BELTCON 1

BELT CONVEYORS - DESIGN, OPERATION AND OPTIMIZATION

PAPER A4

ASPECTS OF CONVEYOR BELTING

G. Davies

Manager: Technical Services Dept.
Goodyear Tyre and Rubber Co.

University of the Witwatersrand
S.A. Institute of Materials Handling
S.A. Institution of Mechanical Engineers

1. SUMMARY

Factors in the compositions of modern conveyor belting.

Properties of conveyor belt fabrics and various methods of construction.

Cover considerations and typical wear rates.

Operating tensions and factors of safety.

Splice limitations and repair facilities.

2.0 INTRODUCTION

Somewhere, somehow, conveyor belting touches the lives of every single person in the civilised world, either directly or indirectly. Whether it is a piece of wood destined to be made into paper, an article of baggage at an airport, a stick of cane destined to be sugar , a lump of iron ore destined for the blast furnace, coal for the power station, corn for silos, transport for people or production lines for factories. The list is never - ending, and without conveyor belting, the world as we know it would come to a halt.

This of course can be said about many other commodities and about transport in general and I only mention it because here in South Africa where there is an accent on mining, conveyor belting becomes a vital strategic commodity for the well-being and continued prosperity of the country. You may be surprised to know that this country of ours consumes in excess of 900 kilometers of conveyor belting annually which probably means there is over 5 000 kilometers in operation.

Let us therefore look at some of its history.

2.1 HISTORY

Transporting bulk materials by conveyor belts dates back to approximately 1795; most of these early installations handled grain over relatively short distances.

The first conveyor belt systems were very primitive and consisted of leather, canvas, or rubber belt travelling over a flat or troughed wooden bed. This type of system was not an unqualified success but it did provide incentive for engineers to consider conveyors as rapid, economical and safe method of moving large volumes of bulk material from one location to another.

During the early 1920's, the Colonial Dock installation of the H.C. Frick Company in the U.S.A., to quote a particularly noteworthy installation, showed what belt conveyors could do in long distance hauling. This installation was underground and handled run of mine coal over some 8 km. The conveyor belt consisted of multiple plies of cotton duck and natural rubber covers, which were the only materials used to manufacture belting at that time. Although outmoded by today's standards, this material handling system was selected in preference to rail haulage, which has proved to be a proper choice, in many subsequent applications.

During World War II natural components became so scarce that the rubber industry was forced to create synthetic materials to replace them. Today, conveyor belting is being produced with an almost endless list of polymers and fabrics to meet the design requirements of any conveying situation. Possible uses of conveyor belting have broadened considerably since the Frick installation and have today become the veins and arteries of almost every basic industry.

Today around any processing activity where materials have to be handled, stored, or dispensed, the belt conveyor can be seen doing a job. The conveyor is taken for granted as an obedient servant ready to move mountains at the touch of a button.

There is hardly any sight prettier to a process operator than the smooth ribbon flow of specification size material on a conveyor belt. But if a conveyor fails everything has to shut down, and the conveyor then becomes the "lousy piece of junk", that caused the operation to lose money. THAT's when the conveyor takes an IMPORTANCE.

Ask someone to describe conveyor belting - well, its just fabric and rubber sheeting - yes, ten out of ten.

Ask someone to describe the difference between good conveyor belting and bad conveyor belting and the answer needs some explaining, except that bad does not last as long as good.

The secret lies in having the right rubbers bonded with the right adhesives to the right fabrics to give a balanced product for each conveyor.

Along with the development of conveyor belting, standard specifications have been established. Some of the most noteworthy being the ISO. DIN, NCB Flame Resistant specifications and the S.A.B.S. Conveyor Belt Specifications 1173/77 and 971/80.

So it should be useful for the engineer designing such equipment as well for the mining and materials handling men who run the machines and their conveyors to know about the modern day development of conveyor belting.

2.2 CONVEYORS DESIGNED AROUND THE BELT

Because conveyors are relatively simple when compared with other units in a processing plant, they often lack the attention given to the "producing" units. However, conveyors should be looked at as integral parts of the processing plant, with equal claim to a share in the profits of the operation. In fact a good many operations owe their success to the efficiency of their conveyors. On the other hand a good many operations are the "headache" problems to a system of poorly operated, poorly maintained, and ill chosen conveyors.

Unfortunately, many engineering jobs on belt - conveyor systems are done without proper consideration being given to the belting at the initial stages of design. Since belting is generally the most expensive single item of the system, as well as virtually the only major component that needs occasional replacement, it would be good practice to select the belting first, on the basis of the required tonnage, speed and layout. Consideration of standardization in belt width and belt specifications should be applied at this point. After the basic conveyor layout and preliminary belting requirements have been established, the engineering of the supporting structures such as idlers, pulleys etc. can be completed.

The user should know enough about belt - conveyor design to decide what he needs and how much of a compromise between what is economically justified and what is perfect design, can be made.

A belt conveyor can be put together with almost any kind of equipment. It can be abused and neglected, yet the belting will keep on moving. It will run over idlers that have not turned for years and drag through accumulations of material that it is supposed to carry and that has buried the idlers which are supposed to make its running easy. It will even, because of misalignment of the conveyor frame, cut its way through steel members. Certainly the conveyor will work under these conditions, though the user pays heavily for it, but if the belt is treated properly, it will respond with years and millions of tons of increased life and service.

The ultimate operating cost per ton kilometer of a belt conveyor system depends primarily on skillful engineering of the system and the suitability of the belt.

The selection of the belt is one of the most important considerations in the design of a belt conveyor. The belt carries the material and transmits the power to move the load, and it is the part most subject to wear.

The design and the engineering of belt - conveyor equipment must be directed to keeping the belt in operation, protecting the belt and prolonging the life of the belt. It would benefit the ultimate user to consult a representative of the belt manufacturers, at the time when the initial engineering studies are made and to reach an agreement on the design specifications.

The general design of belt conveyors is not the topic of this paper. It can be obtained from relevant publications. The following remarks are to be understood merely as recommendations for the correct configuration of conveyor elements which are required to interact with the belt.

2.2.1 BELT TRAINING

Within the scope of recognised standards, the supplier of the belt guarantees the straight in line manufacture of his belts.

