The Construction Principle of Double Cloth

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Abstract

The aim of this project discussed in this paper was to produce such a type of woven cloth that can give a good appearance and hand feel with enhanced thermal resistance property. The construction of double cloth is completely useful as the development of thermal insulation value of a fabric where a fine, smart face appearance is essential. Double weaves are categorized by harness floats in paired or greater combinations on a face and altered paired or greater float combinations on the back. The sets of floats are conserved as a dissimilar single fabric by warp yarns that are alternating at lengthy intervals in between front and back of the cloth. Double cloth is aesthetic in intension for that purpose the existence of two series of threads in every way develops the capacity for creating complicated properties depending upon both color and structural variations. Double Cloth is made by using two or more warp yarns with one or more weft. This fabric does not have any right or wrong side, as they are made with one set of warp yarns and two weft yarns. This cloth is also known as Double faced fabrics. In a double weave, a fabric should contain two detectible weave structures, which are connected to one another in some way after removing the fabric from the loom. Alternatively, in block double weave, the two cloths are connected where they change faces to form pattern generally in one color against background habitually in another color.

Introduction

There is a great importance of this project in woven textile, which can be utilized while making a two layered cloth namely double cloth in which two or more sets of warps and one or more sets of wefts are interconnected to make a two-layered cloth [1]. The movement of threads in between the layers allows complex patterns and surface textures. In modern textile manufacturing, double cloth is occasionally restricted to fabrics where two warps and three wefts are made up as two distinct fabrics which is joined by the third or binding weft [2]. This difference is not always made in double-woven fabrics where two warps and two wefts interface to shape geometric pattern that is also called double cloths. Double cloth is also called doubled faced fabric as it does not have any right side or wrong side. It includes the blankets, satin ribbons, and interlinings. Modern uses of this double cloth are haute couture coats, furnishing fabrics, and some brocades. In the lampas double weave structure, the two weaves are joined by the weft of the subordinate weave that passes either above or below the key weave to generate pattern vs background. In stitched double cloth, the two weave structures are joined where particular warp threads of one of them weave with the weft of the other [3]. The modest signs of double cloth utilize both a point diagram and the weft cross section diagram to demonstration alternations in between top and bottom.

In these diagrams, the warp yarns may be signified by each end to allow easy visualizations. Numerous recurrences of each end weaving pattern join to allow the double face of a fabric. A subtype of these double weaves is velvets, which are designed with a travelling binder warp that is cut after weaving to form a pile on the surface of either fabric base.

Literature review

The weaving of double cloth is an antique practice that we are inherently doing through antecedent. The historical background of double weaving has been found dating back as from early 700AD. William Morris, the craftsman and designer was well known for using double cloth in his intricate pieces of fabric. That time, those were customarily made up with silk and wool with heavily patterned [2]. These were fashioned in the late 19th century. Double cloth can be made up with wool, silk, cotton, viscose or polyester that depends upon the end use. Double cloth had separate warps of wool and silk yarn and were woven by Alexander Morton & Co. of Darvel, Scotland, who would later weave similar fabrics from designs by C.F.A. Voysey and others. Further thoughts in double weaves contain whether shuttle or shuttle less weaving methods are applied and whether immediate weft insertions in top and bottom sheds occur. If shuttle weaving is employed, a nonstop loop of weft yarn is injected crosswise the width of the fabric. This method authority the weaving of an unbroken, sealed tubular fabric. Technical uses of this fabric type comprise vascular grafts and spacesuit joints. In the latter role, a double weave tubular fabric was established at Georgia Tech in the 1970s and 1980s by Dr. Howard Olson for elbow and knee joints as the first solution to avoid vascular devastation of astronauts’ arms and legs through bending motions [4].

Construction principle of double cloth

Actually, double cloths are the fabrics, which contains two layers of yarns those are woven one above the other and stitched
together. Double cloths have at least two series of warp yarns, and two series of weft yarns, namely face and back. Double cloths fabrics are popularly known as two ply fabrics. The upper layer is formed by interlacing the face warp yarns with the face weft yarns, and the lower layer is formed by interlacing the back warp yarns with the back weft yarns. The two layers may be only loosely connected together in which case, each may be readily identified as a different entity or they may be so intricately stitched or tied together that they appear to form a complex single structure [5].

