formlabs

ENGINEERING RESIN

Tough 1500 Resin V2

Stiff but compliant material with toughness that rivals polypropylene

Prototypes requiring the toughness, compliance and resilience of polypropylene.

Impact resistant jigs and fixtures that survive long term use on the factory floor.

Tough and rugged enclosures with functional elements like self-tapping screw bosses and snap fits.

Parts that need a combination of stiffness and ductility to create compliant mechanisms like latches, flexures, and dampers.

V2 **FLTO1502**

Prepared 18/03/2025

Rev. 05 17/10/2025

Tough 1500 Resin V2 is a resilient material with strength, stiffness, and toughness comparable to polypropylene (PP), offering exceptional resistance to fractures, impacts, and shattering.

Create parts that balance stiffness and ductility, whether for compliant mechanisms like rugged enclosures with self-tapping screws and snap fits. Tough 1500 Resin V2 enables a wide range of applications, from functional prototypes to end-use jigs and fixtures.

Tough 1500 Resin V2 is a new material formulation that leverages the Form 4 Series to deliver 10 times higher fracture toughness than the previous version.

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	**Post-Cured [3]**	**Green [2]**	**Post-Cured [3]**	
Tensile Properties	METRIC [1]		IMPERIAL [1]		METHOD
Ultimate Tensile Strength	30 MPa	34 MPa	4350 psi	4930 psi	ASTM D638-14
Tensile Modulus	1250 MPa	1460 MPa	181 ksi	212 ksi	ASTM D638-14
Tensile Strength at Yield	30 MPa	34 MPa	4350 psi	4930 psi	ASTM D638-14
Elongation at Yield	5.6%	6.1%	5.6%	6.1 %	ASTM D638-14
Elongation at Break	210%	155%	210%	155%	ASTM D638-14
Flexural Properties	METRIC [1]		IMPERIAL [1]		METHOD
Flexural Strength	26 MPa	41 MPa	3770 psi	5950 psi	ASTM D790-17
Flexural Modulus	900 MPa	1370 MPa	130 ksi	199 ksi	ASTM D790-17
Toughness Properties	METRIC [1]		IMPERIAL [1]		METHOD
Notched Izod	45 J/m	42 J/m	0.84 ft-lb/in	0.79 ft-lb/in	ASTM D256-10
Unnotched Izod	1080 J/m	910 J/m	20.2 ft-lb/in	17.0 ft-lb/in	ASTM D4812-11
Notched Charpy	8.9 kJ/m^2	7.5 kJ/m^2	4.2 $ft\text{-}lb/in^2$	3.6 $ft\text{-}lb/in^2$	ISO 179-1
Unnotched Charpy	63 kJ/m^2	57 kJ/m^2	30 $ft\text{-}lb/in^2$	27 $ft\text{-}lb/in^2$	ISO 179-1
Gardner Impact Strength at 1/32" (0.79 mm) thickness	7.0 J	5.9 J	62 in-lb	52 in-lb	ASTM D5420-21
Gardner Impact Strength at 1/16" (1.6 mm) thickness	12.4 J	11.1 J	110 in-lb	98 in-lb	ASTM D5420-21
Ross Flex Fatigue	11000 cycles	8000 cycles	11000 cycles	8000 cycles	Internal (23°C, 30 Degree deflection at 1 hz)
Fracture Properties	METRIC [1]		IMPERIAL [1]		METHOD
Maximum Stress Intensity Factor (Kmax)	1.7 $MPa\text{-}m^{1/2}$	1.7 $MPa\text{-}m^{1/2}$	1550 $psi\text{-}in^{1/2}$	1550 $psi\text{-}in^{1/2}$	ASTM D5045-14
Work of Fracture (W_f)	1090 J/m^2	1011 J/m^2	74.7 $ft\text{-}lb/ft^2$	69.3 $ft\text{-}lb/ft^2$	ASTM D5045-14

