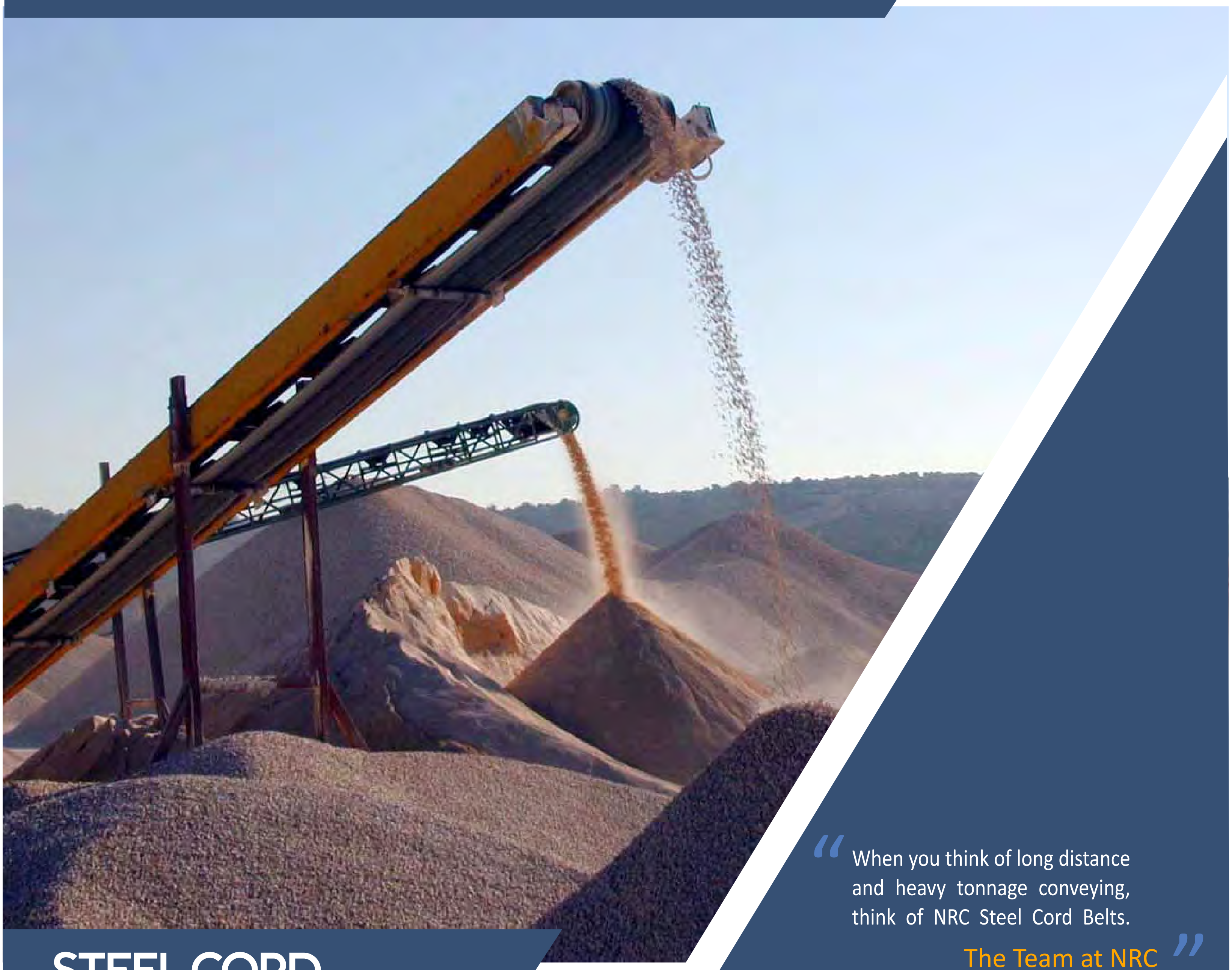
NRC INDUSTRIES LTD.
AN ISO 9001:2008 & 14001:2004 COMPANY
NABL ACCREDITED



STEEL CORD CONVEYOR BELTS

"When you think of long distance and heavy tonnage conveying, think of NRC Steel Cord Belts.

The Team at NRC"

National Accreditation Board for Testing and Calibration Laboratories
(A Constituent Board of Quality Council of India)

CERTIFICATE OF ACCREDITATION

LABORATORY DIVISION, NRC INDUSTRIES LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

9th Mile Stone, Kashmir Road, Verka, Amritsar, Punjab

in the field of

TESTING

Certificate Number TC-6102
Issue Date 10/08/2017
Valid Until 09/08/2019

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL

N. Venkateswaran
Program Director

Anil Relia
Chief Executive Officer

Certificate No. QMS/DRS15/1889

Certificate of Registration

This is to certify that the Quality Management System of

NRC INDUSTRIES LIMITED

9th Milestone, Kashmir Road, Verka, Amritsar- 143501, Punjab, India

Has been successfully assessed & conforms with the following standard

ISO 9001:2008

Scope of Certification

"Manufacturing and Exports of Textile Reinforced Rubber Conveyor Belts"

Initial Registration Date : 01-12-2015
Surveillance 1 Audit Date : 10-11-2016
Surveillance 2 Audit Date : 10-11-2017

Issue Date : 10-12-2015
*Expiry Date : 09-12-2018

** Subject to successful completion of Surveillance Audits*

www.jas-anz.org/register
International Accreditation Forum
DRS is Accredited by JAS-ANZ M5800912IF

D.R. SHARMA
MANAGING DIRECTOR

DRS MANAGEMENT SYSTEM PVT. LTD.
(AN ISO CERTIFICATION BODY)

Office: 216, DLF Centre Point, Sector-11, Mathura Road, Faridabad - 121006, E-mail : drsmspl@gmail.com,
For current validity of the Certificate, visit on www.drscertification.com/clientdetail.aspx

Certificate of Registration

This certificate has been awarded to

NRC Industries Limited

9th Mile Stone, Kashmir Road, Verka, Amritsar, Punjab, 143501, India

in recognition of the organization's Environmental Management System which complies with

ISO 14001:2004

The scope of activities covered by this certificate is defined below

Manufacture and Export of Textile Reinforced Rubber Conveyor Belts

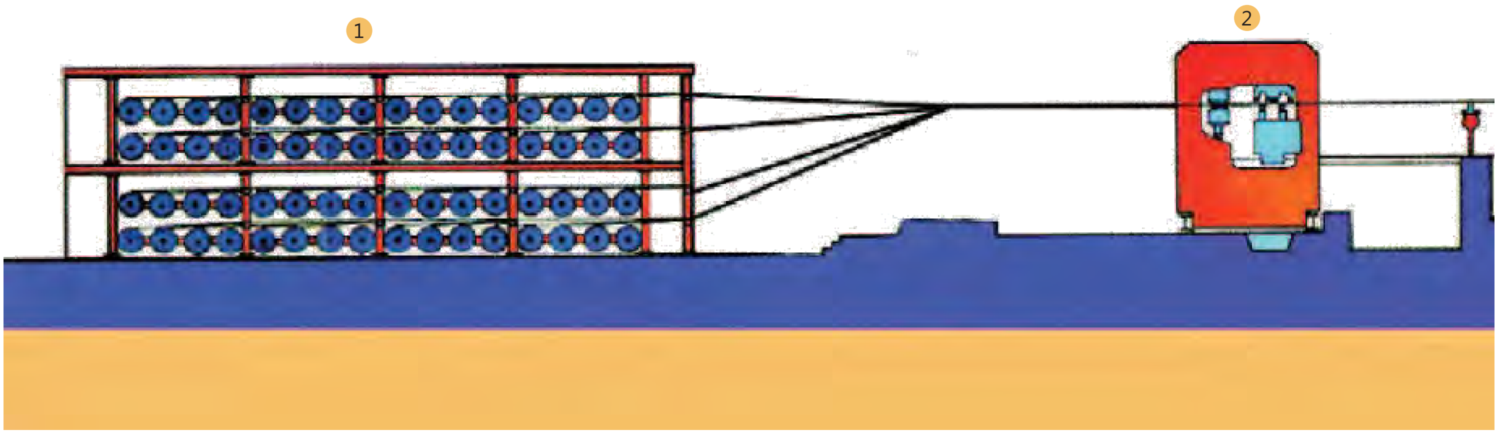
Certificate Number: 52791/A/0001/UK/En
Date of Issue: (Original) 03 May 2012
Date of Issue: 19 May 2015
Issue No: 2
Expiry Date: 18 May 2018

Issued by: *On behalf of the Schemes Manager*

NRC Industries Limited

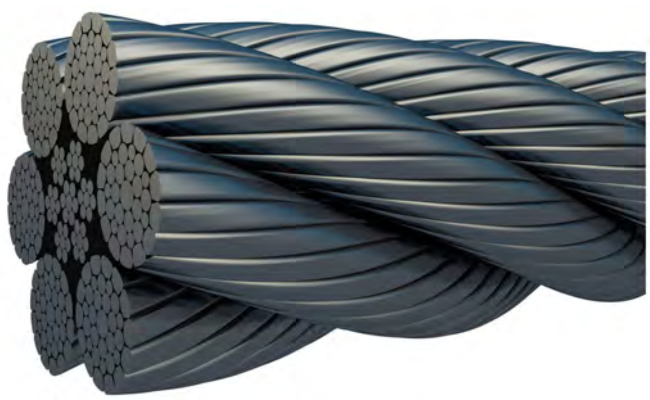
Steel cord conveyor belts, the proven high-performance and reliable mode of material handling, are becoming increasingly cost-effective and popular. We offer innovative solutions to specific material handing problems using steel cord belts.

NRC Industries Limited has the certifications of ISO 9001:2008 for quality management systems, ISO 14001-2004 for environment management systems and certificate of accreditation by NABL (ISO 17025-2005) for finished product testing laboratory.

