Stratasys 400mc System

Material Properties:

Preliminary Investigation into the Mechanical Properties of Stratasys Polycarbonate & M30 ABS materials

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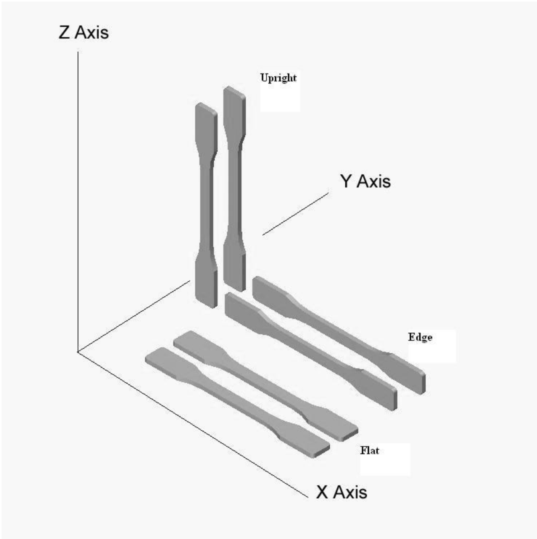
1 Isotropic Properties of PC and M30-ABS materials built on the FDM 400mc System

Isotropy tests (flexure & tensile) were performed on M30-ABS and PC samples produced using a Stratasys FDM 400mc system. Samples were built flat, on edge and in upright orientations. The build parameters and post-processing procedures used can be found in Appendices A & B. Ten samples for each condition were built using default parameters and tip size 12 before being tested in flexure and tension at 20°C.



The mechanical tests were performed using the following calibrated equipment:

- Zwick Z030 Tensile Test Machine with 10KN load cell:

Flexural and tensile tests were undertaken in accordance with the following ISO standards :

ISO 527-1 & 2: Plastics – Determination of Tensile Properties – 1996
ISO 178: Plastics – Determination of Flexural Properties – 1997

1.1 Isotropy Results for M30 ABS

Build Orientation		UTS (MPa)	Young's Modulus (MPa)	% Elongation at Break	Flexural Strength (MPa)	Flexural Modulus (MPa)
Flat	***Ave.***	**32.4**	**3091.7**	**8.3**	**67.2**	**2129.7**
	Max	32.7	3475.3	9.5	68.9	2201.4
	Min	31.3	2774.4	6.6	65.5	2058.1
Edge	***Ave.***	**32.3**	**2544.8**	**9.2**	**64.2**	**1981.8**
	Max	32.8	2881.6	11.7	65.4	2220.7
	Min	31.9	2112.2	6.9	62.3	1704.8
Upright	***Ave.***	**23.1**	**2325.6**	**2.2**	**44.8**	**1746.0**
	Max	24.0	2800.2	2.4	47.4	1783.9
	Min	22.5	2021.3	2.1	42.2	1689.9

