

A Project Report on

Customization of Standard Conveyor

By

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C E R T I F I C A T E

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partial
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ABSTRACT

A conveyer is machine primarily used to transport an object from one point to other at given timeframe. Owing to vast development in traction systems, various types of conveyers are now used in the market to target specific application. Chain conveyers, Screw conveyer, Pneumatic conveyers, roller conveyers etc. are some major varieties seen in the industry. The project focuses on Belt type conveyer system, its design based on application requirement, modifications for better efficiency etc. Belt conveyer is a continuously moving strip of material to transport the object to different places. A belt conveyer by far is the most used conveyer system in FMCG industry due to its mechanical capacities. Smooth frictionless transfer in given time and flexibility of operation makes it the preferred choice. Sesotec India Ltd. Is a leading MNC that offers various solutions for all process stages, product types, conveyer types and for all critical control points of the production process. The conveyer solution to the customer and the modifications in the prescribed solution is what the project deals with.

OBJECTIVES

The customer was facing issues with the detection of metallic impurities in the product. This resulted in quality complaints hindering the testing and inspection process. Also, the belt's wear and tear have to be minimum. The objective of the project is to design a specialized belt conveyer system with enhanced metal detection capacities and more efficient conveying technology including driving parts, belts, etc. The purpose of the project was to enhance the technical aspects of conveyer system and provide a customized design according to customer requirement.

METHODOLOGY

The initial phases of the project were about getting comfortable with the organizational standards and the conveyer systems and terminology. As the technical knows how was upgraded, the focus shifted towards the design parameters and their detailed study. Over the course of project, various reference books were referred to get a clear understanding of necessary concepts. Research papers came handy in understanding the industry applications of conveyer systems. The information from project guides was the valuable source in moving forward. Visit to the client and understanding the basic aspects of conveyer was the practical lookout to the theoretical study. A number of websites were also referred.

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2. INTRODUCTION



The bulk material handling system consists of numerous equipment which work in a coordinated preplanned manner to achieve ultimate functional head. The belt conveyors are very important and prominent equipment in such system, to ensure flow of material through various parts of the system. The designer's first choice is to use belt conveyors for this purpose due to its reliability and ruggedness; except when system layout of nature of the material does not permit use of belt conveyors. The design of a belt conveyor as a whole depends upon design/construction of individual component, but the design of many individual components depends upon ultimate design construction of belt conveyor. This issue is taken care of appropriately in design procedure, and also by arranging the chapters in sequence such that designer/reader has relevant information on components prior to each stage of designing.

Owing to vast development in traction systems, various types of conveyors are now used in the market to target specific application. Chain conveyors, Screw conveyor, Pneumatic conveyors, roller conveyors etc. are some major varieties seen in the industry. The project focuses on Belt type conveyor system, its design based on application requirement, modifications for better efficiency etc. Belt conveyor is a continuously moving strip of material to transport the object to different places. A belt conveyor by far is the most used conveyor system in FMCG industry due to its mechanical capacities. Smooth frictionless transfer in given time and flexibility of operation makes it the preferred choice. Sesotec India Ltd. Is a leading MNC that offers various solutions for all process stages, product types, conveyor types and for all critical control points of the production process.

A conveyor is an integral part in bulk material handling system to ensure proper flow of objects at various locations i.e., production lines, testing, packaging etc. The design of a conveyor system requires proper analysis of required parameters to obtain an optimal functioning unit. This project includes the parameters for conveyor design, components of a belt conveyor, and the modifications carried out according to the customer requirements.

