Engineering methods and practical examples … and beyond

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Extended Abstract

The fundamental principle guiding state action is the imperative to act solely in accordance with the provisions of the law. Thus, it is essential to ensure that the acceptance criteria are in line with legislation, considering the principles of "Equality before the law", and "Proportionality" [1]. The principle of equality before the law means that similar cases should be treated equally. Only when relevant facts significantly differ in a situation can distinctions be made. The principle of equality before the law is enshrined in all European legal systems. Proportionality implies that something should be moderate in relation to the circumstances. The principle of proportionality aims to protect individuals from excessive state regulations and promote a balanced pursuit of the common good.

The principle of proportionality refers to the legal principle that, in cases where encroachments on personal rights are deemed permissible in the public interest, a certain measure should be maintained. This principle is also integral to the concept of a constitutional state in Europe. While some constitutions explicitly mention this principle (e.g., [2]), it is considered an unwritten principle in others.

The concept of treating similar cases similarly and different cases differently implies that, for example, an infrastructure with a daily traffic volume of 100,000 vehicles can be treated differently from one with 1,000 vehicles. Proportionality means that a safety measure cannot be demanded under all circumstances and at any cost.

Having a fixed acceptance criterion that applies to all situations poses the problem of requiring substantial investments for certain facilities that do not correspond to the benefits of the facility, thus conflicting with the principle of proportionality. On the other hand, accepting any level of risk can also be justified due to disproportionate investments.

Therefore, we use in practical applications often the ALARP (As Low As Practically Reasonable) principle in the following quantitative interpretation. First, an upper limit for collective or individual risk is established. Below this limit, the principle of proportionality applies. Proportionality is assessed based on the threshold of marginal lifesaving costs derived by using the LQI [3] [4] or other values predetermined by national authorities (e.g. [5], [6]). There is also a lower limit, below which the investments necessary for proportionate measures are so minimal that no further measures would be found. This approach satisfies the legal requirements of equality before the law and the principle of proportionality.

In practice, quantitative risk analysis and the application of the ALARP principle are increasingly being utilized as they provide valuable decision support for various scenarios. In Switzerland, this principle has e.g. been incorporated into the guidelines for risk analysis in road tunnels on the national highway [7] Risk is quantitatively assessed for all measures, and the risk reduction compared to the current state or planned state is evaluated. This enables the identification and implementation of proportionate measures. It is also important to be able to filter out disproportionate measures. Additionally, this method allows for addressing a multitude of questions during the planning phase, such as:

What is the proportional financial cost of reducing the distance between emergency exits by 50%? Or of implementing a smoke extraction system for a tunnel undergoing a 2-year renovation period, operating in two-way traffic?

By incorporating quantitative risk analysis and the ALARP principle into the planning process, valuable insights can be gained.

In Switzerland, the ALARP principle has also been incorporated into the SIA (Swiss Society of Engineers and Architects) standard "Assessment of Existing Structures" [8]. This standard allows for the risk-based assessment of structural capacity on a case-by-case basis, enabling the continued use of sound structures.

Currently, in Switzerland, the fire protection regulations, which are governed by federal law, are being revised based on a risk-based approach. This risk-based revision was a specific requirement of the government. The implementation of risk acceptance criteria and the ALARP principle are explicitly addressed in these regulations [9].

An essential foundation for the practical application of risk-based approaches is the establishment of acceptance criteria. Sufficient scientific knowledge exists in this regard, and its potential has been demonstrated in practice. Without these established principles in Switzerland, the application and acceptance of risk-based engineering practices would not have progressed to their current state.

By incorporating risk acceptance criteria and the ALARP principle, Switzerland has made significant strides in engineering practices, providing a solid framework for the application of risk-based approaches, and ensuring the safety and effectiveness of infrastructure projects.

References

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