C priedas. Klijų parinkimo bandymo protokolas

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Testreport **TSR 2019049**

Mayer & Mayer Application and Testing Laboratory

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Testreport **TSR 2019049**

Title: **Atlas Auto Qualification**
Roof Profile Connection

Customer: EBS GmbH, AT-7411 Markt Allhau
Atlas Auto Tautvydas Pravilonis
B&B Lithuania

PTDW: Christof Mayer (EBSG)
Kęstutis Janeika (B&B)

Date: 04 – 0x/2019
Done by: CMA/ZCO/CHE

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Introduction / Targets

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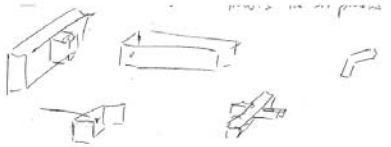
Introduction **TSR 2019049**

Introduction:

Evaluation of Acralock structural adhesives for future application bus roof structure project, replacement of CS235 steel frame construction with VE profile/steel connectors hybrid solution to reduce roof weight.



Step 1: Check bondability of existing pulturded VE profile with standard Acralock adhesives by TDS Tensile Dolly Strength testing. To get best overview and to give the customer the chance to do the correct decision according his future need, the testseries was extended to the whole Acralock product family integrating different adhesive strength ranges and viscosities.

Testseries:	TSR2019049_01:	TDS on VE laminate inside/outside to verify bondability

All tests are done based on various fire tests by ISO 9001-2015 and DIN 6701 certified Mayer & Mayer Application & Laboratories in Austria.

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Targets – Acralock Overview

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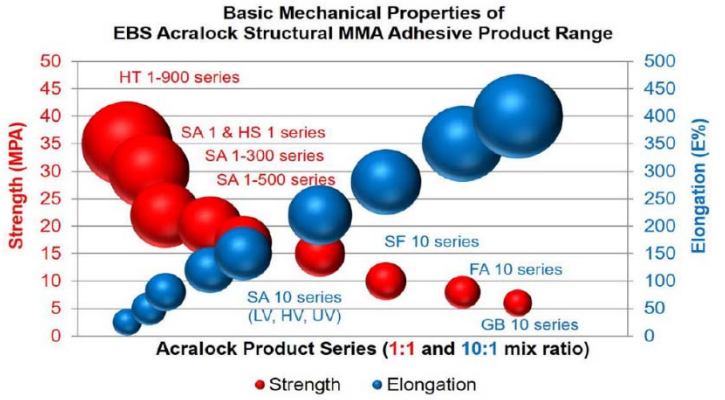

ACRALOCK Structural Adhesives **by Engineered Bonding Solutions** offers as only one worldwide an unique pure MMA based product line with the broadest physical performance range, covering all possible structural and semistructural bonding applications providing the best performing, longest lasting bonded assemblies.

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Summary / Discussion / Conclusion

Result / Discussion / Conclusion

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- All tested adhesives Acralock SA1 series, Acralock SA10 LV series, Acralock SF 10 series, Acralock FA 10 series and Acralock GB 10 series can be used for bonding of the supplied Ugira Lt. pultruded Atlac 430 VE resin profile (VEPTFRP) on the exterior surface as well as the interior surface under precaution, that any change in the used VE profile type (known or unknown) can lead to adhesion problems on the surface due to unknown ingredients inside the pultruded profile which were not testet.
- CS 235 is standard steel commonly used in industry and from bonding side no critical surface (see recommendation of surface preparation below)
- Best Choice for final assembling including bonding of connection CS S235 / VEPTFRP by EBS recommendation:
  - Adhesive: Acralock SA10-15 BLK
  - Surface Prep.: CS S235: Grind off blackoxid layer and oxides (rust)
    + AP1 wipe
    VEFRP: P40
    +Acetone or IPA wipe
- The use of special PP 1-02NAT PP/PE bonding adhesive is not necessary for this type of pultruded VEFRP profile.
- Best practice for assembly of roof segments would be injection of adhesives into injection holes.

