Module Interface Specification for Slope Stability Analysis

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June 19, 2018

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1 Notation

The SSP uses four data types of: Boolean, Real, String, and Sequence. These data types are summarized in the following table. The table lists the name of the data type, its notation method, and a description of the data type.

Data Type	Notation	Description
Boolean	$\mathbb{B}$	A value from the set of true, false
Real	$\mathbb{R}$	Any number in $(-\infty, \infty)$.
String	'string'	A finite sequence of ordered ASCII characters.
Sequence of T	$[T]$	A sequence of any dimension, where T is the type of every element in the sequence. A sequence with specified dimensions will have the superscripts a and b.
Tuple	struc	An unordered sequence of independent data elements, where the data elements are referenced by field name.

In appropriate situations sequences of data elements are stored as tuples. The tuple, referred to as a structure or struc, contains an unordered sequence of independent data elements, where the data elements are referenced by field name. When referencing a structure in the document a link to an appendix section, that identifies the structures different fields with: name, data type and physical description, will be provided.

2 Numerical Algorithms

Morgenstern Price (Section 6)

The non-linear nature of the systems of equations in the Morgenstern Price solver algorithm requires that solutions to the equations for the unknown values: *F_MP* (IM**??**), *Lam* (IM**??**) and *E_force* (IM**??**) are solved iterativley, with an initial guess for two of the values, typically *F_MP* and *Lam*.

RFEM (Section 7)

The non-linear nature of the systems of equations in the RFEM solver algorithm, requires that the solution is done iteratively. The process implemented in the program is as follows. The stiffness constants are calculated as in DD**??** of the SRS, assuming no displacements, and the applied load *gLoad* is calculated as in GD**??** of the SRS. This is used to calculate the displacements *gDisp* as in IM**??**. The calculated displacements can then be used to recalculate the stifness constants, and the reactive force *dLoad* IM**??**. Calculations repeat until the applied load, and the reactive force are in equilibrium.

Genetic Algorithm (Section 8)

The uses a genetic algorithm to find the vertex coordinates of the slip surface that minimizes the factor of safety, as seen in IM**??**. The genetic algorithm will generate new slip surfaces based on merging and mutating previously known slip surfaces with low factors of safety. When a minimum factor of safety cant be found after several iterations the factor of safety is considered minimized, and the critical slip has been found.

3 Module Guide

The module decomposition can be found in table **??**, and the module use hierarchy in figure **??** of the MG.

4 MIS of the Control Module

4.1 Module Name: Control.m

4.2 Uses

4.2.1 Imported Access Programs

Uses Input Module - section 5, **Passes** N/A, **Receives** *params_layers*, *params_piez*, *params_search*, *params_load*, *params_soln*

Uses Genetic Algorithm Module - section 8, **Passes** *params_layers*, *params_piez*, *params_piez*, *params_load*, *params_soln*, **Receives** *cslip*

Uses Output Module - section 13, **Passes** *params_layers*, *params_piez*, *params_load*, *params_soln*, *cslip*, **Receives** N/A

4.3 Interface Syntax

4.3.1 Exported Access Programs

Name	**In**	**Out**	**Exceptions**
Control	-	-	-

4.4 Interface Semantics

4.4.1 State Variables

params_layers : struc_layers (Appendix 14.1.1)

params_piez : struc_piez (Appendix 14.1.2)

params_soln : struc_soln (Appendix 14.1.4)

params_search : struc_search (Appendix 14.1.3) *params_load* : struc_load (Appendix 14.1.5)

cslip : $[\mathbb{R}]^{2,\text{nslip}}$ Sequence of vertex coordinates describing the geometry of the critical slip surface of the slope. Sequence length value *nslip* is defined by the Genetic Algorithm Module (section 8).

4.4.2 Access Program Semantics

Input:
Control does not receive any external input.

Exceptions:
There are no potential exceptions for control.

Output:
Control does not return any values; however, it does control the overall operation of the program. This is done through a series of function calls to the functions provided by the imported modules. The basic flow of the data is: Input, Genetic Algorithm, Output.