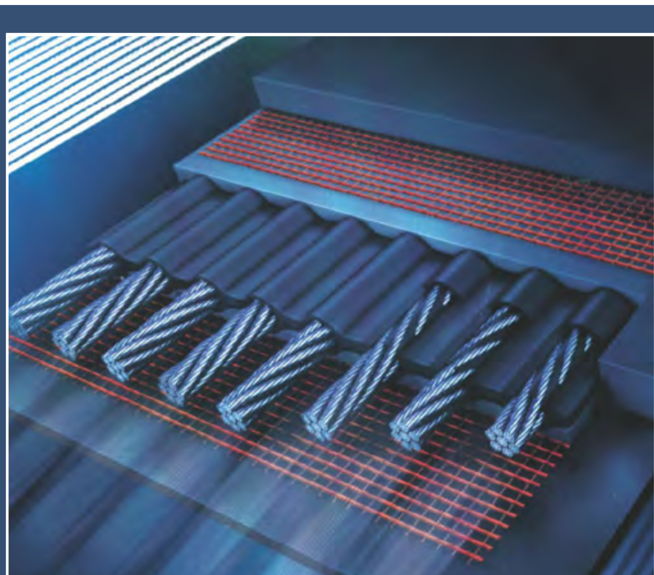


Flow Diagram of the Production Line of NRC Conveyor Belt

Steel cord belts at **NRC** are manufactured in state-of-the-art steel cord line. Steel cords, the key reinforcement material, are coiled in individual reels and placed in the creel let off station which is located in a big dehumidified chamber. The cords are then guided through a fixed path to the cord tensioning unit. Each cord is tensioned individually through this tensioning unit ensuring equal tension to all the cords and thereafter, maintaining them on same plane, during manufacturing of belts.



Steel Cord Creel Racks in Dehumidified Chamber



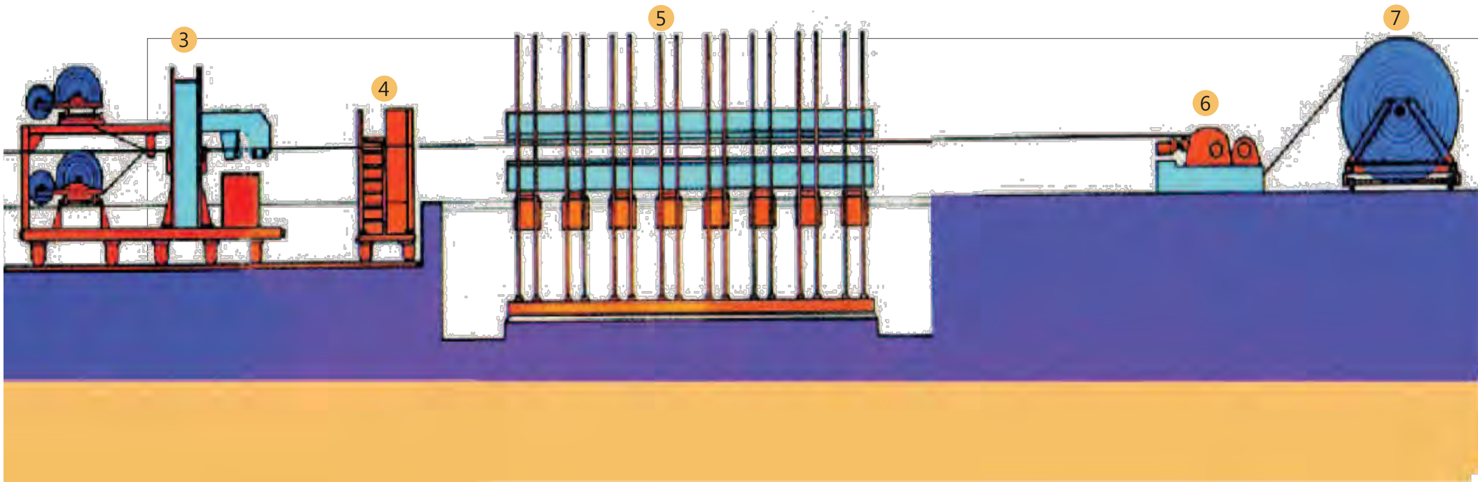
Cords Leaving Clamping and Tensioning Units - All Aligned to a Horizontal Level, Equally Pretensioned, Precisely Spaced

The rubber sheets are assembled in an assembling machine equipped with auto- centering device. The sheets are here laid on top and bottom of cord layer and the assembly is cold pressed together under pre-determined pressure.

The thermal expansion of cord during vulcanisation is taken care of by cord tensioning unit to maintain uniformity.

Vulcanisation takes place in a press heated with pressurised water while distortion of heating platens is prevented by counter heating system incorporated in the bolster.

The whole operation is monitored by a built-in centralised computer in the system.



1 **Steel Cord Creel Racks in Dehumidified Chamber**

2 **Heavy Cord Clamping and Cable Tensioner Device**

Here pre-determined tension is applied to each cord during vulcanising process.

The unique feature of the line is that each cord is equally tensioned, which is important for straight running of the belt and for equal load sharing of the individual cords.

3 **Compactor Lorry with Trimming Devices**

Here assembled top cover and bottom cover are laid on either side of the cords and compacted by pressurising devices for optimum consolidation in cold press.

4 **Motor Driven Inspection Platform**

This is used to inspect belt prior to curing in the press.

5 **Belt Curing Process**

Capacity:

Length	7 m
Width	2400 mm
Max. specific pressure	40 bar

This is provided with uniform heating system by hot water under high pressure.

6 **Anchoring and Pulling Device**

This provides counter force to cord tensioning device and pulls unvulcanised belt on to the press.

7 **Wind-up for Cured Belt With Belt Cutting Device**

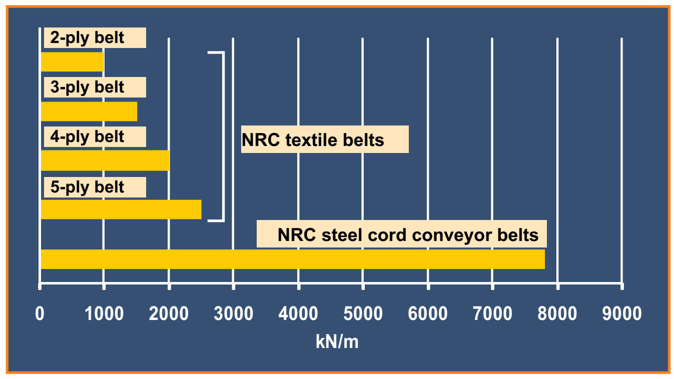
This is the wind-up unit attached with the hydraulic cutting arrangement.

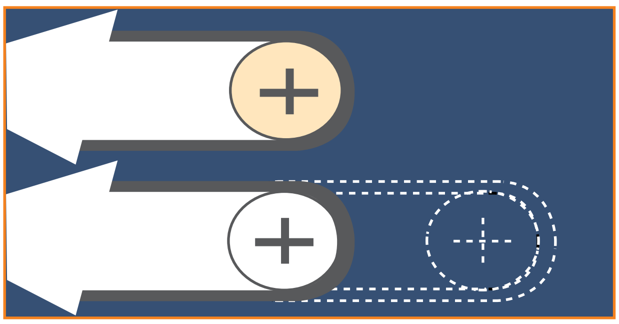
Look No Further for Steel Cord Conveyor Belt

Advantages of Steel Cord Conveyor Belts

High Tensile Strength

NRC steel cord conveyor belts offer much higher tensile strength which is impossible to achieve by a conventional textile belt.





Low Elongation

NRC steel cord conveyor belts have elongation much lower than that of an equivalent textile belt. This allows short take- ups even for long distance conveyors.

Long Life

NRC steel cord conveyor belts provide long life by utilising the high fatigue strength of steel cords.

Smaller Pulley Diameter

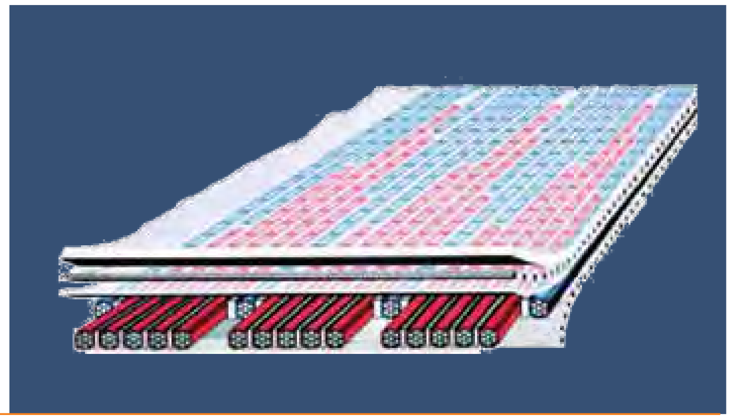
NRC steel cord conveyor belts by virtue of high longitudinal flexibility, require smaller pulley, thus reducing the cost of initial investment.

Excellent Troughability

As the belt is composed of steel cords in a single layer, even with a very high strength, **NRC** steel cord conveyor belts conform perfectly to the contour of the deep troughed idler. This ensures proper belt training and maximum capacity utilisation.

High Splice Efficiency & Increased Splice Life

100% joint efficiency (static) is achievable from vulcanised splice of NRC steel cord conveyor belts. Splices last as long as the belt and loss due to down time can be virtually eliminated. Based on extensive development work, a substantial improvement in dynamic splice efficiency has been achieved. Tests carried out under pulsating tension on a 2 drum machine bear out this gain.



Superior Impact Resistance

NRC steel cord conveyor belts are capable of withstanding very high impact because of its steel tension member and the resilience of rubber cover.

