Characterisation of Fabric Drape Using Spectral Functions

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Absract: The article compares the measurement and calculation methods of the fabric drape coefficient used for computer modeling and describes a new parameter. This is the spectral function that is based on fabric drape and it describes the cloth's 3D plasticity, and ability to be fitted against forms. The new parameter can be used during design as well as during pre-production to for predicting tailorability in the garment industry.

Keywords: drape, material testing of cloth's

1 Introduction

The simulation of cloths using computers is an area that is researched long ago. Pre-production computer programs help in the garment industry to make models, series and to develop the garment. The modelling systems also utilize animation tools. The models designed using computers can be 'dressed' and they can be moved using preprogrammed human movements. The real behaviour of cloths can be simulated using the animated models to design a model for a given figure, although modelling is a complex task. The plasticity and behaviour of cloths is a complex mechanism, since the interaction of strings and threads result in special attributes. Textil cloths are different from other materials and they are characterised by their aniztropy and their ability to deform under small forces. These charachteristics are mainly due to drape, resistance to bending and shear strain. The behaviour of textile cloths differ from other materials (e.g. paper) due to the differences in there characteristics.

To model a textile with a computer simulation, to display a clothing model esthetically in 3D drape is used. Drape is such a deformation that is mainly due to gravitational force while only a part of the textile is fixed. The unfixed part can move around freely, this results in the deformed shape. In case of a skirt if the upper part is fixed then released, then the hanging part of the skirt will free falls, ie. drapes.

In this article we describe the test methods and attributes used for drape and also refer to their change due to structural and production technology parameter changes. Our goal is to search for such a new method which can also be used for computer simulation.

2 Methods Used to Calculate Drape Behavoir of Fabrics

2.1 Determining the Drape Coefficient by Measuring Mass

The drape test can be calculated from the projection of a rather large, freely sagging circle fabricsurface.

A fabric, is placed on the sample holder which has a larger diameter, then the sample holder, the edge of the fabric sags due to its own weight. The drape of a fabric that sags due to its own weight can result in different shapes (Figure 1). A fabric can be considered as fully stiff if a sample with a radius of R_2 is placed on a sample holder with a radius of R_1 and its projection is equal with circle that has the radius of R_2.

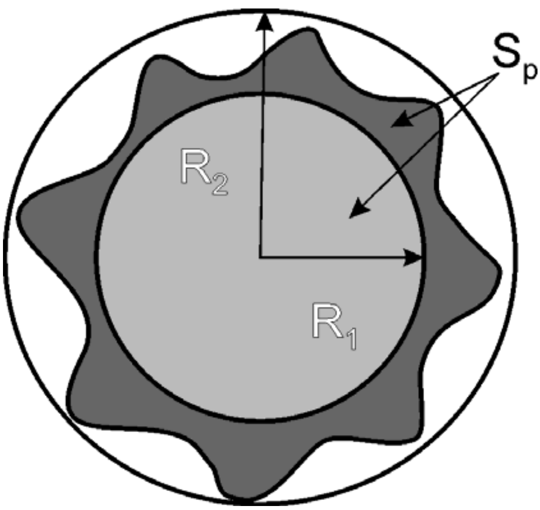


Figure 1
Projection of drape – paper ring with draped image

To calculate the drape coefficient from the values given on Figure 1 using image processing, the following formula can be used [Jevsnik, Gersak, 2004]:

$$CD = \frac{S_p - \pi R_1^{\ 2}}{\pi R_2^{\ 2} - \pi R_1^{\ 2}} * 100 \ (\%) \qquad (1)$$

where

CD drape coefficient [%]

Sp area of the draped sample, including the part on the sample holder [mm^2]

R_1 radius of sample holder [mm]

R_2 radius of the non deformed sample [mm]

The projection can be drawed on a paper ring that is placed on the upper glass plate using a local light source and a built in mirror. According the simplest mass measurement method first the mass of the initial paper ring (M_1) is measured, then the one that was cut out according to the projection (M_2). The drape coefficient in percentage can be determined as ration of M_2 and M_1

