

## Robot Conveyor Belt Rapid Conveying System Design

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### Abstract

The robotic production line rapid conveying system is a device that utilizes the transmission of the robot arm and the conveyor belt to reduce the strength of the worker to some extent and improve the working conditions. For factory enterprises, it is an effective way to reduce costs, save resources, and improve efficiency more effectively. The automation of the production line can improve the precision and accuracy of the processing on the basis of fully improving production efficiency and reducing costs. In terms of safety, there will be a start-stop switch on the basis of the control cabinet, and there will be a corresponding emergency stop switch. When a danger occurs, or when the machine is malfunctioning, when the emergency stop button is pressed, the robot will completely stop working. This also guarantees personal safety and product quality to a certain extent. This paper introduces the conveyor belt transported by the robot production line, as well as the basic functions of the control diagram and the working principle of the module control system. In the function above, the characteristics and advantages of the function are mainly introduced; according to the problems that the conveyor belt is prone to occur in real life, some problems are raised in the process of using the control cabinet, and the contents of the maintenance are also pointed out, and the robot is also pointed out. The development direction of the conveyor system.

### Keywords

Robot, conveyor, control cabinet, overhaul, simulation.

### 1. Introduction

IRB460 Industrial Robot Specifications.

**Table 1.** ABB robot parameters

Brand: ABB	Model: ABB-IRB460	Function: position servo
Drive component type: electromechanical	Control method: automation	Power: 3.2KW
Rated voltage: 200-600V, 50HZ	Product Certification: IS09001	Speed response frequency: 50/60HZ-
Processing customization: No	Dimensions: 1126mm / 850mm	Weight: 460KG
ABBIRB460: ABBIRB460-6/1.2		ABBIRB460: ABBIRB460-6/1.2
ABBIRB460: ABBIRB460-180/3.15		

## 2. Development Status of Industrial Robots at Home and Abroad

At present, our country is generally applying the assembly and processing of simple robots, but the robotic automated production line in foreign countries is already a molding technology. And lead the development of the leading direction, pointing out the direction of development for the future machining market. Automated assembly and production capacity represent the ability of a country's productivity. At the same time, it is also a manifestation of the recognition and concentration of the state's manufacturing development level. In the current foreign machinery manufacturing industry, such as automobiles, warehouse management, electronics and logistics. Most of them realize the automation and production line of robots, ensuring the efficiency and quality of production. At the same time, the rapid processing of the product and the transportation process are realized, reducing costs and unnecessary expenses.

For some typical industries, such as the use of robots to complete the processing of large-scale car stamping processing equipment, as well as assembly, electronics and electrical appliances, parts processing, can be applied to the relevant robotic conveyor to achieve fast processing operations. These robots have also greatly advanced the rapid development of these machinery-related industries, while at the same time improving the advanced and scientific manufacturing technology.

The current development of robotic transportation in the domestic manufacturing industry as an important part of technological development. This is a digital manufacturing industry that has been virtualized abroad and has been largely applied to practice. The use of automated production systems not only meets the needs of production and consumption, but also greatly improves the efficiency of production, ensures the quality of products, and can maximize the level of production in the factory manufacturing industry.

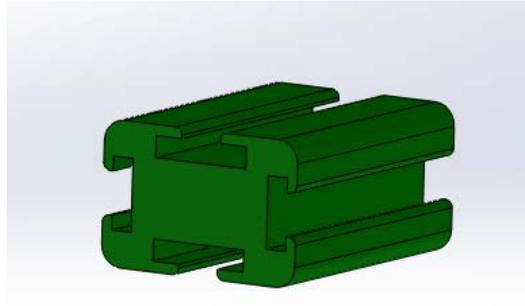
## 3. Production Line Design

The analysis of the production line is mainly to transport the conveyor belt of the workpiece, and the workpiece is transported to the position of the robot arm by the feeding conveyor, and is transported away by the conveyor belt after the processing. The requirement here is that the workpiece must be accurately transported to the position that the robot arm can grasp, and then the belt bracket should be kept stable and safe. The most important thing is that the belt cannot be slipped, tilted and rolled during the rotation. The situation happened. When conveying the workpiece on the conveyor belt, the integrity of the parts and the accuracy of time should be ensured, and the parts can be completely and evenly transported during the blanking process.

