Technical White Paper on Conveyor Belts

1. Preface

1.1 Purpose of the Document

This white paper aims to clarify the technical specifications, structural characteristics, performance indicators, quality requirements and application boundaries of special conveyor belts for quarries (including sand and gravel aggregate yards and mine crushing production lines). It provides authoritative technical basis for the design, selection, procurement, acceptance and subsequent application of quarry conveyor belts, ensuring that the conveyor belts operate stably, safely and efficiently under the harsh working conditions of quarries with high wear, high impact and high dust, extending the service life of equipment and reducing production and operation costs.

1.2 Scope of Application

This white paper applies to fabric-core rubber conveyor belts and steel cord conveyor belts used under various working conditions in quarries, covering typical application scenarios such as horizontal conveying, inclined conveying, transfer impact sections, closed corridors and open-air operations. It is not applicable to underground explosion-proof special working conditions (underground applications must additionally comply with special explosion-proof, flame-retardant and anti-static standards).

1.3 Terms and Definitions

- Conveyor Belt: A flexible conveying component composed of cover rubber, core layer, edge rubber and other parts, used for continuous conveying of quarry materials (ore, crushed stone, sand and gravel, etc.).
- Fabric-Core Conveyor Belt: A conveyor belt with polyester (EP), nylon (NN), cotton canvas (CC) and other fabrics as the core layer, mainly used for medium-short distance, medium-light load conveying.
- Steel Cord Conveyor Belt: A conveyor belt with high-strength steel cords as the core layer, mainly used for long-distance, heavy-load and high-tension conveying scenarios.
- Cover Rubber: A rubber layer coated on the surface of the core layer, divided into the working surface (in contact with materials) and the non-working surface (in contact with rollers and idlers), mainly playing the role of wear resistance, impact resistance and corrosion resistance.

- Joint Efficiency: The ratio of the tensile strength at the joint of the conveyor belt to the tensile strength of the belt body, which is a core indicator for measuring the quality of the joint.

2. Executive Standards

The technical requirements, performance indicators and quality acceptance of the quarry conveyor belts described in this white paper strictly comply with the following national, industrial and international standards. If there are differences between the standards, the more stringent one shall prevail.

- GB/T 7984-2022 "Fabric-Core Conveyor Belts for General Purposes"
- GB/T 9770-2013 "Steel Cord Conveyor Belts"
- GB/T 20021-2017 "Canvas-Core Conveyor Belts"
- GB/T 10822-2021 "Flame-Retardant Conveyor Belts for General Purpose Fabric-Core" (applicable to closed corridors)
- DIN 22101 "Conveyor Belts for Mining - Technical Requirements and Testing"
- ISO 14890 "Conveyor Belts - General Technical Conditions"
- AS 1333 "Safety and Performance Specifications for Mining Conveyor Belts"

3. Characteristics of Quarry Working Conditions

The design of the technical parameters of the quarry conveyor belt must be fully adapted to its unique harsh working conditions, and the specific characteristics are as follows:

3.1 Material Characteristics

- Material Type: Mainly hard materials such as granite, limestone, basalt, ore, crushed stone and sand, some of which have sharp edges and corners.
- Material Particle Size: The conventional particle size is 0～600mm, the mainstream application scenario is 0～300mm, and block materials larger than 600mm may appear at the transfer point and crushing mouth.
- Material Density: 1.4～2.8 t/m^3. The density of materials with different lithologies is different, and the maximum density shall be taken in the design.
- Material Humidity: In open-air operations, the material humidity changes with the environment, and the humidity can reach more than 80% on rainy days, which is easy to cause the conveyor belt to slip and the rollers to stick to materials.

3.2 Environmental Conditions

- Operating Environment: Mainly open-air and semi-open-air, with some scenarios being closed corridors. The dust concentration is high, which is easy to attach to the surface of the conveyor belt and equipment components.
- Temperature Range: -30°C～+80°C. The low temperature in winter in cold areas in the north can be below -30°C, and the open-air temperature in summer in the south can reach +80°C, which requires good high and low temperature resistance.
- Other Environmental Factors: Long-term exposure to ultraviolet radiation, rain erosion, wind and sun, which are easy to cause aging and rubber cracking of the conveyor belt; some quarries have corrosive dust, which requires a certain degree of corrosion resistance.

3.3 Conveying Conditions

- Conveying Inclination: Conventional horizontal conveying (0°), inclined conveying inclination 0°～18°; chevron conveyor belts or sidewall conveyor belts are required for large-inclination conveying (18°～60°).
- Conveying Distance: Short distance (<100m), medium distance (100～300m), long distance (>300m), the longest can reach more than 1000m. For long-distance conveying, the tensile deformation and tensile bearing capacity of the conveyor belt must be considered.
- Impact Load: Large impact is generated when materials fall at the crushing mouth and transfer point, which is easy to cause wear of the cover rubber and damage to the core layer of the conveyor belt, requiring good impact resistance.

