SPLICING METHODOLOGY

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INTRODUCTION

A poorly executed splice could lead to premature splice failure causing unplanned downtime, damage to structures and equipment and possibly injury or loss of life.

Splicing is easy. A safe and effective splice is however, not that straightforward or easy. This paper attempts to highlight the importance of the correct splicing methodology on the three most common types of conveyor belting– steel cord, plied and solid woven.

The splice is the weakest part of the conveyor belt and it must be borne in mind that the maximum strength of a well-executed splice on plied and PVC belting is between 65% to 80% of belt strength. In a steel cord reinforced belt the splice has a maximum strength of 85% to 100% of the belt strength.

During recent years a number of companies have adopted their own splicing procedures and standards. These usually involve increasing splice lengths to achieve better efficiency of the splice. The major limitations here are the size of the available equipment and the time required.

Although the SANS specification does not contain the actual splicing methodology or procedures, it does offer guidelines as to the practices that will enable the splicer to perform a stable, effective and SAFE splice.

Splice training covering the actual methodology described in this paper is offered by most reputable conveyor belt manufacturers, manufacturers of splicing materials as well as the Conveyor Manufacturers Association (CMA).

It must be stressed that it is the end user's right to demand that splicing be performed according to a certain specification, whether it be their own in-house specification or one of the internationally recognized specifications like SANS or DIN.

If the selected service provider cannot adhere to these specifications – GET ONE THAT CAN.

It is in the end user's own interest to insist on adherence to a specification like SANS as this ensures full traceability of product and splice quality.

As specified in SANS 484-1 and 2, SANS 485 and SANS 486:

1. General
2. Layout – Splice pattern
    a. Plied belting — SANS 484-1:2009 Sec 4 – Hot
       SANS 484-2:2009 Sec 4 - Cold

b. Steel cord belting SANS 489:2009 Sec 4

c. Solid woven belting SANS 486:2009 Sec 4

3. Splicing Methodology
    a. Plied belting
    b. Steel cord belting
    c. Solid woven belting
4. Practices not permitted
5. Situations where splicing is not permitted
6. Rejection criteria
7. Reports

1. GENERAL

The properties of the parent belt shall be pre-determined and this information shall be supplied by the mine to the splice contractor in order to ensure compatibility of the raw materials with the parent belt.

2. LAYOUT

Splice shall be constructed in accordance with the requirements as indicated in the SANS specification.

PLIED BELTING

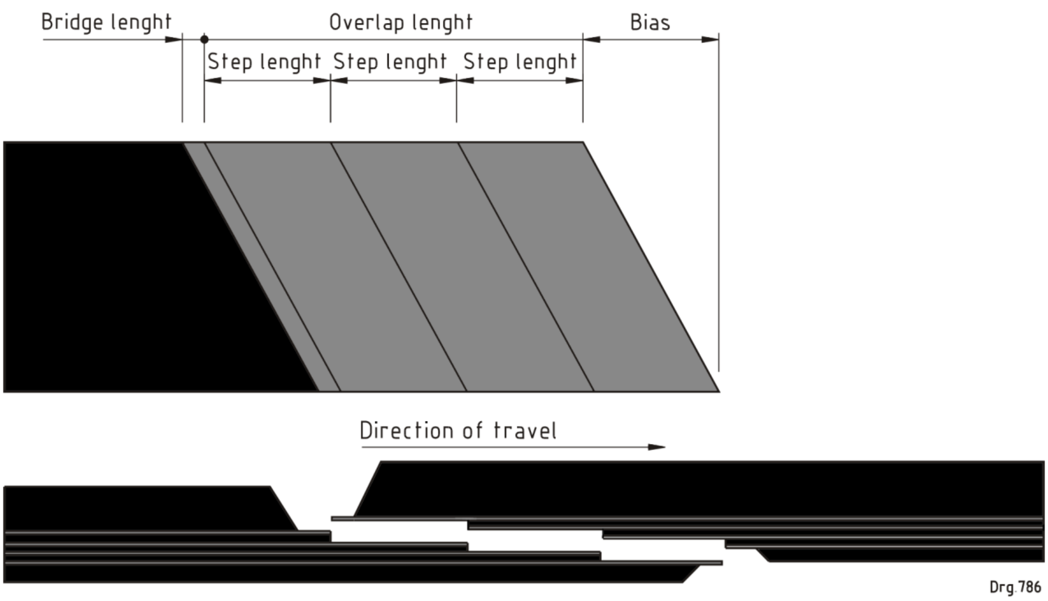


Figure 1. Recommended measurements for plied belting

Minimum step lengths shall be in accordance with Table 1.

1	2	3	4	5	6	7
Minimum splice step lengths						
Belt class	**Splice allowance**[a]	**Number of plies per belt**				
		2	3	4	5	6
160	B	300				
200	B	300	250			
250	B	300	250	250		
315	B	300	250	250		
400	B	300	250	250	250	
500	A	250	250	250	250	250
630	A	300	300	250	250	250
800	A	400	400	300	250	250
1000	A	500	400	400	300	250
1250			450	400	300	300
1400			450	450	400	300
1600				450	400	400
2000				450	450	400
2500					450	450

[a] The splice allowance is expressed in millimetres.

The types of splice allowance are:

a) 2-ply jump slice: allowance = (2 × step length) + 50 + $W \cdot \tan\theta$.

b) Multi-ply splice: allowance = ((N-1) × step length) + 50 + $W \cdot \tan\theta$.

where

θ is the press bias angle;

W is the belt width;

N is the number of belt plies.

Table 1. Class of belt and step lengths

STEEL CORD

4.2.3.1 Stage 1:g Centre cord(s) butted. Lay cords laid alternately from each belt end, starting with the trailing end, working from centre outwards (Figure 2).

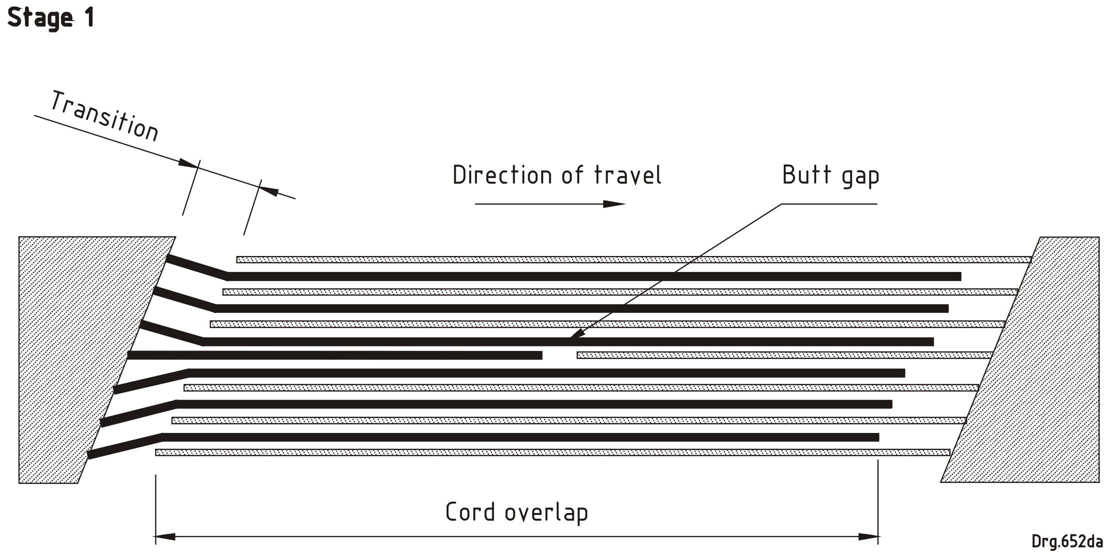


Figure 2. Common splice pattern Stage 1

4.2.3.2 Stage 2: Centre cord(s) butted. Lay cords alternately from each belt end, starting with the trailing end, working from centre outwards. Butt every second cord from each end in the centre of the splice.

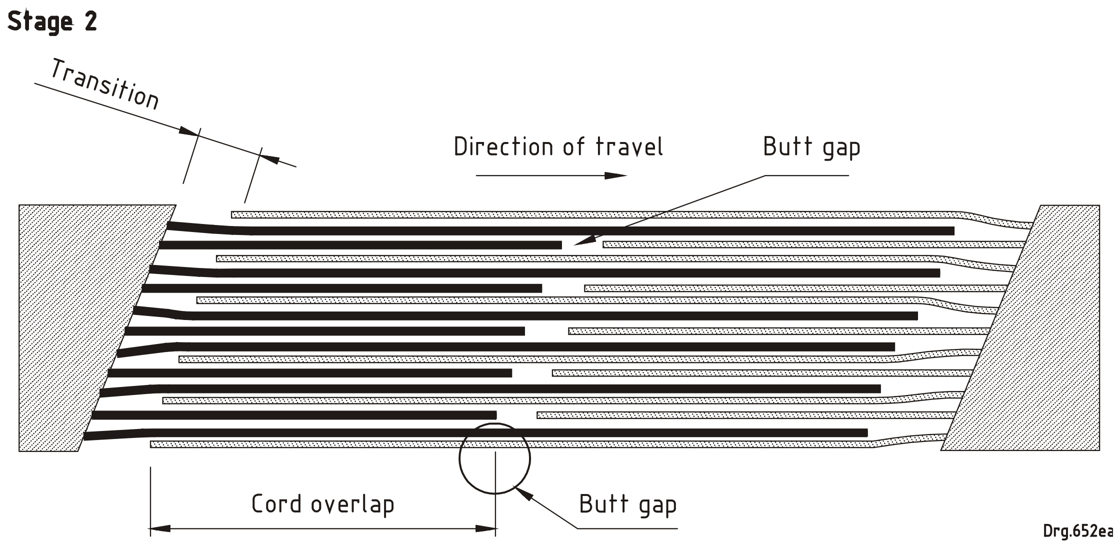


Figure 3. Common splice pattern Stage 2

4.2.3.4 Stage 3: Centre cord(s) butted. Lay cords alternately from each belt end, starting with the trailing end, working from centre outwards. Butt every second and third from each side at one third of splice length (Figure 4).

