

# Risk simulation calculations in geotechnical and constructional practice

## Problem definition

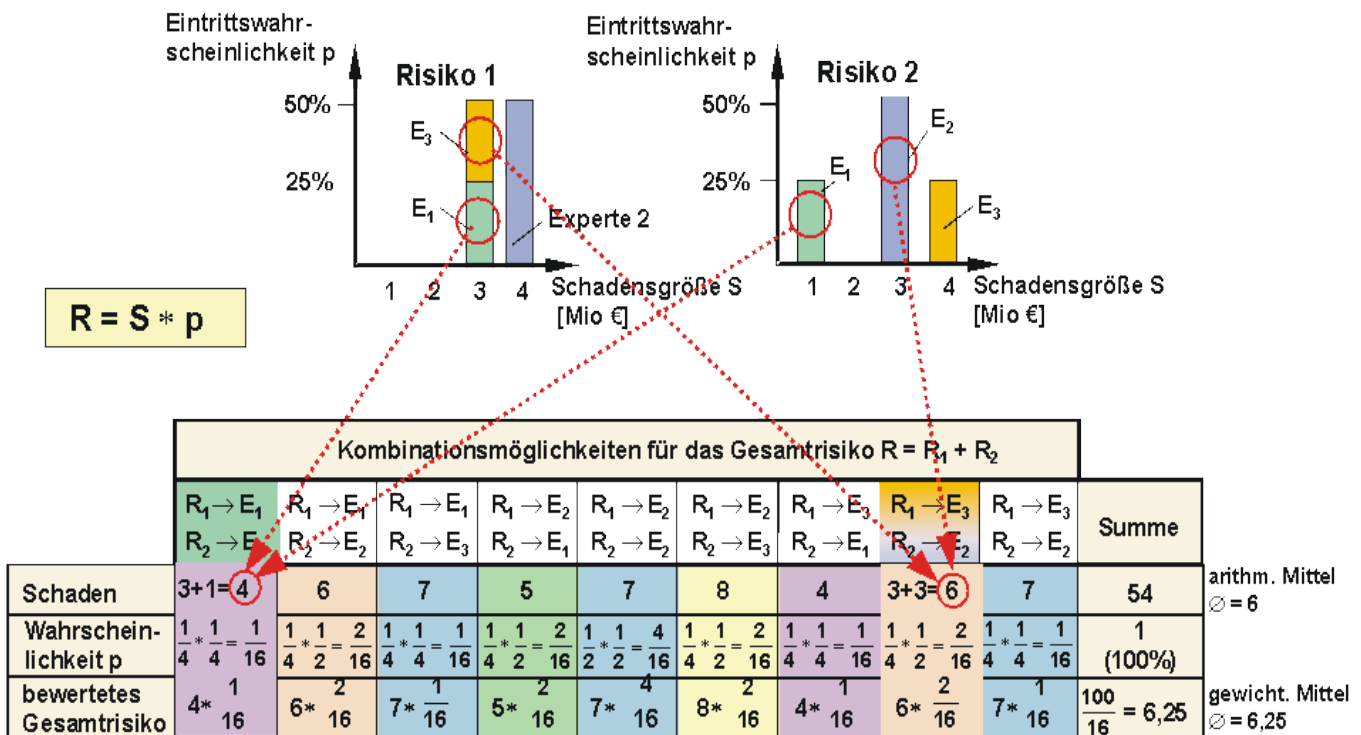
The greatest uncertainty in the field of geotechnics is the insufficient knowledge of spatially scattered soil parameters and the actual soil behaviour. Because of this, several risks are induced in to the construction of geotechnical structures. Not only do these risks apply to the areas of bearing capacity and serviceability, but also to the cost estimate of structures.

## Method of resolution

Risks can be quantified as the product of possible damage size and probability of occurrence. But in most cases, only estimated values that are subject to certain limits of variation can be given for these parameters.

