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Research on Pattern Structure Optimization of Trousers Back Pants Piece Based on Ergonomics

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ABSTRACT

As modern garment design continuously raises requirements for comfort and aesthetics, structural design plays an increasingly important role in enhancing the wearing experience of garments. This paper takes women's trousers as the research object, focusing on the optimization design of the back pants piece pattern structure, aiming to improve the pulling sensation during dynamic movements such as squatting, leg lifting, and bending, thereby enhancing wearing comfort and freedom of movement. Based on the difference between the body's hip circumference (H) and waist circumference (W), the paper systematically analyzes the design methods for key structural parameters of the back pants piece, including: waist rise amount, back crotch seam inset, crotch line position, blocking and stretching section treatment, and dart adjustment. Combined with a specific size (170/94A) for example calculation and analysis, the influence mechanism of each parameter on the amount of activity is verified. Research indicates that by reasonably setting parameters such as the rise amount as (H −W)/5, the inset amount as (H −W)/6, and the crotch line distance as 8cm+(1.2H/100)cm, the activity allowance above the hip line can be effectively increased, significantly alleviating the binding sensation during dynamic movements.

Furthermore, this paper also explores the application of blocking and stretching techniques in the back pants piece. Through the coordinated processing of stretching and gathering, the pants piece conforms better to the curves of the human body, balancing aesthetics and function. The research results provide a theoretical basis and practical reference for the structural design of functional women's wear.

KEY WORDS: ack Pants Piece; Pattern Structure; Blocking and Stretching Technique; Mobility Comfort; Ergonomics

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1. Introduction

Structural design is an important part of garment design and also an extension and deepening of garment styling design [1]. Scientific and reasonable structural design can not only make the relationship between various parts of the garment more coordinated but also enhance the overall aesthetic appeal and wearing comfort of the garment. Especially in the design of professional women's wear, the quality of structural design directly affects the unity of functionality and aesthetic value of the garment. Therefore, designers need to conduct in-depth research based on mastering professional theoretical knowledge and combining it with actual wearing needs.

As an important part of suit culture, trousers have evolved over time and are no longer limited to the field of menswear. They have gradually become a common style in modern women's professional attire, reflecting women's independence and confidence. The structural design of trousers has its specific norms, usually consisting of a front pants piece, a back pants piece, and a waistband sewn together. However, in existing technology, when people perform actions such as leg lifting, bending, or squatting, the back waist area of the trousers often experiences significant pulling, leading to inconvenient movement and discomfort, affecting the overall wearing experience.

Addressing the above issues, this paper focuses on the structural optimization of the back pants piece of trousers. By adjusting key parameters such as the rise amount, inset, crotch line position, blocking and stretching techniques, and dart settings, it explores effective ways to improve the mobility comfort of trousers. The research results aim to provide a theoretical basis and practical reference for the structural design of functional women's wear, promoting a better balance between aesthetics and comfort in garment design.

2. Structural Analysis of the Trousers Back Pants Piece

The back pants piece of trousers is composed of the main body of the pants piece, and its structural design directly affects wearing comfort and freedom of movement. The main body of the pants piece mainly includes key parts such as the hip line, waist opening, back crotch seam, and crotch line. The parameter settings for each part need to comprehensively consider ergonomics and wearing needs.

2.1 Overview of the Pants Piece Pattern

The main body of the pants piece includes the hip line and the first part above the hip line. The waist opening of the first part has a first end connected to the front pants piece, and a second end facing away from the first end. From the first end towards the second end, the line connecting the first end and the second end gradually rises relative to the hip line, and the rise amount at the second end is (H − W)/5. Here, H is the body's hip circumference, and W is the body's waist circumference.

The main body of the pants piece also includes a back crotch seam. From the hip line towards the waist opening, the back crotch seam gradually insets towards the first end. The back crotch seam has a first position at a vertical distance of 15cm from the hip line, and the inset amount at this first position is (H − W)/6.

