# Staff transportation two way on the belt conveyor

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*Wide range of systems has been developed in order to transport coal miners to their working locations safely as well as quickly and efficiently. Among these systems, making use of a coal dispatching belt conveyor system for man riding is an alternative technique. Undoubtedly, the most significant subject that comes out while performing the man riding is to take all the mine safety precautions to eliminate the accident risk.*

*In this article, bidirectional man riding by belt conveyor, which is located in between + 374/ + 49 levels, slope of 16º, and 1230 m length main decline, was carried out for the first time in Turkey by Imbat Mining Co.Inc.'s Eynez Colliery Furthermore, besides the features of the bidirectional man riding system, the mine safety precautions that were taken to fulfill this transportation safely were explained.*

***Key words****: staff transportation, coal miners, coal dispatching belt conveyor system*

## Introduction

Imbat Mining Co., engaged in underground coal mining activities in Karanlıkdere locality of Eynez Village, Soma District of Manisa since 2004 years. Eynez Village is approximately 25 km from South west of Soma.

Company performs services underground lignite coal production; washing-enrichment and bagging daily mine production are average 15.000 tons / day. Between the years of 2004-2011 produced 20.212.238 tones lignite coal, washed and enriched. Including 3300 people in the underground, 63 engineers and 100 technicians, total 3750 people are working in the company.

Business has OHSAS 18001:2007 Occupational Safety Management System Certificate and ISO 14001:2004 Environmental Management System Certificate. Back acres, rear caving, multi-level long foot system is applied as production method. Hydraulic mast-steel winding (hoes) support system was used until November 2011 in the long legs. Mechanized system has been started after this date.

Coal produced is transmitted with chain or belt conveyor. The company has uninterrupted a transport system that extending until to surface enrichment facility from underground. The staff are transported the top of the conveyor belt that installed between +356 / +140 (Fig. 1) elevations in the main shipping decline drivage that 830 m length and 16 degree inclined.

*Fig. 1. This Plan of Inclined Shaft Located for Transportation between + 374 / +49 level.*

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But a new main shipping decline drivage opened between +374 / +49 elevations and 16 degree inclined because of the expansion of the study area and distances of transport. 1230 m. length a belt established in this newly opened drivage. The first time in Turkey began that two-way staff transport through the top floor of the belt to out of the workplace, by the ground floor to into the work place. Design and construction of belt carried out by engineers working in operation. Staff transplantation carried out since 2006 by this method and there have not been any accidents until years 2013 (Önder, 2012).

**Features drivage which is based the belt conveyor**

Belt conveyor used to transport people has been established second main shipping decline drivage between +374 / +49 elevations and 16 degree inclined. Concrete support (Fig. 2-A) were used until to 126 m. from gallery entrance and from continuation of this until 1054 m were used trapezoid (GI-110) support (Fig. 2-B).

The height of section used concrete support is 3.80 m. base width is 5 m. and cross-sectional area is 13.5 m². The height of section used trapezoid support 3.10 m., yoke length are 3.20 m. base width are 5 m cross-sectional area are 12.5 m². The rail line furnished to left side of drivage downward direction, conveyor belt has been established to right side.

