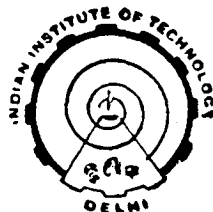


THE GEOMETRY OF THE 2×2 MATT WEAVE

By

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A thesis Submitted to the
Indian Institute of Technology, Delhi
for the award of the degree of
DOCTOR OF PHILOSOPHY



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May, 1987

CERTIFICATE

This is to certify that the thesis entitled "THE GEOMETRY OF THE 2 x 2 MATT WEAVE" being submitted by Mr. Biswapati Chatterjee to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy is a record of the bonafide research work carried out by him. He has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis which, to our knowledge, has reached the requisite standard.

The thesis, or any part thereof, has not been submitted to any other University or Institute for the award of any degree or diploma.



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ACKNOWLEDGEMENTS

The author is grateful to his Supervisors, Prof. N.M. Swani and Dr. P.K. Banerjee of Textile Technology Department, Indian Institute of Technology, Delhi, for their guidance of this project.

The author is thankful to Prof. M.L. Gulrajani, Head, Textile Technology Department, IIT Delhi, for his permission to carry out this project work.

Special thanks go to the ICL 2960 computers of the Institute with whom the author has spent many evenings.

Thanks are due to all my colleagues and laboratory staff of Textile Technology Department without whose help this work would never have materialised.

The author is also thankful to Mr. Rajesh Arora for typing and Mr. K.G. Padam for tracing the figures.


(BISWAPATI CHATTERJEE)

ABSTRACT

Importance of studies on geometry of weave in the field of structural engineering of woven fabrics is well established. The 2 x 2 matt weave has been subjected here to a detailed study by developing theoretical models. The main importance of study of this weave lies in its transitional nature of construction as well as characteristic influence of float on woven structure. Symmetry no doubt simplifies the analysis to a great extent. Nevertheless this study bridges a gap between the simplest variety of weave namely plain weave on one hand and a more complex asymmetric twill weave on the other. From practical point of view, since this weave is used often in manufacture of industrial fabrics this study could be also regarded as a contribution in the field of engineering of woven fabrics.

Two models are proposed based on two extreme cases of nature of contact between interlaced threads. One is assumed to have a point contact between warp and weft threads while the other incorporates distributive contact. Both these models employ planar elastica theory in order to determine configuration of crimped form of thread. The reaction force generated at the point contact

model is assumed to be a concentrated one lying in space while in the other model, an uniform radial distribution of reaction force is active along entire modular length of warp and weft. Based on practical observations the analysis is then restricted to realistic range of structures. Conversion of such observations into suitable mathematical forms then lead to a formation of constrained minimization problem which is solved by numerical method. The solution of feasible structures resulting from minimization yields important relations between measurable geometrical parameters. Here attempts are made to represent the relations in a convenient form suitable for practical purpose by choosing modular length of weft as a scale parameter of the structure. A detailed discussion of theoretical results and comparison with the geometry of the plain weave are subsequently made.

Experiments are carried out to generate a realistic range of data from 12 different samples of 2x2 matt weave. Validation of the models is then made with the help of these data by analysing the phenomena of (i) crimp balance of relaxed fabrics (ii) crimp interchange at low strain level (iii) thickness of the cloths. These analysis indicate suitability of point contact model for representing relaxed 2x2 matt fabrics produced in commercial range, whereas distributive contact model gains in validity for jammed fabrics.

CONTENTS

Page
No.

ABSTRACT

SYMBOLS USED

CHAPTER I	INTRODUCTION	1
CHAPTER II	REVIEW OF LITERATURE	5
CHAPTER III	DEVELOPMENT OF THEORETICAL MODELS	15
3.1.1	Idealisation of structure	15
3.1.2	Analysis of forces acting on bent elastica	16
3.1.3	Shape of crimped form of elastica	17
3.1.4	Expressions of crimp and ratio of crimp height to crimp wavelength	20
3.1.5	Plan of approach to express relations between parameters in suitable form	21
3.1.6	Computational strategy for determination of structure	25
3.1.7	Derivation of strain energy	27
3.1.8	Selection of optimisation technique	28
3.1.9	Running the program for solution	29
3.1.9.1	Square structure	29
3.1.9.2	Nonsquare structure	30
3.2	Development of distributive contact model	31
3.2.1	Assumptions of distributive contact model	33
3.2.2	Derivation of force and moment equilibrium equations	34

3.2.3	Computational strategy for calculation of shape of crimped form of elastica	40
CHAPTER IV	EXPERIMENTS FOR VALIDATION OF MODELS	42
4.1	Objective and planning of experiment	42
4.2	Description of fabric samples	42
4.3	Measurement of parameters	
4.3.1	Measurement of wavelength of crimped thread along warp and weft directions	44
4.3.2	Measurement of thickness	44
4.3.3	Measurement of crimp	45
4.3.4	Measurement of linear density of yarn	45
4.3.5	Measurement for study of crimp interchange phenomenon	46
CHAPTER V	RESULTS OF THEORETICAL INVESTIGATIONS	48
5.1.1	Relation between weave angle & crimp	52
5.1.2	Relation between ratio of crimp amplitude to crimp wavelength and crimp	58
5.1.3	Relation between sum of crimp amplitudes and the distance between thread axis at the point of contact	64
5.1.4	Relation between $\frac{h}{D}$ and $\frac{\lambda}{D}$	65
5.1.5	Crimp balance relation	70
5.1.6	Reaction forces at the point of contact	73
5.1.7	The limiting structure with straight crossing thread	78

5.2	Validation of theoretical results	80
5.2.1	Analysis of crimp balance results	82
5.2.2	Analysis of results of crimp interchange	83
5.2.3	Analysis of fabric thickness	87
5.2.4	Discussion on jamming	89
CHAPTER VI	SUMMARY AND CONCLUSIONS	95
	REFERENCES	