The main body of the pants piece also includes a crotch line, which is located below the hip line, and the distance between the crotch line and the hip line is 8cm+(1.2H/100)cm.

The main body of the pants piece also includes a blocking and stretching section below the crotch line. One side of the blocking and stretching section is the inner side seam edge located on the inner side of the human leg [2]. The position of the blocking and stretching section close to the inner side seam edge is stretched, and the position of the blocking and stretching section located at the back of the human leg is gathered. The blocking and stretching section is the part of the pants piece between the crotch line and a point 23.5cm ± 1.4cm below the crotch line. The stretching amount at the position close to the inner side seam edge in the blocking and stretching section is 1.2H/200; the gathering amount at the position located at the back of the human leg in the blocking and stretching section is 1.2H/200.

Darts are set at the waist opening. The darts are adjusted by stretching to both sides, and the adjustment amount to both sides is (W/400)+(S/70). Here, S is the dart amount. The back pants piece of the trousers also includes a back waistband sewn to the waist opening of the first part. The rise amount of the end of the back waistband sewn to the second end is (H − W)/50+(S/L)+1.6. Here, L is the dart length.

2.2 Beneficial Effects Brought by the Trousers Back Pants Piece and the Trousers

First, the rise amount of the second end is (H − W)/5, which increases the distance from the hip line to the back waist opening, providing the first part of the pants piece main body with distance to move when pulled by human activities.

Second, the rise amount allows the first part to be pulled and move when the human body performs actions like leg lifting, bending, or squatting, avoiding the pulling sensation in the back waist of traditional trousers and solving the technical problems of inconvenient movement and uncomfortable wearing.

Third, the rise amount is proportional to the difference between the body's hip circumference and waist circumference. The larger the hip-waist difference, the stronger the pulling sensation. Using a larger rise amount can increase the movement distance, effectively avoiding the pulling sensation during movement.

3. Structural Analysis of the Trousers Pattern

3.1 Structural Diagram of the Back Pants Piece

The structure of the trousers back pants piece is shown in Figure 1 and Figure 2. The numbering descriptions of related parts are shown in Table 1. The body surface angles of young women have important reference value for trousers pattern structure design [3].

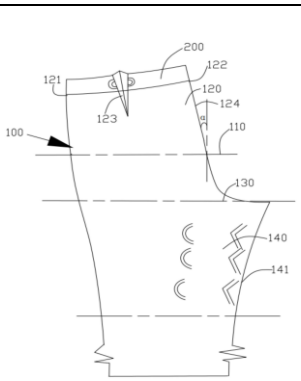

Figure 1: Structural diagram of trousers back pants piece

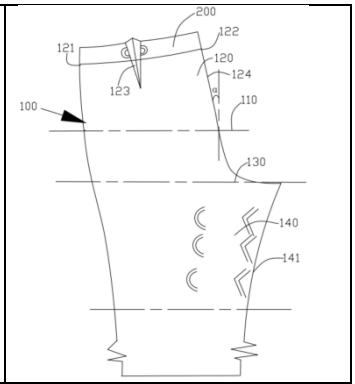

Figure 2: Exploded view of trousers back pants piece

3.2 Description of Structural Parameters of the Back Pants Piece

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The main body of the pants piece (100) includes a hip line (110) and a first part (120) above the hip line. The waist opening of the first part (120) is provided with a first end (121) connected to the front pants piece and a second end (122) facing away from the first end. From the first end (121) towards the second end (122), the waistline gradually rises relative to the hip line (110). The rise amount at the second end (122) is (H − W)/5, where H is the body's hip circumference and W is the body's waist circumference.

The main body of the pants piece (100) also includes a back crotch seam (124). From the hip line (110) towards the waist opening, the back crotch seam (124) gradually insets towards the first end (121). The degree of inset is called the "inset". The point on the back crotch seam (124) at a vertical distance of 15cm from the hip line (110) is the first position (125), and its inset amount is (H − W)/6.

