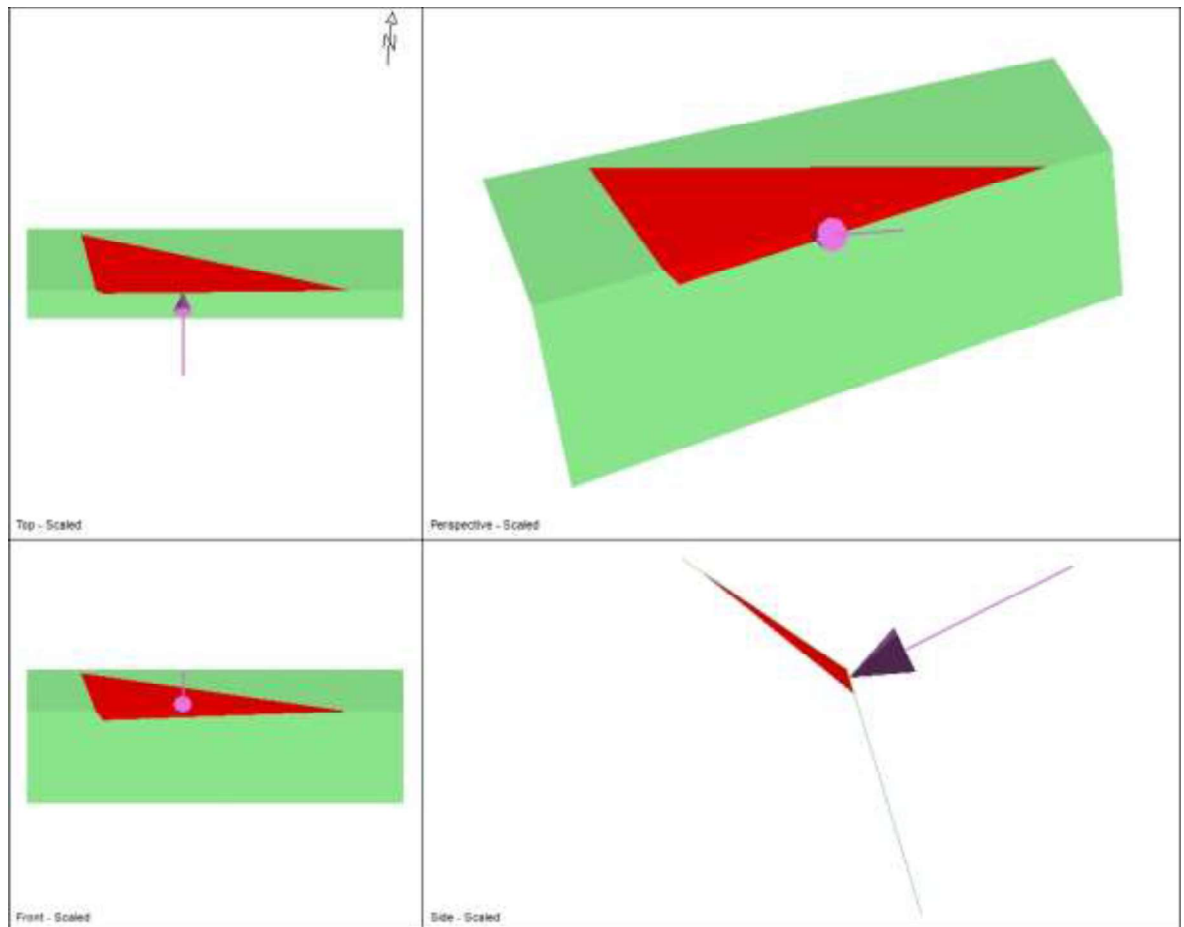
Wedge Vertices:

- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	0.6577520088	0.2998384097	0.7504711523
234	19.8511368607	2.3171444467	0.7504711523
123	2.2980579296	4.1131792872	3.1928613251

TALUD T-9. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.1003
- Safety Factor: 1.5002
- Wedge height (on slope) [m]: 0.80
- Bench width (on upper face) [m]: 4.88
- Wedge volume [m³]: 11.380
- Wedge weight [tonnes]: 29.587
- Wedge area (joint1) [m²]: 2.09
- Wedge area (joint2) [m²]: 70.74
- Wedge area (slope) [m²]: 9.22
- Wedge area (upper face) [m²]: 64.65

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	5.89	29.04
Effective Normal stress [t/m^2]	2.82	0.41
Shear Strength [t/m^2]	1.63	0.24
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 13.44
- Resisting force [tonnes]: 20.16

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	6.83

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	1.03	6.03
Joint 2	21.38	24.00

Persistence:

- Joint 1 [m]: 6.83
- Joint 2 [m]: 24.00

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	123.52	63.40
Joint 1 & Crest	54.23	102.41
Joint 2 & Crest	2.25	14.19

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	73.00	174.00
Upper Face	34.00	174.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 8.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	354.00	10.63

Resultant:

