Prediction of bending rigidity for laminated weft knitted fabric with adhesive interlining

KyoungOk Kim[1], Shigeru Inui[2], Masayuki Takatera[2*]

Department of Bioscience and Textile Technology, Interdisciplinary Division of Science and Technology, Shinshu University, Ueda, Japan
Faculty of Textile Science and Technology, Shinshu University, Ueda, Japan
*takatera@shinshu-u.ac.jp

Abstract: The purpose of this study is to predict bending rigidity of laminated weft knitted fabric using three prediction methods and to determine their suitability for predicting. The methods are as follows: Method 1: the laminate theory using bending rigidities and thicknesses of components, Method 2: an equation derived from the laminate theory taken into account the tensile and in-plane compressive moduli of components, Method 3: an equation in consideration of the position of the neutral axis in bending on a face fabric. Six weft knitted fabrics and ten adhesive interlinings, sixty laminated composites with those combinations were used. Tensile properties and bending rigidities, thicknesses of samples were measured. The other necessary parameters for the prediction were obtained by additional experiments and calculation. It was found that the results by Method 3 showed the closest agreements with experimental ones. It is due to the relative positions of the neutral axes for all knitted fabric samples are not in the centroid. It became clear that the position must be taken into account for calculating bending rigidities of laminated knitted fabric with adhesive interlining.

Introduction

Knitted fabrics have been used for various garments such as sweaters, underwear, hosiery, and baby blankets because of their soft, stretchy and drapery properties. A trend toward a casual lifestyle reflected in knitted garments. As this trend also affects the formal style, people would like to wear softer and stretchier garments even in the case of wearing suits. Thus, suits and other outwear made of knitted fabrics have appeared on the market.

For manufacturing garments, mechanical properties of fabrics are controlled using subsidiary materials due to the insufficient stiffness of a face fabric. An adhesive interlining using a thermoplastic resin is taken as a representative example. Adhesive interlinings are used for knitted fabrics as well as woven fabrics to give suitable appearance and stability to garments.

In the previous studies [1, 2 and 3], the prediction of bending rigidity for laminated fabric with woven fabric and adhesive interlining were investigated using three prediction methods as shown below. It became clear that changes of mechanical properties of components by pressing process are necessary to be considered in laminate theory [1]. It was also found that bending rigidities of laminated fabrics can be predicted using tensile and in-plane compressive moduli of components [2]. For more precise prediction of bending rigidities, the placements of neutral axes were effective to be taken into account for some fabrics [3]. From these results, it was possible to predict bending rigidity of laminated fabric with woven fabric and adhesive interlining. However these predictions were mainly carried out with woven fabrics for face fabrics. The tensile and in-plane compressive properties of knitted fabric have not been investigated yet. Thus, it is uncertain if these methods will be suitable for knitted fabric because of its different structures and mechanical properties with woven fabric.

Viki L. Gibson et al. [4] investigated mechanical properties of a wide range of commercially-produced outerwear fabrics, woven fabrics, double-knits, and warp-knits in terms of the elastic and frictional resistance to bending and shear deformations. They reported the different bending properties depending on different fabric structures. D. Alimaa et al. [5] also investigated bending properties of a series of plain and rib weft knitted structures, and carried out theoretical analyses on the effects of yarn bending properties and fabric structure on the bending rigidity. However, those studies did not investigate laminated knitted fabrics.

Some studies were carried out to predict the bending rigidity of laminated knitted fabrics. Dawes V H et al. [6] investigated the prediction of bending rigidity for composite with one knitted fabric taken into account the tensile and in-plane compressive moduli. However, it showed unsatisfactory prediction results with large prediction errors. Shishoo et al. [7] also introduced regression equations for the bending rigidity of laminated knitted fabrics. They also tested one knitted fabric sample and did not consider the mechanical properties of knitted fabrics. Thus, more precise predicting the bending rigidity of laminated knitted fabric is necessary.

Therefore, our aim in this study is to investigate the validity of these prediction methods of bending rigidity for laminated knitted fabrics, and to determine the most suitable ones. By investigating the prediction method for knitted fabrics, selecting the suitable adhesive interlining for knitted fabric will be possible without testing laminating fabrics on every case.

