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ANALISYS OF SHEAR BEHAVIOURS OF WOVEN FABRICS WITH IMAGE PROCESSING

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Abstract:

The main using area of woven reinforcing structures is the aerospace and car industry through the composite components. Those components frequently have complex surfaces. In plane shear behaviour of textile performs is the most studied mechanical property because this mode of deformation is necessary for forming on double curvature surfaces. The examination of shear behaviours helps to better understanding the properties of woven fabrics. In answer on the bias tensile stress the shear angle between the warp and weft yarns is change. I examined the changing of shear angle during the bias tensile test with two different image processing based method. I used general tensile tester equipment for the measurement and a video extensometer to determine the shear angle. According the results we can see that which method is easier and give more precise results about the changing shear angle of a deformed woven fabric.

Keywords:

deformation, shear behaviour, image processing, video extensometer

1 INTRODUCTION

The shearing behaviour of a fabric determines its performance properties when subjected to a wide variety of complex deformations in use. The ability of a fabric to be deformed by shearing distinguishes it from other thin sheet materials such as paper or plastic films. This property enables fabric to undergo complex deformations and to conform to the shape of the body. Shearing influences draping, flexibility and also the handle of woven fabric. Shear properties are important not only for fabrics but for textile composites as well. [1], [3]

The deformability of textile fabrics and its dependency on the fabric structure is an important issue for technical as well as for apparel textiles. Research work of the1950s–1970s has established theoretical understanding and methods of experimental characterisation of deformation of textiles, based on descriptions on the mesoscopic structural level. New challenges for textile mechanics were opened when different processes of draping of composite textile performs came in the order of the day in the 1990s. Deformability of textile preforms plays a key role in the quality of a composite part formed into a 3D shape. Comparing with the earlier apparel-oriented models, textile mechanics of composite performs must include a description of their behaviour under high loads, with deformations. [4]

Optical full-field strain measurements start to being used in textile deformability research quite recently. Textile deformability testing mainly focuses on in-plane characteristics as shear resistance and biaxial tension. Unfortunately no standard test methods are available, although lately shear normalization exercises were performed and efforts were made to comprehend and compare shear test procedures, among others in a bench-mark exercise on deformability of woven composite reinforcements . Two shear test methods are in vogue: a bias tensile test(with principal directions at

45 with regard to the tensileload)and a dedicated test in a shear fixture,also called 'pictureframe'.The bias test is easy to perform, but introduces an inhomogeneous deformation field, where the unconstrained fibres at the side edges may slip. [5]

In plane shear behaviour of textile performs is the most studied mechanical property because this mode of deformation is necessary for forming on double curvature surfaces In this work, a new experimental device is implemented which makes it possible to measure the tensions in a fabric during a shear test. This device will show that, contrary to the classically used assumptions, the shear stiffness varies with the tensions. In addition, it will be seen that the classical ''picture frame'' test used as pure shear test causes tensions in the yarns of the fabric. [2]

Woven fabric reinforcing are used in the composite area. The shear property is a very important factor in fabric deformation.

The bias-extension test is the most commonly used to determine the fabric plain shear properties.

The main aim is to comparing the different method of determining the shear angle during the uniaxial tension of a bias-cut fabric specimen.

The shear behaviour of fabric is generally measured by cut it out in bias direction.

2 EXPERIMENTAL

The shear angle was measured with two different, image processing based method. First of them measure

The measured specimen could be divided in three different zones: zone A, B and C (Figure 1). Zone A is the central of the stretched specimen there the shear is go off fully. In zone B the shear is go off in half. The zone C is the two end of the specimen, there are no shear between the warp and weft yarn. That why the measuring is only done in the central part of the specimen, here we can measure only the pure shear behaviour. In the first method there was marked line on the warp and weft yarn drawing a square in the centre of the specimen. The square is divided in four part and all the four upper angle is measured and a mean is calculated. The shear zones are form when the tensile load is increase.

The deformation woven structures was measured under unaxial tensile load. In the course of that the angle between the warp and weft yarns was determined. Specimens was cut out in 45° degree according to the weft direction from the fabric.