- Trend [deg]: 354.00
- Plunge [deg]: 26.50
- Force [tonnes]: 10.63

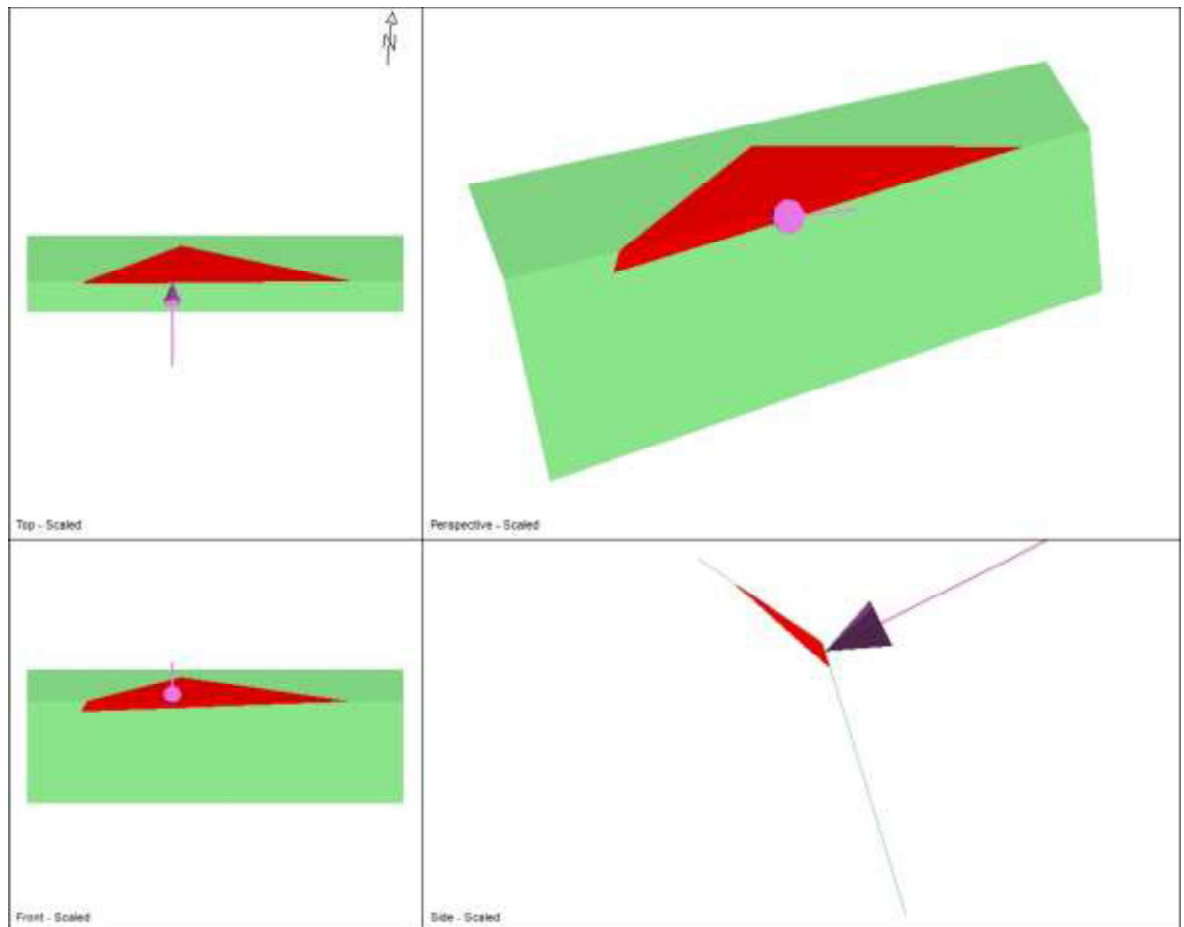
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-0.6268042251	0.1807954000	0.8024182104
234	21.2252178711	2.4775354714	0.8024182104
123	-2.4246338778	4.8973934280	4.0931323766

TALUD T-9. INTERSECCIÓN J2-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J2-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.0985
- Safety Factor: 1.5002
- Wedge height (on slope) [m]: 0.79
- Bench width (on upper face) [m]: 2.75
- Wedge volume [m³]: 5.898
- Wedge weight [tonnes]: 15.336
- Wedge area (joint1) [m²]: 2.66
- Wedge area (joint2) [m²]: 39.23
- Wedge area (slope) [m²]: 8.46
- Wedge area (upper face) [m²]: 34.12

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	17.95
Effective Normal stress [t/m^2]	0.00	0.46
Shear Strength [t/m^2]	0.00	0.26
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 6.91
- Resisting force [tonnes]: 10.36

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
17.49	243.10	8.81

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	0.94	8.11
Joint 2	21.00	13.55

Persistence:

- Joint 1 [m]: 8.81
- Joint 2 [m]: 21.00

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	59.37	141.63
Joint 1 & Crest	118.39	24.18
Joint 2 & Crest	2.25	14.19

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	84.00	155.00
Joint Set 2	39.00	176.00
Slope	73.00	174.00
Upper Face	34.00	174.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 8.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	354.00	6.63

Resultant:

- Trend [deg]: 354.00
- Plunge [deg]: 26.50
- Force [tonnes]: 6.63

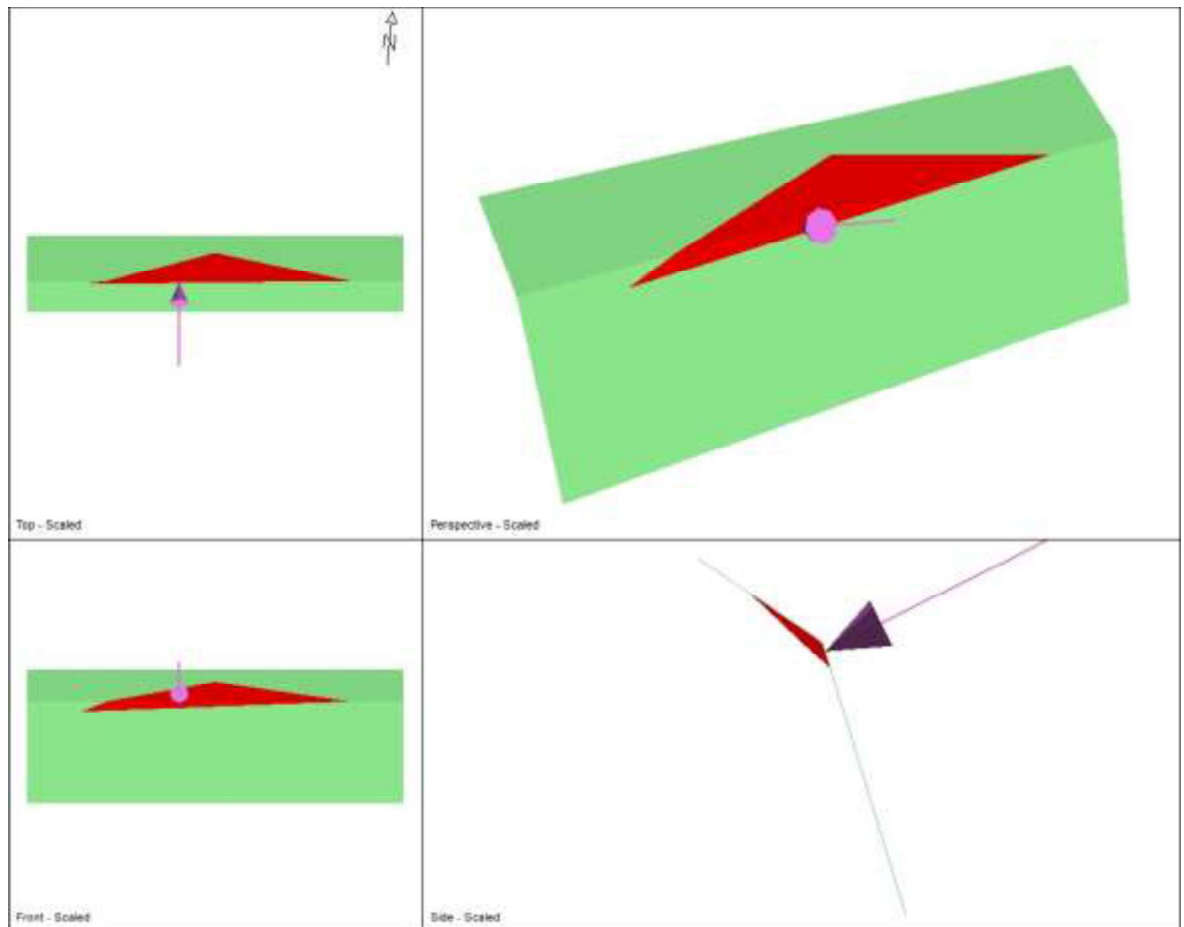
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	0.4176529582	0.2861382770	0.7879947100
234	20.8436937037	2.4330016690	0.7879947100
123	7.4897218028	3.7993829682	2.6461080282

TALUD T-9. INTERSECCIÓN J3-J4

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J3-J4)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.0985
- Safety Factor: 1.5005
- Wedge height (on slope) [m]: 0.79
- Bench width (on upper face) [m]: 2.20
- Wedge volume [m³]: 4.345
- Wedge weight [tonnes]: 11.296
- Wedge area (joint1) [m²]: 31.35
- Wedge area (joint2) [m²]: 2.29
- Wedge area (slope) [m²]: 7.80
- Wedge area (upper face) [m²]: 25.14

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	13.22	0.00
Effective Normal stress [t/m^2]	0.42	0.00
Shear Strength [t/m^2]	0.24	0.00
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 5.09
- Resisting force [tonnes]: 7.63

Failure Mode:

- Sliding on joint1

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
11.92	250.88	11.00

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	21.00	10.83
Joint 2	2.21	8.84

Persistence:

- Joint 1 [m]: 21.00
- Joint 2 [m]: 11.00

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	19.60	148.31
Joint 1 & Crest	2.25	14.19
Joint 2 & Crest	158.16	17.49

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	39.00	176.00
Joint Set 2	57.00	333.00
Slope	73.00	174.00
Upper Face	34.00	174.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 8.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	354.00	4.88

