A MODULAR TIMBER CONSTRUCTION SYSTEM OF HOLLOW-BOX ELEMENTS

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ABSTRACT: Timber hollow-box constructions made with solid wood planks are well established as suspended floor or roof structures. The application as wall construction is neither known nor used in multi-story timber buildings. A comprehensive timber construction system, as hollow-box and ribbed box constructions, which can be used in residential houses as well as multi-story buildings was developed. Furthermore, an organizational and cost-efficient definition of a new business model allowing smaller timber businesses access to the residential building market was developed. Finally the structural and failure behavior as well as the load capacity was investigated and compared by numerical and experimental tests.

KEYWORDS: Hollow-box system, Business model, Experimental and numerical tests

1 INTRODUCTION

Timber hollow-box constructions made with solid wood planks are well established as suspended floor structures or roof structures. The application as wall construction is neither known nor used in multi-story timber buildings. Therefore a comprehensive timber construction system which can be used in residential houses as well as multi-story buildings was developed and will be established. The system is based on the principles as for hollow-box and ribbed box constructions. Different static and physical requirements depending on the application need to be considered. Thus the Swiss “Minergie-Standard”, comparable with a low energy house standard, and a production costs comparable to conventional systems are aimed.

Another main objective within the project was to develop an organizational and cost-efficient definition of a new business model. The results provide smaller timber businesses with access to the residential building market. The hollow-box construction technique is predestined for this kind of new business model and guarantees cost-efficient implementation.

2 BUSINESS MODEL

The research project is investigating solutions for timber construction companies with the EGGO timber construction system. On one hand the development of a system with the timber-box construction technique shall enable firms to construct individually designed buildings with standard and specialized elements. On the other hand through this flexible model for value creation the firms can decide individually which services they will perform themselves and which ones they will outsource to the system owner. The project considers six phases for value creation, as shown in Figure 1. This enables smaller timber construction companies to do new construction and persist in the market. The system allows the construction of multi-family housing up to four stories high. The firms increase their profitability through targeted application of their resources and through maximizing their capacity.

3 CONSTRUCTION SYSTEM

In comparison with the well-known light frame timber panel construction, the new hollow-box wall system is constructed and behaves in a different way. Vertical loads are transferred through the interior and exterior solid wood planks. Moreover the hollow-box system is more rigid due to the glued joints between all solid wood components.

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The modular timber construction system was verified and investigated in numerical and experimental simulations. The aim was to analyze the load carrying behavior and to localize the maximum stresses and failure processes in the numerical analyses. The numerical model considers three different load transfer systems. For the comparison among each other, the wall system was loaded with a constant displacement of $u = 1$ mm at the top. The 3-dimensional numerical model is equivalent to the realistic EGGO-elements and simulates 4-box-elements 1000 mm in width, 2000 mm in length and 200 mm in thickness.

Figure 1: Process as a basis for the new business model

### 4 NUMERICAL AND EXPERIMENTAL VERIFICATION

The modular timber construction system was verified and investigated in numerical and experimental simulations. The aim was to analyze the load carrying behavior and to localize the maximum stresses and failure processes in the numerical analyses. The numerical model considers three different load transfer systems. For the comparison among each other, the wall system was loaded with a constant displacement of $u = 1$ mm at the top. The 3-dimensional numerical model is equivalent to the realistic EGGO-elements and simulates 4-box-elements 1000 mm in width, 2000 mm in length and 200 mm in thickness.

### 5 CONCLUSIONS

The developed timber hollow-box system as a wall construction is highly efficient in terms of statics and thermal insulation; allows prefabrication consolidating timber hollow-box constructions into a single integrated construction system; and provides the technical conditions for a cost-efficient business model that can be implemented across companies. Since the width of solid wood planks without joints are limited, a narrow box grid and a stiff wall construction results.

The structural behavior, failure and load capacity could be investigated by numerical and experimental tests. Both tests show the same behavior which confirms that the load capacity of the elements can be predicted very well and easily.

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### REFERENCES


