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Evaluation of Alternative Methods For Fibre Curvature Measurement on New Zealand Wools.

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SUMMARY

A trial was conducted to evaluate the two available Fibre Curvature methods for New Zealand wool samples using the Sirolan Laserscan and Optical Fibre Diameter Analyser (OFDA) instruments.

Greasy wool samples were prepared using the standard mean fibre diameter preparation methods and test specimens measured on both instruments.

A subset of fifty samples were also prepared and measured for Core Bulk in accordance with NZS 8716.

There was a strong relationship between fibre curvature values obtained using the two instruments and an adequate relationship between fibre curvature and core bulk.

INTRODUCTION

Fibre Curvature measurement is the determination of the curve angle for a given length of snippet fibre. A straight fibre will have a zero curvature value. This measurement has applications in processing prediction and is related to fibre resistance to compression and also bulk. The greater the fibre curvature the higher the resistance to compression (& also bulk) for the sample.

Note: The Draft Test Method for fibre curvature measurement by OFDA is currently under investigation.

The Laserscan instrument uses a discriminator sensor to measure the curvature of a fibre¹. This sensor consists of a ring of 16 photo detectors with a central detector. When this central detector is covered by the shadow formed by snippet, the signals from the other detectors determine the curvature. Each valid fibre is put into a curvature class of 11.25° , with the mean curvature calculated after the specified number of counts have been accepted.

As the OFDA instrument measures its characteristics simultaneously, the snippets from the sample are compressed between two slides, maximising the observable curvature. The equivalent Laserscan measurement is taken from the projection of a three-dimensional curve onto a two-dimensional plane. The resulting average measurement is hence effected by the random orientation of the snippets passing the discriminator sensor.

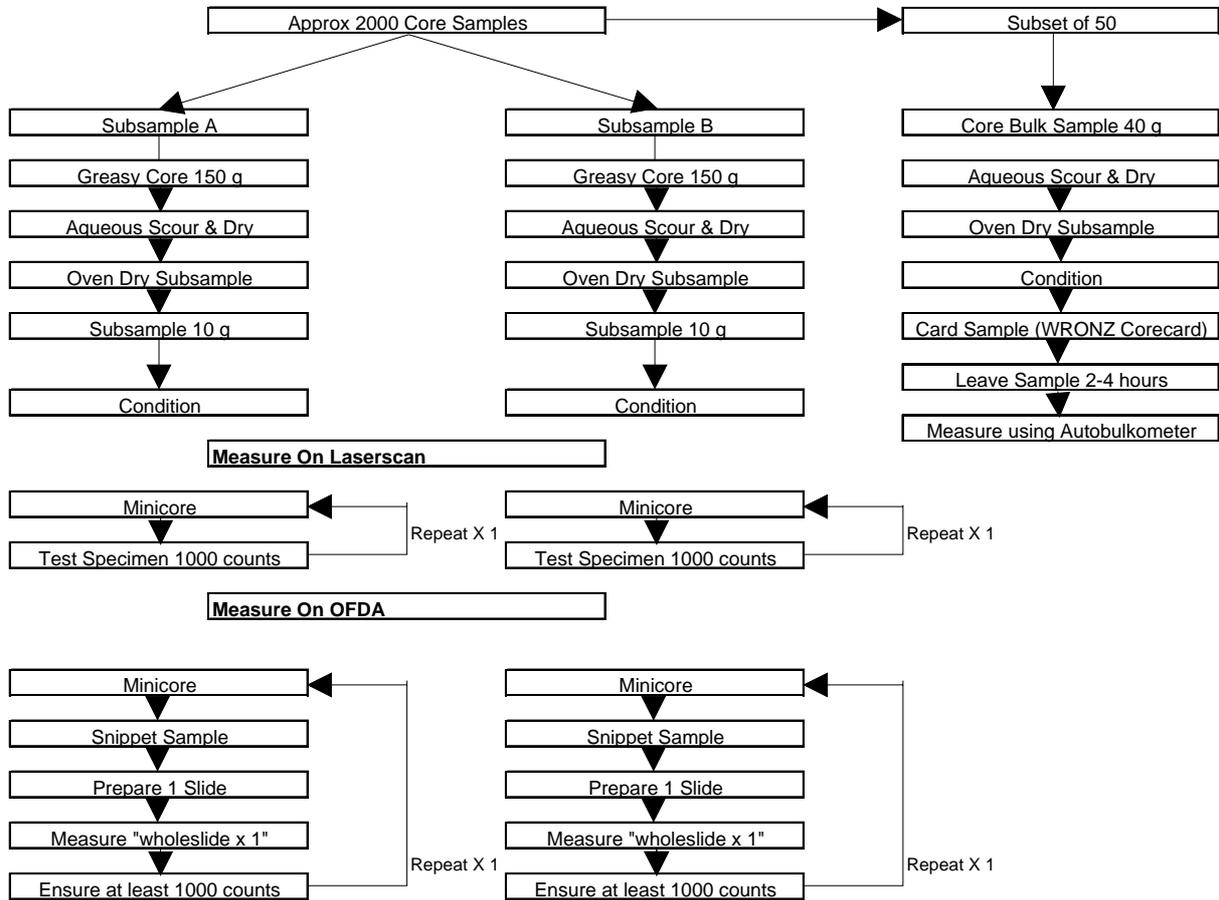
To examine the potential of the alternative fibre diameter instruments (Laserscan and OFDA), initial work was performed to ascertain their respective correlations with bulk measurement. This can have important commercial implications with the ability of these instruments to perform curvature measurement (and hence an estimate of other parameters) with no special preparation other than that required for a fibre diameter measurement^{2,3}.