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Tests

Samples

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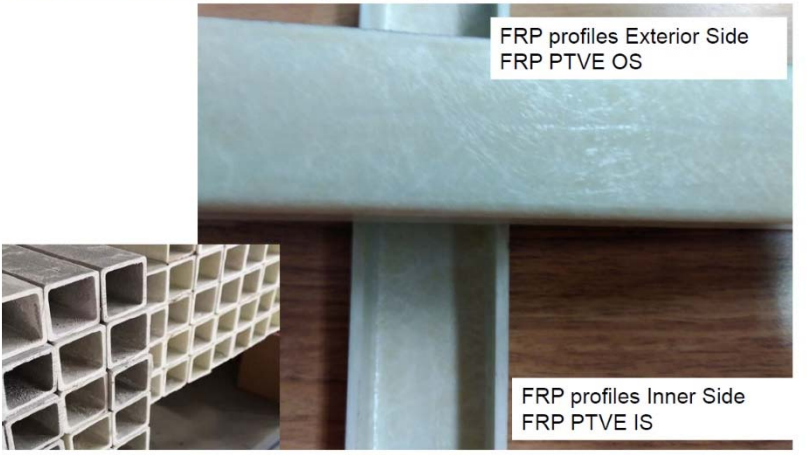
Samples as received, FRP PTVE profiles (Fibre Reinforced Plastic Vinylester Pultruded, UGIRA LT, Glas roving + Atlac)



Samples - Testmatrix

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Substrates:	According testmatrix / sample descriptions – FRP PTVE profile (FRP Pultrusion, Ugira Lt., glas roving + Atlac 430 VE resin) – ALAW5754 Test Dolly	
Surface Preparation:	FRP tupe:	+/- Sanding with P40 sandpaper and Acetone wipe
	Al Dolly:	AP1 wipe (PP1, P40+AP1 wipe)
Adhesives:	Acralock SA1-15NAT, 50 ml, DMA50-00-10, MBQ05-16S Acralock SA10-15BLK, 50 ml, DS51-10-00, MBQX05-16S Acralock SF10-10GRY, 50 ml, DS51-10-00, MBQX05-16S Acralock FA10-10GRY, 50 ml, DS51-10-00, MBQX05-16S Acralock GB10-10GRY, 50 ml, DS51-10-00, MBQX05-16S Acralock PP1-02NAT, 50 ml, DMA50-00-10, MBQ05-16S	

Samples - Testmatrix

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Climate Test:	EN 9142 KAT70 Kataplasma Plastics&FRP (-30/+70° C, 12 h each, 5 cycles)
Stress Test:	TDS: Tensile Dolly strength according ISO4624 @RT, speed 300 N/sec Analysis on strength and failure mode Criterias: C1: Strength C2: Failure Mode
Failure Interpret.:	EN ISO 10365-1995
Target Values:	Values not defined by customer, failure mode cohesive and/or substrate crack after testing required to verify bondability of substrate surfaces
Staistic Analysis:	RC95 Not Done

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Results

TDS Details

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Results TDS Screening

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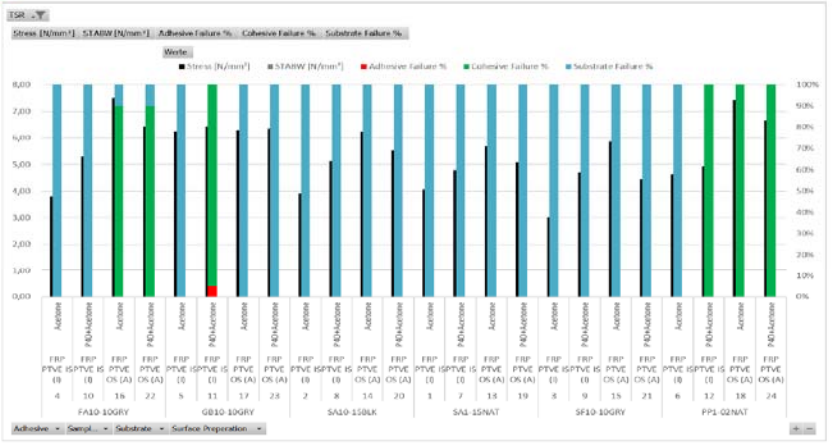

Discussion:

All tested adhesives can be used for bonding this type of pultruded profile which seems to have no adhesion critical ingredients inside the formulation.
Du to mostly failure by substrates, best adhesive to be used is the standard SA10-15 BLK (SA10LV series) because of its general standard availability and best metal bonding characteristics from practice in the past.

