Laboratory Test Results Fire Safety Conveyor Belts

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Testing of fire safety is based on the premise that a band should not be a fire, it would be hard to ignite and if was ignited by an external source of fire should not flame retardant. While fire resistance specifications vary from country to country, formulated to meet any fire performance specifications in the world. Tests on conveyors to assess their compliance with fire safety standards are: Drum friction test: The danger associated with a stalled belt and a driven rotating drum or pulley resulting in frictional heat build up. Laboratory flame test: The possibility of igniting the considerable mass of a conveyor belt with a relatively small ignition source. Gallery fire test: The possibility of a belt, ignited from a larger ignition source, spreading the fire to other areas (often referred to as fire propagation). Electrical resistance test: The possible build-up and subsequent discharge of static electrical charge on moving conveyors.

Keywords: conveyor belt, fire safety, fire resistance, flame

Drum friction test a test piece of conveyor belt, properly wired and tense, is half wound around a rotating steel drum, simulating a stagnant belt. The test is continued to the specified voltage for a certain period of time, or until the belt fails [1, 2]. The presence or absence of flame or glow is noted and cylinder unit temperature is measured. This test was probably the most important safety regarding fire prevention on conveyor.

Laboratory flame test is usually evaluated by applying a flame type in a sample and observing the ring. It noted the time required for flame and / or glow is extinguished by itself [3, 4].

Gallery fire test can only be assessed through a trial by fire in the gallery made a large-scale test involving the use of 7.5 kilograms of propane and 50 min to turn a belt [5, 6]. At the same time test method was very trying required large-scale facilities and created environmental, health and safety issues.

Resistance test analyze PVC and rubber compounds that are specially formulated to ensure that belts are sufficiently conductive to avoid accumulation of static electricity [7, 8]. Electrical resistance is determined by passing an electric current between electrodes voltages placed on the surface of the belt. Internationally recognized acceptance criteria for electrical conductivity is a maximum resistance of 3.0x108 Ohm (300M Ohms).

Probe quality belts are produced in accordance with ISO 9001:2000.

Usually this test will include:

- dimensional measurements;
- warp and weft tensile strengths;
- breaking;
- elongation;
--grip;
- small-scale safety tests (laboratory flame and electrical resistance);
- abrasion;
- transverse stability.

In addition to the tests described above it is also necessary to ensure that every belt will meet the customers requirements and be suitable intended use [9-11]. Belt has the capacity to combine, or by using mechanical fasteners or vulcanised splices [12], all tested by drilling a series of dynamic tests that allow us to perform:

- accelerated testing on both sides of the belt and related method of joining;
- the issue of simulation;
- troughing / transition distance evaluations;
- material testing and product development;
- belt test specific individual client.

Experimental part

Materials and testing equipment

From Single burner test on a length of 2m, we need equipment consisting of:

*Gallery***,** The maximum cross-sectional area of 6 m^2 with a height of not less than 1.9 m and not more than 2.25 m, a width of not less than 1.9 m and not more than 2.75 m, in which a fan blows air adjustable. Gallery concrete floor must have and must have a length of at least 15 m, the measurement is carried out from the input manifold;

Trestle, comprising a frame with internal dimensions 2.25 m length x 1.25 m width, composed of steel pipes to ISO 65: 1981 size DN 15 heavy series. The upper surfaces of the frame must contain stockade keeping bars allowing positioning and maintaining the 15th place steel bars austenitic chromium / nickel appropriate quality, corrosion resistant, acid and heat. The bars should have a diameter of 10 mm and a length of 1.4 m; they are the band that is placed. The upper surface of the bars must be 350 mm from the ground;

Burner, mounted as in the following figure, containing a square with dimensions of (450 ± 9) mm with a total height of (220 ± 5) mm. The burner must be a steel tube welded to ISO 65: 1981 DN size 15, medium or heavy series. The tubing must contain 52 holes, each with diameter of (1.5 ± 0.1) mm, spaced 50 mm;

Anemometer, or other system of measuring air velocity in the gallery, to be positioned at a height of 350 mm in the gallery axis, at least 7.25 m from the entrance gallery and 750 mm at the end of the trestle closest to the entrance of the gallery;

NOTE: It is important that air flow in the gallery to have a laminar flow; For this purpose, the equipment that can be used to promote the laminar flow.

