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Implementation of Poka-Yoke on Production line in Indian manufacturing Industries

Faheem Akhtar*,Dharmendra Tyagi**

* Research Scholar, Department of Mechanical Engineering, SIRTE, Bhopal (M.P.), India
** Professor, Department of Mechanical Engineering, SIRTE, Bhopal (M.P.), India

Abstract- The concept of zero defects is remarkable for its simplicity and directness. One of the concepts of zero defects is poka-yoke, which means & "mistake-proofing". Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The primary goal of this paper is to focus on the improvement of the quality issue in production processes by identifying and implementing poka-yoke concept to improve the defects. Shigeo Shingo was the Japanese engineer who developed the concept of Poka-Yoke that transformed the quality profession in Japan. The main objectives of the study are overall improvement of productivity of the machine output, reduction in human errors and improvement in the safety of the workforce. The main aspect in any manufacturing industry generally is to increase the customer expectation is eliminating the defects and reducing the variances. The defects must be defined properly to ensure the root causes will be eliminating once the process improvement has been identified. Two type of heavy duty conveyor link model LC150 and LC200 are designed in this study and Poka-Yoke method is applied for mistake proofing. The possibility of implementing of the Poka-Yoke method as a factor of improving operation in the process in the assembly line has been shown. Here, the aim of method Poka-Yoke is to eliminate or minimizes human error in manufacturing process and management as a result of mental and physical human imperfections. The study concludes with proposed solutions to improve productivity at the manufacturing industry and future study.

Keywords- Lean Manufacturing, Mistake Proofing, Poka Yoke, Quality Problem, Effectiveness.

I. INTRODUCTION

In every type of businesses today, quality is one of the important parameter to be involved: hospital, school, manufacturing, hospitality, industry etc. It is focused in service areas as well as in production areas. Quality parameter plays a very important role in improving the competency for many companies. What is the reason behind the importance of quality? Some of the benefits of high quality products are higher customer loyalty, success in business; lower cost and enhanced competitiveness. [1]

Figure 1: Procedure using Poka Yoke

In a manufacturing industry, Poka-Yoke is a mechanism that helps the operator to avoid errors. The main aim of Poka-Yoke is to avoid errors by avoiding, correcting or drawing attention of the humans towards the errors. In 1960, Poka-Yoke was first identified by Shigeo Shingo. It was identified when he became frustrated that in manufacturing process he was not able to achieve zero defects. Poka-Yoke is also known as mistake proofing. Shigeo Shingo also realized that he needs to make a clear differentiation between a defect and a mistake. He also understood that mistakes are not always the fault of an operator. Only at the later stage of manufacturing procedures, the defects become visible. [2]

II. LITERATURE REVIEW

(Wijaya *et al.*, 2020) [3] Presents the design and implementation of a poka-yoke system in a stationary spot welding (SSW) production line. The human-based SSW production process in a local automotive component company was considered in this study. Due to the repetitive and fast cycle-time of the production process, human errors are inevitable. Such errors lead to customer claims with the subject company. Based on the data of customer claims, there were three major quality issues (missing nuts, wrong-size nuts, asymmetrical spot weld marks). Due to the production line being manual, control of planned production and actual production was poor, leading to delivery issues (delayed delivery). Together these major issues contributed to 34.7% of customer claims on average from May to December 2018. The objective of this study was to solve the issues in the subject company through design and implementing a poka-yoke system utilizing the internet-of-things (IoT) platform to ensure data acquisition and information storage, and production progress monitoring and data analysis to meet user requirements. The combined approach of the poka-yoke system utilizing IoT in the SSW production line yielded satisfactory results with reduced customer claims to 5.3% for the stated problems from February to May 2019. Hence, the design objective was achieved.

(Singh, Yuvika, 2019) [4] analysed that Every Organization aims to the "zero defects" philosophy which establishes zero error as a goal. This cannot be achieved overnight but can be approached over time by continuously striving for the increased quality by reducing the errors. So it remains a question in our minds that what kinds of techniques are to be adopted to assure zero defects? Poka-Yoke, is one of tool that can be used to achieve manufacturing with zero defects and it has the potential to support the implementation of DMAIC phases of Six Sigma. DMAIC stands for define, measure, analyse, improve and control phases. Several survey & researches were studied by referring to the relevant research papers on applying Poka-Yoke concept in DMAIC phases. It has been pointed out that the PokaYoke solutions suggested in these research papers were not actually implemented in real-time scenario. Hence, our research paper is concluded with a suggestion that prospective researchers in several areas can make more efforts to actually implement Poka-Yoke technique in DMAIC phases for achieving the goals of Six Sigma.