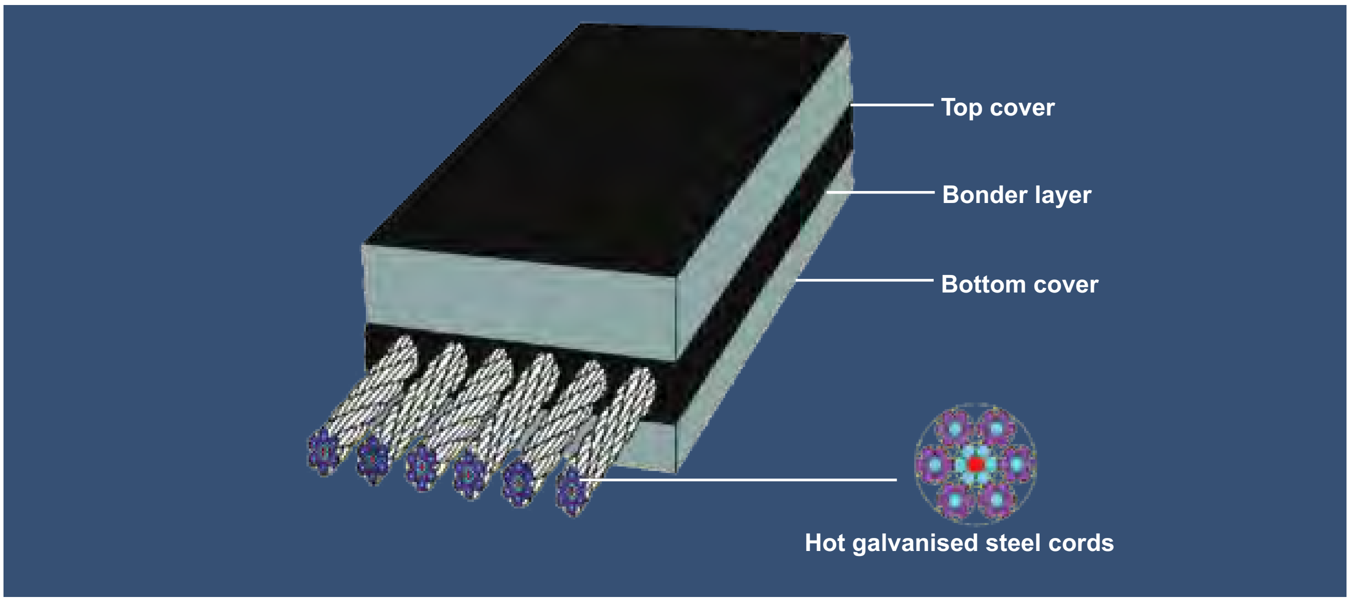
Very High Adhesion Between Rubber and Steel Cord

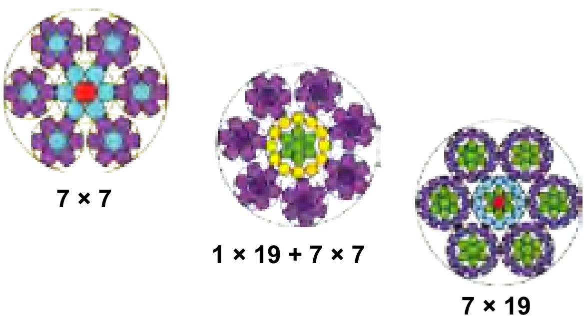
The very high chemical bonding between rubber and steel cord in NRC steel cord conveyor belts ensure complete elimination of the problem arising out of separation of cord and rubber.

Apart from the Above, Other Advantages of NRC Steel Cord Conveyor Belts are as Under:

- It runs straight
- High modulus of elasticity helps it to avoid problem associated with start-up Very little maintenance is needed
- Heat, cold or moisture do not affect the running behaviour Discontinuous feed causes no local elongation
- Thick cover rubber application for higher speed
- Reconditioning is possible

Constructional Features

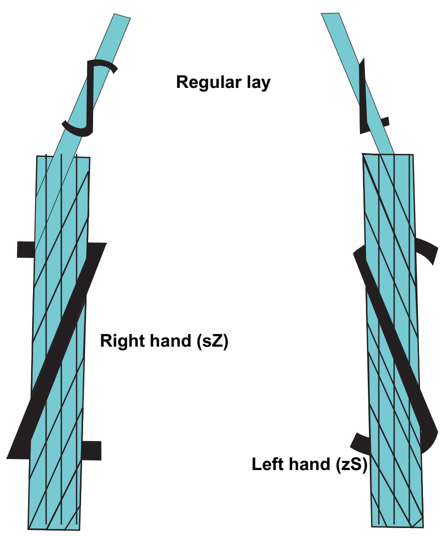




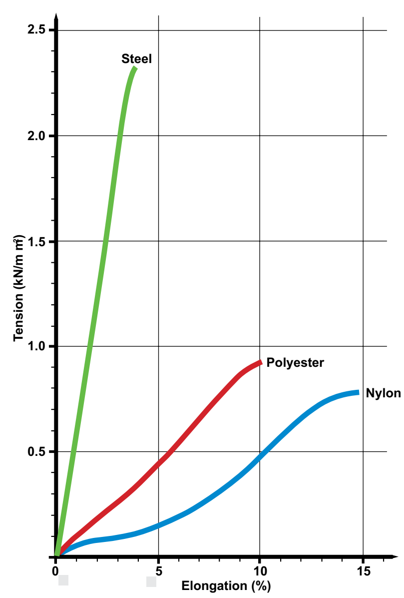
The Core Element: Steel Cord

The cords used in NRC steel cord conveyor belts are made of specially developed high carbon steel. During manufacturing of belts, these cords are held longitudinally in a single layer under pre-determined tension to ensure proper alignment. The cords are zinc-coated to ensure superior bonding between cord and rubber as well as to protect the same against corrosion.

The cords may have several types of configurations like 7×7, 1×19 + 7 × 7 & 7 × 19. Under load, the cords do not tend to creep.



Stress Strain Curve



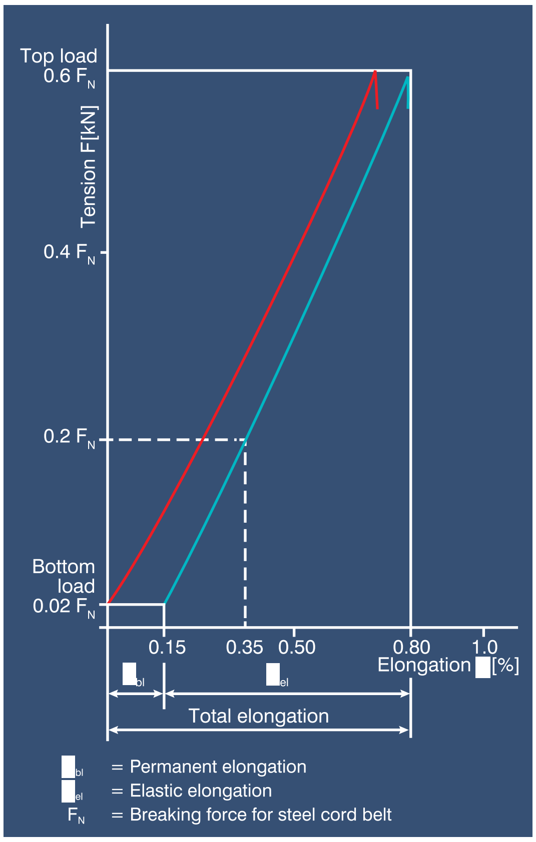
Typical Construction of Steel Cords

Wires are twisted round a core to form a strand. Strands are helically laid to form the cord. The direction of twist for the strand (S or Z) is opposite to the direction for the wires.

The cords in a belt occur as S and Z alternatively. This eliminates accumulation of residual torsion and also minimise possibility of belt mal tracking.

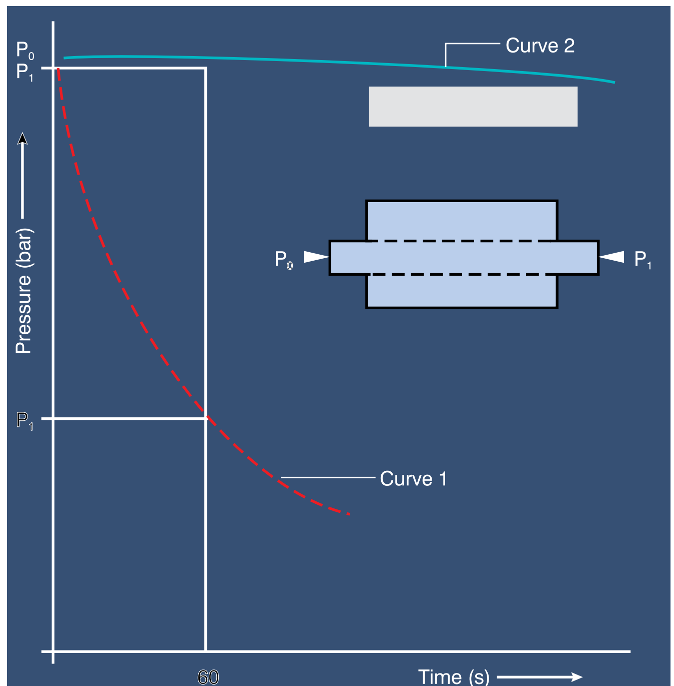
The graph shows the stress-strain characteristics of steel cord when compared with other carcass elements viz. polyester and nylon. While the breaking strength of steel is more, its elongation is considerably less than that of the others.

Elongation



The graph along side shows the behaviour of steel cord when elongated repetitively from a minimum force i.e. 0.02 FN to 0.20 FN, and then to 0.60 FN. At 20% of the breaking force, which is a fair representation of normal operating condition, the permanent elongation is 0.15% and the elastic elongation is 0.20%, thus resulting in a total elongation of around 0.35%.

Penetration of Rubber



Curve 1 showing moderately rubberised curve
Curve 2 showing completely rubberised curve

The penetration of rubber in the interstices of the cord is an important parameter from the point of view of adhesion and protection. It is measured by Differential Pressure method. P_0 drops to P_1 (by not more than 5.0%) for perfectly rubberised cord. The Saline water permeability test is another way to determine the penetration of bonder compound in the interstices.