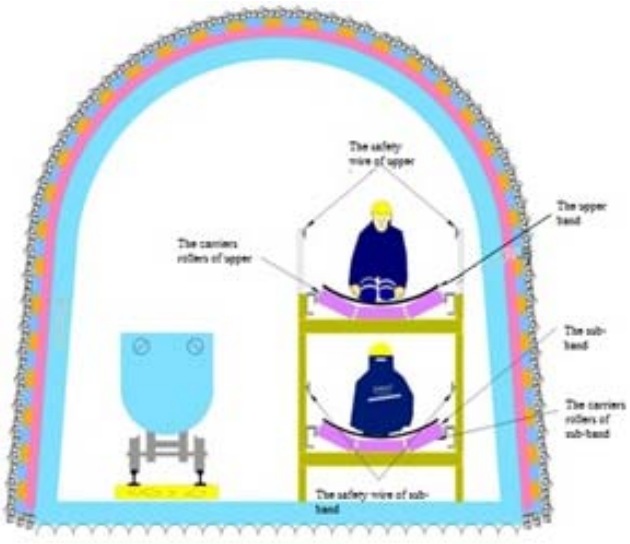


*Fig. 2-A. Cross – section of belt conveyor (Concrete support).*

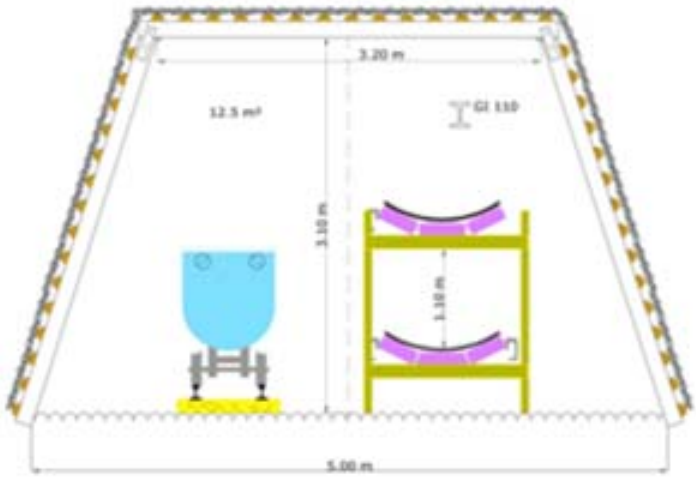


*Fig. 2-B. Cross – section of belt conveyor (trapeze support).*

Transportation of all materials was maintained passing through from this shaft by rail and monorail system.

## Technical information on belt conveyor

### Design of conveyor belt

Entry and exit to the stove at the same time on the belt conveyor that are total length 1230 m Belt conveyor consists the main band and second assistant the inner band that 36 m. distance from head drum and 187 m. length and are longitudinal cross-section in Figure 3-A,3-B.

*Fig. 3-A. Entry and exit on the belt conveyor.*

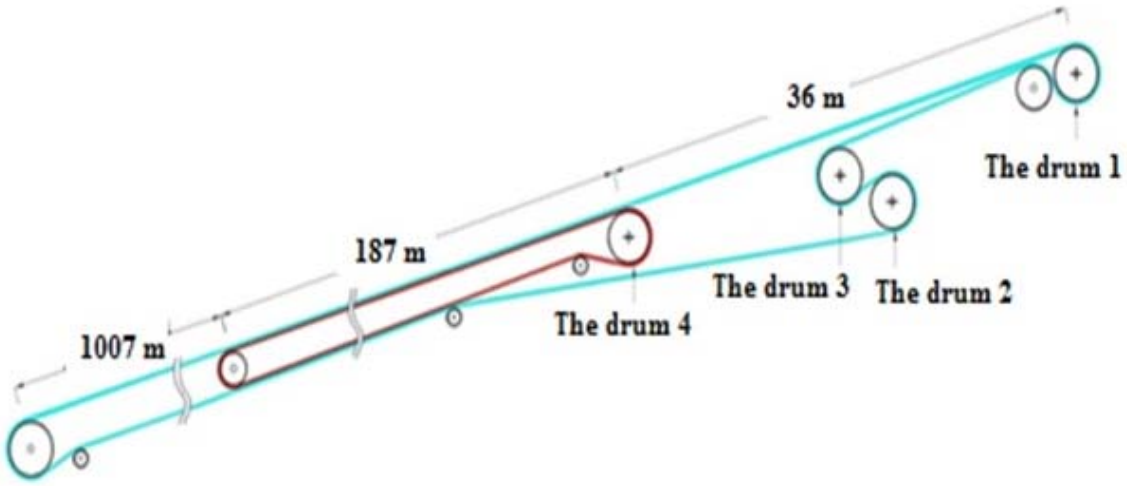


*Fig. 3-B. Longitudinal section of belt conveyor.*

### The Features of Main Belt conveyor

Belt conveyor where the transfer of staff properties that carrying capacity, band width, band length, belt speed (max) ect. shown in Tab. 1,

The band of the tire characteristics that total thickness, width, number of floors cord, thickness of top coating is given in Tab. 2.