The assembly of a belt conveyor should result in a straight line-up. However, when running, belts may nevertheless run-off-line due to outside influences such as rain, wind, off-centre loading, deflection of the conveyor framework etc. The design of a conveyor must take that into account.

It is common practice to have a minimum clearance between each edge of the belt and conveyor structure or any obstacles of 50 to 100 mm depending on the width of the belt. However, for long, highly stressed costly belts it is well worthwhile giving consideration to increasing these dimensions.

The simplest method to train a belt correctly is to trough the belt sufficiently on the top and bottom strand e.g. top strand troughing minimum 20°, bottom strand troughing minimum 10°. Further, the material should be fed centrally onto the belt. Usually no extra equipment should be necessary.

Should training idlers be required, such designs are to be preferred which cannot damage the belt edges (e.g. vertical side guide idlers).

Tilting the troughing idler forward (not over two degrees) in the direction of belttravel produces a self aligning effect, however, this method has the disadvantage of encouraging accelerated pulley cover wear due to increased friction on the troughing rolls. It should therefore, be used as sparingly as possible, especially on the higher angle idlers.

2.2.2 FEEDING OF MATERIAL ONTO BELT

Design of chutes is not the topic of this chapter as it will be adequately covered by another delegate. However, it must be said that the successful operation of a belt conveyor requires : first that the conveyor belt be loaded properly; second that the material carried by the belt be discharged properly. These two requirements are very important and must be given most careful consideration if the belt conveyor is to function as intended.

2.2.3 BELT CLEANING

Many materials conveyed on belts are sticky. Portions cling to the conveying surface of the belt and are not discharged with the rest of the material at the discharge points.

Cleaning material from the belt surface before it enters the return run of the conveyor is important. Failure to get the belt clean allows material to transfer from the belt surface to idler rolls and snub pulleys and to fall under the conveyor. Material build up on the rolls and snubs nullifies the training job when the rolls were clean.

In some cases the best possible cleaning is insufficient, and steps must be taken to mitigate the effects of a dirty belt. Dirt can be kept from building up on the snub pulleys by using soft rubber coverings or by scraping directly against the pulley. Rubber disc return rolls prevent dirt from building up on the rolls and thus save a training problem.

There are numerous effective devices available which I'm sure will be adequately covered by the other delegate when he discusses chute design, however, there is another method which avoids the need of cleaning the belt rather than providing a means of doing the cleaning. This method involves twisting the belt 180 degrees after the belt passes the discharge pulley or internal drive. Thus, the pulley or clean surface of the belt is in contact with the return idlers. A similar twist must be made at the opposite end of the conveyor to bring the conveying cover up again at the tail pulley.

Whilst this method is finding more and more use, it is recommended from a belt standpoint that twisting be limited to those cases where sticky material cannot be adequately cleaned by more conventional methods. The twist increases tension at the belt edge and reduces center tension. This mal-distribution of tension can lead to belt buckling and even longitudinal fold-overs if the twist length is inadequate and/or other features of the twist and its installations are not proper.

2.3 CONVEYOR BELTING

2.3.1 General

While a belt conveyor system is composed of many important parts, none is more economically important than the conveyor belt itself, which, in most cases will represent a substantial part of the initial cost. Therefore, the selection of the conveyor belt must be made with great care.

A conveyor belt is simply a means to an end – a means for transporting material from a starting point A to a finishing point B. To perform the work of moving material from A to B means that the belt develops stresses within it. These appear as longitudinal tension stresses, primarily induced by the drive pulley; bending stresses when the belt passes around the pulleys; flexing stresses, caused when the belt passes over the idlers and indeterminate stresses, induced by impact of the load on the belt surface.

2.3.2 <u>Belt Carcass</u>

As the heart of the conveyor system is the conveyor belt, so too is the carcass the heart of the latter, which has to meet the stresses already mentioned.

Within recent years belt manufacturers, have been able to supply the industry with belts having characteristics far superior to those formerly available; due to intensive research and development both in materials and in techniques of manufacture. These new belts have higher tensile strengths and great flexibility and when properly installed and maintained have a much longer service life.

At this point it may be appropriate to explain what a modern day belt carcass is made of. The old – type method of building-up a conveyor belt from multiple layers of cotton duck, sometimes as many as eight plies, up to about 600 kN/m ultimate tensile has been superseded these days in several ways :

1. The former range of tensile strength has been extended up to 2500kN/m by the use of semi – synthetic and synthetic fibres.

2. The number of plies which was formerly a minimum of 3 but generally 4 to 6 has been reduced to 2 with a tensile strength of 1000kN/m and even to one ply belts.

3. The introduction of the textile - free steel cord belt with tensile strengths anywhere from 500 to 6300kN/m.

A variety of synthetic or man-made fibre is now heavily used in conveyor belts, where cotton once was predominant. Historically four main groups of conveyor belting materials exist.

1.	Cotton Rayon	(natural and semi-snthetic materials)
2.	Nylon (polyamide) Terlyene (polyester)	(100% synthetic materials)
3.	Mixture of bond 2	
4.	Steel cords	

Formerly all fabrics were woven entirely with cotton. Then for a period, rayon became quite popular due to its increased tensile strength. Nylon was first used only as transverse fibres in cotton or rayon fabrics. Then with the development of heat setting processes and special weaves of fabric to reduce belt elongation in service, nylon received much greater use as the longitudinal member. It has good resistance to moisture plus excellent abuse and impact resistance, making it an outstanding construction for all types of service. Polyester has many of the same qualities as nylon with slightly better moisture resistance and is becoming increasingly popular for applications where impact is not of prime importance.

Open mesh fabric or spaced cord plies are sometimes used as breakers under a belt cover, and this increased adhesion of cover to carcass may help distribute impact forces. The treatment given synthetic fabrics along with special fabric weaves has greatly increased belt cover adhesions. Due to this, breakers are not used as much as they once were.

Groups 1 and 3 have fallen into disuse in this country, however, they are still used in some countries where certain properties are required.

The second group are the materials which predominate in South African manufactured belting as they are more suited for the punishing conditions experienced in our mining operations.

Group four respresents steel cord conveyor belting made up from high tensile wire, spun into ropes of 10mm diameter and more. The use of such belting has grown enormously in South Africa since the mid 1970's.