Stage 3

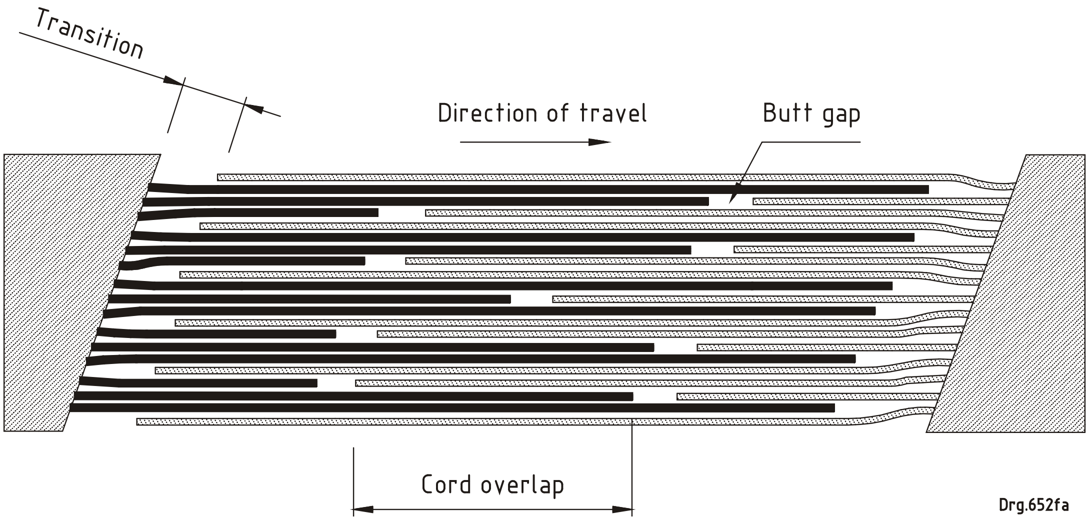


Figure 4. Common splice pattern Stage 3

NOTE 1 Stage 3 splice is used for high strength belts and where the cord spacing precludes (or both) lower stage splice layout.

NOTE 2 Higher stage splices are necessary where cord spacing is insufficient to allow a stage 3 splice. The layout of higher stage splices should be obtained from the belting manufacturer.

The splicing of belts with different cord counts, for example, 107 cords matched to 114 cords are given in Figure 5.

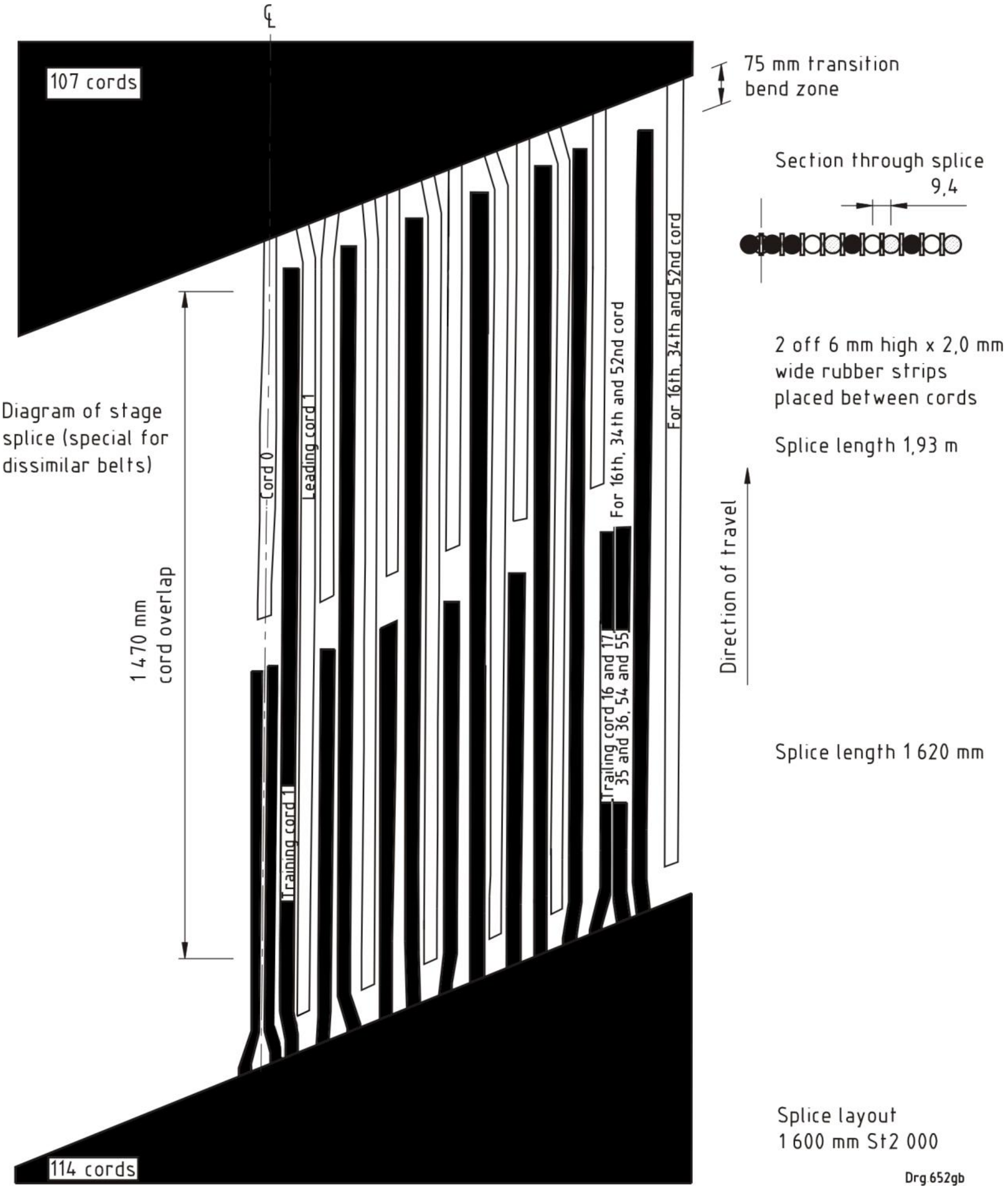


Figure 5. Example of a splice pattern

The number of stages per class of belt shall be in accordance with Table 2.

1	2	3	4	5
Class	**Number of stages**	**Minimum step length** mm, min.	**Butt gaps** mm, min.	**Transition zone** mm, min.
St500	1	550	-	50
St630	1	550	-	50
St800	1	550	-	50
St1000	1	700	-	75
St1250	1	700	-	75
St1400	1	850	-	100
St1600	1	850	-	100
St2000	2	550	25	125
St2500	2	700	25	125
St3150	2	900	25	150
St4000	*	*	*	*
St5000	*	*	*	*
St6300	*	*	*	*
* Obtain information from the belt manufacturer.				

Table 2. Class of belt and stages

SOLID WOVEN BELTING

Splice pattern shall be in accordance with Figure 6. The centre line of the finger triangle shall be parallel to the centre line of the belt. The finger forms the interlacing stress transfer medium of the splice.

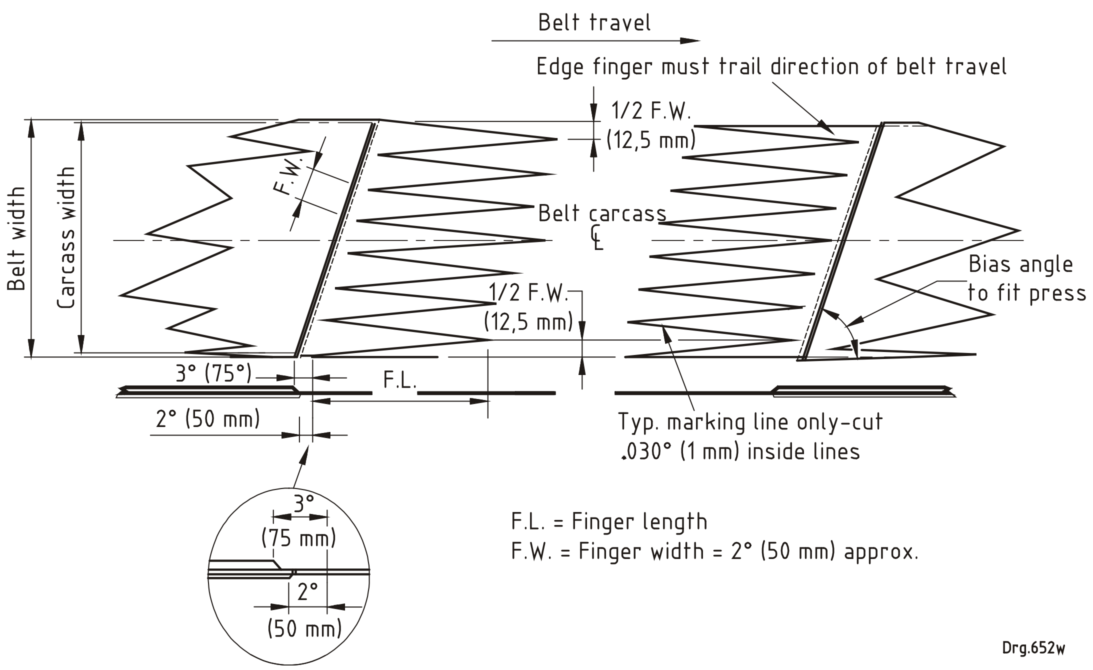


Figure 6. Splice pattern diagram

Minimum finger lengths shall be in accordance with Table 3.