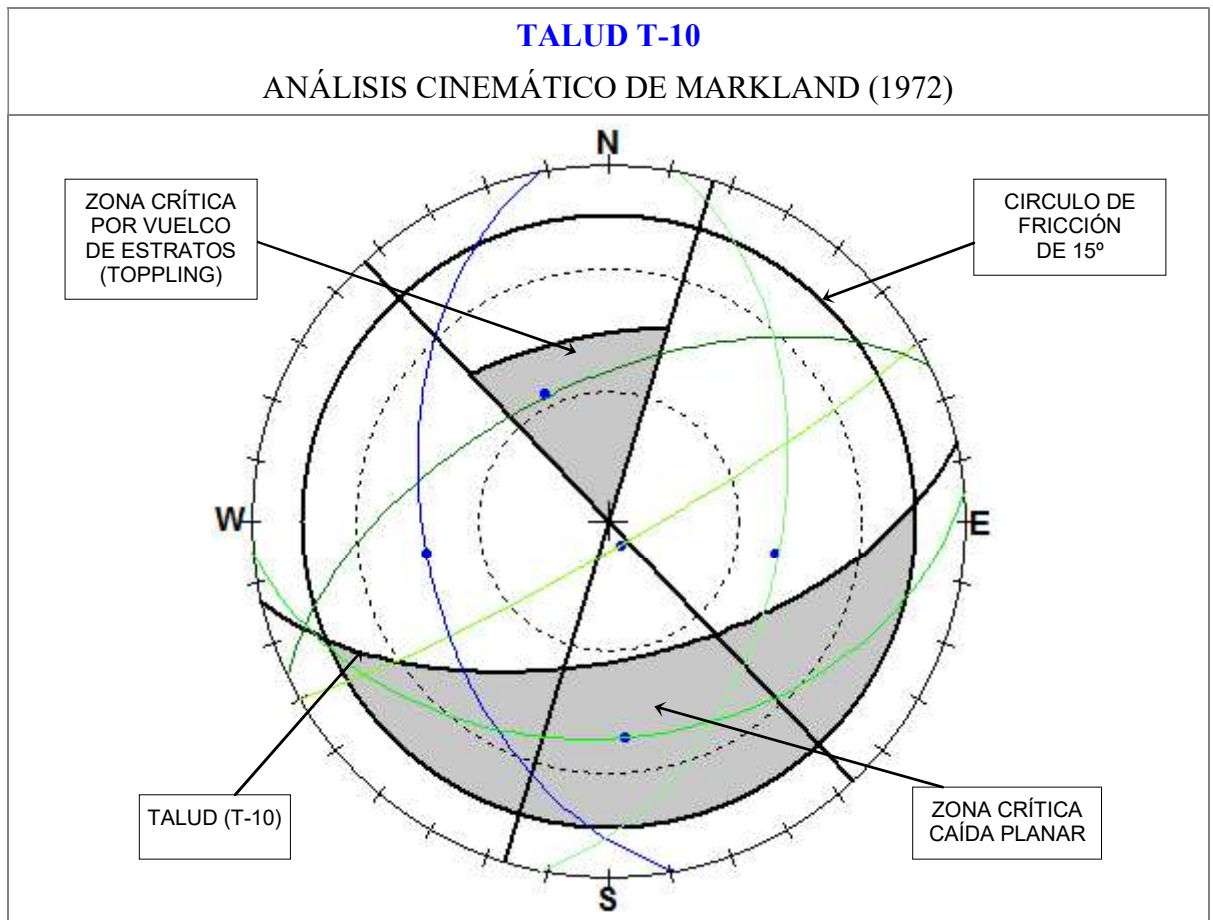
Resultant:

- Trend [deg]: 354.00
- Plunge [deg]: 26.50
- Force [tonnes]: 4.88

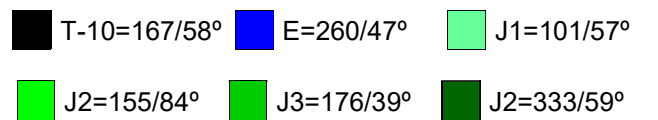
Wedge Vertices:

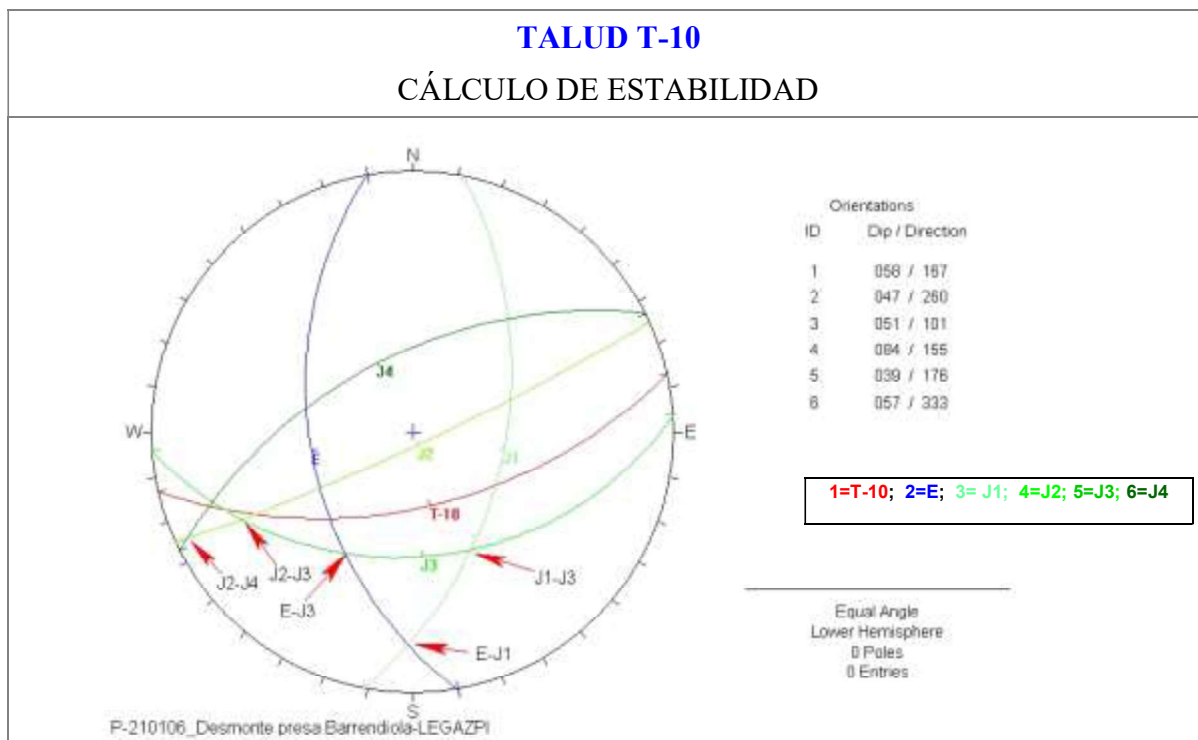
- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	20.8436937037	2.4330016690	0.7879947100
234	2.0191050229	0.4544576716	0.7879947100
123	10.1700742421	3.5251287257	2.2731554264