2.3.2.1 Properties

In the comparison of the various materials we shall also include cotton as the only natural fibre, because this material is still being used as reinforcement for some conveyor belting and as an indication of the superiority of man-made fibres.

2.3.2.2 Breaking Strength

An important design parameter is the breaking strength i.e. the force required to break the yarn. This force is expressed in Newton (1kg force = 9.81 Newtons). Since the total breaking strength is influenced by the yarn count, calculations are based on the specific strength or tenacity, which is expressed in mN/tex. For steelcords the relative strength is commonly expressed in N/mm^2.

An illustration of the relative yarn strengths of 4 reinforcing materials is shown in figure 1. The relative strength is expressed both in tenacity (mN/tex) and tensile strength (N/mm^2).

2.3.2.3 Elongation

Elongation at break (i.e. the percentage elongation at the moment when the yarn breaks) is also a frequently used property. These values are shown in figure 2.

More important than elongation at break is the elongation at lower loads or working elongation. We could for example, ask ourselves :

"What is the elongation of a conveyor belt at a load of 10% of the nominal strength?" or

"What load should (or can) be applied to achieve a certain elongation?".

The load at a certain elongation is the modulus.

Useful information on this point is provided by the load - elongation curves, whereby the breaking strength has been set at 100 (see figure 3). It should be realised that modulus and elongation are dependent on the kind of material, however, within each material it is possible by means of processing to vary the elongation, modulus and shrinkage.

2.3.2.4 Resistance to Rotting and Influence of Moisture

Nylon and polyester, in contrast to cotton and rayon are fully resistant to rotting and the influence of moisture; steel will corrode after a period of time. A distinction should be made between brass-coated or galvanised steel. Braas coated steel is affected a lot sooner by moisture.

2.3.2.5 Classification

In accordance with S.A.B.S. 1173/77 the whole belt breaking strength of conveyor belts is expressed in kilonewtons per metre. The maximum permissible working tension being 10 per cent of the Class. The classification in lengthwise direction is shown in figure 4. As an example when a belt has a Class of 500kN/m, it could be made out of 2 plies of 250, 3 plies of 160 or 4 plies of 125. The belts in these cases would be designated Class 500/2, 500/3 and 500/4 respectively. The strength in the weft is less and varies from 20 to 40 per cent of the warp strength.

So far we have discussed the various carcass materials which are available, now we will explore the numerous constructions which are available in South Africa.

2.3.3 CARCASS CONSTRUCTIONS

Most conveyor belt carcasses are made of one or more plies of woven fabric. Some high-tension carcasses employ a single layer of parallel steelcords.

Conveyor belt fabric is made of warp yarns which run lengthwise, and weft yarns or filling, which run transversely. Four types of weave patterns are commonly used : plain weave, straight - warp weave, solid - woven weave and woven - cord weave.

Plain Weave. Most belt carcasses are formed with a plain weave; that is, the warp and weft yarns alternating across each other.
Since the warp yarns are the tension or load carrying members, the fabrics are designed with the dominant strength in this direction. This can be accomplished by using a greater number of ends per unit width of warp; by using larger, stronger yarns in the warp; or, in some instances by using a combination of both of these techniques.
Straight - Warp Weave. In this weave, the tension bearing warp yarns are essentially straight with little or no crimp. Fill yarns are laid above and below the warps, and the warps and the fills are held together with binder warp yarns.

Solid-Woven Weave. This weave consists of multiple layers of warp and fill yarns held tightly together with binder warp yarn.

The major types of conveyor belt carcasses on the South African market are :-

(a) One - ply type
(b) Two - ply type
(c) Multi - ply type
(d) Steelcord type

(a) One - Ply Type

One-ply type belts may be grouped into Solid-Woven and mono-ply belts.

Solid-Woven Belt

This is a carcass where 3 plies are interwoven to form a single one. The center-ply made from high tensile polyamide or polyester, carries the tension load and is protected by top and bottom plies made from wear-resistant cotton, thus serving in a way as protective covers. It is usually impregnated and covered with P.V.C. with relatively thin top and bottom covers, generally less than 1mm. Abrasion resistance is provided by the combination of P.V.C. and the top and bottom yarns of the fabric. Being fire - resistant it generally serves for underground coal - mining only.

Mono - Ply Belt

This is a straight warp weave with tensile strength up to about 630 kN/m rubber covered only.

(b) Two-Ply Type

For all-round conveyor applications. Tensile ratings from 160 kN/m to 1000 kN/m and in widths up to 1800mm.

The carcass is composed of two - plies of plain - weave fabric, either, of all - nylon or polyester - nylon construction (N.N. or E.P.) with an extra thick layer of rubber between them, thus providing properly engineered, highly effective load support. The need to specify extra plies of carcass fabric, merely to achieve satisfactory load support and impact resistance is eliminated. This belt can be spliced to an efficiency of 100 per cent. (See figure 7).

(c) Multi-Ply Type

The carcass of the multi-ply belt is usually made up of three or more plies of plain - weave N.N. or E.P. fabric which are bonded together by a rubber compound. Belt strength and load support characteristics vary according to the number of plies and the fabric used, but practical consideration limit the number of plies to a maximum of six.

Multi-ply and two-ply belts have been standardised by S.A.B.S. 1173 on the basis of classification according to the minimum full thickness breaking strength of the finished belting in kilonewtons per metre of width. Tensile ratings are from 160 - 2500 kN/m and widths up to 2 metres and more.

(d) Steelcord Type

Steelcord type conveyor belts are made with a single layer of parallel galvanised steel cords, completely imbedded in rubber as the tension element.

Steelcord belting is produced using a broad range of cable diameters and spacings, depending primarily on the desired belt strength. This belting is classified by its ST rating which is the minimum breaking strength in kilonewtons per metre of width. Tensile ratings are from ST500 to ST6300 which is 2,5 times that of the multi-ply fabric belt. However, not only can steel cords withstand much higher tensions than fabric plies, but the actual design of the modern - day, fabric - free, steelcord belt gives a considerably longer life, especially where heavy or sharp-edged material is to be conveyed. As the one layer of steel cords has, even with high tensions, limited thickness, the steelcord belt allows for the provision of very thick covers, up to 25mm in some cases.