*Thermocouples***,** to measure air temperature inside.

From Double burner test, we need equipment consisting of:

- *Gallery***,** as described in the test with a single burner;

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- *Trestle*, as described in the test with only one burner, but its length must be of 2.70 m instead of 2.25 m, and should support the bars 18 of steel with a diameter of 12 mm instead of 15 bar steel with a diameter of 10 mm;

- *Burner*, comprises two adjacent squares of (450 ± 9) mm, located one above the other in two parallel planes at a distance of 280 mm. Axis lower portion of the burner should be at a height of (210 ± 5) mm. The burner must be made of a welded steel pipe, size medium or heavy series DN 15. The pipe must contain 104 holes (52 in each element), diameter (1.5 ± 0.1) mm, spaced at 50 mm. Each element of the burner must have its own gas supply;

- *Anemometer*, or other system of measuring air velocity in the gallery, to be positioned at a height of 350 mm in the gallery axis and at least 750 mm from the end closest to the entrance stockade gallery.

From a fire test in the gallery, we need a device consisting of:

- *Test gallery*, includes a housing made of a refractory material thickness of 25 mm with an opening of 460 mm x 460 mm, a length of 1676 mm, connected to a discharge pipe with a diameter of 300 mm, with a the tapered section stainless steel about 1,5 mm thick. Exhaust pipe must find a fan to vent the air in the gallery, with a speed controlled by adjusting valves;

- *The suction hood*, a 1.5 mm thick stainless steel, placed above the test chamber, for extracting the fumes can escape through the front of the enclosure during a test;

- *Scaffold*, serves as a support band sample;

- *Gas burner*;

- *Propane gas* burner provided at a constant speed through a flow meter, so that the mass of the gas to be used during the test for (565 ± 10 g);

- *Balance,* capable of weighing cylinder and the band before and after the test gas with an accuracy of 5 g or greater;

- *Anemometer,* located in the axis of the test chamber, at a height of 310 mm and 285 mm above the ground in front of the enclosure;

- *Thermocouple,* installed in the exhaust pipe connected to a recording device;

- *Recording device,* allowing the temperature record at least six times per min;

- *Timer,* allowing measurements with an accuracy of 1 s.

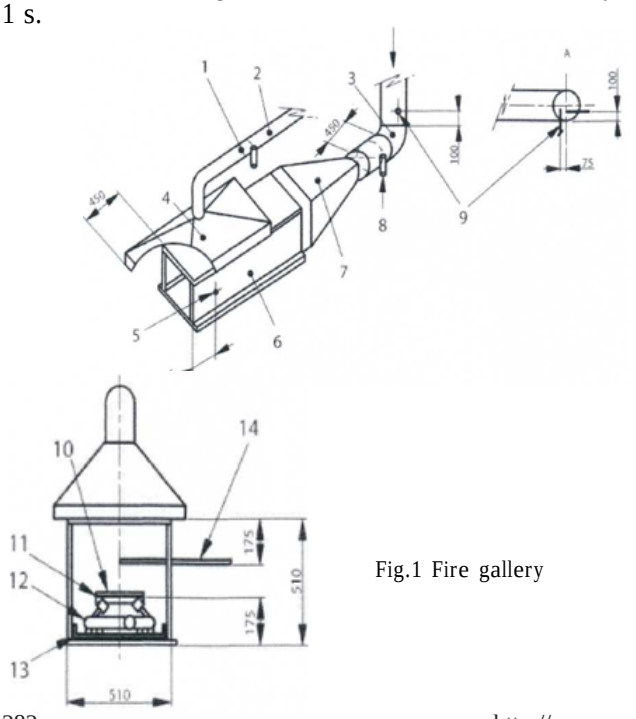

Fig.1 Fire gallery

Results and discussions

Single burner test on a length of 2m

It cuts two specimens, each 2 m length x 1200 mm width, or if the full width belt conveyor has a width of less than 1 200 mm. Allow specimens to rest for 24 h, protected from humidity, ambient temperature positive, to remove any residual curvature.

Temperature at start of test

The ambient temperature at the start of the test must be between 5 and 30°C.

Two tests are performed, one on each side of the strip, such that both pads of the strip to be tested.

Weigh propane gas bottle before the test.