*Tab. 1. The Features of Main Belt Conveyor.*

| | |
|---|---|
| **Carrying capacity** | 1000 ton/h |
| **Band width** | 1200 mm |
| **Band length** | 1230 m. |
| **The upper band carrier roller range** | 1 m. |
| **The lower band carrier roller range** | 3 m. |
| **Slope angle** | 16° |
| **Belt speed (max)** | 2,50 m/sec. |

*Tab. 2. Characteristics of the Tire Belt.*

| | |
|---|---|
| **Width** | 1200 mm |
| **Number of Floors Cord** | 5 |
| **Thickness of Top Coating** | 6,1 mm |
| **Thickness of sub – Coating** | 3,1 mm |
| **Total Thickness** | 24,2 mm |

## Safety Approach about the Belt Conveyor

### Belt Conveyor Electrification

In Belt conveyors are used to transport people total 7 engine that providing drive power is connected 7 in the routing units. Drive and starting system frequency converter (inverter) and the frequency of 50 Hz, speed adjustment range 0-60 Hz. Drum in the system and with the engine information are provided table 3.

*Tab. 3. Characteristics of electric motors.*

| | **MAİN BAND** | | | | | **INNER BAND** | |
|---|---|---|---|---|---|---|---|
| | **DRUM-1** | | **DRUM -2** | | **DRUM -3** | **DRUM - 4** | |
| | **Motor 1** (replacement) | **Motor 2** (master) | **Motor 3** (replacement) | **Motor 4** (follower) | **Motor 5** (replacement) | **Motor 6** (follower) | **Motor 7** (replacement) |
| **Voltage** [V] | 380 | 380 | 380 | 380 | 380 | 380 | 380 |
| **Speed** [D/min.] | 1000 | 1000 | 1500 | 1000 | 1500 | 1500 | 1500 |
| **Power** [KW] | 500 | 500 | 250 | 400 | 250 | 400 | 400 |
| **Reducer Conversion Rate** | 31,5 | 31,5 | 45 | 31,5 | 45 | 31,5 | 31,5 |

2. Motor works as a master on head drum of main band 4. And 6. Engine is activated subsequent to the head engine (no. 2) operate. The engine power of main band is 900 kW.

In addition to, there is 250 kW engine on the drum-3 that executed when necessary. The Engine power of supporting the band is 400 KW. The layout of motors, reducers and drums are provided in figure 4.

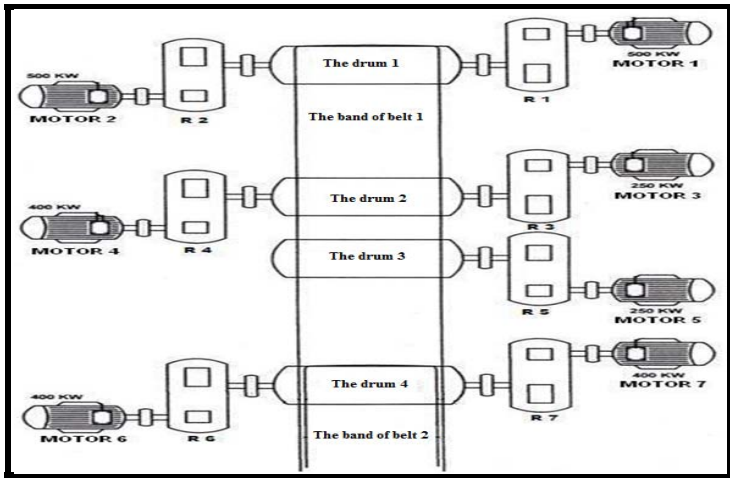


*Fig. 4. Belt conveyor, motor, reducer and drum placement.*

**Braking Systems of Belt conveyor**

The band may need to be stopped suddenly during the transfer of staff, in special cases, as one of the main measures to be taken within the scope of occupational health and safety. For this purpose, created braking systems and safety measures have been taken for personnel, of workplace and belt conveyor. In addition, the main control center of the mine in the face of an emergency situation that may be continuously monitored and, if necessary emergency stop can be achieved by cutting all electrical feeds.

***Rollers with brake***

Because of belt conveyor which belongs to bearings of top rollers (Fig. 5) of all carriers are selected with one-way (brake), if the belt blade possibility is break, it breaks the opposite direction of the direction of movement

*Fig. 5. Rollers with brake.*

***Solenoid valve brake system***

There are solenoid valve brake systems (Fig. 6) 2. and 4. drums. If safety rope is pulled and if emergency stop buttons is pressed solenoid valve brake system is activated. Warning lights were device to monitor failure that may occur in the solenoid valve.

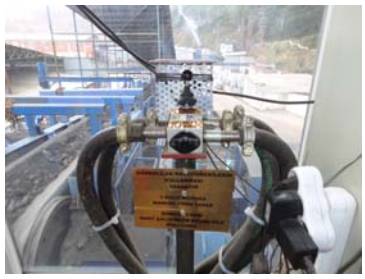

*Fig. 6. Solenoid valve brake system.*

***Emergency stop system***

If necessary to cut electrical feeds of all belt motors, emergency stop system (Main feed direct-stop system) that is shown in Fig. 7, was installed on the operator control panel in the surface automation center.