FAMILIAS DE DISCONTINUIDADES





PARÁMETROS GEOMECÁNICOS

COHESIÓN $C = 0 \text{ t/m}^2$; FRICCIÓN $\phi_e = 15^\circ$; $\phi_j = 30^\circ$; $u = 0$; DENSIDAD $\gamma = 2,6 \text{ t/m}^3$.

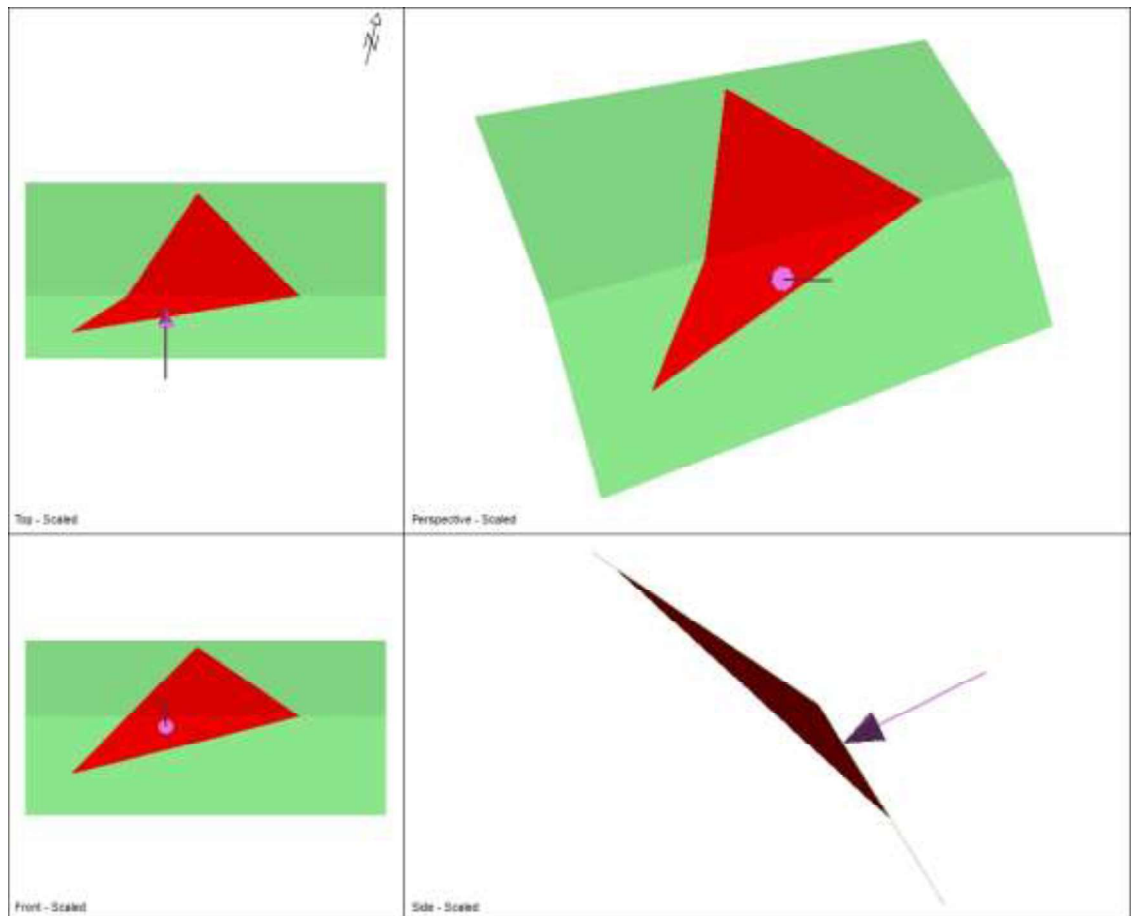
TALUD	INTERSECCIÓN ENTRE PLANOS	TIPO DE DESLIZAMIENTO	FACTOR DE SEGURIDAD (F.S.)	TALUD QUE ELIMINA LA INTERSECCIÓN	FUERZA DE ANCLAJE (1V:2H) NECESARIA PARA F.S.=1,5
T-10	$E \cap J3$	Bloque a través de J3	0,71	42°	1,40 t/m ²
T-10	$J1 \cap J3$	Cuña a través de intersección	0,84	37°	1.80 t/m ²
T-10	$J2 \cap J3$	Bloque a través de J3	0,71	52°	0,40 t/m ²