5 MIS of the Input Module

5.1 Module Name: Input.m

5.2 Interface Syntax

5.2.1 Exported Access Programs

Name	In	Out	Exceptions
Input	'string' (file); bools; reals	struc; struc; struc; struc; struc	input file error

5.3 Interface Semantics

5.3.1 Environment Variables

board : keyboard

in_file : file

5.3.2 Access Program Semantics

Input:
Accepts a path to a file name. file type is readable by Matlab, and is constructed in the format seen in appendix **??**. Command line prompts will control user input values as boolean or real

values through the keyboard environment.

Exceptions:
An input data file that does not follow intended input format will generate an input file error.

Output:

params_layers : struc_layers	(Appendix 14.1.1)
params_piez : struc_piez	(Appendix 14.1.2)
params_search : struc_search	(Appendix 14.1.3)
params_soln : struc_soln	(Appendix 14.1.4)
params_load : struc_load	(Appendix 14.1.5)

6 MIS of the Morgenstern Price Solver Module

6.1 Module Name: MorgPriceSolver.m

6.2 Uses

6.2.1 Imported Access Programs

Uses PropertySorter - section 9, **Passes** *evalslip*, *params_layers*, *params_piez* **Recieves** *params_soilInterior*, *params_soilBase*, *params_internalForce*, *params_angles*

6.3 Interface Syntax

6.3.1 Exported Access Programs

Name	**In**	**Out**	**Exceptions**
Morgenstern Price Solver	Sequence; struc; struc; struc; struc	Real	Non Converging; Spurious *F_MP*

6.4 Interface Semantics

6.4.1 Local Constants

F_MinLim : ℝ — The minimum factor of safety value that the solution must be above to not be considered spurious. [*F_MinLim*=0.5]

max_iter : ℝ — The max number of iterations the algorithm will perform before the solution is considered non converging. [*max_iter*=20] *eps_F* : $\mathbb{R}$ — The value the absolute difference between the factor of safety calculated by the algorithm between consecutive iterations must be below for the answer to be considered converged. [*eps_F*=1E-6]

eps_Lam : $\mathbb{R}$ — The value the absolute difference between the interslice normal to shear force ratio calculated by the algorithm between consecutive iterations must be below for the answer to be considered converged. [*eps_Lam*=1E-6]

6.4.2 State Variables

Lam : $\mathbb{R}$ — The interslice normal to shear force ratio. From IM**??** of the SRS.

E_force : $[\mathbb{R}]^{1,n+1}$ — Sequence of the value of the interslice normal force exerted between slices. A value for each interslice, including ends. Sequence length value n is defined by the input *evalslip*. From IM**??** of the SRS.

Del_F : $\mathbb{R}$ — The difference between the factor of safety of the current iteration and the previous iteration. When converged the value will not be changing and *Del_F* will be small.

Del_Lam : $\mathbb{R}$ — The difference between the interslice normal to shear force ratio of the current iteration and the previous iteration. When converged the value will not be changing and *Del_Lam* will be small.

6.4.3 Access Program Semantics

Input:

evalslip : $[\mathbb{R}]^{2,n+1}$ — Vertex coordinates for the slip surface being evaluated. Identifies shape of the slope, and slice points. Sequence length value of n is defined by the Slicer module (section 10).

params_layers : struc_layers — (Appendix 14.1.1)

params_piez : struc_piez — (Appendix 14.1.2)

params_soln : struc_soln — (Appendix 14.1.4)

params_load : struc_load — (Appendix 14.1.5)

Exceptions:
A solution which does not converge to a consistent solution, where the change in calculated factor of safety (*Del_F*) between iterations is less than *eps_F*, and the change in interslice normal to shear force ratio (*Del_Lam*) is less than *eps_Lam*, in less than *max_iter* iterations will be considered non converging exception case. A solution with a final calculated a factor of safety less than *F_MinLim* will be considered a spurious factor of safety exception case. Solutions that trigger these exception cases will output a factor of safety (*F_MP*) of 1000.

Output:

$F\_MP : \mathbb{R}$ The factor of safety of the slope, as calculated by the Morgenstern Price solution method, measuring the stability of the slope. From IM?? of the SRS.

