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Enabling Delta Life

# Piping Doorlatendheid Rekentool

## Functional Design

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# Piping Doorlatendheid Rekentool

**Functional Design**

11202231-002

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**Title**
Piping Doorlatendheid Rekentool

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**Summary**
This document contains the functional design for "Piping Doorlatendheid Rekentool", an application for calculating the equivalent permeability of a two-layer system, to be used in the WBI piping kernel, which only uses one layer.

**Samenvatting**
Dit document bevat het functioneel ontwerp voor "Piping Doorlatendheid Rekentool", een applicatie die de equivalente doorlatendheid berekent voor een tweelagen systeem, om toe te passen op de WBI piping kernel, die enkel 1 laag toestaat.

**References**
-

| Version | Date | Author | Initials | Review | Initials | Approval | Initials |
|---|---|---|---|---|---|---|---|
| 1.0 | July 2018 | Tom The | TT | Virginie Trompille<br>Hans van Putten | VT<br>HP | Marcel van Gent | MvG |

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# 1 Introduction

## 1.1 Application of the kernel

## 1.2 Purpose and scope of this document

This document contains the functional design for the "Piping Doorlatendheid Rekentool", an application for calculating the equivalent permeability of a two-layer system, to be used in the WBI piping kernel, which only uses one layer. This document contains the use cases and functional requirements of the "Piping Doorlatendheid Rekentool".

## 1.3 Related documents

These are the other documents that are related to this project.

***Table 1.1:*** *Overview of related documents for the "Piping Doorlatendheid Rekentool"*

| Document | Reference |
|---|---|
| Manual | (The, 2018a) |
| Technical Design | (Soriano Pérez, 2018a) |
| Technical Documenation | (Doxygen, 2018) |
| Test Plan | (Soriano Pérez, 2018b) |
| Test Report | (Soriano Pérez, 2018c) |

## 1.4 Versions

### 1.4.1 Version 1.0

This is the first version of the document.

# 2 Usage of the tool

This tool can be used in the WBI assessment process with D-Soil Model. If an equivalent permeability has to be determined for a two-layer model in D-Soil Model, this could be done with this tool.

# 3 Assumptions and constraints

1 The "Piping Doorlatendheid Rekentool" is developed in C# and communicates with the Piping Permeability Tool.
2 As a general constraint, the "Piping Doorlatendheid Rekentool" needs to comply with the relevant general requirements and further rules for the programming, documentation and testing of WBI software. This set of requirements and rules is contained in a separate document (De Waal, 2017).

# 4 Use cases

There is only one use case UC.DeterminePermeability, which will be specifed below.

## 4.1 UC.DeterminePermeability

A user wants to calculate the equivalent permeability of a two-layer system to use it in the WBI piping kernel.

