Study on Influence of Weft Yarn Count on Mechanical Properties of Plain Silk Fabric

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Abstract

Having many precious characteristics, silk fabric offers comfortable feeling with elegant fashion and is always preferred by the customers. However, silk fabric is easily wrinkleable and fragile with reduced properties when it is used. This article contributes to study the influence of weft yarn count on silk fabric properties such as fabric weight in g/m^2, tensile strength, breaking elongation and tear resistance in both warp and weft directions. The experiments are implemented with silk fabric specimens using 72D warp yarn and different weft yarns of 48D, 72D, 96D, 120D &144D. The research results show that when weft yarn count increases the fabric weight in g/m^2 and the tensile strength as well are increased considerably while the longitudinal tensile strength is slightly decreased, the tear resistance in warp direction is increased while the tear resistance and the breaking elongation in weft direction are unchanged. The research results could be a scientific basis for better selection of weft yarn count to produce silk fabric to meet the quality requirements of the end-use product.

Keywords: physical-mechanical properties, weft yarn count, plain silk fabric

1. Problem statement

Silk is a type of fancy fabric preferred by customers for being more comfortable and fashionable than other natural or synthetic fabric [1], [2], [3]. Howerver, silk fabric tend to be misaligned, and easier to get wrinkles or deterioration during usage; furthermore, there have not been many research on silk mechanical properties [4].

This article aims to study the effect of weft yarn count on some mechanical properties of silk fabric such as weight, tensile strength, tear resistance in both warp and weft directions in order to choose the appropriate weft yarn count for silk product to meet quality demand.

2. Research method and material

2.1. Material

Five commercial plain fabrics from Ha Bao Silk Weaving Co. (Lam Dong Province) with details as given in Table 1 were selected for the present study.

2.2. Experimental method

The experiments are conducted in standard conditions, laboratory temperature 20 ± 2 ^oC, relative humidity 65 ± 4% at the Laboratory Center "Vilas 169" of Ho Chi Minh City Textile and Garment Research Institute. The weight of the fabric in g/m^2 was measured according to ISO 3801-77 standard on Ohaus Digital Scale – US; Tensile strength follows ISO 13934-1-2013 standard on Tensometric Tensile Strength Tester – UK; tear resistance follows ISO 13937-1-2000 standard on Elmatear Tear Resistance Tester – UK and crease recovery angle follows ISO 2313-72 on Crease Recovery Tester Device – UK.

This article used Excel 2010 to draw graphs and calculate experimental results.

Table 1. Structural parameters of the five experimental samples

Sample	Warp count (D)	Weft count (D)	Warp density (yarn/cm)	Weft density (yarn/cm)
1	72	48	51	32
2	72	72	51	32
3	72	96	51	32
4	72	120	51	32
5	72	144	51	32

The graph in Fig. 1 demonstrates the relationship between the fabric weight and the weft count.

3. Results and discussions

3.1. Effect of weft count on silk fabric weight in g/m^2

The measured fabric weight in g/m^2 of five silk fabrics with different weft count are shown in Table 2.

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Table 2. Silk fabric weight in g/m^2

Sample	Weft count (D)	Weight (g/m^2)
1	48	57.3
2	72	66.9
3	96	79.2
4	120	91.5
5	144	96.3

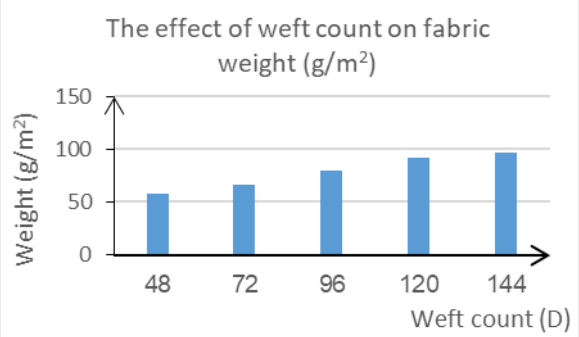

Fig. 1. Effect of weft count on fabric weight in g/m^2

From this graph, we can see that as the weft count increases, the fabric weight also increases. When the weft count rises from 48D to 72D, the fabric weight g/m^2 is raised by 16.8%. When the weft count rises from 72D to 96D, the fabric weight g/m^2 is raised by 18.4 %.

3.2. Effect of weft count on silk fabric tensile strength

The average tensile strength of silk fabric samples in warp (P_{dd}) and weft (P_{dn}) direction are shown in table 3.