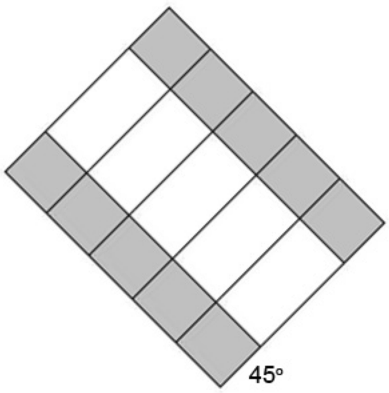


Figure 1: Specimen arrangement

The yarns of reinforcement structures are slipping easily during the cut out the specimen that why there was cut out in special method. To cut out the specimens a 5 pieces of 50x200mm rectangle was drown on a paper and the two side of that in 50mm was fixed on the fabric.

The specimen was cut out with the fabric along the lines. The sticked paper block the slipping of yarns the deformation of the structures. After cutting out the specimen with the paper it was grip in the tensile tester and the paper was removed.

In the centre of the specimen the warp and weft yarns were marked, with drawing four equal squares(). The angles found in the upper point of the four created squares was determined with image processing program in different phase of the tensile process. After that the means of the four angle was calculated.

The searched shear angle can be determined by knowing the vertical and horizontal distance using the trigonometric function. In that case the distances was measured with videoextensometer putting distinctly visible marks on the specimen in the two direction ().

The angle deformation results of the two methods was plotted against the strain (). It can be seen from the graph that the difference between of the two methods smaller than 2%. Consequently both method can be used well to determine the shear angle.

Using the shear angle and the measured tensile force the shear force awaken in the centre of the specimen can be determined:

$$F_{sh} = \frac{F}{2\cos(\gamma/2)} [N] \qquad (2)$$

where the F_{sh} shear angle, F tensile force and γ is the shear angle between the warp and weft yarns (2).

The calculated shear force was plotted against the specific agle deformation (). The shear force is shange in a sudden rise at the maximum angle deformation, when the angle hardly do not change more. The graph is similar to the tensile force-stran graph (), because the tensile and the shear force and the shear angle and the strain are proportional with each other. There was 9 measured specimen because generally that is written in the standard about woven fabric tension.

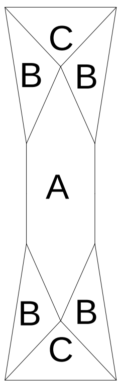
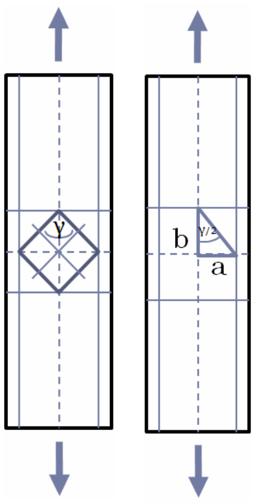


Figure 2: Shear zones on specimen



a) b)

Figure 3: Shear angle measuring methods

a) Direct shear angle measurement, method 1

b) Shear angle determination using trigonometric function, method 2

$$tg(\gamma/2) = \frac{a}{b} \rightarrow \gamma[^\circ] \qquad (1)$$

Table 1: Main properties of observed fabric

No.:	G220
Material:	glass fibre
Yarn density:	6 [1/mm]
Areal density:	220 [g/m^2]
Wave:	plain

3 RESULTS AND DISCUSSION

Figure 3 show the measurement with the 1. method. The warp and weft yarns are marked with pen in the centre of the specimen.