CONCLUSIONES

- Talud estructural estable en roca sana: 37°

TALUD T-10. INTERSECCIÓN E-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (E-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.5778
- Safety Factor: 1.4997
- Wedge height (on slope) [m]: 4.04
- Bench width (on upper face) [m]: 7.22
- Wedge volume [m³]: 33.939
- Wedge weight [tonnes]: 88.242
- Wedge area (joint1) [m²]: 11.56
- Wedge area (joint2) [m²]: 85.75
- Wedge area (slope) [m²]: 28.76
- Wedge area (upper face) [m²]: 52.49

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	103.93
Effective Normal stress [t/m^2]	0.00	1.21
Shear Strength [t/m^2]	0.00	0.70
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 40.01
- Resisting force [tonnes]: 60.00

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
34.12	209.19	15.89

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	6.17	10.00
Joint 2	16.67	11.26

Persistence:

- Joint 1 [m]: 15.89
- Joint 2 [m]: 16.67

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	34.03	68.85
Joint 1 & Crest	129.34	60.51
Joint 2 & Crest	16.63	50.65

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	47.00	260.00
Joint Set 2	39.00	176.00
Slope	58.00	167.00
Upper Face	34.00	167.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 15.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 7.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	347.00	39.15

Resultant:

- Trend [deg]: 347.00
- Plunge [deg]: 26.50
- Force [tonnes]: 39.15

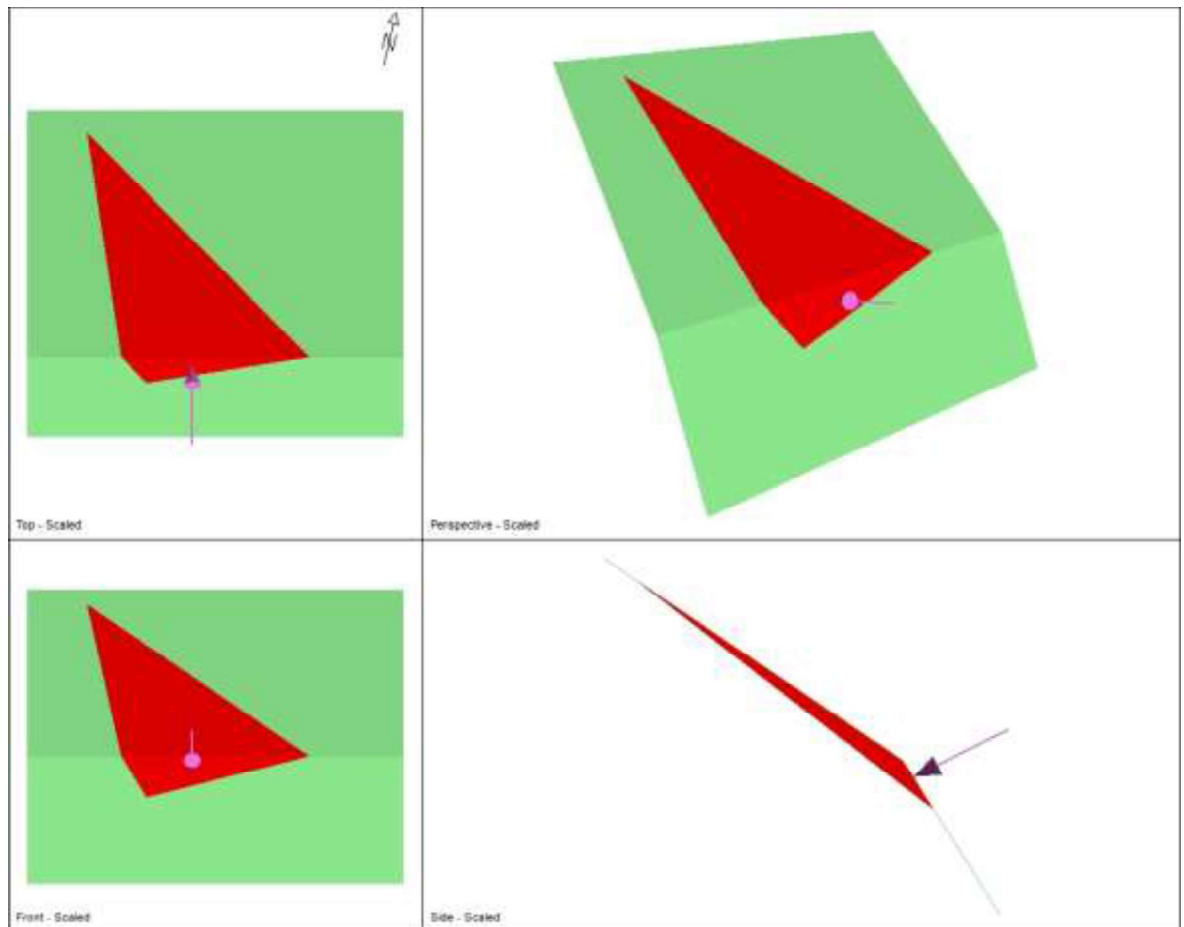
Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	3.2403544324	3.3417601649	4.0443492941
234	14.9923267971	6.0549167669	4.0443492941
123	6.4141390998	11.4803477105	8.9116363873

TALUD T-10. INTERSECCIÓN J1-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J1-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Wedge is scaled, scale factor: 0.3235
- Safety Factor: 1.5004
- Wedge height (on slope) [m]: 2.26
- Bench width (on upper face) [m]: 12.34
- Wedge volume [m³]: 27.801
- Wedge weight [tonnes]: 72.283
- Wedge area (joint1) [m²]: 11.38
- Wedge area (joint2) [m²]: 82.09
- Wedge area (slope) [m²]: 13.78
- Wedge area (upper face) [m²]: 76.79