Material Properties	METRIC [1]		IMPERIAL [1]		METHOD
	Green [2]	Post-Cured [3]	Green [2]	Post-Cured [3]	
Thermal Properties	METRIC [1]		IMPERIAL [1]		METHOD
Heat Deflection Temp. @ 1.8 MPa	42 °C	53 °C	107 °F	127 °F	ASTM D648-16
Heat Deflection Temp. @ 0.45 MPa	54 °C	66 °C	129 °F	151 °F	ASTM D648-16
Thermal Expansion (0-150 °C)	116 µm/m/°C	99 µm/m/°C	64 µin/in/°F	55 µin/in/°F	ASTM E 831-19
Flammability	Not Tested	HB	Not Tested	HB	UL 94
Electric Properties	METRIC [1]				METHOD
	Post-Cured [3]				
Dielectric Strength	23.4 kV/mm				ASTM D149-20
Dielectric Constant (50 Hz)	4.5				ASTM D150 (50 Hz)
Dielectric Constant (1 kHz)	3.9				ASTM D150 (1 kHz)
Dissipation Factor (50 Hz)	0.018				ASTM D150 (50 Hz)
Dissipation Factor (1 kHz)	0.013				ASTM D150 (1 kHz)
Volume Resistivity	$2.91 * 10^{15}$ Ω · cm				ASTM D257-14
Other Properties	METRIC [1]				METHOD
Shore D Hardness	76D				ASTM D2240
Bulk Density	1.12 g/mL				ASTM D792-20
Viscosity at 25 °C	1000 cP				ASTM D792-20
Liquid Density	1.02 g/mL				ASTM D792-20

BIOCOMPATIBILLITY

Tough 1500 Resin has been evaluated as a skin contacting device in accordance with ISO 10993-1, and passed the requirements for the following biocompatibility endpoints:

ISO Standard	Description [3,4]
ISO 10993-5	Not Cytotoxic
ISO 10993-10	Not an Irritant
ISO 10993-10	Not a Sensitizer

CHEMICAL COMPATIBILITY

Percent weight gain over 24 hours for a printed 1 x 1 x 1 cm cube immersed in respective solvent:

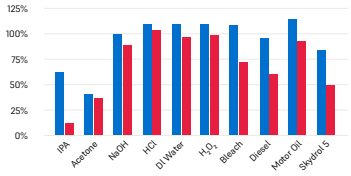
Solvent	24 hr weight gain, %	Solvent	24 hr weight gain, %
Acetic Acid 5%	0.22	Isooctane (aka gasoline)	42.92
Acetone	29.64	Mineral oil (light)	0.02
Isopropyl Alcohol	6.54	Mineral oil (Heavy)	0.04
Bleach ~5% NaOCl	-0.05	Salt Water (3.5% NaCl)	0.24
Butyl Acetate	41.35	Sodium Hydroxide solution (0.025% PH 10)	0.17
Diesel Fuel	0.04	Water	0.21
Diethylene glycol Monomethyl Ether	5.71	Xylene	72.57
Hydraulic Oil	0.04	Strong Acid (HCl conc)	2.15
Skydrol 5	2.41	TPM	5.90
Hydrogen peroxide (3%)	0.31		

Chemical Compatibility (ASTM D543)

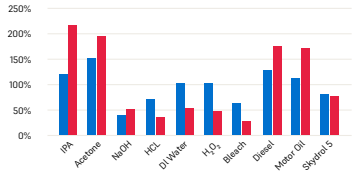
Tested for chemical compatibility according to ASTM D543. The influence of various chemicals was tested by measuring tensile modulus and strength after different exposure times. Exposed samples were stored in containers and fully immersed in the test chemicals for 1 day and 1 week. After removal, exposed samples were washed and conditioned for 24 hours at 22°C before mechanical testing. Mechanical testing was conducted according to ASTM D638 using Type IV tensile samples at standard lab conditions (22°C). Results are reported as a % difference from the measured values of non-exposed samples.