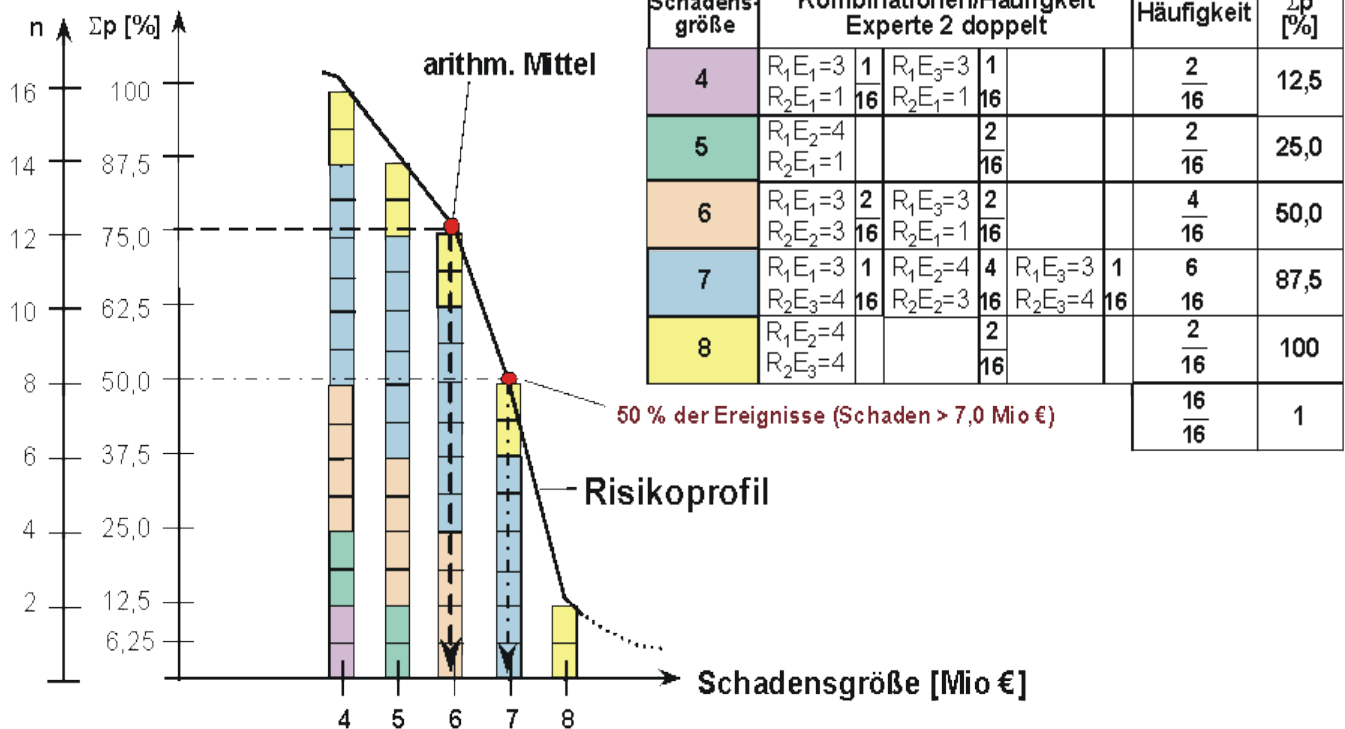
In general, overall risks are composed of several individual risks that are subject to different grades of scattering concerning the average amount of damage and probability of occurrence. Because of the seemingly endless possibilities of combination, an assertion of the overall risk's size and its probability of occurrence cannot be given.

Risk simulation calculation represents a simple method of judging an overall risk made up of different individual risks with scattered data. The idea is to not only calculate the overall risk by using the averaged individual risks, but to calculate the overall risk by using every possible risk combination, taking their individual probabilities of occurrence into consideration.