4. Structure and Technical Parameters of Conveyor Belts

4.1 Overall Structure

The special conveyor belt for quarries adopts a "layered composite structure", which is sequentially from the outside to the inside: working surface cover rubber, core layer (fabric core/steel cord core), non-working surface cover rubber and edge rubber. All layers are closely attached to ensure the overall structural stability. The specific structure is described as follows (text description):

Working Surface Cover Rubber → Core Layer → Non-Working Surface Cover Rubber; edge rubber is on both sides, used to protect the edge of the core layer and prevent edge wear and cracking.

4.2 Technical Requirements for Each Component

4.2.1 Cover Rubber (Working Surface/Non-Working Surface)

The cover rubber adopts special wear-resistant rubber for quarries, preferably a blend system of natural rubber (NR) and styrene-butadiene rubber (SBR), with excellent wear resistance, impact resistance, aging resistance and flex resistance. The specific technical parameters are as follows:

- Wear Resistance: Tested according to DIN 53516 standard, the wear loss ⩽120 mm^3 (conventional working conditions); ⩽100 mm^3 for high-wear and high-impact working conditions.
- Tensile Strength: ⩾18 MPa, elongation at break ⩾450%, ensuring that the cover rubber is not easy to tear or fall off.
- Hardness: Shore A 60～70 degrees, balancing wear resistance and flexibility, avoiding cracking due to excessive hardness and excessive wear due to excessive softness.
- Aging Resistance: After hot air aging (70°C×72h), the tensile strength retention rate ⩾80%, the elongation at break retention rate ⩾75%; no obvious cracks after ozone aging (40°C×72h, concentration 50pphm).
- Thickness Specification: Determined according to the wear degree of the working conditions, as follows:
    - Conventional Wear Section: Working surface 6～8mm, non-working surface 3～4mm;
    - Impact Section (Crushing Mouth, Transfer Point): Working surface 8～12mm, non-working surface 4～6mm;
    - High-Impact and Ultra-Sharp Material Section: Working surface 12～15mm, non-working surface 6mm.

4.2.2 Core Layer (Fabric Core/Steel Cord Core)

The core layer is the force-bearing core of the conveyor belt, responsible for transmitting traction, bearing material weight and impact load. The corresponding core layer type is selected according to the conveying distance and tensile force. The specific technical requirements are as follows:

(1) Fabric Core

Polyester (EP) fabric core is preferred, followed by nylon (NN) fabric core. Cotton canvas (CC) core is only suitable for small-scale, light-load and short-distance scenarios. The specific parameters are as follows:

- Polyester (EP) Fabric Core: Warp tensile strength ⩾100 N/mm·layer, weft tensile strength ⩾40 N/mm·layer, shrinkage rate ⩽1.5% (120°C×30min), good dimensional stability and no elongation, suitable for medium-long distance and medium-heavy load conveying. Common specifications: EP100, EP200, EP300, EP400, EP500.

- Nylon (NN) Fabric Core: Warp tensile strength ⩾200 N/mm·layer, weft tensile strength ⩾50 N/mm·layer, good elasticity and strong impact resistance, but high shrinkage rate (⩽3%), suitable for short-distance and high-impact conveying. Common specifications: NN200, NN300, NN400.
- Number of Fabric Layers: Determined according to the conveyor belt width and tensile force requirements, usually 2～6 layers. The larger the width and the greater the tensile force, the more the number of layers.

(2) Steel Cord Core

High-strength galvanized steel cord is adopted, which is used for long-distance (>300m), heavy-load and high-tension conveying scenarios. The specific parameters are as follows:

- Steel Cord Specification: Diameter 3.0～6.0mm, tensile strength ⩾1770 MPa, galvanized layer weight ⩾150 g/m^2, with good rust resistance.
- Belt Strength Specification: ST630～ST5400 grade, corresponding to the rated tensile strength of 630～5400 N/mm per meter width of the conveyor belt, selected according to the calculation of conveying distance and load.
- Steel Cord Spacing: 10～20mm, evenly spaced to ensure uniform force bearing and avoid local stress concentration leading to fracture.

4.2.3 Edge Rubber

The edge rubber adopts wear-resistant rubber of the same material as the cover rubber, with thickness ⩾10mm and width ⩾50mm, tensile strength ⩾15 MPa, elongation at break ⩾400%. Its main function is to protect the edge of the core layer, prevent edge wear, cracking and delamination, and adapt to the friction demand when the conveyor belt deviates.