(ewita *et al.*, 2019) [5] extended that XYZ is one of the companies that manufacture automotive spare parts. At present the company should focus on producing high quality, non-handicapped products with the fastest production time to win business competition. The company's strategy is to carry out kaizen which is a continuous improvement with the aim of preventing defective materials from entering the production process in the most effective manner. The method used by the company is to conduct inspection on incoming materials using poka-yoke method. The decision to run poka-yoke has been proven by reducing the amount of dimension defects material on the B8A rotor component of the supplier delivered to the production process up to zero the following month and producing a better cycle time in the 79.77 second. It can be concluded that the poka-yoke method is the right way to prevent the defective material from entering into a production process that can cause a defective.

(de Souza *et al.*, 2018) [6] aims to present the Poka-Yoke error-proof system, aimed at the automotive sector, presenting and defining what will become the Poka-Yoke methodology and how it can be used in order to bring benefits to a company by means of its implementation in a case study. Quality problems are part of everyday business and the way in which they are treated/detected is what defines the level of Final Quality that a product or service is delivered to the customer. The use of quality tools or technologies such as Poka-Yoke is necessary to maintain a quality level that meets or exceeds the customer's expectations, besides avoiding high costs with rework, waste of productive material, recall among others and dirty the image of company.

(Premanand and Umamaheswari, 2018) [7] In today's competitive world any organization has to manufacture high quality, defect free products at optimum cost. The success of any industry depends on quality of their product. During actual manufacturing of any product, different operations are carried out by operators .The whole production depends on operator mentality and their interest in work which ultimately causes silly mistake or errors by the operator. Rejection of manufactured product cannot be ignored now a days in manufacturing industry due to worldwide competition. To avoid mistakes in assembly line, poka-yoke mechanism plays an important role in manufacturing industry. In the present work, an attempt is made to identify the areas of improvement in equipment. Kaizen and poka-yoke are implemented to enhance the overall performance to increase the productivity. Why-why method of root cause analysis is used to eliminate the causes. This paper focuses on process improvement in a horn manufacturing company, using mistake proofing technique or Poka -Yoke. The study is aimed at providing process improvement ideas for existing bottleneck areas. The long term success of poka yoke gives output of saving time and can release work pressure in the minds of workers.

(Journal, Engineering and Concrete, 2017) [8] In today's competitive world any organization has to manufacture high quality, defect free products at optimum cost. The new culture of total quality management, total productive management in the manufacturing as well as service sector gave birth to new ways to improve quality of products. By using various tools of TQM like KAIZEN, Six Sigma, JIT, JIDCO, POKA YOKE, FMS etc. organization is intended to develop quality culture. During actual manufacturing of any product there are too many simple and monotonous steps which are carried out by operators. These monotonous work operations result in to mental fatigue and lack of interest in work which ultimately causes silly mistakes of operators and we know that human is prone to errors even

though he doesn't want it. To avoid these simple mistakes, poka yoke concept play important role. By implementing some simple solutions we can avoid mistakes. The long term success of poka yoke gives output of saving time and we release the work pressure on mind of worker. We can use creativity and special skills of workers for more creative operations instead of increasing pressure for monotonous activities.

(Kumar and Kumar, 2017) [9] analysed that dismissal of made parts at different phases of assembling can't go on without serious consequences now days underway situation because of extreme rivalry around the world. All assembling businesses are moving toward zero deformity generation. To actualize this the first and most critical thing which is being finished by the assembling businesses is to avoid blunder or totally dispose of the mistake with the utilization of some demonstrated strategies and this paper concentrates on a use of this methods on a needle bearing assembling organization. Utilization of Poka yoke in assembling forms predominantly to wipe out manual blunder by outlining appropriate means which diminishes the dismissals. The review is gone for giving changes thoughts to existing issues at the manual gathering station for the needle roller orientation. Examinations were directed to recognize reasons for imperfections. Utilizing consequences of unstructured meetings and important information and from manufacturing plant perception the issue was examined utilizing circumstances and end results graph where the primary driver were recognized. Subsequently of the Poka yoke on the needle roller bearing, probability of deformity is disposed of totally.

