

The invention concerns a pile fabric-based component according to the characteristics of the introductory part of claim 1. Also, a method for the manufacture of a component by resinification and subsequent hardening of a fabric according to the characteristics of the introductory part of claim 12.

The use of resin-hardened fibre composites has gained a wide field of application, whether in the form of load-bearing structural members or for performing insulating functions. With maximum possible rigidity and compressive strength, it is also sought to achieve minimum possible weight for special cases, for example aeronautical engineering.

From FR-A-1 393 269 is known a textile insulating element which consists of spaced-apart layers connected by means of intermediate webs. The fabric may be made from glass fibre. Importance is attached to the fact that a component made by this method has a certain flexibility. With respect to manufacture, it is also important that the fabric is to be kept under tension during resinification.

Furthermore, US patent 3 481 427 should be mentioned on the state of the art. It is known from this that a textile component which can be produced by weaving can be combed. Glass fibre is used here too. An element manufactured according to this publication is a rigid component. Manufacture of the intermediate webs by weaving techniques must be regarded as elaborate, as the hollow weaving method is employed for this. This all brings certain problems during resin hardening; the fabric structure sags unless special distance means are used for support. Support cores are therefore inserted. But this leads to extremely elaborate manufacture.

On the other hand, types of weave such as weft velvet and warp velvet are known in the art. For particularly economical production methods, operation is carried out in two layers equally; so-called double velvet is formed, in which the connecting webs between the layer-forming pile threads form a double shed. The length of the floating threads is adjustable, so that longer or shorter web lengths are obtained. Centre cutting of the pile

threads is then carried out on a cutting bench.

In the light of this pile weaving process or Raschel plush weaving process, the present invention set itself the object, starting from a state of the art according to US patent 3 481 427, with simple means with respect to manufacturing techniques and even using existing machines, to provide a lightweight yet stable, multi-layer component practically of sandwich structure.

With the subject of claim 1, this object is achieved in respect of an apparatus. The component provided is distinguished, on the basis of the pile weaving process, by intermediate webs which form rigid spacer elements of the first and second layers and consist of helically twisted single webs.

With the subject of claim 12, the procedure for manufacture is such that after resinification of the fabric, partial removal of resin is performed by squeezing, wherein resin is removed to such an extent that the resiliency of intermediate webs is released.

As a result of such a construction, a component of the kind described with high bending and compressive strength is obtained, which also produces good results with respect to the weight factor. The distance between the layers is no longer bridged by woven sections, but by free-floating surfaces which take over the supporting of the layers relative to each other. Commercial yarns such as aramide fibre, carbon fibre, ceramic fibre or in particular glass fibre or a mixture of the above fibres are used here. Due to the weave structure in combination with the properties of such materials, the web-forming support surfaces have a tendency to stand up. At the same time they keep the two layers apart from each other. The result is a structure which can be obtained by weaving and which tolerates deflections in the tying-up regions undamaged. The resiliency, which is even like an energy accumulator, saves any external support; on the contrary, it was found that after resinification and hardening, the pile fabric produces such stable spacer elements from the many evenly distributed, single, free-standing, intermediate webs that even maximum loads to be

