Deltares

Enabling Delta Life

DAM UI

Functional Design

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DAM UI

Functional Design

1210702-000

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Title
DAM UI

Client	Project	Reference	Pages
Deltares - Geo engineering DKS	1210702-000	1210702-000-GEO-0003	30

Classification
-

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Dike, safety assessment, design, software, macro stability, piping

Summary
This document contains the functional design for DAM UI, a software module that computes the strength of a complete dikering with respect to several failure mechanisms, such as macro stability and piping.

Samenvatting
Dit document bevat het functioneel ontwerp voor DAM UI, een software module die een gebruiker in staat stelt om voor een dijktraject berekeningen uit te voeren voor verschillende faalmechanismen, waaronder macrostabiliteit en piping.

References
Refer to chapter 12.

Version	Date	Author	Initials	Review	Initials	Approval	Initials
0.1	sep 2019	Irene van der Zwan		Kin Sun Lam André Grijze		Leo voogt	

Status
draft
This is a draft report, intended for discussion purposes only. No part of this report may be relied upon by either principals or third parties.

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1 Introduction

1.1 Purpose and scope of this document

This document contains the functional design for the DAM UI, a user interface for the DAM Engine. The DAM Engine is designed for the automated calculation of the strength of dikes. DAM was developed by Deltares with and for STOWA for all water authorities. This document describes requirements and functional design of DAM UI. What will actually will be implemented depends on the requirements of the clients using this DAM UI. If some functionality is not (yet) needed, then that part does not need to be implemented.

1.1.1 Future options

As mentioned above this document contains some options that will not be implemented in the first release, but are foreseen to be implemented in the near future. Therefore although sometimes a reference will be made to these options, these will not be described in detail yet.

That applies in particular to the following subjects:

- NWO module("Niet Waterkerende Objecten")
- WBI failure mechanisms (Piping, Macrostability)

1.2 Other system documents

The full documentation on the program comprises the following documents.

Title	Content
DAM UI- Architecture Overall (The, 2017a)	Description of overall architecture of the DAM UI and its components.
DAM UI- Functional Design (Zwan, 2017)	Description of the requirements and functional design.
DAM UI- Technical Design (The, 2017b)	Description of the implementation of the technical design of DAM UI.
DAM UI- Technical documentation (Doxygen, 2017)	Description of the arguments and usage of different software components, generated from in-line comment with Doxygen.
DAM UI- Test Plan (Trompille, 2017a)	Description of the different regression and acceptation tests, including target values.
DAM UI- Test Report (Trompille, 2017b)	Description of the test results (benchmarks and test scripts).
Architecture Guidelines (Kleijn *et al.*, 2017)	Architecture guidelines that are used by DSC-Deltares.

Table 1.1: *DAM UI system documents.*

1.3 Document revisions

1.3.1 Revision 0.1

First concept of the document.

2 Non-functional requirements

3 Functional requirements

Main purpose of the DAM UI The DAM UI can import data and combines this data to make geotechnical calculations. After calculations (made by DAM Engine) the DAM UI shows the results and make analyzation possible.

3.1 User story Open project

As a geotechnical engineer I want to open existing projects to see what data is used and which calculations are made with what result.

3.2 User story Data format

As a geotechnical engineer I want to store my data in a predescribed format, so that I can reuse the data. The design of this functionality is described in chapter 5.

3.3 User story GIS Data combination

As a geotechnical engineer I want to combine GIS data per location, so that I don't have to do that by hand. The design of this functionality is described in section 6.2

3.4 User story Soil Data combination

As a geotechnical engineer I want to combine subsoil with surfaceline per location, so that I don't have to draw 2D geometries. The design of this functionality is described in section 6.3

3.5 User story DAM Live configuration

As a geotechnical engineer I want to make a DAM Live configuration, so that I can make calculations with DAM engine, using sensors for the input of piezometric lines. The design of this functionality is described in chapter 7.

3.6 User story Data display

As a geotechnical engineer I want to see the data per location in tables, cross section and map view, so I can check the data before calculation. The design of this functionality is described in **??**.

3.7 User story Data editing

As a geotechnical engineer I want to edit the data per location, so I can adept the data before calculation. The design of this functionality is described in chapter 8.

3.8 User story Calculation settings

As a geotechnical engineer I want to see and be able to adept the calculations settings, so I can decide what calculations are made. The design of this functionality is described in chapter 9.

3.9 User story Display results

As a geotechnical engineer I want to see the results of the calculations of the DAM Engine, so I can evaluate the calculations.