2.2 Computer-aided Drape Test

During a computer aided test the drape coefficient is determined using image processing. The Sylvie Cat system [Kuzmina, Tamás, Halász, 2005] measures drape using three dimensional body scanner. Four fixed cameras are located above the sampleholder and they make snapshots of the sample on different heights. The sampleholder is moved vertically to change the height (5 and 10 mm) of the sample. The three dimensional points of the sample's geometry are determined by the curves estimated at different heights. The data is processed by the software designed for the system [P. Tamás; J. Geršak; M. Halász, 2006]:, which can be used effectively for three dimensional simulation. The computer draws the shadow line on a ring and based on the images it creates a 3D image of the given fabric, which can be rotated in several directions. The program calculates the following data: drape coefficient, CD (%), number of waves (pc), minimal and maximal radius (mm). The minimal and maximal radius is used to describe drape, which is the distance from center of the circle to the smallest and largest crimp. (Figure 3).

The test were made on the Budapest Tech Polytechnical Institution using a Cusick Drapetester. The images of drape were captured using a digital camera that was fixed on the device and the drape coefficient was determined using Photoshop image processing software (Figure 2). The calculation of drape coefficient based on counting the number of pixels of inner and outer area of the draped image. The standard atmospherical conditions were not achiavable during the test, so such a sample was selected, where this influence on the measured data can be neglected.

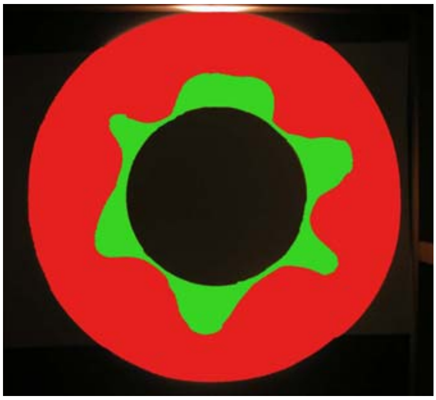


Figure 2
Drape test using image processing (a scanned drape in Adobe PhotoShop 6.0)

3 Interrelation of the Drape Parameters

Stiff fabrics have a high drape coefficient, these can be formed with difficulties. Fabrics with a lower drape coefficient can be formed easier, they fit easier to form and they also fit easier to the shape of the body. The shape and number of fold(nodes) are determined by the material and the production technologies, e.g. the firmness and stiffness of the fabric. A stiff fabric has larger and wider folds, while a fabric that is not as stiff has narrower folds. While finishing with softening largely influences the drape coefficient. [Kokas, Halász, 2005]

The professional literature considers the drape coefficient as a primary fabric characteristic, even though drape can not be always characterised only using the drape coefficient. There is a possibility, that two fabrics have the same drape coefficient, still the shape of folds differ from eachother [Halász, Kokas, 2006].

To create an image during simulation that is equivalent to the reality, the number of folds, their shape, amplitude and distribution is specified alongside the drape coefficient. In case of woven fabrics the position compared to the projection and warp line is also specified for these data (Figure 3).

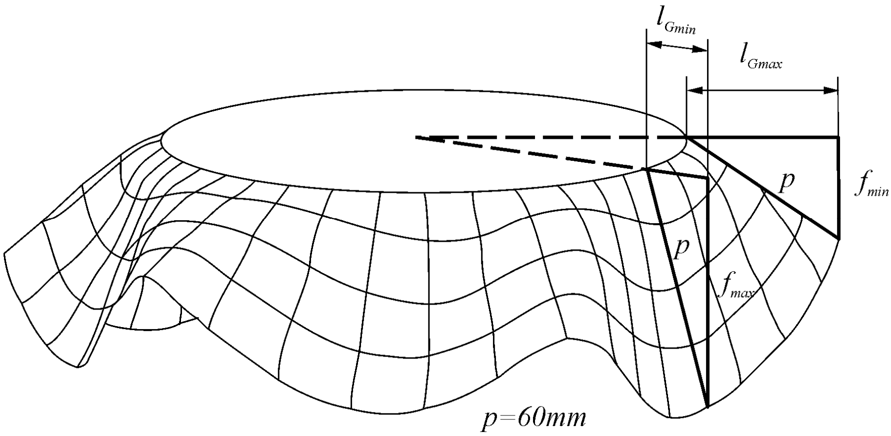


Figure 3
Maximal and minimal depth of folds

The distribution of folds can be calculated using the following formula [Jevsnik, Gersak, 2004]:

