Light curing acrylates in glass structures

Bernhard WELLER
Professor
Technische Universität
Dresden, Germany
Bernhard.Weller@tu-dresden.de

Bernhard Weller, born 1952, received his civil engineering degree from the RWTH Aachen, Germany

Silke TASCHE
Civil Engineer
Technische Universität
Dresden, Germany
Silke.Tasche@tu-dresden.de

Silke Tasche, born 1975, received her civil engineering degree from the Technische Universität Dresden, Germany

Summary

Adhesive joints in glass construction have been carried out by using one- and two-component silicones for more than twenty years. But UV- and light-curing acrylates in glass construction offer further design potentials due to their inherent transparency, their advantages in the production process and an increased material strength. Therefore, the ageing performance of these adhesives was comprehensively tested on bonded joints of float glass and metal. Afterwards the study was completed by further tests on life-sized samples of different glass applications. Now, for the first time it has been proofed that UV- and light-curing acrylates are suitable in principle to be used for certain applications in glass construction.

Keywords: Glass, Metal, Light-curing Acrylates, Load-transmitting Joints, Ageing Resistance.

1. Introduction

The transparent nature of glass challenges the architect to use it as inconspicuously as possible in the construction of buildings. There are numerous examples of its application in vertical and overhead situations which show that extremely lightweight forms of construction in combination with unobtrusive fixings allow a minimal form of structural glazing, the panes or other members are often connected to each other or to the supporting structure with point fixings or clamping plates. Normal drilled point fixings are not the ideal way of handling glass, however. Especially in the area around the hole, peak tensions occur in the material that cannot be plastically reduced.

The use of adhesives as a means of fixing in glass construction is not only appropriate to the material; it also allows the creation of simple, inconspicuous details. With adhesive fixings, loads are transmitted over larger areas. The transmission of loads to the supporting component occurs evenly over the full adhesive area.

2. State of technology

In recent years adhesively bonded joints proved themselves in different applications in constructions with glass. In the range of load carrying adhesively bonded points, which is regulated in ETAG 002, only silicones can be used. Its properties should be described shortly.

These silicones, which were regulated by approval, are very resistant against different media, for example chemicals and UV-radiation. Because of their weathering resistance they can be used as permanent sealing in façades. The material is temperature-resistant up to 200 °C and its elasticity is sufficient at low temperatures. Usually an interval of temperatures from -20 °C to +80 °C is observed in civil engineering and these interval silicones are resistant also against local temperature peaks caused by from dark materials in facades. In general adhesive bonded joints can be destroyed

https://doi.org/10.2749/222137908796294216

by permanent humidity. Because of this drying of the adhesive bonded joints has to be ensured.

The elasticity of silicones consequently absorbs deformations of the construction. As described in ETAG 002 tolerances can be accepted by a minimal thickness of the glued joint of 6 mm. Silicones creep under long-term performance. Furthermore silicones have only a low resistance compared to tensile and tensile shear loading. Therefore occurring loads have to be accommodated by relative large adhered area.

After extensive research the capability of silicones can be described exactly in relation to ageing resistance and to the conduction of loads. In realization of load-transmitting adhesive bonded joint positive properties will be used; negative properties will be balanced by the construction. Now it was time to research the capability of alternative adhesives in constructions with glass.

3. Investigation of Light-curing acrylates

The objective of this study is to raise the current body of knowledge and to investigate alternative types of adhesives; nearly 3000 laboratory tests on load-bearing adhesive joints comprised of glass and various metal surfaces and bonded together with UV- and light-curing acrylates were analyzed and evaluated. The comprehensive examination of material samples under laboratory conditions was rounded off by a number of tests on large-scale samples with load-bearing adhesive joints.

The use of UV- and light-curing acrylates in glass construction may broaden the variety of connection details possible due to their inherent transparency, their advantages in the production process, and an increased material strength. In order to initiate this development, it is essential to study the ageing process of bonded connections between float glass and metal surfaces. Furthermore, the investigation should incorporate combinations of different types of materials utilized for brackets and surface treatments in order to examine punctual and linear adhesive joints.

Accelerated ageing tests were carried out in accordance with the European guideline ETAG 002. The scope of the ageing tests was reasonably extended with regard to the intended use. Among other test scenarios, the test samples were exposed to natural weathering for a period of several years. The interpretation of test results was conducted with a focus on the quality of the bonded connection relative to the influence of the “tin” side or the “air” side, along with other parameters such as the effect of the adhesive layer’s thickness and glass surface treatments on improved long-term stability of the joints. The creep behavior of the acrylate adhesives was monitored and evaluated in comparison to the characteristic behavior of silicones, as well.

Furthermore, the maximum load capacity and serviceability of adhesive connections using UV- and light-curing acrylates was tested in accordance with current regulations for glass structures. This examination covers glass units acting as barriers to prevent people from falling, glass louvers in façades, overhead glazing and doors with bonded infill panels. The majority of tests were conducted on new building components, some of which had been exposed to natural weathering for a few years prior to testing. In addition to the load capacity tests, the capability of adhesive joints to absorb constraint forces due to temperature changes was investigated.

For the first the fundamental suitability of UV- and light-curing acrylates in glass constructions under consideration of specific limitations of applicability was verified.