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Utilisation of Linear Textile Wastes with Use of a Rotary Loom

Abstract
Hitherto unknown possibilities for utilising linear textile wastes are presented, illustrated by two examples of such wastes which differ structurally. Thanks to the application of a multi-shed rotary loom, it was possible to use these linear wastes as warp directly, without any preliminary operations. In the case of haberdashery wastes, which are characterised by interesting colours and structurally complex piles, a woven fabric of the clothing type was successfully formed. On the contrary a woven fabric, which can be used as a very cheap insertion and reinforcement for composites, was manufactured from auxiliary selvedges with complex spatial structures.

Key words: *multi-shed rotary loom, rotary loom, linear textile wastes, utilisation, selvedges.*

Linear Textile Wastes

Auxiliary selvedges from jet and rapier looms constitute a significant amount of the linear textile wastes which are generated during textile manufacturing processes. Such selvages are characterised by very complex structures, which mean that their utilisation is extremely difficult, economically unjustified, or even technologically impossible. The producer suffers losses, whereas new wastes overload the environment.

Two basic kinds of linear textile wastes can be distinguished: firstly, those wastes which are characterised by an artistic value, and secondly, those distinguished by purely technical values, such as for example those which have good thermal and acoustic insulation properties, as well as those of high mechanical strength.

The utilisation of wastes by fibration destroys their valuable features, and is economicallyunpromising. On the contrary, the multi-shed rotary loom [1, 2] is the only one textile machine which affords possibilities of using textile wastes efficiently [1, 2, 3]. The general view of the loom and the virtual model of woven fabric formation are presented in Figure 1.

The choice of a multi-shed rotary loom for waste utilisation has the following advantages:
- No limitations are required regarding the complexity of the linear textile product destined for the warp.
- The loom enables the transformation of the linear textile waste into a woven structure by a single process. The auxiliary selvedge [4] need only be taken from the loom where the woven fabric which the selvedge belongs to has been manufactured; it is then used as the warp (without any additional operation) directly on the rotary loom's discs [5] which form the sheds.

However, when using linear textile products with a very developed surface as the warp, it should be considered very likely that the product's pile will obscure the channel provided for pneumatic weft transport, and in this way prevent weaving (Figure 2).

To prevent such a situation occurring, a new solution to the disk's design has been proposed: the application of an

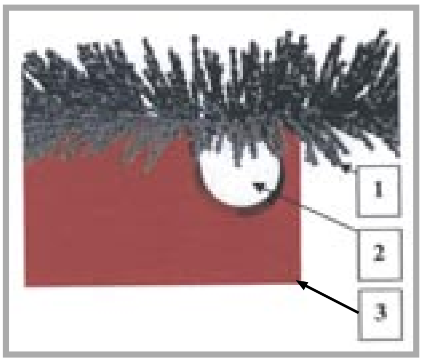

Figure 2. Penetration of the warp's pile into the channel for weft transport; 1 – linear element of warp with a developed surface which forms a barrier to weft transported pneumatically, 2 – channel for weft transport, 3 – fragment of a disc which forms the sheds.

