OBJECTIVE

Composites like glass-fiber- or carbon-fiber-reinforced polymers (GFRP, CFRP) are being used ever more frequently as load-bearing components in the transport sector (aeronautics, shipping, rail), offshore, but also in construction. Accordingly, their fire stability (time to mechanical failure of components in case of fire) is becoming a key property. We investigate the mechanical failure under compression load upon direct application of a flame to polymers on the bench scale, and to FRP components on the intermediate scale.

We offer suitable experimental test methods for materials on the bench scale and for components on the intermediate scale in order to investigate failure mechanisms and assess performance.

The objective of the project is to increase the fire stability of FRP components. By optimizing the design of components, applying intumescent fire protection coatings, or integrating innovative intermediate layers into the FRP, we are currently working with project partners to significantly increase times to failure.

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BAM
Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

COMPOSITES IN FIRE

Devisions 7.5, 7.3 and 5.3

THE PROJECT

Investigation of fire stability of fiber-reinforced polymers (FRP) in fully developed fire under simultaneous mechanical compression load.

What is decisive for the direct application of flame under a simultaneous mechanical pressure load is the time to failure up to when the specimen or component loses structural integrity. The temperatures and deformation of the specimens are recorded using fiber optic sensors and further verified via secondary rope displacement sensors.

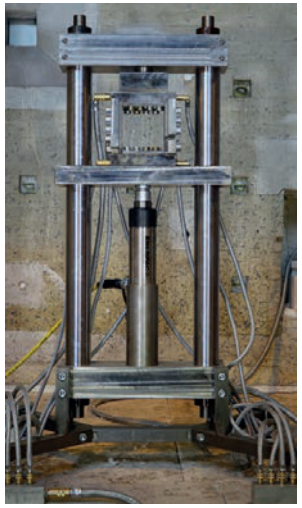
The dimensions of the test stands make it possible to evaluate material concepts in the bench scale and original structural components in the intermediate scale. Realistic failure behavior in terms of mechanics and degradation are reproduced through direct application of flame.

CFRP shell structure reinforced by T-stringer after fire test, detailed shot

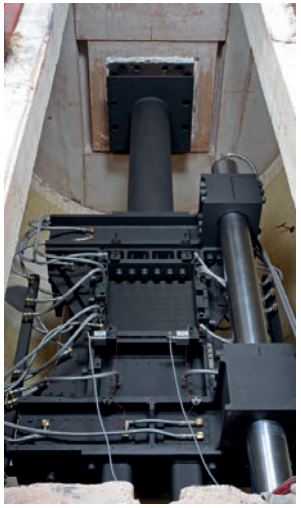
THE TEST STANDS

The bench scale test stand is suitable for the exploratory analysis of new material concepts. With the burner, a flame can be applied directly at irradiations of up to 200 kW/m^2; mechanical loads of up to 230 kN are possible.

The intermediate scale test stand developed by the BAM is designed for a maximum compressive force of 1 MN and a homogeneous application of force to the specimens. Thermal expansion is prevented by a water cooling system integrated in the surface. Realistic strain levels can be generated for a wide spectrum of component geometries. Deployment of a “Next Generation” oil burner (FAR 25.856) delivers globally recognized and comparable results.



Bench-scale test stand



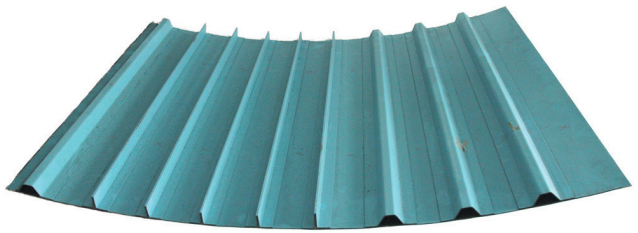
Intermediate-scale test stand integrated in column test furnace at BAM

THE SPECIMENS

Specimens for bench scale testing are typically 150 mm x 145 mm in size.

The specimen clamps of the intermediate scale test stand fulfill the requirements for optimum positioning of the specimen (500-1000 mm x 495 mm). With this, complex geometric forms and structures can be tested just like simpler specimens. The thickness of the specimen can be varied steplessly from 1 mm to 50 mm. Curved structures can be mounted down to a minimum curvature radius of 2000 mm.

Through precise adjustment of the mounting clamping elements, even components with stiffening elements applied (stringers) can be tested for their structural integrity by subjecting them to mechanical load and simultaneous flame.



Original CFRP aviation structure with longitudinal reinforcements