



Abstract diploma work: Timber-concrete composite decks – Analysis of properties and standardising of planning and designing procedures

(Original in German: Holz-Beton-Verbunddecken – Analyse von Eigenschaften und Standardisierung der Planung und Bemessung)

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In comparison to reinforced concrete decks or simple wooden floor systems, the use of timber-concrete composite decks (TCCD) often brings various advantages. In comparison to simple wooden systems, the load-bearing capacity, the structural stiffness and many physical characteristics such as fire resistance and acoustic properties are significantly improved upon. Furthermore, the dead load is also significantly reduced as compared to a reinforced concrete deck and the proportion of ecological materials used is also greater. To harness the advantages of TCCD, the civil engineer needs a thorough understanding of the behaviour of such composite systems. An increasing number of engineering consultants including the PIRMIN JUNG Ingenieure für Holzbau GmbH, where the author did his practical training in 2005, have successfully implemented TCCD in the construction of multi-story buildings during the last few years.

The aim of this thesis is to outline the different properties and aspects of TCCD as well as to standardize the design procedure. The main focus is to evaluate the long-term behaviour of TCCD and to take these aspects into account in the designing procedure. Standardized documents for project leaders, check lists for planning partners and the construction workers on site have been developed. These documents shall help to clarify more efficiently any obscurities and questions that the parties involved might have and to help bring clarity into all aspects of the planning and building procedures.

This thesis involved a research into the archived projects of PIRMIN JUNG Ingenieure für Holzbau GmbH. The essential properties of all the planned TCCD in this office have been summarized in a chart. In addition, a study of the relevant literature relating to this topic has been made. By comparing calculations and making detailed clarifications, the important results and information can be derived. Furthermore, acutely examining the present planning and designing procedures have identified internal requirements and room for potential improvement.

The study of the behaviour of the TCCD includes the comparison of different calculation methods to determine the load-bearing slab width. While different calculation methods for decks with distributed loads show little difference in the results, the calculations for concentrated loads need to be studied carefully. The calculation results for a selected timber-concrete composite element indicate that the stress redistribution due to the so-called "Steiner effect" is limited: even in the case of a rigid bond between the two materials the relative bending of the individual components will remain relatively high.

An extensive literature study was made of research work on the long-term behaviour. The test results described in existing research papers were analysed and compared in order to find out how best factors could be defined to account for the creep and shrinkage of timber and concrete in the calculations. The calculation methods also show how the cracking and reinforcement of the concrete can be taken into account.

The most common connectors are represented in an overview. Two bonding methods are studied in detail, namely the natural bonding between the raw timber surface and the concrete, as well as the use of a bonding system with a shear groove. Permissible design values are defined: for the natural bonding system, old research results needed to be reanalysed for this purpose. The designing procedures are evaluated as well: a suitable selection can be made after considering the structural conditions involved.

Many wood engineers employed at PIRMIN JUNG Ingenieure für Holzbau GmbH had questions regarding the material concrete. The explanations given in the thesis are mainly concerned with the concrete mixture, testing possibilities and the processing.

The main objectives of the thesis have been attained. For future TCCD design, appropriate calculation methods have been established. Checklists for internal use and design examples as well as aids for the submission work are available for standardized planning. A course has been carried out to introduce these technical aids to the wood engineers employed at PIRMIN JUNG Ingenieure für Holzbau GmbH.

The thesis was concerned with decks for multi-story buildings. Another possible use for TCCD is in bridge constructions combined with the prefabrication of TCCD. However, further research is required in this field.