4.3 Overall Performance Indicators

- Tensile Strength: Fabric-core conveyor belt ⩾100 N/mm·layer (corresponding to the fabric layer), steel cord conveyor belt ⩾belt strength specification value.
- Transverse Tear Strength: ⩾300 N/mm, preventing longitudinal tearing of the conveyor belt caused by sharp edges and corners of materials.
- Joint Efficiency: Fabric-core conveyor belt ⩾90% (hot vulcanized joint), steel cord conveyor belt ⩾95% (hot vulcanized joint), cold-bonded joint efficiency ⩾80% (only applicable to fabric-core).
- Flex Resistance: No delamination, cracking or core exposure after 1 million flex tests.
- Water Resistance: After 24 hours of immersion, the tensile strength retention rate ⩾90%, no delamination or bubbling.

4.4 Typical Specification System

Combined with the mainstream working conditions of quarries, the following typical specifications are formulated, which can be customized according to actual needs:

4.4.1 Fabric-Core Conveyor Belts (EP/NN)

Belt Width (mm)	Core Layer Type	Belt Strength Specification	Number of Fabric Layers	Cover Rubber Thickness (Top/Bottom, mm)	Application Scenario
500	EP/NN	EP100/NN200	2～3	6/3	Small quarries, short-distance light-load conveying
650	EP/NN	EP200/NN200	3～4	6/3	Small and medium-sized quarries, medium-short distance conveying
800	EP	EP200～EP300	4～5	8/4	Mainstream quarries, medium-distance medium-load conveying
1000	EP	EP300～EP400	5～6	8/4	Medium-sized mines, medium-long distance heavy-load conveying
1200	EP	EP400～EP500	6	10/5	Large aggregate lines, long-distance heavy-load conveying

4.4.2 Steel Cord Conveyor Belts (ST)

Belt Width (mm)	Belt Strength Specification (ST)	Steel Cord Diameter (mm)	Cover Rubber Thickness (Top/Bottom, mm)	Application Scenario
1000	1000～1600	3.0～4.0	10/5	Medium-long distance heavy-load conveying
1200	1600～2500	4.0～5.0	12/6	Long-distance, high-tension conveying
1400+	2500～5400	5.0～6.0	12～15/6	Large mines, ultra-long distance heavy-load conveying

5. Production Process and Quality Control

5.1 Production Process Requirements

- Rubber Compounding: The rubber compound is mixed by an internal mixer, the mixing temperature is controlled at 140～160°C, and the mixing time is 3～5min to ensure the rubber compound is uniform without impurities and bubbles; the vulcanization system adopts sulfur vulcanization to ensure sufficient vulcanization.
- Core Layer Treatment: The fabric core needs to be dipped in glue, the dipping agent is a special adhesive, and the drying temperature after dipping is 80～100°C to ensure firm bonding between the core layer and the cover rubber; the steel cord core needs to be derusted and galvanized, with no oxide layer or oil on the surface.
- Molding Process: The layered molding method is adopted, laying the non-working surface cover rubber, core layer, working surface cover rubber and edge rubber in sequence, the molding pressure is 0.3～0.5MPa, ensuring that all layers are closely attached without bubbles and delamination.
- Vulcanization Process: A flat vulcanizing machine or drum vulcanizing machine is adopted, the vulcanization temperature is 145～150°C, the vulcanization pressure is 0.8～1.2MPa, and the vulcanization time is determined according to the thickness of the conveyor belt (1～1.5min per millimeter thickness), ensuring sufficient vulcanization without under-vulcanization or over-vulcanization.

5.2 Quality Control Points

5.2.1 Raw Material Quality Control

- Rubber Raw Materials: Natural rubber and styrene-butadiene rubber shall comply with GB/T 8081 and GB/T 8656 standards, without impurities and aging; vulcanizing agents, accelerators, anti-aging agents and other additives shall comply with relevant industrial standards, and unqualified additives are strictly prohibited.
- Core Layer Raw Materials: The fabric core shall comply with GB/T 20021 standard, and the steel cord shall comply with GB/T 8918 standard to ensure that the tensile strength, corrosion resistance and other indicators meet the standards.
- When raw materials enter the factory, factory certificates and test reports shall be provided, and they can be put into production only after passing sampling inspection.

5.2.2 Production Process Quality Control

- Rubber Compounding: Regularly test the tensile strength, hardness, wear resistance and other indicators of the rubber compound to ensure that the performance of the rubber compound meets the standards.
- Molding Process: Check the laying thickness and flatness of each layer to ensure no bubbles, delamination and lack of glue; the edge rubber is closely attached without warping and cracking.
- Vulcanization Process: Real-time monitor the vulcanization temperature, pressure and time to ensure stable vulcanization process parameters and avoid under-vulcanization or over-vulcanization.