This paper reports preliminary investigations into the alternative methods available to measure fibre curvature. It also examines the various applications that this characteristic holds in its prediction of other parameters.

MATERIALS AND METHODS

Approximately 2000 greasy wool samples were measured for fibre curvature using the Sirolan-Laserscan and OFDA instruments. These were prepared in accordance with the respective standards, IWTO-12 and IWTO-47.

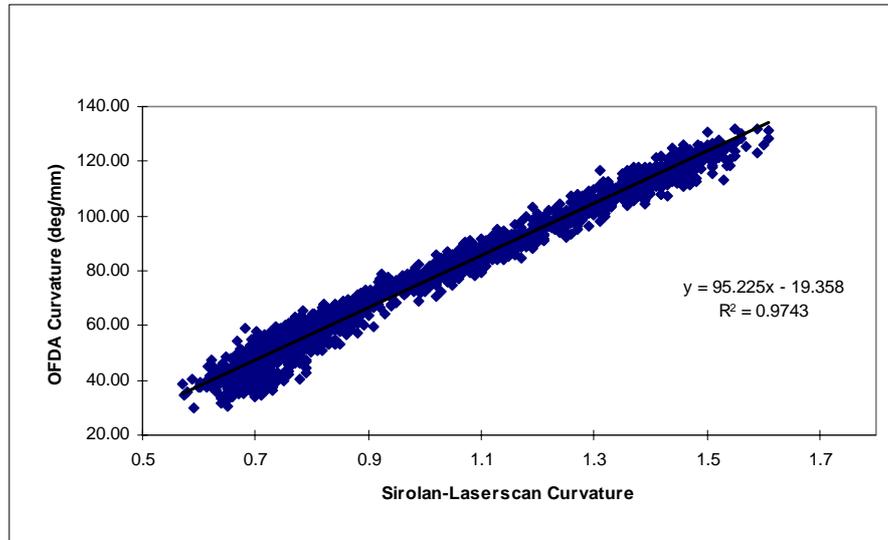
Note: These are the same samples used for "Comparison of IWTO Test Methods for Fibre Diameter Measurement of the New Zealand Wool Clip" report for Nice, 1997. As such, all specimens were obtained from the shirleyed web sample.



RESULTS

All samples, covering a wide range of fibre diameter and wool type, were measured for fibre curvature on Laserscan and OFDA. The plot of the results from both instruments is shown in Figure 1. The relationship between the measurements is very good, with an R^2 value for the linear regression line of 0.974. At both low and high ends of the curvature scale, the deviation from the linear fit is small.

Figure 1. Relationship in Curvature Results Between Laserscan and OFDA



It should also be noted that this relationship between the curvature measurements reported by Laserscan and OFDA in the study by Lobb et al. was carried out on only 35 top samples between 18 and 23 μ m. This could therefore be a more accurate estimate of the true correlation between the two instruments. The Coefficient of Determination for that study was 0.91.

A plot of the Fibre curvature versus the Mean Fibre Diameter of Airflow illustrated a strong relationship between the parameters. The mean fibre curvature result decreases with increasing fibre diameter. This is shown in Figures 2 (OFDA) and 3 (Laserscan). R-squared values for the linear equations of each instrument are 0.926 and 0.881 respectively. Polynomial lines have been overlayed to illustrate the trend for both instruments may be quadratic, the R^2 values increasing to 0.950 and 0.939 respectively. With such a high correlation, it may be possible to estimate the fibre curvature using mean fibre diameter. It should be noted that between 30 - 35 μ m, the relationship appears to level out for both instruments.