In reality, the control of the production line is mainly the control of the PLC. It can more accurately control the speed of the motor and the related working requirements of the start and stop. The ideal production line in practical applications is a production line that is closely related to the front and back processing of the production line. The processed product is a series of work in a balanced operation, and maintains a certain speed. As the reasonable straight path moves toward the completion direction, the entire production line process is a synchronous operation process.

### 3.1. Frame Design

The aluminum alloy is selected and has grooves on the left and right sides. The function of the groove is to make the connecting piece have better contact and fixation with the adjacent rod. This has the advantage that there is no need to temporarily punch the connecting rods, which simplifies the installation and allows for the most space-saving and safe installation in the installation process.

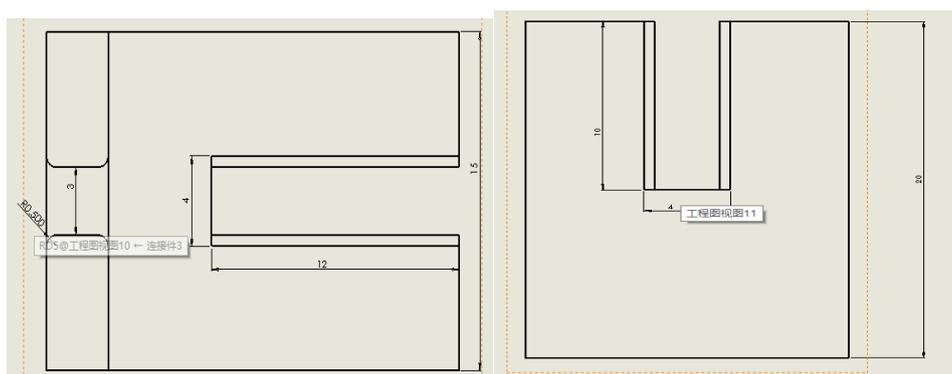


**Fig 1. Stents**

The aluminum alloy parts are selected to prevent the rods from being bent too long, or to meet the weight of the parts and their own weight, so as to avoid damage to the supporting rods during the processing.

### 3.2. Connector Design and Basic Dimensions

The main function of the connecting piece is to connect the two adjacent workpieces so that they can maintain a stable and balanced state under the working condition of the conveyor belt. The connector is mainly at the corner of the rod connection, so that the use of the nut can be reduced. Its two-dimensional map is shown below.



**Fig 2. Basic dimensions of fittings**

### 3.3. Motor Selection and Basic Parameters

Principle of motor selection

- (1) When selecting the relevant motor, it is necessary to choose the environment suitable for the use of the motor, and the relevant requirements for cooling or fixing of the robot can be realized according to specific requirements.
- (2) The selection is compatible with the motor and the mechanical characteristics that meet the requirements can be achieved. For example, speed, speed adjustment, speed stability, start braking time, etc.
- (3) When selecting the motor, ensure sufficient utilization of power, avoid waste of resources, and select a motor with suitable power by calculation.
- (4) Good interchangeability.

In summary, the three-phase asynchronous motor is selected, and the model number is Y225M-8. The basic rating data is as follows:

**Table 2.** Three-phase asynchronous motor parameters

Rated power	Rated voltage	Rated speed	effectiveness	Power factor	Starting torque ratio	Starting current ratio	Maximum torque ratio
45kw	330V	750r/min	92.3%	0.88	1.9	7.0	2.2

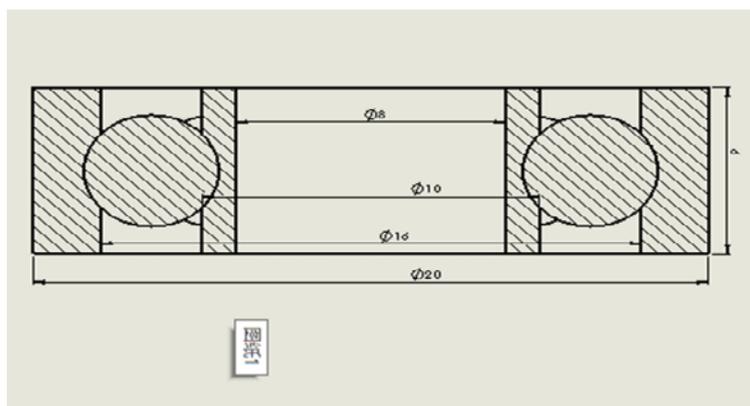
The wiring of the motor is a delta connection, which has a small starting torque. When the motor is in the speed regulation, the frequency control is adopted. Constant torque speed control is adopted in frequency conversion speed regulation. Because such speed regulation has outstanding advantages such as stepless speed regulation and hard mechanical characteristics, it is also a method of more speed regulation that has been used internationally.