Table 1: Tabulated isotropy results for M30 ABS

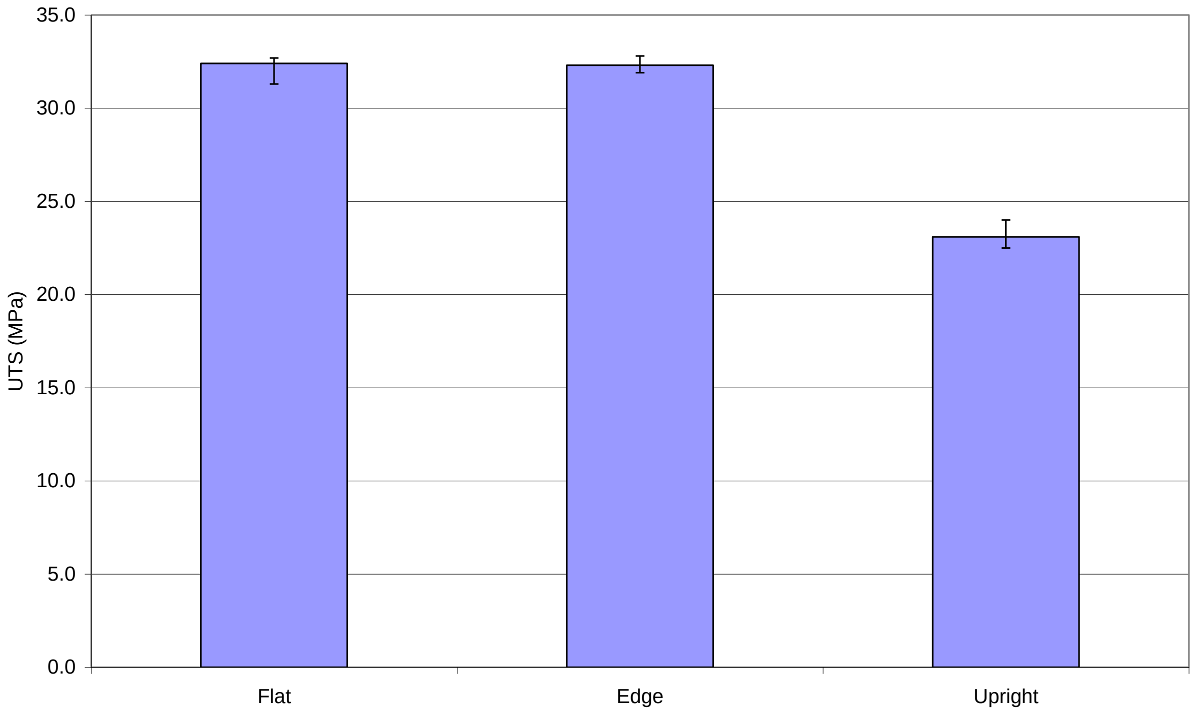


Figure 1: Effect of build orientation on UTS of M30 ABS

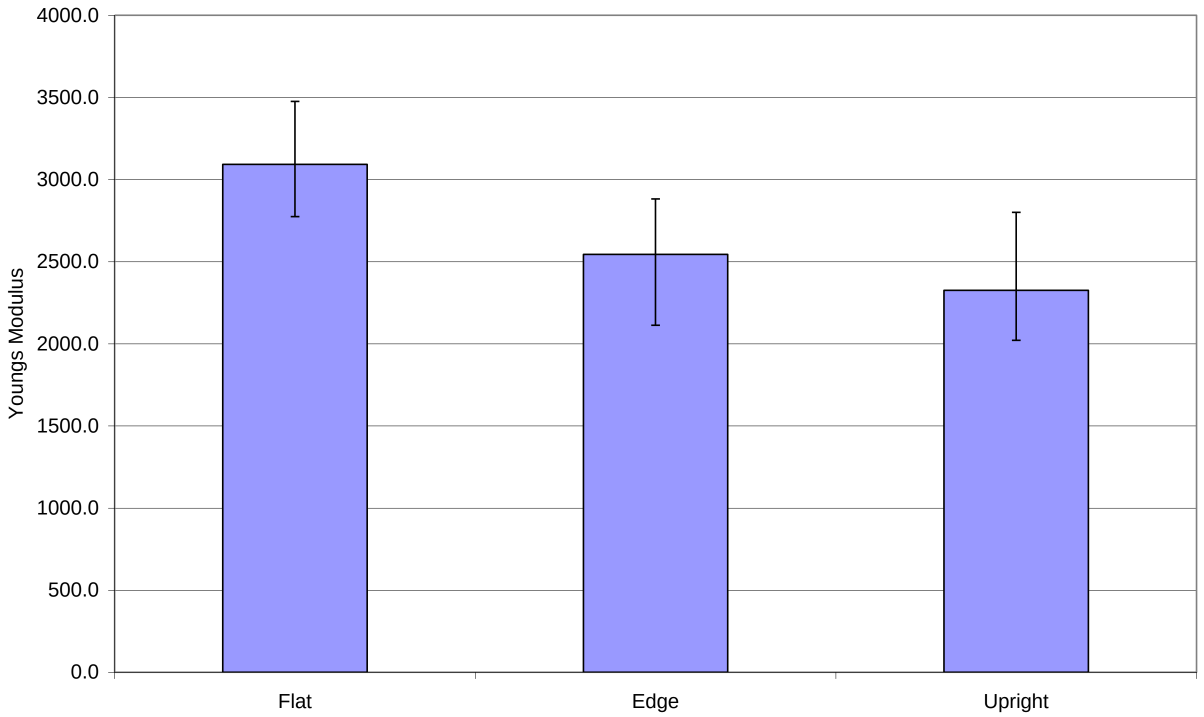


Figure 2: Effect of build orientation on Youngs Modulus of M30-ABS

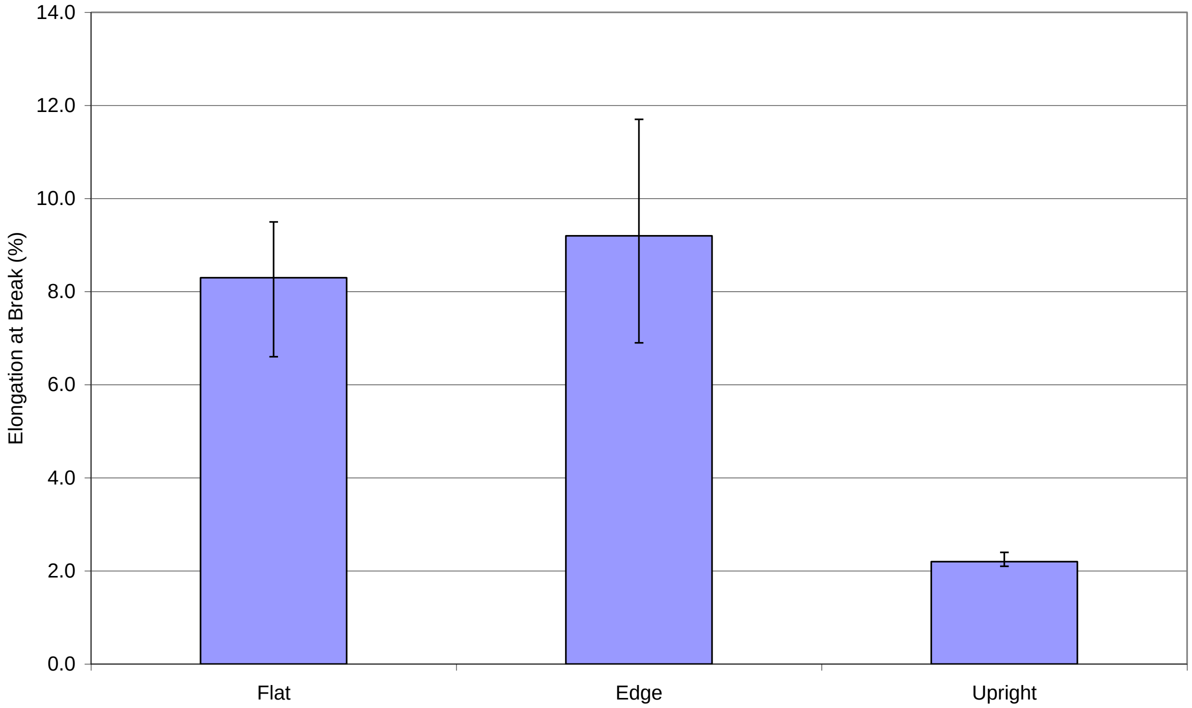


Figure 3: Effect of build orientation on Elongation at Break of M30-ABS

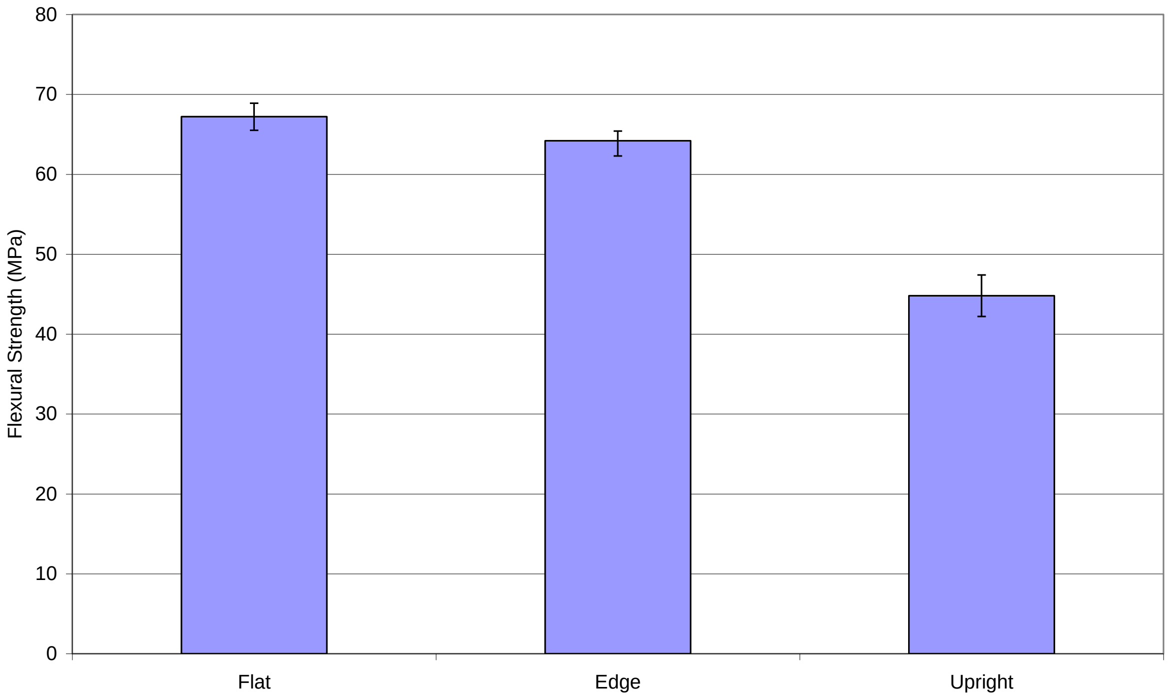


Figure 4: Effect of build orientation on Flexural Strength of M30-ABS

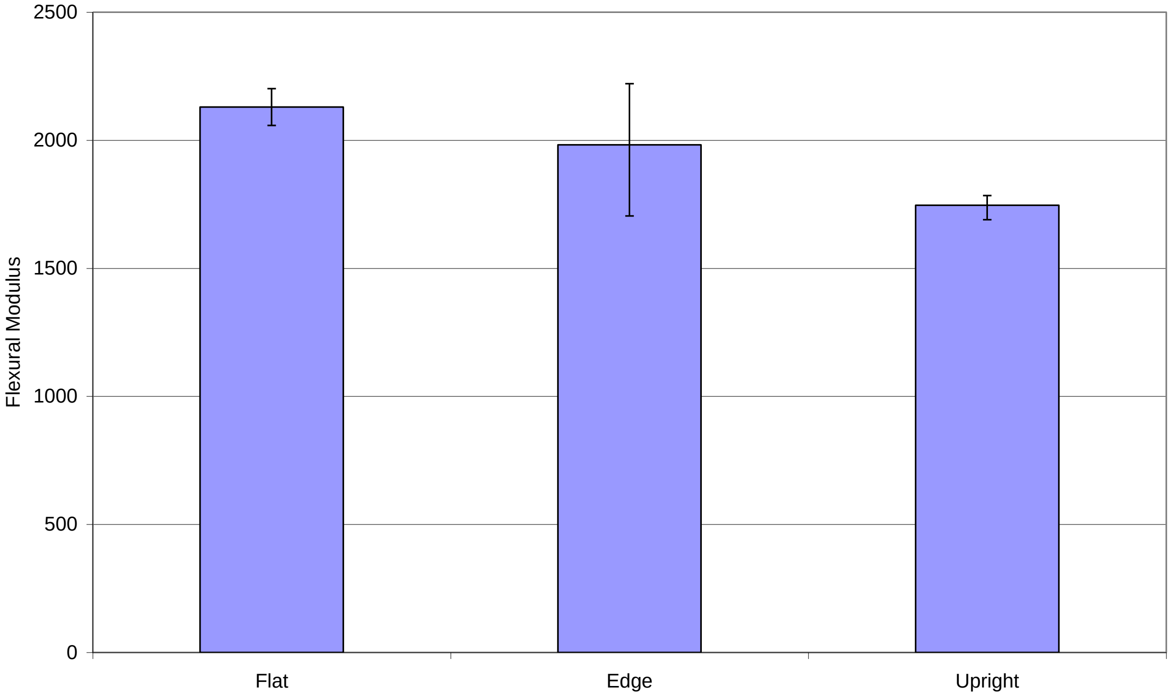


Figure 5: Effect of build orientation on Flexural Modulus of M30-ABS

1.2 Isotropy Results for PC

Build Orientation		UTS (MPa)	Young's Modulus (MPa)	% Elongation at Break	Flexural Strength (MPa)	Flexural Modulus (MPa)
Flat	***Ave.***	**51.0**	**2227.9**	**8.2**	**78.5**	**1805.8**
	Max	53.1	2436.7	8.9	83.3	1866.6
	Min	50.1	1959.4	7.8	72.3	1754.1
Edge	***Ave.***	**59.0**	**2284.4**	**8.1**	**92.3**	**2038.0**
	Max	59.5	2849.3	8.6	94.6	2055.6
	Min	58.2	1791.3	7.7	88.9	2012.7
Upright	***Ave.***	**26.8**	**2172.6**	**2.8**	**67.3**	**1732.2**
	Max	36.1	2580.3	3.8	76.1	1777.6
	Min	20.9	1555.6	2.1	61.0	1681.7