1	2	3
Finger splice length and base		
Tension Rating kN/M	**Finger Length** min (mm)	**Finger Base** min (mm)
630	600	50
800	750	50
1 000	900	50
1 250	1 100	50
1 400	1 300	50
1 600	1 500	50
1 800	1 700	50

Table 3. Minimum finger lengths

3. SPLICING METHODOLOGY

PLIED BELTING HOT VULCANISATION

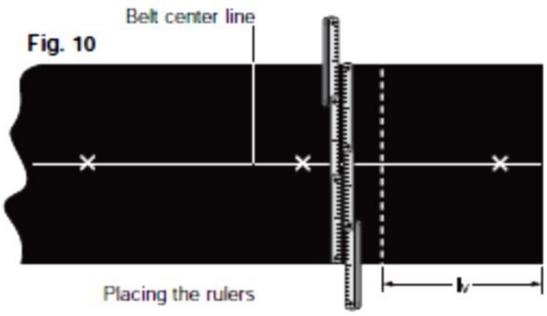
1. Establish and mark centre line of the belt by measuring across the width of the belt at three points in the length of each belt end at a distance of approximately two metres. At least two centre marks on each belt must be outside the splice area.

   The establishment of the centre line is easiest done with two rulers as indicated below.

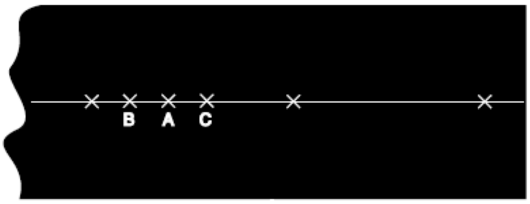
   The three centre markings on each belt end are then connected by means of a chalk line which represents the belt centre line. This centre line ensures exact alignment of the belt ends, which is crucial for straight belt running.

   The centre line outside the splicing area must be durable enough to remain visible throughout the entire splicing process.

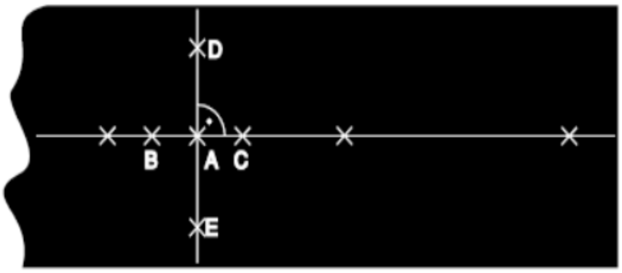
Fig. 10

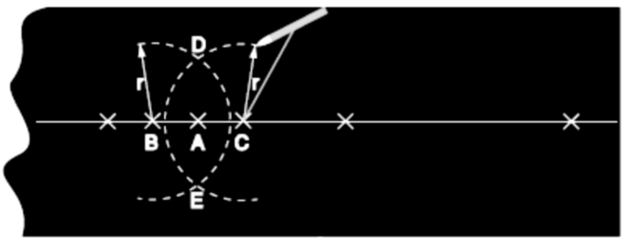


2. Establish a perpendicular reference line across both ends outside the splice area. On narrow belts this can be done by placing a metal square on the centre line.
   On wide belts it is recommended to establish the reference line as follows: Outside the splice area, select a point A on the centre line. Mark points B and C on the centre line equidistant to point A. (AB = AC)

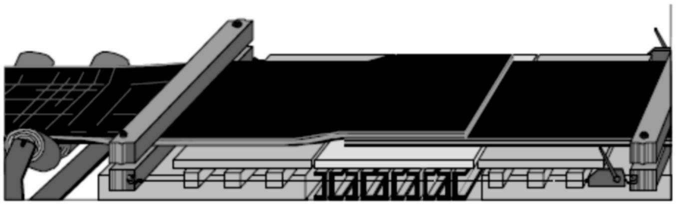


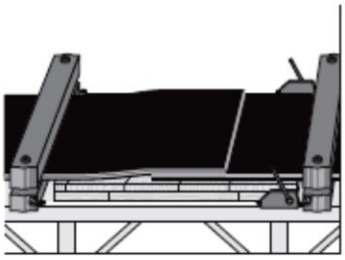
3. Now describe a circle with the same radius around points B and C by means of a plumb line and a pen. The points of intersection of both circles must still be on the belt. (These intersection points are D and E).
   A line drawn between these two points will be perpendicular to the belt edges and forms the reference line, which should pass through point A.



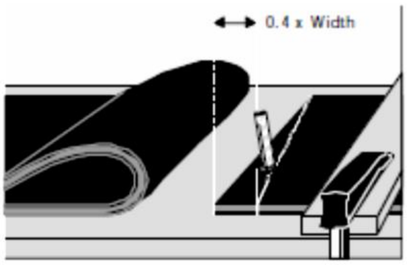


4. Using the centre lines, align the two belt ends and overlap. Overlapping area has to be splice length plus bias cut. Secure belts in this position.



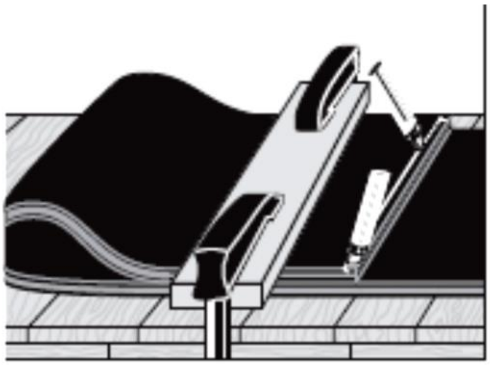


5. Fold back upper belt part and make bias cut on the lower part.

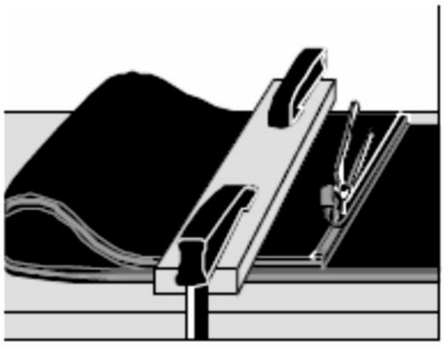


6. Fold back the lower part of the belt and draw a line parallel to the bias cut on the bottom cover side at 25 mm from the belt end.
   Also mark the rubber edges to be preserved.

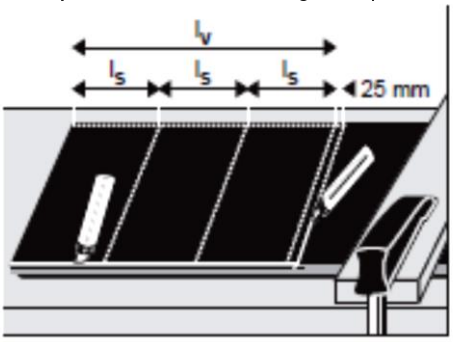
   Cut belt cover along the line with a Don Carlos knife held at an angle of approximately 45°.



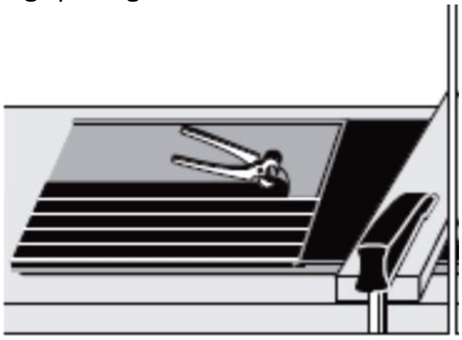
7. Using pincers, strip the cover (thus preparing the future joint gap).



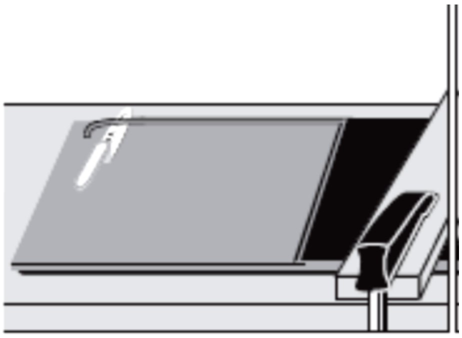
8. Fold back the lower part of the belt again and mark the splice length (Lv according to the chart), step length and rubber edges. Draw another line 25 mm parallel to splice length line. Cut the top cover along this line with a Don Carlos knife held at approximately 45°. Avoid cutting the plies!



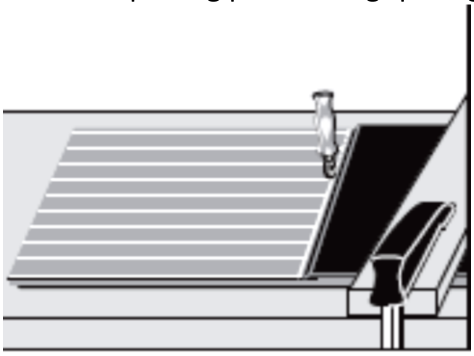
9. Cut the top cover in narrow strips (approximately 20 mm – 30 mm wide) and strip using pincers or grip tongs.



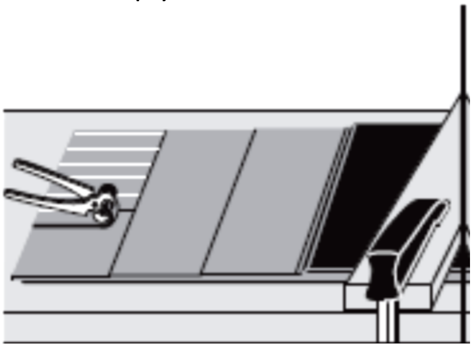
10. Cut the rubber edges off the conveyor belt flush, using an offset knife.



11. Score the top fabric ply with a ply knife 25 mm from the top cover, detach this ply using a ply lifter and strip using pincers or grip tongs.



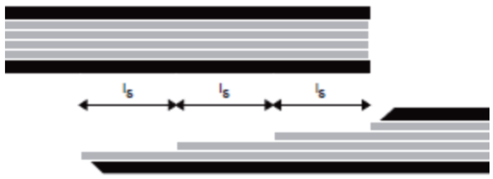
12. Mark subsequent fabric plies according to step length (Ls), score them and strip them off. The last fabric ply has to be retained.



