

Robustness and Resilience

-- Two Key Concepts for a Sustainable Built Environment

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Summary

The first item is Robustness of structures, which has drawn much attention during the past decade. In this paper special interest will be paid to accidental loading and extreme events like natural hazards. The part dealing with Resilience is related to Natural Hazards and Disasters and their influence on the built environment and society. One section deals with vulnerability and resilience of communities, especially in urbanized areas. The paper is of conceptual character and contains some critical review of some past work. It will show the importance of using relevant and clear concepts.

“Today, as civil and structural engineers, we should feel the urgency of our role in mitigating the threats to urban areas caused by climate change and natural disasters” [1].

Keywords: robustness; structures; resilience; urban environment; sustainability.

1. Introduction

The term ‘Robustness of structures’ was not a well-known concept among structural engineers in the mid-1990s. At that time there was a widespread reluctance to discuss ‘robust structures’, because many engineers meant that such structures would be heavy and clumsy. Since then it has been the object of systematic studies and research during about a decade. In fact, some of the characteristics of robustness (e.g. redundancy and ductility of joints) had been studied earlier using another terminology for several years, namely ‘progressive collapse’, which was inspired by some failures of buildings, where a local damage was progressively spreading to a partial collapse. In these cases, the consequence of the damage became disproportionate to the causes of the damage.

The second item “Resilience” relates to properties of a system subject to external disturbances. The system can be an environmental (ecological), structural (mechanical) or social system. A resilient system has the property to regain its basic function and structure after the disturbance has been removed. This should also be valid even for a rather severe disturbance. This concept can also be used to discuss ‘the role of structural engineers in the evaluation and prevention of social risks’. Related concepts are preparedness, vulnerability and risk. One application is “Resilient Cities”, which is a good example of Human Urbanism.

It has become more and more important to consider low-probability high-impact events. Such “Black Swan” events are almost impossible to predict. However, “instead of trying to anticipate these events we should reduce our vulnerability to them” [2]. It is probably wiser to focus on the *consequences*, i.e. to try to evaluate the possible impact of such extreme events. See further the book by Taleb [3].

In this paper we define ‘sustainable’ in its original wider meaning: ‘endure without giving away’, ‘keep sound continuously’. For a built environment to be sustainable it should thus be both robust and resilient.