Prediction methods

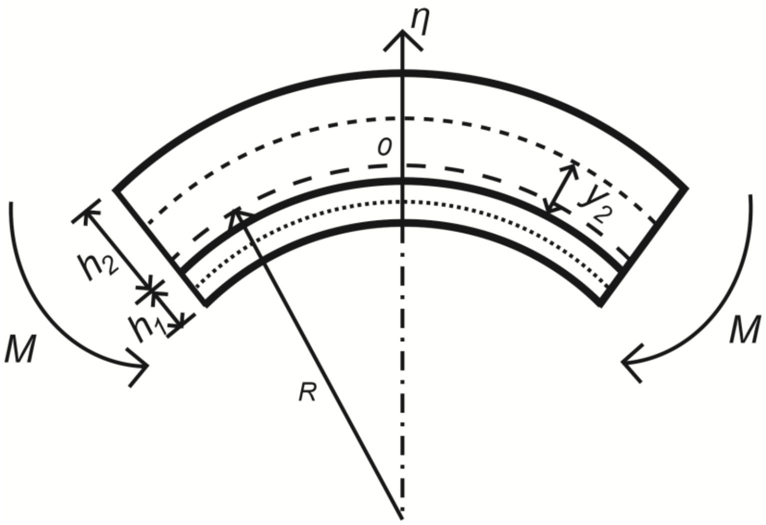


Figure 1 Structure of laminated fabric.

Method 1

The laminate theory for elastic continua can be basically used to predict the bending rigidity of laminated fabric [1]. The equation is given by

$$B_{12} = 3B_1B_2\frac{(h_1+h_2)^2}{(B_1h_2^{\ 2}+B_2h_1^{\ 2})}+B_1+B_2 \qquad (1)$$

where h_1 and h_2 are the thicknesses of adhesive interlining and face fabric as shown in Figure 1. B_1 and B_2 are the bending rigidities of adhesive interlining and face fabric. B_{12} is the bending rigidity of laminated fabric with adhesive interlining. The method used Equation (1) is denoted by *Method* 1.

Method 2

Because a fabric is not elastic continuum, the tensile and in-plane compressive moduli, E_t and E_c may be different from the elastic modulus in bending, E_b. As assuming that E_b, E_t and E_c of both fabrics are independent and the neutral axes in bending are in the centroid of each fabric, Equation (1) can be expressed with in-plane compressive and tensile moduli as follows [2].

$$B_{12} = \frac{T_1T_2}{T_1+T_2}\left(\frac{h_1+h_2}{2}\right)^2+B_1+B_2 \qquad (2)$$

where T_1 and T_2 are apparent in-plane compressive modulus and apparent tensile modulus respectively and were assumed as constants. The apparent tensile modulus, T_2 can be obtained by a tensile test. To obtain the apparent in-plane compressive modulus, T_1, Equation (3) was proposed.

$$T_1 = \frac{-T_2\{B_{12}-(B_1+B_2)\}}{B_{12}-(B_1+B_2)-T_2\left(\frac{h_1+h_2}{2}\right)^2} \qquad (3)$$

T_1 can be obtained by a bending test of a combination of an adhesive interlining and a specific fabric, then, we can predict the bending rigidity of laminates with the interlining and other fabrics by Equations (2). The method used Equations (2) and is denoted by *Method* 2.

Method 3

The relative position of the neutral axis in bending, Y_2 for a face fabric was taken into account in predicting the bending rigidity of laminated fabric for more precisely [3]. The prediction equation in consideration of Y_2 is given by

$$B_{12} = \frac{T_2T_1(h_1+2Y_2h_2)(h_2+h_1)}{4(T_1+T_2)}+B_1+B_2 \qquad (4).$$

Equation (5) can be used to obtain Y_2.

$$Y_2 = \frac{2(B_{12}-B_1-B_2)}{h_2(h_1+h_2)}\left(\frac{1}{T_2}+\frac{1}{T_1}\right)-\frac{h_1}{2h_2} \qquad (5)$$

Y_2 can be obtained by a bending test of a combination of a fabric and an adhesive interlining, then, we can predict the bending rigidity of laminates with fabric and other interlinings. The method used Equations (4) is denoted by *Method* 3.

Experimental

Experiments were carried out to confirm the validity of the three prediction methods for the bending rigidity of laminated knitted fabrics. In the usage of adhesive interlinings, an adhesive interlining was used on the inside of clothing and the face fabric was on the outside of the arc of bending as shown in Figure 1. Weft knitted fabrics having different structures, adhesive interlinings and laminated fabrics with those combinations were prepared as experimental samples.