13. Superimpose the belt ends ensuring correct alignment. Exactly transfer the cut edge of the top fabric ply of the lower part to the upper part.

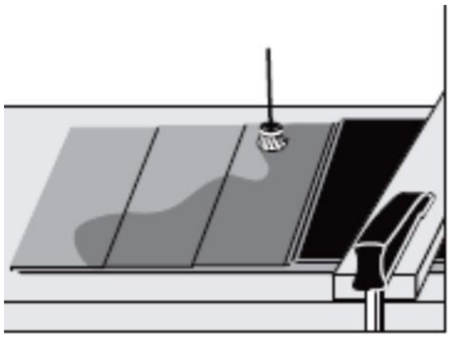
Transfer the subsequent fabric steps of the lower part to the upper part. (Make marks with marking crayon on both edges of the belt.)

Fold back the upper part of the belt, secure and prepare the same as lower part of belt.

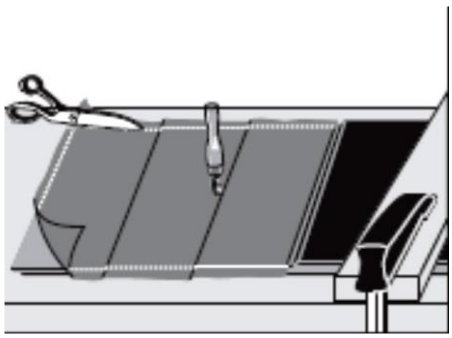


14. Carefully buff the edges of the covers and the surface of the rubber edges with a buffing tool (e.g. rotating wire brush).

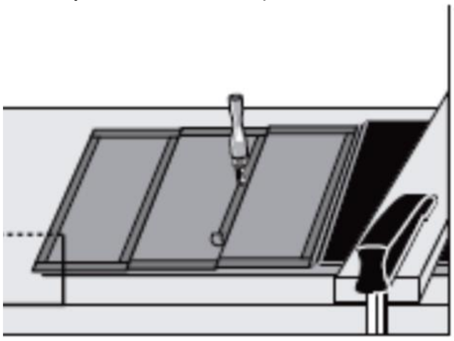
15. Buff the intermediate rubber and buff any uneven spots.
 When buffing take care not to scorch or smear the rubber or leave any shiny spots on the rubber.
 Buff around the edges of the fabric steps, without damaging the fabric.
16. Carefully remove the buffing dust using a dry brush.
17. Thoroughly stir the required amount of heating solution and apply two coats to the whole splicing area and the joint gaps of both belt ends. use a brush with short bristles.
 Let the first coat dry (approximately 30 minutes at 20°C), until it is slightly sticky (check with the back of your finger).



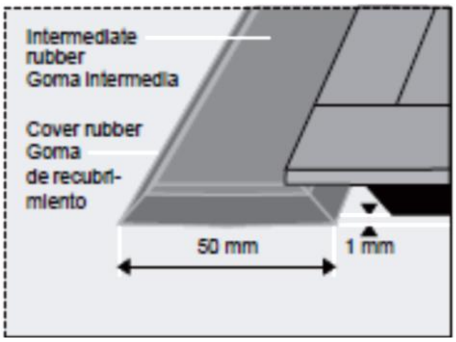
18. Cover the fabric steps of the lower belt part with uncured intermediate rubber.
 Stitch the rubber using a 4 mm stitcher working from inside out. Cut the intermediate rubber to size and remove protecting foil.



19. Cover the rubber edges and fabric steps with a strip of uncured intermediate rubber (approximately 10 mm wide.)



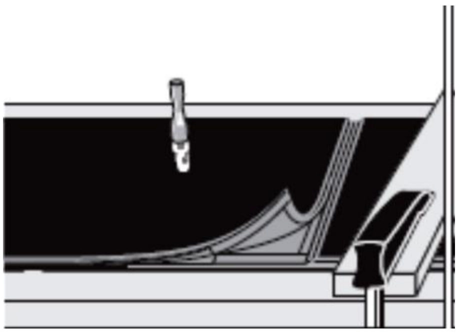
20. For the joint gap on the bottom cover side, cut to size an exactly fitting filler strip consisting of uncured intermediate rubber and uncured cover rubber.
    The applied filler strip must be 1 mm thicker than the rubber of the cover of the belt.



21. Superimpose the upper and lower belts, aligning them exactly and avoiding air entrapment.
    The splicing areas have to match exactly.

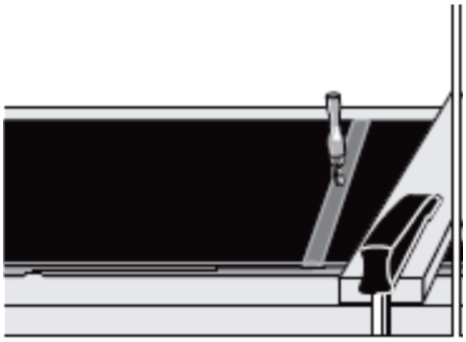
    Do not superimpose fabric joints which are on the same level.

    Press or stitch the entire splicing area from the centre outwards.



22. Apply one strip of uncured intermediate rubber to the joint gap on the top cover side, fill the gap with uncured cover rubber and stitch vigorously. Trim excess filling rubber flush with the belt using offset knife.
    Apply a strip of cover rubber approximately 60 mm wide and 1 mm thick, to the filled joint gap.

    Stitch thoroughly and cover with silicone paper.



23. Vulcanize as prescribed. Mark splice and complete required checks and quality documentation.

PLIED BELTING COLD SPLICING

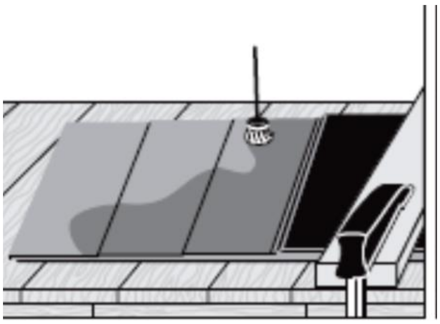
For the cold splicing method – follow steps as described in hot vulcanization method up to step 16.

1. Thoroughly mix cement with hardener.
   IMPORTANT: This mixture must be used within 2 hours (Pot life). Observe working and safety instructions.

   Apply two coats to the whole splicing area and the joint gaps of both belt ends. (Use a brush with short bristles).

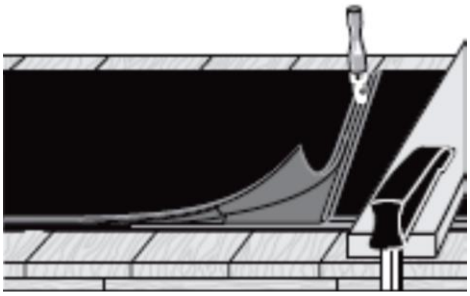
   Let the first coat dry completely. (Minimum 30 minutes).

   The second coat must be allowed to dry only until it is still slightly sticky when checked with back of finger.

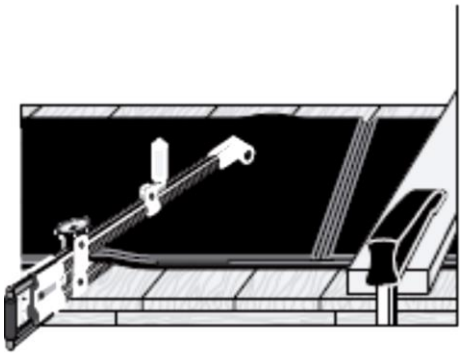


2. Align and superimpose lower and upper part of the belt without trapping air.
   Splice areas must match each other exactly.

Never overlap fabric ply edges.
Stitch on or press the entire splice area from centre outwards.
Stitch on the edges and joint gaps with narrow stitcher (4 mm).



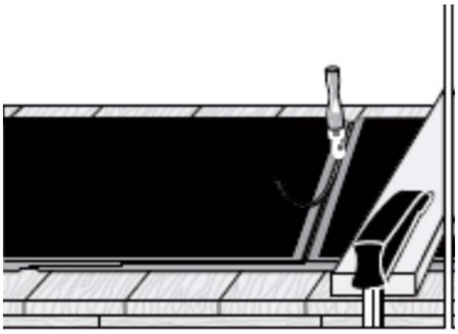
3. Stitch the entire splice area using a double acting roller with pressure screw tightened lightly at first.
   Repeat this operation several times with pressure screw fully tightened.



4. Coat joint gaps once with cement/hardener mixture and allow to dry completely.
   Cut to size suitable pieces of filler rubber and coat the joint gap and filler rubber with cement/hardener mixture.

   Allow this coat to dry till slightly sticky (check with back of finger).

   Apply filler rubber and stitch on.

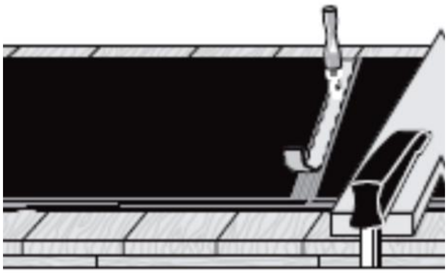


5. Coat the joint gap with cement/hardener mixture.
   Remove protective foil from cover strip.

   Coat the bonding layer of cover strip with cement/hardener mix.

Allow these coats to dry till slightly sticky.

Apply cover strip without trapping air.
First stitch lightly with wider stitcher and then firmly with narrow stitcher.
Repeat this process on second splice gap.



6. Cut even belt edges.
   Mark splice.

   Complete checks and quality documentation.