Solvent	IPA	Acetone	NaOH (0.025% pH=10)	HCl (10%)	DI Water	H_2O_2 (3%)	Bleach (~5% NaOCl)	Diesel	Motor Oil	Skydrol 5
Relative Modulus										
1 day	61.80%	41.01%	99.51%	109.90%	109.98%	110.37%	109.63%	95.71%	115.69%	83.62%
1 week	12.37%	37.77%	88.99%	103.73%	97.23%	98.98%	72.70%	60.43%	93.11%	49.99%
Relative Strength										
1 day	55.66%	54.30%	98.98%	95.49%	99.62%	98.27%	96.26%	94.49%	98.46%	71.99%
1 week	28.85%	49.48%	103.30%	101.11%	99.01%	98.84%	97.71%	63.33%	101.85%	43.65%
Relative Elongation										
1 day	118.46%	150.74%	39.05%	70.50%	103.07%	103.02%	63.63%	127.67%	109.53%	80.51%
1 week	219.26%	196.33%	50.69%	35.01%	52.05%	44.92%	25.90%	176.95%	169.00%	74.90%
Relative Mass										
1 day	112.82%	141.98%	100.22%	100.22%	100.40%	100.41%	100.27%	104.30%	100.42%	108.49%
1 week	135.80%	141.15%	100.23%	100.14%	100.51%	100.71%	100.24%	111.17%	99.95%	119.26%

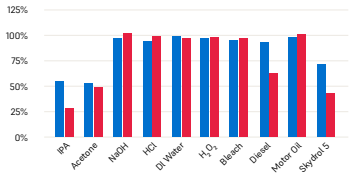
Tensile Modulus after Immersion Time



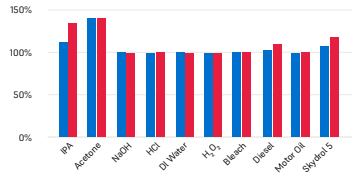
Elongation at Break After Immersion Time



Ultimate Tensile Strength after Immersion Time



Mass Absorption after Immersion Time



● 1 DAY ● 1 WEEK

[1] Material properties can vary with part geometry, print orientation, print settings, and temperature.

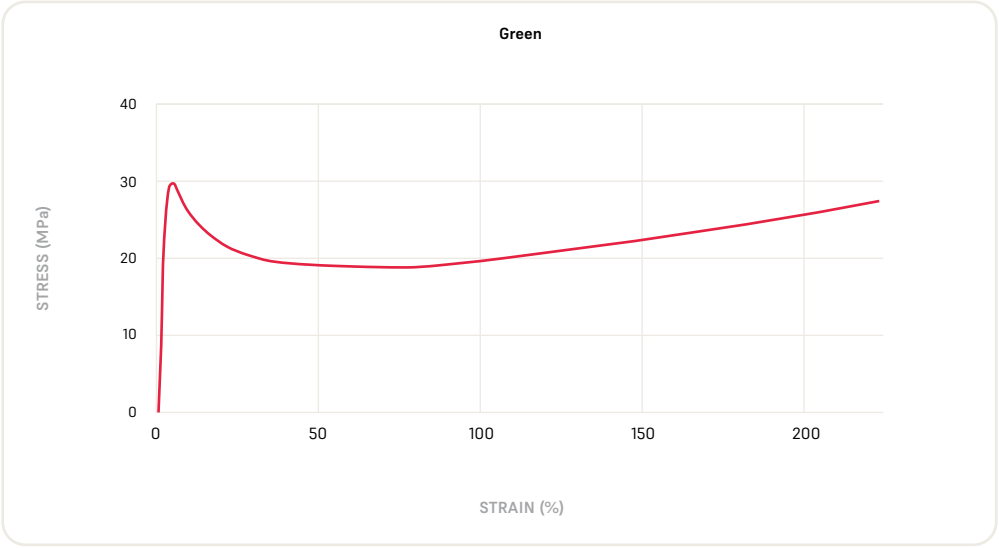
[2] Data was obtained from green parts, printed using Form 4, 100 µm, Tough 1500 V2 settings, without additional treatments.