7 MIS of the RFEM Solver Module

7.1 Module Name: RFEMSolver.m

7.2 Uses

7.2.1 Imported Access Programs

Uses Property Sorter - section 9, **Passes** *evalslip*, *params_layers*, *params_piez* **Receives** *params_soilInterior*, *params_soilBase*, *params_internalForce*, *params_angles*

7.3 Interface Syntax

7.3.1 Exported Access Programs

Name	In	Out	Exceptions
RFEM Solver	Sequence; struc; struc; struc; struc	Real; Sequence; Sequence; Sequence	Non Converging

7.4 Interface Semantics

7.4.1 Local Constants

$F\_MinLim : \mathbb{R}$ The minimum factor of safety value that the solution must be above to not be considered spurious. [F_MinLim=0.5]

7.4.2 State Variables

$gLoad : [\mathbb{R}]^{1,2n}$ Sequence of the applied load placed on the slice elements. x-ordinate and y-ordinate value for each slice. Sequence length value n is defined by the input *evalslip*. From GD?? of SRS.

$dLoad : [\mathbb{R}]^{1,2n}$ Sequence of the internal resistive force exerted by the slice elements that oppose the applied load forces. x-ordinate and y-ordinate value for each slice. Sequence length value n is defined by the input *evalslip*. From DD?? of SRS.

$gDisp : [\mathbb{R}]^{1,2n}$ Sequence of the total displacement the slice elements have experienced. x-ordinate and y-ordinate value for each slice. Sequence length is defined by the input *evalslip*. From IM?? of SRS.

7.4.3 Access Program Semantics

Input:

evalslip : $[\mathbb{R}]^{2,n+1}$	Sequence of vertex coordinates for the slip surface being evaluated. Identifies shape of the slope, and slice points. Sequence length value n is defined by the Slicer module (section 10).
params_layers : struc_layers	(Appendix 14.1.1)
params_piez : struc_piez	(Appendix 14.1.2)
params_soln : struc_soln	(Appendix 14.1.4)
params_load : struc_load	(Appendix 14.1.5)

Exceptions:
A calculated global factor of safety of less than *F_MinLim*, will be considered non converging and the factor of safety *F_RFEM*, and slice local factors of safety *FLoc_RFEM* will be set equal to 1000, and the displacement vectors *DispX* and *DispY* will be set to empty vectors.

Output:

F_RFEM : $\mathbb{R}$	The factor of safety of the slip surface as calculated by the RFEM solution method, measuring the stability of the slope. From IM**??**.
FLoc_RFEM : $[\mathbb{R}]^{1,n}$	Sequence of the factors of safety for the individual slices in the slip surface, identifying the sections of the slope most vulnerable to failure. A value for each slice. Sequence length value n is defined by the input *evalslip*. From IM**??** of the SRS.
DispX : $[\mathbb{R}]^{1,n}$	Sequence of the displacements the slice elements of the slope will experience in the x-ordinate direction to establish equilibrium. Sequence length n is defined by the input *evalslip*. From IM**??** of the SRS.
DispY : $[\mathbb{R}]^{1,n}$	Sequence of the displacements the slice elements of the slope will experience in the y-ordinate direction to establish equilibrium. Sequence length n is defined by the input *evalslip*. From IM**??** of the SRS.

8 MIS of the Genetic Algorithm Module

8.1 Module Name: GenAlgModule.m

8.2 Uses

8.2.1 Imported Access Programs

Uses MorgPrice Module - section 6, **Passes** *evalslip*, *params_layers*, *params_piez*, *params_soln*, *params_load*, **Receives** F_MP_i

Uses Slicer Module - section 10, **Imports** $slip_i$, **Receives** *evalslip*

Uses Kin Admissibility Module - section 11, **Imports** $slip_i$, *strat1*, **Receives** *KinPass*, $slip_i$

Uses Slip Weights Module - section 12, **Imports** *pool*, **Receives** *pool*

8.3 Interface Syntax

8.3.1 Exported Access Programs

Name	**In**	**Out**	**Exceptions**
GenAlg	struc; struc; struc; struc; struc	Array	None

8.4 Interface Semantics

8.4.1 Local Constants

nslip : $\mathbb{R}$ The number of vertices the generated slip surfaces will be described by. [nslip=13]

Mpool : $\mathbb{R}$ The number of slip surfaces that will be in the pool of potential critical slip surfaces. [Mpool=40]

8.4.2 State Variables

pool : $[[\mathbb{R}]^{2,\text{nslip}}, \mathbb{R}, \mathbb{R}]^{1,\text{Mpool}}$ A sequence of data describing the slip surfaces that are currently being considered as possible critical slip surfaces. Contains three data elements describing the slope: A sequence of coordinates describing the geometry of the slip surface ($[\mathbb{R}]^{2,\text{nslip}}$), the factor of safety of the slip surface ($\mathbb{R}$), and a weighting value describing the surfaces factor of safety relative to the other slip surfaces in the pools factors of safety ($\mathbb{R}$).