The braking of the motor can be roughly as follows: energy braking, reverse braking, feedback braking. Here, the feedback brake is selected, that is, by converting the current formed by the magnetic field into the power of the brake motor when the brake is to be braked, thereby generating a power generation feedback brake to the motor.

### 3.4. Selection of Bearing Rods

Bearings should meet fatigue strength and have high hardness requirements, and must also meet toughness and wear resistance. Generally, the chromium-containing alloy steel used in the manufacturing process can reach a hardness of 60 to 65 HRC after heat treatment, and the surface to be worked on it needs to be ground and polished. The material of the cage inside the bearing. It is usually made of low carbon steel stamping, specifically when it is applied to high speed shafts, we use non-ferrous metals. Here, we use rolling bearings because sliding bearings have poor impact resistance, and large noise is likely to occur at high speeds. Rolling body bearings that use liquid friction are not as useful in the service life of the workpiece.

The bearing selection is deep groove ball bearing 608 GB/T276-1994.



**Fig 3.** Deep groove ball bearing

Deep groove ball bearings can withstand both radial and axial forces. The fixed end of the bearing is fixed.

**Table 3.** Basic parameters of deep groove ball bearings

Bearing type		Relative axial load		$F_a / F_r \leq e$		$F_a / F_r > e$	
Name	Code	$F_a / C_{0r}$	Judgment coefficient	X	Y	X	Y
Deep groove ball bearing	60000	0.084	0.28	1	0	0.56	1.45

Bearing life check:

$$P^\varepsilon L_{10} = \text{constant} \quad (1)$$

Where P is the equivalent dynamic load (N);  $L_{10}$  is the basic rated life of the rolling bearing ( $10^6 r$ ); the life index of the ball bearing  $\varepsilon = 3$ . For the basic rating life of the ball bearing is 1, the following applies

$$C * 1 = \text{constant} \quad (2)$$

From the above two formulas can be derived:

$$C * 1 = P^\varepsilon L_{10} \quad (3)$$

Under the relevant action of the equivalent dynamic load P, the basic bearing life calculation formula is used;

$$L_{10} = \left(\frac{C}{P}\right)^\varepsilon \quad (4)$$

The working hours generally use H to indicate the life of the bearing  $L_h$ . In the calculation formula of the basic life of the bearing, let n represent the bearing speed (r/min), so that the speed of the bearing per hour is  $60 * n$ , the formula is as follows:

$$L_h = \frac{10^6}{60n} \left(\frac{C}{P}\right)^\varepsilon \quad (5)$$

### 3.5. Lubrication and Sealing of Bearings

Lubrication and sealing of bearings: Lubrication with grease reduces grease loss, is easy to seal and maintain, and can be run for a longer period of time with one filling. When loading the grease, it is not easy to be too much, and it is kept between 1/3 and 1/2 to avoid overheating of the bearing. In the aspect of sealing, we adopt a combination sealing method. The purpose of sealing is to prevent the loss of lubricating oil, prevent dust particles and impurities from entering the rolling body, and affect the rotation of the rolling elements. In order to reduce the wear of the shaft, the hardness of the surface of the shaft is generally greater than 40HRC, and the surface roughness is generally less than 1.60~1.8um. Our non-contact seals effectively prevent the seal from coming into contact with the rotating parts and are not limited by speed. Here, a rectangular cross-section felt ring is installed, which is installed in a trapezoidal groove, which exerts a certain pressure on the shaft to achieve a good sealing effect.

### 3.6. Key Selection and Check

Here, the flat key connection is adopted, and the structure is simple, easy to disassemble and easy to maintain. The standard chosen is the key C8x20 GB/T 10918-2003.

The key on the motor gear is the key C16X30 GB/T10918-2003

The conditions for the extrusion strength of the flat key are:

$$a_p = \frac{F}{kl} = \frac{T}{\frac{d}{2}kl} = \frac{2T}{kld} \leq [a_p](MPa) \quad (6)$$

Allowable torque transfer:

$$T = \frac{1}{2} kld[a_p](N.mm) \quad (7)$$

Allowable power transfer:

$$P = \frac{1}{9550} T.n(kw) \quad (8)$$

In the above formula is the allowable compressive stress (MPa), T is the torque (N.mm); k is the working height of the key,  $k = h / 2$  (mm); l is the working length of the key, for the C type Key:  $L = Lb/2$ , L is the nominal length of the key (mm); d is the diameter of the shaft (mm).