2.1 INTRODUCTION TO CONVEYOR

A conveyer system is a mechanical system used in transportation of material from one work station to another. According to mode of operation, type of application, powertrain, driving elements conveyers are classified as:

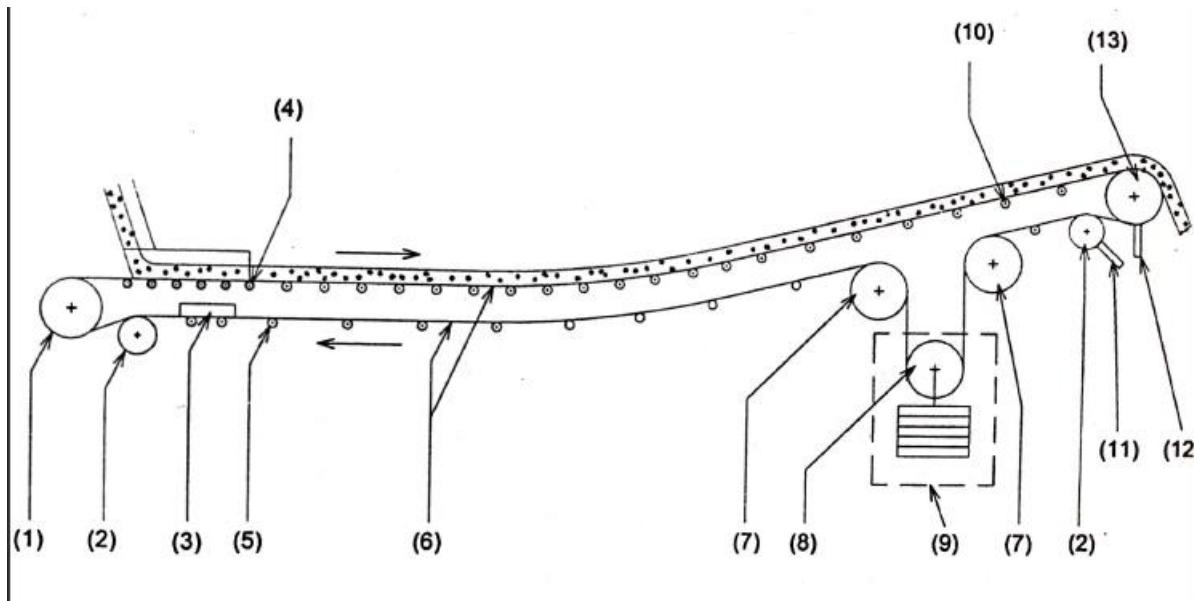
- Chain conveyers
- Screw conveyers
- Belt conveyers
- Fabric conveyers
- Chorded conveyers
- Pneumatic conveyers

The selection of most compatible conveyer depends on the volume of material to be transported. Based on this, conveyers find its applications in food industry, automobile industry, FMCG, medical industry, packaging industry etc.

THE CONVEYER USED FOR THIS PROJECT IS A BELT TYPE CONVEYER

A belt conveyer is continuously moving strip of material over which the material is transported from one point to another. The project includes a belt conveyer with integrated metal detector unit. Since used in FMCG industry, the number of impurities and their rejection and identification plays an important role to the customer. Various difficulties faced by the customer include the metallic impurities too small in size which are not detected by the conventional metal detector. Another issue faced is the wear and tear of belt material which is the major investment. Based on certain parameters various modifications in existing design from our side are made in the standard belt conveyer design with metal detector.

2.2 COMPONENTS IN A CONVEYOR



1. Tail Pulley (in special case, this can also be drive pulley with drive-unit coupled to it)
2. Snub Pulley (at head-end and tail-end)
3. Internal Belt Cleaner (internal belt scrapper)
4. Impact Idlers (impact rollers)
5. Return Idlers (return rollers)
6. Belt (continuous loop of carrying run & return run)
7. Bend Pulleys
8. Take-up Pulley (main-drive roller)
9. Motor
10. Carrying Rollers
11. Pulley Cleaner
12. Belt Cleaner
13. Head Pulley

3. BELTS

Belt is an important which is actually the conveying material .Belt is in contact with material and is taking all the punishment from material such as impact, abrasion, attrition, etc. Often belt is the costliest item effecting capital investment. Belt is wearing item. Improper design can result into fast wear and tear of belt, resulting into high running cost. Conveyor belt primarily consists of carcass and rubber covers.

3.1 TYPES OF BELTS

1. MODULAR BELT

It is made with a series of several long, narrow modular plastic segments which are inter-linked to form a continuous belt.