Obtaining parameters for prediction methods

Bending rigidities of all samples were measured on warp and weft, on wale and course direction respectively using a KES-FB2 pure bending tester [8]. The thickness of each sample was measured using a KES-FB3 compression tester at 49 Pa load in the thickness direction. The load at 0 to about 2.5% of elongation from the load-elongation curve by KES-FB1 tensile tester, on warp and weft, on wale and course direction respectively, was used to calculate the T_2 for each face fabric. T_1 can be obtained when the neutral axes in bending of components are assumed to be in the centroids of both components. However, it is uncertain that the neutral axes of knitted fabric samples pass through those centroids of the cross section. The centroids are the centers of each cross section. Thus, we carried out the experiments in the combination of specific face fabrics (N1 and N2) and interlining, which neutral axes in bending can be assumed to lie in the centroid [2]. With the obtained values, T_1 was calculated using Equation (3). Then, Y_2 of face fabrics were calculated by Equation (5).

Every test was carried out under standardized conditions (20±1°C and 65±5% relative humidity). All samples were preconditioned under these standardized conditions for 24 hours. Every test was conducted on five samples and the averages were used.

The bending rigidities of other laminated fabrics bonded with the face fabrics and different interlinings were predicted using *Method* 1, 2 and 3. Those results were compared with the experimental data.

Experimental samples

The sample specifications are shown in tables 1, 2 and 3. Six weft knitted fabrics were used for face fabrics. Two twill fabrics (N1 and N2 which Y_2 can be assumed to lie in the centroid [2]) were used for face fabrics to obtain T_1 of adhesive interlinings. Ten adhesive interlinings, which are usually used for knitted fabrics in the market, were also used. Sixty combinations of laminated fabrics were constructed and examined. They were polyester plain fabrics and the adhesive agent was polyamide of dot printing type. Laminating interlining to face fabric was done automatically using a press machine (Kobe Denki Kogyosyo, BP-V4812D). Adhesive interlining was put on face fabric and both were inserted in the press machine. The press machine was flat type press machine which had one heating side and another none heating side. The interlining side was heated. After pressing both fabrics, those were bonded. The bonding conditions were 150°C, under 29.4 kPa load and 10s pressing time.

Pressed samples

The mechanical properties of woven fabrics and adhesive interlinings were changed after pressing procedure for laminating. This must be considered when predicting the bending rigidity of laminated fabrics [1]. However, the changes in bending rigidities and thicknesses of knitted fabric are unclear. Thus, the changes in mechanical properties of knitted fabric by pressing were also investigated. To investigate it, the samples which were pressed alone under the same press conditions of laminating were prepared. Those mechanical properties were measured and compared to the samples before pressing. The method is as follows: Face fabric samples were pressed using the press machine under the same conditions of bonding interlining. For adhesive interlinings, polytetrafluoroethylene (PTFE) film (NITTO, No.900, 0.05×300mm) was prepared. Adhesive interlinings were bonded to PTFE films and then PTFE films were removed from adhesive interlining. The samples pressed alone were referred to as ‘pressed samples’. Face fabric and adhesive interlining pressed alone were referred to as ‘pressed face fabric’ and ‘pressed adhesive interlining’.

Table 1 Specifications of knitted fabrics

Sample name	Yarn count (tex) (warp×weft)		Structure	Stitch density(/cm) (Wale×Course)	Material	Pressed face fabric name	Bending rigidity of pressed face fabric(cN·cm^2/cm) (Wale×Course) (Standard deviation)	Thickness of pressed face fabric (cm) (Standard deviation)
N1	16.5 tex×2; R33tex	16.5 tex×2; R33tex	twill (woven)	28×22 (warp×weft)	Wool 100%	P-N1	0.135×0.076 (warp×weft) (0.002×0.001)	0.052 (0.001)
N2	14tex×2; R28tex	14tex×2; R28tex	twill (woven)	29×24 (warp×weft)	Wool 100%	P-N2	0.057×0.037 (warp×weft) (0.001×0.002)	0.050 (0.002)
KN1	30		plain	14×14	cotton 100%	P-KN1	0.071×0.011 (0.003×0.001)	0.064 (0.001)
KN2	22/22		milano rib	14×12	poly85%/cotton15%	P-KN2	0.260×0.147 (0.011×0.009)	0.138 (0.001)
KN3	17		interlock stitch	13×16	cotton 100%	P-KN3	0.051×0.011 (0.002×0.003)	0.103 (0.001)
KN4	23.5/20.5		milano rib	14×12	poly85%/cotton15%	P-KN4	0.248×0.146 (0.018×0.009)	0.107 (0.003)
KN5	15.5		interlock stitch	13×14	cotton 100%	P-KN5	0.108×0.020 (0.009×0.004)	0.102 (0.003)
KN6	20/22.5		milano rib	14×12	poly85%/cotton15%	P-KN6	0.232×0.174 (0.007×0.004)	0.118 (0.004)

