

**MODELLING AND ANALYSIS OF DRAPE BEHAVIOUR
OF WOVEN FABRICS UNDER STATIC AND DYNAMIC
CONDITIONS**

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**DEPARTMENT OF TEXTILE TECHNOLOGY
INDIAN INSTITUTE OF TECHNOLOGY DELHI
NEW DELHI, INDIA 110 016
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OF WOVEN FABRICS UNDER STATIC & DYNAMIC
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by

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DEPARTMENT OF TEXTILE TECHNOLOGY

*Submitted
in fulfillment of the requirements of the degree of Doctor of Philosophy*

to the



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NEW DELHI, INDIA 110 016
FEBRUARY 2010**

CERTIFICATE

This is to certify that the thesis titled “Modelling and Analysis of Drape Behaviour of Woven Fabrics under Static and Dynamic Conditions”, being submitted by Mr. Ajit Kumar Pattanayak to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him. He has worked under my guidance and supervision and fulfilled the requirements for the submission of the thesis, which has attained the standard required for a Ph.D degree of this institute.

The results contained in this thesis have not been submitted, in part or in full, to any other university or institute for the award of any degree or diploma.

(Prof. B. K. Behera)

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Dedicated To My Parents

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Date:

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ABSTRACT

In this study, an alternative instrument with image processing based measurement system is developed to measure the fabric drape. The principle of software is based on the digital image processing algorithm. This image processing based instrument along with customized software is capable of measuring the drape coefficient and the newly defined drape parameters. These newly defined parameters are drape distance ratio (DDR), fold depth index (FDI), amplitude and number of nodes (N). These additional new drape parameters help to have a complete understanding of the drape profile. The new measurement system is verified by comparing the drape coefficient results with the traditional drape meter. The comparison of results shows excellent agreement between image processing technique and the conventional method. The advantage of this instrument is the ease of the operation as this method does not require much time and skill. This instrument is also capable of measuring the newly defined shape parameters accurately for better understanding of the drape profile.

Apart from accurate measurement, efforts are made to predict the various drape parameters by different modeling techniques. Finite element method, statistical method and polar coordinate technique have been used for the prediction of the drape parameters. Finite element method is carried out by the commercial package "ABAQUS". The standard procedure has been followed for the modeling and analysis of the results. In the statistical method, step-wise regression is applied for the formation of the predictive equations by using low stress mechanical properties of 65 different fabric samples which were measured in the Kawabata Evaluation System. This method is validated using Anderson-Darling probability theory. Polar coordinate technique is also applied in this study to model the various draper parameters. This method is basically a measurement technique. In this method, the boundary of the drape profile is traced using 8

neighborhood technique from the captured image. Then the polar- coordinates of the points in the boundary are located at 1° intervals from the center. This technique is more advantageous as it considers the radii rather than pixel counting. The results obtained from these models are compared with results estimated by digital image processing technique and Cusik method for the verification of models. The correlation coefficient between digital image processing and finite element analysis as well as between digital image processing & polar coordinate technique is found to be very good.

In this study, efforts are also made to predict the various drape parameters of woven fabrics by artificial neural network technique. The five drape parameters such as drape coefficient (DC), drape distance ratio (DDR), fold depth index (FDI), amplitude and number of nodes (N) are predicted by using artificial neural network method. The feed forward back propagation network has been used for the prediction of various drape parameters. The input parameters for this network are the seventeen low stress mechanical properties measured by the Kawabata Evaluation System. The error % between the measured values and the predicted values by the network is found to rest under tolerance limit which proves the credibility of the network. The major advantage of this kind of prediction system is the consideration of non-linearity relationship between the input fabric mechanical properties with the various fabric drape parameters.

It has been realized that fabric drape is a 3D phenomenon; hence an instrument is devised to measure the fabric drape simulating different motions known as drape measurement under dynamic conditions. This instrument makes a rotating and up-down movement with swinging motion simultaneously. These motions are incorporated for the simulation of possible forces on the fabric during normal body movement while walking, apart from the gravitational force.

Dynamic fabric drape is evaluated by various parameters such as drape coefficient (DC), drape distance ratio (DDR), fold depth index (FDI), amplitude and number of nodes (N). These parameters are estimated by developing computer software. This customized software was developed using image processing technique in the Matlab environment. Efforts are also made to predict the dynamic drape parameters of cotton woven fabrics with the rotational speed of the supporting disc. The drape parameters were measured by a specially designed apparatus with image processing technique. The results show that the trend of drape parameters with the rotational speed of the disc changes in three regions. In the first and third region, the change was very slow but it changes very sharply in the second region. Then the changes of the drape parameters were modeled using the experimental values through curve fitting technique. The predictive equations were formed for the prediction of various drape parameters at a particular speed of the supporting disc. The equations were validated from the sum of the squared error. As the error term is very low, these equations can be used for the prediction of dynamic drape parameters for certain applications.

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