The main body of the pants piece (100) also includes a crotch line (130), located below the hip line (110), and the distance between them is 8cm+(1.2H/100)cm. This distance is proportional to the body's hip circumference. The larger the hip circumference, the lower the crotch line is relatively positioned, providing more activity space for the hip and waist area.

The main body of the pants piece (100) is provided with a blocking and stretching section (140) below the crotch line (130), corresponding to the lower part of the human buttocks and the upper part of the thigh. One side of the blocking and stretching section (140) is the inner side seam edge (141). The position close to the inner side seam edge (141) is stretched, and the position located at the back of the human leg is gathered. The blocking and stretching section (140) is the part of the pants piece between the crotch line (130) and a point 23.5cm ± 1.4cm below the crotch line. The stretching amount at the position close to the inner side seam edge (141) in the blocking and stretching section (140) is 1.2H/200, and the gathering amount at the position located at the back of the human leg is 1.2H/200.

Darts (123) are set at the waist opening of the first part (120). The darts are adjusted by stretching to both sides, and the adjustment amount to both sides is (W/400)+(S/70), where S is the dart amount.

The back pants piece of the trousers also includes a back waistband (200) sewn to the waist opening of the first part (120). The rise amount of the end of the back waistband sewn to the second end (122) is (H − W)/50+(S/L)+1.6, where L is the dart length.

Table 1: Description of part numbers in the diagram

Number	Part Name	Number	Part Name
100	Main body of pants piece	125	First position
110	Hip line	130	Crotch line
120	First part	140	Blocking and stretching section
121	First end	141	Inner side seam edge
122	Second end	200	Back waistband
123	Dart		
124	Back crotch seam		

3.3 Relationship between Structural Parameters and Human Body Activities

Based on the structures shown in Figure 1 and Figure 2, the key parameters of the trousers back pants piece are set as follows:

The main body of the pants piece (100) includes a hip line (110) and a first part (120) above the hip line. The waist opening of the first part (120) is provided with a first end (121) connected to the front pants piece and a second end (122) facing away from the first end. From the first end (121) towards the second end (122), the waistline gradually rises relative to the hip line (110). The rise amount at the second end (122) is (H − W)/5, where H is the body's hip circumference and W is the body's waist circumference.

The main body of the pants piece (100) also includes a back crotch seam (124). From the hip line (110) towards the waist opening, the back crotch seam (124) gradually insets towards the first end (121). The degree of inset is called the "inset". The point on the back crotch seam (124) at a vertical distance of 15cm from the hip line (110) is the first position (125), and its inset amount is (H − W)/6.

The main body of the pants piece (100) also includes a crotch line (130), located below the hip line (110), and the distance between them is 8cm+(1.2H/100)cm. This distance is proportional to the body's hip circumference. The larger the hip circumference, the lower the crotch line is relatively positioned, providing more activity space for the hip and waist area.

The main body of the pants piece (100) is provided with a blocking and stretching section (140) below the crotch line (130), corresponding to the lower part of the human buttocks and the upper part of the thigh. One side of the blocking and stretching section (140) is the inner side seam edge (141). The position close to the inner side seam edge (141) is stretched, and the position located at the back of the human leg is gathered. The blocking and stretching section (140) is the part of the pants piece between the crotch line (130) and a point 23.5cm ± 1.4cm below the crotch line. The stretching amount at the position close to the inner side seam edge (141) in the blocking and stretching section (140) is 1.2H/200, and the gathering amount at the position located at the back of the human leg is 1.2H/200.

Darts (123) are set at the waist opening of the first part (120). The darts are adjusted by stretching to both sides, and the adjustment amount to both sides is (W/400)+(S/70), where S is the dart amount.

The back pants piece of the trousers also includes a back waistband (200) sewn to the waist opening of the first part (120). The rise amount of the end of the back waistband sewn to the second end (122) is (H − W)/50+(S/L)+1.6, where L is the dart length.