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Results TDS Screening

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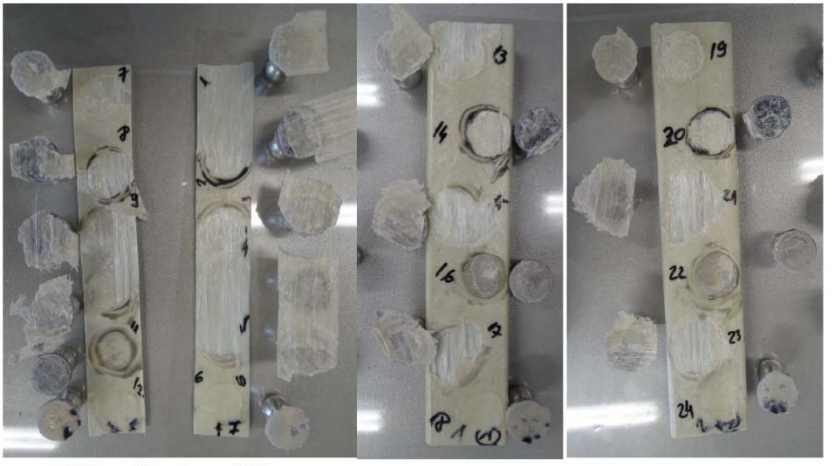

FRP profiles Inner Side
FRP PTVE IS

FRP profiles Exterior Side
FRP PTVE OS

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Appendix

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App. 1 – MP **TSR 2019049**

Refer to Mayer & Mayer database collection – Quality – ISO 17025 – MP`s – TSR2019049

App. 2 – Mayer & Mayer Certifications

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- ISO 9001-2015
  - Developement
  - Testing
  - Manufacturing
  - Sales

  Incl. laboratory work with engineering department, practical experience of more than 5000 testsamples every year

- DIN 6701 Certifcate of competence

App. 3 - EN 4192 Kataplasmacycletest -30/70° C

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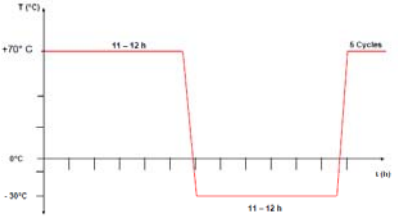
Climate Test: According EN ISO 9142, modified EBS testmethod - Kataplasmacycletest for Plastic/FRP/Paint assemblies



Kataplasmacycletest
+70°C/-30°C
12 h each
5 Cycles.

Standard Kataplasmacycletest, +70°C/-30°C, 100 % watersteam atmosphaere, 12 h each, 5 cycles. This is worst case scenario and maximum stress for simulating 15 years external application for plastic parts. Samples are given to a stainless steel casserole which is filled with water until a certain height. Samples lay on a grating in that way, that they they are very close but don`t come into direct contact to the water and that the watersteam can always cycle around the sample and the water penetrates the bondline and the samples.

Requirements:
Maximum 50 % adhesion failure without climate testing
Minimum 50 % residual strength after Kataplasmacycletest
Maximum 50 % adhesion failure after Kataplasmacycletest

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App. 4 - Failure Interpretation EN ISO 10365

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Table 1 — Designation of failure patterns

	Failure patterns	Designation
Substrate	Failure of one or both adherends (Substrate failure)	SF
	Failure of an adherend (Cohesive substrate failure)	CSF
	Failure through delamination (Delamination failure)	DF
Adhesive	Types of cohesion failure	
	Cohesion failure	CF
	SCF 1 Special cohesion failure SCF 2	SCF
	AF 1 AF 2 Adhesion failure	AF
	Adhesion and cohesion failure with peel	ACFP

If more than one type of failure occurs, an approximate percentage for each type of failure pattern shall be given after each designation (see figure 1).

If a delamination failure occurs (i.e. the coating tears off the adherend), the designation (DF) shall be followed by the nature of the coating.

NOTE 1 Types of coating include primer, varnish, paint, phosphatization, etc.

When an oscillating failure of two patterns occurs, it is indicated by adding "OSC" after the description of the failure patterns:

AF (50 %) + CF (50 %), OSC

NOTE 2 The slip-stick mode of oscillating failure is typical of a system constituted by an elastic adherend and an adhesive which may undergo a transition between different failure mechanisms (cohesion and adhesion failure or ductile and brittle-cohesion failure), elastic energy being periodically stored and released by the adherend.