Table 2: Tabulated isotropy results for PC

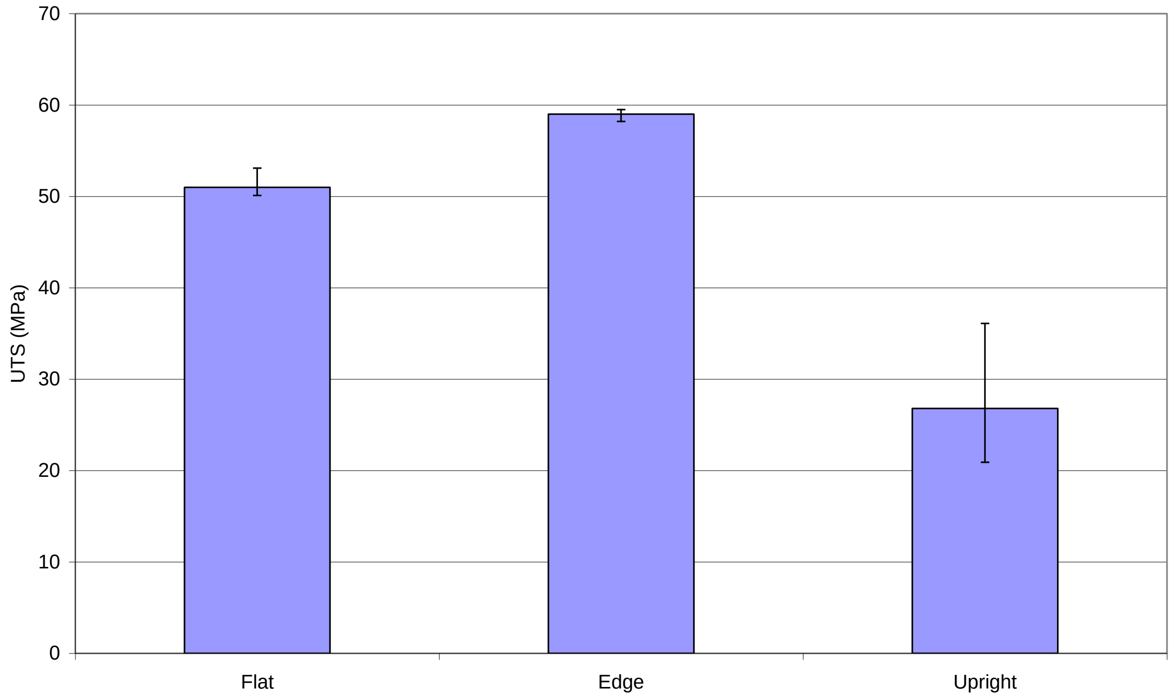


Figure 6: Effect of build orientation on UTS of PC

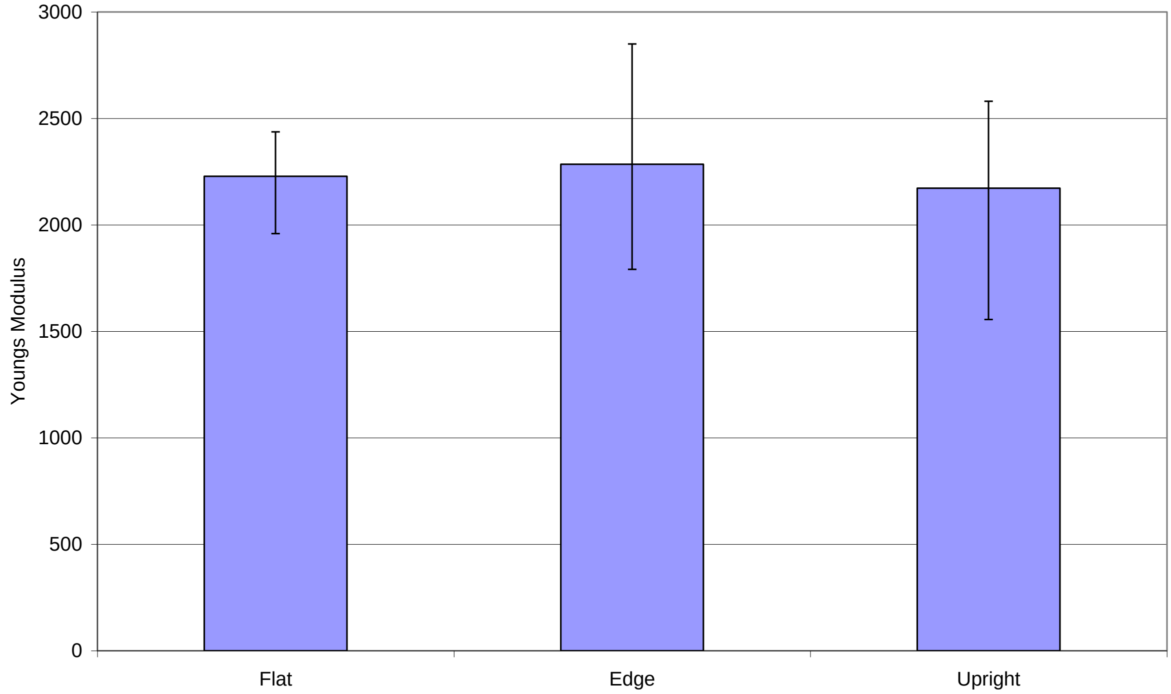


Figure 7: Effect of build orientation on Young's Modulus of PC

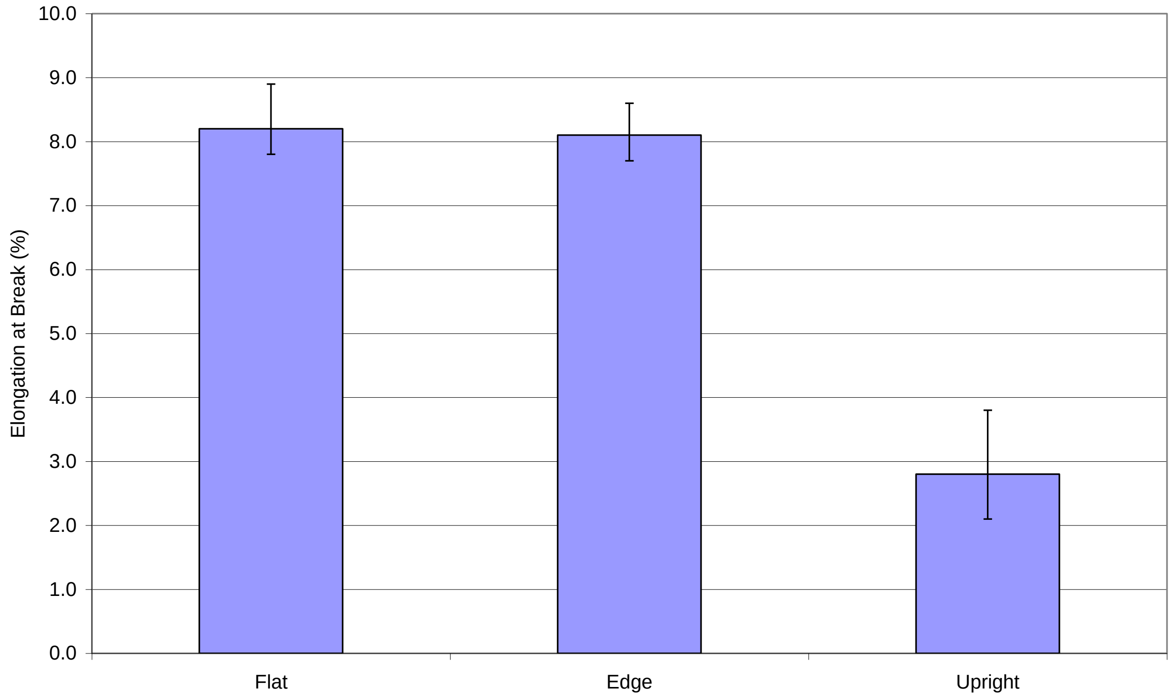


Figure 8: Effect of build orientation on Elongation at Break of PC

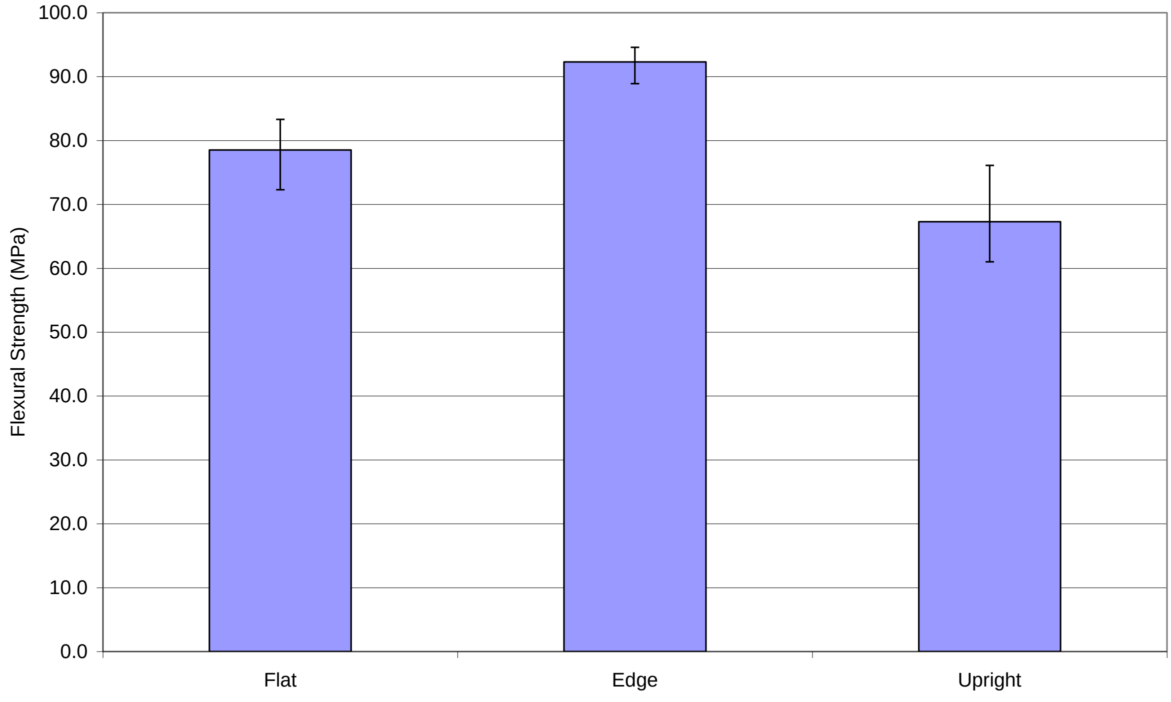


Figure 9: Effect of build orientation on Flexural Strength of PC

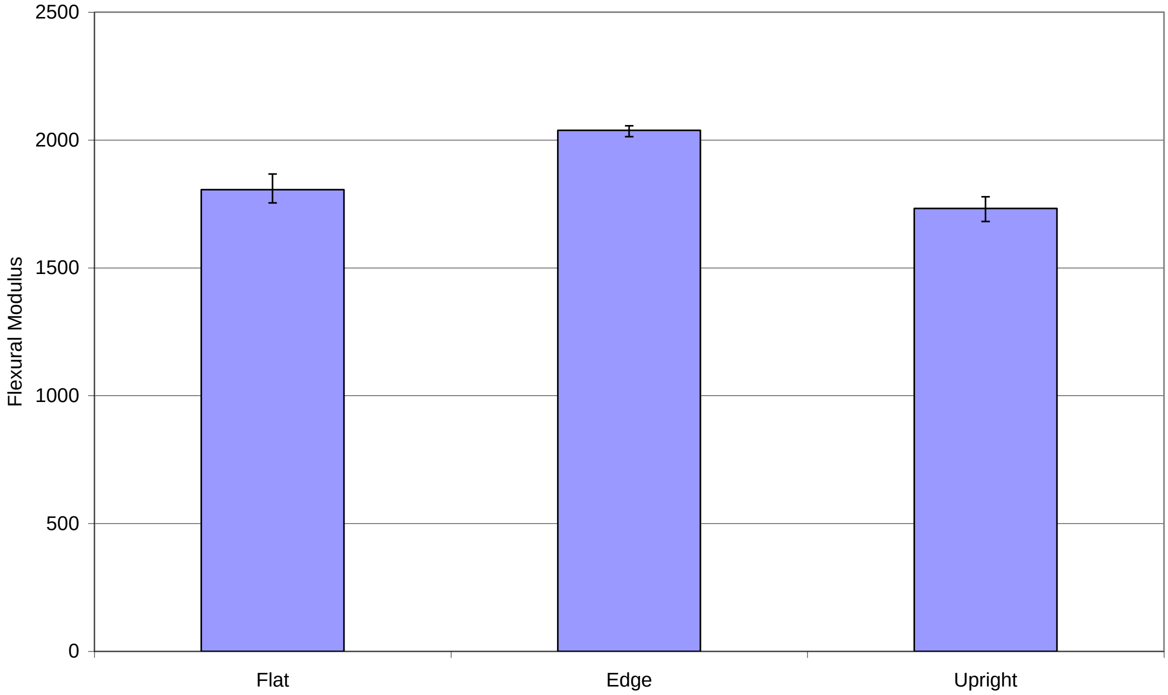


Figure 10: Effect of build orientation on Flexural Modulus of PC

2 Initial characterisation from -40 to +140°C for M30-ABS and PC materials built on the FDM 400mc System

Tensile tests have been carried out to investigate the behaviour of M30-ABS and PC over a range of temperatures.

All the test samples were produced using a Stratasys FDM 400mc system. Parts were produced on edge and in upright orientations.

Ten samples for each condition were built using default parameters and with a tip size of 12 & and a slice thickness of 0.007”. These were then tested at temperatures ranging from -40 to +140°C at 20°C intervals.

The mechanical tests were performed using the following calibrated equipment:

- Zwick Z030 Tensile Test Machine with 10KN load cell:

The tests were undertaken in accordance with the following ISO standard :