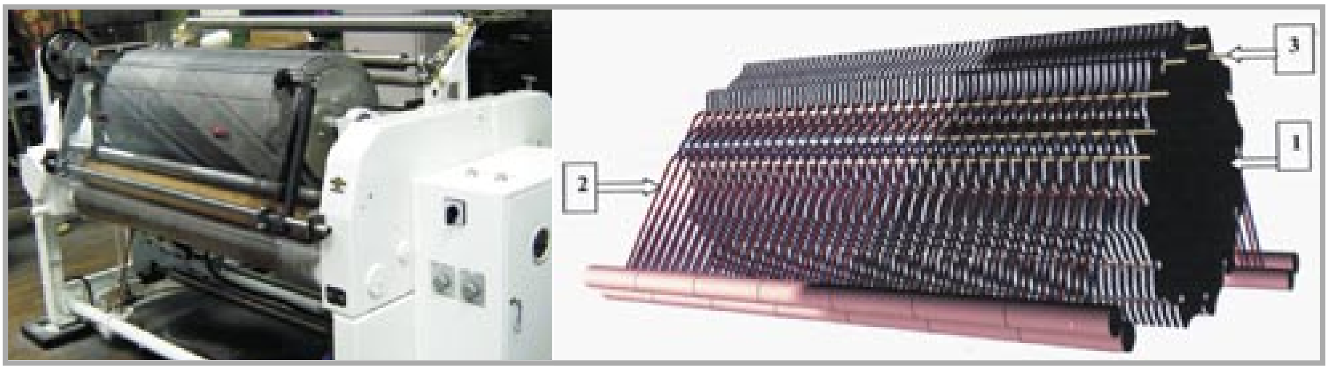

Figure 1. Multi-shed rotary loom; a) general view; b) virtual model of woven fabric formation with use of the rotary loom, with the warp from linear textile wastes; 1 – weaving beam, 2 – warp from linear textile wastes, 3 – wefts.

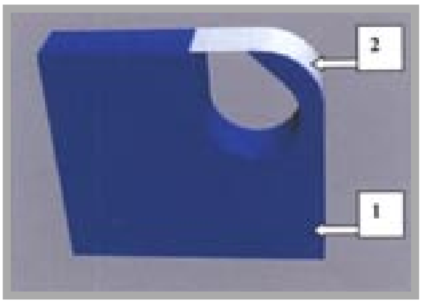

Figure 3. *Fragment of the sheds' forming disc with an elastic latch; 1- disc, 2 – latch.*

elastic spring latch [6] (Figure 3) which would execute the following functions:

- The latch would close in a natural way by the linear element of the warp with a developed surface, during the formation of a woven fabric element;
- The latch would be pulled aside by the weft incorporated in the newly-formed woven fabric's element which has left the weaving beam.

Utilisation of linear textile wastes with an artistic value. Characterisation of haberdashery wastes.

A typical example of linear textile wastes with artistic value may be polyester haberdashery waste generated while manufacturing decorative fringes applied for trimming products, by cutting up one of the edges with knives (Figure 4.a and 4.b).

Pairs of threads with chain stitch placed along the product are the main structural carrier elements of haberdashery waste (Figure 5a). The bent segments of filaments, transversally braided into the thread pairs with chain stitch, are the elements which form the texture of the textile pile (Figure 5b).

The artistic value of waste with horizontally-placed textile pile is clearly visible in Figure 4b.

Assumptions for the utilisation of linear haberdashery wastes

The very interesting structure of linear haberdashery waste with textile pile and exciting colours inclined us to search for a possibility of utilisation so that such a waste could be used to manufacture woven structures destined for clothing, or for decorative products more generally. We assumed that the waste considered should be a warp element (Figure 6). A blended yarn of 20% wool and 80% acrylic fibres with a linear density of 680 tex was accepted as the weft. Its thickness, colour, and texture were harmonised with the haberdashery waste work-

Figure 6. *Virtual model for forming a woven fabric from haberdashery wastes; 1 – warp of waste, 2 – weft of yarn.*

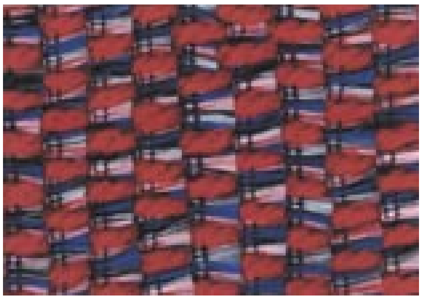

Figure 7. *View of a real woven structure formed from linear haberdashery wastes as warp with the use of a multi-shed rotary loom.*

ing as the warp. Equal densities of warp and weft of 10/1 dm were accepted. The raw materials described above were used as test material for manufacturing woven fabrics on a rotary loom (Figure 7).

Manufacturing a woven fabric with the use of a rotary loom

A pneumatic jet from the Dornier company was used to introduce the weft. Considering the extraordinarily loose structure of the haberdashery wastes and of the yarn weft, the fabric's edge was closed by sealing it with a tape.