2. FLAT PU BELT

It is a belt having its top side made up of polyurethane surface cover layer. It has excellent resistance to oils and greases, also they are more resistant to abrasion.

3. PVC BELT

Polyvinyl Chloride (PVC) conveyor belts are standard belts in the food industry that can be used for basic applications across food processing and handling.

4. POLYPROPYLENE BELT

PP Manure belt is durable and dirt-proof material. It is generally used on chicken farm to save energy and reduce the human resources cost.

2.2 IMPORTANT FACTORS

- Vulcanization of Belt

Hot vulcanization splices are heated and cured under pressure with a vulcanizing press. The damaged portion of belt is carefully trimmed or removed. A new section repaired and bonded in place using cement or other adhesives. The chemicals used in the process require several hours to cure, ensuring a minimum of 8 hours of down time.

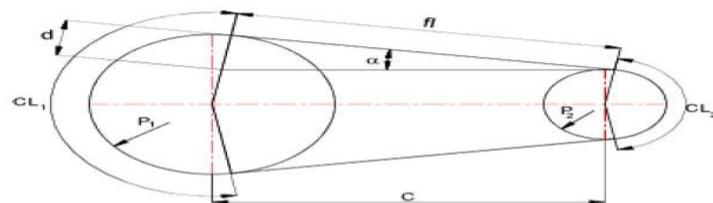
- Retrofit

Retrofitting describes the measures taken in the manufacturing industry to allow new or updated parts to be fitted to existing assemblies. It can improve a machine or system's overall functionality by using advanced and updated equipment and technology.

3.3 TIMING BELT CLOSE LENGTH CALCULATION			
Parameter	Symbol	Unit	value
The belt Pitch		mm	3
No Teeth on Pulley 1	z1	Nos	25
No Teeth on Pulley 2	z2	Nos	20
Pitch dia of a large pulley 1	P1	mm	23.87324
Pitch dia of a small pulley 2	P2	mm	19.09859
Centre To Centre distance	C	mm	200
The Drop distance	d	mm	2.387324
Belt contact angle	α	$^\circ$	0.683934
The belt fall length	f1	mm	199.9858
The contact length Small Pulley	CL2	mm	29.77202
The contact length Large Pulley	CL1	mm	37.78497
The Total Belt Length	L	mm	467.5285
Total number of teeth on belt	z	Nos	155.8428
Number of teeth in mesh (small pulley)			9.924007
Total Belt length by different formula	L	mm	467.5285

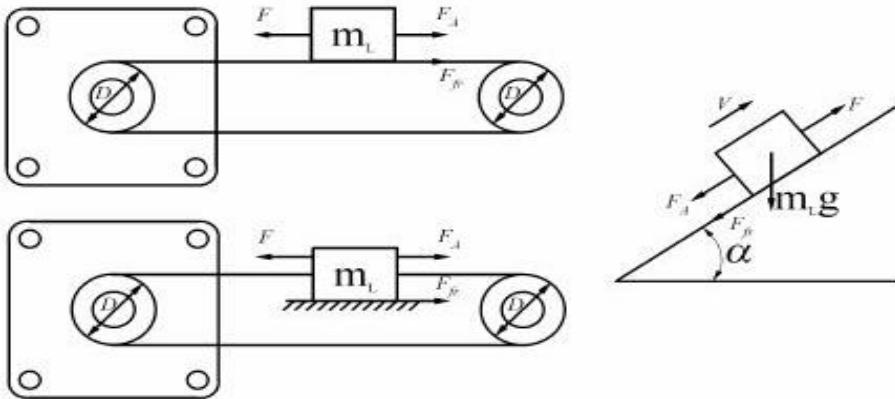
3.4 TIMING PULLEY DIAMETER CALCULATION			
Parameter	Symbol	Unit	value
The belt pitch	P	mm	14
No Teeth on Pulley	N	Nos	30
Pitch Line Depth	a(PLD)	mm	1.397
Pitch Diameter	DP	mm	133.6902
Outside Diameter	DO	mm	130.8962