expected within the framework of use can be taken. There is also a high-grade sound insulating or absorption effect as a result of the high proportion of hollow spaces. Accordingly, there is a high saving of material, which is of great interest again today. The flexibility of the component which is nevertheless produced allows a relatively good capacity for deformation, and in particular a slightly spherical curvature of the sandwich-like body is tolerated without disadvantage. The additional design measure to the effect that the mean length of the intermediate webs is greater than the distance between the layers also proves to be advantageous in practice. The intermediate webs acquire a more or less steeply sloping position as a result; in developing this, it proves advantageous that the intermediate webs are adjusted to extend at an angle. As a result, a load applied across the broad face is also converted to a layer displacement component acting in the same direction. This is particularly favourable with high partial loads, as the whole body is then involved in the resistance to deformation. The corresponding adjustment, i.e. straightening of the webs, makes it possible to determine the yielding movement too. It proved to be favourable that the intermediate webs form an angle of about 65° with a horizontal. Depending on the purpose of the component, a steeper position may be useful. In this case the intermediate webs form an angle of about 85° with a horizontal, and therefore have an almost perpendicular direction to the horizontal. Another means of optimising the flexibility with high non-sagging properties nevertheless lies in that an intermediate web consists of two slightly twisted single webs. As a result there are almost helically shaped spring bodies which however, owing to the only slight twisting, are nevertheless capable of carrying a high load axially. Only in case of overloading does yielding take place due to further bending. In order further to increase this effect, it is further proposed that the intermediate web consists of single webs twisted in a figure of eight. Even larger distances between the layers can be bridged most favourably without loss

of stability by the fact that the single webs are connected to each other in their cross-over region. Hence there is no connection by weaving here, but one using the binding resin. In this way, the total length of the spacer elements is divided into two spring zones adjoining each other in the direction of support and each having the same action, wherein in this connection in addition it proves to be advantageous that the intermediate webs comprise pedestal-like junction zones in the exit region of the layers. The zones, which are comparable to a tree trunk widening towards the base, avoid any stress concentration. Instead, the rotationally symmetrical and therefore annular junction corner is filled out so as to support the webs. An advantageous variant of the web structure consists in that the intermediate webs are arranged alternately at long and short intervals. In a further modification, it is then proposed that intermediate webs crossed with each other are interposed. An advantageous method for the manufacture of the component described by resinification and subsequent hardening of a fabric, wherein after resinification of the fabric, partial removal of resin is performed by squeezing, consists in that where a pile fabric which consists of a commercial yarn such as aramide fibre, carbon fibre, ceramic fibre or in particular glass fibre is used, resin is removed to such an extent that the resiliency of intermediate webs is released. On elimination of the squeezing forces, the resin-coated spacer elements spontaneously return to their starting position. After hardening, the whole structure is solidified. Furthermore it is proposed that looping of the weft threads by hand is carried out in a manner known in the art by means of a reed. This leads not only to almost complete sloping of the intermediate webs between the layers, but above all to exact parallel spacing of the layers of fabric from each other. In cases where the component is to be composed of several fabric sections, the procedure is such that one pile fabric section is split in the connecting region and the other pile fabric section is laid in the opening formed in this way. If there is the intention or need to obtain equality

of planes in the connecting regions too, the space already existing between the layers for spacing can in this case be used by pressing the covered layer in by the thickness of one layer with offset walls. Consequently, the space for spacing has an additional advantageous function. In respect of connection itself too it proves to be favourable that the covering layer sections, as a result of the projecting stumps of intermediate webs, engage as brush-like bodies in the interstices of the fabric of the wall sections underneath. The layers are thus, as it were, "locked". On the other hand, the spring bar-like webs, which are accordingly compressed axially, yield resiliently in the transverse direction without breaking. The resin which ensures this bonding counteracts the tendency towards a return to the original length, so that the connecting region between the two fabric sections is barely perceptible visually either. The subject of the invention is explained in more detail below with reference to an embodiment illustrated by drawings. They show:

- Fig. 1 a section of the component constructed according to the invention, in a perspective view, greatly enlarged,
- Fig. 2 the section through line II-II in Fig. 1,
- Fig. 3 the component in a side view seen in direction A, highly schematised,
- Fig. 4 the component in a side view seen in direction B, also highly schematised,
- Fig. 5 in a side view, a connecting zone between two pile fabric sections of a component,
- Fig. 6 a component in a modified construction, in a side view seen in direction A, again highly schematised,
- Fig. 7 the use of a reed in a schematic view,
- Fig. 8 a variant of the fabric according to Fig. 6, showing different spacings of intermediate webs,
- Fig. 9 a development such that crossed intermediate webs are inserted between the intermediate webs,
- Fig. 10 a corner construction of the component,
- Fig. 11 the component with edges tapering to a flat

construction, using the fabric variant of Fig. 8, and Fig. 12 one using the fabric variant of Fig. 9.

