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Steel and Timber Structures

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Risk and Safety

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Past and ongoing Research and Testing activities in the Area of Timber Structures and Reliability

Reliability Analysis of Timber Structures (COST-Action-Title: E24)

The aim of the research project is to establish the basis for deriving a consistent set of timber materials characteristic values and to calibrate corresponding partial safety factors such that the level of structural reliability for timber structures is equivalent to the safety of concrete and steel structures. This seen in the light of the ongoing revision of the national Swiss codes for the design of structures.
Basis will be taken in the already existing, rather large amount of data concerning strength and stiffness characteristics of structural components made of timber. The data will be analysed statistically in accordance with timber type, classification, storage conditions etc. .
Probabilistic models will be formulated for the description of the strength and stiffness characteristics with due account of effects such as loading duration and temperature.
Applying methods of structural reliability the probabilistic models for the strength and stiffness characteristics together with probabilistic models for permanent and variables loads are then utilized for the calibration of partial safety factors. The partial safety factors are calibrated such that the reliability level of timber structures designed using the partial safety factors corresponds to the reliability level of concrete and steel structures.

The research project will finally identify the uncertainties, which have the largest influence for the reliability of timber structures and give directions on how the statistical basis regarding tests on structural components made of timber may best be augmented to facilitate a more rational and economical design.
In order to organize, coordinate and keep track on the progress of the research project this has been sub-divided into the 4 main tasks as described in the following:

Task 1 : Identification of relevant timber material parameters and data collection.

Task 2: Preliminary probabilistic modeling and sensitivity study.

Task 3: Assessment of characteristic values.

Task 4: Reliability analysis and assessment of partial safety factors.

Fire Resistance of Timber-Concrete Composite Slabs

The aim of the research project is to develop resistance models for the fire resistance of timber concrete-composite slabs and to verify them by fire tests. Further construction details will be developed to improve the fire behavior of such slabs. The results can form a basis for a reconsideration of the use of timber in multi-storey buildings.

Load-carrying behavior of doweled steel-to-timber connections

It is the aim of the research project to describe the load-carrying behavior of multiple fastener steel-to-timber dowel connections. The multiple-shear dowel connection with slotted-in-steel plates is one of the most efficient timber joints for large timber cross sections. The influence of dowel slenderness ratio, tensile strength of the dowels, spacing and end distance of the fasteners on the load-carrying behavior of this type of connections has been studied.

Mechanical Properties and Ultrasonic Grading of Swiss Spruce

Based on extensive testing of specimens of structural size (bending, tension, compression, M/N-interaction) existing timber strength classes of Swiss Standard SIA 164 are compared to the proposed new classes of EN 338. Ultrasonic measurements should show to what extent they could be used in practice for grading and estimating the mechanical properties of timber.

Prestressed composite wood-concrete floors

It is the aim of the research project to investigate the load-carrying behavior of prestressed composite wood-concrete floors.

Purposeful Improvement of the Efficiency of Timber Sections

Normally the failure of timber under bending is located on the tension side. The investigations concentrate on a reinforcement of this critical zones by high strength steel or carbon fiberglass sections, building up a new composite section.

Stecco-Timber Construction: System-Building in House and Office Building

In the run of the idea of "building with system" came the idea to work with wooden elements of low class wood. By gluing the plies together in alternating grain directions hollow space for house wiring is provided. The elements can be put together dry and quickly to form a wall like usual brickwork walls. Additional static and physical tests on whole wall elements will follow.

Bayesian Methods in Risk Analysis

Traditional risk analysis takes basis in frequentistic information about adverse events in terms of e.g. failure rates and mean time till failure. Often the information at hand is rather limited and statistical uncertainties are significant. In addition when there are no relevant data it is often the case that subjective information has to be included in the risk analysis. Classical frequentistic statistical methods fail to combine frequentistic and subjective information.
Bayesian statistical methods can, however, accommodate any mixture of frequentistic and subjective information. It would therefore be interesting to investigate the theoretical relevance and practical applicability of Bayesian statistical methods as a probabilistic framework for risk analysis. The newly developed theories and tools for analysis of Bayesian Probabilistic Nets are highlighted as interesting areas within this problem framework.

Risk Acceptance Criteria

Risk analysis are usually performed in order to verify that a specific activity is acceptable and / or to optimize risk reducing and mitigating actions such that an acceptable risk is achieved in a cost optimal manner. In the last decades risk analysis has become more and more common in connection with the evaluation of different decision alternatives both at a societal level and at an executive level. Whereas the main focus so far has been directed towards setting acceptance criteria in absolute terms for e.g. risk to personnel, risk to the environment and economical risks, only little interest has been directed to the interdependence between the underlying probabilistic models used in the risk analysis and the risk acceptance criteria. It can therefore be expected that the decisions made on the basis of risk analysis are inconsistent with the preferences of the decision maker.

It is therefore interesting to investigate how the probabilistic modeling effectively influences the risk acceptance criteria and to develop consistent approaches for setting risk acceptance criteria and performing risk analysis. Furthermore also the general problem of setting acceptance criteria for different activities in consistency with given preferences is by far an large and unclosed subject which should be studied in much more detail.

Safety Formats for Deteriorating Structures

Codes for design of structures are so-called strength based design codes in the sense that the design equations only include load, stiffness and strength parameters and only implicitly take into account the effect of degradation mechanisms such as e.g. fatigue and corrosion.
The recent large interest in probabilistic modeling of deteriorating structures have shown that the most important degradation mechanisms for typical steel and concrete structures can be modeled consistently and that a significantly more rational structural design may be achieved if degradation mechanisms are explicitly included in the design.
It is therefore interesting to investigate how deterioration most appropriately taken into account in the design codes depending on e.g. the choice of material, the loading, the environment, the quality control, the service life.

Inspection and Maintenance Planning

The safety of deteriorating systems such as e.g. bridges subject to fatigue loading, offshore installations subject to fatigue and concrete structures subject to reinforcement corrosion may be controlled and maintained by appropriate inspection and maintenance activities. However, the inspection and maintenance activities often have a direct impact on the operation of the considered facility and therefore may imply significant costs beyond the direct costs incurred by the inspection and maintenance activities themselves. When planning inspection and maintenance activities it is therefore important that a balance is achieved between the benefit gained in terms of increased safety and the costs incurred by the inspection and maintenance activities themselves.
Risk based methods have been developed for inspection and maintenance planning over the last 10 - 15 years. To some degree the application of these methods has been restricted by the significant numerical effort which is required. New approaches utilizing generic representation of fatigue sensitive structural details have been found very promising in this context.