- **ISO 527-1 & 2:** Plastics – Determination of Tensile Properties – 1996

2.1 Temperature Results for M30 ABS - tensile

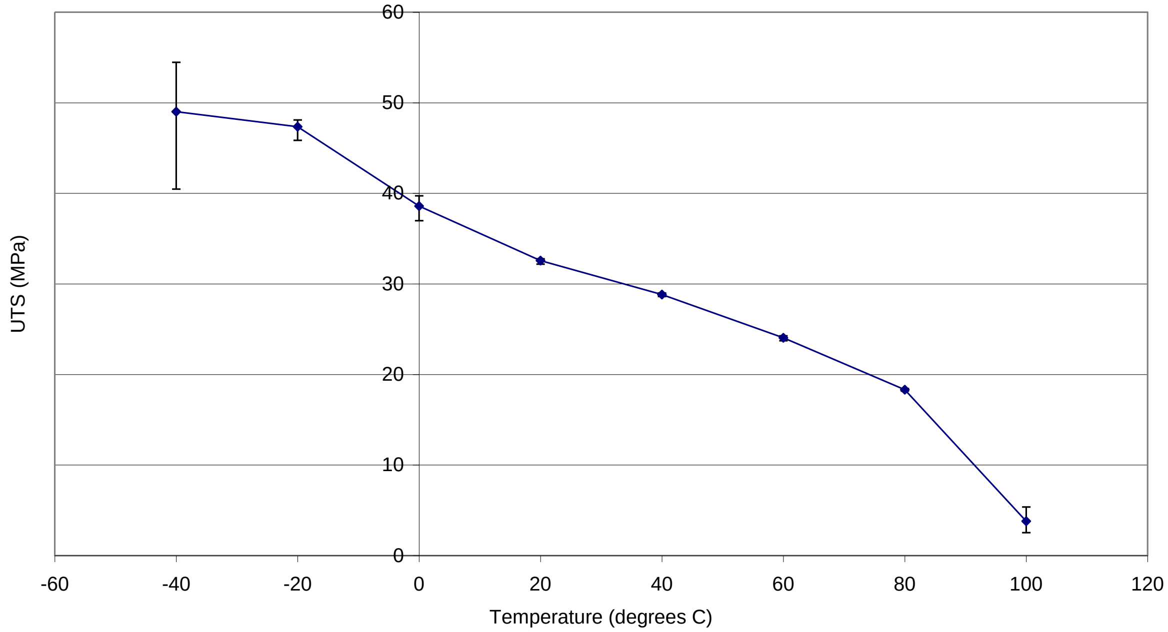


Figure 11: Effect of temperature on UTS of M30 ABS built on edge

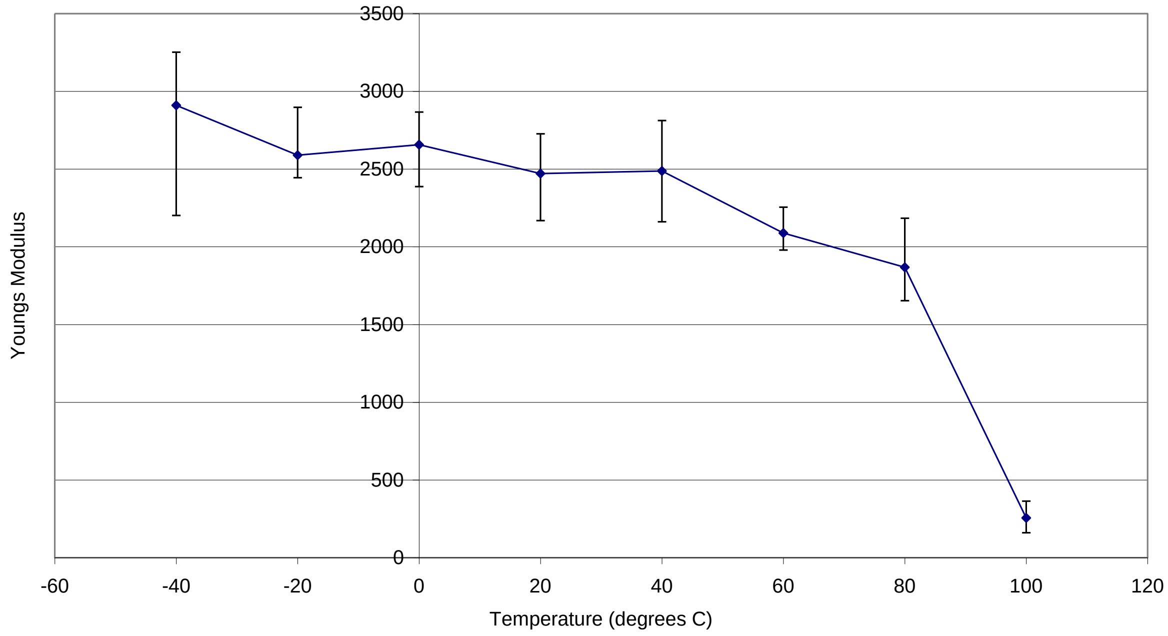


Figure 12: Effect of temperature on Young's Modulus of M30 ABS built on edge

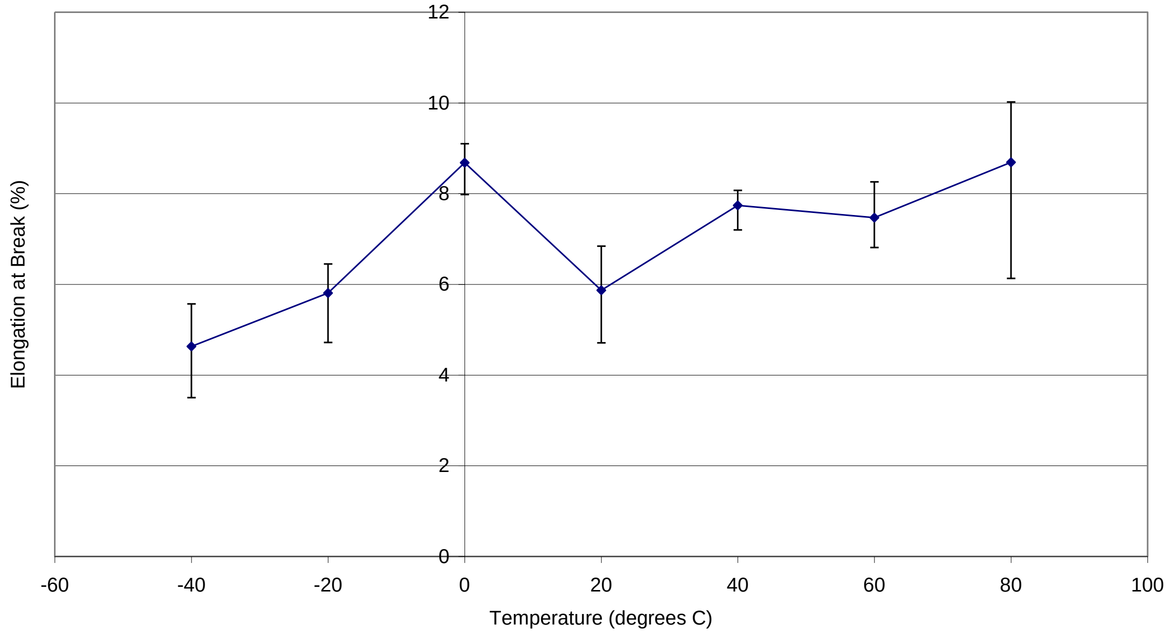


Figure 13: Effect of temperature on Elongation at Break of M30 ABS built on edge

