



The Influence of Core Materials on the Structural Behaviour of Skis.

Joshua Grant Brimecombe

Kelvin Lake (Senior lecture / Programme Director)

School of Engineering

BEng (Hons) Extreme Sports Engineering

Introduction

This project is an investigation into the core materials used within Alpine skis. A combination of primary and secondary research will be used to analyse the use of core materials in a composite panel for a skiing application. This engineering project will express and discuss the importance of the mechanical characteristics and their manipulation. There is a connection between the performance of a ski and the mechanical properties of its construction given by combination of the material properties [1].

The ski industry has seen many changes over the span of the last 2500 years [1]; there has been some major changes in the types of materials and construction used, from complete wood construction to metal and fibre glass composite constructions. Different constructions are laid up in different ways, these major changes have affected the design of the ski including construction, shape and size. Additionally, the changes in ski construction have resulted in skiers having to adapt their skiing techniques, thus making the sport easier to learn and more popular.

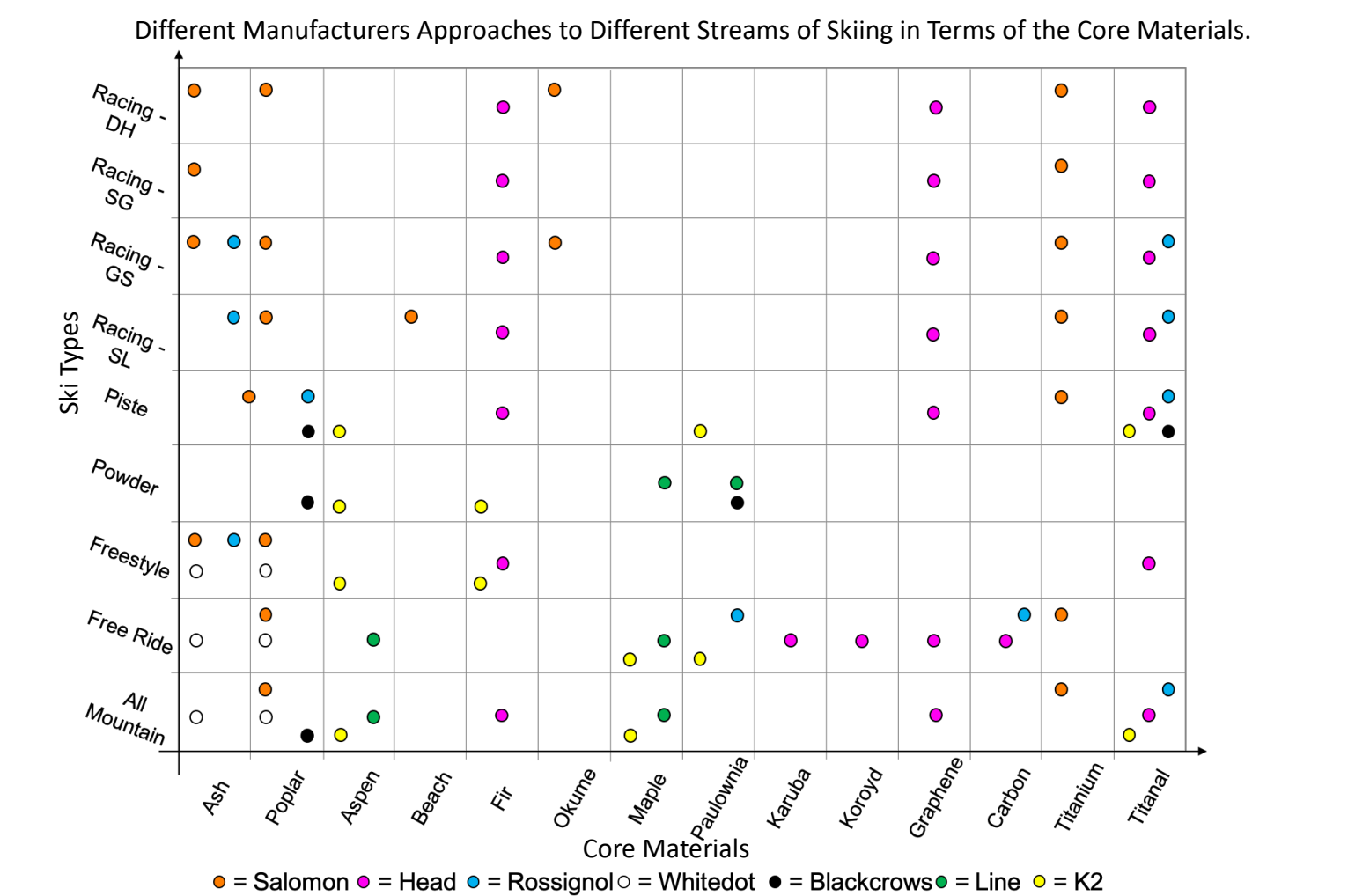
Project Aims

The aim of this project is to develop a key understanding of how core materials affect the overall characteristics of a ski, and their effect on the ski's performance and behaviour.

Whilst being able to inform the design and construction of a ski, from the analysis of results of physical testing and FEA, to inform key design decisions.

Methodology

Market research was conducted and a abundance of data was collected and sorted. A table was created displaying all the data and a graph shown below was formed to link the types of core material with manufactures and types of skiing.