8.4.3 Access Program Semantics

Input:

params_layers : struc_layers (Appendix 14.1.1)

params_piez : struc_piez (Appendix 14.1.2)

params_search : struc_search (Appendix 14.1.3)

params_soln : struc_soln (Appendix 14.1.4)

params_load : struc_load (Appendix 14.1.5)

Exceptions:
There are no potential exceptions for GenAlg.

Output:

cslip : $[\mathbb{R}]^{2,\text{nslip}}$	Sequence of vertex coordinates describing the geometry of the critical slip surface of the slope.

9 MIS of the Property Sorter Module

9.1 Module Name: PropertySorter.m

9.2 Interface Syntax

9.2.1 Exported Access Programs

Name	In	Out	Exceptions
Property Sorter	Sequence; struc; struc	struc; struc; struc; struc	None

9.3 Interface Semantics

9.3.1 Access Program Semantics

Input:

evalslip : $[\mathbb{R}]^{1,n}$	Sequence of vertex coordinates for the slip surface being evaluated. Identifies shape of the slope, and slice points. Sequence length value n is defined by the Slicer module (section 10).
params_layers : struc_layers	(Appendix 14.1.1)
params_piez : struc_piez	(Appendix 14.1.2)

Exceptions:
There are no potential exceptions for Property Sorter.

Output:

params_internalForce : struc_intForce	(Appendix 14.1.6)
params_angles : struc_angles	(Appendix 14.1.7)
params_soilInterior : struc_soilInt	(Appendix 14.1.8)
params_soilBase : struc_soilBase	(Appendix 14.1.9)

10 MIS of the Slip Slicer Module

10.1 Module Name: Slicer.m

10.2 Interface Syntax

10.2.1 Exported Access Programs

Name	**In**	**Out**	**Exceptions**
Slicer	Sequence; bool	Sequence	None

10.3 Interface Semantics

10.3.1 Local Constants

n : $\mathbb{R}$ The number of slices the slip surface will be broken into for evaluation. [n=36]

10.3.2 Assumption

A straight line describing the slip surface is assumed between adjacent vertex coordinates given in the input *slip*.

10.3.3 Access Program Semantics

Input:

$slip$: $[\mathbb{R}]^{2,\text{nslip}}$ Sequence of vertex coordinates of the slip surface being sliced.

$evnslc$: $\mathbb{B}$ Slicing method switch, an element from the *params_soln* structure (Appendix 14.1.4).

Exceptions:
There are no potential exceptions for Slip Slicer.

Output:

$evalslip$: $[\mathbb{R}]^{1,n}$ Sequence of vertex coordinates for the slip surface being evaluated. Identifies shape of the slope, and slice points.

11 MIS of the Kinematic Admissibility Module

11.1 Module Name: KinAdm.m

11.2 Interface Syntax

11.2.1 Exported Access Programs

Name	**In**	**Out**	**Exceptions**
Kin Adm	Sequence; Sequence; struc	bool; Sequence	None

11.3 Interface Semantics

11.3.1 Assumption

A straight line describing the slip surface is assumed between adjacent vertex coordinates given in the input *slip*.

11.3.2 Access Program Semantics

Input:

$slip : [\mathbb{R}]^{2,\text{nslip}}$	Sequence of vertex coordinates of the slip surface being tested. Sequence length value *nslip* is defined by the Genetic Algorithm module (section 8).
$strat1 : [\mathbb{R}]^{2,\text{nvtx}}$	Sequence of the coordinates of the vertexes from the uppermost stratigraphic layer of the slope. Sequence length value *nvtx* is defined by the given input file.
$params\_soln$: struc	(Appendix 14.1.4)

Exceptions:
There are no potential exceptions for KinAdm.

Output:

$KinPass : \mathbb{B}$	Identifies if the input slip surface (*slip*) has passed the admissibility criterion for a slip surface. If true than the slip surface has passed. If false than the slip surface has failed.
$slipPass : [\mathbb{R}]^{1,\text{nslip}}$	Sequence of the slip surface given as input (*slip*) with end vertexes adjusted to ensure they are on the slope surface.