TIMING BELT LENGTH CALCULATION FORMULA



- 1) The Pitch dia of a pulley $P = \text{No Teeth on Pulley} \cdot \text{Pitch} / \pi$
- 2) The Drop distance $d = [P_1 - P_2] / 2$
- 3) The belt contact angle $\alpha = \arcsin(d / C)$..C= Centre distance
- 4) The belt fall length = $f_1 = d / \tan \alpha$
- 5) The contact length Small Pulley= $CL_2 = P_2 \cdot \pi \cdot [90 - \alpha] / 180$ degrees
- 6) The contact length Large Pulley = $CL_1 = P_1 \cdot \pi \cdot [90 + \alpha] / 180$ degrees
- 7) The Belt Length $L = 2.f_1 + CL_1 + CL_2$
- 8) Total number of teeth on belt = L / Pitch
- 9) Number of teeth in mesh (small pulley) = CL_2 / Pitch . Rounded down to nearest whole number.

3.5 BELT DRIVE POWER SELECTION			
Parameter	Symbol	Unit	Value
Conveyor Length	L	mtr	1.8
Conveyor Required Capacity	C _{rp}	Kg/Mtr	25
Required Linear Velocity	V	m/min	17
Weight of the Total load	m _L	Kg	45
Weight of the pulley	m _P	Kg	9
Weight of the belt	m	Kg/Mtr	1.7
Total Weight of belt	m _B	Kg	6.520553
Pulley diameter	D	m	0.075
No. of Pulleys	Nos.	Nos.	2
Inertia of the load	J _L	kg·m ²	0.063281
Inertia of the pulley	J _P	kg·m ²	0.012656
Inertia of the belt	J _B	kg·m ²	0.00917
Inertia of the motor	J _M	kg·m ²	0.002
Inertia of the Total system	J _T	kg·m ²	0.087107
Initial velocity of the motor	ω ₀	rad/s	0
Final velocity of the motor	ω ₁	rad/s	7.555556
Time for velocity change	t	Sec	0.5
Accln Due to Gravity	g	m/s ²	9.81
Acceleration torque	T _a	N·m	1.316284
Load torque	T _L	N·m	7.820342
Output RPM	N		72.15024
Gear Box ratio	i		19.40395
Safety factor	K _s		1.5
Angle of inclination	α	°	13.5
Coefficient of Friction	μ		0.1
Efficiency	η		0.7
Total calculation torque	T_T	N·m	13.70494
Required motor torque	T_M	N·m	1.008995
Motor Power	P	KW	0.147915



Inertia:

$$J_L = \frac{1}{4}m_L D^2 \quad [\text{kg} \cdot \text{m}^2]$$

$$J_p = \frac{1}{8}m_p D^2 \quad [\text{kg} \cdot \text{m}^2] \quad *(\text{Remember to multiply by 2 if there 2 pulleys.})$$

$$J_B = \frac{1}{4}m_B D^2 \quad [\text{kg} \cdot \text{m}^2]$$

$$J_T = J_L + J_p + J_B + J_M \quad [\text{kg} \cdot \text{m}^2]$$

Torque:

$$T_a = J_T \alpha = (J_L + J_p + J_B + J_M) \frac{\omega_1 - \omega_0}{t} \quad [\text{N} \cdot \text{m}]^{**}$$

$$T_L = \frac{m_L g D (\sin \alpha + \mu \cos \alpha)}{2\eta} \quad [\text{N} \cdot \text{m}]^{**}$$

$$T_T = T_L + T_a \quad [\text{N} \cdot \text{m}]$$

$$T_M = K_S T_T \quad [\text{N} \cdot \text{m}]$$

J_L – Inertia of the load [$\text{kg} \cdot \text{m}^2$]

J_p – Inertia of the pulley(s) [$\text{kg} \cdot \text{m}^2$]

J_B – Inertia of the belt [$\text{kg} \cdot \text{m}^2$]

J_M – Inertia of the motor [$\text{kg} \cdot \text{m}^2$]

J_T – Inertia of the system [$\text{kg} \cdot \text{m}^2$]

m_L – Weight of the load [kg]

m_p – Weight of the pulley [kg]

m_B – Weight of the belt [kg]

D – Diameter [m]

ω_0 – Initial velocity of the motor [rad/s]

ω_1 – Final velocity of the motor [rad/s]

t – Time for velocity change [s]

T_a – Acceleration torque [N·m]

T_L – Load torque [N·m]

T_T – Total calculation torque [N·m], $T_T = T_L + T_a$

T_M – Required motor torque [N·m], $T_M = K_S \cdot T_T$

K_S – Safety factor (Reference Value is 1.5 to 2.0.)