*Fig. 7. Emergency stop system.*

***Pneumatic brake system***

There is pneumatic brake system that capable brake by locking 1. Drum, when power is cut off. When engaged generators, braking will be removed.

When there is a fault on top of the other braking systems, pneumatic brake (Fig. 8) will be activated by the valve that cut compressed air, in control room.

*Fig. 8. Pneumatic brake system.*

**Inspection and Maintenance of Belt conveyor (Mechanical and Electrical)**

- Control and maintenance of the conveyor belt carried out according to the procedure of Safety Management System OHSAS 18001:2007 Occupational as well as all control and treatments in the company.
- Engine and reducers temperatures continuously monitored and cooling systems activated automatically enters.
- The control speed and stopping systems with lubrication and cleaning works weekly Saturdays and Sundays, switches systems, communication units, power, mechanical checks are made on each shift.
- All controls taken under the signature processed forms of F5.02-16 1200 control form of band (Mechanical), F6.02-16 1200 control form of band (Electrical)

## Safety precautions

### Training

In Imbat Mining Co., in accordance with Transport Directive Article 1, the first job training is "Human Transplant on the Belt Conveyor Education" as practical. After this training workers receive a certificate. After, guests who came to visit the underground quarry located in the same training and are allowed to get on band.

### Speed Control

Conveyor speed is limited 1m/sec. to human transplants. Both the staffs, as well as coal transport (max. 2.5 m / sec) in the event of exceeding the limit values of the speed of the belt speed sensor system to do the brakes are activated. The central of speed control is shown in Fig. 9.

*Fig. 9. The central speed control.*

### Stopping Mechanisms

The elements stopping mechanism of the belt are shown in Fig. 11. There are two row seat (stop) wire and switches (Fig. 10) are attached to them along the upper and lower layers of belt conveyor, both the right and left sides.

*Fig. 10. Switches stopping systems.*

Safety wires divided into sections each of 100 m along 1230 m. drivage, when required, the band can easily be stopped. Safety wire that total 4 rows, the upper and lower floors, each create 12 separate chapters is connected 12 switches. On the operator panel, there are the electrical apparatus that shows from which parts pulled which safety wire Also, again in case of emergency, "Emergency stop buttons" where near the switch groups and stroke - riding platforms are available to stop the band contrivance (plates) was established to stop the band mechanism by shock on the output platforms, when anybody doesn't achieve go down from the band. These plates, lifted up when coal is shipped to, download to the bottom when the staff transferred, by a piston that managed from control center.