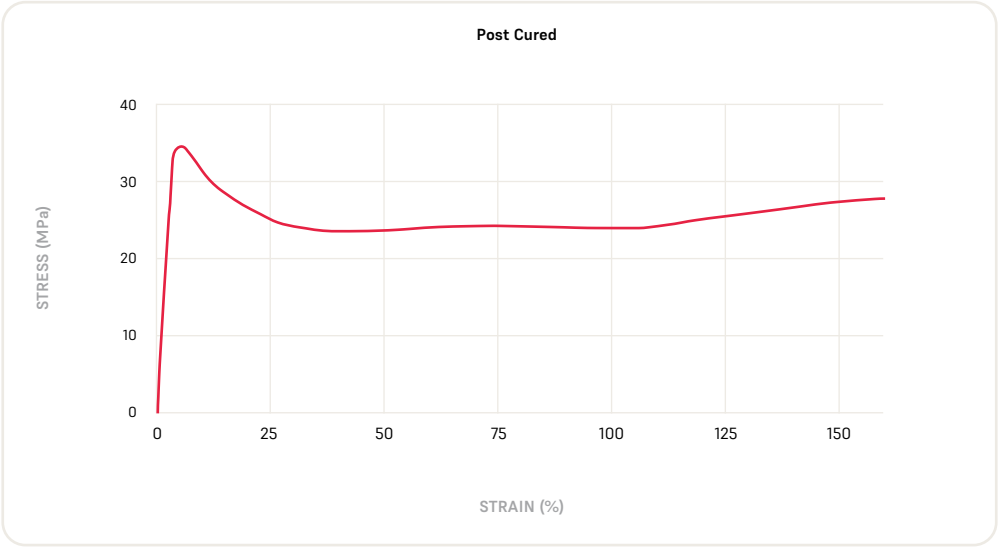
[3] ISO 10993 standard testing samples were printed on a Form 4 with 100um Tough 1500 Resin V2 settings, washed in a Form Wash for 10 minutes (5 min clean, 5 min dirty) dried for at least 30 minutes and post-cured at 70 °C for 12 minutes in a Form Cure (2nd Generation)

[4] Tough 1500 Resin was tested at NAMSA World Headquarters, OH, USA

Representative Tensile Curve (ASTM D638-14)