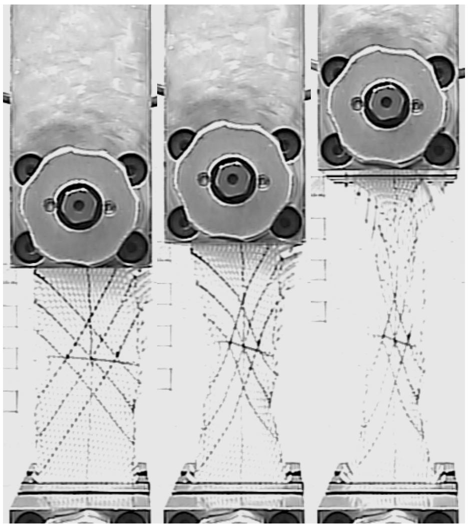


Figure 4: Measuring shear angle with first method

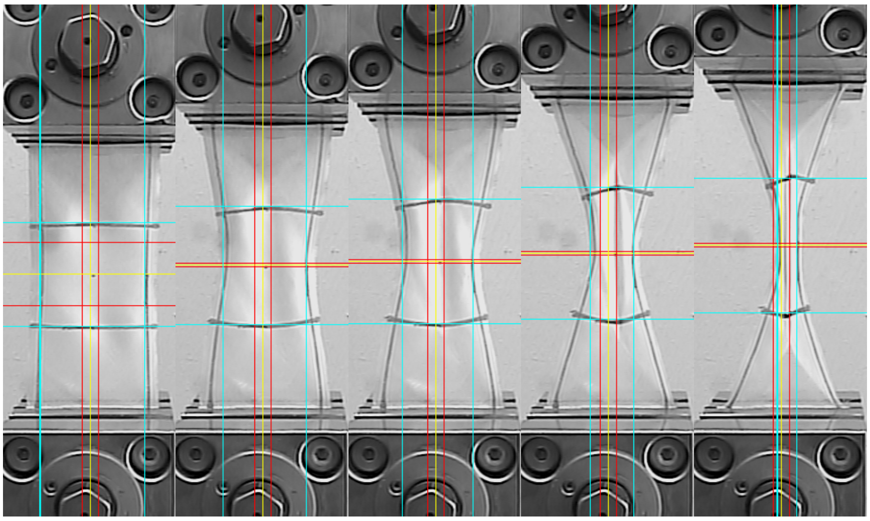


Figure 5: Measuring shear angle with second method

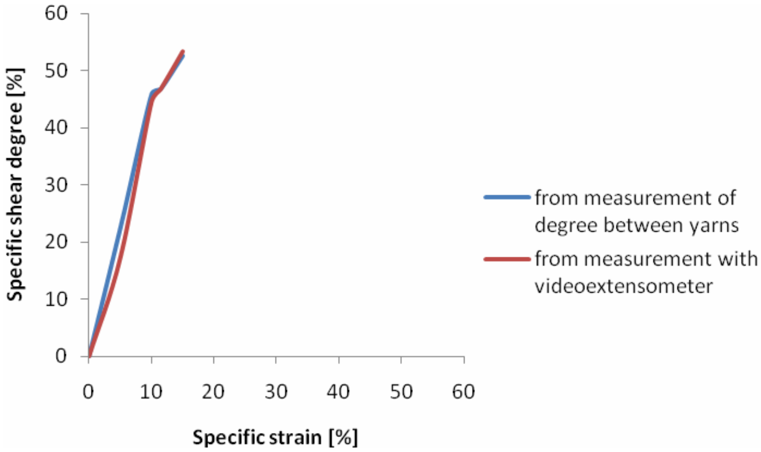


Figure 6: Comparison of two method of shear degree measurement

After determination of shear angle with the two different the shear force was measured with equation (2). The results were plotted in the same graph. It is showed that the results do not differ essentially. the difference is less than 2% between the results of the two method. Plotting the specific shear degree against the specific strain.

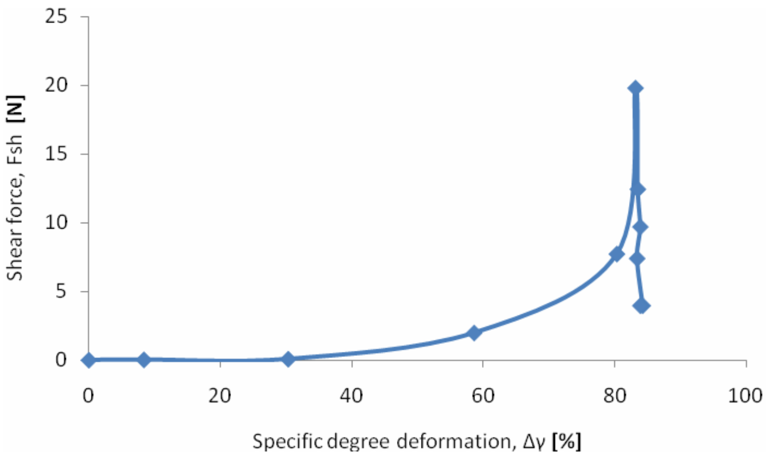


Figure 7: Shear force-specific shear deformation curve

The graph show that the specific degree deformation change 80% that mean the shear angle decrease that. The end of the graph show that the end of the yarn shear the sharing is stop at 80% and after that there is only slipping between yarns.

4 CONCLUSIONS

The shear angle give a good description about the textile deformation behaviours. Both of the used method are determined well the angle between the warp and weft yarns. But with the method use video extensor meter is an easier method to determine the shear angle. The measured shear angle characterize well the deformation of woven fabric. Shear angle is describe well the ability of fabric fitting on double curved shape.

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