DAMLive

Functional Design

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1210702-000

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Title
DAMLive

Client	**Project**	**Reference**	**Pages**
Deltares - Geo engineering DKS	1210702-000	1210702-000-GEO-0003	14

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-

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

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

Samenvatting
Dit document bevat het functioneel ontwerp voor DAMLive, een software module die een gebruiker in staat stelt om voor een dijktraject sterkteberekeningen uit te voeren aan de hand van monitoringsdata en voor verschillende faalmechanismen, waaronder macrostabiliteit en piping.

References
Refer to chapter 4.

Version	Date	Author	Initials	Review	Initials	Approval	Initials
0.1	Sep 2018	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 DAMLive. The DAMLive is designed for the automated calculation of the strength of dikes with the use of the DAM Engine. DAM was developed by Deltares with and for STOWA for all water authorities. This document describes requirements and functional design of DAMLive. What will actually will be implemented depends on the requirements of the clients using this DAMLive. 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:

- —-
- —-

1.2 Other system documents

The full documentation on the program comprises the following documents.

Title	Content
DAMLive Architecture Overall (The, 2017a)	Description of overall architecture of DAM and its components.
DAMLive- Functional Design (Zwan, 2017)	Description of the requirements and functional design.
DAMLive- Technical Design (The, 2017b)	Description of the implementation of the technical design of DAM Engine.
DAMLive- Technical documentation (Doxygen, 2017)	Description of the arguments and usage of different software components, generated from in-line comment with Doxygen.
DAMLive- Test Plan (Trompille, 2017a)	Description of the different regression and acceptation tests, including target values.
DAMLive- 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: *DAMLive system documents.*

1.3 Document revisions

1.3.1 Revision 0.1

First concept of the document.

2 Functional requirements

Main purpose of DAMLive DAMLive can combine a dam project with sensor data to calculation input for the DAM Engine. After calculations made by DAM Engine DAMLive can produce an output files with results.

2.1 REQ Import.Project

DAMLive can import an excisting project. The functionality of DAM UI for making this project is described in **??**.

2.2 REQ Data.Format

DAMLive has a defined format for the sensor data input, so DAMLive users know how to arrange the sensor data. The design of this functionality is described in **??**.

2.3 REQ Data.Content

DAMLive has a defined content for the data input, so DAMLive users know which input data to provide.
The design of this functionality is described in **??**.

2.4 REQ Data.Combination

DAMLive combines sensor data per location with a dam project. The design of this functionality is described in **??**.

2.5 REQ Calc.Settings

DAMLive ables the user to change calculations settings such as failure mechanisms and models.

2.6 REQ Output.data

DAMLive can produce output files.

2.7 REQ Save.Project

The DAMLive can save a project.

3 Calculation Parameters

3.1 DamLiveCalculationParameters.xsd

There are calculation parameters that can be set for the DamLive calculation. You specify them in an XML file that has to conform to the XML scheme "DamLiveCalculationParameters.xsd". The XML contains two main keys:

- CalculationModules
- MStabParamters

3.1.1 CalculationModules

It is possible to simultaneous calculate several failure mechanisms. This is done by setting the XML key for a failure mechanism to 1. The failure mechanisms that can be defined are

- StabilityInside
- StabilityOutside
- PipingWti (not implemented yet)
- PipingBligh (not implemented yet)
- PipingSellmeijer (not implemented yet)

If you select a not implemented failure mechanism, you will get an error message when performing the calculation.
Furthermore there are a couple of failure mechanisms that were available in previous versions but that are now removed. If you specify one of these, you will get an error message:

- Stability (is now StabilityInside)
- PipingSellmeijerProbabilistic
- PipingIJkdijk
- Overtopping

3.1.2 CalculationModules

There are a couple of MStab parameters that can be set. These are:

- IsCalculateAllStabilityProjectsAtOnce
- CalculationModel; supported models:
  - Bishop
  - Spencer
  - Fellenius
  - UpliftVan
  - UpliftSpencer
  - BishopRandomField
  - HorizontalBalance
  - BishopUpliftVan
  - SpencerHigh
  - SpencerLow
- SearchMethod; supported methods:
  - Grid
  - GeneticAlgorithm
- UseZones (boolean)

Furthermore there are a couple of parameters that were available in previous versions but that are now removed. If you specify one of these, you will get an error message.