$$G_p = \frac{\sum\left[l_{G\max}(i) - \bar{l}_{G\max}\right]^2}{\bar{l}_{G\max}{}^2} \quad (2)$$

$$\bar{l}_{G\max} = \frac{\sum l_{G\max}(i)}{n} \quad (3)$$

$$\bar{l}_{G\min} = \frac{\sum l_{G\min}(i)}{n} \quad (4)$$

where

G_p: distribution of folds

$\bar{l}_{G\max}$: average of the maximal depth of the folds [mm]

$\bar{l}_{G\min}$: average of the minimal depth of folds [mm]

l_{Gmax}: maximal depth of fold [mm]

l_{Gmin}: minimal depth of fold [mm]

n: number of folds

The number of data necessary to describe drape results in a difficult comparison of cloths in the garment indusrty. During our tests we were searching for such a new relation, with which the drape characteristics of different fabrics can be compared easily.

4 Determining the Spectral Function of Drape

During our research to improve the testing of drape we used the previousle partly proven assumption, that

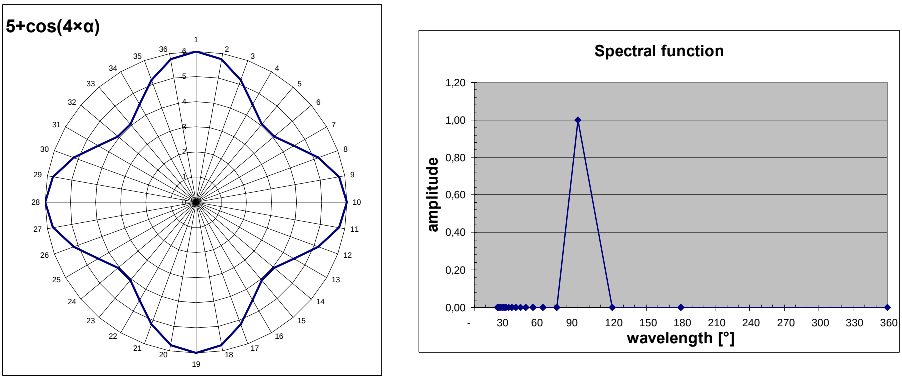
- fabrics with different flexibility can have the same projection ratio and
- the outlines of the projection can be generated using periodic functions superimposed on a circle.

To prove our assumptions

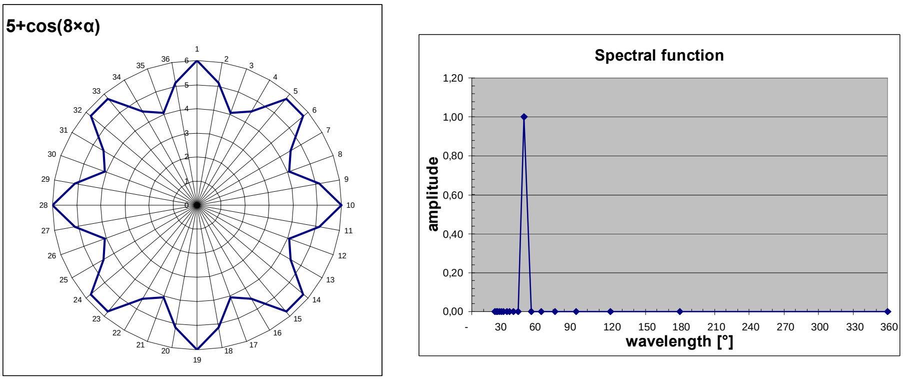
- we created a device that can easily capture the outlines of the sample digitally,
- we created a computer software that determines the radius of the circle that fits best to the digitized outline of the sample and those periodic functions whose sum can produce the original projection,
- we tested the spectral functions separately which examine the amplitudes of periodic functions in relation to angular deflection and
- we tested, whether the newly developed method can demonstrate the influence of different effects on the spectral functions by examining wheter there is any change in them.