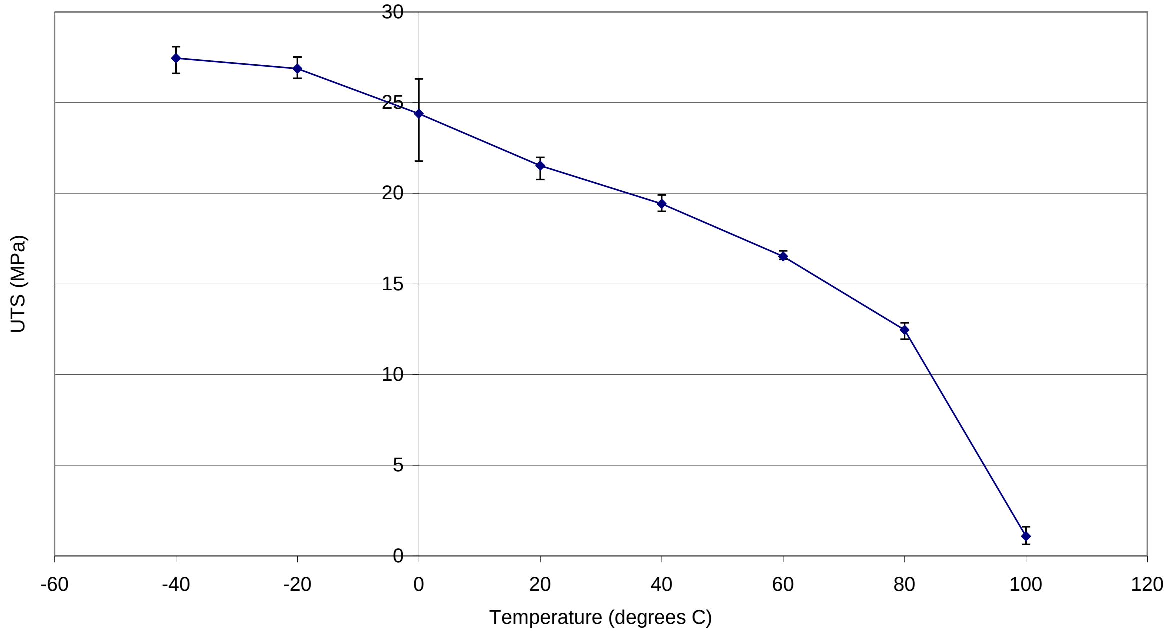


Figure 14: Effect of temperature on UTS of M30 ABS built upright

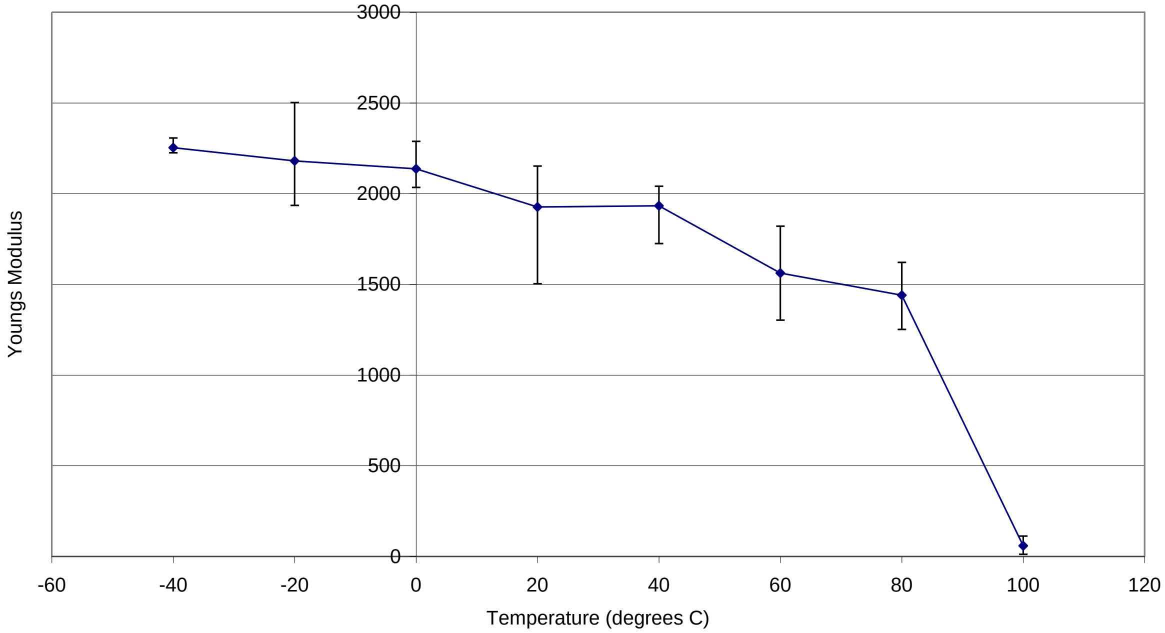


Figure 15: Effect of temperature on Young's Modulus of M30 ABS built upright

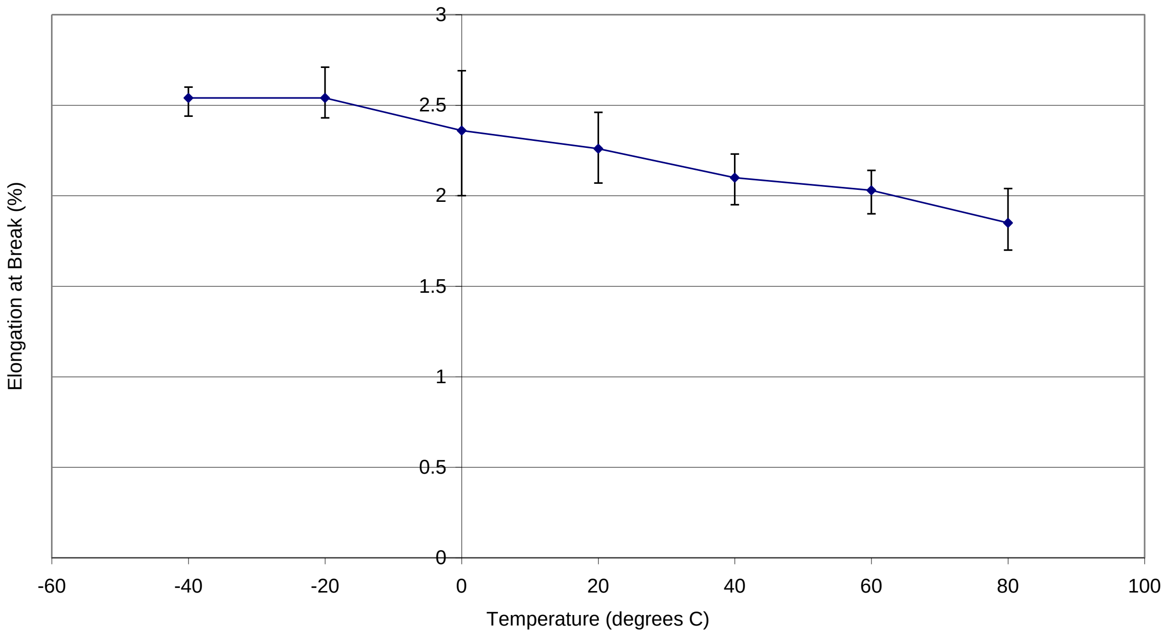


Figure 16: Effect of temperature on Elongation at Break of M30 ABS built upright

2.2 Temperature Results for PC - tensile

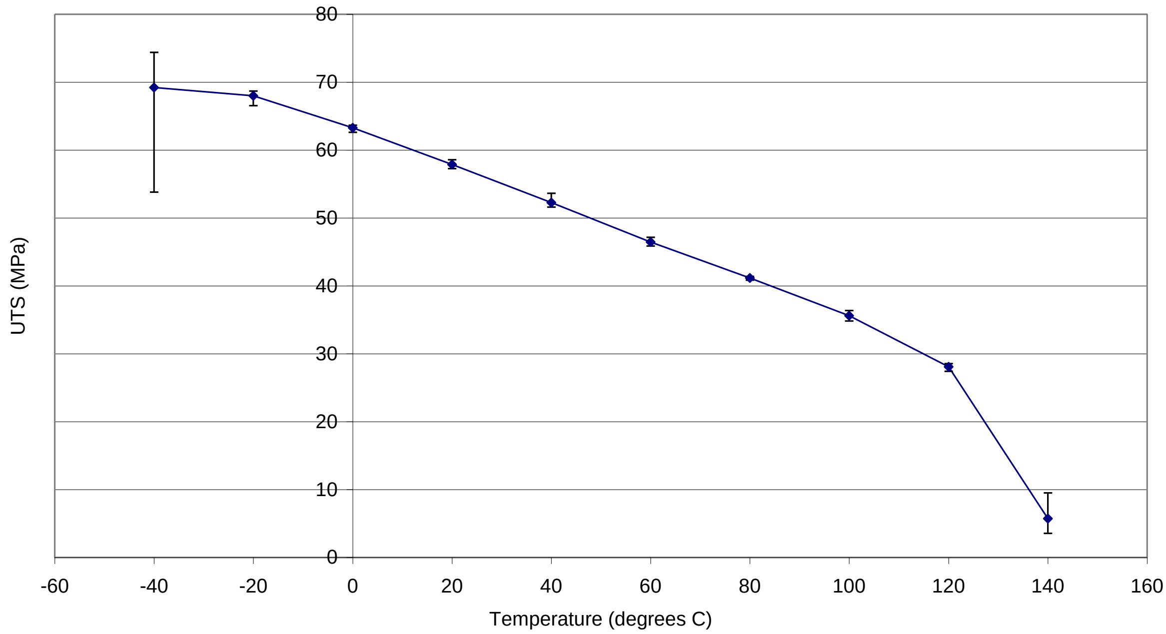


Figure 17: Effect of temperature on UTS of PC built on edge