Mainly, there are two goals to make double cloths

i. To improve the thermal resistance value of the fabric, and
ii. To increase good appearance and hand feel (Figure 1)

**Figure 1**: A figure of double weave fabric.

**Characteristics of double cloths:**

i. At least two layers of yarns are contained

ii. Double cloths have at least two series of warp yarns, and two series of weft yarns

iii. Double cloths fabrics are popularly known as two ply fabrics

iv. The upper layer is formed by interlacing the face warp yarns with the face weft yarns, and the lower layer is formed by interlacing the back warp yarns with the back weft yarns.

v. These fabrics have a good thermal resistance property (Figure 2)

**Figure 2**: Double weave fabric of different colored yarns.

**Construction principle:** Two series of warp and weft threads are engaged primarily in producing its own layer of cloth, thus forming separate face cloth and separate back cloth [6]. After that, these two layers are connected together by stitching and thus appear to form a complex single structure. Here in this cloth, there are two series of warp threads [4], from them, one set is called face warp and the other set is called back warp. By the same way, there are two series of weft, from them, one set is called face weft and the other set is called back weft (Figure 3).

**Figure 3**: Double weave fabric with two colored yarns

**Types of double cloth**

- **Self-stitched double cloth**
- **Center stitched double cloth**
- **Double cloth stitched by thread interchange**
- **Double cloth stitched by cloth interchange**
- **Alternate single ply and double ply construction**

**Self-stitched double cloth:** This double cloth is constructed on the principle of self-thread stitching. Here, in these cloths, the face fabric is formed by the interlacement of the face warp and face weft threads and the back fabric are formed by the interlacement of the back warp and back weft threads. The two fabric layers are stitched together at intermediate points by either face/back warp or face/back weft or both. A distinctive structure with various possible techniques are drawn below [7].

**Characteristics of Self stitched double cloth**

i. These fabrics contain only two sets of warp and two sets of weft yarns

ii. The stitched in between face and back cloth is done by their own threads, where no extra threads are required

iii. The face fabric is formed by the interlacement of the face warp and face weft threads and the back fabric is formed by the interlacement of the back warp and back weft threads

iv. The two fabric layers are stitched together at intermediate points by either face/back warp or face/back weft or both
The stitching is done from the three ways like face warp passes under back weft, back warp passes over face weft or by the combination of both (Figure 4).

Figure 4: Self stitched double cloth.

Center stitched double cloth: These double cloths are constructed on the principle of center thread stitching. In these cloths, besides a face and back series of threads, there is a third series of threads those are introduced as stitching threads at different intervals [8]. The stitching can be done in warp way, weft way or in both the way. Basically, stitching threads stay in between the face layers and the back layers of the cloth and are visible on the face or back at the stitching points.

Characteristics of center stitched double cloth
i. A third series of thread is used as stitching threads, besides having two series of threads namely warp and weft
ii. The separate set of yarn or the third set of yarn that stays in middle position of fabric is known as stitching yarn
iii. Stitching threads are used at different intervals of cloths
iv. Stitching can be done either in warp way, or in weft way, otherwise in both the way
v. Stitching threads keep on, in between the face layers and the back layers of the cloth and are visible on the face or back at the stitching points

Figure 5: Center Stitched double cloth.

Double cloth stitched by thread interchange: It is constructed on the principle of stitching by thread interchange. This fabric is similar to the self stitched double cloths as the stitching is done by means of either the face or the back threads themselves. Basically, the dissimilarity lies in the fact that, a group of face threads interlace or stitch with another group of back threads at regular intervals [9]. An example is given below.

Characteristics of Double cloth stitched by thread interchange
i. Third stitching threads are not required
ii. Stitching is done be the interchange of threads
iii. Sometimes, one thread acts as face thread and sometimes, one thread acts as back thread. For this, in the fabric parts, face warp becomes interlacement back weft and in some portion, back warp becomes interlacement of face weft
iv. This process goes on continuously and stitching is done in the point of interchange position of threads (Figure 6)

Figure 6: Double cloth stitched by thread interchange.

Double cloth stitched by cloth interchange: This cloth is constructed on the principle of cloth interchange. In this cloths, the cloth layers change places at intervals [10-12]. The firmness of this type of structural cloth depends on the frequency of the exchange of the face and back layers of the cloth.

Characteristics of Double cloth stitched by cloth interchange
i. Stitching is done by the interchange of face cloth and back cloth
ii. Threads sometimes acts as a face warp and face weft
iii. This process carries on continuously and the extent of stiffness of fabric depends on the occurrence of the cloth interchange, that is the number of stitching point
iv. Stitching is done in the cloth interchange point (Figure 7)

Figure 7: Double cloth stitched by cloth interchange.