Because of the all-rubber construction, this type of belt is eminently suited for deep troughing idlers, even very narrow belts can be troughed at 45 degrees. Their great strength and low elongation means that they can be operated on long distances with few transfer points, with shorter take-up limits and can be permanently spliced to an efficiency of 100 per cent. (See figure 5).

2.3.4 Belt Covers

Belt covers may be thought of as protection for the belt carcass. The covers must withstand the wear, cutting and gouging of the material being conveyed. The covers also may have to resist heat, oil, or chemical deterioration.

In a few cases, these conditions may be so moderate that no protection and no belt covers are required. In others, abrasion and cutting may be so severe that top covers as heavy as 20,0mm or more are required.

Rubber or rubber-like compounds are used for the top and bottom covers of conveyor belting and for bonding together various components of the belt carcass. These compounds are provided by mixing rubbers or elastomers with various chemicals in order to obtain reinforcement and to develop the physical properties necessary for service conditions.

By definition, an elastomer is an elastic, rubber-like substance. In the case of conveyor belting, the term is extended to refer to all the thermosetting materials which require definite times and temperature for cure, such as natural and synthetic rubbers, as well as such thermoplastic materials as polyvinyl chloride plastic (P.V.C.)

Many years ago, a range of tensile strengths and elongation was adopted by the rubber industry for establishing the quality of the grades of covers. At that time, only natural rubber was available; thus, tensile strength and elongation were the criteria for evaluating rubber compound quality. At the present time, however, there is a wide choice of rubbers or elastomers available, and each can be utilized alone or blended with others to obtain a great number of combinations with intermediate properties, particularly suitable for a wide variety of service conditions. The ranges of tensile strengths and elongation specified previously are no longer necessarily valid as measures of the quality of the cover and, specifically, of its abrasion resistance.

It is possible to classify covers by the basic elastomer used, but evaluation of the quality of the cover should be based on its suitability for particular service, rather than on the kind of elastomer it contains. Each cover has characteristics which, when properly utilized, will provide a conveyor belt for the lowest cost per unit of material carried under specified conditions of service.

Because the primary function of the cover is to protect the carcass, it must resist the wearing effects of abrasion and gouging, which vary according to the type of material conveyed. The top cover will generally be greater in thickness than the bottom cover, because the concentration of wear is usually on the top, or carrying side. The optimum design would mean that the covers would wear out in normal service at the same time as the carcass. This theoretical "total belt", failure after long and useful service will seldom be achieved, but the designer should seek this goal.

Since the carcass of a conveyor belt will fail very rapidly once the covers have worn away, a very small premium for upgrading quality or adding cover gauge may be well repaid in terms of overall belt life. Tables and suggestions are provided as guidelines for the designer, but experienced judgement in this area is the key. The final decision on cover gauge and quality must be tempered by the designer's knowledge of the application, or similar applications.

2.3.4.1 Top Cover

Ideally, it is desirable to furnish a cover quality and thickness where service life will match that of the carcass. Since there are so many possible variations of working conditions, such a selection is difficult and often is achieved only after experience with various combinations of carcasses and covers. Certainly, if experience with previous belts is on record, it should not be ignored. Loss of cover by abrasion with carcass relatively intact would indicate that succeeding belts could profitably carry a heavier or better quality cover. Severe cutting of the cover without serious abrasion loss would indicate a loading problem that would be helped by more cover but probably could be handled more economically by improved loading. Failure due to other causes with cover relatively intact would indicate either less cover or improvement of the conditions producing failure.

The object of any loading point is to introduce material to the belt in such a manner that the least cover wear is experienced. Ideally, material should approach the belt at the same velocity as the belt is travelling and parallel to direction of belt travel. Also, the material should have as little vertical fall as possible. Practically, however, such results are rarely obtained.

Loading on an incline can increase cover wear rate sharply compared to level loading. This is because of load turbulence and slippage as the load settles on the belt and reaches belt speeds. In one particular case where records were kept, a belt loaded on a 14 degree slope had top cover wear roughly three times greater than the belt onto which it emptied with level loading.

All the wear that occurs on a belt cover is not caused by the speed differential between material being loaded and the belt. This is evidenced by the fact that some long belts show as much cover wear as short belts conveying the same material as a part of the same belt system. The only logical explanation of such a result is that wear also must be caused by movement of the load on the belt as it passes over the idlers.

Idler spacing and belt tension must be kept in proper relation, and adequate transverse stability of carcass must be provided to try to hold this load-shifting wear to as low a value as possible.

Analysis of cover wear on worn belts generally shows cover wear in proportion to load depth; that is, top cover wear follows a pattern similar to the cross section of the load.

There have been a few rough rules used for predicting tonnage life of belt covers handling certain materials, particularly bituminous coal, where there is a considerable record of experience available. However, there are so many variables, even within the handling of a single material, that any worthwhile formula for determining tonnage life is next to impossible.

Some typical wear rates measured on Grade 'M' covers are as follows in millimetres per million tons :

Coal	:	0,025 to 0,050
Overburden	:	0,025 to 0,075
Aggregate	:	0,038 to 0,064
Ore	:	0,075 to 0,125

These of course are general figures because of the many variables that affect them. For example, measurements on a coal feeder belt showed cover wear to be as much as 0,17mm per million tons, which probably is the extreme high wear rate for coal.

2.3.4.2 Bottom Cover

The pulley side or bottom cover is generally lighter in gauge than the carrying side or top cover because of the difference in wear resistance needed. The bottom cover's primary function is to resist belt wear against the troughing idler rolls and pulleys. A thicker bottom cover also helps cushion a heavily loaded belt over the troughing idler rolls.

Bottom cover quality is almost always the same as that of the top cover. Recommended bottom cover gauges are as follows :

1. Up to 750mm width : 1,6mm
2. 750mm width and over : 1,6 to 2,5mm
3. Steel cord belts are dependent on cable diameter.

If previous belt history includes failure due to bottom cover wear, use the heavier gauge lacking belt history, excessive material spillage on the return run or sub-standard maintenance also indicates the use of heavier gauges. However, efforts should first be made to prevent spillage and to improve maintenace. Highly stressed belts such as steel cord usually justify the extra protection of a heavy bottom cover.