Cover Element: Cover Rubber

The cover rubber which acts as a protection for the steel cords is specially developed with high tensile strength, high elongation at break, maximum resistance to tear propagation and low abrasion loss. They also meet specific application requirement like:

- General purpose
- Super abrasion resistance
- Heat resistance
- Fire resistance
- Chemical resistance
- Oil resistance

The mixing of rubber with additives is done in the 11D Banbury which is an internal batch mixer with automatic polymer and chemical feeding system. This ensures accuracy and consistency in product quality.

The Bonding Element: Bonder

The bonder rubber ensures permanent bond between rubber and cord through the bonding process. The design gives:

- Adequate penetration of bonder rubber inside the cord
- Prevention to corrosion and ageing
- High cord pullout strength
- High dynamic efficiency
- Inherent resistance to thermal degradation
- High specific fusion with cover
- Prevention of notching effect between individual wires

Selection of Cover Rubber Quality

Cover Type	Physical Properties: Standard & Grade	Min. Tensile Strength (N/mm2)	Min. Elong. at Break	Max. Abrasion Loss (mm3)	Max. Temp. (°C)	Material	Characteristics
General Purpose	DIN X	25	450	120	80	Iron ore, copper ore, stone, rock, etc. lignites overburden	Extra abrasion, cut & gouge resistance. Suitable for transporting sharp, large lumps & rugged material under adverse loading condition
	AS M	24	450	125	80		
	SANS M	25	450	120	80		
	ISO H	24	450	120	80		
	IS M-24	24	450	120	80		
	DIN Y	20	400	150	80	Fine coal, ash, cement, earth, coal, salt, etc.	Abrasion resistance for normal service. Suitable for transporting moderate abrasive material.
	AS N	17	400	200	80		
	SANS N	17	400	150	80		
	ISO D	18	400	100	80		
	IS N-17	17	400	150	80		
Superior Abrasion Resistant	DIN W	18	400	90	80	Quarries, sandpits, lime stone, coal, ash, ore, phosphate, raw material for glass works, etc.	Superior abrasion resistance for the heaviest service condition. Suitable for abrasive material with a large proportion of fines.
	AS A	17	400	70	80		
Heat Resistant	DIN T	12.5	350	250	125	Hot sinter, hot cement, hot powder, chemical & fertilizer, etc.	Heat resistant and also in cut, abrasion and tear resistant.
	IS T1	12.5	350	250	125		
	IS T2	12.5	350	250	150		
Fire Resistant	AS F	14	300	200	80	Materials having fire hazards e.g. sulphur, coal, etc.	Resistance to flame propagation and burning; suitable for surface application.
	CAN CSA-C	17	350	200	80		
	ISO 340	17	350	175	80		
	DIN K (with cover)	20	400	200	80		
	SANS F	14	400	180	80		
	ISO K	15	350	200	80		
	BCS FR	17	350	175	100	Explosive and fire hazardous material coal powder, etc.	Resistance to flame propagation, extremely low burning rate; suitable for underground operation.
	DIN V	15	350	200	100		
	IS-UG	16	350	200	100		
Oil & Grease Resistant	DIN G	12	250	175	100	Chemical & fertilizer, wood, paper & pulp, recycling plants.	Resists penetration and therefore the damaging effect of oil and fat.
	AS Z	12	250	175	100		
	IS OR	12	250	175	100		

In Addition to the Standard Grades of Rubber Cover,
NRC Offers Special Cover Grades Suiting to a Particular Application.

Cover type	Physical Properties: N R C Brand	Min. Tensile Strength (N/mm2)	Min. Elong. at Break	Max. Abrasion Loss (mm3)	Max. Temp. (°C)	Material	Characteristics
Heat Resistant	UHR	12.5	350	200	Max temp. handled 180 °C	Hot sinter, hot cement, fertilizer, etc.	Super heat resistant and also in cut, abrasion and tear resistant
	UHR Super	10	300	200	Max temp. handled 240 °C	Hot clinker, hot cement, hot chemicals and fertilizer etc.	
High Wear and Tear Resistant	HWT	22	400	90	80	Quarries, sand & gravel. limestone, coal, ash	Suitable for high abrasive applications
Energy Optimized	M EOB	18	400	100	100	Fine coal, ash, cement, earth, coal, salt, etc.	General purpose premium quality energy optimized cover
	LRR EOB	18	400	100	100		General purpose energy optimized cover
	FR EOB	15	400	130	80	Explosive and fire hazardous materials, e.g. coal powder, etc	Fire resistant grade EOB as per FR CAN CSA-C

Cover Gauge

In a steel cord belt, the thickness of cover rubber should not be less than (0.7 x cord diameter) or 4 mm, whichever is higher. But an additional amount of cover thickness should also be provided in anticipation of wearing. The additional cover thickness value for the carrying side are selected from the following table :

Type of Influences and Their Rating			Sum of the Rating Values	Additions to Minimum Thickness (mm)
	Favourable	1		
Loading Conditions	Moderate	2	5 to 6	0 to 1
	Not favourable	3		
	Favourable	1		
Frequency of Loading	Moderate	2	7 to 8	1 to 3
	Not favourable	3		
	Favourable	1		
Grain Size	Moderate	2	9 to 11	3 to 6
	Not favourable	3		
	Favourable	1		
Density	Moderate	2	12 to 13	6 to 10
	Not favourable	3		
	Favourable	1		
Abrasion Factor	Moderate	2	14 to 15	> 10
	Not favourable	3		

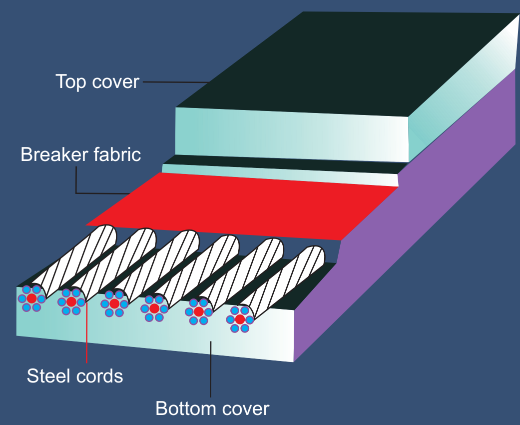
Protection System for Conveyor Belts

Transverse Breaker Fabric

Continuous heavy duty rip check breaker having substantial weft strength is a widely used reinforcing device.

The extremely flexible and high elongation transverse reinforcement does not impart any hindrance on troughability of belt. The high elongation weft cord has considerable capacity to absorb energy. Thus, the stress absorption ability of belt is also considerably improved.

The slit resistance of the belt against penetrating object is considerably enhanced upon weft crowding. The transverse reinforcement does not impose any restriction on pulley diameter.



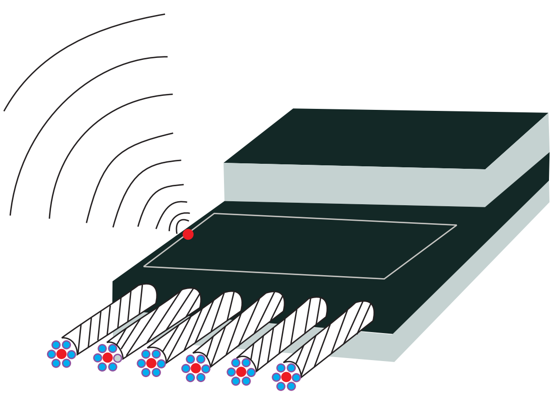
Steel cord belt with transverse breaker fabric

Electronic RIP Detection System

The system is designed to detect the longitudinal tears (RIPS) electronically and to stop the motor through a PLC system so as to obviate further damage.

Induction loops specially constructed of thin cords are embedded under the cover of the belt and above the steel cords. The interval can be decided on, depending on severity of the application. Loops can be supplied in a new belt or retrofitted to an existing belt.

In a conveyor, the danger zone, vulnerable to longitudinal slitting is identified. One set of transmitter and receiver combination is kept preceeding the zone and a second similar set after the zone. On a first run, the PLC unit memorises the time slots of arrival of the induction loops at the danger zone and it calculates the time each loop takes to ride through this part. In the event of a rip (longitudinal tear) at the danger zone, the induction loop before approaching the spot will meet the first set of transmitter/ receiver where it will be detected healthy. Thereafter, on being cut at the danger zone, it will disable the second set of transmitter/receiver in transmitting signals. The PLC, on detection of this accident, will command the motor to stop.

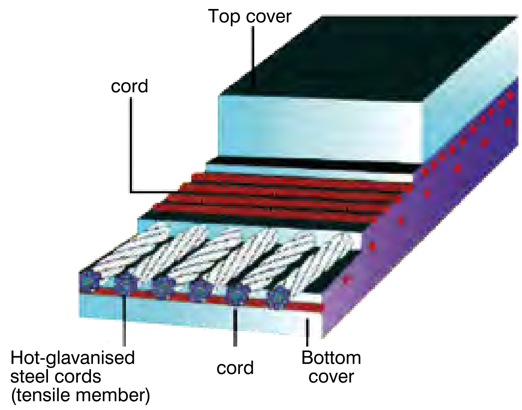


Sensor loop on a steel cord belt

Steel Cord Belts with Breaker

Steel cord conveyor belts are inherently capable of withstanding impact loads/shocks. To increase this resilience further, as demanded by severe operating conditions, transverse reinforcements are additionally provided between the cover and the layer of steel cords.

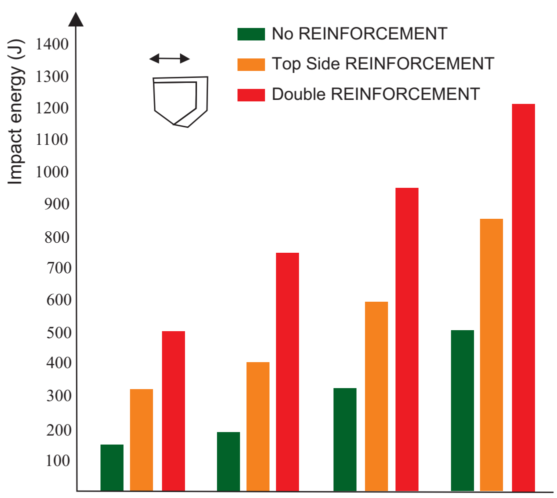
Therefore, the reinforced steel cord conveyor belt is recommended for achieving a remarkable improvement in service life in general and even in critical applications like machine belt in open cast mines with difficult conditions of impact, height and speed.