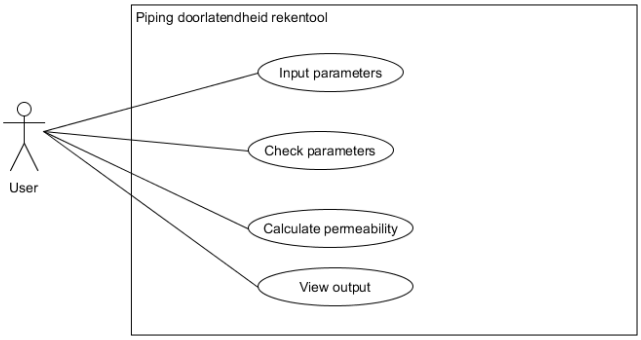


***Figure 4.1:*** *"Piping Doorlatendheid Rekentool" Use case diagram*

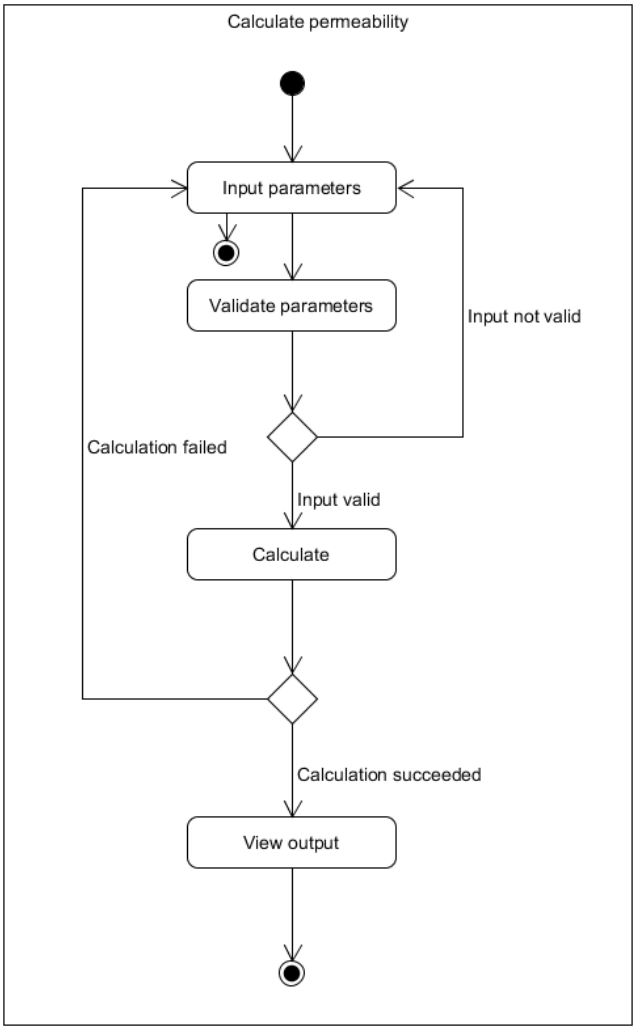


***Figure 4.2:*** *"Piping Doorlatendheid Rekentool" Activity diagram*

# 5 Requirements

## 5.1 Functional Requirements

The functional requirements for the "Piping Doorlatendheid Rekentool" are listed in the table below.

***Table 5.1:*** *Overview of the functional requirements for the "Piping Doorlatendheid Rekentool"*

| | |
|---|---|
| **Input** | |
| Input.Parameters | Input the parameters needed to determine the equivalent permeability for a two-layer system so it can be used in a one layer system. |
| **Validation** | |
| Validate.Input | Validate the input parameters. |
| **Calculation** | |
| Calculate.Permeability | Calculate the equivalent permeability for a two-layer system so it can be used in a one layer system. |
| **Output** | |
| Output.Parameters | View the results of the calculation of the equivalent permeability of the two-layer system so it can be used in a one layer system. |

All these requirements are needed to support the single use case of this system: UC.DeterminePermeability.

## 5.2 Non-functional Requirements

The non-functional requirements for the "Piping Doorlatendheid Rekentool" are listed in the table below.

***Table 5.2:*** *Overview of the non-functional requirements for the "Piping Doorlatendheid Rekentool"*

| | |
|---|---|
| **Calculation** | |
| Language.Dutch | The user interface uses the Dutch language. |
| Performance.Speed | The total calculation itself should not take more than 1 second. |
| Code.Coverage | Code coverage should at least be 80%. |

# 6 Specification of the Requirements

## 6.1 Input.Parameters

A picture is needed to show the user the meaning of the parameters. See Figure 6.1.

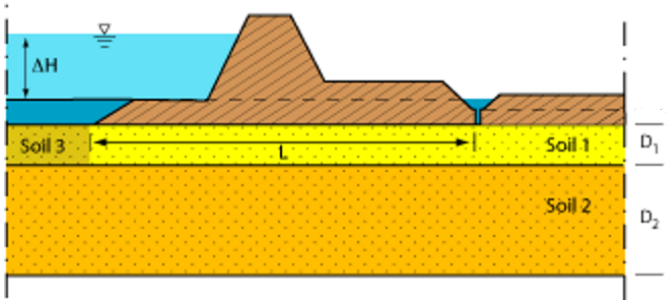


***Figure 6.1:*** *"Piping Doorlatendheid Rekentool" parameters*

For each of the required input parameters the following items should be shown:

- Parameter name
- Input box
- Unit

The input can be split up in 2 sections:

- General parameters
- Geometry and soil parameters

Because one of the constraints is that the application should be in the Dutch language, a table is provided with a Dutch translation of the parameter descriptions. See Appendix B.

### 6.1.1 General parameters

These are the general parameters:

- $\gamma_{\text{sub, p}}$
- $\gamma_{\text{w}}$
- $\nu_{\text{w}}$
- $\eta$
- $\vartheta$

A description of the parameters can be found in Appendix A.

### 6.1.2 Geometry and soil parameters

These are the parameters that apply to the construction and the separate layers:

- $D1$
- $D2$
- $k1$
- $k2$
- $k3$
- $L$

- $d_{70}$
- $d_{70m}$

A description of the parameters can be found in Appendix A.

**Note:** The unit of $d_{70}$ and $d_{70m}$ to be used for the Piping Permeability Tool is [m], but for ease of use for the user the unit used in the "Piping Doorlatendheid Rekentool" will be [$\mu$m].

### 6.2 Validate.Input

All parameters should be checked whether they are within a valid range. The minimum and maximum values of the parameters can be found in Appendix A.

### 6.3 Calculate.Permeability

The equivalent permeability can be calculated with the Piping Permeability Tool. The functional design of the Piping Permeability Tool can be found in (The, 2018b). The API (Application Programming Interface) of the Piping Permeability Tool can be found in (Soriano Pérez, 2018d).
The parameters that are defined in section 6.1 should be used as the input for the Piping Permeability Tool.

### 6.4 Output.Parameters

The calculated output parameters will be displayed on screen. Show the following items for each parameter:

- Parameter name
- Value
- Unit

The following paremeters should be shown as output

- Equivalent permeability ($k$)
- Critical head ($H_c$)

### 6.5 Language.Dutch

The "Piping Doorlatendheid Rekentool" user interface uses the Dutch language. All input field descriptions, log messages and results should be in Dutch. In Appendix B the Dutch translations can be found for the parameters used in the "Piping Doorlatendheid Rekentool".

### 6.6 Performance.Speed

The calculations itself are simple and a calculation in the "Piping Doorlatendheid Rekentool" should not take more than 1 second.