2.3.4.3 Edge Cover

High adhesion levels, and the fact that conveyor belts constructed with nylon or polyester carcasses are unaffected by moisture, prevents ply separation at the edge. This means that it is no longer necessary to specify edge covers as was the case with the older cotton - duck type fabric belts.

3.0 OPERATING TENSIONS AND FACTOR OF SAFETY

S.A.B.S. 1173 which covers general purpose textile reinforced belting defines maximum working tension as the tension in kilonewtons per metre equal to 10 per cent of the minimum full thickness breaking strength of the belting. However, the value of the safety factor will depend on the conditions governing specific installations i.e. the maximum working tension of a Class 1000 belt will be 100kN/m.

At present there is not an S.A.B.S. standard available for steelcord belting, however, the generally accepted factor of safety is 6,7 : 1. In order to use this factor it is normal practice to seek the approval of the belt supplier.

As a guide, the following factors of safety may be used :

Carcass Construction	Operating Tension	Starting Tension
Nylon/Nylon (N.N)	10 : 1	7,0 : 1
Polyester/Nylon (E.P.)	10 : 1	7,0 : 1
Steelcord (ST)	6,7	5,0 : 1

Adverse environmental service factors such as heat, acid, etc. will most likely lead to an increase in the above factors of safety.

4.0 SPLICE LIMITATIONS

Conveyor belts can be spliced endless by means of metal fasteners or by vulcanising. The plate - type fastener has a pull-out strength that is somewhat less than the strength of the belt itself, however, individual belt manufacturers should be consulted in this respect.

Belts of steel cord construction are made endless by vulcanised splicing only. A calculated dispersal of the cut ends and overlapped cables in the splice area makes the strength in the splice as great as the sum of the strength of the individual cables in the belt. (Fig. 5)

Fabric belts can also be vulcanised endless with a vulcanised splice. While this method does not provide a splice as strong as an undisturbed belt section, it is very strong and is free of local stresses. In any one section of the splice, only one of the plies will be discontinuous; hence, the greater the number of plies, the greater the tensile efficiency of the splice. Use of this type joint increases the permissible tension rating as compared to a fastened joint. (Fig. 6)

For splicing of 2 ply belts the "JUMP" type splices as illustrated in Fig. 7, is recommended as this type of joint provides 100 per cent efficiency.

5.0 SAFETY DEVICES AND REPAIR FACILITIES

With all the safety devices such as pull cords, belt limit switches, chute plugging switches, drive pulley belt slip switches, magnetic detection and magnetic removal of tramp irons etc., belt conveyor operation has become quite automatic. A belt conveyor of several kilometers in length may require only two or three men for operation or maintenance.

However, there is one type of accident for which preventive equipment has long been necessary. If some type of tramp iron, loosened steel skirt, or loosened scraper penetrates through the belt and becomes wedged at a transfer or loading point, a long length of expensive belt may be slit entirely. This is because the wedged material can follow and be guided along between two cords in a steel cord belt or between groups of warp (lengthwise) strands in a fabric ply belt. Especially where long, expensive belting is used, some type of rip detection device should be available for stopping the belt if a rip gets started. Recently domestic as well as some overseas belting manufacturers have such devices and have had them installed for in field service.

Specially trained crews should be employed to carry out splicing and repair operations. As in all other things the choice of vulcaniser and auxiliary equipment is of prime importance and such units should be checked out regularly to ensure availability at short notice. Don't overlook the possibility of using "cold" vulcanisation in addition to or in combination with "hot" or conventional vulcanisation in effecting such repairs.

Regular consultation with the belting manufacturers will ensure your being kept up to date with respect to better methods and materials for this most important aspect of operation. Such repair crews should always be engaged in a regular schedule of preventive maintenance, so that trouble if and when it does occur will be contained within manageable limits. Finally, particular care should be taken with the storage of belt repair materials, particularly in areas of difficult climatic conditions, here the instructions of the supplier should be strictly adhered to.

6.0 CONCLUSION

I have attempted to cover the broad field of conveyor belting with its peculiarities, types of materials required and history as briefly as possible and this leaves me to close with a few words about the future.

The future is certainly not stagnant. New fibres have been developed, which are stronger than steel and have already been built into conveyors for field evaluation.

Steel wire, originally designed for the tyre industry, is being woven into a mat for use in conveyor belting.

A priority exists in Development and Research Centres to produce longer wearing belt covers, stronger fabric carcasses with more impact resistance. I can confidently predict the rubber industry will continue to make a major contribution to the further development of belt conveyor systems.