- Probabilistic
- IsOverrulePLLineCreation
- PLLineCreationMethod

3.1.3 CalcualtionParameters XSD

This is the XML schema file for the calculation parameters file.

```
<?xml version="1.0" encoding="utf-8"?>
<!-- Created with Liquid XML Studio 1.0.8.0 (http://www.liquid-technologies.com) -->
<xs:schema xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" attributeFormDefault="unqualified" elemer
  <xs:element name="CalculationParameters">
    <xs:complexType>
      <xs:sequence>
        <xs:element minOccurs="0" name="CalculationModules">
          <xs:complexType>
            <xs:sequence>
              <xs:element minOccurs="0" maxOccurs="1" name="StabilityInside" type="xs:boolean" />
              <xs:element minOccurs="0" maxOccurs="1" name="StabilityOutside" type="xs:boolean" />
              <xs:element minOccurs="0" maxOccurs="1" name="PipingWti" type="xs:boolean" />
              <xs:element minOccurs="0" maxOccurs="1" name="PipingBligh" type="xs:boolean" />
              <xs:element minOccurs="0" maxOccurs="1" name="PipingSellmeijer" type="xs:boolean" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element minOccurs="0" name="MStabParameters">
          <xs:complexType>
            <xs:sequence>
              <xs:element minOccurs="0" maxOccurs="1" name="IsCalculateAllStabilityProjectsAtOnce" type="x
              <xs:element minOccurs="0" maxOccurs="1" name="CalculationModel">
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:enumeration value="Bishop" />
                    <xs:enumeration value="Spencer" />
                    <xs:enumeration value="Fellenius" />
                    <xs:enumeration value="UpliftVan" />
                    <xs:enumeration value="UpliftSpencer" />
                    <xs:enumeration value="BishopRandomField" />
                    <xs:enumeration value="HorizontalBalance" />
                    <xs:enumeration value="BishopUpliftVan" />
                    <xs:enumeration value="SpencerHigh" />