The warp, in the shape of linear haberdashery waste, was fed from a beam. Special attention was paid to ensure that the part with warp pile was placed on the weaving beam in a similar way. This was done in order to obtain different angle shades of the final product, as in the case of velvet.

Potential application ranges

The mechanical properties, the raw material contents and the designs indicate possibilities of applying the woven fabrics discussed in various fields for products with decorative accents, such as clothing, tablecloths, curtains, bedspreads, pillowcases, upholstery, and decorative materials. An application example of a woven

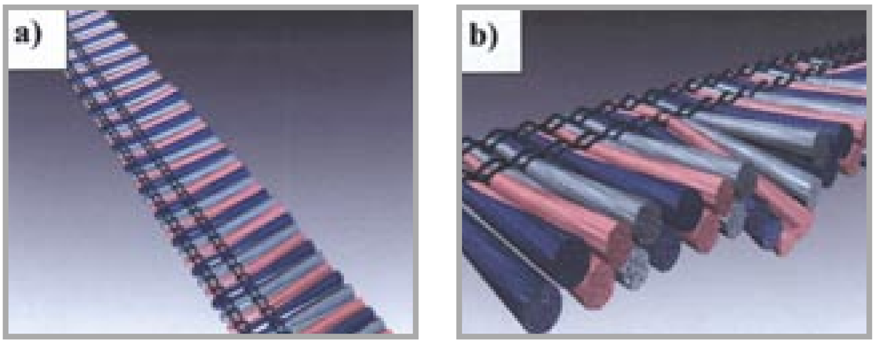

Figure 4. *View of skew projections (a) and (b) of virtual models of haberdashery waste.*

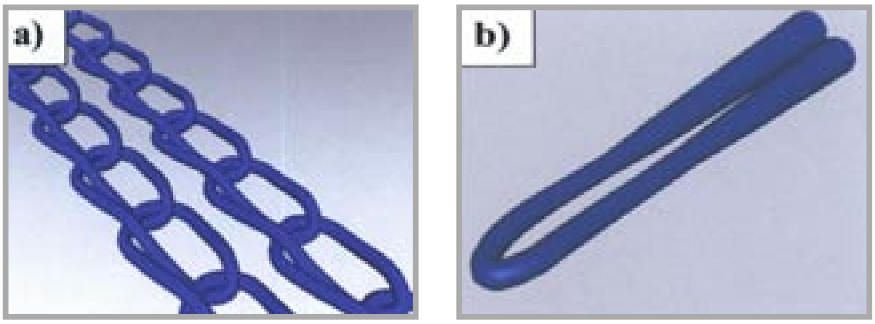

Figure 5. *Structural waste elements; a) thread pair with chain stitch, b) segment of a transversal thread formed from monofilaments.*

Figure 8. Application example of a woven fabric from linear haberdashery wastes manufactured into a vest.

fabric from linear haberdashery wastes as warp in designing a vest is presented in Figure 8.

Utilisation of linear wastes with technical values. Characterisation of auxiliary selvedges.

Auxiliary selvedges have different forms depending on the structure of the woven fabric. Two examples are presented in Figure 9.

Two possibilities of selvedge application are presented below. In the first case, the auxiliary selvedge is characterised by good thermal and acoustic insulation properties, thanks to its developed and fluffy structure, which is formed from a synthetic raw material. Therefore, it was stated that such a selvedge could be applied in the construction technique. In the second case, the high tensile strength of the product was the justification for applying the waste as composite reinforcement.

Thermal and acoustic insulation from loom wastes

Examples of some auxiliary selvedges from rapier looms are presented in Figure 10a. Their fluffy structure has inspired their application. They were used in both the systems of designed woven fabrics: as warp and as weft, with the aim of increasing the effect of thermal and acoustic insulation (Figure 10b).

Composite reinforcement by loom wastes

Selvedges obtained from Omni Plus Picanol pneumatic looms were the object of our tests. This kind of linear waste is widely differentiated by the raw material used. Polyester, polyamide, and viscose fibres are the waste materials in the majority of cases. The selvedge selected for further investigation (Figure 11) was an element of a woven fabric destined for jackets. The factory which manufactured these jackets yields over 12 tonnes per year of such wastes.