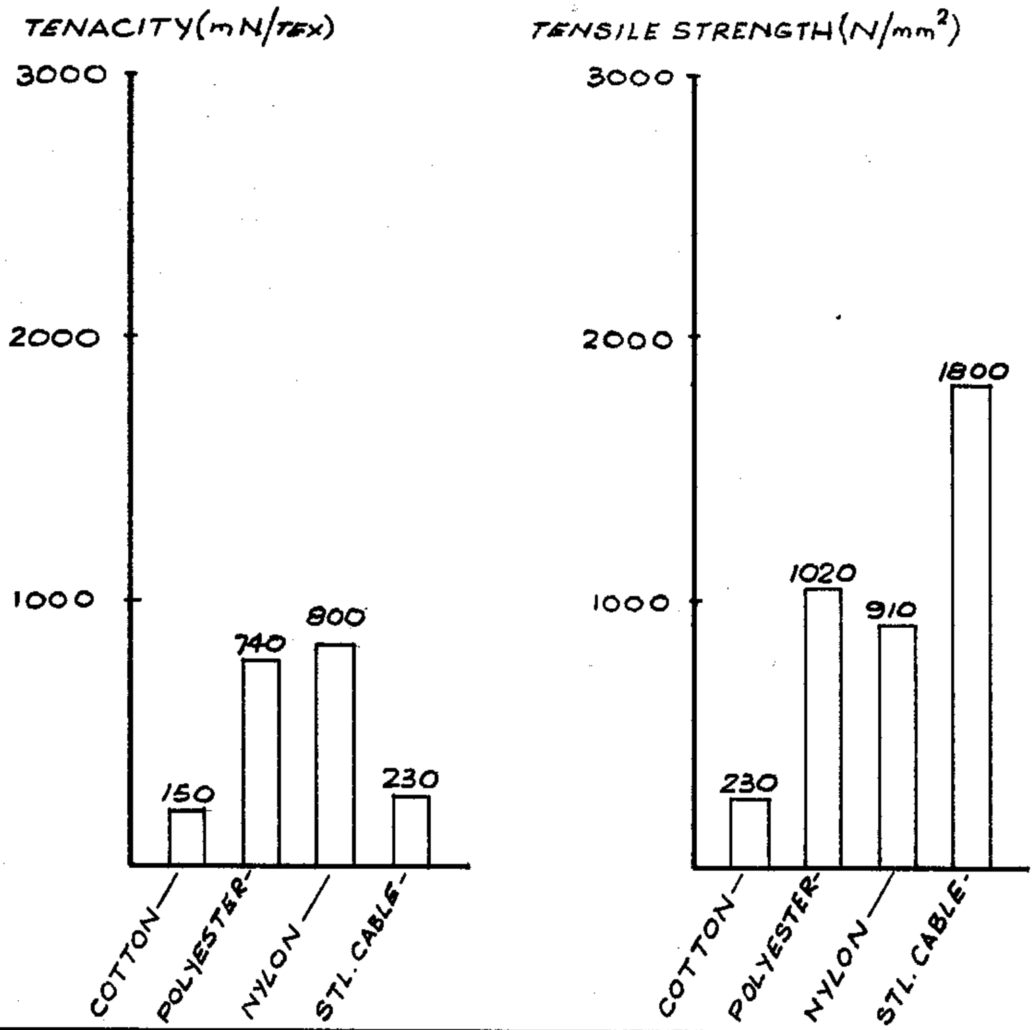

FIG. 1 RELATIVE YARN STRENGTH OF 4 MATERIALS

ELONGATION AT BREAK IN %

COTTON	3 - 7
POLYESTER	10
NYLON	16
STEEL CORD	2

FIG. 2 ELONGATION AT BREAK