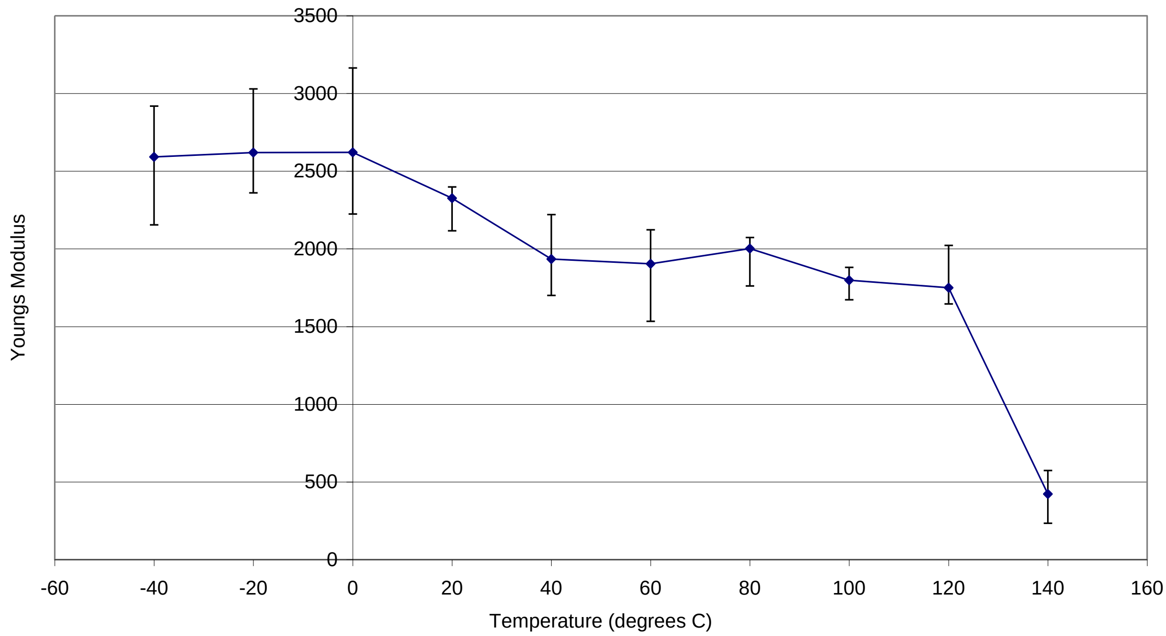


Figure 18: Effect of temperature on Young's Modulus of PC built on edge

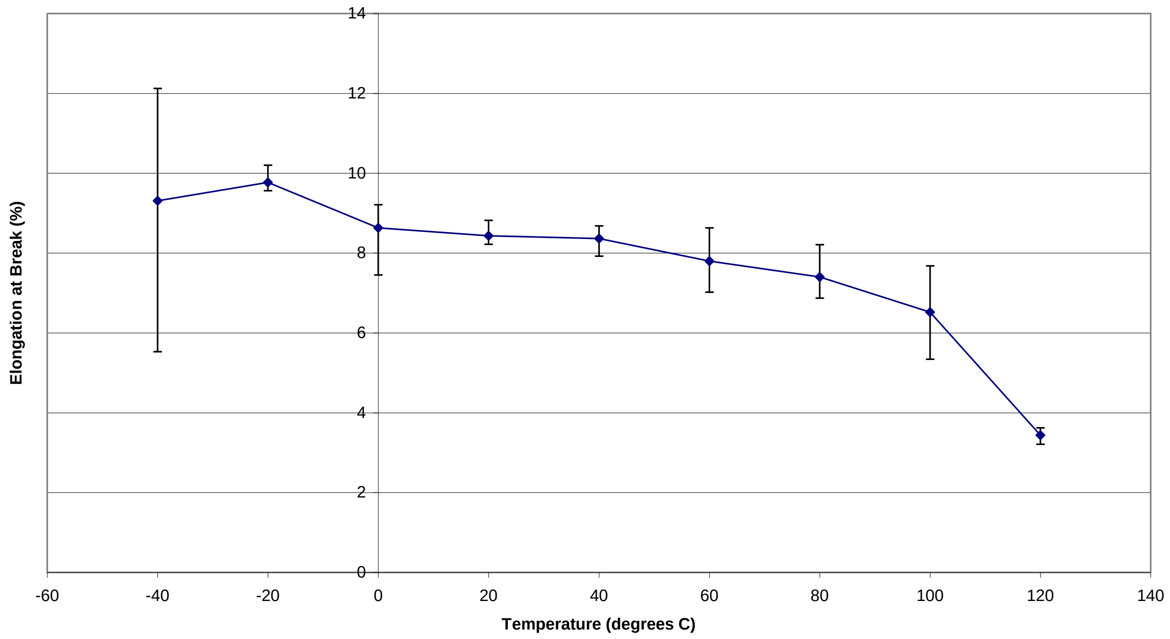


Figure 19: Effect of temperature on Elongation at Break of PC built on edge

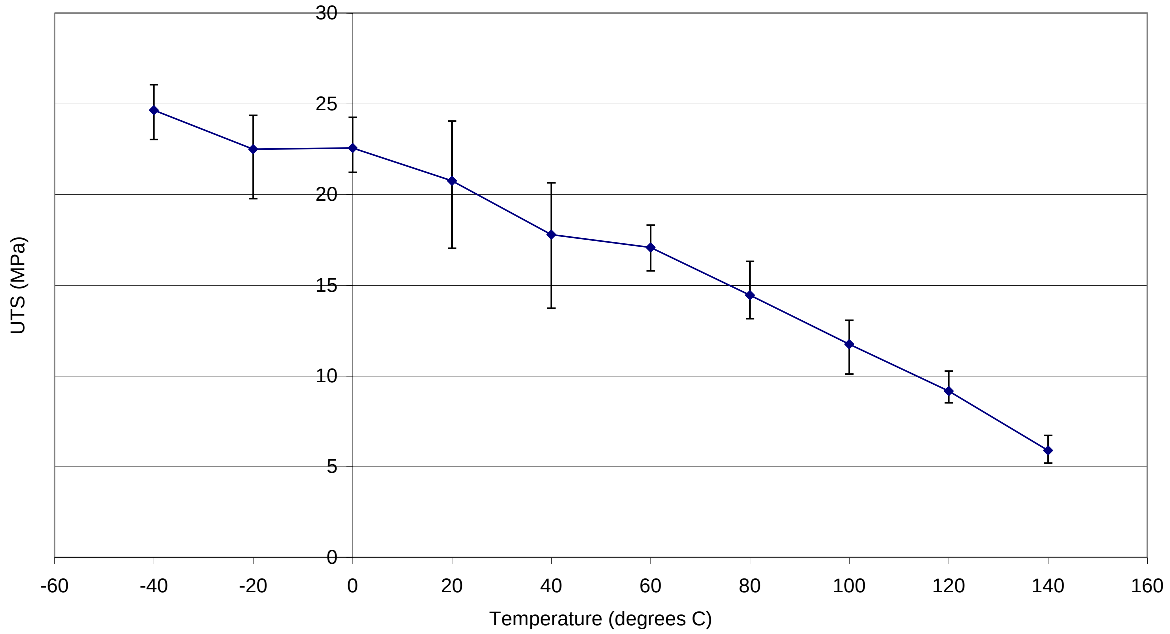


Figure 20: Effect of temperature on UTS of PC built upright

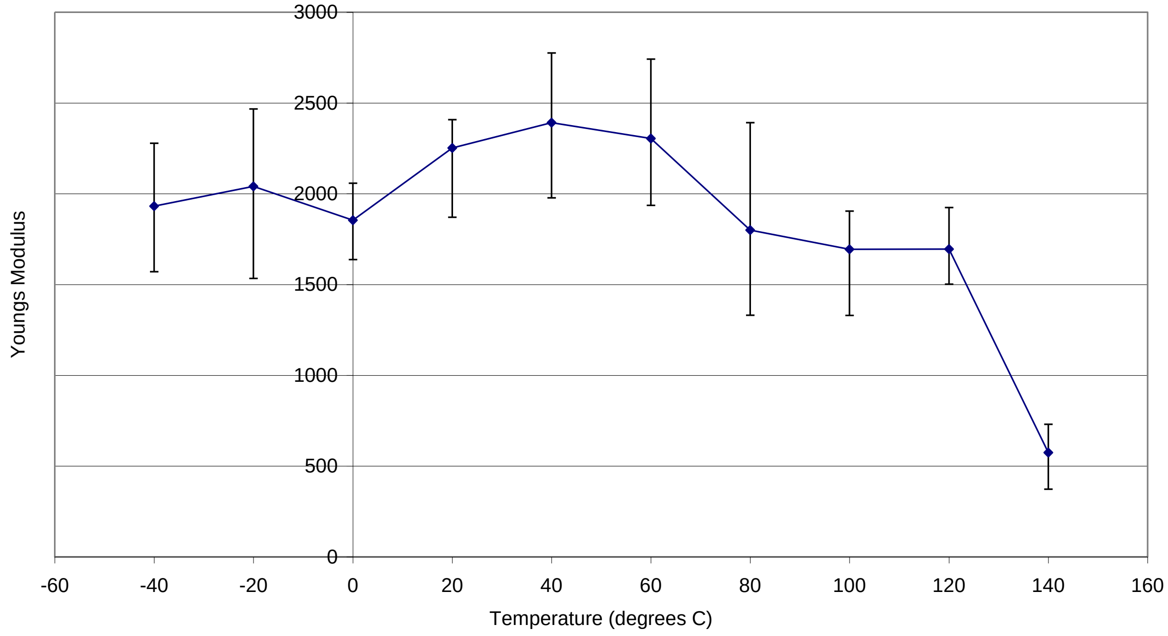


Figure 21: Effect of temperature on Young's Modulus of PC built upright