Table 3. Silk fabric tensile strength

Weft count (D)	Warp tensile strength P_{dd} (N)	Weft tensile strength P_{dn} (N)
48	662.14	241.93
72	638.42	330.11
96	628.55	395.05
120	605.71	458.34
144	597.46	458.51

The effect of weft count on silk fabric tensile strength is shown on Fig. 2.

When the weft count increases, the horizontal tensile strength rises quickly because the weft yarns become bigger and stronger. The vertical tensile strength falls down a little bit or remains unchanged because there is no change in both warp density and warp count. Actually, when weft count increases from 72D to 96D, weft tensile strength went up by 16.4 % and warp tensile strength went down by 1.5 %.

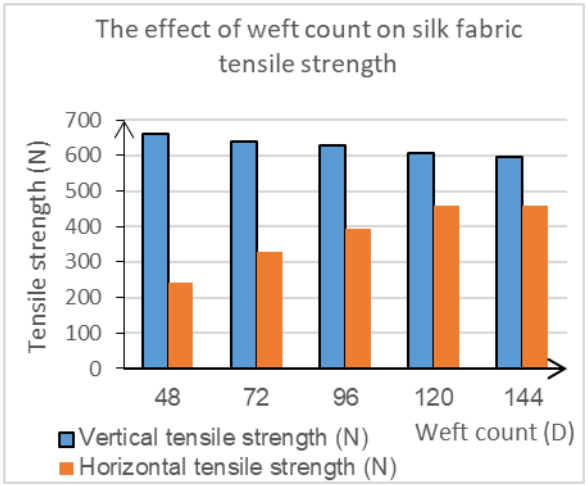

Fig. 2. Effect of weft count on silk fabric tensile strength P_{dd} and P_{dn}

Since weft density is unchanged, as weft count becomes greater, there exist a change in the connection between warp and weft yarn, the bending angle of the warp yarn also becomes larger. If tensile forces are applied in the warp direction, high bending angle will prevent warp yarn from being straightened, therefore reduce warp tensile strength.

3.3. Effect of weft count on silk fabric tear resistance

The resultant warp (P_{xd}) and weft (P_{xn}) tear resistance of silk fabric is shown in Table 4.

Table 4. Silk fabric tear resistance

Weft count (D)	Weft yarn tear strength P_{xd} (N)	Warp yarn tear strength P_{xn} (N)
48	17.81	18.51
72	18.52	18.17
96	19.78	18.17
120	22.12	18.45
144	23.45	18.85

The effect of weft count on silk fabric tear resistance is shown on Fig. 3.

The fabric tear resistance in warp direction P_{xd} increases along with weft count since weft yarns get stronger even though weft density remains the same as weft count increases. On the other hand, when we tear fabric in the weft direction, only warp yarns hold the fabric together, which means that its tear resistance in weft direction P_{xn} is negligibly changed due to little change in both warp density and warp count. From that, we can conclude that weft count affects mainly the tear resistance in warp direction and hardly influences the tear resistance in weft direction due to the fact that weft yarn tear strength is used when the forces are applied in the warp direction and vice versa.

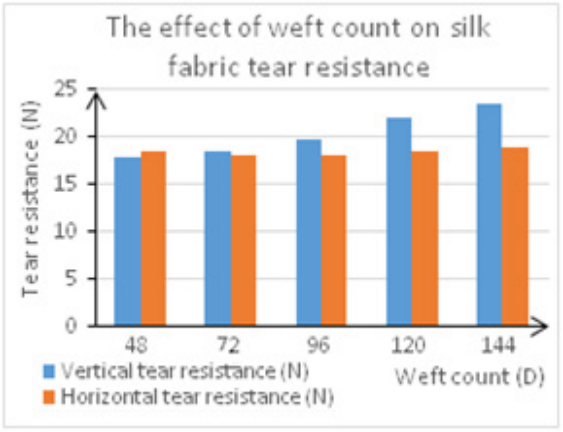

Fig. 3. Effect of weft count on fabric tear resistance in warp and weft direction P_{xd}, P_{xn}

For example, when the weft count went up from 72D to 96D, tear resistance in warp direction roses by 6.4 % while tear resistance in weft direction is almost unchanged because warp count and warp density remain the same and weft count change creates only small change in weft yarn connection over warp yarn.

3.4. Effect of weft count on silk fabric elongation

The measured elongations of silk fabric in warp (ε_d) and weft (ε_n) directions according to the increased weft count are shown in Table 5.

Table 5. Silk fabric elongations

Weft count (D)	Warp elongation ε_d (%)	Weft elongation ε_n (%)
48	29.10	21.50
72	30.12	19.20
96	31.67	19.71
120	30.60	19.10
144	29.90	19.10

The effect of weft count on silk fabric elongation is shown on Fig. 4.