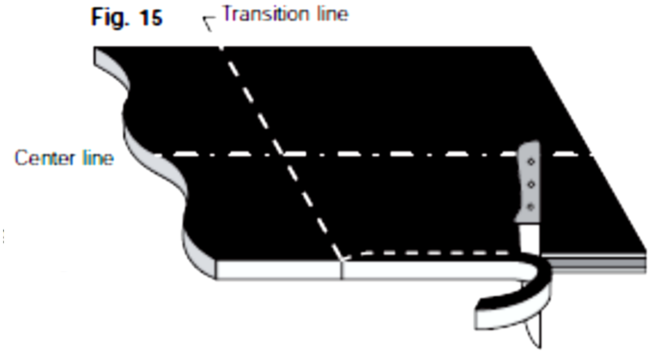
Note:
Belts subjected to light loads and relatively low tensions can be tensioned and put into operation after two hours.

A heavy duty belt should be allowed to stand without load for a minimum of six hours.

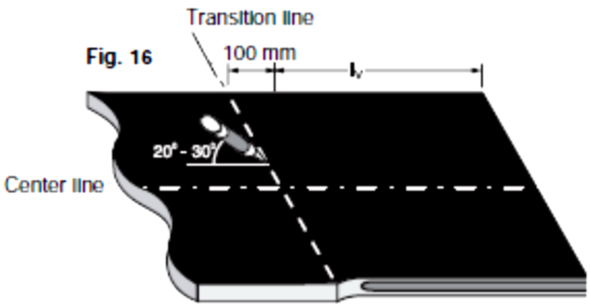
STEEL CORD BELTING

1. Centralize belt and secure as described in plied belting method.
   Cut off the rubber edges along the outer steel cables from transition line to belt ends with a long knife (See below).

Fig. 15



2. Bevel cut through top cover down to steel cables along the transition line using a Don Carlos knife held at an angle of approximately 30 degrees.



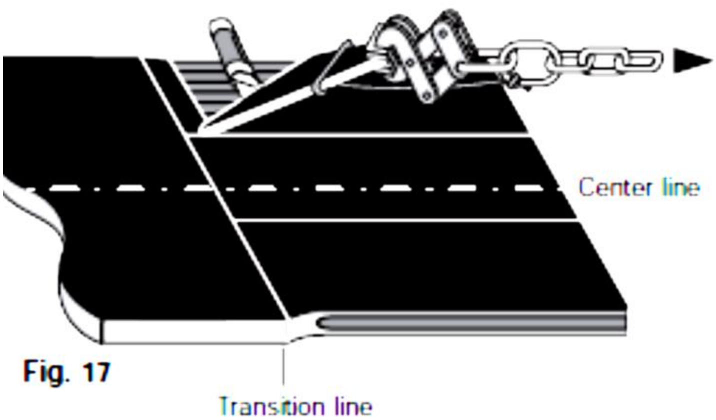
3. Remove top cover and strip steel cables.
   Cut the rubber covers on the carrying and running side into parallel strips with a Don Carlos knife (400 mm – 700 mm wide according to belt width) in the direction of the cables.

   Lift the rubber covers with pincers at one corner of the strip in the area of the transition line and cut it free with the Don Carlos knife just above the steel cables, until the rubber can be gripped with a vice grip.

   By means of the vice grip, a winch and continuous cutting (just above the steel cables) the complete rubber cover is removed. (See below).

   When cutting off the rubber cover, hold the knife at an angle so that the steel cables remain covered in rubber.

   The exposed carcass must be protected from contamination and placed on a clean surface (PE film).



4. After having removed the covers on both sides of the belt, cut out the rubber between the cables with a 6“ knife to within 10 mm – 20 mm of the beveled transition zone. (See below).

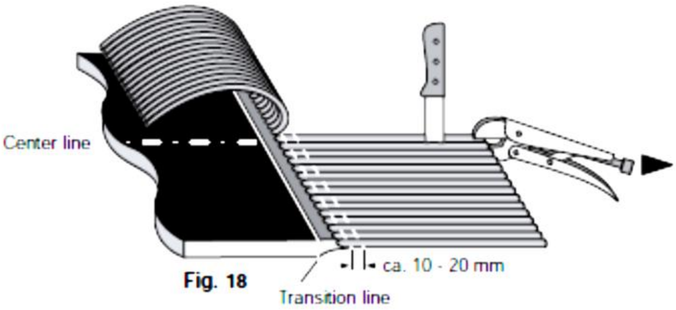
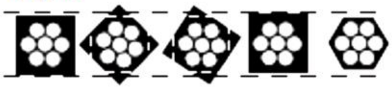


Fig. 18

5. The stripped cables should still be covered with rubber (cubed cable rubber). On cables that are strongly twisted, the corners should also be trimmed. (See below).

Fig. 19



6. Cables with a diameter of 8 mm or more:
   Before cutting out the rubber between the cables, notch the rubber between the cables at an angle of approximately 45°, resulting in a hexagonal rubber. (See below).

   Stripped cables should be handled with clean gloves only and placed onto a clean surface (PE sheet).

Fig. 20

7. Carefully buff the rubber-embedded cables with a grooved wire brush. Avoid overheating, shiny spots and scorching the rubber. Buffing will automatically break the edges of the cubed cable rubber. Non-adhering or loose rubber has to be removed. A minimum of bare metal should be exposed. A very small amount of such exposure can be tolerated. The strength of the splice depends on the level of cable adhesion to the original rubber embedding it. The new tie rubber bonds to the original cable rubber. The splice strength depends on the shear adhesion of the rubber to rubber bond, rather than the rubber to metal bond.

   Damaged, corroded or bare cables have to be buffed until bright. An excessively damaged cable has to be removed. In case of several damaged or corroded cables the supervisor and customer should be informed immediately, and will have to decide whether the splicing should continue, the splice started from scratch or a new belt pulled in. The number and condition of damaged cables should be noted in the splicing records.

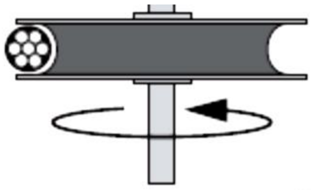
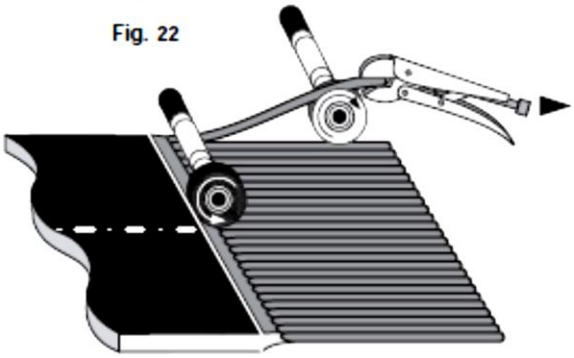


Fig. 22



8. Buffing of the transition zones

   On the carrying and running side of both belt ends the rubber surfaces of the transition zones and another 20 mm – 30 mm on either side must be thoroughly buffed with a rotating wire brush.

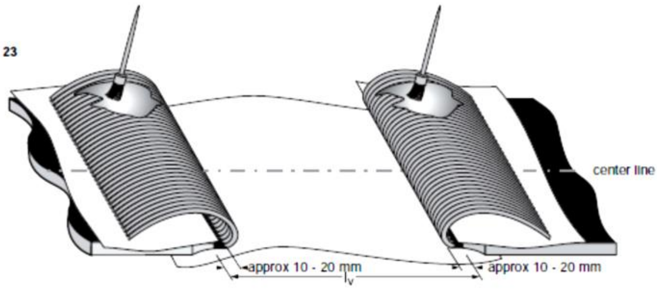
   Overheating, shiny spots and scorching of the rubber should be avoided.

9. Removing the buffing dust

   The buffing dust has to be thoroughly removed with a clean hand brush. Place belt ends back on work tables and arrange cables on a clean surface (PE film).

10. Apply two thin coats of STL-RF heating solution to the transition zones and cables. (See below). Allow the first coat to dry completely before applying the second coat.

Fig. 23



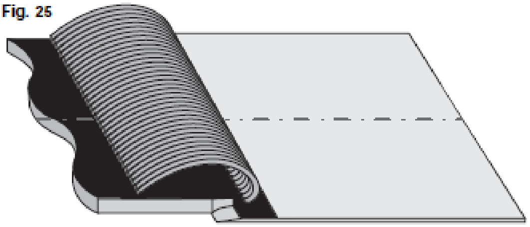
Remove the protection film from the cover stock side of the cover pad. Place the cover pad on the covered heating platens and align. Tie rubber side is now on top.

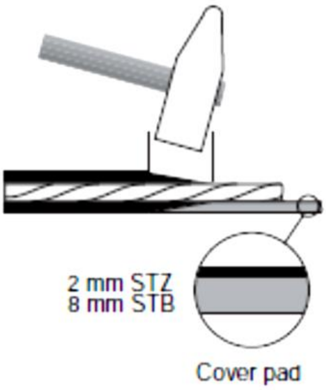
11. In the area of the transition zone remove the protection film by approximately 100 mm. Place one belt end onto the cover pad and mark first splice edge. Fold belt end back again and bevel cover pad at an angle of approximately 30° corresponding to the bevel cut angle of the transition zone.
    Before handling the belt ends, bundle the steel cables and wrap them into PPE film.

    Now apply a thin even coat of STL heating solution to the beveled edge of the cover pad.

If the coat of STL heating solution on the transition zone is no longer tacky enough, apply another coat and allow to try until slightly tacky.
Place the transition zone of the beveled belt on to the beveled edge of the cover pad, press on and tap down with a hammer (See below).

Fig. 25





12.The transition zone of the other belt is matched in the same way.(See below).

