HIGHLY EFFICIENT STRENGTHENING OF LOCAL LOAD INTRODUCTION AREAS OF ENGINEERING WOOD STRUCTURES USING POLYMER CONCRETE GROUTING

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ABSTRACT

The development of wide-span structures occurs high reaction forces at the bearings. The load-bearing capacity is strongly limited, because of the low compression strength and stiffness of wood perpendicular to the grain. One common possibility of strengthening the support is the application of self-tapping screws [1],[2]. Subject of the presented research project is the study of a new, practicable and quite easy to manage type of reinforcement for load transfer areas. To increase the load-carrying capacity drill holes and block shaped areas filled with polymer concrete are inserted into the timber. Due to the rigid bond between wood and polymer concrete as well as a geometrical adaption to the stress distribution, it is possible to increase the load-carrying capacity and the compressive stiffness significantly compared to conventional reinforcement by self-tapping screws.

First inchoate versions of bearing reinforcement have been designed and used very successfully as part of another research project to increase the bending capacity of glulam beams by hybrid material composites [3],[4]. Figure 1 shows one example of the tested designs. The diagram in Figure 2 illustrates the increase of the transversal load bearing capacity compared to FE-simulation of the same member without reinforcement.

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Pilot tests on specimens made of glulam GL24h with practical dimensions were performed to assess the reinforcing effect in direct comparison with self-drilling screws and to unreinforced specimen. The specimens are in dimensions of 800 x 400 x 200 mm. There are tests at
one unreinforced specimen (QD-T1), one with three pc-columns (D = 28 mm, L = 200 mm; QD-T2) reinforced specimen and one with 6 self-tapping screws (Spax ®-S, D = 10 mm, L = 200 mm; QD-T3) reinforced specimen. The diameter of the three pc-columns in specimen QD-T2 was chosen in a way to correspond to the total normal stiffness of the six self-tapping screws in specimen QD-T3 (Figure 3). The load capacity of the PC-column reinforced specimen was 1.4 higher in almost linear-elastic range compared to screw reinforcement (Figure 4).

Figure 3: Cross-section of specimen QD-T2 (left) and QD-T3 (right) and sketch of the test setting with full support

Figure 4: Load-indentation curve for full support tests for local indentation between bearing plate and half height

Knowledge of the distribution of shear stresses in the adhesive joint is essential, to evaluate the carrying capacity. Small-scale experiments (an example is shown in Figure 5) helping to gain insight this question. The experiments were designed to monitor the strain distribution by using the photogrammetric measurement systems which was developed at our department. Among other things influence of the kind of support (full support, end support, middle support) and state of annual rings were investigated. Figure 6 shows the shear stresses for one specimen before the first cracking occurs for various load levels in the composite joint in the wooden part, which are derived from a combination of photogrammetric measurement and associated inverse FE-simulations. The results of these experiments and parameter studies by verified FE-simulations will enable the creation of a practical design approach.

Figure 5: Example for small scale test investigation of the stress and strain distribution

Figure 6: Path analysis of the shear stress in the composite joint in the wooden part, mean of photogrammetric measurements of front and back

REFERENCES