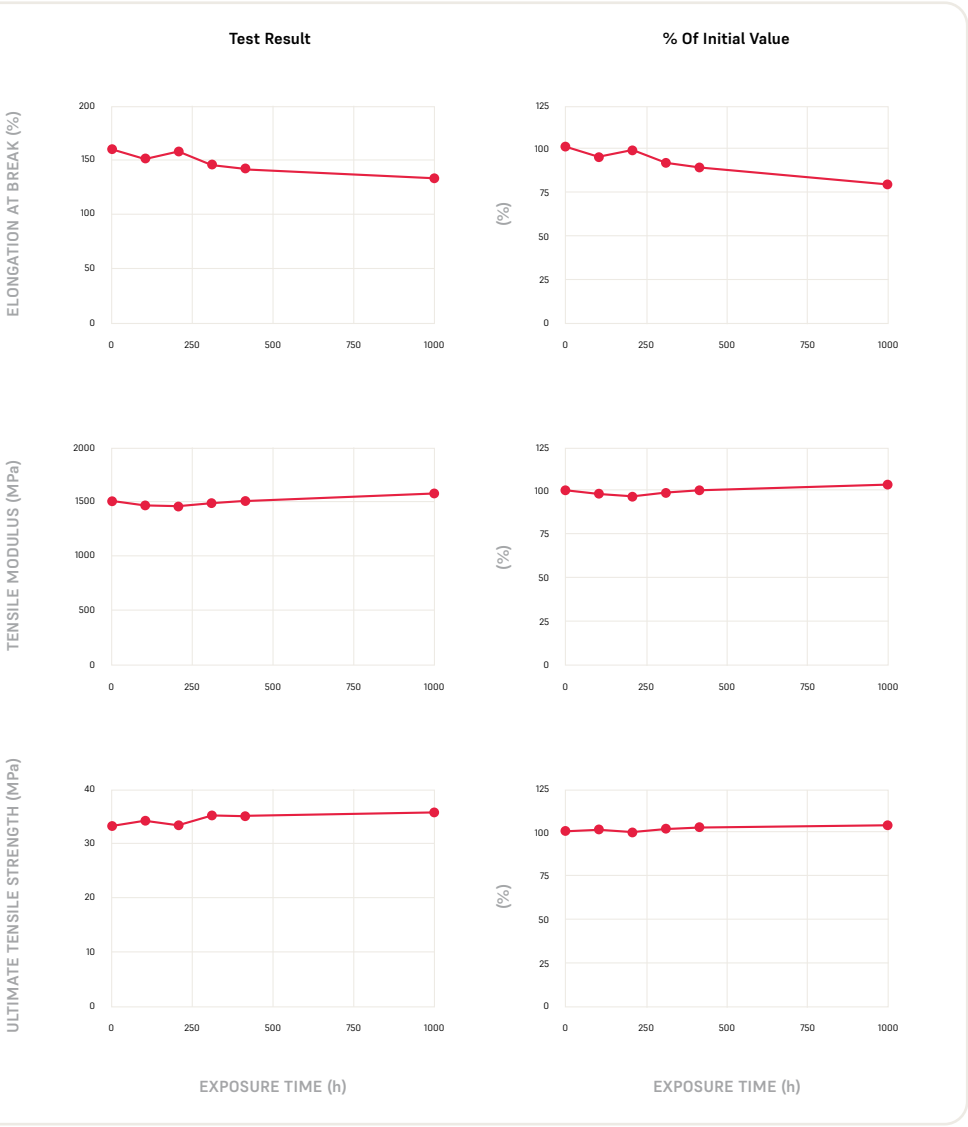
Type I, 50 mm/min





Heat Aging (ASTM D3045)

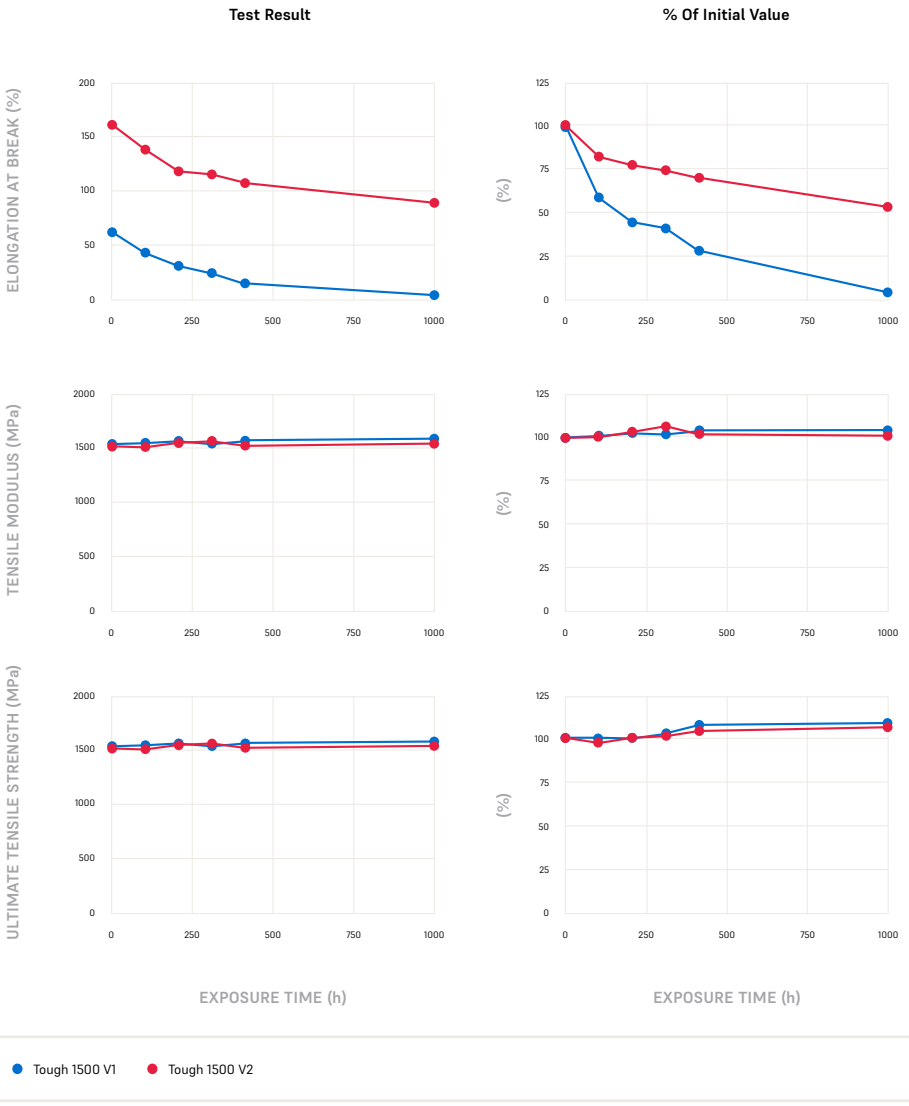
Formlabs evaluated the heat aging performance of Tough 1500 Resin V2 using ASTM D3045, a test method for evaluating heat aging of plastics without load. In this test, mechanical properties of samples placed at 50 °C environments are measured at different durations of time for up to 6 weeks.