3.10 User story Export data

As a geotechnical engineer I want to export data as tables (CSV-format) and/or shapes, so I can use the data for other purposes. The design of this functionality is described in chapter 10.

4 Open Project

To be able to open a project, the user must be able to build a project, to save it and to open it.

4.1 Building a project

The user can define a project by defining different sources, see chapter 5 and chapter 6

4.2 Saving a project

The project can be saved at a location defined by the user.

4.3 Opening a project

The user must be able to open an excisting project. When calculations were made, also the calculation results must be shown. When a project is calculated in a previous version of DAM (i.e. DAM 18.1 instead of 19.1), the calculations must not be shown because the calculations can be outdated due to newer versions of used kernels.

5 Data format

Validation is done during three phases: import, editing in UI and for calculation.

5.1 Validation during import

All required and optional import data is placed in table OverviewDataUIAndEngine.xlsx, tab DAM_input.

DAM UI can import data from csv files and shape files The sequence of import is 1. csv files (except scenarios.csv), overwritten by: 2. shape files, overwritten by: 3. scenario.csv If data is not present during import the default value is used, when a default is available. Default values are mentioned in OverviewDataUIAndEngine.xlsx

Required data Data can be required when importing and/or required when calculating. In OverviewDataUIAndEngine.xlsx is described what data is required and when. Example: crosssection and dikering_ are only required when using shapefiles (see column remark).
If data is required for import and is missing or invalid, the exception handling is dependent of the kind of data, see Table 5.1. Messages are given in the log window.

Parameter	Exception handling
location_id in location.csv (or via shape)	All locations with missing location_id are not imported and message is given.
location_id in scenarios.csv (or via shape)	All scenarios with missing location_id are not imported and message is given.
surfaceline in location.csv_id	All locations with missing surfaceline_id are not imported and message is given.
Profielnaam in surfacelines.csv_id	All surfacelines with missing surfaceline_id are not imported and message is given.
dikering_id via shape	Project is not imported and message is given.
segment_id in locations.csv or via shape	All locations with missing segment_id are not imported and message is given.
segment_id in segment.csv	All locations using segments with missing segment_id are not imported and message is given.
calculation_type in segments.csv	All locations using segments with missing calculation_type are not imported and message is given.
soilprofile_id in segments.csv	All locations using segments with missing soilprofile_id are not imported and message is given.
top_level in soilprofiles.csv	All locations linked (via segment) to soilprofiles with missing top_level are not imported and message is given.
location_scenario_id	All scenarios with missing location_scenario_id are not imported and message is given.
characteristic points (required)	All locations with missing required characteristic points are not imported and message is given.
crosssection (via shape)	All locations with missing cross section are not imported and message is given.

Table 5.1: *Exception handling required data during import*

In OverviewDataUIAndEngine.xls, tab DAM_input also the optional data is listed. If these parameters are not present, no error or warning is given. When a default is available, this value is used, otherwise the parameters is NULL. If the parameter is required for calculation and the value is NULL and the kernel does not provide a default, an error message is given.

5.1.1 Editing characteristic points

When the characteristic points are edited by the user in the UI, they must be validated by rules in following table. Blue text validations are not implemented yet.