Table 2 Specifications of adhesive interlinings

Sample name	Density (/cm)	Adhesive dot number(/cm) (warp × weft)	Adhesive dot size (mm)	Mass per unit area (g/m^2)	Adhesive mass without fabric (g/m^2)	Pressed adhesive interlining name	Bending rigidity of pressed adhesive interlining(cN·cm^2/cm) (warp × weft) (Standard deviation)	Thickness of pressed adhesive interlining(cm) (Standard deviation)
CE1	38×22	10×10	0.17	36.2	8.6	P-CE-1	0.0058×0.0051 (0.0015×0.0016)	0.027 (0.001)
CE2	38×23	10×10	0.17	35.6	8.0	P-CE-2	0.0058×0.0030 (0.0016×0.0010)	0.025 (0.001)
CE3	38×25	10×10	0.17	36.5	8.3	P-CE-3	0.0060×0.0035 (0.0005×0.0009)	0.024 (0.001)
CE4	37×26	10×10	0.17	36.5	8.1	P-CE-4	0.0070×0.0039 (0.0005×0.0005)	0.024 (0.0004)
CE5	37×26	10×10	0.17	35.7	7.7	P-CE-5	0.0085×0.0039 (0.0033×0.0013)	0.023 (0.001)
DP1	39×24	9×9	0.25	38.5	8.7	P-DP-1	0.0064×0.0024 (0.0009×0.0010)	0.024 (0.007)
DP2	39×24	10×10	0.23	39.9	10.0	P-DP-2	0.0059×0.0020 (0.0011×0.0013)	0.024 (0.006)
DP3	39×24	10×10	0.30	41.8	11.6	P-DP-3	0.0074×0.0033 (0.0007×0.0009)	0.025 (0.007)
DP4	39×24	11×11	0.20	37.5	8.7	P-DP-4	0.0059×0.0027 (0.0008×0.0008)	0.024 (0.007)
DP5	39×24	12×12	0.10	39.3	10.1	P-DP-5	0.0062×0.0013 (0.0008×0.0017)	0.025 (0.007)

Table 3 Combinations of face fabric and adhesive interlining

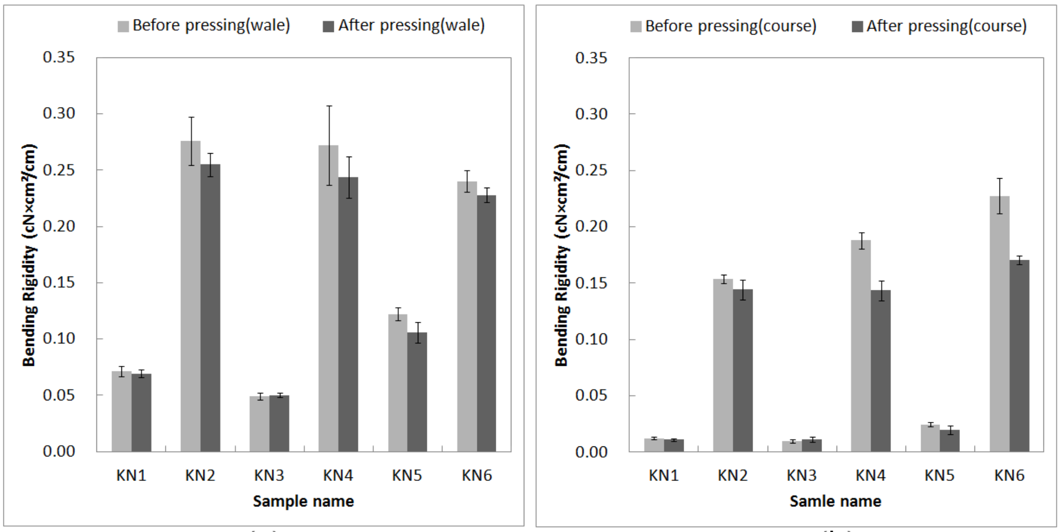
Face fabric / Adhesive interlining	KN1	KN2	KN3	KN4	KN5	KN6
CE1	KN1-CE1	KN2-CE1	KN3-CE1	KN4-CE1	KN5-CE1	KN6-CE1
CE2	KN1-CE2	KN2-CE2	KN3-CE2	KN4-CE2	KN5-CE2	KN6-CE2
CE3	KN1-CE3	KN2-CE3	KN3-CE3	KN4-CE3	KN5-CE3	KN6-CE3
CE4	KN1-CE4	KN2-CE4	KN3-CE4	KN4-CE4	KN5-CE4	KN6-CE4
CE5	KN1-CE5	KN2-CE5	KN3-CE5	KN4-CE5	KN5-CE5	KN6-CE5
DP1	KN1-DP1	KN2-DP1	KN3-DP1	KN4-DP1	KN5-DP1	KN6-DP1
DP2	KN1-DP2	KN2-DP2	KN3-DP2	KN4-DP2	KN5-DP2	KN6-DP2
DP3	KN1-DP3	KN2-DP3	KN3-DP3	KN4-DP3	KN5-DP3	KN6-DP3
DP4	KN1-DP4	KN2-DP4	KN3-DP4	KN4-DP4	KN5-DP4	KN6-DP4
DP5	KN1-DP5	KN2-DP5	KN3-DP5	KN4-DP5	KN5-DP5	KN6-DP5