Alternate single ply and double ply construction: It is constructed on the principle of alternation as single ply and double ply construction [13]. In these cloths, the group of threads are forming the face are merged together with those of the back to form a single layer at intervals. The face layer is separated from the back, wherever a figure is formed. An example is given below [9].

Characteristics of alternate single ply and double ply construction
i. In such fabric, single ply cloth is formed by stitching of two ply in some areas, and open double cloth like pocket is formed due to the absence of stitching of two plies in some areas of fabric
ii. The group of threads are forming the face are merged together with those of the back to form a single layer at intervals
iii. In this way, some single ply and some double ply forms special type of double cloth
iv. The face layer is separated from the back (Figure 8)

The Figure 9 below shows double cloths that is produced without using any stitching threads. These cloths become single cloths after removing it from the loom [14]. In this Figure 9, there is shown a double width cloth and there is shown a tubular.

Figure 9: Double cloths without stitching threads.

Points to be considered before going to a construction of a cloth

i. Relative proportions and thickness of the face and back threads
ii. Selection of the face and back weaves
iii. Tying or stitching
   a. Stitching form face to back
   b. Stitching form back to face
   c. Combination stitching
   d. Stitching with an extra warp
e. Stitching with an extra weft
iv. The construction of the point paper design
v. The beaming drafting, the construction of the pegging or lifting plans, cross section and longitudinal section

The selection of suitable stitching positions: In double fabrics, the stitches join the two fabrics together, if correctly placed, have no effect on the appearance of either the face of the underside of the cloth [15,16]. If a warp satin or a warp faced twill weave is employed for the face fabric, tying by lifting the back warp is only suitable. For weft sateen or a weft faced twill weave, it is better to tie by dropping the face ends. Back warp is less liable to show on the face than the back weft, which in the later system is pulled upwards [17]. For perfect arrangement of the tie, the following four conditions are must:

i. The back ends must be at that point away from the underside of the back cloth
ii. It must surface in between two long warp floats of the face weave
iii. The face picks on which, the back end is raised, must be absent from the surface of the face cloth
iv. It must be only pulled down in a point at which, it’s penetration into the back cloth level is covered by two adjacent weft floats on the underside of the back fabric

In some cases, it is not possible to get the simultaneous coincidence of all the four conditions.

At the same way, if the face ends are lowered for stitching under the back picks:

i. The face end at that point must be absent from the surface of the face cloth
ii. It must be lowered in a point at which, two long back warp floats cover it on the underside of the back cloth
iii. The back pick at the tie point, must be away from the underside of the back cloth
iv. It must penetrate towards the surface in a point at which, it will be covered by two adjacent face weft floats on the surface of the face cloth

Self-stitched double cloth: In a self-stitched double cloth fabric, one series of warp end and weft pick interlace to form the face fabric and the other series of warp end and weft pick interlace to form the back fabric [13]. The face and back threads are supposed to be prearranged in an appropriate order, which depends on the fabric to be woven. Usually, different weaves are selected for the face and back fabrics. From time to time, the weaves are similar [18]. By the interlacement of the corresponding face threads the face fabric is formed and also the back fabric is. Self-stitched double cloths are manufactured on the bellow mentioned principles:

i. Stitching from face to back: the face thread is lowered below the back thread
ii. Stitching from back to face: the back thread is raised above the face warp thread

The below mentioned Figure 10 & 11 shows the creation of self-stitched double cloth and the methods of stitching. Figure shows the stitching together of the two layers of the fabrics by causing the back weft to stitch over the face warp and also shows the stitching together of the two layers of the fabrics by causing the face weft to stitch over the back warp [19]. These diagrams represent the two
principles of stitching self-stitched double cloths.

Figure 11: Self stitched double cloth (Method of stitching)B.

Conditions for selecting the face and back threads

i. Weave types to be selected for the face and the back fabrics, that depends on the ratio of the face and back threads

ii. If the ratio of the face to back threads is 1:1, weaves like 3/1 twill can be used for the face and the back weave can be 2/2 twill

iii. If the weaves are not similar, in any case the relative number of intersections must be similar

iv. If the ratio of the face to back threads is 2:1, a weave like plain can be selected and the back weave can be a basket otherwise a twill. A weave like 3/1 twill is backed by 4/4 twill.

v. Ratio of face and back threads are based on the consideration of the weight of the face fabric.

vi. The proportion of the weft threads is determined by the process of the weft to be inserted into a loom.

vii. The thread ratios generally preferred are 1:1 and 2:1 for the face and back.

viii. The relative thicknesses of the face and back fabrics is ruled by the choosing of relative counts those are in proportion to the thread density per unit area.

