Development of efficient glued joints for frame corners and column bases by means of high strength connecting elements

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Literature known foreign concepts for efficient frame corners with glued-in high strength connecting elements can be differentiated according to the type of the connecting element into those with glued-in steel plates, threaded steel rods or deformed reinforcing bars. Monolithic constructions with sword like steel plates glued in slots along bending tension and compression edges in the corner area and then welded to a steel bar in the mitre-joint show the most transparent force flow. Demountable constructions with glued-in threaded rods are differentiated essentially with respect to size and complexity of the steel made connecting element in the corner serving for the screwed fixation of the rods. In case of corners with glued-in deformed reinforcing bars the rigid connection of the bars is suitably solved by welding the latter to steel straps along the corner edges.

In the frame of the computational finite element based work part several frame corner alternatives were investigated with respect to the effect of the reinforcement arrangement on the stress flow in the corner area. A favorable alternative was then used for deepened investigations on design relevant stress distributions and the derivation of a simplified analytical design model.

The experimental preparatory works for assessment of the corner load capacities comprised axial pull-out tests with threaded steel rods (∅ = 20 mm, strength class 8.8, metric thread) bonded into glulam parallel to fiber especially with long anchorage lenghts of 600 mm. Considerable preparatory work consisted further in the construction of a universally usuable test set-up for investigations of frame corners in building component sizes as well as in the manufacture of the frame corner prototypes.

The structural investigations comprised tests with negative bending moment (decrease of re-entrant angle) on four equally sized steel reinforced frame corners (II-V) with pronounced different corner constructions as well as a calibrating test with a finger jointed frame; the frame span was 6,5 m, the re-entrant angle 110° and the cross-sectional dimensions of the glulam legs, conforming to strength class BS 16h, were 160 x 700 mm. The non-demountable corner II is based on a single finger jointed corner reinforced at the bending tension and compression edges of the corner area by boomerang like shaped steel plates (thickness 8 mm) with corrugated surfaces. Additionally, as reinforcement for the turn-round compression forces, two threaded rods were glued-in parallel to the mitre-joint. The demountable corners III-IV show a largely similar reinforcing resp. connecting principle with four threaded rods glued-in each leg close to the salient corner angle; the rods are then connected rigidly by screwing onto a specific intermediate connecting steel element. The transfer of the bending compression forces, bundeled by threaded rods glued-in close to the re-entrant corner, works via contact. The turn round compression forces are primarily taken up by plywood on-gluings or threaded rods glued parallel to the mitre-joint.

The obtained efficiency of the gross glulam cross-section equalled 0,97 of the characteristic strength level in case of frame corner III, based on threaded rods, showing the highest load bearing capacity; minimally, for the steel plate reinforced corner II, 0,89 of the characteristic strength level was obtained. The results of the computational and experimental investigations on steel reinforced frame corners allow by consideration of some small modifications of the realized constructions a full utilization of the nominal cross-sectional load capacity.