The selvedge under consideration is characterised by a tearing strength of 17 daN and an elongation at break of about 17%. We assumed that the woven fabric obtained from the auxiliary selvedges could be used as filling for composites manufactured by lamination (Figure 12).

As for the composite designed, high strength in the direction of warp only was accepted as a demand, waste yarn with a linear density of 140 tex was used for the

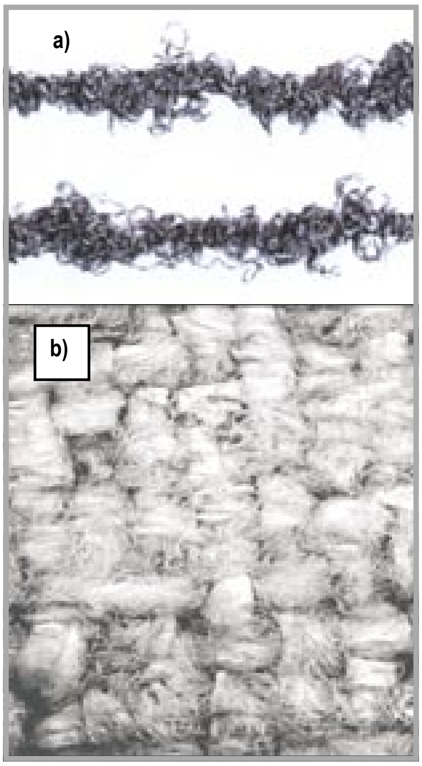

Figure 10. Utilisation of auxiliary selvedges; a) view of linear waste from a loom; b) woven fabric manufactured from auxiliary selvedges.

Figure 11. Virtual model of an auxiliary selvedge obtained from Picanol loom.

weft, for economic reasons. Warp density was accepted as 4/1 dm, and weft density as 5/1 dm. The woven fabric manufactured this way was characterised by an area mass of 300g/m^2.

Considering the high strength along warp of a woven fabric designed in this way, it may be used as reinforcement for many different composites applied in the manufacture of swimming pools, sandpits, toys, garden furniture, flowerpots, roofing, housings, casings, yacht hulls, etc.

We used a polyester resin to manufacture selvedge-reinforced composites from Picanol looms. Samples of these composites are shown in Figures 13 and 14.

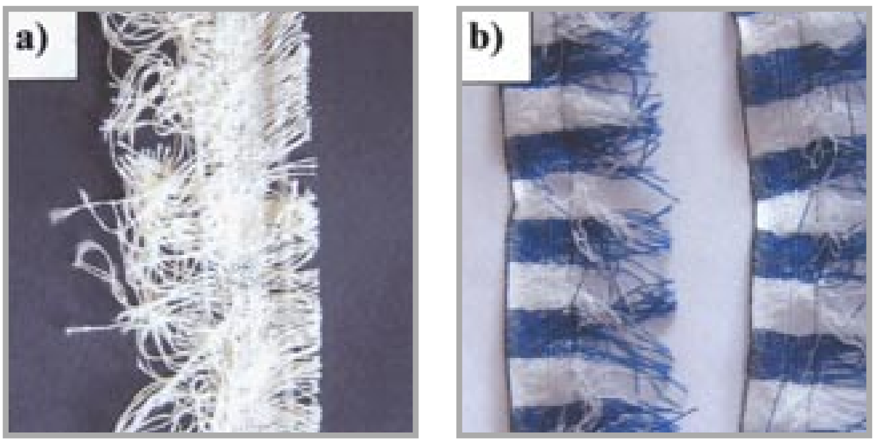

Figure 9. Examples of auxiliary selvedges (a and b) from rapier looms.

