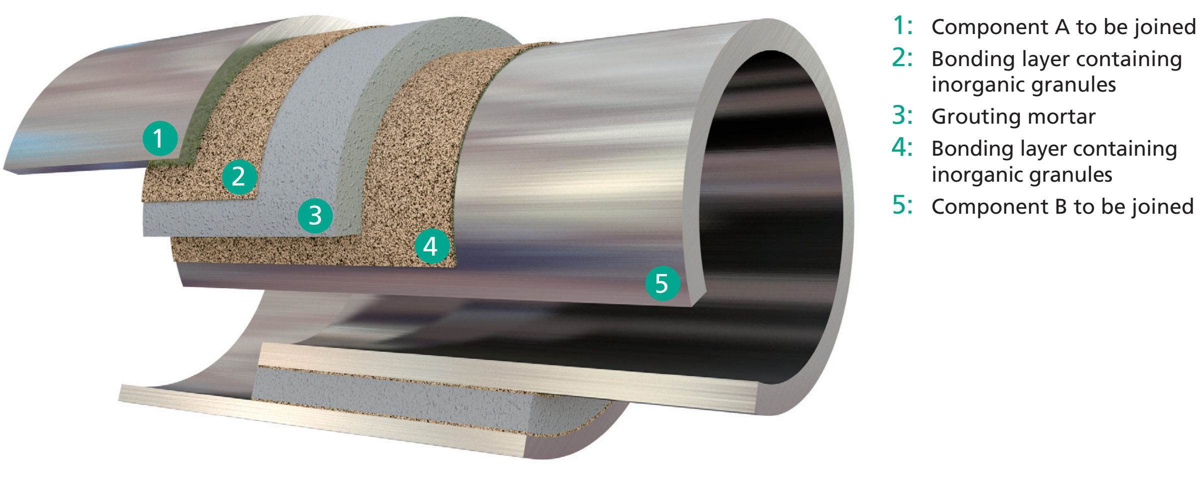
Hybrid Adhesively Bonded Joints

New Robust and Low-cost Technology for Bonding Structural Components

Currently, structural components made of steel, light alloy, or plastic are joined by welding, screwing, and riveting. These joining methods, however, are associated with drawbacks. Screw and rivet connections weaken the component, as they require drilled holes. The local energy input during the welding process has unfavorable impacts on the steel structure, geometric stability, and fatigue strength. By adhesively bonded connections, structural components can be joined without these drawbacks. Conventional bonding using organic adhesives, however, cannot be applied when bonding gap thicknesses are in the millimeter to centimeter range due to unavoidable dimensional tolerances of the components to be joined. Large bonding gaps result in high costs of the adhesive. Moreover, bonding is made more difficult by environmental impacts and the rough work conditions on the construction site. To overcome these obstacles, KIT's Research Center for Steel, Timber and Masonry has developed a hybrid adhesive bonding method for plug and lap joints. This method overcomes the weaknesses described above. By combining inorganic and organic bonding layers, the novel type of adhesive bond can be produced at lower costs and, additionally, is characterized by a higher load bearing capacity.

Various Applications

The new hybrid adhesive bonding method can be applied in particular for joining structural components, such as hollow sections made of steel, light alloys, or plastic. Hybrid adhesive bonding can be applied for structural engineering, infrastructural facilities, bridges, cranes, towers, and wind energy plants as well as in automotive and mechanical engineering. Examples are connections of trussed girders, anchoring of cantilevers, connections in pole constructions, replacement of problematic grout connections in offshore wind energy plants or shaft-hub connections in automotive and mechanical engineering.



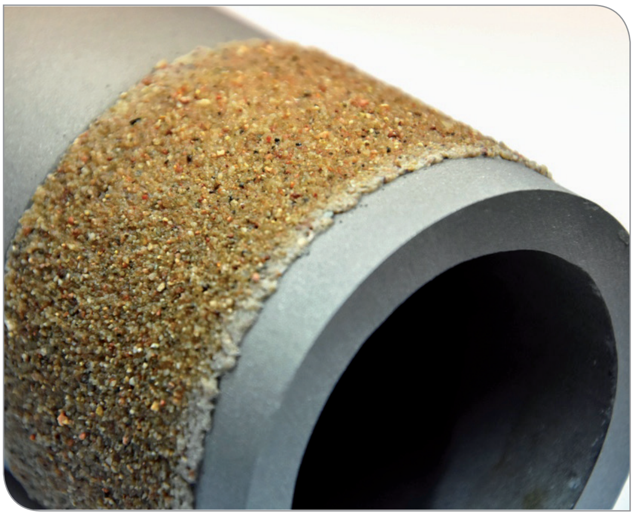
Schematic representation of two tubes connected by hybrid adhesive overlap bonding

Optimized Bonding Technology

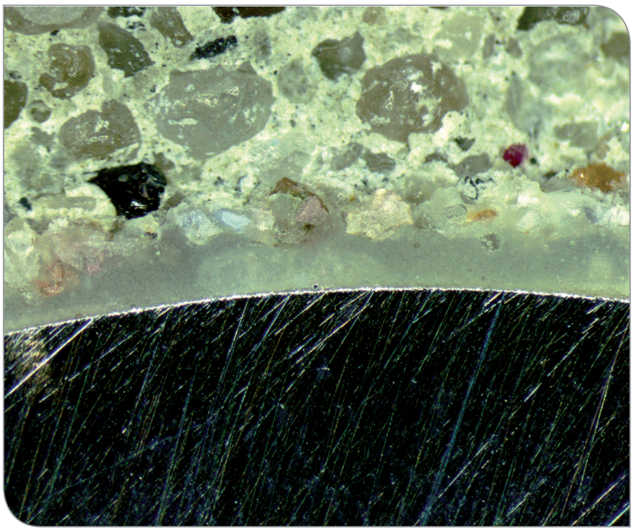
Compared to welding, screw connections or conventional organic adhesive bonds, the combination of inorganic grouting mortar with organic adhesive bonding layers has a number of advantages:

- High quality and production reliability due to organic thin-layer adhesive bonding prior to the transportation of the component to the construction site, e.g. at the manufacturing plant.
- On the construction site, the grouting mortar just hast to be filled in. This is a routine process when grouting base plates of steel pillars or when producing grout connections in offshore wind energy plants.
- Cost reduction due to the use of grouting mortar. Its costs are much lower than those of organic adhesives.
- Tests reveal a high load bearing capacity with minimum scattering of the failure load.
- The adjustable bonding gap allows for the compensation of large manufacturing and assembly tolerances.
- No damaging heat input (as in case of welding); optional wide-area force transmission.

Fraction surfaces of two hollow sections (35 mm and 76 mm in diameter) joined by means of the new hybrid bonding technology (bonding gap thickness 17 mm / overlapping length 45 mm). This connection meets highest load capacity requirements (static loading capacity 110 kN) and can also compensate larger tolerances



Steel tube coated by the adhesive bonding layer containing granules: As a result of variable grain sizes of the granules (e.g. corundum, quartz sand, or crushed gravel), several variants of the adhesive bonding layer can be produced



The microscopic sectional image shows the metal component at the bottom, covered by a thin layer of adhesive and granules and the grouting mortar at the top. The granules can either be mixed into the adhesive or scattered on the surface

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