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# Climate Change and Research Challenges in Civil and Structural Engineering

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## Opinion

Actually, research in civil and structural engineering needs more worldwide collaboration to find solutions for many challenges related to climate change. Particularly, efforts must be focused on the development of modern design codes based on reliability concepts, calibrated from quantitative risk analysis for adapting to, and mitigating the impacts of natural disasters such as storms, sever earthquakes, strong winds ...etc. These codes are the basis for engineering design and play an important role in decision making about the performance of structures over their working life. The consideration of reliability concepts in structural and geotechnical engineering is widely recognized because they are based on probability theory that enables the impact on safety and serviceability of uncertainties in both materials behavior and calculation models. Especially in the field of geotechnical engineering, the uncertainties in the soil properties are relatively high. Therefore, efficient probabilistic techniques are necessary to define reliability levels for structural design. Current design codes, based on partial safety concepts, define the target reliability for different structures (onshore, offshore) depending on the desired safety levels, however worldwide research efforts and developments are needed for engineering practice of risk and reliability analysis. In addition, they should be calibrated and adapted to the actual environmental loading related to climate change.

The actual research on reliability design can be divided into two main parts: the first one concerns the development of advanced methods to take into consideration the behavior of structures under extreme loading conditions such as strong winds, severe earthquakes, floods, cycles of high and low temperatures...etc. These include better understanding and modeling of load processes, better understanding the behavior of structures and developing constitutive models based on full-scale and experimental methods. The second part concerns the need to improve the existing design codes in practice for geotechnical and structural engineering to include the different environmental loading. An important issue is to develop practical probabilistic and reliability methods for engineers for quantification, monitoring and assessment of structural risks. In addition, these codes should provide tools and guidelines to make decisions about the performance of structures under extreme loading conditions.

Nevertheless, the development of rational risk and reliability-based design are needed for human safety, economic and environmental consequences. Therefore, reliability levels should be established in close cooperation between practitioners and researchers on codes development, safety concepts and calibration of modern geotechnical and structural codes of practice. The aims of this collaboration is collecting contributions from codes developers worldwide, discussing the issues that are essential for implementation in practice (ex. Choices related to reliability methods) and providing tools and guidelines for hazards mitigation. All these open up challenges increases the mobilization for organizing more worldwide workshops, exchanging experiences and transfer of knowledge. In this case, an issue of practical importance is creating new tools and techniques for control and monitoring of structural risks. Hence, the monitoring databases may be used to back calculate the performance of existing structures and compare with observations, or to predict future performance. In addition, the development of innovative materials allows designing structures and infrastructures to be more resilient to ensure high performance under natural disasters. Another important aspect of this collaboration is to share databases from worldwide experiences of natural hazards exposure for the development of intelligent systems for the prediction of behavior and future performance of structures and decisions making. In general, these systems based on machine learning may help the advancement in civil and structural engineering research.

In my opinion, the worldwide collaboration is not an easy task, but it is the best way to consider natural hazards in civil and structural design, to mitigate rapidly the effects of climate change on our planet and ensure a better future for humanity.

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## Conflict of Interest

No conflict of interest.