5.2.3 Finished Product Inspection Control

- Appearance Inspection: The surface of the finished conveyor belt has no bubbles, impurities, lack of glue, delamination, core exposure, cracks and other defects; the edge is neat without burrs and warping; the thickness deviation is $\leqslant \pm 0.5$mm, and the width deviation is $\leqslant \pm 5$mm.
- Performance Inspection: Sampling inspection is carried out for each batch of finished products, testing tensile strength, transverse tear strength, wear resistance, joint efficiency and other indicators, and they can leave the factory only if they meet the requirements of this white paper and relevant standards.
- Inspection Records: Establish complete inspection records, including raw material inspection records, production process inspection records and finished product inspection records, which shall be filed for future reference for a period of not less than 3 years.

6. Acceptance Standards and Methods

6.1 Acceptance Basis

The acceptance of quarry conveyor belts is based on this white paper, relevant national/industrial/international standards, supply contracts and factory test reports to ensure that the quality of the conveyor belts meets the agreed requirements.

6.2 Acceptance Content

6.2.1 Appearance Acceptance

Visually inspect the surface and edge of the conveyor belt for no bubbles, impurities, lack of glue, delamination, core exposure, cracks, warping and other defects; measure the belt width and thickness, which shall meet the deviation requirements; the marking is clear, indicating the product name, specification, batch, production date, manufacturer and other information.

6.2.2 Document Acceptance

The supplier shall provide the following documents, which can be accepted only if they are complete and true and effective:

- Product factory certificate;
- Raw material factory certificate and test report;
- Finished product test report (including tensile strength, transverse tear strength, wear resistance and other indicators);
- Production process records;
- Product manual (including installation, use and maintenance points).

6.2.3 Performance Sampling Acceptance

If on-site sampling inspection is required, the sampling ratio shall not be less than 5% of each batch of products. After sampling, it shall be sent to a qualified third-party testing institution to test core indicators such as tensile strength, transverse tear strength and wear resistance. The test results shall be qualified if they meet the requirements of this white paper and relevant standards.

6.3 Handling of Unqualified Acceptance

If appearance defects, incomplete documents or unqualified performance tests are found during the acceptance process, the supplier shall rectify and replace within the agreed time

until the acceptance is qualified; if rectification or replacement is impossible, it shall be handled in accordance with the relevant terms of the supply contract.

7. Packaging, Transportation and Storage

7.1 Packaging

The conveyor belt is packaged in a circular or roll shape. The packaging material is waterproof and wear-resistant canvas or plastic film, which is tightly packaged to prevent wear, moisture and pollution during transportation; each roll of conveyor belt is marked with product name, specification, length, batch, production date, manufacturer and other information.

7.2 Transportation

- During transportation, avoid extrusion, collision, exposure to sunlight and rain to prevent deformation, aging and damage of the conveyor belt;
- When transporting roll-shaped conveyor belts, they shall be fixed firmly to prevent rolling, and the stacking layer shall not exceed 2 layers;
- The transport vehicle shall be clean and dry, without sharp debris, to avoid scratching the surface of the conveyor belt.

7.3 Storage

- The storage site shall be clean, dry and ventilated, away from fire and heat sources (distance ⩾10m), avoiding direct sunlight, rain and moisture;
- The conveyor belt shall be placed horizontally or vertically. When placed vertically, it shall be fixed firmly to prevent rolling; the stacking layer shall not exceed 2 layers to avoid extrusion deformation;
- The storage temperature is controlled at -10℃～+30℃, and the relative humidity ⩽75%;
- Storage Period: No more than 12 months from the date of production. If it exceeds the storage period, it shall be re-inspected and can be used only after passing the inspection.

8. Application Notes

- The selection of conveyor belts shall be combined with the specific working conditions of the quarry (material characteristics, conveying distance, inclination angle, conveying capacity, etc.), and strictly implemented in accordance with this white paper and the selection guide to avoid shortened service life and equipment failure caused by improper selection.

- During installation, ensure that the frame is horizontal, the rollers are parallel, the idlers rotate flexibly, and the tension of the conveyor belt is uniform to avoid deviation and slipping; the joint shall adopt hot vulcanized joint to ensure that the joint efficiency meets the standard.
- During use, regularly clean the material stuck on the rollers and idlers, check the deviation, wear and tear of the conveyor belt, and adjust and repair in time; avoid jamming of sharp materials to prevent tearing of the conveyor belt.
- Regularly maintain the conveyor belt, and replace it in time according to the wear condition to avoid material leakage and equipment damage caused by conveyor belt damage.

9. Supplementary Provisions

- This white paper shall take effect from the date of issuance. For matters not covered herein, reference may be made to relevant national and industrial standards.
- This white paper shall be explained by the issuer. If there is technological upgrading or standard update, this white paper will be revised in a timely manner and notified separately after revision.
- This white paper is only applicable to special conveyor belts for quarries. Conveyor belts used in other scenarios (such as underground, chemical industry, etc.) must additionally comply with relevant special standards.