The component shown 1 is produced on a pile fabric weaving machine. The corresponding pile fabric or Raschel plush fabric is multi-layered, in the practical example two-layered. A first, upper layer bears the reference number 2; a second, lower layer, on the other hand, is marked 3.

Woven-in support threads which form intermediate webs 4 connect and keep the two layers 2, 3 at a distance from each other. The structure is the undivided structure of a double velvet weave.

The number of support threads follows from the weft density of layers 2 and 3, also from the number of support threads measured across the width of weaving, and finally from the repeat of the weave. With e.g. 2000 threads per metre weaving width, 12 weft/cm in the upper layer and lower layer and 3/6 weft weave, there are 800,000 intermediate webs 4 between the two layers 2, 3.

By altering the number of web threads and weft density as well as weave, intermediate webs 4 which are many times higher or lower can be woven in. The required strength of the upper layer 2 and lower layer 3 and bending strength are achieved by suitable use of warp and weft material in the outer layers. Naturally, the web height is variable and can be adjusted individually according to the desired height.

Commercial yarns such as aramide fibre, carbon fibre, ceramic fibre or in particular glass fibre are processed.

As a result of the resiliency inherent in such heavy-duty fibres, and also due to the connecting structure, the support threads forming the intermediate webs 4 tend to straighten up after weaving or return to the load-free state. This leads to parallel spacing of the layers 2 and 3. The inside distance x between the two layers 2 and 3 corresponds to a multiple of layer thickness.

The intermediate webs 4, which are comparable to the pile threads of a double velvet pile weave, are stiffened like the

whole body of the component with hardening resin, so that the intermediate webs 4 form rigid spacer elements between the first layer 2 and the second layer 3. Return of the intermediate webs 4 to their final position shown in Fig. 1 takes place even after complete compression of the woven structure. Accordingly, no damage occurs at all during the weaving process as a result of the necessary deflections, which fact can be used to advantage in the manufacture of such components.

As can be seen from the figures, the mean length of the intermediate webs 4 is greater than the inside distance x between the layers 2, 3. The free support thread sections forming them therefore do not change on the shortest path between the two adjacent layers 2, 3. On the contrary, as can be seen in Fig. 1, there is a slightly sloping position, seen from the direction of viewing A in Fig. 1. This is even clearer from the schematic view, for example according to Fig. 3. In respect of all intermediate webs 4, a slant in the same direction is used, so that one can speak of an adjusted slant.

The angle of inclination (α) in this respect is according to Fig. 3 about 65° , referred to the horizontal supporting base of the component 1, that is, a horizontal.

According to the variant of Fig. 6, all the intermediate webs 4 form with the above-mentioned horizontal an angle (α) of about 85° . Thus there is a very steep slant here.

The variant of Fig. 8 embodies a solution to the effect that the intermediate webs 4 are arranged at alternately long and short intervals. The longer interval roughly corresponds to twice the short interval of the parallel intermediate webs. In Fig. 8 these intermediate webs are constructed in an angular position to the horizontal as in Fig. 6.

The same also applies to the variant of Fig. 9, but with the difference that intermediate webs 8 crossed with each other are provided between every two intermediate webs 4. The crossed intermediate webs are located at the longer interval between two intermediate webs 4. The angle of crossing (β) is around 50° to the horizontal. The pile threads of the fabric forming the

intermediate webs 8 are rooted at a distance from the adjacent row of intermediate webs which roughly corresponds to one-fifth of the length of an intermediate web 8.

From the direction of viewing B in Fig. 1, on the other hand, in all cases there is a vertical direction (cf. Fig. 4) to the said base.