The distinct advantages of breaker are:

- No adverse effect on trough ability
- Resistance to corrosion and rotting
- Higher dynamic capability
- Easier repair possibilities
- Higher elongation and much higher energy required to cause failure

An array of high-elongation, synthetic fiber based cords placed at right angle to the steel cords with a pitch that can vary depending on the need.



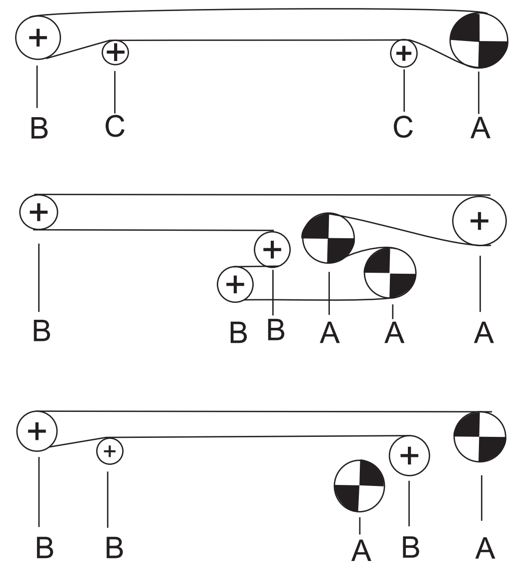
As borne by elaborate tests at laboratories and practically observed for two decades, the reinforcement improves the performance of the belt considerably. Some key parameters with respect to non-reinforced, normal steel cord belts are:

Steel Cord Conveyor Belts

	With single layer reinforcement	With double layer reinforcement
Impact resistance	2.0 times	2.5 to 3 times
Slitting resistance	1.5 times	2.0 times
Cord pull out strength	1.3 times	1.6 times

Pulley Diameter

The minimum admissible pulley diameter is linked with the demand for an adequate service life of the belt and in particular of its splice, the basic consideration being that the service life of the splice equals to that of the belt.



Types of Pulley

A distinction is made between the following types of pulley:

A – Pulleys in the region of high drive tractions with angles of wrap >30°

B – Pulleys in the region of low drive tractions with angles of wrap >30°

C – Pulleys with angles of wrap #30° (snub or deflection pulleys)

Stipulation of the pulley diameter depends essentially on the thickness of the tension member in the conveyor belt selected. The diameter of the pulley at which the highest tension is present (pulley type A) is determined first as per the following equation:

$$\mathbf{D_{Tr(A)} \geq S_z \cdot C_1}$$

where, $D_{Tr(A)}$ = Diameter of the A type pulley in mm

S_z = Cord diameter in mm

C_1 = Material factor for the tension member

Table A: The value of C_1

C_1	Tension member material in warp (longitudinal)
80	Cotton (B)
90	Polymide (P)
108	Polyester (E)
145	Steel cord (St)

The pulley diameter so derived is rounded up to the next higher value taken from column 1 of table B. The pulley group is then selected from the same table based on the pulley load factor.

Steel Cord Belts (Technical Specification)

Table B: Minimum pulley diameter in mm (without lagging)

$D_{Tr\,(A)} \geq S_Z \cdot C_1$	Pulley load factor $(K_{max}/K_N) \cdot 8 \cdot 100$ in %											
	≥ 100% pulley group			60% to 100% pulley group			30% to 60% pulley group			≤ 30% pulley group		
	A	B	C	A	B	C	A	B	C	A	B	C
100	125	100		100								
125	160	125	100	125	100		100					
160	200	160	125	160	125	100	125	100		100	100	
200	250	200	160	200	160	125	160	125	100	125	125	100
250	315	250	200	250	200	160	200	160	125	160	160	125
315	400	315	250	315	250	200	250	200	160	200	200	160
400	500	400	315	400	315	250	315	250	200	250	250	200
500	630	500	400	500	400	315	400	315	250	315	315	250
630	800	630	500	630	500	400	500	400	315	400	400	315
800	1000	800	630	800	630	500	630	500	400	500	500	400
1000	1250	1000	800	1000	800	630	800	630	500	630	630	500
1250	1400	1250	1000	1250	1000	800	1000	800	630	800	800	630
1400	1600	1400	1000	1400	1250	1000	1250	1000	800	1000	1000	800
1600	1800	1600	1250	1600	120	1000	1250	1000	800	1000	1000	800
1800	2000	1800	1250	1800	1400	1250	1600	1250	1000	1250	1250	1000
2000	2200	2000	1400	2000	1600	1250	1600	1250	1000	1250	1250	1000

K_{max} = Maximum belt tension force in the area of the pulley during stationary operation in kN/m

K_N = Nominal breaking force of the belt in kN/m

The pulley diameter may also be selected from table C, as a given guideline.

Table C: Common belt constructions

ST Rating (kN/m)	TC (mm)	BC (mm)	Belt thickness (mm)	Belt wt. X grade (kg/m²)	Belt wt. K grade FR surface (kg/m²)	Pulley diameter (mm) 60% - 100% load factor		
ST 500	4	4	11.00	14.50	15.00	500	400	315
ST 630	6	4	13.00	17.50	18.50	500	400	315
ST 800	6	4	13.00	17.50	18.50	630	500	400
ST 1000	6	4	13.50	19.00	20.00	800	630	500
ST 1250	6	4	14.50	20.50	21.50	800	630	500
ST 1400	6	4	14.50	21.00	22.00	800	630	500
ST 1600	8	6	19.00	27.50	29.00	1000	800	630
ST 1800	8	6	19.00	28.00	29.50	1000	800	630
ST 2000	8	6	19.00	28.50	30.00	1000	800	630
ST 2500	10	8	25.00	37.50	39.50	1250	1000	800
ST 2800	10	8	25.00	39.00	40.50	1250	1000	800
ST 3150	10	8	25.50	40.00	42.00	1250	1000	800
ST 3500	10	8	26.00	42.50	44.50	1250	1000	800
ST 4000	12	8	28.50	48.00	50.50	1400	1250	1000
ST 4500	12	8	29.50	50.00	52.50	1400	1250	1000
ST 5000	12	10	32.50	56.00	58.00	1600	1250	1000
ST 5400	12	10	33.00	57.50	59.50	1600	1250	1000
ST 6300	12	10	33.50	61.50	64.00	1800	1400	1250
ST 6800	12	10	34.00	64.00	66.50	2000	1600	1250
ST 7500	12	10	35.00	69.00	71.50	2000	1600	1250

1. The above figures are approx. values and should be taken into account for design purpose only.
2. NRC reserves the right to change these values and other parameters without notice in tune with technological development
3. For calculation of belt weight having cover thickness other than those given above, consider the following:
   Weight of 1 mm cover for Grade X = 1.11 kg/m²
   Weight of 1 mm cover for Grade K = 1.23 kg/m²

Transition Distance

Steel cord conveyor without pulley lifted i.e. h = 0

Belt width B in mm	Troughing angle of the belt					
	25^0	30^0	35^0	37.5^0	40^0	45^0
800	1400	1670	1940	2080	2210	
1000	1790	2140	2490	2660	2830	3170
1200	2120	2540	2950	3150	3350	3750
1400	2510	3000	3490	3730	3970	4440
1600	2890	3450	4010	4290	4570	5110
1800	3260	3900	4540	4850	5160	5770
2000	3610	4320	5020	5360	5710	6390
2200	4040	4840	5620	6010	6390	7150
2400	4330	5180	6020	6440	6850	7670

Steel cord conveyor with pulley lifted i.e. h ≠ 0

Belt width B in mm	Troughing angle of the belt					
	25^0	30^0	35^0	37.5^0	40^0	45^0
800	(35)925	(40)1125	(45)1320	(50)1380	(50)1510	
1000	(40)1250	(50)1450	(60)1650	(60)1820	(65)1910	(70)2160
1200	(50)1440	(60)1710	(70)1970	(75)2100	(75)2300	(85)2530
1400	(60)1695	(70)2040	(85)2310	(85)2540	(90)2700	(100)3000
1600	(70)1935	(85)2280	(95)2690	(100)2890	(105)3080	(115)3450
1800	(80)2175	(95)2600	(105)3070	(115)3230	(120)3460	(130)3900
2000	(90)2385	(105)2870	(120)3350	(125)3600	(135)3800	(145)4300
2200	(100)2680	(115)3250	(135)3740	(140)4040	(150)4270	(165)4780
2400	(105)2900	(125)3460	(145)4000	(150)4330	(160)4580	(175)5140