α – Angle of inclination [°]

μ – Frictional coefficient of sliding surfaces

η – Efficiency (Reference Value is 0.85 to 0.95.)

g – Gravity constant (9.8 m/s^2)

* This is for solid cylinder, and see page 1 for hollow cylinder.

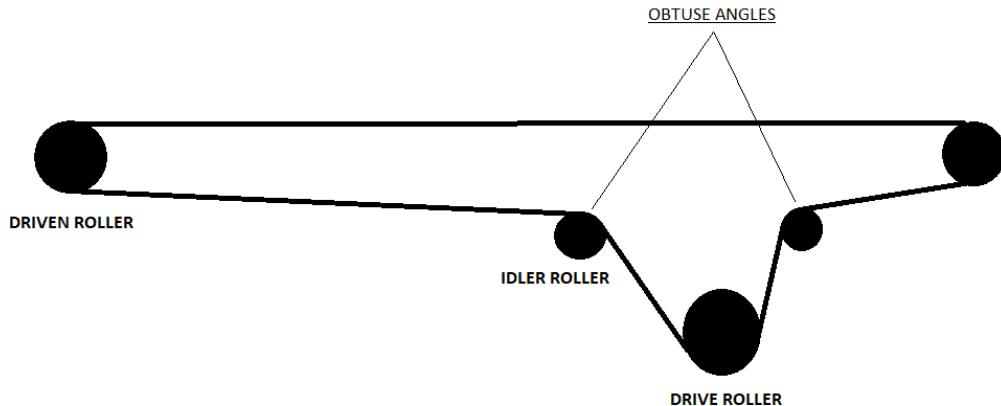
**Please use the max value(s) of the specific application.

3.6 SPECIFICATIONS

- ❖ Conveyor Width: 1000 mm
- ❖ Conveyor Length ETE: 2800 mm
- ❖ Metal Free Zones: MFZ-1 = 1400, MFZ-2 = 2200
- ❖ Belt Type: Flat PU, Vulcanized Cross Finger Joints
- ❖ Conveyor Speed: 0.5 m/s

4. ROLLERS

Rollers are very important components of the conveyor, as same as in contact with the belt and affect its performance to a large extent.



4.1 IDLER ROLLERS

The main function of idler rollers is to support belt from the lower side, thus prevent it from hanging down loosely.

4.2 DRIVEN ROLLERS

The driven roller does not have any kind of power supply such as motor, it is the secondary roller which works on the basis of the drive roller.

4.3 DRIVE ROLLERS

A drive roller is a cylindrically-shaped component which drives a conveyor system. Unlike traditional idler rollers driven by an external power source, a drive roller is an automated modular unit which gets a direct driving mechanical input from an internal electric motor.

4.4 OBTUSE ANGLE

While arranging the rollers in their position, the standard mistake which manufacturers mostly

make is keeping an acute or right angle between roller arrangement. But our group has specifically opted for an obtuse angle. The plus point is that the product or any kind of particle does not get stuck in between the roller and the belt. Belt life also increases and distributed tension over an entire belt surface.

4.5 KNIFE-EDGE ROLLERS

Knife edge conveyors are used in any application where small and/or delicate parts need to be moved from one conveyor to another. They create a tight transfer between two sections ensuring that parts don't fall between gaps. They are common in food and beverage as well as pharmaceutical applications.

5. METAL DETECTORS

Metal detector plays an important role in the conveyors used in FMCG. As the name suggests it detects the presence of metallic impurities passing through the metal detector box. When the impurities with a certain level of magnetic field passes through the metal detector , it cuts the electromagnetic field generated by the coil inside the detector (According to right hand thumb rule).