It crosses the trestle, the longitudinal axis of the manifold, the end of the burner being oriented for the purpose of ventilation. The burner at the end stockade must be at least 8 m from the entrance of the gallery.

It crosses one after another each test specimen so that the edge on the transverse scaffold to be flush with the end of the burner trestle.

Adjust the flow of air in the gallery at an average speed of (1.5 ± 0.1) m / s at a height of 350 mm. Take measurements axis 750 mm stockade stockade end closest to the entrance of the gallery.

It crosses the burner, with the four pipes of the burner parallel to the longitudinal axis of the test piece, and is placed so that the distance between the top of the burner and the upper part of the rod which is placed the strip of (130 ± 5) mm, with the tip cross-hole burners of the array at 50 mm inside the vertical projection of the transverse edges in the test specimen. Turns burner and immediately adjusts the gas consumption (1.30 ± 0.05) kg in 10 min.

NOTE: You can adjust the gas consumption by controlling the gas pressure on the high-pressure diaphragm at about 0.16 MPa for gas consumption of 0.13 kg / min. Pressure relief valve, check valve flap and aperture should be as close as possible to one another.

It uses a precision manometer to control the pressure in the high-pressure diaphragm.

The gas supply is stopped after 10 min. Allow the specimen on the trestle until resolution of all flames or incandescentelor. However, if the extent of the fire appears to represent a danger to people or equipment, the test is stopped prematurely.

Reweigh the gas cylinder on completion.

Damage to the specimen is measured.

Measure the length of the test piece which remains intact throughout the width of the crack from the edge, as shown in the figure, on both sides, top and bottom. It has the lowest of the two measurements as wavelength remaining intact.

The measurement must always be performed in the direction parallel to the longitudinal axis of the strip. If the edges of the specimen are not parallel due to a narrowing irregular longitudinal axis must be assessed visually. Measurement should be on the surface of the specimen even if it was curved.

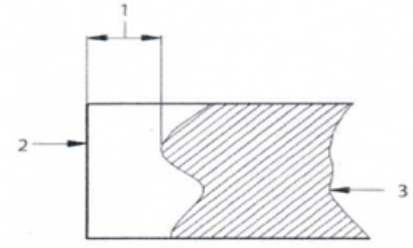

Fig.2 Measuring mode 1. The length of the conveyor belt intact; 2 Edge crack; 3 Conveyor degraded

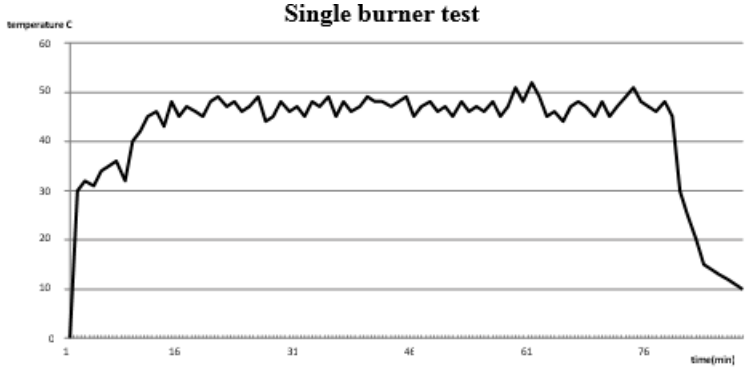

Fig.3 Curve temperature / time in the presence of the specimen

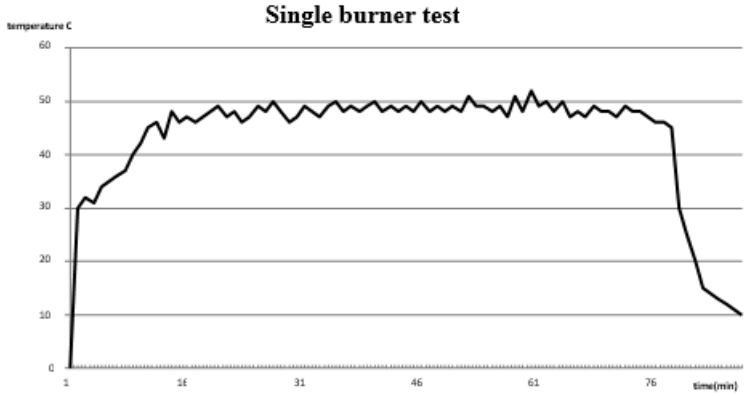

Fig.4 Curve temperature / time in the presence of the specimen

They performed tests on two samples of the same type which originally had a weight of 14.752 kg and revealed the following:

On the bottom (the one that has contact with the drive rollers) intact tape length was 1542 mm and the temperature variation in time was on figure 3.