Picture 1: Analysis with a combination of 2 risks and 3 expert ratings

## Eintrittswahrscheinlichkeit



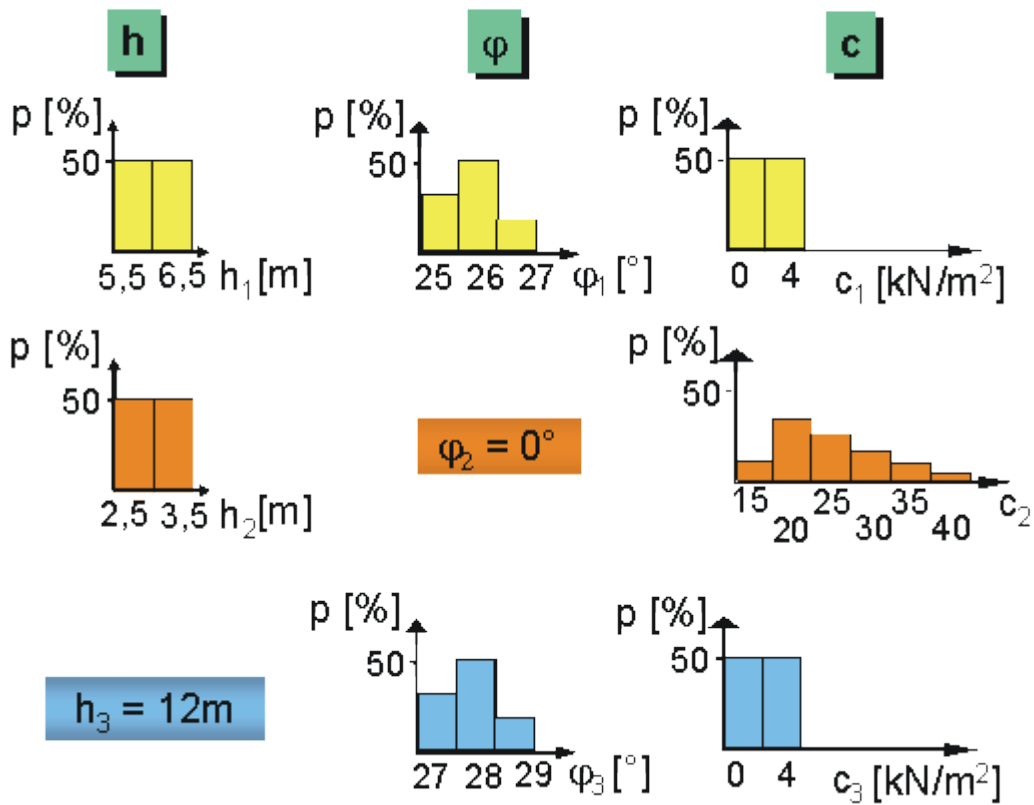
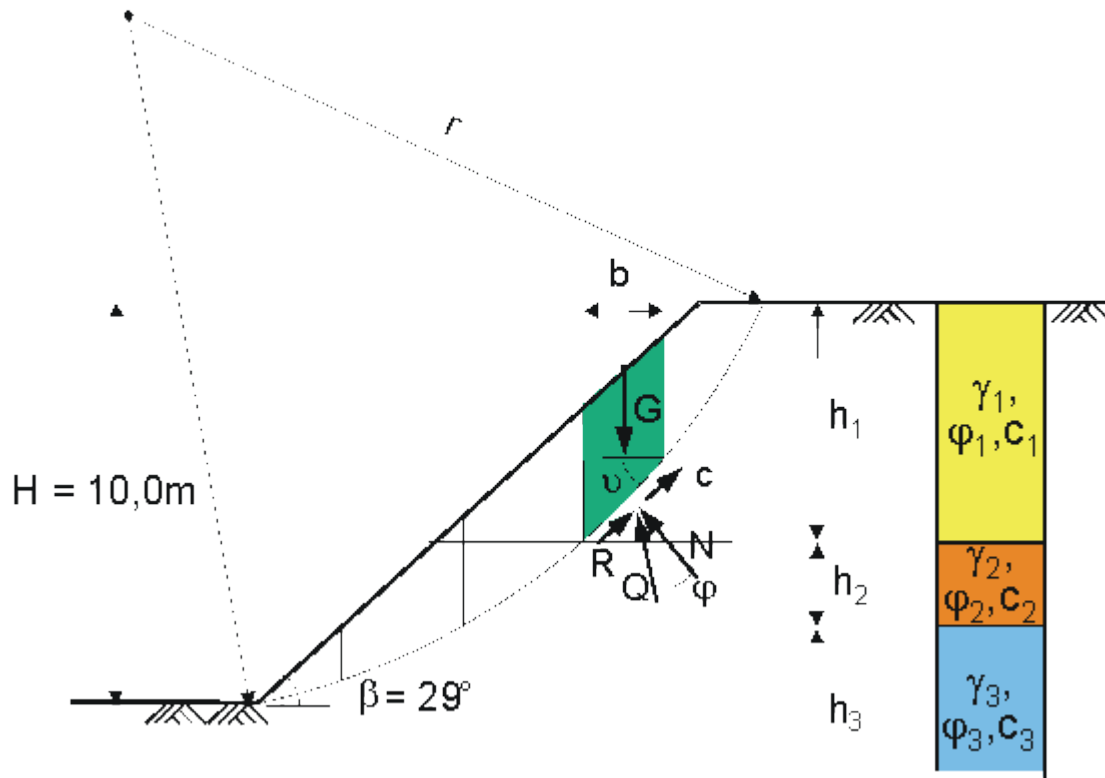
Picture 2: Creation of the overall risk profile