The use of the method is demonstrated on idealized projections, then real samples and cloths that are made of the same compounds, but are exposed to different finishing effects.

On Figure 4 an idealized case can be seen: we show two different theoretical drapes that can occur at the same projection area. Next to the figures we represented the corresponding spectral functions on a graph, which plot the amplitude of folds in relation to the wavelength. For demonstration purposes we connected the discrete points aquired in relation to the angular deflection. It can be seen from the spectral function that the drape is symmetrical (the curve has only one apex), the angular deflection of the characteristic fold is 90 degrees in the first case, while 45 degrees in the second.



a) projection of a stiff fabric



b) projection of a soft fabric

Figure 4

Spectral function for two fabrics (a and b), which have the same drape coefficient

To compare different samples, first we examined that the same sample photographed different time instants what is the resulting drape. On Figure 5 we plotted the spectral function of a sample made of 100% viscose with 90 g/m^2 areal density, based on photographs at different time instants. For demonstration purposes we marked the angle for the amplitude apex. It can be seen, that this value is equal at both time instants, so this data is a characteristic of the tested fabric.

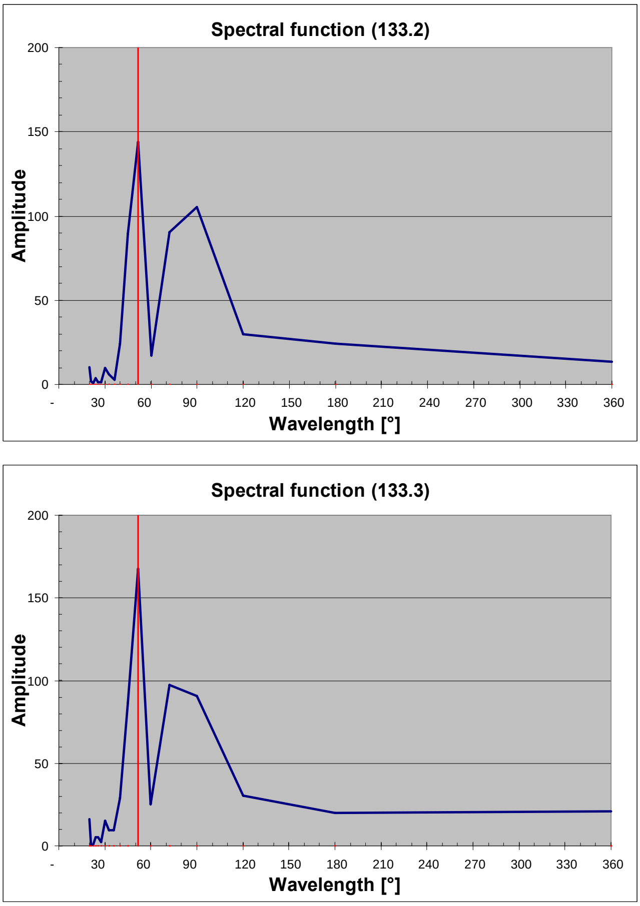
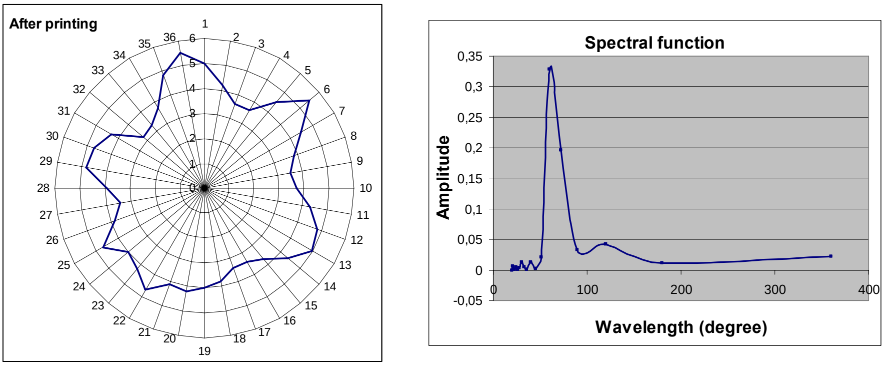
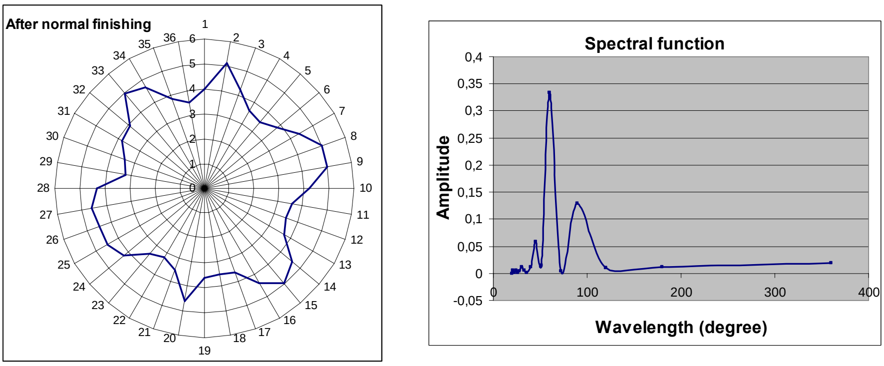