(N. *et al.*, 2017) [10] has analysed that the concept of zero defects is remarkable for its simplicity and directness. One of the concepts of zero defects is Poka-yoke, which means "mistake-proofing". Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The primary goal of this paper is to focus on the improvement of the quality issue in production processes by identifying and implementing poka-yoke concept to improve the defects. In this paper, the quality tools such as Pareto diagram and Ishikawa diagram were applied to obtain the possible root causes of the quality issue and solving the issue by poka-yoke concept. The result shows that through implementing the poka-yoke concept, the quality has improved and this will ultimately ensure the economic benefits to the company.

(Poladia and Shinde, 2017) [11] evaluated that manufacturing defects are the major concern of all manufacturing industries. These defects occur due to poor material quality or lack of skilled labour. This paper focuses upon one such operation that was dependent on the skills of the operator which was deskilled by one of the successful devices in lean production which is used to eliminate waste caused by errors i.e 'mistake-proofing' or 'Poka-yoke'. The use of Poka Yoke in the Ultra SD Cartridge assembly operation eliminated the requirement of skilled operator. This was effectively done by introducing a new locating fixture on the assembly line.

III. METHODOLOGY

Steps of Working

1. Design and study the drawing of heavy duty conveyor link.
2. Identify the different place where maximum error occurs.
3. Select suitable manufacturing technique.
4. Apply Poka Yoke techniques for mistake proofing.

Design Process

Two type of heavy duty conveyor link model is design which names are LC150 and LC200.

The figure below shows the link detail for both the models and the table given below shows the value of all dimensions. 12 dimensions are considered in model designs, Model LC150 and model LC200.

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	LC150	LC200
A	98	98
B	48	48
C	150	200
D	75	100
E	119	168
F	10H7	10H7
G	60	60
H	4.5	4.5
J	32	32
K	M8 (4)	M8 (4)
L	90	140
M	70	70

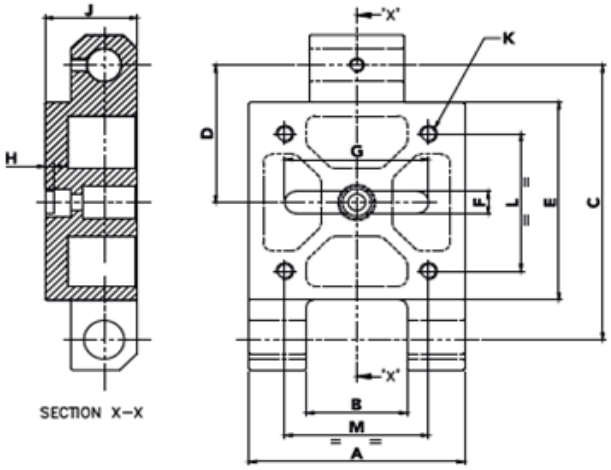

Figure 2: Values of all dimensions

Table 1: Maximum and Minimum tolerances of different place

S. No.	Tolerance Value (mm)		Expectable deviation (mm)
	Maximum	Minimum	
D1	20.993	20.961	0.032
D2	10.031	9.994	0.037
D3	12.011	12.001	0.010
D4	0.991	0.963	0.028
D5	11.033	10.983	0.050
D6	14.021	14.003	0.018

Manufacturing process

1. The first step for the CAM Programmer is the interpretation of the drawing or model of the component.
2. The blank or raw material dimensions are selected and as an outcome the blank model is created. This step will determine the amount of material to be removed, thereby its importance.
3. The processes to be used are selected and this selection is also an outcome from the process. Productivity is determined by the processes selected, which are divided into the main processes, such as Cutting, milling drilling, boring, taping and grinding.