Metal detectors with integrated conveyor belt are all-in-one systems consisting of a tunnel metal detector, a conveyor belt and optional reject mechanisms. They can be integrated without issue into existing production lines. Our systems provide robust and hygienic conveyor belt technology, together with ultra-precise metal detection and extremely easy handling. The modular design allows for custom solutions tailored to you and your products.

5.1 METAL-FREE ZONES

A metal free zone is an area surrounding the industrial or sanitary conveyor where no metal is present. In order to prevent false alarms and detections, no fixed or moving metal is kept near the metal detector's aperture to ensure optimum detection and prevent false results during the inspection process. The metal sensing is in the metal free zones .The two metal free zones (MFZ-1 and MFZ-2) are the one where impurities are sensed and accordingly placement of rollers and other metallic parts is determined.

5.2 SPECIFICATIONS

- 1) MFZ-1 is the zone where absolutely no metal is allowed. It is situated nearer to the coil.
- 2) MFZ-2 is the zone where static metals are allowed, for example fixed screws, nuts etc. It is comparatively at some distance from the coil.

5.3 IMPURITY TYPES DETECTED

- 1)Ferrous impurities
- 2)Non-ferrous impurities
- 3)Stainless steel

6. PARAMETERS

1) Fixed

- Conveyor Width
- Conveyor Length ETE
- Motor Ratings & Type
- Metal Free Zones
- Belt Type & Joints
- Food Grade Certification of MOC
- Conveyor Speed

2) Variable

- Gear Box
- Belt Length & Structure
- Drive & Driven Rollers
- Idlers
- Support Plate

7. RESEARCH PAPERS

1) Industrial Conveyors' Taxonomy and Its Applications-

Abstract:

In any manufacturing processes includes a material handling equipment that can transport raw material or semi-finished products from the one workstation to another. Material handling equipment are designed based on the type of manufacturing product or the process. Therefore, engineers can easily make decision analysis while the selection of the most preferred type of industrial conveyors among others. This paper focuses on the industrial conveyors that classifies all available conveyor types.

Introduction:

The different methodologies are designed to design right material handling equipment in different process of the transportation of raw materials within the manufacturing facility. For instance, depending on the various speed of handling, weight, size, quantity and height of the transportation, production engineers can choose the different methods lifting and handling such as forklifts, overhead cranes and conveyor systems. Conveyor system is a mechanical system used in moving materials from one workstation to another and application in most processing and manufacturing industries such as: chemical, mechanical, automotive and food.

Taxonomy and classification of industrial conveyors:

After the collecting the set of information about industrial conveyors and their applications, we designed certain classes of conveyors. Classification is done based on the usage of different type of conveyors in different industries. Therefore, we decide to make class of conveyors by industries. In order to identify the industries that has to be included into these classes, the application of the following conveyor systems are selected. They are belt, screw, chain, roller and mesh conveyors. According to investigation of current conveyor systems, we determine interactions of the conveyors with industries. Afterwards, these interactions lead to the classification of conveyors by industries. The following classification is obtained during this exploration:

- Automobile industry
- Metallurgical industry;
- Pharmaceutical industry;
- Mining industry;
- Food & drink industry;
- Construction industry

Conclusion:

It can be used as a source of learning in the technical educational institutions.

It provides the widest range of information in the field of research. This is the first database for scholarly researchers. In addition, those who modernize their production routes can get great offers, as our corporate networks are industry-leading industries that require the most conveyor.

8. CONCLUSION

The belt conveyor system is the most efficient conveying unit seen in the FMCG specifically. It significantly increases productivity and enables multi-floor material movement. Given the requirements from the customer a detailed design study is now to be carried out which counts as the second phase of the project. The current status of the project can be concluded as the completion of review and study phase and beginning of the design phase which will be carried

by the simulation phase. From the study, it can be concluded that the conveyer system is a flexible conveying unit of whom some of the parameters can be modified to increase the applicational efficiency. The belt conveyer proves to be an optimal part of bulk material handling and testing system.

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