Over the course of the current research project, around 200 publications and institute reports were initially evaluated and diverging conclusions regarding the performance spectrum of urea-formaldehyde (UF-) bonds were determined. The performed investigations were then divided into mechanical-technological and microscopic investigations on bond strength and long-term integrity of specimens manufactured in the laboratory, and additionally into extensive inspections including sampling of specimens in existing UF-bonded buildings. The laboratory bondings were performed using six UF bond configurations, with five considerably different types of UF-adhesives and hardeners. The bondlines were manufactured primarily at mix-in conditions and in one case via separate resin and hardener application by means of the so-called hardener preapplication procedure.

The results of the tensile shear tests according to EN 302-2 initially confirmed the known fact that UR-adhesives are not resistant to boiling water. In the case of cold water treatment however, all specimens with thin (0.1 mm) and thick (1.0 mm) glue lines produced with mixed-in adhesive applications considerably fulfilled the normative requirements. For separate resin-hardener application though, the requirements for wet and wet-redry bond strength were not met in the case of thick glue lines to an extreme and pronounced extent, respectively. The block shear tests performed according to DIN EN 392 resulted in sufficiently good results for the specimens tested both in a dry and wet state. The delamination tests according to DIN EN 302-2 were performed according to procedure, with low and high (redrying) temperatures for verification of adhesive Types II and I classifications, respectively.

All adhesive configurations applied mixed-in fulfilled the delamination requirements of DIN EN 301 for adhesive Type II. The specimens produced with separate resin-hardener application also passed the requirements, though unexpectedly. The requirements specified for adhesive Type I were greatly fulfilled by all adhesive configurations applied mixed-in, unlike the bonds manufactured with separate resin-hardener application.

With regard to the selection of buildings for both in-situ inspection and sampling of specimens, a data base comprising 1700 recordings was established consisting of extensively investigated data. Visual and haptic investigations of each building’s conditions, including size measurements of cracks and sampling of drill cores, were performed on 71 buildings with UF-bonded glulam beams of predominately full rectangular cross-sections. Additionally, four buildings with I- or box-shaped, so called Kämpf- and Wolff-web beams were also inspected. In total, about 800 members with cross-sectional depths of up to 2.4 m and spans of up to 36 meters were inspected by hand and 639 drill cores from 240 members were sampled for bond strength testing. The findings of the building inspections were documented for each building in a short report. For assessment of the effect of the accumulated duration of load and climate on bond strength, the buildings with glulam beams were split up into two groups of different building ages (G-20 and G-45) with mean and maximum building ages of 20 and 45 years, and 36 and 68 years, both respectively.

Approximately 55% of the buildings, i.e. their timber structures, revealed differently accentuated damages. In a total of 10 buildings, severe damage was observed which resulted exclusively or essentially from degradation of the UF-bond lines. The bond line / interface damages can be separated into two main damage groups. The first is related to high moisture impacts, resulting in pronounced to sometimes severe hydrolytic degradations of the bond lines. As a result of high moisture loads, leakage of the roofs and condensation of water due to “cold” roofs may be caused by poor constructions with regard to building physics requirements. In the second main damage group, embrittlements of the bond lines due to long lasting or cyclically occurring high temperatures in the range of 40°C to 60°C were identified. Irrespective of the mentioned damage-relevant bond line degradations, it should be emphasised that in most cases of building damages, tension stresses perpendicular to the grain due to superimposed actions from loads and climate were the prime causes for damage. For two of the four inspected buildings with UF-bonded I-or box-shaped Kämpf-or Wolff-web beams, immediate rehabilitation due to cracks was advised despite the fact that no current endangerment of ultimate limit states existed. The glue line cracks in the bonds of the narrow edges of the boards of the web plates were confined in general to the outer layers of the web boards layered at ± 15° and ± 90°, respectively. Full cross-sectional cracks of the webs, apart from areas around insufficiently reinforced holes, were not encountered. The bond strengths of the wide side gluings of the web board layers were all deemed to be sufficiently high.

The dry shear strengths of the glulam beams with mean and 5$^{th}$-percentile values of 7.5 N/mm$^2$ and 4.0 N/mm$^2$, respectively, were sufficiently high with respect to the requirements of DIN EN 386. The combined dry shear strength vs. wood failure criterion was satisfied with regard to both individual and mean values of the buildings by 80% and 70%, respectively. The mean re-dry and wet shear strengths of all buildings were 20% and 50% lower as compared to the dry shear strengths. A differentiation with regard to building age demonstrated the following: when taking the average of all individual values, the dry and wet shear strengths of “older” buildings were about 9% lower as compared to the 25-year “younger” buildings, whereas in the case of the re-dry strengths no differences were observed. With regard to the 5$^{th}$-percentile of the strength distributions of the individual buildings, significant reductions of 14%, 24% and 20% of the dry, wet and re-dry shear strengths of the “older” vs. the “younger” buildings were observed. From comparison of the minimum strengths of the individual buildings, the loss of strength can be seen to be approximately 30%.

The investigations undoubtedly confirmed an influence of the service life time of the building on bond ageing and respective strength reduction. It was found that UF-bond lines manufactured which were under-mixed according to the state of the art with glue lines thicknesses < 0,5 mm and hence UF-glued members, used in service according to destination, reveal no significantly higher damage and building safety risk as compared to PRF- and MUF-bonded timber construction elements. The performed investigations showed that old UF-bonded members with thick bond lines manufactured by means of separate hardener application include an increased damage potential. This is especially valid in case of long lasting, very high moisture impacts and at temperatures of around 40°C to 60°C, which can cause bond line embrittlement. The mentioned detrimental climate conditions occur at specific use conditions especially in former, usually “cold” roofs. For prevention of further catastrophic building collapses as occurred in Bad Reichenhall the content of the “building guideline for checking of the structural safety of buildings (N. N. 2006)” must be applied stringently, especially during conditions found to be detrimental for UF-bond lines. Under this condition, the long-term safety of urea-bonded timber construction members, as well as for similar glued wooden constructions, can be guaranteed.