Figure 3: Raw Material (40x120x3000 mm)

This investigation was focused on a comprehensive review of the achievements in the PY domain, as well as on the innovative theoretical approaches to PY and the battle against errors during work process. The aim of Poka-Yoke method is to eliminate or minimize human errors in manufacturing processes and management as a result of mental and physical human imperfections. For the main part is to eliminate errors independent. The main idea of this method is preventing causes, which may result in errors and use relatively cheap control system for determining compliance of the product with the model. Furthermore, the discussed approach to PY classification should also facilitate the creation of a model for the development of PY systems. Finally, this investigation should allow identification of important areas which are still insufficiently researched, such as how to develop PY to keep PY running and prevent PY from failure, which is interesting in its own way.

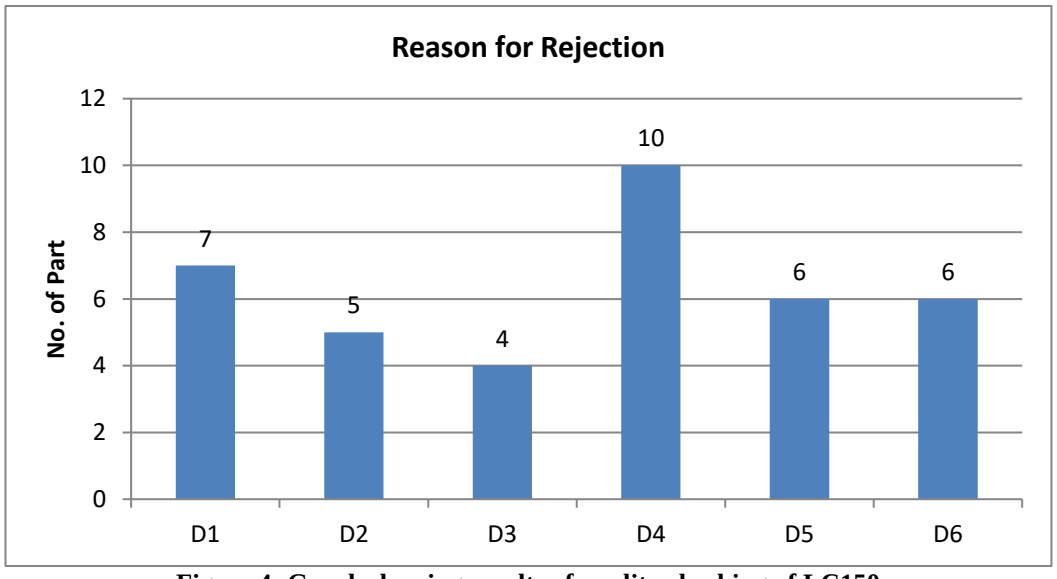

Figure 4: Graph showing results of quality checking of LC150

Total 20 pieces were taken into study for model LC 150, out of which only 4 were accepted and other 16 were rejected as shown in figure 4. It can be concluded that in model LC150 only four pieces were selected. From the graph shown above, it is observed that the maximum numbers of parts were rejected because of dimension errors in dimension 4 (D4).

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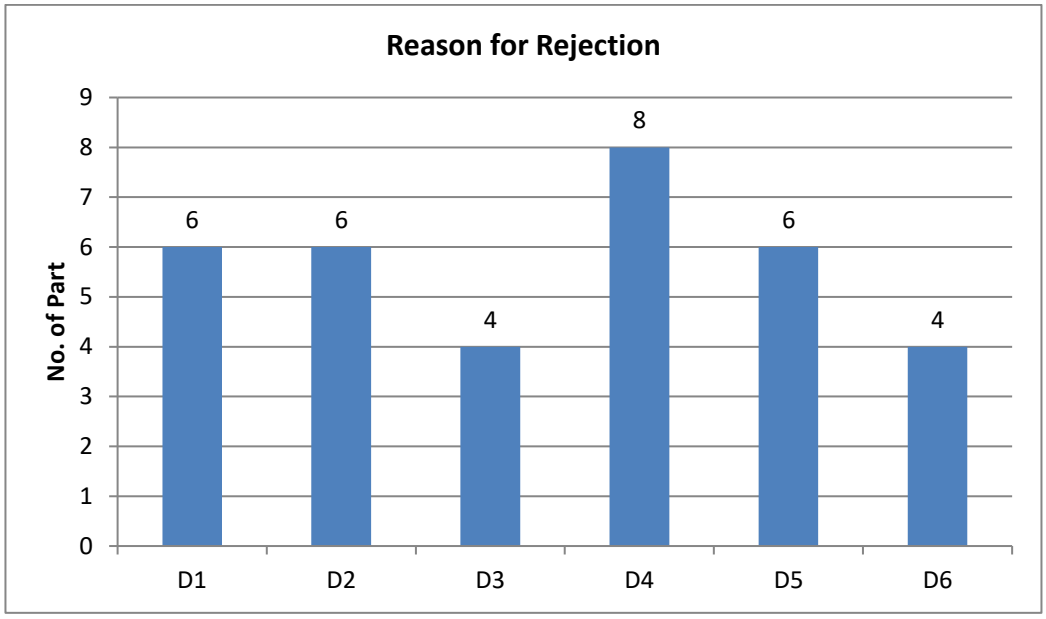