Process of stitching

i. Stitching of the face and the back cloths should be done in a way that, it should not affect the fabric appearance.

ii. If the face warp is lowered below the back pick, it should be well below the face weft and above the back warp threads and vice versa.

iii. The approach of stitching is totally dependent on the nature of the weave.

iv. In case of warp-faced weaves, stitching by the back warp over the face weft is preferable.

v. Alternately, in case of weft-faced weaves, the face ends should be brought below the back picks. At sometimes, both the techniques of stitching should be jointed.

Construction of Self-stitched double cloths: Methods of Self-stitched double cloths are discussed below:

i. Stitching from face to back

ii. Stitching from back to face

iii. Combination stitching

Stitching from face to back

The face warp is stitching with the back weft, so, the warp should have long overlap on the back side. It is necessary to use weft faced weaves with long warp floats at the back [20]. The back fabric also should have weft faced weave. The long weft floats on the upper side of the back fabric can be used for stitching with the warp threads of the face fabric. Divided draft is preferable for this system.

Figure 12: Self-stitched double cloths that Stitches from face to back.
In the below mentioned Figure 12, “A” represents the face weave. “B” represents the back weave. “C” shows the first stage of the actual construction of the double fabric, that may be defined as: insert the face weave on the face ends, face picks only according to the original design [17]. Second stage is similar that refers to the back weave: insert the back weave on the back ends and picks only, according to the original design. Stitching by dropping the face ends on back side. “D” shows the marks for the separating lifts, that ensures, each series of yarns weaves only with its own kind and stated as: lift all face ends on back picks. D is a stage, where, two separate fabrics are produced one above the other. D is the final weave. E is the drawing plan that is divided and F is the lifting or peg plan.

**Stitching from back to face**

Here, in this method, the face and back fabrics are stitched together by causing the back warp to stitch with the face weft. So, the stitching back warp threads are caused to float above the corresponding face weft picks [21]. The various stages of construction of the double cloth constructed by this method. To get this type of stitching, the lower side of the face fabric should have long weft floats and the upper side of the back fabric should have longer warp floats. The stitching point is selected in the middle of the long weft float at the lower side of the face fabric. Divided draft is preferable here, as there are two series of warp threads are found.

**Figure 13:** Self-stitched double cloths that stitches from back to face.

In the below mentioned Figure 13, “A” represents the face weave. “B” represents the back weave. “C” shows the first stage of the actual construction of the double fabric, that may be defined as: insert the face weave on the face ends, face picks only according to the original design. Second stage is similar that refers to the back weave: insert the back weave on the back ends and picks only, according to the original design. “D” shows the marks for the separating lifts that ensures, each series of yarns weaves only with its own kind and stated as: lift all face ends on back picks [22]. D is a stage, where, two separate fabrics are produced one above the other. D is the final weave. E is the drawing plan that is divided and F is the lifting or peg plan.

**Figure 14:** Double cloth produced by combined stitching system.
Double cloth produced by combined stitching system

It is the combination of 1st and 2nd two design. Back to face and face to back these two systems are combined together here. In the below mentioned Figure 14, “A” represents the face weave. “B” represents the back weave. “C” shows the first stage of the actual construction of the double fabric that may be defined as: insert the face weave on the face ends, face picks only according to the original design. Second stage is similar that refers to the back weave: insert the back weave on the back ends and picks only, according to the original design. “D” shows the marks for the separating lifts that ensures, each series of yarns weaves only with its own kind and stated as: lift all face ends on back picks. Face to back and back to face both this two stitching system are combined together. D is a stage, where, two separate fabrics are produced one above the other. D is the final weave. “E” is the drawing plan that is divided and “F” is the lifting or peg plan.

Wadded double cloth

Wadded yarns are used in double cloth to add extra weight and material in fabric. The wadding threads are basically used in warp way, weft way or in both warp and weft way [23]. The wadded yarns are coarser than the other threads and are made of cheaper material. The aim of using wadding threads is nearly indifferent to bed ford cord and welts weaves.