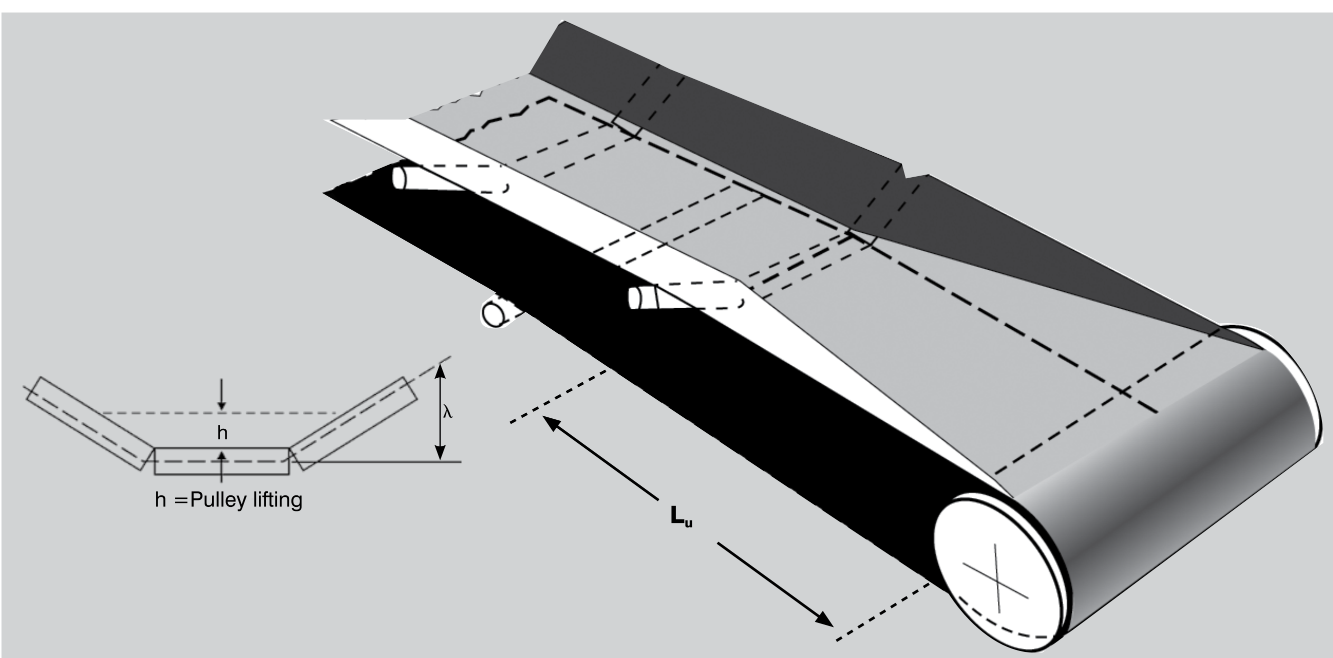
(Values for h in mm in brackets)

Take up Length

For a rough determination of the take up length, the elastic and permanent elongation of a steel cord belt ($\varepsilon_{el} + \varepsilon_{bl}$) is taken as 0.35%

$$S_{sp} = L.\ (\varepsilon_{el} + \varepsilon_{bl})/100$$

where, S_{sp} = Take up length in m
L = Center to center distance in m



Vertical Curves

Concave Curves

With concave belt tracking the radius of the curve is usually so measured that the conveyor belt in each operating and loading condition lies on the idlers, especially on the central idler. Smaller radii of the curves are possible if a lifting off of the idlers is allowed with an unloaded conveyor belt under certain operating conditions. In this case, constructive measures, e.g. intercepting idlers, are required in the area of this conveyor section

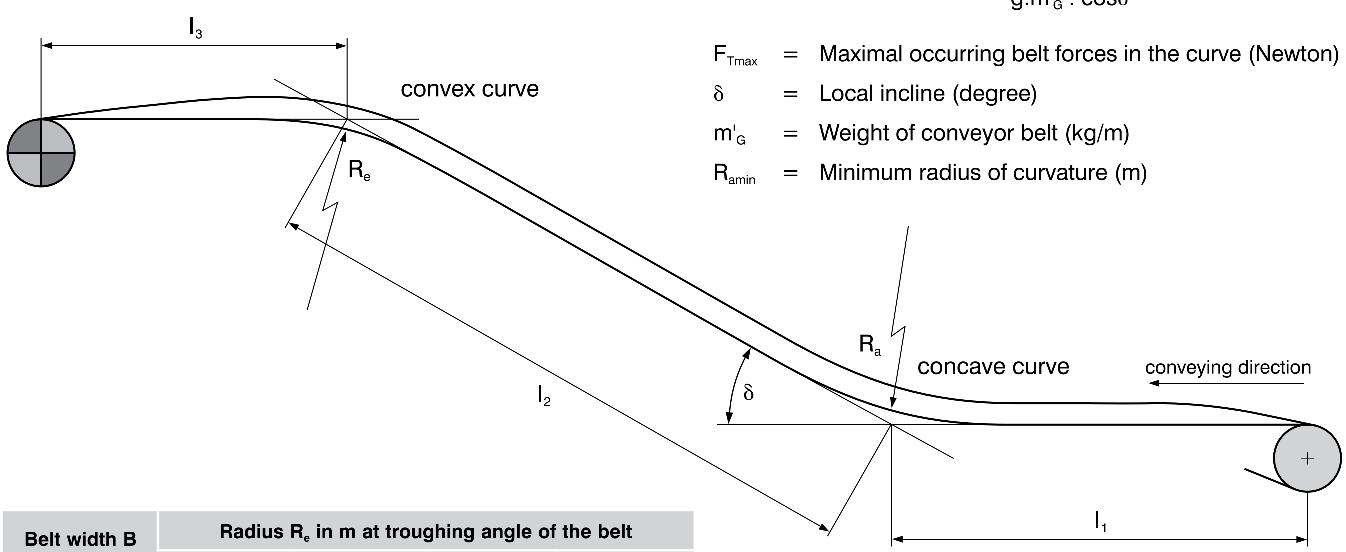
$$R_{amin} = \frac{F_{Tmax}}{g.m'_G \,.\, \cos\delta}$$

F_{Tmax} = Maximal occurring belt forces in the curve (Newton)

δ = Local incline (degree)

m'_G = Weight of conveyor belt (kg/m)

R_{amin} = Minimum radius of curvature (m)



Belt width B in mm	Radius R_e in m at troughing angle of the belt			
	30˝	35˝	40˝	45˝
800	43	50	56	61
1000	55	64	71	78
1200	66	75	84	93
1400	78	89	100	110
1600	89	102	115	120
1800	101	116	130	143
2000	112	128	144	158
2200	125	143	161	177
2400	131	154	172	189

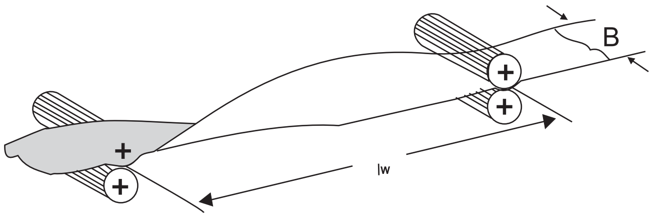
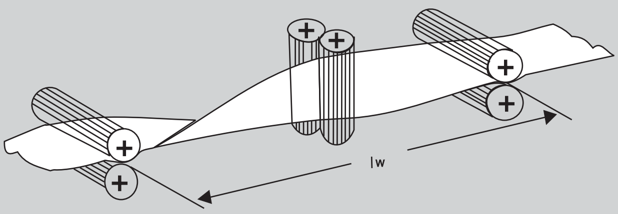
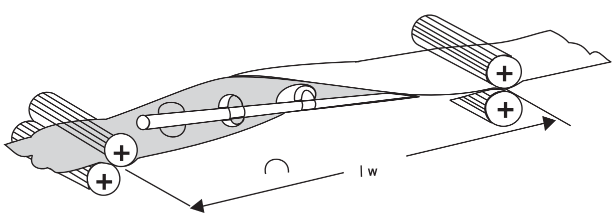
Convex curves

The guide values as stated in the adjacent table for the radii required at a minimum when the belt is tracked in convex curves apply for 3-part equal length idler arrangements.

With a view to their higher strain in curve areas, the idlers should be arranged at a reduced spacing, if necessary.

Belt Turnover

Guide value for the minimum belt turnover length (I_W) as required for textile carcass and steel cord conveyor belts (according to DIN 22101)

Method of turnover	Max. belt width B in mm	Belt turnover length L_w	
		Textile carcass belts	Steel cord belts
Unguided turnover 	Max. 1200	10 × B	—
Guided turnover 	1600	12.5 × B	22 × B
Supported turnover 	2400	10 × B	15 × B

Reel Diameter

Reel diameter D_w (in m)

Belt length L (in m)	Belt thickness d_G (in mm)															
	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
10	0.61	0.63	0.65	0.67	0.69	0.71	0.73	0.75	0.76	0.78	0.79	0.81	0.83	0.84	0.86	0.87
20	0.71	0.75	0.78	0.81	0.84	0.87	0.90	0.92	0.96	0.98	1.01	1.03	1.06	1.08	1.10	1.13
40	0.87	0.93	0.98	1.03	1.08	1.13	1.17	1.21	1.25	1.29	1.33	1.37	1.41	1.44	1.48	1.51
60	1.00	1.08	1.15	1.21	1.27	1.33	1.39	1.44	1.50	1.55	1.59	1.64	1.69	1.73	1.76	1.82
80	1.13	1.21	1.29	1.37	1.44	1.51	1.58	1.64	1.70	1.76	1.82	1.87	1.93	1.98	2.03	2.08
100	1.23	1.33	1.43	1.51	1.59	1.67	1.75	1.82	1.87	1.95	2.02	2.08	2.14	2.20	2.26	2.31
120	1.33	1.44	1.54	1.64	1.73	1.82	1.90	1.98	2.05	2.13	2.20	2.27	2.33	2.40	2.46	2.52
140	1.43	1.55	1.66	1.78	1.86	1.95	2.04	2.13	2.21	2.29	2.37	2.44	2.51	2.58	2.65	2.72
160	1.51	1.64	1.76	1.87	1.98	2.08	2.17	2.27	2.36	2.44	2.52	2.60	2.68	2.75	2.83	2.90
180	1.59	1.73	1.86	1.98	2.09	2.20	2.30	2.40	2.49	2.58	2.66	2.75	2.84	2.92	2.99	3.07
200	1.67	1.82	1.95	2.08	2.20	2.31	2.42	2.52	2.62	2.72	2.81	2.90	2.98	3.07	3.15	3.23
220	1.75	1.90	2.04	2.17	2.30	2.42	2.53	2.64	2.74	2.84	2.94	3.04	3.13	3.21	3.30	
240	1.82	1.98	2.13	2.26	2.40	2.52	2.67	2.75	2.86	2.97	3.07	3.17	3.26	3.35		
260	1.89	2.05	2.21	2.36	2.49	2.62	2.74	2.86	2.98	3.09	3.18	3.29				
280	1.95	2.13	2.29	2.44	2.58	2.72	2.84	2.97	3.08	3.20	3.31					
300	2.02	2.20	2.37	2.52	2.67	2.80	2.94	3.07	3.19	3.31						
320	2.08	2.27	2.44	2.60	2.75	2.90	3.04	3.17	3.29							
340	2.14	2.33	2.51	2.68	2.84	2.98	3.13	3.26								
360	2.20	2.40	2.58	2.75	2.92	3.06	3.21	3.35								
380	2.25	2.46	2.65	2.82	2.99	3.15	3.30									
400	2.31	2.52	2.72	2.90	3.07	3.23										
420	2.37	2.58	2.78	3.96	3.14	3.30										
440	2.42	2.64	2.84	3.03	3.21											
460	2.47	2.70	2.91	3.10	3.29											
480	2.52	2.75	2.97	3.17	3.35											

D_W : Reel diameter
d_G : Belt thickness
L : Belt length
k : Reel core diameter

Values of reel diameter depends on the belt thickness and on reel core diameter.