## State of the art

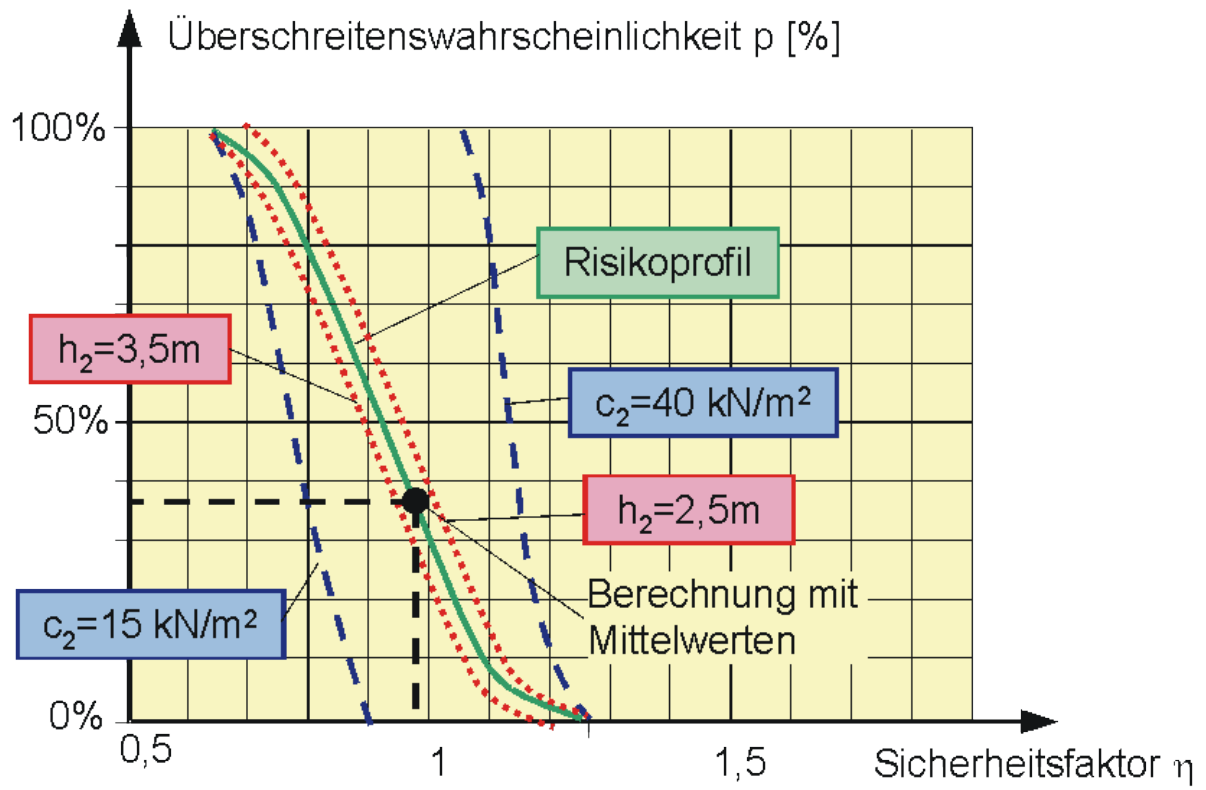
Geotechnics offers a broad field for the usage of risk simulation calculations since the soil parameters are almost scattering values because of the soil inhomogeneity. Typical uses are calculations of the bearing capacity for a foundation, slope stability, dimensioning of temporary workpit supporting systems or the ascertainment of the discharge flow during a drawdown.

The great advantage of risk simulation calculation is the fact that it allows one to quickly determine the authoritative parameters through simple sensitivity tests. In many cases, this allows to reduce the risk preemptively.

The diagrammed example of a slope circle calculation in stratified ground shows the important role of an accurate determination of the soil characteristics. According to current standards, average values are used for this calculation, which might add up to an adequate certainty. Yet, considering the overall probability of failure, it is a certainty that has to be eyed in a critical way. The risk profiles produced by the sensitivity tests show that the gauge of the middle layer surprisingly does not play an important role, while the cohesion of this layer is quite decisive in this problem.