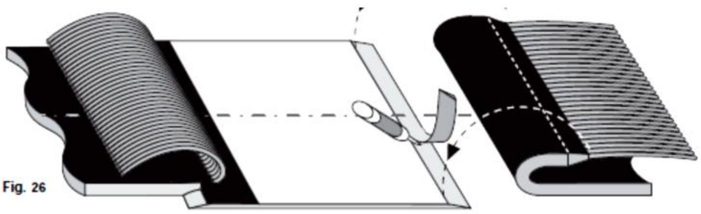


Fig. 26

13. Again check the correct alignment of the belt centre lines and also the splice length (lv) and adjust/correct if required (See below)

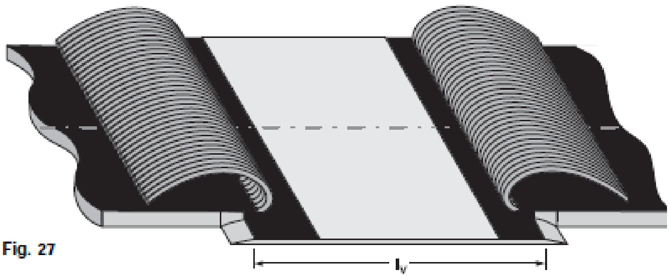
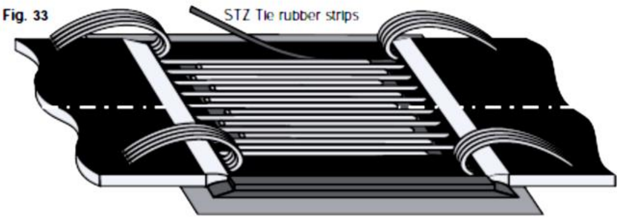


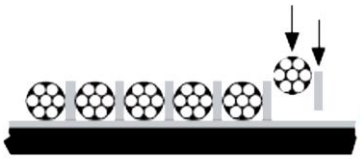
Fig. 27

Completely remove the protecting film from the bottom cover pad and mark the step lines (Ls and Lp)for laying the cables according to the specified splice layout. Scribe these lines with a knife tip as it must remain visible after coating with STL-RF heating solution. Place clean Holland cloth on the bottom cover pad leaving exposed approximately 100 mm in the centre in length direction of the belt. The tack of the tie rubber, which will be exposed further step by step can be improved by a very thin coat of STL-RF heating solution.

14. Starting with the centre cable, cut cables according to the marked step lines and press into bottom cover pad in accordance with the specified splice layout.

Fig. 33

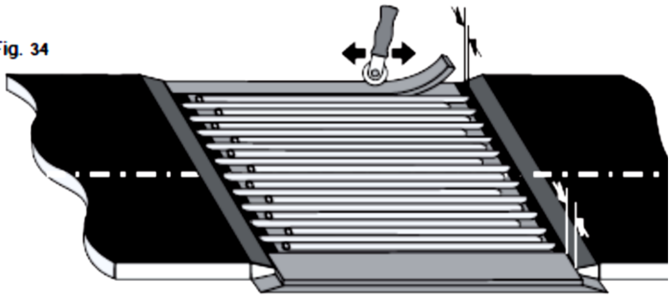




15. If there is sufficient space in the edge area, it is recommended to place a thicker strip or two strips of STZ tie rubber. A STZ tie rubber strip is also placed along the edge cables and pressed on.

    When the last cables are laid there should be sufficient space for the rubber edge.

Fig. 34



16. Apply a generous coat of STL-RF heating solution to the buffed upper bevel cuts of the transition zones on both ends as well as to the built up rubber edges and allow to dry completely.

    Before placing the top cover pad onto the cables and rubber edges proceed as follows:

    - Check thickness of cover pad
    - Remove protection film from tie rubber side.

    Depending on the tack of the tie rubber apply a thin coat of STL heating solution.

    When placing the top cover pad avoid trapping air. Then remove the protective film on the top cover.

Press on and stitch the top cover pad vigorously from the centre outwards or in the direction of the butt joints respectively and firmly tap down with a hammer in the transition zones. (See below).

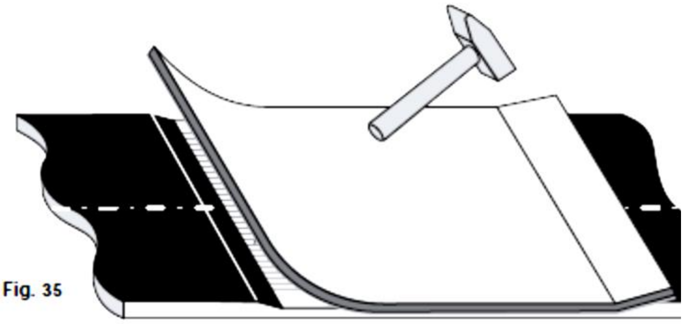


Fig. 35

17. Trim excess rubber in the transition zone with an offset knife. Mark the splice edge with chalk line and trim along with a long knife(See below).

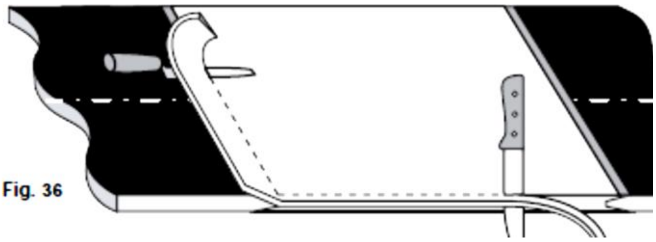


Fig. 36

18. Again check the correct alignment of the belt centre lines of both belt ends with a string. Deviations can now still be corrected. The final control/correction is important for a straight running belt and therefore indispensable.(See below).

Fig. 37

19. Apply 200 mm – 250 mm wide strips of Holland cloth onto the transition zones of the top cover pad and fold the skirting strips around the splice edges.
Cover the complete heating area first with silicone paper and then with Holland cloth. Now the edge bars are applied to both sides of the splice and pressed against the belt edges with edge clamps, which are mounted outside the press area. The edge bars must be approximately 2mm thinner than the belt.

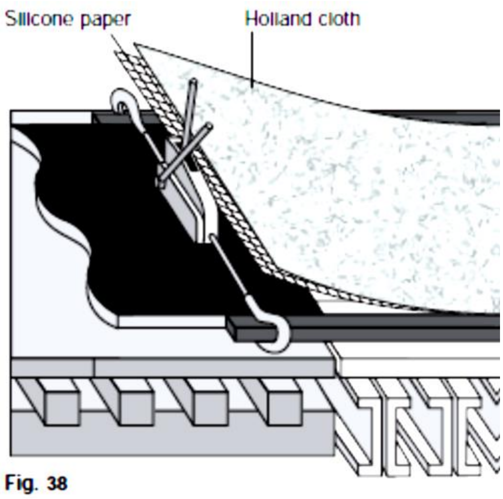
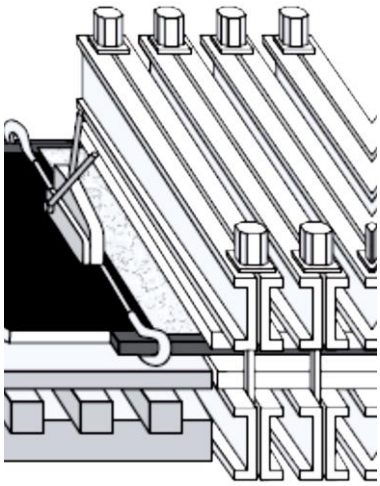


Fig. 38

20. Assemble to platens of vulcanizing press ensuring that top beams are aligned with bottom beams.
The upper heating platens must also be at least 200 mm longer than the splice on either side and at least 75 mm wider than the belt on each side. The edge bars must be fully covered by the heating platens. The arrangement or layout of the heating platens must be recorded in the splice record.



21. Upon completion of curing cycle and dismantling of press:
Mark splice.
Complete checks and quality documentation.

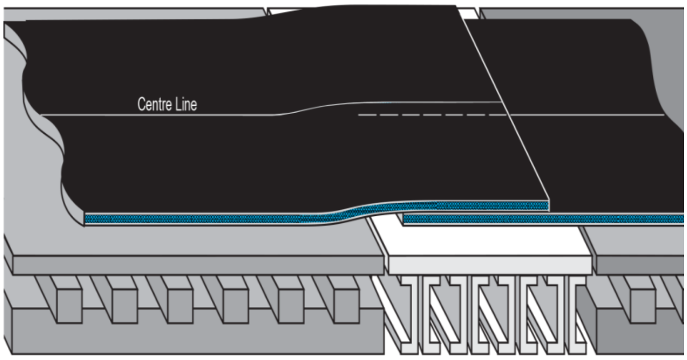
SOLID WOVEN

Solid woven fabric PVC conveyor belts are spliced with the single layer of Milliken fabric cut into the uncured cover rubbers.

1. Prepare vulcanizing station and assemble the lower half of the vulcanizing press.
   Pull the two belt ends to be joined into the splice area so that they have the required overlap length.

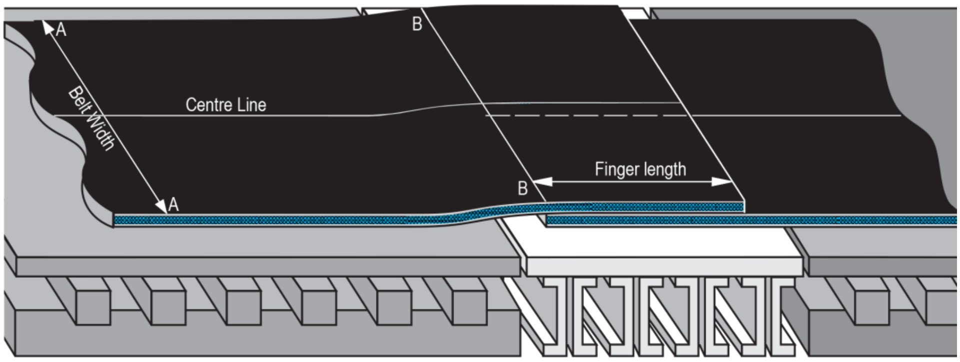
   Establish a centre line on both ends for a distance of a minimum of 3 m in length.

   Mark out the area that will be required to cut out the fingers plus 100 mm to cut out the butt line.