Indoor Aging (ASTM D4459)

Formlabs evaluated the UV aging performance of Tough 1500 Resin V2 using ASTM D4459, a test standard for xenon-arc exposure of plastics for indoor applications. This test simulates polymer aging due to solar radiation exposure through glass. Exposed samples were conditioned for 24 hours at 22 °C before mechanical testing. Control samples were stored at a constant 22 °C. Mechanical testing was conducted according to ASTM D638 at standard lab conditions (22 °C). "0 hrs" represents non-aged samples stored at 22 °C and tested 24 hours after post-processing.

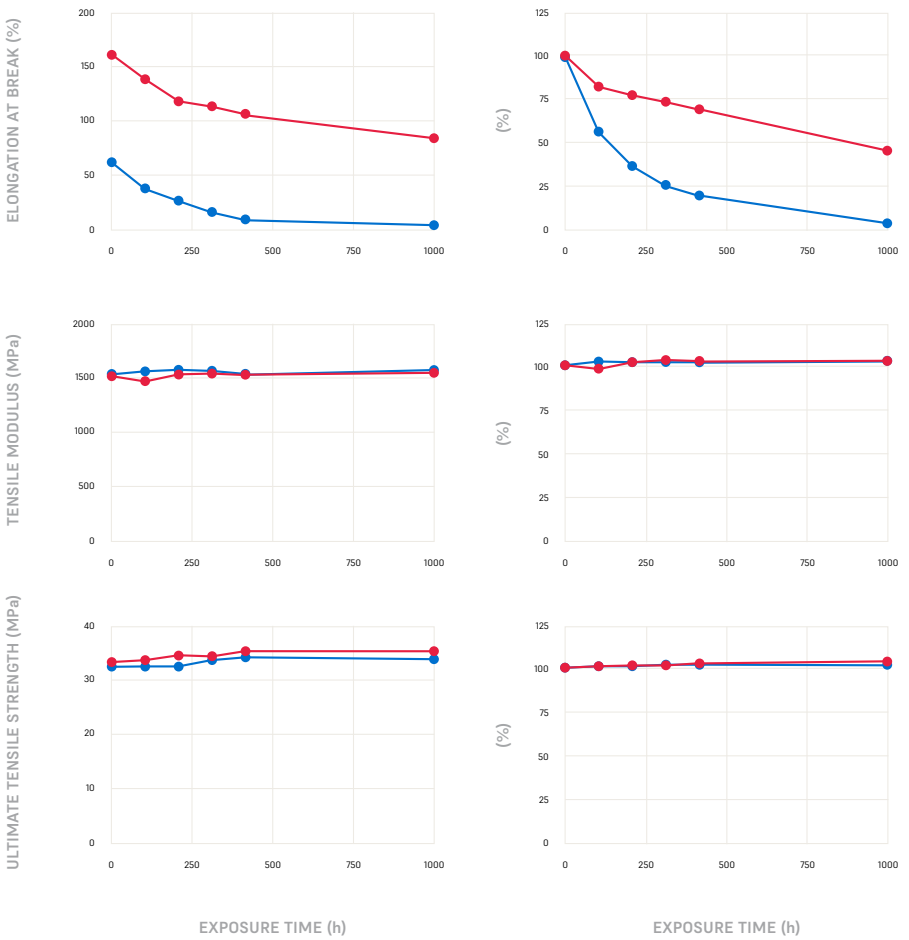
Please note, accelerated weathering testing cannot fully represent all aging conditions.
Formlabs recommends conducting additional outdoor testing relevant for your specific application needs.