12 MIS of the Slip Weighting Module

12.1 Module Name: SlipWeighter.m

12.2 Interface Syntax

12.2.1 Exported Access Programs

Name	In	Out	Exceptions
Slip Weighting	Sequence; Real	Sequence	None

12.3 Interface Semantics

12.3.1 Access Program Semantics

Input:

$pool\_In : [[\mathbb{R}]^{2,\text{nslip}}, \mathbb{R}, \mathbb{R}]^{1,\text{Mpool}}$ A sequence of data sets describing the slip surfaces that are currently being considered as possible critical slip surfaces. Contains three data elements describing the slope: coordinates describing the geometry of the slip surface ($[\mathbb{R}]^{2,\text{nslip}}$),the factor of safety of the slip surface ($\mathbb{R}$), and a weighting value describing the surfaces factor of safety relative to the other slip surfaces in the pools factors of safety ($\mathbb{R}$). Sequence length values *nslip*, and *Mpool* are defined by the Genetic Algorithm Module (section 8).

$Mpool : \mathbb{R}$ The number of slip surfaces in the pool of possible critical slip surfaces being compared and weighting. constant defined in the Genetic Algorithm module (section 8).

Exceptions:
There are no potential exceptions for Slip Weighter.

Output:

$pool\_Out : [[\mathbb{R}]^{2,\text{nslip}}, \mathbb{R}, \mathbb{R}]^{1,\text{Mpool}}$ The sequence given in *pool_In*, with the weight data element recalculated, and the sequence reordered in terms of ascending factors of safety.

13 MIS of the Output Module

13.1 Module Name: Output.m

13.2 Uses

13.2.1 Imported Access Programs

Uses Slicer Module - section 10, **Passes** *cslip*, *evnslc*, **Receives** *eval_cslip*

Uses Morgenstern Price Module - section 6, **Passes** *eval_cslip*, *params_layers*, *params_piez*, *params_load*, *params_soln* **Recieves** *F_MP_Final*

Uses RFEM Module - section 7, **Passes** *eval_cslip*, *params_layers*, *params_piez*, *params_load*, **Receives** *F_RFEM_Final*, *FLoc_RFEM_Final*, *DispX_Final*, *DispY_Final*

13.3 Interface Syntax

13.3.1 Exported Access Programs

Name	**In**	**Out**	**Exceptions**
Output	Sequence; struc; struc; struc; struc	-	None

13.4 Interface Semantics

13.4.1 State Variables

F_MP_Final : $\mathbb{R}$ — The factor of safety as calculated by the Morgenstern Price solution method for the critical slip surface, measuring the stability of the slope.

F_RFEM_Final : $\mathbb{R}$ — The factor of safety as calculated by the RFEM solution method for the critical slip surface, measuring the stability of the slope.

FLoc_RFEM_Final : $[\mathbb{R}]^{1,n}$ — Sequence of the factors of safety for the individual slices along the critical slip surface, identifying the sections of the slope most vulnerable to failure, as calculated by the RFEM solution method. Sequence length value n is defined by the Slicer Module (section 10).

DispX_Final : $[\mathbb{R}]^{1,n}$ — Sequence of the displacement the slice elements of the slope will experience in the x-ordinate direction to achieve equilibrium for the critical slip surface, as calculated by the RFEM solution method. Sequence length value n is defined by the Slicer Module (section 10).

DispY_Final : $[\mathbb{R}]^{1,n}$	Sequence of the displacement the slice elements of the slope will experience in the y-ordinate direction to achieve equilibrium for the critical slip surface, as calculated by the RFEM solution method. Sequence length value n, is defined by the Slicer Module (section 10).

13.4.2 Access Program Semantics

Input:

cslip : $[\mathbb{R}]^{2,\text{nslip}}$	Sequence of vertex coordinates for the critical slip surface of the slope.
params_layers : struc_layers	(Appendix 14.1.1)
params_piez : struc_piez	(Appendix 14.1.2)
params_soln : struc_soln	(Appendix 14.1.4)
params_load : struc_load	(Appendix 14.1.5)

Exceptions:
There are no potential exceptions for Output.