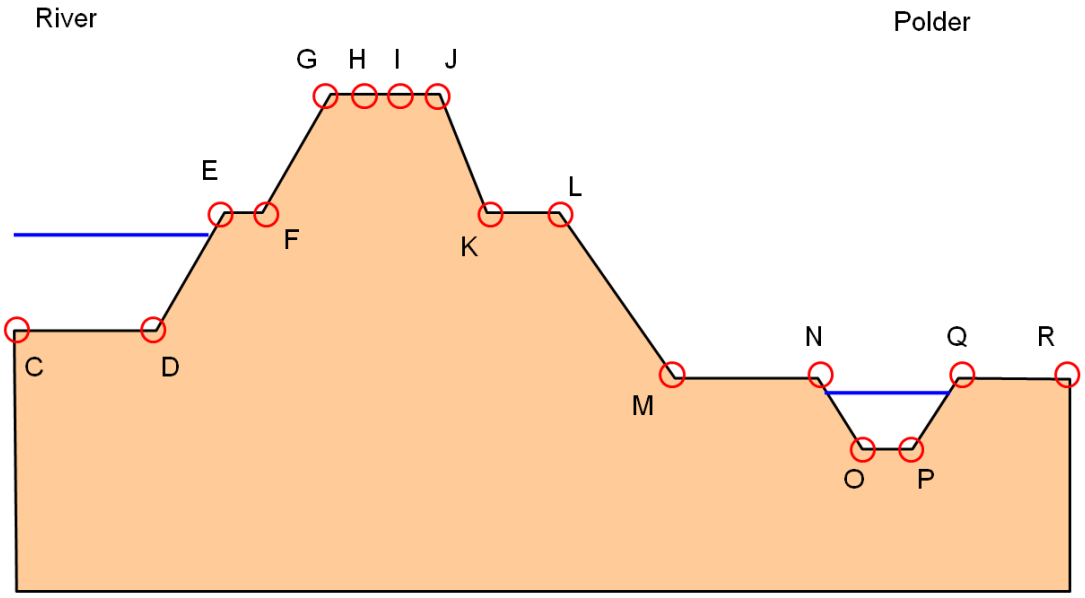

Figure 5.1: *Characteristic points on the surface line*

Name EN	Name NL	Symbol	Unit	Min value	Max value
Surface level outside	Maaiveld buitenwaarts	X_C	m	-	-
		Z_C	m NAP	-	-
Dike toe at river	Teen Dijk buitenwaarts	X_D	m	$>X_C$	$<X_E$
		Z_D	m NAP	$>Z_C$	$<Z_G$
Shoulder top outside	Kruin buitenberm	X_E	m	$>X_D$	$<X_F$
		Z_E	m NAP	$>Z_D$	$<Z_F$
Shoulder base outside	Insteek buitenberm	X_F	m	$>X_E$	$<X_G$
		Z_F	m NAP	$>Z_E$	$<Z_G$
Dike top at river	Kruin buitentalud	X_G	m	$>X_F$	$<X_H$
		Z_G	m NAP	$>Z_D$	-
Traffic load outside	Verkeersbelasting buitenwaarts	X_H	m	$>X_C$	$<X_I$
		Z_H	m NAP	$>Z_G$	$<Z_I$
Traffic load inside	Verkeersbelasting binnenwaarts	X_I	m	$>X_H$	$<X_S$
		Z_I	m NAP	$>Z_H$	$<Z_J$
Dike top at polder	Kruin binnentalud	X_J	m	$>X_I$	$<X_K$
		Z_J	m NAP	$>Z_M$	-
Shoulder base inside	Insteek binnenberm	X_K	m	$>X_J$	$<X_L$
		Z_K	m NAP	$>Z_J$	$<Z_L$
Shoulder top inside	Kruin binnenberm	X_L	m	$>X_K$	$<X_M$
		Z_L	m NAP	$>Z_K$	$<Z_M$
Dike toe at polder	Teen dijk binnenwaarts	X_M	m	$>X_L$	$<X_N$
		Z_M	m NAP	$>Z_L$	$<Z_J$
Ditch dike side	Insteek sloot dijkzijde	X_N	m	$>X_M$	$<X_O$
		Z_N	m NAP	$>Z_M$	$<Z_O$
Bottom ditch dike side	Slootbodem dijkzijde	X_O	m	$>X_N$	$<X_P$
		Z_O	m NAP	$>Z_N$	$<Z_P$
Bottom ditch polder side	Slootbodem polderzijde	X_P	m	$>X_O$	$<X_Q$
		Z_P	m NAP	$>Z_O$	$<Z_Q$
Ditch polder side	Insteek sloot polderzijde	X_Q	m	$>X_P$	$<X_R$
		Z_Q	m NAP	$>Z_P$	$<Z_R$
Surface level inside	Maaiveld binnenwaarts	X_R	m	-	-
		Z_R	m NAP	-	-

If a required characteristic point is missing, (validation)message must be given: Characteristic point <Name> is missing.
Required characteristic points are:

- Surface level outside
- Dike toe at river
- Dike top at river
- Dike top at polder

- Dike toe at polder
- Surface level inside

If a set of characteristic points is not complete, (validation)message must be given: Set Characteristic points <Name> is not complete. NL: Set karakteristieke <Naam> is niet compleet. Sets of characteristic points (Name and points from table) are:

- TrafficLoad (H and I in table) NL: Verkeersbelasting
- ShoulderOutside (E and F in table) NL: Buitenberm
- ShoulderInside (K and L in table) NL: Binnenberm
- Ditch (N,O,P and Q in table) NL: Sloot

Note: All sets are optional, but when one of the characteristic points is asigned, the others of the set must also be present.