Results and discussions

The bending rigidities of knitted fabric before and after pressing were shown in Figure 2. The bending rigidities of most knitted fabrics decreased after pressing both wale and course direction about 12%. The thicknesses of knitted fabrics before and after pressing are shown in Figure 3. After pressing, the thicknesses of most samples, except KN4, become thinner about 16%. Therefore, it was found that the bending rigidity and thickness of knitted fabrics changed after pressing from these results. The change rates in thickness and bending rigidity were about 6% and 3% for woven fabrics [1]. The differences of bending rigidity and thickness for knitted fabrics between before pressing and after pressing were larger than ones of woven fabrics. It is due to the structures of knitted fabric, which have larger spaces between yarns than those of woven fabric.

Method 1

As assuming the components as elastic continua, conventional laminate theory was used in *Method* 1. The bending rigidities of laminated fabrics were predicted using *Method* 1 with the obtained values of pressed samples. The comparison of the predicted bending rigidities and experimental ones are shwon in Figure 4. The mean absolute percentage errors (MAPEs) between calculated and experimental bending rigidities are shown in Table 5. In the results of experimental bending rigidities, bending rigidities of some samples were over 0.6 cN·cm^2/cm and ones of some samples were under 0.6 cN·cm^2/cm. The samples of bending rigidities over 0.6 cN·cm^2/cm are all laminated knitted fabric with milano rib samples (KN2, 4 and 6). They have relatively large flexural rigidities by themselves as shown in Figure 2. The predicted bending rigidities of laminated knitted fabric with milano rib samples were much smaller than the experimental ones. The predicted bending rigidities of laminated knitted fabric with KN1, 3 and 5 were closer to the experimental ones than the laminated knitted fabric with milano rib samples, KN 2, 4 and 6. However, even though the predicted results of laminated knitted fabric with KN2, 4 and 6 (MAPE 15.0%) showed closer agreements with experimental ones than those of the laminated knitted fabric with milano rib samples (MAPE 31.6%), it is still resulted in large prediction errors (MAPE 19.1%). The reasons of disagreement in laminated knitted fabric with milano rib samples will be the difference between elastic modulus in bending, and tensile and in-plane compressive moduli, or the placement of neutral axes in the knitted fabrics. This will be discussed in the parts of *Method* 2 and 3. Due to the large prediction errors, it was found that *Method* 1 was not suitable for predicting bending rigidities of laminated knitted fabrics.



(a) (b)

Figure 2 Bending rigidities of knitted fabrics; (a) wale direction, (b) course direction.

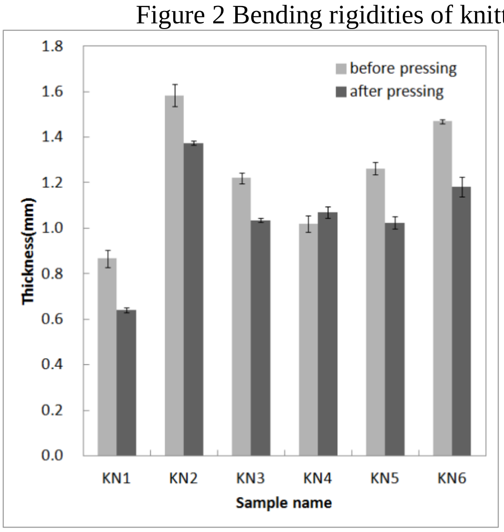


Figure 3 Thicknesses of knitted fabrics before and after pressing.