Figure 5: Graph showing results of quality checking of LC200

Total 20 pieces were taken into study for model LC200, out of which only 5 were accepted and other 15 were rejected. It can be concluded that in model LC150 only four pieces were selected. From the graph shown above, it is observed that the maximum numbers of parts were rejected because of dimension errors in dimension 4 (D4).

Implement manufacturing technique by using Poka-Yoke

First three problems (Machining, Fixture and unskilled labour problem) are resolve by design of new type of fixture and implement Poka yoke technique in fixture. Poka Yokes ensure that the right conditions exist before a process step is executed and thus preventing defects from occurring in the first place. Where this is not possible, Poka Yokes perform a detective function, eliminating defects in the process as early as possible.

Manual clamping for each part is replaced by new fixture in which, and fixture is also fixed in machine

Machining after Poke Yoke

To solve the above problems, Poka yoke technique has been used. High performance machine is used for preventing defects as early as possible.

Figure 6: Machining process and Fixture design after Poka Yoke

IV. RESULTS

After raw material cutting the steel bar obtained are segregated into two types with color codes i.e. LC 150-Yellow bins and LC 200-

Blue bins. This colours coding will be used in at each steps of manufacturing process to be followed. The confusion of workpiece type identification is rectified by assigning colours to the workpiece till they are manufactured, checked, packed and delivered to customer.

Quality Checking in LC 150

Quality Checking is a process of validating a design and/or a design calculation to ensure that it is error-free and of good quality and is good for engineering and/or fabrication or whatever the end-use of it is. D1, D2, D3, D4, D5 and D6 are the dimensions of the models used in this study. The table given below shows the acceptance of all the pieces on the basis of its dimensions. Total 20 pieces were taken into study for model LC 150, and all pieces are accepted.

Table 2: Quality checking in LC150

Piece	D1 (20.993, 20.961)	D2 (10.031, 9.994)	D3 (12.011, 12.001)	D4 (149.991, 149.963)	D5 (11.033, 10.983)	D6 (14.021, 14.003)	Accepted / Rejected
1.	20.976	10.026	12.009	149.971	10.989	14.019	Accepted
2.	20.952	10.014	12.008	149.976	10.984	14.018	Accepted
3.	20.972	10.019	12.003	149.971	11.031	14.016	Accepted
4.	20.992	10.030	12.005	149.972	10.987	14.011	Accepted
5.	20.984	9.998	12.001	149.984	10.984	14.016	Accepted
6.	20.983	10.006	12.010	149.987	11.030	14.014	Accepted
7.	20.987	10.019	12.004	149.972	10.985	14.020	Accepted
8.	20.976	10.024	12.006	149.976	10.989	14.009	Accepted
9.	20.974	9.997	12.008	149.983	10.988	14.014	Accepted
10.	20.972	10.030	12.004	149.989	10.995	14.019	Accepted
11.	20.973	10.027	12.002	149.987	10.999	14.018	Accepted
12.	20.979	10.021	12.003	149.976	11.031	14.011	Accepted
13.	20.984	10.016	12.008	149.974	10.984	14.012	Accepted
14.	20.976	10.013	12.010	149.971	10.986	14.018	Accepted
15.	20.971	10.024	12.003	149.983	10.988	14.017	Accepted
16.	20.983	10.021	12.006	149.984	10.989	14.016	Accepted
17.	20.991	10.027	12.004	149.986	10.995	14.015	Accepted
18.	20.987	9.998	12.008	149.976	10.984	14.013	Accepted
19.	20.973	10.016	12.007	149.974	11.031	14.01	Accepted
20.	20.976	10.019	12.001	149.971	10.984	14.018	Accepted

Quality Checking in LC 200

Quality Checking is a process of validating a design and/or a design calculation to ensure that it is error-free and of good quality and is good for engineering and/or fabrication or whatever the end-use of it is. D1, D2, D3, D4, D5 and D6 are the dimensions of the models used in this study. The table given below shows the acceptance of all the pieces on the basis of its dimensions. Total 20 pieces were taken into study for model LC 200, and all pieces are accepted.