5.2 Validation during editing

DAM UI validates during the import of the data and during editing by user in the User interface. Minimal and maximum values are given in OverviewDataUIAndEngine.xlsx. The data is also validated by the used kernels when calculations are started.

5.3 Validation for calculation

DAM UI validates during the import of the data and during editing by user in the User interface. The data is also validated by the used kernels when calculations are started. Messages are given in the log window.

6 Data combination

DAM can generate input for the kernels by combining the data from the source files. This is done by linking via the location id and via GIS-files (see section 6.2).

6.1 Id/Name

The data is combined by matching Id's (Names) between the several data sources. Not all characters can be used when defining Id's. The following characters are valid:
"ABCDEFGHIJKLMNOPQRSTUVWXYZ"
"abcdefghijklmnopqrstuvwxyz"
"01234567879"
"!#$% &()*+,-."
":;<=>?@"
"[\]^_`"
"{|}~"
" " (space)
A validation of the Id's must be done when performing the data combination.

6.2 Data extraction

The locations are described with a name and RD-coordinates; a point element in GIS files. Each location is connected to a crosssection; a line element in GIS files.

The combination of data from GIS files is made based on these point and line elements.
If the input data is available in a GIS file with line elements the data is collected at the intersection of the crosssection with the line element, see Figure 6.1.

When a parameter is available in a line shape, DAM UI will check, during import of data, if the cross section of a location intersects the shapefile of the parameter. When so, this parameter is connected to this location. If a cross section intersects more than one line of the shapefile, no parameters are connected at all and a message is given that this location is not imported.

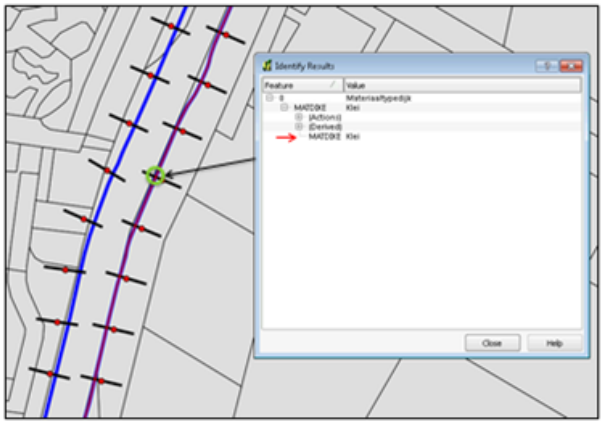

Figure 6.1: *Data is collected from the line element at the intersection*

If the input data is available in a GIS file with area elements the data is collected at from the area where the location point is situated, see Figure 6.2.

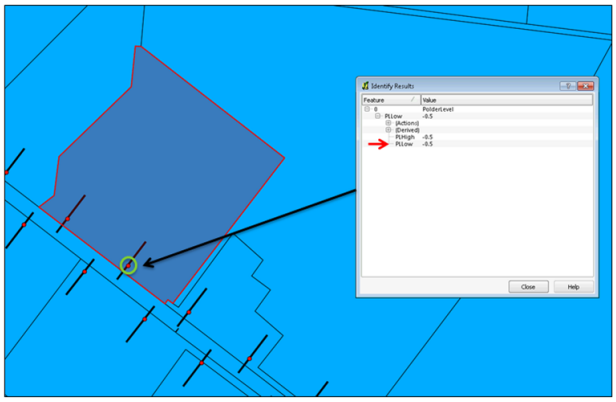

Figure 6.2: *Data is collected from the area element where the location point is situated*

If the inputdata is not available in GIS files, all input data can be linked to each location via a table (csv-format).

6.3 Geometry Generation

The DAM UI can combine a surface line with a subsoil scenario. The result is a geometry, usable for the failure mechanism Macrostability.

6.4 Subsoil

The subsoil model is made up of the following elements:

- Soil segments
- Soil profiles
- Soil layers
- Soil materialparameters

A soil segment is located on a map and can contain several soil scenarios. A soil scenario is a combination of a soil profile and its probability. Each soil profile is build up from layers (1D-profile) or areas (2D-profile). A layer (or area) has the name of a material. And finally this material is described via soil type and several parameters (such as strength parameters).
All is displayed in Figure 6.3.