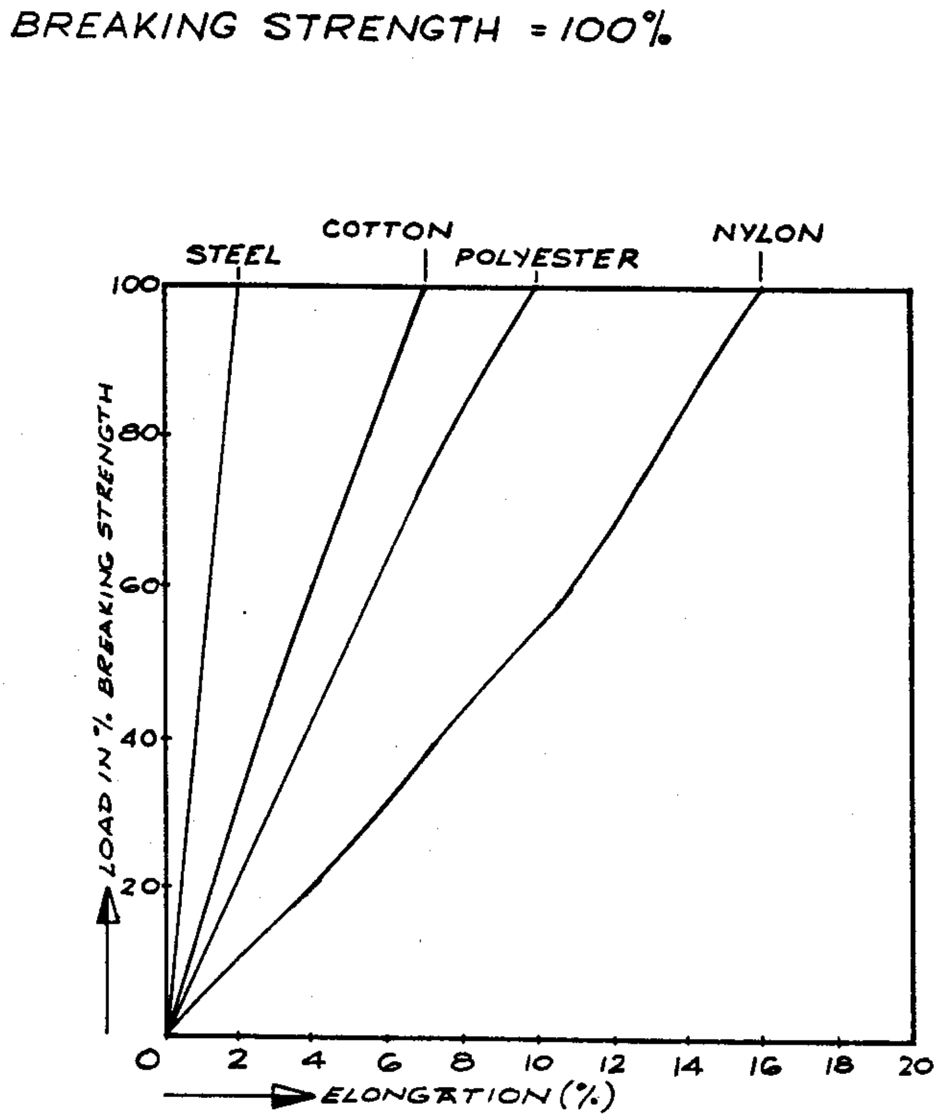

FIG. 3 STRESS STRAIN CURVES OF 4 MATERIALS

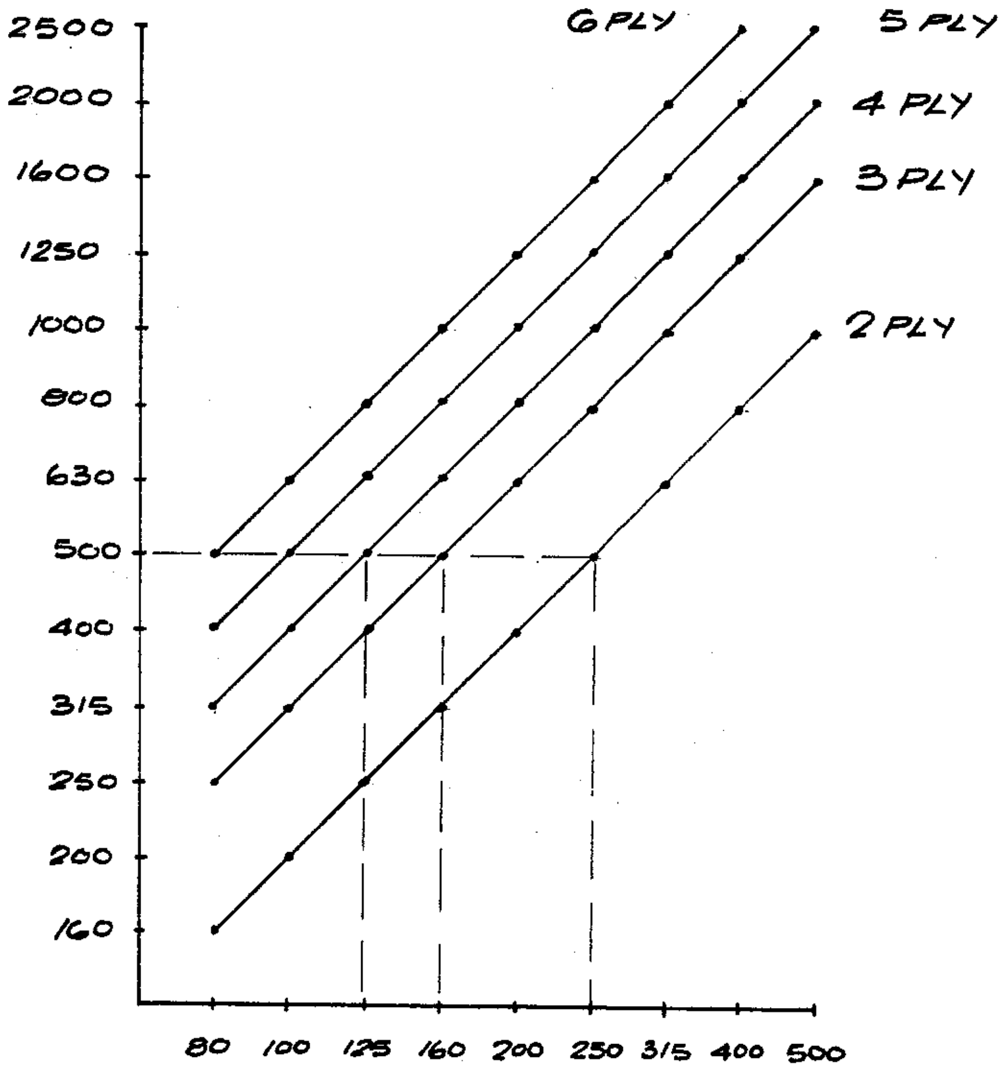

FIG. 4 BELTING CLASS AND FABRIC STRENGTHS

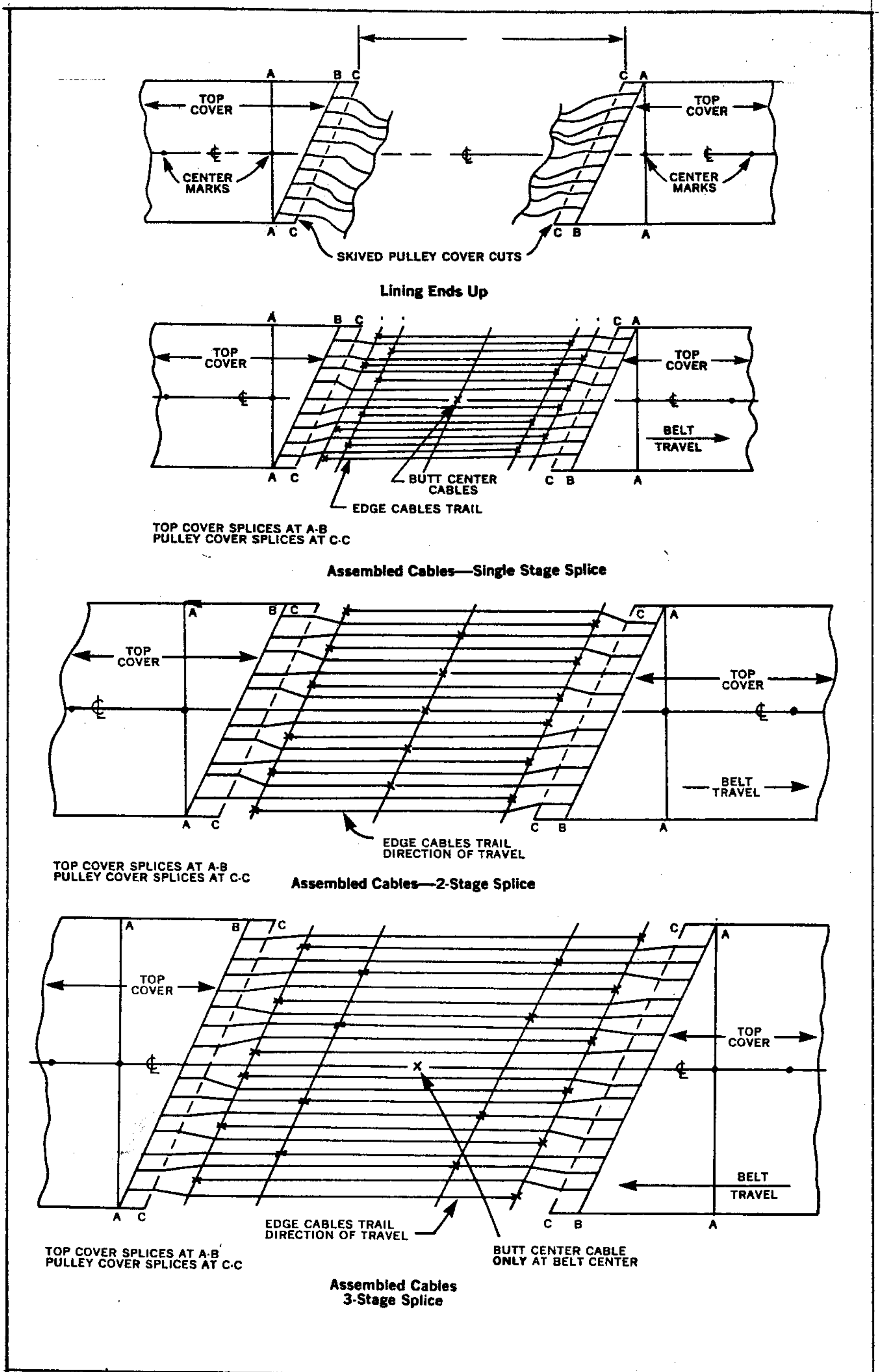