Outdoor Aging (ASTM D4329)

Tough 1500 Resin V2 was tested in accelerated outdoor weathering conditions according to ASTM D4329 (Cycle A). Test samples were exposed to defined conditions of heat, water condensation and UV light. Exposed samples were conditioned for 24 hours at 22°C before mechanical testing. Control samples were stored at a constant 22°C. Mechanical testing was conducted according to ASTM D638 at standard lab conditions (22°C). "0 hrs" represents non-aged samples stored at 22°C and tested 24 hours after post-processing.

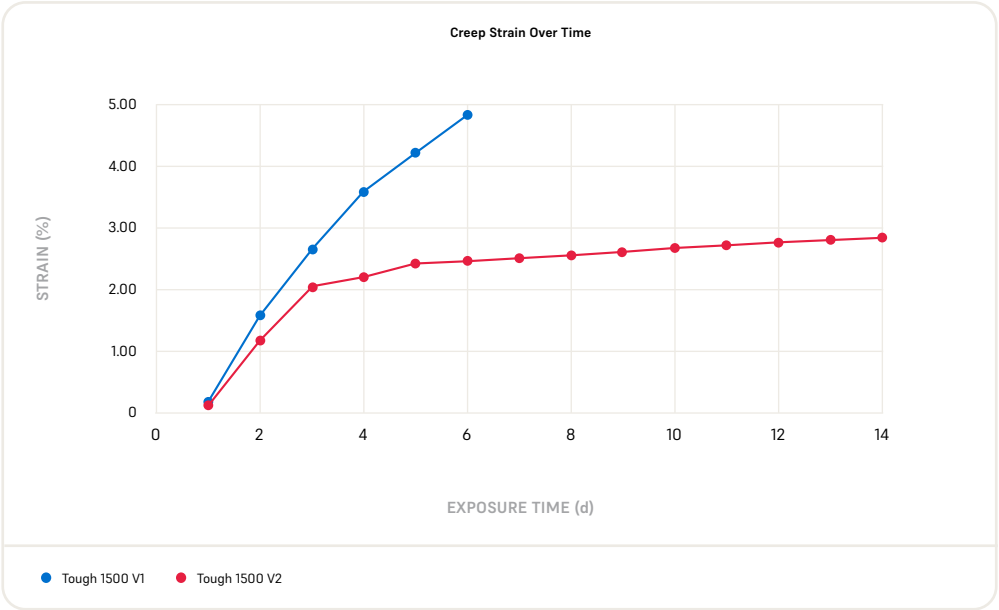
Please note, accelerated weathering testing cannot fully represent all aging conditions.
Formlabs recommends conducting additional outdoor testing relevant for your specific application needs.



ASTM D4329: Cycle A for general applications, QUV/se, UVA 340 nm, 0.89 W/m2-nm, 8 hours UV light at 60°C followed by 4 hours at 50°C condensation in the dark. To reduce any sample warpage during test time samples were placed in tailor-made holders without any fixation clamps or mechanical load. Exposed samples were always removed from QUV before next condensation cycle to avoid samples that are soaked excessively with water before testing.

Flexural Creep ISO 6602

Formlabs evaluated the creep resistance of Tough 1500 Resin V2 using ISO 6602. This test measures a materials rate of deformation at a constant temperature under a fixed load. Speciments were tested at 22 °C under a 4.0 MPa load. Deflection was measured once a day over the course of 14 days.



Dynamic Mechanical Analysis (DMA)

A DMA curve of Tough 1500 Resin V2 from 0 °C to 140 °C at 3 °C/min is shown. A glass transition is observed at 109.6 °C, and an inflection of the storage (elastic) modulus is observed at 60.8 °C.