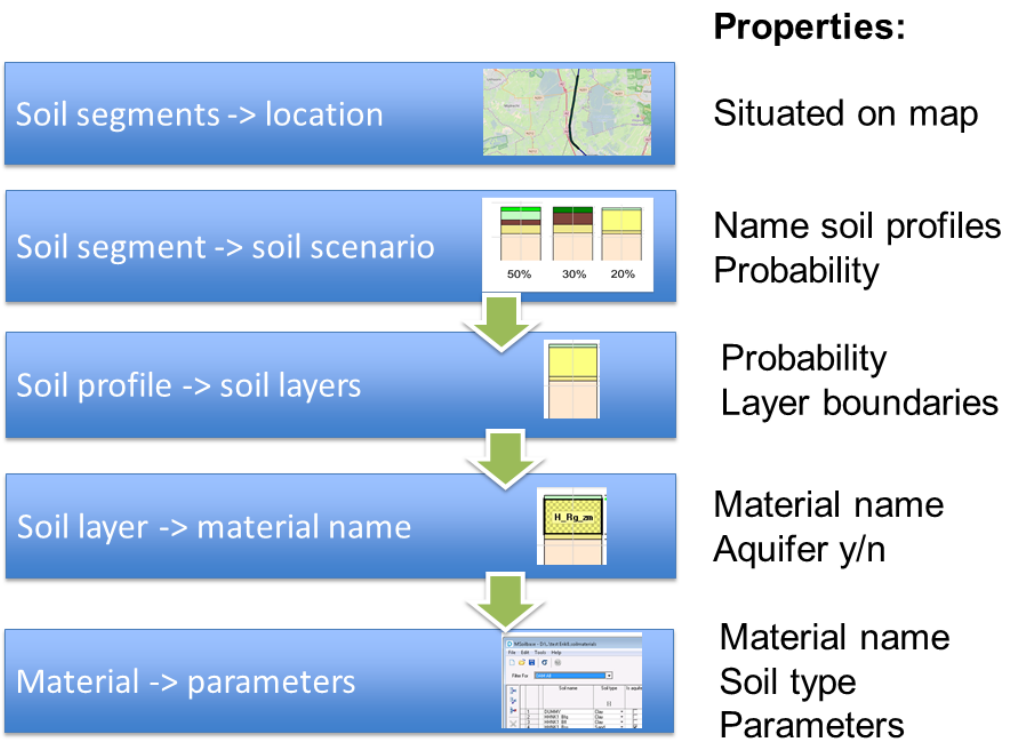

Figure 6.3: *The elements of the subsoil model and their properties*

By linking the location to a soil segment via the locations.csv column segment_id, DAM UI combines the location to all soil profiles of the soil segment. The use of D-Soil Model for this purpose is decribed in chapter 11. The procedure for combining a surfaceline with a soil profile is described in section 6.5.

6.5 Combination of surface line with soil profile

6.5.1 Combination of surface line with a 1D soilprofile

A 1D soil profile is a summation of layers with layer boundaries (Z-values) and materialnames. Combination with a surfaceline is uncomplicated if all the Z-values of the surface line are within the boundaries of the soil profile. If not, the user can define a filling material.

6.5.2 Transfer of 1D soilprofile

The user can vertically transfer the 1D profiles by defining a characteristic point as a reference level. This means that the Z-value of the characteristic point is the top of all 1D-soilprofiles of that location. This reference level is given per project. So if the surfacelevelinside is the reference, for each location the 1D-soilprofiles will start at the Z-value of the surfacelevelinside of that location. On top of the 1D soilprofile the filling material is used.

6.5.3 Combination of surface line with a 2D soilprofile

A 2D profile already has a topboundary with different Z-values. Combination with a surface line is more complicated since this top boundary and surfacel may differ in X and/or Z-values. The origin of the surfaceline can differ from the origin of the top boundary of the soil profile. The user can define this difference. The surfaceline is determing the final length of the combinated 2D-profile. If the surface line xxx soil profile length: subsoil at the right side will be deleted If the surface line xxx soil profile length: subsoil at the right side will be generated with Z-values at boundary.

7 DAM Live Configuration

7.1 Introduction

For DAM Live configuration the same data input as for Design is needed. The extra input concerns sensor data, which is described in this chapter.

7.2 Locations

For each location the schematisation of the piezometric lines must be defined, as well as the group of sensors used. This data is provided in the sensordata file under tabular SensorProfileID. Here the following data must be provided:

Parameter	Description
locationID	Numbering of locations to make linking possible
Profile	Unique name, equal ot name of location_id in locations.csv
NameAlias	An optional name to add information about the sensor
SensorGroup	Unique ID of the group of sensors, see section 7.4
InputPL1OuterWaterLevel	Method for defining the value of this point Options: Ignore: point is not schematized Sensor: value from sensor is used LocationData: value from scenarios.csv is used.
InputPL1PLLineOffsetBelowDikeTopAtRiver	idem
InputPL1PLLineOffsetBelowDikeTopAtPolder	idem
InputPL1PLLineOffsetBelowShoulderBaseInside	idem
InputPL1PLLineOffsetBelowDikeToeAtPolder	idem
InputPL1PolderLevel	idem
InputPL3	idem
InputPL4	idem

Table 7.1: *Sensor Profile*

7.3 Sensors

For each sensor must be defined location, use for which piezometric level and sensortype. This data is provided in the sensordata file under tabular SensorID.