In the process of selecting the flat key, there will be many forms of failure, which can be roughly divided into: the crushing of the weak working surface of the component (belonging to the static joint), the wear loss (belonging to the dynamic connection), and the key being zero. Component shearing (such things have a severe overload of the torque transmitted in the application). Therefore, when the key is selected, it is necessary to have wear resistance, pressure resistance on the pressure surface, and shear strength. Check and calculate.

#### 4. Checking and Confirming the Belt

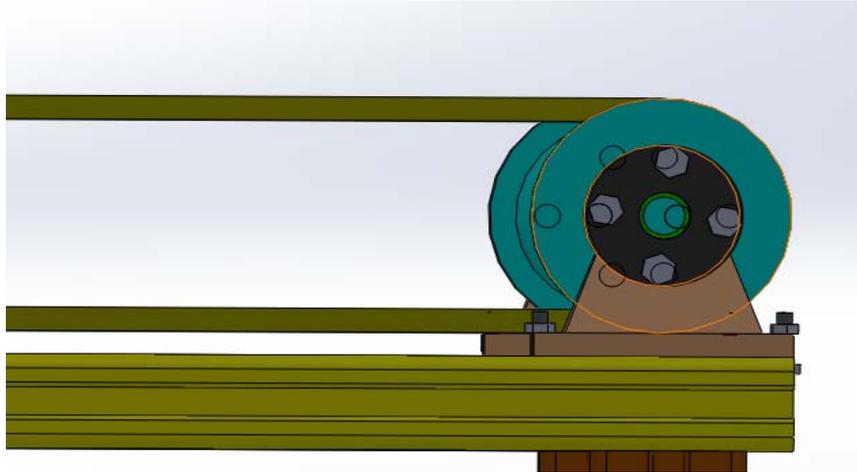
The transmission and the related motion of the two flexures are mainly realized by the belt transmission, and is suitable for the occasion where the center distance between the two shafts is large, and in this case, the structure is simple and the cost is low. Therefore, in the case of a large center distance, the transmission is usually selected.

Belt drive advantages:

- (1) Applicable to the way of transmission with a large center distance
- (2) The relative slip caused by the friction caused by the belt and the pulley in the transmission process can avoid the overload and the damage of the components.
- (3) The belt has good flexibility, which can absorb vibration and slow down the impact more effectively.
- (4) The structure is simple and the cost is low, and if it is broken or damaged, it can be easily replaced.

weakness is:

- (1) Devices that require tension during the transmission process;
- (2) The belt takes up a large space
- (3) The transmission efficiency of the belt is low
- (4) The belt is easy to wear in the process of transmission, the transmission ratio is unstable, and the relative life is relatively short.



**Fig 4.** A diagram of a flat band

## 5. Conclusion

With the rapid development of the economy, the competition of enterprises has become more and more fierce. In order to improve efficiency and reduce production costs, conveyor belts have been widely used. By designing the entire conveyor system, this paper not only saves labor, improves production efficiency, but also reduces production costs, and plays a huge role in industrial production. Conveyor belts are used in a wide variety of applications, and the complexity is different, and the price of conveyor belts is different. This design takes into account the principles of processability and economy, providing a direction for the design of rapid transfer systems.

## References

- [1] Baojin Zhang. Design and research of conveyor belt with automatic screening function based on electromagnetic principle [J]. Mechanical engineer,2016(01):168-169.
- [2] Junfeng Chen. Design and implementation of special glass conveyor belt system [J]. Industrial design,2017(06):174-175.
- [3] Yinghui li, Yunqing Qu. Design of conveyor belt PLC control system [J]. Manufacturing automation,2013,35(07):128-129+143.
- [4] Peng Ma, Jingtang Zhang. Design of centralized control system of coal mine conveyor belt [J]. Automation instrument,2014,35(11):26-31.
- [5] Junjun Yang, Jianxin Wu. Design of conveyor belt of production line and three-dimensional warehouse control system [J]. Mechanical research and application,2015,28(04):225-227.