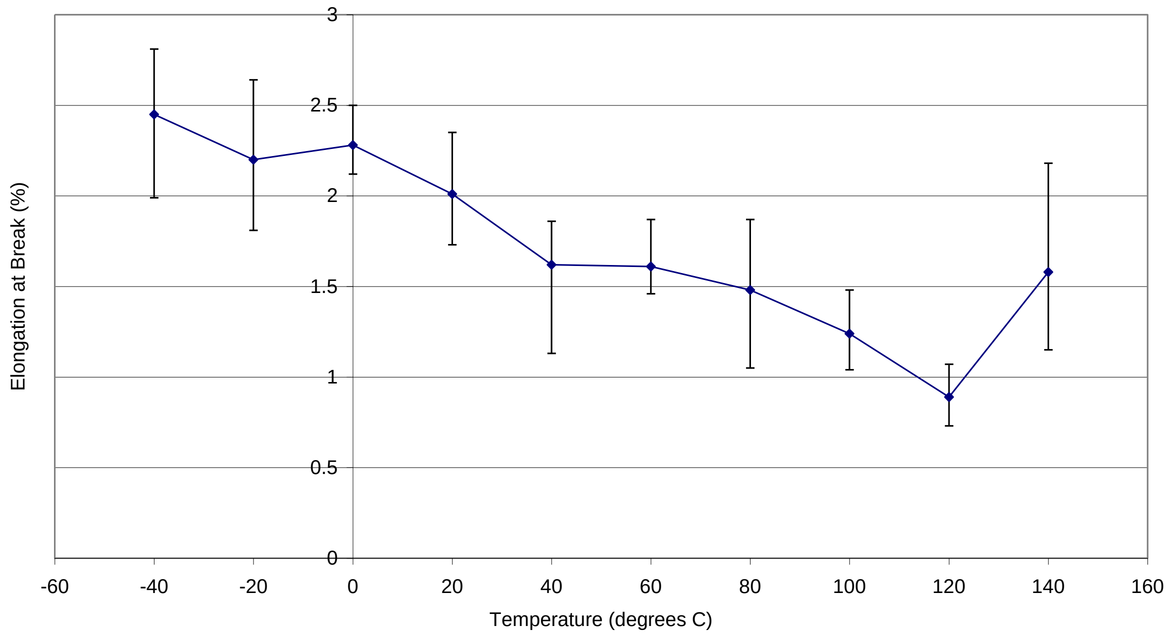


Figure 22: Effect of temperature on Elongation at Break of PC built upright

2.3 Comparison between build orientations

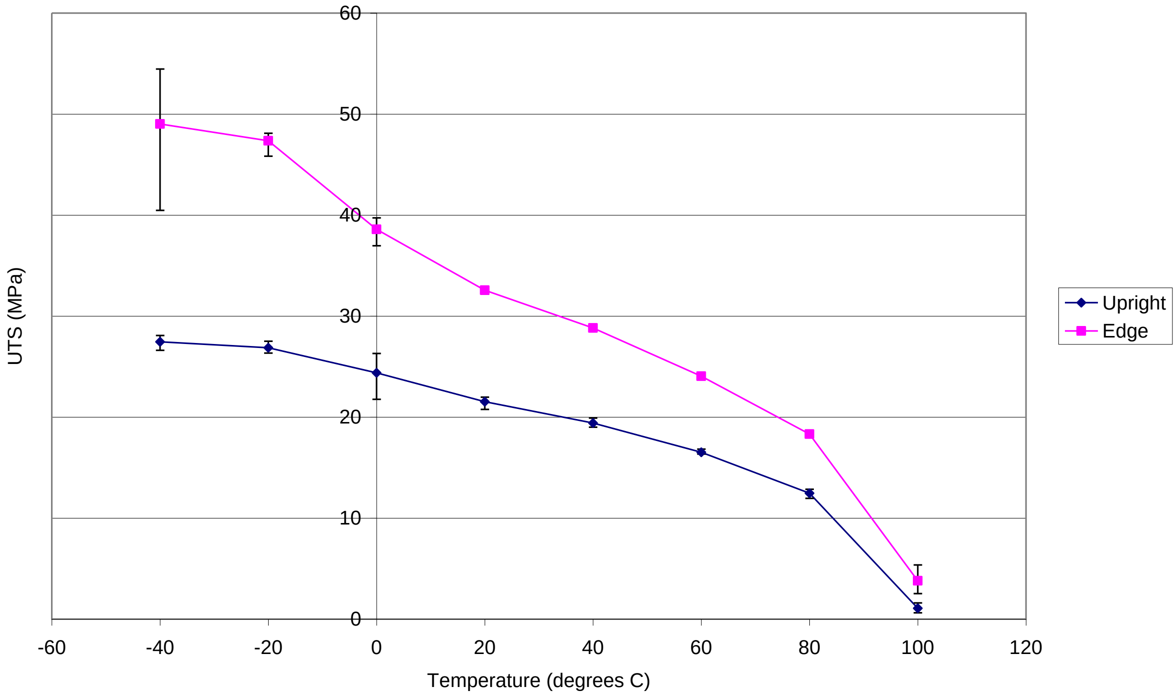


Figure 23: Comparison of the effect of temperature on Tensile Strength of M30-ABS built upright and on edge

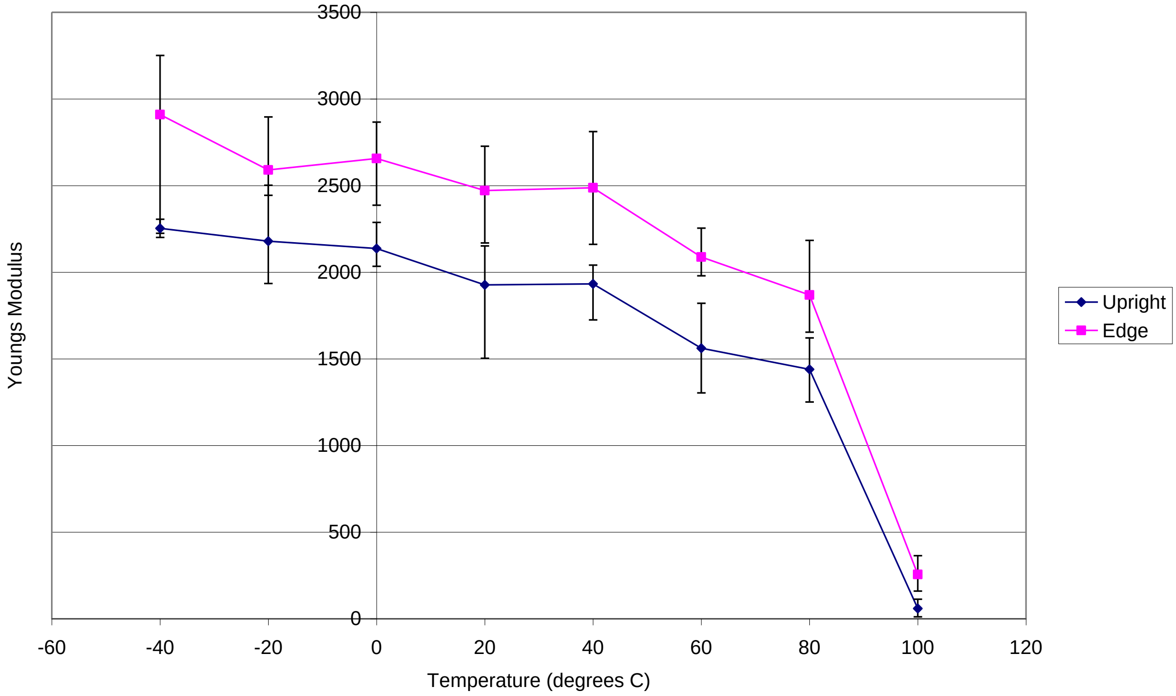


Figure 24: Comparison of the effect of temperature on Young's Modulus of M30-ABS built upright and on edge

