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SELECTED ASPECTS OF EXTRAORDINARY LOADINGS ON STRUCTURES AND METHODS OF INVESTIGATION BY NUMERICAL CALCULATIONS AND/OR EXPERIMENTS

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The effects of catastrophic loadings like terrorist attacks on structures lead to an increasing demand in designing buildings for natural and/or technical hazard loadings like explosion, blast and impact. The challenge is the classification of these threats with respect to its loading effects on the structure. From this, appropriate calculation methods have to be chosen, or elaborate and expensive experimental field tests have to be conducted to give a reliable and accurate prediction for damage and/or (residual) carrying capacity of the building. Experiments should be complemented by simulations. Different calculation methods are classified due to its load situation:

- calculation of dynamic structural response of the entire building including damages for static/design loads (e.g. blast load),
- calculation of structural members like single columns (e.g. near detonation),
- calculation of local damage due to high dynamic effects (e.g. contact detonation).

To perform these simulations, appropriate material models have to be used which characterize the elastic, non-elastic and damage material behavior under high pressures and high strain-rates. These own developed models are based on the classical theory of plasticity and on the theory of continuum damage mechanics focusing on the decrease of stiffness and strength.

Nevertheless, experimental investigations are indispensable. Therefore, these models have been validated by especially performed experiments at the WTD52*.

At last, the global response of a building is calculated with removed (fully damaged) or with weakened (decreased residual carrying capacity due to reduction of stiffness, of strength and of cross section) structural members. Then, the structural behavior is assessed more realistically and more structural capacities are utilized.

It is also of interest how internal forces change and how loads are redistributed. From gained knowledge of structural response, new standards can be developed to design and/or to retrofit buildings. Examples will be presented.

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