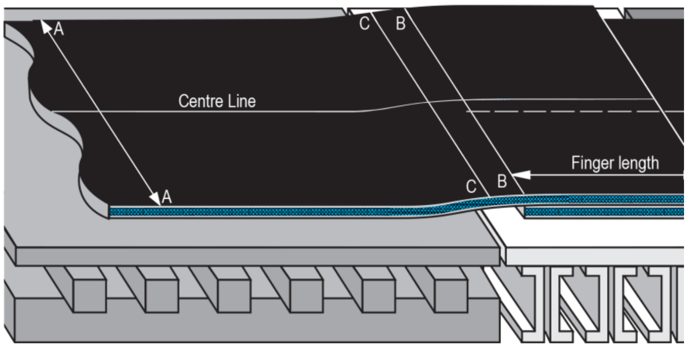
2. With the end belt remaining on the worktable (referred to as the first belt end), square that belt end by drawing a line across the belt 90° to the centreline. Line A A.
   From the square-cut end, work both belt edges and measure the finger length. Draw a line B B, showing the end at the finger length to the opposite belt edge.

   Refer to splice dimensions to determine finger and splice length as given in specifications.



3. From the line B draw in the transition line 'transition length' dimensions in specifications. Taking this value, measure from the B B line marks and draw the transition line which also serves as top and bottom cover bevel cut lines. Line C C.

   Note: All marks should be transferred to belt edges (both sides) for cover removal.

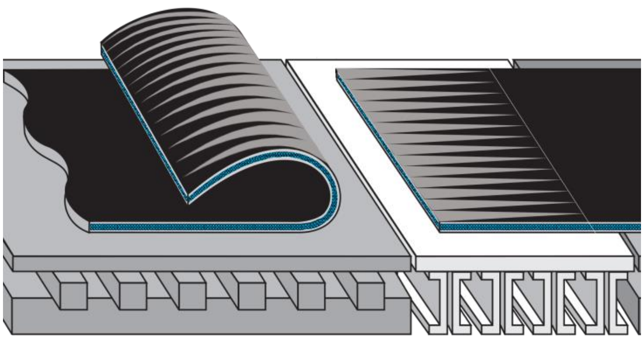


4. Working from the centre line, lay out the finger pattern. The centre finger should point the splice direction of travel. This will allow the edge finger to trail. Refer to the splice 'finger length & finger base' dimensions in specifications.
   Return the second belt end to overlap the first belt end.

   With the centre lines of both belts aligned, vertically transfer the marks from the first belt end to the edges of the second belt end above it. Extend all of the cut lines vertically along both belt edges.

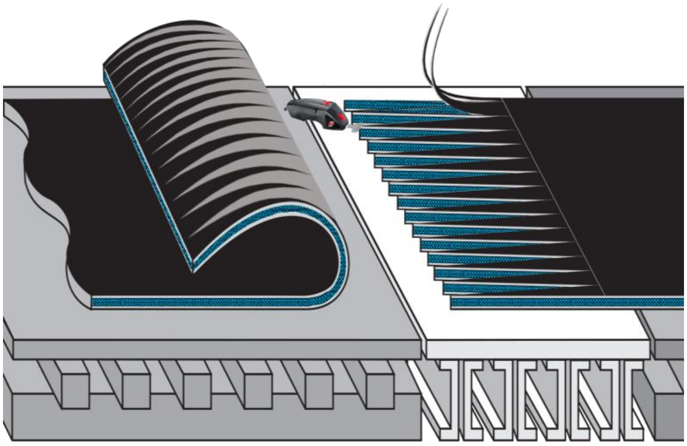
   With the second belt end still overlapping the first belt end, draw the cover bevel cut lines (transition lines) into the top cover.

   Complete the layout of this end by measuring and drawing the remaining finger pattern cut lines into the top cover.

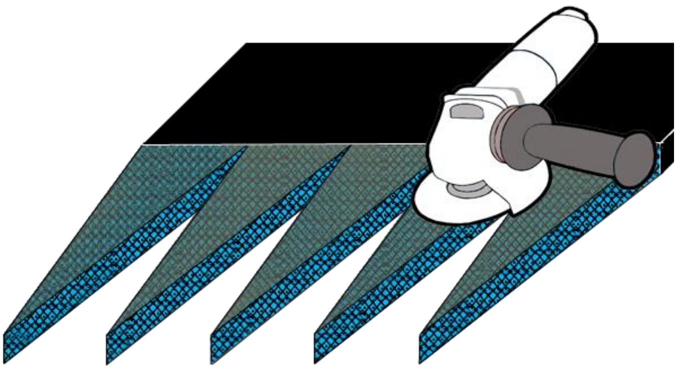


5. Cut the fingers using a Stanley knife.
   Strip covers from both sides using electric cover stripper

   NOTE: *Warm the belt to assist in cutting the fingers. Heating of the belt makes it easier to cut and remove absorbed moisture. Heating may be applied up to a maximum of 50 degree Celsius.*
   NOTE: *It is important to cut the fingers accurately to ensure high splice strengths. It is critical that the cut is perpendicular to the belt surface.*

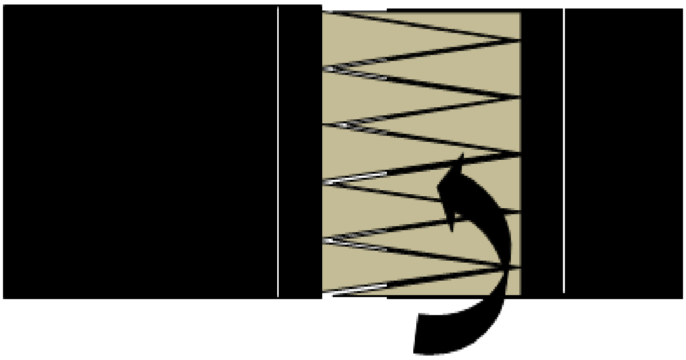


6. Buff fingers and butts using a rotating wire brush.



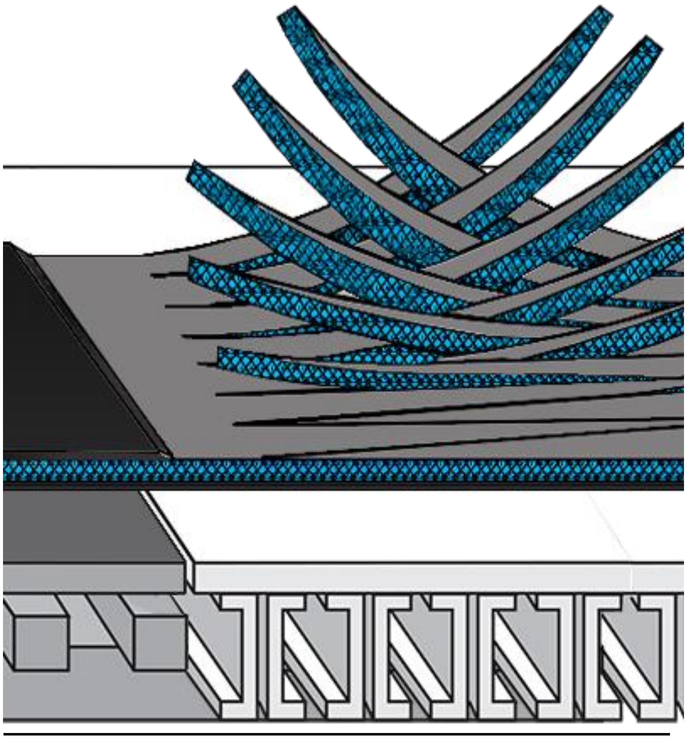
7. The splice is now laid out allowing a 2 mm gap between each finger and ensuring both ends are correctly aligned. The required 2 mm gap is obtained by laying both ends down with an additional 100 mm distance between the two cover butt lines.
   Fix both ends of the belt onto the preparation table to ensure no movement.

Gaps between fingers of minimum 2 mm



8. Lay the lower cover panel, fabric face up on the cooling plate. Ensure the bias of the fabric is 45° along the centre line. Ensure equal overlap on both sides of the splice.
   Spread the paste over the lower cover to a thickness of about 1 mm.

Release belt ends allowing the fingers to lay into the spread paste.
After the first belt end is laid into the compound, apply additional paste to prevent air from going into the area.
Spread the paste over the laid fingers ensuring paste completely fills gaps between fingers and is spread to a depth of about 1 mm. Prevent bubbles from being trapped inside the paste area.
Spread more paste over surface of fingers of 1 mm to ensure it is totally wetted out (it is critical that the entire splice surface is completely coated with paste).



9. Wrap the cover panel over the splice and trim off excess at the bias.
 Cover the entire splice with release paper.
 Place the top cooling platen into position.
 Assemble the top of the press, securely clamp edge bars with restraining devices to prevent any movement of the splice during vulcanization.

10. Assemble press. Do not apply any pressure.
 Heat the press to 80° C and make sure that all platens heat evenly (within five degrees).
 If necessary, control the platens manually. Maintain for two minutes.
 Apply 50% of the curing pressure and continue to increase the temperature to 165°C.
 Apply at 120°C full curing pressure of eight bars.
 Maintain 165°C evenly over all platens for the duration of the curing time.
 Cure the splice for 10 minutes–15 minutes.
 Cool the press upon completion of curing. It's preferable to use water to prevent any possibility of 'over cure'. The cooling time should be as long as it takes for the required temperature to be reached.
 Release pressure from the press once all platens have cooled down to less than 50°C.

Disassemble press and remover release paper.
Inspect the splice and only tension the belt after an ambient temperature is reached.
Mark splice and complete all required checks and quality documents.

