Boron and Hy-Bor® Compression Strength Analysis

SUMMARY: Given the need for compression strength with space and/or weight constraints not achievable with carbon, there is No alternative to Boron. Boron should be considered for applications where weight and/or space are an issue.

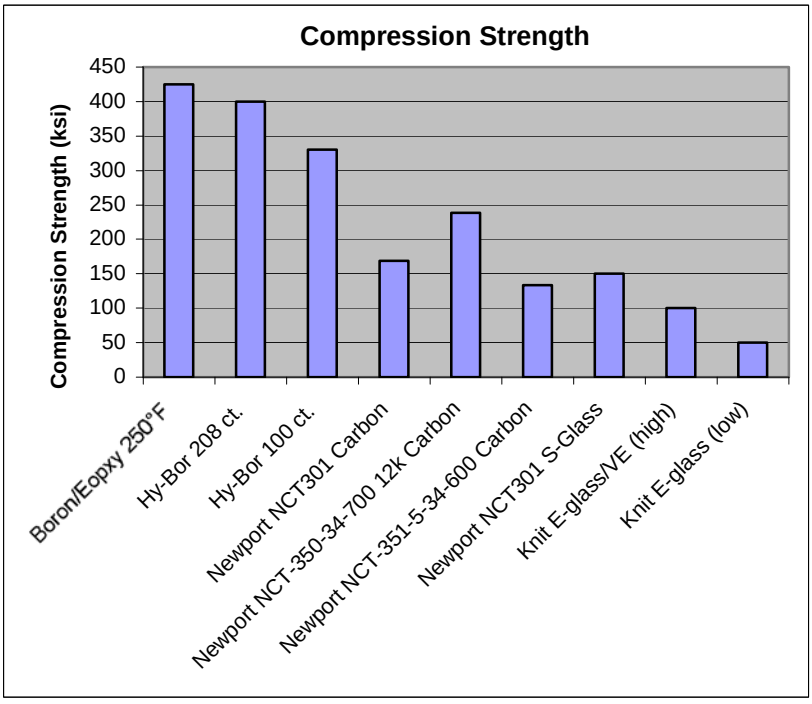
Boron and Hy-Bor® Compression Strength Landscape

It is difficult to compare the compressive strength of fibers in the same way that one might compare the tensile strength of fibers, so the approach here is to compare the compressive strength of unidirectional composites based on different fibers.

The following charts compare Boron products to other unidirectional products, in terms of compression strength. The charts start with "Compression Strength" comparison first, which shows materials that can pack the most compressive strength into a confined space, the higher the better. Then the "Specific Compression Strength" is compared, showing the relative ability of a material to hold a compressive load with the lowest weight, again, the higher the better.

Compression Strength

The first three products are Boron based showing their high compression strength. The next three are carbon/epoxy based and show the range for expected compression strength. The high filament count Hy-Bor products are more than 2x greater than the low compression strength carbon, and less than 2x higher compared to the one high compression carbon product. The next product is S–Glass/epoxy, and is similar to low strength carbon products. The two knit unidirectional E-glass products are the high and low of what might be expected for vinyl ester VARTM laminates.



For labor and debulk calculations, the boron layers will be about **½ the thickness of the carbon layers for the same compression load.**

The Boron products are clearly superior to all other products considered. **Boron products are the Best solution for Designs that require Compression strength in a confined space.**

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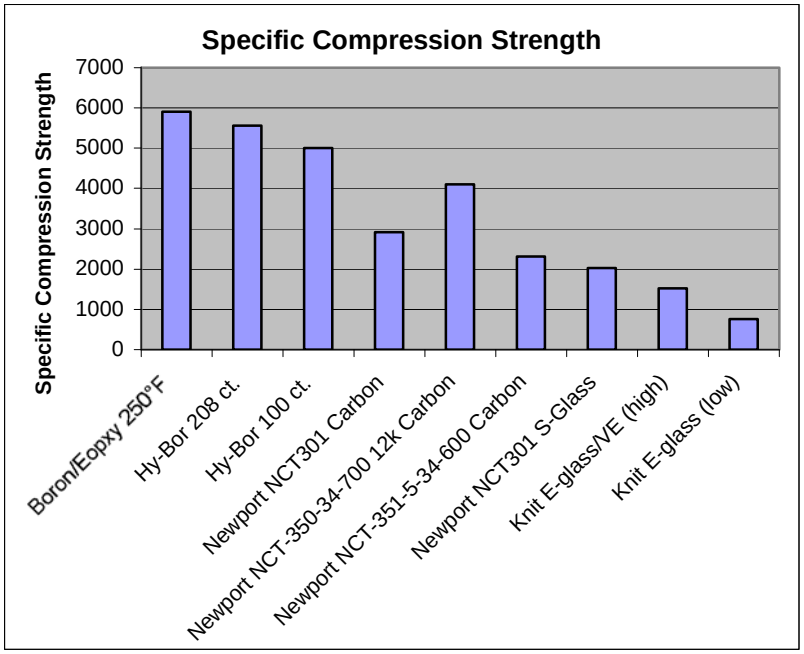
Specific Compression Strength

"Specific Compression Strength" is the ratio of "Compression Strength" to "Density". Low-density materials look better than high-density materials.



The "Specific Compression Strength" chart shows a similar trend to the "Compression Strength", with the carbon products looking better than the previous chart, because the carbon products have a lower density than the boron and glass based products.

The weight comparison of any 2 materials, based on compression design, comes down to the ratio of the "Specific Compression Strength" (i.e. the ratio of the heights of the bars in the chart).

The high filament count boron products being about 2x those of the low strength carbon products means that those **Boron products could handle the same compression load at half the weight.** Boron based products offer the Best solution if high Compression strength is required at the Lowest weight.

There is No Alternative to Boron when Designs require High Compressive Strength combined with space and weight constraints.

Taking a specific application into account, Boron becomes of greater potential value in components like masts, spinnaker poles and rudder/shell combinations; locations where profiles are most important. In the case of a mast, the effective area of the sail is increased if the windward profile of the mast section is reduced. This is because airflow will re-attach to the sail over a shorter distance with less trailing edge turbulence from the smaller mast section ahead of the sail. Similarly, fighter aircraft have taken advantage of Boron composites. Reduced chord thickness in wings, rudders, and flaps equates to greater lift, less drag and lower leading edge temperatures at very high speeds. We obviously stand to receive no gains in terms of heating in marine applications but improvements in aerodynamic performance are positive. This is desirable for high performance sailboats and multi hulls built exclusively for competitive races. The value and opportunities held in reduced cross sections using Boron and Hy-Bor® increases with the overall cost of the racing vessel.

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