The term "mean length" is chosen because the intermediate webs 4 in each case consist of slightly twisted single webs 4', 4'', and the true length turns out longer. The slightly helical ascent is shown in the perspective view, Fig. 1. A single web changes, as seen in the direction of arrow B, from back to front in the direction of inclination, this being referred to the exit region in a layer.

The intermediate web 4 is thus twisted into a figure of eight (comparable to an oval ring turned through 180 degrees about its longitudinal axis), wherein the single webs 4', 4'' are connected to each other in their cross-over region 5. Such node-like cross-over regions 5 are obtained by the fact that the loop sections of the intermediate webs 4, which form the figure of eight, rest on each other with contact.

In the exit region in a layer and accordingly of course also in the entry region, the intermediate webs 4, 8 have pedestal-like junction zones 6, roughly comparable to above-ground protruding roots of trees etc. This leads to a practically frustoconical junction between the inner side of the layers and the spacer elements. The truncated cone base corresponds to a multiple of the cross-section of a single web 4' or 4''. The circle areas which can be seen on the upper side in Fig. 1 are intended to symbolise the layer entry zone of the intermediate webs 4. Threads are tied in in a W-shape.

The intermediate web 4 designed as a figure of eight forms, after tying in the cross-over region 5, two drop-like or chain link-like sections, the cavity of which is marked a, b and which, depending on the adjacent position of the single webs 4', 4'', can however also be completely or partially filled with resin.

In this way or even with free-standing single webs 4', 4'', the result is always a high-strength, column-like or strut-like distance body which nevertheless also displays a certain flexibility in the axial direction.

Partial loads on the broad faces of the component 1 also involve the intermediate webs in the further surrounding area, because as a result of the slightly inclined position, which is moreover also in the same direction, there is a sliding movement of the layers 2 and 3 in the opposite direction (arrows z , z' in Fig. 1). In addition to this good distribution of load, the form of the intermediate webs 4 described also has an energy-consuming effect.

Constant parallelism of the layers 2 and 3 is obtained by looping the weft thread 9 of the upper and lower fabric layers by hand by means of a reed 10 (cf. Fig. 7). The dents of the reed 10 have on the cloth side notches 11 the bottom of which defines the centre-to-centre distance of the layers 2 and 3, that is, upper and lower cloths. The distance can be 8 mm, for instance. The reed moreover allows looping of the weft threads 9 by hand with precision of height.

The warp threads are consistently marked 12 and form the intermediate webs 4, 8.

The uneven distribution of the intermediate webs leads to relatively large gaps in between. As a result, resin absorption decreases. The parts are lighter in weight. The cross-like blockage of the spaces moreover increases the strength.

The embodiments according to Figs. 10 to 12 show with the aid of the embodiment of Fig. 10 a corner construction in which the upper layer 2 is folded into the inner corner of the angled component. This configuration can be locked by an additional layer 13 placed on top on the inside. The additional layer 13 follows an essentially parallel rounded course to the apical zone 14 of the profile.

In Figs. 11 and 12 are shown laminated components. These are joined at the edges. The edge zone 15 is reduced to a minimum of the total thickness. This takes place by bundling

the layers 2, 3 of each component 1. The sloping alignment of the individual components 1 in opposite directions is also an advantage. This leads to internal sealing and very high strength of the whole component.

The above fabric structure is impregnated with marker-containing resin plus hardener. The excess quantity of resin is squeezed or rolled out, so that the internal structure is free from resin except for the wetted, web-forming support threads and the two impregnated fabric layers. The entry regions of the single webs 4', 4'', which are each slightly offset in position, lead to a sliding movement at the branch sections as far as the maximum rebound zone. In this case sufficient resin is wiped off at the same time, so that the cross-over regions 5 are well saturated with resin; reference is made to Fig. 2, in which such a resin accumulation zone can be seen. The corresponding evacuation of resin takes place to such an extent that the resiliency of the intermediate webs 4 is released until, as already indicated, they reach their basic or final position. After the drying process, the result is hardened components of high rigidity and compressive strength. The high deformability of the pile fabric or Raschel plush fabric also allows the manufacture of slightly spherically curved components.