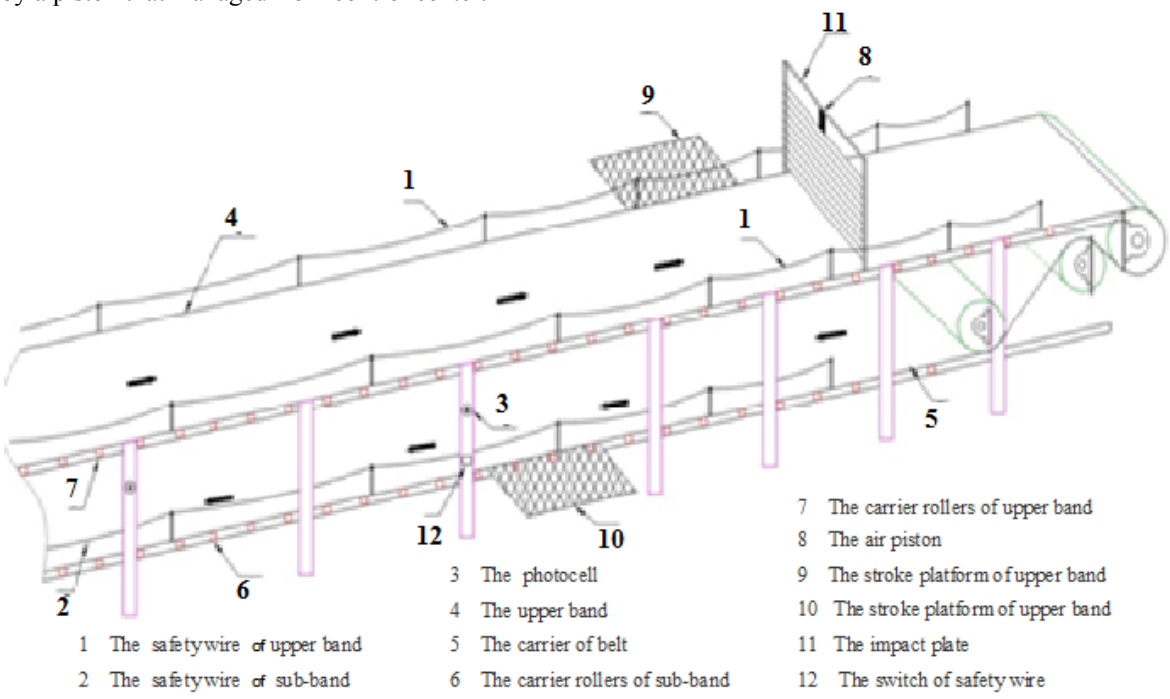


*Fig. 11. The elements stopping of the belt are shown.*


A, B,

*Fig. 12. During transplantation coal (A) and human (B) status of plates.*

**Communication**

Communication is provided as out loud with intercom (push-to-talk speakers) system (Fig. 13) which was established on the stroke-riding platforms and next switch that is in each of 100 m along band. There is also a phone on the stroke and riding platforms.


*Fig. 13. Communication units.*

**Monitoring System**

Stroke and riding platforms and route with the band is monitored and recorded (Fig. 14) in the video for 24 hours, by cameras that are antigrizu properties

*Fig. 14. Belt conveyor control center.*

**Personnel Counting System**

On the Entry and exit stations, overlapping bands and descending staff counting (Fig. 15) transferred to the computer by means of a sensor (Fig. 11). In this way, the number of staff overlapping bands and tapes down to determine possible.

*Fig. 15. Personnel Counting System.*

**Staff Transport Directive on the Belt Conveyor**

1. Only persons who have been trained for Transplant on the Belt Conveyor overlap. Staffs that without certificate that is training for belt conveyor certainly will not be permitted get on the conveyor.
2. Staff on the belt conveyor transport to entrances and exits the place of work that inputs on the lower floor and outputs on the top floor.
3. The staff starts to move on the belt with instruction that given by Occupational Safety Engineers who are responsible upper and lower tape riding platforms. Before this instruction is prohibited to ride on the belt, occupational health and safety engineers supervise to staff during transport until the end.
4. The transport of staff on the belt at shifts will be made within the following hours.

Shift 1: 00:00 - 08:00
Shift 2: 08:00 - 16:00
Shift 3: 16.00 - 24.00

1. Shift out – 2. Shift inputs: 07:30 - 9:00
2. Shift out – 3. Shift inputs: 15:30 - 17:00
3. Shift out – 1. Shift inputs: 23:30 - 01:00

Except for the above mentioned times, if staff need to transport for emergency, the belt will be acting by order of Safety Engineer.

5. The staff rides on belt through the platform riding one by one in sequence.
6. The distance between persons on the belt will be at least 4 meter, during transportation.
7. During transport personnel lamp on helmet and will be lit.
8. The staff will be omitted on tape standing in the way, will be sit on the condition.
9. Transport of coal and / or material is prohibited during transport of the staff.
10. The maximum speed of the belt 1m/sec during transport of staff on the belt conveyor.


*Fig. 16. The platform top for going out.*

11. The distance between the upper band and the lower band with the distance between upper floors and the ceiling of the gallery; stroke-riding stations 180 cm, and it is not be less than100 cm for other places.
12. Independent distance that between belt conveyor with the wall of side of the gallery shall not be less than 80 cm.
13. Platforms are formed on the stroke-riding stations, as can be seen, at least 5 meters long (Fig. 16).
14. Stroke stations are established at least 20 meters behind from rollers of the belt.
15. The emergency stop buttons and the stop wires shall be established bottom and upstairs along to be stopped at any point of the belt conveyor and these systems work all the time.
16. The impact plates shall be installed on upper and lower riding stations of the belt conveyor, if staff don't get off the belt, these plates automatically stop by shock system and these systems certainly always works (Fig. 11).