Double cloth with wadded warp: In these types of fabrics, the wadding threads are used in warp way. Comparatively, it is a well-situated and inexpensive method. During weaving, greater pressure is introduced on warp threads, which requires the use of a better quality wadding material. In the warp wadded structures the wadding ends must be raised on all back picks and left down on all face picks. Application of wadding threads enhances the strength of a double cloth in the direction of the wadding yarn. It is also helpful to increase firmness of the wadding threads those are stitched to the double cloth. These stitches are being placed adjacent to the ordinary stitches to reduce their effect. In the below mentioned Figure 15, “A” represents face and “B” represents back weave. “C” represents the face and back with wadded yarn in warp direction. “D” is the complete design; “E” represents the drafting plan. Face weave is 5/3 twill and back weave is 2/2 twill. In warp wadded structures, the wedding ends are are raised on all back picks and all face picks.

Figure 15: Double cloth with wadded warp.

Double cloth with wedded weft: These fabrics are manufactured by inserting wadded threads in weft way. The wadded picks stay in between the face and back picks. Wadding yarn lies in between the two fabrics without interweaving with either; the same conditions are necessary, so far as regards the face weave, the ties and the back weave, as in the construction of double cloths [20]. The wadded design is the same as the ordinary double design except for the inclusion of the wadding threads, and in order that comparisons may be made, the double weave without the wadding. In weft wadded structures all face ends are up, and all back ends are down, on wadding picks [24].

In this figure, the picks are arranged in the order of 1 face, 1 back, 1 wadding; and the ends 1 face, 1 back. The 7 ends satinette weave, warp surface on both sides of the cloth, is employed, the tying being effected by raising the backing ends in a similar order over the face picks. In the corresponding sectional views, the section on the right of the final design is D and E is the drafting plan that is divided.

In the below mentioned Figure 16, “A” represents the face weave that is 7 ends satin move 3. “B” represents the back weave that is 7 ends satin move 3. “C” is the face and back weave with wadded threads in weft way. “D” is the original weave structure that indicates the tie of face and back weave with wadded threads. In weft wadded structure, all face ends are up; all back ends are down on wedding pick.

In this figure, the picks are arranged in the order of 1 face, 1 back, 1 wadding; and the ends 1 face, 1 back. The 7 ends satinette weave, warp surface on both sides of the cloth, is employed, the tying being effected by raising the backing ends in a similar order over the face picks. In the corresponding sectional views, the section on the right of the final design is D and E is the drafting plan that is divided.
Figure 16: Double cloth with wadded weft.

Figure 17: Center warp stitched cloth.

Center stitched double cloth

In center stitched double cloths, the face and back cloths are stitched together by a third group of threads that is known as center threads [13]. These threads neither belong to the face cloth nor the back cloth. They are used in between the face and back fabrics. The center threads that form stitching, are generally finer than the face and the back threads. The firmness of the stitch is lesser than the self-stitched double cloth. The cloth is stitched by this method has a softer and fuller handle. The center stitching method is applicable in cases where there is difference in thickness or color between the face and back yarns. It is of two types like:
A. Centre warp stitching

B. Center weft stitching

A. Centre warp stitching

Here, stitching a separate series of warp threads is used in between the face and back warps. This warp stitches with the face and back weft threads. In the below mentioned Figure 17, A is face weave, B is back weave. C is the original weave structure that is combination of face and back weave with stitching thread. A stitching is created in the center of warp. D represents the drawing plan and E is the lifting plan.

B. Center weft stitching

In this stitching, the face and back fabrics are stitched together by means of an extra set of weft threads that pass in between them. It needs two series of warp threads and three series of weft threads. The center weft threads, which form the stitching threads pass over the face and back warp threads at suitable intervals. For this method of stitching it is suitable to have the warp floats on the lower sides of the face and back fabrics. This enables easier selection of stitching. Thus the design of a center weft stitched double cloth is constructed.

In the below mentioned Figure 18, A is face weave, B is back weave. C is the original weave structure that is combination of face and back weave with stitching thread. A stitching is created in the center of weft. D represents the drawing plan and E is the lifting plan.

Figure 18: Double cloth with center weft stitching.

**Conclusion**

At last we can say that, double cloth is a type of advanced weave with an advanced construction that creates two textiles, one above the other, by means of at least two sets of warp and two sets of weft. A woven fabric construction made by interlacing two or more sets of warp yarns with two or more sets of filling yarns. Double weave is a family of weave styles in which the face of the fabric is effectively detached from the back except at specific connecting interlacing, yet with each side maintaining sufficient individual structural integrity to be identified as distinct fabrics in themselves. These fabrics are met in both decorative and utilitarian roles and inhabit interesting excesses at either end of those spectra.

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