Reel core diameter k = 0.50 m

Note: 1) 0.15 m to be added on the calculated value for ground clearance.
2) Longer length can be despatched in flat reels.

Testing

NRC laboratory is equipped with the most modern testing facilities to meet excellence in product quality and international standards right from raw material to finished product. Some of the important facilities include:

Rheometer

Rheological behaviour of 100% batch of rubber mix is studied prior to release for production. Cure rate index, plasticity and optimum cure time are determined by this machine.

Universal Testing Machine Equipped with Printer

It is used for determination of specific cord pullout force. It is also used for measuring the strength and elongation of steel cord.

Drum Friction Testing Machine

Drum friction test rig attached with different gadgets is used to determine the fire resistance behaviour of conveyor belt.

Abrasion Testing Machine

Resistance to abrasion behaviour is determined by this machine.

Electrical Resistivity Tester

The antistatic property is determined by ring electrodes.

Multicell Ageing Oven with Microprocessor Based Temperature Controller

It is used to determine the ageing characteristics of finished products.

Dynamic Cord Pull Out Testing Machine

This machine is used to determine the dynamic cord pull out force to find out the dynamic efficiency of cord-rubber bonding systems.

Torsion Bending Test

This test is carried out to determine the resistivity of the metal- rubber bonding system towards corrosive effects.

Rubber Penetration Tester

It is used to ensure optimum penetration of rubber mix into the cord interstices.

Splicing

Structure of Steel Cord Belt Splices as Per Din 22131 (for Surface Use)

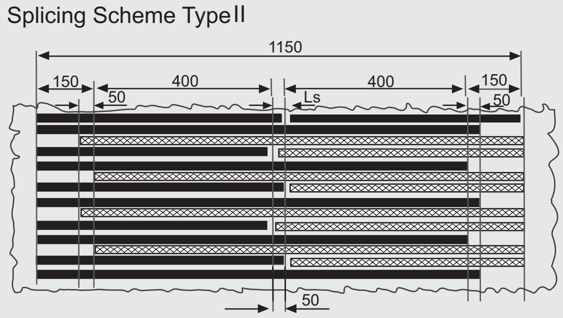
NRC steel cord belt is made endless by vulcanised splicing. Depending on strength, pitch and cord diameter, the number of steps in the splice is selected as per guidelines given in DIN 22131 part IV.

NRC manufactures splice kit for steel cord belt. It consists of specialized materials which are perfectly designed and built with great care to suit the particular belt construction and its application area.The steel cord belt splices demand knowledge and high skill.

Splice dimension (DIN 22131 Part IV)			
Belt rating	No. of steps	Minimum step length (lst)	Minimum joint length (l_v in mm)
ST-1000	1	300	600
ST-1250	1	350	650
ST-1600	1	450	750
ST-2000	2	400	1150
ST-2500	2	500	1350
ST-3150	2	650	1650
ST-3500	3	650	2350
ST-4000	3	750	2650
ST-4500	3	800	2800
ST-5000	4	900	4050
ST-5400	4	1000	4450

For special construction please refer to NRC for providing the splice configuration.

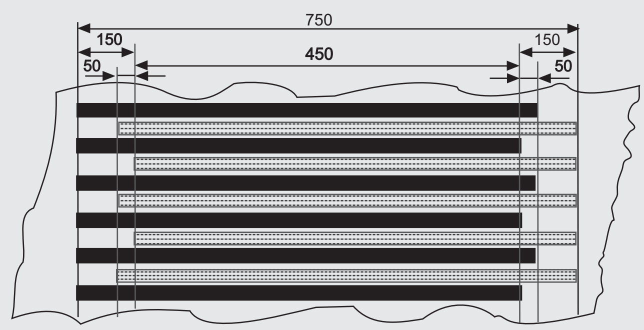
Splicing Scheme Type II



Cord diameter : 5.2 mm
Cord pitch : 12.0 mm
No of cords : 97
Ls : Min 3 × cord diameter

Sketch not true to scale

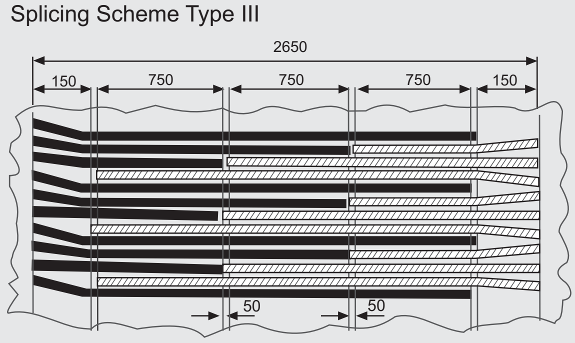
Splicing Scheme Type I



Cord diameter : 4.9 mm
Cord pitch : 14.0 mm
No of cords : 84

Sketch not true to scale

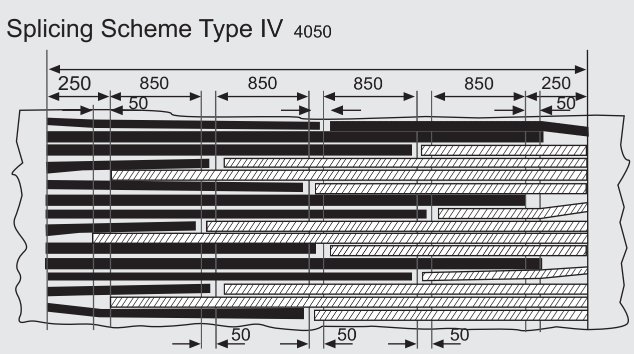
Splicing Scheme Type III



Cord diameter : 8.6 mm
Cord pitch : 15.0 mm
No of cords : 77
Ls : Min 3 × cord diameter

Sketch not true to scale

Splicing Scheme Type IV

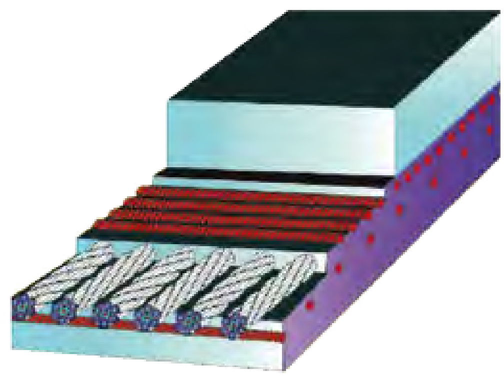


Cord diameter : 9.6 mm
Cord pitch : 12.7 mm
No of cords : 92
Ls : Min 3 × cord diameter

Sketch not true to scale

Technical Data for the Layout of Belt Conveyor Systems

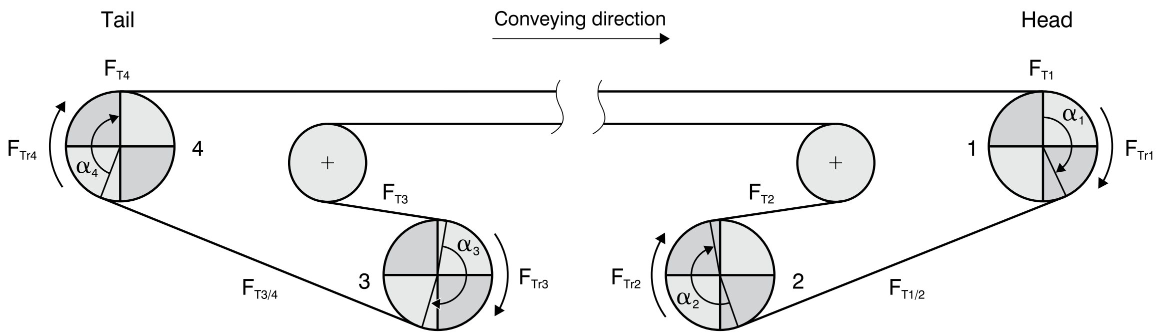
Company ________________	**Person in charge** ________________
Project name ________________	**Phone** ________________
Project no. ________________	**E-mail** ________________
Country ________________	



Location of use	Outdoors – open ☐ – covered ☐ Underground ☐ Indoor ☐ Details of climatic conditions ☐
Conveying flight (provide a diagram, if necessary)	Centre distance ________ m Conveying length L ________ m Conveying height H ________ m
	Gradient of the system δ ________ ° Uphill ☐ Downhill ☐ Section with maximum (descending) gradient δ_{max} ________ ° Curve: Convex – Radius R_e ________ m Concave – Radius R_a ________ m
	Sections with different gradients ☐