Figure 5
Spectral function on two identical fabrics, based on photographs made in different time instants (a and b)

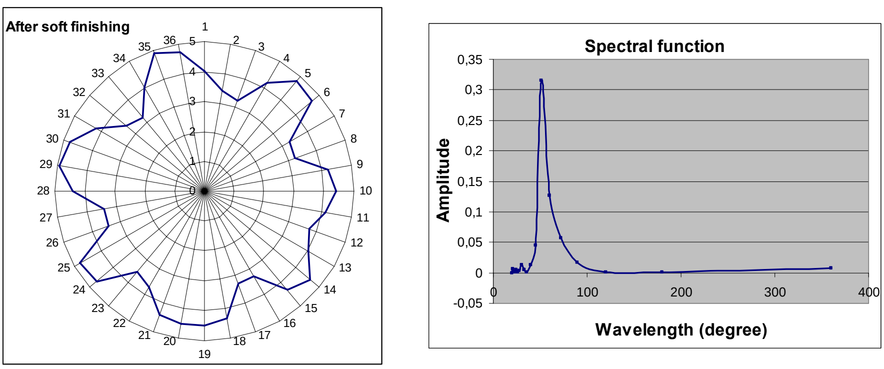
We examined this fabric in different finishing phases (Figure 6). The difference of the ratio of the area of the three samples during the test was minimal, but it could be stated, that using the soft finishing, the drape of the sample decreased.



a) after printing



b) after normal finishing



c) after soft finishing

Figure 6

Spectral function on a fabric with different finishing (a, b and c)

The spectral function which is the result of the Fourier transform of the drape data show the changes occurred during different finishing technologies.

The comparison shows, that with the use soft finishing the longer wavelength folds disappear and the wavelength of folds also decrease.

It can be seen, that the spectral function has only one apex, which means that using soft finishing the drape got smoother and the distribution of folds is almost symmetrical (Figure 6c).

Our tests presume that the spectral function is suitable to describe the ability to drape, to give the frequency of different wavelength folds, the distribution of folds, which enables the draw conclusions regarding symmetry. Further measurement will be made to prove this statistically.

Summary

The drape coefficient alone is not sufficient information about a fabric, so the number of folds, their wavelength, distribution and amplitude is specified as well. In case of cloths the position compared to the projection and warp line is also specified for these data. This is a large amount of data, so it is difficult to handle it, so our goal was to develope a method with which the drape capabilities of different fabrics can be compared easily and fast. Instead of the drape coefficient we gave a new characteristic: the spectral function of the drape. Further research is necessary to prove that the new method is capable of characterising different fabric types. The effect of different technological treatments on the spectral functions has to researched as well. The new method will be most likely a tool for the designers, in the garment industry pre-production process and in the garment technology.

Acknowledgement

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