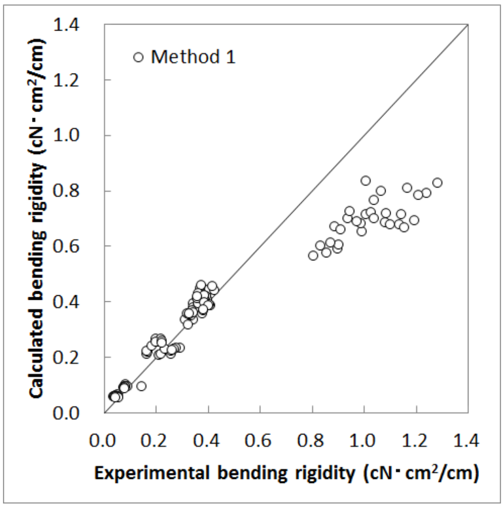


Figure 4 Calculated and experimental bending rigidities of laminated knitted fabrics using *Method* 1.

Method 2

In *Method* 2, aparent in-plane compressive modulus and tensile modulus were taken into account based on the *Method* 1. In addition to the bending rigidity and thickness, apparent in-plane compressive modulus of interlining T_1 and tensile modulus of face fabric T_2 are necessary to calculate the bending rigidities of laminated fabrics in *Method* 2. T_2 were obtained from the tensile properties of pressed knitted fabrics as shown in Table 4. In *Method* 2, if the neutral axes in bending of the components are in the centroid, the T_1 can be obtained using Equation (3). However, the placements of the neutral axes for knitted fabrics are uncertain. Thus, the placements of knitted fabrics were investigated. The obtained T_1 values using Equation (3) with the bending rigidities and thicknesses of the knitted fabrics were compared with the obtained T_1 values with those of N1 and N2. The comparison of the average of T_1 values with knitted fabrics and twill fabrics by Equation (3) are shown in Figure 5. If the neutral axes in bending of knitted fabrics are in the centroid, the T_1 values will be the same as the T_1 values from the tests with twill fabrics. However, the averages were significantly different when compared to those from twill fabrics. The variations of T_1 values for the knitted fabrics were also large. Therefore, it was found that the neutral axes in bending of the knitted fabric samples are not in the centroid. The position of the neutral axes in bending of the knitted fabrics will be discussed as the part of *Method* 3. Therefore, T_1 values from twill fabrics were used in *Method* 2. With the resulting bending rigidities, thicknesses, T_1 and T_2 values of pressed samples, the bending rigidities of laminated fabrics were calculated as shown in Figure 6. The MAPEs between calculated and experimental bending rigidities are shown in Table 5. As shown in Figure 6 and its MAPEs, the calculated bending rigidities of laminated knitted fabrics did not correlate with the experimental ones.

The reason of the disagreements between predicted and experimental bending rigidities by *Method* 2 is due to the position of the neutral axes in bending of face fabrics. As mentioned previously, the neutral axes in bending of knitted fabrics were not in the centroids. When the neutral axes in bending of components are not in the centroid, it is necessary to consider Y_2. Therefore, it was found that *Method* 2 is not suitable for predicting bending rigidities of laminated knitted fabrics.

Table 4 T_2 of pressed face fabrics

Sample name	T_2**(cN/cm)**
P-N1(warp)	14.4
P-N1(weft)	28.9
P-N2(warp)	22.8
P-N2(weft)	4.2
P-KN1(warp)	368.1
P-KN1(weft)	107.3
P-KN2(warp)	544.0
P-KN2(weft)	152.6
P-KN3(warp)	274.6
P-KN3(weft)	48.4
P-KN4(warp)	1130.7
P-KN4(weft)	239.5
P-KN5(warp)	486.7
P-KN5(weft)	85.9
P-KN6(warp)	545.0
P-KN6(weft)	226.9

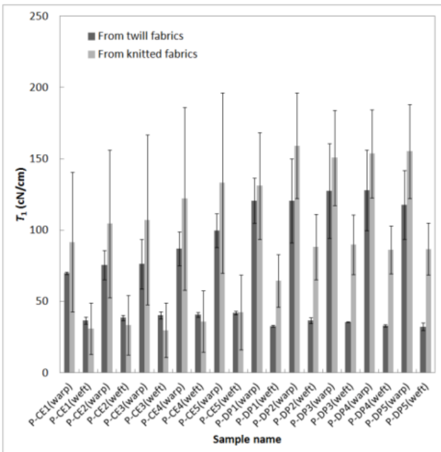


Figure 5 Comparison of averages T_1 of interlinings from tests with twill fabrics and knitted fabrics.