Figure 2. OFDA Fibre Curvature Versus Airflow Mean Fibre Diameter

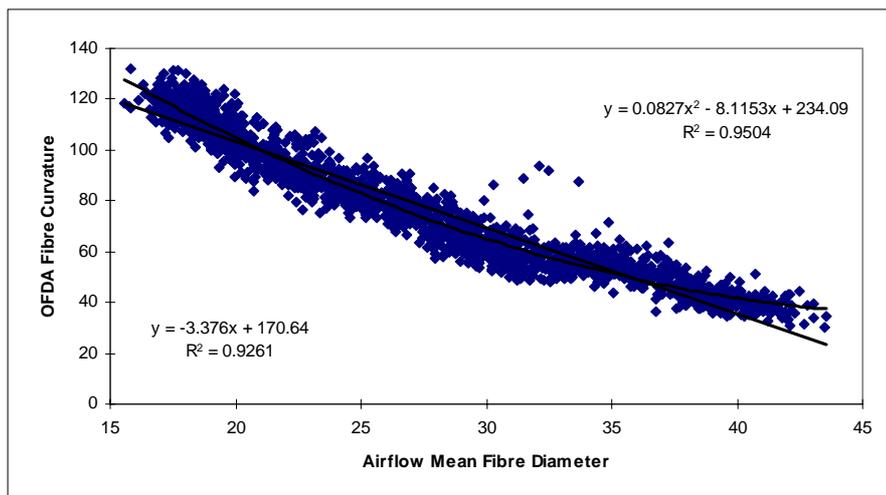
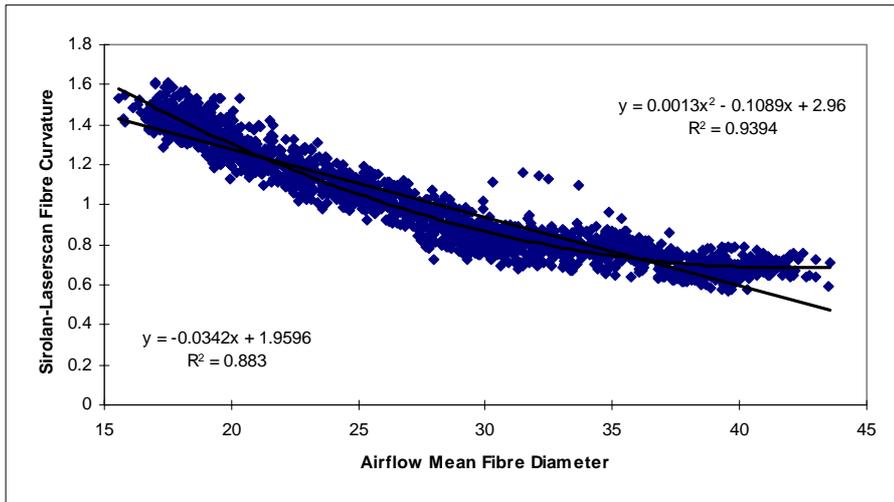


Figure 3. Laserscan Fibre Curvature Versus Airflow Mean Fibre Diameter



Previous research had revealed a prediction of the bulk measurement could be made from the fibre curvature², although only a small number of samples were measured. Figures 4 and 5 show the relationship between the two parameters for the OFDA and Laserscan instruments. An adequate correlation was displayed using the curvature results of OFDA ($R^2=0.597$), while an R^2 value of 0.577 revealed a similar relationship for Laserscan.