Output:
Output does not return any values; however, it creates a plot of the critical slip surface *cslip* as a part of the slope geometry *strat* (from *params_layers*). The plot also displays the displacements the slice elements experience as calculated by the RFEM method in *DispX_Final* and *DispY_Final*. A second plot displaying the value of the local factors of safety at each element *FLoc_RFEM_Final*, and the global factors of safety calculated by the Morgenstern Price module *F_MP_Final*, and by the RFEM module *F_RFEM_Final* on the same plot as straight lines across each element.

14 Appendix

14.1 Parameter Tables

14.1.1 Layer Parameters

The elements in the structure of the containers for the parameters of different slope layers. Assumed that the parameters will be entered such that sequence progresses from the uppermost stratigraphic layer at the first index, to the lowest stratigraphic layer at the last index. *nlayer* refers to the number of soil layers in the slope, and is defined by the input file.

Parameter	**Description**
strat : $[[\mathbb{R}]^{2,\text{nvtx}}]^{1,\text{nlayer}}$	Sequence of coordinate sequences describing the vertexes of each layer. The value *nvtx* is defined by the input file, and can be different for each sequence.
phi : $[\mathbb{R}]^{1,\text{nlayer}}$	Sequence of the effective angle of friction for each stratigraphic layer.
coh : $[\mathbb{R}]^{1,\text{nlayer}}$	Sequence of the effective cohesion for each stratigraphic layer.

gam : $[\mathbb{R}]^{1,\text{nlayer}}$	Sequence of the dry unit weight of soil for each stratigraphic layer.
gams : $[\mathbb{R}]^{1,\text{nlayer}}$	Sequence of the saturated unit weight of soil for each stratigraphic layer.
E : $[\mathbb{R}]^{1,\text{nlayer}}$	Sequence of the Young's modulus for each stratigraphic layer.
nu : $[\mathbb{R}]^{1,\text{nlayer}}$	Sequence of the poissons ratio for each stratigraphic layer.

14.1.2 Piezometric Parameter

The elements in the structure for parameters relating to the piezometric surface existing on the slope. *npz* refers to the number of vertexes describing the piezometric surface, and is defined by the input file.

Parameter	**Description**
piez : $[\mathbb{R}]^{2,\text{npz}}$	Sequence of vertex coordinates describing the geometry of the water table. If there is no water table than *piez* is an empty array.
gamw : $\mathbb{R}$	The unit weight of water.

14.1.3 Search Range Parameters

The elements in the structure for parameters relating to the range of coordinates the critical slip surface will be searched for in.

Parameter	**Description**
Xext : $[\mathbb{R}]^{1,2}$	Sequence of the range of x-ordinates that the exit point of the slip will be searched for in. Exit refers to the point of the slip at lower elevation that the slope mass will move towards during failure.
Xent : $[\mathbb{R}]^{1,2}$	Sequence of the range of x-ordinates that the entry point of the slip will be searched for in. Entry refers to the point of the slip at higher elevation that the slope mass will move away from during failure.
Ylim : $[\mathbb{R}]^{1,2}$	Sequence of range of y-ordinates that the slip will be searched for in. The larger value should be greater than the max y-ordinate of the slope. The smaller Ylim value is the deepest the slip surface is expected to descend to.

14.1.4 Solution Parameters

The elements in the structure for parameters relating to method in which the solution method will be approached.

Parameter	Description
ltor : $\mathbb{B}$	Direction the slope is expected to experience failure in. If true than the side of the slope with a greater x-ordinate value is at a lower elevation. If false than the side of the slope with a greater x-ordinate is at a higher elevation.
ftype : $\mathbb{B}$	Switch between functions to use for interslice shear/normal inclination function. If true then the inclination function is a constant (Spencer's method). If false then the inclination function is a half-sine (standard Morgenstern Price method).
evnslc : $\mathbb{B}$	Switch between method of slicing a slip surface to when preparing for analysis. If true then slice slip surface into equal x-ordinate widths. If false then slice distance between vertices into even number of slices.
cncvu : $\mathbb{B}$	Switch for concave slip surface admissibility criterion. If true then an admissible slip surface must be concave upwards towards the surface. If false then an admissible slip surface does not need to pass this criterion.
obtu : $\mathbb{B}$	Switch for angle limit slip surface admissibility criterion. If true then an admissible slip surface must have all interior angles greater than a set limit. If false then an admissible slip surface does not need to pass this criterion.