Technical Data

Material flow	Conveying speed v ---------- m/s Mass flow I_m ---------- t/h Volume flow I_V ---------- m^3/h Degree of uniformity of mass or volume flow ---------- Load coefficient ----------
Properties of the material handled	Designation of the material handled ---------- Bulk density ρ ---------- t/m^3 Angle of repose β ---------- ° Temperature ------- permanent --------- °C min. ---------- °C max. -------- °C
	Max. lump size ---------- mm Chemically corrosive ---------- ☐ Sharp-edged ---------- ☐ Wet ---------- ☐
Material feed	Feeding direction – in longitudinal direction ---------- ☐ – in transverse direction ---------- ☐ Height of fall ---------- m
	Garland idlers ---------- ☐ Troughing angle ---------- ° Impact idlers ---------- ☐ Feeding device (impact plates or similar) ---------- Chute constriction ---------- ☐ Length of constriction ---------- m
Material discharge	Via head pulley ---------- ☐ Tripper car ---------- ☐ Scraper ---------- ☐
Conveyor belt	Width B ---------- mm Endless belt length ---------- m Support on top run: on carrying idlers ------- ☐ sliding ---------- ☐ Support on return run: on carrying idlers ------- ☐ sliding ---------- ☐ with support rings ------- ☐
Idlers **– Top run**	Carrying idler arrangement ---------- -part Troughing angle I_o ---------- -° Spacing I_o ---------- m Mass (rotating components of an idler set) m_{Ro} ---------- kg Diameter d_{Ro} ---------- mm Tilted position ---------- Flat-to-trough transition length $I_{Ü}$ ---------- mm Pulley lift h_{Tr} ---------- mm Trough-to-flat transition length $I_{Ü}$ ---------- mm Pulley lift h_{Tr} ---------- mm
– Return run	Return idler arrangement ---------- -part Troughing angle I_{θ} ---------- -° Spacing I_u ---------- m Mass (rotating components of an idler set) m_{Ru} ---------- kg Diameter d_{Ru} ---------- mm Tilted position ----------



Pulleys driven/braked	Diameter D_{Tr} : 1 ______, 2 ______, 3 ______, 4 ______ mm Angle of wrap : α_1 ______, α_2 ______, α_3 ______, α_4 ______ º Pulley surface : bare ______ ☐ rubberized ______ ☐ Ceramic ______ ☐ Condition : dry ______ ☐ wet ______ ☐
Drives	Number of drives at Pulley 1: ____ Pulley 2: ____ Pulley 3: ____ Pulley 4: ____ Power - installed $P_{M\ inst}$ ______ kW (Total) - estimated $P_{M\ inst}$ ______ kW
	Slip ring motor ______ ☐ Squirrel cage motor ______ ☐ Starting aid ______ ☐
	Starting factor π_A (related to the motor torque in the steady operating state at rated mass flow): ______ π_{A0} (related to the rated motor torque): ______ Start-up-time t_A ______ s
Braking	Number of brakes on Pulley 1: ____ Pulley 2: ____ Pulley 3: ____ Pulley 4: ____ Total braking torque (related to the motor shaft) ______ Nm
	Braking factor π_B (related to the motor torque in the steady operating state at rated mass flow): ______ π_{B0} (related to the rated motor torque): ______ Braking distance s_B ______ m
Takeup device	Takeup pulley – flying ☐ – fixed ☐ Takeup device at System head ☐ System tail ☐ Existing takeup length ______ m
Conveyor belt cleaning	Scraper ______ ☐ Other devices ______ ☐ Belt turnover ______ ☐ Further details ______
Conveyor belt type	New system ______ ☐ Projected design ______ Extension ______ ☐ Required design ______ Replacement ______ ☐ Previous design ______ Suitability satisfactory ______ yes ☐ ______ no ☐ Observations ______
Conveyor belt splicing	In-situ curing ______ ☐ Mechanical fastener ______ ☐ Delivery ______ open ☐ endless ______ ☐

Belt Tension Theory

1. Tension Calculation Procedure

Through out this calculation the CEMA procedure for belt tension determination will be followed. The procedure can be applied to any conventioal troughed conveyor belt. However it is advised that this analysis must be verified by a competent and experienced conveyor designer.

General factors and terms used in this procedure include :-

"Wb" = Belt mass/m length measured in kg/m length.

"Wm" = Mass of material on the belt/m and calculated from Wm=Q/3.6/S in kg/m length.

"Q" = Capacity of conveyor in tons/hour.

"Ai(carry)" = Rotational idler resistance measured in Newtons normally given by the Vendor and varies between 1 and 3 N/roll (A 3-roll set would have a resistance of 3N to 9N).

"Ai(return)" = Rotational idler resistance measured in Newtons normally given by the Vendor and varies between 1 and 3 N/roll (A 1-roll set would have a resistance of 1N to 3N).

"IS(carry)" = Idler spacing for the carry strand in m.

"IS(return)" = Idler spacing for the return strand in m.

Prior to starting the calculation there are three major "factors" used in the analysis namely;

'Kx' FACTOR

Which is defined as a combination of idler rotational resistance and the belt sliding resistance over the idler.

Kx will be defined as being = .00068 (Wb + Wm) * 9.81 + Ai(carry)/IS(carry) + Ai(return)/IS(return) = N/m length.

'Ky' FACTOR

Which is defined as the resistance of the belt and material to FLEXURE as it moves over the idler.

The Ky factor is considered to be a function of belt tension, material characteristic and load shape.

The Ky factor is considered to be a function of belt tension, material characteristic and load shape.

For the return belt we use a factor of 0.015 throughout.

'Kt' FACTOR

This is the factor which is intended to compensate for increases in bearing resistance at lower ambient temperatures.

Normally this factor is set at 1.0. However, a note of caution is required at extreme low temperatures (below freezing) because the lubrication selection of the idler bearing becomes critical and has resulted in failure of some installations.

At extreme temperatures the belt rubber cover characteristics change, which can also cause a system failure.

The following factors affect the tension in a conveyor system :-

a. The Tension Required to Move the Load Horizontally (T_{hor})

The tension or force required to move the load horizontally over the conveyor length. This will depend on the length of the conveyor, the rate of loading and the calculation/selection of the factors listed above.
T_{hor} will then be calculated from:- T_{hor} = L x Kt (Kx + (Ky x (Wb + Wm) x 9.81) + (0.015 x Wb x 9.81)) with units of N.

b. The Tensioning Required to Lift or Lower the Load (T_{lift})

The tension or force necessary to **raise** or **lower** the load through the vertical distance required. This will depend on the rate of loading and the distance involved. This component can be positive or negative according to whether the load is raised or lowered.

T_{lift} = H x Wm x 9.8 (N)

It is possible to split the conveyor up into a combination of sectors allowing the tension distribution to be calculated throughout the conveyor which is standard practise for computer aided calculation procedures.

c. Additional Tension Factors(T_{misc})

These comprise tensions to accelerate the material, skirt plate drag, tension to rotate the pulleys and an allowance for scraper drag.

These tension components are often insignificant however under extreme cases they should be understood.

Tension to rotate pulleys will be :- T_{pulley} = Pulley mass(kg) * 0.022 * 9.81 with units of N.

Tension to accelerate the material will be :- T_{accel} = Wm * 9.81 *(V^2 - V1^2) with units of N (where V1 = Velocity at chute exit).

Skirt plate tension can be approximated as follows :- T_{skirt} = Wm x Length Skirt (m) x Depth of Material (m) x Friction coeffecient x 9.81 with units of N.

Tension for scrapers is normally assumed to be $T_{scraper}$ 1000N per scraper.

This will give a resultant $T_{misc} = T_{pulley} + T_{accel} + T_{skirt} + T_{scraper}$

The sum of the three outlined above represents the total effective tension or force "TE".

or :- TE = $T_{hor} + T_{lift} + T_{misc}$ (N)

Therefore we are able to calculate the required conveyor power power as :

Shaft power (Kw) = {TE (N) x S (m/s)} / 1000

Application, Storage, Service and Maintenance

Application

At current price levels, steel cord belts, given its technical strengths and long life, stands to be a better choice with respect to the textile belt in several conveyors. It is now being selectively recommended by designers even for the belt rating of 500 kN/m to 1000 kN/m in preference to textile, apart from the higher strengths where it has always been the solitary reliable solution, ever since its inception

Typical areas of application of steel cord belts are:

Lignite mine	Coal mine	Power station
Steel industry	Ore handling plant	Cement industry
Chemicals industry Port	Aluminium and copper mines, etc.	

Storage and Handling

Standard packing of NRC steel cord conveyor belt consists of steel reels with metal centres which can be mounted on 180 mm square bars unless otherwise specified. Length of the roll is normally determined by the maximum weight and diameter which can be handled during transportation and at site with the following limits:

Maximum overall weight - 40 tons

Maximum overall roll height - 3.5 m

Maximum overall diameter/width relationship - 3.5:1

The belts should preferably be stored in steel reels at site in a cool and dry place. If this facility is not available, the belts should at least be protected from direct sunlight.

Service

NRC Offers You:

- Latest international technology, indigenously available at your doorstep.
- The benefit of a constant update on improvement of technology in bulk handling.
- The highest level of quality with the consistency and reliability, true to the spirit of ISO 9001 and ISO 14001 certification.
- The solution to your material handling needs at the concept stage itself.
- A dedicated design for every conveyor project to ensure ultimate cost-benefit of your investment. Belt laying, splicing and commissioning of conveyor belts for new projects.
- The services of an international class towards optimum design and selection of belts, maintainability of belts, solution of conveyor problems, modernisation of conveyors.

Maintenance

Steel cord conveyor belts have proved to be a trouble-free, reliable and long-lasting mode of material transportation. Here are some suggestions on maintenance so as to derive the best service:

Loading at the centre of the belt.

- Cleaning of belt by scrapers.
- Installing training idlers on carrying and return run to avoid belt-hits on the structure.
- Early repair of cover damages.
- Using skirt board with special rubber and not from old belt.
- Maintaining an edge clearance of 75 mm for belt edge from structure.
- Maintaining correct transition distance.

NRC Industries Limited
www.nrcconveyor.com

Notes

NRC Industries Limited

www.nrcconveyor.com

9th Mile Stone, Kashmir Road,
P.O. Verka, AMRITSAR-143501 (INDIA)

T : +91 98146-20906
M : +91 99147-77333

sales@nrcconveyor.com

www.nrcconveyor.com

NRC INDUSTRIES LTD.
AN ISO 9001:2008 & 14001:2004 COMPANY
NABL ACCREDITED