On top (the one in contact with the transported material) was intact tape length of 1286 mm and the temperature variation in time was on figure 4.

Following the fire tests made on the 2 samples showed that this belt is within normal parameters on the fire risk.

Double burner test

It cuts two samples, each 2.5 m length x width 1200 mm, overall width or if the conveyor belt has a width less than 1200 mm. The test pieces allowed to stand for 24 h, protected from moisture in an ambient temperature above 0 ° C, to remove any residual curvature.

Weigh propane gas bottle before the test.

It crosses the trestle, the longitudinal axis of the manifold, the end of the burner being oriented for the purpose of ventilation. The burner at the end stockade must be at least 8 m from the entrance of the gallery.

It crosses one after another each test specimen so that the edge on the transverse scaffold to be flush with the end of the burner trestle.

Adjust the flow of air in the gallery at an average speed of (1.5 ± 0.1) m / s at a height of 350 mm.

Take measurements axis 750 mm stockade stockade end closest to the entrance of the gallery.

When the air speed is stabilized at (1.5 ± 0.1) m / s, it crosses the burner, with four combustion tubes parallel to the longitudinal axis of the specimen and is placed so as to cross the end hole of the string of burners to be 50 mm inside the vertical projection of the transverse edges in the test specimen.

Light up the burners and immediately adjusts the gas consumption (1.30 ± 0.05) kg / 10 min for each burner.

NOTE - You can adjust the gas consumption by controlling the gas pressure on the high-pressure diaphragm at about 0.16 MPa for gas consumption of 0.13 kg / min. pressure relief valve, check valve flap and aperture should be as close as possible to one another. It uses a precision manometer to control the pressure in the high-pressure diaphragm.

The gas supply is stopped after 10 min. Allow the specimen on the trestle until resolution of all flames or incandescentelor. However, if the extent of the fire appears to represent a danger to people or equipment, the test is stopped prematurely.

Reweigh the gas cylinder on completion.

Damage to the specimen is measured.

Measure the length of the test piece which remains intact throughout the width of the crack from the edge, on both sides, top and bottom. It has the lowest of the two measurements as wavelength remaining intact.

The measurement must always be performed in the direction parallel to the longitudinal axis of the band If the edges are not parallel to the test specimen due to a narrowing of irregular shape, the longitudinal axis to be assessed visually. Measurement should be on the surface of the specimen even if it was curved.

It conducted tests on two samples of the same type which originally had a weight of 14.935 kg and revealed the following:

On the bottom (the one that has contact with the drive rollers) tape length of 1432 mm was intact and temperature changes over time has been confrm figure 5.

On top (the one in contact with the transported material) was intact tape length of 1231 mm and the temperature variation in time was on figure 6.

Following the fire tests made on the 2 samples showed that this belt is within normal parameters on the fire risk.

Fire test in the gallery

We prepared two samples with dimensions of 1500 mm length and 230 mm width of a mining conveyor that had a weight of 1752 g.

Propane gas bottle was weighed before the test.

Air velocity was set to 1.03 m / s with an anemometer.

There was discharge temperature for 4 min until it reached room temperature.