Figure 4. OFDA Fibre Curvature Versus Core Bulk

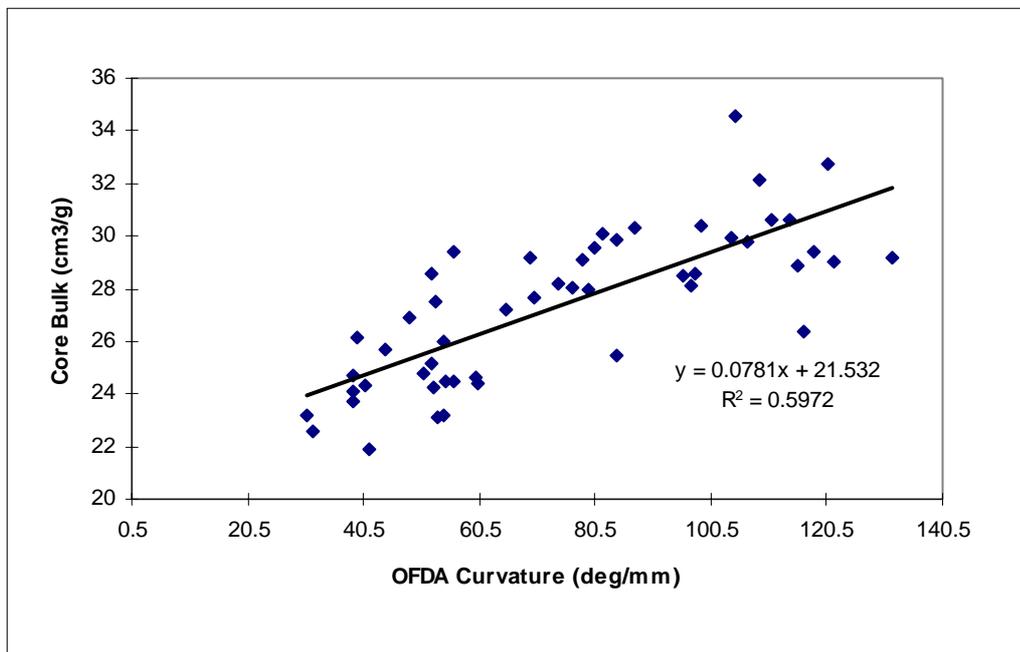
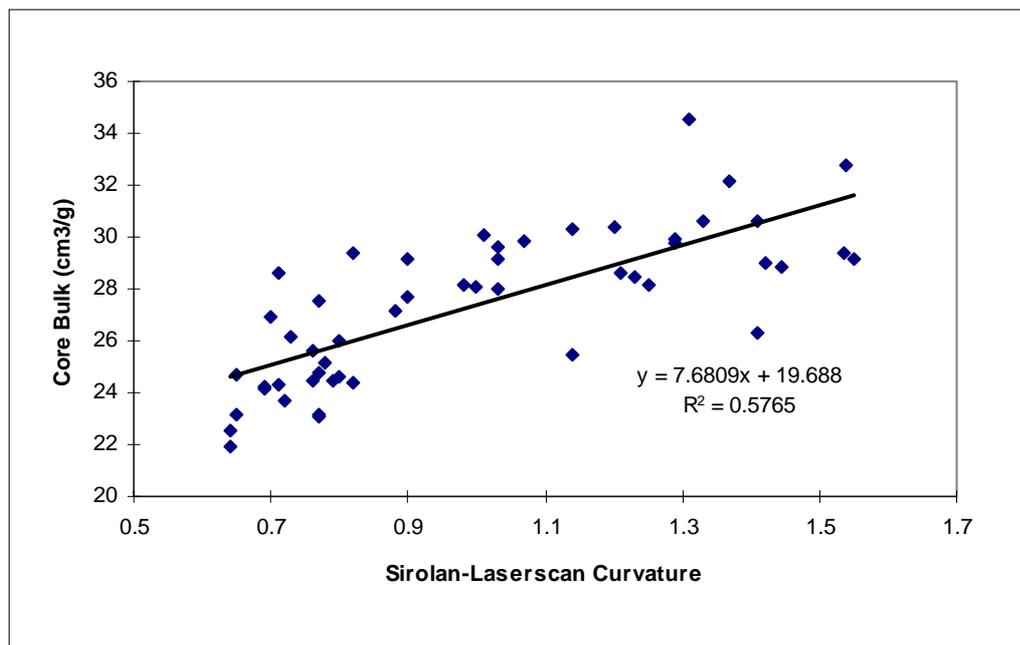


Figure 5. Laserscan Fibre Curvature Versus Core Bulk



CONCLUSION

The correlation between Laserscan and OFDA in fibre curvature measurement was very high. This correlation was consistent across the range for fibre diameter and wool type. The curvature measurements also related extremely well with the fibre diameter from the Airflow instrument. Further investigation is required to review the preparation method for fibre curvature since it would appear specimens obtained from the shirleyed web sample provide good agreement between methods. Inclusion of Laserscan in the Draft Test Method for the measurement of Fibre Curvature is also recommended depending on the outcome of further interlaboratory round trials.

The relationship between OFDA and Laserscan Fibre curvature with Core Bulk gives rise to the instruments potential as a predictor of the Core Bulk for a sample. A prediction equation utilising Fibre Curvature and Mean Fibre diameter as independent variables may provide a reliable prediction for core bulk within the expected tolerances of the core bulk method. It is now intended to engage in more research on fibre curvature to discover the various effects which may influence such factors as core bulk.

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