Figure 2 illustrates a typical pattern of oscillating cohesion and adhesion failure.

Examination of the surface using a suitable instrument may enable the different types of failure pattern to be better distinguished.

AF (50 %) + CF (50 %)

Figure 1 — Example of a "mixed failure"

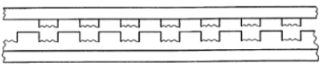

Figure 2 — Example of "oscillating rupture"

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App. 5 – TDS of materials

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Product Data Sheet

Atlac 430

Chemical/physical nature
Atlac 430 is an epoxy bisphenol A vinyl ester, dissolved in styrene.

Performance
Atlac 430 provides resistance to a wide range of acids, alkali, and bleaches for the use in corrosive environments in the chemical processing industry. The favourable combination of thermal resistance and elongation makes this resin suitable for applications exposed to intermittent temperatures.

Major applications
Atlac 430 can be used in all fabrication methods, but is especially adapted to meet the requirements of filament winding, centrifugal casting, hand lay-up and spray-up applications.

Approvals
Cured non-reinforced Atlac 430 conforms to type 1310 according to DIN 16946/2 and is classified group 5 according to DIN 18820/1. According to EN12311/2 Atlac 430 is classified group 7A.

Product specifications upon delivery

Property	Range	Unit	TM
Viscosity, 23 °C	440 - 560	mPa·s	ISO 3219
Colour, Lico 200	0.0 - 3.5	-	ISO 6271
Solids content, 1h	59 - 62	%	ISO 3251
Appearance	clear		visual
Cure time from 25 to 35 °C	10 - 15	min	ISO 2535
Cure time from 35 °C to peak	17 - 24	min	ISO 2535
Peak temperature	140 - 180	°C	ISO 2535

Remarks
TM2013: Z2/100 g/23° C
TM2425: 2.0 g Butanox LPT-IN and 1.0 g Accelerator NL 49P (both AKZO-Nobel) added to 100 g resin

Properties of the liquid resin (typical values)

Property	Value	Unit	TM
Density, 23° C	1082	kg/m³	ISO 1183
Refractive index	1.5675	-	2782
Flash point	33	°C	ISO 2592
Acid value, as such	7	mg KOH/g	ISO 2114
Stability, no init., dark, 25 C	6	Mths	-

Typical values of cast unfilled resin

Property	Value	Unit	TM
Density, 20° C	1145	kg/m³	ISO 1183
Tensile strength	95	MPa	ISO 527-2
Mod. of elasticity in tension	3.6	GPa	ISO 527-2
Elongation at break	4.1	%	ISO 527-2
Flexural strength	150	MPa	ISO 178
Mod. of elasticity in bending	3.4	GPa	ISO 178
Elongation in flex	4.3	%	ISO 178
Impact res. - unnotched sp.	28	kJ/m²	ISO 179
Heat detection temp. (HDT)	105	°C	ISO 75-A
Glass transition temp. (Tg)	130	°C	DIN 53445

Curing conditions
Cured with 1 ml Butanox LPT-IN (AKZO-Nobel) and 0.5 ml Co-act. solution (1 % Co in styrene) added to 100 g resin. Cured 24 h at room temperature and 24 h at 80 °C. For HDT and Tg(dyn) post-curing 24 h at 120° C.

Properties of cured glass reinforced resin (typical values)

Property	Value	Unit	TM
Density	1400	kg/m³	ISO 1183
Glass content	38.6	%	ISO 1172 / 2984
Tensile strength	138	MPa	ISO 527-2
Mod. of elasticity in tension	10	GPa	ISO 527-2
Flexural strength	210	MPa	ISO 178
Mod. of elasticity in bending	10	GPa	ISO 178
Linear expansion	30 x 10⁻⁶	K⁻¹	-
Thermal conductivity	0.2	W/m.K	DIN 52612

Curing conditions
Cured with 1 ml Butanox LPT-IN (AKZO-Nobel) and 0.5 ml Co-act. solution (1 % Co in styrene) added to 100 g resin. Cured 24 h at room temperature and 24 h at 80° C. Laminates were based on 4 layers of 450 g/m² chopped strand mat.