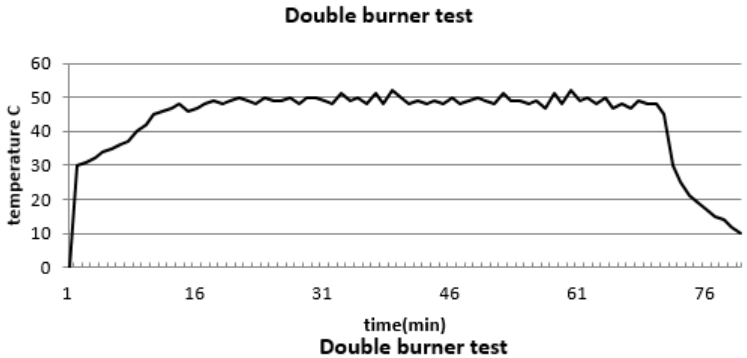

Fig.5 Curve temperature / time in the presence of the specimen

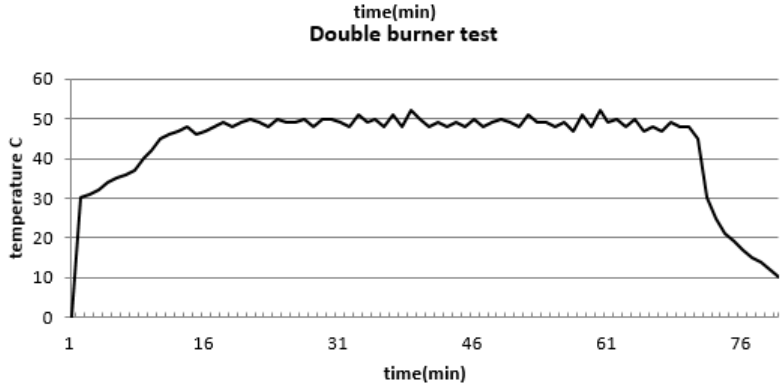

Fig.6 Curve temperature / time in the presence of the specimen

It has been adjusted to the gas flow 348 l/h.

We started the stopwatch.

After 50 min lost power gas burner and the specimen was left to cool for 15 minutes.

Was weighed again on completion of the gas cylinder and gas was observed that the mass consumed during the test was 573 g/50 min., so was within the limits of consumption, according to EN 12881-1 + A1: 2008 name (565 ± 10) g/50 min.

Crushed material was removed and weighed to the tape.

It is calculated an average of the temperatures in each of the first minute of the test, which are shown in the table below was drawn curve and the temperature / time in the presence of the specimen on the bottom (which is in contact with the drive roller) figure 7.

We determined the wavelength consumed during test strip mass from the value before and after the test, namely:

$L_b = (M_i - M_f) / M_i$ x 1500 mm

-M_i=1752 g – mass of the specimen before the test;

-M_f=931 g – mass of the specimen after the test meal;

-L_b – wavelength consumed during test.

L_b= (1752 – 631) / 1752 x 1500 = 960 mm

It is calculated an average of every minute of the temperatures of the two tests, which are shown in the table below was drawn curve and the temperature / time in the presence of test-piece at the top (which is in contact with the material of the shipped) figure 8.

We determined the wavelength consumed during test strip mass from the value before and after the test, namely:

$L_b = (M_i - M_f) / M_i$ x 1500 mm

-M_i=1752 g – mass of the specimen before the test;

-M_f=931 g – mass of the specimen after the test meal;

-L_b – wavelength consumed during test.

L_b= (1752 – 869) / 1752 x 1500 = 756 mm

Temperature (°C)	20	31	42	46	47	48	48	49	48	49	48	48	49	48	49	51	50	49	50	51	50	51	52	51	50
Time (min.)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Temperature (°C)	51	52	51	50	51	51	50	51	52	51	50	51	52	51	50	51	52	51	51	50	51	52	52	51	50
Time (min.)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Temperature (°C)	47	43	38	35	32	29	26	22	21	20	20	20	20	20	20										
Time (min.)	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65										

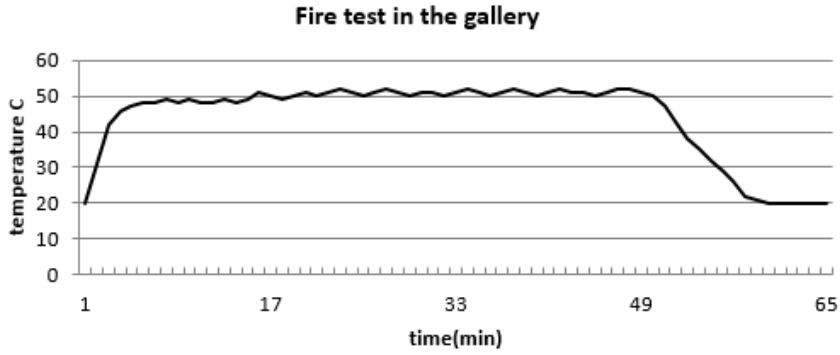

Fig.7 Curve temperature / time in the presence of the specimen

Temperatură (°C)	20	32	43	45	47	48	49	49	50	51	52	51	53	52	51	51	50	51	52	53	53	52	54	54	53
Timp (min.)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Temperatură °C	51	52	53	55	54	53	53	52	53	51	50	51	52	52	51	52	53	54	55	54	54	53	52	51	50
Timp (min.)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Temperatură °C	47	44	41	37	33	30	28	25	23	22	21	20	20	20	20										
Timp (min.)	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65										