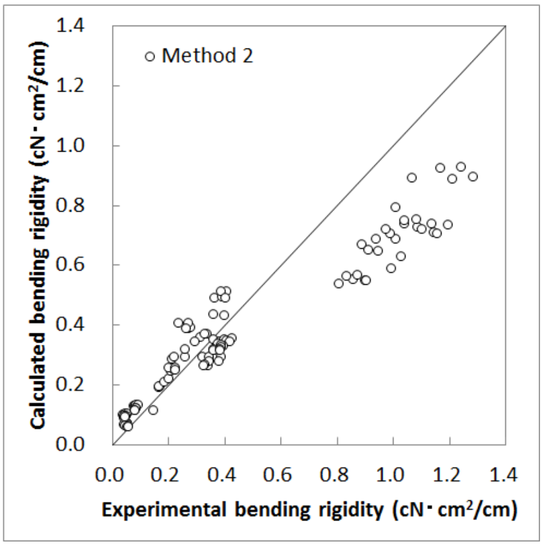


Figure 6 Calculated and experimental bending rigidities of laminated knitted fabrics using *Method* 2

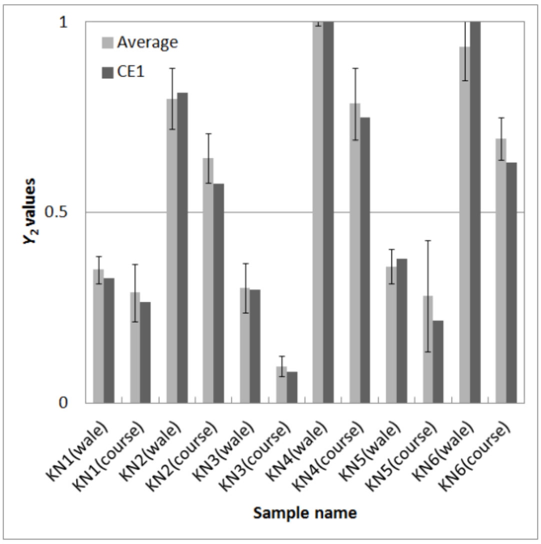


Figure 7 Average Y_2 of knitted fabrics and Y_2 from composites with CE1 interlining.

Method 3

The relative position of neutral axis in bending was taken into account for *Method* 3 in addition to *Method* 2. Y_2 is necessary to predict bending rigidity of laminated knitted fabric using *Method* 3. The average of Y_2 for face fabrics were obtained from composites with different adhesive interlinings as shown in Figure 7. When Y_2 is close to 0, it means that the neutral axis in bending is close to the bottom of a face fabric. On the other hand, when Y_2 is close to 1, it means that the neutral axis in bending is close to the top of a face fabric. When Y_2 is close to 0.5, it means that the neutral axis in bending is close to the centroid. As shown in Figure 7, it was found that Y_2 of the most knitted fabrics do not lie in the centroid.

Y_2 obtained using the data of laminated fabric with CE1 interlining (Figure 7) were arbitrarily selected for calculating bending rigidities of laminated knitted fabric. The calculated and experimental bending rigidities of laminated knitted fabrics by *Method* 3 are shown in Figure 8 with the results by other methods. The MAPEs between calculated and experimental bending rigidity are shown in Table 5. The predicted bending rigidities showed good agreements with experimental ones. Especially, the calculated bending rigidities of laminated knitted fabric with milano rib samples using *Method* 3 showed good agreements with the experimental ones. These results showed that Y_2 for knitted fabric are not in the centroid and must be taken into account to calculate the bending rigidity of laminated fabric with knitted fabrics.

Comparison of three methods

The comparisons of calculated and experimental bending rigidities of laminated knitted fabrics using three methods are shown in Figure 9. Among the predicted bending rigidities using three methods, the results by *Method* 3 showed the closest correlation to the experimental ones as shown in its MAPE, 6.9%.

For all samples, *Method* 2 showed the largest MAPE, over 35%. *Method* 1 also showed relatively large MAPE, over 19%. As mentioned above, especially for the milano rib samples, results by *Method* 1 and 2 showed large MAPEs. It is due to the tensile and in-plane compressive moduli of knitted fabric are significantly different so it is necessary to be considered. According to these results, it became clear that *Method* 1 and 2 are hard to be used to predict bending rigidity of laminated knitted fabrics.

In the case of woven fabric, the calculated results of some face fabric by *Method* 2 showed good agreements with experimental ones [2]. For the samples with large prediction errors by *Method* 2, the calculated results by *Method* 3 showed better agreements with the experimental results than ones by *Method* 2 [3]. However, in the case of knitted fabrics, the calculated results by *Method* 2 still showed large prediction errors for all samples in the results of this study. These results showed that the knitted fabrics are more affected by the position of the neutral axis so the results by *Method* 2 showed large prediction errors. Accordingly, the position of neutral axis for knitted fabric must be considered to calculate the bending rigidity of laminated fabric.