14.1.5 Load Force Parameters

The elements in the structure for parameters relating to the forces acting on a slice caused by external sources or loads. n refers to the number of slices composing the slip surface.

Parameter	Description
Kc : $\mathbb{R}$	The seismic load factor. The ratio of the weight force of the slope that be exerted outwards as a result of vibrations of the earth's surface. From DD**??** of the SRS.
Q : ??	An applied load being exerted into the slope surface. From DD**??** of the SRS.
omega : ??	The angle the applied load is being exerted into the slope surface. From DD**??** of the SRS.

14.1.6 Internal Force Parameters

The elements in the structure for parameters relating to the forces acting on a slice caused by the slope, and water in the slope acting on itself. n refers to the number of slices composing the evaluation slip surface, and is defined by the Slicer module (section 10).

Parameter	Description
Ub : $[\mathbb{R}]^{1,n}$	Sequence of the force acting on the basal surface of a slice as a result of pore water pressure within the slice. Value for each slice. From DD**??** of the SRS.
Ut : $[\mathbb{R}]^{1,n}$	Sequence of the force acting on the upper surface of a slice as a result of pore water pressure standing water on the surface. Value for each slice. From DD**??** of the SRS.
W : $[\mathbb{R}]^{1,n}$	Sequence of the downward force acting on the slice caused by the mass of the slice and the force of gravity. Value for each slice. From DD**??** of the SRS.
H : $[\mathbb{R}]^{1,n-1}$	Sequence of the force acting into the interslice surfaces as a result of pore water pressure within the adjacent slices. Value for each interslice. From DD**??** of the SRS.

14.1.7 Angle Parameters

The elements in the structure for parameters relating to the angles of the slice surfaces. n refers to the number of slices composing the slip surface, and is defined by the input *evalslip* given to the Property Sorter module (section 9).

Parameter	Description
Alpha : $[\mathbb{R}]^{1,n}$	Sequence of the angle that the basal surface of the slice makes with the horizontal. Value for each slice. From DD**??** of the SRS.
Beta : $[\mathbb{R}]^{1,n}$	Sequence of the angle that the upper surface of the slice makes with the horizontal. Value for each slice. From DD**??** of the SRS.

14.1.8 Soil Interslice Properties

The elements in the structure for parameters relating to the soil properties of the slope, as calculated at the interslice interfaces of an evaluation slip. Calculation is based on the ratio of the interface that is in different stratigraphic layers, and the values of the effective angle of friction in the different layers. Interest is only with the interior interslice interfaces therefore for a slope of n slices, there will be $n-1$ interior interslice interfaces. The value n is defined by the input *evalslip* given to the Property Sorter module (section 9).

Parameter	Description
phi_IS : $[\mathbb{R}]^{1,n-1}$	Sequence of the vector of the effective angle of friction calculated at each interslice interface.

coh_IS $:= [\mathbb{R}]^{1,n-1}$	Sequence of the vector of the effective cohesion calculated at each interslice interface.
E_IS $:= [\mathbb{R}]^{1,n-1}$	Sequence of the vector of the Youngs modulus calculated at each interslice interface.
nu_IS $:= [\mathbb{R}]^{1,n-1}$	Sequence of the vector of the Poisson ratio calculated at each interslice interface.

14.1.9 Soil Base Properties

The elements in the structure for parameters relating to the soil properties of the slope, as calculated at the basal surfaces of an evaluation slip. Calculation is based on the ratio of the basal surface that is in different stratigraphic layers, and the values of the effective angle of friction in the different layers. An evaluation slip of n slices will have n basal surfaces, and the value of n is defined by the input *evalslip* given to the Property Sorter module (section 9).

Parameter	**Description**
phi_Base $: [\mathbb{R}]^{1,n}$	Sequence of the vector of the effective angle of friction calculated at each slice basal surface in an evaluation slip.
coh_Base $: [\mathbb{R}]^{1,n}$	Sequence of the vector of the effective cohesion calculated at each slice basal surface in an evaluation slip.
E_Base $: [\mathbb{R}]^{1,n}$	Sequence of the vector of the Young's modulus calculated at each slice basal surface in an evaluation slip.
nu_Base $: [\mathbb{R}]^{1,n}$	Sequence of the vector of the Poisson ratio calculated at each slice basal surface in an evaluation slip.