The setting of the above structural parameters is based on ergonomic principles: the rise amount increases the distance from the hip line to the back waist opening, providing stretch allowance for movements such as squatting and bending; the inset works synergistically with the rise amount to jointly increase the activity space; the crotch line moves down as the hip circumference increases, avoiding crotch constraint; the blocking and stretching section makes the pants piece fit the body curve better; the dart adjustment and the back waistband

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rise amount help disperse stress on the waist opening, ensuring comfortable wearing.

4. Optimizing the Pattern to Enhance Stretching Activity

4.1 How to Handle the Pulling Sensation during Activities

As shown in Figure 1, the back crotch seam (124) gradually insets from the hip line (110) towards the waist opening. The degree of inset is measured by the inset. The inset is proportional to the rise amount, and the rise amount is proportional to the hip-waist difference, therefore the inset is also proportional to the hip-waist difference. The larger the hip-waist difference, the greater the rise amount and inset, and the larger the movement distance of the first part, effectively avoiding the pulling sensation during leg activities.

Taking the standard female body of size 170/94A as an example, with a hip circumference (H) of 100cm and a waist circumference (W) of 78cm, the rise amount at the second end (122) is (100-78)/5 = 4.4cm. Under this structure, the first part (120) has a movable distance when pulled by human activities, avoiding pulling sensation during actions like squatting, leg lifting, and bending.

The hip line (110) is the horizontal line on the main body of the pants piece corresponding to the maximum circumference of the human buttocks. The back crotch seam (124) gradually insets from the hip line towards the waist opening. The degree of inset is measured by the inset. The inset is proportional to the rise amount, and the rise amount is proportional to the hip-waist difference, therefore the inset is also proportional to the hip-waist difference. The larger the hip-waist difference, the greater the rise amount and inset, and the larger the movement distance of the first part, effectively avoiding the pulling sensation during leg activities.

4.2 Relationship between Back Crotch Seam and Hip Line

The point on the back crotch seam (124) at a vertical distance of 15cm from the hip line (110) is the first position (125), and its inset amount is (H − W)/6. Taking the 170/94A body type as an example, the inset amount is (100-78)/6 ≈ 3.7cm, and the tangent value of the inset is 3.7/15. At this time, the rise amount is 4.4cm. Tests show that the movable distance of the first part is 1cm, effectively alleviating the pulling sensation during movement.

4.3 Relationship between Crotch Line and Hip Line

The crotch line (130) is located below the hip line (110), and the distance between them is 8cm+(1.2H/100)cm, which is proportional to the hip circumference. Taking the 170/94A body type as an example, the distance is 8cm + (1.2×100/100)cm = 9.2cm. The downward shift of the crotch line provides more activity space for the upper part. Tests show that the movable distance between the hip line and the crotch line is 1.2cm. The first part has a movement distance of 1cm, resulting in a total activity amount of 2.2cm, significantly improving movement flexibility.

The blocking and stretching section (140) is set below the crotch line (130), corresponding to the lower part of the buttocks and the upper part of the thigh. The position of the blocking and stretching section close to the inner side seam edge (141) is stretched, and the position at the back of the human leg is gathered. The stretching amount and the gathering amount are both 1.2H/200, ensuring that the inner and outer side seams can be sewn together normally.

Taking the 170/94A body type as an example, both the stretching amount and the gathering amount are 1.2×100/200 = 0.6cm. The stretching amount and gathering amount are proportional to the hip circumference. The larger the hip circumference, the greater the stretching and gathering amounts, making the pants piece fit the body better, avoiding excess fabric, and enhancing the aesthetic appearance.

4.4 Relationship between Waist Opening and Darts

Darts (123) are set at the waist opening of the first part (120) and are adjusted to both sides. The adjustment amount is (W/400)+(S/70). The adjustment amount is proportional to the waist circumference. The larger the waist circumference, the greater the adjustment amount, providing allowance at the back waist opening and avoiding tightness and discomfort.