                    <xs:enumeration value="SpencerLow" />
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
              <xs:element minOccurs="0" maxOccurs="1" name="SearchMethod">
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:enumeration value="Grid" />
                    <xs:enumeration value="GeneticAlgorithm" />
                  </xs:restriction>
                </xs:simpleType>
              </xs:element>
              <xs:element minOccurs="0" maxOccurs="1" name="UseZones" type="xs:boolean" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

4 Literature

Doxygen, 2017. *DAM Engine - Technical documentation, Generated by Doxygen 1.8.10*. Tech. rep., Deltares.

Kleijn, E., A. Grijze, H. Elzinga, S. Hummel and T. The, 2017. *Architecture Guidelines*. Tech. rep., Deltares.

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Appendix

A Sensor Data format

A.1 Location

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 A.1.

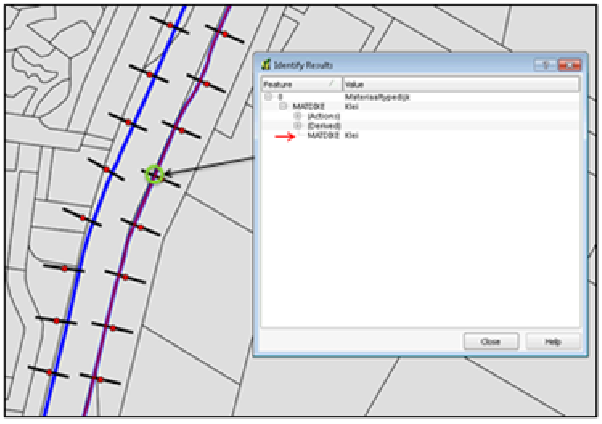

Figure A.1: *Data is collected from the line element at the intersection*

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 A.2.

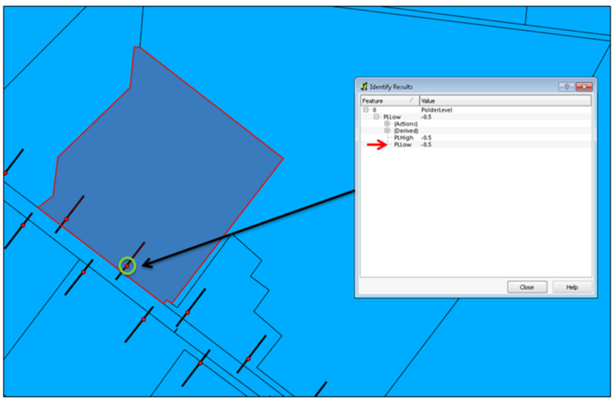

Figure A.2: *Data is collected from the area element where the location point is situated*

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

A.2 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 A.3.

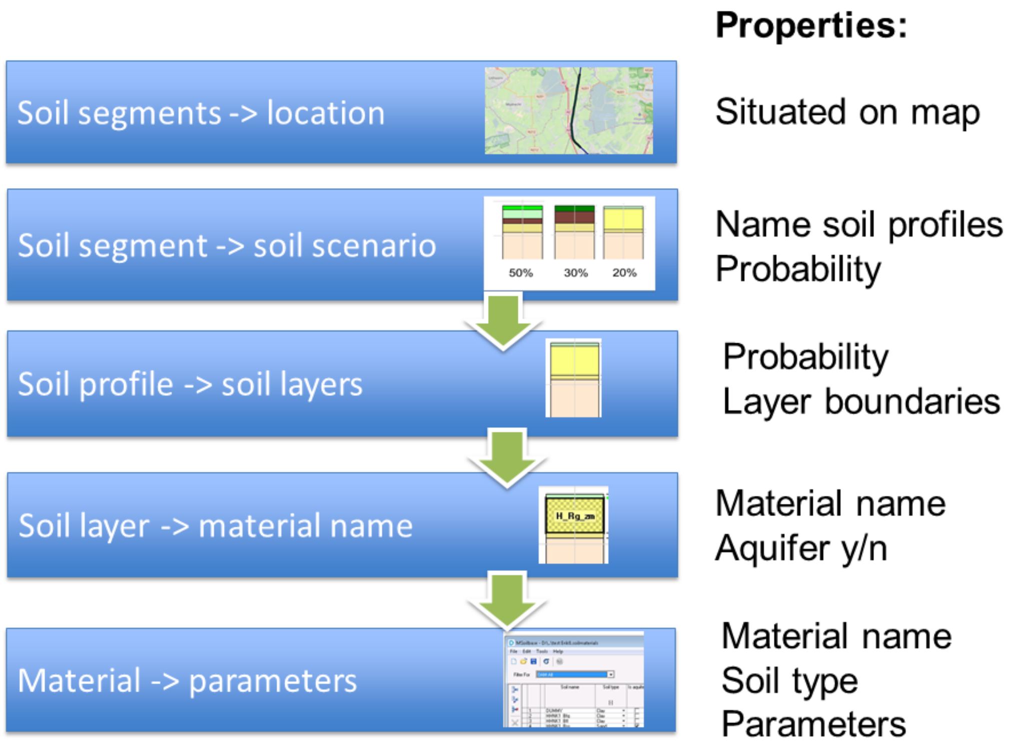

Figure A.3: *The elements of the subsoil model and their properties*

By linking the location to a soil segment, see section A.1, DAMLive combines the location to all soil profiles of the soil segment. The procedure for combining a surfaceline with a soil profile is described in section A.3.

A.3 Combination of surface line with soil profile

A.3.1 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.

A.3.2 Combination of surface line with a 2D soilprofile

A 2D profile already has a topboundary with different Z-values. Combiniation 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.