### 6.7 Code.Coverage

Code coverage of the "Piping Doorlatendheid Rekentool" should be at least 80%.

# 7 Error Handling

In case of disfunctioning the "Piping Doorlatendheid Rekentool" should not crash and give clear error messages in a log. If the calculation cannot be performed no result values will be shown. The log messages should give as much as possible information on how to solve the problem(s).

# 8 Literature


Doxygen, 2018. *Piping Doorlatendheid Rekentool Technical Documentation*. Tech. rep., Deltares.

Putten, H. van, 2016. "Voorstel voor technische en functionele ontwerpen voor het WTI software instrumentarium."

Soriano Pérez, C. S., 2018a. *Piping Doorlatendheid Rekentool Technical Design*. Tech. Rep. 11202231-002-HYE-0011, Deltares.

Soriano Pérez, C. S., 2018b. *Piping Doorlatendheid Rekentool Test Plan*. Tech. Rep. 11202231-002-HYE-0012, Deltares.

Soriano Pérez, C. S., 2018c. *Piping Doorlatendheid Rekentool Test Report 18.1*. Tech. Rep. 11202231-002-HYE-0013, Deltares.

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Waal, J. de, 2017. *Organisatie beheer en onderhoud WBI2017 producten*. Tech. Rep. 11200574-009-GEO-000, Deltares.

# A Parameters

***Table A.1:*** *Overview of the input parameters for the "Piping Doorlatendheid Rekentool"*

| Symbol | Unit | Min | Max | Default | Description |
|---|---|---|---|---|---|
| $\gamma_{sub,p}$ | (kN/m$^3$) | 0.00001 | $\infty$ | 16.5 | submerged volumetric weight of sand particles |
| $\gamma_w$ | (kN/m$^3$) | 0.00001 | $\infty$ | 9.81 | volumetric weight of water |
| $\eta$ | (-) | 0.1 | 1.0 | 0.25 | White's constant |
| $\vartheta$ | (graden) | 18.0 | 72.0 | 37 | bedding angle |
| $k1$ | (m/s) | 0.00001 | $\infty$ | - | Darcy permeability of soil 1 |
| $k2$ | (m/s) | 0.00001 | $\infty$ | - | Darcy permeability of soil 2 |
| $k3$ | (m/s) | 0.00001 | $\infty$ | - | Darcy permeability of soil 3 |
| $d_{70}$ | ($\mu$m) | 1.0 10$^{-5}$ | $\infty$ | - | 70%-fractile of the aquifer's grain size distribution |
| $d_{70m}$ | ($\mu$m) | 1.0 10$^{-5}$ | $\infty$ | 208 | $d_{70}$-reference value in Sellmeijer, revised |
| $L$ | (m) | 0.00001 | $\infty$ | - | seepage length |
| $D1$ | (m) | 0.00001 | $\infty$ | - | layer 1 thickness |
| $D2$ | (m) | 0.00001 | $\infty$ | - | layer 2 thickness |
| $\nu_w$ | (m$^2$/s) | 1.0 10$^{-10}$ | 1.0 | 1.33 10$^{-6}$ | kinematic viscosity of water |

***Table A.2:*** *Overview of the output parameters for the "Piping Doorlatendheid Rekentool"*

| Symbol | Unit | Default | Description |
|---|---|---|---|
| $k$ | (m/s) | - | equivalent Darcy permeability |
| $H_c$ | (m) | - | critical headdrop |

# B Translations

Because one of the constraints is that the application should be in the Dutch language, a table is provided with a Dutch translation of the parameter descriptions.

***Table B.1:*** *Dutch translations of the parameters for the "Piping Doorlatendheid Rekentool"*

| Symbol | UK Description | NL Beschrijving |
|---|---|---|
| $\gamma_{sub,p}$ | submerged volumetric weight of sand particles | nat soortelijk gewicht van korrels |
| $\gamma_w$ | volumetric weight of water | soortelijk gewicht van water |
| $\eta$ | White's constant | coëfficiënt van White |
| $\vartheta$ | bedding angle | rolhoek |
| $k$ | Darcy permeability | Darcy doorlatendheid |
| $k_1$ | Darcy permeability of soil 1 | Darcy doorlatendheid materiaal 1 |
| $k_2$ | Darcy permeability of soil 2 | Darcy doorlatendheid materiaal 2 |
| $k_3$ | Darcy permeability of soil 3 | Darcy doorlatendheid materiaal 3 |
| $d_{70}$ | 70%-fractile of the aquifer's grain size distribution | 70%-fractie van de korrelgrootteverdeling |
| $d_{70m}$ | $d_{70}$-reference value in Sellmeijer, revised | referentiewaarde van $d_{70}$ |
| $L$ | seepage length | kwelweglengte |
| $D$ | layer thickness | laagdikte |
| $D1$ | layer 1 thickness | dikte laag 1 |
| $D2$ | layer 2 thickness | dikte laag 2 |
| $\nu_w$ | kinematic viscosity of water | kinematische viscositeit van water |
| $H_c$ | critical headdrop | kritiek verval |