In conclusion, it was found that *Method* 3 is the most suitable method to precisely calculate bending rigidities of laminated fabrics with knitted fabrics.

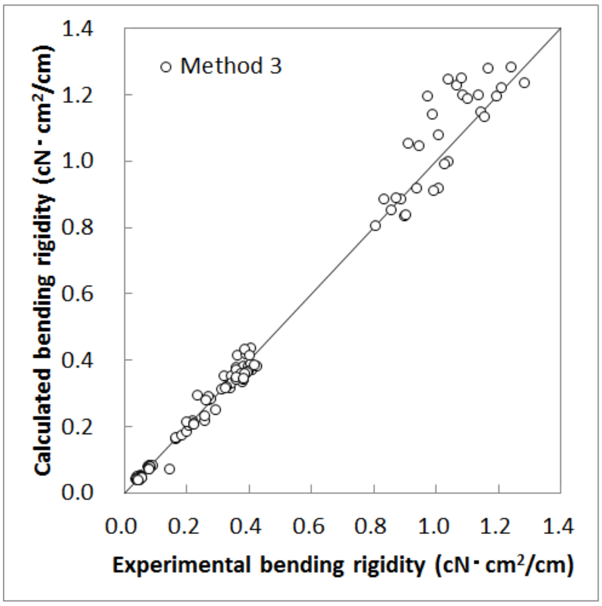


Figure 8 Calculated and experimental bending rigidities of laminated knitted fabrics using *Method* 3

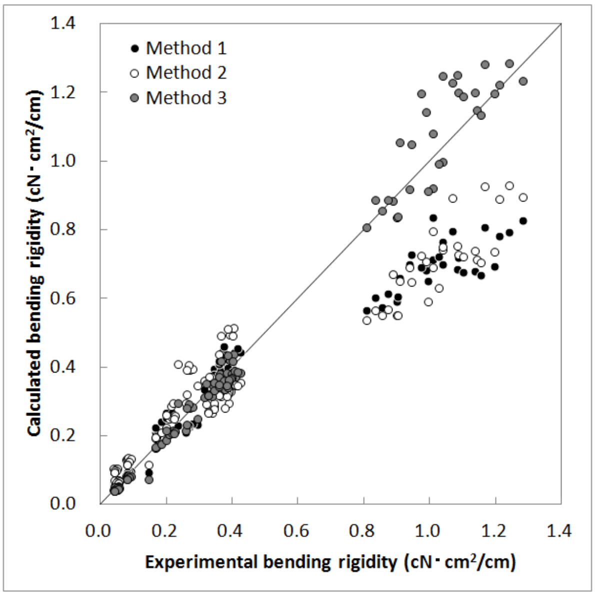


Figure 9 Calculated and experimental bending rigidities of laminated knitted fabrics using three methods.

Table 5 Mean absolute percentage errors (MAPEs) between calculated and experimental bending rigidity

Sample condition \ Method	*Method* 1	*Method* 2	*Method* 3
All laminated knitted fabrics	19.1	35.3	6.9
laminated knitted fabric with KN2, 4 and 6 (Milano rib samples)	31.6	31.0	7.2
laminated knitted fabric with KN1, 3 and 5	15.0	36.7	6.8

Conclusion

Bending rigidities of laminated knitted fabrics with adhesive interlinings were calculated using three prediction methods with mechanical properties of components such as h_1, h_2, B_1, B_2, T_1, T_2 and Y_2. The predicted bending rigidity of laminated knitted fabrics by both *Method* 1 and 2 showed large prediction errors. The predicted results using *Method* 3 in consideration of Y_2 showed the strong correlation with the experimental ones among the predicted ones by the other methods.

Therefore, it was found that the disagreement in the results using *Method* 1 and 2 was due to the position of the neutral axis. With these results, it became clear that Y_2 of a knitted fabric must be taken into account for predicting the bending rigidity of laminated knitted fabric more precisely. A suitable adhesive interlining for a knitted fabric can be selected using *Method* 3. Until now, the selection of adhesive interlining was carried out based on experiments and previous data. If the data concerning adhesive interlinings and face fabrics has been compiled once, the prediction of the performance of laminated fabrics made of different combination will be possible. Designers and manufacturers will be able to reduce the cost and time for selecting a suitable adhesive interlining.

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