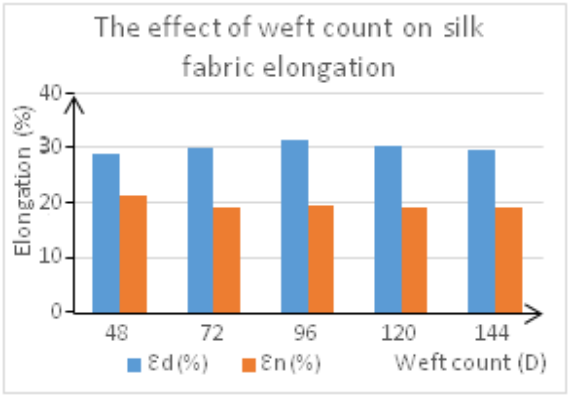

Fig. 4. Effect of weft count on silk fabric elongation in warp and weft direction ε_d, ε_n

The fabric elongation is virtually independent of the weft count both in warp and weft direction.

3.5. Effect of weft count on silk fabric crease recovery angle

The results of measured crease recovery angle of silk fabric on warp yarn (P_d, T_d) and weft yarn (P_n, T_n) in both left and right direction are demonstrated in Table 6.

Table 6. Fabric crease recovery angle

Weft count (D)	P_d (^{0})	T_d (^{0})	P_n (^{0})	T_n (^{0})
48	83	125	88	128
72	128	137	125	148
96	142	154	147	155
120	148	156	152	157
144	153	155	149	156

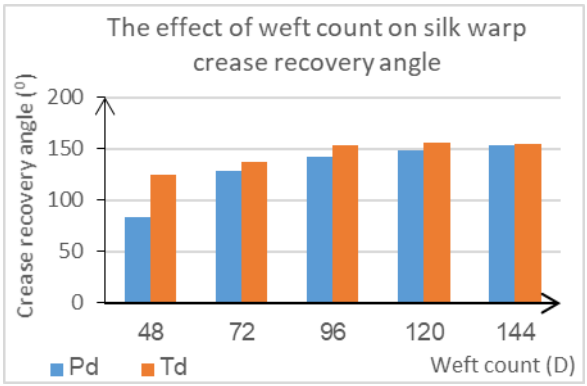

Fig. 5a. Effect of weft count on silk warp crease recovery angle

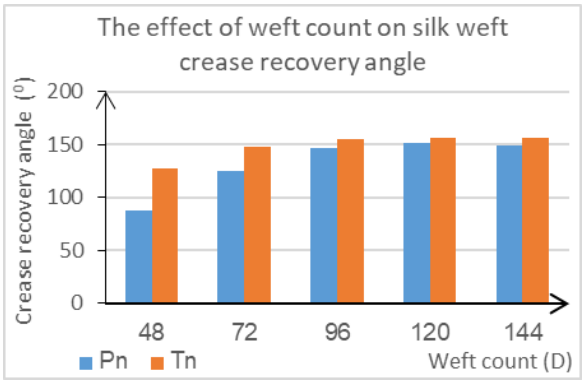

Fig. 5b. The effect of weft count on silk weft crease recovery angle

The effect of weft count on silk warp crease recovery angle is visualized in Fig. 5a.

As the weft count increased from 48D to 72D, the fabric right warp crease recovery angle roses by 54.2 %, and left warp angle by 9.6 %. However, as weft count went from 72D to 96D, crease recovery

angle is only increased by 10.9 % on the right side, and if we continue to increase the weft count from 96D to 144D, then crease recovery angle remains basically the same.

The effect of weft count on silk weft crease recovery angle is visualized in Fig. 5b.

As the weft count is increased from 48D to 72D, the fabric right weft crease recovery angle rose by 42%, and left angle by 15.6%. However, as weft count went from 72D to 96D, crease recovery angle is only increased by 17.6 % on the right side, and if we continue to increase the weft count from 96D to 144D, then the crease recovery angle remains basically the same.

4. Conclusions

- Our research suggests that altering weft count can cause multiple changes to fabric mechanical properties,
- Silk with higher weft count is thicker and heavier, but have linearly proportional weft tensile strength and warp tear resistance. Its warp tensile strength as well as weft tear resistance are rarely affected by this factor,
- As weft count increase, crease recovery angle of the fabric rises quickly at first, but halt afterward,
- These results provide the scientific basis to select the appropriate weft count for silk to meet product requirements.

Acknowledgments

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