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	17.87	67.34
Effective Normal stress [t/m^2]	1.57	0.82
Shear Strength [t/m^2]	0.91	0.47
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 32.79
- Resisting force [tonnes]: 49.20

Failure Mode:

- Sliding on intersection line (joints 1&2)

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
36.83	153.66	17.66

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	3.00	15.00
Joint 2	9.33	19.25

Persistence:

- Joint 1 [m]: 17.66
- Joint 2 [m]: 19.25

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	100.66	32.14
Joint 1 & Crest	62.72	97.21
Joint 2 & Crest	16.63	50.65

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	51.00	101.00
Joint Set 2	39.00	176.00
Slope	58.00	167.00
Upper Face	34.00	167.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 7.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	347.00	24.55

Resultant:

- Trend [deg]: 347.00
- Plunge [deg]: 26.50
- Force [tonnes]: 24.55

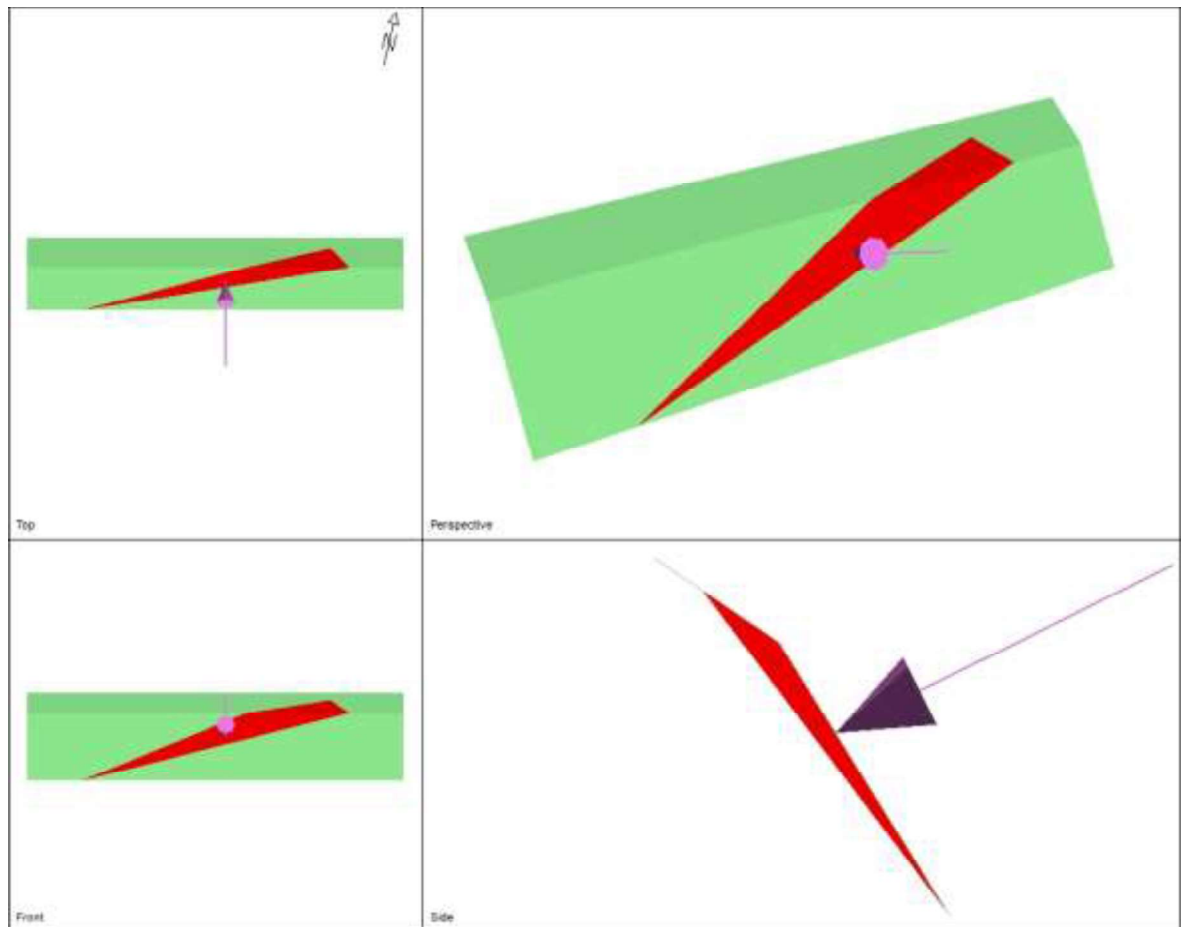
Wedge Vertices:

- Coordinates in Easting,Northing,Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	-1.6604200331	1.0690047278	2.2646645074
234	8.3950687519	3.3904972345	2.2646645074
123	-6.2708908517	12.6662503259	10.5861699823

TALUD T-10. INTERSECCIÓN J2-J3

ANÁLISIS DE ESTABILIDAD DE INTERSECCIÓN DE DISCONTINUIDADES



Swedge Analysis Information

Document Name:

- P-210106_Desmonte presa Barrendiola-LEGAZPI (J2-J3)

Project Summary:

- Job Title: P-210106_Desmonte presa Barrendiola-LEGAZPI
- Company: IKERLUR SL
- Date Created: 24/02/2021, 12:34:33

Analysis Results:

- Analysis type: Deterministic
- Safety Factor: 1.4999
- Wedge height (on slope) [m]: 7.00
- Bench width (on upper face) [m]: 1.98
- Wedge volume [m³]: 14.172
- Wedge weight [tonnes]: 36.846
- Wedge area (joint1) [m²]: 19.39
- Wedge area (joint2) [m²]: 40.73
- Wedge area (slope) [m²]: 43.75
- Wedge area (upper face) [m²]: 12.66

Effective Normal and Strength Properties:

	Joint 1	Joint 2
Effective Normal force [tonnes]	0.00	43.40
Effective Normal stress [t/m^2]	0.00	1.07
Shear Strength [t/m^2]	0.00	0.62
Strength due to Waviness [t/m^2]	0.00	0.00

- Driving force [tonnes]: 16.71
- Resisting force [tonnes]: 25.06

Failure Mode:

- Sliding on joint2

Joint Sets 1&2 line of Intersection:

Plunge [deg]	Trend [deg]	Length [m]
17.49	243.10	27.74

Trace Lengths:

	Slope Face [m]	Upper Face [m]
Joint 1	18.93	8.97
Joint 2	28.85	3.09

Persistence:

- Joint 1 [m]: 27.74
- Joint 2 [m]: 28.85

Intersection Angles:

	Slope Face	Upper Face
Joint 1 & Joint 2	9.22	113.90
Joint 1 & Crest	154.15	15.45
Joint 2 & Crest	16.63	50.65

Dip and Dip Direction:

	Dip [deg]	Dip Direction [deg]
Joint Set 1	84.00	155.00
Joint Set 2	39.00	176.00
Slope	58.00	167.00
Upper Face	34.00	167.00

Joint Set 1 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Joint Set 2 Data:

- Cohesion [t/m^2]: 0.00
- Friction Angle [deg]: 30.00

Slope Data:

- Slope height [m]: 7.00
- Rock unit weight [t/m^3]: 2.60
- Water pressures in the slope: NO
- Overhanging slope face: NO
- Externally applied force: YES
- Tension crack: NO

External Force Data:

- Number of external forces: 1

#	Plunge [deg]	Trend [deg]	Force [tonnes]
1	26.50	347.00	16.35

Resultant:

- Trend [deg]: 347.00
- Plunge [deg]: 26.50
- Force [tonnes]: 16.35

Wedge Vertices:

- Coordinates in Easting, Northing, Up Format
- 1=Joint1, 2=Joint2, 3=Upper Face, 4=Slope

Point	x	y	z
124	0.0000000000	0.0000000000	0.0000000000
134	15.6191061703	8.0950966674	7.0000000000
234	25.9488683958	10.4799101872	7.0000000000
123	23.5944694342	11.9689926636	8.3358923915

DISEÑO DE BULONES

Hoja de cálculo según: “*Guía para el diseño y la ejecución de anclajes al terreno en obras de carreteras*” del Ministerio de Fomento

DISEÑO DE BULONES

PERMANENTES

Título TRABAJO	Localidad	Ref.
Estabilización de un desmonte situado en estribo izquierdo de la presa de Barrendiola	LEGAZPI	P-210106

DATOS DE ORIGEN		Valor	Ud
Carga nominal del anclaje	P_N	25	tn
Coefficiente de mayoración	F1	1.50	
Diámetro de la barra	ϕ	125	mm
Número Pi	π	3.14159265	
Sección del tirante	A_T	122.72	cm ²
Perímetro nominal del tirante	p_T	39.27	cm
Diámetro nominal del bulbo	D_N	0.125	m
Límite de rotura acero	f_{pk}	5,600	kg/cm ²
Límite elástico acero	f_{yk}	5,100	kg/cm ²
Resistencia hormigón	f_{ck}	30	MPa
Adherencia límite tirante-lechada	τ_{lim}	8.36	MPa
Adherencia límite de la roca	a_{lim}	0.8	MPa
Coefficiente	F3	1.65	

1- MAYORACIÓN DE CARGAS ACTUANTES

$$1.1 - P_{Nd} = F1 \times P_N$$

Carga nominal πP_{Nd} 37.5 tn

2- TENSIÓN ADMISIBLE DEL ACERO DEL TIRANTE

$$2.1 - \frac{P_{Nd}}{A_T} \leq \frac{f_{pk}}{1.30}$$

$$0.31 \leq 4.31$$

CUMPLE

$$2.2 - \frac{P_{Nd}}{A_T} \leq \frac{f_{yk}}{1.15}$$

$$0.31 \leq 4.43$$

CUMPLE

3- DESLIZAMIENTO DEL TIRANTE EN LA LECHADA

$$3.1 - \frac{P_{Nd}}{(L_b \times p_T)} \leq \frac{\tau_{lim}}{1.2}$$

Longitud de cálculo de bulbo

$$L_b > 0.14 \text{ m}$$

4- ARRANCAMIENTO DEL BULBO

$$4.1 - \frac{P_{Nd}}{(\pi \times D_N \times L_b)} \leq$$

Adherencia admisible del bulbo

$$a_{adm} = a_{lim} / F3$$

$$49.44 \text{ tn/m}^2$$

Longitud de cálculo de bulbo

$$L_b > 1.93 \text{ m}$$