By local and varying compression of the impregnated fabrics, different component thicknesses can also be produced from a fabric.

The sandwich structure produced counteracts any tendency towards delamination, perhaps in the direction of detachment of a layer, as a result of a single coherent structure.

In the case of larger components exceeding the weaving width, such a component 1 is composed of several fabric sections 1', 1''. For this, one pile fabric section 1' is split in the region of connection to the other pile fabric section 1''. This measure is shown by the schematic view in Fig. 5. The gap is marked 7 there and is produced by a centre cut corresponding to the desired depth of overlap. The corresponding edge zone of the adjoining fabric section 1'' is inserted in the resulting

opening. While maintaining a constant total thickness of the component 1, the edge layers close to the connecting region are compressed in the direction of the distance space. Impregnation with resin as described and squeezing out then follow. The fabric springs back in the manner explained. Due to support on the rear side in the connecting region V, the corresponding resiliency can be limited, so that there is the same thickness of the component 1 throughout. The edge zone, which is flattened more, disappears in the already existing distance space. The brush-like web stumps which are free-standing due to the dividing cut are embedded in anchoring relationship in the outside of the overlapped edge of the fabric section 1''. This leads to intimate, durable bonding.

Claims

1. Pile fabric-based component, with at least one first (2) and second (3) layer and intermediate webs connecting these layers (2, 3), wherein the pile fabric consists of a commercial yarn such as aramide fibre, carbon fibre, ceramic fibre or in particular glass fibre, and wherein the pile fabric is resinified to the point of hardening, wherein the intermediate webs (4) form rigid spacer elements of the first layer (2) and second layer (3) and consist of helically twisted single webs (4', 4'').
2. Component according to claim 1, characterised in that the mean length of the intermediate webs (4) is greater than the distance (x) between the layers (2, 3).
3. Component according to one or more of the preceding claims, characterised in that the intermediate webs (4) are adjusted to extend at an angle.
4. Component according to one or more of the preceding claims, characterised in that the intermediate webs (4) form an angle (α) of about 65° with a horizontal.
5. Component according to one or more of the preceding claims, characterised in that the intermediate webs (4) form an angle (α) of about 85° with a horizontal.
6. Component according to one or more of the preceding claims, characterised in that an intermediate web (4) consists of two slightly twisted single webs (4', 4'').
7. Component according to one or more of the preceding claims, characterised in that the intermediate web (4) consists of single webs (4', 4'') twisted in a figure of eight.



8. Component according to one or more of the preceding claims, characterised in that the single webs (4', 4'') are connected to each other in their cross-over region (5).

9. Component according to one or more of the preceding claims, characterised in that the intermediate webs (4) comprise pedestal-like junction zones (6) in the exit region of the layers (2, 3).

10. Component according to one or more of the preceding claims, characterised in that the intermediate webs (4) are arranged alternately at longer and shorter intervals.

11. Component according to one or more of the preceding claims, characterised in that intermediate webs (8) crossed with each other are interposed.

12. Method for the manufacture of a component, in particular according to any of claims 1 to 11, by resinification and subsequent hardening of a fabric, wherein after resinification of the fabric, partial removal of resin is performed by squeezing, characterised in that where a pile fabric which forms intermediate webs as rigid spacer elements between the first and second layers is used, resin is removed to such an extent that the resiliency of intermediate webs (4 or 8) is released.

13. Method according to claim 12, characterised in that during the weaving process, looping of the weft threads (9) by hand is carried out in a manner known in the art by means of a reed (10).

14. Method according to claim 12, wherein the component is composed of several fabric sections, characterised in that one pile fabric section (1') is split in the connecting region (V) and the other pile fabric section (1'') is laid in the opening formed in this way.