Taking the 170/94A body type as an example, with a waist circumference of 78cm and a dart amount of 3.0cm, the adjustment amount on each side is (78/400) + (3/70) ≈ 0.24cm, resulting in a total adjustment amount of 0.48cm.

The back waistband (200) is sewn to the waist opening of the first part. The rise amount of the end sewn to the second end (122) is (H − W)/50+(S/L)+1.6. Taking the 170/94A body type as an example, with a dart length of 12cm, the rise amount of the back waistband is (100-78)/50 + (3/12) + 1.6 ≈ 2.3cm. A reasonable back waistband rise amount allows the stress on the waist opening to be dispersed during movement. The part above the hip line shares the stretching force together. After squatting and standing up, the waist opening quickly recovers, does not bind the waist, and provides comfortable wearing.

4.5 Analysis of Optimization Effects

Through the optimization design of the above structural parameters, the mobility comfort of the trousers back pants piece has been significantly improved.

In terms of activity allowance, taking the 170/94A body type as an example, the rise amount of 4.4cm in the first part provides 1cm of movement distance, and the upward shift of the crotch line by 9.2cm provides 1.2cm of movement distance, resulting in a total activity amount of 2.2cm. This allowance effectively alleviates the pulling sensation in the back waist area during movements such as squatting, leg lifting, and bending, allowing the wearer to move more freely.

In terms of fit, the blocking and stretching section, through the coordinated processing of stretching and gathering, with both stretching and gathering amounts being 0.6cm, makes the pants piece fit the curves of the back of the thigh and buttocks better, avoiding excess fabric during movement, which not only enhances the aesthetic appearance but also reduces discomfort caused by fabric friction.

In terms of waist opening stress distribution, the back waistband rise amount of 2.3cm ensures more uniform stress on the waist opening during movement. The part above the hip line shares the stretching force together. After squatting and standing up, the waist opening can quickly return to its original position, avoiding a binding sensation and maintaining comfort even after long periods of wear.

In summary, the optimization scheme proposed in this paper, while maintaining the original style and silhouette of the trousers, effectively improves the mobility comfort of wearing by scientifically adjusting key structural parameters, achieving a unity of aesthetics and function.

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5. Conclusion and Outlook

5.1 Research Summary

This paper focuses on the optimization design of the trousers back pants piece pattern structure. Through theoretical analysis and example verification, the following results have been achieved:

The setting of the rise amount (H − W)/5 increases the distance from the hip line to the back waist opening, providing necessary stretching space for movements such as squatting and bending, effectively alleviating the pulling sensation during dynamic movements. The inset works synergistically with the rise amount. The back crotch seam inset amount (H − W)/6 ensures that the inset increases with the increase in hip-waist difference, meeting the activity needs of different body types.

The distance between the crotch line and the hip line, 8cm+(1.2H/100)cm, shifts downward as the hip circumference increases, providing more activity space for the buttocks and avoiding crotch constraint. The blocking and stretching technique makes the pants piece fit the curve of the back of the thigh better, with equal stretching and gathering amounts (1.2H/200), balancing aesthetics and function [2].

The dart adjustment amount (W/400)+(S/70) provides allowance at the waist opening. The back waistband rise amount (H − W)/50+(S/L)+1.6 ensures quick recovery of the waist opening after movement, providing comfortable wearing.

5.2 Research Outlook

Future research can be extended to the field of multi-body type adaptation, exploring parameter adjustment models for body types with larger or smaller hip-waist differences [3]. 3D motion capture systems could be introduced for dynamic wearing experimental verification, providing more accurate data support for structural optimization. Combining CAD pattern-making software and artificial intelligence algorithms, the automated optimization path of structural parameters can be explored to improve design efficiency. At the same time, fabric factors should be considered to achieve an integrated optimization of "fabric --- structure --- function".

Functional clothing design requires designers, on the premise of solid professional knowledge, to deeply integrate ergonomic principles with wearing needs, and continuously promote industry innovation and development.

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