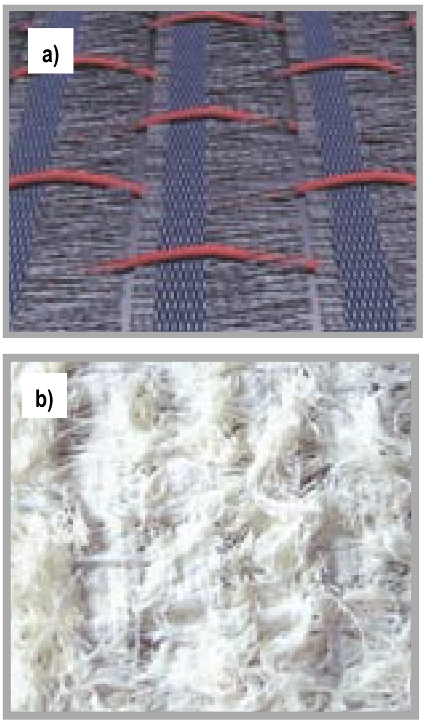

Figure 12. Woven fabric for composite reinforcing with warp from auxiliary selvedges; a) virtual model, b) real view.

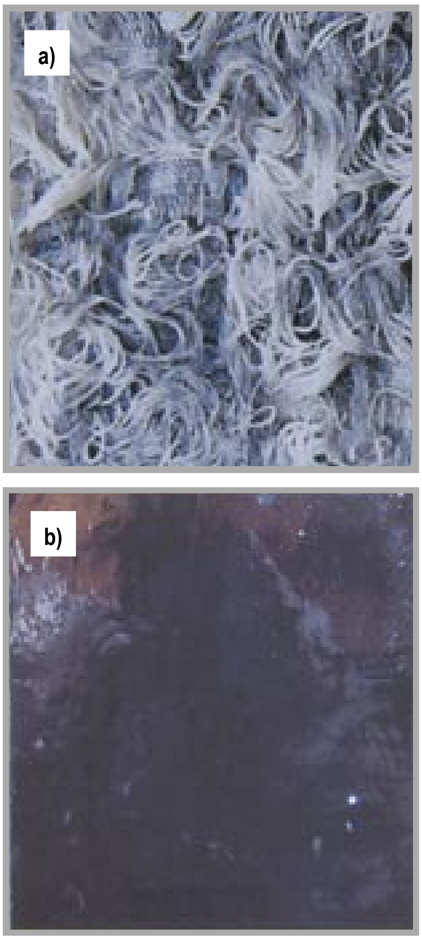

Figure 13. Real view of the right (a) and left side (b) of a composite one-side laminated, and reinforced by a woven fabric with warp from auxiliary selvedges.

Conclusions

Auxiliary selvedges are wastes which must be periodically stored and ultimately removed from the factory. At present, enterprises dealing with such problemsdeal with the problem in the following ways:

- by selling a part of the total amount of these wastes, which reduces the losses previously incurred by buying the raw material required to manufacture the part of the woven fabric which is destined for the selvedge;
- by defibration of the linear wastes with complex structures, which is connected with significant investment costs, and results in a product which requires further successive operations to manufacture a final product which is ready to use;
- by removing the auxiliary selvedges to waste dumps.

The last possibility requires the expenditure of creating and maintaining such dumps; what is more, the enterprise's budget should consider that in the foreseeable future the regulations and restrictions related to environmental protection will be significantly tightened. This should force the producers to take actions leading to efficient and economic waste utilisation. The technique and technology presented in this paper will permit the manufacture, in a single technological process, of products from linear textile wastes which may be further used in different applications.

The process of utilising linear textile wastes to manufacture woven fabrics with the use of a rotary loom has the following advantages:

- great simplicity, characterised by the formation of a new product in a single technological process,
- very low energy expenses for loom operation, and
- a very strong ecological accent, the full utilisation of the waste.

Comparing the defibration techniques of wastes applied hitherto, and the nonwovens formed from them, the new technique of producing woven structures from wastes in a single process with the use of a rotary loom has clearly evident advantages from the investment, energy, and economic points of view.

Figure 14. Real view in transmitted light of a both-side laminated composite, half-transparent, and reinforced by a woven fabric with warp from auxiliary selvedges.

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