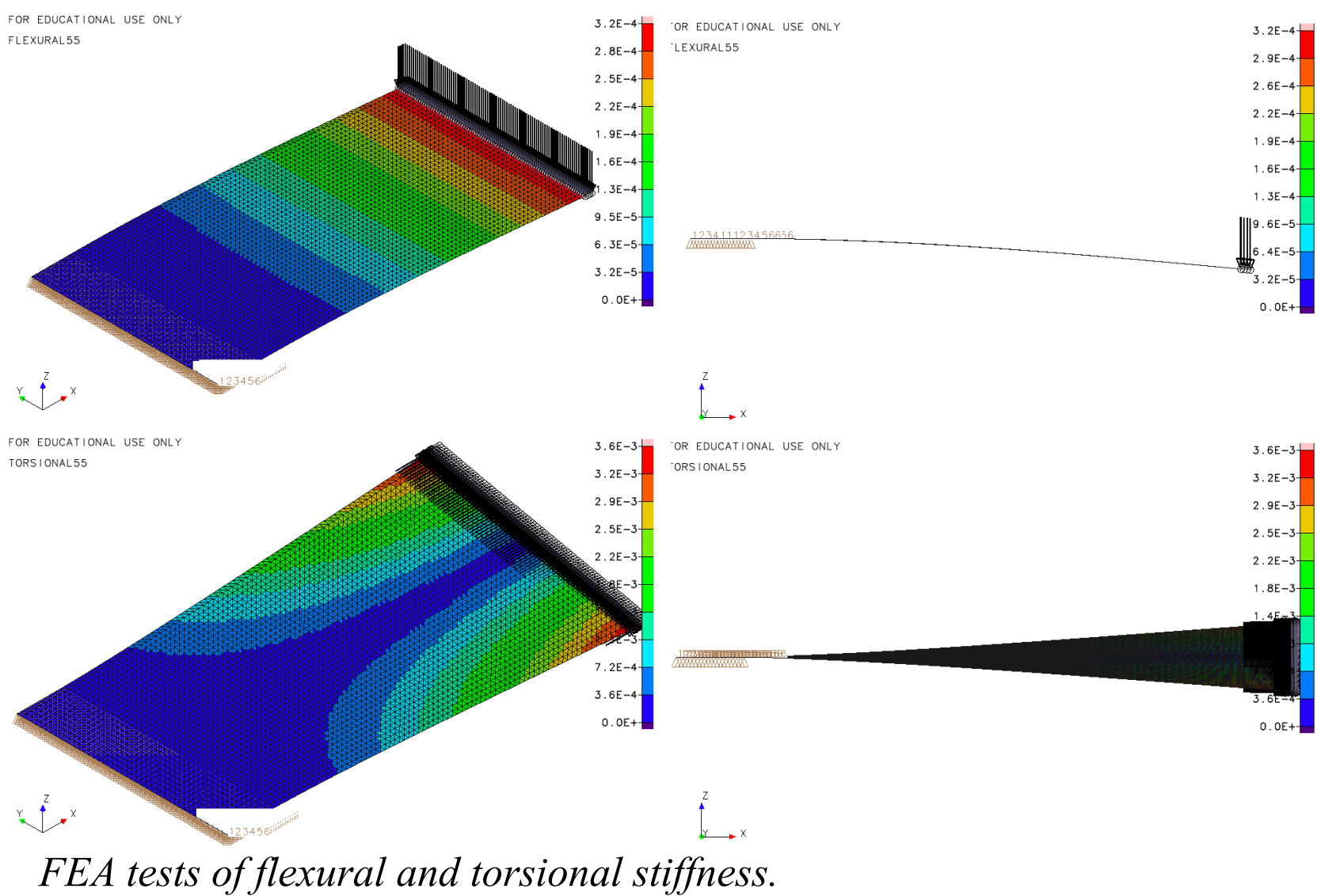


This scatter graph displays the use of core materials in different types of ski, whilst visually displaying the manufactures.

Finite Element Analysis was used to model a composite sandwich panel with five different core materials, which allowed me to analyse the panels for different characteristics. The characteristics outlined by the secondary research were flexural, torsional stiffness and vibration; these were identified to effect the performance and possibly be influenced by the core material [2] [3].

Results

Results for the normal vibrational modes flexural and torsional stiffness were collected, through Finite Element Analysis. Ash, Beech Fir, Titanium and Titanal cores were tested to see their resultant effect on the mechanical characteristics.



FEA tests of flexural and torsional stiffness.

Table 1 core material flexural and torsional stiffness test under a 10kg load. (Ash, Beech, Fir, Titanal and Titanium)

10kg Stiffness Tests Results		
Core material	Flexural Stiffness (mm)	Torsional Stiffness (mm)
Ash	0.4024	5.0581
Beech	0.4094	5.7406
Fir	0.4141	6.0036
Titanal	0.1582	0.6949
Titanium	0.1231	0.5304

All the results followed a trend of negative correlation, as the related material properties and engineering constants increase deflection reduces; with Young's modulus effecting flexural stiffness and shear modulus effecting torsional stiffness.

Conclusions

The effect of the core material on specific mechanical characteristics is evaluated with the use of FEA testing. FEA testing was used to investigate the vibration modes, flexural and torsional stiffnesses. The results stay on a trend of acting like the related material properties shown in the 'Results and Analysis' section of this project. This has determined a link between specific material properties and the resultant characteristics.

A basic computational model has also been produced as a result of the FEA testing, it could be used to optimise for the thickness of core required or number or orientation of composite plies with little adaption. These would allow further FEA and optimisation testing to be conducted with limited time or resources, allowing extensive data to be collected and analysed.

References

[1] Glenne, B., DeRocco, A. & Vandergrift, J., 1997. The Modern Alpine Ski. Cold Regions Science and Technology, 8 February, Volume 26, pp. 35-38.

[2] Mastrogiuseppe, P., 2007. The effects of core material and thickness on the performance and behaviour of a ski, Montréal, Québec: McGill University.

[3] Casey, H., 2003. Materials in Skiing. In: Materials in Sports Equipment, 2003, p.326-342. Los Alamos National Laboratory: Woodhead Publishing Limited, pp. 326-342.