17. The shock plates of top belt are in the up position, during the transportation of coal through an air piston (Fig. 11) that administered control center. When personnel transporting, it is turned down for people can pass without hitting (Fig. 12).
18. There are warning signs illuminated that shows approaching the landing station
19. There is telephone device or signaling systems for communication between control center of belt and boarding-landing stations.
20. When the experts of explosives are transported to entry and exit instead of working other workers transporting is prohibited.
21. The stop wires of the belt, impact plates, communications and warning systems regular maintenance and is controlled each shift and the report written in the book.
22. There is fire extinguisher in places for asylum that positioned with an interval of 50 meters along inclined shaft (Aydın, 2005; Bayılloglu et. Al., 2011; Law, 1984).

## Review

### Increase in total productivity

The time lost of employees their return to work and instead of going out is negatively affected the effective working time as well as the productivity of workers in underground businesses. It is possible to take this time the minimum level; workers will not lose more time on foot and will have more time for production.

According to a study determined that about workers who working in underground coal mines in Germany workers spending at different quantity energy depending on their movement. A worker that quickly walks upwards 3.2 km/h speed in a gallery 3 degree slope consumes 1100 kJ/h energy; down to 4.8 km/h speed spend 1,500 kJ/h energy. The same worker only spend 300 kJ/h energy when goes up or down in this gallery by sitting on the conveyor belt. Thus in this way production efficiency of business positively affected as well as the productivity of workers (Moller and Ascui, 2004).

The time gained through belt conveyor that used for transportation of staff, established in inclined shaft of elevation +374 / + 49 indicated table 4, and calculated the contribution to production the following.

*Tab. 4. The place of business on conveyor and on foot landing and exit times comparison.*

| | On foot | On belt conveyor | The time gained |
|---|---|---|---|
| **The time underground landing** | 35 min. | 20 min. | 15 min. |
| **The time out from underground** | 50 min. | 20 min. | 30 min. |

Achievement total time by landing and departure to place of business on belt conveyor:

Time Gained inshift = 15 min + 30 min = 45 min

Time Earned per day = 3 shifts x 45 min = 135 min/day = 2.25 hours/day

The production quantity of 1 hour = $\frac{15000 \text{ tons/day}}{7 \text{ Hours/Shift}}$ **x** 3 Shifts/day= 714.2 tons / hour

The contribution to production of earned time;

The gain production = 714.2 tons / hour x 2.25 hours / day = 1606.95 tons / day

According to the calculation given above daily 1606.95 tons gain of productivity provided thanks to belt conveyor because workers remain in production each shift at least 45 min.

### Evaluation for Occupational Health and Safety

As well as the gain effective working time, It is great importance that personnel effortlessly arrive at the workplace such as mining "difficult and dangerous" .it is believed that ,trying to be more careful, help to reduce work – related accident, because the staff who energetic begins to work.

Also there are prevented accidents that may occur by 3300 workers passes away on the walk from 1230 meter inclined shaft. Thus, occupational accidents decreased 20 % and the production increased 27 % 2011 year and beyond, despite the number of workers increased 8.5 %.

## Conclusion

Personnel transportation on the belt conveyor that use easy has significant advantages, if It has adequate safety measures and has appropriate technically equipment to human .Compared to other systems for the transport of people (lifts, coolie-car, monorail.etc.) the belt conveyor provides significant save by both human and coal transportation.

In addition to, Because It makes continuous human transportation, staff hasn't problem of wait. This is important that it not created stress and tension on employees who very crowded, especially in mine have employment–intensive.

## Resources

[1] Aydın, E., İmbat A.Ş.: Bantla İnsan Nakliyatı Yönergesi, *2005*.
[2] Önder, Ö., İmbat Madencilik A.Ş.: Tanıtım Notları, *http://www.imbatmadencilik.com*, *2012*.
[3] Bayıllıoğlu, Z.G. Yılmaz, A.İ.: Bant Konveyör ile İnsan Nakliyatının İş Sağlığı ve Güvenliği Açısından Değerlendirilmesi, *Maden İşletmelerinde İSG Sempozyumu Bildiriler Kitabı, (2011), p. 91-104, Adana, (In Turkish)*
[4] Moller, W. Ascui, E.R.: The Planning of an Underground Manriding Conveyor System for Iscor's Tshikondeni Colliery, *2004*.
[5] Law, *1984*, Maden ve Taşocakları İşletmelerinde ve Tünel Yapımında Alınacak İşçi Sağlığı ve İş Güvenliği Önlemlerine İlişkin Tüzük.