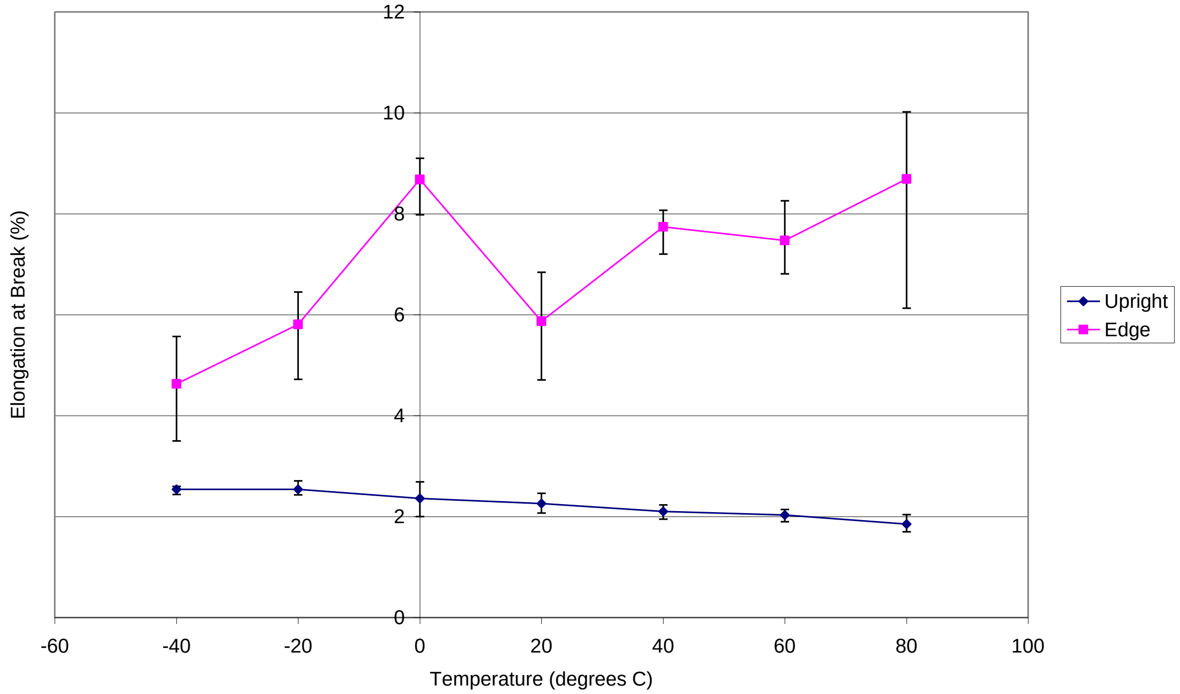


Figure 25: Comparison of the effect of temperature on Elongation at Break of M30-ABS built upright and on edge

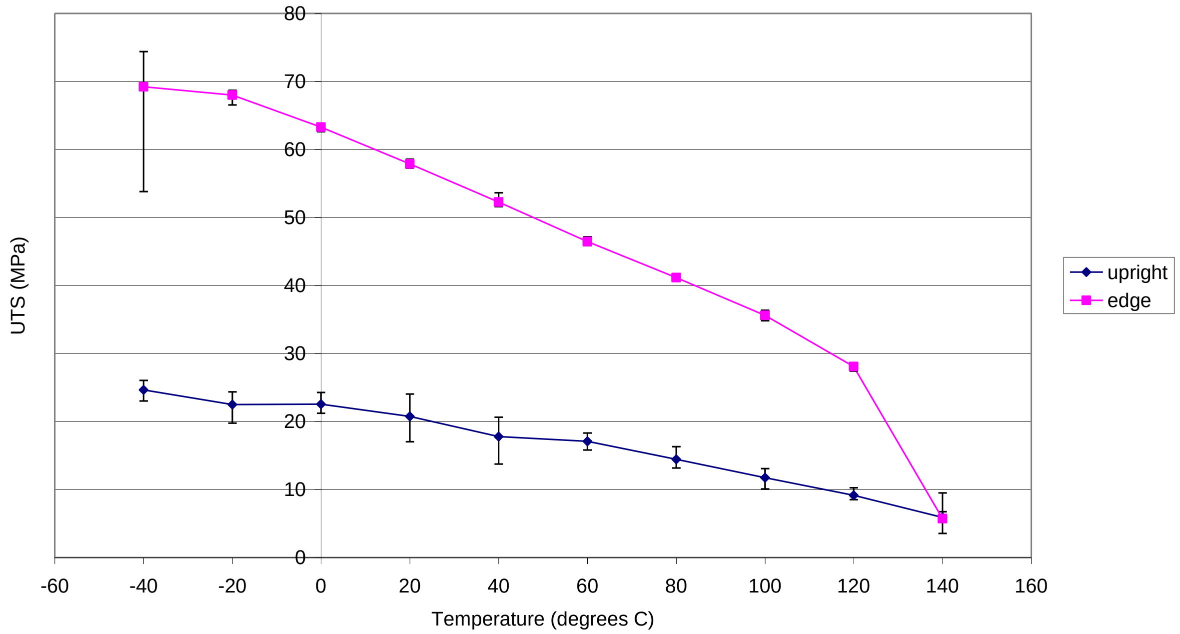


Figure 26: Comparison of the effect of temperature on Tensile Strength of PC built upright and on edge

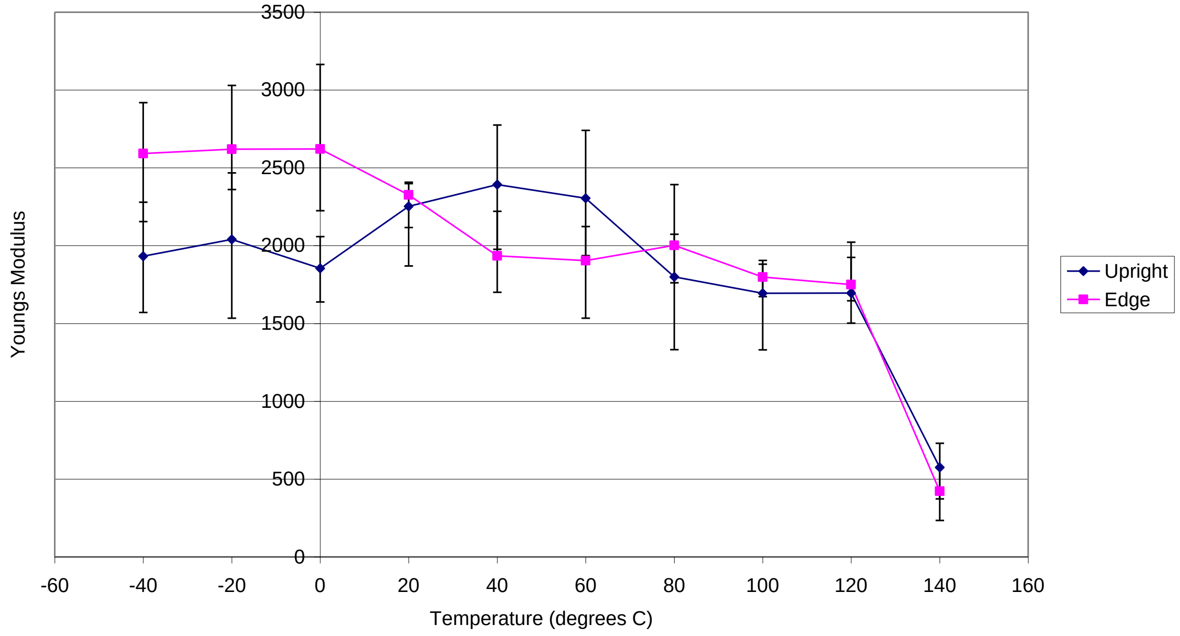


Figure 27: Comparison of the effect of temperature on Young's Modulus of PC built upright and on edge

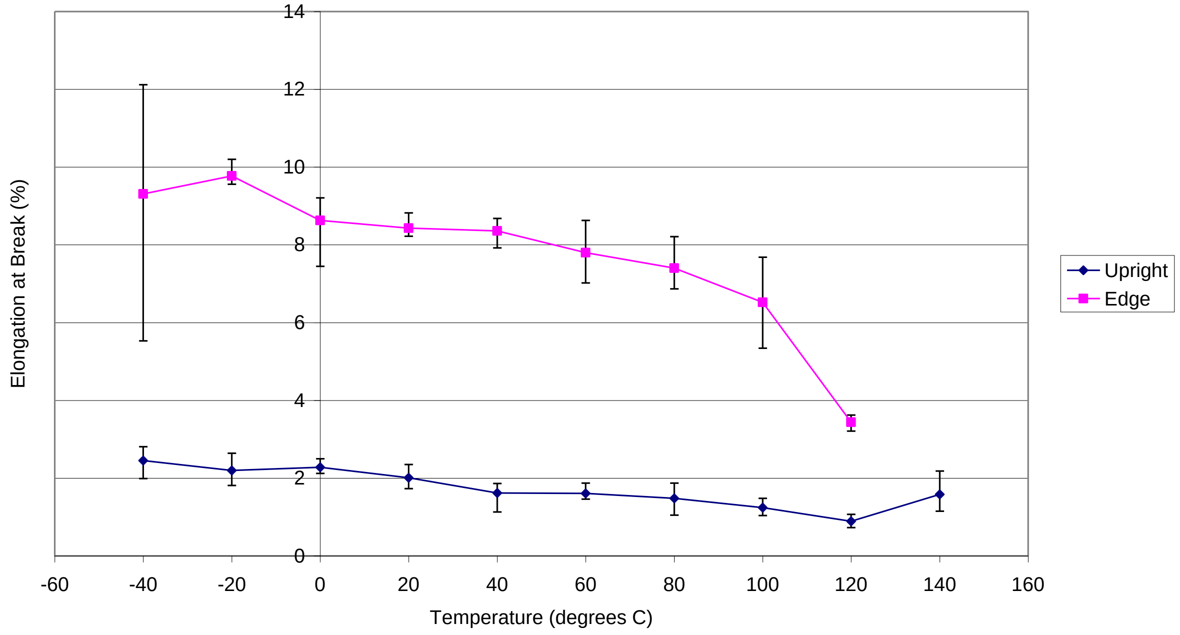


Figure 28: Comparison of the effect of temperature on Elongation at Break of PC built upright and on edge