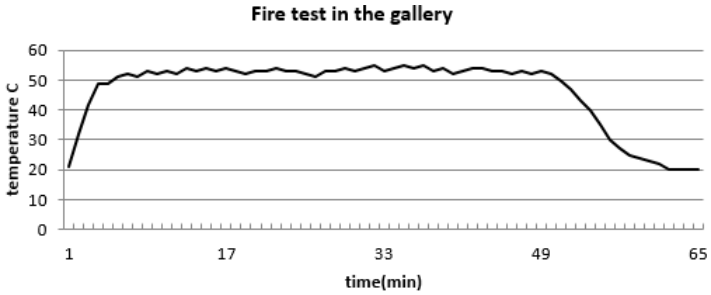

Fig.8 Curve temperature / time in the presence of the specimen

Conclusions

Testing of fire safety is based on the premise that a belt should not be a fire, it would be hard to ignite and if was ignited by an external source of fire should not flame retardant. While fire resistance specifications vary from country to country, formulated to meet any fire performance specifications in the world. Tests on conveyors to assess their compliance with fire safety standards are associated with the following four specific hazards:

- Associated danger of a stalemate belt and a pulley powered rotary drum and hence friction heat;
- The possibility of ignition of a conveyor belt with a relatively small source of ignition;
- The possibility that a belt to be lit from a larger source of ignition;
- Possible electrostatic discharges up and later on moving conveyor.

After fire tests with a single burner, made the 2 specimens of tape with a length of 2000 mm, a result that carpet tape is within normal parameters on the fire risk.

As a result of the double burner fire tests made on two test pieces of the tape with a length of 2500 mm long and 1200 mm wide, it has been found that with the removal of the burning flame they are not maintained.

For the test of fire spreading to medium scale were used two samples of tape with a length of 1500 mm long and 230 mm wide and have found that after a period of eight minutes ended any flame or incandescent per specimen and debris.

Fires that grow indoors (mining galleries) are accompanied by the release of products of combustion fumes, soot, fumes, etc. These products life-threatening users on the affected area, fire and influence the evolution of overall response, impede or render impossible the rapid intervention of firefighters and causes environmental impacts.

References

1.SCHULTZ, GEORGE A., Conveyor Safety and Regulations 2002-2003
2.SCHULTZ, GEORGE A., Training for Conveyor Safety October 2003
11.LUCAS J., W. THABET, AND P. WORLIKAR., Using Virtual Reality (VR) to Improve Conveyor Belt Safety in Surface Mining 2007
3.CADORIN, J.F., Compartment Fire Models for Structural Engineering, Collection des Publications de la Faculte des Sciences appliquees no 234, Liege, iunie 2003, pagini. 86-101
4.CADORIN, J.F., FRANSSEN, J.M., A tool to design steel elements submitted to compartment fires - OZone V2 - Part 1: Pre and post flashover compartment fire model, Fire Safety Journal, 2002
5.*** SR EN 12881-1+A1/SPTEMBER 2008
6.*** SR ISO 8421-1/1999
7.JOSSEY-BASS. CLARK, R. C., & MAYER, R. E., Learning and the science of instruction: Pfeiffer San Francisco 2003
8.BELT CONVEYOR MANUAL, www.fennerdunlop.com Australia
9.ARCHIBALD, J. F., HASSANI, F., 1999 Mine Backfill, An Operator's Guide. An interactive CD-ROM for mine operators and engineers 1999
10.WORLIKAR P., THABET, W., A Multi-Media Rich Digital Manual for Conveyor Belts Safety 2008
11. LUCAS, J.,THABET, W., WORKLIKAR, p., Using Virtual Reality (VR) to Improve Conveyor Belt Safety in Surface Mining 2007
12..GOLDBECK, L. Conveyor Safety and Education. Aggregates Manager 2003

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