Picture 3: The slide circle in stratified soil with scattered input data

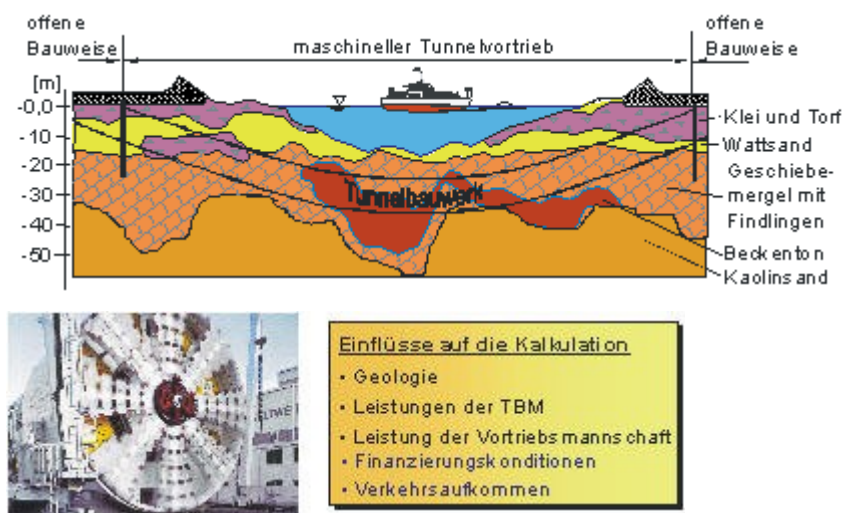


Picture 4 : Overall risk profile and sensitivity studies

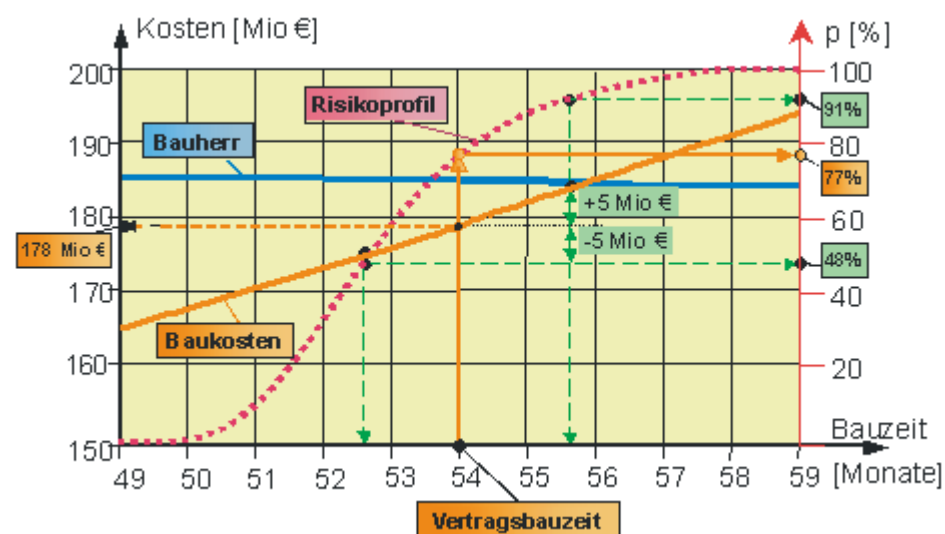
## Risk simulation calculations in construction practice

Cost estimation also proves to be a worthwhile field of the risk simulation calculations. In this case, the scattered individual risks are the calculations approaches that have been evaluated differently by various experts. In general, this leads to a risk profile being drawn up in dependency on the construction period. Furthermore, if one transforms the construction period into construction costs, the change of costs over time can be read off a diagram, as well as the probability that a certain construction period will not be exceeded. This is very helpful during projects that have been pre-financed by the contractor, since the contractual completion of the structure is of foremost importance because of construction time interests.

This method was successfully used during the calculation of an underwater tunnelling project, during which different initial parameters were tested on their influence on construction costs and period.



Picture 5: The longitudinal section of a tunnel with the geological profile



Picture 6: Coupling of building costs and the risk profile in dependence of the construction period

## Future prospects

Risk simulation has the possibility to quantify risks in a certain range and to regard problems like scattered initial parameters in their full extend. The authoritative parameters can be identified using the sensibility tests. For construction practice in particular, hope exists that the better transparency will open new possibilities in contract composition.

## Literature

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