Parameter	Description
ID	Unique ID of the sensor
SensorName	Name of the sensor. For FEWS this must be corresponding with the name in the time-series.
RelativeLocationSensorAlongProfileManual	Location of the sensor, relative to the start of the profile (x=0)
RelativeLocationSensorFromDikeLine	Location of the sensor, relative to a dike line (X=X-Dike crest at river) of the profile
DepthSensor	Level of the sensor
PLLine-Mapping	Corresponding piezometric level
SensorType	Options: WaterLevel; a sensor indicating water level (used for PL1) PiezoMetricHead; a sensor indicating water pressure (used for PL 2,3 or 4).

Table 7.2: *Sensors*

7.4 Grouping sensors

The sensors are grouped per location. This data is provided in the sensordata file under tabular SensorGroupID.

Parameter	Description
ID	Id of the group of sensors, equal to SensorGroup in **??**
SensorSelection	Id's of the sensor belonging to the group

Table 7.3: *Sensor Group*

7.5 Dike line in Profile

To define the dike line information about the profile is needed. This data is provided in the sensordata file under tabular DikeLineInProfile.

Parameter	Description
locationID	idem as in Table 7.1
Profile	idem as in Table 7.1
RelativeLocationDikeLineAlongProfile	idem as in Table 7.2
ProfileLength	Length of profile in meters

Table 7.4: *Dike line in profile*

8 Data edit

8.1 Navigator

Data in Navigator window is not editable. Only locations are selectable.

8.2 Tables

In https://repos.deltares.nl/repos/dam/DamOverall/trunk/doc/DAM General/OverviewDataUIAndEngine.xlsx column Editable in UI is given which data should be editable It is not possible to add locations.

8.3 Cross section

Data in cross section is not editable.

8.4 Properties

How the data is editable varies from tab:

- Tab Location
  Data is similar editable as locations tab in table window.
- Tab Location scenarios
  Data is editable, but it is not possible to add scenarios.
- Tab Surface line (NL-Hoogte geometrie)
  The column characteristic points is editable via a pull down menu with characteristic points. The pull down menu contains all possible characteristic points. The validation is done directly; so if an user changes something incorrect in the surface line window, validation message appears in Validation window. Validation rules are described in section 5.1.1. Note: The surface line points can not be edited, so after import it is not possible to let a traffic load point coincide with another characteristic point. Traffic load points can only coincide with a another characteristic point when it is defined in the import files.
- Tab Calculations
  Data is not editable.

9 Calculation settings

9.1 Macrostability

9.2 Piping

9.2.1 Models

In DAM the following piping models can be used:

- Bligh
- Sellmeijer VNK
- Sellmeijer 4 forces
- Sellmeijer revised (WBI)

For the description of the models, see https://publicwiki.deltares.nl/display/DAM/Piping

10 Data export

The user must be able to export the following data from DAM UI:

Surfacelines with characteristic points The surface lines and the corresponding characteristic points must be exported in the same format as the import files. Its is a complete set of all locations of the project.

Scenarios file

Calculation file

Calculation image

11 Use of D-Soilmodel

D-Soil Model is used for the import of subsoil and geometry. D-Soil Model and DAM 18.1 use the similar source files, see table

To way to use the projectname.soil instead of the separate source files is described in this chapter, devided per source file.

11.1 Soilmaterials
11.2 Soilprofiles-1D
11.3 Soilprofiles-2D
11.4 Segments
11.5 Geometry

DAM 18.1	D-Soil Model	DAM 19.1
soilmaterials.mdb	soilmaterials.mdb	
soilprofiles.csv	soilprofiles.csv	
segments.csv	segments.csv	projectnaam.soil
segments.shp	segments.shp	
surfacelines.csv	surfacelines.csv	
characteristicpoints.csv	characteristicpoints.csv	
locations.csv		locations.csv
scenarios.csv		scenarios.csv
shp-bestanden		shp-bestanden

12 Literature

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Appendix