FIG. 5 ARRANGEMENT OF STEELCORD SPLICES

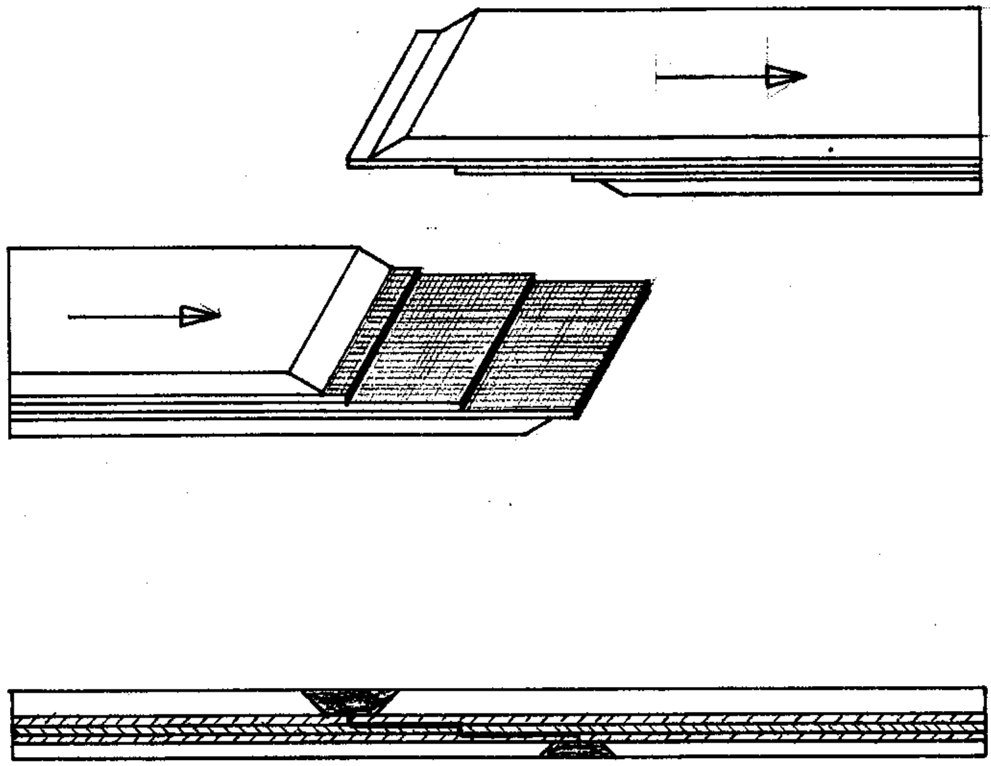

FIG 6 STEPPED MULTI-PLY SPLICE -3 PLY

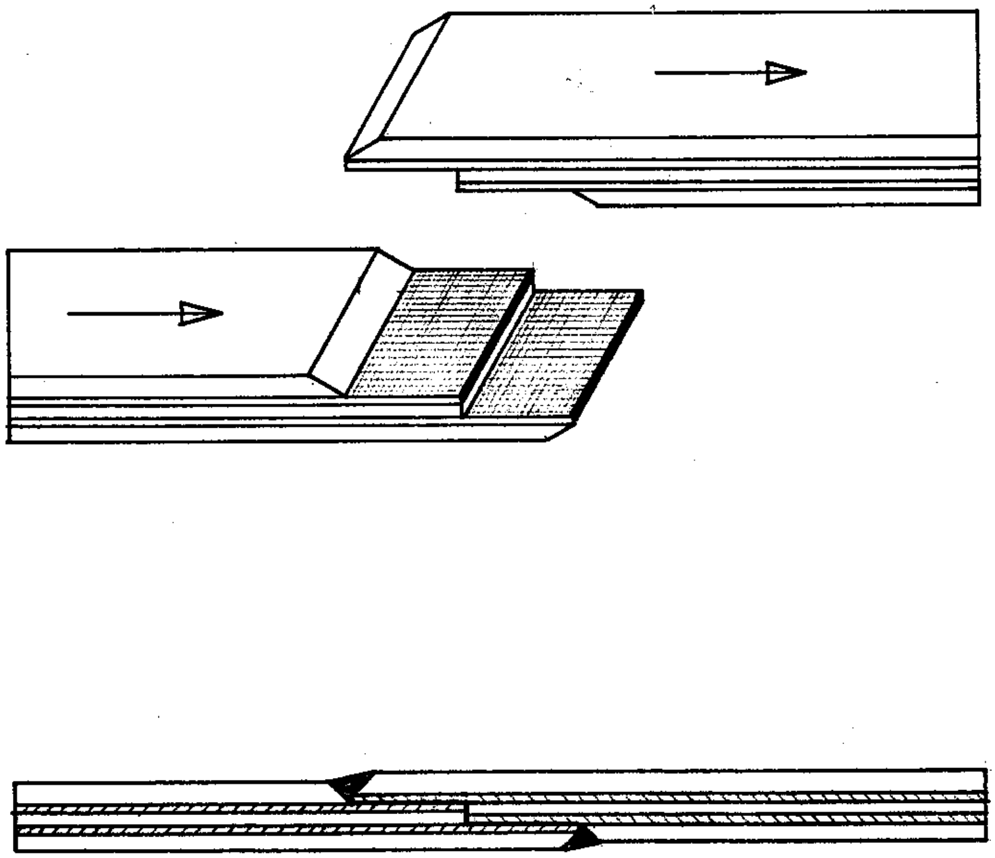

FIG. 7 STEPPED 'JUMP' TYPE SPLICE -2 PLY