Table 3: Quality checking in LC200

Piece	D1 (20.993, 20.961)	D2 (10.031, 9.994)	D3 (12.011, 12.001)	D4 (199.991, 199.963)	D5 (11.033, 10.983)	D6 (14.021, 14.003)	Accepted / Rejected
1.	20.975	10.019	12.006	199.971	10.989	14.019	Accepted
2.	20.984	10.014	12.007	199.972	10.981	14.005	Accepted
3.	20.989	10.016	12.009	199.985	10.984	14.009	Accepted
4.	20.991	10.025	12.001	199.981	11.021	14.015	Accepted
5.	20.976	10.029	12.010	199.973	10.989	14.019	Accepted
6.	20.974	10.019	12.005	199.979	10.984	14.013	Accepted
7.	20.982	10.024	12.004	199.987	10.985	14.017	Accepted
8.	20.973	10.017	12.009	199.990	11.030	14.011	Accepted
9.	20.981	10.030	12.006	199.967	10.987	14.006	Accepted

10.	20.990	9.998	12.002	199.973	10.988	14.014	Accepted
11.	20.965	10.029	12.003	199.969	10.989	14.019	Accepted
12.	20.971	10.018	12.008	199.970	10.985	14.013	Accepted
13.	20.968	10.027	12.010	199.985	11.031	14.014	Accepted
14.	20.964	10.019	12.004	199.976	10.987	14.016	Accepted
15.	20.990	10.021	12.001	199.981	10.983	14.015	Accepted
16.	20.981	10.027	12.009	199.970	10.985	14.018	Accepted
17.	20.974	10.019	12.006	199.983	10.986	14.017	Accepted
18.	20.983	10.023	12.002	199.982	10.984	14.003	Accepted
19.	20.971	10.020	12.005	199.971	11.032	14.020	Accepted
20.	20.967	10.019	12.004	199.974	10.989	14.015	Accepted

Storing

Storage problem of the models is a serious issue. It is important to place all the pieces properly. Improper storage can lead to destruction in models. For avoiding this, plastic protex sheets are placed in between the pieces. This will increase the accuracy and decreases the chances of error. During the time of packing, it should be kept in mind that all the pieces are properly packed. Pieces must be packed with bubble wrap or other wraps to avoid destruction.

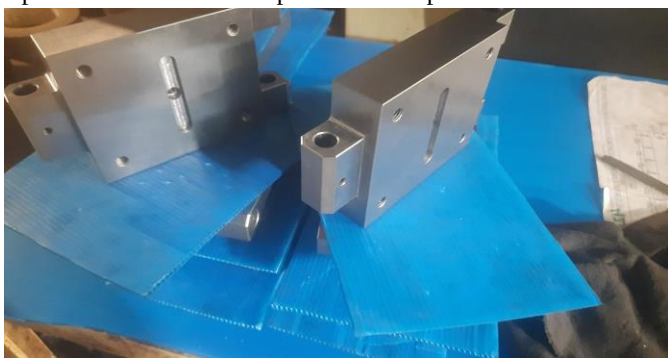


Figure 7: WIP (Work in progress) and Final Storing

V. CONCLUSION

Errors arise from various reasons, but most of them can be prevented if only people are be able to identify the problem at the time of formation, define the causes and make appropriate corrective steps. Prevention of defects in the process before their appearance is the best way of defects reduction and thus reduces the costs.

- Both machining error and human errors are reduced by designing new fixture and applying poka yoke over these designs.
- The problems of scratches are removed by providing proper storage facility design.
- High performance machines are adopted for manufacturing heavy duty conveyor link for increasing efficiency.

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