BASIC TOOLS REQUIRED FOR SPLICING

Figure 7. Wire brush

Figure 8. Steel cable cutter

Figure 9. Don Carlos knife

Figure 10. Ply lifter

Figure 11. Stitcher – 4 mm

Figure 12. Grooved wire brush

Figure 13. Double acting roller

Figure 14. Cover stripper

Figure 15. Hawk Bill notch ply knife

Figure 16. Splicing tools

Figure 17. Offset knife

Figure 18. Pincers

Figure 19. Cold splicing cement

4. PRACTICES NOT PERMITTED

The following practices are not permitted:

a. Multi-section curing – a practice whereby a splice is cured using a press that is too small for the splice to be cured. This can result in procuring of material directly adjacent to the press.

b. Repairs on a vulcanized splice.

c. The use of cotton waste and paper towels for the application of solvents and solutions. Residue of these materials could become trapped in the splice area resulting in poor vulcanization, poor adhesion and possible blows (expanding air in rubber).

d. Incorrect storage of splice materials. Excessive heat will cause splicing material to age prematurely. This could lead to semi-cured intermediate and cover rubber resulting in a weak and unsafe splice.

e. The use of conveyor belting in place of edge bars. Conveyor belting can deform under pressure resulting in splicing material being displaced during the curing process. This will in turn result in insufficient bonding in the splice and an under gauge splice.

f. Post vulcanization cutting of the edges (steel cord). Possible to expose edge cords resulting in corrosion.

g. The use of any chlorinated solvent is prohibited (steel cord.) The solvent could attack the steel cords resulting in corrosion and a weak splice.

5. SITUATIONS WHERE SPLICING IS NOT PERMITTED.

Splicing is not permitted in the following situations:

a. If ambient temperature is less than 5°C above the dew point.

b. If in the case of plied belting, the difference in the number of plies between the two belts is two or greater.

c. If the materials used in the construction of the splice do not conform to the properties of the parent belt.

d. If the differential in cord count exceeds 15%.- steel cord.

e. Any loss of 10% or more in pressure during vulcanization time.

f. Any deviation of cure time or temperature in excess of 5%.

g. Any other non-conformance item as detailed by the owner's technical representative on site.

6. REJECTION CRITERIA

The rejection criteria of a completed splice are as follows:

a. If the difference in thickness of the two belts spliced exceeds 3 mm.

b. Any exposed cords.

c. Any blisters or bulges on the belt and/or bridges adjacent to the splice or in the splice area.

d. Belt run out, within 15 m of the splice, of more than ± 3% of the belt width to a maximum of 75 mm in total.

e. The vulcanized Shore ‘A’ hardness of the cover rubber is not within the compound manufacturer's specification parameters.

f. Any evidence of porosity on splice edges.

g. Splice constructor who has not followed the requirements of this standard.

h. The use of splicing materials which do not comply with the provisions of the respective clauses of the SANS standard.
i. Loss of pressure by more than 10 % during the vulcanising time.
j. The critical curing temperature, as specified by the belt and raw materials manufacturers, is not reached or maintained for the specified time period.
k. Floppy edges in excess of H/L and the number of deviations. (Figure 20)
l. Any other non-conformance items as detailed by the owner's technical representative on site.

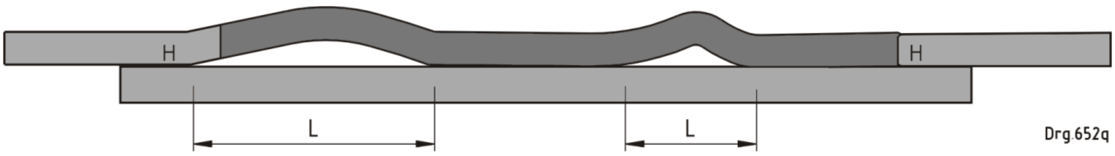


Figure20. Diagram for use in the measurement of floppy edges

7. REPORTS

Job Card Pack

A job card pack consisting of the documents listed below shall be supplied to the customer before the contractor leaves the site.

a. Raw materials quality control
b. Compliance documentation
c. Risk assessment
   Working at heights
   Stored energy in the belt
   Lockout procedure followed
   Sufficient ventilation
d. Calibration documentation
e. Quality plan
f. Raw materials list
g. Quality assurance agreement

Attachments:

Annexure D, E , F, G

ABOUT THE AUTHOR

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André is technical area manager for Dunlop Industrial Products, a member of the REMA Tip Top Group of Companies.

André is also general manager for REMA TIP TOP Technologies South Africa.

He was jointly responsible for developing the first Continuous Belt Thickness Monitoring System capable of measuring belt wear and thickness while in operation.

André was also involved in the development of the RFID Rip detection system for steel cord, plied and solid woven conveyor belting.

Studied mechanical engineering at Vaal Triangle Technicon.

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ANNEXURES

Annexure D
(normative)

Raw materials quality control

Sample of a raw materials quality control data table

Item	Batch No.	Manufacturer	Date of expiry	Other traceable reference
Top cover compound				
Bottom cover compound				
Bonder compound				
Steel primer				
Solution				
Solvent				

Annexure E
(normative)

Sample quality plan

Mine/Company .... Job No. .... Belt class/Type ....

Splicer name .... Contractor ....

Conveyor No. .... Splice No. ....

Splice length .... Splice type ....

Date ....

Raw material supplier(s) ....

QP No.	Activity	Specification	Action		
		Clause No.	Splicer	Mine / company	Third party
1	Establish type and class of belt		A		W
2	Establish work station		A		W
3	Check splice distance in relation to other splices.		V		W
4 4A	Check materials Record batch numbers and date of expiry		V A		V W
5	Check splicing equipment		A		W
6	Set up press and tables		A		W

6A	Inspect set up				
7 7A	Align belt and Inspect alignment		A		W
8	Mark and cut steps		A		W
9 9A	Trial assemble splice Inspect trial assembly		A		W
10 10A	Final assemble splice Inspect final assembly		A		W
11	Pre-cure inspection		A		W
12 12A	Cure splice Record cure parameters		A A		W W
13 13A	Inspect splice Record dimensions		A		V
14	Commission splice		H	A	W
A = Action V = Verification H = Hold W = Witness					

Cure started: .... Cure completed: ....

Verification interval …………………… (measured in minutes)

Curing parameters		
Time	**Pressure**	**Temperature**

Complete cure results					
Location	**Thick** mm	**Splice length** mm	**Top and bottom cover Shore 'A' hardness**		
			Location	**Top cover**	**Bottom cover**
Leading end Left hand Right hand			Left hand As per diagram		
Centre			Centre as per diagram		
Trailing end Left hand Right hand			Right hand As per diagram		
	Average hardness				
	Nominal hardness [a]				
[a] Nominal hardness is as specified by the material manufacturer. Actual may differ by ± 5 points					

Annexure F
(normative)

Raw materials

Materials used for a splice shall be supplied by an approved manufacturer of conveyor belt splicing materials, and shall include the following:

a) bonder compound;

b) cleaning solvent;

c) cover compound;

d) rubber solution;

e) steel cord primer (approved for bare steel to bonder compound application); and

f) acceptable release agent.

Annexure G
(normative)

Sample quality assurance agreement

G.1	Set up		Comments
1.1	QC plan approved and available		
1.2	Working station suitable for splicing		
1.3	Idler rolls & brackets adjacent to splice removed		
1.4	Top surface of bottom platen level with top of troughing roller (if applicable)		
1.5	Bottom platen edges parallel to direction of run of belt		
1.6	Wooden boards in place approximately 250 mm wider than belt		
1.7	Top surfaces of boards are same level as top surface of bottom press platen		
1.8	Tables are stable with a minimum length of 3 m		
1.9	All splicing materials to specification and within recommended shelf life		
Accepted by constructor		Accepted by owner	

G.2	Alignment		Comments
2.1	Belting is lined up in either direction for a minimum distance of 3 m		
2.2	Belt is central on the conveyor supporting rollers		
2.3	Ends overlap on the bottom platen		
2.4	Overlap is sufficient		
2.5	Centre line is established in either direction for a minimum of 3 m		
2.6	Chalk reference lines are drawn across the ends of each belt		
Accepted by constructor		Accepted by owner	

G.3	Preparation	Comments
3.1	Centre line established	
3.2	Fingers cut perpendicular to belt surface.	
3.3	Splice leading end fingers outermost as per diagram.	

3.4	Cover material removed from fingers using slow speed grinder or plane	
3.5	Carcass not over buffed or degraded in any way.	
3.6	Carcass lightly buffed for 50 mm past cover panel butt line.	
3.7	Belt ends pulled back to provide 2 mm to 3 mm gap between fingers	
3.8	Belt firmly clamped to preparation table (outside splice area)	
Accepted by constructor		Accepted by owner	

GI.4	**Assembly**	**Comments**
4.1	Cover panel butt lines marked onto lower plate surface	
4.2	Belt ends folded back and fastened	
4.3	Release agent or silicon paper placed over lower plate	
4.1	Lower cover panel laid	
4.2	Gaps between fingers 2 mm to 3 mm and/or as specified	
4.3	Paste spread over lower panel to a thickness as specified	
4.4	Fingers laid into paste and alignment correct.	
4.5	Paste spread between fingers completely filling gaps	
4.6	Bottom and top cover panels correctly laid	
4.7	Release agent or silicone paper completely covering splice, including splice edges	
4.8	Edge bars (curing irons) of specified gauge correctly positioned	
4.9	Top platen correctly positioned	
4.10	Press traverses correctly positioned	
4.11	Edge bars (curing irons) securely clamped.	
Accepted by constructor		Accepted by owner	

G.5	**Curing**	**Comments**
5.1	The temperature of the platens is 100 °C	
5.2	The length of splice is correct	
5.3	Alignment is correct	
5.4	Upper platen is positioned to match lower platen	
5.5	Traverses correctly positioned	
5.6	Pre-tensioned bolts are uniformly tightened	
6.7	Platen pressure reaches 600 kPa	
5.8	Curing temperature reaches specification	
Accepted by constructor		Accepted by owner	

G.6	**Testing**	**Comments**
6.1	Dimensions within tolerance	
6.2	Splice/parent belt alignment within tolerance	
6.3	Spew PVC/Nitrile removed	
6.4	No blistering	
6.5	No lack of adhesion	
6.6	Shore hardness of covers within tolerance	
6.7	Commissioning acceptable and engineer’s approval obtained	
Accepted by constructor		Accepted by owner	